

LINUX MEDIA INFRASTRUCTURE API

LINUX MEDIA INFRASTRUCTURE API

Copyright © 2009-2011 LinuxTV Developers

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.1 or any later version published by the Free Software Foundation. A copy of the license is included in the chapter entitled "GNU Free Documentation License"

Table of Contents

Introduction.....	??
I. Video for Linux Two API Specification	??
1. Common API Elements	??
1.1. Opening and Closing Devices.....	??
1.1.1. Device Naming	??
1.1.2. Related Devices	??
1.1.3. Multiple Opens.....	??
1.1.4. Shared Data Streams	??
1.1.5. Functions.....	??
1.2. Querying Capabilities	??
1.3. Application Priority	??
1.4. Video Inputs and Outputs.....	??
1.5. Audio Inputs and Outputs	??
1.6. Tuners and Modulators	??
1.6.1. Tuners.....	??
1.6.2. Modulators	??
1.6.3. Radio Frequency	??
1.7. Video Standards	??
1.7.1. Digital Video (DV) Timings	??
1.8. User Controls	??
1.9. Extended Controls.....	??
1.9.1. Introduction.....	??
1.9.2. The Extended Control API.....	??
1.9.3. Enumerating Extended Controls	??
1.9.4. Creating Control Panels	??
1.9.5. MPEG Control Reference	??
1.9.5.1. Generic MPEG Controls	??
1.9.5.2. CX2341x MPEG Controls	??
1.9.6. Camera Control Reference.....	??
1.9.7. FM Transmitter Control Reference.....	??
1.10. Data Formats.....	??
1.10.1. Data Format Negotiation.....	??
1.10.2. Image Format Enumeration	??
1.11. Single- and multi-planar APIs	??
1.11.1. Multi-planar formats	??
1.11.2. Calls that distinguish between single and multi-planar APIs	??
??	??
1.12. Image Cropping, Insertion and Scaling	??
1.12.1. Cropping Structures	??
1.12.2. Scaling Adjustments	??

1.12.3. Examples.....	??
1.13. Streaming Parameters	??
2. Image Formats	??
2.1. Single-planar format structure	??
2.2. Multi-planar format structures	??
2.3. Standard Image Formats	??
2.4. Colorspaces	??
2.5. Indexed Format	??
2.6. RGB Formats	??
Packed RGB formats.....	??
V4L2_PIX_FMT_SBGGR8 ('BA81')	??
V4L2_PIX_FMT_SGBRG8 ('GBRG').....	??
V4L2_PIX_FMT_SGRBG8 ('GRBG').....	??
V4L2_PIX_FMT_SRGGB8 ('RGGB').....	??
V4L2_PIX_FMT_SBGGR16 ('BYR2').....	??
V4L2_PIX_FMT_SRGGB10 ('RG10'),	
V4L2_PIX_FMT_SGRBG10 ('BA10'),	
V4L2_PIX_FMT_SGBRG10 ('GB10'),	
V4L2_PIX_FMT_SBGGR10 ('BG10'),	??
V4L2_PIX_FMT_SRGGB12 ('RG12'),	
V4L2_PIX_FMT_SGRBG12 ('BA12'),	
V4L2_PIX_FMT_SGBRG12 ('GB12'),	
V4L2_PIX_FMT_SBGGR12 ('BG12'),	??
2.7. YUV Formats.....	??
Packed YUV formats	??
V4L2_PIX_FMT_GREY ('GREY')	??
V4L2_PIX_FMT_Y10 ('Y10 ')	??
V4L2_PIX_FMT_Y12 ('Y12 ')	??
V4L2_PIX_FMT_Y10BPack ('Y10B').....	??
V4L2_PIX_FMT_Y16 ('Y16 ')	??
V4L2_PIX_FMT_YUYV ('YUYV').....	??
V4L2_PIX_FMT_UYVY ('UYVY').....	??
V4L2_PIX_FMT_YVYU ('YVYU').....	??
V4L2_PIX_FMT_VYUY ('VYUY').....	??
V4L2_PIX_FMT_Y41P ('Y41P').....	??
V4L2_PIX_FMT_YVU420 ('YV12'), V4L2_PIX_FMT_YUV420	
('YU12')	??
V4L2_PIX_FMT_YUV420M ('YU12M').....	??
V4L2_PIX_FMT_YVU410 ('YVU9'), V4L2_PIX_FMT_YUV410	
('YUV9').....	??
V4L2_PIX_FMT_YUV422P ('422P')	??
V4L2_PIX_FMT_YUV411P ('411P')	??

V4L2_PIX_FMT_NV12 ('NV12'), V4L2_PIX_FMT_NV21 ('NV21')	??
V4L2_PIX_FMT_NV12M ('NV12M')	??
V4L2_PIX_FMT_NV12MT ('TM12')	??
V4L2_PIX_FMT_NV16 ('NV16'), V4L2_PIX_FMT_NV61 ('NV61')	??
V4L2_PIX_FMT_M420 ('M420')	??
2.8. Compressed Formats	??
2.9. Reserved Format Identifiers	??
3. Input/Output	??
3.1. Read/Write	??
3.2. Streaming I/O (Memory Mapping)	??
3.3. Streaming I/O (User Pointers)	??
3.4. Asynchronous I/O	??
3.5. Buffers	??
3.5.1. Timecodes	??
3.6. Field Order	??
4. Interfaces	??
4.1. Video Capture Interface	??
4.1.1. Querying Capabilities	??
4.1.2. Supplemental Functions	??
4.1.3. Image Format Negotiation	??
4.1.4. Reading Images	??
4.2. Video Overlay Interface	??
4.2.1. Querying Capabilities	??
4.2.2. Supplemental Functions	??
4.2.3. Setup	??
4.2.4. Overlay Window	??
4.2.5. Enabling Overlay	??
4.3. Video Output Interface	??
4.3.1. Querying Capabilities	??
4.3.2. Supplemental Functions	??
4.3.3. Image Format Negotiation	??
4.3.4. Writing Images	??
4.4. Video Output Overlay Interface	??
4.4.1. Querying Capabilities	??
4.4.2. Framebuffer	??
4.4.3. Overlay Window and Scaling	??
4.4.4. Enabling Overlay	??
4.5. Codec Interface	??
4.6. Effect Devices Interface	??
4.7. Raw VBI Data Interface	??
4.7.1. Querying Capabilities	??

4.7.2. Supplemental Functions.....	??
4.7.3. Raw VBI Format Negotiation	??
4.7.4. Reading and writing VBI images.....	??
4.8. Sliced VBI Data Interface	??
4.8.1. Querying Capabilities	??
4.8.2. Supplemental Functions.....	??
4.8.3. Sliced VBI Format Negotiation	??
4.8.4. Reading and writing sliced VBI data	??
4.8.5. Sliced VBI Data in MPEG Streams	??
4.8.5.1. MPEG Stream Embedded, Sliced VBI Data Format:	
NONE	??
4.8.5.2. MPEG Stream Embedded, Sliced VBI Data Format:	
IVTV	??
4.9. Teletext Interface.....	??
4.10. Radio Interface.....	??
4.10.1. Querying Capabilities	??
4.10.2. Supplemental Functions.....	??
4.10.3. Programming.....	??
4.11. RDS Interface.....	??
4.11.1. Querying Capabilities	??
4.11.2. Reading RDS data.....	??
4.11.3. Writing RDS data.....	??
4.11.4. RDS datastructures.....	??
4.12. Event Interface	??
4.13. Sub-device Interface	??
4.13.1. Controls.....	??
4.13.2. Events.....	??
4.13.3. Pad-level Formats.....	??
4.13.3.1. Format Negotiation	??
4.13.3.2. Cropping and scaling	??
4.13.4. Media Bus Formats	??
4.13.4.1. Media Bus Pixel Codes.....	??
4.13.4.1.1. Packed RGB Formats.....	??
4.13.4.1.2. Bayer Formats	??
4.13.4.1.3. Packed YUV Formats	??
4.13.4.1.4. JPEG Compressed Formats.....	??
5. V4L2 Driver Programming	??
6. Libv4l Userspace Library	??
6.1. Introduction.....	??
6.1.1. libv4lconvert	??
6.1.2. libv4l1	??
6.1.3. libv4l2	??
6.1.3.1. Libv4l device control functions	??

6.1.4. v4l1compat.so wrapper library	??
7. Changes.....	??
7.1. Differences between V4L and V4L2	??
7.1.1. Opening and Closing Devices.....	??
7.1.2. Querying Capabilities	??
7.1.3. Video Sources	??
7.1.4. Tuning	??
7.1.5. Image Properties	??
7.1.6. Audio.....	??
7.1.7. Frame Buffer Overlay	??
7.1.8. Cropping	??
7.1.9. Reading Images, Memory Mapping	??
7.1.9.1. Capturing using the read method	??
7.1.9.2. Capturing using memory mapping.....	??
7.1.10. Reading Raw VBI Data	??
7.1.11. Miscellaneous	??
7.2. Changes of the V4L2 API.....	??
7.2.1. Early Versions	??
7.2.2. V4L2 Version 0.16 1999-01-31	??
7.2.3. V4L2 Version 0.18 1999-03-16	??
7.2.4. V4L2 Version 0.19 1999-06-05	??
7.2.5. V4L2 Version 0.20 (1999-09-10).....	??
7.2.6. V4L2 Version 0.20 incremental changes	??
7.2.7. V4L2 Version 0.20 2000-11-23	??
7.2.8. V4L2 Version 0.20 2002-07-25	??
7.2.9. V4L2 in Linux 2.5.46, 2002-10	??
7.2.10. V4L2 2003-06-19.....	??
7.2.11. V4L2 2003-11-05.....	??
7.2.12. V4L2 in Linux 2.6.6, 2004-05-09.....	??
7.2.13. V4L2 in Linux 2.6.8.....	??
7.2.14. V4L2 spec erratum 2004-08-01	??
7.2.15. V4L2 in Linux 2.6.14.....	??
7.2.16. V4L2 in Linux 2.6.15.....	??
7.2.17. V4L2 spec erratum 2005-11-27.....	??
7.2.18. V4L2 spec erratum 2006-01-10.....	??
7.2.19. V4L2 spec erratum 2006-02-03.....	??
7.2.20. V4L2 spec erratum 2006-02-04.....	??
7.2.21. V4L2 in Linux 2.6.17.....	??
7.2.22. V4L2 spec erratum 2006-09-23 (Draft 0.15).....	??
7.2.23. V4L2 in Linux 2.6.18.....	??
7.2.24. V4L2 in Linux 2.6.19.....	??
7.2.25. V4L2 spec erratum 2006-10-12 (Draft 0.17).....	??
7.2.26. V4L2 in Linux 2.6.21.....	??

7.2.27. V4L2 in Linux 2.6.22.....	??
7.2.28. V4L2 in Linux 2.6.24.....	??
7.2.29. V4L2 in Linux 2.6.25.....	??
7.2.30. V4L2 in Linux 2.6.26.....	??
7.2.31. V4L2 in Linux 2.6.27.....	??
7.2.32. V4L2 in Linux 2.6.28.....	??
7.2.33. V4L2 in Linux 2.6.29.....	??
7.2.34. V4L2 in Linux 2.6.30.....	??
7.2.35. V4L2 in Linux 2.6.32.....	??
7.2.36. V4L2 in Linux 2.6.33.....	??
7.2.37. V4L2 in Linux 2.6.34.....	??
7.2.38. V4L2 in Linux 2.6.37.....	??
7.2.39. V4L2 in Linux 2.6.39.....	??
7.2.40. Relation of V4L2 to other Linux multimedia APIs	??
7.2.40.1. X Video Extension	??
7.2.40.2. Digital Video	??
7.2.40.3. Audio Interfaces	??
7.2.41. Experimental API Elements.....	??
7.2.42. Obsolete API Elements	??
A. Function Reference	??
V4L2 close()	??
V4L2 ioctl()	??
ioctl VIDIOC_CROPCAP	??
ioctl VIDIOC_DBG_G_CHIP_IDENT	??
ioctl VIDIOC_DBG_G_REGISTER, VIDIOC_DBG_S_REGISTER ...	??
ioctl VIDIOC_DQEVENT.....	??
ioctl VIDIOC_ENCODER_CMD, VIDIOC_TRY_ENCODER_CMD..	??
ioctl VIDIOC_ENUMAUDIO	??
ioctl VIDIOC_ENUMAUDOUT	??
ioctl VIDIOC_ENUM_DV_PRESETS	??
ioctl VIDIOC_ENUM_FMT	??
ioctl VIDIOC_ENUM_FRAMESIZES	??
ioctl VIDIOC_ENUM_FRAMEINTERVALS	??
ioctl VIDIOC_ENUMINPUT	??
ioctl VIDIOC_ENUMOUTPUT	??
ioctl VIDIOC_ENUMSTD	??
ioctl VIDIOC_G_AUDIO, VIDIOC_S_AUDIO	??
ioctl VIDIOC_G_AUDOUT, VIDIOC_S_AUDOUT	??
ioctl VIDIOC_G_CROP, VIDIOC_S_CROP	??
ioctl VIDIOC_G_CTRL, VIDIOC_S_CTRL.....	??
ioctl VIDIOC_G_DV_PRESET, VIDIOC_S_DV_PRESET	??
ioctl VIDIOC_G_DV_TIMINGS, VIDIOC_S_DV_TIMINGS.....	??
ioctl VIDIOC_G_ENC_INDEX	??

ioctl VIDIOC_G_EXT_CTRL, VIDIOC_S_EXT_CTRL,	
VIDIOC_TRY_EXT_CTRL.....	??
ioctl VIDIOC_G_FBUF, VIDIOC_S_FBUF.....	??
ioctl VIDIOC_G_FMT, VIDIOC_S_FMT, VIDIOC_TRY_FMT	??
ioctl VIDIOC_G_FREQUENCY, VIDIOC_S_FREQUENCY	??
ioctl VIDIOC_G_INPUT, VIDIOC_S_INPUT	??
ioctl VIDIOC_G_JPEGCOMP, VIDIOC_S_JPEGCOMP	??
ioctl VIDIOC_G_MODULATOR, VIDIOC_S_MODULATOR	??
ioctl VIDIOC_G_OUTPUT, VIDIOC_S_OUTPUT	??
ioctl VIDIOC_G_PARM, VIDIOC_S_PARM	??
ioctl VIDIOC_G_PRIORITY, VIDIOC_S_PRIORITY	??
ioctl VIDIOC_G_SLICED_VBI_CAP	??
ioctl VIDIOC_G_STD, VIDIOC_S_STD	??
ioctl VIDIOC_G_TUNER, VIDIOC_S_TUNER.....	??
ioctl VIDIOC_LOG_STATUS	??
ioctl VIDIOC_OVERLAY	??
ioctl VIDIOC_QBUF, VIDIOC_DQBUF.....	??
ioctl VIDIOC_QUERYBUF	??
ioctl VIDIOC_QUERYCAP	??
ioctl VIDIOC_QUERYCTRL, VIDIOC_QUERYMENU	??
ioctl VIDIOC_QUERY_DV_PRESET	??
ioctl VIDIOC_QUERYSTD	??
ioctl VIDIOC_REQBUFS	??
ioctl VIDIOC_S_HW_FREQ_SEEK	??
ioctl VIDIOC_STREAMON, VIDIOC_STREAMOFF	??
ioctl VIDIOC_SUBDEV_ENUM_FRAME_INTERVAL.....	??
ioctl VIDIOC_SUBDEV_ENUM_FRAME_SIZE	??
ioctl VIDIOC_SUBDEV_ENUM_MBUS_CODE	??
ioctl VIDIOC_SUBDEV_G_CROP, VIDIOC_SUBDEV_S_CROP	??
ioctl VIDIOC_SUBDEV_G_FMT, VIDIOC_SUBDEV_S_FMT	??
ioctl VIDIOC_SUBDEV_G_FRAME_INTERVAL,	
VIDIOC_SUBDEV_S_FRAME_INTERVAL	??
ioctl VIDIOC_SUBSCRIBE_EVENT,	
VIDIOC_UNSUBSCRIBE_EVENT.....	??
V4L2 mmap().....	??
V4L2 munmap().....	??
V4L2 open().....	??
V4L2 poll()	??
V4L2 read().....	??
V4L2 select()	??
V4L2 write()	??
B. Video For Linux Two Header File.....	??
C. Video Capture Example	??

D. Video Grabber example using libv4l.....	??
List of Types	??
References.....	??
II. LINUX DVB API	??
8. Introduction.....	??
8.1. What you need to know	??
8.2. History.....	??
8.3. Overview	??
8.4. Linux DVB Devices	??
8.5. API include files.....	??
9. DVB Frontend API	??
9.1. Frontend Data Types	??
9.1.1. frontend type	??
9.1.2. frontend capabilities	??
9.1.3. frontend information	??
9.1.4. diseqc master command.....	??
9.1.5. diseqc slave reply	??
9.1.6. diseqc slave reply	??
9.1.7. SEC continuous tone.....	??
9.1.8. SEC tone burst	??
9.1.9. frontend status.....	??
9.1.10. frontend parameters	??
9.1.11. frontend events.....	??
9.2. Frontend Function Calls.....	??
9.2.1. open()	??
9.2.2. close().....	??
9.2.3. FE_READ_STATUS.....	??
9.2.4. FE_READ_BER	??
9.2.5. FE_READ_SNR	??
9.2.6. FE_READ_SIGNAL_STRENGTH.....	??
9.2.7. FE_READ_UNCORRECTED_BLOCKS.....	??
9.2.8. FE_SET_FRONTEND.....	??
9.2.9. FE_GET_FRONTEND	??
9.2.10. FE_GET_EVENT	??
9.2.11. FE_GET_INFO.....	??
9.2.12. FE_DISEQC_RESET_OVERLOAD.....	??
9.2.13. FE_DISEQC_SEND_MASTER_CMD.....	??
9.2.14. FE_DISEQC_RECV_SLAVE_REPLY	??
9.2.15. FE_DISEQC_SEND_BURST	??
9.2.16. FE_SET_TONE	??
9.2.17. FE_SET_VOLTAGE.....	??
9.2.18. FE_ENABLE_HIGH_LNB_VOLTAGE	??
9.2.19. FE_SET_FRONTEND_TUNE_MODE	??

9.2.20. FE_DISHNETWORK_SEND_LEGACY_CMD	??
9.3. FE_GET_PROPERTY/FE_SET_PROPERTY	??
9.3.1. FE_GET_PROPERTY	??
9.3.2. FE_SET_PROPERTY	??
9.3.3. Property types	??
9.3.4. Parameters that are common to all Digital TV standards	??
9.3.4.1. DTV_FREQUENCY	??
9.3.4.2. DTV_BANDWIDTH_HZ	??
9.3.4.3. DTV_DELIVERY_SYSTEM	??
9.3.4.4. DTV_TRANSMISSION_MODE	??
9.3.4.5. DTV_GUARD_INTERVAL	??
9.3.5. ISDB-T frontend	??
9.3.5.1. ISDB-T only parameters	??
9.3.5.1.1. DTV_ISDBT_PARTIAL_RECEPTION	??
9.3.5.1.2. DTV_ISDBT_SOUND_BROADCASTING	??
9.3.5.1.3. DTV_ISDBT_SB_SUBCHANNEL_ID	??
9.3.5.1.4. DTV_ISDBT_SB_SEGMENT_IDX	??
9.3.5.1.5. DTV_ISDBT_SB_SEGMENT_COUNT	??
9.3.5.1.6. Hierarchical layers	??
9.3.5.1.6.1. DTV_ISDBT_LAYER_ENABLED	??
9.3.5.1.6.2. DTV_ISDBT_LAYER*_FEC	??
9.3.5.1.6.3. DTV_ISDBT_LAYER*_MODULATION	??
9.3.5.1.6.4. DTV_ISDBT_LAYER*_SEGMENT_COUNT	??
9.3.5.1.6.5. DTV_ISDBT_LAYER*_TIME_INTERLEAVING	??
9.3.5.2. DVB-T2 parameters	??
9.3.5.2.1. DTV_DVBT2_PLP_ID	??
10. DVB Demux Device	??
10.1. Demux Data Types	??
10.1.1. dmux_output_t	??
10.1.2. dmux_input_t	??
10.1.3. dmux_pes_type_t	??
10.1.4. dmux_event_t	??
10.1.5. dmux_scrambling_status_t	??
10.1.6. struct dmux_filter	??
10.1.7. struct dmux_sct_filter_params	??
10.1.8. struct dmux_pes_filter_params	??
10.1.9. struct dmux_event	??
10.1.10. struct dmux_stc	??
10.2. Demux Function Calls	??
10.2.1. open()	??
10.2.2. close()	??

10.2.3. read()	??
10.2.4. write()	??
10.2.5. DMX_START	??
10.2.6. DMX_STOP	??
10.2.7. DMX_SET_FILTER	??
10.2.8. DMX_SET_PES_FILTER	??
10.2.9. DMX_SET_BUFFER_SIZE	??
10.2.10. DMX_GET_EVENT	??
10.2.11. DMX_GET_STC	??
11. DVB Video Device	??
11.1. Video Data Types	??
11.1.1. video_format_t	??
11.1.2. video_display_format_t	??
11.1.3. video stream source	??
11.1.4. video play state	??
11.1.5. struct video_event	??
11.1.6. struct video_status	??
11.1.7. struct video_still_picture	??
11.1.8. video capabilities	??
11.1.9. video system	??
11.1.10. struct video_highlight	??
11.1.11. video SPU	??
11.1.12. video SPU palette	??
11.1.13. video NAVI pack	??
11.1.14. video attributes	??
11.2. Video Function Calls	??
11.2.1. open()	??
11.2.2. close()	??
11.2.3. write()	??
11.2.4. VIDEO_STOP	??
11.2.5. VIDEO_PLAY	??
11.2.6. VIDEO_FREEZE	??
11.2.7. VIDEO_CONTINUE	??
11.2.8. VIDEO_SELECT_SOURCE	??
11.2.9. VIDEO_SET_BLANK	??
11.2.10. VIDEO_GET_STATUS	??
11.2.11. VIDEO_GET_EVENT	??
11.2.12. VIDEO_SET_DISPLAY_FORMAT	??
11.2.13. VIDEO_STILLPICTURE	??
11.2.14. VIDEO_FAST_FORWARD	??
11.2.15. VIDEO_SLOWMOTION	??
11.2.16. VIDEO_GET_CAPABILITIES	??
11.2.17. VIDEO_SET_ID	??

11.2.18. VIDEO_CLEAR_BUFFER.....	??
11.2.19. VIDEO_SET_STREAMTYPE.....	??
11.2.20. VIDEO_SET_FORMAT.....	??
11.2.21. VIDEO_SET_SYSTEM.....	??
11.2.22. VIDEO_SET_HIGHLIGHT.....	??
11.2.23. VIDEO_SET_SPU.....	??
11.2.24. VIDEO_SET_SPU_PALETTE.....	??
11.2.25. VIDEO_GET_NAVI.....	??
11.2.26. VIDEO_SET_ATTRIBUTES.....	??
12. DVB Audio Device.....	??
12.1. Audio Data Types.....	??
12.1.1. audio_stream_source_t.....	??
12.1.2. audio_play_state_t.....	??
12.1.3. audio_channel_select_t.....	??
12.1.4. struct audio_status.....	??
12.1.5. struct audio_mixer.....	??
12.1.6. audio encodings.....	??
12.1.7. struct audio_karaoke.....	??
12.1.8. audio attributes.....	??
12.2. Audio Function Calls.....	??
12.2.1. open().....	??
12.2.2. close().....	??
12.2.3. write().....	??
12.2.4. AUDIO_STOP.....	??
12.2.5. AUDIO_PLAY.....	??
12.2.6. AUDIO_PAUSE.....	??
12.2.7. AUDIO_SELECT_SOURCE.....	??
12.2.8. AUDIO_SET_MUTE.....	??
12.2.9. AUDIO_SET_AV_SYNC.....	??
12.2.10. AUDIO_SET_BYPASS_MODE.....	??
12.2.11. AUDIO_CHANNEL_SELECT.....	??
12.2.12. AUDIO_GET_STATUS.....	??
12.2.13. AUDIO_GET_CAPABILITIES.....	??
12.2.14. AUDIO_CLEAR_BUFFER.....	??
12.2.15. AUDIO_SET_ID.....	??
12.2.16. AUDIO_SET_MIXER.....	??
12.2.17. AUDIO_SET_STREAMTYPE.....	??
12.2.18. AUDIO_SET_EXT_ID.....	??
12.2.19. AUDIO_SET_ATTRIBUTES.....	??
12.2.20. AUDIO_SET_KARAOKE.....	??
13. DVB CA Device.....	??
13.1. CA Data Types.....	??
13.1.1. ca_slot_info_t.....	??

13.1.2. ca_descr_info_t	??
13.1.3. ca_cap_t	??
13.1.4. ca_msg_t	??
13.1.5. ca_descr_t	??
13.2. CA Function Calls	??
13.2.1. open()	??
13.2.2. close()	??
14. DVB Network API	??
14.1. DVB Net Data Types	??
15. Kernel Demux API	??
15.1. Kernel Demux Data Types	??
15.1.1. dmux_success_t	??
15.1.2. TS filter types	??
15.1.3. dmux_ts_pes_t	??
15.1.4. demux_demux_t	??
15.1.5. Demux directory	??
15.2. Demux Directory API	??
15.2.1. dmux_register_demux()	??
15.2.2. dmux_unregister_demux()	??
15.2.3. dmux_get_demuxes()	??
15.3. Demux API	??
15.3.1. open()	??
15.3.2. close()	??
15.3.3. write()	??
15.3.4. allocate_ts_feed()	??
15.3.5. release_ts_feed()	??
15.3.6. allocate_section_feed()	??
15.3.7. release_section_feed()	??
15.3.8. descramble_mac_address()	??
15.3.9. descramble_section_payload()	??
15.3.10. add_frontend()	??
15.3.11. remove_frontend()	??
15.3.12. get_frontends()	??
15.3.13. connect_frontend()	??
15.3.14. disconnect_frontend()	??
15.4. Demux Callback API	??
15.4.1. dmux_ts_cb()	??
15.4.2. dmux_section_cb()	??
15.5. TS Feed API	??
15.5.1. set()	??
15.5.2. start_filtering()	??
15.5.3. stop_filtering()	??
15.6. Section Feed API	??

15.7. set()	??
15.8. allocate_filter()	??
15.9. release_filter()	??
15.10. start_filtering()	??
15.11. stop_filtering()	??
16. Examples	??
16.1. Tuning	??
16.2. The DVR device	??
E. DVB Frontend Header File	??
III. Remote Controller API	??
17. Remote Controllers	??
17.1. Introduction	??
17.2. Changing default Remote Controller mappings	??
17.3. LIRC Device Interface	??
17.3.1. Introduction	??
17.3.2. LIRC read fop	??
17.3.3. LIRC write fop	??
17.3.4. LIRC ioctl fop	??
IV. Media Controller API	??
18. Media Controller	??
18.1. Introduction	??
18.2. Media device model	??
F. Function Reference	??
media open()	??
media close()	??
media ioctl()	??
ioctl MEDIA_IOC_DEVICE_INFO	??
ioctl MEDIA_IOC_ENUM_ENTITIES	??
ioctl MEDIA_IOC_ENUM_LINKS	??
ioctl MEDIA_IOC_SETUP_LINK	??
G. GNU Free Documentation License	??
G.1. 0. PREAMBLE	??
G.2. 1. APPLICABILITY AND DEFINITIONS	??
G.3. 2. VERBATIM COPYING	??
G.4. 3. COPYING IN QUANTITY	??
G.5. 4. MODIFICATIONS	??
G.6. 5. COMBINING DOCUMENTS	??
G.7. 6. COLLECTIONS OF DOCUMENTS	??
G.8. 7. AGGREGATION WITH INDEPENDENT WORKS	??
G.9. 8. TRANSLATION	??
G.10. 9. TERMINATION	??
G.11. 10. FUTURE REVISIONS OF THIS LICENSE	??

G.12. Addendum.....	??
---------------------	----

List of Tables

1-1. Control IDs	??
1-2. MPEG Control IDs	??
1-3. CX2341x Control IDs.....	??
1-4. Camera Control IDs.....	??
1-5. FM_TX Control IDs	??
2-1. struct v4l2_pix_format	??
2-2. struct v4l2_plane_pix_format.....	??
2-3. struct v4l2_pix_format_mplane.....	??
2-4. enum v4l2_colourspace	??
2-5. Indexed Image Format.....	??
2-1. Packed RGB Image Formats	??
2-2. Packed RGB Image Formats (corrected).....	??
2-1. Packed YUV Image Formats	??
2-9. Compressed Image Formats	??
2-10. Reserved Image Formats	??
3-1. struct v4l2_buffer.....	??
3-2. struct v4l2_plane.....	??
3-3. enum v4l2_buf_type	??
3-4. Buffer Flags	??
3-5. enum v4l2_memory	??
3-6. struct v4l2_timecode.....	??
3-7. Timecode Types.....	??
3-8. Timecode Flags.....	??
3-9. enum v4l2_field	??
4-1. struct v4l2_window	??
4-2. struct v4l2_clip ²	??
4-3. struct v4l2_rect	??
4-4. struct v4l2_vbi_format	??
4-5. Raw VBI Format Flags.....	??
4-6. struct v4l2_sliced_vbi_format	??
4-7. Sliced VBI services	??
4-8. struct v4l2_sliced_vbi_data	??
4-9. struct v4l2_mpeg_vbi_fmt_itv.....	??
4-10. Magic Constants for struct v4l2_mpeg_vbi_fmt_itv <i>magic</i> field.....	??
4-11. struct v4l2_mpeg_vbi_itv0	??
4-12. struct v4l2_mpeg_vbi_ITV0.....	??
4-13. struct v4l2_mpeg_vbi_itv0_line	??
4-14. Line Identifiers for struct v4l2_mpeg_vbi_itv0_line <i>id</i> field.....	??
4-15. struct v4l2_rds_data.....	??
4-16. Block description.....	??
4-17. Block defines	??

4-18. Sample Pipeline Configuration.....	??
4-19. struct v4l2_mbus_framefmt.....	??
4-20. RGB formats.....	??
4-21. Bayer Formats.....	??
4-22. YUV Formats	??
4-23. JPEG Formats	??
7-1. V4L Device Types, Names and Numbers.....	??
A-1. struct v4l2_cropcap.....	??
A-2. struct v4l2_rect	??
A-1. struct v4l2_dbg_match.....	??
A-2. struct v4l2_dbg_chip_ident	??
A-3. Chip Match Types.....	??
A-4. Chip Identifiers	??
A-1. struct v4l2_dbg_match.....	??
A-2. struct v4l2_dbg_register	??
A-3. Chip Match Types.....	??
A-1. struct v4l2_event.....	??
A-1. struct v4l2_encoder_cmd.....	??
A-2. Encoder Commands.....	??
A-3. Encoder Command Flags.....	??
A-1. struct v4l2_dv_enum_presets	??
A-2. struct DV Presets	??
A-1. struct v4l2_fmtdesc.....	??
A-2. Image Format Description Flags	??
A-1. struct v4l2_frmsize_discrete.....	??
A-2. struct v4l2_frmsize_stepwise.....	??
A-3. struct v4l2_frmsizeenum	??
A-4. enum v4l2_frmsizetypes.....	??
A-1. struct v4l2_frmival_stepwise.....	??
A-2. struct v4l2_frmivalenum.....	??
A-3. enum v4l2_frmivaltypes	??
A-1. struct v4l2_input	??
A-2. Input Types	??
A-3. Input Status Flags	??
A-4. Input capabilities.....	??
A-1. struct v4l2_output	??
A-2. Output Type	??
A-3. Output capabilities.....	??
A-1. struct v4l2_standard.....	??
A-2. struct v4l2_fract	??
A-3. typedef v4l2_std_id	??
A-4. Video Standards (based on [ITU BT.470])	??
A-1. struct v4l2_audio	??

A-2. Audio Capability Flags	??
A-3. Audio Mode Flags	??
A-1. struct v4l2_audioout	??
A-1. struct v4l2_crop	??
A-1. struct v4l2_control	??
A-1. struct v4l2_dv_preset.....	??
A-1. struct v4l2_bt_timings	??
A-2. struct v4l2_dv_timings	??
A-3. DV Timing types.....	??
A-1. struct v4l2_enc_idx.....	??
A-2. struct v4l2_enc_idx_entry	??
A-3. Index Entry Flags.....	??
A-1. struct v4l2_ext_control	??
A-2. struct v4l2_ext_controls.....	??
A-3. Control classes	??
A-1. struct v4l2_framebuffer	??
A-2. Frame Buffer Capability Flags	??
A-3. Frame Buffer Flags	??
A-1. struct v4l2_format.....	??
A-1. struct v4l2_frequency	??
A-1. struct v4l2_jpegcompression	??
A-2. JPEG Markers Flags	??
A-1. struct v4l2_modulator.....	??
A-2. Modulator Audio Transmission Flags	??
A-1. struct v4l2_streamparm	??
A-2. struct v4l2_captureparm	??
A-3. struct v4l2_outputparm.....	??
A-4. Streaming Parameters Capabilites	??
A-5. Capture Parameters Flags	??
A-1. enum v4l2_priority	??
A-1. struct v4l2_sliced_vbi_cap	??
A-2. Sliced VBI services.....	??
A-1. struct v4l2_tuner	??
A-2. enum v4l2_tuner_type	??
A-3. Tuner and Modulator Capability Flags	??
A-4. Tuner Audio Reception Flags	??
A-5. Tuner Audio Modes	??
A-6. Tuner Audio Matrix	??
A-1. struct v4l2_capability.....	??
A-2. Device Capabilities Flags	??
A-1. struct v4l2_queryctrl.....	??
A-2. struct v4l2_querymenu	??
A-3. enum v4l2_ctrl_type	??

A-4. Control Flags	??
A-1. struct v4l2_requestbuffers.....	??
A-1. struct v4l2_hw_freq_seek.....	??
A-1. struct v4l2_subdev_frame_interval_enum.....	??
A-1. struct v4l2_subdev_frame_size_enum.....	??
A-1. struct v4l2_subdev_mbus_code_enum	??
A-1. struct v4l2_subdev_crop	??
A-1. struct v4l2_subdev_format	??
A-2. enum v4l2_subdev_format_whence	??
A-1. struct v4l2_subdev_frame_interval.....	??
A-1. struct v4l2_event_subscription	??
A-2. Event Types.....	??
A-3. struct v4l2_event_vsync	??
17-1. IR default keymapping	??
17-2. Notes	??
F-1. struct media_device_info	??
F-1. struct media_entity_desc	??
F-2. Media entity types	??
F-3. Media entity flags	??
F-1. struct media_links_enum.....	??
F-2. struct media_pad_desc	??
F-3. Media pad flags	??
F-4. struct media_links_desc	??
F-5. Media link flags	??

Introduction

This document covers the Linux Kernel to Userspace API's used by video and radio straming devices, including video cameras, analog and digital TV receiver cards, AM/FM receiver cards, streaming capture devices.

It is divided into three parts.

The first part covers radio, capture, cameras and analog TV devices.

The second part covers the API used for digital TV and Internet reception via one of the several digital tv standards. While it is called as DVB API, in fact it covers several different video standards including DVB-T, DVB-S, DVB-C and ATSC. The API is currently being updated to documment support also for DVB-S2, ISDB-T and ISDB-S.

The third part covers Remote Controller API

For additional information and for the latest development code, see:
<http://linuxtv.org>.

For discussing improvements, reporting troubles, sending new drivers, etc, please mail to: Linux Media Mailing List (LMML).
(<http://vger.kernel.org/vger-lists.html#linux-media>).

I. Video for Linux Two API Specification

Revision 2.6.39

Table of Contents

1. Common API Elements	??
2. Image Formats	??
3. Input/Output	??
4. Interfaces	??
5. V4L2 Driver Programming	??
6. Libv4l Userspace Library.....	??
7. Changes	??
A. Function Reference	??
B. Video For Linux Two Header File	??
C. Video Capture Example.....	??
D. Video Grabber example using libv4l	??
List of Types.....	??
References	??

Michael H Schimek, Bill Dirks, Hans Verkuil, Martin Rubli, Andy Walls, Mauro Carvalho Chehab, Muralidharan Karicheri, and Pawel Osciak

Copyright © 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011 Bill Dirks, Michael H. Schimek, Hans Verkuil, Martin Rubli, Andy Walls, Muralidharan Karicheri, Mauro Carvalho Chehab, Pawel Osciak

Except when explicitly stated as GPL, programming examples within this part can be used and distributed without restrictions.

Revision History

Revision 2.6.39 2011-03-01 Revised by: mcc, po
Removed VIDIOC_*_OLD from videodev2.h header and update it to reflect latest changes. Added
Revision 2.6.37 2010-08-06 Revised by: hv
Removed obsolete vtx (videotext) API.
Revision 2.6.33 2009-12-03 Revised by: mk
Added documentation for the Digital Video timings API.
Revision 2.6.32 2009-08-31 Revised by: mcc
Now, revisions will match the kernel version where the V4L2 API changes will be used by the Linu
Revision 0.29 2009-08-26 Revised by: ev
Added documentation for string controls and for FM Transmitter controls.
Revision 0.28 2009-08-26 Revised by: gl
Added V4L2_CID_BAND_STOP_FILTER documentation.
Revision 0.27 2009-08-15 Revised by: mcc
Added libv4l and Remote Controller documentation; added v4l2grab and keytable application exam
Revision 0.26 2009-07-23 Revised by: hv
Finalized the RDS capture API. Added modulator and RDS encoder capabilities. Added support fo
Revision 0.25 2009-01-18 Revised by: hv
Added pixel formats VYUY, NV16 and NV61, and changed the debug ioctls VIDIOC_DBG_G/S_
Revision 0.24 2008-03-04 Revised by: mhs
Added pixel formats Y16 and SBGGR16, new controls and a camera controls class. Removed VID
Revision 0.23 2007-08-30 Revised by: mhs
Fixed a typo in VIDIOC_DBG_G/S_REGISTER. Clarified the byte order of packed pixel formats.
Revision 0.22 2007-08-29 Revised by: mhs
Added the Video Output Overlay interface, new MPEG controls, V4L2_FIELD_INTERLACED_
Revision 0.21 2006-12-19 Revised by: mhs
Fixed a link in the VIDIOC_G_EXT_CTRLs section.
Revision 0.20 2006-11-24 Revised by: mhs
Clarified the purpose of the audioset field in struct v4l2_input and v4l2_output.
Revision 0.19 2006-10-19 Revised by: mhs
Documented V4L2_PIX_FMT_RGB444.
Revision 0.18 2006-10-18 Revised by: mhs
Added the description of extended controls by Hans Verkuil. Linked V4L2_PIX_FMT_MPEG to V
Revision 0.17 2006-10-12 Revised by: mhs
Corrected V4L2_PIX_FMT_HM12 description.
Revision 0.16 2006-10-08 Revised by: mhs

VIDIOC_ENUM_FRAMESIZES and VIDIOC_ENUM_FRAMEINTERVALS are now part of the
Revision 0.15 2006-09-23 Revised by: mhs
Cleaned up the bibliography, added BT.653 and BT.1119. capture.c/start_capturing() for user pointing
Revision 0.14 2006-09-14 Revised by: mr
Added VIDIOC_ENUM_FRAMESIZES and VIDIOC_ENUM_FRAMEINTERVALS proposal for
Revision 0.13 2006-04-07 Revised by: mhs
Corrected the description of struct v4l2_window clips. New V4L2_STD_ and V4L2_TUNER_MODE_ macros
Revision 0.12 2006-02-03 Revised by: mhs
Corrected the description of struct v4l2_captureparm and v4l2_outputparm.
Revision 0.11 2006-01-27 Revised by: mhs
Improved the description of struct v4l2_tuner.
Revision 0.10 2006-01-10 Revised by: mhs
VIDIOC_G_INPUT and VIDIOC_S_PARM clarifications.
Revision 0.9 2005-11-27 Revised by: mhs
Improved the 525 line numbering diagram. Hans Verkuil and I rewrote the sliced VBI section. He also
Revision 0.8 2004-10-04 Revised by: mhs
Somehow a piece of junk slipped into the capture example, removed.
Revision 0.7 2004-09-19 Revised by: mhs
Fixed video standard selection, control enumeration, downscaling and aspect example. Added read/write
Revision 0.6 2004-08-01 Revised by: mhs
v4l2_buffer changes, added video capture example, various corrections.
Revision 0.5 2003-11-05 Revised by: mhs
Pixel format erratum.
Revision 0.4 2003-09-17 Revised by: mhs
Corrected source and Makefile to generate a PDF. SGML fixes. Added latest API changes. Closed gaps
Revision 0.3 2003-02-05 Revised by: mhs
Another draft, more corrections.
Revision 0.2 2003-01-15 Revised by: mhs
Second draft, with corrections pointed out by Gerd Knorr.
Revision 0.1 2002-12-01 Revised by: mhs
First draft, based on documentation by Bill Dirks and discussions on the V4L mailing list.

Chapter 1. Common API Elements

Programming a V4L2 device consists of these steps:

- Opening the device
- Changing device properties, selecting a video and audio input, video standard, picture brightness a. o.
- Negotiating a data format
- Negotiating an input/output method
- The actual input/output loop
- Closing the device

In practice most steps are optional and can be executed out of order. It depends on the V4L2 device type, you can read about the details in Chapter 4. In this chapter we will discuss the basic concepts applicable to all devices.

1.1. Opening and Closing Devices

1.1.1. Device Naming

V4L2 drivers are implemented as kernel modules, loaded manually by the system administrator or automatically when a device is first opened. The driver modules plug into the "videodev" kernel module. It provides helper functions and a common application interface specified in this document.

Each driver thus loaded registers one or more device nodes with major number 81 and a minor number between 0 and 255. Assigning minor numbers to V4L2 devices is entirely up to the system administrator, this is primarily intended to solve conflicts between devices.¹ The module options to select minor numbers are named after the device special file with a "_nr" suffix. For example "video_nr" for /dev/video video capture devices. The number is an offset to the base minor number associated with the device type.² When the driver supports multiple devices of the same type more than one minor number can be assigned, separated by commas:

```
> insmod mydriver.o video_nr=0,1 radio_nr=0,1
```

In /etc/modules.conf this may be written as:

```
alias char-major-81-0 mydriver
alias char-major-81-1 mydriver
alias char-major-81-64 mydriver           ❶
options mydriver video_nr=0,1 radio_nr=0,1 ❷
```

- ❶ When an application attempts to open a device special file with major number 81 and minor number 0, 1, or 64, load "mydriver" (and the "videodev" module it depends upon).
- ❷ Register the first two video capture devices with minor number 0 and 1 (base number is 0), the first two radio device with minor number 64 and 65 (base 64).

When no minor number is given as module option the driver supplies a default. Chapter 4 recommends the base minor numbers to be used for the various device types. Obviously minor numbers must be unique. When the number is already in use the *offending device* will not be registered.

By convention system administrators create various character device special files with these major and minor numbers in the `/dev` directory. The names recommended for the different V4L2 device types are listed in Chapter 4.

The creation of character special files (with `mknod`) is a privileged operation and devices cannot be opened by major and minor number. That means applications cannot *reliable* scan for loaded or installed drivers. The user must enter a device name, or the application can try the conventional device names.

Under the device filesystem (`devfs`) the minor number options are ignored. V4L2 drivers (or by proxy the "videodev" module) automatically create the required device files in the `/dev/v4l` directory using the conventional device names above.

1.1.2. Related Devices

Devices can support several related functions. For example video capturing, video overlay and VBI capturing are related because these functions share, amongst other, the same video input and tuner frequency. V4L and earlier versions of V4L2 used the same device name and minor number for video capturing and overlay, but different ones for VBI. Experience showed this approach has several problems³, and to make things worse the V4L videodev module used to prohibit multiple opens of a device.

As a remedy the present version of the V4L2 API relaxed the concept of device types with specific names and minor numbers. For compatibility with old applications drivers must still register different minor numbers to assign a default function to the device. But if related functions are supported by the driver they must be available under all registered minor numbers. The desired function can be selected after opening the device as described in Chapter 4.

Imagine a driver supporting video capturing, video overlay, raw VBI capturing, and FM radio reception. It registers three devices with minor number 0, 64 and 224 (this numbering scheme is inherited from the V4L API). Regardless if `/dev/video` (81, 0) or `/dev/vbi` (81, 224) is opened the application can select any one of the video capturing, overlay or VBI capturing functions. Without programming (e. g. reading from the device with `dd` or `cat`) `/dev/video` captures video images, while `/dev/vbi` captures raw VBI data. `/dev/radio` (81, 64) is invariable a radio device, unrelated to the video functions. Being unrelated does not imply the devices can be used at the same time, however. The `open()` function may very well return an `EBUSY` error code.

Besides video input or output the hardware may also support audio sampling or playback. If so, these functions are implemented as OSS or ALSA PCM devices and eventually OSS or ALSA audio mixer. The V4L2 API makes no provisions yet

to find these related devices. If you have an idea please write to the linux-media mailing list: <http://www.linuxtv.org/lists.php>.

1.1.3. Multiple Opens

In general, V4L2 devices can be opened more than once. When this is supported by the driver, users can for example start a "panel" application to change controls like brightness or audio volume, while another application captures video and audio. In other words, panel applications are comparable to an OSS or ALSA audio mixer application. When a device supports multiple functions like capturing and overlay *simultaneously*, multiple opens allow concurrent use of the device by forked processes or specialized applications.

Multiple opens are optional, although drivers should permit at least concurrent accesses without data exchange, i. e. panel applications. This implies `open()` can return an EBUSY error code when the device is already in use, as well as `ioctl()` functions initiating data exchange (namely the `VIDIOC_S_FMT` `ioctl`), and the `read()` and `write()` functions.

Mere opening a V4L2 device does not grant exclusive access.⁴ Initiating data exchange however assigns the right to read or write the requested type of data, and to change related properties, to this file descriptor. Applications can request additional access privileges using the priority mechanism described in Section 1.3.

1.1.4. Shared Data Streams

V4L2 drivers should not support multiple applications reading or writing the same data stream on a device by copying buffers, time multiplexing or similar means. This is better handled by a proxy application in user space. When the driver supports stream sharing anyway it must be implemented transparently. The V4L2 API does not specify how conflicts are solved.

1.1.5. Functions

To open and close V4L2 devices applications use the `open()` and `close()` function, respectively. Devices are programmed using the `ioctl()` function as explained in the following sections.

1.2. Querying Capabilities

Because V4L2 covers a wide variety of devices not all aspects of the API are equally applicable to all types of devices. Furthermore devices of the same type have different capabilities and this specification permits the omission of a few complicated and less important parts of the API.

The `VIDIOC_QUERYCAP` ioctl is available to check if the kernel device is compatible with this specification, and to query the functions and I/O methods supported by the device. Other features can be queried by calling the respective ioctl, for example `VIDIOC_ENUMINPUT` to learn about the number, types and names of video connectors on the device. Although abstraction is a major objective of this API, the ioctl also allows driver specific applications to reliably identify the driver.

All V4L2 drivers must support `VIDIOC_QUERYCAP`. Applications should always call this ioctl after opening the device.

1.3. Application Priority

When multiple applications share a device it may be desirable to assign them different priorities. Contrary to the traditional "rm -rf /" school of thought a video recording application could for example block other applications from changing video controls or switching the current TV channel. Another objective is to permit low priority applications working in background, which can be preempted by user controlled applications and automatically regain control of the device at a later time.

Since these features cannot be implemented entirely in user space V4L2 defines the `VIDIOC_G_PRIORITY` and `VIDIOC_S_PRIORITY` ioctls to request and query the access priority associate with a file descriptor. Opening a device assigns a medium priority, compatible with earlier versions of V4L2 and drivers not supporting these ioctls. Applications requiring a different priority will usually call `VIDIOC_S_PRIORITY` after verifying the device with the `VIDIOC_QUERYCAP` ioctl.

Ioctls changing driver properties, such as `VIDIOC_S_INPUT`, return an `EBUSY` error code after another application obtained higher priority. An event mechanism to notify applications about asynchronous property changes has been proposed but not added yet.

1.4. Video Inputs and Outputs

Video inputs and outputs are physical connectors of a device. These can be for example RF connectors (antenna/cable), CVBS a.k.a. Composite Video, S-Video or

RGB connectors. Only video and VBI capture devices have inputs, output devices have outputs, at least one each. Radio devices have no video inputs or outputs.

To learn about the number and attributes of the available inputs and outputs applications can enumerate them with the `VIDIOC_ENUMINPUT` and `VIDIOC_ENUMOUTPUT` `ioctl`, respectively. The struct `v4l2_input` returned by the `VIDIOC_ENUMINPUT` `ioctl` also contains signal status information applicable when the current video input is queried.

The `VIDIOC_G_INPUT` and `VIDIOC_G_OUTPUT` `ioctl` return the index of the current video input or output. To select a different input or output applications call the `VIDIOC_S_INPUT` and `VIDIOC_S_OUTPUT` `ioctl`. Drivers must implement all the input `ioctl`s when the device has one or more inputs, all the output `ioctl`s when the device has one or more outputs.

Example 1-1. Information about the current video input

```
struct v4l2_input input;
int index;

if (-1 == ioctl (fd, VIDIOC_G_INPUT, &index)) {
    perror ("VIDIOC_G_INPUT");
    exit (EXIT_FAILURE);
}

memset (&input, 0, sizeof (input));
input.index = index;

if (-1 == ioctl (fd, VIDIOC_ENUMINPUT, &input)) {
    perror ("VIDIOC_ENUMINPUT");
    exit (EXIT_FAILURE);
}

printf ("Current input: %s\n", input.name);
```

Example 1-2. Switching to the first video input

```
int index;

index = 0;

if (-1 == ioctl (fd, VIDIOC_S_INPUT, &index)) {
    perror ("VIDIOC_S_INPUT");
    exit (EXIT_FAILURE);
}
```

1.5. Audio Inputs and Outputs

Audio inputs and outputs are physical connectors of a device. Video capture devices have inputs, output devices have outputs, zero or more each. Radio devices have no audio inputs or outputs. They have exactly one tuner which in fact *is* an audio source, but this API associates tuners with video inputs or outputs only, and radio devices have none of these.⁵ A connector on a TV card to loop back the received audio signal to a sound card is not considered an audio output.

Audio and video inputs and outputs are associated. Selecting a video source also selects an audio source. This is most evident when the video and audio source is a tuner. Further audio connectors can combine with more than one video input or output. Assumed two composite video inputs and two audio inputs exist, there may be up to four valid combinations. The relation of video and audio connectors is defined in the *audio_{set}* field of the respective struct `v4l2_input` or struct `v4l2_output`, where each bit represents the index number, starting at zero, of one audio input or output.

To learn about the number and attributes of the available inputs and outputs applications can enumerate them with the `VIDIOC_ENUMAUDIO` and `VIDIOC_ENUMAUDOUT` ioctl, respectively. The struct `v4l2_audio` returned by the `VIDIOC_ENUMAUDIO` ioctl also contains signal status information applicable when the current audio input is queried.

The `VIDIOC_G_AUDIO` and `VIDIOC_G_AUDOUT` ioctl report the current audio input and output, respectively. Note that, unlike `VIDIOC_G_INPUT` and `VIDIOC_G_OUTPUT` these ioctls return a structure as `VIDIOC_ENUMAUDIO` and `VIDIOC_ENUMAUDOUT` do, not just an index.

To select an audio input and change its properties applications call the `VIDIOC_S_AUDIO` ioctl. To select an audio output (which presently has no changeable properties) applications call the `VIDIOC_S_AUDOUT` ioctl.

Drivers must implement all input ioctls when the device has one or more inputs, all output ioctls when the device has one or more outputs. When the device has any audio inputs or outputs the driver must set the `V4L2_CAP_AUDIO` flag in the struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl.

Example 1-3. Information about the current audio input

```
struct v4l2_audio audio;

memset (&audio, 0, sizeof (audio));

if (-1 == ioctl (fd, VIDIOC_G_AUDIO, &audio)) {
    perror ("VIDIOC_G_AUDIO");
    exit (EXIT_FAILURE);
}
```



```
}

printf ("Current input: %s\n", audio.name);
```

Example 1-4. Switching to the first audio input

```
struct v4l2_audio audio;

memset (&audio, 0, sizeof (audio)); /* clear audio.mode, audio.reserved */

audio.index = 0;

if (-1 == ioctl (fd, VIDIOC_S_AUDIO, &audio)) {
    perror ("VIDIOC_S_AUDIO");
    exit (EXIT_FAILURE);
}
```

1.6. Tuners and Modulators

1.6.1. Tuners

Video input devices can have one or more tuners demodulating a RF signal. Each tuner is associated with one or more video inputs, depending on the number of RF connectors on the tuner. The *type* field of the respective struct `v4l2_input` returned by the `VIDIOC_ENUMINPUT` ioctl is set to `V4L2_INPUT_TYPE_TUNER` and its *tuner* field contains the index number of the tuner.

Radio devices have exactly one tuner with index zero, no video inputs.

To query and change tuner properties applications use the `VIDIOC_G_TUNER` and `VIDIOC_S_TUNER` ioctl, respectively. The struct `v4l2_tuner` returned by `VIDIOC_G_TUNER` also contains signal status information applicable when the tuner of the current video input, or a radio tuner is queried. Note that `VIDIOC_S_TUNER` does not switch the current tuner, when there is more than one at all. The tuner is solely determined by the current video input. Drivers must support both ioctls and set the `V4L2_CAP_TUNER` flag in the struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl when the device has one or more tuners.

1.6.2. Modulators

Video output devices can have one or more modulators, uh, modulating a video signal for radiation or connection to the antenna input of a TV set or video recorder. Each modulator is associated with one or more video outputs, depending on the number of RF connectors on the modulator. The *type* field of the respective struct `v4l2_output` returned by the `VIDIOC_ENUMOUTPUT` ioctl is set to `V4L2_OUTPUT_TYPE_MODULATOR` and its *modulator* field contains the index number of the modulator. This specification does not define radio output devices.

To query and change modulator properties applications use the `VIDIOC_G_MODULATOR` and `VIDIOC_S_MODULATOR` ioctl. Note that `VIDIOC_S_MODULATOR` does not switch the current modulator, when there is more than one at all. The modulator is solely determined by the current video output. Drivers must support both ioctls and set the `V4L2_CAP_MODULATOR` flag in the struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl when the device has one or more modulators.

1.6.3. Radio Frequency

To get and set the tuner or modulator radio frequency applications use the `VIDIOC_G_FREQUENCY` and `VIDIOC_S_FREQUENCY` ioctl which both take a pointer to a struct `v4l2_frequency`. These ioctls are used for TV and radio devices alike. Drivers must support both ioctls when the tuner or modulator ioctls are supported, or when the device is a radio device.

1.7. Video Standards

Video devices typically support one or more different video standards or variations of standards. Each video input and output may support another set of standards. This set is reported by the *std* field of struct `v4l2_input` and struct `v4l2_output` returned by the `VIDIOC_ENUMINPUT` and `VIDIOC_ENUMOUTPUT` ioctl, respectively.

V4L2 defines one bit for each analog video standard currently in use worldwide, and sets aside bits for driver defined standards, e. g. hybrid standards to watch NTSC video tapes on PAL TVs and vice versa. Applications can use the predefined bits to select a particular standard, although presenting the user a menu of supported standards is preferred. To enumerate and query the attributes of the supported standards applications use the `VIDIOC_ENUMSTD` ioctl.

Many of the defined standards are actually just variations of a few major standards. The hardware may in fact not distinguish between them, or do so internal and

switch automatically. Therefore enumerated standards also contain sets of one or more standard bits.

Assume a hypothetical tuner capable of demodulating B/PAL, G/PAL and I/PAL signals. The first enumerated standard is a set of B and G/PAL, switched automatically depending on the selected radio frequency in UHF or VHF band. Enumeration gives a "PAL-B/G" or "PAL-I" choice. Similar a Composite input may collapse standards, enumerating "PAL-B/G/H/I", "NTSC-M" and "SECAM-D/K".⁶

To query and select the standard used by the current video input or output applications call the `VIDIOC_G_STD` and `VIDIOC_S_STD` ioctl, respectively. The *received* standard can be sensed with the `VIDIOC_QUERYSTD` ioctl. Note parameter of all these ioctls is a pointer to a `v4l2_std_id` type (a standard set), *not* an index into the standard enumeration.⁷ Drivers must implement all video standard ioctls when the device has one or more video inputs or outputs.

Special rules apply to USB cameras where the notion of video standards makes little sense. More generally any capture device, output devices accordingly, which is

- incapable of capturing fields or frames at the nominal rate of the video standard, or
- where **timestamps** refer to the instant the field or frame was received by the driver, not the capture time, or
- where **sequence numbers** refer to the frames received by the driver, not the captured frames.

Here the driver shall set the `std` field of struct `v4l2_input` and struct `v4l2_output` to zero, the `VIDIOC_G_STD`, `VIDIOC_S_STD`, `VIDIOC_QUERYSTD` and `VIDIOC_ENUMSTD` ioctls shall return the `EINVAL` error code.⁸

Example 1-5. Information about the current video standard

```
v4l2_std_id std_id;
struct v4l2_standard standard;

if (-1 == ioctl (fd, VIDIOC_G_STD, &std_id)) {
    /* Note when VIDIOC_ENUMSTD always returns EINVAL this
       is no video device or it falls under the USB exception,
       and VIDIOC_G_STD returning EINVAL is no error. */

    perror ("VIDIOC_G_STD");
    exit (EXIT_FAILURE);
}

memset (&standard, 0, sizeof (standard));
standard.index = 0;
```

```

while (0 == ioctl (fd, VIDIOC_ENUMSTD, &standard)) {
    if (standard.id & std_id) {
        printf ("Current video standard: %s\n", standard.name);
        exit (EXIT_SUCCESS);
    }

    standard.index++;
}

/* EINVAL indicates the end of the enumeration, which cannot be
   empty unless this device falls under the USB exception. */

if (errno == EINVAL || standard.index == 0) {
    perror ("VIDIOC_ENUMSTD");
    exit (EXIT_FAILURE);
}

```

Example 1-6. Listing the video standards supported by the current input

```

struct v4l2_input input;
struct v4l2_standard standard;

memset (&input, 0, sizeof (input));

if (-1 == ioctl (fd, VIDIOC_G_INPUT, &input.index)) {
    perror ("VIDIOC_G_INPUT");
    exit (EXIT_FAILURE);
}

if (-1 == ioctl (fd, VIDIOC_ENUMINPUT, &input)) {
    perror ("VIDIOC_ENUM_INPUT");
    exit (EXIT_FAILURE);
}

printf ("Current input %s supports:\n", input.name);

memset (&standard, 0, sizeof (standard));
standard.index = 0;

while (0 == ioctl (fd, VIDIOC_ENUMSTD, &standard)) {
    if (standard.id & input.std)
        printf ("%s\n", standard.name);

    standard.index++;
}

```

```
/* EINVAL indicates the end of the enumeration, which cannot be
   empty unless this device falls under the USB exception. */

if (errno != EINVAL || standard.index == 0) {
    perror ("VIDIOC_ENUMSTD");
    exit (EXIT_FAILURE);
}
```

Example 1-7. Selecting a new video standard

```
struct v4l2_input input;
v4l2_std_id std_id;

memset (&input, 0, sizeof (input));

if (-1 == ioctl (fd, VIDIOC_G_INPUT, &input.index)) {
    perror ("VIDIOC_G_INPUT");
    exit (EXIT_FAILURE);
}

if (-1 == ioctl (fd, VIDIOC_ENUMINPUT, &input)) {
    perror ("VIDIOC_ENUMINPUT");
    exit (EXIT_FAILURE);
}

if (0 == (input.std & V4L2_STD_PAL_BG)) {
    fprintf (stderr, "Oops. B/G PAL is not supported.\n");
    exit (EXIT_FAILURE);
}

/* Note this is also supposed to work when only B
   or G/PAL is supported. */

std_id = V4L2_STD_PAL_BG;

if (-1 == ioctl (fd, VIDIOC_S_STD, &std_id)) {
    perror ("VIDIOC_S_STD");
    exit (EXIT_FAILURE);
}
```

1.7.1. Digital Video (DV) Timings

The video standards discussed so far has been dealing with Analog TV and the corresponding video timings. Today there are many more different hardware interfaces such as High Definition TV interfaces (HDMI), VGA, DVI connectors etc., that carry video signals and there is a need to extend the API to select the video timings for these interfaces. Since it is not possible to extend the `v4l2_std_id` due to the limited bits available, a new set of IOCTLs is added to set/get video timings at the input and output:

- **DV Presets:** Digital Video (DV) presets. These are IDs representing a video timing at the input/output. Presets are pre-defined timings implemented by the hardware according to video standards. A `__u32` data type is used to represent a preset unlike the bit mask that is used in `v4l2_std_id` allowing future extensions to support as many different presets as needed.
- **Custom DV Timings:** This will allow applications to define more detailed custom video timings for the interface. This includes parameters such as width, height, polarities, frontporch, backporch etc.

To enumerate and query the attributes of DV presets supported by a device, applications use the `VIDIOC_ENUM_DV_PRESETS` ioctl. To get the current DV preset, applications use the `VIDIOC_G_DV_PRESET` ioctl and to set a preset they use the `VIDIOC_S_DV_PRESET` ioctl.

To set custom DV timings for the device, applications use the `VIDIOC_S_DV_TIMINGS` ioctl and to get current custom DV timings they use the `VIDIOC_G_DV_TIMINGS` ioctl.

Applications can make use of the Table A-4 and Table A-3 flags to decide what ioctls are available to set the video timings for the device.

1.8. User Controls

Devices typically have a number of user-settable controls such as brightness, saturation and so on, which would be presented to the user on a graphical user interface. But, different devices will have different controls available, and furthermore, the range of possible values, and the default value will vary from device to device. The control ioctls provide the information and a mechanism to create a nice user interface for these controls that will work correctly with any device.

All controls are accessed using an ID value. V4L2 defines several IDs for specific purposes. Drivers can also implement their own custom controls using

V4L2_CID_PRIVATE_BASE and higher values. The pre-defined control IDs have the prefix V4L2_CID_, and are listed in Table 1-1. The ID is used when querying the attributes of a control, and when getting or setting the current value.

Generally applications should present controls to the user without assumptions about their purpose. Each control comes with a name string the user is supposed to understand. When the purpose is non-intuitive the driver writer should provide a user manual, a user interface plug-in or a driver specific panel application. Predefined IDs were introduced to change a few controls programmatically, for example to mute a device during a channel switch.

Drivers may enumerate different controls after switching the current video input or output, tuner or modulator, or audio input or output. Different in the sense of other bounds, another default and current value, step size or other menu items. A control with a certain *custom* ID can also change name and type.⁹ Control values are stored globally, they do not change when switching except to stay within the reported bounds. They also do not change e. g. when the device is opened or closed, when the tuner radio frequency is changed or generally never without application request. Since V4L2 specifies no event mechanism, panel applications intended to cooperate with other panel applications (be they built into a larger application, as a TV viewer) may need to regularly poll control values to update their user interface.¹⁰

Table 1-1. Control IDs

ID	Type	Description
V4L2_CID_BASE		First predefined ID, equal to V4L2_CID_BRIGHTNESS.
V4L2_CID_USER_BASE		Synonym of V4L2_CID_BASE.
V4L2_CID_BRIGHTNESS	integer	Picture brightness, or more precisely, the black level.
V4L2_CID_CONTRAST	integer	Picture contrast or luma gain.
V4L2_CID_SATURATION	integer	Picture color saturation or chroma gain.
V4L2_CID_HUE	integer	Hue or color balance.
V4L2_CID_AUDIO_VOLUME	integer	Overall audio volume. Note some drivers also provide an OSS or ALSA mixer interface.
V4L2_CID_AUDIO_BALANCE	integer	Audio stereo balance. Minimum corresponds to all the way left, maximum to right.
V4L2_CID_AUDIO_BASS	integer	Audio bass adjustment.
V4L2_CID_AUDIO_TREBLE	integer	Audio treble adjustment.

ID	Type	Description
V4L2_CID_AUDIO_MUTE	boolean	Mute audio, i. e. set the volume to zero, however without affecting V4L2_CID_AUDIO_VOLUME. Like ALSA drivers, V4L2 drivers must mute at load time to avoid excessive noise. Actually the entire device should be reset to a low power consumption state.
V4L2_CID_AUDIO_LOUDNESS	boolean	Loudness mode (bass boost).
V4L2_CID_BLACK_LEVEL	integer	Another name for brightness (not a synonym of V4L2_CID_BRIGHTNESS). This control is deprecated and should not be used in new drivers and applications.
V4L2_CID_AUTO_WHITE_BALANCE	boolean	Automatic white balance (cameras).
V4L2_CID_DO_WHITE_BALANCE	button	This is an action control. When set (the value is ignored), the device will do a white balance and then hold the current setting. Contrast this with the boolean V4L2_CID_AUTO_WHITE_BALANCE, which, when activated, keeps adjusting the white balance.
V4L2_CID_RED_BALANCE	integer	Red chroma balance.
V4L2_CID_BLUE_BALANCE	integer	Blue chroma balance.
V4L2_CID_GAMMA	integer	Gamma adjust.
V4L2_CID_WHITENESS	integer	Whiteness for grey-scale devices. This is a synonym for V4L2_CID_GAMMA. This control is deprecated and should not be used in new drivers and applications.
V4L2_CID_EXPOSURE	integer	Exposure (cameras). [Unit?]
V4L2_CID_AUTOGAIN	boolean	Automatic gain/exposure control.
V4L2_CID_GAIN	integer	Gain control.
V4L2_CID_HFLIP	boolean	Mirror the picture horizontally.
V4L2_CID_VFLIP	boolean	Mirror the picture vertically.

ID	Type	Description
V4L2_CID_HCENTER_DEPRECATED (formerly V4L2_CID_HCENTER)	integer	Horizontal image centering. This control is deprecated. New drivers and applications should use the Camera class controls V4L2_CID_PAN_ABSOLUTE, V4L2_CID_PAN_RELATIVE and V4L2_CID_PAN_RESET instead.
V4L2_CID_VCENTER_DEPRECATED (formerly V4L2_CID_VCENTER)	integer	Vertical image centering. Centering is intended to <i>physically</i> adjust cameras. For image cropping see Section 1.12, for clipping Section 4.2. This control is deprecated. New drivers and applications should use the Camera class controls V4L2_CID_TILT_ABSOLUTE, V4L2_CID_TILT_RELATIVE and V4L2_CID_TILT_RESET instead.
V4L2_CID_POWER_LINE_FREQUENCY	enum	Enables a power line frequency filter to avoid flicker. Possible values for enum v4l2_power_line_frequency are: V4L2_CID_POWER_LINE_FREQUENCY_DISABLED (0), V4L2_CID_POWER_LINE_FREQUENCY_50HZ (1) and V4L2_CID_POWER_LINE_FREQUENCY_60HZ (2).
V4L2_CID_HUE_AUTO	boolean	Enables automatic hue control by the device. The effect of setting V4L2_CID_HUE while automatic hue control is enabled is undefined, drivers should ignore such request.
V4L2_CID_WHITE_BALANCE_TEMPERATURE	integer	This control specifies the white balance settings as a color temperature in Kelvin. A driver should have a minimum of 2800 (incandescent) to 6500 (daylight). For more information about color temperature see Wikipedia (http://en.wikipedia.org/wiki/Color_temperature).
V4L2_CID_SHARPNESS	integer	Adjusts the sharpness filters in a camera. The minimum value disables the filters, higher values give a sharper picture.

ID	Type	Description
V4L2_CID_BACKLIGHT_COMPENSATION	integer	Adjusts the backlight compensation in a camera. The minimum value disables backlight compensation.
V4L2_CID_CHROMA_AGC	boolean	Chroma automatic gain control.
V4L2_CID_CHROMA_GAIN	integer	Adjusts the Chroma gain control (for use when chroma AGC is disabled).
V4L2_CID_COLOR_KILLER	boolean	Enable the color killer (i. e. force a black & white image in case of a weak video signal).
V4L2_CID_COLORFX	enum	Selects a color effect. Possible values for enum v4l2_colorfx are: V4L2_COLORFX_NONE (0), V4L2_COLORFX_BW (1), V4L2_COLORFX_SEPIA (2), V4L2_COLORFX_NEGATIVE (3), V4L2_COLORFX_EMBOSS (4), V4L2_COLORFX_SKETCH (5), V4L2_COLORFX_SKY_BLUE (6), V4L2_COLORFX_GRASS_GREEN (7), V4L2_COLORFX_SKIN_WHITEN (8) and V4L2_COLORFX_VIVID (9).
V4L2_CID_ROTATE	integer	Rotates the image by specified angle. Common angles are 90, 270 and 180. Rotating the image to 90 and 270 will reverse the height and width of the display window. It is necessary to set the new height and width of the picture using the VIDIOC_S_FMT ioctl according to the rotation angle selected.
V4L2_CID_BG_COLOR	integer	Sets the background color on the current output device. Background color needs to be specified in the RGB24 format. The supplied 32 bit value is interpreted as bits 0-7 Red color information, bits 8-15 Green color information, bits 16-23 Blue color information and bits 24-31 must be zero.
V4L2_CID_ILLUMINATORS_1	boolean	Switch on or off the illuminator 1 or 2 of the device (usually a microscope).
V4L2_CID_ILLUMINATORS_2	boolean	

ID	Type	Description
V4L2_CID_LASTP1		End of the predefined control IDs (currently V4L2_CID_ILLUMINATORS_2 + 1).
V4L2_CID_PRIVATE_BASE		ID of the first custom (driver specific) control. Applications depending on particular custom controls should check the driver name and version, see Section 1.2.

Applications can enumerate the available controls with the `VIDIOC_QUERYCTRL` and `VIDIOC_QUERYMENU` ioctls, get and set a control value with the `VIDIOC_G_CTRL` and `VIDIOC_S_CTRL` ioctls. Drivers must implement `VIDIOC_QUERYCTRL`, `VIDIOC_G_CTRL` and `VIDIOC_S_CTRL` when the device has one or more controls, `VIDIOC_QUERYMENU` when it has one or more menu type controls.

Example 1-8. Enumerating all controls

```
struct v4l2_queryctrl queryctrl;
struct v4l2_querymenu querymenu;

static void
enumerate_menu (void)
{
    printf ("  Menu items:\n");

    memset (&querymenu, 0, sizeof (querymenu));
    querymenu.id = queryctrl.id;

    for (querymenu.index = queryctrl.minimum;
        querymenu.index <= queryctrl.maximum;
        querymenu.index++) {
        if (0 == ioctl (fd, VIDIOC_QUERYMENU, &querymenu)) {
            printf ("    %s\n", querymenu.name);
        }
    }
}

memset (&queryctrl, 0, sizeof (queryctrl));

for (queryctrl.id = V4L2_CID_BASE;
    queryctrl.id < V4L2_CID_LASTP1;
    queryctrl.id++) {
    if (0 == ioctl (fd, VIDIOC_QUERYCTRL, &queryctrl)) {
        if (queryctrl.flags & V4L2_CTRL_FLAG_DISABLED)
```

```

        continue;

    printf ("Control %s\n", queryctrl.name);

    if (queryctrl.type == V4L2_CTRL_TYPE_MENU)
        enumerate_menu ();
    } else {
        if (errno == EINVAL)
            continue;

        perror ("VIDIOC_QUERYCTRL");
        exit (EXIT_FAILURE);
    }
}

for (queryctrl.id = V4L2_CID_PRIVATE_BASE;;
     queryctrl.id++) {
    if (0 == ioctl (fd, VIDIOC_QUERYCTRL, &queryctrl)) {
        if (queryctrl.flags & V4L2_CTRL_FLAG_DISABLED)
            continue;

        printf ("Control %s\n", queryctrl.name);

        if (queryctrl.type == V4L2_CTRL_TYPE_MENU)
            enumerate_menu ();
    } else {
        if (errno == EINVAL)
            break;

        perror ("VIDIOC_QUERYCTRL");
        exit (EXIT_FAILURE);
    }
}

```

Example 1-9. Changing controls

```

struct v4l2_queryctrl queryctrl;
struct v4l2_control control;

memset (&queryctrl, 0, sizeof (queryctrl));
queryctrl.id = V4L2_CID_BRIGHTNESS;

if (-1 == ioctl (fd, VIDIOC_QUERYCTRL, &queryctrl)) {
    if (errno != EINVAL) {
        perror ("VIDIOC_QUERYCTRL");
        exit (EXIT_FAILURE);
    } else {

```

Chapter 1. Common API Elements

```
    printf ("V4L2_CID_BRIGHTNESS is not supported\n");
}
} else if (queryctrl.flags & V4L2_CTRL_FLAG_DISABLED) {
    printf ("V4L2_CID_BRIGHTNESS is not supported\n");
} else {
    memset (&control, 0, sizeof (control));
    control.id = V4L2_CID_BRIGHTNESS;
    control.value = queryctrl.default_value;

    if (-1 == ioctl (fd, VIDIOC_S_CTRL, &control)) {
        perror ("VIDIOC_S_CTRL");
        exit (EXIT_FAILURE);
    }
}

memset (&control, 0, sizeof (control));
control.id = V4L2_CID_CONTRAST;

if (0 == ioctl (fd, VIDIOC_G_CTRL, &control)) {
    control.value += 1;

    /* The driver may clamp the value or return ERANGE, ignored here */

    if (-1 == ioctl (fd, VIDIOC_S_CTRL, &control)
        && errno != ERANGE) {
        perror ("VIDIOC_S_CTRL");
        exit (EXIT_FAILURE);
    }
    /* Ignore if V4L2_CID_CONTRAST is unsupported */
} else if (errno != EINVAL) {
    perror ("VIDIOC_G_CTRL");
    exit (EXIT_FAILURE);
}

control.id = V4L2_CID_AUDIO_MUTE;
control.value = TRUE; /* silence */

/* Errors ignored */
ioctl (fd, VIDIOC_S_CTRL, &control);
```

1.9. Extended Controls

1.9.1. Introduction

The control mechanism as originally designed was meant to be used for user settings (brightness, saturation, etc). However, it turned out to be a very useful model for implementing more complicated driver APIs where each driver implements only a subset of a larger API.

The MPEG encoding API was the driving force behind designing and implementing this extended control mechanism: the MPEG standard is quite large and the currently supported hardware MPEG encoders each only implement a subset of this standard. Further more, many parameters relating to how the video is encoded into an MPEG stream are specific to the MPEG encoding chip since the MPEG standard only defines the format of the resulting MPEG stream, not how the video is actually encoded into that format.

Unfortunately, the original control API lacked some features needed for these new uses and so it was extended into the (not terribly originally named) extended control API.

Even though the MPEG encoding API was the first effort to use the Extended Control API, nowadays there are also other classes of Extended Controls, such as Camera Controls and FM Transmitter Controls. The Extended Controls API as well as all Extended Controls classes are described in the following text.

1.9.2. The Extended Control API

Three new ioctls are available: `VIDIOC_G_EXT_CTRLS`, `VIDIOC_S_EXT_CTRLS` and `VIDIOC_TRY_EXT_CTRLS`. These ioctls act on arrays of controls (as opposed to the `VIDIOC_G_CTRL` and `VIDIOC_S_CTRL` ioctls that act on a single control). This is needed since it is often required to atomically change several controls at once.

Each of the new ioctls expects a pointer to a struct `v4l2_ext_controls`. This structure contains a pointer to the control array, a count of the number of controls in that array and a control class. Control classes are used to group similar controls into a single class. For example, control class `V4L2_CTRL_CLASS_USER` contains all user controls (i. e. all controls that can also be set using the old `VIDIOC_S_CTRL` ioctl). Control class `V4L2_CTRL_CLASS_MPEG` contains all controls relating to MPEG encoding, etc.

All controls in the control array must belong to the specified control class. An error is returned if this is not the case.

It is also possible to use an empty control array (`count == 0`) to check whether the specified control class is supported.

The control array is a struct `v4l2_ext_control` array. The `v4l2_ext_control` structure is very similar to struct `v4l2_control`, except for the fact that it also allows for 64-bit values and pointers to be passed.

It is important to realize that due to the flexibility of controls it is necessary to check whether the control you want to set actually is supported in the driver and what the valid range of values is. So use the `VIDIOC_QUERYCTRL` and `VIDIOC_QUERYMENU` ioctls to check this. Also note that it is possible that some of the menu indices in a control of type `V4L2_CTRL_TYPE_MENU` may not be supported (`VIDIOC_QUERYMENU` will return an error). A good example is the list of supported MPEG audio bitrates. Some drivers only support one or two bitrates, others support a wider range.

1.9.3. Enumerating Extended Controls

The recommended way to enumerate over the extended controls is by using `VIDIOC_QUERYCTRL` in combination with the `V4L2_CTRL_FLAG_NEXT_CTRL` flag:

```
struct v4l2_queryctrl qctrl;

qctrl.id = V4L2_CTRL_FLAG_NEXT_CTRL;
while (0 == ioctl (fd, VIDIOC_QUERYCTRL, &qctrl)) {
    /* ... */
    qctrl.id |= V4L2_CTRL_FLAG_NEXT_CTRL;
}
```

The initial control ID is set to 0 ORed with the `V4L2_CTRL_FLAG_NEXT_CTRL` flag. The `VIDIOC_QUERYCTRL` ioctl will return the first control with a higher ID than the specified one. When no such controls are found an error is returned.

If you want to get all controls within a specific control class, then you can set the initial `qctrl.id` value to the control class and add an extra check to break out of the loop when a control of another control class is found:

```
qctrl.id = V4L2_CTRL_CLASS_MPEG | V4L2_CTRL_FLAG_NEXT_CTRL;
while (0 == ioctl (fd, VIDIOC_QUERYCTRL, &qctrl)) {
    if (V4L2_CTRL_ID2CLASS (qctrl.id) != V4L2_CTRL_CLASS_MPEG)
        break;
    /* ... */
    qctrl.id |= V4L2_CTRL_FLAG_NEXT_CTRL;
}
```

The 32-bit `qctrl.id` value is subdivided into three bit ranges: the top 4 bits are reserved for flags (e. g. `V4L2_CTRL_FLAG_NEXT_CTRL`) and are not actually part of the ID. The remaining 28 bits form the control ID, of which the most significant 12 bits define the control class and the least significant 16 bits identify the control within the control class. It is guaranteed that these last 16 bits are always non-zero for controls. The range of 0x1000 and up are reserved for driver-specific controls. The macro `V4L2_CTRL_ID2CLASS(id)` returns the control class ID based on a control ID.

If the driver does not support extended controls, then `VIDIOC_QUERYCTRL` will fail when used in combination with `V4L2_CTRL_FLAG_NEXT_CTRL`. In that case the old method of enumerating control should be used (see 1.8). But if it is supported, then it is guaranteed to enumerate over all controls, including driver-private controls.

1.9.4. Creating Control Panels

It is possible to create control panels for a graphical user interface where the user can select the various controls. Basically you will have to iterate over all controls using the method described above. Each control class starts with a control of type `V4L2_CTRL_TYPE_CTRL_CLASS`. `VIDIOC_QUERYCTRL` will return the name of this control class which can be used as the title of a tab page within a control panel.

The flags field of struct `v4l2_queryctrl` also contains hints on the behavior of the control. See the `VIDIOC_QUERYCTRL` documentation for more details.

1.9.5. MPEG Control Reference

Below all controls within the MPEG control class are described. First the generic controls, then controls specific for certain hardware.

1.9.5.1. Generic MPEG Controls

Table 1-2. MPEG Control IDs

ID	Type
Description	
<code>V4L2_CID_MPEG_CLASS</code>	class
The MPEG class descriptor. Calling <code>VIDIOC_QUERYCTRL</code> for this control will return a description of this control class. This description can be used as the caption of a Tab page in a GUI, for example.	

ID	Type	Description
V4L2_CID_MPEG_STREAM_TYPE	enum v4l2_mpeg_stream_type	The MPEG-1, -2 or -4 output stream type. One cannot assume anything here. Each hardware MPEG encoder tends to support different subsets of the available MPEG stream types. The currently defined stream types are: ENTRYTBL not supported.
V4L2_CID_MPEG_STREAM_PID_PMT	integer	Program Map Table Packet ID for the MPEG transport stream (default 16)
V4L2_CID_MPEG_STREAM_PID_AUDIO	integer	Audio Packet ID for the MPEG transport stream (default 256)
V4L2_CID_MPEG_STREAM_PID_VIDEO	integer	Video Packet ID for the MPEG transport stream (default 260)
V4L2_CID_MPEG_STREAM_PID_PCR	integer	Packet ID for the MPEG transport stream carrying PCR fields (default 259)
V4L2_CID_MPEG_STREAM_PES_ID_AUDIO	integer	Audio ID for MPEG PES
V4L2_CID_MPEG_STREAM_PES_ID_VIDEO	integer	Video ID for MPEG PES
V4L2_CID_MPEG_STREAM_VBI_FMT	enum v4l2_mpeg_stream_vbi_fmt	Some cards can embed VBI data (e. g. Closed Caption, Teletext) into the MPEG stream. This control selects whether VBI data should be embedded, and if so, what embedding method should be used. The list of possible VBI formats depends on the driver. The currently defined VBI format types are:

ID	Type
Description ENTRYTBL not supported.	
V4L2_CID_MPEG_AUDIO_SAMPLING_FREQ	enum v4l2_mpeg_audio_sampling_freq
Description MPEG Audio sampling frequency. Possible values are: ENTRYTBL not supported.	
V4L2_CID_MPEG_AUDIO_ENCODING	enum v4l2_mpeg_audio_encoding
Description MPEG Audio encoding. Possible values are: ENTRYTBL not supported.	
V4L2_CID_MPEG_AUDIO_L1_BITRATE	enum v4l2_mpeg_audio_l1_bitrate
Description MPEG-1/2 Layer I bitrate. Possible values are: ENTRYTBL not supported.	
V4L2_CID_MPEG_AUDIO_L2_BITRATE	enum v4l2_mpeg_audio_l2_bitrate
Description MPEG-1/2 Layer II bitrate. Possible values are: ENTRYTBL not supported.	
V4L2_CID_MPEG_AUDIO_L3_BITRATE	enum v4l2_mpeg_audio_l3_bitrate
Description MPEG-1/2 Layer III bitrate. Possible values are: ENTRYTBL not supported.	
V4L2_CID_MPEG_AUDIO_AAC_BITRATE	integer
Description AAC bitrate in bits per second.	
V4L2_CID_MPEG_AUDIO_AC3_BITRATE	enum v4l2_mpeg_audio_ac3_bitrate
Description AC-3 bitrate. Possible values are: ENTRYTBL not supported.	
V4L2_CID_MPEG_AUDIO_MODE	enum v4l2_mpeg_audio_mode

ID	Type	Description
V4L2_CID_MPEG_AUDIO_MODE_EXTENSION	enum v4l2_mpeg_audio_mode_extension	MPEG Audio mode. Possible values are: ENTRYTBL not supported.
V4L2_CID_MPEG_AUDIO_MODE_EXTENSION	enum v4l2_mpeg_audio_mode_extension	Joint Stereo audio mode extension. In Layer I and II they indicate which subbands are in intensity stereo. All other subbands are coded in stereo. Layer III is not (yet) supported. Possible values are: ENTRYTBL not supported.
V4L2_CID_MPEG_AUDIO_EMPHASIS	enum v4l2_mpeg_audio_emphasis	Audio Emphasis. Possible values are: ENTRYTBL not supported.
V4L2_CID_MPEG_AUDIO_CRC	enum v4l2_mpeg_audio_crc	CRC method. Possible values are: ENTRYTBL not supported.
V4L2_CID_MPEG_AUDIO_MUTE	boolean	Mutes the audio when capturing. This is not done by muting audio hardware, which can still produce a slight hiss, but in the encoder itself, guaranteeing a fixed and reproducible audio bitstream. 0 = unmuted, 1 = muted.
V4L2_CID_MPEG_VIDEO_ENCODING	enum v4l2_mpeg_video_encoding	MPEG Video encoding method. Possible values are: ENTRYTBL not supported.
V4L2_CID_MPEG_VIDEO_ASPECT	enum v4l2_mpeg_video_aspect	Video aspect. Possible values are: ENTRYTBL not supported.
V4L2_CID_MPEG_VIDEO_B_FRAMES	integer	Number of B-Frames (default 2)

ID	Type	Description
V4L2_CID_MPEG_VIDEO_GOP_SIZE	integer	<p>GOP size (default 12)</p>
V4L2_CID_MPEG_VIDEO_GOP_CLOSURE	boolean	<p>GOP closure (default 1)</p>
V4L2_CID_MPEG_VIDEO_PULLDOWN	boolean	<p>Enable 3:2 pulldown (default 0)</p>
V4L2_CID_MPEG_VIDEO_BITRATE_MODE	enum v4l2_mpeg_video_bitrate_mode	<p>Video bitrate mode. Possible values are: ENTRYTBL not supported.</p>
V4L2_CID_MPEG_VIDEO_BITRATE	integer	<p>Video bitrate in bits per second.</p>
V4L2_CID_MPEG_VIDEO_BITRATE_PEAK	integer	<p>Peak video bitrate in bits per second. Must be larger or equal to the average video bitrate. It is ignored if the video bitrate mode is set to constant bitrate.</p>
V4L2_CID_MPEG_VIDEO_TEMPORAL_SKIPPING	integer	<p>For every captured frame, skip this many subsequent frames (default 0).</p>
V4L2_CID_MPEG_VIDEO_MUTE	boolean	<p>"Mutes" the video to a fixed color when capturing. This is useful for testing, to produce a fixed video bitstream. 0 = unmuted, 1 = muted.</p>
V4L2_CID_MPEG_VIDEO_MUTE_YUV	integer	<p>Sets the "mute" color of the video. The supplied 32-bit integer is interpreted as follows (bit 0 = least significant bit):</p>

ID	Type
Description	
ENTRYTBL not supported.	

1.9.5.2. CX2341x MPEG Controls

The following MPEG class controls deal with MPEG encoding settings that are specific to the Conexant CX23415 and CX23416 MPEG encoding chips.

Table 1-3. CX2341x Control IDs

ID	Type
Description	
V4L2_CID_MPEG_CX2341X_VIDEO_SPATIAL_FILTER_MODE	enumv4l2_mpeg_cx2341x_video_spatial_filter_mode
Sets the Spatial Filter mode (default MANUAL). Possible values are: ENTRYTBL not supported.	
V4L2_CID_MPEG_CX2341X_VIDEO_SPATIAL_FILTER	integer(0-15)
The setting for the Spatial Filter. 0 = off, 15 = maximum. (Default is 0.)	
V4L2_CID_MPEG_CX2341X_VIDEO_LUMA_SPATIAL_FILTER_TYPE	enumv4l2_mpeg_cx2341x_video_luma_spatial_filter_type
Select the algorithm to use for the Luma Spatial Filter (default 1D_HOR). Possible values: ENTRYTBL not supported.	
V4L2_CID_MPEG_CX2341X_VIDEO_CHROMA_SPATIAL_FILTER_TYPE	enumv4l2_mpeg_cx2341x_video_chroma_spatial_filter_type
Select the algorithm for the Chroma Spatial Filter (default 1D_HOR). Possible values are: ENTRYTBL not supported.	
V4L2_CID_MPEG_CX2341X_VIDEO_TEMPORAL_FILTER_MODE	enumv4l2_mpeg_cx2341x_video_temporal_filter_mode
Sets the Temporal Filter mode (default MANUAL). Possible values are: ENTRYTBL not supported.	

ID	Type	Description
V4L2_CID_MPEG_CX2341X_VIDEO_TEMPORAL_FILTER	integer(0-31)	The setting for the Temporal Filter. 0 = off, 31 = maximum. (Default is 8 for full-scale capturing and 0 for scaled capturing.)
V4L2_CID_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE	enum v4l2_mpeg_cx2341x_video_median_filter_type	Median Filter Type (default OFF). Possible values are: ENTRYTBL not supported.
V4L2_CID_MPEG_CX2341X_VIDEO_LUMINANCE_FILTER_BOTTOM	integer(0-255)	Threshold above which the luminance median filter is enabled (default 0)
V4L2_CID_MPEG_CX2341X_VIDEO_LUMINANCE_FILTER_TOP	integer(0-255)	Threshold below which the luminance median filter is enabled (default 255)
V4L2_CID_MPEG_CX2341X_VIDEO_CHROMA_FILTER_BOTTOM	integer(0-255)	Threshold above which the chroma median filter is enabled (default 0)
V4L2_CID_MPEG_CX2341X_VIDEO_CHROMA_FILTER_TOP	integer(0-255)	Threshold below which the chroma median filter is enabled (default 255)
V4L2_CID_MPEG_CX2341X_STREAM_INSERT_NAV_PACKETS	boolean	The CX2341X MPEG encoder can insert one empty MPEG-2 PES packet into the stream between every four video frames. The packet size is 2048 bytes, including the packet_start_code_prefix and stream_id fields. The stream_id is 0xBF (private stream 2). The payload consists of 0x00 bytes, to be filled in by the application. 0 = do not insert, 1 = insert packets.

1.9.6. Camera Control Reference

The Camera class includes controls for mechanical (or equivalent digital) features of a device such as controllable lenses or sensors.

Table 1-4. Camera Control IDs

ID	Type	Description
V4L2_CID_CAMERA_CLASS	class	The Camera class descriptor. Calling <code>VIDIOC_QUERYCTRL</code> for this control will return a description of this control class.
V4L2_CID_EXPOSURE_AUTO	enum <code>v4l2_exposure_auto_type</code>	Enables automatic adjustments of the exposure time and/or iris aperture. The effect of manual changes of the exposure time or iris aperture while these features are enabled is undefined, drivers should ignore such requests. Possible values are: ENTRYTBL not supported.
V4L2_CID_EXPOSURE_ABSOLUTE	integer	Determines the exposure time of the camera sensor. The exposure time is limited by the frame interval. Drivers should interpret the values as 100 <u>textmus</u> units, where the value 1 stands for 1/10000th of a second, 10000 for 1 second and 100000 for 10 seconds.
V4L2_CID_EXPOSURE_AUTO_PRIORITY	boolean	When <code>V4L2_CID_EXPOSURE_AUTO</code> is set to <code>AUTO</code> or <code>APERTURE_PRIORITY</code> , this control determines if the device may dynamically vary the frame rate. By default this feature is disabled (0) and the frame rate must remain constant.
V4L2_CID_PAN_RELATIVE	integer	This control turns the camera horizontally by the specified amount. The unit is undefined. A positive value moves the camera to the right (clockwise when viewed from above), a negative value to the left. A value of zero does not cause motion. This is a write-only control.
V4L2_CID_TILT_RELATIVE	integer	

ID	Type	Description
		This control turns the camera vertically by the specified amount. The unit is undefined. A positive value moves the camera up, a negative value down. A value of zero does not cause motion. This is a write-only control.
V4L2_CID_PAN_RESET	button	When this control is set, the camera moves horizontally to the default position.
V4L2_CID_TILT_RESET	button	When this control is set, the camera moves vertically to the default position.
V4L2_CID_PAN_ABSOLUTE	integer	This control turns the camera horizontally to the specified position. Positive values move the camera to the right (clockwise when viewed from above), negative values to the left. Drivers should interpret the values as arc seconds, with valid values between $-180 * 3600$ and $+180 * 3600$ inclusive.
V4L2_CID_TILT_ABSOLUTE	integer	This control turns the camera vertically to the specified position. Positive values move the camera up, negative values down. Drivers should interpret the values as arc seconds, with valid values between $-180 * 3600$ and $+180 * 3600$ inclusive.
V4L2_CID_FOCUS_ABSOLUTE	integer	This control sets the focal point of the camera to the specified position. The unit is undefined. Positive values set the focus closer to the camera, negative values towards infinity.
V4L2_CID_FOCUS_RELATIVE	integer	This control moves the focal point of the camera by the specified amount. The unit is undefined. Positive values move the focus closer to the camera, negative values towards infinity. This is a write-only control.
V4L2_CID_FOCUS_AUTO	boolean	Enables automatic focus adjustments. The effect of manual focus adjustments while this feature is enabled is undefined, drivers should ignore such requests.

ID	Type	Description
V4L2_CID_ZOOM_ABSOLUTE	integer	Specify the objective lens focal length as an absolute value. The zoom unit is driver-specific and its value should be a positive integer.
V4L2_CID_ZOOM_RELATIVE	integer	Specify the objective lens focal length relatively to the current value. Positive values move the zoom lens group towards the telephoto direction, negative values towards the wide-angle direction. The zoom unit is driver-specific. This is a write-only control.
V4L2_CID_ZOOM_CONTINUOUS	integer	Move the objective lens group at the specified speed until it reaches physical device limits or until an explicit request to stop the movement. A positive value moves the zoom lens group towards the telephoto direction. A value of zero stops the zoom lens group movement. A negative value moves the zoom lens group towards the wide-angle direction. The zoom speed unit is driver-specific.
V4L2_CID_IRIS_ABSOLUTE	integer	This control sets the camera's aperture to the specified value. The unit is undefined. Larger values open the iris wider, smaller values close it.
V4L2_CID_IRIS_RELATIVE	integer	This control modifies the camera's aperture by the specified amount. The unit is undefined. Positive values open the iris one step further, negative values close it one step further. This is a write-only control.
V4L2_CID_PRIVACY	boolean	Prevent video from being acquired by the camera. When this control is set to TRUE (1), no image can be captured by the camera. Common means to enforce privacy are mechanical obturation of the sensor and firmware image processing, but the device is not restricted to these methods. Devices that implement the privacy control must support read access and may support write access.
V4L2_CID_BAND_STOP_FILTER	integer	Switch the band-stop filter of a camera sensor on or off, or specify its strength. Such band-stop filters can be used, for example, to filter out the fluorescent light component.

1.9.7. FM Transmitter Control Reference

The FM Transmitter (FM_TX) class includes controls for common features of FM transmissions capable devices. Currently this class includes parameters for audio compression, pilot tone generation, audio deviation limiter, RDS transmission and tuning power features.

Table 1-5. FM_TX Control IDs

ID	Type	Description
V4L2_CID_FM_TX_CLASS	class	The FM_TX class descriptor. Calling VIDIOC_QUERYCTRL for this control will return a description of this control class.
V4L2_CID_RDS_TX_DEVIATION	integer	Configures RDS signal frequency deviation level in Hz. The range and step are driver-specific.
V4L2_CID_RDS_TX_PI	integer	Sets the RDS Programme Identification field for transmission.
V4L2_CID_RDS_TX_PTY	integer	Sets the RDS Programme Type field for transmission. This encodes up to 31 pre-defined programme types.
V4L2_CID_RDS_TX_PS_NAME	string	Sets the Programme Service name (PS_NAME) for transmission. It is intended for static display on a receiver. It is the primary aid to listeners in programme service identification and selection. In Annex E of EN 50067, the RDS specification, there is a full description of the correct character encoding for Programme Service name strings. Also from RDS specification, PS is usually a single eight character text. However, it is also possible to find receivers which can scroll strings sized as 8 x N characters. So, this control must be configured with steps of 8 characters. The result is it must always contain a string with size multiple of 8.
V4L2_CID_RDS_TX_RADIO_TEXT	string	

ID	Type
Description	
Sets the Radio Text info for transmission. It is a textual description of what is being broadcasted. RDS Radio Text can be applied when broadcaster wishes to transmit longer PS names, programme-related information or any other text. In these cases, RadioText should be used in addition to V4L2_CID_RDS_TX_PS_NAME. The encoding for Radio Text strings is also fully described in Annex E of EN 50067. The length of Radio Text strings depends on which RDS Block is being used to transmit it, either 32 (2A block) or 64 (2B block). However, it is also possible to find receivers which can scroll strings sized as 32 x N or 64 x N characters. So, this control must be configured with steps of 32 or 64 characters. The result is it must always contain a string with size multiple of 32 or 64.	
V4L2_CID_AUDIO_LIMITER_ENABLE	boolean
Enables or disables the audio deviation limiter feature. The limiter is useful when trying to maximize the audio volume, minimize receiver-generated distortion and prevent overmodulation.	
V4L2_CID_AUDIO_LIMITER_RELEASE	integer
Sets the audio deviation limiter feature release time. Unit is in useconds. Step and range are driver-specific.	
V4L2_CID_AUDIO_LIMITER_DEVIATION	integer
Configures audio frequency deviation level in Hz. The range and step are driver-specific.	
V4L2_CID_AUDIO_COMPRESSION_ENABLE	boolean
Enables or disables the audio compression feature. This feature amplifies signals below the threshold by a fixed gain and compresses audio signals above the threshold by the ratio of Threshold/(Gain + Threshold).	
V4L2_CID_AUDIO_COMPRESSION_GAIN	integer
Sets the gain for audio compression feature. It is a dB value. The range and step are driver-specific.	
V4L2_CID_AUDIO_COMPRESSION_THRESHOLD	integer
Sets the threshold level for audio compression feature. It is a dB value. The range and step are driver-specific.	
V4L2_CID_AUDIO_COMPRESSION_ATTACK_TIME	integer

ID	Type	Description
V4L2_CID_AUDIO_COMPRESSION_RELEASE_TIME	integer	Sets the attack time for audio compression feature. It is a useconds value. The range and step are driver-specific.
V4L2_CID_PILOT_TONE_ENABLED	boolean	Sets the release time for audio compression feature. It is a useconds value. The range and step are driver-specific.
V4L2_CID_PILOT_TONE_DEVIATION	integer	Enables or disables the pilot tone generation feature.
V4L2_CID_PILOT_TONE_FREQUENCY	integer	Configures pilot tone frequency deviation level. Unit is in Hz. The range and step are driver-specific.
V4L2_CID_TUNE_PREEMPHASIS	integer	Configures pilot tone frequency value. Unit is in Hz. The range and step are driver-specific.
V4L2_CID_TUNE_POWER_LEVEL	integer	Configures the pre-emphasis value for broadcasting. A pre-emphasis filter is applied to the broadcast to accentuate the high audio frequencies. Depending on the region, a time constant of either 50 or 75 useconds is used. The enum <code>v4l2_preemphasis</code> defines possible values for pre-emphasis. Here they are: ENTRYTBL not supported.
V4L2_CID_TUNE_ANTENNA_CAPACITOR	integer	Sets the output power level for signal transmission. Unit is in dBuV. Range and step are driver-specific.
		This selects the value of antenna tuning capacitor manually or automatically if set to zero. Unit, range and step are driver-specific.

For more details about RDS specification, refer to EN 50067 document, from CENELEC.

1.10. Data Formats

1.10.1. Data Format Negotiation

Different devices exchange different kinds of data with applications, for example video images, raw or sliced VBI data, RDS datagrams. Even within one kind many different formats are possible, in particular an abundance of image formats.

Although drivers must provide a default and the selection persists across closing and reopening a device, applications should always negotiate a data format before engaging in data exchange. Negotiation means the application asks for a particular format and the driver selects and reports the best the hardware can do to satisfy the request. Of course applications can also just query the current selection.

A single mechanism exists to negotiate all data formats using the aggregate struct `v4l2_format` and the `VIDIOC_G_FMT` and `VIDIOC_S_FMT` ioctls.

Additionally the `VIDIOC_TRY_FMT` ioctl can be used to examine what the hardware *could* do, without actually selecting a new data format. The data formats supported by the V4L2 API are covered in the respective device section in Chapter 4. For a closer look at image formats see Chapter 2.

The `VIDIOC_S_FMT` ioctl is a major turning-point in the initialization sequence. Prior to this point multiple panel applications can access the same device concurrently to select the current input, change controls or modify other properties. The first `VIDIOC_S_FMT` assigns a logical stream (video data, VBI data etc.) exclusively to one file descriptor.

Exclusive means no other application, more precisely no other file descriptor, can grab this stream or change device properties inconsistent with the negotiated parameters. A video standard change for example, when the new standard uses a different number of scan lines, can invalidate the selected image format. Therefore only the file descriptor owning the stream can make invalidating changes.

Accordingly multiple file descriptors which grabbed different logical streams prevent each other from interfering with their settings. When for example video overlay is about to start or already in progress, simultaneous video capturing may be restricted to the same cropping and image size.

When applications omit the `VIDIOC_S_FMT` ioctl its locking side effects are implied by the next step, the selection of an I/O method with the `VIDIOC_REQBUFS` ioctl or implicit with the first `read()` or `write()` call.

Generally only one logical stream can be assigned to a file descriptor, the exception being drivers permitting simultaneous video capturing and overlay using the same file descriptor for compatibility with V4L and earlier versions of V4L2. Switching the logical stream or returning into "panel mode" is possible by closing and reopening the device. Drivers *may* support a switch using `VIDIOC_S_FMT`.

All drivers exchanging data with applications must support the `VIDIOC_G_FMT` and `VIDIOC_S_FMT` ioctl. Implementation of the `VIDIOC_TRY_FMT` is highly recommended but optional.

1.10.2. Image Format Enumeration

Apart of the generic format negotiation functions a special ioctl to enumerate all image formats supported by video capture, overlay or output devices is available.¹¹

The `VIDIOC_ENUM_FMT` ioctl must be supported by all drivers exchanging image data with applications.

Important: Drivers are not supposed to convert image formats in kernel space. They must enumerate only formats directly supported by the hardware. If necessary driver writers should publish an example conversion routine or library for integration into applications.

1.11. Single- and multi-planar APIs

Some devices require data for each input or output video frame to be placed in discontinuous memory buffers. In such cases, one video frame has to be addressed using more than one memory address, i.e. one pointer per "plane". A plane is a sub-buffer of the current frame. For examples of such formats see Chapter 2.

Initially, V4L2 API did not support multi-planar buffers and a set of extensions has been introduced to handle them. Those extensions constitute what is being referred to as the "multi-planar API".

Some of the V4L2 API calls and structures are interpreted differently, depending on whether single- or multi-planar API is being used. An application can choose whether to use one or the other by passing a corresponding buffer type to its ioctl calls. Multi-planar versions of buffer types are suffixed with an `'_MPLANE'` string. For a list of available multi-planar buffer types see enum `v4l2_buf_type`.

1.11.1. Multi-planar formats

Multi-planar API introduces new multi-planar formats. Those formats use a separate set of FourCC codes. It is important to distinguish between the multi-planar API and a multi-planar format. Multi-planar API calls can handle all

single-planar formats as well (as long as they are passed in multi-planar API structures), while the single-planar API cannot handle multi-planar formats.

1.11.2. Calls that distinguish between single and multi-planar APIs

`VIDIOC_QUERYCAP`

Two additional multi-planar capabilities are added. They can be set together with non-multi-planar ones for devices that handle both single- and multi-planar formats.

`VIDIOC_G_FMT`, `VIDIOC_S_FMT`, `VIDIOC_TRY_FMT`

New structures for describing multi-planar formats are added: `struct v4l2_pix_format_mplane` and `struct v4l2_plane_pix_format`. Drivers may define new multi-planar formats, which have distinct FourCC codes from the existing single-planar ones.

`VIDIOC_QBUF`, `VIDIOC_DQBUF`, `VIDIOC_QUERYBUF`

A new `struct v4l2_plane` structure for describing planes is added. Arrays of this structure are passed in the new `m.planes` field of `struct v4l2_buffer`.

`VIDIOC_REQBUFS`

Will allocate multi-planar buffers as requested.

1.12. Image Cropping, Insertion and Scaling

Some video capture devices can sample a subsection of the picture and shrink or enlarge it to an image of arbitrary size. We call these abilities cropping and scaling. Some video output devices can scale an image up or down and insert it at an arbitrary scan line and horizontal offset into a video signal.

Applications can use the following API to select an area in the video signal, query the default area and the hardware limits. *Despite their name, the `VIDIOC_CROPCAP`, `VIDIOC_G_CROP` and `VIDIOC_S_CROP` ioctls apply to input as well as output devices.*

Scaling requires a source and a target. On a video capture or overlay device the source is the video signal, and the cropping ioctls determine the area actually sampled. The target are images read by the application or overlaid onto the graphics

screen. Their size (and position for an overlay) is negotiated with the `VIDIOC_G_FMT` and `VIDIOC_S_FMT` ioctls.

On a video output device the source are the images passed in by the application, and their size is again negotiated with the `VIDIOC_G/S_FMT` ioctls, or may be encoded in a compressed video stream. The target is the video signal, and the cropping ioctls determine the area where the images are inserted.

Source and target rectangles are defined even if the device does not support scaling or the `VIDIOC_G/S_CROP` ioctls. Their size (and position where applicable) will be fixed in this case. *All capture and output device must support the `VIDIOC_CROPCAP` ioctl such that applications can determine if scaling takes place.*

1.12.1. Cropping Structures

Figure 1-1. Image Cropping, Insertion and Scaling



For capture devices the coordinates of the top left corner, width and height of the area which can be sampled is given by the *bounds* substructure of the struct `v4l2_cropcap` returned by the `VIDIOC_CROPCAP` ioctl. To support a wide range of hardware this specification does not define an origin or units. However by convention drivers should horizontally count unscaled samples relative to 0H (the leading edge of the horizontal sync pulse, see Figure 4-1). Vertically ITU-R line numbers of the first field (Figure 4-2, Figure 4-3), multiplied by two if the driver can capture both fields.

The top left corner, width and height of the source rectangle, that is the area actually sampled, is given by struct `v4l2_crop` using the same coordinate system as struct `v4l2_cropcap`. Applications can use the `VIDIOC_G_CROP` and `VIDIOC_S_CROP` ioctls to get and set this rectangle. It must lie completely within the capture boundaries and the driver may further adjust the requested size and/or position according to hardware limitations.

Each capture device has a default source rectangle, given by the *defrect* substructure of struct `v4l2_cropcap`. The center of this rectangle shall align with the center of the active picture area of the video signal, and cover what the driver writer considers the complete picture. Drivers shall reset the source rectangle to the default when the driver is first loaded, but not later.

For output devices these structures and ioctls are used accordingly, defining the *target* rectangle where the images will be inserted into the video signal.

1.12.2. Scaling Adjustments

Video hardware can have various cropping, insertion and scaling limitations. It may only scale up or down, support only discrete scaling factors, or have different scaling abilities in horizontal and vertical direction. Also it may not support scaling at all. At the same time the struct `v4l2_crop` rectangle may have to be aligned, and both the source and target rectangles may have arbitrary upper and lower size limits. In particular the maximum *width* and *height* in struct `v4l2_crop` may be smaller than the struct `v4l2_cropcap.bounds` area. Therefore, as usual, drivers are expected to adjust the requested parameters and return the actual values selected.

Applications can change the source or the target rectangle first, as they may prefer a particular image size or a certain area in the video signal. If the driver has to adjust both to satisfy hardware limitations, the last requested rectangle shall take priority, and the driver should preferably adjust the opposite one. The `VIDIOC_TRY_FMT` ioctl however shall not change the driver state and therefore only adjust the requested rectangle.

Suppose scaling on a video capture device is restricted to a factor 1:1 or 2:1 in either direction and the target image size must be a multiple of 16×16 pixels. The source cropping rectangle is set to defaults, which are also the upper limit in this example, of 640×400 pixels at offset 0, 0. An application requests an image size of 300×225 pixels, assuming video will be scaled down from the "full picture" accordingly. The driver sets the image size to the closest possible values 304×224 , then chooses the cropping rectangle closest to the requested size, that is 608×224 ($224 \times 2:1$ would exceed the limit 400). The offset 0, 0 is still valid, thus unmodified. Given the default cropping rectangle reported by `VIDIOC_CROPCAP` the application can easily propose another offset to center the cropping rectangle.

Now the application may insist on covering an area using a picture aspect ratio closer to the original request, so it asks for a cropping rectangle of 608×456 pixels. The present scaling factors limit cropping to 640×384 , so the driver returns the cropping size 608×384 and adjusts the image size to closest possible 304×192 .

1.12.3. Examples

Source and target rectangles shall remain unchanged across closing and reopening a device, such that piping data into or out of a device will work without special preparations. More advanced applications should ensure the parameters are suitable before starting I/O.

Example 1-10. Resetting the cropping parameters

(A video capture device is assumed; change V4L2_BUF_TYPE_VIDEO_CAPTURE for other devices.)

```
struct v4l2_cropcap cropcap;
struct v4l2_crop crop;

memset (&cropcap, 0, sizeof (cropcap));
cropcap.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;

if (-1 == ioctl (fd, VIDIOC_CROPCAP, &cropcap)) {
    perror ("VIDIOC_CROPCAP");
    exit (EXIT_FAILURE);
}

memset (&crop, 0, sizeof (crop));
crop.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
crop.c = cropcap.defrect;

/* Ignore if cropping is not supported (EINVAL). */

if (-1 == ioctl (fd, VIDIOC_S_CROP, &crop)
    && errno != EINVAL) {
    perror ("VIDIOC_S_CROP");
    exit (EXIT_FAILURE);
}
```

Example 1-11. Simple downscaling

(A video capture device is assumed.)

```
struct v4l2_cropcap cropcap;
struct v4l2_format format;

reset_cropping_parameters ();

/* Scale down to 1/4 size of full picture. */

memset (&format, 0, sizeof (format)); /* defaults */

format.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;

format.fmt.pix.width = cropcap.defrect.width >> 1;
format.fmt.pix.height = cropcap.defrect.height >> 1;
format.fmt.pix.pixelformat = V4L2_PIX_FMT_YUYV;
```

```
if (-1 == ioctl (fd, VIDIOC_S_FMT, &format)) {
    perror ("VIDIOC_S_FORMAT");
    exit (EXIT_FAILURE);
}

/* We could check the actual image size now, the actual scaling factor
   or if the driver can scale at all. */
```

Example 1-12. Selecting an output area

```
struct v4l2_cropcap cropcap;
struct v4l2_crop crop;

memset (&cropcap, 0, sizeof (cropcap));
cropcap.type = V4L2_BUF_TYPE_VIDEO_OUTPUT;

if (-1 == ioctl (fd, VIDIOC_CROPCAP, &cropcap)) {
    perror ("VIDIOC_CROPCAP");
    exit (EXIT_FAILURE);
}

memset (&crop, 0, sizeof (crop));

crop.type = V4L2_BUF_TYPE_VIDEO_OUTPUT;
crop.c = cropcap.defrect;

/* Scale the width and height to 50 % of their original size
   and center the output. */

crop.c.width /= 2;
crop.c.height /= 2;
crop.c.left += crop.c.width / 2;
crop.c.top += crop.c.height / 2;

/* Ignore if cropping is not supported (EINVAL). */

if (-1 == ioctl (fd, VIDIOC_S_CROP, &crop)
    && errno != EINVAL) {
    perror ("VIDIOC_S_CROP");
    exit (EXIT_FAILURE);
}
```

Example 1-13. Current scaling factor and pixel aspect

(A video capture device is assumed.)

```

struct v4l2_cropcap cropcap;
struct v4l2_crop crop;
struct v4l2_format format;
double hscale, vscale;
double aspect;
int dwidth, dheight;

memset (&cropcap, 0, sizeof (cropcap));
cropcap.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;

if (-1 == ioctl (fd, VIDIOC_CROPCAP, &cropcap)) {
    perror ("VIDIOC_CROPCAP");
    exit (EXIT_FAILURE);
}

memset (&crop, 0, sizeof (crop));
crop.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;

if (-1 == ioctl (fd, VIDIOC_G_CROP, &crop)) {
    if (errno != EINVAL) {
        perror ("VIDIOC_G_CROP");
        exit (EXIT_FAILURE);
    }

    /* Cropping not supported. */
    crop.c = cropcap.defrect;
}

memset (&format, 0, sizeof (format));
format.fmt.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;

if (-1 == ioctl (fd, VIDIOC_G_FMT, &format)) {
    perror ("VIDIOC_G_FMT");
    exit (EXIT_FAILURE);
}

/* The scaling applied by the driver. */

hscale = format.fmt.pix.width / (double) crop.c.width;
vscale = format.fmt.pix.height / (double) crop.c.height;

aspect = cropcap.pixelaspect.numerator /
    (double) cropcap.pixelaspect.denominator;
aspect = aspect * hscale / vscale;

```

```
/* Devices following ITU-R BT.601 do not capture
   square pixels. For playback on a computer monitor
   we should scale the images to this size. */

dwidth = format.fmt.pix.width / aspect;
dheight = format.fmt.pix.height;
```

1.13. Streaming Parameters

Streaming parameters are intended to optimize the video capture process as well as I/O. Presently applications can request a high quality capture mode with the `VIDIOC_S_PARM` ioctl.

The current video standard determines a nominal number of frames per second. If less than this number of frames is to be captured or output, applications can request frame skipping or duplicating on the driver side. This is especially useful when using the `read()` or `write()`, which are not augmented by timestamps or sequence counters, and to avoid unnecessary data copying.

Finally these ioctls can be used to determine the number of buffers used internally by a driver in read/write mode. For implications see the section discussing the `read()` function.

To get and set the streaming parameters applications call the `VIDIOC_G_PARM` and `VIDIOC_S_PARM` ioctl, respectively. They take a pointer to a `struct v4l2_streamparm`, which contains a union holding separate parameters for input and output devices.

These ioctls are optional, drivers need not implement them. If so, they return the `EINVAL` error code.

Notes

1. Access permissions are associated with character device special files, hence we must ensure device numbers cannot change with the module load order. To this end minor numbers are no longer automatically assigned by the "videodev" module as in V4L but requested by the driver. The defaults will suffice for most people unless two drivers compete for the same minor numbers.
2. In earlier versions of the V4L2 API the module options were named after the device special file with a "unit_" prefix, expressing the minor number itself, not

an offset. Rationale for this change is unknown. Lastly the naming and semantics are just a convention among driver writers, the point to note is that minor numbers are not supposed to be hardcoded into drivers.

3. Given a device file name one cannot reliably find related devices. For once names are arbitrary and in a system with multiple devices, where only some support VBI capturing, a `/dev/video2` is not necessarily related to `/dev/vbi2`. The V4L `VIDIOCUNIT` ioctl would require a search for a device file with a particular major and minor number.
4. Drivers could recognize the `O_EXCL` open flag. Presently this is not required, so applications cannot know if it really works.
5. Actually struct `v4l2_audio` ought to have a *tuner* field like struct `v4l2_input`, not only making the API more consistent but also permitting radio devices with multiple tuners.
6. Some users are already confused by technical terms PAL, NTSC and SECAM. There is no point asking them to distinguish between B, G, D, or K when the software or hardware can do that automatically.
7. An alternative to the current scheme is to use pointers to indices as arguments of `VIDIOC_G_STD` and `VIDIOC_S_STD`, the struct `v4l2_input` and struct `v4l2_output` *std* field would be a set of indices like *audio*set.

Indices are consistent with the rest of the API and identify the standard unambiguously. In the present scheme of things an enumerated standard is looked up by `v4l2_std_id`. Now the standards supported by the inputs of a device can overlap. Just assume the tuner and composite input in the example above both exist on a device. An enumeration of "PAL-B/G", "PAL-H/I" suggests a choice which does not exist. We cannot merge or omit sets, because applications would be unable to find the standards reported by `VIDIOC_G_STD`. That leaves separate enumerations for each input. Also selecting a standard by `v4l2_std_id` can be ambiguous. Advantage of this method is that applications need not identify the standard indirectly, after enumerating.

So in summary, the lookup itself is unavoidable. The difference is only whether the lookup is necessary to find an enumerated standard or to switch to a standard by `v4l2_std_id`.

8. See Section 3.5 for a rationale. Probably even USB cameras follow some well known video standard. It might have been better to explicitly indicate elsewhere if a device cannot live up to normal expectations, instead of this exception.
9. It will be more convenient for applications if drivers make use of the `V4L2_CTRL_FLAG_DISABLED` flag, but that was never required.
10. Applications could call an ioctl to request events. After another process called `VIDIOC_S_CTRL` or another ioctl changing shared properties the `select()` function would indicate readability until any ioctl (querying the properties) is called.

11. Enumerating formats an application has no a-priori knowledge of (otherwise it could explicitly ask for them and need not enumerate) seems useless, but there are applications serving as proxy between drivers and the actual video applications for which this is useful.

Chapter 2. Image Formats

The V4L2 API was primarily designed for devices exchanging image data with applications. The `v4l2_pix_format` and `v4l2_pix_format_mplane` structures define the format and layout of an image in memory. The former is used with the single-planar API, while the latter is used with the multi-planar version (see Section 1.11). Image formats are negotiated with the `VIDIOC_S_FMT` ioctl. (The explanations here focus on video capturing and output, for overlay frame buffer formats see also `VIDIOC_G_FBUF`.)

2.1. Single-planar format structure

Table 2-1. struct `v4l2_pix_format`

<code>__u32</code>	<i>width</i>	Image width in pixels.
<code>__u32</code>	<i>height</i>	Image height in pixels.
Applications set these fields to request an image size, drivers return the closest possible values. In case of planar formats the <i>width</i> and <i>height</i> applies to the largest plane. To avoid ambiguities drivers must return values rounded up to a multiple of the scale factor of any smaller planes. For example when the image format is YUV 4:2:0, <i>width</i> and <i>height</i> must be multiples of two.		
<code>__u32</code>	<i>pixelformat</i>	The pixel format or type of compression, set by the application. This is a little endian four character code. V4L2 defines standard RGB formats in Table 2-1, YUV formats in Section 2.7, and reserved codes in Table 2-10
<code>enum v4l2_field</code>	<i>field</i>	Video images are typically interlaced. Applications can request to capture or output only the top or bottom field, or both fields interlaced or sequentially stored in one buffer or alternating in separate buffers. Drivers return the actual field order selected. For details see Section 3.6.
<code>__u32</code>	<i>bytesperline</i>	Distance in bytes between the leftmost pixels in two adjacent lines.

Both applications and drivers can set this field to request padding bytes at the end of each line. Drivers however may ignore the value requested by the application, returning *width* times bytes per pixel or a larger value required by the hardware. That implies applications can just set this field to zero to get a reasonable default. Video hardware may access padding bytes, therefore they must reside in accessible memory. Consider cases where padding bytes after the last line of an image cross a system page boundary. Input devices may write padding bytes, the value is undefined. Output devices ignore the contents of padding bytes.

When the image format is planar the *bytesperline* value applies to the largest plane and is divided by the same factor as the *width* field for any smaller planes. For example the Cb and Cr planes of a YUV 4:2:0 image have half as many padding bytes following each line as the Y plane. To avoid ambiguities drivers must return a *bytesperline* value rounded up to a multiple of the scale factor.

<code>__u32</code>	<code>sizeimage</code>	Size in bytes of the buffer to hold a complete image, set by the driver. Usually this is <i>bytesperline</i> times <i>height</i> . When the image consists of variable length compressed data this is the maximum number of bytes required to hold an image.
<code>enum v4l2_colorspace</code>	<code>colorspace</code>	This information supplements the <i>pixelformat</i> and must be set by the driver, see Section 2.4.
<code>__u32</code>	<code>priv</code>	Reserved for custom (driver defined) additional information about formats. When not used drivers and applications must set this field to zero.

2.2. Multi-planar format structures

The `v4l2_plane_pix_format` structures define size and layout for each of the planes in a multi-planar format. The `v4l2_pix_format_mplane` structure contains information common to all planes (such as image width and height) and an array of `v4l2_plane_pix_format` structures, describing all planes of that format.

Table 2-2. struct `v4l2_plane_pix_format`

<code>__u32</code>	<code>sizeimage</code>	Maximum size in bytes required for image data in this plane.
<code>__u16</code>	<code>bytesperline</code>	Distance in bytes between the leftmost pixels in two adjacent lines.
<code>__u16</code>	<code>reserved[7]</code>	Reserved for future extensions. Should be zeroed by the application.

Table 2-3. struct v4l2_pix_format_mplane

<code>__u32</code>	<code>width</code>	Image width in pixels.
<code>__u32</code>	<code>height</code>	Image height in pixels.
<code>__u32</code>	<code>pixelformat</code>	The pixel format. Both single- and multi-planar four character codes can be used.
<code>enum v4l2_field</code>	<code>field</code>	See struct v4l2_pix_format.
<code>enum v4l2_colorspace</code>	<code>colorspace</code>	See struct v4l2_pix_format.
<code>struct v4l2_plane_pix_format</code>	<code>plane_fmt [VIDEO_MAX_PLANES]</code>	An array of structures describing format of each plane this pixel format consists of. The number of valid entries in this array has to be put in the <code>num_planes</code> field.
<code>__u8</code>	<code>num_planes</code>	Number of planes (i.e. separate memory buffers) for this format and the number of valid entries in the <code>plane_fmt</code> array.
<code>__u8</code>	<code>reserved[11]</code>	Reserved for future extensions. Should be zeroed by the application.

2.3. Standard Image Formats

In order to exchange images between drivers and applications, it is necessary to have standard image data formats which both sides will interpret the same way. V4L2 includes several such formats, and this section is intended to be an unambiguous specification of the standard image data formats in V4L2.

V4L2 drivers are not limited to these formats, however. Driver-specific formats are possible. In that case the application may depend on a codec to convert images to one of the standard formats when needed. But the data can still be stored and retrieved in the proprietary format. For example, a device may support a proprietary

compressed format. Applications can still capture and save the data in the compressed format, saving much disk space, and later use a codec to convert the images to the X Windows screen format when the video is to be displayed.

Even so, ultimately, some standard formats are needed, so the V4L2 specification would not be complete without well-defined standard formats.

The V4L2 standard formats are mainly uncompressed formats. The pixels are always arranged in memory from left to right, and from top to bottom. The first byte of data in the image buffer is always for the leftmost pixel of the topmost row. Following that is the pixel immediately to its right, and so on until the end of the top row of pixels. Following the rightmost pixel of the row there may be zero or more bytes of padding to guarantee that each row of pixel data has a certain alignment. Following the pad bytes, if any, is data for the leftmost pixel of the second row from the top, and so on. The last row has just as many pad bytes after it as the other rows.

In V4L2 each format has an identifier which looks like `PIX_FMT_XXX`, defined in the `videodev.h` header file. These identifiers represent four character (FourCC) codes which are also listed below, however they are not the same as those used in the Windows world.

For some formats, data is stored in separate, discontinuous memory buffers. Those formats are identified by a separate set of FourCC codes and are referred to as "multi-planar formats". For example, a YUV422 frame is normally stored in one memory buffer, but it can also be placed in two or three separate buffers, with Y component in one buffer and CbCr components in another in the 2-planar version or with each component in its own buffer in the 3-planar case. Those sub-buffers are referred to as "planes".

2.4. Colorspaces

[intro]

Gamma Correction

[to do]

$$E'_R = f(R)$$

$$E'_G = f(G)$$

$$E'_B = f(B)$$

Construction of luminance and color-difference signals

[to do]

$$E'_Y = \text{Coeff}_R E'_R + \text{Coeff}_G E'_G + \text{Coeff}_B E'_B$$

$$(E'_R - E'_Y) = E'_R - \text{Coeff}_R E'_R - \text{Coeff}_G E'_G - \text{Coeff}_B E'_B$$

$$(E'_B - E'_Y) = E'_B - \text{Coeff}_R E'_R - \text{Coeff}_G E'_G - \text{Coeff}_B E'_B$$

Re-normalized color-difference signals

The color-difference signals are scaled back to unity range [-0.5;+0.5]:

$$K_B = 0.5 / (1 - \text{Coeff}_B)$$

$$K_R = 0.5 / (1 - \text{Coeff}_R)$$

$$P_B = K_B (E'_B - E'_Y) = 0.5 (\text{Coeff}_R / \text{Coeff}_B) E'_R + 0.5 (\text{Coeff}_G / \text{Coeff}_B) E'_G + 0.5 E'_B$$

$$P_R = K_R (E'_R - E'_Y) = 0.5 E'_R + 0.5 (\text{Coeff}_G / \text{Coeff}_R) E'_G + 0.5 (\text{Coeff}_B / \text{Coeff}_R) E'_B$$

Quantization

[to do]

$$Y' = (\text{Lum. Levels} - 1) \cdot E'_Y + \text{Lum. Offset}$$

$$C_B = (\text{Chrom. Levels} - 1) \cdot P_B + \text{Chrom. Offset}$$

$$C_R = (\text{Chrom. Levels} - 1) \cdot P_R + \text{Chrom. Offset}$$

Rounding to the nearest integer and clamping to the range [0;255] finally yields the digital color components Y'CbCr stored in YUV images.

Example 2-1. ITU-R Rec. BT.601 color conversion

Forward Transformation

```
int ER, EG, EB;           /* gamma corrected RGB input [0;255] */
int Yl, Cb, Cr;           /* output [0;255] */

double r, g, b;           /* temporaries */
double yl, pb, pr;

int
clamp (double x)
{
    int r = x;             /* round to nearest */

    if (r < 0)              return 0;
    else if (r > 255)       return 255;
    else                    return r;
}
```

```
r = ER / 255.0;
g = EG / 255.0;
b = EB / 255.0;

y1 = 0.299 * r + 0.587 * g + 0.114 * b;
pb = -0.169 * r - 0.331 * g + 0.5 * b;
pr = 0.5 * r - 0.419 * g - 0.081 * b;

Y1 = clamp (219 * y1 + 16);
Cb = clamp (224 * pb + 128);
Cr = clamp (224 * pr + 128);

/* or shorter */

y1 = 0.299 * ER + 0.587 * EG + 0.114 * EB;

Y1 = clamp ( (219 / 255.0) * y1 + 16);
Cb = clamp (((224 / 255.0) / (2 - 2 * 0.114)) * (EB - y1) + 128);
Cr = clamp (((224 / 255.0) / (2 - 2 * 0.299)) * (ER - y1) + 128);
```

Inverse Transformation

```
int Y1, Cb, Cr;          /* gamma pre-corrected input [0;255] */
int ER, EG, EB;          /* output [0;255] */

double r, g, b;          /* temporaries */
double y1, pb, pr;

int
clamp (double x)
{
    int r = x;            /* round to nearest */

    if (r < 0)             return 0;
    else if (r > 255)      return 255;
    else                  return r;
}

y1 = (255 / 219.0) * (Y1 - 16);
pb = (255 / 224.0) * (Cb - 128);
pr = (255 / 224.0) * (Cr - 128);

r = 1.0 * y1 + 0 * pb + 1.402 * pr;
g = 1.0 * y1 - 0.344 * pb - 0.714 * pr;
b = 1.0 * y1 + 1.772 * pb + 0 * pr;

ER = clamp (r * 255); /* [ok? one should prob. limit y1,pb,pr] */
```

EG = clamp (g * 255);
EB = clamp (b * 255);

Table 2-4. enum v4l2_colorspace

Identifier	Value	Description	Chromaticities ^a			White Point	Gamma Correction	Luminance E'Y	Quantization	
			Red	Green	Blue				Y'	Cb, Cr
V4L2_COLORSPACE_NTSC	1	NTSC, PAL, SECAM, E170M according to SMPTE 170M, ITU BT.601	x = 0.630	y = 0.340	x = 0.310	y = 0.595	x = 0.155	y = 0.070	E' = 1.0, I for 0.299 E'Y + 0.587 E'G + 0.099 E'B	224 P _{B,R} + 128
V4L2_COLORSPACE_BT2020	2	BT.2020, SMPTE 240M Line (US) HDTV, see SMPTE 240M	x = 0.630	y = 0.340	x = 0.310	y = 0.595	x = 0.155	y = 0.070	E' = 1.0, I for 0.299 E'Y + 0.587 E'G + 0.099 E'B	224 P _{B,R} + 128
V4L2_COLORSPACE_BT709	3	HDTV REC 709 and modern devices, see ITU BT.709	x = 0.640	y = 0.330	x = 0.300	y = 0.600	x = 0.150	y = 0.060	E' = 1.0, I for 0.299 E'Y + 0.587 E'G + 0.099 E'B	224 P _{B,R} + 128
V4L2_COLORSPACE_BT878	4	Broken BT878 extents _b , ITU BT.601	?	?	?	?	?	?	0.299 E'Y + 0.587 E'G + 0.114 E'B	224 P _{B,R} + 128 (probably)

Identifier	Value	Description	Chromaticities ^a			White Point	Gamma Correction	Luminance E'_Y	Quantization	
			Red	Green	Blue				Y'	Cb, Cr
V4L2_COLORSPACE_MJPEG	5	MJPEG according to ITU BT.470, ITU BT.601	$x = 0.675$ $y = 0.33$	$x = 0.213$ $y = 0.717$	$x = 0.147$ $y = 0.081$	$x = 0.3127$, Illuminant C	?	$0.299 E'_R$ $+ 0.587 E'_G$ $+ 0.114 E'_B$	$219 Y'$	$224 C_{B,R} + 128$
V4L2_COLORSPACE_470_SYSTEM_BG	6	625 line PAL and SECAM systems according to ITU BT.470, ITU BT.601	$x = 0.640$ $y = 0.33$	$x = 0.299$ $y = 0.607$	$x = 0.155$ $y = 0.061$	$x = 0.313$, Illuminant D ₆₅	?	$0.299 E'_R$ $+ 0.587 E'_G$ $+ 0.114 E'_B$	$219 Y'$	$224 C_{B,R} + 128$
V4L2_COLORSPACE_JPEG	7	JPEG Y'CbCr, see JFIF, ITU BT.601	?	?	?	?	?	$0.299 E'_R$ $+ 0.587 E'_G$ $+ 0.114 E'_B$	$255 Y'$	$255 C_{B,R} + 128$
V4L2_COLORSPACE_RGB	8	24-bit RGB	$x = 0.640$ $y = 0.33$	$x = 0.300$ $y = 0.600$	$x = 0.150$ $y = 0.060$	$x = 0.3127$, Illuminant D ₆₅	$E' = 1.0$	n/a		

Identifier	Value	Description	Chromaticities ^a			White Point	Gamma Correction	Luminance E'_Y	Quantization	
			Red	Green	Blue				Y'	Cb, Cr
<div>Notes:</div> <div><div>a. The coordinates of the color primaries are given in the CIE system (1931)</div><div>b. The ubiquitous Bt878 video capture chip quantizes E'_Y to 238 levels, yielding a range of $Y' = 16 \dots 253$, unlike Rec. 601 $Y' = 16 \dots 235$. This is not a typo in the Bt878 documentation, it has been implemented in silicon. The chroma extents are unclear.</div><div>c. No identifier exists for M/PAL which uses the chromaticities of M/NTSC, the remaining parameters are equal to B and G/PAL.</div><div>d. Note JFIF quantizes $Y'P_BP_R$ in range $[0;+1]$ and $[-0.5;+0.5]$ to 257 levels, however $Y'CbCr$ signals are still clamped to $[0;255]$.</div></div>										

2.5. Indexed Format

In this format each pixel is represented by an 8 bit index into a 256 entry ARGB palette. It is intended for Video Output Overlays only. There are no ioctls to access the palette, this must be done with ioctls of the Linux framebuffer API.

Table 2-5. Indexed Image Format

Identifier Byte 0	
Code	
B i 7 6 5 4 3 2 1 0	
V4L2_PIX_FMT_PAL8	
'PALi8i6 i5 i4 i3 i2 i1 i0	

2.6. RGB Formats

Packed RGB formats

Name				
Packed RGB formats — Packed RGB formats				
Description				
These formats are designed to match the pixel formats of typical PC graphics frame buffers. They occupy 8, 16, 24 or 32 bits per pixel. These are all packed-pixel formats, meaning all the data for a pixel lie next to each other in memory.				
When one of these formats is used, drivers shall report the colorspace V4L2_COLORSPACE_SRGB.				
Table 2-1. Packed RGB Image Formats				
Identifier	Byte 0 in Code memory	Byte 1	Byte 2	Byte 3
	Bit 7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
V4L2_PIX_FMT_RGB332	'RGB'	b ₀ g ₂ g ₁ g ₀ r ₂ r ₁ r ₀		
V4L2_PIX_FMT_RGB444	'R444'	g ₂ g ₁ g ₀ b ₃ b ₂ b ₁ b ₀	a ₃ a ₂ a ₁ a ₀ r ₃ r ₂ r ₁ r ₀	
V4L2_PIX_FMT_RGB555	'RGB555'	g ₁ g ₀ r ₄ r ₃ r ₂ r ₁ r ₀	a b ₄ b ₃ b ₂ b ₁ b ₀ g ₄ g ₃	
V4L2_PIX_FMT_RGB565	'RGB565'	g ₁ g ₀ r ₄ r ₃ r ₂ r ₁ r ₀	b ₄ b ₃ b ₂ b ₁ b ₀ g ₅ g ₄ g ₃	
V4L2_PIX_FMT_RGB555X	'RGB555X'	b ₄ b ₃ b ₂ b ₁ b ₀ g ₄ g ₃	g ₂ g ₁ g ₀ r ₄ r ₃ r ₂ r ₁ r ₀	

Identifier	Byte 0 in Code memory	Byte 1	Byte 2	Byte 3
	Bit 7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
V4L2_PIX_FMT_RGB565X	'RGB'	b ₃ b ₂ b ₁ b ₀ g ₅ g ₄ g ₃	g ₂ g ₁ g ₀ r ₄ r ₃ r ₂ r ₁ r ₀	
V4L2_PIX_FMT_BGR666	'BGR'	b ₃ b ₂ b ₁ b ₀ g ₅ g ₄	g ₃ g ₂ g ₁ g ₀ r ₅ r ₄ r ₃ r ₂	r ₁ r ₀
V4L2_PIX_FMT_BGR24	'BGR'	b ₃ b ₂ b ₁ b ₀ g ₇ g ₆ g ₅ g ₄ g ₃ g ₂ g ₁ g ₀	r ₇ r ₆ r ₅ r ₄ r ₃ r ₂ r ₁ r ₀	
V4L2_PIX_FMT_RGB24	'RGB'	r ₇ r ₆ r ₅ r ₄ r ₃ r ₂ r ₁ r ₀	g ₇ g ₆ g ₅ g ₄ g ₃ g ₂ g ₁ g ₀	b ₇ b ₆ b ₅ b ₄ b ₃ b ₂ b ₁ b ₀
V4L2_PIX_FMT_BGR32	'BGR'	b ₃ b ₂ b ₁ b ₀ g ₇ g ₆ g ₅ g ₄ g ₃ g ₂ g ₁ g ₀	r ₇ r ₆ r ₅ r ₄ r ₃ r ₂ r ₁ r ₀	a ₇ a ₆ a ₅ a ₄ a ₃ a ₂ a ₁ a ₀
V4L2_PIX_FMT_RGB32	'RGB'	r ₇ r ₆ r ₅ r ₄ r ₃ r ₂ r ₁ r ₀	g ₇ g ₆ g ₅ g ₄ g ₃ g ₂ g ₁ g ₀	b ₇ b ₆ b ₅ b ₄ b ₃ b ₂ b ₁ b ₀ a ₇ a ₆ a ₅ a ₄ a ₃ a ₂ a ₁ a ₀

Bit 7 is the most significant bit. The value of a = alpha bits is undefined when reading from the driver, ignored when writing to the driver, except when alpha blending has been negotiated for a Video Overlay or Video Output Overlay.

Example 2-1. V4L2_PIX_FMT_BGR24 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	B ₀₀	G ₀₀	R ₀₀	B ₀₁	G ₀₁	R ₀₁	B ₀₂	G ₀₂	R ₀₂	B ₀₃	G ₀₃	R ₀₃
start + 12:	B ₁₀	G ₁₀	R ₁₀	B ₁₁	G ₁₁	R ₁₁	B ₁₂	G ₁₂	R ₁₂	B ₁₃	G ₁₃	R ₁₃
start + 24:	B ₂₀	G ₂₀	R ₂₀	B ₂₁	G ₂₁	R ₂₁	B ₂₂	G ₂₂	R ₂₂	B ₂₃	G ₂₃	R ₂₃
start + 36:	B ₃₀	G ₃₀	R ₃₀	B ₃₁	G ₃₁	R ₃₁	B ₃₂	G ₃₂	R ₃₂	B ₃₃	G ₃₃	R ₃₃

Important: Drivers may interpret these formats differently.

Some RGB formats above are uncommon and were probably defined in error. Drivers may interpret them as in Table 2-2.

Table 2-2. Packed RGB Image Formats (corrected)

Identifier	Byte 0 in Code memory	Byte 1	Byte 2	Byte 3
	B7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
V4L2_PIX_FMT_RGB332	'RGB'	r ₁ r ₀ g ₂ g ₁ g ₀ b ₁ b ₀		
V4L2_PIX_FMT_RGB444	'RGB'	r ₄ r ₃ r ₂ r ₁ r ₀ g ₄ g ₃ g ₂ g ₁ g ₀ b ₄ b ₃ b ₂ b ₁ b ₀	a ₃ a ₂ a ₁ a ₀ r ₃ r ₂ r ₁ r ₀	
V4L2_PIX_FMT_RGB555	'RGB'	r ₄ r ₃ r ₂ r ₁ r ₀ g ₄ g ₃ g ₂ g ₁ g ₀ b ₄ b ₃ b ₂ b ₁ b ₀	a r ₄ r ₃ r ₂ r ₁ r ₀ g ₄ g ₃	
V4L2_PIX_FMT_RGB565	'RGB'	r ₄ r ₃ r ₂ r ₁ r ₀ g ₅ g ₄ g ₃ g ₂ g ₁ g ₀ b ₄ b ₃ b ₂ b ₁ b ₀	r ₄ r ₃ r ₂ r ₁ r ₀ g ₅ g ₄ g ₃	
V4L2_PIX_FMT_RGB555X	'RGBX'	r ₄ r ₃ r ₂ r ₁ r ₀ g ₄ g ₃ g ₂ g ₁ g ₀ b ₄ b ₃ b ₂ b ₁ b ₀		
V4L2_PIX_FMT_RGB565X	'RGBX'	r ₃ r ₂ r ₁ r ₀ g ₅ g ₄ g ₃ g ₂ g ₁ g ₀ b ₄ b ₃ b ₂ b ₁ b ₀		
V4L2_PIX_FMT_BGR666	'BGR'	b ₄ b ₃ b ₂ b ₁ b ₀ g ₅ g ₄ g ₃ g ₂ g ₁ g ₀ r ₅ r ₄ r ₃ r ₂ r ₁ r ₀		
V4L2_PIX_FMT_BGR24	'BGR'	b ₆ b ₅ b ₄ b ₃ b ₂ b ₁ b ₀ g ₇ g ₆ g ₅ g ₄ g ₃ g ₂ g ₁ g ₀ r ₇ r ₆ r ₅ r ₄ r ₃ r ₂ r ₁ r ₀		
V4L2_PIX_FMT_RGB24	'RGB'	r ₆ r ₅ r ₄ r ₃ r ₂ r ₁ r ₀ g ₇ g ₆ g ₅ g ₄ g ₃ g ₂ g ₁ g ₀ b ₇ b ₆ b ₅ b ₄ b ₃ b ₂ b ₁ b ₀		

Identifier	Byte 0 in Code memory	Byte 1	Byte 2	Byte 3
	Bit 7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
V4L2_PIX_FMT_BGR32	'BGR'	b7 b6 b5 b4 b3 b2 b1 b0	g7 g6 g5 g4 g3 g2 g1 g0	r7 r6 r5 r4 r3 r2 r1 r0
V4L2_PIX_FMT_RGB32	'RGB'	r7 r6 r5 r4 r3 r2 r1 r0	g7 g6 g5 g4 g3 g2 g1 g0	b7 b6 b5 b4 b3 b2 b1 b0

A test utility to determine which RGB formats a driver actually supports is available from the LinuxTV v4l-dvb repository. See <http://linuxtv.org/repo/> for access instructions.

V4L2_PIX_FMT_SBGGR8 ('BA81')

Name

V4L2_PIX_FMT_SBGGR8 — Bayer RGB format

Description

This is commonly the native format of digital cameras, reflecting the arrangement of sensors on the CCD device. Only one red, green or blue value is given for each pixel. Missing components must be interpolated from neighbouring pixels. From left to right the first row consists of a blue and green value, the second row of a green and red value. This scheme repeats to the right and down for every two columns and rows.

Example 2-1. V4L2_PIX_FMT_SBGGR8 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	B00	G01	B02	G03
------------	-----	-----	-----	-----

start + 4:	G ₁₀	R ₁₁	G ₁₂	R ₁₃
start + 8:	B ₂₀	G ₂₁	B ₂₂	G ₂₃
start + 12:	G ₃₀	R ₃₁	G ₃₂	R ₃₃

V4L2_PIX_FMT_SGBRG8 ('GBRG')

Name

V4L2_PIX_FMT_SGBRG8 — Bayer RGB format

Description

This is commonly the native format of digital cameras, reflecting the arrangement of sensors on the CCD device. Only one red, green or blue value is given for each pixel. Missing components must be interpolated from neighbouring pixels. From left to right the first row consists of a green and blue value, the second row of a red and green value. This scheme repeats to the right and down for every two columns and rows.

Example 2-1. V4L2_PIX_FMT_SGBRG8 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	G ₀₀	B ₀₁	G ₀₂	B ₀₃
start + 4:	R ₁₀	G ₁₁	R ₁₂	G ₁₃
start + 8:	G ₂₀	B ₂₁	G ₂₂	B ₂₃
start + 12:	R ₃₀	G ₃₁	R ₃₂	G ₃₃

V4L2_PIX_FMT_SGRBG8 ('GRBG')

Name

V4L2_PIX_FMT_SGRBG8 — Bayer RGB format

Description

This is commonly the native format of digital cameras, reflecting the arrangement of sensors on the CCD device. Only one red, green or blue value is given for each pixel. Missing components must be interpolated from neighbouring pixels. From left to right the first row consists of a green and blue value, the second row of a red and green value. This scheme repeats to the right and down for every two columns and rows.

Example 2-1. V4L2_PIX_FMT_SGRBG8 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	G ₀₀	R ₀₁	G ₀₂	R ₀₃
start + 4:	R ₁₀	B ₁₁	R ₁₂	B ₁₃
start + 8:	G ₂₀	R ₂₁	G ₂₂	R ₂₃
start + 12:	R ₃₀	B ₃₁	R ₃₂	B ₃₃

V4L2_PIX_FMT_SRGBB8 ('RGGB')

Name

V4L2_PIX_FMT_SRGBB8 — Bayer RGB format

Description

This is commonly the native format of digital cameras, reflecting the arrangement of sensors on the CCD device. Only one red, green or blue value is given for each pixel. Missing components must be interpolated from neighbouring pixels. From left to right the first row consists of a red and green value, the second row of a green and blue value. This scheme repeats to the right and down for every two columns and rows.

Example 2-1. `V4L2_PIX_FMT_SRGGB8` 4×4 pixel image

Byte Order. Each cell is one byte.

start + 0:	R ₀₀	G ₀₁	R ₀₂	G ₀₃
start + 4:	G ₁₀	B ₁₁	G ₁₂	B ₁₃
start + 8:	R ₂₀	G ₂₁	R ₂₂	G ₂₃
start + 12:	G ₃₀	B ₃₁	G ₃₂	B ₃₃

V4L2_PIX_FMT_SBGGR16 ('BYR2')

Name

`V4L2_PIX_FMT_SBGGR16` — Bayer RGB format

Description

This format is similar to `V4L2_PIX_FMT_SBGGR8`, except each pixel has a depth of 16 bits. The least significant byte is stored at lower memory addresses (little-endian). Note the actual sampling precision may be lower than 16 bits, for example 10 bits per pixel with values in range 0 to 1023.

Example 2-1. `V4L2_PIX_FMT_SBGGR16` 4×4 pixel image

Byte Order. Each cell is one byte.

start + 0:	B00low	B00high	G01low	G01high	B02low	B02high
start + 8:	G10low	G10high	R11low	R11high	G12low	G12high
start + 16:	B20low	B20high	G21low	G21high	B22low	B22high
start + 24:	G30low	G30high	R31low	R31high	G32low	G32high

**V4L2_PIX_FMT_SRGGB10 ('RG10'),
V4L2_PIX_FMT_SGRBG10 ('BA10'),
V4L2_PIX_FMT_SGBRG10 ('GB10'),
V4L2_PIX_FMT_SBGGR10 ('BG10'),**

Name

V4L2_PIX_FMT_SRGGB10, V4L2_PIX_FMT_SGRBG10,
V4L2_PIX_FMT_SGBRG10, V4L2_PIX_FMT_SBGGR10 — 10-bit Bayer formats
expanded to 16 bits

Description

The following four pixel formats are raw sRGB / Bayer formats with 10 bits per colour. Each colour component is stored in a 16-bit word, with 6 unused high bits filled with zeros. Each n-pixel row contains n/2 green samples and n/2 blue or red samples, with alternating red and blue rows. Bytes are stored in memory in little endian order. They are conventionally described as GRGR... BGBG..., RGRG... GBGB..., etc. Below is an example of one of these formats

Example 2-1. V4L2_PIX_FMT_SBGGR10 4 × 4 pixel image

Byte Order. Each cell is one byte, high 6 bits in high bytes are 0.

start + 0:	B00low	B00high	G01low	G01high	B02low	B02high
start + 8:	G10low	G10high	R11low	R11high	G12low	G12high

start + 16:	B _{20low}	B _{20high}	G _{21low}	G _{21high}	B _{22low}	B _{22high}
start + 24:	G _{30low}	G _{30high}	R _{31low}	R _{31high}	G _{32low}	G _{32high}

V4L2_PIX_FMT_SRGGB12 ('RG12'),
V4L2_PIX_FMT_SGRBG12 ('BA12'),
V4L2_PIX_FMT_SGBRG12 ('GB12'),
V4L2_PIX_FMT_SBGGR12 ('BG12'),

Name

V4L2_PIX_FMT_SRGGB12, V4L2_PIX_FMT_SGRBG12,
V4L2_PIX_FMT_SGBRG12, V4L2_PIX_FMT_SBGGR12 — 12-bit Bayer formats
expanded to 16 bits

Description

The following four pixel formats are raw sRGB / Bayer formats with 12 bits per colour. Each colour component is stored in a 16-bit word, with 6 unused high bits filled with zeros. Each n-pixel row contains n/2 green samples and n/2 blue or red samples, with alternating red and blue rows. Bytes are stored in memory in little endian order. They are conventionally described as GRGR... BGBG..., RGRG... GBGB..., etc. Below is an example of one of these formats

Example 2-1. V4L2_PIX_FMT_SBGGR12 4 × 4 pixel image

Byte Order. Each cell is one byte, high 6 bits in high bytes are 0.

start + 0:	B _{00low}	B _{00high}	G _{01low}	G _{01high}	B _{02low}	B _{02high}
start + 8:	G _{10low}	G _{10high}	R _{11low}	R _{11high}	G _{12low}	G _{12high}
start + 16:	B _{20low}	B _{20high}	G _{21low}	G _{21high}	B _{22low}	B _{22high}
start + 24:	G _{30low}	G _{30high}	R _{31low}	R _{31high}	G _{32low}	G _{32high}

2.7. YUV Formats

YUV is the format native to TV broadcast and composite video signals. It separates the brightness information (Y) from the color information (U and V or Cb and Cr). The color information consists of red and blue *color difference* signals, this way the green component can be reconstructed by subtracting from the brightness component. See Section 2.4 for conversion examples. YUV was chosen because early television would only transmit brightness information. To add color in a way compatible with existing receivers a new signal carrier was added to transmit the color difference signals. Secondary in the YUV format the U and V components usually have lower resolution than the Y component. This is an analog video compression technique taking advantage of a property of the human visual system, being more sensitive to brightness information.

Packed YUV formats

Name

`Packed YUV formats` — Packed YUV formats

Description

Similar to the packed RGB formats these formats store the Y, Cb and Cr component of each pixel in one 16 or 32 bit word.

Table 2-1. Packed YUV Image Formats

Identifier	Byte 0 in Code memory	Byte 1	Byte 2	Byte 3
	Bit 7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0

Example 2-1. V4L2_PIX_FMT_GREY 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00	Y'01	Y'02	Y'03
start + 4:	Y'10	Y'11	Y'12	Y'13
start + 8:	Y'20	Y'21	Y'22	Y'23
start + 12:	Y'30	Y'31	Y'32	Y'33

V4L2_PIX_FMT_Y10 ('Y10 ')

Name

V4L2_PIX_FMT_Y10 — Grey-scale image

Description

This is a grey-scale image with a depth of 10 bits per pixel. Pixels are stored in 16-bit words with unused high bits padded with 0. The least significant byte is stored at lower memory addresses (little-endian).

Example 2-1. V4L2_PIX_FMT_Y10 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00low	Y'00high	Y'01low	Y'01high	Y'02low	Y'02high	Y'03low	Y'03high
start + 8:	Y'10low	Y'10high	Y'11low	Y'11high	Y'12low	Y'12high	Y'13low	Y'13high
start + 16:	Y'20low	Y'20high	Y'21low	Y'21high	Y'22low	Y'22high	Y'23low	Y'23high
start + 24:	Y'30low	Y'30high	Y'31low	Y'31high	Y'32low	Y'32high	Y'33low	Y'33high

V4L2_PIX_FMT_Y12 ('Y12 ')

Name

V4L2_PIX_FMT_Y12 — Grey-scale image

Description

This is a grey-scale image with a depth of 12 bits per pixel. Pixels are stored in 16-bit words with unused high bits padded with 0. The least significant byte is stored at lower memory addresses (little-endian).

Example 2-1. V4L2_PIX_FMT_Y12 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00low	Y'00high	Y'01low	Y'01high	Y'02low	Y'02high	Y'03low	Y'03high
start + 8:	Y'10low	Y'10high	Y'11low	Y'11high	Y'12low	Y'12high	Y'13low	Y'13high
start + 16:	Y'20low	Y'20high	Y'21low	Y'21high	Y'22low	Y'22high	Y'23low	Y'23high
start + 24:	Y'30low	Y'30high	Y'31low	Y'31high	Y'32low	Y'32high	Y'33low	Y'33high

V4L2_PIX_FMT_Y10BPACK ('Y10B')

Name

V4L2_PIX_FMT_Y10BPACK — Grey-scale image as a bit-packed array

Description

This is a packed grey-scale image format with a depth of 10 bits per pixel. Pixels are stored in a bit-packed array of 10bit bits per pixel, with no padding between them and with the most significant bits coming first from the left.

Example 2-1. V4L2_PIX_FMT_Y10BPACK 4 pixel data stream taking 5 bytes

Bit-packed representation. pixels cross the byte boundary and have a ratio of 5 bytes for each 4 pixels.

Y'00[9:2]				Y'03[7:0]
	Y'00[1:0]Y'01[9:4]	Y'01[3:0]Y'02[9:6]	Y'02[5:0]Y'03[9:8]	

V4L2_PIX_FMT_Y16 ('Y16 ')

Name

V4L2_PIX_FMT_Y16 — Grey-scale image

Description

This is a grey-scale image with a depth of 16 bits per pixel. The least significant byte is stored at lower memory addresses (little-endian). Note the actual sampling

precision may be lower than 16 bits, for example 10 bits per pixel with values in range 0 to 1023.

Example 2-1. `V4L2_PIX_FMT_Y16` 4×4 pixel image

Byte Order. Each cell is one byte.

start + 0:	<code>Y'00low</code>	<code>Y'00high</code>	<code>Y'01low</code>	<code>Y'01high</code>	<code>Y'02low</code>	<code>Y'02high</code>	<code>Y'03low</code>	<code>Y'03high</code>
start + 8:	<code>Y'10low</code>	<code>Y'10high</code>	<code>Y'11low</code>	<code>Y'11high</code>	<code>Y'12low</code>	<code>Y'12high</code>	<code>Y'13low</code>	<code>Y'13high</code>
start + 16:	<code>Y'20low</code>	<code>Y'20high</code>	<code>Y'21low</code>	<code>Y'21high</code>	<code>Y'22low</code>	<code>Y'22high</code>	<code>Y'23low</code>	<code>Y'23high</code>
start + 24:	<code>Y'30low</code>	<code>Y'30high</code>	<code>Y'31low</code>	<code>Y'31high</code>	<code>Y'32low</code>	<code>Y'32high</code>	<code>Y'33low</code>	<code>Y'33high</code>

V4L2_PIX_FMT_YUYV ('YUYV')

Name

`V4L2_PIX_FMT_YUYV` — Packed format with $\frac{1}{2}$ horizontal chroma resolution, also known as YUV 4:2:2

Description

In this format each four bytes is two pixels. Each four bytes is two Y's, a Cb and a Cr. Each Y goes to one of the pixels, and the Cb and Cr belong to both pixels. As you can see, the Cr and Cb components have half the horizontal resolution of the Y component. `V4L2_PIX_FMT_YUYV` is known in the Windows environment as YUY2.

Example 2-1. V4L2_PIX_FMT_UYVY 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00	Cb00	Y'01	Cr00	Y'02	Cb01	Y'03	Cr01
start + 8:	Y'10	Cb10	Y'11	Cr10	Y'12	Cb11	Y'13	Cr11
start + 16:	Y'20	Cb20	Y'21	Cr20	Y'22	Cb21	Y'23	Cr21
start + 24:	Y'30	Cb30	Y'31	Cr30	Y'32	Cb31	Y'33	Cr31

Color Sample Location.

	0		1		2		3
0	Y	C	Y		Y	C	Y
1	Y	C	Y		Y	C	Y
2	Y	C	Y		Y	C	Y
3	Y	C	Y		Y	C	Y

V4L2_PIX_FMT_UYVY ('UYVY')

Name

V4L2_PIX_FMT_UYVY — Variation of V4L2_PIX_FMT_YUYV with different order of samples in memory

Description

In this format each four bytes is two pixels. Each four bytes is two Y's, a Cb and a Cr. Each Y goes to one of the pixels, and the Cb and Cr belong to both pixels. As you can see, the Cr and Cb components have half the horizontal resolution of the Y component.

Example 2-1. V4L2_PIX_FMT_UYVY 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Cb ₀₀	Y' ₀₀	Cr ₀₀	Y' ₀₁	Cb ₀₁	Y' ₀₂	Cr ₀₁	Y' ₀₃
start + 8:	Cb ₁₀	Y' ₁₀	Cr ₁₀	Y' ₁₁	Cb ₁₁	Y' ₁₂	Cr ₁₁	Y' ₁₃
start + 16:	Cb ₂₀	Y' ₂₀	Cr ₂₀	Y' ₂₁	Cb ₂₁	Y' ₂₂	Cr ₂₁	Y' ₂₃
start + 24:	Cb ₃₀	Y' ₃₀	Cr ₃₀	Y' ₃₁	Cb ₃₁	Y' ₃₂	Cr ₃₁	Y' ₃₃

Color Sample Location.

	0		1		2		3
0	Y	C	Y		Y	C	Y
1	Y	C	Y		Y	C	Y
2	Y	C	Y		Y	C	Y
3	Y	C	Y		Y	C	Y

V4L2_PIX_FMT_YVYU ('YVYU')

Name

V4L2_PIX_FMT_YVYU — Variation of V4L2_PIX_FMT_YUYV with different order of samples in memory

Description

In this format each four bytes is two pixels. Each four bytes is two Y's, a Cb and a Cr. Each Y goes to one of the pixels, and the Cb and Cr belong to both pixels. As you can see, the Cr and Cb components have half the horizontal resolution of the Y component.

Example 2-1. `V4L2_PIX_FMT_YVYU` 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00	Cr00	Y'01	Cb00	Y'02	Cr01	Y'03	Cb01
start + 8:	Y'10	Cr10	Y'11	Cb10	Y'12	Cr11	Y'13	Cb11
start + 16:	Y'20	Cr20	Y'21	Cb20	Y'22	Cr21	Y'23	Cb21
start + 24:	Y'30	Cr30	Y'31	Cb30	Y'32	Cr31	Y'33	Cb31

Color Sample Location.

	0		1		2		3
0	Y	C	Y		Y	C	Y
1	Y	C	Y		Y	C	Y
2	Y	C	Y		Y	C	Y
3	Y	C	Y		Y	C	Y

V4L2_PIX_FMT_VYUY ('VYUY')

Name

`V4L2_PIX_FMT_VYUY` — Variation of `V4L2_PIX_FMT_YUYV` with different order of samples in memory

Description

In this format each four bytes is two pixels. Each four bytes is two Y's, a Cb and a Cr. Each Y goes to one of the pixels, and the Cb and Cr belong to both pixels. As you can see, the Cr and Cb components have half the horizontal resolution of the Y component.

Example 2-1. V4L2_PIX_FMT_VYUY 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Cr ₀₀	Y' ₀₀	Cb ₀₀	Y' ₀₁	Cr ₀₁	Y' ₀₂	Cb ₀₁	Y' ₀₃
start + 8:	Cr ₁₀	Y' ₁₀	Cb ₁₀	Y' ₁₁	Cr ₁₁	Y' ₁₂	Cb ₁₁	Y' ₁₃
start + 16:	Cr ₂₀	Y' ₂₀	Cb ₂₀	Y' ₂₁	Cr ₂₁	Y' ₂₂	Cb ₂₁	Y' ₂₃
start + 24:	Cr ₃₀	Y' ₃₀	Cb ₃₀	Y' ₃₁	Cr ₃₁	Y' ₃₂	Cb ₃₁	Y' ₃₃

Color Sample Location.

	0		1		2		3
0	Y	C	Y		Y	C	Y
1	Y	C	Y		Y	C	Y
2	Y	C	Y		Y	C	Y
3	Y	C	Y		Y	C	Y

V4L2_PIX_FMT_Y41P ('Y41P')

Name

V4L2_PIX_FMT_Y41P — Format with ¼ horizontal chroma resolution, also known as YUV 4:1:1

Description

In this format each 12 bytes is eight pixels. In the twelve bytes are two CbCr pairs and eight Y's. The first CbCr pair goes with the first four Y's, and the second CbCr pair goes with the other four Y's. The Cb and Cr components have one fourth the horizontal resolution of the Y component.

Do not confuse this format with V4L2_PIX_FMT_YUV411P. Y41P is derived from "YUV 4:1:1 *packed*", while YUV411P stands for "YUV 4:1:1 *planar*".

Example 2-1. V4L2_PIX_FMT_Y41P 8 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Cb ₀₀	Y' ₀₀	Cr ₀₀	Y' ₀₁	Cb ₀₁	Y' ₀₂	Cr ₀₁	Y' ₀₃	Y' ₀₄	Y' ₀₅	Y' ₀₆	Y' ₀₇
start + 12:	Cb ₁₀	Y' ₁₀	Cr ₁₀	Y' ₁₁	Cb ₁₁	Y' ₁₂	Cr ₁₁	Y' ₁₃	Y' ₁₄	Y' ₁₅	Y' ₁₆	Y' ₁₇
start + 24:	Cb ₂₀	Y' ₂₀	Cr ₂₀	Y' ₂₁	Cb ₂₁	Y' ₂₂	Cr ₂₁	Y' ₂₃	Y' ₂₄	Y' ₂₅	Y' ₂₆	Y' ₂₇
start + 36:	Cb ₃₀	Y' ₃₀	Cr ₃₀	Y' ₃₁	Cb ₃₁	Y' ₃₂	Cr ₃₁	Y' ₃₃	Y' ₃₄	Y' ₃₅	Y' ₃₆	Y' ₃₇

Color Sample Location.

	0	1	2	3	4	5	6	7		
0	Y	Y	C	Y	Y	Y	Y	C	Y	Y
1	Y	Y	C	Y	Y	Y	Y	C	Y	Y
2	Y	Y	C	Y	Y	Y	Y	C	Y	Y
3	Y	Y	C	Y	Y	Y	Y	C	Y	Y

**V4L2_PIX_FMT_YVU420 ('YV12'),
V4L2_PIX_FMT_YUV420 ('YU12')**

Name

V4L2_PIX_FMT_YVU420, V4L2_PIX_FMT_YUV420 — Planar formats with ½ horizontal and vertical chroma resolution, also known as YUV 4:2:0

Description

These are planar formats, as opposed to a packed format. The three components are separated into three sub- images or planes. The Y plane is first. The Y plane has one

byte per pixel. For `V4L2_PIX_FMT_YVU420`, the Cr plane immediately follows the Y plane in memory. The Cr plane is half the width and half the height of the Y plane (and of the image). Each Cr belongs to four pixels, a two-by-two square of the image. For example, Cr_0 belongs to Y'_{00} , Y'_{01} , Y'_{10} , and Y'_{11} . Following the Cr plane is the Cb plane, just like the Cr plane. `V4L2_PIX_FMT_YUV420` is the same except the Cb plane comes first, then the Cr plane.

If the Y plane has pad bytes after each row, then the Cr and Cb planes have half as many pad bytes after their rows. In other words, two Cx rows (including padding) is exactly as long as one Y row (including padding).

Example 2-1. `V4L2_PIX_FMT_YVU420` 4×4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'_{00}	Y'_{01}	Y'_{02}	Y'_{03}
start + 4:	Y'_{10}	Y'_{11}	Y'_{12}	Y'_{13}
start + 8:	Y'_{20}	Y'_{21}	Y'_{22}	Y'_{23}
start + 12:	Y'_{30}	Y'_{31}	Y'_{32}	Y'_{33}
start + 16:	Cr_{00}	Cr_{01}		
start + 18:	Cr_{10}	Cr_{11}		
start + 20:	Cb_{00}	Cb_{01}		
start + 22:	Cb_{10}	Cb_{11}		

Color Sample Location.

	0		1		2		3
0	Y		Y		Y		Y
		C				C	
1	Y		Y		Y		Y
2	Y		Y		Y		Y
		C				C	
3	Y		Y		Y		Y

V4L2_PIX_FMT_YUV420M ('YU12M')

Name

V4L2_PIX_FMT_YUV420M — Variation of V4L2_PIX_FMT_YUV420 with planes non contiguous in memory.

Description

This is a multi-planar format, as opposed to a packed format. The three components are separated into three sub- images or planes. The Y plane is first. The Y plane has one byte per pixel. The Cb data constitutes the second plane which is half the width and half the height of the Y plane (and of the image). Each Cb belongs to four pixels, a two-by-two square of the image. For example, Cb_0 belongs to Y'_{00} , Y'_{01} , Y'_{10} , and Y'_{11} . The Cr data, just like the Cb plane, is in the third plane.

If the Y plane has pad bytes after each row, then the Cb and Cr planes have half as many pad bytes after their rows. In other words, two Cx rows (including padding) is exactly as long as one Y row (including padding).

V4L2_PIX_FMT_NV12M is intended to be used only in drivers and applications that support the multi-planar API, described in Section 1.11.

Example 2-1. V4L2_PIX_FMT_YVU420M 4 × 4 pixel image

Byte Order. Each cell is one byte.

start0 + 0:	Y'00	Y'01	Y'02	Y'03
start0 + 4:	Y'10	Y'11	Y'12	Y'13
start0 + 8:	Y'20	Y'21	Y'22	Y'23
start0 + 12:	Y'30	Y'31	Y'32	Y'33
start1 + 0:	Cb00	Cb01		
start1 + 2:	Cb10	Cb11		
start2 + 0:	Cr00	Cr01		
start2 + 2:	Cr10	Cr11		

Color Sample Location.

0	1	2	3
---	---	---	---

0	Y		Y		Y		Y
		C				C	
1	Y		Y		Y		Y
2	Y		Y		Y		Y
		C				C	
3	Y		Y		Y		Y

V4L2_PIX_FMT_YVU410 ('YVU9'), V4L2_PIX_FMT_YUV410 ('YUV9')

Name

V4L2_PIX_FMT_YVU410, V4L2_PIX_FMT_YUV410 — Planar formats with ¼ horizontal and vertical chroma resolution, also known as YUV 4:1:0

Description

These are planar formats, as opposed to a packed format. The three components are separated into three sub-images or planes. The Y plane is first. The Y plane has one byte per pixel. For V4L2_PIX_FMT_YVU410, the Cr plane immediately follows the Y plane in memory. The Cr plane is ¼ the width and ¼ the height of the Y plane (and of the image). Each Cr belongs to 16 pixels, a four-by-four square of the image. Following the Cr plane is the Cb plane, just like the Cr plane.

V4L2_PIX_FMT_YUV410 is the same, except the Cb plane comes first, then the Cr plane.

If the Y plane has pad bytes after each row, then the Cr and Cb planes have ¼ as many pad bytes after their rows. In other words, four Cx rows (including padding) are exactly as long as one Y row (including padding).

Example 2-1. `V4L2_PIX_FMT_YVU410` 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00	Y'01	Y'02	Y'03
start + 4:	Y'10	Y'11	Y'12	Y'13
start + 8:	Y'20	Y'21	Y'22	Y'23
start + 12:	Y'30	Y'31	Y'32	Y'33
start + 16:	Cr00			
start + 17:	Cb00			

Color Sample Location.

	0	1	2	3
0	Y	Y	Y	Y
1	Y	Y	Y	Y
2	Y	Y	Y	Y
3	Y	Y	Y	Y

V4L2_PIX_FMT_YUV422P ('422P')

Name

`V4L2_PIX_FMT_YUV422P` — Format with ½ horizontal chroma resolution, also known as YUV 4:2:2. Planar layout as opposed to `V4L2_PIX_FMT_YUYV`

Description

This format is not commonly used. This is a planar version of the YUYV format. The three components are separated into three sub-images or planes. The Y plane is

first. The Y plane has one byte per pixel. The Cb plane immediately follows the Y plane in memory. The Cb plane is half the width of the Y plane (and of the image). Each Cb belongs to two pixels. For example, Cb_0 belongs to Y'_{00} , Y'_{01} . Following the Cb plane is the Cr plane, just like the Cb plane.

If the Y plane has pad bytes after each row, then the Cr and Cb planes have half as many pad bytes after their rows. In other words, two Cx rows (including padding) is exactly as long as one Y row (including padding).

Example 2-1. v4L2_PIX_FMT_YUV422P 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00	Y'01	Y'02	Y'03
start + 4:	Y'10	Y'11	Y'12	Y'13
start + 8:	Y'20	Y'21	Y'22	Y'23
start + 12:	Y'30	Y'31	Y'32	Y'33
start + 16:	Cb00	Cb01		
start + 18:	Cb10	Cb11		
start + 20:	Cb20	Cb21		
start + 22:	Cb30	Cb31		
start + 24:	Cr00	Cr01		
start + 26:	Cr10	Cr11		
start + 28:	Cr20	Cr21		
start + 30:	Cr30	Cr31		

Color Sample Location.

	0		1		2		3
0	Y	C	Y		Y	C	Y
1	Y	C	Y		Y	C	Y
2	Y	C	Y		Y	C	Y
3	Y	C	Y		Y	C	Y

V4L2_PIX_FMT_YUV411P ('411P')

Name

V4L2_PIX_FMT_YUV411P — Format with ¼ horizontal chroma resolution, also known as YUV 4:1:1. Planar layout as opposed to V4L2_PIX_FMT_Y41P

Description

This format is not commonly used. This is a planar format similar to the 4:2:2 planar format except with half as many chroma. The three components are separated into three sub-images or planes. The Y plane is first. The Y plane has one byte per pixel. The Cb plane immediately follows the Y plane in memory. The Cb plane is ¼ the width of the Y plane (and of the image). Each Cb belongs to 4 pixels all on the same row. For example, Cb₀ belongs to Y'₀₀, Y'₀₁, Y'₀₂ and Y'₀₃. Following the Cb plane is the Cr plane, just like the Cb plane.

If the Y plane has pad bytes after each row, then the Cr and Cb planes have ¼ as many pad bytes after their rows. In other words, four C x rows (including padding) is exactly as long as one Y row (including padding).

Example 2-1. V4L2_PIX_FMT_YUV411P 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y' ₀₀	Y' ₀₁	Y' ₀₂	Y' ₀₃
start + 4:	Y' ₁₀	Y' ₁₁	Y' ₁₂	Y' ₁₃
start + 8:	Y' ₂₀	Y' ₂₁	Y' ₂₂	Y' ₂₃
start + 12:	Y' ₃₀	Y' ₃₁	Y' ₃₂	Y' ₃₃
start + 16:	Cb ₀₀			
start + 17:	Cb ₁₀			
start + 18:	Cb ₂₀			
start + 19:	Cb ₃₀			
start + 20:	Cr ₀₀			
start + 21:	Cr ₁₀			
start + 22:	Cr ₂₀			
start + 23:	Cr ₃₀			

Color Sample Location.

	0	1	2	3
0	Y	Y	C	Y
1	Y	Y	C	Y
2	Y	Y	C	Y
3	Y	Y	C	Y

V4L2_PIX_FMT_NV12 ('NV12'), V4L2_PIX_FMT_NV21 ('NV21')

Name

V4L2_PIX_FMT_NV12, V4L2_PIX_FMT_NV21 — Formats with ½ horizontal and vertical chroma resolution, also known as YUV 4:2:0. One luminance and one chrominance plane with alternating chroma samples as opposed to V4L2_PIX_FMT_YVU420

Description

These are two-plane versions of the YUV 4:2:0 format. The three components are separated into two sub-images or planes. The Y plane is first. The Y plane has one byte per pixel. For V4L2_PIX_FMT_NV12, a combined CbCr plane immediately follows the Y plane in memory. The CbCr plane is the same width, in bytes, as the Y plane (and of the image), but is half as tall in pixels. Each CbCr pair belongs to four pixels. For example, Cb₀/Cr₀ belongs to Y'₀₀, Y'₀₁, Y'₁₀, Y'₁₁.

V4L2_PIX_FMT_NV21 is the same except the Cb and Cr bytes are swapped, the CrCb plane starts with a Cr byte.

If the Y plane has pad bytes after each row, then the CbCr plane has as many pad bytes after its rows.

Example 2-1. V4L2_PIX_FMT_NV12 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00	Y'01	Y'02	Y'03
start + 4:	Y'10	Y'11	Y'12	Y'13
start + 8:	Y'20	Y'21	Y'22	Y'23
start + 12:	Y'30	Y'31	Y'32	Y'33
start + 16:	Cb00	Cr00	Cb01	Cr01
start + 20:	Cb10	Cr10	Cb11	Cr11

Color Sample Location.

	0		1		2		3
0	Y		Y		Y		Y
		C				C	
1	Y		Y		Y		Y
2	Y		Y		Y		Y
		C				C	
3	Y		Y		Y		Y

V4L2_PIX_FMT_NV12M ('NV12M')

Name

V4L2_PIX_FMT_NV12M — Variation of V4L2_PIX_FMT_NV12 with planes non contiguous in memory.

Description

This is a multi-planar, two-plane version of the YUV 4:2:0 format. The three components are separated into two sub-images or planes. V4L2_PIX_FMT_NV12M

differs from `V4L2_PIX_FMT_NV12` in that the two planes are non-contiguous in memory, i.e. the chroma plane do not necessarily immediately follows the luma plane. The luminance data occupies the first plane. The Y plane has one byte per pixel. In the second plane there is a chrominance data with alternating chroma samples. The CbCr plane is the same width, in bytes, as the Y plane (and of the image), but is half as tall in pixels. Each CbCr pair belongs to four pixels. For example, Cb_0/Cr_0 belongs to Y'_{00} , Y'_{01} , Y'_{10} , Y'_{11} .

`V4L2_PIX_FMT_NV12M` is intended to be used only in drivers and applications that support the multi-planar API, described in Section 1.11.

If the Y plane has pad bytes after each row, then the CbCr plane has as many pad bytes after its rows.

Example 2-1. `V4L2_PIX_FMT_NV12M` 4×4 pixel image

Byte Order. Each cell is one byte.

start0 + 0:	Y'_{00}	Y'_{01}	Y'_{02}	Y'_{03}
start0 + 4:	Y'_{10}	Y'_{11}	Y'_{12}	Y'_{13}
start0 + 8:	Y'_{20}	Y'_{21}	Y'_{22}	Y'_{23}
start0 + 12:	Y'_{30}	Y'_{31}	Y'_{32}	Y'_{33}
start1 + 0:	Cb_{00}	Cr_{00}	Cb_{01}	Cr_{01}
start1 + 4:	Cb_{10}	Cr_{10}	Cb_{11}	Cr_{11}

Color Sample Location.

	0		1		2		3
0	Y		Y		Y		Y
		C				C	
1	Y		Y		Y		Y
2	Y		Y		Y		Y
		C				C	
3	Y		Y		Y		Y

V4L2_PIX_FMT_NV12MT ('TM12')

Name

V4L2_PIX_FMT_NV12MT — Formats with ½ horizontal and vertical chroma resolution. This format has two planes - one for luminance and one for chrominance. Chroma samples are interleaved. The difference to V4L2_PIX_FMT_NV12 is the memory layout. Pixels are grouped in macroblocks of 64x32 size. The order of macroblocks in memory is also not standard.

Description

This is the two-plane versions of the YUV 4:2:0 format where data is grouped into 64x32 macroblocks. The three components are separated into two sub-images or planes. The Y plane has one byte per pixel and pixels are grouped into 64x32 macroblocks. The CbCr plane has the same width, in bytes, as the Y plane (and the image), but is half as tall in pixels. The chroma plane is also grouped into 64x32 macroblocks.

Width of the buffer has to be aligned to the multiple of 128, and height alignment is 32. Every four adjacent buffers - two horizontally and two vertically are grouped together and are located in memory in Z or flipped Z order.

Layout of macroblocks in memory is presented in the following figure.

Figure 2-1. V4L2_PIX_FMT_NV12MT macroblock Z shape memory layout

The requirement that width is multiple of 128 is implemented because, the Z shape cannot be cut in half horizontally. In case the vertical resolution of macroblocks is odd then the last row of macroblocks is arranged in a linear order.

In case of chroma the layout is identical. Cb and Cr samples are interleaved. Height of the buffer is aligned to 32.

Example 2-1. Memory layout of macroblocks in V4L2_PIX_FMT_NV12 format pixel image - extreme case

Figure 2-2. Example V4L2_PIX_FMT_NV12MT memory layout of macroblocks

Memory layout of macroblocks of `V4L2_PIX_FMT_NV12MT` format in most extreme case.

V4L2_PIX_FMT_NV16 ('NV16'), V4L2_PIX_FMT_NV61 ('NV61')

Name

`V4L2_PIX_FMT_NV16`, `V4L2_PIX_FMT_NV61` — Formats with $\frac{1}{2}$ horizontal chroma resolution, also known as YUV 4:2:2. One luminance and one chrominance plane with alternating chroma samples as opposed to `V4L2_PIX_FMT_YVU420`

Description

These are two-plane versions of the YUV 4:2:2 format. The three components are separated into two sub-images or planes. The Y plane is first. The Y plane has one byte per pixel. For `V4L2_PIX_FMT_NV16`, a combined CbCr plane immediately follows the Y plane in memory. The CbCr plane is the same width and height, in bytes, as the Y plane (and of the image). Each CbCr pair belongs to two pixels. For example, Cb_0/Cr_0 belongs to Y'_{00} , Y'_{01} . `V4L2_PIX_FMT_NV61` is the same except the Cb and Cr bytes are swapped, the CrCb plane starts with a Cr byte.

If the Y plane has pad bytes after each row, then the CbCr plane has as many pad bytes after its rows.

Example 2-1. `V4L2_PIX_FMT_NV16` 4×4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00	Y'01	Y'02	Y'03
start + 4:	Y'10	Y'11	Y'12	Y'13
start + 8:	Y'20	Y'21	Y'22	Y'23
start + 12:	Y'30	Y'31	Y'32	Y'33
start + 16:	Cb00	Cr00	Cb01	Cr01
start + 20:	Cb10	Cr10	Cb11	Cr11

start + 24:	Cb ₂₀	Cr ₂₀	Cb ₂₁	Cr ₂₁
start + 28:	Cb ₃₀	Cr ₃₀	Cb ₃₁	Cr ₃₁

Color Sample Location.

	0		1		2		3
0	Y		Y		Y		Y
		C				C	
1	Y		Y		Y		Y
		C				C	
2	Y		Y		Y		Y
		C				C	
3	Y		Y		Y		Y
		C				C	

V4L2_PIX_FMT_M420 ('M420')

Name

V4L2_PIX_FMT_M420 — Format with ½ horizontal and vertical chroma resolution, also known as YUV 4:2:0. Hybrid plane line-interleaved layout.

Description

M420 is a YUV format with ½ horizontal and vertical chroma subsampling (YUV 4:2:0). Pixels are organized as interleaved luma and chroma planes. Two lines of luma data are followed by one line of chroma data.

The luma plane has one byte per pixel. The chroma plane contains interleaved CbCr pixels subsampled by ½ in the horizontal and vertical directions. Each CbCr pair belongs to four pixels. For example, Cb₀/Cr₀ belongs to Y'₀₀, Y'₀₁, Y'₁₀, Y'₁₁.

All line lengths are identical: if the Y lines include pad bytes so do the CbCr lines.

Example 2-1. V4L2_PIX_FMT_M420 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'00	Y'01	Y'02	Y'03
start + 4:	Y'10	Y'11	Y'12	Y'13
start + 8:	Cb00	Cr00	Cb01	Cr01
start + 16:	Y'20	Y'21	Y'22	Y'23
start + 20:	Y'30	Y'31	Y'32	Y'33
start + 24:	Cb10	Cr10	Cb11	Cr11

Color Sample Location.

	0		1		2		3
0	Y		Y		Y		Y
		C				C	
1	Y		Y		Y		Y
2	Y		Y		Y		Y
		C				C	
3	Y		Y		Y		Y

2.8. Compressed Formats

Table 2-9. Compressed Image Formats

Identifier	Code	Details
V4L2_PIX_FMT_JPEG	'JPEG'	TBD. See also VIDIOC_G_JPEGCOMP, VIDIOC_S_JPEGCOMP.
V4L2_PIX_FMT_MPEG	'MPEG'	MPEG stream. The actual format is determined by extended control V4L2_CID_MPEG_STREAM_TYPE, see Table 1-2.

2.9. Reserved Format Identifiers

These formats are not defined by this specification, they are just listed for reference and to avoid naming conflicts. If you want to register your own format, send an e-mail to the linux-media mailing list <http://www.linuxtv.org/lists.php> for inclusion in the `videodev2.h` file. If you want to share your format with other developers add a link to your documentation and send a copy to the linux-media mailing list for inclusion in this section. If you think your format should be listed in a standard format section please make a proposal on the linux-media mailing list.

Table 2-10. Reserved Image Formats

Identifier	Code	Details
V4L2_PIX_FMT_DV	'dvsd'	unknown
V4L2_PIX_FMT_ET61X251	'E625'	Compressed format of the ET61X251 driver.
V4L2_PIX_FMT_HI240	'HI24'	8 bit RGB format used by the BTTV driver.
V4L2_PIX_FMT_HM12	'HM12'	YUV 4:2:0 format used by the IVTV driver, http://www.ivtvdriver.org/ (http://www.ivtvdriver.org/) The format is documented in the kernel sources in the file <code>Documentation/video4linux/cx2341x/README.h</code>
V4L2_PIX_FMT_CPIA1	'CPIA'	YUV format used by the gspca cpia1 driver.
V4L2_PIX_FMT_SPCA501	'S501'	YUYV per line used by the gspca driver.
V4L2_PIX_FMT_SPCA505	'S505'	YYUV per line used by the gspca driver.
V4L2_PIX_FMT_SPCA508	'S508'	YUVY per line used by the gspca driver.
V4L2_PIX_FMT_SPCA561	'S561'	Compressed GBRG Bayer format used by the gspca driver.
V4L2_PIX_FMT_SGRBG10DPCM	'DB10'	10 bit raw Bayer DPCM compressed to 8 bits.
V4L2_PIX_FMT_PAC207	'P207'	Compressed BGGR Bayer format used by the gspca driver.
V4L2_PIX_FMT_MR97310A	'M310'	Compressed BGGR Bayer format used by the gspca driver.

Identifier	Code	Details
V4L2_PIX_FMT_OV511	'O511'	OV511 JPEG format used by the gspca driver.
V4L2_PIX_FMT_OV518	'O518'	OV518 JPEG format used by the gspca driver.
V4L2_PIX_FMT_PJPG	'PJPG'	Pixart 73xx JPEG format used by the gspca driver.
V4L2_PIX_FMT_SQ905C	'905C'	Compressed RGGB bayer format used by the gspca driver.
V4L2_PIX_FMT_MJPEG	'MJPG'	Compressed format used by the Zoran driver
V4L2_PIX_FMT_PWC1	'PWC1'	Compressed format of the PWC driver.
V4L2_PIX_FMT_PWC2	'PWC2'	Compressed format of the PWC driver.
V4L2_PIX_FMT_SN9C10X	'S910'	Compressed format of the SN9C102 driver.
V4L2_PIX_FMT_SN9C20X_I420	'S920'	YUV 4:2:0 format of the gspca sn9c20x driver.
V4L2_PIX_FMT_SN9C2028	'SONX'	Compressed GBRG bayer format of the gspca sn9c2028 driver.
V4L2_PIX_FMT_STV0680	'S680'	Bayer format of the gspca stv0680 driver.
V4L2_PIX_FMT_WNVA	'WNVA'	Used by the Winnov Videum driver, http://www.thedirks.org/winnov/ (http://www.thedirks.org/winnov/)
V4L2_PIX_FMT_TM6000	'TM60'	Used by Trident tm6000
V4L2_PIX_FMT_CIT_YYVYUY	'CITV'	Used by xirlink CIT, found at IBM webcams. Uses one line of Y then 1 line of VYUY
V4L2_PIX_FMT_KONICA420	'KONI'	Used by Konica webcams. YUV420 planar in blocks of 256 pixels.
V4L2_PIX_FMT_YYUV	'YYUV'	unknown
V4L2_PIX_FMT_Y4	'Y04 '	Old 4-bit greyscale format. Only the least significant 4 bits of each byte are used, the other bits are set to 0.
V4L2_PIX_FMT_Y6	'Y06 '	Old 6-bit greyscale format. Only the least significant 6 bits of each byte are used, the other bits are set to 0.

Chapter 3. Input/Output

The V4L2 API defines several different methods to read from or write to a device. All drivers exchanging data with applications must support at least one of them.

The classic I/O method using the `read()` and `write()` function is automatically selected after opening a V4L2 device. When the driver does not support this method attempts to read or write will fail at any time.

Other methods must be negotiated. To select the streaming I/O method with memory mapped or user buffers applications call the `VIDIOC_REQBUFS` ioctl. The asynchronous I/O method is not defined yet.

Video overlay can be considered another I/O method, although the application does not directly receive the image data. It is selected by initiating video overlay with the `VIDIOC_S_FMT` ioctl. For more information see Section 4.2.

Generally exactly one I/O method, including overlay, is associated with each file descriptor. The only exceptions are applications not exchanging data with a driver ("panel applications", see Section 1.1) and drivers permitting simultaneous video capturing and overlay using the same file descriptor, for compatibility with V4L and earlier versions of V4L2.

`VIDIOC_S_FMT` and `VIDIOC_REQBUFS` would permit this to some degree, but for simplicity drivers need not support switching the I/O method (after first switching away from read/write) other than by closing and reopening the device.

The following sections describe the various I/O methods in more detail.

3.1. Read/Write

Input and output devices support the `read()` and `write()` function, respectively, when the `V4L2_CAP_READWRITE` flag in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl is set.

Drivers may need the CPU to copy the data, but they may also support DMA to or from user memory, so this I/O method is not necessarily less efficient than other methods merely exchanging buffer pointers. It is considered inferior though because no meta-information like frame counters or timestamps are passed. This information is necessary to recognize frame dropping and to synchronize with other data streams. However this is also the simplest I/O method, requiring little or no setup to exchange data. It permits command line stunts like this (the `vidctrl` tool is fictitious):

```
> vidctrl /dev/video --input=0 --format=YUYV --size=352x288  
> dd if=/dev/video of=myimage.422 bs=202752 count=1
```

To read from the device applications use the `read()` function, to write the `write()` function. Drivers must implement one I/O method if they exchange data with applications, but it need not be this.¹ When reading or writing is supported, the driver must also support the `select()` and `poll()` function.²

3.2. Streaming I/O (Memory Mapping)

Input and output devices support this I/O method when the `V4L2_CAP_STREAMING` flag in the `capabilities` field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl is set. There are two streaming methods, to determine if the memory mapping flavor is supported applications must call the `VIDIOC_REQBUFS` ioctl.

Streaming is an I/O method where only pointers to buffers are exchanged between application and driver, the data itself is not copied. Memory mapping is primarily intended to map buffers in device memory into the application's address space. Device memory can be for example the video memory on a graphics card with a video capture add-on. However, being the most efficient I/O method available for a long time, many other drivers support streaming as well, allocating buffers in DMA-able main memory.

A driver can support many sets of buffers. Each set is identified by a unique buffer type value. The sets are independent and each set can hold a different type of data. To access different sets at the same time different file descriptors must be used.³

To allocate device buffers applications call the `VIDIOC_REQBUFS` ioctl with the desired number of buffers and buffer type, for example `V4L2_BUF_TYPE_VIDEO_CAPTURE`. This ioctl can also be used to change the number of buffers or to free the allocated memory, provided none of the buffers are still mapped.

Before applications can access the buffers they must map them into their address space with the `mmap()` function. The location of the buffers in device memory can be determined with the `VIDIOC_QUERYBUF` ioctl. In the single-planar API case, the `m.offset` and `length` returned in a struct `v4l2_buffer` are passed as sixth and second parameter to the `mmap()` function. When using the multi-planar API, struct `v4l2_buffer` contains an array of struct `v4l2_plane` structures, each containing its own `m.offset` and `length`. When using the multi-planar API, every plane of every buffer has to be mapped separately, so the number of calls to `mmap()` should be equal to number of buffers times number of planes in each buffer. The offset and length values must not be modified. Remember, the buffers are allocated in physical

memory, as opposed to virtual memory, which can be swapped out to disk. Applications should free the buffers as soon as possible with the `munmap()` function.

Example 3-1. Mapping buffers in the single-planar API

```
struct v4l2_requestbuffers reqbuf;
struct {
    void *start;
    size_t length;
} *buffers;
unsigned int i;

memset(&reqbuf, 0, sizeof(reqbuf));
reqbuf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
reqbuf.memory = V4L2_MEMORY_MMAP;
reqbuf.count = 20;

if (-1 == ioctl (fd, VIDIOC_REQBUFS, &reqbuf)) {
    if (errno == EINVAL)
        printf("Video capturing or mmap-streaming is not supported\n");
    else
        perror("VIDIOC_REQBUFS");

    exit(EXIT_FAILURE);
}

/* We want at least five buffers. */

if (reqbuf.count < 5) {
    /* You may need to free the buffers here. */
    printf("Not enough buffer memory\n");
    exit(EXIT_FAILURE);
}

buffers = calloc(reqbuf.count, sizeof(*buffers));
assert(buffers != NULL);

for (i = 0; i < reqbuf.count; i++) {
    struct v4l2_buffer buffer;

    memset(&buffer, 0, sizeof(buffer));
    buffer.type = reqbuf.type;
    buffer.memory = V4L2_MEMORY_MMAP;
    buffer.index = i;

    if (-1 == ioctl (fd, VIDIOC_QUERYBUF, &buffer)) {
```

Chapter 3. Input/Output

```
perror("VIDIOC_QUERYBUF");
exit(EXIT_FAILURE);
}

buffers[i].length = buffer.length; /* remember for munmap() */

buffers[i].start = mmap(NULL, buffer.length,
    PROT_READ | PROT_WRITE, /* recommended */
    MAP_SHARED,             /* recommended */
    fd, buffer.m.offset);

if (MAP_FAILED == buffers[i].start) {
    /* If you do not exit here you should unmap() and free()
       the buffers mapped so far. */
    perror("mmap");
    exit(EXIT_FAILURE);
}
}

/* Cleanup. */

for (i = 0; i < reqbuf.count; i++)
    munmap(buffers[i].start, buffers[i].length);
```

Example 3-2. Mapping buffers in the multi-planar API

```
struct v4l2_requestbuffers reqbuf;
/* Our current format uses 3 planes per buffer */
#define FMT_NUM_PLANES = 3;

struct {
    void *start[FMT_NUM_PLANES];
    size_t length[FMT_NUM_PLANES];
} *buffers;
unsigned int i, j;

memset(&reqbuf, 0, sizeof(reqbuf));
reqbuf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE_MPLANE;
reqbuf.memory = V4L2_MEMORY_MMAP;
reqbuf.count = 20;

if (ioctl(fd, VIDIOC_REQBUFS, &reqbuf) < 0) {
    if (errno == EINVAL)
        printf("Video capturing or mmap-streaming is not supported\n");
    else
        perror("VIDIOC_REQBUFS");
```

```

    exit(EXIT_FAILURE);
}

/* We want at least five buffers. */

if (reqbuf.count < 5) {
    /* You may need to free the buffers here. */
    printf("Not enough buffer memory\n");
    exit(EXIT_FAILURE);
}

buffers = calloc(reqbuf.count, sizeof(*buffers));
assert(buffers != NULL);

for (i = 0; i < reqbuf.count; i++) {
    struct v4l2_buffer buffer;
    struct v4l2_plane planes[FMT_NUM_PLANES];

    memset(&buffer, 0, sizeof(buffer));
    buffer.type = reqbuf.type;
    buffer.memory = V4L2_MEMORY_MMAP;
    buffer.index = i;
    /* length in struct v4l2_buffer in multi-planar API stores the size
     * of planes array. */
    buffer.length = FMT_NUM_PLANES;
    buffer.m.planes = planes;

    if (ioctl(fd, VIDIOC_QUERYBUF, &buffer) < 0) {
        perror("VIDIOC_QUERYBUF");
        exit(EXIT_FAILURE);
    }

    /* Every plane has to be mapped separately */
    for (j = 0; j < FMT_NUM_PLANES; j++) {
        buffers[i].length[j] = buffer.m.planes[j].length; /* remember for munmap */

        buffers[i].start[j] = mmap(NULL, buffer.m.planes[j].length,
                                   PROT_READ | PROT_WRITE, /* recommended */
                                   MAP_SHARED,                /* recommended */
                                   fd, buffer.m.planes[j].m.offset);

        if (MAP_FAILED == buffers[i].start[j]) {
            /* If you do not exit here you should unmap() and free()
             the buffers and planes mapped so far. */
            perror("mmap");
            exit(EXIT_FAILURE);
        }
    }
}

```



```
    }  
}  
  
/* Cleanup. */  
  
for (i = 0; i < reqbuf.count; i++)  
    for (j = 0; j < FMT_NUM_PLANES; j++)  
        munmap(bufbers[i].start[j], bufbers[i].length[j]);
```

Conceptually streaming drivers maintain two buffer queues, an incoming and an outgoing queue. They separate the synchronous capture or output operation locked to a video clock from the application which is subject to random disk or network delays and preemption by other processes, thereby reducing the probability of data loss. The queues are organized as FIFOs, buffers will be output in the order enqueued in the incoming FIFO, and were captured in the order dequeued from the outgoing FIFO.

The driver may require a minimum number of buffers enqueued at all times to function, apart of this no limit exists on the number of buffers applications can enqueue in advance, or dequeue and process. They can also enqueue in a different order than buffers have been dequeued, and the driver can *fill* enqueued *empty* buffers in any order.⁴ The index number of a buffer (struct `v4l2_buffer` *index*) plays no role here, it only identifies the buffer.

Initially all mapped buffers are in dequeued state, inaccessible by the driver. For capturing applications it is customary to first enqueue all mapped buffers, then to start capturing and enter the read loop. Here the application waits until a filled buffer can be dequeued, and re-enqueues the buffer when the data is no longer needed. Output applications fill and enqueue buffers, when enough buffers are stacked up the output is started with `VIDIOC_STREAMON`. In the write loop, when the application runs out of free buffers, it must wait until an empty buffer can be dequeued and reused.

To enqueue and dequeue a buffer applications use the `VIDIOC_QBUF` and `VIDIOC_DQBUF` ioctl. The status of a buffer being mapped, enqueued, full or empty can be determined at any time using the `VIDIOC_QUERYBUF` ioctl. Two methods exist to suspend execution of the application until one or more buffers can be dequeued. By default `VIDIOC_DQBUF` blocks when no buffer is in the outgoing queue. When the `O_NONBLOCK` flag was given to the `open()` function, `VIDIOC_DQBUF` returns immediately with an `EAGAIN` error code when no buffer is available. The `select()` or `poll()` function are always available.

To start and stop capturing or output applications call the `VIDIOC_STREAMON` and `VIDIOC_STREAMOFF` ioctl. Note `VIDIOC_STREAMOFF` removes all buffers from both queues as a side effect. Since there is no notion of doing anything "now" on a multitasking system, if an application needs to synchronize with another event it

should examine the struct `v4l2_buffer` *timestamp* of captured buffers, or set the field before enqueueing buffers for output.

Drivers implementing memory mapping I/O must support the `VIDIOC_REQBUFS`, `VIDIOC_QUERYBUF`, `VIDIOC_QBUF`, `VIDIOC_DQBUF`, `VIDIOC_STREAMON` and `VIDIOC_STREAMOFF` `ioctl`, the `mmap()`, `munmap()`, `select()` and `poll()` function.⁵

[capture example]

3.3. Streaming I/O (User Pointers)

Input and output devices support this I/O method when the `V4L2_CAP_STREAMING` flag in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` `ioctl` is set. If the particular user pointer method (not only memory mapping) is supported must be determined by calling the `VIDIOC_REQBUFS` `ioctl`.

This I/O method combines advantages of the read/write and memory mapping methods. Buffers (planes) are allocated by the application itself, and can reside for example in virtual or shared memory. Only pointers to data are exchanged, these pointers and meta-information are passed in struct `v4l2_buffer` (or in struct `v4l2_plane` in the multi-planar API case). The driver must be switched into user pointer I/O mode by calling the `VIDIOC_REQBUFS` with the desired buffer type. No buffers (planes) are allocated beforehand, consequently they are not indexed and cannot be queried like mapped buffers with the `VIDIOC_QUERYBUF` `ioctl`.

Example 3-3. Initiating streaming I/O with user pointers

```
struct v4l2_requestbuffers reqbuf;

memset (&reqbuf, 0, sizeof (reqbuf));
reqbuf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
reqbuf.memory = V4L2_MEMORY_USERPTR;

if (ioctl (fd, VIDIOC_REQBUFS, &reqbuf) == -1) {
    if (errno == EINVAL)
        printf ("Video capturing or user pointer streaming is not supported\n");
    else
        perror ("VIDIOC_REQBUFS");

    exit (EXIT_FAILURE);
}
```

Buffer (plane) addresses and sizes are passed on the fly with the `VIDIOC_QBUF` ioctl. Although buffers are commonly cycled, applications can pass different addresses and sizes at each `VIDIOC_QBUF` call. If required by the hardware the driver swaps memory pages within physical memory to create a continuous area of memory. This happens transparently to the application in the virtual memory subsystem of the kernel. When buffer pages have been swapped out to disk they are brought back and finally locked in physical memory for DMA.⁶

Filled or displayed buffers are dequeued with the `VIDIOC_DQBUF` ioctl. The driver can unlock the memory pages at any time between the completion of the DMA and this ioctl. The memory is also unlocked when `VIDIOC_STREAMOFF` is called, `VIDIOC_REQBUFS`, or when the device is closed. Applications must take care not to free buffers without dequeuing. For once, the buffers remain locked until further, wasting physical memory. Second the driver will not be notified when the memory is returned to the application's free list and subsequently reused for other purposes, possibly completing the requested DMA and overwriting valuable data.

For capturing applications it is customary to enqueue a number of empty buffers, to start capturing and enter the read loop. Here the application waits until a filled buffer can be dequeued, and re-enqueues the buffer when the data is no longer needed. Output applications fill and enqueue buffers, when enough buffers are stacked up output is started. In the write loop, when the application runs out of free buffers it must wait until an empty buffer can be dequeued and reused. Two methods exist to suspend execution of the application until one or more buffers can be dequeued. By default `VIDIOC_DQBUF` blocks when no buffer is in the outgoing queue. When the `O_NONBLOCK` flag was given to the `open()` function, `VIDIOC_DQBUF` returns immediately with an `EAGAIN` error code when no buffer is available. The `select()` or `poll()` function are always available.

To start and stop capturing or output applications call the `VIDIOC_STREAMON` and `VIDIOC_STREAMOFF` ioctl. Note `VIDIOC_STREAMOFF` removes all buffers from both queues and unlocks all buffers as a side effect. Since there is no notion of doing anything "now" on a multitasking system, if an application needs to synchronize with another event it should examine the struct `v4l2_buffer` *timestamp* of captured buffers, or set the field before enqueueing buffers for output.

Drivers implementing user pointer I/O must support the `VIDIOC_REQBUFS`, `VIDIOC_QBUF`, `VIDIOC_DQBUF`, `VIDIOC_STREAMON` and `VIDIOC_STREAMOFF` ioctl, the `select()` and `poll()` function.⁷

3.4. Asynchronous I/O

This method is not defined yet.

3.5. Buffers

A buffer contains data exchanged by application and driver using one of the Streaming I/O methods. In the multi-planar API, the data is held in planes, while the buffer structure acts as a container for the planes. Only pointers to buffers (planes) are exchanged, the data itself is not copied. These pointers, together with meta-information like timestamps or field parity, are stored in a struct `v4l2_buffer`, argument to the `VIDIOC_QUERYBUF`, `VIDIOC_QBUF` and `VIDIOC_DQBUF` ioctl. In the multi-planar API, some plane-specific members of struct `v4l2_buffer`, such as pointers and sizes for each plane, are stored in struct `v4l2_plane` instead. In that case, struct `v4l2_buffer` contains an array of plane structures.

Nominally timestamps refer to the first data byte transmitted. In practice however the wide range of hardware covered by the V4L2 API limits timestamp accuracy. Often an interrupt routine will sample the system clock shortly after the field or frame was stored completely in memory. So applications must expect a constant difference up to one field or frame period plus a small (few scan lines) random error. The delay and error can be much larger due to compression or transmission over an external bus when the frames are not properly stamped by the sender. This is frequently the case with USB cameras. Here timestamps refer to the instant the field or frame was received by the driver, not the capture time. These devices identify by not enumerating any video standards, see Section 1.7.

Similar limitations apply to output timestamps. Typically the video hardware locks to a clock controlling the video timing, the horizontal and vertical synchronization pulses. At some point in the line sequence, possibly the vertical blanking, an interrupt routine samples the system clock, compares against the timestamp and programs the hardware to repeat the previous field or frame, or to display the buffer contents.

Apart of limitations of the video device and natural inaccuracies of all clocks, it should be noted system time itself is not perfectly stable. It can be affected by power saving cycles, warped to insert leap seconds, or even turned back or forth by the system administrator affecting long term measurements.⁸

Table 3-1. struct v4l2_buffer

<code>__u32</code>	<code>index</code>	Number of the buffer, set by the application. This field is only used for memory mapping I/O and can range from zero to the number of buffers allocated with the <code>VIDIOC_REQBUFS</code> ioctl (struct <code>v4l2_requestbuffers count</code>) minus one.
--------------------	--------------------	--

enum v4l2_buf_type

Type of the buffer, same as **struct** v4l2_format *type* or **struct** v4l2_requestbuffers *type*, set by the application.

__u32 bytesused

The number of bytes occupied by the data in the buffer. It depends on the negotiated data format and may change with each buffer for compressed variable size data like JPEG images. Drivers must set this field when *type* refers to an input stream, applications when an output stream.

__u32 flags

Flags set by the application or driver, see Table 3-4.

enum v4l2_field *field*

Indicates the field order of the image in the buffer, see Table 3-9. This field is not used when the buffer contains VBI data. Drivers must set it when *type* refers to an input stream, applications when an output stream.

```
struct timeval    timestamp
```

For input streams this is the system time (as returned by the `gettimeofday()` function) when the first data byte was captured. For output streams the data will not be displayed before this time, secondary to the nominal frame rate determined by the current video standard in enqueued order. Applications can for example zero this field to display frames as soon as possible. The driver stores the time at which the first data byte was actually sent out in the *timestamp* field. This permits applications to monitor the drift between the video and system clock.

```
struct v4l2_timecode
```

When *type* is `V4L2_BUF_TYPE_VIDEO_CAPTURE` and the

`V4L2_BUF_FLAG_TIMECODE` flag is set in *flags*, this structure contains a frame timecode. In

`V4L2_FIELD_ALTERNATE` mode the top and bottom field contain the same timecode.

Timecodes are intended to help video editing and are typically recorded on video tapes, but also embedded in compressed formats like MPEG. This field is independent of the *timestamp* and *sequence* fields.

```
__u32            sequence
```

Set by the driver, counting the frames in the sequence.

In `V4L2_FIELD_ALTERNATE` mode the top and bottom field have the same sequence number. The count starts at zero and includes dropped or repeated frames. A dropped frame was received by an input device but could not be stored due to lack of free buffer space. A repeated frame was displayed again by an output device because the application did not pass new data in time.

Note this may count the frames received e.g. over USB, without taking into account the frames dropped by the remote hardware due to limited compression throughput or bus bandwidth. These devices identify by not enumerating any video standards, see Section 1.7.

`enum v4l2_memory`

This field must be set by applications and/or drivers in accordance with the selected I/O method.

`union` `m`
`__u32` `offset`

For the single-planar API and when `memory` is `V4L2_MEMORY_MMAP` this is the offset of the buffer from the start of the device memory. The value is returned by the driver and apart of serving as parameter to the `mmap()` function not useful for applications. See Section 3.2 for details

`unsigned long` `userptr`

For the single-planar API and when `memory` is `V4L2_MEMORY_USERPTR` this is a pointer to the buffer (casted to unsigned long type) in virtual memory, set by the application. See Section 3.3 for details.

`struct` `*planes`
`v4l2_plane`

When using the multi-planar API, contains a userspace pointer to an array of `struct v4l2_plane`. The size of the array should be put in the `length` field of this `v4l2_buffer` structure.

<code>__u32</code>	<code>length</code>	Size of the buffer (not the payload) in bytes for the single-planar API. For the multi-planar API should contain the number of elements in the <code>planes</code> array.
<code>__u32</code>	<code>input</code>	Some video capture drivers support rapid and synchronous video input changes, a function useful for example in video surveillance applications. For this purpose applications set the <code>V4L2_BUF_FLAG_INPUT</code> flag, and this field to the number of a video input as in struct <code>v4l2_input</code> field <code>index</code> .
<code>__u32</code>	<code>reserved</code>	A place holder for future extensions and custom (driver defined) buffer types <code>V4L2_BUF_TYPE_PRIVATE</code> and higher. Applications should set this to 0.

Table 3-2. struct `v4l2_plane`

<code>__u32</code>	<code>bytesused</code>	The number of bytes occupied by data in the plane (its payload).
<code>__u32</code>	<code>length</code>	Size in bytes of the plane (not its payload).
union	<code>m</code> <code>__u32</code>	<code>mem_offset</code> When the memory type in the containing struct <code>v4l2_buffer</code> is <code>V4L2_MEMORY_MMAP</code> , this is the value that should be passed to <code>mmap()</code> , similar to the <code>offset</code> field in struct <code>v4l2_buffer</code> .

<code>__unsigned long</code>	<code>userptr</code>	When the memory type in the containing struct <code>v4l2_buffer</code> is <code>V4L2_MEMORY_USERPTR</code> , this is a userspace pointer to the memory allocated for this plane by an application.
<code>__u32</code>	<code>data_offset</code>	Offset in bytes to video data in the plane, if applicable.
<code>__u32</code>	<code>reserved[11]</code>	Reserved for future use. Should be zeroed by an application.

Table 3-3. enum v4l2_buf_type

<code>V4L2_BUF_TYPE_VIDEO_CAPTURE</code>	1	Buffer of a single-planar video capture stream, see Section 4.1.
<code>V4L2_BUF_TYPE_VIDEO_CAPTURE_MPLANE</code>	9	Buffer of a multi-planar video capture stream, see Section 4.1.
<code>V4L2_BUF_TYPE_VIDEO_OUTPUT</code>	2	Buffer of a single-planar video output stream, see Section 4.3.
<code>V4L2_BUF_TYPE_VIDEO_OUTPUT_MPLANE</code>	10	Buffer of a multi-planar video output stream, see Section 4.3.
<code>V4L2_BUF_TYPE_VIDEO_OVERLAY</code>	3	Buffer for video overlay, see Section 4.2.
<code>V4L2_BUF_TYPE_VBI_CAPTURE</code>	4	Buffer of a raw VBI capture stream, see Section 4.7.
<code>V4L2_BUF_TYPE_VBI_OUTPUT</code>	5	Buffer of a raw VBI output stream, see Section 4.7.
<code>V4L2_BUF_TYPE_SLICED_VBI_CAPTURE</code>	6	Buffer of a sliced VBI capture stream, see Section 4.8.
<code>V4L2_BUF_TYPE_SLICED_VBI_OUTPUT</code>	7	Buffer of a sliced VBI output stream, see Section 4.8.
<code>V4L2_BUF_TYPE_VIDEO_OUTPUT_OVERLAY</code>	8	Buffer for video output overlay (OSD), see Section 4.4. Status: Experimental .
<code>V4L2_BUF_TYPE_PRIVATE</code>	0x80	This and higher values are reserved for custom (driver defined) buffer types.

Table 3-4. Buffer Flags

V4L2_BUF_FLAG_MAPPED	0x0001	The buffer resides in device memory and has been mapped into the application's address space, see Section 3.2 for details. Drivers set or clear this flag when the <code>VIDIOC_QUERYBUF</code> , <code>VIDIOC_QBUF</code> or <code>VIDIOC_DQBUF</code> ioctl is called. Set by the driver.
V4L2_BUF_FLAG_QUEUED	0x0002	Internally drivers maintain two buffer queues, an incoming and outgoing queue. When this flag is set, the buffer is currently on the incoming queue. It automatically moves to the outgoing queue after the buffer has been filled (capture devices) or displayed (output devices). Drivers set or clear this flag when the <code>VIDIOC_QUERYBUF</code> ioctl is called. After (successful) calling the <code>VIDIOC_QBUF</code> ioctl it is always set and after <code>VIDIOC_DQBUF</code> always cleared.
V4L2_BUF_FLAG_DONE	0x0004	When this flag is set, the buffer is currently on the outgoing queue, ready to be dequeued from the driver. Drivers set or clear this flag when the <code>VIDIOC_QUERYBUF</code> ioctl is called. After calling the <code>VIDIOC_QBUF</code> or <code>VIDIOC_DQBUF</code> it is always cleared. Of course a buffer cannot be on both queues at the same time, the <code>V4L2_BUF_FLAG_QUEUED</code> and <code>V4L2_BUF_FLAG_DONE</code> flag are mutually exclusive. They can be both cleared however, then the buffer is in "dequeued" state, in the application domain to say so.
V4L2_BUF_FLAG_ERROR	0x0040	When this flag is set, the buffer has been dequeued successfully, although the data might have been corrupted. This is recoverable, streaming may continue as normal and the buffer may be reused normally. Drivers set this flag when the <code>VIDIOC_DQBUF</code> ioctl is called.

V4L2_BUF_FLAG_KEYFRAME	0x0008	Drivers set or clear this flag when calling the <code>VIDIOC_DQBUF</code> ioctl. It may be set by video capture devices when the buffer contains a compressed image which is a key frame (or field), i. e. can be decompressed on its own.
V4L2_BUF_FLAG_PFRAME	0x0010	Similar to <code>V4L2_BUF_FLAG_KEYFRAME</code> this flags predicted frames or fields which contain only differences to a previous key frame.
V4L2_BUF_FLAG_BFRAME	0x0020	Similar to <code>V4L2_BUF_FLAG_PFRAME</code> this is a bidirectional predicted frame or field. [ooc tbd]
V4L2_BUF_FLAG_TIMECODE	0x0100	The <i>timecode</i> field is valid. Drivers set or clear this flag when the <code>VIDIOC_DQBUF</code> ioctl is called.
V4L2_BUF_FLAG_INPUT	0x0200	The <i>input</i> field is valid. Applications set or clear this flag before calling the <code>VIDIOC_QBUF</code> ioctl.

Table 3-5. enum v4l2_memory

V4L2_MEMORY_MMAP	1	The buffer is used for memory mapping I/O.
V4L2_MEMORY_USERPTR	2	The buffer is used for user pointer I/O.
V4L2_MEMORY_OVERLAY	3	[to do]

3.5.1. Timecodes

The `v4l2_timecode` structure is designed to hold a SMPTE 12M or similar timecode. (struct timeval timestamps are stored in struct `v4l2_buffer` field *timestamp*.)

Table 3-6. struct v4l2_timecode

__u32	<i>type</i>	Frame rate the timecodes are based on, see Table 3-7.
__u32	<i>flags</i>	Timecode flags, see Table 3-8.
__u8	<i>frames</i>	Frame count, 0 ... 23/24/29/49/59, depending on the type of timecode.

<code>__u8</code>	<i>seconds</i>	Seconds count, 0 ... 59. This is a binary, not BCD number.
<code>__u8</code>	<i>minutes</i>	Minutes count, 0 ... 59. This is a binary, not BCD number.
<code>__u8</code>	<i>hours</i>	Hours count, 0 ... 29. This is a binary, not BCD number.
<code>__u8</code>	<i>userbits[4]</i>	The "user group" bits from the timecode.

Table 3-7. Timecode Types

<code>V4L2_TC_TYPE_24FPS</code>	1	24 frames per second, i. e. film.
<code>V4L2_TC_TYPE_25FPS</code>	2	25 frames per second, i. e. PAL or SECAM video.
<code>V4L2_TC_TYPE_30FPS</code>	3	30 frames per second, i. e. NTSC video.
<code>V4L2_TC_TYPE_50FPS</code>	4	
<code>V4L2_TC_TYPE_60FPS</code>	5	

Table 3-8. Timecode Flags

<code>V4L2_TC_FLAG_DROPFRAME</code>	0x0001	Indicates "drop frame" semantics for counting frames in 29.97 fps material. When set, frame numbers 0 and 1 at the start of each minute, except minutes 0, 10, 20, 30, 40, 50 are omitted from the count.
<code>V4L2_TC_FLAG_COLORFRAME</code>	0x0002	The "color frame" flag.
<code>V4L2_TC_USERBITS_field</code>	0x000C	Field mask for the "binary group flags".
<code>V4L2_TC_USERBITS_USERDEF</code>	0x0000	Unspecified format.
<code>V4L2_TC_USERBITS_8BITCHARS</code>	0x0008	8-bit ISO characters.

3.6. Field Order

We have to distinguish between progressive and interlaced video. Progressive video transmits all lines of a video image sequentially. Interlaced video divides an image into two fields, containing only the odd and even lines of the image, respectively. Alternating the so called odd and even field are transmitted, and due to a small delay between fields a cathode ray TV displays the lines interleaved, yielding the original frame. This curious technique was invented because at refresh rates similar to film the image would fade out too quickly. Transmitting fields reduces the flicker without the necessity of doubling the frame rate and with it the bandwidth required for each channel.

It is important to understand a video camera does not expose one frame at a time, merely transmitting the frames separated into fields. The fields are in fact captured at two different instances in time. An object on screen may well move between one field and the next. For applications analysing motion it is of paramount importance to recognize which field of a frame is older, the *temporal order*.

When the driver provides or accepts images field by field rather than interleaved, it is also important applications understand how the fields combine to frames. We distinguish between top (aka odd) and bottom (aka even) fields, the *spatial order*: The first line of the top field is the first line of an interlaced frame, the first line of the bottom field is the second line of that frame.

However because fields were captured one after the other, arguing whether a frame commences with the top or bottom field is pointless. Any two successive top and bottom, or bottom and top fields yield a valid frame. Only when the source was progressive to begin with, e. g. when transferring film to video, two fields may come from the same frame, creating a natural order.

Counter to intuition the top field is not necessarily the older field. Whether the older field contains the top or bottom lines is a convention determined by the video standard. Hence the distinction between temporal and spatial order of fields. The diagrams below should make this clearer.

All video capture and output devices must report the current field order. Some drivers may permit the selection of a different order, to this end applications initialize the *field* field of struct `v4l2_pix_format` before calling the `VIDIOC_S_FMT` ioctl. If this is not desired it should have the value `V4L2_FIELD_ANY` (0).

Table 3-9. enum v4l2_field

V4L2_FIELD_ANY	0	Applications request this field order when any one of the V4L2_FIELD_NONE, V4L2_FIELD_TOP, V4L2_FIELD_BOTTOM, or V4L2_FIELD_INTERLACED formats is acceptable. Drivers choose depending on hardware capabilities or e. g. the requested image size, and return the actual field order. struct <code>v4l2_buffer</code> <i>field</i> can never be V4L2_FIELD_ANY.
V4L2_FIELD_NONE	1	Images are in progressive format, not interlaced. The driver may also indicate this order when it cannot distinguish between V4L2_FIELD_TOP and V4L2_FIELD_BOTTOM.
V4L2_FIELD_TOP	2	Images consist of the top (aka odd) field only.
V4L2_FIELD_BOTTOM	3	Images consist of the bottom (aka even) field only. Applications may wish to prevent a device from capturing interlaced images because they will have "comb" or "feathering" artefacts around moving objects.
V4L2_FIELD_INTERLACED	4	Images contain both fields, interleaved line by line. The temporal order of the fields (whether the top or bottom field is first transmitted) depends on the current video standard. M/NTSC transmits the bottom field first, all other standards the top field first.
V4L2_FIELD_SEQ_TB	5	Images contain both fields, the top field lines are stored first in memory, immediately followed by the bottom field lines. Fields are always stored in temporal order, the older one first in memory. Image sizes refer to the frame, not fields.

V4L2_FIELD_SEQ_BT	6	Images contain both fields, the bottom field lines are stored first in memory, immediately followed by the top field lines. Fields are always stored in temporal order, the older one first in memory. Image sizes refer to the frame, not fields.
V4L2_FIELD_ALTERNATE	7	The two fields of a frame are passed in separate buffers, in temporal order, i. e. the older one first. To indicate the field parity (whether the current field is a top or bottom field) the driver or application, depending on data direction, must set struct <code>v4l2_buffer</code> <i>field</i> to <code>V4L2_FIELD_TOP</code> or <code>V4L2_FIELD_BOTTOM</code> . Any two successive fields pair to build a frame. If fields are successive, without any dropped fields between them (fields can drop individually), can be determined from the struct <code>v4l2_buffer</code> <i>sequence</i> field. Image sizes refer to the frame, not fields. This format cannot be selected when using the read/write I/O method.
V4L2_FIELD_INTERLACED_TB	8	Images contain both fields, interleaved line by line, top field first. The top field is transmitted first.
V4L2_FIELD_INTERLACED_BT	9	Images contain both fields, interleaved line by line, top field first. The bottom field is transmitted first.

Figure 3-1. Field Order, Top Field First Transmitted

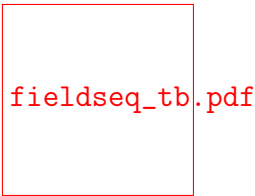


Figure 3-2. Field Order, Bottom Field First Transmitted

Notes

1. It would be desirable if applications could depend on drivers supporting all I/O interfaces, but as much as the complex memory mapping I/O can be inadequate for some devices we have no reason to require this interface, which is most useful for simple applications capturing still images.
2. At the driver level `select()` and `poll()` are the same, and `select()` is too important to be optional.
3. One could use one file descriptor and set the buffer type field accordingly when calling `VIDIOC_QBUF` etc., but it makes the `select()` function ambiguous. We also like the clean approach of one file descriptor per logical stream. Video overlay for example is also a logical stream, although the CPU is not needed for continuous operation.
4. Random enqueue order permits applications processing images out of order (such as video codecs) to return buffers earlier, reducing the probability of data loss. Random fill order allows drivers to reuse buffers on a LIFO-basis, taking advantage of caches holding scatter-gather lists and the like.
5. At the driver level `select()` and `poll()` are the same, and `select()` is too important to be optional. The rest should be evident.
6. We expect that frequently used buffers are typically not swapped out. Anyway, the process of swapping, locking or generating scatter-gather lists may be time consuming. The delay can be masked by the depth of the incoming buffer queue, and perhaps by maintaining caches assuming a buffer will be soon enqueued again. On the other hand, to optimize memory usage drivers can limit the number of buffers locked in advance and recycle the most recently used buffers first. Of course, the pages of empty buffers in the incoming queue need not be saved to disk. Output buffers must be saved on the incoming and outgoing queue because an application may share them with other processes.
7. At the driver level `select()` and `poll()` are the same, and `select()` is too important to be optional. The rest should be evident.

8. Since no other Linux multimedia API supports unadjusted time it would be foolish to introduce here. We must use a universally supported clock to synchronize different media, hence time of day.

Chapter 4. Interfaces

4.1. Video Capture Interface

Video capture devices sample an analog video signal and store the digitized images in memory. Today nearly all devices can capture at full 25 or 30 frames/second. With this interface applications can control the capture process and move images from the driver into user space.

Conventionally V4L2 video capture devices are accessed through character device special files named `/dev/video` and `/dev/video0` to `/dev/video63` with major number 81 and minor numbers 0 to 63. `/dev/video` is typically a symbolic link to the preferred video device. Note the same device files are used for video output devices.

4.1.1. Querying Capabilities

Devices supporting the video capture interface set the `V4L2_CAP_VIDEO_CAPTURE` or `V4L2_CAP_VIDEO_CAPTURE_MPLANE` flag in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl. As secondary device functions they may also support the video overlay (`V4L2_CAP_VIDEO_OVERLAY`) and the raw VBI capture (`V4L2_CAP_VBI_CAPTURE`) interface. At least one of the read/write or streaming I/O methods must be supported. Tuners and audio inputs are optional.

4.1.2. Supplemental Functions

Video capture devices shall support audio input, tuner, controls, cropping and scaling and streaming parameter ioctls as needed. The video input and video standard ioctls must be supported by all video capture devices.

4.1.3. Image Format Negotiation

The result of a capture operation is determined by cropping and image format parameters. The former select an area of the video picture to capture, the latter how images are stored in memory, i. e. in RGB or YUV format, the number of bits per pixel or width and height. Together they also define how images are scaled in the process.

As usual these parameters are *not* reset at `open()` time to permit Unix tool chains, programming a device and then reading from it as if it was a plain file. Well written V4L2 applications ensure they really get what they want, including cropping and scaling.

Cropping initialization at minimum requires to reset the parameters to defaults. An example is given in Section 1.12.

To query the current image format applications set the `type` field of a struct `v4l2_format` to `V4L2_BUF_TYPE_VIDEO_CAPTURE` or `V4L2_BUF_TYPE_VIDEO_CAPTURE_MPLANE` and call the `VIDIOC_G_FMT` ioctl with a pointer to this structure. Drivers fill the struct `v4l2_pix_format` `pix` or the struct `v4l2_pix_format_mplane` `pix_mp` member of the `fmt` union.

To request different parameters applications set the `type` field of a struct `v4l2_format` as above and initialize all fields of the struct `v4l2_pix_format` `vbi` member of the `fmt` union, or better just modify the results of `VIDIOC_G_FMT`, and call the `VIDIOC_S_FMT` ioctl with a pointer to this structure. Drivers may adjust the parameters and finally return the actual parameters as `VIDIOC_G_FMT` does.

Like `VIDIOC_S_FMT` the `VIDIOC_TRY_FMT` ioctl can be used to learn about hardware limitations without disabling I/O or possibly time consuming hardware preparations.

The contents of struct `v4l2_pix_format` and struct `v4l2_pix_format_mplane` are discussed in Chapter 2. See also the specification of the `VIDIOC_G_FMT`, `VIDIOC_S_FMT` and `VIDIOC_TRY_FMT` ioctls for details. Video capture devices must implement both the `VIDIOC_G_FMT` and `VIDIOC_S_FMT` ioctl, even if `VIDIOC_S_FMT` ignores all requests and always returns default parameters as `VIDIOC_G_FMT` does. `VIDIOC_TRY_FMT` is optional.

4.1.4. Reading Images

A video capture device may support the `read()` function and/or streaming (memory mapping or user pointer) I/O. See Chapter 3 for details.

4.2. Video Overlay Interface

Video overlay devices have the ability to genlock (TV-)video into the (VGA-)video signal of a graphics card, or to store captured images directly in video memory of a graphics card, typically with clipping. This can be considerable more efficient than capturing images and displaying them by other means. In the old days when only

nuclear power plants needed cooling towers this used to be the only way to put live video into a window.

Video overlay devices are accessed through the same character special files as video capture devices. Note the default function of a `/dev/video` device is video capturing. The overlay function is only available after calling the `VIDIOC_S_FMT` ioctl.

The driver may support simultaneous overlay and capturing using the read/write and streaming I/O methods. If so, operation at the nominal frame rate of the video standard is not guaranteed. Frames may be directed away from overlay to capture, or one field may be used for overlay and the other for capture if the capture parameters permit this.

Applications should use different file descriptors for capturing and overlay. This must be supported by all drivers capable of simultaneous capturing and overlay. Optionally these drivers may also permit capturing and overlay with a single file descriptor for compatibility with V4L and earlier versions of V4L2.¹

4.2.1. Querying Capabilities

Devices supporting the video overlay interface set the `V4L2_CAP_VIDEO_OVERLAY` flag in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl. The overlay I/O method specified below must be supported. Tuners and audio inputs are optional.

4.2.2. Supplemental Functions

Video overlay devices shall support audio input, tuner, controls, cropping and scaling and streaming parameter ioctls as needed. The video input and video standard ioctls must be supported by all video overlay devices.

4.2.3. Setup

Before overlay can commence applications must program the driver with frame buffer parameters, namely the address and size of the frame buffer and the image format, for example RGB 5:6:5. The `VIDIOC_G_FBUF` and `VIDIOC_S_FBUF` ioctls are available to get and set these parameters, respectively. The `VIDIOC_S_FBUF` ioctl is privileged because it allows to set up DMA into physical memory, bypassing the memory protection mechanisms of the kernel. Only the superuser can change the frame buffer address and size. Users are not supposed to run TV applications as

root or with SUID bit set. A small helper application with suitable privileges should query the graphics system and program the V4L2 driver at the appropriate time.

Some devices add the video overlay to the output signal of the graphics card. In this case the frame buffer is not modified by the video device, and the frame buffer address and pixel format are not needed by the driver. The `VIDIOC_S_FBUF` ioctl is not privileged. An application can check for this type of device by calling the `VIDIOC_G_FBUF` ioctl.

A driver may support any (or none) of five clipping/blending methods:

1. Chroma-keying displays the overlaid image only where pixels in the primary graphics surface assume a certain color.
2. A bitmap can be specified where each bit corresponds to a pixel in the overlaid image. When the bit is set, the corresponding video pixel is displayed, otherwise a pixel of the graphics surface.
3. A list of clipping rectangles can be specified. In these regions *no* video is displayed, so the graphics surface can be seen here.
4. The framebuffer has an alpha channel that can be used to clip or blend the framebuffer with the video.
5. A global alpha value can be specified to blend the framebuffer contents with video images.

When simultaneous capturing and overlay is supported and the hardware prohibits different image and frame buffer formats, the format requested first takes precedence. The attempt to capture (`VIDIOC_S_FMT`) or overlay (`VIDIOC_S_FBUF`) may fail with an `EBUSY` error code or return accordingly modified parameters..

4.2.4. Overlay Window

The overlaid image is determined by cropping and overlay window parameters. The former select an area of the video picture to capture, the latter how images are overlaid and clipped. Cropping initialization at minimum requires to reset the parameters to defaults. An example is given in Section 1.12.

The overlay window is described by a struct `v4l2_window`. It defines the size of the image, its position over the graphics surface and the clipping to be applied. To get the current parameters applications set the `type` field of a struct `v4l2_format` to `V4L2_BUF_TYPE_VIDEO_OVERLAY` and call the `VIDIOC_G_FMT` ioctl. The driver fills the `v4l2_window` substructure named `win`. It is not possible to retrieve a previously programmed clipping list or bitmap.

To program the overlay window applications set the *type* field of a `struct v4l2_format` to `V4L2_BUF_TYPE_VIDEO_OVERLAY`, initialize the *win* substructure and call the `VIDIOC_S_FMT` ioctl. The driver adjusts the parameters against hardware limits and returns the actual parameters as `VIDIOC_G_FMT` does. Like `VIDIOC_S_FMT`, the `VIDIOC_TRY_FMT` ioctl can be used to learn about driver capabilities without actually changing driver state. Unlike `VIDIOC_S_FMT` this also works after the overlay has been enabled.

The scaling factor of the overlaid image is implied by the width and height given in `struct v4l2_window` and the size of the cropping rectangle. For more information see Section 1.12.

When simultaneous capturing and overlay is supported and the hardware prohibits different image and window sizes, the size requested first takes precedence. The attempt to capture or overlay as well (`VIDIOC_S_FMT`) may fail with an `EBUSY` error code or return accordingly modified parameters.

Table 4-1. `struct v4l2_window`

<code>struct v4l2_rect</code>	<i>w</i>	Size and position of the window relative to the top, left corner of the frame buffer defined with <code>VIDIOC_S_FBUF</code> . The window can extend the frame buffer width and height, the <i>x</i> and <i>y</i> coordinates can be negative, and it can lie completely outside the frame buffer. The driver clips the window accordingly, or if that is not possible, modifies its size and/or position.
<code>enum v4l2_field</code>	<i>field</i>	Applications set this field to determine which video field shall be overlaid, typically one of <code>V4L2_FIELD_ANY</code> (0), <code>V4L2_FIELD_TOP</code> , <code>V4L2_FIELD_BOTTOM</code> or <code>V4L2_FIELD_INTERLACED</code> . Drivers may have to choose a different field order and return the actual setting here.

<code>__u32</code>	<code>chromakey</code>	<p>When chroma-keying has been negotiated with <code>VIDIOC_S_FBUF</code> applications set this field to the desired pixel value for the chroma key. The format is the same as the pixel format of the framebuffer (struct <code>v4l2_framebuffer</code> <code>fmt.pixelformat</code> field), with bytes in host order. E. g. for <code>V4L2_PIX_FMT_BGR24</code> the value should be <code>0xRRGGBB</code> on a little endian, <code>0xBBGGRR</code> on a big endian host.</p>
<code>struct v4l2_clip *</code>	<code>clips</code>	<p>When chroma-keying has <i>not</i> been negotiated and <code>VIDIOC_G_FBUF</code> indicated this capability, applications can set this field to point to an array of clipping rectangles.</p> <p>Like the window coordinates w, clipping rectangles are defined relative to the top, left corner of the frame buffer. However clipping rectangles must not extend the frame buffer width and height, and they must not overlap. If possible applications should merge adjacent rectangles. Whether this must create x-y or y-x bands, or the order of rectangles, is not defined. When clip lists are not supported the driver ignores this field. Its contents after calling <code>VIDIOC_S_FMT</code> are undefined.</p>
<code>__u32</code>	<code>clipcount</code>	<p>When the application set the <code>clips</code> field, this field must contain the number of clipping rectangles in the list. When clip lists are not supported the driver ignores this field, its contents after calling <code>VIDIOC_S_FMT</code> are undefined. When clip lists are supported but no clipping is desired this field must be set to zero.</p>

`void *` *bitmap* When chroma-keying has *not* been negotiated and `VIDIOC_G_FBUF` indicated this capability, applications can set this field to point to a clipping bit mask.

It must be of the same size as the window, *w.width* and *w.height*. Each bit corresponds to a pixel in the overlaid image, which is displayed only when the bit is *set*. Pixel coordinates translate to bits like:

```
((__u8 *) bitmap)[w.width * y + x / 8] & (1 << (x & 7))
```

where $0 \leq x < w.width$ and $0 \leq y < w.height$.^a

When a clipping bit mask is not supported the driver ignores this field, its contents after calling `VIDIOC_S_FMT` are undefined. When a bit mask is supported but no clipping is desired this field must be set to `NULL`.

Applications need not create a clip list or bit mask. When they pass both, or despite negotiating chroma-keying, the results are undefined. Regardless of the chosen method, the clipping abilities of the hardware may be limited in quantity or quality. The results when these limits are exceeded are undefined.^b

`__u8` *global_alpha* The global alpha value used to blend the framebuffer with video images, if global alpha blending has been negotiated (`V4L2_FBUF_FLAG_GLOBAL_ALPHA`, see `VIDIOC_S_FBUF`, Table A-3). Note this field was added in Linux 2.6.23, extending the structure. However the `VIDIOC_G/S/TRY_FMT` ioctls, which take a pointer to a `v4l2_format` parent structure with padding bytes at the end, are not affected.

Notes:

- a. Should we require *w.width* to be a multiple of eight?
- b. When the image is written into frame buffer memory it will be undesirable if the driver clips out less pixels than expected, because the application and graphics system are not aware these regions need to be refreshed. The driver should clip out more pixels or not write the image at all.

Table 4-2. struct v4l2_clip²

<code>struct v4l2_rect</code>	<code>c</code>	Coordinates of the clipping rectangle, relative to the top, left corner of the frame buffer. Only window pixels <i>outside</i> all clipping rectangles are displayed.
<code>struct v4l2_clip *</code>	<code>next</code>	Pointer to the next clipping rectangle, NULL when this is the last rectangle. Drivers ignore this field, it cannot be used to pass a linked list of clipping rectangles.

Table 4-3. struct v4l2_rect

<code>__s32</code>	<code>left</code>	Horizontal offset of the top, left corner of the rectangle, in pixels.
<code>__s32</code>	<code>top</code>	Vertical offset of the top, left corner of the rectangle, in pixels. Offsets increase to the right and down.
<code>__s32</code>	<code>width</code>	Width of the rectangle, in pixels.
<code>__s32</code>	<code>height</code>	Height of the rectangle, in pixels. Width and height cannot be negative, the fields are signed for hysterical reasons.

4.2.5. Enabling Overlay

To start or stop the frame buffer overlay applications call the `VIDIOC_OVERLAY` ioctl.

4.3. Video Output Interface

Video output devices encode stills or image sequences as analog video signal. With this interface applications can control the encoding process and move images from user space to the driver.

Conventionally V4L2 video output devices are accessed through character device special files named `/dev/video` and `/dev/video0` to `/dev/video63` with major number 81 and minor numbers 0 to 63. `/dev/video` is typically a symbolic link to

the preferred video device. Note the same device files are used for video capture devices.

4.3.1. Querying Capabilities

Devices supporting the video output interface set the `V4L2_CAP_VIDEO_OUTPUT` or `V4L2_CAP_VIDEO_OUTPUT_MPLANE` flag in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl. As secondary device functions they may also support the raw VBI output (`V4L2_CAP_VBI_OUTPUT`) interface. At least one of the read/write or streaming I/O methods must be supported. Modulators and audio outputs are optional.

4.3.2. Supplemental Functions

Video output devices shall support audio output, modulator, controls, cropping and scaling and streaming parameter ioctls as needed. The video output and video standard ioctls must be supported by all video output devices.

4.3.3. Image Format Negotiation

The output is determined by cropping and image format parameters. The former select an area of the video picture where the image will appear, the latter how images are stored in memory, i. e. in RGB or YUV format, the number of bits per pixel or width and height. Together they also define how images are scaled in the process.

As usual these parameters are *not* reset at `open()` time to permit Unix tool chains, programming a device and then writing to it as if it was a plain file. Well written V4L2 applications ensure they really get what they want, including cropping and scaling.

Cropping initialization at minimum requires to reset the parameters to defaults. An example is given in Section 1.12.

To query the current image format applications set the *type* field of a struct `v4l2_format` to `V4L2_BUF_TYPE_VIDEO_OUTPUT` or `V4L2_BUF_TYPE_VIDEO_OUTPUT_MPLANE` and call the `VIDIOC_G_FMT` ioctl with a pointer to this structure. Drivers fill the struct `v4l2_pix_format` *pix* or the struct `v4l2_pix_format_mplane` *pix_mp* member of the *fmt* union.

To request different parameters applications set the *type* field of a struct `v4l2_format` as above and initialize all fields of the struct `v4l2_pix_format` *vbi* member of the *fmt* union, or better just modify the results of `VIDIOC_G_FMT`,

and call the `VIDIOC_S_FMT` ioctl with a pointer to this structure. Drivers may adjust the parameters and finally return the actual parameters as `VIDIOC_G_FMT` does.

Like `VIDIOC_S_FMT` the `VIDIOC_TRY_FMT` ioctl can be used to learn about hardware limitations without disabling I/O or possibly time consuming hardware preparations.

The contents of struct `v4l2_pix_format` and struct `v4l2_pix_format_mplane` are discussed in Chapter 2. See also the specification of the `VIDIOC_G_FMT`, `VIDIOC_S_FMT` and `VIDIOC_TRY_FMT` ioctls for details. Video output devices must implement both the `VIDIOC_G_FMT` and `VIDIOC_S_FMT` ioctl, even if `VIDIOC_S_FMT` ignores all requests and always returns default parameters as `VIDIOC_G_FMT` does. `VIDIOC_TRY_FMT` is optional.

4.3.4. Writing Images

A video output device may support the `write()` function and/or streaming (memory mapping or user pointer) I/O. See Chapter 3 for details.

4.4. Video Output Overlay Interface

Experimental: This is an experimental interface and may change in the future.

Some video output devices can overlay a framebuffer image onto the outgoing video signal. Applications can set up such an overlay using this interface, which borrows structures and ioctls of the Video Overlay interface.

The OSD function is accessible through the same character special file as the Video Output function. Note the default function of such a `/dev/video` device is video capturing or output. The OSD function is only available after calling the `VIDIOC_S_FMT` ioctl.

4.4.1. Querying Capabilities

Devices supporting the *Video Output Overlay* interface set the `V4L2_CAP_VIDEO_OUTPUT_OVERLAY` flag in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl.

4.4.2. Framebuffer

Contrary to the *Video Overlay* interface the framebuffer is normally implemented on the TV card and not the graphics card. On Linux it is accessible as a framebuffer device (`/dev/fbN`). Given a V4L2 device, applications can find the corresponding framebuffer device by calling the `VIDIOC_G_FBUF` ioctl. It returns, amongst other information, the physical address of the framebuffer in the *base* field of struct `v4l2_framebuffer`. The framebuffer device ioctl `F BIOGET_FSCREENINFO` returns the same address in the *smem_start* field of struct `fb_fix_screeninfo`. The `F BIOGET_FSCREENINFO` ioctl and struct `fb_fix_screeninfo` are defined in the `linux/fb.h` header file.

The width and height of the framebuffer depends on the current video standard. A V4L2 driver may reject attempts to change the video standard (or any other ioctl which would imply a framebuffer size change) with an `EBUSY` error code until all applications closed the framebuffer device.

Example 4-1. Finding a framebuffer device for OSD

```
#include <linux/fb.h>

struct v4l2_framebuffer fbuf;
unsigned int i;
int fb_fd;

if (-1 == ioctl (fd, VIDIOC_G_FBUF, &fbuf)) {
    perror ("VIDIOC_G_FBUF");
    exit (EXIT_FAILURE);
}

for (i = 0; i < 30; ++i) {
    char dev_name[16];
    struct fb_fix_screeninfo si;

    snprintf (dev_name, sizeof (dev_name), "/dev/fb%u", i);

    fb_fd = open (dev_name, O_RDWR);
    if (-1 == fb_fd) {
        switch (errno) {
            case ENOENT: /* no such file */
            case ENXIO:  /* no driver */
                continue;

            default:
                perror ("open");
                exit (EXIT_FAILURE);
        }
    }
}
```

```

    }

    if (0 == ioctl (fb_fd, FBIOGET_FSCREENINFO, &si)) {
        if (si.smem_start == (unsigned long) fbuf.base)
            break;
    } else {
        /* Apparently not a framebuffer device. */
    }

    close (fb_fd);
    fb_fd = -1;
}

/* fb_fd is the file descriptor of the framebuffer device
   for the video output overlay, or -1 if no device was found. */

```

4.4.3. Overlay Window and Scaling

The overlay is controlled by source and target rectangles. The source rectangle selects a subsection of the framebuffer image to be overlaid, the target rectangle an area in the outgoing video signal where the image will appear. Drivers may or may not support scaling, and arbitrary sizes and positions of these rectangles. Further drivers may support any (or none) of the clipping/blending methods defined for the Video Overlay interface.

A struct `v4l2_window` defines the size of the source rectangle, its position in the framebuffer and the clipping/blending method to be used for the overlay. To get the current parameters applications set the `type` field of a struct `v4l2_format` to `V4L2_BUF_TYPE_VIDEO_OUTPUT_OVERLAY` and call the `VIDIOC_G_FMT` ioctl. The driver fills the `v4l2_window` substructure named `win`. It is not possible to retrieve a previously programmed clipping list or bitmap.

To program the source rectangle applications set the `type` field of a struct `v4l2_format` to `V4L2_BUF_TYPE_VIDEO_OUTPUT_OVERLAY`, initialize the `win` substructure and call the `VIDIOC_S_FMT` ioctl. The driver adjusts the parameters against hardware limits and returns the actual parameters as `VIDIOC_G_FMT` does. Like `VIDIOC_S_FMT`, the `VIDIOC_TRY_FMT` ioctl can be used to learn about driver capabilities without actually changing driver state. Unlike `VIDIOC_S_FMT` this also works after the overlay has been enabled.

A struct `v4l2_crop` defines the size and position of the target rectangle. The scaling factor of the overlay is implied by the width and height given in struct `v4l2_window` and struct `v4l2_crop`. The cropping API applies to *Video Output* and *Video Output Overlay* devices in the same way as to *Video Capture* and *Video Overlay* devices,

merely reversing the direction of the data flow. For more information see Section 1.12.

4.4.4. Enabling Overlay

There is no V4L2 ioctl to enable or disable the overlay, however the framebuffer interface of the driver may support the `FBIOLANK` ioctl.

4.5. Codec Interface

Suspended: This interface has been be suspended from the V4L2 API implemented in Linux 2.6 until we have more experience with codec device interfaces.

A V4L2 codec can compress, decompress, transform, or otherwise convert video data from one format into another format, in memory. Applications send data to be converted to the driver through a `write()` call, and receive the converted data through a `read()` call. For efficiency a driver may also support streaming I/O.

[to do]

4.6. Effect Devices Interface

Suspended: This interface has been be suspended from the V4L2 API implemented in Linux 2.6 until we have more experience with effect device interfaces.

A V4L2 video effect device can do image effects, filtering, or combine two or more images or image streams. For example video transitions or wipes. Applications send data to be processed and receive the result data either with `read()` and `write()` functions, or through the streaming I/O mechanism.

[to do]

4.7. Raw VBI Data Interface

VBI is an abbreviation of Vertical Blanking Interval, a gap in the sequence of lines of an analog video signal. During VBI no picture information is transmitted, allowing some time while the electron beam of a cathode ray tube TV returns to the top of the screen. Using an oscilloscope you will find here the vertical synchronization pulses and short data packages ASK modulated³ onto the video signal. These are transmissions of services such as Teletext or Closed Caption.

Subject of this interface type is raw VBI data, as sampled off a video signal, or to be added to a signal for output. The data format is similar to uncompressed video images, a number of lines times a number of samples per line, we call this a VBI image.

Conventionally V4L2 VBI devices are accessed through character device special files named `/dev/vbi` and `/dev/vbi0` to `/dev/vbi31` with major number 81 and minor numbers 224 to 255. `/dev/vbi` is typically a symbolic link to the preferred VBI device. This convention applies to both input and output devices.

To address the problems of finding related video and VBI devices VBI capturing and output is also available as device function under `/dev/video`. To capture or output raw VBI data with these devices applications must call the `VIDIOC_S_FMT` ioctl. Accessed as `/dev/vbi`, raw VBI capturing or output is the default device function.

4.7.1. Querying Capabilities

Devices supporting the raw VBI capturing or output API set the `V4L2_CAP_VBI_CAPTURE` or `V4L2_CAP_VBI_OUTPUT` flags, respectively, in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl. At least one of the read/write, streaming or asynchronous I/O methods must be supported. VBI devices may or may not have a tuner or modulator.

4.7.2. Supplemental Functions

VBI devices shall support video input or output, tuner or modulator, and controls ioctls as needed. The video standard ioctls provide information vital to program a VBI device, therefore must be supported.

4.7.3. Raw VBI Format Negotiation

Raw VBI sampling abilities can vary, in particular the sampling frequency. To

properly interpret the data V4L2 specifies an `ioctl` to query the sampling parameters. Moreover, to allow for some flexibility applications can also suggest different parameters.

As usual these parameters are *not* reset at `open()` time to permit Unix tool chains, programming a device and then reading from it as if it was a plain file. Well written V4L2 applications should always ensure they really get what they want, requesting reasonable parameters and then checking if the actual parameters are suitable.

To query the current raw VBI capture parameters applications set the `type` field of a struct `v4l2_format` to `V4L2_BUF_TYPE_VBI_CAPTURE` or `V4L2_BUF_TYPE_VBI_OUTPUT`, and call the `VIDIOC_G_FMT` `ioctl` with a pointer to this structure. Drivers fill the struct `v4l2_vbi_format` `vbi` member of the `fmt` union.

To request different parameters applications set the `type` field of a struct `v4l2_format` as above and initialize all fields of the struct `v4l2_vbi_format` `vbi` member of the `fmt` union, or better just modify the results of `VIDIOC_G_FMT`, and call the `VIDIOC_S_FMT` `ioctl` with a pointer to this structure. Drivers return an `EINVAL` error code only when the given parameters are ambiguous, otherwise they modify the parameters according to the hardware capabilities and return the actual parameters. When the driver allocates resources at this point, it may return an `EBUSY` error code to indicate the returned parameters are valid but the required resources are currently not available. That may happen for instance when the video and VBI areas to capture would overlap, or when the driver supports multiple opens and another process already requested VBI capturing or output. Anyway, applications must expect other resource allocation points which may return `EBUSY`, at the `VIDIOC_STREAMON` `ioctl` and the first `read()`, `write()` and `select()` call.

VBI devices must implement both the `VIDIOC_G_FMT` and `VIDIOC_S_FMT` `ioctl`, even if `VIDIOC_S_FMT` ignores all requests and always returns default parameters as `VIDIOC_G_FMT` does. `VIDIOC_TRY_FMT` is optional.

Table 4-4. struct `v4l2_vbi_format`

<code>__u32</code>	<code>sampling_rate</code>	Samples per second, i. e. unit 1 Hz.
<code>__u32</code>	<code>offset</code>	Horizontal offset of the VBI image, relative to the leading edge of the line synchronization pulse and counted in samples: The first sample in the VBI image will be located $offset / sampling_rate$ seconds following the leading edge. See also Figure 4-1.
<code>__u32</code>	<code>samples_per_line</code>	

<code>__u32</code>	<code>sample_format</code>	Defines the sample format as in Chapter 2, a four-character-code. ^a Usually this is <code>V4L2_PIX_FMT_GREY</code> , i. e. each sample consists of 8 bits with lower values oriented towards the black level. Do not assume any other correlation of values with the signal level. For example, the MSB does not necessarily indicate if the signal is 'high' or 'low' because 128 may not be the mean value of the signal. Drivers shall not convert the sample format by software.
<code>__u32</code>	<code>start[2]</code>	This is the scanning system line number associated with the first line of the VBI image, of the first and the second field respectively. See Figure 4-2 and Figure 4-3 for valid values. VBI input drivers can return start values 0 if the hardware cannot reliably identify scanning lines, VBI acquisition may not require this information.
<code>__u32</code>	<code>count[2]</code>	The number of lines in the first and second field image, respectively.

Drivers should be as flexibility as possible. For example, it may be possible to extend or move the VBI capture window down to the picture area, implementing a 'full field mode' to capture data service transmissions embedded in the picture.

An application can set the first or second `count` value to zero if no data is required from the respective field; `count[1]` if the scanning system is progressive, i. e. not interlaced. The corresponding start value shall be ignored by the application and driver. Anyway, drivers may not support single field capturing and return both count values non-zero.

Both `count` values set to zero, or line numbers outside the bounds depicted in Figure 4-2 and Figure 4-3, or a field image covering lines of two fields, are invalid and shall not be returned by the driver.

To initialize the `start` and `count` fields, applications must first determine the current video standard selection. The `v4l2_std_id` or the `framelines` field of struct `v4l2_standard` can be evaluated for this purpose.

<code>__u32</code>	<i>flags</i>	See Table 4-5 below. Currently only drivers set flags, applications must set this field to zero.
<code>__u32</code>	<i>reserved[2]</i>	This array is reserved for future extensions. Drivers and applications must set it to zero.

Notes:

- a. A few devices may be unable to sample VBI data at all but can extend the video capture window to the VBI region.

Table 4-5. Raw VBI Format Flags

<code>V4L2_VBI_UNSYNC</code>	<code>0x0001</code>	This flag indicates hardware which does not properly distinguish between fields. Normally the VBI image stores the first field (lower scanning line numbers) first in memory. This may be a top or bottom field depending on the video standard. When this flag is set the first or second field may be stored first, however the fields are still in correct temporal order with the older field first in memory. ^a
------------------------------	---------------------	---

V4L2_VBI_INTERLACED	0x0002	<p>By default the two field images will be passed sequentially; all lines of the first field followed by all lines of the second field (compare Section 3.6</p> <p>V4L2_FIELD_SEQ_TB and V4L2_FIELD_SEQ_BT, whether the top or bottom field is first in memory depends on the video standard). When this flag is set, the two fields are interlaced (cf. V4L2_FIELD_INTERLACED). The first line of the first field followed by the first line of the second field, then the two second lines, and so on. Such a layout may be necessary when the hardware has been programmed to capture or output interlaced video images and is unable to separate the fields for VBI capturing at the same time. For simplicity setting this flag implies that both <i>count</i> values are equal and non-zero.</p>
---------------------	--------	--

- Notes:
- a. Most VBI services transmit on both fields, but some have different semantics depending on the field number. These cannot be reliably decoded or encoded when V4L2_VBI_UNSYNC is set.

Figure 4-1. Line synchronization

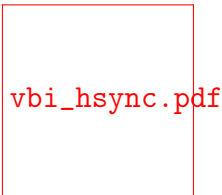
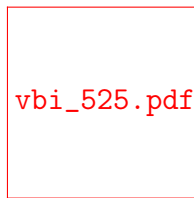
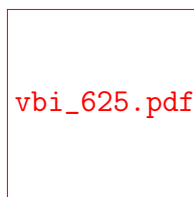


Figure 4-2. ITU-R 525 line numbering (M/NTSC and M/PAL)

(1) For the purpose of this specification field 2 starts in line 264 and not 263.5 because half line capturing is not supported.

Figure 4-3. ITU-R 625 line numbering

(1) For the purpose of this specification field 2 starts in line 314 and not 313.5 because half line capturing is not supported.

Remember the VBI image format depends on the selected video standard, therefore the application must choose a new standard or query the current standard first. Attempts to read or write data ahead of format negotiation, or after switching the video standard which may invalidate the negotiated VBI parameters, should be refused by the driver. A format change during active I/O is not permitted.

4.7.4. Reading and writing VBI images

To assure synchronization with the field number and easier implementation, the smallest unit of data passed at a time is one frame, consisting of two fields of VBI images immediately following in memory.

The total size of a frame computes as follows:

```
(count[0] + count[1]) *
samples_per_line * sample size in bytes
```

The sample size is most likely always one byte, applications must check the `sample_format` field though, to function properly with other drivers.

A VBI device may support read/write and/or streaming (memory mapping or user pointer) I/O. The latter bears the possibility of synchronizing video and VBI data by

using buffer timestamps.

Remember the `VIDIOC_STREAMON` ioctl and the first `read()`, `write()` and `select()` call can be resource allocation points returning an `EBUSY` error code if the required hardware resources are temporarily unavailable, for example the device is already in use by another process.

4.8. Sliced VBI Data Interface

VBI stands for Vertical Blanking Interval, a gap in the sequence of lines of an analog video signal. During VBI no picture information is transmitted, allowing some time while the electron beam of a cathode ray tube TV returns to the top of the screen.

Sliced VBI devices use hardware to demodulate data transmitted in the VBI. V4L2 drivers shall *not* do this by software, see also the **raw VBI interface**. The data is passed as short packets of fixed size, covering one scan line each. The number of packets per video frame is variable.

Sliced VBI capture and output devices are accessed through the same character special files as raw VBI devices. When a driver supports both interfaces, the default function of a `/dev/vbi` device is *raw* VBI capturing or output, and the sliced VBI function is only available after calling the `VIDIOC_S_FMT` ioctl as defined below. Likewise a `/dev/video` device may support the sliced VBI API, however the default function here is video capturing or output. Different file descriptors must be used to pass raw and sliced VBI data simultaneously, if this is supported by the driver.

4.8.1. Querying Capabilities

Devices supporting the sliced VBI capturing or output API set the `V4L2_CAP_SLICED_VBI_CAPTURE` or `V4L2_CAP_SLICED_VBI_OUTPUT` flag respectively, in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl. At least one of the read/write, streaming or asynchronous I/O methods must be supported. Sliced VBI devices may have a tuner or modulator.

4.8.2. Supplemental Functions

Sliced VBI devices shall support video input or output **and** tuner or modulator **ioctls** if they have these capabilities, and they may support control **ioctls**. The video

standard ioctls provide information vital to program a sliced VBI device, therefore must be supported.

4.8.3. Sliced VBI Format Negotiation

To find out which data services are supported by the hardware applications can call the `VIDIOC_G_SLICED_VBI_CAP` ioctl. All drivers implementing the sliced VBI interface must support this ioctl. The results may differ from those of the `VIDIOC_S_FMT` ioctl when the number of VBI lines the hardware can capture or output per frame, or the number of services it can identify on a given line are limited. For example on PAL line 16 the hardware may be able to look for a VPS or Teletext signal, but not both at the same time.

To determine the currently selected services applications set the `type` field of struct `v4l2_format` to `V4L2_BUF_TYPE_SLICED_VBI_CAPTURE` or `V4L2_BUF_TYPE_SLICED_VBI_OUTPUT`, and the `VIDIOC_G_FMT` ioctl fills the `fmt.sliced` member, a struct `v4l2_sliced_vbi_format`.

Applications can request different parameters by initializing or modifying the `fmt.sliced` member and calling the `VIDIOC_S_FMT` ioctl with a pointer to the `v4l2_format` structure.

The sliced VBI API is more complicated than the raw VBI API because the hardware must be told which VBI service to expect on each scan line. Not all services may be supported by the hardware on all lines (this is especially true for VBI output where Teletext is often unsupported and other services can only be inserted in one specific line). In many cases, however, it is sufficient to just set the `service_set` field to the required services and let the driver fill the `service_lines` array according to hardware capabilities. Only if more precise control is needed should the programmer set the `service_lines` array explicitly.

The `VIDIOC_S_FMT` ioctl modifies the parameters according to hardware capabilities. When the driver allocates resources at this point, it may return an `EBUSY` error code if the required resources are temporarily unavailable. Other resource allocation points which may return `EBUSY` can be the `VIDIOC_STREAMON` ioctl and the first `read()`, `write()` and `select()` call.

Table 4-6. struct `v4l2_sliced_vbi_format`

<code>__u32</code>	<code>service_set</code>	<p>If <code>service_set</code> is non-zero when passed with <code>VIDIOC_S_FMT</code> or <code>VIDIOC_TRY_FMT</code>, the <code>service_lines</code> array will be filled by the driver according to the services specified in this field. For example, if <code>service_set</code> is initialized with <code>V4L2_SLICED_TELETEXT_B V4L2_SLICED_WSS_625</code>, a driver for the cx25840 video decoder sets lines 7-22 of both fields_a to <code>V4L2_SLICED_TELETEXT_B</code> and line 23 of the first field to <code>V4L2_SLICED_WSS_625</code>. If <code>service_set</code> is set to zero, then the values of <code>service_lines</code> will be used instead.</p> <p>On return the driver sets this field to the union of all elements of the returned <code>service_lines</code> array. It may contain less services than requested, perhaps just one, if the hardware cannot handle more services simultaneously. It may be empty (zero) if none of the requested services are supported by the hardware.</p>
--------------------	--------------------------	---

`__u16` `service_lines[2][24]` Applications initialize this array with sets of data services the driver shall look for or insert on the respective scan line. Subject to hardware capabilities drivers return the requested set, a subset, which may be just a single service, or an empty set. When the hardware cannot handle multiple services on the same line the driver shall choose one. No assumptions can be made on which service the driver chooses. Data services are defined in Table 4-7. Array indices map to ITU-R line numbers (see also Figure 4-2 and Figure 4-3) as follows:

Element	525 line systems	625 line systems
<code>service_lines[0][1]</code>		1
<code>service_lines[0][23]</code>		23
<code>service_lines[16][1]</code>		314
<code>service_lines[18][23]</code>		336

`__u32` `io_size` Drivers must set `service_lines[0][0]` and `service_lines[1][0]` to zero. Maximum number of bytes passed by one `read()` or `write()` call, and the buffer size in bytes for the `VIDIOC_QBUF` and `VIDIOC_DQBUF` `ioctl`. Drivers set this field to the size of struct `v4l2_sliced_vbi_data` times the number of non-zero elements in the returned `service_lines` array (that is the number of lines potentially carrying data).

__u32

reserved[2]

This array is reserved for future extensions. Applications and drivers must set it to zero.

- Notes:
- a. According to ETS 300 706 lines 6-22 of the first field and lines 5-22 of the second field may carry Teletext data.

Table 4-7. Sliced VBI services

Symbol	Value	Reference	lines, usually	Payload
V4L2_SLICED_TELETEXT_B (Teletext System B)	0x0001B	ETS 300 706 ITU BT.657	PAL/SECAM line 21, 320-335 (second field 7-22)	Last 42 of the 45 byte Teletext packet, that is without clock run-in and framing code, lsb first transmitted.
V4L2_SLICED_VPS	0x0400	ETS 300 223	PAL line 16	Byte number 3 to 15 according to Figure 9 of ETS 300 231, lsb first transmitted.
V4L2_SLICED_CAPTION	0x1006B	EIA 608-B	NTSC line 21, 284 (second field 21)	Two bytes in transmission order, including parity bit, lsb first transmitted.
V4L2_SLICED_WSS	0x2400	ITU BT.1123 EN 300 294	PAL/SECAM line 21	Byte 0 msb lsb msb Bit 7 6 5 4 3 2 1 0 x x
V4L2_SLICED_VBI_525	0x2400	Set of services applicable to 525 line systems.		
V4L2_SLICED_VBI_625	0x2401	Set of services applicable to 625 line systems.		

Drivers may return an `EINVAL` error code when applications attempt to read or write data without prior format negotiation, after switching the video standard (which may invalidate the negotiated VBI parameters) and after switching the video input (which may change the video standard as a side effect). The `VIDIOC_S_FMT`

`ioctl` may return an `EBUSY` error code when applications attempt to change the format while i/o is in progress (between a `VIDIOC_STREAMON` and `VIDIOC_STREAMOFF` call, and after the first `read()` or `write()` call).

4.8.4. Reading and writing sliced VBI data

A single `read()` or `write()` call must pass all data belonging to one video frame. That is an array of `v4l2_sliced_vbi_data` structures with one or more elements and a total size not exceeding `io_size` bytes. Likewise in streaming I/O mode one buffer of `io_size` bytes must contain data of one video frame. The `id` of unused `v4l2_sliced_vbi_data` elements must be zero.

Table 4-8. struct v4l2_sliced_vbi_data

<code>__u32</code>	<code>id</code>	A flag from Table A-2 identifying the type of data in this packet. Only a single bit must be set. When the <code>id</code> of a captured packet is zero, the packet is empty and the contents of other fields are undefined. Applications shall ignore empty packets. When the <code>id</code> of a packet for output is zero the contents of the <code>data</code> field are undefined and the driver must no longer insert data on the requested <code>field</code> and <code>line</code> .
<code>__u32</code>	<code>field</code>	The video field number this data has been captured from, or shall be inserted at. 0 for the first field, 1 for the second field.
<code>__u32</code>	<code>line</code>	The field (as opposed to frame) line number this data has been captured from, or shall be inserted at. See Figure 4-2 and Figure 4-3 for valid values. Sliced VBI capture devices can set the line number of all packets to 0 if the hardware cannot reliably identify scan lines. The field number must always be valid.
<code>__u32</code>	<code>reserved</code>	This field is reserved for future extensions. Applications and drivers must set it to zero.

__u8	<i>data</i> [48] The packet payload. See Table A-2 for the contents and number of bytes passed for each data type. The contents of padding bytes at the end of this array are undefined, drivers and applications shall ignore them.
------	--

Packets are always passed in ascending line number order, without duplicate line numbers. The `write()` function and the `VIDIOC_QBUF` ioctl must return an `EINVAL` error code when applications violate this rule. They must also return an `EINVAL` error code when applications pass an incorrect field or line number, or a combination of *field*, *line* and *id* which has not been negotiated with the `VIDIOC_G_FMT` or `VIDIOC_S_FMT` ioctl. When the line numbers are unknown the driver must pass the packets in transmitted order. The driver can insert empty packets with *id* set to zero anywhere in the packet array.

To assure synchronization and to distinguish from frame dropping, when a captured frame does not carry any of the requested data services drivers must pass one or more empty packets. When an application fails to pass VBI data in time for output, the driver must output the last VPS and WSS packet again, and disable the output of Closed Caption and Teletext data, or output data which is ignored by Closed Caption and Teletext decoders.

A sliced VBI device may support read/write and/or streaming (memory mapping and/or user pointer) I/O. The latter bears the possibility of synchronizing video and VBI data by using buffer timestamps.

4.8.5. Sliced VBI Data in MPEG Streams

If a device can produce an MPEG output stream, it may be capable of providing negotiated sliced VBI services as data embedded in the MPEG stream. Users or applications control this sliced VBI data insertion with the `V4L2_CID_MPEG_STREAM_VBI_FMT` control.

If the driver does not provide the `V4L2_CID_MPEG_STREAM_VBI_FMT` control, or only allows that control to be set to `V4L2_MPEG_STREAM_VBI_FMT_NONE`, then the device cannot embed sliced VBI data in the MPEG stream.

The `V4L2_CID_MPEG_STREAM_VBI_FMT` control does not implicitly set the device driver to capture nor cease capturing sliced VBI data. The control only indicates to embed sliced VBI data in the MPEG stream, if an application has negotiated sliced VBI service be captured.

It may also be the case that a device can embed sliced VBI data in only certain types of MPEG streams: for example in an MPEG-2 PS but not an MPEG-2 TS. In this situation, if sliced VBI data insertion is requested, the sliced VBI data will be embedded in MPEG stream types when supported, and silently omitted from MPEG stream types where sliced VBI data insertion is not supported by the device.

The following subsections specify the format of the embedded sliced VBI data.

4.8.5.1. MPEG Stream Embedded, Sliced VBI Data Format: NONE

The `V4L2_MPEG_STREAM_VBI_FMT_NONE` embedded sliced VBI format shall be interpreted by drivers as a control to cease embedding sliced VBI data in MPEG streams. Neither the device nor driver shall insert "empty" embedded sliced VBI data packets in the MPEG stream when this format is set. No MPEG stream data structures are specified for this format.

4.8.5.2. MPEG Stream Embedded, Sliced VBI Data Format: IVTV

The `V4L2_MPEG_STREAM_VBI_FMT_IVTV` embedded sliced VBI format, when supported, indicates to the driver to embed up to 36 lines of sliced VBI data per frame in an MPEG-2 *Private Stream 1 PES* packet encapsulated in an MPEG-2 *Program Pack* in the MPEG stream.

Historical context: This format specification originates from a custom, embedded, sliced VBI data format used by the `ivtv` driver. This format has already been informally specified in the kernel sources in the file

`Documentation/video4linux/cx2341x/README.vbi`. The maximum size of the payload and other aspects of this format are driven by the CX23415 MPEG decoder's capabilities and limitations with respect to extracting, decoding, and displaying sliced VBI data embedded within an MPEG stream.

This format's use is *not* exclusive to the `ivtv` driver *nor* exclusive to CX2341x devices, as the sliced VBI data packet insertion into the MPEG stream is implemented in driver software. At least the `cx18` driver provides sliced VBI data insertion into an MPEG-2 PS in this format as well.

The following definitions specify the payload of the MPEG-2 *Private Stream 1 PES* packets that contain sliced VBI data when `V4L2_MPEG_STREAM_VBI_FMT_IVTV` is set. (The MPEG-2 *Private Stream 1 PES* packet header and encapsulating MPEG-2 *Program Pack* header are not detailed here. Please refer to the MPEG-2 specifications for details on those packet headers.)

The payload of the MPEG-2 *Private Stream 1 PES* packets that contain sliced VBI data is specified by struct `v4l2_mpeg_vbi_fmt_itv`. The payload is variable length, depending on the actual number of lines of sliced VBI data present in a video frame. The payload may be padded at the end with unspecified fill bytes to align the end of the payload to a 4-byte boundary. The payload shall never exceed 1552 bytes (2 fields with 18 lines/field with 43 bytes of data/line and a 4 byte magic number).

Table 4-9. struct `v4l2_mpeg_vbi_fmt_itv`

<code>__u8</code>	<code>magic[4]</code>	A "magic" constant from Table 4-10 that indicates this is a valid sliced VBI data payload and also indicates which member of the anonymous union, <code>itv0</code> or <code>ITV0</code> , to use for the payload data.
union	(anonymous)	
	struct <code>itv0</code> <code>v4l2_mpeg_vbi_itv0</code>	The primary form of the sliced VBI data payload that contains anywhere from 1 to 35 lines of sliced VBI data. Line masks are provided in this form of the payload indicating which VBI lines are provided.
	struct <code>ITV0</code> <code>v4l2_mpeg_vbi_ITV0</code>	An alternate form of the sliced VBI data payload used when 36 lines of sliced VBI data are present. No line masks are provided in this form of the payload; all valid line mask bits are implicitly set.

Table 4-10. Magic Constants for struct `v4l2_mpeg_vbi_fmt_itv` *magic* field

Defined Symbol	Value	Description
<code>V4L2_MPEG_VBI_IVTV_MAGIC_ITV0</code>	<code>"itv0"</code>	Indicates the <code>itv0</code> member of the union in struct <code>v4l2_mpeg_vbi_fmt_itv</code> is valid.
<code>V4L2_MPEG_VBI_IVTV_MAGIC_ITV0</code>	<code>"ITV0"</code>	Indicates the <code>ITV0</code> member of the union in struct <code>v4l2_mpeg_vbi_fmt_itv</code> is valid and that 36 lines of sliced VBI data are present.

Table 4-11. struct v4l2_mpeg_vbi_itv0

__le32	<i>linemask</i> [2]	<p>Bitmasks indicating the VBI service lines present. These <i>linemask</i> values are stored in little endian byte order in the MPEG stream. Some reference <i>linemask</i> bit positions with their corresponding VBI line number and video field are given below. <i>b</i>₀ indicates the least significant bit of a <i>linemask</i> value:</p> <pre> linemask[0] <i>b</i>₀: line 6 first field linemask[0] <i>b</i>₁₇: line 23 first field linemask[0] <i>b</i>₁₈: line 6 second field linemask[0] <i>b</i>₃₁: line 19 second field linemask[1] <i>b</i>₀: line 20 second field linemask[1] <i>b</i>₃: line 23 second field linemask[1] <i>b</i>₄–<i>b</i>₃₁: unused and set to 0 </pre>
struct v4l2_mpeg_vbi_itv0_line	<i>line</i> [35]	<p>This is a variable length array that holds from 1 to 35 lines of sliced VBI data. The sliced VBI data lines present correspond to the bits set in the <i>linemask</i> array, starting from <i>b</i>₀ of <i>linemask</i>[0] up through <i>b</i>₃₁ of <i>linemask</i>[0], and from <i>b</i>₀ of <i>linemask</i>[1] up through <i>b</i>₃ of <i>linemask</i>[1]. <i>line</i>[0] corresponds to the first bit found set in the <i>linemask</i> array, <i>line</i>[1] corresponds to the second bit found set in the <i>linemask</i> array, etc. If no <i>linemask</i> array bits are set, then <i>line</i>[0] may contain one line of unspecified data that should be ignored by applications.</p>

Table 4-12. struct v4l2_mpeg_vbi_ITV0

struct	<i>line</i> [36]	A fixed length array of 36 lines of sliced VBI data. <i>line</i> [0] through <i>line</i> [17] correspond to lines 6 through 23 of the first field. <i>line</i> [18] through <i>line</i> [35] corresponds to lines 6 through 23 of the second field.
v4l2_mpeg_vbi_itv0_line		

Table 4-13. struct v4l2_mpeg_vbi_itv0_line

__u8	<i>id</i>	A line identifier value from Table 4-14 that indicates the type of sliced VBI data stored on this line.
__u8	<i>data</i> [42]	The sliced VBI data for the line.

Table 4-14. Line Identifiers for struct v4l2_mpeg_vbi_itv0_line *id* field

Defined Symbol	Value	Description
V4L2_MPEG_VBI_IVTV_TELETEXT_B	1	Refer to Sliced VBI services for a description of the line payload.
V4L2_MPEG_VBI_IVTV_CAPTION_525	4	Refer to Sliced VBI services for a description of the line payload.
V4L2_MPEG_VBI_IVTV_WSS_525	5	Refer to Sliced VBI services for a description of the line payload.
V4L2_MPEG_VBI_IVTV_VPS	7	Refer to Sliced VBI services for a description of the line payload.

4.9. Teletext Interface

This interface was aimed at devices receiving and demodulating Teletext data [ETS 300 706, ITU BT.653], evaluating the Teletext packages and storing formatted pages in cache memory. Such devices are usually implemented as microcontrollers with serial interface (I²C) and could be found on old TV cards, dedicated Teletext decoding cards and home-brew devices connected to the PC parallel port.

The Teletext API was designed by Martin Buck. It was defined in the kernel header file `linux/videotext.h`, the specification is available from <ftp://ftp.gwdg.de/pub/linux/misc/videotext/> (<ftp://ftp.gwdg.de/pub/linux/misc/videotext/>). (Videotext is the name of the German

public television Teletext service.)

Eventually the Teletext API was integrated into the V4L API with character device file names `/dev/vtx0` to `/dev/vtx31`, device major number 81, minor numbers 192 to 223.

However, teletext decoders were quickly replaced by more generic VBI demodulators and those dedicated teletext decoders no longer exist. For many years the vtx devices were still around, even though nobody used them. So the decision was made to finally remove support for the Teletext API in kernel 2.6.37.

Modern devices all use the `raw` or `sliced` VBI API.

4.10. Radio Interface

This interface is intended for AM and FM (analog) radio receivers and transmitters.

Conventionally V4L2 radio devices are accessed through character device special files named `/dev/radio` and `/dev/radio0` to `/dev/radio63` with major number 81 and minor numbers 64 to 127.

4.10.1. Querying Capabilities

Devices supporting the radio interface set the `V4L2_CAP_RADIO` and `V4L2_CAP_TUNER` or `V4L2_CAP_MODULATOR` flag in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl. Other combinations of capability flags are reserved for future extensions.

4.10.2. Supplemental Functions

Radio devices can support `controls`, and must support the `tuner` or `modulator` ioctls.

They do not support the video input or output, audio input or output, video standard, cropping and scaling, compression and streaming parameter, or overlay ioctls. All other ioctls and I/O methods are reserved for future extensions.

4.10.3. Programming

Radio devices may have a couple audio controls (as discussed in Section 1.8) such as a volume control, possibly custom controls. Further all radio devices have one tuner or modulator (these are discussed in Section 1.6) with index number zero to select the radio frequency and to determine if a monaural or FM stereo program is

received/emitted. Drivers switch automatically between AM and FM depending on the selected frequency. The `VIDIOC_G_TUNER` or `VIDIOC_G_MODULATOR` ioctl reports the supported frequency range.

4.11. RDS Interface

The Radio Data System transmits supplementary information in binary format, for example the station name or travel information, on an inaudible audio subcarrier of a radio program. This interface is aimed at devices capable of receiving and/or transmitting RDS information.

For more information see the core RDS standard EN 50067 and the RBDS standard NRSC-4.

Note that the RBDS standard as is used in the USA is almost identical to the RDS standard. Any RDS decoder/encoder can also handle RBDS. Only some of the fields have slightly different meanings. See the RBDS standard for more information.

The RBDS standard also specifies support for MMBS (Modified Mobile Search). This is a proprietary format which seems to be discontinued. The RDS interface does not support this format. Should support for MMBS (or the so-called 'E blocks' in general) be needed, then please contact the linux-media mailing list: <http://www.linuxtv.org/lists.php>.

4.11.1. Querying Capabilities

Devices supporting the RDS capturing API set the `V4L2_CAP_RDS_CAPTURE` flag in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP` ioctl. Any tuner that supports RDS will set the `V4L2_TUNER_CAP_RDS` flag in the *capability* field of struct `v4l2_tuner`. If the driver only passes RDS blocks without interpreting the data the `V4L2_TUNER_SUB_RDS_BLOCK_IO` flag has to be set, see [Reading RDS data](#). For future use the flag `V4L2_TUNER_SUB_RDS_CONTROLS` has also been defined. However, a driver for a radio tuner with this capability does not yet exist, so if you are planning to write such a driver you should discuss this on the linux-media mailing list: <http://www.linuxtv.org/lists.php>.

Whether an RDS signal is present can be detected by looking at the *rxsubchans* field of struct `v4l2_tuner`: the `V4L2_TUNER_SUB_RDS` will be set if RDS data was detected.

Devices supporting the RDS output API set the `V4L2_CAP_RDS_OUTPUT` flag in the *capabilities* field of struct `v4l2_capability` returned by the `VIDIOC_QUERYCAP`

`ioctl`. Any modulator that supports RDS will set the `V4L2_TUNER_CAP_RDS` flag in the `capability` field of struct `v4l2_modulator`. In order to enable the RDS transmission one must set the `V4L2_TUNER_SUB_RDS` bit in the `txsubchans` field of struct `v4l2_modulator`. If the driver only passes RDS blocks without interpreting the data the `V4L2_TUNER_SUB_RDS_BLOCK_IO` flag has to be set. If the tuner is capable of handling RDS entities like program identification codes and radio text, the flag `V4L2_TUNER_SUB_RDS_CONTROLS` should be set, see [Writing RDS data](#) and [FM Transmitter Control Reference](#).

4.11.2. Reading RDS data

RDS data can be read from the radio device with the `read()` function. The data is packed in groups of three bytes.

4.11.3. Writing RDS data

RDS data can be written to the radio device with the `write()` function. The data is packed in groups of three bytes, as follows:

4.11.4. RDS datastructures

Table 4-15. struct `v4l2_rds_data`

<code>__u8</code>	<code>lsb</code>	Least Significant Byte of RDS Block
<code>__u8</code>	<code>msb</code>	Most Significant Byte of RDS Block
<code>__u8</code>	<code>block</code>	Block description

Table 4-16. Block description

Bits 0-2	Block (aka offset) of the received data.
Bits 3-5	Deprecated. Currently identical to bits 0-2. Do not use these bits.
Bit 6	Corrected bit. Indicates that an error was corrected for this data block.
Bit 7	Error bit. Indicates that an uncorrectable error occurred during reception of this block.

Table 4-17. Block defines

V4L2_RDS_BLOCK7_MSK	Mask for bits 0-2 to get the block ID.
V4L2_RDS_BLOCK0_A	Block A.
V4L2_RDS_BLOCK1_B	Block B.
V4L2_RDS_BLOCK2_C	Block C.
V4L2_RDS_BLOCK3_D	Block D.
V4L2_RDS_BLOCK4_C_ALT	Block C'.
V4L2_RDS_BLOCK7_INVALID	An invalid block. only
V4L2_RDS_BLOCK0_CORRECTED	Error was detected but corrected. only
V4L2_RDS_BLOCK0_ERROR	An uncorrectable error occurred. only

4.12. Event Interface

The V4L2 event interface provides means for user to get immediately notified on certain conditions taking place on a device. This might include start of frame or loss of signal events, for example.

To receive events, the events the user is interested in first must be subscribed using the `VIDIOC_SUBSCRIBE_EVENT` ioctl. Once an event is subscribed, the events of subscribed types are dequeuable using the `VIDIOC_DQEVENT` ioctl. Events may be unsubscribed using `VIDIOC_UNSUBSCRIBE_EVENT` ioctl. The special event type `V4L2_EVENT_ALL` may be used to unsubscribe all the events the driver supports.

The event subscriptions and event queues are specific to file handles. Subscribing an event on one file handle does not affect other file handles.

The information on dequeuable events is obtained by using `select` or `poll` system calls on video devices. The V4L2 events use `POLLPRI` events on `poll` system call

and exceptions on select system call.

4.13. Sub-device Interface

Experimental: This is an experimental interface and may change in the future.

The complex nature of V4L2 devices, where hardware is often made of several integrated circuits that need to interact with each other in a controlled way, leads to complex V4L2 drivers. The drivers usually reflect the hardware model in software, and model the different hardware components as software blocks called sub-devices.

V4L2 sub-devices are usually kernel-only objects. If the V4L2 driver implements the media device API, they will automatically inherit from media entities. Applications will be able to enumerate the sub-devices and discover the hardware topology using the media entities, pads and links enumeration API.

In addition to make sub-devices discoverable, drivers can also choose to make them directly configurable by applications. When both the sub-device driver and the V4L2 device driver support this, sub-devices will feature a character device node on which ioctls can be called to

- query, read and write sub-devices controls
- subscribe and unsubscribe to events and retrieve them
- negotiate image formats on individual pads

Sub-device character device nodes, conventionally named `/dev/v4l-subdev*`, use major number 81.

4.13.1. Controls

Most V4L2 controls are implemented by sub-device hardware. Drivers usually merge all controls and expose them through video device nodes. Applications can control all sub-devices through a single interface.

Complex devices sometimes implement the same control in different pieces of hardware. This situation is common in embedded platforms, where both sensors and image processing hardware implement identical functions, such as contrast adjustment, white balance or faulty pixels correction. As the V4L2 controls API

doesn't support several identical controls in a single device, all but one of the identical controls are hidden.

Applications can access those hidden controls through the sub-device node with the V4L2 control API described in Section 1.8. The ioctls behave identically as when issued on V4L2 device nodes, with the exception that they deal only with controls implemented in the sub-device.

Depending on the driver, those controls might also be exposed through one (or several) V4L2 device nodes.

4.13.2. Events

V4L2 sub-devices can notify applications of events as described in Section 4.12. The API behaves identically as when used on V4L2 device nodes, with the exception that it only deals with events generated by the sub-device. Depending on the driver, those events might also be reported on one (or several) V4L2 device nodes.

4.13.3. Pad-level Formats

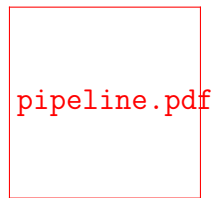
Warning

Pad-level formats are only applicable to very complex device that need to expose low-level format configuration to user space. Generic V4L2 applications do *not* need to use the API described in this section.

Note: For the purpose of this section, the term *format* means the combination of media bus data format, frame width and frame height.

Image formats are typically negotiated on video capture and output devices using the **cropping and scaling** ioctls. The driver is responsible for configuring every block in the video pipeline according to the requested format at the pipeline input and/or output.

For complex devices, such as often found in embedded systems, identical image sizes at the output of a pipeline can be achieved using different hardware configurations. One such example is shown on Figure 4-4, where image scaling can be performed on both the video sensor and the host image processing hardware.

Figure 4-4. Image Format Negotiation on Pipelines

The sensor scaler is usually of less quality than the host scaler, but scaling on the sensor is required to achieve higher frame rates. Depending on the use case (quality vs. speed), the pipeline must be configured differently. Applications need to configure the formats at every point in the pipeline explicitly.

Drivers that implement the **media API** can expose pad-level image format configuration to applications. When they do, applications can use the `VIDIOC_SUBDEV_G_FMT` and `VIDIOC_SUBDEV_S_FMT` ioctls. to negotiate formats on a per-pad basis.

Applications are responsible for configuring coherent parameters on the whole pipeline and making sure that connected pads have compatible formats. The pipeline is checked for formats mismatch at `VIDIOC_STREAMON` time, and an `EPIPE` error code is then returned if the configuration is invalid.

Pad-level image format configuration support can be tested by calling the `VIDIOC_SUBDEV_G_FMT` ioctl on pad 0. If the driver returns an `EINVAL` error code pad-level format configuration is not supported by the sub-device.

4.13.3.1. Format Negotiation

Acceptable formats on pads can (and usually do) depend on a number of external parameters, such as formats on other pads, active links, or even controls. Finding a combination of formats on all pads in a video pipeline, acceptable to both application and driver, can't rely on formats enumeration only. A format negotiation mechanism is required.

Central to the format negotiation mechanism are the get/set format operations. When called with the *which* argument set to `V4L2_SUBDEV_FORMAT_TRY`, the `VIDIOC_SUBDEV_G_FMT` and `VIDIOC_SUBDEV_S_FMT` ioctls operate on a set of formats parameters that are not connected to the hardware configuration. Modifying those 'try' formats leaves the device state untouched (this applies to both the software state stored in the driver and the hardware state stored in the device itself).

While not kept as part of the device state, try formats are stored in the sub-device file handles. A `VIDIOC_SUBDEV_G_FMT` call will return the last try format set *on the same sub-device file handle*. Several applications querying the same sub-device at the same time will thus not interact with each other.

To find out whether a particular format is supported by the device, applications use the `VIDIOC_SUBDEV_S_FMT` ioctl. Drivers verify and, if needed, change the requested *format* based on device requirements and return the possibly modified value. Applications can then choose to try a different format or accept the returned value and continue.

Formats returned by the driver during a negotiation iteration are guaranteed to be supported by the device. In particular, drivers guarantee that a returned format will not be further changed if passed to an `VIDIOC_SUBDEV_S_FMT` call as-is (as long as external parameters, such as formats on other pads or links' configuration are not changed).

Drivers automatically propagate formats inside sub-devices. When a try or active format is set on a pad, corresponding formats on other pads of the same sub-device can be modified by the driver. Drivers are free to modify formats as required by the device. However, they should comply with the following rules when possible:

- Formats should be propagated from sink pads to source pads. Modifying a format on a source pad should not modify the format on any sink pad.
- Sub-devices that scale frames using variable scaling factors should reset the scale factors to default values when sink pads formats are modified. If the 1:1 scaling ratio is supported, this means that source pads formats should be reset to the sink pads formats.

Formats are not propagated across links, as that would involve propagating them from one sub-device file handle to another. Applications must then take care to configure both ends of every link explicitly with compatible formats. Identical formats on the two ends of a link are guaranteed to be compatible. Drivers are free to accept different formats matching device requirements as being compatible.

Table 4-18 shows a sample configuration sequence for the pipeline described in Figure 4-4 (table columns list entity names and pad numbers).

Table 4-18. Sample Pipeline Configuration

	Sensor/0	Frontend/0	Frontend/1	Scaler/0	Scaler/1
Initial state		2048x1536		-	-
Configure frontend input		2048x1536		2048x1536	2046x1534
Configure scaler input		2048x1536		2048x1536	2046x1534

	Sensor/0	Frontend/0	Frontend/1	Scaler/0	Scaler/1
Configure		2048x1536		2048x1536	2046x1534
scaler					
output					

1. Initial state. The sensor output is set to its native 3MP resolution. Resolutions on the host frontend and scaler input and output pads are undefined.
2. The application configures the frontend input pad resolution to 2048x1536. The driver propagates the format to the frontend output pad. Note that the propagated output format can be different, as in this case, than the input format, as the hardware might need to crop pixels (for instance when converting a Bayer filter pattern to RGB or YUV).
3. The application configures the scaler input pad resolution to 2046x1534 to match the frontend output resolution. The driver propagates the format to the scaler output pad.
4. The application configures the scaler output pad resolution to 1280x960.

When satisfied with the try results, applications can set the active formats by setting the *which* argument to `V4L2_SUBDEV_FORMAT_TRY`. Active formats are changed exactly as try formats by drivers. To avoid modifying the hardware state during format negotiation, applications should negotiate try formats first and then modify the active settings using the try formats returned during the last negotiation iteration. This guarantees that the active format will be applied as-is by the driver without being modified.

4.13.3.2. Cropping and scaling

Many sub-devices support cropping frames on their input or output pads (or possible even on both). Cropping is used to select the area of interest in an image, typically on a video sensor or video decoder. It can also be used as part of digital zoom implementations to select the area of the image that will be scaled up.

Crop settings are defined by a crop rectangle and represented in a struct `v4l2_rect` by the coordinates of the top left corner and the rectangle size. Both the coordinates and sizes are expressed in pixels.

The crop rectangle is retrieved and set using the `VIDIOC_SUBDEV_G_CROP` and `VIDIOC_SUBDEV_S_CROP` ioctls. Like for pad formats, drivers store try and active crop rectangles. The format negotiation mechanism applies to crop settings as well.

On input pads, cropping is applied relatively to the current pad format. The pad format represents the image size as received by the sub-device from the previous block in the pipeline, and the crop rectangle represents the sub-image that will be transmitted further inside the sub-device for processing. The crop rectangle be entirely contained inside the input image size.

Input crop rectangle are reset to their default value when the input image format is modified. Drivers should use the input image size as the crop rectangle default value, but hardware requirements may prevent this.

Cropping behaviour on output pads is not defined.

4.13.4. Media Bus Formats

Table 4-19. struct v4l2_mbus_framefmt

<code>__u32</code>	<i>width</i>	Image width, in pixels.
<code>__u32</code>	<i>height</i>	Image height, in pixels.
<code>__u32</code>	<i>code</i>	Format code, from <code>enum v4l2_mbus_pixelcode</code> .
<code>__u32</code>	<i>field</i>	Field order, from <code>enum v4l2_field</code> . See Section 3.6 for details.
<code>__u32</code>	<i>colospace</i>	Image colorspace, from <code>enum v4l2_colospace</code> . See Section 2.4 for details.
<code>__u32</code>	<i>reserved[7]</i>	Reserved for future extensions. Applications and drivers must set the array to zero.

4.13.4.1. Media Bus Pixel Codes

The media bus pixel codes describe image formats as flowing over physical busses (both between separate physical components and inside SoC devices). This should not be confused with the V4L2 pixel formats that describe, using four character codes, image formats as stored in memory.

While there is a relationship between image formats on busses and image formats in memory (a raw Bayer image won't be magically converted to JPEG just by storing it to memory), there is no one-to-one correspondance between them.

4.13.4.1.1. Packed RGB Formats

Those formats transfer pixel data as red, green and blue components. The format code is made of the following information.

- The red, green and blue components order code, as encoded in a pixel sample. Possible values are RGB and BGR.
- The number of bits per component, for each component. The values can be different for all components. Common values are 555 and 565.
- The number of bus samples per pixel. Pixels that are wider than the bus width must be transferred in multiple samples. Common values are 1 and 2.
- The bus width.
- For formats where the total number of bits per pixel is smaller than the number of bus samples per pixel times the bus width, a padding value stating if the bytes are padded in their most high order bits (PADHI) or low order bits (PADLO).
- For formats where the number of bus samples per pixel is larger than 1, an endianness value stating if the pixel is transferred MSB first (BE) or LSB first (LE).

For instance, a format where pixels are encoded as 5-bits red, 5-bits green and 5-bit blue values padded on the high bit, transferred as 2 8-bit samples per pixel with the most significant bits (padding, red and half of the green value) transferred first will be named V4L2_MBUS_FMT_RGB555_2X8_PADHI_BE.

The following tables list existing packet RGB formats.

Table 4-20. RGB formats

Identifier	Code	Data organization								
		Bit	7	6	5	4	3	2	1	0
V4L2_MBUS_FMT_RGB444_2X8_PADHI_BE	0x1001						r3	r2	r1	r0
			g3	g2	g1	g0	b3	b2	b1	b0
V4L2_MBUS_FMT_RGB444_2X8_PADHI_LE	0x1002						b3	b2	b1	b0
			0	0	0	0	r3	r2	r1	r0

Identifier	Code	Data organization								
		Bit	7	6	5	4	3	2	1	0
V4L2_MBUS_FMT_RGB555_2X8_PADLHI_BE	0x1003						r1	r0	g4	g3
			g2	g1	g0	b4	b3	b2	b1	b0
V4L2_MBUS_FMT_RGB555_2X8_PADLHI_LE	0x1004						b3	b2	b1	b0
			g2	g1	g0	b4	b3	b2	b1	b0
V4L2_MBUS_FMT_BGR565_2X8_BE	0x1005	0		r4	r3	r2	r1	r0	g4	g3
						b2	b1	b0	g5	g4
			g2	g1	g0					
V4L2_MBUS_FMT_BGR565_2X8_LE	0x1006									
			g2	g1	g0	r4	r3	r2	r1	r0
			g2	g1	g0	r4	r3	r2	r1	r0
V4L2_MBUS_FMT_RGB565_2X8_BE	0x1007									
			b4	b3	b2	b1	b0	g5	g4	g3
			b4	b3	b2	b1	b0	g5	g4	g3
V4L2_MBUS_FMT_RGB565_2X8_LE	0x1008									
			g2	g1	g0	b4	b3	b2	b1	b0
			g2	g1	g0	b4	b3	b2	b1	b0
			r4	r3	r2	r1	r0	g5	g4	g3

4.13.4.1.2. Bayer Formats

Those formats transfer pixel data as red, green and blue components. The format code is made of the following information.

- The red, green and blue components order code, as encoded in a pixel sample. The possible values are shown in Figure 4-5.
- The number of bits per pixel component. All components are transferred on the same number of bits. Common values are 8, 10 and 12.
- If the pixel components are DPCM-compressed, a mention of the DPCM compression and the number of bits per compressed pixel component.

- The number of bus samples per pixel. Pixels that are wider than the bus width must be transferred in multiple samples. Common values are 1 and 2.
- The bus width.
- For formats where the total number of bits per pixel is smaller than the number of bus samples per pixel times the bus width, a padding value stating if the bytes are padded in their most high order bits (PADHI) or low order bits (PADLO).
- For formats where the number of bus samples per pixel is larger than 1, an endianness value stating if the pixel is transferred MSB first (BE) or LSB first (LE).

For instance, a format with uncompressed 10-bit Bayer components arranged in a red, green, green, blue pattern transferred as 2 8-bit samples per pixel with the least significant bits transferred first will be named

V4L2_MBUS_FMT_SRGGB10_2X8_PADHI_LE.

Figure 4-5. Bayer Patterns



The following table lists existing packet Bayer formats. The data organization is given as an example for the first pixel only.

Table 4-21. Bayer Formats

Identifier Code	Data organization												
Bit	11	10	9	8	7	6	5	4	3	2	1	0	
V4L2_MBUS_FMT_SBGGR8_1X8 0x3001					b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀	
V4L2_MBUS_FMT_SGBRG8_1X8 0x3013					g ₇	g ₆	g ₅	g ₄	g ₃	g ₂	g ₁	g ₀	
V4L2_MBUS_FMT_SGRBG8_1X8 0x3002					g ₇	g ₆	g ₅	g ₄	g ₃	g ₂	g ₁	g ₀	

Identifier Code	Data organization												
	Bit	11	10	9	8	7	6	5	4	3	2	1	0
V4L2_MBUS_FMT_SRGB8_1X8 0x3014						r7	r6	r5	r4	r3	r2	r1	r0
V4L2_MBUS_FMT_SBGGR10_DPCM8_1X8 0x300b								b5	b4	b3	b2	b1	b0
V4L2_MBUS_FMT_SGBRG10_DPCM8_1X8 0x300c								g5	g4	g3	g2	g1	g0
V4L2_MBUS_FMT_SGRBG10_DPCM8_1X8 0x3009								g5	g4	g3	g2	g1	g0
V4L2_MBUS_FMT_SRGB10_DPCM8_1X8 0x300d								r5	r4	r3	r2	r1	r0
V4L2_MBUS_FMT_SBGGR10_2X8_PADH0_BE0 0x3003									0	0	0	b9	b8
		-	-	-	-	b7	b6	b5	b4	b3	b2	b1	b0
V4L2_MBUS_FMT_SBGGR10_2X8_PADH16_LEb5 0x3004								b5	b4	b3	b2	b1	b0
		-	-	-	-	0	0	0	0	0	0	b9	b8
V4L2_MBUS_FMT_SBGGR10_2X8_PADL0_BEb7 0x3005									b6	b5	b4	b3	b2
		-	-	-	-	b1	b0	0	0	0	0	0	0
V4L2_MBUS_FMT_SBGGR10_2X8_PADL16_LE0 0x3006									0	0	0	0	0
		-	-	-	-	b9	b8	b7	b6	b5	b4	b3	b2
V4L2_MBUS_FMT_SBGGR10_1X10b7 0x3007						b7	b6	b5	b4	b3	b2	b1	b0
V4L2_MBUS_FMT_SGBRG10_1X10g7 0x300e						g7	g6	g5	g4	g3	g2	g1	g0

Identifier Code	Data organization																			
	Bit	11	10	9	8	7	6	5	4	3	2	1	0							
V4L2_MBUS_FMT_SGRBG10_1010 0x300a	g	10	g	10	g	7	g	6	g	5	g	4	g	3	g	2	g	1	g	0
V4L2_MBUS_FMT_SRGB10_1010 0x300f	r	10	r	10	r	7	r	6	r	5	r	4	r	3	r	2	r	1	r	0
V4L2_MBUS_FMT_SBGGR12_1212 0x3008	b	12	b	12	b	7	b	6	b	5	b	4	b	3	b	2	b	1	b	0
V4L2_MBUS_FMT_SGBRG12_1212 0x3010	g	12	g	12	g	7	g	6	g	5	g	4	g	3	g	2	g	1	g	0
V4L2_MBUS_FMT_SGRBG12_1212 0x3011	g	12	g	12	g	7	g	6	g	5	g	4	g	3	g	2	g	1	g	0
V4L2_MBUS_FMT_SRGB12_1212 0x3012	r	12	r	12	r	7	r	6	r	5	r	4	r	3	r	2	r	1	r	0

4.13.4.1.3. Packed YUV Formats

Those data formats transfer pixel data as (possibly downsampled) Y, U and V components. The format code is made of the following information.

- The Y, U and V components order code, as transferred on the bus. Possible values are YUYV, UYVY, YVYU and VYUY.
- The number of bits per pixel component. All components are transferred on the same number of bits. Common values are 8, 10 and 12.
- The number of bus samples per pixel. Pixels that are wider than the bus width must be transferred in multiple samples. Common values are 1, 1.5 (encoded as 1_5) and 2.
- The bus width. When the bus width is larger than the number of bits per pixel component, several components are packed in a single bus sample. The components are ordered as specified by the order code, with components on the left of the code transferred in the high order bits. Common values are 8 and 16.

For instance, a format where pixels are encoded as 8-bit YUV values downsampled to 4:2:2 and transferred as 2 8-bit bus samples per pixel in the U, Y, V, Y order will be named V4L2_MBUS_FMT_UYVY8_2X8.

The following table lists existing packet YUV formats.

Table 4-22. YUV Formats

Identifier Code	Data organization															
	Bit								9	8	7	6	5	4	3	2 1 0
	19	18	17	16	15	14	13	12	11	10						
V4L2_MBUS_FMT_Y8_1X8 0x2001	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2 y1 y0
V4L2_MBUS_FMT_UYVY8_1_5X8 0x2002	-	-	-	-	-	-	-	-	-	-	u7	u6	u5	u4	u3	u2 u1 u0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y7 y6 y5 y4 y3 y2 y1 y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y7 y6 y5 y4 y3 y2 y1 y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	v7 v6 v5 v4 v3 v2 v1 v0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y7 y6 y5 y4 y3 y2 y1 y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y7 y6 y5 y4 y3 y2 y1 y0
V4L2_MBUS_FMT_VYUY8_1_5X8 0x2003	-	-	-	-	-	-	-	-	-	-	v7	v6	v5	v4	v3	v2 v1 v0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y7 y6 y5 y4 y3 y2 y1 y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y7 y6 y5 y4 y3 y2 y1 y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	u7 u6 u5 u4 u3 u2 u1 u0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y7 y6 y5 y4 y3 y2 y1 y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	y7 y6 y5 y4 y3 y2 y1 y0

Identifier Code	Data organization																				
	Bit										9	8	7	6	5	4	3	2	1	0	
	19	18	17	16	15	14	13	12	11	10											
V4L2_MBUS_FMT_YUYV8_1_5X8 0x2004	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0			
	-	-	-	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	u7	u6	u5	u4	u3	u2	u1	u0
	-	-	-	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	v7	v6	v5	v4	v3	v2	v1	v0
V4L2_MBUS_FMT_YVYU8_1_5X8 0x2005	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0			
	-	-	-	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	v7	v6	v5	v4	v3	v2	v1	v0
	-	-	-	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	u7	u6	u5	u4	u3	u2	u1	u0
V4L2_MBUS_FMT_UYVY8_2X8 0x2006	-	-	-	-	-	-	-	-	-	-	u7	u6	u5	u4	u3	u2	u1	u0			
	-	-	-	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0
	-	-	-	-	-	-	-	-	-	-	-	-	-	v7	v6	v5	v4	v3	v2	v1	v0
	-	-	-	-	-	-	-	-	-	-	-	-	-	y7	y6	y5	y4	y3	y2	y1	y0

160

Identifier Code	Data organization															
Bit	9 8 7 6 5 4 3 2 1 0															
19 18 17 16 15 14 13 12 11 10																
	-	-	-	-	-	-	-	-	-	-	y ₉	y ₈	y ₇	y ₆	y ₅	y ₄ y ₃ y ₂ y ₁ y ₀
	-	-	-	-	-	-	-	-	-	-	v ₉	v ₈	v ₇	v ₆	v ₅	v ₄ v ₃ v ₂ v ₁ v ₀
V4L2_MBUS_FMT_YVYU10_2X10 0x200c	-	-									y ₉	y ₈	y ₇	y ₆	y ₅	y ₄ y ₃ y ₂ y ₁ y ₀
	-	-	-	-	-	-	-	-	-	-	v ₉	v ₈	v ₇	v ₆	v ₅	v ₄ v ₃ v ₂ v ₁ v ₀
	-	-	-	-	-	-	-	-	-	-	y ₉	y ₈	y ₇	y ₆	y ₅	y ₄ y ₃ y ₂ y ₁ y ₀
	-	-	-	-	-	-	-	-	-	-	u ₉	u ₈	u ₇	u ₆	u ₅	u ₄ u ₃ u ₂ u ₁ u ₀
V4L2_MBUS_FMT_Y12_1X12 0x2013	-	-									y ₉	y ₈	y ₇	y ₆	y ₅	y ₄ y ₃ y ₂ y ₁ y ₀
										y ₁₁ y ₁₀						
V4L2_MBUS_FMT_UYVY8_1X16 0x200f											u ₃	u ₂	u ₁	u ₀	y ₇	y ₆ y ₅ y ₄ y ₃ y ₂ y ₁ y ₀
	-	-	-	-	v ₇	v ₆	v ₅	v ₄	v ₃	v ₂	v ₁	v ₀	y ₇	y ₆	y ₅	y ₄ y ₃ y ₂ y ₁ y ₀
V4L2_MBUS_FMT_VYUY8_1X16 0x2010											v ₄	v ₃	v ₂	v ₁	v ₀	y ₇ y ₆ y ₅ y ₄ y ₃ y ₂ y ₁ y ₀
	-	-	-	-	u ₇	u ₆	u ₅	u ₄	u ₃	u ₂	u ₁	u ₀	y ₇	y ₆	y ₅	y ₄ y ₃ y ₂ y ₁ y ₀
V4L2_MBUS_FMT_YUYV8_1X16 0x2011											y ₄	y ₃	y ₂	y ₁	y ₀	u ₇ u ₆ u ₅ u ₄ u ₃ u ₂ u ₁ u ₀
	-	-	-	-	y ₇	y ₆	y ₅	y ₄	y ₃	y ₂	y ₁	y ₀	v ₇	v ₆	v ₅	v ₄ v ₃ v ₂ v ₁ v ₀
V4L2_MBUS_FMT_YVYU8_1X16 0x2012											y ₄	y ₃	y ₂	y ₁	y ₀	v ₇ v ₆ v ₅ v ₄ v ₃ v ₂ v ₁ v ₀

Identifier Code	Data organization
	<div>Bit<div>9876543210</div></div>
	<div>19181716151413121110</div>
	<div>- - - - y7 y6 y5 y4 y3 y2 y1 y0 u7 u6 u5 u4 u3 u2 u1 u0</div>
V4L2_MBUS_FMT_YUYV10_1X20	<div>y8 y7 y6 y5 y4 y3 y2 y1 y0 u9 u8 u7 u6 u5 u4 u3 u2 u1 u0</div>
0x200d	
	<div>y9 y8 y7 y6 y5 y4 y3 y2 y1 y0 v9 v8 v7 v6 v5 v4 v3 v2 v1 v0</div>
V4L2_MBUS_FMT_YVYU10_1X20	<div>y8 y7 y6 y5 y4 y3 y2 y1 y0 v9 v8 v7 v6 v5 v4 v3 v2 v1 v0</div>
0x200e	
	<div>y9 y8 y7 y6 y5 y4 y3 y2 y1 y0 u9 u8 u7 u6 u5 u4 u3 u2 u1 u0</div>

4.13.4.1.4. JPEG Compressed Formats

Those data formats consist of an ordered sequence of 8-bit bytes obtained from JPEG compression process. Additionally to the `_JPEG` prefix the format code is made of the following information.

- The number of bus samples per entropy encoded byte.
- The bus width.

For instance, for a JPEG baseline process and an 8-bit bus width the format will be named `V4L2_MBUS_FMT_JPEG_1X8`.

The following table lists existing JPEG compressed formats.

Table 4-23. JPEG Formats

Identifier	Code	Remarks
------------	------	---------

Identifier	Code	Remarks
V4L2_MBUS_FMT_JPEG_0x4001	0x4001	Besides of its usage for the parallel bus this format is recommended for transmission of JPEG data over MIPI CSI bus using the User Defined 8-bit Data types.

Notes

1. A common application of two file descriptors is the XFree86 Xv/V4L interface driver and a V4L2 application. While the X server controls video overlay, the application can take advantage of memory mapping and DMA.

In the opinion of the designers of this API, no driver writer taking the efforts to support simultaneous capturing and overlay will restrict this ability by requiring a single file descriptor, as in V4L and earlier versions of V4L2. Making this optional means applications depending on two file descriptors need backup routines to be compatible with all drivers, which is considerable more work than using two fds in applications which do not. Also two fd's fit the general concept of one file descriptor for each logical stream. Hence as a complexity trade-off drivers *must* support two file descriptors and *may* support single fd operation.

2. The X Window system defines "regions" which are vectors of struct BoxRec { short x1, y1, x2, y2; } with width = x2 - x1 and height = y2 - y1, so one cannot pass X11 clip lists directly.
3. ASK: Amplitude-Shift Keying. A high signal level represents a '1' bit, a low level a '0' bit.

Chapter 5. V4L2 Driver Programming

to do

Chapter 6. Libv4l Userspace Library

6.1. Introduction

libv4l is a collection of libraries which adds a thin abstraction layer on top of video4linux2 devices. The purpose of this (thin) layer is to make it easy for application writers to support a wide variety of devices without having to write separate code for different devices in the same class.

An example of using libv4l is provided by `v4l2grab`.

libv4l consists of 3 different libraries:

6.1.1. libv4lconvert

libv4lconvert is a library that converts several different pixel formats found in V4L2 drivers into a few common RGB and YUY formats.

It currently accepts the following V4L2 driver formats: `V4L2_PIX_FMT_BGR24`, `V4L2_PIX_FMT_HM12`, `V4L2_PIX_FMT_JPEG`, `V4L2_PIX_FMT_MJPEG`, `V4L2_PIX_FMT_MR97310A`, `V4L2_PIX_FMT_OV511`, `V4L2_PIX_FMT_OV518`, `V4L2_PIX_FMT_PAC207`, `V4L2_PIX_FMT_PJPG`, `V4L2_PIX_FMT_RGB24`, `V4L2_PIX_FMT_SBGR8`, `V4L2_PIX_FMT_SGBRG8`, `V4L2_PIX_FMT_SGRBG8`, `V4L2_PIX_FMT_SN9C10X`, `V4L2_PIX_FMT_SN9C20X_I420`, `V4L2_PIX_FMT_SPCA501`, `V4L2_PIX_FMT_SPCA505`, `V4L2_PIX_FMT_SPCA508`, `V4L2_PIX_FMT_SPCA561`, `V4L2_PIX_FMT_SQ905C`, `V4L2_PIX_FMT_SRGB8`, `V4L2_PIX_FMT_UYVY`, `V4L2_PIX_FMT_YUV420`, `V4L2_PIX_FMT_YUYV`, `V4L2_PIX_FMT_YVU420`, and `V4L2_PIX_FMT_YVYU`.

Later on libv4lconvert was expanded to also be able to do various video processing functions to improve webcam video quality. The video processing is split in to 2 parts: `libv4lconvert/control` and `libv4lconvert/processing`.

The control part is used to offer video controls which can be used to control the video processing functions made available by `libv4lconvert/processing`. These controls are stored application wide (until reboot) by using a persistent shared memory object.

`libv4lconvert/processing` offers the actual video processing functionality.

6.1.2. libv4l1

This library offers functions that can be used to quickly make v4l1 applications work with v4l2 devices. These functions work exactly like the normal open/close/etc, except that libv4l1 does full emulation of the v4l1 api on top of v4l2 drivers, in case of v4l1 drivers it will just pass calls through.

Since those functions are emulations of the old V4L1 API, it shouldn't be used for new applications.

6.1.3. libv4l2

This library should be used for all modern V4L2 applications.

It provides handles to call V4L2 open/ioctl/close/poll methods. Instead of just providing the raw output of the device, it enhances the calls in the sense that it will use libv4lconvert to provide more video formats and to enhance the image quality.

In most cases, libv4l2 just passes the calls directly through to the v4l2 driver, intercepting the calls to VIDIOC_TRY_FMT, VIDIOC_G_FMT, VIDIOC_S_FMT, VIDIOC_ENUM_FRAMESIZES and VIDIOC_ENUM_FRAMEINTERVALS in order to emulate the formats V4L2_PIX_FMT_BGR24, V4L2_PIX_FMT_RGB24, V4L2_PIX_FMT_YUV420, and V4L2_PIX_FMT_YVU420, if they aren't available in the driver. VIDIOC_ENUM_FMT keeps enumerating the hardware supported formats, plus the emulated formats offered by libv4l at the end.

6.1.3.1. Libv4l device control functions

The common file operation methods are provided by libv4l.

Those functions operate just like glibc open/close/dup/ioctl/read/mmap/munmap:

- `int v4l2_open(const char *file, int oflag, ...)` - operates like the standard `open()` function.
- `int v4l2_close(int fd)` - operates like the standard `close()` function.
- `int v4l2_dup(int fd)` - operates like the standard `dup()` function, duplicating a file handler.
- `int v4l2_ioctl (int fd, unsigned long int request, ...)` - operates like the standard `ioctl()` function.
- `int v4l2_read (int fd, void* buffer, size_t n)` - operates like the standard `read()` function.
- `void v4l2_mmap(void *start, size_t length, int prot, int flags, int fd, int64_t offset);` - operates like the standard `mmap()` function.

- `int v4l2_munmap(void *_start, size_t length);` - operates like the standard `munmap()` function.

Those functions provide additional control:

- `int v4l2_fd_open(int fd, int v4l2_flags)` - opens an already opened fd for further use through v4l2lib and possibly modify libv4l2's default behavior through the `v4l2_flags` argument. Currently, `v4l2_flags` can be `V4L2_DISABLE_CONVERSION`, to disable format conversion.
- `int v4l2_set_control(int fd, int cid, int value)` - This function takes a value of 0 - 65535, and then scales that range to the actual range of the given v4l control id, and then if the cid exists and is not locked sets the cid to the scaled value.
- `int v4l2_get_control(int fd, int cid)` - This function returns a value of 0 - 65535, scaled to from the actual range of the given v4l control id. when the cid does not exist, could not be accessed for some reason, or some error occurred 0 is returned.

6.1.4. v4l1compat.so wrapper library

This library intercepts calls to `open/close/ioctl/mmap/mmunmap` operations and redirects them to the libv4l counterparts, by using `LD_PRELOAD=/usr/lib/v4l1compat.so`. It also emulates V4L1 calls via V4L2 API. It allows usage of binary legacy applications that still don't use libv4l.

Chapter 7. Changes

The following chapters document the evolution of the V4L2 API, errata or extensions. They are also intended to help application and driver writers to port or update their code.

7.1. Differences between V4L and V4L2

The Video For Linux API was first introduced in Linux 2.1 to unify and replace various TV and radio device related interfaces, developed independently by driver writers in prior years. Starting with Linux 2.5 the much improved V4L2 API replaces the V4L API, although existing drivers will continue to support V4L applications in the future, either directly or through the V4L2 compatibility layer in the `videodev` kernel module translating ioctls on the fly. For a transition period not all drivers will support the V4L2 API.

7.1.1. Opening and Closing Devices

For compatibility reasons the character device file names recommended for V4L2 video capture, overlay, radio and raw vbi capture devices did not change from those used by V4L. They are listed in Chapter 4 and below in Table 7-1.

The teletext devices (minor range 192-223) have been removed in V4L2 and no longer exist. There is no hardware available anymore for handling pure teletext. Instead raw or sliced VBI is used.

The V4L `videodev` module automatically assigns minor numbers to drivers in load order, depending on the registered device type. We recommend that V4L2 drivers by default register devices with the same numbers, but the system administrator can assign arbitrary minor numbers using driver module options. The major device number remains 81.

Table 7-1. V4L Device Types, Names and Numbers

Device Type	File Name	Minor Numbers
Video capture and overlay	<code>/dev/video</code> and <code>/dev/bttv0a</code> , <code>/dev/video0</code> to <code>/dev/video63</code>	0-63

Device Type	File Name	Minor Numbers
Radio receiver	/dev/radio0, /dev/radio0 to /dev/radio63	64-127
Raw VBI capture	/dev/vbi, /dev/vbi0 to /dev/vbi31	224-255
Notes: a. According to Documentation/devices.txt these should be symbolic links to /dev/video0. Note the original btvt interface is not compatible with V4L or V4L2. b. According to Documentation/devices.txt a symbolic link to /dev/radio0.		

V4L prohibits (or used to prohibit) multiple opens of a device file. V4L2 drivers *may* support multiple opens, see Section 1.1 for details and consequences.

V4L drivers respond to V4L2 ioctls with an EINVAL error code. The compatibility layer in the V4L2 videodev module can translate V4L ioctl requests to their V4L2 counterpart, however a V4L2 driver usually needs more preparation to become fully V4L compatible. This is covered in more detail in Chapter 5.

7.1.2. Querying Capabilities

The V4L VIDIOCGCAP ioctl is equivalent to V4L2's VIDIOC_QUERYCAP.

The *name* field in struct video_capability became *card* in struct v4l2_capability, *type* was replaced by *capabilities*. Note V4L2 does not distinguish between device types like this, better think of basic video input, video output and radio devices supporting a set of related functions like video capturing, video overlay and VBI capturing. See Section 1.1 for an introduction.

struct video_capability type	struct v4l2_capability capabilities flags	Purpose
VID_TYPE_CAPTURE	V4L2_CAP_VIDEO_CAPTURE	The video capture interface is supported.
VID_TYPE_TUNER	V4L2_CAP_TUNER	The device has a tuner or modulator.
VID_TYPE_TELETEXT	V4L2_CAP_VBI_CAPTURE	The raw VBI capture interface is supported.
VID_TYPE_OVERLAY	V4L2_CAP_VIDEO_OVERLAY	The video overlay interface is supported.

struct video_capability type	struct v4l2_capability capabilities flags	Purpose
VID_TYPE_CHROMAKEY	V4L2_FBUF_CAP_CHROMAKEY in field <i>capability</i> of struct v4l2_framebuffer	Whether chromakey overlay is supported. For more information on overlay see Section 4.2.
VID_TYPE_CLIPPING	V4L2_FBUF_CAP_LIST_CLIP and V4L2_FBUF_CAP_BITMAP_SUPPORTED in field <i>capability</i> of struct v4l2_framebuffer	Whether clipping the overlaid image is supported, see Section 4.2.
VID_TYPE_FRAMERAM	V4L2_FBUF_CAP_EXTERNOV in field <i>capability</i> of struct v4l2_framebuffer	Whether overlay overwrites frame buffer memory, see Section 4.2.
VID_TYPE_SCALES	–	This flag indicates if the hardware can scale images. The V4L2 API implies the scale factor by setting the cropping dimensions and image size with the VIDIOC_S_CROP and VIDIOC_S_FMT ioctl, respectively. The driver returns the closest sizes possible. For more information on cropping and scaling see Section 1.12.
VID_TYPE_MONOCHROME	–	Applications can enumerate the supported image formats with the VIDIOC_ENUM_FMT ioctl to determine if the device supports grey scale capturing only. For more information on image formats see Chapter 2.

struct video_capability type	struct v4l2_capability capabilities flags	Purpose
VID_TYPE_SUBCAPTURE	–	Applications can call the VIDIOC_G_CROP ioctl to determine if the device supports capturing a subsection of the full picture ("cropping" in V4L2). If not, the ioctl returns the EINVAL error code. For more information on cropping and scaling see Section 1.12.
VID_TYPE_MPEG_DECODER	–	Applications can enumerate the supported image formats with the VIDIOC_ENUM_FMT ioctl to determine if the device supports MPEG streams.
VID_TYPE_MPEG_ENCODER	–	See above.
VID_TYPE_MJPEG_DECODER	–	See above.
VID_TYPE_MJPEG_ENCODER	–	See above.

The *audios* field was replaced by *capabilities* flag V4L2_CAP_AUDIO, indicating *if* the device has any audio inputs or outputs. To determine their number applications can enumerate audio inputs with the VIDIOC_G_AUDIO ioctl. The audio ioctls are described in Section 1.5.

The *maxwidth*, *maxheight*, *minwidth* and *minheight* fields were removed. Calling the VIDIOC_S_FMT or VIDIOC_TRY_FMT ioctl with the desired dimensions returns the closest size possible, taking into account the current video standard, cropping and scaling limitations.

7.1.3. Video Sources

V4L provides the VIDIOCGCHAN and VIDIOCSCCHAN ioctl using struct *video_channel* to enumerate the video inputs of a V4L device. The equivalent V4L2

ioctl's are `VIDIOC_ENUMINPUT`, `VIDIOC_G_INPUT` and `VIDIOC_S_INPUT` using struct `v4l2_input` as discussed in Section 1.4.

The `channel` field counting inputs was renamed to `index`, the video input types were renamed as follows:

struct <code>video_channel</code> type	struct <code>v4l2_input</code> type
<code>VIDEO_TYPE_TV</code>	<code>V4L2_INPUT_TYPE_TUNER</code>
<code>VIDEO_TYPE_CAMERA</code>	<code>V4L2_INPUT_TYPE_CAMERA</code>

Unlike the `tuners` field expressing the number of tuners of this input, V4L2 assumes each video input is connected to at most one tuner. However a tuner can have more than one input, i. e. RF connectors, and a device can have multiple tuners. The index number of the tuner associated with the input, if any, is stored in field `tuner` of struct `v4l2_input`. Enumeration of tuners is discussed in Section 1.6.

The redundant `VIDEO_VC_TUNER` flag was dropped. Video inputs associated with a tuner are of type `V4L2_INPUT_TYPE_TUNER`. The `VIDEO_VC_AUDIO` flag was replaced by the `audioset` field. V4L2 considers devices with up to 32 audio inputs. Each set bit in the `audioset` field represents one audio input this video input combines with. For information about audio inputs and how to switch between them see Section 1.5.

The `norm` field describing the supported video standards was replaced by `std`. The V4L specification mentions a flag `VIDEO_VC_NORM` indicating whether the standard can be changed. This flag was a later addition together with the `norm` field and has been removed in the meantime. V4L2 has a similar, albeit more comprehensive approach to video standards, see Section 1.7 for more information.

7.1.4. Tuning

The V4L `VIDIOCGTUNER` and `VIDIOCSTUNER` ioctl and struct `video_tuner` can be used to enumerate the tuners of a V4L TV or radio device. The equivalent V4L2 ioctl's are `VIDIOC_G_TUNER` and `VIDIOC_S_TUNER` using struct `v4l2_tuner`. Tuners are covered in Section 1.6.

The `tuner` field counting tuners was renamed to `index`. The fields `name`, `range_low` and `range_high` remained unchanged.

The `VIDEO_TUNER_PAL`, `VIDEO_TUNER_NTSC` and `VIDEO_TUNER_SECAM` flags indicating the supported video standards were dropped. This information is now contained in the associated struct `v4l2_input`. No replacement exists for the `VIDEO_TUNER_NORM` flag indicating whether the video standard can be switched. The `mode` field to select a different video standard was replaced by a whole new set

of `ioctl`s and structures described in Section 1.7. Due to its ubiquity it should be mentioned the BTTV driver supports several standards in addition to the regular `VIDEO_MODE_PAL` (0), `VIDEO_MODE_NTSC`, `VIDEO_MODE_SECAM` and `VIDEO_MODE_AUTO` (3). Namely N/PAL Argentina, M/PAL, N/PAL, and NTSC Japan with numbers 3-6 (sic).

The `VIDEO_TUNER_STEREO_ON` flag indicating stereo reception became `V4L2_TUNER_SUB_STEREO` in field `rxsubchans`. This field also permits the detection of monaural and bilingual audio, see the definition of struct `v4l2_tuner` for details. Presently no replacement exists for the `VIDEO_TUNER_RDS_ON` and `VIDEO_TUNER_MBS_ON` flags.

The `VIDEO_TUNER_LOW` flag was renamed to `V4L2_TUNER_CAP_LOW` in the struct `v4l2_tuner capability` field.

The `VIDIOCGFREQ` and `VIDIOCSFREQ` `ioctl` to change the tuner frequency where renamed to `VIDIOC_G_FREQUENCY` and `VIDIOC_S_FREQUENCY`. They take a pointer to a struct `v4l2_frequency` instead of an unsigned long integer.

7.1.5. Image Properties

V4L2 has no equivalent of the `VIDIOCGPICT` and `VIDIOCSPICT` `ioctl` and struct `video_picture`. The following fields where replaced by V4L2 controls accessible with the `VIDIOC_QUERYCTRL`, `VIDIOC_G_CTRL` and `VIDIOC_S_CTRL` `ioctl`s:

struct <code>video_picture</code>	V4L2 Control ID
<i>brightness</i>	<code>V4L2_CID_BRIGHTNESS</code>
<i>hue</i>	<code>V4L2_CID_HUE</code>
<i>colour</i>	<code>V4L2_CID_SATURATION</code>
<i>contrast</i>	<code>V4L2_CID_CONTRAST</code>
<i>whiteness</i>	<code>V4L2_CID_WHITENESS</code>

The V4L picture controls are assumed to range from 0 to 65535 with no particular reset value. The V4L2 API permits arbitrary limits and defaults which can be queried with the `VIDIOC_QUERYCTRL` `ioctl`. For general information about controls see Section 1.8.

The *depth* (average number of bits per pixel) of a video image is implied by the selected image format. V4L2 does not explicitly provide such information assuming applications recognizing the format are aware of the image depth and others need not know. The *palette* field moved into the struct `v4l2_pix_format`:

struct video_picture <i>palette</i>	struct v4l2_pix_format <i>pixfmt</i>
VIDEO_PALETTE_GREY	V4L2_PIX_FMT_GREY
VIDEO_PALETTE_HI240	V4L2_PIX_FMT_HI240 ^a
VIDEO_PALETTE_RGB565	V4L2_PIX_FMT_RGB565
VIDEO_PALETTE_RGB555	V4L2_PIX_FMT_RGB555
VIDEO_PALETTE_RGB24	V4L2_PIX_FMT_BGR24
VIDEO_PALETTE_RGB32	V4L2_PIX_FMT_BGR32 ^b
VIDEO_PALETTE_YUV422	V4L2_PIX_FMT_YUYV
VIDEO_PALETTE_YUYV ^c	V4L2_PIX_FMT_YUYV
VIDEO_PALETTE_UYVY	V4L2_PIX_FMT_UYVY
VIDEO_PALETTE_YUV420	None
VIDEO_PALETTE_YUV411	V4L2_PIX_FMT_Y41P ^d
VIDEO_PALETTE_RAW	None ^e
VIDEO_PALETTE_YUV422P	V4L2_PIX_FMT_YUV422P
VIDEO_PALETTE_YUV411P	V4L2_PIX_FMT_YUV411P ^f
VIDEO_PALETTE_YUV420P	V4L2_PIX_FMT_YVU420
VIDEO_PALETTE_YUV410P	V4L2_PIX_FMT_YVU410
<p>Notes:</p> <p>a. This is a custom format used by the BTTV driver, not one of the V4L2 standard formats.</p> <p>b. Presumably all V4L RGB formats are little-endian, although some drivers might interpret them according to machine endianness. V4L2 defines little-endian, big-endian and red/blue swapped variants. For details see Section 2.6.</p> <p>c. VIDEO_PALETTE_YUV422 and VIDEO_PALETTE_YUYV are the same formats. Some V4L drivers respond to one, some to the other.</p> <p>d. Not to be confused with V4L2_PIX_FMT_YUV411P, which is a planar format.</p> <p>e. V4L explains this as: "RAW capture (BT848)"</p> <p>f. Not to be confused with V4L2_PIX_FMT_Y41P, which is a packed format.</p>	

V4L2 image formats are defined in Chapter 2. The image format can be selected with the `VIDIOC_S_FMT` ioctl.

7.1.6. Audio

The `VIDIOCGAUDIO` and `VIDIOCSAUDIO` ioctl and struct `video_audio` are used to enumerate the audio inputs of a V4L device. The equivalent V4L2 ioctls are `VIDIOC_G_AUDIO` and `VIDIOC_S_AUDIO` using struct `v4l2_audio` as discussed in Section 1.5.

The *audio* "channel number" field counting audio inputs was renamed to *index*.

On `VIDIOC_S_AUDIO` the *mode* field selects *one* of the `VIDEO_SOUND_MONO`, `VIDEO_SOUND_STEREO`, `VIDEO_SOUND_LANG1` or `VIDEO_SOUND_LANG2` audio demodulation modes. When the current audio standard is BTSC `VIDEO_SOUND_LANG2` refers to SAP and `VIDEO_SOUND_LANG1` is meaningless. Also undocumented in the V4L specification, there is no way to query the selected mode. On `VIDIOC_G_AUDIO` the driver returns the *actually received* audio programmes in this field. In the V4L2 API this information is stored in the struct `v4l2_tuner` *rxsubchans* and *audmode* fields, respectively. See Section 1.6 for more information on tuners. Related to audio modes struct `v4l2_audio` also reports if this is a mono or stereo input, regardless if the source is a tuner.

The following fields were replaced by V4L2 controls accessible with the `VIDIOC_QUERYCTRL`, `VIDIOC_G_CTRL` and `VIDIOC_S_CTRL` ioctls:

struct <code>video_audio</code>	V4L2 Control ID
<i>volume</i>	<code>V4L2_CID_AUDIO_VOLUME</code>
<i>bass</i>	<code>V4L2_CID_AUDIO_BASS</code>
<i>treble</i>	<code>V4L2_CID_AUDIO_TREBLE</code>
<i>balance</i>	<code>V4L2_CID_AUDIO_BALANCE</code>

To determine which of these controls are supported by a driver V4L provides the *flags* `VIDEO_AUDIO_VOLUME`, `VIDEO_AUDIO_BASS`, `VIDEO_AUDIO_TREBLE` and `VIDEO_AUDIO_BALANCE`. In the V4L2 API the `VIDIOC_QUERYCTRL` ioctl reports if the respective control is supported. Accordingly the `VIDEO_AUDIO_MUTABLE` and `VIDEO_AUDIO_MUTE` flags were replaced by the boolean `V4L2_CID_AUDIO_MUTE` control.

All V4L2 controls have a *step* attribute replacing the struct `video_audio` *step* field. The V4L audio controls are assumed to range from 0 to 65535 with no particular reset value. The V4L2 API permits arbitrary limits and defaults which can be queried with the `VIDIOC_QUERYCTRL` ioctl. For general information about controls see Section 1.8.

7.1.7. Frame Buffer Overlay

The V4L2 ioctls equivalent to `VIDIOCGFBUF` and `VIDIOCSFBUF` are `VIDIOC_G_FBUF` and `VIDIOC_S_FBUF`. The *base* field of struct `video_buffer` remained unchanged, except V4L2 defines a flag to indicate non-destructive overlays instead of a NULL pointer. All other fields moved into the struct `v4l2_pix_format` *fmt* substructure of struct `v4l2_framebuffer`. The *depth* field was replaced by *pixelformat*. See Section 2.6 for a list of RGB formats and their respective color depths.

Instead of the special ioctls `VIDIOCGWIN` and `VIDIOCSWIN` V4L2 uses the general-purpose data format negotiation ioctls `VIDIOC_G_FMT` and `VIDIOC_S_FMT`. They take a pointer to a struct `v4l2_format` as argument. Here the `win` member of the `fmt` union is used, a struct `v4l2_window`.

The `x`, `y`, `width` and `height` fields of struct `video_window` moved into struct `v4l2_rect` substructure `w` of struct `v4l2_window`. The `chromakey`, `clips`, and `clipcount` fields remained unchanged. Struct `video_clip` was renamed to struct `v4l2_clip`, also containing a struct `v4l2_rect`, but the semantics are still the same.

The `VIDEO_WINDOW_INTERLACE` flag was dropped. Instead applications must set the `field` field to `V4L2_FIELD_ANY` or `V4L2_FIELD_INTERLACED`. The `VIDEO_WINDOW_CHROMAKEY` flag moved into struct `v4l2_framebuffer`, under the new name `V4L2_FBUF_FLAG_CHROMAKEY`.

In V4L, storing a bitmap pointer in `clips` and setting `clipcount` to `VIDEO_CLIP_BITMAP` (-1) requests bitmap clipping, using a fixed size bitmap of 1024×625 bits. Struct `v4l2_window` has a separate `bitmap` pointer field for this purpose and the bitmap size is determined by `w.width` and `w.height`.

The `VIDIOCCAPTURE` ioctl to enable or disable overlay was renamed to `VIDIOC_OVERLAY`.

7.1.8. Cropping

To capture only a subsection of the full picture V4L defines the `VIDIOCGCAPTURE` and `VIDIOCSCAPTURE` ioctls using struct `video_capture`. The equivalent V4L2 ioctls are `VIDIOC_G_CROP` and `VIDIOC_S_CROP` using struct `v4l2_crop`, and the related `VIDIOC_CROPCAP` ioctl. This is a rather complex matter, see Section 1.12 for details.

The `x`, `y`, `width` and `height` fields moved into struct `v4l2_rect` substructure `c` of struct `v4l2_crop`. The `decimation` field was dropped. In the V4L2 API the scaling factor is implied by the size of the cropping rectangle and the size of the captured or overlaid image.

The `VIDEO_CAPTURE_ODD` and `VIDEO_CAPTURE_EVEN` flags to capture only the odd or even field, respectively, were replaced by `V4L2_FIELD_TOP` and `V4L2_FIELD_BOTTOM` in the field named `field` of struct `v4l2_pix_format` and struct `v4l2_window`. These structures are used to select a capture or overlay format with the `VIDIOC_S_FMT` ioctl.

7.1.9. Reading Images, Memory Mapping

7.1.9.1. Capturing using the read method

There is no essential difference between reading images from a V4L or V4L2 device using the `read()` function, however V4L2 drivers are not required to support this I/O method. Applications can determine if the function is available with the `VIDIOC_QUERYCAP` ioctl. All V4L2 devices exchanging data with applications must support the `select()` and `poll()` functions.

To select an image format and size, V4L provides the `VIDIOCSPICT` and `VIDIOCSWIN` ioctls. V4L2 uses the general-purpose data format negotiation ioctls `VIDIOC_G_FMT` and `VIDIOC_S_FMT`. They take a pointer to a struct `v4l2_format` as argument, here the struct `v4l2_pix_format` named `pix` of its `fmt` union is used.

For more information about the V4L2 read interface see Section 3.1.

7.1.9.2. Capturing using memory mapping

Applications can read from V4L devices by mapping buffers in device memory, or more often just buffers allocated in DMA-able system memory, into their address space. This avoids the data copying overhead of the read method. V4L2 supports memory mapping as well, with a few differences.

V4L	V4L2
	The image format must be selected before buffers are allocated, with the <code>VIDIOC_S_FMT</code> ioctl. When no format is selected the driver may use the last, possibly by another application requested format.
Applications cannot change the number of buffers. The it is built into the driver, unless it has a module option to change the number when the driver module is loaded.	The <code>VIDIOC_REQBUFS</code> ioctl allocates the desired number of buffers, this is a required step in the initialization sequence.

V4L	V4L2
Drivers map all buffers as one contiguous range of memory. The <code>VIDIOCGMBUF</code> ioctl is available to query the number of buffers, the offset of each buffer from the start of the virtual file, and the overall amount of memory used, which can be used as arguments for the <code>mmap()</code> function.	Buffers are individually mapped. The offset and size of each buffer can be determined with the <code>VIDIOC_QUERYBUF</code> ioctl.
The <code>VIDIOCMCAPTURE</code> ioctl prepares a buffer for capturing. It also determines the image format for this buffer. The ioctl returns immediately, eventually with an <code>EAGAIN</code> error code if no video signal had been detected. When the driver supports more than one buffer applications can call the ioctl multiple times and thus have multiple outstanding capture requests. The <code>VIDIOCSYNC</code> ioctl suspends execution until a particular buffer has been filled.	Drivers maintain an incoming and outgoing queue. <code>VIDIOC_QBUF</code> enqueues any empty buffer into the incoming queue. Filled buffers are dequeued from the outgoing queue with the <code>VIDIOC_DQBUF</code> ioctl. To wait until filled buffers become available this function, <code>select()</code> or <code>poll()</code> can be used. The <code>VIDIOC_STREAMON</code> ioctl must be called once after enqueueing one or more buffers to start capturing. Its counterpart <code>VIDIOC_STREAMOFF</code> stops capturing and dequeues all buffers from both queues. Applications can query the signal status, if known, with the <code>VIDIOC_ENUMINPUT</code> ioctl.

For a more in-depth discussion of memory mapping and examples, see Section 3.2.

7.1.10. Reading Raw VBI Data

Originally the V4L API did not specify a raw VBI capture interface, only the device file `/dev/vbi` was reserved for this purpose. The only driver supporting this interface was the BTTV driver, de-facto defining the V4L VBI interface. Reading from the device yields a raw VBI image with the following parameters:

struct v4l2_vbi_format	V4L, BTTV driver
<code>sampling_rate</code>	28636363 Hz NTSC (or any other 525-line standard); 35468950 Hz PAL and SECAM (625-line standards)
<code>offset</code>	?

struct v4l2_vbi_format	V4L, BTTV driver
<code>samples_per_line</code>	2048
<code>sample_format</code>	V4L2_PIX_FMT_GREY. The last four bytes (a machine endianness integer) contain a frame counter.
<code>start[]</code>	10, 273 NTSC; 22, 335 PAL and SECAM
<code>count[]</code>	16, 16 _a
<code>flags</code>	0
Notes: a. Old driver versions used different values, eventually the custom BTTV_VBISIZE ioctl was added to query the correct values.	

Undocumented in the V4L specification, in Linux 2.3 the `VIDIOCGVBIFMT` and `VIDIOCSVBIFMT` ioctls using struct `vbi_format` were added to determine the VBI image parameters. These ioctls are only partially compatible with the V4L2 VBI interface specified in Section 4.7.

An *offset* field does not exist, *sample_format* is supposed to be `VIDEO_PALETTE_RAW`, equivalent to `V4L2_PIX_FMT_GREY`. The remaining fields are probably equivalent to struct `v4l2_vbi_format`.

Apparently only the Zoran (ZR 36120) driver implements these ioctls. The semantics differ from those specified for V4L2 in two ways. The parameters are reset on `open()` and `VIDIOCSVBIFMT` always returns an `EINVAL` error code if the parameters are invalid.

7.1.11. Miscellaneous

V4L2 has no equivalent of the `VIDIOCGUNIT` ioctl. Applications can find the VBI device associated with a video capture device (or vice versa) by reopening the device and requesting VBI data. For details see Section 1.1.

No replacement exists for `VIDIOCKEY`, and the V4L functions for microcode programming. A new interface for MPEG compression and playback devices is documented in Section 1.9.

7.2. Changes of the V4L2 API

Soon after the V4L API was added to the kernel it was criticised as too inflexible. In

August 1998 Bill Dirks proposed a number of improvements and began to work on documentation, example drivers and applications. With the help of other volunteers this eventually became the V4L2 API, not just an extension but a replacement for the V4L API. However it took another four years and two stable kernel releases until the new API was finally accepted for inclusion into the kernel in its present form.

7.2.1. Early Versions

1998-08-20: First version.

1998-08-27: The `select()` function was introduced.

1998-09-10: New video standard interface.

1998-09-18: The `VIDIOC_NONCAP` ioctl was replaced by the otherwise meaningless `O_TRUNC` `open()` flag, and the aliases `O_NONCAP` and `O_NOIO` were defined.

Applications can set this flag if they intend to access controls only, as opposed to capture applications which need exclusive access. The `VIDEO_STD_XXX` identifiers are now ordinals instead of flags, and the `video_std_construct()` helper function takes id and transmission arguments.

1998-09-28: Revamped video standard. Made video controls individually enumerable.

1998-10-02: The `id` field was removed from struct `video_standard` and the color subcarrier fields were renamed. The `VIDIOC_QUERYSTD` ioctl was renamed to `VIDIOC_ENUMSTD`, `VIDIOC_G_INPUT` to `VIDIOC_ENUMINPUT`. A first draft of the Codec API was released.

1998-11-08: Many minor changes. Most symbols have been renamed. Some material changes to struct `v4l2_capability`.

1998-11-12: The read/write direction of some ioctls was misdefined.

1998-11-14: `V4L2_PIX_FMT_RGB24` changed to `V4L2_PIX_FMT_BGR24`, and `V4L2_PIX_FMT_RGB32` changed to `V4L2_PIX_FMT_BGR32`. Audio controls are now accessible with the `VIDIOC_G_CTRL` and `VIDIOC_S_CTRL` ioctls under names starting with `V4L2_CID_AUDIO`. The `V4L2_MAJOR` define was removed from `videodev.h` since it was only used once in the `videodev` kernel module. The `YUV422` and `YUV411` planar image formats were added.

1998-11-28: A few ioctl symbols changed. Interfaces for codecs and video output devices were added.

1999-01-14: A raw VBI capture interface was added.

1999-01-19: The `VIDIOC_NEXTBUF` ioctl was removed.

7.2.2. V4L2 Version 0.16 1999-01-31

1999-01-27: There is now one QBUF ioctl, VIDIOC_QWBUF and VIDIOC_QRBUF are gone. VIDIOC_QBUF takes a v4l2_buffer as a parameter. Added digital zoom (cropping) controls.

7.2.3. V4L2 Version 0.18 1999-03-16

Added a v4l to V4L2 ioctl compatibility layer to videodev.c. Driver writers, this changes how you implement your ioctl handler. See the Driver Writer's Guide. Added some more control id codes.

7.2.4. V4L2 Version 0.19 1999-06-05

1999-03-18: Fill in the category and catname fields of v4l2_queryctrl objects before passing them to the driver. Required a minor change to the VIDIOC_QUERYCTRL handlers in the sample drivers.

1999-03-31: Better compatibility for v4l memory capture ioctls. Requires changes to drivers to fully support new compatibility features, see Driver Writer's Guide and v4l2cap.c. Added new control IDs: V4L2_CID_HFLIP, _VFLIP. Changed V4L2_PIX_FMT_YUV422P to _YUV422P, and _YUV411P to _YUV411P.

1999-04-04: Added a few more control IDs.

1999-04-07: Added the button control type.

1999-05-02: Fixed a typo in videodev.h, and added the V4L2_CTRL_FLAG_GRAYED (later V4L2_CTRL_FLAG_GRABBED) flag.

1999-05-20: Definition of VIDIOC_G_CTRL was wrong causing a malfunction of this ioctl.

1999-06-05: Changed the value of V4L2_CID_WHITENESS.

7.2.5. V4L2 Version 0.20 (1999-09-10)

Version 0.20 introduced a number of changes which were *not backward compatible* with 0.19 and earlier versions. Purpose of these changes was to simplify the API, while making it more extensible and following common Linux driver API conventions.

1. Some typos in V4L2_FMT_FLAG symbols were fixed. struct v4l2_clip was changed for compatibility with v4l. (1999-08-30)

2. `V4L2_TUNER_SUB_LANG1` was added. (1999-09-05)
3. All `ioctl()` commands that used an integer argument now take a pointer to an integer. Where it makes sense, `ioctls` will return the actual new value in the integer pointed to by the argument, a common convention in the V4L2 API. The affected `ioctls` are: `VIDIOC_PREVIEW`, `VIDIOC_STREAMON`, `VIDIOC_STREAMOFF`, `VIDIOC_S_FREQ`, `VIDIOC_S_INPUT`, `VIDIOC_S_OUTPUT`, `VIDIOC_S_EFFECT`. For example

```
err = ioctl (fd, VIDIOC_XXX, V4L2_XXX);
becomes
```

```
int a = V4L2_XXX; err = ioctl(fd, VIDIOC_XXX, &a);
```

4. All the different get- and set-format commands were swept into one `VIDIOC_G_FMT` and `VIDIOC_S_FMT` `ioctl` taking a union and a type field selecting the union member as parameter. Purpose is to simplify the API by eliminating several `ioctls` and to allow new and driver private data streams without adding new `ioctls`.

This change obsoletes the following `ioctls`: `VIDIOC_S_INFMT`, `VIDIOC_G_INFMT`, `VIDIOC_S_OUTFMT`, `VIDIOC_G_OUTFMT`, `VIDIOC_S_VBIFMT` and `VIDIOC_G_VBIFMT`. The image format structure `v4l2_format` was renamed to struct `v4l2_pix_format`, while struct `v4l2_format` is now the envelopping structure for all format negotiations.

5. Similar to the changes above, the `VIDIOC_G_PARM` and `VIDIOC_S_PARM` `ioctls` were merged with `VIDIOC_G_OUTPARM` and `VIDIOC_S_OUTPARM`. A *type* field in the new struct `v4l2_streamparm` selects the respective union member.

This change obsoletes the `VIDIOC_G_OUTPARM` and `VIDIOC_S_OUTPARM` `ioctls`.

6. Control enumeration was simplified, and two new control flags were introduced and one dropped. The *catname* field was replaced by a *group* field.

Drivers can now flag unsupported and temporarily unavailable controls with `V4L2_CTRL_FLAG_DISABLED` and `V4L2_CTRL_FLAG_GRABBED` respectively. The *group* name indicates a possibly narrower classification than the *category*. In other words, there may be multiple groups within a category. Controls within a group would typically be drawn within a group box. Controls in different categories might have a greater separation, or may even appear in separate windows.

7. The struct `v4l2_buffer` *timestamp* was changed to a 64 bit integer, containing the sampling or output time of the frame in nanoseconds. Additionally timestamps will be in absolute system time, not starting from zero at the beginning of a stream. The data type name for timestamps is `stamp_t`, defined as a signed 64-bit integer. Output devices should not send a buffer out until the

time in the timestamp field has arrived. I would like to follow SGI's lead, and adopt a multimedia timestamping system like their UST (Unadjusted System Time). See http://web.archive.org/web/*/http://reality.sgi.com/cpirazzi_engr/lg/time/intro.html. UST uses timestamps that are 64-bit signed integers (not struct timeval's) and given in nanosecond units. The UST clock starts at zero when the system is booted and runs continuously and uniformly. It takes a little over 292 years for UST to overflow. There is no way to set the UST clock. The regular Linux time-of-day clock can be changed periodically, which would cause errors if it were being used for timestamping a multimedia stream. A real UST style clock will require some support in the kernel that is not there yet. But in anticipation, I will change the timestamp field to a 64-bit integer, and I will change the `v4l2_masterclock_gettime()` function (used only by drivers) to return a 64-bit integer.

8. A *sequence* field was added to struct `v4l2_buffer`. The *sequence* field counts captured frames, it is ignored by output devices. When a capture driver drops a frame, the sequence number of that frame is skipped.

7.2.6. V4L2 Version 0.20 incremental changes

1999-12-23: In struct `v4l2_vbi_format` the *reserved1* field became *offset*. Previously drivers were required to clear the *reserved1* field.

2000-01-13: The `V4L2_FMT_FLAG_NOT_INTERLACED` flag was added.

2000-07-31: The `linux/poll.h` header is now included by `videodev.h` for compatibility with the original `videodev.h` file.

2000-11-20: `V4L2_TYPE_VBI_OUTPUT` and `V4L2_PIX_FMT_Y41P` were added.

2000-11-25: `V4L2_TYPE_VBI_INPUT` was added.

2000-12-04: A couple typos in symbol names were fixed.

2001-01-18: To avoid namespace conflicts the `fourcc` macro defined in the `videodev.h` header file was renamed to `v4l2_fourcc`.

2001-01-25: A possible driver-level compatibility problem between the `videodev.h` file in Linux 2.4.0 and the `videodev.h` file included in the `videodevX` patch was fixed. Users of an earlier version of `videodevX` on Linux 2.4.0 should recompile their V4L and V4L2 drivers.

2001-01-26: A possible kernel-level incompatibility between the `videodev.h` file in the `videodevX` patch and the `videodev.h` file in Linux 2.2.x with `devfs` patches applied was fixed.

2001-03-02: Certain V4L ioctls which pass data in both direction although they are defined with read-only parameter, did not work correctly through the backward

compatibility layer. [Solution?]

2001-04-13: Big endian 16-bit RGB formats were added.

2001-09-17: New YUV formats and the `VIDIOC_G_FREQUENCY` and `VIDIOC_S_FREQUENCY` ioctls were added. (The old `VIDIOC_G_FREQ` and `VIDIOC_S_FREQ` ioctls did not take multiple tuners into account.)

2000-09-18: `V4L2_BUF_TYPE_VBI` was added. This may *break compatibility* as the `VIDIOC_G_FMT` and `VIDIOC_S_FMT` ioctls may fail now if the struct `v4l2_fmt` `type` field does not contain `V4L2_BUF_TYPE_VBI`. In the documentation of the struct `v4l2_vbi_format` `offset` field the ambiguous phrase "rising edge" was changed to "leading edge".

7.2.7. V4L2 Version 0.20 2000-11-23

A number of changes were made to the raw VBI interface.

1. Figures clarifying the line numbering scheme were added to the V4L2 API specification. The `start[0]` and `start[1]` fields no longer count line numbers beginning at zero. Rationale: a) The previous definition was unclear. b) The `start[]` values are ordinal numbers. c) There is no point in inventing a new line numbering scheme. We now use line number as defined by ITU-R, period. Compatibility: Add one to the start values. Applications depending on the previous semantics may not function correctly.
2. The restriction "`count[0] > 0` and `count[1] > 0`" has been relaxed to "`(count[0] + count[1]) > 0`". Rationale: Drivers may allocate resources at scan line granularity and some data services are transmitted only on the first field. The comment that both `count` values will usually be equal is misleading and pointless and has been removed. This change *breaks compatibility* with earlier versions: Drivers may return `EINVAL`, applications may not function correctly.
3. Drivers are again permitted to return negative (unknown) start values as proposed earlier. Why this feature was dropped is unclear. This change may *break compatibility* with applications depending on the start values being positive. The use of `EBUSY` and `EINVAL` error codes with the `VIDIOC_S_FMT` ioctl was clarified. The `EBUSY` error code was finally documented, and the `reserved2` field which was previously mentioned only in the `videodev.h` header file.
4. New buffer types `V4L2_TYPE_VBI_INPUT` and `V4L2_TYPE_VBI_OUTPUT` were added. The former is an alias for the old `V4L2_TYPE_VBI`, the latter was missing in the `videodev.h` file.

7.2.8. V4L2 Version 0.20 2002-07-25

Added sliced VBI interface proposal.

7.2.9. V4L2 in Linux 2.5.46, 2002-10

Around October-November 2002, prior to an announced feature freeze of Linux 2.5, the API was revised, drawing from experience with V4L2 0.20. This unnamed version was finally merged into Linux 2.5.46.

1. As specified in Section 1.1.2, drivers must make related device functions available under all minor device numbers.
2. The `open()` function requires access mode `O_RDWR` regardless of the device type. All V4L2 drivers exchanging data with applications must support the `O_NONBLOCK` flag. The `O_NOIO` flag, a V4L2 symbol which aliased the meaningless `O_TRUNC` to indicate accesses without data exchange (panel applications) was dropped. Drivers must stay in "panel mode" until the application attempts to initiate a data exchange, see Section 1.1.
3. The struct `v4l2_capability` changed dramatically. Note that also the size of the structure changed, which is encoded in the `ioctl` request code, thus older V4L2 devices will respond with an `EINVAL` error code to the new `VIDIOC_QUERYCAP` `ioctl`.

There are new fields to identify the driver, a new RDS device function `V4L2_CAP_RDS_CAPTURE`, the `V4L2_CAP_AUDIO` flag indicates if the device has any audio connectors, another I/O capability `V4L2_CAP_ASYNCIO` can be flagged. In response to these changes the `type` field became a bit set and was merged into the `flags` field. `V4L2_FLAG_TUNER` was renamed to `V4L2_CAP_TUNER`, `V4L2_CAP_VIDEO_OVERLAY` replaced `V4L2_FLAG_PREVIEW` and `V4L2_CAP_VBI_CAPTURE` and `V4L2_CAP_VBI_OUTPUT` replaced `V4L2_FLAG_DATA_SERVICE`. `V4L2_FLAG_READ` and `V4L2_FLAG_WRITE` were merged into `V4L2_CAP_READWRITE`.

The redundant fields `inputs`, `outputs` and `audios` were removed. These properties can be determined as described in Section 1.4 and Section 1.5.

The somewhat volatile and therefore barely useful fields `maxwidth`, `maxheight`, `minwidth`, `minheight`, `maxframerate` were removed. This information is available as described in Section 1.10 and Section 1.7.

`V4L2_FLAG_SELECT` was removed. We believe the `select()` function is important enough to require support of it in all V4L2 drivers exchanging data

with applications. The redundant `V4L2_FLAG_MONOCHROME` flag was removed, this information is available as described in Section 1.10.

4. In struct `v4l2_input` the `assoc_audio` field and the `capability` field and its only flag `V4L2_INPUT_CAP_AUDIO` was replaced by the new `audioset` field. Instead of linking one video input to one audio input this field reports all audio inputs this video input combines with.

New fields are `tuner` (reversing the former link from tuners to video inputs), `std` and `status`.

Accordingly struct `v4l2_output` lost its `capability` and `assoc_audio` fields. `audioset`, `modulator` and `std` were added instead.

5. The struct `v4l2_audio` field `audio` was renamed to `index`, for consistency with other structures. A new capability flag `V4L2_AUDCAP_STEREO` was added to indicate if the audio input in question supports stereo sound. `V4L2_AUDCAP_EFFECTS` and the corresponding `V4L2_AUDMODE` flags were removed. This can be easily implemented using controls. (However the same applies to AVL which is still there.)

Again for consistency the struct `v4l2_audioout` field `audio` was renamed to `index`.

6. The struct `v4l2_tuner` `input` field was replaced by an `index` field, permitting devices with multiple tuners. The link between video inputs and tuners is now reversed, inputs point to their tuner. The `std` substructure became a simple set (more about this below) and moved into struct `v4l2_input`. A `type` field was added.

Accordingly in struct `v4l2_modulator` the `output` was replaced by an `index` field.

In struct `v4l2_frequency` the `port` field was replaced by a `tuner` field containing the respective tuner or modulator index number. A `tuner type` field was added and the `reserved` field became larger for future extensions (satellite tuners in particular).

7. The idea of completely transparent video standards was dropped. Experience showed that applications must be able to work with video standards beyond presenting the user a menu. Instead of enumerating supported standards with an ioctl applications can now refer to standards by `v4l2_std_id` and symbols defined in the `videodev2.h` header file. For details see Section 1.7. The `VIDIOC_G_STD` and `VIDIOC_S_STD` now take a pointer to this type as argument. `VIDIOC_QUERYSTD` was added to autodetect the received standard, if the hardware has this capability. In struct `v4l2_standard` an `index` field was added for `VIDIOC_ENUMSTD`. A `v4l2_std_id` field named `id` was added as machine readable identifier, also replacing the `transmission` field. The misleading `framerate` field was renamed to `frameperiod`. The now obsolete

`colorstandard` information, originally needed to distinguish between variations of standards, were removed.

Struct `v4l2_enumstd` ceased to be. `VIDIOC_ENUMSTD` now takes a pointer to a struct `v4l2_standard` directly. The information which standards are supported by a particular video input or output moved into struct `v4l2_input` and struct `v4l2_output` fields named `std`, respectively.

8. The struct `v4l2_queryctrl` fields `category` and `group` did not catch on and/or were not implemented as expected and therefore removed.
9. The `VIDIOC_TRY_FMT` ioctl was added to negotiate data formats as with `VIDIOC_S_FMT`, but without the overhead of programming the hardware and regardless of I/O in progress.

In struct `v4l2_format` the `fmt` union was extended to contain struct `v4l2_window`. All image format negotiations are now possible with `VIDIOC_G_FMT`, `VIDIOC_S_FMT` and `VIDIOC_TRY_FMT`; ioctl. The `VIDIOC_G_WIN` and `VIDIOC_S_WIN` ioctls to prepare for a video overlay were removed. The `type` field changed to type enum `v4l2_buf_type` and the buffer type names changed as follows.

Old defines	enum <code>v4l2_buf_type</code>
<code>V4L2_BUF_TYPE_CAPTURE</code>	<code>V4L2_BUF_TYPE_VIDEO_CAPTURE</code>
<code>V4L2_BUF_TYPE_CODECI</code>	Omitted for now
<code>V4L2_BUF_TYPE_CODECO</code>	Omitted for now
<code>V4L2_BUF_TYPE_EFFECTSIN</code>	Omitted for now
<code>V4L2_BUF_TYPE_EFFECTSIN2</code>	Omitted for now
<code>V4L2_BUF_TYPE_EFFECTSOUT</code>	Omitted for now
<code>V4L2_BUF_TYPE_VIDEOOUT</code>	<code>V4L2_BUF_TYPE_VIDEO_OUTPUT</code>
–	<code>V4L2_BUF_TYPE_VIDEO_OVERLAY</code>
–	<code>V4L2_BUF_TYPE_VBI_CAPTURE</code>
–	<code>V4L2_BUF_TYPE_VBI_OUTPUT</code>
–	<code>V4L2_BUF_TYPE_SLICED_VBI_CAPTURE</code>
–	<code>V4L2_BUF_TYPE_SLICED_VBI_OUTPUT</code>
<code>V4L2_BUF_TYPE_PRIVATE_BASE</code>	<code>V4L2_BUF_TYPE_PRIVATE</code>

10. In struct `v4l2_fmtdesc` a enum `v4l2_buf_type` field named `type` was added as in struct `v4l2_format`. The `VIDIOC_ENUM_FBUFMT` ioctl is no longer needed and was removed. These calls can be replaced by `VIDIOC_ENUM_FMT` with type `V4L2_BUF_TYPE_VIDEO_OVERLAY`.

11. In struct `v4l2_pix_format` the *depth* field was removed, assuming applications which recognize the format by its four-character-code already know the color depth, and others do not care about it. The same rationale lead to the removal of the `V4L2_FMT_FLAG_COMPRESSED` flag. The

`V4L2_FMT_FLAG_SWCONVECOMPRESSED` flag was removed because drivers are not supposed to convert images in kernel space. A user library of conversion functions should be provided instead. The

`V4L2_FMT_FLAG_BYTESPERLINE` flag was redundant. Applications can set the *bytesperline* field to zero to get a reasonable default. Since the remaining flags were replaced as well, the *flags* field itself was removed.

The interlace flags were replaced by a enum `v4l2_field` value in a newly added *field* field.

Old flag	enum <code>v4l2_field</code>
<code>V4L2_FMT_FLAG_NOT_INTERLACED</code>	?
<code>V4L2_FMT_FLAG_INTERLACED =</code> <code>V4L2_FMT_FLAG_COMBINED</code>	<code>V4L2_FIELD_INTERLACED</code>
<code>V4L2_FMT_FLAG_TOPFIELD =</code> <code>V4L2_FMT_FLAG_ODDFIELD</code>	<code>V4L2_FIELD_TOP</code>
<code>V4L2_FMT_FLAG_BOTFIELD =</code> <code>V4L2_FMT_FLAG_EVENFIELD</code>	<code>V4L2_FIELD_BOTTOM</code>
–	<code>V4L2_FIELD_SEQ_TB</code>
–	<code>V4L2_FIELD_SEQ_BT</code>
–	<code>V4L2_FIELD_ALTERNATE</code>

The color space flags were replaced by a enum `v4l2_colorspace` value in a newly added *colorspace* field, where one of

`V4L2_COLORSPACE_SMPTE170M`, `V4L2_COLORSPACE_BT878`,

`V4L2_COLORSPACE_470_SYSTEM_M` or

`V4L2_COLORSPACE_470_SYSTEM_BG` replaces `V4L2_FMT_CS_601YUV`.

12. In struct `v4l2_requestbuffers` the *type* field was properly defined as enum `v4l2_buf_type`. Buffer types changed as mentioned above. A new *memory* field of type enum `v4l2_memory` was added to distinguish between I/O methods using buffers allocated by the driver or the application. See Chapter 3 for details.
13. In struct `v4l2_buffer` the *type* field was properly defined as enum `v4l2_buf_type`. Buffer types changed as mentioned above. A *field* field of type enum `v4l2_field` was added to indicate if a buffer contains a top or bottom field. The old field flags were removed. Since no unadjusted system time clock was added to the kernel as planned, the *timestamp* field changed

back from type `stamp_t`, an unsigned 64 bit integer expressing the sample time in nanoseconds, to struct `timeval`. With the addition of a second memory mapping method the `offset` field moved into union `m`, and a new `memory` field of type enum `v4l2_memory` was added to distinguish between I/O methods. See Chapter 3 for details.

The `V4L2_BUF_REQ_CONTIG` flag was used by the V4L compatibility layer, after changes to this code it was no longer needed. The `V4L2_BUF_ATTR_DEVICEMEM` flag would indicate if the buffer was indeed allocated in device memory rather than DMA-able system memory. It was barely useful and so was removed.

14. In struct `v4l2_framebuffer` the `base[3]` array anticipating double- and triple-buffering in off-screen video memory, however without defining a synchronization mechanism, was replaced by a single pointer. The `V4L2_FBUF_CAP_SCALEUP` and `V4L2_FBUF_CAP_SCALEDOWN` flags were removed. Applications can determine this capability more accurately using the new cropping and scaling interface. The `V4L2_FBUF_CAP_CLIPPING` flag was replaced by `V4L2_FBUF_CAP_LIST_CLIPPING` and `V4L2_FBUF_CAP_BITMAP_CLIPPING`.
15. In struct `v4l2_clip` the `x`, `y`, `width` and `height` field moved into a `c` substructure of type struct `v4l2_rect`. The `x` and `y` fields were renamed to `left` and `top`, i. e. offsets to a context dependent origin.
16. In struct `v4l2_window` the `x`, `y`, `width` and `height` field moved into a `w` substructure as above. A `field` field of type `%v4l2-field`; was added to distinguish between field and frame (interlaced) overlay.
17. The digital zoom interface, including struct `v4l2_zoomcap`, struct `v4l2_zoom`, `V4L2_ZOOM_NONCAP` and `V4L2_ZOOM_WHILESTREAMING` was replaced by a new cropping and scaling interface. The previously unused struct `v4l2_cropcap` and `v4l2_crop` were redefined for this purpose. See Section 1.12 for details.
18. In struct `v4l2_vbi_format` the `SAMPLE_FORMAT` field now contains a four-character-code as used to identify video image formats and `V4L2_PIX_FMT_GREY` replaces the `V4L2_VBI_SF_UBYTE` define. The `reserved` field was extended.
19. In struct `v4l2_captureparm` the type of the `timeperframe` field changed from unsigned long to struct `v4l2_fract`. This allows the accurate expression of multiples of the NTSC-M frame rate 30000 / 1001. A new field `readbuffers` was added to control the driver behaviour in read I/O mode.

Similar changes were made to struct `v4l2_outputparm`.
20. The struct `v4l2_performance` and `VIDIOC_G_PERF` ioctl were dropped. Except when using the read/write I/O method, which is limited anyway, this information is already available to applications.

21. The example transformation from RGB to YCbCr color space in the old V4L2 documentation was inaccurate, this has been corrected in Chapter 2.

7.2.10. V4L2 2003-06-19

1. A new capability flag `V4L2_CAP_RADIO` was added for radio devices. Prior to this change radio devices would identify solely by having exactly one tuner whose type field reads `V4L2_TUNER_RADIO`.
2. An optional driver access priority mechanism was added, see Section 1.3 for details.
3. The audio input and output interface was found to be incomplete.

Previously the `VIDIOC_G_AUDIO` ioctl would enumerate the available audio inputs. An ioctl to determine the current audio input, if more than one combines with the current video input, did not exist. So `VIDIOC_G_AUDIO` was renamed to `VIDIOC_G_AUDIO_OLD`, this ioctl was removed on Kernel 2.6.39. The `VIDIOC_ENUMAUDIO` ioctl was added to enumerate audio inputs, while `VIDIOC_G_AUDIO` now reports the current audio input.

The same changes were made to `VIDIOC_G_AUDOUT` and `VIDIOC_ENUMAUDOUT`.

Until further the "videodev" module will automatically translate between the old and new ioctls, but drivers and applications must be updated to successfully compile again.

4. The `VIDIOC_OVERLAY` ioctl was incorrectly defined with write-read parameter. It was changed to write-only, while the write-read version was renamed to `VIDIOC_OVERLAY_OLD`. The old ioctl was removed on Kernel 2.6.39. Until further the "videodev" kernel module will automatically translate to the new version, so drivers must be recompiled, but not applications.
5. Section 4.2 incorrectly stated that clipping rectangles define regions where the video can be seen. Correct is that clipping rectangles define regions where *no* video shall be displayed and so the graphics surface can be seen.
6. The `VIDIOC_S_PARM` and `VIDIOC_S_CTRL` ioctls were defined with write-only parameter, inconsistent with other ioctls modifying their argument. They were changed to write-read, while a `_OLD` suffix was added to the write-only versions. The old ioctls were removed on Kernel 2.6.39. Drivers and applications assuming a constant parameter need an update.

7.2.11. V4L2 2003-11-05

1. In Section 2.6 the following pixel formats were incorrectly transferred from Bill Dirks' V4L2 specification. Descriptions below refer to bytes in memory, in ascending address order.

Symbol	In this document prior to revision 0.5	Corrected
V4L2_PIX_FMT_RGB24	B, G, R	R, G, B
V4L2_PIX_FMT_BGR24	R, G, B	B, G, R
V4L2_PIX_FMT_RGB32	B, G, R, X	R, G, B, X
V4L2_PIX_FMT_BGR32	R, G, B, X	B, G, R, X

The V4L2_PIX_FMT_BGR24 example was always correct.

In Section 7.1.5 the mapping of the V4L VIDEO_PALETTE_RGB24 and VIDEO_PALETTE_RGB32 formats to V4L2 pixel formats was accordingly corrected.

2. Unrelated to the fixes above, drivers may still interpret some V4L2 RGB pixel formats differently. These issues have yet to be addressed, for details see Section 2.6.

7.2.12. V4L2 in Linux 2.6.6, 2004-05-09

1. The VIDIOC_CROPCAP ioctl was incorrectly defined with read-only parameter. It is now defined as write-read ioctl, while the read-only version was renamed to VIDIOC_CROPCAP_OLD. The old ioctl was removed on Kernel 2.6.39.

7.2.13. V4L2 in Linux 2.6.8

1. A new field *input* (former *reserved[0]*) was added to the struct `v4l2_buffer` structure. Purpose of this field is to alternate between video inputs (e. g. cameras) in step with the video capturing process. This function must be enabled with the new `V4L2_BUF_FLAG_INPUT` flag. The *flags* field is no longer read-only.

7.2.14. V4L2 spec erratum 2004-08-01

1. The return value of the V4L2 `open()(2)` function was incorrectly documented.
2. Audio output ioctls end in `-AUDOUT`, not `-AUDIOOUT`.
3. In the Current Audio Input example the `VIDIOC_G_AUDIO` ioctl took the wrong argument.
4. The documentation of the `VIDIOC_QBUF` and `VIDIOC_DQBUF` ioctls did not mention the struct `v4l2_buffer` *memory* field. It was also missing from examples. Also on the `VIDIOC_DQBUF` page the `EIO` error code was not documented.

7.2.15. V4L2 in Linux 2.6.14

1. A new sliced VBI interface was added. It is documented in Section 4.8 and replaces the interface first proposed in V4L2 specification 0.8.

7.2.16. V4L2 in Linux 2.6.15

1. The `VIDIOC_LOG_STATUS` ioctl was added.
2. New video standards `V4L2_STD_NTSC_443`, `V4L2_STD_SECAM_LC`, `V4L2_STD_SECAM_DK` (a set of SECAM D, K and K1), and `V4L2_STD_ATSC` (a set of `V4L2_STD_ATSC_8_VSB` and `V4L2_STD_ATSC_16_VSB`) were defined. Note the `V4L2_STD_525_60` set now includes `V4L2_STD_NTSC_443`. See also Table A-3.
3. The `VIDIOC_G_COMP` and `VIDIOC_S_COMP` ioctl were renamed to `VIDIOC_G_MPEGCOMP` and `VIDIOC_S_MPEGCOMP` respectively. Their argument was replaced by a struct `v4l2_mpeg_compression` pointer. (The `VIDIOC_G_MPEGCOMP` and `VIDIOC_S_MPEGCOMP` ioctls were removed in Linux 2.6.25.)

7.2.17. V4L2 spec erratum 2005-11-27

The capture example in Appendix C called the `VIDIOC_S_CROP` ioctl without checking if cropping is supported. In the video standard selection example in Section 1.7 the `VIDIOC_S_STD` call used the wrong argument type.

7.2.18. V4L2 spec erratum 2006-01-10

1. The `V4L2_IN_ST_COLOR_KILL` flag in struct `v4l2_input` not only indicates if the color killer is enabled, but also if it is active. (The color killer disables color decoding when it detects no color in the video signal to improve the image quality.)
2. `VIDIOC_S_PARM` is a write-read ioctl, not write-only as stated on its reference page. The ioctl changed in 2003 as noted above.

7.2.19. V4L2 spec erratum 2006-02-03

1. In struct `v4l2_captureparm` and struct `v4l2_outputparm` the *timeperframe* field gives the time in seconds, not microseconds.

7.2.20. V4L2 spec erratum 2006-02-04

1. The *clips* field in struct `v4l2_window` must point to an array of struct `v4l2_clip`, not a linked list, because drivers ignore the struct `v4l2_clip.next` pointer.

7.2.21. V4L2 in Linux 2.6.17

1. New video standard macros were added: `V4L2_STD_NTSC_M_KR` (NTSC M South Korea), and the sets `V4L2_STD_MN`, `V4L2_STD_B`, `V4L2_STD_GH` and `V4L2_STD_DK`. The `V4L2_STD_NTSC` and `V4L2_STD_SECAM` sets now include `V4L2_STD_NTSC_M_KR` and `V4L2_STD_SECAM_LC` respectively.
2. A new `V4L2_TUNER_MODE_LANG1_LANG2` was defined to record both languages of a bilingual program. The use of `V4L2_TUNER_MODE_STEREO` for this purpose is deprecated now. See the `VIDIOC_G_TUNER` section for details.

7.2.22. V4L2 spec erratum 2006-09-23 (Draft 0.15)

1. In various places `V4L2_BUF_TYPE_SLICED_VBI_CAPTURE` and `V4L2_BUF_TYPE_SLICED_VBI_OUTPUT` of the sliced VBI interface were not mentioned along with other buffer types.
2. In `ioctl VIDIOC_G_AUDIO`, `VIDIOC_S_AUDIO(2)` it was clarified that the struct `v4l2_audio` *mode* field is a flags field.
3. `ioctl VIDIOC_QUERYCAP(2)` did not mention the sliced VBI and radio capability flags.
4. In `ioctl VIDIOC_G_FREQUENCY`, `VIDIOC_S_FREQUENCY(2)` it was clarified that applications must initialize the tuner *type* field of struct `v4l2_frequency` before calling `VIDIOC_S_FREQUENCY`.
5. The *reserved* array in struct `v4l2_requestbuffers` has 2 elements, not 32.
6. In Section 4.3 and Section 4.7 the device file names `/dev/vout` which never caught on were replaced by `/dev/video`.
7. With Linux 2.6.15 the possible range for VBI device minor numbers was extended from 224-239 to 224-255. Accordingly device file names `/dev/vbi0` to `/dev/vbi31` are possible now.

7.2.23. V4L2 in Linux 2.6.18

1. New `ioctls` `VIDIOC_G_EXT_CTRLS`, `VIDIOC_S_EXT_CTRLS` and `VIDIOC_TRY_EXT_CTRLS` were added, a flag to skip unsupported controls with `VIDIOC_QUERYCTRL`, new control types `V4L2_CTRL_TYPE_INTEGER64` and `V4L2_CTRL_TYPE_CTRL_CLASS` (Table A-3), and new control flags `V4L2_CTRL_FLAG_READ_ONLY`, `V4L2_CTRL_FLAG_UPDATE`, `V4L2_CTRL_FLAG_INACTIVE` and `V4L2_CTRL_FLAG_SLIDER` (Table A-4). See Section 1.9 for details.

7.2.24. V4L2 in Linux 2.6.19

1. In struct `v4l2_sliced_vbi_cap` a buffer type field was added replacing a reserved field. Note on architectures where the size of enum types differs from int types the size of the structure changed. The `VIDIOC_G_SLICED_VBI_CAP` `ioctl` was redefined from being read-only to write-read. Applications must initialize the type field and clear the reserved fields now. These changes may *break the compatibility* with older drivers and applications.

2. The ioctls `VIDIOC_ENUM_FRAMESIZES` and `VIDIOC_ENUM_FRAMEINTERVALS` were added.
3. A new pixel format `V4L2_PIX_FMT_RGB444` (Table 2-1) was added.

7.2.25. V4L2 spec erratum 2006-10-12 (Draft 0.17)

1. `V4L2_PIX_FMT_HM12` (Table 2-10) is a YUV 4:2:0, not 4:2:2 format.

7.2.26. V4L2 in Linux 2.6.21

1. The `videodev2.h` header file is now dual licensed under GNU General Public License version two or later, and under a 3-clause BSD-style license.

7.2.27. V4L2 in Linux 2.6.22

1. Two new field orders `V4L2_FIELD_INTERLACED_TB` and `V4L2_FIELD_INTERLACED_BT` were added. See Table 3-9 for details.
2. Three new clipping/blending methods with a global or straight or inverted local alpha value were added to the video overlay interface. See the description of the `VIDIOC_G_FBUF` and `VIDIOC_S_FBUF` ioctls for details.

A new `global_alpha` field was added to `v4l2_window`, extending the structure. This may *break compatibility* with applications using a struct `v4l2_window` directly. However the `VIDIOC_G/S/TRY_FMT` ioctls, which take a pointer to a `v4l2_format` parent structure with padding bytes at the end, are not affected.

3. The format of the `chromakey` field in struct `v4l2_window` changed from "host order RGB32" to a pixel value in the same format as the framebuffer. This may *break compatibility* with existing applications. Drivers supporting the "host order RGB32" format are not known.

7.2.28. V4L2 in Linux 2.6.24

1. The pixel formats `V4L2_PIX_FMT_PAL8`, `V4L2_PIX_FMT_YUV444`, `V4L2_PIX_FMT_YUV555`, `V4L2_PIX_FMT_YUV565` and `V4L2_PIX_FMT_YUV32` were added.

7.2.29. V4L2 in Linux 2.6.25

1. The pixel formats `V4L2_PIX_FMT_Y16` and `V4L2_PIX_FMT_SBGGR16` were added.
2. New controls `V4L2_CID_POWER_LINE_FREQUENCY`, `V4L2_CID_HUE_AUTO`, `V4L2_CID_WHITE_BALANCE_TEMPERATURE`, `V4L2_CID_SHARPNESS` and `V4L2_CID_BACKLIGHT_COMPENSATION` were added. The controls `V4L2_CID_BLACK_LEVEL`, `V4L2_CID_WHITENESS`, `V4L2_CID_HCENTER` and `V4L2_CID_VCENTER` were deprecated.
3. A Camera controls class was added, with the new controls `V4L2_CID_EXPOSURE_AUTO`, `V4L2_CID_EXPOSURE_ABSOLUTE`, `V4L2_CID_EXPOSURE_AUTO_PRIORITY`, `V4L2_CID_PAN_RELATIVE`, `V4L2_CID_TILT_RELATIVE`, `V4L2_CID_PAN_RESET`, `V4L2_CID_TILT_RESET`, `V4L2_CID_PAN_ABSOLUTE`, `V4L2_CID_TILT_ABSOLUTE`, `V4L2_CID_FOCUS_ABSOLUTE`, `V4L2_CID_FOCUS_RELATIVE` and `V4L2_CID_FOCUS_AUTO`.
4. The `VIDIOC_G_MPEGCOMP` and `VIDIOC_S_MPEGCOMP` ioctls, which were superseded by the extended controls interface in Linux 2.6.18, were finally removed from the `videodev2.h` header file.

7.2.30. V4L2 in Linux 2.6.26

1. The pixel formats `V4L2_PIX_FMT_Y16` and `V4L2_PIX_FMT_SBGGR16` were added.
2. Added user controls `V4L2_CID_CHROMA_AGC` and `V4L2_CID_COLOR_KILLER`.

7.2.31. V4L2 in Linux 2.6.27

1. The `VIDIOC_S_HW_FREQ_SEEK` ioctl and the `V4L2_CAP_HW_FREQ_SEEK` capability were added.

2. The pixel formats `V4L2_PIX_FMT_YVYU`, `V4L2_PIX_FMT_PCA501`, `V4L2_PIX_FMT_PCA505`, `V4L2_PIX_FMT_PCA508`, `V4L2_PIX_FMT_PCA561`, `V4L2_PIX_FMT_SGBRG8`, `V4L2_PIX_FMT_PAC207` and `V4L2_PIX_FMT_PJPG` were added.

7.2.32. V4L2 in Linux 2.6.28

1. Added `V4L2_MPEG_AUDIO_ENCODING_AAC` and `V4L2_MPEG_AUDIO_ENCODING_AC3` MPEG audio encodings.
2. Added `V4L2_MPEG_VIDEO_ENCODING_MPEG_4_AVC` MPEG video encoding.
3. The pixel formats `V4L2_PIX_FMT_SGRBG10` and `V4L2_PIX_FMT_SGRBG10DPCM8` were added.

7.2.33. V4L2 in Linux 2.6.29

1. The `VIDIOC_G_CHIP_IDENT` ioctl was renamed to `VIDIOC_G_CHIP_IDENT_OLD` and `VIDIOC_DBG_G_CHIP_IDENT` was introduced in its place. The old struct `v4l2_chip_ident` was renamed to `v4l2_chip_ident_old`.
2. The pixel formats `V4L2_PIX_FMT_VYUY`, `V4L2_PIX_FMT_NV16` and `V4L2_PIX_FMT_NV61` were added.
3. Added camera controls `V4L2_CID_ZOOM_ABSOLUTE`, `V4L2_CID_ZOOM_RELATIVE`, `V4L2_CID_ZOOM_CONTINUOUS` and `V4L2_CID_PRIVACY`.

7.2.34. V4L2 in Linux 2.6.30

1. New control flag `V4L2_CTRL_FLAG_WRITE_ONLY` was added.
2. New control `V4L2_CID_COLORFX` was added.

7.2.35. V4L2 in Linux 2.6.32

1. In order to be easier to compare a V4L2 API and a kernel version, now V4L2 API is numbered using the Linux Kernel version numeration.
2. Finalized the RDS capture API. See Section 4.11 for more information.
3. Added new capabilities for modulators and RDS encoders.
4. Add description for libv4l API.
5. Added support for string controls via new type `V4L2_CTRL_TYPE_STRING`.
6. Added `V4L2_CID_BAND_STOP_FILTER` documentation.
7. Added FM Modulator (FM TX) Extended Control Class: `V4L2_CTRL_CLASS_FM_TX` and their Control IDs.
8. Added Remote Controller chapter, describing the default Remote Controller mapping for media devices.

7.2.36. V4L2 in Linux 2.6.33

1. Added support for Digital Video timings in order to support HDTV receivers and transmitters.

7.2.37. V4L2 in Linux 2.6.34

1. Added `V4L2_CID_IRIS_ABSOLUTE` and `V4L2_CID_IRIS_RELATIVE` controls to the Camera controls class.

7.2.38. V4L2 in Linux 2.6.37

1. Remove the vtx (videotext/teletext) API. This API was no longer used and no hardware exists to verify the API. Nor were any userspace applications found that used it. It was originally scheduled for removal in 2.6.35.

7.2.39. V4L2 in Linux 2.6.39

1. The old `VIDIOC_*_OLD` symbols and V4L1 support were removed.

2. Multi-planar API added. Does not affect the compatibility of current drivers and applications. See [multi-planar API](#) for details.

7.2.40. Relation of V4L2 to other Linux multimedia APIs

7.2.40.1. X Video Extension

The X Video Extension (abbreviated XVideo or just Xv) is an extension of the X Window system, implemented for example by the XFree86 project. Its scope is similar to V4L2, an API to video capture and output devices for X clients. Xv allows applications to display live video in a window, send window contents to a TV output, and capture or output still images in XPixmaps¹. With their implementation XFree86 makes the extension available across many operating systems and architectures.

Because the driver is embedded into the X server Xv has a number of advantages over the V4L2 [video overlay interface](#). The driver can easily determine the overlay target, i. e. visible graphics memory or off-screen buffers for a destructive overlay. It can program the RAMDAC for a non-destructive overlay, scaling or color-keying, or the clipping functions of the video capture hardware, always in sync with drawing operations or windows moving or changing their stacking order.

To combine the advantages of Xv and V4L a special Xv driver exists in XFree86 and XOrg, just programming any overlay capable Video4Linux device it finds. To enable it `/etc/X11/XF86Config` must contain these lines:

```
Section "Module"
    Load "v4l"
EndSection
```

As of XFree86 4.2 this driver still supports only V4L ioctls, however it should work just fine with all V4L2 devices through the V4L2 backward-compatibility layer. Since V4L2 permits multiple opens it is possible (if supported by the V4L2 driver) to capture video while an X client requested video overlay. Restrictions of simultaneous capturing and overlay are discussed in [Section 4.2](#) apply.

Only marginally related to V4L2, XFree86 extended Xv to support hardware YUV to RGB conversion and scaling for faster video playback, and added an interface to MPEG-2 decoding hardware. This API is useful to display images captured with V4L2 devices.

7.2.40.2. Digital Video

V4L2 does not support digital terrestrial, cable or satellite broadcast. A separate project aiming at digital receivers exists. You can find its homepage at <http://linuxtv.org>. The Linux DVB API has no connection to the V4L2 API except that drivers for hybrid hardware may support both.

7.2.40.3. Audio Interfaces

[to do - OSS/ALSA]

7.2.41. Experimental API Elements

The following V4L2 API elements are currently experimental and may change in the future.

- Video Output Overlay (OSD) Interface, Section 4.4.
- `V4L2_BUF_TYPE_VIDEO_OUTPUT_OVERLAY`, enum `v4l2_buf_type`, Table 3-3.
- `V4L2_CAP_VIDEO_OUTPUT_OVERLAY`, `VIDIOC_QUERYCAP` ioctl, Table A-2.
- `VIDIOC_ENUM_FRAMESIZES` and `VIDIOC_ENUM_FRAMEINTERVALS` ioctls.
- `VIDIOC_G_ENC_INDEX` ioctl.
- `VIDIOC_ENCODER_CMD` and `VIDIOC_TRY_ENCODER_CMD` ioctls.
- `VIDIOC_DBG_G_REGISTER` and `VIDIOC_DBG_S_REGISTER` ioctls.
- `VIDIOC_DBG_G_CHIP_IDENT` ioctl.

7.2.42. Obsolete API Elements

The following V4L2 API elements were superseded by new interfaces and should not be implemented in new drivers.

- `VIDIOC_G_MPEGCOMP` and `VIDIOC_S_MPEGCOMP` ioctls. Use Extended Controls, Section 1.9.

Notes

1. This is not implemented in XFree86.

Appendix A. Function Reference

V4L2 close()

Name

`v4l2-close` — Close a V4L2 device

Synopsis

```
#include <unistd.h>
int close(int fd);
```

Arguments

fd

File descriptor returned by `open()`.

Description

Closes the device. Any I/O in progress is terminated and resources associated with the file descriptor are freed. However data format parameters, current input or output, control values or other properties remain unchanged.

Return Value

The function returns 0 on success, -1 on failure and the `errno` is set appropriately. Possible error codes:

EBADF

fd is not a valid open file descriptor.

V4L2 ioctl()

Name

`v4l2_ioctl` — Program a V4L2 device

Synopsis

```
#include <sys/ioctl.h>
int ioctl(int fd, int request, void *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

V4L2 ioctl request code as defined in the `videodev2.h` header file, for example `VIDIOC_QUERYCAP`.

argp

Pointer to a function parameter, usually a structure.

Description

The `ioctl()` function is used to program V4L2 devices. The argument *fd* must be an open file descriptor. An ioctl *request* has encoded in it whether the argument is an input, output or read/write parameter, and the size of the argument *argp* in bytes. Macros and defines specifying V4L2 ioctl requests are located in the `videodev2.h` header file. Applications should use their own copy, not include the version in the kernel sources on the system they compile on. All V4L2 ioctl requests, their respective function and parameters are specified in Appendix A.

Return Value

On success the `ioctl()` function returns 0 and does not reset the `errno` variable. On failure -1 is returned, when the `ioctl` takes an output or read/write parameter it remains unmodified, and the `errno` variable is set appropriately. See below for possible error codes. Generic errors like `EBADF` or `EFAULT` are not listed in the sections discussing individual `ioctl` requests.

Note `ioctls` may return undefined error codes. Since errors may have side effects such as a driver reset applications should abort on unexpected errors.

EBADF

fd is not a valid open file descriptor.

EBUSY

The property cannot be changed right now. Typically this error code is returned when I/O is in progress or the driver supports multiple opens and another process locked the property.

EFAULT

argp references an inaccessible memory area.

ENOTTY

fd is not associated with a character special device.

EINVAL

The *request* or the data pointed to by *argp* is not valid. This is a very common error code, see the individual `ioctl` requests listed in Appendix A for actual causes.

ENOMEM

Not enough physical or virtual memory was available to complete the request.

ERANGE

The application attempted to set a control with the `VIDIOC_S_CTRL` `ioctl` to a value which is out of bounds.

ioctl VIDIOC_CROPCAP

Name

VIDIOC_CROPCAP — Information about the video cropping and scaling abilities

Synopsis

```
int ioctl(int fd, int request, struct v4l2_cropcap *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_CROPCAP

argp

Description

Applications use this function to query the cropping limits, the pixel aspect of images and to calculate scale factors. They set the *type* field of a `v4l2_cropcap` structure to the respective buffer (stream) type and call the `VIDIOC_CROPCAP` `ioctl` with a pointer to this structure. Drivers fill the rest of the structure. The results are constant except when switching the video standard. Remember this switch can occur implicit when switching the video input or output.

Table A-1. struct `v4l2_cropcap`

<code>enum v4l2_buf_type</code> <i>type</i>	Type of the data stream, set by the application. Only these types are valid here: V4L2_BUF_TYPE_VIDEO_CAPTURE, V4L2_BUF_TYPE_VIDEO_OUTPUT, V4L2_BUF_TYPE_VIDEO_OVERLAY, and custom (driver defined) types with code V4L2_BUF_TYPE_PRIVATE and higher.
<code>struct v4l2_rect</code> <i>bounds</i>	Defines the window within capturing or output is possible, this may exclude for example the horizontal and vertical blanking areas. The cropping rectangle cannot exceed these limits. Width and height are defined in pixels, the driver writer is free to choose origin and units of the coordinate system in the analog domain.
<code>struct v4l2_rect</code> <i>defrect</i>	Default cropping rectangle, it shall cover the "whole picture". Assuming pixel aspect 1/1 this could be for example a 640 × 480 rectangle for NTSC, a 768 × 576 rectangle for PAL and SECAM centered over the active picture area. The same co-ordinate system as for <i>bounds</i> is used.
<code>struct v4l2_fract</code> <i>pixelaspect</i>	This is the pixel aspect (y / x) when no scaling is applied, the ratio of the actual sampling frequency and the frequency required to get square pixels. When cropping coordinates refer to square pixels, the driver sets <i>pixelaspect</i> to 1/1. Other common values are 54/59 for PAL and SECAM, 11/10 for NTSC sampled according to [ITU BT.601].

Table A-2. struct v4l2_rect

<code>__s32</code>	<code>left</code>	Horizontal offset of the top, left corner of the rectangle, in pixels.
<code>__s32</code>	<code>top</code>	Vertical offset of the top, left corner of the rectangle, in pixels.
<code>__s32</code>	<code>width</code>	Width of the rectangle, in pixels.
<code>__s32</code>	<code>height</code>	Height of the rectangle, in pixels. Width and height cannot be negative, the fields are signed for hysterical reasons.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The struct `v4l2_cropcap` *type* is invalid or the `ioctl` is not supported. This is not permitted for video capture, output and overlay devices, which must support `VIDIOC_CROPCAP`.

`ioctl` `VIDIOC_DBG_G_CHIP_IDENT`

Name

`VIDIOC_DBG_G_CHIP_IDENT` — Identify the chips on a TV card

Synopsis

```
int ioctl(int fd, int request, struct v4l2_dbg_chip_ident
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_DBG_G_CHIP_IDENT`

argp

Description

Experimental: This is an experimental interface and may change in the future.

For driver debugging purposes this ioctl allows test applications to query the driver about the chips present on the TV card. Regular applications must not use it. When you found a chip specific bug, please contact the linux-media mailing list (<http://www.linuxtv.org/lists.php>) so it can be fixed.

To query the driver applications must initialize the `match.type` and `match.addr` or `match.name` fields of a struct `v4l2_dbg_chip_ident` and call `VIDIOC_DBG_G_CHIP_IDENT` with a pointer to this structure. On success the driver stores information about the selected chip in the `ident` and `revision` fields. On failure the structure remains unchanged.

When `match.type` is `V4L2_CHIP_MATCH_HOST`, `match.addr` selects the *n*th non-I²C chip on the TV card. You can enumerate all chips by starting at zero and incrementing `match.addr` by one until `VIDIOC_DBG_G_CHIP_IDENT` fails with an `EINVAL` error code. The number zero always selects the host chip, e. g. the chip connected to the PCI or USB bus.

When `match.type` is `V4L2_CHIP_MATCH_I2C_DRIVER`, `match.name` contains the I2C driver name. For instance "saa7127" will match any chip supported by the saa7127 driver, regardless of its I²C bus address. When multiple chips supported by the same driver are present, the ioctl will return `V4L2_IDENT_AMBIGUOUS` in the `ident` field.

When `match.type` is `V4L2_CHIP_MATCH_I2C_ADDR`, `match.addr` selects a chip by its 7 bit I²C bus address.

Appendix A. Function Reference

When `match.type` is `V4L2_CHIP_MATCH_AC97`, `match.addr` selects the `nth` AC97 chip on the TV card. You can enumerate all chips by starting at zero and incrementing `match.addr` by one until `VIDIOC_DBG_G_CHIP_IDENT` fails with an `EINVAL` error code.

On success, the `ident` field will contain a chip ID from the Linux `media/v4l2-chip-ident.h` header file, and the `revision` field will contain a driver specific value, or zero if no particular revision is associated with this chip.

When the driver could not identify the selected chip, `ident` will contain `V4L2_IDENT_UNKNOWN`. When no chip matched the ioctl will succeed but the `ident` field will contain `V4L2_IDENT_NONE`. If multiple chips matched, `ident` will contain `V4L2_IDENT_AMBIGUOUS`. In all these cases the `revision` field remains unchanged.

This ioctl is optional, not all drivers may support it. It was introduced in Linux 2.6.21, but the API was changed to the one described here in 2.6.29.

We recommended the `v4l2-dbg` utility over calling this ioctl directly. It is available from the LinuxTV `v4l-dvb` repository; see <http://linuxtv.org/repo/> for access instructions.

Table A-1. struct v4l2_dbg_match

<code>__u32</code>	<code>type</code>	See Table A-3 for a list of possible types.	
union	(anonymous)		
	<code>__u32</code>	<code>addr</code>	Match a chip by this number, interpreted according to the <code>type</code> field.
	<code>char</code>	<code>name[32]</code>	Match a chip by this name, interpreted according to the <code>type</code> field.

Table A-2. struct v4l2_dbg_chip_ident

struct <code>v4l2_dbg_match</code>	<code>match</code>	How to match the chip, see Table A-1.
<code>__u32</code>	<code>ident</code>	A chip identifier as defined in the Linux <code>media/v4l2-chip-ident.h</code> header file, or one of the values from Table A-4.
<code>__u32</code>	<code>revision</code>	A chip revision, chip and driver specific.

Table A-3. Chip Match Types

<code>V4L2_CHIP_MATCH_HOST</code>	0	Match the <i>n</i> th chip on the card, zero for the host chip. Does not match I2C chips.
<code>V4L2_CHIP_MATCH_I2C_DRIVER</code>	1	Match an I2C chip by its driver name.
<code>V4L2_CHIP_MATCH_I2C_ADDRESS</code>	2	Match a chip by its 7 bit I2C bus address.
<code>V4L2_CHIP_MATCH_AC97</code>	3	Match the <i>n</i> th anciliary AC97 chip.

Table A-4. Chip Identifiers

<code>V4L2_IDENT_NONE</code>	0	No chip matched.
<code>V4L2_IDENT_AMBIGUOUS</code>	1	Multiple chips matched.
<code>V4L2_IDENT_UNKNOWN</code>	2	A chip is present at this address, but the driver could not identify it.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The driver does not support this `ioctl`, or the `match_type` is invalid.

`ioctl` `VIDIOC_DBG_G_REGISTER`, `VIDIOC_DBG_S_REGISTER`

Name

`VIDIOC_DBG_G_REGISTER`, `VIDIOC_DBG_S_REGISTER` — Read or write hardware registers

Synopsis

```
int ioctl(int fd, int request, struct v4l2_dbg_register  
*argp);
```

```
int ioctl(int fd, int request, const struct v4l2_dbg_register  
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_DBG_G_REGISTER`, `VIDIOC_DBG_S_REGISTER`

argp

Description

Experimental: This is an experimental interface and may change in the future.

For driver debugging purposes these ioctls allow test applications to access hardware registers directly. Regular applications must not use them.

Since writing or even reading registers can jeopardize the system security, its stability and damage the hardware, both ioctls require superuser privileges. Additionally the Linux kernel must be compiled with the `CONFIG_VIDEO_ADV_DEBUG` option to enable these ioctls.

To write a register applications must initialize all fields of a struct `v4l2_dbg_register` and call `VIDIOC_DBG_S_REGISTER` with a pointer to this structure. The `match.type` and `match.addr` or `match.name` fields select a chip on the TV card,

the *reg* field specifies a register number and the *val* field the value to be written into the register.

To read a register applications must initialize the *match.type*, *match.chip* or *match.name* and *reg* fields, and call `VIDIOC_DBG_G_REGISTER` with a pointer to this structure. On success the driver stores the register value in the *val* field. On failure the structure remains unchanged.

When *match.type* is `V4L2_CHIP_MATCH_HOST`, *match.addr* selects the *nth* non-I²C chip on the TV card. The number zero always selects the host chip, e. g. the chip connected to the PCI or USB bus. You can find out which chips are present with the `VIDIOC_DBG_G_CHIP_IDENT` ioctl.

When *match.type* is `V4L2_CHIP_MATCH_I2C_DRIVER`, *match.name* contains the I2C driver name. For instance "saa7127" will match any chip supported by the saa7127 driver, regardless of its I²C bus address. When multiple chips supported by the same driver are present, the effect of these ioctls is undefined. Again with the `VIDIOC_DBG_G_CHIP_IDENT` ioctl you can find out which I²C chips are present.

When *match.type* is `V4L2_CHIP_MATCH_I2C_ADDR`, *match.addr* selects a chip by its 7 bit I²C bus address.

When *match.type* is `V4L2_CHIP_MATCH_AC97`, *match.addr* selects the *nth* AC97 chip on the TV card.

Success not guaranteed: Due to a flaw in the Linux I²C bus driver these ioctls may return successfully without actually reading or writing a register. To catch the most likely failure we recommend a `VIDIOC_DBG_G_CHIP_IDENT` call confirming the presence of the selected I²C chip.

These ioctls are optional, not all drivers may support them. However when a driver supports these ioctls it must also support `VIDIOC_DBG_G_CHIP_IDENT`. Conversely it may support `VIDIOC_DBG_G_CHIP_IDENT` but not these ioctls.

`VIDIOC_DBG_G_REGISTER` and `VIDIOC_DBG_S_REGISTER` were introduced in Linux 2.6.21, but their API was changed to the one described here in kernel 2.6.29.

We recommended the `v4l2-dbg` utility over calling these ioctls directly. It is available from the LinuxTV `v4l-dvb` repository; see <http://linuxtv.org/repo/> for access instructions.

Table A-1. struct `v4l2_dbg_match`

<code>__u32</code>	<i>type</i>	See Table A-3 for a list of possible types.
--------------------	-------------	---

union	(anonymous)		
	__u32	<i>addr</i>	Match a chip by this number, interpreted according to the <i>type</i> field.
	char	<i>name[32]</i>	Match a chip by this name, interpreted according to the <i>type</i> field.

Table A-2. struct v4l2_dbg_register

struct	<i>match</i>	How to match the chip, see Table A-1.
v4l2_dbg_match		
__u64	<i>reg</i>	A register number.
__u64	<i>val</i>	The value read from, or to be written into the register.

Table A-3. Chip Match Types

V4L2_CHIP_MATCH_HOST	0	Match the <i>nth</i> chip on the card, zero for the host chip. Does not match I2C chips.
V4L2_CHIP_MATCH_I2C_DRIVER	1	Match an I2C chip by its driver name.
V4L2_CHIP_MATCH_I2C_ADDRESS	2	Match a chip by its 7 bit I2C bus address.
V4L2_CHIP_MATCH_AC97	3	Match the <i>nth</i> anciliary AC97 chip.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The driver does not support this ioctl, or the kernel was not compiled with the `CONFIG_VIDEO_ADV_DEBUG` option, or the *match_type* is invalid, or the selected chip or register does not exist.

EPERM

Insufficient permissions. Root privileges are required to execute these ioctls.

ioctl VIDIOC_DQEVENT

Name

VIDIOC_DQEVENT — Dequeue event

Synopsis

```
int ioctl(int fd, int request, struct v4l2_event *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_DQEVENT

argp

Description

Dequeue an event from a video device. No input is required for this ioctl. All the fields of the struct `v4l2_event` structure are filled by the driver. The file handle will also receive exceptions which the application may get by e.g. using the `select` system call.

Table A-1. struct v4l2_event

<code>__u32</code>	<code>type</code>	Type of the event.
<code>union</code>	<code>u</code>	Event data for event
	<code>struct v4l2_event_vsync</code>	V4L2_EVENT_VSYNC.
	<code>__u8 data[64]</code>	Event data. Defined by the event type. The union should be used to define easily accessible type for events.
<code>__u32</code>	<code>pending</code>	Number of pending events excluding this one.
<code>__u32</code>	<code>sequence</code>	Event sequence number. The sequence number is incremented for every subscribed event that takes place. If sequence numbers are not contiguous it means that events have been lost.
<code>struct timespec</code>	<code>timestamp</code>	Event timestamp.

<code>__u32</code>	<code>reserved[9]</code>	Reserved for future extensions. Drivers must set the array to zero.
--------------------	--------------------------	---

ioctl VIDIOC_ENCODER_CMD, VIDIOC_TRY_ENCODER_CMD

Name

`VIDIOC_ENCODER_CMD`, `VIDIOC_TRY_ENCODER_CMD` — Execute an encoder command

Synopsis

```
int ioctl(int fd, int request, struct v4l2_encoder_cmd *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_ENCODER_CMD`, `VIDIOC_TRY_ENCODER_CMD`

argp

Description

Experimental: This is an experimental interface and may change in the future.

These ioctls control an audio/video (usually MPEG-) encoder.

`VIDIOC_ENCODER_CMD` sends a command to the encoder,

`VIDIOC_TRY_ENCODER_CMD` can be used to try a command without actually executing it.

To send a command applications must initialize all fields of a `struct v4l2_encoder_cmd` and call `VIDIOC_ENCODER_CMD` or `VIDIOC_TRY_ENCODER_CMD` with a pointer to this structure.

The `cmd` field must contain the command code. The `flags` field is currently only used by the STOP command and contains one bit: If the

`V4L2_ENC_CMD_STOP_AT_GOP_END` flag is set, encoding will continue until the end of the current *Group Of Pictures*, otherwise it will stop immediately.

A `read()` call sends a START command to the encoder if it has not been started yet. After a STOP command, `read()` calls will read the remaining data buffered by the driver. When the buffer is empty, `read()` will return zero and the next `read()` call will restart the encoder.

A `close()` call sends an immediate STOP to the encoder, and all buffered data is discarded.

These ioctls are optional, not all drivers may support them. They were introduced in Linux 2.6.21.

Table A-1. struct v4l2_encoder_cmd

<code>__u32</code>	<code>cmd</code>	The encoder command, see Table A-2.
<code>__u32</code>	<code>flags</code>	Flags to go with the command, see Table A-3. If no flags are defined for this command, drivers and applications must set this field to zero.
<code>__u32</code>	<code>data[8]</code>	Reserved for future extensions. Drivers and applications must set the array to zero.

Table A-2. Encoder Commands

V4L2_ENC_CMD_START	0	Start the encoder. When the encoder is already running or paused, this command does nothing. No flags are defined for this command.
V4L2_ENC_CMD_STOP	1	Stop the encoder. When the V4L2_ENC_CMD_STOP_AT_GOP_END flag is set, encoding will continue until the end of the current <i>Group Of Pictures</i> , otherwise encoding will stop immediately. When the encoder is already stopped, this command does nothing.
V4L2_ENC_CMD_PAUSE	2	Pause the encoder. When the encoder has not been started yet, the driver will return an EPERM error code. When the encoder is already paused, this command does nothing. No flags are defined for this command.
V4L2_ENC_CMD_RESUME	3	Resume encoding after a PAUSE command. When the encoder has not been started yet, the driver will return an EPERM error code. When the encoder is already running, this command does nothing. No flags are defined for this command.

Table A-3. Encoder Command Flags

V4L2_ENC_CMD_STOP_AT_GOP_END	0x0001	Stop encoding at the end of the current <i>Group Of Pictures</i> , rather than immediately.
------------------------------	--------	---

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The driver does not support this `ioctl`, or the `cmd` field is invalid.

EPERM

The application sent a PAUSE or RESUME command when the encoder was not running.

ioctl VIDIOC_ENUMAUDIO

Name

VIDIOC_ENUMAUDIO — Enumerate audio inputs

Synopsis

```
int ioctl(int fd, int request, struct v4l2_audio *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_ENUMAUDIO

argp

Description

To query the attributes of an audio input applications initialize the *index* field and zero out the *reserved* array of a struct `v4l2_audio` and call the `VIDIOC_ENUMAUDIO` `ioctl` with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code when the index is out of bounds. To

enumerate all audio inputs applications shall begin at index zero, incrementing by one until the driver returns `EINVAL`.

See `ioctl VIDIOC_G_AUDIO`, `VIDIOC_S_AUDIO(2)` for a description of `struct v4l2_audio`.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The number of the audio input is out of bounds, or there are no audio inputs at all and this `ioctl` is not supported.

ioctl VIDIOC_ENUMAUDOUT

Name

`VIDIOC_ENUMAUDOUT` — Enumerate audio outputs

Synopsis

```
int ioctl(int fd, int request, struct v4l2_audioout *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_ENUMAUDOUT`

argp

Description

To query the attributes of an audio output applications initialize the *index* field and zero out the *reserved* array of a struct `v4l2_audioout` and call the `VIDIOC_G_AUDOUT` ioctl with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code when the index is out of bounds. To enumerate all audio outputs applications shall begin at index zero, incrementing by one until the driver returns `EINVAL`.

Note connectors on a TV card to loop back the received audio signal to a sound card are not audio outputs in this sense.

See ioctl `VIDIOC_G_AUDOUT`, `VIDIOC_S_AUDOUT(2)` for a description of struct `v4l2_audioout`.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The number of the audio output is out of bounds, or there are no audio outputs at all and this ioctl is not supported.

ioctl VIDIOC_ENUM_DV_PRESETS

Name

`VIDIOC_ENUM_DV_PRESETS` — Enumerate supported Digital Video presets

Synopsis

```
int ioctl(int fd, int request, struct v4l2_dv_enum_preset
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_ENUM_DV_PRESETS`

argp

Description

To query the attributes of a DV preset, applications initialize the *index* field and zero the reserved array of struct `v4l2_dv_enum_preset` and call the `VIDIOC_ENUM_DV_PRESETS` `ioctl` with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code when the index is out of bounds. To enumerate all DV Presets supported, applications shall begin at index zero, incrementing by one until the driver returns `EINVAL`. Drivers may enumerate a different set of DV presets after switching the video input or output.

Table A-1. struct v4l2_dv_enum_presets

<code>__u32</code>	<i>index</i>	Number of the DV preset, set by the application.
<code>__u32</code>	<i>preset</i>	This field identifies one of the DV preset values listed in Table A-2.
<code>__u8</code>	<i>name</i> [24]	Name of the preset, a NUL-terminated ASCII string, for example: "720P-60", "1080I-60". This information is intended for the user.

Appendix A. Function Reference

__u32	<i>width</i>	Width of the active video in pixels for the DV preset.
__u32	<i>height</i>	Height of the active video in lines for the DV preset.
__u32	<i>reserved</i> [4]	Reserved for future extensions. Drivers must set the array to zero.

Table A-2. struct DV Presets

Preset	Preset value	Description
V4L2_DV_INVALID	0	Invalid preset value.
V4L2_DV_480P59_94	1	720x480 progressive video at 59.94 fps as per BT.1362.
V4L2_DV_576P50_2	2	720x576 progressive video at 50 fps as per BT.1362.
V4L2_DV_720P24_3	3	1280x720 progressive video at 24 fps as per SMPTE 296M.
V4L2_DV_720P25_4	4	1280x720 progressive video at 25 fps as per SMPTE 296M.
V4L2_DV_720P30_5	5	1280x720 progressive video at 30 fps as per SMPTE 296M.
V4L2_DV_720P50_6	6	1280x720 progressive video at 50 fps as per SMPTE 296M.
V4L2_DV_720P59_94	7	1280x720 progressive video at 59.94 fps as per SMPTE 274M.
V4L2_DV_720P60_8	8	1280x720 progressive video at 60 fps as per SMPTE 274M/296M.
V4L2_DV_1080I29_97	9	1920x1080 interlaced video at 29.97 fps as per BT.1120/SMPTE 274M.
V4L2_DV_1080I30_10	10	1920x1080 interlaced video at 30 fps as per BT.1120/SMPTE 274M.
V4L2_DV_1080I25_11	11	1920x1080 interlaced video at 25 fps as per BT.1120.
V4L2_DV_1080I50_12	12	1920x1080 interlaced video at 50 fps as per SMPTE 296M.
V4L2_DV_1080I60_13	13	1920x1080 interlaced video at 60 fps as per SMPTE 296M.

V4L2_DV_1080P24_14	1920x1080 progressive video at 24 fps as per SMPTE 296M.
V4L2_DV_1080P25_15	1920x1080 progressive video at 25 fps as per SMPTE 296M.
V4L2_DV_1080P30_16	1920x1080 progressive video at 30 fps as per SMPTE 296M.
V4L2_DV_1080P50_17	1920x1080 progressive video at 50 fps as per BT.1120.
V4L2_DV_1080P60_18	1920x1080 progressive video at 60 fps as per BT.1120.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The struct `v4l2_dv_enum_preset` *index* is out of bounds.

ioctl VIDIOC_ENUM_FMT

Name

`VIDIOC_ENUM_FMT` — Enumerate image formats

Synopsis

```
int ioctl(int fd, int request, struct v4l2_fmtdesc *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_ENUM_FMT`

argp

Description

To enumerate image formats applications initialize the *type* and *index* field of struct `v4l2_fmtdesc` and call the `VIDIOC_ENUM_FMT` ioctl with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code. All formats are enumerable by beginning at index zero and incrementing by one until `EINVAL` is returned.

Table A-1. struct `v4l2_fmtdesc`

<code>__u32</code>	<i>index</i>	Number of the format in the enumeration, set by the application. This is in no way related to the <i>pixelformat</i> field.
<code>enum v4l2_buf_type</code>	<i>type</i>	Type of the data stream, set by the application. Only these types are valid here: <code>V4L2_BUF_TYPE_VIDEO_CAPTURE</code> , <code>V4L2_BUF_TYPE_VIDEO_CAPTURE_MPLANE</code> , <code>V4L2_BUF_TYPE_VIDEO_OUTPUT</code> , <code>V4L2_BUF_TYPE_VIDEO_OUTPUT_MPLANE</code> , <code>V4L2_BUF_TYPE_VIDEO_OVERLAY</code> , and custom (driver defined) types with code <code>V4L2_BUF_TYPE_PRIVATE</code> and higher.
<code>__u32</code>	<i>flags</i>	See Table A-2
<code>__u8</code>	<i>description</i> [32]	Description of the format, a NUL-terminated ASCII string. This information is intended for the user, for example: "YUV 4:2:2".

<code>__u32</code>	<code>pixelformat</code>	The image format identifier. This is a four character code as computed by the <code>v4l2_fourcc()</code> macro:
--------------------	--------------------------	---

```
#define v4l2_fourcc(a,b,c,d) (((__u32)(a)<<0)|((__u32)(b)<<8)|((__u32)(c)<<16)|((__u32)(d)<<24))
```

Several image formats are already defined by this specification in Chapter 2. Note these codes are not the same as those used in the Windows world.

<code>__u32</code>	<code>reserved[4]</code>	Reserved for future extensions. Drivers must set the array to zero.
--------------------	--------------------------	---

Table A-2. Image Format Description Flags

<code>V4L2_FMT_FLAG_COMPRESSED</code>	<code>0x0001</code>	This is a compressed format.
<code>V4L2_FMT_FLAG_EMULATED</code>	<code>0x0002</code>	This format is not native to the device but emulated through software (usually <code>libv4l2</code>), where possible try to use a native format instead for better performance.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`
The struct `v4l2_fmtdesc` *type* is not supported or the *index* is out of bounds.

ioctl VIDIOC_ENUM_FRAMESIZES

Name

VIDIOC_ENUM_FRAMESIZES — Enumerate frame sizes

Synopsis

```
int ioctl(int fd, int request, struct v4l2_frmsizeenum *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_ENUM_FRAMESIZES

argp

Pointer to a struct `v4l2_frmsizeenum` that contains an index and pixel format and receives a frame width and height.

Description

Experimental: This is an experimental interface and may change in the future.

This `ioctl` allows applications to enumerate all frame sizes (i. e. width and height in pixels) that the device supports for the given pixel format.

The supported pixel formats can be obtained by using the `VIDIOC_ENUM_FMT` function.

The return value and the content of the `v4l2_frmsizeenum.type` field depend on the type of frame sizes the device supports. Here are the semantics of the function for the different cases:

- **Discrete:** The function returns success if the given index value (zero-based) is valid. The application should increase the index by one for each call until `EINVAL` is returned. The `v4l2_frmsizeenum.type` field is set to

`V4L2_FRMSIZE_TYPE_DISCRETE` by the driver. Of the union only the *discrete* member is valid.

- **Step-wise:** The function returns success if the given index value is zero and `EINVAL` for any other index value. The `v4l2_frmsizeenum.type` field is set to `V4L2_FRMSIZE_TYPE_STEPWISE` by the driver. Of the union only the *stepwise* member is valid.
- **Continuous:** This is a special case of the step-wise type above. The function returns success if the given index value is zero and `EINVAL` for any other index value. The `v4l2_frmsizeenum.type` field is set to `V4L2_FRMSIZE_TYPE_CONTINUOUS` by the driver. Of the union only the *stepwise* member is valid and the *step_width* and *step_height* values are set to 1.

When the application calls the function with index zero, it must check the *type* field to determine the type of frame size enumeration the device supports. Only for the `V4L2_FRMSIZE_TYPE_DISCRETE` type does it make sense to increase the index value to receive more frame sizes.

Note that the order in which the frame sizes are returned has no special meaning. In particular does it not say anything about potential default format sizes.

Applications can assume that the enumeration data does not change without any interaction from the application itself. This means that the enumeration data is consistent if the application does not perform any other `ioctl` calls while it runs the frame size enumeration.

Structs

In the structs below, *IN* denotes a value that has to be filled in by the application, *OUT* denotes values that the driver fills in. The application should zero out all members except for the *IN* fields.

Table A-1. struct `v4l2_frmsize_discrete`

<code>__u32</code>	<i>width</i>	Width of the frame [pixel].
<code>__u32</code>	<i>height</i>	Height of the frame [pixel].

Table A-2. struct `v4l2_frmsize_stepwise`

<code>__u32</code>	<i>min_width</i>	Minimum frame width [pixel].
<code>__u32</code>	<i>max_width</i>	Maximum frame width [pixel].
<code>__u32</code>	<i>step_width</i>	Frame width step size [pixel].

<code>__u32</code>	<code>min_height</code>	Minimum frame height [pixel].
<code>__u32</code>	<code>max_height</code>	Maximum frame height [pixel].
<code>__u32</code>	<code>step_height</code>	Frame height step size [pixel].

Table A-3. struct v4l2_frmsizeenum

<code>__u32</code>	<code>index</code>	IN: Index of the given frame size in the enumeration.
<code>__u32</code>	<code>pixel_format</code>	IN: Pixel format for which the frame sizes are enumerated.
<code>__u32</code>	<code>type</code>	OUT: Frame size type the device supports.
union		OUT: Frame size with the given index.
<code>struct v4l2_frmsize_discrete</code>		
<code>struct v4l2_frmsize_stepwise</code>		
<code>__u32</code>	<code>reserved[2]</code>	Reserved space for future use.

Enums

Table A-4. enum v4l2_frmsizetypes

<code>V4L2_FRMSIZE_TYPE_DISCRETE</code>	1	Discrete frame size.
<code>V4L2_FRMSIZE_TYPE_CONTINUOUS</code>	2	Continuous frame size.
<code>V4L2_FRMSIZE_TYPE_STEPWISE</code>	3	Step-wise defined frame size.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:
See the description section above for a list of return values that `errno` can have.

ioctl VIDIOC_ENUM_FRAMEINTERVALS

Name

VIDIOC_ENUM_FRAMEINTERVALS — Enumerate frame intervals

Synopsis

```
int ioctl(int fd, int request, struct v4l2_fmvalenum *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_ENUM_FRAMEINTERVALS

argp

Pointer to a struct `v4l2_fmvalenum` structure that contains a pixel format and size and receives a frame interval.

Description

This `ioctl` allows applications to enumerate all frame intervals that the device supports for the given pixel format and frame size.

Appendix A. Function Reference

The supported pixel formats and frame sizes can be obtained by using the `VIDIOC_ENUM_FMT` and `VIDIOC_ENUM_FRAMESIZES` functions.

The return value and the content of the `v4l2_frmivalenum.type` field depend on the type of frame intervals the device supports. Here are the semantics of the function for the different cases:

- **Discrete:** The function returns success if the given index value (zero-based) is valid. The application should increase the index by one for each call until `EINVAL` is returned. The `'v4l2_frmivalenum.type'` field is set to `'V4L2_FRMIVAL_TYPE_DISCRETE'` by the driver. Of the union only the `'discrete'` member is valid.
- **Step-wise:** The function returns success if the given index value is zero and `EINVAL` for any other index value. The `v4l2_frmivalenum.type` field is set to `V4L2_FRMIVAL_TYPE_STEPWISE` by the driver. Of the union only the `stepwise` member is valid.
- **Continuous:** This is a special case of the step-wise type above. The function returns success if the given index value is zero and `EINVAL` for any other index value. The `v4l2_frmivalenum.type` field is set to `V4L2_FRMIVAL_TYPE_CONTINUOUS` by the driver. Of the union only the `stepwise` member is valid and the `step` value is set to 1.

When the application calls the function with index zero, it must check the `type` field to determine the type of frame interval enumeration the device supports. Only for the `V4L2_FRMIVAL_TYPE_DISCRETE` type does it make sense to increase the index value to receive more frame intervals.

Note that the order in which the frame intervals are returned has no special meaning. In particular does it not say anything about potential default frame intervals.

Applications can assume that the enumeration data does not change without any interaction from the application itself. This means that the enumeration data is consistent if the application does not perform any other `ioctl` calls while it runs the frame interval enumeration.

Notes

- **Frame intervals and frame rates:** The V4L2 API uses frame intervals instead of frame rates. Given the frame interval the frame rate can be computed as follows:

```
frame_rate = 1 / frame_interval
```

Structs

In the structs below, *IN* denotes a value that has to be filled in by the application, *OUT* denotes values that the driver fills in. The application should zero out all members except for the *IN* fields.

Table A-1. struct v4l2_frmival_stepwise

struct v4l2_fract	<i>min</i>	Minimum frame interval [s].
struct v4l2_fract	<i>max</i>	Maximum frame interval [s].
struct v4l2_fract	<i>step</i>	Frame interval step size [s].

Table A-2. struct v4l2_frmivalenum

__u32	<i>index</i>	IN: Index of the given frame interval in the enumeration.
__u32	<i>pixel_format</i>	IN: Pixel format for which the frame intervals are enumerated.
__u32	<i>width</i>	IN: Frame width for which the frame intervals are enumerated.
__u32	<i>height</i>	IN: Frame height for which the frame intervals are enumerated.
__u32	<i>type</i>	OUT: Frame interval type the device supports.
union		OUT: Frame interval with the given index.
	struct v4l2_fract <i>discrete</i>	Frame interval [s].
	struct v4l2_frmival_stepwise <i>stepwise</i>	
__u32	<i>reserved[2]</i>	Reserved space for future use.

Enums

Table A-3. enum v4l2_fmvaltypes

V4L2_FRMIVAL_TYPE_DISCRETE	Discrete frame interval.
V4L2_FRMIVAL_TYPE_CONTINUOUS	Continuous frame interval.
V4L2_FRMIVAL_TYPE_STEPWISE	Step-wise defined frame interval.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:
See the description section above for a list of return values that `errno` can have.

ioctl VIDIOC_ENUMINPUT

Name

VIDIOC_ENUMINPUT — Enumerate video inputs

Synopsis

```
int ioctl(int fd, int request, struct v4l2_input *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_ENUMINPUT

argp

Description

To query the attributes of a video input applications initialize the *index* field of struct `v4l2_input` and call the `VIDIOC_ENUMINPUT` ioctl with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code when the index is out of bounds. To enumerate all inputs applications shall begin at index zero, incrementing by one until the driver returns `EINVAL`.

Table A-1. struct `v4l2_input`

<code>__u32</code>	<i>index</i>	Identifies the input, set by the application.
<code>__u8</code>	<i>name</i> [32]	Name of the video input, a NUL-terminated ASCII string, for example: "Vin (Composite 2)". This information is intended for the user, preferably the connector label on the device itself.
<code>__u32</code>	<i>type</i>	Type of the input, see Table A-2.

Appendix A. Function Reference

<code>__u32</code>	<code>audioset</code>	<p>Drivers can enumerate up to 32 video and audio inputs. This field shows which audio inputs were selectable as audio source if this was the currently selected video input. It is a bit mask. The LSB corresponds to audio input 0, the MSB to input 31. Any number of bits can be set, or none.</p> <p>When the driver does not enumerate audio inputs no bits must be set.</p> <p>Applications shall not interpret this as lack of audio support. Some drivers automatically select audio sources and do not enumerate them since there is no choice anyway.</p> <p>For details on audio inputs and how to select the current input see Section 1.5.</p>
<code>__u32</code>	<code>tuner</code>	<p>Capture devices can have zero or more tuners (RF demodulators). When the <code>type</code> is set to <code>V4L2_INPUT_TYPE_TUNER</code> this is an RF connector and this field identifies the tuner. It corresponds to struct <code>v4l2_tuner</code> field <code>index</code>. For details on tuners see Section 1.6.</p>
<code>v4l2_std_id</code>	<code>std</code>	<p>Every video input supports one or more different video standards. This field is a set of all supported standards. For details on video standards and how to switch see Section 1.7.</p>
<code>__u32</code>	<code>status</code>	<p>This field provides status information about the input. See Table A-3 for flags. With the exception of the sensor orientation bits <code>status</code> is only valid when this is the current input.</p>
<code>__u32</code>	<code>capabilities</code>	<p>This field provides capabilities for the input. See Table A-4 for flags.</p>
<code>__u32</code>	<code>reserved[3]</code>	<p>Reserved for future extensions. Drivers must set the array to zero.</p>

Table A-2. Input Types

V4L2_INPUT_TYPE_TUNER	1	This input uses a tuner (RF demodulator).
V4L2_INPUT_TYPE_CAMERA	2	Analog baseband input, for example CVBS / Composite Video, S-Video, RGB.

Table A-3. Input Status Flags

General		
V4L2_IN_ST_NO_POWER	0x00000001	Attached device is off.
V4L2_IN_ST_NO_SIGNAL	0x00000002	
V4L2_IN_ST_NO_COLOR	0x00000004	The hardware supports color decoding, but does not detect color modulation in the signal.
Sensor Orientation		
V4L2_IN_ST_HFLIP	0x00000010	The input is connected to a device that produces a signal that is flipped horizontally and does not correct this before passing the signal to userspace.
V4L2_IN_ST_VFLIP	0x00000020	The input is connected to a device that produces a signal that is flipped vertically and does not correct this before passing the signal to userspace. Note that a 180 degree rotation is the same as HFLIP VFLIP
Analog Video		
V4L2_IN_ST_NO_H_LOCK	0x00000100	No horizontal sync lock.

Appendix A. Function Reference

V4L2_IN_ST_COLOR_KILL	0x00000200	A color killer circuit automatically disables color decoding when it detects no color modulation. When this flag is set the color killer is enabled <i>and</i> has shut off color decoding.
Digital Video		
V4L2_IN_ST_NO_SYNC	0x00010000	No synchronization lock.
V4L2_IN_ST_NO_EQU	0x00020000	No equalizer lock.
V4L2_IN_ST_NO_CARRIER	0x00040000	Carrier recovery failed.
VCR and Set-Top Box		
V4L2_IN_ST_MACROVISION	0x01000000	Macrovision is an analog copy prevention system mangling the video signal to confuse video recorders. When this flag is set Macrovision has been detected.
V4L2_IN_ST_NO_ACCESS	0x02000000	Conditional access denied.
V4L2_IN_ST_VTR	0x04000000	VTR time constant. [?]

Table A-4. Input capabilities

V4L2_IN_CAP_PRESETS	0x00000001	This input supports setting DV presets by using VIDIOC_S_DV_PRESET.
V4L2_IN_CAP_CUSTOM_TIMINGS	0x00000002	This input supports setting custom video timings by using VIDIOC_S_DV_TIMINGS.
V4L2_IN_CAP_STD	0x00000004	This input supports setting the TV standard by using VIDIOC_S_STD.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The struct `v4l2_input` *index* is out of bounds.

ioctl VIDIOC_ENUMOUTPUT

Name

VIDIOC_ENUMOUTPUT — Enumerate video outputs

Synopsis

```
int ioctl(int fd, int request, struct v4l2_output *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_ENUMOUTPUT

argp

Description

To query the attributes of a video outputs applications initialize the *index* field of struct `v4l2_output` and call the VIDIOC_ENUMOUTPUT ioctl with a pointer to this structure. Drivers fill the rest of the structure or return an EINVAL error code when the index is out of bounds. To enumerate all outputs applications shall begin at index zero, incrementing by one until the driver returns EINVAL.

Table A-1. struct v4l2_output

<code>__u32</code>	<i>index</i>	Identifies the output, set by the application.
<code>__u8</code>	<i>name[32]</i>	Name of the video output, a NUL-terminated ASCII string, for example: "Vout". This information is intended for the user, preferably the connector label on the device itself.
<code>__u32</code>	<i>type</i>	Type of the output, see Table A-2.
<code>__u32</code>	<i>audioset</i>	Drivers can enumerate up to 32 video and audio outputs. This field shows which audio outputs were selectable as the current output if this was the currently selected video output. It is a bit mask. The LSB corresponds to audio output 0, the MSB to output 31. Any number of bits can be set, or none. When the driver does not enumerate audio outputs no bits must be set. Applications shall not interpret this as lack of audio support. Drivers may automatically select audio outputs without enumerating them.
		For details on audio outputs and how to select the current output see Section 1.5.
<code>__u32</code>	<i>modulator</i>	Output devices can have zero or more RF modulators. When the <i>type</i> is <code>V4L2_OUTPUT_TYPE_MODULATOR</code> this is an RF connector and this field identifies the modulator. It corresponds to struct <code>v4l2_modulator</code> field <i>index</i> . For details on modulators see Section 1.6.
<code>v4l2_std_id</code>	<i>std</i>	Every video output supports one or more different video standards. This field is a set of all supported standards. For details on video standards and how to switch see Section 1.7.

__u32	capabilities	This field provides capabilities for the output. See Table A-3 for flags.
__u32	reserved[3]	Reserved for future extensions. Drivers must set the array to zero.

Table A-2. Output Type

V4L2_OUTPUT_TYPE_MODULATOR	This output is an analog TV modulator.
V4L2_OUTPUT_TYPE_ANALOG	Analog baseband output, for example Composite / CVBS, S-Video, RGB.
V4L2_OUTPUT_TYPE_ANALOG_OVERLAY	

Table A-3. Output capabilities

V4L2_OUT_CAP_PRESETS	0x00000001	This output supports setting DV presets by using VIDIOC_S_DV_PRESET.
V4L2_OUT_CAP_CUSTOM_TIMINGS	0x00000002	This output supports setting custom video timings by using VIDIOC_S_DV_TIMINGS.
V4L2_OUT_CAP_STD	0x00000004	This output supports setting the TV standard by using VIDIOC_S_STD.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The struct `v4l2_output` *index* is out of bounds.

ioctl VIDIOC_ENUMSTD

Name

VIDIOC_ENUMSTD — Enumerate supported video standards

Synopsis

```
int ioctl(int fd, int request, struct v4l2_standard *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_ENUMSTD

argp

Description

To query the attributes of a video standard, especially a custom (driver defined) one, applications initialize the *index* field of struct `v4l2_standard` and call the `VIDIOC_ENUMSTD` `ioctl` with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code when the index is out of bounds. To enumerate all standards applications shall begin at index zero, incrementing by one until the driver returns `EINVAL`. Drivers may enumerate a different set of standards after switching the video input or output.¹

Table A-1. struct v4l2_standard

<code>__u32</code>	<i>index</i>	Number of the video standard, set by the application.
--------------------	--------------	---

<code>v4l2_std_id</code>	<code>id</code>	The bits in this field identify the standard as one of the common standards listed in Table A-3, or if bits 32 to 63 are set as custom standards. Multiple bits can be set if the hardware does not distinguish between these standards, however separate indices do not indicate the opposite. The <code>id</code> must be unique. No other enumerated <code>v4l2_standard</code> structure, for this input or output anyway, can contain the same set of bits.
<code>__u8</code>	<code>name[24]</code>	Name of the standard, a NUL-terminated ASCII string, for example: "PAL-B/G", "NTSC Japan". This information is intended for the user.
<code>struct v4l2_fract</code>	<code>frameperiod</code>	The frame period (not field period) is numerator / denominator. For example M/NTSC has a frame period of 1001 / 30000 seconds.
<code>__u32</code>	<code>framelines</code>	Total lines per frame including blanking, e. g. 625 for B/PAL.
<code>__u32</code>	<code>reserved[4]</code>	Reserved for future extensions. Drivers must set the array to zero.

Table A-2. struct v4l2_fract

<code>__u32</code>	<code>numerator</code>
<code>__u32</code>	<code>denominator</code>

Table A-3. typedef v4l2_std_id

<code>__u64</code>	<code>v4l2_std_id</code>	This type is a set, each bit representing another video standard as listed below and in Table A-4. The 32 most significant bits are reserved for custom (driver defined) video standards.
--------------------	--------------------------	---

```
#define V4L2_STD_PAL_B ((v4l2_std_id) 0x00000001)
```

Appendix A. Function Reference

```
#define V4L2_STD_PAL_B1      ((v4l2_std_id) 0x00000002)
#define V4L2_STD_PAL_G      ((v4l2_std_id) 0x00000004)
#define V4L2_STD_PAL_H      ((v4l2_std_id) 0x00000008)
#define V4L2_STD_PAL_I      ((v4l2_std_id) 0x00000010)
#define V4L2_STD_PAL_D      ((v4l2_std_id) 0x00000020)
#define V4L2_STD_PAL_D1     ((v4l2_std_id) 0x00000040)
#define V4L2_STD_PAL_K      ((v4l2_std_id) 0x00000080)

#define V4L2_STD_PAL_M      ((v4l2_std_id) 0x00000100)
#define V4L2_STD_PAL_N      ((v4l2_std_id) 0x00000200)
#define V4L2_STD_PAL_Nc     ((v4l2_std_id) 0x00000400)
#define V4L2_STD_PAL_60     ((v4l2_std_id) 0x00000800)
```

V4L2_STD_PAL_60 is a hybrid standard with 525 lines, 60 Hz refresh rate, and PAL color modulation with a 4.43 MHz color subcarrier. Some PAL video recorders can play back NTSC tapes in this mode for display on a 50/60 Hz agnostic PAL TV.

```
#define V4L2_STD_NTSC_M      ((v4l2_std_id) 0x00001000)
#define V4L2_STD_NTSC_M_JP  ((v4l2_std_id) 0x00002000)
#define V4L2_STD_NTSC_443   ((v4l2_std_id) 0x00004000)
```

V4L2_STD_NTSC_443 is a hybrid standard with 525 lines, 60 Hz refresh rate, and NTSC color modulation with a 4.43 MHz color subcarrier.

```
#define V4L2_STD_NTSC_M_KR   ((v4l2_std_id) 0x00008000)

#define V4L2_STD_SECAM_B     ((v4l2_std_id) 0x00010000)
#define V4L2_STD_SECAM_D     ((v4l2_std_id) 0x00020000)
#define V4L2_STD_SECAM_G     ((v4l2_std_id) 0x00040000)
#define V4L2_STD_SECAM_H     ((v4l2_std_id) 0x00080000)
#define V4L2_STD_SECAM_K     ((v4l2_std_id) 0x00100000)
#define V4L2_STD_SECAM_K1    ((v4l2_std_id) 0x00200000)
#define V4L2_STD_SECAM_L     ((v4l2_std_id) 0x00400000)
#define V4L2_STD_SECAM_LC    ((v4l2_std_id) 0x00800000)

/* ATSC/HDTV */
#define V4L2_STD_ATSC_8_VSB  ((v4l2_std_id) 0x01000000)
#define V4L2_STD_ATSC_16_VSB ((v4l2_std_id) 0x02000000)
```

V4L2_STD_ATSC_8_VSB and V4L2_STD_ATSC_16_VSB are U.S. terrestrial digital TV standards. Presently the V4L2 API does not support digital TV. See also the Linux DVB API at <http://linuxtv.org>.

Appendix A. Function Reference

```

#define V4L2_STD_PAL_BG      (V4L2_STD_PAL_B      | \
    V4L2_STD_PAL_B1        | \
    V4L2_STD_PAL_G)
#define V4L2_STD_B          (V4L2_STD_PAL_B      | \
    V4L2_STD_PAL_B1        | \
    V4L2_STD_SECAM_B)
#define V4L2_STD_GH         (V4L2_STD_PAL_G      | \
    V4L2_STD_PAL_H        | \
    V4L2_STD_SECAM_G      | \
    V4L2_STD_SECAM_H)
#define V4L2_STD_PAL_DK     (V4L2_STD_PAL_D      | \
    V4L2_STD_PAL_D1        | \
    V4L2_STD_PAL_K)
#define V4L2_STD_PAL        (V4L2_STD_PAL_BG     | \
    V4L2_STD_PAL_DK        | \
    V4L2_STD_PAL_H        | \
    V4L2_STD_PAL_I)
#define V4L2_STD_NTSC       (V4L2_STD_NTSC_M     | \
    V4L2_STD_NTSC_M_JP     | \
    V4L2_STD_NTSC_M_KR)
#define V4L2_STD_MN         (V4L2_STD_PAL_M      | \
    V4L2_STD_PAL_N        | \
    V4L2_STD_PAL_Nc       | \
    V4L2_STD_NTSC)
#define V4L2_STD_SECAM_DK   (V4L2_STD_SECAM_D     | \
    V4L2_STD_SECAM_K      | \
    V4L2_STD_SECAM_K1)
#define V4L2_STD_DK         (V4L2_STD_PAL_DK     | \
    V4L2_STD_SECAM_DK)

#define V4L2_STD_SECAM      (V4L2_STD_SECAM_B     | \
    V4L2_STD_SECAM_G      | \
    V4L2_STD_SECAM_H      | \
    V4L2_STD_SECAM_DK     | \
    V4L2_STD_SECAM_L      | \
    V4L2_STD_SECAM_LC)

#define V4L2_STD_525_60     (V4L2_STD_PAL_M      | \
    V4L2_STD_PAL_60       | \
    V4L2_STD_NTSC         | \
    V4L2_STD_NTSC_443)
#define V4L2_STD_625_50     (V4L2_STD_PAL        | \
    V4L2_STD_PAL_N        | \
    V4L2_STD_PAL_Nc       | \
    V4L2_STD_SECAM)

#define V4L2_STD_UNKNOWN    0
#define V4L2_STD_ALL        (V4L2_STD_525_60     | \

```


Appendix A. Function Reference

V4L2_STD_625_50)

Table A-4. Video Standards (based on [ITU BT.470])

Characteristics	M/NTSC	G/PAL	N/PAL	B, B1, G/PAL	D, D1, K/PAL	H/PAL	I/PAL	G/SECAM	B, B1, G/SECAM	D, D1, K/SECAM	H/PAL	I/PAL
Frame lines	525	625										
Frame period (s)	1001/30000	1/25										
Chrominance sub-carrier frequency (Hz)	3579545 ± 10	3579614 ± 10	4433618 ± 5	4433618.75 ± 5	4433618.75 ± 5	4433618.75 ± 5	4433618.75 ± 5	4433618.75 ± 5	4433618.75 ± 5	4433618.75 ± 5	4433618.75 ± 5	4433618.75 ± 5
Nominal radio-frequency channel bandwidth (MHz)	6	6	6	B: 7; B1, G: 8	8	8	8	8	8	8	8	8
Sound carrier relative to vision carrier (MHz)	+ 4.5	+ 4.5	+ 4.5	+ 5.5 ± 0.001 c d e f	+ 6.5 ± 0.001	+ 5.5	+ 5.9996 ± 0.0005	+ 5.5	+ 6.5 ± 0.001	+ 6.5 ± 0.001	+ 6.5	+ 6.5 g

Characteristics				B, D1, G/PAL/PAL	D, D1, H/PAL/PAL			B, D, G/SECAM/SECAM	D, D1, H/SECAM/SECAM		
M/NTSC	N/PAL	N/PAL	N/PAL	B1, D1, G/PAL/PAL	D1, H/PAL/PAL			B, D, G/SECAM/SECAM	D, D1, H/SECAM/SECAM		

Notes:

- a. Japan uses a standard similar to M/NTSC (V4L2_STD_NTSC_M_JP).
- b. The values in brackets apply to the combination N/PAL a.k.a. Nc used in Argentina (V4L2_STD_PAL_Nc).
- c. In the Federal Republic of Germany, Austria, Italy, the Netherlands, Slovakia and Switzerland a system of two sound carriers is used, the frequency of the second carrier being 242.1875 kHz above the frequency of the first sound carrier. For stereophonic sound transmissions a similar system is used in Australia.
- d. New Zealand uses a sound carrier displaced 5.4996 ± 0.0005 MHz from the vision carrier.
- e. In Denmark, Finland, New Zealand, Sweden and Spain a system of two sound carriers is used. In Iceland, Norway and Poland the same system is being introduced. The second carrier is 5.85 MHz above the vision carrier and is DQPSK modulated with 728 kbit/s sound and data multiplex. (NICAM system)
- f. In the United Kingdom, a system of two sound carriers is used. The second sound carrier is 6.552 MHz above the vision carrier and is DQPSK modulated with a 728 kbit/s sound and data multiplex able to carry two sound channels. (NICAM system)
- g. In France, a digital carrier 5.85 MHz away from the vision carrier may be used in addition to the main sound carrier. It is modulated in differentially encoded QPSK with a 728 kbit/s sound and data multiplexer capable of carrying two sound channels. (NICAM system)

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The struct `v4l2_standard` `index` is out of bounds.

Notes

1. The supported standards may overlap and we need an unambiguous set to find the current standard returned by `VIDIOC_G_STD`.

ioctl VIDIOC_G_AUDIO, VIDIOC_S_AUDIO

Name

VIDIOC_G_AUDIO, VIDIOC_S_AUDIO — Query or select the current audio input and its attributes

Synopsis

```
int ioctl(int fd, int request, struct v4l2_audio *argp);
```

```
int ioctl(int fd, int request, const struct v4l2_audio *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_AUDIO, VIDIOC_S_AUDIO

argp

Description

To query the current audio input applications zero out the *reserved* array of a struct `v4l2_audio` and call the `VIDIOC_G_AUDIO` `ioctl` with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code when the device has no audio inputs, or none which combine with the current video input.

Audio inputs have one writable property, the audio mode. To select the current audio input *and* change the audio mode, applications initialize the *index* and *mode* fields, and the *reserved* array of a `v4l2_audio` structure and call the `VIDIOC_S_AUDIO`

ioctl. Drivers may switch to a different audio mode if the request cannot be satisfied. However, this is a write-only ioctl, it does not return the actual new audio mode.

Table A-1. struct v4l2_audio

__u32	<i>index</i>	Identifies the audio input, set by the driver or application.
__u8	<i>name</i> [32]	Name of the audio input, a NUL-terminated ASCII string, for example: "Line In". This information is intended for the user, preferably the connector label on the device itself.
__u32	<i>capability</i>	Audio capability flags, see Table A-2.
__u32	<i>mode</i>	Audio mode flags set by drivers and applications (on VIDIOC_S_AUDIO ioctl), see Table A-3.
__u32	<i>reserved</i> [2]	Reserved for future extensions. Drivers and applications must set the array to zero.

Table A-2. Audio Capability Flags

V4L2_AUDCAP_STEREO	0x00001	This is a stereo input. The flag is intended to automatically disable stereo recording etc. when the signal is always monaural. The API provides no means to detect if stereo is <i>received</i> , unless the audio input belongs to a tuner.
V4L2_AUDCAP_AVL	0x00002	Automatic Volume Level mode is supported.

Table A-3. Audio Mode Flags

V4L2_AUDMODE_AVL	0x00001	AVL mode is on.
------------------	---------	-----------------

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

No audio inputs combine with the current video input, or the number of the selected audio input is out of bounds or it does not combine, or there are no audio inputs at all and the ioctl is not supported.

EBUSY

I/O is in progress, the input cannot be switched.

ioctl VIDIOC_G_AUDOUT, VIDIOC_S_AUDOUT

Name

VIDIOC_G_AUDOUT, VIDIOC_S_AUDOUT — Query or select the current audio output

Synopsis

```
int ioctl(int fd, int request, struct v4l2_audioout *argp);
```

```
int ioctl(int fd, int request, const struct v4l2_audioout  
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_AUDOUT, VIDIOC_S_AUDOUT

argp

Description

To query the current audio output applications zero out the *reserved* array of a struct `v4l2_audioout` and call the `VIDIOC_G_AUDOUT` ioctl with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code when the device has no audio inputs, or none which combine with the current video output.

Audio outputs have no writable properties. Nevertheless, to select the current audio output applications can initialize the *index* field and *reserved* array (which in the future may contain writable properties) of a `v4l2_audioout` structure and call the `VIDIOC_S_AUDOUT` ioctl. Drivers switch to the requested output or return the `EINVAL` error code when the index is out of bounds. This is a write-only ioctl, it does not return the current audio output attributes as `VIDIOC_G_AUDOUT` does.

Note connectors on a TV card to loop back the received audio signal to a sound card are not audio outputs in this sense.

Table A-1. struct `v4l2_audioout`

<code>__u32</code>	<i>index</i>	Identifies the audio output, set by the driver or application.
<code>__u8</code>	<i>name</i> [32]	Name of the audio output, a NUL-terminated ASCII string, for example: "Line Out". This information is intended for the user, preferably the connector label on the device itself.
<code>__u32</code>	<i>capability</i>	Audio capability flags, none defined yet. Drivers must set this field to zero.
<code>__u32</code>	<i>mode</i>	Audio mode, none defined yet. Drivers and applications (on <code>VIDIOC_S_AUDOUT</code>) must set this field to zero.
<code>__u32</code>	<i>reserved</i> [2]	Reserved for future extensions. Drivers and applications must set the array to zero.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

No audio outputs combine with the current video output, or the number of the selected audio output is out of bounds or it does not combine, or there are no audio outputs at all and the `ioctl` is not supported.

EBUSY

I/O is in progress, the output cannot be switched.

ioctl VIDIOC_G_CROP, VIDIOC_S_CROP

Name

`VIDIOC_G_CROP`, `VIDIOC_S_CROP` — Get or set the current cropping rectangle

Synopsis

```
int ioctl(int fd, int request, struct v4l2_crop *argp);
```

```
int ioctl(int fd, int request, const struct v4l2_crop *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_CROP, VIDIOC_S_CROP

argp

Description

To query the cropping rectangle size and position applications set the *type* field of a `v4l2_crop` structure to the respective buffer (stream) type and call the `VIDIOC_G_CROP` ioctl with a pointer to this structure. The driver fills the rest of the structure or returns the `EINVAL` error code if cropping is not supported.

To change the cropping rectangle applications initialize the *type* and struct `v4l2_rect` substructure named *c* of a `v4l2_crop` structure and call the `VIDIOC_S_CROP` ioctl with a pointer to this structure.

The driver first adjusts the requested dimensions against hardware limits, i. e. the bounds given by the capture/output window, and it rounds to the closest possible values of horizontal and vertical offset, width and height. In particular the driver must round the vertical offset of the cropping rectangle to frame lines modulo two, such that the field order cannot be confused.

Second the driver adjusts the image size (the opposite rectangle of the scaling process, source or target depending on the data direction) to the closest size possible while maintaining the current horizontal and vertical scaling factor.

Finally the driver programs the hardware with the actual cropping and image parameters. `VIDIOC_S_CROP` is a write-only ioctl, it does not return the actual parameters. To query them applications must call `VIDIOC_G_CROP` and `VIDIOC_G_FMT`. When the parameters are unsuitable the application may modify the cropping or image parameters and repeat the cycle until satisfactory parameters have been negotiated.

When cropping is not supported then no parameters are changed and `VIDIOC_S_CROP` returns the `EINVAL` error code.

Table A-1. struct v4l2_crop

`enum v4l2_buf_type` *type*

Type of the data stream, set by the application. Only these types are valid here:

V4L2_BUF_TYPE_VIDEO_CAPTURE,
V4L2_BUF_TYPE_VIDEO_OUTPUT,
V4L2_BUF_TYPE_VIDEO_OVERLAY,
and custom (driver defined) types with
code V4L2_BUF_TYPE_PRIVATE and
higher.

`struct v4l2_rect` *c*

Cropping rectangle. The same
co-ordinate system as for
`struct v4l2_cropcap` *bounds* is used.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

Cropping is not supported.

ioctl VIDIOC_G_CTRL, VIDIOC_S_CTRL

Name

VIDIOC_G_CTRL, VIDIOC_S_CTRL — Get or set the value of a control

Synopsis

```
int ioctl(int fd, int request, struct v4l2_control *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_CTRL, VIDIOC_S_CTRL

argp

Description

To get the current value of a control applications initialize the *id* field of a struct `v4l2_control` and call the `VIDIOC_G_CTRL` ioctl with a pointer to this structure. To change the value of a control applications initialize the *id* and *value* fields of a struct `v4l2_control` and call the `VIDIOC_S_CTRL` ioctl.

When the *id* is invalid drivers return an `EINVAL` error code. When the *value* is out of bounds drivers can choose to take the closest valid value or return an `ERANGE` error code, whatever seems more appropriate. However, `VIDIOC_S_CTRL` is a write-only ioctl, it does not return the actual new value.

These ioctls work only with user controls. For other control classes the `VIDIOC_G_EXT_CTRLS`, `VIDIOC_S_EXT_CTRLS` or `VIDIOC_TRY_EXT_CTRLS` must be used.

Table A-1. struct v4l2_control

<code>__u32</code>	<i>id</i>	Identifies the control, set by the application.
<code>__s32</code>	<i>value</i>	New value or current value.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The struct `v4l2_control` *id* is invalid.

ERANGE

The struct `v4l2_control` *value* is out of bounds.

EBUSY

The control is temporarily not changeable, possibly because another applications took over control of the device function this control belongs to.

ioctl VIDIOC_G_DV_PRESET, VIDIOC_S_DV_PRESET

Name

`VIDIOC_G_DV_PRESET`, `VIDIOC_S_DV_PRESET` — Query or select the DV preset of the current input or output

Synopsis

```
int ioctl(int fd, int request, struct v4l2_dv_preset *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_G_DV_PRESET`, `VIDIOC_S_DV_PRESET`

argp

Description

To query and select the current DV preset, applications use the `VIDIOC_G_DV_PRESET` and `VIDIOC_S_DV_PRESET` ioctls which take a pointer to a struct `v4l2_dv_preset` type as argument. Applications must zero the reserved array in struct `v4l2_dv_preset`. `VIDIOC_G_DV_PRESET` returns a dv preset in the field `preset` of struct `v4l2_dv_preset`.

`VIDIOC_S_DV_PRESET` accepts a pointer to a struct `v4l2_dv_preset` that has the preset value to be set. Applications must zero the reserved array in struct `v4l2_dv_preset`. If the preset is not supported, it returns an `EINVAL` error code

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

This ioctl is not supported, or the `VIDIOC_S_DV_PRESET,VIDIOC_S_DV_PRESET` parameter was unsuitable.

`EBUSY`

The device is busy and therefore can not change the preset.

Table A-1. struct `v4l2_dv_preset`

<code>__u32</code>	<code>preset</code>	Preset value to represent the digital video timings
<code>__u32</code>	<code>reserved[4]</code>	Reserved fields for future use

ioctl `VIDIOC_G_DV_TIMINGS`, `VIDIOC_S_DV_TIMINGS`

Name

`VIDIOC_G_DV_TIMINGS`, `VIDIOC_S_DV_TIMINGS` — Get or set custom

DV timings for input or output

Synopsis

```
int ioctl(int fd, int request, struct v4l2_dv_timings *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_G_DV_TIMINGS`, `VIDIOC_S_DV_TIMINGS`

argp

Description

To set custom DV timings for the input or output, applications use the `VIDIOC_S_DV_TIMINGS` `ioctl` and to get the current custom timings, applications use the `VIDIOC_G_DV_TIMINGS` `ioctl`. The detailed timing information is filled in using the structure `struct v4l2_dv_timings`. These `ioctls` take a pointer to the `struct v4l2_dv_timings` structure as argument. If the `ioctl` is not supported or the timing values are not correct, the driver returns `EINVAL` error code.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

This `ioctl` is not supported, or the `VIDIOC_S_DV_TIMINGS` parameter was unsuitable.

EBUSY

The device is busy and therefore can not change the timings.

Table A-1. struct v4l2_bt_timings

__u32	<i>width</i>	Width of the active video in pixels
__u32	<i>height</i>	Height of the active video in lines
__u32	<i>interlaced</i>	Progressive (0) or interlaced (1)
__u32	<i>polarities</i>	This is a bit mask that defines polarities of sync signals. bit 0 (V4L2_DV_VSYNC_POS_POL) is for vertical sync polarity and bit 1 (V4L2_DV_HSYNC_POS_POL) is for horizontal sync polarity. If the bit is set (1) it is positive polarity and if is cleared (0), it is negative polarity.
__u64	<i>pixelclock</i>	Pixel clock in Hz. Ex. 74.25MHz->74250000
__u32	<i>hfrontporch</i>	Horizontal front porch in pixels
__u32	<i>hsync</i>	Horizontal sync length in pixels
__u32	<i>hbackporch</i>	Horizontal back porch in pixels
__u32	<i>vfrontporch</i>	Vertical front porch in lines
__u32	<i>vsync</i>	Vertical sync length in lines
__u32	<i>vbackporch</i>	Vertical back porch in lines
__u32	<i>il_vfrontporch</i>	Vertical front porch in lines for bottom field of interlaced field formats
__u32	<i>il_vsync</i>	Vertical sync length in lines for bottom field of interlaced field formats
__u32	<i>il_vbackporch</i>	Vertical back porch in lines for bottom field of interlaced field formats

Table A-2. struct v4l2_dv_timings

__u32	<i>type</i>	Type of DV timings as listed in Table A-3.
union		

```
struct v4l2_bt_timings
{
    __u32    reserved[32]
};
```

Timings defined by BT.656/1120 specifications

Table A-3. DV Timing types

Timing type	value	Description
V4L2_DV_BT_656_1120		BT.656/1120 timings

ioctl VIDIOC_G_ENC_INDEX

Name

VIDIOC_G_ENC_INDEX — Get meta data about a compressed video stream

Synopsis

```
int ioctl(int fd, int request, struct v4l2_enc_idx *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_ENC_INDEX

argp

Description

Experimental: This is an experimental interface and may change in the future.

The `VIDIOC_G_ENC_INDEX` ioctl provides meta data about a compressed video stream the same or another application currently reads from the driver, which is useful for random access into the stream without decoding it.

To read the data applications must call `VIDIOC_G_ENC_INDEX` with a pointer to a struct `v4l2_enc_idx`. On success the driver fills the `entry` array, stores the number of elements written in the `entries` field, and initializes the `entries_cap` field.

Each element of the `entry` array contains meta data about one picture. A `VIDIOC_G_ENC_INDEX` call reads up to `V4L2_ENC_IDX_ENTRIES` entries from a driver buffer, which can hold up to `entries_cap` entries. This number can be lower or higher than `V4L2_ENC_IDX_ENTRIES`, but not zero. When the application fails to read the meta data in time the oldest entries will be lost. When the buffer is empty or no capturing/encoding is in progress, `entries` will be zero.

Currently this ioctl is only defined for MPEG-2 program streams and video elementary streams.

Table A-1. struct `v4l2_enc_idx`

<code>__u32</code>	<code>entries</code>	The number of entries the driver stored in the <code>entry</code> array.
<code>__u32</code>	<code>entries_cap</code>	The number of entries the driver can buffer. Must be greater than zero.
<code>__u32</code>		Reserved for future extensions. Drivers must set the array to zero.
<code>struct v4l2_enc_idx_entry</code>	<code>entry[V4L2_ENC_IDX_ENTRIES]</code>	Meta data about a compressed video stream. Each element of the array corresponds to one picture, sorted in ascending order by their <code>offset</code> .

Table A-2. struct `v4l2_enc_idx_entry`

Appendix A. Function Reference

<code>__u64</code>	<code>offset</code>	The offset in bytes from the beginning of the compressed video stream to the beginning of this picture, that is a <i>PES packet header</i> as defined in ISO 13818-1 or a <i>picture header</i> as defined in ISO 13818-2. When the encoder is stopped, the driver resets the offset to zero.
<code>__u64</code>	<code>pts</code>	The 33 bit <i>Presentation Time Stamp</i> of this picture as defined in ISO 13818-1.
<code>__u32</code>	<code>length</code>	The length of this picture in bytes.
<code>__u32</code>	<code>flags</code>	Flags containing the coding type of this picture, see Table A-3.
<code>__u32</code>	<code>reserved[2]</code>	Reserved for future extensions. Drivers must set the array to zero.

Table A-3. Index Entry Flags

<code>V4L2_ENC_IDX_FRAME_I</code>	<code>0x00</code>	This is an Intra-coded picture.
<code>V4L2_ENC_IDX_FRAME_P</code>	<code>0x01</code>	This is a Predictive-coded picture.
<code>V4L2_ENC_IDX_FRAME_B</code>	<code>0x02</code>	This is a Bidirectionally predictive-coded picture.
<code>V4L2_ENC_IDX_FRAME_MASK</code>	<code>0x0F</code>	<i>AND</i> the flags field with this mask to obtain the picture coding type.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The driver does not support this `ioctl`.

**`ioctl VIDIOC_G_EXT_CTRLs,`
`VIDIOC_S_EXT_CTRLs,`**

VIDIOC_TRY_EXT_CTRL

Name

VIDIOC_G_EXT_CTRL, VIDIOC_S_EXT_CTRL, VIDIOC_TRY_EXT_CTRL — Get or set the value of several controls, try control values

Synopsis

```
int ioctl(int fd, int request, struct v4l2_ext_controls
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_EXT_CTRL, VIDIOC_S_EXT_CTRL, VIDIOC_TRY_EXT_CTRL

argp

Description

These ioctls allow the caller to get or set multiple controls atomically. Control IDs are grouped into control classes (see Table A-3) and all controls in the control array must belong to the same control class.

Applications must always fill in the *count*, *ctrl_class*, *controls* and *reserved* fields of struct `v4l2_ext_controls`, and initialize the struct `v4l2_ext_control` array pointed to by the *controls* fields.

Appendix A. Function Reference

To get the current value of a set of controls applications initialize the *id*, *size* and *reserved2* fields of each struct `v4l2_ext_control` and call the `VIDIOC_G_EXT_CTRLS` ioctl. String controls must also set the *string* field.

If the *size* is too small to receive the control result (only relevant for pointer-type controls like strings), then the driver will set *size* to a valid value and return an `ENOSPC` error code. You should re-allocate the string memory to this new size and try again. It is possible that the same issue occurs again if the string has grown in the meantime. It is recommended to call `VIDIOC_QUERYCTRL` first and use *maximum+1* as the new *size* value. It is guaranteed that that is sufficient memory.

To change the value of a set of controls applications initialize the *id*, *size*, *reserved2* and *value/string* fields of each struct `v4l2_ext_control` and call the `VIDIOC_S_EXT_CTRLS` ioctl. The controls will only be set if *all* control values are valid.

To check if a set of controls have correct values applications initialize the *id*, *size*, *reserved2* and *value/string* fields of each struct `v4l2_ext_control` and call the `VIDIOC_TRY_EXT_CTRLS` ioctl. It is up to the driver whether wrong values are automatically adjusted to a valid value or if an error is returned.

When the *id* or *ctrl_class* is invalid drivers return an `EINVAL` error code. When the value is out of bounds drivers can choose to take the closest valid value or return an `ERANGE` error code, whatever seems more appropriate. In the first case the new value is set in struct `v4l2_ext_control`.

The driver will only set/get these controls if all control values are correct. This prevents the situation where only some of the controls were set/get. Only low-level errors (e. g. a failed i2c command) can still cause this situation.

Table A-1. struct `v4l2_ext_control`

<code>__u32</code>	<i>id</i>	Identifies the control, set by the application.
--------------------	-----------	---

__u32	<i>size</i>		The total size in bytes of the payload of this control. This is normally 0, but for pointer controls this should be set to the size of the memory containing the payload, or that will receive the payload. If <code>VIDIOC_G_EXT_CTRL</code> s finds that this value is less than is required to store the payload result, then it is set to a value large enough to store the payload result and <code>ENOSPC</code> is returned. Note that for string controls this <i>size</i> field should not be confused with the length of the string. This field refers to the size of the memory that contains the string. The actual <i>length</i> of the string may well be much smaller.
__u32	<i>reserved2[1]</i>		Reserved for future extensions. Drivers and applications must set the array to zero.
union	(anonymous)		
	__s32	<i>value</i>	New value or current value.
	__s64	<i>value64</i>	New value or current value.
	char *	<i>string</i>	A pointer to a string.

Table A-2. struct v4l2_ext_controls

__u32	<i>ctrl_class</i>	The control class to which all controls belong, see Table A-3.
__u32	<i>count</i>	The number of controls in the controls array. May also be zero.
__u32	<i>error_idx</i>	Set by the driver in case of an error. It is the index of the control causing the error or equal to 'count' when the error is not associated with a particular control. Undefined when the ioctl returns 0 (success).

<code>__u32</code>	<code>reserved[2]</code>	Reserved for future extensions. Drivers and applications must set the array to zero.
<code>struct v4l2_ext_controls *</code>		Pointer to an array of <code>count</code> <code>v4l2_ext_control</code> structures. Ignored if <code>count</code> equals zero.

Table A-3. Control classes

<code>V4L2_CTRL_CLASS_USER</code>	<code>0x980000</code>	The class containing user controls. These controls are described in Section 1.8. All controls that can be set using the <code>VIDIOC_S_CTRL</code> and <code>VIDIOC_G_CTRL</code> <code>ioctl</code> belong to this class.
<code>V4L2_CTRL_CLASS_MPEG</code>	<code>0x990000</code>	The class containing MPEG compression controls. These controls are described in Section 1.9.5.
<code>V4L2_CTRL_CLASS_CAMERA</code>	<code>0x9a0000</code>	The class containing camera controls. These controls are described in Section 1.9.6.
<code>V4L2_CTRL_CLASS_FM_TX</code>	<code>0x9b0000</code>	The class containing FM Transmitter (FM TX) controls. These controls are described in Section 1.9.7.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The struct `v4l2_ext_control` `id` is invalid or the struct `v4l2_ext_controls` `ctrl_class` is invalid. This error code is also returned by the `VIDIOC_S_EXT_CTRL`s and `VIDIOC_TRY_EXT_CTRL`s `ioctls` if two or more control values are in conflict.

ERANGE

The struct `v4l2_ext_control` `value` is out of bounds.

EBUSY

The control is temporarily not changeable, possibly because another applications took over control of the device function this control belongs to.

ENOSPC

The space reserved for the control's payload is insufficient. The field *size* is set to a value that is enough to store the payload and this error code is returned.

ioctl VIDIOC_G_FBUF, VIDIOC_S_FBUF

Name

VIDIOC_G_FBUF, VIDIOC_S_FBUF — Get or set frame buffer overlay parameters

Synopsis

```
int ioctl(int fd, int request, struct v4l2_framebuffer *argp);
```

```
int ioctl(int fd, int request, const struct v4l2_framebuffer *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_FBUF, VIDIOC_S_FBUF

argp

Description

Applications can use the `VIDIOC_G_FBUF` and `VIDIOC_S_FBUF` ioctl to get and set the framebuffer parameters for a **Video Overlay** or **Video Output Overlay (OSD)**. The type of overlay is implied by the device type (capture or output device) and can be determined with the `VIDIOC_QUERYCAP` ioctl. One `/dev/videoN` device must not support both kinds of overlay.

The V4L2 API distinguishes destructive and non-destructive overlays. A destructive overlay copies captured video images into the video memory of a graphics card. A non-destructive overlay blends video images into a VGA signal or graphics into a video signal. *Video Output Overlays* are always non-destructive.

To get the current parameters applications call the `VIDIOC_G_FBUF` ioctl with a pointer to a `v4l2_framebuffer` structure. The driver fills all fields of the structure or returns an `EINVAL` error code when overlays are not supported.

To set the parameters for a *Video Output Overlay*, applications must initialize the `flags` field of a struct `v4l2_framebuffer`. Since the framebuffer is implemented on the TV card all other parameters are determined by the driver. When an application calls `VIDIOC_S_FBUF` with a pointer to this structure, the driver prepares for the overlay and returns the framebuffer parameters as `VIDIOC_G_FBUF` does, or it returns an error code.

To set the parameters for a *non-destructive Video Overlay*, applications must initialize the `flags` field, the `fmt` substructure, and call `VIDIOC_S_FBUF`. Again the driver prepares for the overlay and returns the framebuffer parameters as `VIDIOC_G_FBUF` does, or it returns an error code.

For a *destructive Video Overlay* applications must additionally provide a `base` address. Setting up a DMA to a random memory location can jeopardize the system security, its stability or even damage the hardware, therefore only the superuser can set the parameters for a destructive video overlay.

Table A-1. struct v4l2_framebuffer

<code>__u32</code>	<code>capability</code>	Overlay capability flags set by the driver, see Table A-2.
<code>__u32</code>	<code>flags</code>	Overlay control flags set by application and driver, see Table A-3
<code>void *</code>	<code>base</code>	Physical base address of the framebuffer, that is the address of the pixel in the top left corner of the framebuffer. ^a

This field is irrelevant to *non-destructive Video Overlays*. For *destructive Video Overlays* applications must provide a base address. The driver may accept only base addresses which are a multiple of two, four or eight bytes. For *Video Output Overlays* the driver must return a valid base address, so applications can find the corresponding Linux framebuffer device (see Section 4.4).

`struct v4l2_pix_format`

Layout of the frame buffer. The `v4l2_pix_format` structure is defined in Chapter 2, for clarification the fields and acceptable values are listed below:

<code>__u32</code>	<code>width</code>	Width of the frame buffer in pixels.
<code>__u32</code>	<code>height</code>	Height of the frame buffer in pixels.
<code>__u32</code>	<code>pixelformat</code>	The pixel format of the framebuffer.

For *non-destructive Video Overlays* this field only defines a format for the `struct v4l2_window` `chromakey` field.

For *destructive Video Overlays* applications must initialize this field. For *Video Output Overlays* the driver must return a valid format.

		Usually this is an RGB format (for example V4L2_PIX_FMT_RGB565) but YUV formats (only packed YUV formats when chroma keying is used, not including V4L2_PIX_FMT_YUYV and V4L2_PIX_FMT_UYVY) and the V4L2_PIX_FMT_PAL8 format are also permitted. The behavior of the driver when an application requests a compressed format is undefined. See Chapter 2 for information on pixel formats. Drivers and applications shall ignore this field. If applicable, the field order is selected with the VIDIOC_S_FMT ioctl, using the <i>field</i> field of struct v4l2_window.
enum v4l2_field	<i>field</i>	
__u32	<i>bytesperline</i>	Distance in bytes between the leftmost pixels in two adjacent lines.

This field is irrelevant to *non-destructive Video Overlays*. For *destructive Video Overlays* both applications and drivers can set this field to request padding bytes at the end of each line. Drivers however may ignore the requested value, returning *width* times bytes-per-pixel or a larger value required by the hardware. That implies applications can just set this field to zero to get a reasonable default.

For *Video Output Overlays* the driver must return a valid value.

Video hardware may access padding bytes, therefore they must reside in accessible memory. Consider for example the case where padding bytes after the last line of an image cross a system page boundary. Capture devices may write padding bytes, the value is undefined. Output devices ignore the contents of padding bytes.

When the image format is planar the *bytesperline* value applies to the largest plane and is divided by the same factor as the *width* field for any smaller planes. For example the Cb and Cr planes of a YUV 4:2:0 image have half as many padding bytes following each line as the Y plane. To avoid ambiguities drivers must return a *bytesperline* value rounded up to a multiple of the scale factor.

<code>__u32</code>	<code>sizeimage</code>	This field is irrelevant to <i>non-destructive Video Overlays</i> . For <i>destructive Video Overlays</i> applications must initialize this field. For <i>Video Output Overlays</i> the driver must return a valid format. Together with <i>base</i> it defines the framebuffer memory accessible by the driver.
<code>enum v4l2_colorspace</code>	<code>colorspace</code>	This information supplements the <i>pixelformat</i> and must be set by the driver, see Section 2.4.
<code>__u32</code>	<code>priv</code>	Reserved for additional information about custom (driver defined) formats. When not used drivers and applications must set this field to zero.

Notes:

- a. A physical base address may not suit all platforms. GK notes in theory we should pass something like PCI device + memory region + offset instead. If you encounter problems please discuss on the linux-media mailing list: <http://www.linuxtv.org/lists.php>.

Table A-2. Frame Buffer Capability Flags

V4L2_FBUF_CAP_EXTERNOVERLAY	0x0001	The device is capable of non-destructive overlays. When the driver clears this flag, only destructive overlays are supported. There are no drivers yet which support both destructive and non-destructive overlays.
V4L2_FBUF_CAP_CHROMAKEY	0x0002	The device supports clipping by chroma-keying the images. That is, image pixels replace pixels in the VGA or video signal only where the latter assume a certain color. Chroma-keying makes no sense for destructive overlays.
V4L2_FBUF_CAP_LIST_CLIP	0x0004	The device supports clipping using a list of clip rectangles.
V4L2_FBUF_CAP_BITMAP_CLIP	0x0008	The device supports clipping using a bit mask.
V4L2_FBUF_CAP_LOCAL_ALPHA	0x0010	The device supports clipping/blending using the alpha channel of the framebuffer or VGA signal. Alpha blending makes no sense for destructive overlays.
V4L2_FBUF_CAP_GLOBAL_ALPHA	0x0020	The device supports alpha blending using a global alpha value. Alpha blending makes no sense for destructive overlays.
V4L2_FBUF_CAP_LOCAL_INV_ALPHA	0x0040	The device supports clipping/blending using the inverted alpha channel of the framebuffer or VGA signal. Alpha blending makes no sense for destructive overlays.

V4L2_FBUF_CAP_SRC_CHROMAKEY	0x0080	The device supports Source Chroma-keying. Framebuffer pixels with the chroma-key colors are replaced by video pixels, which is exactly opposite of V4L2_FBUF_CAP_CHROMAKEY
-----------------------------	--------	--

Table A-3. Frame Buffer Flags

V4L2_FBUF_FLAG_PRIMARY	0x0001	The framebuffer is the primary graphics surface. In other words, the overlay is destructive. [?]
V4L2_FBUF_FLAG_OVERLAY	0x0002	The frame buffer is an overlay surface the same size as the capture. [?]

The purpose of V4L2_FBUF_FLAG_PRIMARY and V4L2_FBUF_FLAG_OVERLAY was never quite clear. Most drivers seem to ignore these flags. For compatibility with the *bttv* driver applications should set the V4L2_FBUF_FLAG_OVERLAY flag.

V4L2_FBUF_FLAG_CHROMAKEY	0x0004	Use chroma-keying. The chroma-key color is determined by the <i>chromakey</i> field of struct <i>v4l2_window</i> and negotiated with the VIDIOC_S_FMT ioctl, see Section 4.2 and Section 4.4.
--------------------------	--------	---

There are no flags to enable clipping using a list of clip rectangles or a bitmap. These methods are negotiated with the VIDIOC_S_FMT ioctl, see Section 4.2 and Section 4.4.

V4L2_FBUF_FLAG_LOCAL_ALPHA	0x0008	Use the alpha channel of the framebuffer to clip or blend framebuffer pixels with video images. The blend function is: $\text{output} = \text{framebuffer pixel} * \text{alpha} + \text{video pixel} * (1 - \text{alpha})$. The actual alpha depth depends on the framebuffer pixel format.
----------------------------	--------	--

V4L2_FBUF_FLAG_GLOBAL_ALPHA	0x0010	Use a global alpha value to blend the framebuffer with video images. The blend function is: $\text{output} = (\text{framebuffer pixel} * \text{alpha} + \text{video pixel} * (255 - \text{alpha})) / 255$. The alpha value is determined by the <i>global_alpha</i> field of struct <i>v4l2_window</i> and negotiated with the VIDIOC_S_FMT ioctl, see Section 4.2 and Section 4.4.
-----------------------------	--------	--

V4L2_FBUF_FLAG_LOCAL_INV	0x0020	Like V4L2_FBUF_FLAG_LOCAL_ALPHA, use the alpha channel of the framebuffer to clip or blend framebuffer pixels with video images, but with an inverted alpha value. The blend function is: $\text{output} = \text{framebuffer pixel} * (1 - \text{alpha}) + \text{video pixel} * \text{alpha}$. The actual alpha depth depends on the framebuffer pixel format.
V4L2_FBUF_FLAG_SRC_CHROMA_KEY	0x0040	Use source chroma-keying. The source chroma-key color is determined by the <i>chromakey</i> field of struct <code>v4l2_window</code> and negotiated with the <code>VIDIOC_S_FMT</code> ioctl, see Section 4.2 and Section 4.4. Both chroma-keying are mutual exclusive to each other, so same <i>chromakey</i> field of struct <code>v4l2_window</code> is being used.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EPERM

`VIDIOC_S_FBUF` can only be called by a privileged user to negotiate the parameters for a destructive overlay.

EBUSY

The framebuffer parameters cannot be changed at this time because overlay is already enabled, or capturing is enabled and the hardware cannot capture and overlay simultaneously.

EINVAL

The ioctl is not supported or the `VIDIOC_S_FBUF` parameters are unsuitable.

ioctl VIDIOC_G_FMT, VIDIOC_S_FMT, VIDIOC_TRY_FMT

Name

VIDIOC_G_FMT, VIDIOC_S_FMT, VIDIOC_TRY_FMT — Get or set the data format, try a format

Synopsis

```
int ioctl(int fd, int request, struct v4l2_format *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_FMT, VIDIOC_S_FMT, VIDIOC_TRY_FMT

argp

Description

These ioctls are used to negotiate the format of data (typically image format) exchanged between driver and application.

To query the current parameters applications set the *type* field of a struct `v4l2_format` to the respective buffer (stream) type. For example video capture devices use `V4L2_BUF_TYPE_VIDEO_CAPTURE` or `V4L2_BUF_TYPE_VIDEO_CAPTURE_MPLANE`. When the application calls the `VIDIOC_G_FMT` ioctl with a pointer to this structure the driver fills the respective member of the *fmt* union. In case of video capture devices that is either the struct `v4l2_pix_format` *pix* or the struct `v4l2_pix_format_mplane` *pix_mp*

member. When the requested buffer type is not supported drivers return an `EINVAL` error code.

To change the current format parameters applications initialize the `type` field and all fields of the respective `fmt` union member. For details see the documentation of the various devices types in Chapter 4. Good practice is to query the current parameters first, and to modify only those parameters not suitable for the application. When the application calls the `VIDIOC_S_FMT` ioctl with a pointer to a `v4l2_format` structure the driver checks and adjusts the parameters against hardware abilities. Drivers should not return an error code unless the input is ambiguous, this is a mechanism to fathom device capabilities and to approach parameters acceptable for both the application and driver. On success the driver may program the hardware, allocate resources and generally prepare for data exchange. Finally the `VIDIOC_S_FMT` ioctl returns the current format parameters as `VIDIOC_G_FMT` does. Very simple, inflexible devices may even ignore all input and always return the default parameters. However all V4L2 devices exchanging data with the application must implement the `VIDIOC_G_FMT` and `VIDIOC_S_FMT` ioctl. When the requested buffer type is not supported drivers return an `EINVAL` error code on a `VIDIOC_S_FMT` attempt. When I/O is already in progress or the resource is not available for other reasons drivers return the `EBUSY` error code.

The `VIDIOC_TRY_FMT` ioctl is equivalent to `VIDIOC_S_FMT` with one exception: it does not change driver state. It can also be called at any time, never returning `EBUSY`. This function is provided to negotiate parameters, to learn about hardware limitations, without disabling I/O or possibly time consuming hardware preparations. Although strongly recommended drivers are not required to implement this ioctl.

Table A-1. struct v4l2_format

<code>enum v4l2_buf_type</code>	<code>type</code>	Type of the data stream, see Table 3-3.
<code>union</code>	<code>fmt</code>	
	<code>struct v4l2_pix_format</code>	Definition of an image format, see Chapter 2, used by video capture and output devices.

<code>struct v4l2_pix_format_mplane</code>	Definition of an image format, see Chapter 2, used by video capture and output devices that support the multi-planar version of the API.
<code>struct v4l2_window</code> <i>win</i>	Definition of an overlaid image, see Section 4.2, used by video overlay devices.
<code>struct v4l2_vbi_format</code> <i>vbi</i>	Raw VBI capture or output parameters. This is discussed in more detail in Section 4.7. Used by raw VBI capture and output devices.
<code>struct v4l2_sliced_vbi_format</code> <i>sliced_vbi</i>	Sliced VBI capture or output parameters. See Section 4.8 for details. Used by sliced VBI capture and output devices.
<code>__u8</code> <i>raw_data[200]</i>	Place holder for future extensions and custom (driver defined) formats with <i>type</i> <code>V4L2_BUF_TYPE_PRIVATE</code> and higher.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EBUSY

The data format cannot be changed at this time, for example because I/O is already in progress.

EINVAL

The struct `v4l2_format` *type* field is invalid, the requested buffer type not supported, or `VIDIOC_TRY_FMT` was called and is not supported with this buffer type.

ioctl VIDIOC_G_FREQUENCY, VIDIOC_S_FREQUENCY

Name

`VIDIOC_G_FREQUENCY`, `VIDIOC_S_FREQUENCY` — Get or set tuner or modulator radio frequency

Synopsis

```
int ioctl(int fd, int request, struct v4l2_frequency *argp);
```

```
int ioctl(int fd, int request, const struct v4l2_frequency  
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_FREQUENCY, VIDIOC_S_FREQUENCY

argp

Description

To get the current tuner or modulator radio frequency applications set the *tuner* field of a struct `v4l2_frequency` to the respective tuner or modulator number (only input devices have tuners, only output devices have modulators), zero out the *reserved* array and call the `VIDIOC_G_FREQUENCY` ioctl with a pointer to this structure. The driver stores the current frequency in the *frequency* field.

To change the current tuner or modulator radio frequency applications initialize the *tuner*, *type* and *frequency* fields, and the *reserved* array of a struct `v4l2_frequency` and call the `VIDIOC_S_FREQUENCY` ioctl with a pointer to this structure. When the requested frequency is not possible the driver assumes the closest possible value. However `VIDIOC_S_FREQUENCY` is a write-only ioctl, it does not return the actual new frequency.

Table A-1. struct v4l2_frequency

<code>__u32</code>	<i>tuner</i>	The tuner or modulator index number. This is the same value as in the struct <code>v4l2_input</code> <i>tuner</i> field and the struct <code>v4l2_tuner</code> <i>index</i> field, or the struct <code>v4l2_output</code> <i>modulator</i> field and the struct <code>v4l2_modulator</code> <i>index</i> field.
<code>enum v4l2_tuner_type</code>	<i>type</i>	The tuner type. This is the same value as in the struct <code>v4l2_tuner</code> <i>type</i> field. The field is not applicable to modulators, i. e. ignored by drivers.
<code>__u32</code>	<i>frequency</i>	Tuning frequency in units of 62.5 kHz, or if the struct <code>v4l2_tuner</code> or struct <code>v4l2_modulator</code> <i>capabilities</i> flag <code>V4L2_TUNER_CAP_LOW</code> is set, in units of 62.5 Hz.
<code>__u32</code>	<i>reserved</i> [8]	Reserved for future extensions. Drivers and applications must set the array to zero.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The *tuner* index is out of bounds or the value in the *type* field is wrong.

ioctl VIDIOC_G_INPUT, VIDIOC_S_INPUT

Name

`VIDIOC_G_INPUT`, `VIDIOC_S_INPUT` — Query or select the current video input

Synopsis

```
int ioctl(int fd, int request, int *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_G_INPUT`, `VIDIOC_S_INPUT`

argp

Description

To query the current video input applications call the `VIDIOC_G_INPUT` ioctl with a pointer to an integer where the driver stores the number of the input, as in the struct `v4l2_input` *index* field. This ioctl will fail only when there are no video inputs, returning `EINVAL`.

To select a video input applications store the number of the desired input in an integer and call the `VIDIOC_S_INPUT` ioctl with a pointer to this integer. Side effects are possible. For example inputs may support different video standards, so the driver may implicitly switch the current standard. It is good practice to select an input before querying or negotiating any other parameters.

Information about video inputs is available using the `VIDIOC_ENUMINPUT` ioctl.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The number of the video input is out of bounds, or there are no video inputs at all and this ioctl is not supported.

`EBUSY`

I/O is in progress, the input cannot be switched.

ioctl VIDIOC_G_JPEGCOMP, VIDIOC_S_JPEGCOMP

Name

`VIDIOC_G_JPEGCOMP`, `VIDIOC_S_JPEGCOMP` —

Synopsis

```
int ioctl(int fd, int request, v4l2_jpegcompression *argp);
```

```
int ioctl(int fd, int request, const v4l2_jpegcompression  
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_G_JPEGCOMP`, `VIDIOC_S_JPEGCOMP`

argp

Description

[to do]

Ronald Bultje elaborates:

APP is some application-specific information. The application can set it itself, and it'll be stored in the JPEG-encoded fields (eg; interlacing information for in an AVI or so). COM is the same, but it's comments, like 'encoded by me' or so.

`jpeg_markers` describes whether the huffman tables, quantization tables and the restart interval information (all JPEG-specific stuff) should be stored in the JPEG-encoded fields. These define how the JPEG field is encoded. If you omit them, applications assume you've used standard encoding. You usually do want to add them.

Table A-1. struct `v4l2_jpegcompression`

int	<i>quality</i>
int	<i>APPn</i>

int	<i>APP_len</i>	
char	<i>APP_data</i> [60]	
int	<i>COM_len</i>	
char	<i>COM_data</i> [60]	
__u32	<i>jpeg_markers</i>	See Table A-2.

Table A-2. JPEG Markers Flags

V4L2_JPEG_MARKER_DHT	(1<<3)	Define Huffman Tables
V4L2_JPEG_MARKER_DQT	(1<<4)	Define Quantization Tables
V4L2_JPEG_MARKER_DRI	(1<<5)	Define Restart Interval
V4L2_JPEG_MARKER_COM	(1<<6)	Comment segment
V4L2_JPEG_MARKER_APP	(1<<7)	App segment, driver will always use APP0

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

This ioctl is not supported.

ioctl VIDIOC_G_MODULATOR, VIDIOC_S_MODULATOR

Name

VIDIOC_G_MODULATOR, VIDIOC_S_MODULATOR — Get or set modulator attributes

Synopsis

```
int ioctl(int fd, int request, struct v4l2_modulator *argp);
```

```
int ioctl(int fd, int request, const struct v4l2_modulator  
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_G_MODULATOR`, `VIDIOC_S_MODULATOR`

argp

Description

To query the attributes of a modulator applications initialize the *index* field and zero out the *reserved* array of a struct `v4l2_modulator` and call the `VIDIOC_G_MODULATOR` `ioctl` with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code when the index is out of bounds. To enumerate all modulators applications shall begin at index zero, incrementing by one until the driver returns `EINVAL`.

Modulators have two writable properties, an audio modulation set and the radio frequency. To change the modulated audio subprograms, applications initialize the *index* and *txsubchans* fields and the *reserved* array and call the `VIDIOC_S_MODULATOR` `ioctl`. Drivers may choose a different audio modulation if the request cannot be satisfied. However this is a write-only `ioctl`, it does not return the actual audio modulation selected.

To change the radio frequency the `VIDIOC_S_FREQUENCY` `ioctl` is available.

Table A-1. struct v4l2_modulator

__u32	<i>index</i>	Identifies the modulator, set by the application.
__u8	<i>name</i> [32]	Name of the modulator, a NUL-terminated ASCII string. This information is intended for the user.
__u32	<i>capability</i>	Modulator capability flags. No flags are defined for this field, the tuner flags in struct <code>v4l2_tuner</code> are used accordingly. The audio flags indicate the ability to encode audio subprograms. They will <i>not</i> change for example with the current video standard.
__u32	<i>rangelow</i>	The lowest tunable frequency in units of 62.5 KHz, or if the <i>capability</i> flag <code>V4L2_TUNER_CAP_LOW</code> is set, in units of 62.5 Hz.
__u32	<i>rangehigh</i>	The highest tunable frequency in units of 62.5 KHz, or if the <i>capability</i> flag <code>V4L2_TUNER_CAP_LOW</code> is set, in units of 62.5 Hz.
__u32	<i>txsubchans</i>	With this field applications can determine how audio sub-carriers shall be modulated. It contains a set of flags as defined in Table A-2. Note the tuner <i>rxsubchans</i> flags are reused, but the semantics are different. Video output devices are assumed to have an analog or PCM audio input with 1-3 channels. The <i>txsubchans</i> flags select one or more channels for modulation, together with some audio subprogram indicator, for example a stereo pilot tone.
__u32	<i>reserved</i> [4]	Reserved for future extensions. Drivers and applications must set the array to zero.

Table A-2. Modulator Audio Transmission Flags

Appendix A. Function Reference

V4L2_TUNER_SUB_MONO	0x0001	Modulate channel 1 as mono audio, when the input has more channels, a down-mix of channel 1 and 2. This flag does not combine with V4L2_TUNER_SUB_STEREO or V4L2_TUNER_SUB_LANG1.
V4L2_TUNER_SUB_STEREO	0x0002	Modulate channel 1 and 2 as left and right channel of a stereo audio signal. When the input has only one channel or two channels and V4L2_TUNER_SUB_SAP is also set, channel 1 is encoded as left and right channel. This flag does not combine with V4L2_TUNER_SUB_MONO or V4L2_TUNER_SUB_LANG1. When the driver does not support stereo audio it shall fall back to mono.
V4L2_TUNER_SUB_LANG1	0x0008	Modulate channel 1 and 2 as primary and secondary language of a bilingual audio signal. When the input has only one channel it is used for both languages. It is not possible to encode the primary or secondary language only. This flag does not combine with V4L2_TUNER_SUB_MONO, V4L2_TUNER_SUB_STEREO or V4L2_TUNER_SUB_SAP. If the hardware does not support the respective audio matrix, or the current video standard does not permit bilingual audio the VIDIOC_S_MODULATOR ioctl shall return an EINVAL error code and the driver shall fall back to mono or stereo mode.
V4L2_TUNER_SUB_LANG2	0x0004	Same effect as V4L2_TUNER_SUB_SAP.

V4L2_TUNER_SUB_SAP	0x0004	<p>When combined with V4L2_TUNER_SUB_MONO the first channel is encoded as mono audio, the last channel as Second Audio Program. When the input has only one channel it is used for both audio tracks. When the input has three channels the mono track is a down-mix of channel 1 and 2. When combined with V4L2_TUNER_SUB_STEREO channel 1 and 2 are encoded as left and right stereo audio, channel 3 as Second Audio Program. When the input has only two channels, the first is encoded as left and right channel and the second as SAP. When the input has only one channel it is used for all audio tracks. It is not possible to encode a Second Audio Program only. This flag must combine with V4L2_TUNER_SUB_MONO or V4L2_TUNER_SUB_STEREO. If the hardware does not support the respective audio matrix, or the current video standard does not permit SAP the VIDIOC_S_MODULATOR ioctl shall return an EINVAL error code and driver shall fall back to mono or stereo mode.</p>
V4L2_TUNER_SUB_RDS	0x0010	<p>Enable the RDS encoder for a radio FM transmitter.</p>

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The struct `v4l2_modulator` *index* is out of bounds.

ioctl VIDIOC_G_OUTPUT, VIDIOC_S_OUTPUT

Name

VIDIOC_G_OUTPUT, VIDIOC_S_OUTPUT — Query or select the current video output

Synopsis

```
int ioctl(int fd, int request, int *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_OUTPUT, VIDIOC_S_OUTPUT

argp

Description

To query the current video output applications call the `VIDIOC_G_OUTPUT` `ioctl` with a pointer to an integer where the driver stores the number of the output, as in the struct `v4l2_output` `index` field. This `ioctl` will fail only when there are no video outputs, returning the `EINVAL` error code.

To select a video output applications store the number of the desired output in an integer and call the `VIDIOC_S_OUTPUT` `ioctl` with a pointer to this integer. Side effects are possible. For example outputs may support different video standards, so the driver may implicitly switch the current standard. It is good practice to select an output before querying or negotiating any other parameters.

Information about video outputs is available using the `VIDIOC_ENUMOUTPUT` `ioctl`.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The number of the video output is out of bounds, or there are no video outputs at all and this `ioctl` is not supported.

EBUSY

I/O is in progress, the output cannot be switched.

`ioctl VIDIOC_G_PARM, VIDIOC_S_PARM`

Name

`VIDIOC_G_PARM`, `VIDIOC_S_PARM` — Get or set streaming parameters

Synopsis

```
int ioctl(int fd, int request, v4l2_streamparm *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_G_PARM`, `VIDIOC_S_PARM`

argp

Description

The current video standard determines a nominal number of frames per second. If less than this number of frames is to be captured or output, applications can request frame skipping or duplicating on the driver side. This is especially useful when using the `read()` or `write()`, which are not augmented by timestamps or sequence counters, and to avoid unnecessary data copying.

Further these `ioctl`s can be used to determine the number of buffers used internally by a driver in read/write mode. For implications see the section discussing the `read()` function.

To get and set the streaming parameters applications call the `VIDIOC_G_PARM` and `VIDIOC_S_PARM` `ioctl`, respectively. They take a pointer to a struct `v4l2_streamparm` which contains a union holding separate parameters for input and output devices.

Table A-1. struct v4l2_streamparm

<code>enum v4l2_buf_type</code>		The buffer (stream) type, same as struct <code>v4l2_format</code> <i>type</i> , set by the application.
<code>union</code>	<i>parm</i>	
	<code>struct v4l2_captureparm</code>	Parameters for capture devices, used when <i>type</i> is <code>V4L2_BUF_TYPE_VIDEO_CAPTURE</code> .
	<code>struct v4l2_outputparm</code>	Parameters for output devices, used when <i>type</i> is <code>V4L2_BUF_TYPE_VIDEO_OUTPUT</code> .
<code>__u8</code>	<i>raw_data</i> [200]	A place holder for future extensions and custom (driver defined) buffer types <code>V4L2_BUF_TYPE_PRIVATE</code> and higher.

Table A-2. struct v4l2_captureparm

<code>__u32</code>	<i>capability</i>	See Table A-4.
<code>__u32</code>	<i>capturemode</i>	Set by drivers and applications, see Table A-5.

<code>struct v4l2_fract</code>	<code>timeperframe</code>	<p>This is the desired period between successive frames captured by the driver, in seconds. The field is intended to skip frames on the driver side, saving I/O bandwidth.</p> <p>Applications store here the desired frame period, drivers return the actual frame period, which must be greater or equal to the nominal frame period determined by the current video standard (<code>struct v4l2_standard</code> <code>frameperiod</code> field). Changing the video standard (also implicitly by switching the video input) may reset this parameter to the nominal frame period. To reset manually applications can just set this field to zero.</p> <p>Drivers support this function only when they set the <code>V4L2_CAP_TIMEPERFRAME</code> flag in the <code>capability</code> field.</p>
<code>__u32</code>	<code>extendedmode</code>	<p>Custom (driver specific) streaming parameters. When unused, applications and drivers must set this field to zero. Applications using this field should check the driver name and version, see Section 1.2.</p>
<code>__u32</code>	<code>readbuffers</code>	<p>Applications set this field to the desired number of buffers used internally by the driver in <code>read()</code> mode. Drivers return the actual number of buffers. When an application requests zero buffers, drivers should just return the current setting rather than the minimum or an error code. For details see Section 3.1.</p>
<code>__u32</code>	<code>reserved[4]</code>	<p>Reserved for future extensions. Drivers and applications must set the array to zero.</p>

Table A-3. struct v4l2_outputparm

<code>__u32</code>	<code>capability</code>	See Table A-4.
<code>__u32</code>	<code>outputmode</code>	Set by drivers and applications, see Table A-5.
<code>struct v4l2_fract</code>	<code>timeperframe</code>	This is is the desired period between successive frames output by the driver, in seconds.

The field is intended to repeat frames on the driver side in `write()` mode (in streaming mode timestamps can be used to throttle the output), saving I/O bandwidth.

Applications store here the desired frame period, drivers return the actual frame period, which must be greater or equal to the nominal frame period determined by the current video standard (`struct v4l2_standard` `frameperiod` field). Changing the video standard (also implicitly by switching the video output) may reset this parameter to the nominal frame period. To reset manually applications can just set this field to zero.

Drivers support this function only when they set the `V4L2_CAP_TIMEPERFRAME` flag in the `capability` field.

<code>__u32</code>	<code>extendedmode</code>	Custom (driver specific) streaming parameters. When unused, applications and drivers must set this field to zero. Applications using this field should check the driver name and version, see Section 1.2.
<code>__u32</code>	<code>writebuffers</code>	Applications set this field to the desired number of buffers used internally by the driver in <code>write()</code> mode. Drivers return the actual number of buffers. When an application requests zero buffers, drivers should just return the current setting rather than the minimum or an error code. For details see Section 3.1.
<code>__u32</code>	<code>reserved[4]</code>	Reserved for future extensions. Drivers and applications must set the array to zero.

Table A-4. Streaming Parameters Capabilites

V4L2_CAP_TIMEPERFRAME	0x1000	The frame skipping/repeating controlled by the <i>timeperframe</i> field is supported.
-----------------------	--------	--

Table A-5. Capture Parameters Flags

Appendix A. Function Reference

V4L2_MODE_HIGHQUALITY	0x0001	<p>High quality imaging mode. High quality mode is intended for still imaging applications. The idea is to get the best possible image quality that the hardware can deliver. It is not defined how the driver writer may achieve that; it will depend on the hardware and the ingenuity of the driver writer. High quality mode is a different mode from the the regular motion video capture modes. In high quality mode:</p> <ul style="list-style-type: none">• The driver may be able to capture higher resolutions than for motion capture.• The driver may support fewer pixel formats than motion capture (eg; true color).• The driver may capture and arithmetically combine multiple successive fields or frames to remove color edge artifacts and reduce the noise in the video data.• The driver may capture images in slices like a scanner in order to handle larger format images than would otherwise be possible.• An image capture operation may be significantly slower than motion capture.• Moving objects in the image might have excessive motion blur.• Capture might only work through the <code>read()</code> call.
-----------------------	--------	---

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

This `ioctl` is not supported.

`ioctl` `VIDIOC_G_PRIORITY`, `VIDIOC_S_PRIORITY`

Name

`VIDIOC_G_PRIORITY`, `VIDIOC_S_PRIORITY` — Query or request the access priority associated with a file descriptor

Synopsis

```
int ioctl(int fd, int request, enum v4l2_priority *argp);
```

```
int ioctl(int fd, int request, const enum v4l2_priority  
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_G_PRIORITY`, `VIDIOC_S_PRIORITY`

argp

Pointer to an enum `v4l2_priority` type.

Description

To query the current access priority applications call the `VIDIOC_G_PRIORITY` ioctl with a pointer to an enum `v4l2_priority` variable where the driver stores the current priority.

To request an access priority applications store the desired priority in an enum `v4l2_priority` variable and call `VIDIOC_S_PRIORITY` ioctl with a pointer to this variable.

Table A-1. enum `v4l2_priority`

<code>V4L2_PRIORITY_UNSET</code>	0	
<code>V4L2_PRIORITY_BACKGROUND</code>	1	Lowest priority, usually applications running in background, for example monitoring VBI transmissions. A proxy application running in user space will be necessary if multiple applications want to read from a device at this priority.
<code>V4L2_PRIORITY_INTERACTIVE</code>	2	
<code>V4L2_PRIORITY_DEFAULT</code>	2	Medium priority, usually applications started and interactively controlled by the user. For example TV viewers, Teletext browsers, or just "panel" applications to change the channel or video controls. This is the default priority unless an application requests another.
<code>V4L2_PRIORITY_RECORD</code>	3	Highest priority. Only one file descriptor can have this priority, it blocks any other fd from changing device properties. Usually applications which must not be interrupted, like video recording.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The requested priority value is invalid, or the driver does not support access priorities.

EBUSY

Another application already requested higher priority.

ioctl VIDIOC_G_SLICED_VBI_CAP

Name

VIDIOC_G_SLICED_VBI_CAP — Query sliced VBI capabilities

Synopsis

```
int ioctl(int fd, int request, struct v4l2_sliced_vbi_cap
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_SLICED_VBI_CAP

argp

Description

To find out which data services are supported by a sliced VBI capture or output device, applications initialize the *type* field of a struct `v4l2_sliced_vbi_cap`, clear the *reserved* array and call the `VIDIOC_G_SLICED_VBI_CAP` ioctl. The driver fills in the remaining fields or returns an `EINVAL` error code if the sliced VBI API is unsupported or *type* is invalid.

Note the *type* field was added, and the ioctl changed from read-only to write-read, in Linux 2.6.19.

Table A-1. struct `v4l2_sliced_vbi_cap`

__u16	service_set	A set of all data services supported by the driver. Equal to the union of all elements of the <i>service_lines</i> array.	
__u16	service_lines[256]	Each element of this array contains a set of data services the hardware can look for or insert into a particular scan line. Data services are defined in Table A-2. Array indices map to ITU-R line numbers (see also Figure 4-2 and Figure 4-3) as follows:	
	Element	525 line systems	625 line systems
	service_lines[0][1]		1
	service_lines[0][23]		23
	service_lines[16][1]		314
	service_lines[16][23]		336

The number of VBI lines the hardware can capture or output per frame, or the number of services it can identify on a given line may be limited. For example on PAL line 16 the hardware may be able to look for a VPS or Teletext signal, but not both at the same time. Applications can learn about these limits using the `VIDIOC_S_FMT` ioctl as described in Section 4.8.

Drivers must set `service_lines[0][0]` and `service_lines[1][0]` to zero.

`enum v4l2_buf_type` *type*

Type of the data stream, see Table 3-3. Should be `V4L2_BUF_TYPE_SLICED_VBI_CAPTURE` or `V4L2_BUF_TYPE_SLICED_VBI_OUTPUT`.

`__u32` *reserved[3]*

This array is reserved for future extensions. Applications and drivers must set it to zero.

Table A-2. Sliced VBI services

Symbol	Value	Reference	Lines, usually	Payload
<code>V4L2_SLICED_TELETEXT</code> (Teletext System B)	<code>0x0001B</code>	ETS 300 704, ITU BT.657	PAL/SECAM line 22, 320-335 (second field 7-22)	Last 42 of the 45 byte Teletext packet, that is without clock run-in and framing code, lsb first transmitted.

Symbol	Value	Reference	Lines, usually	Payload
V4L2_SLICED_VPS	0x0400	ETS 300 231	PAL line 16	Byte number 3 to 15 according to Figure 9 of ETS 300 231, lsb first transmitted.
V4L2_SLICED_CAPTION	0x1000	EIA 608-B	NTSC line 21, 284 (second field 21)	Two bytes in transmission order, including parity bit, lsb first transmitted.
V4L2_SLICED_WSS	0x2000	EN 300 291	PAL/SECAM line 129	<div> <div>Byte</div> <div>msb</div> <div>0</div> <div>lsb</div> <div>msb</div> </div> <div> <div>Bit</div> <div>7</div> <div>6</div> <div>5</div> <div>4</div> <div>3</div> <div>2</div> <div>1</div> <div>0</div> <div>x</div> <div>x</div> </div>
V4L2_SLICED_VBI_525	0x4000	Set of services applicable to 525 line systems.		
V4L2_SLICED_VBI_625	0x4100	Set of services applicable to 625 line systems.		

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The device does not support sliced VBI capturing or output, or the value in the `type` field is wrong.

ioctl VIDIOC_G_STD, VIDIOC_S_STD

Name

VIDIOC_G_STD, VIDIOC_S_STD — Query or select the video standard of the current input

Synopsis

```
int ioctl(int fd, int request, v4l2_std_id *argp);
```

```
int ioctl(int fd, int request, const v4l2_std_id *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_STD, VIDIOC_S_STD

argp

Description

To query and select the current video standard applications use the VIDIOC_G_STD and VIDIOC_S_STD ioctls which take a pointer to a `v4l2_std_id` type as argument. VIDIOC_G_STD can return a single flag or a set of flags as in struct `v4l2_standard` field *id*. The flags must be unambiguous such that they appear in only one enumerated `v4l2_standard` structure.

VIDIOC_S_STD accepts one or more flags, being a write-only ioctl it does not return the actual new standard as VIDIOC_G_STD does. When no flags are given or the current input does not support the requested standard the driver returns an EINVAL error code. When the standard set is ambiguous drivers may return EINVAL or choose any of the requested standards.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

This ioctl is not supported, or the VIDIOC_S_STD parameter was unsuitable.

EBUSY

The device is busy and therefore can not change the standard

ioctl VIDIOC_G_TUNER, VIDIOC_S_TUNER

Name

VIDIOC_G_TUNER, VIDIOC_S_TUNER — Get or set tuner attributes

Synopsis

```
int ioctl(int fd, int request, struct v4l2_tuner *argp);
```

```
int ioctl(int fd, int request, const struct v4l2_tuner *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_TUNER, VIDIOC_S_TUNER

argp

Description

To query the attributes of a tuner applications initialize the *index* field and zero out the *reserved* array of a struct `v4l2_tuner` and call the `VIDIOC_G_TUNER` ioctl with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code when the index is out of bounds. To enumerate all tuners applications shall begin at index zero, incrementing by one until the driver returns `EINVAL`.

Tuners have two writable properties, the audio mode and the radio frequency. To change the audio mode, applications initialize the *index*, *audmode* and *reserved* fields and call the `VIDIOC_S_TUNER` ioctl. This will *not* change the current tuner, which is determined by the current video input. Drivers may choose a different audio mode if the requested mode is invalid or unsupported. Since this is a write-only ioctl, it does not return the actually selected audio mode.

To change the radio frequency the `VIDIOC_S_FREQUENCY` ioctl is available.

Table A-1. struct v4l2_tuner

<code>__u32</code>	<i>index</i>	Identifies the tuner, set by the application.
<code>__u8</code>	<i>name</i> [32]	Name of the tuner, a NUL-terminated ASCII string. This information is intended for the user.
<code>enum v4l2_tuner_type</code>	<i>type</i>	Type of the tuner, see Table A-2.
<code>__u32</code>	<i>capability</i>	Tuner capability flags, see Table A-3. Audio flags indicate the ability to decode audio subprograms. They will <i>not</i> change, for example with the current video standard. When the structure refers to a radio tuner only the <code>V4L2_TUNER_CAP_LOW</code> , <code>V4L2_TUNER_CAP_STEREO</code> and <code>V4L2_TUNER_CAP_RDS</code> flags can be set.
<code>__u32</code>	<i>rangelow</i>	The lowest tunable frequency in units of 62.5 kHz, or if the <i>capability</i> flag <code>V4L2_TUNER_CAP_LOW</code> is set, in units of 62.5 Hz.

Appendix A. Function Reference

<code>__u32</code>	<code>rangehigh</code>	The highest tunable frequency in units of 62.5 kHz, or if the <i>capability</i> flag <code>V4L2_TUNER_CAP_LOW</code> is set, in units of 62.5 Hz.
<code>__u32</code>	<code>rxsubchans</code>	<p>Some tuners or audio decoders can determine the received audio subprograms by analyzing audio carriers, pilot tones or other indicators. To pass this information drivers set flags defined in Table A-4 in this field. For example:</p> <p><code>V4L2_TUNER_SUB_MONO</code> receiving mono audio</p> <p><code>STEREO SAP</code> receiving stereo audio and a secondary audio program</p> <p><code>MONO STEREO</code> receiving mono or stereo audio, the hardware cannot distinguish</p> <p><code>LANG1 LANG2</code> receiving bilingual audio</p> <p><code>MONO STEREO LANG1 LANG2</code> receiving mono, stereo or bilingual audio</p> <p>When the <code>V4L2_TUNER_CAP_STEREO</code>, <code>_LANG1</code>, <code>_LANG2</code> or <code>_SAP</code> flag is cleared in the <i>capability</i> field, the corresponding <code>V4L2_TUNER_SUB_</code> flag must not be set here.</p> <p>This field is valid only if this is the tuner of the current video input, or when the structure refers to a radio tuner.</p>

<code>__u32</code>	<i>audmode</i>	The selected audio mode, see Table A-5 for valid values. The audio mode does not affect audio subprogram detection, and like a control it does not automatically change unless the requested mode is invalid or unsupported. See Table A-6 for possible results when the selected and received audio programs do not match. Currently this is the only field of struct <code>v4l2_tuner</code> applications can change.
<code>__u32</code>	<i>signal</i>	The signal strength if known, ranging from 0 to 65535. Higher values indicate a better signal.
<code>__s32</code>	<i>afc</i>	Automatic frequency control: When the <i>afc</i> value is negative, the frequency is too low, when positive too high.
<code>__u32</code>	<i>reserved[4]</i>	Reserved for future extensions. Drivers and applications must set the array to zero.

Table A-2. enum `v4l2_tuner_type`

<code>V4L2_TUNER_RADIO</code>	1
<code>V4L2_TUNER_ANALOG_TV</code>	2

Table A-3. Tuner and Modulator Capability Flags

<code>V4L2_TUNER_CAP_LOW</code>	0x0001	When set, tuning frequencies are expressed in units of 62.5 Hz, otherwise in units of 62.5 kHz.
---------------------------------	--------	---

Appendix A. Function Reference

V4L2_TUNER_CAP_NORM	0x0002	This is a multi-standard tuner; the video standard can or must be switched. (B/G PAL tuners for example are typically not considered multi-standard because the video standard is automatically determined from the frequency band.) The set of supported video standards is available from the struct <code>v4l2_input</code> pointing to this tuner, see the description of <code>ioctl VIDIOC_ENUMINPUT</code> for details. Only <code>V4L2_TUNER_ANALOG_TV</code> tuners can have this capability.
V4L2_TUNER_CAP_STEREO	0x0010	Stereo audio reception is supported.
V4L2_TUNER_CAP_LANG1	0x0040	Reception of the primary language of a bilingual audio program is supported. Bilingual audio is a feature of two-channel systems, transmitting the primary language monaural on the main audio carrier and a secondary language monaural on a second carrier. Only <code>V4L2_TUNER_ANALOG_TV</code> tuners can have this capability.
V4L2_TUNER_CAP_LANG2	0x0020	Reception of the secondary language of a bilingual audio program is supported. Only <code>V4L2_TUNER_ANALOG_TV</code> tuners can have this capability.

V4L2_TUNER_CAP_SAP	0x0020	<p>Reception of a secondary audio program is supported. This is a feature of the BTSC system which accompanies the NTSC video standard. Two audio carriers are available for mono or stereo transmissions of a primary language, and an independent third carrier for a monaural secondary language. Only</p> <p>V4L2_TUNER_ANALOG_TV tuners can have this capability.</p> <p>Note the V4L2_TUNER_CAP_LANG2 and V4L2_TUNER_CAP_SAP flags are synonyms. V4L2_TUNER_CAP_SAP applies when the tuner supports the V4L2_STD_NTSC_M video standard.</p>
V4L2_TUNER_CAP_RDS	0x0080	<p>RDS capture is supported. This capability is only valid for radio tuners.</p>

Table A-4. Tuner Audio Reception Flags

V4L2_TUNER_SUB_MONO	0x0001	The tuner receives a mono audio signal.
V4L2_TUNER_SUB_STEREO	0x0002	The tuner receives a stereo audio signal.
V4L2_TUNER_SUB_LANG1	0x0008	The tuner receives the primary language of a bilingual audio signal. Drivers must clear this flag when the current video standard is V4L2_STD_NTSC_M.
V4L2_TUNER_SUB_LANG2	0x0004	The tuner receives the secondary language of a bilingual audio signal (or a second audio program).
V4L2_TUNER_SUB_SAP	0x0004	<p>The tuner receives a Second Audio Program. Note the</p> <p>V4L2_TUNER_SUB_LANG2 and V4L2_TUNER_SUB_SAP flags are synonyms. The V4L2_TUNER_SUB_SAP flag applies when the current video standard is V4L2_STD_NTSC_M.</p>
V4L2_TUNER_SUB_RDS	0x0010	The tuner receives an RDS channel.

Table A-5. Tuner Audio Modes

V4L2_TUNER_MODE_MONO	0	Play mono audio. When the tuner receives a stereo signal this a down-mix of the left and right channel. When the tuner receives a bilingual or SAP signal this mode selects the primary language.
V4L2_TUNER_MODE_STEREO	1	Play stereo audio. When the tuner receives bilingual audio it may play different languages on the left and right channel or the primary language is played on both channels. Playing different languages in this mode is deprecated. New drivers should do this only in <code>MODE_LANG1_LANG2</code> . When the tuner receives no stereo signal or does not support stereo reception the driver shall fall back to <code>MODE_MONO</code> .
V4L2_TUNER_MODE_LANG1	3	Play the primary language, mono or stereo. Only <code>V4L2_TUNER_ANALOG_TV</code> tuners support this mode.
V4L2_TUNER_MODE_LANG2	2	Play the secondary language, mono. When the tuner receives no bilingual audio or SAP, or their reception is not supported the driver shall fall back to mono or stereo mode. Only <code>V4L2_TUNER_ANALOG_TV</code> tuners support this mode.
V4L2_TUNER_MODE_SAP	2	Play the Second Audio Program. When the tuner receives no bilingual audio or SAP, or their reception is not supported the driver shall fall back to mono or stereo mode. Only <code>V4L2_TUNER_ANALOG_TV</code> tuners support this mode. Note the <code>V4L2_TUNER_MODE_LANG2</code> and <code>V4L2_TUNER_MODE_SAP</code> are synonyms.

V4L2_TUNER_MODE_LANG1_LANG2^a Play the primary language on the left channel, the secondary language on the right channel. When the tuner receives no bilingual audio or SAP, it shall fall back to `MODE_LANG1` or `MODE_MONO`. Only `V4L2_TUNER_ANALOG_TV` tuners support this mode.

Table A-6. Tuner Audio Matrix

	Selected <code>V4L2_TUNER_MODE_</code>				
Received <code>V4L2_TUNER_SUB_</code>	MONO	STEREO	LANG1	LANG2 = SAP	LANG1_LANG2^a
MONO	Mono	Mono/Mono	Mono	Mono	Mono/Mono
MONO SAP	Mono	Mono/Mono	Mono	SAP	Mono/SAP (preferred) or Mono/Mono
STEREO	L+R	L/R	Stereo L/R (preferred) or Mono L+R	Stereo L/R (preferred) or Mono L+R	L/R (preferred) or L+R/L+R
STEREO SAP	L+R	L/R	Stereo L/R (preferred) or Mono L+R	SAP	L+R/SAP (preferred) or L/R or L+R/L+R
LANG1 LANG2	Language 1	Lang1/Lang2 (depre- cated ^b) or Lang1/Lang1	Language 1	Language 2	Lang1/Lang2 (preferred) or Lang1/Lang1

Notes:

- a. This mode has been added in Linux 2.6.17 and may not be supported by older drivers.
- b. Playback of both languages in `MODE_STEREO` is deprecated. In the future drivers should produce only the primary language in this mode. Applications should request `MODE_LANG1_LANG2` to record both languages or a stereo signal.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The struct `v4l2_tuner` *index* is out of bounds.

ioctl VIDIOC_LOG_STATUS

Name

`VIDIOC_LOG_STATUS` — Log driver status information

Synopsis

```
int ioctl(int fd, int request);
```

Description

As the video/audio devices become more complicated it becomes harder to debug problems. When this `ioctl` is called the driver will output the current device status to the kernel log. This is particular useful when dealing with problems like no sound, no video and incorrectly tuned channels. Also many modern devices autodetect video and audio standards and this `ioctl` will report what the device thinks what the standard is. Mismatches may give an indication where the problem is.

This `ioctl` is optional and not all drivers support it. It was introduced in Linux 2.6.15.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The driver does not support this ioctl.

ioctl VIDIOC_OVERLAY

Name

VIDIOC_OVERLAY — Start or stop video overlay

Synopsis

```
int ioctl(int fd, int request, const int *argp);
```

Arguments

*fd*File descriptor returned by `open()`.*request*

VIDIOC_OVERLAY

argp

Description

This ioctl is part of the **video overlay I/O** method. Applications call VIDIOC_OVERLAY to start or stop the overlay. It takes a pointer to an integer which must be set to zero by the application to stop overlay, to one to start.

Drivers do not support VIDIOC_STREAMON or VIDIOC_STREAMOFF with V4L2_BUF_TYPE_VIDEO_OVERLAY.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

Video overlay is not supported, or the parameters have not been set up. See Section 4.2 for the necessary steps.

ioctl VIDIOC_QBUF, VIDIOC_DQBUF

Name

`VIDIOC_QBUF`, `VIDIOC_DQBUF` — Exchange a buffer with the driver

Synopsis

```
int ioctl(int fd, int request, struct v4l2_buffer *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_QBUF`, `VIDIOC_DQBUF`

argp

Description

Applications call the `VIDIOC_QBUF` ioctl to enqueue an empty (capturing) or filled (output) buffer in the driver's incoming queue. The semantics depend on the selected I/O method.

To enqueue a buffer applications set the *type* field of a struct `v4l2_buffer` to the same buffer type as was previously used with struct `v4l2_format` *type* and struct `v4l2_requestbuffers` *type*. Applications must also set the *index* field. Valid index numbers range from zero to the number of buffers allocated with `VIDIOC_REQBUFS` (struct `v4l2_requestbuffers` *count*) minus one. The contents of the struct `v4l2_buffer` returned by a `VIDIOC_QUERYBUF` ioctl will do as well. When the buffer is intended for output (*type* is `V4L2_BUF_TYPE_VIDEO_OUTPUT`, `V4L2_BUF_TYPE_VIDEO_OUTPUT_MPLANE`, or `V4L2_BUF_TYPE_VBI_OUTPUT`) applications must also initialize the *bytesused*, *field* and *timestamp* fields, see Section 3.5 for details. Applications must also set *flags* to 0. If a driver supports capturing from specific video inputs and you want to specify a video input, then *flags* should be set to `V4L2_BUF_FLAG_INPUT` and the field *input* must be initialized to the desired input. The *reserved* field must be set to 0. When using the multi-planar API, the *m.planes* field must contain a userspace pointer to a filled-in array of struct `v4l2_plane` and the *length* field must be set to the number of elements in that array.

To enqueue a memory mapped buffer applications set the *memory* field to `V4L2_MEMORY_MMAP`. When `VIDIOC_QBUF` is called with a pointer to this structure the driver sets the `V4L2_BUF_FLAG_MAPPED` and `V4L2_BUF_FLAG_QUEUED` flags and clears the `V4L2_BUF_FLAG_DONE` flag in the *flags* field, or it returns an `EINVAL` error code.

To enqueue a user pointer buffer applications set the *memory* field to `V4L2_MEMORY_USERPTR`, the *m.userptr* field to the address of the buffer and *length* to its size. When the multi-planar API is used, *m.userptr* and *length* members of the passed array of struct `v4l2_plane` have to be used instead. When `VIDIOC_QBUF` is called with a pointer to this structure the driver sets the `V4L2_BUF_FLAG_QUEUED` flag and clears the `V4L2_BUF_FLAG_MAPPED` and `V4L2_BUF_FLAG_DONE` flags in the *flags* field, or it returns an error code. This ioctl locks the memory pages of the buffer in physical memory, they cannot be swapped out to disk. Buffers remain locked until dequeued, until the `VIDIOC_STREAMOFF` or `VIDIOC_REQBUFS` ioctl is called, or until the device is closed.

Applications call the `VIDIOC_DQBUF` ioctl to dequeue a filled (capturing) or displayed (output) buffer from the driver's outgoing queue. They just set the *type*, *memory* and *reserved* fields of a struct `v4l2_buffer` as above, when `VIDIOC_DQBUF` is called with a pointer to this structure the driver fills the remaining fields or returns an error code. The driver may also set

`V4L2_BUF_FLAG_ERROR` in the *flags* field. It indicates a non-critical (recoverable) streaming error. In such case the application may continue as normal, but should be aware that data in the dequeued buffer might be corrupted. When using the multi-planar API, the *planes* array does not have to be passed; the *m.planes* member must be set to `NULL` in that case.

By default `VIDIOC_DQBUF` blocks when no buffer is in the outgoing queue. When the `O_NONBLOCK` flag was given to the `open()` function, `VIDIOC_DQBUF` returns immediately with an `EAGAIN` error code when no buffer is available.

The `v4l2_buffer` structure is specified in Section 3.5.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EAGAIN

Non-blocking I/O has been selected using `O_NONBLOCK` and no buffer was in the outgoing queue.

EINVAL

The buffer *type* is not supported, or the *index* is out of bounds, or no buffers have been allocated yet, or the *userptr* or *length* are invalid.

ENOMEM

Not enough physical or virtual memory was available to enqueue a user pointer buffer.

EIO

`VIDIOC_DQBUF` failed due to an internal error. Can also indicate temporary problems like signal loss. Note the driver might dequeue an (empty) buffer despite returning an error, or even stop capturing. Reusing such buffer may be unsafe though and its details (e.g. *index*) may not be returned either. It is recommended that drivers indicate recoverable errors by setting the `V4L2_BUF_FLAG_ERROR` and returning 0 instead. In that case the application should be able to safely reuse the buffer and continue streaming.

ioctl VIDIOC_QUERYBUF

Name

VIDIOC_QUERYBUF — Query the status of a buffer

Synopsis

```
int ioctl(int fd, int request, struct v4l2_buffer *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_QUERYBUF

argp

Description

This `ioctl` is part of the memory mapping I/O method. It can be used to query the status of a buffer at any time after buffers have been allocated with the `VIDIOC_REQBUFS` `ioctl`.

Applications set the *type* field of a struct `v4l2_buffer` to the same buffer type as was previously used with struct `v4l2_format` *type* and struct `v4l2_requestbuffers` *type*, and the *index* field. Valid index numbers range from zero to the number of buffers allocated with `VIDIOC_REQBUFS` (struct `v4l2_requestbuffers` *count*) minus one. The *reserved* field should be set to 0. When using the multi-planar API, the *m.planes* field must contain a userspace pointer to an array of struct `v4l2_plane` and the *length* field has to be set to the number of elements in that array. After

calling `VIDIOC_QUERYBUF` with a pointer to this structure drivers return an error code or fill the rest of the structure.

In the *flags* field the `V4L2_BUF_FLAG_MAPPED`, `V4L2_BUF_FLAG_QUEUED` and `V4L2_BUF_FLAG_DONE` flags will be valid. The *memory* field will be set to the current I/O method. For the single-planar API, the *m.offset* contains the offset of the buffer from the start of the device memory, the *length* field its size. For the multi-planar API, fields *m.mem_offset* and *length* in the *m.planes* array elements will be used instead. The driver may or may not set the remaining fields and flags, they are meaningless in this context.

The `v4l2_buffer` structure is specified in Section 3.5.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The buffer *type* is not supported, or the *index* is out of bounds.

ioctl VIDIOC_QUERYCAP

Name

`VIDIOC_QUERYCAP` — Query device capabilities

Synopsis

```
int ioctl(int fd, int request, struct v4l2_capability *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_QUERYCAP`

argp

Description

All V4L2 devices support the `VIDIOC_QUERYCAP` ioctl. It is used to identify kernel devices compatible with this specification and to obtain information about driver and hardware capabilities. The ioctl takes a pointer to a struct `v4l2_capability` which is filled by the driver. When the driver is not compatible with this specification the ioctl returns an `EINVAL` error code.

Table A-1. struct v4l2_capability

<code>__u8</code>	<code>driver[16]</code>	Name of the driver, a unique NUL-terminated ASCII string. For example: "bttv". Driver specific applications can use this information to verify the driver identity. It is also useful to work around known bugs, or to identify drivers in error reports. The driver version is stored in the <i>version</i> field. Storing strings in fixed sized arrays is bad practice but unavoidable here. Drivers and applications should take precautions to never read or write beyond the end of the array and to make sure the strings are properly NUL-terminated.
-------------------	-------------------------	--

<code>__u8</code>	<code>card[32]</code>	Name of the device, a NUL-terminated ASCII string. For example: "Yoyodyne TV/FM". One driver may support different brands or models of video hardware. This information is intended for users, for example in a menu of available devices. Since multiple TV cards of the same brand may be installed which are supported by the same driver, this name should be combined with the character device file name (e. g. <code>/dev/video2</code>) or the <code>bus_info</code> string to avoid ambiguities.
<code>__u8</code>	<code>bus_info[32]</code>	Location of the device in the system, a NUL-terminated ASCII string. For example: "PCI Slot 4". This information is intended for users, to distinguish multiple identical devices. If no such information is available the field may simply count the devices controlled by the driver, or contain the empty string (<code>bus_info[0] = 0</code>).
<code>__u32</code>	<code>version</code>	Version number of the driver. Together with the <code>driver</code> field this identifies a particular driver. The version number is formatted using the <code>KERNEL_VERSION()</code> macro:
<pre>#define KERNEL_VERSION(a,b,c) (((a) << 16) + ((b) << 8) + (c)) __u32 version = KERNEL_VERSION(0, 8, 1); printf ("Version: %u.%u.%u\n", (version >> 16) & 0xFF, (version >> 8) & 0xFF, version & 0xFF);</pre>		
<code>__u32</code>	<code>capabilities</code>	Device capabilities, see Table A-2.
<code>__u32</code>	<code>reserved[4]</code>	Reserved for future extensions. Drivers must set this array to zero.

Table A-2. Device Capabilities Flags

V4L2_CAP_VIDEO_CAPTURE	0x00000000	The device supports the single-planar API through the Video Capture interface.
V4L2_CAP_VIDEO_CAPTURE_MPLANE	0x00000010	The device supports the multi-planar API through the Video Capture interface.
V4L2_CAP_VIDEO_OUTPUT	0x00000000	The device supports the single-planar API through the Video Output interface.
V4L2_CAP_VIDEO_OUTPUT_MPLANE	0x00000020	The device supports the multi-planar API through the Video Output interface.
V4L2_CAP_VIDEO_OVERLAY	0x00000000	The device supports the Video Overlay interface. A video overlay device typically stores captured images directly in the video memory of a graphics card, with hardware clipping and scaling.
V4L2_CAP_VBI_CAPTURE	0x00000000	The device supports the Raw VBI Capture interface, providing Teletext and Closed Caption data.
V4L2_CAP_VBI_OUTPUT	0x00000020	The device supports the Raw VBI Output interface.
V4L2_CAP_SLICED_VBI_CAPTURE	0x00000040	The device supports the Sliced VBI Capture interface.
V4L2_CAP_SLICED_VBI_OUTPUT	0x00000080	The device supports the Sliced VBI Output interface.
V4L2_CAP_RDS_CAPTURE	0x00000100	The device supports the RDS capture interface.
V4L2_CAP_VIDEO_OUTPUT_OVERLAY	0x00000200	The device supports the Video Output Overlay (OSD) interface. Unlike the <i>Video Overlay</i> interface, this is a secondary function of video output devices and overlays an image onto an outgoing video signal. When the driver sets this flag, it must clear the V4L2_CAP_VIDEO_OVERLAY flag and vice versa. ^a
V4L2_CAP_HW_FREQ_SEEK	0x00000400	The device supports the VIDIOC_S_HW_FREQ_SEEK ioctl for hardware frequency seeking.
V4L2_CAP_RDS_OUTPUT	0x00000800	The device supports the RDS output interface.

Appendix A. Function Reference

V4L2_CAP_TUNER	0x00010000	The device has some sort of tuner to receive RF-modulated video signals. For more information about tuner programming see Section 1.6.
V4L2_CAP_AUDIO	0x00020000	The device has audio inputs or outputs. It may or may not support audio recording or playback, in PCM or compressed formats. PCM audio support must be implemented as ALSA or OSS interface. For more information on audio inputs and outputs see Section 1.5.
V4L2_CAP_RADIO	0x00040000	This is a radio receiver.
V4L2_CAP_MODULATOR	0x00080000	The device has some sort of modulator to emit RF-modulated video/audio signals. For more information about modulator programming see Section 1.6.
V4L2_CAP_READWRITE	0x01000000	The device supports the <code>read()</code> and/or <code>write()</code> I/O methods.
V4L2_CAP_ASYNCIO	0x02000000	The device supports the asynchronous I/O methods.
V4L2_CAP_STREAMING	0x04000000	The device supports the streaming I/O method.

Notes:

- a. The struct `v4l2_framebuffer` lacks an enum `v4l2_buf_type` field, therefore the type of overlay is implied by the driver capabilities.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The device is not compatible with this specification.

ioctl VIDIOC_QUERYCTRL,

VIDIOC_QUERYMENU

Name

VIDIOC_QUERYCTRL, VIDIOC_QUERYMENU — Enumerate controls and menu control items

Synopsis

```
int ioctl(int fd, int request, struct v4l2_queryctrl *argp);
```

```
int ioctl(int fd, int request, struct v4l2_querymenu *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_QUERYCTRL, VIDIOC_QUERYMENU

argp

Description

To query the attributes of a control applications set the *id* field of a struct `v4l2_queryctrl` and call the `VIDIOC_QUERYCTRL` `ioctl` with a pointer to this structure. The driver fills the rest of the structure or returns an `EINVAL` error code when the *id* is invalid.

It is possible to enumerate controls by calling `VIDIOC_QUERYCTRL` with successive *id* values starting from `V4L2_CID_BASE` up to and exclusive `V4L2_CID_BASE_LASTP1`. Drivers may return `EINVAL` if a control in this range is

Appendix A. Function Reference

not supported. Further applications can enumerate private controls, which are not defined in this specification, by starting at `V4L2_CID_PRIVATE_BASE` and incrementing *id* until the driver returns `EINVAL`.

In both cases, when the driver sets the `V4L2_CTRL_FLAG_DISABLED` flag in the *flags* field this control is permanently disabled and should be ignored by the application.¹

When the application ORs *id* with `V4L2_CTRL_FLAG_NEXT_CTRL` the driver returns the next supported control, or `EINVAL` if there is none. Drivers which do not support this flag yet always return `EINVAL`.

Additional information is required for menu controls: the names of the menu items. To query them applications set the *id* and *index* fields of struct `v4l2_querymenu` and call the `VIDIOC_QUERYMENU` ioctl with a pointer to this structure. The driver fills the rest of the structure or returns an `EINVAL` error code when the *id* or *index* is invalid. Menu items are enumerated by calling `VIDIOC_QUERYMENU` with successive *index* values from struct `v4l2_queryctrl` *minimum* to *maximum*, inclusive. Note that it is possible for `VIDIOC_QUERYMENU` to return an `EINVAL` error code for some indices between *minimum* and *maximum*. In that case that particular menu item is not supported by this driver. Also note that the *minimum* value is not necessarily 0.

See also the examples in Section 1.8.

Table A-1. struct `v4l2_queryctrl`

<code>__u32</code>	<i>id</i>	Identifies the control, set by the application. See Table 1-1 for predefined IDs. When the ID is ORed with <code>V4L2_CTRL_FLAG_NEXT_CTRL</code> the driver clears the flag and returns the first control with a higher ID. Drivers which do not support this flag yet always return an <code>EINVAL</code> error code.
<code>enum v4l2_ctrl_type</code>	<i>type</i>	Type of control, see Table A-3.
<code>__u8</code>	<i>name</i> [32]	Name of the control, a NUL-terminated ASCII string. This information is intended for the user.

<code>__s32</code>	<i>minimum</i>	<p>Minimum value, inclusive. This field gives a lower bound for <code>V4L2_CTRL_TYPE_INTEGER</code> controls and the lowest valid index for <code>V4L2_CTRL_TYPE_MENU</code> controls. For <code>V4L2_CTRL_TYPE_STRING</code> controls the minimum value gives the minimum length of the string. This length <i>does not include the terminating zero</i>. It may not be valid for any other type of control, including <code>V4L2_CTRL_TYPE_INTEGER64</code> controls. Note that this is a signed value.</p>
<code>__s32</code>	<i>maximum</i>	<p>Maximum value, inclusive. This field gives an upper bound for <code>V4L2_CTRL_TYPE_INTEGER</code> controls and the highest valid index for <code>V4L2_CTRL_TYPE_MENU</code> controls. For <code>V4L2_CTRL_TYPE_STRING</code> controls the maximum value gives the maximum length of the string. This length <i>does not include the terminating zero</i>. It may not be valid for any other type of control, including <code>V4L2_CTRL_TYPE_INTEGER64</code> controls. Note that this is a signed value.</p>

Appendix A. Function Reference

<code>__s32</code>	<code>step</code>	<p>This field gives a step size for <code>V4L2_CTRL_TYPE_INTEGER</code> controls. For <code>V4L2_CTRL_TYPE_STRING</code> controls this field refers to the string length that has to be a multiple of this step size. It may not be valid for any other type of control, including <code>V4L2_CTRL_TYPE_INTEGER64</code> controls.</p> <p>Generally drivers should not scale hardware control values. It may be necessary for example when the <i>name</i> or <i>id</i> imply a particular unit and the hardware actually accepts only multiples of said unit. If so, drivers must take care values are properly rounded when scaling, such that errors will not accumulate on repeated read-write cycles.</p> <p>This field gives the smallest change of an integer control actually affecting hardware. Often the information is needed when the user can change controls by keyboard or GUI buttons, rather than a slider. When for example a hardware register accepts values 0-511 and the driver reports 0-65535, step should be 128.</p> <p>Note that although signed, the step value is supposed to be always positive.</p>
<code>__s32</code>	<code>default_value</code>	<p>The default value of a <code>V4L2_CTRL_TYPE_INTEGER</code>, <code>_BOOLEAN</code> or <code>_MENU</code> control. Not valid for other types of controls. Drivers reset controls only when the driver is loaded, not later, in particular not when the <code>func-open</code>; is called.</p>
<code>__u32</code>	<code>flags</code>	<p>Control flags, see Table A-4.</p>

<code>__u32</code>	<code>reserved[2]</code>	Reserved for future extensions. Drivers must set the array to zero.
--------------------	--------------------------	---

Table A-2. struct v4l2_querymenu

<code>__u32</code>	<code>id</code>	Identifies the control, set by the application from the respective struct <code>v4l2_queryctrl</code> <code>id</code> .
<code>__u32</code>	<code>index</code>	Index of the menu item, starting at zero, set by the application.
<code>__u8</code>	<code>name[32]</code>	Name of the menu item, a NUL-terminated ASCII string. This information is intended for the user.
<code>__u32</code>	<code>reserved</code>	Reserved for future extensions. Drivers must set the array to zero.

Table A-3. enum v4l2_ctrl_type

Type	Description		
	<i>minimum</i>	<i>step</i>	<i>maximum</i>
<code>V4L2_CTRL_TYPE_INTEGER</code>	any	any	any
An integer-valued control ranging from minimum to maximum inclusive. The step value indicates the increment between values which are actually different on the hardware.			
<code>V4L2_CTRL_TYPE_BOOLEAN</code>	0	1	1
A boolean-valued control. Zero corresponds to "disabled", and one means "enabled".			
<code>V4L2_CTRL_TYPE_MENU</code>	≥ 0	1	N
The control has a menu of N choices. The names of the menu items can be enumerated with the <code>VIDIOC_QUERYMENU</code> ioctl.			
<code>V4L2_CTRL_TYPE_BUTTON</code>	0	0	0
A control which performs an action when set. Drivers must ignore the value passed with <code>VIDIOC_S_CTRL</code> and return an <code>EINVAL</code> error code on a <code>VIDIOC_G_CTRL</code> attempt.			
<code>V4L2_CTRL_TYPE_INTEGER64</code>	n/a	n/a	n/a
A 64-bit integer valued control. Minimum, maximum and step size cannot be queried.			

Type	Description		
	<i>minimum</i>	<i>step</i>	<i>maximum</i>
V4L2_CTRL_TYPE_STRING	\geq	\geq	The minimum and maximum string lengths.
0	1	0	The step size means that the string must be (minimum + N * step) characters long for N \geq 0. These lengths do not include the terminating zero, so in order to pass a string of length 8 to VIDIOC_S_EXT_CTRLs you need to set the <i>size</i> field of struct <code>v4l2_ext_control</code> to 9. For VIDIOC_G_EXT_CTRLs you can set the <i>size</i> field to <i>maximum</i> + 1. Which character encoding is used will depend on the string control itself and should be part of the control documentation.
V4L2_CTRL_TYPE_CTRL_CLASS	n/a	n/a	This is not a control. When VIDIOC_QUERYCTRL is called with a control ID equal to a control class code (see Table A-3) + 1, the ioctl returns the name of the control class and this control type. Older drivers which do not support this feature return an EINVAL error code.

Table A-4. Control Flags

V4L2_CTRL_FLAG_DISABLED	0x0001	This control is permanently disabled and should be ignored by the application. Any attempt to change the control will result in an EINVAL error code.
V4L2_CTRL_FLAG_GRABBED	0x0002	This control is temporarily unchangeable, for example because another application took over control of the respective resource. Such controls may be displayed specially in a user interface. Attempts to change the control may result in an EBUSY error code.
V4L2_CTRL_FLAG_READ_ONLY	0x0004	This control is permanently readable only. Any attempt to change the control will result in an EINVAL error code.

V4L2_CTRL_FLAG_UPDATE	0x0008	A hint that changing this control may affect the value of other controls within the same control class. Applications should update their user interface accordingly.
V4L2_CTRL_FLAG_INACTIVE	0x0010	This control is not applicable to the current configuration and should be displayed accordingly in a user interface. For example the flag may be set on a MPEG audio level 2 bitrate control when MPEG audio encoding level 1 was selected with another control.
V4L2_CTRL_FLAG_SLIDER	0x0020	A hint that this control is best represented as a slider-like element in a user interface.
V4L2_CTRL_FLAG_WRITE_ONLY	0x0040	This control is permanently writable only. Any attempt to read the control will result in an EACCES error code. This flag is typically present for relative controls or action controls where writing a value will cause the device to carry out a given action (e. g. motor control) but no meaningful value can be returned.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The struct `v4l2_queryctrl` *id* is invalid. The struct `v4l2_querymenu` *id* is invalid or *index* is out of range (less than *minimum* or greater than *maximum*) or this particular menu item is not supported by the driver.

EACCES

An attempt was made to read a write-only control.

Notes

1. `V4L2_CTRL_FLAG_DISABLED` was intended for two purposes: Drivers can skip predefined controls not supported by the hardware (although returning `EINVAL` would do as well), or disable predefined and private controls after hardware detection without the trouble of reordering control arrays and indices (`EINVAL` cannot be used to skip private controls because it would prematurely end the enumeration).

ioctl VIDIOC_QUERY_DV_PRESET

Name

`VIDIOC_QUERY_DV_PRESET` — Sense the DV preset received by the current input

Synopsis

```
int ioctl(int fd, int request, struct v4l2_dv_preset *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_QUERY_DV_PRESET`

argp

Description

The hardware may be able to detect the current DV preset automatically, similar to sensing the video standard. To do so, applications call

`VIDIOC_QUERY_DV_PRESET` with a pointer to a struct `v4l2_dv_preset` type. Once the hardware detects a preset, that preset is returned in the `preset` field of struct `v4l2_dv_preset`. If the preset could not be detected because there was no signal, or the signal was unreliable, or the signal did not map to a supported preset, then the value `V4L2_DV_INVALID` is returned.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

This `ioctl` is not supported.

`EBUSY`

The device is busy and therefore can not sense the preset

`ioctl VIDIOC_QUERYSTD`

Name

`VIDIOC_QUERYSTD` — Sense the video standard received by the current input

Synopsis

```
int ioctl(int fd, int request, v4l2_std_id *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_QUERYSTD

argp

Description

The hardware may be able to detect the current video standard automatically. To do so, applications call `VIDIOC_QUERYSTD` with a pointer to a `v4l2_std_id` type. The driver stores here a set of candidates, this can be a single flag or a set of supported standards if for example the hardware can only distinguish between 50 and 60 Hz systems. When detection is not possible or fails, the set must contain all standards supported by the current video input or output.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

This ioctl is not supported.

EBUSY

The device is busy and therefore can not detect the standard

ioctl VIDIOC_REQBUFS

Name

VIDIOC_REQBUFS — Initiate Memory Mapping or User Pointer I/O

Synopsis

```
int ioctl(int fd, int request, struct v4l2_requestbuffers
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_REQBUFS`

argp

Description

This `ioctl` is used to initiate **memory mapped or user pointer I/O**. Memory mapped buffers are located in device memory and must be allocated with this `ioctl` before they can be mapped into the application's address space. User buffers are allocated by applications themselves, and this `ioctl` is merely used to switch the driver into user pointer I/O mode and to setup some internal structures.

To allocate device buffers applications initialize all fields of the `v4l2_requestbuffers` structure. They set the *type* field to the respective stream or buffer type, the *count* field to the desired number of buffers, *memory* must be set to the requested I/O method and the *reserved* array must be zeroed. When the `ioctl` is called with a pointer to this structure the driver will attempt to allocate the requested number of buffers and it stores the actual number allocated in the *count* field. It can be smaller than the number requested, even zero, when the driver runs out of free memory. A larger number is also possible when the driver requires more buffers to function correctly. For example video output requires at least two buffers, one displayed and one filled by the application.

When the I/O method is not supported the `ioctl` returns an `EINVAL` error code.

Applications can call `VIDIOC_REQBUFS` again to change the number of buffers, however this cannot succeed when any buffers are still mapped. A *count* value of

Appendix A. Function Reference

zero frees all buffers, after aborting or finishing any DMA in progress, an implicit `VIDIOC_STREAMOFF`.

Table A-1. struct v4l2_requestbuffers

<code>__u32</code>	<code>count</code>	The number of buffers requested or granted.
<code>enum v4l2_buf_type</code>	<code>type</code>	Type of the stream or buffers, this is the same as the struct <code>v4l2_format</code> <code>type</code> field. See Table 3-3 for valid values.
<code>enum v4l2_memory</code>	<code>memory</code>	Applications set this field to <code>V4L2_MEMORY_MMAP</code> or <code>V4L2_MEMORY_USERPTR</code> .
<code>__u32</code>	<code>reserved[2]</code>	A place holder for future extensions and custom (driver defined) buffer types <code>V4L2_BUF_TYPE_PRIVATE</code> and higher. This array should be zeroed by applications.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EBUSY

The driver supports multiple opens and I/O is already in progress, or reallocation of buffers was attempted although one or more are still mapped.

EINVAL

The buffer type (`type` field) or the requested I/O method (`memory`) is not supported.

ioctl VIDIOC_S_HW_FREQ_SEEK

Name

`VIDIOC_S_HW_FREQ_SEEK` — Perform a hardware frequency seek

Synopsis

```
int ioctl(int fd, int request, struct v4l2_hw_freq_seek
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_S_HW_FREQ_SEEK`

argp

Description

Start a hardware frequency seek from the current frequency. To do this applications initialize the *tuner*, *type*, *seek_upward*, *spacing* and *wrap_around* fields, and zero out the *reserved* array of a struct `v4l2_hw_freq_seek` and call the `VIDIOC_S_HW_FREQ_SEEK ioctl` with a pointer to this structure.

This `ioctl` is supported if the `V4L2_CAP_HW_FREQ_SEEK` capability is set.

Table A-1. struct v4l2_hw_freq_seek

<code>__u32</code>	<i>tuner</i>	The tuner index number. This is the same value as in the struct <code>v4l2_input</code> <i>tuner</i> field and the struct <code>v4l2_tuner</code> <i>index</i> field.
<code>enum v4l2_tuner_type</code>	<i>type</i>	The tuner type. This is the same value as in the struct <code>v4l2_tuner</code> <i>type</i> field.
<code>__u32</code>	<i>seek_upward</i>	If non-zero, seek upward from the current frequency, else seek downward.
<code>__u32</code>	<i>wrap_around</i>	If non-zero, wrap around when at the end of the frequency range, else stop seeking.

<code>__u32</code>	<code>spacing</code>	If non-zero, defines the hardware seek resolution in Hz. The driver selects the nearest value that is supported by the device. If spacing is zero a reasonable default value is used.
<code>__u32</code>	<code>reserved[7]</code>	Reserved for future extensions. Drivers and applications must set the array to zero.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The `tuner` index is out of bounds or the value in the `type` field is wrong.

`EAGAIN`

The `ioctl` timed-out. Try again.

`ioctl` `VIDIOC_STREAMON`, `VIDIOC_STREAMOFF`

Name

`VIDIOC_STREAMON`, `VIDIOC_STREAMOFF` — Start or stop streaming I/O

Synopsis

```
int ioctl(int fd, int request, const int *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_STREAMON`, `VIDIOC_STREAMOFF`

argp

Description

The `VIDIOC_STREAMON` and `VIDIOC_STREAMOFF` `ioctl` start and stop the capture or output process during streaming (memory mapping or user pointer) I/O.

Specifically the capture hardware is disabled and no input buffers are filled (if there are any empty buffers in the incoming queue) until `VIDIOC_STREAMON` has been called. Accordingly the output hardware is disabled, no video signal is produced until `VIDIOC_STREAMON` has been called. The `ioctl` will succeed only when at least one output buffer is in the incoming queue.

The `VIDIOC_STREAMOFF` `ioctl`, apart of aborting or finishing any DMA in progress, unlocks any user pointer buffers locked in physical memory, and it removes all buffers from the incoming and outgoing queues. That means all images captured but not dequeued yet will be lost, likewise all images enqueued for output but not transmitted yet. I/O returns to the same state as after calling `VIDIOC_REQBUFS` and can be restarted accordingly.

Both `ioctl`s take a pointer to an integer, the desired buffer or stream type. This is the same as `struct v4l2_requestbuffers` *type*.

Note applications can be preempted for unknown periods right before or after the `VIDIOC_STREAMON` or `VIDIOC_STREAMOFF` calls, there is no notion of starting or stopping "now". Buffer timestamps can be used to synchronize with other events.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

Streaming I/O is not supported, the buffer *type* is not supported, or no buffers have been allocated (memory mapping) or enqueued (output) yet.

EPIPE

The driver implements pad-level format configuration and the pipeline configuration is invalid.

ioctl VID- IOC_SUBDEV_ENUM_FRAME_INTERVAL

Name

VIDIOC_SUBDEV_ENUM_FRAME_INTERVAL — Enumerate frame intervals

Synopsis

```
int ioctl(int fd, int request, struct  
v4l2_subdev_frame_interval_enum * argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_SUBDEV_ENUM_FRAME_INTERVAL

argp

Description

Experimental: This is an experimental interface and may change in the future.

This ioctl lets applications enumerate available frame intervals on a given sub-device pad. Frame intervals only makes sense for sub-devices that can control the frame period on their own. This includes, for instance, image sensors and TV tuners.

For the common use case of image sensors, the frame intervals available on the sub-device output pad depend on the frame format and size on the same pad. Applications must thus specify the desired format and size when enumerating frame intervals.

To enumerate frame intervals applications initialize the *index*, *pad*, *code*, *width* and *height* fields of struct `v4l2_subdev_frame_interval_enum` and call the `VIDIOC_SUBDEV_ENUM_FRAME_INTERVAL` ioctl with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code if one of the input fields is invalid. All frame intervals are enumerable by beginning at index zero and incrementing by one until `EINVAL` is returned.

Available frame intervals may depend on the current 'try' formats at other pads of the sub-device, as well as on the current active links. See `VIDIOC_SUBDEV_G_FMT` for more information about the try formats.

Sub-devices that support the frame interval enumeration ioctl should implemented it on a single pad only. Its behaviour when supported on multiple pads of the same sub-device is not defined.

Table A-1. struct v4l2_subdev_frame_interval_enum

<code>__u32</code>	<i>index</i>	Number of the format in the enumeration, set by the application.
<code>__u32</code>	<i>pad</i>	Pad number as reported by the media controller API.
<code>__u32</code>	<i>code</i>	The media bus format code, as defined in Section 4.13.4.
<code>__u32</code>	<i>width</i>	Frame width, in pixels.
<code>__u32</code>	<i>height</i>	Frame height, in pixels.
struct <code>v4l2_fract</code>	<i>interval</i>	Period, in seconds, between consecutive video frames.
<code>__u32</code>	<i>reserved[9]</i>	Reserved for future extensions. Applications and drivers must set the array to zero.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The struct `v4l2_subdev_frame_interval_enum` *pad* references a non-existing pad, one of the *code*, *width* or *height* fields are invalid for the given pad or the *index* field is out of bounds.

ioctl VIDIOC_SUBDEV_ENUM_FRAME_SIZE

Name

VIDIOC_SUBDEV_ENUM_FRAME_SIZE — Enumerate media bus frame sizes

Synopsis

```
int ioctl(int fd, int request, struct  
v4l2_subdev_frame_size_enum * argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_SUBDEV_ENUM_FRAME_SIZE

argp

Description

Experimental: This is an experimental interface and may change in the future.

This ioctl allows applications to enumerate all frame sizes supported by a sub-device on the given pad for the given media bus format. Supported formats can be retrieved with the `VIDIOC_SUBDEV_ENUM_MBUS_CODE` ioctl.

To enumerate frame sizes applications initialize the *pad*, *code* and *index* fields of the struct `v4l2_subdev_mbus_code_enum` and call the `VIDIOC_SUBDEV_ENUM_FRAME_SIZE` ioctl with a pointer to the structure. Drivers fill the minimum and maximum frame sizes or return an `EINVAL` error code if one of the input parameters is invalid.

Sub-devices that only support discrete frame sizes (such as most sensors) will return one or more frame sizes with identical minimum and maximum values.

Not all possible sizes in given [minimum, maximum] ranges need to be supported. For instance, a scaler that uses a fixed-point scaling ratio might not be able to produce every frame size between the minimum and maximum values. Applications must use the `VIDIOC_SUBDEV_S_FMT` ioctl to try the sub-device for an exact supported frame size.

Available frame sizes may depend on the current 'try' formats at other pads of the sub-device, as well as on the current active links and the current values of V4L2 controls. See `VIDIOC_SUBDEV_G_FMT` for more information about try formats.

Table A-1. struct v4l2_subdev_frame_size_enum

<code>__u32</code>	<i>index</i>	Number of the format in the enumeration, set by the application.
<code>__u32</code>	<i>pad</i>	Pad number as reported by the media controller API.
<code>__u32</code>	<i>code</i>	The media bus format code, as defined in Section 4.13.4.
<code>__u32</code>	<i>min_width</i>	Minimum frame width, in pixels.
<code>__u32</code>	<i>max_width</i>	Maximum frame width, in pixels.
<code>__u32</code>	<i>min_height</i>	Minimum frame height, in pixels.
<code>__u32</code>	<i>max_height</i>	Maximum frame height, in pixels.
<code>__u32</code>	<i>reserved[9]</i>	Reserved for future extensions. Applications and drivers must set the array to zero.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The struct `v4l2_subdev_frame_size_enum` *pad* references a non-existing pad, the *code* is invalid for the given pad or the *index* field is out of bounds.

ioctl VIDIOC_SUBDEV_ENUM_MBUS_CODE

Name

`VIDIOC_SUBDEV_ENUM_MBUS_CODE` — Enumerate media bus formats

Synopsis

```
int ioctl(int fd, int request, struct  
v4l2_subdev_mbus_code_enum * argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_SUBDEV_ENUM_MBUS_CODE`

argp

Description

Experimental: This is an experimental interface and may change in the future.

To enumerate media bus formats available at a given sub-device pad applications initialize the *pad* and *index* fields of struct `v4l2_subdev_mbus_code_enum` and call the `VIDIOC_SUBDEV_ENUM_MBUS_CODE` ioctl with a pointer to this structure. Drivers fill the rest of the structure or return an `EINVAL` error code if either the *pad* or *index* are invalid. All media bus formats are enumerable by beginning at index zero and incrementing by one until `EINVAL` is returned.

Available media bus formats may depend on the current 'try' formats at other pads of the sub-device, as well as on the current active links. See `VIDIOC_SUBDEV_G_FMT` for more information about the try formats.

Table A-1. struct `v4l2_subdev_mbus_code_enum`

<code>__u32</code>	<i>pad</i>	Pad number as reported by the media controller API.
<code>__u32</code>	<i>index</i>	Number of the format in the enumeration, set by the application.
<code>__u32</code>	<i>code</i>	The media bus format code, as defined in Section 4.13.4.
<code>__u32</code>	<i>reserved</i> [9]	Reserved for future extensions. Applications and drivers must set the array to zero.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The struct `v4l2_subdev_mbus_code_enum` *pad* references a non-existing pad, or the *index* field is out of bounds.

ioctl `VIDIOC_SUBDEV_G_CROP`,

VIDIOC_SUBDEV_S_CROP

Name

VIDIOC_SUBDEV_G_CROP, VIDIOC_SUBDEV_S_CROP — Get or set the crop rectangle on a subdev pad

Synopsis

```
int ioctl(int fd, int request, struct v4l2_subdev_crop *argp);
```

```
int ioctl(int fd, int request, const struct v4l2_subdev_crop *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_SUBDEV_G_CROP, VIDIOC_SUBDEV_S_CROP

argp

Description

Experimental: This is an experimental interface and may change in the future.

To retrieve the current crop rectangle applications set the *pad* field of a struct `v4l2_subdev_crop` to the desired pad number as reported by the media API and the *which* field to `V4L2_SUBDEV_FORMAT_ACTIVE`. They then call the

`VIDIOC_SUBDEV_G_CROP` ioctl with a pointer to this structure. The driver fills the members of the `rect` field or returns `EINVAL` error code if the input arguments are invalid, or if cropping is not supported on the given pad.

To change the current crop rectangle applications set both the `pad` and `which` fields and all members of the `rect` field. They then call the `VIDIOC_SUBDEV_S_CROP` ioctl with a pointer to this structure. The driver verifies the requested crop rectangle, adjusts it based on the hardware capabilities and configures the device. Upon return the struct `v4l2_subdev_crop` contains the current format as would be returned by a `VIDIOC_SUBDEV_G_CROP` call.

Applications can query the device capabilities by setting the `which` to `V4L2_SUBDEV_FORMAT_TRY`. When set, 'try' crop rectangles are not applied to the device by the driver, but are mangled exactly as active crop rectangles and stored in the sub-device file handle. Two applications querying the same sub-device would thus not interact with each other.

Drivers must not return an error solely because the requested crop rectangle doesn't match the device capabilities. They must instead modify the rectangle to match what the hardware can provide. The modified format should be as close as possible to the original request.

Table A-1. struct v4l2_subdev_crop

<code>__u32</code>	<code>pad</code>	Pad number as reported by the media framework.
<code>__u32</code>	<code>which</code>	Crop rectangle to get or set, from enum <code>v4l2_subdev_format_whence</code> .
<code>struct v4l2_rect</code>	<code>rect</code>	Crop rectangle boundaries, in pixels.
<code>__u32</code>	<code>reserved[8]</code>	Reserved for future extensions. Applications and drivers must set the array to zero.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EBUSY

The crop rectangle can't be changed because the pad is currently busy. This can be caused, for instance, by an active video stream on the pad. The ioctl must not be retried without performing another action to fix the problem first.

Only returned by `VIDIOC_SUBDEV_S_CROP`

EINVAL

The struct `v4l2_subdev_crop` *pad* references a non-existing pad, the *which* field references a non-existing format, or cropping is not supported on the given subdev pad.

ioctl VIDIOC_SUBDEV_G_FMT, VIDIOC_SUBDEV_S_FMT

Name

VIDIOC_SUBDEV_G_FMT, VIDIOC_SUBDEV_S_FMT — Get or set the data format on a subdev pad

Synopsis

```
int ioctl(int fd, int request, struct v4l2_subdev_format *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_SUBDEV_G_FMT, VIDIOC_SUBDEV_S_FMT

argp

Description

Experimental: This is an experimental interface and may change in the future.

These ioctls are used to negotiate the frame format at specific subdev pads in the image pipeline.

To retrieve the current format applications set the *pad* field of a struct `v4l2_subdev_format` to the desired pad number as reported by the media API and the *which* field to `V4L2_SUBDEV_FORMAT_ACTIVE`. When they call the `VIDIOC_SUBDEV_G_FMT` ioctl with a pointer to this structure the driver fills the members of the *format* field.

To change the current format applications set both the *pad* and *which* fields and all members of the *format* field. When they call the `VIDIOC_SUBDEV_S_FMT` ioctl with a pointer to this structure the driver verifies the requested format, adjusts it based on the hardware capabilities and configures the device. Upon return the struct `v4l2_subdev_format` contains the current format as would be returned by a `VIDIOC_SUBDEV_G_FMT` call.

Applications can query the device capabilities by setting the *which* to `V4L2_SUBDEV_FORMAT_TRY`. When set, 'try' formats are not applied to the device by the driver, but are changed exactly as active formats and stored in the sub-device file handle. Two applications querying the same sub-device would thus not interact with each other.

For instance, to try a format at the output pad of a sub-device, applications would first set the try format at the sub-device input with the `VIDIOC_SUBDEV_S_FMT` ioctl. They would then either retrieve the default format at the output pad with the `VIDIOC_SUBDEV_G_FMT` ioctl, or set the desired output pad format with the `VIDIOC_SUBDEV_S_FMT` ioctl and check the returned value.

Try formats do not depend on active formats, but can depend on the current links configuration or sub-device controls value. For instance, a low-pass noise filter might crop pixels at the frame boundaries, modifying its output frame size.

Drivers must not return an error solely because the requested format doesn't match the device capabilities. They must instead modify the format to match what the hardware can provide. The modified format should be as close as possible to the original request.

Table A-1. struct `v4l2_subdev_format`

<code>__u32</code>	<i>pad</i>	Pad number as reported by the media controller API.
--------------------	------------	---

<code>__u32</code>	<i>which</i>	Format to modified, from <code>enum v4l2_subdev_format_whence</code> .
<code>struct v4l2_mbus_framefmt</code>	<i>refmt</i>	Definition of an image format, see Table 4-19 for details.
<code>__u32</code>	<i>reserved[8]</i>	Reserved for future extensions. Applications and drivers must set the array to zero.

Table A-2. `enum v4l2_subdev_format_whence`

<code>V4L2_SUBDEV_FORMAT_TRY</code>	Try formats, used for querying device capabilities.
<code>V4L2_SUBDEV_FORMAT_ACTIVE</code>	Active formats, applied to the hardware.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EBUSY

The format can't be changed because the pad is currently busy. This can be caused, for instance, by an active video stream on the pad. The `ioctl` must not be retried without performing another action to fix the problem first. Only returned by `VIDIOC_SUBDEV_S_FMT`

EINVAL

The `struct v4l2_subdev_format` *pad* references a non-existing pad, or the *which* field references a non-existing format.

`ioctl` `VIDIOC_SUBDEV_G_FRAME_INTERVAL`, `VIDIOC_SUBDEV_S_FRAME_INTERVAL`

Name

`VIDIOC_SUBDEV_G_FRAME_INTERVAL`,
`VIDIOC_SUBDEV_S_FRAME_INTERVAL` — Get or set the frame interval on a subdev pad

Synopsis

```
int ioctl(int fd, int request, struct
v4l2_subdev_frame_interval *argp );
```

Arguments

fd

File descriptor returned by `open()`.

request

`VIDIOC_SUBDEV_G_FRAME_INTERVAL`,
`VIDIOC_SUBDEV_S_FRAME_INTERVAL`

argp

Description

Experimental: This is an experimental interface and may change in the future.

These `ioctl`s are used to get and set the frame interval at specific subdev pads in the image pipeline. The frame interval only makes sense for sub-devices that can control the frame period on their own. This includes, for instance, image sensors and TV tuners. Sub-devices that don't support frame intervals must not implement these `ioctl`s.

To retrieve the current frame interval applications set the *pad* field of a `struct v4l2_subdev_frame_interval` to the desired pad number as reported by the media controller API. When they call the `VIDIOC_SUBDEV_G_FRAME_INTERVAL`

`ioctl` with a pointer to this structure the driver fills the members of the `interval` field.

To change the current frame interval applications set both the `pad` field and all members of the `interval` field. When they call the `VIDIOC_SUBDEV_S_FRAME_INTERVAL` `ioctl` with a pointer to this structure the driver verifies the requested interval, adjusts it based on the hardware capabilities and configures the device. Upon return the struct `v4l2_subdev_frame_interval` contains the current frame interval as would be returned by a `VIDIOC_SUBDEV_G_FRAME_INTERVAL` call.

Drivers must not return an error solely because the requested interval doesn't match the device capabilities. They must instead modify the interval to match what the hardware can provide. The modified interval should be as close as possible to the original request.

Sub-devices that support the frame interval `ioctls` should implement them on a single pad only. Their behaviour when supported on multiple pads of the same sub-device is not defined.

Table A-1. struct v4l2_subdev_frame_interval

<code>__u32</code>	<code>pad</code>	Pad number as reported by the media controller API.
<code>struct v4l2_fract</code>	<code>interval</code>	Period, in seconds, between consecutive video frames.
<code>__u32</code>	<code>reserved[9]</code>	Reserved for future extensions. Applications and drivers must set the array to zero.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EBUSY

The frame interval can't be changed because the pad is currently busy. This can be caused, for instance, by an active video stream on the pad. The `ioctl` must not be retried without performing another action to fix the problem first. Only returned by `VIDIOC_SUBDEV_S_FRAME_INTERVAL`

EINVAL

The struct `v4l2_subdev_frame_interval` `pad` references a non-existing pad, or the pad doesn't support frame intervals.

ioctl VIDIOC_SUBSCRIBE_EVENT, VIDIOC_UNSUBSCRIBE_EVENT

Name

VIDIOC_SUBSCRIBE_EVENT, VIDIOC_UNSUBSCRIBE_EVENT —
Subscribe or unsubscribe event

Synopsis

```
int ioctl(int fd, int request, struct v4l2_event_subscription
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_SUBSCRIBE_EVENT, VIDIOC_UNSUBSCRIBE_EVENT

argp

Description

Subscribe or unsubscribe V4L2 event. Subscribed events are dequeued by using the VIDIOC_DQEVENT ioctl.

Table A-1. struct v4l2_event_subscription

<code>__u32</code>	<i>type</i>	Type of the event.
<code>__u32</code>	<i>reserved[7]</i>	Reserved for future extensions. Drivers and applications must set the array to zero.

Table A-2. Event Types

<code>V4L2_EVENT_ALL</code>	0	All events. <code>V4L2_EVENT_ALL</code> is valid only for <code>VIDIOC_UNSUBSCRIBE_EVENT</code> for unsubscribing all events at once.
<code>V4L2_EVENT_VSYNC</code>	1	This event is triggered on the vertical sync. This event has struct <code>v4l2_event_vsync</code> associated with it.
<code>V4L2_EVENT_EOS</code>	2	This event is triggered when the end of a stream is reached. This is typically used with MPEG decoders to report to the application when the last of the MPEG stream has been decoded.
<code>V4L2_EVENT_PRIVATE_START</code>	0x08000000	Base event number for driver-private events.

Table A-3. struct `v4l2_event_vsync`

<code>__u8</code>	<i>field</i>	The upcoming field. See enum <code>v4l2_field</code> .
-------------------	--------------	--

V4L2 mmap()

Name

`v4l2-mmap` — Map device memory into application address space

Synopsis

```
#include <unistd.h>
#include <sys/mman.h>
void *mmap(void *start, size_t length, int prot, int flags,
int fd, off_t offset);
```

Arguments

start

Map the buffer to this address in the application's address space. When the `MAP_FIXED` flag is specified, *start* must be a multiple of the pagesize and `mmap` will fail when the specified address cannot be used. Use of this option is discouraged; applications should just specify a `NULL` pointer here.

length

Length of the memory area to map. This must be the same value as returned by the driver in the struct `v4l2_buffer` *length* field for the single-planar API, and the same value as returned by the driver in the struct `v4l2_plane` *length* field for the multi-planar API.

prot

The *prot* argument describes the desired memory protection. Regardless of the device type and the direction of data exchange it should be set to `PROT_READ | PROT_WRITE`, permitting read and write access to image buffers. Drivers should support at least this combination of flags. Note the Linux `video-buf` kernel module, which is used by the `bttv`, `saa7134`, `saa7146`, `cx88` and `vivi` driver supports only `PROT_READ | PROT_WRITE`. When the driver does not support the desired protection the `mmap()` function fails.

Note device memory accesses (e. g. the memory on a graphics card with video capturing hardware) may incur a performance penalty compared to main memory accesses, or reads may be significantly slower than writes or vice versa. Other I/O methods may be more efficient in this case.

flags

The *flags* parameter specifies the type of the mapped object, mapping options and whether modifications made to the mapped copy of the page are private to the process or are to be shared with other references.

Appendix A. Function Reference

`MAP_FIXED` requests that the driver selects no other address than the one specified. If the specified address cannot be used, `mmap()` will fail. If `MAP_FIXED` is specified, `start` must be a multiple of the pagesize. Use of this option is discouraged.

One of the `MAP_SHARED` or `MAP_PRIVATE` flags must be set. `MAP_SHARED` allows applications to share the mapped memory with other (e. g. child-) processes. Note the Linux `video-buf` module which is used by the `bttv`, `saa7134`, `saa7146`, `cx88` and `vivi` driver supports only `MAP_SHARED`.

`MAP_PRIVATE` requests copy-on-write semantics. V4L2 applications should not set the `MAP_PRIVATE`, `MAP_DENYWRITE`, `MAP_EXECUTABLE` or `MAP_ANON` flag.

fd

File descriptor returned by `open()`.

offset

Offset of the buffer in device memory. This must be the same value as returned by the driver in the struct `v4l2_buffer` *m* union `offset` field for the single-planar API, and the same value as returned by the driver in the struct `v4l2_plane` *m* union `mem_offset` field for the multi-planar API.

Description

The `mmap()` function asks to map `length` bytes starting at `offset` in the memory of the device specified by `fd` into the application address space, preferably at address `start`. This latter address is a hint only, and is usually specified as 0.

Suitable length and offset parameters are queried with the `VIDIOC_QUERYBUF` ioctl. Buffers must be allocated with the `VIDIOC_REQBUFS` ioctl before they can be queried.

To unmap buffers the `munmap()` function is used.

Return Value

On success `mmap()` returns a pointer to the mapped buffer. On error `MAP_FAILED` (-1) is returned, and the `errno` variable is set appropriately. Possible error codes are:

EBADF

fd is not a valid file descriptor.

EACCES

fd is not open for reading and writing.

EINVAL

The *start* or *length* or *offset* are not suitable. (E. g. they are too large, or not aligned on a `PAGESIZE` boundary.)

The *flags* or *prot* value is not supported.

No buffers have been allocated with the `VIDIOC_REQBUFS` ioctl.

ENOMEM

Not enough physical or virtual memory was available to complete the request.

V4L2 `munmap()`

Name

`v4l2-munmap` — Unmap device memory

Synopsis

```
#include <unistd.h>
#include <sys/mman.h>
int munmap(void *start, size_t length);
```

Arguments

start

Address of the mapped buffer as returned by the `mmap()` function.

length

Length of the mapped buffer. This must be the same value as given to `mmap()` and returned by the driver in the struct `v4l2_buffer` *length* field for the single-planar API and in the struct `v4l2_plane` *length* field for the multi-planar API.

Description

Unmaps a previously with the `mmap()` function mapped buffer and frees it, if possible.

Return Value

On success `munmap()` returns 0, on failure -1 and the `errno` variable is set appropriately:

`EINVAL`

The *start* or *length* is incorrect, or no buffers have been mapped yet.

V4L2 open()

Name

`v4l2-open` — Open a V4L2 device

Synopsis

```
#include <fcntl.h>
int open(const char *device_name, int flags);
```

Arguments

device_name

Device to be opened.

flags

Open flags. Access mode must be `O_RDWR`. This is just a technicality, input devices still support only reading and output devices only writing.

When the `O_NONBLOCK` flag is given, the `read()` function and the `VIDIOC_DQBUF` ioctl will return the `EAGAIN` error code when no data is available or no buffer is in the driver outgoing queue, otherwise these functions block until data becomes available. All V4L2 drivers exchanging data with applications must support the `O_NONBLOCK` flag.

Other flags have no effect.

Description

To open a V4L2 device applications call `open()` with the desired device name. This function has no side effects; all data format parameters, current input or output, control values or other properties remain unchanged. At the first `open()` call after loading the driver they will be reset to default values, drivers are never in an undefined state.

Return Value

On success `open` returns the new file descriptor. On error -1 is returned, and the `errno` variable is set appropriately. Possible error codes are:

EACCES

The caller has no permission to access the device.

EBUSY

The driver does not support multiple opens and the device is already in use.

ENXIO

No device corresponding to this device special file exists.

ENOMEM

Not enough kernel memory was available to complete the request.

EMFILE

The process already has the maximum number of files open.

ENFILE

The limit on the total number of files open on the system has been reached.

V4L2 poll()

Name

`v4l2-poll` — Wait for some event on a file descriptor

Synopsis

```
#include <sys/poll.h>
int poll(struct pollfd *ufds, unsigned int nfds, int timeout);
```

Description

With the `poll()` function applications can suspend execution until the driver has captured data or is ready to accept data for output.

When streaming I/O has been negotiated this function waits until a buffer has been filled or displayed and can be dequeued with the `VIDIOC_DQBUF` ioctl. When buffers are already in the outgoing queue of the driver the function returns immediately.

On success `poll()` returns the number of file descriptors that have been selected (that is, file descriptors for which the `revents` field of the respective `pollfd` structure is non-zero). Capture devices set the `POLLIN` and `POLLRDNORM` flags in the `revents` field, output devices the `POLLOUT` and `POLLWRNORM` flags. When the function timed out it returns a value of zero, on failure it returns -1 and the `errno` variable is set appropriately. When the application did not call `VIDIOC_QBUF` or

`VIDIOC_STREAMON` yet the `poll()` function succeeds, but sets the `POLLERR` flag in the `revents` field.

When use of the `read()` function has been negotiated and the driver does not capture yet, the `poll` function starts capturing. When that fails it returns a `POLLERR` as above. Otherwise it waits until data has been captured and can be read. When the driver captures continuously (as opposed to, for example, still images) the function may return immediately.

When use of the `write()` function has been negotiated the `poll` function just waits until the driver is ready for a non-blocking `write()` call.

All drivers implementing the `read()` or `write()` function or streaming I/O must also support the `poll()` function.

For more details see the `poll()` manual page.

Return Value

On success, `poll()` returns the number structures which have non-zero `revents` fields, or zero if the call timed out. On error -1 is returned, and the `errno` variable is set appropriately:

EBADF

One or more of the `ufds` members specify an invalid file descriptor.

EBUSY

The driver does not support multiple read or write streams and the device is already in use.

EFAULT

`ufds` references an inaccessible memory area.

EINTR

The call was interrupted by a signal.

EINVAL

The `nfds` argument is greater than `OPEN_MAX`.

V4L2 read()

Name

`v4l2-read` — Read from a V4L2 device

Synopsis

```
#include <unistd.h>
ssize_t read(int fd, void *buf, size_t count);
```

Arguments

fd

File descriptor returned by `open()`.

buf

count

Description

`read()` attempts to read up to *count* bytes from file descriptor *fd* into the buffer starting at *buf*. The layout of the data in the buffer is discussed in the respective device interface section, see [##](#). If *count* is zero, `read()` returns zero and has no other results. If *count* is greater than `SSIZE_MAX`, the result is unspecified. Regardless of the *count* value each `read()` call will provide at most one frame (two fields) worth of data.

By default `read()` blocks until data becomes available. When the `O_NONBLOCK` flag was given to the `open()` function it returns immediately with an `EAGAIN` error code when no data is available. The `select()` or `poll()` functions can always be used to suspend execution until data becomes available. All drivers supporting the `read()` function must also support `select()` and `poll()`.

Drivers can implement read functionality in different ways, using a single or multiple buffers and discarding the oldest or newest frames once the internal buffers are filled.

`read()` never returns a "snapshot" of a buffer being filled. Using a single buffer the driver will stop capturing when the application starts reading the buffer until the read is finished. Thus only the period of the vertical blanking interval is available for reading, or the capture rate must fall below the nominal frame rate of the video standard.

The behavior of `read()` when called during the active picture period or the vertical blanking separating the top and bottom field depends on the discarding policy. A driver discarding the oldest frames keeps capturing into an internal buffer, continuously overwriting the previously, not read frame, and returns the frame being received at the time of the `read()` call as soon as it is complete.

A driver discarding the newest frames stops capturing until the next `read()` call. The frame being received at `read()` time is discarded, returning the following frame instead. Again this implies a reduction of the capture rate to one half or less of the nominal frame rate. An example of this model is the video read mode of the bttv driver, initiating a DMA to user memory when `read()` is called and returning when the DMA finished.

In the multiple buffer model drivers maintain a ring of internal buffers, automatically advancing to the next free buffer. This allows continuous capturing when the application can empty the buffers fast enough. Again, the behavior when the driver runs out of free buffers depends on the discarding policy.

Applications can get and set the number of buffers used internally by the driver with the `VIDIOC_G_PARM` and `VIDIOC_S_PARM` ioctls. They are optional, however. The discarding policy is not reported and cannot be changed. For minimum requirements see Chapter 4.

Return Value

On success, the number of bytes read is returned. It is not an error if this number is smaller than the number of bytes requested, or the amount of data required for one frame. This may happen for example because `read()` was interrupted by a signal. On error, -1 is returned, and the `errno` variable is set appropriately. In this case the next read will start at the beginning of a new frame. Possible error codes are:

EAGAIN

Non-blocking I/O has been selected using `O_NONBLOCK` and no data was immediately available for reading.

EBADF

fd is not a valid file descriptor or is not open for reading, or the process already has the maximum number of files open.

EBUSY

The driver does not support multiple read streams and the device is already in use.

EFAULT

buf references an inaccessible memory area.

EINTR

The call was interrupted by a signal before any data was read.

EIO

I/O error. This indicates some hardware problem or a failure to communicate with a remote device (USB camera etc.).

EINVAL

The `read()` function is not supported by this driver, not on this device, or generally not on this type of device.

V4L2 select()

Name

`v4l2-select` — Synchronous I/O multiplexing

Synopsis

```
#include <sys/time.h>
#include <sys/types.h>
#include <unistd.h>
int select(int nfds, fd_set *readfds, fd_set *writefds, fd_set
*exceptfds, struct timeval *timeout);
```

Description

With the `select()` function applications can suspend execution until the driver has captured data or is ready to accept data for output.

When streaming I/O has been negotiated this function waits until a buffer has been filled or displayed and can be dequeued with the `VIDIOC_DQBUF` ioctl. When buffers are already in the outgoing queue of the driver the function returns immediately.

On success `select()` returns the total number of bits set in the `fd_sets`. When the function timed out it returns a value of zero. On failure it returns -1 and the `errno` variable is set appropriately. When the application did not call `VIDIOC_QBUF` or `VIDIOC_STREAMON` yet the `select()` function succeeds, setting the bit of the file descriptor in `readfds` or `wrtefds`, but subsequent `VIDIOC_DQBUF` calls will fail.¹

When use of the `read()` function has been negotiated and the driver does not capture yet, the `select()` function starts capturing. When that fails, `select()` returns successful and a subsequent `read()` call, which also attempts to start capturing, will return an appropriate error code. When the driver captures continuously (as opposed to, for example, still images) and data is already available the `select()` function returns immediately.

When use of the `write()` function has been negotiated the `select()` function just waits until the driver is ready for a non-blocking `write()` call.

All drivers implementing the `read()` or `write()` function or streaming I/O must also support the `select()` function.

For more details see the `select()` manual page.

Return Value

On success, `select()` returns the number of descriptors contained in the three returned descriptor sets, which will be zero if the timeout expired. On error -1 is returned, and the `errno` variable is set appropriately; the sets and `timeout` are undefined. Possible error codes are:

EBADF

One or more of the file descriptor sets specified a file descriptor that is not open.

Appendix A. Function Reference

EBUSY

The driver does not support multiple read or write streams and the device is already in use.

EFAULT

The *readfds*, *writelfds*, *exceptfds* or *timeout* pointer references an inaccessible memory area.

EINTR

The call was interrupted by a signal.

EINVAL

The *nfds* argument is less than zero or greater than `FD_SETSIZE`.

Notes

1. The Linux kernel implements `select()` like the `poll()` function, but `select()` cannot return a `POLLERR`.

V4L2 write()

Name

`v4l2-write` — Write to a V4L2 device

Synopsis

```
#include <unistd.h>
ssize_t write(int fd, void *buf, size_t count);
```

Arguments

fd

File descriptor returned by `open()`.

buf

count

Description

`write()` writes up to *count* bytes to the device referenced by the file descriptor *fd* from the buffer starting at *buf*. When the hardware outputs are not active yet, this function enables them. When *count* is zero, `write()` returns 0 without any other effect.

When the application does not provide more data in time, the previous video frame, raw VBI image, sliced VPS or WSS data is displayed again. Sliced Teletext or Closed Caption data is not repeated, the driver inserts a blank line instead.

Return Value

On success, the number of bytes written are returned. Zero indicates nothing was written. On error, -1 is returned, and the `errno` variable is set appropriately. In this case the next write will start at the beginning of a new frame. Possible error codes are:

EAGAIN

Non-blocking I/O has been selected using the `O_NONBLOCK` flag and no buffer space was available to write the data immediately.

EBADF

fd is not a valid file descriptor or is not open for writing.

EBUSY

The driver does not support multiple write streams and the device is already in use.

EFAULT

buf references an inaccessible memory area.

EINTR

The call was interrupted by a signal before any data was written.

EIO

I/O error. This indicates some hardware problem.

EINVAL

The `write()` function is not supported by this driver, not on this device, or generally not on this type of device.

Notes

1. The supported standards may overlap and we need an unambiguous set to find the current standard returned by `VIDIOC_G_STD`.
1. `V4L2_CTRL_FLAG_DISABLED` was intended for two purposes: Drivers can skip predefined controls not supported by the hardware (although returning `EINVAL` would do as well), or disable predefined and private controls after hardware detection without the trouble of reordering control arrays and indices (`EINVAL` cannot be used to skip private controls because it would prematurely end the enumeration).
1. The Linux kernel implements `select()` like the `poll()` function, but `select()` cannot return a `POLLERR`.

Appendix B. Video For Linux Two Header File

```
/*
 * Video for Linux Two header file
 *
 * Copyright (C) 1999-2007 the contributors
 *
 * This program is free software; you can redistribute it and/or modify
 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation; either version 2 of the License, or
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
 * GNU General Public License for more details.
 *
 * Alternatively you can redistribute this file under the terms of the
 * BSD license as stated below:
 *
 * Redistribution and use in source and binary forms, with or without
 * modification, are permitted provided that the following conditions
 * are met:
 * 1. Redistributions of source code must retain the above copyright
 * notice, this list of conditions and the following disclaimer.
 * 2. Redistributions in binary form must reproduce the above copyright
 * notice, this list of conditions and the following disclaimer in
 * the documentation and/or other materials provided with the
 * distribution.
 * 3. The names of its contributors may not be used to endorse or promote
 * products derived from this software without specific prior written
 * permission.
 *
 * THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS
 * "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT
 * LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR
 * A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT
 * OWNER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL,
 * SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED
 * TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR
 * PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF
 * LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING
 * NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS
 * SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
```


Appendix B. Video For Linux Two Header File

```
*
*      Header file for v4l or V4L2 drivers and applications
* with public API.
* All kernel-specific stuff were moved to media/v4l2-dev.h, so
* no #if __KERNEL tests are allowed here
*
*      See http://linuxtv.org for more info
*
*      Author: Bill Dirks <bill@thedirks.org>
*              Justin Schoeman
*              Hans Verkuil <hverkuil@xs4all.nl>
*              et al.
*/
#ifndef __LINUX_VIDEODEV2_H
#define __LINUX_VIDEODEV2_H

#ifdef __KERNEL__
#include <linux/time.h>      /* need struct timeval */
#else
#include <sys/time.h>
#endif
#include <linux/compiler.h>
#include <linux/ioctl.h>
#include <linux/types.h>

/*
 * Common stuff for both V4L1 and V4L2
 * Moved from videodev.h
 */
#define VIDEO_MAX_FRAME      32
#define VIDEO_MAX_PLANES    8

#ifndef __KERNEL__

/* These defines are V4L1 specific and should not be used with the V4L2 API
   They will be removed from this header in the future. */

#define VID_TYPE_CAPTURE      1      /* Can capture */
#define VID_TYPE_TUNER        2      /* Can tune */
#define VID_TYPE_TELETEXT     4      /* Does teletext */
#define VID_TYPE_OVERLAY      8      /* Overlay onto frame buffer */
#define VID_TYPE_CHROMAKEY     16     /* Overlay by chromakey */
#define VID_TYPE_CLIPPING     32     /* Can clip */
#define VID_TYPE_FRAMERAM     64     /* Uses the frame buffer memory */
#define VID_TYPE_SCALES        128    /* Scalable */
#define VID_TYPE_MONOCHROME    256    /* Monochrome only */
#define VID_TYPE_SUBCAPTURE    512    /* Can capture subareas of the image */
#define VID_TYPE_MPEG_DECODER  1024   /* Can decode MPEG streams */
```

Appendix B. Video For Linux Two Header File

```
#define VID_TYPE_MPEG_ENCODER    2048    /* Can encode MPEG streams */
#define VID_TYPE_MJPEG_DECODER   4096    /* Can decode MJPEG streams */
#define VID_TYPE_MJPEG_ENCODER   8192    /* Can encode MJPEG streams */
#endif

/*
 *      M I S C E L L A N E O U S
 */

/* Four-character-code (FOURCC) */
#define v4l2_fourcc(a, b, c, d)\
    ((__u32)(a) | ((__u32)(b) << 8) | ((__u32)(c) << 16) | ((__u32)(d) << 24))

/*
 *      E N U M S
 */
enum v4l2_field {
    V4L2_FIELD_ANY                = 0, /* driver can choose from none,
                                         top, bottom, interlaced
                                         depending on whatever it thinks
                                         is approximate ... */
    V4L2_FIELD_NONE               = 1, /* this device has no fields ... */
    V4L2_FIELD_TOP                = 2, /* top field only */
    V4L2_FIELD_BOTTOM             = 3, /* bottom field only */
    V4L2_FIELD_INTERLACED         = 4, /* both fields interlaced */
    V4L2_FIELD_SEQ_TB             = 5, /* both fields sequential into one
                                         buffer, top-bottom order */
    V4L2_FIELD_SEQ_BT             = 6, /* same as above + bottom-top order */
    V4L2_FIELD_ALTERNATE          = 7, /* both fields alternating into
                                         separate buffers */
    V4L2_FIELD_INTERLACED_TB      = 8, /* both fields interlaced, top field
                                         first and the top field is
                                         transmitted first */
    V4L2_FIELD_INTERLACED_BT      = 9, /* both fields interlaced, top field
                                         first and the bottom field is
                                         transmitted first */
};

#define V4L2_FIELD_HAS_TOP(field) \
    ((field) == V4L2_FIELD_TOP || \
     (field) == V4L2_FIELD_INTERLACED || \
     (field) == V4L2_FIELD_INTERLACED_TB || \
     (field) == V4L2_FIELD_INTERLACED_BT || \
     (field) == V4L2_FIELD_SEQ_TB || \
     (field) == V4L2_FIELD_SEQ_BT)

#define V4L2_FIELD_HAS_BOTTOM(field) \
    ((field) == V4L2_FIELD_BOTTOM || \
     (field) == V4L2_FIELD_INTERLACED || \
     (field) == V4L2_FIELD_INTERLACED_TB || \
     (field) == V4L2_FIELD_INTERLACED_BT || \
     (field) == V4L2_FIELD_SEQ_TB || \
     (field) == V4L2_FIELD_SEQ_BT)
```

Appendix B. Video For Linux Two Header File

```
(field) == V4L2_FIELD_INTERLACED_BT ||\
(field) == V4L2_FIELD_SEQ_TB    ||\
(field) == V4L2_FIELD_SEQ_BT)
#define V4L2_FIELD_HAS_BOTH(field) \
((field) == V4L2_FIELD_INTERLACED ||\
(field) == V4L2_FIELD_INTERLACED_TB ||\
(field) == V4L2_FIELD_INTERLACED_BT ||\
(field) == V4L2_FIELD_SEQ_TB ||\
(field) == V4L2_FIELD_SEQ_BT)

enum v4l2_buf_type {
    V4L2_BUF_TYPE_VIDEO_CAPTURE        = 1,
    V4L2_BUF_TYPE_VIDEO_OUTPUT         = 2,
    V4L2_BUF_TYPE_VIDEO_OVERLAY        = 3,
    V4L2_BUF_TYPE_VBI_CAPTURE           = 4,
    V4L2_BUF_TYPE_VBI_OUTPUT            = 5,
    V4L2_BUF_TYPE_SLICED_VBI_CAPTURE    = 6,
    V4L2_BUF_TYPE_SLICED_VBI_OUTPUT     = 7,
#if 1
    /* Experimental */
    V4L2_BUF_TYPE_VIDEO_OUTPUT_OVERLAY  = 8,
#endif
    V4L2_BUF_TYPE_VIDEO_CAPTURE_MPLANE  = 9,
    V4L2_BUF_TYPE_VIDEO_OUTPUT_MPLANE   = 10,
    V4L2_BUF_TYPE_PRIVATE                = 0x80,
};

#define V4L2_TYPE_IS_MULTIPLANAR(type) \
((type) == V4L2_BUF_TYPE_VIDEO_CAPTURE_MPLANE \
|| (type) == V4L2_BUF_TYPE_VIDEO_OUTPUT_MPLANE)

#define V4L2_TYPE_IS_OUTPUT(type) \
((type) == V4L2_BUF_TYPE_VIDEO_OUTPUT \
|| (type) == V4L2_BUF_TYPE_VIDEO_OUTPUT_MPLANE \
|| (type) == V4L2_BUF_TYPE_VIDEO_OVERLAY \
|| (type) == V4L2_BUF_TYPE_VIDEO_OUTPUT_OVERLAY \
|| (type) == V4L2_BUF_TYPE_VBI_OUTPUT \
|| (type) == V4L2_BUF_TYPE_SLICED_VBI_OUTPUT)

enum v4l2_tuner_type {
    V4L2_TUNER_RADIO                    = 1,
    V4L2_TUNER_ANALOG_TV                = 2,
    V4L2_TUNER_DIGITAL_TV               = 3,
};

enum v4l2_memory {
    V4L2_MEMORY_MMAP                    = 1,
    V4L2_MEMORY_USERPTR                 = 2,
```

```
V4L2_MEMORY_OVERLAY          = 3,
};

/* see also http://vektor.theorem.ca/graphics/ycbcr/ */
enum v4l2_colorspace {
    /* ITU-R 601 -- broadcast NTSC/PAL */
    V4L2_COLORSPACE_SMPTE170M    = 1,

    /* 1125-Line (US) HDTV */
    V4L2_COLORSPACE_SMPTE240M    = 2,

    /* HD and modern captures. */
    V4L2_COLORSPACE_REC709       = 3,

    /* broken BT878 extents (601, luma range 16-253 instead of 16-235) */
    V4L2_COLORSPACE_BT878        = 4,

    /* These should be useful. Assume 601 extents. */
    V4L2_COLORSPACE_470_SYSTEM_M = 5,
    V4L2_COLORSPACE_470_SYSTEM_BG = 6,

    /* I know there will be cameras that send this. So, this is
     * unspecified chromaticities and full 0-255 on each of the
     * Y'CbCr components
     */
    V4L2_COLORSPACE_JPEG         = 7,

    /* For RGB colourspace, this is probably a good start. */
    V4L2_COLORSPACE_SRGB         = 8,
};

enum v4l2_priority {
    V4L2_PRIORITY_UNSET          = 0, /* not initialized */
    V4L2_PRIORITY_BACKGROUND     = 1,
    V4L2_PRIORITY_INTERACTIVE    = 2,
    V4L2_PRIORITY_RECORD         = 3,
    V4L2_PRIORITY_DEFAULT        = V4L2_PRIORITY_INTERACTIVE,
};

struct v4l2_rect {
    __s32    left;
    __s32    top;
    __s32    width;
    __s32    height;
};

struct v4l2_fract {
    __u32    numerator;
};
```

Appendix B. Video For Linux Two Header File

```
        __u32    denominator;

};

/*
 *      D R I V E R   C A P A B I L I T I E S
 */
struct v4l2_capability {
    __u8    driver[16];        /* i.e.ie; "bttv" */
    __u8    card[32];         /* i.e.ie; "Hauppauge WinTV" */
    __u8    bus_info[32];     /* "PCI:" + pci_name(pci_dev) */
    __u32    version;         /* should use KERNEL_VERSION() */
    __u32    capabilities;    /* Device capabilities */
    __u32    reserved[4];

};

/* Values for 'capabilities' field */
#define V4L2_CAP_VIDEO_CAPTURE        0x00000001 /* Is a video capture device */
#define V4L2_CAP_VIDEO_OUTPUT        0x00000002 /* Is a video output device */
#define V4L2_CAP_VIDEO_OVERLAY       0x00000004 /* Can do video overlay */
#define V4L2_CAP_VBI_CAPTURE         0x00000010 /* Is a raw VBI capture device */
#define V4L2_CAP_VBI_OUTPUT          0x00000020 /* Is a raw VBI output device */
#define V4L2_CAP_SLICED_VBI_CAPTURE  0x00000040 /* Is a sliced VBI capture device */
#define V4L2_CAP_SLICED_VBI_OUTPUT    0x00000080 /* Is a sliced VBI output device */
#define V4L2_CAP_RDS_CAPTURE         0x00000100 /* RDS data capture device */
#define V4L2_CAP_VIDEO_OUTPUT_OVERLAY 0x00000200 /* Can do video output overlay */
#define V4L2_CAP_HW_FREQ_SEEK        0x00000400 /* Can do hardware frequency seek */
#define V4L2_CAP_RDS_OUTPUT          0x00000800 /* Is an RDS encoder device */

/* Is a video capture device that supports multiplanar formats */
#define V4L2_CAP_VIDEO_CAPTURE_MPLANE 0x00001000
/* Is a video output device that supports multiplanar formats */
#define V4L2_CAP_VIDEO_OUTPUT_MPLANE  0x00002000

#define V4L2_CAP_TUNER                0x00010000 /* has a tuner */
#define V4L2_CAP_AUDIO                0x00020000 /* has audio support */
#define V4L2_CAP_RADIO                0x00040000 /* is a radio device */
#define V4L2_CAP_MODULATOR           0x00080000 /* has a modulator */

#define V4L2_CAP_READWRITE             0x01000000 /* read/write system calls */
#define V4L2_CAP_ASYNCIO              0x02000000 /* async I/O */
#define V4L2_CAP_STREAMING             0x04000000 /* streaming I/O ioctl */

/*
 *      V I D E O   I M A G E   F O R M A T
 */
struct v4l2_pix_format {
    __u32    width;
    __u32    height;
```

Appendix B. Video For Linux Two Header File

```
__u32                pixelformat;
enum v4l2_field       field;
__u32                bytesperline; /* for padding, zero if un
__u32                sizeimage;
enum v4l2_colorspace  colorspace;
__u32                priv;         /* private data, depends

};

/*      Pixel format      FOURCC      depth  Descr:

/* RGB formats */
#define V4L2_PIX_FMT_RGB332 v4l2_fourcc('R', 'G', 'B', '1') /* 8   RGB-3
#define V4L2_PIX_FMT_RGB444 v4l2_fourcc('R', '4', '4', '4') /* 16  xxxxr
#define V4L2_PIX_FMT_RGB555 v4l2_fourcc('R', 'G', 'B', 'O') /* 16  RGB-5
#define V4L2_PIX_FMT_RGB565 v4l2_fourcc('R', 'G', 'B', 'P') /* 16  RGB-5
#define V4L2_PIX_FMT_RGB555X v4l2_fourcc('R', 'G', 'B', 'Q') /* 16  RGB-5
#define V4L2_PIX_FMT_RGB565X v4l2_fourcc('R', 'G', 'B', 'R') /* 16  RGB-5
#define V4L2_PIX_FMT_BGR666 v4l2_fourcc('B', 'G', 'R', 'H') /* 18  BGR-6
#define V4L2_PIX_FMT_BGR24 v4l2_fourcc('B', 'G', 'R', '3') /* 24  BGR-8
#define V4L2_PIX_FMT_RGB24 v4l2_fourcc('R', 'G', 'B', '3') /* 24  RGB-8
#define V4L2_PIX_FMT_BGR32 v4l2_fourcc('B', 'G', 'R', '4') /* 32  BGR-8
#define V4L2_PIX_FMT_RGB32 v4l2_fourcc('R', 'G', 'B', '4') /* 32  RGB-8

/* Grey formats */
#define V4L2_PIX_FMT_GREY v4l2_fourcc('G', 'R', 'E', 'Y') /* 8   Greysc
#define V4L2_PIX_FMT_Y4 v4l2_fourcc('Y', '0', '4', ' ') /* 4   Greysc
#define V4L2_PIX_FMT_Y6 v4l2_fourcc('Y', '0', '6', ' ') /* 6   Greysc
#define V4L2_PIX_FMT_Y10 v4l2_fourcc('Y', '1', '0', ' ') /* 10  Greysc
#define V4L2_PIX_FMT_Y16 v4l2_fourcc('Y', '1', '6', ' ') /* 16  Greysc

/* Grey bit-packed formats */
#define V4L2_PIX_FMT_Y10BPACK v4l2_fourcc('Y', '1', '0', 'B') /* 10  G

/* Palette formats */
#define V4L2_PIX_FMT_PAL8 v4l2_fourcc('P', 'A', 'L', '8') /* 8   8-bit

/* Luminance+Chrominance formats */
#define V4L2_PIX_FMT_YVU410 v4l2_fourcc('Y', 'V', 'U', '9') /* 9   YVU 4
#define V4L2_PIX_FMT_YVU420 v4l2_fourcc('Y', 'V', '1', '2') /* 12  YVU 4
#define V4L2_PIX_FMT_YUYV v4l2_fourcc('Y', 'U', 'Y', 'V') /* 16  YUV 4
#define V4L2_PIX_FMT_YYUV v4l2_fourcc('Y', 'Y', 'U', 'V') /* 16  YUV 4
#define V4L2_PIX_FMT_YVYU v4l2_fourcc('Y', 'V', 'Y', 'U') /* 16  YVU 4:
#define V4L2_PIX_FMT_UYVY v4l2_fourcc('U', 'Y', 'V', 'Y') /* 16  YUV 4
#define V4L2_PIX_FMT_VYUY v4l2_fourcc('V', 'Y', 'U', 'Y') /* 16  YUV 4
#define V4L2_PIX_FMT_YUV422P v4l2_fourcc('4', '2', '2', 'P') /* 16  YVU42
#define V4L2_PIX_FMT_YUV411P v4l2_fourcc('4', '1', '1', 'P') /* 16  YVU41
#define V4L2_PIX_FMT_Y41P v4l2_fourcc('Y', '4', '1', 'P') /* 12  YUV 4
#define V4L2_PIX_FMT_YUV444 v4l2_fourcc('Y', '4', '4', '4') /* 16  xxxxyy
```

Appendix B. Video For Linux Two Header File

```
#define V4L2_PIX_FMT_YUV555 v4l2_fourcc('Y', 'U', 'V', 'O') /* 16 YUV-5
#define V4L2_PIX_FMT_YUV565 v4l2_fourcc('Y', 'U', 'V', 'P') /* 16 YUV-5
#define V4L2_PIX_FMT_YUV32 v4l2_fourcc('Y', 'U', 'V', '4') /* 32 YUV-8
#define V4L2_PIX_FMT_YUV410 v4l2_fourcc('Y', 'U', 'V', '9') /* 9 YUV 4
#define V4L2_PIX_FMT_YUV420 v4l2_fourcc('Y', 'U', '1', '2') /* 12 YUV 4
#define V4L2_PIX_FMT_HI240 v4l2_fourcc('H', 'I', '2', '4') /* 8 8-bit
#define V4L2_PIX_FMT_HM12 v4l2_fourcc('H', 'M', '1', '2') /* 8 YUV 4
#define V4L2_PIX_FMT_M420 v4l2_fourcc('M', '4', '2', '0') /* 12 YUV 4

/* two planes -- one Y, one Cr + Cb interleaved */
#define V4L2_PIX_FMT_NV12 v4l2_fourcc('N', 'V', '1', '2') /* 12 Y/CbCr
#define V4L2_PIX_FMT_NV21 v4l2_fourcc('N', 'V', '2', '1') /* 12 Y/CrCb
#define V4L2_PIX_FMT_NV16 v4l2_fourcc('N', 'V', '1', '6') /* 16 Y/CbCr
#define V4L2_PIX_FMT_NV61 v4l2_fourcc('N', 'V', '6', '1') /* 16 Y/CrCb

/* two non contiguous planes - one Y, one Cr + Cb interleaved */
#define V4L2_PIX_FMT_NV12M v4l2_fourcc('N', 'M', '1', '2') /* 12 Y/CbCr
#define V4L2_PIX_FMT_NV12MT v4l2_fourcc('T', 'M', '1', '2') /* 12 Y/CbCr

/* three non contiguous planes - Y, Cb, Cr */
#define V4L2_PIX_FMT_YUV420M v4l2_fourcc('Y', 'M', '1', '2') /* 12 YUV420

/* Bayer formats - see http://www.siliconimaging.com/RGB%20Bayer.htm */
#define V4L2_PIX_FMT_SBGGR8 v4l2_fourcc('B', 'A', '8', '1') /* 8 BGBG.
#define V4L2_PIX_FMT_SGBRG8 v4l2_fourcc('G', 'B', 'R', 'G') /* 8 GBGB.
#define V4L2_PIX_FMT_SGRBG8 v4l2_fourcc('G', 'R', 'B', 'G') /* 8 GRGR.
#define V4L2_PIX_FMT_SRGG8 v4l2_fourcc('R', 'G', 'G', 'B') /* 8 RGRG.
#define V4L2_PIX_FMT_SBGGR10 v4l2_fourcc('B', 'G', '1', '0') /* 10 BGBG.
#define V4L2_PIX_FMT_SGBRG10 v4l2_fourcc('G', 'B', '1', '0') /* 10 GBGB.
#define V4L2_PIX_FMT_SGRBG10 v4l2_fourcc('B', 'A', '1', '0') /* 10 GRGR.
#define V4L2_PIX_FMT_SRGG10 v4l2_fourcc('R', 'G', '1', '0') /* 10 RGRG.
    /* 10bit raw bayer DPCM compressed to 8 bits */
#define V4L2_PIX_FMT_SGRBG10DPCM8 v4l2_fourcc('B', 'D', '1', '0')
    /*
    * 10bit raw bayer, expanded to 16 bits
    * xxxxxxxxxgxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx...
    */
#define V4L2_PIX_FMT_SBGGR16 v4l2_fourcc('B', 'Y', 'R', '2') /* 16 BGBG.

/* compressed formats */
#define V4L2_PIX_FMT_MJPEG v4l2_fourcc('M', 'J', 'P', 'G') /* Motion-JP
#define V4L2_PIX_FMT_JPEG v4l2_fourcc('J', 'P', 'E', 'G') /* JFIF JPEG
#define V4L2_PIX_FMT_DV v4l2_fourcc('d', 'v', 's', 'd') /* 1394
#define V4L2_PIX_FMT_MPEG v4l2_fourcc('M', 'P', 'E', 'G') /* MPEG-1/2

/* Vendor-specific formats */
#define V4L2_PIX_FMT_CPIA1 v4l2_fourcc('C', 'P', 'I', 'A') /* cpia1 YUV
#define V4L2_PIX_FMT_WNVA v4l2_fourcc('W', 'N', 'V', 'A') /* Winnov hv
```

Appendix B. Video For Linux Two Header File

```
#define V4L2_PIX_FMT_SN9C10X    v4l2_fourcc('S', '9', '1', '0') /* SN9C10x c
#define V4L2_PIX_FMT_SN9C20X_I420 v4l2_fourcc('S', '9', '2', '0') /* SN9C
#define V4L2_PIX_FMT_PWC1      v4l2_fourcc('P', 'W', 'C', '1') /* pwc older
#define V4L2_PIX_FMT_PWC2      v4l2_fourcc('P', 'W', 'C', '2') /* pwc newer
#define V4L2_PIX_FMT_ET61X251  v4l2_fourcc('E', '6', '2', '5') /* ET61X251
#define V4L2_PIX_FMT_SPCA501    v4l2_fourcc('S', '5', '0', '1') /* YUYV per
#define V4L2_PIX_FMT_SPCA505    v4l2_fourcc('S', '5', '0', '5') /* YYUV per
#define V4L2_PIX_FMT_SPCA508    v4l2_fourcc('S', '5', '0', '8') /* YUVY per
#define V4L2_PIX_FMT_SPCA561    v4l2_fourcc('S', '5', '6', '1') /* compress
#define V4L2_PIX_FMT_PAC207     v4l2_fourcc('P', '2', '0', '7') /* compress
#define V4L2_PIX_FMT_MR97310A   v4l2_fourcc('M', '3', '1', '0') /* compress
#define V4L2_PIX_FMT_SN9C2028   v4l2_fourcc('S', '0', 'N', 'X') /* compress
#define V4L2_PIX_FMT_SQ905C     v4l2_fourcc('9', '0', '5', 'C') /* compress
#define V4L2_PIX_FMT_PJPG       v4l2_fourcc('P', 'J', 'P', 'G') /* Pixart 7
#define V4L2_PIX_FMT_OV511      v4l2_fourcc('O', '5', '1', '1') /* ov511 JPB
#define V4L2_PIX_FMT_OV518      v4l2_fourcc('O', '5', '1', '8') /* ov518 JPB
#define V4L2_PIX_FMT_STV0680    v4l2_fourcc('S', '6', '8', '0') /* stv0680 k
#define V4L2_PIX_FMT_TM6000     v4l2_fourcc('T', 'M', '6', '0') /* tm5600/tr
#define V4L2_PIX_FMT_CIT_YYVYUY v4l2_fourcc('C', 'I', 'T', 'V') /* one lin
#define V4L2_PIX_FMT_KONICA420  v4l2_fourcc('K', 'O', 'N', 'I') /* YUV420

/*
 *      F O R M A T   E N U M E R A T I O N
 */
struct v4l2_fmtdesc {
    __u32          index;           /* Format number          */
    enum v4l2_buf_type type;        /* buffer type            */
    __u32          flags;
    __u8           description[32]; /* Description string     */
    __u32          pixelformat;     /* Format fourcc           */
    __u32          reserved[4];
};

#define V4L2_FMT_FLAG_COMPRESSED 0x0001
#define V4L2_FMT_FLAG_EMULATED   0x0002

#if 1
    /* Experimental Frame Size and frame rate enumeration */
    /*
     *      F R A M E   S I Z E   E N U M E R A T I O N
     */
    enum v4l2_frmsizetypes {
        V4L2_FRMSIZE_TYPE_DISCRETE    = 1,
        V4L2_FRMSIZE_TYPE_CONTINUOUS   = 2,
        V4L2_FRMSIZE_TYPE_STEPWISE     = 3,
    };

    struct v4l2_frmsize_discrete {
```


Appendix B. Video For Linux Two Header File

```
        __u32          width;          /* Frame width [pixel] */
        __u32          height;         /* Frame height [pixel] */
};

struct v4l2_frmsize_stepwise {
        __u32          min_width;      /* Minimum frame width [p
        __u32          max_width;      /* Maximum frame width [p
        __u32          step_width;     /* Frame width step size
        __u32          min_height;     /* Minimum frame height [p
        __u32          max_height;     /* Maximum frame height [p
        __u32          step_height;    /* Frame height step size
};

struct v4l2_frmsizeenum {
        __u32          index;          /* Frame size number */
        __u32          pixel_format;   /* Pixel format */
        __u32          type;           /* Frame size type the dev

        union {
                struct v4l2_frmsize_discrete discrete;
                struct v4l2_frmsize_stepwise stepwise;
        };

        __u32          reserved[2];    /* Reserved space for futu
};

/*
 *      F R A M E   R A T E   E N U M E R A T I O N
 */
enum v4l2_frmivaltypes {
        V4L2_FRMIVAL_TYPE_DISCRETE      = 1,
        V4L2_FRMIVAL_TYPE_CONTINUOUS    = 2,
        V4L2_FRMIVAL_TYPE_STEPWISE      = 3,
};

struct v4l2_frmival_stepwise {
        struct v4l2_fract      min;     /* Minimum frame interval
        struct v4l2_fract      max;     /* Maximum frame interval
        struct v4l2_fract      step;    /* Frame interval step si
};

struct v4l2_frmivalenum {
        __u32          index;          /* Frame format index */
        __u32          pixel_format;   /* Pixel format */
        __u32          width;          /* Frame width */
        __u32          height;         /* Frame height */
        __u32          type;           /* Frame interval type the
```

Appendix B. Video For Linux Two Header File

```
union {
    struct v4l2_fract          /* Frame interval */
        discrete;
    struct v4l2_frmival_stepwise
        stepwise;
};

__u32    reserved[2];        /* Reserved space for future use */
};
#endif

/*
 *      T I M E C O D E
 */
struct v4l2_timecode {
    __u32    type;
    __u32    flags;
    __u8     frames;
    __u8     seconds;
    __u8     minutes;
    __u8     hours;
    __u8     userbits[4];
};

/*  Type  */
#define V4L2_TC_TYPE_24FPS      1
#define V4L2_TC_TYPE_25FPS      2
#define V4L2_TC_TYPE_30FPS      3
#define V4L2_TC_TYPE_50FPS      4
#define V4L2_TC_TYPE_60FPS      5

/*  Flags  */
#define V4L2_TC_FLAG_DROPFRAME    0x0001 /* "drop-frame" mode */
#define V4L2_TC_FLAG_COLORFRAME    0x0002
#define V4L2_TC_USERBITS_field      0x000C
#define V4L2_TC_USERBITS_USERDEFINED 0x0000
#define V4L2_TC_USERBITS_8BITCHARS  0x0008
/* The above is based on SMPTE timecodes */

struct v4l2_jpegcompression {
    int    quality;

    int    APPn;          /* Number of APP segment to be written,
                           * must be 0..15 */
    int    APP_len;       /* Length of data in JPEG APPn segment */
    char    APP_data[60]; /* Data in the JPEG APPn segment. */

    int    COM_len;       /* Length of data in JPEG COM segment */
    char    COM_data[60]; /* Data in JPEG COM segment */
};
```

Appendix B. Video For Linux Two Header File

```
    __u32 jpeg_markers;    /* Which markers should go into the JPEG
                           * output. Unless you exactly know what
                           * you do, leave them untouched.
                           * Including less markers will make the
                           * resulting code smaller, but there will
                           * be fewer applications which can read it
                           * The presence of the APP and COM marker
                           * is influenced by APP_len and COM_len
                           * ONLY, not by this property! */

#define V4L2_JPEG_MARKER_DHT (1<<3)    /* Define Huffman Tables */
#define V4L2_JPEG_MARKER_DQT (1<<4)    /* Define Quantization Tables */
#define V4L2_JPEG_MARKER_DRI (1<<5)    /* Define Restart Interval */
#define V4L2_JPEG_MARKER_COM (1<<6)    /* Comment segment */
#define V4L2_JPEG_MARKER_APP (1<<7)    /* App segment, driver will
                                         * always use APP0 */

};

/*
 *      M E M O R Y - M A P P I N G   B U F F E R S
 */
struct v4l2_requestbuffers {
    __u32                count;
    enum v4l2_buf_type   type;
    enum v4l2_memory     memory;
    __u32                reserved[2];
};

/**
 * struct v4l2_plane - plane info for multi-planar buffers
 * @bytesused:        number of bytes occupied by data in the plane (payload)
 * @length:           size of this plane (NOT the payload) in bytes
 * @mem_offset:       when memory in the associated struct v4l2_buffer is
 *                   V4L2_MEMORY_MMAP, equals the offset from the start
 *                   of the device memory for this plane (or is a "cookie"
 *                   which should be passed to mmap() called on the video node)
 * @userptr:          when memory is V4L2_MEMORY_USERPTR, a userspace pointer
 *                   pointing to this plane
 * @data_offset:       offset in the plane to the start of data; usually 0
 *                   unless there is a header in front of the data
 *
 * Multi-planar buffers consist of one or more planes, e.g. an YCbCr buffer
 * with two planes can have one plane for Y, and another for interleaved
 * components. Each plane can reside in a separate memory buffer, or even
 * a completely separate memory node (e.g. in embedded devices).
 */
struct v4l2_plane {
    __u32                bytesused;
    __u32                data_offset;
    __u32                reserved[2];
};
```

Appendix B. Video For Linux Two Header File

```
        __u32                length;
    union {
        __u32                mem_offset;
        unsigned long        userptr;
    } m;
    __u32                    data_offset;
    __u32                    reserved[11];
};

/**
 * struct v4l2_buffer - video buffer info
 * @index:      id number of the buffer
 * @type:       buffer type (type == *_MPLANE for multiplanar buffers)
 * @bytesused:  number of bytes occupied by data in the buffer (payload);
 *             unused (set to 0) for multiplanar buffers
 * @flags:      buffer informational flags
 * @field:      field order of the image in the buffer
 * @timestamp:  frame timestamp
 * @timecode:   frame timecode
 * @sequence:   sequence count of this frame
 * @memory:     the method, in which the actual video data is passed
 * @offset:     for non-multiplanar buffers with memory == V4L2_MEMORY_MMIO
 *             offset from the start of the device memory for this plane,
 *             (or a "cookie" that should be passed to mmap() as offset)
 * @userptr:    for non-multiplanar buffers with memory == V4L2_MEMORY_USERPTR
 *             a userspace pointer pointing to this buffer
 * @planes:     for multiplanar buffers; userspace pointer to the array of
 *             info structs for this buffer
 * @length:     size in bytes of the buffer (NOT its payload) for single-plane
 *             buffers (when type != *_MPLANE); number of elements in the
 *             planes array for multi-plane buffers
 * @input:      input number from which the video data has has been captured
 *
 * Contains data exchanged by application and driver using one of the Stream
 * I/O methods.
 */
struct v4l2_buffer {
    __u32                index;
    enum v4l2_buf_type    type;
    __u32                bytesused;
    __u32                flags;
    enum v4l2_field        field;
    struct timeval        timestamp;
    struct v4l2_timecode   timecode;
    __u32                sequence;

    /* memory location */
    enum v4l2_memory        memory;
};
```

Appendix B. Video For Linux Two Header File

```
        union {
            __u32                offset;
            unsigned long        userptr;
            struct v4l2_plane    *planes;
        } m;
        __u32                    length;
        __u32                    input;
        __u32                    reserved;
};

/*  Flags for 'flags' field */
#define V4L2_BUF_FLAG_MAPPED      0x0001 /* Buffer is mapped (flag) */
#define V4L2_BUF_FLAG_QUEUED      0x0002 /* Buffer is queued for processing */
#define V4L2_BUF_FLAG_DONE        0x0004 /* Buffer is ready */
#define V4L2_BUF_FLAG_KEYFRAME    0x0008 /* Image is a keyframe (I-frame) */
#define V4L2_BUF_FLAG_PFRAME      0x0010 /* Image is a P-frame */
#define V4L2_BUF_FLAG_BFRAME      0x0020 /* Image is a B-frame */
/* Buffer is ready, but the data contained within is corrupted. */
#define V4L2_BUF_FLAG_ERROR        0x0040
#define V4L2_BUF_FLAG_TIMECODE    0x0100 /* timecode field is valid */
#define V4L2_BUF_FLAG_INPUT       0x0200 /* input field is valid */

/*
 *      O V E R L A Y   P R E V I E W
 */
struct v4l2_framebuffer {
    __u32                capability;
    __u32                flags;
/* FIXME: in theory we should pass something like PCI device + memory
 * region + offset instead of some physical address */
    void                *base;
    struct v4l2_pix_format    fmt;
};

/*  Flags for the 'capability' field. Read only */
#define V4L2_FBUF_CAP_EXTERNOVERLAY  0x0001
#define V4L2_FBUF_CAP_CHROMAKEY      0x0002
#define V4L2_FBUF_CAP_LIST_CLIPPING  0x0004
#define V4L2_FBUF_CAP_BITMAP_CLIPPING 0x0008
#define V4L2_FBUF_CAP_LOCAL_ALPHA     0x0010
#define V4L2_FBUF_CAP_GLOBAL_ALPHA    0x0020
#define V4L2_FBUF_CAP_LOCAL_INV_ALPHA 0x0040
#define V4L2_FBUF_CAP_SRC_CHROMAKEY   0x0080
/*  Flags for the 'flags' field. */
#define V4L2_FBUF_FLAG_PRIMARY        0x0001
#define V4L2_FBUF_FLAG_OVERLAY        0x0002
#define V4L2_FBUF_FLAG_CHROMAKEY      0x0004
#define V4L2_FBUF_FLAG_LOCAL_ALPHA     0x0008
#define V4L2_FBUF_FLAG_GLOBAL_ALPHA    0x0010
```

Appendix B. Video For Linux Two Header File

```
#define V4L2_FBUF_FLAG_LOCAL_INV_ALPHA    0x0020
#define V4L2_FBUF_FLAG_SRC_CHROMAKEY     0x0040

struct v4l2_clip {
    struct v4l2_rect    c;
    struct v4l2_clip    __user *next;
};

struct v4l2_window {
    struct v4l2_rect    w;
    enum v4l2_field      field;
    __u32                chromakey;
    struct v4l2_clip     __user *clips;
    __u32                clipcount;
    void                 __user *bitmap;
    __u8                global_alpha;
};

/*
 *      C A P T U R E   P A R A M E T E R S
 */
struct v4l2_captureparm {
    __u32                capability;    /* Supported modes */
    __u32                capturemode;   /* Current mode */
    struct v4l2_fract     timeperframe; /* Time per frame in .1us units */
    __u32                extendedmode; /* Driver-specific extensions */
    __u32                readbuffers;   /* # of buffers for read */
    __u32                reserved[4];
};

/* Flags for 'capability' and 'capturemode' fields */
#define V4L2_MODE_HIGHQUALITY    0x0001 /* High quality imaging mode */
#define V4L2_CAP_TIMEPERFRAME    0x1000 /* timeperframe field is supported */

struct v4l2_outputparm {
    __u32                capability;    /* Supported modes */
    __u32                outputmode;   /* Current mode */
    struct v4l2_fract     timeperframe; /* Time per frame in seconds */
    __u32                extendedmode; /* Driver-specific extensions */
    __u32                writebuffers; /* # of buffers for write */
    __u32                reserved[4];
};

/*
 *      I N P U T   I M A G E   C R O P P I N G
 */
struct v4l2_cropcap {
    enum v4l2_buf_type    type;
```

Appendix B. Video For Linux Two Header File

```
        struct v4l2_rect      bounds;
        struct v4l2_rect      defrect;
        struct v4l2_fract      pixelaspect;
};

struct v4l2_crop {
    enum v4l2_buf_type        type;
    struct v4l2_rect          c;
};

/*
 *      A N A L O G   V I D E O   S T A N D A R D
 */

typedef __u64 v4l2_std_id;

/* one bit for each */
#define V4L2_STD_PAL_B      ((v4l2_std_id) 0x00000001)
#define V4L2_STD_PAL_B1    ((v4l2_std_id) 0x00000002)
#define V4L2_STD_PAL_G      ((v4l2_std_id) 0x00000004)
#define V4L2_STD_PAL_H      ((v4l2_std_id) 0x00000008)
#define V4L2_STD_PAL_I      ((v4l2_std_id) 0x00000010)
#define V4L2_STD_PAL_D      ((v4l2_std_id) 0x00000020)
#define V4L2_STD_PAL_D1     ((v4l2_std_id) 0x00000040)
#define V4L2_STD_PAL_K      ((v4l2_std_id) 0x00000080)

#define V4L2_STD_PAL_M      ((v4l2_std_id) 0x00000100)
#define V4L2_STD_PAL_N      ((v4l2_std_id) 0x00000200)
#define V4L2_STD_PAL_Nc     ((v4l2_std_id) 0x00000400)
#define V4L2_STD_PAL_60     ((v4l2_std_id) 0x00000800)

#define V4L2_STD_NTSC_M      ((v4l2_std_id) 0x00001000)
#define V4L2_STD_NTSC_M_JP  ((v4l2_std_id) 0x00002000)
#define V4L2_STD_NTSC_443   ((v4l2_std_id) 0x00004000)
#define V4L2_STD_NTSC_M_KR  ((v4l2_std_id) 0x00008000)

#define V4L2_STD_SECAM_B     ((v4l2_std_id) 0x00010000)
#define V4L2_STD_SECAM_D     ((v4l2_std_id) 0x00020000)
#define V4L2_STD_SECAM_G     ((v4l2_std_id) 0x00040000)
#define V4L2_STD_SECAM_H     ((v4l2_std_id) 0x00080000)
#define V4L2_STD_SECAM_K     ((v4l2_std_id) 0x00100000)
#define V4L2_STD_SECAM_K1    ((v4l2_std_id) 0x00200000)
#define V4L2_STD_SECAM_L     ((v4l2_std_id) 0x00400000)
#define V4L2_STD_SECAM_LC    ((v4l2_std_id) 0x00800000)

/* ATSC/HDTV */
#define V4L2_STD_ATSC_8_VSB  ((v4l2_std_id) 0x01000000)
#define V4L2_STD_ATSC_16_VSB ((v4l2_std_id) 0x02000000)
```

```

/* FIXME:
   Although std_id is 64 bits, there is an issue on PPC32 architecture that
   makes switch(__u64) to break. So, there's a hack on v4l2-common.c round
   this value to 32 bits.
   As, currently, the max value is for V4L2_STD_ATSC_16_VSB (30 bits wide),
   it should work fine. However, if needed to add more than two standards,
   v4l2-common.c should be fixed.
*/

/* some merged standards */
#define V4L2_STD_MN      (V4L2_STD_PAL_M|V4L2_STD_PAL_N|V4L2_STD_PAL_Nc|V4L2_STD_PAL_K)
#define V4L2_STD_B      (V4L2_STD_PAL_B|V4L2_STD_PAL_B1|V4L2_STD_SECAM_B)
#define V4L2_STD_GH     (V4L2_STD_PAL_G|V4L2_STD_PAL_H|V4L2_STD_SECAM_G|V4L2_STD_SECAM_H)
#define V4L2_STD_DK     (V4L2_STD_PAL_DK|V4L2_STD_SECAM_DK)

/* some common needed stuff */
#define V4L2_STD_PAL_BG  (V4L2_STD_PAL_B      |\
                          V4L2_STD_PAL_B1     |\
                          V4L2_STD_PAL_G)
#define V4L2_STD_PAL_DK (V4L2_STD_PAL_D      |\
                          V4L2_STD_PAL_D1     |\
                          V4L2_STD_PAL_K)
#define V4L2_STD_PAL    (V4L2_STD_PAL_BG     |\
                          V4L2_STD_PAL_DK     |\
                          V4L2_STD_PAL_H      |\
                          V4L2_STD_PAL_I)
#define V4L2_STD_NTSC   (V4L2_STD_NTSC_M     |\
                          V4L2_STD_NTSC_M_JP  |\
                          V4L2_STD_NTSC_M_KR)
#define V4L2_STD_SECAM_DK (V4L2_STD_SECAM_D   |\
                           V4L2_STD_SECAM_K   |\
                           V4L2_STD_SECAM_K1)
#define V4L2_STD_SECAM  (V4L2_STD_SECAM_B     |\
                          V4L2_STD_SECAM_G     |\
                          V4L2_STD_SECAM_H     |\
                          V4L2_STD_SECAM_DK    |\
                          V4L2_STD_SECAM_L     |\
                          V4L2_STD_SECAM_LC)

#define V4L2_STD_525_60 (V4L2_STD_PAL_M      |\
                          V4L2_STD_PAL_60     |\
                          V4L2_STD_NTSC       |\
                          V4L2_STD_NTSC_443)
#define V4L2_STD_625_50 (V4L2_STD_PAL       |\
                          V4L2_STD_PAL_N      |\
                          V4L2_STD_PAL_Nc     |\
                          V4L2_STD_SECAM)

```


Appendix B. Video For Linux Two Header File

```
#define V4L2_STD_ATSC          (V4L2_STD_ATSC_8_VSB      |\
                                V4L2_STD_ATSC_16_VSB)

#define V4L2_STD_UNKNOWN      0
#define V4L2_STD_ALL          (V4L2_STD_525_60          |\
                                V4L2_STD_625_50)

struct v4l2_standard {
    __u32          index;
    v4l2_std_id    id;
    __u8          name[24];
    struct v4l2_fract frameperiod; /* Frames, not fields */
    __u32          framelines;
    __u32          reserved[4];
};

/*
 *      V I D E O      T I M I N G S      D V      P R E S E T
 */
struct v4l2_dv_preset {
    __u32    preset;
    __u32    reserved[4];
};

/*
 *      D V      P R E S E T S      E N U M E R A T I O N
 */
struct v4l2_dv_enum_preset {
    __u32    index;
    __u32    preset;
    __u8    name[32]; /* Name of the preset timing */
    __u32    width;
    __u32    height;
    __u32    reserved[4];
};

/*
 *      D V      P R E S E T      V A L U E S
 */
#define V4L2_DV_INVALID          0
#define V4L2_DV_480P59_94      1 /* BT.1362 */
#define V4L2_DV_576P50          2 /* BT.1362 */
#define V4L2_DV_720P24          3 /* SMPTE 296M */
#define V4L2_DV_720P25          4 /* SMPTE 296M */
#define V4L2_DV_720P30          5 /* SMPTE 296M */
#define V4L2_DV_720P50          6 /* SMPTE 296M */
#define V4L2_DV_720P59_94      7 /* SMPTE 274M */
#define V4L2_DV_720P60          8 /* SMPTE 274M/296M */
```

Appendix B. Video For Linux Two Header File

```
#define V4L2_DV_1080I29_97 9 /* BT.1120/ SMPTE 274M */
#define V4L2_DV_1080I30 10 /* BT.1120/ SMPTE 274M */
#define V4L2_DV_1080I25 11 /* BT.1120 */
#define V4L2_DV_1080I50 12 /* SMPTE 296M */
#define V4L2_DV_1080I60 13 /* SMPTE 296M */
#define V4L2_DV_1080P24 14 /* SMPTE 296M */
#define V4L2_DV_1080P25 15 /* SMPTE 296M */
#define V4L2_DV_1080P30 16 /* SMPTE 296M */
#define V4L2_DV_1080P50 17 /* BT.1120 */
#define V4L2_DV_1080P60 18 /* BT.1120 */

/*
 * D V B T T I M I N G S
 */

/* BT.656/BT.1120 timing data */
struct v4l2_bt_timings {
    __u32 width; /* width in pixels */
    __u32 height; /* height in lines */
    __u32 interlaced; /* Interlaced or progressive */
    __u32 polarities; /* Positive or negative polarity */
    __u64 pixelclock; /* Pixel clock in HZ. Ex. 74.25MHz->742500000 */
    __u32 hfrontporch; /* Horizontal front porch in pixels */
    __u32 hsync; /* Horizontal Sync length in pixels */
    __u32 hbackporch; /* Horizontal back porch in pixels */
    __u32 vfrontporch; /* Vertical front porch in pixels */
    __u32 vsync; /* Vertical Sync length in lines */
    __u32 vbackporch; /* Vertical back porch in lines */
    __u32 il_vfrontporch; /* Vertical front porch for bottom field of
        * interlaced field formats
        */
    __u32 il_vsync; /* Vertical sync length for bottom field of
        * interlaced field formats
        */
    __u32 il_vbackporch; /* Vertical back porch for bottom field of
        * interlaced field formats
        */
    __u32 reserved[16];
} __attribute__((packed));

/* Interlaced or progressive format */
#define V4L2_DV_PROGRESSIVE 0
#define V4L2_DV_INTERLACED 1

/* Polarities. If bit is not set, it is assumed to be negative polarity */
#define V4L2_DV_VSYNC_POS_POL 0x00000001
#define V4L2_DV_HSYNC_POS_POL 0x00000002
```

Appendix B. Video For Linux Two Header File

```
/* DV timings */
struct v4l2_dv_timings {
    __u32 type;
    union {
        struct v4l2_bt_timings bt;
        __u32 reserved[32];
    };
} __attribute__((packed));

/* Values for the type field */
#define V4L2_DV_BT_656_1120 0 /* BT.656/1120 timing type */

/*
 *      V I D E O   I N P U T S
 */
struct v4l2_input {
    __u32 index; /* Which input */
    __u8 name[32]; /* Label */
    __u32 type; /* Type of input */
    __u32 audioset; /* Associated audios (bitfield) */
    __u32 tuner; /* Associated tuner */
    v4l2_std_id std;
    __u32 status;
    __u32 capabilities;
    __u32 reserved[3];
};

/* Values for the 'type' field */
#define V4L2_INPUT_TYPE_TUNER 1
#define V4L2_INPUT_TYPE_CAMERA 2

/* field 'status' - general */
#define V4L2_IN_ST_NO_POWER 0x00000001 /* Attached device is off */
#define V4L2_IN_ST_NO_SIGNAL 0x00000002
#define V4L2_IN_ST_NO_COLOR 0x00000004

/* field 'status' - sensor orientation */
/* If sensor is mounted upside down set both bits */
#define V4L2_IN_ST_HFLIP 0x00000010 /* Frames are flipped horizontally */
#define V4L2_IN_ST_VFLIP 0x00000020 /* Frames are flipped vertically */

/* field 'status' - analog */
#define V4L2_IN_ST_NO_H_LOCK 0x00000100 /* No horizontal sync lock */
#define V4L2_IN_ST_COLOR_KILL 0x00000200 /* Color killer is active */

/* field 'status' - digital */
#define V4L2_IN_ST_NO_SYNC 0x00010000 /* No synchronization lock */
```

Appendix B. Video For Linux Two Header File

```
#define V4L2_IN_ST_NO_EQU      0x00020000  /* No equalizer lock */
#define V4L2_IN_ST_NO_CARRIER 0x00040000  /* Carrier recovery failed */

/* field 'status' - VCR and set-top box */
#define V4L2_IN_ST_MACROVISION 0x01000000  /* Macrovision detected */
#define V4L2_IN_ST_NO_ACCESS   0x02000000  /* Conditional access denied */
#define V4L2_IN_ST_VTR         0x04000000  /* VTR time constant */

/* capabilities flags */
#define V4L2_IN_CAP_PRESETS     0x00000001 /* Supports S_DV_PRESETS */
#define V4L2_IN_CAP_CUSTOM_TIMINGS 0x00000002 /* Supports S_DV_TIMING */
#define V4L2_IN_CAP_STD         0x00000004 /* Supports S_STD */

/*
 *      V I D E O   O U T P U T S
 */
struct v4l2_output {
    __u32      index;           /* Which output */
    __u8       name[32];        /* Label */
    __u32      type;            /* Type of output */
    __u32      audioset;        /* Associated audios (bitfield) */
    __u32      modulator;       /* Associated modulator */
    v4l2_std_id std;
    __u32      capabilities;
    __u32      reserved[3];
};

/* Values for the 'type' field */
#define V4L2_OUTPUT_TYPE_MODULATOR      1
#define V4L2_OUTPUT_TYPE_ANALOG          2
#define V4L2_OUTPUT_TYPE_ANALOGVGAOVERLAY 3

/* capabilities flags */
#define V4L2_OUT_CAP_PRESETS     0x00000001 /* Supports S_DV_PRESETS */
#define V4L2_OUT_CAP_CUSTOM_TIMINGS 0x00000002 /* Supports S_DV_TIMING */
#define V4L2_OUT_CAP_STD         0x00000004 /* Supports S_STD */

/*
 *      C O N T R O L S
 */
struct v4l2_control {
    __u32      id;
    __s32      value;
};

struct v4l2_ext_control {
    __u32 id;
    __u32 size;
    __u32 reserved2[1];
};
```

Appendix B. Video For Linux Two Header File

```
        union {
            __s32 value;
            __s64 value64;
            char *string;
        };
    } __attribute__((packed));

struct v4l2_ext_controls {
    __u32 ctrl_class;
    __u32 count;
    __u32 error_idx;
    __u32 reserved[2];
    struct v4l2_ext_control *controls;
};

/* Values for ctrl_class field */
#define V4L2_CTRL_CLASS_USER 0x00980000 /* Old-style 'user' controls */
#define V4L2_CTRL_CLASS_MPEG 0x00990000 /* MPEG-compression controls */
#define V4L2_CTRL_CLASS_CAMERA 0x009a0000 /* Camera class controls */
#define V4L2_CTRL_CLASS_FM_TX 0x009b0000 /* FM Modulator control class */

#define V4L2_CTRL_ID_MASK (0xffffffff)
#define V4L2_CTRL_ID2CLASS(id) ((id) & 0x0fff0000UL)
#define V4L2_CTRL_DRIVER_PRIV(id) (((id) & 0xffff) >= 0x1000)

enum v4l2_ctrl_type {
    V4L2_CTRL_TYPE_INTEGER = 1,
    V4L2_CTRL_TYPE_BOOLEAN = 2,
    V4L2_CTRL_TYPE_MENU = 3,
    V4L2_CTRL_TYPE_BUTTON = 4,
    V4L2_CTRL_TYPE_INTEGER64 = 5,
    V4L2_CTRL_TYPE_CTRL_CLASS = 6,
    V4L2_CTRL_TYPE_STRING = 7,
};

/* Used in the VIDIOC_QUERYCTRL ioctl for querying controls */
struct v4l2_queryctrl {
    __u32 id;
    enum v4l2_ctrl_type type;
    __u8 name[32]; /* Whatever */
    __s32 minimum; /* Note signedness */
    __s32 maximum;
    __s32 step;
    __s32 default_value;
    __u32 flags;
    __u32 reserved[2];
};
```

Appendix B. Video For Linux Two Header File

```
/* Used in the VIDIOC_QUERYMENU ioctl for querying menu items */
struct v4l2_querymenu {
    __u32          id;
    __u32          index;
    __u8           name[32];      /* Whatever */
    __u32          reserved;
};

/* Control flags */
#define V4L2_CTRL_FLAG_DISABLED      0x0001
#define V4L2_CTRL_FLAG_GRABBED      0x0002
#define V4L2_CTRL_FLAG_READ_ONLY    0x0004
#define V4L2_CTRL_FLAG_UPDATE       0x0008
#define V4L2_CTRL_FLAG_INACTIVE     0x0010
#define V4L2_CTRL_FLAG_SLIDER       0x0020
#define V4L2_CTRL_FLAG_WRITE_ONLY   0x0040

/* Query flag, to be ORed with the control ID */
#define V4L2_CTRL_FLAG_NEXT_CTRL     0x80000000

/* User-class control IDs defined by V4L2 */
#define V4L2_CID_BASE                 (V4L2_CTRL_CLASS_USER | 0x900)
#define V4L2_CID_USER_BASE           V4L2_CID_BASE
/* IDs reserved for driver specific controls */
#define V4L2_CID_PRIVATE_BASE        0x08000000

#define V4L2_CID_USER_CLASS           (V4L2_CTRL_CLASS_USER | 1)
#define V4L2_CID_BRIGHTNESS          (V4L2_CID_BASE+0)
#define V4L2_CID_CONTRAST             (V4L2_CID_BASE+1)
#define V4L2_CID_SATURATION           (V4L2_CID_BASE+2)
#define V4L2_CID_HUE                 (V4L2_CID_BASE+3)
#define V4L2_CID_AUDIO_VOLUME        (V4L2_CID_BASE+5)
#define V4L2_CID_AUDIO_BALANCE       (V4L2_CID_BASE+6)
#define V4L2_CID_AUDIO_BASS          (V4L2_CID_BASE+7)
#define V4L2_CID_AUDIO_TREBLE        (V4L2_CID_BASE+8)
#define V4L2_CID_AUDIO_MUTE          (V4L2_CID_BASE+9)
#define V4L2_CID_AUDIO_LOUDNESS      (V4L2_CID_BASE+10)
#define V4L2_CID_BLACK_LEVEL          (V4L2_CID_BASE+11) /* Deprecated */
#define V4L2_CID_AUTO_WHITE_BALANCE  (V4L2_CID_BASE+12)
#define V4L2_CID_DO_WHITE_BALANCE    (V4L2_CID_BASE+13)
#define V4L2_CID_RED_BALANCE         (V4L2_CID_BASE+14)
#define V4L2_CID_BLUE_BALANCE        (V4L2_CID_BASE+15)
#define V4L2_CID_GAMMA               (V4L2_CID_BASE+16)
#define V4L2_CID_WHITENESS           (V4L2_CID_GAMMA) /* Deprecated */
#define V4L2_CID_EXPOSURE            (V4L2_CID_BASE+17)
#define V4L2_CID_AUTOGAIN            (V4L2_CID_BASE+18)
#define V4L2_CID_GAIN                (V4L2_CID_BASE+19)
#define V4L2_CID_HFLIP               (V4L2_CID_BASE+20)
```

Appendix B. Video For Linux Two Header File

```
#define V4L2_CID_VFLIP                                (V4L2_CID_BASE+21)

/* Deprecated; use V4L2_CID_PAN_RESET and V4L2_CID_TILT_RESET */
#define V4L2_CID_HCENTER                              (V4L2_CID_BASE+22)
#define V4L2_CID_VCENTER                              (V4L2_CID_BASE+23)

#define V4L2_CID_POWER_LINE_FREQUENCY                (V4L2_CID_BASE+24)
enum v4l2_power_line_frequency {
    V4L2_CID_POWER_LINE_FREQUENCY_DISABLED    = 0,
    V4L2_CID_POWER_LINE_FREQUENCY_50HZ       = 1,
    V4L2_CID_POWER_LINE_FREQUENCY_60HZ       = 2,
};

#define V4L2_CID_HUE_AUTO                            (V4L2_CID_BASE+25)
#define V4L2_CID_WHITE_BALANCE_TEMPERATURE          (V4L2_CID_BASE+26)
#define V4L2_CID_SHARPNESS                          (V4L2_CID_BASE+27)
#define V4L2_CID_BACKLIGHT_COMPENSATION              (V4L2_CID_BASE+28)
#define V4L2_CID_CHROMA_AGC                          (V4L2_CID_BASE+29)
#define V4L2_CID_COLOR_KILLER                       (V4L2_CID_BASE+30)
#define V4L2_CID_COLORFX                             (V4L2_CID_BASE+31)
enum v4l2_colorfx {
    V4L2_COLORFX_NONE            = 0,
    V4L2_COLORFX_BW              = 1,
    V4L2_COLORFX_SEPIA           = 2,
    V4L2_COLORFX_NEGATIVE        = 3,
    V4L2_COLORFX_EMBOSS          = 4,
    V4L2_COLORFX_SKETCH           = 5,
    V4L2_COLORFX_SKY_BLUE        = 6,
    V4L2_COLORFX_GRASS_GREEN     = 7,
    V4L2_COLORFX_SKIN_WHITEN     = 8,
    V4L2_COLORFX_VIVID           = 9,
};

#define V4L2_CID_AUTOBRIGHTNESS                      (V4L2_CID_BASE+32)
#define V4L2_CID_BAND_STOP_FILTER                    (V4L2_CID_BASE+33)

#define V4L2_CID_ROTATE                              (V4L2_CID_BASE+34)
#define V4L2_CID_BG_COLOR                            (V4L2_CID_BASE+35)

#define V4L2_CID_CHROMA_GAIN                          (V4L2_CID_BASE+36)

#define V4L2_CID_ILLUMINATORS_1                      (V4L2_CID_BASE+37)
#define V4L2_CID_ILLUMINATORS_2                      (V4L2_CID_BASE+38)

/* last CID + 1 */
#define V4L2_CID_LASTP1                              (V4L2_CID_BASE+39)

/* MPEG-class control IDs defined by V4L2 */
#define V4L2_CID_MPEG_BASE                          (V4L2_CTRL_CLASS_MPEG | 0)
#define V4L2_CID_MPEG_CLASS                        (V4L2_CTRL_CLASS_MPEG | 1)
```

```

/* MPEG streams */
#define V4L2_CID_MPEG_STREAM_TYPE (V4L2_CID_MPEG_BASE+0)
enum v4l2_mpeg_stream_type {
    V4L2_MPEG_STREAM_TYPE_MPEG2_PS    = 0, /* MPEG-2 program stream */
    V4L2_MPEG_STREAM_TYPE_MPEG2_TS    = 1, /* MPEG-2 transport stream */
    V4L2_MPEG_STREAM_TYPE_MPEG1_SS    = 2, /* MPEG-1 system stream */
    V4L2_MPEG_STREAM_TYPE_MPEG2_DVD   = 3, /* MPEG-2 DVD-compatible stream */
    V4L2_MPEG_STREAM_TYPE_MPEG1_VCD   = 4, /* MPEG-1 VCD-compatible stream */
    V4L2_MPEG_STREAM_TYPE_MPEG2_SVCD  = 5, /* MPEG-2 SVCD-compatible stream */
};

#define V4L2_CID_MPEG_STREAM_PID_PMT (V4L2_CID_MPEG_BASE+1)
#define V4L2_CID_MPEG_STREAM_PID_AUDIO (V4L2_CID_MPEG_BASE+2)
#define V4L2_CID_MPEG_STREAM_PID_VIDEO (V4L2_CID_MPEG_BASE+3)
#define V4L2_CID_MPEG_STREAM_PID_PCR (V4L2_CID_MPEG_BASE+4)
#define V4L2_CID_MPEG_STREAM_PES_ID_AUDIO (V4L2_CID_MPEG_BASE+5)
#define V4L2_CID_MPEG_STREAM_PES_ID_VIDEO (V4L2_CID_MPEG_BASE+6)
#define V4L2_CID_MPEG_STREAM_VBI_FMT (V4L2_CID_MPEG_BASE+7)
enum v4l2_mpeg_stream_vbi_fmt {
    V4L2_MPEG_STREAM_VBI_FMT_NONE = 0, /* No VBI in the MPEG stream */
    V4L2_MPEG_STREAM_VBI_FMT_IVTV = 1, /* VBI in private packets, IVTV */
};

/* MPEG audio */
#define V4L2_CID_MPEG_AUDIO_SAMPLING_FREQ (V4L2_CID_MPEG_BASE+100)
enum v4l2_mpeg_audio_sampling_freq {
    V4L2_MPEG_AUDIO_SAMPLING_FREQ_44100 = 0,
    V4L2_MPEG_AUDIO_SAMPLING_FREQ_48000 = 1,
    V4L2_MPEG_AUDIO_SAMPLING_FREQ_32000 = 2,
};

#define V4L2_CID_MPEG_AUDIO_ENCODING (V4L2_CID_MPEG_BASE+101)
enum v4l2_mpeg_audio_encoding {
    V4L2_MPEG_AUDIO_ENCODING_LAYER_1 = 0,
    V4L2_MPEG_AUDIO_ENCODING_LAYER_2 = 1,
    V4L2_MPEG_AUDIO_ENCODING_LAYER_3 = 2,
    V4L2_MPEG_AUDIO_ENCODING_AAC     = 3,
    V4L2_MPEG_AUDIO_ENCODING_AC3     = 4,
};

#define V4L2_CID_MPEG_AUDIO_L1_BITRATE (V4L2_CID_MPEG_BASE+102)
enum v4l2_mpeg_audio_l1_bitrate {
    V4L2_MPEG_AUDIO_L1_BITRATE_32K   = 0,
    V4L2_MPEG_AUDIO_L1_BITRATE_64K   = 1,
    V4L2_MPEG_AUDIO_L1_BITRATE_96K   = 2,
    V4L2_MPEG_AUDIO_L1_BITRATE_128K  = 3,
    V4L2_MPEG_AUDIO_L1_BITRATE_160K  = 4,
    V4L2_MPEG_AUDIO_L1_BITRATE_192K  = 5,
    V4L2_MPEG_AUDIO_L1_BITRATE_224K  = 6,
    V4L2_MPEG_AUDIO_L1_BITRATE_256K  = 7,
};

```


Appendix B. Video For Linux Two Header File

```
V4L2_MPEG_AUDIO_L1_BITRATE_288K = 8,
V4L2_MPEG_AUDIO_L1_BITRATE_320K = 9,
V4L2_MPEG_AUDIO_L1_BITRATE_352K = 10,
V4L2_MPEG_AUDIO_L1_BITRATE_384K = 11,
V4L2_MPEG_AUDIO_L1_BITRATE_416K = 12,
V4L2_MPEG_AUDIO_L1_BITRATE_448K = 13,
};
#define V4L2_CID_MPEG_AUDIO_L2_BITRATE (V4L2_CID_MPEG_BASE+103)
enum v4l2_mpeg_audio_l2_bitrate {
    V4L2_MPEG_AUDIO_L2_BITRATE_32K = 0,
    V4L2_MPEG_AUDIO_L2_BITRATE_48K = 1,
    V4L2_MPEG_AUDIO_L2_BITRATE_56K = 2,
    V4L2_MPEG_AUDIO_L2_BITRATE_64K = 3,
    V4L2_MPEG_AUDIO_L2_BITRATE_80K = 4,
    V4L2_MPEG_AUDIO_L2_BITRATE_96K = 5,
    V4L2_MPEG_AUDIO_L2_BITRATE_112K = 6,
    V4L2_MPEG_AUDIO_L2_BITRATE_128K = 7,
    V4L2_MPEG_AUDIO_L2_BITRATE_160K = 8,
    V4L2_MPEG_AUDIO_L2_BITRATE_192K = 9,
    V4L2_MPEG_AUDIO_L2_BITRATE_224K = 10,
    V4L2_MPEG_AUDIO_L2_BITRATE_256K = 11,
    V4L2_MPEG_AUDIO_L2_BITRATE_320K = 12,
    V4L2_MPEG_AUDIO_L2_BITRATE_384K = 13,
};
#define V4L2_CID_MPEG_AUDIO_L3_BITRATE (V4L2_CID_MPEG_BASE+104)
enum v4l2_mpeg_audio_l3_bitrate {
    V4L2_MPEG_AUDIO_L3_BITRATE_32K = 0,
    V4L2_MPEG_AUDIO_L3_BITRATE_40K = 1,
    V4L2_MPEG_AUDIO_L3_BITRATE_48K = 2,
    V4L2_MPEG_AUDIO_L3_BITRATE_56K = 3,
    V4L2_MPEG_AUDIO_L3_BITRATE_64K = 4,
    V4L2_MPEG_AUDIO_L3_BITRATE_80K = 5,
    V4L2_MPEG_AUDIO_L3_BITRATE_96K = 6,
    V4L2_MPEG_AUDIO_L3_BITRATE_112K = 7,
    V4L2_MPEG_AUDIO_L3_BITRATE_128K = 8,
    V4L2_MPEG_AUDIO_L3_BITRATE_160K = 9,
    V4L2_MPEG_AUDIO_L3_BITRATE_192K = 10,
    V4L2_MPEG_AUDIO_L3_BITRATE_224K = 11,
    V4L2_MPEG_AUDIO_L3_BITRATE_256K = 12,
    V4L2_MPEG_AUDIO_L3_BITRATE_320K = 13,
};
#define V4L2_CID_MPEG_AUDIO_MODE (V4L2_CID_MPEG_BASE+105)
enum v4l2_mpeg_audio_mode {
    V4L2_MPEG_AUDIO_MODE_STEREO = 0,
    V4L2_MPEG_AUDIO_MODE_JOINT_STEREO = 1,
    V4L2_MPEG_AUDIO_MODE_DUAL = 2,
    V4L2_MPEG_AUDIO_MODE_MONO = 3,
};
```

Appendix B. Video For Linux Two Header File

```
#define V4L2_CID_MPEG_AUDIO_MODE_EXTENSION      (V4L2_CID_MPEG_BASE+106)
enum v4l2_mpeg_audio_mode_extension {
    V4L2_MPEG_AUDIO_MODE_EXTENSION_BOUND_4   = 0,
    V4L2_MPEG_AUDIO_MODE_EXTENSION_BOUND_8   = 1,
    V4L2_MPEG_AUDIO_MODE_EXTENSION_BOUND_12  = 2,
    V4L2_MPEG_AUDIO_MODE_EXTENSION_BOUND_16  = 3,
};

#define V4L2_CID_MPEG_AUDIO_EMPHASIS           (V4L2_CID_MPEG_BASE+107)
enum v4l2_mpeg_audio_emphasis {
    V4L2_MPEG_AUDIO_EMPHASIS_NONE            = 0,
    V4L2_MPEG_AUDIO_EMPHASIS_50_DIV_15_uS    = 1,
    V4L2_MPEG_AUDIO_EMPHASIS_CCITT_J17       = 2,
};

#define V4L2_CID_MPEG_AUDIO_CRC                (V4L2_CID_MPEG_BASE+108)
enum v4l2_mpeg_audio_crc {
    V4L2_MPEG_AUDIO_CRC_NONE                 = 0,
    V4L2_MPEG_AUDIO_CRC_CRC16                = 1,
};

#define V4L2_CID_MPEG_AUDIO_MUTE               (V4L2_CID_MPEG_BASE+109)
#define V4L2_CID_MPEG_AUDIO_AAC_BITRATE       (V4L2_CID_MPEG_BASE+110)
#define V4L2_CID_MPEG_AUDIO_AC3_BITRATE       (V4L2_CID_MPEG_BASE+111)
enum v4l2_mpeg_audio_ac3_bitrate {
    V4L2_MPEG_AUDIO_AC3_BITRATE_32K         = 0,
    V4L2_MPEG_AUDIO_AC3_BITRATE_40K         = 1,
    V4L2_MPEG_AUDIO_AC3_BITRATE_48K         = 2,
    V4L2_MPEG_AUDIO_AC3_BITRATE_56K         = 3,
    V4L2_MPEG_AUDIO_AC3_BITRATE_64K         = 4,
    V4L2_MPEG_AUDIO_AC3_BITRATE_80K         = 5,
    V4L2_MPEG_AUDIO_AC3_BITRATE_96K         = 6,
    V4L2_MPEG_AUDIO_AC3_BITRATE_112K        = 7,
    V4L2_MPEG_AUDIO_AC3_BITRATE_128K        = 8,
    V4L2_MPEG_AUDIO_AC3_BITRATE_160K        = 9,
    V4L2_MPEG_AUDIO_AC3_BITRATE_192K        = 10,
    V4L2_MPEG_AUDIO_AC3_BITRATE_224K        = 11,
    V4L2_MPEG_AUDIO_AC3_BITRATE_256K        = 12,
    V4L2_MPEG_AUDIO_AC3_BITRATE_320K        = 13,
    V4L2_MPEG_AUDIO_AC3_BITRATE_384K        = 14,
    V4L2_MPEG_AUDIO_AC3_BITRATE_448K        = 15,
    V4L2_MPEG_AUDIO_AC3_BITRATE_512K        = 16,
    V4L2_MPEG_AUDIO_AC3_BITRATE_576K        = 17,
    V4L2_MPEG_AUDIO_AC3_BITRATE_640K        = 18,
};

/* MPEG video */
#define V4L2_CID_MPEG_VIDEO_ENCODING          (V4L2_CID_MPEG_BASE+200)
enum v4l2_mpeg_video_encoding {
    V4L2_MPEG_VIDEO_ENCODING_MPEG_1         = 0,
    V4L2_MPEG_VIDEO_ENCODING_MPEG_2         = 1,
```

Appendix B. Video For Linux Two Header File

```
V4L2_MPEG_VIDEO_ENCODING_MPEG_4_AVC = 2,
};
#define V4L2_CID_MPEG_VIDEO_ASPECT (V4L2_CID_MPEG_BASE+201)
enum v4l2_mpeg_video_aspect {
    V4L2_MPEG_VIDEO_ASPECT_1x1      = 0,
    V4L2_MPEG_VIDEO_ASPECT_4x3      = 1,
    V4L2_MPEG_VIDEO_ASPECT_16x9     = 2,
    V4L2_MPEG_VIDEO_ASPECT_221x100 = 3,
};
#define V4L2_CID_MPEG_VIDEO_B_FRAMES (V4L2_CID_MPEG_BASE+202)
#define V4L2_CID_MPEG_VIDEO_GOP_SIZE (V4L2_CID_MPEG_BASE+203)
#define V4L2_CID_MPEG_VIDEO_GOP_CLOSURE (V4L2_CID_MPEG_BASE+204)
#define V4L2_CID_MPEG_VIDEO_PULLDOWN (V4L2_CID_MPEG_BASE+205)
#define V4L2_CID_MPEG_VIDEO_BITRATE_MODE (V4L2_CID_MPEG_BASE+206)
enum v4l2_mpeg_video_bitrate_mode {
    V4L2_MPEG_VIDEO_BITRATE_MODE_VBR = 0,
    V4L2_MPEG_VIDEO_BITRATE_MODE_CBR = 1,
};
#define V4L2_CID_MPEG_VIDEO_BITRATE (V4L2_CID_MPEG_BASE+207)
#define V4L2_CID_MPEG_VIDEO_BITRATE_PEAK (V4L2_CID_MPEG_BASE+208)
#define V4L2_CID_MPEG_VIDEO_TEMPORAL_DECIMATION (V4L2_CID_MPEG_BASE+209)
#define V4L2_CID_MPEG_VIDEO_MUTE (V4L2_CID_MPEG_BASE+210)
#define V4L2_CID_MPEG_VIDEO_MUTE_YUV (V4L2_CID_MPEG_BASE+211)

/* MPEG-class control IDs specific to the CX2341x driver as defined by V4L2
#define V4L2_CID_MPEG_CX2341X_BASE (V4L2_CID_MPEG_BASE+212)
#define V4L2_CID_MPEG_CX2341X_VIDEO_SPATIAL_FILTER_MODE (V4L2_CID_MPEG_CX2341X_BASE+0)
enum v4l2_mpeg_cx2341x_video_spatial_filter_mode {
    V4L2_MPEG_CX2341X_VIDEO_SPATIAL_FILTER_MODE_MANUAL = 0,
    V4L2_MPEG_CX2341X_VIDEO_SPATIAL_FILTER_MODE_AUTO   = 1,
};
#define V4L2_CID_MPEG_CX2341X_VIDEO_SPATIAL_FILTER (V4L2_CID_MPEG_CX2341X_BASE+1)
#define V4L2_CID_MPEG_CX2341X_VIDEO_LUMA_SPATIAL_FILTER_TYPE (V4L2_CID_MPEG_CX2341X_BASE+2)
enum v4l2_mpeg_cx2341x_video_luma_spatial_filter_type {
    V4L2_MPEG_CX2341X_VIDEO_LUMA_SPATIAL_FILTER_TYPE_OFF
    V4L2_MPEG_CX2341X_VIDEO_LUMA_SPATIAL_FILTER_TYPE_1D_HOR
    V4L2_MPEG_CX2341X_VIDEO_LUMA_SPATIAL_FILTER_TYPE_1D_VERT
    V4L2_MPEG_CX2341X_VIDEO_LUMA_SPATIAL_FILTER_TYPE_2D_HV_SEPARABLE
    V4L2_MPEG_CX2341X_VIDEO_LUMA_SPATIAL_FILTER_TYPE_2D_SYM_NON_SEPARABLE
};
#define V4L2_CID_MPEG_CX2341X_VIDEO_CHROMA_SPATIAL_FILTER_TYPE (V4L2_CID_MPEG_CX2341X_BASE+3)
enum v4l2_mpeg_cx2341x_video_chroma_spatial_filter_type {
    V4L2_MPEG_CX2341X_VIDEO_CHROMA_SPATIAL_FILTER_TYPE_OFF      = 0,
    V4L2_MPEG_CX2341X_VIDEO_CHROMA_SPATIAL_FILTER_TYPE_1D_HOR = 1,
};
#define V4L2_CID_MPEG_CX2341X_VIDEO_TEMPORAL_FILTER_MODE (V4L2_CID_MPEG_CX2341X_BASE+4)
enum v4l2_mpeg_cx2341x_video_temporal_filter_mode {
    V4L2_MPEG_CX2341X_VIDEO_TEMPORAL_FILTER_MODE_MANUAL = 0,
```

Appendix B. Video For Linux Two Header File

```
V4L2_MPEG_CX2341X_VIDEO_TEMPORAL_FILTER_MODE_AUTO    = 1,
};
#define V4L2_CID_MPEG_CX2341X_VIDEO_TEMPORAL_FILTER    (V4L2_CID_MPEG_CX2341X_VIDEO_TEMPORAL_FILTER_MODE_AUTO)
#define V4L2_CID_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE (V4L2_CID_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_OFF)
enum v4l2_mpeg_cx2341x_video_median_filter_type {
    V4L2_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_OFF      = 0,
    V4L2_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_HOR      = 1,
    V4L2_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_VERT     = 2,
    V4L2_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_HOR_VERT = 3,
    V4L2_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_DIAG     = 4,
};
#define V4L2_CID_MPEG_CX2341X_VIDEO_LUMA_MEDIAN_FILTER_BOTTOM (V4L2_CID_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_OFF)
#define V4L2_CID_MPEG_CX2341X_VIDEO_LUMA_MEDIAN_FILTER_TOP   (V4L2_CID_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_OFF)
#define V4L2_CID_MPEG_CX2341X_VIDEO_CHROMA_MEDIAN_FILTER_BOTTOM (V4L2_CID_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_OFF)
#define V4L2_CID_MPEG_CX2341X_VIDEO_CHROMA_MEDIAN_FILTER_TOP   (V4L2_CID_MPEG_CX2341X_VIDEO_MEDIAN_FILTER_TYPE_OFF)
#define V4L2_CID_MPEG_CX2341X_STREAM_INSERT_NAV_PACKETS      (V4L2_CID_MPEG_CX2341X_VIDEO_TEMPORAL_FILTER_MODE_AUTO)

/* Camera class control IDs */
#define V4L2_CID_CAMERA_CLASS_BASE      (V4L2_CTRL_CLASS_CAMERA | 0x900)
#define V4L2_CID_CAMERA_CLASS          (V4L2_CTRL_CLASS_CAMERA | 1)

#define V4L2_CID_EXPOSURE_AUTO          (V4L2_CID_CAMERA_CLASS_BASE + 1)
enum v4l2_exposure_auto_type {
    V4L2_EXPOSURE_AUTO = 0,
    V4L2_EXPOSURE_MANUAL = 1,
    V4L2_EXPOSURE_SHUTTER_PRIORITY = 2,
    V4L2_EXPOSURE_APERTURE_PRIORITY = 3
};
#define V4L2_CID_EXPOSURE_ABSOLUTE      (V4L2_CID_CAMERA_CLASS_BASE + 2)
#define V4L2_CID_EXPOSURE_AUTO_PRIORITY (V4L2_CID_CAMERA_CLASS_BASE + 3)

#define V4L2_CID_PAN_RELATIVE            (V4L2_CID_CAMERA_CLASS_BASE + 4)
#define V4L2_CID_TILT_RELATIVE           (V4L2_CID_CAMERA_CLASS_BASE + 5)
#define V4L2_CID_PAN_RESET               (V4L2_CID_CAMERA_CLASS_BASE + 6)
#define V4L2_CID_TILT_RESET              (V4L2_CID_CAMERA_CLASS_BASE + 7)

#define V4L2_CID_PAN_ABSOLUTE            (V4L2_CID_CAMERA_CLASS_BASE + 8)
#define V4L2_CID_TILT_ABSOLUTE           (V4L2_CID_CAMERA_CLASS_BASE + 9)

#define V4L2_CID_FOCUS_ABSOLUTE          (V4L2_CID_CAMERA_CLASS_BASE + 10)
#define V4L2_CID_FOCUS_RELATIVE          (V4L2_CID_CAMERA_CLASS_BASE + 11)
#define V4L2_CID_FOCUS_AUTO              (V4L2_CID_CAMERA_CLASS_BASE + 12)

#define V4L2_CID_ZOOM_ABSOLUTE            (V4L2_CID_CAMERA_CLASS_BASE + 13)
#define V4L2_CID_ZOOM_RELATIVE            (V4L2_CID_CAMERA_CLASS_BASE + 14)
#define V4L2_CID_ZOOM_CONTINUOUS         (V4L2_CID_CAMERA_CLASS_BASE + 15)

#define V4L2_CID_PRIVACY                  (V4L2_CID_CAMERA_CLASS_BASE + 16)
```

Appendix B. Video For Linux Two Header File

```
#define V4L2_CID_IRIS_ABSOLUTE (V4L2_CID_CAMERA_CLASS_BASE + 1)
#define V4L2_CID_IRIS_RELATIVE (V4L2_CID_CAMERA_CLASS_BASE + 2)

/* FM Modulator class control IDs */
#define V4L2_CID_FM_TX_CLASS_BASE (V4L2_CTRL_CLASS_FM_TX | 0)
#define V4L2_CID_FM_TX_CLASS (V4L2_CTRL_CLASS_FM_TX | 1)

#define V4L2_CID_RDS_TX_DEVIATION (V4L2_CID_FM_TX_CLASS_BASE + 1)
#define V4L2_CID_RDS_TX_PI (V4L2_CID_FM_TX_CLASS_BASE + 2)
#define V4L2_CID_RDS_TX_PTY (V4L2_CID_FM_TX_CLASS_BASE + 3)
#define V4L2_CID_RDS_TX_PS_NAME (V4L2_CID_FM_TX_CLASS_BASE + 4)
#define V4L2_CID_RDS_TX_RADIO_TEXT (V4L2_CID_FM_TX_CLASS_BASE + 5)

#define V4L2_CID_AUDIO_LIMITER_ENABLED (V4L2_CID_FM_TX_CLASS_BASE + 6)
#define V4L2_CID_AUDIO_LIMITER_RELEASE_TIME (V4L2_CID_FM_TX_CLASS_BASE + 7)
#define V4L2_CID_AUDIO_LIMITER_DEVIATION (V4L2_CID_FM_TX_CLASS_BASE + 8)

#define V4L2_CID_AUDIO_COMPRESSION_ENABLED (V4L2_CID_FM_TX_CLASS_BASE + 9)
#define V4L2_CID_AUDIO_COMPRESSION_GAIN (V4L2_CID_FM_TX_CLASS_BASE + 10)
#define V4L2_CID_AUDIO_COMPRESSION_THRESHOLD (V4L2_CID_FM_TX_CLASS_BASE + 11)
#define V4L2_CID_AUDIO_COMPRESSION_ATTACK_TIME (V4L2_CID_FM_TX_CLASS_BASE + 12)
#define V4L2_CID_AUDIO_COMPRESSION_RELEASE_TIME (V4L2_CID_FM_TX_CLASS_BASE + 13)

#define V4L2_CID_PILOT_TONE_ENABLED (V4L2_CID_FM_TX_CLASS_BASE + 14)
#define V4L2_CID_PILOT_TONE_DEVIATION (V4L2_CID_FM_TX_CLASS_BASE + 15)
#define V4L2_CID_PILOT_TONE_FREQUENCY (V4L2_CID_FM_TX_CLASS_BASE + 16)

#define V4L2_CID_TUNE_PREEMPHASIS (V4L2_CID_FM_TX_CLASS_BASE + 17)
enum v4l2_preemphasis {
    V4L2_PREEMPHASIS_DISABLED = 0,
    V4L2_PREEMPHASIS_50_uS = 1,
    V4L2_PREEMPHASIS_75_uS = 2,
};
#define V4L2_CID_TUNE_POWER_LEVEL (V4L2_CID_FM_TX_CLASS_BASE + 18)
#define V4L2_CID_TUNE_ANTENNA_CAPACITOR (V4L2_CID_FM_TX_CLASS_BASE + 19)

/*
 *      T U N I N G
 */
struct v4l2_tuner {
    __u32 index;
    __u8 name[32];
    enum v4l2_tuner_type type;
    __u32 capability;
    __u32 rangelow;
    __u32 rangehigh;
    __u32 rxsubchans;
```

```

        __u32                audmode;
        __s32                signal;
        __s32                afc;
        __u32                reserved[4];
};

struct v4l2_modulator {
        __u32                index;
        __u8                 name[32];
        __u32                capability;
        __u32                rangelow;
        __u32                rangehigh;
        __u32                txsubchans;
        __u32                reserved[4];
};

/*  Flags for the 'capability' field */
#define V4L2_TUNER_CAP_LOW          0x0001
#define V4L2_TUNER_CAP_NORM        0x0002
#define V4L2_TUNER_CAP_STEREO      0x0010
#define V4L2_TUNER_CAP_LANG2       0x0020
#define V4L2_TUNER_CAP_SAP         0x0020
#define V4L2_TUNER_CAP_LANG1       0x0040
#define V4L2_TUNER_CAP_RDS         0x0080
#define V4L2_TUNER_CAP_RDS_BLOCK_IO 0x0100
#define V4L2_TUNER_CAP_RDS_CONTROLS 0x0200

/*  Flags for the 'rxsubchans' field */
#define V4L2_TUNER_SUB_MONO         0x0001
#define V4L2_TUNER_SUB_STEREO      0x0002
#define V4L2_TUNER_SUB_LANG2       0x0004
#define V4L2_TUNER_SUB_SAP         0x0004
#define V4L2_TUNER_SUB_LANG1       0x0008
#define V4L2_TUNER_SUB_RDS         0x0010

/*  Values for the 'audmode' field */
#define V4L2_TUNER_MODE_MONO        0x0000
#define V4L2_TUNER_MODE_STEREO     0x0001
#define V4L2_TUNER_MODE_LANG2      0x0002
#define V4L2_TUNER_MODE_SAP        0x0002
#define V4L2_TUNER_MODE_LANG1      0x0003
#define V4L2_TUNER_MODE_LANG1_LANG2 0x0004

struct v4l2_frequency {
        __u32                tuner;
        enum v4l2_tuner_type  type;
        __u32                frequency;
        __u32                reserved[8];
};

```

Appendix B. Video For Linux Two Header File

```
};

struct v4l2_hw_freq_seek {
    __u32          tuner;
    enum v4l2_tuner_type type;
    __u32          seek_upward;
    __u32          wrap_around;
    __u32          spacing;
    __u32          reserved[7];
};

/*
 *      R D S
 */

struct v4l2_rds_data {
    __u8    lsb;
    __u8    msb;
    __u8    block;
} __attribute__((packed));

#define V4L2_RDS_BLOCK_MSK      0x7
#define V4L2_RDS_BLOCK_A      0
#define V4L2_RDS_BLOCK_B      1
#define V4L2_RDS_BLOCK_C      2
#define V4L2_RDS_BLOCK_D      3
#define V4L2_RDS_BLOCK_C_ALT   4
#define V4L2_RDS_BLOCK_INVALID 7

#define V4L2_RDS_BLOCK_CORRECTED 0x40
#define V4L2_RDS_BLOCK_ERROR     0x80

/*
 *      A U D I O
 */
struct v4l2_audio {
    __u32    index;
    __u8     name[32];
    __u32    capability;
    __u32    mode;
    __u32    reserved[2];
};

/*  Flags for the 'capability' field */
#define V4L2_AUDCAP_STEREO      0x00001
#define V4L2_AUDCAP_AVL        0x00002

/*  Flags for the 'mode' field */
```

```

#define V4L2_AUDMODE_AVL                                0x00001

struct v4l2_audioout {
    __u32    index;
    __u8     name[32];
    __u32    capability;
    __u32    mode;
    __u32    reserved[2];
};

/*
 *      M P E G      S E R V I C E S
 *
 *      NOTE: EXPERIMENTAL API
 */
#if 1
#define V4L2_ENC_IDX_FRAME_I      (0)
#define V4L2_ENC_IDX_FRAME_P      (1)
#define V4L2_ENC_IDX_FRAME_B      (2)
#define V4L2_ENC_IDX_FRAME_MASK  (0xf)

struct v4l2_enc_idx_entry {
    __u64 offset;
    __u64 pts;
    __u32 length;
    __u32 flags;
    __u32 reserved[2];
};

#define V4L2_ENC_IDX_ENTRIES (64)
struct v4l2_enc_idx {
    __u32 entries;
    __u32 entries_cap;
    __u32 reserved[4];
    struct v4l2_enc_idx_entry entry[V4L2_ENC_IDX_ENTRIES];
};

#define V4L2_ENC_CMD_START      (0)
#define V4L2_ENC_CMD_STOP      (1)
#define V4L2_ENC_CMD_PAUSE     (2)
#define V4L2_ENC_CMD_RESUME    (3)

/* Flags for V4L2_ENC_CMD_STOP */
#define V4L2_ENC_CMD_STOP_AT_GOP_END    (1 << 0)

struct v4l2_encoder_cmd {
    __u32 cmd;

```


Appendix B. Video For Linux Two Header File

```
        __u32 flags;
        union {
            struct {
                __u32 data[8];
            } raw;
        };
};

#endif

/*
 *      D A T A      S E R V I C E S      ( V B I )
 *
 *      Data services API by Michael Schimek
 */

/* Raw VBI */
struct v4l2_vbi_format {
    __u32    sampling_rate;           /* in 1 Hz */
    __u32    offset;
    __u32    samples_per_line;
    __u32    sample_format;           /* V4L2_PIX_FMT_* */
    __s32    start[2];
    __u32    count[2];
    __u32    flags;                   /* V4L2_VBI_* */
    __u32    reserved[2];             /* must be zero */
};

/* VBI flags */
#define V4L2_VBI_UNSYNC      (1 << 0)
#define V4L2_VBI_INTERLACED (1 << 1)

/* Sliced VBI
 *
 *      This implements is a proposal V4L2 API to allow SLICED VBI
 *      required for some hardware encoders. It should change without
 *      notice in the definitive implementation.
 */

struct v4l2_sliced_vbi_format {
    __u16    service_set;
    /* service_lines[0][...] specifies lines 0-23 (1-23 used) of the s
       service_lines[1][...] specifies lines 0-23 (1-23 used) of the s
                                   (equals frame lines 313-336 for 625 line
                                   standards, 263-286 for 525 line standard
    __u16    service_lines[2][24];
    __u32    io_size;
```

Appendix B. Video For Linux Two Header File

```
        __u32    reserved[2];                /* must be zero */
};

/* Teletext World System Teletext
   (WST), defined on ITU-R BT.653-2 */
#define V4L2_SLICED_TELETEXT_B              (0x0001)
/* Video Program System, defined on ETS 300 231*/
#define V4L2_SLICED_VPS                     (0x0400)
/* Closed Caption, defined on EIA-608 */
#define V4L2_SLICED_CAPTION_525             (0x1000)
/* Wide Screen System, defined on ITU-R BT1119.1 */
#define V4L2_SLICED_WSS_625                 (0x4000)

#define V4L2_SLICED_VBI_525                 (V4L2_SLICED_CAPTION_525)
#define V4L2_SLICED_VBI_625                 (V4L2_SLICED_TELETEXT_B | V4L2_SLICED_WSS_625)

struct v4l2_sliced_vbi_cap {
    __u16    service_set;
    /* service_lines[0][...] specifies lines 0-23 (1-23 used) of the s
       service_lines[1][...] specifies lines 0-23 (1-23 used) of the s
                                   (equals frame lines 313-336 for 625 line
                                   standards, 263-286 for 525 line standard
    __u16    service_lines[2][24];
    enum v4l2_buf_type type;
    __u32    reserved[3];    /* must be 0 */
};

struct v4l2_sliced_vbi_data {
    __u32    id;
    __u32    field;          /* 0: first field, 1: second field */
    __u32    line;           /* 1-23 */
    __u32    reserved;       /* must be 0 */
    __u8     data[48];
};

/*
 * Sliced VBI data inserted into MPEG Streams
 */

/*
 * V4L2_MPEG_STREAM_VBI_FMT_IVTV:
 *
 * Structure of payload contained in an MPEG 2 Private Stream 1 PES Packet
 * MPEG-2 Program Pack that contains V4L2_MPEG_STREAM_VBI_FMT_IVTV Sliced
 * data
 *
 * Note, the MPEG-2 Program Pack and Private Stream 1 PES packet header
 * definitions are not included here. See the MPEG-2 specifications for o
```

Appendix B. Video For Linux Two Header File

```
* on these headers.
*/

/* Line type IDs */
#define V4L2_MPEG_VBI_IVTV_TELETEXT_B      (1)
#define V4L2_MPEG_VBI_IVTV_CAPTION_525    (4)
#define V4L2_MPEG_VBI_IVTV_WSS_625        (5)
#define V4L2_MPEG_VBI_IVTV_VPS            (7)

struct v4l2_mpeg_vbi_itv0_line {
    __u8 id;          /* One of V4L2_MPEG_VBI_IVTV_* above */
    __u8 data[42];    /* Sliced VBI data for the line */
} __attribute__((packed));

struct v4l2_mpeg_vbi_itv0 {
    __le32 linemask[2]; /* Bitmasks of VBI service lines present */
    struct v4l2_mpeg_vbi_itv0_line line[35];
} __attribute__((packed));

struct v4l2_mpeg_vbi_ITV0 {
    struct v4l2_mpeg_vbi_itv0_line line[36];
} __attribute__((packed));

#define V4L2_MPEG_VBI_IVTV_MAGIC0          "itv0"
#define V4L2_MPEG_VBI_IVTV_MAGIC1          "ITV0"

struct v4l2_mpeg_vbi_fmt_itv {
    __u8 magic[4];
    union {
        struct v4l2_mpeg_vbi_itv0 itv0;
        struct v4l2_mpeg_vbi_ITV0 ITV0;
    };
} __attribute__((packed));

/*
 *      A G G R E G A T E   S T R U C T U R E S
 */

/**
 * struct v4l2_plane_pix_format - additional, per-plane format definition
 * @sizeimage:          maximum size in bytes required for data, for which
 *                      this plane will be used
 * @bytesperline:        distance in bytes between the leftmost pixels in t
 *                      adjacent lines
 */
struct v4l2_plane_pix_format {
    __u32                sizeimage;
    __u16                bytesperline;
}
```

```

        __u16                reserved[7];
} __attribute__ ((packed));

/**
 * struct v4l2_pix_format_mplane - multiplanar format definition
 * @width:                image width in pixels
 * @height:               image height in pixels
 * @pixelformat:          little endian four character code (fourcc)
 * @field:                field order (for interlaced video)
 * @colorspace:           supplemental to pixelformat
 * @plane_fmt:            per-plane information
 * @num_planes:           number of planes for this format
 */
struct v4l2_pix_format_mplane {
        __u32                width;
        __u32                height;
        __u32                pixelformat;
        enum v4l2_field      field;
        enum v4l2_colorspace colorspace;

        struct v4l2_plane_pix_format plane_fmt[VIDEO_MAX_PLANES];
        __u8                num_planes;
        __u8                reserved[11];
} __attribute__ ((packed));

/**
 * struct v4l2_format - stream data format
 * @type:                type of the data stream
 * @pix:                 definition of an image format
 * @pix_mp:              definition of a multiplanar image format
 * @win:                 definition of an overlaid image
 * @vbi:                 raw VBI capture or output parameters
 * @sliced:              sliced VBI capture or output parameters
 * @raw_data:            placeholder for future extensions and custom formats
 */
struct v4l2_format {
        enum v4l2_buf_type type;
        union {
                struct v4l2_pix_format      pix;          /* V4L2_BUF_TYPE_VIDEO_CAPTURE_MPLANE */
                struct v4l2_pix_format_mplane pix_mp;      /* V4L2_BUF_TYPE_VIDEO_CAPTURE_MPLANE */
                struct v4l2_window          win;          /* V4L2_BUF_TYPE_VIDEO_WINDOW */
                struct v4l2_vbi_format      vbi;          /* V4L2_BUF_TYPE_VIDEO_VBI */
                struct v4l2_sliced_vbi_format sliced;      /* V4L2_BUF_TYPE_VIDEO_VBI_SLICED */
                __u8                raw_data[200];        /* user-defined raw data */
        } fmt;
};

/*      Stream type-dependent parameters

```

Appendix B. Video For Linux Two Header File

```
    */
struct v4l2_streamparm {
    enum v4l2_buf_type type;
    union {
        struct v4l2_captureparm capture;
        struct v4l2_outputparm output;
        __u8    raw_data[200]; /* user-defined */
    } parm;
};

/*
 *      E V E N T S
 */

#define V4L2_EVENT_ALL                0
#define V4L2_EVENT_VSYNC              1
#define V4L2_EVENT_EOS                2
#define V4L2_EVENT_PRIVATE_START      0x08000000

/* Payload for V4L2_EVENT_VSYNC */
struct v4l2_event_vsync {
    /* Can be V4L2_FIELD_ANY, _NONE, _TOP or _BOTTOM */
    __u8 field;
} __attribute__((packed));

struct v4l2_event {
    __u32                                type;
    union {
        struct v4l2_event_vsync vsync;
        __u8                    data[64];
    } u;
    __u32                                pending;
    __u32                                sequence;
    struct timespec                    timestamp;
    __u32                                reserved[9];
};

struct v4l2_event_subscription {
    __u32                                type;
    __u32                                reserved[7];
};

/*
 *      A D V A N C E D   D E B U G G I N G
 *
 *      NOTE: EXPERIMENTAL API, NEVER RELY ON THIS IN APPLICATIONS!
 *      FOR DEBUGGING, TESTING AND INTERNAL USE ONLY!
 */
```

```

/* VIDIOC_DBG_G_REGISTER and VIDIOC_DBG_S_REGISTER */

#define V4L2_CHIP_MATCH_HOST      0 /* Match against chip ID on host (0)
#define V4L2_CHIP_MATCH_I2C_DRIVER 1 /* Match against I2C driver name */
#define V4L2_CHIP_MATCH_I2C_ADDR  2 /* Match against I2C 7-bit address
#define V4L2_CHIP_MATCH_AC97      3 /* Match against anciliary AC97 chip

struct v4l2_dbg_match {
    __u32 type; /* Match type */
    union { /* Match this chip, meaning determined by type */
        __u32 addr;
        char name[32];
    };
} __attribute__((packed));

struct v4l2_dbg_register {
    struct v4l2_dbg_match match;
    __u32 size; /* register size in bytes */
    __u64 reg;
    __u64 val;
} __attribute__((packed));

/* VIDIOC_DBG_G_CHIP_IDENT */
struct v4l2_dbg_chip_ident {
    struct v4l2_dbg_match match;
    __u32 ident; /* chip identifier as specified in <media/v4l2-
    __u32 revision; /* chip revision, chip specific */
} __attribute__((packed));

/*
 *      I O C T L   C O D E S   F O R   V I D E O   D E V I C E S
 *
 */
#define VIDIOC_QUERYCAP      _IOR('V',  0, struct v4l2_capability)
#define VIDIOC_RESERVED     _IO('V',  1)
#define VIDIOC_ENUM_FMT     _IOWR('V',  2, struct v4l2_fmtdesc)
#define VIDIOC_G_FMT        _IOWR('V',  4, struct v4l2_format)
#define VIDIOC_S_FMT        _IOWR('V',  5, struct v4l2_format)
#define VIDIOC_REQBUFS      _IOWR('V',  8, struct v4l2_requestbuffers)
#define VIDIOC_QUERYBUF     _IOWR('V',  9, struct v4l2_buffer)
#define VIDIOC_G_FBUF       _IOR('V', 10, struct v4l2_framebuffer)
#define VIDIOC_S_FBUF       _IOW('V', 11, struct v4l2_framebuffer)
#define VIDIOC_OVERLAY      _IOW('V', 14, int)
#define VIDIOC_QBUF         _IOWR('V', 15, struct v4l2_buffer)
#define VIDIOC_DQBUF        _IOWR('V', 17, struct v4l2_buffer)
#define VIDIOC_STREAMON     _IOW('V', 18, int)
#define VIDIOC_STREAMOFF    _IOW('V', 19, int)

```

Appendix B. Video For Linux Two Header File

```
#define VIDIOC_G_PARM          _IOWR('V', 21, struct v4l2_streamparm)
#define VIDIOC_S_PARM          _IOWR('V', 22, struct v4l2_streamparm)
#define VIDIOC_G_STD           _IOR('V', 23, v4l2_std_id)
#define VIDIOC_S_STD           _IOW('V', 24, v4l2_std_id)
#define VIDIOC_ENUMSTD         _IOWR('V', 25, struct v4l2_standard)
#define VIDIOC_ENUMINPUT       _IOWR('V', 26, struct v4l2_input)
#define VIDIOC_G_CTRL          _IOWR('V', 27, struct v4l2_control)
#define VIDIOC_S_CTRL          _IOWR('V', 28, struct v4l2_control)
#define VIDIOC_G_TUNER         _IOWR('V', 29, struct v4l2_tuner)
#define VIDIOC_S_TUNER         _IOW('V', 30, struct v4l2_tuner)
#define VIDIOC_G_AUDIO         _IOR('V', 33, struct v4l2_audio)
#define VIDIOC_S_AUDIO         _IOW('V', 34, struct v4l2_audio)
#define VIDIOC_QUERYCTRL       _IOWR('V', 36, struct v4l2_queryctrl)
#define VIDIOC_QUERYMENU       _IOWR('V', 37, struct v4l2_querymenu)
#define VIDIOC_G_INPUT         _IOR('V', 38, int)
#define VIDIOC_S_INPUT         _IOWR('V', 39, int)
#define VIDIOC_G_OUTPUT        _IOR('V', 46, int)
#define VIDIOC_S_OUTPUT        _IOWR('V', 47, int)
#define VIDIOC_ENUMOUTPUT      _IOWR('V', 48, struct v4l2_output)
#define VIDIOC_G_AUDOUT        _IOR('V', 49, struct v4l2_audioout)
#define VIDIOC_S_AUDOUT        _IOW('V', 50, struct v4l2_audioout)
#define VIDIOC_G_MODULATOR    _IOWR('V', 54, struct v4l2_modulator)
#define VIDIOC_S_MODULATOR    _IOW('V', 55, struct v4l2_modulator)
#define VIDIOC_G_FREQUENCY     _IOWR('V', 56, struct v4l2_frequency)
#define VIDIOC_S_FREQUENCY     _IOW('V', 57, struct v4l2_frequency)
#define VIDIOC_CROPCAP         _IOWR('V', 58, struct v4l2_cropcap)
#define VIDIOC_G_CROP          _IOWR('V', 59, struct v4l2_crop)
#define VIDIOC_S_CROP          _IOW('V', 60, struct v4l2_crop)
#define VIDIOC_G_JPEGCOMP       _IOR('V', 61, struct v4l2_jpegcompression)
#define VIDIOC_S_JPEGCOMP       _IOW('V', 62, struct v4l2_jpegcompression)
#define VIDIOC_QUERYSTD        _IOR('V', 63, v4l2_std_id)
#define VIDIOC_TRY_FMT         _IOWR('V', 64, struct v4l2_format)
#define VIDIOC_ENUMAUDIO        _IOWR('V', 65, struct v4l2_audio)
#define VIDIOC_ENUMAUDOUT      _IOWR('V', 66, struct v4l2_audioout)
#define VIDIOC_G_PRIORITY      _IOR('V', 67, enum v4l2_priority)
#define VIDIOC_S_PRIORITY      _IOW('V', 68, enum v4l2_priority)
#define VIDIOC_G_SLICED_VBI_CAP _IOWR('V', 69, struct v4l2_sliced_vbi_cap)
#define VIDIOC_LOG_STATUS       _IO('V', 70)
#define VIDIOC_G_EXT_CTRLS      _IOWR('V', 71, struct v4l2_ext_controls)
#define VIDIOC_S_EXT_CTRLS      _IOWR('V', 72, struct v4l2_ext_controls)
#define VIDIOC_TRY_EXT_CTRLS    _IOWR('V', 73, struct v4l2_ext_controls)
#if 1
#define VIDIOC_ENUM_FRAMESIZES  _IOWR('V', 74, struct v4l2_frmsizeenum)
#define VIDIOC_ENUM_FRAMEINTERVALS _IOWR('V', 75, struct v4l2_frmivalenum)
#define VIDIOC_G_ENC_INDEX      _IOR('V', 76, struct v4l2_enc_idx)
#define VIDIOC_ENCODER_CMD      _IOWR('V', 77, struct v4l2_encoder_cmd)
#define VIDIOC_TRY_ENCODER_CMD  _IOWR('V', 78, struct v4l2_encoder_cmd)
#endif
#endif
```

```
#if 1
/* Experimental, meant for debugging, testing and internal use.
   Only implemented if CONFIG_VIDEO_ADV_DEBUG is defined.
   You must be root to use these ioctls. Never use these in applications!
#define VIDIOC_DBG_S_REGISTER    _IOW('V', 79, struct v4l2_dbg_register)
#define VIDIOC_DBG_G_REGISTER    _IOWR('V', 80, struct v4l2_dbg_register)

/* Experimental, meant for debugging, testing and internal use.
   Never use this ioctl in applications! */
#define VIDIOC_DBG_G_CHIP_IDENT  _IOWR('V', 81, struct v4l2_dbg_chip_ident)
#endif

#define VIDIOC_S_HW_FREQ_SEEK    _IOW('V', 82, struct v4l2_hw_freq_seek)
#define VIDIOC_ENUM_DV_PRESETS   _IOWR('V', 83, struct v4l2_dv_enum_preset)
#define VIDIOC_S_DV_PRESET       _IOWR('V', 84, struct v4l2_dv_preset)
#define VIDIOC_G_DV_PRESET       _IOWR('V', 85, struct v4l2_dv_preset)
#define VIDIOC_QUERY_DV_PRESET   _IOR('V', 86, struct v4l2_dv_preset)
#define VIDIOC_S_DV_TIMINGS      _IOWR('V', 87, struct v4l2_dv_timings)
#define VIDIOC_G_DV_TIMINGS      _IOWR('V', 88, struct v4l2_dv_timings)
#define VIDIOC_DQEVENT           _IOR('V', 89, struct v4l2_event)
#define VIDIOC_SUBSCRIBE_EVENT   _IOW('V', 90, struct v4l2_event_subscribe)
#define VIDIOC_UNSUBSCRIBE_EVENT _IOW('V', 91, struct v4l2_event_subscribe)

/* Reminder: when adding new ioctls please add support for them to
   drivers/media/video/v4l2-compat-ioctl32.c as well! */

#define BASE_VIDIOC_PRIVATE      192                /* 192-255 are private */

#endif /* __LINUX_VIDEODEV2_H */
```


Appendix C. Video Capture Example

```
/*
 * V4L2 video capture example
 *
 * This program can be used and distributed without restrictions.
 *
 * This program is provided with the V4L2 API
 * see http://linuxtv.org/docs.php for more information
 */

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <assert.h>

#include <getopt.h>          /* getopt_long() */

#include <fcntl.h>           /* low-level i/o */
#include <unistd.h>
#include <errno.h>
#include <sys/stat.h>
#include <sys/types.h>
#include <sys/time.h>
#include <sys/mman.h>
#include <sys/ioctl.h>

#include <linux/videodev2.h>

#define CLEAR(x) memset(&(x), 0, sizeof(x))

enum io_method {
    IO_METHOD_READ,
    IO_METHOD_MMAP,
    IO_METHOD_USERPTR,
};

struct buffer {
    void    *start;
    size_t   length;
};

static char    *dev_name;
static enum io_method   io = IO_METHOD_MMAP;
```

Appendix C. Video Capture Example

```
static int          fd = -1;
struct buffer      *buffers;
static unsigned int  n_buffers;
static int          out_buf;
static int          force_format;
static int          frame_count = 70;

static void errno_exit(const char *s)
{
    fprintf(stderr, "%s error %d, %s\n", s, errno, strerror(errno));
    exit(EXIT_FAILURE);
}

static int xioctl(int fh, int request, void *arg)
{
    int r;

    do {
        r = ioctl(fh, request, arg);
    } while (-1 == r && EINTR == errno);

    return r;
}

static void process_image(const void *p, int size)
{
    if (out_buf)
        fwrite(p, size, 1, stdout);

    fflush(stderr);
    fprintf(stderr, ".");
    fflush(stdout);
}

static int read_frame(void)
{
    struct v4l2_buffer buf;
    unsigned int i;

    switch (io) {
    case IO_METHOD_READ:
        if (-1 == read(fd, buffers[0].start, buffers[0].length))
            switch (errno) {
                case EAGAIN:
                    return 0;

                case EIO:
                    /* Could ignore EIO, see spec. */

```

```
                /* fall through */

                default:
                    errno_exit("read");
            }
        }

        process_image(bufbers[0].start, bufbers[0].length);
        break;

case IO_METHOD_MMAP:
    CLEAR(buf);

    buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    buf.memory = V4L2_MEMORY_MMAP;

    if (-1 == xioctl(fd, VIDIOC_DQBUF, &buf)) {
        switch (errno) {
            case EAGAIN:
                return 0;

            case EIO:
                /* Could ignore EIO, see spec. */

                /* fall through */

            default:
                errno_exit("VIDIOC_DQBUF");
        }
    }

    assert(buf.index < n_bufbers);

    process_image(bufbers[buf.index].start, buf.bytesused);

    if (-1 == xioctl(fd, VIDIOC_QBUF, &buf))
        errno_exit("VIDIOC_QBUF");
    break;

case IO_METHOD_USERPTR:
    CLEAR(buf);

    buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    buf.memory = V4L2_MEMORY_USERPTR;

    if (-1 == xioctl(fd, VIDIOC_DQBUF, &buf)) {
        switch (errno) {
```

Appendix C. Video Capture Example

```
        case EAGAIN:
            return 0;

        case EIO:
            /* Could ignore EIO, see spec. */

            /* fall through */

        default:
            errno_exit("VIDIOC_DQBUF");
    }
}

for (i = 0; i < n_buffers; ++i)
    if (buf.m.userptr == (unsigned long)buffers[i].start
        && buf.length == buffers[i].length)
        break;

assert(i < n_buffers);

process_image((void *)buf.m.userptr, buf.bytesused);

if (-1 == xioctl(fd, VIDIOC_QBUF, &buf))
    errno_exit("VIDIOC_QBUF");
break;
}

return 1;
}

static void mainloop(void)
{
    unsigned int count;

    count = frame_count;

    while (count-- > 0) {
        for (;;) {
            fd_set fds;
            struct timeval tv;
            int r;

            FD_ZERO(&fds);
            FD_SET(fd, &fds);

            /* Timeout. */
            tv.tv_sec = 2;
            tv.tv_usec = 0;
```

```
        r = select(fd + 1, &fds, NULL, NULL, &tv);

        if (-1 == r) {
            if (EINTR == errno)
                continue;
            errno_exit("select");
        }

        if (0 == r) {
            fprintf(stderr, "select timeout\n");
            exit(EXIT_FAILURE);
        }

        if (read_frame())
            break;
        /* EAGAIN - continue select loop. */
    }
}

static void stop_capturing(void)
{
    enum v4l2_buf_type type;

    switch (io) {
    case IO_METHOD_READ:
        /* Nothing to do. */
        break;

    case IO_METHOD_MMAP:
    case IO_METHOD_USERPTR:
        type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        if (-1 == xioctl(fd, VIDIOC_STREAMOFF, &type))
            errno_exit("VIDIOC_STREAMOFF");
        break;
    }
}

static void start_capturing(void)
{
    unsigned int i;
    enum v4l2_buf_type type;

    switch (io) {
    case IO_METHOD_READ:
        /* Nothing to do. */
        break;
```

Appendix C. Video Capture Example

```
case IO_METHOD_MMAP:
    for (i = 0; i < n_buffers; ++i) {
        struct v4l2_buffer buf;

        CLEAR(buf);
        buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        buf.memory = V4L2_MEMORY_MMAP;
        buf.index = i;

        if (-1 == xioctl(fd, VIDIOC_QBUF, &buf))
            errno_exit("VIDIOC_QBUF");
    }
    type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    if (-1 == xioctl(fd, VIDIOC_STREAMON, &type))
        errno_exit("VIDIOC_STREAMON");
    break;

case IO_METHOD_USERPTR:
    for (i = 0; i < n_buffers; ++i) {
        struct v4l2_buffer buf;

        CLEAR(buf);
        buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        buf.memory = V4L2_MEMORY_USERPTR;
        buf.index = i;
        buf.m.userptr = (unsigned long)buffers[i].start;
        buf.length = buffers[i].length;

        if (-1 == xioctl(fd, VIDIOC_QBUF, &buf))
            errno_exit("VIDIOC_QBUF");
    }
    type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    if (-1 == xioctl(fd, VIDIOC_STREAMON, &type))
        errno_exit("VIDIOC_STREAMON");
    break;
}

static void uninit_device(void)
{
    unsigned int i;

    switch (io) {
case IO_METHOD_READ:
        free(buffers[0].start);
        break;

```

```
case IO_METHOD_MMAP:
    for (i = 0; i < n_buffers; ++i)
        if (-1 == munmap(buffers[i].start, buffers[i].length))
            errno_exit("munmap");
    break;

case IO_METHOD_USERPTR:
    for (i = 0; i < n_buffers; ++i)
        free(buffers[i].start);
    break;
}

free(buffers);
}

static void init_read(unsigned int buffer_size)
{
    buffers = calloc(1, sizeof(*buffers));

    if (!buffers) {
        fprintf(stderr, "Out of memory\n");
        exit(EXIT_FAILURE);
    }

    buffers[0].length = buffer_size;
    buffers[0].start = malloc(buffer_size);

    if (!buffers[0].start) {
        fprintf(stderr, "Out of memory\n");
        exit(EXIT_FAILURE);
    }
}

static void init_mmap(void)
{
    struct v4l2_requestbuffers req;

    CLEAR(req);

    req.count = 4;
    req.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    req.memory = V4L2_MEMORY_MMAP;

    if (-1 == xioctl(fd, VIDIOC_REQBUFS, &req)) {
        if (EINVAL == errno) {
            fprintf(stderr, "%s does not support "
                    "memory mapping\n", dev_name);
            exit(EXIT_FAILURE);
        }
    }
}
```


Appendix C. Video Capture Example

```
        } else {
            errno_exit("VIDIOC_REQBUFS");
        }
    }

    if (req.count < 2) {
        fprintf(stderr, "Insufficient buffer memory on %s\n",
            dev_name);
        exit(EXIT_FAILURE);
    }

    buffers = calloc(req.count, sizeof(*buffers));

    if (!buffers) {
        fprintf(stderr, "Out of memory\n");
        exit(EXIT_FAILURE);
    }

    for (n_buffers = 0; n_buffers < req.count; ++n_buffers) {
        struct v4l2_buffer buf;

        CLEAR(buf);

        buf.type      = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        buf.memory     = V4L2_MEMORY_MMAP;
        buf.index      = n_buffers;

        if (-1 == xioctl(fd, VIDIOC_QUERYBUF, &buf))
            errno_exit("VIDIOC_QUERYBUF");

        buffers[n_buffers].length = buf.length;
        buffers[n_buffers].start =
            mmap(NULL /* start anywhere */,
                buf.length,
                PROT_READ | PROT_WRITE /* required */,
                MAP_SHARED /* recommended */,
                fd, buf.m.offset);

        if (MAP_FAILED == buffers[n_buffers].start)
            errno_exit("mmap");
    }
}

static void init_userp(unsigned int buffer_size)
{
    struct v4l2_requestbuffers req;

    CLEAR(req);
```

```

req.count    = 4;
req.type     = V4L2_BUF_TYPE_VIDEO_CAPTURE;
req.memory   = V4L2_MEMORY_USERPTR;

if (-1 == xioctl(fd, VIDIOC_REQBUFS, &req)) {
    if (EINVAL == errno) {
        fprintf(stderr, "%s does not support "
                    "user pointer i/o\n", dev_name);
        exit(EXIT_FAILURE);
    } else {
        errno_exit("VIDIOC_REQBUFS");
    }
}

buffers = calloc(4, sizeof(*buffers));

if (!buffers) {
    fprintf(stderr, "Out of memory\n");
    exit(EXIT_FAILURE);
}

for (n_buffers = 0; n_buffers < 4; ++n_buffers) {
    buffers[n_buffers].length = buffer_size;
    buffers[n_buffers].start = malloc(buffer_size);

    if (!buffers[n_buffers].start) {
        fprintf(stderr, "Out of memory\n");
        exit(EXIT_FAILURE);
    }
}

}

static void init_device(void)
{
    struct v4l2_capability cap;
    struct v4l2_cropcap cropcap;
    struct v4l2_crop crop;
    struct v4l2_format fmt;
    unsigned int min;

    if (-1 == xioctl(fd, VIDIOC_QUERYCAP, &cap)) {
        if (EINVAL == errno) {
            fprintf(stderr, "%s is no V4L2 device\n",
                    dev_name);
            exit(EXIT_FAILURE);
        } else {
            errno_exit("VIDIOC_QUERYCAP");

```

Appendix C. Video Capture Example

```
        }
    }

    if (!(cap.capabilities & V4L2_CAP_VIDEO_CAPTURE)) {
        fprintf(stderr, "%s is no video capture device\n",
                dev_name);
        exit(EXIT_FAILURE);
    }

    switch (io) {
    case IO_METHOD_READ:
        if (!(cap.capabilities & V4L2_CAP_READWRITE)) {
            fprintf(stderr, "%s does not support read i/o\n",
                    dev_name);
            exit(EXIT_FAILURE);
        }
        break;

    case IO_METHOD_MMAP:
    case IO_METHOD_USERPTR:
        if (!(cap.capabilities & V4L2_CAP_STREAMING)) {
            fprintf(stderr, "%s does not support streaming i/o\n",
                    dev_name);
            exit(EXIT_FAILURE);
        }
        break;
    }

    /* Select video input, video standard and tune here. */

    CLEAR(cropcap);

    cropcap.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;

    if (0 == xioctl(fd, VIDIOC_CROPCAP, &cropcap)) {
        crop.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
        crop.c = cropcap.defrect; /* reset to default */

        if (-1 == xioctl(fd, VIDIOC_S_CROP, &crop)) {
            switch (errno) {
            case EINVAL:
                /* Cropping not supported. */
                break;
            default:
                /* Errors ignored. */
                break;
            }
        }
    }
}
```

```

        }
    }
} else {
    /* Errors ignored. */
}

CLEAR(fmt);

fmt.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
if (force_format) {
    fmt.fmt.pix.width      = 640;
    fmt.fmt.pix.height     = 480;
    fmt.fmt.pix.pixelformat = V4L2_PIX_FMT_YUYV;
    fmt.fmt.pix.field      = V4L2_FIELD_INTERLACED;

    if (-1 == xioctl(fd, VIDIOC_S_FMT, &fmt))
        errno_exit("VIDIOC_S_FMT");

    /* Note VIDIOC_S_FMT may change width and height. */
} else {
    /* Preserve original settings as set by v4l2-ctl for example */
    if (-1 == xioctl(fd, VIDIOC_G_FMT, &fmt))
        errno_exit("VIDIOC_G_FMT");
}

/* Buggy driver paranoia. */
min = fmt.fmt.pix.width * 2;
if (fmt.fmt.pix.bytesperline < min)
    fmt.fmt.pix.bytesperline = min;
min = fmt.fmt.pix.bytesperline * fmt.fmt.pix.height;
if (fmt.fmt.pix.sizeimage < min)
    fmt.fmt.pix.sizeimage = min;

switch (io) {
case IO_METHOD_READ:
    init_read(fmt.fmt.pix.sizeimage);
    break;

case IO_METHOD_MMAP:
    init_mmap();
    break;

case IO_METHOD_USERPTR:
    init_userp(fmt.fmt.pix.sizeimage);
    break;
}
}

```

Appendix C. Video Capture Example

```
static void close_device(void)
{
    if (-1 == close(fd))
        errno_exit("close");

    fd = -1;
}

static void open_device(void)
{
    struct stat st;

    if (-1 == stat(dev_name, &st)) {
        fprintf(stderr, "Cannot identify '%s': %d, %s\n",
                dev_name, errno, strerror(errno));
        exit(EXIT_FAILURE);
    }

    if (!S_ISCHR(st.st_mode)) {
        fprintf(stderr, "%s is no device\n", dev_name);
        exit(EXIT_FAILURE);
    }

    fd = open(dev_name, O_RDWR /* required */ | O_NONBLOCK, 0);

    if (-1 == fd) {
        fprintf(stderr, "Cannot open '%s': %d, %s\n",
                dev_name, errno, strerror(errno));
        exit(EXIT_FAILURE);
    }
}

static void usage(FILE *fp, int argc, char **argv)
{
    fprintf(fp,
            "Usage: %s [options]\n\n"
            "Version 1.3\n"
            "Options:\n"
            "-d | --device name    Video device name [%s]\n"
            "-h | --help           Print this message\n"
            "-m | --mmap           Use memory mapped buffers [default]\n"
            "-r | --read           Use read() calls\n"
            "-u | --userp          Use application allocated buffers\n"
            "-o | --output          Outputs stream to stdout\n"
            "-f | --format          Force format to 640x480 YUYV\n"
            "-c | --count          Number of frames to grab [%i]\n"
            "",
```

```

        argv[0], dev_name, frame_count);
    }

    static const char short_options[] = "d:hmruofc:";

    static const struct option
    long_options[] = {
        { "device", required_argument, NULL, 'd' },
        { "help",    no_argument,      NULL, 'h' },
        { "mmap",    no_argument,      NULL, 'm' },
        { "read",    no_argument,      NULL, 'r' },
        { "userp",   no_argument,      NULL, 'u' },
        { "output",  no_argument,      NULL, 'o' },
        { "format",  no_argument,      NULL, 'f' },
        { "count",   required_argument, NULL, 'c' },
        { 0, 0, 0, 0 }
    };

    int main(int argc, char **argv)
    {
        dev_name = "/dev/video0";

        for (;;) {
            int idx;
            int c;

            c = getopt_long(argc, argv,
                           short_options, long_options, &idx);

            if (-1 == c)
                break;

            switch (c) {
            case 0: /* getopt_long() flag */
                break;

            case 'd':
                dev_name = optarg;
                break;

            case 'h':
                usage(stdout, argc, argv);
                exit(EXIT_SUCCESS);

            case 'm':
                io = IO_METHOD_MMAP;
                break;

```

Appendix C. Video Capture Example

```
        case 'r':
            io = IO_METHOD_READ;
            break;

        case 'u':
            io = IO_METHOD_USERPTR;
            break;

        case 'o':
            out_buf++;
            break;

        case 'f':
            force_format++;
            break;

        case 'c':
            errno = 0;
            frame_count = strtol(optarg, NULL, 0);
            if (errno)
                errno_exit(optarg);
            break;

        default:
            usage(stderr, argc, argv);
            exit(EXIT_FAILURE);
    }

    open_device();
    init_device();
    start_capturing();
    mainloop();
    stop_capturing();
    uninit_device();
    close_device();
    fprintf(stderr, "\n");
    return 0;
}
```

Appendix D. Video Grabber example using libv4l

This program demonstrates how to grab V4L2 images in ppm format by using libv4l handlers. The advantage is that this grabber can potentially work with any V4L2 driver.

```
/* V4L2 video picture grabber
   Copyright (C) 2009 Mauro Carvalho Chehab <mchehab@infradead.org>

   This program is free software; you can redistribute it and/or modify
   it under the terms of the GNU General Public License as published by
   the Free Software Foundation version 2 of the License.

   This program is distributed in the hope that it will be useful,
   but WITHOUT ANY WARRANTY; without even the implied warranty of
   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
   GNU General Public License for more details.
   */

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <fcntl.h>
#include <errno.h>
#include <sys/ioctl.h>
#include <sys/types.h>
#include <sys/time.h>
#include <sys/mman.h>
#include <linux/videodev2.h>
#include "../libv4l/include/libv4l2.h"

#define CLEAR(x) memset(&(x), 0, sizeof(x))

struct buffer {
    void    *start;
    size_t  length;
};

static void xioctl(int fh, int request, void *arg)
{
    int r;
```


Appendix D. Video Grabber example using libv4l

```
do {
    r = v4l2_ioctl(fh, request, arg);
} while (r == -1 && ((errno == EINTR) || (errno == EAGAIN)));

if (r == -1) {
    fprintf(stderr, "error %d, %s\n", errno, strerror(errno));
    exit(EXIT_FAILURE);
}

}

int main(int argc, char **argv)
{
    struct v4l2_format          fmt;
    struct v4l2_buffer          buf;
    struct v4l2_requestbuffers   req;
    enum v4l2_buf_type          type;
    fd_set                      fds;
    struct timeval              tv;
    int                          r, fd = -1;
    unsigned int                i, n_buffers;
    char                        *dev_name = "/dev/video0";
    char                        out_name[256];
    FILE                         *fout;
    struct buffer                *buffers;

    fd = v4l2_open(dev_name, O_RDWR | O_NONBLOCK, 0);
    if (fd < 0) {
        perror("Cannot open device");
        exit(EXIT_FAILURE);
    }

    CLEAR(fmt);
    fmt.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    fmt.fmt.pix.width          = 640;
    fmt.fmt.pix.height         = 480;
    fmt.fmt.pix.pixelformat    = V4L2_PIX_FMT_RGB24;
    fmt.fmt.pix.field          = V4L2_FIELD_INTERLACED;
    xioctl(fd, VIDIOC_S_FMT, &fmt);
    if (fmt.fmt.pix.pixelformat != V4L2_PIX_FMT_RGB24) {
        printf("Libv4l didn't accept RGB24 format. Can't proceed.\n");
        exit(EXIT_FAILURE);
    }
    if ((fmt.fmt.pix.width != 640) || (fmt.fmt.pix.height != 480))
        printf("Warning: driver is sending image at %dx%d\n",
            fmt.fmt.pix.width, fmt.fmt.pix.height);

    CLEAR(req);
```

Appendix D. Video Grabber example using libv4l

```
req.count = 2;
req.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
req.memory = V4L2_MEMORY_MMAP;
xioc1(fd, VIDIOC_REQBUFS, &req);

buffers = calloc(req.count, sizeof(*buffers));
for (n_buffers = 0; n_buffers < req.count; ++n_buffers) {
    CLEAR(buf);

    buf.type      = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    buf.memory    = V4L2_MEMORY_MMAP;
    buf.index     = n_buffers;

    xioc1(fd, VIDIOC_QUERYBUF, &buf);

    buffers[n_buffers].length = buf.length;
    buffers[n_buffers].start = v4l2_mmap(NULL, buf.length,
                                         PROT_READ | PROT_WRITE, MAP_SHARED,
                                         fd, buf.m.offset);

    if (MAP_FAILED == buffers[n_buffers].start) {
        perror("mmap");
        exit(EXIT_FAILURE);
    }
}

for (i = 0; i < n_buffers; ++i) {
    CLEAR(buf);
    buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    buf.memory = V4L2_MEMORY_MMAP;
    buf.index = i;
    xioc1(fd, VIDIOC_QBUF, &buf);
}
type = V4L2_BUF_TYPE_VIDEO_CAPTURE;

xioc1(fd, VIDIOC_STREAMON, &type);
for (i = 0; i < 20; i++) {
    do {
        FD_ZERO(&fds);
        FD_SET(fd, &fds);

        /* Timeout. */
        tv.tv_sec = 2;
        tv.tv_usec = 0;

        r = select(fd + 1, &fds, NULL, NULL, &tv);
    } while ((r == -1 && (errno = EINTR)));
    if (r == -1) {
```

Appendix D. Video Grabber example using libv4l

```
        perror("select");
        return errno;
    }

    CLEAR(buf);
    buf.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
    buf.memory = V4L2_MEMORY_MMAP;
    xioctl(fd, VIDIOC_DQBUF, &buf);

    sprintf(out_name, "out%03d.ppm", i);
    fout = fopen(out_name, "w");
    if (!fout) {
        perror("Cannot open image");
        exit(EXIT_FAILURE);
    }
    fprintf(fout, "P6\n%d %d 255\n",
            fmt.fmt.pix.width, fmt.fmt.pix.height);
    fwrite(bufs[buf.index].start, buf.bytesused, 1, fout);
    fclose(fout);

    xioctl(fd, VIDIOC_QBUF, &buf);
}

type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
xioctl(fd, VIDIOC_STREAMOFF, &type);
for (i = 0; i < n_buffers; ++i)
    v4l2_munmap(bufs[i].start, buf[i].length);
v4l2_close(fd);

return 0;
}
```

List of Types

```

v4l2_std_id
enum v4l2_buf_type
enum v4l2_colorspace
enum v4l2_ctrl_type
enum v4l2_exposure_auto_type
enum v4l2_field
enum v4l2_fmvaltypes
enum v4l2_frmsizetypes
enum v4l2_memory
enum v4l2_mpeg_audio_ac3_bitrate
enum v4l2_mpeg_audio_crc
enum v4l2_mpeg_audio_emphasis
enum v4l2_mpeg_audio_encoding
enum v4l2_mpeg_audio_l1_bitrate
enum v4l2_mpeg_audio_l2_bitrate
enum v4l2_mpeg_audio_l3_bitrate
enum v4l2_mpeg_audio_mode
enum v4l2_mpeg_audio_mode_extension
enum v4l2_mpeg_audio_sampling_freq
enum v4l2_mpeg_cx2341x_video_chroma_spatial_filter_type
enum v4l2_mpeg_cx2341x_video_luma_spatial_filter_type
enum v4l2_mpeg_cx2341x_video_median_filter_type
enum v4l2_mpeg_cx2341x_video_spatial_filter_mode
enum v4l2_mpeg_cx2341x_video_temporal_filter_mode
enum v4l2_mpeg_stream_type
enum v4l2_mpeg_stream_vbi_fmt
enum v4l2_mpeg_video_aspect
enum v4l2_mpeg_video_bitrate_mode
enum v4l2_mpeg_video_encoding
enum v4l2_power_line_frequency
enum v4l2_priority
enum v4l2_tuner_type
enum v4l2_preemphasis
struct v4l2_audio
struct v4l2_audioout
struct v4l2_bt_timings
struct v4l2_buffer
struct v4l2_capability
struct v4l2_captureparm
struct v4l2_clip
struct v4l2_control
struct v4l2_crop
struct v4l2_cropcap
struct v4l2_dbg_chip_ident
struct v4l2_dbg_match
struct v4l2_dbg_register
struct v4l2_dv_enum_preset
struct v4l2_dv_preset
struct v4l2_dv_timings
struct v4l2_enc_idx
struct v4l2_enc_idx_entry
struct v4l2_encoder_cmd
struct v4l2_ext_control
struct v4l2_ext_controls
struct v4l2_fmtdesc
struct v4l2_format
struct v4l2_fract
struct v4l2_framebuffer
struct v4l2_frequency
struct v4l2_fmval_stepwise
enum v4l2_fmvalenum
struct v4l2_frmvalenum
struct v4l2_frmval_stepwise
struct v4l2_frmvalenum
struct v4l2_hw_freq_seek
struct v4l2_input
struct v4l2_jpegcompression
struct v4l2_modulator
struct v4l2_mpeg_vbi_fmt_ivtv
struct v4l2_output
struct v4l2_outputparm
struct v4l2_pix_format
struct v4l2_queryctrl
struct v4l2_querymenu
struct v4l2_rect
struct v4l2_requestbuffers
struct v4l2_sliced_vbi_cap
struct v4l2_sliced_vbi_data
struct v4l2_sliced_vbi_format

```

List of Types

struct v4l2_standard

struct v4l2_streamparm

struct v4l2_timecode

struct v4l2_tuner

struct v4l2_vbi_format

struct v4l2_window

References

- [EIA 608-B] Electronic Industries Alliance
(<http://www.eia.org>), *EIA 608-B*
"Recommended Practice for Line 21
Data Service".
- [EN 300 294] European
Telecommunication Standards
Institute (<http://www.etsi.org>), *EN*
300 294 "625-line television Wide
Screen Signalling (WSS)".
- [ETS 300 231] European
Telecommunication Standards
Institute (<http://www.etsi.org>), *ETS*
300 231 "Specification of the
domestic video Programme Delivery
Control system (PDC)".
- [ETS 300 706] European
Telecommunication Standards
Institute (<http://www.etsi.org>), *ETS*
300 706 "Enhanced Teletext
specification".
- [ISO 13818-1] International
Telecommunication Union
(<http://www.itu.ch>), International
Organisation for Standardisation
(<http://www.iso.ch>), *ITU-T Rec.*
H.222.0 | ISO/IEC 13818-1
"Information technology — Generic
coding of moving pictures and
associated audio information:
Systems".
- [ISO 13818-2] International
Telecommunication Union
(<http://www.itu.ch>), International
Organisation for Standardisation
(<http://www.iso.ch>), *ITU-T Rec.*
H.262 | ISO/IEC 13818-2
"Information technology — Generic
coding of moving pictures and
associated audio information: Video".
- [ITU BT.470] International
Telecommunication Union
(<http://www.itu.ch>), *ITU-R*
Recommendation BT.470-6
"Conventional Television Systems".
- [ITU BT.601] International
Telecommunication Union
(<http://www.itu.ch>), *ITU-R*
Recommendation BT.601-5 "Studio
Encoding Parameters of Digital
Television for Standard 4:3 and
Wide-Screen 16:9 Aspect Ratios".
- [ITU BT.653] International
Telecommunication Union
(<http://www.itu.ch>), *ITU-R*
Recommendation BT.653-3 "Teletext
systems".
- [ITU BT.709] International
Telecommunication Union
(<http://www.itu.ch>), *ITU-R*
Recommendation BT.709-5
"Parameter values for the HDTV
standards for production and
international programme exchange".
- [ITU BT.1119] International
Telecommunication Union
(<http://www.itu.ch>), *ITU-R*
Recommendation BT.1119 "625-line
television Wide Screen Signalling
(WSS)".
- [JFIF] Independent JPEG Group
(<http://www.jpeg.org>), *JPEG File*
Interchange Format: Version 1.02.
- [SMPTE 12M] Society of Motion Picture
and Television Engineers
(<http://www.smpete.org>), *SMPTE*

12M-1999 DVB Video Device and Film Timing and Control Code"	??
12. DVB Audio Device.....	??
13. DVB CA Device.....	??
[SMPTE 170M] Society of Motion Picture and Television Engineers	??
14. DVB Network API	??
(http://www.smpte.org), SMPTE	??
15. Kernel Demux API.....	??
16. DVB Frontend Header File.....	??
170M-1999 "Television - Composite Analog Video Signal - NTSC for Studio Applications".	??
[SMPTE 240M] Society of Motion Picture and Television Engineers (http://www.smpte.org), SMPTE 240M-1999 "Television - Signal Parameters - 1125-Line High-Definition Production".	
[EN 50067] European Committee for Electrotechnical Standardization (http://www.cenelec.eu), Specification of the radio data system (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 to 108,0 MHz.	
[NRSC-4] National Radio Systems Committee (http://www.nrsstandards.org), NTSC-4: United States RBDS Standard.	

II. LINUX DVB API

Version 5.2

Table of Contents

8. Introduction.....	??
9. DVB Frontend API	??
10. DVB Demux Device.....	??

Ralph J. K. Metzler and Marcus O. C. MetzlerMauro Carvalho Chehab

Copyright © 2002, 2003 Convergence GmbH

Copyright © 2009-2011 Mauro Carvalho Chehab

Revision History

Revision 2.0.4 2011-05-06 Revised by: mcc

Add more information about DVB APIv5, better describing the frontend GET/SET props ioctl's.

Revision 2.0.3 2010-07-03 Revised by: mcc

Add some frontend capabilities flags, present on kernel, but missing at the specs.

Revision 2.0.2 2009-10-25 Revised by: mcc

documents FE_SET_FRONTEND_TUNE_MODE and FE_DISHETWORK_SEND_LEGACY_C

Revision 2.0.1 2009-09-16 Revised by: mcc

Added ISDB-T test originally written by Patrick Boettcher

Revision 2.0.0 2009-09-06 Revised by: mcc

Conversion from LaTeX to DocBook XML. The contents is the same as the original LaTeX version.

Revision 1.0.0 2003-07-24 Revised by: rjkm

Initial revision on LaTeX.

Chapter 8. Introduction

8.1. What you need to know

The reader of this document is required to have some knowledge in the area of digital video broadcasting (DVB) and should be familiar with part I of the MPEG2 specification ISO/IEC 13818 (aka ITU-T H.222), i.e you should know what a program/transport stream (PS/TS) is and what is meant by a packetized elementary stream (PES) or an I-frame.

Various DVB standards documents are available from <http://www.dvb.org> and/or <http://www.etsi.org>.

It is also necessary to know how to access unix/linux devices and how to use ioctl calls. This also includes the knowledge of C or C++.

8.2. History

The first API for DVB cards we used at Convergence in late 1999 was an extension of the Video4Linux API which was primarily developed for frame grabber cards. As such it was not really well suited to be used for DVB cards and their new

features like audio and MPEG2 streams and filtering several section and PES data streams at the same time.

The main targets of the demultiplexer are the MPEG2 audio and video decoders. In early 2000 we were approached by Nokia with a proposal for a new standard Linux DVB API. As a community to the development of terminals based on open standards, Nokia and Convergence made it available to all Linux developers and

Figure 8-1. shows a crude schematic of the control and data flow between those components. Convergence is the maintainer of the Linux DVB API. Together with the LinuxTV community (i.e.

on a DVB PCI card not all of these have to be present since some functionality can be provided by the Linux driver for the SiMpeg/Hauppauge DVB PCI card) or Convergence provides a first implementation of the Linux DVB API. Also not every card or STB provides conditional access hardware.

8.3. Overview

8.4. Linux DVB Devices

Figure 8-1. Components of a DVB card/STB

The Linux DVB API lets you control these hardware components through currently six Unix-style character devices for video, audio, frontend, demux, CA and IP-over-DVB networking. The video and audio devices control the MPEG2 decoder hardware, the frontend device the tuner and the DVB demodulator. The demux device gives you control over the PES and section filters of the hardware. If the hardware does not support filtering these filters can be implemented in software. Finally, the CA device controls all the conditional access capabilities of the hardware. If a DVB PCI card or DVB set-top box (STB) usually consists of the following main hardware components, the CA functions are made available to the application through this device.

- Frontend consisting of tuner and DVB demodulator
- All devices can be found in the `/dev` tree under `/dev/dvb`. The individual devices are called:
 - `/dev/dvb/adapterN/videoM`, the raw signal reaches the DVB hardware from a satellite dish or antenna or directly from cable. The frontend down-converts and demodulates this signal into an MPEG transport stream (TS). In case of a satellite frontend, this includes a facility for satellite equipment control (SEC), which allows control of LNB
 - `/dev/dvb/adapterN/audioM`,
 - `/dev/dvb/adapterN/frontendM`, switches or dish rotors.
- Conditional Access (CA) hardware like CI adapters and smartcard slots
- `/dev/dvb/adapterN/netM`, The complete TS is passed through the CA hardware. Programs to which the user has access (controlled by the smart card) are decoded in real time and re-inserted into the TS.
- `/dev/dvb/adapterN/demuxM`,
- `/dev/dvb/adapterN/demuxM`, Demultiplexes the incoming DVB stream

when the demultiplexer the DVB hardware consists of a single unit and streams. Besides usually several of such audio and video streams starting from a TS data we will learn the with `/dev/dvb/adapterN/netM` the program the connection of the set-top box and nothing is provided the devices is the same whether `devfs` is used or not.

More details about the data structures and function calls of all the devices are described in the following chapters.

8.5. API include files

For each of the DVB devices a corresponding include file exists. The DVB API include files should be included in application sources with a partial path like:

```
#include <linux/dvb/frontend.h>
```

To enable applications to support different API version, an additional include file *linux/dvb/version.h* exists, which defines the constant *DVB_API_VERSION*. This document describes *DVB_API_VERSION 3*.

Chapter 9. DVB Frontend API

The DVB frontend device controls the tuner and DVB demodulator hardware. It can be accessed through `/dev/dvb/adapter0/frontend0`. Data types and ioctl definitions can be accessed by including `linux/dvb/frontend.h` in your application.

DVB frontends come in three varieties: DVB-S (satellite), DVB-C (cable) and DVB-T (terrestrial). Transmission via the internet (DVB-IP) is not yet handled by this API but a future extension is possible. For DVB-S the frontend device also supports satellite equipment control (SEC) via DiSEqC and V-SEC protocols. The DiSEqC (digital SEC) specification is available from Eutelsat (http://www.eutelsat.com/satellites/4_5_5.html).

Note that the DVB API may also be used for MPEG decoder-only PCI cards, in which case there exists no frontend device.

9.1. Frontend Data Types

9.1.1. frontend type

For historical reasons frontend types are named after the type of modulation used in transmission.

```
typedef enum fe_type {
    FE_QPSK,      /* DVB-S */
    FE_QAM,       /* DVB-C */
    FE_OFDM       /* DVB-T */
} fe_type_t;
```

9.1.2. frontend capabilities

Capabilities describe what a frontend can do. Some capabilities can only be supported for a specific frontend type.

```
typedef enum fe_caps {
    FE_IS_STUPID                = 0,
    FE_CAN_INVERSION_AUTO       = 0x1,
    FE_CAN_FEC_1_2              = 0x2,
    FE_CAN_FEC_2_3              = 0x4,
```

9.1.4. diseqc master command

A message sent from the frontend to DiSEqC capable equipment.

```
FE_CAN_FEC_4_5 = 0x10,
FE_CAN_FEC_6_7 = 0x40,
FE_CAN_FEC_8_9 = 0x80,
FE_CAN_FEC_10_11 = 0x100,
FE_CAN_FEC_12_13 = 0x200,
FE_CAN_QPSK = 0x400,
FE_CAN_QAM_16 = 0x800,
FE_CAN_QAM_32 = 0x1000,
FE_CAN_QAM_64 = 0x2000,
FE_CAN_QAM_128 = 0x4000,
FE_CAN_QAM_256 = 0x8000,
FE_CAN_QAM_AUTO = 0x10000,
FE_CAN_TRANSMISSION_MODE_AUTO = 0x20000,
FE_CAN_BANDWIDTH_AUTO = 0x40000,
FE_CAN_GUARD_INTERVAL_AUTO = 0x80000,
FE_CAN_HIERARCHY_AUTO = 0x100000,
FE_CAN_8VSB = 0x200000,
FE_CAN_16VSB = 0x400000,
FE_HAS_EXTENDED_CAPS = 0x800000,
FE_CAN_TURBO_FEC = 0x8000000,
FE_CAN_2G_MODULATION = 0x10000000,
FE_NEEDS_BENLING = 0x20000000,
FE_CAN_RECOVER = 0x40000000,
FE_CAN_MUTE_TS = 0x80000000,
} fe_caps_t;
```

9.1.5. diseqc slave reply

A reply to the frontend from DiSEqC 2.0 capable equipment.

```
FE_CAN_TRANSMISSION_MODE_AUTO = 0x20000,
FE_CAN_BANDWIDTH_AUTO = 0x40000,
FE_CAN_GUARD_INTERVAL_AUTO = 0x80000,
FE_CAN_HIERARCHY_AUTO = 0x100000,
FE_CAN_8VSB = 0x200000,
FE_CAN_16VSB = 0x400000,
FE_HAS_EXTENDED_CAPS = 0x800000,
FE_CAN_TURBO_FEC = 0x8000000,
FE_CAN_2G_MODULATION = 0x10000000,
FE_NEEDS_BENLING = 0x20000000,
FE_CAN_RECOVER = 0x40000000,
FE_CAN_MUTE_TS = 0x80000000,
} fe_caps_t;
```

9.1.6. diseqc slave reply

The voltage is usually used with non-DiSEqC capable LNBs to switch the polarization (horizontal/vertical). When using DiSEqC equipment this voltage has to be switched consistently to the DiSEqC commands as described in the DiSEqC spec.

9.1.3. frontend information

Information about the frontend can be queried with `FE_GET_INFO`.

```
} fe_sec_voltage_t;

struct dvb_frontend_info {
    char        name[128];
    fe_type_t   type;
    uint32_t    frequency_min;
    uint32_t    frequency_max;
    uint32_t    frequency_steps_size;
    uint32_t    frequency_tolerance;
    uint32_t    symbol_rate_max;
    uint32_t    symbol_rate_tolerance; /* ppm */
    typedef enum fe_sec_voltage { /* ms */
        SEC_VOLTAGE_ON,
        SEC_VOLTAGE_OFF
    } fe_sec_voltage_t;
    fe_sec_tone_mode_t;
}
```

9.1.7. SEC continuous tone

The continuous 22KHz tone is usually used with non-DiSEqC capable LNBs to switch the high/low band of a dual band LNB. When using DiSEqC equipment this voltage has to be switched consistently to the DiSEqC commands as described in the DiSEqC spec.

9.1.8. SEC tone burst

For satellite QPSK frontends you have to use the `QPSKParameters` member defined by

The 22KHz tone burst is usually used with non-DiSEqC capable switches to select between two connected LNBs/satellites. When using DiSEqC equipment this

voltage has to be switched consistently to the DiSEqC commands as described in the DiSEqC spec.

```
uint32_t symbol_rate; /* Symbol rate in Symbols per second */
fe_code_rate_t fec_inner; /* forward error correction (see above) */
};

typedef enum fe_sec_mini_cmd {
SEC_MINI_A,
SEC_MINI_B
} fe_sec_mini_cmd_t;

struct dvb_qam_parameters {
uint32_t symbol_rate; /* symbol rate in Symbols per second */
fe_code_rate_t fec_inner; /* forward error correction (see above) */
fe_modulation_t modulation; /* modulation type (see above) */
};
```

for cable QAM frontend you use the `QAMParameters` structure

9.1.9. frontend status

DVB-T frontends are supported by the `OFDMParameters` structure

Several functions of the frontend device use the `fe_status` data type defined by

```
struct dvb_ofdm_parameters {
typedef enum fe_status {
FE_BANDWIDTH_t = Bandwidth;
FE_HAS_SIGNAL = 0x01 /* found something above the noise level */
FE_HAS_CARRIER = 0x02 /* found a DVB signal */
FE_HAS_VITERBI = 0x04 /* FEC is stable */
FE_MODULATION_t = Constellation; /* modulation type (see above) */
FE_HAS_SYNC = 0x08 /* found sync bytes */
FE_TRANSMISSION_mode_t = Transmission_mode;
FE_HAS_LOCK = 0x10 /* everything's working... */
fe_guard_interval_t guard_interval;
FE_TIMEOUT_t = 0x20 /* no lock within the last ~2 seconds */
fe_hierarchy_t = hierarchy_information;
FE_REINIT = 0x40 /* frontend was reinitialized, */
} fe_status_t; /* application is recommended to reset
```

In the case of QPSK frontends the `Frequency` field specifies the intermediate frequency, i.e. the offset which is effectively added to the local oscillator frequency (LOF) of the LNB. The intermediate frequency has to be specified in units of kHz.

For QAM and OFDM frontends the `Frequency` specifies the absolute frequency and

9.1.10. frontend parameters

The `Inversion` field can take one of these values:

The kind of parameters passed to the frontend device for tuning depend on the kind of hardware you are using. All kinds of parameters are combined as an union in the

FrontendParameters structure:

```
typedef enum fe_spectral_inversion {
INVERSION_OFF,
INVERSION_ON,
INVERSION_AUTO
} fe_spectral_inversion_t;

struct dvb_frontend_parameters {
uint32_t frequency; /* (absolute) frequency in Hz for QAM/OFDM */
/* intermediate frequency in kHz for QPSK */
fe_spectral_inversion_t inversion;
union {
struct dvb_qpsk_parameters qpsk;

```

It indicates if spectral inversion should be presumed or not. In the automatic setting (INVERSION_AUTO) the hardware will try to figure out the correct setting by itself.

The possible values for the `parameters` field are

```
struct dvb_ofdm_parameters ofdm;
typedef enum fe_code_rate {
FEC_NONE = 0,
```

```
FEC_1_2,  
FEC_2_3,  
FEC_3_4,  
FEC_4_5,  
FEC_5_6,  
FEC_6_7,  
FEC_7_8,  
FEC_8_9,  
FEC_AUTO  
} fe_code_rate_t;
```

which correspond to error correction rates of 1/2, 2/3, etc., no error correction or auto detection.

For cable and terrestrial frontends (QAM and OFDM) one also has to specify the quadrature modulation mode which can be one of the following:

```
typedef enum fe_modulation {  
QPSK,  
QAM_16,  
QAM_32,  
QAM_64,  
QAM_128,  
QAM_256,  
QAM_AUTO  
} fe_modulation_t;
```

Finally, there are several more parameters for OFDM:

```
typedef enum fe_transmit_mode {  
TRANSMISSION_MODE_2K,  
TRANSMISSION_MODE_8K,  
TRANSMISSION_MODE_AUTO  
} fe_transmit_mode_t;  
  
typedef enum fe_bandwidth {  
BANDWIDTH_8_MHZ,  
BANDWIDTH_7_MHZ,  
BANDWIDTH_6_MHZ,  
BANDWIDTH_AUTO  
} fe_bandwidth_t;  
  
typedef enum fe_guard_interval {  
GUARD_INTERVAL_1_32,  
GUARD_INTERVAL_1_16,  
GUARD_INTERVAL_1_8,  
GUARD_INTERVAL_1_4,  
GUARD_INTERVAL_AUTO  
} fe_guard_interval_t;  
  
typedef enum fe_hierarchy {  
HIERARCHY_NONE,  
HIERARCHY_1,  
HIERARCHY_2,  
HIERARCHY_4,  
HIERARCHY_AUTO
```

SYNOPSIS

```
int open(const char *deviceName, int flags);
```

PARAMETERS

const char *deviceName	Name of specific video device.
int flags	A bit-wise OR of the following flags:
	O_RDONLY read-only access
	O_RDWR read/write access
	O_NONBLOCK open in non-blocking mode
	(blocking mode is the default)

ERRORS

ENODEV	Device driver not loaded/available.
EINTERNAL	Internal error.
EBUSY	Device or resource busy.
EINVAL	Invalid argument.

9.2.2. close()**DESCRIPTION**

This system call closes a previously opened front-end device. After closing a front-end device, its corresponding hardware might be powered down automatically.

SYNOPSIS

```
int close(int fd);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

ERRORS

EBADF	fd is not a valid open file descriptor.
-------	---

9.2.3. FE_READ_STATUS

DESCRIPTION

This ioctl call returns status information about the front-end. This call only requires read-only access to the device.

SYNOPSIS

```
int ioctl(int fd, int request = FE_READ_STATUS, fe_status_t *status);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals FE_READ_STATUS for this command.
struct fe_status_t *status	Points to the location where the front-end status word is to be stored.

ERRORS

EBADF	fd is not a valid open file descriptor.
EFAULT	status points to invalid address.

9.2.4. FE_READ_BER

DESCRIPTION

This ioctl call returns the bit error rate for the signal currently received/demodulated by the front-end. For this command, read-only access to the device is sufficient.

SYNOPSIS

```
int ioctl(int fd, int request = FE_READ_BER, uint32_t *ber);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals <code>FE_READ_BER</code> for this command.
uint32_t *ber	The bit error rate is stored into *ber.

ERRORS

EBADF	fd is not a valid open file descriptor.
EFAULT	ber points to invalid address.
ENOSIGNAL	There is no signal, thus no meaningful bit error rate. Also returned if the front-end is not turned on.
ENOSYS	Function not available for this device.

9.2.5. FE_READ_SNR

DESCRIPTION

This ioctl call returns the signal-to-noise ratio for the signal currently received by the front-end. For this command, read-only access to the device is sufficient.

SYNOPSIS

```
int ioctl(int fd, int request = FE_READ_SNR, int16_t *snr);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals <code>FE_READ_SNR</code> for this command.
int16_t *snr	The signal-to-noise ratio is stored into *snr.

ERRORS

EBADF	fd is not a valid open file descriptor.
-------	---

EFAULT	snr points to invalid address.
ENOSIGNAL	There is no signal, thus no meaningful signal strength value. Also returned if front-end is not turned on.
ENOSYS	Function not available for this device.

9.2.6. FE_READ_SIGNAL_STRENGTH

DESCRIPTION

This ioctl call returns the signal strength value for the signal currently received by the front-end. For this command, read-only access to the device is sufficient.

SYNOPSIS

```
int ioctl( int fd, int request = FE_READ_SIGNAL_STRENGTH, int16_t
*strength);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals <code>FE_READ_SIGNAL_STRENGTH</code> for this command.
int16_t *strength	The signal strength value is stored into *strength.

ERRORS

EBADF	fd is not a valid open file descriptor.
EFAULT	status points to invalid address.
ENOSIGNAL	There is no signal, thus no meaningful signal strength value. Also returned if front-end is not turned on.
ENOSYS	Function not available for this device.

9.2.7. FE_READ_UNCORRECTED_BLOCKS

DESCRIPTION

This ioctl call returns the number of uncorrected blocks detected by the device driver during its lifetime. For meaningful measurements, the increment in block count during a specific time interval should be calculated. For this command, read-only access to the device is sufficient.

Note that the counter will wrap to zero after its maximum count has been reached.

SYNOPSIS

```
int ioctl( int fd, int request = FE_READ_UNCORRECTED_BLOCKS, uint32_t
*ublocks);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals FE_READ_UNCORRECTED_BLOCKS for this command.
uint32_t *ublocks	The total number of uncorrected blocks seen by the driver so far.

ERRORS

EBADF	fd is not a valid open file descriptor.
EFAULT	ublocks points to invalid address.
ENOSYS	Function not available for this device.

9.2.8. FE_SET_FRONTEND

DESCRIPTION

This ioctl call starts a tuning operation using specified parameters. The result of this call will be successful if the parameters were valid and the tuning could be initiated. The result of the tuning operation in itself, however, will arrive asynchronously as an event (see documentation for `FE_GET_EVENT` and `FrontendEvent`.) If a new `FE_SET_FRONTEND` operation is initiated before the previous one was completed, the previous operation will be aborted in favor of the new one. This command requires read/write access to the device.

SYNOPSIS

```
int ioctl(int fd, int request = FE_SET_FRONTEND, struct
dvb_frontend_parameters *p);
```

PARAMETERS

int fd	File descriptor returned by a previous call to <code>open()</code> .
int request	Equals <code>FE_SET_FRONTEND</code> for this command.
struct <code>dvb_frontend_parameters *p</code>	Points to parameters for tuning operation.

ERRORS

EBADF	fd is not a valid open file descriptor.
EFAULT	p points to invalid address.
EINVAL	Maximum supported symbol rate reached.

9.2.9. FE_GET_FRONTEND

DESCRIPTION

This ioctl call queries the currently effective frontend parameters. For this command, read-only access to the device is sufficient.

SYNOPSIS

```
int ioctl(int fd, int request = FE_GET_FRONTEND, struct
dvb_frontend_parameters *p);
```

PARAMETERS

int fd	File descriptor returned by a previous call to <code>open()</code> .
int request	Equals <code>FE_SET_FRONTEND</code> for this command.
struct <code>dvb_frontend_parameters</code> *p	Points to parameters for tuning operation.

ERRORS

EBADF	fd is not a valid open file descriptor.
EFAULT	p points to invalid address.
EINVAL	Maximum supported symbol rate reached.

9.2.10. FE_GET_EVENT

DESCRIPTION

<p>This <code>ioctl</code> call returns a frontend event if available. If an event is not available, the behavior depends on whether the device is in blocking or non-blocking mode. In the latter case, the call fails immediately with <code>errno</code> set to <code>EWOULDBLOCK</code>. In the former case, the call blocks until an event becomes available.</p>
<p>The standard Linux <code>poll()</code> and/or <code>select()</code> system calls can be used with the device file descriptor to watch for new events. For <code>select()</code>, the file descriptor should be included in the <code>exceptfds</code> argument, and for <code>poll()</code>, <code>POLLPRI</code> should be specified as the wake-up condition. Since the event queue allocated is rather small (room for 8 events), the queue must be serviced regularly to avoid overflow. If an overflow happens, the oldest event is discarded from the queue, and an error (<code>E_OVERFLOW</code>) occurs the next time the queue is read. After reporting the error condition in this fashion, subsequent <code>FE_GET_EVENT</code> calls will return events from the queue as usual.</p>
<p>For the sake of implementation simplicity, this command requires read/write access to the device.</p>

SYNOPSIS

<pre>int ioctl(int fd, int request = QPSK_GET_EVENT, struct dvb_frontend_event *ev);</pre>
--

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals FE_GET_EVENT for this command.
struct dvb_frontend_event *ev	Points to the location where the event, if any, is to be stored.

ERRORS

EBADF	fd is not a valid open file descriptor.
EFAULT	ev points to invalid address.
EWOULDBLOCK	There is no event pending, and the device is in non-blocking mode.
EOVERFLOW	
	Overflow in event queue - one or more events were lost.

9.2.11. FE_GET_INFO

DESCRIPTION

This ioctl call returns information about the front-end. This call only requires read-only access to the device.

SYNOPSIS

```
int ioctl(int fd, int request = FE_GET_INFO, struct dvb_frontend_info *info);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals FE_GET_INFO for this command.
struct dvb_frontend_info *info	Points to the location where the front-end information is to be stored.

ERRORS

EBADF	fd is not a valid open file descriptor.
EFAULT	info points to invalid address.

9.2.12. FE_DISEQC_RESET_OVERLOAD

DESCRIPTION

If the bus has been automatically powered off due to power overload, this ioctl call restores the power to the bus. The call requires read/write access to the device. This call has no effect if the device is manually powered off. Not all DVB adapters support this ioctl.

SYNOPSIS

```
int ioctl(int fd, int request = FE_DISEQC_RESET_OVERLOAD);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals <code>FE_DISEQC_RESET_OVERLOAD</code> for this command.

ERRORS

EBADF	fd is not a valid file descriptor.
EPERM	Permission denied (needs read/write access).
EINTERNAL	Internal error in the device driver.

9.2.13. FE_DISEQC_SEND_MASTER_CMD

DESCRIPTION

This ioctl call is used to send a a DiSEqC command.

SYNOPSIS


```
int ioctl(int fd, int request = FE_DISEQC_SEND_MASTER_CMD, struct
dvb_diseqc_master_cmd *cmd);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals FE_DISEQC_SEND_MASTER_CMD for this command.
struct dvb_diseqc_master_cmd *cmd	Pointer to the command to be transmitted.

ERRORS

EBADF	fd is not a valid file descriptor.
EFAULT	Seq points to an invalid address.
EINVAL	The data structure referred to by seq is invalid in some way.
EPERM	Permission denied (needs read/write access).
EINTERNAL	Internal error in the device driver.

9.2.14. FE_DISEQC_RECV_SLAVE_REPLY

DESCRIPTION

This ioctl call is used to receive reply to a DiSEqC 2.0 command.

SYNOPSIS

```
int ioctl(int fd, int request = FE_DISEQC_RECV_SLAVE_REPLY, struct
dvb_diseqc_slave_reply *reply);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

int request	Equals FE_DISEQC_RECV_SLAVE_REPLY for this command.
struct dvb_diseqc_slave_reply *reply	Pointer to the command to be received.

ERRORS

EBADF	fd is not a valid file descriptor.
EFAULT	Seq points to an invalid address.
EINVAL	The data structure referred to by seq is invalid in some way.
EPERM	Permission denied (needs read/write access).
EINTERNAL	Internal error in the device driver.

9.2.15. FE_DISEQC_SEND_BURST

DESCRIPTION

This ioctl call is used to send a 22KHz tone burst.

SYNOPSIS

int ioctl(int fd, int request = FE_DISEQC_SEND_BURST, fe_sec_mini_cmd_t burst);

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals FE_DISEQC_SEND_BURST for this command.
fe_sec_mini_cmd_t burst	burst A or B.

ERRORS

EBADF	fd is not a valid file descriptor.
EFAULT	Seq points to an invalid address.

EINVAL	The data structure referred to by seq is invalid in some way.
EPERM	Permission denied (needs read/write access).
EINTERNAL	Internal error in the device driver.

9.2.16. FE_SET_TONE

DESCRIPTION

This call is used to set the generation of the continuous 22kHz tone. This call requires read/write permissions.

SYNOPSIS

```
int ioctl(int fd, int request = FE_SET_TONE, fe_sec_tone_mode_t tone);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals FE_SET_TONE for this command.
fe_sec_tone_mode_t tone	The requested tone generation mode (on/off).

ERRORS

ENODEV	Device driver not loaded/available.
EBUSY	Device or resource busy.
EINVAL	Invalid argument.
EPERM	File not opened with read permissions.
EINTERNAL	Internal error in the device driver.

9.2.17. FE_SET_VOLTAGE

DESCRIPTION

This call is used to set the bus voltage. This call requires read/write permissions.

SYNOPSIS

```
int ioctl(int fd, int request = FE_SET_VOLTAGE, fe_sec_voltage_t voltage);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals FE_SET_VOLTAGE for this command.
fe_sec_voltage_t voltage	The requested bus voltage.

ERRORS

ENODEV	Device driver not loaded/available.
EBUSY	Device or resource busy.
EINVAL	Invalid argument.
EPERM	File not opened with read permissions.
EINTERNAL	Internal error in the device driver.

9.2.18. FE_ENABLE_HIGH_LNB_VOLTAGE

DESCRIPTION

If high != 0 enables slightly higher voltages instead of 13/18V (to compensate for long cables). This call requires read/write permissions. Not all DVB adapters support this ioctl.

SYNOPSIS

```
int ioctl(int fd, int request = FE_ENABLE_HIGH_LNB_VOLTAGE, int high);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

int request	Equals FE_SET_VOLTAGE for this command.
int high	The requested bus voltage.

ERRORS

ENODEV	Device driver not loaded/available.
EBUSY	Device or resource busy.
EINVAL	Invalid argument.
EPERM	File not opened with read permissions.
EINTERNAL	Internal error in the device driver.

9.2.19. FE_SET_FRONTEND_TUNE_MODE

DESCRIPTION

Allow setting tuner mode flags to the frontend.

SYNOPSIS

```
int ioctl(int fd, int request = FE_SET_FRONTEND_TUNE_MODE, unsigned int flags);
```

PARAMETERS

unsigned int flags	FE_TUNE_MODE_ONESHOT When set, this flag will disable any zigzagging or other "normal" tuning behaviour. Additionally, there will be no automatic monitoring of the lock status, and hence no frontend events will be generated. If a frontend device is closed, this flag will be automatically turned off when the device is reopened read-write.
--------------------	---

ERRORS

EINVAL	Invalid argument.
--------	-------------------

9.2.20.

FE_DISHNETWORK_SEND_LEGACY_CMD

DESCRIPTION

WARNING: This is a very obscure legacy command, used only at stv0299 driver. Should not be used on newer drivers.
It provides a non-standard method for selecting Diseqc voltage on the frontend, for Dish Network legacy switches.

As support for this ioctl were added in 2004, this means that such dishes were already legacy in 2004.

SYNOPSIS

```
int ioctl(int fd, int request = FE_DISHNETWORK_SEND_LEGACY_CMD,
unsigned long cmd);
```

PARAMETERS

unsigned long cmd	sends the specified raw cmd to the dish via DISEqC.
-------------------	---

ERRORS

There are no errors in use for this call

9.3.

FE_GET_PROPERTY/FE_SET_PROPERTY

```
/* Reserved fields should be set to 0 */
struct dtv_property {
    __u32 cmd;
    union {
        __u32 data;
        struct {
            __u8 data[32];
            __u32 len;
            __u32 reserved1[3];
        };
    };
};
```

```

        void *reserved2;
    } buffer;
} u;
int result;
} __attribute__((packed));

/* num of properties cannot exceed DTV_IOCTL_MAX_MSGS per ioctl */
#define DTV_IOCTL_MAX_MSGS 64

struct dtv_properties {
    __u32 num;
    struct dtv_property *props;
};

```

9.3.1. FE_GET_PROPERTY

DESCRIPTION

This ioctl call returns one or more frontend properties. This call only requires read-only access to the device.

SYNOPSIS

```
int ioctl(int fd, int request = FE_GET_PROPERTY, dtv_properties *props);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int num	Equals FE_GET_PROPERTY for this command.
struct dtv_property *props	Points to the location where the front-end property commands are stored.

ERRORS

EINVAL	Invalid parameter(s) received or number of parameters out of the range.
ENOMEM	Out of memory.
EFAULT	Failure while copying data from/to userspace.
EOPNOTSUPP	Property type not supported.

9.3.2. FE_SET_PROPERTY

DESCRIPTION

This ioctl call sets one or more frontend properties. This call only requires read-only access to the device.

SYNOPSIS

```
int ioctl(int fd, int request = FE_SET_PROPERTY, dtv_properties *props);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int num	Equals FE_SET_PROPERTY for this command.
struct dtv_property *props	Points to the location where the front-end property commands are stored.

ERRORS

EINVAL	Invalid parameter(s) received or number of parameters out of the range.
ENOMEM	Out of memory.
EFAULT	Failure while copying data from/to userspace.
EOPNOTSUPP	Property type not supported.

9.3.3. Property types

On FE_GET_PROPERTY/FE_SET_PROPERTY, the actual action is determined by the dtv_property cmd/data pairs. With one single ioctl, is possible to get/set up to 64 properties. The actual meaning of each property is described on the next sections.

The available frontend property types are:

```
#define DTV_UNDEFINED  0
#define DTV_TUNE       1
#define DTV_CLEAR      2
#define DTV_FREQUENCY  3
```


9.3.4. Parameters that are common to all Digital TV standards

```
#define DTV_FREQUENCY 8
#define DTV_BANDWIDTH_HZ 5
#define DTV_INVERSION 6
#define DTV_DISEQC_MASTER 7
#define DTV_ISDBT_SB_SEGMENT_IDX 8
#define DTV_ISDBT_SB_SEGMENT_COUNT 9
Central frequency of the channel, in HZ.
#define DTV_VOLTAGE 10
Notes:
#define DTV_TONE 11
```

1) For ISDB-T the channels are usually transmitted with an offset of 143kHz. E.g. a valid frequency could be 474143 kHz. The stepping is bound to the bandwidth of the channel which is 6MHz.

2) As in ISDB-Tsb the channel consists of only one or three segments the frequency step is 429kHz, 3*429 respectively. As for ISDB-T the central frequency of the channel is expected.

```
#define DTV_DELIVERY_SYSTEM 17
#define DTV_ISDBT_PARTIAL_RECEPTION 18
#define DTV_ISDBT_SOUND_BROADCASTING 19
```

9.3.4.2. DTV_BANDWIDTH_HZ

```
#define DTV_ISDBT_LAYERA_BCC_CHANNEL_ID 20
#define DTV_ISDBT_SB_SEGMENT_IDX 21
Bandwidth for the channel, in HZ.
#define DTV_ISDBT_SB_SEGMENT_COUNT 22
Possible values: 1712000, 5000000, 6000000, 7000000, 8000000, 10000000.
```

```
#define DTV_ISDBT_LAYERA_MODULATION 24
Notes:
#define DTV_ISDBT_LAYERA_SEGMENT_COUNT 25
1) For ISDB-T it should be always 6000000Hz (6MHz)
#define DTV_ISDBT_LAYERA_TIME_INTERLEAVING 26
2) For ISDB-Tsb it can vary depending on the number of connected segments
```

3) Bandwidth doesn't apply for DVB-C transmissions, as the bandwidth for DVB-C depends on the symbol rate

```
#define DTV_ISDBT_LAYERB_SEGMENT_COUNT 29
#define DTV_ISDBT_LAYERB_TIME_INTERLEAVING 30
4) Bandwidth in ISDB-T is fixed (6MHz) or can be easily derived from other parameters (DTV_ISDBT_SB_SEGMENT_IDX, DTV_ISDBT_SB_SEGMENT_COUNT).
```

```
#define DTV_ISDBT_LAYERC_MODULATION 32
#define DTV_ISDBT_LAYERC_SEGMENT_COUNT 33
5) DVB-T supports 6, 7 and 8MHz.
#define DTV_ISDBT_LAYERC_TIME_INTERLEAVING 34
6) In addition, DVB-T2 supports 1, 1.72, 5 and 10MHz.
```

```
#define DTV_API_VERSION 35
#define DTV_CODE_RATE_HP 36
#define DTV_CODE_RATE_LP 37
9.3.4.3. DTV_DELIVERY_SYSTEM
```

```
#define DTV_TRANSMISSION_MODE 39
Specifies the type of Delivery system
#define DTV_HIERARCHY 40
Possible values:
#define DTV_ISDBT_LAYER_ENABLED 41
typedef enum DTV_Delivery_System {
    SYS_UNDEFINED,
    SYS_DVBC_ANNEX_AC,
```

9.3.4.5 DTV_GUARD_INTERVAL

Possible values are:

```
typedef enum fe_guard_interval {
    SYS_DVBS2_GUARD_INTERVAL_1_32,
    SYS_DVBS2_GUARD_INTERVAL_1_16,
    SYS_ISDBT_GUARD_INTERVAL_1_8,
    SYS_ISDBT_GUARD_INTERVAL_1_4,
    SYS_ISDBT_GUARD_INTERVAL_AUTO,
    SYS_DVBH_GUARD_INTERVAL_1_128,
    SYS_DVBH_GUARD_INTERVAL_19_128,
    SYS_DVBH_GUARD_INTERVAL_19_256,
} SYS_GUARD_interval_t;

SYS_DAB,
```

Notes: DVBT2,

1) If DTV_GUARD_INTERVAL is set the GUARD_INTERVAL_AUTO the hardware will try to find the correct guard interval (if capable) and will use TMCC to fill in the missing parameters.

9.3.4.4 DTV_TRANSMISSION_MODE

Intervals 19_128, 19_128 and 19_256 are used only for DVB-T2 at present

Specifies the number of carriers used by the standard

Possible values are:

9.3.5. ISDB-T frontend

```
typedef enum fe_transmit_mode {
```

This section describes shortly what are the possible parameters in the Linux

DVB-API called "S2API" and now DVB API 5 in order to tune an

ISDB-T/ISDB-Tsb demodulator:

```
TRANSMISSION_MODE_4K,
```

This ISDB-T/ISDB-Tsb API extension should reflect all information needed to tune

any ISDB-T/ISDB-Tsb hardware. Of course it is possible that some very

sophisticated devices won't need certain parameters to tune.

```
TRANSMISSION_MODE_32K,
```

1) fe_transmit_mode_t;

The information given here should help application writers to know how to handle

ISDB-T and ISDB-Tsb hardware using the Linux DVB-API.

Notes:

The details given here about ISDB-T and ISDB-Tsb are just enough to basically

1) ISDB-T supports three carrier/symbol-size: 8K, 4K, 2K. It is called "mode" in the

standard; Mode 1 is 2K, mode 2 is 4K, mode 3 is 8K

information is left out. For more detailed information see the following documents:

2) If DTV_TRANSMISSION_MODE is set the TRANSMISSION_MODE_AUTO the

hardware will try to find the correct FFT-size (if capable) and will use TMCC to fill

Broadcasting" and

in the missing parameters.

ARIB TR-B14 - "Operational Guidelines for Digital Terrestrial Television

3) DVB-T specifies 2K and 8K as valid sizes.

4) DVB-T2 specifies 1K, 2K, 4K, 8K, 16K and 32K.

In order to read this document one has to have some knowledge the channel

structure in ISDB-T and ISDB-Tsb. I.e. it has to be known to the reader that an

ISDB-T multiplexing layer consists of 13 segments, that in each segment 3 layers consisting of those segments sub-channels like a predefined IDs. A sub-channel is used to help the demodulator to synchronize on the channel.

Parameters used by ISDB-T and ISDB-Tsb:

An ISDB-T channel is always centered over all sub-channels. As for the example above, in ISDB-Tsb it is no longer as simple as that.

9.3.5.1. ISDB-T only parameters

The `DTV_ISDBT_SB_SUBCHANNEL_ID` parameter is used to give the sub-channel ID of the segment to be demodulated.

9.3.5.1.1. `DTV_ISDBT_PARTIAL_RECEPTION`
Possible values: 0, 1, -1 (AUTO)

If `DTV_ISDBT_SOUND_BROADCASTING` is '0' this bit-field represents whether the channel is in partial reception mode or not.

9.3.5.1.4. `DTV_ISDBT_SB_SEGMENT_IDX`

If '1', `DTV_ISDBT_LAYERA_*` values are assigned to the center segment and

This field only applies if `DTV_ISDBT_SOUND_BROADCASTING` is '1'.

`DTV_ISDBT_LAYERA_SEGMENT_COUNT` has to be 4.

`DTV_ISDBT_SB_SEGMENT_IDX` gives the index of the segment to be demodulated

If in addition `DTV_ISDBT_SOUND_BROADCASTING` is '1' for an ISDB-Tsb channel where several of them are transmitted in the connected manner.

`DTV_ISDBT_PARTIAL_RECEPTION` represents whether this ISDB-Tsb channel is

consisting of one segment and layer or three segments and two layers.

Possible values: 0, 1, -1 (AUTO) `DTV_ISDBT_SB_SEGMENT_COUNT - 1`

Note: This value cannot be determined by an automatic channel search.

9.3.5.1.2. `DTV_ISDBT_SOUND_BROADCASTING`

9.3.5.1.5. `DTV_ISDBT_SB_SEGMENT_COUNT`

This field represents whether the other `DTV_ISDBT_*`-parameters are referring to

an ISDB-T and an ISDB-Tsb channel. (See also `DTV_ISDBT_SOUND_BROADCASTING` is '1'.

`DTV_ISDBT_PARTIAL_RECEPTION` gives the total count of connected ISDB-Tsb channels.

Possible values: 0, 1, -1 (AUTO)

Possible values: 1 .. 13

Note: This value cannot be determined by an automatic channel search.

9.3.5.1.3. `DTV_ISDBT_SB_SUBCHANNEL_ID`

This field only applies if `DTV_ISDBT_SOUND_BROADCASTING` is '1'.

9.3.5.1.6. Hierarchical layers

(Note of the author: This might not be the correct description of the

ISDB-T channels can be coded hierarchically. As opposed to DVB-T in ISDB-T hierarchical layers can be decoded simultaneously. For that reason a ISDB-T background needed to program a device)

demodulator has 3 viterbi and 3 reed-solomon-decoders.

An ISDB-Tsb channel (1 or 3 segments) can be broadcasted alone or in a set of

ISDB-T has 3 hierarchical layers which each can use a part of the available segments. The total number of segments over all layers has to 13 in ISDB-T.

independently. The number of connected ISDB-Tsb segment can vary, e.g.

depending on the frequency spectrum bandwidth available.

9.3.5.1.6.1. `DTV_ISDBT_LAYER_ENABLED`

Example: Assume 8 ISDB-Tsb connected segments are broadcasted. The

hierarchical reception of ISDB-T is achieved by changing or disabling layers in the decoding process. In ISDB-T all positions in the `DTV_ISDBT_LAYER_ENABLED` array are set to 1 (if applicable) to be demodulated. This is the default.

If the channel is in the partial reception mode (`DTV_ISDBT_PARTIAL_RECEPTION = 1`) the central segment can be decoded independently of the other 12 segments. In that mode layer A has to have a `SEGMENT_COUNT` of 1.

In ISDB-Tsb only layer A is used, it can be 1 or 3 in ISDB-Tsb according to `DTV_ISDBT_PARTIAL_RECEPTION`. `SEGMENT_COUNT` must be filled accordingly.

Possible values: 0x1, 0x2, 0x4 (l-able)

`DTV_ISDBT_LAYER_ENABLED[0:0]` - layer A

`DTV_ISDBT_LAYER_ENABLED[1:1]` - layer B

`DTV_ISDBT_LAYER_ENABLED[2:2]` - layer C

`DTV_ISDBT_LAYER_ENABLED[31:3]` unused

9.3.5.1.6.2. *DTV_ISDBT_LAYER*_FEC*

Possible values: `FEC_AUTO`, `FEC_1_2`, `FEC_2_3`, `FEC_3_4`, `FEC_5_6`, `FEC_7_8`

9.3.5.1.6.3. *DTV_ISDBT_LAYER*_MODULATION*

Possible values: `QAM_AUTO`, `QPSK`, `QAM_16`, `QAM_64`, `DQPSK`

Note: If layer C is `DQPSK` layer B has to be `DQPSK`. If layer B is `DQPSK` and `DTV_ISDBT_PARTIAL_RECEPTION=0` layer has to be `DQPSK`.

9.3.5.1.6.4. *DTV_ISDBT_LAYER*_SEGMENT_COUNT*

Possible values: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, -1 (AUTO)

Note: Truth table for `DTV_ISDBT_SOUND_BROADCASTING` and `DTV_ISDBT_PARTIAL_RECEPTION` and `LAYER*_SEGMENT_COUNT`

PR	SB	Layer A width	Layer B width	Layer C width	total width
0	0	1 .. 13	1 .. 13	1 .. 13	13
1	0	1	1 .. 13	1 .. 13	13
0	1	1	0	0	1
1	1	1	2	0	13

9.3.5.1.6.5. *DTV_ISDBT_LAYER*_TIME_INTERLEAVING*

Possible values: 0, 1, 2, 3, -1 (AUTO)

Note: The real inter-leaver depth-names depend on the mode (fft-size); the values here are referring to what can be found in the TMCC-structure - independent of the mode.

9.3.5.2. DVB-T2 parameters

This section covers parameters that apply only to the DVB-T2 delivery method. DVB-T2 support is currently in the early stages development so expect this section to grow and become more detailed with time.

9.3.5.2.1. *DTV_DVBT2_PLP_ID*

DVB-T2 supports Physical Layer Pipes (PLP) to allow transmission of many data types via a single multiplex. The API will soon support this at which point this section will be expanded.

Chapter 10. DVB Demux Device

The DVB demux device controls the filters of the DVB hardware/software. It can be accessed through `/dev/adap0/demux0`. Data types and and ioctl definitions can be accessed by including `linux/dvb/dmx.h` in your application.

10.1. Demux Data Types

10.1.1. `dmx_output_t`

```
typedef enum
{
    DMX_OUT_DECODER,
    DMX_OUT_TAP,
    DMX_OUT_TS_TAP
} dmx_output_t;
```

`DMX_OUT_TAP` delivers the stream output to the demux device on which the ioctl is called.

`DMX_OUT_TS_TAP` routes output to the logical DVR device `/dev/dvb/adap0/dvr0`, which delivers a TS multiplexed from all filters for which `DMX_OUT_TS_TAP` was specified.

10.1.2. `dmx_input_t`

```
typedef enum
{
    DMX_IN_FRONTEND,
    DMX_IN_DVR
} dmx_input_t;
```

10.1.3. `dmx_pes_type_t`

```
typedef enum
{
    DMX_PES_AUDIO,
```

```
#define DMX_PES_CRC_CHECK_CRC      1
#define DMX_PES_CRC_CHECK_CRC_NOT 2
#define DMX_PES_SUBTITLE_IMMEDIATE_START 4
} DMX_PES_PCR,
  DMX_PES_OTHER
} dmx_pes_type_t;
```

10.1.8. struct dm_x_pes_filter_params

10.1.4. dm_x_event_t

```
struct dm_x_pes_filter_params
{
    typedef enum
    {
        uint16_t          pid;
        DMX_SCRAMBLING_EV,  input;
        DMX_FRONTEND_EV      output;
    } dm_x_pes_type_t;
    dm_x_pes_type_t      pes_type;
    uint32_t             flags;
};
```

10.1.5. dm_x_scrambling_status_t

```
typedef enum
{
    DMX_SCRAMBLING_OFF,
    DMX_SCRAMBLING_ON
} dm_x_scrambling_status_t;
struct dm_x_event
{
    dm_x_scrambling_status_t;
    dm_x_event_t          event;
    time_t                timeStamp;
    union
```

10.1.6. struct dm_x_filter

```
    dm_x_scrambling_status_t scrambling;
typedef struct dm_x_filter
{
};
    uint8_t          filter[DMX_FILTER_SIZE];
    uint8_t          mask[DMX_FILTER_SIZE];
} dm_x_filter_t;
```

10.1.10. struct dm_x_stc

10.1.7. struct dm_x_sct_filter_params

```
struct dm_x_sct_filter_params
{
    unsigned int num;          /* input : which STC? 0..N */
    struct dm_x_sct_filter_params output; /* divisor for stc to get 90 kHz clock */
    uint64_t stc;              /* output: stc in 'base'*90 kHz units */
    uint16_t pid;
    dm_x_filter_t filter;
    uint32_t timeout;
    uint32_t flags;
```

10.2. Demux Function Calls

10.2.1. open()

DESCRIPTION

This system call, used with a device name of `/dev/dvb/adapter0/demux0`, allocates a new filter and returns a handle which can be used for subsequent control of that filter. This call has to be made for each filter to be used, i.e. every returned file descriptor is a reference to a single filter. `/dev/dvb/adapter0/dvr0` is a logical device to be used for retrieving Transport Streams for digital video recording. When reading from this device a transport stream containing the packets from all PES filters set in the corresponding demux device (`/dev/dvb/adapter0/demux0`) having the output set to `DMX_OUT_TS_TAP`. A recorded Transport Stream is replayed by writing to this device. The significance of blocking or non-blocking mode is described in the documentation for functions where there is a difference. It does not affect the semantics of the `open()` call itself. A device opened in blocking mode can later be put into non-blocking mode (and vice versa) using the `F_SETFL` command of the `fcntl` system call.

SYNOPSIS

```
int open(const char *deviceName, int flags);
```

PARAMETERS

<code>const char *deviceName</code>	Name of demux device.
<code>int flags</code>	A bit-wise OR of the following flags:
	<code>O_RDWR</code> read/write access
	<code>O_NONBLOCK</code> open in non-blocking mode
	(blocking mode is the default)

ERRORS

<code>ENODEV</code>	Device driver not loaded/available.
<code>EINVAL</code>	Invalid argument.
<code>EMFILE</code>	“Too many open files”, i.e. no more filters available.

ENOMEM	The driver failed to allocate enough memory.
--------	--

10.2.2. close()

DESCRIPTION

This system call deactivates and deallocates a filter that was previously allocated via the open() call.

SYNOPSIS

```
int close(int fd);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

ERRORS

EBADF	fd is not a valid open file descriptor.
-------	---

10.2.3. read()

DESCRIPTION

This system call returns filtered data, which might be section or PES data. The filtered data is transferred from the driver's internal circular buffer to buf. The maximum amount of data to be transferred is implied by count.

When returning section data the driver always tries to return a complete single section (even though buf would provide buffer space for more data). If the size of the buffer is smaller than the section as much as possible will be returned, and the remaining data will be provided in subsequent calls.

The size of the internal buffer is $2 * 4096$ bytes (the size of two maximum sized sections) by default. The size of this buffer may be changed by using the `DMX_SET_BUFFER_SIZE` function. If the buffer is not large enough, or if the read operations are not performed fast enough, this may result in a buffer overflow error. In this case `EOverflow` will be returned, and the circular buffer will be emptied. This call is blocking if there is no data to return, i.e. the process will be put to sleep waiting for data, unless the `O_NONBLOCK` flag is specified.

Note that in order to be able to read, the filtering process has to be started by defining either a section or a PES filter by means of the `ioctl` functions, and then starting the filtering process via the `DMX_START` `ioctl` function or by setting the `DMX_IMMEDIATE_START` flag. If the reading is done from a logical DVR demux device, the data will constitute a Transport Stream including the packets from all PES filters in the corresponding demux device `/dev/dvb/adaptor0/demux0` having the output set to `DMX_OUT_TS_TAP`.

SYNOPSIS

```
size_t read(int fd, void *buf, size_t count);
```

PARAMETERS

<code>int fd</code>	File descriptor returned by a previous call to <code>open()</code> .
<code>void *buf</code>	Pointer to the buffer to be used for returned filtered data.
<code>size_t count</code>	Size of <code>buf</code> .

ERRORS

<code>EWouldBlock</code>	No data to return and <code>O_NONBLOCK</code> was specified.
<code>EBADF</code>	<code>fd</code> is not a valid open file descriptor.
<code>ECRC</code>	Last section had a CRC error - no data returned. The buffer is flushed.
<code>EOverflow</code>	
	The filtered data was not read from the buffer in due time, resulting in non-read data being lost. The buffer is flushed.

ETIMEDOUT	The section was not loaded within the stated timeout period. See ioctl DMX_SET_FILTER for how to set a timeout.
EFAULT	The driver failed to write to the callers buffer due to an invalid *buf pointer.

10.2.4. write()

DESCRIPTION

This system call is only provided by the logical device /dev/dvb/adapter0/dvr0, associated with the physical demux device that provides the actual DVR functionality. It is used for replay of a digitally recorded Transport Stream. Matching filters have to be defined in the corresponding physical demux device, /dev/dvb/adapter0/demux0. The amount of data to be transferred is implied by count.

SYNOPSIS

```
ssize_t write(int fd, const void *buf, size_t count);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
void *buf	Pointer to the buffer containing the Transport Stream.
size_t count	Size of buf.

ERRORS

EWOULDBLOCK	No data was written. This might happen if O_NONBLOCK was specified and there is no more buffer space available (if O_NONBLOCK is not specified the function will block until buffer space is available).
-------------	--

EBUSY	This error code indicates that there are conflicting requests. The corresponding demux device is setup to receive data from the front- end. Make sure that these filters are stopped and that the filters with input set to DMX_IN_DVR are started.
EBADF	fd is not a valid open file descriptor.

10.2.5. DMX_START

DESCRIPTION

This ioctl call is used to start the actual filtering operation defined via the ioctl calls DMX_SET_FILTER or DMX_SET_PES_FILTER.

SYNOPSIS

```
int ioctl( int fd, int request = DMX_START);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals DMX_START for this command.

ERRORS

EBADF	fd is not a valid file descriptor.
EINVAL	Invalid argument, i.e. no filtering parameters provided via the DMX_SET_FILTER or DMX_SET_PES_FILTER functions.
EBUSY	This error code indicates that there are conflicting requests. There are active filters filtering data from another input source. Make sure that these filters are stopped before starting this filter.

10.2.6. DMX_STOP

DESCRIPTION

This ioctl call is used to stop the actual filtering operation defined via the ioctl calls DMX_SET_FILTER or DMX_SET_PES_FILTER and started via the DMX_START command.

SYNOPSIS

```
int ioctl( int fd, int request = DMX_STOP);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals DMX_STOP for this command.

ERRORS

EBADF	fd is not a valid file descriptor.
-------	------------------------------------

10.2.7. DMX_SET_FILTER

DESCRIPTION

This ioctl call sets up a filter according to the filter and mask parameters provided. A timeout may be defined stating number of seconds to wait for a section to be loaded. A value of 0 means that no timeout should be applied. Finally there is a flag field where it is possible to state whether a section should be CRC-checked, whether the filter should be a "one-shot" filter, i.e. if the filtering operation should be stopped after the first section is received, and whether the filtering operation should be started immediately (without waiting for a DMX_START ioctl call). If a filter was previously set-up, this filter will be canceled, and the receive buffer will be flushed.

SYNOPSIS

```
int ioctl( int fd, int request = DMX_SET_FILTER, struct dmx_sct_filter_params
*params);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals DMX_SET_FILTER for this command.
struct dm_x_sct_filter_params *params	Pointer to structure containing filter parameters.

ERRORS

EBADF	fd is not a valid file descriptor.
EINVAL	Invalid argument.

10.2.8. DMX_SET_PES_FILTER

DESCRIPTION

This ioctl call sets up a PES filter according to the parameters provided. By a PES filter is meant a filter that is based just on the packet identifier (PID), i.e. no PES header or payload filtering capability is supported.
The transport stream destination for the filtered output may be set. Also the PES type may be stated in order to be able to e.g. direct a video stream directly to the video decoder. Finally there is a flag field where it is possible to state whether the filtering operation should be started immediately (without waiting for a DMX_START ioctl call). If a filter was previously set-up, this filter will be cancelled, and the receive buffer will be flushed.

SYNOPSIS

int ioctl(int fd, int request = DMX_SET_PES_FILTER, struct dm_x_pes_filter_params *params);
--

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals DMX_SET_PES_FILTER for this command.

<code>struct dmx_pes_filter_params *params</code>	Pointer to structure containing filter parameters.
---	--

ERRORS

EBADF	fd is not a valid file descriptor.
EINVAL	Invalid argument.
EBUSY	This error code indicates that there are conflicting requests. There are active filters filtering data from another input source. Make sure that these filters are stopped before starting this filter.

10.2.9. DMX_SET_BUFFER_SIZE

DESCRIPTION

This ioctl call is used to set the size of the circular buffer used for filtered data. The default size is two maximum sized sections, i.e. if this function is not called a buffer size of 2 * 4096 bytes will be used.

SYNOPSIS

```
int ioctl( int fd, int request = DMX_SET_BUFFER_SIZE, unsigned long size);
```

PARAMETERS

<code>int fd</code>	File descriptor returned by a previous call to <code>open()</code> .
<code>int request</code>	Equals <code>DMX_SET_BUFFER_SIZE</code> for this command.
<code>unsigned long size</code>	Size of circular buffer.

ERRORS

EBADF	fd is not a valid file descriptor.
ENOMEM	The driver was not able to allocate a buffer of the requested size.

10.2.10. DMX_GET_EVENT

DESCRIPTION

This ioctl call returns an event if available. If an event is not available, the behavior depends on whether the device is in blocking or non-blocking mode. In the latter case, the call fails immediately with `errno` set to `EWOULDBLOCK`. In the former case, the call blocks until an event becomes available.

The standard Linux `poll()` and/or `select()` system calls can be used with the device file descriptor to watch for new events. For `select()`, the file descriptor should be included in the `exceptfds` argument, and for `poll()`, `POLLPRI` should be specified as the wake-up condition. Only the latest event for each filter is saved.

SYNOPSIS

```
int ioctl( int fd, int request = DMX_GET_EVENT, struct dmx_event *ev);
```

PARAMETERS

<code>int fd</code>	File descriptor returned by a previous call to <code>open()</code> .
<code>int request</code>	Equals <code>DMX_GET_EVENT</code> for this command.
<code>struct dmx_event *ev</code>	Pointer to the location where the event is to be stored.

ERRORS

<code>EBADF</code>	<code>fd</code> is not a valid file descriptor.
<code>EFAULT</code>	<code>ev</code> points to an invalid address.
<code>EWOULDBLOCK</code>	There is no event pending, and the device is in non-blocking mode.

10.2.11. DMX_GET_STC

DESCRIPTION

This ioctl call returns the current value of the system time counter (which is driven by a PES filter of type DMX_PES_PCR). Some hardware supports more than one STC, so you must specify which one by setting the num field of stc before the ioctl (range 0...n). The result is returned in form of a ratio with a 64 bit numerator and a 32 bit denominator, so the real 90kHz STC value is $stc \rightarrow stc / stc \rightarrow base$.

SYNOPSIS

```
int ioctl( int fd, int request = DMX_GET_STC, struct dmx_stc *stc);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals DMX_GET_STC for this command.
struct dmx_stc *stc	Pointer to the location where the stc is to be stored.

ERRORS

EBADF	fd is not a valid file descriptor.
EFAULT	stc points to an invalid address.
EINVAL	Invalid stc number.

Chapter 11. DVB Video Device

The DVB video device controls the MPEG2 video decoder of the DVB hardware. It can be accessed through `/dev/dvb/adapater0/video0`. Data types and ioctl definitions can be accessed by including `linux/dvb/video.h` in your application.

Note that the DVB video device only controls decoding of the MPEG video stream, not its presentation on the TV or computer screen. On PCs this is typically handled by an associated video4linux device, e.g. `/dev/video`, which allows scaling and defining output windows.

Some DVB cards don't have their own MPEG decoder, which results in the omission of the audio and video device as well as the video4linux device.

The ioctls that deal with SPUs (sub picture units) and navigation packets are only supported on some MPEG decoders made for DVD playback.

11.1. Video Data Types

11.1.1. `video_format_t`

The `video_format_t` data type defined by

```
typedef enum {  
    VIDEO_FORMAT_4_3,  
    VIDEO_FORMAT_16_9  
} video_format_t;
```

is used in the `VIDEO_SET_FORMAT` function (??) to tell the driver which aspect ratio the output hardware (e.g. TV) has. It is also used in the data structures `video_status` (??) returned by `VIDEO_GET_STATUS` (??) and `video_event` (??) returned by `VIDEO_GET_EVENT` (??) which report about the display format of the current video stream.

11.1.2. `video_display_format_t`

In case the display format of the video stream and of the display hardware differ the application has to specify how to handle the cropping of the picture. This can be done using the `VIDEO_SET_DISPLAY_FORMAT` call (??) which accepts

```
typedef enum {
    VIDEO_PAN_SCAN,
    VIDEO_LETTER_BOX,
    VIDEO_FORMAT_C, video_format;
    VIDEO_CENTER_CUT_OUT
}; video_display_format_t;
};
```

as argument.

11.1.6. struct video_status

The VIDEO_GET_STATUS call returns the following structure informing about the video stream source is set through the VIDEO_SELECT_SOURCE call and can take the following values, depending on whether we are replaying from an internal (demuxer) or external (user write) source.

```
struct video_status {
    boolean video_blank;
    typedef enum {
        VIDEO_SOURCE_DEMUX, play_state;
        VIDEO_SOURCE_MEMORY_t stream_source;
    } video_format_t; video_format;
    video_displayformat_t display_format;
};
```

VIDEO_SOURCE_DEMUX selects the demultiplexer (fed either by the frontend or the DVR device) as the source of the video stream. If

VIDEO_SOURCE_MEMORY is selected the stream comes from the application. If video_blank is set video will be blanked out. If the channel is changed or if playback is stopped. Otherwise, the last picture will be displayed. play_state

indicates if the video is currently frozen, stopped, or being played back. The

stream_source corresponds to the selected source for the video stream. It can come

either from the demultiplexer or from memory. The video_format indicates the

aspect ratio (one of 4:3 or 16:9) of the currently played video stream. Finally,

The following values can be returned by the VIDEO_GET_STATUS call. The play_format corresponds to the selected playing mode. In case the source video represents the state of video playback the output device.

```
typedef enum {
    VIDEO_STOPPED,
    VIDEO_PLAYING,
    VIDEO_FREEZED
};
```

11.1.7. struct video_still_picture

An I-frame displayed via the VIDEO_STILLPICTURE call is passed on within the following structure.

```
/* pointer to and size of a single iframe in memory */
struct video_still_picture {
```

The following is the structure of a video event as it is returned by the VIDEO_GET_EVENT call.

```
char *iFrame;
int32_t size;
};
struct video_event {
    int32_t type;
```

11.1.8. video capabilities

A call to VIDEO_GET_CAPABILITIES returns an unsigned integer with the following bits set according to the hardware's capabilities.

```

uint8_t color1; /* 3-0 Background pixel contrast */
uint8_t contrast2; /* 7-4 Emphasis pixel-2 contrast */
/* 3-0 Emphasis pixel-1 contrast */

/* Definitions for capabilities: */
/* can the hardware BackdoorMPEG1 and/orMPEG2? */
#define VIDEO_CAP_MPEG1 1 /* 7-4 Emphasis pixel-2 color */
#define VIDEO_CAP_MPEG2 2 /* Emphasis pixel-1 color */
/* can you send a system and/or program stream to video device?
uint32_t ypos; /* 23-22 auto action mode */
(you still have to open the video and the audio device but only
send the stream to the video device) */
#define VIDEO_CAP_SYS 0 /* end y */
uint32_t xpos; /* 23-22 button color number */
#define VIDEO_CAP_PROG 8
/* can the driver also handle SPU, NAVI and CSS encoded data?
(CSS API is not present yet) */
#define VIDEO_CAP_SPU 16
#define VIDEO_CAP_NAVI 32
#define VIDEO_CAP_CSS 64

```

11.1.11. video SPU

11.1.9. video system

Calling VIDEO_SET_SYSTEM sets the desired video system for TV output. The following system types can be set:

```
typedef enum _vpu_spu {
    VIDEO_SYSTEM_PAL,
    boolean active,
    VIDEO_SYSTEM_NTSC,
    int stream_id,
    VIDEO_SYSTEM_PALn,
} video_spu_t;
VIDEO_SYSTEM_PALn,
VIDEO_SYSTEM_PALM,
VIDEO_SYSTEM_NTSC60,
VIDEO_SYSTEM_PAL60,
VIDEO_SYSTEM_PALn,
```

11.1.12. video SPU palette

The following structure is used to set the SPU palette by calling VIDEO_SPU_PALETTE:

11.1.10. struct video highlight

```
struct video_spu_palette{
Calling the ioctl VIDEO_SET_HIGHLIGHTS posts the SPU highlight information.
    int length;
The call expects the following format for that information:
    uint8_t *palette;
```

```
typedef spu_palette_t;
struct video_highlight {
    boolean active; /* 1=show highlight, 0=hide highlight */
};
```

11.1.13. video NAVI pack

In order to get the navigational data the following structure has to be passed to the ioctl VIDEO_GET_NAVI:

```
typedef
struct video_navi_pack{
    int length;          /* 0 ... 1024 */
    uint8_t data[1024];
} video_navi_pack_t;
```

11.1.14. video attributes

The following attributes can be set by a call to VIDEO_SET_ATTRIBUTES:

```
typedef uint16_t video_attributes_t;
/* bits: descr. */
/* 15-14 Video compression mode (0=MPEG-1, 1=MPEG-2) */
/* 13-12 TV system (0=525/60, 1=625/50) */
/* 11-10 Aspect ratio (0=4:3, 3=16:9) */
/* 9- 8 permitted display mode on 4:3 monitor (0=both, 1=only pan-sca
/* 7 line 21-1 data present in GOP (1=yes, 0=no) */
/* 6 line 21-2 data present in GOP (1=yes, 0=no) */
/* 5- 3 source resolution (0=720x480/576, 1=704x480/576, 2=352x480/57
/* 2 source letterboxed (1=yes, 0=no) */
/* 0 film/camera mode (0=camera, 1=film (625/50 only)) */
```

11.2. Video Function Calls

11.2.1. open()

DESCRIPTION

This system call opens a named video device (e.g. /dev/dvb/adapater0/video0) for subsequent use.

When an open() call has succeeded, the device will be ready for use. The significance of blocking or non-blocking mode is described in the documentation for functions where there is a difference. It does not affect the semantics of the open() call itself. A device opened in blocking mode can later be put into non-blocking mode (and vice versa) using the F_SETFL command of the fcntl system call. This is a standard system call, documented in the Linux manual page for fcntl. Only one user can open the Video Device in O_RDWR mode. All other attempts to open the device in this mode will fail, and an error-code will be returned. If the Video Device is opened in O_RDONLY mode, the only ioctl call that can be used is VIDEO_GET_STATUS. All other call will return an error code.

SYNOPSIS

```
int open(const char *deviceName, int flags);
```

PARAMETERS

const char *deviceName	Name of specific video device.
int flags	A bit-wise OR of the following flags:
	O_RDONLY read-only access
	O_RDWR read/write access
	O_NONBLOCK open in non-blocking mode
	(blocking mode is the default)

ERRORS

ENODEV	Device driver not loaded/available.
EINTERNAL	Internal error.
EBUSY	Device or resource busy.
EINVAL	Invalid argument.

11.2.2. close()**DESCRIPTION**

This system call closes a previously opened video device.

SYNOPSIS

```
int close(int fd);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

ERRORS

EBADF	fd is not a valid open file descriptor.
-------	---

11.2.3. write()

DESCRIPTION

This system call can only be used if VIDEO_SOURCE_MEMORY is selected in the ioctl call VIDEO_SELECT_SOURCE. The data provided shall be in PES format, unless the capability allows other formats. If O_NONBLOCK is not specified the function will block until buffer space is available. The amount of data to be transferred is implied by count.

SYNOPSIS

```
size_t write(int fd, const void *buf, size_t count);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
void *buf	Pointer to the buffer containing the PES data.
size_t count	Size of buf.

ERRORS

EPERM	Mode VIDEO_SOURCE_MEMORY not selected.
ENOMEM	Attempted to write more data than the internal buffer can hold.
EBADF	fd is not a valid open file descriptor.

11.2.4. VIDEO_STOP

DESCRIPTION

This ioctl call asks the Video Device to stop playing the current stream. Depending on the input parameter, the screen can be blanked out or displaying the last decoded frame.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_STOP, boolean mode);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_STOP for this command.
Boolean mode	Indicates how the screen shall be handled.
	TRUE: Blank screen when stop.
	FALSE: Show last decoded frame.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error, possibly in the communication with the DVB subsystem.

11.2.5. VIDEO_PLAY

DESCRIPTION

This ioctl call asks the Video Device to start playing a video stream from the selected source.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_PLAY);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_PLAY for this command.

ERRORS

EBADF	fd is not a valid open file descriptor
-------	--

EINTERNAL	Internal error, possibly in the communication with the DVB subsystem.
-----------	---

11.2.6. VIDEO_FREEZE

DESCRIPTION

This ioctl call suspends the live video stream being played. Decoding and playing are frozen. It is then possible to restart the decoding and playing process of the video stream using the VIDEO_CONTINUE command. If VIDEO_SOURCE_MEMORY is selected in the ioctl call VIDEO_SELECT_SOURCE, the DVB subsystem will not decode any more data until the ioctl call VIDEO_CONTINUE or VIDEO_PLAY is performed.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_FREEZE);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_FREEZE for this command.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error, possibly in the communication with the DVB subsystem.

11.2.7. VIDEO_CONTINUE

DESCRIPTION

This ioctl call restarts decoding and playing processes of the video stream which was played before a call to VIDEO_FREEZE was made.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_CONTINUE);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_CONTINUE for this command.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error, possibly in the communication with the DVB subsystem.

11.2.8. VIDEO_SELECT_SOURCE

DESCRIPTION

This ioctl call informs the video device which source shall be used for the input data. The possible sources are demux or memory. If memory is selected, the data is fed to the video device through the write command.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SELECT_SOURCE, video_stream_source_t source);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SELECT_SOURCE for this command.

video_stream_source_t source	Indicates which source shall be used for the Video stream.
------------------------------	--

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error, possibly in the communication with the DVB subsystem.

11.2.9. VIDEO_SET_BLANK

DESCRIPTION

This ioctl call asks the Video Device to blank out the picture.

SYNOPSIS

int ioctl(fd, int request = VIDEO_SET_BLANK, boolean mode);

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SET_BLANK for this command.
boolean mode	TRUE: Blank screen when stop.
	FALSE: Show last decoded frame.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error, possibly in the communication with the DVB subsystem.
EINVAL	Illegal input parameter

11.2.10. VIDEO_GET_STATUS

DESCRIPTION

This ioctl call asks the Video Device to return the current status of the device.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_GET_STATUS, struct video_status *status);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_GET_STATUS for this command.
struct video_status *status	Returns the current status of the Video Device.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error, possibly in the communication with the DVB subsystem.
EFAULT	status points to invalid address

11.2.11. VIDEO_GET_EVENT

DESCRIPTION

This ioctl call returns an event of type video_event if available. If an event is not available, the behavior depends on whether the device is in blocking or non-blocking mode. In the latter case, the call fails immediately with errno set to EWOULDBLOCK. In the former case, the call blocks until an event becomes available. The standard Linux poll() and/or select() system calls can be used with the device file descriptor to watch for new events. For select(), the file descriptor should be included in the exceptfds argument, and for poll(), POLLPRI should be specified as the wake-up condition. Read-only permissions are sufficient for this ioctl call.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_GET_EVENT, struct video_event *ev);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_GET_EVENT for this command.
struct video_event *ev	Points to the location where the event, if any, is to be stored.

ERRORS

EBADF	fd is not a valid open file descriptor
EFAULT	ev points to invalid address
EWOULDBLOCK	There is no event pending, and the device is in non-blocking mode.
EOVERFLOW	
	Overflow in event queue - one or more events were lost.

11.2.12. VIDEO_SET_DISPLAY_FORMAT

DESCRIPTION

This ioctl call asks the Video Device to select the video format to be applied by the MPEG chip on the video.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SET_DISPLAY_FORMAT,
video_display_format_t format);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

int request	Equals VIDEO_SET_DISPLAY_FORMAT for this command.
video_display_format_t format	Selects the video format to be used.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error.
EINVAL	Illegal parameter format.

11.2.13. VIDEO_STILLPICTURE

DESCRIPTION

This ioctl call asks the Video Device to display a still picture (I-frame). The input data shall contain an I-frame. If the pointer is NULL, then the current displayed still picture is blanked.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_STILLPICTURE, struct video_still_picture
*sp);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_STILLPICTURE for this command.
struct video_still_picture *sp	Pointer to a location where an I-frame and size is stored.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error.
EFAULT	sp points to an invalid iframe.

11.2.14. VIDEO_FAST_FORWARD

DESCRIPTION

This ioctl call asks the Video Device to skip decoding of N number of I-frames. This call can only be used if VIDEO_SOURCE_MEMORY is selected.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_FAST_FORWARD, int nFrames);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_FAST_FORWARD for this command.
int nFrames	The number of frames to skip.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error.
EPERM	Mode VIDEO_SOURCE_MEMORY not selected.
EINVAL	Illegal parameter format.

11.2.15. VIDEO_SLOWMOTION

DESCRIPTION

This ioctl call asks the video device to repeat decoding frames N number of times. This call can only be used if VIDEO_SOURCE_MEMORY is selected.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SLOWMOTION, int nFrames);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SLOWMOTION for this command.
int nFrames	The number of times to repeat each frame.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error.
EPERM	Mode VIDEO_SOURCE_MEMORY not selected.
EINVAL	Illegal parameter format.

11.2.16. VIDEO_GET_CAPABILITIES

DESCRIPTION

This ioctl call asks the video device about its decoding capabilities. On success it returns an integer which has bits set according to the defines in section ??.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_GET_CAPABILITIES, unsigned int *cap);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_GET_CAPABILITIES for this command.
unsigned int *cap	Pointer to a location where to store the capability information.

ERRORS

EBADF	fd is not a valid open file descriptor
EFAULT	cap points to an invalid iframe.

11.2.17. VIDEO_SET_ID

DESCRIPTION

This ioctl selects which sub-stream is to be decoded if a program or system stream is sent to the video device.

SYNOPSIS

```
int ioctl(int fd, int request = VIDEO_SET_ID, int id);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SET_ID for this command.
int id	video sub-stream id

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.
EINVAL	Invalid sub-stream id.

11.2.18. VIDEO_CLEAR_BUFFER

DESCRIPTION

This ioctl call clears all video buffers in the driver and in the decoder hardware.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_CLEAR_BUFFER);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_CLEAR_BUFFER for this command.

ERRORS

EBADF	fd is not a valid open file descriptor
-------	--

11.2.19. VIDEO_SET_STREAMTYPE

DESCRIPTION

This ioctl tells the driver which kind of stream to expect being written to it. If this call is not used the default of video PES is used. Some drivers might not support this call and always expect PES.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SET_STREAMTYPE, int type);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SET_STREAMTYPE for this command.
int type	stream type

ERRORS

EBADF	fd is not a valid open file descriptor
EINVAL	type is not a valid or supported stream type.

11.2.20. VIDEO_SET_FORMAT

DESCRIPTION

This ioctl sets the screen format (aspect ratio) of the connected output device (TV) so that the output of the decoder can be adjusted accordingly.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SET_FORMAT, video_format_t format);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SET_FORMAT for this command.
video_format_t format	video format of TV as defined in section ??.

ERRORS

EBADF	fd is not a valid open file descriptor
EINVAL	format is not a valid video format.

11.2.21. VIDEO_SET_SYSTEM

DESCRIPTION

This ioctl sets the television output format. The format (see section ??) may vary from the color format of the displayed MPEG stream. If the hardware is not able to display the requested format the call will return an error.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SET_SYSTEM , video_system_t system);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SET_FORMAT for this command.
video_system_t system	video system of TV output.

ERRORS

EBADF	fd is not a valid open file descriptor
-------	--

EINVAL	system is not a valid or supported video system.
--------	--

11.2.22. VIDEO_SET_HIGHLIGHT

DESCRIPTION

This ioctl sets the SPU highlight information for the menu access of a DVD.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SET_HIGHLIGHT , video_highlight_t *vhilite)
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SET_HIGHLIGHT for this command.
video_highlight_t *vhilite	SPU Highlight information according to section ??.

ERRORS

EBADF	fd is not a valid open file descriptor.
EINVAL	input is not a valid highlight setting.

11.2.23. VIDEO_SET_SPU

DESCRIPTION

This ioctl activates or deactivates SPU decoding in a DVD input stream. It can only be used, if the driver is able to handle a DVD stream.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SET_SPU , video_spu_t *spu)
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SET_SPU for this command.
video_spu_t *spu	SPU decoding (de)activation and subid setting according to section ??.

ERRORS

EBADF	fd is not a valid open file descriptor
EINVAL	input is not a valid spu setting or driver cannot handle SPU.

11.2.24. VIDEO_SET_SPU_PALETTE

DESCRIPTION

This ioctl sets the SPU color palette.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SET_SPU_PALETTE, video_spu_palette_t
★palette )
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SET_SPU_PALETTE for this command.
video_spu_palette_t *palette	SPU palette according to section ??.

ERRORS

EBADF	fd is not a valid open file descriptor
EINVAL	input is not a valid palette or driver doesn't handle SPU.

11.2.25. VIDEO_GET_NAVI

DESCRIPTION

This ioctl returns navigational information from the DVD stream. This is especially needed if an encoded stream has to be decoded by the hardware.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_GET_NAVI , video_navi_pack_t *navipack)
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_GET_NAVI for this command.
video_navi_pack_t *navipack	PCI or DSI pack (private stream 2) according to section ??.

ERRORS

EBADF	fd is not a valid open file descriptor
EFAULT	driver is not able to return navigational information

11.2.26. VIDEO_SET_ATTRIBUTES

DESCRIPTION

This ioctl is intended for DVD playback and allows you to set certain information about the stream. Some hardware may not need this information, but the call also tells the hardware to prepare for DVD playback.

SYNOPSIS

```
int ioctl(fd, int request = VIDEO_SET_ATTRIBUTE ,video_attributes_t vattr)
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals VIDEO_SET_ATTRIBUTE for this command.
video_attributes_t vattr	video attributes according to section ??.

ERRORS

EBADF	fd is not a valid open file descriptor
EINVAL	input is not a valid attribute setting.

Chapter 12. DVB Audio Device

The DVB audio device controls the MPEG2 audio decoder of the DVB hardware. It can be accessed through `/dev/dvb/adapter0/audio0`. Data types and and ioctl definitions can be accessed by including `linux/dvb/video.h` in your application.

Please note that some DVB cards don't have their own MPEG decoder, which results in the omission of the audio and video device.

12.1. Audio Data Types

This section describes the structures, data types and defines used when talking to the audio device.

12.1.1. `audio_stream_source_t`

The audio stream source is set through the `AUDIO_SELECT_SOURCE` call and can take the following values, depending on whether we are replaying from an internal (demux) or external (user write) source.

```
typedef enum {
    AUDIO_SOURCE_DEMUX,
    AUDIO_SOURCE_MEMORY
} audio_stream_source_t;
```

`AUDIO_SOURCE_DEMUX` selects the demultiplexer (fed either by the frontend or the DVR device) as the source of the video stream. If

`AUDIO_SOURCE_MEMORY` is selected the stream comes from the application through the `write()` system call.

12.1.2. `audio_play_state_t`

The following values can be returned by the `AUDIO_GET_STATUS` call representing the state of audio playback.

```
typedef enum {
    AUDIO_STOPPED,
    AUDIO_PLAYING,
    AUDIO_PAUSED
```


12.1.6. audio encodings

A call to AUDIO_GET_CAPABILITIES returns an unsigned integer with the following bits set according to the hardware capabilities.

12.1.3. audio_channel_select_t

The audio channel selected via AUDIO_CHANNEL_SELECT is determined by the following values:

```
#define AUDIO_CAP_DIS      1
#define AUDIO_CAP_LPCM     2
#define AUDIO_CAP_MPL      4
#define AUDIO_CAP_MP2      8
#define AUDIO_CAP_MP3     16
typedef enum {
#define AUDIO_CAP_AAC      32
#define AUDIO_CAP_OGG     64
#define AUDIO_CAP_SDDS    128
#define AUDIO_CAP_AC3     256
} audio_channel_select_t;
```

12.1.7. struct audio_karaoke

12.1.4. struct audio_status

The ioctl AUDIO_SET_KARAOKE uses the following format:

The AUDIO_GET_STATUS call returns the following structure informing about various states of the playback operation.

```
struct audio_karaoke {
    int vocal1;
    int vocal2;
    boolean sync_state;
    boolean karaoke_state;
    audio_play_state_t play_state;
    audio_stream_source_t stream_source;
    audio_channel_select_t channel_select;
    boolean bypass_mode;
} audio_status_t;
```

If Vocal1 or Vocal2 are non-zero, they get mixed into left and right t at 70% each. If both, Vocal1 and Vocal2 are non-zero, Vocal1 gets mixed into the left channel and Vocal2 into the right channel at 100% each. If Melody is non-zero, the melody channel gets mixed into left and right.

12.1.8. audio attributes

12.1.5. struct audio_mixer

The following attributes can be set by a call to AUDIO_SET_ATTRIBUTES:

The following structure is used by the AUDIO_SET_MIXER call to set the audio volume.

```
typedef uint16_t audio_attributes_t;
/* bits: descr. */
/* 15-13 audio coding mode (0=ac3, 2=mpeg1, 3=mpeg2ext, 4=LPCM, 6=DTS,
typedef struct audio_mixer {
/* 12 multichannel extension */
/* 11-10 audio type (0=not spec, 1=language included) */
/* 9-8 audio application mode (0=not spec, 1=karaoke, 2=surround) */
/* 7-6 max normalization / DRC (mpeg audio: 1=DRC exists) (lpcm: 0=16bit,
/* 5- 4 Sample frequency fs (0=48kHz, 1=96kHz) */
/* 2- 0 number of audio channels (n+1 channels) */
```

12.2. Audio Function Calls

12.2.1. open()

DESCRIPTION

This system call opens a named audio device (e.g. /dev/dvb/adapater0/audio0) for subsequent use. When an open() call has succeeded, the device will be ready for use. The significance of blocking or non-blocking mode is described in the documentation for functions where there is a difference. It does not affect the semantics of the open() call itself. A device opened in blocking mode can later be put into non-blocking mode (and vice versa) using the F_SETFL command of the fcntl system call. This is a standard system call, documented in the Linux manual page for fcntl. Only one user can open the Audio Device in O_RDWR mode. All other attempts to open the device in this mode will fail, and an error code will be returned. If the Audio Device is opened in O_RDONLY mode, the only ioctl call that can be used is AUDIO_GET_STATUS. All other call will return with an error code.

SYNOPSIS

```
int open(const char *deviceName, int flags);
```

PARAMETERS

const char *deviceName	Name of specific audio device.
int flags	A bit-wise OR of the following flags:
	O_RDONLY read-only access
	O_RDWR read/write access
	O_NONBLOCK open in non-blocking mode
	(blocking mode is the default)

ERRORS

ENODEV	Device driver not loaded/available.
EINTERNAL	Internal error.
EBUSY	Device or resource busy.
EINVAL	Invalid argument.

12.2.2. close()

DESCRIPTION

This system call closes a previously opened audio device.

SYNOPSIS

```
int close(int fd);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

ERRORS

EBADF	fd is not a valid open file descriptor.
-------	---

12.2.3. write()

DESCRIPTION

This system call can only be used if AUDIO_SOURCE_MEMORY is selected in the ioctl call AUDIO_SELECT_SOURCE. The data provided shall be in PES format. If O_NONBLOCK is not specified the function will block until buffer space is available. The amount of data to be transferred is implied by count.

SYNOPSIS

```
size_t write(int fd, const void *buf, size_t count);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
void *buf	Pointer to the buffer containing the PES data.
size_t count	Size of buf.

ERRORS

EPERM	Mode AUDIO_SOURCE_MEMORY not selected.
ENOMEM	Attempted to write more data than the internal buffer can hold.
EBADF	fd is not a valid open file descriptor.

12.2.4. AUDIO_STOP

DESCRIPTION

This ioctl call asks the Audio Device to stop playing the current stream.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_STOP);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_STOP for this command.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error.

12.2.5. AUDIO_PLAY

DESCRIPTION

This ioctl call asks the Audio Device to start playing an audio stream from the selected source.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_PLAY);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_PLAY for this command.

ERRORS

EBADF	fd is not a valid open file descriptor
EINTERNAL	Internal error.

12.2.6. AUDIO_PAUSE

DESCRIPTION

This ioctl call suspends the audio stream being played. Decoding and playing are paused. It is then possible to restart again decoding and playing process of the audio stream using AUDIO_CONTINUE command.
If AUDIO_SOURCE_MEMORY is selected in the ioctl call AUDIO_SELECT_SOURCE, the DVB-subsystem will not decode (consume) any more data until the ioctl call AUDIO_CONTINUE or AUDIO_PLAY is performed.

SYNOPSIS

int ioctl(int fd, int request = AUDIO_PAUSE);

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_PAUSE for this command.

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.

12.2.7. AUDIO_SELECT_SOURCE

DESCRIPTION

This ioctl call informs the audio device which source shall be used for the input data. The possible sources are demux or memory. If AUDIO_SOURCE_MEMORY is selected, the data is fed to the Audio Device through the write command.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_SELECT_SOURCE, audio_stream_source_t
source);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_SELECT_SOURCE for this command.
audio_stream_source_t source	Indicates the source that shall be used for the Audio stream.

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.
EINVAL	Illegal input parameter.

12.2.8. AUDIO_SET_MUTE

DESCRIPTION

This ioctl call asks the audio device to mute the stream that is currently being played.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_SET_MUTE, boolean state);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_SET_MUTE for this command.
boolean state	Indicates if audio device shall mute or not.
	TRUE Audio Mute
	FALSE Audio Un-mute

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.
EINVAL	Illegal input parameter.

12.2.9. AUDIO_SET_AV_SYNC

DESCRIPTION

This ioctl call asks the Audio Device to turn ON or OFF A/V synchronization.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_SET_AV_SYNC, boolean state);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_AV_SYNC for this command.
boolean state	Tells the DVB subsystem if A/V synchronization shall be ON or OFF.
	TRUE AV-sync ON
	FALSE AV-sync OFF

ERRORS

EBADF	fd is not a valid open file descriptor.
-------	---

EINTERNAL	Internal error.
EINVAL	Illegal input parameter.

12.2.10. AUDIO_SET_BYPASS_MODE

DESCRIPTION

This ioctl call asks the Audio Device to bypass the Audio decoder and forward the stream without decoding. This mode shall be used if streams that can't be handled by the DVB system shall be decoded. Dolby DigitalTM streams are automatically forwarded by the DVB subsystem if the hardware can handle it.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_SET_BYPASS_MODE, boolean mode);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_SET_BYPASS_MODE for this command.
boolean mode	Enables or disables the decoding of the current Audio stream in the DVB subsystem.
	TRUE Bypass is disabled
	FALSE Bypass is enabled

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.
EINVAL	Illegal input parameter.

12.2.11. AUDIO_CHANNEL_SELECT

DESCRIPTION

This ioctl call asks the Audio Device to select the requested channel if possible.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_CHANNEL_SELECT,
audio_channel_select_t);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_CHANNEL_SELECT for this command.
audio_channel_select_t ch	Select the output format of the audio (mono left/right, stereo).

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.
EINVAL	Illegal input parameter ch.

12.2.12. AUDIO_GET_STATUS

DESCRIPTION

This ioctl call asks the Audio Device to return the current state of the Audio Device.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_GET_STATUS, struct audio_status *status);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

int request	Equals AUDIO_GET_STATUS for this command.
struct audio_status *status	Returns the current state of Audio Device.

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.
EFAULT	status points to invalid address.

12.2.13. AUDIO_GET_CAPABILITIES

DESCRIPTION

This ioctl call asks the Audio Device to tell us about the decoding capabilities of the audio hardware.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_GET_CAPABILITIES, unsigned int *cap);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_GET_CAPABILITIES for this command.
unsigned int *cap	Returns a bit array of supported sound formats.

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.
EFAULT	cap points to an invalid address.

12.2.14. AUDIO_CLEAR_BUFFER

DESCRIPTION

This ioctl call asks the Audio Device to clear all software and hardware buffers of the audio decoder device.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_CLEAR_BUFFER);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_CLEAR_BUFFER for this command.

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.

12.2.15. AUDIO_SET_ID

DESCRIPTION

This ioctl selects which sub-stream is to be decoded if a program or system stream is sent to the video device. If no audio stream type is set the id has to be in [0xC0,0xDF] for MPEG sound, in [0x80,0x87] for AC3 and in [0xA0,0xA7] for LPCM. More specifications may follow for other stream types. If the stream type is set the id just specifies the substream id of the audio stream and only the first 5 bits are recognized.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_SET_ID, int id);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_SET_ID for this command.
int id	audio sub-stream id

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.
EINVAL	Invalid sub-stream id.

12.2.16. AUDIO_SET_MIXER

DESCRIPTION

This ioctl lets you adjust the mixer settings of the audio decoder.

SYNOPSIS

```
int ioctl(int fd, int request = AUDIO_SET_MIXER, audio_mixer_t *mix);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_SET_ID for this command.
audio_mixer_t *mix	mixer settings.

ERRORS

EBADF	fd is not a valid open file descriptor.
EINTERNAL	Internal error.
EFAULT	mix points to an invalid address.

12.2.17. AUDIO_SET_STREAMTYPE

DESCRIPTION

This ioctl tells the driver which kind of audio stream to expect. This is useful if the stream offers several audio sub-streams like LPCM and AC3.

SYNOPSIS

```
int ioctl(fd, int request = AUDIO_SET_STREAMTYPE, int type);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_SET_STREAMTYPE for this command.
int type	stream type

ERRORS

EBADF	fd is not a valid open file descriptor
EINVAL	type is not a valid or supported stream type.

12.2.18. AUDIO_SET_EXT_ID

DESCRIPTION

This ioctl can be used to set the extension id for MPEG streams in DVD playback. Only the first 3 bits are recognized.

SYNOPSIS

```
int ioctl(fd, int request = AUDIO_SET_EXT_ID, int id);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

int request	Equals AUDIO_SET_EXT_ID for this command.
int id	audio sub_stream_id

ERRORS

EBADF	fd is not a valid open file descriptor
EINVAL	id is not a valid id.

12.2.19. AUDIO_SET_ATTRIBUTES

DESCRIPTION

This ioctl is intended for DVD playback and allows you to set certain information about the audio stream.

SYNOPSIS

```
int ioctl(fd, int request = AUDIO_SET_ATTRIBUTES, audio_attributes_t attr );
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_SET_ATTRIBUTES for this command.
audio_attributes_t attr	audio attributes according to section ??

ERRORS

EBADF	fd is not a valid open file descriptor
EINVAL	attr is not a valid or supported attribute setting.

12.2.20. AUDIO_SET_KARAOKE

DESCRIPTION

This ioctl allows one to set the mixer settings for a karaoke DVD.

SYNOPSIS

```
int ioctl(fd, int request = AUDIO_SET_STREAMTYPE, audio_karaoke_t
*karaoke);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
int request	Equals AUDIO_SET_STREAMTYPE for this command.
audio_karaoke_t *karaoke	karaoke settings according to section ??.

ERRORS

EBADF	fd is not a valid open file descriptor
EINVAL	karaoke is not a valid or supported karaoke setting.

Chapter 13. DVB CA Device

The DVB CA device controls the conditional access hardware. It can be accessed through `/dev/dvb/adapter0/ca0`. Data types and and ioctl definitions can be accessed by including `linux/dvb/ca.h` in your application.

13.1. CA Data Types

13.1.1. `ca_slot_info_t`

```
/* slot interface types and info */

typedef struct ca_slot_info_s {
    int num;                /* slot number */

    int type;               /* CA interface this slot supports */
#define CA_CI                1 /* CI high level interface */
#define CA_CI_LINK          2 /* CI link layer level interface */
#define CA_CI_PHYS          4 /* CI physical layer level interface */
#define CA_SC                128 /* simple smart card interface */

    unsigned int flags;
#define CA_CI_MODULE_PRESENT 1 /* module (or card) inserted */
#define CA_CI_MODULE_READY  2
} ca_slot_info_t;
```

13.1.2. `ca_descr_info_t`

```
typedef struct ca_descr_info_s {
    unsigned int num; /* number of available descramblers (keys) */
    unsigned int type; /* type of supported scrambling system */
#define CA_ECD                1
#define CA_NDS                2
#define CA_DSS                4
} ca_descr_info_t;
```


13.1.3. ca_cap_t

```
typedef struct ca_cap_s {
    unsigned int slot_num; /* total number of CA card and module slots */
    unsigned int slot_type; /* OR of all supported types */
    unsigned int descr_num; /* total number of descrambler slots (keys) */
    unsigned int descr_type; /* OR of all supported types */
} ca_cap_t;
```

13.1.4. ca_msg_t

```
/* a message to/from a CI-CAM */
typedef struct ca_msg_s {
    unsigned int index;
    unsigned int type;
    unsigned int length;
    unsigned char msg[256];
} ca_msg_t;
```

13.1.5. ca_descr_t

```
typedef struct ca_descr_s {
    unsigned int index;
    unsigned int parity;
    unsigned char cw[8];
} ca_descr_t;
```

13.2. CA Function Calls

13.2.1. open()

DESCRIPTION

This system call opens a named ca device (e.g. /dev/ost/ca) for subsequent use. When an open() call has succeeded, the device will be ready for use. The significance of blocking or non-blocking mode is described in the documentation for functions where there is a difference. It does not affect the semantics of the open() call itself. A device opened in blocking mode can later be put into non-blocking mode (and vice versa) using the F_SETFL command of the fcntl system call. This is a standard system call, documented in the Linux manual page for fcntl. Only one user can open the CA Device in O_RDWR mode. All other attempts to open the device in this mode will fail, and an error code will be returned.

SYNOPSIS

```
int open(const char *deviceName, int flags);
```

PARAMETERS

const char *deviceName	Name of specific video device.
int flags	A bit-wise OR of the following flags:
	O_RDONLY read-only access
	O_RDWR read/write access
	O_NONBLOCK open in non-blocking mode
	(blocking mode is the default)

ERRORS

ENODEV	Device driver not loaded/available.
EINTERNAL	Internal error.
EBUSY	Device or resource busy.
EINVAL	Invalid argument.

13.2.2. close()**DESCRIPTION**

This system call closes a previously opened audio device.

SYNOPSIS

```
int close(int fd);
```

PARAMETERS

int fd	File descriptor returned by a previous call to open().
--------	--

ERRORS

EBADF	fd is not a valid open file descriptor.
-------	---

Chapter 14. DVB Network API

The DVB net device enables feeding of MPE (multi protocol encapsulation) packets received via DVB into the Linux network protocol stack, e.g. for internet via satellite applications. It can be accessed through `/dev/dvb/adapter0/net0`. Data types and `ioctl` definitions can be accessed by including `linux/dvb/net.h` in your application.

14.1. DVB Net Data Types

To be written...

Chapter 15. Kernel Demux API

The kernel demux API defines a driver-internal interface for registering low-level, hardware specific driver to a hardware independent demux layer. It is only of interest for DVB device driver writers. The header file for this API is named *demux.h* and located in *drivers/media/dvb/dvb-core*.

Maintainer note: This section must be reviewed. It is probably out of date.

15.1. Kernel Demux Data Types

15.1.1. `dmx_success_t`

```
typedef enum {
    DMX_OK = 0, /* Received Ok */
    DMX_LENGTH_ERROR, /* Incorrect length */
    DMX_OVERRUN_ERROR, /* Receiver ring buffer overrun */
    DMX_CRC_ERROR, /* Incorrect CRC */
    DMX_FRAME_ERROR, /* Frame alignment error */
    DMX_FIFO_ERROR, /* Receiver FIFO overrun */
    DMX_MISSED_ERROR /* Receiver missed packet */
} dmx_success_t;
```

15.1.2. TS filter types

```
/*-----
/* TS packet reception */
/*-----

/* TS filter type for set_type() */

#define TS_PACKET      1    /* send TS packets (188 bytes) to callback (0) */
#define TS_PAYLOAD_ONLY 2    /* in case TS_PACKET is set, only send the TS
    payload (<=184 bytes per packet) to callback */
#define TS_DECODER      4    /* send stream to built-in decoder (if present) */
```

15.1.3. `dmx_ts_pes_t`

`dmx_ts_pes_t` is a structure that contains private data of the API client */

```
int (*set) (struct dmx_pes_feed_s* feed,
```

The structure

```
uint16_t pid,
    size_t circular_buffer_size,
typedef enum
{
    struct timespec timeout);
DMX_TS_PES_AUDIO) /* also send packets to audio decoder (if it exists) */
DMX_TS_PES_VIDEO) /* (struct dmx_pes_feed_s* feed);
DMX_TS_PES_TELETEXT) (struct dmx_pes_feed_s* feed,
DMX_TS_PES_SUBTITLE) /* filter);
DMX_TS_PES_PCR) (struct dmx_pes_feed_s* feed,
DMX_TS_PES_OTHER) /* filter);
} dmx_pes_feed_t;
```

describes the PES type for filters which write to a built-in decoder. The correspond (and should be kept identical) to the types in the `demux` device.

```
__u8 filter_mask [DMX_MAX_FILTER_SIZE];
struct dmx_ts_feed_s* parent; /* Back-pointer */
void (*priv) /* Set to non-zero when filtering in progress */
} struct dmx_ts_feed_s* parent; /* Back-pointer */
void* priv; /* Pointer to private data of the API client */
struct dmx_section_feed_s {
    struct dmx_ts_feed_s* parent; /* Back-pointer */
    void* priv; /* Pointer to private data of the API client */
    int (*set_descramble) (struct dmx_section_feed_s* feed,
        struct timespec timeout);
    int (*start_circular_buffer) (struct dmx_ts_feed_s* feed);
    int (*stop_descramble) (struct dmx_ts_feed_s* feed);
    int (*set_type) (struct dmx_ts_feed_s* feed,
        int type,
        dmx_section_filter_t* filter);
    int (*release_filter) (struct dmx_section_feed_s* feed,
        dmx_section_filter_t* filter);
    int (*start_filtering) (struct dmx_section_feed_s* feed);
    int (*stop_filtering) (struct dmx_section_feed_s* feed);
} /*-----
typedef struct dmx_section_feed_s {
    /*-----
    /*-----
    typedef struct dmx_pes_filter_s {
    /* struct dmx_pes_s* parent; /* Back-pointer */-----
    void* priv; /* Pointer to private data of the API client */
    typedef int (*dmx_ts_cb) ( __u8 * buffer1,
        size_t buffer1_length,
    typedef struct dmx_pes_feed_s {
    int is_filtering; /* non-zero when filtering in progress */
    struct dmx_section_feed_s* parent; /* Back-pointer */
```

```

*/      dmx_success_t success);

typedef DMX_SECTIONING_cb) ( __u8 * buffer1, 1
#define DMXB_REFERENCE_FILTERING 2
#define DMXB_SECTION_FILTERING 4
#define DMXB_MEMORY_BASED_FILTERING 8 /* write() available */
#define DMXB_CBS_CHECKING * source, 16
#define DMXB_CS_DESCRAMBLING 32
#define DMX_SECTION_PAYLOAD_DESCRAMBLING 64
typedef DMX_ADDRESSES_DESCRAMBLING_cb) ( __u8 * buffer1, 128
    size_t buffer1_len,
    __u8 * buffer2,
    size_t buffer2_len,
    dmx_sectioning_t source,
    dmx_success_t success);

/*
/*-DMX_FE_ENTRY()-Casts elements in the list of registered-----
/* DVBFrontendsEndom*/the generic type struct list_head
/*to the type*-dmx_frontend_t-----
*.
typedef enum {
    DMX_OTHER_FE = 0,
} dmxi_sate_dmxife_entry(list) list_entry(list, dmx_frontend_t, connectivity_t);
    DMX_CABLE_FE,
    DMX_CETERRESTRIAL_FE(
        DMXTLVDS_FEW, following char* fields point to NULL terminated strings */
        DMXRASIDFE, /* DVB-ASI interfaceUnique demux identifier */
        DMXRMEMORYOFF /* Name of the demux vendor */
    ) dmxf_model_end_source_t; /* Name of the demux model */
    __u32 capabilities; /* Bitfield of capability flags */
typedef frontend_t* frontend; /* Front-end connected to the demux */
/*The following char* fields point to NULL terminated strings */
char* pdiv; /* Pointer from private data to the API client */
char* vendor; /* Number of the front-end vendor */
char** model; (struct dmx_demux/*Name of the front-end model */
    struct close) head struct connectivetyx_list demux List of front-ends that can
int how connect(struct admdemux s* demux, const char* buf, size_t count);
int deallocate_ts_feed) (struct dmx_demux_s* demux,
void mprio; feed_t** Pheader to private data of the API client */
    dmx_frontend_callback_t* source;
} idmx(freehead ts_feed) (struct dmx_demux_s* demux,
    dmx_ts_feed_t* feed);
/*int-(allocate_pes_feed)-(struct-dmx-demux-s*-demux,-----
/* MPEGM2_PSDemoz** feed,
/*----dmx_pes_cb-callback)------
    int (*release_pes_feed) (struct dmx_demux_s* demux,
/*     dmx_pes_feed_t* feed);
in place allocate isethenonavailable struct dmx_demux s* demux s.
```



```
        dmx_section_feed_t** feed,
        dmx_section_cb callback);
int (*release_section_feed) (struct dmx_demux_s* demux,
        dmx_section_feed_t* feed);
int (*descramble_mac_address) (struct dmx_demux_s* demux,
        __u8* buffer1,
        size_t buffer1_length,
        __u8* buffer2,
        size_t buffer2_length,
        __u16 pid);
int (*descramble_section_payload) (struct dmx_demux_s* demux,
        __u8* buffer1,
        size_t buffer1_length,
        __u8* buffer2, size_t buffer2_length,
        __u16 pid);
int (*add_frontend) (struct dmx_demux_s* demux,
        dmx_frontend_t* frontend);
int (*remove_frontend) (struct dmx_demux_s* demux,
        dmx_frontend_t* frontend);
struct list_head* (*get_frontends) (struct dmx_demux_s* demux);
int (*connect_frontend) (struct dmx_demux_s* demux,
        dmx_frontend_t* frontend);
int (*disconnect_frontend) (struct dmx_demux_s* demux);

/* added because js cannot keep track of these himself */
int (*get_pes_pids) (struct dmx_demux_s* demux, __u16 *pids);
};
typedef struct dmx_demux_s dmx_demux_t;
```

15.1.5. Demux directory

```
/*
 * DMX_DIR_ENTRY(): Casts elements in the list of registered
 * demuxes from the generic type struct list_head* to the type dmx_demux_t*.
 */

#define DMX_DIR_ENTRY(list) list_entry(list, dmx_demux_t, reg_list)

int dmx_register_demux (dmx_demux_t* demux);
int dmx_unregister_demux (dmx_demux_t* demux);
struct list_head* dmx_get_demuxes (void);
```

15.2. Demux Directory API

SYNOPSIS

```
int dmxd_register_demux ( dmxd_demux_t *demux )
```

PARAMETERS

dmxd_demux_t* demux	Pointer to the demux structure.
---------------------	---------------------------------

RETURNS

0	The function was completed without errors.
-EEXIST	A demux with the same value of the id field already stored in the directory.
-ENOSPC	No space left in the directory.

15.2.2. dmxd_unregister_demux()**DESCRIPTION**

This function is called to indicate that the given demux interface is no longer available. The caller of this function is responsible for freeing the memory of the demux structure, if it was dynamically allocated before calling dmxd_register_demux(). The cleanup_module() function of the kernel module that contains the demux driver should call this function. Note that this function fails if the demux is currently in use, i.e., release_demux() has not been called for the interface.

SYNOPSIS

```
int dmxd_unregister_demux ( dmxd_demux_t *demux )
```

PARAMETERS

dmxd_demux_t* demux	Pointer to the demux structure which is to be unregistered.
---------------------	---

RETURNS

0	The function was completed without errors.
---	--

ENODEV	The specified demux is not registered in the demux directory.
EBUSY	The specified demux is currently in use.

15.2.3. dmx_get_demuxes()

DESCRIPTION

Provides the caller with the list of registered demux interfaces, using the standard list structure defined in the include file linux/list.h. The include file demux.h defines the macro DMX_DIR_ENTRY() for converting an element of the generic type struct list_head* to the type dmx_demux_t*. The caller must not free the memory of any of the elements obtained via this function call.

SYNOPSIS

```
struct list_head *dmx_get_demuxes ()
```

PARAMETERS

none	
------	--

RETURNS

struct list_head *	A list of demux interfaces, or NULL in the case of an empty list.
--------------------	---

15.3. Demux API

The demux API should be implemented for each demux in the system. It is used to select the TS source of a demux and to manage the demux resources. When the demux client allocates a resource via the demux API, it receives a pointer to the API of that resource.

Each demux receives its TS input from a DVB front-end or from memory, as set via the demux API. In a system with more than one front-end, the API can be used to select one of the DVB front-ends as a TS source for a demux, unless this is fixed in

the HW platform. The demux API only controls front-ends regarding their connections with demuxes; the APIs used to set the other front-end parameters, such as tuning, are not defined in this document.

The functions that implement the abstract interface demux should be defined static or module private and registered to the Demux Directory for external access. It is not necessary to implement every function in the demux_t struct, however (for example, a demux interface might support Section filtering, but not TS or PES filtering). The API client is expected to check the value of any function pointer before calling the function: the value of NULL means “function not available”.

Whenever the functions of the demux API modify shared data, the possibilities of lost update and race condition problems should be addressed, e.g. by protecting parts of code with mutexes. This is especially important on multi-processor hosts.

Note that functions called from a bottom half context must not sleep, at least in the 2.2.x kernels. Even a simple memory allocation can result in a kernel thread being put to sleep if swapping is needed. For example, the Linux kernel calls the functions of a network device interface from a bottom half context. Thus, if a demux API function is called from network device code, the function must not sleep.

15.3.1. open()

DESCRIPTION

This function reserves the demux for use by the caller and, if necessary, initializes the demux. When the demux is no longer needed, the function close() should be called. It should be possible for multiple clients to access the demux at the same time. Thus, the function implementation should increment the demux usage count when open() is called and decrement it when close() is called.

SYNOPSIS

```
int open ( demux_t* demux );
```

PARAMETERS

demux_t* demux	Pointer to the demux API and instance data.
----------------	---

RETURNS

0	The function was completed without errors.
---	--

-EUSERS	Maximum usage count reached.
-EINVAL	Bad parameter.

15.3.2. close()

DESCRIPTION

This function reserves the demux for use by the caller and, if necessary, initializes the demux. When the demux is no longer needed, the function `close()` should be called. It should be possible for multiple clients to access the demux at the same time. Thus, the function implementation should increment the demux usage count when `open()` is called and decrement it when `close()` is called.

SYNOPSIS

```
int close(demux_t* demux);
```

PARAMETERS

demux_t* demux	Pointer to the demux API and instance data.
----------------	---

RETURNS

0	The function was completed without errors.
-ENODEV	The demux was not in use.
-EINVAL	Bad parameter.

15.3.3. write()

DESCRIPTION

This function provides the demux driver with a memory buffer containing TS packets. Instead of receiving TS packets from the DVB front-end, the demux driver software will read packets from memory. Any clients of this demux with active TS, PES or Section filters will receive filtered data via the Demux callback API (see 0). The function returns when all the data in the buffer has been consumed by the demux. Demux hardware typically cannot read TS from memory. If this is the case, memory-based filtering has to be implemented entirely in software.

SYNOPSIS

```
int write(demux_t* demux, const char* buf, size_t count);
```

PARAMETERS

demux_t* demux	Pointer to the demux API and instance data.
const char* buf	Pointer to the TS data in kernel-space memory.
size_t length	Length of the TS data.

RETURNS

0	The function was completed without errors.
-ENOSYS	The command is not implemented.
-EINVAL	Bad parameter.

15.3.4. allocate_ts_feed()

DESCRIPTION

Allocates a new TS feed, which is used to filter the TS packets carrying a certain PID. The TS feed normally corresponds to a hardware PID filter on the demux chip.

SYNOPSIS

```
int allocate_ts_feed(dmx_demux_t* demux, dmx_ts_feed_t** feed, dmx_ts_cb callback);
```

PARAMETERS

demux_t* demux	Pointer to the demux API and instance data.
dmx_ts_feed_t** feed	Pointer to the TS feed API and instance data.
dmx_ts_cb callback	Pointer to the callback function for passing received TS packet

RETURNS

0	The function was completed without errors.
-EBUSY	No more TS feeds available.
-ENOSYS	The command is not implemented.
-EINVAL	Bad parameter.

15.3.5. release_ts_feed()

DESCRIPTION

Releases the resources allocated with `allocate_ts_feed()`. Any filtering in progress on the TS feed should be stopped before calling this function.

SYNOPSIS

```
int release_ts_feed(dmx_demux_t* demux, dmx_ts_feed_t* feed);
```

PARAMETERS

demux_t* demux	Pointer to the demux API and instance data.
dmx_ts_feed_t* feed	Pointer to the TS feed API and instance data.

RETURNS

0	The function was completed without errors.
-EINVAL	Bad parameter.

15.3.6. allocate_section_feed()

DESCRIPTION

Allocates a new section feed, i.e. a demux resource for filtering and receiving sections. On platforms with hardware support for section filtering, a section feed is directly mapped to the demux HW. On other platforms, TS packets are first PID filtered in hardware and a hardware section filter then emulated in software. The caller obtains an API pointer of type `dmx_section_feed_t` as an out parameter. Using this API the caller can set filtering parameters and start receiving sections.

SYNOPSIS

```
int allocate_section_feed(dmx_demux_t* demux, dmx_section_feed_t **feed,
dmx_section_cb callback);
```

PARAMETERS

<code>dmx_t *demux</code>	Pointer to the demux API and instance data.
<code>dmx_section_feed_t **feed</code>	Pointer to the section feed API and instance data.
<code>dmx_section_cb callback</code>	Pointer to the callback function for passing received sections.

RETURNS

0	The function was completed without errors.
-EBUSY	No more section feeds available.
-ENOSYS	The command is not implemented.
-EINVAL	Bad parameter.

15.3.7. release_section_feed()

DESCRIPTION

Releases the resources allocated with `allocate_section_feed()`, including allocated filters. Any filtering in progress on the section feed should be stopped before calling this function.

SYNOPSIS

```
int release_section_feed(dmx_demux_t* demux, dmx_section_feed_t *feed);
```

PARAMETERS

demux_t *demux	Pointer to the demux API and instance data.
dmx_section_feed_t *feed	Pointer to the section feed API and instance data.

RETURNS

0	The function was completed without errors.
-EINVAL	Bad parameter.

15.3.8. descramble_mac_address()

DESCRIPTION

This function runs a descrambling algorithm on the destination MAC address field of a DVB Datagram Section, replacing the original address with its un-encrypted version. Otherwise, the description on the function `descramble_section_payload()` applies also to this function.

SYNOPSIS

```
int descramble_mac_address(dmx_demux_t* demux, __u8 *buffer1, size_t
buffer1_length, __u8 *buffer2, size_t buffer2_length, __u16 pid);
```

PARAMETERS

dmx_demux_t *demux	Pointer to the demux API and instance data.
__u8 *buffer1	Pointer to the first byte of the section.
size_t buffer1_length	Length of the section data, including headers and CRC, in buffer1.

<code>__u8* buffer2</code>	Pointer to the tail of the section data, or NULL. The pointer has a non-NULL value if the section wraps past the end of a circular buffer.
<code>size_t buffer2_length</code>	Length of the section data, including headers and CRC, in <code>buffer2</code> .
<code>__u16 pid</code>	The PID on which the section was received. Useful for obtaining the descrambling key, e.g. from a DVB Common Access facility.

RETURNS

0	The function was completed without errors.
-ENOSYS	No descrambling facility available.
-EINVAL	Bad parameter.

15.3.9. descramble_section_payload()

DESCRIPTION

This function runs a descrambling algorithm on the payload of a DVB Datagram Section, replacing the original payload with its un-encrypted version. The function will be called from the demux API implementation; the API client need not call this function directly. Section-level scrambling algorithms are currently standardized only for DVB-RCC (return channel over 2-directional cable TV network) systems. For all other DVB networks, encryption schemes are likely to be proprietary to each data broadcaster. Thus, it is expected that this function pointer will have the value of NULL (i.e., function not available) in most demux API implementations. Nevertheless, it should be possible to use the function pointer as a hook for dynamically adding a “plug-in” descrambling facility to a demux driver.

While this function is not needed with hardware-based section descrambling, the `descramble_section_payload` function pointer can be used to override the default hardware-based descrambling algorithm: if the function pointer has a non-NULL value, the corresponding function should be used instead of any descrambling hardware.

SYNOPSIS

```
int descramble_section_payload(dmx_demux_t* demux, __u8 *buffer1, size_t
buffer1_length, __u8 *buffer2, size_t buffer2_length, __u16 pid);
```

PARAMETERS

dmx_demux_t *demux	Pointer to the demux API and instance data.
__u8 *buffer1	Pointer to the first byte of the section.
size_t buffer1_length	Length of the section data, including headers and CRC, in buffer1.
__u8 *buffer2	Pointer to the tail of the section data, or NULL. The pointer has a non-NULL value if the section wraps past the end of a circular buffer.
size_t buffer2_length	Length of the section data, including headers and CRC, in buffer2.
__u16 pid	The PID on which the section was received. Useful for obtaining the descrambling key, e.g. from a DVB Common Access facility.

RETURNS

0	The function was completed without errors.
-ENOSYS	No descrambling facility available.
-EINVAL	Bad parameter.

15.3.10. add_frontend()

DESCRIPTION

Registers a connectivity between a demux and a front-end, i.e., indicates that the demux can be connected via a call to `connect_frontend()` to use the given front-end as a TS source. The client of this function has to allocate dynamic or static memory for the frontend structure and initialize its fields before calling this function. This function is normally called during the driver initialization. The caller must not free the memory of the frontend struct before successfully calling `remove_frontend()`.

SYNOPSIS

```
int add_frontend(dmx_demux_t *demux, dmx_frontend_t *frontend);
```

PARAMETERS

dmx_demux_t* demux	Pointer to the demux API and instance data.
dmx_frontend_t* frontend	Pointer to the front-end instance data.

RETURNS

0	The function was completed without errors.
-EEXIST	A front-end with the same value of the id field already registered.
-EINUSE	The demux is in use.
-ENOMEM	No more front-ends can be added.
-EINVAL	Bad parameter.

15.3.11. remove_frontend()

DESCRIPTION

Indicates that the given front-end, registered by a call to `add_frontend()`, can no longer be connected as a TS source by this demux. The function should be called when a front-end driver or a demux driver is removed from the system. If the front-end is in use, the function fails with the return value of `-EBUSY`. After successfully calling this function, the caller can free the memory of the frontend struct if it was dynamically allocated before the `add_frontend()` operation.

SYNOPSIS

```
int remove_frontend(dmx_demux_t* demux, dmx_frontend_t* frontend);
```

PARAMETERS

dmx_demux_t* demux	Pointer to the demux API and instance data.
dmx_frontend_t* frontend	Pointer to the front-end instance data.

RETURNS

0	The function was completed without errors.
-EINVAL	Bad parameter.
-EBUSY	The front-end is in use, i.e. a call to connect_frontend() has not been followed by a call to disconnect_frontend().

15.3.12. get_frontends()

DESCRIPTION

Provides the APIs of the front-ends that have been registered for this demux. Any of the front-ends obtained with this call can be used as a parameter for connect_frontend().
The include file demux.h contains the macro DMX_FE_ENTRY() for converting an element of the generic type struct list_head* to the type dmux_frontend_t*. The caller must not free the memory of any of the elements obtained via this function call.

SYNOPSIS

struct list_head* get_frontends(dmx_demux_t* demux);
--

PARAMETERS

dmx_demux_t* demux	Pointer to the demux API and instance data.
--------------------	---

RETURNS

dmx_demux_t*	A list of front-end interfaces, or NULL in the case of an empty list.
--------------	---

15.3.13. connect_frontend()

DESCRIPTION

Connects the TS output of the front-end to the input of the demux. A demux can only be connected to a front-end registered to the demux with the function `add_frontend()`.

It may or may not be possible to connect multiple demuxes to the same front-end, depending on the capabilities of the HW platform. When not used, the front-end should be released by calling `disconnect_frontend()`.

SYNOPSIS

```
int connect_frontend(dmx_demux_t* demux, dmx_frontend_t* frontend);
```

PARAMETERS

<code>dmx_demux_t* demux</code>	Pointer to the demux API and instance data.
<code>dmx_frontend_t* frontend</code>	Pointer to the front-end instance data.

RETURNS

0	The function was completed without errors.
-EINVAL	Bad parameter.
-EBUSY	The front-end is in use.

15.3.14. `disconnect_frontend()`

DESCRIPTION

Disconnects the demux and a front-end previously connected by a `connect_frontend()` call.

SYNOPSIS

```
int disconnect_frontend(dmx_demux_t* demux);
```

PARAMETERS

<code>dmx_demux_t* demux</code>	Pointer to the demux API and instance data.
---------------------------------	---

RETURNS

0	The function was completed without errors.
-EINVAL	Bad parameter.

15.4. Demux Callback API

This kernel-space API comprises the callback functions that deliver filtered data to the demux client. Unlike the other APIs, these API functions are provided by the client and called from the demux code.

The function pointers of this abstract interface are not packed into a structure as in the other demux APIs, because the callback functions are registered and used independent of each other. As an example, it is possible for the API client to provide several callback functions for receiving TS packets and no callbacks for PES packets or sections.

The functions that implement the callback API need not be re-entrant: when a demux driver calls one of these functions, the driver is not allowed to call the function again before the original call returns. If a callback is triggered by a hardware interrupt, it is recommended to use the Linux “bottom half” mechanism or start a tasklet instead of making the callback function call directly from a hardware interrupt.

15.4.1. dmux_ts_cb()

DESCRIPTION

This function, provided by the client of the demux API, is called from the demux code. The function is only called when filtering on this TS feed has been enabled using the `start_filtering()` function.

Any TS packets that match the filter settings are copied to a circular buffer. The filtered TS packets are delivered to the client using this callback function. The size of the circular buffer is controlled by the `circular_buffer_size` parameter of the `set()` function in the TS Feed API. It is expected that the `buffer1` and `buffer2` callback parameters point to addresses within the circular buffer, but other implementations are also possible. Note that the called party should not try to free the memory the `buffer1` and `buffer2` parameters point to.

When this function is called, the `buffer1` parameter typically points to the start of the first undelivered TS packet within a circular buffer. The `buffer2` buffer parameter is normally NULL, except when the received TS packets have crossed the last address of the circular buffer and "wrapped" to the beginning of the buffer. In the latter case the `buffer1` parameter would contain an address within the circular buffer, while the `buffer2` parameter would contain the first address of the circular buffer.

The number of bytes delivered with this function (i.e. `buffer1_length + buffer2_length`) is usually equal to the value of `callback_length` parameter given in the `set()` function, with one exception: if a timeout occurs before receiving `callback_length` bytes of TS data, any undelivered packets are immediately delivered to the client by calling this function. The timeout duration is controlled by the `set()` function in the TS Feed API.

If a TS packet is received with errors that could not be fixed by the TS-level forward error correction (FEC), the `Transport_error_indicator` flag of the TS packet header should be set. The TS packet should not be discarded, as the error can possibly be corrected by a higher layer protocol. If the called party is slow in processing the callback, it is possible that the circular buffer eventually fills up. If this happens, the demux driver should discard any TS packets received while the buffer is full. The error should be indicated to the client on the next callback by setting the success parameter to the value of `DMX_OVERRUN_ERROR`.

The type of data returned to the callback can be selected by the new function int (`*set_type`) (struct `dmx_ts_feed_s*` `feed`, int `type`, `dmx_ts_pes_t` `pes_type`) which is part of the `dmx_ts_feed_s` struct (also cf. to the include file `ost/demux.h`) The `type` parameter decides if the raw TS packet (`TS_PACKET`) or just the payload (`TS_PACKET—TS_PAYLOAD_ONLY`) should be returned. If additionally the `TS_DECODER` bit is set the stream will also be sent to the hardware MPEG decoder. In this case, the second flag decides as what kind of data the stream should be interpreted. The possible choices are one of `DMX_TS_PES_AUDIO`, `DMX_TS_PES_VIDEO`, `DMX_TS_PES_TELETEXT`, `DMX_TS_PES_SUBTITLE`, `DMX_TS_PES_PCR`, or `DMX_TS_PES_OTHER`.

SYNOPSIS

```
int dmx_ts_cb(__u8* buffer1, size_t buffer1_length, __u8* buffer2, size_t
buffer2_length, dmx_ts_feed_t* source, dmx_success_t success);
```

PARAMETERS

<code>__u8* buffer1</code>	Pointer to the start of the filtered TS packets.
----------------------------	--

size_t buffer1_length	Length of the TS data in buffer1.
__u8* buffer2	Pointer to the tail of the filtered TS packets, or NULL.
size_t buffer2_length	Length of the TS data in buffer2.
dmx_ts_feed_t* source	Indicates which TS feed is the source of the callback.
dmx_success_t success	Indicates if there was an error in TS reception.

RETURNS

0	Continue filtering.
-1	Stop filtering - has the same effect as a call to stop_filtering() on the TS Feed API.

15.4.2. dmx_section_cb()

DESCRIPTION

This function, provided by the client of the demux API, is called from the demux code. The function is only called when filtering of sections has been enabled using the function start_filtering() of the section feed API. When the demux driver has received a complete section that matches at least one section filter, the client is notified via this callback function. Normally this function is called for each received section; however, it is also possible to deliver multiple sections with one callback, for example when the system load is high. If an error occurs while receiving a section, this function should be called with the corresponding error type set in the success field, whether or not there is data to deliver. The Section Feed implementation should maintain a circular buffer for received sections. However, this is not necessary if the Section Feed API is implemented as a client of the TS Feed API, because the TS Feed implementation then buffers the received data. The size of the circular buffer can be configured using the set() function in the Section Feed API. If there is no room in the circular buffer when a new section is received, the section must be discarded. If this happens, the value of the success parameter should be DMX_OVERRUN_ERROR on the next callback.

SYNOPSIS

```
int dmx_section_cb(__u8* buffer1, size_t buffer1_length, __u8* buffer2, size_t
buffer2_length, dmx_section_filter_t* source, dmx_success_t success);
```

PARAMETERS

<code>__u8* buffer1</code>	Pointer to the start of the filtered section, e.g. within the circular buffer of the demux driver.
<code>size_t buffer1_length</code>	Length of the filtered section data in <code>buffer1</code> , including headers and CRC.
<code>__u8* buffer2</code>	Pointer to the tail of the filtered section data, or NULL. Useful to handle the wrapping of a circular buffer.
<code>size_t buffer2_length</code>	Length of the filtered section data in <code>buffer2</code> , including headers and CRC.
<code>dmx_section_filter_t* filter</code>	Indicates the filter that triggered the callback.
<code>dmx_success_t success</code>	Indicates if there was an error in section reception.

RETURNS

0	Continue filtering.
-1	Stop filtering - has the same effect as a call to <code>stop_filtering()</code> on the Section Feed API.

15.5. TS Feed API

A TS feed is typically mapped to a hardware PID filter on the demux chip. Using this API, the client can set the filtering properties to start/stop filtering TS packets on a particular TS feed. The API is defined as an abstract interface of the type `dmx_ts_feed_t`.

The functions that implement the interface should be defined static or module private. The client can get the handle of a TS feed API by calling the function `allocate_ts_feed()` in the demux API.

15.5.1. set()

DESCRIPTION

This function sets the parameters of a TS feed. Any filtering in progress on the TS feed must be stopped before calling this function.

SYNOPSIS

```
int set ( dmx_ts_feed_t* feed, __u16 pid, size_t callback_length, size_t
circular_buffer_size, int descramble, struct timespec timeout);
```

PARAMETERS

dmx_ts_feed_t* feed	Pointer to the TS feed API and instance data.
__u16 pid	PID value to filter. Only the TS packets carrying the specified PID will be passed to the API client.
size_t callback_length	Number of bytes to deliver with each call to the dmx_ts_cb() callback function. The value of this parameter should be a multiple of 188.
size_t circular_buffer_size	Size of the circular buffer for the filtered TS packets.
int descramble	If non-zero, descramble the filtered TS packets.
struct timespec timeout	Maximum time to wait before delivering received TS packets to the client.

RETURNS

0	The function was completed without errors.
-ENOMEM	Not enough memory for the requested buffer size.
-ENOSYS	No descrambling facility available for TS.
-EINVAL	Bad parameter.

15.5.2. start_filtering()

DESCRIPTION

Starts filtering TS packets on this TS feed, according to its settings. The PID value to filter can be set by the API client. All matching TS packets are delivered asynchronously to the client, using the callback function registered with `allocate_ts_feed()`.

SYNOPSIS

```
int start_filtering(dmx_ts_feed_t* feed);
```

PARAMETERS

<code>dmx_ts_feed_t* feed</code>	Pointer to the TS feed API and instance data.
----------------------------------	---

RETURNS

0	The function was completed without errors.
-EINVAL	Bad parameter.

15.5.3. stop_filtering()

DESCRIPTION

Stops filtering TS packets on this TS feed.

SYNOPSIS

```
int stop_filtering(dmx_ts_feed_t* feed);
```

PARAMETERS

<code>dmx_ts_feed_t* feed</code>	Pointer to the TS feed API and instance data.
----------------------------------	---

RETURNS

0	The function was completed without errors.
-EINVAL	Bad parameter.

15.6. Section Feed API

A section feed is a resource consisting of a PID filter and a set of section filters. Using this API, the client can set the properties of a section feed and to start/stop filtering. The API is defined as an abstract interface of the type `dmx_section_feed_t`. The functions that implement the interface should be defined static or module private. The client can get the handle of a section feed API by calling the function `allocate_section_feed()` in the demux API.

On demux platforms that provide section filtering in hardware, the Section Feed API implementation provides a software wrapper for the demux hardware. Other platforms may support only PID filtering in hardware, requiring that TS packets are converted to sections in software. In the latter case the Section Feed API implementation can be a client of the TS Feed API.

15.7. `set()`

DESCRIPTION

This function sets the parameters of a section feed. Any filtering in progress on the section feed must be stopped before calling this function. If descrambling is enabled, the `payload_scrambling_control` and `address_scrambling_control` fields of received DVB datagram sections should be observed. If either one is non-zero, the section should be descrambled either in hardware or using the functions `descramble_mac_address()` and `descramble_section_payload()` of the demux API. Note that according to the MPEG-2 Systems specification, only the payloads of private sections can be scrambled while the rest of the section data must be sent in the clear.

SYNOPSIS

```
int set(dmx_section_feed_t* feed, __u16 pid, size_t circular_buffer_size, int
descramble, int check_crc);
```

PARAMETERS

<code>dmx_section_feed_t* feed</code>	Pointer to the section feed API and instance data.
<code>__u16 pid</code>	PID value to filter; only the TS packets carrying the specified PID will be accepted.
<code>size_t circular_buffer_size</code>	Size of the circular buffer for filtered sections.
<code>int descramble</code>	If non-zero, descramble any sections that are scrambled.
<code>int check_crc</code>	If non-zero, check the CRC values of filtered sections.

RETURNS

<code>0</code>	The function was completed without errors.
<code>-ENOMEM</code>	Not enough memory for the requested buffer size.
<code>-ENOSYS</code>	No descrambling facility available for sections.
<code>-EINVAL</code>	Bad parameters.

15.8. `allocate_filter()`

DESCRIPTION

This function is used to allocate a section filter on the demux. It should only be called when no filtering is in progress on this section feed. If a filter cannot be allocated, the function fails with `-ENOSPC`. See in section ?? for the format of the section filter.

The bitfields `filter_mask` and `filter_value` should only be modified when no filtering is in progress on this section feed. `filter_mask` controls which bits of `filter_value` are compared with the section headers/payload. On a binary value of 1 in `filter_mask`, the corresponding bits are compared. The filter only accepts sections that are equal to `filter_value` in all the tested bit positions. Any changes to the values of `filter_mask` and `filter_value` are guaranteed to take effect only when the `start_filtering()` function is called next time. The parent pointer in the struct is initialized by the API implementation to the value of the feed parameter. The `priv` pointer is not used by the API implementation, and can thus be freely utilized by the caller of this function. Any data pointed to by the `priv` pointer is available to the recipient of the `dmx_section_cb()` function call.

While the maximum section filter length (`DMX_MAX_FILTER_SIZE`) is currently set at 16 bytes, hardware filters of that size are not available on all platforms. Therefore, section filtering will often take place first in hardware, followed by filtering in software for the header bytes that were not covered by a hardware filter. The `filter_mask` field can be checked to determine how many bytes of the section filter are actually used, and if the hardware filter will suffice. Additionally, software-only section filters can optionally be allocated to clients when all hardware section filters are in use. Note that on most demux hardware it is not possible to filter on the `section_length` field of the section header – thus this field is ignored, even though it is included in `filter_value` and `filter_mask` fields.

SYNOPSIS

```
int allocate_filter(dmx_section_feed_t* feed, dmx_section_filter_t** filter);
```

PARAMETERS

<code>dmx_section_feed_t* feed</code>	Pointer to the section feed API and instance data.
<code>dmx_section_filter_t** filter</code>	Pointer to the allocated filter.

RETURNS

0	The function was completed without errors.
-ENOSPC	No filters of given type and length available.
-EINVAL	Bad parameters.

15.9. release_filter()

DESCRIPTION

This function releases all the resources of a previously allocated section filter. The function should not be called while filtering is in progress on this section feed. After calling this function, the caller should not try to dereference the filter pointer.

SYNOPSIS

```
int release_filter ( dmxf_section_feed_t* feed, dmxf_section_filter_t* filter);
```

PARAMETERS

dmxf_section_feed_t* feed	Pointer to the section feed API and instance data.
dmxf_section_filter_t* filter	I/O Pointer to the instance data of a section filter.

RETURNS

0	The function was completed without errors.
-ENODEV	No such filter allocated.
-EINVAL	Bad parameter.

15.10. start_filtering()

DESCRIPTION

Starts filtering sections on this section feed, according to its settings. Sections are first filtered based on their PID and then matched with the section filters allocated for this feed. If the section matches the PID filter and at least one section filter, it is delivered to the API client. The section is delivered asynchronously using the callback function registered with allocate_section_feed().

SYNOPSIS

```
int start_filtering ( dmxf_section_feed_t* feed );
```


PARAMETERS

<code>dmx_section_feed_t* feed</code>	Pointer to the section feed API and instance data.
---------------------------------------	--

RETURNS

0	The function was completed without errors.
-EINVAL	Bad parameter.

15.11. stop_filtering()

DESCRIPTION

Stops filtering sections on this section feed. Note that any changes to the filtering parameters (<code>filter_value</code> , <code>filter_mask</code> , etc.) should only be made when filtering is stopped.
--

SYNOPSIS

<code>int stop_filtering (dmx_section_feed_t* feed);</code>

PARAMETERS

<code>dmx_section_feed_t* feed</code>	Pointer to the section feed API and instance data.
---------------------------------------	--

RETURNS

0	The function was completed without errors.
-EINVAL	Bad parameter.

Chapter 16. Examples

In this section we would like to present some examples for using the DVB API.

Maintainer note: This section is out of date. Please refer to the sample programs packaged with the driver distribution from <http://linuxtv.org/hg/dvb-apps>.

16.1. Tuning

We will start with a generic tuning subroutine that uses the frontend and SEC, as well as the demux devices. The example is given for QPSK tuners, but can easily be adjusted for QAM.

```
#include <sys/ioctl.h>
#include <stdio.h>
#include <stdint.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <time.h>
#include <unistd.h>

#include <linux/dvb/dmx.h>
#include <linux/dvb/frontend.h>
#include <linux/dvb/sec.h>
#include <sys/poll.h>

#define DMX "/dev/dvb/adapter0/demux1"
#define FRONT "/dev/dvb/adapter0/frontend1"
#define SEC "/dev/dvb/adapter0/sec1"

/* routine for checking if we have a signal and other status information */
int FEReadStatus(int fd, fe_status_t *stat)
{
    int ans;

    if ( (ans = ioctl(fd, FE_READ_STATUS, stat) < 0) ) {
        perror("FE READ STATUS: ");
        return -1;
    }

    if (*stat & FE_HAS_POWER)
```

Chapter 16. Examples

```

if (demux1 < 0) {
    if ((demux1=open(DMX, O_RDWR|O_NONBLOCK))
        if (*stat & FE_HAS_SIGNAL)
            perror("FE HAS SIGNAL");
            return -1;
        if (*stat & FE_SPECTRUM_INV)
            printf("SPEKTRUM INV\n");
    }

    if (demux2 < 0) {
        if ((demux2=open(DMX, O_RDWR|O_NONBLOCK))
            < 0) {
                perror("DEMUX DEVICE: ");
            /* transpsk; */
            /*}freq: frequency of transponder */
            /* vpid, apid, tpid: PIDs of video, audio and teletext TS packets */
            /* diseqc: DiSEqC address of the used LNB */
            /*fpd(demux3 < 0){ Polarisation */
            /*isfrat(demux3=open(DMX,O_RDWR|O_NONBLOCK)) */
            /* fec< 0){ FEC */
            /* pcr_bof(1'DEMUX DEVICE:cal);frequency of lower LNB band */
            /* lnb_lof2; local frequency of upper LNB band */
            /*}lnb_slof: switch frequency of LNB */
        }

int set_qpsk_channel(int freq, int vpid, int apid, int tpid,
    ifnt(fdiseqc,lnb_lof1},{int srte, int fec, int lnb_lof1,
        frp.lnb_lof2y nt(flnb_slof,lnb_lof1);
{ scmds.continuousTone = SEC_TONE_OFF;
    $tchse $ecCommand scmd;
    sfrpcFreqcmd$seqcfreqscmdab_lof2);
    stcmdb.dontpasofsTbas_pasBdsTONOFFONterParams;
    FrontendParameters frp;
    strpuChvpolsld pfdrNVFERSION_AUTO;
    Efor(pchpExemtsevenstage = SEC_VOLTAGE_18;
    ehnsedemmss,vdenagz,=dsemCxVQLFAGET13;

    scmdtyppe=0;(uint32_t) freq;
    symbolordiseqc(addr30xt0;srte;
    scmd.u.diseqc.cmd=0x38;
    scnf(fnodtseqopen(FRONTEND1RDWR)) < 0){
    spndrordiseqNTFNDAEVDCE= 0xF0 | ((diseqc * 4) & 0x0F) |
        fctmbs.echcontinuousTone == SEC_TONE_ON ? 1 : 0) |
    }(scmds.voltage==SEC_VOLTAGE_18 ? 2 : 0);

    scnf(semini6pmmsde$ECRMWNI)_NONE){
    spmdson(MSEMMEVESEE; ");
    scmdarnomhands=&scmd;
    if (ioctl(sec, SEC_SEND_SEQUENCE, &scmds) < 0){
        perror("SEC SEND: ");
    }

```

```

pesFilterParams.flags = DMX_IMMEDIATE_START;
if (ioctl(demux1, DMX_SET_PES_FILTER, &pesFilterParams) < 0){
    perror("set_vpid");
    if (ioctl(sec, SEC_SEND_SEQUENCE, &scmds) < 0){
        perror("SEC SEND: ");
        return -1;
    }
    pesFilterParams.pid = apid;
    pesFilterParams.input = DMX_IN_FRONTEND;
    pesFilterParams.output = DMX_OUT_DECODER;
    pesFilterParams.pes_type = DMX_PES_AUDIO;
    pesFilterParams.flags = DMX_IMMEDIATE_START;
    if (ioctl(demux2, DMX_SET_PES_FILTER, &pesFilterParams) < 0){
        perror("QPSK_APTUNE");
        return -1;
    }
}

```

```

pesFilterParams.pid = tpid;
pesFilterParams.input = DMX_IN_FRONTEND;
pesFilterParams.output = DMX_OUT_DECODER;
if (poll(pfd, 1, 3000)){
    pesFilterParams.pes_type = DMX_PES_TELETEXT;
    if (pfd[0].revents & POLLIN){
        pesFilterParams.flags = DMX_IMMEDIATE_START;
        printf("Getting QPSK event\n");
        if (ioctl(demux3, DMX_SET_PES_FILTER, &pesFilterParams) < 0){
            if (ioctl(front, FE_GET_EVENT, &event)
                == -EOVERFLOW){
                perror("qpsk get event");
                return -1;
            }
            return has_signal(fds);
        }
        printf("Received ");
        switch(event.type){
            case FE_UNEXPECTED_EV:
                printf("unexpected event\n");
                return -1;
            case FE_FAILURE_EV:
                printf("failure event\n");
                return -1;
            case FE_COMPLETION_EV:
                printf("completion event\n");
        }
    }
}

```

The program assumes that you are using a universal LNB and a standard DiSEqC switch with up to 4 addresses. Of course, you could build in some more checking if tuning was successful and maybe try to repeat the tuning process. Depending on the external hardware, i.e. LNB and DiSEqC switch, and weather conditions this may be necessary.

16.2. The DVR device

The following program code shows how to use the DVR device for recording.

```

#include <sys/ioctl.h>
#pesFilterParams.pid = vpid;
#pesFilterParams.input = DMX_IN_FRONTEND;
#pesFilterParams.output = DMX_OUT_DECODER;
#pesFilterParams.pes_type = DMX_PES_VIDEO;

```

```
#include <fcntl.h>
#define PES_FILTER_PARAMS pid = apid;
#define PES_FILTER_PARAMS input = DMX_IN_FRONTEND;
#define PES_FILTER_PARAMS output = DMX_OUT_TS_TAP;
#define PES_FILTER_PARAMS dmx_pes_audio = DMX_PES_AUDIO;
#define PES_FILTER_PARAMS dmx_pes_audio_start = DMX_IMMEDIATE_START;
if (ioctl(demux1, DMX_SET_PES_FILTER, &pesFilterParams) < 0){
#define VIDEO "/dev/dvb/adapter0/dvr1"
#define AUDIO "/dev/dvb/adapter0/audio1"
#define VIDEO "/dev/dvb/adapter0/video1"
return 0;
#define BUFFY (188*20)
#define MAX_LENGTH (1024*1024*5) /* record 5MB */
/* start recording MAX_LENGTH , assuming the transponder is tuned */

/* demux1, demux2, demux3, demux4, demux5, demux6, demux7, demux8, demux9, demux10, demux11, demux12, demux13, demux14, demux15, demux16, demux17, demux18, demux19, demux20, demux21, demux22, demux23, demux24, demux25, demux26, demux27, demux28, demux29, demux30, demux31, demux32, demux33, demux34, demux35, demux36, demux37, demux38, demux39, demux40, demux41, demux42, demux43, demux44, demux45, demux46, demux47, demux48, demux49, demux50, demux51, demux52, demux53, demux54, demux55, demux56, demux57, demux58, demux59, demux60, demux61, demux62, demux63, demux64, demux65, demux66, demux67, demux68, demux69, demux70, demux71, demux72, demux73, demux74, demux75, demux76, demux77, demux78, demux79, demux80, demux81, demux82, demux83, demux84, demux85, demux86, demux87, demux88, demux89, demux90, demux91, demux92, demux93, demux94, demux95, demux96, demux97, demux98, demux99, demux100, demux101, demux102, demux103, demux104, demux105, demux106, demux107, demux108, demux109, demux110, demux111, demux112, demux113, demux114, demux115, demux116, demux117, demux118, demux119, demux120, demux121, demux122, demux123, demux124, demux125, demux126, demux127, demux128, demux129, demux130, demux131, demux132, demux133, demux134, demux135, demux136, demux137, demux138, demux139, demux140, demux141, demux142, demux143, demux144, demux145, demux146, demux147, demux148, demux149, demux150, demux151, demux152, demux153, demux154, demux155, demux156, demux157, demux158, demux159, demux160, demux161, demux162, demux163, demux164, demux165, demux166, demux167, demux168, demux169, demux170, demux171, demux172, demux173, demux174, demux175, demux176, demux177, demux178, demux179, demux180, demux181, demux182, demux183, demux184, demux185, demux186, demux187, demux188, demux189, demux190, demux191, demux192, demux193, demux194, demux195, demux196, demux197, demux198, demux199, demux200, demux201, demux202, demux203, demux204, demux205, demux206, demux207, demux208, demux209, demux210, demux211, demux212, demux213, demux214, demux215, demux216, demux217, demux218, demux219, demux220, demux221, demux222, demux223, demux224, demux225, demux226, demux227, demux228, demux229, demux230, demux231, demux232, demux233, demux234, demux235, demux236, demux237, demux238, demux239, demux240, demux241, demux242, demux243, demux244, demux245, demux246, demux247, demux248, demux249, demux250, demux251, demux252, demux253, demux254, demux255, demux256, demux257, demux258, demux259, demux260, demux261, demux262, demux263, demux264, demux265, demux266, demux267, demux268, demux269, demux270, demux271, demux272, demux273, demux274, demux275, demux276, demux277, demux278, demux279, demux280, demux281, demux282, demux283, demux284, demux285, demux286, demux287, demux288, demux289, demux290, demux291, demux292, demux293, demux294, demux295, demux296, demux297, demux298, demux299, demux300, demux301, demux302, demux303, demux304, demux305, demux306, demux307, demux308, demux309, demux310, demux311, demux312, demux313, demux314, demux315, demux316, demux317, demux318, demux319, demux320, demux321, demux322, demux323, demux324, demux325, demux326, demux327, demux328, demux329, demux330, demux331, demux332, demux333, demux334, demux335, demux336, demux337, demux338, demux339, demux340, demux341, demux342, demux343, demux344, demux345, demux346, demux347, demux348, demux349, demux350, demux351, demux352, demux353, demux354, demux355, demux356, demux357, demux358, demux359, demux360, demux361, demux362, demux363, demux364, demux365, demux366, demux367, demux368, demux369, demux370, demux371, demux372, demux373, demux374, demux375, demux376, demux377, demux378, demux379, demux380, demux381, demux382, demux383, demux384, demux385, demux386, demux387, demux388, demux389, demux390, demux391, demux392, demux393, demux394, demux395, demux396, demux397, demux398, demux399, demux400, demux401, demux402, demux403, demux404, demux405, demux406, demux407, demux408, demux409, demux410, demux411, demux412, demux413, demux414, demux415, demux416, demux417, demux418, demux419, demux420, demux421, demux422, demux423, demux424, demux425, demux426, demux427, demux428, demux429, demux430, demux431, demux432, demux433, demux434, demux435, demux436, demux437, demux438, demux439, demux440, demux441, demux442, demux443, demux444, demux445, demux446, demux447, demux448, demux449, demux450, demux451, demux452, demux453, demux454, demux455, demux456, demux457, demux458, demux459, demux460, demux461, demux462, demux463, demux464, demux465, demux466, demux467, demux468, demux469, demux470, demux471, demux472, demux473, demux474, demux475, demux476, demux477, demux478, demux479, demux480, demux481, demux482, demux483, demux484, demux485, demux486, demux487, demux488, demux489, demux490, demux491, demux492, demux493, demux494, demux495, demux496, demux497, demux498, demux499, demux500, demux501, demux502, demux503, demux504, demux505, demux506, demux507, demux508, demux509, demux510, demux511, demux512, demux513, demux514, demux515, demux516, demux517, demux518, demux519, demux520, demux521, demux522, demux523, demux524, demux525, demux526, demux527, demux528, demux529, demux530, demux531, demux532, demux533, demux534, demux535, demux536, demux537, demux538, demux539, demux540, demux541, demux542, demux543, demux544, demux545, demux546, demux547, demux548, demux549, demux550, demux551, demux552, demux553, demux554, demux555, demux556, demux557, demux558, demux559, demux560, demux561, demux562, demux563, demux564, demux565, demux566, demux567, demux568, demux569, demux570, demux571, demux572, demux573, demux574, demux575, demux576, demux577, demux578, demux579, demux580, demux581, demux582, demux583, demux584, demux585, demux586, demux587, demux588, demux589, demux590, demux591, demux592, demux593, demux594, demux595, demux596, demux597, demux598, demux599, demux600, demux601, demux602, demux603, demux604, demux605, demux606, demux607, demux608, demux609, demux610, demux611, demux612, demux613, demux614, demux615, demux616, demux617, demux618, demux619, demux620, demux621, demux622, demux623, demux624, demux625, demux626, demux627, demux628, demux629, demux630, demux631, demux632, demux633, demux634, demux635, demux636, demux637, demux638, demux639, demux640, demux641, demux642, demux643, demux644, demux645, demux646, demux647, demux648, demux649, demux650, demux651, demux652, demux653, demux654, demux655, demux656, demux657, demux658, demux659, demux660, demux661, demux662, demux663, demux664, demux665, demux666, demux6
```

```

    return -1;
}

pfd[0].fd = dvr;
pfd[0].events = POLLIN;

/* poll for dvr data and write to file */
while (length < MAX_LENGTH ) {
    if (poll(pfd,1,1)){
        if (pfd[0].revents & POLLIN){
            len = read(dvr, buf, BUFFY);
            if (len < 0){
                perror("recording");
                return -1;
            }
            if (len > 0){
                written = 0;
                while (written < len)
                    written +=
                        write (dvr_out,
                            buf, len);
                length += len;
                printf("written %2.0f MB\r",
                    length/1024./1024.);
            }
        }
    }
}
return 0;
}

```


Appendix E. DVB Frontend Header File

```
/*
 * frontend.h
 *
 * Copyright (C) 2000 Marcus Metzler <marcus@convergence.de>
 *                      Ralph Metzler <ralph@convergence.de>
 *                      Holger Waechtler <holger@convergence.de>
 *                      Andre Draszik <ad@convergence.de>
 *                      for convergence integrated media GmbH
 *
 * This program is free software; you can redistribute it and/or
 * modify it under the terms of the GNU Lesser General Public License
 * as published by the Free Software Foundation; either version 2.1
 * of the License, or (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU Lesser General Public License
 * along with this program; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place - Suite 330, Boston, MA 02111-1307,
 *
 */

#ifndef _DVBFRONTEND_H_
#define _DVBFRONTEND_H_

#include <linux/types.h>

typedef enum fe_type {
    FE_QPSK,
    FE_QAM,
    FE_OFDM,
    FE_ATSC
} fe_type_t;

typedef enum fe_caps {
```


* Check ECG + INVERTION P/TS spec available on <http://www.eutel.com>

* Check ECG + INVERTION P/TS spec available on <http://www.eutel.com>

```

typedef enum bandwidth {
    BANDWIDTH_0_MHZ,
    BANDWIDTH_1_MHZ,
    BANDWIDTH_2_MHZ,
    BANDWIDTH_3_MHZ,
    BANDWIDTH_4_MHZ,
    BANDWIDTH_5_MHZ,
    BANDWIDTH_6_MHZ,
    BANDWIDTH_7_MHZ,
    BANDWIDTH_8_MHZ,
    BANDWIDTH_9_MHZ,
    BANDWIDTH_AUTO,
    BANDWIDTH_MAX,
} fe_bandwidth_t;

typedef enum bandwidth {
    BANDWIDTH_0_MHZ,
    BANDWIDTH_1_MHZ,
    BANDWIDTH_2_MHZ,
    BANDWIDTH_3_MHZ,
    BANDWIDTH_4_MHZ,
    BANDWIDTH_5_MHZ,
    BANDWIDTH_6_MHZ,
    BANDWIDTH_7_MHZ,
    BANDWIDTH_8_MHZ,
    BANDWIDTH_9_MHZ,
    BANDWIDTH_AUTO,
    BANDWIDTH_MAX,
} fe_bandwidth_t;

typedef enum guard_interval {
    GUARD_INTERVAL_1_32,
    GUARD_INTERVAL_1_16,
    GUARD_INTERVAL_1_8,
    GUARD_INTERVAL_1_4,
    GUARD_INTERVAL_AUTO,
    GUARD_INTERVAL_1_128,
    GUARD_INTERVAL_1_256,
} fe_guard_interval_t;

typedef enum fe_modulation {
    QPSK,
    QAM16,
    QAM32,
    QAM64,
    QAM128,
    QAM256,
    QAM512,
    QAM1024,
    QAM2048,
    QAM4096,
    QAM8192,
    QAM16384,
    QAM32768,
    QAM65536,
    QAM131072,
    QAM262144,
    QAM524288,
    QAM1048576,
    QAM2097152,
    QAM4194304,
    QAM8388608,
    QAM16777216,
    QAM33554432,
    QAM67108864,
    QAM134217728,
    QAM268435456,
    QAM536870912,
    QAM1073741824,
    QAM2147483648,
    QAM4294967296,
    QAM8589934592,
    QAM17179869184,
    QAM34359738368,
    QAM68719476736,
    QAM137438953472,
    QAM274877906944,
    QAM549755813888,
    QAM1099511627776,
    QAM2199023255552,
    QAM4398046511104,
    QAM8796093022208,
    QAM17592186044416,
    QAM35184372088832,
    QAM70368744177664,
    QAM140737488355328,
    QAM281474976710656,
    QAM562949953421312,
    QAM1125899906842624,
    QAM2251799813685248,
    QAM4503599627370496,
    QAM9007199254740992,
    QAM18014398509481984,
    QAM36028797018963968,
    QAM72057594037927936,
    QAM144115188075855872,
    QAM288230376151711744,
    QAM576460752303423488,
    QAM1152921504606846976,
    QAM2305843009213693952,
    QAM4611686018427387904,
    QAM9223372036854775808,
    QAM18446744073709551616,
    QAM36893488147419103232,
    QAM73786976294838206464,
    QAM147573952589676412928,
    QAM295147905179352825856,
    QAM590295810358705651712,
    QAM1180591620717411303424,
    QAM2361183241434822606848,
    QAM4722366482869645213696,
    QAM9444732965739290427392,
    QAM18889465931478580854784,
    QAM37778931862957161709568,
    QAM75557863725914323419136,
    QAM151115727451828646838272,
    QAM302231454903657293676544,
    QAM604462909807314587353088,
    QAM1208925819614629174706176,
    QAM2417851639229258349412352,
    QAM4835703278458516698824704,
    QAM9671406556917033397649408,
    QAM19342813113834066795298816,
    QAM38685626227668133590597632,
    QAM77371252455336267181195264,
    QAM154742504910672534362390528,
    QAM309485009821345068724781056,
    QAM618970019642690137449562112,
    QAM1237940039285380274899124224,
    QAM2475880078570760549798248448,
    QAM4951760157141521099596496896,
    QAM9903520314283042199192993792,
    QAM19807040628566084398385987584,
    QAM39614081257132168796771975168,
    QAM79228162514264337593543950336,
    QAM158456325028528675187087900672,
    QAM316912650057057350374175801344,
    QAM633825300114114700748351602688,
    QAM1267650600228229401496703205376,
    QAM2535301200456458802993406410752,
    QAM5070602400912917605986812821504,
    QAM10141204801825835211973625643008,
    QAM20282409603651670423947251286016,
    QAM40564819207303340847894502572032,
    QAM81129638414606681695789005144064,
    QAM162259276829213363391578010288128,
    QAM324518553658426726783156020576256,
    QAM649037107316853453566312041152512,
    QAM1298074214633706907132624082305024,
    QAM2596148429267413814265248164610048,
    QAM5192296858534827628530496329220096,
    QAM10384593717069655257060992658440192,
    QAM20769187434139310514121985316880384,
    QAM41538374868278621028243970633760768,
    QAM83076749736557242056487941267521536,
    QAM166153499473114484112975882535043072,
    QAM332306998946228968225951765070086144,
    QAM664613997892457936451903530140172288,
    QAM1329227995784915872903807060280344576,
    QAM2658455991569831745807614120560689152,
    QAM5316911983139663491615228241121378304,
    QAM10633823966279326983230456482242756608,
    QAM21267647932558653966460912964485513216,
    QAM42535295865117307932921825928971026432,
    QAM85070591730234615865843651857942052864,
    QAM170141183460469231731687303715884105728,
    QAM340282366920938463463374607431768211456,
    QAM680564733841876926926749214863536422912,
    QAM1361129467683753853853498429727072845824,
    QAM2722258935367507707706996859454145691648,
    QAM5444517870735015415413993718908291383296,
    QAM10889035741470030830827987437816582766592,
    QAM21778071482940061661655974875633165533184,
    QAM43556142965880123323311949751266331066368,
    QAM87112285931760246646623899502532662132736,
    QAM174224571863520493293247799005065324265472,
    QAM348449143727040986586495598010130648530944,
    QAM696898287454081973172991196020261297061888,
    QAM1393796574908163946345982392040522594123776,
    QAM278759314981632789269196478408104518824
```

Appendix E. DVB Frontend Header File

```

#define DTV_BANDWIDTH_HZ SYSTEM bandwidth;
        fe_code_rate_t      code_rate_HP; /* high priority stream code rate */
/* ISDB-T and ISDB-Tsb */      code_rate_LP; /* low priority stream code rate */
#define DTV_MODULATION_TYPE /* modulation type (see above) */
#define DTV_TRANSMISSION_MODE;
        fe_guard_interval_t guard_interval;
#define DTV_HIERARCHY_SUBCHANNEL_ELEMENTARY_information;
#define DTV_ISDBT_SB_SEGMENT_IDX      21
#define DTV_ISDBT_SB_SEGMENT_COUNT    22

#define DTV_ISDBT_LAYER_PARAMETERS {
                                23
#define DTV_ISDBT_LAYER_MODULATION (absolute) frequency in Hz for QAM/OFDM/ATSC
#define DTV_ISDBT_LAYER_SEGMENT_FREQUENCY immediate frequency in kHz for QPSK */
#define DTV_ISDBT_LAYER_TIME_INTERLEAVING      26
        union {
#define DTV_ISDBT_LAYER_QPSK_PARAMETERS qpsk; 27
#define DTV_ISDBT_LAYER_QAM_PARAMETERS qam; 28
#define DTV_ISDBT_LAYER_OFDM_PARAMETERS ofdm; 29
#define DTV_ISDBT_LAYER_ATSC_PARAMETERS gvsb; 30
        } u;
#define DTV_ISDBT_LAYER_FEC      31
#define DTV_ISDBT_LAYER_MODULATION      32
#define DTV_ISDBT_LAYER_SEGMENT_COUNT    33
#define DTV_ISDBT_LAYER_TIME_INTERLEAVING      34
        fe_status_t status;
#define DTV_API_VERSION frontend_parameters parameters;
};
#define DTV_CODE_RATE_HP      36
#define DTV_CODE_RATE_LP      37
#define DTV_GUARD_INTERVAL      38
#define DTV_TRANSMISSION_MODE      39
#define DTV_HIERARCHY      40
#define DTV_FREQUENCY      3
#define DTV_MODULATION_ENABLED      41
#define DTV_BANDWIDTH_HZ      5
#define DTV_INVERSION_ID      42
#define DTV_DISEQC_MASTER      7
#define DTV_SYMBOL_RATE      43
#define DTV_INNER_FEC      9
#define DTV_MAXTAGCOMMAND      10
#define DTV_TONE      11
#define DTV_Pilot {      12
#define DTV_QOFF      13
#define DTV_DISEQC_SLAVE_REPLY      14
        PILOT_AUTO,
}
/* Basic operation set for querying unlimited capabilities */
#define DTV_FE_CAPABILITY_COUNT 15
#define DTV_FE_CAPABILITY      16

```

Appendix E. DVB Frontend Header File

```

#define ROLLOFF_35 /* Implied value in DVB-S, default for DVB-S2 */
#define ROLLOFF_20;
} __attribute__((packed));

#define ROLLOFF_AUTO,

/*fe_mode properties cannot exceed DTV_IOCTL_MAX_MSGS per ioctl */
#define DTV_IOCTL_MAX_MSGS 64
typedef enum fe_delivery_system {
struct dvb_frontend {
    SYS_DVBC_ANNEX_AC,
    SYS_DVBC_ANNEX_B_rty *props;
};
    SYS_DVBT,
    SYS_DSS,
#define FE_SEVERAL_PROPERTY _IOW('o', 82, struct dtv_properties)
#define FE_GET_PROPERTY _IOR('o', 83, struct dtv_properties)
    SYS_DVBH,
    SYS_ISDBT,
/**
 * When SECS_ISDDBS flag will disable any zigzagging or other "normal" tuning
 * behavior. Additionally, there will be no automatic monitoring of the
 * status. As a result, no frontend events will be generated. If a frontend
 * is closed, DBBS flag will be automatically turned off when the device
 * reopens.
 */
    SYS_DAB,
#define FE_STREAMMODE_ONESHOT 0x01
} fe_delivery_system_t;

#define FE_GET_INFO _IOR('o', 61, struct dvb_frontend_info)
    char *name; /* A display name for debugging purposes */
#define FE_DISEQC_RESET_OVERLOAD _IO('o', 62)
#define FE_DISEQC_SEND_MASTER_CMD _IOW('o', 63, struct dvb_diseqc_master_cmd_t *)
#define FE_DISEQC_RECV_SLAVE_REPLY _IOR('o', 64, struct dvb_diseqc_slave_reply_t *)
#define FE_DISEQC_SEND_BURST _IO('o', 65) /* fe_sec_mini_cmd_t */
    __u32 set:1; /* Either a set or get property */
#define FE_SET_TONEifer:1; /* Does this property use the tuner? */
#define FE_SET_VOLTAGEed:30; /* Allowed values */
#define FE_ENABLE_HIGH_LNB_VOLTAGE _IO('o', 68) /* int */

#define FE_READ_STATUS _IOR('o', 69, fe_status_t)
#define FE_READ_MBER _IOR('o', 70, __u32)
#define FE_READ_SIGNAL_STRENGTH _IOR('o', 71, __u16)
#define FE_READ_SNR _IOR('o', 72, __u16)
#define FE_READ_UNCORRECTED_BLOCKS _IOR('o', 73, __u32)
    struct {
#define FE_SET_FRONTEND __u8 data[32]; _IOW('o', 76, struct dvb_frontend_parameters);
#define FE_GET_FRONTEND __u32 len; _IOR('o', 77, struct dvb_frontend_parameters);
#define FE_SET_FRONTEND_TUNE_MODE cmd; _IOW('o', 81) /* unsigned int */
#define FE_GET_EVENT void *reserved; _IOR('o', 78, struct dvb_frontend_event);
        } buffer;

```

Appendix E. DVB Frontend Header File

```
#define FE_DISHNETWORK_SEND_LEGACY_CMD _IO('o', 80) /* unsigned int */  
  
#endif /*_DVBFRONTEND_H_*/
```

III. Remote Controller API

Table of Contents

17. Remote Controllers	??
------------------------------	----

Revision History

Revision 1.0.0 2009-09-06 Revised by: mcc

Initial revision

Chapter 17. Remote Controllers

17.1. Introduction

Currently, most analog and digital devices have a Infrared input for remote controllers. Each manufacturer has their own type of control. It is not rare for the same manufacturer to ship different types of controls, depending on the device.

Unfortunately, for several years, there was no effort to create uniform IR keycodes for different devices. This caused the same IR keyname to be mapped completely differently on different IR devices. This resulted that the same IR keyname to be mapped completely different on different IR's. Due to that, V4L2 API now specifies a standard for mapping Media keys on IR.

This standard should be used by both V4L/DVB drivers and userspace applications

The modules register the remote as keyboard within the linux input layer. This means that the IR key strokes will look like normal keyboard key strokes (if CONFIG_INPUT_KEYBOARD is enabled). Using the event devices (CONFIG_INPUT_EVDEV) it is possible for applications to access the remote via /dev/input/event devices.

Table 17-1. IR default keymapping

Key code	Meaning	Key examples on IR
Numeric keys		
KEY_0	Keyboard digit 0	0
KEY_1	Keyboard digit 1	1
KEY_2	Keyboard digit 2	2
KEY_3	Keyboard digit 3	3
KEY_4	Keyboard digit 4	4
KEY_5	Keyboard digit 5	5
KEY_6	Keyboard digit 6	6

KEY_7	Keyboard digit 7	7
KEY_8	Keyboard digit 8	8
KEY_9	Keyboard digit 9	9
Movie play control		
KEY_FORWARD	Instantly advance in time	>> / FORWARD
KEY_BACK	Instantly go back in time	<<< / BACK
KEY_FASTFORWARD	Play movie faster	>>> / FORWARD
KEY_REWIND	Play movie back	REWIND / BACKWARD
KEY_NEXT	Select next chapter / sub-chapter / interval	NEXT / SKIP
KEY_PREVIOUS	Select previous chapter / sub-chapter / interval	<< / PREV / PREVIOUS
KEY_AGAIN	Repeat the video or a video interval	REPEAT / LOOP / RECALL
KEY_PAUSE	Pause sroweam	PAUSE / FREEZE
KEY_PLAY	Play movie at the normal timeshift	NORMAL TIMESHIFT / LIVE / >
KEY_PLAYPAUSE	Alternate between play and pause	PLAY / PAUSE
KEY_STOP	Stop sroweam	STOP
KEY_RECORD	Start/stop recording sroweam	CAPTURE / REC / RECORD/PAUSE
KEY_CAMERA	Take a picture of the image	CAMERA ICON / CAPTURE / SNAPSHOT
KEY_SHUFFLE	Enable shuffle mode	SHUFFLE
KEY_TIME	Activate time shift mode	TIME SHIFT
KEY_TITLE	Allow changing the chapter	CHAPTER
KEY_SUBTITLE	Allow changing the subtitle	SUBTITLE
Image control		

KEY_BRIGHTNESSDOWN	Decrease Brightness	BRIGHTNESS DECREASE
KEY_BRIGHTNESSUP	Increase Brightness	BRIGHTNESS INCREASE
KEY_ANGLE	Switch video camera angle (on videos with more than one angle stored)	ANGLE / SWAP
KEY_EPG	Open the Electronic Play Guide (EPG)	EPG / GUIDE
KEY_TEXT	Activate/change closed caption mode	CLOSED CAPTION/TELETEXT / DVD TEXT / TELETEXT / TTX
Audio control		
KEY_AUDIO	Change audio source	AUDIO SOURCE / AUDIO / MUSIC
KEY_MUTE	Mute/unmute audio	MUTE / DEMUTE / UNMUTE
KEY_VOLUMEDOWN	Decrease volume	VOLUME- / VOLUME DOWN
KEY_VOLUMEUP	Increase volume	VOLUME+ / VOLUME UP
KEY_MODE	Change sound mode	MONO/STEREO
KEY_LANGUAGE	Select Language	1ST / 2ND LANGUAGE / DVD LANG / MTS/SAP / MTS SEL
Channel control		
KEY_CHANNEL	Go to the next favorite channel	ALT / CHANNEL / CH SURFING / SURF / FAV
KEY_CHANNELDOWN	Decrease channel sequentially	CHANNEL - / CHANNEL DOWN / DOWN
KEY_CHANNELUP	Increase channel sequentially	CHANNEL + / CHANNEL UP / UP
KEY_DIGITS	Use more than one digit for channel	PLUS / 100/ 1xx / xxx / -/-- / Single Double Triple Digit
KEY_SEARCH	Start channel autoscanner	SCAN / AUTOSCAN
Colored keys		
KEY_BLUE	IR Blue key	BLUE
KEY_GREEN	IR Green Key	GREEN

KEY_RED	IR Red key	RED
KEY_YELLOW	IR Yellow key	YELLOW
Media selection		
KEY_CD	Change input source to Compact Disc	CD
KEY_DVD	Change input to DVD	DVD / DVD MENU
KEY_EJECTCLOSECD	Open/close the CD/DVD player	->) / CLOSE / OPEN
KEY_MEDIA	Turn on/off Media application	PC/TV / TURN ON/OFF APP
KEY_PC	Selects from TV to PC	PC
KEY_RADIO	Put into AM/FM radio mode	RADIO / TV/FM / TV/RADIO / FM / FM/RADIO
KEY_TV	Select tv mode	TV / LIVE TV
KEY_TV2	Select Cable mode	AIR/CBL
KEY_VCR	Select VCR mode	VCR MODE / DTR
KEY_VIDEO	Alternate between input modes	SOURCE / SELECT / DISPLAY / SWITCH INPUTS / VIDEO
Power control		
KEY_POWER	Turn on/off computer	SYSTEM POWER / COMPUTER POWER
KEY_POWER2	Turn on/off application	TV ON/OFF / POWER
KEY_SLEEP	Activate sleep timer	SLEEP / SLEEP TIMER
KEY_SUSPEND	Put computer into suspend mode	STANDBY / SUSPEND
Window control		
KEY_CLEAR	Stop sroweam and return to default input video/audio	CLEAR / RESET / BOSS KEY
KEY_CYCLEWINDOWS	Minimize windows and move to the next one	ALT-TAB / MINIMIZE / DESKTOP
KEY_FAVORITES	Open the favorites sroweam window	TV WALL / Favorites

KEY_MENU	Call application menu	2ND CONTROLS (USA: MENU) / DVD/MENU / SHOW/HIDE CTRL
KEY_NEW	Open/Close Picture in Picture	PIP
KEY_OK	Send a confirmation code to application	OK / ENTER / RETURN
KEY_SCREEN	Select screen aspect ratio	4:3 16:9 SELECT
KEY_ZOOM	Put device into zoom/full screen mode	ZOOM / FULL SCREEN / ZOOM+ / HIDE PANNEL / SWITCH
Navigation keys		
KEY_ESC	Cancel current operation	CANCEL / BACK
KEY_HELP	Open a Help window	HELP
KEY_HOMEPAGE	Navigate to Homepage	HOME
KEY_INFO	Open On Screen Display	DISPLAY INFORMATION / OSD
KEY_WWW	Open the default browser	WEB
KEY_UP	Up key	UP
KEY_DOWN	Down key	DOWN
KEY_LEFT	Left key	LEFT
KEY_RIGHT	Right key	RIGHT
Miscellaneous keys		
KEY_DOT	Return a dot	.
KEY_FN	Select a function	FUNCTION

It should be noticed that, sometimes, there some fundamental missing keys at some cheaper IR's. Due to that, it is recommended to:

Table 17-2. Notes

On simpler IR's, without separate channel keys, you need to map UP as

KEY_CHANNELUP

On simpler IR's, without separate channel keys, you need to map DOWN as

KEY_CHANNELDOWN

On simpler IR's, without separate volume keys, you need to map LEFT as
KEY_VOLUMEDOWN

On simpler IR's, without separate volume keys, you need to map RIGHT as
KEY_VOLUMEUP

17.2. Changing default Remote Controller mappings

The event interface provides two ioctls to be used against the /dev/input/event device, to allow changing the default keymapping.

This program demonstrates how to replace the keymap tables.

```
/* keytable.c - This program allows checking/replacing keys at IR
   Copyright (C) 2006-2009 Mauro Carvalho Chehab <mchehab@infradead.org>

   This program is free software; you can redistribute it and/or modify
   it under the terms of the GNU General Public License as published by
   the Free Software Foundation, version 2 of the License.

   This program is distributed in the hope that it will be useful,
   but WITHOUT ANY WARRANTY; without even the implied warranty of
   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
   GNU General Public License for more details.
*/

#include <ctype.h>
#include <errno.h>
#include <fcntl.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <linux/input.h>
#include <sys/ioctl.h>

#include "parse.h"

void prtcode (int *codes)
{
    struct parse_key *p;

    for (p=keynames;p->name!=NULL;p++) {
```


17.3. LIRC Device Interface

17.3.1. Introduction

The LIRC device interface is a bi-directional interface for transporting raw IR data between userspace and kernelspace. Fundamentally, it is just a chardev (/dev/lircX, for X = 0, 1, 2, ...), with a number of standard struct file operations defined on it. With respect to transporting raw IR data to and fro, the essential fops are read, write and ioctl.

Example dmesg output upon a driver registering w/LIRC:

```
$ dmesg |grep lirc_dev
lirc_dev: IR Remote Control driver registered, major 248
rc rc0: lirc_dev: driver ir-lirc-codec (mceusb) registered at minor = 0
```

What you should see for a chardev

```
$ ls -l /dev/lirc*
```

```
crw-rw---- 1 root root 248, 0 Jul 2 22:20 /dev/lirc0
```

17.3.2. LIRC read fop

The lircd userspace daemon reads raw IR data from the LIRC chardev. The exact format of the data depends on what modes a driver supports, and what mode has been selected. lircd obtains supported modes and sets the active mode via the ioctl interface, detailed at Section 17.3.4. The generally preferred mode is LIRC_MODE_MODE2, in which packets containing an int value describing an IR signal are read from the chardev.

```
/* Get scancode table */
```

See also <http://www.lirc.org/html/technical.html> for more info.

```
for (i = 0; i < 256; i++) {
    codes[0] = (j << 8) | i;
    if (!ioctl(fd, EVIOCGKEYCODE, codes) && codes[1]
        prtcodes(codes);
}
```

17.3.3. LIRC write fop

The data written to the chardev is a pulse/space sequence of integer values. Pulses and spaces are only marked implicitly by their position. The data must start and end with a pulse, therefore, the data must always include an uneven number of samples. The write function must block until the data has been transmitted by the hardware.

17.3.4. LIRC ioctl top

Some devices have internal timers that can be used to detect when there's no IR activity for a long time. This can help lircd in detecting that a IR signal is finished and can speed up the decoding process. Returns an integer value with unsigned long for the arg. For the purposes of ioctl portability across 32-bit and 64-bit, these values are capped to their 32-bit sizes.

The following ioctls can be used to change specific hardware settings. In general each driver should have a default set of settings. The driver implementation is expected to apply the default settings if the device is closed by user-space, so that every application opening the device can rely on working with the default settings initially.

LIRC_GET_MIN_PULSE_SPACE
Get the minimum pulse space. Some devices are able to filter out spikes in the incoming signal using given filter rules. These ioctls return the hardware capabilities that describe the bounds of the possible filters. Filter settings depend on the IR protocols that are expected. lircd derives the settings from all protocols definitions found in its config file.

LIRC_GET_FEATURES
Obviously, get the underlying hardware device's features. If a driver does not announce support of certain features, calling of the corresponding ioctls is undefined.

LIRC_GET_LENGTH
Retrieves the code length in bits (only for LIRC_MODE_LIRCCODE). Reads on the device must be done in blocks matching the bit count. The bit could should be rounded up so that it matches full bytes.

LIRC_GET_SEND_MODE
Get supported transmit mode. Only LIRC_MODE_PULSE is supported by lircd.

LIRC_SET_{SEND,REC}_MODE
Set send/receive mode. Largely obsolete for send, as only LIRC_MODE_PULSE is supported. Get supported receive mode. Only LIRC_MODE_MODE2 and LIRC_MODE_LIRCCODE are supported by lircd.

LIRC_SET_{SEND,REC}_CARRIER
Set send/receive carrier (in Hz).
Get carrier frequency (in Hz) currently used for transmit.

LIRC_SET_TRANSMITTER_MASK
This enables the given set of transmitters. The first transmitter is encoded by the least significant bit (i.e. 1). When an invalid bit mask is given, i.e. a bit is set, even though the device does not have so many transmitters, then this ioctl returns the number of available transmitters and does nothing otherwise.

LIRC_GET_REC_CARRIER
Get/set the duty cycle (from 0 to 100) of the carrier signal. Currently, no special meaning is defined for 0 or 100, but this could be used to switch off the integration for IR inactive timeouts (should be reserved).

LIRC_SET_{SEND,REC}_DUTY_CYCLE
LIRC_GET_MIN_TIMEOUT and LIRC_GET_MAX_TIMEOUT). A value of 0 (if supported by the hardware) disables all hardware timeouts and data should be reported as soon as possible. If the exact value cannot be set, then the next possible value, greater, than the given value should be set.

LIRC_SET_REC_TIMEOUT
Some receiver have maximum resolution which is defined by internal sample rate or data format limitations. E.g. it's common that signals can only be reported in 50 microsecond steps. This integer value is used by lircd to automatically adjust the aeps tolerance value in the lircd config file.

LIRC_GET_REC_RESOLUTION
LIRC_SET_REC_TIMEOUT REPORTS

LIRC_GET_REC_RESOLUTION
LIRC_SET_REC_TIMEOUT REPORTS

LIRC_SET_REC_TIMEOUT REPORTS

LIRC_SET_REC_TIMEOUT REPORTS

Disabled (1) or disabled (0) disable carrier reports in LIRC_MODE1 and LIRC_MODE2. By default, while carrier reports should be active will do nothing.

LIRC_SET_REC_FILTER_{,PULSE,SPACE}

Pulses/spaces shorter than this are filtered out by hardware. If filters cannot be set independently for pulse/space, the corresponding ioctls must return an error and LIRC_SET_REC_FILTER shall be used instead.

LIRC_SET_MEASURE_CARRIER_MODE

Enable (1)/disable (0) measure mode. If enabled, from the next key press on, the driver will send LIRC_MODE2_FREQUENCY packets. By default this should be turned off.

LIRC_SET_REC_{DUTY_CYCLE,CARRIER}_RANGE

To set a range use

LIRC_SET_REC_DUTY_CYCLE_RANGE/LIRC_SET_REC_CARRIER_RANGE
with the lower bound first and later
LIRC_SET_REC_DUTY_CYCLE/LIRC_SET_REC_CARRIER with the
upper bound.

LIRC_NOTIFY_DECODE

This ioctl is called by lircd whenever a successful decoding of an incoming IR signal could be done. This can be used by supporting hardware to give visual feedback to the user e.g. by flashing a LED.

LIRC_SETUP_{START,END}

Setting of several driver parameters can be optimized by encapsulating the according ioctl calls with LIRC_SETUP_START/LIRC_SETUP_END. When a driver receives a LIRC_SETUP_START ioctl it can choose to not commit further setting changes to the hardware until a LIRC_SETUP_END is received. But this is open to the driver implementation and every driver must also handle parameter changes which are not encapsulated by LIRC_SETUP_START and LIRC_SETUP_END. Drivers can also choose to ignore these ioctls.

LIRC_SET_WIDEBAND_RECEIVER

Some receivers are equipped with special wide band receiver which is intended to be used to learn output of existing remote. Calling that ioctl with (1) will enable it, and with (0) disable it. This might be useful of receivers that have otherwise narrow band receiver that prevents them to be used with some remotes. Wide band receiver might also be more precise On the other hand its disadvantage it usually reduced range of reception. Note: wide band receiver might be implicitly enabled if you enable carrier reports. In that case it will be

IV. Media Controller API

Table of Contents

18. Media Controller.....	??
F. Function Reference.....	??

Revision History

Revision 1.0.0 2010-11-10 Revised by: lp
Initial revision

Chapter 18. Media Controller

18.1. Introduction

Media devices increasingly handle multiple related functions. Many USB cameras include microphones, video capture hardware can also output video, or SoC camera interfaces also perform memory-to-memory operations similar to video codecs.

Independent functions, even when implemented in the same hardware, can be modelled as separate devices. A USB camera with a microphone will be presented to userspace applications as V4L2 and ALSA capture devices. The devices' relationships (when using a webcam, end-users shouldn't have to manually select the associated USB microphone), while not made available directly to applications by the drivers, can usually be retrieved from sysfs.

With more and more advanced SoC devices being introduced, the current approach will not scale. Device topologies are getting increasingly complex and can't always be represented by a tree structure. Hardware blocks are shared between different functions, creating dependencies between seemingly unrelated devices.

Kernel abstraction APIs such as V4L2 and ALSA provide means for applications to access hardware parameters. As newer hardware expose an increasingly high number of those parameters, drivers need to guess what applications really require based on limited information, thereby implementing policies that belong to userspace.

The media controller API aims at solving those problems.

18.2. Media device model

Discovering a device internal topology, and configuring it at runtime, is one of the goals of the media controller API. To achieve this, hardware devices are modelled as an oriented graph of building blocks called entities connected through pads.

An entity is a basic media hardware or software building block. It can correspond to a large variety of logical blocks such as physical hardware devices (CMOS sensor for instance), logical hardware devices (a building block in a System-on-Chip image processing pipeline), DMA channels or physical connectors.

A pad is a connection endpoint through which an entity can interact with other entities. Data (not restricted to video) produced by an entity flows from the entity's output to one or more entity inputs. Pads should not be confused with physical pins at chip boundaries.

A link is a point-to-point oriented connection between two pads, either on the same entity or on different entities. Data flows from a source pad to a sink pad.

Appendix F. Function Reference

media open()

Name

`media-open` — Open a media device

Synopsis

```
#include <fcntl.h>
int open(const char *device_name, int flags);
```

Arguments

device_name

Device to be opened.

flags

Open flags. Access mode must be either `O_RDONLY` or `O_RDWR`. Other flags have no effect.

Description

To open a media device applications call `open()` with the desired device name. The function has no side effects; the device configuration remain unchanged.

When the device is opened in read-only mode, attempts to modify its configuration will result in an error, and `errno` will be set to `EBADF`.

Return Value

`open` returns the new file descriptor on success. On error, -1 is returned, and `errno` is set appropriately. Possible error codes are:

File descriptor returned by `open()`.

EACCES

The requested access to the file is not allowed.

Description

EMFILE

Closes the media device. Resources associated with the file descriptor are freed.

The process already has the maximum number of files open.
The device configuration remain unchanged.

ENFILE

The system limit on the total number of open files has been reached.

Return Value

ENOMEM

`close` returns 0 on success. On error, -1 is returned, and `errno` is set appropriately.

Possible error codes are:
Insufficient kernel memory was available.

ENXIO

EBADF

No device corresponding to this device special file exists.
`fd` is not a valid open file descriptor.

media_close()

Name

`media_close = Close a media device`

Synopsis

```
#include <sys/types.h>
int close(int fd); int request, void *argp);
```

Arguments

The *request* or the data pointed to by *argp* is not valid. This is a very common error code, see the individual ioctl requests listed in Appendix F for actual causes.

File descriptor returned by `open()`.

ENOMEM

request

Insufficient kernel memory was available to complete the request.

Media ioctl request code as defined in the `media.h` header file, for example

ENOENT MEDIA_IOC_SETUP_LINK.

fd is not associated with a character special device.

argp

Pointer to a request-specific structure.

ioctl MEDIA_IOC_DEVICE_INFO

The `ioctl()` function manipulates media device parameters. The argument *fd* must be an open file descriptor.

Name

The ioctl *request* code specifies the media function to be called. It has encoded in `MEDIA_IOC_DEVICE_INFO` whether the argument is an input, output or read/write parameter, and the size of the argument *argp* in bytes.

Synopsis

Macros and structures definitions specifying media ioctl requests and their parameters are located in the `media.h` header file. All media ioctl requests, their respective function and parameters are specified in Appendix F.

```
int ioctl(int fd, int request, struct media_device_info
          *argp);
```

Return Value

`ioctl()` returns 0 on success. On failure, -1 is returned, and the `errno` variable is set appropriately. Generic error codes are listed below, and request-specific error codes are listed in the individual requests descriptions.

Arguments

When an ioctl that takes an output or read/write parameter fails, the parameter remains unmodified.

File descriptor returned by `open()`.

EINVAL

fd is not a valid open file descriptor.

EFAULT

argp references an inaccessible memory area.

Description

All media devices must support the `MEDIA_IOC_DEVICE_INFO` ioctl. To query device information, applications call the ioctl with a pointer to a struct `media_device_info`. The driver fills the structure and returns the information to the application. The ioctl never fails.

Table F-1. struct media_device_info

char	<i>driver</i> [16]	Name of the driver implementing the media API as a NUL-terminated ASCII string. The driver version is stored in the <i>driver_version</i> field. Driver specific applications can use this information to verify the driver identity. It is also useful to work around known bugs, or to identify drivers in error reports.
char	<i>model</i> [32]	Device model name as a NUL-terminated UTF-8 string. The device version is stored in the <i>device_version</i> field and is not be appended to the model name.
char	<i>serial</i> [40]	Serial number as a NUL-terminated ASCII string.
char	<i>bus_info</i> [32]	Location of the device in the system as a NUL-terminated ASCII string. This includes the bus type name (PCI, USB, ...) and a bus-specific identifier.
__u32	<i>media_version</i>	Media API version, formatted with the <code>KERNEL_VERSION()</code> macro.
__u32	<i>hw_revision</i>	Hardware device revision in a driver-specific format.
__u32	<i>media_version</i>	Media device driver version, formatted with the <code>KERNEL_VERSION()</code> macro. Together with the <i>driver</i> field this identifies a particular driver.
__u32	<i>reserved</i> [31]	Reserved for future extensions. Drivers and applications must set this array to zero.

The *serial* and *bus_info* fields can be used to distinguish between multiple

instances of otherwise identical hardware. The serial number takes precedence when provided and can be assumed to be unique. If the serial number is an empty string, the *bus_info* field can be used instead. The *bus_info* field is guaranteed to be unique, but can vary across reboots or device unplug/replug.

Return value

This function doesn't return specific error codes.

ioctl MEDIA_IOC_ENUM_ENTITIES

Name

MEDIA_IOC_ENUM_ENTITIES — Enumerate entities and their properties

Synopsis

```
int ioctl(int fd, int request, struct media_entity_desc
*argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

MEDIA_IOC_ENUM_ENTITIES

argp

Description

To query the attributes of an entity, applications set the `id` field of a `struct media_entity_desc` structure and call the `MEDIA_IOC_ENUM_ENTITIES` ⁵⁷⁷ `ioctl` with a pointer to this structure. The driver fills the rest of the structure or returns an `EINVAL` error code when the `id` is invalid.

Appendix F. Function Reference

__u32	<i>revision</i>			Entity revision in a driver/hardware specific format.
__u32	<i>flags</i>			Entity flags, see Table F-3 for details.
__u32	<i>group_id</i>			Entity group ID
__u16	<i>pads</i>			Number of pads
__u16	<i>links</i>			Total number of outbound links. Inbound links are not counted in this field.
union				
	<i>struct</i>	<i>v4l</i>		Valid for V4L sub-devices and nodes only.
		__u32	<i>major</i>	V4L device node major number. For V4L sub-devices with no device node, set by the driver to 0.
		__u32	<i>minor</i>	V4L device node minor number. For V4L sub-devices with no device node, set by the driver to 0.

struct	<i>fb</i>		Valid for frame buffer nodes only.
	__u32	<i>major</i>	Frame buffer device node major number.
	__u32	<i>minor</i>	Frame buffer device node minor number.
struct	<i>alsa</i>		Valid for ALSA devices only.
	__u32	<i>card</i>	ALSA card number
	__u32	<i>device</i>	ALSA device number
	__u32	<i>subdevice</i>	ALSA sub-device number
int	<i>dvb</i>		DVB card number
__u8	<i>raw[180]</i>		

Table F-2. Media entity types

<code>MEDIA_ENT_T_DEVNODE</code>	Unknown device node
<code>MEDIA_ENT_T_DEVNODE_V4L</code>	V4L video, radio or vbi device node
<code>MEDIA_ENT_T_DEVNODE_FB</code>	Frame buffer device node
<code>MEDIA_ENT_T_DEVNODE_ALSA</code>	ALSA card
<code>MEDIA_ENT_T_DEVNODE_DVB</code>	DVB card
<code>MEDIA_ENT_T_V4L2_SUBDEV</code>	Unknown V4L sub-device
<code>MEDIA_ENT_T_V4L2_SUBDEV_SENSOR</code>	Video sensor
<code>MEDIA_ENT_T_V4L2_SUBDEV_FLASH</code>	Flash controller
<code>MEDIA_ENT_T_V4L2_SUBDEV_LENS</code>	Lens controller

Table F-3. Media entity flags

`MEDIA_ENT_FL_DEFAULT`

Default entity for its type. Used to discover the default audio, VBI and video devices, the default camera sensor, ...

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

`EINVAL`

The struct `media_entity_desc` *id* references a non-existing entity.

ioctl MEDIA_IOC_ENUM_LINKS

Name

`MEDIA_IOC_ENUM_LINKS` — Enumerate all pads and links for a given entity

Synopsis

```
int ioctl(int fd, int request, struct media_links_enum *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

`MEDIA_IOC_ENUM_LINKS`

argp

Description

To enumerate pads and/or links for a given entity, applications set the `entity` field of a struct `media_links_enum` structure and initialize the struct `media_pad_desc` and struct `media_link_desc` structure arrays pointed by the `pads` and `links` fields. They then call the `MEDIA_IOC_ENUM_LINKS` ioctl with a pointer to this structure.

If the `pads` field is not NULL, the driver fills the `pads` array with information about the entity's pads. The array must have enough room to store all the entity's pads. The number of pads can be retrieved with the `MEDIA_IOC_ENUM_ENTITIES` ioctl.

If the `links` field is not NULL, the driver fills the `links` array with information about the entity's outbound links. The array must have enough room to store all the entity's outbound links. The number of outbound links can be retrieved with the `MEDIA_IOC_ENUM_ENTITIES` ioctl.

Only forward links that originate at one of the entity's source pads are returned during the enumeration process.

Table F-1. struct media_links_enum

<code>__u32</code>	<i>entity</i>	Entity id, set by the application.
struct struct media_pad_desc	<i>*pads</i>	Pointer to a pads array allocated by the application. Ignored if NULL.
struct struct media_link_desc	<i>*links</i>	Pointer to a links array allocated by the application. Ignored if NULL.

Table F-2. struct media_pad_desc

<code>__u32</code>	<i>entity</i>	ID of the entity this pad belongs to.
<code>__u16</code>	<i>index</i>	0-based pad index.
<code>__u32</code>	<i>flags</i>	Pad flags, see Table F-3 for more details.

Table F-3. Media pad flags

<code>MEDIA_PAD_FL_SINK</code>	Input pad, relative to the entity. Input pads sink data and are targets of links.
<code>MEDIA_PAD_FL_SOURCE</code>	Output pad, relative to the entity. Output pads source data and are origins of links.

Table F-4. struct media_links_desc

<code>struct struct media_links_desc</code>	<code>source</code>	Pad at the origin of this link.
<code>struct struct media_links_desc</code>	<code>sink</code>	Pad at the target of this link.
<code>__u32</code>	<code>flags</code>	Link flags, see Table F-5 for more details.

Table F-5. Media link flags

<code>MEDIA_LNK_FL_ENABLED</code>	The link is enabled and can be used to transfer media data. When two or more links target a sink pad, only one of them can be enabled at a time.
<code>MEDIA_LNK_FL_IMMUTABLE</code>	The link enabled state can't be modified at runtime. An immutable link is always enabled.
<code>MEDIA_LNK_FL_DYNAMIC</code>	The link enabled state can be modified during streaming. This flag is set by drivers and is read-only for applications.

One and only one of `MEDIA_PAD_FL_SINK` and `MEDIA_PAD_FL_SOURCE` must be set for every pad.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The struct `media_links_enum` *id* references a non-existing entity.

Link configuration has no side effect on other links. If an enabled link at the sink pad prevents the link from being enabled, the driver returns with an EBUSY error code.

ioctl MEDIA_IOC_SETUP_LINK

Only links marked with the `ENABLED` link flag can be enabled/disabled while streaming media data. Attempting to enable or disable a streaming non-dynamic link will return an EBUSY error code.

If the specified link can't be found the driver returns with an EINVAL error code.

Name

`MEDIA_IOC_SETUP_LINK` — Modify the properties of a link

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

Synopsis

EBUSY

The link properties can't be changed because the link is currently busy. This can be caused, for instance, by an active media stream (audio or video) on the link. The ioctl shouldn't be retried if no other action is performed before to fix the problem.

EINVAL

Arguments

The struct `media_link_desc` references a non-existing link, or the link is immutable and an attempt to modify its configuration was made.

fd

File descriptor returned by `open()`.

request

`MEDIA_IOC_SETUP_LINK`

argp

Description

To change link properties applications fill a struct `media_link_desc` with link identification information (source and sink pad) and the new requested link flags. They then call the `MEDIA_IOC_SETUP_LINK` ioctl with a pointer to that structure.

The only configurable property is the `ENABLED` link flag to enable/disable a link. Links marked with the `IMMUTABLE` link flag can not be enabled or disabled.

Appendix G. GNU Free Documentation License

G.1. 0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other written document “free” in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or noncommercially. Secondly, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of “copyleft”, which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

G.2. 1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. The “Document”, below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as “you”.

A “Modified Version” of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A “Secondary Section” is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document’s overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (For example, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical

conception without subjecting it to a dated matter, of copies, or must add, follow philosophical in section 3 political position regarding them.

The may also add copies under the Secondary Sections of above and you may published, play copies of Invariant Sections, in the notice that says that the Document is released under this License.

The “Cover Texts” are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License.

G.4. 3. COPYING IN QUANTITY

If you publish printed copies of the Document numbering more than 100, and the Document’s license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts; Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects”.

If the required texts for either cover are too voluminous to fit legibly, you should put them into adjacent pages. Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML designed for human modification. Opaque formats include PostScript, PDF, proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML produced by some word processors for output purposes only. If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a publicly accessible machine-readable network location containing a complete Transparent copy of the Document, free of added material, which the general network-using public has access to download anonymously at no charge using public standard network protocols. The “Title Page” means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, “Title Page” means the text near the most prominent appearance of the work’s title, preceding the beginning of the body of the text. If you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

G.3. 2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license

G.5. 4. MODIFICATIONS

notice (your rights, license and notice to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical means to restrict copying of the Document. You may make copies of the Document in any medium, provided that you capture as the Modified change

Version of this License. Invariant Sections with the Document, and the Document's Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has less than five). These titles must be distinct from any other section titles.

- **M.** Delete any section entitled “Endorsements”. Such a section may not be included in the Modified Version.
- **A.** Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a
- **N.** Do not retitle any existing section as “Endorsements”, or to conflict in title, with any Invariant Section.

If the Modified Version includes new front matter sections or appendices that

- **B.** List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has less than five). These titles must be distinct from any other section titles.

You may add a section entitled “Endorsements”, provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the

- **D.** Preserve all the copyright notices of the Document.

You may add an appropriate copyright notice for your modifications, adjacent to the other copyright notices.

Modified Version, only by a passage of Front-Cover Text, and some of Back-Cover Text, to the end of the list of Cover Texts in the

Document already in the Document, for the same cover, previously added by you, or by arrangement made by the same entity you are acting on behalf of, you

- **G.** Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.
- **H.** Include an unaltered copy of this License.

The author(s) and publisher(s) of the Document do not by this License give

- **I.** Preserve the section entitled “History”, and its title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section entitled “History” in the

Document, create one stating the title, year, authors, and publisher of the

Document as given on its Title Page, then add an item describing the Modified

G.6. 5. COMBINING DOCUMENTS

- **J.** Preserve the network location, if any, given in the Document for public access. You may combine the Document with other documents released under this License, to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the “History” section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.

The combined work need only contain one copy of this License, and multiple

- **K.** In any section entitled “Acknowledgements” or “Dedications”, preserve the identical Invariant Sections may be replaced with a single copy. If there are multiple section's title, and preserve in the section all the substance and tone of each of the Invariant Sections with the same name but different contents, make the title of each contributor acknowledgements and/or dedications given therein.

such section unique by adding at the end of it, in parentheses, the name of the

G.9. 8. TRANSLATION

original publisher of the section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with In the combination, you must combine any sections entitled "History" in the various translations requires special permission from their copyright holders, but you may original documents, forming one section entitled "History"; likewise combine any include translations of some or all Invariant Sections in addition to the original, sections entitled "Acknowledgements", and any sections entitled "Dedications". versions of these Invariant Sections. You may include a translation of this License You must delete all sections entitled "Endorsements".

provided that you also include the original English version of this License. In case of a disagreement between the translation and the original English version of this License, the original English version will prevail.

G.7. 6. COLLECTIONS OF DOCUMENTS

G.10. 9. TERMINATION

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided You may not copy, modify, sublicense, or distribute the Document except as that you follow the rules of this License for verbatim copying of each of the expressly provided for under this License. Any other attempt to copy, modify, sublicense or distribute the Document is void, and will automatically terminate your documents in all other respects.

rights under this License. However, parties who have received copies, or rights, You may extract a single document from such a collection, and distribute it from you under this License will not have their licenses terminated so long as such individually under this License, provided you insert a copy of this License into the parties remain in full compliance.

extracted document, and follow this License in all other respects regarding verbatim copying of that document.

G.11. 10. FUTURE REVISIONS OF THIS LICENSE

G.10. 9. AGGREGATION WITH INDEPENDENT WORKS

The Free Software Foundation (<http://www.gnu.org/fsf/fsf.html>) may publish new, revised versions of the GNU Free Documentation License from time to time. Such A compilation of the Document or its derivatives with other separate and new versions will be similar in spirit to the present version, but may differ in detail independent documents or works, in or on a volume of a storage or distribution to address new problems or concerns. See <http://www.gnu.org/copyleft/> medium, does not as a whole count as a Modified Version of the Document, (<http://www.gnu.org/copyleft/>), provided no compilation copyright is claimed for the compilation. Such a

Each version of the License is an "aggregate", and this License does not apply to the other Document-specific works thus compiled with the Document, for this account of their being version applies if they you have the option of following the terms of the Document. If the Cover Text requirement of section 3 is applicable to these copies of the Document as then it by the Document is less than one quarter of the entire aggregate, the Document's Cover Text may be placed on covers that surround only the Document within the aggregate. Otherwise they must appear on covers around the whole aggregate.

G.12. Addendum

To use this License in a document you have written, include a copy of the License in the document and put the following copyright and license notices just after the title page:

Copyright © YEAR YOUR NAME.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.1 or any later version published by the Free Software Foundation; with the **Invariant Sections** being LIST THEIR TITLES, with the **Front-Cover Texts** being LIST, and with the **Back-Cover Texts** being LIST. A copy of the license is included in the section entitled “GNU Free Documentation License”.

If you have no **Invariant Sections**, write “with no Invariant Sections” instead of saying which ones are invariant. If you have no **Front-Cover Texts**, write “no Front-Cover Texts” instead of “Front-Cover Texts being LIST”; likewise for **Back-Cover Texts**.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License (<http://www.gnu.org/copyleft/gpl.html>), to permit their use in free software.

