Video for Linux Two API Specification

Draft 0.12

Michael H Schimek

mschimek@gmx.at

Bill Dirks

Hans Verkuil

Video for Linux Two API Specification: Draft 0.12

by Michael H Schimek, Bill Dirks, and Hans Verkuil

Revision History

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 contributed a VIDIOC_LOC
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 and user pointer i/o to video cap
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 in the history chapter.
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.

Table of Contents

List of Tables

Introduction

[to do]

If you have questions or ideas regarding the API, please try the Video4Linux mailing list: https://listman.redhat.com/mailman/listinfo/video4linux-list

For documentation related requests contact the maintainer at mschimek@gmx.at (mailto:mschimek@gmx.at).

The latest version of this document and the DocBook SGML sources is currently hosted at http://v4l2spec.bytesex.org, and http://linuxtv.org/downloads/video4linux/API/V4L2_API.

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 recomended 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 problems[3], 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 Video4Linux mailing list: https://listman.redhat.com/mailman/listinfo/video4linux-list.

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 reliable 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 ioctls when the device has one or more inputs, all the output ioctls 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 *audioset* 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` 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_TUNER` (sic) 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.

1.6.4. Satellite Receivers

To be discussed. See also proposals by Peter Schlaf, video4linux-list@redhat.com on 23 Oct 2002, subject: "Re: [V4L] Re: v4l2 api".

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 hypothetic 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_ENUM_INPUT");
        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);
}
```

1.8. 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_BRIGHTNESS`	integer	Picture brightness, or more precisely, the black level. Will not turn up the intelligence of the program you're watching.
`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.
`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.

ID	Type	Description
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). [?]
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.
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.
V4L2_CID_HCENTER	integer	Horizontal image centering.
V4L2_CID_VCENTER	integer	Vertical image centering. Centering is intended to *physically* adjust cameras. For image cropping see Section 1.10>, for clipping Section 4.2>.
V4L2_CID_LASTP1		End of the predefined control IDs (currently V4L2_CID_VCENTER + 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);
                } else {
                        perror ("VIDIOC_QUERYMENU");
                        exit (EXIT_FAILURE);
                }
        }
}

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 {
                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. Data Formats

1.9.1. 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.

1.9.2. 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.

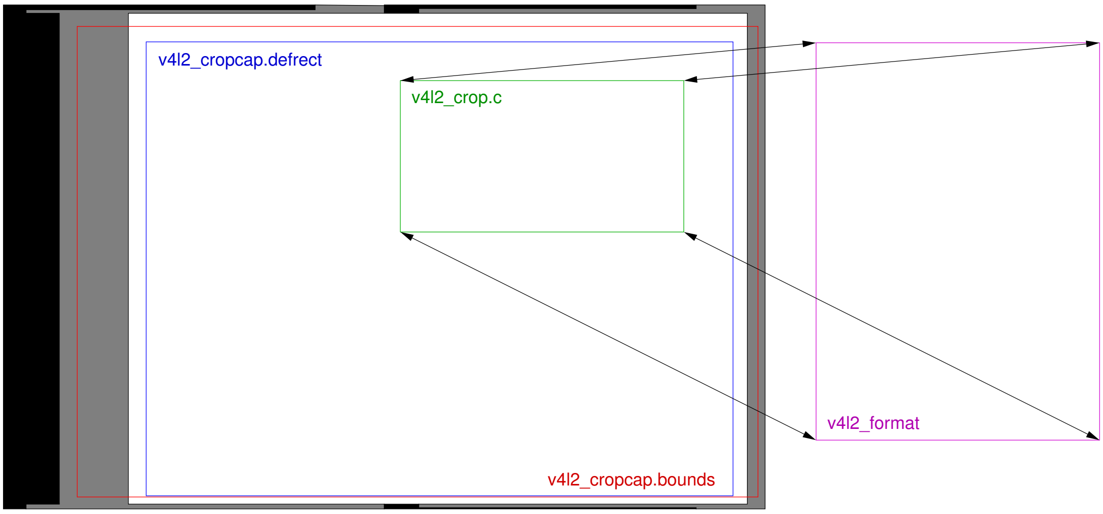
> **Important:** Drivers are not supposed to convert image formats in kernel space. They must enumerate only formats directly supported by the hardware. If necessary driver writers should publish an example conversion routine or library for integration into applications.

1.10. Cropping and Scaling

Some video capture devices can take a subsection of the complete picture and shrink or enlarge to an image of arbitrary size. We call these abilities cropping and scaling. Not quite correct "cropping" shall also refer to the inverse process, output devices showing an image in only a region of the picture, and/or scaled from a source image of different size.

To crop and scale this API defines a source and target rectangle. On a video capture and overlay device the source is the received video picture, the target is the captured or overlaid image. On a video output device the source is the image passed by the application and the target is the generated video picture. The remainder of this section refers only to video capture drivers, the definitions apply to output drivers accordingly.

Figure 1-1. Cropping and Scaling



It is assumed the driver can capture a subsection of the picture within an arbitrary capture window. Its bounds are defined by struct v4l2_cropcap, giving the coordinates of the top, left corner and width and height of the window in pixels. Origin and units of the coordinate system in the analog domain are arbitrarily chosen by the driver writer.[12]

The source rectangle is defined by struct v4l2_crop, giving the coordinates of its top, left corner, width and height using the same coordinate system as struct v4l2_cropcap. The source rectangle must lie completely within the capture window. Further each driver defines a default source rectangle. 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. The source rectangle is set to the default when the driver is first loaded, but not later.

The target rectangle is given either by the `width` and `height` fields of struct v4l2_pix_format or the `width` and `height` fields of the struct v4l2_rect `w` substructure of struct v4l2_window.

In principle cropping and scaling always happens. When the device supports scaling but not cropping, applications will be unable to change the cropping rectangle. It remains at the defaults all the time. When the device supports cropping but not scaling, changing the image size will also affect the cropping size in order to maintain a constant scaling factor. The position of the cropping rectangle is only adjusted to move the rectangle completely inside the capture window.

When cropping and scaling is supported applications can change both the source and target rectangle. Various hardware limitations must be expected, for example discrete scaling factors, different scaling abilities in horizontal and vertical direction, limitations of the image size or the cropping alignment. Therefore as usual drivers adjust the requested parameters against hardware capabilities and return the actual values selected. An important difference, because two rectangles are defined, is that the last rectangle changed shall take priority, and the driver may also adjust the opposite rectangle.

Suppose scaling is restricted to a factor 1:1 or 2:1 in either direction and the image size must be a multiple of 16 × 16 pixels. The cropping rectangle be set to the upper limit, 640 × 400 pixels at offset 0, 0. Let a video capture application request an image size of 300 × 225 pixels, assuming video will be scaled down from the "full picture" accordingly. The driver will set the image size to the closest possible values 304 × 224, then choose the cropping rectangle closest to the requested size, that is 608 × 224 (224 × 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 an aspect closer to the original request. Sheepish 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 accordingly adjusts the image size to 304 × 192.

Eventually some crop or scale parameters are locked, for example when the driver supports simultaneous video capturing and overlay, another application already started overlay and the cropping parameters cannot be changed anymore. Also `VIDIOC_TRY_FMT` cannot change the cropping rectangle. In these cases the driver has to approach the closest values possible without adjusting the opposite rectangle.

The struct v4l2_cropcap, which also reports the pixel aspect ratio, can be obtained with the `VIDIOC_CROPCAP` ioctl. To get or set the current cropping rectangle applications call the `VIDIOC_G_CROP` or `VIDIOC_S_CROP` ioctl, respectively. All video capture and output devices must support the `VIDIOC_CROPCAP` ioctl. The `VIDIOC_G_CROP` and `VIDIOC_S_CROP` ioctls only when the cropping rectangle can be changed.

Note as usual the cropping parameters remain unchanged across closing and reopening a device. Applications should ensure the parameters are suitable before starting I/O.

Example 1-10. Resetting the cropping parameters

(A video capture device is assumed.)

```
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 now what we got, the exact scaling factor
   or if the driver can scale at all. At mere 2:1 the cropping
   rectangle was probably not changed. */
```

Example 1-12. 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);
}

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;

/* Aspect corrected display size */

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

1.11. 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 unneccessary 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, we must ensure device numbers cannot change with 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 are used which compete for the same minor numbers.
2. In earlier versions of the V4L2 API the module options where 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 reliable find related devices. For once names are arbitrary, they can be chosen freely by the system administrator. Also when there are multiple devices and only some support VBI capturing, say, `/dev/video2` is not necessarily related to `/dev/vbi2`. We already noted finding devices by name or minor number is unreliable, accordingly useful is the ioctl offered by V4L to query the minor numbers of related devices.
4. Drivers could recognize the `O_EXCL` open flag. Presently this is not required, so application 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 *`audioset`*.

   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 explicitely 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.

12. It may be desirable to refer to the cropping area in terms of sampling frequency and scanning system lines, but in order to support a wide range of hardware we better make as few assumptions as possible.

Chapter 2. Image Formats

The V4L2 API was primarily designed for devices exchanging image data with applications. The v4l2_pix_format structure defines the format and layout of an image in memory. 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`.)

Table 2-1. struct v4l2_pix_format

__u32	*width*	Image width in pixels.
__u32	*height*	Image height in pixels.
Applications set these fields to request an image size, drivers return the closest possible values. In case of planar forma		
__u32	*pixelformat*	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 2-3>, YUV formats in Section 2.4>, and reserved codes in Table 2-4>
enum v4l2_field	*field*	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>.
__u32	*bytesperline*	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 ig		
__u32	*sizeimage*	Size in bytes of the buffer to hold a complete image, set by the driver. Usually this is *bytesperline* times *height*. When the image consists of variable length compressed data this is the maximum number of bytes required to hold an image.
enum v4l2_colorspace	*colorspace*	This information supplements the *pixelformat* and must be set by the driver, see Section 2.2>.
__u32	*priv*	Reserved for custom (driver defined) additional information about formats. When not used drivers and applications must set this field to zero.

2.1. 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 codes which are also listed below, however they are not the same as those used in the Windows world.

2.2. 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]

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

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

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

Re-normalized color-difference signals

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

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

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

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

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

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 = (Chrom. Levels - 1) · P_R + 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 Y1, Cb, Cr;         /* 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;
}

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 2-2. enum v4l2_colorspace

Identifier	Value	Description	Chromaticities[a]			White Point	Gamma Correction	Luminance E'_Y		
			Red	Green	Blue				Y'	Cb, Cr
V4L2_COLORSPACE_SMPTE170M	1	NTSC/PAL according to SMPTE170M>, ITU601>	x = 0.630, y = 0.340	x = 0.310, y = 0.595	x = 0.155, y = 0.070	x = 0.3127, y = 0.3290, Illuminant D_{65}	E' = 4.5 I for I ≤ 0.018, 1.099 $I^{0.45}$ - 0.099 for 0.018 < I	0.299 E'_R + 0.587 E'_G + 0.114 E'_B	219 E'_Y + 16	224 $P_{B,R}$ + 128
V4L2_COLORSPACE_SMPTE240M	2	1125-Line (US) HDTV, see SMPTE240M>	x = 0.630, y = 0.340	x = 0.310, y = 0.595	x = 0.155, y = 0.070	x = 0.3127, y = 0.3290, Illuminant D_{65}	E' = 4 I for I ≤ 0.0228, 1.1115 $I^{0.45}$ - 0.1115 for 0.0228 < I	0.212 E'_R + 0.701 E'_G + 0.087 E'_B	219 E'_Y + 16	224 $P_{B,R}$ + 128
V4L2_COLORSPACE_REC709	3	HDTV and modern devices, see ITU709>	x = 0.640, y = 0.330	x = 0.300, y = 0.600	x = 0.150, y = 0.060	x = 0.3127, y = 0.3290, Illuminant D_{65}	E' = 4.5 I for I ≤ 0.018, 1.099 $I^{0.45}$ - 0.099 for 0.018 < I	0.2125 E'_R + 0.7154 E'_G + 0.0721 E'_B	219 E'_Y + 16	224 $P_{B,R}$ + 128
V4L2_COLORSPACE_BT878	4	Broken Bt878 extents[b], ITU601>	?	?	?	?	?	0.299 E'_R + 0.587 E'_G + 0.114 E'_B	*237* E'_Y + 16	224 $P_{B,R}$ + 128 (probably)

Identifier	Value	Description	Chromaticities[a] Red	Green	Blue	White Point	Gamma Correction	Luminance E'_Y	Y'	Cb, Cr
`V4L2_COLORSPACE_470_SYSTEM_M`	5	M/NTSC[c] according to ITU470>, ITU601>	x = 0.67, y = 0.33	x = 0.21, y = 0.71	x = 0.14, y = 0.08	x = 0.310, y = 0.316, Illuminant C	?	$0.299 E'_R + 0.587 E'_G + 0.114 E'_B$	$219 E'_Y + 16$	$224 P_{B,R} + 128$
`V4L2_COLORSPACE_470_SYSTEM_BG`	6	625-line PAL and SECAM systems according to ITU470>, ITU601>	x = 0.64, y = 0.33	x = 0.29, y = 0.60	x = 0.15, y = 0.06	x = 0.313, y = 0.329, Illuminant D_{65}	?	$0.299 E'_R + 0.587 E'_G + 0.114 E'_B$	$219 E'_Y + 16$	$224 P_{B,R} + 128$
`V4L2_COLORSPACE_JPEG`	7	JPEG Y'CbCr, see JFIF>, ITU601>	?	?	?	?	?	$0.299 E'_R + 0.587 E'_G + 0.114 E'_B$	$256 E'_Y + 16$	$256 P_{B,R} + 128$
`V4L2_COLORSPACE_SRGB`	8	[?]	x = 0.640, y = 0.330	x = 0.300, y = 0.600	x = 0.150, y = 0.060	x = 0.3127, y = 0.3290, Illuminant D_{65}	$E' = 4,5\ I$ for $I \leq 0.018$, $1,099\ I^{0.45} - 0.099$ for $0.018 < I$			

Notes: a. The coordinates of the color primaries are given in the CIE system (1931) b. The ubiquitous Bt878 video c

2.3. RGB Formats

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 2-3. Packed RGB Image Formats

Identifier	Code	Byte 0								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

Identifier	Code	Byte 0	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`	'RGB1'	b_1 b_0 g_2 g_1 g_0 r_2 r_1 r_0			
`V4L2_PIX_FMT_RGB555`	'RGBO'	g_2 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_4 g_3		
`V4L2_PIX_FMT_RGB565`	'RGBP'	g_2 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`	'RGBQ'	? 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		
`V4L2_PIX_FMT_RGB565X`	'RGBR'	b_4 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_BGR24`	'BGR3'	b_7 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`	'RGB3'	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`	'BGR4'	b_7 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_RGB32`	'RGB4'	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	? ? ? ? ? ? ? ?

Bit 7 is the most significant bit. ? = undefined bit, ignored on output, random value on input.

Example 2-2. `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.

The `V4L2_PIX_FMT_RGB555`, `V4L2_PIX_FMT_RGB565`, `V4L2_PIX_FMT_RGB555X` and `V4L2_PIX_FMT_RGB565X` formats are uncommon. Video and display hardware typically supports variants with reversed order of color components, i. e. blue towards the least, red towards the most significant bit. Although presumably the original authors had the common formats in mind, the definitions were always very clear and cannot be simply regarded as erroneous.

If `V4L2_PIX_FMT_RGB332` has been chosen in accordance with the 15 and 16 bit formats, this format might as well be interpreted differently, as "rrrgggbb" rather than "bbgggrrr".

Finally some drivers, most prominently the BTTV driver, might interpret `V4L2_PIX_FMT_RGB32` as the big-endian variant of `V4L2_PIX_FMT_BGR32`, consisting of bytes "?RGB" in memory. V4L2 never defined such a format, lack of a `X` suffix to the symbol suggests it was intended this way, and a new symbol and four character code should have been used instead.

Until these issues are solved, application writers are advised that drivers might interpret these formats either way.

2.4. 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 2.2> 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.

V4L2_PIX_FMT_GREY ('GREY')

Name

`V4L2_PIX_FMT_GREY` — Grey-scale image.

Description

This is a grey-scale image. It is really a degenerate Y'CbCr format which simply contains no Cb or Cr data.

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_YUYV ('YUYV')

Name

V4L2_PIX_FMT_YUYV — Packed format with ½ 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_YUYV 4 × 4 pixel image

Byte Order. Each cell is one byte.

start + 0:	Y'_{00}	Cb_{00}	Y'_{01}	Cr_{00}	Y'_{02}	Cb_{01}	Y'_{03}	Cr_{01}
start + 8:	Y'_{10}	Cb_{10}	Y'_{11}	Cr_{10}	Y'_{12}	Cb_{11}	Y'_{13}	Cr_{11}
start + 16:	Y'_{20}	Cb_{20}	Y'_{21}	Cr_{20}	Y'_{22}	Cb_{21}	Y'_{23}	Cr_{21}
start + 24:	Y'_{30}	Cb_{30}	Y'_{31}	Cr_{30}	Y'_{32}	Cb_{31}	Y'_{33}	Cr_{31}

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_Y41P ('Y41P')

Name

`V4L2_PIX_FMT_Y41P` — Packed 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*", possibly in reference to a Windows FOURCC, 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_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:	Cr_{00}			
start + 17:	Cb_{00}			

Color Sample Location.

	0		1		2		3
0	Y		Y		Y		Y
1	Y		Y		Y		Y
				C			
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:	Cb_{00}	Cb_{01}		
start + 18:	Cb_{10}	Cb_{11}		
start + 20:	Cb_{20}	Cb_{21}		
start + 22:	Cb_{30}	Cb_{31}		
start + 24:	Cr_{00}	Cr_{01}		
start + 26:	Cr_{10}	Cr_{11}		
start + 28:	Cr_{20}	Cr_{21}		
start + 30:	Cr_{30}	Cr_{31}		

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, Cb_0 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	Y
1	Y	Y	C	Y	Y
2	Y	Y	C	Y	Y
3	Y	Y	C	Y	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, Cb_0/Cr_0 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:	Cb_{00}	Cr_{00}	Cb_{01}	Cr_{01}
start + 20:	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

2.5. Compressed Formats

[to do, see also VIDIOC_G_MPEGCOMP, VIDIOC_S_MPEGCOMP, VIDIOC_G_JPEGCOMP, VIDIOC_S_JPEGCOMP. The only compressed standard format should be [M]JPEG.]

2.6. 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 V4L mailing list https://listman.redhat.com/mailman/listinfo/video4linux-list for inclusion in the videodev.h file. If you want to share your format with other developers add a link to your documentation and send a copy to the maintainer of this document, Michael Schimek <mschimek@gmx.at>, for inclusion in this section. If you think your format should be listed in a standard format section please make a proposal on the V4L mailing list.

Table 2-4. Reserved Image Formats

Identifier	Code	Details
V4L2_PIX_FMT_YYUV	'YYUV'	unknown
V4L2_PIX_FMT_HI240	'HI24'	Used by the BTTV driver, http://bytesex.org/bttv/
V4L2_PIX_FMT_MJPEG	'MJPG'	Used by the Zoran driver
V4L2_PIX_FMT_JPEG	'JPEG'	unknown [?]
V4L2_PIX_FMT_DV	'dvsd'	unknown
V4L2_PIX_FMT_MPEG	'MPEG'	unknown
V4L2_PIX_FMT_WNVA	'WNVA'	Used by the Winnov Videum driver, http://www.thedirks.org/winnov/

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. The *`m.offset`* and *`length`* returned in a struct v4l2_buffer are passed as sixth and second parameter to the `mmap()` function. 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

```
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)) {
                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, /* required */
                                 MAP_SHARED,             /* recommended */
                                 fd, buffer.m.offset);

        if (buffers[i].start == MAP_FAILED) {
                /* You may need to unmap and free the so far
                   mapped buffers here. */
                perror ("mmap");
                exit (EXIT_FAILURE);
        }
}

/* Cleanup. */

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

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 enqueuing 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 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. The driver must be switched into user pointer I/O mode by calling the `VIDIOC_REQBUFS` with the desired buffer type. No buffers are allocated beforehands, consequently they are not indexed and cannot be queried like mapped buffers with the `VIDIOC_QUERYBUF` ioctl.

Example 3-2. 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 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 enqueuing 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. Only pointers to buffers 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.

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

__u32	*index*	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 `VIDIOC_REQBUFS` ioctl (struct v4l2_requestbuffers *count*) minus one.
enum v4l2_buf_type	*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 3-3>.
enum v4l2_field	*field*	Indicates the field order of the image in the buffer, see Table 3-8>. 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	*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 zer

enum v4l2_memory	*memory*		This field must be set by applications and/or drivers in accordance with the selected I/O method.
union	*m*		
	__u32	*offset*	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*	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.

__u32	*length*	Size of the buffer (not the payload) in bytes.
__u32	*input*	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 `V4L2_BUF_FLAG_INPUT` flag, and this field to the number of a video input as in struct v4l2_input field *index*.
__u32	*reserved*	A place holder for future extensions and custom (driver defined) buffer types `V4L2_BUF_TYPE_PRIVATE` and higher.

Table 3-2. enum v4l2_buf_type

`V4L2_BUF_TYPE_VIDEO_CAPTURE`	1	Buffer of a video capture stream, see Section 4.1>.
`V4L2_BUF_TYPE_VIDEO_OUTPUT`	2	Buffer of a video output stream, see Section 4.3>.
`V4L2_BUF_TYPE_VIDEO_OVERLAY`	3	Buffer for video overlay, see Section 4.2>.
`V4L2_BUF_TYPE_VBI_CAPTURE`	4	Buffer of a raw VBI capture stream, see Section 4.6>.
`V4L2_BUF_TYPE_VBI_OUTPUT`	5	Buffer of a raw VBI output stream, see Section 4.6>.
`V4L2_BUF_TYPE_PRIVATE`	0x80	This and higher values are reserved for custom (driver defined) buffer types.

Table 3-3. 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 VIDIOC_QUERYBUF, VIDIOC_QBUF or VIDIOC_DQBUF 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 `VIDIOC_QUERYBUF` ioctl is called. After (successful) calling the `VIDIOC_QBUF` ioctl it is always set and after `VIDIOC_DQBUF` 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 VIDIOC_QUERYBUF ioctl is called. After calling the VIDIOC_QBUF or VIDIOC_DQBUF it is always cleared. Of course a buffer cannot be on both queues at the same time, the V4L2_BUF_FLAG_QUEUED and V4L2_BUF_FLAG_DONE 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_KEYFRAME	0x0008	Drivers set or clear this flag when calling the VIDIOC_DQBUF 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 V4L2_BUF_FLAG_KEYFRAME this flags predicted frames or fields which contain only differences to a previous key frame.
V4L2_BUF_FLAG_BFRAME	0x0020	Similar to V4L2_BUF_FLAG_PFRAME this is a bidirectional predicted frame or field. [ooc tbd]
V4L2_BUF_FLAG_TIMECODE	0x0100	The *timecode* field is valid. Drivers set or clear this flag when the VIDIOC_DQBUF ioctl is called.
V4L2_BUF_FLAG_INPUT	0x0200	The *input* field is valid. Applications set or clear this flag before calling the VIDIOC_QBUF ioctl.

Table 3-4. 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 SMPTE12M> or similar timecode. (struct timeval timestamps are stored in struct v4l2_buffer field *timestamp*.)

Table 3-5. struct v4l2_timecode

__u32	*type*	Frame rate the timecodes are based on, see Table 3-6>.
__u32	*flags*	Timecode flags, see Table 3-7>.
__u8	*frames*	Frame count, 0 ... 23/24/29/49/59, depending on the type of timecode.
__u8	*seconds*	Seconds count, 0 ... 59. This is a binary, not BCD number.

__u8	*minutes*	Minutes count, 0 ... 59. This is a binary, not BCD number.
__u8	*hours*	Hours count, 0 ... 29. This is a binary, not BCD number.
__u8	*userbits*[4]	The "user group" bits from the timecode.

Table 3-6. Timecode Types

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

Table 3-7. Timecode Flags

`V4L2_TC_FLAG_DROPFRAME`	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.
`V4L2_TC_FLAG_COLORFRAME`	0x0002	The "color frame" flag.
`V4L2_TC_USERBITS_field`	0x000C	Field mask for the "binary group flags".
`V4L2_TC_USERBITS_USERDEFINED`	0x0000	Unspecified format.
`V4L2_TC_USERBITS_8BITCHARS`	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 and bottom 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 3-8. 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 v4l2_buffer *field* 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 field only.
`V4L2_FIELD_BOTTOM`	3	Images consist of the bottom 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 v4l2_buffer *`field`* to `V4L2_FIELD_TOP` or `V4L2_FIELD_BOTTOM`. 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 v4l2_buffer *`sequence`* field. Image sizes refer to the frame, not fields. This format cannot be selected when using the read/write I/O method.

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

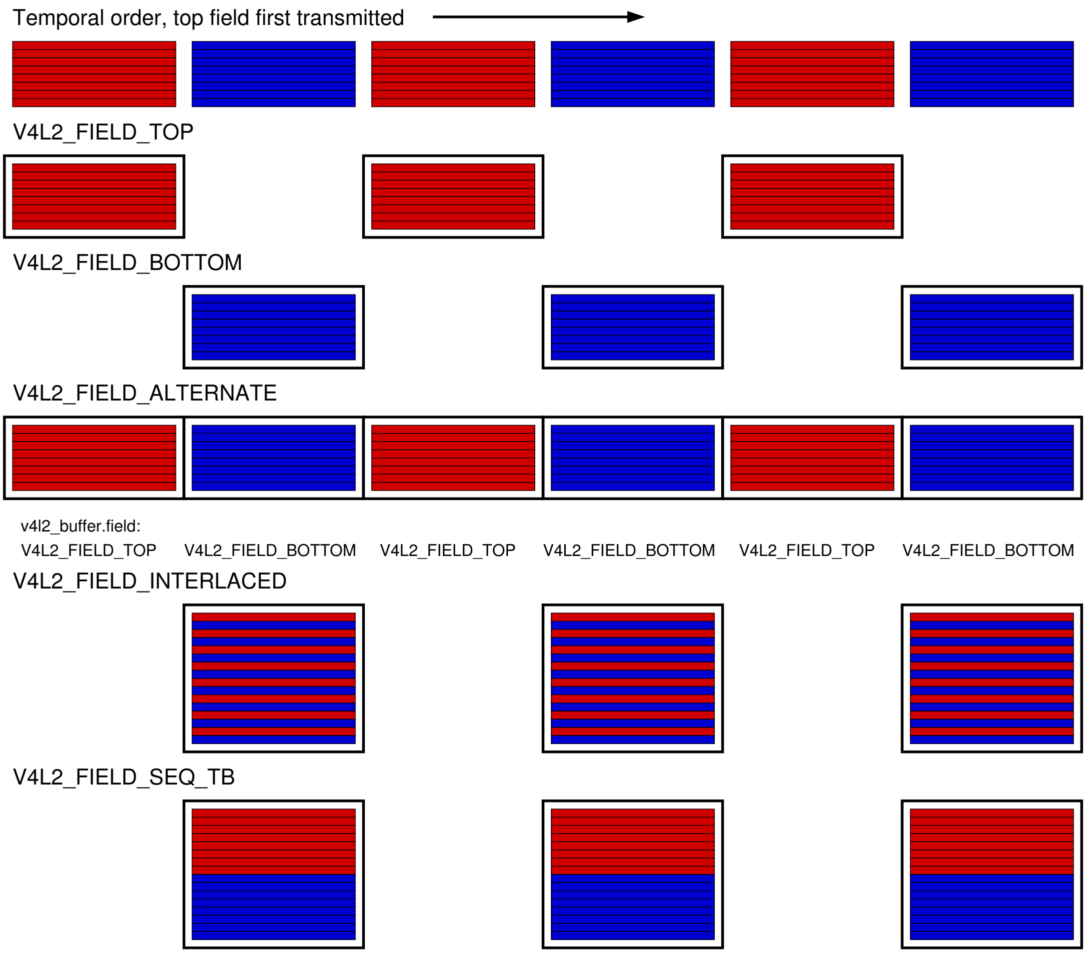
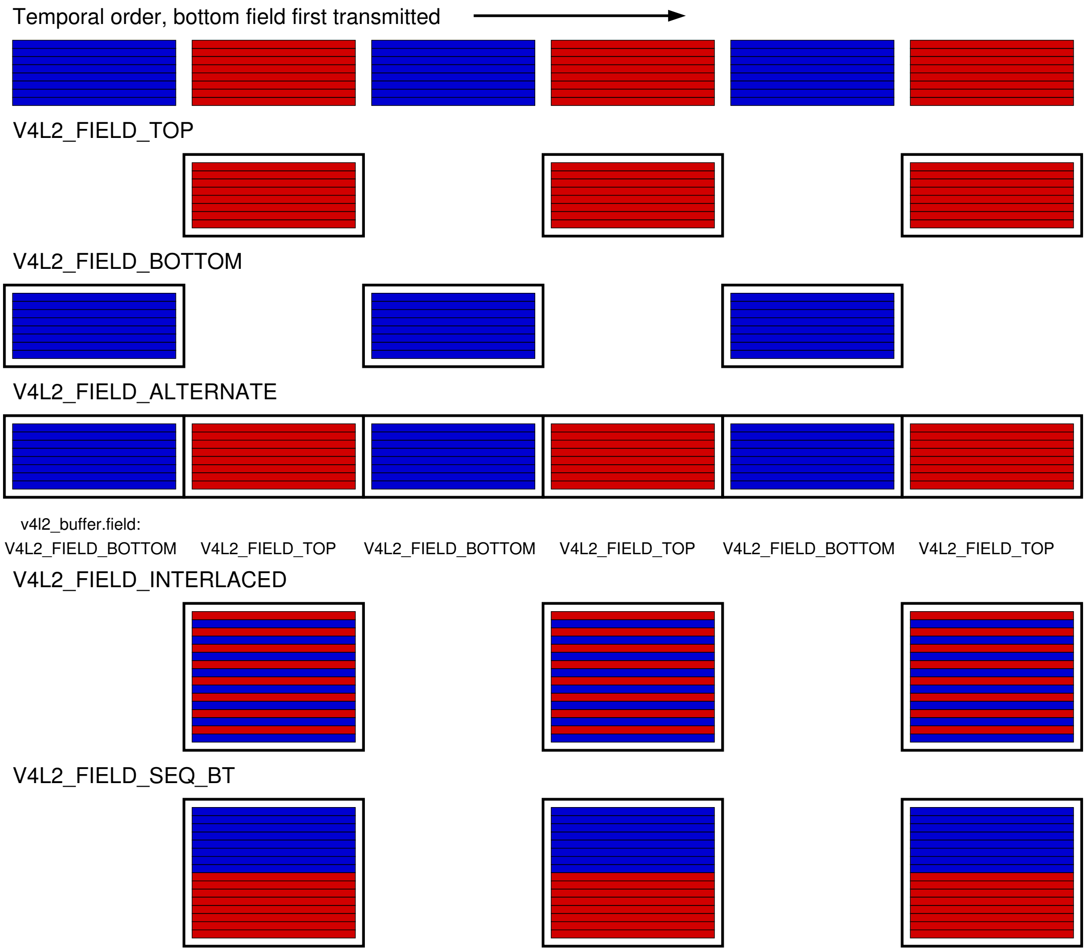


Figure 3-2. Field Order, Bottom Field First Transmitted



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. Device Types

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 capture device.

4.1.1. Querying Capabilities

Devices supporting the video capture interface set the `V4L2_CAP_VIDEO_CAPTURE` flag in the *`capabilities`* field of struct v4l2_capability returned by the `VIDIOC_QUERYCAP`. 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 1.10>.

To query the current image format applications set the *`type`* field of a struct v4l2_format to `V4L2_BUF_TYPE_VIDEO_CAPTURE` and call the `VIDIOC_G_FMT` ioctl with a pointer to this structure. Drivers fill the struct v4l2_pix_format *`pix`* 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 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`. 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 three clipping 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.

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 1.10>.

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`*. Retrieving a previously programmed clipping list or bitmap is not possible.

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 1.10>.

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

struct v4l2_rect	*w*	Size and position of the window relative to the top, left corner of the frame buffer defined with `VIDIOC_S_FBUF`. The window can extend the frame buffer width and height, the *x* and *y* 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.
enum v4l2_field	*field*	Applications set this field to determine which video field shall be overlaid, typically one of `V4L2_FIELD_ANY` (0), `V4L2_FIELD_TOP`, `V4L2_FIELD_BOTTOM` or `V4L2_FIELD_INTERLACED`. Drivers may have to choose a different field order and return the actual setting here.
__u32	*chromakey*	When chroma-keying has been negotiated with `VIDIOC_S_FBUF` applications set this field to the desired host order RGB32 value for the chroma key. [host order? alpha channel?]
struct v4l2_clip *	*clips*	When chroma-keying has *not* been negotiated and `VIDIOC_G_FBUF` indicated this capability, applications can set this field to point to the first in a list of clipping rectangles.
Like the window coordinates *w*, clipping rectangles are defined relative to the top, left corner of the frame buffer. Howe		
__u32	*clipcount*	When the application set the *clips* 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 `VIDIOC_S_FMT` are undefined. When clip lists are supported but no clipping is desired this field must be set to zero.
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 ima		
Notes:		

Table 4-2. struct v4l2_clip[2]

struct v4l2_rect	*c*	Coordinates of the clipping rectangle, relative to the top, left corner of the frame buffer. Only window pixels *outside* all clipping rectangles are displayed.
struct v4l2_clip *	*next*	Pointer to the next clipping rectangle in the list, NULL when this is the last rectangle.

Table 4-3. struct v4l2_rect

__s32	*left*	Horizontal offset of the top, left corner of the rectangle, in pixels.
__s32	*top*	Vertical offset of the top, left corner of the rectangle, in pixels. Offsets increase to the right and down.
__s32	*width*	Width of the rectangle, in pixels.
__s32	*height*	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/vout` and `/dev/vout0` to `/dev/voutN`. No minor numbers were recommended yet. `/dev/vout` is typically a symbolic link to the preferred video output device.

4.3.1. Querying Capabilities

Devices supporting the video output interface set the `V4L2_CAP_VIDEO_OUTPUT` flag in the *capabilities* field of struct v4l2_capability returned by the `VIDIOC_QUERYCAP`. 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 1.10>.

To query the current image format applications set the *type* field of a struct v4l2_format to `V4L2_BUF_TYPE_VIDEO_OUTPUT` and call the `VIDIOC_G_FMT` ioctl with a pointer to this structure. Drivers fill the struct v4l2_pix_format *pix* 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 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. 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 the `write()` call, and receive the converted data through the `read()` call. For efficiency, a driver may also support streaming I/O.

[to do]

4.5. 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]

4.6. 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 modulated[3] 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/vbi15` with major number 81 and minor numbers 224 to 239. `/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 is also available as device function under `/dev/video`, VBI output under `/dev/vout`. To capture raw VBI data from these devices applications must call the `VIDIOC_S_FMT` ioctl. Accessed as `/dev/vbi`, raw VBI capturing or output is the default device function.

4.6.1. 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`. 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.

4.6.2. 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.

4.6.3. 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 capabilites 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

__u32	*`sampling_rate`*	Samples per second, i. e. unit 1 Hz.
__u32	*`offset`*	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>.
__u32	*`samples_per_line`*	
__u32	*`sample_format`*	Defines the sample format as in Chapter 2>, a four-character-code.[a] Usually this is `V4L2_PIX_FMT_GREY`, 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.

__u32	*start*[2]	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 reliable identify scanning lines, VBI acquisition may not require this information.
__u32	*count*[2]	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

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

Notes:

Table 4-5. Raw VBI Format Flags

`V4L2_VBI_UNSYNC`	0x0001	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	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> `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 *count* values are equal and non-zero.

Notes: a. Most VBI services transmit on both fields, but some have different semantics depending on the field number

Figure 4-1. Line synchronization

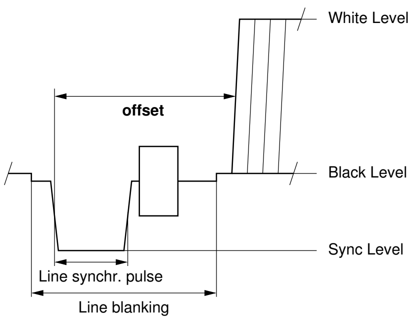
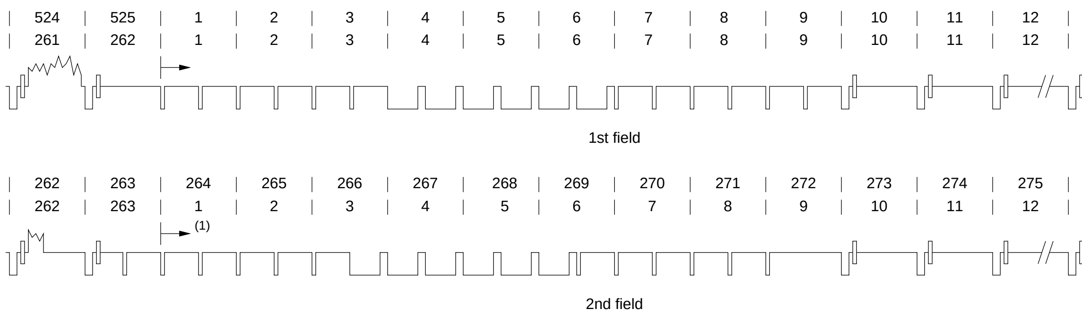
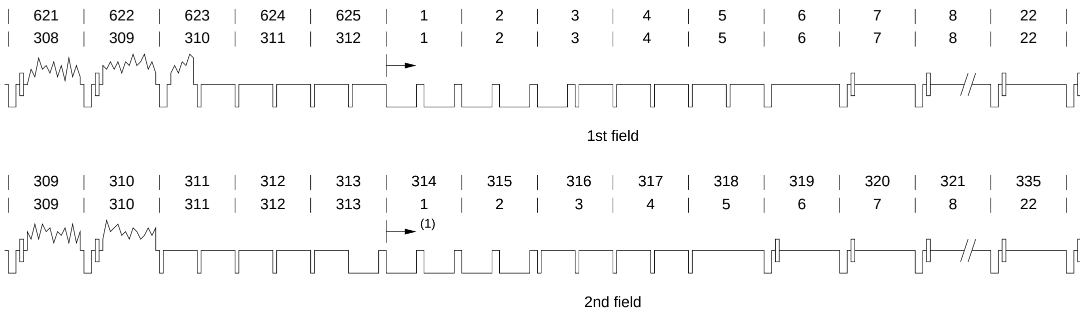


Figure 4-2. ITU-R 525 line numbering (M/NTSC and M/PAL)



(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.

4.6.4. 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.

4.7. 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. Different file descriptors must be used to pass raw and sliced VBI data simultaneously, if this is supported by the driver.

4.7.1. 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.

4.7.2. 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.

4.7.3. 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 returns an EINVAL error code only when the given parameters are ambiguous, otherwise it 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

__u32	*service_set*	If *service_set* is non-zero when passed with `VIDIOC_S_FMT` or V		
__u16	*service_lines*[2][24]	Applications initialize this array with sets of data services the driver		
		Element	525 line systems	625 line systems
		service_lines[0][1]	1	1
		service_lines[0][23]	23	23
		service_lines[1][1]	264	314

		service_lines[1][23]	286	336

		Drivers must set *service_lines*[0][0] and *service_lines*[1][0]
__u32	*io_size*	Maximum number of bytes passed by one `read()` or `write()` call,
__u32	*reserved*[2]	This array is reserved for future extensions. Applications and drivers

Notes:

Table 4-7. Sliced VBI services

Symbol	Value	Reference	Lines, usually	Payload
`V4L2_SLICED_TELETEXT_B` (Teletext System B)	0x0001	TELETEXT>	PAL/SECAM line 7-22, 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.
`V4L2_SLICED_VPS`	0x0400	VPS>	PAL line 16	Byte number 3 to 15 according to Figure 9 of ETS 300 231, lsb first transmitted.
`V4L2_SLICED_CAPTION_525`	0x1000	EIA608>	NTSC line 21, 284 (second field 21)	Two bytes in transmission order, including parity bit, lsb first transmitted.

`V4L2_SLICED_WSS_625`	0x4000	WSS>	PAL/SECAM line 23	`Byte 0 1`
				`msb lsb msb`
				`Bit 7 6 5 4 3 2 1 0 x x 13 12`

`V4L2_SLICED_VBI_525`	0x1000	Set of services applicable to 525 line systems.		
`V4L2_SLICED_VBI_625`	0x4401	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).

4.7.4. 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

__u32	*id*	A flag from Table 2> identifying the type of data in this packet. Only a single bit must be set. When the *id* 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 *id* of a packet for output is zero the contents of the *data* field are undefined and the driver must no longer insert data on the requested *field* and *line*.
__u32	*field*	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.
__u32	*line*	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.
__u32	*reserved*	This field is reserved for future extensions. Applications and drivers must set it to zero.
__u8	*data*[48]	The packet payload. See Table 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. Teletext Interface

This interface aims at devices receiving and demodulating Teletext data [TELETEXT>], evaluating the Teletext packages and storing formatted pages in cache memory. Such devices are usually implemented as microcontrollers with serial interface (I^2C) and can be found on older 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 is defined in the kernel header file `linux/videotext.h`, the specification is available from http://home.pages.de/~videotext/. (Videotext is the name of the German public television Teletext service.) Conventional character device file names are `/dev/vtx` and `/dev/vttuner`, with device number 83, 0 and 83, 16 respectively. A similar interface exists for the Philips SAA5249 Teletext decoder [specification?] with character device file names `/dev/tlkN`, device number 102, N.

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. For reference the V4L Teletext API specification is reproduced here in full: "Teletext interfaces talk the existing VTX API." Teletext devices with major number 83 and 102 will be removed in Linux 2.6.

There are no plans to replace the Teletext API or to integrate it into V4L2. Please write to the Video4Linux mailing list: https://listman.redhat.com/mailman/listinfo/video4linux-list when the need arises.

4.9. Radio Interface

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

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.

4.9.1. Querying Capabilities

Devices supporting the radio interface set the `V4L2_CAP_RADIO` and `V4L2_CAP_TUNER` 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.

4.9.2. Supplemental Functions

Radio devices can support controls, and must support the tuner 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.

4.9.3. 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 (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. Drivers switch automatically between AM and FM depending on the selected frequency. The `VIDIOC_G_TUNER` ioctl reports the supported frequency range.

4.10. RDS Interface

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

The V4L API defines its RDS API as follows.

From radio devices supporting it, RDS data can be read with the `read()` function. The data is packed in groups of three, as follows:

1. First Octet Least Significant Byte of RDS Block
2. Second Octet Most Significant Byte of RDS Block
3. Third Octet Bit 7: Error bit. Indicates that an uncorrectable error occurred during reception of this block. Bit 6: Corrected bit. Indicates that an error was corrected for this data block. Bits 5-3: Received Offset. Indicates the offset received by the sync system. Bits 2-0: Offset Name. Indicates the offset applied to this data.

It was argued the RDS API should be extended before integration into V4L2, no new API has been devised yet. Please write to the Video4Linux mailing list for discussion: https://listman.redhat.com/mailman/listinfo/video4linux-list. Meanwhile no V4L2 driver should set the `V4L2_CAP_RDS_CAPTURE` capability flag.

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.

I. Function Reference

Table of Contents

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 videodev.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 videodev.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 Reference I, *Function Reference*>.

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 Reference I, *Function Reference*> for actual causes.

ENOMEM

Insufficient memory 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 1. struct v4l2_cropcap

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	*bounds*	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.
struct v4l2_rect	*defrect*	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 `bounds` is used.
struct v4l2_fract	*pixelaspect*	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 `pixelaspect` to 1/1. Other common values are 54/59 for PAL and SECAM, 11/10 for NTSC sampled according to [ITU601>].

Table 2. struct v4l2_rect

__s32	*left*	Horizontal offset of the top, left corner of the rectangle, in pixels.
__s32	*top*	Vertical offset of the top, left corner of the rectangle, in pixels.
__s32	*width*	Width of the rectangle, in pixels.
__s32	*height*	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_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_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 1. struct v4l2_fmtdesc

__u32	*index*	Number of the format in the enumeration, set by the application. This is in no way related to the *pixelformat* field.
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.
__u32	*flags*	See Table 2>
__u8	*description*[32]	Description of the format, a NUL-terminated ASCII string. This information is intended for the user, for example: "YUV 4:2:2".

__u32	*pixelformat*	The image format identifier. This is a four character code as computed by the v4l2_fourcc() macro:

```
#define v4l2_fourcc(a,b,c,d) (((__u32)(a)<<0)|((__u32)(b)<<8)|((__u32)(c)<<16)|((__u32
```

__u32	*reserved*[4]	Reserved for future extensions. Drivers must set the array to zero.

Table 2. Image Format Description Flags

`V4L2_FMT_FLAG_COMPRESSED`	0x0001	This is a compressed format.

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_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 1. struct v4l2_input

__u32	*index*	Identifies the input, set by the application.
__u8	*name*[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.
__u32	*type*	Type of the input, see Table 2>.

__u32	*audioset*	Video inputs combine with zero or more audio inputs. For example one composite video connectors may exist, but two audio connectors. On the other hand, video from a tuner will likely combine only with audio from the same tuner. Devices with N audio inputs number them 0 ... N-1 with N $\leq$ 32. Each bit position of *audioset* represents one audio input. For details on audio inputs and how to switch see Section 1.5>.
__u32	*tuner*	Capture devices can have zero or more tuners (RF demodulators). When the *type* is set to `V4L2_INPUT_TYPE_TUNER` this is an RF connector and this field identifies the tuner. It corresponds to struct v4l2_tuner field *index*. For details on tuners see Section 1.6>.
v4l2_std_id	*std*	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>.
__u32	*status*	This field provides status information about the input. See Table 3> for flags. *status* is only valid when this is the current input.
__u32	*reserved*[4]	Reserved for future extensions. Drivers must set the array to zero.

Table 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 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.
Analog Video		
`V4L2_IN_ST_NO_H_LOCK`	0x00000100	No horizontal sync lock.
`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 *and* 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. [?]

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 1. struct v4l2_output

__u32	*index*	Identifies the output, set by the application.
__u8	*name*[32]	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.
__u32	*type*	Type of the output, see Table 2>.

__u32	*audioset*	Video outputs combine with zero or more audio outputs. For example one composite video connectors may exist, but two audio connectors. On the other hand, video to a modulator will likely combine only with audio to the same modulator. Devices with N audio outputs number them 0 ... N-1 with N $\leq$ 32. Each bit position of *audioset* represents one audio output. For details on audio outputs and how to switch see Section 1.5>.
__u32	*modulator*	Output devices can have zero or more RF modulators. When the *type* is V4L2_OUTPUT_TYPE_MODULATOR this is an RF connector and this field identifies the modulator. It corresponds to struct v4l2_modulator field *index*. For details on modulators see Section 1.6>.
v4l2_std_id	*std*	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	*reserved*[4]	Reserved for future extensions. Drivers must set the array to zero.

Table 2. Output Type

V4L2_OUTPUT_TYPE_MODULATOR	1	This output is an analog TV modulator.
V4L2_OUTPUT_TYPE_ANALOG	2	Analog baseband output, for example Composite / CVBS, S-Video, RGB.
V4L2_OUTPUT_TYPE_ANALOGVGAOVERLAY	3	[?]

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 1. struct v4l2_standard

__u32	*index*	Number of the video standard, set by the application.
v4l2_std_id	*id*	The bits in this field identify the standard as one of the common standards listed in Table 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 *id* must be unique. No other enumerated v4l2_standard structure, for this input or output anyway, can contain the same set of bits.

__u8	*name*[24]	Name of the standard, a NUL-terminated ASCII string, for example: "PAL-B/G", "NTSC Japan". This information is intended for the user.
struct v4l2_fract	*frameperiod*	The frame period (not field period) is numerator / denominator. For example M/NTSC has a frame period of 1001 / 30000 seconds.
__u32	*framelines*	Total lines per frame including blanking, e. g. 625 for B/PAL.
__u32	*reserved*[4]	Reserved for future extensions. Drivers must set the array to zero.

Table 2. struct v4l2_fract

__u32	*numerator*
__u32	*denominator*

Table 3. typedef v4l2_std_id

__u64	*v4l2_std_id*	This type is a set, each bit representing another video standard as listed below and in Table 4>. The 32 most significant bits are reserved for custom (driver defined) video standards.

```
#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)
```

`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_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.

```
#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)
#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)

#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        |\
                                 V4L2_STD_625_50)
```

Table 4. Video Standards (based on [ITU470>])

Characteristics	M/NTSC[a]	M/PAL	N/PAL[b]	B, B1, G/PAL	D, D1, K/PAL	H/PAL	I/PAL	B, G/SECAM	D, K/SECAM	K1/SECAM	L/SECAM
Frame lines	525										
Frame period (s)	1001/30000										
Chrominance sub-carrier frequency (Hz)	3579545 ± 10	3579611.49 ± 10	4433618.75 ± 5 (3582056.25 ± 5)	4433618.75 ± 5			4433618.75 ± 1				
Nominal radio-frequency channel bandwidth (MHz)	6	6	6	B: 7; B1, G: 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 ± 0.001	+ 6.5 ± 0.001	+ 6.5	+ 6.5 [g]

Notes: a. Japan uses a standard similar to M/NTSC (V4L2_STD_NTSC_M_JP). b. The values in brackets apply to t

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 1. struct v4l2_audio

__u32	`index`	Identifies the audio input, set by the driver or application.
__u8	`name`[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	`capability`	Audio capability flags, see Table 2>.
__u32	`mode`	Audio mode set by drivers and applications (on `VIDIOC_S_AUDIO` ioctl), see Table 3>.
__u32	`reserved`[2]	Reserved for future extensions. Drivers and applications must set the array to zero.

Table 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 *received*, unless the audio input belongs to a tuner.
`V4L2_AUDCAP_AVL`	0x00002	Automatic Volume Level mode is supported.

Table 3. Audio Modes

`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 1. struct v4l2_audioout

__u32	*`index`*	Identifies the audio output, set by the driver or application.

__u8	*name*[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.
__u32	*capability*	Audio capability flags, none defined yet. Drivers must set this field to zero.
__u32	*mode*	Audio mode, none defined yet. Drivers and applications (on `VIDIOC_S_AUDOUT`) must set this field to zero.
__u32	*reserved*[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_MPEGCOMP, VIDIOC_S_MPEGCOMP

Name

`VIDIOC_G_MPEGCOMP`, `VIDIOC_S_MPEGCOMP` — Get or set compression parameters

Synopsis

```
int ioctl(int fd, int request, v4l2_mpeg_compression *argp);
```

Arguments

fd

File descriptor returned by `open()`.

request

VIDIOC_G_MPEGCOMP, VIDIOC_S_MPEGCOMP

argp

Description

[to do]

Table 1. struct v4l2_mpeg_compression

[to do]

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_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 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.

Table 1. struct v4l2_control

__u32	*id*	Identifies the control, set by the application.
__s32	*value*	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_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

The `VIDIOC_G_FBUF` and `VIDIOC_S_FBUF` ioctl are used to get and set the frame buffer parameters for video overlay.

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 the EINVAL error code when overlay is not supported. To set the parameters applications initialize the *flags* field, *base* unless the overlay is of `V4L2_FBUF_CAP_EXTERNOVERLAY` type, and the struct v4l2_pix_format *fmt* substructure. The driver accordingly prepares for overlay or returns an error code.

When the driver does *not* support `V4L2_FBUF_CAP_EXTERNOVERLAY`, i. e. it will write into video memory, the `VIDIOC_S_FBUF` ioctl is a privileged function and only the superuser can change the frame buffer parameters.

Table 1. struct v4l2_framebuffer

__u32	*capability*	Overlay capability flags set by the driver, see Table 2>.
__u32	*flags*	Overlay control flags set by application and driver, see Table 3>

void *	*base*		Physical base address of the frame buffer, the address of the pixel at coordinates (0; 0) in the frame buffer. This field is not used when `VIDIOC_G_FBUF` sets the `V4L2_FBUF_CAP_EXTERNOVERLAY` flag in the *capability* field.[a]
struct v4l2_pix_format	*fmt*		Physical layout of the frame buffer. The v4l2_pix_format structure is defined in Chapter 2>, for clarification the fields and expected values are listed below.
	__u32	*width*	Width of the frame buffer in pixels.
	__u32	*height*	Height of the frame buffer in pixels. When the driver *clears* `V4L2_FBUF_CAP_EXTERNOVERLAY`, the visible portion of the frame buffer can be smaller than width and height.
	__u32	*pixelformat*	The pixel format of the graphics surface, set by the application. Usually this is an RGB format (for example RGB 5:6:5) but YUV formats are also permitted. The behavior of the driver when requesting a compressed format is undefined. See Chapter 2> for information on pixel formats. This field is not used when the driver sets `V4L2_FBUF_CAP_EXTERNOVERLAY`.
	enum v4l2_field	*field*	Ignored. The field order is selected with the `VIDIOC_S_FMT` ioctl using struct v4l2_window.
	__u32	*bytesperline*	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 ig			
	__u32	*sizeimage*	Applications must initialize this field. Together with *base* it defines the frame buffer memory accessible by the driver. The field is not used when the driver sets `V4L2_FBUF_CAP_EXTERNOVERLAY`.
	enum v4l2_colorspace	*colorspace*	This information supplements the *pixelformat* and must be set by the driver, see Section 2.2>.
	__u32	*priv*	Reserved for additional information about custom (driver defined) formats. When not used drivers and applications must set this field to zero.

Notes:

Table 2. Frame Buffer Capability Flags

V4L2_FBUF_CAP_EXTERNOVERLAY	0x0001	The video is overlaid externally onto the video signal of the graphics card.
V4L2_FBUF_CAP_CHROMAKEY	0x0002	The device supports clipping by chroma-keying the image into the display.
V4L2_FBUF_CAP_LIST_CLIPPING	0x0004	The device supports clipping using a list of clip rectangles.
V4L2_FBUF_CAP_BITMAP_CLIPPING	0x0008	The device supports clipping using a bit mask.

Table 3. Frame Buffer Flags

V4L2_FBUF_FLAG_PRIMARY	0x0001	The frame buffer is the primary graphics surface. In other words, the overlay is destructive, the video hardware will write the image into visible graphics memory as opposed to merely displaying the image in place of the original display contents.
V4L2_FBUF_FLAG_OVERLAY	0x0002	The frame buffer is an overlay surface the same size as the capture. [?]
V4L2_FBUF_FLAG_CHROMAKEY	0x0004	Use chromakey (when V4L2_FBUF_CAP_CHROMAKEY indicates this capability). The other clipping methods are negotiated with the VIDIOC_S_FMT ioctl, see also Section 4.2>.

Return Value

On success 0 is returned, on error -1 and the errno variable is set appropriately:

EACCES

VIDIOC_S_FBUF can only be called by a privileged user.

EBUSY

The frame buffer 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`. 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 the struct v4l2_pix_format *pix* 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 1. struct v4l2_format

enum v4l2_buf_type	*type*		Type of the data stream, see Table 3-2>.
union	*fmt*		
	struct v4l2_pix_format	*pix*	Definition of an image format, see Chapter 2>, used by video capture and output devices.
	struct v4l2_window	*win*	Definition of an overlaid image, see Section 4.2>, used by video overlay devices.
	struct v4l2_vbi_format	*vbi*	Raw VBI capture or output parameters. This is discussed in more detail in Section 4.6>. Used by raw VBI capture and output devices.
	struct v4l2_sliced_vbi_format	*sliced*	Sliced VBI capture or output parameters. See Section 4.7> for details. Used by sliced VBI capture and output devices.
	__u8	*raw_data*[200]	Place holder for future extensions and custom (driver defined) formats with *type* `V4L2_BUF_TYPE_PRIVATE` 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* 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 1. struct v4l2_frequency

__u32	*tuner*	The tuner or modulator index number. This is the same value as in the struct v4l2_input *tuner* field and the struct v4l2_tuner *index* field, or the struct v4l2_output *modulator* field and the struct v4l2_modulator *index* field.
enum v4l2_tuner_type	*type*	The tuner type. This is the same value as in the struct v4l2_tuner *type* field. The field is not applicable to modulators, i. e. ignored by drivers.
__u32	*frequency*	Tuning frequency in units of 62.5 kHz, or if the struct v4l2_tuner or struct v4l2_modulator *capabilities* flag `V4L2_TUNER_CAP_LOW` is set, in units of 62.5 Hz.
__u32	*reserved*[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* field is out of bounds.

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 (e.g. 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 1. struct v4l2_jpegcompression

int	*quality*
int	*APPn*
int	*APP_len*
char	*APP_data*[60]

int	*COM_len*	
char	*COM_data*[60]	
__u32	*jpeg_markers*	See Table 2>.

Table 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 1. struct v4l2_modulator

__u32	*index*	Identifies the modulator, set by the application.
__u8	*name*[32]	Name of the modulator, a NUL-terminated ASCII string. This information is intended for the user.
__u32	*capability*	Modulator capability flags. No flags are defined for this field, the tuner flags in struct v4l2_tuner are used accordingly. The audio flags indicate the ability to encode audio subprograms. They will *not* change for example with the current video standard.
__u32	*rangelow*	The lowest tunable frequency in units of 62.5 KHz, or if the *capability* flag `V4L2_TUNER_CAP_LOW` is set, in units of 62.5 Hz.
__u32	*rangehigh*	The highest tunable frequency in units of 62.5 KHz, or if the *capability* flag `V4L2_TUNER_CAP_LOW` is set, in units of 62.5 Hz.
__u32	*txsubchans*	With this field applications can determine how audio sub-carriers shall be modulated. It contains a set of flags as defined in Table 2>. Note the tuner *rxsubchans* 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 *txsubchans* flags select one or more channels for modulation, together with some audio subprogram indicator, for example a stereo pilot tone.
__u32	*reserved*[4]	Reserved for future extensions. Drivers and applications must set the array to zero.

Table 2. Modulator Audio Transmission Flags

`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` or `V4L2_TUNER_SUB_STEREO`. 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_LANG1`.
`V4L2_TUNER_SUB_SAP`	0x0004	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.

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 unneccessary data copying.

Further 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.

Table 1. struct v4l2_streamparm

enum v4l2_buf_type	*type*		The buffer (stream) type, same as struct v4l2_format *type*, set by the application.
union	*parm*		
	struct v4l2_captureparm	*capture*	Parameters for capture devices, used when *type* is `V4L2_BUF_TYPE_VIDEO_CAPTURE`.

struct v4l2_outputparm	*output*	Parameters for output devices, used when *type* is `V4L2_BUF_TYPE_VIDEO_OUTPUT`.
__u8	*raw_data*[200]	A place holder for future extensions and custom (driver defined) buffer types `V4L2_BUF_TYPE_PRIVATE` and higher.

Table 2. struct v4l2_captureparm

__u32	*capability*	See Table 4>.
__u32	*capturemode*	Set by drivers and applications, see Table 5>.
struct v4l2_fract	*timeperframe*	This is 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. 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 input) 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.
__u32	*extendedmode*	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>.
__u32	*readbuffers*	Applications set this field to the desired number of buffers used internally by the driver in `read()` 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>.
__u32	*reserved*[4]	Reserved for future extensions. Drivers and applications must set the array to zero.

Table 3. struct v4l2_outputparm

__u32	*capability*	See Table 4>.
__u32	*outputmode*	Set by drivers and applications, see Table 5>.
struct v4l2_fract	*timeperframe*	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

__u32	*extendedmode*	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>.
__u32	*writebuffers*	Applications set this field to the desired number of buffers used internally by the driver in `write()` 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>.
__u32	*reserved*[4]	Reserved for future extensions. Drivers and applications must set the array to zero.

Table 4. Streaming Parameters Capabilites

`V4L2_CAP_TIMEPERFRAME`	0x1000	The frame skipping/repeating controlled by the *timeperframe* field is supported.

Table 5. Capture Parameters Flags

`V4L2_MODE_HIGHQUALITY`	0x0001	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:• The driver may be able to capture higher resolutions than for motion capture. • The driver may support fewer pixel formats than motion capture (e.g. 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 `read()` 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 1. enum v4l2_priority

`V4L2_PRIORITY_UNSET`	0	
`V4L2_PRIORITY_BACKGROUND`	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.
`V4L2_PRIORITY_INTERACTIVE`	2	

`V4L2_PRIORITY_DEFAULT`	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.
`V4L2_PRIORITY_RECORD`	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 can call the `VIDIOC_G_SLICED_VBI_CAP` ioctl. It takes a pointer to a struct v4l2_sliced_vbi_cap which is filled by the driver.

Table 1. struct v4l2_sliced_vbi_cap

<table>
<tr><td>__u16</td><td>service_set</td><td>A set of all data services supported by the driver. Equal to the union</td></tr>
<tr><td>__u16</td><td>service_lines[2][24]</td><td>Each element of this array contains a set of data services the hardwa
<table>
<tr><td>Element</td><td>525 line systems</td><td>625 line systems</td></tr>
<tr><td>service_lines[0][1]</td><td>1</td><td>1</td></tr>
<tr><td>service_lines[0][23]</td><td>23</td><td>23</td></tr>
<tr><td>service_lines[1][1]</td><td>264</td><td>314</td></tr>
<tr><td>service_lines[1][23]</td><td>286</td><td>336</td></tr>
</table>
The number of VBI lines the hardware can capture or output per fra</td></tr>
</table>

		Drivers must set *service_lines*[0][0] and *service_lines*[1][0]
__u32	*reserved*[4]	This array is reserved for future extensions. Drivers must set it to zer

Table 2. Sliced VBI services

Symbol	Value	Reference	Lines, usually	Payload
`V4L2_SLICED_TELETEXT_B` (Teletext System B)	0x0001	TELETEXT>	PAL/SECAM line 7-22, 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.
`V4L2_SLICED_VPS`	0x0400	VPS>	PAL line 16	Byte number 3 to 15 according to Figure 9 of ETS 300 231, lsb first transmitted.
`V4L2_SLICED_CAPTION_525`	0x1000	EIA608>	NTSC line 21, 284 (second field 21)	Two bytes in transmission order, including parity bit, lsb first transmitted.
`V4L2_SLICED_WSS_625`	0x4000	WSS>	PAL/SECAM line 23	`Byte 0 1` `msb lsb msb` `Bit 7 6 5 4 3 2 1 0 x x 13 12`
`V4L2_SLICED_VBI_525`	0x1000	Set of services applicable to 525 line systems.		
`V4L2_SLICED_VBI_625`	0x4401	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.

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.

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 1. struct v4l2_tuner

__u32	*index*	Identifies the tuner, set by the application.
__u8	*name*[32]	Name of the tuner, a NUL-terminated ASCII string.
enum v4l2_tuner_type	*type*	Type of the tuner, see Table 2>.

__u32	*capability*	Tuner capability flags, see Table 3>. Audio flags inc
__u32	*rangelow*	The lowest tunable frequency in units of 62.5 kHz, o
__u32	*rangehigh*	The highest tunable frequency in units of 62.5 kHz,
__u32	*rxsubchans*	Some tuners or audio decoders can determine the re
		`V4L2_TUNER_SUB_MONO` receiving mono au
		`STEREO | SAP` receiving stereo au
		`MONO | STEREO` receiving mono or
		`LANG1 | LANG2` receiving bilingua
		`MONO | STEREO | LANG1 | LANG2` receiving mono, st
		When the `V4L2_TUNER_CAP_STEREO`, `_LANG1`, `_L`
__u32	*audmode*	The selected audio mode, see Table 5> for valid val
__u32	*signal*	The signal strength if known, ranging from 0 to 655
__s32	*afc*	Automatic frequency control: When the *afc* value i
__u32	*reserved*[4]	Reserved for future extensions. Drivers and applicat

Table 2. enum v4l2_tuner_type

`V4L2_TUNER_RADIO`	1
`V4L2_TUNER_ANALOG_TV`	2

Table 3. Tuner and Modulator Capability Flags

`V4L2_TUNER_CAP_LOW`	0x0001	When set, tuning frequencies are expressed in units of 62.5 Hz, otherwise in units of 62.5 kHz.
`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 v4l2_input pointing to this tuner, see the description of ioctl `VIDIOC_ENUMINPUT` for details. Only `V4L2_TUNER_ANALOG_TV` 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 `V4L2_TUNER_ANALOG_TV` tuners can have this capability.

V4L2_TUNER_CAP_LANG2	0x0020	Reception of the secondary language of a bilingual audio program is supported. Only V4L2_TUNER_ANALOG_TV tuners can have this capability.
V4L2_TUNER_CAP_SAP	0x0020	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 V4L2_TUNER_ANALOG_TV tuners can have this capability. 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.

Table 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	The tuner receives a Second Audio Program. Note the 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.

Table 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 on both channels. When it receives no stereo signal or does not support stereo reception the driver shall behave as in mono mode.

`V4L2_TUNER_MODE_LANG1`	3	Play the primary language, mono or stereo. Only `V4L2_TUNER_ANALOG_TV` 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 `V4L2_TUNER_ANALOG_TV` 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 `V4L2_TUNER_ANALOG_TV` tuners support this mode. Note the `V4L2_TUNER_MODE_LANG2` and `V4L2_TUNER_MODE_SAP` are synonyms.

Table 6. Tuner Audio Matrix

	Selected `V4L2_TUNER_MODE_`			
Received `V4L2_TUNER_SUB_`	**`MONO`**	**`STEREO`**	**`LANG1`**	**`LANG2 / SAP`**
`MONO`	Mono	Mono/Mono	Mono	Mono
`MONO | SAP`	Mono	Mono/Mono	Mono	SAP
`STEREO`	L+R	L/R	Stereo L/R (preferred) or Mono L+R	Stereo L/R (preferred) or Mono L+R
`STEREO | SAP`	L+R	L/R	Stereo L/R (preferred) or Mono L+R	SAP
`LANG1 | LANG2`	Language 1	Lang1/Lang2 (preferred) or Lang1/Lang1	Language 1	Language 2

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 memory mapped buffer applications set the *type* field of a struct v4l2_buffer to the same buffer type as previously struct v4l2_format *type* and struct v4l2_requestbuffers *type*, the *memory* field to `V4L2_MEMORY_MMAP` 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 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` or `V4L2_BUF_TYPE_VBI_OUTPUT`) applications must also initialize the *bytesused*, *field* and *timestamp* fields. See Section 3.5> for details. 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 *type* field of a struct v4l2_buffer to the same buffer type as previously struct v4l2_format *type* and struct v4l2_requestbuffers *type*, the *memory* field to `V4L2_MEMORY_USERPTR` and the *m.userptr* field to the address of the buffer and *length* to its size. When the buffer is intended for output additional fields must be set as above. 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 are 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`* and *`memory`* 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.

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

Insufficient memory 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.

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 previously 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. 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 `V4L2_MEMORY_MMAP`, the *m.offset* contains the offset of the buffer from the start of the device memory, the *length* field its size. 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 individual 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 the EINVAL error code.

Table 1. struct v4l2_capability

__u8	*driver*[16]	Name of the driver, a unique NUL-terminated ASCII string. For example: "bttv". Driver specific applications shall use this information to verify the driver identity. It is also useful to work around known bugs, or to print the driver name and version in an error report to aid debugging. The driver version is stored in the *version* 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 properly terminate the strings.

__u8	*card*[32]	Name of the device, a NUL-terminated ASCII string. For example: "Yoyodyne TV/FM". Remember that one driver may support different brands or models of video hardware. This information can be used to build a menu of available devices for a device-select user interface. Since drivers may support multiple installed devices this name should be combined with the *bus_info* string to avoid ambiguities.
__u8	*bus_info*[32]	Location of the device in the system, a NUL-terminated ASCII string. For example: "PCI Slot 4". This information is intended for the user, 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 (*bus_info*[0] = 0). [pci_dev->slot_name example].
__u32	*version*	Version number of the driver. Together with the *driver* field this identifies a particular driver. The version number is formatted using the `KERNEL_VERSION()` macro:

```
#define KERNEL_VERSION(a,b,c) (((a) << 16) + ((b) << 8) + (c)) __u32 version = KERNEL_V
```

__u32	*capabilities*	Device capabilities, see Table 2>.
__u32	*reserved*[4]	Reserved for future extensions. Drivers must set this array to zero.

Table 2. Device Capabilities Flags

`V4L2_CAP_VIDEO_CAPTURE`	0x00000001	The device supports the video capture interface.
`V4L2_CAP_VIDEO_OUTPUT`	0x00000002	The device supports the video output interface.
`V4L2_CAP_VIDEO_OVERLAY`	0x00000004	The device supports the video overlay interface. Overlay typically stores captured images directly in the video memory of a graphics card, with support for clipping.
`V4L2_CAP_VBI_CAPTURE`	0x00000010	The device supports the VBI capture interface, see Section 4.6>, Section 4.7>.
`V4L2_CAP_VBI_OUTPUT`	0x00000020	The device supports the VBI output interface, see Section 4.6>, Section 4.7>.
`V4L2_CAP_RDS_CAPTURE`	0x00000100	[to be defined]
`V4L2_CAP_TUNER`	0x00010000	The device has some sort of tuner or modulator to receive or emit RF-modulated video signals. For more information see Section 1.6>.

`V4L2_CAP_AUDIO`	0x00020000	The device has audio inputs or outputs. For more information see Section 1.5>. It may or may not support PCM sampling or output, this function must be implemented as ALSA or OSS PCM interface.
`V4L2_CAP_READWRITE`	0x01000000	The device supports the read() and/or write() 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.

Return Value

On success 0 is returned, on error -1 and the `errno` variable is set appropriately:

EINVAL

The kernel 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`, or starting from `V4L2_CID_PRIVATE_BASE` until the driver returns EINVAL. When the `V4L2_CTRL_FLAG_DISABLED` flag is set in the *`flags`* field, this control is permanently disabled and should be ignored by the application.[1]

Additional information is required for menu controls, the name of 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`* (0) to *`maximum`*, inclusive.

Table 1. struct v4l2_queryctrl

__u32	*id*	Identifies the control, set by the application. See Table 1-1> for predefined IDs.
enum v4l2_ctrl_type	*type*	Type of control, see Table 3>.
__u8	*name*[32]	Name of the control, a NUL-terminated ASCII string. This information is intended for the user.
__s32	*minimum*	Minimum value, inclusive. This field is mostly useful to define a lower bound for integer controls. Note the value is signed.
__s32	*maximum*	Maximum value, inclusive. Note the value is signed.
__s32	*step*	Generally drivers should not scale hardware control values. It may be necessary for example when the *name* or *id* 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. This field reports 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. Note although signed, the step value is supposed to be always positive.
__s32	*default_value*	The default value of the control. Drivers reset controls only when the driver is loaded, not later, in particular not when the `open()` is called.
__u32	*flags*	Control flags, see Table 4>.
__u32	*reserved*[2]	Reserved for future extensions. Drivers must set the array to zero.

Table 2. struct v4l2_querymenu

__u32	*id*	Identifies the control, set by the application from the respective struct v4l2_queryctrl *id*.
__u32	*index*	Index of the menu item, starting at zero, set by the application.
__u8	*name*[32]	Name of the menu item, a NUL-terminated ASCII string. This information is intended for the user.
__u32	*reserved*	Reserved for future extensions. Drivers must set the array to zero.

Table 3. enum v4l2_ctrl_type

Type	*minimum*	*step*	*maximum*	Description
`V4L2_CTRL_TYPE_INTEGER`	low value	increment (positive) [__u32?]	high value	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.
`V4L2_CTRL_TYPE_BOOLEAN`	0	1	1	A boolean-valued control. Zero corresponds to "disabled", and one means "enabled".
`V4L2_CTRL_TYPE_MENU`	0	1	N-1	The control has a menu of N choices. The names of the menu items can be enumerated with the `VIDIOC_QUERYMENU` ioctl.
`V4L2_CTRL_TYPE_BUTTON`	0	0	0	A control which performs an action when set. Drivers must ignore the value passed with `VIDIOC_S_CTRL` and return an EINVAL error code on a `VIDIOC_G_CTRL` attempt.

Table 4. Control Flags

`V4L2_CTRL_FLAG_DISABLED`	0x0001	This control is permanently disabled and should be ignored by the application. An attempt to change this control results 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. An attempt to change a "grabbed" control results in an EBUSY error code.

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`* or *`index`* is invalid.

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 custom controls after hardware detection without the trouble of reordering control arrays and indices.`

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.

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.

To allocate device buffers applications initialize three fields of a v4l2_requestbuffers structure. They set the *type* field to the respective stream or buffer type, the *count* field to the desired number of buffers, and *memory* must be set to `V4L2_MEMORY_MMAP`. When the ioctl is called with a pointer to this structure the driver attempts to allocate the requested number of buffers and 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 possible when the driver requires more buffers to function correctly.[1] When memory mapping I/O 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 zero frees all buffers, after aborting or finishing any DMA in progress, an implicit `VIDIOC_STREAMOFF`.

To negotiate user pointer I/O, applications initialize only the *type* field and set *memory* to `V4L2_MEMORY_USERPTR`. When the ioctl is called with a pointer to this structure the driver prepares for user pointer I/O, when this I/O method is not supported the ioctl returns an EINVAL error code.

Table 1. struct v4l2_requestbuffers

__u32	*count*	The number of buffers requested or granted. This field is only used when *memory* is set to V4L2_MEMORY_MMAP.
enum v4l2_buf_type	*type*	Type of the stream or buffers, this is the same as the struct v4l2_format *type* field. See Table 3-2> for valid values.
enum v4l2_memory	*memory*	Applications set this field to V4L2_MEMORY_MMAP or V4L2_MEMORY_USERPTR.
__u32	*reserved*[32]	A place holder for future extensions and custom (driver defined) buffer types V4L2_BUF_TYPE_PRIVATE and higher.

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.

Notes

1. For example video output requires at least two buffers, one displayed and one filled by the application.

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 ioctls 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.

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.

prot

The *prot* argument describes the desired memory protection. It must be set to `PROT_READ` | `PROT_WRITE`, indicating pages may be read and written. This is a technicality independent of the device type and direction of data exchange. Note device memory accesses may incur a performance penalty. It can happen when writing to capture buffers, when reading from output buffers, or always. When the application intends to modify buffers, other I/O methods may be more efficient.

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.

`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 to share this mapping with all other processes that map this object. `MAP_PRIVATE` requests copy-on-write semantics. We recommend to set `MAP_SHARED`. The `MAP_PRIVATE`, `MAP_DENYWRITE`, `MAP_EXECUTABLE` and `MAP_ANON` flags should not be set.

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.

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.

EACCESS

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.) Or no buffers have been allocated with the `VIDIOC_REQBUFS` ioctl.

ENOMEM

No memory is available.

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.

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

Insufficient kernel memory was available.

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

All drivers implementing the `read()` or `write()` function or streaming I/O must also support the `poll()` function. See the `poll()` manual page for details.

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 streaming parameter ioctls, see ##streaming-par. They are optional, however. The discarding policy is not reported and cannot be changed. For minimum requirements see the respective device interface section in ##.

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 is outside your accessible address space.

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 n, fd_set *readfds, fd_set *writefds, fd_set *exceptfds,
struct timeval *timeout);
```

Description

All drivers implementing the `read()` or `write()` function or streaming I/O must also support the `select()` function. See the `select()` manual page for details.

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*. If *count* is zero, 0 will be returned without causing any other effect. [implementation tbd]

When the application does not provide more data in time, the previous frame is displayed again.

Return Value

On success, the number of bytes written are returned. Zero indicates nothing was written. [tbd] 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 O_NONBLOCK and no buffer space was available to write the data immediately. [tbd]

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` is outside your accessible address space.

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.

Chapter 5. V4L2 Driver Programming

to do

Chapter 6. History

The following chapters document the evolution of the V4L2 API, errata or extensions. They shall also aid application and driver writers porting their software to later versions of V4L2.

6.1. 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, developped 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 in the future, either directly or through the V4L2 compatibility layer. For a transition period not all drivers will support the V4L2 API.

6.1.1. Opening and Closing Devices

For compatibility reasons the character device file names recommended for V4L2 video capture, overlay, radio, teletext and raw vbi capture devices did not change from those used by V4L. They are listed in Chapter 4> and below in Table 6-1>.

The V4L "videodev" module automatically assigns minor numbers to drivers in load order, depending on the registered device type. We recommend V4L2 drivers by default register devices with the same numbers, but in principle the system administrator can assign arbitrary minor numbers using driver module options. The major device number remains 81.

Table 6-1. V4L Device Types, Names and Numbers

Device Type	File Name	Minor Numbers
Video capture and overlay	`/dev/video` and `/dev/bttv0`[a], `/dev/video0` to `/dev/video63`	0-63
Radio receiver	`/dev/radio`[b], `/dev/radio0` to `/dev/radio63`	64-127
Teletext decoder	`/dev/vtx`, `/dev/vtx0` to `/dev/vtx31`	192-223
Raw VBI capture	`/dev/vbi`, `/dev/vbi0` to `/dev/vbi15`	224-239[c]

Notes: a. According to Documentation/devices.txt these should be symbolic links to `/dev/video0`. Note the origina

V4L prohibits (or used to) multiple opens. V4L2 drivers *may* support multiple opens, see Section 1.1> for details and consequences.

V4L drivers respond to V4L2 ioctls with the EINVAL error code. The V4L2 "videodev" module backward compatibility layer 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>.

6.1.2. 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.
`VID_TYPE_CHROMAKEY`	`V4L2_FBUF_CAP_CHROMAKEY` in field *capability* 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_CLIPPING` and `V4L2_FBUF_CAP_BITMAP_CLIPPING` in field *capability* of struct v4l2_framebuffer	Whether clipping the overlaid image is supported, see Section 4.2>.
`VID_TYPE_FRAMERAM`	`V4L2_FBUF_CAP_EXTERNOVERLAY` *not set* in field *capability* 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 1.10>.
`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 1.10>.

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.

6.1.3. Video Sources

V4L provides the VIDIOCGCHAN and VIDIOCSCHAN ioctl using struct video_channel to enumerate the video inputs of a V4L device. The equivalent V4L2 ioctls 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:

struct video_channel *type*	struct v4l2_input *type*
VIDEO_TYPE_TV	V4L2_INPUT_TYPE_TUNER
VIDEO_TYPE_CAMERA	V4L2_INPUT_TYPE_CAMERA

Unlike the *tuners* field expressing the number of tuners of this input, V4L2 assumes each video input is associated with at most one tuner. On the contrary a tuner can have more than one input, i.e. RF connectors, and a device can have multiple tuners. The index 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 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.

6.1.4. 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 ioctls 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*, *rangelow* and *rangehigh* 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 ioctls 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.

6.1.5. 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` ioctls:

struct video_picture	V4L2 Control ID
brightness	`V4L2_CID_BRIGHTNESS`
hue	`V4L2_CID_HUE`
colour	`V4L2_CID_SATURATION`
contrast	`V4L2_CID_CONTRAST`
whiteness	`V4L2_CID_WHITENESS`

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 explicitely 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 *palette*	struct v4l2_pix_format *pixfmt*
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
Notes: a. This is a custom format used by the BTTV driver, not one of the V4L2 standard formats. b. Presumably al	

V4L2 image formats are defined in Chapter 2>. The image format can be selected with the `VIDIOC_S_FMT` ioctl.

6.1.6. 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 `VIDIOCSAUDIO` 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 `VIDIOCGAUDIO` 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 where replaced by V4L2 controls accessible with the `VIDIOC_QUERYCTRL`, `VIDIOC_G_CTRL` and `VIDIOC_S_CTRL` ioctls:

struct video_audio	V4L2 Control ID
volume	V4L2_CID_AUDIO_VOLUME
bass	V4L2_CID_AUDIO_BASS
treble	V4L2_CID_AUDIO_TREBLE
balance	V4L2_CID_AUDIO_BALANCE

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 where 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>.

6.1.7. 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 using a flag to indicate non-destructive overlay instead of a `NULL` pointer. All other fields moved into the struct v4l2_pix_format substructure *fmt* of struct v4l2_framebuffer. The *depth* field was replaced by *pixelformat*. A conversion table is available in the Section 2.3>.

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 struct v4l2_window named *win* of its *fmt* union is used.

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, renamed to `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`.

6.1.8. Cropping

To capture only a subsection of the full picture V4L provides the `VIDIOCGCAPTURE` and `VIDIOCSCAPTURE` ioctl 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 1.10> 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. 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 determine the capture or overlay format with the VIDIOC_S_FMT ioctl.

6.1.9. Reading Images, Memory Mapping

6.1.9.1. Capturing using the read method

There is no essential difference between reading images from a V4L or V4L2 device using the read() function. Supporting this method is optional for V4L2 devices. Whether the function is available can be determined with the VIDIOC_QUERYCAP ioctl. All V4L2 devices exchanging data with applications must support the select() and poll() function.

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>.

6.1.9.2. 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 copy 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 VIDIOC_S_FMT 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 allocated. The number is built into the driver, unless it has a module option to change the number when the driver module is loaded.	The VIDIOC_REQBUFS ioctl allocates the desired number of buffers, this is a required step in the initialization sequence.
Drivers map all buffers as one contiguous range of memory. The VIDIOCGMBUF 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 to the mmap() function.	Buffers are individually mapped. The offset and size of each buffer can be determined with the VIDIOC_QUERYBUF ioctl.

V4L	V4L2
The `VIDIOCMCAPTURE` ioctl prepares a buffer for capturing. It also determines the image format for this buffer. The ioctl returns immediately, eventually with an EAGAIN 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 `VIDIOCSYNC` ioctl suspends execution until a particular buffer has been filled.	Drivers maintain an incoming and outgoing queue. `VIDIOC_QBUF` enqueues any empty buffer into the incoming queue. Filled buffers are dequeued from the outgoing queue with the `VIDIOC_DQBUF` ioctl. To wait until filled buffers become available this function, `select()` or `poll()` can be used. The `VIDIOC_STREAMON` ioctl must be called once after enqueuing one or more buffers to start capturing. Its counterpart `VIDIOC_STREAMOFF` stops capturing and dequeues all buffers from both queues. Applications can query the signal status, if known, with the `VIDIOC_ENUMINPUT` ioctl.

For a more in-depth discussion of memory mapping and examples, see Section 3.2>.

6.1.10. Reading Raw VBI Data

Originally the V4L API did not specify a raw VBI capture interface, merely 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
sampling_rate	28636363 Hz NTSC (precisely all 525-line standards); 35468950 Hz PAL and SECAM (625-line)
offset	?
samples_per_line	2048
sample_format	V4L2_PIX_FMT_GREY. The last four bytes (machine endianess integer) contain a frame counter.
start[]	10, 273 NTSC; 22, 335 PAL and SECAM
count[]	16, 16[a]
flags	0
Notes: a. Old driver versions used different values, eventually the custom `BTTV_VBISIZE` ioctl was added to query th	

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 4.6>.

An *`offset`* field does not exist, *`sample_format`* is supposed to be `VIDEO_PALETTE_RAW`, here 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 the EINVAL error code if the parameters are invalid.

6.1.11. 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>.

Presently no replacement exists for `VIDIOCKEY`, the V4L functions regarding MPEG compression and decompression, and microcode programming. Drivers may implement the respective V4L ioctls for these purposes.

6.2. History 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 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.

6.2.1. Early Versions

1998-08-20: First version.

1998-08-27: select() function was introduced.

1998-09-10: New video standard interface.

1998-09-18: The VIDIOC_NONCAP ioctl was replaced by the O_TRUNC open() flag (with synonym O_NONCAP/O_NOIO) to indicate a non-capturing open. The VIDEO_STD_XXX identifiers are now ordinals rather than bits, and video_std_construct helper function takes id and transmission as arguments.

1998-09-28: Revamped video standard. Made video controls individually enumerable.

1998-10-02: Removed id from video_standard, renamed color subcarrier fields. Renamed VIDIOC_QUERYSTD to VIDIOC_ENUMSTD and VIDIOC_G_INPUT to VIDIOC_ENUMINPUT. Added preliminary /proc/videodev file. First draft of CODEC driver API spec.

1998-11-08: Updating for many minor changes to the V4L2 spec. Most symbols have been renamed. Some material changes to v4l2_capability.

1998-11-12 bugfix: some of the VIDIOC_* symbols were not constructed with the right macros, which could lead to errors on what should have been valid ioctl() calls.

1998-11-14: V4L2_PIX_FMT_RGB24 changed to V4L2_PIX_FMT_BGR24. Same for RGB32. Audio UI controls moved to VIDIOC_S_CTRL system and assigned V4L2_CID_AUDIO_* symbols. Removed V4L2_MAJOR from videodev.h since it is only used at one place in videodev. Added YUV422 and YUV411 planar formats.

1998-11-28: Changed a few ioctl symbols. Added stuff for codec and video output devices.

1999-01-14: Added raw VBI interface.

1999-01-19: Removed VIDIOC_NEXTBUF ioctl.

6.2.2. 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.

6.2.3. 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.

6.2.4. 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.

6.2.5. V4L2 Version 0.20 1999-09-10

Version 0.20 introduced a number of changes not backward compatible with 0.19 and earlier. The purpose was to simplify the API, while at the same time make it more extensible, and follow common Linux driver API conventions.

1. Fixed typos in some V4L2_FMT_FLAG symbols. Changed struct v4l2_clip to be compatible with v4l. (1999-08-30)
2. Added V4L2_TUNER_SUB_LANG1. (1999-09-05)
3. All ioctl() commands that took an integer argument before, will now take a pointer to an integer. Where it makes sense, the driver will return the actual value used in the integer pointed to by the argument. This is a common convention, and also makes certain things easier in libv4l2 and other system code when the parameter to ioctl() is always a pointer. The ioctl commands affected are: VIDIOC_PREVIEW, VIDIOC_STREAMON, VIDIOC_STREAMOFF, VIDIOC_S_FREQ, VIDIOC_S_INPUT, VIDIOC_S_OUTPUT, VIDIOC_S_EFFECT. For example, where before you might have had code like:

```
err = ioctl (fd, VIDIOC_XXX, V4L2_XXX);
```

that becomes

```
int a = V4L2_XXX; err = ioctl(fd, VIDIOC_XXX, &a);
```

4. All the different set-format ioctl() commands are swept into a single set-format command whose parameter consists of an integer value indicating the type of format, followed by the format data. The same for the get-format commands, of course. This will simplify the API by eliminating several ioctl codes and also make it possible to add additional kinds of data streams, or driver-private kinds of streams without having to add more set-format ioctls. The parameter to VIDIOC_S_FMT is as follows. The first field is a V4L2_BUF_TYPE_XXX value that indicates which stream the set-format is for, and implicitly, what type of format data. After that is a union of the different format structures. More can be added later without breaking backward compatibility. Nonstandard driver-private formats can be used by casting raw_data.

   ```
   struct v4l2_format {
           __u32           type;
           union {
                   struct v4l2_pix_format          pix;
                   struct v4l2_vbi_format          vbi;
                    ... and so on ...
                   __u8                            raw_data[200];
           }               fmt;
   };
   ```

   For a get-format, the application fills in the type field, and the driver fills in the rest. What was before the image format structure, struct v4l2_format, becomes struct v4l2_pix_format. These ioctls become obsolete: VIDIOC_S_INFMT, VIDIOC_G_INFMT, VIDIOC_S_OUTFMT, VIDIOC_G_OUTFMT, VIDIOC_S_VBIFMT VIDIOC_G_VBIFMT.

5. Similar to item 2, VIDIOC_G/S_PARM and VIDIOC_G/S_OUTPARM are merged, along with the corresponding 'get' functions. A type field will indicate which stream the parameters are for, set to a V4L2_BUF_TYPE_* value.

   ```
   struct v4l2_streamparm {
           __u32           type;
           union {
                   struct v4l2_captureparm         capture;
                   struct v4l2_outputparm          output;
                   __u8                            raw_data[200];
           }               parm;
   };
   ```

   These ioctls become obsolete: VIDIOC_G_OUTPARM, VIDIOC_S_OUTPARM.

6. The way controls are enumerated is simplified. Simultaneously, two new control flags are introduced and the existing flag is dropped. Also, the catname field is dropped in favor of a group name. To enumerate controls call VIDIOC_QUERYCTRL with successive id's starting from V4L2_CID_BASE or V4L2_CID_PRIVATE_BASE and stop when the driver returns the EINVAL error code. Controls that are not supported on the hardware are marked with the V4L2_CTRL_FLAG_DISABLED flag.

   Additionally, controls that are temporarily unavailable, or that can only be controlled from another file descriptor are marked with the V4L2_CTRL_FLAG_GRABBED flag. Usually, a control that is GRABBED, but not DISABLED can be read, but changed. 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 even be in separate windows.

7. The v4l2_buffer timestamp field is changed to a 64-bit integer, and holds the time of the frame based on the system time, in 1 nanosecond units. Additionally, timestamps will be in absolute system time, not starting from zero at the beginning of a stream as it is now. 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://reality.sgi.com/cpirazzi_engr/lg/time/intro.html. [This link is no longer valid.] 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. The sequence field is added to the struct v4l2_buffer. The sequence field indicates which frame this is in the sequence-- 0, 1, 2, 3, 4, etc. Set by capturing devices. Ignored by output devices. If a capture driver drops a frame, the sequence number of that frame is skipped. A break in the sequence will indicate to the application which frame was dropped.

6.2.6. V4L2 Version 0.20 incremental changes

1999-12-23: In struct v4l2_vbi_format field *reserved1* became *offset*. Previously *reserved1* was required to always read zero.

2000-01-13: Added V4L2_FMT_FLAG_NOT_INTERLACED.

2000-07-31: Included linux/poll.h in videodev.h for compatibility with the original videodev.h.

2000-11-20: Added V4L2_TYPE_VBI_OUTPUT. Added V4L2_PIX_FMT_Y41P.

2000-11-25: Added V4L2_TYPE_VBI_INPUT.

2000-12-04: Fixed a couple typos in symbol names.

2001-01-18: Fixed a namespace conflict (the fourcc macro changed to v4l2_fourcc).

2001-01-25: Fixed a possible driver-level compatibility problem between the original 2.4.0 videodev.h and the videodev.h that comes with videodevX. If you were using an earlier version of videodevX on 2.4.0, then you should recompile your v4l and V4L2 drivers to be safe.

2001-01-26: videodevX: Fixed a possible kernel-level incompatibility between the videodevX videodev.h and the 2.2.x videodev.h that had the devfs patches applied. videodev: Changed fourcc to v4l2_fourcc to avoid namespace pollution. Some other cleanup.

2001-03-02: Certain v4l ioctls that really pass data both ways, but whose types are read-only, did not work correctly through the backward compatibility layer. [Solution?]

2001-04-13: Added big endian 16-bit RGB formats.

2001-09-17: Added new YUV formats. Added VIDIOC_G_FREQUENCY and VIDIOC_S_FREQUENCY. (The VIDIOC_G/S_FREQ ioctls did not take multiple tuners into account.)

2000-09-18: Added V4L2_BUF_TYPE_VBI. Raw VBI VIDIOC_G_FMT and VIDIOC_S_FMT may fail if field `type` is not V4L2_BUF_TYPE_VBI. Changed the ambiguous phrase "rising edge" to "leading edge" in the definition of struct v4l2_vbi_format field `offset`.

6.2.7. V4L2 Version 0.20 2000-11-23

A number of changes were made to the raw VBI interface.

1. Added figures clarifying the line numbering scheme. The description of `start`[0] and `start`[1] as base 0 offset has been dropped. Rationale: a) The previous definition was unclear. b) The `start`[] values are not an offset into anything, as a means of identifying scanning lines it can only be counterproductive to deviate from common numbering conventions. Compatibility: Add one to the start values. Applications depending on the previous semantics of start values 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 allocating resources at scanning line granularity and first field only data services. The comment that both 'count' values will usually be equal is misleading and pointless and has been removed. Compatibility: Drivers may return EINVAL, applications depending on the previous restriction may not function correctly.
3. Restored description of the driver option to return negative start values. Existed in the initial revision of this document, not traceable why it disappeared in later versions. Compatibility: Applications depending on the returned start values being positive may not function correctly. Clarification on the use of EBUSY and EINVAL in VIDIOC_S_FMT ioctl. Added EBUSY paragraph to section. Added description of reserved2, previously mentioned only in videodev.h.
4. Added V4L2_TYPE_VBI_INPUT and V4L2_TYPE_VBI_OUTPUT here and in videodev.h. The first is an alias for the older V4L2_TYPE_VBI, the latter was missing in videodev.h.

6.2.8. V4L2 Version 0.20 2002-07-25

Added sliced VBI interface proposal.

6.2.9. 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 device type. All V4L2 drivers exchanging data with applications must support the `O_NONBLOCK` flag. The `O_NOIO` flag (alias of meaningless `O_TRUNC`) to indicate accesses without data exchange (panel applications) was dropped. Drivers must assume panel mode until the application attempts to initiate 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 (as of yet unspecified) 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. Field *type* became a set in response to the change above and was merged with *flags*. `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` merged to `V4L2_CAP_READWRITE`.

   Redundant fields *inputs*, *outputs*, *audios* were removed, these 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 1.9> and Section 1.7>.

   `V4L2_FLAG_SELECT` was removed, this function is considered important enough that all V4L2 drivers exchanging data with applications must support `select()`. The redundant flag `V4L2_FLAG_MONOCHROME` was removed, this information is available as described in Section 1.9>.

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* where added.

5. The struct v4l2_audio field *audio* was renamed to *index*, consistent with other structures. Capability flag `V4L2_AUDCAP_STEREO` was added to indicated if this is a stereo input. `V4L2_AUDCAP_EFFECTS` and the corresponding `V4L2_AUDMODE` flags where removed, this can be easily implemented using controls. (However the same applies to AVL which is still there.)

   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 the tuner they are on. 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. To this end V4L2 returned to defined standards as v4l2_std_id, replacing references to standards throughout the API. For details see Section 1.7>. `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. 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. *framerate*, which is misleading, was renamed to *frameperiod*. The

now obsolete *colorstandard* information, originally needed to distguish 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. As a result all data format negotiation is now possible with `VIDIOC_G_FMT`, `VIDIOC_S_FMT` and `VIDIOC_TRY_FMT`; the `VIDIOC_G_WIN`, `VIDIOC_S_WIN` and ioctl to prepare for overlay were removed. The *type* field changed to type enum v4l2_buf_type and the buffer type names changed as follows.

Old defines	enum v4l2_buf_type
V4L2_BUF_TYPE_CAPTURE	V4L2_BUF_TYPE_VIDEO_CAPTURE
V4L2_BUF_TYPE_CODECIN	Preliminary omitted
V4L2_BUF_TYPE_CODECOUT	Preliminary omitted
V4L2_BUF_TYPE_EFFECTSIN	Preliminary omitted
V4L2_BUF_TYPE_EFFECTSIN2	Preliminary omitted
V4L2_BUF_TYPE_EFFECTSOUT	Preliminary omitted
V4L2_BUF_TYPE_VIDEOOUT	V4L2_BUF_TYPE_VIDEO_OUTPUT
-	V4L2_BUF_TYPE_VIDEO_OVERLAY
-	V4L2_BUF_TYPE_VBI_CAPTURE
-	V4L2_BUF_TYPE_VBI_OUTPUT
V4L2_BUF_TYPE_PRIVATE_BASE	V4L2_BUF_TYPE_PRIVATE

10. In struct v4l2_fmtdesc a enum v4l2_buf_type field named *type* was added as in struct v4l2_format. As a result the `VIDIOC_ENUM_FBUFFMT` 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* was removed, assuming applications recognizing the format are aware of the image depth and others need not know. 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 image formats in kernel space. The `V4L2_FMT_FLAG_BYTESPERLINE` flag was redundant, applications can set the *bytesperline* field to zero to get a reasonable default. Since also the remaining flags were replaced, 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 v4l2_field
V4L2_FMT_FLAG_NOT_INTERLACED	?
V4L2_FMT_FLAG_INTERLACED = V4L2_FMT_FLAG_COMBINED	V4L2_FIELD_INTERLACED

Old flag	**enum v4l2_field**
`V4L2_FMT_FLAG_TOPFIELD` = `V4L2_FMT_FLAG_ODDFIELD`	`V4L2_FIELD_TOP`
`V4L2_FMT_FLAG_BOTFIELD` = `V4L2_FMT_FLAG_EVENFIELD`	`V4L2_FIELD_BOTTOM`
-	`V4L2_FIELD_SEQ_TB`
-	`V4L2_FIELD_SEQ_BT`
-	`V4L2_FIELD_ALTERNATE`

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 typed 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 mapping 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 typed 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 field flags were removed. Realizing the efforts to introduce an unadjusted system time clock failed, the *`timestamp`* field changed back from type stamp_t, an unsigned 64 bit integer expressing 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 mapping 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 has been 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`* field 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 where redefined for this purpose. See Section 1.10> 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. `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. A new field *readbuffers* was added to control the driver behaviour in read I/O mode.

    According 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 the application.
21. The example transformation from RGB to YCbCr color space in the old V4L2 documentation was inaccurate, this has been corrected in Chapter 2>.

6.2.10. 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 soley by having exactly one tuner whose type field reads `V4L2_TUNER_RADIO`.
2. An optional 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 will be removed in the future. 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 to the new versions, drivers and applications must be updated when they are recompiled.
4. The `VIDIOC_OVERLAY` ioctl was incorrectly defined with read-write parameter. It was changed to write-only, while the read-write version was renamed to `VIDIOC_OVERLAY_OLD`. This function will be removed in the future. Until further the "videodev" 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` were defined with write-only parameter, inconsistent with other ioctls modifying their argument. They were changed to read-write, while a `_OLD` suffix was added to the write-only version. These functions will be removed in the future. Drivers, and applications assuming a constant parameter, need an update.

6.2.11. V4L2 2003-11-05

1. In Section 2.3> the following pixel formats were incorrectly transferred from Bill Dirks' V4L2 specification. Descriptions refer to bytes in memory, in ascending address order.

Symbol	In this document prior to revision 0.5	Correct
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 6.1.5> the mapping of VIDEO_PALETTE_RGB24 and VIDEO_PALETTE_RGB32 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 2.3>.

6.2.12. V4L2 in Linux 2.6.6, 2004-05-09

1. The VIDIOC_CROPCAP ioctl was incorrectly defined with read-only parameter. It was changed to read-write, while the read-only version was renamed to VIDIOC_CROPCAP_OLD. This function will be removed in the future.

6.2.13. V4L2 in Linux 2.6.8

1. A new field *input* (former *reserved[0]*) was added to the struct v4l2_buffer structure. It must be enabled with the new V4L2_BUF_FLAG_INPUT flag. The *flags* field is no longer read-only.

6.2.14. V4L2 spec erratum 2004-08-01

1. The return value of the V4L2 open()(2)> function was incorrect.
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 VIDIOC_QBUF and VIDIOC_DQBUF ioctl did not mention the struct v4l2_buffer *memory* field, it was also missing from examples. Added description of the VIDIOC_DQBUF EIO error.

6.2.15. V4L2 in Linux 2.6.14

1. A new sliced VBI interface (see Section 4.7>) was added. It replaces the interface proposed in V4L2 specification 0.8.

6.2.16. 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 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.

6.2.17. V4L2 spec erratum 2005-11-27

The capture example in Appendix B> called `VIDIOC_S_CROP` without checking if cropping (`VIDIOC_CROPCAP`) is supported. In the video standard selection example in Section 1.7> the `VIDIOC_S_STD` call used the wrong argument type.

6.2.18. V4L2 spec erratum 2006-01-10

1. The `V4L2_IN_ST_COLOR_KILL` flag in struct v4l2_input does not only indicate if the color killer is enabled, but also if it is active (disabling color decoding because it detects no color modulation).
2. `VIDIOC_S_PARM` is a read/write ioctl, not write-only as stated on the respective function reference page. The ioctl changed in 2003 as noted above.

6.2.19. 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.

6.3. Relation of V4L2 to other Linux multimedia APIs

6.3.1. 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 XPixmaps[1]. 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 non-destructive overlay. It can program the RAMDAC for 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, 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 mentioned 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 can be used to improve displaying captured images.

6.3.2. Digital Video

V4L2 does not, at this time and possibly never, support digital terrestrial, cable or satellite broadcast. A separate project aiming at digital receivers exists. You can find its homepage at http://linuxtv.org. This group found the requirements sufficiently different from analog television to choose independent development of their interfaces.

6.3.3. Audio Interfaces

[to do - OSS/ALSA]

Notes

1. This is not implemented in XFree86.

Appendix A. Video For Linux Two Header File

```
#ifndef __LINUX_VIDEODEV2_H
#define __LINUX_VIDEODEV2_H
/*
 *      Video for Linux Two
 *
 *      Header file for v4l or V4L2 drivers and applications, for
 *      Linux kernels 2.2.x or 2.4.x.
 *
 *      See http://bytesex.org/v4l/ for API specs and other
 *      v4l2 documentation.
 *
 *      Author: Bill Dirks <bdirks@pacbell.net>
 *              Justin Schoeman
 *              et al.
 */
#ifdef __KERNEL__
#include <linux/time.h> /* need struct timeval */
#include <linux/poll.h>
#if LINUX_VERSION_CODE < KERNEL_VERSION(2,5,69)
#include <linux/devfs_fs_kernel.h>
#endif
#if LINUX_VERSION_CODE > KERNEL_VERSION(2,5,0)
#include <linux/device.h>
#endif
#endif
#include <linux/compiler.h> /* need __user */


#define OBSOLETE_OWNER 1 /* It will be removed for 2.6.15 */
#define HAVE_V4L2 1

/*
 * Common stuff for both V4L1 and V4L2
 * Moved from videodev.h
 */

#define VIDEO_MAX_FRAME               32

#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 */
#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 */

#ifdef __KERNEL__
```

```
#define VFL_TYPE_GRABBER        0
#define VFL_TYPE_VBI            1
#define VFL_TYPE_RADIO          2
#define VFL_TYPE_VTX            3

struct video_device
{
        /* device info */
#if LINUX_VERSION_CODE >= KERNEL_VERSION(2,6,0)
        struct device *dev;
#endif
        char name[32];
        int type;       /* v4l1 */
        int type2;      /* v4l2 */
        int hardware;
        int minor;

        /* device ops + callbacks */
        struct file_operations *fops;
        void (*release)(struct video_device *vfd);

#if LINUX_VERSION_CODE < KERNEL_VERSION(2,5,0)
        /* old, obsolete interface -- dropped in 2.5.x, don't use it */
        int (*open)(struct video_device *, int mode);
        void (*close)(struct video_device *);
        long (*read)(struct video_device *, char *, unsigned long, int noblock);
        long (*write)(struct video_device *, const char *, unsigned long, int noblock);
        unsigned int (*poll)(struct video_device *, struct file *, poll_table *);
        int (*ioctl)(struct video_device *, unsigned int , void *);
        int (*mmap)(struct video_device *, const char *, unsigned long);
        int (*initialize)(struct video_device *);
#endif

#if OBSOLETE_OWNER /* to be removed in 2.6.15 */
        /* obsolete -- fops->owner is used instead */
        struct module *owner;
        /* dev->driver_data will be used instead some day.
         * Use the video_{get|set}_drvdata() helper functions,
         * so the switch over will be transparent for you.
         * Or use {pci|usb}_{get|set}_drvdata() directly. */
        void *priv;
#endif

        /* for videodev.c intenal usage -- please don't touch */
        int users;                     /* video_exclusive_{open|close} ... */
        struct semaphore lock;         /* ... helper function uses these   */
#if LINUX_VERSION_CODE < KERNEL_VERSION(2,5,69)
        devfs_handle_t devfs_handle;   /* devfs */
#else
        char devfs_name[64];           /* devfs */
#endif
#if LINUX_VERSION_CODE >= KERNEL_VERSION(2,6,0)
        struct class_device class_dev; /* sysfs */
#endif
};
```

```
#define VIDEO_MAJOR     81

extern int video_register_device(struct video_device *, int type, int nr);
extern void video_unregister_device(struct video_device *);
extern int video_usercopy(struct inode *inode, struct file *file,
                          unsigned int cmd, unsigned long arg,
                          int (*func)(struct inode *inode, struct file *file,
                                      unsigned int cmd, void *arg));

/* helper functions to alloc / release struct video_device, the
   later can be used for video_device->release() */
struct video_device *video_device_alloc(void);
void video_device_release(struct video_device *vfd);

#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)<<0)|((__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 */
};
#define V4L2_FIELD_HAS_TOP(field)       \
        ((field) == V4L2_FIELD_TOP      ||\
         (field) == V4L2_FIELD_INTERLACED ||\
         (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_SEQ_TB   ||\
         (field) == V4L2_FIELD_SEQ_BT)
#define V4L2_FIELD_HAS_BOTH(field)      \
        ((field) == V4L2_FIELD_INTERLACED ||\
         (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,
#if 1 /*KEEP*/
        /* Experimental Sliced VBI */
        V4L2_BUF_TYPE_SLICED_VBI_CAPTURE = 6,
        V4L2_BUF_TYPE_SLICED_VBI_OUTPUT  = 7,
#endif
        V4L2_BUF_TYPE_PRIVATE            = 0x80,
};

enum v4l2_ctrl_type {
        V4L2_CTRL_TYPE_INTEGER       = 1,
        V4L2_CTRL_TYPE_BOOLEAN       = 2,
        V4L2_CTRL_TYPE_MENU          = 3,
        V4L2_CTRL_TYPE_BUTTON        = 4,
};

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 colourspaces, 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;
        __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. "bttv" */
        __u8    card[32];       /* i.e. "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 */
#if 1 /*KEEP*/
#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 */
#endif
#define V4L2_CAP_RDS_CAPTURE            0x00000100  /* RDS data capture */

#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_READWRITE              0x01000000  /* read/write systemcalls */
#define V4L2_CAP_ASYNCIO                0x02000000  /* async I/O */
#define V4L2_CAP_STREAMING              0x04000000  /* streaming I/O ioctls */
```

```
/*
 *      V I D E O   I M A G E   F O R M A T
 */

struct v4l2_pix_format
{
        __u32                   width;
        __u32                   height;
        __u32                   pixelformat;
        enum v4l2_field         field;
        __u32                   bytesperline;   /* for padding, zero if unused */
        __u32                   sizeimage;
        enum v4l2_colorspace    colorspace;
        __u32                   priv;           /* private data, depends on pixelformat
};

/*           Pixel format    FOURCC                    depth  Description   */
#define V4L2_PIX_FMT_RGB332  v4l2_fourcc('R','G','B','1') /*  8  RGB-3-3-2     */
#define V4L2_PIX_FMT_RGB555  v4l2_fourcc('R','G','B','O') /* 16  RGB-5-5-5     */
#define V4L2_PIX_FMT_RGB565  v4l2_fourcc('R','G','B','P') /* 16  RGB-5-6-5     */
#define V4L2_PIX_FMT_RGB555X v4l2_fourcc('R','G','B','Q') /* 16  RGB-5-5-5 BE  */
#define V4L2_PIX_FMT_RGB565X v4l2_fourcc('R','G','B','R') /* 16  RGB-5-6-5 BE  */
#define V4L2_PIX_FMT_BGR24   v4l2_fourcc('B','G','R','3') /* 24  BGR-8-8-8     */
#define V4L2_PIX_FMT_RGB24   v4l2_fourcc('R','G','B','3') /* 24  RGB-8-8-8     */
#define V4L2_PIX_FMT_BGR32   v4l2_fourcc('B','G','R','4') /* 32  BGR-8-8-8-8   */
#define V4L2_PIX_FMT_RGB32   v4l2_fourcc('R','G','B','4') /* 32  RGB-8-8-8-8   */
#define V4L2_PIX_FMT_GREY    v4l2_fourcc('G','R','E','Y') /*  8  Greyscale     */
#define V4L2_PIX_FMT_YVU410  v4l2_fourcc('Y','V','U','9') /*  9  YVU 4:1:0     */
#define V4L2_PIX_FMT_YVU420  v4l2_fourcc('Y','V','1','2') /* 12  YVU 4:2:0     */
#define V4L2_PIX_FMT_YUYV    v4l2_fourcc('Y','U','Y','V') /* 16  YUV 4:2:2     */
#define V4L2_PIX_FMT_UYVY    v4l2_fourcc('U','Y','V','Y') /* 16  YUV 4:2:2     */
#define V4L2_PIX_FMT_YUV422P v4l2_fourcc('4','2','2','P') /* 16  YVU422 planar */
#define V4L2_PIX_FMT_YUV411P v4l2_fourcc('4','1','1','P') /* 16  YVU411 planar */
#define V4L2_PIX_FMT_Y41P    v4l2_fourcc('Y','4','1','P') /* 12  YUV 4:1:1     */

/* two planes -- one Y, one Cr + Cb interleaved  */
#define V4L2_PIX_FMT_NV12    v4l2_fourcc('N','V','1','2') /* 12  Y/CbCr 4:2:0  */
#define V4L2_PIX_FMT_NV21    v4l2_fourcc('N','V','2','1') /* 12  Y/CrCb 4:2:0  */

/*  The following formats are not defined in the V4L2 specification */
#define V4L2_PIX_FMT_YUV410  v4l2_fourcc('Y','U','V','9') /*  9  YUV 4:1:0     */
#define V4L2_PIX_FMT_YUV420  v4l2_fourcc('Y','U','1','2') /* 12  YUV 4:2:0     */
#define V4L2_PIX_FMT_YYUV    v4l2_fourcc('Y','Y','U','V') /* 16  YUV 4:2:2     */
#define V4L2_PIX_FMT_HI240   v4l2_fourcc('H','I','2','4') /*  8  8-bit color   */

/* see http://www.siliconimaging.com/RGB%20Bayer.htm */
#define V4L2_PIX_FMT_SBGGR8  v4l2_fourcc('B','A','8','1') /*  8  BGBG.. GRGR.. */

/* compressed formats */
#define V4L2_PIX_FMT_MJPEG    v4l2_fourcc('M','J','P','G') /* Motion-JPEG   */
#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          */

/*  Vendor-specific formats   */
#define V4L2_PIX_FMT_WNVA     v4l2_fourcc('W','N','V','A') /* Winnov hw compress */
#define V4L2_PIX_FMT_SN9C10X  v4l2_fourcc('S','9','1','0') /* SN9C10x compression */
```

```
#define V4L2_PIX_FMT_PWC1     v4l2_fourcc('P','W','C','1') /* pwc older webcam */
#define V4L2_PIX_FMT_PWC2     v4l2_fourcc('P','W','C','2') /* pwc newer webcam */

/*
 *      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


/*
 *      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 */


#if 1
/*
 *      M P E G   C O M P R E S S I O N   P A R A M E T E R S
 *
 *  ### WARNING: this is still work-in-progress right now, most likely
 *  ###          there will be some incompatible changes.
 *
 */
```

```
enum  v4l2_bitrate_mode {
        V4L2_BITRATE_NONE = 0,  /* not specified */
        V4L2_BITRATE_CBR,       /* constant bitrate */
        V4L2_BITRATE_VBR,       /* variable bitrate */
};
struct v4l2_bitrate {
        /* rates are specified in kbit/sec */
        enum  v4l2_bitrate_mode  mode;
        __u32                   min;
        __u32                   target;  /* use this one for CBR */
        __u32                   max;
};

enum v4l2_mpeg_streamtype {
        V4L2_MPEG_SS_1,         /* MPEG-1 system stream */
        V4L2_MPEG_PS_2,         /* MPEG-2 program stream */
        V4L2_MPEG_TS_2,         /* MPEG-2 transport stream */
        V4L2_MPEG_PS_DVD,       /* MPEG-2 program stream with DVD header fixups */
};
enum v4l2_mpeg_audiotype {
        V4L2_MPEG_AU_2_I,       /* MPEG-2 layer 1 */
        V4L2_MPEG_AU_2_II,      /* MPEG-2 layer 2 */
        V4L2_MPEG_AU_2_III,     /* MPEG-2 layer 3 */
        V4L2_MPEG_AC3,          /* AC3 */
        V4L2_MPEG_LPCM,         /* LPCM */
};
enum v4l2_mpeg_videotype {
        V4L2_MPEG_VI_1,         /* MPEG-1 */
        V4L2_MPEG_VI_2,         /* MPEG-2 */
};
enum v4l2_mpeg_aspectratio {
        V4L2_MPEG_ASPECT_SQUARE = 1,   /* square pixel */
        V4L2_MPEG_ASPECT_4_3    = 2,   /*  4 : 3       */
        V4L2_MPEG_ASPECT_16_9   = 3,   /* 16 : 9       */
        V4L2_MPEG_ASPECT_1_221  = 4,   /*  1 : 2,21    */
};

struct v4l2_mpeg_compression {
        /* general */
        enum v4l2_mpeg_streamtype       st_type;
        struct v4l2_bitrate             st_bitrate;

        /* transport streams */
        __u16                           ts_pid_pmt;
        __u16                           ts_pid_audio;
        __u16                           ts_pid_video;
        __u16                           ts_pid_pcr;

        /* program stream */
        __u16                           ps_size;
        __u16                           reserved_1;    /* align */

        /* audio */
        enum v4l2_mpeg_audiotype        au_type;
        struct v4l2_bitrate             au_bitrate;
```

```
        __u32                          au_sample_rate;
        __u8                           au_pesid;
        __u8                           reserved_2[3]; /* align */

        /* video */
        enum v4l2_mpeg_videotype       vi_type;
        enum v4l2_mpeg_aspectratio     vi_aspect_ratio;
        struct v4l2_bitrate            vi_bitrate;
        __u32                          vi_frame_rate;
        __u16                          vi_frames_per_gop;
        __u16                          vi_bframes_count;
        __u8                           vi_pesid;
        __u8                           reserved_3[3]; /* align */

        /* misc flags */
        __u32                          closed_gops:1;
        __u32                          pulldown:1;
        __u32                          reserved_4:30; /* align */

        /* I don't expect the above being perfect yet ;) */
        __u32                          reserved_5[8];
};
#endif

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 */

        __u32 jpeg_markers;     /* Which markers should go into the JPEG
                                 * output. Unless you exactly know what
                                 * you do, leave them untouched.
                                 * Inluding less markers will make the
                                 * resulting code smaller, but there will
                                 * be fewer aplications 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
                                        * allways 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_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;
        union {
                __u32           offset;
                unsigned long   userptr;
        } 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 */
#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
/*  Flags for the 'flags' field. */
#define V4L2_FBUF_FLAG_PRIMARY          0x0001
#define V4L2_FBUF_FLAG_OVERLAY          0x0002
#define V4L2_FBUF_FLAG_CHROMAKEY        0x0004

struct v4l2_clip
{
        struct v4l2_rect        c;
        struct v4l2_clip        *next;
};

struct v4l2_window
{
        struct v4l2_rect        w;
        enum v4l2_field         field;
        __u32                   chromakey;
        struct v4l2_clip        __user *clips;
        __u32                   clipcount;
        void                    __user *bitmap;
};


/*
 *      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;
        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_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)

/* 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)
#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)

#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_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   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        reserved[4];
};
/*  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' - 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 */
#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 */

/*
 *      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        reserved[4];
};
/*  Values for the 'type' field */
#define V4L2_OUTPUT_TYPE_MODULATOR              1
#define V4L2_OUTPUT_TYPE_ANALOG                 2
#define V4L2_OUTPUT_TYPE_ANALOGVGAOVERLAY       3

/*
 *      C O N T R O L S
 */
struct v4l2_control
{
        __u32                id;
        __s32                value;
};

/*  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];
};
```

```
/*  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

/*  Control IDs defined by V4L2 */
#define V4L2_CID_BASE                   0x00980900
/*  IDs reserved for driver specific controls */
#define V4L2_CID_PRIVATE_BASE           0x08000000

#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)
#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) /* ? Not sure */
#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)
#define V4L2_CID_VFLIP                  (V4L2_CID_BASE+21)
#define V4L2_CID_HCENTER                (V4L2_CID_BASE+22)
#define V4L2_CID_VCENTER                (V4L2_CID_BASE+23)
#define V4L2_CID_LASTP1                 (V4L2_CID_BASE+24) /* last CID + 1 */

/*
 *      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

/*  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

/*  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

struct v4l2_frequency
{
        __u32                 tuner;
        enum v4l2_tuner_type  type;
        __u32                 frequency;
        __u32                 reserved[8];
};

/*
 *      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
#define V4L2_AUDMODE_32BITS             0x00002

struct v4l2_audioout
{
        __u32   index;
        __u8    name[32];
        __u32   capability;
        __u32   mode;
        __u32   reserved[2];
};

/*
 *      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)

#if 1 /*KEEP*/
/* 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 first field
           service_lines[1][...] specifies lines 0-23 (1-23 used) of the second field
                                 (equals frame lines 313-336 for 625 line video
                                  standards, 263-286 for 525 line standards) */
```

```
        __u16   service_lines[2][24];
        __u32   io_size;
        __u32   reserved[2];            /* must be zero */
};

#define V4L2_SLICED_TELETEXT_B          (0x0001)
#define V4L2_SLICED_VPS                 (0x0400)
#define V4L2_SLICED_CAPTION_525         (0x1000)
#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_VPS | V4L2_

struct v4l2_sliced_vbi_cap
{
        __u16   service_set;
        /* service_lines[0][...] specifies lines 0-23 (1-23 used) of the first field
           service_lines[1][...] specifies lines 0-23 (1-23 used) of the second field
                                 (equals frame lines 313-336 for 625 line video
                                  standards, 263-286 for 525 line standards) */
        __u16   service_lines[2][24];
        __u32   reserved[4];    /* 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];
};
#endif

/*
 *      A G G R E G A T E   S T R U C T U R E S
 */

/*      Stream data format
 */
struct v4l2_format
{
        enum v4l2_buf_type type;
        union
        {
                struct v4l2_pix_format          pix;     // V4L2_BUF_TYPE_VIDEO_CAPTURE
                struct v4l2_window              win;     // V4L2_BUF_TYPE_VIDEO_OVERLAY
                struct v4l2_vbi_format          vbi;     // V4L2_BUF_TYPE_VBI_CAPTURE
#if 1 /*KEEP*/
                struct v4l2_sliced_vbi_format   sliced;  // V4L2_BUF_TYPE_SLICED_VBI_CAP
#endif
                __u8    raw_data[200];                   // user-defined
        } fmt;
};


/*      Stream type-dependent parameters
```

```
 */
struct v4l2_streamparm
{
        enum v4l2_buf_type type;
        union
        {
                struct v4l2_captureparm capture;
                struct v4l2_outputparm  output;
                __u8    raw_data[200];  /* user-defined */
        } parm;
};



/*
 *      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)
#if 1 /* experimental */
#define VIDIOC_G_MPEGCOMP       _IOR  ('V',  6, struct v4l2_mpeg_compression)
#define VIDIOC_S_MPEGCOMP       _IOW  ('V',  7, struct v4l2_mpeg_compression)
#endif
#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)
#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)
#if 1 /*KEEP*/
#define VIDIOC_G_SLICED_VBI_CAP _IOR  ('V', 69, struct v4l2_sliced_vbi_cap)
#endif
#define VIDIOC_LOG_STATUS       _IO   ('V', 70)

/* for compatibility, will go away some day */
#define VIDIOC_OVERLAY_OLD      _IOWR ('V', 14, int)
#define VIDIOC_S_PARM_OLD       _IOW  ('V', 22, struct v4l2_streamparm)
#define VIDIOC_S_CTRL_OLD       _IOW  ('V', 28, struct v4l2_control)
#define VIDIOC_G_AUDIO_OLD      _IOWR ('V', 33, struct v4l2_audio)
#define VIDIOC_G_AUDOUT_OLD     _IOWR ('V', 49, struct v4l2_audioout)
#define VIDIOC_CROPCAP_OLD      _IOR  ('V', 58, struct v4l2_cropcap)

#define BASE_VIDIOC_PRIVATE     192             /* 192-255 are private */


#ifdef __KERNEL__
/*
 *
 *      V 4 L 2   D R I V E R   H E L P E R   A P I
 *
 *      Some commonly needed functions for drivers (v4l2-common.o module)
 */
#include <linux/fs.h>

/*  Video standard functions  */
extern unsigned int v4l2_video_std_fps(struct v4l2_standard *vs);
extern int v4l2_video_std_construct(struct v4l2_standard *vs,
                                    int id, char *name);

/* prority handling */
struct v4l2_prio_state {
        atomic_t prios[4];
};
int v4l2_prio_init(struct v4l2_prio_state *global);
int v4l2_prio_change(struct v4l2_prio_state *global, enum v4l2_priority *local,
                     enum v4l2_priority new);
int v4l2_prio_open(struct v4l2_prio_state *global, enum v4l2_priority *local);
int v4l2_prio_close(struct v4l2_prio_state *global, enum v4l2_priority *local);
enum v4l2_priority v4l2_prio_max(struct v4l2_prio_state *global);
int v4l2_prio_check(struct v4l2_prio_state *global, enum v4l2_priority *local);
```

```
/* names for fancy debug output */
extern char *v4l2_field_names[];
extern char *v4l2_type_names[];
extern char *v4l2_ioctl_names[];

/*  Compatibility layer interface  --  v4l1-compat module */
typedef int (*v4l2_kioctl)(struct inode *inode, struct file *file,
                           unsigned int cmd, void *arg);
int v4l_compat_translate_ioctl(struct inode *inode, struct file *file,
                               int cmd, void *arg, v4l2_kioctl driver_ioctl);

#endif /* __KERNEL__ */
#endif /* __LINUX_VIDEODEV2_H */

/*
 * Local variables:
 * c-basic-offset: 8
 * End:
 */
```

Appendix B. Video Capture Example

```
/*
 *  V4L2 video capture example
 *
 *  This program can be used and distributed without restrictions.
 */

#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 <asm/types.h>          /* for videodev2.h */

#include <linux/videodev2.h>

#define CLEAR(x) memset (&(x), 0, sizeof (x))

typedef enum {
        IO_METHOD_READ,
        IO_METHOD_MMAP,
        IO_METHOD_USERPTR,
} io_method;

struct buffer {
        void *                  start;
        size_t                  length;
};

static char *           dev_name        = NULL;
static io_method        io              = IO_METHOD_MMAP;
static int              fd              = -1;
struct buffer *         buffers         = NULL;
static unsigned int     n_buffers       = 0;

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                    fd,
                                 int                    request,
                                 void *                 arg)
{
        int r;

        do r = ioctl (fd, request, arg);
        while (-1 == r && EINTR == errno);

        return r;
}

static void
process_image                   (const void *           p)
{
        fputc ('.', stdout);
        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 (buffers[0].start);

                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_buffers);

                process_image (buffers[buf.index].start);

                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) {
                        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);

                if (-1 == xioctl (fd, VIDIOC_QBUF, &buf))
                        errno_exit ("VIDIOC_QBUF");

                break;
```

```
        }

        return 1;
}

static void
mainloop                        (void)
{
        unsigned int count;

        count = 100;

        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;

        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.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);
                } 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");
                }
        }
```

```
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;
        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. */

        /* 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;
        }
}

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"
                 "Options:\n"
                 "-d | --device name   Video device name [/dev/video]\n"
                 "-h | --help          Print this message\n"
                 "-m | --mmap          Use memory mapped buffers\n"
                 "-r | --read          Use read() calls\n"
                 "-u | --userp         Use application allocated buffers\n"
                 "",
                 argv[0]);
}

static const char short_options [] = "d:hmru";

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' },
        { 0, 0, 0, 0 }
};

int
main                            (int                    argc,
                                 char **                argv)
{
        dev_name = "/dev/video";

        for (;;) {
                int index;
                int c;

                c = getopt_long (argc, argv,
                                 short_options, long_options,
                                 &index);

                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;

                case 'r':
                        io = IO_METHOD_READ;
                        break;

                case 'u':
                        io = IO_METHOD_USERPTR;
                        break;

                default:
                        usage (stderr, argc, argv);
                        exit (EXIT_FAILURE);
                }
        }

        open_device ();

        init_device ();

        start_capturing ();

        mainloop ();

        stop_capturing ();

        uninit_device ();

        close_device ();

        exit (EXIT_SUCCESS);

        return 0;
}
```

Appendix C. GNU Free Documentation License

C.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. Secondarily, 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.

C.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 connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The “Invariant Sections” are certain Secondary Sections whose titles are designated, as being those 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.

A “Transparent” copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, whose contents can be viewed and edited directly and straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup has been designed to thwart or discourage subsequent modification by readers is not Transparent. A copy that is not "Transparent" is called "Opaque".

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.

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.

C.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 notice saying this License applies 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 measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

C.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 the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

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 computer-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. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time 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.

C.5. 4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things 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 previous version if the original publisher of that version gives permission.
- **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).
- **C.** State on the Title Page the name of the publisher of the Modified Version, as the publisher.
- **D.** Preserve all the copyright notices of the Document.
- **E.** Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.
- **F.** Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.
- **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.
- **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 Version as stated in the previous sentence.
- **J.** Preserve the network location, if any, given in the Document for public access 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.
- **K.** In any section entitled "Acknowledgements" or "Dedications", preserve the section's title, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.

- **L.** Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.
- **M.** Delete any section entitled "Endorsements". Such a section may not be included in the Modified Version.
- **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 qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version's license notice. 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 authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version .

C.6. 5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that 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.

In the combination, you must combine any sections entitled "History" in the various original documents, forming one section entitled "History"; likewise combine any sections entitled "Acknowledgements", and any sections entitled "Dedications". You must delete all sections entitled "Endorsements."

C.7. 6. COLLECTIONS OF DOCUMENTS

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 that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and dispbibute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

C.8. 7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, does not as a whole count as a Modified Version of the Document, provided no compilation copyright is claimed for the compilation. Such a compilation is called an "aggregate", and this License does not apply to the other self-contained works thus compiled with the Document , on account of their being thus compiled, if they are not themselves derivative works of the Document. If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one quarter of the entire aggregate, the Document's Cover Texts may be placed on covers that surround only the Document within the aggregate. Otherwise they must appear on covers around the whole aggregate.

C.9. 8. TRANSLATION

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 translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License 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.

C.10. 9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided for under this License. Any other attempt to copy, modify, sublicense or distribute the Document is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

C.11. 10. FUTURE REVISIONS OF THIS LICENSE

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 new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See http://www.gnu.org/copyleft/ (http://www.gnu.org/copyleft).

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License "or any later version" applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation.

C.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.

Bibliography

[EIA608] Electronic Industries Alliance (http://www.eia.org), *EIA 608 "Recommended Practice for Line 21 Data Service"*.

[ITU470] International Telecommunication Union (http://www.itu.ch), *ITU-R Recommendation BT.470-6 "Conventional Television Systems"*.

[ITU601] 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"*.

[ITU709] 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"*.

[JFIF] Independent JPEG Group (http://www.ijg.org), *JPEG File Interchange Format: Version 1.02*.

[SMPTE12M] Society of Motion Picture and Television Engineers (http://www.smpte.org), *SMPTE 12M-1999 "Television, Audio and Film - Time and Control Code"*.

[SMPTE170M] Society of Motion Picture and Television Engineers (http://www.smpte.org), *SMPTE 170M-1999 "Television - Composite Analog Video Signal - NTSC for Studio Applications"*.

[SMPTE240M] Society of Motion Picture and Television Engineers (http://www.smpte.org), *SMPTE 240M-1999 "Television - Signal Parameters - 1125-Line High-Definition Production"*.

[TELETEXT] European Telecommunication Standards Institute (http://www.etsi.org), *ETS 300 706 "Enhanced Teletext specification"*.

[V4L] Alan Cox, *Video4Linux API Specification*.

This file is part of the Linux kernel sources under `Documentation/video4linux`.

[V4LPROG] Alan Cox, *Video4Linux Programming (a.k.a. The Video4Linux Book)*, 2000.

About V4L *driver* programming. This book is part of the Linux kernel DocBook documentation, for example at http://kernelnewbies.org/documents/. SGML sources are included in the kernel sources.

[VPS] European Telecommunication Standards Institute (http://www.etsi.org), *ETS 300 231 "Specification of the domestic video Programme Delivery Control system (PDC)"*.

[WSS] International Telecommunication Union (http://www.itu.ch), European Telecommunication Standards Institute (http://www.etsi.org), *ITU-R Recommendation BT.1119, EN 300 294 "625-line television Wide Screen Signalling (WSS)"*.