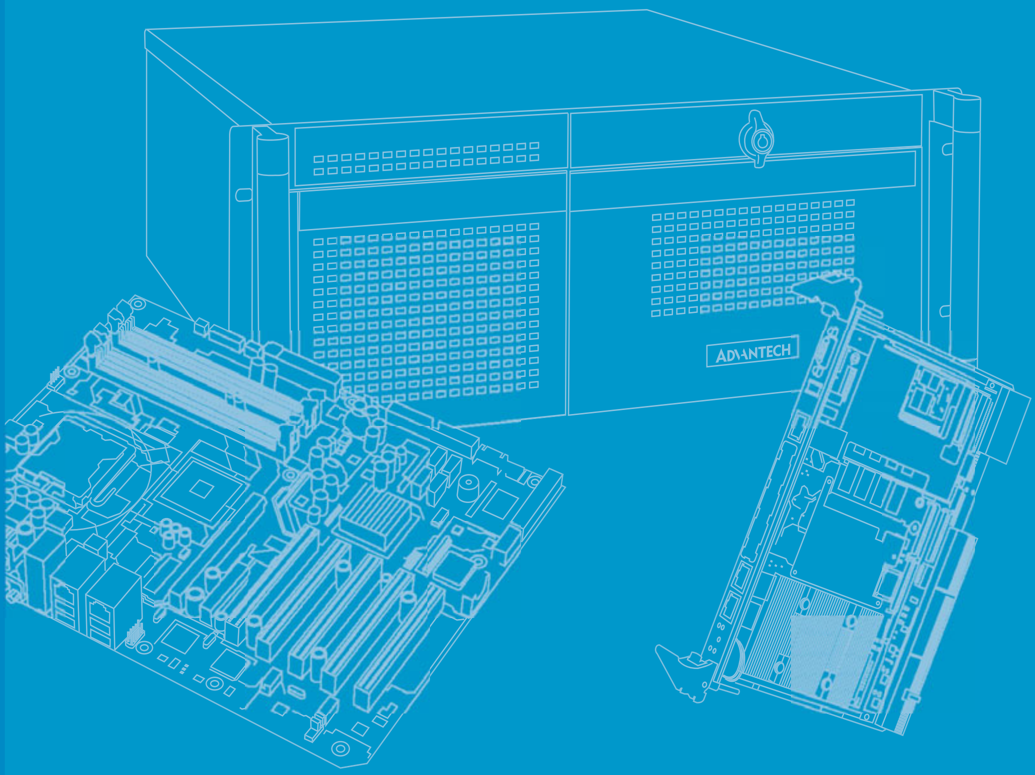

User Manual

DSPC-8661-PCXE
DSPC-8662-PCXE

Linux Programming Guide

ADVANTECH
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- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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2. Contact your distributor, sales representative, or Advantech's customer service center for technical support if you need additional assistance. Please have the following information ready before you call:
   – Product name and serial number
   – Description of your peripheral attachments
   – Description of your software (operating system, version, application software, etc.)
   – A complete description of the problem
   – The exact wording of any error messages

Safety Instructions

1. Read these safety instructions carefully.
2. Keep this User Manual for later reference.
3. Disconnect this equipment from any AC outlet before cleaning. Use a damp cloth. Do not use liquid or spray detergents for cleaning.
4. For plug-in equipment, the power outlet socket must be located near the equipment and must be easily accessible.
5. Keep this equipment away from humidity.
6. Put this equipment on a reliable surface during installation. Dropping it or letting it fall may cause damage.
7. The openings on the enclosure are for air convection. Protect the equipment from overheating. DO NOT COVER THE OPENINGS.
8. Make sure the voltage of the power source is correct before connecting the equipment to the power outlet.
9. Position the power cord so that people cannot step on it. Do not place anything over the power cord.
10. All cautions and warnings on the equipment should be noted.
11. If the equipment is not used for a long time, disconnect it from the power source to avoid damage by transient overvoltage.
12. Never pour any liquid into an opening. This may cause fire or electrical shock.
13. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
14. If one of the following situations arises, get the equipment checked by service personnel:
15. The power cord or plug is damaged.
16. Liquid has penetrated into the equipment.
17. The equipment has been exposed to moisture.
18. The equipment does not work well, or you cannot get it to work according to the user's manual.
19. The equipment has been dropped and damaged.
20. The equipment has obvious signs of breakage.
21. DO NOT LEAVE THIS EQUIPMENT IN AN ENVIRONMENT WHERE THE STORAGE TEMPERATURE MAY GO BELOW -20° C (-4° F) OR ABOVE 60° C (140° F). THIS COULD DAMAGE THE EQUIPMENT. THE EQUIPMENT SHOULD BE IN A CONTROLLED ENVIRONMENT.

22. CAUTION: DANGER OF EXPLOSION IF BATTERY IS INCORRECTLY REPLACED. REPLACE ONLY WITH THE SAME OR EQUIVALENT TYPE RECOMMENDED BY THE MANUFACTURER, DISCARD USED BATTERIES ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS.
23. The sound pressure level at the operator's position according to IEC 704-1:1982 is no more than 70 dB (A).

DISCLAIMER: This set of instructions is given according to IEC 704-1. Advantech disclaims all responsibility for the accuracy of any statements contained herein.

Safety Precaution - Static Electricity

Follow these simple precautions to protect yourself from harm and the products from damage.

- To avoid electrical shock, always disconnect the power from your PC chassis before you work on it. Don't touch any components on the CPU card or other cards while the PC is on.
- Disconnect power before making any configuration changes. The sudden rush of power as you connect a jumper or install a card may damage sensitive electronic components.

Contents

Chapter 1

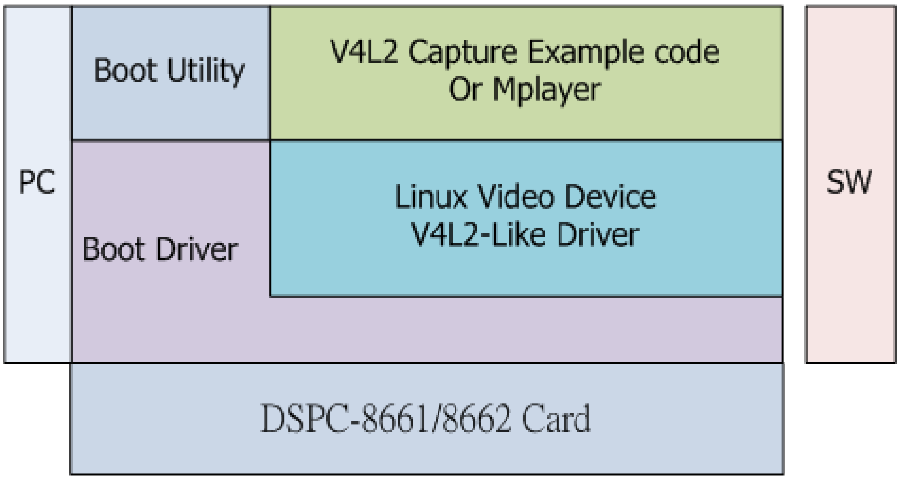
Introduction

1.1 Overview

This document describes how to set up and use linux driver for Netra-base PCIe card DSPC-8661-PCXE and DSPC-8662-PCXE (abbreviated as DSPC-8661/DSPC-8662 below). The driver and application for DSPC-8661/8662 are released as a package. Below figure show software package stack developed in host PC.

Linux host PCIE driver is used to create mapping between PC memory and Netra memory.

Linux driver contain boot portion and V4L2-Like (Video For Linux 2 Like) API. This document described here, allow capture video using the v4l2-like driver API.



1.2 Key Acronyms and Vocabulary

Terms	Description
Netra	TI DM8168
PCIe	PCI-Express
EP	PCIe Endpoint
RC	PCIe Root Complex
V4L2	Video for Linux II
V4L2-Like	Video for Linux II with additional function

Chapter 2

Package Content

This package is created in Linux to help customer quickly boot Netra through PCIE, the package includes:

Table 2.1: Package content list

Path	Purpose
driver	Linux boot and V4L2-Like driver
utility	Boot Loader Utility included pre-built board u-boot, kernel image and filesystem.
V4l2_samples-0.4.1	V4L2-Like (Video for Linux 2 Like) sample code modified by Advantech.

Chapter 3

Installation

3.1 Host System Requirement

A reference of the OS used to develop and execute this software release is:

1. Linux distribution: Ubuntu 10.04 LTS.
2. Kernel: Linux kernel version 2.6.35.22. In fact, the driver should work with any kernel with version >=2.6.20.

3.2 Build Instruction

3.2.1 Build and install driver

The driver is closely tied to Linux kernel running on PC, therefore, it must be rebuilt to work with the supporting kernel. The command and messages for building PCIE driver is listed below:

```
# cd {pkage_dir}/
# sh install.sh

make    -C  /lib/modules/2.6.32-38-generic/build  M=/home/user/
src/ti816x_pcie/driver clean
make[1]: Entering directory `/usr/src/linux-headers-2.6.32-38-
generic'
  CLEAN   /home/user/src/ti816x_pcie/driver/.tmp_versions
   CLEAN    /home/user/src/ti816x_pcie/driver/Module.symvers /
home/user/src/ti816x_pcie/driver/modules.order
make[1]: Leaving directory `/usr/src/linux-headers-2.6.32-38-
generic'
rm -rf modules.order Module.markers
make    -C  /lib/modules/2.6.32-38-generic/build  M=/home/user/
src/ti816x_pcie/driver modules
make[1]: Entering directory `/usr/src/linux-headers-2.6.32-38-
generic'
  CC [M]  /home/user/src/ti816x_pcie/driver/ti816x_pcie_drv.o
...
...
make[1]: Entering directory `/usr/src/linux-headers-2.6.32-38-
generic'
  INSTALL /home/user/src/ti816x_pcie/driver/ti816x_pcie.ko
  DEPMOD  2.6.32-38-generic
make[1]: Leaving directory `/usr/src/linux-headers-2.6.32-38-
generic'
```

User need to reboot Host PC

```
# sudo reboot
```

3.2.2 Build boot loader utility

The command for building boot application is listed below:

```
# cd util
# make clean
# make
```

Make boot application as executable:

```
# chmod a+x saBootApp
```

3.2.3 Build V4L2-Like example code

The command for building V4L2-Like example code is listed below:

```
# cd V4l2-example.x.x
# make clean
# make
```

Make example code as executable:

```
# chmod a+x capturer_mmap
```

3.3 Driver Usage

Linux host PCIE driver is used to create mapping between PC memory and Netra memory. The device information is shown by dmesg command.

After finishing previous steps, users can run the following boot application and V4L2-Like example code to access boot driver directly without “insmod”.

User could check devices node in files system as following command, there will be only one device for DSPC-8661, 4 devices for DSPC-8662.

```
# ls -al /dev/ti81xx/ti816x-*
crw-rw-rw- 1 root root 251, 0 2012-03-12 16:32 /dev/ti81xx/
ti816x-0
crw-rw-rw- 1 root root 251, 1 2012-03-12 16:32 /dev/ti81xx/
ti816x-1
crw-rw-rw- 1 root root 251, 2 2012-03-12 16:32 /dev/ti81xx/
ti816x-2
crw-rw-rw- 1 root root 251, 3 2012-03-12 16:32 /dev/ti81xx/
ti816x-3
```

3.4 Boot Loader Utility Usage

Run the boot application providing U-Boot, bootscript, kernel and filesystem:

For DSPC-8661:

```
# ./saBootApp -d /dev/ti81xx/ti816x-0 -u u-boot_8661.bin -s
boot_ramfs_8661.scr -k uImage_DM816X_sdpc8661 -f ramdisk.gz
```

For DSPC-8662:

```
# ./saBootApp -d /dev/ti81xx/ti816x-n -u u-boot_8662.bin -s
boot_ramfs_8662.scr -k uImage_DM816X_sdpc8662 -f ramdisk.gz
```

, which ***n*** is the device exist in /dev/ti81xx/.

The boot application will use boot driver to configure the EP and download the images to complete boot operation and all arguments are necessary.

Here are the usage options:

-d	device	Select device name [/dev/ti81xx/ti816x-n]
-u	u-boot file	Select u-boot file name
-s	script image	Boot script image
-k	kernel image	Boot kernel image
-f	filesystem	Ramdisk file
-?		Print help message.

Currently boot loader could only execute once, do not boot the card twice, it will cause card fail.

3.5 V4L2-Like Example Application Usage

Before using this example, user should refer to section 7.2.1 find out which video device is available in your system. Run the example application providing video device, video format or video standard.

```
# ./capturer_mmap -D /dev/video0 -p 0 // set video format
or
# ./capturer_mmap -D /dev/video0 -s 0// set video standard
```

Run the example application providing video device and storage path to capture data:

```
# ./capturer_mmap -D /dev/video0 -f {folder for storage}
```

The V4L2-Like example application will process negotiation with video device and start to stream data from dedicated EP then store data to the folder user set.

Here are the usage options:

-D | --device name Select device name [/dev/video0]

-s | --standard show current Video standard after auto-detection

-F | --framerate framerate:1~30

-b | --bitrate bitrate:64~2000(Kbps)

-q | --quality quality:1~30

-p | --pixel-format number Pixel Format (0 = H264, 1 = RAW, 2 = MJPG)

-f | --path path Select directory path to store data

-w | --window-size < 960*540|640*480 >Video size:960*540 or 640*480

-I | --input source Select input source

-h | --help Print this message

Chapter 4

PCIe EP Boot Driver

This driver runs on x86 PC running Linux kernel 2.6.32 onwards. It will configure each DM816x/DM814x EP device detected in the system and configures them to be able to carry boot operation. This API is included by default in the 2.6 kernel series.

4.1 Features Supported

- Support for detecting and configuring each DM816x device to device node in Linux file-system.
- Provides character device interface on Linux Kernel to PCIe boot user-space application
- Provide mmap support to enable the boot application to copy image files (U-Boot, kernel etc) to EP memory
- Can be built as loadable module or into kernel

4.2 Supported IOCTLs

It is a Linux based PCIE driver which is used to map between PC memory and DM8168 memory, the implemented I/O control is listed below, The IOCTL and data structure declarations are in drivers/ti816x_pcie_drv.h file in release package source.

Table 4.1: Driver I/O control code list

IOCTL code	Description
TI816X_PCI_IOCTL_DWNLD_DONE	Write/Read to boot control flag for checking boot status.
TI816X_PCI_IOCTL_SET_BAR_WINDOW	Change the memory address mapping of the specified window
TI816X_PCI_IOCTL_GET_BAR_INFO	Get the current BAR information of the specified window
TI816X_PCI_BUF_SETOB	TBD

4.2.1 TI81XX_PCI_GET_BAR_INFO

Returns the size in bytes of the specified BAR.

```
int dev_desc;
dev_desc = open("/dev/ti81xx/ti816x-0", O_RDWR);
...
struct ti81xx_bar_info bar;
bar.num = bar_number;
ioctl(dev_desc, TI81XX_PCI_GET_BAR_INFO, &bar);
...
```

In the above code fragment, the driver returns BAR size in 'size' field of the 'bar' structure object on success.

4.2.2 TI81XX_PCI_SET_BAR_WINDOW

Application can specify the internal address on EP for specified BAR. For example, the boot application sets BAR1 to OCMC1 start on EP (0x40400000) for DM816x EP using this ioctl.

```
...
struct ti816x_bar_info bar;
bar.num = 1;
bar.addr = 0x40400000;
ioctl(dev_desc, TI81XX_PCI_SET_BAR_WINDOW, &bar);
...
```

4.2.3 TI81XX_PCI _DWNLD_DONE

Write/Read the bootflag on EP. The driver writes '1' to the location 0x4043FFFC on DM816x EP and read it back to check the flag to be cleared by boot code.

```
...
ioctl(dev_desc, TI81XX_PCI_SET_DWNLD_DONE, 3);
...
```

4.3 Source Files

The driver files are present at following path relative to package source directory for DM81xx.

- {Package Dir}/driver/ti81xx_pcie_drv.h
- {Package Dir}/driver/ti81xx_pcie_drv.c

Chapter 5

PCIe EP Boot Application

This application runs on RC running Linux and accesses the interfaces provided by the EP Boot Driver to download U-Boot, Kernel, etc images to EP and trigger EP boot.

5.1 Features Supported

- Download U-Boot, U-Boot bootscript, Kernel and filesystem images to EP memory.
- Dirver allow user dynamically map into different DDR memory space, this feature support transfer bigger file size, ex, ramdisk filesystem, from PC to PCIe EP without the limitation of BARn windows size.
- Uses 2 stage boot loading
- Requires only 3 BARs (BAR0, BAR1 and BAR2) to perform complete boot operation. Uses EP boot driver to move internal EP windows to access OCMC and DDR.

5.2 Features NOT Supported

- Cannot operate without EP Boot Driver

5.3 Source Files

The driver files are present at following path relative to package source directory for DM81xx.

- {Package Dir}/util/saBootApp.c

Chapter 6

Video For Linux 2 - Like Driver

V4L2 driver is a standard video device driver API of Linux OS. The detail V4L2 API description could be referred at V4L2 API document. Following description will enhance the features that current V4L2-Like driver provided.

After installing boot driver correctly, the V4L2-Like driver will also register video devices in Host Linux system. This driver works with the internal kernel API designed for video device. Most part of the API is same as V4L2, but we extend some features for DSPC-8661/8662.

6.1 Features Supported for Basic V4L2 ioctl() handling

The following table shows the available ioctl operation codes of normal V4L2 driver with their corresponding structures types supported by this driver:

Table 6.1: ioctl parameters for Video For Linux II

op. code	I/O	structure
VIDIOC_QUERYCAP	IOR	struct v4l2_capability. The flag V4L2_CAP_STREAMING of the capabilities field in the v4l2_capability structure is set
VIDIOC_ENUM_FMT	IOWR	struct v4l2_fmtdesc, refer to section 6.2.1
VIDIOC_G_FMT	IOWR	struct v4l2_format, refer to section 6.2.1
VIDIOC_S_FMT	IOWR	struct v4l2_format, refer to section 6.2.1
VIDIOC_REQBUFS	IOWR	struct v4l2_requestbuffers
VIDIOC_QUERYBUF	IOWR	struct v4l2_buffer
VIDIOC_QBUF	IOWR	struct v4l2_buffer
VIDIOC_DQBUF	IOWR	struct v4l2_buffer
VIDIOC_STREAMON	IOW	int
VIDIOC_STREAMOFF	IOW	int
VIDIOC_ENUMINPUT	IOWR	struct v4l2_input
VIDIOC_G_CTRL	IOWR	struct v4l2_control
VIDIOC_S_CTRL	IOW	struct v4l2_control
VIDIOC_QUERYCTRL	IOWR	struct v4l2_queryctrl
VIDIOC_QUERYMENU	IOWR	struct v4l2_querymenu
VIDIOC_QUERYSTD	IOR	v4l2_std_id, only for DSPC-8661
VIDIOC_TRY_FMT	IOWR	struct v4l2_format

The section 7, explain in more detail the steps in a V4l2 program.

6.2 Extended Features

6.2.1 Pixel Format in VIDIOC_G_FMT and VIDIOC_S_FMT

Additional format is able to access at VIDIOC_G_FMT and VIDIOC_S_FMT ioctl. User could set following fourcc value in fmt.pix.pixelformat field to specify the data format. Next table shows current supported format:

Format	FOURCC Value	Description
V4L2_PIX_FMT_TI_H264	davc	H.264 format
V4L2_PIX_FMT_MJPEG	MJPG	Motion JPEG format
V4L2_PIX_FMT_NV12	NV12	Raw Image, 4:2:0, Y planar, CbCr Interleaved

Additional format is also able to be queried by using VIDIOC_TRY_FMT ioctl.

User could reference the set_format function in example code. ({Package_Dir}/V4l2_samples-x.x.x/capturer_mmap.c)

6.2.2 Private Control Command

V4l2 provide private control command interface for application to access extra command defined by driver. Below table show the additional control commands included encoder arguments setting and video standard setting.

Below example code show how to setup frame rate in private control command.

```
struct v4l2_control std= {.id = V4L2_CID_VENC_FRAMERATE,
                          .value = venc_framerate};

if (-1 == ioctl (*fd, VIDIOC_G_CTRL, &std))
     perror ("VIDIOC_G_CTRL::V4L2_CID_VENC_FRAMERATE");

std.value = venc_framerate;

if (-1 == ioctl (*fd, VIDIOC_S_CTRL, &std))
     perror ("VIDIOC_S_CTRL::V4L2_CID_VENC_FRAMERATE");
```

Private Control command	Value	Description
Encoder arguments		
V4L2_CID_VENC_FMT	'dvac' 'MJPG' 'NV12'	Set the FOURCC value same as Pixel Format in VIDIOC_G_FMT and VIDIOC_S_FMT
V4L2_CID_VENC_BITRATE	64-4000	Set encoder bitrate.
V4L2_CID_VENC_QUALITY	1-30	Set encoder I-frame interval.
V4L2_CID_VENC_FRAMERATE	1-30	Set target encoder framerate.
Video standard setting		
V4L2_CID_VID_DIM_STD	0-10	It is read-only command. Auto-detection will be enabled in default. The value will be set to detected standard after executing VIDIOC_STREAMON command. Current supported standard shown as follow, DSPC-8661 only support item 8 and 9.: 0. SYSTEM_STD_1080P_60 1. SYSTEM_STD_1080P_50 2. SYSTEM_STD_1080I_60 3. SYSTEM_STD_1080I_50 4. SYSTEM_STD_1080P_30 5. SYSTEM_STD_1080P_24 6. SYSTEM_STD_720P_60 7. SYSTEM_STD_720P_50 8. SYSTEM_STD_576I 9. SYSTEM_STD_480I 10. Auto-detection
V4L2_CID_VID_DIM_H	Small than auto-detected height	Auto-detection in default. Set the value of scale output height.
V4L2_CID_VID_DIM_W	Small than auto-detected width	Auto-detection in default. Set the value of scale output width.
V4L2_CID_VID_DIM_IS	NTSC/PAL	Set video input source 0:NTSC 1:PAL

6.3 Features NOT supported

Current driver only support memory mapping capability in capture mode.

6.4 Audio Supported

Audio data was transferred in packet format. Each frame buffer reserved 8192 bytes for audio packet. Audio packet header is attached to the end of each frame buffer first. User could check the audio packet header to receive available audio data. The audio packet structure is shown as below.

Offset	Default	Description	Mnemonic
00h	0	Id[5]	Reserved
05h	1	Number of channels	Reserved
06h	16000	Audio sample rate 16000 for DSPC-8661 48000 for DSPC8662	Reserved
08h	0	Timestamp	Reserved
10h		Audio packet payload length, in bytes.	
14h		Audio packet payload length, in bytes.	
18h		Audio packet payload data	

User application could get the audio data through memory mapping frame buffer at user space. Frame buffer memory mapping detailed in section 7.2.4.

Chapter 7

Video For Linux 2 Sample Code

The V4l2 example code is referenced from http://alumnos.elo.utfsm.cl/~yanez/video-for-linux-2-sample-programs/

The code in released package has been modified for adding some different device driver controls and application usage.

By using this sample code, user could setup video format, setup video standard and capture the video/audio to files.

The usage of this sample has been described in section 3.5.

7.1 Programming Structure

In DSPC-8661/8662 V4L2-Like driver use case, user application should also follow below Video for Linux II standard procedure to execute the next steps:

- Open the device.
- Properties Negotiation (video input, video standard, and more)
- Pixel Format Negotiation
- Request Buffers and Query Buffer
- Main Loop
- Close the device

7.2 Procedure

7.2.1 Open the device

After installing boot driver correctly, the V4L2-Like driver will also register video devices in Host Linux system as shown in below. User could open the video devices with the open function.

In DSPC-8662, there are 16 video devices registered for one chip, but only first two video devices were available.

```
#ls -al /dev/video*
crw-rw----+ 1 root video 81,  0 2012-03-13 08:06 /dev/video0
crw-rw----+ 1 root video 81,  1 2012-03-13 08:06 /dev/video1
...
crw-rw----+ 1 root video 81, 15 2012-03-13 08:06 /dev/video15
```

7.2.2 Properties Negotiation

As normal V4L2 video device, it°Øs necessary to negotiate the possible values of some properties. The properties to set on V4L2-Like device driver are:

- Pixel Format
- Image Size
- Request Buffers and Query Buffer

7.2.3 Pixel Format and Image Size Negotiation.

The pixel format is how every pixel is stored in memory, and the application need to know this format to allow the properly interpretation of that pixel and how big the memory space is. In V4L2-Like device driver, there are compression formats exist, H264 and MJPEG, as described in section 6.2.1.

User could follow this sample code to setup the

```
      struct v4l2_format fmt;
      CLEAR (fmt);
      //set pixel format properties
      fmt.type              = V4L2_BUF_TYPE_VIDEO_CAPTURE;
      fmt.fmt.pix.width= width;
      fmt.fmt.pix.height= height;

      fmt.fmt.pix.pixelformat = V4L2_PIX_FMT_TI_H264;

      if (-1 == xioctl (*fd, VIDIOC_S_FMT, &fmt))
          errno_exit  ("\nError:  pixel  format  not  sup-
ported\n");
```

7.2.4 Request Buffers and Query Buffer Using Memory mapping

This is the fastest method, read and write functions are not needed, instead of those, the mmap() function is used. This functions returns a pointer to the start of a valid memory area, this memory is used by the application to read the data. A device support this method when the flag V4L2_CAP_STREAMING of the capabilities field in the v4l2_capability struct is set.

A device supports this method if the field V4L2_CAP_STREAMING in the member capabilities of the 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.

```
      struct v4l2_requestbuffers req;
      req.count               = 2;
      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");
          }
      }
```

This method combines the advantage of the both previous methods. In the user pointer method buffers are allocated by the application and can be shared memory (mmap) or virtual. Only pointers to data are exchanged, these pointers is 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.

The example code here show how to memory map one of requested buffers.

```
{
      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_QUERYBUF, &buf))
          errno_exit ("VIDIOC_QUERYBUF");
      buffers[i].length = buf.length;
      buffers[i].start = mmap (NULL /* start anywhere */,
                               buf.length,
                               PROT_READ | PROT_WRITE /* required
*/,
                               MAP_SHARED /* recommended */,
                               *fd, buf.m.offset);
      if (MAP_FAILED == buffers[i].start)
          errno_exit ("mmap");
}
```

7.2.5 Getting audio data

Audio data was transfer in packet format described in section 6.4. User application could get the audio data while mapping frame buffer into user memory space. Following example shows how to read audio packet with shifted pointer.

```
      void *aud_ptr = &vid_ptr[PKT_QUE_AUD_OFT];
      audpkt_t *audpkt = (audpkt_t *) aud_ptr;
      len = audpkt->len;// available data length
      src = &aud_ptr[sizeof(audpkt_t)];
      //writing to standard output
      ret = file_write_frames(src, len, ch, audf[ch]);
      audpkt->len = 0;// Clear packet length
```

7.2.6 Main loop

If user pointer or memory mapping is used, that are streaming oriented methods, the first step is the start of the transmission of data. In addition these methods have buffers with queues, in that way, V4L2 enqueue data, and the application dequeue the data, with a FIFO criteria. In the case of output devices, the process is the same but inverse. In addition the buffer must be previously configured with the properties of the frames, to know the size of one frame, for allocation of memory. And at the end of the loop, the data transmission must be stopped and the buffers freed.

In the case of use of read/write functions in the main loop, the application only have one memory buffer, that one allows the store of one frame. On a capture application in every loop the read function must be called to capture one frame.

For the 3 methods is valid the use of the select() function, to wait for events, avoiding the use of CPU when is waiting.

7.2.7 Private control command settings

User could setup extended features through VIDIOC_G_CTRL or VIDIOC_S_CTRL operation code of V4L2 driver ioctl API.

Following example show how to set and get extra video standard from V4L2_CID_VID_DIM_STD command, mentioned in section 6.2.2.

```
struct v4l2_control std= {.id = V4L2_CID_VID_DIM_STD,
                          .value = 0};

if (-1 == ioctl (*fd, VIDIOC_G_CTRL, &std))
    perror ("VIDIOC_G_CTRL::V4L2_CID_VID_DIM_STD");

std.value = video_standard;
if (-1 == ioctl (*fd, VIDIOC_S_CTRL, &std))
    perror ("VIDIOC_S_CTRL::V4L2_CID_VID_DIM_STD");
```

7.2.8 Close the device.

The close function is used to close the device.