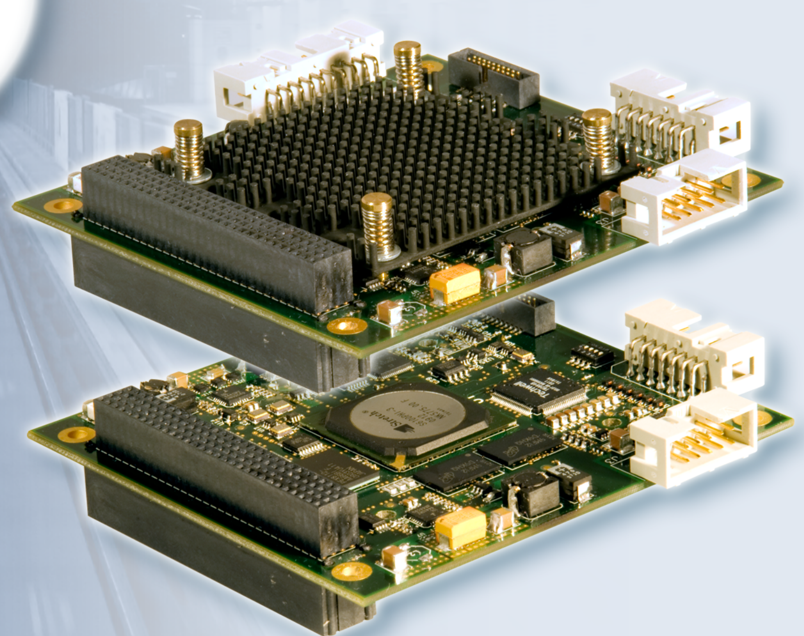
PICOLO U4 H.264 PCI-104™

Documentation

Download the
PICOLO U4 H.264 PCI-104
driver from
www.euresys.com



This documentation describes both Picolo U4 H.264 PCI-104 and Picolo U4 H.264 PCI-104 RH boards.
The documentation is relevant for both variants, and we will use the generic term Picolo U4 H.264 PCI-104.

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Disclaimer

Contents

Installation

1. Precautions of Use

General precautions

- **Electrostatic Sensitive Device.** Boards may be damaged by electrostatic discharges. Follow the procedure hereby described and apply any general procedure aimed at reducing the risk associated to electrostatic discharge. Damage caused by improper handling is not covered by the manufacturer warranty.
- **Electromagnetic Compatibility.** Euresys boards are compliant with electromagnetic compatibility regulatory requirements. To ensure this compliance, it is mandatory to secure the board bracket with the relevant screw according to the procedure hereby described.
- **Risk of Electrical Shock.** Do not operate the computer with any enclosure cover removed. During the hardware installation, ensure the AC power cord is unplugged before touching any internal part of the computer.
- **Heating Device.** In operation, it is normal that a board dissipates some heat. To ensure the adequate cooling effect of the fan equipping your computer, it is mandatory to correctly fit all enclosure covers, including blank brackets.
- **Hot Plugging Forbidden.** Uncontrolled plugging and unplugging of equipment may damage a board. Always switch-off the computer, the cameras and any relevant system device when connecting or disconnecting a cable at the frame grabber or auxiliary board bracket.
- **Poor Grounding Protection.** The computer and the camera can be located in distant areas with distinct ground connections. Poor ground interconnection, ground loop or ground fault may induce unwanted voltage between equipments, causing excessive current in the interconnecting cables. This faulty situation can damage the frame grabber or the camera electrical interface. The user must follow proper equipment grounding practices at all ends of the interconnecting cables. In addition, it is recommended to use cable assemblies with overall shield solidly connected to the conductive shell of all connectors. Besides the beneficial effect of cable shielding on electromagnetic compatibility, the shield connection can increase the protection level against grounding problems in temporarily absorbing unwanted fault current.

Specific recommendations

- Don't warp or bend the PCB assembly excessively.
- Don't apply excessive torque or force on the connectors.
- Don't apply excessive shocks on the assembly.

2. Supported Platforms

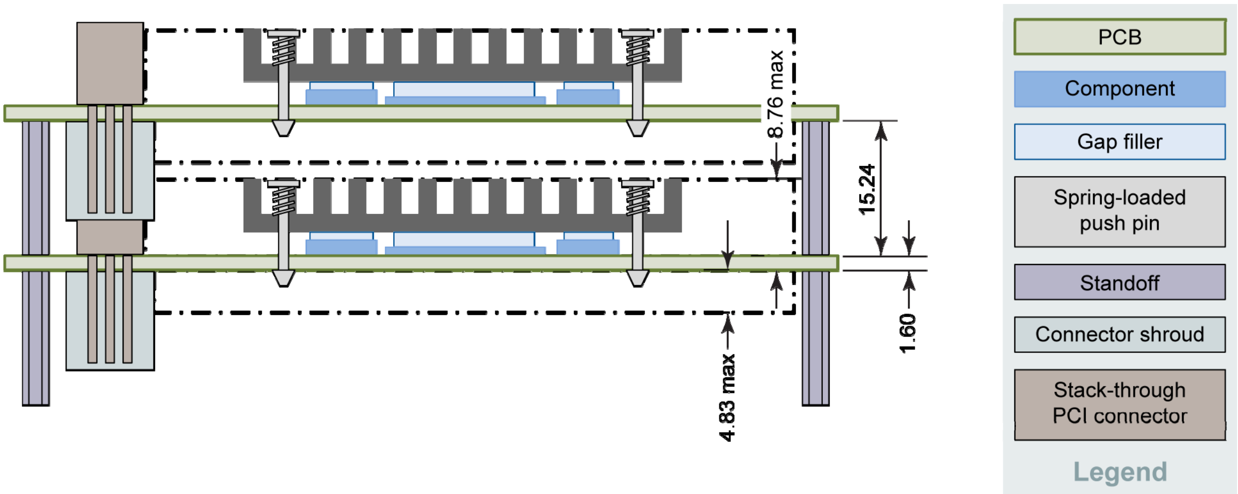
For the supported CPU architectures, operating systems and development tools, please refer to the Release Notes that come with your driver on the Euresys website.

3. PCI-104 Board Installation

Picolo U4 H.264 PCI-104 can be easily inserted in computers/industrial PCs/chassis due to PCI-104 compact size. Up to 4 boards can be stacked together based on the PCI-104 specifications.

Recommended Installation Procedure

- Switch off the computer and all connected peripherals (monitor, printer...).
- Discharge any static electricity that could be accumulated by your body. You can achieve this by touching an unpainted metal part of the enclosure of your computer with a bare hand. Make sure that the computer is linked to the AC power outlet with proper earth connection.
- Disconnect all cables from your computer, including AC power.
- Open the computer enclosure accordingly to the manufacturer instructions. Insert the PCI-104 board accordingly.
- Module stacking:
  - The Euresys PCI-104 boards are stackable PCI-104 add-in modules. Euresys PCI-104 boards connect to the host PC and other modules through a stackable 120-pin 2mm pitch connector compliant with PCI-104 specification*. The connector pins are protected by a connector shroud.
  - Note that a PCI-104 module can be stacked with PC-104Plus, PCI-104, and PCI-104 Express modules, but **NOT** with PC/104 modules. A maximum of 4 PCI devices is allowed in the stack.
  - The components height on both sides of the Euresys PCI-104 boards are compliant with the restrictions required by PCI-104 specification. This enables the board stacking with the standard board-to-board spacing.
  - Before stacking the boards, the PCI SLOT SELECTOR switch (on the back of the board) must be set according to the board stack position.
  - Secure mechanically the stack by means of 4 standard stainless steel standoffs. Refer to PCI-104 specification* for a description of the standoffs. The standoffs are not delivered with the Euresys PCI-104 boards.
- Establish the camera connection.
- Close the computer enclosure according to the manufacturer instructions.



Module stacking

* PC/104 Embedded Consortium. PCI-104 Specification Version 1.0. [Online] November 2003.

4. Driver Installation

The Virtual File System driver is distributed on the Euresys website download area: www.euresys.com > DOWNLOAD. The first time access requires a profile creation and select a user ID and a password.

The installation script creates 8 devices in the **/dev** directory.

The entries for Picolo U4 H.264 PCI-104 boards are named **U4H264PCI104_0** to **U4H264PCI104_7**.

The presence of these files does not indicate that the corresponding board is installed in the system. Refer to Testing Your Board for details

Note that the number of created device files is independent of the number of boards present in the system.

Inserting/Removing the Virtual File System Driver

The Virtual File System driver is inserted automatically during the boot procedure of the Linux system.

You can use the **rmmod** command to remove the Virtual File System driver.

Mounting the File System

The following steps mount the first device detected as **/mnt/my_board** folder.

- Type the root password, **$su** (*)
- Create a device folder. This folder name can be freely chosen by the user, for instance **#mkdir /mnt/my_board**
- Mount the **U4H264PCI104** device, **#mount -t U4H264PCI104VFS/dev/U4H264PCI104_0/mnt/my_board**

Note that all devices must be individually mounted after each PC boot.

(*) Some Linux distribution may not support the **su** command, alternatively **sudo** command can be used for each command requiring the root privileges (denoted with a # prompt). If none of these commands are available, refer to your distribution documentation for executing commands with the root privileges.

Unmounting the File System

You can use the **Unmount** command to unmount the file system, for instance **#unmount/mnt/my_board**

When un-mounting a Virtual File System:

- The default configuration settings are applied to all the objects.
- All the acquisitions in progress are stopped.

5. Testing Your Board

Verifying Picolo U4 H.264 PCI-104 Board Installation

In the **/proc** folder, a text file named **U4H264PCI104Info** lists the detected Picolo U4 H.264 PCI-104 boards. For example, if one Picolo U4 H.264 PCI-104 board has been detected, the **U4H264PCI104Info** text file contains the following line:

```
CardCount=1Card/0/VFSType=U4H264Card/0/Version=2.0.0.3
Card/0/BoardType=PicoloU4H264Card/0/SerialNumber=U4000012Card/0/PartNumber=00001
234-56
```

Notes

- This file also contains the Virtual File System driver version.
- Before revision 2.0 of the driver, the file was named /proc/UxH264. This file is still available for backward compatibility only.

Checking the Video Signal Presence

The following procedure checks the presence of a valid PAL video signal on the video input 1 of the Picolo U4 H.264 PCI-104 board:

- Browse to the folder**/mnt/my_board/visual/source0/**
- Open the file **config.xml**

The file content is displayed as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualSource SYSTEM "config.dtd">
<VisualSource version="1.0">
    <Verbose Immediate="true"/>
    <VideoPresent ReadOnly="true" Immediate="true">
        <DetectedVideoStandard_PAL ReadOnly="true" Immediate="true"/>
    </VideoPresent>
    <VideoStandard_PAL/>
    <Contrast Immediate="true">100</Contrast>
    <Brightness Immediate="true">0</Brightness>
    <Saturation Immediate="true">100</Saturation>
    <Caption0 Immediate="true">
        <String></String>
        <TopLeft/>
    </Caption0>
    <Caption1 Immediate="true">
        <String></String>
        <TopLeft/>
    </Caption1>
    <Mask0 Immediate="true">
        <X>0</X>
        <Y>0</Y>
```

```
            <W>0</W>
            <H>0</H>
        </Mask0>
        <Mask1 Immediate="true">
            <X>0</X>
            <Y>0</Y>
            <W>0</W>
            <H>0</H>
        </Mask1>
        <Mask2 Immediate="true">
            <X>0</X>
            <Y>0</Y>
            <W>0</W>
            <H>0</H>
        </Mask2>
        <Mask3 Immediate="true">
            <X>0</X>
            <Y>0</Y>
            <W>0</W>
            <H>0</H>
        </Mask3>
    </VisualSource>
```

- A detected video signal is reported by the presence of the **VideoPresent** XML element. No detected video is reported by the presence of the **VideoAbsent** XML element.
- A PAL standard video signal is detected on the video input 1 when the **DetectedVideoStandard_PAL** XML element is present.

To check the presence of other standard video signals, the **DetectedVideoStandard_xxxx** XML element in the **config.xml** file is set in accordance with the video signal standard detected (i.e. xxxx = NTSC or CCIR or EIA).

Displaying Live Images

The following procedure requires a system with a graphical environment (kde, gnome...).

- Download the sample programs from the Euresys web site.
- From the folder where you have decompressed the sample programs, launch **raw2stream** application. Refer to the sample programs documentation for more details.

Hardware Reference

1. PICOLO U4 H.264 PCI-104 Overview

Picolo U4 H.264 PCI-104 is a ruggedized video capture board featuring real-time H.264 on-board compression for 4 video channels along with high-quality audio capabilities. Thanks to a high resistance to extreme temperatures, shocks, vibrations and humidity, Picolo U4 H.264 PCI-104 is particularly well suited for embedded security systems for rail and road transportation, police vehicles equipment or any mobile or outdoor video-surveillance application. The ruggedized characteristics of the board are also appropriate for video-surveillance systems installed in extreme industrial environments.

The on-board decoders and processor perform **on-the-fly data processing**: scaling, fixed cropping, contrast, brightness, saturation, color conversion, mask or caption insertion, decimation and storage format. The acquired streams, one compressed and one uncompressed, with different configurations, can be sent from the frame grabber memory to two different memory locations, such as the computer main memory for storage, and the graphic board memory for preview and display.

The following lists the main features of the board.

System

- Ruggedized cards supporting EN50155, EN50155:2007 for Class 3 and EN61373 standards
  - Temperature range from -25°C to +85°C (-13°F to +185°F)
  - Sustained vibration and shocks
  - High humidity levels
- Interface
  - PCI-104 compliant add-in module
- Connectors
  - 1 VIDEO 7 x 2-pins 0.1" pitch right-angled header
  - 1 AUDIO 5 x 2-pins 0.1" pitch right-angled header
  - 1 I/O 10 x 2-pins 0.1" pitch right-angled header
  - 1 PCI-104 4 x 30-pins 2-mm pitch stackable connector
- Temperature monitor

Video Capture

Video Decoder/Formatter - Analog Video Decoding

- Multi-standard PAL-B/D/G/H/I, or NTSC-M
- 4 independent video acquisition channels
- Independently programmable frame rate and acquisition parameters for each video acquisition channels
  - Image size:
    - 4CIF: 704x576 (PAL) or 704x480 (NTSC)
    - 2CIF: 704x288 (PAL) or 704x240 (NTSC)
    - CIF: 352x288 (PAL) or 352x240 (NTSC)
    - QCIF: 176x144 (PAL) or 176x112 (NTSC)
  - Contrast, brightness and saturation controls available
  - Video presence and video standard detection, overlay caption text, privacy masking regions

On-Board Compression

Video Encoder

- H.264 (MPEG-4 Part 10) Baseline profile (Level 3)
- 2 simultaneous and independently configurable output streams for each video channel
- One independently configurable H.264 encoded streams
  - Full resolution and full frame rate possible up to 2.0 Mbps (average) per video acquisition channel
    - Resolution settings: 4CIF, 2CIF, CIF, QCIF
    - Configurable reduction of the frame rate
    - Configurable bit rate control: CPQ, CBR, VBR
  - One raw uncompressed stream - subject to PCI bus available bandwidth
    - Resolution settings: 4CIF, 2CIF, CIF, QCIF
    - Configurable reduction of the frame rate
    - Image storage formats available: YUV420PL (native format) and Y8
    - Other formats possible: YUV422PL, YUV422, RGB15, RGB16, RGB24 and RGB32
- Data transfer
  - High-performance DMA transfer
  - Scattered transfer

Audio Capture

- 4 independent and high-quality audio acquisition channels
- Line-level analog audio input signals
- Selectable audio formats:
  - 64 kbps G.711 μ-law, 64 kbps G.711 A-law
  - Linear PCM @ 8, 16, 22.05, 44.1 and 48 kHz
- Audio-video synchronization supported by accurate time stamping of audio and video data

Video Pass-Through Selector

Any of 4 video inputs, or the cascade video input, can be routed to video output.

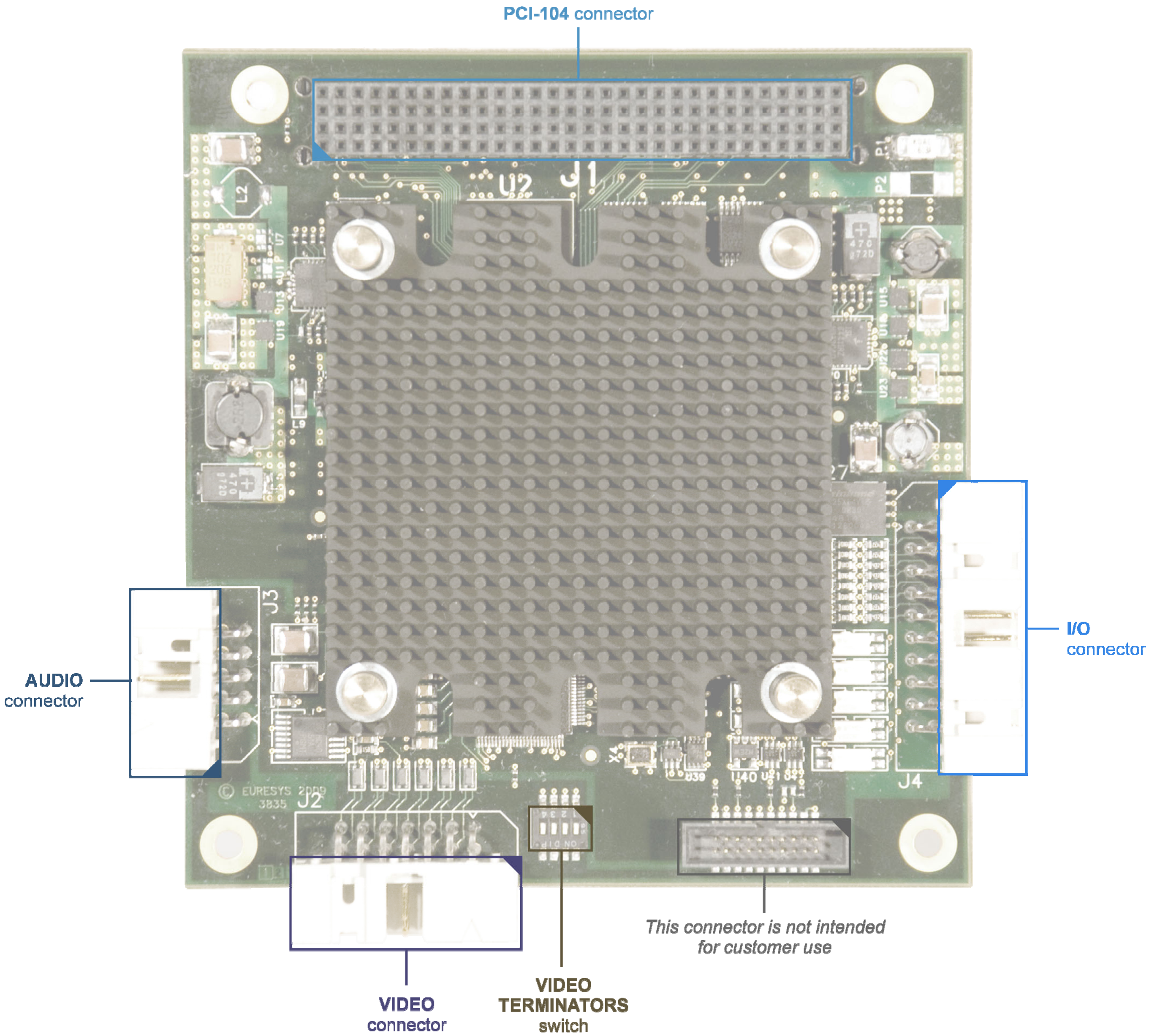
I/O Sub-System

- 4 solid-state relay outputs
- 4 contact-closure inputs
- 1 WATCHDOG output

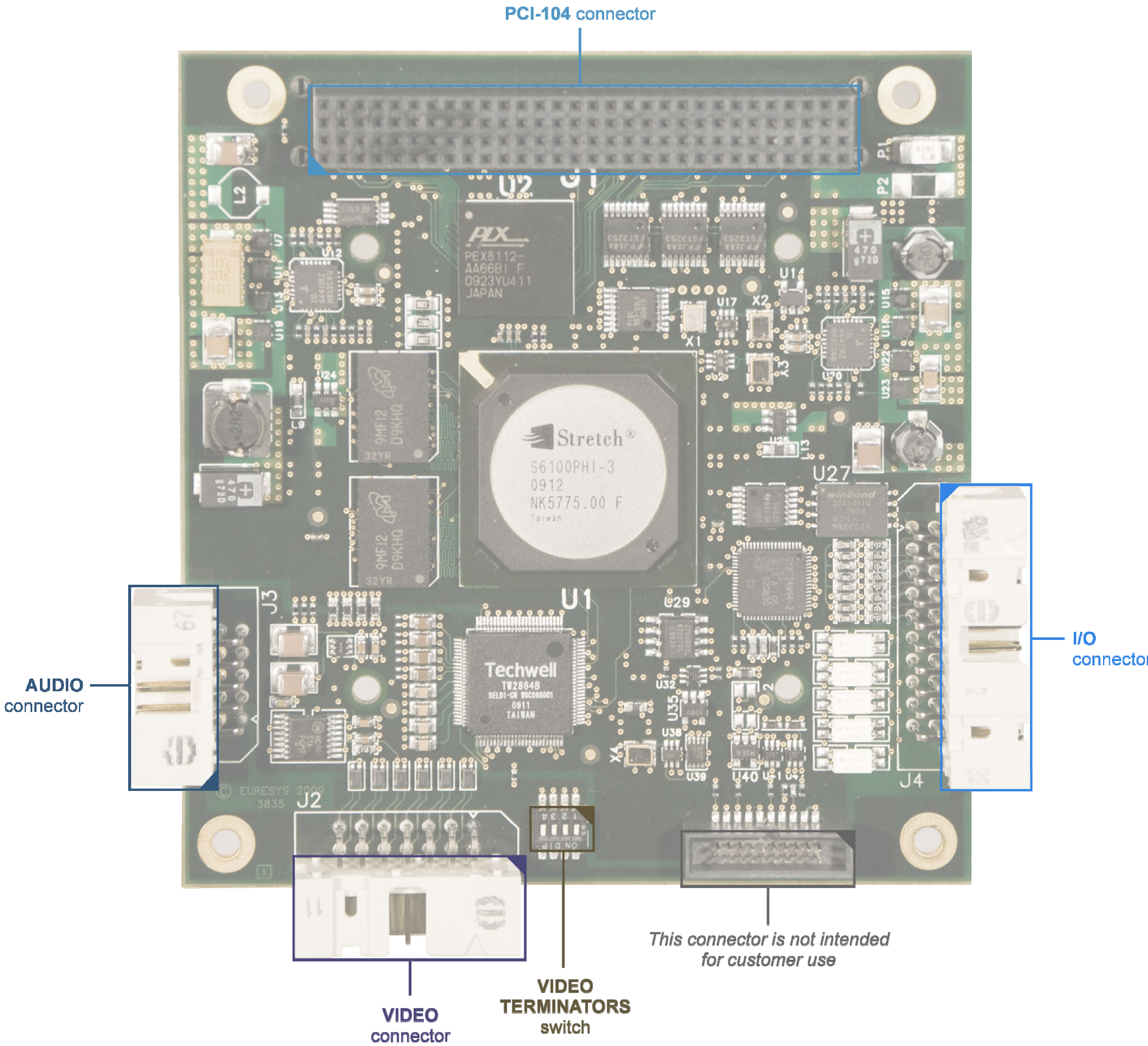
2. Board Specifications

2.1 Board Layout and Block Diagram

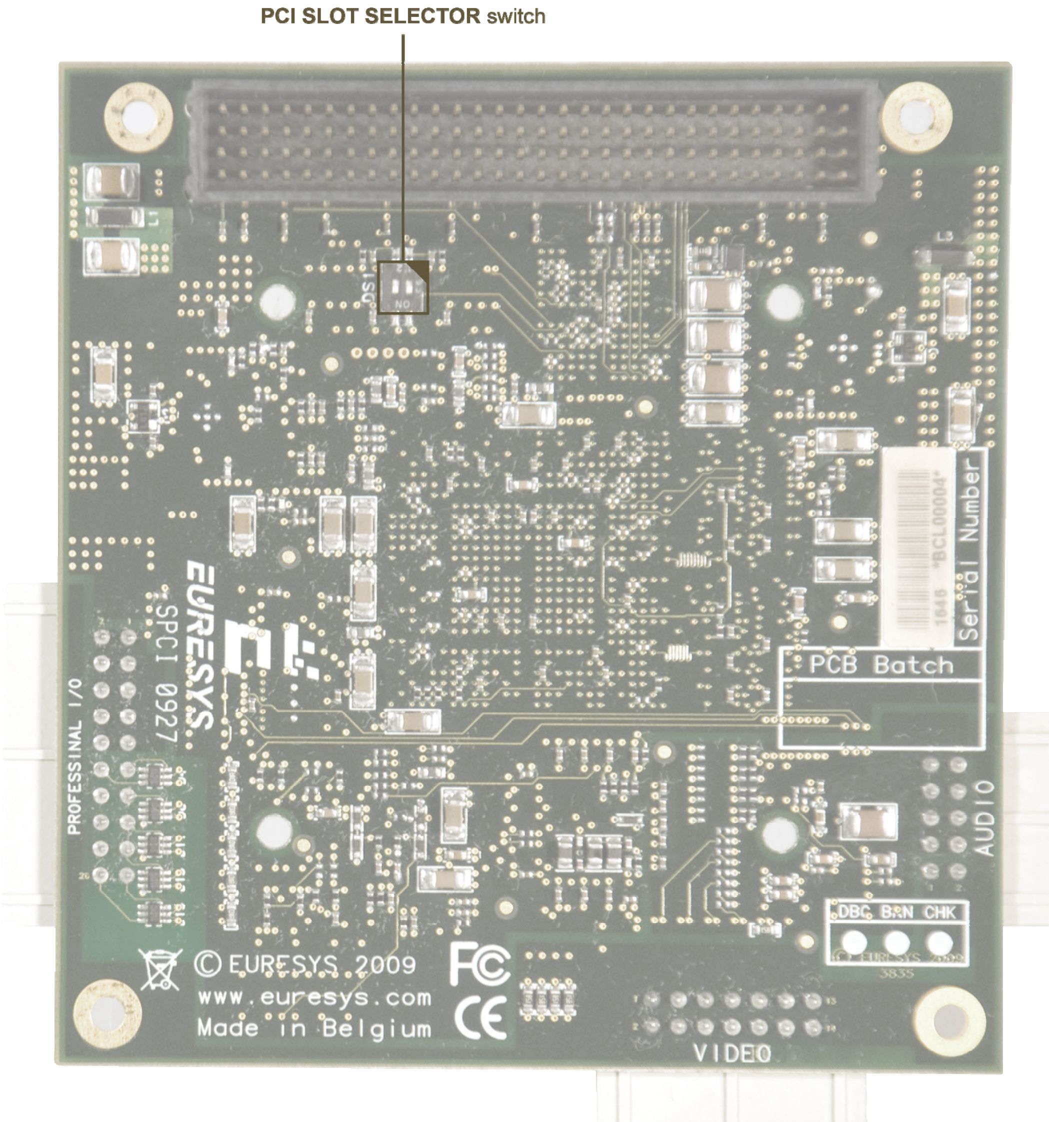
Connector name	Connector type
VIDEO	7 x 2-pins 0.1" pitch right-angled header
AUDIO	5 x 2-pins 0.1" pitch right-angled header
I/O	10 x 2-pins 0.1" pitch right-angled header
PCI-104	4 x 30-pins 2 mm pitch stackable connector
Switch name	**Switch type**
PCI SLOT SELECTOR	2-position slide-type DIP switch
VIDEO TERMINATORS	4-position slide-type DIP switch
Board dimensions	**167 mm x 111 mm**



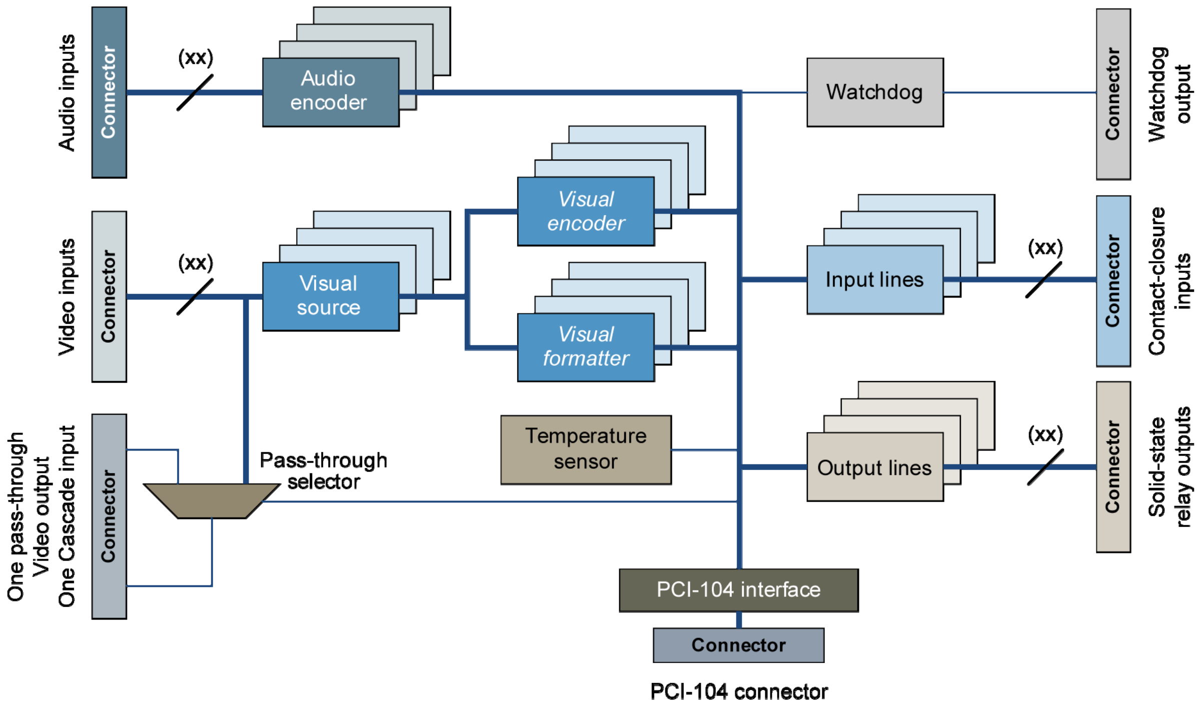
Picolo U4 H.264 PCI-104 board layout (top view)



Picolo U4 H.264 PCI-104 RH board layout (top view)



Picolo U4 H.264 PCI-104 board layout (bottom view)

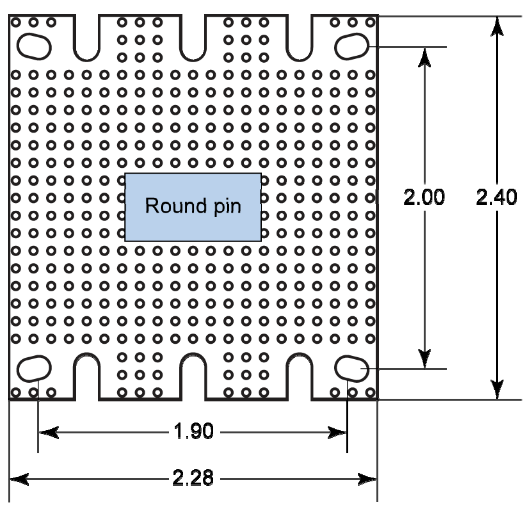


Picolo U4 H.264 PCI-104 block diagram (xx = 4)

2.2 Heatsink and Mount

Picolo U4 H.264 PCI-104 is delivered with a mounted standard heatsink. Picolo U4 H.264 PCI-104 RH is delivered without heatsink, which allows users to mount a custom heatsink.

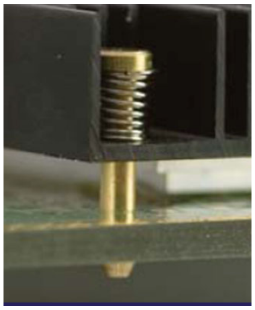
Standard Mounted Heatsink



Heatsink

The standard heatsink is a high-efficiency round-pin design constructed with black anodized aluminum.

The heatsink height is 5.8 mm (0.23 inches). This standard mounted heatsink is designed to fit with the available space between adjacent modules.



Heatsink mount

Custom Heatsink Mount

As the standard mounted heatsink, the custom heatsink chosen to be placed on the board has to be efficiently and securely mounted on the PCB with spring-loaded push pins.

Thermally conductive elastic gap filler must be inserted between module components requiring cooling and the heatsink. The gap filler is compressed adequately to establish a good thermal conduction for all involved components.

2.3 PCI-104

PCI Interface

Picolo U4 H.264 PCI-104 is a PCI-104 compliant device.It conforms to all non-optional aspects of the PCI-104 Specification, including both mechanical and electrical specifications.

PCI Signaling Voltage

Picolo U4 H.264 PCI-104 is a universal PCI-104 add-in module. A universal add-in module can be used on both 3.3V or 5V I/O signaling buses.

Picolo U4 H.264 PCI-104 uses the VI/O signal to determine its signaling level.

The PCI host board drives the VI/O pins according to the desired PCI signaling level. If VI/O is set to 3.3V, then the system will use 3.3V I/O signaling. Likewise, if VI/O is set to 5V, then the system will use 5V I/O signaling.

PCI Bus Size

Picolo U4 H.264 PCI-104 is a 32-bit PCI device.

PCI Bus Clock

Picolo U4 H.264 PCI-104 embeds a PCI bridge that operates on both 33 MHz and 66 MHz bus clock frequencies.

Notes

- Operating a PCI-104 bus at 66 MHz is not reliable when additional add-on module is plugged on the PCI-104 stack. Consequently, if a PCI-104 stack contains more than one add-on PCI-104 module, it is mandatory to configure the PCI bus controller, usually hosted by the CPU board, for 33 MHz operation.
- For reliable operation, the clock driver of the bus controller must deliver a PCI-compliant PCI clock signal to all the PCI-104 modules.

2.4 Watchdog Connector

The watchdog closes the PC reset relay during 1 second when it detects a malfunction of the system. You need to install an electrical connection between the PC reset relay and the PC reset connection on the motherboard. For this purpose, the Euresys frame grabbers are fitted with a PC reset header.

For the location of the PC reset header, refer to Board Layout and Block Diagram. If several PCI-104 boards are stacked, one reset connection is sufficient.

2.5 Power Supply

Picolo U4 H.264 PCI-104 power source comes from the PCI-104 connector.

The power is delivered from the +5V pins.

Picolo U4 H.264 PCI-104 uses the +5V pins of the PCI-104 connector as power source. The +3.3V, +12V, and -12V pins of the PCI-104 connector are left unconnected.

+5V power supply requirements

Parameter	Min	Typ.	Max	Units
PCI-104 module +5V supply voltage	4.75	5	5.25	V
PCI-104 module +5V supply current	0.9		1.3	A
PCI-104 module power	4.2		6.8	W

Typical supply current values are measured during board operation at 25°C ambient temperature and nominal supply voltage.

The power requirements of the U4 platform complies entirely with the PCI-104 module power requirements as defined in § 4.2 of PCI-104 Specification version 1.0.

2.6 Environmental

Storage Conditions

Requirement during storage conditions	Min	Max	Units
Temperature range	-40/-40	+70/+158	°C/°F
Humidity range	10	90	% RH non-condensing

Recovery From Extreme Storage Conditions

The card may not be powered immediately after leaving storage conditions that are outside the normal operating conditions.

A recovery time is required to ensure that:

- All components have reached the normal temperature conditions
- Eventually, all traces of condensed water have disappeared

Temperature

Operating Specification

Picolo U4 H.264 PCI-104 is designed and manufactured to operate in the temperature range specified by EN 50155 for Class T3 electronic equipment used on rolling stock in railways applications.

Temperature conditions with 1m/s airflow

Requirement during operating conditions	Min	Max	Units
Air temperature around the board	-25/-13	+85/+158	°C/°F
Recommended limit for board temperature		+95/+203	°C/°F
Absolute limit for board temperature		+100/+212	°C/°F

It is mandatory that the cooling system of the PC/104 stack including one or more Picolo U4 H.264 PCI-104 is efficient enough to keep the board temperature below the recommended limit even for the highest level of ambient air temperature.

Picolo U4 H.264 PCI-104 embeds a temperature sensor that measures the board temperature in the vicinity of the processor. The measurement has an absolute accuracy of ± 2°C (± 3.6°F) over the -25°C to 100°C temperature range. The board temperature is reported in °C to the application software through the API.

Picolo U4 H.264 PCI-104 embeds a "thermal protection" that safely turns off the processor, and prevents against irrecoverable board damages when the board temperature reaches the absolute limit.

Humidity

Operating Specification

Picolo U4 H.264 PCI-104 is designed and manufactured to operate in the relative humidity conditions specified by EN 50155 over the Class T3 external temperature range of -25°C(-13°F) to +40°C(-113°F) .

- Relative humidity averaged over a year ≤ 75%
- Relative humidity during 30 consecutive days ≤ 90 %
- Condensation may not cause damage or malfunction.

A coating varnish is applied on both sides of the PCB assembly.

Shocks and Vibrations

Operating Specification

Picolo U4 H.264 PCI-104 is designed and manufactured to operate normally while it sustains shocks and vibrations specified in EN 61373.

Picolo U4 H.264 PCI-104 is considered as a Category 1 Class B2 equipment as defined in EN61373; i.e. an equipment mounted inside a case that is attached on the vehicle frame.

Electromagnetic Compatibility (EMC)

Operating Specification

Picolo U4 H.264 PCI-104 is designed and manufactured to fulfill the requirement of

- The EN 50155:2007 standard
- The European Council Directive 2004/108/EEC including
  - The EN 55022:1998 class A
  - The EN 55024:1998 and amendments A1 (2001) , and A2 (2003)
- The Federal Communications Commission of the United State for Class A devices

2.7 Declaration of Conformity

Notice for USA

Compliance Information Statement (Declaration of Conformity Procedure)
DoC FCC Part 15

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules.

These limits are designed to provide reasonable protection against harmful interference in a residential installation or when the equipment is operated in a commercial environment.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- 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.

Notice for Europe

This product is in conformity with the Council Directive 89/336/EEC
amended by 92/31/EEC and 93/68/EEC

This equipment has been tested and found to comply with EN55022/CISPR22 and EN55024/CISPR24. To meet EC requirements, shielded cables must be used to connect a peripheral to the board. This product has been tested in a typical class B compliant host system. It is assumed that this product will also achieve compliance in any class B compliant unit.

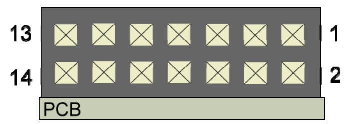
This product is in conformity with the European Union RoHS Directive, that stands for "the restriction of the use of certain hazardous substances in electrical and electronic equipment". This directive will ban the placing on the EU market of new electrical and electronic equipment containing more than agreed levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame retardants, from 1 July 2006.

3. Connectors and Switches Specifications

3.1 VIDEO Connector

VIDEO Connector Layout

The **VIDEO** connector is a 0.1" pitch right-angled 7 x 2-pins shrouded header.



VIDEO connector layout

VIDEO connector pins assignment

Pin #	Pin name	Function	Pin #	Pin name	Function
1	**GND**	Ground	**2**	**GND**	Ground
3	**VID_IN_1**	Video Input 1 - Signal	**4**	**VRN_IN1**	Video Input 1 - Return
5	**VID_IN_2**	Video Input 2 - Signal	**6**	**VRN_IN2**	Video Input 2 - Return
7	**VID_IN_3**	Video Input 3 - Signal	**8**	**VRN_IN3**	Video Input 3 - Return
9	**VID_IN_4**	Video Input 4 - Signal	**10**	**VRN_IN14**	Video Input 4 - Return
11	**VID_IN_CAS**	Cascade Video Input Signal	**12**	**VRN_CAS**	Cascade Video Input Return
13	**VID_OUT**	Video Output	**14**	**VRN_OUT**	Video Output Return

Video Inputs Electrical Specifications

The **VIDEO** connector has **4** identical Video Inputs. Each port has two pins named **VID_INxx** and **VRN_INxx** respectively, where **xx** is a number ranging from **1** to **4**. The "hot conductor" of the transmission line transporting the video signal **xx** has to be connected to the **VID_INxx** pin, while the "cold conductor" of the transmission line has to be connected to the corresponding **VRN_INxx** pin. If the transmission line is a coaxial line, the "hot conductor" is the inner conductor, and the "cold conductor" is the outer conductor.

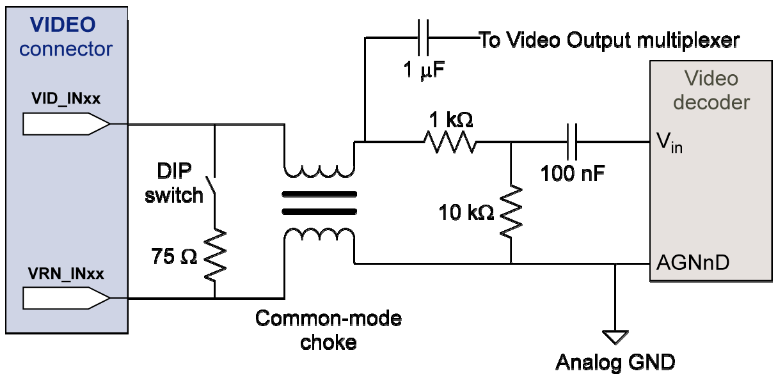
A switchable 75Ω termination resistor is inserted directly across **VID_INxx** and **VRN_INxx**. The termination resistor can be disconnected by a DIP switch.

The factory settings of the termination resistor DIP switch are **ON**.

The video signal flows through a common-mode choke which attenuates any common-mode noise present on the video signal. The **VRN_INxx** pin is connected to the analog **GND** through one winding of the common-mode choke. The **VID_INxx** pin is connected to the second winding.

The filtered video signal (slightly attenuated by the 1kΩ/10kΩ resistor network) is AC-coupled to a video input of the video decoder. The 1 kΩ resistor protects the video decoder input against excessive currents in case of abnormal signal levels applied on the Video inputs.

The filtered video signal is also AC-coupled to an input of the video multiplexer circuit.



Video Input circuit

Video inputs - DC characteristics

Parameter	Min	Typ.	Max	Units
Input voltage range - Absolute max rating	-0.55		+2.2	V
Input impedance - Terminator OFF		11		kΩ
Input impedance - Terminator ON		75		Ω

For a correct operation of the video decoder, the video signal must satisfy all following electrical requirements.

Video signal electrical requirements

Parameter	Min	Typ.	Max	Units
Overall peak-to-peak amplitude	0.5	1.0	1.5	V
Sync amplitude	150	300	400	mV
Rise/Fall time of sync edges	50		300	ns

Lower video signal amplitudes are not recommended.

The signal attenuation induced by the 1kΩ/10kΩ resistor network circuit is compensated by the front-end amplifier in the input stage of the video decoder.

Video Output Electrical Specifications

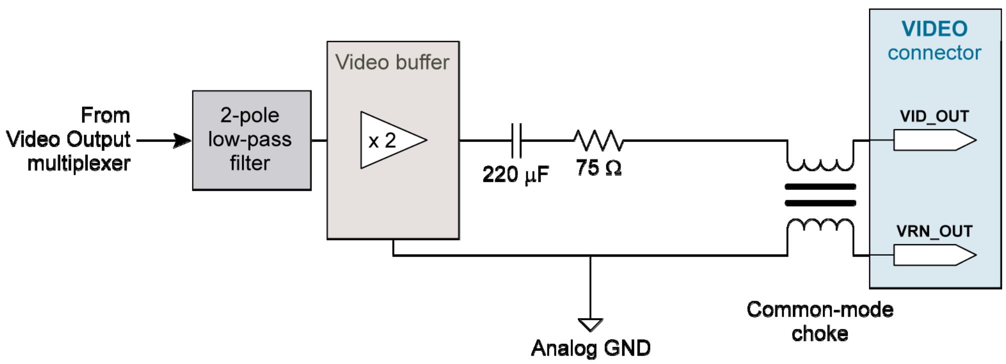
The **VIDEO** connector has one Video Output port.

Each port has two pins named **VID_OUT** and **VRN_OUT** respectively. The "hot conductor" of the transmission line transporting the video signal has to be connected to the **VID_OUT** pin, while the "cold conductor" of the transmission line has to be connected to the **VRN_OUT** pin. If the transmission line is a coaxial line, the "hot conductor" is the inner conductor, and the "cold conductor" is the outer conductor.

The output of the Video Output multiplexer is low-pass filtered, then amplified by a video buffer with a fixed gain of 2.

The output of the buffer is AC-coupled and serially terminated by a 75Ω termination resistor inserted in the output path.

The video output is further filtered by a common-mode choke, which prevents common-mode noise present on the video signal to penetrate inside. The **VRN_OUT** pin is connected to the analog **GND** through one winding of the common-mode choke. The **VID_OUT** pin is connected to the second winding.



Video Output circuit

Video Output - DC characteristics

Parameter	Min	Typ.	Max	Units
Output impedance		75		Ω

Video Output - AC characteristics

Parameter	Min	Typ.	Max	Units
Bandwidth	50		7,000,000	Hz

Cascade Video Input Electrical Specifications

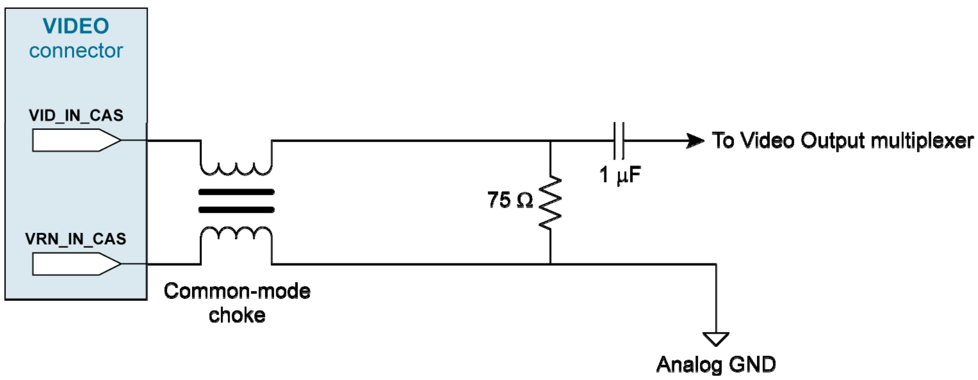
The **VIDEO** connector has one Cascade Video Input port.

The ports have two pins named **VID_IN_CAS** and **VRN_IN_CAS** respectively. The "hot conductor" of the transmission line transporting the video signal "**xx"** has to be connected to the **VID_IN_CAS** pin, while the "cold conductor" of the transmission line has to be connected to the corresponding **VRN_IN_CAS** pin. If the transmission line is a coaxial line, the "hot conductor" is the inner conductor, and the "cold conductor" is the outer conductor.

A fixed 75Ω termination resistor is inserted across **VID_IN_CAS** and **VRN_IN_CAS**.

When this is applied on the **VIDEO** connector port, the cascade video signal flows through a common-mode choke, which attenuates the common-mode noise present on the video signal. The **VRN_IN_CAS** pin is connected to the analog **GND** through one winding of the common-mode choke. The **VID_IN_CAS** pin is connected to the second winding.

The filtered video signal is available on the **VIDEO CASCADE** connector. It is applied to the Video Output multiplexer through a coupling capacitor.



Cascade Video Input circuit

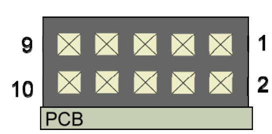
Cascade Video Input - DC characteristics

Parameter	Min	Typ.	Max	Units
Input voltage range - Absolute max rating	-2		+2	V
Input impedance		75		Ω

3.2 AUDIO Connector

AUDIO Connector Layout

The **AUDIO** connector is a 0.1" pitch right-angled 5 x 2-pins shrouded header.



AUDIO connector layout

AUDIO connector pins assignment

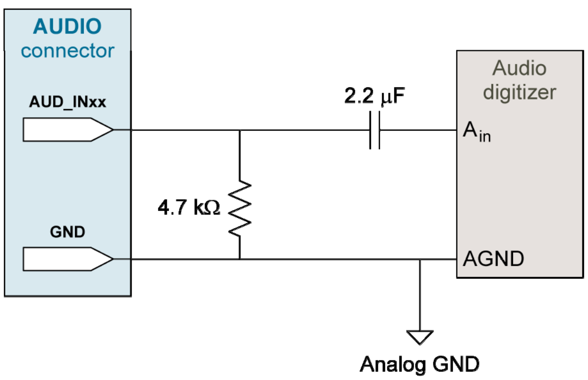
Pin #	Pin name	Function	Pin #	Pin name	Function
1	**GND**	Ground	**2**	**GND**	Ground
3	**AUD_IN_1**	Audio Input 1 - Signal	**4**	**GND**	Audio Input 1 Return
5	**AUD_IN_2**	Audio Input 2 - Signal	**6**	**GND**	Audio Input 2 Return
7	**AUD_IN_3**	Audio Input 3 - Signal	**8**	**GND**	Audio Input 3 Return
9	**AUD_IN_4**	Audio Input 4 - Signal	**10**	**GND**	Audio Input 4 Return

Audio Inputs Electrical Specifications

There are 4 identical line-level analog Audio Input ports on the AUDIO connector.

Each port has two pins named **AUD_INxx** and **GND** respectively, where **xx** is a number ranging from **1** to **4**.

The line-level audio signal is applied to the ADC input through a AC coupling capacitor.



Audio Input circuit

Audio Input - DC characteristics

Parameter	Min	Typ.	Max	Units
Input voltage range - Absolute max rating	-30		+30	V
Input impedance at 1 kHz		>4.7		kΩ

For a correct operation of the audio decoder, the audio signal must satisfy the following electrical requirements:

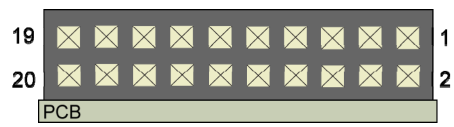
Audio signal characteristics

Parameter	Min	Typ.	Max	Units
Audio level range	0.5	1.0	1.65	V_{ptp}

3.3 General Purpose and Watchdog I/O Connector

I/O Connector Layout

The **I/O** connector is a 0.1" pitch right-angled 10 x 2 pins shrouded header.



I/O connector layout

I/O connector pins assignment

Pin #	Pin name	Function	Pin #	Pin name	Function
1	**GND**	Ground	**2**	**GND**	Ground
3	**IN1-A**	Input 1 - A side	**4**	**IN1-B**	Input 1 - B side
5	**IN2-A**	Input 2 - A side	**6**	**IN2-B**	Input 2 - B side
7	**IN3-A**	Input 3 - A side	**8**	**IN3-B**	Input 3 - B side
9	**IN4-A**	Input 4 - A side	**10**	**IN4-B**	Input 4 - B side
11	**OUT1-A**	Output 1 - A side	**12**	**OUT1-B**	Output 1 - B side
13	**OUT2-A**	Output 2 - A side	**14**	**OUT2-B**	Output 2 - B side
15	**OUT3-A**	Output 3 - A side	**16**	**OUT3-B**	Output 3 - B side
17	**OUT4-A**	Output 4 - A side	**18**	**OUT4-B**	Output 4 - B side
19	**RST-A**	Reset output - A side	**20**	**RST-B**	Reset output - B side

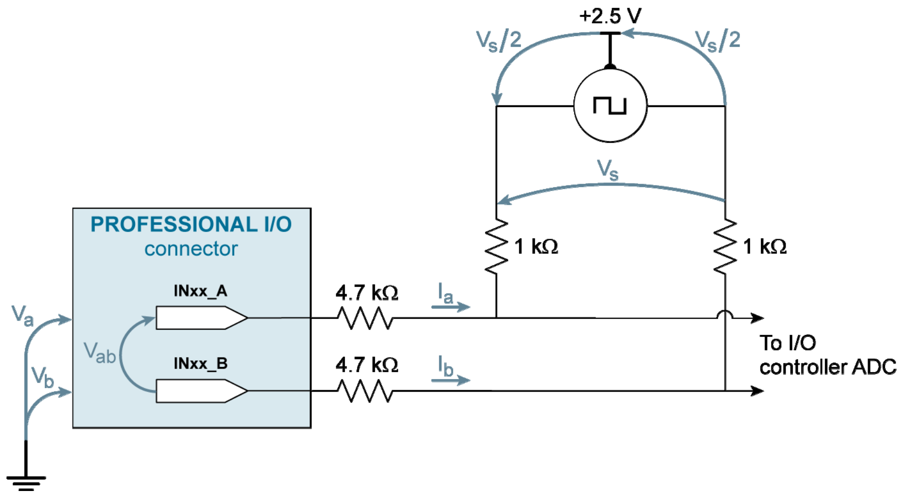
General Purpose Inputs IN1 to IN4 Electrical Specifications

There are 4 identical general purpose digital inputs on the **I/O** connector. Each port exposes two pins named **INxx-A** and **INxx-B** respectively, where **xx** is a number ranging from **1** to **4**.

This digital non-isolated differential input is polarity insensitive. Following type of devices are accepted:

- Digital Totem-Pole drivers at TTL, 5V CMOS, or 12V levels
- Potential-free contact closure (dry contacts)
- Fixed-potential contact closure (one pin of the contact at fixed potential)

The I/O controller measures the differential voltage and the differential impedance across both pins of each port sequentially. Therefore, it stimulates the external devices by applying alternatively positive and negative stimulation voltage V_s, as shown on the following diagram.



Professional Inputs 1-16 circuit

- When the measured impedance is above the impedance threshold, the I/O controller reports an **OPEN** state.
- When the measured impedance is below the impedance threshold, the I/O controller considers the differential voltage.
- When the measured differential voltage is above the voltage threshold, the I/O controller returns a **HIGH** state, else it returns a **LOW** state.

The impedance threshold is not adjustable. The voltage threshold is selectable among three values to determine the logic level of TTL, 5V CMOS, or 12V signals.

Hint. When you connect a low-impedance digital source (for instance a TTL gate), the capability to detect an open state can be used to detect a broken line.

Absolute max ratings

Parameter	Symbol	Min	Typ.	Max	Units
Absolute max voltage	Va_{AbsMax}, Vb_{AbsMax}			25	V
Absolute min voltage	Va_{AbsMin}, Vb_{AbsMin}	-25			V

The port does not operate correctly over the specified range. For normal operating conditions, refer to the DC characteristics table below.

The specification applies for both on and off power conditions.

DC characteristics

Parameter	Test condition(*)	Symbol	Min	Typ.	Max	Units
AC stimulation voltage		|Vs|		1.67		V_{ptp}
DC bias voltage		V_{bias}		2.5		V
Input voltage range	"Logic input" operation	Va_{range}, Vb_{range}	-7.8		12.8	V
Input current	Va (or Vb) = -5.0 V	Ia (or Ib)		1,32		mA
	Va (or Vb) = -0.0 V			0,44		mA
	Va (or Vb) = 2.5 V			0,00		mA
	Va (or Vb) = 5.0 V			-0,44		mA
	Va (or Vb) = 12.0 V			-1,67		mA
TTL Logic input operation (3V p.t.p signal)						
Differential voltage threshold	Va in Vb within input voltage range	V_{TTLth}		1.5		V
Common-mode voltage(**)		V_{TTLcmv}	-6.3	1.5(***)	11.3	V
5V CMOS logic input operation (5V p.p. signal)						
Differential voltage threshold	Va in Vb within input voltage range	V_{CMOSth}		2.5		V
Common-mode voltage(**)		$V_{CMOScmv}$	-5.3	2.5(***)	10.3	V
12V logic input operation (12V p.t.p signal)						
Differential voltage threshold	Va in Vb within input voltage range	V_{12Vth}		6		V
Common-mode voltage(**)		V_{12Vcmv}	-1.8	6(***)	6.8	V
Contact operation - both pins floating						
Differential impedance threshold	Potential-free contact	R_{PFth}		5		kΩ
Common-mode voltage(**)		V_{PFcmv}		2.5		V
Contact operation - one pin at fixed potential						
Differential impedance threshold		R_{Fxth}		8.5		kΩ
Common-mode voltage(****)		V^{FXcmv}	-7.8		12.8	V

(*) T = 25 °C, unless specified.

(**) Common-mode voltage = (Va + Vb)/2.

(***) One pin at GND.

(****) Common-mode voltage = voltage Va (or Vb) of pin at fixed potential.

AC characteristics

Parameter	Test condition(*)	Symbol	Value	Units
Sampling rate		f	200	Hz
Deglitching filter tap count(**)	Filter setting at 10 ms	tc	2	Samples
	Filter setting at 100 ms		20	Samples
Minimum pulse width(***)	Filter setting at 10 ms	pw_{Min}	35	ms
	Filter setting at 100 ms		115	ms

(*) T_{amb} = 25°C, unless otherwise specified.

(**) 'tc' is the number of taps of the deglitching filter. The deglitching filter removes all transient input states having a number of consecutive identical samples smaller or equal to the value tc.

(***) This indicates the smallest pulse that the input lines can safely detect. This minimal value cannot be guaranteed in all circumstances; however, it can serve as guide lines for the system design.

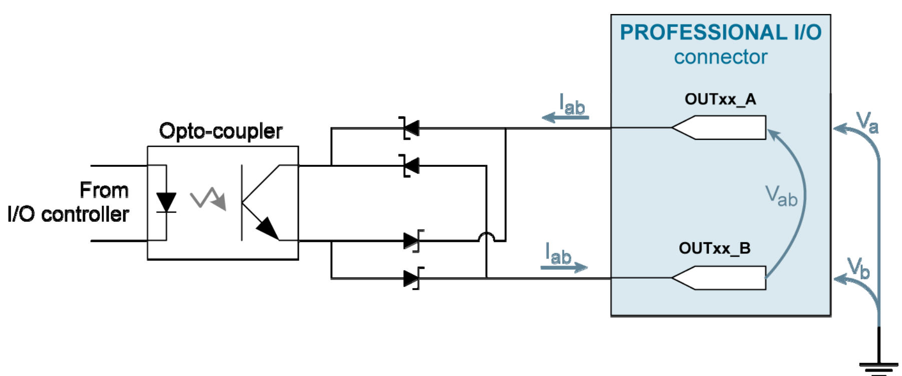
General Purpose Digital Outputs OUT1 to OUT4 Electrical Specifications

There are 4 general purpose outputs on the **I/O** connector.

Each port has two pins named **OUTxx-A** and **OUTxx-B** respectively, where **xx** is a number ranging from **1** to **4**.

This output port emulates a potential-free and polarity-free solid-state contact.

The contact remains in the **OPEN** state during board initialization procedure.



Professional Outputs 1-16 circuit

Absolute max ratings

Parameter	Test condition(*)	Symbol	Min	Typ.	Max	Units
Maximum voltage	Contact open	$\lvert Vab \rvert_{max}$	-30		30	V
Maximum current	Contact closed	$\lvert Iab \rvert_{max}$			25	mA

(*) T_{amb} = 20°C/+85°C

DC characteristics

Parameter	Test condition(*)	Symbol	Min	Typ.	Max	Units
Voltage drop	Contact closed, |Iab| = 0.5 mA	$\|Vab\|_{drop}$		0.7		V
	Contact closed, |Iab| = 1 mA			0.72		V
	Contact closed, |Iab| = 3 mA			0.84		V
	Contact closed, |Iab| = 5 mA			0.86		V
	Contact closed, |Iab| = 7 mA			0.92		V
	Contact closed, |Iab| = 10 mA			0.94		V
	Contact closed, |Iab| = 15 mA			1		V
	Contact closed, |Iab| = 20 mA			1.12		V
	Contact closed, |Iab| = 25 mA			1.4		V
Leakage current	Contact closed, |Vab| = 15 V	$\|Iab\|_{leak}$		20	100	µA
Isolation voltage		$\|Va\|_{max}$, $\|Vb\|_{max}$			500	V_{ACrms}

(*) T_{amb} = 20°C/+85°C

AC characteristics

Parameter	Test condition (*)	Symbol	Min	Typ.	Max	Units
Turn-off time	|Vab| = 5V; |Iab| = 0.5 mA	t_{off}	33,3	100	200	µs
	|Vab| = 5V; |Iab| = 1 mA		20,0	60	120	
	|Vab| = 5V; |Iab| = 3 mA		6,7	20	40	
	|Vab| = 5V; |Iab| = 5 mA		3,7	11	22	
	|Vab| = 5V; |Iab| = 7 mA		3,0	9	18	
	|Vab| = 5V; |Iab| = 10 mA		2,0	6	12	
	|Vab| = 5V; |Iab| = 15 mA		1,7	5	10	
	|Vab| = 5V; |Iab| = 20 mA		1,3	4	8	
	|Vab| = 5V; |Iab| = 25 mA		1,0	3	6	
Turn-on time	|Vab| = 5V; |Iab| = 0.5 mA	t_{on}	0,4	1	2	
	|Vab| = 5V; |Iab| = 1 mA		0,4	1,1	2,2	
	|Vab| = 5V; |Iab| = 3 mA		0,4	1,2	2,4	
	|Vab| = 5V; |Iab| = 5 mA		0,5	1,3	2,6	
	|Vab| = 5V; |Iab| = 7 mA		0,5	1,4	2,8	
	|Vab| = 5V; |Iab| = 10 mA		0,5	1,5	3	
	|Vab| = 5V; |Iab| = 15 mA		0,5	1,6	3,2	
	|Vab| = 5V; |Iab| = 20 mA		0,6	1,8	3,4	
	|Vab| = 5V; |Iab| = 25 mA		0,6	2	4	

(*) T_{amb} = 20°C/+85°C

Watchdog Output Electrical Specifications

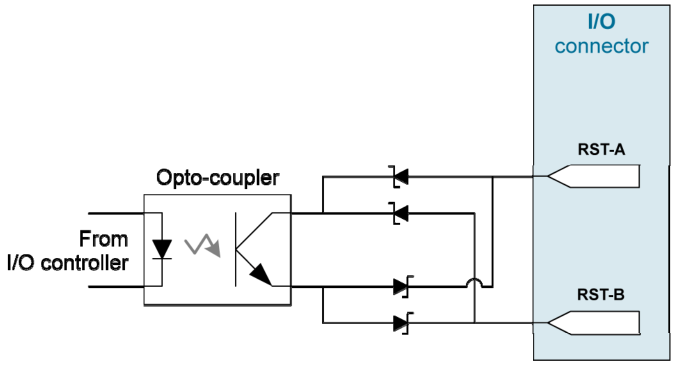
There is a single Watchdog Output on the **I/O** connector.

Each port has two pins named **RST-A** and **RST-B**.

This output port emulates a potential-free and polarity-free solid-state contact.

The contact remains in the **OPEN** state during board initialization procedure.

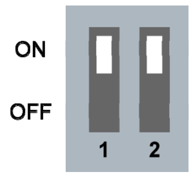
The Watchdog Output shares the same electrical specifications as the general purpose outputs.



Watchdog Output circuit

3.4 PCI SLOT SELECTOR Switch

The **PCI SLOT SELECTOR** switch is a 2-position slide-type DIP switch.



2-position PCI SLOT SELECTOR switch

PCI SLOT SELECTOR switch assignments

Switch	Function
1	PCI-104 module slot selector (LS Bit)
2	PCI-104 module slot selector (MS Bit)

PCI SLOT SELECTOR configuration

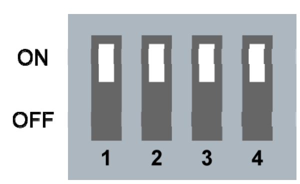
Switch 1 / Switch 2	Slot #	IDSEL	REQ#	GNT#	CLK	INT0#
ON / ON	1	IDSEL0	REQ0#	GNT0#	CLK0	INTA#
OFF / ON	2	IDSEL1	REQ1#	GNT1#	CLK1	INTB#
ON / OFF	3	IDSEL2	REQ2#	GNT2#	CLK2	INTC#
OFF / OFF	4	IDSEL3	REQ3#	GNT3#	CLK3	INTD#

All switches are set to ON at factory. It means that Picolo U4 H.264 PCI-104 is configured for module slot1:

- Uses IDSEL0 as a chip select during configuration read and write transactions
- Uses REQ0# / GNT0# lines for PCI bus arbitration
- Uses the INTA# line as interrupt line 0
- Uses CLK0 as PCI bus clock source

3.5 VIDEO TERMINATORS Switch

The **VIDEO TERMINATORS** switch is a 4-position slide-type DIP switch.



4-position VIDEO TERMINATORS switch

VIDEO TERMINATORS switch assignments

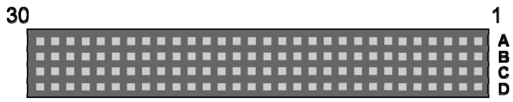
Switch	Function
1	Video Input 1 Terminator Switch
2	Video Input 2 Terminator Switch
3	Video Input 3 Terminator Switch
4	Video Input 4 Terminator Switch

By default, all switches are ON. It means that all video input lines are terminated with a 75-ohm resistor to GND.

When a switch is in the ON position, the corresponding terminator is connected.

3.6 PCI-104 Connector

The **PCI-104** connector is a stack-through 4 x 30-pins 2mm pitch connector. The connector pins are protected by a connector shroud installed on the bottom of the PC board.



PCI-104 connector

PCI-104 connector pins assignment

Pin #	Pin name			
	Row A	Row B	Row C	Row D
1	GND	Reserved(*)	+5V(**)	AD00
2	VI/O	AD02	AD01	+5V(**)
3	AD05	GND	AD04	AD03
4	C/BE0#	AD07	GND	AD06
5	GND	AD09	AD08	GND
6	AD11	VI/O	AD10	M66EN (****)
7	AD14	AD13	GND	AD12
8	+3.3V(*)	C/BE1#	AD15	+3.3V(*)
9	SERR#	GND	Reserved	PAR
10	GND	PERR#	+3.3V(*)	Reserved
11	STOP#	+3.3V(*)	LOCK#	GND
12	+3.3V(*)	TRDY#	GND	DEVSEL#
13	FRAME#	GND	IRDY#	+3.3V(*)
14	GND	AD16	+3.3V(*)	C/BE2#
15	AD18	+3.3V(*)	AD17	GND
16	AD21	AD20	GND	AD19
17	+3.3V(*)	AD23	AD22	+3.3V(*)
18	IDSEL0	GND	IDSEL1	IDSEL2
19	AD24	C/BE3#	VI/O	IDSEL3
20	GND	AD26	AD25	GND
21	AD29	+5V(**)	AD28	AD27
22	+5V	AD30	GND	AD31
23	REQ0#	GND	REQ1#	VI/O
24	GND	REQ2#	+5V(**)	GNT0#
25	GNT1#	VI/O	GNT2#	GND
26	+5V(**)	CLK0	GND	CLK1
27	CLK2	+5V(**)	CLK3	GND
28	GND	INTD#	+5V(**)	RST#
29	+12V(***)	INTA#	INTB#	INTC#
30	-12V(*)	REQ3#	GNT3#	GND

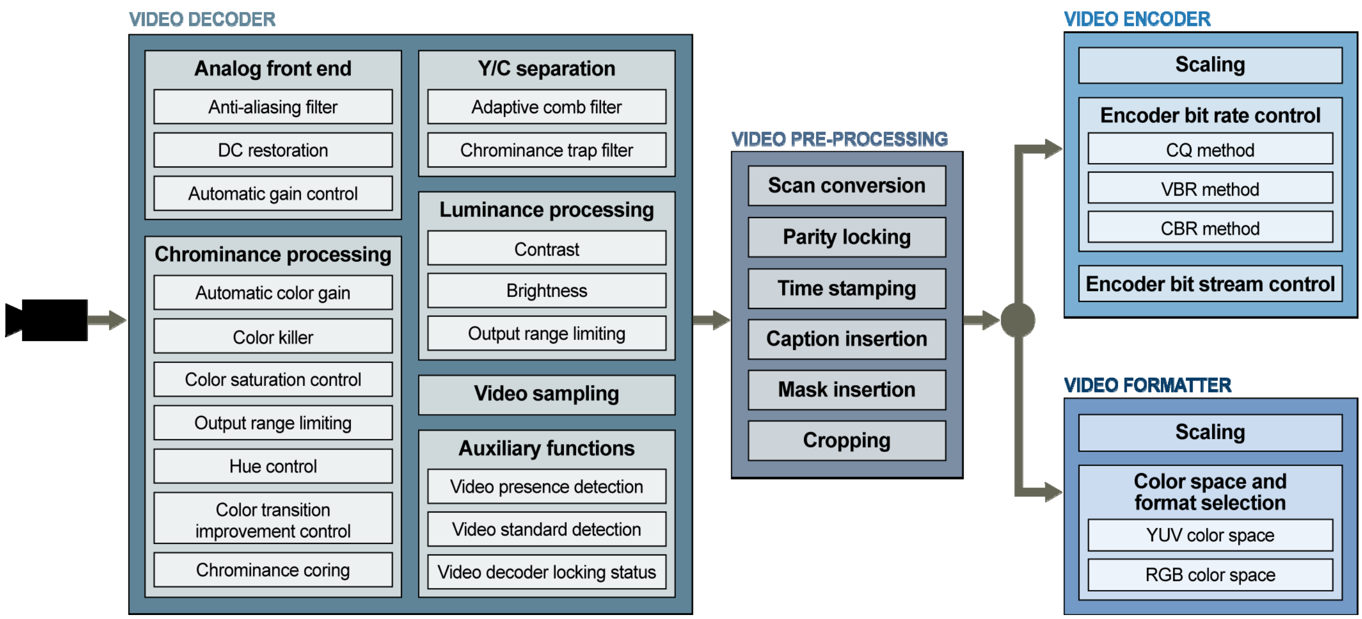
(*) These pins are not connected.

(**) The "+5V" pins are connected only when the "+5V supply assembly option" is selected.

(***) The "+12V" pin is connected only when the "+12V supply assembly option" is selected

(****) The M66EN pin is unconnected according to the PCI-104 specification for 66 MHz capable PCI-104 Add-on modules as recommended in the PCI-104 standard.

4. Frame Grabber Operation



Frame grabber operation block diagram

4.1 Video Decoder

Multi-Standard Video Decoder

The video decoder of Picolo U4 H.264 PCI-104 supports the following popular analog color television standards:

- **PAL-B/D**
- **NTSC-M**

You can use the Virtual File System API to determine the video standard.

Setting the video standard enforces the following settings of the video decoder:

- The video system setting
- The color killer configuration.

The following table shows the enforced settings of the decoder for each one of the 4 allowed values of the standard:

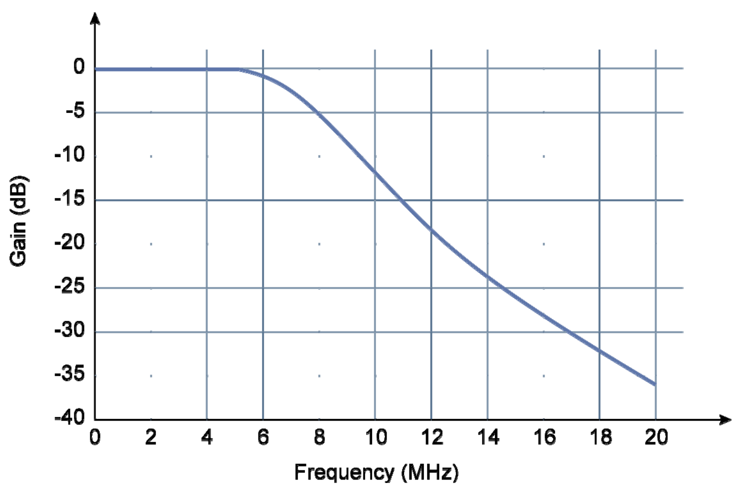
Standard	Video system	Color killer
PAL	PAL-B/D	Color is always alive
NTSC	NTSC-M	
CCIR	PAL-B/D	Color is always killed
EIA	NTSC-M	

Analog Front End

The following sections show the functional blocks that process the analog video signal.

Anti-Aliasing Filter

The analog front end of the video decoder includes an anti-aliasing low-pass filter that attenuates undesirable high frequencies in the video signal before converting to digital video signal.

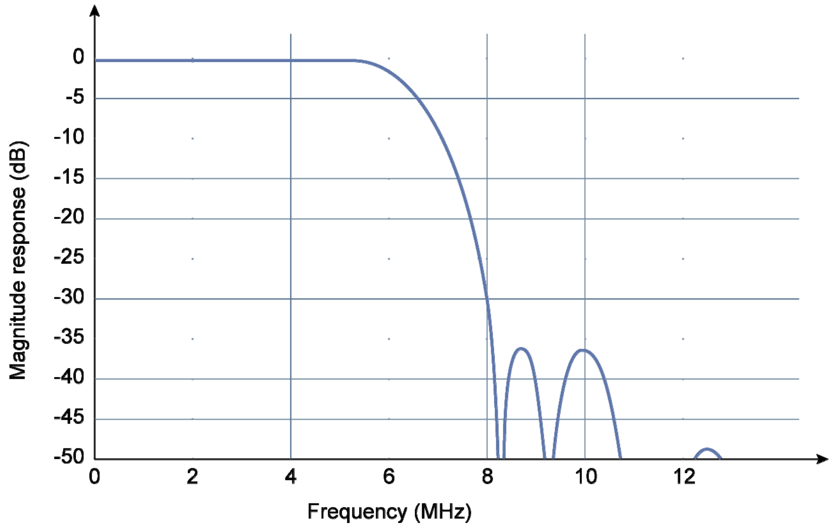


Frequency response of the anti-aliasing filter

The filter attenuation is always set to -3 dB at 7 MHz, and -10 dB at 10 MHz.

Decimation Filter

The over-sampled digitized composite video data are decimated using a digital decimation filter.



Decimation filter

Automatic Gain Control (AGC)

The analog front end of the video decoder includes a variable gain amplifier and an automatic gain control loop that restore the nominal sync amplitude of the signal before converting to digital video signal. In other words, the video decoder can receive incoming signals at various strength and yet maintain a constant video signal by adjusting the weaker signal to receive more gain, stronger signals to receive less gain or none at all.

The AGC is always enabled. The gain range of the variable gain amplifier ranges from -6 dB up to 18 dB, allowing a wide range of video signal amplitudes to be correctly decoded.

DC Restoration

The DC level of the video is restored using back-porch clamping technique.

Y/C Separation

Adaptive Comb Filter

This filter extracts the luminance and the chrominance out of the color composite PAL/NTSC signals. This filter improves the luminance resolution, and reduces noise such as cross-luminance (rain bowling) and cross-color (dot crawl). The adaptive comb filter is always enabled.

Luminance Processing

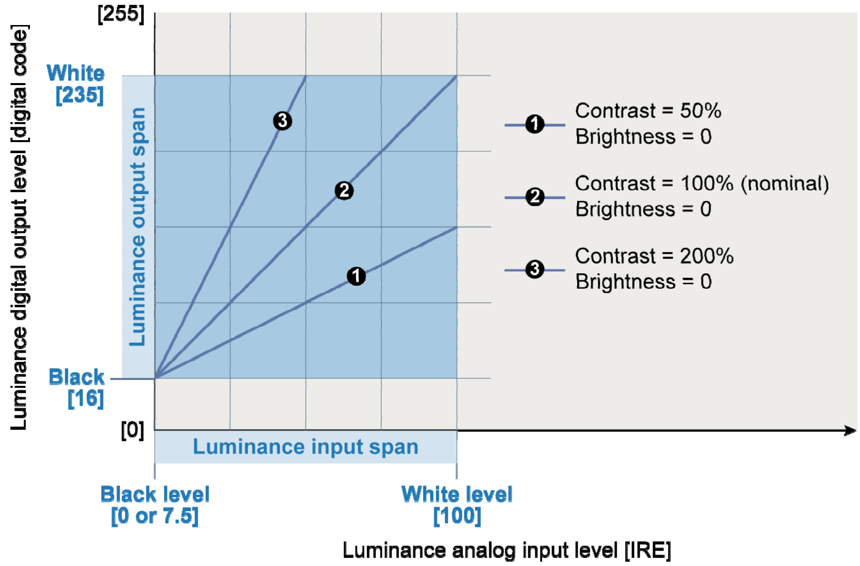
The following sections show the functional blocks used for luminance processing.

Contrast

You can adjust picture contrast by applying gain on luminance component through the Contrast element. This contrast control can be used at anytime, even during acquisition. The decoder provides a luminance gain adjustment in 256 steps, ranging from 0 up to 200 %, with a default value of 100 %.

The following figure shows the luminance transfer function for three contrast settings and the nominal brightness setting.

The luminance output span is expressed in 8-bit digital codes according to ITU-R BT.601-4 specification.

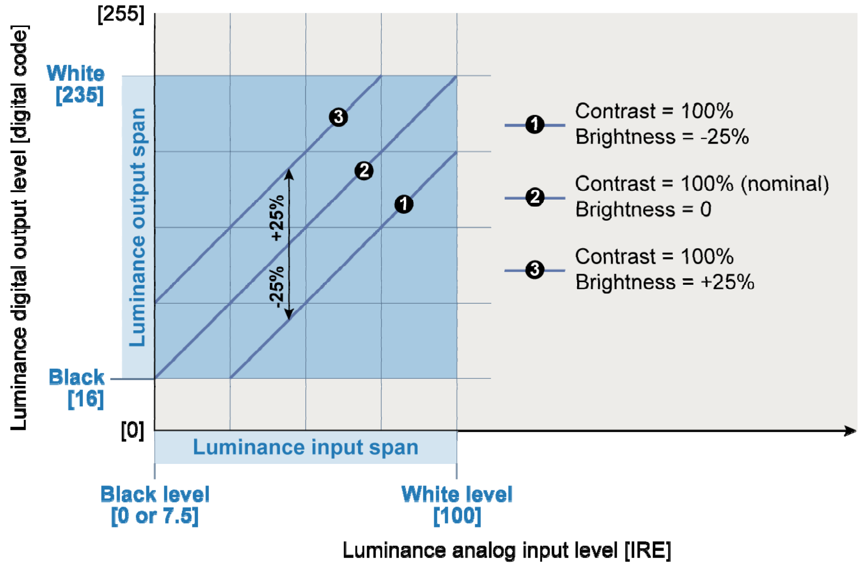


Contrast (luminance gain) control

Brightness

You can adjust picture brightness by applying offset on luminance component through the Brightness element. This contrast control can be used at anytime, even during acquisition. Picolo U4 H.264 PCI-104 provides an offset gain adjustment in 256 steps, ranging from -25 % up to 25 % of the output span.

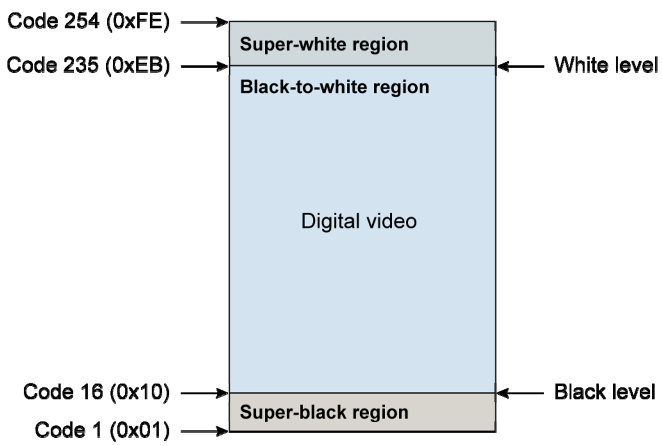
The following figure shows the luminance transfer function for three brightness settings and the nominal brightness setting.



Brightness (luminance gain) control

Luminance Output Range Limiting

The luminance component Y is delivered in 8-bit digital codes, according to ITU-R BT.601-4 specification. The luminance spans over 220 levels, with the black level corresponding to code 16 (0x10), and white level corresponding to code 235 (0xEB). The following diagram shows the luminance output range.



Luminance output range

The range of luminance output is divided into three regions, as shown in the above drawing.

- The **super-black** region (code from 1 up to 15) and the **super-white** region (code from 236 up to 254) provide some extra margins for occasional excursion of the signal beyond the normal limits, or for some contrast and/or brightness settings.

- The **black-to-white** region is the effective luminance output span: a correctly adjusted digital video renderer considers exclusively this region.

The luminance output range is normally bounded in the range [2..254]. The darkest luminance levels will not produce a luminance output code below 2, and the brightest luminance levels will not produce a luminance output code above 254 (0xFE).

Chrominance Processing

The following sections show the functional blocks used for chrominance processing.

Automatic Color Gain

The automatic color gain restores the nominal chrominance levels. The gain range extends from -6 dB (attenuation by a factor of 2) up to +30 dB (amplification by a factor of 32). The automatic color gain is always enabled.

Color Killer

Automatic color killer disables the chrominance decoding when the incoming video signal is a black-and-white signal, or when the incoming signal is very weak or noisy.

You can configure the automatic color killer through the Virtual File System API.

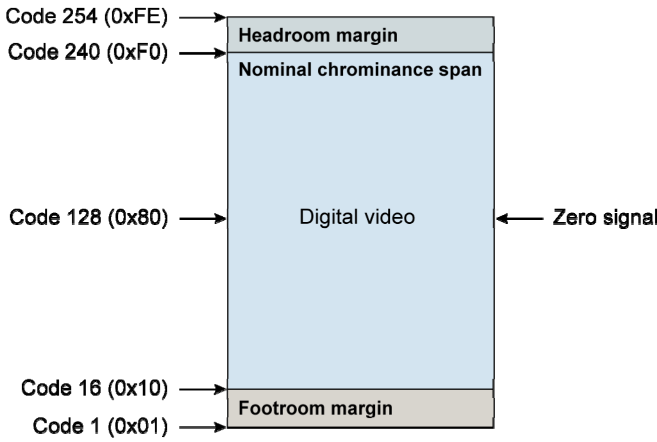
Color Saturation Control

You can adjust color saturation by applying gain on chrominance component through the Saturation element. his color saturation control can be used at anytime, even during acquisition. The decoder provides a luminance gain adjustment in 256 steps, ranging from 0 up to 200 %, with a default value of 100 %.

Output Range Limiting

The chrominance components U and V are delivered in 8-bit digital codes, according to ITU-R BT.601-4 specification. The chrominance spans over 225 levels in the center part of the [0..255] scale, with zero signal corresponding to 128 (0x80). The nominal range of chrominance levels is 16 (0x10) up to 240 (0xF0).

The chrominance output range is bounded in the decoder. The lowest value for a chrominance component is 2. The highest value for a chrominance component is 254 (0xFE).



ITU-R BT.601-4 chrominance output range

The chrominance output range is normally bounded in the range [2..254]. The darkest chrominance levels will not produce a chrominance output code below 2. The brightest chrominance levels will not produce a chrominance output code above 254 (0xFE).

Hue Control

The hue control is always fixed to 0 %.

Color Transition Improvement Control

CTI gain is always set at 75 %.

Chrominance Coring

The coring is always set to 128 ± 2. This means that chrominance codes 126, 127, 129 and 130 are substituted by chrominance code 128.

Video Sampling

The on-board video decoder digitizes the analog video signal using the YUV 4:2:2 sampling method. The luminance component Y is sampled at 13.5 MHz, and the chrominance components U and V are sampled at half-frequency at 6.75 MHz. The sampling rates are identical for both 625-line and 525-line television systems.

The sampling rates are not adjustable, the actual luminance sampling rate is proportional to the line frequency of the video signal, in order to produce a fixed integer amount of samples per line. There are 858 samples per line in case of 525-line television systems, and 864 samples per line in case of 625-line television systems. The sampling clock is a phase-locked on the falling edge of the sync tip.

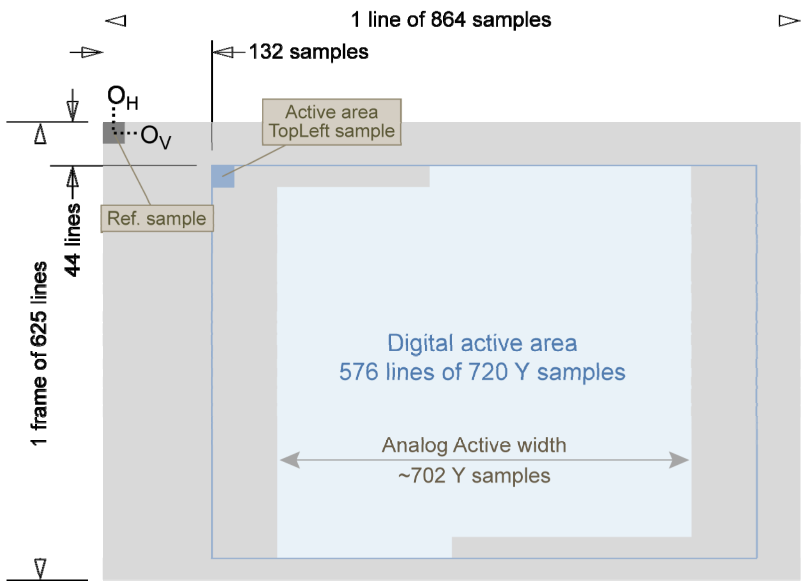
The sample aspect ratio is about 11/10 for 525-line system, and about 54/59 for 625-line system.

Digital Active Area

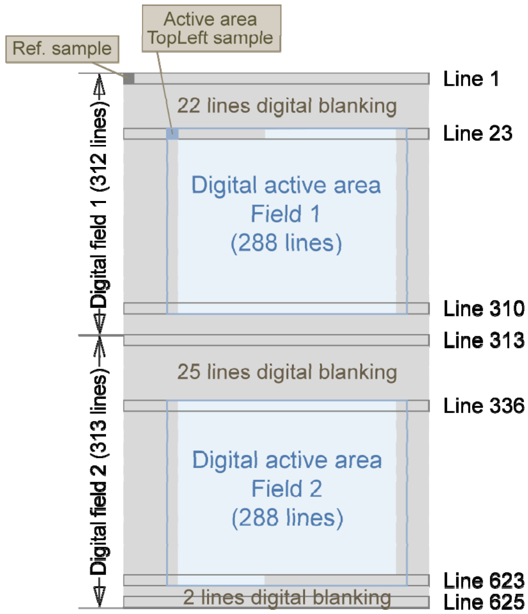
The digital active area is a rectangular area of digitally active samples. Its size and position depend on the actual television system of the video signal.

Digital Active Area (625-line television system)

For 625-line television system, the size and position of the digital active area is shown in the next figure.



Digital active area definition — 625-line system
One frame after scan conversion (spatial line ordering)



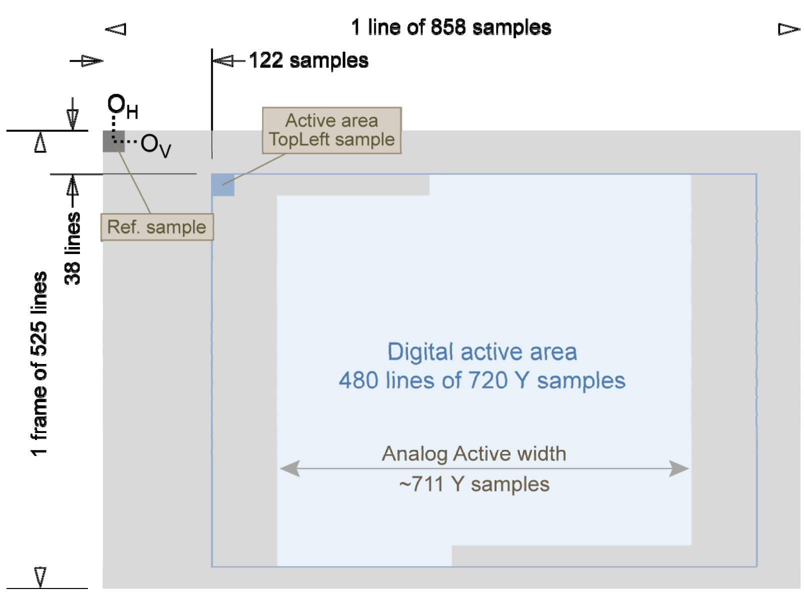
Digital active area definition — 625-line system
Two successive fields before scan conversion (temporal line ordering)

The digital active area size and position are defined according to ITU-R BT.601 standard.

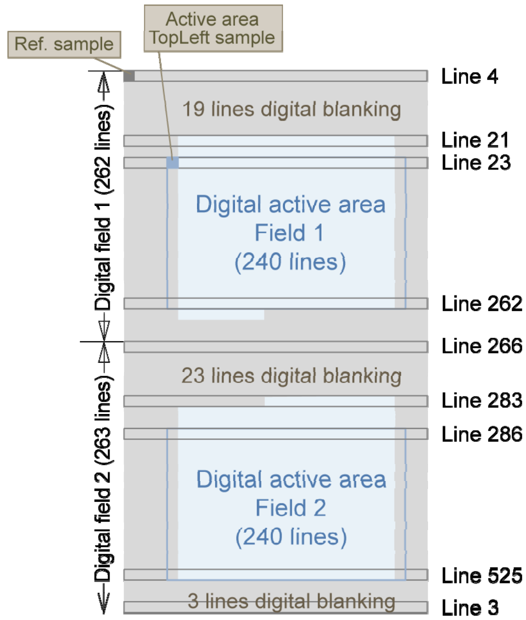
The analog active width is about 18 pixels narrower than the digital active width, leaving a blanked margin of 8~9 pixels on the left and right sides. The first and the last lines of the digital active area contain partial video lines.

Digital Active Area (525-line television system)

For 525-line television system, the size and position of the digital active area are shown in the next figure.



Digital active area definition — 525-line system
One frame after scan conversion (spatial line ordering)



Digital active area definition — 625-line system
Two successive fields before scan conversion (temporal line ordering)

The digital active area size and position are defined according to ITU-R BT.601 standard.

The digital active height and the vertical position are defined according to SMPTE recommended practice RP-202, "Video Alignment for MPEG coding". The digital active area includes the 240 lowest full lines of each field, for a total of 480 lines.

The analog active width is about 9 pixels narrower than the digital active width, leaving a blanked margin of 4~5 pixels on the left and right sides.

Auxiliary Functions

The following sections show the auxiliary functions available for the video decoder.

Video Decoder Locking Status

You can use the Virtual File System API to report the video decoder locking status.

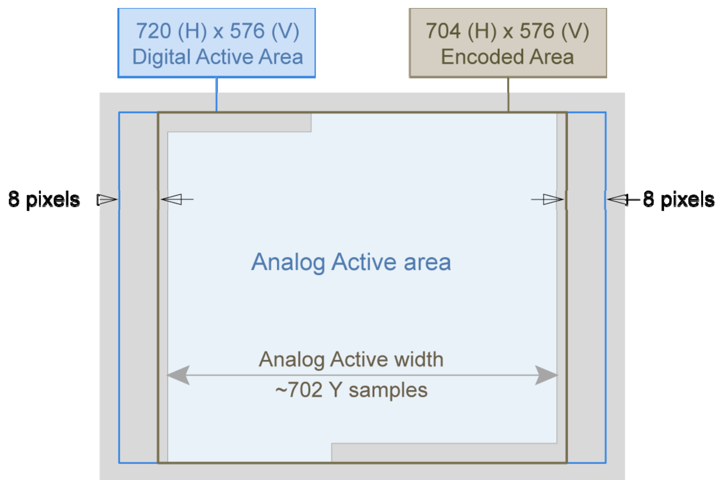
Video Standard Detection

You can use the Virtual File System API to report the detected standard.

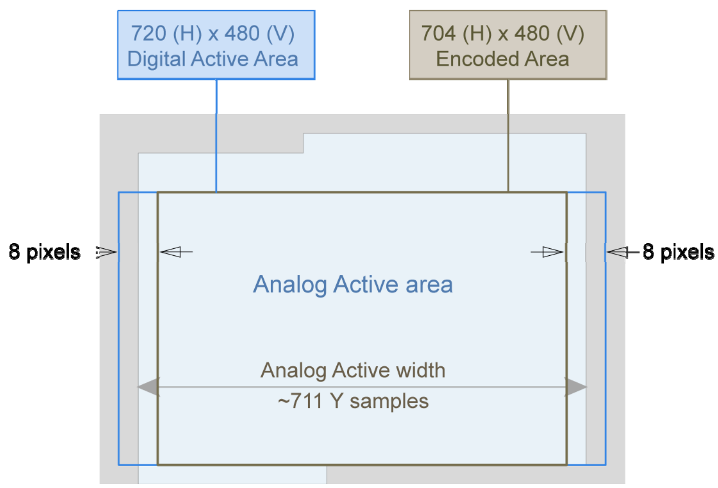
4.2 Video Pre-Processing

Cropping

The source image is always cropped horizontally to retain 704 pixels per line, for both 525-line and 625-line television systems. The cropped area is centered on the digital active area. Eight pixels are cropped at both and right sides.



Cropping
625-line television system



Cropping
525-line television system

The cropped area is:

- 704 (H) x 576 (V) for 625-line television system

- 704 (H) x 480 (V) for 525-line television system

For 625-line system:

- The cropped area still contains some blank pixels at both left and right sides, typically 1 pixel wide in case of a nominal analog video signal.
- The cropped area still contains some blank pixels at both top and bottom sides, typically 1/2 line at left side of topmost line, 1/2 line at right side of bottommost line in case of a nominal analog video signal.

For 525-line system:

- There are no blank pixels at left and right sides of the cropped area, assuming a nominal analog video signal.
- There are no blank half-lines at top and bottom sides of the cropped area, assuming a nominal analog video signal.

Mask Insertion

Every video channel of Picolo U4 H.264 PCI-104 embeds a privacy mask insertion function.

Up to four rectangular regions of the Digital Active Area can be masked. The masked regions are colored in black. The masked regions are inserted on both the formatted and compressed streams.

The mask boundaries fit the macro block borders; the mask area is automatically modified to the smallest enclosing region which fits the 16 x 16 macro blocks border.

The digital active area is divided into square macro blocks of 16 x 16 pixels. The PAL digital active area is composed with 44 x 36 macroblocks; the NTSC digital active area is composed with 44 x 30 macroblocks.

You can define the position and the size of the four regions using the Mask0, Mask1, Mask2, Mask3 element.

Picolo U4 H.264 PCI-104 can achieve 4 privacy masks updates per second for all inputs.

Caption Insertion

Every video channel of Picolo U4 H.264 PCI-104 embeds a text caption insertion function.

Up to 5(*) lines of up to 47 characters can be engraved in the image. The same text is inserted on both the formatted and compressed streams.

(*)The number of caption text lines may be limited to 2 according to the driver's specification. For example, 5 lines is applicable with the version 2.0 of the Virtual File System driver.

The character set is the 7-bit ASCII character set. Non-printable characters are displayed as small rectangles. The font is not configurable. The character cell size is 16x26 pixels.

The text can be located at four pre-defined positions, or anywhere in the active area (custom position):

- **Top left**: the text line is top justified with a top margin of 16 rows of pixels. The text line is left justified with a left margin of 16 columns of pixels.
- **Top right**: the text line is top justified with a top margin of 16 rows of pixels. The text line is right justified with a right margin of 16 columns of pixels.
- **Bottom left**: the text line is bottom justified with a bottom margin of 16 rows of pixels. The text line is left justified with a left margin of 16 columns of pixels.

- **Bottom right**: the text line is bottom justified with a bottom margin of 16 rows of pixels. The text line is right justified with a right margin of 16 columns of pixels.
- **Custom**: the text line is left justified. The position of the top-left pixel of the first character is freely configurable.

The caption foreground is white. The character background is semi-transparent: the excursion of the video luminance is limited upwards

You can control the caption insertion by using the Caption0, Caption1 element.

Picolo U4 H.264 PCI-104 can achieve 4 caption text updates per second for all inputs.

Scan Conversion

The video decoder delivers an ITU-R BT.656 YUV422 digital video stream to the data input port of the on-board processor.

Two consecutive fields of the incoming stream are assembled to build a YUV420 planar image frame, that is stored in a temporary buffer —the video buffer— located into the memory space of the on-board processor.

The video buffer serves as data source for both the video encoder and the video formatter.

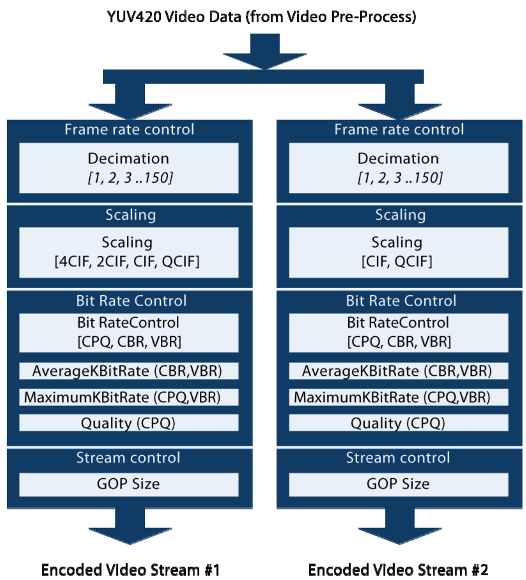
Time Stamping

Picolo U4 H.264 PCI-104 embeds a local time clock. The local time clock is implemented with a counter that increments at a rate of 90 kHz.

Every video frame (consisting of a pair of fields) is time-stamped. The time stamp is the local time when the first sample of field 1 is delivered by the video decoder through the bus. The video time stamp period is typically 33 milliseconds for NTSC video signals, and 40 milliseconds for PAL video signals.

Every audio frame (consisting of 160 milliseconds of audio data) is time-stamped. The time stamp is actually the local time when the first audio sample is delivered by the audio interface through the bus.

4.3 Video Encoder



Frame Rate Control (Video Encoder)

The frame rate of each encoded videos stream can be reduced by adjusting the Decimation element.

$$\text{frame rate} = \frac{\text{full frame rate}}{\text{decimation}}$$

where full frame rate is:

- 29.97 Hz for 525-line television systems
- 25.00 Hz for 625-line television systems

Decimation is any integer value within **[1..150]**. By default, the value is **1**. You can modify the value at anytime even during the acquisition.

This simple decimation method offers the theoretical advantage of a constant interval between captured frames.

However, in case of congestion of the output path, the frame rate control circuit may occasionally increase the interval between captured frames. Such occurrence is not signaled to the application.

To minimize the risk of a congestion of the video encoder output path, the available PCI bandwidth is first allocated to the video encoder output path, the remaining bandwidth is allocated to the video formatter output path.

Scaling (Video Encoder)

The Video Encoder embeds a scaling function that scales down the images from the native 4CIF resolution to one of the following resolutions 2CIF, CIF, and QCIF.

The resolution of each Encoded Video Stream can be defined independently.The stream can be configured for any one of the four available resolutions: 4CIF, 2CIF, CIF, and QCIF.The second stream is restricted to the lowest two resolutions: CIF, and QCIF.

You are able to reduce the image size on both horizontal and vertical axis by using the Virtual File System API.

The default resolution is 4CIF for the first stream and CIF for the second stream.

Following table shows the size of the images, the television system and the selected scaling factor.

Scaling	Scaling factor (H x V)	625-line system (H x V)	525-line system (H x V)
4CIF	1 x 1	704 x 576	704 x 480
2CIF	1 x 2	704 x 288	704 x 240
CIF	2 x 2	352 x 288	352 x 240
QCIF	4 x 4	176 x 144	176 x 112(*)

(*) In QCIF resolution, the video encoder delivers 8 lines less than the video formatter. These lines are the 4 top and the 4 bottom lines which are not encoded.

Encoder Bit Rate Control

Three methods are provided to control the bit rate, VBR, CPQ and CBR. You can select the bit rate control method by assigning the BitRateControl element. By default, the value is CPQ.

VBR Method

The VBR —Variable Bit Rate— method delivers an encoded video bit stream at a variable bit rate, depending on the level of motion detected in the scene. This method is a variant of the CPQ method, where you specify a maximum bit rate and an average bit rate, using the MaximumKBitRateControl element and AverageKBitRateControl element.

Typically, the average setting is 50% of the maximum setting. Full frame rate is not anymore possible when setting values above 2,000.

CPQ Method

The CPQ —Constant Picture Quality— method delivers an encoded video bit stream at a constant picture quality level. You can adjust the picture quality level by using the
Quality element.

The maximum bit rate is specified by the application by means of the MaximumKBitRateControl element.

Full frame rate is not anymore possible when setting values above 2,000.

Note. The effective bit rate is continuously varying, in order to maintain a constant subjective image quality.

CBR Method

The CBR —Constant Bit Rate— method delivers an encoded video bit stream at a constant bit rate. You can adjust the targeted bit rate by using the MaximumKBitRateControl element. Full frame rate is not anymore possible when setting values above 2,000.

Note. The effective bit rate is not strictly constant, it may suffer from large short-term variations. However, the long-term average bit rate matches relatively closely the setting.

Encoder Bit Stream Controls

I PERIOD (GOP Size)

I PERIOD defines the period, in frames, of the I-frames. This is also known as the GOP size, that is the number of frames in a Group Of Pictures.

You can select the GOP size by using the GOPSize element. By default, the value of GOPSize is 30.

Encoded Bit Stream Structure

On Picolo U4 H.264 PCI-104, the encoded bit stream is structured as follows:

- SPS NAL Unit
- PPS NAL Unit
- IDR NAL Unit
- (GOPSize – 1) P-frames
- SPS NAL Unit
- PPS NAL Unit
- IDR NAL Unit

Note: Each GOP starts with an IDR slice preceded by SPS and PPS NAL Units allowing an H.264 decoder to start decoding anywhere in the stream.

4.4 Video Formatter

Frame Rate Control (Video Formatter)

The frame rate of the formatted videos stream can be reduced by adjusting the Decimation element.

$$\text{frame rate} = \frac{\text{full frame rate}}{\text{decimation}}$$

where full frame rate is:

- 29.97 Hz for 525-line television systems
- 25.00 Hz for 625-line television systems

Decimation is any value within [**1...150**]. By default, the value is **1**. You can modify the value at anytime even during the acquisition.

This simple decimation method offers the theoretical advantage of a constant interval between captured frames.

However, in case of congestion of the output path, the frame rate control circuit may occasionally increase the interval between captured frames. Such occurrence is not signaled to the application.

To minimize the risk if a congestion of the video encoder output path, the available output bandwidth is first allocated to the video encoder output path, the remaining bandwidth is allocated to the video formatter output path.

Scaling (Video Formatter)

You are able to reduce the image size on both horizontal and vertical axis by using the Virtual File System API.

Size of the images, the television system and the selected scaling factor

Scaling	Scaling factor (H x V)	625-line system (H x V)	525-line system (H x V)
4CIF	1 x 1	704 x 576	704 x 480
2CIF	1 x 2	704 x 288	704 x 240
CIF	2 x 2	352 x 288	352 x 240
QCIF	4 x 4	176 x 144	176 x 120 (*)

(*) The width and the height of the delivered image are a multiple of 16 except for the height of the QCIF image, which is multiple of 8 but not multiple of 16.

Color Space and Format Selection

Picolo U4 H.264 PCI-104 is capable of delivering images either in RGB or in the YUV color spaces. with the following images formats:

Format	Color Space	Data packing
Y8	YUV	N/A
YUV422		Packed
YUV420PL		Planar
YUV422PL		
RGB15	RGB	Packed
RGB16		
RGB24		
RGB32		

You can select the format through the Virtual File System API.

YUV Color Space

If a format of the YUV color space is selected, the pixel data is delivered using the YCbCr color space. The video formatter does not need to perform any color space transformation, and the output levels of Y, U, V components delivered are identical to the output levels of Y, Cb, Cr components delivered by the video decoder. No additional gamma correction is performed.

Output values of Y, Cb and Cr components for a "75% amplitude, 75% saturated YCbCr color bar" test pattern

Componen t	Light gray	Yellow	Cyan	Green	Magenta	Red	Blue	Black
Y	180	162	131	112	84	65	35	16
Cb (U)	128	44	156	72	184	100	212	128
Cr (V)	128	142	44	58	198	212	114	128

The above results are obtained under the following conditions.

- The **Contrast** setting must be nominal (100% luminance gain).
- The **Brightness** setting must be nominal (null luminance offset).
- The **Saturation** setting must be nominal (100% color saturation).

RGB Color Space

If a format of the RGB color space is selected, the pixel data is delivered using the RGB color space. The video formatter converts the ITU-R BT.601 digital YCbCr pixel data in a RGB pixel data using the following formulas.

```
R' = 1.164(Y - 16) + 1.596(Cr - 128)
G' = 1.164(Y - 16) - 0.813(Cr - 128) - 0.392(Cb - 128)
B' = 1.164(Y - 16) + 2.017(Cb - 128)
```

R', **G'**, **B'** must be saturated at the 0 and 255 levels.

The output range of R, G, B components occupies the full digital range, as shown in the following table.

Output range of R, G, B components

Format	Output code for black	Output code for white
RGB15	R = 0, G = 0, B = 0	R = 31, G = 31, B = 31
RGB16	R = 0, G = 0, B = 0	R = 31, G = 63, B = 31
RGB24	R = 0, G = 0, B = 0	R = 255, G = 255, B = 255
RGB32	R = 0, G = 0, B = 0	R = 255, G = 255, B = 255

No additional gamma correction is performed.

Output values of R, G, B components for a "75% amplitude, 75% saturated YCbCr color bar" test pattern

Component	Light gray	Yellow	Cyan	Green	Magenta	Red	Blue	Black
R (Red)	191	191	0	0	191	191	0	0
G (Green)	191	191	191	191	0	0	0	0
B (Blue)	191	0	191	0	191	0	191	0

The above results are obtained under the following conditions.

- The **Contrast** setting must be nominal (100% luminance gain).
- The **Brightness** setting must be nominal (null luminance offset).
- The **Saturation** setting must be nominal (100% color saturation).

4.5 Audio Digitizer and Encoder

Picolo U4 H.264 PCI-104 has 4 high-quality audio acquisition channels. Each audio channel converts a line-level analog audio signal into a digital audio stream.

A frequency synthesizer generates the master audio clock signal from a stable oscillator. Two master audio clock frequencies are available:

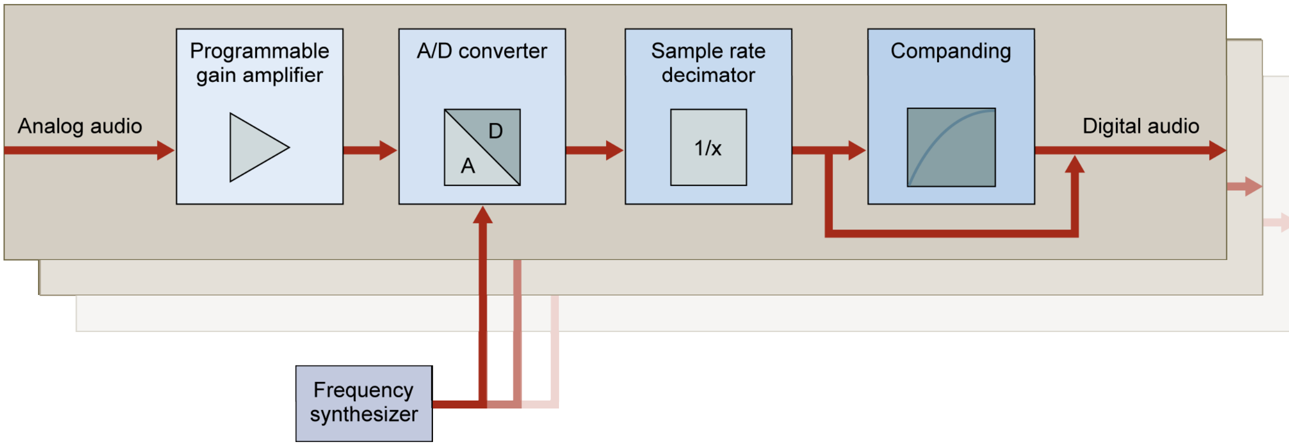
- 44.1 kHz
- 48 kHz

The frequency selection of the master audio clock is common to all the audio channels of a board. All the audio ADC's of the Picolo U4 H.264 PCI-104 are clocked at the same frequency.

The processing chain of each audio channel is composed of the following stages:

- A programmable gain amplifier for audio volume control.
- An analog-to-digital converter clocked at the master audio clock frequency.

- A sample rate decimator for the sample rate control.
- A companding block used exclusively for the generation of G.711 digital audio.



4 audio channels

Configurations

Available configurations of the audio channels

Sample rate (kHz)	Sample depth (bits)	Companding law	ADC clock
8	8	µ-law	48 kHz
8	8	A-law	48 kHz
8	16	PCM	48 kHz
16	16	Linear	48 kHz
22.05	16	Linear	44.1 kHz
44.1	16	Linear	44.1 kHz
48	16	Linear	48 kHz

Each audio channel is configured individually through the Virtual File System API.

The audio sampling frequencies of all the audio channels of a board must belong to one of the following two groups:

- The '48 kHz group' containing the following frequencies: 8, 16, and 48 kHz.
- The '44.1 kHz group' containing the following frequencies: 22.05, and 44.1 kHz.

Volume Control

Each audio channel has an independent audio volume that can be modified any time. The volume adjusts the gain of the gain of the input amplifier.

The volume is controlled through the Virtual File System API.

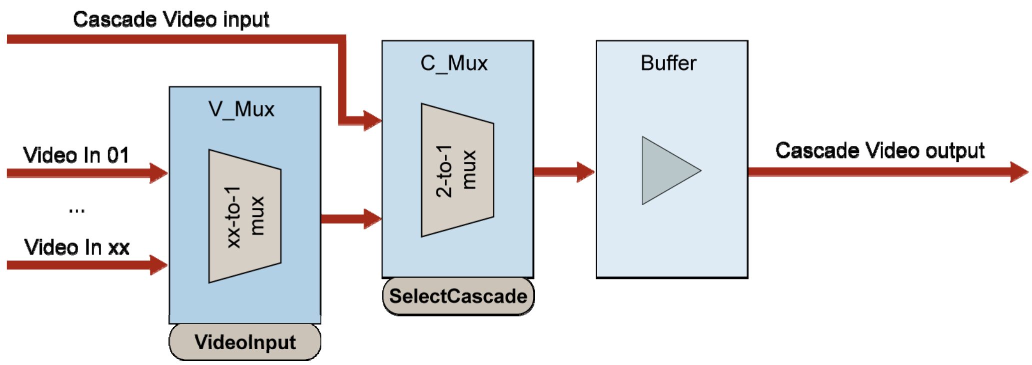
The gain range of the volume control is sufficiently large to accept both "professional" and "consumer" line-level audio signal; however, it is not sufficient to allow direct connection of microphones. Refer to Audio Inputs Electrical Specifications applicable to the audio inputs of Picolo U4 H.264 PCI-104.

In order to optimize the signal-to-noise ratio, the user is invited to adjust the volume such that the highest amplitude of the incoming analog audio produces digital codes just below the maximum value.

The amplifier delivers a level-corrected analog audio signal to the A/D converter.

4.6 Video Pass-Through Selector

The video pass-through selector is capable of selecting any of the 4 video signals applied on **VID_IN1**, ..., **VID_IN4** and Cascade Video input ports. The selected video signal is then buffered and routed to the Cascade Video output port.



Video pass-through selector functional block diagram (xx = 4)

The video multiplexer has 2 stages of selectors. The first stage —V_Mux— selects one out of the 4 video inputs; the second stage —C_Mux— selects either the Cascade Video input, either the output of the first selector stage.

At power-on or reset, both stages revert to their default value: the V-Mux selects **VID_IN01** and the C_Mux selects the Cascade Video Input.

Note that a selection of the Cascade Video input preserves the selection of V_Mux.

Note. The buffered Video Cascade allows all video input signals of multiple Picolo U4 H.264 PCI-104 to be multiplexed on a single Video output for connection to a single display monitor.

The video signals are switched asynchronously regardless of the video timing; consequently, a video monitor connected on the Cascade Video output may temporally unlock after a channel switching.

The video input signals are not significantly altered by the channel switching, allowing channel switching during image acquisition.

5. Board I/O Operation

5.1 General Purpose Inputs

The I/O controller manages:

- 4 general purpose inputs
- 4 general purpose outputs
- 1 watchdog output
- 1 temperature monitor

Configuration

The inputs are initially configured at power-on as follows:

- 4 kΩ impedance threshold
- TTL voltage threshold
- 100 millisecond de-bounce filter off

The initial configuration is suitable for both TTL signaling and contact closure devices. Alternate threshold voltages can be selected, for each input style individually through the Virtual File System API.

Threshold	Threshold voltage	Notes
TTL	1.5 V	For TTL signaling and contact closure devices. This is the default configuration.
CMOS	2.5 V	For 5V CMOS signaling.
12V	6.0 V	For 12V signaling.

Alternate time constants can be selected, for each input filter individually, through the Virtual File System API.

InputFilter	Time constant	Notes
Off	—	Filter is turned off.
10ms	10 ms	Filter is turned on with a 10ms time constant .
100ms	100 ms	A 100ms filter is very efficient to reject 50/60Hz perturbation. This is the default configuration.

Alternate impedance thresholds cannot be selected.

State

The I/O controller measures both the voltage and the impedance across every input at a rate of 200 Hz. It compares the measured values with the threshold and determines the input state according to the following resolution table:

Measured impedance	Measured voltage	State
Below impedance threshold	**Below voltage threshold**	Low
Below impedance threshold	**Above voltage threshold**	High
Above impedance threshold	**Don't care**	Disconnected

The input state is reported through the Virtual File System API. The value must be interpreted differently according to the type of device attached to the input:

Level	Meaning for contact devices	Meaning for logic devices
Low	Contact is closed.	The logic level is 0.
High	N/A.	The logic level is 1.
Disconnected	Contact is open.	The line is disconnected.

5.2 General Purpose Outputs

The I/O controllers of Picolo U4 H.264 PCI-104 manage 4 general purpose "solid-state relay" outputs, the electrical style is SSRLY —Solid-State Relay.

The state of the output can be changed at anytime through the Virtual File System API.

State	Description
Closed	The solid-state relay is closed (i.e. it makes a short circuit as its outputs).
Open	The solid-state relay is open (i.e. it makes an open circuit).

All solid-state relays of professional outputs and watchdog are placed in the Open state:

- in the I/O controller initialization phase, after a Power On
- after the watchdog I/O controller issues a PC reset

5.3 Temperature Monitor

The I/O controllers of Picolo U4 H.264 PCI-104 embed a temperature monitor. An I/O controller performs a board temperature measurement every 1.28 seconds, and reports the result in the Temperature element.

The application should check for regularly temperature and:

- produces a warning message when the temperature exceeds the recommended limit.
- prepares for a system shutdown when the temperature is approaching the absolute limit.

Overheating Protection

When the temperature monitor detects a temperature sensor malfunction, or measures a temperature exceeding the absolute limit, Picolo U4 H.264 PCI-104 is automatically placed into the reduced power mode.

In the reduced power mode:

- The board power consumption is significantly reduced, which will limit or stop the board temperature rise.
- All acquisitions are stopped and usually cause the application to fail.

The reduced power mode remains until the PC is restarted. The normal operation is resumed after board initialization, providing that the temperature sensor operates normally and the measured board temperature has sufficiently decreased, namely:

- below the recommended limit in case of a PC reset,
- below the absolute limit in case of a Power-On reset.

5.4 Watchdog

Maintaining a reliable video-surveillance operation on a PC for several years is difficult. For example, mains electrical perturbations can lead to a failure in the PC using the video-surveillance system. Hence, manual intervention is required to restart it, but this will lead to video-surveillance operation breakdown due to the delay. To ensure that video-surveillance task is continuously monitored, a hardware device, called **watchdog**, is implemented on this frame grabber.

The watchdog is a hardware device which monitors the video-surveillance software application running on the PC. If there is no activity of the software application during a defined time, called **time-out**, the watchdog concludes in a system failure, and closes a PC reset relay which restarts the system.

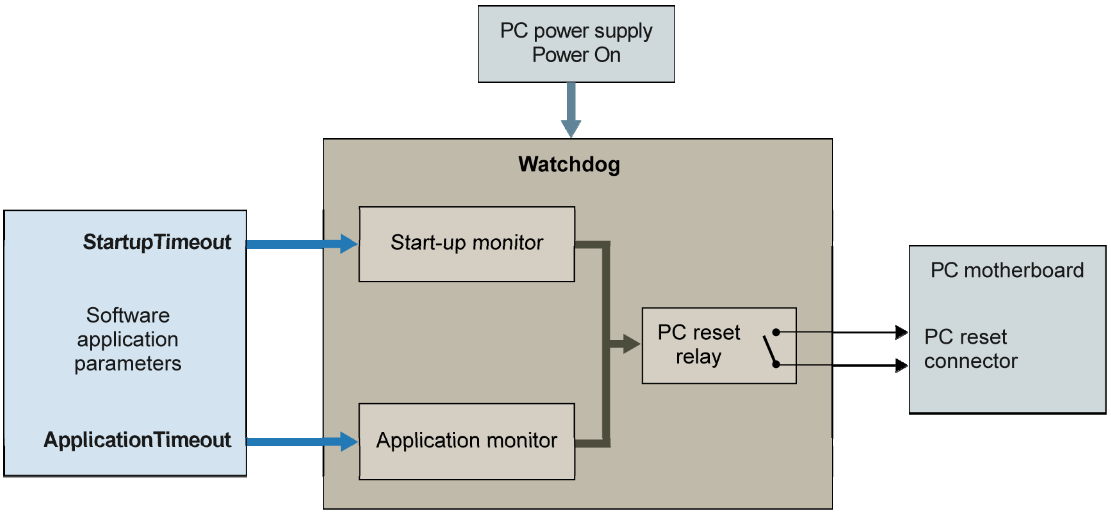
The watchdog consists of two main devices, called monitors:

- The **start-up monitor** is responsible for monitoring the system when the computer is booting, and until the software application is launched.
- The **application monitor** is responsible for monitoring the system during the normal operation of the software application.

The monitors are based on a time-out mechanism. The software application must signal to the monitor that it is operational before a time-out period. If the application does not respond within this time-out period, the monitor will conclude that a system malfunction has occurred.

Watchdog Block Diagram

The block diagram of the watchdog is shown below.



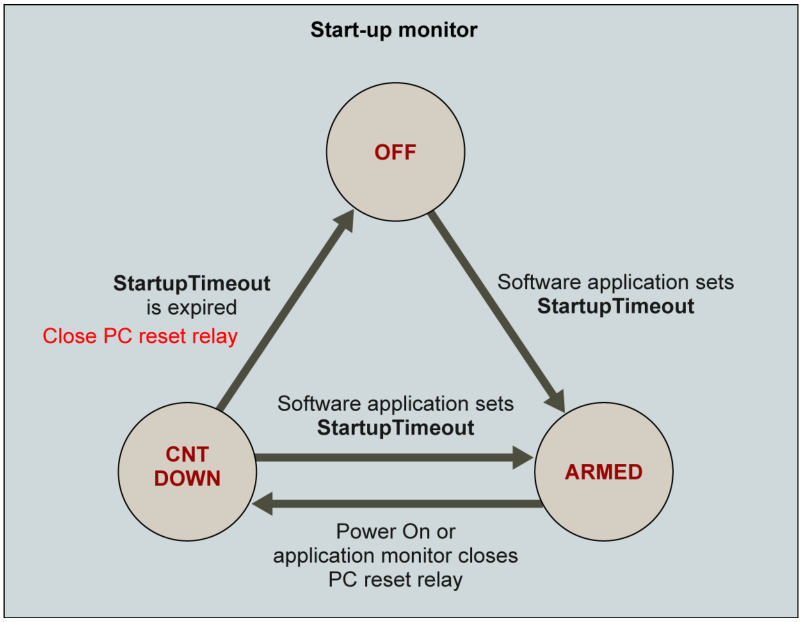
Watchdog block diagram

The above block diagram connects with three inputs and one output:

- Power On: the watchdog requires the power supply of the monitored PC. At Power On, the watchdog is operational, and starts to monitor the system.
- **StartupTimeout**: the software application is responsible to adequately define a maximum time. It allows the system to complete the start-up sequence by setting the **StartupTimeout** element.
- **ApplicationTimeout**: the software application is responsible to adequately define a maximum time. It allows the application to periodically signal its correct operation by setting the **ApplicationTimeout** element.
- PC reset connector: when the watchdog concludes that the start-up has failed, or that the application is no longer running, it restarts the system by closing the PC reset relay. For this purpose, an electrical connection has to be installed between the PC reset relay and the reset connector of the PC motherboard.

Start-up Monitor

The start-up monitor is graphically represented by a state-device as follows:



Start-up monitor block diagram

The factory preset of the start-up monitor is the **OFF** state. When the software application sets the **StartupTimeout** element, the start-up monitor goes in the **ARMED** state. In the **ARMED** state, the start-up monitor waits for a new start-up sequence. The start-up monitor is able to memorize its state and the **StartupTimeout** element. In other words, its fully operational when power is applied, and before the launch of the software application.

The start-up monitor can be in three states: **OFF**, **ARMED**, or **CNT DOWN**.

OFF

In the **OFF** state, the start-up monitor is disabled.

ARMED

In the **ARMED** state, the start-up monitor is waiting for a start-up sequence to monitor. For example, the start-up monitor detects a new start-up sequence when power is applied (Power On), or a start-up sequence can be engaged following a PC reset relay closure generated by the application monitor.

CNT DOWN

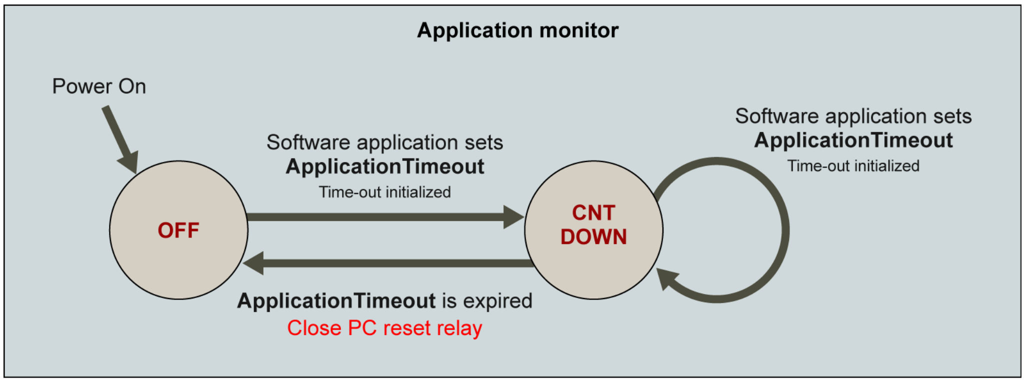
The start-up monitor goes in the **CNT DOWN** state, and begins to count the time that elapses. Two situations may occur in the **CNT DOWN** state:

- The application is working correctly, and sets the **StartupTimeout** element within the time-out expiration. The start-up monitor concludes that the start-up sequence has been completed. The start-up monitor goes in the **ARMED** state, waits for a new start-up sequence, and the application monitor is triggered.

- The start-up is abnormally long, and the application could not set the **StartupTimeout** element before time-out expiration. The start-up monitor concludes that the start-up sequence has not been completed. The start-up monitor goes in the **OFF** state, and closes the PC reset relay for about 1 second.

Application Monitor

The application monitor is graphically represented by a state-device as follows:



Application monitor block diagram

The application monitor cannot memorize its state when power is switched off. During Power On, it always starts in the **OFF** state. The application monitor becomes active, and goes in the **CNT DOWN** state under the software application control by simply setting the **ApplicationTimeout** element to a desired value.

The application monitor can be in two states: **OFF**, or **CNT DOWN**.

OFF

In the **OFF** state, the application monitor is disabled.

CNT DOWN

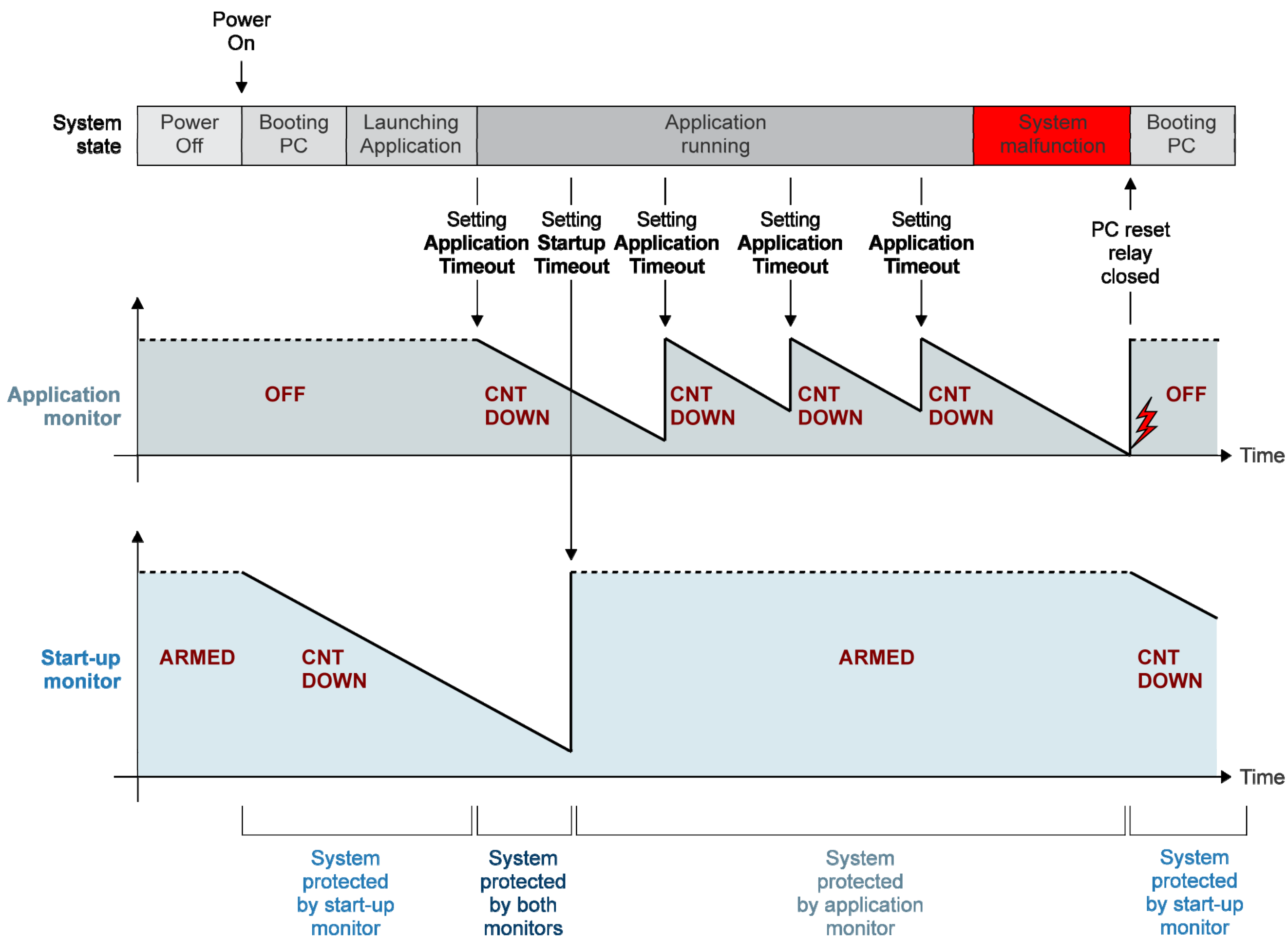
Once in the **CNT DOWN** state, the application monitor waits for a new setting of the **ApplicationTimeout** element. Two situations may occur in the **CNT DOWN** state:

- The software application is alive, and sets the **ApplicationTimeout** element before the time-out expiration. The application monitor concludes that the application is correctly running. The application monitor stays in the **CNT DOWN** state, and waits for the next **ApplicationTimeout** element setting during the time-out period.
- A malfunction occurs, and the application does not run the appropriate code which sets the **ApplicationTimeout** element. Time-out expiration occurs, and the application monitor concludes that the application is no longer running. The application monitor goes in the **OFF** state, and closes the PC reset relay during about 1 second.

Watchdog Timing Diagram

The implementation of two distinct monitors allows the programmer to define two separate watchdog time-out, one for the start-up phase, and one for the normal operation phase.

The timing diagram of the watchdog operation is shown below.



Watchdog timing diagram

1. It is assumed that the software application has set the **StartupTimeout** element during a previous PC operation. Hence the start-up monitor has memorized an **ARMED** state. When the PC power supply is switched on, the start-up monitor goes in the **CNT DOWN** state.
2. After the PC has booted up, the application is launched and begins its normal operation. At this point, the start-up monitor counting down is stopped when the application sets the **StartupTimeout** element. The start-up monitor goes in the **ARMED** state, and is ready to monitor the next start-up sequence.
3. The application monitor goes in the **CNT DOWN** state when the application sets the **ApplicationTimeout** element.
4. The system is now in normal operation and the application periodically sets the **ApplicationTimeout** element to inform the application monitor that everything is working properly.

5. If a system malfunction occurs —for example, the application is frozen and the internal counter of the application monitor reaches 0 after the time-out period— the application monitor closes the PC reset relay during 1 second, and goes in the **OFF** state. The relay closure generates a reboot of the PC. The start-up monitor changes from the **ARMED** state to the **CNT DOWN** state, and monitors the coming start-up sequence.

To ensure system monitoring without interruption, the software application must perform a initial setting of **ApplicationTimeout** element before **StartupTimeout** element.

Watchdog Resets Logging

The advanced I/O sub-system counts the occurrences of watchdog resets, and delivers the result in the ResetCount element. This is a way to count the number of malfunctions the system has encountered. You can clear this value by using the ClearResetCount element.

Virtual File System Reference

1. Virtual File System Driver Overview

The Virtual File System driver for Picolo U4 H.264 PCI-104 is a memory-based file system driver. Each board appears as a file system populated with files organized as a directory tree. These files are managed using standard file management functions of the operating system.

The Virtual File System driver supports the following board features:

- Audio inputs
- Video inputs
- Input lines
- Output lines
- Audio sampling rates
- Watchdog
- Pass-through selector

The top-level of the directory structure looks as follows:

/mymountpoint	Root directory (user-defined mount point)
config.xml	Board configuration XML ...
config.dtd	... and corresponding DTD file
exceptions.xml	Events issued in exceptional situations XML ...
exceptions.dtd	... and corresponding DTD file
visual	Directory for visual capture function
audio	Directory for audio capture function
inputlines	Directory for general purpose inputs function
outputlines	Directory for general purpose outputs function
watchdog	Directory for watchdog function
passthroughselector	Directory for pass-through selector function

Refer to the corresponding topic in File System Structure for more details.

You will see the complete virtual file system for this device. The command and result are displayed hereafter:

```
$ ls -g
total 0
drwxrwxrwx  6 root    0   2009-12-16 12:09 audio
-r--r--r--  1 root    1288      2009-12-16 12:09 config.dtd
-rw-rw-rw-  1 root    0   2009-12-16 12:09 config.xml
-r--r--r--  1 root    4377      2009-12-16 12:09 exceptions.dtd
-rw-rw-rw-  1 root    0   2009-12-16 12:09 exceptions.xml
drwxrwxrwx  6 root    0   2009-12-16 12:09 inputlines
drwxrwxrwx  6 root    0   2009-12-16 12:09 outputlines
drwxrwxrwx  2 root    0   2009-12-16 12:09 passthroughselector
drwxrwxrwx  6 root    0   2009-12-16 12:09 visual
drwxrwxrwx  2 root    0   2009-12-16 12:09 watchdog
```

The data acquired by the board are provided as **binary files** containing raw data:

- Compressed video data
- Uncompressed video data
- Audio data

Each data file is associated with a metadata file that contains a plain-text XML description of the captured data.

The board is controlled through **plain-text XML files**:

- Configuration settings are made through Configuration files.
- Events are reported into Events files.
- Abnormal events and errors are reported into Exceptions files.

Every XML file is associated with a Document Type Definition (DTD) file that validates the syntax of the XML file.

There are three types of files on the Picolo H.264 file system:

- **Data files**
  - Data files are binary files.
  - Each file corresponds to one memory buffer.
  - The buffers contain the data delivered by the card, without any addition or modification by the driver.
- **XML files**
  - XML files are text files.
  - They follow the XML syntax.
  - They contain configuration, event, metadata, or exception data.
- **DTD files**
  - DTD files are text files.
  - They contain a set of markup declarations that define a particular type of XML document.
  - They contain the validation rules for the card's XML files.

2. File System Structure

2.1 Root

The following diagram shows the root directory of the file system. The **config.xml** file holds status and settings of the board, like serial number, device identification. The **exceptions.xml** file collects all the exceptions produced by the board.

Access to the board's main functions, like audio and video capture, is done through the sub-directories.

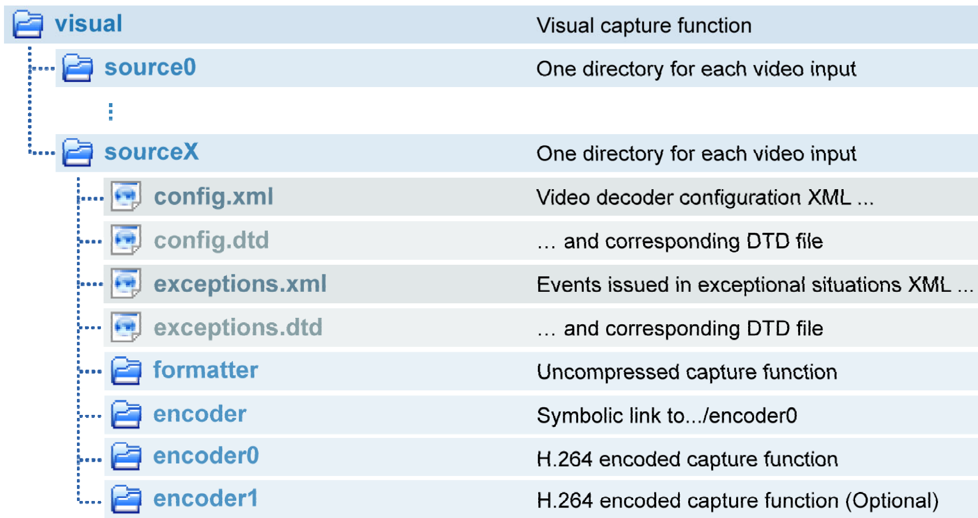
/mymountpoint	Root directory (user-defined mount point)
config.xml	Board configuration XML ...
config.dtd	... and corresponding DTD file
exceptions.xml	Events issued in exceptional situations XML ...
exceptions.dtd	... and corresponding DTD file
visual	Directory for visual capture function
audio	Directory for audio capture function
inputlines	Directory for general purpose inputs function
outputlines	Directory for general purpose outputs function
watchdog	Directory for watchdog function
passthroughselector	Directory for pass-through selector function

2.2 Visual

The **visual** directory contains a number of sub-directories named **source0** to **sourceX**, corresponding to video inputs 1 to X+1 respectively. There are no files in the **visual** directory.

Visual Source

The following figure shows the contents of the **visual/sourceX** directory.



The **visual/source**X directory contains the files corresponding to the visual source X.

The **config.xml** file holds status and settings of that visual source. The **exceptions.xml** file reflects the exceptions associated with that visual source.

The formatter and encoder sub-directories correspond to the visual encoder and visual formatter blocks associated with this visual source. Most visual source settings affect both the formatter and the encoder.

/encoder is a symbolic link towards encoder0. It ensure the backward compatibility

The **/encoder0** directory is available on all H.264 boards.

The **/encoder1** directory is available only on boards having the capability to deliver more than 1 encoded stream, e.g. Picolo U4 H.264, Picolo U8 H.264 and Picolo U16 H.264.

Visual Encoder

The following figure shows the contents of the **visual/sourceX/encoderY** directory. It corresponds to the encoder block Y associated with sourceX

encoderY	H.264 capture function
config.xml	Encoder configuration XML ...
config.dtd	... and corresponding DTD file
metadata.xml	Captured data description XML ...
metadata.dtd	... and corresponding DTD file
exceptions.xml	Events issued in exceptional situations XML ...
exceptions.dtd	... and corresponding DTD file
data	Captured data directory (one file per buffer)
0	
1	
⋮	

The **config.xml** file holds status and settings of the visual encoder associated with the visual source X. The **exceptions.xml** file reflects the exceptions associated with that encoder.

The visual encoder produces data. The captured data is made available to the user application as files in the data sub-directory. The **metadata.xml** file contains a description of the captured data.

Visual Formatter

The following figure shows the contents of the **visual/sourceX/formatter** directory (uncompressed capture function).

formatter	Uncompressed capture function
config.xml	Formatter configuration XML ...
config.dtd	... and corresponding DTD file
metadata.xml	Captured data description XML ...
metadata.dtd	... and corresponding DTD file
exceptions.xml	Events issued in exceptional situations XML ...
exceptions.dtd	... and corresponding DTD file
data	Captured data directory (one file per buffer)
0	
1	
⋮	

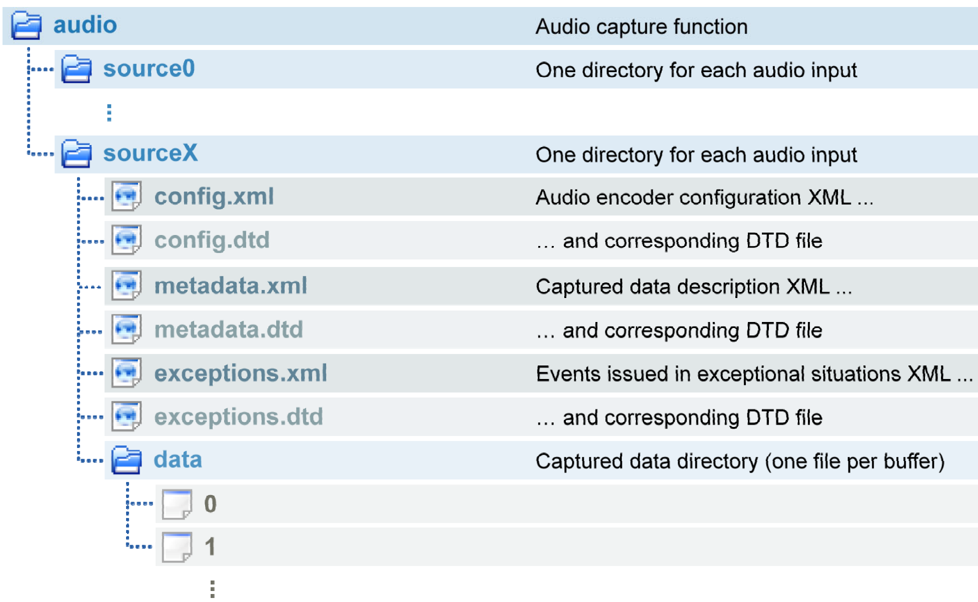
The **config.xml** file stores the status and settings of the visual source. The **exceptions.xml** file reflects the exceptions associated with that visual formatter.

The visual formatter produces data. The captured data are made available to the user application as files in the **data** sub-directory. There is one file per buffer for each captured data directory. The **metadata.xml** file contains a description of the captured data.

2.3 Audio

The **audio** directory contains a number of sub-directories named **source0** to **sourceX**, corresponding to audio inputs 1 to X+1 respectively. There are no files in the **audio** directory.

The following figure shows the contents of the **audio/sourceX** directory.



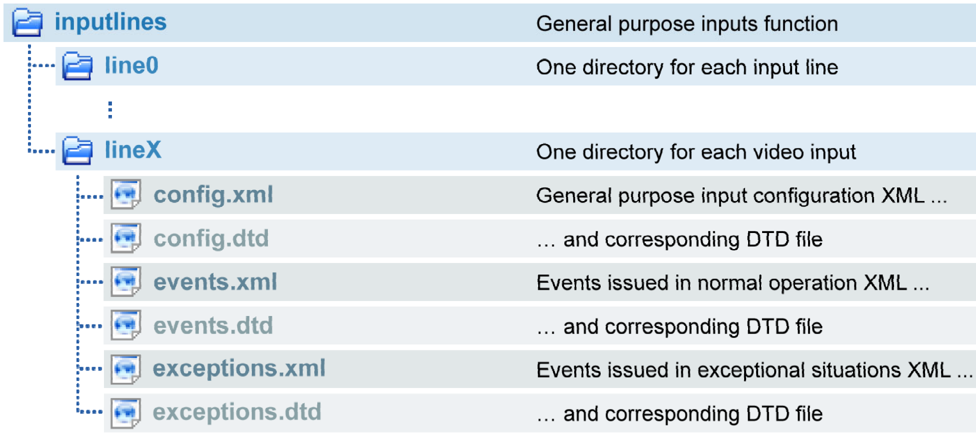
The **config.xml** file stores the status and settings of the audio block. The **exceptions.xml** file reflects the exceptions associated with that audio block.

The audio encoder produces data. The captured data are made available to the user application as files in the **data** sub-directory. There is one file per buffer for each captured data directory. The **metadata.xml** file contains a description of the captured data.

2.4 Input Lines

The **inputlines** directory contains a number of sub-directories named **line0** to **lineX**, corresponding to the general-purpose input lines 1 to X+1 respectively. There are no files in the **inputlines** directory.

The following figure shows the contents of the **inputlines/lineX** directory.



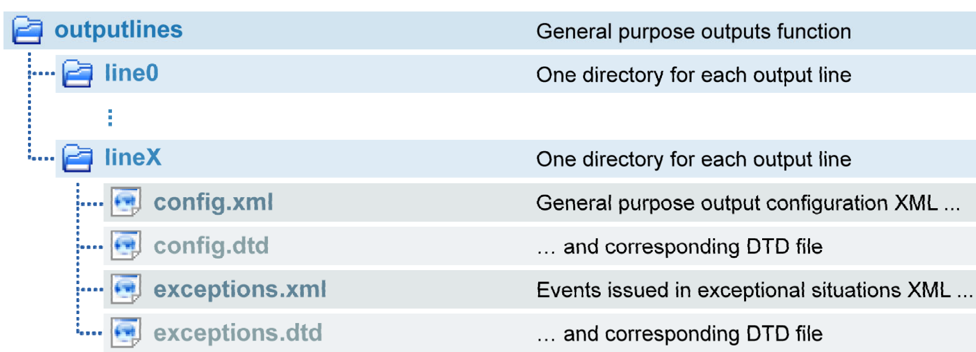
The **config.xml** file stores the status and settings of the input line. The **exceptions.xml** file reflects the exceptions associated with that input line.

The input line produces events data. The captured data are made available to the user application as files in the **data** sub-directory. The **events.xml** file provides the list of the last events produced by that input line.

2.5 Output Lines

The **outputlines** directory contains a number of sub-directories named **line0** to **lineX**, corresponding to the general-purpose output lines 1 to X+1 respectively. There are no files in the **outputlines** directory.

The following figure shows the contents of the **outputlines/lineX** directory.



The **config.xml** file stores the status and settings of the output line. The **exceptions.xml** file reflects the exceptions associated with that output line.

2.6 Watchdog

The following figure shows the contents of the **watchdog** directory.

watchdog	Watchdog function
config.xml	Watchdog configuration XML ...
config.dtd	… and corresponding DTD file
exceptions.xml	Events issued in exceptional situations XML ...
exceptions.dtd	… and corresponding DTD file

The **config.xml** file stores the status and settings of the watchdog. The **exceptions.xml** file reflects the exceptions associated with the watchdog.

2.7 Pass-Through Selector

The following figure shows the contents of the **passthroughselector** directory.

passthroughselector	Pass-through selector function
config.xml	Selector configuration XML ...
config.dtd	… and corresponding DTD file
exceptions.xml	Events issued in exceptional situations XML ...
exceptions.dtd	… and corresponding DTD file

The **config.xml** file stores the status and settings of the pass-through selector. The **exceptions.xml** file reflects the exceptions associated with the pass-through selector function.

3. File Operations

3.1 Basic Operations

The following list shows basic file operations:

- Opening/reading an XML file
- Writing/closing an XML file
- Reading a data file
- Mapping a data file
- Deleting a data file
- Updating the exceptions, data or config files

  Poll, **ePoll**, and **Select** methods are applicable to metadata and events files, these XML files are automatically updated when any hardware event occurs. These methods aslo return the values immediately when used on exceptions, data or config files.

  The **INotify** method is applicable to all files. If **INotify** is applied to data, metadata, events or exceptions files, any hardware event update or process that modifies a file will be signaled through the **INotify** method.

Command-Line Operations

The following lists the command-line operations:

- Copying an XML configuration file from a hard disk location to the appropriate Picolo U4 H.264 PCI-104 directory for a prepared configuration
- Copying a data file from a Picolo U4 H.264 PCI-104 directory to a hard disk location is an elementary video recorder operation
- Displaying and editing an XML configuration file manually provides direct interaction with the board

Common Operations

Deleting a data buffer

The data buffer can be deleted using one of the following three methods:

- Writing to the relevant **metadata.xml** file. A **MetaData** XML element consists of two sub-elements: **Index** and **Dispose**. The **Index** element specifies the index of the buffer to be disposed. Refer to Visual Encoder MetaData File, Visual Formatter MetaData File and Audio Encoder Metadata File for more details
- Deleting the data file
- Deleting the **metadata.xml** file. All the data buffers having an entry in the **metadata.xml** will be deleted

These methods are applicable to all types of data buffers: encoded video, formatted video and audio data buffers.

Acknowledging an event

An event is acknowledged by writing to the events.xml file. An event XML element consists of two sub-elements: Index and Acknowledge. The Index element specifies the index of the event to be disposed. Refer to Events File for more details.

Acknowledging an exception

An exception is acknowledged by writing to the exceptions.xml file. An Exception XML element consists of two sub-elements: Index and Acknowledge. The Index element specifies the index of the exception to be disposed. Refer to Exceptions File for more details.

3.2 Configuration

Files associated with configuration.

Name: **config.xml**

Document Type Definition: **config.dtd**

Purpose

This validated XML file provides status and configuration for a constituent of Picolo U4 H.264 PCI-104. The corresponding constituent depends of the file location in the directory structure. The validation is done using the Document Type Definition (DTD) file located in the same directory.

Attributes

The configuration XML file is readable and writable. The DTD file is always read-only.

Read

When the application opens the XML file, the driver generates its content. This ensures that reading the file, even partially, always produces valid data.

Reading the whole file provides a listing of all current status and configuration settings. However, the "write-only" elements are not listed.

Write

When writing the file, the driver processes the written data, and forwards the corresponding settings to the hardware, when the file is finally closed by the writing application. This ensures that only valid XML files will be processed.

Writing valid XML content containing only a subset of the boards's configuration settings is allowed. When doing so, the driver will only change the specified settings, and leave the other settings unchanged.

Delete

Deleting a configuration file is allowed, in some circumstances. It resets all settings and puts the corresponding constituent in default state. A new file reappears immediately thereafter, with updated content.

Synchronization

Several applications can access the files simultaneously. When doing so, it is the application's responsibility to synchronize the file accesses.

3.3 Events

Files associated with events.

Name: **events.xml**

Document Type Definition: **events.dtd**

Purpose

This validated XML file provides the list of the latest events for a constituent of Picolo U4 H.264 PCI-104. The corresponding constituent depends of the file's location in the directory structure. The validation is done using the appropriate Document Type Definition (DTD) file, located in the same directory.

Attributes

The events XML file is readable and writable. The DTD file is always read-only.

Event Queue

Each time an event is signaled by the hardware, it is logged by the Virtual File System driver in a ring buffer queue. The queue is made to contain up to a configurable number of events. When the queue is full, the oldest events are automatically overwritten.

Read

When the application opens the XML file, the driver generates its content from the information of the driver-maintained event queue. This ensures that reading the file, even partially, always produces valid data.

Reading the whole file provides the listing of all events from the event log.

Write

The file can be written, to selectively remove events from the event log.

When writing the file, the driver processes the written data, and removes the acknowledged events from the event queue. This happens when the file is closed, to ensure that only valid XML files will be processed.

Writing valid XML content containing only a subset of the events (typically only acknowledged events to be deleted) is allowed.

A flagged event is removed as soon as the XML block corresponding to that event is completely parsed. If a parsing error occurs, only the event causing the error and the subsequent ones are ignored.

The only XML elements required to remove an event are **Index** and **Acknowledge**. All other elements are allowed but ignored.

Delete

Deleting an event file is allowed, at any time. It flushes the event queue, removing all logged events. A new file reappears immediately thereafter, with updated content.

The delete operation doesn't modify the **QueueSize** parameter.

Synchronization

Several applications can access the files simultaneously. When doing so, it is the application's responsibility to synchronize the file accesses.

3.4 Exceptions

Files associated with exceptions:

Name: **exceptions.xml**

Document Type Definition: **exceptions.dtd**

Purpose

This validated XML file provides exception information. It contains the list of the latest exceptional events issued by a constituent of Picolo U4 H.264 PCI-104. The corresponding constituent depends of the file's location in the directory structure. The validation is done using the appropriate Document Type Definition (DTD) file, located in the same directory.

Attributes

The exceptions XML file is readable and writable. The DTD file is always read-only.

Exception Queue

Each time an exception is signaled by the hardware or the Virtual File System driver, it is logged by in a queue. The queue is made to contain up to a configurable number of items. When the queue is full, the oldest items are automatically overwritten.

Read

When the application opens the XML file, the driver generates its content from the information of the driver-maintained exception queue. This ensures that reading the file, even partially, always produces valid data.

Reading the whole file provides the listing of all exception from the exception queue.

Write

The file can be written, to selectively remove exceptions from the queue.

When writing the file, the driver processes the written data, and removes the acknowledged exceptions from the queue. This happens when the file is closed, to ensure that only valid XML files will be processed.

Writing valid XML content containing only a subset of the exceptions (typically only acknowledged exceptions to be deleted) is allowed.

An acknowledged exception is removed as soon as the XML block corresponding to that exception is completely parsed. If a parsing error occurs, only the exception causing the error and the subsequent ones are ignored.

The only XML elements required to remove an exception are **Index** and **Acknowledge**. All other elements are allowed but ignored.

Delete

Deleting an exceptions file is allowed, at any time. It flushes the exceptions queue, removing all logged exceptions. A new file reappears immediately thereafter, with updated content.

The delete operation doesn't modify the **QueueSize** parameter.

Synchronization

Several applications can access the files simultaneously. When doing so, it is the application's responsibility to synchronize the file accesses.

3.5 Metadata

Files associated with metadata:

Name: **metadata.xml**

Document Type Definition: **metadata.dtd**

Purpose

This validated XML file provides the status of the corresponding frame store. It contains the status of and the metadata associated with each buffer in the corresponding data directory. The validation is done using the appropriate Document Type Definition (DTD) file, located in the same directory.

Attributes

The metadata XML file is readable and writable. The DTD file is always read-only.

Metadata Queue

Each time a buffer is filled with new data from the board, the driver provides associated metadata. This data is stored by the Virtual File System driver in a queue. The queue always holds as many items as buffers and corresponding files in the data directory.

The application tells the driver when a buffer (a data file) may be disposed of and eventually overwritten by new data. This modifies items in the queue.

Read

When the application opens the XML file, the driver generates its content from the information of the driver-maintained queue. This ensures that reading the file, even partially, always produces valid data.

Reading the whole file provides the listing of all metadata from queue.

Write

The file can be written, to selectively edit metadata.

The only useful action is to add the **Dispose** element to a **MetaData** element. The corresponding buffer and data files are disposed of as soon as the XML block corresponding to that metadata is completely parsed. If a parsing error occurs, the metadata causing the error and the subsequent ones are ignored.

The only XML elements required to dispose a buffer are **Index** and **Dispose**. All other elements are allowed but ignored.

Delete

Deleting a metadata file is allowed, at any time. It flushes the metadata queue and marks all buffers unlocked. A new file reappears immediately thereafter, with updated content.

Synchronization

Several applications can access the files simultaneously. When doing so, it is the application's responsibility to synchronize the file accesses.

3.6 Data

Files associated with data buffers.

Name following this syntax: **<Zero-based buffer index>**

Purpose

Data files represent buffers. They are as many files as buffers in the frame store. The buffers are entitled to contain data coming from the board by DMA.

Attributes

The data files are readable and writable.

Frame Store

The frame store is the collection of buffers entitled to receive the data coming from one Picolo U4 H.264 PCI-104 capture channel. Three types of Picolo U4 H.264 PCI-104 constituents feature a frame store: the visual encoder, the visual formatter and the audio encoder.

The frame store buffers are allocated by the Virtual File System driver in virtual memory. The size of the frame store and buffers is set by the user application through the configuration files.

At system initialization, the frame store contains no buffers, and there are no files in the corresponding data directory. The buffers are allocated and the files created, when the user application sets the appropriate configuration settings.

When the number of filled buffers reaches **BufferCount**, the acquisition is suspended until the user release some buffer(s).

The buffers are passed to the hardware for DMA operations.

Read

Data files can be read at anytime, as long as they exist. When the application reads a data file, the Virtual File System driver provides the buffer's content, without delay.

Mmap

Data files can be mapped in application's memory, as long as they exist, giving direct access to the buffer's content.

Write

Writing in a data file causes the buffer's content to be updated accordingly, without delay.

Delete

Deleting a data file is allowed, but it effectively does not delete the file. Instead, the buffer is disposed of (as per writing the **Dispose** element in **metadata.xml**) and the corresponding metadata is updated accordingly.

Synchronization

Several applications can access the files simultaneously. When doing so, it is the application's responsibility to synchronize the file accesses.

4. XML Files Description

4.1 XML Files Foreword

This topic describes the conventions used throughout the XML Files Description section.

Child elements of root Element0 element

XML elements	Attributes	Content	Number of occurrences	Description
Element1		Elements	1	xxxxxx
Element2a/E2a	Immediate	EMPTY	0/1	xxxxxx
Element3a/E3a **Element3b/E3b**	ReadOnly	PCDATA	Any	xxxxxx

"XML elements" column

The element verbose name and its concise alias appear on the same line, and are separated by a ***/***.
Example: **Element2a/E2a** means that **E2a** is the concise alias of **Element2a**.

When several elements are put together in the same line, that means that these elements are mutually exclusive. At most one of these elements may be present in the XML file.
Example: **Element3a/E3a Element3b/E3b** means that only one of the 4 elements may be present in the XML file.

"Attributes" column

This column shows the attributes of the element, as they appear in a verbose XML file generated by the driver. The attributes can bet set either to **true** or **false** (default).

Immediate elements take effect immediately. Non-Immediate elements are "cached parameters". They can be set at any time, but their effect is postponed until the next activation. Note that a read operation returns the previously written value and an error, if any, is reported at next activation.

Writing a **ReadOnly** element has no effect.

WriteOnly elements are not present when reading an XML file generated by the driver.

"Content" column

Elements means that the element encloses child elements. The children elements are listed further in another table.

EMPTY means that the element does not enclose any content. The opening and closing tags are merged into one tag.
Example: the **EMPTY** element **Element2a** would appear as follows in the XML file generated by the driver: **<Element2a/>**.

PCDATA means that the element encloses parsed character data.
Example: the **PCDATA** element **Element3a** would appear as follows in the XML file generated by the driver: **<Element3a>123456ABCD</Element3a>**.

"Number of occurrences" column

0/1 means that the number of occurrences of the element is 0 or 1 (optional element).

1 means that the number of occurrences of the element is 1 (mandatory element).

Any means that the number of occurrences is 0 or more.

"Description" column

This column gives further information about the element.

4.2 Board Configuration

Child elements of Picolo root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
PicoloU4H264PCI104 **PicoloU4H264** **PicoloU8H264** **PicoloU16H264** **PicoloV16H264**		EMPTY	0/1	Name of the board.
SerialNumber/SN	ReadOnly	PCDATA	0/1	Serial number of the board.
PartNumber/PN	ReadOnly	PCDATA	0/1	Part number of the board.
TimeStamp/TS	ReadOnly	PCDATA	0/1	Value of the local time counter at file open time. Expressed in 1/90,000 seconds. (*)
Temperature/T	ReadOnly	PCDATA	0/1	Temperature of the board at file open time. Expressed in °C. Value range for Picolo U4 H.264 PCI-104: **[-40…150]**

(*) The local time is implemented with a 64-bit counter incrementing at a rate of 90 kHz.

XML File Examples

<root>/config.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE Picolo SYSTEM "config.dtd">
<Picolo version="1.0">
    <Verbose Immediate="true"/>
    <PicoloU4H264PCI104 ReadOnly="true"/>
    <SerialNumber ReadOnly="true">6</SerialNumber>
    <PartNumber ReadOnly="true">12345</PartNumber>
    <TimeStamp ReadOnly="true">1597481371</TimeStamp>
    <Temperature ReadOnly="true">39</Temperature>
</Picolo>
```

<root>/config.xml – Read operation – Concise mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE Picolo SYSTEM "config.dtd">
<Picolo version="1.0">
    <CS Immediate="true"/>
    <PicoloU4H264PCI104 ReadOnly="true"/>
    <SN ReadOnly="true">6</SN>
    <PN ReadOnly="true">12345</PN>
    <TS ReadOnly="true">1597481371</TS>
    <T ReadOnly="true">39</T>
</Picolo>
```

4.3 Visual Source Configuration

Child elements of VisualSource root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
VideoPresent/VP	ReadOnly Immediate	Elements	0/1	Presence indication of a valid video signal on the corresponding video input.
VideoAbsent/VA	ReadOnly Immediate	EMPTY	0/1	Presence indication of a valid video signal on the corresponding video input.
VideoStandard_PAL/PAL **VideoStandard_NTSC/NTSC** **VideoStandard_CCIR/CCIR** **VideoStandard_EIA/EIA**		EMPTY	0/1	Video standard setting of the video decoder.
Contrast/C	Immediate	PCDATA	0/1	Luminance gain (contrast) control. Value range: **[0..200]**. Default value: **100**.
Brightness/B	Immediate	PCDATA	0/1	Luminance offset (brightness) control. Value range: **[-100..100]**. Default value: **0**.
Saturation/S	Immediate	PCDATA	0/1	Chrominance gain (saturation control). Value range: **[0..200]**. Default value: **100**.
Caption0	Immediate	Elements	0/1	The first image caption. This element is absent if **String** is not defined or empty.
Caption1	Immediate	Elements	0/1	The second image caption. This element is absent if **String** is not defined or empty. (*)
Mask0	Immediate	Elements	0/1	The 1st privacy mask region. This element is absent if the mask is not defined, for example when **W** and **H** are both **0**. (*)
Mask1	Immediate	Elements	0/1	The 2nd privacy mask region. This element is absent if the mask is not defined, for example when **W** and **H** are both **0**.
Mask2	Immediate	Elements	0/1	The 3rd privacy mask region. This element is absent if the mask is not defined, for example when **W** and **H** are both **0**.
Mask3	Immediate	Elements	0/1	The 4th privacy mask region. This element is absent if the mask is not defined, for example when **W** and **H** are both **0**.

(*) The caption is inserted on both the formatted and compressed streams. The caption text layer is above the privacy mask layer. A privacy mask doesn't mask the caption text. The text is left justified. The character set is the 7-bit US ASCII character set; non-printable characters are displayed as small rectangles. The multibytes UTF-8 characters are not allowed. The font is not configurable. The character cell size is 16 x 26. The character foreground is white. The character background is semi-transparent: the excursion of the video luminance is limited upwards.

Child elements of VideoPresent

XML elements	Attributes	Content	Number of occurrences	Description
DetectedVideoStandard_PAL/DS_PAL **DetectedVideoStandard_NTSC/DS_NTSC** **DetectedVideoStandard_CCIR/DS_CCIR** **DetectedVideoStandard_EIA/DS_EIA**	ReadOnly Immediate	EMPTY	0/1	The video standard of the video signal detected by the video decoder. This element is absent if **VideoAbsent** is present.

Child elements of Caption0, Caption1

XML elements	Attributes	Content	Number of occurrences	Description
String/STR	Immediate	PCDATA	0/1	The caption text string. Max string length: 47 characters. Setting an empty string disables the parent caption element.
TopLeft/TL **BottomLeft/BL** **TopRight/TR** **BottomRight/BR**	Immediate	EMPTY	0/1	Pre-defined position of a text caption. There are 4 pre-defined positions. The default position is **TopLeft**. With the pre-defined positions, a margin of 16 pixels is inserted between the image edges and the text.
X	Immediate	PCDATA	0/1	Customized X-coordinate of the top-left corner of the first character cell of the caption text. (*)
Y	Immediate	PCDATA	0/1	Customized Y-coordinate of the top-left corner of the first character cell of the caption text. (*)

(*) The coordinate origin (0, 0) is the top-left corner of the display. The X-coordinate range is **[0..703]**. The Y-coordinate range is **[0..574]**. Coordinates are positive integers expressed in pixels unit of the full resolution image.

Child elements of Mask0, Mask1, Mask2, Mask3

XML elements	Attributes	Content	Number of occurrences	Description
X	Immediate	PCDATA	1	X-coordinate of the top-left corner of the rectangular area. (*)
Y	Immediate	PCDATA	1	Y-coordinate of the top-left corner of the rectangular area. (*)
W	Immediate	PCDATA	1	Width of the rectangular area. (**)
H	Immediate	PCDATA	1	Height of the rectangular area. (**)

(*) The coordinate origin (0, 0) is the top-left corner of the display. The X-coordinate range is **[0..703]**. The Y-coordinate range is **[0..574]**. Coordinates are positive integers expressed in pixels unit of the full resolution image.

(**) Setting both **W** and **H** to **0** disables the parent mask element.

XML File Example

<root>/visual/source*/config.xml – Read operation –Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualSource SYSTEM "config.dtd">
<VisualSource version="1.0">
    <Verbose Immediate="true"/>
    <VideoPresent ReadOnly="true" Immediate="true">
        <DetectedVideoStandard_PAL ReadOnly="true" Immediate="true"/>
    </VideoPresent>
    <VideoStandard_PAL/>
    <Contrast Immediate="true">100</Contrast>
    <Brightness Immediate="true">0</Brightness>
    <Saturation Immediate="true">100</Saturation>
    <Caption0 Immediate="true">
        <String>Vid : 1</String>
        <TopLeft/>
    </Caption0>
    <Caption1 Immediate="true">
        <String>18-01-10 13:40:08</String>
        <BottomLeft/>
    </Caption1>
    <Mask0 Immediate="true">
        <X>25</X>
        <Y>50</Y>
        <W>75</W>
        <H>100</H>
    </Mask0>
    <Mask1 Immediate="true">
        <X>0</X>
        <Y>0</Y>
        <W>0</W>
        <H>0</H>
    </Mask1>
    <Mask2 Immediate="true">
        <X>0</X>
        <Y>0</Y>
        <W>0</W>
        <H>0</H>
    </Mask2>
    <Mask3 Immediate="true">
        <X>0</X>
        <Y>0</Y>
        <W>0</W>
        <H>0</H>
    </Mask3>
</VisualSource>
```

4.4 Visual Encoder0 Configuration

Child elements of VisualEncoder0 root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
Active/ACT **Idle/I**	Immediate	EMPTY	0/1	Controls the visual encoder operation.
Decimation/D	Immediate	PCDATA	0/1	Frame rate decimation control. 1 frame is captured every N frames. N is ranging from **1** to **150**. Default value: **1**.
ConstantPictureQuality/CPQ **VariableBitRate/VBR** **ConstantBitRate/CBR**	Immediate	Elements	0/1	Bit rate control method of the H.264 encoder. The default method is: constant picture quality.
GOPSize/GS		PCDATA	0/1	Number of encoded frames per group of pictures.
Scaling4CIF/S4CIF **Scaling2CIF/S2CIF** **ScalingCIF/SCIF** **ScalingQCIF/SQCIF**		EMPTY	0/1	Selects the resolution of the encoded image. The default resolution is 4CIF.
SizeX/SX	ReadOnly	PCDATA	0/1	Width of the encoded image, expressed in pixels.
SizeY/SY	ReadOnly	PCDATA	0/1	Height of the encoded image, expressed in pixels.
BufferSize/BS		PCDATA	0/1	Size, expressed in bytes, of one encoded video buffer. Default value: **204,800** (200 kB).
BufferCount/BC		PCDATA	0/1	Number of encoded video buffers. Default value: **3**.
BufferOffset/BO		PCDATA	0/1	Address offset of the first data. Default value: **0**.

Child elements of ConstantPictureQuality element

XML elements	Attributes	Content	Number of occurrences	Description
Quality/Q	Immediate	PCDATA	1	Quality level of the encoded picture. Value range: **1** to **100**. Default value: **30**.
MaximumKBitRate/MBR	Immediate	PCDATA	1	Maximum bit rate setting of the H.264 encoder Default value: **4000**.

Child elements of VariableBitRate element

XML elements	Attributes	Content	Number of occurrences	Description
MaximumKBitRate/MBR	Immediate	PCDATA	1	Maximum bit rate setting of the H.264 encoder. Default value: **4000**.
AverageKBitRate/ABR	Immediate	PCDATA	1	Average bit rate setting of the H.264 encoder. Default value: **2000**.

Child elements of ConstantBitRate element

XML elements	Attributes	Content	Number of occurrences	Description
MaximumKBitRate/MBR	Immediate	PCDATA	1	Maximum bit rate setting of the H.264 encoder. Default value: **4000**.

XML File Example

<root> /visual/source*/encoder0/config.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualEncoder0 SYSTEM "config.dtd">
<VisualEncoder0 version="1.0">
    <Verbose Immediate="true"/>
    <Idle Immediate="true"/>
    <Decimation Immediate="true">1</Decimation>
    <ConstantPictureQuality Immediate="true">
        <Quality Immediate="true">30</Quality>
        <MaximumKBitRate Immediate="true">2000</MaximumKBitRate>
    </ConstantPictureQuality>
    <GOPSize>30</GOPSize>
    <Scaling4CIF/>
    <SizeX ReadOnly="true">704</SizeX>
    <SizeY ReadOnly="true">576</SizeY>
    <BufferSize>204800</BufferSize>
    <BufferCount>10</BufferCount>
    <BufferOffset>0</BufferOffset>
</VisualEncoder0>
```

4.5 Visual Formatter Configuration

Child elements of VisualFormatter root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
Active/ACT **Idle/I**	Immediate	EMPTY	0/1	Controls the visual formatter operation.
Decimation/D	Immediate	PCDATA	0/1	Frame rate decimation control. One frame is capture every N frames. N is ranging from **1** to **150**. Default value: **1**.
FormatYUV422/YUV422 **FormatY8/Y8** **FormatYUV420PL/YUV420PL** **FormatYUV422PL/YUV422PL**		EMPTY	0/1	Pixel format of the formatted images. The default pixel format is YUV420PL.
Scaling4CIF/S4CIF **Scaling2CIF/S2CIF** **ScalingCIF/SCIF** **ScalingQCIF/SQCIF**		EMPTY	0/1	Selects the resolution of the formatted image. The default resolution is 4CIF.
SizeX/SX	ReadOnly	PCDATA	0/1	Width of the encoded image, expressed in pixels.
SizeY/SY	ReadOnly	PCDATA	0/1	Height of the encoded image, expressed in pixels.
MinBufferSize/MBS	ReadOnly	PCDATA	0/1	Smallest buffer size required to store the whole image.
BufferSizeAuto/BSA		EMPTY	0/1	The buffer size is automatically determined by the driver. This is the default setting.
BufferSize/BS		PCDATA	0/1	Size, expressed in bytes, of one formatted video buffer.
BufferCount/BC		PCDATA	0/1	Number of formatted video buffers. Default value: **3**.
BufferOffset/BO		PCDATA	0/1	Address offset of the first data. Default value: **0**.
PitchAuto/PA		EMPTY	0/1	The buffer pitch is determined automatically by the driver.
Pitch/P		PCDATA	0/1	The buffer pitch, expressed in bytes. Applicable to packed pixel formats only.
PitchY/PY		PCDATA		The buffer pitch, expressed in bytes of Y planes. Applicable to YUV planar pixel formats only.
PitchU/PU		PCDATA		The buffer pitch, expressed in bytes of U planes. Applicable to YUV planar pixel formats only.
PitchV/PV		PCDATA		The buffer pitch, expressed in bytes of V planes. Applicable to YUV planar pixel formats only.

Buffer Pitch Settings

The buffer pitch can be set automatically or manually for all image formats.

The **automatic mode** is invoked with **PitchAuto**. This is the default setting.

In that mode, the pitch is calculated automatically as follows:

- For packed formats, the buffer pitch is the smallest number of bytes that contains one row of packed pixel data; actually:
  number_of_pixel_columns * number_of_bytes_per_pixel
- For planar formats, the buffer pitch of the planes Y, U, V is determined separately:
  - **PitchY = number_of_pixel_columns * number_of_bytes_per_Y**
    where **number_of_bytes_per_Y = 1**; the Y component uses a single byte for all the supported planar formats
  - **PitchU = RoundUp16((number_of_pixel_columns * number_of_bytes_per_C) / HDF)**
  - **PitchV = RoundUp16((number_of_pixel_columns * number_of_bytes_per_C) / HDF)**
    where **number_of_bytes_per_C = 1**; the U and V color component uses a single byte for all the supported planar formats
    and where **HDF = 2**; the Horizontal Decimation factor of the U and V color components is 2 for all the supported planar formats

The **manual mode** is invoked with **Pitch** for packed formats or with **PitchY**, **PitchU**, **PitchV** for planar formats.

Buffer Size Settings

The buffer size can be set automatically or manually for all image formats independently and for both automatic and manual method of the buffer pitch settings.

The **automatic mode** is invoked with **BufferSizeAuto**. This is the default setting.

In that mode, the size is calculated automatically as follows

- For packed formats:
  number_of_pixel_rows * Pitch
- For planar formats, the buffer size is the sum of the minimal storage required for the 3 planes Y, U, and V:
  - **SizeY = number_of_pixel_rows * PitchY**
  - **SizeU = (number_of_pixel_rows * PitchU) / VDecimFactor**
  - **SizeV = (number_of_pixel_rows * PitchV) / VDecimFactor**
    where **VDecimFactor = 1** for YUV422PL and **2** for YUV420PL formats

The **manual mode** is invoked with **BufferSize**.

MinBufferSize reports the minimum size needed to store the image. The calculation of **MinBufferSize** takes the size, pitches, offset and color format into account.

XML File Example

<root> /visual/source*/formatter/config.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualFormatter SYSTEM "config.dtd">
<VisualFormatter version="1.0">
    <Verbose Immediate="true"/>
    <Idle Immediate="true"/>
    <Decimation Immediate="true">1</Decimation>
    <FormatYUV420PL/>
    <Scaling4CIF/>
    <SizeX ReadOnly="true">704</SizeX>
    <SizeY ReadOnly="true">576</SizeY>
    <MinBufferSize ReadOnly="true">608256</MinBufferSize>
    <BufferSizeAuto/>
    <BufferCount>5</BufferCount>
    <BufferOffset>0</BufferOffset>
    <PitchAuto/>
</VisualFormatter>
```

4.6 Audio Configuration

Picolo U4 H.264 PCI-104 supports the following audio configurations:

- 8-bit μ-law companded audio at 8 kHz (G.711)
- 8-bit A-law companded audio at 8 kHz (G.711)
- 16-bit linear PCM audio at 8 kHz
- 16-bit linear PCM audio at 16 kHz
- 16-bit linear PCM audio at 22.05 kHz
- 16-bit linear PCM audio at 44.1 kHz
- 16-bit linear PCM audio at 48 kHz

The default audio configuration is 6-bit linear PCM 8 kHz.

Child elements of AudioEncoder root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
Active/ACT **Idle/I**	Immediate	EMPTY	0/1	Controls the audio encoder operation.
Volume/V	Immediate	PCDATA	0/1	Controls the volume. Value range: **[25..275]**. Default value: **100**.
FormatG711ALAW/G711A **FormatG711ULAW/G711U** **FormatLPCM16/LPCM16**		EMPTY	0/1	Selects the audio format. The default format is G.711 A.
BufferSizeAuto/BSA		EMPTY	0/1	The buffer size is automatically determined by the driver. Its capacity corresponds to 160 milliseconds regardless the sampling rate. This is the default setting.
BufferSize/BS		PCDATA	0/1	Size, expressed in bytes, of one encoded audio buffer. Default value: **0**.(*)
BufferCount/BC		PCDATA	0/1	Number of encoded audio buffers. Default value: **3**.
BufferOffset/BO		PCDATA	0/1	Address offset of the first data. Default value: **0**.

(*) The buffer is filled with at most 160 millisecond of data regardless the sampling rate.

Child elements of FormatLPCM16 element

XML elements	Attributes	Content	Number of occurrences	Description
SamplingRate8KHz/K8 **SamplingRate16KHz/K16** **SamplingRate22.05KHz/K22.05** **SamplingRate44.1KHz/K44.1** **SamplingRate48KHz/K48**		EMPTY	0/1	Audio sampling rate. (*) The default sampling rate is 8 kHz.

(*) Each audio source can be configured individually. However, the following restriction applies: The audio sampling frequencies of all the audio sources of a board must belong to one frequency groups. There are two groups:

- The '48 kHz group' contains the following frequencies: 8, 16, and 48 kHz.
- The '44.1 kHz group' contains the following frequencies: 22.05, and 44.1 kHz.

XML File Example

<root>/audio/source*/config.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE AudioEncoder SYSTEM "config.dtd">
<AudioEncoder version="1.0">
    <Verbose Immediate="true"/>
    <Idle Immediate="true"/>
    <Volume Immediate="true">100</Volume>
    <FormatLPCM16><SamplingRate8KHz/></FormatLPCM16>
    <BufferSizeAuto/>
    <BufferCount>3</BufferCount>
    <BufferOffset>0</BufferOffset>
</AudioEncoder>
```

4.7 Input Line Configuration

Child elements of InputLine root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose /VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
Active/ACT **Idle/I**	Immediate	EMPTY	0/1	Controls the input line operation.
High/H **Low/L** **Disconnected/D**	ReadOnly	EMPTY	0/1	State of the input line.
StyleTTL/TTL **StyleCMOS/12V** **Style12V/S12V**	Immediate	EMPTY	0/1	Electrical style of the input line.
FilterOff/F_O **Filter10ms/F_10** **Filter100ms/F_100**	Immediate	EMPTY	0/1	Time constant of the debouncing filter.

XML File Example

<root>/inputlines/line*/config.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE InputLine SYSTEM "config.dtd">
<InputLine version="1.0">
    <Verbose Immediate="true"/>
    <Idle Immediate="true"/>
    <Disconnected ReadOnly="true"/>
    <StyleTTL Immediate="true"/>
    <Filter100ms Immediate="true"/>
</InputLine>
```

4.8 Output Line Configuration

Child elements of OutputLine root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose /VB Concise/CS	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
Open/O Closed/C	Immediate	EMPTY	0/1	State of the input line.

XML File Example

<root>/outputlines/line*/config.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE OutputLine SYSTEM "config.dtd">
<OutputLine version="1.0">
    <Verbose Immediate="true"/>
    <Open Immediate="true"/>
</OutputLine>
```

4.9 Watchdog Configuration

Child elements of Watchdog root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB Concise/CS	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
StartupTimeOut/ST	WriteOnly Immediate	PCDATA	0/1	Duration of the startup timeout. Expressed in seconds. Value range: **[1..65534]**.
ApplicationTimeout/AT	WriteOnly Immediate	PCDATA	0/1	Duration of the application timeout. Expressed in seconds. Value range: **[0..65534]**. Writing **0** disables the application timeout.
ResetCount/RC	ReadOnly Immediate	PCDATA	0/1	Count of watchdog initiated resets.
ClearResetCount/CC	WriteOnly Immediate	EMPTY	0/1	Clears the counter of watchdog initiated resets.

Setting the application or the startup timeout values will be performed on all boards controlled by the driver.

The **ResetCount** element reports the maximum value from all boards controlled by the driver.

XML File Examples

<root>/watchdog/config.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE WatchDog SYSTEM "config.dtd">
<WatchDog version="1.0">
    <Verbose Immediate="true"/>
    <ResetCount Immediate="true" ReadOnly="true">0</ResetCount>
</WatchDog>
```

<root>/watchdog/config.xml – Write operation – Set the application timeout

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE WatchDog SYSTEM "config.dtd">
<WatchDog version="1.0">
    <ApplicationTimeOut>2000</ApplicationTimeOut>
</WatchDog>
```

4.10 Pass-Through Selector Configuration

Child elements of PassThroughSelector root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
VideoInput0/VIN0 **…** **VideoInput3/VIN3 (*)** **Cascade/C**	Immediate	EMPTY	0/1	Selection of the video input to pass-through the video multiplexer. The default selection is **Cascade**.

(*) The number of elements designating video inputs is as follow:

Board	Elements
Picolo U4 H.264 PCI-104	VideoInput0/VIN0 … VideoInput3/VIN3
Picolo U4 H.264	VideoInput0/VIN0 … VideoInput3/VIN3
Picolo U8 H.264	VideoInput0/VIN0 … VideoInput7/VIN7
Picolo U16 H.264	VideoInput0/VIN0 … VideoInput15/VIN15
Picolo V16 H.264	VideoInput0/VIN0 … VideoInput15/VIN15

XML File Example

<root>/passthroughselector/config.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE PassThroughSelector SYSTEM "config.dtd">
<PassThroughSelector version="1.0">
    <Verbose Immediate="true"/>
    <Cascade Immediate="true"/>
</PassThroughSelector>
```

4.11 Exceptions File

Child elements of ExceptionFile root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
QueueSize/QS	Immediate	EMPTY	0/1	Capacity of the exceptions queue.
Count/C	Immediate ReadOnly	PCDATA	0/1	Number of exceptions in the exceptions file.
Exception/E		Elements	Any	One exception.

Child elements of Exception element

XML elements	Attributes	Content	Number of occurrences	Description
Index/IX	ReadOnly	PCDATA	0/1	The unique index of the exception. Note that the **Index** element must be included in order to to erase/acknowledge an exception.
Acknowledge/ACK	Immediate WriteOnly	EMPTY	0/1	Acknowledges the exception and removes it from the exceptions file.
ErrorType/ET	ReadOnly	PCDATA	0/1	
ErrorTypeName/TN	ReadOnly	PCDATA	0/1	
TimeStamp/TS	ReadOnly	PCDATA	0/1	Local time counter value at exception time.
FileSystemHandling/FSH		Elements	0/1	
XMLProcessing/XP		Elements	0/1	
ResourceHandling/RH		Elements	0/1	
ParameterSetting/PS		Elements	0/1	
Delivery/DV		Elements	0/1	

Child elements of FileSystemHandling element

XML elements	Attributes	Content	Number of occurrences	Description
ErrorCode/EC	ReadOnly	PCDATA	1	The error code.
ErrorName/EN	ReadOnly	PCDATA	1	The error name.
File/F	ReadOnly	PCDATA	1	Name of the file causing the exception.
Operation/O	ReadOnly	PCDATA	1	Name of the operation causing the exception.
Hint/H	ReadOnly	PCDATA	1	Hint about the exception.

Child elements of XMLProcessing element

XML elements	Attributes	Content	Number of occurrences	Description
ErrorCode/EC	ReadOnly	PCDATA	1	The error code.
ErrorName/EN	ReadOnly	PCDATA	1	The error name.
File/F	ReadOnly	PCDATA	1	Name of the XML file causing the exception.
Line/L	ReadOnly	PCDATA	1	Line number of the XML file causing the exception.
Column/CL	ReadOnly	PCDATA	1	Column number of the XML file causing the exception.
Hint/H	ReadOnly	PCDATA	1	Hint about the exception.

Child elements of ResourceHandling element

XML elements	Attributes	Content	Number of occurrences	Description
ErrorCode/EC	ReadOnly	PCDATA	1	The error code.
ErrorName/EN	ReadOnly	PCDATA	1	The error name.
Operation/O	ReadOnly	PCDATA	1	Name of the operation causing the exception.
Hint/H	ReadOnly	PCDATA	1	Hint about the exception.

Child elements of ParameterSetting element

XML elements	Attributes	Content	Number of occurrences	Description
ErrorCode/EC	ReadOnly	PCDATA	1	The error code.
ErrorName/EN	ReadOnly	PCDATA	1	The error name.
Parameter/P	ReadOnly	PCDATA	1	Name of the parameter causing the exception.
Hint/H	ReadOnly	PCDATA	1	Hint about the exception.

Child elements of Delivery element

XML elements	Attributes	Content	Number of occurrences	Description
ErrorCode/EC	ReadOnly	PCDATA	1	The error code.
ErrorName/EN	ReadOnly	PCDATA	1	The error name.
Operation/O	ReadOnly	PCDATA	1	Name of the operation causing the exception.
Hint/H	ReadOnly	PCDATA	1	Hint about the exception.

XML File Examples

<root>/exceptions.xml – Read operation – Verbose mode – No exceptions

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ExceptionFile SYSTEM "exceptions.dtd">
<ExceptionFile version="1.0">
    <Verbose Immediate="true"/>
    <QueueSize Immediate="true">10</QueueSize>
    <Count ReadOnly="true" Immediate="true">0</Count>
</ExceptionFile>
```

<root>/exceptions.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="utf-8"?>
<!DOCTYPE ExceptionFile SYSTEM "exceptions.dtd">
<ExceptionFile>
    <Verbose/>
    <QueueSize>10</QueueSize>
    <Count>2</Count>
    <Exception>
        <Index>1</Index>
        <ErrorType>1</ErrorType>
        <ErrorTypeName>XML Processing Error</ErrorTypeName>
        <XMLProcessing>
            <ErrorCode>12</ErrorCode>
            <ErrorName>Invalid Element</ErrorName>
            <File>config.xml</File>
            <Line>5</Line>
            <Column>12</Column>
            <Hint>Element "brightness" is invalid.</Hint>
        </XMLProcessing>
    </Exception>
    <Exception>
        <Index>0</Index>
        <ErrorType>1</ErrorType>
        <ErrorTypeName>XML Processing Error</ErrorTypeName>
```

```
        <XMLProcessing>
            <ErrorCode>12</ErrorCode>
            <ErrorName>Invalid Element</ErrorName>
            <File>config.xml</File>
            <Line>5</Line>
            <Column>12</Column>
            <Hint>Element "brightness" is invalid.</Hint>
        </XMLProcessing>
    </Exception>
</ExceptionFile>
```

<root>/exceptions.xml – Write operation – Acknowledge the Exception of Index 0

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ExceptionFile SYSTEM " exceptions.dtd">
<ExceptionFile version="1.0">
    <Exception>
        <Index>0</Index>
        <Acknowledge/>
    </Exception>
</ExceptionFile>
```

4.12 Events File

Child elements of InputLineEventFile root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
QueueSize/QS	Immediate	PCDATA	0/1	Capacity of the events queue.
Count/C	Immediate ReadOnly	PCDATA	0/1	Number of events in this file.
High/H **Low/L** **Disconnected/D**		EMPTY	Any	State of the input line after the transition causing the event.

Child elements of High, Low, Disconnected elements

XML elements	Attributes	Content	Number of occurrences	Description
Index/IX	ReadOnly	PCDATA	1	The unique index of the event.
TimeStamp/TS	ReadOnly	PCDATA	0/1	Local time counter value at event time.
Acknowledge/ACK	Immediate WriteOnly	EMPTY	0/1	Acknowledges the event and removes it from the events file.

XML File Examples

<root>/inputlines/line*/events.xml – Read operation – Verbose mode – No events

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE InputLineEventFile SYSTEM "events.dtd">
<InputLineEventFile version="1.0">
    <Verbose Immediate="true"/>
    <QueueSize Immediate="true">10</QueueSize>
    <Count ReadOnly="true" Immediate="true">0</Count>
</InputLineEventFile>
```

<root>/inputlines/line*/events.xml – Read operation – Verbose mode – Two events

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE InputLineEventFile SYSTEM "events.dtd">
<InputLineEventFile version="1.0">
    <Count>2</Count>
    <High>
        <Index>0</Index>
        <TimeStamp>2132154654</TimeStamp>
    </High>
```

```
    <Low>
        <Index>1</Index>
        <TimeStamp>4442154654</TimeStamp>
    </Low>
</InputLineEventFile>
```

<root>/inputlines/line*/events.xml – Write operation – Acknowledge the High event of Index 0

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE InputLineEventFile SYSTEM "events.dtd">
<InputLineEventFile version="1.0">
    <High>
        <Index>0</Index>
        <Acknowledge/>
    </High>
</InputLineEventFile>
```

4.13 Visual Encoder MetaData File

Child elements of VisualEncoderMetaDataFile root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
Count/C	Immediate ReadOnly	PCDATA	0/1	Number of **MetaData** occurrences in this file.
MetaData/MD		Elements	Any	One metadata.

Child elements of MetaData element

XML elements	Attributes	Content	Number of occurrences	Description
Index/IX	ReadOnly	PCDATA	1	The unique index of the **MetaData**.
TimeStamp/TS	ReadOnly	PCDATA	0/1	Local time counter value at begin of data buffer recording time.
Dispose/D	WriteOnly Immediate	EMPTY	0/1	Remove the **MetaData** entry and re-cycle the corresponding data buffer.
File/F	ReadOnly	PCDATA	0/1	The name of the buffer/data file. The file is located in the data sub-directory.
Size/S	ReadOnly	PCDATA	0/1	The size of the corresponding data.
VideoPresent/VP **VideoAbsent/VA**	ReadOnly	EMPTY	0/1	The presence status of the video signal on the corresponding video input.
IDRSlice/IDR **PSlice/PS** **SequenceParameterSet/SPS** **PictureParameterSet/PPS**	ReadOnly	EMPTY	0/1	The type of H.264 data.
OverflowSize/OS	ReadOnly	PCDATA	0/1	The amount of bytes that could not be put into the buffer because the amount of data produced by the hardware exceeded the buffer size. When not **0**, it indicates the amount of dropped data.

XML File Examples

<root>/visual/source*/encoder/metadata.xml – Read operation – Verbose mode – No metadata

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualEncoderMetaDataFile SYSTEM "metadata.dtd">
<VisualEncoderMetaDataFile version="1.0">
    <Verbose Immediate="true"/>
    <Count ReadOnly="true" Immediate="true">0</Count>
</VisualEncoderMetaDataFile>
```

<root>/visual/source*/encoder/metadata.xml – Read operation – Verbose mode

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualEncoderMetaDataFile SYSTEM "metadata.dtd">
<VisualEncoderMetaDataFile version="1.0">
    <Verbose/>
    <Count>2</Count>
    <MetaData>
        <Index>0</Index>
        <TimeStamp>3213212</TimeStamp>
        <File>15</File>
        <Size>123121</Size>
        <VideoPresent/>
        <IDRSlice/>
        <OverflowSize>0</OverflowSize>
    </MetaData>
    <MetaData>
        <Index>1</Index>
        <TimeStamp>45665687</TimeStamp>
        <File>16</File>
        <Size>32027</Size>
        <VideoPresent/>
        <PSlice/>
        <OverflowSize>0</OverflowSize>
    </MetaData>
</VisualEncoderMetaDataFile>
```

<root>/visual/source*/encoder/metadata.xml – Write operation – Dispose of the buffer of Index 0

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualEncoderMetaDataFile SYSTEM "metadata.dtd">
<VisualEncoderMetaDataFile version="1.0">
    <MetaData>
        <Index>0</Index>
        <Dispose/>
    </MetaData>
</VisualEncoderMetaDataFile>
```

4.14 Visual Formatter MetaData File

Child elements of VisualFormatterMetaDataFile root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB **Concise/CS**	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
Count/C	Immediate ReadOnly	PCDATA	0/1	Number of **MetaData** occurrences in this file.
MetaData/MD		Elements	Any	One metadata.

Child elements of MetaData elements

XML elements	Attributes	Content	Number of occurrences	Description
Index/IX	ReadOnly	PCDATA	1	The unique index of the **MetaData**.
TimeStamp/TS	ReadOnly	PCDATA	0/1	Local Time counter value at begin of data buffer recording time.
Dispose/D	WriteOnly Immediate	EMPTY	0/1	Remove the **MetaData** entry and re-cycle the corresponding data buffer.
File/F	ReadOnly	PCDATA	0/1	The name of the buffer/data file. The file is located in the data sub-directory.
Size/S	ReadOnly	PCDATA	0/1	The size of the corresponding data.
VideoPresent/VP **VideoAbsent/VA**	ReadOnly	EMPTY	0/1	The presence status of the video signal on the corresponding video input.

XML File Examples

<root>/visual/source*/formatter/metadata – Read operation – Verbose mode – No metadata

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualFormatterMetaDataFile SYSTEM "metadata.dtd">
<VisualFormatterMetaDataFile version="1.0">
    <Verbose Immediate="true"/>
    <Count ReadOnly="true" Immediate="true">0</Count>
</VisualFormatterMetaDataFile>
```

<root>/visual/source*/formatter/metadata – Read operation – Verbose mode – Two metadata

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualFormatterMetaDataFile SYSTEM "metadata.dtd">
<VisualFormatterMetaDataFile version="1.0">
    <Verbose/>
    <Count>2</Count>
    <MetaData>
        <Index>0</Index>
        <TimeStamp>3213212</TimeStamp>
        <File>15</File>
        <Size>1232121</Size>
        <VideoPresent/>
    </MetaData>
    <MetaData>
        <Index>1</Index>
        <TimeStamp>45665687</TimeStamp>
        <File>23</File>
        <Size>1232121</Size>
        <VideoPresent/>
    </MetaData>
</VisualFormatterMetaDataFile>
```

<root>/visual/source*/formatter/metadata.xml – Write operation – Dispose of the buffer of Index 0

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE VisualFormatterMetaDataFile SYSTEM "metadata.dtd">
<VisualFormatterMetaDataFile version="1.0">
    <MetaData>
        <Index>0</Index>
        <Dispose/>
    </MetaData>
</VisualFormatterMetaDataFile>
```

4.15 Audio Encoder Metadata File

Child elements of AudioEncoderMetaDataFile root element

XML elements	Attributes	Content	Number of occurrences	Description
Verbose/VB Concise/CS	Immediate	EMPTY	0/1	Syntax that the driver uses to generate this XML file. By default, the driver uses the verbose syntax.
Count/C	Immediate ReadOnly	PCDATA	0/1	Number of **MetaData** occurrences in this file.
MetaData/MD		Elements	Any	One metadata.

Child elements of MetaData element

XML elements	Attributes	Content	Number of occurrences	Description
Index/IX	ReadOnly	PCDATA	1	The unique index of the **MetaData**.
TimeStamp/TS	ReadOnly	PCDATA	0/1	Local time counter value at begin of data buffer recording time.
Dispose/D	WriteOnly Immediate	EMPTY	0/1	Remove the **MetaData** entry and re-cycle the corresponding data buffer.
File/F	ReadOnly	PCDATA	0/1	The name of the buffer/data file. The file is located in the data sub-directory.
Size/S	ReadOnly	PCDATA	0/1	The size of the corresponding data.

XML File Examples

<root>/visual/source*/formatter/metadata.xml – Read operation – Verbose mode – No metadata

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE AudioEncoderMetaDataFile SYSTEM "metadata.dtd">
<AudioEncoderMetaDataFile version="1.0">
    <Verbose Immediate="true"/>
    <Count ReadOnly="true" Immediate="true">0</Count>
</AudioEncoderMetaDataFile>
```

<root>/visual/source*/formatter/metadata.xml – Read operation – Verbose mode

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE AudioEncoderMetaDataFile SYSTEM "metadata.dtd">
<AudioEncoderMetaDataFile version="1.0">
    <Verbose/>
    <Count>3</Count>
    <MetaData>
        <Index>15</Index>
        <TimeStamp>1073741824</TimeStamp>
        <File>0</File>
        <Size>215212</Size>
    </MetaData>
    <MetaData>
        <Index>16</Index>
        <TimeStamp>3213215474</TimeStamp>
        <File>25</File>
        <Size>215212</Size>
    </MetaData>
    <MetaData>
        <Index>17</Index>
        <TimeStamp>5546545512</TimeStamp>
        <File>45</File>
        <Size>215212</Size>
    </MetaData>
</AudioEncoderMetaDataFile>
```

<root>/audio/source*/metadata.xml – Write operation – Dispose of the buffer of Index 0

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE AudioEncoderMetaDataFile SYSTEM "metadata.dtd">
<AudioEncoderMetaDataFile version="1.0">
    <MetaData>
        <Index>0</Index>
        <Dispose/>
    </MetaData>
</AudioEncoderMetaDataFile>
```

5. Memory and Persistence Considerations

Memory Considerations

The Virtual File System driver uses the driver-allocated virtual memory to store the files.

You control how much memory to be use for the board's functions.

- The amount of memory used for data storage is defined by setting the **BufferSize** and **BufferCount** elements in the configuration files of the visual encoders, the visual formatters, and the audio encoders.
- The amount of memory used for event storage is defined by setting the **QueueSize** element in the events files of the input lines.
- The amount of memory used for exception storage is defined by setting the **QueueSize** element in the exceptions file.

Persistence Considerations

The driver state and board's settings are stored in virtual memory and do not persist if the system is rebooted or shut down. Only the watchdog settings is excluded.

At driver startup, default settings are applied to all the objects.

Removing (deleting) a configuration file resets the corresponding object to default state except for the verbose/concise setting that remains unchanged.

Appendix

1. Resources Identification (Software)

The resources are split into the following classes:

- Video resources including:
  - Video inputs
  - Video cascade input
  - Video output
- Audio resources
- General-purpose inputs resources
- General-purpose outputs resources

For both the VFS and the DirectShow drivers, the resources are identified by a zero-based index. In the hardware documentation of the connectors and the cables, the signals are labeled using a one-based numeric index.

1.1 Video Resources

Function	Driver identification	Video terminators switch #	PH14 Sig/Ret pins #
Video input 1	0	1	3/4
Video input 2	1	2	5/6
Video input 3	2	3	7/8
Video input 4	3	4	9/10

- Driver identification: this is the index in the application program designating a video input resource.
- PH14 designates the 14-pin Video connector of Picolo U4 H.264 PCI-104.

1.2 Audio Resources

Function	Driver identification	PH10 Sig/Ret pins #
Audio input 1	0	3/4
Audio input 2	1	5/6
Audio input 3	2	7/8
Audio input 4	3	9/10

- Driver identification: this is the index in the application program designating an audio resource.
- PH10 designates the 10-pin Audio connector.

1.3 I/O Resources

Function	Driver identification	PH20 A/B pins #
Input 1	0	3/4
Input 2	1	5/6
Input 3	2	7/8
Input 4	3	9/10
Output 1	0	11/12
Output 2	1	13/14
Output 3	2	15/16
Output 4	3	17/18

- Driver identification: this is the index in the application program designating a video input resource.
- PH20 designates the 20-pin I/O connector on the card.

2. Format Description

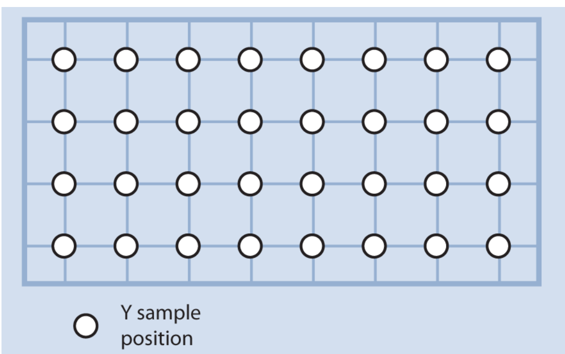
2.1 Y8

Format	FourCC	Storage type	Storage requirement
Y8	Y800	PACKED	1 Bytes/pixel

Spatial sampling periods

Component	Horizontal	Vertical
Y	1	1

Spatial map



Plane assignment

Plane#	Plane name	Storage requirement
0	Y	1 Byte/pixel
1	-	-
2	-	-
3	-	-

Plane 0	**Memory layout**																															
Word 0	Pixel 3: Y								Pixel 2: Y								Pixel 1: Y								Pixel 0: Y							
Byte#	3								2								1								0							
Bit#	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

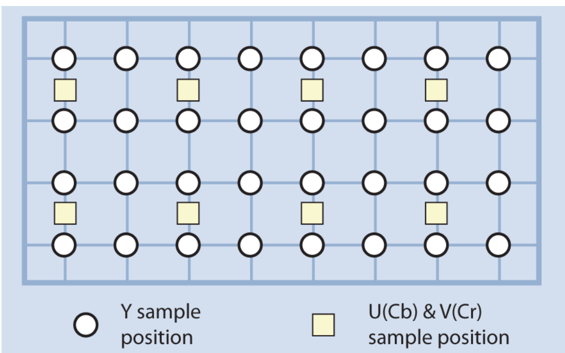
2.2 YUV420Planar

Format	FourCC	Storage type	Storage requirement
YUV420 Planar	I420, IYUV, YV12	PLANAR	1.5 Bytes/pixel

Spatial sampling periods

Component	Horizontal	Vertical
Y	1	1
U (Cb)	2	2
V (Cr)	2	2

Spatial map



- The sampling pattern of the YUV420 format is as specified by the MPEG-2 and the MPEG-4 Part 2 standards.
- The sampling is orthogonal for both the luminance and chrominance samples.
- The chrominance spatial frequency is one half of the luminance spatial frequency in both the horizontal and vertical directions.
- There is one chrominance sample for every quadruplet of luminance samples.
- The position of the chrominance sample is exactly in the center of the rectangle defined by the 4 nearest luminance sampling positions.

Plane assignment

Plane #	Plane name	Storage requirement
0	Y	1 Byte/pixel
1	U	0.25 Byte/pixel
2	V	0.25 Byte/pixel
3	-	-

<table>
<tr><th>Plane 0</th><th colspan="32">Memory layout</th></tr>
<tr><th>Word 0</th><td colspan="8">Pixel 3: Y</td><td colspan="8">Pixel 2: Y</td><td colspan="8">Pixel 1: Y</td><td colspan="8">Pixel 0: Y</td></tr>
<tr><th>Byte#</th><td colspan="8">3</td><td colspan="8">2</td><td colspan="8">1</td><td colspan="8">0</td></tr>
<tr><th>Bit#</th><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

<table>
<tr><th>Plane 1</th><th colspan="32">Memory layout</th></tr>
<tr><th>Word 0</th><td colspan="8">Pixel 6: U (Cb)</td><td colspan="8">Pixel 4: U (Cb)</td><td colspan="8">Pixel 2: U (Cb)</td><td colspan="8">Pixel 0: U (Cb)</td></tr>
<tr><th>Byte#</th><td colspan="8">3</td><td colspan="8">2</td><td colspan="8">1</td><td colspan="8">0</td></tr>
<tr><th>Bit#</th><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

<table>
<tr><th>Plane 2</th><th colspan="32">Memory layout</th></tr>
<tr><th>Word 0</th><td colspan="8">Pixel 6: V (Cr)</td><td colspan="8">Pixel 4: V (Cr)</td><td colspan="8">Pixel 2: V (Cr)</td><td colspan="8">Pixel 0: V (Cr)</td></tr>
<tr><th>Byte#</th><td colspan="8">3</td><td colspan="8">2</td><td colspan="8">1</td><td colspan="8">0</td></tr>
<tr><th>Bit#</th><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

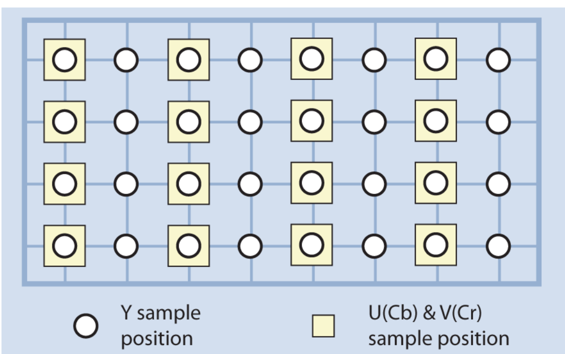
2.3 YUV422 Packed

Format	FourCC	Storage type	Storage requirement
YUV422 Packed	Y42P, YUYV, YUY2	PACKED	2 Bytes/pixel

Spatial sampling periods

Component	Horizontal	Vertical
Y	1	1
U (Cb)	2	1
V (Cr)	2	1

Spatial map



Plane assignment

Plane#	Plane name	Storage requirement
0	YUV	2 Byte/pixel
1	-	-
2	-	-
3	-	-

<table>
<tr><th>Plane 0</th><th colspan="32">Memory layout</th></tr>
<tr><th>Word 0</th><td colspan="8">Pixel 0: V(Cr)</td><td colspan="8">Pixel 1: Y</td><td colspan="8">Pixel 0: U(Cb)</td><td colspan="8">Pixel 0: Y</td></tr>
<tr><th>Byte#</th><td colspan="8">3</td><td colspan="8">2</td><td colspan="8">1</td><td colspan="8">0</td></tr>
<tr><th>Bit#</th><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

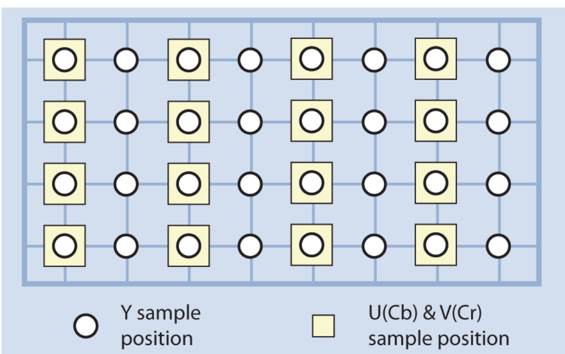
2.4 YUV422 Planar

Format	FourCC	Storage type	Storage requirement
YUV420 Planar	Y42B	PLANAR	2 Bytes/pixel

Spatial sampling periods

Component	Horizontal	Vertical
Y	1	1
U (Cb)	2	1
V (Cr)	2	1

Spatial map



Plane assignment

Plane#	Plane name	Storage requirement
0	Y	1 Byte/pixel
1	U	0.5 Byte/pixel
2	V	0.5 Byte/pixel
3	-	-

<table>
<tr><th>Plane 0</th><th colspan="32">Memory layout</th></tr>
<tr><th>Word 0</th><td colspan="8">Pixel 3: Y</td><td colspan="8">Pixel 2: Y</td><td colspan="8">Pixel 1: Y</td><td colspan="8">Pixel 0: Y</td></tr>
<tr><th>Byte#</th><td colspan="8">3</td><td colspan="8">2</td><td colspan="8">1</td><td colspan="8">0</td></tr>
<tr><th>Bit#</th><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

Plane 1	Memory layout																															
Word 0	Pixel 6: U (Cb)								Pixel 4: U (Cb)								Pixel 2: U (Cb)								Pixel 0: U (Cb)							
Byte#	3								2								1								0							
Bit#	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Plane 2	Memory layout																															
Word 0	Pixel 6: V (Cr)								Pixel 4: V (Cr)								Pixel 2: V (Cr)								Pixel 0: V (Cr)							
Byte#	3								2								1								0							
Bit#	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

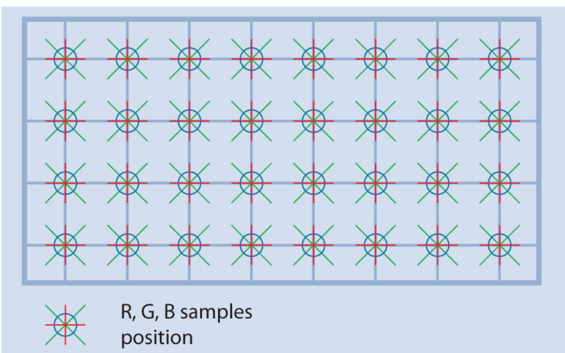
2.5 RGB24 Packed

Format	FourCC	Storage type	Storage requirement
RGB24 Packed	BI_RGB,RGB	PACKED	3 Bytes/pixel

Spatial sampling periods

Component	Horizontal	Vertical
R	1	1
G	1	1
B	1	1

Spatial map



Plane assignment

Plane#	Plane name	Storage requirement
0	RGB	3 Byte/pixel
1	-	-
2	-	-
3	-	-

Plane 0	Memory layout																															
Word 2	Pixel 3: R								Pixel 3: G								Pixel 3: B								Pixel 2: R							
Word 1	Pixel 2: G								Pixel 2: B								Pixel 1: R								Pixel 1: G							
Word 0	Pixel 1: B								Pixel 0: R								Pixel 0: G								Pixel 0: B							
Byte#	3								2								1								0							
Bit#	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

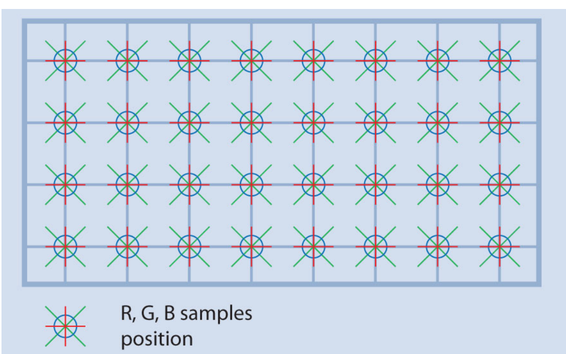
2.6 RGB32 Packed

Format	FourCC	Storage type	Storage requirement
RGB32 Packed	BI_RGB,RGB	PACKED	4 Bytes/pixel

Spatial sampling periods

Component	Horizontal	Vertical
R	1	1
G	1	1
B	1	1

Spatial map



Plane assignment

Plane#	Plane name	Storage requirement
0	XRGB	4 Byte/pixel
1	-	-
2	-	-
3	-	-

Plane 0	**Memory layout**																															
Word 0	"1111 1111"								Pixel 0: R								Pixel 0: G								Pixel 0: B							
Byte#	3								2								1								0							
Bit#	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

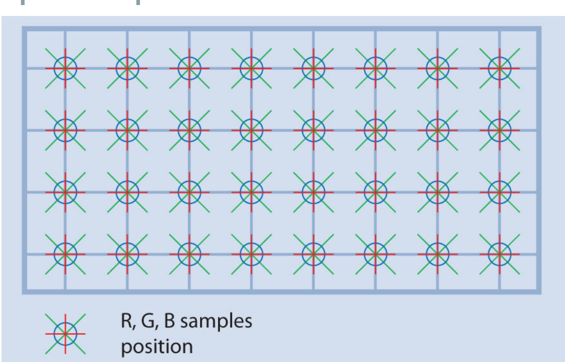
2.7 RGB15

Format	FourCC	Storage type	Storage requirement
RGB15	BI_RGB,RGB	PACKED	2 Bytes/pixel

Spatial sampling periods

Component	Horizontal	Vertical
R	1	1
G	1	1
B	1	1

Spatial map



Plane assignment

Plane#	Plane name	Storage requirement
0	RGB	2 Byte/pixel
1	-	-
2	-	-
3	-	-

Plane 0	**Memory layout**																															
Word 0	0	Pixel 1:R					Pixel 1:G					Pixel 1:B					0	Pixel 0:R					Pixel 0:G					Pixel 0:B				
Byte#	3								2								1								0							
Bit#	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

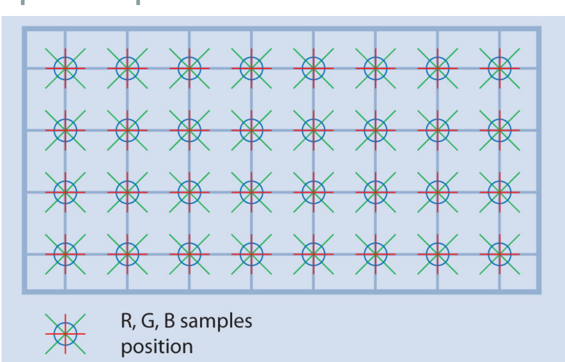
2.8 RGB16

Format	FourCC	Storage type	Storage requirement
RGB16	BI_RGB,RGB	PACKED	2 Bytes/pixel

Spatial sampling periods

Component	Horizontal	Vertical
R	1	1
G	1	1
B	1	1

Spatial map



Plane assignment

Plane#	Plane name	Storage requirement
0	RGB	2 Byte/pixel
1	-	-
2	-	-
3	-	-

<table>
<tr><th>Plane 0</th><th colspan="32">Memory layout</th></tr>
<tr><th>Word 0</th><td colspan="5">Pixel 1:R</td><td colspan="6">Pixel 1:G</td><td colspan="5">Pixel 1:B</td><td colspan="5">Pixel 0:R</td><td colspan="6">Pixel 0:G</td><td colspan="5">Pixel 0:B</td></tr>
<tr><th>Byte#</th><td colspan="8">3</td><td colspan="8">2</td><td colspan="8">1</td><td colspan="8">0</td></tr>
<tr><th>Bit#</th><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

3. Thermal Design Guide

3.1 Thermal Imaging

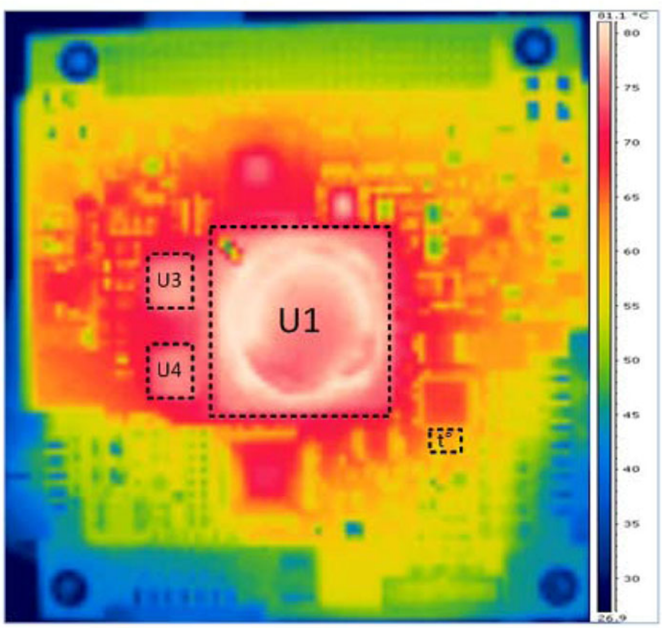
The following picture shows a thermogram of the top side of a Picolo U4 H.264 PCI-104 RH.

The board was operating in the following conditions:

- Full processing load
- Without forced airflow in an ambient temperature of 25°C
- Horizontal mount (natural air convection is perpendicular to the board plane)
- On top of PCI-104 stack composed of 2 items:
  - A Eurotech ISIS CPU module with an Intel Atom processor
  - A single Picolo U4 H.264 PCI-104 RH module

The position of U1, U3, U4 are the main power contributors, and the on-board temperature probe "t°" is added to the picture.

The right side of the picture shows the calibrated temperature scale in °C.



The thermogram shows that:

- The hottest components are reaching case temperatures as high as 80°C, namely 55°C above the ambient air temperature.
- Most of the heat is produced at the center of the module; the hottest components are U1, U3, and U4.
- The heat is spread around by conduction into the printed circuit board material. The temperature decreases progressively from the board center to the boundaries of the printed circuit board.

Heat Production

At full processing load, the board produces typically 6 Watts (6.8 Watts max) of heat power.

The following table shows the power contribution of each of the hottest components:

Reference	Power dissipation (Watt)	Relative contribution (% total power)
U1	4,00	67%
U3	0,63	10%
U4	0,63	10%
Other components	0,75	12%
Total power	6,00	100%

Note. U1, U3, and U4 contribute together for 88% of the total power.

Board Thermal Requirements

The fundamental thermal requirement is: "The junction temperature of all integrated circuits must be kept below the max limit".

With reference to thermogram, the most critical components are U1, U3, U4. The requirements for these components are:

- The maximum junction temperature of U1 may not exceed 125°C.
- The maximum junction temperature of U2, and U3 may not exceed 100°C.

Note that the junction temperatures cannot practically be measured, these requirements are replaced by the following requirements that are easily verified:

- The board temperature measured by the on-board temperature sensor may not exceed 95°C (203°F).
- The heatsink has to drain 4W of heat power, and its temperature measured at its hottest point may not exceed 90°C.
- The interface between the critical components and the heatsink uses a thermal pad with better or equal characteristic than the one specified hereafter in   Using Off-The-Shelf Footprint Compatible Heatsinks.

3.2 Using Standard Heatsink

Picolo U4 H.264 PCI-104 is equipped with a Euresys standard heatsink. Here are the references of the heatsink:

Manufacturer	Model	Height	Thermal impedance at 200 LFM (~ 1 m/s)
Radian Heatsinks	HS2067DB	5.8 mm	4 K / W

The mounted heatsink is compliant with the PCI-104 specification and has limited height, but its thermal impedance meets the requirements.

The heatsink is fixed to the board with the following four spring-loaded brass push pins:

Manufacturer	Model	Height
Radian Heatsinks	HS8103SP008	14.9 mm

The thermal contacts between the heatsink and the U1, U3, and U4 components are implemented with the following thermal pads:

Manufacturer	Model	Thermal resistance	Location
Parker Chomerics	Therm-A-GAP, G579 1 mm thickness, circle, diameter 19 mm	1.6 K / W	U1
Parker Chomerics	Therm-A-GAP, G579, 1.78 mm thickness, rectangle 8x27mm	4 K / W	U3, U4

The heatsink extracts the heat efficiently from the electronic components, and transfers it to the ambient air circulating between adjacent modules.

It is mandatory to establish airflow along the fins of the heatsink to remove the heat from the inter-module gap. For safe operation up to maximum ambient air temperature of 85°C, it is necessary to have a linear air speed of at a min of 1 m/s (200 LFM).

This can be achieved by a fan installed in the chassis containing the PC/104 stack.

3.3 Using Off-The-Shelf Footprint Compatible Heatsinks

The following solutions is applicable to:

- Picolo U4 H.264 PCI-104 RH.

The following requirements have to be fulfill:

- Select a heatsink that matches Euresys standard heatsinks footprints
- Mount the heatsink on the board using
  - Thermal pads on U1, U3, and U4
  - The four fixation holes

The following selection criteria are to be considered:

- Mechanical footprint compatibility (width, position of holes)
- Thermal efficiency

It is recommended to use the following heatsinks:

Manufacturer	Model	Height	Thermal resistance at 200 LFM (~ 1 m / s)
Radian Heatsinks	HS2069DB	11.5 mm	1.8 K / W
Radian Heatsinks	HS2074DB	17.8 mm	1.2 K / W
Radian Heatsinks	HS2158DB	22.9 mm	1.1 K / W

There are other on-the-shelf heatsink on the market that are compatible with the board footprint. Such heatsink is typically used for cooling of Half-Brick DC-DC converters.

The above listed heatsinks provide better thermal characteristics but module height is increase beyond the limit allowed by the standard pitch of a PCI-104 stack. If another module needs to be plugged on top of a module equipped with such a heatsink, it is necessary to increase the module pitch using longer spacers and PCI-104 M/F connector.

The heatsink has to be fixed to the board using the 4 fixation holes. The usage of spring-loaded brass push pins is recommended.

A good thermal contact between the heatsink and the U1, U3, and U4 components is mandatory. The recommended method is to use thermal pads. Note that the thermal pads of U3 and U4 needs to be 0.8 mm thicker than for U1.

It is mandatory to establish airflow along the fins of the heatsink to remove the heat from the inter-module gap. This can be achieved by installing a fan in the chassis containing the PC/104 stack. However, fan-less design can be considered providing that the thermal resistance of the selected heatsink and the natural air convection is facilitated by orientating the board vertically.

The minimal air speed depends on the thermal resistance of the selected heatsink and the max ambient temperature requirement of the system. Before using Picolo U4 PCI-104, verify that all conditions listed in Board Thermal Requirements are met for the worst case environmental conditions.

A part of the available volume specified by the PCI-104 standard is left free in order to allow a thermal bridge to be inserted in the PCI-104 stack.

3.4 Using Custom Heatsinks

The following solutions are applicable to:

- Picolo U4 H.264 PCI-104 RH.

The following requirements have to be fulfill:

- Design a heatsink ensuring that:
  - its footprint fits the mechanical requirements of the board
  - Its thermal impedance is sufficiently low to fulfill all the requirements listed in Board Thermal Requirements
- Mount the heatsink on the board using
  - Thermal pads on U1, U3, and U4
  - The four fixation holes

The following two classes of custom heatsink can be considered:

- Metallic structures that establishes a low thermal impedance between the device-to-be-cooled and the ambient air. These structures are characterized by a very large surface at the metal-air interface. Such a custom heatsink can be manufactured by customization of standardized aluminum extruded profiles using drilling and/or grinding machines.
- Metallic structures that establishes a low thermal impedance between the device-to-be-cooled and the ambient air. These structure are characterized by a large cross-section and the use of highly conductive metal such as copper or aluminum. Such a custom heatsink can be manufactured by a customization of straight metal bars using drilling and/or grinding machine.

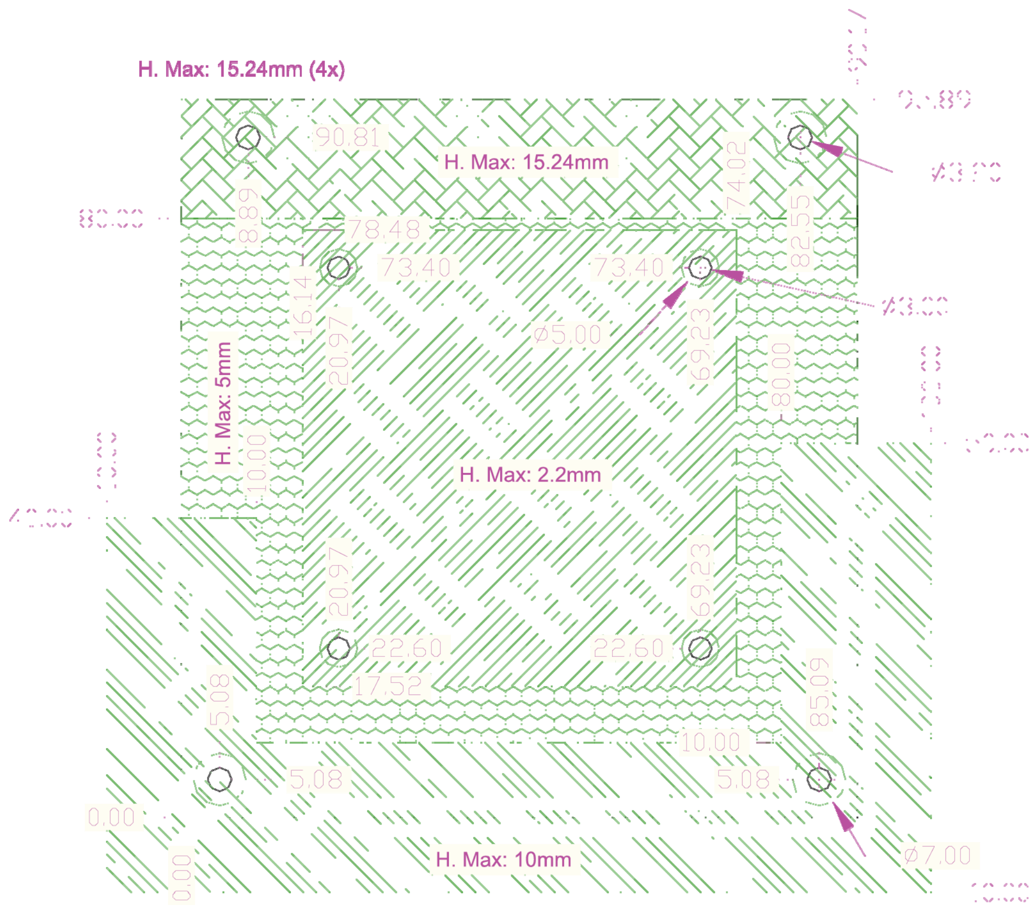
3.5 Board Mechanical Requirements

The following guidelines describes the mechanical requirements for the heatsink on Picolo U4 H.264 PCI-104 RH.

The following drawing shows:

- The outline of the PC-104 module
- The position and the diameter of the 4 holes at the corner of the PCI-104 module
- The position and the diameter of the 4 holes intended for the fixation of the heatsink
- The outline of 4 areas. Each being characterized by a "H.Max" indication.

The H.max indication indicates the maximum component height above the PCB surface for that area. All dimensions are expressed in mm.



The Central Area

The central area is characterized by a H. Max; of 2.2 mm. The area is rectangular; it covers all the main heat contributing components.

It contains four non-plated-through holes having a diameter of 3 mm. Each hole occupies the center of a 5 mm diameter area that contains no components and no PCB traces on the outer layers. The holes are specifically designed for the fixation of a heatsink with push-pins.

The standard heatsink delivered with the Picolo U4 H.264 PCI-104 version of the product, namely, fits entirely in the central area.

The Peripheral Area

The peripheral area is characterized by a H. Max; of 5 mm. This area surrenders the central area.

If a custom-designed heatsink extends over this area it is mandatory that the mounted heatsink leaves at least 5 mm of space above the PCB surface for the components.

The User Connector Area

The user connector area is characterized by a H. Max; of 10 mm. This area covers all the user connectors (video/audio/io).

If a custom-designed heatsink extends over this area it is mandatory that the mounted heatsink leaves at least 10 mm of space above the PCB surface for the connectors. Notice also that the accessibility to the connectors might be impeded!

The PCI-104 Connector Area

The PCI-104 connector area is characterized by a H. Max; of 15.24 mm. This area corresponds to the PCI-104 connector stack..

If a custom-designed heatsink extends over this area it is mandatory that the mounted heatsink leaves at least 15.24 mm of space above the PCB surface for the connector. Notice also that this is possible only for the top module of the system.

Glossary

A

Absolute audio power levels

Can be expressed using the dBm logarithmic scale. The 0 dBm level is defined as an absolute power level of 1 mW. To convert watts into dBm, use the formula:

```
PowerdBm = 10 * log(1000 * PowerWatt)
```

Note that for a 600 Ω load, dBu level = dBm level.

Absolute audio voltage levels

Independently of the load impedance, can be expressed using the dBu logarithmic scale. The 0 dBu level is defined as an absolute voltage level that produces 1 mW of power across a 600 Ω load. To convert Vrms into dBu, use the formula:

```
VoltagedBu = 20 * log(VoltageVoltRMS / 0.7746)
```

Can also be expressed using the dBV logarithmic scale. The 0 dBV level is defined as an absolute voltage of 1 Vrms.

Analog

A type of signal in an electronic circuit that takes on a continuous range of values.

Audio digitizer

Digitizes an analog audio signal, and delivers a digital audio stream.

B

Bandwidth

A measurement of the rate of data transfer, in bits or bytes per second.

Back-porch clamping

During the back-porch interval (between the sync tip and the begin of a video line) of the video signal, also known as "blank level", the DC-restoration circuit maintains the blank level at a constant DC voltage, using a servo-loop that minimizes the error.

Brightness

In NTSC and PAL video signals, the brightness information at any particular instant in a picture is conveyed by the corresponding instantaneous DC level of active video.

Bit

The smallest unit of information, that can be represented either as 1 or 0.

Byte

Consists of 8 bits. Values from 0 to 255, commonly used to represent the gray-scale value of a pixel.

C

CCIR

CCIR is the standard monochrome video format used in most of Europe, Israel, and some other places in the world. CCIR products are also generally referred to as PAL because all PAL products can also handle black and white CCIR video.

Chrominance

A signal that represents the color information of an image.

CIF formats

CIF formats, commonly used in video teleconferencing systems for specific resolution, 352 x 288 for PAL and 352 x 240 for NTSC.

Contrast

The difference between the darkest and the brightest parts of an image.

COM

The Component Object Model was introduced by Microsoft in 1993. It is an object-oriented programming model, used to enable inter-process communication and dynamic object creation, in any programming language that supports the technology.

Comb filter

An electrical filter circuit that passes a series of frequencies and rejects the frequencies in between, it combs out the frequencies. Used on a composite video signal, to separate the chrominance signal and reject the luminance signal, or to select the luminance signal and reject the chrominance signal.

Cropping

Remove any unwanted areas in an image.

Cross luminance

See Dot crawl.

D

D-1 resolution

D-1 is a resolution standard for TV specifications. It means 720 x 486 in NTSC systems, and 720 x 576 in PAL and SECAM systems.

dBm

dB(1 mW)

A dBm is a standard unit for measuring levels of power in relation to a 1 milliwatt reference signal. Similar to dB, except that dB is relative to the power of the input signal, dBm always relates to a 1 milliwatt signal. In other words, dB is a relative measurement, and dBm is an absolute measurement.

```
XdBm = XdBW + 30
```

dBu

dB(0.775 Vrms)

Voltage relative to 0.775 volts.

Originally dBv, it was changed to dBu to avoid confusion with dBV. The "v" comes from "volt", while "u" comes from "unloaded". dBu can be used regardless of impedance, but is derived from a 600 Ω load dissipating 0 dBm (1 mW).

dBV

dB(1 Vrms)

A logarithmic voltage ratio with a reference voltage relative to 1 volt, regardless of impedance.

Deinterlace

The process of converting interlaced analog video signal into a non-interlaced form.

Digital

A method of storing, processing and transmitting information through the use of distinct electronic or optical pulses that represent the binary digits 0 and 1.

DirectShow

A multimedia framework and API produced by Microsoft for software developers to perform various operations with media files or streams.

Dot crawl

A visual defect consisting of animated checkerboard patterns, which appears along horizontal color transitions. This occurs when the video decoder mixed up the high-frequency luminance information as chrominance information.

E

EIA

Electrical Industries Association. Monochrome video signal for North America and Japan TV standard (525 lines 60 Hz).

F

Frame

One frame is made up of two fields.

Frame grabber

A device that interfaces with a camera and, on command, samples the video, converts the sample to a digital value (if the frame grabber is analog instead of digital), and stores that in a computer's memory.

Field

One half of a frame.

Frequency

The number of completed waveform in a given time, measured in cycles per second (Hz).

G

G.711 PCM audio encoder

Digitizes audio according to ITU-G.711, using either μ-law or A-law, and delivers a PCM encoded audio stream.

Gain

Any increase or decrease in strength of an electrical signal and is often measured in terms of decibels.

GUID

Globally Unique Identifier is a distinct 128-bit reference number that is used to identify a particular software application.

GOP

Group Of Pictures.

H

H.264

A high quality video compression with different ranges of bit rates. Also known as **MPEG-4 Part 10**, or **MPEG AVC** (Advanced Video Coding). This standard can be applied to a wide variety of applications, networks and systems due to it flexibility.

Hz

The measurement unit of frequency (cycles per second).

I

IDR picture

When the decoder receives an IDR picture, all subsequent transmitted slices can be decoded without references to any frame decoded prior to IDR picture.

Image aspect ratio

The ratio of the width to the height of a frame of a video image. For conventional PAL/NTSC television standards, the aspect ratio is 4:3, or 1.333.

Impedance

The total of the resistive and reactive opposition, measured in ohms, that a circuit presents to the flow of alternating current at a given frequency.

Interlaced

A video storage mode consisting of fields (odd or even lines) with each field containing half of the lines in a frame.

I/O

Input/Output.

ISO

International Standards Organization.

ITU

International Telecommunications Union.

J

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K

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L

LED

Light Emitting Diode.

Line level audio

Line level is a term used to describe the strength of an audio signal used to transmit analog sound information between audio components and sending to recording devices. It is used as it minimizes noise and distortion when processing, transferring or reproducing recorded sound.

Luminance

A signal that represents the scene brightness of the video signal information. The difference between luminance and brightness is that the latter is non-measurable and sensory. The color video picture information contains two components, luminance (brightness and contrast) and chrominance (hue and saturation).

M

Macroblock

Block of 16x16 pixels, used in image H.264 compression for instance.

Mask

Block out certain portions of an image to prevent viewing.

Moiré pattern

An unwanted effect that appears in the video picture when high frequencies are folding back to the lower frequencies.

Monochrome

A black and white picture.

N

Noise

An unwanted signal produced by all electrical circuits. Noise cannot be eliminated but only minimized.

NTSC

American committee that sets the standards for color television as used today in the US, Canada, Japan and parts of South America. NTSC television uses a 3.57945 MHz sub-carrier whose phase varies with the instantaneous hue of the televised color, and whose amplitude varies with the instantaneous saturation of the color. NTSC employs 525 lines per frame and 59.94 fields per second.

O

OEM

Original Equipment Manufacturer.

P

PAL

Phase alternating line. Describes the color phase change in a PAL color signal. PAL is a European color TV system featuring 625 lines per frame, 50 fields per second and a 4.43361875- MHz sub-carrier. Used mainly in Europe, China, Malaysia, Australia, New Zealand, the Middle East and parts of Africa.

PCI

Peripheral Component Interconnect. A personal computer local bus designed by Intel, which runs at 33 MHz and supports Plug and Play.

PCI Express

An emerging (2004/2005) standard for high-speed graphics, likely to result in a 20 % boost over 2003-era AGP 8x performance.

PC reset relay

The PC reset relay is a component of the watchdog installed on Euresys frame grabbers. It is closed when the PC has to be reset.

Pulse-code modulation

It is a digital representation of an analog signal in a numeric code, usually in binary code. This is achieved by sampling the signal at a regular interval and then convert it into a digital signal.

Q

QCIF

Quarter CIF. 176 x 144 for PAL and 176 x 120 for NTSC.

R

Resolution

A measure of number of dots in the horizontal lines of the camera or television system capability to reproduce image detail. For example, 720 x 576 is capable of displaying 720 dots on each 576 lines, or about 420,000 pixels.

RGB color space

RGB is based on three primary colors, red, green and blue. It is used for video color representation.

S

Saturation

The intensity of the colors in the active picture. The degree by which the eye perceives a color as departing from a gray or white scale of the same brightness. For example, red is highly saturated, whereas a pale pink is not. A 100 % saturated color does not contain any white, adding white reduces saturation.

Scaling

Enlarging an image according to a scale.

SECAM

Sequential Color And Memory. Color television broadcast system used in France.

SIF formats

SIF is a version of CIF for exchanging videos images for NTSC, PAL and SECAM. 240 x 352 for NTSC and 288 x 352 for PAL and SECAM.

Signal-to-noise (S/N) ratio

An S/N ratio can be given for the luminance signal, chrominance signal and audio signal. The S/N ratio is the ratio of noise to actual total signal, and it shows how much higher the signal level is than the level of noise. It is expressed in decibels (dB), and the bigger the value is, the crisper and clearer the picture and sound will be during playback.

Start-up

The start-up is a sequence of operations starting from the booting of the PC and ending with the launch of the application.

T

(empty)

U

(empty)

V

Video decoder

The video decoder recovers the PAL or NTSC color composite analog video signal, and converts it into a YUV422 digital video stream.

Video encoder

The video encoder superimposes digital signal information on other digital signal, according to ITU-T rec. H.264 Baseline profile video compression standard, and delivers an encoded video stream.

Video formatter

The video formatter formats digital video in either RGB or YUV color spaces, and delivers a raw video stream.

Video pass-through selector

The video pass-through selector selects any of the 16 analog Video Inputs, or the Video Cascade Input, and delivers a buffered analog video signal to the Video Output.

Vrms

For audio signals, and AC signals in general, the voltage level is often expressed as the **r**oot **m**ean **s**quare of the voltages.

Note that, in case of a sinusoidal signal:

```
VPeakToPeak ≈ 2.8 * Vrms
```

W

Watchdog

This device restarts the system in the event of a system failure, for instance a malfunction of the software application.

Waveform

The shape of the electromagnetic wave. A graphical representation of voltage and current in relation to time.

X

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Y

Y/C

Video signal containing separate luminance and chrominance components.

YUV

A color encoding scheme for natural pictures in which luminance and chrominance are separate. YUV allows the encoding of luminance information at full bandwidth, and chrominance information at half bandwidth.

Z

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Index

A

B

C

D

E