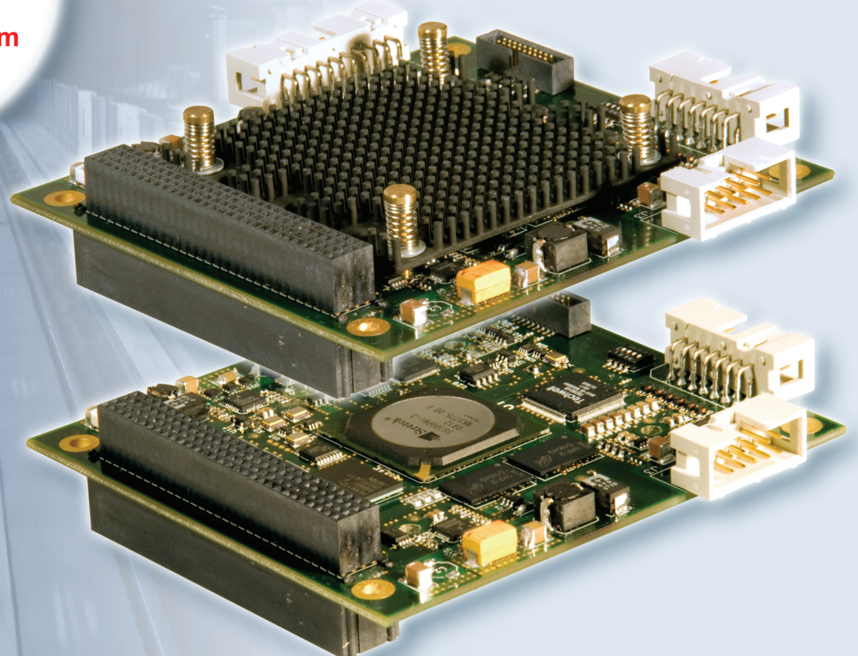
PICOLO U4 H.264 PCI-104™

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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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

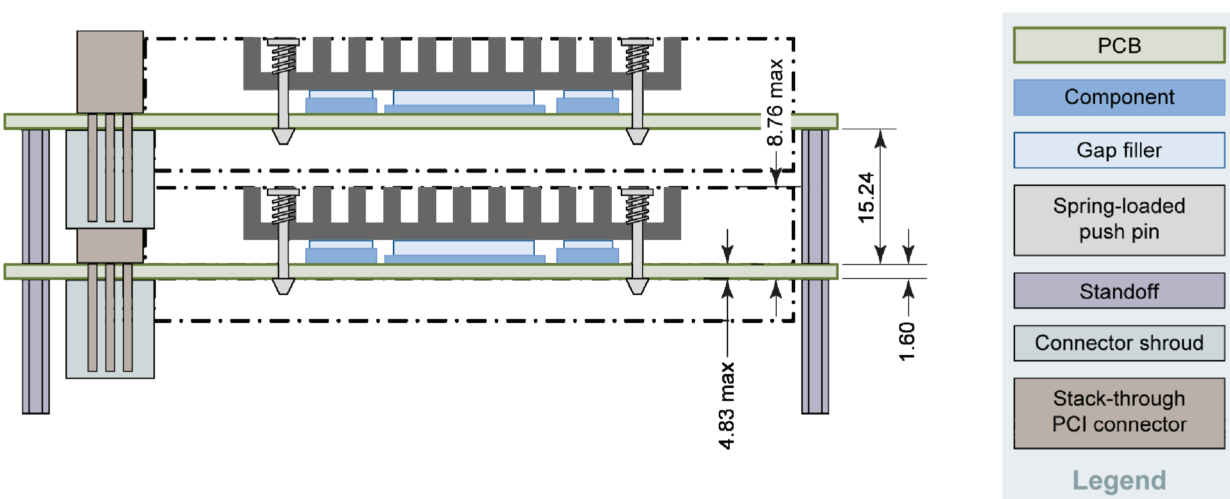
For the supported CPU architectures, operating systems and development tools, please refer to the Release Notes that come with your driver on the Euresys website.

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 (DS)

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

Once the package is downloaded, install the driver. Note that if you have an existing Picolo U4 H.264 PCI-104 driver already installed, you will be prompted to uninstall it before being able to continue. The following lists the files (**C:\Program Files\Euresys\U4H264PCI104** directory by default):

- **C:\Program Files\Euresys\U4H264PCI104** contains script files for driver installation.
- **C:\Program Files\Euresys\U4H264PCI104\DriversDS** contains the driver.
- **C:\Program Files\Euresys\U4H264PCI104\Include** contains the following header files:
  - **Picolo_IMethod.h**
  - **Picolo_KUCommon.h**
  - **Picolo_U4H264_PCI-104.h**
  - **U4H264_PCI104_CLsID.h**
  - **U4H264_PCI104_Definitions.h**
  - **U4H264_PCI104_PropertyPage.h**
- **C:\Program Files\Euresys\U4H264PCI104\Redist** contains one Microsoft redistributable file (**vcredist_x86.exe**).

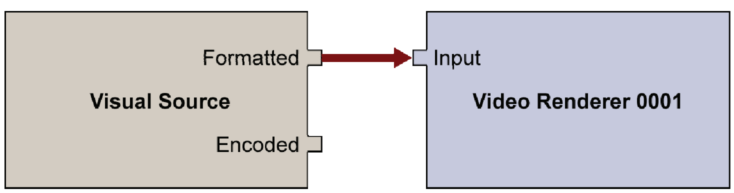
Redistributable installs (by default) the runtime and associated files in order to use the custom property pages through GraphEdit. If the redistributable are not correctly installed, the custom property pages are not visible. If an external program abnormally removes the redistributable, it is still possible to re-install them by launching the corresponding program that is copied in **C:\Program Files\Euresys\U4H264PCI104\Redist**.

5. Testing Your Board

You can use the GraphEdit application to test the working condition of the board. For more information on the DirectShow filters, refer to DirectShow Reference.

Formatted Video Testing

- Open GraphEdit.
- Select Graph > Insert Filters.
- Select WDM Streaming Capture Devices > U4H264PCI104 Visual Source.
- Click [Insert Filter]. The filter is displayed with two output pins named "Formatted" and "Encoded" respectively.
- Select Graph > Insert Filters.
- Select DirectShow Filters > Video Renderer.
- Click the "Formatted" pin, and drag the arrow to the "Input" pin of the Video Renderer.
- Right-click the U4H264PCI104 Visual Source Filter, and select [Filter Properties].
- Select [U4H264PCI104 Video Source] tab.
- Select the Input Channel that your video source is currently connected to, and click [OK].
- Select [U4H264PCI104 Video Formatter] tab.
- Select the [Flip Vertical] checkbox. Take note, selecting this checkbox depends on the type of video renderer that is used.
- Click [Play]. The video should appear. If not, test with all the input channels.

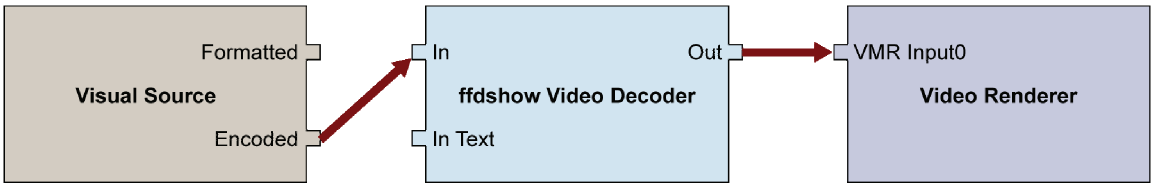


Formatted video testing

Encoded Video Testing

- Repeat steps 2 to 4 of the formatted video testing.
- Insert the H.264 decoder filter, for example, **ffdshow** Video Decoder. If you do not have the decoder filter, download any other DirectShow H.264 decoder.
- Click the "Encoded" pin, and drag the arrow to the "In" pin of the **ffdshow** Video Decoder.
- Right-click the "Out" pin, and select [Render Pin].
- Right-click the U4H264PCI104 Visual Source filter, and select [Filter Properties].
- Select [U4H264PCI104 Video Source] tab.
- Select the Input Channel that your video source is currently connected to, and click [OK].

- Click [Play]. The encoded video should appear. If not, test with all the input channels.



Encoded video testing

Hint. Once you built the graphs, select File > Save As to save the graphs, so you don't need to rebuild them every time.

6. Preparing Your Code

The following header files are to be included in the project of the application when using Picolo U4 H.264 PCI-104 driver.

- **Picolo_IMethod.h**
- **Picolo_KUCommon.h**
- **Picolo_U4H264_PCI-104.h**
- **U4H264_PCI104_CLsID.h**
- **U4H264_PCI104_Definitions.h**
- **U4H264_PCI104_PropertyPage.h**

Naming Conventions

The main interfaces starts with the prefix **CLSID**, for example **CLSID_IU4H264PCI104VisualEncoder**.

The properties starts with the prefix **KSPROPERTY_<interface name>_**, for example **KSPROPERTY_VisualEncoder_Decimation**.

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

- 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
- I/O sub-system
  - 4 solid-state relay outputs
  - 4 contact-closure inputs
  - 2 WATCHDOG output

Video Capture

- 4 independent video acquisition channels
- Video decoder — analog video decoding
  - Multi-standard PAL-B/D/G/H/I, or NTSC-M
  - Gain, contrast and color saturation adjustments
- Video encoder — on-board compression
  - H.264 (MPEG-4 Part 10) Baseline profile (Level 3)
  - Full resolution and full frame rate possible up to 2.0 Mbps (average) per videos acquisition channel
  - Resolution settings:
    - 4CIF: 704x576 (PAL) or 704x480 (NTSC)
    - 2CIF: 704x288 (PAL) or 704x240 (NTSC)
    - CIF: 352x288 (PAL) or 352x240 (NTSC)

    - QCIF: 176x144 (PAL) or 176x112 (NTSC)

- Video formatter — simultaneous raw image acquisition
  - Fixed cropping
  - Downscaling
  - Resolution settings:
    - 4CIF: 704x576 (PAL) or 704x480 (NTSC)
    - 2CIF: 704x288 (PAL) or 704x240 (NTSC)
    - CIF: 352x288 (PAL) or 352x240 (NTSC)
    - QCIF: 176x144 (PAL) or 176x120 (NTSC)
  - Image storage formats available:
    - Packed: Y8
    - Planar: YUV420PL (native format)
  - Configurable reduction of the frame rate: 1/N
- Data transfer
  - High-performance DMA transfer
  - Scattered transfer
- Miscellaneous
  - Time stamping
  - Video presence detection
  - Caption and mask insertion

Audio Capture

- 4 independent and high-quality audio acquisition channels
- Line-level analog audio input signals
- Digital audio output signals
  - 8 kHz, 8 bits, G.711 μ-law
  - 8 kHz, 8 bits, G.711 A-law
  - 8 kHz, 16 bits, PCM
  - 16 kHz, 16 bits, linear
  - 22.05 kHz, 16 bits, linear
  - 44.1 kHz, 16 bits, linear
  - 48 kHz, 16 bits, linear
- Audio-video synchronization supported by accurate time stamping of audio and video data

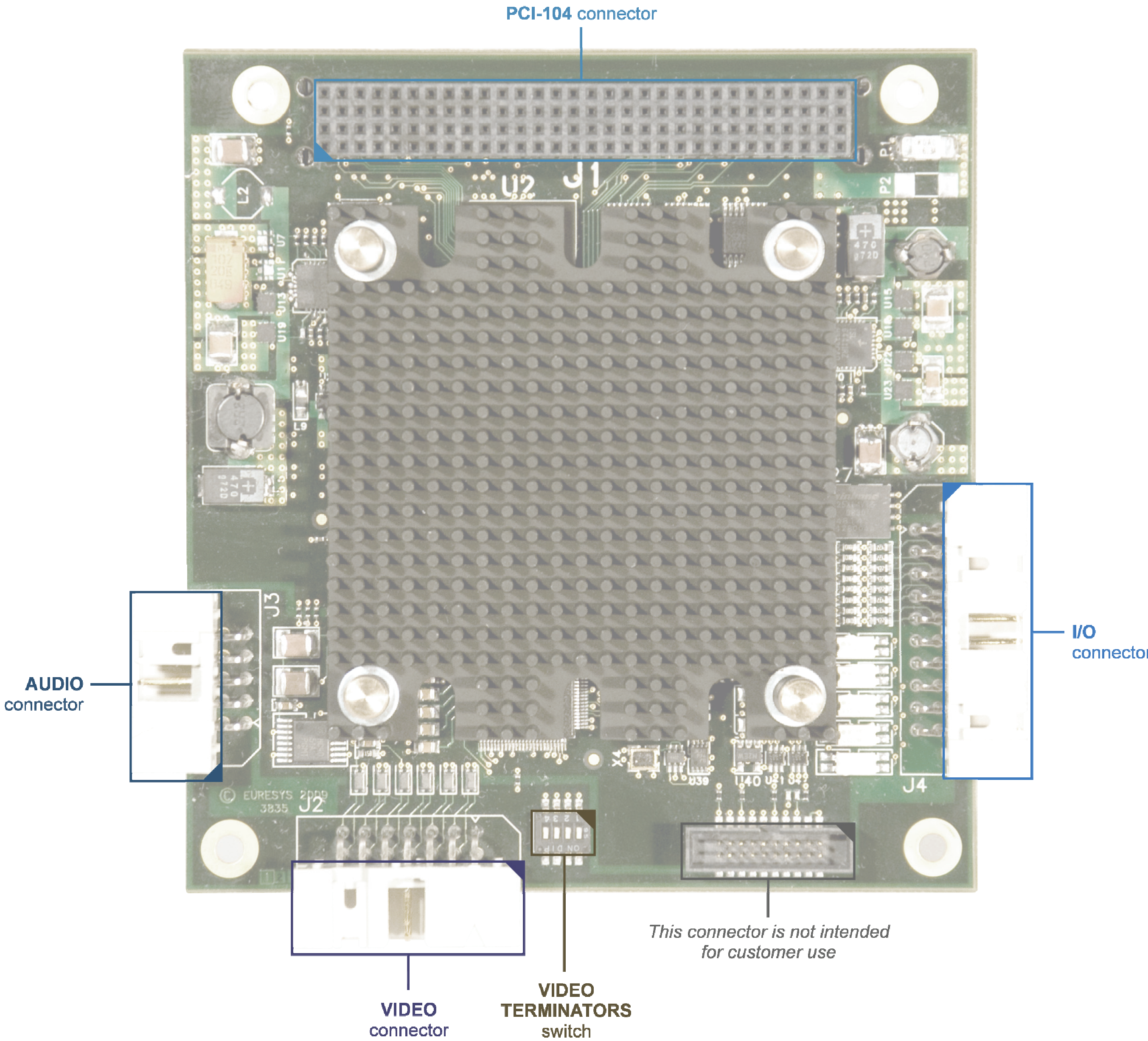
Video Pass-Through Selector

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

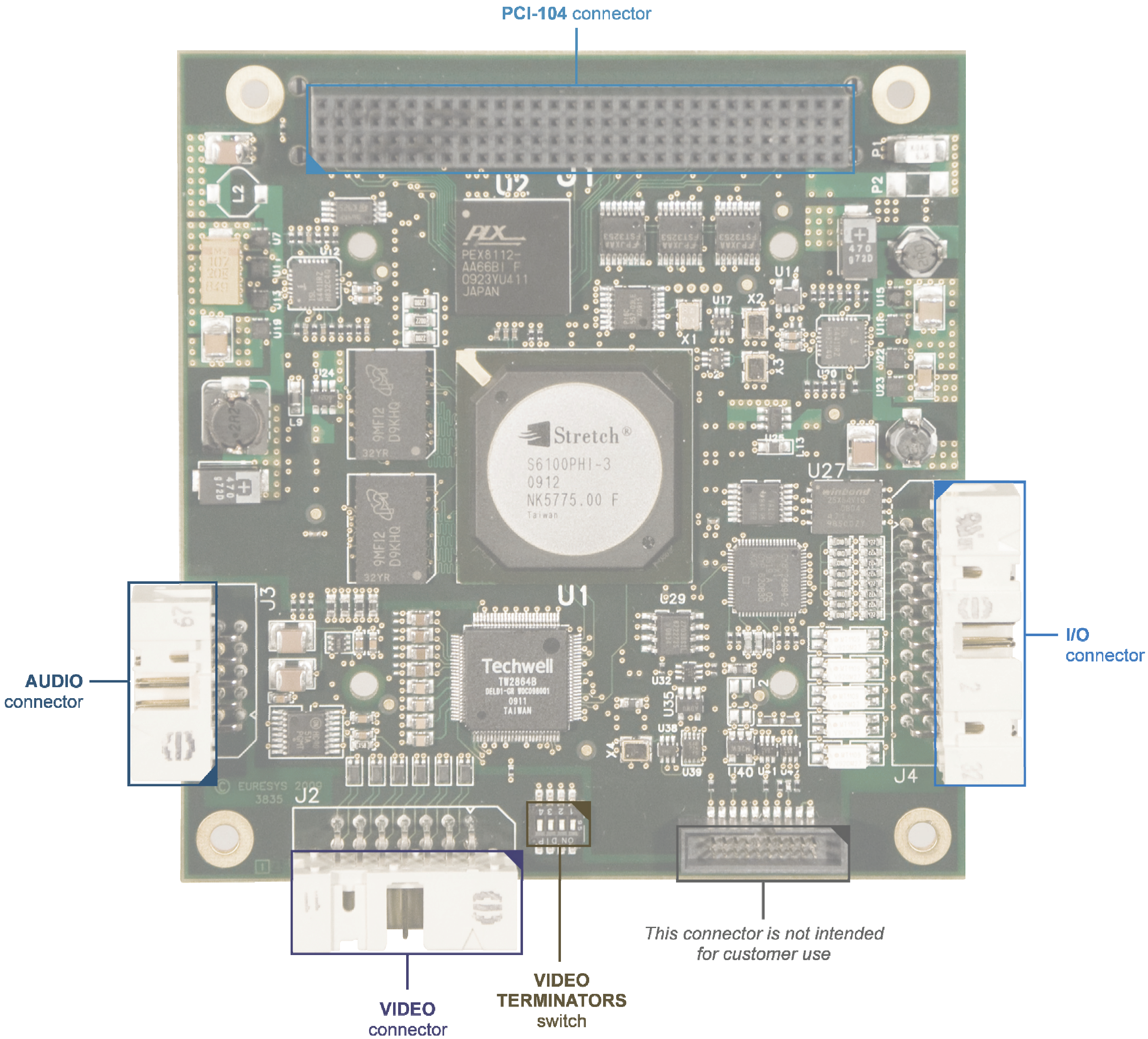
2. Board Specifications

2.1 Board Layout and Block Diagram

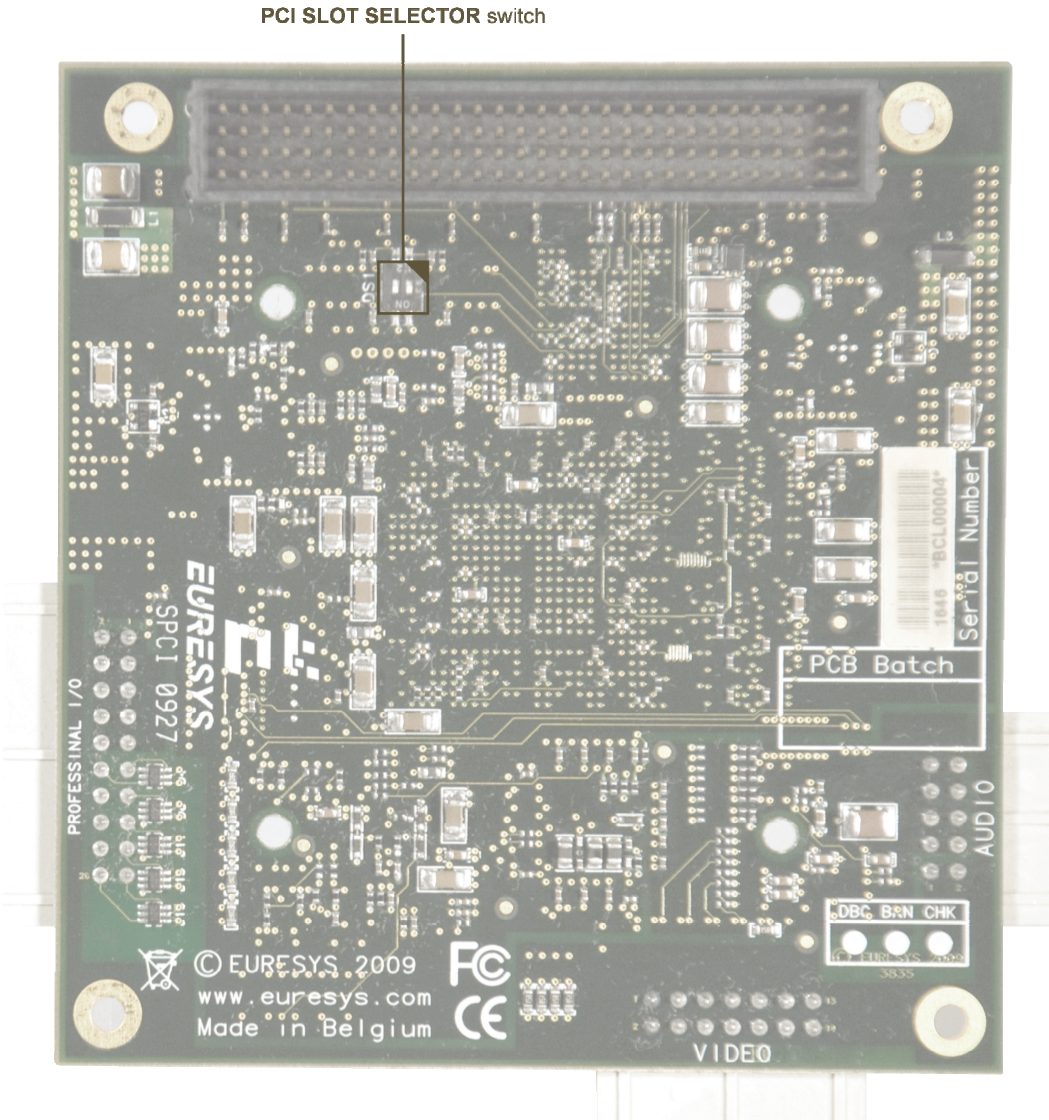
Connector name	Connector type
VIDEO	7 x 2-pins 0.1" pitch right-angled header
AUDIO	5 x 2-pins 0.1" pitch right-angled header
I/O	10 x 2-pins 0.1" pitch right-angled header
PCI-104	4 x 30-pins 2 mm pitch stackable connector
Switch name	**Switch type**
PCI SLOT SELECTOR	2-position slide-type DIP switch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



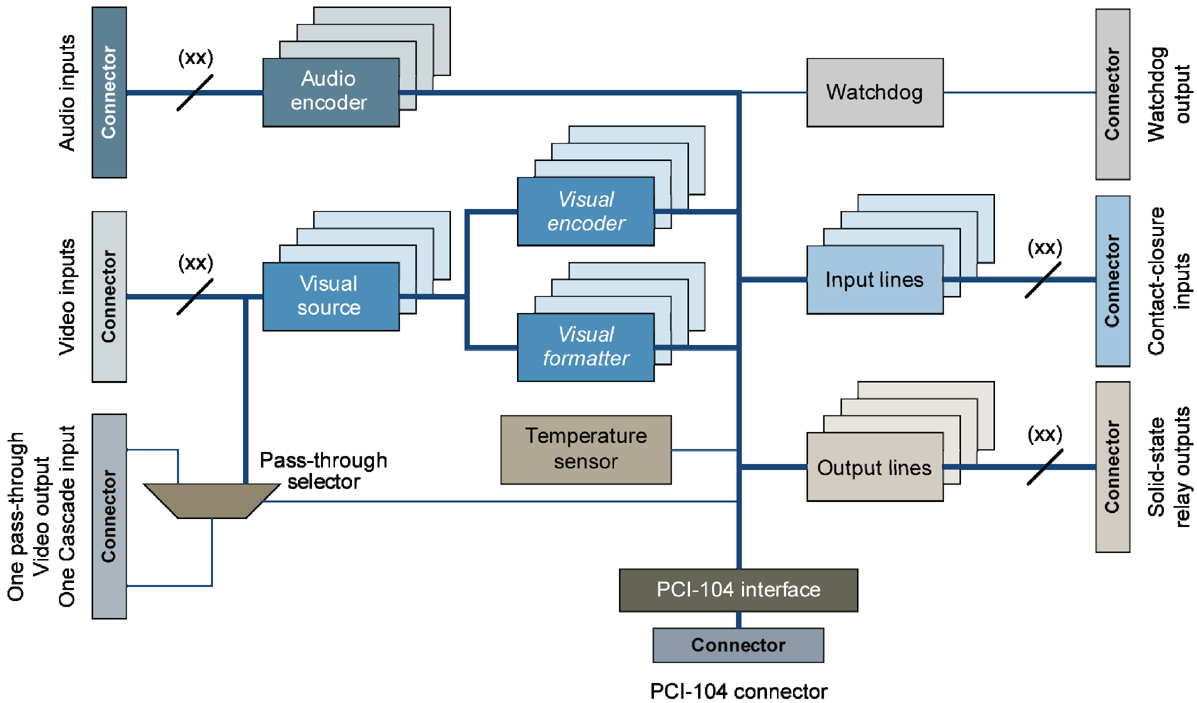
Picolo U4 H.264 PCI-104 board layout (top view)



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



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

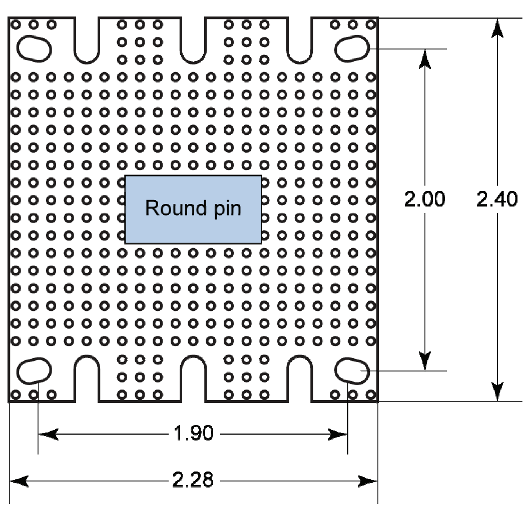


Picolo U4 H.264 PCI-104 block diagram (xx = 4)

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.

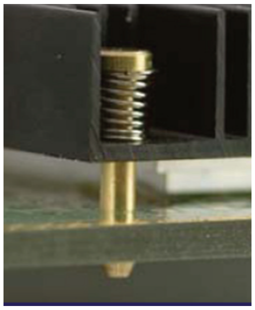
Standard Mounted Heatsink



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

The Picolo U4 H.264 PCI-104 is equipped with a PCI-104 bus.

PCI Express Bus Compatibility

Picolo U4 H.264 PCI-104 is a 32-bit PCI device that can be operated at 33 MHz exclusively.

PCI-104 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.

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 OCI-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.

Note:

- 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 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

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. Refer to Cooling System Design Guide for more details.

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

The 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

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

2.6 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

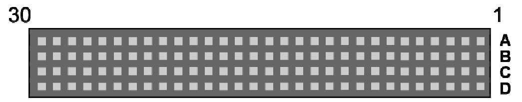
This equipment has been tested and found to comply with EN55022/CISPR22 and EN55024/CISPR24. To meet EC requirements, shielded cables must be used to connect a peripheral to the board. This product has been tested in a typical class B compliant host system. It is assumed that this product will also achieve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

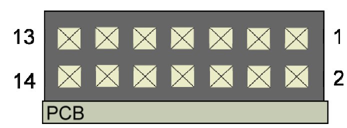
(***) The "+12V" pin is connected only when the "+12V supply assembly option" is selected

(****) 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.

3.2 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.

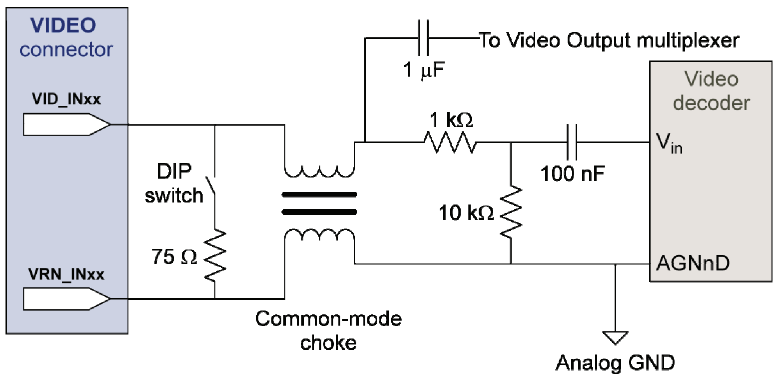
A switchable 75Ω termination resistor is inserted directly across **VID_INxx** and **VRN_INxx**. The termination resistor can be disconnected by a DIP switch.

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

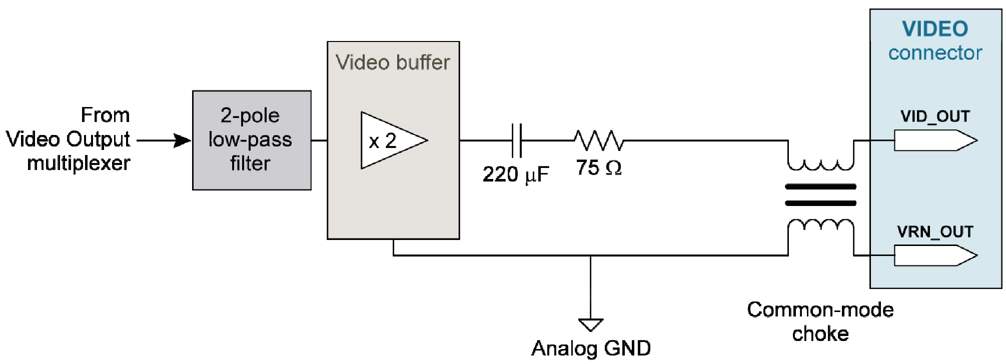
The **VIDEO** connector has one Video Output port.

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

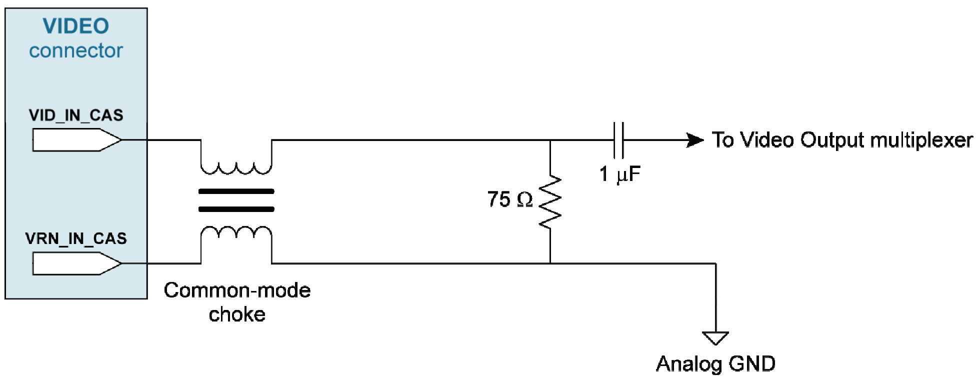
The **VIDEO** connector has one Cascade Video Input port.

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

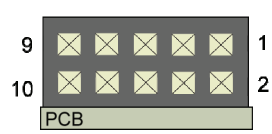
Cascade Video Input - DC characteristics

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

3.3 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

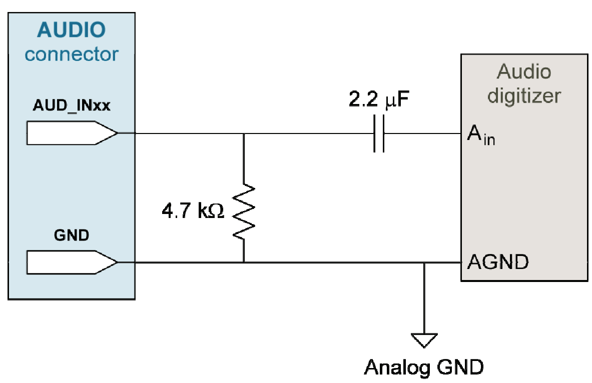
Pin #	Pin name	Function	Pin #	Pin name	Function
1	**GND**	Ground	**2**	**GND**	Ground
3	**AUD_IN_1**	Audio Input 1 - Signal	**4**	**GND**	Audio Input 1 Return
5	**AUD_IN_2**	Audio Input 2 - Signal	**6**	**GND**	Audio Input 2 Return
7	**AUD_IN_3**	Audio Input 3 - Signal	**8**	**GND**	Audio Input 3 Return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

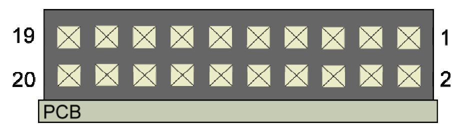
Audio signal characteristics

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

3.4 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

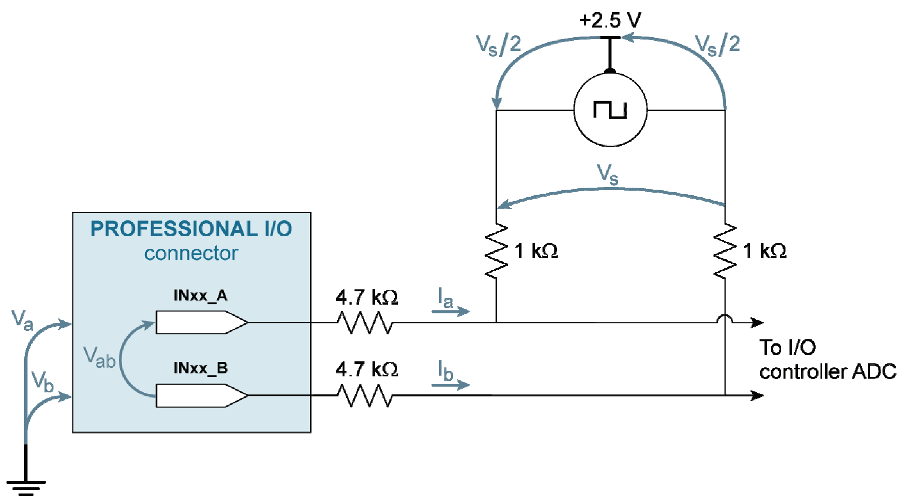
General Purpose Inputs IN1 to IN4 Electrical Specifications

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.

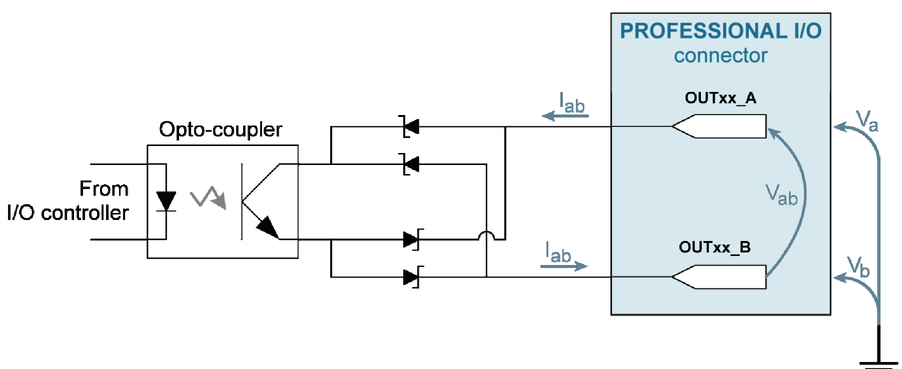
General Purpose Digital Outputs OUT1 to OUT4 Electrical Specifications

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	$\|Vab\|_{max}$			30	V
Maximum current	Contact closed	$\|Iab\|_{max}$			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		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

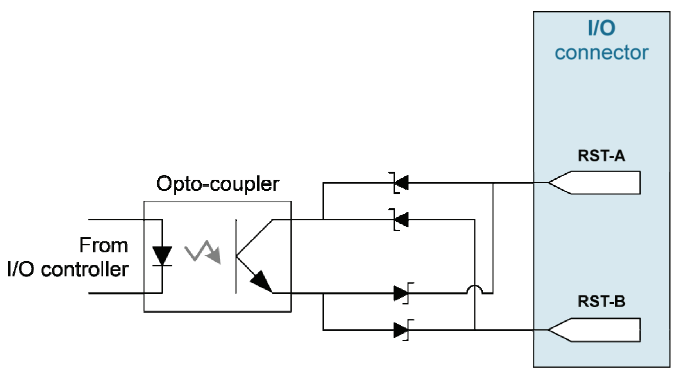
There is a single Watchdog Output on the **I/O** connector.

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.

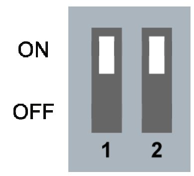
The Watchdog Output shares the same electrical specifications as the general purpose outputs.



Watchdog Output circuit

3.5 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

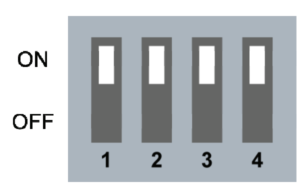
Switch 1 / Switch 2	Slot #	IDSEL	REQ#	GNT#	CLK	INT0#
ON / ON	1	IDSEL0	REQ0#	GNT0#	CLK0	INTA#
OFF / ON	2	IDSEL1	REQ1#	GNT1#	CLK1	INTB#
ON / OFF	3	IDSEL2	REQ2#	GNT2#	CLK2	INTC#
OFF / OFF	4	IDSEL3	REQ3#	GNT3#	CLK3	INTD#

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

3.6 VIDEO TERMINATORS Switch

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



4-position VIDEO TERMINATORS switch

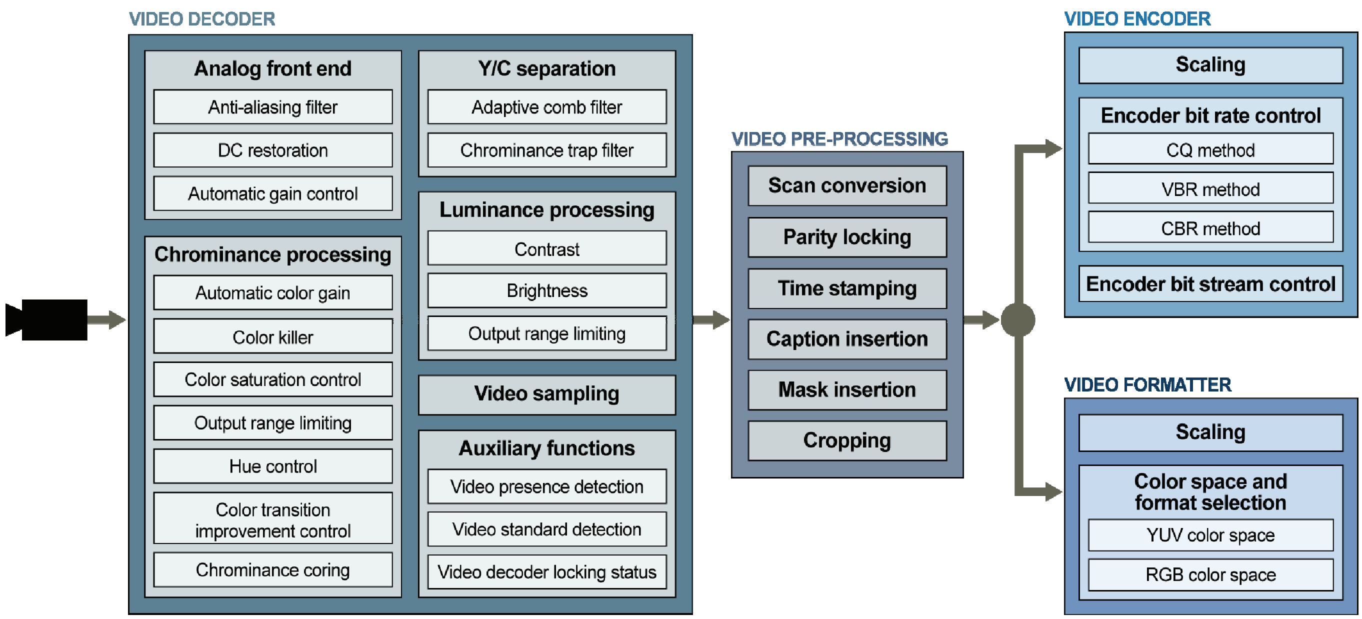
VIDEO TERMINATORS switch assignments

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.

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 Directshow 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:

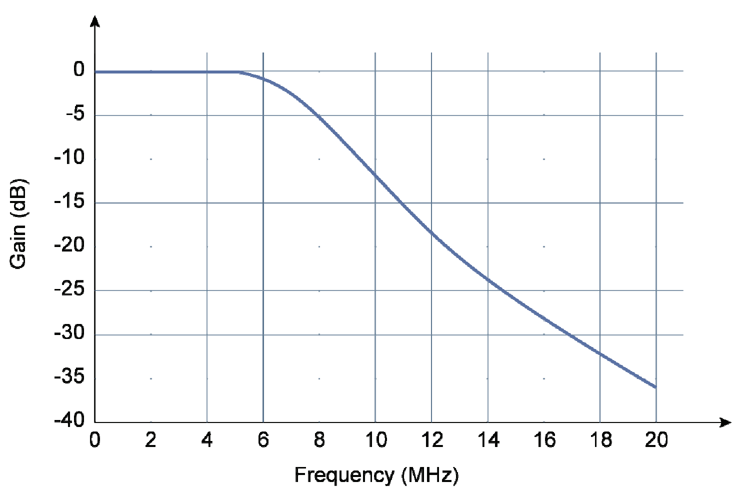
Standard	Video system	Color killer
PAL	PAL-B/D	Color is always alive
NTSC	NTSC-M	
CCIR	PAL-B/D	Color is always killed
EIA	NTSC-M	

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.

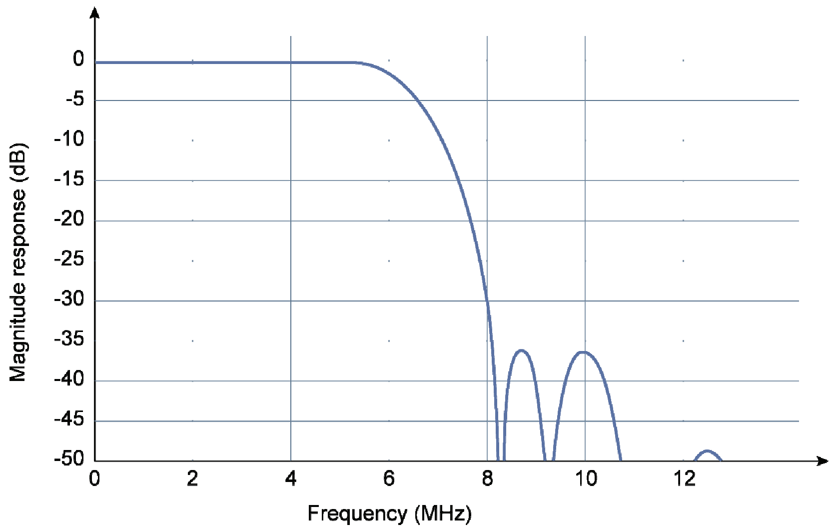


Frequency response of the anti-aliasing filter

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

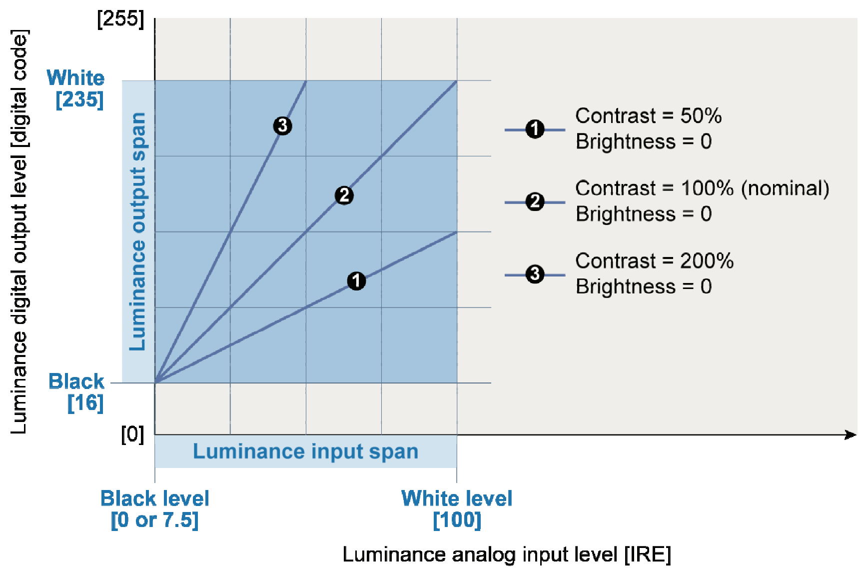
The following sections show the functional blocks used for luminance processing.

Contrast

You can adjust picture contrast by applying gain on luminance component through the Contrast property. 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.

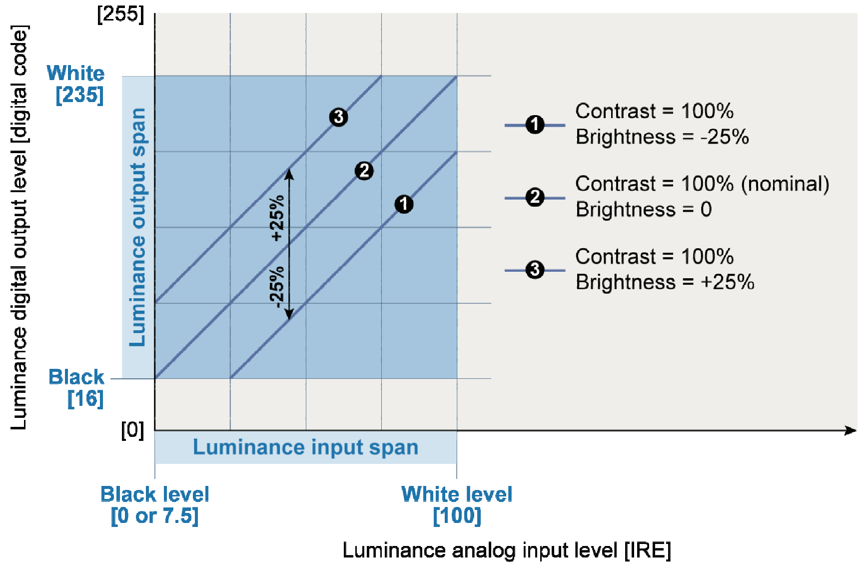


Contrast (luminance gain) control

Brightness

You can adjust picture brightness by applying offset on luminance component through the Brightness property. 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.

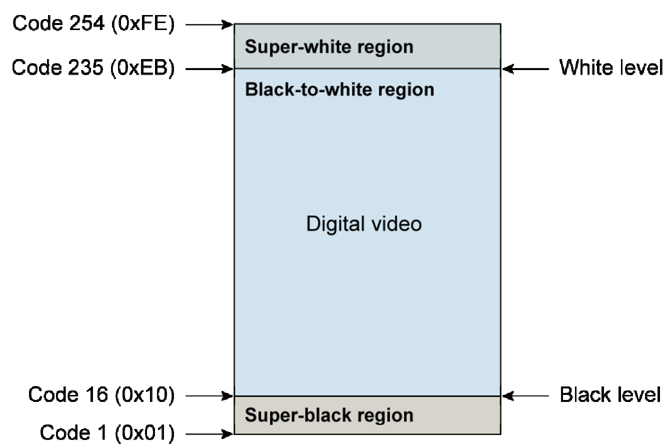
The following figure shows the luminance transfer function for three brightness settings and the nominal brightness setting.



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 Directshow API.

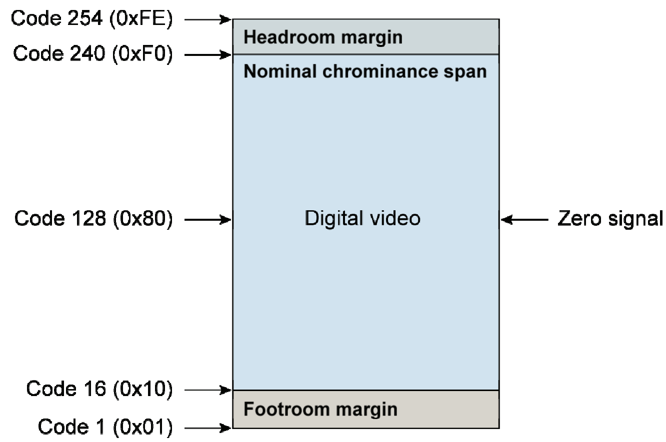
Color Saturation Control

You can adjust color saturation by applying gain on chrominance component through the Saturation property. 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.

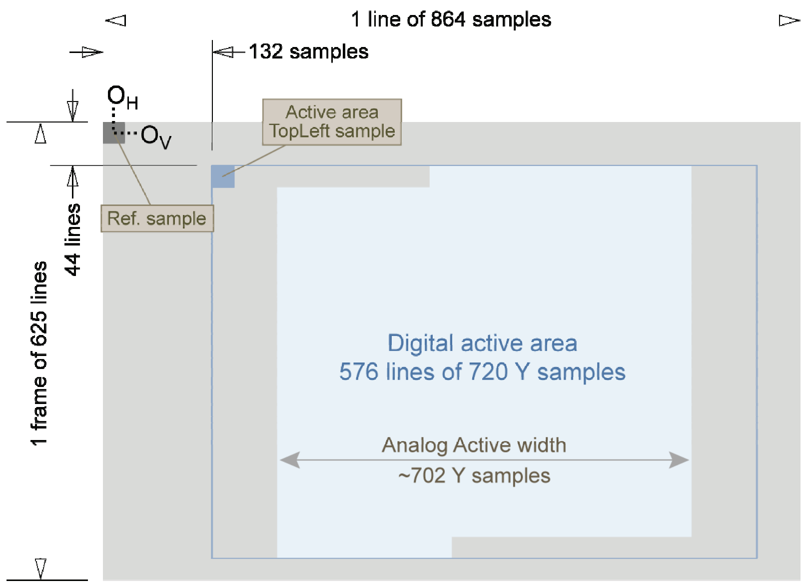
The sample aspect ratio is about 11/10 for 525-line system, and about 54/59 for 625-line system.

Digital Active Area

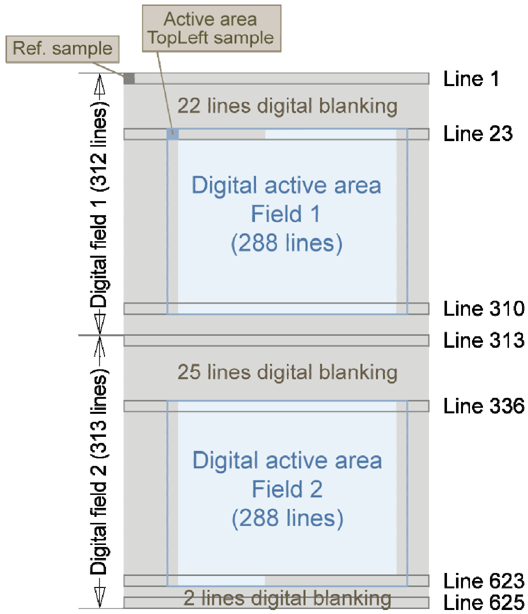
The digital active area is a rectangular area of digitally active samples. Its size and position depend on the actual television system of the video signal.

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)



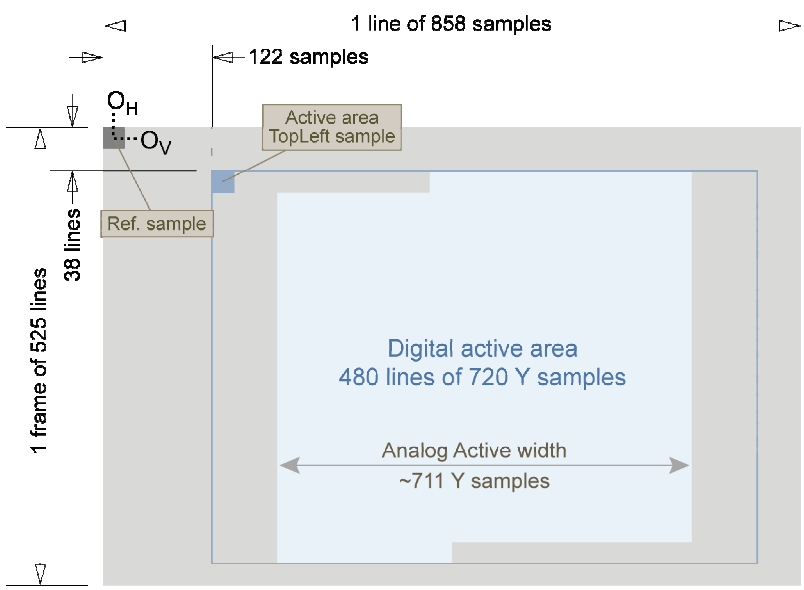
Digital active area definition — 625-line system
Two successive fields before scan conversion (temporal line ordering)

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

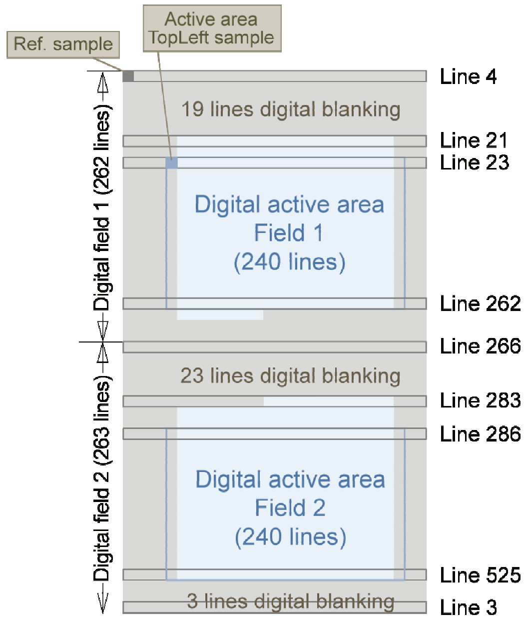
The analog active width is about 18 pixels narrower than the digital active width, leaving a blanked margin of 8~9 pixels on the left and right sides. The first and the last lines of the digital active area contain partial video lines.

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 Directshow API to report the video decoder locking status.

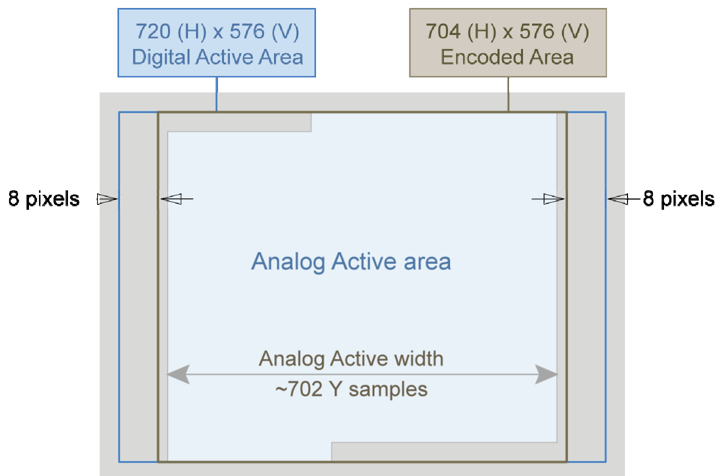
Video Standard Detection

You can use the Directshow API to report the detected standard.

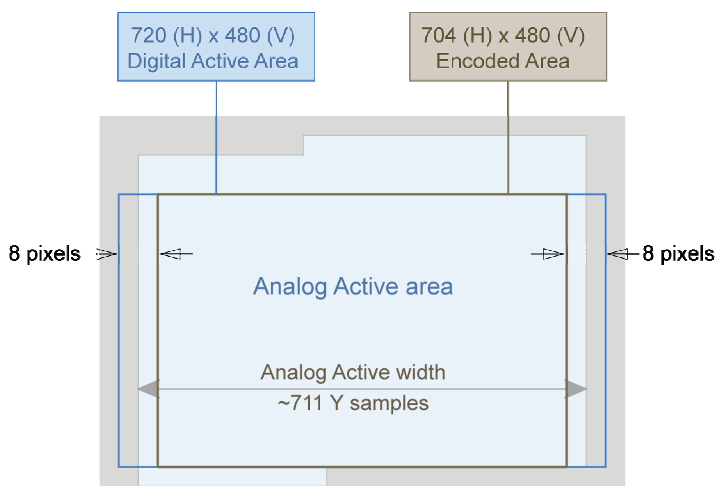
4.2 Video Pre-Processing

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 Masks property.

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 Caption property.

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.

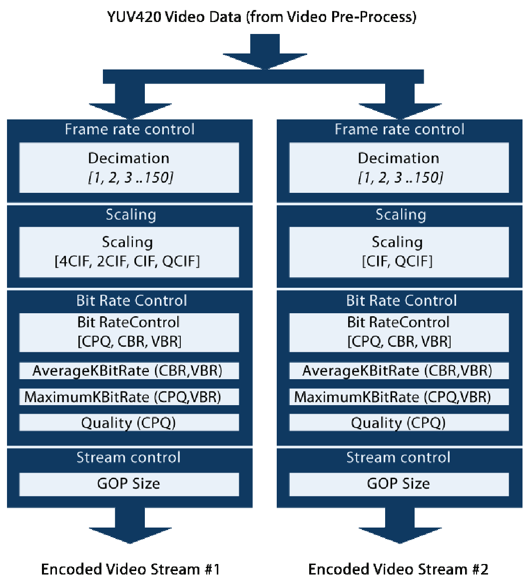
Time Stamping

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 property.

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

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 first 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 Directshow 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 property. 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 property and AverageKBitRateControl property.

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 property.

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

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 property. 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 property. 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 property.

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

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 Directshow 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 Directshow 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

Component	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 Format Description

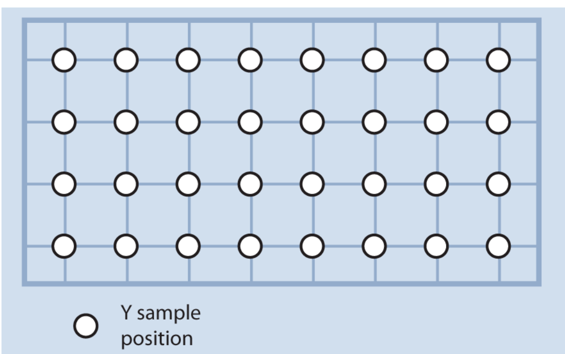
Y8

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

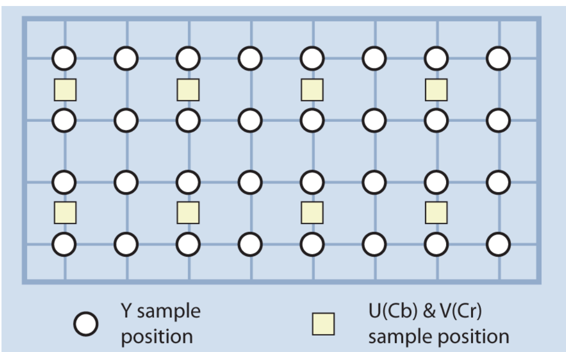
YUV420Planar

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



Note:

- The sampling patternof the YUV420format 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	-	-

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

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

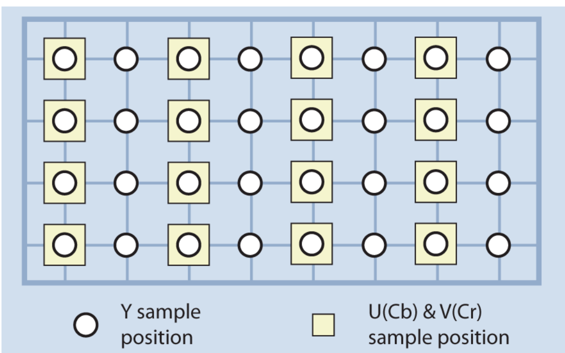
YUV422 Packed

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	-	-

Plane 0	Memory layout																															
Word 0	Pixel 0: V(Cr)								Pixel 1: Y								Pixel 0: U(Cb)								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

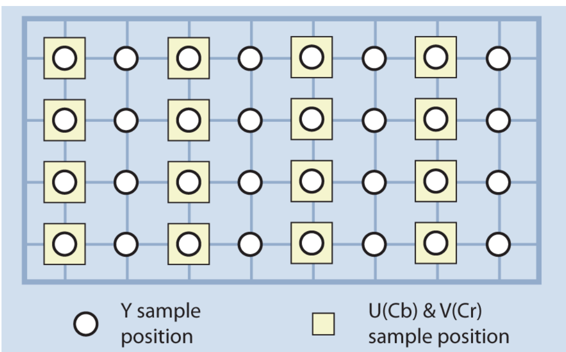
YUV422 Planar

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><td>Word 0</td><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><td>Byte #</td><td colspan="8">3</td><td colspan="8">2</td><td colspan="8">1</td><td colspan="8">0</td></tr>
<tr><td>Bit#</td><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><td>Word 0</td><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><td>Byte #</td><td colspan="8">3</td><td colspan="8">2</td><td colspan="8">1</td><td colspan="8">0</td></tr>
<tr><td>Bit#</td><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 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

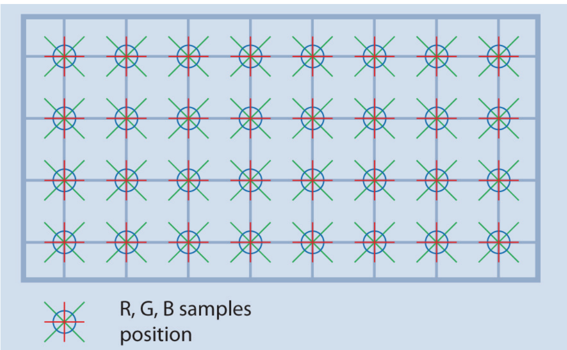
RGB24 Packed

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

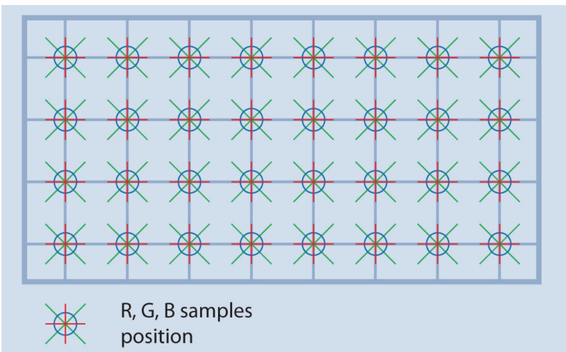
RGB32 Packed

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

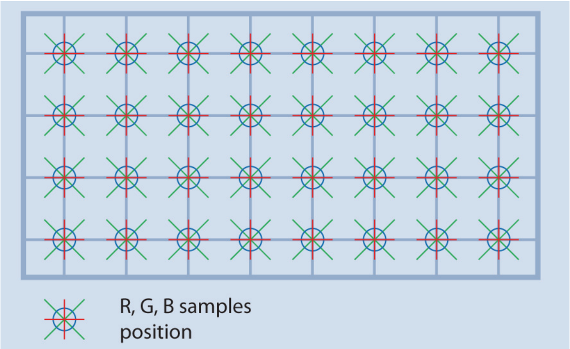
RGB15

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

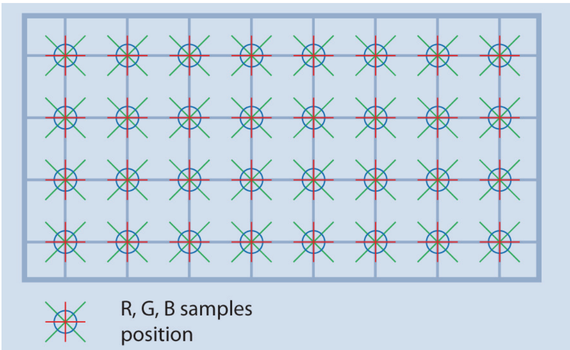
RGB16

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	-	-

Plane 0	Memory layout																															
Word 0	Pixel 1:R					Pixel 1:G						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

4.6 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.

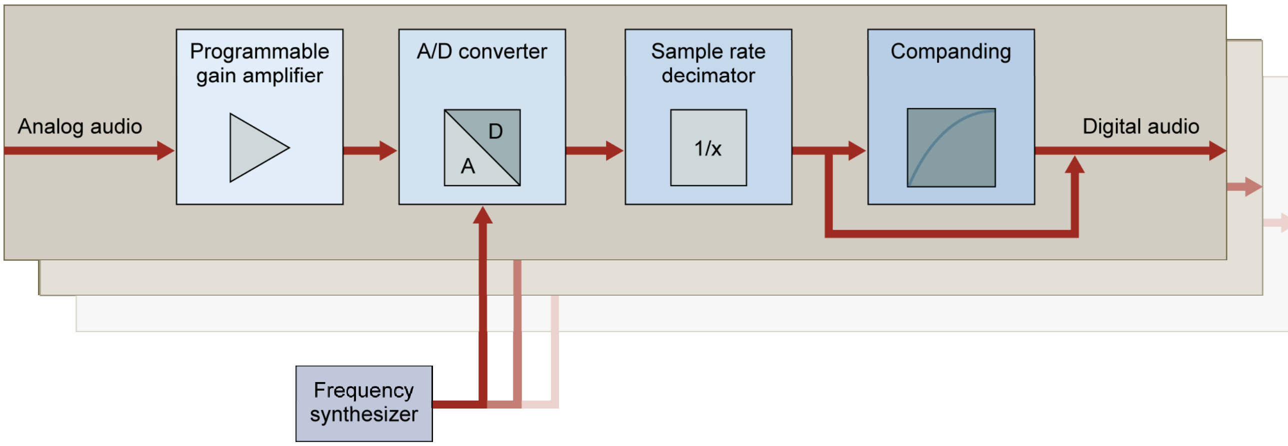
A frequency synthesizer generates the master audio clock signal from a stable oscillator. Two master audio clock frequencies are available:

- 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 Directshow 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 Directshow API.

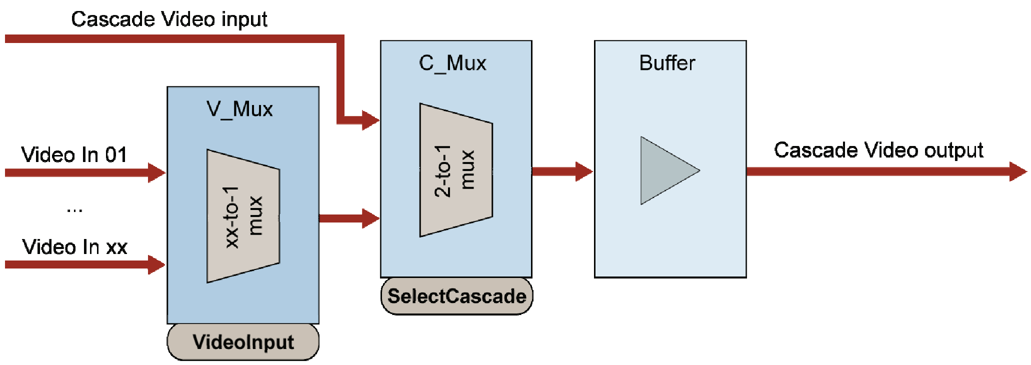
The gain range of the volume control is sufficiently large to accept both "professional" and "consumer" line-level audio signal; however, it is not sufficient to allow direct connection of microphones. Refer to Audio Inputs Electrical Specifications applicable to the audio inputs of Picolo U4 H.264 PCI-104.

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.

4.7 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 Directshow 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 Directshow 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 Directshow 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 Directshow 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 property.

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.

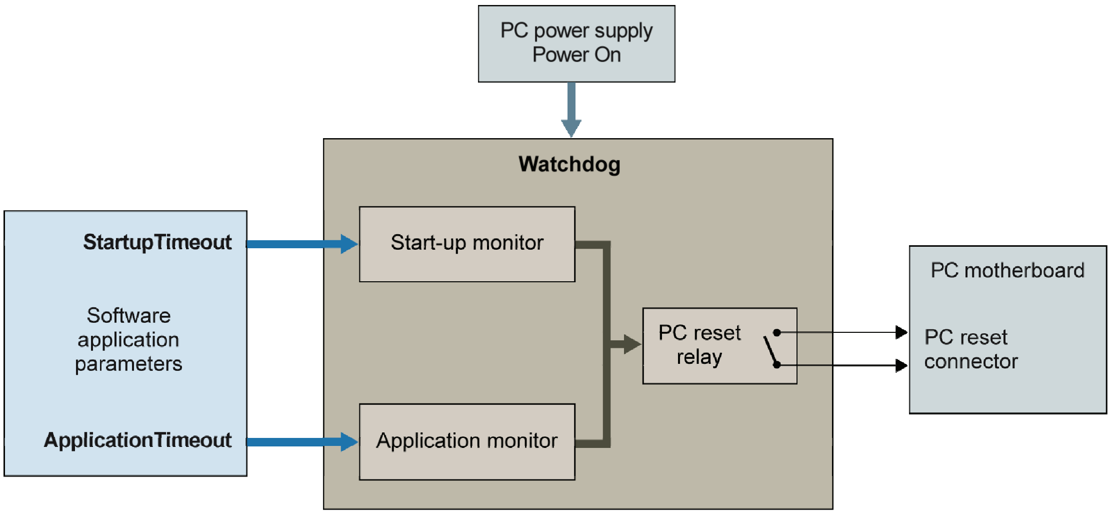
The watchdog consists of two main devices, called monitors:

- 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.



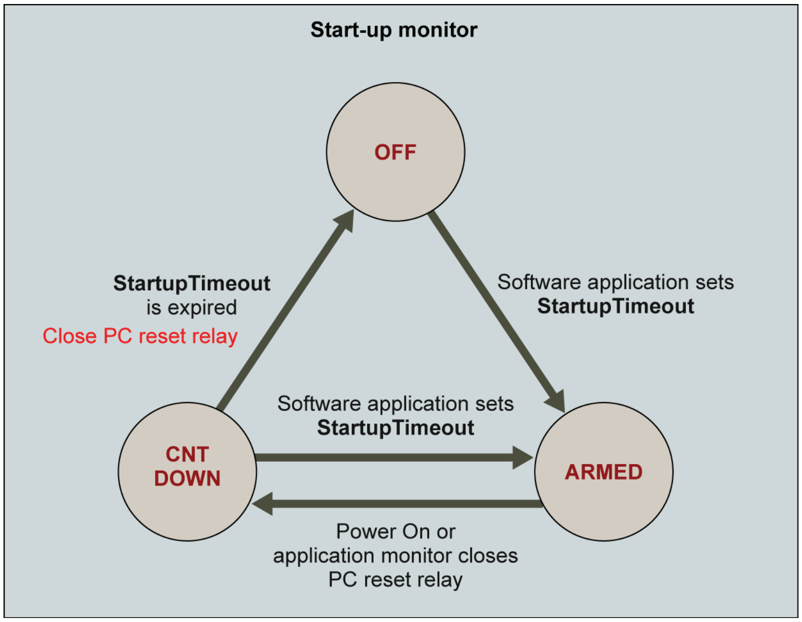
Watchdog block diagram

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** property.
- **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** property.
- 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** property, 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** property. 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

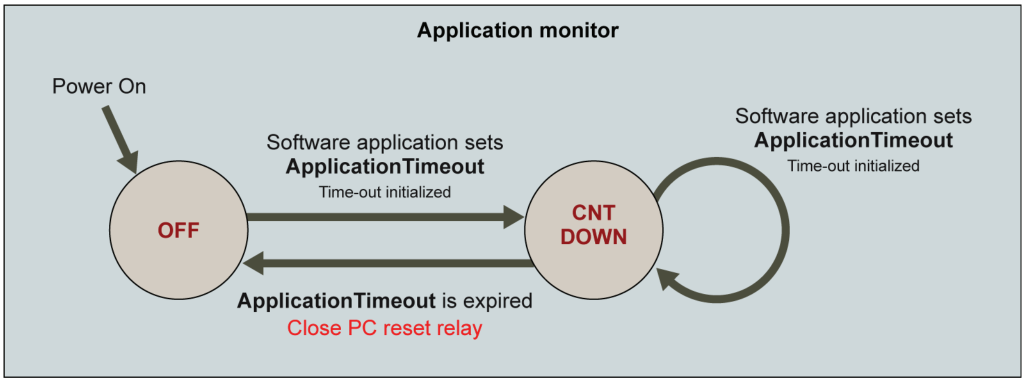
The start-up monitor goes in the **CNT DOWN** state, and begins to count the time that elapses. Two situations may occur in the **CNT DOWN** state:

- The application is working correctly, and sets the **StartupTimeout** property 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** property 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** property 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

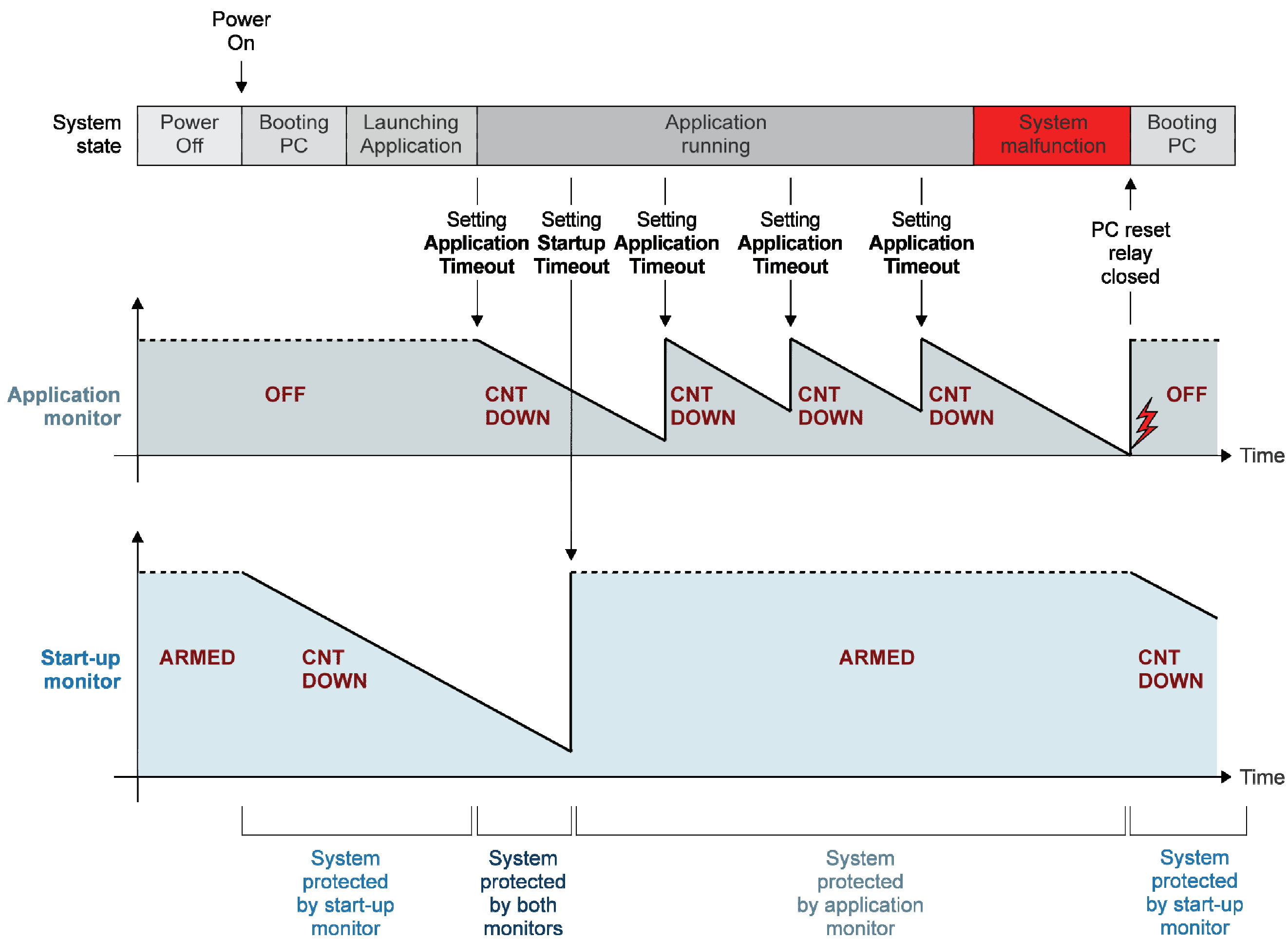
Once in the **CNT DOWN** state, the application monitor waits for a new setting of the **ApplicationTimeout** property. Two situations may occur in the **CNT DOWN** state:

- The software application is alive, and sets the **ApplicationTimeout** property 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** property setting during the time-out period.
- A malfunction occurs, and the application does not run the appropriate code which sets the **ApplicationTimeout** property. 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** property 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** property. 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** property.
4. The system is now in normal operation and the application periodically sets the **ApplicationTimeout** property 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** property before **StartupTimeout** property.

Watchdog Resets Logging

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

DirectShow Reference

This documentation focuses on the Euresys DirectShow filters. It does not replace Microsoft's DirectShow SDK documentation. A sound knowledge of DirectShow concepts is needed before starting.

1. Drivers Model

The device driver of Picolo U4 H.264 PCI-104 is an AVStream streaming mini driver providing several filters. The filters provided by the driver are accessible in DirectShow through **KsProxy**. This makes all boards functionalities accessible in DirectShow.

The kernel streaming filter exposes its configuration API through the **property set** mechanism. There are several **standard** property sets, as well as **custom** property sets.

In DirectShow, the property sets become COM interfaces. Standard property sets are supported by standard COM interfaces and standard property pages (dialog boxes). Custom property sets are supported through custom COM interfaces and custom property pages.

2. PICOLO U4 H.264 PCI-104 Configuration

2.1 Immediate and Cached Settings

The settings of Picolo U4 H.264 PCI-104 are controlled through properties of interfaces belonging to the Picolo U4 H.264 PCI-104 filters. Two types of settings are considered regarding the timing of application.

In case of **immediate** settings:

- Any change of the corresponding property is immediately applied. The value is stored in non-volatile memory, and restored automatically after power-on reset.
- Reading the property value reports the current state of the setting.

In case of **cached** settings:

- Any change of the corresponding property is cached, it becomes effective the next time the Filter graph leaves the **STOP** state.
- Reading the property value reports the cached value, and **NOT** the actual state of the setting.

Cached settings affect deeply the hardware and/or driver configuration. A reconfiguration of the hardware and driver is required when one or several cached setting has changed.

2.2 Filter Graph

Filter Graph is the central component in DirectShow. Applications use it to build and control filter graphs. Filter Graph also handles synchronization, event notification, and other aspects of managing the filter graph.

There are **3 Filter Graph states**:

- **STOP**. No media data is streaming, and the Picolo U4 H.264 PCI-104 filters are idling.
- **PAUSE**. The Picolo U4 H.264 PCI-104 source filters are streaming data.
- **RUN**. The Picolo U4 H.264 PCI-104 source filters are streaming data.

When the Filter Graph state changes from **RUN** or **PAUSE** towards **STOP**, data streaming is stopped in all Picolo U4 H.264 PCI-104 filters present in the graph.

When the Filter Graph state changes from **STOP** towards **PAUSE** or **RUN**, the delivery of records is started in all Picolo U4 H.264 PCI-104 filters present in the graph.

Filter Property Pages

There is a property sheet for every programmatic interface.

2.3 Graph Reference Clock

Picolo U4 H.264 PCI-104 attaches a time stamp on each Media Sample. The time stamps of all audio and video streams delivered by a Picolo U4 H.264 PCI-104 board are obtained from a local time base, clocked by a stable X-Tal controlled oscillator. The time is expressed in 100 ns unit, and conforms to the DirectShow requirements.

According to the user setting or to the DirectShow decision rules, the graph reference clock can be provided by various time bases, different from the Picolo U4 H.264 PCI-104 local time base (for example, the system clock or an audio renderer clock).

Note. Despite the accuracy of the time bases, the time bases are desynchronizing progressively (long-term drifting), and significant differences in the time measurements can appear when running the graph over a long period.

Picolo U4 H.264 PCI-104 automatically compensates the long-term drift of the time bases. Therefore, it measures the differences that can exist between the graph reference clock and the local clock used to perform time stamp, and maintains this difference below 100 ms by smoothly adjusting the local time base on the graph reference clock. This compensation is performed independently for each pin.

This long-term drift compensation is designed to operate correctly if the accuracy of the graph reference clock is within +/-1%.

2.4 Batch Installation

The following procedures shows how to automate the installation of the driver on several target machines by using command line.

1. Install driver on one machine using the supplied installation tool. Run the installer tool and follow on-screen instructions.
2. From the installation directory, navigate to the following files and directories: **/setup** directory, **/driversDS** directory, **install.bat** file and **uninstall.bat** file. Use these files to make your own package.
3. Copy your own package on the target machine in a directory of your choice.
4. On the target machines, run install.bat for the installation of the driver. Un-install the driver by using install.bat.

3. DirectShow Filters

The DirectShow® Interface of the DirectShow® drivers exposes all functionalities of the boards through a collection of DirectShow® Filters.

The transport and delivery of media data are performed via DirectShow standard means such as Pin Interface, Media Sample Interface, etc.

The configuration settings and the control of Picolo U4 H.264 PCI-104 features are done through a set of both standard and custom COM interfaces and property pages.

3.1 Filters Instantiation

The number of operable filters is limited by Picolo U4 H.264 PCI-104 hardware resources. The filter creation fails and reports and error when the operable instances count is exceeded.

Operable instances count for each filter

Filter	Maximum operable instances count
Visual Source	One per graph per Video Input, maximum two per video input(*)(**)
Audio Encoder	One per Audio Input
Input Line	One per Professional Input
Output Line	One per Professional Output
Watchdog	One per board
Pass-Through Selector	One per board
Board	N/A(***)

(*) A graph may contain only one instance of visual source filter per video input.

(**) Two instances of visual source filter for the same video Input can be created in separate graphs providing that the encoded pin and formatted pin are connected only once.

(***) The maximum number of board filter instances is solely limited by system resources.

3.2 Visual Source Filter

Encoded Pins

The **Encoded** output pin streams data in H.264 format. It exhibits **MEDIATYPE_Video** and following **Media_SubTypes**:

- **FourCC H264**

- **FourCC h264**
- **FourCC AVC1**
- **FourCC avc1**

Choosing any of the H.264 variants enables connection with various third-party filters supporting H.264, and does not affect the encoder settings.

The Encoded pin has one custom interface, IU4H264PCI104VisualEncoder, and has also a custom property page.

Standard Pin Interfaces

- IAMBufferNegotiation
- IAMStreamConfig
  - Scaling
  - Format
- IAMStreamControl
- IksPin
- IKsPropertySet
- IMediaSeeking
- IPin
- IQualityControl
- ISpecifyPropertyPages

Notes

- Method **IMediasample::IsSyncPoint** returns true on frame that contains IDR NAL unit, false otherwise.
- The SPS, PPS, and IDR NAL units are merged into the one single media sample.
- 4CIF and the 2CIF resolutions are not allowed on the second encoded stream

Formatted Pins

The **Formatted** output pin streams data in several uncompressed video formats. It exhibits **MEDIATYPE_Video** and following **Media_SubTypes**:

MEDIASUBTYPE	FourCC	Euresys format name	Description	Ranking (**)
MEDIASUBTYPE_I420	I420	YUV420PL	YUV 4:2:0 video stored in planar format, with the following plane order: Y,U, and V.	1
MEDIASUBTYPE_YV12	YV12	YUV420PL	YUV 4:2:0 video stored in planar format, with the following plane order: Y,U, and V. YV12 is identical to I420 except that the U and V planes are swapped.	2
MEDIASUBTYPE_RGB32	N/A	RGB32	ARGB video in 8-8-8-8 Packed format	(***)
MEDIASUBTYPE_RGB24	N/A	RGB24	RGB video in 8-8-8 Packed format	(***)
MEDIASUBTYPE_RGB565	N/A	RGB16	RGB video in 5-6-5 Packed format	(***)
MEDIASUBTYPE_RGB555	N/A	RGB15	RGB video in 5-5-5 Packed format	(***)
MEDIASUBTYPE_RGB8 (*)	Y800	Y8	8-bit monochrome video.	3
MEDIASUBTYPE_YUY2	YUY2	YUY422	YUV 4:2.2 video stored in Packed format	(***)

(*) MEDIASUBTYPE_RGB8 operates from the Color Space Converter delivered by Microsoft.

(**) It is recommended to select a format with the lowest ranking value.

(***) The RGB video formats are not recommended on Picolo Ux Series

The media type is negotiated by the pins at connection time. Setting the format through the custom pin interfaces restricts the possible formats to the selected one. The Formatted pin has one custom interface, IU4H264PCI104VisualEncoder, and has also a custom property page.

Standard Pin Interfaces

- IAMBufferNegotiation
- IAMStreamConfig
    - Scaling
    - Format
- IAMStreamControl
- IKsPin
- IKsPropertySet
- IMediaSeeking
- IPin
- IQualityControl
- ISpecifyPropertyPages

Standard Interfaces (Visual Source Filter)

KsProxy standard interfaces

Interface	Description
IAMFilterMiscFlags	Queries whether a filter is a source filter or a renderer.
IBaseFilter	Is the primary interface for all DirectShow filters.
IKsPropertySet	Sets properties on a kernel-mode filter.
IMediaFilter	Controls the streaming state of a filter
IPersist, IPersistStream	Saves and loads objects that use a simple serial stream for their storage needs.
ISpecifyPropertyPages	Indicates that an object supports property pages.

Other standard interfaces

Interface	Description	Notes
IAMAnalogVideoDecoder	Controls video digitization on a WDM video capture card.	The **put_TVFormat** method sets the analog video format.. Accepts following standards in the **AnalogVideoStandard** enumeration: **NTSC_M**, **PAL_B**, **PAL_D**, **PAL_H**, **PAL_I**. These methods are not supported: **get_HorizontalLocked** **get_VCRHorizontalLocking** **get_OutputEnable** **put_VCRHorizontalLocking** **put_OutputEnable**
IAMVideoProcAmp	Adjusts the qualities of a video signal, such as brightness, contrast, and saturation.	Also available in **IU4H264PCI104VisualSource** interface. Both interfaces need to be maintained in sync.
IAMVideoCompression	Sets and retrieves video compression properties.	
ICodecAPI	Configures an encoder or decoder.	

IU4H264PCI104VisualSource Custom Interface

Property	Description	Type, access	Value range	Related topics
BoardIndex	Board index in the system, from 0 on.	Integer, Get Only	**[0..]**	Board Filter
Camera	Camera attached to the input pin. (*)	Integer, Set(Get)	**0...3**	VIDEO/VIDEO IN Connectors
DetectedStandard	Detected standard of the video signal.	Enum, Get Only	**PAL** **NTSC** **CCIR** **EIA**	Auxiliary Functions
SignalDetected	Video signal detection state.	Bool, Get Only		Auxiliary Functions
Contrast	Luminance gain (%). Default: **100**. (**)(***)	Int, Set(Get)	**[0..200]**	Luminance Processing
Brightness	Luminance offset (%). Unit is one gray level. Default: **0**. (**)(***)	Int, Set(Get)	**[-100..100]**	Luminance Processing
Saturation	Color saturation (%). Default: **100**. (**)(***)	Int, Set(Get)	**[0..200]**	Chrominance Processing
Caption	Caption settings in the encoded stream. (**) The caption text is inserted simultaneously on formatted and compressed streams. See details in the Caption property table below.			Caption Insertion
Masks	Masks collection in the encoded stream. (**) The privacy mask is inserted simultaneously on formatted and compressed streams. See details in the Masks property table below.			Mask Insertion
NumberOfInputs	Reports the maximum number of visual sources per board	Integer, Get Only	**4**	
NumberOfCaptions	Reports the maximum number of captions per visual source	Integer, Get Only	**5**	

(*) Cached setting.

(**) Immediate setting that can be changed at any time.

(***) Contrast, Brightness, and Saturation and also available through the IAMVideoProAmp standard interface.

Caption property

Property	Description	Type, access	Value range
Caption.Data	Index of the caption line.	Enum, Set Only	**[CAPTION_INDEX_0, .CAPTION_INDEX_1, CAPTION_INDEX_2, CAPTION_INDEX_3, CAPTION_INDEX_4]**
Caption.StringBuffer	Caption text. An empty string inhibits the caption insertion.	Enum, Set(Get)	**<string of up to 47 7-bit ASCII characters>**
Caption.PositionType	Selects the type of the position definition.	Enum, Set(Get)	**[CAPTION_POSITION_TOP_LEFT = 0, CAPTION_POSITION_BOTTOM_LEFT, CAPTION_POSITION_TOP_RIGHT, CAPTION_POSITION_BOTTOM_RIGHT, CAPTION_POSITION_CUSTOM]**
Caption.X	X-coordinate of the upper-left corner pixel of the leftmost character. (The coordinate [0, 0] is the upper left corner of the full image.) Relevant only when **PositionType=Custom**.	Integer, Set(Get)	**[0..703]**
Caption.Y	Y-coordinate of the upper-left corner pixel of the leftmost character. (The coordinate [0, 0] is the upper left corner of the full image.) Relevant only when **PositionType=Custom**.	Integer, Set(Get)	**[0..575]**

The above properties are Immediate setting that can be changed at any time.

Notes:

- Each line of caption text is independently configurable
- Caption text is inserted simultaneously on formatted and compressed stream
- Coordinates are expressed in pixel units of the full-res image,coordinates origin is the top-left corner of the image
- Properties X and Y are relevant only with custom position type

Masks property

Property	Description	Type, access	Value range
Masks.Data	Index of the mask region. Four privacy regions are independently configurable.	Enum, Set Only	**[0..3]**
Masks.X	X-coordinate of the upper-left corner of the rectangular masked region. (The coordinate [0, 0] is the upper left corner of the full image.) (*)	Integer, Set(Get)	**[0..703]**
Masks.Y	Y-coordinate of the upper-left corner of the rectangular masked region. (The coordinate [0, 0] is the upper left corner of the full image.) (*)	Integer, Set(Get)	**[0..575]**
Masks.Width	Width of the rectangular masked region. A width of 0 inhibits the mask insertion. (*)	Integer, Set(Get)	**[0..704]**
Masks.Height	Height of the rectangular masked region. A height of 0 inhibits the mask insertion. (*)	Integer, Set(Get)	**[0..576]**

The above properties are Immediate setting that can be changed at any time.

(*) The mask area is automatically modified to the smallest enclosing region which fits the 16x16 macroblocks border.

Event	Description	Related topics
KSEVENT_VisualSource_SignalDetect	Informs on video signal status change.	Auxiliary Functions

Code Snippets

Refer to Naming Conventions before setting up your code.

Camera Index Property

```
//////////////////////////////////////////////////////////
// Set the camera index property                       //
// cameraIndex holds value to be written               //
// pFilter is a pointer to the U4 H.264 PCI104 Filter   //
//////////////////////////////////////////////////////////

// Declaration
IU4H264PCI104VisualSource *pVS;
PICOLO_PROPERTY Control;

// Get the VisualSource interface
pFilter->QueryInterface( CLSID_IU4H264PCI104VisualSource, (void **)&pVS );

// Fill control structure
Control.Property.Id = KSPROPERTY_VisualSource_Camera;
Control.PropertySetting.Data = cameraIndex;
```

```
// Set the camera property according the to control structure value
pVS->Set(&Control);

// Release interface
pVS->Release();
```

Caption Property

```
/////////////////////////////////////////////////////////////////////
// Setting the Caption property                                    //
// captionIndex holds the Caption index                            //
// captionPosition holds the Caption position(if used)             //
// captionX holds the x position where the text should be displayed //
// captionY holds the y position where the text should be displayed //
// captionText holds the text to be displayed                      //
// pFilter is a pointer to the U4 H.264 PCI104 Filter              //
/////////////////////////////////////////////////////////////////////

// Declaration
IU4H264PCI104VisualSource *pVS;

PICOLO_PROPERTY Control;

// Get the VisualSource interface
pFilter->QueryInterface( CLSID_IU4H264PCI104VisualSource, (void **)&pVS );

// Fill control structure
Control.Property.Id = KSPROPERTY_VisualSource_Caption;
Control.PropertySetting.Data = captionIndex;
Control.PropertySetting.PositionType = captionPosition;
Control.PropertySetting.X = captionX;
Control.PropertySetting.Y = captionY;

// Hardware does not accept unicode strings.
StringCbCopyA( Control.PropertySetting.StringBuffer, sizeof(
Control.PropertySetting.StringBuffer ), captionText );

// Set the caption property according to the control structure values
pVS->Set(&Control);

// Release interface
pVS->Release();

Masks Property
```

```
/////////////////////////////////////////////////////////////////
// Setting the Mask property                                   //
// maskIndex holds the Mask index                              //
// maskX holds the x position top left corner of the mask      //
// maskY holds the y position top left corner of the mask      //
// maskWidth holds width of the mask                           //
// maskHeight holds height of the mask                         //
// pFilter is a pointer to the U4 H.264 PCI104 Filter          //
/////////////////////////////////////////////////////////////////

// Declaration
IU4H264PCI104VisualSource *pVS;
PICOLO_PROPERTY Control;

// Get the VisualSource interface
pFilter->QueryInterface( CLSID_IU4H264PCI104VisualSource, (void **)&pVS );

// Fill control structure
Control.Property.Id = KSPROPERTY_VisualSource_Mask;
Control.PropertySetting.Data = maskIndex;
Control.PropertySetting.X = maskX;
Control.PropertySetting.Y = maskY;
Control.PropertySetting.Width = maskWidth;
Control.PropertySetting.Height = maskHeight;

// Set the mask property according to the control structure values
pVS->Set(&Control);

// Release interface
pVS->Release();
```

IU4H264PCI104VisualEncoder Custom Interface

Refer to Naming Conventions before setting up your code.

Property	Description	Type, access	Value range	Related topics
Decimation	Frame rate decimation process in the encoded stream. Default: **1**. (**)	Int, Set(Get)	**[1..150]**	Frame Rate Control (Video Encoder)
BitRateControl	Bit rate control method of the encoder. Default: **CPQ**. (*)	Enum, Set(Get)	**CPQ** **CBR** **VBR**	Encoder Bit Rate Control
Quality	Quality level of the picture. Default: **30**. (*)	Int, Set(Get)	**[1..100]**	Encoder Bit Rate Control
AverageKBitRate	Average bit rate of the encoder. Default: **2000**. (*)	Int, Set(Get)	**[0..4000]**	Encoder Bit Rate Control
MaximumKBitRate	Maximum bit rate of the encoder. Default: **4000**. (*)	Int, Set(Get)	**[0..4000]**	Encoder Bit Rate Control
GOPSize	Number of frames per group. Default: **30**. No specified upper limit. (*)	Int, Set(Get)	**[1..30..128]**	Encoder Bit Stream Controls

(*) Cached setting.

(**) Immediate setting that can be changed at any time.

IU4H264PCI104VisualFormatter Custom Interface

Refer to Naming Conventions before setting up your code.

Property	Description	Type, access	Value range	Related topics
Decimation	Frame rate decimation process of the formatted stream. Default: **1**. (*)	Int, Set(Get)	**[1..150]**	Frame Rate Control (Video Formatter)
FlipVertical	Controls the top/down image flippinf. Default: **OFF**.	Enum, Set(Get)	**[OFF,ON]**	

(*) Immediate setting that can be changed at any time.

3.3 Audio Source Filter

Encoded Pins (Audio Encoder)

The **Encoded** output pin streams audio data in PCM. It exhibits **MEDIATYPE_Audio**.

Standard Pin Interfaces

- IAMBufferNegotiation
- IAMStreamConfig
    - Available media subtypes are:
        - **MEDIASUBTYPE_ALAW**
        - **MEDIASUBTYPE_muLAW**
        - **MEDIASUBTYPE_pcm**
- IAMStreamControl
- IKsPin
- IKsPropertySet
- IMediaSeeking
- IPin
- IQualityControl
- ISpecifyPropertyPages

The audio sampling rate is configured through IAMStreamConfig interface

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 8-bit A-law 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.

Standard Interfaces (Audio Source Filter)

KsProxy standard interfaces

Interface	Description
IAMFilterMiscFlags	Queries whether a filter is a source filter or a renderer.
IBaseFilter	Is the primary interface for all DirectShow filters.
IKsPropertySet	Sets properties on a kernel-mode filter.
IMediaFilter	Controls the streaming state of a filter
IPersist, IPersistStream	Saves and loads objects that use a simple serial stream for their storage needs.
ISpecifyPropertyPages	Indicates that an object supports property pages.

Other standard interfaces

Interface	Description	Notes
IBasicAudio	Set audio output volumes	Balance control is not applicable. Volume control is also available through the customer filter property **Volume**.

IU4H264PCI104AudioSource Custom Interface

Refer to Naming Conventions before setting up your code.

Property	Description	Type, access	Value range	Related topics
BoardIndex	Board index in the system, from 0 on.	Integer, Get Only	**[0..]**	Board Filter
Input	Audio input sourcing the audio encoder. Default: **1**.(*)	Integer, Set(Get)	**[0...3]**	AUDIO Connector
Volume	Volume (%). Default: **100**. (**)	Int, Set(Get)	**[25..275]**	Audio Digitizer and Encoder
NumberOfInputs	Reports the maximum number of audio sources per board	Data: Integer, Get Only	**[4]**	

(*) Cached setting.

(**) Immediate setting that can be changed at any time.

3.4 Input Line Filter

Standard Interfaces (Input Line Filter)

KsProxy standard interfaces

Interface	Description
IAMFilterMiscFlags	Queries whether a filter is a source filter or a renderer.
IBaseFilter	Is the primary interface for all DirectShow filters.
IKsPropertySet	Sets properties on a kernel-mode filter.
IMediaFilter	Controls the streaming state of a filter
IPersist, IPersistStream	Saves and loads objects that use a simple serial stream for their storage needs.
ISpecifyPropertyPages	Indicates that an object supports property pages.

IU4H264PCI104InputLine Custom Interface

Refer to Naming Conventions before setting up your code.

Property	Description	Type, access	Value range	Related topics
BoardIndex	Board index in the system, from 0 on.	Integer, Get Only	**[0..]**	Board Filter
Input	Input line sourcing the input controller. Default: **1**. (*)	Integer, Set(Get)	**[0...3]**	General Purpose Inputs
State	State of the input line.	Enum, Get Only	**Low** **High** **Disconnected**	General Purpose Inputs
InputFilter	Time constant of the debouncing filter. Default: **_100ms**. (**)	Enum, Set(Get)	**Off** **_10ms** **_100ms**	General Purpose Inputs
InputStyle	Electrical style of the input line. Default: **TTL**.	Enum, Set(Get)	**TTL** **CMOS** **_12V**	General Purpose Inputs
NumberOfInputs	Reports the maximum number of input lines per board	Data: Integer, Get Only	**[4]**	

(*) Cached setting.

(**) Immediate setting that can be changed at any time.

Event	Description
KSEVENT_InputLine_GoLow	Informs on line state going **Low**.
KSEVENT_InputLine_GoHigh	Informs on line state going **High**.
KSEVENT_InputLine_GoDisconnected	Informs on line state going **Disconnected**.

3.5 Output Line Filter

Standard Interfaces (Output Line Filter)

KsProxy standard interfaces

Interface	Description
IAMFilterMiscFlags	Queries whether a filter is a source filter or a renderer.
IBaseFilter	Is the primary interface for all DirectShow filters.
IKsPropertySet	Sets properties on a kernel-mode filter.
IMediaFilter	Controls the streaming state of a filter
IPersist, IPersistStream	Saves and loads objects that use a simple serial stream for their storage needs.
ISpecifyPropertyPages	Indicates that an object supports property pages.

IU4H264PCI104OutputLine Custom Interface

Refer to Naming Conventions before setting up your code.

Property	Description	Type, access	Value range	Related topics
BoardIndex	Board index in the system, from 0 on.	Integer, Get Only	**[0..]**	Board Filter
Output	Output line driven by the output controller. Default: **1**. (*)	Integer, Set(Get)	**[0...3]**	PROFESSIONAL I/O connectors
State	Output state. Default: **Open**. (*)	Enum, Set(Get)	**Closed** **Open**	General Purpose Outputs
NumberOfOutputs	Reports the maximum number of output lines per board	Data: Integer, Get Only	**[4]**	

(*) Immediate setting that can be changed at any time.

3.6 Watchdog Filter

Standard Interfaces (Watchdog Filter)

KsProxy standard interfaces

Interface	Description
IAMFilterMiscFlags	Queries whether a filter is a source filter or a renderer.
IBaseFilter	Is the primary interface for all DirectShow filters.
IKsPropertySet	Sets properties on a kernel-mode filter.
IMediaFilter	Controls the streaming state of a filter
IPersist, IPersistStream	Saves and loads objects that use a simple serial stream for their storage needs.
ISpecifyPropertyPages	Indicates that an object supports property pages.

IU4H264PCI104Watchdog Custom Interface

Refer to Naming Conventions before setting up your code.

The watchdog interface properties comply with the standard Euresys watchdog API. This interface controls only the watchdog for a single board.

Property	Description	Type, access	Value range	Related topics
BoardIndex	Board index in the system, from 0 on.	Integer, Get Only	**[0..]**	Board Filter
StartupTimeout	Start-up time-out duration (seconds). (*)	Int, Set(Get)	**[1..65535]**	Watchdog
ApplicationTimeout	Application time-out (seconds). (*)	Int, Set(Get)	**[1..65535]**	
ResetCount	Number of watchdog-initiated resets. (*)	Int, Get(Set)	**[0..65535]**	

(*) Immediate setting that can be changed at any time, it's value is stored in Non-volatile memory and restored automatically after power-on reset.

3.7 Pass-Through Selector Filter

Standard Interfaces (Pass-Through Selector Filter)

KsProxy standard interfaces

Interface	Description
IAMFilterMiscFlags	Queries whether a filter is a source filter or a renderer.
IBaseFilter	Is the primary interface for all DirectShow filters.
IKsPropertySet	Sets properties on a kernel-mode filter.
IMediaFilter	Controls the streaming state of a filter
IPersist, IPersistStream	Saves and loads objects that use a simple serial stream for their storage needs.
ISpecifyPropertyPages	Indicates that an object supports property pages.

IU4H264PCI104PassThroughSelector Custom Interface

Refer to Naming Conventions before setting up your code.

Property	Description	Type, access	Value range	Related topics
BoardIndex	Board index in the system, from 0 on.	Integer, Get Only	**[0..]**	Board Filter
SelectCascade	If **TRUE**, the Cascade Video Input is selected. Default: **TRUE**. (*)	Bool, Set(Get)	**TRUE** **FALSE**	Video Pass-Through Selector
VideoInput	Video Input to pass through (if **SelectCascade** is **FALSE**).	Integer, Set(Get)	**[0...3]**	Video Pass-Through Selector
NumberOfInputs	Reports the maximum number of video inputs per board	Data: Integer, Get Only	**[4]**	

(*) Immediate setting that can be changed at any time.

3.8 Board Filter

Standard Interfaces (Board Filter)

KsProxy standard interfaces

Interface	Description
IAMFilterMiscFlags	Queries whether a filter is a source filter or a renderer.
IBaseFilter	Is the primary interface for all DirectShow filters.
IKsPropertySet	Sets properties on a kernel-mode filter.
IMediaFilter	Controls the streaming state of a filter
IPersist, IPersistStream	Saves and loads objects that use a simple serial stream for their storage needs.
ISpecifyPropertyPages	Indicates that an object supports property pages.

IU4H264PCI104Board Custom Interface

Refer to Naming Conventions before setting up your code.

Property	Description	Type, access	Value range	Related topics
Position	Position of the board in the system (*)	Integer, Get Only		
SerialNumber	Board serial number. (**)	String, Get Only	String of 16 digits corresponding to the serial number label	
PartNumber	Board part number. (**)	String, Get Only	String of 16 digits corresponding to the part number label	
Type	Reports the board type.	String, Get Only	**Picolo U4 H.264 PCI-104**	
Temperature	Reports the board temperature (°C).	Integer, Get Only	**[-40…150]**	Temperature Monitor

(*) An index, from 0 on, in the list of Picolo U4 H.264 PCI-104 boards enumerated by the driver.

(**) The serial and part numbers are assigned at factory. Their combination is unique for a board of a given type.

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. Example, on the Picolo U4 H.264 PCI-104, the indexes 0… 15 designate a particular resource of one class.

1. Video Resources

Function	Driver Identification	Video Teminators Switch#	PH 14 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

Legend:

- Driver Identification: this is the index in the application program designating a video input resource.
- PH14 designates the 14-pin Video connector on the Picolo U4 PCI-104 card.

2. Audio Resources

Function	Driver Identification	PH 10 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

Legend:

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

3. IO Resources

Function	Driver Identification	PH 20 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

Legend:

- 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

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

(empty)

K

(empty)

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

(empty)

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

G

H

I

J

K

L

M

N

O

P

Q

R