

# PHOENIX-HDSI PCI EXPRESS

## HIGH PERFORMANCE/HIGH SPEED DIGITAL FRAME GRABBER

- Dual input SDI and HD-SDI configuration.
- PCI Express burst rates in excess of 190Mbytes/sec across the x1 interface.
- Simultaneous capture from two independent SDI or switch between two HD-SDI sources.
- Low latency SDI/HD-SDI signal pass through.
- 8-bit and 10-bit uncompressed video capture.
- Supported video formats include SDI 525/625 line, 720p and 1080i.
- Two serial ports configurable as RS-232 or RS-485 signalling.
- Bus mastering hardware control of scatter-gather requires 0% host CPU intervention.
- Hardware YUV to RGB conversion.
- Utilises software configurable FPGA technology for maximum flexibility.
- Software Development Kit (SDK) supports various operating systems for rapid integration.
- RoHS compliant.



## OVERVIEW

**Phoenix-D20HDSI** is a PCI Express board for the acquisition of digital data from a variety of uncompressed 8-bit and 10-bit SDI and HD-SDI sources. It supports the SMPTE 292M standard and can capture from 270Mbit/s and 540Mbit/s standard definition SDI sources as well as up to 1.484Gbit/s high definition HD-SDI sources.

The video pass through feature can provide a buffered output of the SDI or HD-SDI inputs via the auxiliary connector.

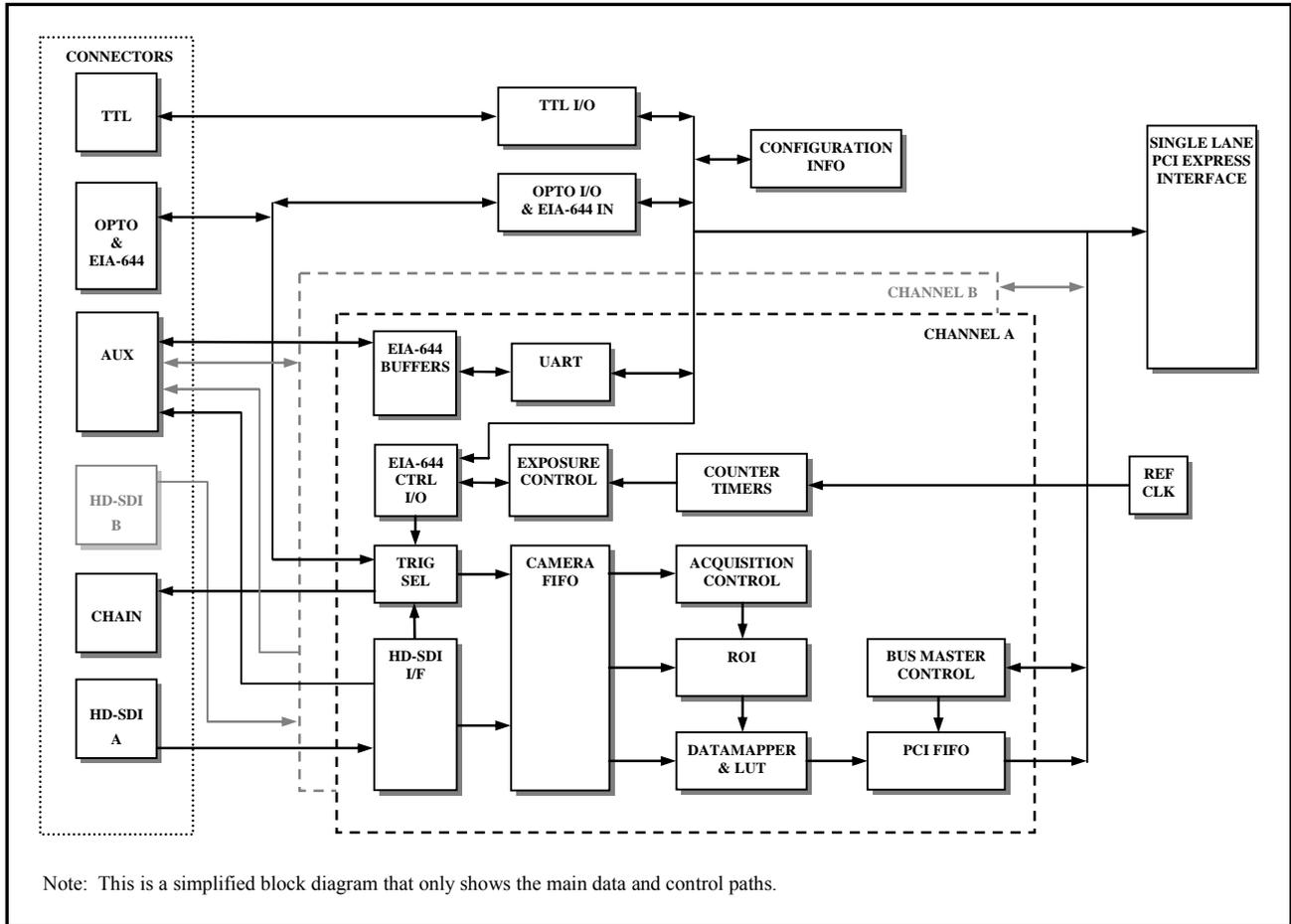
ROI and sub-sampling controls are used to increase application processing speed by only storing the required data. In addition the LUT functionality provides support for gamma correction, dynamic range cropping and binary thresholding in real time. The DataMapper further reduces the load on the host processor by mapping and packing the acquired data prior to transfer across the PCI bus. For example, the acquired data can be mapped into a suitable format and transferred directly to the graphics display, without the need for any host processing.

The PCI Express interface comprises intelligent scatter-gather hardware which reads its instructions direct from memory without any host CPU intervention. This in turn controls the DMA engine, which transfers the packed video data into any target memory which can be reached from the PCI Express bus. This can be system memory, graphics memory, or even other devices on the same or other busses, such as DSP cards, etc.

The majority of the functionality is implemented in a single FPGA (Field Programmable Gate Array) providing a flexible solution for interfacing to SDI and HD-SDI compliant sources. The FPGA implements the PCI Express interface including support for Posted Packets (i.e. DMA), hardware scatter-gather control, Region of Interest (ROI) and sub-sampling control, DataMapping functions, Datapath FIFOs, and Counter/Timer support. In addition the board contains Look Up Table (LUT) functionality, a dual Universal Asynchronous Receiver Transmitter (UART), 4 bit opto-isolated I/O, two 2 bit differential input ports and two 8 bit TTL I/O ports.

The Software Development Kit (SDK), available as a separate item, allows rapid system development and integration. It provides comprehensive example applications and optimized libraries, and is available for a variety of operating systems via a common API, including Windows and Linux (32 bit and 64 bit environments) as well as Mac OS X, DOS, VxWorks and QNX. Drivers for third party applications are also available such as Common Vision Blox, Image-Pro Plus, StreamPix, Labview etc. As well as functions that control the hardware, the libraries include general purpose functions for the manipulation and display of images. A separate datasheet describes the SDK in detail.

# SYSTEM BLOCK DIAGRAM



## HARDWARE SPECIFICATION

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<i>Camera FIFO:</i>	Data from the video source is stored in a FIFO prior to being processed by <b>Phoenix</b> . For certain high bandwidth applications it is possible to extend the FIFO size - please contact your distributor for more details.
<i>HD Formats:</i>	1080i60, 1080i59.94, 1080i50, 1080PsF30, 1080PsF25, 1080PsF24, 720p60, 720p59.94, 720p50.
<i>SD Formats:</i>	625/50, 525/59.94.
<i>Audio Input:</i>	For a list of supported audio formats please contract Active Silicon.
<i>Acquisition Control:</i>	<p>The acquisition trigger control module is used to determine which video frames to acquire from the camera. The system can be configured for a single trigger event to acquire all subsequent frames, a trigger event per frame, or continuous acquisition irrespective of the trigger condition. The trigger event is programmable between level or edge sensing on one of the opto-isolated or EIA-644 control inputs.</p> <p>The hardware can also delay the trigger event by a fixed time period or number of lines, and allows the trigger event transducer to be located remotely from the camera.</p>
<i>Region of Interest:</i>	The Region Of Interest (ROI) controls which part of the camera output data to acquire. In areascan mode, this is a rectangular region with software programmable width, height and x / y offset.
<i>Sub-Sampling:</i>	Software controlled hardware sub-sampling is also supported. A factor of x1, x2, x4 or x8 can be independently selected for both x and y directions, e.g. a horizontal factor of x4 and a vertical factor of x2 would acquire every 4th pixel across a line and every 2nd line down the frame.
<i>DataMapper:</i>	<p>The raw camera data can be reformatted in hardware for ease of subsequent processing. For example, a mono data source can be converted into 32 bit color data, ready to be sent directly to graphics card memory, thus reducing the host processor overhead. The optimum use of system resources is determined by the user's application, e.g. packing mono data into 32 bit color reduces the host processor overhead at the expense of increasing the amount of data transferred across the PCI Express bus.</p> <p>The output formats supported include, 8, 16 and 32 bit mono, as well as 15, 16, 24, 32 and 48 bit color in YUV, RGB and BGR ordering, thus supporting big and little endian processor formats.</p>
<i>LUT:</i>	A 16 bit in, 16 bit out (i.e. 65,536 by 16) LUT per channel allows arbitrary mappings between the input data from the video source and the output data to the destination memory. This allows functions such as gamma correction, brightness, contrast and thresholding to be performed in real time in hardware on a per color or per camera basis. The LUT may also be used to shift the LSB aligned video data to MSB alignment ready for processing.
<i>PCI FIFO:</i>	A 4096 by 32 bit FIFO provides buffering between the camera and the PCI Express bus, as well as packet buffering in the PCI Express interface. Note that this is not a frame store; <b>Phoenix</b> uses high speed DMA to transfer the camera data into system memory, and therefore the image size is only limited by the amount of memory available on the host.
<i>Bus Master Control:</i>	<p>Core to <b>Phoenix</b> is a dedicated RISC processor and a highly optimised DMA engine. The RISC processor generates PCI Express Non-Posted requests to system memory to read transfer length, destination address and other control information directly from host memory. For optimal efficiency, the resulting instructions are held in a pipeline buffer before being used to generate Posted packets containing image data.</p> <p>The RISC processor optionally generates a PCI interrupt to signal that the transfer has completed, before continuing to execute the next instruction, and also supports jump instructions that allow a single piece of RISC code to loop continuously.</p> <p>This whole process is completely autonomous to the hardware and requires 0% CPU overhead to maintain. The DMA engine is thus capable of sending data at the full PCI Express rate and the throughput is only limited by the max payload size and the response time of the host machine.</p>

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<i>Interrupts:</i>	An interrupt signal is available, and can be configured via software to interrupt on a number of different events, including acquisition complete, FIFO overflow, Start/End of Frame/Line, etc.
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<i>Counter Timers:</i>	<p>Four 32 bit counter timers are available for each channel of the <b>Phoenix</b>. The counter timers are dedicated for the following functions:</p> <ol style="list-style-type: none"> <li>1. Astable timer used as an acquisition trigger for areascan cameras, thus controlling the overall frame rate. The period of the astable can be set from 1<math>\mu</math>s up to 70 minutes in 1<math>\mu</math>s increments.</li> <li>2. Dual monostables for generating two exposure output signals, e.g. ExSync and PRIN. Both monostables are triggered by the same software selectable event but can be programmed with different time periods, once again to 1<math>\mu</math>s resolution. This provides a flexible exposure control system.</li> <li>3. Trigger delay counter used to postpone acquisition triggering by a programmable time delay or line count. This allows the acquisition trigger sensor to be mounted remotely from the camera. (Note: As the counter is non-retriggerable, subsequent trigger events will be ignored until a pending event has completed its delay).</li> <li>4. A versatile event counter is provided to count a number of different events types - Lines (LVAL), Frames (FVAL) or microseconds, within a specified gate condition - Line (LVAL), Frame (FVAL), Acquisition Trigger or Entire Acquisition. The event count provides readings for both the current value, as well as the final value at the end of the previous gate condition. For example the event counter can be configured to provide the current line number within a frame, as well as the total number of lines in the previous frame. Other uses include providing the frame period, the number of lines in the previous acquisition trigger envelope – and hence how much data there is to process, or the number of images processed so far.</li> </ol>
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<i>Opto-Isolated I/O:</i>	<p>4 bits of opto-isolated I/O are provided to interface to external systems. As standard, <b>Phoenix</b> is configured with 2 bits of input and 2 bits of output, but this can be varied as factory build option - please contact your distributor for further information.</p> <p>The outputs are designed to sink up to 20mA, and will withstand 24V when “off”. The inputs sense voltages between 3.3V and 24V as a logic high input. A 4.7k<math>\Omega</math> current limiting series resistor is fitted on all inputs.</p> <p>The outputs can be individually set and cleared via software, controlled from the internal timer resources, or fed from other input events, e.g. acquisition triggers, etc.</p>
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<i>EIA-644 Control In:</i>	Two 2 bit EIA-644 (LVDS) input ports are provided to interface with other systems. They can be used as additional acquisition trigger sources, or as inputs from shaft encoders, etc.
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<i>TTL I/O:</i>	Two 8 bit TTL I/O ports are provided to interface with other systems. Each 8 bit port can be independently configured as all input or all output under software control. When used as outputs, each bit can source 24mA at min 2.2V or sink 24mA at max 0.55V. When used as inputs, an applied voltage of between 2V and 5V is read as a logical “1” and an applied voltage of between 0V and 0.8V as a logical “0”.
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<i>Serial Port:</i>	<p><b>Phoenix</b> is fitted with a dual channel Universal Asynchronous Receiver Transmitter (UART), containing 64 character hardware transmit and receive FIFOs for each channel (the software libraries buffer the transmit and receive data to provide larger user FIFOs).</p> <p>Each channel independently supports 1, 1.5 or 2 stop bits; 5, 6, 7 or 8 data bits; and odd, even or no parity. The baudrate can be configured with standard values from 300 baud up to 115,200 baud. <b>Phoenix</b> also supports software (XON, XOFF) flow control within the UART without host CPU intervention.</p> <p>The hardware supports both RS-485 (EIA-485) and RS-232 (EIA-232) signalling levels. In RS-232 mode RTS, CTS, TX and RX are all supported. Note that TX and RTS are <b>Phoenix</b> outputs; RX and CTS are <b>Phoenix</b> inputs.</p>
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**Connectors:**

**Phoenix** is fitted with two BNC connectors rated for HD-SDI data rates of 1.485Gbits/s.

A single 13W3 connector is used for video pass through and two RS-485 serial ports.

For opto-isolated, EIA-644 & TTL I/O there are internal 20 & 26 way 0.1" IDC headers, with the option to bring these out to a 50 way mini D on an adjacent PCI slot.

A 10 way 0.1" IDC header ("Chain") allows two **Phoenix** boards to be used together to simultaneously acquire from multiple sources.

The next section shows the pinout of the connectors.

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## CONNECTOR PINOUTS

### Video Input

**Phoenix-D20HDSDI** is fitted with two video BNC connectors on the PCI Express end bracket for connecting to SDI or HD-SDI video sources.

Connector type: 75Ω BNC socket.

BNC A is connected to video input channel A

BNC B is connected to video input channel B

### Auxiliary Connector

**Phoenix-D20HDSDI** is fitted with a 13W3 D-type connector on the PCI Express end bracket for video pass through and serial communication ports.

Connector type: 13W3 plug.

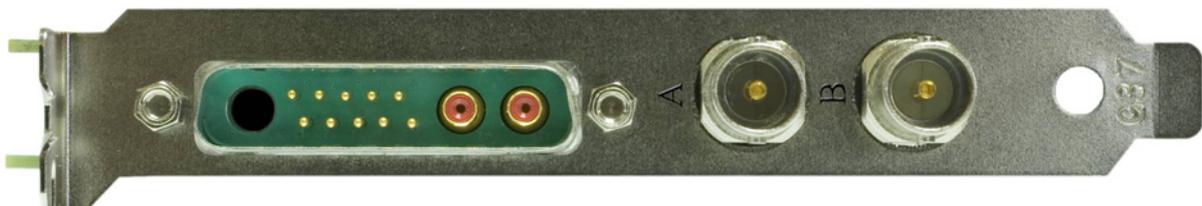
PIN	SIGNAL
1	ComTxA-
2	ComRxA-
3	GND
4	ComTxB-
5	ComRxB-
6	ComTxA+
7	ComRxA+
8	GND
9	ComTxB+
10	ComRxB+
A1	Video Pass Through Channel A
A2	Video Pass Through Channel B
A3	Not Fitted

### NOTES:

- In RS-232 mode Camera RX, CTS, TX & RTS are connected to ComRx+, ComRx-, ComTx+ & ComTx- respectively for each port (refer to the Serial Port section).

### Front Panel

The picture below shows the two BNC video inputs and the auxiliary connector.



**TTL I/O Connector**

*Phoenix-D20HSDI* is fitted with an internal 26 way header for TTL I/O.  
Connector type: Standard 26 way 0.1” pitch box header for use with IDC sockets.

PIN	SIGNAL	PIN	SIGNAL
1 (1)	TTL A0 (LSB)	2 (2)	TTL A1
3 (3)	TTL A2	4 (4)	TTL A3
5 (5)	TTL A4	6 (6)	GND
7 (7)	TTL A5	8 (8)	TTL A6
9 (9)	TTL A7 (MSB)	10 (10)	TTL A Len
11 (11)	GND	12 (12)	CcOutA1 TTL
13 (13)	CcOutA2 TTL	14 (26)	TTL B0 (LSB)
15 (27)	TTL B1	16 (28)	TTL B2
17 (29)	TTL B3	18 (30)	TTL B4
19 (31)	GND	20 (32)	TTL B5
21 (33)	TTL B6	22 (34)	TTL B7 (MSB)
23 (35)	TTL B Len	24 (36)	GND
25 (37)	CcOutB1 TTL	26 (38)	CcOutB2 TTL

**NOTES:**

1. The naming convention used is standard bit ordering, i.e. TTL A0 and TTL A7 are the LSB and MSB bits respectively of TTL Port A.
2. TTL X Len is a latch enable signal for the appropriate port. If it is held at a logical “0”, then the current values on the I/O port pins are read. If it is held at a logical “1”, then the values on the I/O port pins when TTL X Len transitioned from “0” to “1” are read. By default, this signal is fitted with a 4.7kΩ pull-down resistor, such that it can be left unconnected.
3. CcOutAX TTL are buffered output-only TTL versions of the CCX EIA-644 signals available on the Camera Link connector.
4. The pin numbers in parentheses are for the Combined I/O Adapter.

**Opto-Isolated & EIA-644 I/O Connector**

*Phoenix-D20HSDI* is fitted with an internal 20 way header for opto-isolated and EIA-644 I/O.  
Connector type: Standard 20 way 0.1” pitch box header for use with IDC sockets.

PIN	SIGNAL	PIN	SIGNAL
1 (16)	OptoA1 Signal	2 (17)	OptoA1 GND
3 (18)	OptoA2 Signal	4 (19)	OptoA2 GND
5 (20)	AuxInA1+	6 (21)	AuxInA1-
7 (22)	AuxInA2+	8 (23)	AuxInA2-
9 (24)	GND	10 (25)	GND
11 (41)	OptoB1 Signal	12 (42)	OptoB1 GND
13 (43)	OptoB2 Signal	14 (44)	OptoB2 GND
15 (45)	AuxInB1+	16 (46)	AuxInB1-
17 (47)	AuxInB2+	18 (48)	AuxInB2-
19 (49)	GND	20 (50)	GND

**NOTES:**

1. The opto-isolated I/O consists of a signal and a ground connection, all of which are all isolated from each other and the main GND signal.
2. The standard build of *Phoenix-D20HSDI* provides two opto-isolated inputs (OptoA1 & OptoB1) and two opto-isolated outputs (OptoA2 & OptoB2). These can be supplied with other combinations of input or output - please consult your distributor for more information.
3. The opto-isolated outputs are designed to sink up to 20mA of current from a 24V supply, and the inputs sense voltages between 3.3V and 24V as a logic high input.
4. AuxInXY are EIA-644 (LVDS) inputs used to connect external devices such as shaft encoders, or other trigger devices.

**Combined I/O Adapter (optional item)**

An interface adapter (*AS-PHX-ADP-50MD-IO*) is also available which utilises a free adjacent PCI slot to access all the I/O signals from the two internal 0.1” IDC headers. It consists of a single 50 way mini D connector (Honda part number “PCS-E50PM”), fitted with 4-40 UNC thread screwlocks, mounted on a PCI end bracket.

The pin numbers for this 50 way connector are in parentheses in the above tables.



## CONFORMANCE

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<i>PCI Express Interface:</i>	PCI Express Bus interface to Specification Revision 1.1, with a max payload size of 512 bytes. <b>Phoenix-D20HDSI</b> supports both Short (32 bit) and Long (64 bit) Address packets for native 64 bit addressing. It also generates Posted Writes for image data, thus achieving transfer rates in excess of 190 Mbytes/sec, subject to host performance. The board requires 16 MBytes of address space, and a further 256 bytes of I/O space.
<i>Serial Digital Interface:</i>	<b>Phoenix-D20HDSI</b> supports SMPTE 292M, SMPTE 344M and SMPTE 259M.
<i>Approvals:</i>	<p>EU      CE mark for compliance with EMC EN 55022:1998 (class A) and EN 55024:1998 in accordance with EU directive 89/336/EEC. RoHS Compliant.</p> <p>USA    EMC FCC Class A.</p> <p>The printed circuit board is manufactured by UL recognised manufacturers and has a flammability rating of 94-V0.</p>

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## PHYSICAL AND ENVIRONMENTAL DETAILS

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<i>Dimensions:</i>	PCB: 168mm by 110mm. Overall: 189mm by 110mm.
<i>Approximate weight:</i>	160g.
<i>Power consumption (typical):</i>	+3.3V. 1A.
<i>Storage Temperature:</i>	-15°C to +70°C.
<i>Operating Temperature:</i>	0°C to +55°C.
<i>Relative Humidity:</i>	10% to 90% non-condensing (operating and storage).

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## ORDERING INFORMATION

<i>PART NUMBER</i>	<i>DESCRIPTION</i>
<i>AS-PHX-D20HDSI-PE1</i>	SDI and HD-SDI dual channel capture card for x1 PCI Express slot.
<i>AS-PHX-SDK-xxx-CD</i>	Software Development Kit for xxx operating system. For a full list of all supported operating systems please refer to the SDK datasheet, or contact your distributor.
<i>AS-CBL-HDSI-A-xxx</i>	BNC to BNC cable x metres in length for use with SDI and HD-SDI video sources.

An initial order for the *Phoenix* with an SDK and cable is supplied in a presentation case.

## THE PHOENIX RANGE

The following products are available in the Phoenix range:

- CoaXPress frame grabbers.
- Base only Camera Link frame grabber.
- Base, Dual Base and Medium Camera Link frame grabber.
- Base, Medium and Full Camera Link frame grabber.
- 36 bit LVDS frame grabber.
- SDI and HD-SDI frame grabber.

They are available in standard PCI Express, PCI, PMC, CompactPCI, PCI/104-Express and PC/104-Plus form factors.

More products are in development. Please consult your distributor for information on the availability of other camera interface, PCI interface, and form factor options.

## CONTACT DETAILS



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