Active Silicon

BLUEBIRD ADAPTER SERIES

BlueBird SDI – H.264 IP Adapter

Carrier Board Design Guide

AS-ADP-H264-001-EVAL-A

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1. Introduction

This document provides information for designing a custom system carrier board for the BlueBird SDI - H.264 IP Adapter (AS-ADP-H264-001-A). The BlueBird SDI – H.264 IP Adapter Evaluation Board (part number: AS-AP30C02-001-A) is used as an example of a suitable carrier board.

The intended audience is electronic engineers and PCB layout engineers designing carrier boards that will connect to the BlueBird SDI - H.264 IP Adapter. It should be read in conjunction with the documentation for the adapter. System software engineers should also refer to application software API documentation.

The BlueBird SDI - H.264 IP Adapter connects to a carrier board (e.g. AS-ADP-H264-001-EVAL-A) using a 60-way high speed hermaphroditic connector which carries all power and data signals. Four M2.5 threaded mounting pillars can be used for additional mechanical retention.

The IP adapter receives 100Ω SMPTE differential video signals at SD (270Mbps), HD (1.485Gps) or 3G (2.97Gps) data rates; it compresses the video data (using the H.264 codec) and re-transmits it over Ethernet using the ONVIF (Open Network Video Interface Forum) RTP format. Text / graphics can be overlaid on the on the video output.

Additional hardware functionality includes:

1. DSI display output.
2. SD Card interface.
3. USB2 interface, which may be configured as host, peripheral or OTG based on carrier board design.
4. Dual COM/serial ports (one of which may be re-purposed as either RS-485 flow control or as RTS/CTS for the primary port).

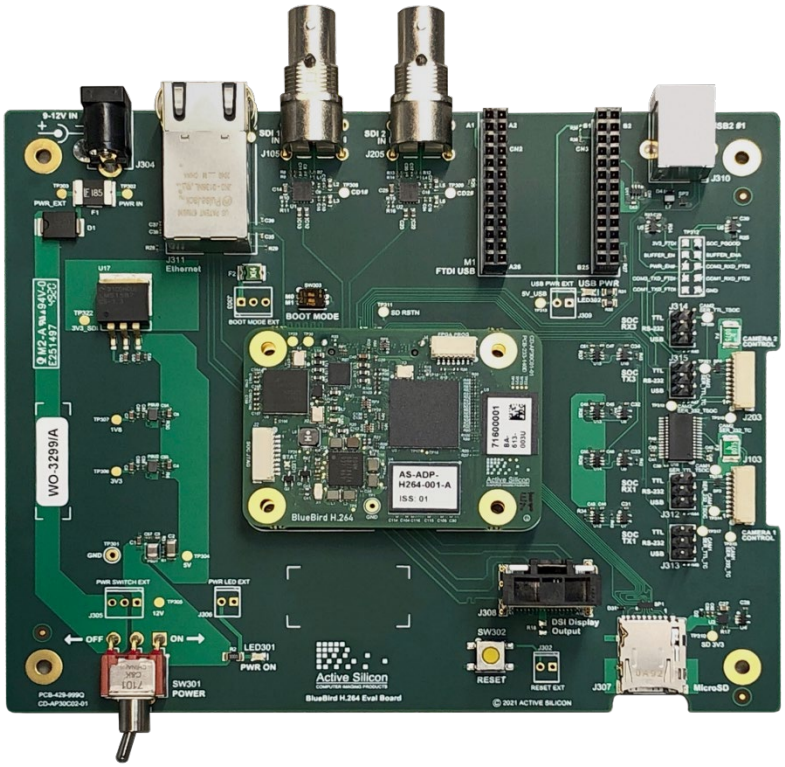

Figure 1. BlueBird SDI - H.264 IP Adapter Evaluation Board with the BlueBird SDI - H.264 IP Adapter fitted.

2. Electrical Interface Specification

The BlueBird SDI - H.264 IP Adapter interfaces to external systems via a 60-way Samtec LSHM hermaphroditic board to board connector with 3mm height, (Samtec part number LSHM-130-03.0-L-DV-A-S-K-TR). Mating connectors can have heights from 2.5mm to 6mm (most common variants are 3mm and 4mm), giving mated stack height options of 5.5mm, 6mm, 7mm and 9mm (board-to-board distance).

Connection direction in the following tables is with reference to the carrier board, i.e. connections labelled input are an input to the carrier board, outputs are outputs from the carrier board (to the BlueBird SDI - H.264 IP Adapter board).

Important:

The tables below list the pinout of the evaluation board, due to the hermaphroditic nature of these connectors the pinout on the connector mounted on the BlueBird SDI - H.264 IP Adapter will be mirrored, meaning that odd and even pins will swap. For example, pin 1 on the adapter board will connect to pin 2 on the evaluation board, pin 2 on the adapter board will connect to pin 1 on the evaluation board, and so on. This can be illustrated by comparing to the pinout on the BlueBird H.264 IP Adapter datasheet or by referring to Figure 3 and Figure 4.

Hence pin 1 on the BlueBird SDI - H.264 IP Adapter connects to pin 2 on the carrier, pin 2 on the IP adapter connects to pin 1 on the carrier board, pin 3 connects to pin 4, pin 4 connects to pin 3, and so on.

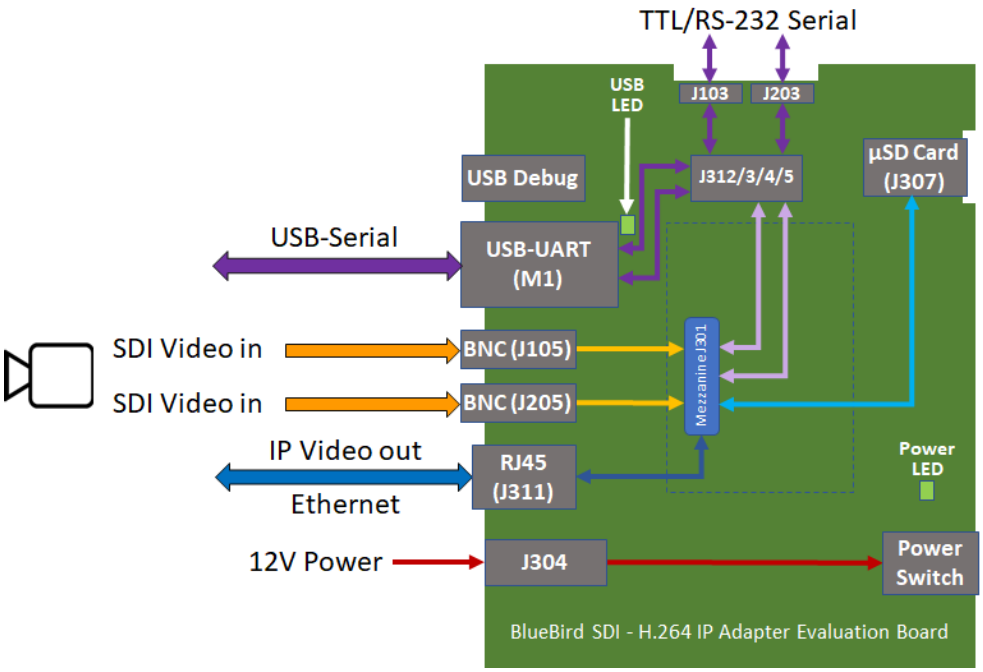

Figure 2. Bluebird SDI - H.264 IP Adapter Evaluation Board (AS-ADP-H264-001-EVAL-A) block diagram.

PIN NO.	FUNCTION	TYPE	SIGNAL LEVEL	COMMENT
1	GND			
3	DDO0_N	Differential Output	SMPTE	_N and _P are reversed See Section 2.1.
5	DDO0_P	Differential Output	SMPTE	
7	GND			
9	DDO1_N	Differential Output	SMPTE	_N and _P are reversed See Section 2.1.
11	DDO1_P	Differential Output	SMPTE	
13	GND			
15	USB1_DN	Differential IO	USB2	See Section2.2.
17	USB1_DP	Differential IO	USB2	
19	USB1_ID	Host / peripheral select output	Weak pull-up to 1V8 on adapter board	
21	USB1_VBUS	USB Bus voltage sense (output)	Max 5V5	
23	MEZZ TX3	Input	LVCMOS 3V3	10k pull up to 3V3 on BlueBird SDI - H.264 IP Adapter inputs. See Section 2.3 for full description.
25	MEZZ_RX3	Output	LVCMOS 3V3	
27	MEZZ TX1	Input	LVCMOS 3V3	
29	MEZZ_RX1	Output	LVCMOS 3V3	
31	SD_DET_SW	Output	Pulled up to 3V3 on adapter board	Tie to GND when SD card is present.
33	SD_DAT2	I/O Push-Pull	3V3 / 1V8	Interface to SD card mounted on the carrier board. If the firmware in the adapter board flash memory is corrupt, it will boot from the SD card connected to this interface. See Section 2.4
35	SD_CD/DAT3	I/O Push-Pull	3V3 / 1V8	
37	SD_CMD	Input	3V3 / 1V8	
39	SD_CLK	I/O Push-Pull	3V3 / 1V8	
41	SD_DAT0	I/O Push-Pull	3V3 / 1V8	
43	SD_DAT1	I/O Push-Pull	3V3 / 1V8	
45	SD_RST#	Input	LVCMOS 3V3	Disables SD Card power when low.
47	BOOT_MODE0	Output	Pulled to GND on BlueBird H.264 IP Adapter	Strap to 3V3 to override defaults
49	BOOT_MODE1	Output	Pulled to GND on BlueBird H.264 IP Adapter	Strap to 3V3 to override defaults
51	LINK1000_LED	Input	LVCMOS 3V3	1000 and 10/100 signals are the wrong way around on Issue 01 eval. boards, see section 2.6
53	LINK10_100_LED	Input	LVCMOS 3V3	
55	ACT_LED	Input	LVCMOS 3V3	Ethernet Activity
57	GND			
59	5V	Power Output		

Table 1. Evaluation board (issue02) mezzanine connector pinout (odd pins).

PIN NO.	FUNCTION	TYPE	SIGNAL LEVEL	COMMENT
2	GND			
4	Ethernet pair 0 P	Differential IO +ve	1000BASET (IEEE 802.3) PAM5 encoding Max +/- 1V swing	100-Ohm matched differential pairs
6	Ethernet pair 0 N	Differential IO -ve		
7	Ethernet pair 1 P	Differential IO +ve		
10	Ethernet pair 1 N	Differential IO -ve		
12	Ethernet pair 2 P	Differential IO +ve		
14	Ethernet pair 2 N	Differential IO -ve		
16	Ethernet pair 3 P	Differential IO +ve		
18	Ethernet pair 3 N	Differential IO -ve		
20	GND			
22	DSI_CLK_N	Input	MIPI DSI	100-Ohm matched differential pairs
24	DSI_CLK_P	Input	MIPI DSI	
26	DSI_D0_N	Input	MIPI DSI	
28	DSI_D0_P	Input	MIPI DSI	
30	DSI_D1_N	Input	MIPI DSI	
32	DSI_D1_P	Input	MIPI DSI	
34	DSI_D2_N	Input	MIPI DSI	
36	DSI_D2_P	Input	MIPI DSI	
38	DSI_D3_N	Input	MIPI DSI	
40	DSI_D3_P	Input	MIPI DSI	
42	GND			
44	DSI_SDA	Open drain I/O	1V8	10k pull up to 1V8. 4k7 pull up to 1V8 on BlueBird SDI - H.264 IP Adapter
46	DSI_SCK	Open drain input	1V8	10k pull up to 1V8, 4k7 pull up to 1V8 on BlueBird SDI - H.264 IP Adapter
48	DSI_EN	Input	LVCMOS 1V8	Display Enable 10k pull up to 1V8
50	DSI_BL_PWM	Input	LVCMOS 1V8	Display Backlight PWM 10k pull up to 1V8
52	DSI_TS_INT#	Input	LVCMOS 1V8	Display Reset 10k pull up to 1V8
54	SYS_RST#	Open drain input	1V8	4k7 pull up to 1V8 on BlueBird SDI - H.264 IP Adapter
56	MEZZ_PGOOD	Input	LVCMOS 3V3	Power Up Sequence complete (not including software-controlled power rails)
58	GND			
60	5V	Power Output		

Table 2. Evaluation board mezzanine connector pinout (even pins).

2.1. SMPTE Differential Outputs

The SMPTE differential outputs from the carrier board will typically be sourced from a receiver / equalizer IC and connected to the mezzanine connector. The Semtech GS2994 part is used on the BlueBird SDI - H.264 IP Adapter Evaluation Board.

The impedance of the differential pairs should be 100 Ohm +/- 10%.

Polarity reversal is supported for the SMPTE differential signals, which means that positive and negative pin assignment within a pair may be swapped if this facilitates PCB routing.

Note: the wiring shown in Table 1 and 2 is correct for the BlueBird SDI - H.264 IP Adapter Evaluation Board; however, (compared to the adapter) the evaluation board has the SMPTE _P and _N signals reversed. Please refer to Figure 3 and Figure 4 for details.

Also note the change in the pin numbering between the adapter and the evaluation board.

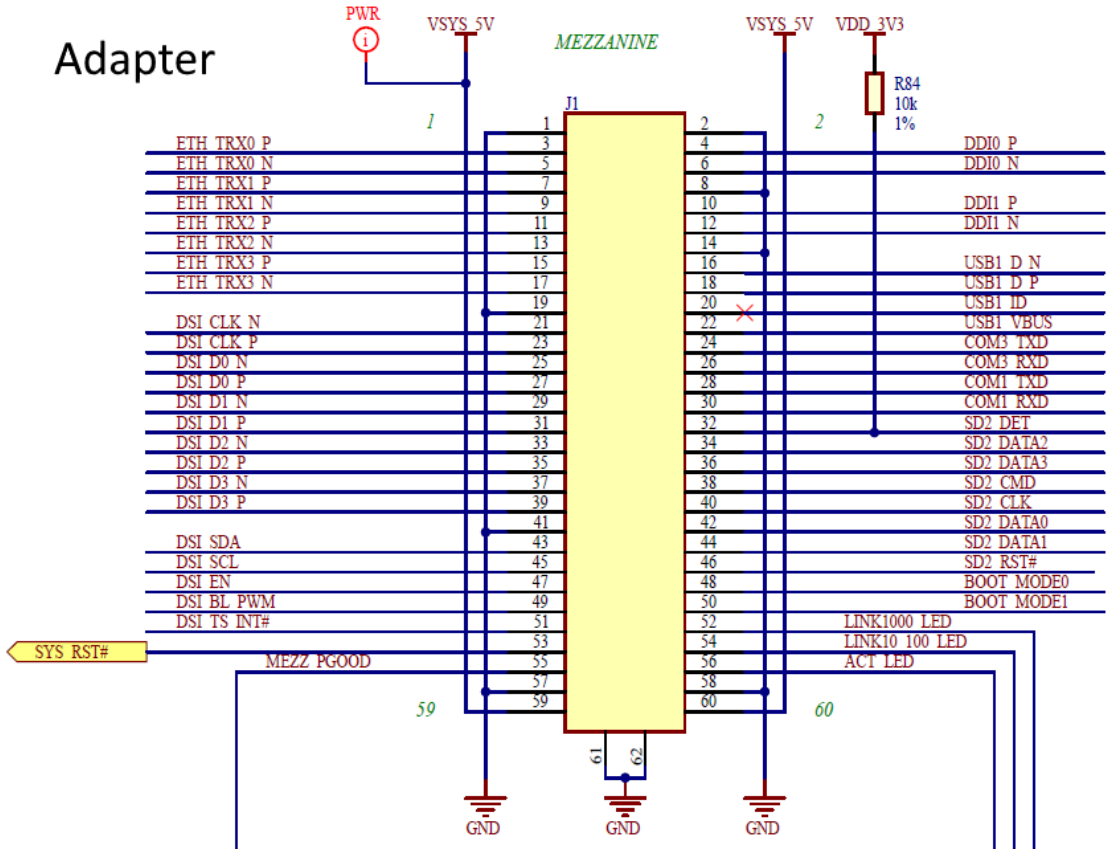

Figure 3. BlueBird SDI - H.264 IP Adapter mezzanine connector pinout.

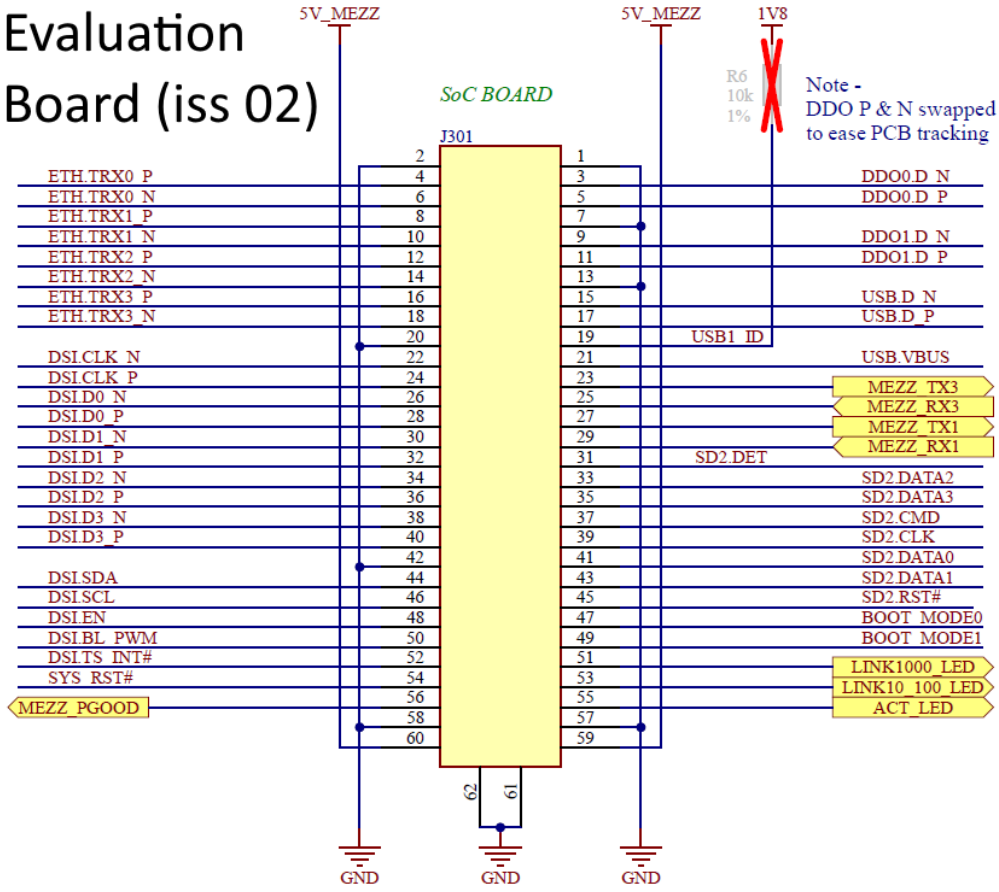

Figure 4. BlueBird SDI - H.264 IP Adapter Evaluation Board (issue 02) mezzanine connector pinout.

AC coupling capacitors of 4u7F on each (differential) signal line are recommended. Consideration should be given to the capacitance de-rating with voltage of the capacitors, as high value capacitors in very small packages invariably have significant de-rating characteristics.

The drive level from the receiver chip will depend on the characteristics / drive configuration of the chip chosen, so it is not possible to specify a single capacitor type that will work optimally with all possible carrier board receiver configurations. However, excessively large packages should be avoided to minimize parasitics, particularly associated with the pad size.

Anti-pads should be used under AC coupling capacitors.

DC coupling may be used provided that the equalizer output is guaranteed to meet the common mode input voltage range and swing range of the Semtech GS3470 part on the BlueBird SDI - H.264 IP Adapter. These are listed in Table 3 below.

PARAMETER	MIN	TYPICAL	MAX
Common mode voltage (V)	0.90	0.96	1.06
Swing (mVppd)	200	400	1000

Table 3. DC Signal Levels for BlueBird SDI - H.264 IP Adapter SMPTE Inputs.

2.2. USB2 Interface

This interface comprises a standard bi-directional differential pair operating at up to 400 Mbps, plus USB1_ID and USB1_VBUS pins.

The USB1_ID pin defines whether the BlueBird SDI - H.264 IP Adapter operates as host or peripheral. If unconnected, the adapter operates as a peripheral, if grounded, the adapter operates as a host.

This allows the BlueBird SDI - H.264 IP Adapter to operate as a host, a peripheral, or as a USB “On The Go” (OTG) device, depending on the circuit design of the carrier board.

OTG devices must use a single micro-AB USB connector. An OTG cable has a micro A plug at one end and a micro B plug at the other. These plugs have an additional pin, which is grounded on the micro-A plug and floating on the micro-B plug. The BlueBird SDI - H.264 IP Adapter could be notified about whether the USB is to operate as host or peripheral, based on which plug end is fitted to the carrier board OTG micro-AB connector.

Note that for OTG designs the carrier board circuitry must also implement power supply switching depending on whether the part is operating as host or peripheral (host must supply 5V power rail to the cable).

It is recommended that the differential pairs are protected using ESD protection devices and common mode chokes on the carrier board, placed close to the carrier board USB connector.

It is recommended that the USB 5V rail power detect line is protected using a suitable bi-directional ESD protection diode, placed close to the carrier board USB connector.

PART DESCRIPTION	PART USED ON ASL CARRIER BOARD
Differential pair ESD Protection	Semtech RCLAMP0522P.TCT
Differential pair common mode choke	Coilcraft 0805USB-901MLC
5V USB detect ESD Protection	ON Semiconductor ESD5B5.0ST1G

Table 4. Recommended USB2 ESD and EMC protection components.

2.3. COM Ports

Pins 23 to 29 interface to COM serial ports 1 and 3 on the BlueBird SDI - H.264 IP Adapter.

In Table 1 “TX” is used to denote “transmit” from the perspective of the adapter. These signals are **inputs** to the carrier and should be connected to the RX pins of a UART on the carrier.

“RX” is used to denote “receive” from the perspective of the adapter. These signals are **outputs** from the carrier board and should be connected to the TX pins of a UART on the carrier. Please refer to Figure 3 and Figure 4 for details.

Signalling level on these connections is 3V3 LVCMOS, with idle (bit value zero) high, in anticipation of the signal being inverted by an RS-232/RS-485 UART.

All signals are pulled to a 3V3 power rail generated on the adapter by 10k resistors.

Custom Firmware Versions

UART3 may be configured as CTS / RTS signals for UART1.

UART3 CTS may also be used as RS-485 flow control.

The BlueBird H.264 IP Adapter may also be configured as DTE (Data Terminal Equipment) rather than DCE. This multiplexes the signals so that RX becomes TX and vice versa.

Signal level inversion may be implemented in the BlueBird H.264 IP Adapter.

Contact Active Silicon for further information on custom BlueBird H.264 IP Adapter firmware versions.

2.4. SD Card Interface

The interface is compatible with all SD card types, but the additional data pins available on UHS II cards are not supported. UHS II cards will operate at lower data rate UHS I modes over this interface.

Standard build variants of the BlueBird SDI - H.264 IP Adapter operate the SD card in SDR25 mode.

The function of the pins depends on whether the card is operated in SD or SPI mode. Memory cards can support either mode, but for this implementation the SD card mode will be used by the adapter.

SD CARD PIN NO.	NAME	TYPE	DESCRIPTION
1	CD/DAT3	I/O PP (Push / Pull drivers)	Card Detect / Data Line (Bit 3)
2	CMD	I/O PP	Command / Response
3	VSS1	PWR	GND
4	VDD	PWR	3V3
5	CLK	Input to SD Card	Clock
6	VSS2	PWR	GND
7	DAT0	I/O PP	Data Line (Bit 0)
8	DAT1	I/O PP	Data Line (Bit 1)
9	DAT2	I/O PP	Data Line (Bit 2)

Table 5. SD card pinout.

Highlighted signals in Table 5 are routed from the 60-way BlueBird SDI - H.264 IP Adapter interface connector. The adapter exports two additional signals:

SD_DET_SW

This signal is pulled to 3V3 on the BlueBird SDI - H.264 IP Adapter.

Connect this signal to GND to indicate presence of an SD card.

SD_RST#

Disables power to SD Card when low.

On power up, the SD card operates at 3V3 signalling levels.

UHS-I cards accept commands that switch the card to 1V8 level signalling, allowing the card to operate at higher signalling speeds. The BlueBird SDI - H.264 IP Adapter will also switch to 1V8 level signalling.

If the card is unable to switch to 1V8 signalling, for example if it's an older non-UHS card, 3V3 signalling is maintained and the card data rates are limited to "High Speed" mode.

If a UHS card is present, signalling should switch to 1V8 levels, and SDR25 data rates (25 MB/sec) will be used.

Default speed operation for the adapter is SDR25 (50MHz clock, 25Mbyte/sec).

Maximum power consumption for SDHC (High Capacity), SDUC and SDXC cards operating at this speed is defined as 720mW in the SD card specification.

For higher operating speeds, SD card power consumption limit is defined in the SD Card specification to be either 1.44W or 2.88W, depending on operating speed.

Please contact Active Silicon for further information on higher operating speeds.

2.5. Boot Mode

The BOOT_MODE0 and BOOT_MODE1 signals select the hardware device from which BlueBird SDI - H.264 IP Adapter firmware is loaded. Both signals have a 10k pull-down on the adapter to give a default configuration of “00” but can be overridden by strapping the signals to 3V3 on the carrier board.

The device boot configuration for pre-programmed devices will be set according to the following table.

BOOT_MODE1	BOOT_MODE0	BOOT SOURCE
0	0	Boot source is set by the internal fuses on the BlueBird SDI - H.264 IP Adapter. Fuses are not set by default. In this state the adapter will attempt to boot from an SD card on the SD2 interface. If this card is not present, the adapter attempts to load boot firmware using serial download from USB1.
0	1	The adapter will first try to boot from an SD card. If no SD card is present, the adapter will attempt to download the firmware over the USB interface. (The carrier board must be configured as a USB peripheral, or USB OTG device).
1	0	Boot Mode Pin configuration sets boot from eMMC.
1	1	Reserved for use by iMX8 manufacturer. Do not use.

Table 6. Boot mode signal configuration.

If not required, leave these pins unconnected.

2.6. Ethernet

Four bi-directional differential pairs provide the 1000BASET (IEEE 802.3ab) link.

These should be routed with impedance of 100 Ohms +/- 10%.

Isolation magnetics (which are commonly incorporated into an RJ-45 connector) must be fitted to the carrier board system.

The driver type used on the BlueBird SDI - H.264 IP Adapter is push-pull. For this reason, centre taps of should be AC coupled to GND using 100nF / 50V capacitors, rather than driven to a specific mid-level.

Carrier board designers must ensure that the Ethernet interface is electrically isolated to the required safety standards (i.e. 1500V isolation).

This is most easily achieved by using an RJ-45 connector with integrated magnetics, where the isolation requirements have already been met.

The signal LINK1000_LED is asserted high if communication is with another 1000BASET device.

The adapter signal LINK10_100_LED is asserted high if a 10BASET or 100BASET is connected to the system, in which case the adapter will have negotiated down to the required speed.

The ACT_LED signal is asserted high when there is activity on the Ethernet link.

Note: in the issue 01 BlueBird SDI - H.264 IP Adapter Evaluation Board the 1000 and 10_100 LINK LEDs signals are reversed (compared to the adapter). This has been fixed in issue 02 boards, please refer to Figure 3 and Figure 4 for correct connection details.

2.7. DSI Display Output

The DSI differential pairs should be designed to have an impedance of 100 Ohms +/- 10%.

The link comprises up to four data lanes plus a clock and the DSI interface can operate in either low power (LP) mode or high speed (HS) mode.

High-speed data is sent in extended packets, with the DSI interface switching back to LP mode between HS transmissions.

In low power mode, low-speed signals are sent using 1V2 LVCMOS signalling levels. These signals are bi-directional and operate across the DATA0 lane, with a maximum data rate of 10 Mb/s.

In high-speed mode, differential signals are transmitted using the SLVS-400 standard.

These signals have a common mode voltage of ~200mV, and swing of ~200mV. Data transmission is DDR.

Maximum clock speed in this implementation is 600MHz, equating to 1.2GBps for each of the four data links. The actual speed used will depend on the capabilities of the connected display.

2.8. System Signals

SYS_RST#

This signal is an active low input to the BlueBird SDI - H.264 IP Adapter board.

This signal is debounced. It should be pulled low for 30ms or longer to initiate a reset.

MEZZ_PGOOD

This is an output from the BlueBird SDI - H.264 IP Adapter.

It is pulled low with a 10k resistor on the BlueBird SDI - H.264 IP Adapter until all hardware defined power rails are active, at which point it will rise to a 3V3 LVCMOS high level.

3. Power Requirements

The BlueBird SDI - H.264 IP Adapter is powered by a single 5V power rail supplied from the carrier board.

The following recommendations are based on (but not identical to) standard computer ATX PSU specifications.

1. Power supply tolerance should be +/- 5%, including under step load transient of 0A4.
2. Maximum current draw will be 1A.
3. Output ripple should be less than 50mV under any load between 50mA and 1A.
4. Power supply rise must be smooth and continuous (monotonic) between 0V5 and 4V75.
5. For any 5ms segment of this rise time period, a straight line drawn between the end points of the waveform segment must have a slope greater than 0.4V /ms.
6. Ramp time, defined as the time between voltage rail reaching 0V5 and 4V5 should be in the range 0.2ms to 20ms.

3.1. Back-Drive Protection

The carrier board should be designed in a manner which prevents the BlueBird SDI - H.264 IP Adapter being back driven by the carrier board if the carrier board powers up before the adapter board, and vice-versa.

The MEZZ_PGOOD signal from the BlueBird SDI - H.264 IP Adapter should be used to indicate when the adapter has reached its power-up complete state.

3.2. Fusing

The BlueBird SDI - H.264 IP Adapter does not include any fusing.

Carrier board designers must include fusing to comply with relevant safety standards in any territory in which the carrier board / BlueBird SDI - H.264 IP Adapter assembly is to be used.

4. Mechanical

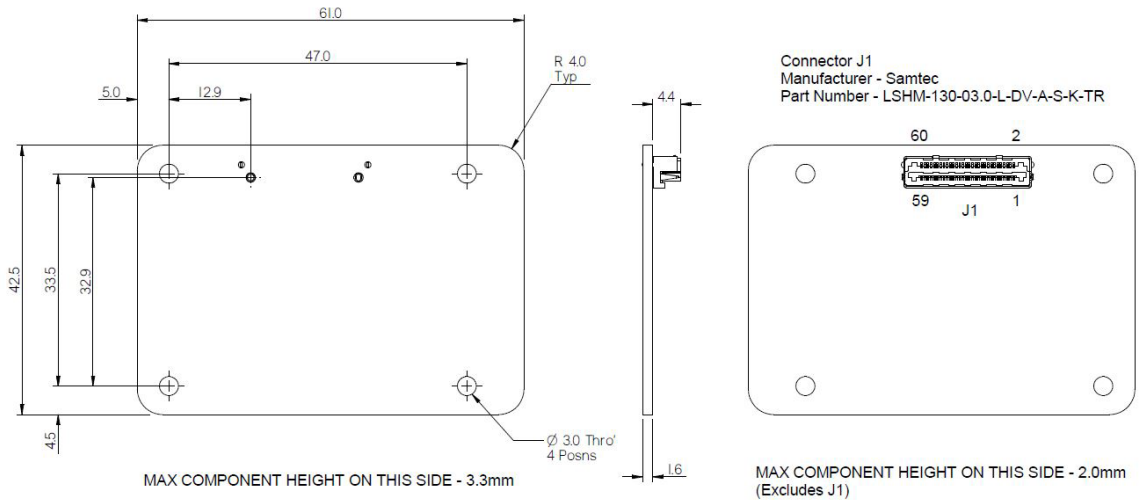

Figure 5. BlueBird SDI - H.264 IP Adapter mechanical overview.

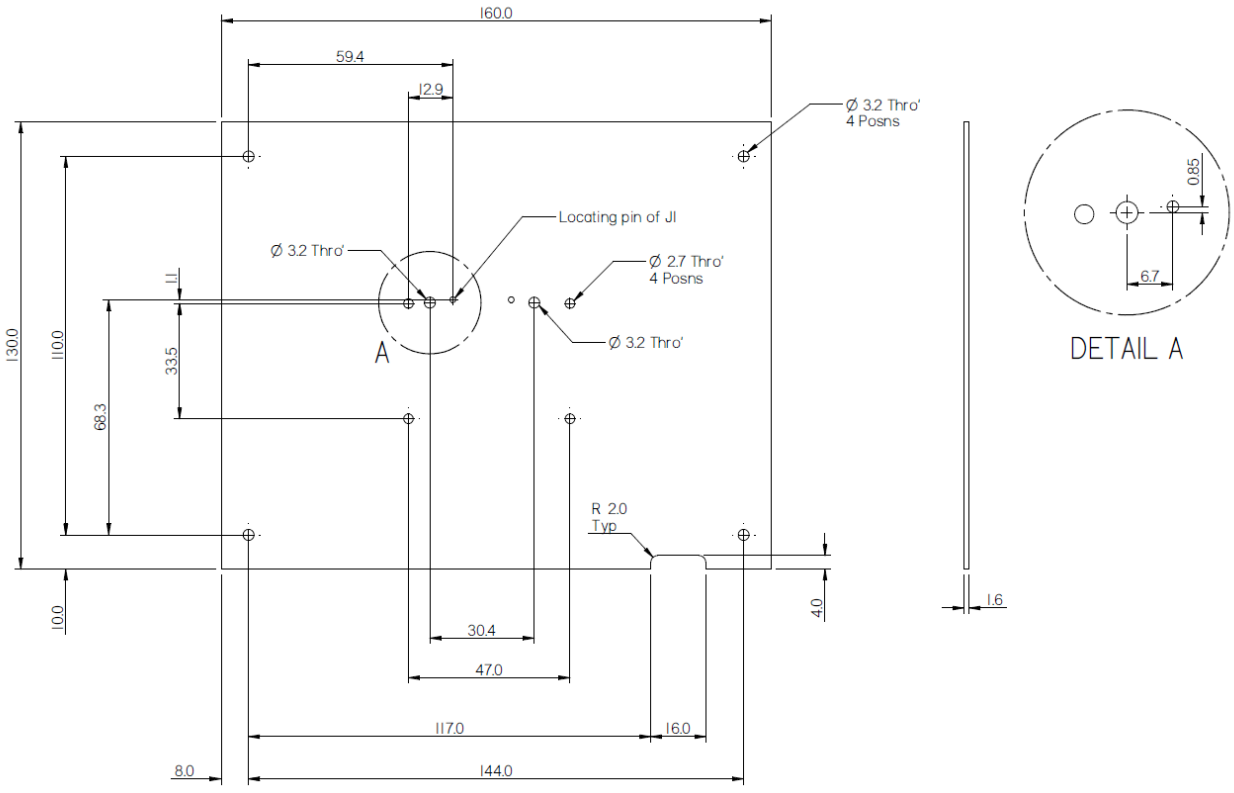

Figure 6. BlueBird SDI - H.264 IP Adapter Evaluation Board mechanical overview.

5. ORDERING INFORMATION

PART NUMBER	DESCRIPTION
AS-ADP-H264-001-A	BlueBird SDI - H.264 IP Adapter
AS-ADP-H264-001-EVAL-A	BlueBird SDI - H.264 IP Adapter Evaluation/Carrier board

Active Silicon

CONTACT DETAILS

Head Office:

Active Silicon Ltd
1 Waterside Court, Waterside Drive
Langley, Berks., SL3 6EZ, UK.

Tel: +44 (0)1753 650600
Email info@activesilicon.com
Website: www.activesilicon.com

North America Office:

Active Silicon, Inc.
479 Jumpers Hole Road, Suite 301,
Severna Park, MD 21146, USA.

Tel: +1 410-696-7642
Email: sales.us@activesilicon.com
Website: www.activesilicon.com

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