Active Silicon

BLUEBIRD ADAPTER SERIES

BlueBird Analog – SDI Adapter

Carrier Board Design Guide

AS-AP31C02-001-A

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Technical abbreviations used in this document	
HD	High Definition (video). https://en.wikipedia.org/wiki/High-definition_video
1080p30	HD video with resolution of 1920 x 1080 at 30 frames per second, progressive scanning. https://en.wikipedia.org/wiki/High-definition_video
HD-TVI	Proprietary high definition analog video standard.
HD-AHD	Proprietary high definition analog video standard.
FPGA	Field Programmable Gate Array https://en.wikipedia.org/wiki/Field-programmable_gate_array

1. Introduction

This document provides information for designing a custom system carrier board for the BlueBird Analog - SDI Adapter board (part number: AS-ADP-AHD-001-A). The BlueBird Analog - SDI Evaluation Board (part number: AS-AP31C02-001-A) is used as an example of a suitable carrier board.

The intended audience for this document is electronic engineers and PCB layout engineers designing carrier boards. It should be read in conjunction with the datasheet for the BlueBird Analog - SDI Adapter. System software engineers should also refer to the adapter VISCA commands documented in the datasheet.

The function of the BlueBird Analog - SDI Adapter is to receive standard definition PAL / NTSC and high definition AHD / HD-TVI analog video signals (at up to 1080p30Hz), convert the video to a corresponding SMPTE SDI standard and transmit the SDI video from the U.FL connector. 720p analog signals are not supported.

The BlueBird Analog - SDI Adapter has two mounting holes that can be used with M2 threaded mounting screws/pillars to mechanically retain the adapter to the carrier board. Electronically the adapter board connects to the carrier board using a single 20-way high speed board-to-board hermaphroditic connector that carries all power and data signals except the SDI output (which is supplied from a separate U.FL connector on the adapter board). On the 20-way board-to-board connector there are two single-ended analog video inputs and one differential video input. The active input is selected (at power up or reset) by configuration signals on the 20-way connector or (at any time) by a VISCA command. VISCA communication is supported over a 3.3V TTL serial communication interface on the 20-way connector. On the BlueBird Analog - SDI Evaluation Board this is connected to a FTDI USB-UART module.

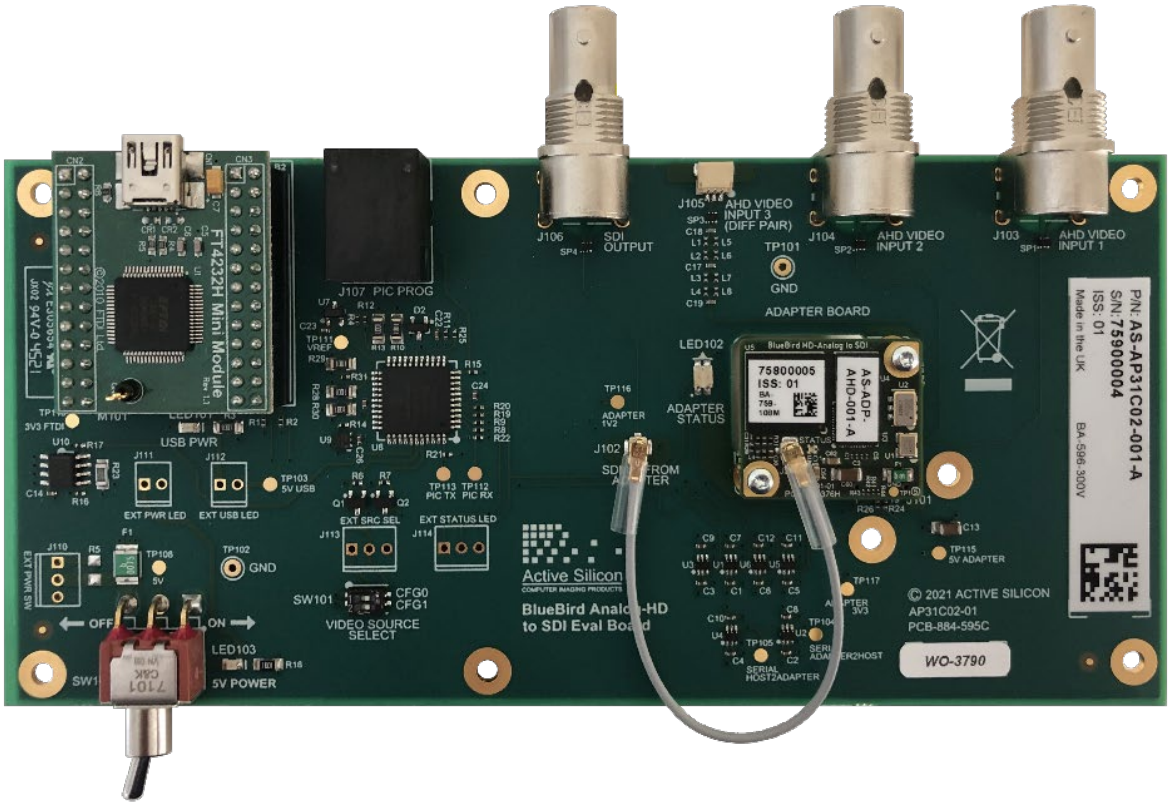

Figure 1: BlueBird Analog - SDI Evaluation Board with the BlueBird Analog - SDI Adapter fitted.

2. Electrical Interface Specification

The BlueBird Analog - SDI Adapter interfaces to the carrier board via a 20-way FCI Mezzostak hermaphroditic board-to-board connector with 2mm height, (FCI part number 10106813-021112LF). This may be mated with a connector on the carrier board having heights of from 2mm to 3.5mm (most common variant is 2mm), giving mated stack height options of 4mm, 4.5mm, 5mm and 5.5mm.

Connection direction in the following tables is with reference to the carrier board, i.e. an 'input' is an input to the carrier board, an 'output' is an output from the carrier board (to the adapter board).

PIN NO.	FUNCTION	SIGNAL LEVEL	PIN NO.	FUNCTION	SIGNAL LEVEL
2	1.2V reference	Input	1	JTAG TMS	3V3 LVCMOS Output
4	Diff. Signal -ve	100Ω analog O/P	3	JTAG TDI	3V3 LVCMOS Output
6	Diff. Signal +ve	100Ω analog O/P	5	JTAG TDO	3V3 LVCMOS Input
8	GND		7	JTAG CLK	3V3 LVCMOS Output
10	Video Signal 2	75Ω analog O/P	9	3.3V ref.	Input
12	GND		11	Config0	3V3 LVCMOS Input
14	Video Signal 1	75Ω analog O/P	13	Config1	3V3 LVCMOS Input
16	GND		15	5V	Output
18	Tx	3.3V LVCMOS (TTL compatible) Input	17	5V	Output
20	Rx	3.3V LVCMOS (TTL compatible) Output	19	GND	

Table 1. BlueBird Analog - SDI Adapter Evaluation/Carrier Board connector (J101) pinout.

Important:

Due to the physical nature of the connector, the pin-out on the carrier board is mirrored with respect to the Analog – SDI adapter board so that pin 1 on the adapter board mates to pin 2 on the carrier, pin 3 to pin 4 and so on.

2.1. Analog Single Ended Inputs

On the carrier board the tracks for these signals should be laid out as 75-Ohm single ended.

There should be ESD protection on the carrier board close to the external cable connector. A suitable part is Semtec part number RCLAMP0522P.TCT.

Unused analog single ended input signals may be left unconnected.

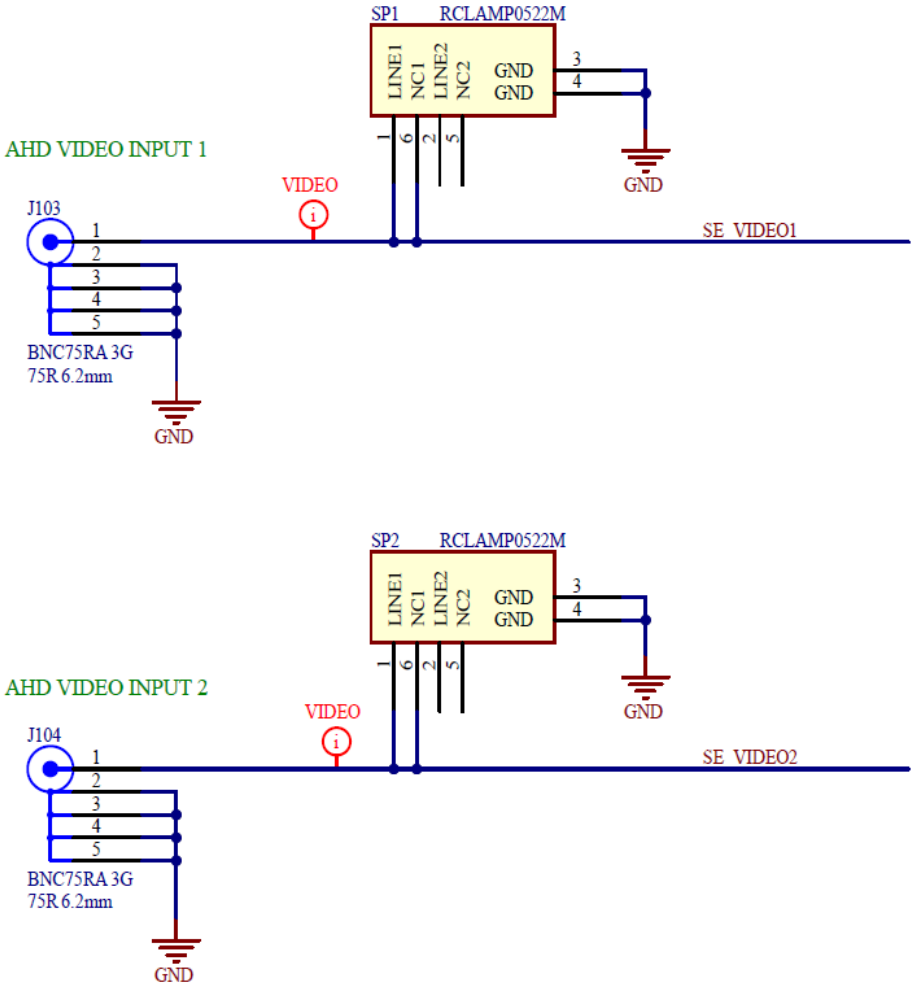

Figure 2: BlueBird Analog - SDI Adapter Evaluation board single ended input circuits

2.2. Analog Differential Inputs

On the carrier board the tracks for these signals should be laid out as 100-Ohm differential.

There should be ESD protection on the carrier board close to the external cable connector. A suitable part is Semtec part number RCLAMP0522P.TCT.

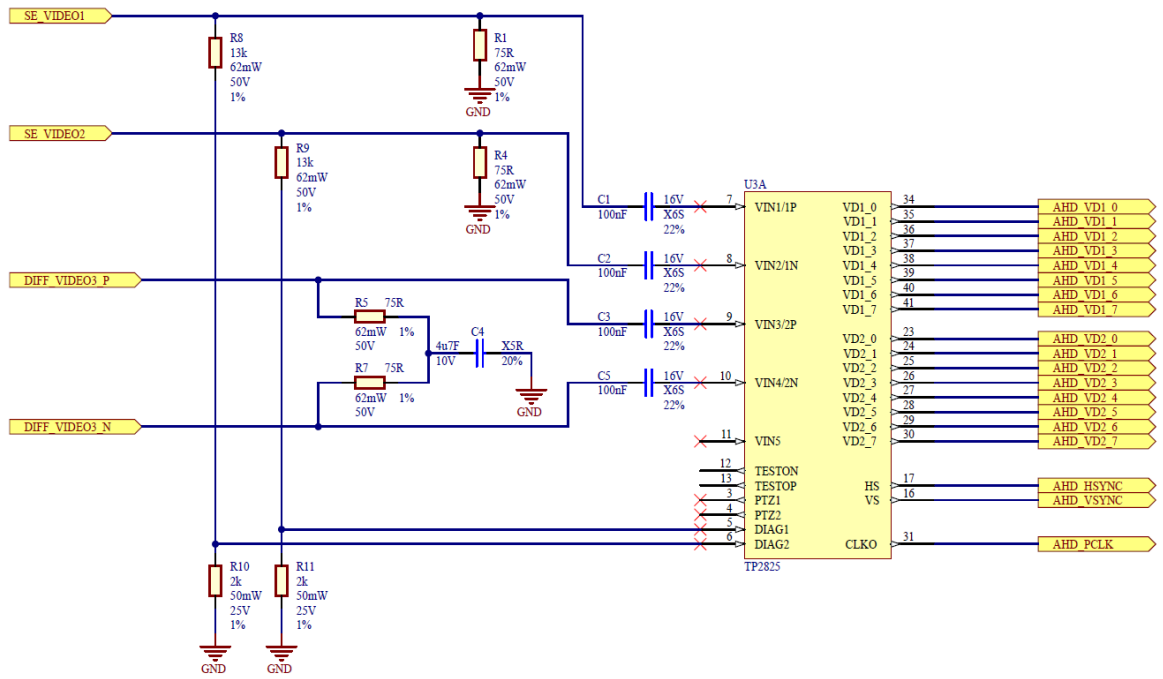

Figure 3: BlueBird Analog - SDI Adapter board single ended and differential input circuits

For optimal performance, a passive low-pass filter with a cut-off frequency corresponding to the analog operating mode is recommended. A suitable filter design is shown in Figure 4.

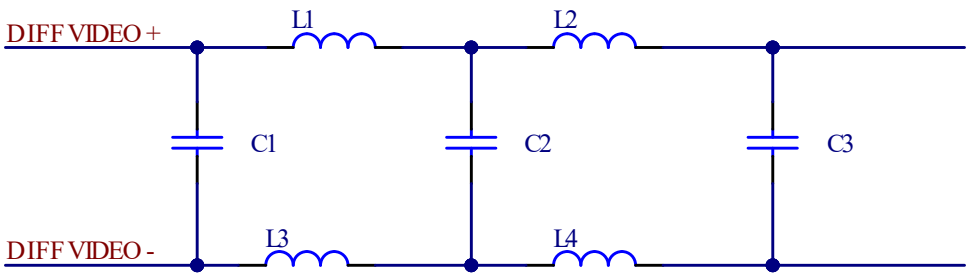

Figure 4: Low Pass Filter Design

TARGET INPUT MODE	L1 / L2 / L3 / L4	C1	C2	C3	3dB Point
1080p 25/30	390nH	24pF	47pF	24pF	24.06MHz
1080p 50/60	240nH	18pF	33pF	18pF	37.58MHz
Actual (used on Eval. Board)	200nH	22	33	22	40.16MHz

Table 2. Suitable/possible values for Adapter differential video input low-pass filter components.

Note that 1080p 50/60Hz operating modes are not supported in the current product.

For use with unspecified signals, set the component values so that the cut-off frequency is appropriate for the most demanding operating mode.

For high noise environments, a common mode filter such as TDK part number ACT45L-201-2P-TL000 may also be used.

Unused analog differential input signals may be left unconnected.

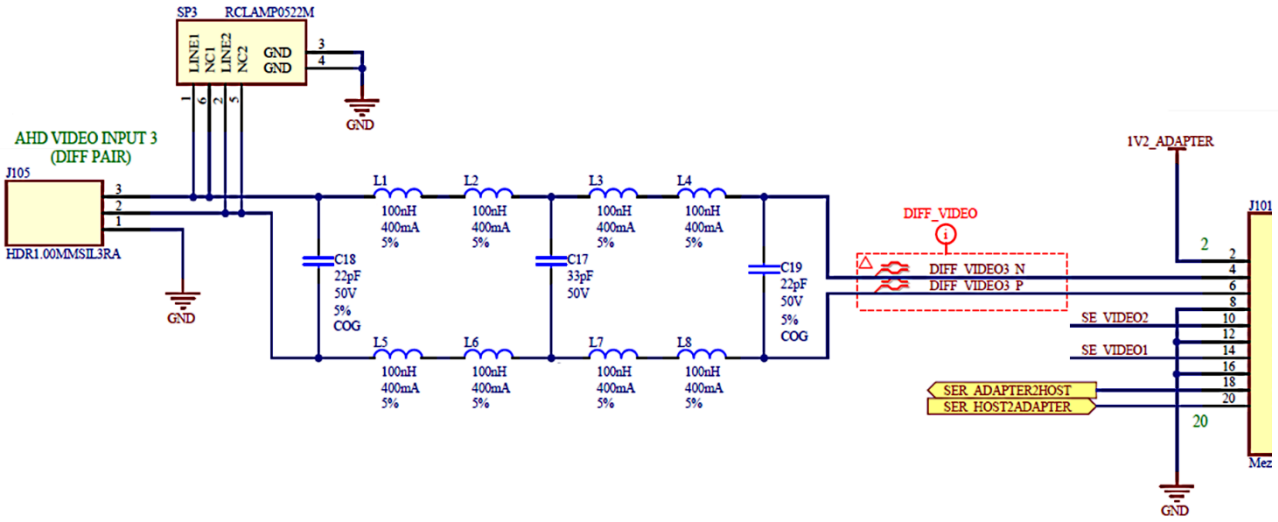

Figure 5: BlueBird Analog - SDI Adapter Evaluation Board differential input low-pass filter circuit.

The actual design of the filter implemented the on the BlueBird Analog - SDI Evaluation Board is shown above, the components used were chosen based on availability rather than optimal design, giving an indication of the amount of variation there can be in the filter design.

2.3. Serial Interface

Pins 18 and 20 (on the carrier board 20-way board-to-board connector) are the serial TX and RX interfaces to the adapter, operating at 3V3 level, with idle (bit value zero) high.

On the adapter the serial RX and TX signals have been implemented with weak pull-ups; if they are not being used they can be left unconnected.

2.4. Input Source Select

The CONFIG0 and CONFIG1 signals select the input video source on power up and reset, as shown in Table 2.

CONFIG1	CONFIG0	VIDEO INPUT CHANNEL SELECTION
GND	GND	Test pattern
GND	3.3V	Channel 1 (single ended)
3.3V	GND	Channel 2 (single ended)
3.3V	3.3V	Channel 3 (differential)

Table 3. Adapter video input selection on power up.

The CONFIG0 and CONFIG1 signals have been implemented with a weak pull-up on the BlueBird Analog - SDI adapter, making the default input channel 3 (differential video).

If the CONFIG signals are used on the carrier board, they should be actively driven to 0V or 3V3.

A pull up (10k or less) to the adapter 3V3 reference output rail can be implemented on the carrier board, and this signal can then be pulled low by either a switch or transistor in an open-collector configuration.

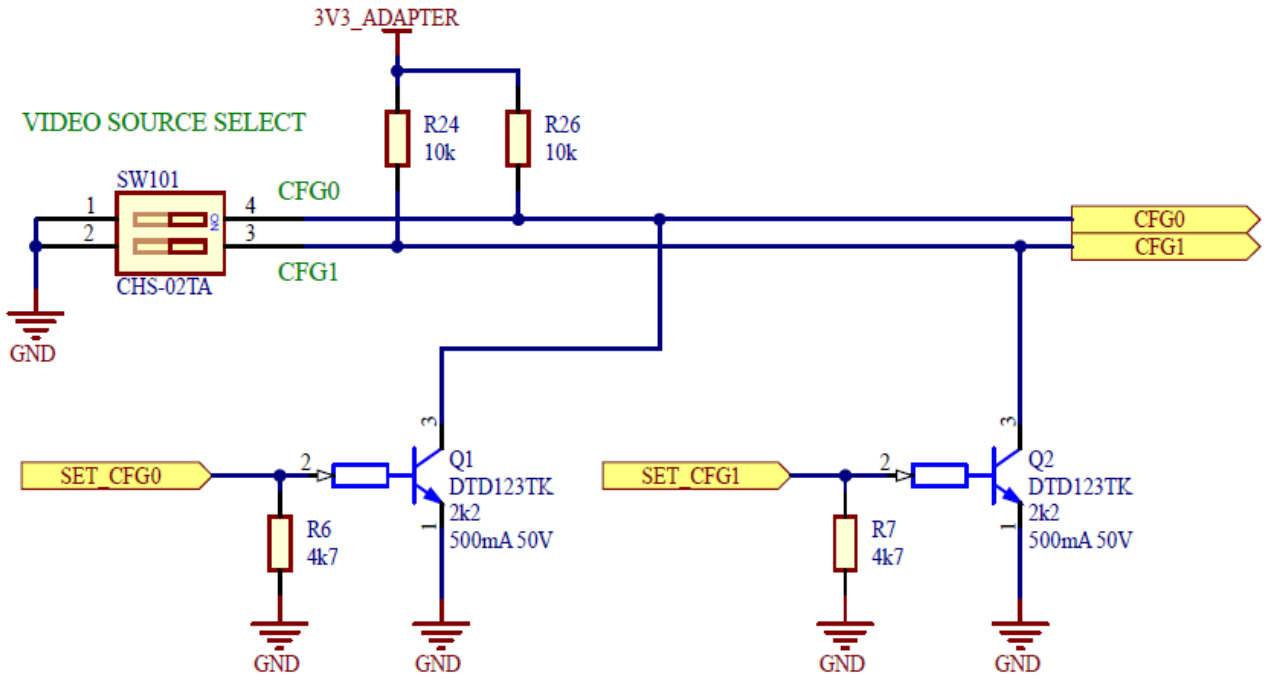

Figure 6: BlueBird Analog - SDI Evaluation Board configuration signal circuit

2.5. JTAG Programming

Programming of the FPGA on the adapter board is via the four standard JTAG signals, TMS, TCK, TDO and TDI. There is no requirement for a TRST# signal. Maximum programming clock speed is 30MHz.

2.6. ESD Protection

ESD protection should be used on all externally facing inputs as appropriate for the overall system design.

The Active Silicon evaluation/carrier board uses Semtech part number RCLAMP0522P.TCT for this purpose.

3. Power Requirements

The adapter board is powered by a single 5V power rail supplied from the carrier board.

1. Power supply tolerance should be +/- 5%, including under step load transient of 200mA.
2. Typical maximum operating current draw (@1080p30) will be approximately 210mA.
3. Output ripple should be less than 50mV under any load.
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.

The 5V rail powers the switched mode power supplies on the adapter board, which produce the 1V2 and 3V3 power rails used internally on the adapter board.

The adapter switched mode supplies implement bulk decoupling capacitance on the 5V side to minimize high amplitude switching noise on the 5V power rail. However, if the 5V supply is not located close to the 20-way board-to-board connector on the carrier board, there may be some benefit in adding further bulk decoupling capacitance on the 5V power rail, for example a 22uF ceramic capacitor.

The 1V2 and 3V3 power rails generated on the adapter board are available on two of the 20-way board-to-board connector pins. There are three primary reasons for this:

1. To provide the required reference voltage when performing JTAG programming of the FPGA.
2. To allow the accuracy of the onboard voltages to be measured during production test.
3. As part of a solution to provide back-drive protection during the power-up sequence (see next section).

There is an estimated minimum 200mA spare current capacity on both the 1V2 and 3V3 power outputs.

However, making use of this power to drive large circuit elements on the carrier board will increase both thermal stress and electrical noise on the adapter board, degrading the adapter board performance.

For this reason, it is recommended that carrier board power draw on these rails should be kept as small as possible.

3.1. Back-Drive Protection

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

A convenient means of accomplishing this is to use a Texas SN74LVC1T45DCKR level translator, using the adapter sourced reference voltage to power one side of the part and the carrier board sourced rail to power the other. When either of the rails is not present, the level-translator will act a signal isolator.

4. Mechanical

The dimensions of the BlueBird Analog - SDI Adapter are shown in Figure 7 below. The adapter board has two mounting holes that can be used with M2 threaded mounting screws/pillars to mechanically retain the adapter to the carrier board.

The adapter board interfaces to the carrier board via a 20-way FCI Mezzostak hermaphroditic board-to-board connector with 2mm height, (FCI part number 10106813-021112LF). This may be mated with a connector on the base board having heights of from 2mm to 3.5mm (most common variant is 2mm), giving mated stack height options of 4mm, 4.5mm, 5mm and 5.5mm.

To cope with manufacturing tolerances on the alignment of the Mezzostak connectors the mounting holes on the carrier board should be 2.5mm diameter.

The 2.2mm mounting holes on the adapter board are connected to ground. It is expected that metal pillars will be used so that they can provide a thermal path to a large ground plane/heat sink on the carrier board.

It is recommended that this approach is used when designing a new carrier board.

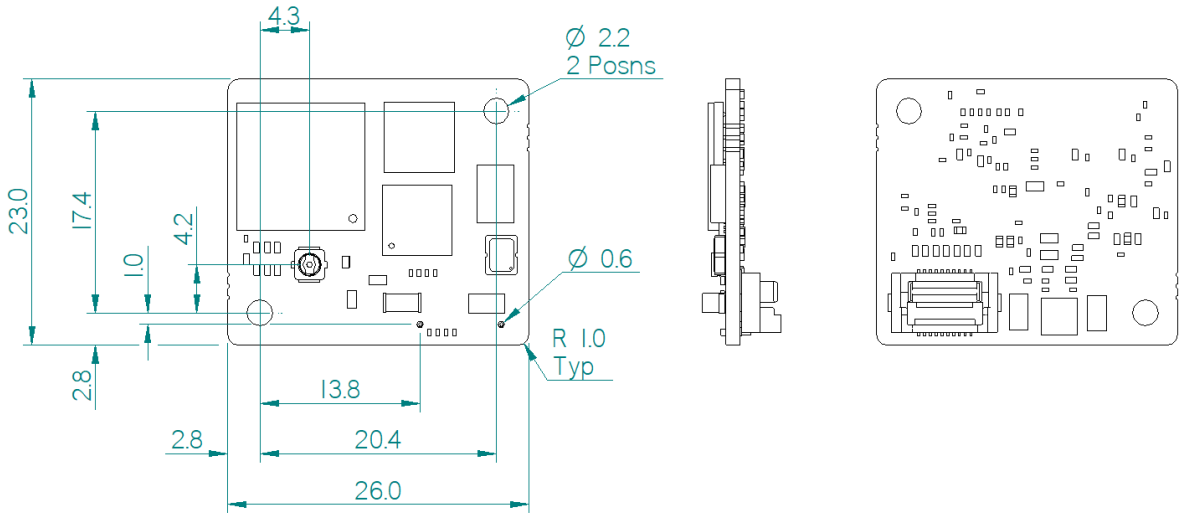

Figure 7: BlueBird Analog - SDI Adapter (AS-ADP-AHD-001-A) mechanical overview (all dimensions in mm).

5. ORDERING INFORMATION

PART NUMBER	DESCRIPTION
AS-ADP-AHD-001-A	BlueBird Analog - SDI Adapter
AS-AP31C02-001-A	BlueBird Analog - SDI Evaluation Board
AS-ADP-AHD-001-EVAL-A	Evaluation Kit for the BlueBird Analog - SDI Adapter, including the BlueBird Analog - SDI Evaluation Board (**AS-AP31C02-001-A**) with power supply and U.FL/USB cable.

Revision History

VERSION	DATE	CHANGES
v.1.0.0	24-10-2024	First release.

This document is to be used in conjunction with the AS-ADP-AHD-001-A documentation and documentation from device manufacturers, do not use this design guide as the only reference for any design.

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