User Guide

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SIB1256
4 x 16 SiPM Sensor Interface Board
SensL ArraySL-4

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General Safety Precautions

Use Proper Power Source

The SIB1256 is powered with a +5V power source directly from Vertilon's PhotoniQ multi-channel data acquisition systems. A separate +48V power source included with the product is used to generate the high voltage bias signals. Use with any other power sources may result in damage to the product.

Operate Inputs within Specified Range

To avoid electric shock, fire hazard, or damage to the product, do not apply a voltage to any input outside of its specified range.

Electrostatic Discharge Sensitive

Electrostatic discharges may result in damage to the SIB1256. For this reason, the SIB1256 board is intended to be operated in a user's conductive instrument enclosure.

Do Not Operate in Wet or Damp Conditions

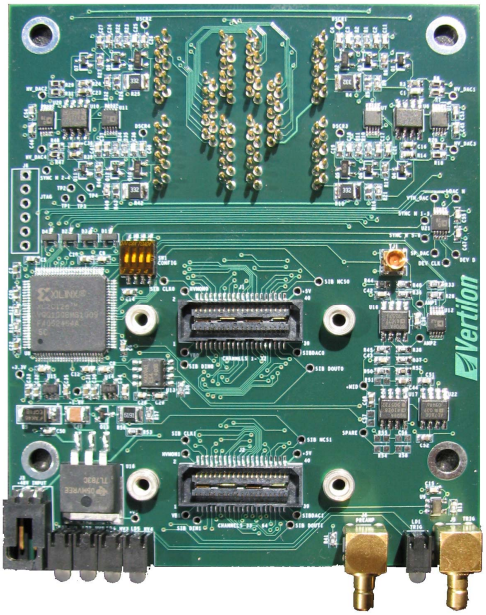
To avoid electric shock or damage to the product, do not operate in wet or damp conditions.

Do Not Operate in Explosive Atmosphere

To avoid injury or fire hazard, do not operate in an explosive atmosphere.

Product Overview

- Interface board for SensL ArraySL-4, silicon photomultiplier 4 x 4 array
- Supports up to four ArraySL-4 devices for a total of 64 channels
- Leading edge discriminator for event trigger and timing
- Adjustable gain and threshold for discriminator channel
- Fault protected high voltage bias supplies for each SiPM array
- Bias supplies include status LEDs and trim for device gain matching
- 100% compatible with Vertilon's PhotoniQ multichannel DAQs
- Simplified control through PhotoniQ graphical user interface



The SIB1256 sensor interface board allows up to four SensL ArraySL-4 silicon photomultiplier arrays (SiPM) to easily interface to a Vertilon PhotoniQ multichannel data acquisition system. The SiPM devices are inserted into receptacle pins on the bottom side of the printed circuit board where their anode output signals are routed directly to two sensor interface board (SIB) connectors. The SIB connectors conform to Vertilon's standard, low-noise, multi-channel, cable interconnection system. Each connector mates to a micro-coaxial cable assembly that connects 32 device outputs to the PhotoniQ. Bias to SiPM arrays is provided by four on-board adjustable high voltage bias supplies that are enabled and configured through the PhotoniQ graphical user interface. Gain matching between the arrays is easily accomplished through the GUI using the voltage trimming function on each bias supply. The supplies are fault protected and include status LEDs to indicate when enabled or when a fault is detected. A special current-sense output from each bias supply is summed together in a variable gain preamplifier on the SIB1256 to represent the total AC charge signal measured by all four SiPM arrays. This signal, which is available to the user on an SMB jack, is fed into a user-programmable threshold leading edge discriminator. The discriminator generates a trigger signal on an SMB jack when an event exceeding a particular energy threshold is detected on any of the ArraySL-4 devices. The trigger output is typically connected to the trigger input on the PhotoniQ data acquisition system where it is used to initiate the collection of the energy signals from the sensor devices connected to the DAQ system's inputs. The full functionality and operation of the SIB1256 is conveniently controlled through the PhotoniQ's graphical user interface. Intelligent software in the PhotoniQ constantly monitors the status of its SIB connectors to determine the type of sensor interface board attached to them. Once recognized, a dialog box specific to the recognized SIB is made available in the GUI through which the user has complete control over its operation.

The various functions on the SIB1256 are described in greater detail on the following pages. When necessary, refer to the functional block diagram shown in Figure 1 below.

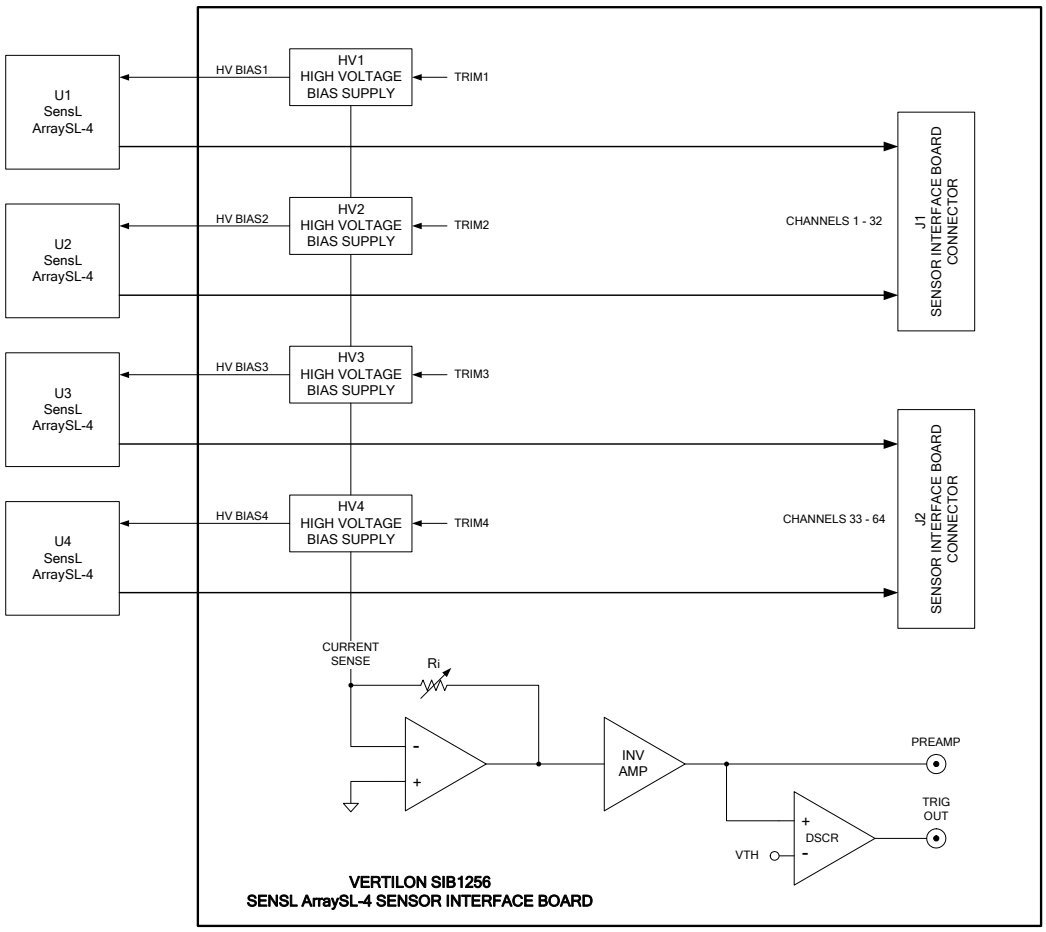


Figure 1: Functional Block Diagram

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Specifications

(T_A = +25C, unless otherwise noted)

Description	Sym	Min	Typ	Max	Units	Notes
INPUT CHANNELS						
Quantity			64			64 direct coupled channels to PhotoniQ channels 1 to 64.
Anode Bias Voltage	VB		+1.50		V	Detector anode voltage supplied from PhotoniQ data acquisition system
HIGH VOLTAGE BIAS SUPPLIES						
Quantity	HV1 – HV4		4			One for each ArraySL-4
Nominal Voltage Range		+26.8		+31.4	V	The actual voltage applied to the detector common cathode is +1.5V greater to account for the +1.5V anode bias when a PhotoniQ is connected to the SIB1256.
Trim Range		-200		+200	mV	Added to the nominal bias voltage.
PREAMPLIFIER						
Transimpedance (Low Gain)	R_{in}		200		Ω	
Transimpedance (Med Gain)	R_{in}		400		Ω	
Transimpedance (High Gain)	R_{in}		600		Ω	Gain selected through GUI interface.
LEADING EDGE DISCRIMINATOR						
Threshold Adjustment Range	V_{th}	0		2.5	V	Referenced to baseline level at discriminator input. Threshold (0 to 100%) controlled through GUI interface.
Threshold to Output Delay	t_d		7		nsec	
TRIGGER OUTPUT						
Output Impedance			50		Ω	
Logic High Output Level	V_{OH}	+4.3	+4.8		V	(I_{OH} = -32mA)
Logic Low Output Level	V_{OL}		+0.2	+0.6	V	(I_{OL} = 32mA)
DIMENSIONS						
Width	W		84		mm	
Length	L		102		mm	(not including SMB connectors which extend past PCB edge)
Thickness	T		1.57		mm	(printed circuit board only)

Table 1: Specifications

Typical Setup

A typical radiation detection setup using a SIB1256 is shown below. Four SensL ArraySL-4 silicon photomultipliers in a 2 x 2 arrangement are attached to the SIB1256 which is positioned in an optical assembly to detect incoming radiation. The 64 outputs from the SiPM arrays are routed on the SIB1256 to the SIB connector that connects to a PhotoniQ IQSP482 or IQSP582 multichannel data acquisition system. The discriminator channel produces a trigger to the PhotoniQ whenever a radiation event is detected on any of the SiPMs. The energy level threshold for the radiation event is set by the user through the PhotoniQ graphical user interface. Charge signals from the 64 anodes of the ArraySL-4 devices are acquired by the PhotoniQ for each trigger produced by the SIB1256. Digitized output data from the PhotoniQ is sent through a USB 2.0 connection to a PC for display, logging, or real time processing. In the figure below, the PhotoniQ GUI is set to display an 8 x 8 image of the energy levels for each event captured.

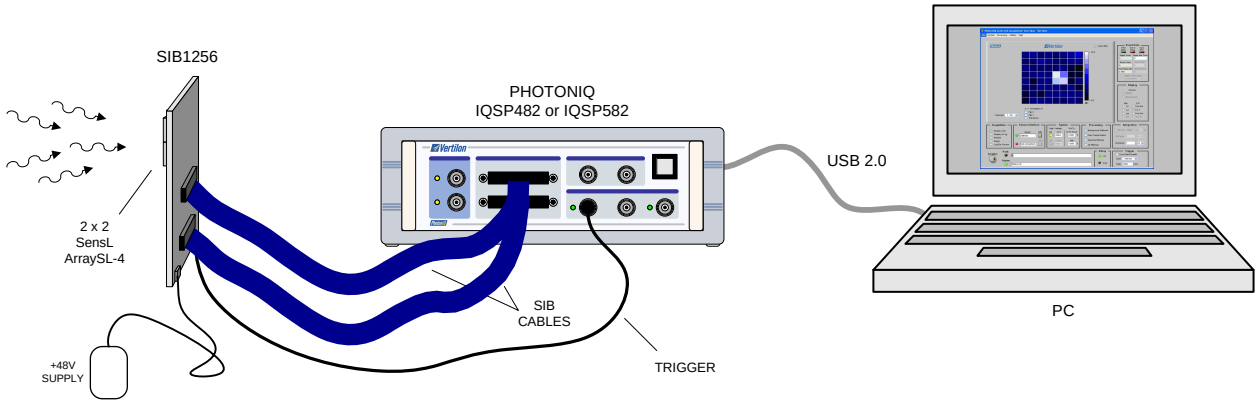

Figure 2: Typical Setup

ArraySL-4 Detector Configuration

The SIB1256 supports up to four SensL ArraySL-4 silicon photomultiplier devices. The devices are attached to the SIB1256 as shown in the figure below. If one device is used, the device is plugged into the receptacle pin pattern in the center of the board. When using four ArraySL-4s in a 2 x 2 configuration, they are plugged into the four receptacle pin patterns symmetrically positioned around the center of the SIB1256. Care should be taken to avoid bending the device pins when inserting the ArraySL-4 into the receptacle pins. The receptacle pins are sized for direct insertion of the ArraySL-4 without the additional socket that is normally attached to it. The socket can be used however but a large amount of insertion force will be required.

Detector Channels

The 64 anode signals from the ArraySL-4 devices are routed directly on the SIB1256 to the SIB connector. These signals connect to channels 1 through 64 of a Vertilon PhotoniQ IQSP482 or IQSP582 charge integrating data acquisition system. For applications using either one or two ArraySL-4 devices, a 32 channel Vertilon DAQ such as the IQSP480 or IQSP580 can be used instead. The PhotoniQ utilizes DC-coupled high speed transimpedance amplifiers that maintain a DC bias voltage of +1.50 volts on each of its inputs. Because the ArraySL-4 devices are of the common cathode type, the current polarity to the PhotoniQ preamplifiers is *into* the inputs. For this reason, the *Input Polarity* under the *Data Configuration* menu in the PhotoniQ GUI should be set to *negative*. See the PhotoniQ user's manual for more details.

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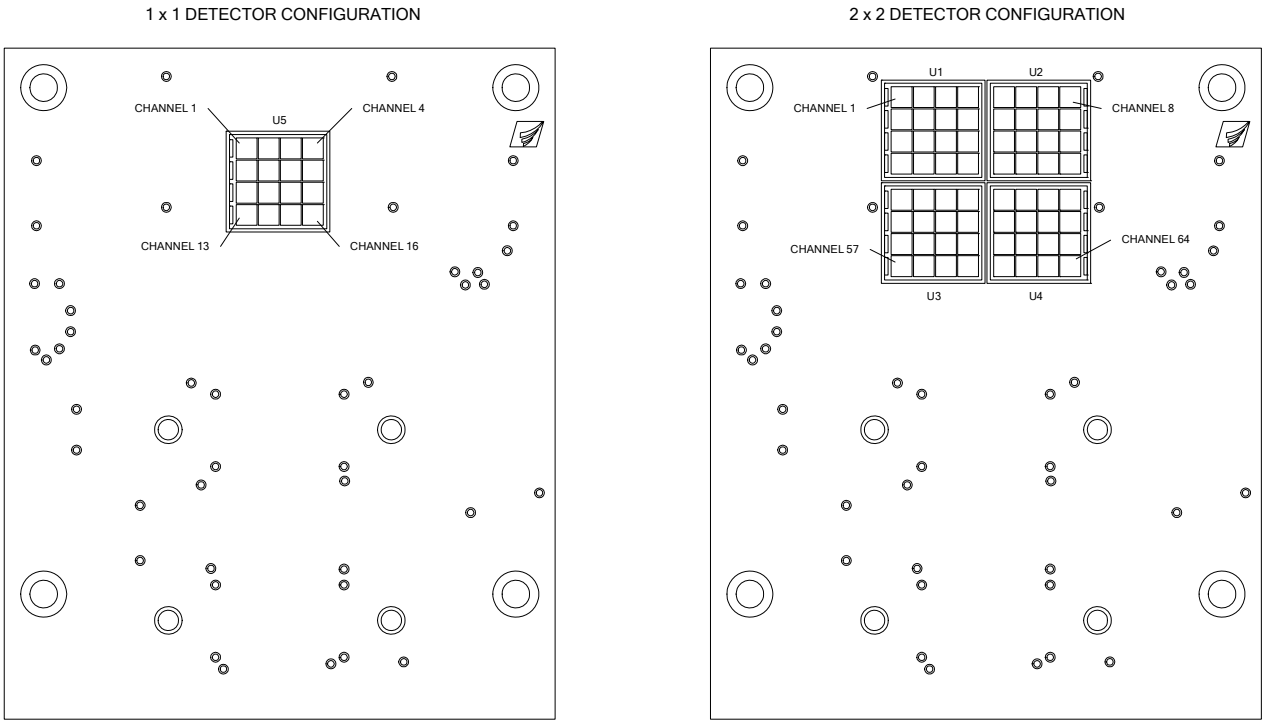

Figure 3: ArraySL-4 Detector Configuration

High Voltage Bias Supplies

Four high voltage bias supplies are available on the SIB1256 — one for each ArraySL-4 device. The supplies are configured using the dialog box available through the PhotoniQ GUI shown on the next page. The bias level to the detectors is set using the *High Voltage Bias* control box. Each supply can be trimmed by ±200mV around this nominal bias level using the *Bias Trim* control boxes. The supplies are individually enabled and disabled using the *Array Enable* check boxes or can be master controlled by the *High Voltage Bias Enable* check box. Green status LEDs on the SIB1256 indicate if the bias supply is enabled or disabled. If a fault such as a short to ground is detected while a supply is enabled, its corresponding status LED will turn red. The fault can be cleared only if the fault condition is fixed and the data from the dialog box is resent to the SIB1256. The +48V supply must be connected to the SIB1256 to use the on-board bias supplies. If it is not connected and a supply is enabled, the supply's status LED will indicate a fault. Note that the actual bias voltage measured on the cathode pins for the ArraySL-4's will be 1.5V greater than the voltage specified in the GUI dialog box because the device anodes are held at +1.5V by the PhotoniQ transimpedance amplifiers.

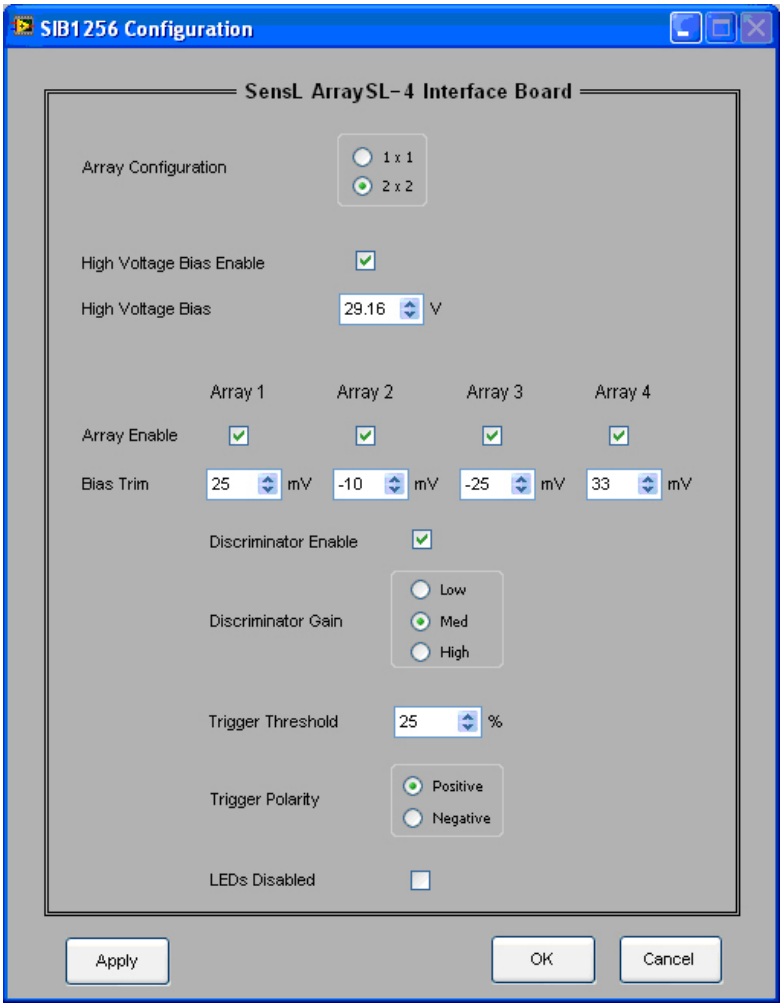

Figure 4: SIB1256 Dialog Box

Preamplifier

Each bias supply to the ArraySL-4 devices has a special output that connects to the input of a single current-sensitive preamplifier on the SIB1256. The preamplifier generates a voltage signal in response to a current signal on its input from any of the four bias supplies. This voltage signal is available on an SMB output connector on the SIB1256 and is also fed to the input of the discriminator. There are three settings for the preamplifier gain — low, medium, and high.

Discriminator

The discriminator generates a logic signal when a pulse from the preamplifier exceeds a user-defined threshold. The SIB1256 GUI dialog box allows the user to set this threshold between 0 and 100% where 100% is equal to the maximum possible signal amplitude in the discriminator channel. When a pulse is detected, the trigger output from the board becomes active. The polarity can be set to either *positive* or *negative*.

Figure 5 shows the operation of the leading edge discriminator. A negative-going current pulse into the preamplifier results in a negative-going pulse on its output. This pulse is compared to a threshold that is adjusted using the SIB1256 dialog box in the PhotoniQ GUI. A logic high (for *positive* polarity control) is generated after a small delay (t_d) from when the pulse first crosses the threshold, V_{th}. The discriminator switches back to a logic low when the pulse crosses the threshold from the opposite direction as it returns back to the baseline level. The trigger LED blinks when a trigger signal is generated.

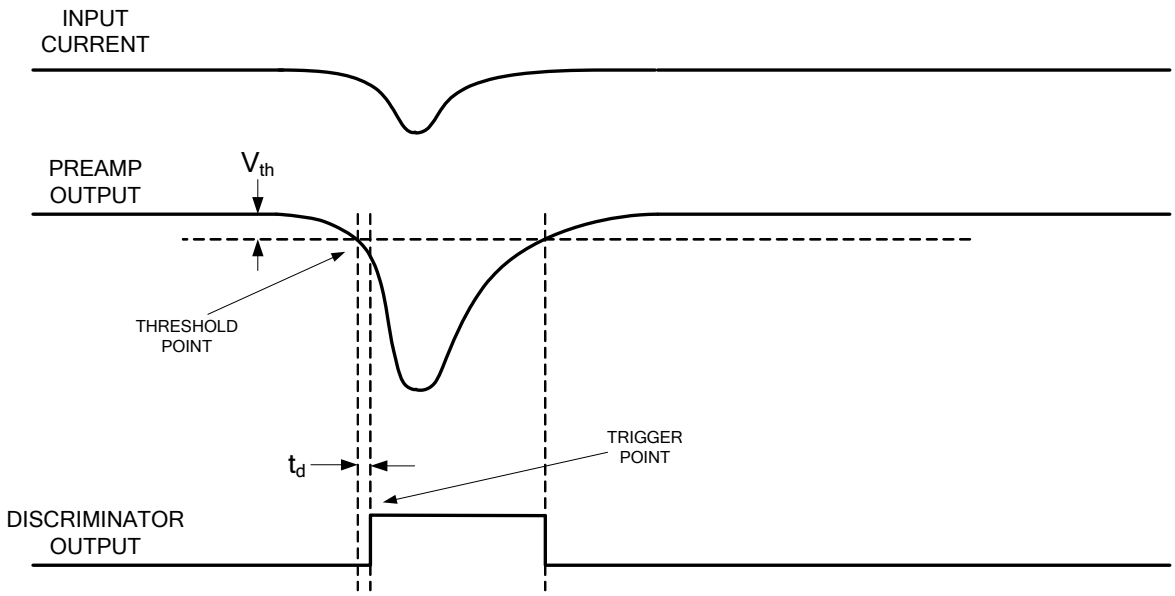

Figure 5: Leading Edge Discriminator Timing

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Top View

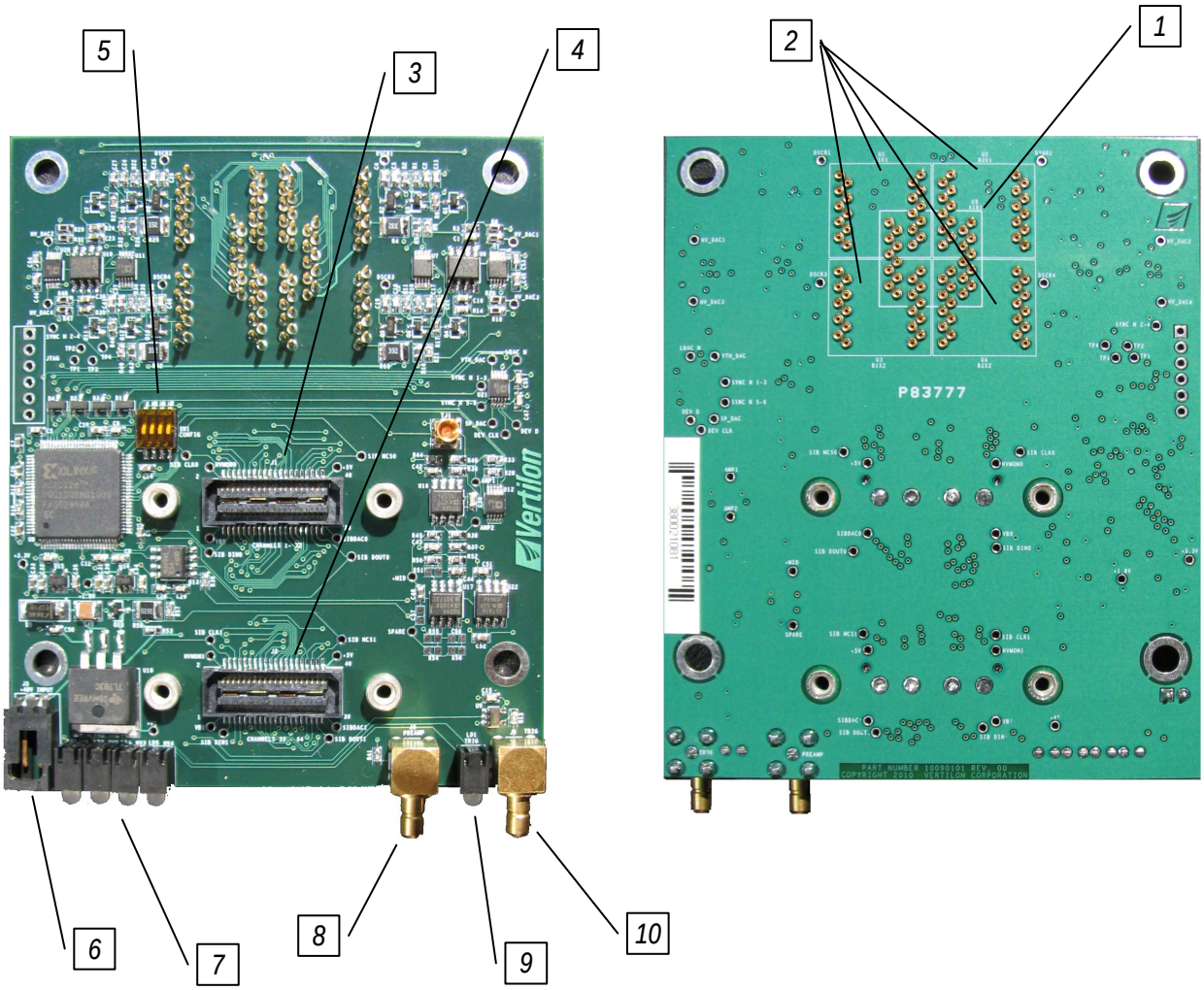

Figure 6: PCB Top and Bottom Views

1. Connection Pins for ArraySL-4 (U5)
2. Connection Pins for ArraySL-4 (U1 – U4)
3. SIB Connector, Channels 1 to 32 (J1)
4. SIB Connector, Channels 33 to 64 (J2)
5. Configuration Switches
6. +48V Power Input (J3)
7. High Voltage Bias Status LEDs
8. Preamplifier Output (J4)
9. Trigger Status LED
10. Trigger Output (J5)

Component Locations and Functions

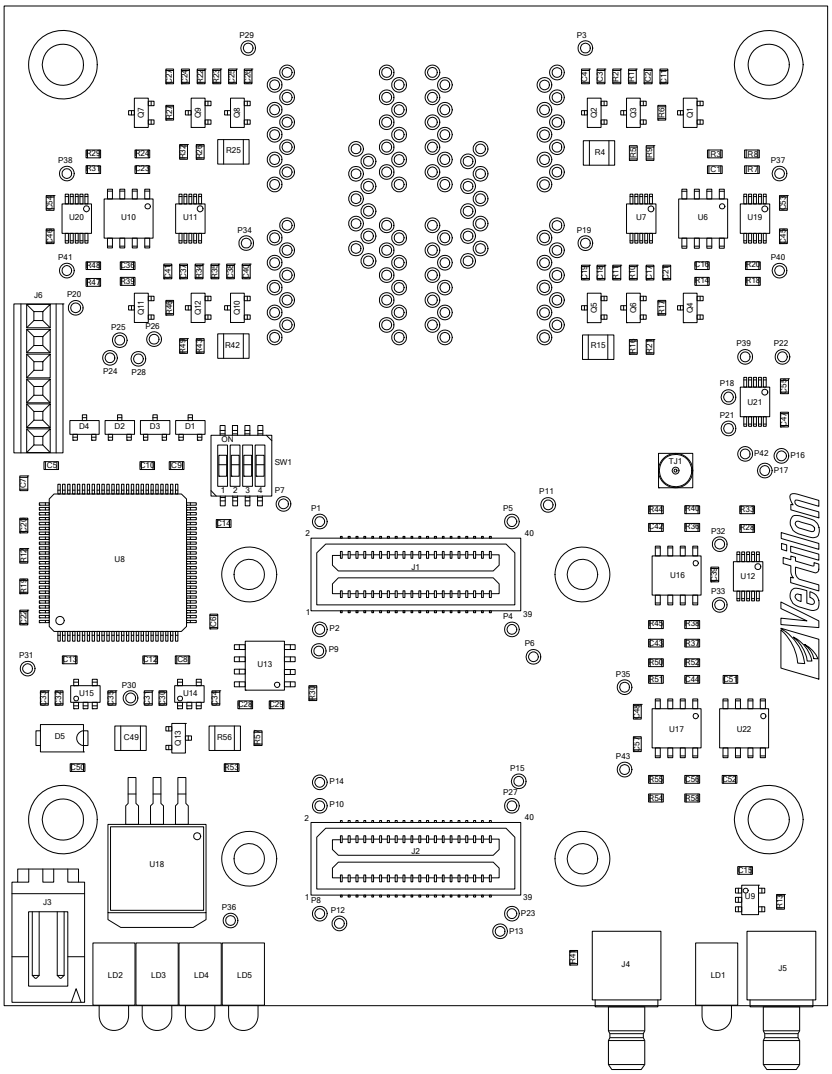

Figure 7: Component Locations and Functions

Name	Function	Description
J1	CHANNEL 1 - 32	Sensor interface board connector, channels 1 through 32 from ArraySL-4 devices
J2	CHANNEL 33 - 64	Sensor interface board connector, channels 33 through 64 from ArraySL-4 devices
J3	+48V	+48V power input for high voltage bias supplies
J4	PREAMP	Preamplifier output
J5	TRIG OUT	Trigger output
J6	JTAG	JTAG interface

Table 2: Connectors

Name	Function	Description
LD1	HV1 STATUS	Bicolor (red/green) LED indicator for HV bias supply #1
LD2	HV2 STATUS	Bicolor (red/green) LED indicator for HV bias supply #2
LD3	HV3 STATUS	Bicolor (red/green) LED indicator for HV bias supply #3
LD4	HV4 STATUS	Bicolor (red/green) LED indicator for HV bias supply #4
LD3	TRIG OUT	Green LED indicator for trigger output
SW1: 1-2	DEV ADDR 1:0	Sets the device address for control by the PhotoniQ. Set both switches to “ON”.
SW1: 3-4	DEV TYPE 1:0	Sets the device type for control by the PhotoniQ. Set both switches to “ON”.

Table 3: LEDs and Switches

Name	Ref #	Description
+5.0V	P5	+5.0V power supply from the PhotoniQ
+3.3V	P31	+3.3V internal power supply
+1.8V	P30	+1.8V internal power supply
+MID	P35	Preamplifier baseline voltage, normally +2.5V
VB	P2	Bias voltage from PhotoniQ to SiPM anodes. Normally at +1.50V when PhotoniQ set to negative input polarity.
+VS	P36	+41V internal power supply voltage.

Table 4: Test Points

SIB Connector Pinout

The SIB1256 connectors and cables are fully compatible with all Vertilon PhotoniQ systems. For applications utilizing data acquisition systems other than Vertilon's PhotoniQ series, the pinouts for connectors J1 and J2 are provided in Table 5 as a reference.

J1				J2			
Signal Name	Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name	Pin #
VB	1	HVMON	2	VB	1	HVMON	2
SIB_DIN0	3	SIB_CLK0	4	SIB_DIN1	3	SIB_CLK1	4
P16	5	P32	6	P48	5	P64	6
P15	7	P31	8	P47	7	P63	8
P14	9	P30	10	P46	9	P62	10
P13	11	P29	12	P45	11	P61	12
P12	13	P28	14	P44	13	P60	14
P11	15	P27	16	P43	15	P59	16
P10	17	P26	18	P42	17	P58	18
P9	19	P25	20	P41	19	P57	20
P8	21	P24	22	P40	21	P56	22
P7	23	P23	24	P39	23	P55	24
P6	25	P22	26	P38	25	P54	26
P5	27	P21	28	P37	27	P53	28
P4	29	P20	30	P36	29	P52	30
P3	31	P19	32	P35	31	P51	32
P2	33	P18	34	P34	33	P50	34
P1	35	P17	36	P33	35	P49	36
SIB_DOUT0	37	SIB_NCS0	38	SIB_DOUT1	37	SIB_NCS1	38
SIBDAC	39	+5V	40	SIBDAC	39	+5V	40

Table 5: Sensor Interface Board (SIB) Connectors

Power (+5V) supplied through pin 40 if PhotoniQ is not used
Pins 3, 4, 37, 38 used by PhotoniQ and should be left unconnected
Ground supplied through SIB cable shielding

Mechanical Information

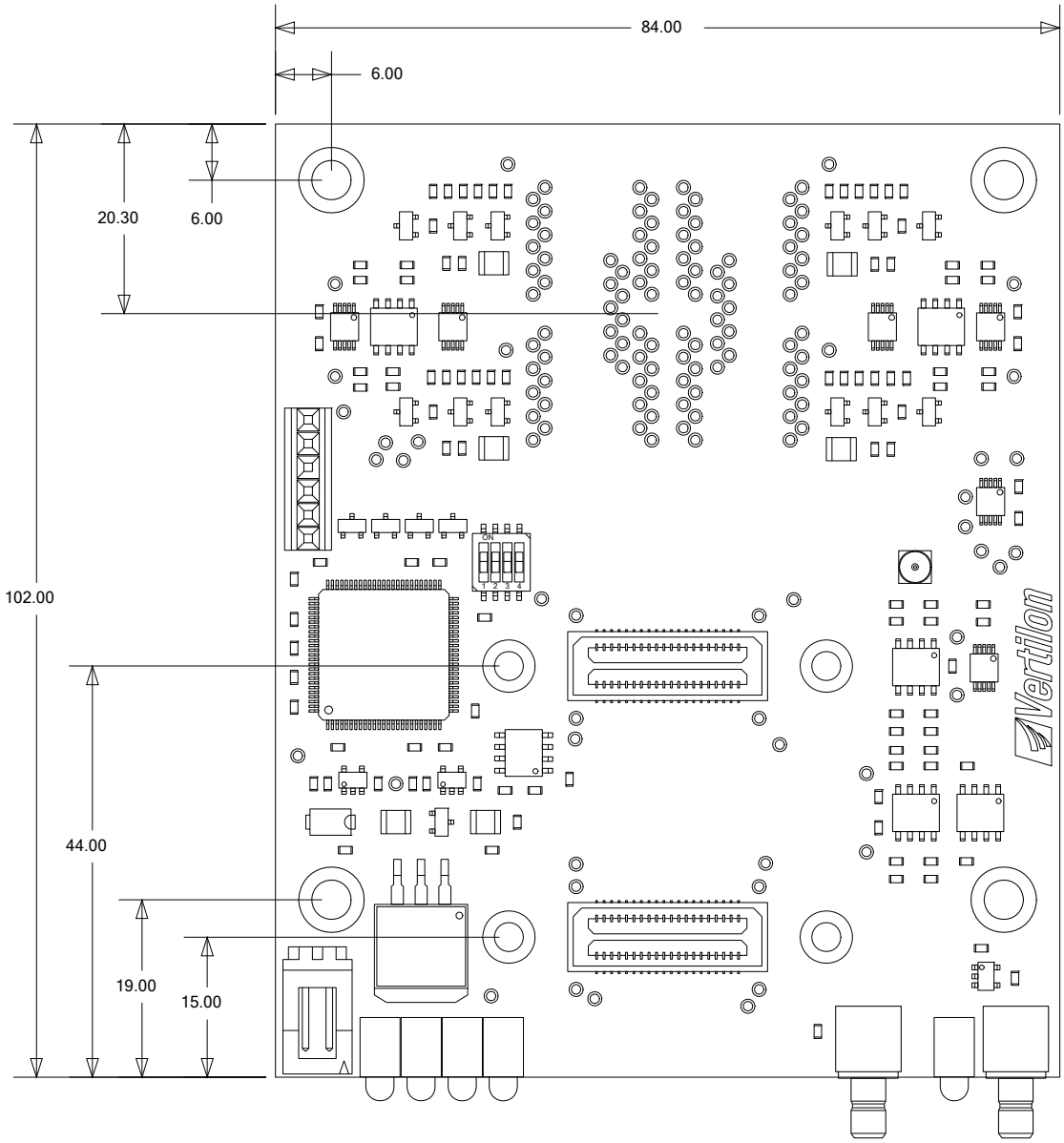

Figure 8: SIB1256 Printed Circuit Board Dimensions

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