User Guide

SIB1064
8 x 8 MPPC Sensor Interface Board
Hamamatsu S13615-1025N-08

Vertilon Corporation, 66 Tadmuck Road, Westford, MA 01886 / Tel: (978) 692-7070 / Fax: (978) 692-7010 / www.vertilon.com

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General Safety Precautions

Use Proper Power Source

The SIB1064 is powered with a +5V power source directly from Vertilon's PhotoniQ multi-channel data acquisition systems. A separate -100V power source from the PhotoniQ is used to generate the high voltage bias signal to the S13615 MPPC array. Use with any other power sources may result in damage to the SIB1064 or the MPPC array.

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 SIB1064. For this reason, the SIB1064 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.

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Product Overview

- Interface board for Hamamatsu S13615-1025N-08 8 x 8 MPPC array
- Supports 64 parallel charge output channels from MPPC array
- Leading edge discriminator for event trigger and timing
- Adjustable gain and threshold for discriminator channel
- High voltage circuitry to bias the S13615 device
- Integrated temperature sensor
- 100% compatible with Vertilon's PhotoniQ 64 channel DAQs
- Simplified control through PhotoniQ graphical user interface

The SIB1064 sensor interface board allows the Hamamatsu S13615-1025N-08 8 x 8 multi-pixel photon counter (MPPC) array to easily interface to a Vertilon PhotoniQ multichannel data acquisition system. The MPPC device is attached to the bottom side of the printed circuit board where the 64 cathode output signals are routed directly to the sensor interface board (SIB) connectors. The SIB connectors conform to Vertilon's standard, low-noise, multi-channel, cable interconnection system. The connectors mate to a micro-coaxial cable assembly that passes the 64 device outputs to the PhotoniQ. Bias to MPPC array is provided on a high voltage cable by the PhotoniQ where it can be enabled and configured through the PhotoniQ graphical user interface. A special current-sense output from the bias interface circuitry is routed to the input of a variable gain preamplifier on the SIB1064 indicating the total AC current signal to all 64 MPPC channels. This signal, which is available to the user on an SMB jack, is fed into a leading edge discriminator with a user-programmable threshold. The discriminator generates a trigger signal on an SMB jack when an event exceeding a predefined energy threshold is detected on the S13615-1025N-08 device. 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 MPPC array connected to the DAQ system's inputs. Alternatively, it can be connected to external digital timing hardware such as a coincidence detector. A temperature sensor located on the SIB1064 provides a continuous readout of the ambient temperature near the S13615-1025N-08. The full functionality and operation of the SIB1064 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 SIB1064 are described in greater detail on the following pages. When necessary, refer to the functional block diagram shown in Figure 1 below.

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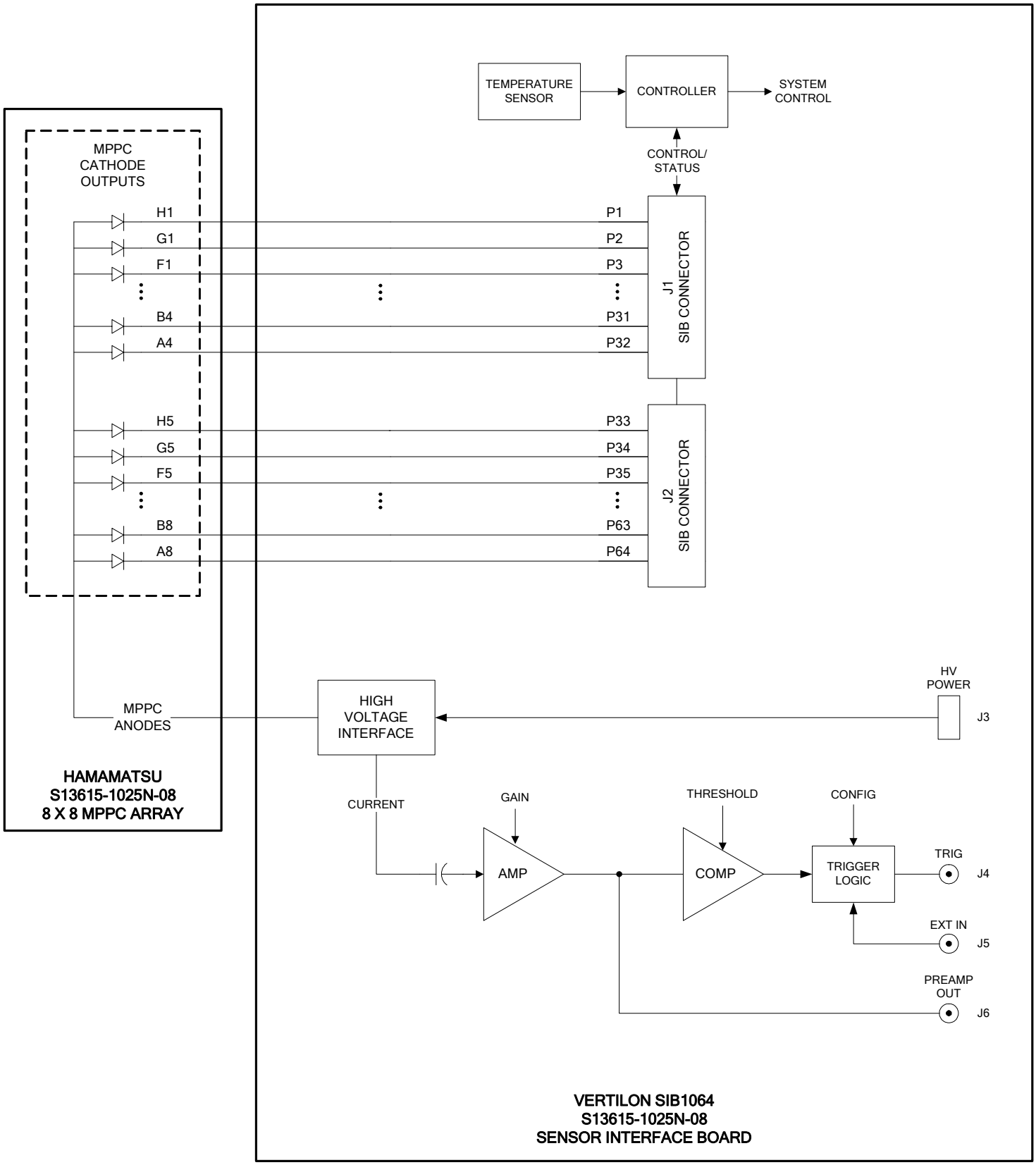

Figure 1: Functional Block Diagram

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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.
Cathode Bias Voltage	VB		+0.25		V	Detector cathode voltage supplied from PhotoniQ data acquisition system
Cathode Pulldown Resistance	R		N/A		Ω	The cathodes do not have on-board pulldown resistors.
PREAMPLIFIER						
Transimpedance (Low Gain)	R_{in}		249		Ω	Gain selected through GUI interface.
Transimpedance (Med Gain)	R_{in}		374		Ω	
Transimpedance (High Gain)	R_{in}		750		Ω	
Nominal Baseline Voltage			+2.50		V	
Signal Range		+0.50		+2.50	V	Maximum signal amplitude is 2.0V below baseline. Note: these levels are halved when the preamplifier SMB output is terminated into 50 ohms.
LEADING EDGE DISCRIMINATOR						
Threshold Adjustment Range	V_{th}	1.5		2.5	V	Nominal baseline level at discriminator input is 2.5V. Threshold (0 to 50%) controlled through GUI interface.
Threshold to Output Delay	t_d		40		nsec	Tested with a 375 mV rectangular pulse measured at the preamplifier output. Discriminator threshold set at 10%.
TRIGGER OUTPUT						
Additional Delay	t_{ad}		390		nsec	Enabled through GUI interface.
Holdoff Time	t_{hoff}		5.5		usec	Enabled through GUI interface.
Pulse Width	t_{tpw}		200		nsec	
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		57.4		mm	
Length	L		57.4		mm	
Thickness	T		1.57		mm	(printed circuit board only)

Table 1: Specifications

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Typical Radiation Detection Setup

A typical radiation detection setup using a SIB1064 is shown below. The Hamamatsu S13615-1025N-08 multi-pixel photon counter array is attached to the SIB1064 which is positioned in an optical assembly to detect incoming radiation. The 64 outputs from the MPPC array are routed on the SIB1064 to the SIB connectors that connect to a PhotoniQ IQSP482 or IQSP582 multichannel data acquisition system. The discriminator channel on the SIB1064 produces a trigger to the PhotoniQ whenever a radiation event is detected on any of the MPPCs in the array. The energy level threshold for the radiation event is set by the user through the PhotoniQ graphical user interface. Charge signals from the 64 cathodes of the S13615-1025N-08 device are acquired by the PhotoniQ for each trigger produced by the SIB1064. 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.

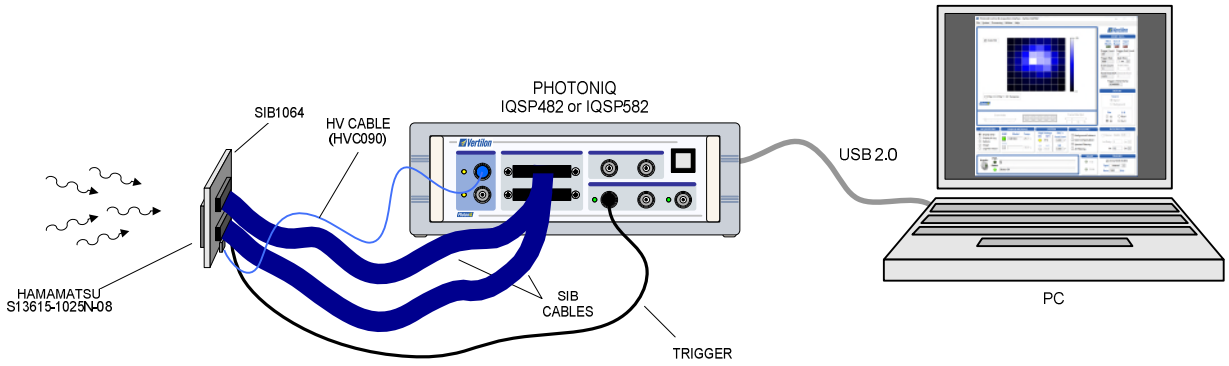

Figure 2: Typical Radiation Detection Setup

S13615-1025N-08 Detector Mounting

The SIB1064 supports the Hamamatsu S13615-1025N-08 8 x 8 multi-pixel photon counter array. This particular model of the device is soldered directly to the bottom of the sensor interface board. The MPPC device attached to a SIB1064 is shown below. The Hamamatsu S13615-1050N-08 can also be mounted to the board with no change in fucntionality.

Figure 3: S13615-1025N-08 Detector Mounting

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Detector Channels

The 64 cathode signals from the S13615-1025N-08 device are routed directly on the SIB1064 to the SIB connectors. These signals connect to channels 1 through 64 of a Vertilon PhotoniQ IQSP482 or IQSP582 charge integrating data acquisition system. The PhotoniQ utilizes DC-coupled high speed transimpedance amplifiers that maintain a DC bias voltage of +0.250 volts on each of its inputs. Because the S13615-1025N-08 is configured on the SIB1064 as a common anode type, the polarity of the current to the PhotoniQ preamplifiers is *out of* the inputs. For this reason, the *Input Polarity* under the *Data Configuration* menu in the PhotoniQ GUI should be set to *positive*. See the PhotoniQ user's manual for more details. The figure below shows a typical SIB1064 display of random particle signals on the 8 x 8 MPPC array.

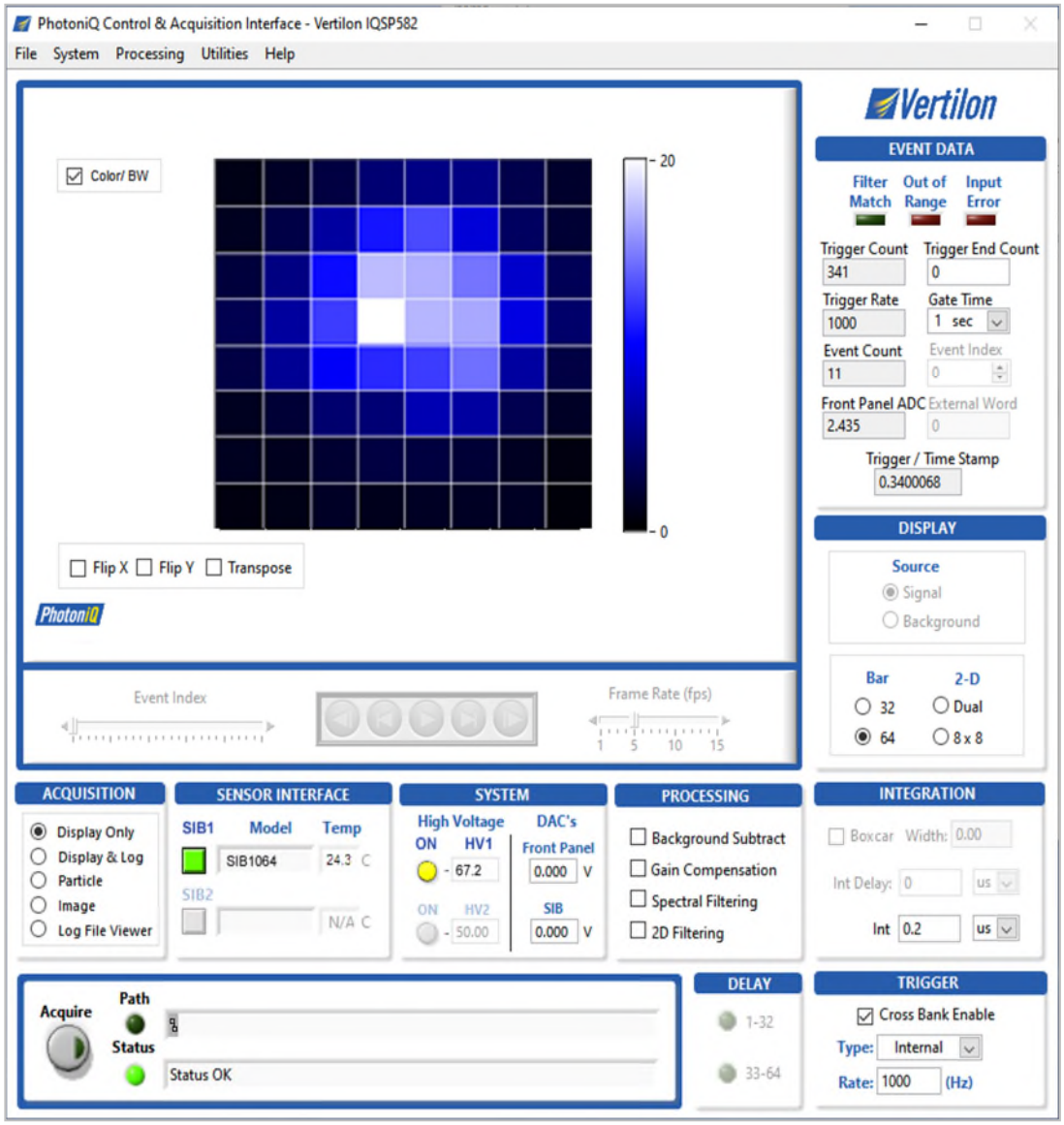

Figure 4: PhotoniQ IQSP582 Graphical User Interface

Detector Channel Mapping

The 64 MPPC channels from the S13615-1025N-08 are labeled in Hamamatsu's datasheet as channels A1 through H8. These channels map to Vertilon's PhotoniQ data acquisition system channels according to the table below.

Hamamatsu MPPC Array Channel Number	Vertilon DAQ Channel Number
A1, A2, …, A8	57, 58, …, 64
B1, B2, …, B8	49, 50, …, 56
C1, C2, …, C8	41, 42, …, 48
D1, D2, …, D8	33, 34, …, 40
E1, E2, …, E8	25, 26, …, 32
F1, F2, …, F8	17, 18, …, 24
G1, G2, …, G8	9, 10, …, 16
H1, H2, …, H8	1, 2, …, 8

Table 2: MPPC Array Channel Mapping

High Voltage Interface

The SIB1064 employs the interface circuit shown below between the high voltage input connector, J3, and the common anodes of the S13615 device. The monitor output (HVMON) allows the high voltage anode bias to the MPPCs to be indirectly monitored at a reduced voltage level. Voltage readings at the monitor point should be scaled by a factor of 21. Calibration of the scale factor may be required for very accurate measurements.

Warning: The high voltage section of the SIB1064 contains signals at voltage levels near negative 100 volts. Never touch a component or signal in this area.

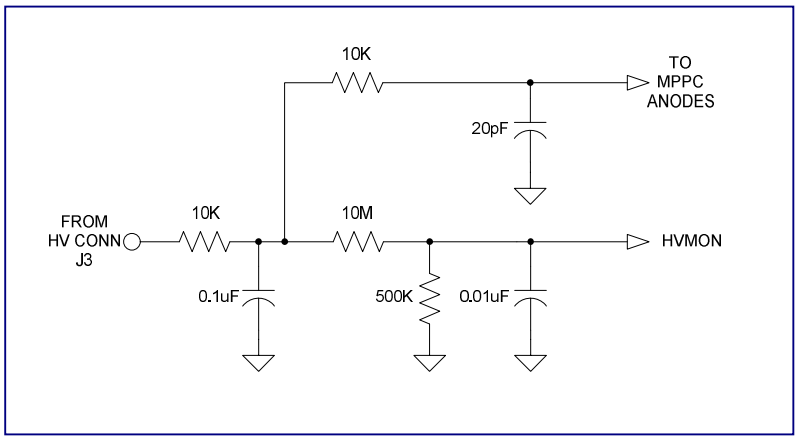

Figure 5: MPPC High Voltage Interface Circuit

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Preamplifier

The anodes from each MPPC device in the S13615 array are bussed together and connected to the input of a single current-sensitive preamplifier on the SIB1064. The preamplifier generates a voltage signal in response to the current signal on its input from any of the 64 MPPCs in the array. This voltage signal is available on an SMB output connector on the SIB1064 and is also fed to the input of the discriminator. There are three settings for the preamplifier gain — low, medium, and high — which are selected through the SIB1064 configuration dialog box in the PhotoniQ graphical user interface shown below.

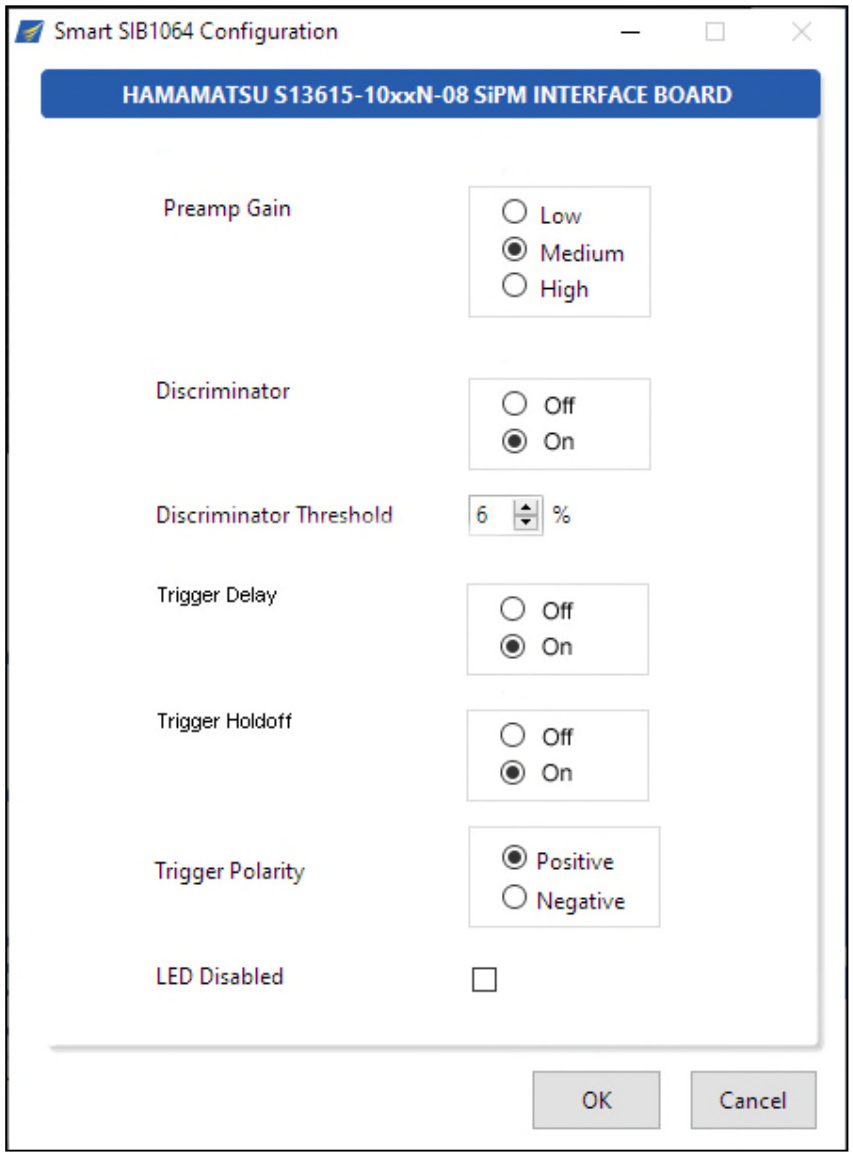

Figure 6: SIB1064 Dialog Box

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Discriminator

The discriminator generates a logic signal when a pulse from the preamplifier exceeds a user-defined threshold. The SIB1064 GUI dialog box allows the user to set this threshold as well as other trigger-specific features.

Figure 7 shows the operation of the leading edge discriminator. A positive-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 SIB1064 configuration 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.

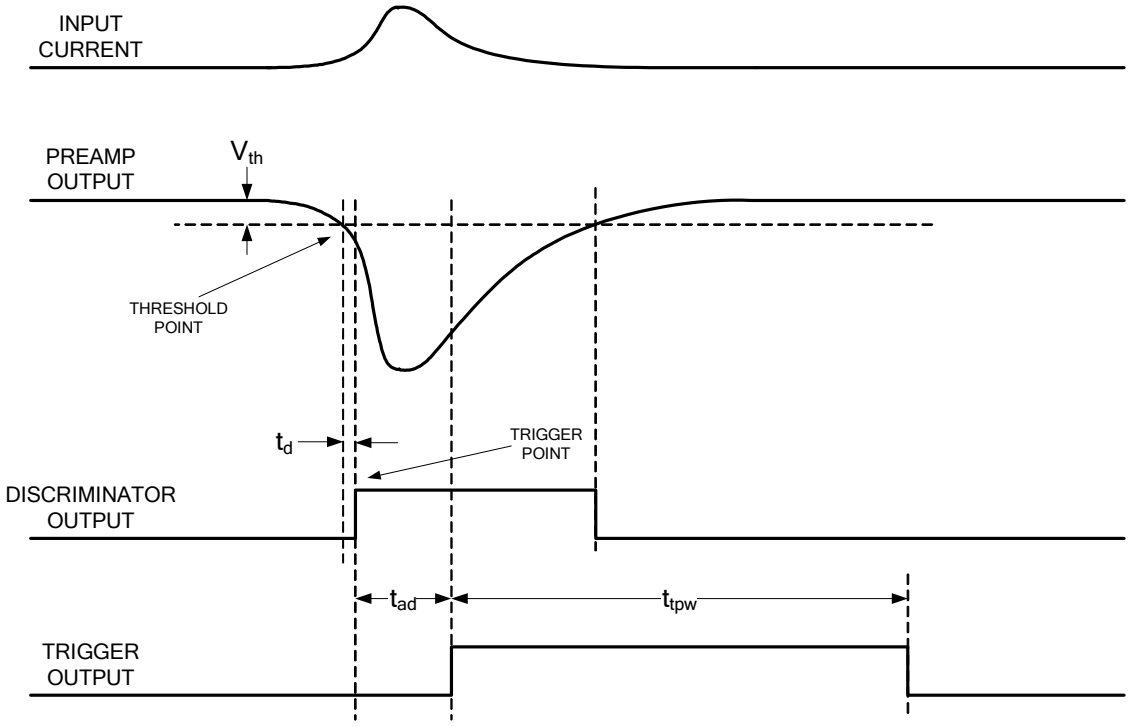

Figure 7: Leading Edge Discriminator Timing

Discriminator Threshold

The threshold can be set between 0 and 50% (equivalent to a one volt threshold) where 50% is equal to one half of the maximum possible signal amplitude in the discriminator channel. When a pulse crosses the threshold, the trigger output from the board becomes active. Typically this level is empirically determined by the user. It should be set high enough to minimize false triggering on noise. Additionally, the threshold can be set to correspond to a particular energy level as in radiation detection applications that use single channel analyzers (SCA).

Trigger Delay

When set to *On*, this feature adds an additional delay of t_{ad} to the trigger output signal. The extra delay is useful in applications that generate very short (<50 nsec) light signals into a Vertilon PhotoniQ data acquisition system operating in *Pre-trigger* mode. This allows the PhotoniQ DAQ to be operated at the shortest *Integration Time* possible and with zero *Integration Delay*.

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Trigger Holdoff

This feature reduces excessive triggers that occur from noise or from very high event rates by holding off additional triggers within a preset time period. The trigger holdoff time, T_{hoff}, is internally set to optimally match the Vertilon IQSP582 DAQ maximum trigger rate.

Trigger Polarity

The output trigger polarity can be set to either *positive* or *negative*.

LED Disabled

An additional feature of the discriminator is a status LED that can be selectively enabled and disabled in the SIB1064 GUI dialog box. Under normal triggering conditions, this LED blinks green when an event is detected, and is off when no event is detected.

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Top / Bottom Views

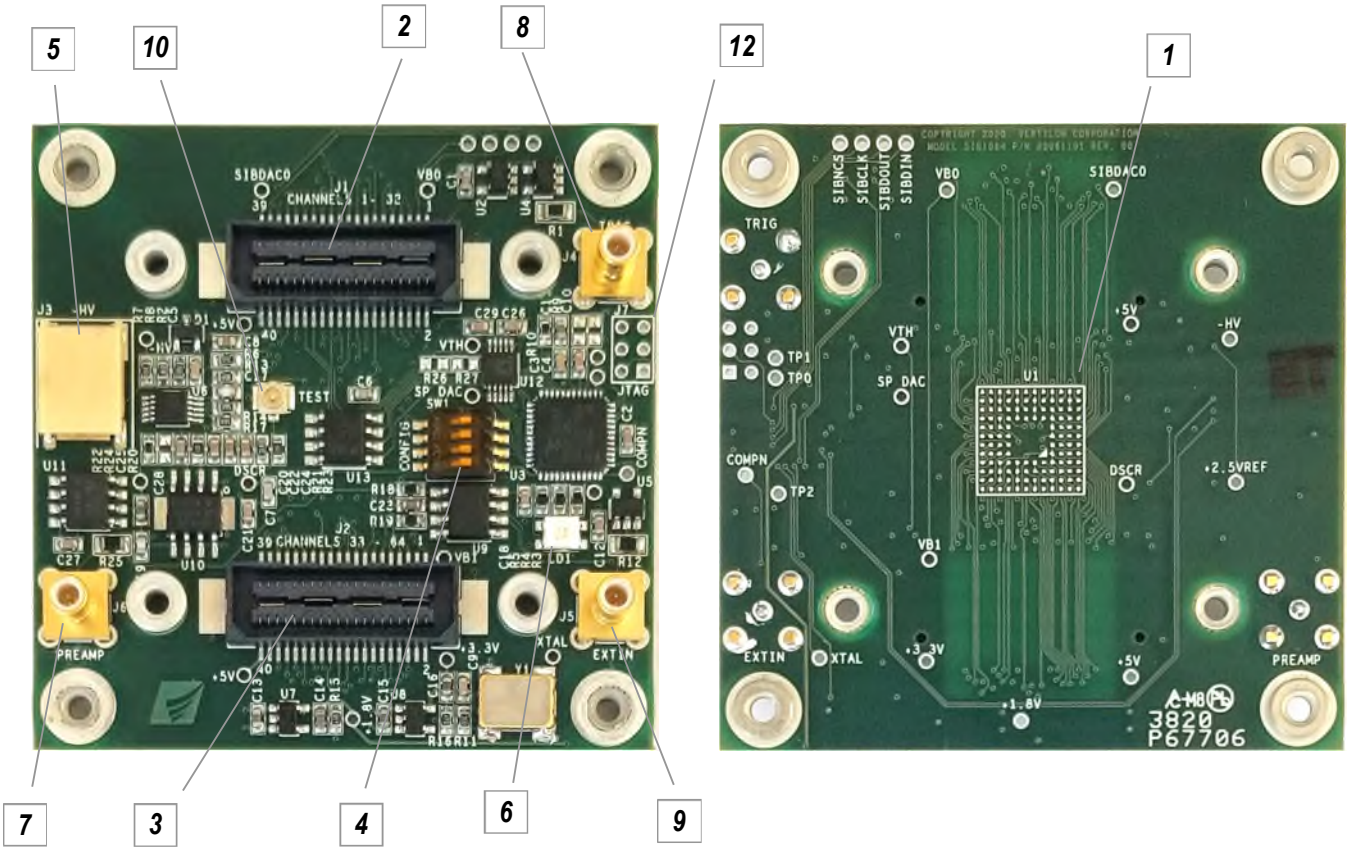

Figure 8: PCB Top and Bottom Views

1. S13615-1025N-08 Mounting Location
2. SIB Connector, Channels 1 to 32 (J1)
3. SIB Connector, Channels 33 to 64 (J2)
4. Configuration Switches
5. MPPC Negative Bias Input (J3)
6. Trigger Status LED
7. Preamplifier Output (J6)
8. Trigger Output (J4)
9. External Input (Unused) (J5)
10. Test Input Jack (Factory Use Only)
11. Temperature Sensor
12. JTAG Interface (Factory Use Only)

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Component Locations and Functions

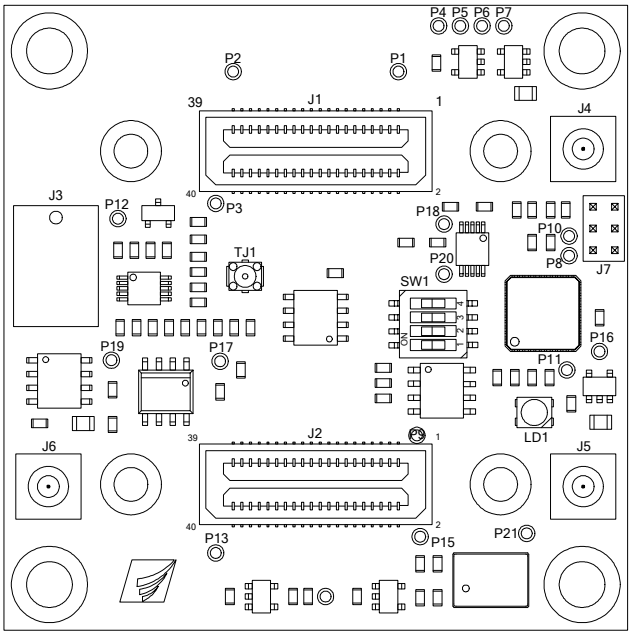

Figure 9: Top Component Locations and Functions

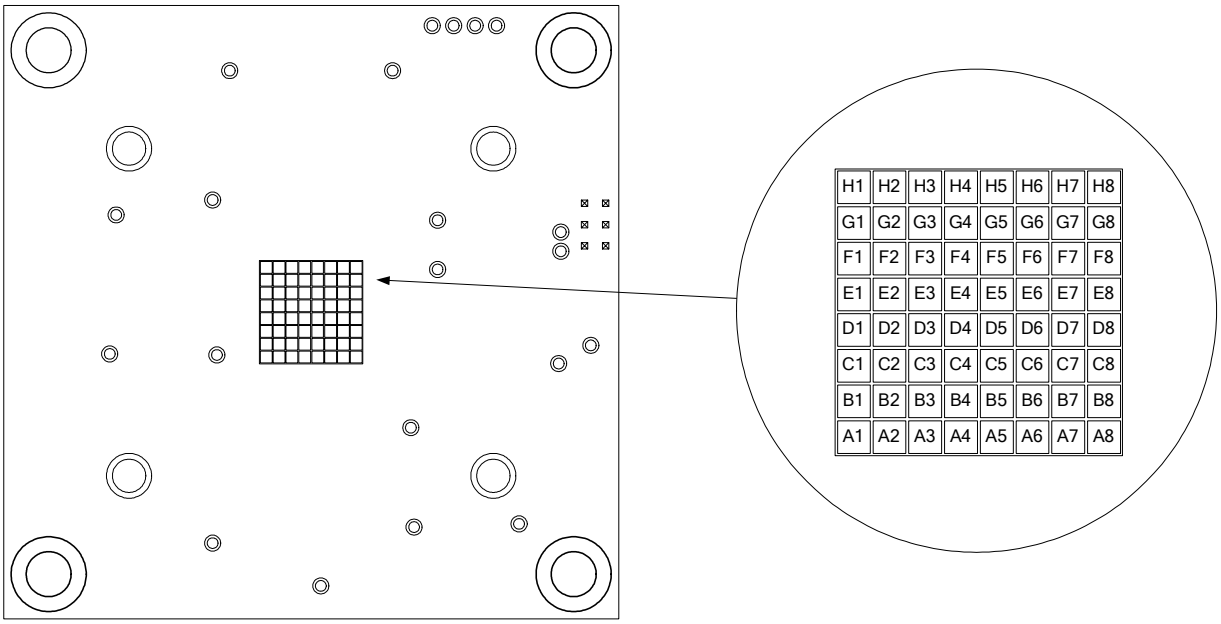

Figure 10: Bottom Component Locations and Functions

Name	Function	Description
J1	CHANNELS 1 - 32	Sensor interface board connector, PhotoniQ channels 1 through 32.
J2	CHANNELS 33 - 64	Sensor interface board connector, PhotoniQ channels 33 through 54.
J3	-HV	External high voltage power input for bias to the MPPC array
J4	TRIG OUT	Trigger output
J5	EXT IN	External Input (unused, reserved for expansion)
J6	PREAMP	Preamplifier output
J7	JTAG	JTAG interface (for factory use only)
TJ1	TEST	Test input (for factory use only)

Table 3: Connectors

Name	Function	Description
LD1	STATUS	Green LED indicator for SIB1064 trigger status.
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 4: LEDs and Switches

Name	Ref #	Description
+5.0V	P3	+5.0V power supply from the PhotoniQ
+5.0V	P13	+5.0V power supply from the PhotoniQ
+3.3V	P15	+3.3V internal power supply
+1.8V	P14	+1.8V internal power supply
+2.5VREF	P19	+2.5V reference voltage
VB	P1	Bias voltage from PhotoniQ to MPPC anodes. Normally at +0.250V when PhotoniQ set to positive input polarity.
-HV	P12	MPPC array common anode voltage.
VTH	P18	Adjustable discriminator threshold

Table 5: Test Points

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SIB Connector Pinout

The SIB1064 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 6 as a reference.

J1				J2			
Signal Name	**Pin #**	**Signal Name**	**Pin #**	**Signal Name**	**Pin #**	**Signal Name**	**Pin #**
VB	1	HVMON0	2	VB	1	HVMON1	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
SIBDAC0	39	+5V	40	SIBDAC1	39	+5V	40

Table 6: 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

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Mechanical Information

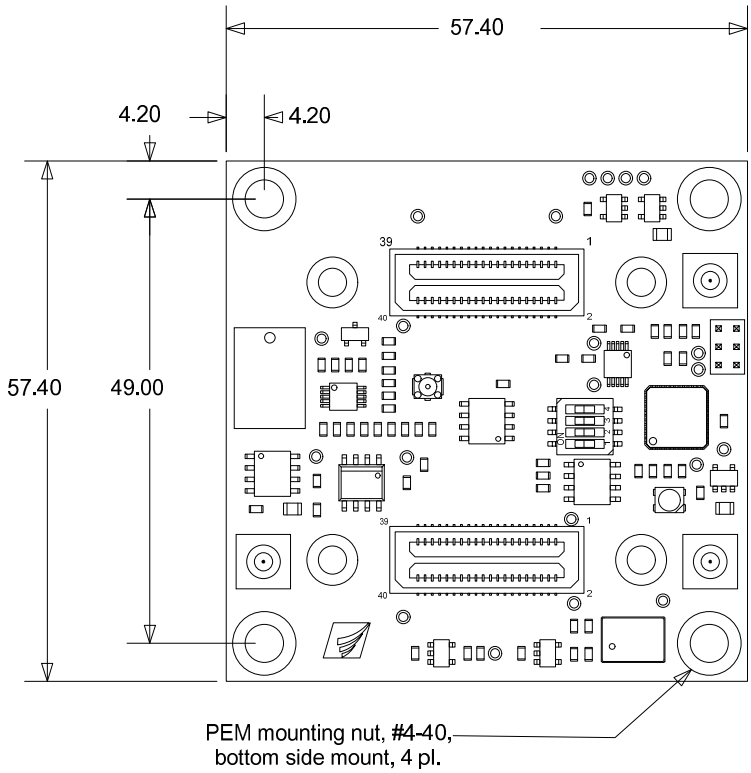

Figure 11: SIB1064 Printed Circuit Board Dimensions

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