

User Guide

*SIB464
8 x 8 SiPM Sensor Interface Board
On Semi ArrayJ-60035-64P*



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General Safety Precautions

Use Proper Power Source

The SIB464 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 for the high voltage bias to the SiPM array. Use with any other power sources may result in damage to the SIB464 or the SiPM 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 SIB464. For this reason, the SIB464 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 On Semi ArrayJ-60035-64P, 8 x 8 SiPM array
- Supports 64 parallel charge output channels from SiPM array
- Leading edge discriminator for event trigger and timing
- Adjustable gain and threshold for discriminator channel
- Onboard adjustable bias supply from +25V to +30V
- Integrated temperature sensor
- 100% compatible with Vertilon's PhotoniQ multichannel DAQs
- Simplified control through PhotoniQ graphical user interface



The SIB464 sensor interface board allows the On Semi ArrayJ-60035-64P 8 x 8 silicon photomultiplier (SiPM) array to easily interface to a Vertilon PhotoniQ multichannel data acquisition system. The SiPM device is inserted into two board-to-board mating connectors on the bottom side of the printed circuit board where the 64 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 array is provided by an on-board positive high voltage supply that is enabled and configured through the PhotoniQ graphical user interface. A special current-sense output from the bias supply is routed to the input of a variable gain preamplifier on the SIB464 to represent the total AC current signal to all 64 SiPM channels. 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 predefined energy threshold is detected on the ArrayJ-60035-64P 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 SiPM 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 SIB464 provides a continuous readout of the ambient temperature near the ArrayJ-60035-64P. The full functionality and operation of the SIB464 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 SIB464 are described in greater detail on the following pages. When necessary, refer to the functional block diagram shown in Figure 1 below.

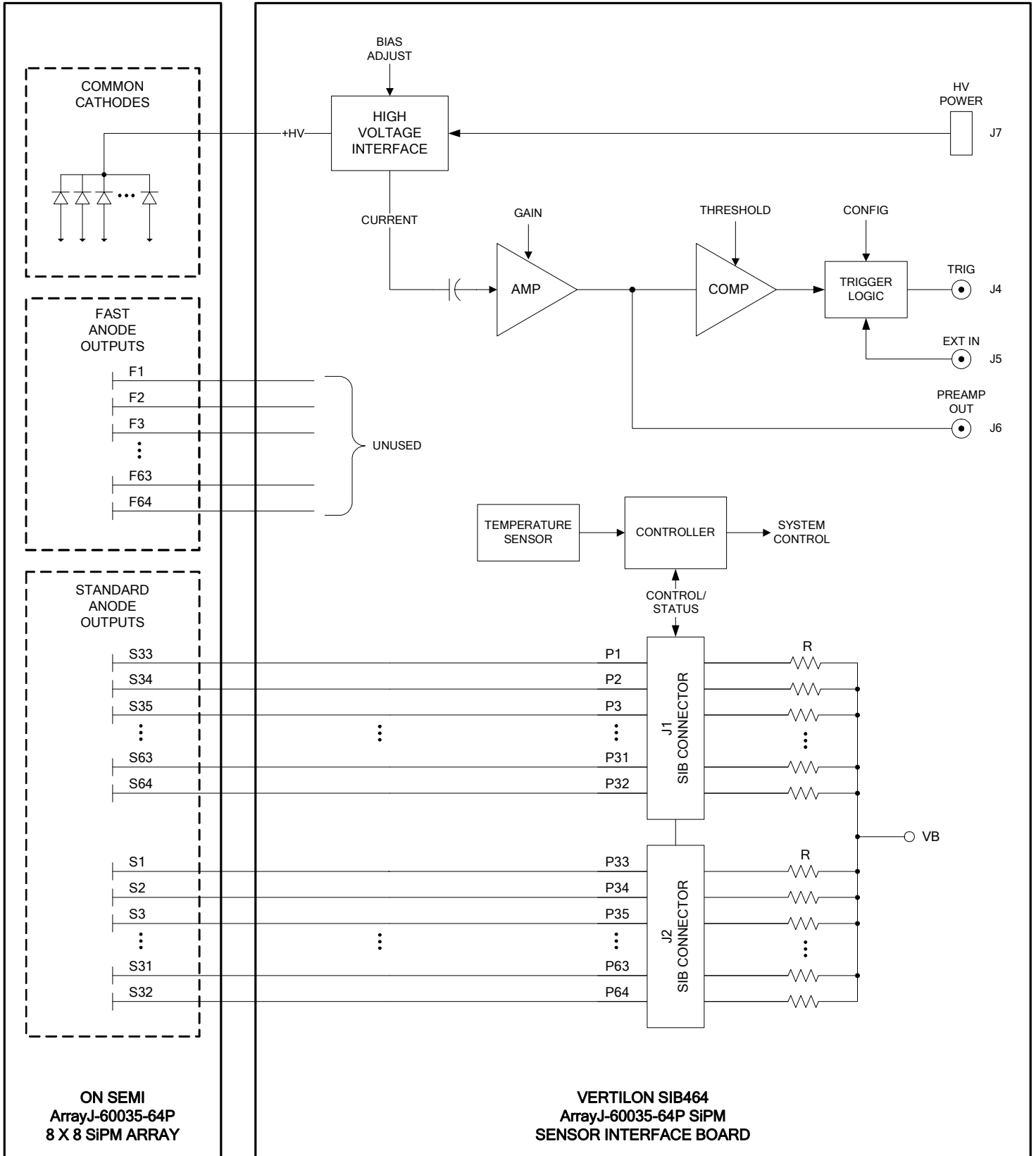


Figure 1: Functional Block Diagram

Specifications

(T_A = +25°C, 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	V _B		+1.50		V	Detector anode voltage supplied from PhotoniQ data acquisition system. V _B equals 0V for MCPC682 systems.
Anode Pulldown Resistance	R		1M		Ω	This is used to minimize static buildup. This value is 1KΩ when connected to MCPC682 systems.
HIGH VOLTAGE BIAS SUPPLY						
Nominal Voltage Range		+25.0		+30.0	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 SIB464.
PREAMPLIFIER						
Transimpedance (Low Gain)	R _{in}		187		Ω	Gain selected through GUI interface.
Transimpedance (Med Low Gain)	R _{in}		250		Ω	
Transimpedance (Med High Gain)	R _{in}		374		Ω	
Transimpedance (High Gain)	R _{in}		750		Ω	
Nominal Baseline Voltage			1.50		V	
Signal Range		1.50		3.50	V	Maximum signal amplitude is 2.0V above 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 1.5V. Threshold (0 to 50%) 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		57.4		mm	
Length	L		57.4		mm	
Thickness	T		1.57		mm	(printed circuit board only)

Table 1: Specifications

Typical Setup

A typical radiation detection setup using a SIB464 is shown below. The On Semi ArrayJ-60035-64P silicon photomultiplier array is attached to the SIB464 which is positioned in an optical assembly to detect incoming radiation. The 64 outputs from the SiPM array are routed on the SIB464 to the SIB connectors that connect to a PhotoniQ IQSP482 or IQSP582 multichannel data acquisition system. The discriminator channel on the SIB464 produces a trigger to the PhotoniQ whenever a radiation event is detected on any of the SiPMs 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 anodes of the ArrayJ-60035-64P device are acquired by the PhotoniQ for each trigger produced by the SIB464. 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.

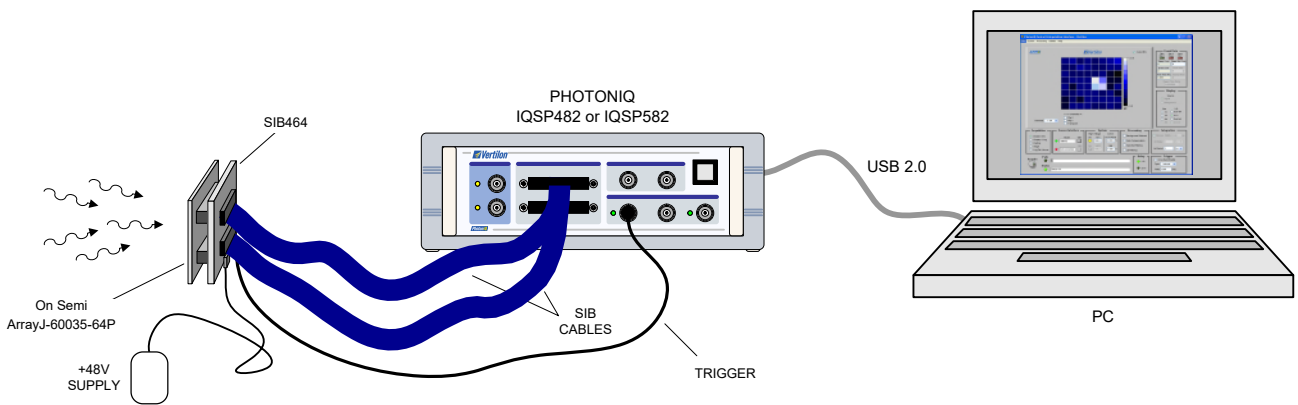


Figure 2: Typical Setup

ArrayJ-60035-64P Detector Mounting

The SIB464 supports the On Semi ArrayJ-60035-64P 8 x 8 silicon photomultiplier array. The device is attached to the SIB464 as shown in the photograph below.

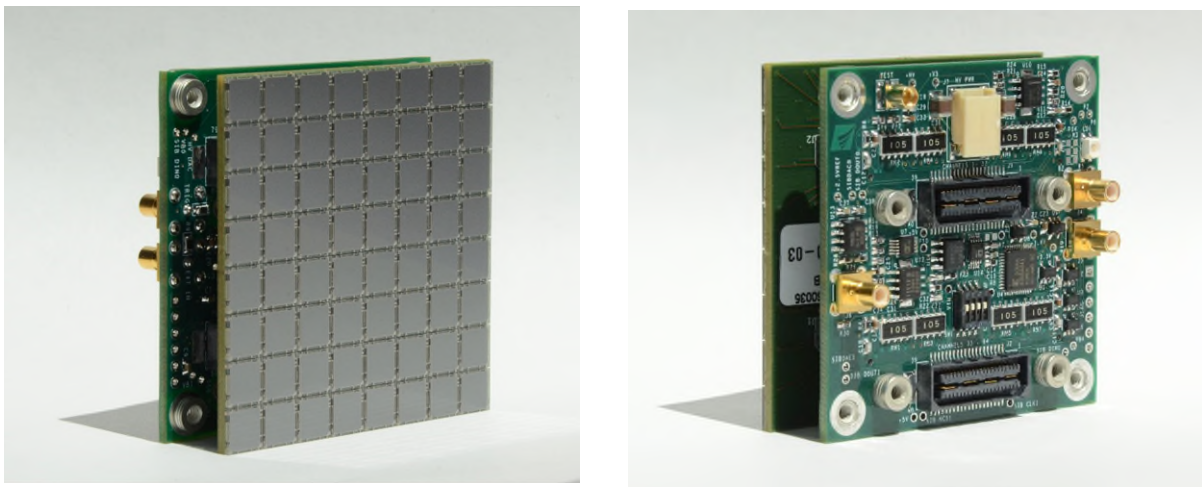


Figure 3: ArrayJ-60035-64P Detector Mounting

Detector Channels

The 64 standard anode signals from the ArrayJ-60035-64P device are routed directly on the SIB464 to the SIB connectors — the fast anode outputs are unused. 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 +1.50 volts on each of its inputs. Because the ArrayJ-60035-64P is 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. The figure below shows a typical two-dimensional display of random particle signals on the 8 x 8 SiPM array.

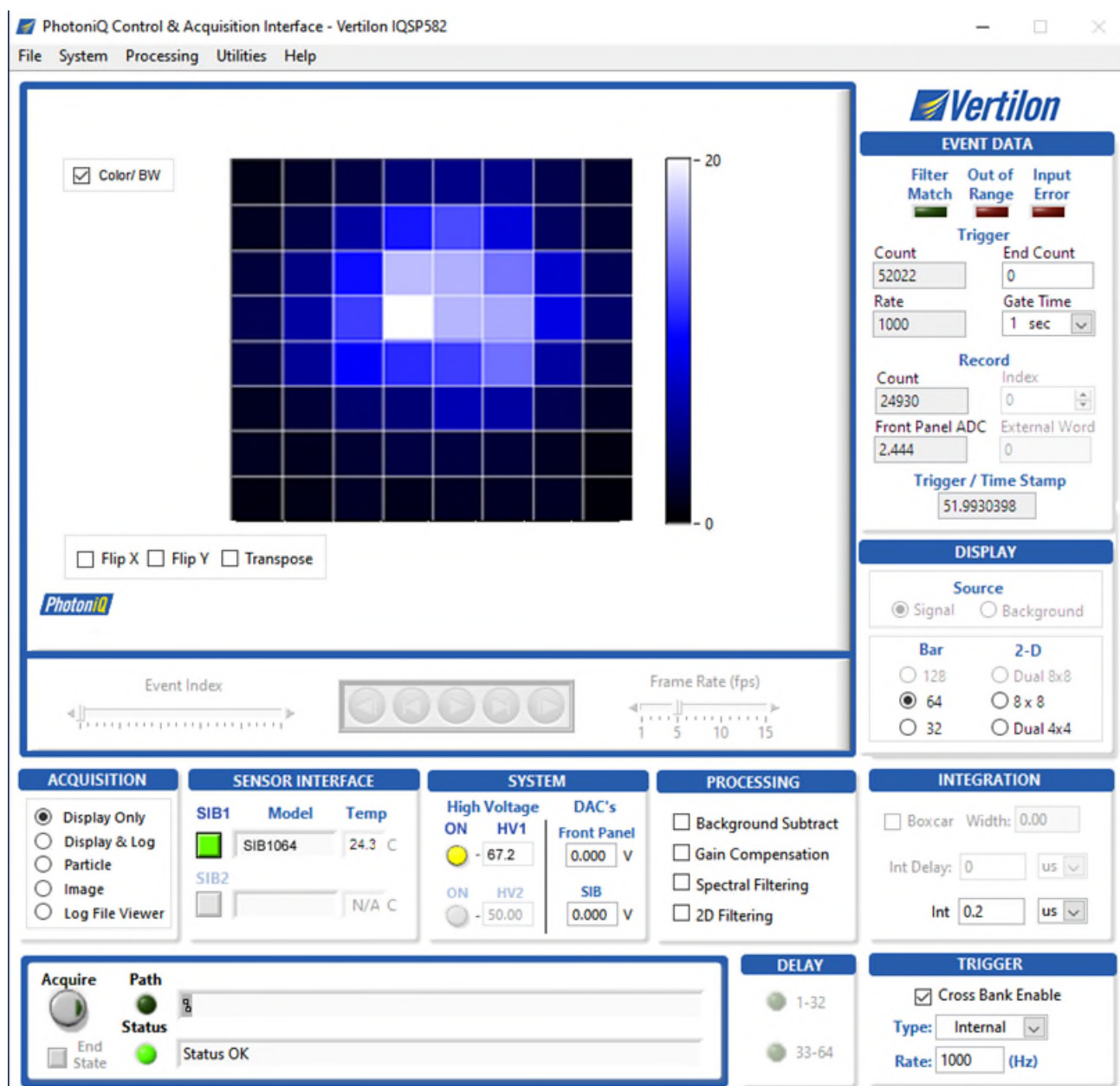


Figure 4: PhotoniQ IQSP582 Graphical User Interface

Detector Channel Mapping

The 64 SiPM channels from the ArrayJ-60035-64P are labeled in On Semi's datasheet as channels 1 through 64. These channels map to Vertilon's PhotoniQ data acquisition system channels according to the table below.

On Semi SiPM Array Channel Number	Vertilon DAQ Channel Number
1, 2, ..., 8	57, 58, ..., 64
9, 10, ..., 16	49, 50, ..., 56
17, 18, ..., 24	41, 42, ..., 48
25, 26, ..., 32	33, 34, ..., 40
33, 34, ..., 40	25, 26, ..., 32
41, 42, ..., 48	17, 18, ..., 24
49, 50, ..., 56	9, 10, ..., 16
57, 58, ..., 64	1, 2, ..., 8

Table 2: SiPM Array Channel Mapping

High Voltage Bias Supply

The high voltage bias supply on the SIB464 is configured using the dialog box available through the PhotoniQ GUI shown on the next page. The bias level to the 64 SiPMs is set using the *High Voltage Bias* control box. The supply is enabled and disabled using the *High Voltage Bias Enable* check box. The +48V supply must be connected to the SIB464 to use the on-board bias supply. Note that the actual bias voltage measured on the common cathode pin for the ArrayJ-60035-64P 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.

Preamplifier

The bias supply to the ArrayJ-60035-64P device has a special output that connects to the input of a current-sensitive preamplifier on the SIB464. The preamplifier generates a voltage signal in response to a current signal on its input from the bias supply. This voltage signal is available on an SMB output connector on the SIB464 and is also fed to the input of the discriminator. There are four settings for the preamplifier gain — low, medium low, medium high, and high.

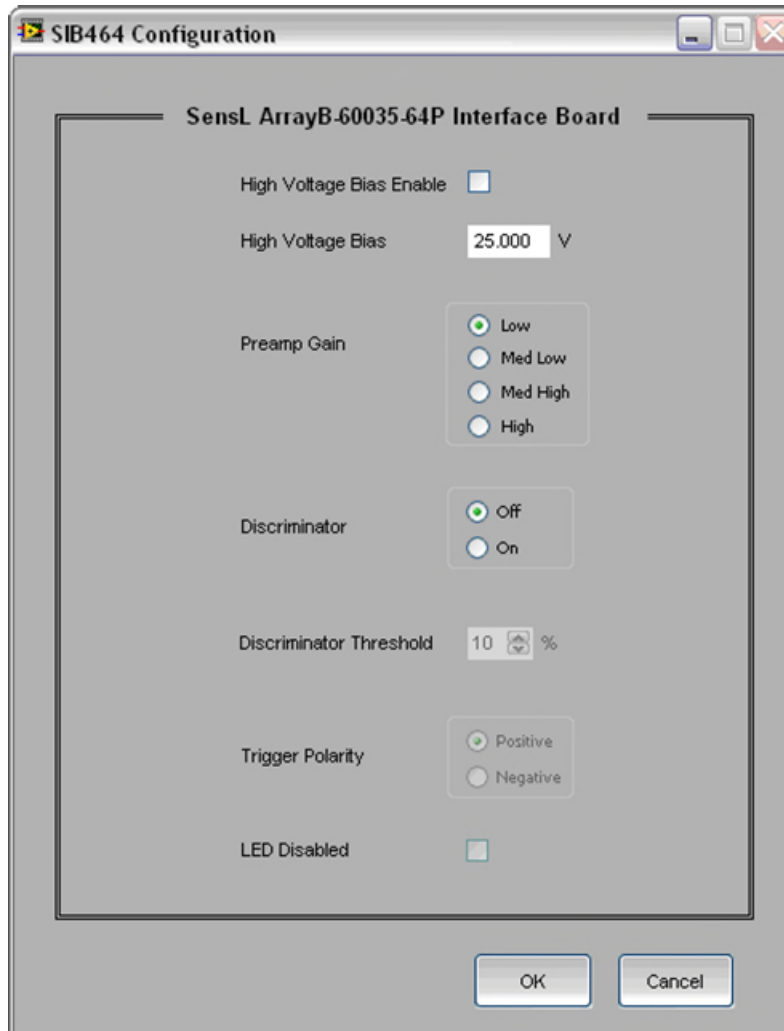


Figure 5: SIB464 Dialog Box

Discriminator

The discriminator generates a logic signal when a pulse from the preamplifier exceeds a user-defined threshold. The SIB464 GUI dialog box allows the user to set this threshold between 0 and 50% where 50% is equal to one half of 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 6 shows the actual operation of the leading edge discriminator. The test conditions are with the preamplifier operating at maximum gain, the trigger threshold at 50mV above the baseline, and the trigger polarity set to positive. A negative-going current pulse into the preamplifier results in a positive-going pulse on its output. This pulse is compared to a threshold that is adjusted using the SIB464 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. To minimize the possibility of unpredictable triggering conditions, the minimum trigger pulse width from the SIB464 discriminator circuit is 35 nsec.

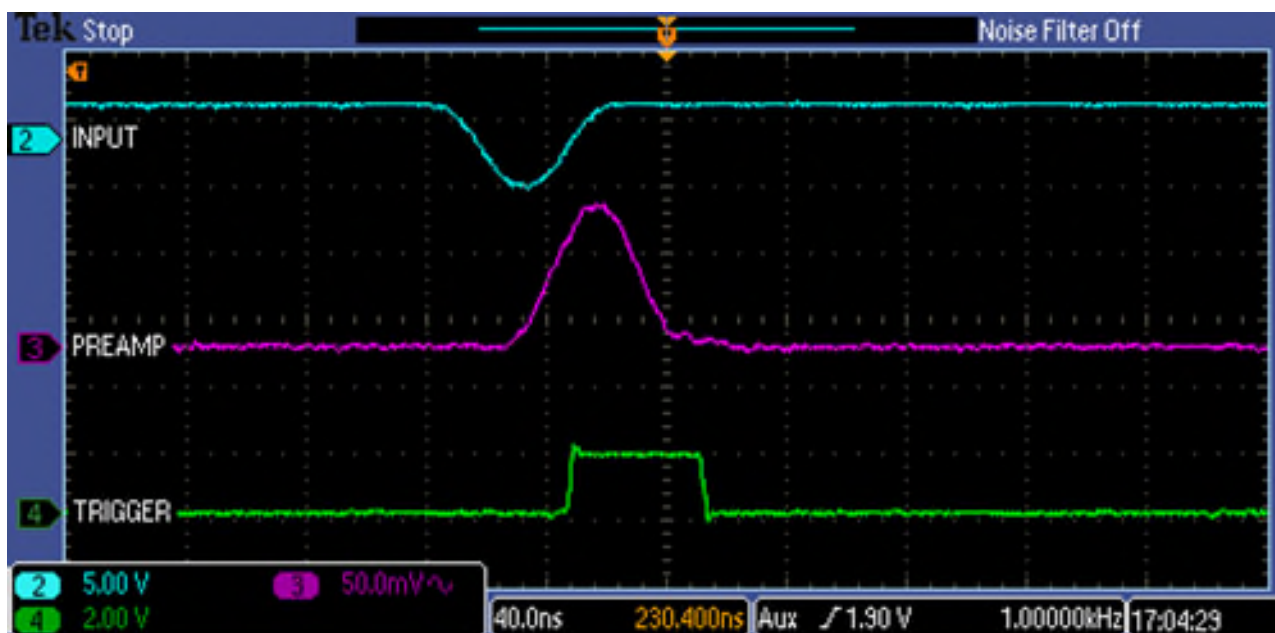


Figure 6: Leading Edge Discriminator Timing

An additional feature of the discriminator is a status LED that can be selectively enabled and disabled in the SIB464 GUI dialog box. Under normal triggering conditions, this LED blinks green when an event is detected, and is off when no event is detected. The LED blinks red if the user sets the discriminator threshold to a value below the discriminator channel's baseline level.

Top / Bottom Views

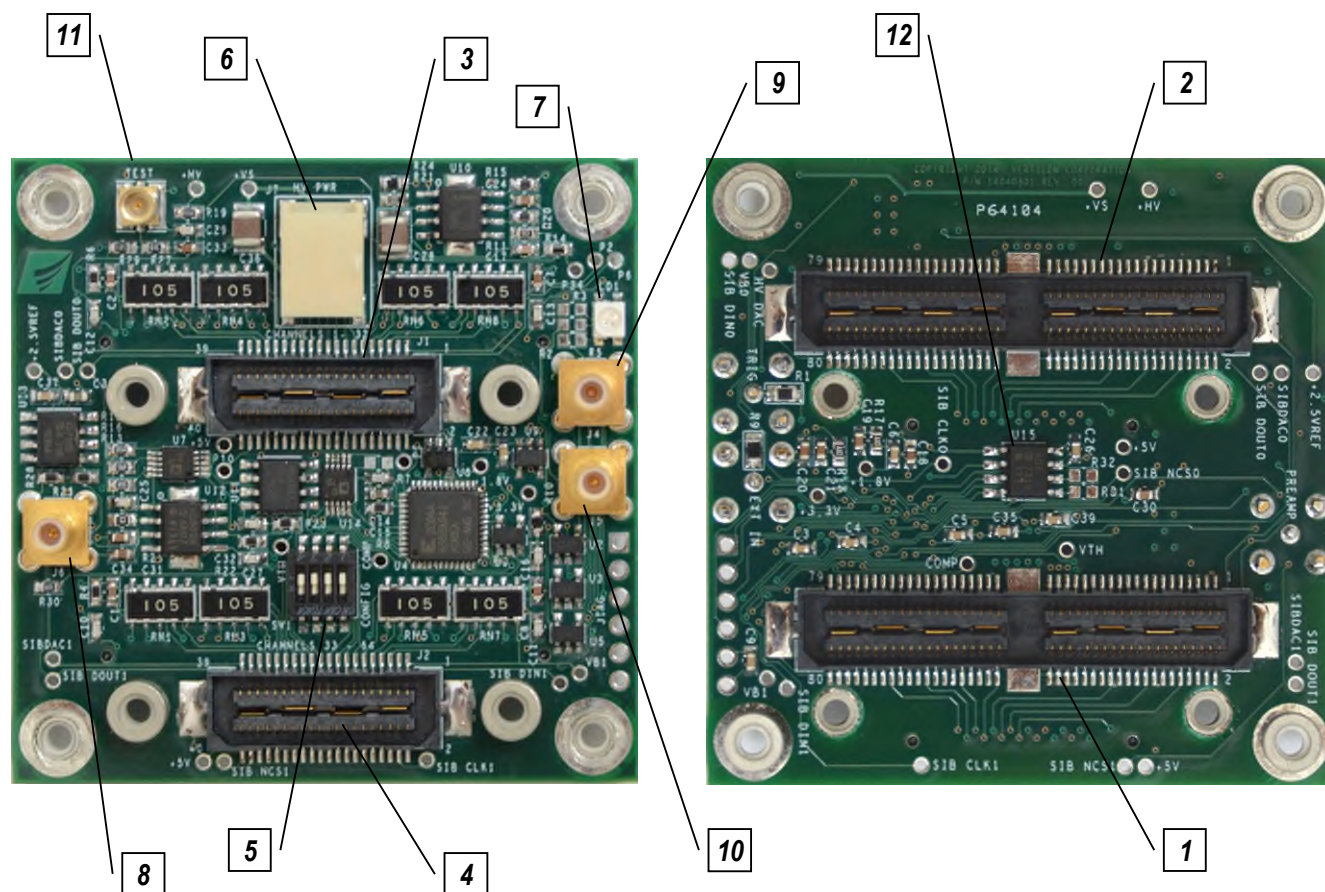


Figure 7: PCB Top and Bottom Views

- | | |
|--|--|
| 1. Connector for J1 on ArrayJ-60035-64P | 7. Trigger Status LED |
| 2. Connector for J2 on ArrayJ-60035-64P | 8. Preamplifier Output (J6) |
| 3. SIB Connector, Channels 1 to 32 (J1) | 9. Trigger Output (J4) |
| 4. SIB Connector, Channels 33 to 64 (J2) | 10. External Input (Unused) (J5) |
| 5. Configuration Switches | 11. Test Input Jack (Factory Use Only) |
| 6. +48V Power Input (J7) | 12. Temperature Sensor |

Component Locations and Functions

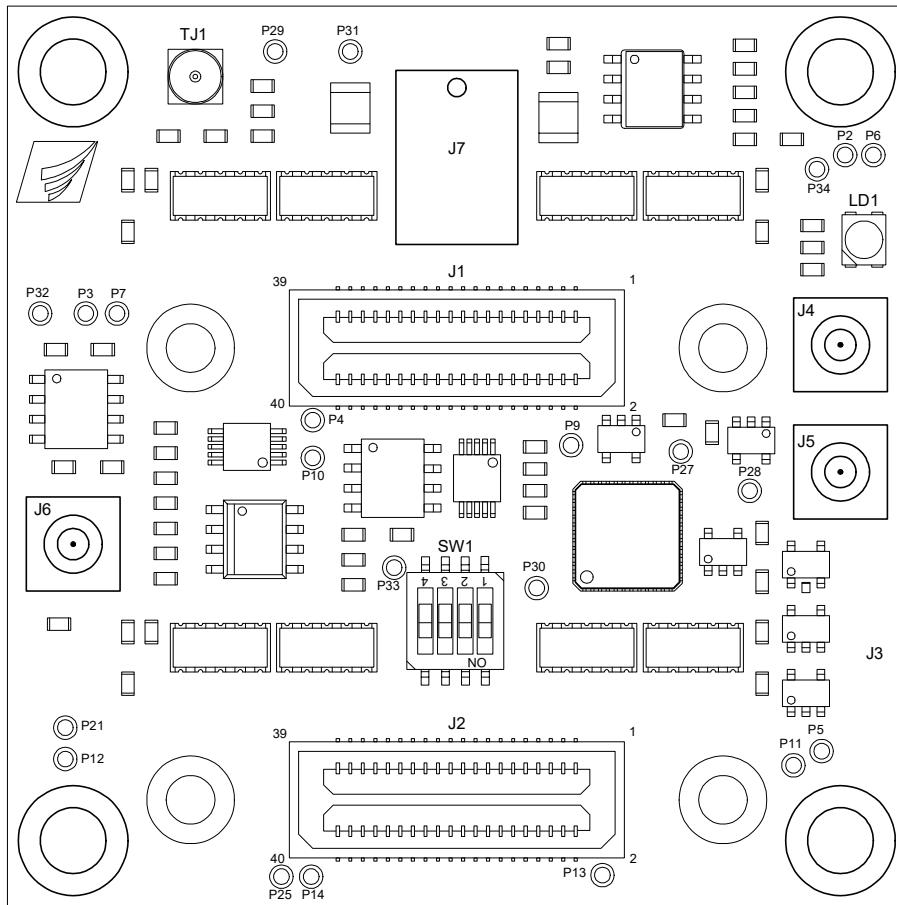


Figure 8: Top Component Locations and Functions

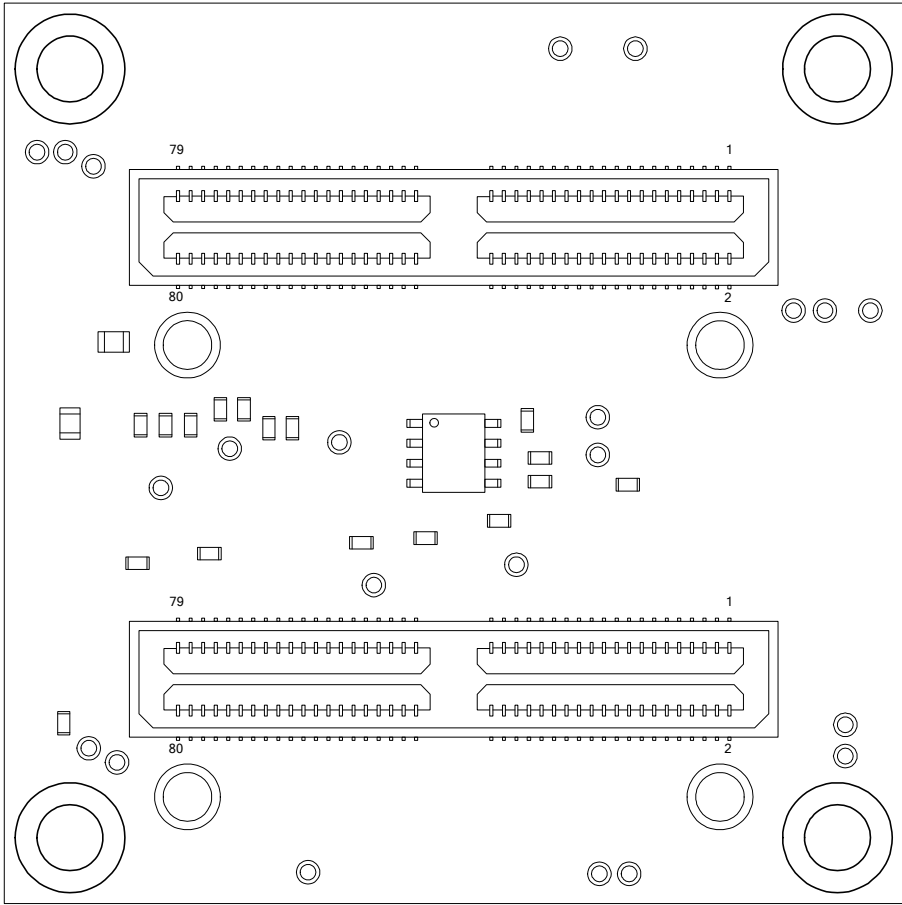


Figure 9: Bottom Component Locations and Functions

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 64
J3	JTAG	JTAG interface (for factory use only)
J4	TRIG OUT	Trigger output
J5	EXT IN	External Input (unused, reserved for expansion)
J6	PREAMP	Preamplifier output
J7	+48V	+48V power input for high voltage bias supply
TJ1	TEST	Test input (for factory use only)

Table 3: Connectors

Name	Function	Description
LD1	STATUS	Bicolor (red/green) LED indicator for SIB464 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	P4	+5.0V power supply from the PhotoniQ
+3.3V	P28	+3.3V internal power supply
+1.8V	P27	+1.8V internal power supply
+2.5VREF	P32	+2.5V reference voltage
VB	P2	Bias voltage from PhotoniQ to SiPM anodes. Normally at +1.50V when PhotoniQ set to negative input polarity.
+VS	P31	+48V power supply voltage.
+HV	P29	SiPM array common cathode voltage.

Table 5: Test Points

SIB Connector Pinout

The SIB464 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

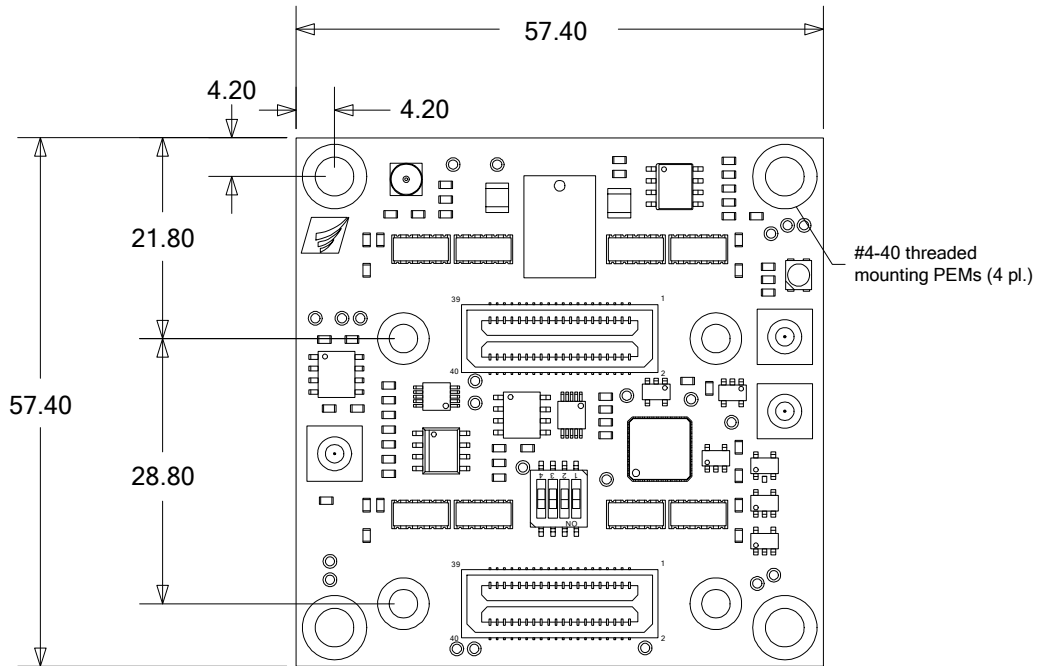
Table 6: Sensor Interface Board (SIB) Connectors

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

Mechanical Information



ALL DIMENSIONS IN MILLIMETER

Figure 10: SIB464 Printed Circuit Board Dimensions



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