User Guide

PRP110
Ten Channel High Bandwidth Preamplifier

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General Safety Precautions

Use Proper Power Source

The PRP110 is powered with a customer-supplied asymmetric bipolar power source. Use with any power source outside of the recommended specifications in this document 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 PRP110. For this reason, the PRP110 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

- Ten Channel PMT / SiPM Preamplifier
- High Gain / Bandwidth
- Large Input and Output Dynamic Range
- BNC Inputs and Outputs
- Two User-Selectable Gain Settings
- Small Compact PCB Form Factor
- Jumper Configurable Input Gain and Polarity

The PRP110 is a ten channel high bandwidth preamplifier module specifically designed for direct connection to anger logic circuitry for multianode photomultiplier tubes (MAPMT) and silicon photomultiplier (SiPM) arrays. The module is arranged as two groups of five channels with each group consisting of four anger logic channels and one channel for connection to a timing output such as a PMT's last dynode signal. The polarity of the preamplifiers is such that the four anger logic and last dynode outputs all produce negative-going signals. Two versions of the PRP110 are available. The PRP110A is a 10X gain version of the product while the PRP110B is a 5X gain version with increased input dynamic range. Both product versions have a miniature rotary switch on each channel so that the overall gain can be reduced by a factor of four in high signal level applications. Dual stacked BNCs are utilized for the signal inputs and outputs. Two types of power input connectors are available on the PCB — a discrete four wire header and a six pin 2mm flat cable connector. Each connector type appears twice on the PRP110 so that multiple power connection schemes including daisy chaining can easily be accommodated.

The various functions on the PRP110 are described in greater detail on the following pages. When necessary, refer to the functional block diagram shown in Figure 1 below.

Included Parts

- PRP110 ten channel preamplifier board
- Input power connector plus contacts
- Flat cable daisy-chaining kit
- Trimmer tool
- User Manual

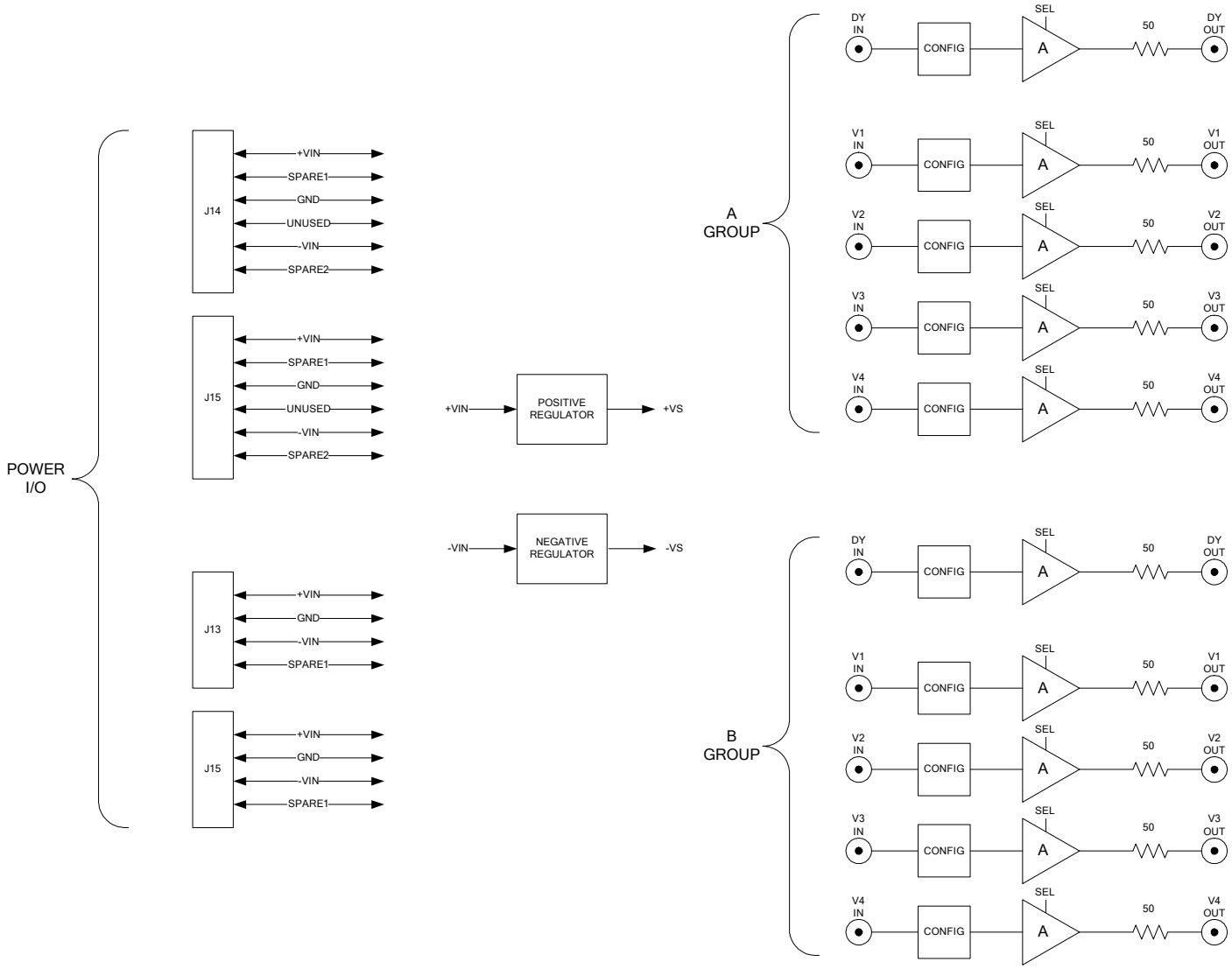


Figure 1: Functional Block Diagram

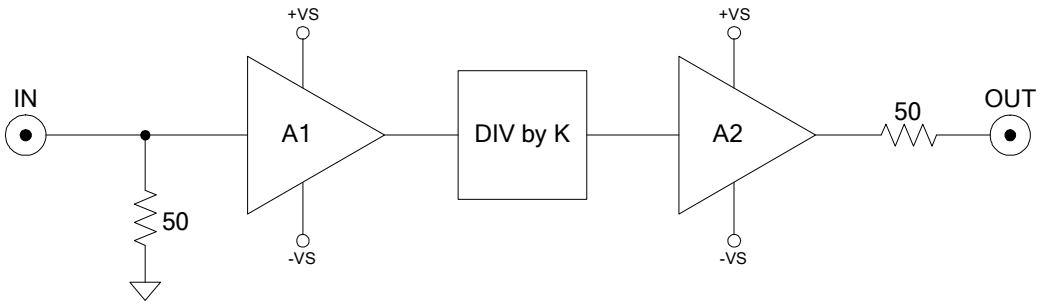


Figure 2: Preamplifier Channel

Specifications

(T_A = +25C, unless otherwise noted)

Description	Sym	Min	Typ	Max	Units	Notes
ANGER LOGIC PREAMPLIFIER						
Input Dynamic Range			-4 -8		V	PRP110A PRP110B
First Stage Gain	A1		+2 +1			PRP110A PRP110B
Divider	K		1 4			High gain, rotary switch set to position "1" Low gain, rotary switch set to position "2"
Second Stage Gain	A2		+10			
Overall Gain (High Setting)	A		+10 +5			PRP110A into 50 ohms PRP110B into 50 ohms
Overall Gain (Low Setting)	A		+2.5 +1.25			PRP110A into 50 ohms PRP110B into 50 ohms
LAST DYNODE PREAMPLIFIER						
Input Dynamic Range			+4 +8		V	PRP110A PRP110B
First Stage Gain	A1		-2 -1			PRP110A PRP110B
Divider	K		1 4			High gain, rotary switch set to position "1" Low gain, rotary switch set to position "2"
Second Stage Gain	A2		+10			
Overall Gain (High Setting)	A		-10 -5			PRP110A into 50 ohms PRP110B into 50 ohms
Overall Gain (Low Setting)	A		-2.5 -1.25			PRP110A into 50 ohms PRP110B into 50 ohms
ALL PREAMPLIFIERS						
Input Resistance	Rin		50		Ω	
Small Signal Bandwidth			236		MHz	Vout = 0.2V pk-pk
Large Signal Bandwidth			146		MHz	Vout = 2V pk-pk
Output Slew Rate			470		V/us	
Output Baseline Level			12 55	50 110	mV mV	No load Isink = 5mA
Maximum Output Pulse			-4		V	Into 50 ohms
Output Impedance	Rout		50		Ω	
POWER SUPPLY						
Positive Power Supply Voltage	+Vin	+4	+4.5	+5	V	
Negative Power Supply Voltage	-Vin	-11	-11.5	-12	V	
Power Supply Current	+Iin / -Iin		200		mA	
Internal Regulated Positive Voltage	+Vs		+1.25		V	
Internal Regulated Negative Voltage	-Vs		-8.9		V	
DIMENSIONS						
Width	W		51		mm	
Length	L		198.4		mm	
Thickness	T		1.57		mm	(printed circuit board only)

Table 1: Specifications

Absolute Maximum Ratings

Parameter	Rating
Momentary Positive Power Supply Voltage	+15 V
Momentary Negative Power Supply Voltage	-15 V
Continuous Positive Power Supply Voltage	+7 V
Continuous Negative Power Supply Voltage	-14 V
Positive Input Voltage (Anger Preamplifier)	+6 V
Negative Input Voltage (Anger Preamplifier)	-14 V
Positive Input Voltage (Last Dynode Preamplifier)	+10 V
Negative Input Voltage (Last Dynode Preamplifier)	-3 V

Table 2: Absolute Maximum Ratings

Power Inputs / Outputs

The PRP110 requires a positive (+Vin) and negative (-Vin) power supply from the user as specified in specifications Table 1. Each power input is separately regulated on the board to produce a clean, ripple-free power source to the PRP110 amplifiers. The positive (+Vs) and negative (-Vs) regulated voltages effectively define the output voltage limits of the amplifiers. Because the PRP110 amplifiers have a 10 volt maximum power supply range, the regulated supplies are asymmetrically specified towards the negative range so that the maximum negative-going output dynamic range can be achieved. The regulators also provide a significant level of power supply overvoltage protection for the on-board circuitry. When possible it is best to provide input voltages that are near the low end of the range in the specifications table. This will minimize the amount of heat on the PRP110 due to the power dissipation in the voltage regulators.

There are four power input / output connectors on the PRP110 — two discrete four wire headers and two six pin 2mm flat cable connectors. All power I/O is in parallel to support module daisy-chaining and other power supply wiring schemes. The power connector information is shown in the table below.

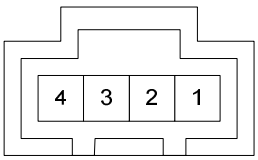
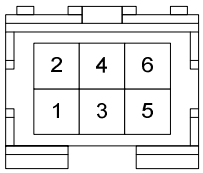
Designator	Type	Connector P/N	Mating P/N	Pinout
J13 J16	Discrete wire, 4 pin	Molex 70543-0003	Molex 0050579404	1: +Vin 2: Ground 3: -Vin 4: Spare1 
J14 J15	Flat cable, 2mm, 6 pin	Amphenol 98414-G06-06LF	Amphenol 89361-706LF	1: +Vin 2: Spare1 3: Ground 4: N/C 5: -Vin 6: Spare2 

Table 3: Power Connectors

Anger Logic Preamplifiers

Multianode PMT anger logic signals are usually connected to external electronics that compute the position and energy of randomly arriving particle events. The PRP110 has a total of eight anger logic non-inverting preamplifiers — four in group A and four in group B — that connect directly to two sets of anger logic signals from a pair of MAPMTs. In typical applications the current from the MAPMT anger logic is in the negative direction and thus the associated PRP110 non-inverting preamplifiers produce negative-going output signals. As shown in Figure 2, the preamplifiers are composed of two stages with a switchable voltage divider between the stages. Most of the gain is in the second stage with the first stage serving the principal purpose of isolating the input signal from output overloading. This configuration produces the maximum gain while allowing for large dynamic range input signals. The overall gain of each preamplifier can be reduced using the miniature rotary switch. Rotating the actuator into the clockwise position will switch the preamplifier to the reduced gain configuration. The preamplifier input is located in the upper position of the dual stacked BNCs, the output is in the bottom position.

Last Dynode Preamplifiers

The PMT last dynode output is used with an external discriminator for generating a trigger signal to data acquisition electronics or a time-to-digital converter for determining time of arrival or coincidence detection. The PRP110 has two inverting preamplifiers for the MAPMT last dynode signal — one in group A and one in group B. Since the last dynode current is typically in the positive direction, these inverting preamplifiers produce negative-going output signals to match the direction of the anger logic signals. Other than for the polarity difference, the last dynode preamplifiers are identical to the anger logic preamplifiers. The preamplifier input is located in the upper position of the dual stacked BNCs, the output is in the bottom position.

Amplifier Configurations

All ten preamplifier channels are identical before pre-configuration at the factory. Using resistor jumpers at the first stage preamplifier, PRP110 channels are configured as either negative input anger logic channels or positive input last dynode channels. These channels are further configured as either PRP110A 10X gain or PRP110B 5X gain versions. Although not recommended for modification by the user, the modules are configured by simply soldering 0603 zero ohm resistors into the appropriate marked locations on the PCB as shown in

Figure **4** below. Table 4 below describes the jumper configurations for each preamplifier configuration. A check mark means the jumper resistor is installed — otherwise the location is left open.

Input Signal Polarity	Gain	Ra	Rb	Rc	Rd	Re
Positive	-10X			√		
Negative	+10X	√			√	
Positive	-5X		√			√
Negative	+5X				√	

Table 4: Preamplifier Configuration Jumpers

Gain Switches

The PRP110 utilizes ten miniature two-position switches to adjust the gain of the four anger preamplifiers and last dynode preamplifier. The preamplifier gain can be set to either a low or high setting by using the included adjustment tool to rotate the switches' rotor. It is recommended that the user avoid turning the switches beyond the stops at the end of each position. The figure below indicates the switch position for each gain.

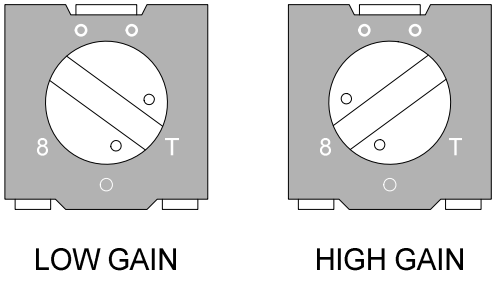


Figure 3: Gain Switch Positions

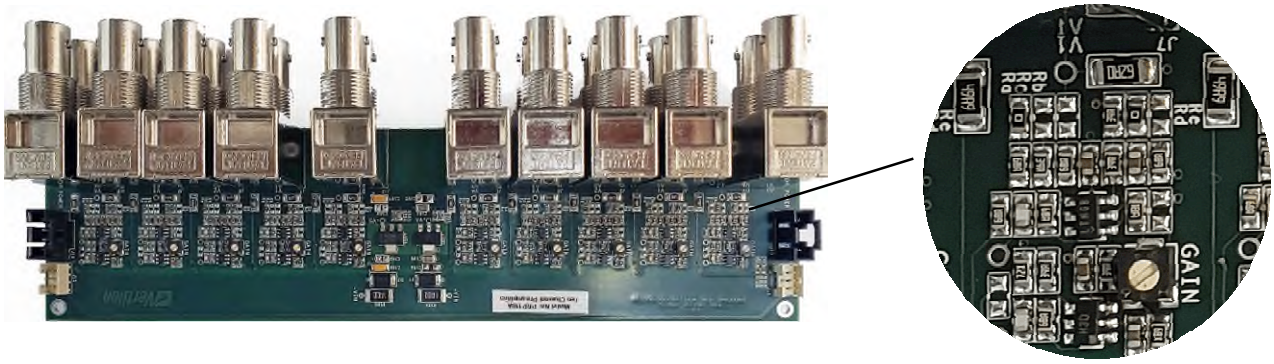
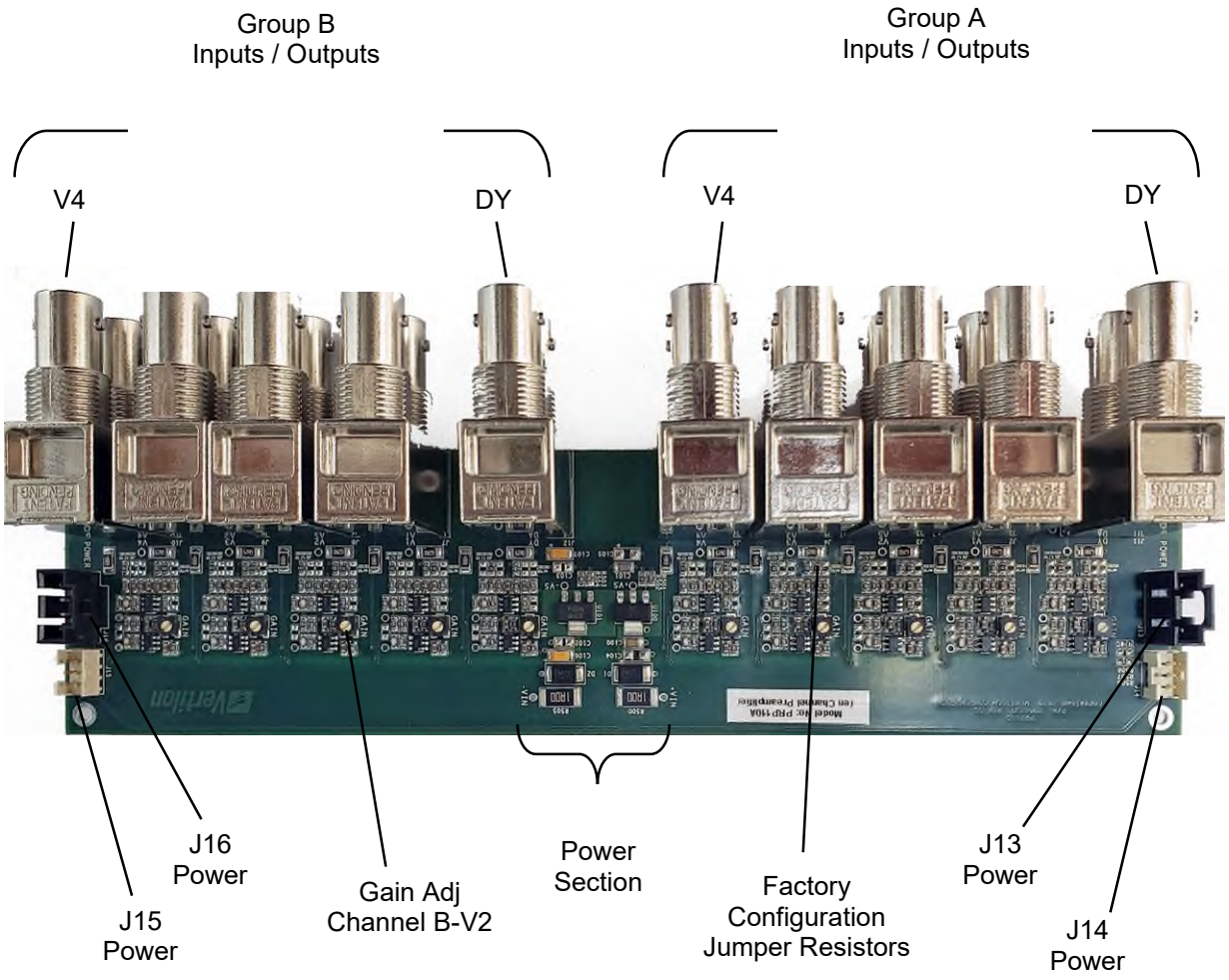


Figure 4: Configuration Jumper Locations

Top View



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Mechanical Information

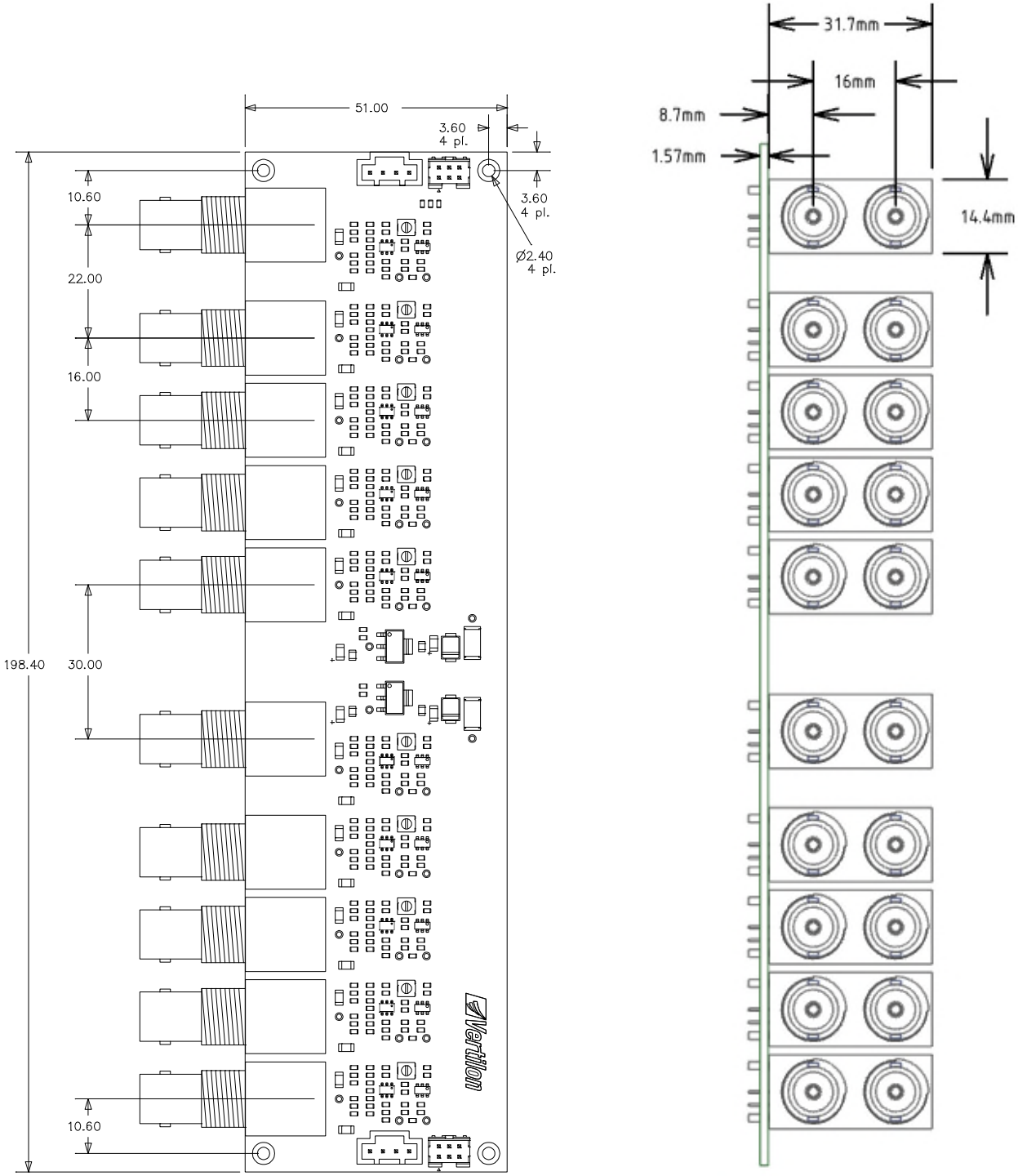

Figure 6: PRP110 Printed Circuit Board Dimensions

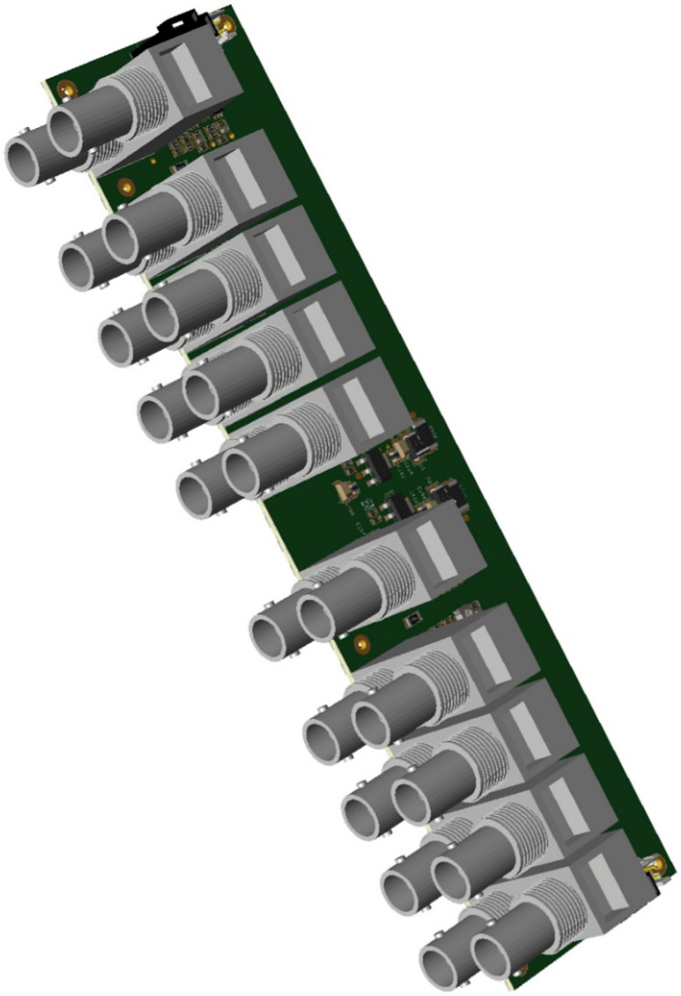

Figure 7: PRP110 3D View

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Revision List

Rev #	Date	Assembly Rev	Description
1.1	12/20/2023	A	Added polarity to Configuration Jumper Table 4 Added gain switch diagram Specified location of input and output BNCs Added J13, J14, J15, and J16 connector pinout drawing.
1.0	05/15/20	A	First release

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