PC5 User Manual

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1 Introduction

1.1 PC5 Description

The PC5 is a power supply for the detector and preamplifier. It provides (1) the high voltage bias for the detector (either polarity, up to 1500 V), (2) power for the thermoelectric cooler (with closed loop temperature control), and (3) the low voltages required for the preamplifier (+/-5 V or +/-8.5 V).

The settings of the PC5 must match the configuration of the preamplifier and detector or the components may be damaged. The user is not meant to modify the PC5 configuration.

The PC5 may come with a subset of the connectors installed than shown in this document. Only the connectors that are compatible with the ordered configuration are installed.

The PC5 can be used with Amptek's DP5 signal processor or with a custom signal processor. Figure 1 shows the two most common configurations.

1. With the DP5 as shown at the top, the DP5 controls the PC5. It turns on the power supplies, controls the high voltage bias and temperature by DACs, monitors the actual high voltage and temperature, and checks the bias polarity. The input power (5 VDC) can be supplied into the DP5 (via a standard plug) or into the PC5 (via an 8 pin header or standard plug). Communications may be through the DP5 or RS232 communication to the DP5 is possible through the PC5.
2. With a different processor, the PC5 uses potentiometers and fixed resistors to determine the configuration. It is not under software control and provides no readout. Power is supplied through the PC5's 8 pin header or through a jack on the PC5. This is the "standalone" configuration.

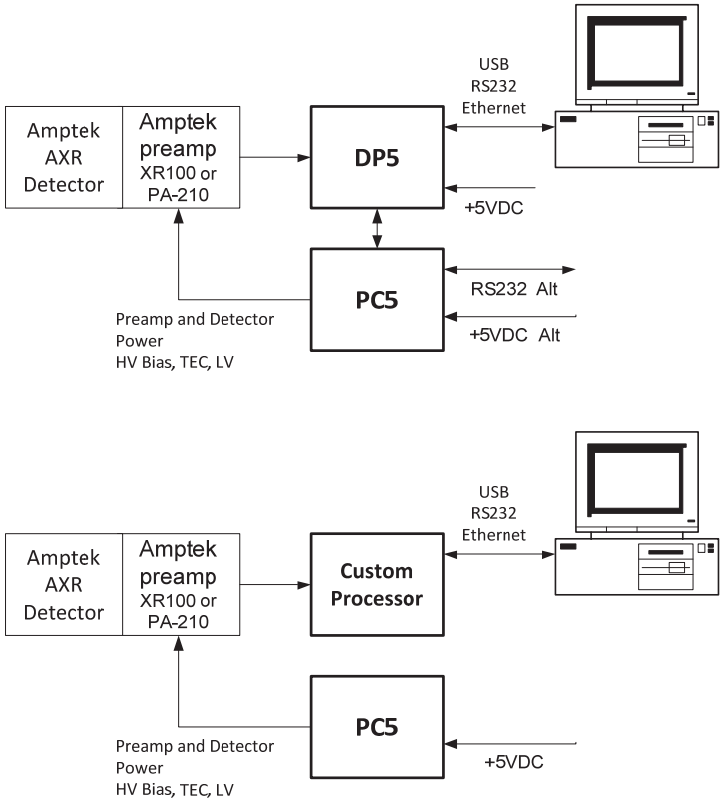

Figure 1. PC5 two most common configurations.

1.2 DP5 Family

Amptek has a family of products built around its core DP5 digital pulse processing technology, designed for pulse height spectroscopy. It was originally designed for the detection of ionizing radiation, principally X-ray and gamma-ray spectroscopy. A generic system, illustrated below, includes (a) a sensor, a.k.a. detector, (b) a charge sensitive preamplifier, (c) analog prefilter circuitry, (d) an ADC, (e) an FPGA which implements pulse shaping and multichannel analysis, (f) a communications interface, (g) power supplies, (h) data acquisition and control software, and (i) analysis software.

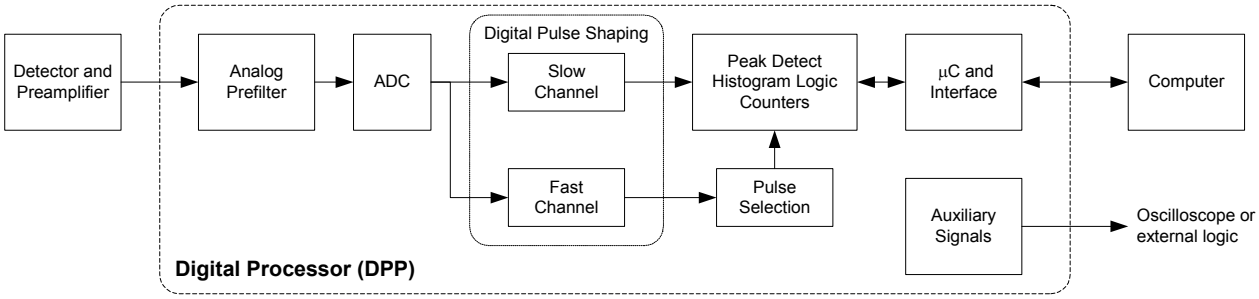

Figure 2. Generic spectroscopy system

The core DP5 technology shared by all the systems includes the ADC, the FPGA, the communication interface, and the data acquisition and control software. All products in the DP5 product family include nearly the same digital signal processing algorithms, the same communication interfaces (both the primary serial interfaces and the auxiliary I/O), and use the same data acquisition and control software. The DPPMCA software package is a complete, compiled data acquisition and control software package used across the family; Amptek also offers an SDK for custom software solutions.

The products in the DP5 family differ in the sensor for which they are designed, which leads to changes in the analog prefilter, power supplies, and form factor. They also differ in their completeness: some of Amptek's products are "complete" while others offer only a portion of the functionality for the user to integrate into a complete system.

Amptek has written a "User Manual for Amptek's DP5 Product Family" which summarizes those characteristics that are common across the entire DP5 family. This manual concentrates on only those aspects which are unique to the PC5 circuit board.

1.3 Options and Variations

Configurations

The PC5 was designed so that it can be configured to support a wide variety of detectors. Some parameters can be set via software commands, through the DP5 (i.e. the HV bias voltage or the detectors temperature). Many other configuration options are set via hardware jumpers or minor changes to the components on the core board (changes to the Bill-of-Materials). These BOM changes are indicated by a set of configuration indicators.

2 Specifications

Physical	
Dimensions	8.9 x 6.4 cm (3.5 x 2.5 in)
Weight	30 g

General & Environmental	
Operating temperature	-40 °C to +65 °C (for the electronics) All electronic components in the DP5 family are rated for the industrial range, up to +85°C. Components are warmer than the ambient temperature and thus we recommend limiting the ambient temperature to <65°C. Some detectors may have tighter temperature limits; even where they operate over a wide range, performance is usually a strong function of detector temperature.
Warranty Period	1 Year
Typical Device Lifetime	5 to 10 years, depending on use
Storage and Shipping	Long term storage: 10+ years in dry environment Typical Storage and Shipping: -40 °C to +85 °C, 10 to 90% humidity non-condensing
Compliance	RoHS Compliant

Power	
Nominal Input:	@ +5 VDC: 400 mA (2 W) typical, at full cooling.
Input Range:	+4 V to +5.5 V (at 0.5 to 0.35 A typical)
Initial transient:	2 A for <100 μs
Power Source:	External supply or USB bus

The PC5 supplies power to the preamplifiers. When used in conjunction with a DP5, as is typical, the pair together draw about 700 mA (3.5W) at full cooling.

3 Mechanical Interface

3.1 Dimensions

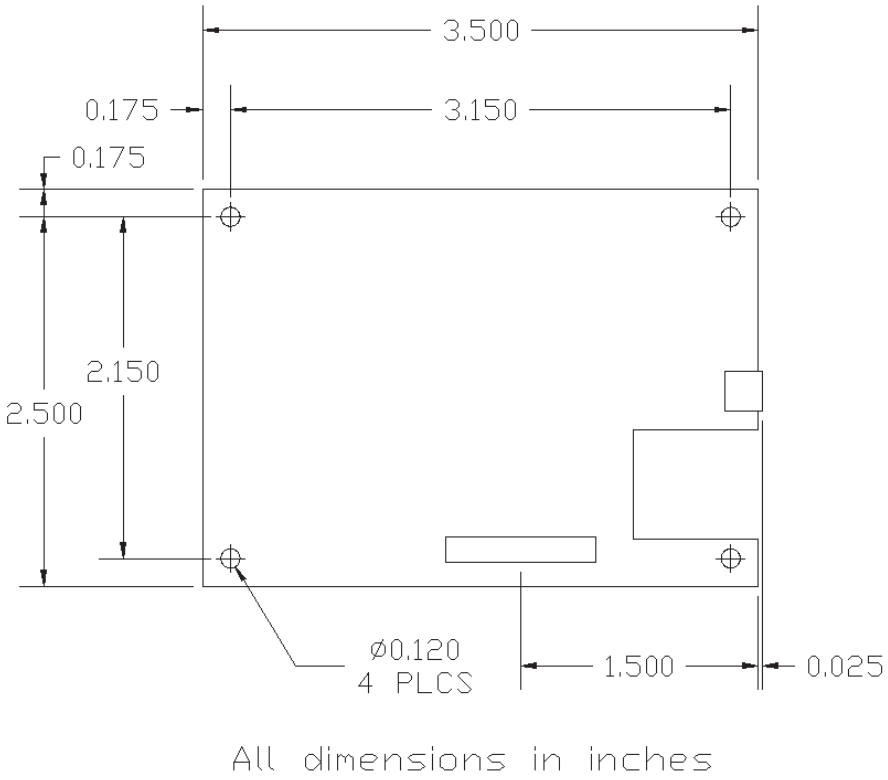

Figure 3. Mechanical overall dimensions.

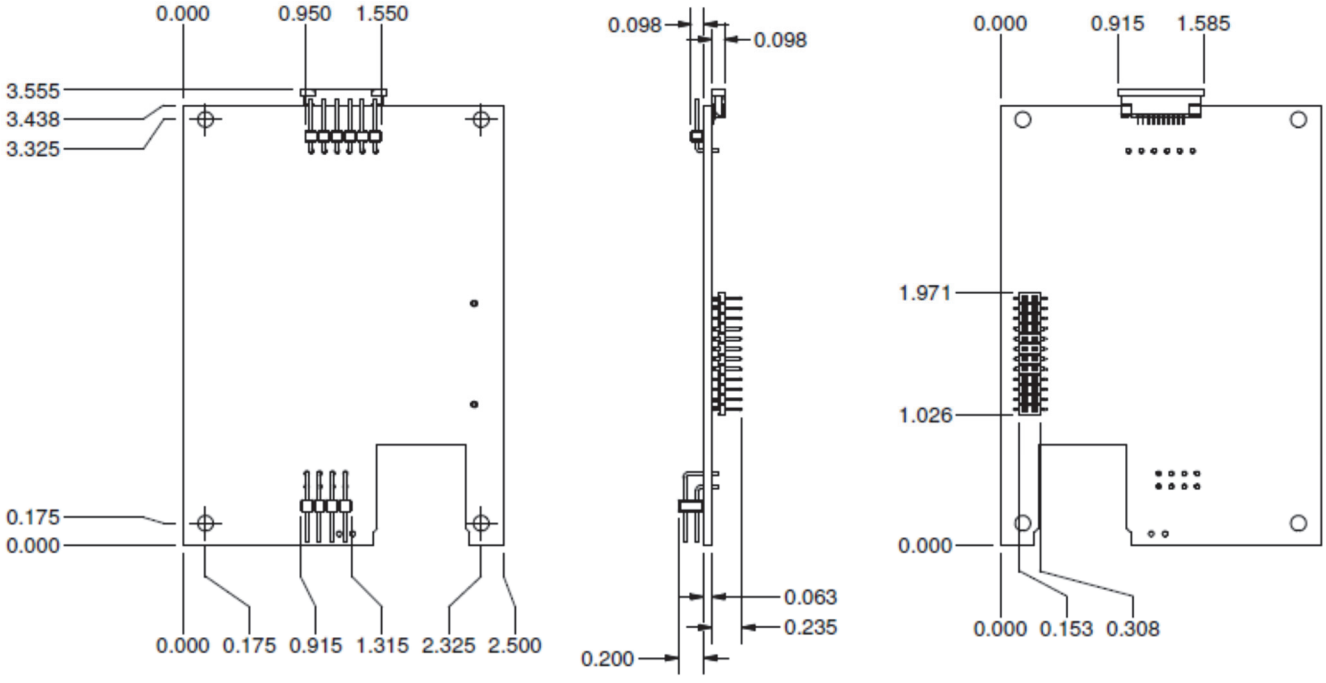

Figure 4. Mechanical connector locations and dimensions. All dimensions in inches.

3.2 Connectors

Note that the PC5 build configuration dictates which of the following connectors are installed – never are they all installed.

Power (J1)

Power Jack on PC5: Hirose MQ172-3PA(55) [obsoleted in 2016, replaced by MQ172-3PA(30)].

Mating Plug: Hirose MQ172-3SA-CV(50) [obsoleted in 2016, replaced by MQ172-3SA-CV(30)] [The replacements are form/fit/function compatible.]

Pin #	Name
1	VIN (+5 V DC)
2	GND
3	Do Not Connect

Power connector to XR100 (J2)

Part #: Molex 22-28-8062

Mating: Molex C-Grid Crimp Connector. Housing P/N 50-57-9006, terminal P/N 16-02-0119.

Pin #	Name
1	Detector temperature. This is an input to the PC5 from the detector
2	HV Bias. From 0 to +/-1500V, depending on the detector.
3	-8.5 or -5 V. Supplies power to the preamp
4	+8.5 or +5 V. Supplies power to the preamp
5	GND
6	TC+. Provides power to the thermoelectric cooler (< 4 V)

DP5 Backplane Connector (J3)

Documented in detail in the "DP5 User Manual."

Alternate power and RS232 connector (J4)

This is an alternate power and RS232 connector. In OEM applications, for mating between boards, this can be more useful than the board edge connectors.

Part #: Molex 71764-0108 (4x2 connector)

Mating: Molex C-Grid Crimp Connector. Housing P/N 22-55-2081, terminal P/N 16-02-1114.

Pin #	Name
1	GND
2	Power In
3	RS232-TX (output from DP5)
4	RS232-RX (input to DP5)
5	Shut down. Holding this pin low turns off PC5 supplies
6	GND
7	NC
8	GND

Power and signal connector to PA210/PA230 (J5)

Part #: Samtec ZF1-10-01-T-WT

Pin #	Name
1	GND
2	TC+. Provides power to the thermoelectric cooler (< 4 V)
3	+8.5 or +5 V. Supplies power to the preamp
4	-8.5 or -5 V. Supplies power to the preamp
5	Signal return. Tied to GND on PA210/PA230
6	Signal Out
7	Detector temperature. This is an input to the PC5 from the detector
8	GND
9	NC
10	HV Bias. From 0 to +/-1500 V, depending on the detector.

Signal connector to DP5 for PA210/PA230 (J7)

Part #: TMM-102-01-S-D-SM

Mating: SMM-102-02-S-D-LC

Pin #	Name
1	Signal Out
2	NC
3	Signal Return (ties to pin 5 of J5)
4	NC

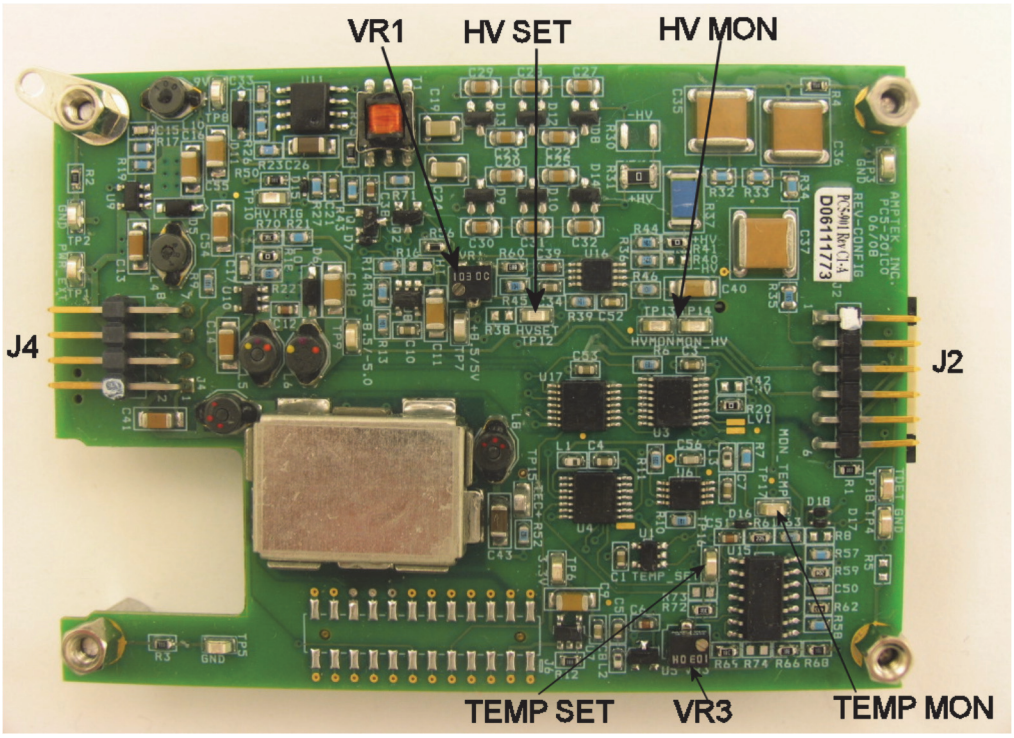

Photo of the top side of the PC5

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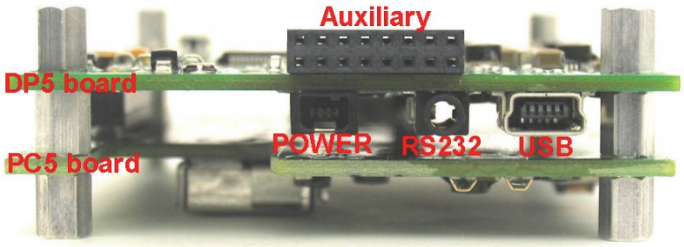

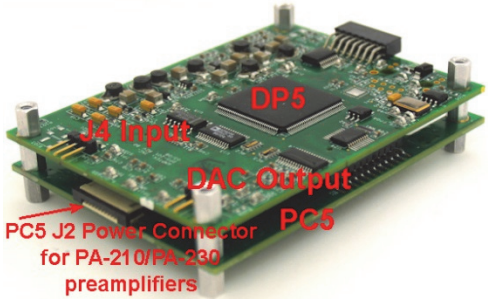

Photos of the DP5 and PC5 showing connector locations.

4 Electrical Interface

4.1 Power Interface

Absolute Maximum Power Supply Voltage +5.5 VDC

Absolute Minimum Power Supply Voltage +4.0 VDC

Input power outside this range will damage DP5 components.

4.2 Analog Input Interface

[These specifications are for the DP5 analog input – the PC5 passes the analog signal to the DP5.]

Absolute Maximum Input Voltage Range -5.5 V to +5.5 V

Polarity: Either positive or negative. Configure in firmware

Reset or resistive: Either is acceptable but must be configured in hardware.

Step size: 5 mV to 1V.

5 PC5 Design

5.1 PC5 Architecture

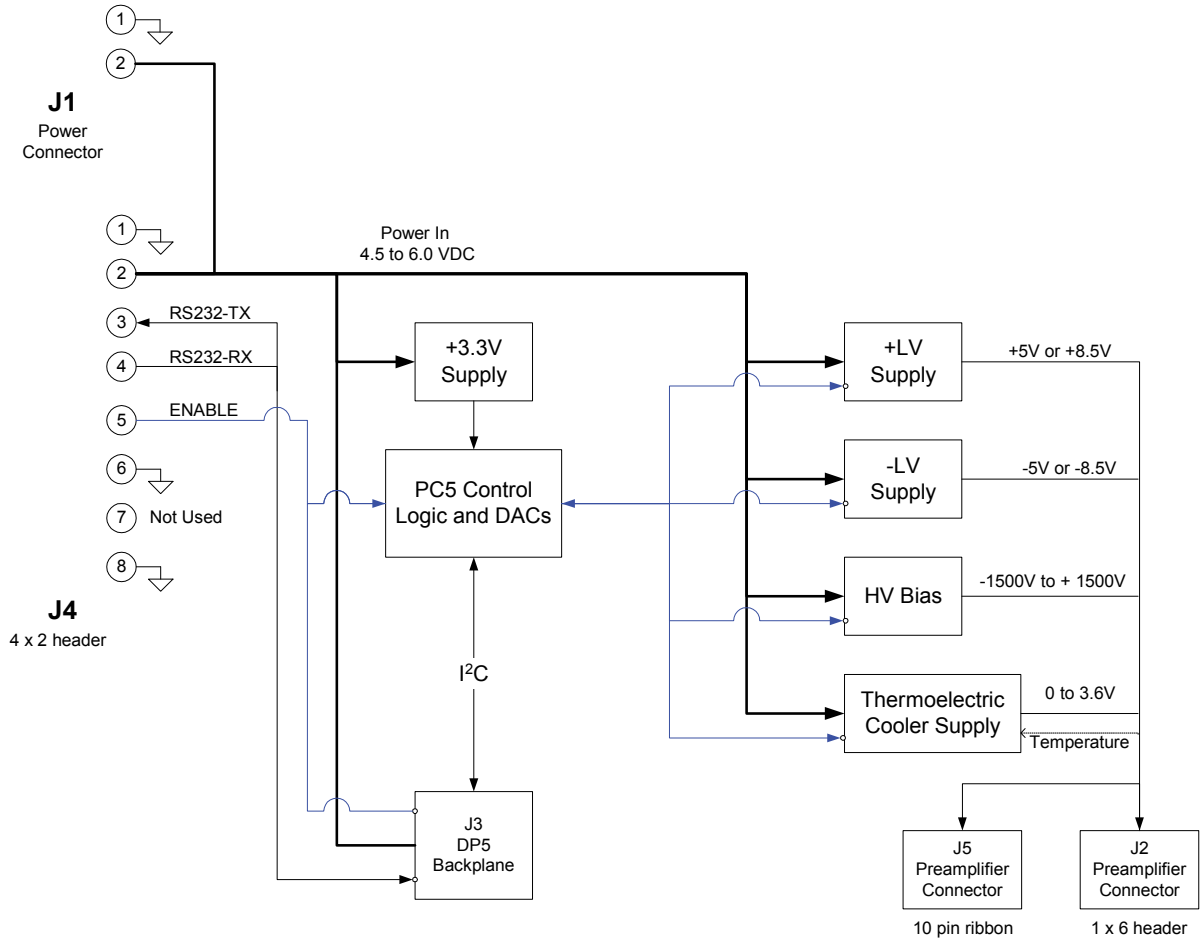

Figure 5. PC5 design

The PC5 contains several separate switching regulators. Four provide the power for the preamplifier and detector: two low voltages for the preamplifier, the HV bias for the detector, and the power for the thermoelectric cooler. There are several important details for this circuit.

- The PC5 supply voltage must be between +4.5 and +6.0 VDC. Power can be supplied via J1, or J4, or from the DP5 via J3. If the DP5 is installed it can be powered via the PC5 J1 or J4.
- The power dissipated will depend on many variables. The PC5, preamplifier, and detector typically draw a maximum of 1.5 W (300 mA at 5 V). The PC5 and DP5 together typically draw 3.5 W (700 mA at 5 V).
- Nominal switching frequencies are >1 MHz, except for the HV bias which switches at 50 kHz.
- The enable pin can be controlled from the DP5 or J4. The enable pin is pulled up to 3.3 V with 10 Kohm. In the absence of a DP5, this pullup will turn on the PC5 supplies, unless the enable pin is pulled down externally.
- The PC5 control logic is generally under control of the DP5 via I^2C. This enables the various supplies, determines the set point, and monitors the values which are reported back to the DP5. If no DP5 is used then potentiometers and resistors are installed to provide fixed control.

5.2 HV Bias Supply Discussion

A simplified schematic for the HV supply is shown in the schematic below for positive polarity. The output is divided by a factor of 500 into the error amplifier circuit. TP12 measures the HV set point while TP13 measures the actual HV bias. Both measure 2 mV/V, so for a 240 V bias these test points should be 0.48 V. For use with a DP5, VR1 is not installed and the DAC controls the value. For use without a DP5, VR1 is installed (along with other components) and the DAC is disconnected.

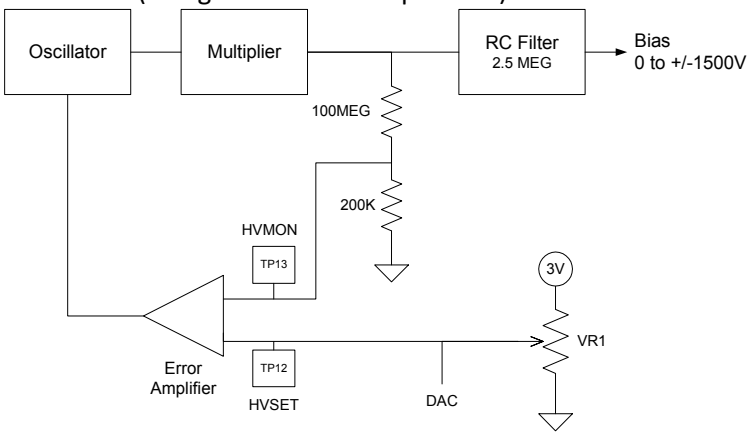

Figure 6. Schematic for HV Bias supply circuit.

- Negative polarity is similar but the divider output is inverted. Both HVMON and HVSET are still positive. Changing polarity requires removal and installation of several zero ohm resistors and is done at the factory.
- <u>The bias polarity and magnitude are selected based on the detector in use. These are very important, since the wrong polarity or excess magnitude can cause irreparable damage to a detector. This type of damage is not covered under warranty.</u>
- The output RC filter has a series resistance of 2.5 MΩ. This provides current limiting (0.6 mA maximum). Because the control feedback is taken after the filter, the voltage drop across the 2.5MΩ

filter is compensated for – in other words, the output HV should be independent of load[1]. Also note that the output of the filter, at the J2 or J5 connector, cannot be measured with a conventional DVM (input impedance 10 MΩ). A high impedance probe is required.

5.3 Thermoelectric Cooler Discussion

The control circuit for the thermoelectric cooler is shown in the schematic below. This circuit maintains a fixed temperature rather than a fixed output voltage. A temperature sensor is located in the detector hybrid. The conditioning circuitry generates an output of 10 mV/K (2.2 V at 220 K). This is compared to the set point to generate the error signal.

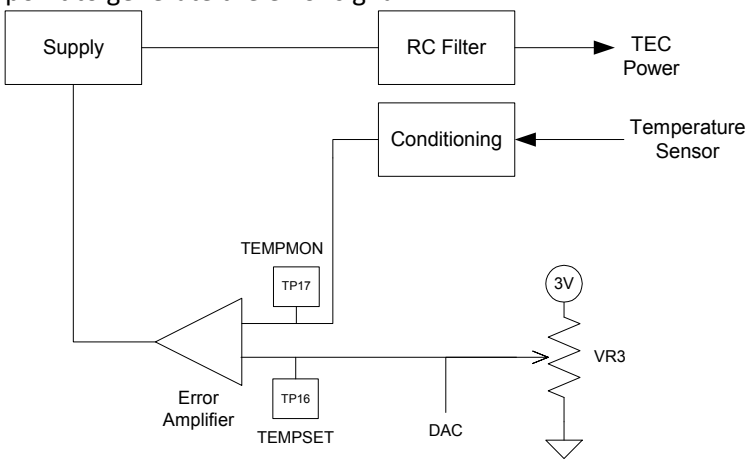

Figure 7. Schematic for thermoelectric cooler supply circuit.

For use with a DP5, VR3 is not installed and the DAC controls the value. For use without a DP5, VR3 is installed (along with other components) and the DAC is disconnected. There exists a maximum temperature differential which a given cooler can achieve. If the set point is lower than this, then the supply will provide maximal cooling (with an output current limit) but the detector temperature is no longer regulated. It will change as the system temperature changes.

A typical two-stage cooler can generate an 85 °C ΔT. Example: If room temperature is 20 °C, then the maximum cold temperature is -65 °C. It is vital that the detector temperature remain constant. Therefore the set point must be set such that no matter what the ambient temperature reaches, the detector temperature stay constant. Example: If room temperature is 40 °C the temperature set point must be set such that this is regulated, so the coldest the detector can be set to is -45 °C. This means that even at 20 °C room temperature the detector will be at -45 °C, but it will be constant from 20 to 40 °C.

The temperature sensor, inside the detector, is a 1N914. The forward voltage, at a fixed current, is a function of temperature and is used to regulate the detector temperature. A typical calibration curve can be found at www.amptek.com.

[1] Note that PC5s earlier than Rev D0 (early 2013) take the feedback from before the output filter, so that there will be some voltage drop across the 2.5MΩ filter, depending on current.

5.4 Preamp Signal Connections

The schematic below illustrates how the preamp signal is brought to J7 for PA210/230 applications.

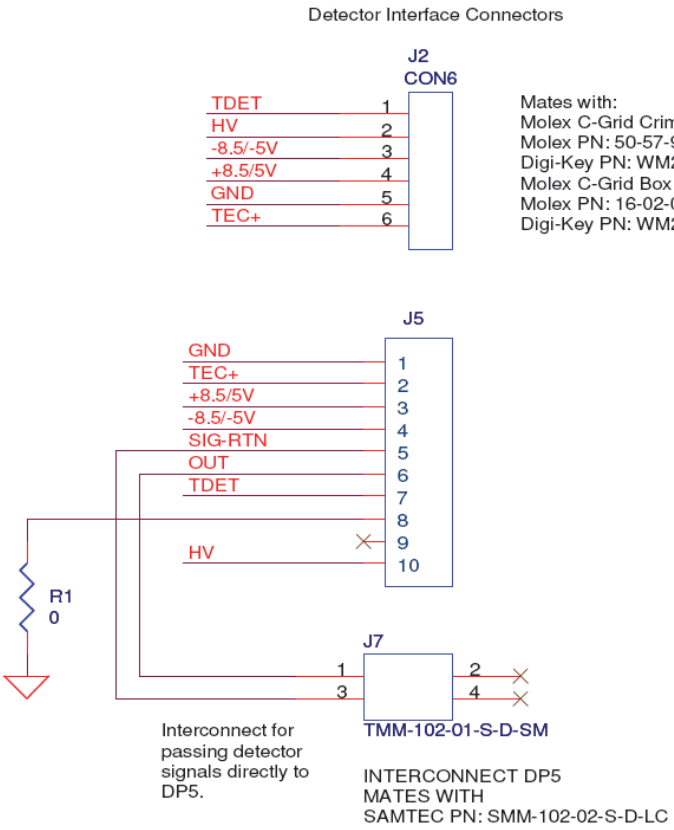

Figure 8. Preamp signal connections

6 PC5 Application Advice

6.1 Using the PC5 without a DP5

The PC5 must be ordered with the correct configuration. It is not intended for the user to change configurations for different products.

XR100

When using the PC5 with an XR100 box the following configuration is needed:

- Preamp power set to +/- 8.5 V (R16 = 0 Ohm/short, R18 = open).
- J2 connector used to connect power to XR100.
- VR1 and additional components installed for HV control (installed at the factory).
- VR3 and additional components installed for temperature control (installed at factory).
- XR100 Amp Out connected directly to user supplied signal processor.
- Input power is applied either to J1 with the AC adapter or to J4 from a power supply.

PA-210/PA-230

When using the PC5 with a PA-210 or PA-230 the following configuration is needed:

- Preamp power set to +/- 5 V (R16 = open, R18 = 0 Ohm/short).
- VR1 and additional components installed for HV control (installed at the factory).
- VR3 and additional components installed for temperature control (installed at factory).
- J5 installed and connected to PA preamp with flex cable.
- J7 installed. Unlike the XR100 that has a separate signal out, the PA preamps send the signal through the power flex cable. As a result, the signal must be taken from the PC5 J7 connector and then connected to the user supplied signal processor.
- Input power is applied either to J1 with the AC adapter or to J4 from a power supply.