DP5-X User Manual

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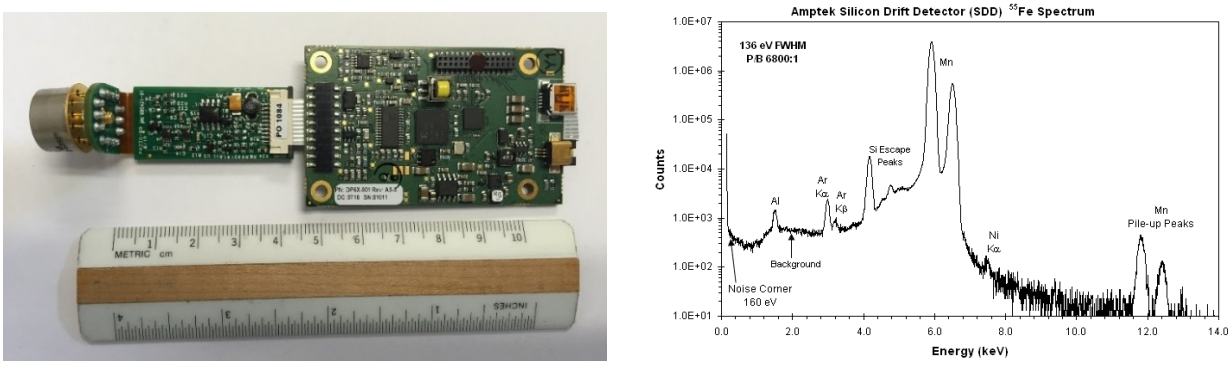
1 Introduction

1.1 DP5-X System Description

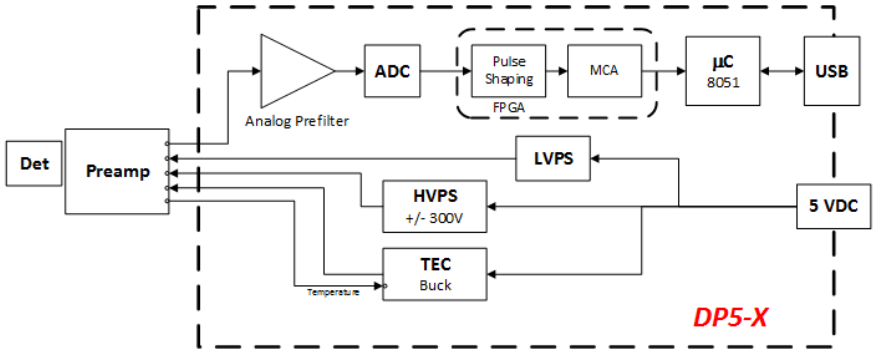
The DP5-X is a high performance digital pulse processor and power supply module, designed specifically for OEMs using Amptek's SiPIN, SDD, and FAST SDD® detectors. It is a board level component which includes the key functions previously found in the DP5 and PC5 but at much smaller size and lower cost. It is designed to interface with Amptek's PA210 and PA230 preamplifiers. It includes all power supplies needed for the detector, requiring only DC power and a standard communication interface. It includes an "interconnect" for interfacing to customer-supplied boards.

The DP5-X is essentially a specialized version of the DP5 and PC5, for OEMs using Amptek's SiPIN, SDD, and FAST SDD® detectors. It does not replace the DP5 and PC5; these boards remain available for customers using Amptek's CdTe detectors, other types of detectors (HPGe, SiPMT), other preamps, and for customers needing advanced features. The DP5 is the more flexible and general purpose processor. Amptek designed the complete system (DP5-X and new PA210/230 configurations) to provide the best possible performance/price point for OEMs.

The DP5-X uses the same FW6 software interface as Amptek's DP5, X-123, and other processors. The pulse processing logic is the same as that found in the DP5. The use of digital pulse shaping technology improves several key parameters relative to older approaches: (1) better performance, specifically better resolution and higher count rates; (2) greater flexibility since more configuration options are available, selected by software, and (3) improved stability and reproducibility. The DPP digitizes the preamplifier output, applies real-time digital processing to the signal, detects the peak amplitude, and bins this in its histogram memory. The spectrum is then transmitted to the user's computer. The DP5-X also supplies the power to the detector, including low voltages for the preamps, high voltage to bias the detector, and a supply for the thermoelectric cooler which provides closed loop control with a maximum temperature differential of 85 °C. All of these are under software control.



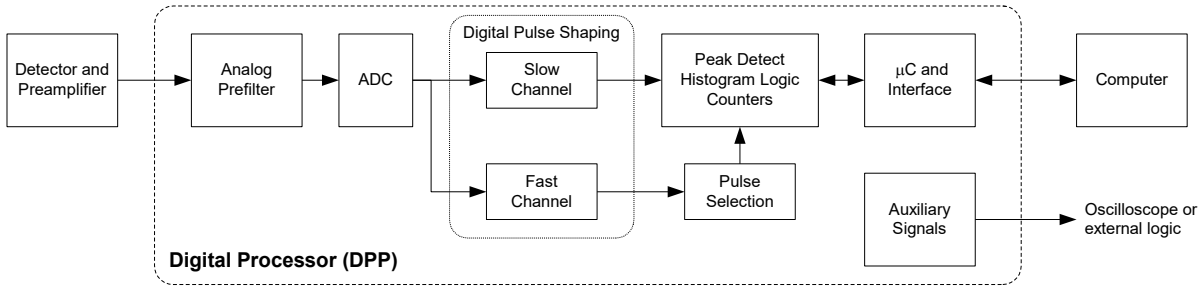
Photograph of DP5-X with detector and PA230 preamp (left) and a typical ^{55}Fe spectrum (right).



Block diagram of the DP5-X in a system,

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.



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 data acquisition and control application 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", with elements (a) through (i), while others offer only a portion of the functionality for the user to integrate into a complete system.

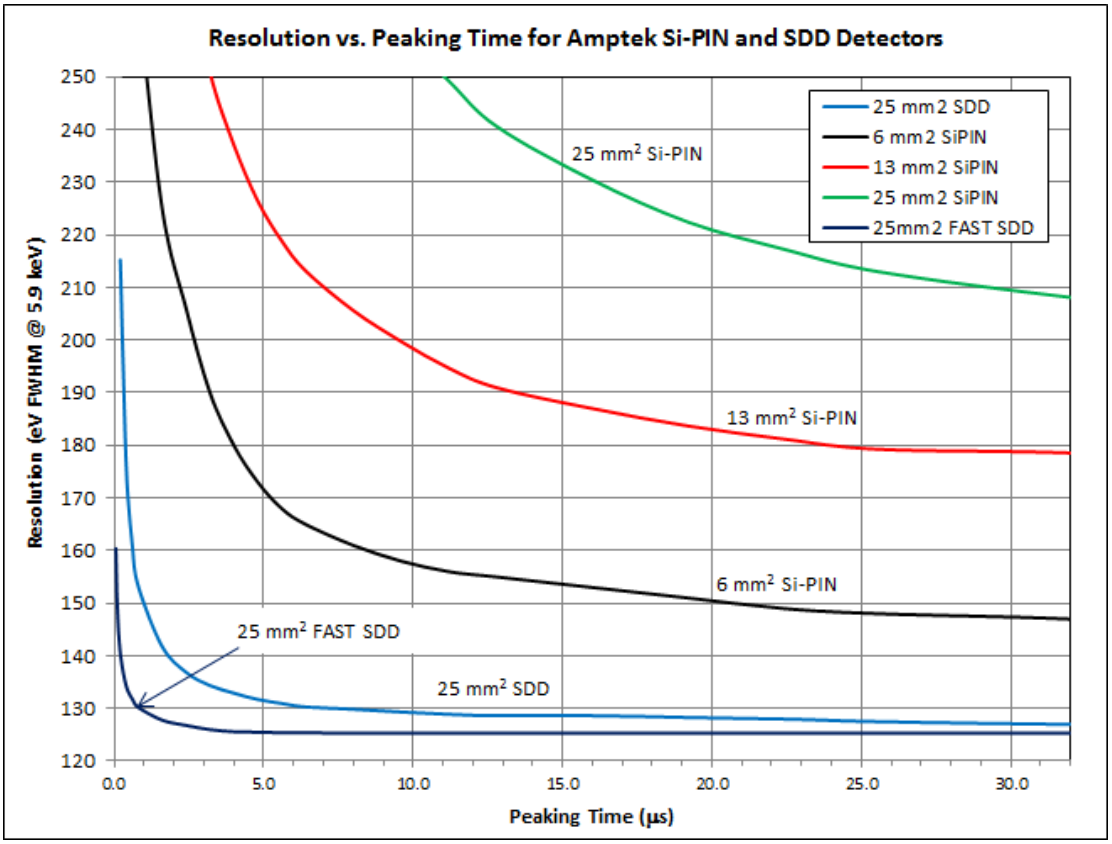
1.3 DP5-X Options

- HVPS: The DP5-X is available with a positive HV for SiPIN detectors and negative HV for SDD and FAST SDD® detectors.
- Output DAC: The standard DP5-X configuration does not include the output DAC, which is used to view pulses for diagnostic purposes. This is available only in the special "evaluation" option.
- Ethernet controller": The standard DP5-X configuration does not include the Ethernet controller; this is available only in the special "evaluation" option.

2 Specifications

2.1 Spectroscopic Performance

The performance specifications – the resolution, count rate, etc. – are determined by the detector which has been chosen. The plots below show typical performance, for ^{55}Fe at full cooling. Refer to Amptek's detector specifications for more information.



2.2 Processing, physical, and power

The DP5 specification table is identical to that found in the "User Manual for Amptek's DP5 Product Family". The physical and power specifications are listed below.

Physical	
Dimensions	4.8 x 6.4 cm (1.5" x 2.5")
Weight	30 g

Power (with detector)						
Characteristic	**Symbol**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Supply Voltage	V_{In}	4.0	5.0	12.0	V	
Supply Current	I_{IN}			0.9	A	V_{IN} = 5.0 V, initial cooldown
			0.70		A	V_{IN} = 5.0 V, steady state full cooling
			0.50		A	V_{IN} = 5.0 V, ΔT=70 °C
			0.40		A	V_{IN} = 5.0 V, ΔT=50 °C
			0.35		A	V_{IN} = 5.0 V, no cooling or bias
Inrush Current	I_{INRUSH}		2		A	<100 µsec
Input Capacitance	C_{IN}		50		µF	

- The table above shows power dissipation with a detector and preamp installed.
- The power dissipated by the DP5-X depends most strongly on the detector temperature, which is set in software. At full cooling, ΔT=70 °C, the DP5-X draws about 0.7 A at 5 V, or 3.5 W. If the detector is not cooled as much, power dissipation decreases to less than half of this. The table above is for a typical detector, but the actual value depends on the type of detector (e.g. its area) and varies between units.
- Note that USB power is rated to 2.5 W, therefore theDP5-X cannot be powered over USB.
- The DP5-X can be powered from a relatively wide input voltage range, from 4V to 12V DC, simplifying use in battery power applications. The total power dissipation increases with input voltage, due to the reduced efficiency of step down converters.
- The inrush current is that required to charge up a set of capacitors, with a total of 50 µF capacitance.

3 Mechanical Interface

3.1 Dimensions

TBD

3.2 Connectors

Power (J1)

Power Jack on DP5-X: Hirose MQ172-3PA(30).

Mating Plug: Hirose MQ172-3SA-CV(30)

Pin #	Name
1	VIN
2	GND
3	Do Not Connect

USB (J4)

Standard USB 'mini-B' jack. (The DP5-X is 'self-powered': it draws no power from the USB.)

Auxiliary (J5)

30-pin, 0.05" mm spacing, P/N CLP-115-02-G-D-A

For a mating connector, see Samtec with your application needs

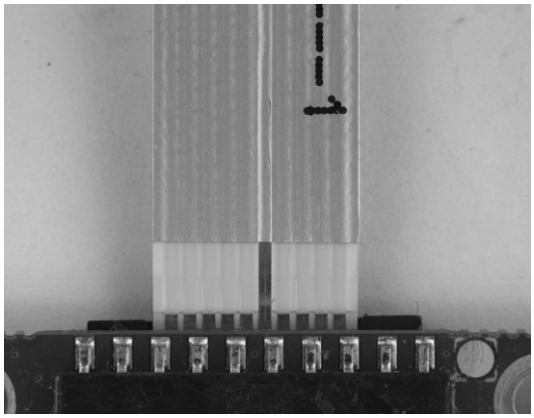
Pin #	Name	Use	Pin #	Name	Use
1	DACOUT		2	AUX1	
3	C2D	Test	4	AUX2	
5	/RST/C2CK	Test	6	AUX3	
7	SDA	I2C	8	AUX4	
9	SCL	I2C	10	TDP	Ethernet
11	/RS232_INVAL		12	TDN	Ethernet
13	RX0	RS232	14	RDP	Ethernet
15	TX0	RS232	16	RDN	Ethernet
17	LED_GRN	Ethernet	18	VBUS	USB
19	LED_YEL	Ethernet	20	USB-	USB
21	SPARE		22	USB+	USB
23	GND		24	3.3V	External 3.3V
25	GND		26	3.3V	External 3.3V
27	GND		28	PWR	External power
29	GND		30	PWR	External power

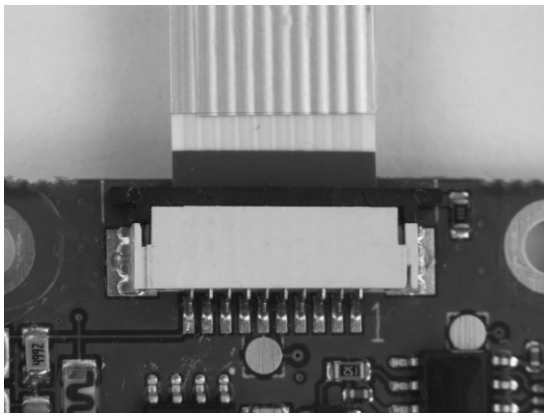
Power and signal connector to PA210/PA230 (J2)

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

Note the orientation of the shielded flax flex connector shown below. Orientation is very important! If the connector is turned around, all the signals will go through and the system will operate, but the SIGNAL line gets connected to the connector shield, meaning it is unshielded; the system is far more susceptible to EMI.

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.





Photographs showing orientation. Note location of pin 1 on the flat flex connector.

J3

This connector is DNI when the DP5-X is used with the PA210 or PA230.

3.3 Thermal

The DP5-X dissipates up to 3.5 W of power, which is a large amount of power for such a small board. There good thermal conduction through the ground plane of the board to the corner holes. It is important that the DP5-X be attached via these posts to a heat sink. If proper heat sinking is not used, then the DP5-X can overheat and will have trouble cooling the detector, compromising performance and operating life.

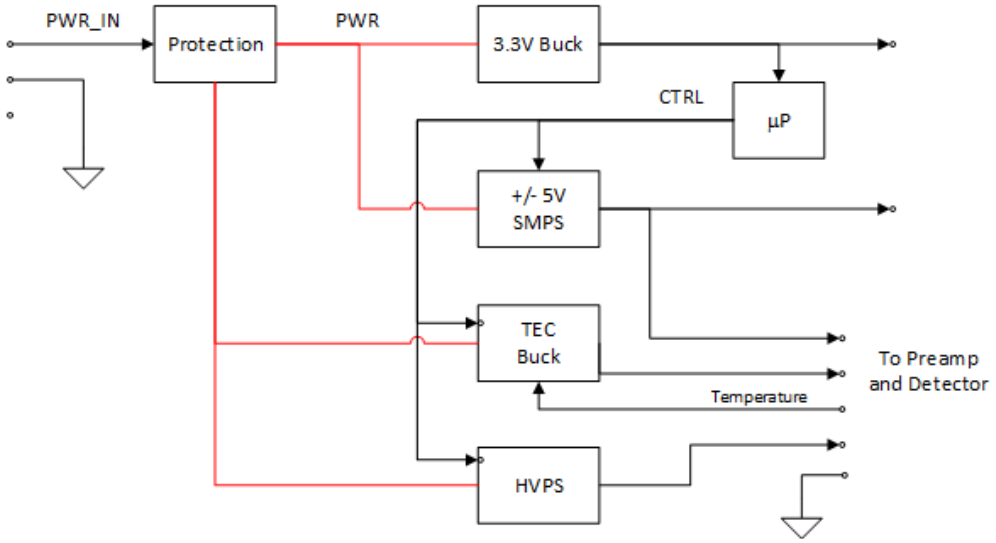
4 Electrical Interface

Only the power interface differs from that described in the family wide manual.

4.1 Power Interface

A schematic illustrating the circuit at the power input is shown below. The PWR_IN line goes through a protection circuit, then to different switching power supplies in parallel. Each has a 4.7 µF input capacitor. Some turn on as soon as power as applied, while others are under control of the microprocessor.

- Protection: The protection device protects against reverse input polarity and has over- and under-voltage lockouts. The DP5-X will not power on with an input voltage below 4 V or above 12 V. The input protection network operates over the range of -40 V to +60 V. Beyond this range, damage to the DP5-X will occur.
- Grounding: The DP5-X board ground is attached to (1) all four corner posts, (2) to the ground pins on the power, USB, and auxiliary connectors, and (3) to the ground pin on the preamp connector



Schematic of power supply architecture.

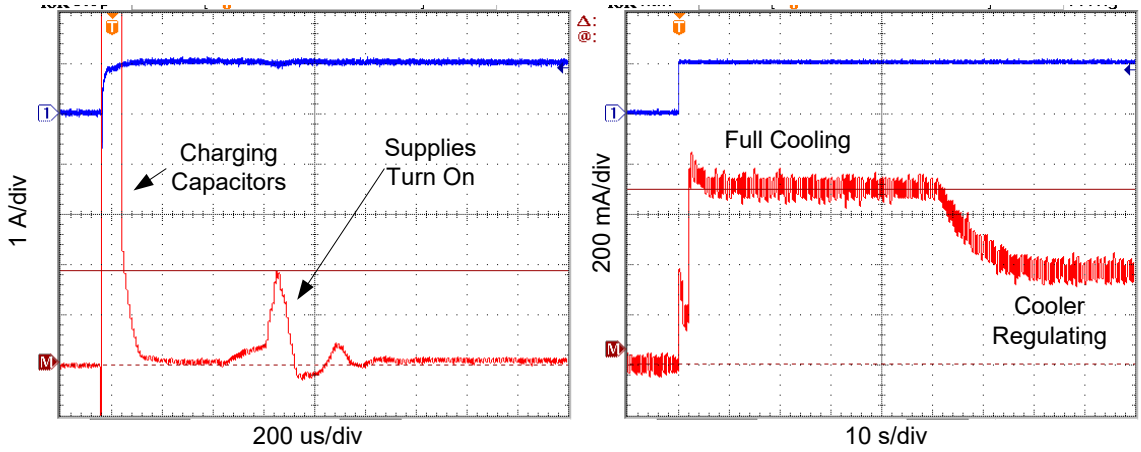
Turn-On Transients

The figure below**Error! Reference source not found.** illustrates the transient currents seen as the DP5-X turns on.

1) When 5 VDC is first applied to the power input, a large transient current is drawn to charge up the 50 µF of input capacitance, from the input capacitors on all the supplies.
2) About 400 µsec later, the low voltage switching supplies turn on. The maximum inrush current is about 2 A, with a duration of <100 µsec. It is important that the external supply be able to provide this current. If this current is limited, some of the supplies can be destroyed.
3) After the DP5 is powered up, it then powers up the PC5, based on configuration settings stored in the DP5. Depending on the "Set Power-on State" configuration option, this either happens automatically (approx. 2 seconds after power is applied), or upon command from the host PC. The unit draws about 300 mA at 5 V.

4) When the cooling is turned on, I_{IN} goes to its maximum, drawing approximately 700 mA.

5) In this figure, the set point was 230 K, the ambient 295 K, and a SDD on a two stage cooler was used. After about 50 seconds, the temperature approached the set point and so began regulating. The current decreased to its steady state value, 400 mA.



5 DP5-X Design

5.1 Detector and preamplifier

The DP5-X only supports Amptek's SiPIN, SDD, and FAST SDD® detectors. Amptek's CdTe detectors and the many other detectors available on the market must be used with the DP5.

The DP5-X only supports Amptek's PA-210 and PA-230 preamps AND must be used with specific configurations of these. Amptek designed the entire preamp/DPP system to provide the optimum price and performance point. Using an older PA-210 or PA-230 with the DP5-X will seriously compromise performance.

5.2 Analog prefilter

The analog prefilter is unchanged from the standard DP5 design.

5.3 Power supplies

The overall power supply design were discussed in the previous interface section.