X-123 User Manual

Complete X-Ray Spectrometer - All Available Detector Types

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TUV Rheinland Certification Available on Request

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1. Warnings and Precautions

1.1. CAUTION: READ MANUAL BEFORE USING THE X123

1.2. DO NOT DROP, HIT, OR OTHER-WISE CAUSE MECHANICAL SHOCK TO THE DETECTOR, OR CAUSE DAMAGE TO THE DETECTOR

- Mechanical shock can damage components inside the TO-8 package.
- There is vacuum inside the TO-8 for cooling. Damage to the package can cause a vacuum leak, preventing good cooling. DAMAGE TO THE PACKAGE IS NOT COVERED UNDER WARRANTY.

1.3. DO NOT TOUCH THE THIN WINDOW ON THE END OF THE DETECTOR

- *BROKEN WINDOWS DAMAGED BY IMPROPER HANDLING WILL NOT BE COVERED BY WARRANTY.*
- The detector windows are made from very thin film/foil materials (beryllium , Si_3N_4, Boron Carbide, etc.). The windows are extremely brittle and shatter easily.
- Do not permit any objects or materials to come into contact with the window.

- If damaged, the window cannot be repaired or replaced. If the window breaks, the TO-8 detector assembly must be replaced.
- Keep the red protective cover installed when not in use.

1.4. AVOID RADIATION DAMAGE TO THE DETECTOR

- *A RADIATION DAMAGED DETECTOR WILL NOT BE COVERED UNDER WARRANTY.*
- The detector will experience radiation damage if it is exposed to a high flux environment, e.g. directly from a synchrotron.
- If the flux is low enough for spectroscopic operation, e.g. a count rate of a few hundred kcps, there will be no radiation damage in many years of continuous operation. But there are beams that produce a flux many orders of magnitude higher than this, and these will cause damage.
- Also, avoid radiation exposure to the electronics, the preamplifier and signal processor.

1.4.1. **HIGH VOLTAGE IS PRESENT IN THE PREAMPLIFIER.** This is typically +180 V for SiPIN or -135V for SDD's and +700V for CdTe. The current is limited to <100μA so is not a personnel hazard.

For best performance the detector and preamplifier should be mounted to a heat sink. They should be kept away from incandescent lamps and not held in the hand. The thermoelectric cooler dissipates up to 2 W. A low thermal resistance path to a heat sink is needed to keep the detector cool, which is needed for the lowest electronic noise and for spectrum stability.

For best performance pay attention to possible sources of electromagnetic interference. Use a single point electrical ground, use the shortest length cables possible, and keep the system far from sources of electromagnetic interference, such as computer monitors, high power high voltage power supplies, etc. The signals from the detector are very small so performance can be degraded by EMI.

1.5. PROPOSITION 65 WARNING

WARNING

This product contains the following chemicals, which are known to the State of California to cause cancer, birth defects or other reproductive harm if exposed to them through improper use, storage, or disposal of the product:

Prop 65 Chemical	Type of Toxicity	CAS No.	Product part containing the chemical
Beryllium	Cancer	--	Detector window

Please consult this owner's manual for proper use, storage, care, and disposal of the product. For more information, go to: www.p65warnings.ca.gov

2. Introduction

2.1. X-123 Description

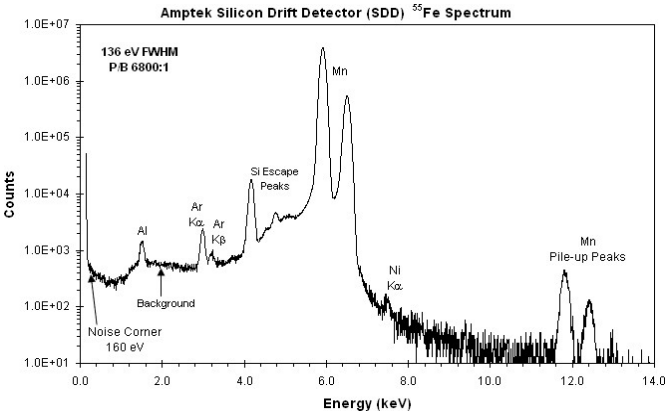
The X-123 combines, in a single package, Amptek's high performance X-ray spectroscopy components: an X-ray detector (options include the FastSDD, SDD, SiPIN, or CdTe) and preamplifier, (2) the DP5 digital pulse processor and MCA, and (3) the PC5 power supply. The result is a complete system which can fit in your hand with no performance compromise. It requires only +5 VDC power and a standard communication interface. With the X-123, anyone can rapidly obtain high quality X-ray spectra.

The detector is mounted on a thermoelectric cooler along with the input FET and coupled to a custom charge sensitive preamplifier. The thermoelectric cooler reduces the electronic noise in the detector and preamplifier, but the cooling is transparent to the user: it operates like a room temperature system.

The pulse processor is the DP5, a second-generation digital pulse processor (DPP) which replaces both the shaping amplifier and MCA found in analog systems. The digital technology improves several key parameters: (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 PC5 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. The X-123SDD input is unregulated +5 VDC with a current of about 400-900 mA, depending on configuration.

The complete system is packaged in 7 x 10 x 2.5 cm3 aluminum box. The detector is mounted on an extender; with lengths from 3/8" to 9" (vacuum flanges are available). In its standard configuration, only two connections are required: power (+5 VDC) and communications (USB, RS232, or Ethernet). An auxiliary connector provides several additional inputs and outputs, used if the X-123 will be integrated with other equipment. This includes an MCA gate, timing outputs, and eight SCA outputs. The X-123SDD is supplied with data acquisition and control software. It also includes a Software Development Kit (SDK), to integrate the unit with custom software. Optional accessories include software for analyzing X-ray spectra, several collimation and mounting options, and X-ray tubes to complete a compact system for X-ray fluorescence.

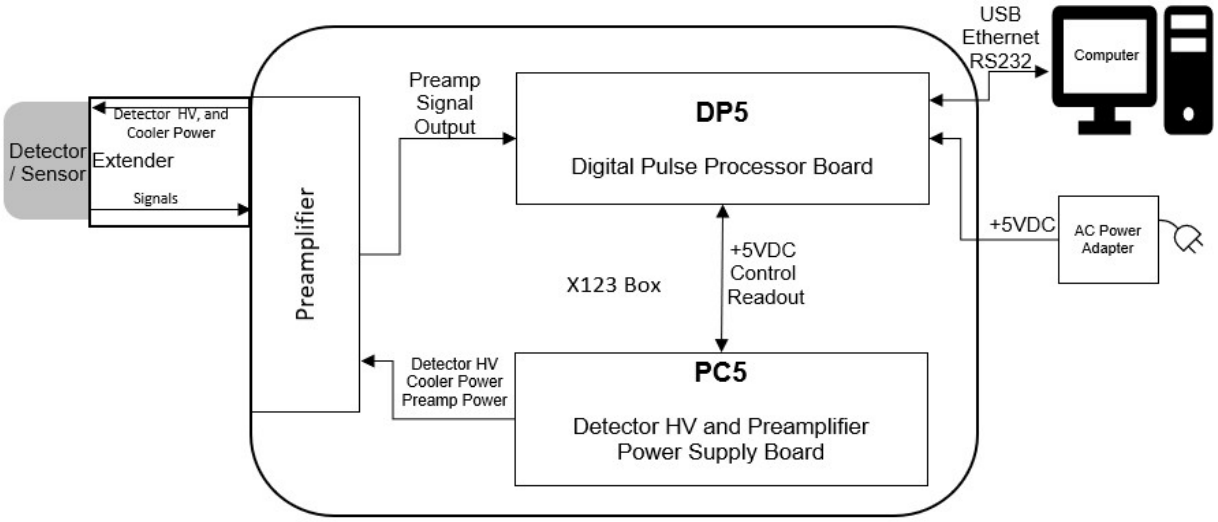
2.2. Photograph below of complete X-123 (left) and a typical 55Fe spectrum (right).



3. DP5 Family Design

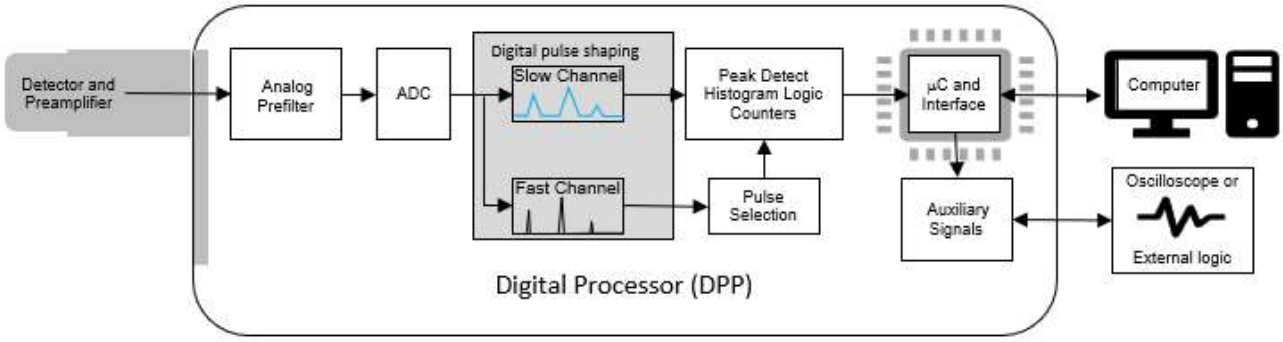
Amptek has a family of products built around its core DP5 digital pulse processing technology, designed for pulse height spectroscopy. It was originally designed for the detection of ionizing radiation, principally X- ray and gamma-ray spectroscopy. A generic system, illustrated below, includes a sensor,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

3.1. Block diagram of the Standard X-123 Design



3.2. X123 Signals Flow Diagram

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 detector, preamplifier, DPP, and power supplies), while others offer only a portion of the functionality for the user to integrate into a complete system.

4. X-123 Options and Variations

4.1. Detector

The X-123 is available with any of Amptek's standard detectors: FastSDD, SDD, SiPIN, and CdTe. Each of these is recommended for a different application and the X-123 hardware will only accommodate one detector type.

4.1.1. The X-123 FAST SDD® is Amptek's highest performance detector, providing both the highest resolution (as low as 122 eV FWHM at 55Fe) and highest count rates (above 1 Mcps). It is available with the C2 low energy window, for measuring low energy X-rays, down to the Be Kα line. The X-123 FAST SDD® is recommended for count rates > 100 kcps and, with the C2 window, for measurements < 1 keV.

4.1.2. The X-123-SDD (now obsolete) is a high-performance detector with broad applications in XRF. It has good resolution (as low as 125 eV FWHM at 55Fe) and good count rates (tens to hundreds of kcps). It provides the performance needed for most XRF applications, previously offered at a lower cost than the FastSDD.

4.1.3. The X-123-SiPIN is recommended for cost sensitive XRF applications with less demanding resolution and/or count rate requirements. It is available with areas of 6, 13, or 25 mm^2 with typical resolutions of 150 to 200 eV FWHM at 55Fe. It is best at count rates of a few to tens of kcps.

4.1.4. The X-123-CdTe is recommended for higher energy X-rays, above 30 keV or so. The 0.5 mm silicon used in the other detectors loses sensitivity above 15 keV, while the CdTe detector remains near 100% efficient for all characteristic X-rays, to 100 keV. It is often used in characterizing X-ray tubes as well as XRF for rare earth metals, lead, mercury, and other higher Z materials.

4.2. Extender Options

4.2.1. In the X-123, the detector is normally mounted on an extender, as seen in the photo above on the left. This is usually convenient for placing the detector inside shielding and in close proximity to a sample. The standard X-123 has a 1.5" extender but is available with a 3/8" extender (short), a 5" extender, and a 9" extender. The 5" and 9" options are commonly used in vacuum applications, extending through a vacuum flange into a vacuum chamber.

4.3. PA210/PA230 Interface

4.3.1. Another common option, shown to the right above, is to separate the detector/preamplifier from the rest of the electronics, contained in the metal enclosure. A 10-pin flat flex connector runs from the preamp to the X-123 box. This has the advantage of more flexibility in mounting but can be

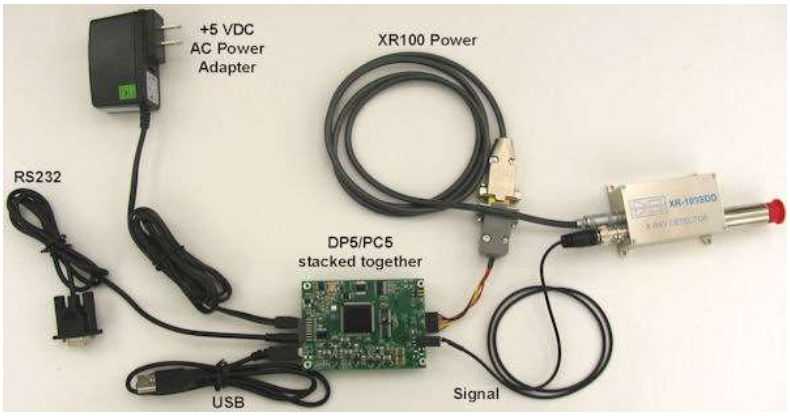
more susceptible to electromagnetic interference, grounding, etc.

4.4. Other configurations options – See Amptek.com for details on other configuration options.

4.4.1. OEM options https://www.amptek.com/products/x-ray-detectors/oem-xrf-solutions/oem-solutions-for-xrf-systems

4.4.2. Vacuum Options https://www.amptek.com/products/x-ray-detectors/accessories-for-xrf-eds/vacuum-applications-for-amptek-detectors

4.5. XR100 Interface



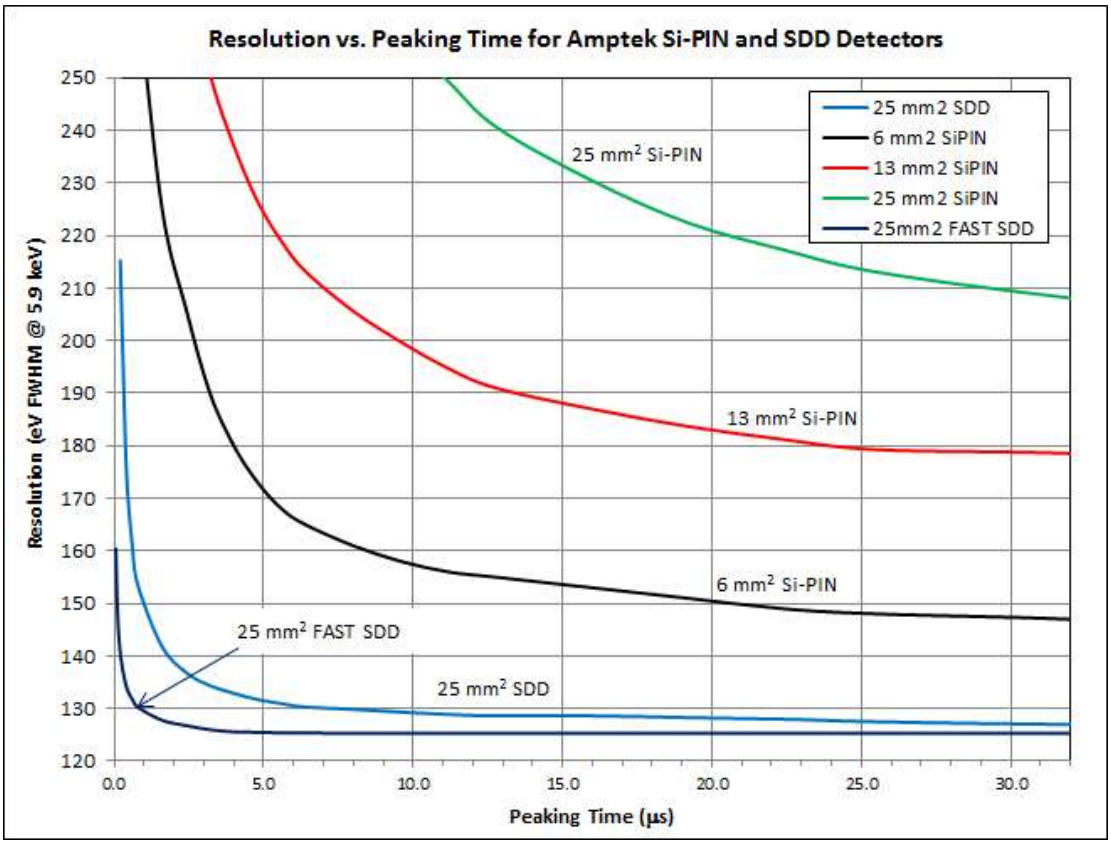
4.5.1. Another option, shown above with the X123 box removed, is the using the XR100 preamplifier box with the X123 Electronics. This uses a BNC and 6-pin Lemo connected to the XR100 box, and the cables run to 2 flat Molex connectors on the DP5/PC5 stack. This option uses a special config of the DP5/PC5 in which the preamplifier voltage is +/- 8.5V instead of the normal +/- 5V on all the other options.

4.6. Vacuum Use

4.6.1. The X-123 is suitable for vacuum applications, e.g., in EDS. The photo illustrates an X-123 with flex cables to the vacuum flange, and with the preamplifier and detector in the vacuum space. This design is not suitable for **U**ltra-**H**igh **V**acuum (Amptek provides other systems appropriate for **UHV**) and the entire X-123 should not be placed in vacuum. https://www.amptek.com/products/x-ray-detectors/accessories-for-xrf-eds/vacuum-applications-for-amptek-detectors

5. X123 Specifications

5.1. 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 55Fe at full cooling. Refer to Amptek's detector specifications for more information.



5.2. Amptek SiPIN Specifications

General			
Detector Type	SiPIN		
Detector Size (mm^2)	6	13	25
Collimated Area mm^2	4.4	11.1	21.5
Thickness	500µm		
Collimator Type	Internal Multilayer		
Preamplifier Type	JFET with Amptek custom reset through HV		
Energy resolution @ 5.9 keV (55Fe)			
6 mm^2:139 to 159 eV FWHM at T_{pk}=32 µs			
13 mm^2:150 to 205 eV FWHM at T_{pk}=32 µs			
25 mm^2:190 to 225 eV FWHM at T_{pk}=32 µs			
Other Performance			
Peak to background (typical)	16,000:1 for 6 mm^2 15,000:1 for 13 mm^2 > 12,000:1 for 25 mm^2		
Maximum input count rate	> 50 kcps		
Throughput count rate stability	Determined by signal processor & its settings		
Window Options			
Be	1 mil (25 µm) 0.5 mil (12.5 µm) 1 µm Parylene on each		
Signal Output			
Sensitivity	1 mV/keV		
Gain stability	<20 ppm/°C		
Polarity	Negative signal		
Reset range	-5 to +5 V (typical)		
Cooling			
Cooling performance	ΔT > 85°C		
Cooler type	Two stage thermoelectric		
Temp monitor	Diode		
Power			
HV Bias	+ 180V (typical)		
Max cooling power	3.5 V / 0.45A		
Total power	< 2 W (full cooling)		
Other			
Operating range	-35°C to +80°C Performance degrades at elevated detector temperatures.		
Storage & shipping	-40°C to +85°C, 10% to 90% RH noncondensing		
RoHS	Compliant		
Lifetime	Typical 5 to 10 years, depending on use		
Warranty Period	1 year		

Preamplifier Options

- Amptek's Si-PINs are available with the XR-100 preamplifier, with the PA210 or PA230 OEM preamplifiers, or as part of the X-123 and X-55.

Signal Processing Options

- Amptek's Si-PINs may be used with Amptek's DP5 or DP5-X, or the PX5, or as part of the X-123 or X-55.

Specification Notes

- Performance listed here is measured at full cooling (<220K).
- The "peak to background ratio" is the ratio of counts in the Mn Kα peak channel to the counts at 1 keV.
- "Gain stability" refers to the change in sensitivity when the preamp temperature changes but the detector temperature is stable.

Operating Notes

- Detector must be operated with an appropriate heat sink.
- The SiPIN is suitable for vacuum applications. Amptek provides several system configurations.

5.3. Amptek CdTe Specifications

General	
Detector Type	Cadmium Telluride (CdTe) Diode
Detector Size (mm^2)	5 x 5 mm (25mm^2)
Detector Thickness	1mm CdTe
Collimator Type	None
Preamplifier Type	Amptek Custom, Reset-style
Energy resolution @ 122 keV (57Co)	
25 mm^2:≤1.5keV FWHM Co-57 T_{pk}=2.4 µs	
Other Performance	
Signal risetime	Up to 300 ns (typical)
Maximum input count rate	> 50 kcps
Throughput count rate stability	Determined by signal processor & its settings
Window Options	
Be Graphite	4 mil (100 µm), 1 µm Parylene 1mil (25µm)
Signal Output	
Sensitivity	0.7 mV/keV
Gain stability	<20 ppm/°C
Polarity	Negative signal
Reset range	-5 to +5 V (typical)
Cooling	
Cooling performance	ΔT > 85°C
Cooler type	Two stage thermoelectric
Temp monitor	Diode

Power	
HV Bias	+ 700V (typical)
Max cooling power	4 V / 0.35A
Total power	< 2 W (full cooling)
Other	
Operating range	0°C to +40°C Performance degrades at elevated detector temperatures.
Storage & shipping	-20°C to +50°C, 10% to 90% RH noncondensing
RoHS	Compliant
Lifetime	Typical 5 to 10 years, depending on use
Warranty Period	1 year

Preamplifier Options

- Amptek's CdTe are available with the XR-100 preamplifier, with the PA910 or PA930 OEM preamplifiers, or as part of the X-123 and X-55.

Signal Processing Options

- Amptek's CdTe may be used with Amptek's DP5 or DP5-X, or the PX5, or as part of the X-123 or X-55.

Specification Notes

- Performance listed here is measured at full cooling (<220K).
- The "peak to background ratio" is the ratio of counts in the Mn Kα peak channel to the counts at 1 keV.
- "Gain stability" refers to the change in sensitivity when the preamp temperature changes but the detector temperature is stable.

Operating Notes

- Detector must be operated with an appropriate heat sink.
- The CdTe is suitable for vacuum applications. Amptek provides several system configurations.

5.4. Amptek SDD Specifications (now obsolete)

General	
Detector Type	Silicon Drift Detector (SDD)
Detector Size	25 mm^2
Collimated Area	17 mm^2
Thickness	500 µm
Collimator Type	Internal Multilayer
Preamplifier Type	JFET reset type
Energy resolution @ 5.9 keV (^{55}Fe)	
125 to 135 eV FWHM (guaranteed) at T_{pk}=11.2 µs	
128 eV at 4.0 µs (typical)	
147 eV at 1.0 µs (typical)	
Other Performance	
Peak to background	≥ 20,000:1 (typical)
Signal risetime	< 60 ns
Maximum input count rate	> 200 kcps
Throughput count rate stability	Determined by signal processor & its settings
Window Options	
Be	1/3 mil (8 µm) 1/2 mil (12.5µm) 1 µm Parylene on each
Signal Output	
Sensitivity	0.8 mV/keV
Gain stability	<20 ppm/°C
Polarity	Positive signal
Reset range	-5 to +5 V (typical)
Cooling	
Cooling performance	ΔT > 85°C
Cooler type	Two stage thermoelectric
Temp monitor	Diode
Power	
HV Bias	-100V to – 180V @ 25 µA
Max cooling power	3.5 V / 0.45A
Total power	< 2 W (full cooling)
Other	
Operating range	-35°C to +80°C Performance degrades at elevated detector temperatures.
Storage & shipping	-40°C to +85°C, 10% to 90% RH noncondensing
RoHS	Compliant
Lifetime	Typical 5 to 10 years, depending on use
Warranty Period	1 year

Preamplifier Options

- Amptek's SDD is available with the XR-100 preamplifier, with the PA210 or PA230 OEM preamplifiers, or as part of the X-123 and X-55.

Signal Processing Options

- Amptek's SDD may be used with Amptek's DP5 or DP5-X, or the PX5, or as part of the X-123 or X-55.

Specification Notes

- Performance listed here is measured at full cooling (<220K).
- The "peak to background ratio" is the ratio of counts in the Mn Kα peak channel to the counts at 1 keV.
- "Gain stability" refers to the change in sensitivity when the preamp temperature changes but the detector temperature is stable.

Operating Notes

- Detector must be operated with an appropriate heat sink.
- The SDD is suitable for vacuum applications. Amptek provides several system configurations.

5.5. Amptek 25 mm² FAST SDD® Specifications

General	
Detector Type	Silicon Drift Detector (SDD)
Detector Size	25 mm²
Collimated Area	17 mm²
Thickness	500 μm
Collimator Type	Internal Multilayer
Preamplifier Type	CMOS reset type
Energy resolution @ 5.9 keV (^{55}Fe)	
122 to 129 eV FWHM (guaranteed) at T_{pk}=4.0 μs	
126 eV (typical) at 1.0 μs	
134 eV (typical) at 0.2 μs	
Energy resolution @ C Kα: 45 eV (typical)	
Other Performance	
Peak to background	≥ 20,000:1 (typical)
Signal risetime	< 35 ns
Maximum input count rate	> 1 Mcps
Throughput count rate stability	Determined by signal processor & its settings
Window Options	
Be	1/3 mil (8 μm) 1/2 mil (12.5 μm) 1 μm Parylene on each
C series (low energy)	C1: 90 nm Si_3N_4, 250 nm Al, 30 mm² C2: 40 nm Si_3N_4, 30 nm Al, 30 mm² Grid: Hexagonal, 15 μm thick Si, 78% open area C2 is NOT LIGHT TIGHT
Signal Output	
Sensitivity	3.6 mV/keV
Gain stability	<20 ppm/°C
Polarity	Positive signal
Reset range	-0.05 to 2 V (typical)
Cooling	
Cooling performance	T > 85°C
Cooler type	Two stage thermoelectric
Temp monitor	Diode
Power	
HV Bias	-100 V to – 180V @ 25 μA
Max cooling power	3.5 V / 0.45A
Total power	< 2 W (full cooling)
Other	
Operating range	-35°C to +80°C Performance degrades at elevated detector temperatures.
Storage & shipping	-40°C to +85°C, 10% to 90% RH noncondensing
RoHS	Compliant
Lifetime	Typical 5 to 10 years, depending on use
Warranty Period	1 year

Preamplifier Options

- Amptek's FAST SDD® is available with the XR-100 preamplifier, with the PA210 or PA230 OEM preamplifiers, or as part of the X-123 and X-55.

Signal Processing Options

- Amptek's FAST SDD® may be used with Amptek's DP5 or DP5-X, or the PX5, or as part of the X-123 or X-55.

Specification Notes

- Performance listed here is measured at full cooling (<220K).
- The "peak to background ratio" is the ratio of counts in the Mn Kα peak channel to the counts at 1 keV.
- "Gain stability" refers to the change in sensitivity when the preamp temperature changes but the detector temperature is stable.

Operating Notes

- Detector must be operated with an appropriate heat sink.
- The FAST SDD® is suitable for vacuum applications. Amptek provides several system configurations.

5.6. Amptek 25 mm² x1mm thick FAST SDD® Specification

General	
Detector Type	Silicon Drift Detector (SDD)
Detector Size	25 mm²
Collimated Area	17 mm²
Thickness	1000 □m
Collimator Type	Internal Multilayer
Preamplifier Type	CMOS reset type
Energy resolution @ 5.9 keV (55Fe)	
122 to 131 eV FWHM (guaranteed) at T_{pk}=4.0 µs	
126 eV (typical) at 1.0 □s	
134 eV (typical) at 0.2 □s	
Other Performance	
Peak to	> 20,000:1 (typical)
Signal risetime	< 35 ns
Maximum input	> 1 Mcps
Throughput	Determined by signal
Window Options	
Be	1/3 mil (8 □m)
Signal Output	
Sensitivity	3.6 mV/keV
Gain stability	<20 ppm/°C
Polarity	Positive signal
Reset range	-0.05 to 2 V (typical)
Cooling	
Cooling	ΔT > 85°C
Cooler type	Two stage thermoelectric
Temp monitor	Diode
Power	
HV Bias	-425V @ 25 µA (typical)
Max cooling	3.5 V / 0.45A
Total power	< 2 W (full cooling)
Other	
Operating	-35°C to +80°C
Storage &	-40°C to +85°C, 10% to 90% RH
RoHS	Compliant
Lifetime	Typical 5 to 10 years,
Warranty	1 year

Preamplifier Options

- Amptek's FAST SDD® is available with the XR-100 preamplifier, with the PA210 or PA230 OEM preamplifiers, or as part of the X-123 and X-55.

Signal Processing Options

- Amptek's FAST SDD® may be used with Amptek's DP5 or DP5-X, or the PX5, or as part of the X-123 or X-55.

Specification Notes

- Performance listed here is measured at full cooling (<220K).
- The "peak to background ratio" is the ratio of counts in the Mn Kα peak channel to the counts at 1 keV.
- "Gain stability" refers to the change in sensitivity when the preamp temperature changes but the detector temperature is stable.

Operating Notes

- Detector must be operated with an appropriate heat sink.
- The FAST SDD® is suitable for vacuum applications. Amptek provides several system configurations.

5.7. Amptek 70 mm² FAST SDD® Specifications

General		
Detector Type	Silicon Drift Detector (SDD)	
Detector Size	70 mm²	
Collimated Area	50 mm²	
Thickness	500 µm	
Collimator Type	Internal Multilayer	
Preamplifier Type	CMOS reset type	
Energy resolution @ 5.9 keV (^{55}Fe)		
123 to 135 eV FWHM (guaranteed) at Tpk=4.0 µs		
127 eV (typical) at 1.0 µs		
139 eV (typical) at 0.2 µs		
Energy resolution @ C Kα: 45 eV (typical)		
Other Performance		
Peak to background	≥ 20,000:1 (typical)	
Signal risetime	< 60 ns	
Maximum input count rate	> 1 Mcps	
Throughput & count rate stability	Determined by signal processor & its settings	
Window Options		
Be	1/2 mil (12.5 µm) 1 µm Parylene on each	
C series (low energy)	C2	C1
	40 nm Si3N4	90 nm Si3N4
	30 nm Al	250 nm Al
	30 mm² grid	30 mm² grid
	Grid: Hexagonal, 15 µm thick Si, 78% open area C2 is NOT LIGHT TIGHT	
Signal Output		
Sensitivity	3.6 mV/keV	
Gain stability	<20 ppm/°C	
Polarity	Positive signal	
Reset range	-0.05 to 2 V (typical)	
Cooling		
Cooling performance	ΔT > 85°C	
Cooler type	Two-stage thermoelectric	
Temp monitor	Diode	
Power		
HV Bias	-100V to –180V @ 25 µA	
Max cooling power	3.5 V / 0.45A	
Total power	< 2 W (full cooling)	
Other		
Operating range	-35°C to +80°C Performance degrades at elevated detector temperatures.	
Storage & shipping	-40°C to +85°C, 10% to 90% RH noncondensing	
RoHS	Compliant	
Lifetime	Typical 5 to 10 years, depending on use	
Warranty Period	1 year	

Preamplifier Options

- Amptek's FAST SDD® is available with the XR-100 preamplifier, with the PA210 or PA230 OEM preamplifiers, or as part of the X-123 and X-55.

Signal Processing Options

- Amptek's FAST SDD® may be used with Amptek's DP5 or DP5-X, or the PX5, or as part of the X-123 or X-55.

Specification Notes

- Performance listed here is measured at full cooling (<220K).
- The "peak to background ratio" is the ratio of counts in the Mn Kα peak channel to the counts at 1 keV.
- "Gain stability" refers to the change in sensitivity when the preamp temperature changes but the detector temperature is stable.

Operating Notes

- Detector must be operated with an appropriate heat sink.
- The FAST SDD® is suitable for vacuum applications. Amptek provides several system configurations.

5.8. Amptek 70 mm^2 x1mm thick FAST SDD® Specification

General	
Detector Type	Silicon Drift Detector (SDD)
Detector Size	70 mm^2
Collimated Area	40 mm^2
Thickness	1000 µm
Collimator Type	Internal Multilayer
Preamplifier Type	CMOS reset type
Energy resolution @ 5.9 keV (55Fe)	
122 to 131 eV FWHM (guaranteed) at T_{pk}=4.0µs	
126 eV (typical) at 1.0 µs	
134 eV (typical) at 0.2 µs	
Other Performance	
Peak to	> 20,000:1 (typical)
Signal risetime	< 35 ns
Maximum input	> 1 Mcps
Throughput	Determined by signal
Window Options	
Be	1/3 mil (8 ⍰m)
Signal Output	
Sensitivity	3.6 mV/keV
Gain stability	<20 ppm/°C
Polarity	Positive signal
Reset range	-0.05 to 2 V (typical)
Cooling	
Cooling	ΔT > 85°C
Cooler type	Two stage thermoelectric
Temp monitor	Diode
Power	
HV Bias	-425V @ 25 µA (typical)
Max cooling	3.5 V / 0.45A
Total power	< 2 W (full cooling)
Other	
Operating range	-35°C to +80°C
Storage &	-40°C to +85°C, 10% to 90%
RoHS	Compliant
Lifetime	Typical 5 to 10 years,
Warranty	1 year

Preamplifier Options

- Amptek's FAST SDD® is available with the XR-100 preamplifier, with the PA210 or PA230 OEM preamplifiers, or as part of the X-123 and X-55.

Signal Processing Options

- Amptek's FAST SDD® may be used with Amptek's DP5 or DP5-X, or the PX5, or as part of the X-123 or X-55.

Specification Notes

- Performance listed here is measured at full cooling (<220K).
- The "peak to background ratio" is the ratio of counts in the Mn Kα peak channel to the counts at 1 keV.
- "Gain stability" refers to the change in sensitivity when the preamp temperature changes but the detector temperature is stable.

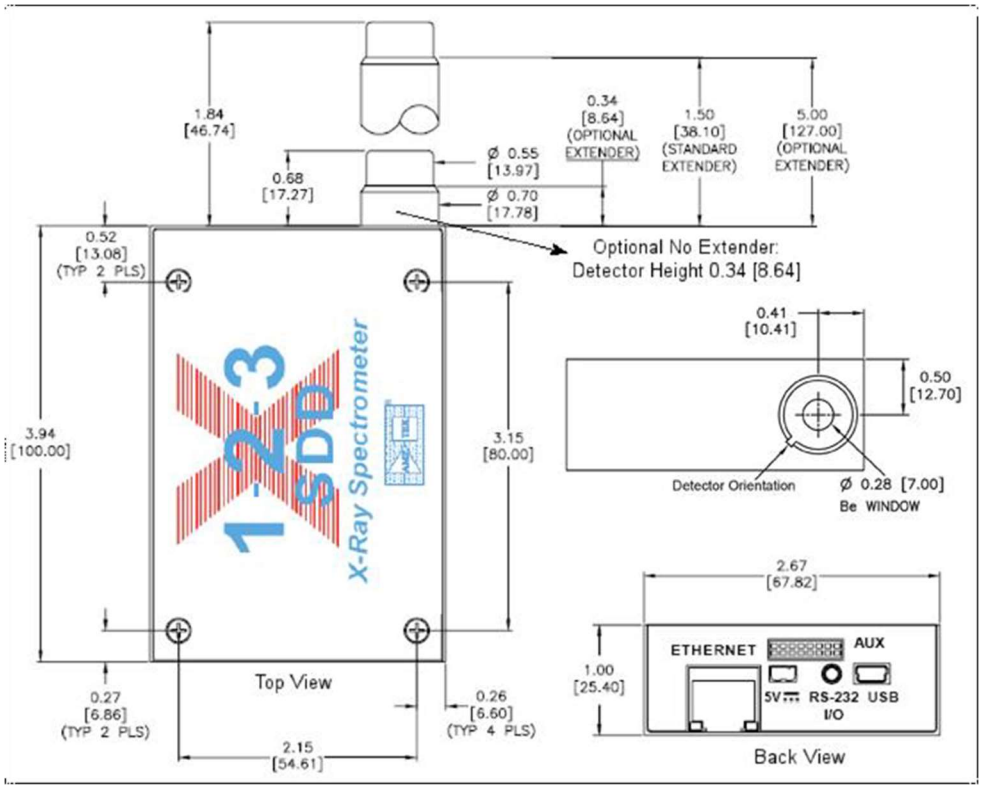
Operating Notes

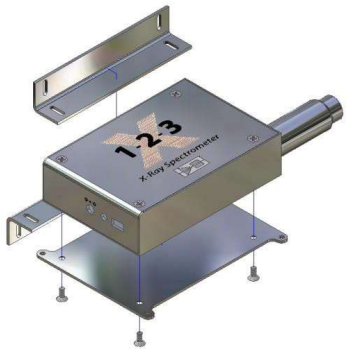
- Detector must be operated with an appropriate heat sink.
- The FAST SDD® is suitable for vacuum applications. Amptek provides several system configurations

5.9. Physical Specifications

5.9.1. 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	7 x 10 cm x 2.5 cm (2.7 x 3.9 x 1 in) Excludes extender
Extender	1.5” (3.8 cm) standard Options: None, 3/8”, 5”, 9”, and vacuum flanges
Weight	200 g (7 oz)





5.10. Power Specifications

Characteristic	Symbol	Min	Typical	Max	Units	Conditions
Supply Voltage	V_{in}	4.0	5.0	5.5	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 power dissipated by the X-123 depends most strongly on the detector temperature, which is set in

software. At full cooling, ΔT=70 C, the X-123 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 the X-123 cannot be powered over USB.

5.10.1. Turn-On Transients

The figure below illustrates the transient currents seen as the X-123 turns on.

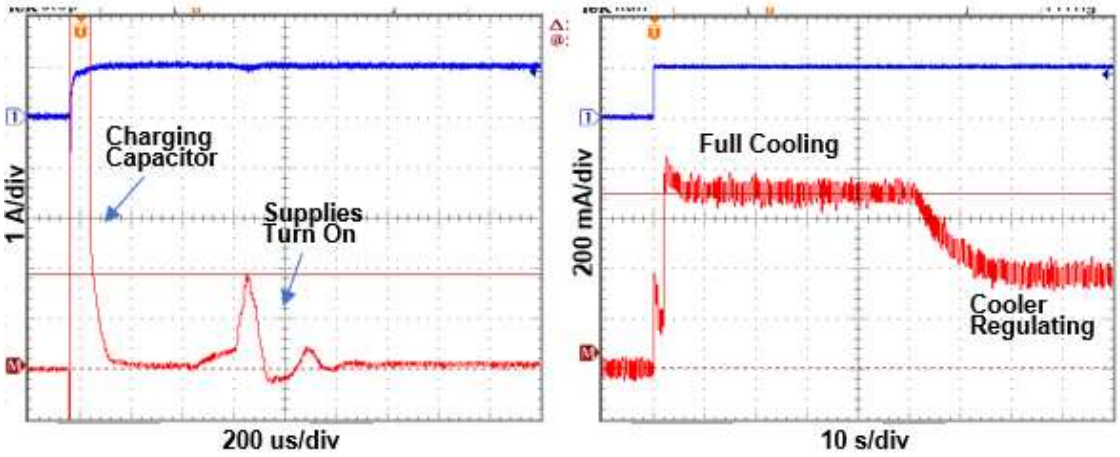
When 5 VDC is first applied to the power input, a large transient current is drawn to charge up the 50 µF of input capacitance, from the input capacitors on all the supplies.

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.

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.

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

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.



5.11. Thermal Specification

5.11.1. The X-123 dissipates up to 3.5 W of power. It is important that the body of the X-123 be attached to a heat sink that can dissipate that much heat. If proper heat sinking is not used, then the X-123 chassis temperature rises, and thus the detector temperature rises, and spectroscopic performance is compromised.

6. Electrical Interface

6.1. Connectors

6.1.1. Power Connector

6.1.1.1. Power Jack on X-123SDD: Hirose MQ172-3PA(55) [obsoleted in 2016, replaced by MQ172-3PA(30)].

6.1.1.2. 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
2	GND
3	Do Not Connect

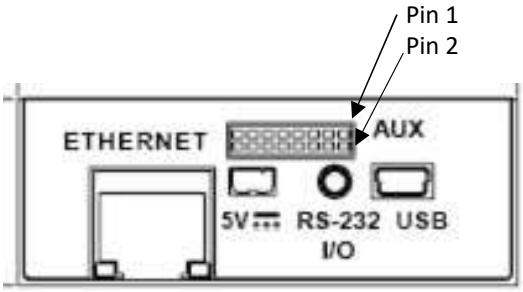
6.1.2. Auxiliary connector

6.1.2.1. 16-pin, 2-mm spacing, cable assembly (Samtec P/N) TCSD-08-S(D)-xx.xx-01-F-N

6.1.2.2. Mates with TCMD-08-D-08.00-01-RF

6.1.2.3. Pin identifiers

Pin #	Name	Pin #	Name
1	SCA1	2	SCA2
3	SCA3	4	SCA4
5	SCA5	6	SCA6
7	SCA7	8	SCA8
9	AUX_IN_1	10	AUX_OUT_1
11	AUX_IN_2	12	AUX_OUT_2
13	IO2	14	IO3
15	GND	16	GND



6.1.3. Ethernet Connector

6.1.3.1. Standard Ethernet connector (RJ-45)

6.1.4. USB Connector

6.1.4.1. Standard USB ‘mini-B’ jack. (The X-123SDD is ‘self-powered’: it draws no power from the USB.)

6.1.5. RS-232 Connector

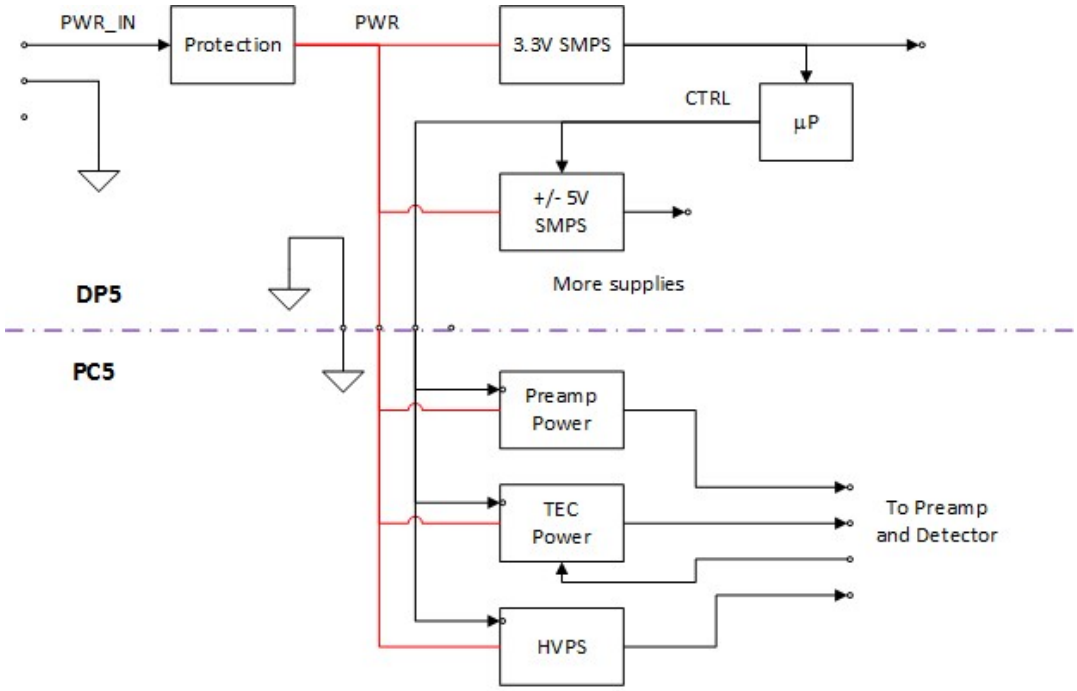
6.1.5.1. Standard 2.5 mm stereo audio jack. Amptek can provide a cable with an adapter that connects this to a DB9 serial connector.

Contact	Signal
Tip	TXD (output from X-123)
Ring	RXD (input to X-123)
Sleeve	GND

6.2. Power Interface

6.2.1. 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. Five of these are located on the DP5, five on the PC5. 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.

6.2.2. Schematic of power supply architecture.



6.2.3.

6.3. Protection: The protection device protects against reverse input polarity and has over- and under-voltage lockouts. The X-123 will not power on with an input voltage below 3.8 V or above 5.5 V. The input protection network operates over the range of -40 V to +60 V. Beyond this range, damage to the X-123 will occur1.

6.3.1. This applies to X-123s from 2016 or later. Earlier X-123s contained a DP5 Rev C (or earlier), which did not have the over- and under-voltage protection (this was added to the DP5 Rev D.) An input voltage higher than 5.5 V may damage these units. The earlier DP5s did have reverse polarity protection.

6.4. Grounding: The chassis ground of the X-123, which is tied to the box and to the other boards, is connected to the return current pins in the power connector.

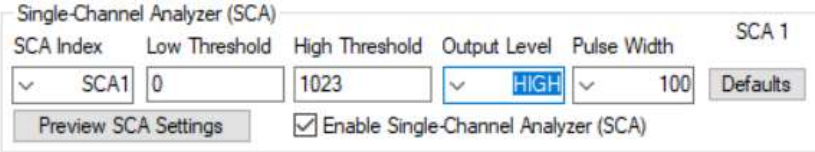
7. Auxilliary Outputs and Signals

7.1. AUX Connector interface

AUX OUT						
Output High Voltage	V_{OH}	3.0 1.8	3.3		V V	Typ: No load Min: I_{OH} = -100 µA Min: I_{OH} = -16 mA
Output Low Voltage	V_{OL}		0.0	0.1 1.2	V	Typ: No load Min: I_{OH} = 100 µA Min: I_{OH} = 16 mA
Output Resistance	R_{OUT}		50		Ω	
AUX IN						
Input Voltage		0		5.5	V	
Positive-going Input Threshold	V_{T+}	1.4		2.35	V	
Negative-going Input Threshold	V_{T-}	0.7		1.45	V	
Input Resistance	R_{IN}		100		KΩ	
SCA OUT						
Output High Voltage	V_{OH}	2.9 2.0	3.3		V V	Typ: No load Min: I_{OH} = -100 µA Min: I_{OH} = -12 mA
Output Low Voltage	V_{OL}		0.0	0.2 1.0	V	Typ: No load Max: I_{OH} = 100 µA Max: I_{OH} = 12 mA
Output Resistance	R_{OUT}		47		Ω	

7.2. SCA Outputs

The SCA channels 1-8 (Aux connector Pins 1 through 8) can be used to output a logic pulse on events that meet set requirements; counts that fall within the channels between the settings for “Low Threshold” and “High Threshold” channels. The pulse output is based on the “Output Level” setting and the “Pulse Width” setting. See the image below of the tool to set the SCA’s in our DPPMCA software.



7.2.1. SCA Index – Can be selected to change which SCA output you are configuring.

7.2.2. Low Threshold / High Threshold – Set the channels which are excluded at and below / at and above. For example, setting “Low Threshold” at 100 and “High Threshold” at 102, will only output a pulse when events occur in channel 101.

7.2.3. Output Level

OFF - output is always low

Output High – output is normally low, and will produce a pulse which is high on SCA selected events

Output Low – output is normally high, and will produce a pulse which is low on SCA selected events

7.2.4. Pulse Width – Sets the pulse width to either 100 or 1000ns.

7.3. AUXIN1 – Aux connector Pin 9 - Can be used with the Gate function to stop acquisition of signal, can be used as an input to the G.P. counter

7.4. AUXIN2 – Aux connector Pin 11- Can be used as the External sync for list mode- See SYNC in the Amptek Digital Products Programmers Guide.

7.5. AUXOUT1 and 2 – Aux connector Pin 10 and 12 - Can be used to output signals shown in the table below.

ICR	Produces a pulse when the fast channel detects a peak
PILEUP	Produces a pulse when two or more events are piled up, if Pileup Reject is enabled
MCSTB	Toggles when the MCS timebase expires
ONESH	PUR Oneshot: Goes low during the interval when an event would be considered piled up
DETRES	Detector Reset: Goes low when detector reset is detected, stays low for the configured detector lockout interval
MCAEN	Logic high when the MCA is enabled; low when MCA is disabled
PEAKH	Low-to-high transition indicates peak detect has switched to searching for a maximum; High-to-low transition indicates peak detect has switched to searching for a minimum
SCA8	Same as SCA8 output – outputs a 100nS or 1uS pulse when an event occurs in ROI defined by SCA8
RTDOS	RTD oneshot – indicates the time window during which the RTD discrimination is performed
RTDREJ	Produces a pulse when RTD rejects an event
VETO	Produces a logic 0 (low) when a piled-up event is vetoed, if PUR is enabled
LIVE	(Reserved)

7.6. DACOUT – The DACOUT is not normally connected to an output as it is typically used for diagnostics. It can be accessed by opening the X123 cover and connecting to the Auxout pin near the preamplifier or by probing the test pad. The signal can be routed to the RS232 port with a few minor board modifications. Its output can be chosen as one of those shown in the table below. The offset can be adjusted from -500mV to +499mV.

FAST	fast channel shaped peak, uses fast peaking time to adjust.
SHAPED	Shaped peak, uses Peaking time and Flat top width to adjust.
INPUT	This is the input signal which feeds into the ADC. It should appear as a tail pulse after all the gain stages and polarity reversal.
PEAK	The output of the peak hold. It looks a lot like SHAPED, but it holds the peak (or minimum) until the peak detect records the peak and switches modes.
SDD	Advance parameter used at Amptek.
SUM	A logic pulse anytime a sum peak is detected (2nd pulse occurs before the shaping time ends from the 1st pulse). These are normally set to be rejected from the MCA spectrum.
PZBD	Advance parameter used at Amptek.
RTDP	A logic pulse displays if a pulse has been removed due to the risetime discriminator.

8. Warranty

AMPTEK, INC. warrants to the original purchaser this instrument to be free from defects in materials and workmanship for a period of one year from shipment. AMPTEK, INC. will, without charge, repair or replace (at its option) a defective instrument upon return to the factory. This warranty does not apply in the event of misuse or abuse of the instrument or unauthorized alterations or repair. AMPTEK, INC. shall not be liable for any consequential damages, including without limitation, damages resulting from the loss of use due to failure of this instrument. The factory MUST be notified prior to return shipment. All products returned under the warranty must be shipped prepaid to the factory with documentation describing the problem and the circumstances under which it was observed. The instrument will be evaluated, repaired, or replaced, and promptly returned if the warranty claims are substantiated. A nominal fee will be charged for unsubstantiated claims. Please include the model and serial number in all correspondence with the factory.

9. Technical Questions

For all technical questions, please contact the Amptek factory.

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