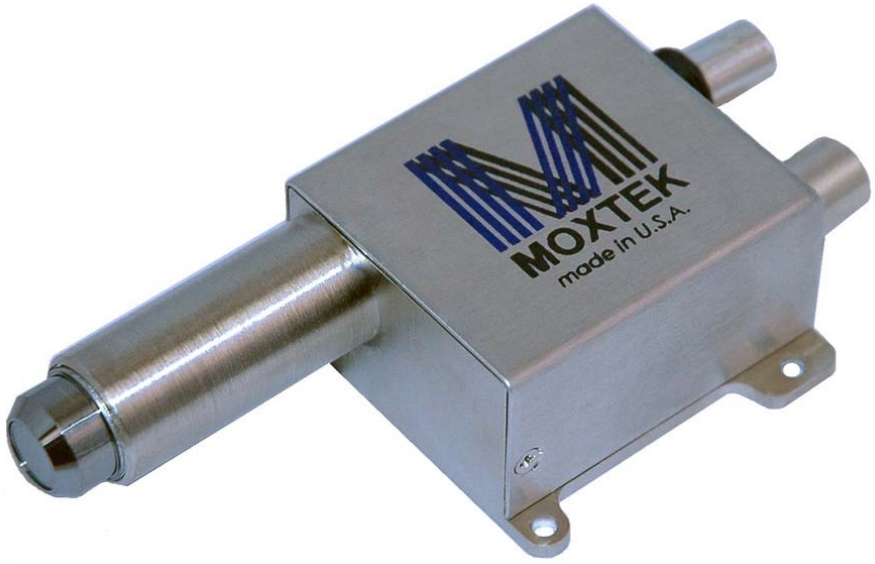
X-RAY Detectors

XPIN®-BT X-ray Detector Operation Manual



XPIN-BT

MOXTEK®

XPIN®-BT X-Ray Detector Operation Manual

Contents

MOXTEK®

XPIN-BT X-ray Detector

The XPIN-BT detector is a compact, low-cost Energy Dispersive X-Ray Florescence (EDXRF) detector. The XPIN-BT combines a silicon PIN diode, a Moxtek ultra-low-noise JFET, and a high performance two-stage thermoelectric cooler (TEC) achieving great resolution and x-ray sensitivity. The XPIN preamp provides a low-noise signal output to an analog or digital pulse shaping amplifier. This detector does not require any external cooling. *The XPIN-BT package is ideal for benchtop and portable applications requiring simple mounting, automatic temperature control, and metal preamp shielding*

Initial Inspection

When the XPIN-BT detector is received, it should be unpacked and inspected as soon as possible. Inspect the detector and DuraBeryllium® window for any damage that may have resulted during shipping. If the detector has been damaged, please contact Moxtek immediately (see Figure 1). A serial number for identifying each detector is located on the preamp detector case.

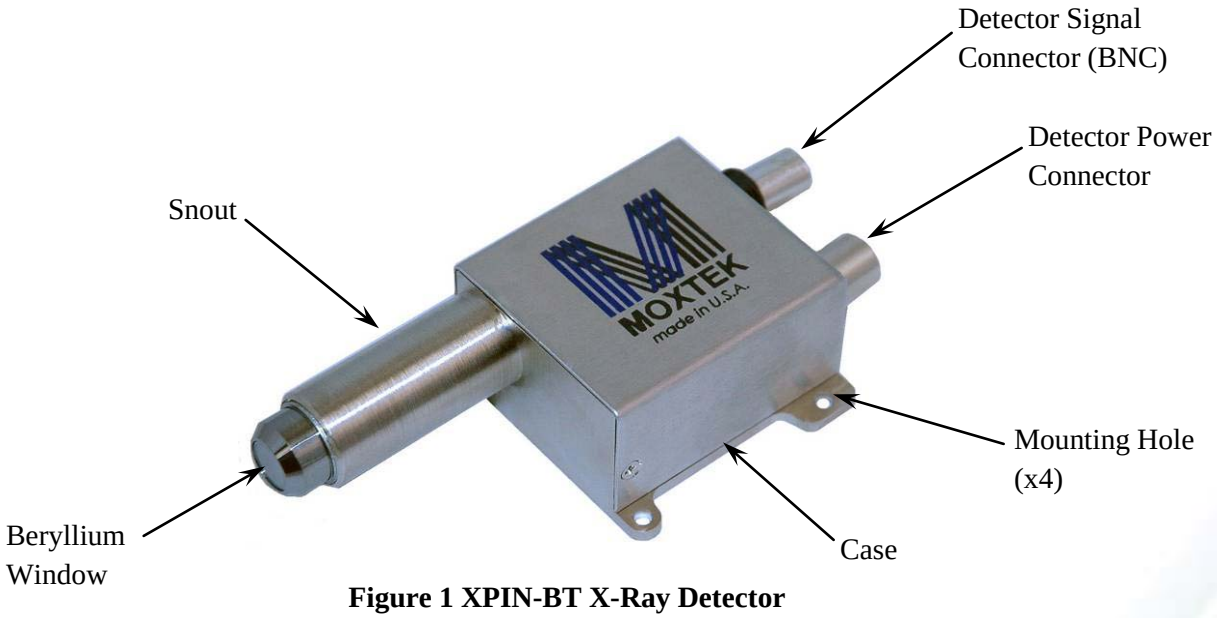


Figure 1 XPIN-BT X-Ray Detector

Accessories

(Ordered separately)

- Mechanical Adapter Plate (see Figure 2)
- Signal BNC Cable (see Figure 3)
- Power Lemo Cable (see Figure 4)

Figure 2 Adapter Plate

Figure 3 Signal BNC Cable

Figure 4 Power Lemo Cable

Detector Handling and Operating Precautions

Care must be taken not to damage the beryllium window. Excessive shock can damage both the detector and the thermoelectric cooler. Do not drop or allow the detector to strike any surface.

CAUTION: *Moxtek detectors contain beryllium. Inhaling beryllium dust causes lung disease. Refer to the Beryllium Material Safety Data Sheet (MSDS).*

CAUTION: *The beryllium window can be easily damaged by improper treatment. Do NOT touch the beryllium window surface with anything, including a cotton swab or soft brush. Sudden impacts can damage the window.*

CAUTION: *Do not remove the lid from the case. If problems occur, contact Moxtek. The warranty will be voided if the lid is removed.*

CAUTION: *When supplying the detector with high voltage (HV), take precautions to avoid electric shock.*

CAUTION: *Check local, state, and/or federal regulations before disposing of the detector.*

Detector Setup

Mechanical

The XPIN-BT detector is equipped with mounting holes so it can be mounted to a fixture. Mounting the detector to a metal fixture will help keep the detector cool in ambient temperatures greater than 40°C. It may be necessary to use a fan to cool the detector if the heat sinking is not adequate. Mechanical drawings for mounting are included in the Appendix.

An optional adapter plate is available for detector use in a customer's existing mounting block. To attach the adapter to the detector, slide the adapter under the connectors in the back of the detector, align the adapter's two mounting screw holes with those on the detector and then secure the adapter with the two mounting screws (see Figure 5).

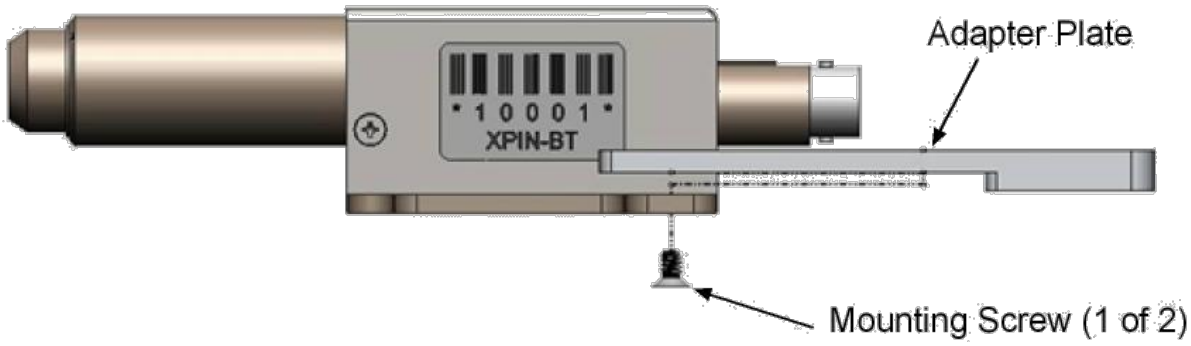


Figure 5 Adapter Plate Attached to Detector

Cable Connections of XPIN-BT Detector

Refer to Figure 6

- Connect one end of the power cable to the power connector of the detector, and the other end to the detector power supply.
- Connect one end of the BNC cable to the signal connector of the detector, and the other end to digital pulse processor or an analog pulse shaping amplifier.
- Ensure there are no ground loops between the detector, x-ray source, power supply, or other supporting electronics which could result in unwanted noise in the system.

Figure 6 Power and Signal Cable Attached

Electrical

Four voltages are required to operate the XPIN detector:

(See Appendix, Preamp Connector Pinouts)

- -9V (± 5%) @35mA for preamplifier power (Pin 3)
- +9V (± 5%) @ 55mA for preamplifier power (Pin 4)
- +170VDC for PIN Diode bias (Pin 2)
- TE Cooler voltage (Pin 6,5) (See Appendix, Temperature Control Operation)

Detector Temperature Control Operation

There are two methods of operation for controlling the detectors internal temperature. The first method is using the internal temperature controller built into the preamplifier. *This internal temperature controller is the standard configuration.* To operate the internal temperature controller 5V @ 1A is applied to the TE cooler power pin 6. Pin 5 is the return ground. When the preamplifier is configured with internal temperature controller, Pin 1 is an open collector output that can be used to determine if the detector is at temperature. When the detector is at temperature, Pin 1 is shorted to ground. When the detector is not at temperature this Pin 1 is floating.

If operating the detector with an external temperature controller, the preamplifier needs to be re-configured. This method of temperature control is not standard. The voltage on Pin 1 becomes proportional to the temperature of the detector (see the Appendix for the Voltage to Temperature Chart). Pin 6 is the control voltage which ranges from 0 to 3.5V at 0.56A max. Pin 5 remains the return ground for the TE cooler. Increasing the voltage on Pin 6 will cool the detector and decreasing the voltage will allow the detector to warm up.

Operating the XPIN-BT Detector

When operating the XPIN-BT X-ray Detector, adhere to the maximum input specifications listed in the product datasheet. This document can be downloaded at our company website: www.moxtek.com.

Attach the detector to a power supply using the power cable and attach the BNC signal cable to a digital pulse processor or to an analog pulse shaping amplifier. Turn on the power to the preamplifier and then wait until the temperature controller has stabilized to the operating temperature before collecting spectrum. The resolution of the detector is not stable until the temperature is at the operating temperature. The standard internal temperature controller is setup to operate the detector at -35°C. When operating the detector manually you can operate the detector at any desired temperature, however it is recommended that the detector be operated colder than -25°C. Operating the detector at temperatures warmer than -25°C will significantly reduce the resolution of the detector.

When the detector is operating, the signal out will look like a saw tooth ramp (shown in Figure 7.) The x-ray events are contained on the slope of the ramp. The detector will rail if a reset pulse is not set to bring the ramp back to the top. This is called a Reset Event. During the Reset Event there is no signal.

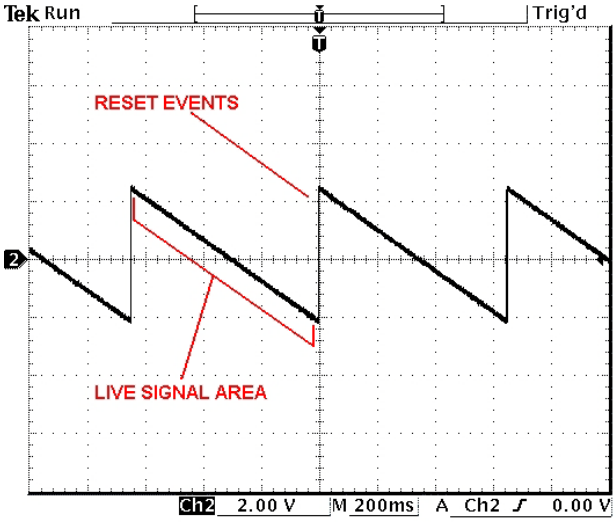


Figure 7 Ramp Signal

Figure 8 shows a typical reset. The Reset Event is typically less then 20µS and goes from -2V to +2V.

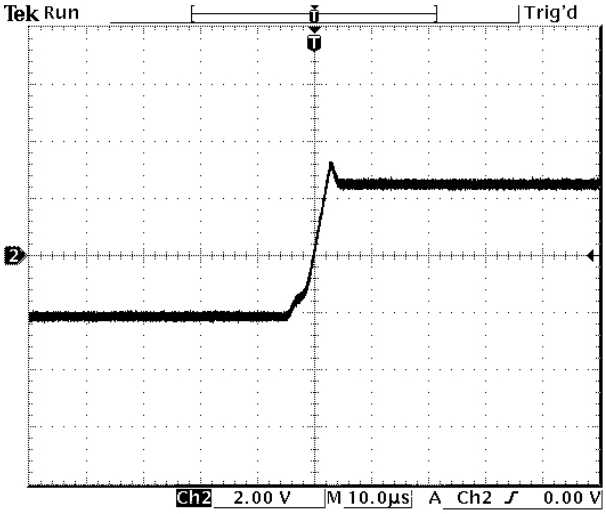


Figure 8 Reset Event

When the detector senses an x-ray, a step is created during the live signal area of the ramp. The height of the step corresponds to the energy of the x-ray, with larger steps meaning higher energy (see Figure 9).

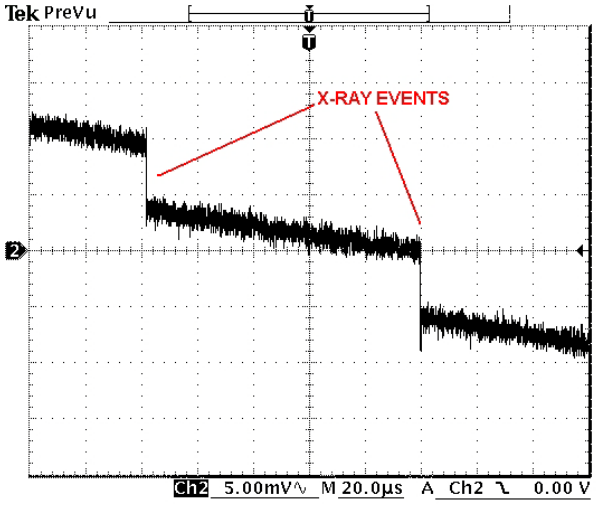


Figure 9 X-Ray Events

The Detector Ramp signal is typically connected to a pulse shaping amplifier (PSA) or digital pulse processor (DPP) which converts the steps into pulses. The output of the PSA or DPP is connected to a Multi-Channel Analyzer (MCA) where the data is stored and downloaded to a computer for analysis.

Technical Support

For product technical support, please contact Moxtek at 801-225-0930 or at www.moxtek.com.

Warranty

Please contact Moxtek for product warranty information (801) 225-0930. Failure to adhere to the specifications listed in the product datasheet and this operation manual may damage the detector and void the detector warranty.

Appendix

Preamp Connector Pin-outs

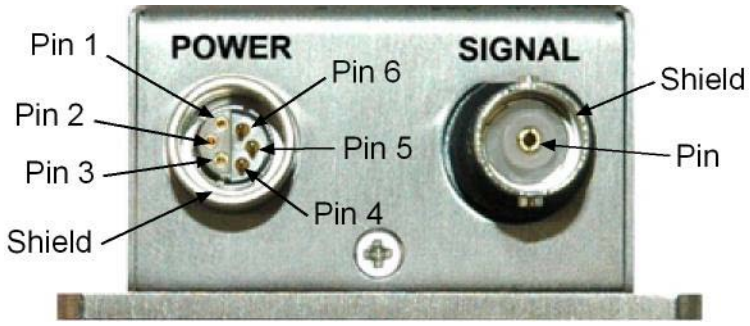


Figure 10 Preamp Connector Pin-outs

Power Connector Standard Internal Temperature Control		
Pin	**Description**	**Set**
1	Ready Signal	Open Collector
2	High Voltage	+170 VDC
3	Detector Power	- 9 VDC
4	Detector Power	+9 VDC
5	Temperature GND	GND
6	Temp Control Power	+5 VDC
Shield	Detector Ground	GND

Signal Connector (BNC)	
Contact	**Description**
Pin	Detector Signal
shield	Signal GND

Power Connector External Temperature Control		
Pin	**Description**	**Set**
1	Temperature Out	(see Appendix)
2	High Voltage	+170 VDC
3	Detector Power	- 9 VDC
4	Detector Power	+9 VDC
5	Temperature GND	GND
6	TEC Control Voltage	0 to 3.5 VDC
Shield	Detector Ground	GND

Preamplifier Power connector part number:
Manufacture: Lemo
Part #: EPL.1S.306.HLN

Mating connector:
Manufacture: Lemo
Part #: FFA.1S.306.CLA57

Thermistor Temperature Sensor

The thermistor is a temperature sensitive resistor. The output of the thermistor is buffered to create feedback voltage on Pin 1 of the power connector. Refer to Table 3 and equation below for thermistor temperature vs. Pin 1 feedback voltage.

Thermistor: Betatherm 0.3K1CG2

Thermistor Equation:

$$T = \frac{1}{A + B * LN(R) + C * LN(R)^3} - 273.15$$

Where:

T = Temperature °C

R = Thermistor Resistance Ω

A = 0.0018590668

B = 0.0002367000

C = 0.0000007811

R is the resistance of the thermistor. The resistance of the thermistor can be calculated from the voltage on pin 1 using the following equation.

Thermistor Equation

$$R = \frac{V * R_1}{V_s - V}$$

Where:
R = Thermistor Ω
R_1 = Pull-Up Resistor (3.32KΩ)
V = Output Voltage
V_s = Supply Voltage (typ +5 Volts)

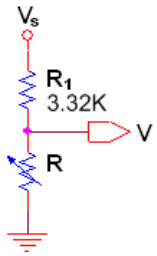
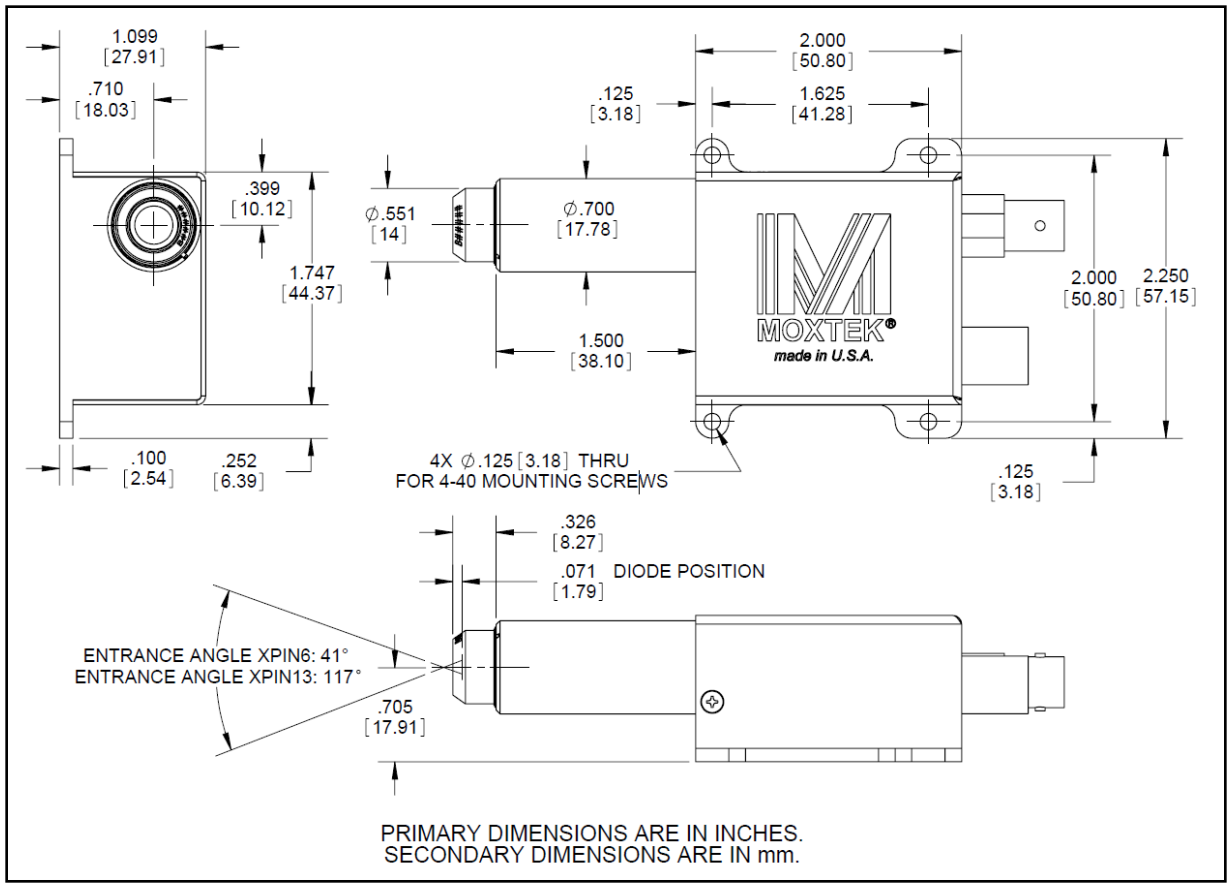


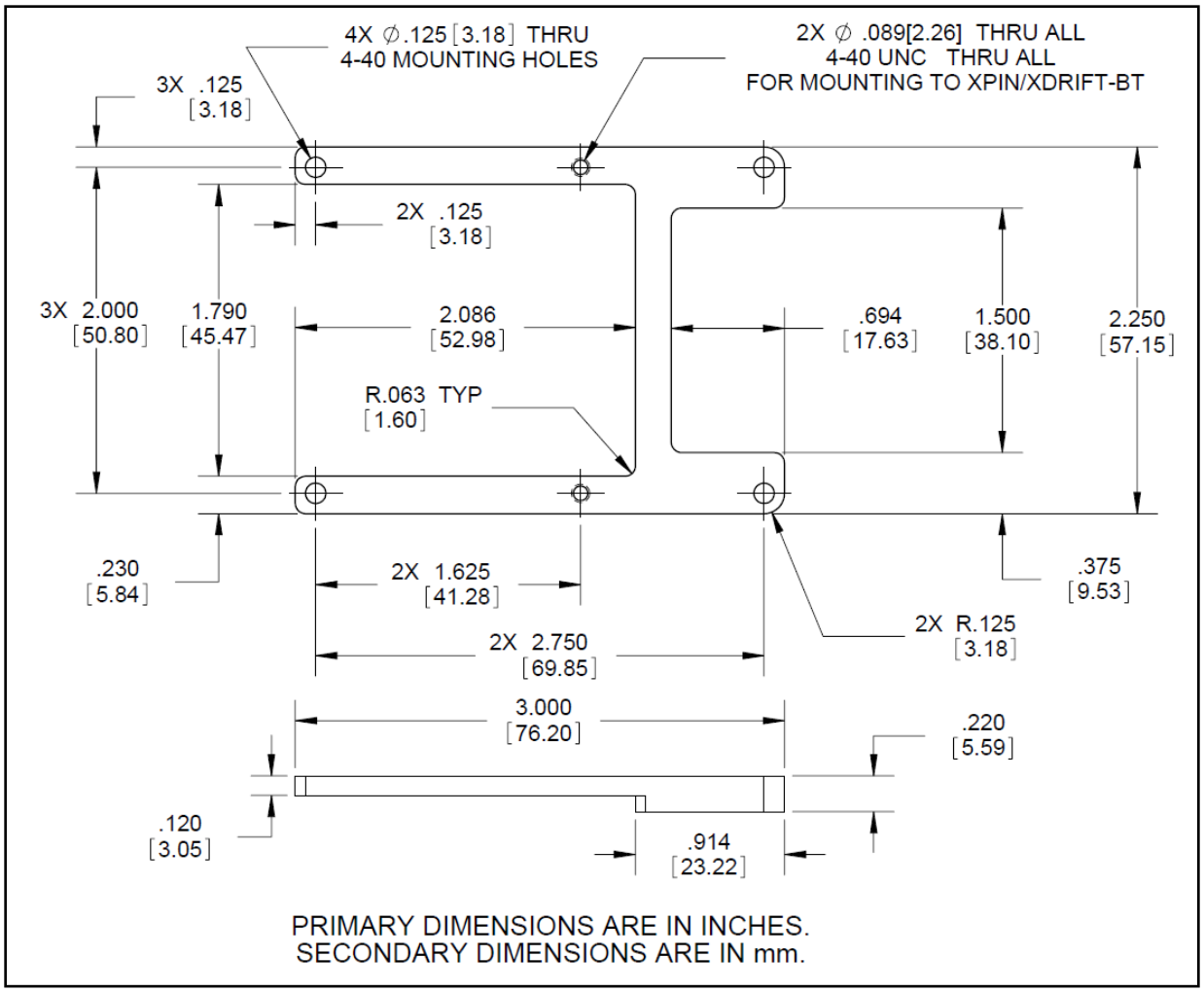
Table 1 Temperature vs. Thermistor Voltage (Pin 1)

Temp °C	Volts
50	0.184
49	0.190
48	0.196
47	0.203
46	0.209
45	0.216
44	0.223
43	0.230
42	0.238
41	0.246
40	0.254
39	0.262
38	0.271
37	0.280
36	0.289
35	0.298
34	0.308
33	0.319
32	0.329
31	0.340
30	0.351
29	0.363
28	0.375
27	0.388
26	0.401
25	0.414
24	0.428
23	0.443
22	0.457
21	0.473
20	0.489
19	0.505
18	0.522
17	0.540
16	0.558
15	0.576
14	0.596
13	0.616
12	0.636
11	0.657
10	0.679
9	0.702
8	0.725
7	0.750
6	0.774
5	0.800
4	0.826
3	0.854
2	0.881
1	0.910
0	0.940
-1	0.970
-2	1.002
-3	1.034
-4	1.067
-5	1.101
-6	1.136
-7	1.172
-8	1.209
-9	1.246
-10	1.285
-11	1.324
-12	1.365
-13	1.406
-14	1.449
-15	1.492
-16	1.536
-17	1.581
-18	1.627
-19	1.673
-20	1.721
-21	1.769
-22	1.818
-23	1.868
-24	1.919
-25	1.970
-26	2.022
-27	2.075
-28	2.128
-29	2.182
-30	2.237
-31	2.292
-32	2.347
-33	2.402
-34	2.458
-35	2.515
-36	2.571
-37	2.628
-38	2.684
-39	2.741
-40	2.798
-41	2.854
-42	2.911
-43	2.967
-44	3.023
-45	3.079
-46	3.134
-47	3.189
-48	3.244
-49	3.298
-50	3.351
-51	3.403
-52	3.455
-53	3.507
-54	3.557
-55	3.607
-56	3.656
-57	3.704
-58	3.750
-59	3.797
-60	3.842
-61	3.886
-62	3.929
-63	3.971
-64	4.012
-65	4.051
-66	4.090
-67	4.128
-68	4.165
-69	4.200
-70	4.235

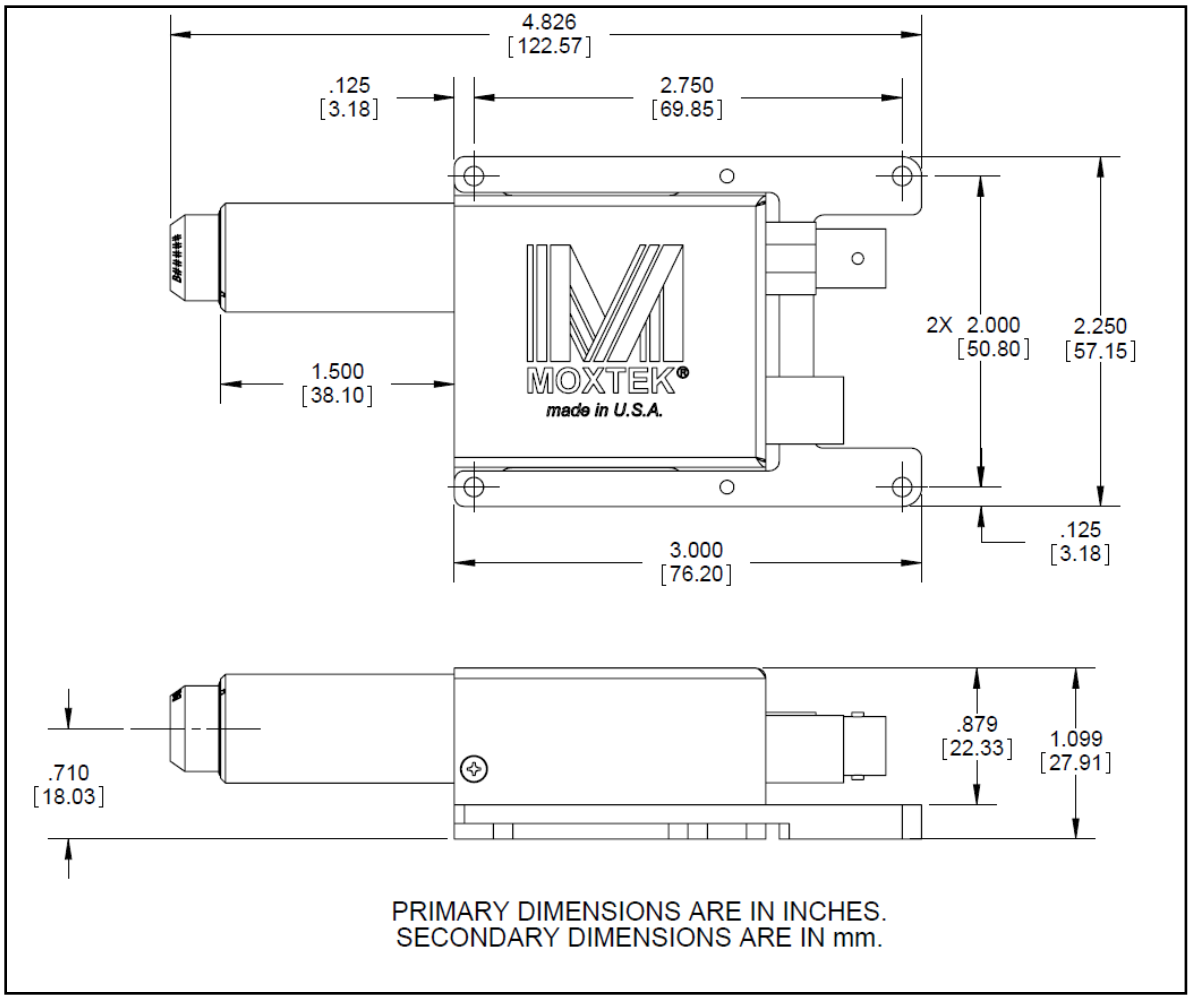
Mechanical Drawing of XPIN-BT Detector



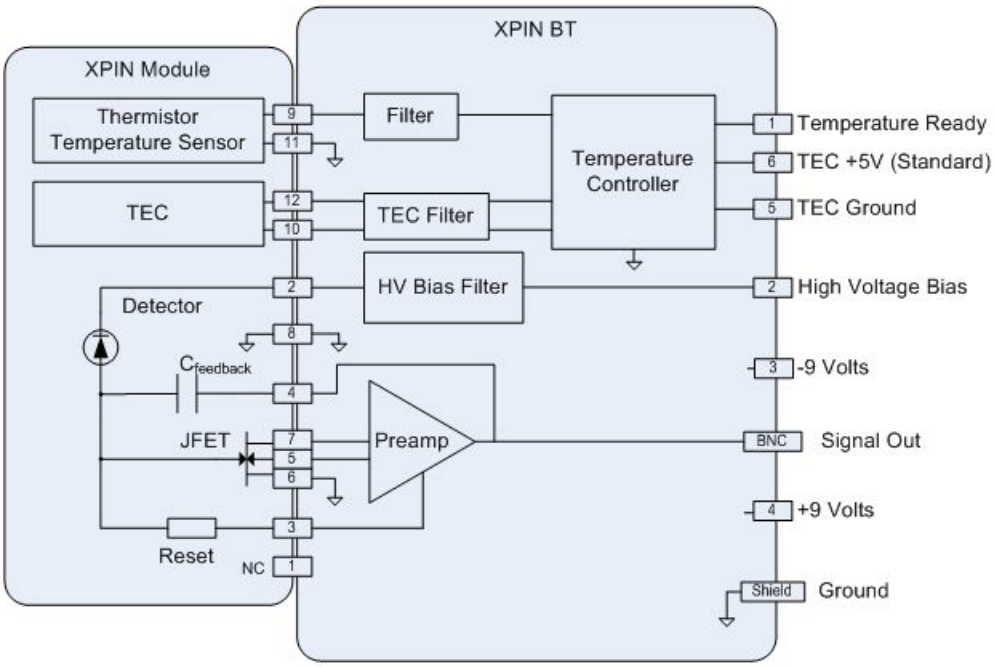
Mechanical Drawing of Adapter Plate



Mechanical Drawing of XPIN-BT and Adapter Plate



Internal Temperature Controller Block Diagram



External Temperature Controller Block Diagram