X-ray

MXDPP-50 Digital Pulse Processor (DPP)

Operation Manual

DET-MAN-1001, Rev A

MOXTEK®

452 West 1260 North
Orem, UT 84057 USA

Table of Contents

Introduction **5**
Theory of Operation **5**
Analog Preprocessor 6
Analog to Digital Converter 6
Equalizer 6
Slow Filter 6
Fast Filters and Pile-Up Rejecter 7
Multi-Channel Analyzer 7
Single Channel Analyzer 8
Non-Volatile EEPROM 8
Detector High Voltage Supply 8
Detector Temperature Controller 9
Detector Preamplifier Power Supply 10
Hardware **11**
MXDPP-50 Box 11
Connection Diagram 11
Electrical Pinouts 12
Mechanical drawing 14
MXDPP-50 OEM Card Stack 15
Connection Diagram – BT 15
Connection Diagram – XT 16
Electrical Pinouts 16
Mechanical Drawings 20
Software **21**
Main Window 21
File Dropdown Menu 22
Edit Dropdown Menu 22
View Dropdown Menu 23
DPP Dropdown 23
Tools Dropdown Menu 24
Help Dropdown Menu 24
Quick Command Toolbar 25
Chart Area 26
DPP Status/Statistics Section 28
Comm Tab 30
DPP Tab 31

Chart Tab ... 32
ROI Tab ... 33
Cal Tab ... 34
X-ray Tab ... 36
Advanced Settings Window ... 37
Acquisition Controls ... 37
Configuration Files ... 38
DPP Memory ... 38
Filter / Pile Up Rejection ... 38
Miscellaneous ... 39
Outputs ... 40
Preset Selection ... 40
Preset Sound Selection ... 41
Tuning Factors ... 41
Communication ... 42
Detector Settings ... 42
Single Channel Analyzer ... 43
DPP Statistics/Monitor ... 44
Working Directory ... 44
Setting Descriptions ... 45
Software Development Kit ... 46
DPP Parameter Specifications ... 47
Peaking Times ... 47
Holding Times ... 47
Digital Gain ... 48
Threshold ... 48
Clock Divider and Speed ... 49
Preprocessor Index ... 50
Preprocessor Time Constant ... 50
Preprocessor Gain ... 51
Equalization Factor ... 51
Zero Factor ... 51
Reset Inhibit Length ... 51
Base Line Restore Mode ... 51
Base Line Restore Window ... 52
Dead Time Length ... 52
Channel Offset ... 52
Preset Selections ... 52
Detector Settings ... 53

High Voltage Polarity 53
High Voltage Bias Set Point 53
Temperature Controller Mode 53
Temperature Controller Set Point 53
Ramp Polarity 55
Auxiliary Outputs 56
Auxiliary Inputs 56
Reference 57
Ordering Information 57
Contact Information 57
Warranty 57
Revision History 58

Introduction

The MXDPP-50 Digital Pulse Processor (DPP) controls, powers, and monitors Moxtek's x-ray detectors. The MXDPP-50 includes an integrated multichannel analyzer (MCA), detector temperature controller, and detector power supply. A high performance x-ray florescence (XRF) workstation can be created by combining the MXDPP-50 with a Moxtek XPIN™ detector, Moxtek MAGNUM® x-ray source, computer, and the Moxtek X-SpectrumDX software. The MXDPP-50 is a clear alternative to older analog systems which are susceptible to count rate instabilities and require frequent adjustment to the signal processing subsystem.

The MXDPP-50 comes in two package options:

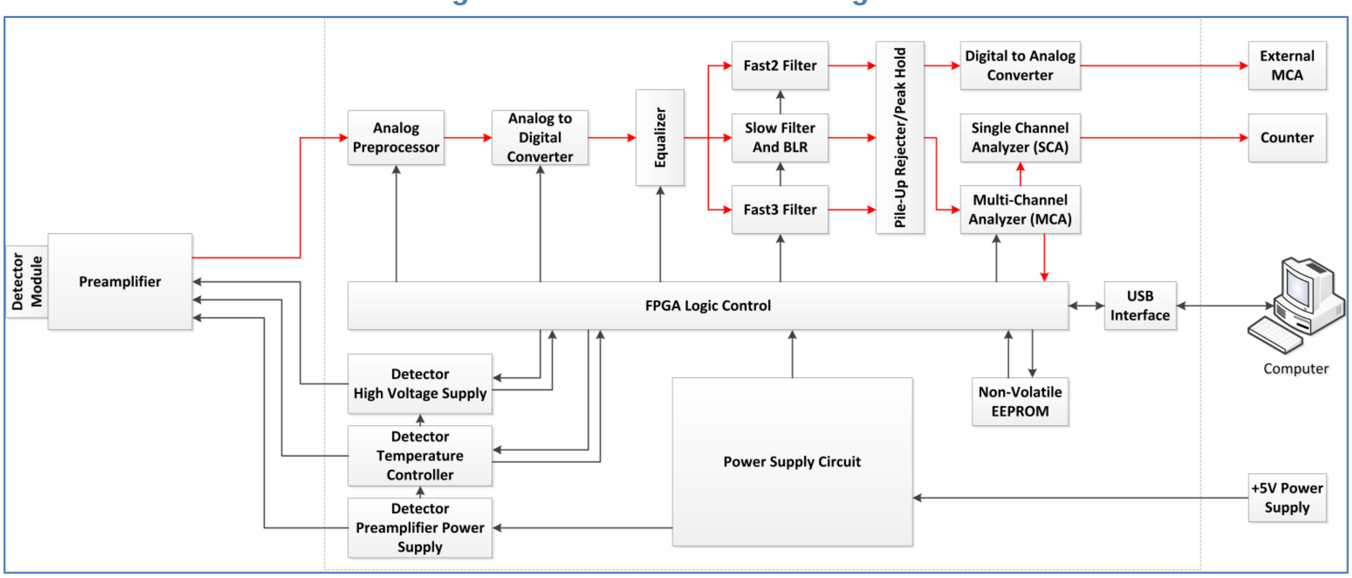
- MXDPP-50 Box Bench Top Box for end users at laboratories and universities.
- MXDPP-50 OEM OEM Card Stack for insertion into OEM instruments.

The Moxtek X-SpectrumDX software provides basic XRF functionality. It provides a simple interface to the Moxtek MXDPP-50 Digital Pulse Processor for setting and changing the DPP parameters, downloading spectra, and basic XRF analysis such as automatic peak search, calibration and basic x-ray line data.

Theory of Operation

The MXDPP-50 supplies the necessary voltages and controls required by Moxtek's XPIN-XT and BT detectors. The MXDPP-50 supplies the proper preamplifier voltages, it has a programmable high voltage bias supply, and it also has an integrated programmable temperature controller. The MXDPP-50 accepts and processes both negative and positive detector ramp signals.

Figure 1 – MXDPP50 Block Diagram



Analog Preprocessor

The typical detector ramp signal is a sawtooth waveform that goes from -2V to +2V. To digitize the ramp signal directly would require an expensive high precision Analog to Digital Converter (ADC) with a large dynamic range. Instead the detector signal is sent through the preprocessor circuit which subtracts out the ramp by differentiating the signal. Each x-ray event is a step on the ramp signal. The preprocessor differentiates the steps and converts them into pulses with a decay time equal to the preprocessor time constant. The preprocessor time constant is programmable and can be optimized based on the peaking time selected for the slow filter. There is a relay on the input of the preprocessor that is used to select the polarity of the detector input signal. Typically Si-PIN detectors have a negative ramp polarity and SDDs have a positive ramp polarity. The relay is controlled by software so no jumpers required to switch between different signal input polarities.

Figure 2 – Simplified Preprocessor Circuit

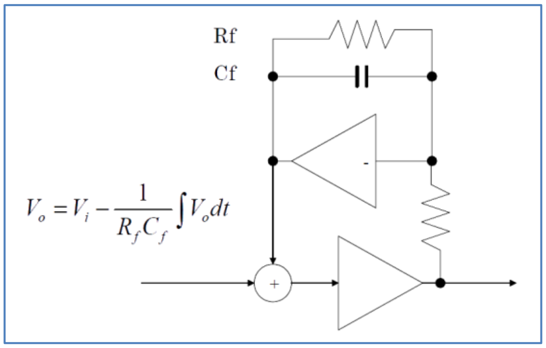
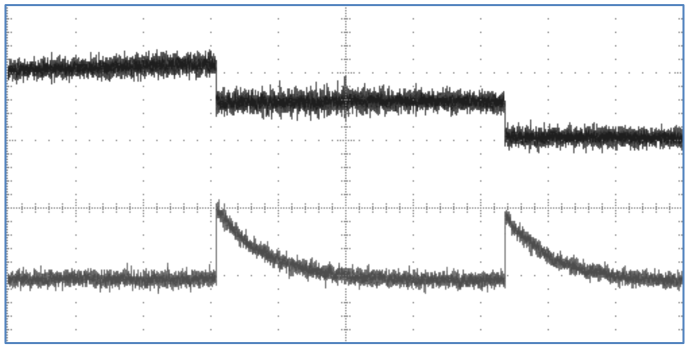


Figure 3 – Input and Output of Preprocessor



Analog to Digital Converter

The MXDPP-50 uses a fast high precision 50 MHz 14 bit ADC to digitize the signal coming out of the preprocessor. The ADC uses a differential input to achieve the best performance and cancel out electronic noise.

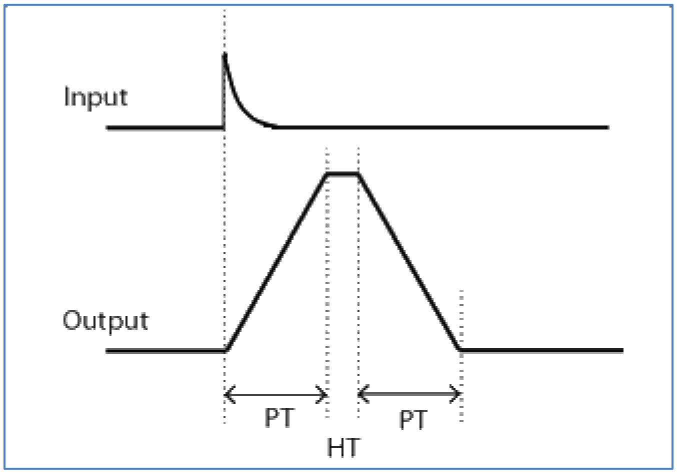
Equalizer

Due to the manufacturing variability of resistors and capacitors the preprocessor time constant is not exact. This is where the equalizer comes in. The equalizer adjusts the signal to take into account the variability/tolerance of the resistors and capacitors used in the preprocessor. Each DPP board requires a slightly different equalization factor. The equalization factor is tuned for each board at the factory and saved in the USB description where it can be read by the software and used to calculate the correct preprocessor time constant to use.

Slow Filter

The Slow filter is the main shaping filter of the DPP. The slow filter converts the digitized signal from the preprocessor to a trapezoidal shape. The trapezoidal shape consists of the rise time which is called the peaking time (PT), a holding time (HT) or flat top, and then the fall time which is the same as the rise time.

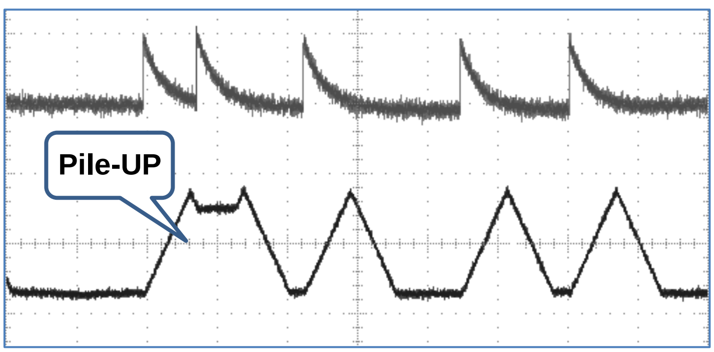
Figure 4 – Model of Filter Output



Fast Filters and Pile-Up Rejecter

The MXDPP-50 has two Fast filters to optimize pile up rejection. The Fast filters are used when the DPP receives a second event before it is done processing the first event. The Fast filter is just like the Slow filter but the peaking time is set much faster than the Slow filter. This way the DPP can process multiple fast events in the time it take to process one slow event. The Pile-Up Rejecter then counts the number of fast events during the slow event and if there is more than one it discards the slow event.

Figure 5 – Pile-Up Example



Multi-Channel Analyzer

The Multi-Channel Analyzer (MCA) analyzes the height of each event in the slow filter channel. The MCA contains 4096 channels in which each channel represents a range of pulse heights. Each time a pulse height is measured it adds a count to the corresponding channel. Each channel can hold up to 4G number of counts before rolling over. The data in the MCA is cleared before starting an acquisition run. During and after the acquisition the computer can download the data in the MCA and display it on a computer screen as the spectrum.

Single Channel Analyzer

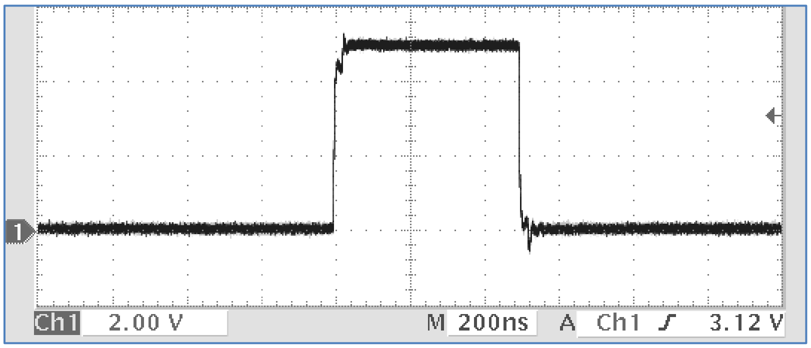
The MXDPP-50 contains 8 independent Single Channel Analyzers (SCA). The user sets a lower MCA channel limit and an upper MCA channel limit and any x-ray events within the limits triggers the output of the SCA. There are two modes of operation in the SCA, rate and pulse mode.

Rate Mode: The SCA output is a series of pulses with a frequency that is equivalent to the count rate within the limits set for the SCA channel. The SCA performs dead time correction to estimate the actual count rate corrected for dead time.

Pulse Mode: For each event within the limits set for the SCA channel the SCA outputs a single pulse.

The SCA Pulse is an active high 500ns long TTL compatible pulse.

Figure 6 – SCA Output pulse



Non-Volatile EEPROM

The Non-Volatile EEPROM memory holds the DPP parameters while the DPP is powered off. When the DPP powers on and goes through the boot sequence the parameters stored in the EEPROM are loaded into the active FPGA memory. The EEPROM is set to default settings at the factory. The user is able to overwrite the default settings and load their default configuration using the X-SpectrumDX software.

Detector High Voltage Supply

The detector high voltage supply (HV) is a low noise programmable supply specifically designed to bias Si-PIN and SDD detectors. The HV supply is adjustable from 0 to +250Vdc via the software interface. The HV polarity is also selectable in the software which makes the full range from -250V to +250Vdc. Typically Si-PIN diode detectors require a positive bias supply and SDD detectors require a negative bias supply.

Detector Temperature Controller

The integrated Temperature Controller is designed to work with Moxtek detectors. The temperature controller uses an analog PID circuit to control the voltage to the detector Thermoelectric Cooler (TEC). The temperature read back is done from a thermistor inside the detector. A 3.32KΩ pull-up resistor is used to form a voltage divider between it and the detector thermistor to convert the thermistor resistance to a voltage the DPP can read. The temperature controller set point is controlled from the DPP.

Figure 7 – Detector Thermistor and Pull-Up Resistor

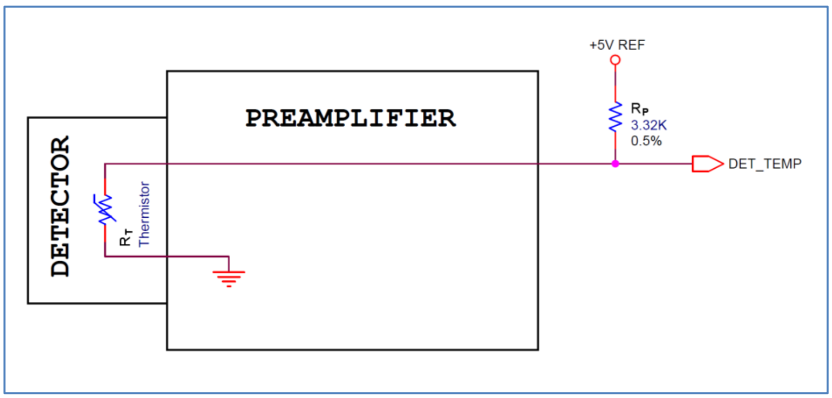
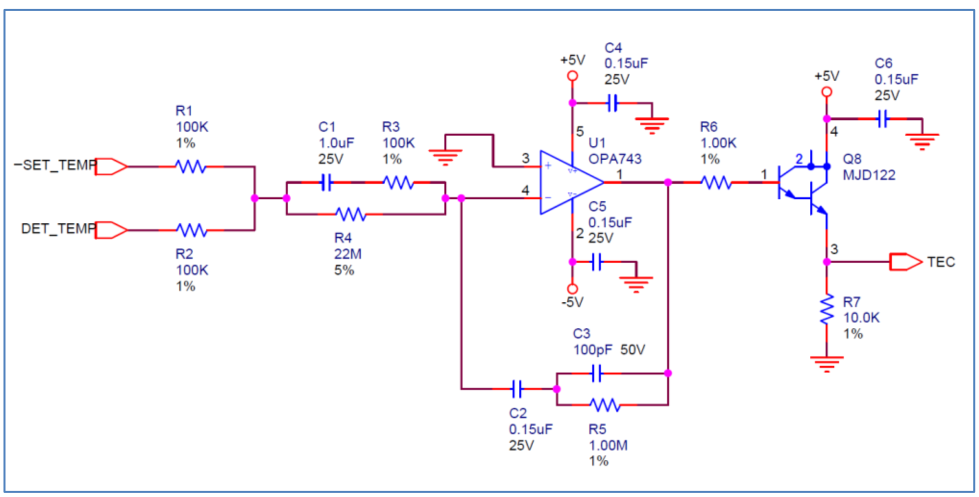


Figure 8 – Temperature Controller PID circuit



The MXDPP-50 can also work with Moxtek's BT detectors which have their own integrated temperature controller. The temperature controller on the DPP has two modes of operation, Box and Detector. The mode of operation indicates where the temperature controlling takes place; Box for inside the DPP box or card stack and Detector for inside the detector. While the temperature controller is in Detector mode it cannot read the actual temperature of the detector, the only temperature feedback available is the detector ready signal which turns on when the detector is close to the set temperature. In Box mode the DPP can read both the detector temperature and the detector ready signal.

Detector Preamplifier Power Supply

The Detector Preamplifier Power Supply is a low noise supply designed to power the detectors preamplifier. For Moxtek's BT detectors the power supply outputs ±9V and for Moxtek's XT detectors the power supply outputs ±5V.

Hardware

MXDPP-50 Box

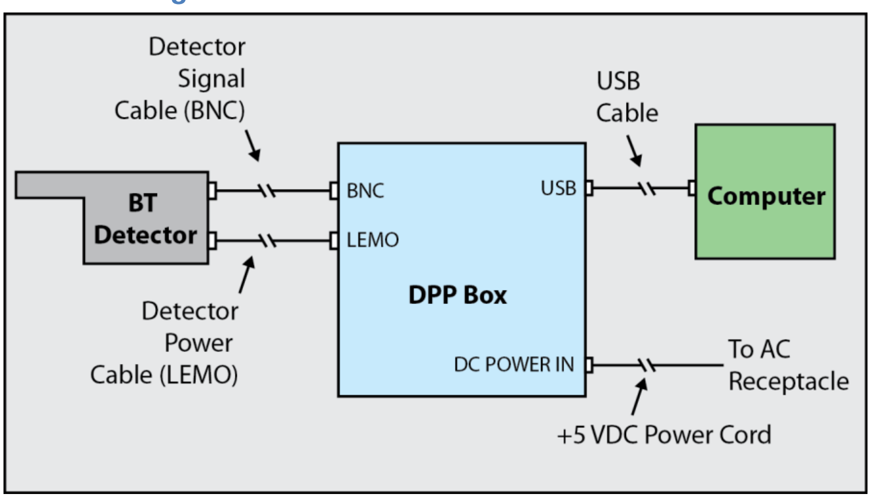
The MXDPP-50 Box is a great option for end users such as laboratories and universities where the DPP can sit on a bench top or shelf.

Figure 9 – MXDPP-50, Box Configuration

Connection Diagram

The MXDPP-50 is designed to work with Moxtek's BT detectors (sold separately). The detector power is connected through a LEMO cable which supplies the preamplifier power, high voltage bias, temperature controller power, and temperature feedback. The detector signal is connected through a BNC cable. The MXDPP-50 box is connected to the computer through a USB cable. The DPP box and detector are both powered through a single +5V power adapter.

Figure 10 – MXDPP-50 Box to BT Detector



Electrical Pinouts

Figure 11 – MXDPP-50 Box Front Panel

SIGNAL IN (Detector Signal)

Manufacturer: Amphenol
Manufacturer PN: 31-5538-10RFX
Mating Connector/Cable: Any Standard BNC

Pin	Function	I/O Value	Response/Description
1	Detector Signal	Ramp Input	BT Detector Signal Input
Shield	Signal Ground	Ground	Detector Signal Ground

Detector (Detector Power)

Manufacturer: LEMO
Manufacturer PN: EPL.1S.306.HLN
Mating Connector/Cable: LEMO FFA.1S.306.CLAC57

Pin	Function	I/O Value	Response/Description
1	Temperature / Ready	Input	Detector Temperature or Detector Ready
2	High Voltage Bias	Adjustable Output -250 to +250Vdc	Diode High Voltage Bias
3	Preamp Power -	-9V Output	Negative Preamplifier Power
4	Preamp Power +	+9V Output	Positive Preamplifier Power
5	TC Ground / TEC -	TC Ground / Return	Temperature Controller Ground or TEC-
6	TC Power / TEC +	Output	Temperature Controller Power or TEC+
Shield	Detector Ground	Ground	Detector Ground

Figure 12 – MXDPP-50 Box Back Panel

+5V (Power Connector)

Manufacturer: CUI Inc.
Manufacturer PN: PJ-063AH
Mating Connector/Cable: Barrel 2.1mm ID, 5.5mm OD
Recommended Power Adapter: CUI Inc. EPSA050250U-P5P-EJ

Pin	Function	I/O Value	Response/Description
1	Power	Input	DPP Power (+5V)
2	Ground	Ground	Ground

AUX I/O PORT (Auxiliary Connector)

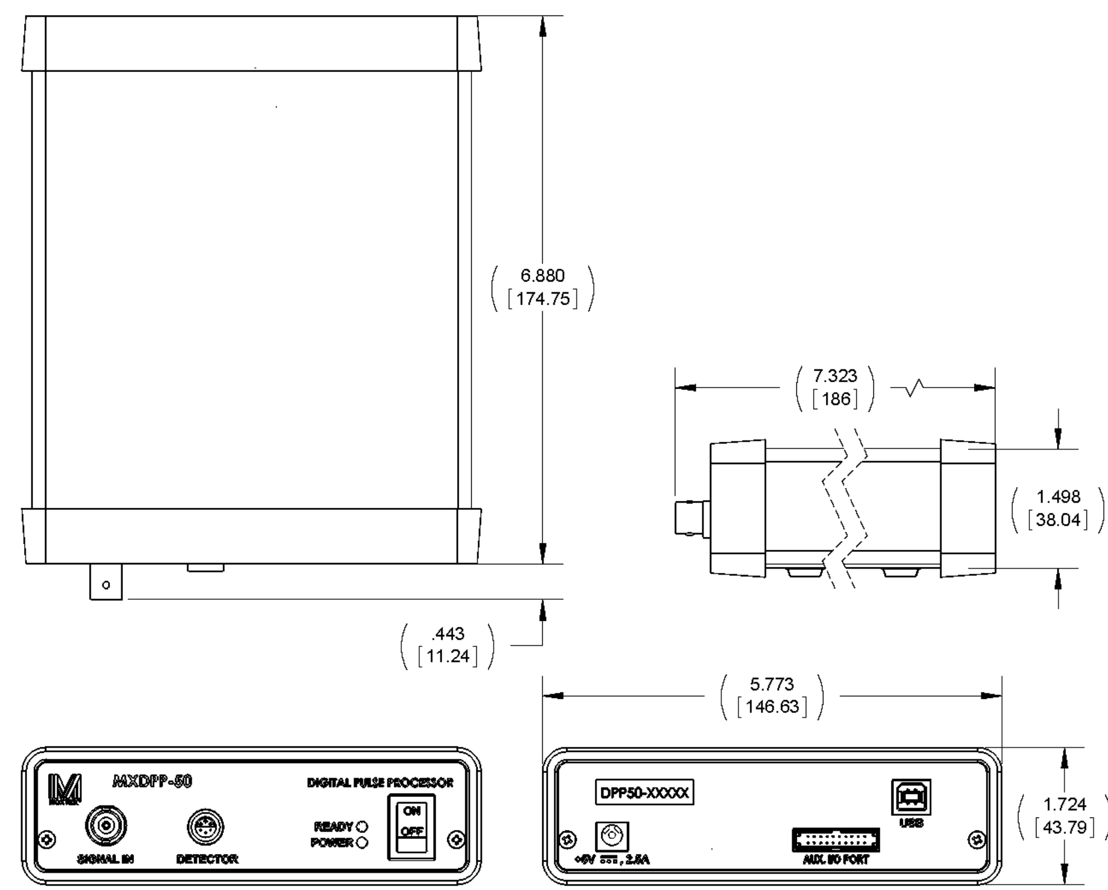
Manufacturer: Samtec
Manufacturer PN: T2M-110-01-L-D-RA
Mating Connector/Cable: Samtec S2SD-10-24C-L-04.00-DR-NUS

Pin	Function	I/O Value	Response/Description
1	Power	Input	Power (+5V)
2	Power	Input	Power (+5V)
3	Ground	Ground	Ground
4	Ground	Ground	Ground
5	DET Ready	Output	Detector Ready Signal 0-5V
6	DPP Analog Out	Output	Analog Output from DAC
7	SCA 1	Output	Single Channel Analyzer Output
8	SCA 2	Output	Single Channel Analyzer Output
9	SCA 3	Output	Single Channel Analyzer Output
10	SCA 4	Output	Single Channel Analyzer Output
11	SCA 5	Output	Single Channel Analyzer Output

Pin	Function	I/O Value	Response/Description
12	SCA 6	Output	Single Channel Analyzer Output
13	SCA 7	Output	Single Channel Analyzer Output
14	SCA 8	Output	Single Channel Analyzer Output
15	AUX OUT 1	Output	Auxiliary Digital Output
16	AUX OUT 2	Output	Auxiliary Digital Output
17	AUX IN 1	Input	Auxiliary Digital Input
18	AUX IN 2	Input	Auxiliary Digital Input
19	Ground	Ground	Ground
20	Ground	Ground	Ground

Mechanical drawing

Figure 13 – MXDPP-50 Box Mechanical Drawing



NOTES:
1. SECONDARY DIMENSIONS ARE IN MILLIMETERS

MXDPP-50 OEM Card Stack

The MXDPP-50 OEM Card Stack is a great option for customers that want to embed the MXDPP-50 into their own system. The OEM Card Stack provides a small outline and mounting hardware for mounting it into tight spaces in the customer's instruments.

The MXDPP-50 OEM Card Stack comes in two configurations, XT and BT. The XT configuration is for use with Moxtek's smaller XT detectors. The XT configuration provides interfaces for Moxtek's XT-P10 style detectors via the Molex Pico Blade connector J6 and Moxtek's XT-P20 style detectors via the Flat Flex Cable (FFC) connector J7 The BT configuration contains the same XT style connectors along with connectors for use with Moxtek's BT detectors.

Figure 14 – MXDPP-50, OEM-XT Configuration

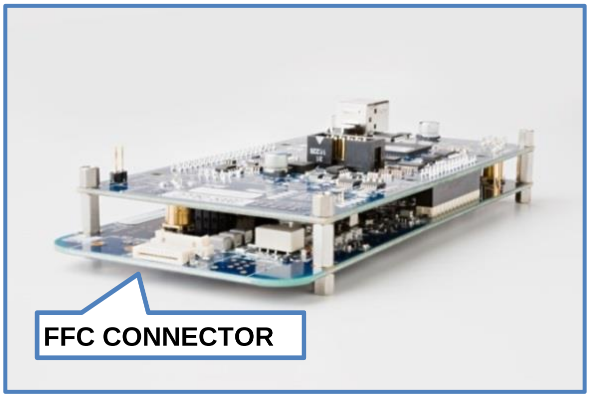
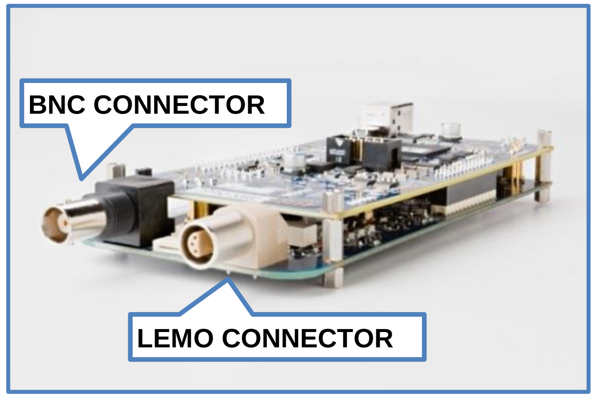


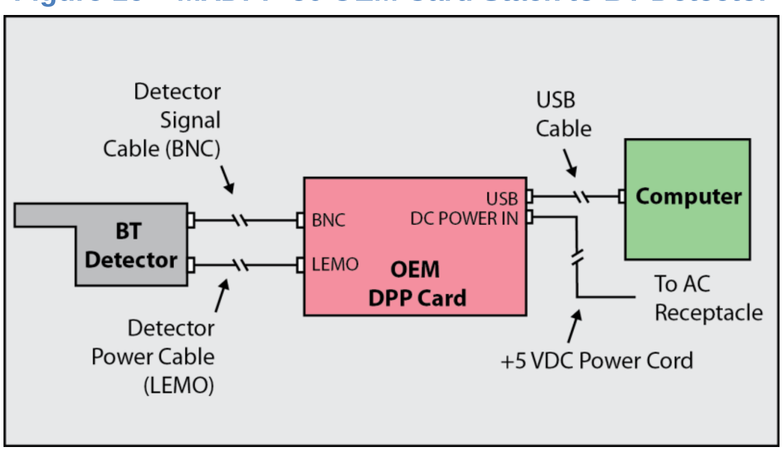
Figure 15 – MXDPP-50, OEM-BT Configuration



Connection Diagram – BT

The MXDPP-50 OEM-BT is designed to work with Moxtek's BT detectors (sold separately). The detector power is connected through a LEMO cable which supplies the preamplifier power, high voltage bias, temperature controller power, and temperature feedback. The detector signal is connected through a BNC cable. The MXDPP-50 OEM Card Stack is connected to the computer through a USB cable. The DPP and detector are both powered through a single +5V wall adapter.

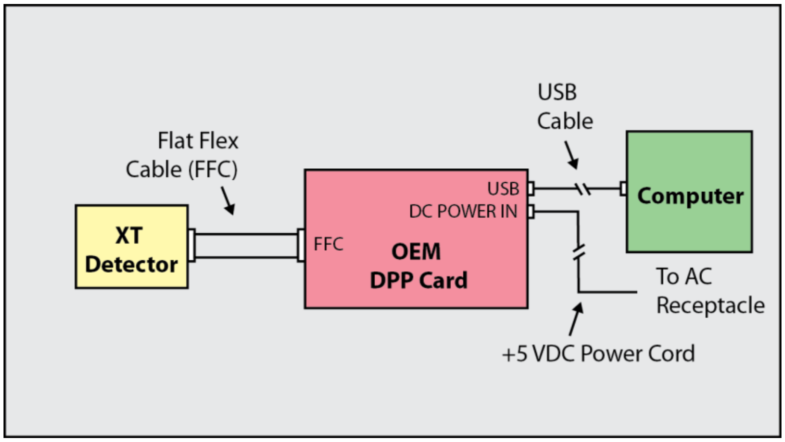
Figure 16 – MXDPP-50 OEM Card Stack to BT Detector



Connection Diagram – XT

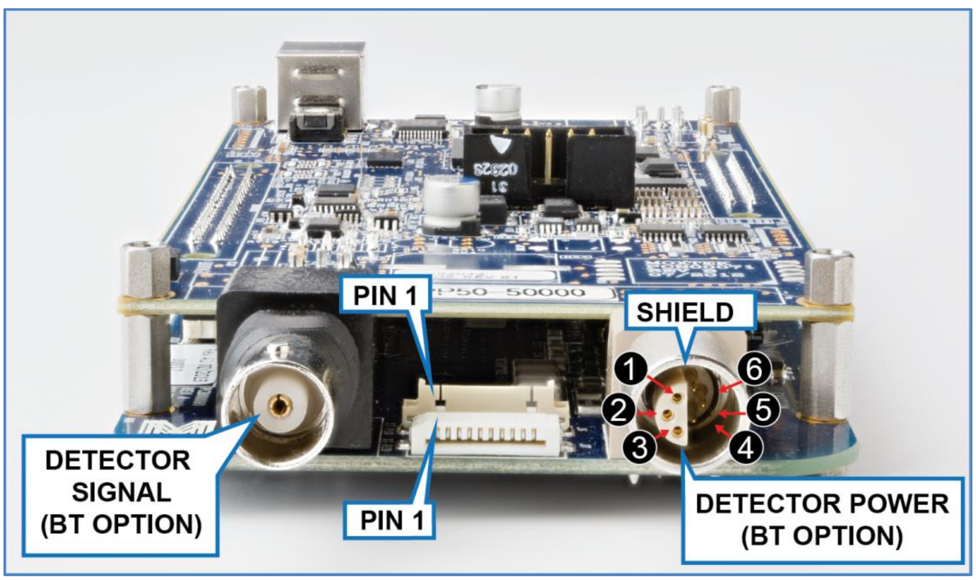
The MXDPP-50 OEM-XT is designed to work with Moxtek's XT detectors (sold separately). The detector power and signal is connected through a Flat Flex Cable (FFC) cable which supplies the preamplifier power, high voltage bias, temperature controller power, and temperature feedback. The MXDPP-50 OEM Card Stack is connected to the computer through a USB cable. The DPP and detector are both powered through a single +5V wall adapter.

Figure 17 – MXDPP-50 OEM Card Stack to XT Detector



Electrical Pinouts

Figure 18 – OEM-BT Detector Connectors



Detector XT-P10 (J6)

Manufacturer: Molex
Manufacturer PN: 53398-0971
Mating Connector/Cable: MOLEX 51021-0900 and 50058-8100

Pin	Function	I/O Value	Response/Description
1	High Voltage Bias	Adjustable Output -250 to +250Vdc	Diode High Voltage Bias
2	Signal Ground	Ground	Detector Signal Ground
3	Temperature	Thermistor Input	Detector Temperature Input
4	Signal Input	Ramp Input	Detector Signal Input
5	Preamp Ground	Ground	Preamplifier Ground
6	Preamp Power -	-5V Output	Negative Preamplifier Power
7	Preamp Power +	+5V Output	Positive Preamplifier Power
8	TEC+	Adjustable Output 0 to 3.5Vdc	Thermoelectric Cooler Output Controlled by Temperature Controller
9	TEC-	TEC Return	Thermoelectric Cooler Return

Detector XT-P20 (J7)

Manufacturer: Molex
Manufacturer PN: 52793-1070
Mating Connector/Cable: Samtec FJ-10-D-04.00-4

Pin	Function	I/O Value	Response/Description
1	High Voltage Bias	Adjustable Output -250 to +250Vdc	Diode High Voltage Bias
2	Not Connected	N/A	Not Used
3	Signal Ground	Ground	Detector Signal Ground
4	Temperature	Thermistor Input	Detector Temperature Input
5	Signal Input	Ramp Input	Detector Signal Input
6	Preamp Ground	Ground	Preamplifier Ground
7	Preamp Power -	-5V Output	Negative Preamplifier Power
8	Preamp Power +	+5V Output	Positive Preamplifier Power
9	TEC+	Adjustable Output 0 to 3.5Vdc	Thermoelectric Cooler Output Controlled by Temperature Controller
10	TEC-	TEC Return	Thermoelectric Cooler Return

Detector Signal (BT Option)

Manufacturer: Amphenol
Manufacturer PN: 31-5538-10RFX
Mating Connector/Cable: Any Standard BNC

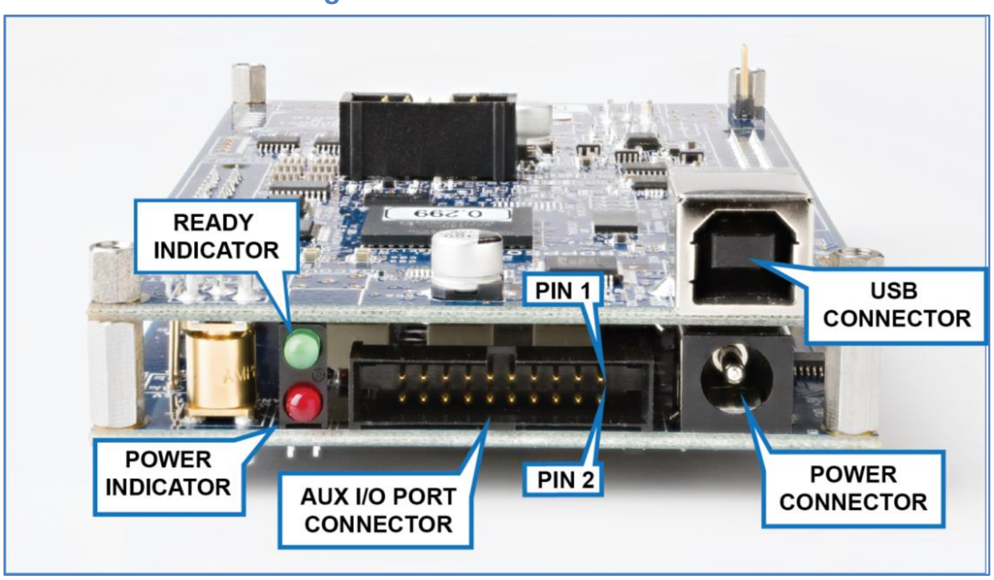
Pin	Function	I/O Value	Response/Description
1	Detector Signal	Ramp Input	BT Detector Signal Input
Shield	Signal Ground	Ground	Detector Signal Ground

Detector Power (BT Option)

Manufacturer: LEMO
Manufacturer PN: EPL.1S.306.HLN
Mating Connector/Cable: LEMO FFA.1S.306.CLAC57

Pin	Function	I/O Value	Response/Description
1	Temperature / Ready	Input	Detector Temperature or Detector Ready
2	High Voltage Bias	Adjustable Output -250 to +250Vdc	Diode High Voltage Bias
3	Preamp Power -	-9V Output	Negative Preamplifier Power
4	Preamp Power +	+9V Output	Positive Preamplifier Power
5	TC Ground / TEC -	TC Ground / Return	Temperature Controller Ground or TEC-
6	TC Power / TEC +	Output	Temperature Controller Power or TEC+
Shield	Detector Ground	Ground	Detector Ground

Figure 19 – OEM Connectors



+5V (Power Connector)

Manufacturer:	CUI Inc.
Manufacturer PN:	PJ-063AH
Mating Connector/Cable:	Barrel 2.1mm ID, 5.5mm OD
Recommended Power Adapter:	CUI Inc. EPSA050250U-P5P-EJ

Pin	Function	I/O Value	Response/Description
1	Power	Input	DPP Power (+5V)
2	Ground	Ground	Ground

AUX I/O PORT (Auxiliary Connector)

Manufacturer:	Samtec
Manufacturer PN:	T2M-110-01-L-D-RA
Mating Connector/Cable:	Samtec S2SD-10-24C-L-04.00-DR-NUS

Pin	Function	I/O Value	Response/Description
1	Power	Input	Power (+5V)
2	Power	Input	Power (+5V)
3	Ground	Ground	Ground
4	Ground	Ground	Ground
5	DET Ready	Output	Detector Ready Signal 0-5V
6	DPP Analog Out	Output	Analog Output from DAC
7	SCA 1	Output	Single Channel Analyzer Output
8	SCA 2	Output	Single Channel Analyzer Output
9	SCA 3	Output	Single Channel Analyzer Output
10	SCA 4	Output	Single Channel Analyzer Output
11	SCA 5	Output	Single Channel Analyzer Output
12	SCA 6	Output	Single Channel Analyzer Output
13	SCA 7	Output	Single Channel Analyzer Output
14	SCA 8	Output	Single Channel Analyzer Output
15	AUX OUT 1	Output	Auxiliary Digital Output
16	AUX OUT 2	Output	Auxiliary Digital Output
17	AUX IN 1	Input	Auxiliary Digital Input
18	AUX IN 2	Input	Auxiliary Digital Input
19	Ground	Ground	Ground
20	Ground	Ground	Ground

Mechanical Drawings

Figure 20 – MXDPP-50 OEM-XT Card Stack Mechanical Drawing

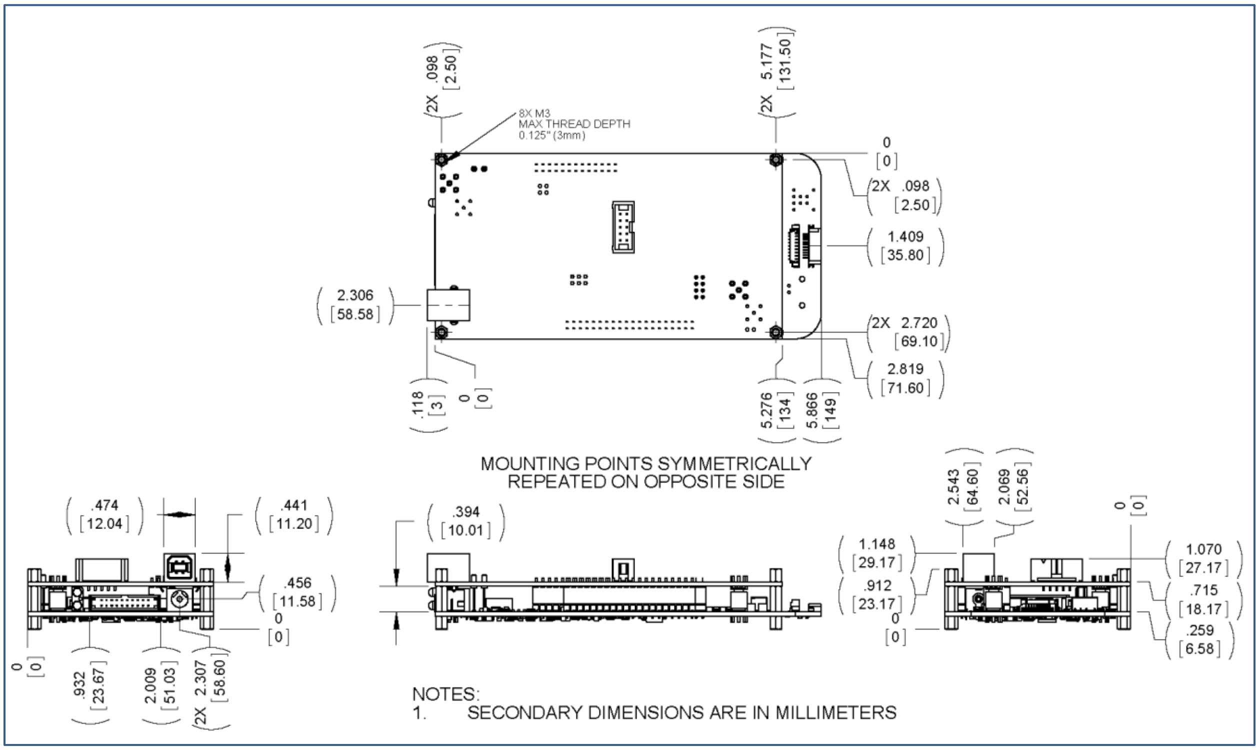
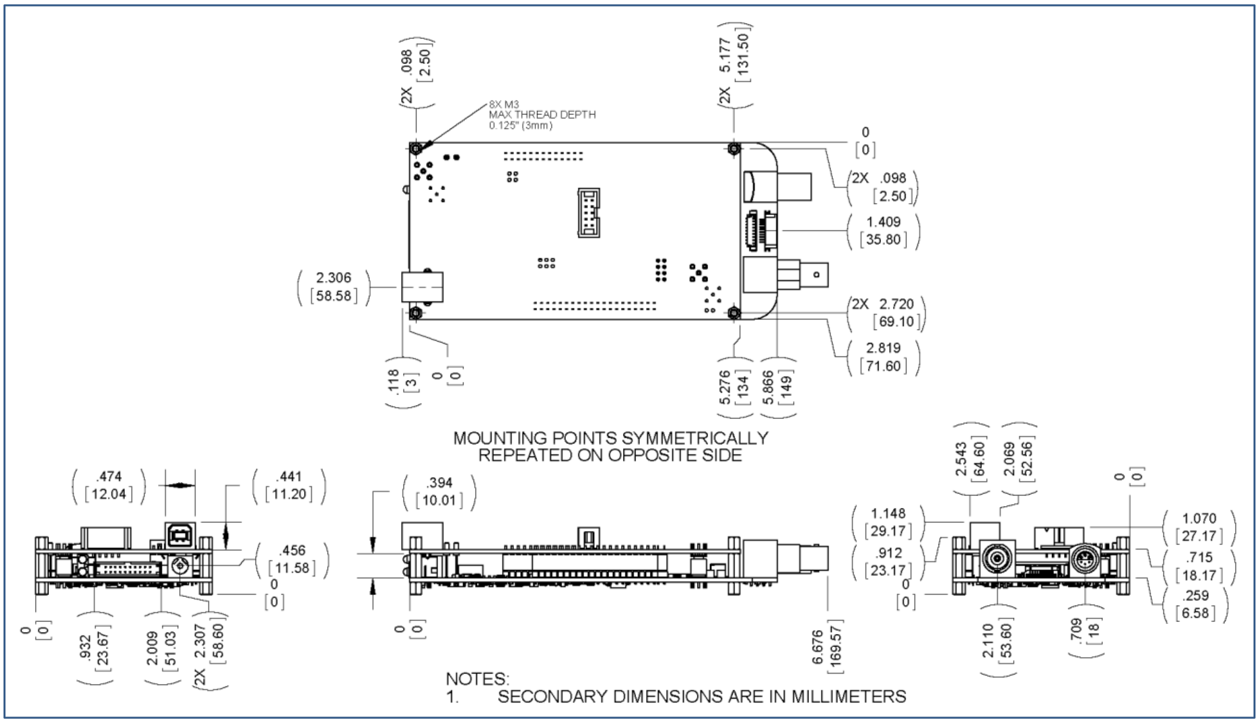


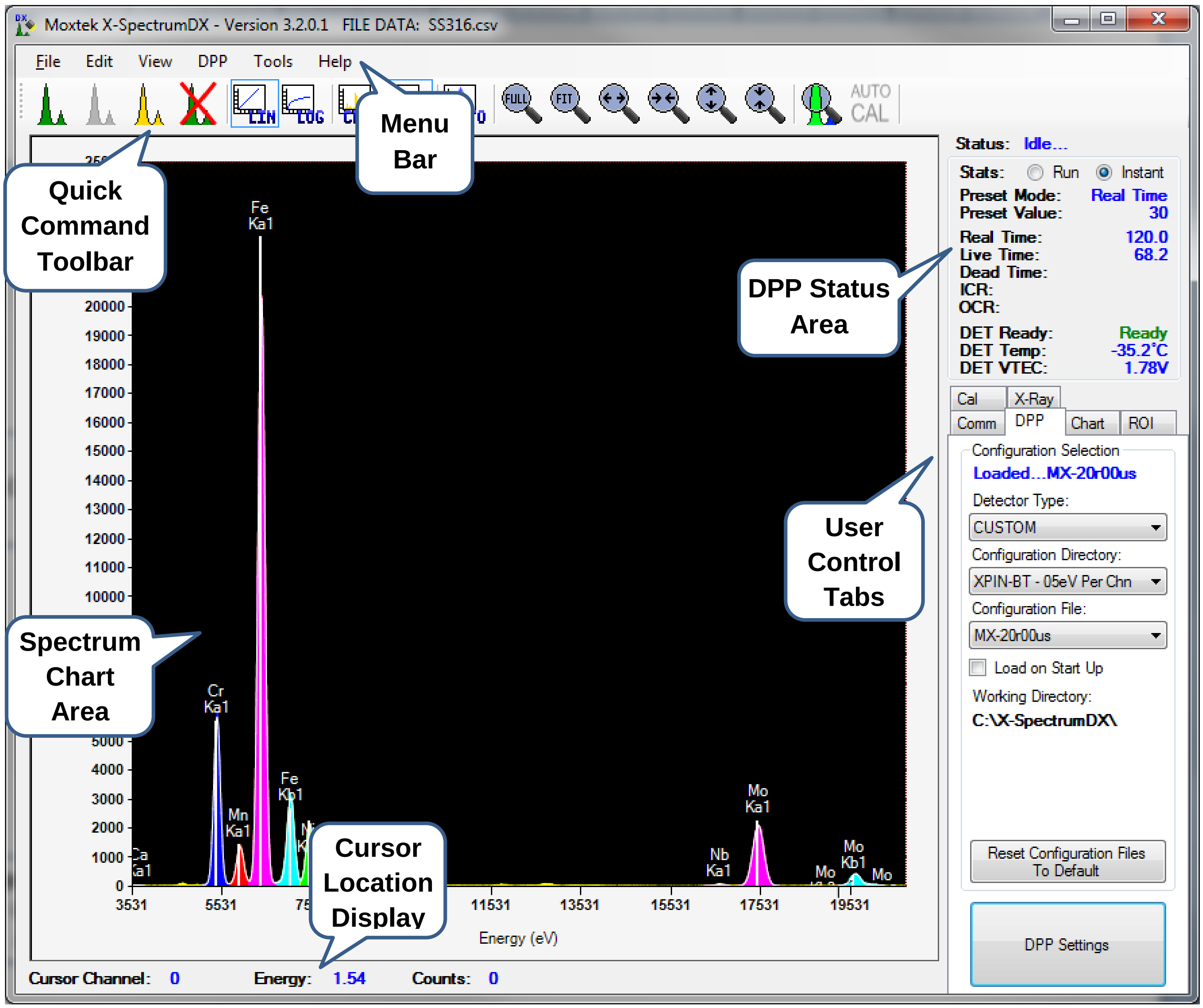
Figure 21 – MXDPP-50 OEM-BT Card Stack Mechanical Drawing



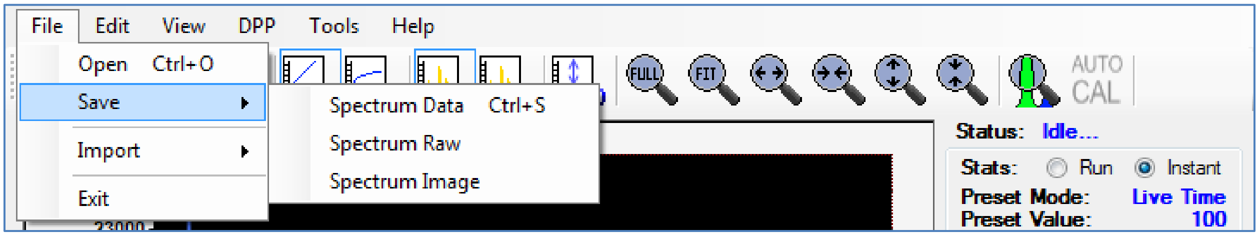
Software

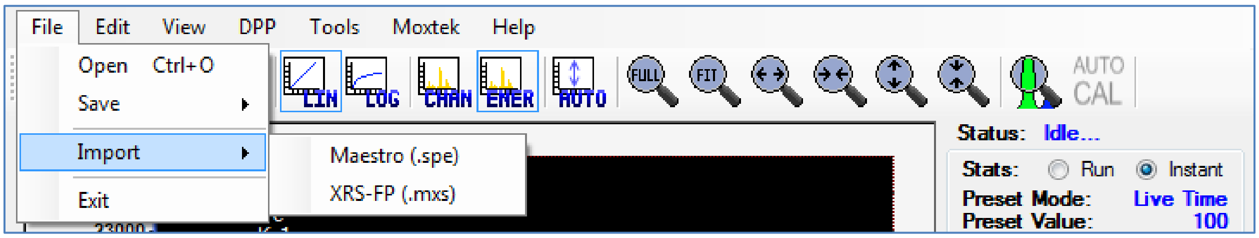
Main Window

The Main Window provides access to most of the controls the basic user will need.



File Dropdown Menu





Open Opens a file containing a previously saved spectrum. The software comes with several example spectra.

Save > Spectrum Data Saves the spectrum, the ROI, the calibration and superimposed x-ray lines to a .csv file.

Save > Spectrum Raw Saves only the counts, channels and energy to a .csv file.

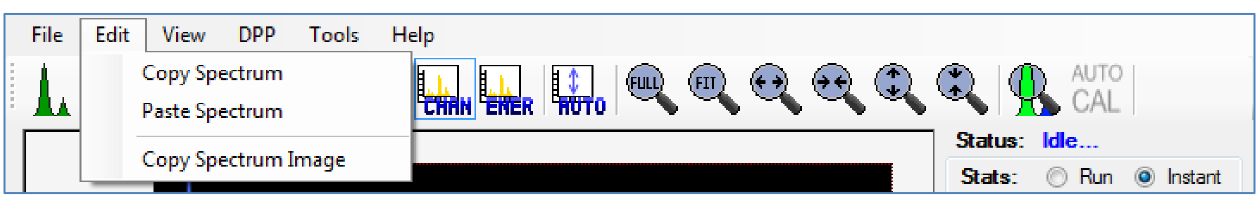
Save > Spectrum Image Copies the image from the chart and saves it to an image file. Images cannot be opened in X-Spectrum DX for analysis.

Import > Maestro (.spe) Imports Maestro formatted spectrum data files (.spe).

Import > XRS-FP (.sp0) Imports XRS-FP formatted spectrum data files (.sp0).

Exit Exits the software.

Edit Dropdown Menu

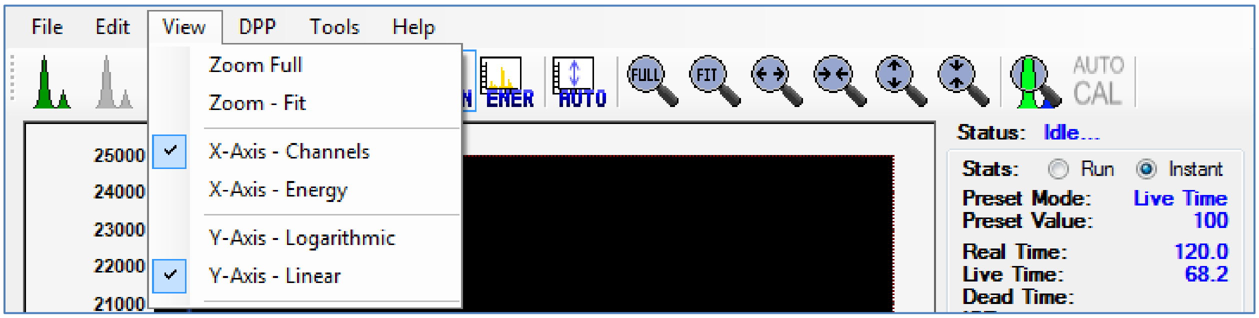


Copy Spectrum Copies the spectrum data into the Windows clipboard so it can be pasted into a text or spreadsheet editor without having to be saved first.

Paste Spectrum If you have copied the text of a spreadsheet equivalent to a spectrum, the chart will display the spectrum from the text.

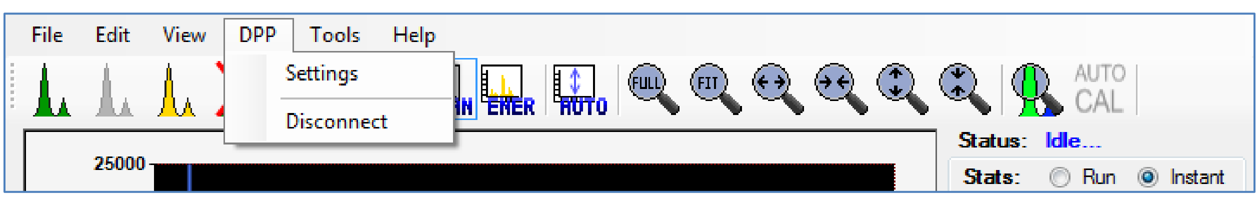
Copy Spectrum Image	Places an image of the chart into the Windows clipboard so it can be pasted into a Word document, image editor or other program that accepts image pasting.

View Dropdown Menu



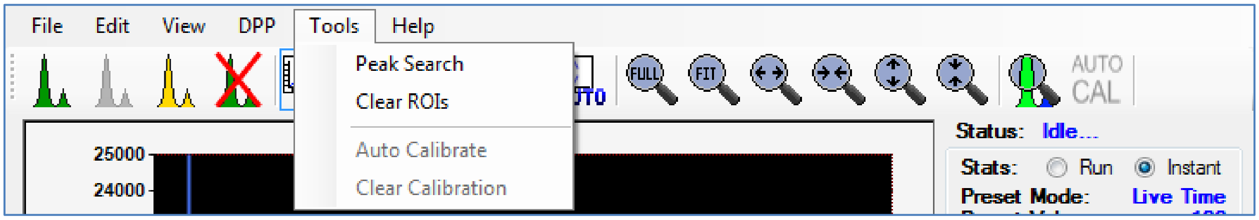
Zoom Full	Sets the range of the X-axis to the full energy range that can be displayed.
Zoom Fit	Sets the range of the X-axis to include only the area with useful counts.
X-axis – Channels	Changes the X-axis to display as un-calibrated channels.
X-axis – Energy	Changes X-axis to display as calibrated energy.
Y-axis – Logarithmic	Changes the scaling of the Y-axis to logarithmic. Logarithmic allows seeing more detail with smaller peaks without cutting off larger peaks.
Y-axis – Linear	Changes the scaling of the Y-axis to linear. Linear gives an accurate comparison of peak sizes.

DPP Dropdown



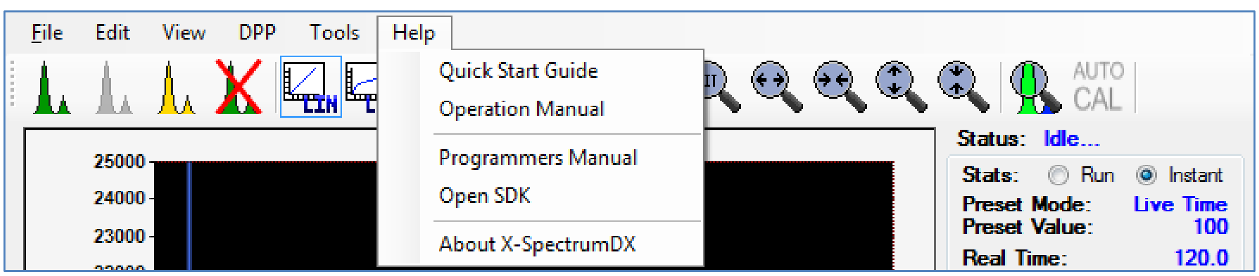
Settings	Opens the Advanced DPP settings Window.
Disconnect	Disconnects the DPP from the software, disabling any communication between the software and the DPP, but allowing a new connection to be made.

Tools Dropdown Menu



Peak Search	Searches the spectrum data for all peaks and creates ROIs for each of them. The peak search window and max number of ROIs settings are used from the ROI tab.
Clear ROIs	Removes all current ROIs.
Auto Calibrate	Calibrates the spectrum using the two highest peaks as reference channels for the peak energies input in the auto-calibrate settings. If there aren't any ROIs created the Auto Calibrate command will perform a peak search before calibrating.
Clear Calibration	Removes the calibration.

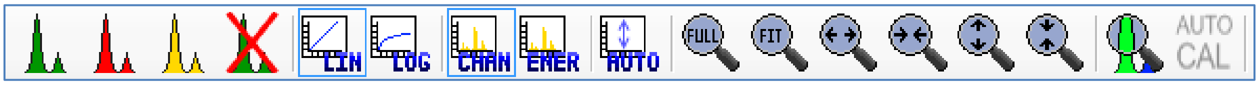
Help Dropdown Menu

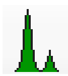
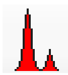
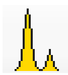
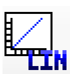
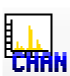
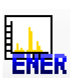
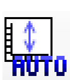
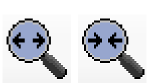


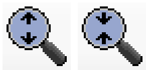
Quick Start Guide	Opens the quick start guide, which contains instructions on installing, connecting and basic use of the Moxtek DPP-50 and X-Spectrum DX software.
Operation Manual	Opens this manual.
Programmer's Manual	Opens the Programmer's Manual, which contains instructions on how to control the DPP using custom software.
Open SDK	Opens the folder containing the software development kit code for the DPP. Currently the SDK is available in Visual Basic and LabVIEW with a virtual com port. (See Programmer's Manual).

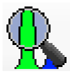
About X-Spectrum DX	Shows the software version and information on how to contact Moxtek.

Quick Command Toolbar



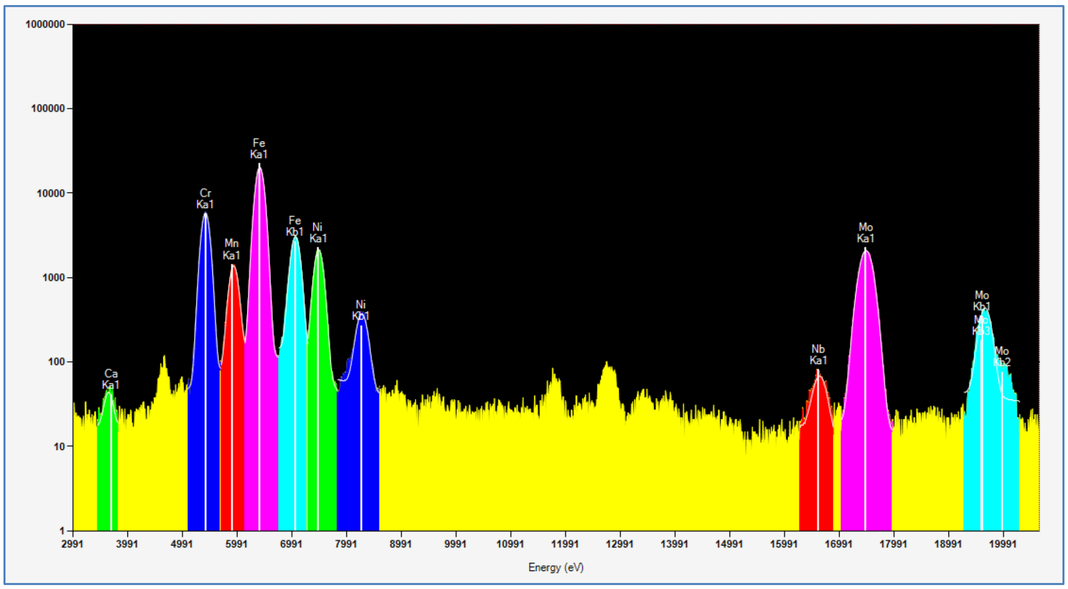
 ***Start Acquisition***	Starts acquiring a spectrum.
 ***Stop Acquisition***	Stops acquiring a spectrum in progress.
 ***Resume Acquisition***	If an acquisition in progress has been stopped, this will resume it.
 ***Clear spectrum***	Clears any data that has been collected. If an acquisition is in progress, it will restart it.
 ***Linear***	Changes the chart's Y-axis to linear scale.
 ***Logarithmic***	Changes the chart's Y-axis to logarithmic scale.
 ***Channels***	Changes the chart's X-axis to display channels.
 ***Energy***	Changes the chart's X-axis to display energy. Display of x-ray energy is not available until a calibration has been performed.
 ***Auto Scale***	Sets the Y-axis to automatically scale to fit the highest peak. (Double clicking on the Y-axis will get the same result)
 ***Zoom Full***	Sets the scale of the X-axis to show all channels or the full available range of x-ray energies.
 ***Zoom Fit***	Sets the X-axis scale to show only significant data.
 ***X-axis Zoom***	Increases or decreases the scale of the X-axis. (Double clicking on the X-axis will zoom out all the way)

 ***Y-axis Zoom*** Increases or decreases the scale of the Y-axis.
(Double clicking on the Y-axis will zoom out all the way)

 ***Peak Search*** Performs a peak search; creating ROIs around each peak.

Auto Calibrate Auto-calibrates the spectrum, using the two highest peaks and the energies set in the calibration settings as reference. (See Calibrate)

Chart Area



Spectrum Area Main area where the spectrum is displayed.

Mouse Commands

Left-Click: Places the cursor at the X-axis location of the mouse click.

Left-Click and Drag: Moves the cursor to correspond to the X-axis location of the mouse.

Right-Click: If the mouse cursor is over one of the ROIs then the *ROI Context Menu* will appear.

Right-Click and Drag: Draws a zoom box starting with the initial location of the right-click and ends where the right mouse button is released. Once the button is release the *Zoom/Add ROI* context menu will appear.

Y-axis

Indicates the number of x-ray counts at a particular energy or channel.

Mouse Commands

Left-Click and Drag: Pans the spectrum up and down. (Not available in Logarithmic scale.)

Right-Click and Drag: Zoom in and out of the Y-axis. (Not available in Logarithmic scale.)

Double-Click: Zooms out Y-axis and turns on auto scale.

X-axis

Indicates the channel or x-ray energy for a particular number of counts.

Mouse Commands

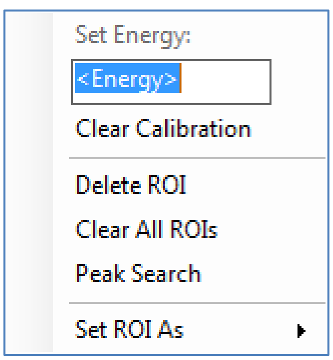
Left-Click and Drag: Pans the spectrum left to right.

Right-Click and Drag: Zoom in and out of the X-axis.

Double-Click: Zooms out X-axis.

ROI Context Menu

The ROI Context Menu is displayed when the user right-clicks on one of the ROIs in the spectrum.



Set Energy

A manual calibration option. Sets the center channel of the target ROI to the energy value entered in the text box. Repeating this step with a second peak will complete the 2-point calibration.

Clear Calibration

Clears the current calibration.

Delete ROI

Deletes the ROI that was the target of the right-click.

Clear All ROIs

Clears all ROIs.

Peak Search

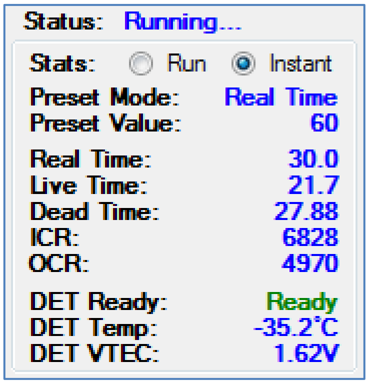
Clears all the ROIs and performs a new peak search.

Set ROI as (SCA)

Sets the upper and lower limit of the target ROI to the specified Single Analyzer Channel (SCA).

DPP Status/Statistics Section

The DPP Status/Statistics section displays the current status of the DPP and some of the acquisition statistics.



Status

Indicates the current status of the DPP and software.

Running: The DPP is acquiring a spectrum.

Idle: The DPP is ready to start acquiring a spectrum.

Reading from DPP: The software is reading parameters from DPP.

Writing to DPP: The software is writing parameters to the DPP.

Not Connected: The software is not connected to a DPP and no signals can be sent or received.

Stats

Specifies the mode at which the statistics are displayed.

Run: The average statistics for the entire run is displayed.

Instant: The instantaneous statistics from the DPP are displayed. The rate at which statistics are updated depends on the Interval DPP parameter.

Preset Mode

Indicates the current preset setting mode.

Preset Value

Indicates the current preset setting value.

Real Time

Displays the DPPs Real Time timer.

Live Time

Displays the DPPs Live Time Timer.

Dead Time

Displays the DPPs Dead Time Timer.

ICR

Displays the calculated Incoming Count Rate.

OCR

Displays the actual count rate after pile-up has been subtracted.

DET Ready

If the detector is near the temperature set point then the DET Ready will display “Ready” in green text. If it is too warm or too cold, it will display “Not Ready” in red text.

DET Temp

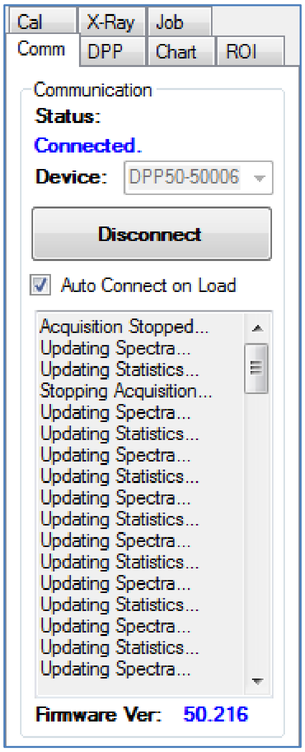
Displays the current temperature of the detector in °C (Only available when TC mode is set to Box).

DET VTEC

Moxtek XPIN detectors use a thermoelectric cooler (TEC) to cool the device. VTEC is the voltage applied to the TEC for cooling. (Only available when TC mode is set to Box).

Comm Tab

The Communication Tab contains the controls for establishing communication to the DPP.



Status

Shows the status of the DPP communication.

Connected: The software has successfully connected to the DPP.

Not Connected: The software has not connected to the DPP.

Connect Error: There was an error in connecting to the DPP.

(More information will be displayed in the Comm History Log)

Device

A dropdown menu that automatically populates with a list of all available MXDPP-50s connected to the computer.

Connect/Disconnect

Connects or Disconnects from the DPP.

Auto Connect on Load

When this box is checked, the software automatically attempts to connect to the DPP with the serial number indicated in the "Device" dropdown menu on startup.

Communication History Log

Displays a history of the some of the communication activity to and from the DPP.

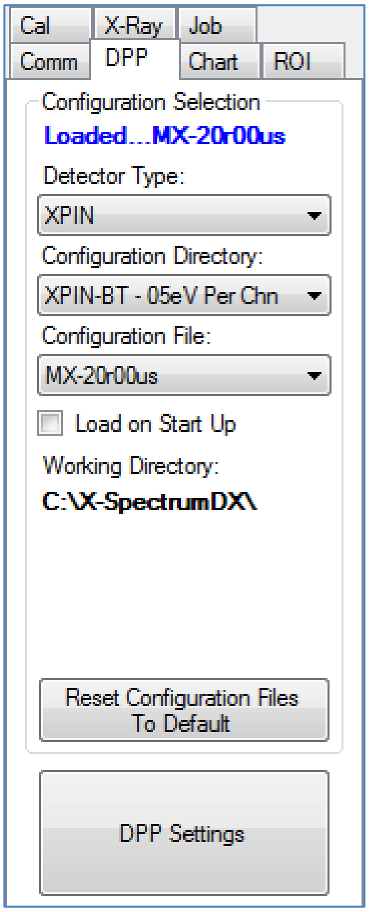
Firmware Ver

Displays current firmware version loaded onto the DPP.

(Currently there is no way for the user to update the firmware. firmware updates can only be performed at the factory.)

DPP Tab

The DPP Tab contains basic controls for setting the DPP and detector parameters.



Configuration Selection

Displays the filename of the configuration file loaded.

Detector Type

Drop down menu to select preconfigured detector settings.

Configuration Directory

Drop down menu to select a directory that contains pre-set DPP configuration files. Custom directories can be created and will auto populate in the pull-down list.

Configuration File

Drop down menu to select pre-set configuration files that are located in the selected configuration directory. The default pre-set configuration files have been optimized to give the best resolution for a given peaking time under Moxtek's internal testing conditions.

Load on Start Up

If this box is checked the software will load the selected configuration file automatically when a connection is established with the DPP.

Working Directory

Displays the current X-SpectrumDX working directory.

Reset Configuration Files to Default

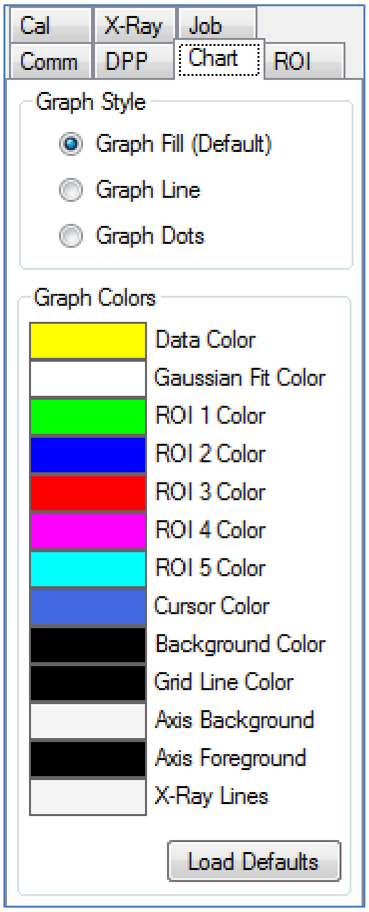
The configuration files can be modified by the user in order to optimize performance for their specific application. Clicking "Reset Configuration Files to Default" will restore any changes to the configuration files back to the original files from the initial software installation and archive any current files under the Archive folder in the current working directory.

DPP Settings

Opens the Advanced Settings window where the user can change the current DPP parameters.

Chart Tab

The Chart tab contains controls for changing the appearance of the spectrum.



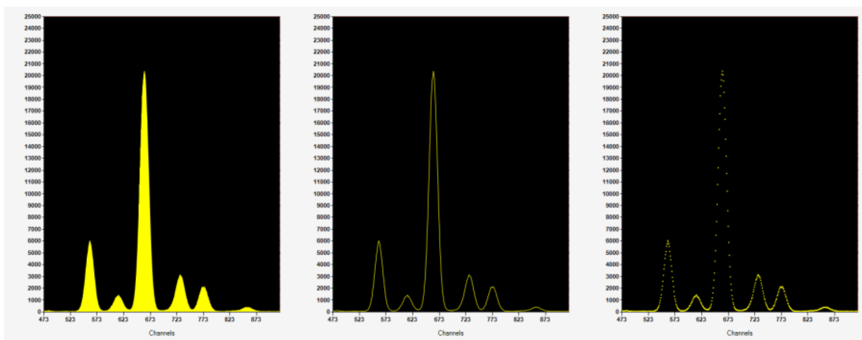
Graph Style

Displays the filename of the configuration file loaded.

Graph Fill: Graphs the spectrum by filling in the data down to zero on the Y-scale.

Graph Line: Graphs the spectrum by drawing a line between each data point.

Graph Dots: Graphs the spectrum by displaying a single dot for each data point.



Graph Colors

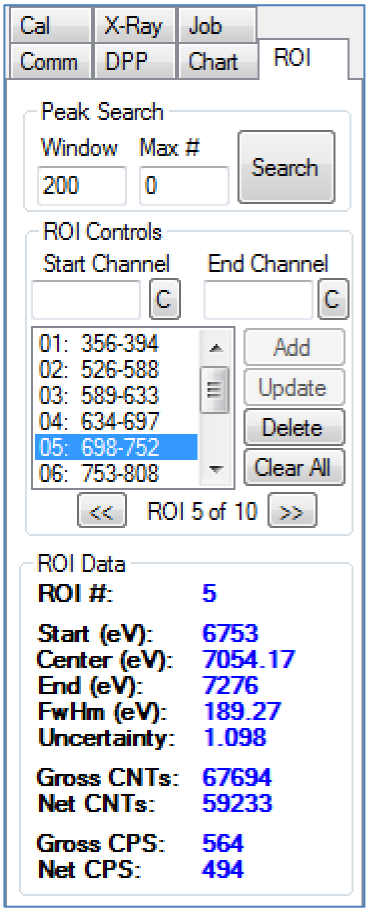
Allows the user to change the color that each of the items are drawn in on the spectrum. Clicking on the color box next to each item will display a color picker dialog box.

Load Defaults

Resets all the graph colors to their default value.

ROI Tab

The ROI Tab contains controls to add, delete, and display info about each Region of Interest (ROI)



Peak Search

Automatically searches for peaks in the spectrum data and creates an ROI around the peaks found.

Window: Changes the sensitivity of the peak search algorithm. The lower the number the more sensitive.

Max #: Specifies the maximum number of ROIs to create. If more peaks are found, then only the higher peaks will be included.

ROI Controls

Provides controls for creating, updating, deleting, and clearing ROIs.

Start Channel: Starting channel of the ROI peak. The channel number can be typed into the textbox manually or the current cursor channel can be automatically added by clicking on the "C" button next to the textbox.

End Channel: Ending channel of the ROI peak. The channel number can be typed into the textbox manually or the current cursor channel can be automatically added by clicking on the "C" button next to the textbox.

Add: Creates a new ROI based on the Start and End channels in the above textboxes.

Update: Updates the selected ROI in the list to the left with the new start and end channels from the above textboxes.

Delete: Deletes the selected ROI in the list to the left.

Clear All: Deletes all ROIs.

ROI Data

Displays the ROI and statistical data for the select ROI.

ROI #: Indicates which ROI has been selected.

Start (Ch or eV): Displays the ROI start in channels or energy depending on the X-axis display mode.

Center (Ch or eV): Displays the ROI center in channels or energy depending on the X-axis display mode.

End (Ch or eV): Displays the ROI end in channels or energy depending on the X-axis display mode.

FwHm (Ch or eV): Displays the resolution in Full Width Half Max of the ROI in channels or energy depending on the X-axis display mode.

Uncertainty: Displays the uncertainty of the FwHm calculation.

Gross CNTs: Displays the total counts within the ROI peak.

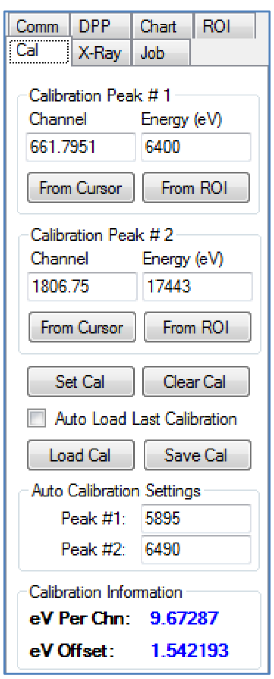
Net CNTs: Displays the total counts within the ROI peak minus the background.

Gross CPS: Displays the gross count rate in the ROI peak by taking the gross counts and dividing by the real time.

Net CPS: Displays the net count rate in the ROI peak by taking the net counts and dividing by the real time.

Cal Tab

The Cal tab provides controls to calibrate the spectrum to specific energies.



Calibration Peak #1 & #2

The Calibration Peak sections provide controls for manually calibrating the spectrum. The calibration is based on a two point calibration method where a linear line equation is used to represent channels as energy.

Channel: The channel in the spectrum at which the energy will be set to.

Energy (eV): The corresponding energy to set the channel to.

From Cursor: The channel textbox can be automatically populated to the current cursor position by clicking this box.

From ROI: The channel textbox can be automatically populated to the center channel of the ROI at which the cursor is currently on.

Set Cal

Using the values under the Calibration Peak #1 and 2 the calibration curve is calculated when this button is clicked.

Clear Cal

Clears any calibration information that has been done.

Auto Load Last Calibration

When this check box is checked the software will automatically load the last calibration curve when the software is started.

Load Cal

Loads a previously saved calibration from file.

Save Cal

Saves the current calibration to file.

Auto Calibration Settings

Sets the energy of the peaks to use in the auto calibration command. The auto calibration uses the two tallest peaks in the spectrum and sets their center channels to the values in these two text boxes.

Calibration Information

Displays the coefficients to the calibration curve/line.

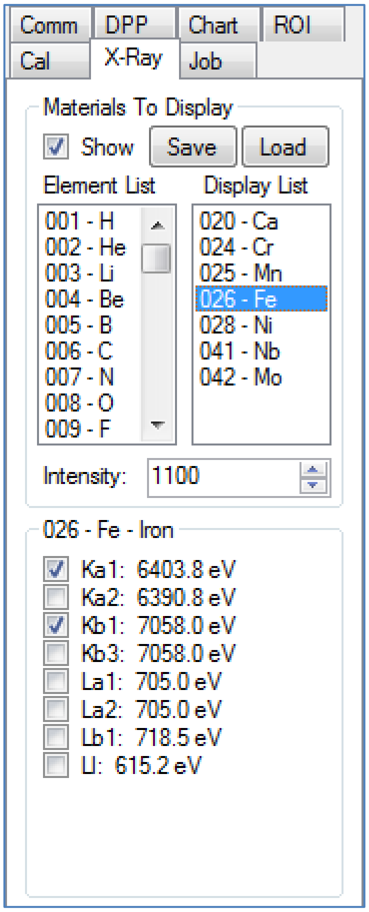
$$y = mx + b$$

Where:

y = Energy
x = Channel
m = eV Per Channel
b = eV Offset

X-ray Tab

The X-ray Tab contains a library of x-ray emission energies and options for displaying them on the spectrum.



Show

When this box is checked, lines indicating x-ray energies will be drawn on the spectrum. When unchecked, those lines will not be visible.

Save

The current x-ray line settings will be saved to file.

Load

Loads previously saved x-ray lines from file.

Element List

Lists of elements from the periodic table. Double-clicking on one of elements adds it to the display list.

Display List

A list of elements that have lines displayed on the spectrum. Double clicking on one of the elements will remove it from the display list.

Intensity

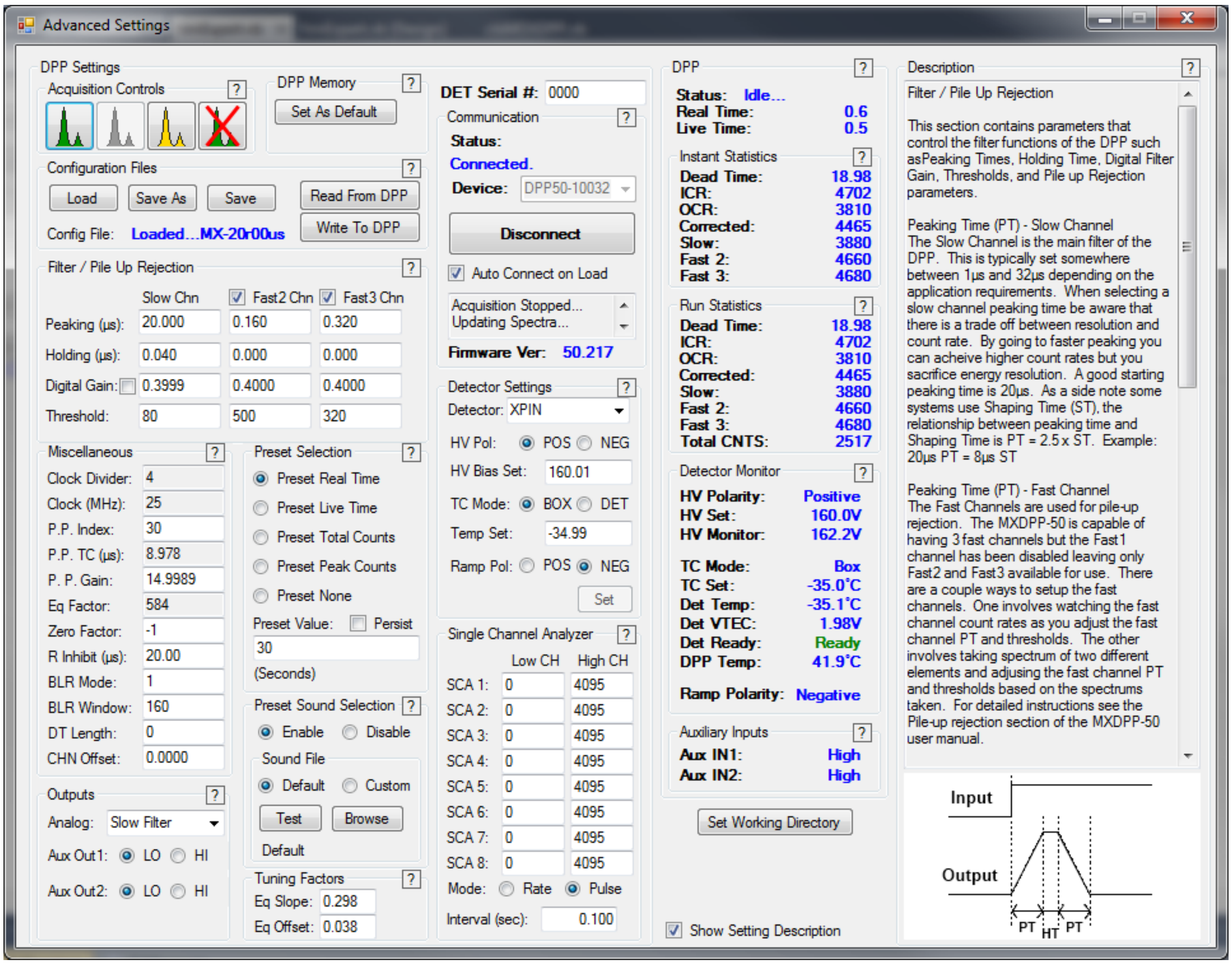
The height of the displayed x-ray lines on the spectrum. When an element in the display list is selected, decreasing the intensity decreases the height of the line on the chart. The intensity is automatically scaled so 1000 corresponds to the height of the tallest peak.

Element Shell List

Selecting an element from the display list will bring up a set of check boxes, which indicate which emission lines are drawn on the spectrum. The lines automatically scale to the heights relative to the strongest emission line from the element. Checking the boxes next to the names of the indicated emission lines will display those specific emission lines on the chart, and unchecking them will remove those lines from the chart.

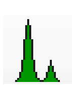
Advanced Settings Window

The Advanced Settings window contains controls for changing the DPP parameters along with some additional controls that are not available in the Main window.



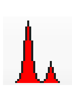
Acquisition Controls

The Acquisition controls in the Advanced window mirror the controls on the Main window.



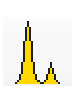
Start Acquisition

Starts acquiring a spectrum.



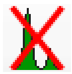
Stop Acquisition

Stops acquiring a spectrum in progress.



Resume Acquisition

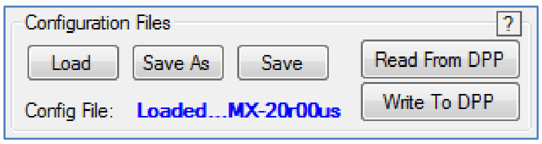
Resumes acquisition of a spectrum that was stopped.

 ***Clear spectrum***

Clears any data that has been collected. If an acquisition is in progress, it will restart it.

Configuration Files

The Configuration Files section contains controls for loading and saving DPP parameters to file. It also contains controls for reading and writing the DPP parameters to and from the DPP.



Load

Loads a previously saved configuration file and populates the DPP parameters into the parameters controls. The parameters are not written to the DPP at this time.

Save As

Saves the current DPP parameters to a new configuration file.

Save

Saves the current DPP parameters to the current configuration file overwriting any parameters already there.

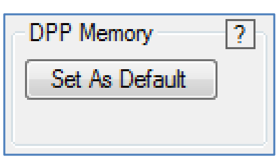
Read From DPP

Reads the DPP parameters from the DPP and populates them in the parameter controls.

Write To DPP

Writes the current DPP parameters to the DPP and reads them back again.

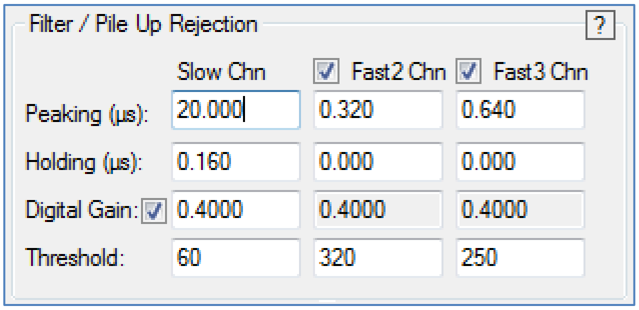
DPP Memory



Clicking the *Set As Default* button will write the current DPP parameters to the DPPs non-volatile EEPROM memory. The parameters that are written to memory will automatically be loaded into the DPPs working memory on boot up when power is applied to the DPP.

Filter / Pile Up Rejection

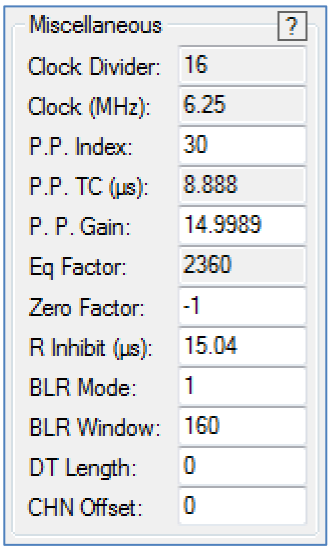
The Filter/Pile Up Rejection section contains controls associated to the DPP Filter parameters and pile up rejection parameters. For detailed descriptions of the Filer and Pile up rejection parameters see the DPP Parameter section of this manual.



The check boxes located next to the Fast2 and Fast3 channels turn on and off the Fast2 and Fast3 filters by setting their associated thresholds to the highest value of 4096.

The check box located next to the Digital Gain locks the Fast2 and Fast3 gains to the same value as the Slow gain.

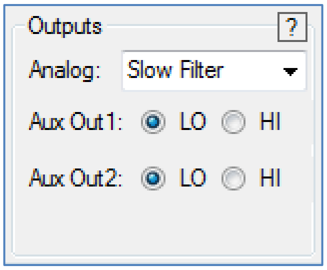
Miscellaneous



The Miscellaneous section contains miscellaneous controls for adjusting the DPP parameters. For detailed descriptions of the miscellaneous parameters see the DPP Parameter section of this manual.

Outputs

The Outputs section contains controls for changing the outputs. The MXDPP-50 has one analog output port and two digital outputs.



Analog

Selects analog output mode.

Slow Filter: Outputs the trapezoidal pulses from Slow filter channel.

Fast2 Filter: Outputs the trapezoidal pulses from the Fast2 filter channel.

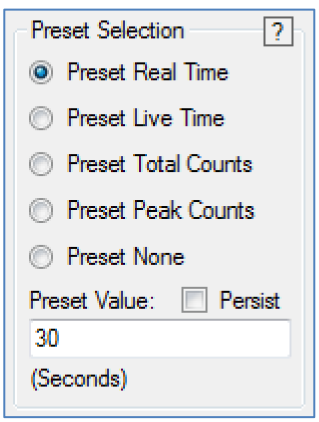
Fast3 Filter: Outputs the trapezoidal pulses from Fast3 filter channel.

Aux Out 1 & 2

Sets the output of the auxiliary 1 or 2 channel to low (0V) or high (5V).

Preset Selection

The Preset Selection mode stops the acquisition at a predetermined state.



Preset Real Time

Stops when the Real Time counter reaches the specified preset value.

Preset Live Time

Stops when the Live Time counter reaches the specified preset value.

Preset Total Counts

Stops when the Total Counts register reaches the specified preset value.

Preset Peak Counts

Stops when the Peak Count register reaches the specified preset value.

Preset None

Sets all presets to their maximum value.

Preset Value

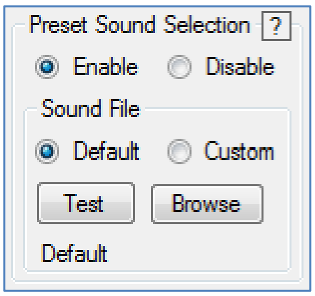
Sets the value at which to stop at for the selected preset mode.

Persist

When this is checked the preset settings will not be overwritten by preset settings loaded from a configuration file.

Preset Sound Selection

The Preset Sound is a sound that is played through the computer speakers to indicate that the acquisition has reached the selected preset.



Enable

Enables the sound to play when the preset condition is met.

Disable

Prevents the sound from playing when the preset condition is met.

Default

Plays the default windows beep sound.

Custom

Plays a user defined sound file.

Test

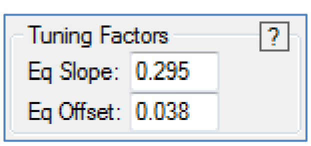
Test plays the preset sound.

Browse

Allows the user to browse and select the custom sound file to use as the preset sound selection. Only WAV and MP3 files can be used.

Tuning Factors

The Tuning Factors are tuned at the factory and saved to each DPP. When a connection is made to a DPP, these numbers are automatically acquired. Due to tolerance difference in electronic components each individual DPP must be tuned to compensate for electronic part tolerances. The Tuning Factors are used to calculate the Preprocessor Time Constant and the Equalization Factor.



Eq Slope

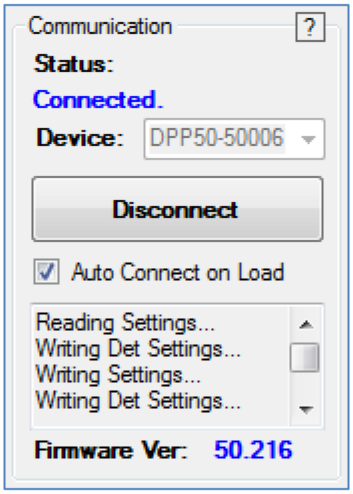
The Equalizer Slope is used to calculate the Preprocessor Time Constant and the Equalization Factor.

Eq Offset

The Equalizer Offset is used to calculate the Preprocessor Time Constant and the Equalization Factor.

Communication

The Communication section in the Advanced Settings window is a clone of the Comm tab on the Main Window.



Status

Shows the status of the DPP communication.

Connected: The software has successfully connected to the DPP.

Not Connected: The software has not connected to the DPP.

Connect Error: There was an error in connecting to the DPP (More information will be displayed in the Comm History Log)

Device

A dropdown menu that automatically populates with a list of all available MXDPP-50s connected to the computer.

Connect/Disconnect

Connects or Disconnects from the DPP.

Auto Connect on Load

When this box is checked, the software automatically attempts to connect to the DPP with the serial number indicated in the “Device” dropdown menu on startup.

Communication History Log

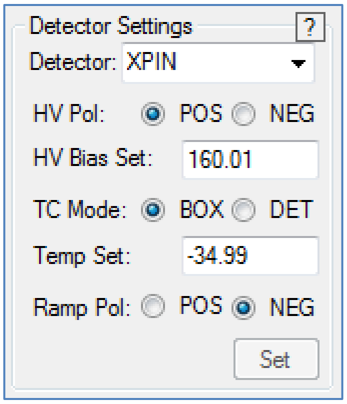
Displays a history of the some of the communication activity to and from the DPP.

Firmware Ver

Displays current firmware version loaded onto the DPP (Currently there is no way for the user to update the firmware. Firmware updates can only be performed at the factory.)

Detector Settings

The detector settings section sets the various detector and temperature controller settings.



Detector

Drop down list to select and write pre-configured Moxtek detector types to the DPP

HV Pol

Selects the polarity of high voltage bias supply.

HV Bias Set

Sets the high voltage bias supply set point voltage.

TC Mode

Selects the temperature controller mode.

Temp Set

Sets the temperature controller temperature set point.

Ramp Pol

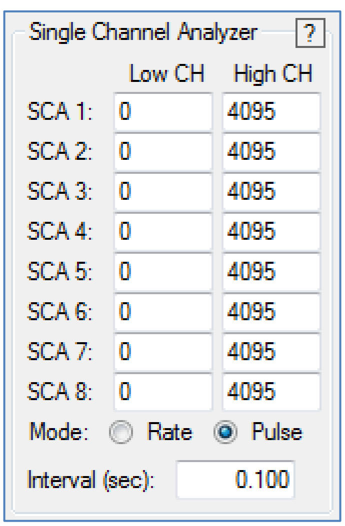
Selects the polarity of the detector input ramp signal.

Set

Writes the select detector settings to the DPP.

Single Channel Analyzer

The Single Channel Analyzer (SCA) section sets the window for each of the SCA channels along with the mode of operation.



SCA 1 to 8

Sets the low and high channel of the SCA window for each of the eight SCA channels.

Mode

Selects the output mode of the SCA.

Rate Mode: The SCA output is a series of pulses with a frequency that is equivalent to the count rate within the limits set for the SCA channel.

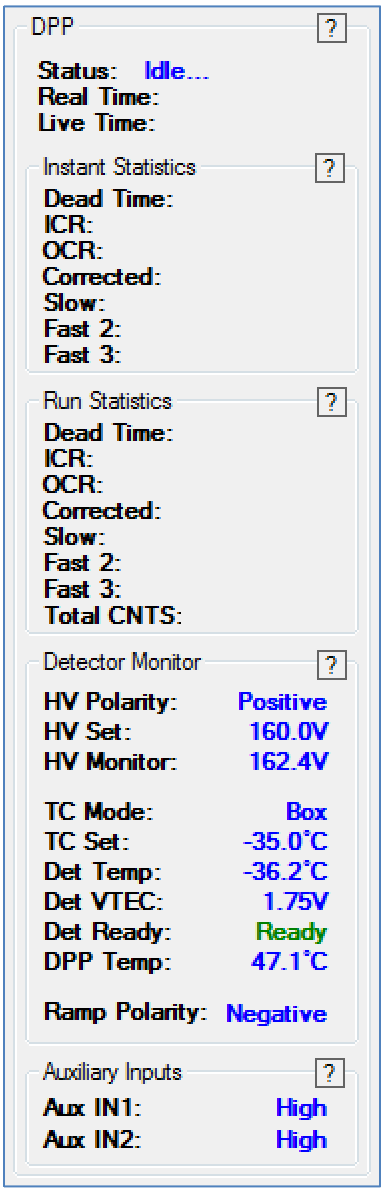
Pulse Mode: For each event within the limits set for the SCA channel the SCA outputs a single pulse.

Interval

Sets the calculation interval for the SCA Rate mode. Also sets the calculation of the instantaneous statistics.

DPP Statistics/Monitor

Displays the acquisition statistics along with the detector monitor values and the Auxiliary inputs.



Instant Statistics

The instantaneous statistics from the DPP are displayed. The rate at which statistics are updated depends on the Interval DPP parameter.

Run Statistics

The average statistics over the entire run are displayed.

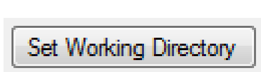
Detector Monitor

Displays the monitor values for the detector settings.

Auxiliary Inputs

Displays the current state of the Auxiliary inputs.

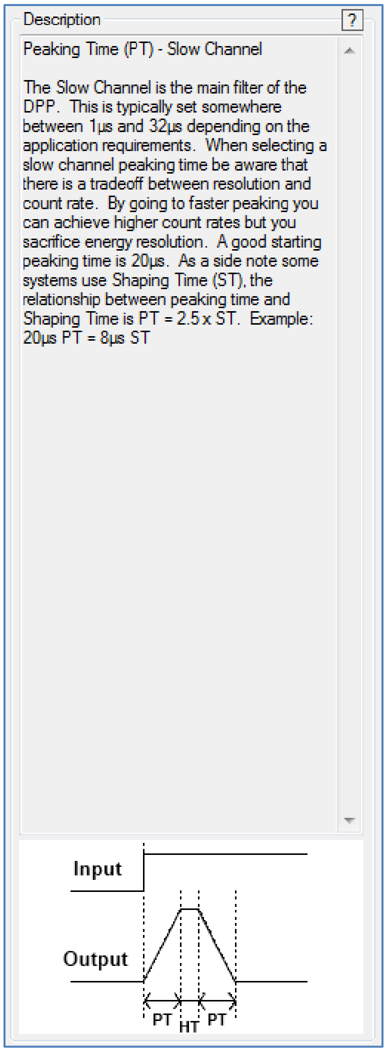
Working Directory

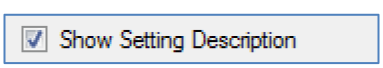


Changes the X-SpectrumDX working directory.

Setting Descriptions

The Setting Descriptions section shows a brief description of each of the DPP parameters/controls when each of them are selected.





Show Setting Description

When checked this window is expanded to show the help descriptions. When each of the controls on this form are selected a brief description of the control/parameter is displayed on the right side of the window. When unchecked the window is shrunk to take up less screen space.

Section Help Boxes ?

Displays a description of the section and the controls within each section when clicked.

Software Development Kit

The X-SpectrumDX program comes with a Software Development Kit (SDK) which enables the user to integrate the MXDPP-50 DPP into their own software for custom applications.

The SDK is located in the X-SpectrumDX working directory under the Reference folder

C:\X-SpectrumDX\Reference\SDK

The SDK contains the following

- MXDPP-50 Digital Pulse Processor (DPP) Programmers Reference Manual (DET-MAN-1002).pdf
- Fully Documented Example Code
  - Visual Studio 2010 – Visual Basic
  - LabVIEW

DPP Parameter Specifications

Peaking Times

The Slow Channel is the main filter of the DPP. This is typically set somewhere between 1µs and 32µs depending on the application requirements. When selecting a slow channel peaking time be aware that there is a tradeoff between resolution and count rate. By going to faster peaking you can achieve higher count rates but you sacrifice energy resolution. A good starting peaking time for a Si-PIN detector is 20µs. A good starting peaking time for an SDD detector is 4µs. As a side note some systems use Shaping Time (ST), the relationship between peaking time and Shaping Time is approximately PT = 2.5 x ST.

Example:

20µs PT = 8µs ST

The Fast Channels are used for pile-up rejection. The MXDPP-50 is capable of having 3 fast channels but the Fast1 channel has been disabled leaving only Fast2 and Fast3 available for use. There are a couple ways to setup the fast channels. One involves watching the fast channel count rates as you adjust the fast channel PT and thresholds. The other involves taking spectrum of two different elements and adjusting the fast channel PT and thresholds based on the spectrums taken. To work properly the Fast2 and Fast3 peaking times must be faster than the Slow Channel peaking time.

A good rule of thumb for setting the fast channel peaking time is to select the fastest possible for Fast2 (this will vary depending on the current clock speed) and set the Fast3 peaking time so that you have good peak separation for the element you are interested in. For example for Al-Ka, choose a Fast3 PT that is good to separate Al-Ka and the electric noise at 0keV. Since the slow and fast channels have the same logics, you can enter the parameters for a fast channel temporarily in the slow channel parameters in order to observe the spectrum.

Holding Times

For the Slow channel holding time you want to make sure you have at least one processor clock cycle (t_S) during the flat top to eliminate the effect of changing interval from the time of the x-ray event to the next digital sampling as illustrated in the figure below.

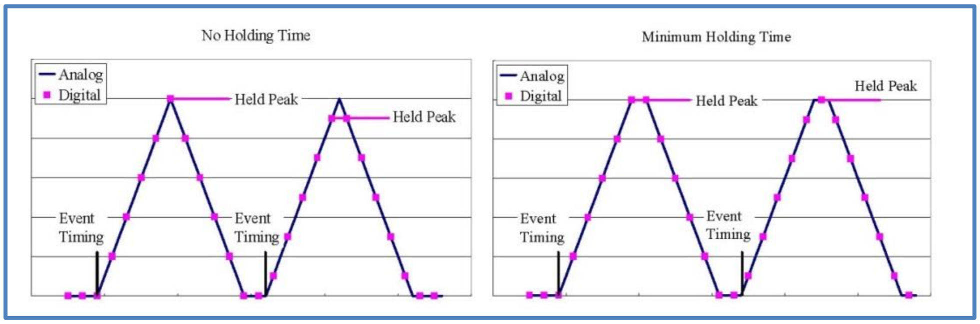
Equation 1 – Sample Speed

$$t_S = \frac{1}{Clock\ Speed}$$

For example the minimum holding time interval for a 25MHz clock is 40ns.

The Fast channels do not require a holding time since the peak height is never sampled. In most situations set them to 0.

Figure 22 – Effect of Holding Time



Digital Gain

The digital gain is the gain after the signal has been digitized. This can be used to adjust the eV/Channel in the spectrum. When choosing a digital gain one thing to consider is "What is the highest energy x-rays you are going to look at?" Make sure your gain is low enough to still see the highest energy x-rays on the Spectrum. Typically the Slow and Fast channel gains are set to the same value. Keep in mind that when changing the digital gains, the thresholds may need to be changed too as they do not scale with the digital gain.

Threshold

The Slow threshold is used to cut off the noise in the low end of the spectrum. The setting is in channels. If you have low end noise taking up 40 channels in the spectrum then you should set the threshold just above the noise at 45 or 50. The fast channel thresholds do the same thing but in the fast channels. You can set the slow channel peaking time to the same as the fast channel (make sure the Slow and Fast gains are the same) to see what the fast channel spectrum would look like and adjust the gain from there. Remember to change the slow channel PT back after setting up the fast channel thresholds.

Figure 23 – Spectrum Without Threshold Set

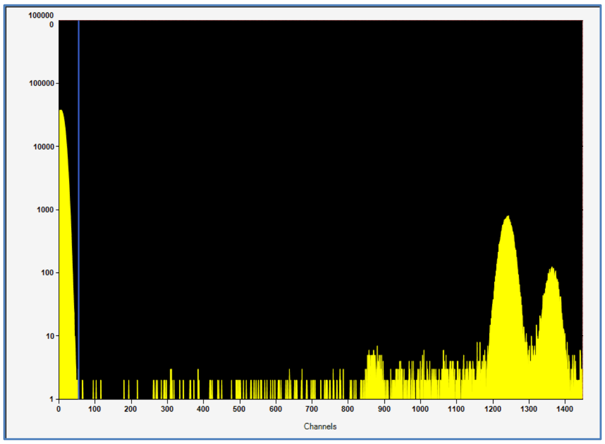
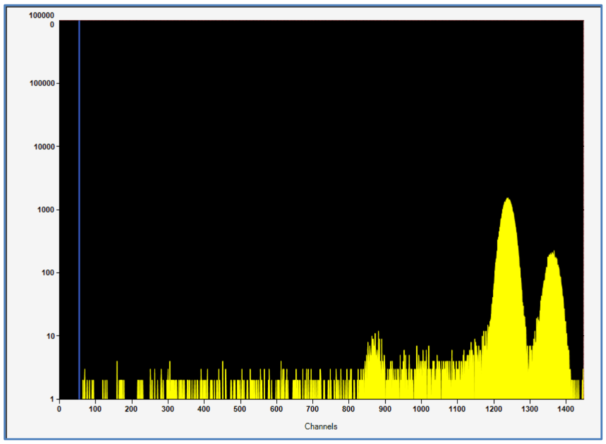


Figure 24 – Spectrum with Threshold Set



Clock Divider and Speed

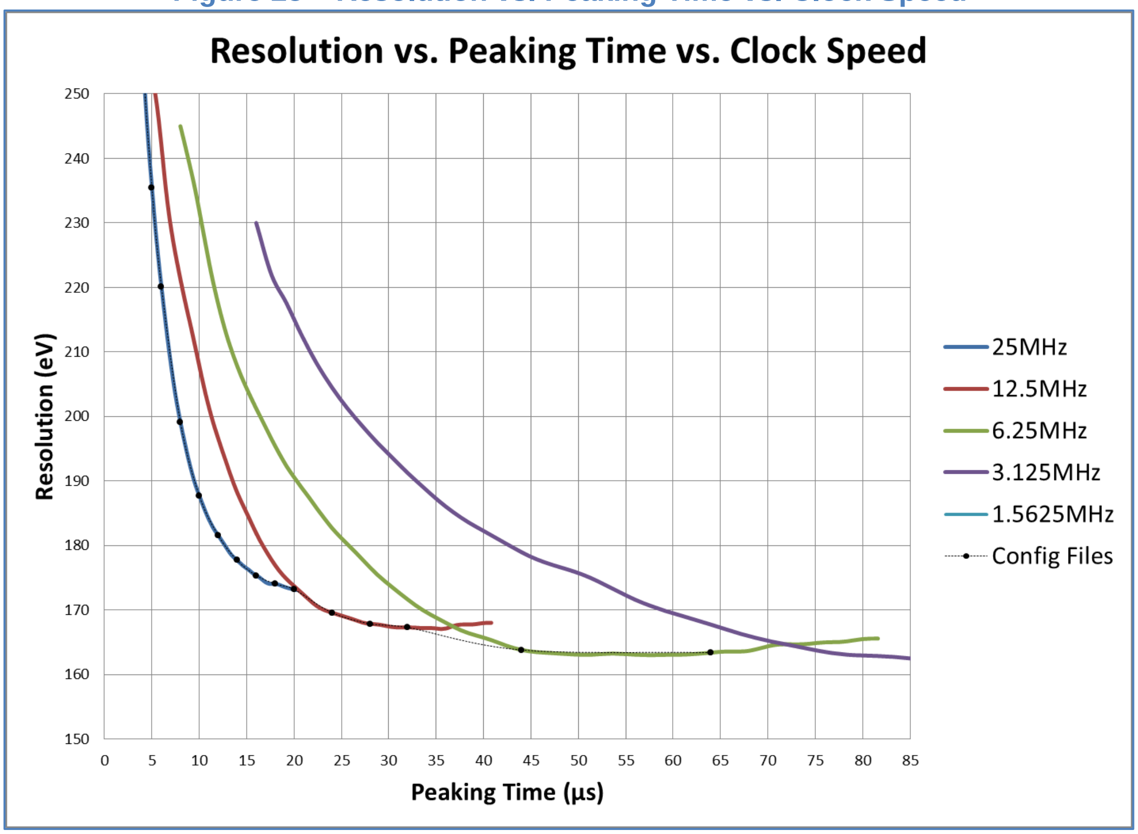
The DPP clock runs at 100MHz but each peaking time settings doesn't need to run at the full clock speed. Instead the DPP divides the clock and runs it at a slower frequency for the selected peaking time. The following table shows the recommended clock speed for each peaking time range.

Table 1 – Clock Divider, Speed, and Peaking Time Range

Clock Divider	Clock Speed (MHz)	Peaking Time Range (µs)
4	25	0.08 – 20.00
8	12.5	20.08 – 40.00
16	6.25	40.16 – 80.00
32	3.125	80.32 – 160.00
64	1.5625	160.64 – 327.04

For each clock speed there are 511 slow peaking times that the DPP is capable of running at. Each clock speed has its own resolution vs. peaking time curve due to sampling rates. The X-SpectrumDX software automatically selects the optimal clock speed for the desired peaking time based on the table above. The chart below shows an example of each of the resolution vs. peaking time curves along with the curve created using the X-SpectrumDX default configuration files.

Figure 25 – Resolution vs. Peaking Time vs. Clock Speed



Preprocessor Index

The Preprocessor Index is used to calculate the decay time of the preprocessor. For slow channel peaking times < 2.56 see the table below, above 2.56 use *1.5 x Slow Peaking Time* to determine the setting for the Preprocessor Index.

Table 2 – Preprocessor Index Table

Slow PT (µs)	P.P. Index (T)	Preprocessor Time Constant (τ)
0.08 – 0.12	0	0.036
0 .16 – 0.80	1	0.320
0.84 – 1.64	2	0.604
1.68 – 2.52	3	0.888
> 2.56	T Formula	τ Formula

Equation 2 – Preprocessor Index

$$T = \mathrm{PT} \times 1.5$$

Where:

PT = Slow Peaking Time

Preprocessor Time Constant

The preprocessor converts the step-like ramp output from the detector to a train of exponential decay pulses. The preprocessor time constant (τ) is the decay time of the differentiator filter used in the preprocessor. Use the following formula to calculate τ for the given Preprocessor Index. The EQ slope and EQ offset vary from DPP to DPP and are tuned at the factory.

Equation 3 – Preprocessor Time Constant

$$\tau = T \times m + b$$

Where:

T = *Preprocessor Index*
m = *EQ slope*
b = *EQ offset*

Preprocessor Gain

The Preprocessor Gain is the analog gain before the signal is digitized. Fine gain adjustments should be done with the Digital Gain. A typical value for Moxtek XPIN-XT detectors is 50 and for Moxtek XPIN-BT detectors are 15.

Equalization Factor

The Equalization Factor is used to factor out the error caused from tolerances of the Resistor and Capacitors in the preprocessor. Variances in the preprocessor electronic components can cause undershoots and overshoots in the slow and fast channels. These errors can cause peak broadening and/or peak shifting in the spectrum. The EQ Factor is calculated using the Equalization Factor formula below.

Equation 4 – Equalization Factor

$$E = \frac{t_S}{\tau} \times 2^{17}$$

Where:

t_S = *Sampling Speed*
τ = *Preprocessor Time Constant*

Zero Factor

The Zero Factor sets the zero input level of the A/D converter input. The optimum value gives the same position of the peaks in cases of baseline restorer on and off. Automatic adjustment is done if Zero Factor is -1.

Reset Inhibit Length

The Reset Inhibit Length tells the DPP the time to wait after each Reset event before starting to collect data. The longer the parameter is the quality of the spectrum is better but throughput is worse. The optimum value depends on the peaking time with longer peaking times requiring more time to recover after the reset event.

Base Line Restore Mode

The Base Line Restorer Mode turns on and off the baseline restorer. For normal operation leave it ON (1).

Base Line Restore Window

The Base Line Restore window changes the width of the amplitude for the baseline integrations. A good starting value is 20 but could be as high as 160. If the number is unnecessarily large then larger peak shift at high count rates could occur.

Dead Time Length

The Dead Time Length changes the length of the dead-time for each event. If everything including detector, preamplifier, and the signal processing is ideal, it can be 1. However in many cases after processing high energy event, undershoot or overshoot of the filter output produces ghost signal in low energy region. For spectroscopic applications such as XRF it is recommended to set to 1 which means DL = 1.5 x PT. For monochromatic applications then set DT Length to 0 which means DL = 1 x PT.

Channel Offset

The Channel Offset command adjusts small offset in the relationship between channel and the energy. Default value is 0.

Preset Selections

The Presets are conditions that must be met before the DPP automatically stops an acquisition. There are four Preset conditions available in the MXDPP-50.

Real Time – Stops when the Real Time counter reaches the specified preset value. Real time is like a stop watch, it counts how many seconds the acquisition has been active. The maximum Real Time setting is 4,294,967,295.

Live Time – Stops when the Live Time counter reaches the specified preset value. Live time clock is always longer than the Real Time clock due to Dead Time in the processing of the signal. While one x-ray event is processing the DPP is unavailable to process additional events until that event is complete. The Live Time Clock is stopped while the DPP is processing each event and resumes in-between events. The maximum Live Time setting is 4,294,967,295.

Total Counts – Stops when the Total Counts register reaches the specified preset value. The counts in each channel/bin in the DPP are added together and the sum is put into the Total Count register. The maximum Total Counts setting is 4,294,967,295.

Peak Counts – Stops when the Peak Count register reaches the specified preset value. The number of counts in the highest peak in the spectrum is put into the Peak Count register. The maximum Peak Counts setting is 4,294,967,295.

To have the acquisition run without one of the presets set all presets to their maximum value.

Detector Settings

The MXDPP-50 detector settings are programmable through the software interface. This makes the MXDPP-50 versatile enough to work with all Moxtek detectors without jumper settings. The high voltage supply, temperature controller, and the ramp polarity are all programmable from the software.

High Voltage Polarity

The High Voltage Polarity selects whether the high voltage supply outputs a Positive or Negative voltage. Typically Si-PIN diode detectors have a Positive high voltage polarity and SDD detectors have a Negative high voltage polarity. There is a relay on the output of the high voltage power supply that switches the output from positive to negative.

High Voltage Bias Set Point

The high voltage bias supply is controlled from a 0 - 2.5V signal. When setting the High Voltage Bias Set Point the DPP outputs a voltage to the bias supply using a Digital to Analog Converter (DAC).

Equation 5 – High Voltage Bias Set Point

$$HV = V_S \times 100$$

Where:

V_S = *Voltage Set Point*

Temperature Controller Mode

The temperature controller on the DPP has two modes of operation, Box and Detector. The mode of operation indicates where the temperature controlling takes place; Box for inside the DPP box or card stack and Detector for inside the detector. There are a few relays on the DPP that open or close based on the Temperature Controller Mode.

Temperature Controller Set Point

The temperature set point tells the temperature controller what temperature to drive the detector to. This is only available when the temperature controller is set to BOX mode and the detector does not have a built in temperature controller. Typical operating range is -25°C to -45°C. Typically the colder the detector is the better resolution performance it will have. If the detector is in a hot environment without adequate heat sinking then the detector may not be able to get to the cold temperatures.

The DPP sends a voltage to the temperature controller that represents the desired set point temperature. The voltage can range from 0 to 5V.

Equation 6 – Temperature to Thermistor Resistance (Inverse Steinhart-Hart equation)

$$R_T = \exp\left(\sqrt[3]{\sqrt{\left(\frac{B}{3C}\right)^3 + \left(\frac{A - \frac{1}{T}}{2C}\right)^2} - \left(\frac{A - \frac{1}{T}}{2C}\right)} - \sqrt[3]{\sqrt{\left(\frac{B}{3C}\right)^3 + \left(\frac{A - \frac{1}{T}}{2C}\right)^2} + \left(\frac{A - \frac{1}{T}}{2C}\right)}\right)$$

Where:

T = *Temperature °C*
A = *0.0018590668*
B = *0.0002367000*
C = *0.0000007811*

Equation 7 – Thermistor Resistance to Set Point Voltage

$$V_T = \frac{V_{REF} \times R_T}{R_T + R_P}$$

Where:

R_T = *Thermistor Resistance Ω*
R_P = *Pull-Up Resistor*
V_T = *Temperature Voltage (DET_TEMP)*
V_{REF} = *Voltage Reference*

The reverse of the equations are listed below.

Equation 8 – Set Point Voltage to Thermistor Resistance

$$R_T = \frac{V_T \times R_P}{V_{REF} - V_T}$$

Where:

R_T = *Thermistor Resistance Ω*
R_P = *Pull-Up Resistor*
V_T = *Temperature Voltage (DET_TEMP)*
V_{REF} = *Voltage Reference*

Equation 9 – Thermistor Resistance to Temperature °C (Steinhart-Hart equation)

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

Where:

R_T = *Thermistor Resistance Ω*
A = *0.0018590668*
B = *0.0002367000*
C = *0.0000007811*

Ramp Polarity

The detector ramp polarity can be either Positive going or Negative going. The MXDPP-50 contains a relay that switches the inputs to work with either Positive or Negative detector ramp signals. Typically Si-PIN diode detectors have Negative ramps and SDDs have Positive ramps.

Figure 26 – Example of Negative Ramp

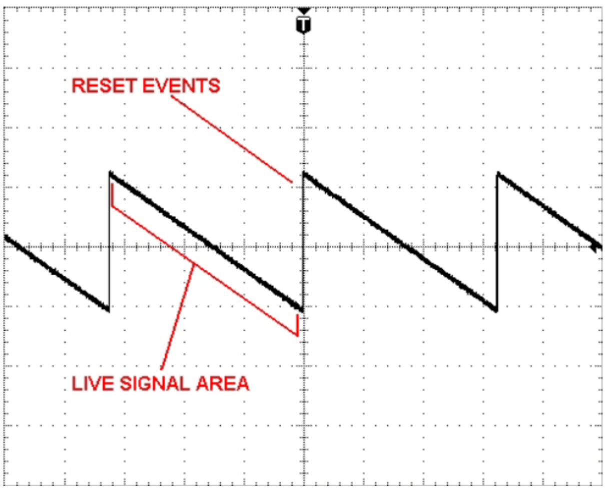
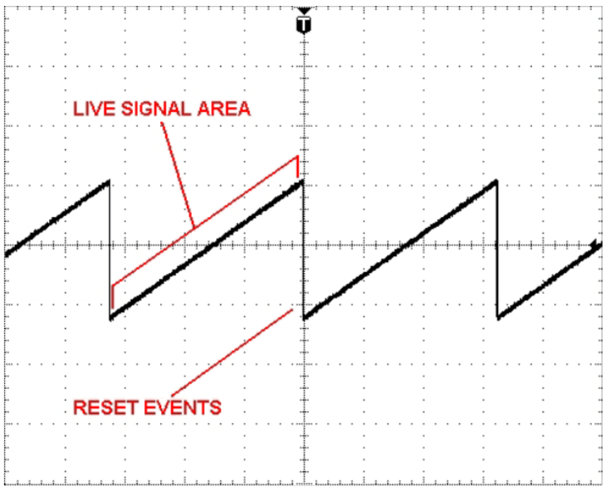


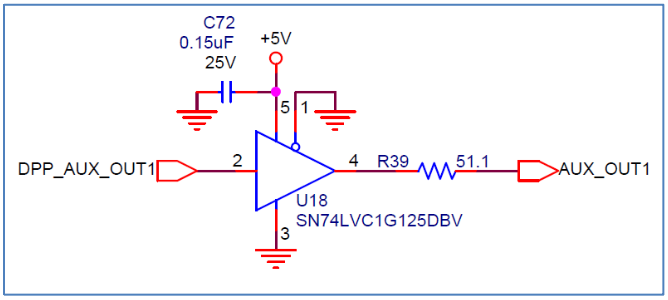
Figure 27 – Example of Positive Ramp



Auxiliary Outputs

The Auxiliary outputs can be used to drive various things such as indicator lights or relays. Each output is driven by its own Texas Instrument SN74LVC1G125DBV chip. Each output can drive up to 32mA.

Figure 28 – Auxiliary Out Drive Circuit



Auxiliary Inputs

The Auxiliary inputs can be used to monitor various external logic signals. The auxiliary input has a 10KΩ input resistor connected to a Texas Instrument SN74LVC245APWR chip.

Reference

Ordering Information

Moxtek Part Number	Kit Description	Kit Contents
DET00130	MXDPP-50 Box Kit *(Contains everything needed to run the MXDPP-50 except the detector)*	MXDPP-50 Box MXDPP-50 Software and Cable Kit **Includes bonus x-ray Slide Ruler* BT Detector Cable Kit
DET00131-XT	MXDPP-50 OEM-XT Card Stack	MXDPP-50 OEM-XT Card Stack
DET00131-BT	MXDPP-50 OEM-BT Card Stack	MXDPP-50 OEM-BT Card Stack
ASM00661	MXDPP-50 Software and Cable Kit	X-SpectrumDX Software CD +5V Power Supply Adapter USB Cable *Bonus x-ray Slide Ruler*
ASM00662	BT Detector Cable Kit	BT Detector Power Cable (LEMO) BT Detector Signal Cable (BNC)
ASM00663	XT Detector Cable	XT Detector Cable (FFC) 100mm

Note: The detector is sold separately.

Contact Information

Please contact Moxtek for price and delivery information (801) 225-0930 or request a quote at www.moxtek.com.

Warranty

Refer to Moxtek's standard warranty. Contact Moxtek for details.

Revision History

Rev	DCN #	Author	Date	Description of Change
A	2012-2507	C Carter, J Van Wagoner, T Zeal	09/06/2013	Initial release