Instruments That Advance The Art

µDXP

microDXP

Low Power Digital Spectrometer For Portable Applications

OVERVIEW

The XIA µDXP card is a complete, low power digital spectrometer the size of a credit card. It includes both spectroscopy amplifier and MCA functions and is intended for both handheld and embedded table-top applications. Digital filtering is shared between a field programmable gate array (FPGA) and a digital signal processor (DSP) that also provides MCA functions. RS232 serial communication is via a PIC processor. Additional µDXP I/O paths include: a direct connection to a high speed synchronous serial port on the DSP; an optional 16-bit wide high throughput parallel bus; and several general-purpose digital I/O lines, including I^2C capability, through which the µDXP can control external instrumentation. All operating firmware is stored in non-volatile memory and is factory preloaded but can also be upgraded in the field. To minimize OEM costs, many card features are optional: only those that are actually required for an application need be purchased. XIA would be pleased to discuss developing custom µDXP spectroscopy, process or control code on an NRE basis.

POSSIBLE APPLICATIONS

While developed for x-ray applications, the µDXP's design is flexible enough to address other applications with appropriate firmware modifications. Please call XIA to discuss the details.

X-ray spectroscopy: The µDXP is well suited to handheld, table-top, and embedded process control applications.

Gamma-ray spectroscopy: Combining the µDXP's high quality ADC, 8K spectrum, and XIA's proprietary ballistic deficit correction firmware results in a high quality gamma-ray spectrometer for portable or dedicated applications.

Array detectors: The low cost µDXP offers an economic approach to providing full spectroscopic support for arrays of detectors, including those where coincidence timing information is important.

Scintillation detectors: The µDXP supports both direct and preamplifier connection to scintillator/photodiode and scintillator/photomultiplier combinations.

Neutron/gamma discrimination: using firmware migrated from our high performance Polaris spectrometer, the µDXP can implement particle ID with CsI or other detectors.

DEVELOPMENT KIT

The µDXP RS232 development kit is available to get spectrometry applications up and running quickly. All communications cabling, power supply and a micro-COM interface motherboard are included.

ACTUAL SIZE

GENERAL SPECIFICATIONS

DETECTORS / PREAMPLIFIERS SUPPORTED

Preamplifiers: the µDXP supports both reset and feedback preamplifiers of almost any gain, of either polarity, and up to ±5V voltage range or even higher on request.

Solid state detectors: Si(Li), HPGe, PIN diode, SDD (Silicon Drift Detector), and CdTe are readily supported.

Other detectors: as a general purpose spectrometer, the µDXP can also be adapted to such diverse detectors as proportional counters and scintillator/photomultiplier tube combinations, as well as to CZT, surface barrier, and liquid Xenon detectors where pulse shape processing can significantly enhance results.

POWER CONSUMPTION

Power consumption depends upon both the clock speed and on what other options are selected. The table below shows basic design values. Various sleep modes with sub-second wake up times are available, controlled by the µDXP or its host.

Mode	Digitizing Rate	Power	Max. Throughput
Standard	8 MSPS	525 mW	>100 kcps
Fast	16 MSPS	575 mW	>200 kcps

A fixed gain version is available for a further power savings of 125 mW.

POWER REQUIREMENTS

Digital: +3.3V, 300 mA peak, 150 mA steady

Analog: There are two voltage supply options:

Option 1:±5.0V, 50 mA each, clean, regulated voltages.

Option 2:>±5.25V, 50 mA each, to supply ±5V on board linear regulators. This option allows a deep sleep mode (<50 mW) under µDXP control by shutting down the regulators.

COMMUNICATIONS

Primary: RS232 (serial port) at 115 kBaud (10 Kbytes/sec – 300 ms to transfer a 1K spectrum at 3 bytes per channel). Slower rates on request. A PIC microcontroller handles RS232 communications, and offers a simple command interface.

Secondary: 1) a DSP serial port connection provides high-speed synchronous serial communication (up to 16 Mbps).

2) An optional 16-bit wide parallel connection is available, offering peak throughputs of up to 10 MB/sec.

Auxiliary I/O: the µDXP has 4 general-purpose I/O lines to communicate with the FPGA and an input gate to indicate valid data taking conditions. Three additional lines connect to the PIC microcontroller: two are configured as an industry standard I^2C interface that allows the µDXP to control off-board peripherals; the third line can be used to interrupt the PIC controller, or for general purpose I/O.

FIRMWARE

All firmware is stored in onboard non-volatile memory and normally ships with the part; no downloads from the host are needed. New configurations or upgrades can be downloaded in the field without removing parts from the board – the DSP and FPGA firmware through the serial port, while other parts need special tools for reconfiguration.

SPECTROMETER SPECIFICATIONS

OVERVIEW

The spectrometer is implemented using an analog signal conditioning section, an ADC, an FPGA and a DSP. The FPGA runs firmware ("Decimation N FiPPI") that first decimates the input signal by producing sums of 2^N consecutive samples and then operates on them using a set of digital filter functions (called a "FiPPI" for *Fi*lter *P*eak and *P*ileup *I*nspection), including a fast channel x-ray detection filter, a slower shaping energy filter, peak capture, pileup inspection, and baseline correction. These functions operate at the ADC sampling speed. Values captured in the FiPPI are passed to the DSP which builds a spectrum and performs various secondary functions to improve energy resolution. In adapting the µDXP to a specific application, the following quantities can be specified: analog gain, ADC/FiPPI clock speed, peaking times, and MCA functions.

GAIN

Two analog gain options are available:

Option 1: Variable gain, using a variable gain op-amp that is set from the host via a 16-bit DAC.

Option 2: Hard-wired gain is factory set to match a selected detector design using precision, Low TempCo resistors. Power consumption is reduced by 125 mW compared to the specifications given in the table above (for the variable gain version.)

CLOCK SPEED

The µDXP's primary speed characteristic and its basic power consumption are set by the digitizing rate of the ADC. The standard digitizing rate is 8 MHz; a 16 MHz version is available for higher rate processing. Higher rates are possible, consult XIA.

PEAKING TIMES

The five standard Decimation N FiPPIs (N = 0, 1, 2, 3, 4) combine with the two available clock speeds (8 & 16 MHz) to create 10 peaking time ranges with values from 0.375 µs to 48 µs. Each peaking time range is a set of 5 peaking times whose values have the ratios 1, 1.5, 2, 3, and 4 relative to the first or "base" value. For example, a base value of 6 µs results in a range of 6, 9, 12, 18, and 24 µs. The 10 base values are shown in the table below. Only six values are unique.

The shortest peaking time range on the µDXP card is for N = 0 and 16 MHz, and has the values 0.375, 0.563, 0.750, 1.125, and 1.500 µs. The longest range is for N = 4 and 8 MHz, and has the values 12, 18, 24, 36, and 48 µs. Non-standard Decimation N values are not difficult for XIA to create on an NRE basis for special applications. Two peaking time options are available:

Clock Rate	N=0	N=1	N=2	N=3	N=4
8 MHz	0.75	1.5	3.0	6.0	12
16 MHz	0.375	0.75	1.5	3.0	6.0

Base peaking time(µs) versus clock rate and decimation

Standard Peaking Time Option: The µDXP card comes with a single preloaded Decimation N FiPPI, where N may range from 0 to 4, giving base peaking times shown in the table above. Using the µDXP development kit, an alternate FiPPI can be loaded to give a different peaking time range (with this option, only one FiPPI can be loaded at a time.)

Enhanced Peaking Time Option: The DXP card comes with three preloaded Decimation N FiPPI's, where the N values are typically 0, 2, and 4. A desired FiPPI may be selected by the host at any time during operation.

MCA

MCA functions are implemented in the on-card DSP.

Spectrum size: Up to 8K channels, 24 bits deep.

Regions of interest: Using optional firmware, up to 16 ROIs may be defined and their summed counts read out.

Counting time: counting can be for either fixed counting time or fixed live time. The MCA can report total input counts detected, output counts to the spectrum, and spectrometer on-line time so that accurate dead time corrections can be made.

SPECIALIZED FUNCTIONS ON NRE BASIS

A major µDXP capability is its onboard DSP's ability to make spectral calculations in real time and control external equipment based on the results. These functions may be simple (sound an alarm if the ratio of two peaks falls outside of an allowed range); complex (estimate the weight % gold in a sample); high speed (separate copper from ferrous scraps with 25 ms sampling times or output a deadtime-corrected TTL pulse stream representing ROI counts in real time), or power saving (various sleep modes after specific times). XIA will be pleased to quote NRE costs for developing such special purpose µDXP code.

BOARD SIZE

The µDXP measures 2.125 x 3.375 inches (credit card size). Larger sizes or other geometries available on an NRE basis.

XIA LLC
31057 Genstar Rd.
Hayward, CA 94544 USA

510.401.5760 (tel)
510.401.5761 (fax)
www.xia.com
Email inquiries: microDXP@xia.com