PMT-1000

BRIDGEPORT INSTRUMENTS, LLC   **Versatile MCA for PMT**

Plug-on MCA with
High Voltage

This is the Swiss Army Knife equivalent of an MCA. With many built-in functions it assists the user in their varied measurement tasks.

It measures the radioactivity of samples, automatically subtracts the background and reports the accuracy of the measurement.

It can raise an alarm if a sample truly is more radioactive than expected.

It can act like a portal monitor, where it records passing vehicles or persons and raises an alarm if something unusual is found. Of course, it tracks slowly changing radiation backgrounds to avoid false alarms.

For companies developing radiation detection instruments, BPI offers the service to add desired functionality to the embedded MCA software.

For example, for custom applications the MCA can even perform radio-isotope identification.
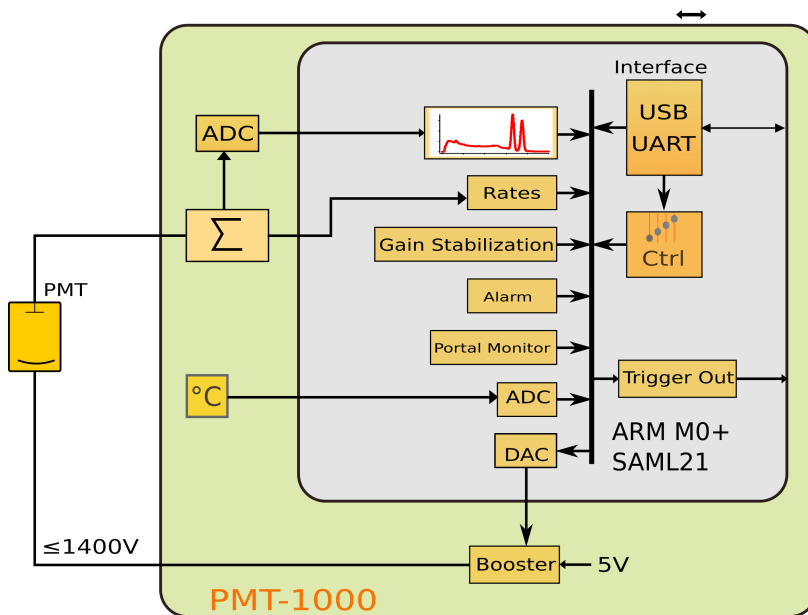
The MCA, the high voltage generator and the high voltage divider are all combined into a single unit with a JEDEC B14A socket. There are model variants for 8 and 10 dynode PMT.

The unit is environmentally sealed and users only need to protect the pins of the PMT against moisture.

The PMT-1000 is ideal for

- NaI and plastic scintillators
- Contamination probes for food, soil, pipes, lumber, etc.
- Portable and stationary portal monitors, backpacks etc.
- Autonomous environmental monitors.
- Industrial applications such as density gauges and devices to measure the fill-level of pipes in chemical plants.

● MCA
- Two-bank MCA; sample vs background
- Two 1K×32 or one 2K×32 MCA
- Digital gain stabilization
- Digital alarm pulse out with adjustable threshold

● Sample counting
- Measure sample and background count rate, with statistical errors
- Compute difference count rate
- Compute probability that sample rate is more than background
- Counting, and alarming, can be restricted to an MCA region of interest.

● Dynamic alarms
- Alarm on a passing source
- Compute alarm 10×/s
- Programmable false alarm rate
- Automatic background tracking

● Ideal for embedded systems:
- Very low power consumption 5V@30mA=150mW
- Automatic gain stabilization and alarming.
- USB or UART serial interface.
- Open-source software
- Including for Raspberry Pi

PMT-1000 Summary

The MCA is shipped with a number of useful built-in functions.

- Simple 1Kx32 or 2Kx32 histogram with count rates and error analysis
- Measuring the radioactivity of samples while subtracting backgrounds and computing alarms.
- Computing alarms 10 times per second for a wearable backpack or a portal monitor
- Maintain a stable MCA gain and trigger threshold as the temperature changes.

This MCA realizes its standard and custom capabilities using 32-bit software implemented on a modern ARM M0+ processor.

Principle of operation
- Embedded ARM 32-bit SoC controls all aspects.
- Low power high voltage generator and divider: internal 3.3V@14mA for HV=1000V
- Fully transistorized high-voltage divider reacts quickly to count rate changes.
- Histograms, counters and all computations are implemented in C-Code.
- Developers may request custom software and functions.

ARM M0+ Functions
- Control the 1400V booster to power the PMT
- Software-controlled gain stabilization via lookup tables of operating voltage vs temperature.
- Selectable gain stabilization on energy deposited within an MCA region of interest.
- Measure count rates and statistical errors
- Compute alarm probabilities
- Compute portal monitor alarming

Histogramming rate
- 150kcps for periodic pulses.
- 6.5µs non-extendable dead time per event

Security
- Embedded software can not be read back.
- Default gain stabilization tables cannot be read back.
- Developer and user can program gain stabilization tables that cannot be read back.

PMT operating voltage

For the user's benefit, BPI provides software to communicate with the MCA via USB or serial port. All software and data formats are completely open-source.

BPI provides client software examples for Linux/Windows, x86, x64 or ARM.

The built-in capabilities are powerful. For example the MCA can autonomously operate a portal monitor or backpack detector. It will track changes of the background radioactivity, and raise an alarm on the fact that the last 4 seconds of measured counts were too much to be caused by background. This can be used to create an incredibly low-cost core component for a sweeper, a backpack or a portal monitor.

- Positive or negative polarity; up to 1400V
- 8 and 10-dynode pinouts

Server-side software
- Device communicates via USB on Windows and Linux; x86/x64 & ARM processors, using libusb0.1
- MCA Data Server encapsulates device operation
- JSON command interface
- TCP/IP communication via robust transport layer using ZeroMQ (zeromq.org).

Client software
- wxWidgets and Matplotlib GUI (wxMCA)
- Example clients in Python communicate with MCA Data Server via ZMQ
- Client can be written in any programming language.
- API in Python
- Hardware simulator for "Try before you buy".

Power supply
- Supply: 3.3V to 5.5V; 5V@30mA for HV=1000V

Environmental
- Operational from -40°C to +60°C

Part numbers
- For R6231/3: PMT-1K-NaI-P81T
- For CR105: PMT-1K-NaI-P10T
- For CR119: PMT-1K-NaI-P80T
- For negative HV: -N80T, -N81T, -N10T
- PMT-1K-PVT; high gain for plastic scint.

PMT-1000 Capabilities

Capability	Description
Analog	The input of the PMT-1000 is DC-coupled to the PMT anode. Input pulses are processed via a track and hold amplifier and measured with a 12-bit ADC. The operating voltage can be adjusted for the desired maximum energy.
Gain stabilization	The PMT-1000 uses either built-in or user-programmable look up tables vs temperature to adjust the PMT operating voltage and digital gain as a function of temperature. Alternatively, the device can stabilize on the average energy deposited in a given region of interest.
Histogram size 2×1K × 32-bit	There are two histogram banks, one for sample counting and one for background counting. Both include 16 entries for statistical data and a 1024 by 32-bit histogram. There is a histo_2k mode in which the two banks are combined into one large bank, providing a 2K × 32-bit histogram.
Counter and histogram	The PMT-1000 can count pulses and acquire histograms in either of two active banks, one for samples to be measured and one for storing a background measurement. The device reports count rates and statistical 2-σ errors. Users can choose to see total counts or counts restricted to one region of interest. In this mode, counting and alarming can be restricted to events falling into a region of interest; eg. bins 580 to 750 of the MCA to capture counts on the 662keV energy of Cs-137 (when the MCA has a gain of 1keV/bin)
Trigger Out	The PMT-1000 has a trigger output with a powerful line driver. It can be programmed to pulse on every detected gamma-ray, or to provide a long pulse for an external light to indicate an alarm. Either way, the pulse width is programmable.
Net Counter	The PMT-1000 reports the difference between sample and background count rate together with the combined statistical 2-σ errors.
Difference histogram	The PMT-1000 can report the sample histogram and counting statistics with the background histogram subtracted. The sample and background histogram can be accumulated for different times.
Analysis	The PMT-1000 reports the probability that the measured sample count rate is compatible with the background count rate. That probability can be computed from the total count rate or from the counts acquired within a region of interest.
RIID Analysis	The PMT-1000 can perform radio-isotope identification. This custom code addition will depend on the detector type and size. Commercial RIID is not export-restricted as it ignores special nuclear materials.
Dynamic alarming	The PMT-1000 can analyze and report count rates in time slices of 100ms, ie at a rate of 10/s. The device automatically tracks slowly changing backgrounds and will alarm on a passing source. Its digital output can be used to drive an audio or visual alarm. Alarms can be computed from the total count rate or from the counts acquired within a region of interest. Alarms are raised on the computed probability that the measured counts over a programmable time period are not compatible with the measured background.
Read-and-clear counting	The PMT-1000 implements a read-and-clear command, in which the microcontroller clears the counters right after copying data to the output buffer – for efficient, nearly loss-less reading of count rates and histograms.
Communication	The PMT-1000 implements a USB-2.0 compatible USB 1.2 interface. A driver using libusb0.1 is available on many platforms and OS: x86/x64/ARM, Win7/10, Linux, Rasbian and others.
Security	Software deployed on the PMT-1000 can not be read back. Gain-stabilization parameters and lookup tables can be protected by the developer against read back by programming a lock bit.
Simulator	The control software includes a hardware simulator, which models most aspects of the PMT-1000. The data acquisition examples also work with the simulator. This feature lets developers see how easy it is to use the PMT-1000 in their application.