MSTD-16

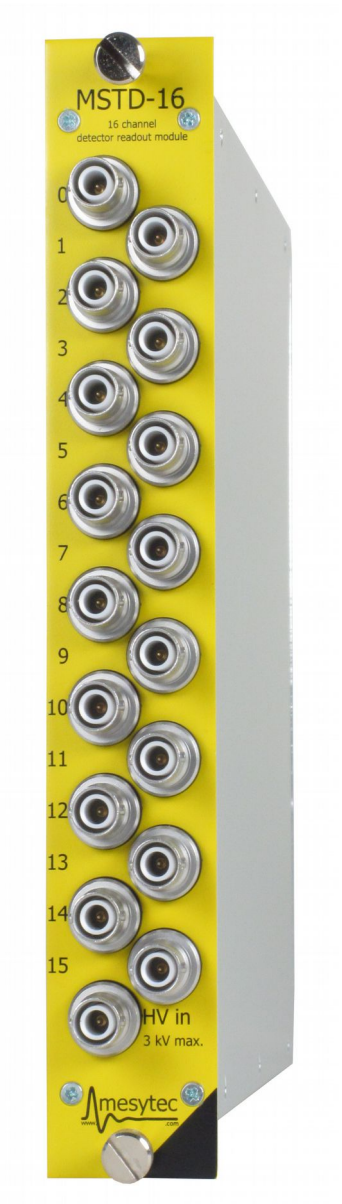
(Data sheet V1.0_01)

Frontend readout module
for standard
neutron detector tubes

MSTD-16 is a frontend module to read out up to 16 standard 3He or BF3 neutron detector tubes. It can be remotely controlled and transmits time stamped amplitude data to the data collector. The high peak rates of modern spectrometers require fast readout electronics allowing to register data at the detector rate limit (about 100 kHz per tube) with lowest possible dead time ratio.

Features:

- **Rate capability:** 100 kHz per tube, 800 kHz continuous per MSTD-16 module with 16 detectors connected. Integrated data buffer for high peak rates
- **Efficiency:** very stable due to clearly settable and stable amplitude thresholds
- **Time stamping** at frontend: 100 ns resolution
- **Bias supply**, filtered up to 3500 V. Also well suited for BF3 filled tubes. Preamp inputs withstand full discharges of up to 2500 V.
- **Detector interfacing:** high voltage coax cables (MSDT-16 frontend connectors: SHV). Cable lengths up to 3 m have only minor effect on noise.
- **Power consumption:** 2.6 W at ±6 V, allows operation in vacuum.
- **Data bus:** Lemo cable. Max 30 m length



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Functional Overview

Readout path
The detector tubes are read out in groups of sixteen which are connected to a single NIM module **MSTD-16**. Each of the modules buffers the amplitude and time stamp data of the 16 connected detector tubes and transmits them over a fast serial bus to a central NIM-module, **MCPD-8** (mesytec central processing device). The event bus is physically a coax wire. The MCPD-8 collects data of up to eight MSTD-16 modules, buffers the data and transmits it via Ethernet to one (or more) data collecting PCs. mesydaq software runs on Linux and handles the incoming data. Data is stored on harddisk and displayed live in histograms.

Transmitted event data
The MSTD-16 modules provide amplitude (with 9 bit resolution) and time stamp (100 ns resolution) data.

Remote control
For controlling the complete system, there is a data path back from the PC via Ethernet and eventbus. It is possible to configure gains, thresholds and pulsers from the PC, make pulser testruns, and store the complete data set in a configuration file which is downloaded to the peripheral modules at the beginning of a new run.

Diagnostics
A built in test pulser, which feeds directly to the detector inputs of the MSTD-16, easily allows to check all the signal path from preamplifier to the PC. The pulser, as all functions, can be remote controlled by software.

Time stamping
The MPSD-8 and MSTD-16 frontend modules use their own time base (100 ns step) to label the incoming events in their buffer. When the events are sent to the MCPD-8 via event bus, the time delay from receiving the event at MSTD-16 input to transmitting it to MCPD-8 via bus is added to the event information. The receiving MCPD-8 adds this time offset to the event time stamp.

Rate capability, dead time
For a perfect readout electronics, the dead time of the system should only be determined by the detector properties. The dead time is about 2.5 us for thin detector tubes.

The MSTD-16 uses two very fast converters to digitize the amplitude of 16 detectors. This converter adds almost no dead time because the analog section can buffer the amplitudes of each of the 16 detectors for up to three conversion times.

An example for a TOF setup with fast detectors (2.5 us dead time): MSTD-16 is receiving an elastic bragg peak on one tube with 100 kHz, the other tubes will have a rate of 10 kHz.

So at the position of the bragg peak, at the moment the elastic neutrons hit the detector (some us) this detector will have a detector induced dead time ratio of 25 % and 0.15 % converter dead time. The other detectors of the same module at the same time will have a detector dead time of 2.5 % and 0.15 % converter dead time.

After the elastic peak, the rate will usually decay by orders of magnitude and the dead times will be negligible. No additional dead time is added through all the processing chain down to the PC.

Input sensitivity (customer specific)
Can be varied by a factor of 4 by remote control
Standard range: $1.2*10^{-13}$ C (gain=1) ± factor of 2

Dark rate @ U_{HV} = 1200 V, no detectors connected, 1 hour of warm up, sensitivity $1.2*10^{-13}$C. f < 1 count / hour per channel.

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Operation in vacuum

Outgasing, safe bias operation

The MSTD-16 can be safely operated under vacuum conditions from 10^{-1} mb to about 10^{-5} mb. The upper limit (measured at 2.0 kV) is due to HV discharge starting at this pressure. The lower limit is due to outgasing of PCB and cables. The virtual leakage from PCB is about $5*10^{-4}$ mb*l/s after 24 hours of pumping.

Heating

The PCB temperature in a vessel with 25 °C is 30 °C over most of the area and max. 40 °C at a single position near the ADC. The measured temperatures allow safe operation in vacuum without special cooling.

Internal building blocks

Preamlifiers

The detector charge signals are amplified by low noise charge sensitive preamplifiers. The preamp gain can be adjusted via remote control to compensate for Detector gain variations.

Pulse Shaping

The signals from the gain adjust stage are filtered by trapezoidal shapers with 1 us FWHM.
The signals runs through a baseline restorer and then to the window discriminator. The digital output of the discriminator is used to actively restore the signal. This is essential at high rates to reduce drift of base line and keep a stable detection threshold.
Then the signals of the tubes are digitized, and a time stamp is added.

Mechanics

MSTD-16 is available as standard NIM module or in a housing for stand alone operation (e.g. mounted directly behind the detector bank).
In any case it comes in a 1/12 NIM size case (164 x 250 x 34 mm³ plus SHV connectors of 20 mm).

MPSD-8+ in a stand alone box with fixture latches. Mechanical properties are identical to MSTD-16.

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