MPD-8

data sheet V1.3

8 channel particle discriminator module for liquid scintillators

mesytec MPD-8 is an eight channel pulse shape discriminator module. MPD-8 is used for particle discrimination in multi channel liquid scintillation detectors (for example BC501 or NE213).
For discriminator monitoring only 2 channels of peak sensing ADCs per scintillator channel are needed. Fast preamps are integrated. The 8 channel unit fits into a single width (1/12) NIM module.

Features:

- Fast PMT input amplifier with 4 gain settings
- Signal filter, optimised for liquid scintillators
- Pulse shape detection unit based on a CFD for rising edge start and zero crossing detector (CFD) for tail length detection
- adjustable CFD trigger threshold.
- PSD (pulse shape detection) output for neutron detection, amplitude independent (1 us peaking time)
- Amplitude output (1 us peaking time, matched to PSD pulse)
- 4 ECL trigger and identification signals per channel
- Variable threshold for neutron - identification.
- Common trigger output, NIM, chainable (also usable as ADC gate).
- Fast mode: deadtime reduced to 250 ns. Trigger output width reduced to 70 ns.
- All parameters can be set via USB or mesytec control bus.

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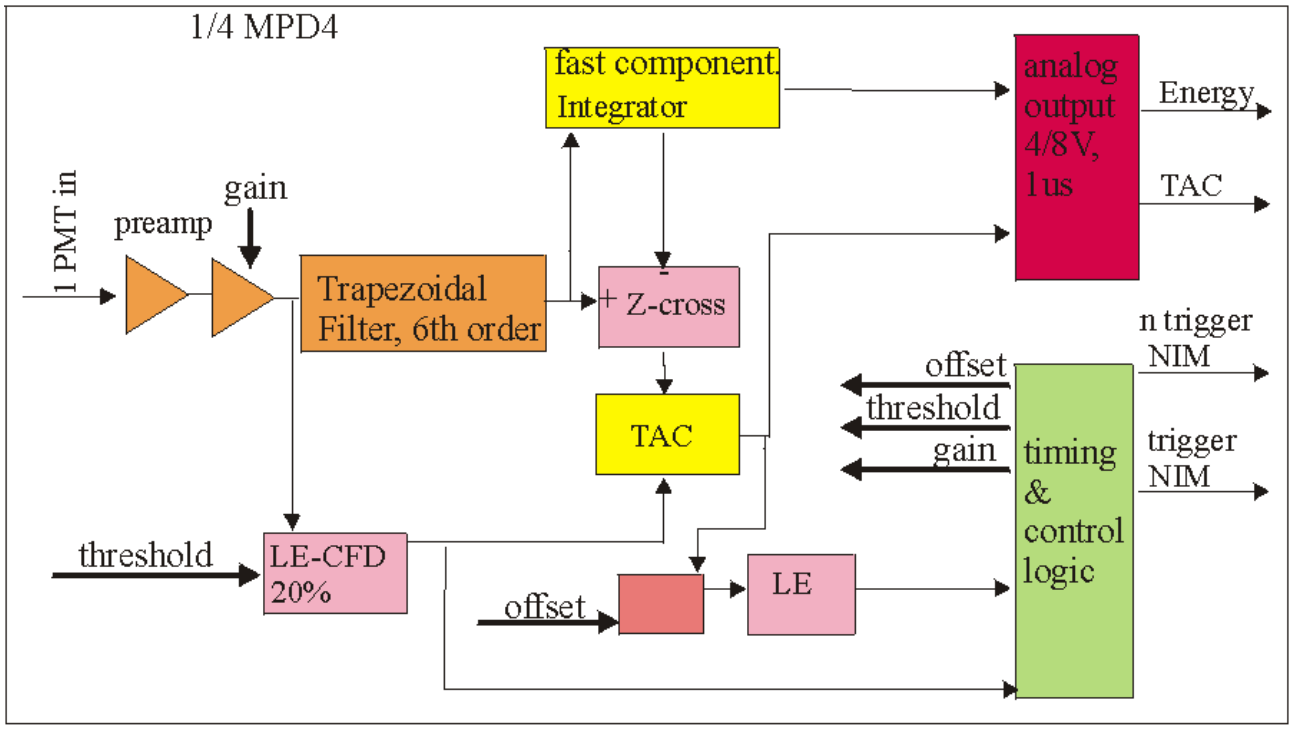
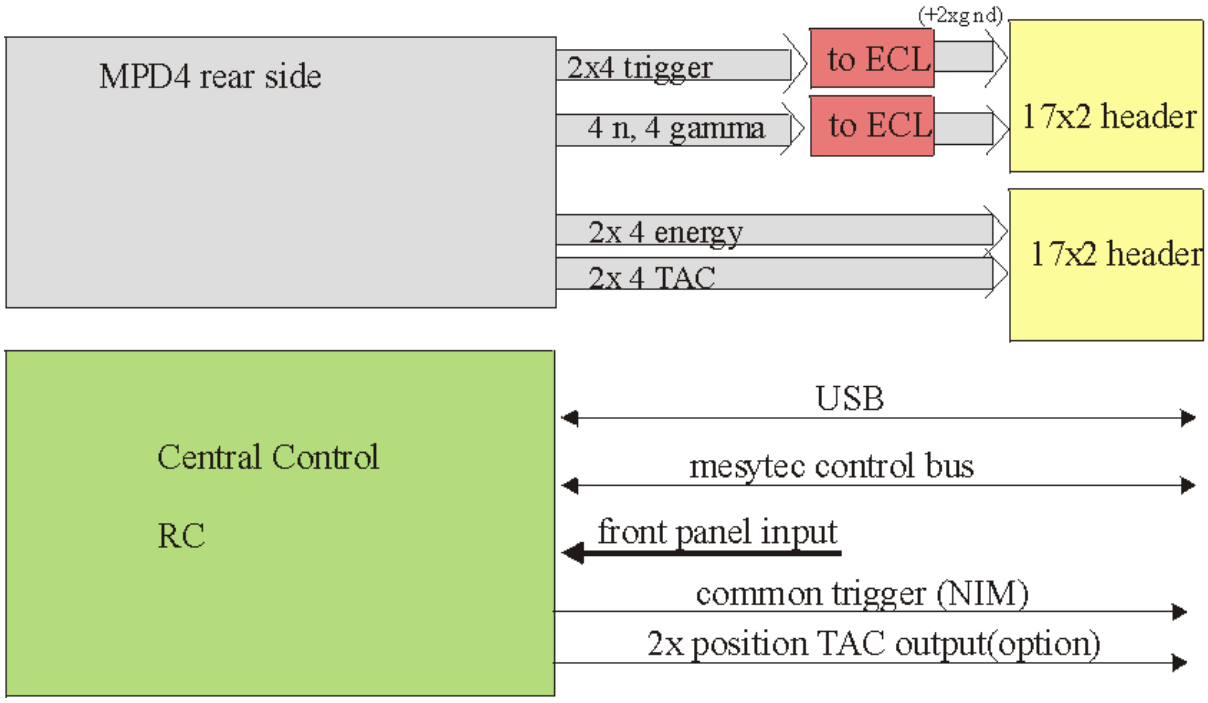
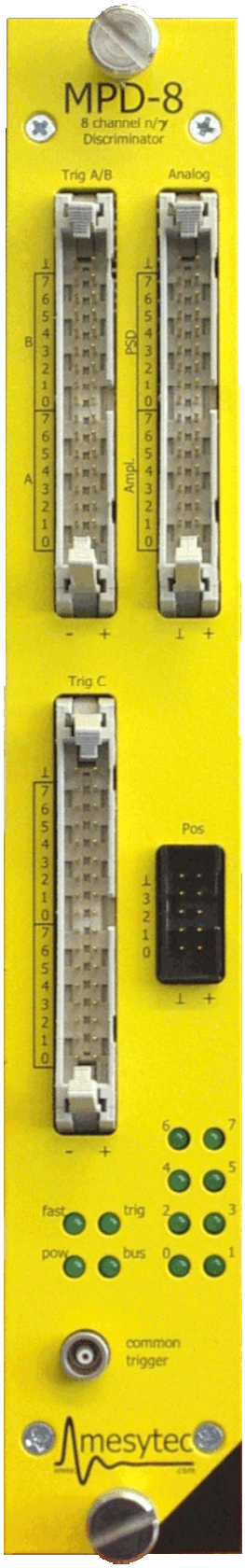
MPD4 / MPD8 Schematics:







PSD / Amplitude output connector:
Right upper connector. Top pins are PSD output, bottom pins are amplitude outputs
- *PSD* corresponds to ratio of fast to slow component of scintillator light output.. Range 0..4V
- *Amplitude* is the Integrated PMT charge output. Full range is 4V

Trigger – ECL1:
Upper left connector.
Upper pins are trigger group B (n, rej -> see settings)
Lower pins are trigger group A (n,g,rej,all -> see settings)

Trigger – ECL2:
Lower left connector. Trigger output. Always delivers a trigger when signal crosses the CFD threshold

Position TAC-outputs:
For position sensitive detectors, provides 4 position signal. Range 0.5 to 4V.
Conversion ratio: 130mV / ns,
At the present revision there are significant differential nonlinearities

LEDs:
light up when signals exceed CFD-threshold.
Indicators for “fast”, common trigger, Power, bus activity.

Common trigger output:
connected to trigger group A
NIM-trigger when any of the 8 channels responds. Can be chained with more modules, and must be terminated at the last module.

Settings will be saved in permanent memory and will be restored after power up.

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Input:
PMT signal input (anode signal, negative), terminated with 50Ohm. Variable gain by a factor of 10 in 4 steps.

RC bus section:

Bus:
Lemo input for the mesytec rc bus. Has to be terminated with 50 Ohms at the last device in chain. The two lemo inputs are connected to allow easy chaining of the bus.

ID:
Bus address (0 … 9 … F), each device on a bus has to have a unique address.

Serial connection:

USB:
Serial connection for device control

Virtual Com Port drivers for several operating systems can be found at www.ftdichip.com/Drivers/VCP.htm

Parameter settings:

Threshold

PMTs are directly connected to the inputs. The CFD threshold is preadjusted to an offset of 1% full range, allowing a dynamic range of 100:1. Maximum range (255) is 50% of max range adjusted with “gain”
For lowest threshold setting we suggest to power on the detectors, remove any source and adjust the threshold to give a low or no count rate.

Gain

The gain value should be selected as low as possible. Prefer to increase the PMT voltage which will result in better noise immunity of the connection from PMT to MPD8.
Input ranges are:

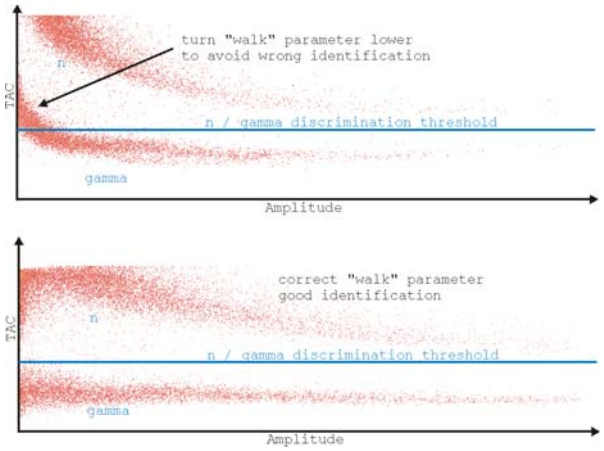
Gain	Range
0	5 V
1	2.5 V
2	1.2 V
3	0.6 V

Ndis

The MPD-8 PSD-output has a fixed discrimination threshold of 1 V to discriminate neutrons from gammas.
If PSD output is below threshold, signal is identified as “gamma”, above threshold as “neutrons”. With Ndis parameter the PSD outputs can be shifted up and down to get the correct identification cut.
A typical difference in PSD amplitude for neutrons and gammas is 1V.

Walk

If the maximum discrimination resolution is needed, the additional parameter "walk" can be adjusted: take a spectrum "Ampl vs. PSD" with gammas on the scintillator and adjust the curve with the "walk" parameter to get a flat top for the gamma line. The "walk" parameter influences the PSD amplitude in the low energetic region.



Qwin

is only for outmost optimisation purpose and should normally not be changed (default = 100). It will also influence the "walk" parameter.

Stability of PSD signals:
The MPD-8 has to handle output signals of many different PMTs combined with different scintillator liquids and scintillator geometries. So the factory calibration only can give start values for “walk” and “ndis” values. Some detector combinations may give no defined PSD output values with the default settings. In this case start with a significantly higher value of “walk” and adjust it down to the correct value. Also “ndis” may not be a good start value and has to be adjusted.

Operating modes:

Standard mode:
used for system adjustment or very precise measurements or at moderate rates to preserve all information. Amplitude and PSD signals are available. Dead time is determined by the Amplitude and PSD output signals and the conversion and readout time of the external peak sensing ADC.

Fast mode:
For non position sensitive scintillator panels, usually only the number of neutron hits within the acquisition time is important. By using scalers to count neutron events and, if necessary, total number of events (for dead time determination) the amount of data and the dead time can be reduced by large factors.

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The MPD-8 allows to switch to fast mode which reduces the total dead time to 250 ns.

Signal	**standard mode**	**fast mode**
Ampl_out	1us long pulse, 4 V	-
PSD_out	1us long pulse, 4 V	-
Pos_TAC	1 us long pulse	-
ECL outputs	1 us ns	60 ns
com trigger	1 us	60 ns
position	1us long pulse 4V	-
dead time per event	1.25 us	250 ns

Power consumption:

+12V 80mA
+6V 850mA
-6V 1.25A

Remote Controlled Operation:

MPD-8 can be remotely controlled in two modes: USB control and mesytec remote control. Bus (MRC)

USB Control:

For USB control a USB 1.1 or 2.0 connection is required. The MPD-8 operates as a generic serial device on a virtual com port. Virtual Com Port (VCP) drivers for various operating systems for this rc mode can be derived from the manufacturer of the USB interface chip: www.ftdichip.com/Drivers/VCP.htm

The MPD-8 can then be controlled e.g. using a terminal program or a proprietary control software.

Command list:
(each cmd terminated by <CR>)

?	Help / Display all commands
DS	Display Setup (lists gains, thresholds, Ndis values, …)
SF	
SG *val*	Set common Gain = 0…3 0 = 5V input range
SN *chan val*	Set Ndis value chan = 0…8 (8 = all common) val = 0…255
SO A	n = 0, g = 1, rej = 2, all = 3
SO B	0 = n, 1 = rej
SQ *chan val*	Set integration window width, for experts only. Value = 100+-100
ST *val*	Set common threshold value = 0…255
SW *chan val*	Set corr. value for Walk chan = 0…7 val = 100 +/- 100 (100 = no corr.)

Settings via USB remote control will also be saved in permanent memory and will be restored after next power up.

MRC control:

MPD-8 can also be controlled using the MRC-1 or MRCC controller module.

Up to 16 modules (not only MPD-8) can be connected on one bus, up to 32 on the two buses of the MRC-1 or MRCC. The MPD8 provides two Lemo connectors of the rear side to easily chain several modules.
The last module on a bus has to be terminated with 50 Ohms.

Remote control via MRC-1 / MRCC is basically reading and writing the control register page of the MPD-8

Memory List MPD-8:

MPD-8 can be controlled by reading / writing the control register page via the mesytec rc bus.
The following table shows the memory layout:

Adr	Name	widt	function
0	Ndis0	[7:0]	Neutron discriminator (PSD-shift) 100+-100
1	Ndis1	[7:0]	Neutron discriminator (PSD-shift) 100+-100
2	Ndis2	[7:0]	Neutron discriminator (PSD-shift) 100+-100
3	Ndis3	[7:0]	Neutron discriminator (PSD-shift) 100+-100
4	Ndis4	[7:0]	Neutron discriminator (PSD-shift) 100+-100
5	Ndis5	[7:0]	Neutron discriminator (PSD-shift) 100+-100
6	Ndis6	[7:0]	Neutron discriminator (PSD-shift) 100+-100
7	Ndis7	[7:0]	Neutron discriminator (PSD-shift) 100+-100
8	Walk0	[7:0]	Walk 100+-100
9	Walk1	[7:0]	Walk 100+-100
10	Walk2	[7:0]	Walk 100+-100
11	Walk3	[7:0]	Walk 100+-100
12	Walk4	[7:0]	Walk 100+-100
13	Walk5	[7:0]	Walk 100+-100
14	Walk6	[7:0]	Walk 100+-100
15	Walk7	[7:0]	Walk 100+-100
16	Common Thr	[7:0]	Threshold, 256 steps
32	Common Gain	[1:0]	Gain, 4 steps **Default 0**
33	fast	[0]	1=fast **Default 0**
34	Out_sourceA	[1:0]	ECL Output source A n = 0, g = 1, rej = 2, all = 3; **Default 3**
35	Out_sourceB	[0]	ECL Output source B 0 = n, 1 = rej **Default 0**
48	Qwin0	[7:0]	Integration window 100+-100
49	Qwin1	[7:0]	100+-100
50	Qwin2	[7:0]	100+-100
51	Qwin3	[7:0]	100+-100
52	Qwin4	[7:0]	100+-100
53	Qwin5	[7:0]	100+-100
54	Qwin6	[7:0]	100+-100
55	Qwin7	[7:0]	100+-100

The memory positions can be written with SE command and can be read with RE command.

Identification code for MPD-8 (detected when running the scan bus command "SC") is IDC = 24

Command Summary:

Each MRC command has to follow the format described below:

CMD *bus [dev] [adr] [val]*

data formats:
bus = bus number [0...1]
dev = device number [0...15]
adr = parameter number [0...31]
val = [0...255] (or [0...3] for gain);

Mnemonic Description

SC *bus* returns id code: IDC=24

SE *bus dev adr val*
set memory cell *adr* for device *dev* on bus *bus* to value *val*

RE *bus dev adr*
read memory cell *adr* from device *dev* on bus *bus*

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