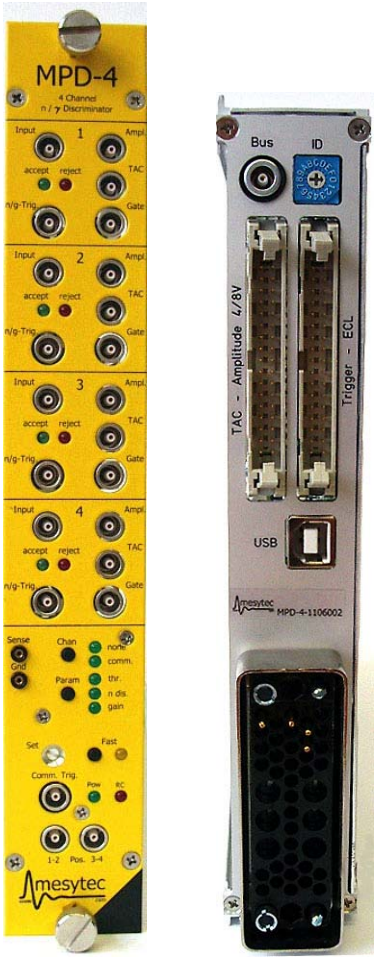
mesytec MPD-4 is a four channel pulse shape discriminator module. MPD-4 is used for particle discrimination in multi channel liquid scintillation detectors (for example BC501 or NE213).
For discriminator monitoring only 2 channels of peak sensing ADCs per scintillator channel are needed. Fast preamps are integrated. The 4 channel unit fits into a single width (1/12) NIM module.

MPD-4 includes:

- Fast variable gain PMT input amplifier
- 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 threshold.
- TAC output for neutron detection, amplitude independent (1 us peaking time)
- Amplitude output (1us peaking time, matched to TAC pulse)
- Trigger output (n + γ signals)
- Trigger output selectable n or γ (can be used as ADC gate)
- 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 30ns.
- Rear side: 2 header connectors with 2x4 triggers, 4 x n- discriminator signals, 4 x gamma-discriminator-signals, ECL
- 4 x energy, 4 x TAC output, 4/8 V switchable
- All parameters can be set via front panel, USB or mesytec control bus.



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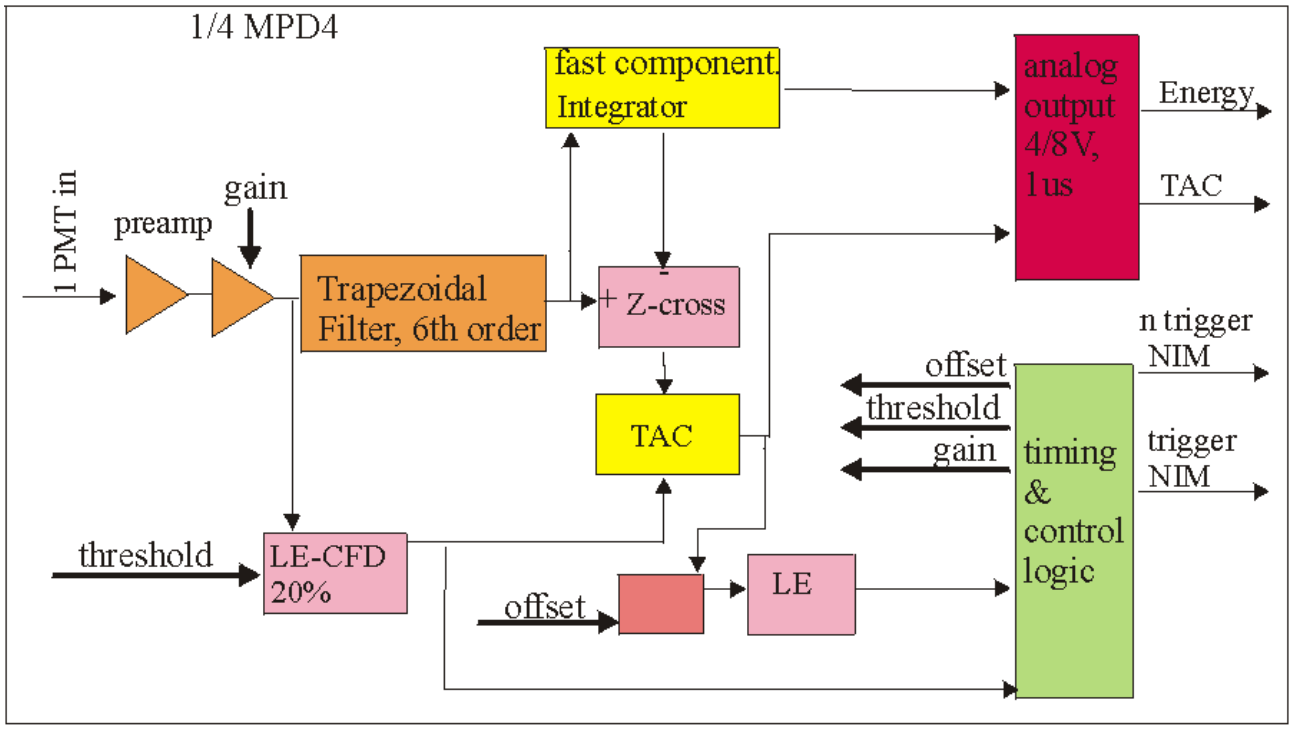
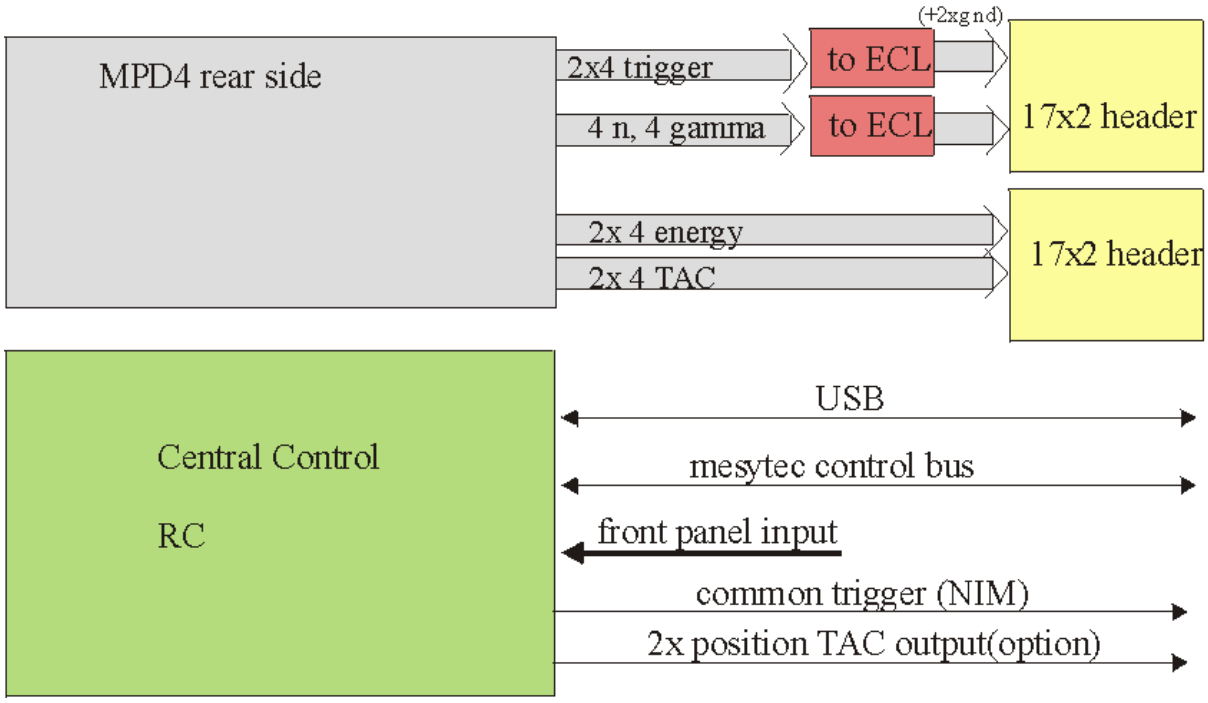
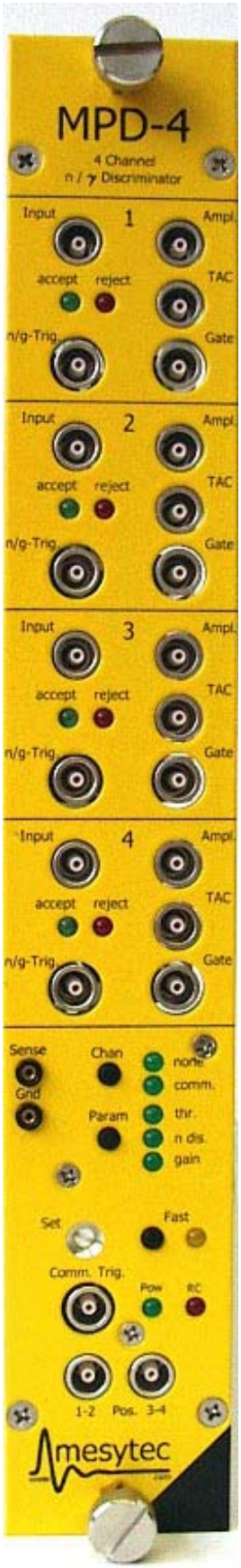
MPD4 Schematics:







4-fold channel section:

Input:
PMT signal input (anode signal, negative), terminated with 50Ohm. Variable gain by a factor of 20 in 16 steps.
Gain = 0 means a maximum signal of -3V, gain = 20 means max -150mV.

Ampl_out:
Integrated PMT charge output. Full range of 4V and 8V can be selected via internal jumper

TAC_out:
Corresponds to ratio of fast to slow component of scintillator light output.
Full range of 4V and 8V can be selected via internal jumper

Gate_out:
NIM pulse when signal exceeds CFD threshold, not particle selective. Length is adapted to deliver ADC gate for Ampl and TAC outputs.

n/g-Trig:
can be configured as neutron, gamma, all or reject output.
NIM-signal, adapted to deliver ADC gate for ampl and tac outputs.

accept LED:
lights up when signal exceeds CFD-threshold, is below maximum value, has a processable amplitude ratio of fast and slow component.

reject LED:
lights up when signal exceeds CFD-threshold and is not accepted.
Also works as channel indicator during channel adjustment.

Control section:
"Chan" switch:
toggles around the following channel selections:
C1 -> C2 -> C3 -> C4 ->no channel selected (but in single channel mode) -> common (all channels selected)
The selected channel will light its “reject” LED as indicator.

"Para"-switch:
toggles around the following parameters to be tuned:
thresholds -> n.dis -> gain.

Input_coder:
central input device for all parameters: the selected parameter in the selected channel(s) is modified.

"fast" switch:
switches between fast and slow mode

Sense / gnd output:
The currently tuned parameter is represented as a voltage from 0 to +2.0V

Common trigger output:
NIM-trigger when any of the 4 trigger outputs respond. NIM current output -16 mA., can be dasy chained with other modules. In fast mode it outputs "all"

TAC-outputs:
For position sensitive detectors, provides position signal

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

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RC bus section:

Bus:
Lemo input for the mesytec rc bus. Has to be terminated with 50 Ohms at the last device in chain.

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

Output section:

TAC_/ Amplitude out:
corresponds to ratio of fast to slow component of scintillator light output. Full range of 4V and 8V can be selected via RC

Trigger - ECL:
NIM pulse when signal exceeds CFD threshold, length adapted to deliver ADC gate for ampl and tac outputs.

Gnd		+	-
A1		C1_Ta	
T1		C1_Tb	
A2		C2_Ta	
T2		C2_Tb	
A3		C3_Ta	
T3		C3_Tb	
A4		C4_Ta	
T4		C4_Tb	
A1		C1_Ta	
T1		C1_Tc	
A2		C2_Ta	
T2		C2_Tc	
A3		C3_Ta	
T3		C3_Tc	
A4		C4_Ta	
T4		C4_Tc	
Gnd		Gnd	

A = amplitude
T = TAC

Ta = Gate (= front panel gate)
Tb = n- trigger
Tc = n/g/rej/trig (= front panel trigger)

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

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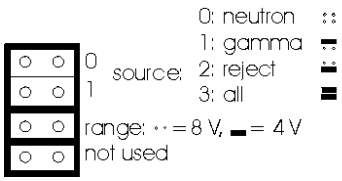
Jumper settings:

Inside the MPD-4 there are four jumper positions to control the output voltage and the source for front trigger, ECL trigger and “common” outputs.



A label inside the device also shows these settings.

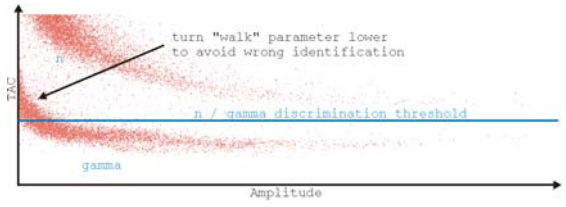
Parameter setting:

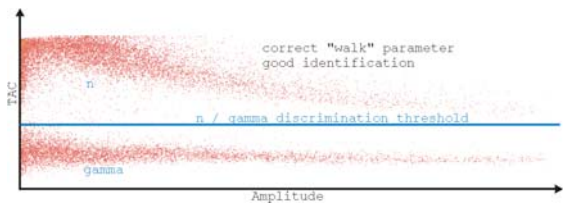
Threshold
The PMTs are directly connected to the inputs. The CFD threshold is preadjusted to an offset of 1% full range, allowing a dynamic range of 100:1. For lowest threshold setting we suggest to power on the detectors, remove any source and adjust the threshold to give a low or no count rate.

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 MPD4.

ndis
The MPD-4 TAC-output has a fixed discrimination threshold of 1.9 V (0.95 V in 4 V mode) to discriminate neutrons from gammas. If the TAC output is below the threshold, gammas are identified, above the threshold neutrons are identified. With '"ndis" parameter the TAC outputs can be shifted up and down to get the correct identification cut.
The typical difference in TAC amplitude for neutrons and gammas are 1V to 1.5V (8V range).

walk (ajustment range 50...150)
If the maximum discrimination resolution is needed, the additional parameter "walk" can be adjusted: take a spectrum "Ampl vs. TAC" 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 TAC 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 TAC signals:
The MPD4 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 output values with the default settings. In this case start with a significantly higher value of “walk” and then adjust it down to the correct value. Also “ndis” may not be a good start value and has to be adjusted.

Operating modes:

Slow mode:
used for system adjustment or very precise measurements or at moderate rates to preserve all information. Amplitude and TAC signals are available. Dead time is determined by the Amplitude and TAC output signals and the conversion and readout time of the external peak sensing ADC (typ. 2 us with MADC32).

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.
The MPD-4 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, 4/8 V	-
TAC_out	1us long pulse, 4/8 V	-
trig-Gate_out	1 us long pulse	60 ns
Gam/n_out	1 us long pulse	60 ns
Pos_TAC	1 us long pulse	-
rear side ECL	1 us ns	60 ns
com trigger	1 us	60 ns
common position TACs	1us long pulse 4/8V	-
dead time per event	1.25 us	250 ns

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Power consumption:

+12V 120mA
+6V 600mA
-6V -800mA

Remote Controlled Operation:

MPD-4 can be remotely controlled in two modes: USB control and mesytec remote control (MRC).

USB Control:

For USB control a USB 1.1 or 2.0 connection is required. The MPD-4 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-4 can then be controlled e.g. using a terminal program or a proprietary control software.

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

VER	Show firmware revision
DS	Display Setup (lists gains, thresholds, Ndis values, mode,…)
SG *chan val*	Set Gain chan = 0…4 (4 = all common) val = 0…15
SN *chan val*	Set Ndis value chan = 0…4 (4 = all common) val = 0…255
ST *chan val*	Set Threshold value chan = 0…4 (4 = all common) val = 0…255
SW *chan val*	Set corr. value for Walk chan = 0…3 val = 100 +/- 50 (100 = no corr.)
CC	Set to common mode only FW-Rev ver 2.7 and higher
CS	Set to single mode only FW-Rev ver 2.7 and higher
SQ *chan val*	Set corr. value for integration window for short signal component chan = 0…3 val = 100 +/- 100 (100 = no corr.) Default values need not to be modified normally.

Settings via USB remote control will also be saved in permanent memory and will be restored after next power up. For Fw-Rev 2.7 and higher common or single mode should be set to define which parameter set to load (also at next power up).
In the older revisions this selection must be done via front panel switch. Set to “none” to select single, and “common” to set common mode set. The push button must be pressed at least once after USB programming.

MRC control:

MPD-4 can also be controlled using the MRC-1 controller module.

Up to 16 modules (not only MPD-4) can be connected on one bus, up to 32 on the two buses of the MRC-1, just using T-pieces.
The last module on a bus has to be terminated with 50 Ohms.

Remote control via MRC-1 is basically reading and writing the control register page of the MPD-4

Memory List MPD-4:

MPD-4 can be controlled by reading / writing the control register page via the mesytec rc bus.
The following table shows the memory layout:

ADR	parameter	comment
0	Gain channel 1	Gain setting for channel 1 … 3, Values from 0 … 15
1	Gain channel 2	
2	Gain channel 3	
3	Gain channel 4	
4	Ndis channel 1	TAC shift for channel 1 … 3, Values from 0 … 255
5	Ndis channel 2	
6	Ndis channel 3	
7	Ndis channel 4	
8	Qwin channel 1	Corr. val. f. integration of short sign. component,Values 100 +/- 100 (100 = no corr.)
9	Qwin channel 2	
10	Qwin channel 3	
11	Qwin channel 4	
12	Threshold channel 1	Threshold settings for channel 1 … 3, Values from 0 … 255
13	Threshold channel 2	
14	Threshold channel 3	
15	Threshold channel 4	
16	Walk corr. channel 1	Offset to factory walk correction Values 100 +/- 50 (100 = no offset)
17	Walk corr. channel 2	
18	Walk corr. channel 3	
19	Walk corr. channel 4	
23	Fast mode	0 = slow mode 1 = fast mode
25	Output range (read only)	0 = 4 V 1 = 8 V
40	Output source (read / write) falls back to jumper setting after power up and "RC off"	Output source for trig outputs: 0 = neutrons, 1 = gammas, 2 = reject, 3 = all (n+g)

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

RC mode has to be ON for writing,
reading is possible also with RC OFF.
While RC ON, front panel control will be blocked.

The ON/OFF command makes the remote control active or inactive. The power up default is inactive. While inactive the manual values from the front panel elements are set.

When shut down during RC on, the RC values will be restored after next power up and rc will be active again. Output range and source will restart with jumper setting

Identification code for MPD-4 (detected when running the scan bus command "SC") is IDC = 21

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...15] for gain);

Mnemonic Description

SC *bus* returns id code: IDC=21

ON *bus dev*
activate rc for device *dev* on bus *bus*

OFF bus dev
turn off rc for device *dev* on bus *bus*

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*