

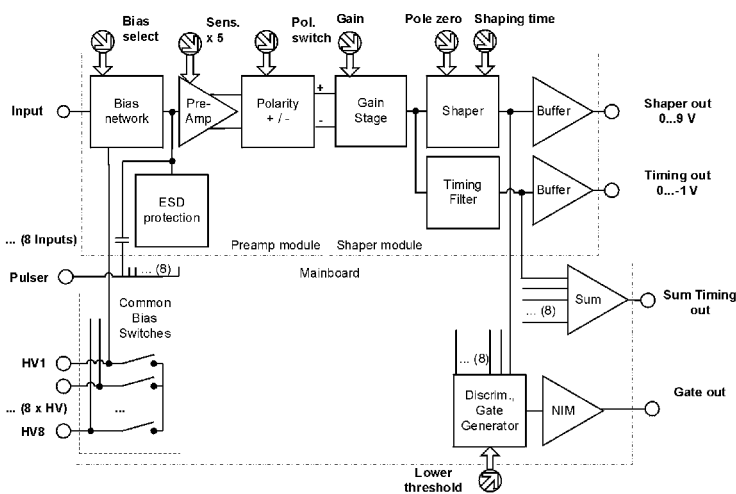
mesytec **MSI-8** is a compact 8 channel preamplifier shaper box with integrated timing filter amplifiers. Due to the modular setup, preamplifier and shaper module types can be selected individually for each channel. MSI-8 is the ideal solution for setups with a mix of different detectors requiring individual bias supply and energy ranges. It is also well suited for moderately segmented strip detectors or as an easy to use and flexible lab system.

### Features:

- 8 channel compact standalone module
- Preamplifier and shaper modules individually selectable
- Shaper with baseline restorer
- Two shaping times, jumper selectable
- Integrated timing filter amplifier
- Individual and common timing output
- Single and common detector bias
- All outputs can be terminated with 50  $\Omega$
- Lemo connectors for in- and outputs
- Discriminator gate output for peak sensing ADC

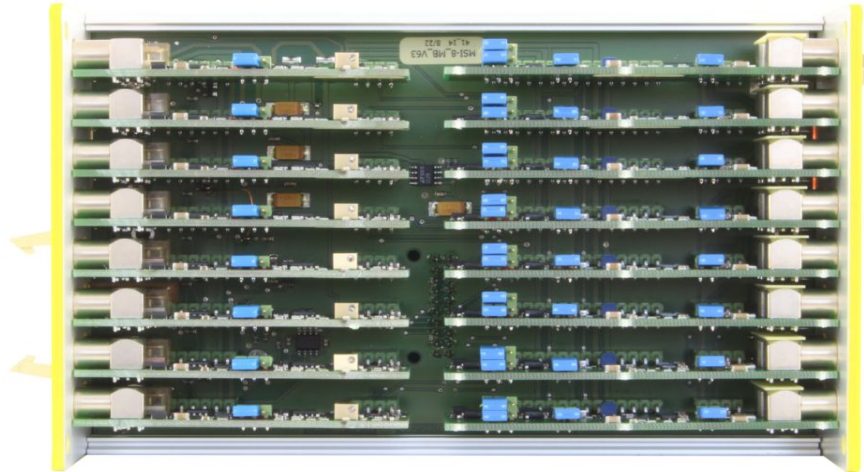


### Schematics:

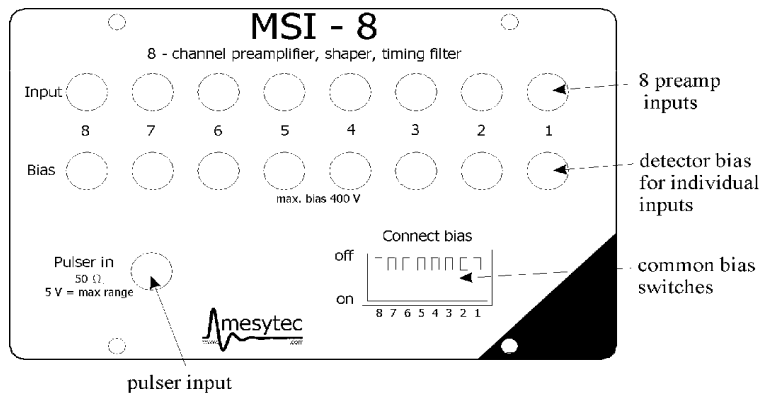


## System Design

MSI-8 has a very flexible modular design. Preamplifiers and shaper, timing filter amplifiers are pcb modules mounted on a common main board. They can be chosen individually for each channel. This gives maximum flexibility for multi channel setups with different detectors.



## Rear Panel



### Preamplifier inputs

- Lemo connectors directly situated on the preamplifier module

### Detector bias

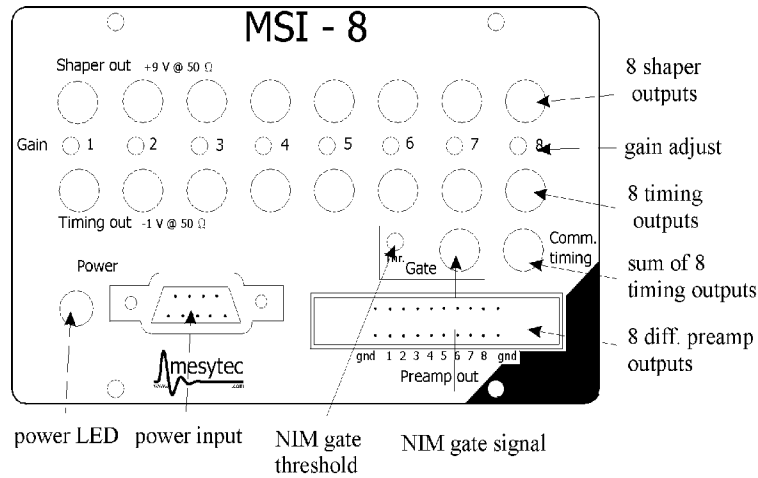
- Lemo connectors directly situated on the preamplifier module

### Pulser input

- Tail pulse, or square pulse
- Internally terminated with 50 Ω
- 5 V for maximum output voltage at minimum gain

### Common bias switches

bias inputs (not the detector inputs!) with switch „on“ are connected with each other. This allows bias supply with a single lemo connector plugged to one of the connected bias inputs. E.G. for strip detectors, switch all bias inputs to „on“ and connect bias voltage to one bias input.

**Front Panel**

**Shaper outputs**

- Lemo connector
- Positive, gaussian pulse
- Max 10 V (8 V at 50 Ω)
- Two jumper selectable shaping times (standard is 1 us FWHM and 2 us FWHM)

**Timing output**

- Lemo connectors
- Fast negative signal
- Max -1 V

**Common timing**

- Gain can be adjusted by a factor of 10
- Another factor 5 by preamp sensitivity switch (at the preamp module)

**Differential preamp outputs**

- 20 pin standard connector
- 8 differential preamp signals
- Can be connected to a twisted pair cable and terminated with 100 Ω
- Amplitude: ±1 V for maximum range

**Gate output and gate threshold adjust**

- NIM signal output
- Useful for gating an external peak sensing ADC in lab tests. As long as one of the shaper outputs exceeds the threshold voltage, the NIM-output gets negative.

**Power supply**

- SUB-D 9 female connector. (NIM convention)

- Supply voltages (currents for box with 8 shapers and 8 preamps)

+12 V	250 mA
+6 V	50 mA
-6 V	-170 mA
total power: 4.3 W	

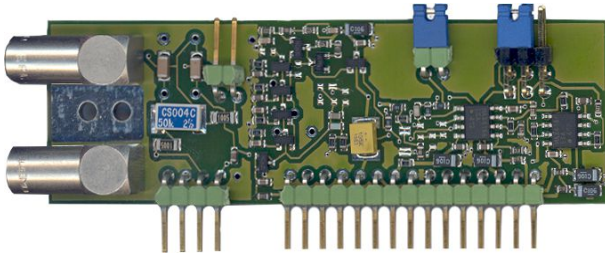
- Pin connections (numbers are noted on the connector):

pin	name	pin	name
1	Gnd	6	Not connected
2	Gnd	7	Not connected
3	+6 V	8	Not connected
4	+12 V	9	Not connected
5	-6 V		

**Box size**

length = 170 mm  
width = 105 mm  
height = 67 mm

### Preamp Module (MMPR-1)



#### Input

- The standard preamplifiers can handle capacity of up to 1000 pF

#### Detector bias

- Maximum bias voltage:  $\pm 400$  V
- Bias filter 10 M $\Omega$  / 50 M $\Omega$  (selectable by internal jumper)

#### Power consumption

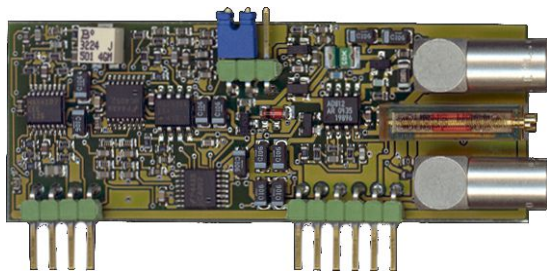
- Low power: typ 150 mW
- cooling not necessary

For details see data sheet of MMPR-1

### Shaper Module (MMSH-1)

The module includes a shaper with passive baseline restorer, an output driver for 10 V (8 V @ 50  $\Omega$ ) and a timing filter stage with timing output.

The jumper allows to select one of the two shaping times.



#### Shaper Output

- Filtering: quasi gaussian (CR(RC)<sup>5</sup>)
- Shaping time (FWHM):

2  $\mu$ s: low noise, for low rate applications, very well selected strip detectors.

Standard detectors often have a lot of 1/f noise resulting in better noise to signal ratio with shorter shaping time.

1  $\mu$ s: standard, best for large Si-detectors, standard strip detectors

0.5  $\mu$ s: optimized for high countrates

0.25  $\mu$ s: optimized for very high countrates >100 kHz, use fast ADC!

- Baseline shift with frequency:

- A passive baseline restorer is integrated
- For 1  $\mu$ s shaping time and a rate of 100 kHz, the baseline shifts less than 100 mV (1 %)
- DC Offset at shaper output:  $\Delta U < 10$  mV

#### Pole zero adjust:

- Modules are adjusted to less than 20 mV of undershoot at the shaper output
- **You can readjust if necessary**

#### Timing Output

- Timing filter amplifier (is included on the shaper module)
  - integration: 7 ns
  - differentiation: 200 ns
- Noise:
  - $N = (70 + C_{Det}) * 0.35$
  - $C_{Det}$  = cable + detector capacity, in pF;
  - $N$  = noise FWHM in keV;

#### Power consumption

+12 V 10 mA  
 -6 V 10 mA  
 total power = 180 mW

#### Connector

(left pin = 1)

pin	name	pin	name
1	gnd	6	+12 V
2	in+	7	gnd
3	in-	8	out shaper
4	gnd	9	out timing
5	-6 V	10	gnd

For details see data sheet MMSH-1

## Timing considerations

### Best timing

- Use high bias voltage to get maximum charge carrier velocity in the intrinsic zone of the detectors
- Implant particles with low range on the p-side (=strip side or guardring side for 2 sided detectors)!

### Time resolution with leading edge discriminator

- Use a low threshold to minimize walk
- If you have a wide range of input amplitudes, use shaped signals for walk-correction
- If the signal is much larger than the noise, the timing resolution  $\Delta t$  can be estimated:

$$\Delta t = 20ns * \left( \frac{N}{S} \right)$$

$N$  = noise [MeV]

$S$  = signal amplitude [MeV]

- For 100 pF detector + cable capacity and 1 MeV signal this means a timing resolution of  $\Delta t = 1$  ns
- Timing resolutions better than 100 ps are difficult, even for large signals

### With constant fraction discriminator

- fraction = 0.25, delay = 15 ns
- timing is 25 % worse, but walk correction is intrinsic

### Common timing output

- For low energies (<10 MeV) about three times worse than single channel timing (noise increased by  $\sqrt{8}$ )
- For higher energies  
Noise is not the limiting factor. If a coincidence with responding energy channels is used in software, the 8 channels can be calibrated with individual timing offset parameters. If there is no coincidence, the timing information will not get better than 0.5 ns due to delay tolerances for the 8 channels.