

RAL Microelectronics Design Group

MODULAR PRE-AMPLIFIER AND SHAPING AMPLIFIER SYSTEM FOR SILICON STRIP DETECTOR READ-OUT

User guide version 4 (updated 29/8/2001)

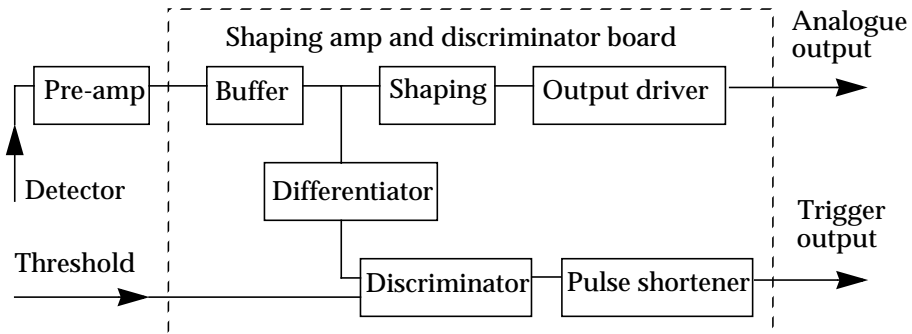
PRE-AMPLIFIER (RAL108)

- Pre-amp gain 10mV/MeV (37 nV/ e⁻) into 100 Ω
- Noise ~ 2.2keV FWHM (~ 255 e⁻ rms)
- Noise slope ~ 72eV/pF FWHM (~ 8 e⁻/pF rms)
- Rise time (10-90%) ~ 5ns (0 pF), ~ 40ns (100 pF)
- Fall time (100-37%) 50 ± 4 μs
- Dynamic range 0 - 200 MeV (± 2V into 100 Ω)
- Integral non-linearity < 0.1%

SHAPING AMPLIFIER and DISCRIMINATOR (RAL109)

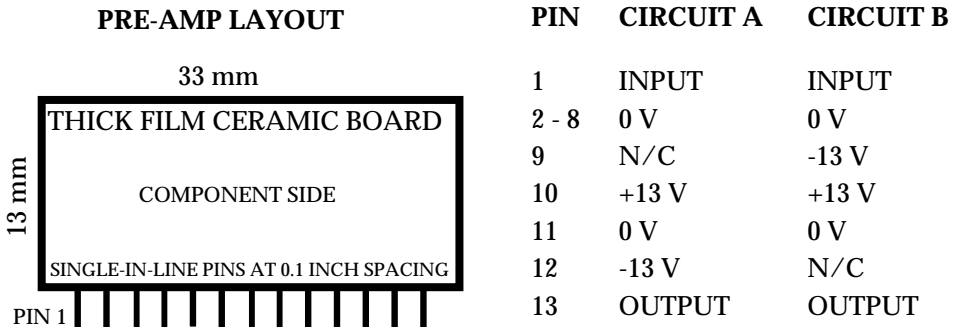
- Shaping CR-(RC)², τ = 0.5 μs
- Input Differential, 100 Ω impedance
- Pole-zero adjustment 40 - 60 μs
- Gain Maximum 50 (20MeV=10V)
Minimum 5 (200MeV=10V)
- Noise < 1mV rms at output
< 5keV FWHM at maximum gain
- Discriminator threshold < 1.5-14% (referred to analogue output)
- Time walk < 20ns over full dynamic range
- Resolution < 500ps rms (> 2 x discriminator threshold)
- Trigger output Adjustable 55-300 ns ECL

BLOCK DIAGRAM OF ONE CHANNEL



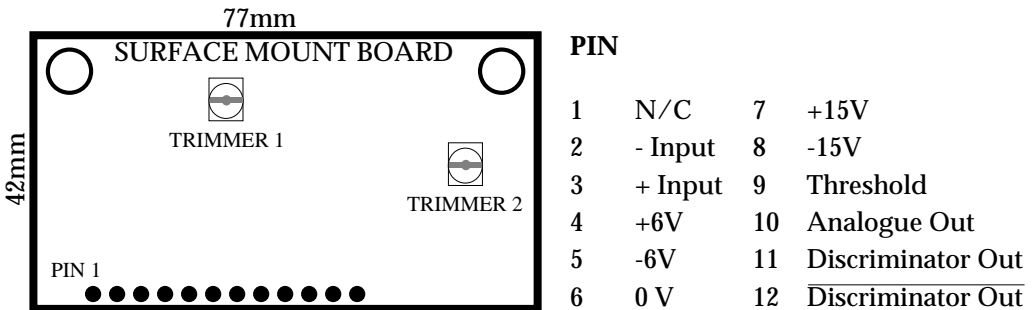
PRE-AMPLIFIER DESCRIPTION

Two versions of the pre-amp have been designed for either negative or positive charge (Circuit A and circuit B respectively). The circuits are identical apart from the output stages which drive into 200Ω (100Ω pre-amp output resistance in series with the 100Ω shaping amp motherboard input resistance). The pre-amps plug into a motherboard which provides filtered power supply lines at +13 V (14mA) and -13V (4.3mA). Total power dissipation is 280mW per channel. The outputs are AC coupled through $100\mu\text{F}$ to twisted pair cables. Inputs are capacitively coupled through 10nF to the detector.



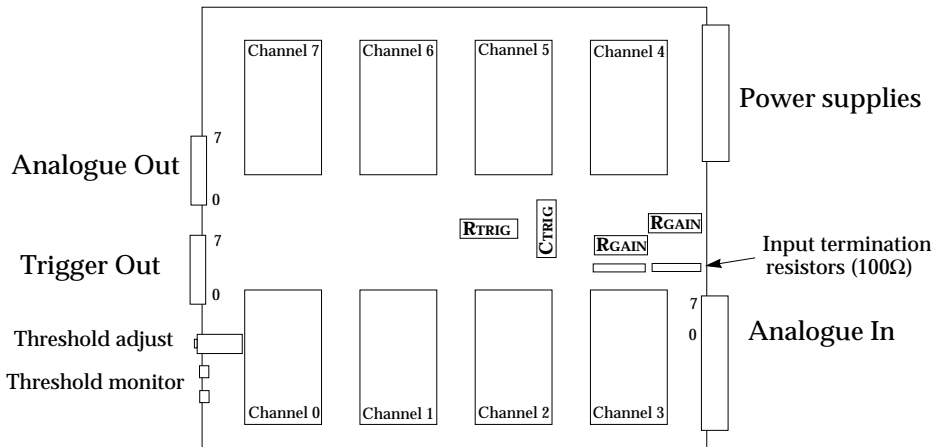
SHAPING AMPLIFIER DESCRIPTION

Each surface mount board contains an input buffer with a gain determined by resistors on the motherboard. This is followed by pole-zero cancellation (trimmer 1 adjusts the time constant over the range 40 to $60\mu\text{s}$). The output of the subsequent RC shaping stages is connected to a base-line restoration circuit, the output of which is amplified to drive 0-10V into $1\text{k}\Omega$. The output offset can be set to zero by trimmer 2. The board has a discriminator connected to the input buffer via a C-R differentiator of time constant 200ns. The threshold is set on pin 9, and is resistively divided by 22 on the board.



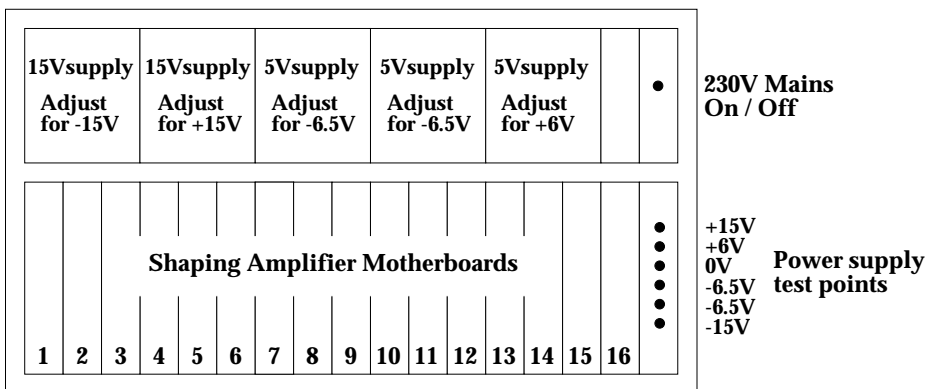
SHAPING AMPLIFIER MOTHERBOARD

Eight shaping amplifier boards are mounted on the motherboard, which has plug-in components to control the gain of the input buffer and the width of ECL trigger outputs (R_{GAIN}, R_{TRIG} and C_{TRIG}).



KM6 RACK SYSTEM

Sixteen motherboards plug into a KM6 sub-rack containing power supplies and connectors, giving a system of 128 channels in total. The power dissipation is about 160W, or just over one watt per channel. The power supply voltages can be monitored on the front panel. For optimum system performance, the 5V supplies should be adjusted to +6V and -6.5V.



DETAILED DESCRIPTION OF SHAPING AMPLIFIER

1. Shaping Amplifier gain

The gain is set by the plug-in resistors R_{GAIN} (in the range 0 - 10 k Ω) and is given by

$$\text{gain} = 500 / (1000 + R_{GAIN}) \quad \text{V/MeV}$$

Maximum gain is 20 MeV = 10 V at output.

2. Base-line restoration

The Robinson base-line restoration circuit has a restoration rate of 1.5 mV/ μ s, measured at the shaping amp output. This rate is low enough to avoid any non-linearity in the amplifier, but sufficient to eliminate base-line shifts for signal rates up to 10kHz or more.

3. Overload performance.

The shaping amp can cope with overloads by a factor of two with quick recovery (<10 μ s), even at high signal rates. A modification to the circuit allows fast recovery from four-times overloads, so that low energy particles can be accurately measured in a background of high energy particles (the modification however doubles the minimum threshold and increases shaping amplifier noise by 25%)

4. Discriminator performance

The discriminator threshold is adjusted by a trimmer on the motherboard (which controls all eight amps on the board). The minimum threshold is determined by the onset of oscillation in the comparator, typically at voltages equivalent to 200-300 keV particles. The motherboard contains eight pulse shortening circuits with output widths in the range 55-300 ns which are controlled by plug-in resistors and capacitors (R_{TRIG} and C_{TRIG}).

Pulse widths (ns) for a range of R_{TRIG} and C_{TRIG} values

	1k	1.2k	1.5k	1.8k	2.0k	2.2k	2.4k
100pF	55	75	100	140	165	190	200
120pF	80	100	130	170	200	220	240
150pF	100	125	170	210	250	280	300