



SIGNAL PROCESSING

2003BT™

Silicon Detector Preamplifier

For typical use with positively biased silicon detectors.



FEATURES

- Low noise design: less than 2.0 keV (Si) at 0 pF
- High energy rate capability: up to 2×10^6 MeV per second
- FET input, diode protected
- Independent energy and fast timing outputs
- Fast rise time less than 3 ns at 0 pF
- Small size
- Capable of operating in a vacuum chamber

DESCRIPTION

The Model 2003BT charge sensitive FET input preamp is designed for optimum performance with Silicon detectors such as the Mirion Passivated Implanted Planar Silicon (PIPS®) detectors and legacy Silicon Surface Barrier (SSB) detectors. Operating as a charge to voltage converter, the unit accepts charge carriers produced in the detector during each absorbed nuclear event. The output then provides a voltage in direct proportion to the collected charge at the rate of 0.45 V per pC. This translates to a gain of 20 mV per MeV for room temperature silicon detectors.

For typical use with positively biased silicon detectors, the extremely linear energy output provides a positive polarity pulse ideal for energy spectroscopy. The coincident timing output provides a negative polarity fast differentiated pulse ideal for resolution of nuclear events in time.

The high charge rate capability of the design is evidenced by an energy rate capacity of greater than 2×10^6 MeV per second when used with silicon detectors. In order to take full advantage of such a high count rate capability, a main amplifier with a correspondingly high count rate ability, such as the Model 2025 or Model 2026, should be used.

2003BT | SILICON DETECTOR PREAMPLIFIER

The basic operation of the preamplifier is indicated in the functional schematic. The first stage acts as an operational integrator which produces an output potential proportional to the accumulated charge on the feedback capacitor C_f . The integrator drives the energy output directly. The timing output is derived from the integrator error signal through a pulse shaping network. Such an arrangement allows for the low noise and fast rise times, as in Table 1. To preserve pulse fidelity the energy output is buffered through a series terminating resistor of 93 Ω .

The preamplifier offers a noise contribution of only 2.0 keV, FWHM, Si, with a rate of increase with increasing input capacitance of ± 10 eV per pF. All necessary power is provided by a Mirion main amplifier through the 300 cm (10 ft) compatible cable furnished with the preamp.

SPECIFICATIONS

Inputs

- Detector input: Accepts charge pulse from semiconductor detectors including PIPS and SSB types
- HV input: Allows detector biasing up to ± 1000 V dc; detector series bias resistance is 110 $M\Omega$
- Test input: Charge coupled to the preamp input at 1 pC per V; available at the end of the preamp cable

Outputs

- Energy output: Inverted with a tail pulse time constant of 250 μ s and an amplitude of up to ± 10 V unterminated; $Z_{out} = 93 \Omega$, direct coupled. Rise time as in Table 1; dc offset adjustable to zero
- Timing output (with positively biased detectors only): Noninverted, fast differentiated pulse with rise time as in Table 1 and fall time variable. Direct coupled current source output to drive 50 Ω load

Performance

- Integral nonlinearity: $\leq \pm 0.04\%$ for ± 10 V output
- Gain drift: $\leq \pm 0.005\%$ per $^{\circ}C$ (± 50 ppm per $^{\circ}C$), 0-50 $^{\circ}C$
- Detector bias isolation: ± 1000 V dc maximum
- Noise: See Table 1
- Charge sensitivity: 0.45 V/pC
- Energy sensitivity: 20 mV/MeV (Si)
- Rise time: See Table 1



Connectors

- Power: Amphenol 17-20090
- Detector: BNC
- HV input: SHV
- Energy and timing outputs: BNC
- 300 cm (10 ft) preamp power cable with required connectors is supplied with the preamplifier

Power Requirements

- +24 V dc – 10 mA +12 V dc – 30 mA
- -24 V dc – 4 mA -12 V dc – 6 mA

Physical

- Size: 7.6 x 5.1 x 3.8 cm (3 x 2 x 1.5 in.)
- Net weight: 0.2 kg (0.5 lb)
- Shipping weight: 0.9 kg (2 lb)

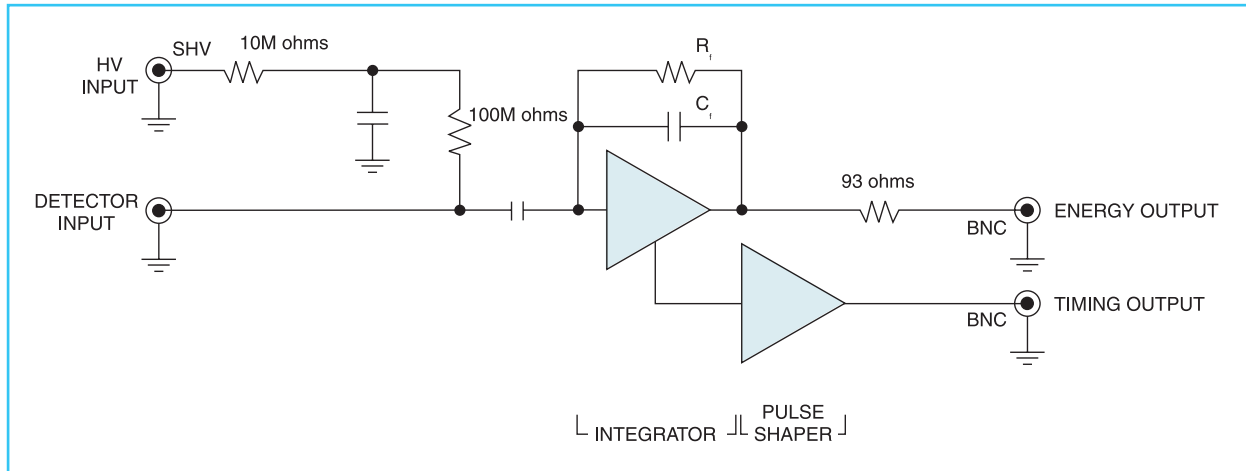
Environmental

- Operating temperature: 0 to 50 $^{\circ}C$
- Operating humidity: 0-80% relative, non-condensing
- Meets the environmental conditions specified by EN 61010, Installation Category I, Pollution Degree 2

Table 1

C_{source} in Picofarads	Noise in keV FWHM, Si	Rise Time in Nanoseconds	
		Energy Output	Timing Output
0	<2.0	<12	<3
100	<3.0	<14	<5
500	<6.5	<22	<10
1000	<9.5	<28	<16

Noise performance using the Model 2025 Spectroscopy Amplifier set at 2 μ s unipolar near-Gaussian shaping.



Functional Schematic

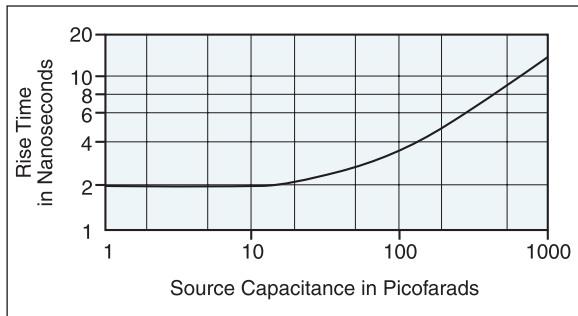


Figure 1 Typical Rise Time vs. Source Capacitance for the Timing Output

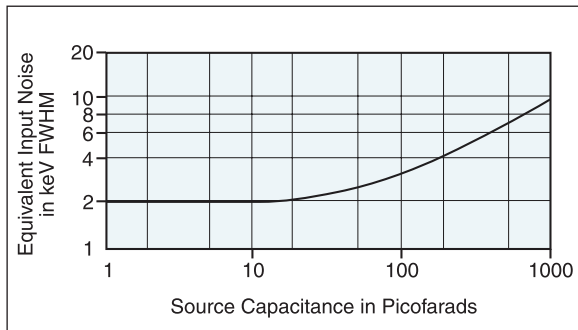
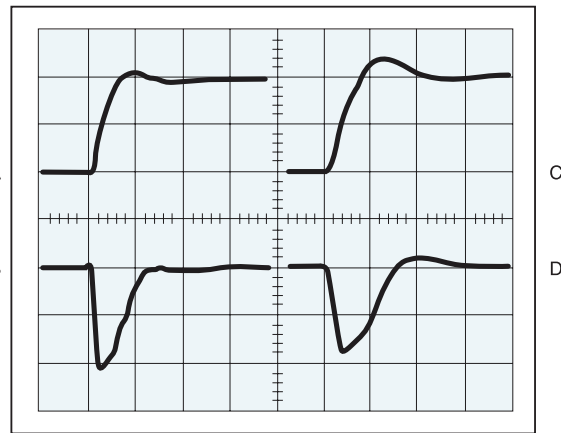


Figure 2 Typical Noise Performance vs. Source Capacitance



Vertical Sensitivity 50 mV/div.
Horizontal Sensitivity 20 ns/div.

Figure 3 Pulse Response
(A) Energy Output and (B) Timing Output with Csource = 10pF
(C) Energy Output and (D) Timing Output with Csource = 100pF

