

## “Front-End” Electronics

The front-end electronics (Fig. 1) include the input field-effect transistor (FET) and the feedback element of the charge-sensitive preamplifier. The feedback element comprises a capacitor and a resistor (passive feedback) or a transistor (active feedback). Preamplifiers with active feedback, such as the transistor-reset preamplifier (TRP), are used for achieving ultra-high count rates.

A temperature-sensing element, also located in the cryogenic vacuum enclosure, automatically shuts off the HV power supply if the detector temperature begins to rise. The front-end electronics are enclosed in the cryogenically-cooled enclosure to minimize electronic noise. Both the input FET and the feed-back element have optimum noise characteristics at ~120 K.

## Preamplifiers Used with HPGe and Si(Li) Detectors

With the exception of the front-end electronics, both the sealed HV filter and charge-sensitive hybridized preamplifier circuitry are assemblies located behind the detector within the PopTop capsule (Fig. 2). They are outside the vacuum chamber and are at room temperature.

The very long time constant of the HV filter ensures that the voltage is applied gradually to the detector. This protects the FET from voltage spikes. When cold, any modern HPGe detector from ORTEC may have the full bias voltage switched on without risking damage to the FET.

Some additional observations about preamplifiers used with Photon [HPGe or Si(Li)] Detectors (See Fig. 1): all are of the “charge sensitive” type, and all have the “front-end” cryogenically cooled for lowest electronic noise and energy resolution. Three different feedback mechanisms are used:

- 1) The simplest and most common is “resistive feedback.” In this case the feedback circuit contains a resistor and a capacitor in parallel.
- 2) For coaxial detectors used at high count rates (>75 kcps) the feedback circuit contains a junction transistor, switched on when the voltage at the gate of the input FET exceeds a certain threshold voltage. This resets the input FET gate voltage to zero. This type of preamplifier is called a transistor-reset preamplifier (TRP).
- 3) For small detectors (IGLET, IGLET-X, SLP, GLP), electronically equipped for optimum resolution below 50 keV, the feedback circuit contains an LED (light-emitting diode) which rezeros the voltage at the gate of the input FET via a mechanism similar to that of the TRP, but using light instead of an electronic switch. Ultra-low noise performance is achieved with this type of preamplifier [Pulsed Optical Feedback (POF)] because the feedback resistance is infinite (in contrast to resistive feedback), and the capacitance on the gate of the input FET is not increased by the addition of the collector-to-ground capacitance of a junction transistor (as with the TRP). Very high feedback resistance and very low capacitance are the keys to low noise performance.

Model A250 Series ORTEC resistive-feedback preamplifiers require only 1 watt of power. This makes the preamplifiers ideal for demanding portable applications such as Safeguards. The transistor-reset preamplifier (“Plus” option) requires ~1.8 watts of power.

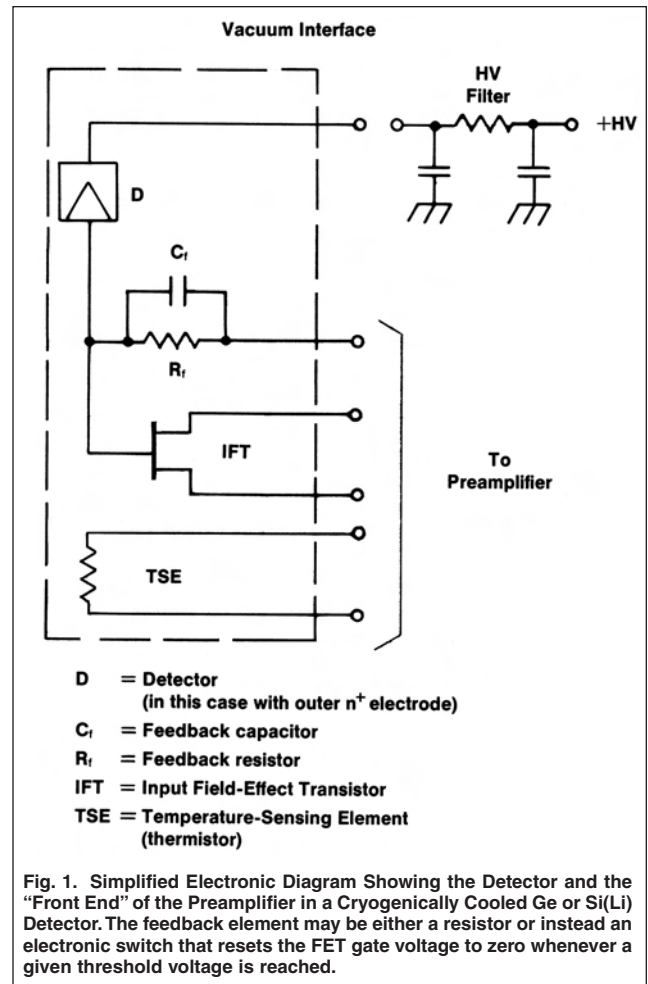


Fig. 1. Simplified Electronic Diagram Showing the Detector and the “Front End” of the Preamplifier in a Cryogenically Cooled Ge or Si(Li) Detector. The feedback element may be either a resistor or instead an electronic switch that resets the FET gate voltage to zero whenever a given threshold voltage is reached.

Table 2. Energy Rate of Preamplifiers Supplied with Photon Detectors.

Preamplifier Type	Detector Type	Maximum Energy Rate (MeV Sec <sup>-1</sup> )
Resistive Feedback	GEM, GMX,	145,000
	LO-AX, GLP (25, 32, 36 mm)	4,000
	GLP (6, 10, 16 mm)	2,200
Transistor Reset (Order “Plus”)	GEM, GMX	1,000,000
Pulsed Optical Feedback (Order “POF”)	IGLET, IGLET-X, SLP, GLP, SLB (6, 10, 16 mm)	4,000*
Modified For HCR (Resistive Feedback)	All GLPs	10,000

\*The POF does not “lock up” or saturate at high count rates, unlike resistor-feedback designs. At ultra-high count rates with the POF, throughput is limited by reset pulse rates. 4000 MeV/s is an estimate of maximum “useable” energy rate.

# Photon Detector Electronics

## Automatic HV Shutdown

If the system is warmed up with bias on, the automatic HV shutdown feature protects the input FET and the critical detector surfaces. ORTEC uses a thermistor on the mount, not the detector element itself, to sense the onset of warmup.

## Cable Pack

Unless otherwise specified at time of order, each ORTEC detector is supplied with a single, captive cable bundle 3 ft in length and terminating into individual in-line connectors:

Signal out 93-Ω BNC

Timing out 93-Ω BNC

Test in 93-Ω BNC

HV in 75-Ω Male

Preamp power 9-pin D female

A mating cable pack of individual conductors, 10 ft in length is provided for connections to supporting electronic systems.



## SMART-1 Intelligent Detector Option

SMART-1 is an option on GEM, GMX, GLP, LO-AX, SGD and Profile series detectors. The option integrates a microprocessor controlled module with the detector assembly. The module, controlled via an RS-232 link from the MCA, provides the HV bias for the detector element and provides state of health information on the following detector functions:

Preamplifier  $\pm 12$ ,  $\pm 24$  V

Detector element temperature

Detector high voltage on/off/set/read

Detector overload status

Detector shutdown status

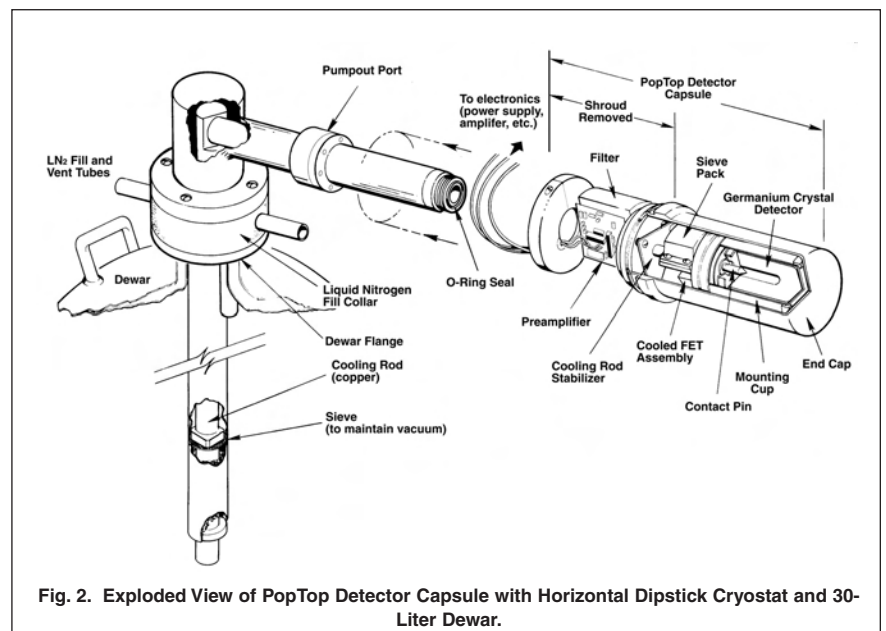
Detector serial number (read only)

Detector authentication code (read/write)



## Reference

1. G.F. Knoll, *Radiation Detection and Measurements* (second edition), John Wiley and Sons, New York, 1989.



Specifications subject to change  
102609

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