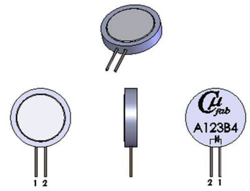
CAMBRIDGE MICROFAB LIMITED

High Temperature Neutron Sensor

HT-50



PRODUCT DESCRIPTION

The HT-50 silicon carbide neutron sensor is designed for thermal neutron metrology. It is a 50mm^2 active area heterojunction diode in a 2 pin ceramic package, with excellent neutron specificity.

The HT-50 sensor can be operated up to 175ºC. It exhibits lower leakage current than the AT-50 sensor. It is used in reverse bias with a recommended bias supply of 45V.

In use the sensor produces a current pulse coinciding with each single neutron interaction. The pulse rise time at ambient temperature is under 100 nS. The decay time is dependent on readout electronics; an exponential decay with t $^{1/2}$ of ~ 25 µS is typical.

BENEFITS

- Excellent thermal neutron specificity
- Very low gamma sensitivity
- High thermal neutron efficiency
- Detects single Neutron interactions
- Sub-nA leakage current between ambient and 175ºC
- Compact
- Low power requirement
- Robust design – developed for Oil and Gas Survey applications

APPLICATIONS

- Oil and Gas Exploration
- Reactor Compartment monitoring
- Environmental monitoring
- Security screening
- Radiological safety
- Neutron flux guide metrics
- Nuclear physics instrumentation
- Nuclear reactor diagnostics

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TECHNICAL DATA

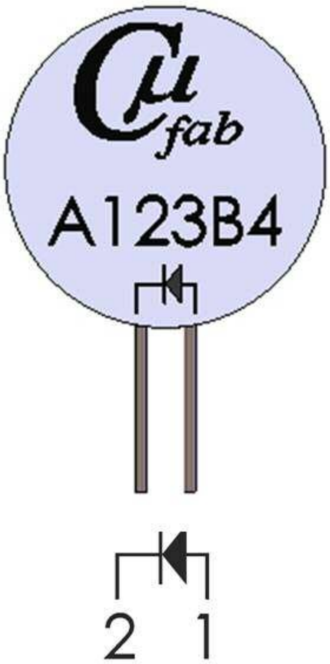

Fig. 1 Pin Configuration

P lead pitch	2.54	mm
D diameter	16.5	mm
T thickness	4.0	mm
Active area	50	mm^2

Fig. 2 Dimensions

SPECIFICATIONS

Symbol	Description	Max	Min	Typ	Unit
V_{rb}	Reverse bias voltage	100*	0	45	V
I_f	Safe Forward Current	0.1	N/A	N/A	mA
I_l	Leakage current at 45Volts reverse bias at 20ºC	0.1	0	0.05	nA
T_{sto}	Storage temperature	110	0	20	ºC
T_{op}	Operating temperature	175	10	150	ºC
P_{itch}	Lead pitch			2.54	mm
D_{iam}	Package diameter			16.5	mm
T_{hic}	Package thickness	4.5	3.2	4.0	mm
A_{act}	Device active area			50	mm^2
A_{neu}	Thermal neutron cross sectional area.			8.12	mm^2
C_{min}	Capacitance at operating bias			600	pF
C_{max}	Typical unbiased capacitance			3500	pF
N_{eff}	Thermal neutron detection efficiency	8.0	5	7	%

*** Do Not Exceed**

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OPERATING GUIDELINES

Simplest operation is achieved using a Microfab HT-50 Thermal Neutron Sensor Kit.

For users requiring integration with their own or 3rd party equipment we offer the following guidelines:

- The HT-50 should be operated in a screened, light-tight enclosure.
- Isolation from mechanical vibration is desirable.
- The HT-50, the preamplifier and the interconnection should be electrically screened
- The enclosure should provide the necessary electrical screening
- The HT-50 should be connected to a low noise, high gain, charge sensitive preamplifier using the shortest possible low capacitance screened interconnection
- Typically Pin 1 of the HT-50 is connected to the preamplifier input.
- Typically Pin 2 of the HT-50 is connected to a stabilised current limited bias voltage at +45V.
- Reverse bias gives improved signal-to-noise ratio, faster signal rise time and reduces the device capacitance.
- The HT-50 should NOT be forward biased. Passing forward current in excess of 0.1mA may cause permanent damage.
- A feedback network comprising ~50 MΩ resistor in parallel with ~1 pF capacitor is appropriate.
- The signal rise time associated with neutron events is very fast so to condition the signal it is appropriate to use a shaping amplifier set to ~1μS shaping time constant.

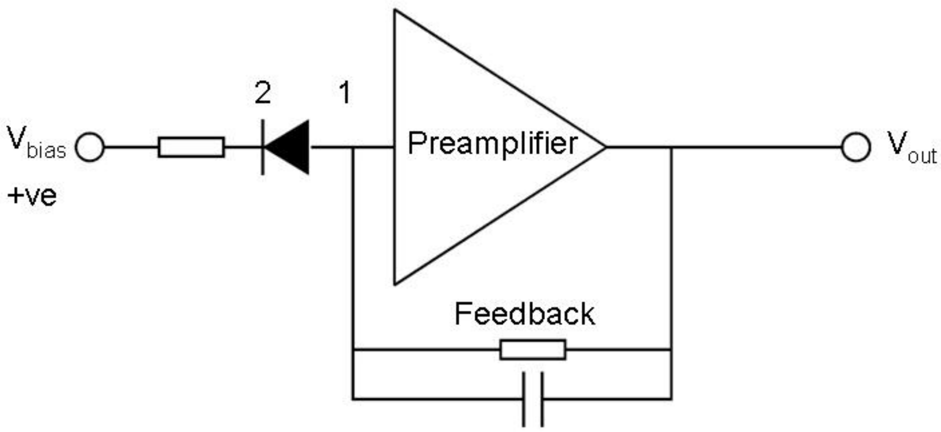

Fig. 3 Biasing and Readout

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SIGNAL CHARACTERISTICS

Neutron detection events are indicated by a sharp negative pulse from the output of a Microfab inverting gain preamplifier, with exponential recovery based on the feedback loop time constant (see Figures 4, 5 & 6).

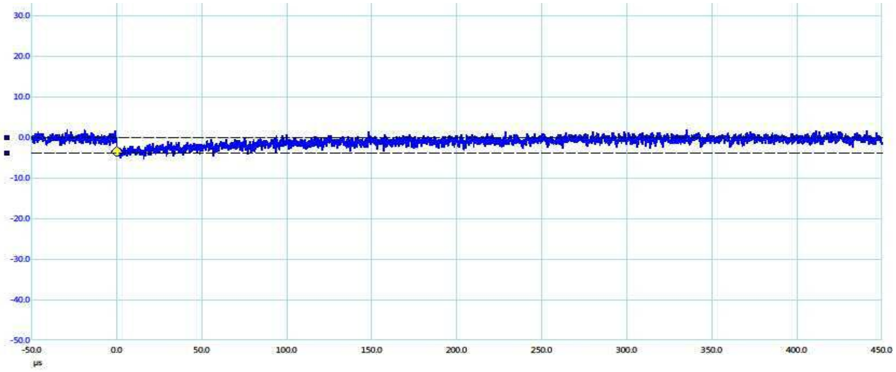

Fig 4. Low Amplitude Pulse at 18.5^{o}C

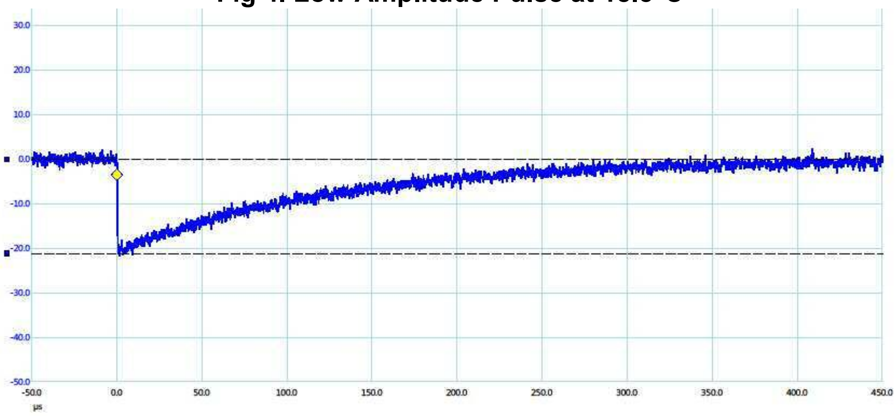

Fig 5. High Amplitude Pulse at 18.5^{o}C

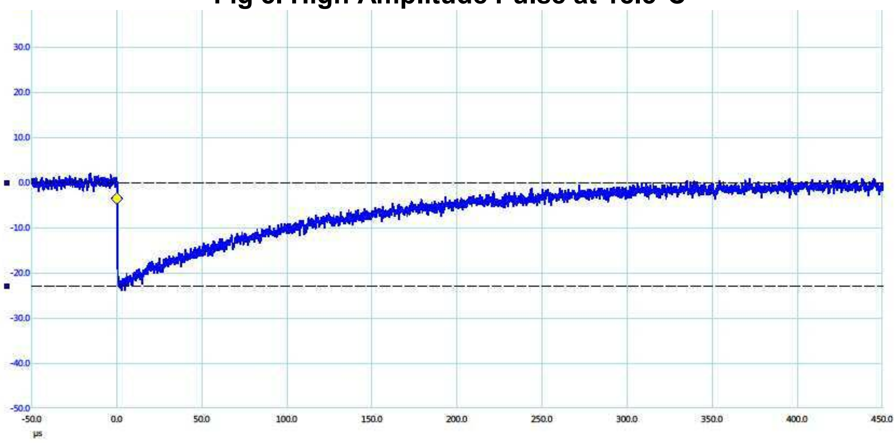

Fig 6. High Amplitude Pulse at 150^{o}C

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Detection spectra are substantially similar at temperatures up to 150 ºC. Above 150 ºC the edge of the noise floor begins to move to higher channel numbers.The preamplifier pulse amplitude will vary between the noise level and a maximum due to the random direction and various energies of neutron reaction products. The original event energies possible are 1.78MeV, 6% alpha branch, 1.47MeV, 94% alpha branch, 1.03MeV 6% Li+ branch, and 840keV, 94% Li+ branch and events due to these maximum energies are visible as edges in the event spectrum shown in Figure 7.

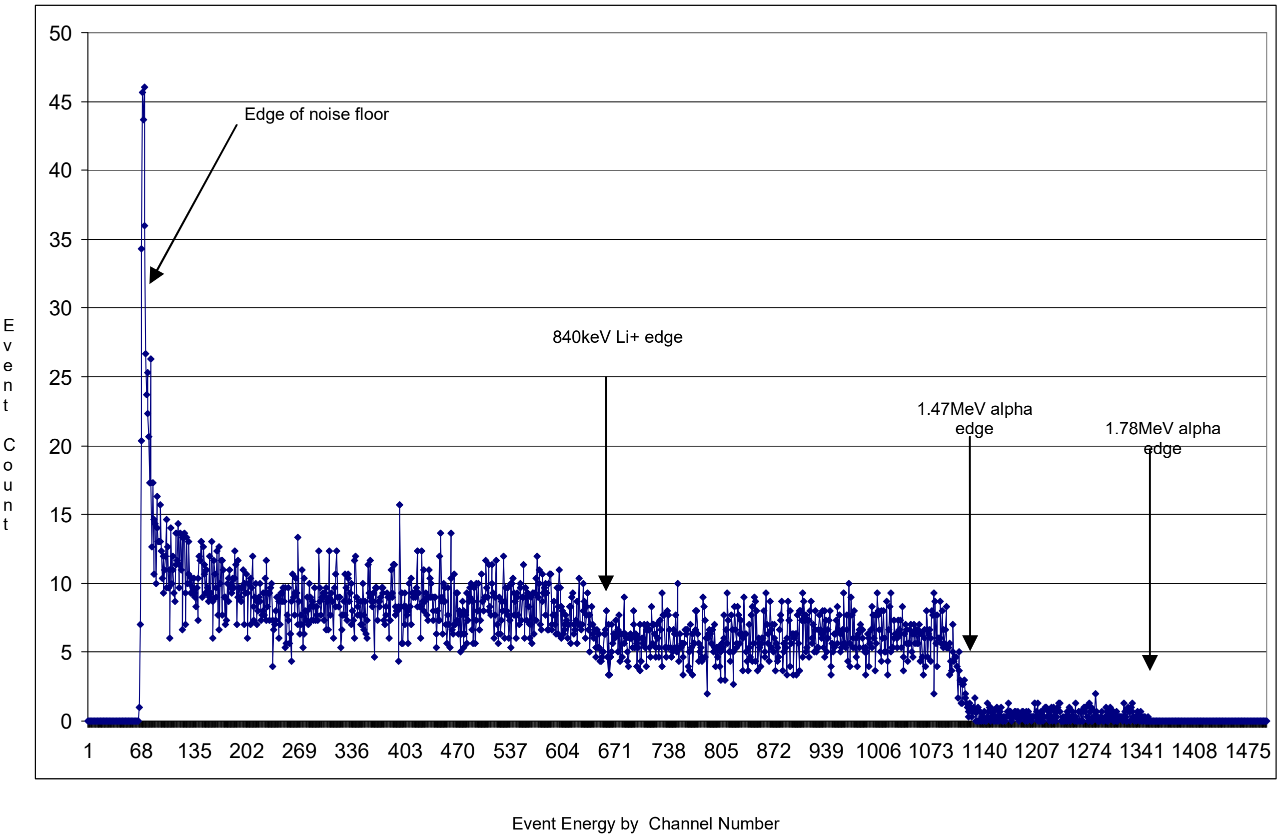

Fig. 7 Energy distribution of typical thermalised neutron spectrum

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