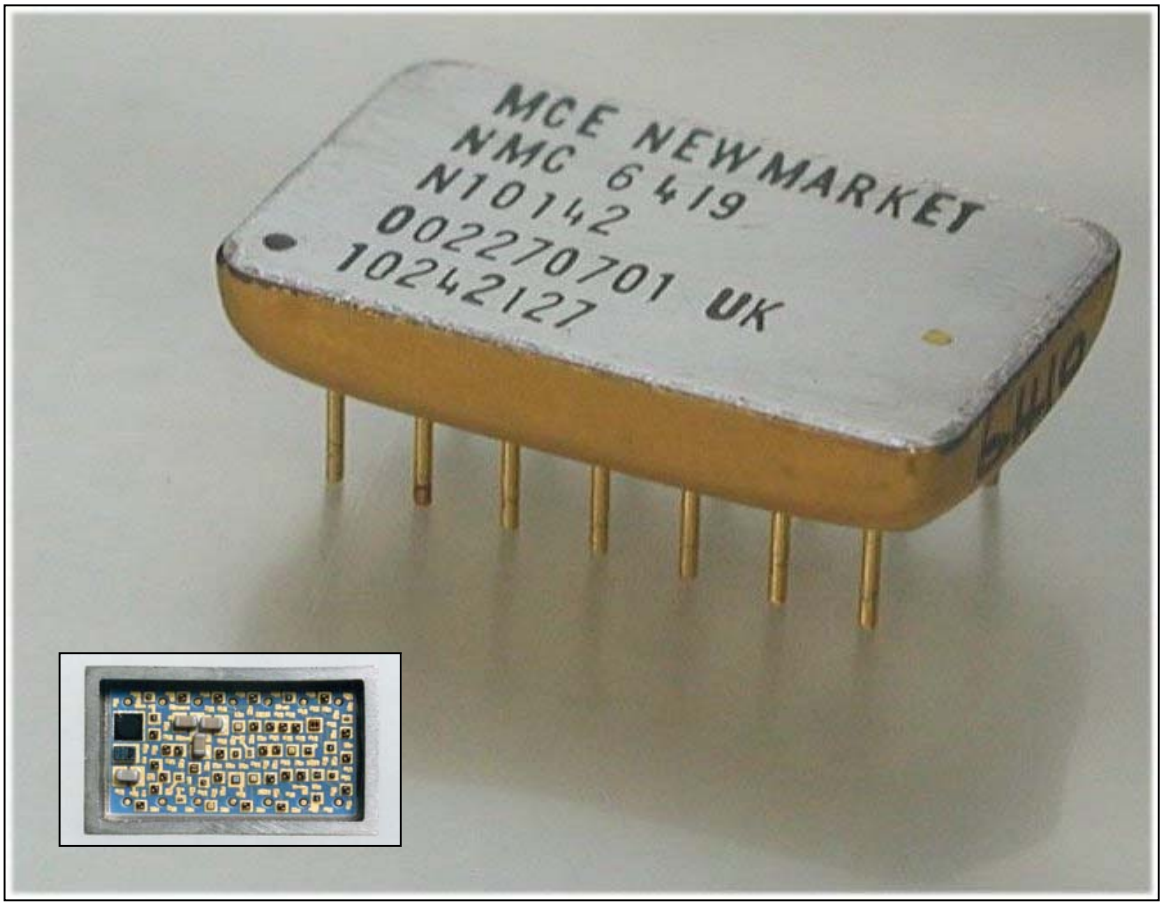
Nuclear Event Detector



General description

The Matra BAe Dynamics (MBD) Nuclear Event Detector (NED) offers a low power, hybrid solution to the detection of radiation in low level (tactical) nuclear weapon environments.

The NED has provision for setting a nominal trigger threshold between 1E3 and 1E5 Gy(Si)/s [1E5 and 1E7 cGy(Si)/s = rad(Si)/s] using a single external resistor.

The detection output pulse width can be set between 0.1ms and 10ms {nominal} with a single external capacitor.

The NED outputs may be used to support Nuclear Hardening design e.g. To initiate power supply circumvention and generate microprocessor system interrupts.

The NED is currently available in a standard footprint 14 pin dual in line (DIL) package (0.1" pitch and 0.3" spacing).
A surface mount variant is being developed (contact manufacturer for details).

The NED has a Nuclear Event Detection (NED) pulsed output.

The NED has a Nuclear Event Flag (NEF) output which can be reset by either of two complementary inputs.

The NED has a built-in-test (TEST) input.

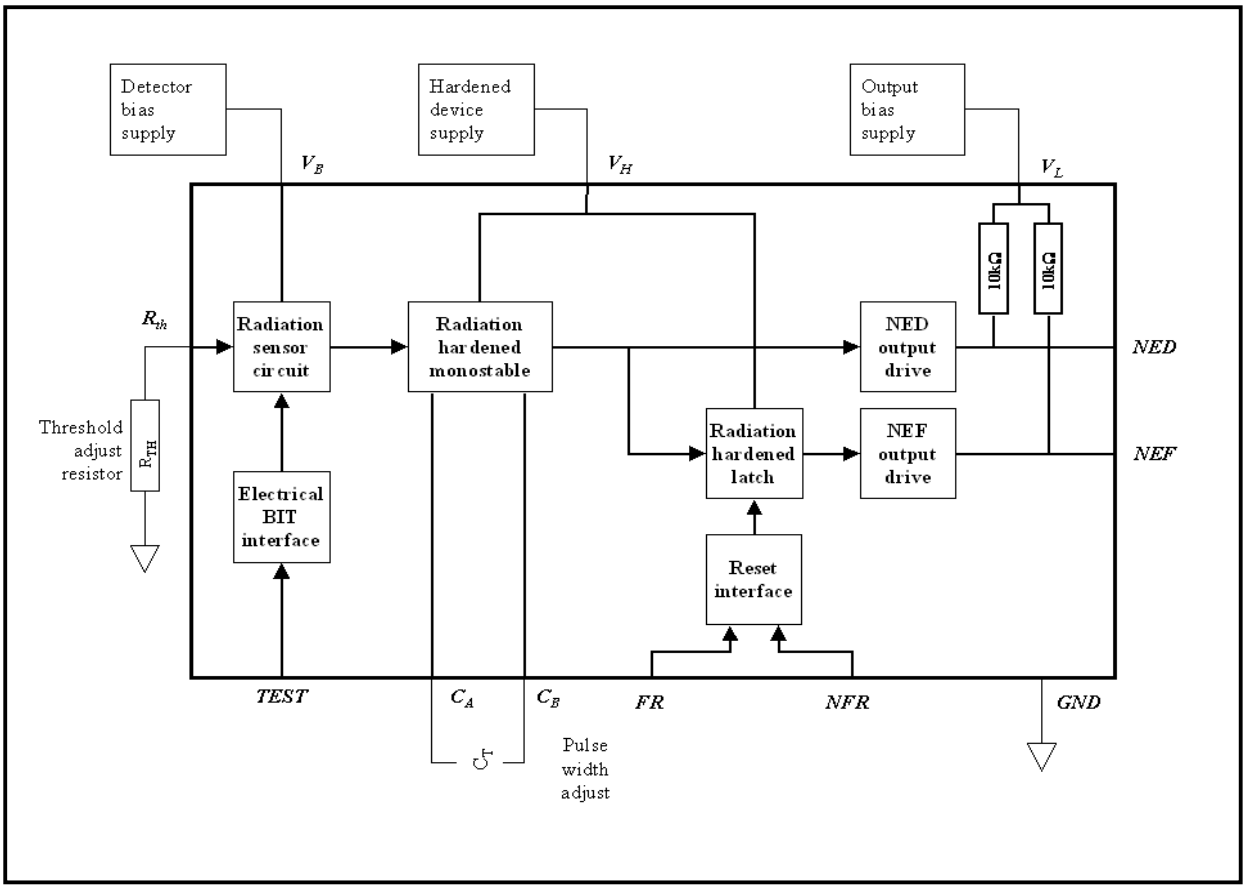
The NED is radiation hard to tactical weapon environments and operates over the military temperature range.

Nuclear Event Detector

Functional Description

Pin	Designation	Description / function
1	*VL*	Output load supply - provides a supply to the NED and NEF outputs via internal 10 kohm resistors. External pull up resistors may also be used.
2	*NED*	Nuclear Event Detection output - provides an active low output for the period set by th external timing capacitor.
3	n/c	No internal connection.
4	*CB*	External timing capacitor (low) - connection for external timing capacitor. If an electrolytic capacitor is used, this pin should be connected to the -ve side.
5	*CA*	External timing capacitor (high) - connection for external timing capacitor. If an electrolytic capacitor is used, this pin should be connected to the +ve side.
6	*TEST*	Built in test input - provides means for electrical stimulation of the NED.
7	*GND*	Ground and case.
8	*VB*	PIN diode bias supply - provides a separate supply to the radiation detector.
9	*Rth*	External threshold set resistor - connection for the external radiation threshold set resistor. The other end of the resistor should be connected to ground (Pin 7). The resistor should be as close as possible to the NED.
10	n/c	No internal connection.
11	*NFR*	Flag reset (active low) - provides an active low reset input to the NEF bistable.
12	*FR*	Flag reset (active high) - provides an active high reset input to the NEF bistable.
13	*NEF*	Nuclear Event Flag output - provides an active low bistable output. The bistable output is set when the NED triggers.
14	*VH*	Device supply - provides supply to the internal NED electronics.

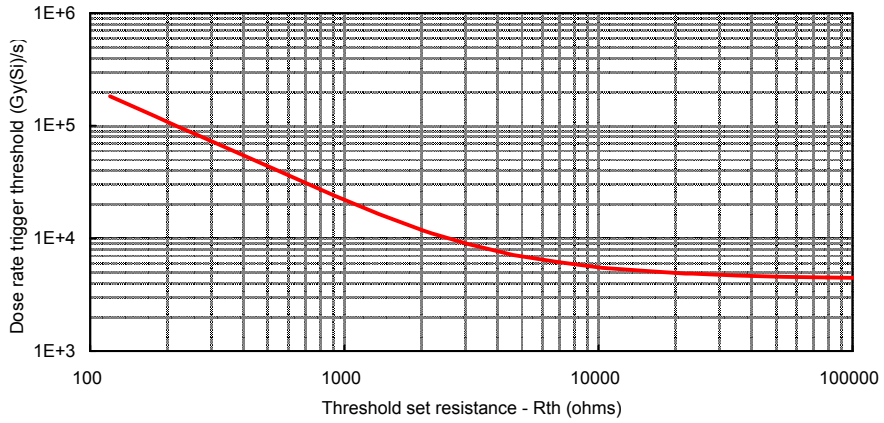
NED Block Diagram



Nuclear Event Detector

Typical performance curves

Figure 1 : Trip threshold vs. threshold resistance



Radiation pulse width = 100ns

Figure 2 : NED output pulse width vs. timing capacitance

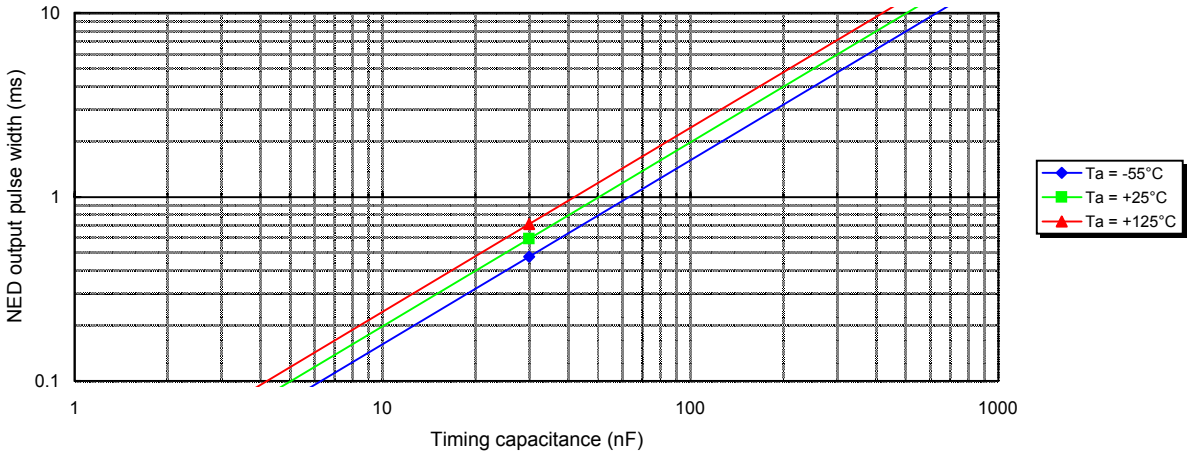
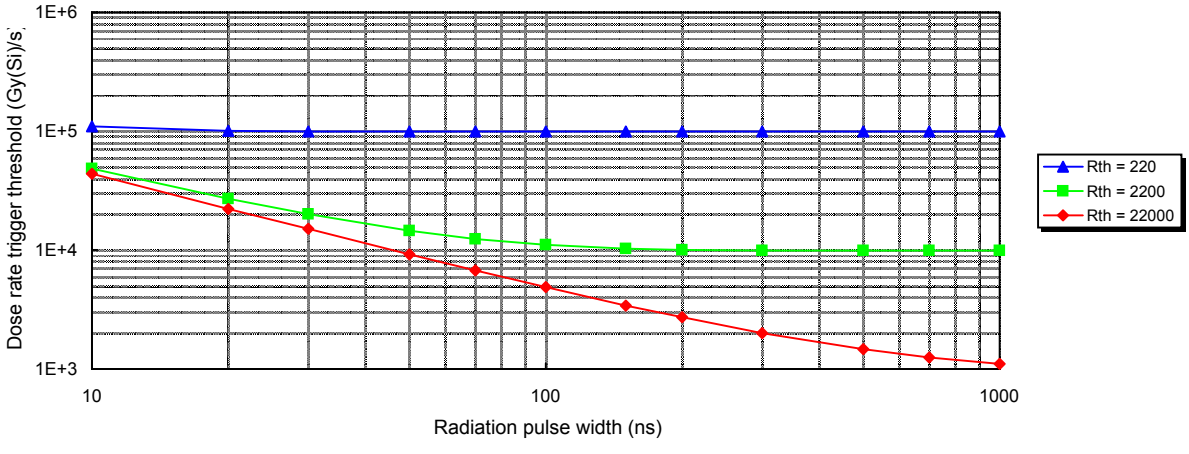


Figure 3 : Trip threshold vs. radiation pulse width



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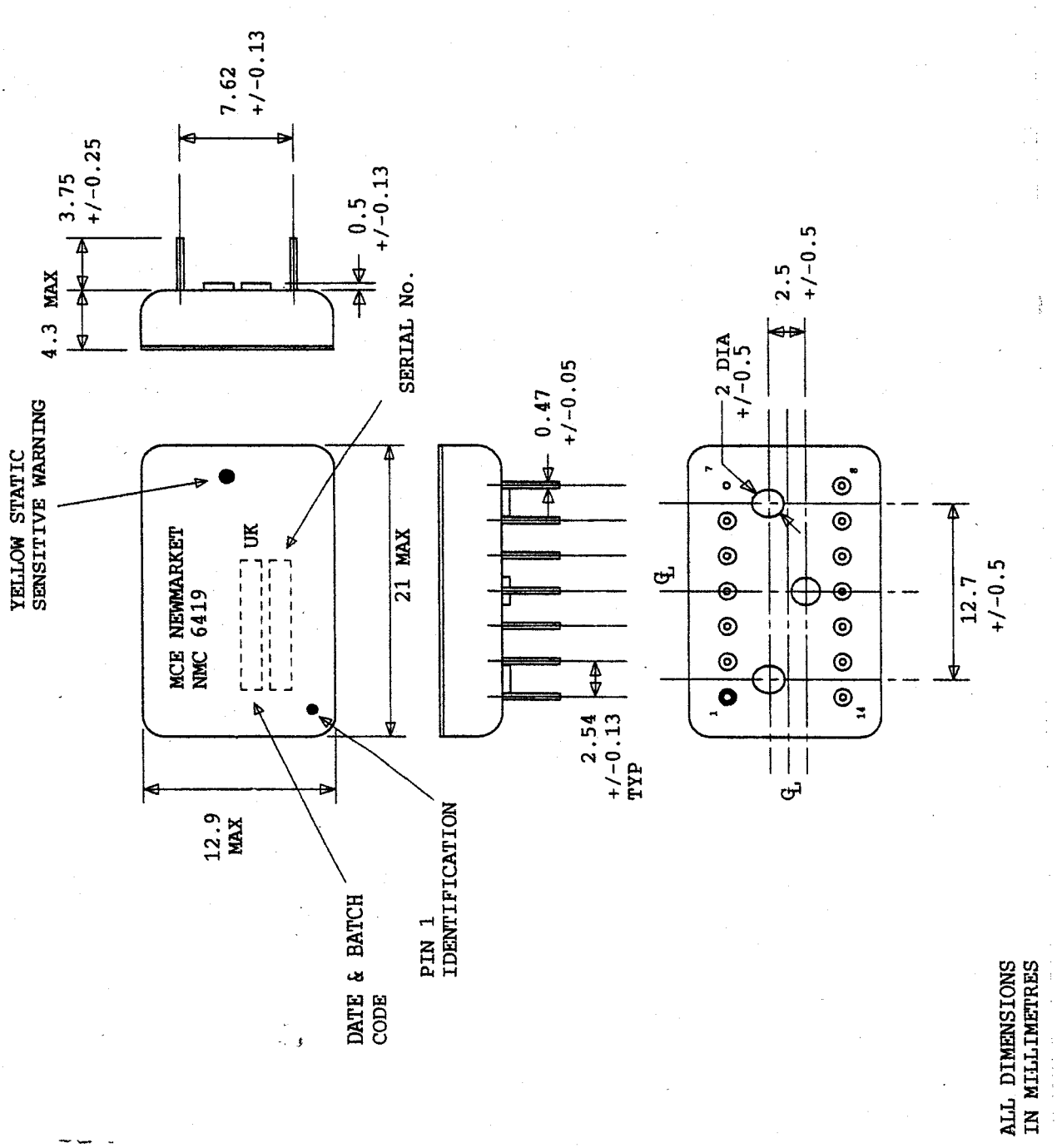
Package Outline



Nuclear Event Detector

Electrical specification

	PARAMETER	LIMIT
ABSOLUTE MAXIMUM RATINGS	Voltage at pins 6, 11, 12 and 14 w.r.t. pin 7	7.0V
	Voltage at pins 1 and 8 w.r.t. pin 7	30.0V
	Storage temperature range	-55°C < Ta < +150°C
ELECTRICAL CHARACTERISTICS	Maximum environmental operating conditions §	
	Operating temperature range	-55°C < Ta < +125°C
	Ionising radiation dose rate	2E6 Gy(Si)/s
	Ionising total dose	5 Gy(Si)
	Neutron fluence	1E11 n/cm²

DC

	PARAMETER		CONDITION	MIN	TYP	MAX	UNITS
Power	***VH***	VH		4.5	5.0	5.5	V
		IH	Standby, VH=5.5V			2.0	mA
			Flag set, VH=5.5V			6.0	mA
			Operational, VH=5.5V			15.0	mA
			During irradiation, VH=5.5V †			100	mA
	VL	VL		4.5	15.0	20.0	V
		IL	VL=20.0V			100	µA
	VB	VB	Standby / flag set	4.5	15.0	20.0	V
		IB	Standby / flag set			2.0	µA
			During irradiation, VB=20V ‡			100	mA
Inputs	***FR***	Vil				0.7	V
		Iil	Vi=0.7V		0.5	1.0	mA
		Vih		3.0			V
		Iih	Vi=3.0V		2.3	3.0	mA
		Vsw		0.7	2.1	2.9	V
	NFR	Vil				0.7	V
		Iil	Vi=0.7V		-1.0	-3.0	mA
		Vih		4.0			V
		Iih	Vi=4.0V		-0.1	-1.0	mA
		Vsw		0.8	1.2	1.6	V
	TEST	Vil				0.7	V
		Iil	Vi=0.7V		0.5	1.0	mA
		Vih		4.0			V
		Iih	Vi=4.0V		3.3	4.0	mA
		Vsw		0.7	2.1	2.9	V
Outputs	***NED***	Voh	VL=20V, Io=-100µA	18.5			V
		Vol	Iol=10mA			0.6	V
			Iol=20mA			0.7	V
	NEF	Voh	VL=20V, Io=-100µA	18.5			V
		Vol	Iol=10mA			0.6	V
			Iol=20mA			0.7	V

AC

	PARAMETER		CONDITION	MIN	TYP	MAX	UNITS
Inputs	***TEST***	Pulse width¶	Vtest=0 to 4V	250			ns
		NED delay¶			1	10	µs
		NEF delay			1	10	µs
	FR	Pulse width	Vfr=0 to 4V	250			ns
		NED delay			1	1	µs
	NFR	Pulse width	Vnfr=5 to 0.7V	500			ns
		NED delay			1	1	µs
Outputs	***NED***	Delay	Pull up=220ohms		50	50	ns
	NEF	Delay	Pull up=220ohms		200	200	ns
	Pulse width		Vh=4.5 to 5.5V	10	20	30	µs/nF

Notes :
§ Electrical characteristic specifications valid over full environmental ranges
† Maximum charge during irradiation = 50nC
‡ Maximum charge into Rth input = 2nC excluding current into threshold set resistor
¶ NED active when TEST input active - pulse duration timed from negative edge of TEST input

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Technical

There has been extensive research into Nuclear Event Detectors (NED) together with associated circuits and circumvention techniques. Very few products are available on the open market however. The design of circuits operate through an event is fraught with difficulties and few researchers have taken concepts further than achieving a desired radiation performance operating at nominal supplies and ambient temperature. Because of the largely unpredictable response of integrated circuits to the dose rate environment, integrated circuits can only be used with extreme care. The best devices for use in these radiation environments ideally include isolation of the substrate (e.g. SOS or SOI) however devices utilising these technologies are few and far between and usually carry a major cost penalty. The majority of implemented designs are based on discrete components where the response can be tailored to assist the required response of the device.

Detection of the ionising radiation is usually only the first stage and either circumvention or power supply switching is required to remove power from the electronics to be protected. Careful implementation is required to avoid increasing the power supply output impedance thereby causing the electronics to suffer from dropouts during normal operation, ensuring that power supplies are inhibited when crowbars are active to avoid crowbar destruction and to prevent spurious triggering and EMI related shut down. Matra BAe Dynamics (MBD) has a wealth of such experience.

Primary power supplies are invariably required to operate through an event with power on as it is difficult to remove the energy stored in the input stages; this forces design constraints which must be considered in the power supply design.

In general, the NED power and the power for any interface and/or crowbar drive circuits is derived from a system secondary supply. There are a many variables to consider, for example, the input supply tolerance, the operating voltage range of NEDs, the voltage drop across the isolation circuit, the power required by the NED in the active state, capacitor tolerance and the pulsed shutdown period tolerance. Careful attention must be paid to the power isolation circuit between the power supplies and the NED. MBD has implemented patented designs.

A surface mount NED is planned to accommodate the changes in packaging technology.

With the requirement for low standby currents, particularly in hand held, portable or battery maintained equipments, a short-term evolutionary design modification for a low power variant is planned. The maximum standby current is expected to decrease from 2mA to <500µA.

A radical redesign is planned for the longer term to produce a micropower, low voltage NED to support the proliferation of low power technologies and portable equipments

For technical information please contact:-

Radiation Effects Department Head (FPC 005)
Matra BAe Dynamics
PO Box 5, Filton
Bristol
BS34 7QW
Tel: +44 (0) 1179 318235

For product information please contact:-

Sales and Marketing Manager
Micro Circuit Engineering (MCE) Newmarket
Exning Road
Suffolk
CB8 0AU
Tel: +44 (0) 1638 663381

