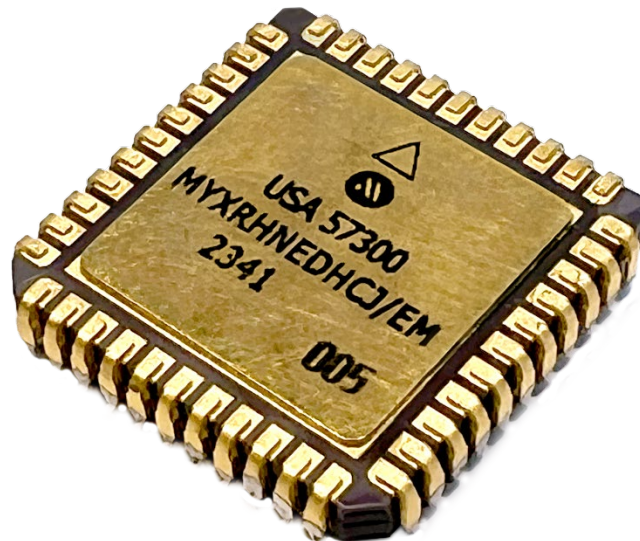


Nuclear Event Detector (NED)

Preliminary Datasheet

Part Number: MYXRHNEHCJ/X



Preliminary Data Sheet

Micross Components' MYXRHNEHCJ/X Nuclear Event Detector provides a functional replacement for the nearly 40-year old legacy NED solution. However, the MYXRHNEHCJ/X provides improvements in multiple areas including reductions in size, weight and power; reduced minimum dose rate threshold, (4X lower), reduced detector delay time (25% faster), reduced dose rate threshold variation over temperature, and improvements in obsolescence mitigation and reliability, including the use in-house sourced PIN diode and ASIC.

Key Features

- Gamma dose rate sensitivity threshold range adjustable from 5×10^4 to 2×10^7 rads(Si)/sec.
- 44 pin J-Lead SMT package
- Differential line drivers and receivers
- Radiation specs:
 - Total Dose (device survivability): 1×10^6 rads(Si)
 - Dose Rate (operate through): 1×10^{12} rads(Si)/sec
 - Neutron Fluence (operate through): 5×10^{13} neutrons/cm²
- Delay from radiation detected to output signal asserted: 15 ns
- 3.3V power requirement
- -55 to +125° C temperature range
- Differential line drivers and receivers all operate through prompt dose without extra shielding

Benefits

- Low minimum dose rate sensitivity
- Fast delay time to enable rapid shutdown and minimize damage to other electronics
- Rad hard for strategic environments
- Small size
- Built-in differential drivers and receivers provide improved noise immunity
- Use output signal to shut down power supplies, take processors offline and block memory write operations

Applications

- Aircraft and drones
- Missiles and bombs
- Satellites
- Military ground vehicles
- Nuclear Material Storage

Revision History

Revision	Description	Release Date
0.1	Initial Draft of Advanced Information Datasheet	08/15/2023
0.2	Updated After Testing	03/22/2024
1.0	Initial Release of Advanced Information Datasheet	04/08/2024
1.1	Correction to Table 1, Neutron Fluence	04/09/2024
1.2	Updated block diagram and outline drawing, addition of signal pinout and description table, addition of PC board pad recommended pad locations drawing and various editorial changes.	09/26/2024
1.3	Updated signal descriptions for pins 27 and 28, NED_RST_H and NED_RST_L, to correct error in indicated signal polarity.	10/10/2024
1.4	Reversed signal names for NED_DET_H and NED_DET_L signals (pins 4 and 5) and for NED_FLG_H and NED_FLG_L signals (pins 43 and 44). Also, updated the descriptions for these signals.	10/11/2024
1.5	Corrected errors in signal description for pins 43 and 44, NED_FLG_H and NED_FLG_L.	10/30/2024
1.6	Updated outline drawing, including adding dimensional tolerances.	2/19/2025
1.7	Updated ordering information	4/16/2025

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1.0 Description

Micross Components' MYXRNEDHCJ/X Nuclear Event Detector (NED, Figure 1) can detect gamma radiation pulses from a nuclear event. Within 15 ns following the leading edge of an incoming gamma radiation pulse, the NED will assert its differential pulse and level output signals. The NED's level output may then be reset by the assertion of a differential input signal. The MYXRNEDHCJ/X features a minimum dose rate threshold of 5×10^4 rads(Si)/sec, thereby providing higher sensitivity than currently available NEDs. Users can increase the dose rate threshold upwards, to up to 2×10^7 rads(Si)/sec, by means of an external adjustment resistor. The NED, which is available in a 44 pin J-Lead ceramic package, is radiation hardened, enabling it to operate reliably in environments with high gamma doses and dose rates, neutrons and heavy ions; and provide immunity to latch up. It achieves this by using a rad-hard-by-design ASIC designed specifically for this purpose. Since the ASIC contains the line drivers and receivers on-board as Rad Hard blocks, no additional consideration is need for those functions.

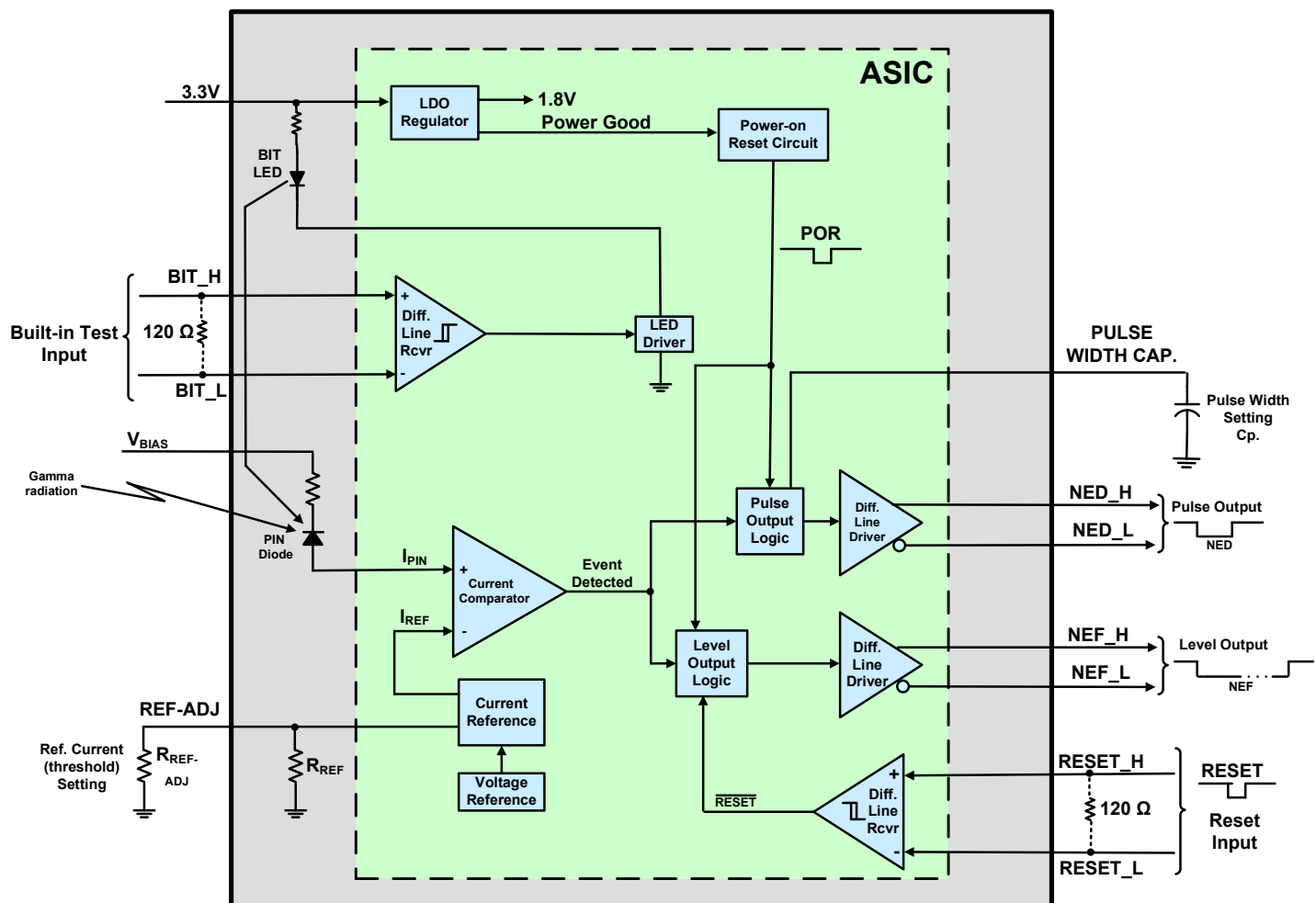


Figure 1. Nuclear Event Detector (NED) Block Diagram

2.0 Specifications

Table 1 provides the absolute maximum ratings for the MYXRNEDHCJ/X nuclear event detector (NED), while Table 2 provides the electrical and mechanical specifications and characteristics.

Table 1. Absolute Maximum Range			
Parameter	Min	Max	Unit
Hardened Supply Voltage	-0.5	5.0	V
PIN Diode Bias Voltage	0	100	V
Differential Receivers Line Voltage	-8.0	8.0	V
Differential Drivers Line Voltage	-0.5	3.6	V
ESD Sensitivity	Class 2		
Junction Temperature, T _J	-55	150	°C
Storage Temperature Range	-65	150	°C
Total Dose (Device Survivability)		1 x 10 ⁶	rads(Si)
Dose Rate (Operate Through)		1 x 10 ¹²	rads(Si)/sec
Neutron Fluence		5 x 10 ¹³	neutrons/cm ²
SEE LET Threshold		40	MeV-cm ² /g

Table 2. Electrical Specs and Characteristics						
Parameter	Symbol	Conditions	Min	Max	Unit	Group A Subgroups
Approximate Dose Rate Detection Range		V _{BIAS} = 20 volts	5 x 10 ⁴	2 x 10 ⁷	Rads(Si)/sec	
Dose Rate Threshold Variation Over Temperature		Relative to Room Temperature Threshold Over Temperature Range	-20	+20	%	
Hardened Power Supply Operational Voltage	V _{CC}		3.0	3.6	V	1,2,3
Hardened Power Supply Current (Notes 1 and 2) Both differential driver output circuits unterminated One differential driver output circuit terminated Both differential driver output circuits terminated	I _{CC}	V _{CC} = 3.3V		5 35 65	mA mA mA	1,2,3

Parameter	Symbol	Conditions	Min	Max	Unit	Group A Subgroups
PIN Diode Bias Voltage	V_{BIAS}		4.5	100	V	1,2,3
PIN Diode Bias Current Standby	I_{BIAS}			10	μA	1,2,3
Radiation propagation delay time (Notes 3 and 4)	t_D	$V_{BIAS} = 20 \text{ Volts}$		20	ns	
Gamma dose rate = 1×10^5 rads(Si)/second						
Gamma dose rate = 2×10^5 rads(Si)/second				15		
Gamma dose rate = 2×10^7 rads(Si)/second				7		
Differential Receivers' Voltage Threshold	V_{DR}	$V_{CC} = 3.3V$	-0.2	0.2	V_{PK}	1,2,3
Differential Receivers' Common Mode Voltage Range	V_{CM}	$V_{CC} = 3.3V$	-7.0	7.0	V	1,2,3
Differential Receivers' Hysteresis Voltage	$V_{RX-HYST}$	$V_{CC} = 3.3V$	50 typ.		mV	1,2,3
Differential Line Driver Differential Output Voltage	V_{DT}	$V_{CC} = 3.3V$	3.0	10.0	$V_{PK-to-PK}$	1,2,3
Pulse Output Pulse Width Range	t_{PULSE}	Adjustable by External Capacitor	0.1	10	ms	
RESET Pulse Width	t_{RESET}		250		ns	9,10,11
Operating Temperature Range	$T_{OPERATION}$		-55	+125	°C	
Package Options			Plastic and Ceramic BGA			
Outline Dimensions			17.11 x 17.55 x 3.05 typ. (0.691 x 0.691 x 0.12) typ.		mm (in)	
Mass (weight) Plastic BGA			0.2 typ. (0.007 typ.)		g (oz)	
Ceramic BGA			0.5 typ. (0.018 typ.)		g (oz)	
Lot Qualification and Acceptance Testing			In accordance with MIL-PRF-38534 Class H			

Notes:

1. The max. values for I_{CC} assume the dose rate threshold is set to its minimum value of 5×10^4 rads(Si)/sec. For the external adjustment threshold resistor selected for the maximum dose rate threshold of 2×10^7 rads(Si)/sec, the max. value of I_{CC} increases by 7 mA. Refer to section 3.5.

2. For the NED and NEF line drivers, the termination loads on the line drivers are assumed to be 120 ohms differential (resistive). The use of RC terminations will reduce power dissipation accordingly.
3. Dose rate threshold is set to its minimum value of 5×10^4 rads(Si)/sec.
4. Delay time t_d is defined as the time from the 50% point of the rising edge of the incoming gamma radiation pulse to the 50% point of the high-to-low voltage transition for the NED and NEF differential output signals.

3.0 Operation

3.1 ASIC-Based Design

Microcross' ASIC-based design provides multiple benefits relative to legacy nuclear event detectors:

1. It enables construction of a NED in a smaller and lighter package, capable of surviving prompt dose radiation.
2. Inclusion of differential drivers on chip improves overall response time, while legacy products suffer further response time degradation when external drivers are added.
3. By greatly reducing the number of components, wire bonds and interconnects, the Microcross NEDs' reliability (MTBF) will be significantly higher than that of other NEDs.
4. Use of sub-micron ASIC technology and operation from lower power supply voltages will reduce the NED's power consumption and dissipation.
5. As a means of mitigating against obsolescence, Microcross is not dependent on third-party suppliers for key components.
6. Microcross' selected trusted foundry is on-shore and offers a 180 nm process with the capability to produce chips that meet the NED's radiation requirements. These requirements are:
 - Total gamma dose: 300 krad(Si), with a goal of 1 Mrad(Si)
 - Gamma dose rate (operate-through): 1×10^{12} rads(Si)/sec
 - Neutron fluence: 10^{13} n/cm²

3.2 Functional Overview

As shown in Figure 1, the MYXRNEDHCHJ/X NED includes a 3.3V-to-1.8V LDO regulator. With the exception of the PIN diode and the two differential line drivers, all circuitry in the NED is powered by this on-ASIC's 1.8V supply rail. The two differential line drivers are powered directly by the 3.3V input power.

The NED includes a PIN diode to sense incoming gamma radiation from a nuclear explosion. Gamma radiation will result in current flowing through the reverse-biased PIN diode into the "+" side of a current comparator.

The input to the "-" side of the current comparator is provided by a reference circuit. This reference current is user-adjustable by means of the external resistor $R_{REF-ADJ}$ (see Figure 1 and section 3.8). As explained in section 3.5, installing a lower value for $R_{REF-ADJ}$ will increase the value of the reference current and as a result, increase the value of the NED's dose rate threshold.

When the PIN diode current exceeds the reference current, the output state of the comparator will assert active, thereby indicating that a nuclear event has been detected.

Following power turn-on, when the 1.8V regulator senses that its output has exceeded a voltage of approximately 1.0 volt, it will assert its POWER GOOD output signal. This will result in the generation of a

negative-going “POR” (power-on reset) pulse. This pulse will reset the NED’s two differential outputs NED and NEF to their quiescent (inactive) states of logic “1”. Once this occurs, the NED and NEF outputs will remain in their de-asserted states (high) until a nuclear event is detected.

Following the detection of a nuclear event, NED and NEF will transition from their quiescent, de-asserted states of logic “1” (high) to their active, asserted states of logic “0” (low). The NED output will assert low for a fixed amount of time, as determined by the value of an external capacitor (see Figure 1). The NEF (Flag) output will remain asserted until the receipt of a negative going pulse on the RESET differential input. A logic “0” pulse on the RESET input of 250 ns or more will clear the NEF output back to its de-asserted state.

3.3 PIN Diode

Similar to most existing NED designs, the sensing element in Microcross’s Nuclear Event Detector is a PIN diode. Most commercially available PIN diodes targeted to sensing applications are designed to operate at longer wavelengths, such as RF, visible, infrared, ultraviolet and X-ray. In particular, they’re not designed to be optimized for detecting gamma radiation. For use in its NED, Microcross has designed and fabricated its own PIN diode that’s optimized for detecting gamma radiation. This internal development and captive manufacturing will ensure Microcross with a reliable supply of PIN diodes, providing very strong mitigation against future obsolescence.

During its PIN diode development, Microcross Components focused on the goals of wide dynamic range and fast response time in response to short duration pulses of gamma radiation. The PIN diode development involved extensive testing and characterization of the PIN diode in a flash X-ray facility.

To provide a reverse bias voltage to the NED’s PIN diode, it’s highly recommended to apply a minimum voltage of +15V to the PIN_Diode_Bias input (V_{BIAS}). Although it’s possible to operate the NED from a lower value of V_{BIAS} , this will reduce the NED’s sensitivity and therefore increase its dose rate threshold. It’s also possible to reduce the NED’s minimum dose threshold level and response time to a nuclear event by increasing the value of this voltage above 15V.

In the case of a nuclear event, the PIN diode current can spike to very high levels depending on the radiation level. To provide protection, the NED includes a 2.5 k Ω current-limiting resistor in series with the PIN diode. For a worst case scenario and assuming $V_{BIAS} = 15V$, the maximum reverse bias current that would flow through the NED = $15V / 2.5\text{ k}\Omega = 6\text{ mA}$.

3.4 Detector Circuit

In addition to the PIN diode, the most critical functional block of the NED is its detector circuit. For this function, Microcross designed a current comparator circuit in its NED ASIC. In contrast to the voltage comparator used in legacy NEDs, Microcross’s use of a current comparator provides better speed performance by minimizing the impedance seen by the detector. This minimizes the value and effect of the circuit’s inherent RC time constant.

The detector circuit includes a reference current circuit. The reference circuit provides a DC current output based on the input from a precision voltage source. To allow users to set the value of the NED’s dose rate threshold, the reference current and therefore the dose rate threshold is programmable by means of an external resistor. The reference current circuit includes temperature compensation to offset temperature-dependent variations in the PIN diode and the current comparator. One of the goals for the detector’s current comparator circuit is to provide very fast detection speed that’s largely independent of the NED’s threshold sensitivity setting.

Based on the use of a custom PIN diode and the inherent advantages of a current comparator, the MYXRHNEHHCJ/X provides superior performance for minimum dose rate threshold and delay time performance.

The MYXRHNEHCJ/X provides a minimum dose rate threshold of to 5×10^4 rads(Si)/sec or lower. The major benefit of this is to detect the fast rising edge of the nuclear event sooner and to reduce the number of false negative indications.

Relative to other NEDs, the MYXRHNEHCJ/X also provides a significant improvement for the delay time between the leading edge of a gamma radiation pulse and the assertion of its output signal. The MYXRHNEHCJ/X will reduce the value of this internal time delay to 15ns. For users, NED delay time is a critical parameter, since shorter delays enable improved protection of other on-board electronic circuitry.

3.5 Variable Dose Rate Threshold

As shown in Figure 1, the NED provides a means to program the value of its dose rate threshold. This is done by connecting a resistor designated as $R_{REF-ADJ}$ between the signal $R_{REF-ADJ}$ and GROUND. If no resistor is connected between $R_{REF-ADJ}$ and GROUND, the dose rate threshold defaults to its minimum value of approximately 5×10^4 rad(Si)/sec. To configure the NED for a higher value of dose rate threshold, it's necessary to connect an external resistor between $R_{REF-ADJ}$ and GROUND.

To program for a value of dose rate threshold = DRT, the value of the external resistor should be:

$$R_{REF-ADJ} = \frac{2.9E9}{DRT^{1.0961}}$$

For example, to configure the NED for a dose rate threshold of 5×10^5 rad(Si)/sec, the value of the external resistor should be:

$$R_{REF-ADJ} = \frac{2.9E9}{(500,000)^{1.0961}} = 1,643 \, \Omega$$

3.6 Differential Line Drivers and Receivers

As shown in Figure 1, the MYXRHNEHCJ/X includes differential line drivers and receivers for the various digital output and input signals. It includes differential drivers for the NED pulse output and NEF level output, and differential receivers for the RESET and BIT input signals.

Differential drivers and receivers provide improved signal integrity, noise rejection and common mode rejection relative to single-ended drivers and receivers, especially single-ended drivers consisting of open-collector or open-drain circuits. Micross designed the differential drivers and receivers to provide reliable operation in the presence of the types of noise transients that occur during nearby nuclear events. To lessen the effects of noise, the receivers include built-in circuit protection, hysteresis and common mode rejection. The NED's differential drivers and receivers are designed to meet or exceed the requirements of the EIA RS-422 standard. For the transmitter outputs, this will include a minimum differential output voltage of 3.0 volts peak-to-peak.

The differential receiver for the RESET input will be biased to provide a logic "1" (inactive) output when there's no incoming signal, while the differential receiver for the BIT (Built-in Test) input will be biased to provide a logic "0" (inactive) output when there's no incoming signal. In addition, the differential receivers will include positive and negative threshold voltages of less than ± 0.2 V peak, provide a minimum hysteresis voltage of 50 mV and operate with common mode voltages equal to or greater than the range of -7V to +7V.

The external signals for the differential and single-ended line drivers and receivers will include clamping diodes to VCC and GROUND to protect against electrostatic discharge (ESD).

The delays through the MYXRNEDHCJ/X's on-ASIC differential line drivers are approximately 5 ns. Note that other NEDs provide single-ended open-collector drivers rather than differential drivers. In order to gain the benefit of differential signaling using these NEDs, it's necessary to use external differential drivers. For the MYXRNEDHCJ/X, the inclusion of the internal differential drivers provides a large improvement over the use of external drivers, which add additional delays of approximately 15 ns.

To ensure reliable operation of the NED_H and NED_L differential pulse type output and/or the NEF_H and NEF_L differential level type output, it's necessary to terminate the end of the differential cable going into a differential receiving circuit with a resistor that matches the cable's differential characteristic impedance. For signals adhering to the RS-422 standard, the standard value for the cable characteristic impedance and terminating resistance is 120 ohms.

3.7 Differential and Single-ended Operation

The NED's BIT and RESET inputs, and NED and NEF outputs can be operated as either differential pairs or as single-ended signals. As shown in Figure 1, to operate the BIT and/or RESET inputs in differential mode, it is recommended to connect a 120 ohm termination resistor between BIT_H and BIT_L or between RESET_H and RESET_L. To operate these inputs in single-ended mode, it is recommended to connect a termination resistor between the used input signal (e.g., BIT_H) and GROUND and to connect the unused input (e.g., BIT_L) to a voltage of approximately $0.5 \times V_{DD}$ through a simple resistive voltage divider.

Similarly, the NED's NED and NEF output signals can also be operated as either differential pairs or as single-ended signals. When operating NED_H and NED_L and/or NEF_H and NEF_L in differential mode, it is recommended to connect a termination resistor across the receiving end of the differential link. The value of this resistor should match the characteristic impedance of the interconnecting cable. For RS-422 type signals, cables with 120 ohm impedance are commonly used. To use these output signals in single-ended mode, it is recommended to connect a termination resistor (e.g., 120 ohms) between the used signal conductor (e.g., NED_H) and GROUND at the receiving end of the signal link.

3.8 NED_H/NED_L Pulse Width Setting

To program the pulse width duration from the NED_DET_H/NED_DET_L differential output, connect a capacitor between the signal Pulse Width Cap. and ground. The value of this capacitor should be:

$$\text{Cap value} = \frac{\text{Pulse (sec)}}{16,000}$$

For example, for a pulse width = 100 μ s,

$$\text{Cap value} = \frac{0.0001}{16,000} = 6.25 \text{ nF}$$

3.9 Radiation Testing

Each MYXRNEDHCJ/X NED chipped will be tested for a dose rate threshold of approximately 5×10^4 rads(Si)/sec, the specified minimum value.

3.10 Built-In Self-Test

To enable Built-in self-test (BIT), the MYXRNEDHCJ/X includes an LED. This LED will be controlled by the BIT (built-in test) input signal. When BIT is asserted to logic “1”, the LED will illuminate the PIN diode. During this test, if the Event Detected signal asserts high, the self-test will be considered to have passed and the NED’s output signal will assert active. However, if the NED and NEF signals remain inactive, the self-test will have failed.

3.11 Pinout and Signal Descriptions

Table 3 provides the pinout and signal descriptions for the NED.

Table 3. Signal Pinout and Descriptions			
Pin Number	Signal Name	Input or Output	Description
1	N/C	--	
2	GROUND	--	GROUND
3	GROUND	--	GROUND
4	NED_DET_H	Output	NED differential pulse output. Quiescently, NED_DET_H outputs a high level and NED_DET_L outputs a low level. When the NED detects a nuclear event, NED_DET_H transitions to a low level and NED_DET_L transitions to a high level for the programmed duration of the pulse output. The length of the pulse is determined by the value of the external pulse width control capacitor connected between pin 14 and GROUND.
5	NED_DET_L	Output	
6	N/C	--	
7	GROUND	--	GROUND
8	GROUND	--	GROUND
9	N/C	--	
10	V _{DD}	Input	3.3V power input
11	V _{DD}	Input	3.3V power input
12	V _{DD}	Input	3.3V power input
13	N/C	--	
14	Pulse Width Cap.	--	As described in section 3.8, the duration of the NED’s pulse type output asserted by the differential pair NED_DET_H and NED_DET_L needs to be configured by connecting a capacitor between Pulse Width Cap. and GROUND.
15	N/C	--	
16	N/C	--	
17	POR_cap	--	This pin may be left unconnected. However, it may be used to increase the NED’s power-on reset time. To do that, connect an external capacitor between POR_cap and GROUND.
18	GROUND	--	GROUND
19	N/C	--	
20	N/C	--	
21	GROUND	--	GROUND
22	R _{REF-ADJ}	--	External resistor to adjust the NED dose rate threshold. To configure the NED for its minimum dose rate threshold of 5×10^4 rad(Si)/sec, this pin should be left open. As described in section 3.8, the NED’s dose rate

Table 3. Signal Pinout and Descriptions

Pin Number	Signal Name	Input or Output	Description
			threshold can be adjusted to a higher value by connecting a resistor between R _{REF-ADJ} and GROUND.
23	N/C	--	
24	BIT-H	Input	Differential Built-in Test (BIT) input. To perform the NED's built-in test, this signal should be asserted with BIT-H driven high relative to BIT-L. To determine if the NED has passed its built-in test, verify that the NEDA_DET_H(L) pulses for the period programmed by the Pulse Width Cap. and that NEDA_FLG_L asserts its latched level output until NED_RST_H(L) is asserted.
25	BIT-L	Input	
26	N/C	--	
27	NED_RST_H	Input	Differential NED Reset input. For normal operation, NED_RST_H should be asserted high and NED_RST_L should be asserted low. Following detection of a nuclear event, the NED_FLG_H(L) latched differential level output will assert. To clear the NED_FLG_H(L) output, it's necessary to assert NED_RST_H(L). This is done by driving NED_RST_H low and NED_RST_L high for a minimum of 250 ns.
28	NED_RST_L	Input	
29	1.8V	Input	Internal 1.8V output. No connection necessary.
30	N/C	--	
31	N/C	--	
32	GROUND	--	GROUND
33	GROUND	--	GROUND
34	N/C	--	
35	PIN_Diode_Bias	Input	PIN Diode Bias. To provide a reverse bias voltage to the NED's PIN diode, it's necessary to apply a minimum voltage of +15V to the PIN_Diode_Bias input. It's possible to reduce the NED's response time to a nuclear event by increasing the value of this voltage.
36	N/C	--	N/C
37	N/C	--	N/C
38	N/C	--	N/C
39	N/C	--	N/C
40	N/C	--	N/C
41	N/C	--	N/C
42	N/C	--	N/C
43	NED_FLG_H	Output	NED latched flag output. Quiescently, NED_FLG_H outputs a high level and NED_FLG_L outputs a low level. When the NED detects a nuclear event, NED_FLG_H transitions to a low level and NED_FLG_L transitions to a high level. The state of this differential output signal is internally latched and the output remains asserted until the NED_RST_H(L) input is asserted by driving NED_RST_H low and NED_RST_L high for a minimum of 250 ns.

3.12 Packaging

For the MYXRNEDHCJ/X, the package size is a 17.53 x 17.53 x 3.05 mm (0.690 x 0.690 x 0.12 in.), 44-pin J-lead surface mount package. Figure 2 is the package outline drawing, while Figure 3 is the recommended PC board pad placement diagram.

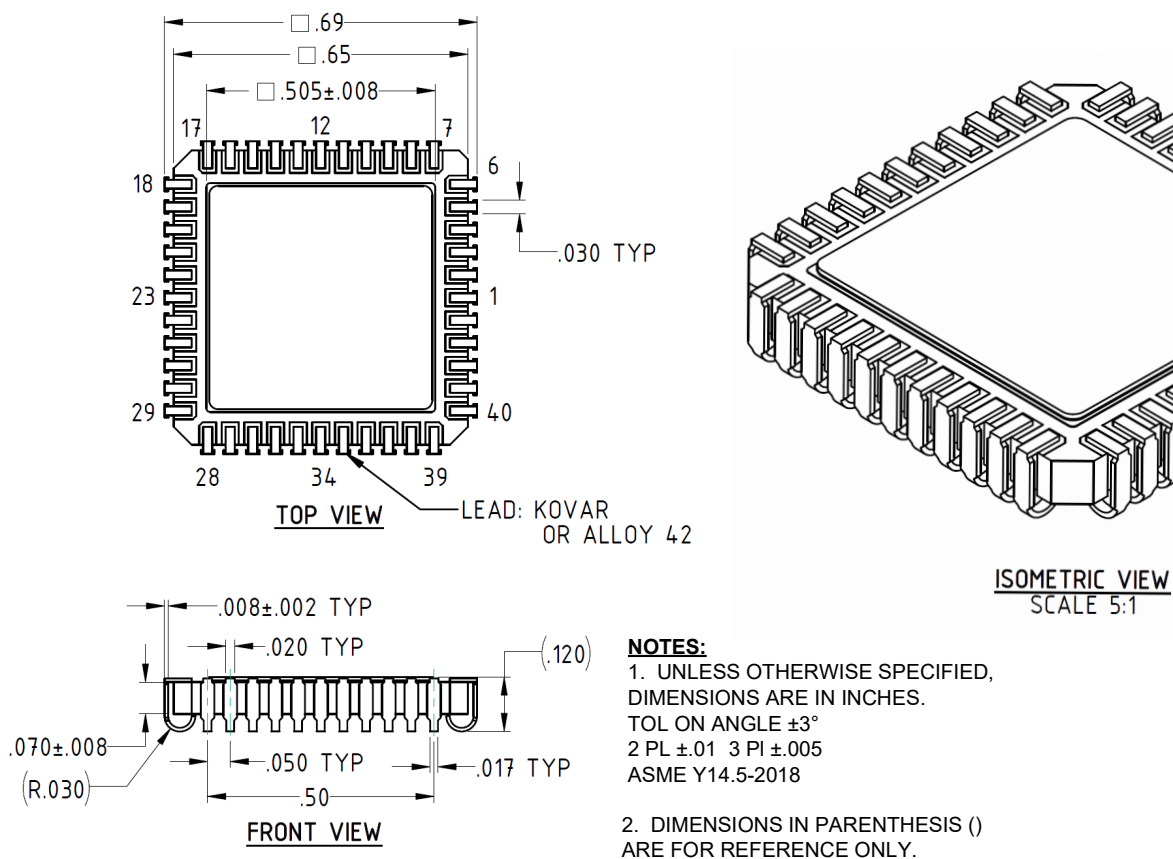
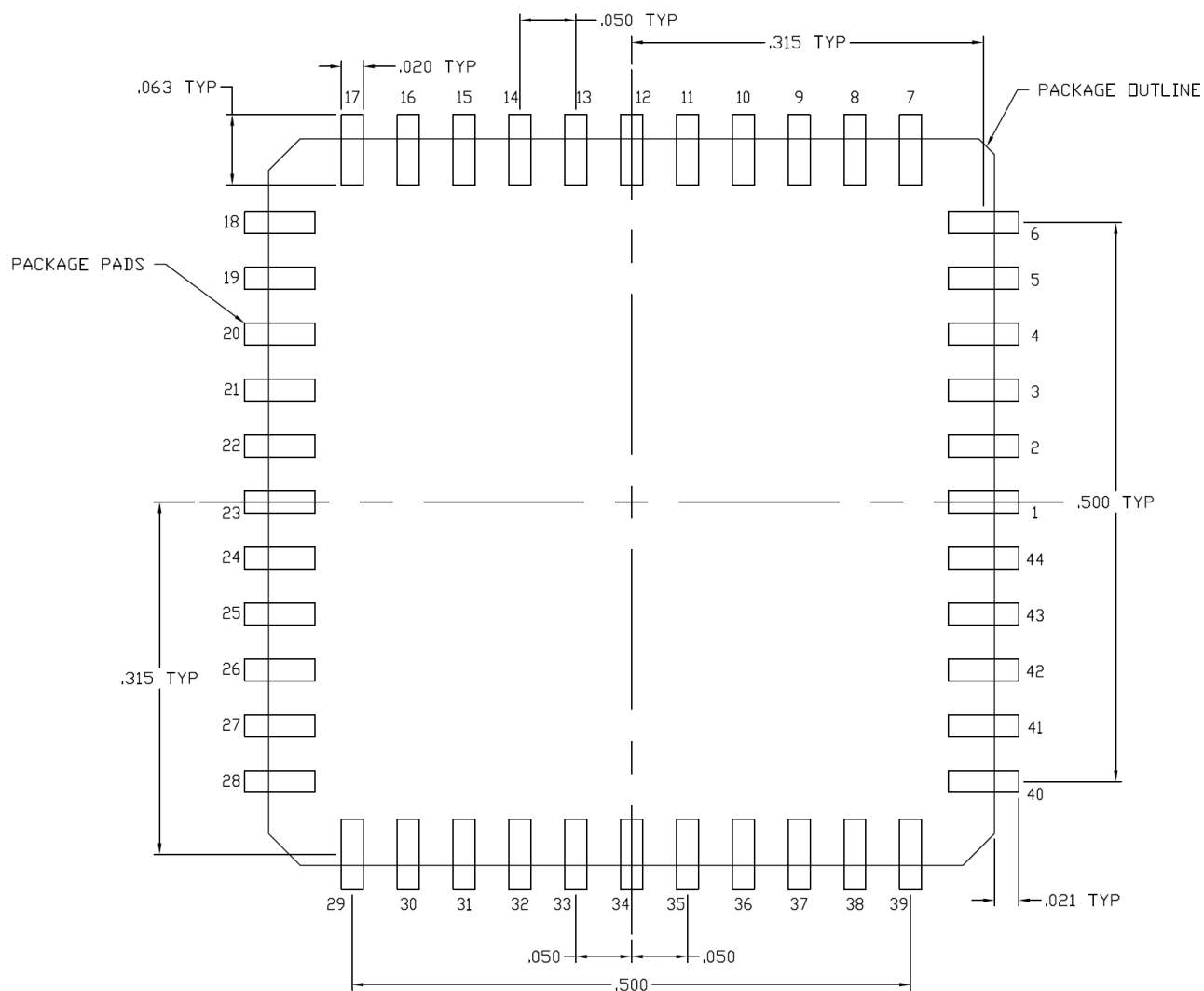
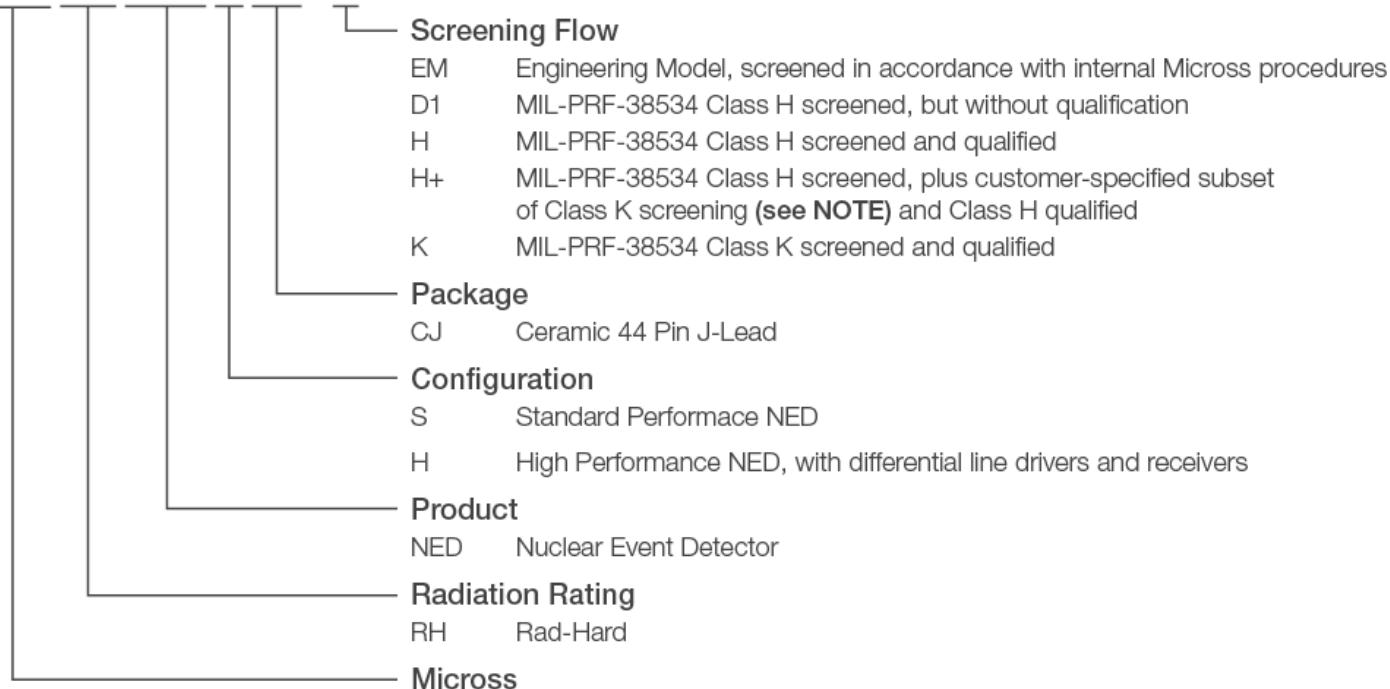


Figure 2. 44-pin J-Lead Surface Mount Package Outline



4.0 Ordering Information

MYX RH NED D CJ / X



NOTE: Customer-specified Class H+ screening options include PIND Testing, X-Ray, 100% Pull Test, One-Lot Date Code, Pre-Cap Source Inspection and Solder Dipping

Disclaimer:

The information in this Preliminary Data Sheet is believed to be accurate; however, no responsibility is assumed by Microcross Hi-Rel Components for its use, and no license or rights are granted by implication or otherwise in connection therewith. Specifications are subject to change without notice. Further, although Microcross is currently able to supply small quantities of this product to interested customers, the product described herein has not yet been qualified in accordance with MIL-PRF-38534. For production, Microcross plans on offering versions of the product with Class H or Class K qualification in compliance with MIL-PRF-38534.