

50Ω

DC to 20 GHz

**The Big Deal**

- Internally matched to 50 Ohm
- Minimal slope deviation of  $\pm 0.4$  dB typical
- Small form-factor 0.80 x 0.56 inches
- Power handling of 2W



CASE STYLE: RA2937

**Product Overview**

Mini-Circuits' ZEQ-9-24K+ is a broadband, connectorized negative slope equalizer, with a slope of 9.2 dB typ. over the range of DC to 20 GHz. The model is bi-directional and offers excellent electrical performance in applications where frequency dependent losses due to skin-depth (positive gain slope) hinders the overall system performance. The small form factor model comes with complementary connectors to avoid use of any additional adapters and operates over a wide temperature range of  $-55^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$ .

**Key Features**

| Feature                                      | Advantages   |
|--|--|
| Minimal slope deviation of $\pm 0.4$ dB typ. | Provides low signal distortion over the broadband range from DC – 20 GHz   |
| Good 50 Ohm match over broadband             | Model offers good return loss of 15 dB typ. over entire band, minimizing signal distortion.  |
| Small form factor                            | Model is offered in a small case size of 0.80" x 0.56" providing advantages in densely clustered systems.                                      |
| Wide operating temperature                   | The device operates over a wide temperature range of $-55^{\circ}\text{C}$ to $+105^{\circ}\text{C}$ with slope deviation of $\pm 0.4$ dB typ. |

**Notes**

- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.  
 B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.  
 C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the Standard Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at [www.minicircuits.com/MCLStore/terms.jsp](http://www.minicircuits.com/MCLStore/terms.jsp)

In-Line, Coaxial

# Broadband Slope Equalizer

50Ω DC to 20 GHz

## ZEQ-9-24K+



Generic photo used for illustration purposes only

CASE STYLE: RA2937

| Connectors      | Model      |
|-----------------|------------|
| 2.92mm (K-type) | ZEQ-9-24K+ |

**+RoHS Compliant**

The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

### Maximum Ratings

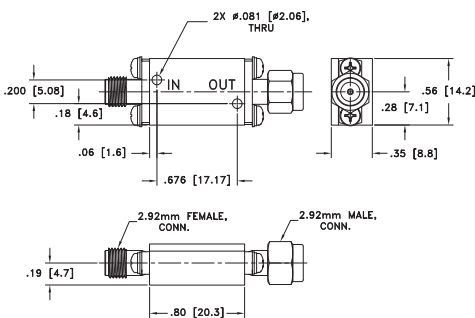
|                       |                |
|-----------------------|----------------|
| Operating Temperature | -55°C to 105°C |
| Storage Temperature   | -65°C to 150°C |
| Input power*          | +33 dBm        |

Permanent damage may occur if any of these limits are exceeded.  
\*Max. RF power rating is the same in either directions.  
Derate to 30 dBm at 105°C.

### Coaxial Connections

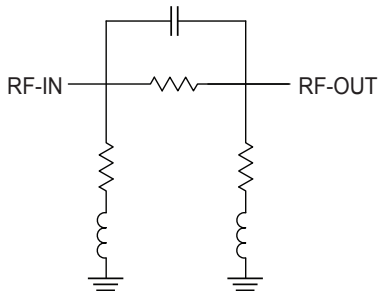
|        |                |
|--------|----------------|
| Input  | 2.92 mm Female |
| Output | 2.92 mm Male   |

### Outline Drawing

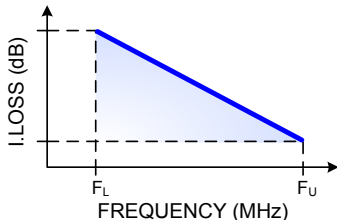


Weight: 25 grams

### Simplified Functional Schematic



### Typical Frequency Response



### Features

- Negative slope of 9.2 dB typ. (other slope values available)
- Wideband operation, DC – 20 GHz
- Minimal slope variation, +/- 0.4 dB typ.
- Small form factor 0.80" x 0.56"

### Applications

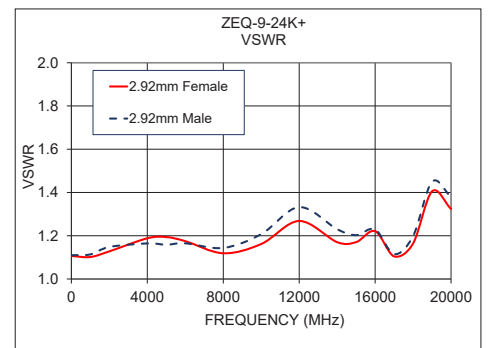
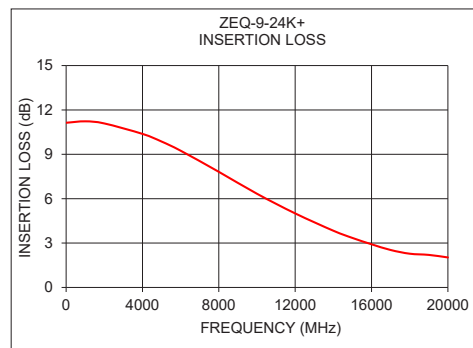
- Amplifier Gain slope compensation
- Cable loss compensation

### Electrical Specifications at 25°C

| Parameter       | Condition (GHz) | Min. | Typ.  | Max. | Units |
|-----------------|-----------------|------|-------|------|-------|
| Frequency Range |                 | DC   | 11.10 | 20   | GHz   |
| Insertion Loss  | 0.01            |      | 11.10 |      | dB    |
|                 | 1.00            |      | 11.20 |      |       |
|                 | 5.00            |      | 9.90  |      |       |
|                 | 10.00           |      | 6.40  |      |       |
|                 | 20.00           |      | 2.00  |      |       |
| VSWR            | DC-18           |      | 1.3   |      | :1    |
|                 | 18-20           |      | 1.4   |      |       |

### Typical Performance Data at 25°C

| Frequency (MHz) | Insertion Loss (dB) | VSWR           |              |
|-----------------|---------------------|----------------|--------------|
|                 |                     | Female 2.92 mm | Male 2.92 mm |
| 10              | 11.13               | 1.11           | 1.11         |
| 1000            | 11.23               | 1.10           | 1.11         |
| 2000            | 11.09               | 1.13           | 1.15         |
| 4000            | 10.38               | 1.19           | 1.16         |
| 5000            | 9.86                | 1.19           | 1.16         |
| 6000            | 9.24                | 1.17           | 1.17         |
| 8000            | 7.82                | 1.12           | 1.14         |
| 10000           | 6.33                | 1.16           | 1.21         |
| 12000           | 5.01                | 1.27           | 1.33         |
| 14000           | 3.84                | 1.17           | 1.23         |
| 15000           | 3.35                | 1.17           | 1.20         |
| 16000           | 2.92                | 1.22           | 1.23         |
| 17000           | 2.53                | 1.10           | 1.12         |
| 18000           | 2.28                | 1.16           | 1.20         |
| 19000           | 2.20                | 1.41           | 1.45         |
| 20000           | 2.03                | 1.32           | 1.38         |



### Notes

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ZEQ-9-24K+  
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# Coaxial Slope Equalizer

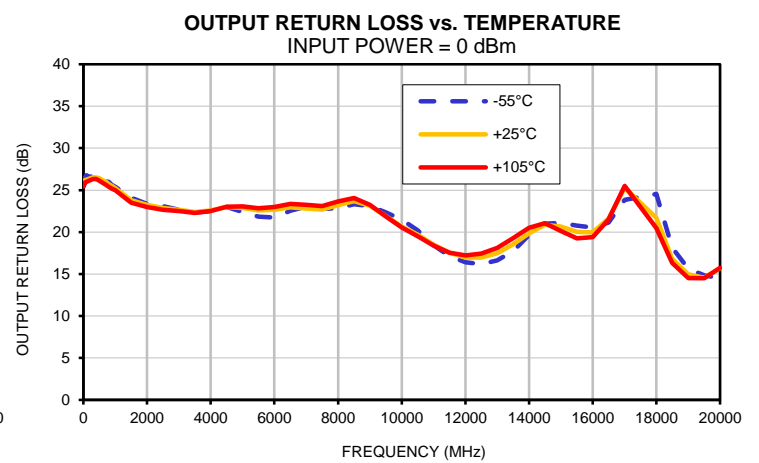
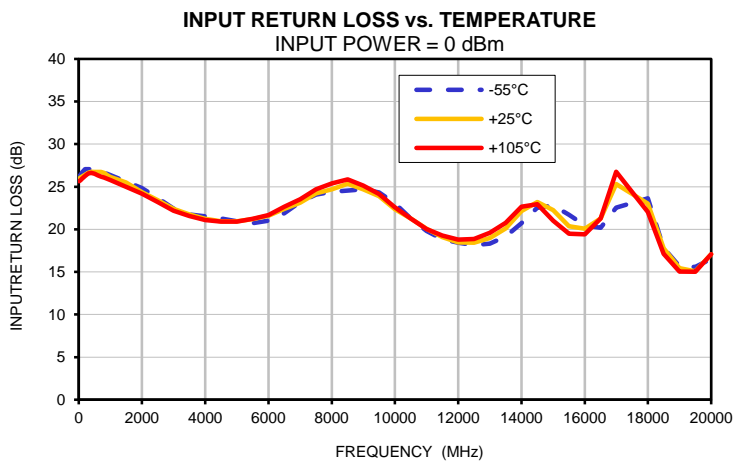
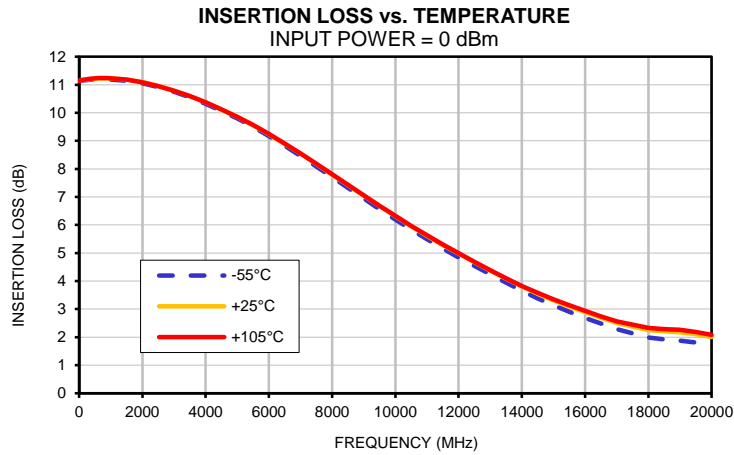
# ZEQ-9-24K+

## Typical Performance Data

| FREQ.<br>(MHz) | INSERTION LOSS<br>(dB) |       |         | INPUT RETURN LOSS<br>(dB) |       |         | OUTPUT RETURN LOSS<br>(dB) |       |         |
|----------------|------------------------|-------|---------|---------------------------|-------|---------|----------------------------|-------|---------|
|                | @-55°C                 | @25°C | @+105°C | @-55°C                    | @25°C | @+105°C | @-55°C                     | @25°C | @+105°C |
| 10             | 11.12                  | 11.13 | 11.14   | 26.23                     | 25.94 | 25.65   | 25.86                      | 25.69 | 25.43   |
| 50             | 11.14                  | 11.15 | 11.15   | 26.38                     | 26.09 | 25.77   | 26.51                      | 26.19 | 25.90   |
| 100            | 11.15                  | 11.16 | 11.17   | 26.68                     | 26.19 | 25.94   | 26.77                      | 26.23 | 26.00   |
| 200            | 11.16                  | 11.18 | 11.19   | 27.08                     | 26.42 | 26.27   | 26.55                      | 26.38 | 26.15   |
| 300            | 11.18                  | 11.20 | 11.21   | 27.07                     | 26.64 | 26.54   | 26.74                      | 26.53 | 26.33   |
| 400            | 11.18                  | 11.21 | 11.22   | 27.07                     | 26.75 | 26.64   | 26.70                      | 26.50 | 26.34   |
| 500            | 11.19                  | 11.22 | 11.23   | 27.14                     | 26.74 | 26.50   | 26.51                      | 26.42 | 26.11   |
| 600            | 11.19                  | 11.23 | 11.24   | 27.04                     | 26.75 | 26.32   | 26.44                      | 26.17 | 25.88   |
| 700            | 11.20                  | 11.23 | 11.24   | 26.76                     | 26.72 | 26.18   | 26.05                      | 26.01 | 25.66   |
| 800            | 11.19                  | 11.23 | 11.24   | 26.57                     | 26.63 | 26.07   | 25.99                      | 25.74 | 25.39   |
| 900            | 11.19                  | 11.23 | 11.24   | 26.53                     | 26.37 | 25.93   | 25.61                      | 25.52 | 25.19   |
| 1000           | 11.19                  | 11.22 | 11.23   | 26.38                     | 26.16 | 25.80   | 25.38                      | 25.26 | 25.00   |
| 1500           | 11.14                  | 11.18 | 11.18   | 25.62                     | 25.49 | 24.98   | 24.09                      | 23.79 | 23.51   |
| 2000           | 11.05                  | 11.09 | 11.08   | 24.85                     | 24.38 | 24.18   | 23.37                      | 23.25 | 22.99   |
| 2500           | 10.92                  | 10.96 | 10.95   | 23.69                     | 23.41 | 23.21   | 23.12                      | 22.89 | 22.67   |
| 3000           | 10.75                  | 10.80 | 10.79   | 22.45                     | 22.41 | 22.19   | 22.65                      | 22.65 | 22.51   |
| 3500           | 10.55                  | 10.60 | 10.60   | 21.74                     | 21.75 | 21.56   | 22.32                      | 22.41 | 22.30   |
| 4000           | 10.32                  | 10.38 | 10.37   | 21.52                     | 21.24 | 21.10   | 22.52                      | 22.58 | 22.52   |
| 4500           | 10.07                  | 10.13 | 10.13   | 21.28                     | 20.95 | 20.91   | 22.97                      | 23.00 | 23.01   |
| 5000           | 9.79                   | 9.86  | 9.86    | 20.93                     | 20.95 | 20.89   | 22.38                      | 22.89 | 23.05   |
| 5500           | 9.50                   | 9.56  | 9.56    | 20.71                     | 21.18 | 21.25   | 21.83                      | 22.58 | 22.86   |
| 6000           | 9.17                   | 9.24  | 9.24    | 21.03                     | 21.60 | 21.66   | 21.72                      | 22.65 | 22.98   |
| 6500           | 8.82                   | 8.90  | 8.90    | 21.90                     | 22.39 | 22.64   | 22.54                      | 22.94 | 23.38   |
| 7000           | 8.46                   | 8.54  | 8.55    | 23.20                     | 23.13 | 23.54   | 23.03                      | 22.81 | 23.24   |
| 7500           | 8.08                   | 8.18  | 8.18    | 24.09                     | 24.21 | 24.68   | 22.76                      | 22.69 | 23.12   |
| 8000           | 7.71                   | 7.80  | 7.81    | 24.42                     | 24.71 | 25.39   | 22.86                      | 23.21 | 23.65   |
| 8500           | 7.32                   | 7.42  | 7.43    | 24.54                     | 25.34 | 25.85   | 23.30                      | 23.71 | 24.06   |
| 9000           | 6.94                   | 7.05  | 7.05    | 24.71                     | 24.71 | 25.14   | 23.10                      | 23.15 | 23.26   |
| 9500           | 6.56                   | 6.67  | 6.68    | 24.35                     | 23.90 | 24.15   | 22.35                      | 21.92 | 21.87   |
| 10000          | 6.19                   | 6.31  | 6.33    | 23.06                     | 22.38 | 22.58   | 21.46                      | 20.65 | 20.54   |
| 10500          | 5.84                   | 5.96  | 5.97    | 21.26                     | 21.26 | 21.27   | 20.20                      | 19.68 | 19.51   |
| 11000          | 5.49                   | 5.62  | 5.63    | 19.83                     | 20.07 | 20.05   | 18.44                      | 18.52 | 18.40   |
| 11500          | 5.16                   | 5.29  | 5.31    | 18.84                     | 19.07 | 19.25   | 17.16                      | 17.54 | 17.57   |
| 12000          | 4.85                   | 4.98  | 4.99    | 18.41                     | 18.45 | 18.80   | 16.41                      | 16.96 | 17.21   |
| 12500          | 4.54                   | 4.68  | 4.69    | 18.15                     | 18.42 | 18.86   | 16.20                      | 16.98 | 17.44   |
| 13000          | 4.24                   | 4.38  | 4.39    | 18.33                     | 18.96 | 19.58   | 16.61                      | 17.49 | 18.11   |
| 13500          | 3.95                   | 4.09  | 4.10    | 19.15                     | 20.12 | 20.78   | 17.74                      | 18.57 | 19.28   |
| 14000          | 3.66                   | 3.81  | 3.83    | 20.72                     | 22.16 | 22.65   | 19.68                      | 19.83 | 20.51   |
| 14500          | 3.39                   | 3.55  | 3.58    | 22.54                     | 23.21 | 22.95   | 20.99                      | 20.87 | 21.05   |
| 15000          | 3.13                   | 3.32  | 3.35    | 22.79                     | 22.24 | 21.03   | 21.11                      | 20.66 | 20.13   |
| 15500          | 2.90                   | 3.10  | 3.14    | 21.71                     | 20.36 | 19.48   | 20.76                      | 20.04 | 19.26   |
| 16000          | 2.69                   | 2.89  | 2.94    | 20.47                     | 20.07 | 19.41   | 20.55                      | 19.95 | 19.41   |
| 16500          | 2.49                   | 2.69  | 2.74    | 20.18                     | 21.27 | 21.27   | 21.13                      | 21.64 | 21.50   |
| 17000          | 2.29                   | 2.51  | 2.56    | 22.56                     | 25.32 | 26.76   | 23.85                      | 25.28 | 25.51   |
| 18000          | 1.99                   | 2.25  | 2.33    | 23.64                     | 23.00 | 22.04   | 24.56                      | 21.71 | 20.48   |
| 18500          | 1.92                   | 2.20  | 2.29    | 17.81                     | 17.75 | 17.11   | 18.14                      | 16.82 | 16.34   |
| 19000          | 1.88                   | 2.18  | 2.26    | 15.67                     | 15.46 | 15.05   | 15.63                      | 14.97 | 14.51   |
| 19500          | 1.82                   | 2.11  | 2.19    | 15.58                     | 15.07 | 15.02   | 14.86                      | 14.56 | 14.50   |
| 20000          | 1.74                   | 2.01  | 2.08    | 16.55                     | 17.08 | 17.07   | 14.49                      | 15.72 | 15.72   |

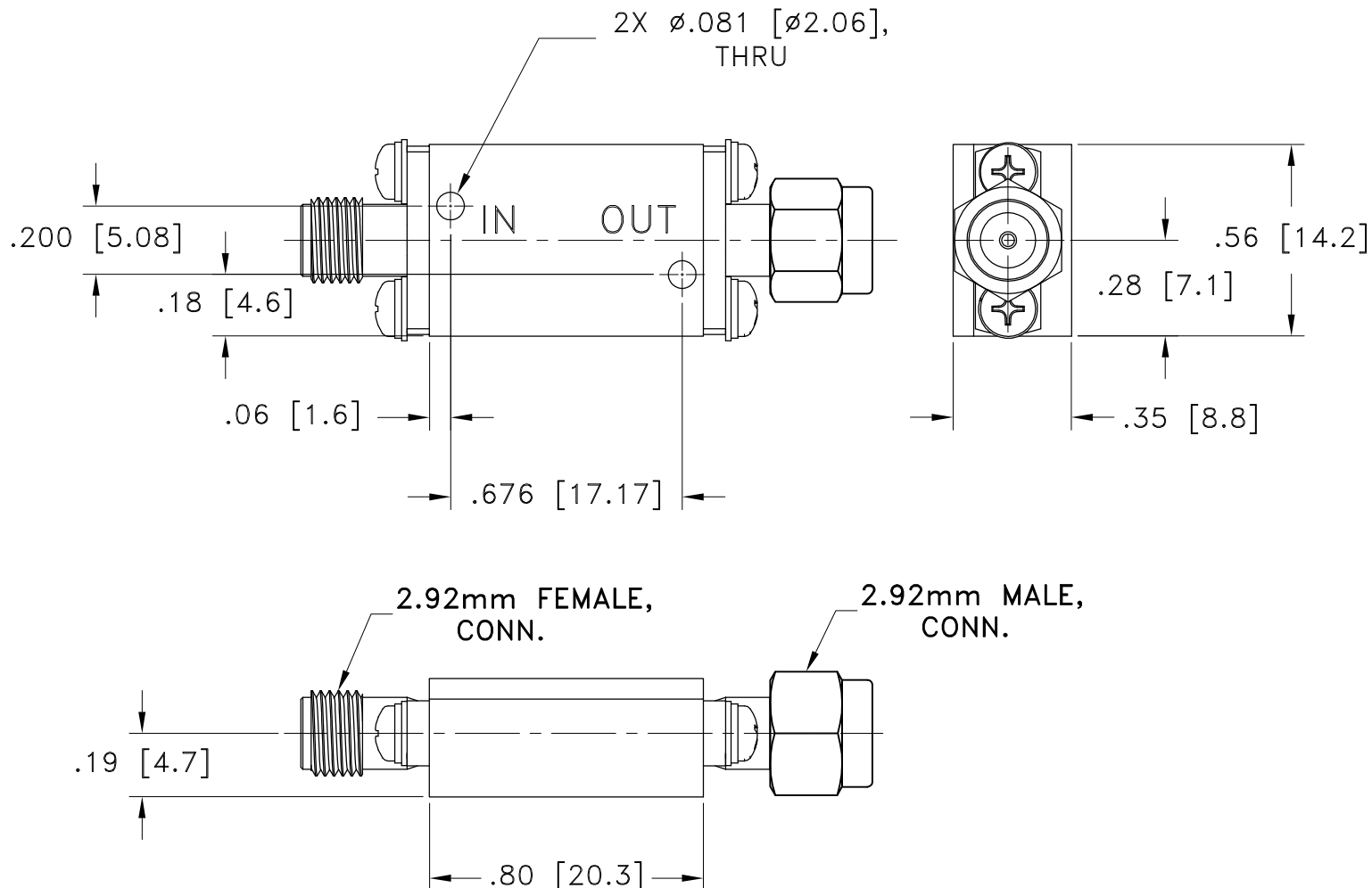


## Typical Performance Curves



## Outline Dimensions

RA2937



Weight: 25 grams

Dimensions are in inches (mm). Tolerances: 2 Pl.  $\pm$ .015; 3 Pl.  $\pm$ .005

### Notes:

1. Case material: Brass.
2. Case Finish: Gold plate.

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

| <b>Specification</b>       | <b>Test/Inspection Condition</b>   | <b>Reference/Spec</b>                |
|----------------------------|--|--------------------------------------|
| Operating Temperature      | -55° to 105°C<br>Ambient Environment   | Individual Model Data Sheet          |
| Storage Temperature        | -65° to +150° C<br>Ambient Environment   | Individual Model Data Sheet          |
| Humidity                   | 90% RH, 65°C (non-condensing)<br>Units may require bake-out after humidity to restore full performance | MIL-STD-202, Method 103              |
| Thermal Shock              | -65° to 125°C, 5 cycles  | MIL-STD-202, Method 107, Condition B |
| Vibration (High Frequency) | 20g peak, 10-2000 Hz, 12 times in each of three perpendicular directions (total 36)                    | MIL-STD-202, Method 204, Condition D |