*Coaxial*

# Bandpass Filter

## ZFBP-13.5-S+

50Ω 12 to 15 MHz



*Generic photo used for illustration purposes only*
CASE STYLE: H16

## The Big Deal

- High rejection, (50dB from 30-1000 MHz)
- Low frequency bandpass filter
- Connectorized package

## Product Overview

ZFBP-13.5-S+ is a bandpass filter built in rugged connectorized package, covering 12 to 15 MHz. These units offer good matching within the band pass and high rejection. This will find its application in semiconductor processing equipment. It has repeatable performance across production lots and consistent performance across temperature.

## Key Features

| Feature | Advantages |
|---|---|
| Good passband insertion loss and roll-off | Low insertion loss will be used in designs optimized for high performance applications. Good roll-off will attenuate frequencies closer to the passband with good rejection value of >20dB. |
| Good ultimate rejection | This enables the filters to attenuate spurious signals and reject harmonics for broad band frequency. |
| Connectorized package | The connectorized packages can easily interface with other devices and well suited for test set-ups. |
| Good VSWR, 1.3:1 typical in passband | This model has very good return loss for this bandwidth and provides good interface when used with other devices. |

**Notes**
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**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

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| Connectors | Model |
|---|---|
| **SMA-Female** | ZFBP-13.5-S+ |

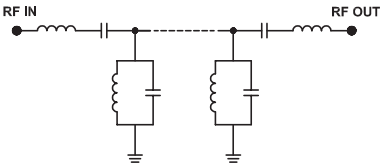
### Features

- High stopband Rejection
- Good VSWR, 1.3:1 typical in passband
- Connectorized package

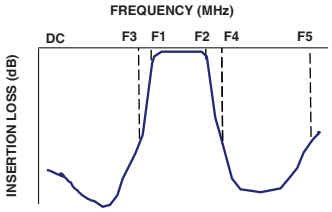
### Applications

- Harmonic Rejection
- Medical Instrumentation
- Industrial process equipments
- Lab use

### Functional Schematic




### Typical Frequency Response




***+RoHS Compliant***

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

### Electrical Specifications at 25°C

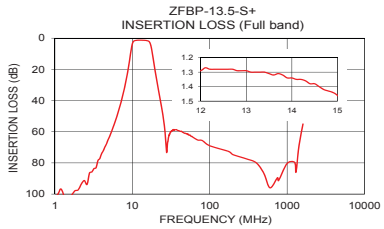
| Parameter | | F# | Frequency (MHz) | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **Pass Band** | Center Frequency | — | — | — | 13.5 | — | MHz |
| | Insertion Loss | F1-F2 | 12 -15 | — | 1.5 | 3.0 | dB |
| | VSWR | F1-F2 | 12 -15 | — | 1.3 | 1.7 | :1 |
| **Stop Band, Lower** | Insertion Loss | DC-F3 | DC - 8 | 20 | 31 | — | dB |
| | VSWR | DC-F3 | DC - 8 | — | 46 | — | :1 |
| **Stop Band, Upper** | Insertion Loss | F4-F5 | 22 -1600 | 20 | 33 | — | dB |
| | VSWR | F4-F5 | 22 -1600 | — | 12 | — | :1 |

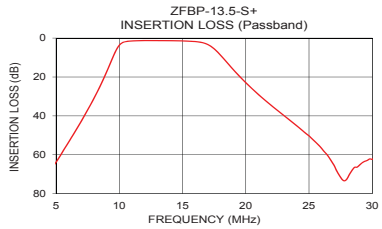
| Maximum Ratings | |
|---|---|
| Operating Temperature | -40°C to 85°C |
| Storage Temperature | -55°C to 100°C |
| RF Power Input | 0.5W max. |

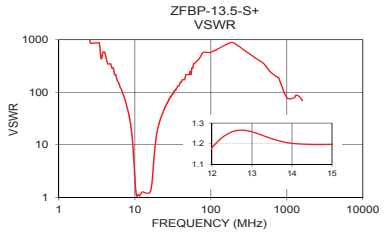
Permanent damage may occur if any of these limits are exceeded.

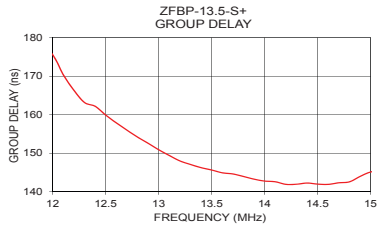
### Typical Performance Data at 25°C

| Frequency (MHz) | Insertion Loss (dB) | VSWR (:1) | Frequency (MHz) | Group Delay (nsec) |
|---|---|---|---|---|
| 0.5 | 102.04 | 1737.18 | 12.0 | 175.55 |
| 5.0 | 63.88 | 289.53 | 12.2 | 166.33 |
| 7.0 | 42.69 | 91.43 | 12.4 | 162.19 |
| 8.0 | 30.99 | 48.26 | 12.6 | 157.87 |
| 8.8 | 20.32 | 24.14 | 12.8 | 154.19 |
| 9.2 | 14.38 | 14.03 | 13.0 | 150.90 |
| 9.6 | 8.31 | 6.32 | 13.2 | 148.00 |
| 10.4 | 1.96 | 1.16 | 13.4 | 146.25 |
| 12.0 | 1.29 | 1.18 | 13.5 | 145.64 |
| 13.5 | 1.31 | 1.22 | 13.6 | 144.92 |
| 15.0 | 1.46 | 1.20 | 13.8 | 143.96 |
| 17.0 | 3.32 | 2.27 | 14.0 | 142.77 |
| 17.6 | 6.10 | 4.27 | 14.1 | 142.59 |
| 18.6 | 13.17 | 10.50 | 14.2 | 141.92 |
| 20.0 | 22.92 | 20.22 | 14.3 | 141.95 |
| 22.0 | 34.52 | 32.79 | 14.4 | 142.26 |
| 50.0 | 61.41 | 217.15 | 14.5 | 141.98 |
| 500.0 | 86.71 | 347.44 | 14.6 | 141.92 |
| 1000.0 | 80.29 | 78.97 | 14.8 | 142.58 |
| 1600.0 | 55.07 | 69.49 | 15.0 | 145.14 |




Notes

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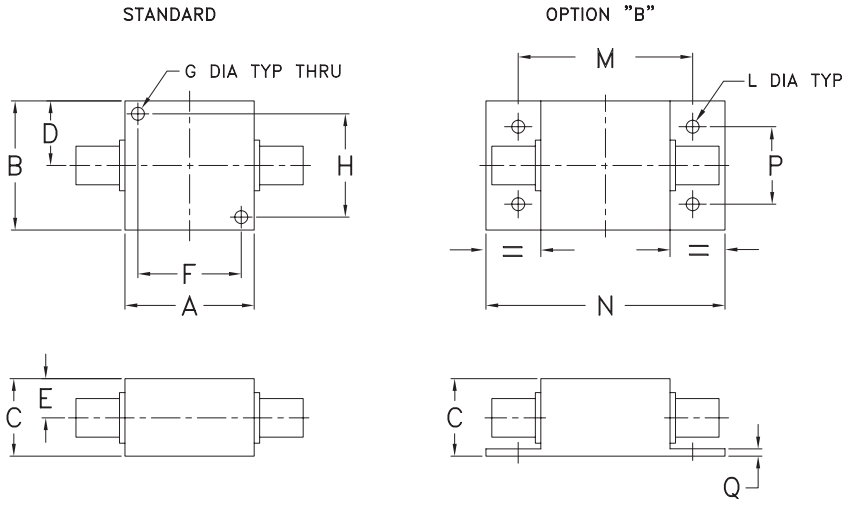
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## Coaxial Connections

| | |
|---|---|
| PORT - 1 | SMA Female |
| PORT - 2 | SMA Female |

## Outline Drawing




## Outline Dimensions ( inch / mm )

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 1.25 | 1.25 | .75 | .63 | .38 | 1.000 | .125 | 1.000 |
| 31.75 | 31.75 | 19.05 | 16.00 | 9.65 | 25.40 | 3.18 | 25.40 |

| J | K | L | M | N | P | Q | wt |
|---|---|---|---|---|---|---|---|
| -- | -- | .125 | 1.688 | 2.18 | .750 | .06 | grams |
| -- | -- | 3.18 | 42.88 | 55.37 | 19.05 | 1.52 | 70.0 |

*Note: Please refer to case style drawing for details*

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# Coaxial Band Pass Filter ZFBP-13.5-S+

*Typical Performance Data*

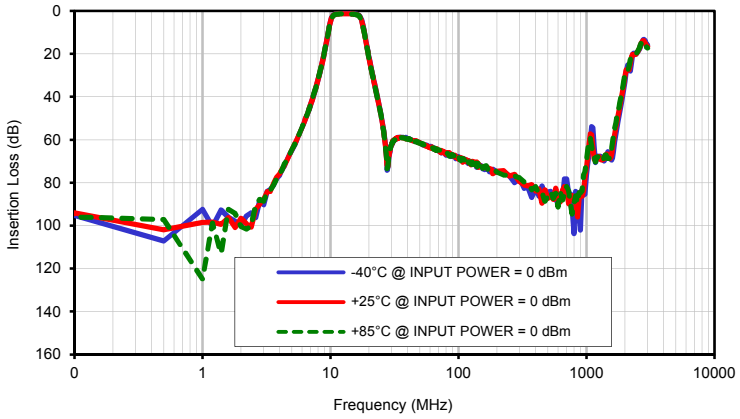
| FREQ. | INSERTION LOSS | | | INPUT RETURN LOSS | | | OUTPUT RETURN LOSS | | |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (dB) | | | (dB) | | | (dB) | | |
| | @-40°C | @+25°C | @+85°C | @-40°C | @+25°C | @+85°C | @-40°C | @+25°C | @+85°C |
| 0.1 | 95.25 | 94.07 | 95.92 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| 0.5 | 107.13 | 101.94 | 97.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| 2.0 | 100.05 | 96.54 | 100.49 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| 3.0 | 90.34 | 87.67 | 88.63 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 |
| 4.0 | 76.60 | 75.79 | 75.62 | 0.03 | 0.05 | 0.05 | 0.03 | 0.04 | 0.04 |
| 5.0 | 65.04 | 64.74 | 64.71 | 0.05 | 0.07 | 0.06 | 0.06 | 0.06 | 0.08 |
| 6.0 | 54.35 | 54.38 | 54.32 | 0.10 | 0.11 | 0.12 | 0.09 | 0.11 | 0.12 |
| 7.0 | 43.65 | 43.56 | 43.54 | 0.16 | 0.20 | 0.22 | 0.15 | 0.19 | 0.21 |
| 8.0 | 32.15 | 32.06 | 32.04 | 0.30 | 0.35 | 0.39 | 0.29 | 0.35 | 0.38 |
| 8.8 | 21.82 | 21.74 | 21.72 | 0.59 | 0.68 | 0.74 | 0.56 | 0.66 | 0.71 |
| 9.0 | 19.01 | 18.93 | 18.92 | 0.72 | 0.83 | 0.89 | 0.71 | 0.81 | 0.88 |
| 9.2 | 16.11 | 16.03 | 16.03 | 0.95 | 1.07 | 1.14 | 0.92 | 1.05 | 1.12 |
| 9.6 | 10.15 | 10.11 | 10.15 | 1.88 | 2.08 | 2.20 | 1.84 | 2.04 | 2.16 |
| 10.0 | 4.92 | 4.97 | 5.06 | 4.94 | 5.28 | 5.44 | 4.86 | 5.20 | 5.38 |
| 10.4 | 2.24 | 2.36 | 2.47 | 13.24 | 13.73 | 13.88 | 13.09 | 13.64 | 13.89 |
| 11.0 | 1.45 | 1.57 | 1.66 | 28.50 | 28.20 | 27.85 | 31.46 | 31.85 | 32.27 |
| 12.0 | 1.22 | 1.32 | 1.39 | 24.98 | 25.09 | 25.24 | 25.46 | 25.85 | 26.31 |
| 12.2 | 1.19 | 1.30 | 1.36 | 22.81 | 23.04 | 23.24 | 23.09 | 23.49 | 23.89 |
| 12.4 | 1.19 | 1.29 | 1.36 | 21.49 | 21.77 | 21.98 | 21.70 | 22.10 | 22.45 |
| 12.6 | 1.19 | 1.29 | 1.35 | 20.80 | 21.09 | 21.29 | 21.00 | 21.38 | 21.68 |
| 12.8 | 1.19 | 1.29 | 1.35 | 20.58 | 20.84 | 21.01 | 20.77 | 21.11 | 21.34 |
| 13.0 | 1.19 | 1.29 | 1.36 | 20.69 | 20.90 | 21.01 | 20.91 | 21.17 | 21.30 |
| 13.2 | 1.19 | 1.29 | 1.36 | 21.03 | 21.14 | 21.16 | 21.29 | 21.41 | 21.43 |
| 13.4 | 1.20 | 1.30 | 1.36 | 21.51 | 21.46 | 21.36 | 21.84 | 21.75 | 21.63 |
| 13.5 | 1.21 | 1.31 | 1.37 | 21.78 | 21.62 | 21.46 | 22.14 | 21.93 | 21.72 |
| 13.6 | 1.22 | 1.31 | 1.39 | 22.04 | 21.78 | 21.56 | 22.44 | 22.10 | 21.81 |
| 13.8 | 1.21 | 1.32 | 1.38 | 22.51 | 22.04 | 21.70 | 23.03 | 22.41 | 21.95 |
| 14.0 | 1.23 | 1.33 | 1.39 | 22.90 | 22.24 | 21.81 | 23.55 | 22.67 | 22.08 |
| 14.2 | 1.25 | 1.34 | 1.41 | 23.20 | 22.41 | 21.93 | 24.00 | 22.91 | 22.23 |
| 14.4 | 1.26 | 1.37 | 1.42 | 23.48 | 22.64 | 22.14 | 24.44 | 23.22 | 22.48 |
| 14.6 | 1.28 | 1.38 | 1.44 | 23.79 | 22.94 | 22.45 | 24.93 | 23.63 | 22.86 |
| 14.8 | 1.30 | 1.41 | 1.48 | 24.13 | 23.35 | 22.91 | 25.57 | 24.21 | 23.43 |
| 15.0 | 1.34 | 1.44 | 1.51 | 24.54 | 23.85 | 23.46 | 26.33 | 24.94 | 24.14 |
| 16.0 | 1.55 | 1.69 | 1.76 | 23.58 | 23.24 | 23.23 | 26.43 | 25.21 | 24.69 |
| 17.0 | 2.56 | 2.77 | 2.88 | 11.24 | 11.04 | 11.04 | 11.67 | 11.41 | 11.36 |
| 17.6 | 4.70 | 5.02 | 5.17 | 5.52 | 5.49 | 5.54 | 5.70 | 5.66 | 5.69 |
| 18.0 | 7.09 | 7.46 | 7.63 | 3.40 | 3.45 | 3.50 | 3.51 | 3.55 | 3.60 |
| 18.6 | 11.45 | 11.85 | 12.01 | 1.86 | 1.94 | 2.01 | 1.92 | 2.01 | 2.06 |
| 19.0 | 14.46 | 14.83 | 15.00 | 1.38 | 1.47 | 1.53 | 1.43 | 1.51 | 1.57 |
| 19.6 | 18.80 | 19.15 | 19.30 | 1.00 | 1.08 | 1.13 | 1.04 | 1.11 | 1.16 |
| 20.0 | 21.52 | 21.84 | 22.00 | 0.85 | 0.93 | 0.97 | 0.87 | 0.95 | 1.00 |
| 20.6 | 25.35 | 25.66 | 25.81 | 0.69 | 0.76 | 0.80 | 0.71 | 0.78 | 0.81 |
| 21.0 | 27.75 | 28.06 | 28.21 | 0.63 | 0.69 | 0.72 | 0.64 | 0.70 | 0.74 |
| 21.6 | 31.19 | 31.49 | 31.63 | 0.55 | 0.60 | 0.63 | 0.56 | 0.61 | 0.64 |
| 22.0 | 33.38 | 33.67 | 33.82 | 0.50 | 0.55 | 0.57 | 0.51 | 0.56 | 0.59 |
| 25.0 | 49.21 | 49.54 | 49.63 | 0.31 | 0.34 | 0.35 | 0.31 | 0.34 | 0.36 |
| 30.0 | 62.37 | 62.29 | 62.21 | 0.18 | 0.21 | 0.21 | 0.18 | 0.21 | 0.22 |
| 50.0 | 61.35 | 61.54 | 61.50 | 0.06 | 0.07 | 0.08 | 0.07 | 0.07 | 0.08 |
| 200.0 | 75.17 | 74.66 | 75.04 | 0.00 | 0.03 | 0.03 | 0.01 | 0.03 | 0.04 |
| 400.0 | 82.99 | 83.91 | 81.84 | 0.03 | 0.07 | 0.09 | 0.03 | 0.07 | 0.08 |
| 500.0 | 84.37 | 87.39 | 86.51 | 0.05 | 0.10 | 0.12 | 0.04 | 0.10 | 0.11 |
| 600.0 | 86.02 | 88.55 | 91.28 | 0.08 | 0.14 | 0.16 | 0.07 | 0.13 | 0.15 |
| 800.0 | 103.65 | 86.78 | 89.58 | 0.14 | 0.22 | 0.26 | 0.14 | 0.21 | 0.24 |
| 1000.0 | 76.23 | 73.17 | 69.69 | 0.28 | 0.45 | 0.56 | 0.26 | 0.40 | 0.51 |
| 1200.0 | 69.26 | 68.74 | 68.14 | 0.41 | 0.49 | 0.52 | 0.44 | 0.49 | 0.50 |
| 1400.0 | 68.93 | 67.55 | 67.23 | 0.37 | 0.49 | 0.54 | 0.32 | 0.45 | 0.50 |
| 1600.0 | 68.76 | 64.02 | 61.34 | 0.44 | 0.61 | 0.67 | 0.36 | 0.50 | 0.58 |
| 1800.0 | 48.94 | 46.42 | 44.72 | 0.47 | 0.64 | 0.76 | 0.41 | 0.60 | 0.72 |
| 2000.0 | 32.75 | 30.53 | 29.84 | 0.84 | 1.37 | 1.75 | 0.70 | 1.24 | 1.66 |
| 2600.0 | 17.72 | 17.24 | 16.93 | 0.90 | 1.42 | 1.77 | 0.74 | 1.15 | 1.40 |
| 3000.0 | 15.83 | 16.60 | 17.25 | 2.28 | 2.36 | 2.42 | 1.36 | 1.62 | 1.77 |

*Typical Performance Data*

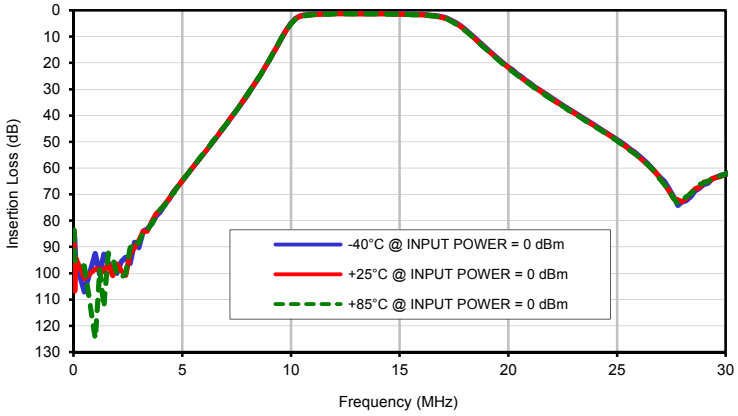
| FREQ. (MHz) | GROUP DELAY (nsec) | | |
|---|---|---|---|
| | @-40°C | @+25°C | @+85°C |
| 12.5 | 162.35 | 162.18 | 162.01 |
| 12.6 | 159.51 | 159.36 | 159.52 |
| 12.7 | 157.64 | 157.56 | 157.61 |
| 12.8 | 155.04 | 155.07 | 155.29 |
| 12.9 | 153.53 | 153.44 | 153.77 |
| 13.0 | 151.67 | 151.76 | 152.02 |
| 13.1 | 150.40 | 150.77 | 150.74 |
| 13.2 | 148.84 | 148.90 | 149.25 |
| 13.3 | 147.95 | 147.96 | 148.31 |
| 13.4 | 146.69 | 146.81 | 146.36 |
| 13.5 | 145.26 | 145.49 | 145.42 |
| 13.6 | 144.44 | 144.57 | 144.33 |
| 13.7 | 143.61 | 144.08 | 143.56 |
| 13.8 | 142.50 | 143.29 | 143.10 |
| 13.9 | 142.08 | 142.46 | 142.60 |
| 14.0 | 141.94 | 142.06 | 141.86 |
| 14.1 | 141.48 | 141.60 | 142.03 |
| 14.2 | 140.69 | 140.85 | 141.20 |
| 14.3 | 140.67 | 140.63 | 140.57 |
| 14.4 | 140.73 | 140.42 | 140.70 |
| 14.5 | 140.73 | 140.42 | 140.70 |
| 15.0 | 142.46 | 142.60 | 142.76 |

## *Typical Performance Curves*

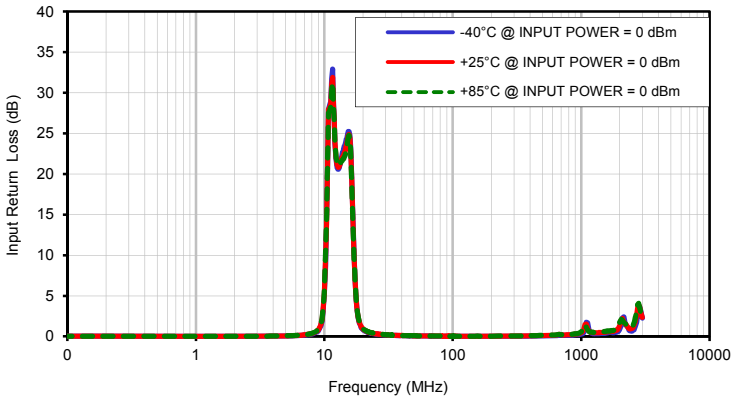
**Insertion Loss vs. Temperature**



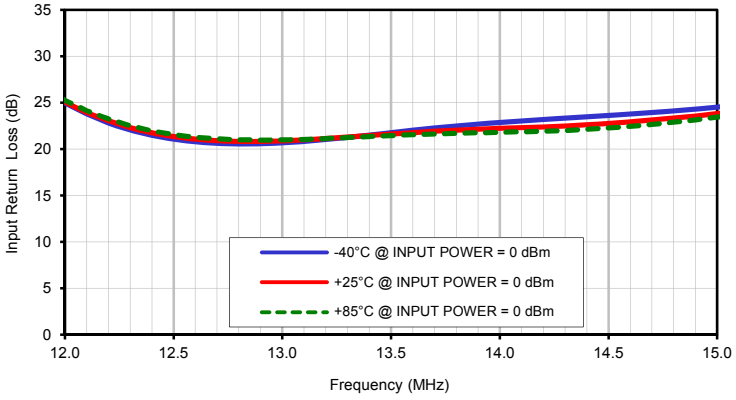

**Insertion Loss vs. Temperature**



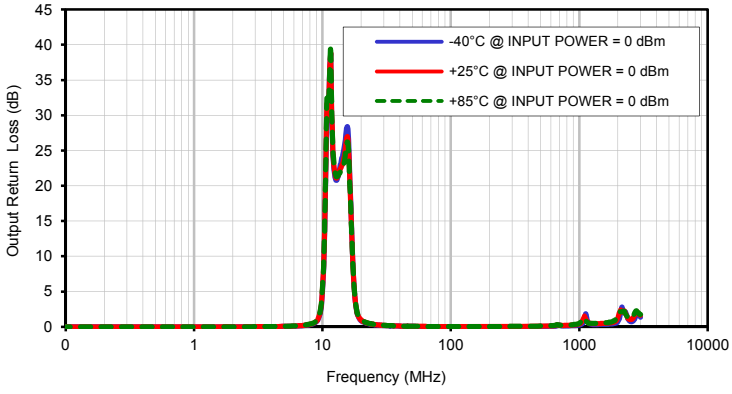

**Input Return Loss vs. Temperature**



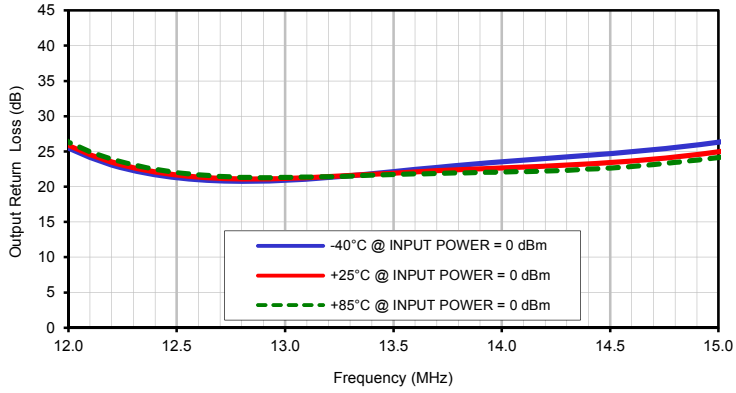

**Input Return Loss vs. Temperature**



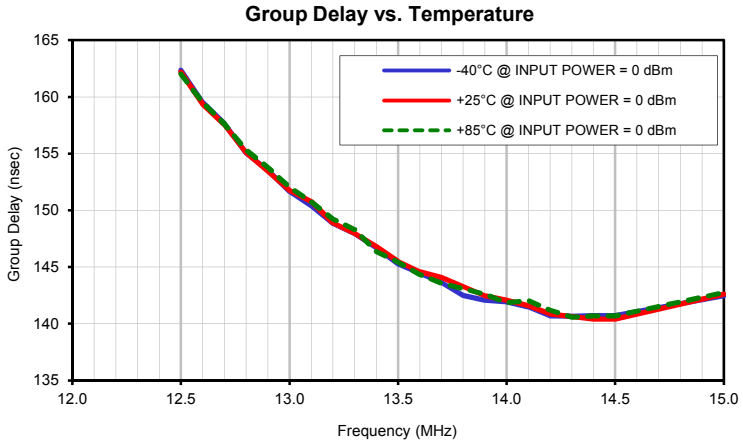

**Output Return Loss vs. Temperature**




**Output Return Loss vs. Temperature**



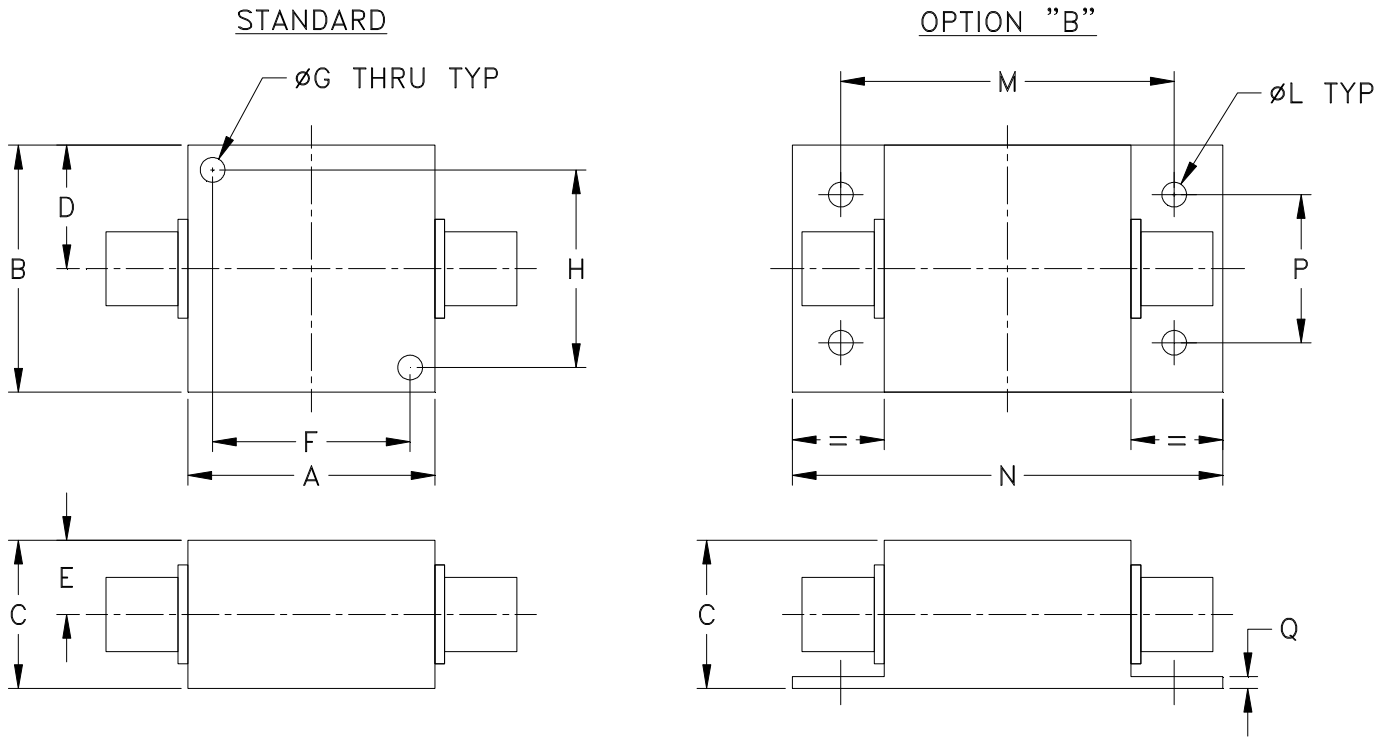
*Typical Performance Curves*



# Case Style H

## Outline Dimensions

**H16**




| CASE# | A | B | C | D | E | F | G | H | J | K | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H16 | 1.25 (31.75) | 1.25 (31.75) | .75 (19.05) | .63 (16.00) | .38 (9.65) | 1.000 (25.40) | .125 (3.18) | 1.000 (25.40) | -- | -- | .125 (3.18) | 1.688 (42.88) | 2.18 (55.37) |

| CASE# | P | Q | WT.GRAMS |
|---|---|---|---|
| H16 | .750 (19.05) | .06 (1.52) | 70 |

**Dimensions are in inches (mm). Tolerances: 2PL. ± .03; 3PL. ± .015**

### Notes:

1. Case material: Aluminum alloy.
2. Case finish:
   For RoHS Case Styles: Clear chemical conversion coating, non-chrome or trivalent chrome based.
3. Mounting bracket available on request. Add suffix B to part number.
4. Bracket version, option B, dimension "C" changes from .75 to .94 inches when connectors are type N.
5. Refer to the individual model data sheet for the type of connectors available.

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**Environmental Specifications** **ENV28T5**

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.

| Specification | Test/Inspection Condition | Reference/Spec |
|---|---|---|
| Operating Temperature | -40° to 85°C | Individual Model Data Sheet |
| Storage Temperature | -55° to 100° C<br>Ambient Environment | Individual Model Data Sheet |
| Barometric Pressure | 100,000 Feet | MIL-STD-202, Method 105, Condition D |
| Humidity | 90% RH, 65°C<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 |
| Mechanical Shock | 100g, 6ms sawtooth, 3 shocks each direction 3 axes (total 18) | MIL-STD-202, Method 213, Condition I |


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