LTCC SURFACE MOUNT

# Bandpass Filter

# BFHKI-2492+

50Ω 22 to 28 GHz

## THE BIG DEAL

- LTCC Band Pass Filter with Integrated Interposer Board
- Wide Stopband Rejection, Typ. 40 dB up to 67 GHz
- Small Size, 4.95 mm x 3.65 mm
- Shielded Construction
- Protected by US Patents 11,638,370 and 11,744,057

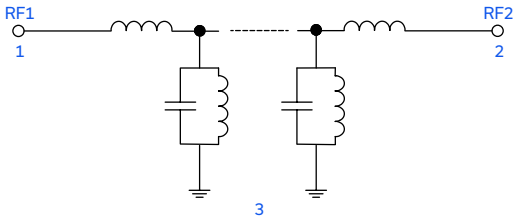


*Generic photo used for illustration purposes only*

## APPLICATIONS

- Test & Measurement Equipment
- Aerospace and Defense Signal Conditioning

## FUNCTIONAL DIAGRAM




## PRODUCT OVERVIEW

BFHKI-2492+ is a miniature low-temperature co-fired ceramic (LTCC) ultra-high stopband rejection band pass filter with a 22 to 28 GHz passband that supports a variety of applications. This model achieves 40 dB typical stopband rejection up to 67 GHz when mounted on coplanar waveguide layouts. Housed in a small 4.95 mm by 3.65 mm ceramic form factor, the filter is ideal for dense signal chain PCB layouts where it complements MMIC size and performance. The BFHKI family with integrated interposer board enables installation onto PCB layouts with automated manufacturing equipment. This model provides a 3.3 dB typical insertion loss over a wide band due to its rugged monolithic construction. The LTCC fabrication process assures minimal RF performance variation while delivering a product that is well-suited for environmental extremes of high humidity and temperature.

## KEY FEATURES

| Features | Advantages |
|---|---|
| Surface Mountable due to Integrated Interposer Board | Enables installation with automated manufacturing equipment, making this suitable for high-volume processes. |
| Wide Rejection | Provides high stopband rejection of 40 dB typical up to 67 GHz. |
| Small Size (4.95 x 3.65mm) | Allows for high layout density of circuit boards, while minimizing effects of parasitics. |
| Wide Operating and Storage Temperature (-55 to 125°C) | Enables use in high reliability and extreme environment conditions, such as in aerospace & defense applications. |
| Cost Effective | LTCC is a scalable technology that is cost-effective due to ease of production in high-volume. |

REV. OR
ECO-020866
BFHKI-2492+
MCL NY
240220

# Bandpass Filter

# BFHKI-2492+

50Ω 22 to 28 GHz

## ELECTRICAL SPECIFICATIONS[1,2,3] AT +25°C

| Parameter | | F# | Frequency (GHz) | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|
| Passband | Center Frequency[4] | — | — | — | 25 | — | GHz |
| | Insertion Loss | F2-F3 | 22 – 28 | — | 3.3 | 4.5 | dB |
| | Return Loss | F2-F3 | 22 - 28 | — | 8 | — | dB |
| Stopband, Lower | Rejection | DC-F1 | 0.1 – 16 | 40 | 50 | — | dB |
| Stopband, Upper | Rejection | F4-F5 | 34 – 50 | 40 | 50 | — | dB |
| | | | 50 – 60 | — | 50 | — | |
| | | | 60 – 67 | — | 40 | — | |

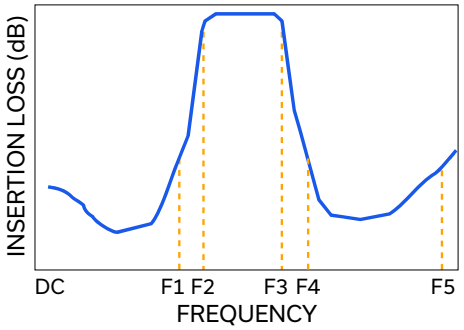
1. Tested on Evaluation Board P/N TB-BFHKI-2492C+. Measured with the connector and feedline effects de-embedded using the 2XThru IEEE P370 method.
2. Bi-directional, RF1 and RF2 ports can be interchanged.
3. This component should not be used as a DC block. In applications with DC voltage and/or current at either the input or output ports, external DC-blocking capacitors are required.
4. Typical variation ±3%.

## ABSOLUTE MAXIMUM RATINGS[5]

| Parameter | Ratings |
|---|---|
| Operating Temperature | -55°C to +125°C |
| Storage Temperature | -55°C to +125°C |
| Input Power[6] | 1 W |

5. Permanent damage may occur if any of these limits are exceeded.
6. Power rating applies only to signals within the passband. Power rating above +25°C operating temperature decreases linearly to 0.5 W at +125°C.

## TYPICAL FREQUENCY RESPONSE AT +25°C

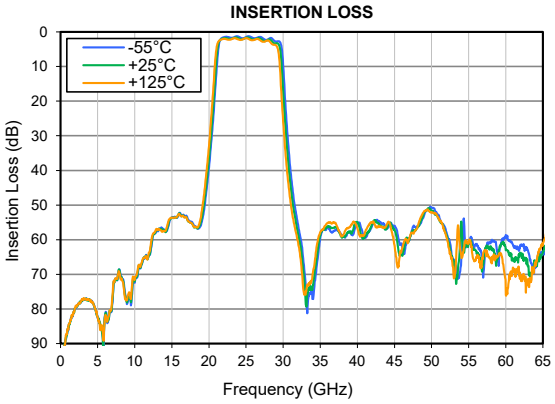


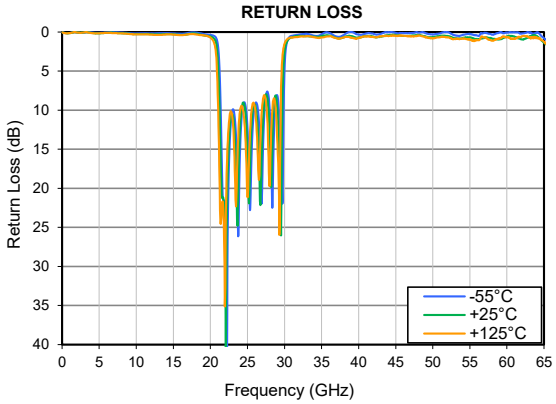
# Bandpass Filter

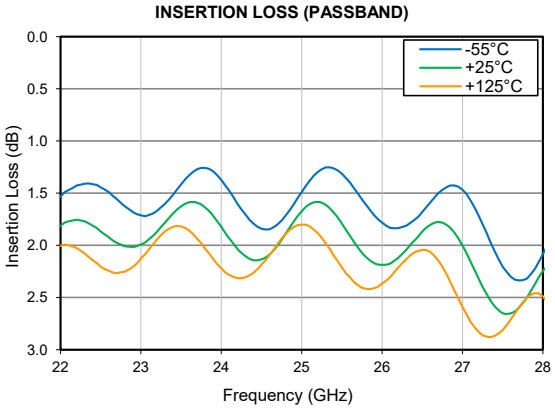
## BFHKI-2492+

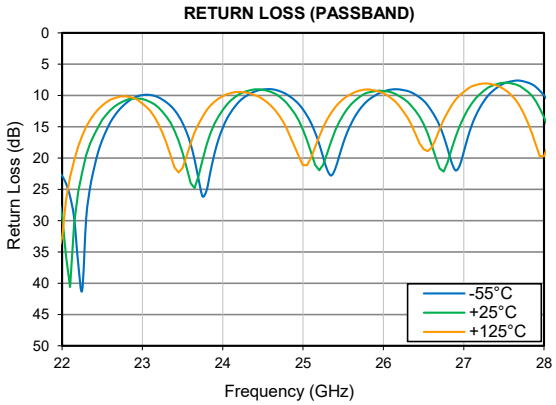
50Ω 22 to 28 GHz

## TYPICAL PERFORMANCE GRAPHS



# Bandpass Filter

# BFHKI-2492+

50Ω 22 to 28 GHz

## FUNCTIONAL DIAGRAM

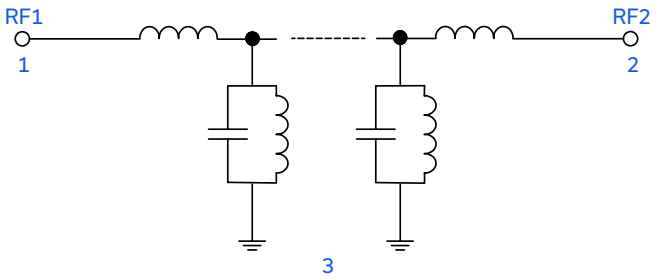
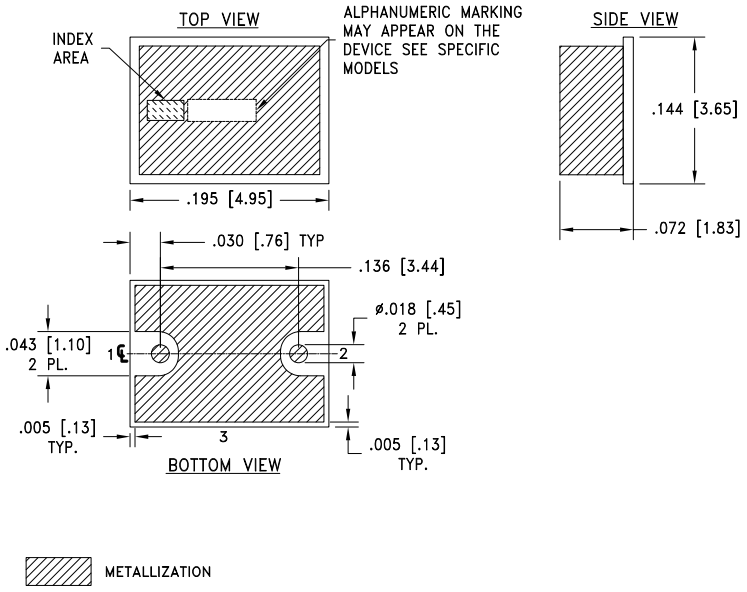



Figure 1. BFHKI-2492+ Functional Diagram

## PAD DESCRIPTION

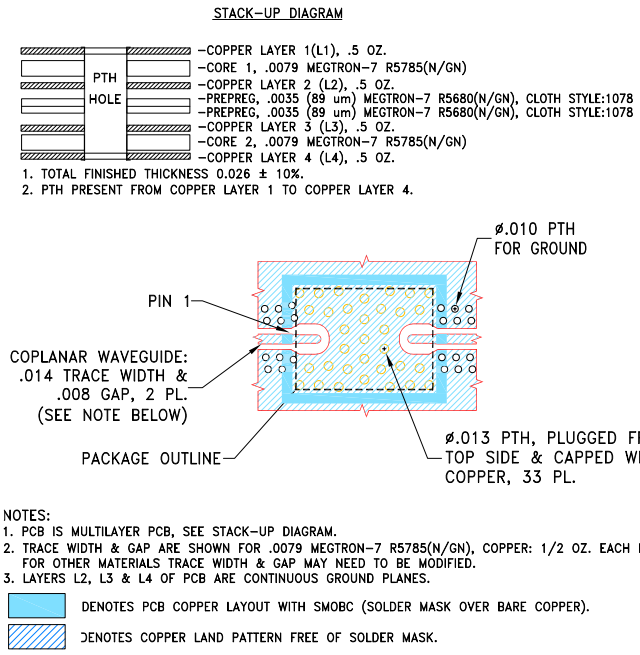
| Function | Pad Number | Description |
|---|---|---|
| RF1[2] | 1 | Connects to RF Input Port |
| RF2[2] | 2 | Connects to RF Output Port |
| GROUND | 3 | Connects to Ground on PCB, (See drawing PL-767) |

## CASE STYLE DRAWING




Weight: .135 grams.
Dimensions are in inches [mm]. Tolerances: 2 Pl.±.01; 3 Pl. ±.005

## SUGGESTED PCB LAYOUT (PL-767)




NOTES:
1. PCB IS MULTILAYER PCB, SEE STACK-UP DIAGRAM.
2. TRACE WIDTH & GAP ARE SHOWN FOR .0079 MEGTRON-7 R5785(N/GN), COPPER: 1/2 OZ. EACH LAYER. FOR OTHER MATERIALS TRACE WIDTH & GAP MAY NEED TO BE MODIFIED.
3. LAYERS L2, L3 & L4 OF PCB ARE CONTINUOUS GROUND PLANES.

DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER).

DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK.

Figure 2. Suggested PCB Layout for BFHKI-2492+

## PRODUCT MARKING*: F472

*Marking may contain other features or characters for internal lot control.

# Bandpass Filter

## BFHKI-2492+

50Ω 22 to 28 GHz

**ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASH BOARD.** CLICK HERE

| | |
|---|---|
| **Performance Data & Graphs** | Data<br>Graphs<br>S-Parameter (S2P Files) Data Set (.zip file) De-embedded to device pads |
| **Case Style** | NM3237 Finish: Gold over Nickel Plating |
| **RoHS Status** | Compliant |
| **Tape and Reel** | F77 |
| **Suggested Layout for PCB Design** | PL-767 |
| **Evaluation Board** | TB-BFHKI-2492C+<br>Gerber File |
| **Environmental Rating** | ENV06T12 |

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-Circuits' applicable established test performance criteria and measurement instructions.
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# LTCC Lowpass Filter BFHKI-2492+

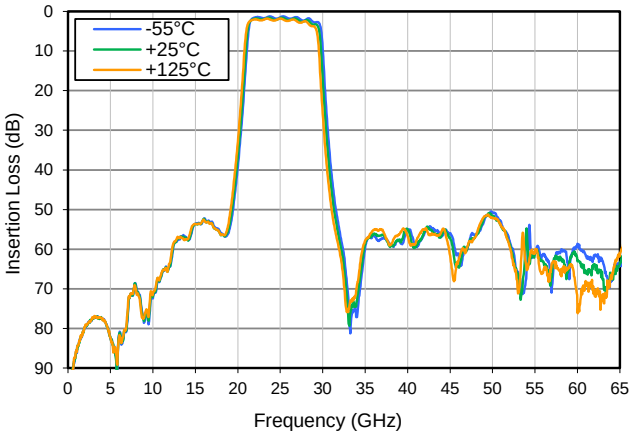
*Typical Performance Data*

| FREQUENCY (GHz) | INSERTION LOSS (dB) | | | RETURN LOSS (dB) | | |
|---|---|---|---|---|---|---|
| | @-55°C | @+25°C | @+125°C | @-55°C | @+25°C | @+125°C |
| 0.1 | 112.39 | 105.00 | 103.52 | 0.04 | 0.06 | 0.08 |
| 1.0 | 85.54 | 85.84 | 85.44 | 0.12 | 0.13 | 0.14 |
| 2.0 | 79.86 | 79.64 | 79.75 | 0.06 | 0.05 | 0.06 |
| 3.0 | 77.55 | 77.25 | 77.30 | 0.07 | 0.05 | 0.04 |
| 4.0 | 77.48 | 77.66 | 77.37 | 0.04 | 0.11 | 0.13 |
| 5.0 | 82.53 | 82.26 | 82.28 | 0.09 | 0.16 | 0.16 |
| 6.0 | 81.78 | 82.07 | 82.62 | 0.05 | 0.10 | 0.11 |
| 7.0 | 78.01 | 77.17 | 75.98 | 0.02 | 0.09 | 0.13 |
| 8.0 | 69.12 | 69.50 | 70.19 | 0.07 | 0.15 | 0.18 |
| 9.0 | 78.41 | 77.70 | 76.86 | 0.13 | 0.22 | 0.24 |
| 10.0 | 72.42 | 71.92 | 71.18 | 0.17 | 0.28 | 0.28 |
| 11.0 | 66.81 | 66.65 | 66.04 | 0.15 | 0.26 | 0.29 |
| 12.0 | 64.47 | 64.36 | 63.48 | 0.16 | 0.27 | 0.33 |
| 13.0 | 57.33 | 57.06 | 56.99 | 0.15 | 0.30 | 0.37 |
| 14.0 | 57.27 | 57.46 | 57.57 | 0.14 | 0.26 | 0.31 |
| 15.0 | 53.55 | 53.67 | 53.66 | 0.17 | 0.29 | 0.32 |
| 16.0 | 52.31 | 52.34 | 52.61 | 0.21 | 0.37 | 0.39 |
| 17.0 | 53.17 | 53.61 | 53.76 | 0.11 | 0.27 | 0.30 |
| 18.0 | 56.15 | 56.48 | 56.40 | 0.07 | 0.21 | 0.31 |
| 19.0 | 55.20 | 54.07 | 52.27 | 0.23 | 0.40 | 0.41 |
| 20.0 | 39.17 | 36.66 | 32.93 | 0.36 | 0.57 | 0.70 |
| 21.0 | 11.90 | 8.31 | 4.96 | 1.57 | 3.41 | 7.92 |
| 22.0 | 1.53 | 1.81 | 2.00 | 22.87 | 29.26 | 32.64 |
| 22.5 | 1.44 | 1.87 | 2.20 | 17.12 | 13.91 | 11.61 |
| 23.0 | 1.71 | 1.99 | 2.13 | 9.94 | 10.58 | 11.28 |
| 23.5 | 1.42 | 1.63 | 1.82 | 14.42 | 19.14 | 21.60 |
| 24.0 | 1.37 | 1.82 | 2.22 | 15.20 | 12.31 | 10.10 |
| 24.5 | 1.84 | 2.13 | 2.18 | 9.04 | 9.09 | 10.61 |
| 25.0 | 1.49 | 1.67 | 1.80 | 12.25 | 15.50 | 21.12 |
| 25.5 | 1.31 | 1.79 | 2.21 | 17.63 | 13.12 | 10.57 |
| 26.0 | 1.78 | 2.19 | 2.36 | 9.38 | 9.29 | 9.65 |
| 26.5 | 1.68 | 1.87 | 2.04 | 10.82 | 14.53 | 18.60 |
| 27.0 | 1.47 | 2.00 | 2.59 | 19.06 | 13.46 | 9.42 |
| 27.5 | 2.21 | 2.65 | 2.81 | 8.09 | 7.96 | 8.97 |
| 28.0 | 2.08 | 2.25 | 2.49 | 9.98 | 13.44 | 19.72 |
| 29.0 | 2.81 | 3.31 | 3.80 | 8.08 | 9.39 | 13.30 |
| 30.0 | 9.60 | 17.17 | 25.82 | 4.78 | 2.49 | 1.48 |
| 31.0 | 40.17 | 44.34 | 49.19 | 0.48 | 0.66 | 0.70 |
| 32.0 | 55.69 | 58.27 | 60.79 | 0.32 | 0.49 | 0.59 |
| 33.0 | 72.28 | 76.79 | 75.92 | 0.23 | 0.52 | 0.53 |
| 34.0 | 77.05 | 73.09 | 69.60 | 0.47 | 0.62 | 0.65 |
| 35.0 | 59.54 | 58.71 | 57.84 | 0.27 | 0.48 | 0.70 |
| 36.0 | 56.51 | 56.17 | 55.13 | 0.10 | 0.46 | 0.55 |
| 37.0 | 57.21 | 56.45 | 55.25 | 0.56 | 0.75 | 0.80 |
| 38.0 | 58.68 | 59.20 | 58.89 | 0.38 | 0.69 | 0.69 |
| 39.0 | 57.95 | 57.69 | 56.33 | 0.00 | 0.53 | 0.71 |
| 40.0 | 55.13 | 54.97 | 56.74 | 0.33 | 0.70 | 0.75 |
| 41.0 | 59.35 | 59.31 | 58.02 | 0.19 | 0.51 | 0.57 |
| 42.0 | 55.90 | 55.44 | 54.95 | 0.23 | 0.58 | 0.66 |
| 43.0 | 54.77 | 55.76 | 56.30 | 0.22 | 0.59 | 0.57 |
| 44.0 | 56.85 | 56.62 | 55.51 | 0.02 | 0.40 | 0.51 |
| 45.0 | 55.95 | 57.05 | 61.68 | 0.11 | 0.40 | 0.47 |
| 46.0 | 61.49 | 64.35 | 62.82 | 0.14 | 0.50 | 0.47 |
| 47.0 | 60.14 | 60.09 | 59.55 | 0.14 | 0.51 | 0.55 |
| 48.0 | 56.19 | 56.71 | 56.84 | 0.07 | 0.37 | 0.45 |
| 49.0 | 52.98 | 52.12 | 51.78 | 0.15 | 0.56 | 0.68 |
| 50.0 | 50.74 | 51.67 | 52.16 | 0.29 | 0.67 | 0.78 |
| 51.0 | 53.22 | 54.09 | 54.05 | 0.17 | 0.50 | 0.67 |
| 52.0 | 57.78 | 58.70 | 59.37 | 0.01 | 0.51 | 0.66 |
| 53.0 | 65.74 | 66.60 | 71.19 | 0.43 | 0.78 | 0.90 |
| 54.0 | 65.60 | 54.75 | 64.56 | 0.39 | 0.80 | 0.84 |
| 55.0 | 61.10 | 61.15 | 60.15 | 0.23 | 0.69 | 0.94 |
| 56.0 | 61.38 | 63.16 | 65.39 | 0.45 | 0.90 | 1.00 |
| 57.0 | 69.61 | 66.65 | 63.62 | 0.10 | 0.70 | 0.65 |
| 58.0 | 60.68 | 62.09 | 66.54 | 0.34 | 0.85 | 1.12 |
| 59.0 | 66.07 | 64.30 | 64.78 | 0.06 | 0.91 | 0.79 |
| 60.0 | 58.65 | 63.09 | 76.00 | 0.08 | 0.55 | 0.68 |
| 61.0 | 61.78 | 65.78 | 68.79 | 0.03 | 0.56 | 0.88 |
| 62.0 | 61.86 | 63.76 | 70.58 | 0.17 | 0.94 | 0.53 |
| 63.0 | 63.06 | 67.65 | 71.35 | 0.05 | 0.64 | 0.71 |
| 64.0 | 68.12 | 67.12 | 66.90 | 0.09 | 0.50 | 0.65 |
| 65.0 | 64.16 | 63.41 | 60.96 | 0.80 | 1.37 | 1.26 |

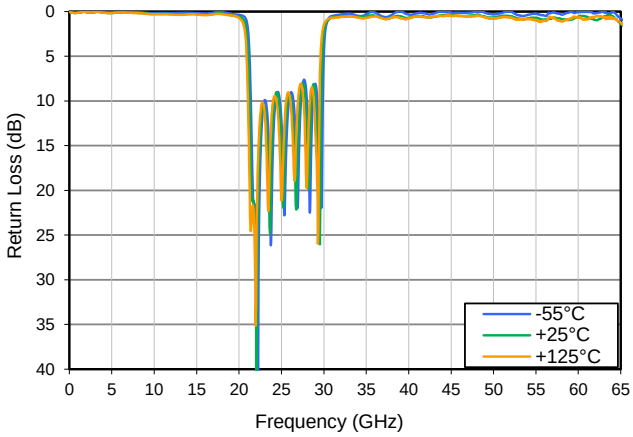
# LTCC Lowpass Filter BFHKI-2492+

*Typical Performance Data*

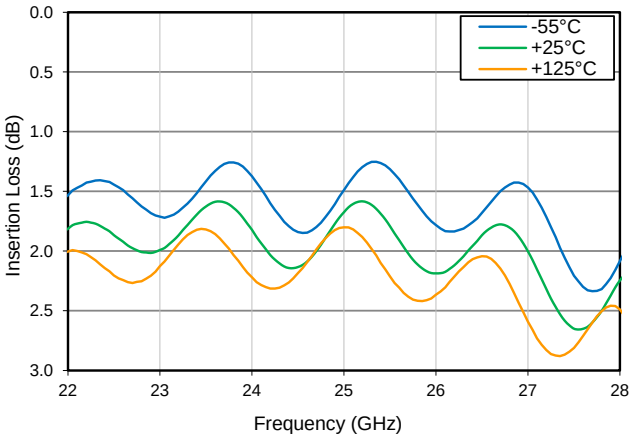
**INSERTION LOSS**



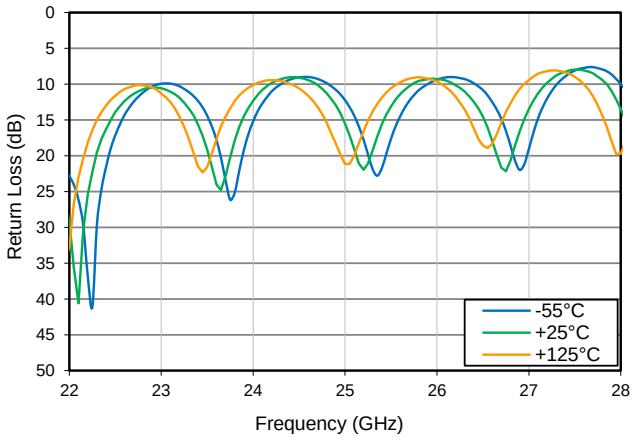

**RETURN LOSS**




**INSERTION LOSS (PASSBAND)**

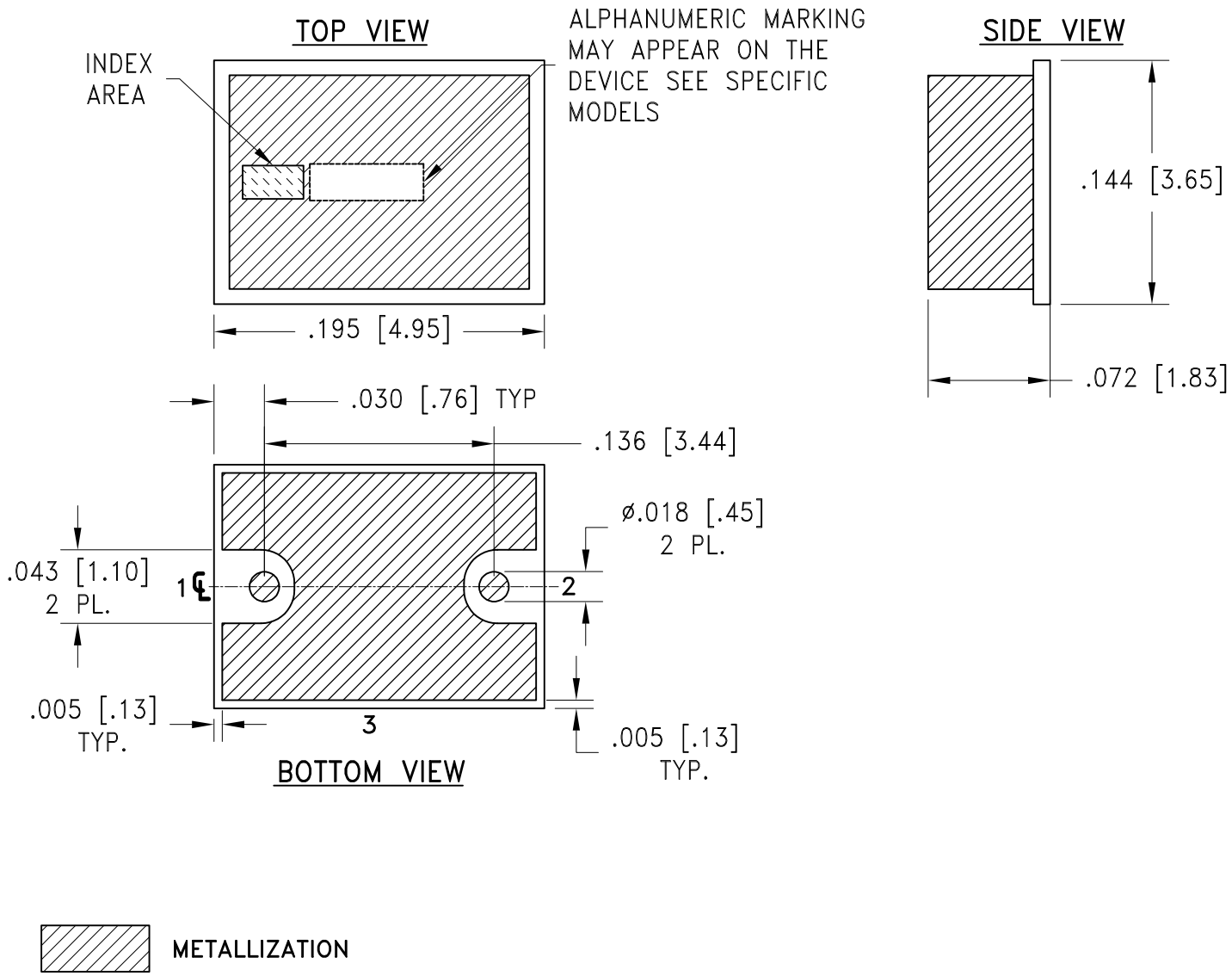



**RETURN LOSS (PASSBAND)**



# Case Style NM

## Outline Dimensions NM3237




Weight: .135 grams.

Dimensions are in inches (mm). Tolerances: 2 Pl.±.01; 3 Pl. ±.005

**Notes**:

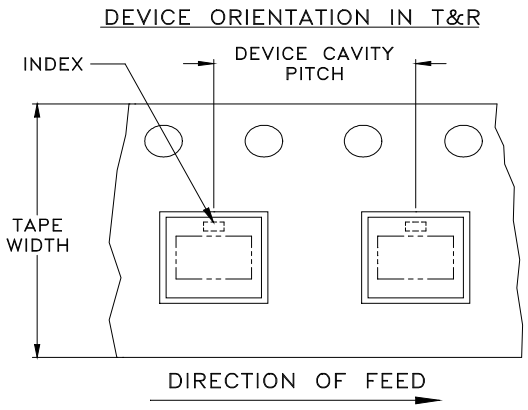
1. Case material: LTCC on printed circut board base.
2. Termination Finish: **as shown below or indicated on Data Sheet.**
   For RoHS Case Styles: Gold Plate over Nickel plate. All models, (+) suffix.


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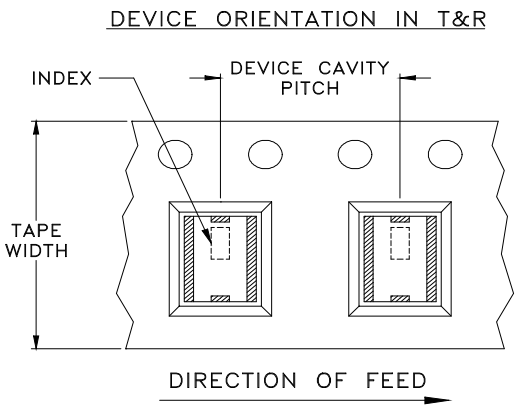



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# Tape & Reel Packaging TR-F77




Note: The shape of the pocket may differ




Note: The location and shape of the metallization may differ

| Applicable Case Styles |
|---|
| GU1604, GU1804, GU2644, TT1618-2 |

| Applicable Case Styles |
|---|
| MZ4532C, NM1812C, NM1812C-1, NM1812C-2, NM1812C-3, NM1812C-5, NM1812C-6, NM3237 NM1812C-9 |

| Tape Width, mm | Device Cavity Pitch, mm | Reel Size, inches | Devices per Reel | |
|---|---|---|---|---|
| 12 | 8 | 7 | Small quantity standards (see note) | 20 |
| | | | | 50 |
| | | | | 100 |
| | | | | 200 |
| | | | | 500 |
| | | | | 1000 |
| | | 13 | Standard | 2000 |

Note: Please Consult individual model data sheet to determine device per reel availability.

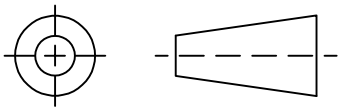
Mini-Circuits carrier tape materials provide protection from ESD (Electro-Static Discharge) during handling and transportation. Tapes are static dissipative and comply with industry standards EIA-481/EIA-541.

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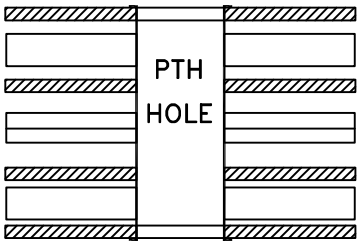
THIRD ANGLE PROJECTION



| REVISIONS | | | | | |
|---|---|---|---|---|---|
| REV | ECN No. | DESCRIPTION | DATE | DR | AUTH |
| OR | ECO-019771 | NEW RELEASE | 11/06/23 | ITG | IL |
| | | | | | |
| | | | | | |
| | | | | | |

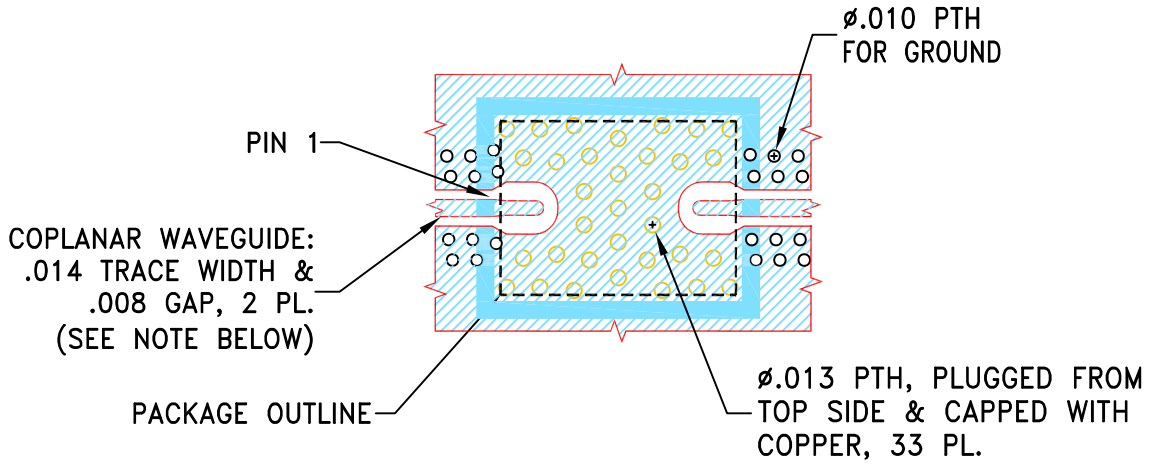
# SUGGESTED MOUNTING CONFIGURATION FOR NM3237 CASE STYLE

## STACK-UP DIAGRAM




-COPPER LAYER 1(L1), .5 OZ.
-CORE 1, .0079 MEGTRON-7 R5785(N/GN)
-COPPER LAYER 2 (L2), .5 OZ.
-PREPREG, .0035 (89 um) MEGTRON-7 R5680(N/GN), CLOTH STYLE:1078
-PREPREG, .0035 (89 um) MEGTRON-7 R5680(N/GN), CLOTH STYLE:1078
-COPPER LAYER 3 (L3), .5 OZ.
-CORE 2, .0079 MEGTRON-7 R5785(N/GN)
-COPPER LAYER 4 (L4), .5 OZ.

1. TOTAL FINISHED THICKNESS 0.026 ± 10%.
2. PTH PRESENT FROM COPPER LAYER 1 TO COPPER LAYER 4.




## NOTES:

1. PCB IS MULTILAYER PCB, SEE STACK-UP DIAGRAM.
2. TRACE WIDTH & GAP ARE SHOWN FOR .0079 MEGTRON-7 R5785(N/GN), COPPER: 1/2 OZ. EACH LAYER. FOR OTHER MATERIALS TRACE WIDTH & GAP MAY NEED TO BE MODIFIED.
3. LAYERS L2, L3 & L4 OF PCB ARE CONTINUOUS GROUND PLANES.



DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER).



DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK.

| UNLESS OTHERWISE SPECIFIED | | INITIALS | DATE |
|---|---|---|---|
| DIMENSIONS ARE IN INCHES | DRAWN | ITG | 11/06/23 |
| TOLERANCES ON: | CHECKED | GF | 11/06/23 |
| 2 PL DECIMALS ± | APPROVED | IL | 11/06/23 |
| 3 PL DECIMALS ± .005 | | | |
| ANGLES ± | | | |
| FRACTIONS ± | | | |

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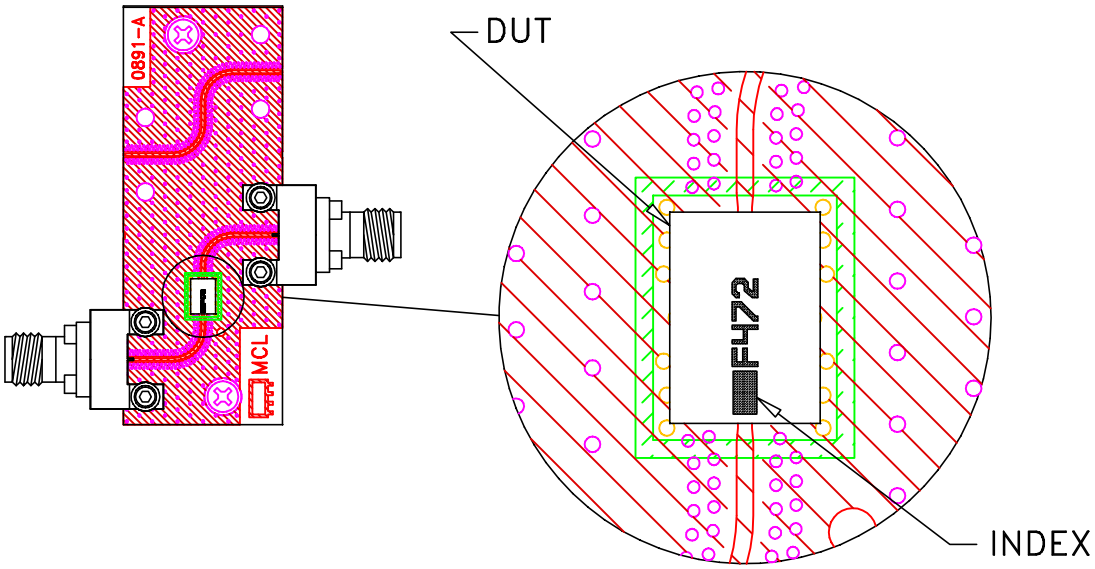
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PL,NM3237, TB-BFHKI-XXXXC+

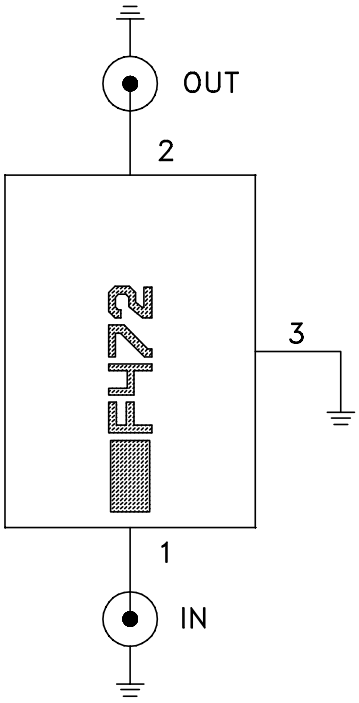
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# Evaluation Board and Circuit




TB-BFHKI-2492C+




Schematic Diagram

1. 50 Ohm 1.85 mm Female end Launch connectors.
2. PCB Material: MEGTRON-7 R5785(N or GN) or equivalent, Dielectric Constant=3.37 Thickness=.0079 inch.

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# Environmental Specifications ENV06T12

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 | -55° to 125° C<br>Ambient Environment | Individual Model Data Sheet |
| Storage Temperature | -55° to 125° C<br>Ambient Environment | Individual Model Data Sheet |
| Thermal Cycling | -55 to 125°C, 100 cycles, Dwell Time 15 minutes. | MIL-STD-202, Method 107, Condition A-3 |
| Humidity | 85°C, 90-95% Relative Humidity, 250hours | |
| Solderability | 10X / 30X Magnification | J-STD-002C Test S, J-STD-002C Test S1 |
| High Temp Storage | 125°C, 250 hours | |
| Bend Test | 1mm, deflection for 5 seconds<br>Span of bending: 2.75" | -- |


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