# X3 Frequency Multiplier

# RMK-3-93+

50Ω Output 5400 to 9000 MHz

## The Big Deal

- Broadband tripler for 5.4-9 GHz signal production
- High rejection of F2 and F4 (-55 dBc typ)
- Low conversion loss, 15 dB typ
- Outstanding performance at a low price



CASE STYLE: TT1224

## Product Overview

The RMK-3-93+ is a broadband frequency tripler offering excellent performance for C- to X-band signals. The aqueous washable and RoHS-compliant package features rugged, wire-welded construction, in a small 0.25” x 0.31” x 0.16” plastic case.

## Key Features

| Feature | Advantages |
|---|---|
| Broad bandwidth | Ideal for satellite up- and down-converters and line-of-sight communication links, as well as items operating in the 8.5-9.0 GHz radiolocation band |
| High rejection of F2 and F4 | Proprietary internal circuitry achieves high harmonic suppression, keeping filtering requirements to a minimum |
| Low conversion loss | High output reduces external gain requirements after frequency tripling. |
| Low price | Practical, low cost solution for providing high frequency sources from lower frequency VCOs and synthesizers. |

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

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## RMK-3-93+

50Ω Output 5400 to 9000 MHz



*Generic photo used for illustration purposes only*

CASE STYLE: TT1224

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

*Available Tape and Reel at no extra cost*

| Reel Size | Devices/Reel |
|---|---|
| 7" | 10, 20, 50, 100, 200 |
| 13" | 500 |

### Maximum Ratings

| | |
|---|---|
| Operating Temperature | -40°C to 85°C |
| Storage Temperature | -55°C to 100°C |
| RF Input Power | 17 dBm |

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

### Pin Connections

| | |
|---|---|
| INPUT | 1 |
| OUTPUT | 4 |
| GROUND | 2,3,5,6 |

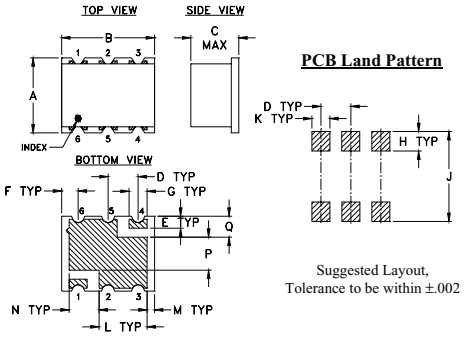
### Features

- broadband
- high rejection F2 & F4, -55 dBc typ.
- low cost
- aqueous washable

### Applications

- synthesizers
- local oscillators
- satellite up and down converters

### Outline Drawing

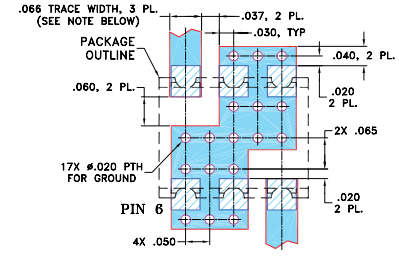



### Outline Dimensions (inch / mm)

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| .25 | .31 | .16 | .100 | .040 | .055 | .060 | .065 |
| 6.35 | 7.87 | 4.06 | 2.54 | 1.02 | 1.40 | 1.52 | 1.65 |

| J | K | L | M | N | P | Q | wt. |
|---|---|---|---|---|---|---|---|
| .300 | .060 | .160 | .025 | .100 | .110 | .070 | grams |
| 7.62 | 1.52 | 4.06 | 0.64 | 2.54 | 2.79 | 1.78 | 0.16 |

### *Demo Board MCL P/N: TB-393*
### *Suggested PCB Layout (PL-258)*




NOTES: 1. TRACE WIDTH IS SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS .030" ± .002"; COPPER: 1/2 OZ. EACH SIDE. FOR OTHER MATERIALS TRACE WIDTH MAY NEED TO BE MODIFIED.
2. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.

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

DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK

### Electrical Specifications

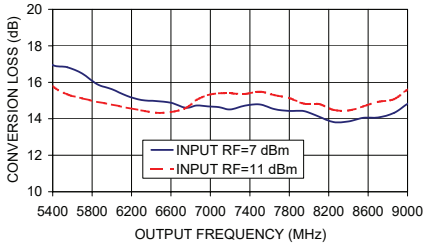
| MULTIPLICATION FACTOR | FREQUENCY (MHz) | | INPUT POWER (dBm) | | CONVERSION LOSS (dB) | | *HARMONIC OUTPUT (dBc) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F1 Input | F3 Output | Min. | Max. | Typ. | Max. | F1 Typ. | F1 Min. | F2 Typ. | F2 Min. | F4 Typ. | F4 Min. |
| 3 | 1800-3000 | 5400-9000 | 7 | 11 | 15 | 19.5 | 6 | -6 | 55 | 35 | 55 | 35 |

* Harmonics of input frequency below the power level of F3

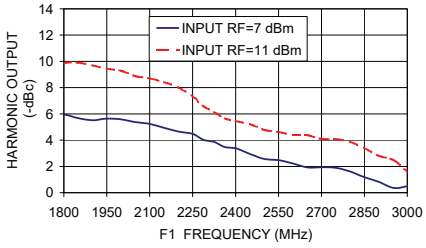
### Typical Performance Data

| Input Frequency (MHz) | INPUT RF= 7 dBm Conversion Loss (dB) | Harmonic Output Below F3 (-dBc) F1 | F2 | F4 | INPUT RF= 11 dBm Conversion Loss (dB) | Harmonic Output Below F3 (-dBc) F1 | F2 | F4 |
|---|---|---|---|---|---|---|---|---|
| 1800.00 | 16.94 | 5.94 | 64.33 | 62.56 | 15.79 | 9.86 | 73.68 | 61.49 |
| 1900.00 | 16.48 | 5.52 | 63.05 | 58.30 | 15.12 | 9.69 | 73.46 | 60.98 |
| 2000.00 | 15.62 | 5.58 | 65.59 | 58.27 | 14.78 | 9.29 | 72.77 | 61.61 |
| 2100.00 | 15.03 | 5.24 | 67.56 | 57.08 | 14.46 | 8.70 | 70.70 | 60.24 |
| 2200.00 | 14.88 | 4.66 | 65.40 | 54.92 | 14.37 | 8.01 | 67.50 | 60.03 |
| 2287.50 | 14.73 | 4.02 | 64.99 | 54.30 | 15.04 | 6.58 | 66.22 | 58.98 |
| 2325.00 | 14.68 | 3.86 | 66.04 | 54.86 | 15.30 | 6.15 | 66.18 | 58.85 |
| 2400.00 | 14.51 | 3.38 | 67.92 | 55.19 | 15.39 | 5.45 | 65.72 | 57.81 |
| 2450.00 | 14.72 | 2.95 | 67.05 | 54.79 | 15.36 | 5.22 | 64.01 | 57.96 |
| 2500.00 | 14.79 | 2.57 | 65.67 | 53.79 | 15.49 | 4.78 | 62.00 | 57.62 |
| 2550.00 | 14.53 | 2.48 | 66.05 | 53.40 | 15.30 | 4.62 | 60.87 | 57.76 |
| 2600.00 | 14.43 | 2.23 | 66.21 | 52.72 | 15.14 | 4.40 | 60.52 | 57.74 |
| 2650.00 | 14.42 | 1.93 | 68.53 | 51.96 | 14.83 | 4.38 | 62.14 | 59.76 |
| 2700.00 | 14.12 | 1.94 | 71.91 | 52.32 | 14.81 | 4.09 | 65.47 | 62.24 |
| 2750.00 | 13.82 | 1.89 | 67.73 | 52.40 | 14.49 | 4.08 | 68.87 | 63.23 |
| 2800.00 | 13.85 | 1.62 | 62.77 | 52.06 | 14.45 | 3.86 | 69.45 | 62.33 |
| 2850.00 | 14.05 | 1.18 | 59.98 | 51.75 | 14.68 | 3.39 | 67.86 | 60.15 |
| 2900.00 | 14.07 | 0.82 | 58.96 | 51.55 | 14.93 | 2.81 | 66.70 | 58.49 |
| 2955.00 | 14.33 | 0.35 | 57.62 | 50.67 | 15.08 | 2.45 | 66.24 | 57.64 |
| 3010.00 | 14.90 | 0.57 | 56.61 | 49.65 | 15.68 | 1.47 | 65.11 | 56.28 |

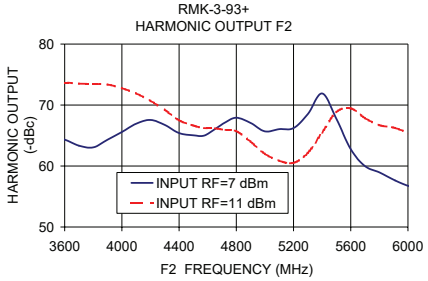
RMK-3-93+
CONVERSION LOSS



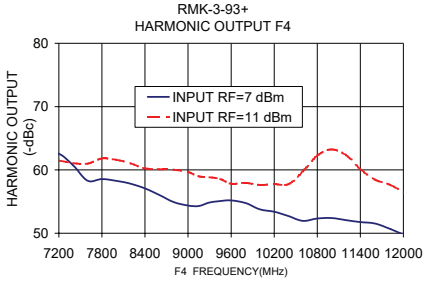

RMK-3-93+
HARMONIC OUTPUT F1




RMK-3-93+
HARMONIC OUTPUT F2




RMK-3-93+
HARMONIC OUTPUT F4




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# Frequency Multiplier (Tripler) RMK-3-93+

*Typical Performance Data*

| FREQUENCY (MHz) | | | | CONVERSION LOSS (dB) | RF IN = 7 dBm | | |
|---|---|---|---|---|---|---|---|
| | | | | | HARMONIC OUTPUT* (-dBc) | | |
| X1 OUTPUT | X2 OUTPUT | X3 OUTPUT | X4 OUTPUT | X3 OUTPUT | X1 OUTPUT | X2 OUTPUT | X4 OUTPUT |
| 1800.0 | 3600.0 | 5400.0 | 7200.0 | 16.94 | 5.94 | 64.33 | 62.56 |
| 1850.0 | 3700.0 | 5550.0 | 7400.0 | 16.82 | 5.67 | 63.33 | 60.72 |
| 1900.0 | 3800.0 | 5700.0 | 7600.0 | 16.48 | 5.52 | 63.05 | 58.30 |
| 1950.0 | 3900.0 | 5850.0 | 7800.0 | 15.90 | 5.64 | 64.32 | 58.55 |
| 2000.0 | 4000.0 | 6000.0 | 8000.0 | 15.62 | 5.58 | 65.59 | 58.27 |
| 2050.0 | 4100.0 | 6150.0 | 8200.0 | 15.26 | 5.38 | 66.93 | 57.83 |
| 2100.0 | 4200.0 | 6300.0 | 8400.0 | 15.03 | 5.24 | 67.56 | 57.08 |
| 2150.0 | 4300.0 | 6450.0 | 8600.0 | 14.97 | 4.94 | 66.75 | 56.03 |
| 2200.0 | 4400.0 | 6600.0 | 8800.0 | 14.88 | 4.66 | 65.40 | 54.92 |
| 2250.0 | 4500.0 | 6750.0 | 9000.0 | 14.60 | 4.48 | 65.03 | 54.37 |
| 2287.5 | 4575.0 | 6862.5 | 9150.0 | 14.73 | 4.02 | 64.99 | 54.30 |
| 2325.0 | 4650.0 | 6975.0 | 9300.0 | 14.68 | 3.86 | 66.04 | 54.86 |
| 2362.5 | 4725.0 | 7087.5 | 9450.0 | 14.64 | 3.47 | 67.19 | 55.08 |
| 2400.0 | 4800.0 | 7200.0 | 9600.0 | 14.51 | 3.38 | 67.92 | 55.19 |
| 2450.0 | 4900.0 | 7350.0 | 9800.0 | 14.72 | 2.95 | 67.05 | 54.79 |
| 2500.0 | 5000.0 | 7500.0 | 10000.0 | 14.79 | 2.57 | 65.67 | 53.79 |
| 2550.0 | 5100.0 | 7650.0 | 10200.0 | 14.53 | 2.48 | 66.05 | 53.40 |
| 2600.0 | 5200.0 | 7800.0 | 10400.0 | 14.43 | 2.23 | 66.21 | 52.72 |
| 2650.0 | 5300.0 | 7950.0 | 10600.0 | 14.42 | 1.93 | 68.53 | 51.96 |
| 2700.0 | 5400.0 | 8100.0 | 10800.0 | 14.12 | 1.94 | 71.91 | 52.32 |
| 2750.0 | 5500.0 | 8250.0 | 11000.0 | 13.82 | 1.89 | 67.73 | 52.40 |
| 2800.0 | 5600.0 | 8400.0 | 11200.0 | 13.85 | 1.62 | 62.77 | 52.06 |
| 2850.0 | 5700.0 | 8550.0 | 11400.0 | 14.05 | 1.18 | 59.98 | 51.75 |
| 2900.0 | 5800.0 | 8700.0 | 11600.0 | 14.07 | 0.82 | 58.96 | 51.55 |
| 2955.0 | 5910.0 | 8865.0 | 11820.0 | 14.33 | 0.35 | 57.62 | 50.67 |
| 3010.0 | 6020.0 | 9030.0 | 12040.0 | 14.90 | 0.57 | 56.61 | 49.65 |

* Harmonic Output below power level of X3 Output.

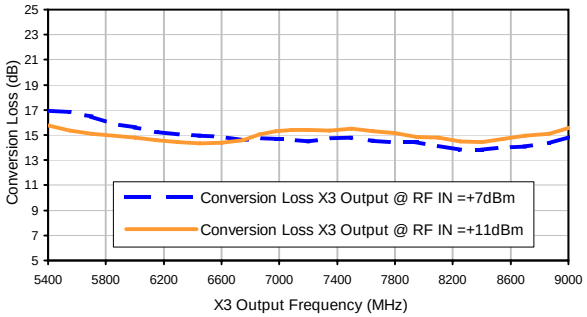
| FREQUENCY (MHz) | | | | CONVERSION LOSS (dB) | RF IN = 11dBm | | |
|---|---|---|---|---|---|---|---|
| | | | | | HARMONIC OUTPUT* (-dBc) | | |
| X1 OUTPUT | X2 OUTPUT | X3 OUTPUT | X4 OUTPUT | X3 OUTPUT | X1 OUTPUT | X2 OUTPUT | X4 OUTPUT |
| 1800.0 | 3600.0 | 5400.0 | 7200.0 | 15.79 | 9.86 | 73.68 | 61.49 |
| 1850.0 | 3700.0 | 5550.0 | 7400.0 | 15.34 | 9.90 | 73.51 | 61.07 |
| 1900.0 | 3800.0 | 5700.0 | 7600.0 | 15.12 | 9.69 | 73.46 | 60.98 |
| 1950.0 | 3900.0 | 5850.0 | 7800.0 | 14.93 | 9.44 | 73.36 | 61.81 |
| 2000.0 | 4000.0 | 6000.0 | 8000.0 | 14.78 | 9.29 | 72.77 | 61.61 |
| 2050.0 | 4100.0 | 6150.0 | 8200.0 | 14.61 | 8.88 | 71.89 | 61.03 |
| 2100.0 | 4200.0 | 6300.0 | 8400.0 | 14.46 | 8.70 | 70.70 | 60.24 |
| 2150.0 | 4300.0 | 6450.0 | 8600.0 | 14.33 | 8.42 | 69.22 | 60.11 |
| 2200.0 | 4400.0 | 6600.0 | 8800.0 | 14.37 | 8.01 | 67.50 | 60.03 |
| 2250.0 | 4500.0 | 6750.0 | 9000.0 | 14.59 | 7.34 | 66.63 | 59.68 |
| 2287.5 | 4575.0 | 6862.5 | 9150.0 | 15.04 | 6.58 | 66.22 | 58.98 |
| 2325.0 | 4650.0 | 6975.0 | 9300.0 | 15.30 | 6.15 | 66.18 | 58.85 |
| 2362.5 | 4725.0 | 7087.5 | 9450.0 | 15.40 | 5.65 | 65.93 | 58.56 |
| 2400.0 | 4800.0 | 7200.0 | 9600.0 | 15.39 | 5.45 | 65.72 | 57.81 |
| 2450.0 | 4900.0 | 7350.0 | 9800.0 | 15.36 | 5.22 | 64.01 | 57.96 |
| 2500.0 | 5000.0 | 7500.0 | 10000.0 | 15.49 | 4.78 | 62.00 | 57.62 |
| 2550.0 | 5100.0 | 7650.0 | 10200.0 | 15.30 | 4.62 | 60.87 | 57.76 |
| 2600.0 | 5200.0 | 7800.0 | 10400.0 | 15.14 | 4.40 | 60.52 | 57.74 |
| 2650.0 | 5300.0 | 7950.0 | 10600.0 | 14.83 | 4.38 | 62.14 | 59.76 |
| 2700.0 | 5400.0 | 8100.0 | 10800.0 | 14.81 | 4.09 | 65.47 | 62.24 |
| 2750.0 | 5500.0 | 8250.0 | 11000.0 | 14.49 | 4.08 | 68.87 | 63.23 |
| 2800.0 | 5600.0 | 8400.0 | 11200.0 | 14.45 | 3.86 | 69.45 | 62.33 |
| 2850.0 | 5700.0 | 8550.0 | 11400.0 | 14.68 | 3.39 | 67.86 | 60.15 |
| 2900.0 | 5800.0 | 8700.0 | 11600.0 | 14.93 | 2.81 | 66.70 | 58.49 |
| 2955.0 | 5910.0 | 8865.0 | 11820.0 | 15.08 | 2.45 | 66.24 | 57.64 |
| 3010.0 | 6020.0 | 9030.0 | 12040.0 | 15.68 | 1.47 | 65.11 | 56.28 |

* Harmonic Output below power level of X3 Output.

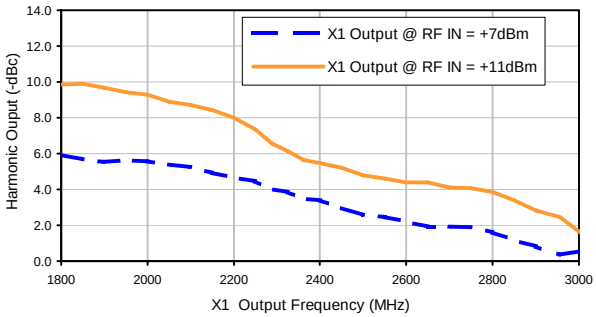
# Frequency Multiplier (Tripler) RMK-3-93+

*Typical Performance Curves*

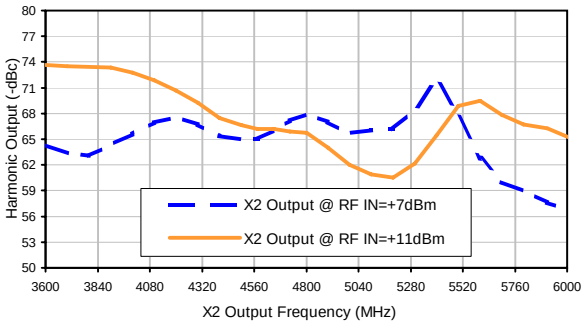
**Conversion Loss X3 Output**



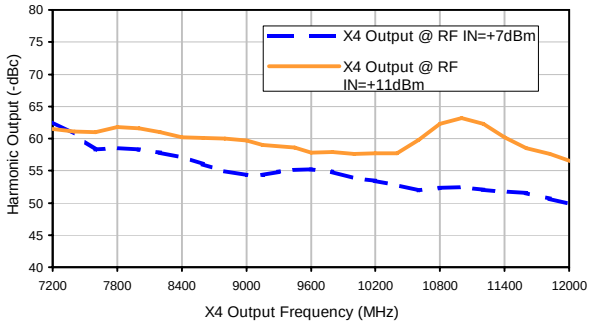

**Harmonic X1 Output**




**Harmonic X2 Output**



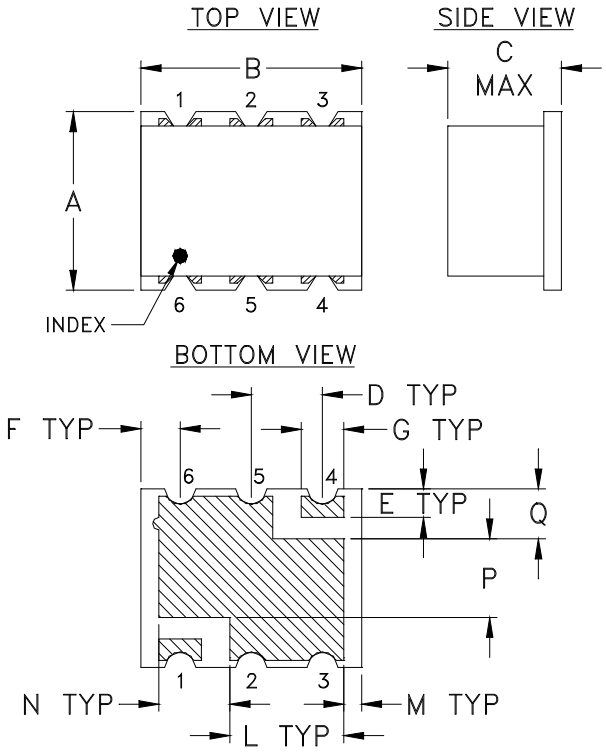

**Harmonic X4 Output**



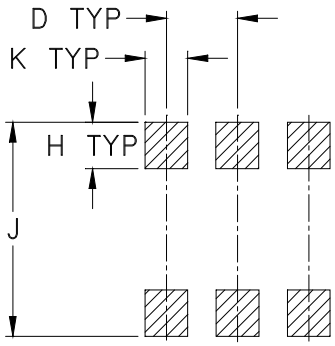
# Case Style TT

**TT1224**

## Outline Dimensions




## PCB Land Pattern




Suggested Layout,
Tolerance to be within ±.002

| CASE # | A | B | C | D | E | F | G | H | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TT1224 | .25 (6.35) | .31 (7.87) | .16 (4.06) | .100 (2.54) | .040 (1.02) | .055 (1.40) | .060 (1.52) | .065 (1.65) | .300 (7.62) | .060 (1.52) | .160 (4.06) |

| CASE # | M | N | P | Q | WT. GRAM |
|---|---|---|---|---|---|
| TT1224 | .025 (.64) | .100 (2.54) | .110 (2.79) | .070 (1.78) | .16 |

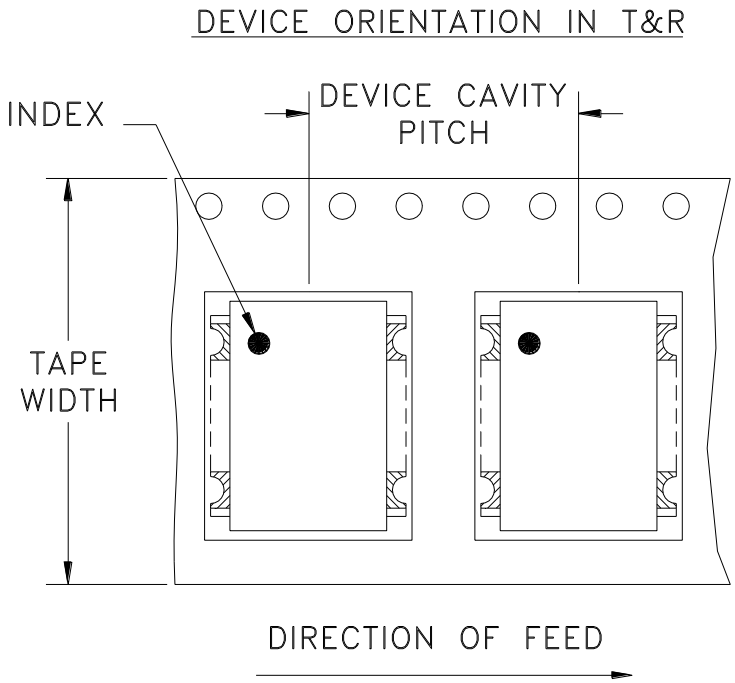
**Dimensions are in inches (mm). Tolerances: 2Pl. ± .01; 3 Pl. ± .005**

### Notes:

1. Case material: Plastic.
2. Termination: 2-10 µ inch (.05-.25 microns) Gold over 100-300 µ inch (2.54-7.62 microns) Nickel plate


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# Tape & Reel Packaging TR-F2




| Tape Width, mm | Device Cavity Pitch, mm | Reel Size, inches | Devices per Reel See note |
|---|---|---|---|
| 16 | 12 | 7 | 10 |
| | | | 20 |
| | | | 50 |
| | | | 100 |
| | | | 200 |
| | | 13 | 500 |

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.

Go to: www.minicircuits.com/pages/pdfs/tape.pdf

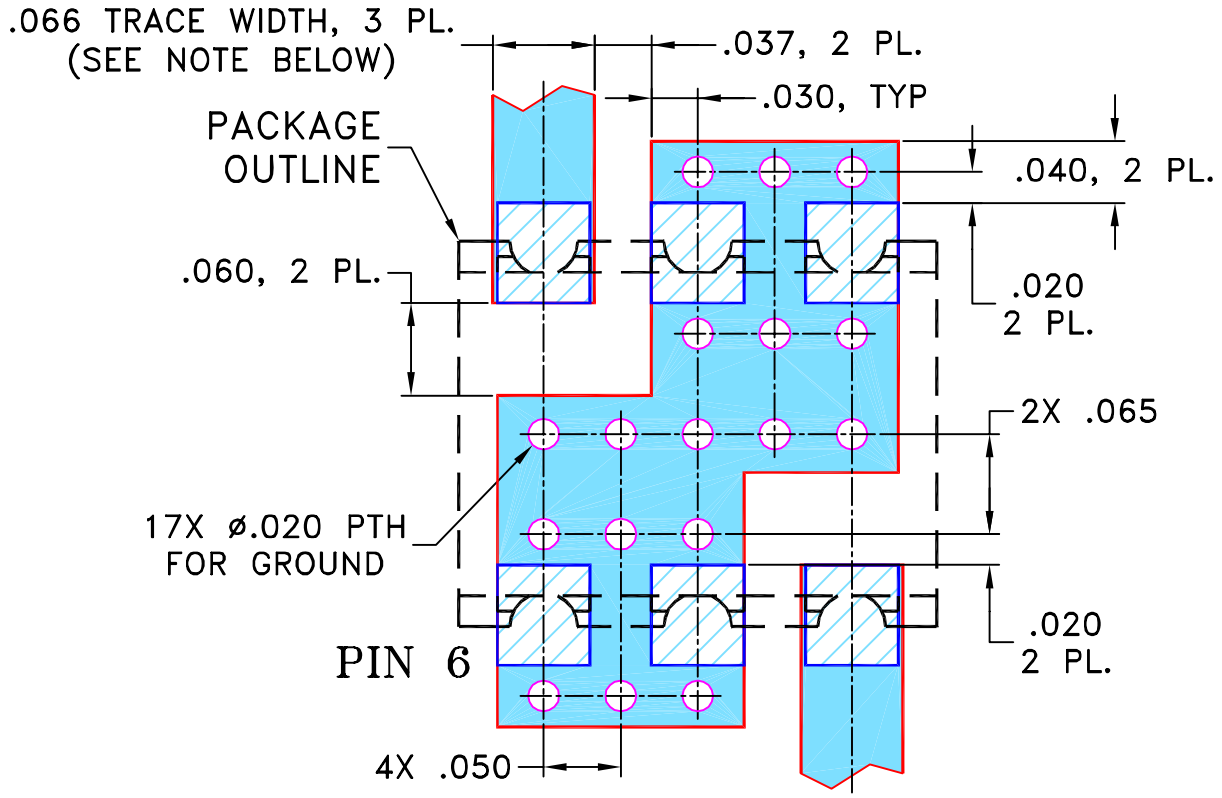
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THIRD ANGLE PROJECTION

| REVISIONS | | | | | |
|---|---|---|---|---|---|
| REV | ECN No. | DESCRIPTION | DATE | DR | AUTH |
| OR | M108897 | NEW RELEASE | 01/04/07 | AV | DJ |
| | | | | | |
| | | | | | |
| | | | | | |

# SUGGESTED MOUNTING CONFIGURATION FOR TT1224 CASE STYLE "rv" PIN CONNECTION




NOTES:
1. TRACE WIDTH IS SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS .030" ± .002"; COPPER: 1/2 OZ. EACH SIDE. FOR OTHER MATERIALS TRACE WIDTH MAY NEED TO BE MODIFIED.
2. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.

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 | AV | 12/14/06 |
| TOLERANCES ON: | CHECKED | IL | 01/04/07 |
| 2 PL DECIMALS ± | APPROVED | DJ | 01/04/07 |
| 3 PL DECIMALS ± .005 | | | |
| ANGLES ± | | | |
| FRACTIONS ± | | | |


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ASHEETA1.DWG REV:A DATE:01/12/95

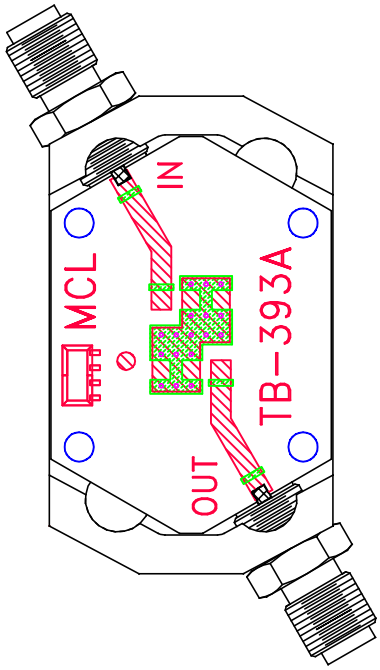

Mini-Circuits® 13 Neptune Avenue Brooklyn NY 11235


PL, rv, TT1224, RMK-3-662+, TB-393

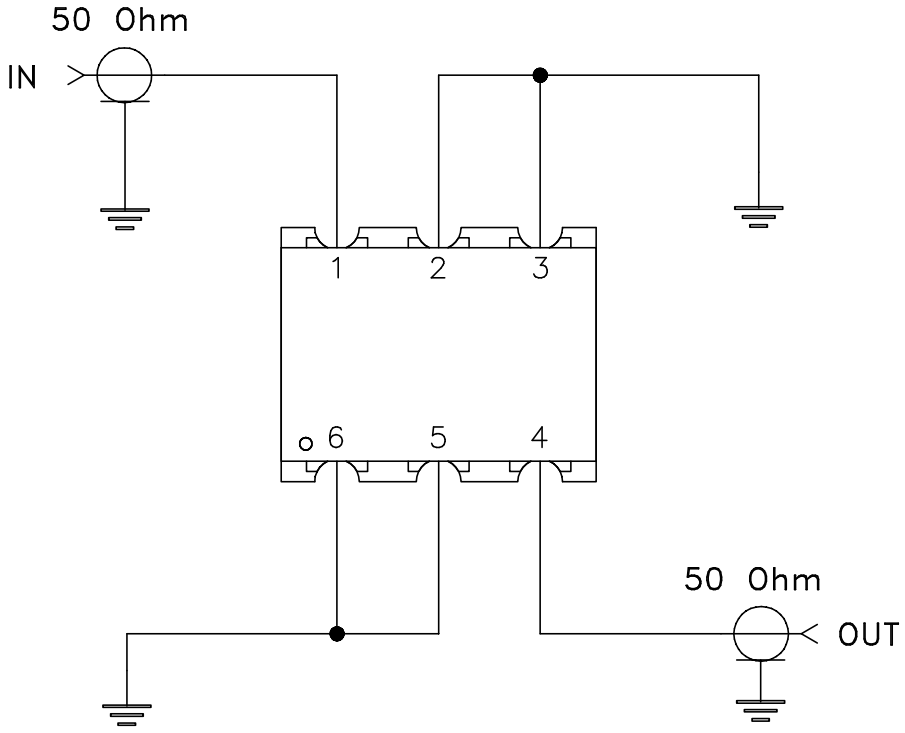
| SIZE | CODE IDENT | DRAWING NO: | REV: |
|---|---|---|---|
| A | 15542 | 98-PL-258 | OR |

| FILE: | SCALE: | SHEET: |
|---|---|---|
| 98PL258 | 8:1 | 1 OF 1 |

# Evaluation Board and Circuit




TB-393




Schematic Diagram

## Notes:

1. SMA Female connectors.
2. PCB Material: Rogers RO4350 or equivalent, Dielectric Constant=3.5, Thickness=.030 inch.

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# Environmental Specifications ENV02T1

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<br>Ambient Environment | Individual Model Data Sheet |
| Storage Temperature | -55° to 100° C<br>Ambient Environment | Individual Model Data Sheet |
| Humidity | 90 to 95% RH, 240 hours, 50°C | MIL-STD-202, Method 103, Condition A, Except 50°C and end-point electrical test done within 12 hours |
| Thermal Shock | -55° to 100°C, 100 cycles | MIL-STD-202, Method 107, Condition A-3, except +100°C |
| Solder Reflow Heat | Sn-Pb Eutetic Process: 225°C peak<br>Pb-Free Process 245° - 250°C peak | J-STD-020, Table 4-1, 4-2 and 5-2, Figure 5-1 |
| Solderability | 10X Magnification | J-STD-002, 95% Coverage |
| 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 | 50g, 11 ms, 1/2-sine, 18 shocks: 3 each direction, each of 3 axes | MIL-STD-202, Method 213, Condition A |
| Marking Resistance to Solvents | Isopropyl alcohol + mineral spirits at 25°C; terpene defluxer at 25°C;<br>distilled water + proylene glycol monomethyl ether + monoethanolamine at 63°C to 70°C | MIL-STD-202, Method 215 |


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