# X5 Frequency Multiplier

# RMK-5-352+

50Ω Output 2750 to 3500 MHz

## The Big Deal

- Low conversion loss, 22 dB
- Excellent harmonic suppression, -40 dBc @ F4 and F6.

CASE STYLE: TT1224

## Product Overview

Mini-Circuits' RMK-5-352+ is a surface mount frequency multiplier with a multiplication factor of 5, converting input frequencies from 550 to 700 MHz into output frequencies from 2750 to 3500 MHz. This model is rated for +17 dBm input power and provides low conversion loss and excellent harmonic suppression. The multiplier comes housed in a shielded surface-mount package (0.25 x 0.31 x 0.16") with wraparound terminations for excellent solderability.

## Key Features

| Feature | Advantages |
|---|---|
| Low conversion loss, 22 dB typ. | Low conversion loss results in higher output signal power, reducing the need for amplification at later stages. |
| Excellent harmonic suppression:<br>• F4, 40 dBc<br>• F6, 40 dBc | Reduces spurious signals and the need for additional filtering. Reduces spectral regrowth in multiple-channel systems. |
| Low cost | Provides an easy, cost-effective solution for generating high-frequency signals from a lower frequency signal source. |
| Small size, 0.25 x 0.31 x 0.16" | Saves space in dense circuit board layouts |

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## RMK-5-352+

50Ω Output 2750 to 3500 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 | 20 dBm |

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

### Pin Connections

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

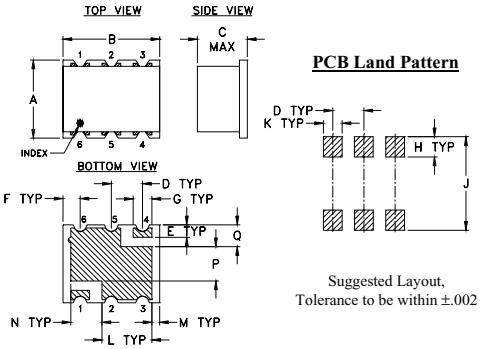
### Features

- low conversion loss, 22 dB typ.
- high rejection of adjacent harmonics, -40 dBc typ.
- aqueous washable

### Applications

- synthesizers
- local oscillators
- satellite up and down converters

### Outline Drawing

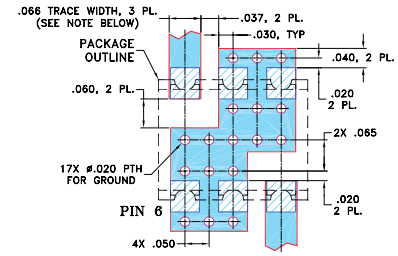



### Outline Dimensions (inch / mm)

| 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 at 25°C

| Parameter | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Multiplier Factor | | | 5 | | |
| Frequency Range, Input (F1) | | 550 | — | 700 | MHz |
| Frequency Range, Output (F5) | | 2750 | — | 3500 | MHz |
| Input Power | | — | 17 | — | dBm |
| Conversion Loss | | — | 22 | 24.5 | dB |
| Harmonic Ouput* | F1 | — | -6.5 | -1 | dBc |
| | F2 | — | -56 | -40 | |
| | F3 | — | 0 | +9.5 | |
| | F4 | — | -40 | -30 | |
| | F6 | — | -40 | -30 | |
| | F7 | — | -10.5 | -4 | |

* Harmonics of input frequency relative to the power level of F5

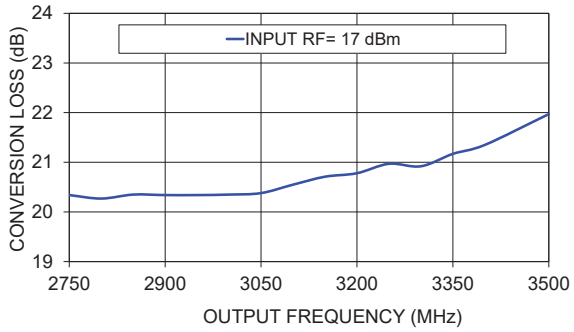
### Typical Performance Data

| Frequency Input (MHz) | Frequency Output (MHz) | Conv. Loss (dB) F5 | Harmonic Rejection Relative to F5, (dBc) at RF Input Power 17 dBm F1 | F2 | F3 | F4 | F6 | F7 |
|---|---|---|---|---|---|---|---|---|
| 550 | 2750 | 20.34 | -10.60 | -60.86 | -2.26 | -45.75 | -47.76 | -8.88 |
| 560 | 2800 | 20.27 | -10.29 | -61.69 | -2.04 | -45.80 | -47.37 | -9.33 |
| 570 | 2850 | 20.35 | -9.88 | -62.52 | -1.57 | -45.67 | -46.93 | -9.63 |
| 580 | 2900 | 20.34 | -9.64 | -63.68 | -1.20 | -45.87 | -46.49 | -9.83 |
| 590 | 2950 | 20.34 | -9.33 | -65.18 | -0.80 | -45.91 | -46.01 | -10.21 |
| 600 | 3000 | 20.35 | -8.97 | -66.96 | -0.44 | -46.17 | -45.66 | -10.29 |
| 610 | 3050 | 20.38 | -8.63 | -70.08 | -0.12 | -46.26 | -45.16 | -10.59 |
| 620 | 3100 | 20.55 | -8.27 | -71.80 | 0.50 | -46.43 | -44.74 | -10.70 |
| 630 | 3150 | 20.71 | -7.86 | -69.97 | 0.90 | -46.45 | -44.63 | -11.08 |
| 640 | 3200 | 20.78 | -7.47 | -67.44 | 1.31 | -46.70 | -44.57 | -11.31 |
| 650 | 3250 | 20.97 | -6.97 | -65.66 | 1.93 | -46.98 | -44.60 | -11.18 |
| 660 | 3300 | 20.92 | -6.79 | -63.85 | 2.18 | -47.38 | -44.55 | -11.36 |
| 670 | 3350 | 21.17 | -6.28 | -61.83 | 2.75 | -47.80 | -44.32 | -11.32 |
| 680 | 3400 | 21.35 | -5.85 | -60.26 | 3.25 | -48.78 | -44.09 | -11.36 |
| 700 | 3500 | 21.97 | -4.81 | -56.10 | 4.36 | -50.58 | -43.30 | -11.73 |

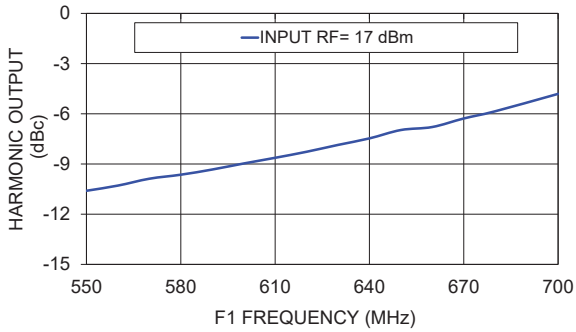
Notes

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

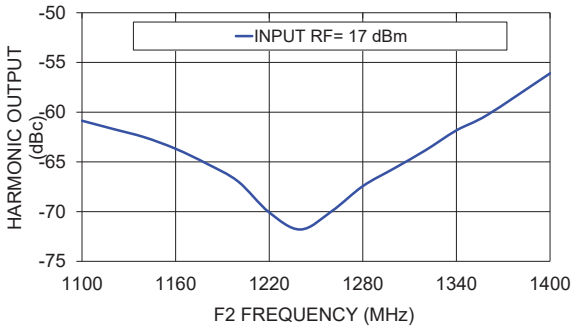
RMK-5-352+
CONVERSION LOSS



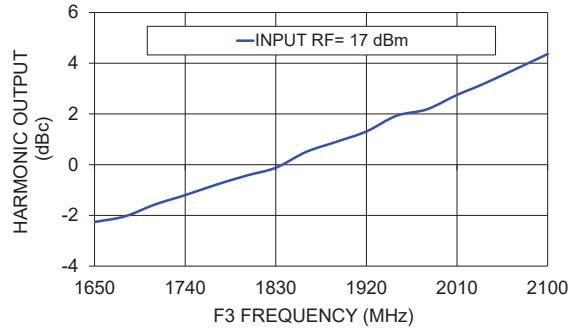

RMK-5-352+
HARMONIC OUTPUT F1



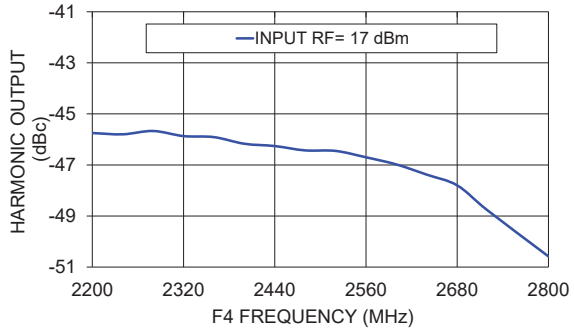

RMK-5-352+
HARMONIC OUTPUT F2



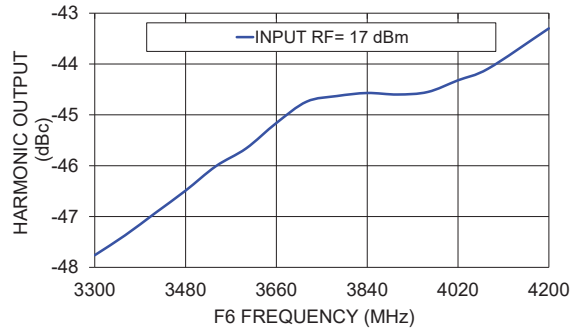

RMK-5-352+
HARMONIC OUTPUT F3



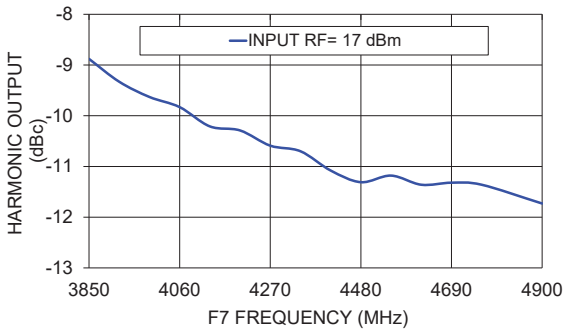

RMK-5-352+
HARMONIC OUTPUT F4




RMK-5-352+
HARMONIC OUTPUT F6




RMK-5-352+
HARMONIC OUTPUT F7

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# Frequency Multiplier (X5) RMK-5-352+

## *Typical Performance Data*

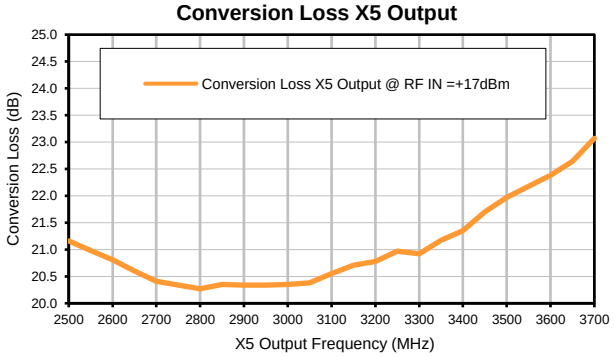
| FREQUENCY (MHz) | | | | | | | CONVERSION LOSS (dB) | RF IN = +17 dBm HARMONIC OUTPUT* (-dBc) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X1 OUTPUT | X2 OUTPUT | X3 OUTPUT | X4 OUTPUT | X5 OUTPUT | X6 OUTPUT | X7 OUTPUT | X5 OUTPUT | X1 OUTPUT | X2 OUTPUT | X3 OUTPUT | X4 OUTPUT | X6 OUTPUT | X7 OUTPUT |
| 500 | 1000 | 1500 | 2000 | 2500 | 3000 | 3500 | 21.16 | 11.37 | 61.94 | 3.60 | 46.01 | 54.30 | 6.72 |
| 510 | 1020 | 1530 | 2040 | 2550 | 3060 | 3570 | 20.98 | 11.25 | 62.60 | 3.29 | 45.59 | 53.98 | 7.36 |
| 520 | 1040 | 1560 | 2080 | 2600 | 3120 | 3640 | 20.81 | 11.10 | 61.08 | 3.14 | 45.88 | 50.78 | 7.68 |
| 530 | 1060 | 1590 | 2120 | 2650 | 3180 | 3710 | 20.60 | 10.95 | 60.74 | 2.94 | 45.95 | 48.73 | 7.99 |
| 540 | 1080 | 1620 | 2160 | 2700 | 3240 | 3780 | 20.41 | 10.83 | 60.66 | 2.64 | 45.88 | 48.31 | 8.43 |
| 550 | 1100 | 1650 | 2200 | 2750 | 3300 | 3850 | 20.34 | 10.60 | 60.86 | 2.26 | 45.75 | 47.76 | 8.88 |
| 560 | 1120 | 1680 | 2240 | 2800 | 3360 | 3920 | 20.27 | 10.29 | 61.69 | 2.04 | 45.80 | 47.37 | 9.33 |
| 570 | 1140 | 1710 | 2280 | 2850 | 3420 | 3990 | 20.35 | 9.88 | 62.52 | 1.57 | 45.67 | 46.93 | 9.63 |
| 580 | 1160 | 1740 | 2320 | 2900 | 3480 | 4060 | 20.34 | 9.64 | 63.68 | 1.20 | 45.87 | 46.49 | 9.83 |
| 590 | 1180 | 1770 | 2360 | 2950 | 3540 | 4130 | 20.34 | 9.33 | 65.18 | 0.80 | 45.91 | 46.01 | 10.21 |
| 600 | 1200 | 1800 | 2400 | 3000 | 3600 | 4200 | 20.35 | 8.97 | 66.96 | 0.44 | 46.17 | 45.66 | 10.29 |
| 610 | 1220 | 1830 | 2440 | 3050 | 3660 | 4270 | 20.38 | 8.63 | 70.08 | 0.12 | 46.26 | 45.16 | 10.59 |
| 620 | 1240 | 1860 | 2480 | 3100 | 3720 | 4340 | 20.55 | 8.27 | 71.80 | -0.50 | 46.43 | 44.74 | 10.70 |
| 630 | 1260 | 1890 | 2520 | 3150 | 3780 | 4410 | 20.71 | 7.86 | 69.97 | -0.90 | 46.45 | 44.63 | 11.08 |
| 640 | 1280 | 1920 | 2560 | 3200 | 3840 | 4480 | 20.78 | 7.47 | 67.44 | -1.31 | 46.70 | 44.57 | 11.31 |
| 650 | 1300 | 1950 | 2600 | 3250 | 3900 | 4550 | 20.97 | 6.97 | 65.66 | -1.93 | 46.98 | 44.60 | 11.18 |
| 660 | 1320 | 1980 | 2640 | 3300 | 3960 | 4620 | 20.92 | 6.79 | 63.85 | -2.18 | 47.38 | 44.55 | 11.36 |
| 670 | 1340 | 2010 | 2680 | 3350 | 4020 | 4690 | 21.17 | 6.28 | 61.83 | -2.75 | 47.80 | 44.32 | 11.32 |
| 680 | 1360 | 2040 | 2720 | 3400 | 4080 | 4760 | 21.35 | 5.85 | 60.26 | -3.25 | 48.78 | 44.09 | 11.36 |
| 690 | 1380 | 2070 | 2760 | 3450 | 4140 | 4830 | 21.70 | 5.23 | 57.95 | -3.78 | 49.94 | 43.53 | 11.57 |
| 700 | 1400 | 2100 | 2800 | 3500 | 4200 | 4900 | 21.97 | 4.81 | 56.10 | -4.36 | 50.58 | 43.30 | 11.73 |
| 710 | 1420 | 2130 | 2840 | 3550 | 4260 | 4970 | 22.18 | 4.30 | 54.46 | -4.85 | 50.71 | 43.03 | 11.63 |
| 720 | 1440 | 2160 | 2880 | 3600 | 4320 | 5040 | 22.38 | 3.78 | 52.85 | -5.36 | 50.27 | 42.50 | 11.64 |
| 730 | 1460 | 2190 | 2920 | 3650 | 4380 | 5110 | 22.64 | 3.23 | 51.17 | -5.84 | 51.67 | 41.92 | 11.68 |
| 740 | 1480 | 2220 | 2960 | 3700 | 4440 | 5180 | 23.07 | 2.69 | 49.79 | -6.38 | 55.11 | 41.66 | 11.72 |

* Harmonic Output below power level of X5 Output.

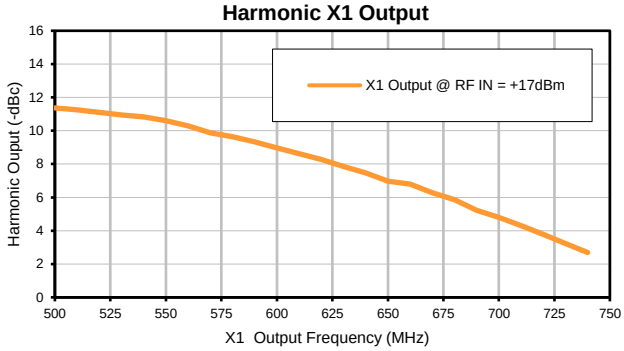
# Frequency Multiplier (X5) RMK-5-352+

## *Typical Performance Curves*

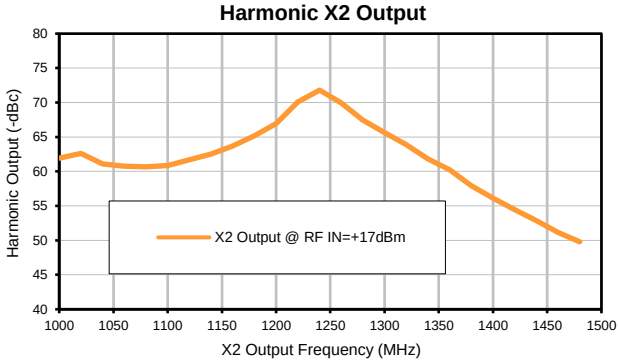
**Conversion Loss X5 Output**



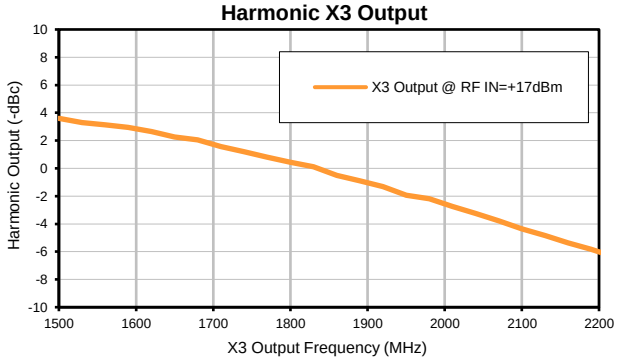

**Harmonic X1 Output**



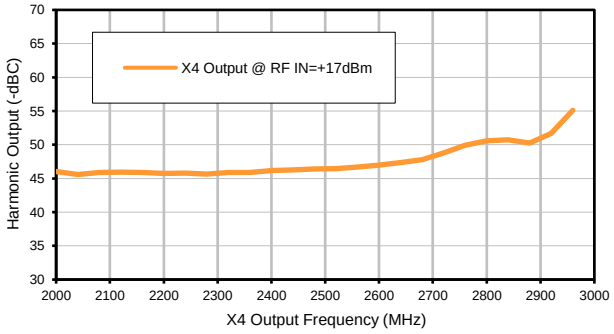

**Harmonic X2 Output**



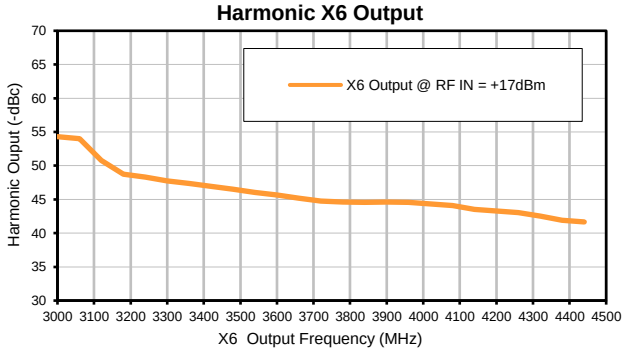

**Harmonic X3 Output**



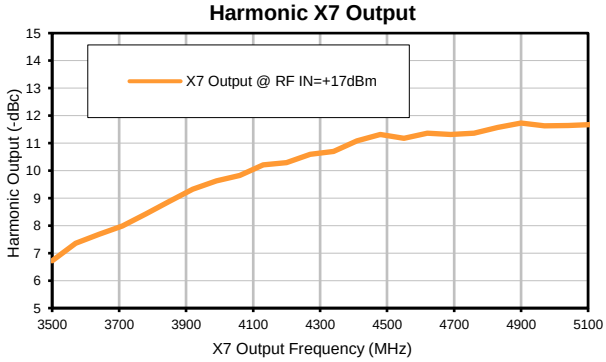

**Harmonic X4 Output**




**Harmonic X6 Output**



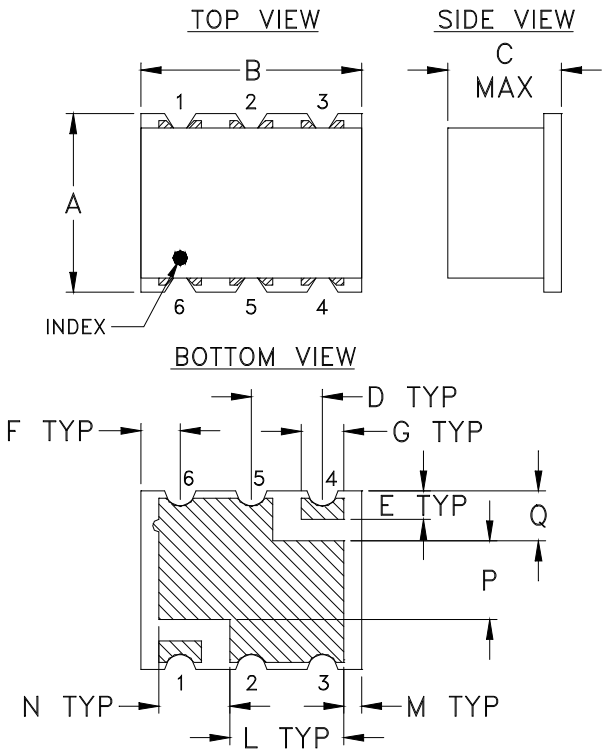

**Harmonic X7 Output**



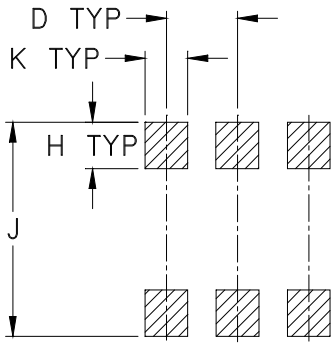
# Case Style TT

**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) |

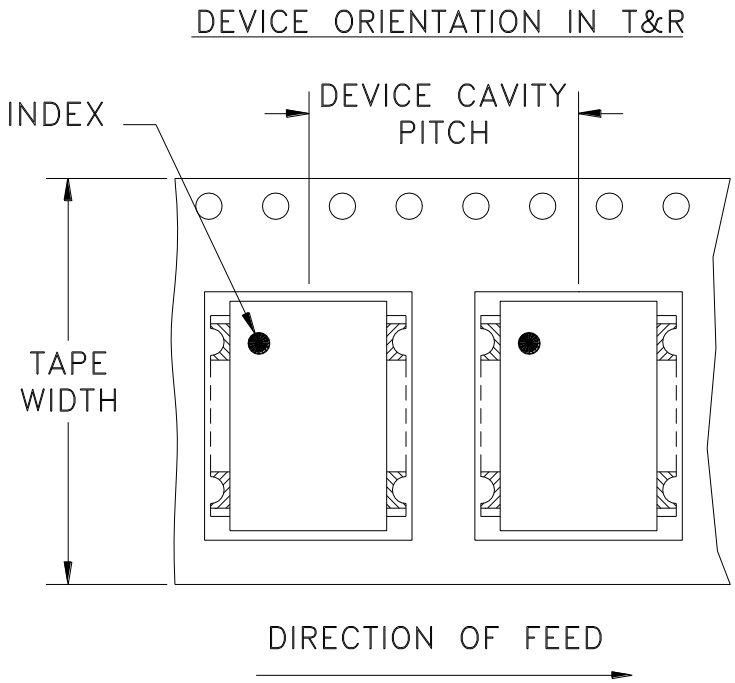
| CASE # | M | N | P | Q | WT. GRAM |
|---|---|---|---|---|---|
| TT1224 | .025 (.64) | .100 (2.54) | .110 (2.79) | .070 (1.78) | .16 |

**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

# 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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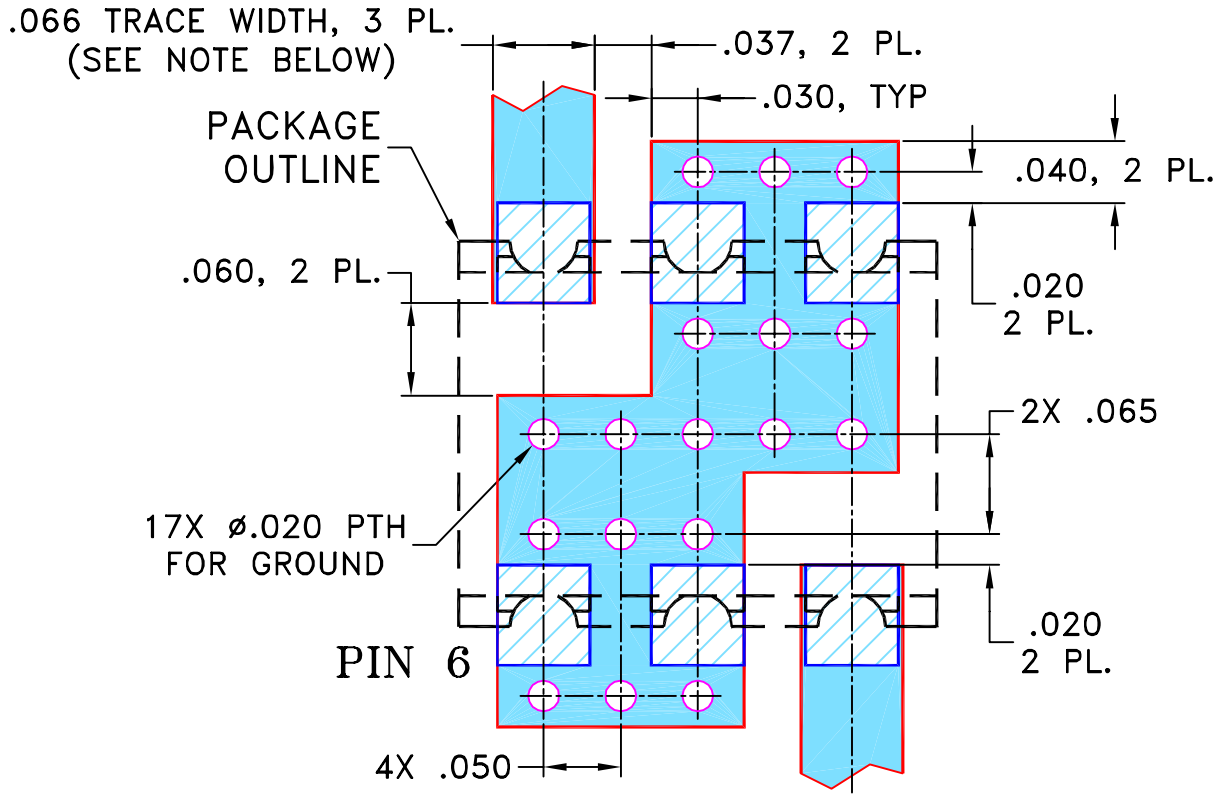
Mini-Circuits ISO 9001 & ISO 14001 Certified

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:
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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 ± | | | |



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

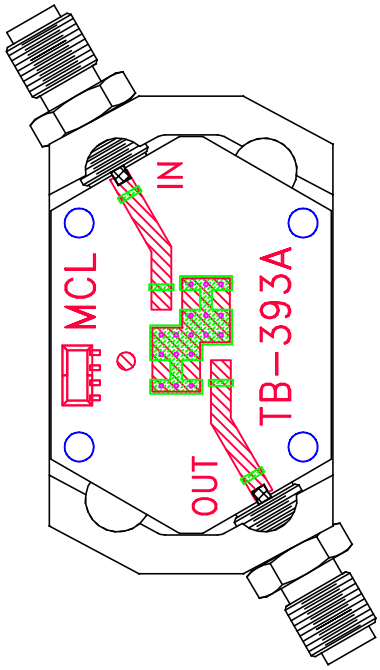
Mini-Circuits®
13 Neptune Avenue
Brooklyn NY 11235

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

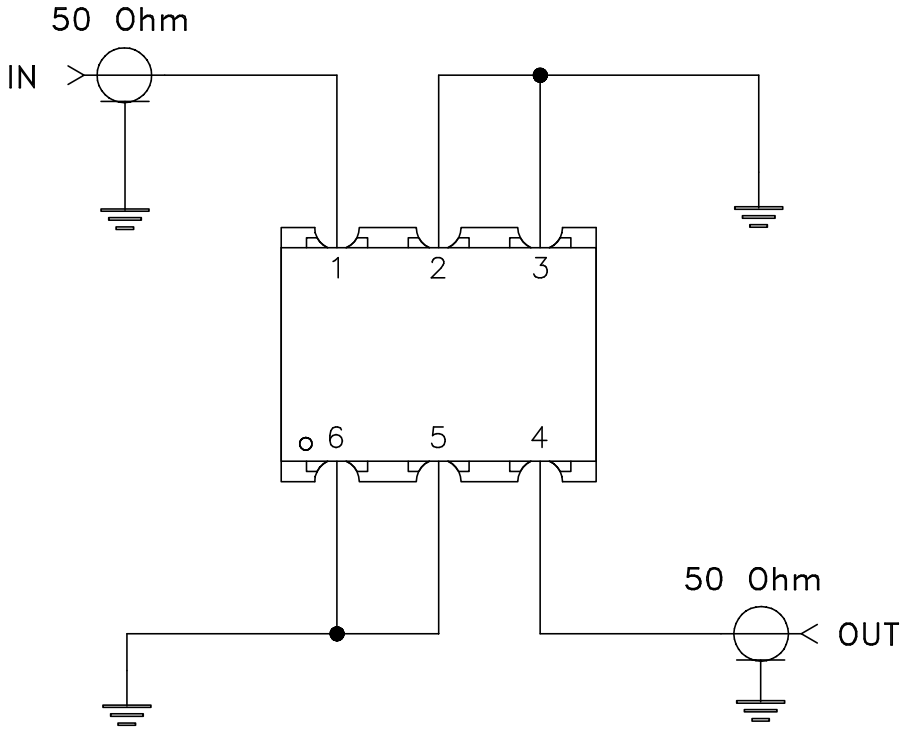
| SIZE | CODE IDENT | DRAWING NO: | REV: |
|---|---|---|---|
| A | 15542 | 98-PL-258 | OR |

| 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 |