

# X5 Frequency Multiplier

RMK-5-13+

50Ω     Output 750 to 1000 MHz

## The Big Deal

- Broadband, 750 to 1000 MHz output
- Good harmonic suppression:  
F4, 63 dBc; F6, 68 dBc
- Small size, 0.25 x 0.31 x 0.16"



CASE STYLE: TT1224

## Product Overview

i-Circuits' RMK-5-13+ frequency multiplier provides a multiplication factor of 5, converting input frequencies from 150 to 200 MHz into output frequencies from 750 to 1000 MHz, supporting applications including synthesizers, local oscillators, satellite up and down converters and more. The unit supports signal input power of +17 dBm with 21.2 dB conversion loss and very good harmonic suppression. The multiplier comes housed in a miniature surface-mount package (0.25 x 0.31 x 0.16") ideal for dense circuit board layouts.

## Key Features

| Feature                                                                                                          | Advantages                                                                                                            |
|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Low conversion loss, 21.2 dB                                                                                     | With a low conversion loss, the unit produces higher output power, reducing the need for amplification.               |
| Very good harmonic suppression <ul style="list-style-type: none"><li>• F4, 63 dBc</li><li>• F6, 68 dBc</li></ul> | Reduces spurious signals and the need for additional filtering.                                                       |
| Low cost                                                                                                         | Provides an easy, cost-effective solution for generating high-frequency signals from a lower frequency signal source. |
| Small size                                                                                                       | Measuring only 0.25 x 0.31 x 0.16", the RMK-5-13+ saves space in crowded PCB layouts.                                 |

### 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)



**X5**

50Ω

## Output 750 to 1000 MHz

|                       |                |
|-----------------------|----------------|
| Operating Temperature | -40°C to 85°C  |
| Storage Temperature   | -55°C to 100°C |
| RF Input Power        | 21 dBm         |

Permanent damage may occur if any of these limits are exceeded

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

**TOP VIEW**

**SIDE VIEW**

**PCB Land Pattern**

**BOTTOM VIEW**

Suggested Layout,  
Tolerance to be within  $\pm 0.02$

| 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  |

Figure 1 is a mechanical drawing of the package outline for the 17X16 package. The drawing shows a rectangular package with various dimensions and features. Key dimensions include: .065 TRACE WIDTH, 3 PL. (SEE NOTE BELOW); .037, 2 PL.; .030, TYP.; .040, 2 PL.; .020, 2 PL.; 2X .065; .020, 2 PL.; 4X .050; .060, 2 PL.; 17X .020 PTH FOR GROUND; and PIN 6. The package outline is shown in blue, and the lead frame is shown in red.

## Notes

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- low conversion loss, 21.2 dB typ.
- excellent adjacent harmonic rejection, F4, 63 dBc typ., F6, 68 dBc typ
- aqueous washable

- synthesizers
- local oscillators
- satellite up and down converters

| Parameter                    |    | Min. | Typ. | Max. | Unit |
|------------------------------|----|------|------|------|------|
| Multiplier Factor            |    |      | 5    |      |      |
| Frequency Range, Input (F1)  |    | 150  | —    | 200  | MHz  |
| Frequency Range, Output (F3) |    | 750  | —    | 1000 | MHz  |
| Input Power                  |    | —    | 17.0 | —    | dBm  |
| Conversion Loss              |    | —    | 21.2 | 24.5 | dB   |
| Harmonic Output*             | F1 | -3   | 2.0  | —    | -dBc |
|                              | F2 | 40   | 65   | —    |      |
|                              | F3 | -10  | 5    | —    |      |
|                              | F4 | 40   | 63   | —    |      |
|                              | F6 | 40   | 68   | —    |      |
|                              | F7 | -1   | 4.0  | —    |      |

\* Harmonics of input frequency below the power level of F5

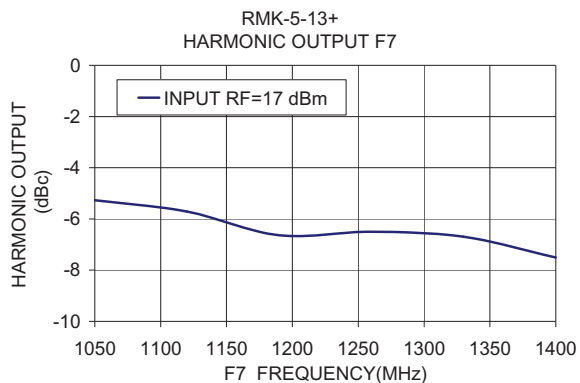
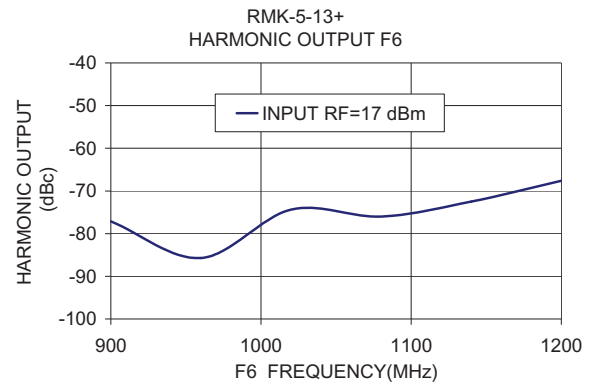
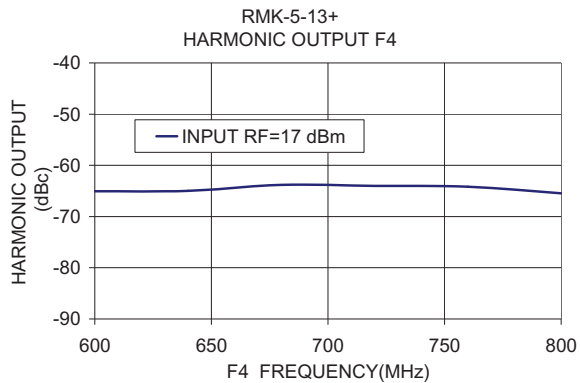
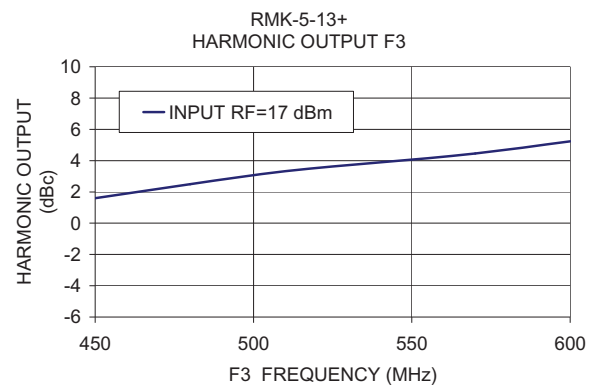
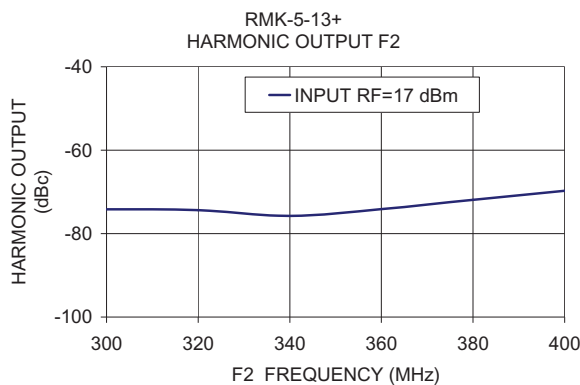
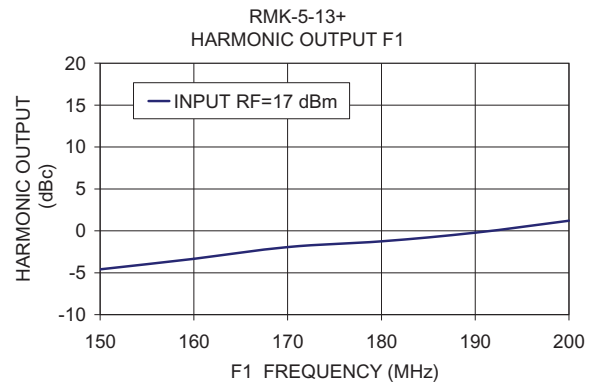
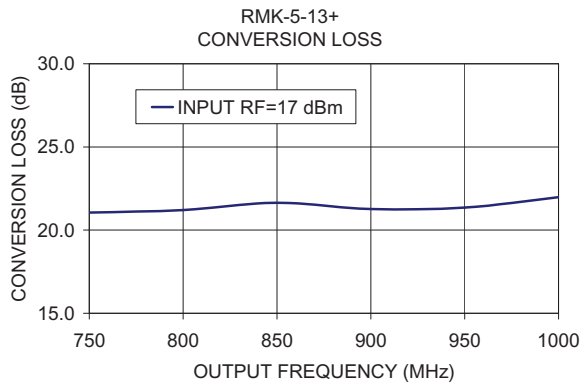
| Frequency   |              | Conv. Loss (dB) | Harmonic Rejection Below F5, (dBc)<br><i>at RF Input Power 17 dBm</i> |        |      |        |        |       |
|-------------|--------------|-----------------|-----------------------------------------------------------------------|--------|------|--------|--------|-------|
| Input (MHz) | Output (MHz) |                 | F5                                                                    | F1     | F2   | F3     | F4     | F6    |
| 150.00      | 750.00       | 21.06           | -4.59                                                                 | -74.17 | 1.60 | -65.07 | -77.10 | -5.27 |
| 160.00      | 800.00       | 21.21           | -3.35                                                                 | -74.39 | 2.49 | -64.97 | -85.69 | -5.71 |
| 170.00      | 850.00       | 21.64           | -1.94                                                                 | -75.77 | 3.32 | -63.82 | -74.36 | -6.64 |
| 180.00      | 900.00       | 21.27           | -1.26                                                                 | -74.11 | 3.89 | -64.03 | -76.02 | -6.50 |
| 190.00      | 950.00       | 21.35           | -0.22                                                                 | -71.91 | 4.45 | -64.16 | -72.50 | -6.69 |
| 200.00      | 1000.00      | 21.98           | 1.20                                                                  | -69.72 | 5.23 | -65.48 | -67.62 | -7.51 |



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



# RMK-5-13+



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# Frequency Multiplier (X5)

RMK-5-13+

## Typical Performance Data

| FREQUENCY (MHz) |              |              |              |              |              |              | CONVERSION<br>LOSS<br>(dB) | RF IN = +17 dBm            |              |              |              |              |              |
|-----------------|--------------|--------------|--------------|--------------|--------------|--------------|----------------------------|----------------------------|--------------|--------------|--------------|--------------|--------------|
|                 |              |              |              |              |              |              |                            | HARMONIC OUTPUT*<br>(-dBc) |              |              |              |              |              |
| X1<br>OUTPUT    | X2<br>OUTPUT | X3<br>OUTPUT | X4<br>OUTPUT | X5<br>OUTPUT | X6<br>OUTPUT | X7<br>OUTPUT | X5 OUTPUT                  | X1<br>OUTPUT               | X2<br>OUTPUT | X3<br>OUTPUT | X4<br>OUTPUT | X6<br>OUTPUT | X7<br>OUTPUT |
| 130             | 260          | 390          | 520          | 650          | 780          | 910          | 21.95                      | 6.26                       | 79.83        | -0.24        | 64.11        | 67.24        | 4.59         |
| 140             | 280          | 420          | 560          | 700          | 840          | 980          | 22.06                      | 4.91                       | 73.97        | -1.09        | 64.09        | 74.11        | 5.39         |
| 150             | 300          | 450          | 600          | 750          | 900          | 1050         | 21.06                      | 4.59                       | 74.17        | -1.60        | 65.07        | 77.10        | 5.27         |
| 160             | 320          | 480          | 640          | 800          | 960          | 1120         | 21.21                      | 3.35                       | 74.39        | -2.49        | 64.97        | 85.69        | 5.71         |
| 170             | 340          | 510          | 680          | 850          | 1020         | 1190         | 21.64                      | 1.94                       | 75.77        | -3.32        | 63.82        | 74.36        | 6.64         |
| 180             | 360          | 540          | 720          | 900          | 1080         | 1260         | 21.27                      | 1.26                       | 74.11        | -3.89        | 64.03        | 76.02        | 6.50         |
| 190             | 380          | 570          | 760          | 950          | 1140         | 1330         | 21.35                      | 0.22                       | 71.91        | -4.45        | 64.16        | 72.50        | 6.69         |
| 200             | 400          | 600          | 800          | 1000         | 1200         | 1400         | 21.98                      | -1.20                      | 69.72        | -5.23        | 65.48        | 67.62        | 7.51         |
| 210             | 420          | 630          | 840          | 1050         | 1260         | 1470         | 22.10                      | -2.13                      | 68.35        | -5.81        | 64.91        | 65.38        | 7.67         |
| 220             | 440          | 660          | 880          | 1100         | 1320         | 1540         | 22.11                      | -2.95                      | 66.35        | -6.17        | 65.04        | 64.84        | 7.56         |

\* Harmonic Output below power level of X5 Output.



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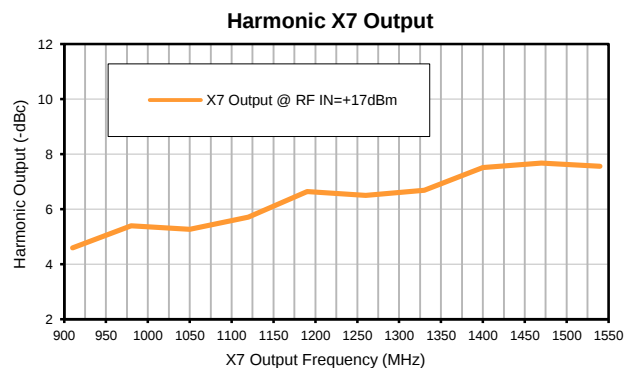
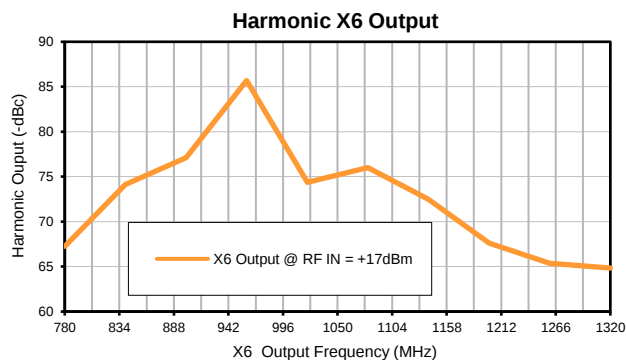
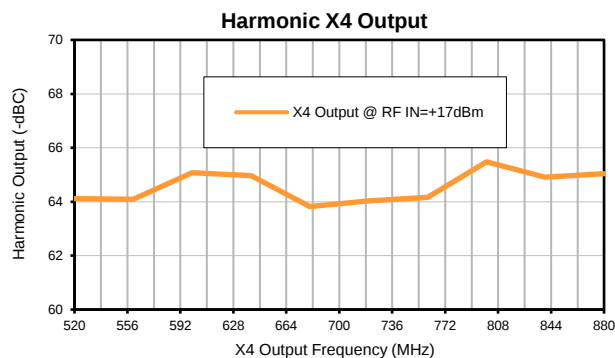
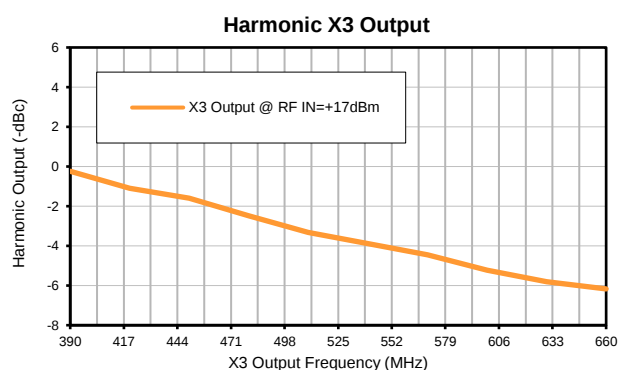
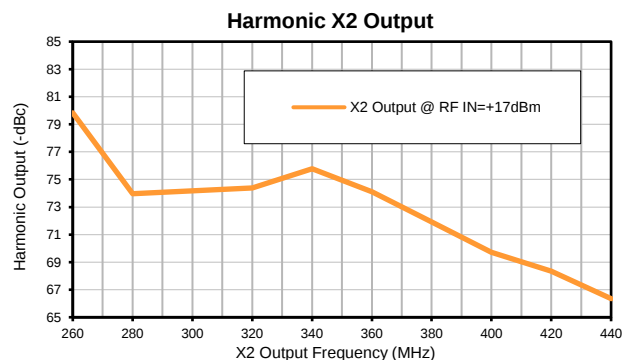
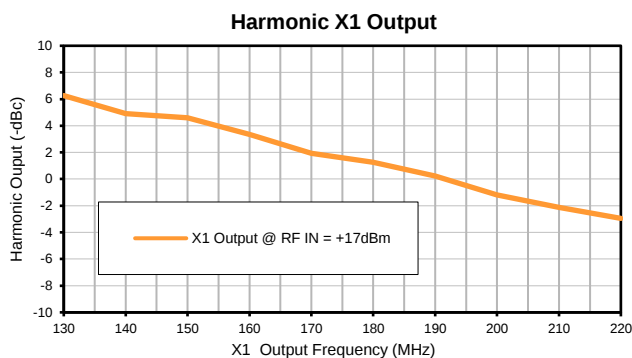
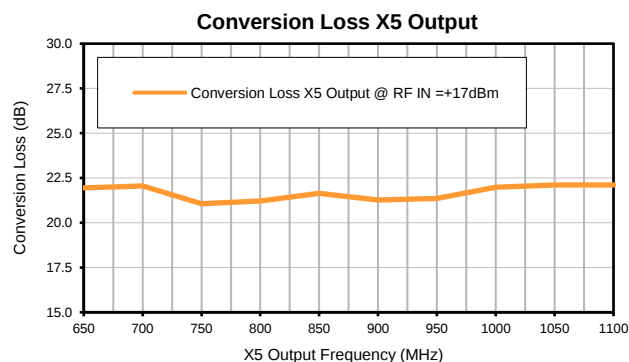


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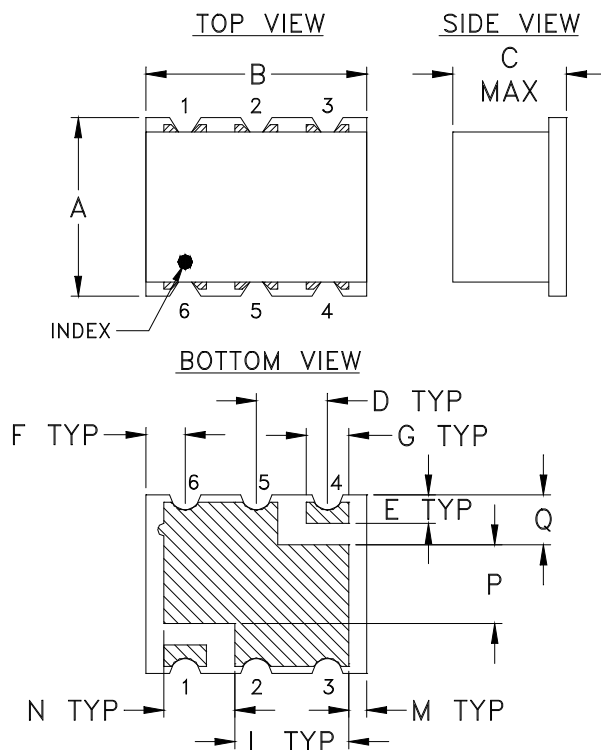
IF/RF MICROWAVE COMPONENTS

REV. OR  
RMK-5-13+  
1/29/2015  
Page 1 of 1

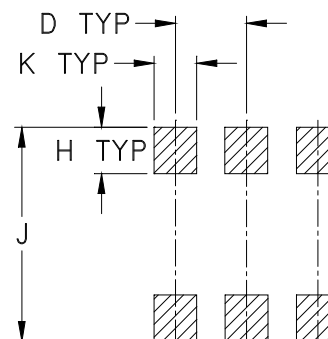
## Typical Performance Curves



## Outline Dimensions



## PCB Land Pattern



Suggested Layout,  
Tolerance to be within  $\pm .002$

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

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

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

### Notes:

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



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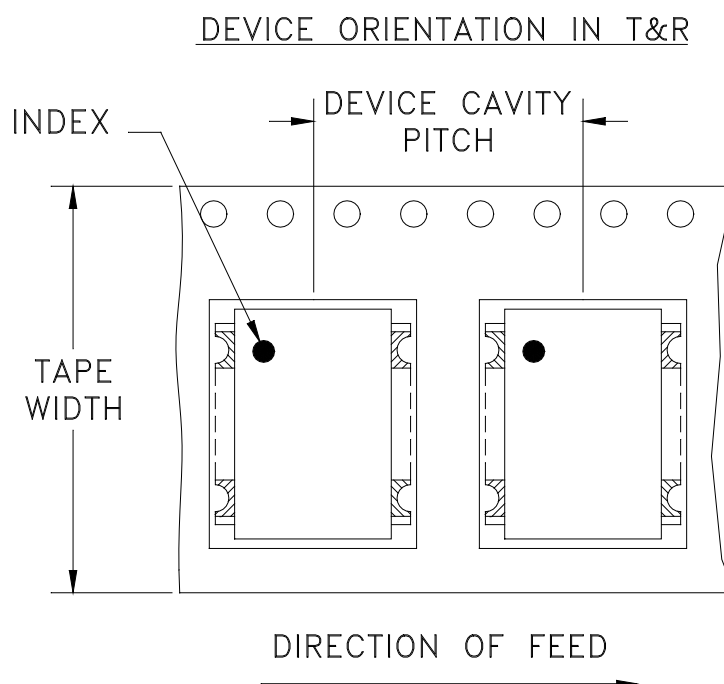


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RF/IF MICROWAVE COMPONENTS



# Tape & Reel Packaging TR-F2



| Tape Width, mm | Device Cavity Pitch, mm | Reel Size, inches | Devices per Reel<br>See note |
|----------------|-------------------------|-------------------|------------------------------|
| 16             | 12                      | 7                 | 10                           |
|                |                         |                   | 20                           |
|                |                         |                   | 50                           |
|                |                         |                   | 100                          |
|                |                         |                   | 200                          |
|                |                         | 13                | 500                          |
|                |                         |                   | 1000                         |

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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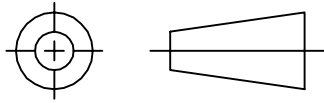


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## THIRD ANGLE PROJECTION

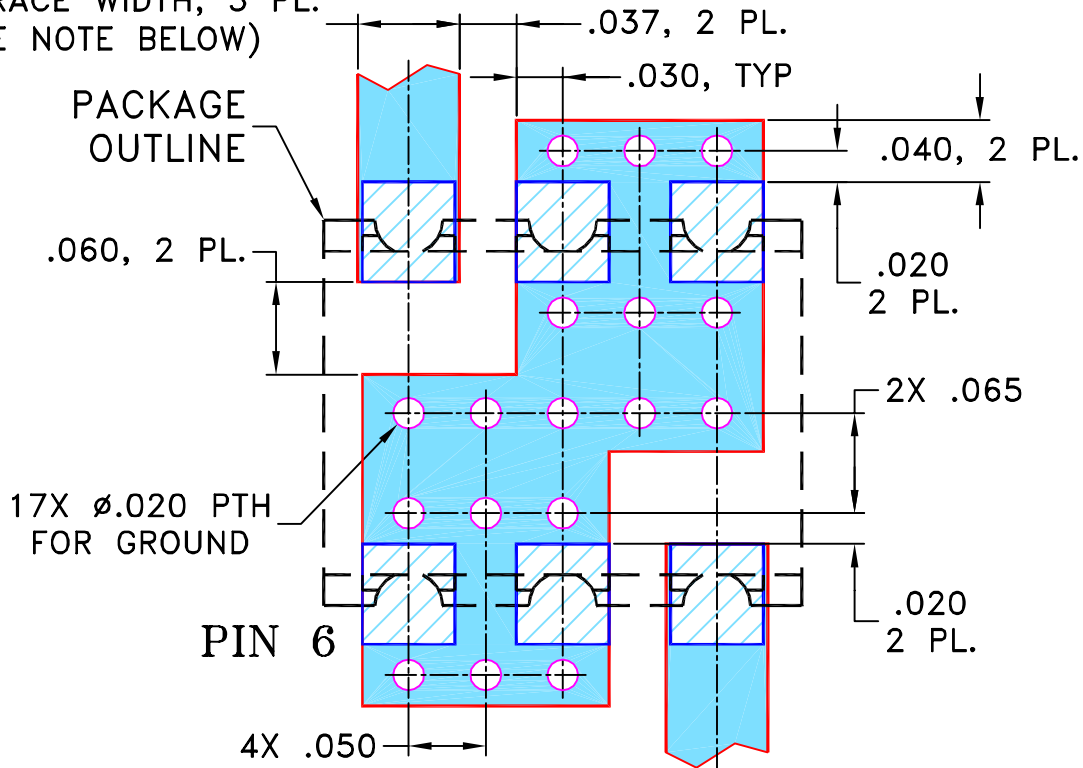


## REVISIONS

| 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

.066 TRACE WIDTH, 3 PL.  
(SEE NOTE BELOW)



- NOTES: 1. TRACE WIDTH IS SHOWN FOR ROGERS R04350B WITH DIELECTRIC THICKNESS .030"  $\pm$  .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

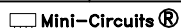
01/04/07

2 PL DECIMALS  $\pm$ 

APPROVED

DJ

01/04/07

3 PL DECIMALS  $\pm$  .005ANGLES  $\pm$ FRACTIONS  $\pm$ 

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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  
A

CODE IDENT  
15542

DRAWING NO:  
98-PL-258

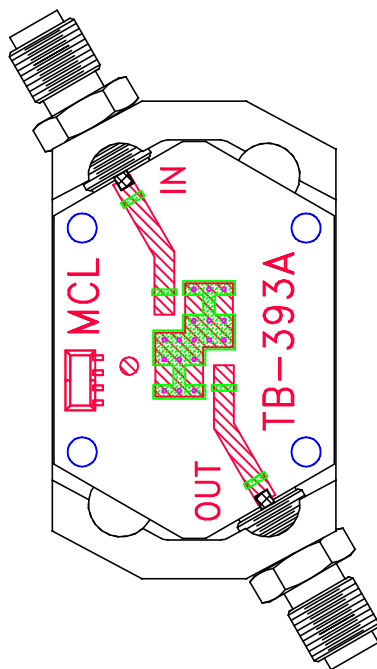
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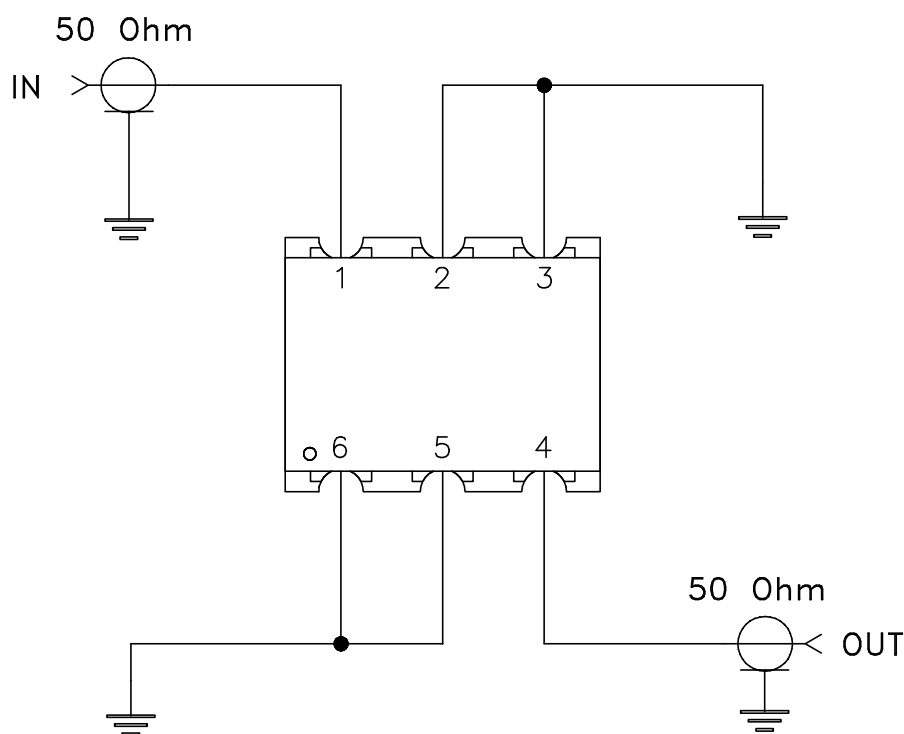
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SHEET: 1 OF 1

# Evaluation Board and Circuit



TB-393



Schematic Diagram

## Notes:

1. SMA Female connectors.
2. PCB Material: Rogers R04350 or equivalent,  
Dielectric Constant=3.5, Thickness=.030 inch.

 Mini-Circuits®



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                                                                              |