



Mini-Circuits

SURFACE MOUNT top hat

# Directional Coupler

**TCD-12-222X+**

50 $\Omega$

5 to 2250 MHz

## THE BIG DEAL

- Wideband, 5 to 2250 MHz
- Low mainline loss, 2.0 dB typ.
- Aqueous washable
- Leads for excellent solderability
- Protected by US Patent 6,140,887

## APPLICATIONS

- VHF/UHF
- CATV
- Cellular



Generic photo used for illustration purposes only

CASE STYLE: DB1627

### +RoHS Compliant

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

## PRODUCT OVERVIEW

Mini-Circuits' TCD-12-222X+ surface mount directional coupler provides 12.6 dB nominal coupling with excellent flatness from 5 to 2250 MHz, supporting a wide variety of applications including VHF/UHF, CATV, cellular and more. This model provides low mainline loss, high directivity and excellent return loss. The coupler is built with core and wire construction mounted on a 6-lead plastic base (0.16 x 0.15 x 0.16") and includes Mini-Circuits' TopHat® feature for faster, more accurate pick-and-place assembly.

## KEY FEATURES

| Feature                                                   | Advantages                                                                                                      |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Low mainline loss, 2.0 dB                                 | Provides good through-path signal power transmission.                                                           |
| High directivity, 10 – 21 dB                              | High directivity allows accurate signal sampling through the coupled port with minimal measurement error.       |
| Excellent return loss, 14 – 25 dB (input/output/coupling) | Provides excellent matching for 50 $\Omega$ systems and minimal signal reflection.                              |
| 1W power handling                                         | Usable in systems with a variety of high-power requirements.                                                    |
| Top Hat® feature                                          | Improves speed and accuracy of pick and place assembly and provides clear device marking for visual inspection. |





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## Directional Coupler

TCD-12-222X+

50Ω

5 to 2250 MHz

## ELECTRICAL SPECIFICATIONS AT 25°C

| Parameter                                             | Frequency (MHz) | Min. | Typ.     | Max. | Unit |
|-------------------------------------------------------|-----------------|------|----------|------|------|
| Frequency Range                                       | —               | 5    | —        | 2250 | MHz  |
| Mainline Loss <sup>1</sup> (above theoretical 0.3 dB) | 5               | —    | 0.4      | 1.0  | dB   |
|                                                       | 950             | —    | 0.6      | 1.1  |      |
|                                                       | 2250            | —    | 2.5      | 3.5  |      |
| Coupling                                              | 5-2250          | —    | 12.6±0.8 | —    |      |
| Coupling Flatness (±)                                 | 5-2250          | —    | 0.6      | 1.0  |      |
| Directivity                                           | 5               | 17   | 21       | —    | dB   |
|                                                       | 950             | 11   | 15       | —    |      |
|                                                       | 2250            | 6    | 10       | —    |      |
| Return Loss (Input)                                   | 5               | —    | 21       | —    | dB   |
|                                                       | 950             | —    | 17       | —    |      |
|                                                       | 2250            | —    | 16       | —    |      |
| Return Loss (Output)                                  | 5               | —    | 25       | —    | dB   |
|                                                       | 950             | —    | 17       | —    |      |
|                                                       | 2250            | —    | 14       | —    |      |
| Return Loss (Coupling)                                | 5               | —    | 24       | —    | dB   |
|                                                       | 950             | —    | 17       | —    |      |
|                                                       | 2250            | —    | 15       | —    |      |
| Input Power                                           | 5-100           | —    | —        | 0.5  | W    |
|                                                       | 100-2250        | —    | —        | 1.0  |      |

1. Mainline loss includes theoretical power loss 0.3 dB at coupled port.

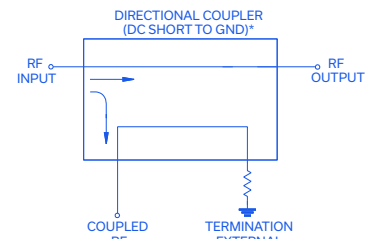
## MAXIMUM RATINGS

| Parameter             | Ratings        |
|-----------------------|----------------|
| Operating Temperature | -40°C to 85°C* |
| Storage Temperature   | -55°C to 100°C |

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

\* Case temperature is defined as temperature on ground leads.

## ELECTRICAL SCHEMATIC



\*Electrical schematic is for Directional coupler with internal transformer(s) and external termination





# Directional Coupler

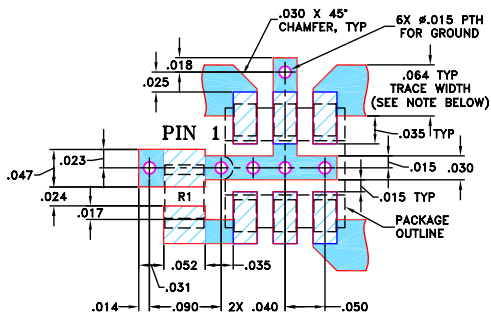
# TCD-12-222X+

50Ω

5 to 2250 MHz

|                   |   |
|-------------------|---|
| INPUT             | 3 |
| OUTPUT            | 4 |
| COUPLED           | 1 |
| GROUND            | 2 |
| 50Ω TERM EXTERNAL | 6 |
| NOT USED          | 5 |

**DEMO BOARD MCL P/N:** TB-71  
**SUGGESTED PCB LAYOUT** (PL-009)

 DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK

ORIENTATION DOT ON TOP HAT

MODEL MARKING (ORIENTATION)

COMPONENT AREA

A

B

1 2 3

Y Y

6 5 4

G TYP

C MAX

D TYP

1 2 3

E TYP

4 5 6

F TYP

TOP-HAT / PICK & PLACE SURFACE AREA (.10X.10) MIN

TOP-HAT TOTAL THICKNESS: .013 inches MAX.

PCB Land Pattern

Orientation dot on Top-Hat & orientation feature on substrate corresponds to pin #1.

## OUTLINE DIMENSIONS (Inches)

|      |      |      |      |      |       |
|------|------|------|------|------|-------|
| A    | B    | C    | D    | E    | F     |
| .160 | .150 | .160 | .050 | .040 | .025  |
| 4.06 | 3.81 | 4.06 | 1.27 | 1.02 | 0.64  |
| G    | H    | J    | K    |      | wt    |
| .028 | .065 | .190 | .030 |      | grams |
| 0.71 | 1.65 | 4.83 | 0.76 |      | 0.15  |

### TAPE & REEL INFORMATION: F47



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# Directional Coupler

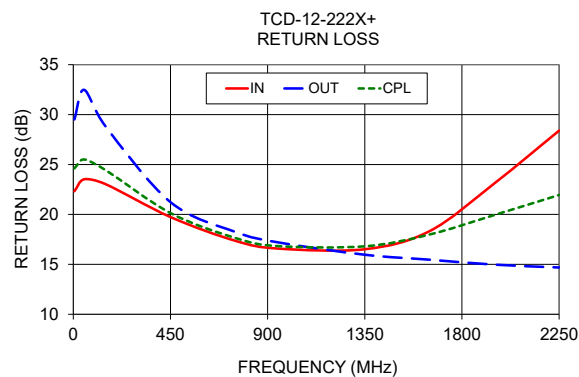
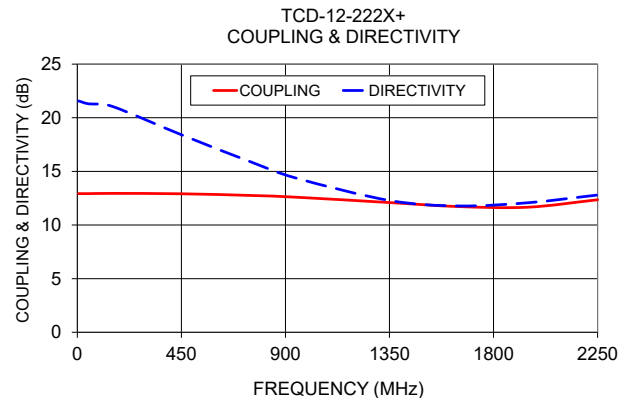
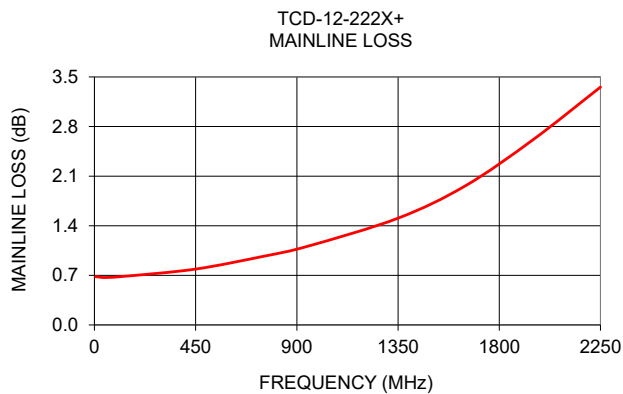
**TCD-12-222X+**

50Ω

5 to 2250 MHz

## TYPICAL PERFORMANCE DATA

| Frequency<br>(MHz) | Mainline Loss<br>(dB) | Coupling<br>(dB) | Directivity<br>(dB) | Return Loss<br>(dB) |       |       |
|--------------------|-----------------------|------------------|---------------------|---------------------|-------|-------|
|                    | In-Out                | In-Cpl           |                     | In                  | Out   | Cpl   |
| 5                  | 0.68                  | 12.93            | 21.57               | 22.32               | 29.51 | 24.61 |
| 50                 | 0.67                  | 12.93            | 21.29               | 23.52               | 32.47 | 25.50 |
| 150                | 0.69                  | 12.95            | 21.07               | 23.03               | 28.80 | 24.43 |
| 450                | 0.79                  | 12.91            | 18.41               | 19.74               | 21.23 | 20.14 |
| 750                | 0.97                  | 12.76            | 15.89               | 17.36               | 18.25 | 17.65 |
| 950                | 1.11                  | 12.59            | 14.35               | 16.58               | 17.20 | 16.83 |
| 1350               | 1.51                  | 12.09            | 12.29               | 16.52               | 15.97 | 16.81 |
| 1650               | 1.96                  | 11.72            | 11.78               | 18.33               | 15.47 | 17.99 |
| 1950               | 2.61                  | 11.66            | 12.08               | 23.10               | 14.97 | 19.94 |
| 2250               | 3.36                  | 12.35            | 12.80               | 28.39               | 14.69 | 21.95 |



- NOTES**
- 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.
  - Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
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# Directional Coupler

## TCD-12-222X+

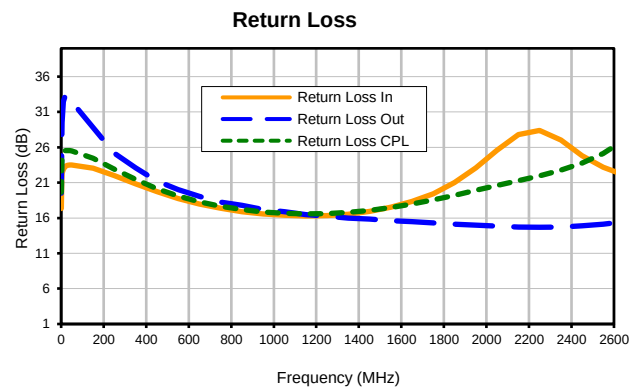
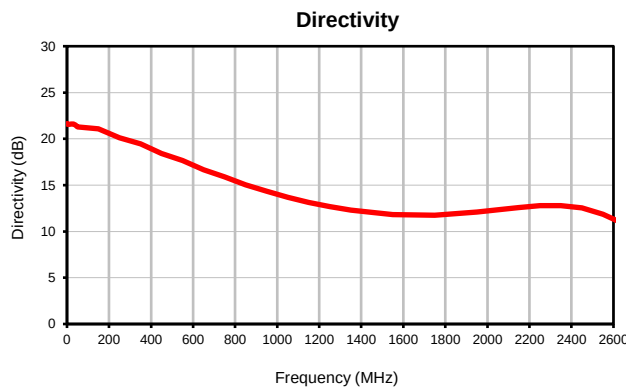
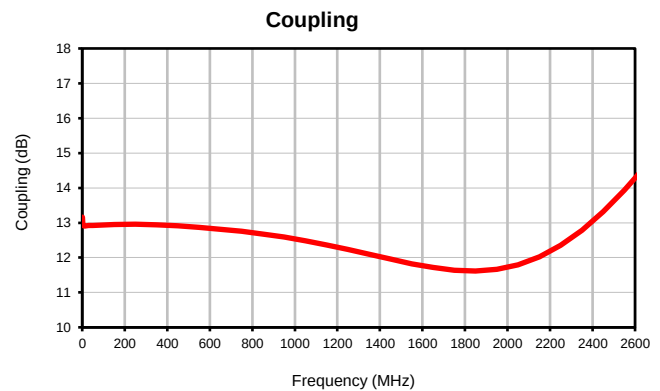
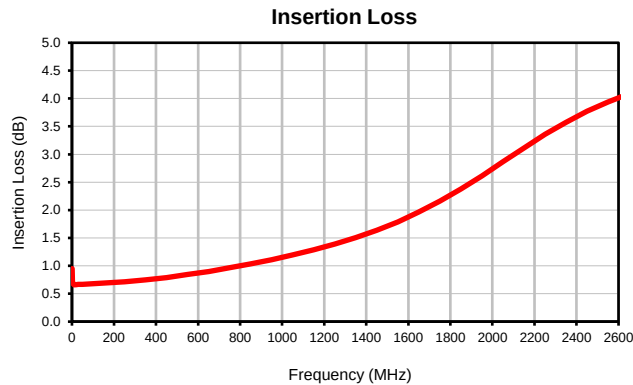
### Typical Performance Data

| FREQUENCY<br>(MHz) | INSERTION<br>LOSS<br>(dB) | COUPLING<br>(dB) | DIRECTIVITY<br>(dB) | RETURN LOSS |       |       |
|--------------------|---------------------------|------------------|---------------------|-------------|-------|-------|
|                    |                           |                  |                     | (dB)        |       |       |
|                    |                           |                  |                     | IN          | OUT   | CPL   |
| 1                  | 0.95                      | 13.17            | 21.64               | 17.34       | 19.50 | 19.63 |
| 3                  | 0.73                      | 12.97            | 21.55               | 21.29       | 26.47 | 23.52 |
| 5                  | 0.68                      | 12.93            | 21.57               | 22.32       | 29.51 | 24.61 |
| 10                 | 0.66                      | 12.91            | 21.57               | 22.85       | 32.47 | 25.31 |
| 20                 | 0.67                      | 12.91            | 21.61               | 23.31       | 33.33 | 25.52 |
| 30                 | 0.67                      | 12.92            | 21.59               | 23.46       | 33.10 | 25.52 |
| 40                 | 0.67                      | 12.92            | 21.49               | 23.49       | 32.60 | 25.52 |
| 50                 | 0.67                      | 12.93            | 21.29               | 23.52       | 32.47 | 25.50 |
| 150                | 0.69                      | 12.95            | 21.07               | 23.03       | 28.80 | 24.43 |
| 250                | 0.71                      | 12.95            | 20.09               | 21.98       | 25.16 | 22.89 |
| 350                | 0.75                      | 12.94            | 19.46               | 20.83       | 23.07 | 21.44 |
| 450                | 0.79                      | 12.91            | 18.41               | 19.74       | 21.23 | 20.14 |
| 550                | 0.85                      | 12.87            | 17.64               | 18.74       | 20.01 | 19.12 |
| 650                | 0.90                      | 12.82            | 16.67               | 17.97       | 19.04 | 18.29 |
| 750                | 0.97                      | 12.76            | 15.89               | 17.36       | 18.25 | 17.65 |
| 850                | 1.03                      | 12.68            | 15.03               | 16.91       | 17.77 | 17.18 |
| 950                | 1.11                      | 12.59            | 14.35               | 16.58       | 17.20 | 16.83 |
| 1050               | 1.19                      | 12.48            | 13.69               | 16.37       | 16.91 | 16.64 |
| 1150               | 1.29                      | 12.36            | 13.14               | 16.28       | 16.46 | 16.58 |
| 1250               | 1.39                      | 12.23            | 12.69               | 16.32       | 16.26 | 16.64 |
| 1350               | 1.51                      | 12.09            | 12.29               | 16.52       | 15.97 | 16.81 |
| 1450               | 1.64                      | 11.96            | 12.04               | 16.92       | 15.83 | 17.09 |
| 1550               | 1.79                      | 11.82            | 11.81               | 17.50       | 15.62 | 17.50 |
| 1650               | 1.96                      | 11.72            | 11.78               | 18.33       | 15.47 | 17.99 |
| 1750               | 2.16                      | 11.64            | 11.76               | 19.44       | 15.29 | 18.57 |
| 1850               | 2.38                      | 11.62            | 11.91               | 21.03       | 15.14 | 19.20 |
| 1950               | 2.61                      | 11.66            | 12.08               | 23.10       | 14.97 | 19.94 |
| 2050               | 2.86                      | 11.80            | 12.35               | 25.57       | 14.85 | 20.60 |
| 2150               | 3.12                      | 12.02            | 12.57               | 27.78       | 14.71 | 21.29 |
| 2250               | 3.36                      | 12.35            | 12.80               | 28.39       | 14.69 | 21.95 |
| 2350               | 3.57                      | 12.78            | 12.80               | 27.01       | 14.73 | 22.77 |
| 2450               | 3.77                      | 13.31            | 12.54               | 24.82       | 14.91 | 23.76 |
| 2550               | 3.94                      | 13.93            | 11.84               | 23.18       | 15.14 | 25.13 |
| 2650               | 4.09                      | 14.63            | 10.81               | 22.06       | 15.47 | 27.08 |

# Directional Coupler

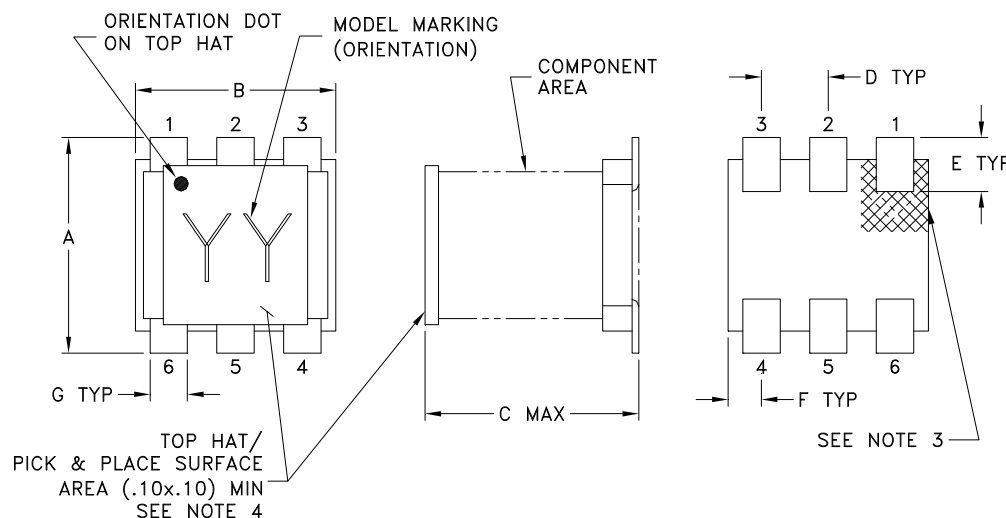
## Typical Performance Curves

TCD-12-222X+

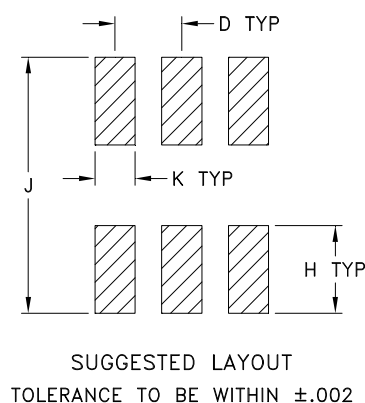


## Outline Dimensions

DB1627



## PCB Land Pattern



| CASE # | A              | B              | C              | D              | E              | F              | G              | H              | J              | K              | WT. GRAM |
|--------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------|
| DB1627 | .160<br>(4.06) | .150<br>(3.81) | .160<br>(4.06) | .050<br>(1.27) | .040<br>(1.02) | .025<br>(0.64) | .028<br>(0.71) | .065<br>(1.65) | .190<br>(4.83) | .030<br>(0.76) | .15      |

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

### Notes:

- Case material: Plastic.
- Termination finish:  
For RoHS Case Styles: Tin plate over Nickel plate. All models, (+) suffix.  
For RoHS-5 Case Styles: Tin-Lead plate. All models, no (+) suffix.
- Orientation dot on top hat & orientation feature on substrate correspondence to pin #1.
- Top-Hat total thickness: .013 inches MAX.



P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site



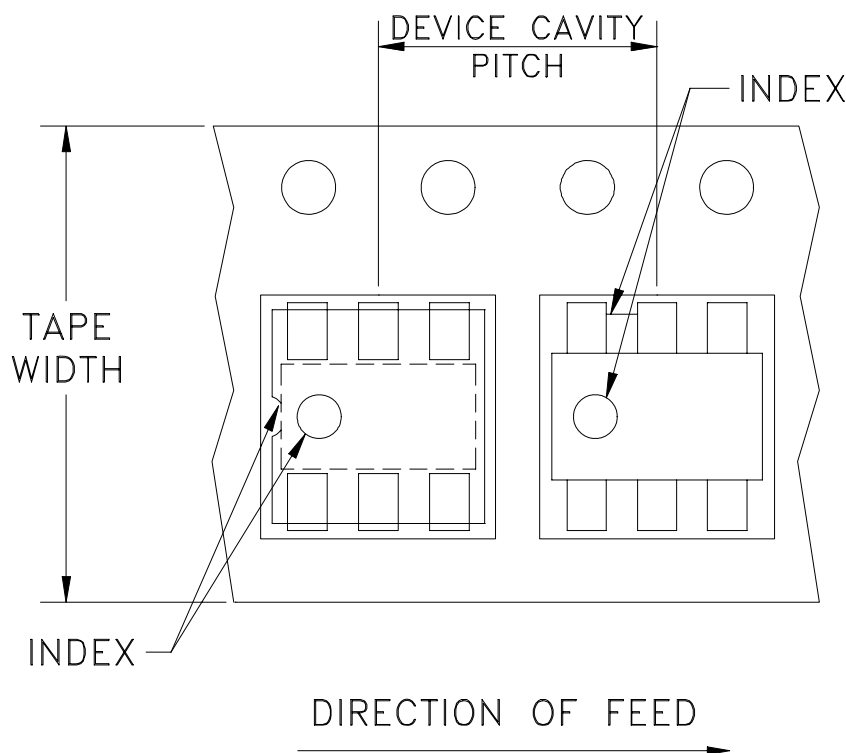
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RF/IF MICROWAVE COMPONENTS



# Tape & Reel Packaging TR-F47

## DEVICE ORIENTATION IN T&R



| Tape Width,<br>mm | Device Cavity<br>Pitch, mm | Reel Size,<br>inches | Devices per Reel<br>see note |
|-------------------|----------------------------|----------------------|------------------------------|
| 12                | 8                          | 13                   | 1000, 2000                   |
|                   |                            | 7                    | 20, 50, 100, 200, 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.

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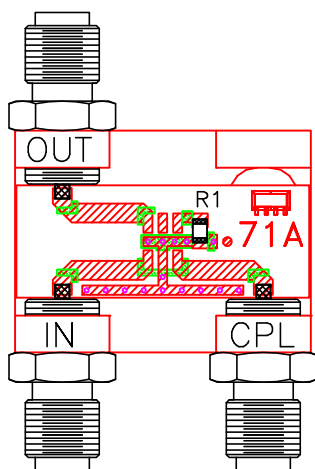
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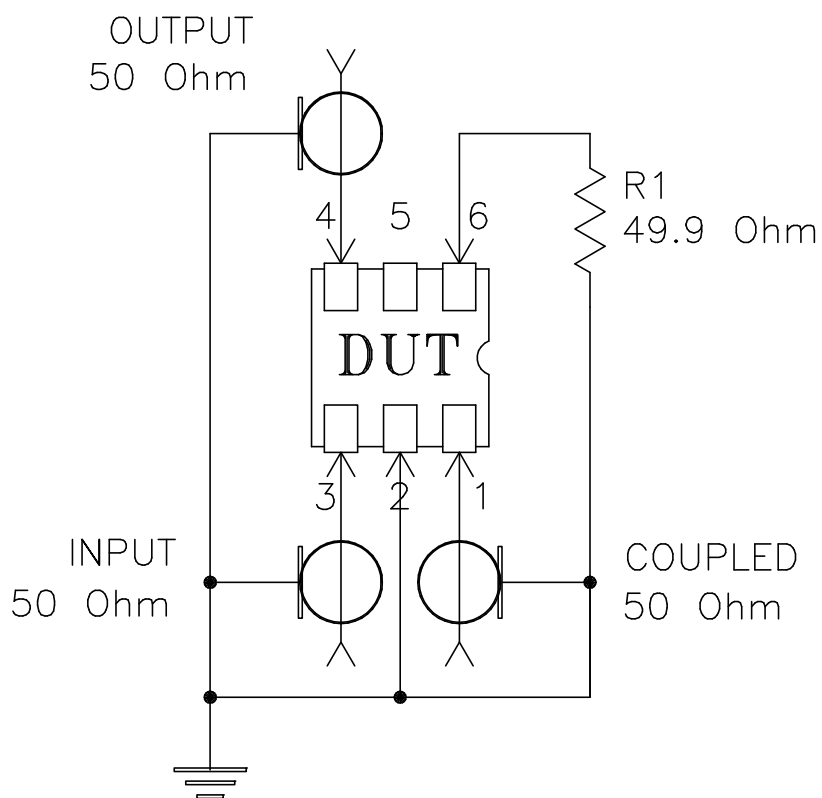




# Evaluation Board and Circuit



TB-71



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                                                                              |