



MICROWAVE

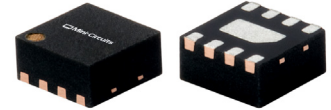
# Gain Equalizer

## EQY-4-63+

50Ω 4 dB DC to 6 GHz

### THE BIG DEAL

- 4.2 dB Slope
- Small Package 2x2 mm MCLP™
- Wide Bandwidth, DC to 6 GHz
- Excellent Return Loss, 20 dB typ.



Generic photo used for illustration purposes only

CASE STYLE: MC1631-1

### +RoHS Compliant

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

### APPLICATIONS

- Cellular
- PCS
- Communications
- Radar
- Defense

### PRODUCT OVERVIEW

EQY-4-63+ is an absorptive Gain Equalizer fabricated using highly repetitive GaAs IPD\* MMIC process incorporating resistors, capacitors and inductors having negative insertion loss slope. EQY-4-63+ has a nominal attenuation slope of 4.2 dB and is packaged in tiny 2 x 2 mm, 8-Lead MCLP™ package.

### KEY FEATURES

| Feature  | Advantages  |
|--|---|
| Negative Insertion Loss Slope vs. Frequency    | Useful for compensating negative gain slope of amplifiers, receivers, transmitters to achieve flat gain versus frequency.   |
| Wide range of values<br>1,2,3,4,5,6,8 & 10 dB  | Enables circuit designer to change nominal insertion loss values without motherboard redesign making the EQY series ideal for select at test application.                                   |
| Wideband operation, DC to 6 GHz                | Supports a wide array of applications including wireless cellular, microwave communications, satellite, defense and aerospace, medical broadband and optic applications.                    |
| Excellent Power Handling Capability<br>+31 dBm | Enables its use at the output of a variety of amplifiers  |
| Small Size and simple to use<br>(2x2mm)        | As a single chip solution, the EQY series occupies less board space than a lumped element approach, minimizes component count and ensures repeatable performance over wide frequency range. |

\*GaAs IPD (Gallium Arsenide Integrated Passive Device)

REV. B  
ECO-022431  
EQY-4-63+  
MCLNY  
240715





MICROWAVE

# Gain Equalizer

## EQY-4-63+

50Ω 4 dB DC to 6 GHz

### ELECTRICAL SPECIFICATIONS<sup>1</sup> AT +25°C, 50Ω, UNLESS OTHERWISE NOTED.

| Parameter       | Condition (GHz) | Min. | Typ. | Max. | Units |
|-----------------|-----------------|------|------|------|-------|
| Frequency Range |                 | DC   |      | 6    | GHz   |
| Insertion Loss  | 0.01            | 4.4  | 4.8  | 5.2  | dB    |
|                 | 1               | —    | 4.5  | —    |       |
|                 | 2               | —    | 3.6  | —    |       |
|                 | 3               | 2.3  | 2.7  | 3.0  |       |
|                 | 4               | —    | 1.9  | —    |       |
|                 | 5               | 0.6  | 1.1  | 1.5  |       |
|                 | 6               | —    | 0.6  | —    |       |
| VSWR            | 0.01 - 1        | —    | 1.07 | —    | :1    |
|                 | 1 - 2           | —    | 1.11 | —    |       |
|                 | 2 - 3           | —    | 1.16 | —    |       |
|                 | 3 - 4           | —    | 1.19 | —    |       |
|                 | 4 - 5           | —    | 1.25 | —    |       |
|                 | 5 - 6           | —    | 1.32 | —    |       |

1. Measured on Mini-Circuits Characterization Test Board TB-1041-4-63+. See Characterization Test Circuit (Fig. 1)

### ABSOLUTE MAXIMUM RATINGS<sup>2</sup>

| Parameter                  | Ratings         |
|----------------------------|-----------------|
| Operating Case Temperature | -40°C to +85°C  |
| Storage Temperature        | -65°C to +150°C |
| RF Input Power             | +31 dBm         |

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





MICROWAVE

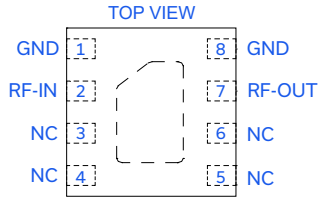
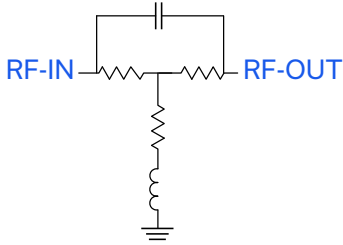
# Gain Equalizer

## EQY-4-63+

Mini-Circuits

50Ω 4 dB DC to 6 GHz

### SIMPLIFIED SCHEMATIC & PAD DESCRIPTION



| Function | Pad Number   | Description                                   |
|----------|--------------|---|
| RF-IN    | 2            | RF-Input pad                                  |
| RF-OUT   | 7            | RF-Output pad                                 |
| GND      | 1,8 & Paddle | Ground  |
| NC       | 3-6          | No connection, connected to ground externally |

### CHARACTERIZATION TEST CIRCUIT

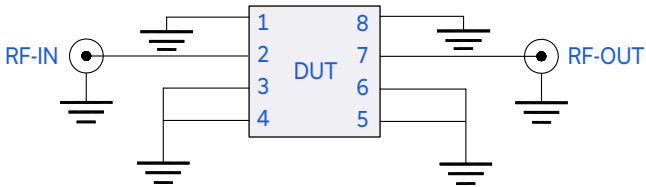
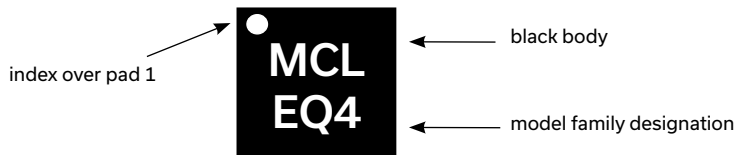


Fig 1. Block Diagram of Test Circuit used for characterization. Test Board TB-1041-4-63+  
Conditions: Attenuation & Return Loss  $P_{IN}=0$  dBm

### PRODUCT MARKING



Marking may contain other features or characters for internal lot control





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# Gain Equalizer

## EQY-4-63+

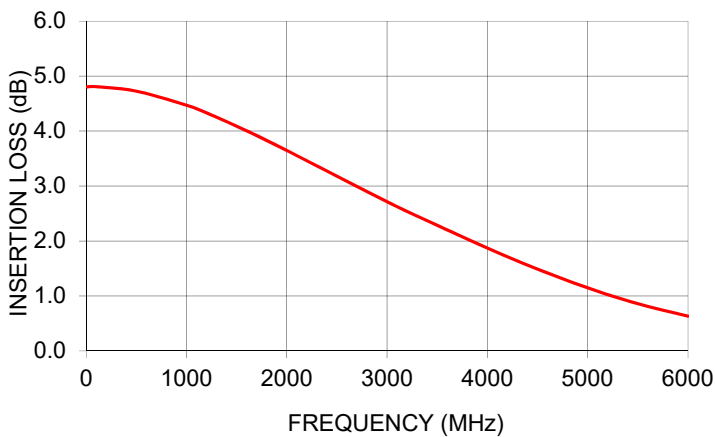
Mini-Circuits

50Ω 4 dB DC to 6 GHz

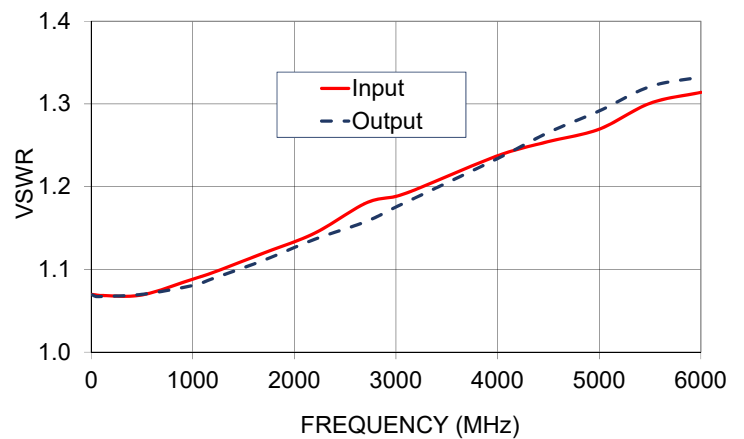
### TYPICAL PERFORMANCE DATA AT +25°C

| Frequency (MHz) | Insertion Loss (dB) | Input VSWR (:1) | Output VSWR (:1) |
|-----------------|---------------------|-----------------|------------------|
| 10              | 4.80                | 1.07            | 1.07             |
| 50              | 4.81                | 1.07            | 1.07             |
| 100             | 4.81                | 1.07            | 1.07             |
| 500             | 4.73                | 1.07            | 1.07             |
| 1000            | 4.47                | 1.09            | 1.08             |
| 1200            | 4.33                | 1.10            | 1.09             |
| 1700            | 3.92                | 1.12            | 1.11             |
| 2200            | 3.46                | 1.14            | 1.14             |
| 2700            | 2.99                | 1.18            | 1.16             |
| 3000            | 2.72                | 1.19            | 1.18             |
| 3200            | 2.54                | 1.20            | 1.19             |
| 4000            | 1.87                | 1.24            | 1.23             |
| 4500            | 1.49                | 1.25            | 1.27             |
| 5000            | 1.15                | 1.27            | 1.29             |
| 5500            | 0.86                | 1.30            | 1.32             |
| 6000            | 0.63                | 1.31            | 1.33             |

EQY-4-63+  
INSERTION LOSS



EQY-4-63+  
VSWR





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**EQY-4-63+**

50Ω 4 dB DC to 6 GHz

Mini-Circuits

ADDITIONAL DETAILED TECHNICAL INFORMATION IS AVAILABLE ON OUR DASH BOARD. [CLICK HERE](#)

|  |  |
|--|--|
| Performance Data                                     | Data Table   |
|  | Swept Graphs   |
| Case Style   | MC1631-1 Plastic package, Lead finish: Matte-tin                 |
| Tape & Reel<br>Standard quantities available on reel | F66<br>7" reels with 20, 50, 100, 200, 500, 1K, 2K or 3K devices |
| Suggested Layout for PCB Design                      | PL-576   |
| Evaluation Board                                     | TB-1041-4-63+  |
| Environmental Ratings                                | ENV08T1  |

## ESD RATING

Human Body Model (HBM): Class 2 (Pass 2000V) in accordance with ANSI/ESD STM 5.1 - 2001 Machine.

### 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/terms/viewterm.html](http://www.minicircuits.com/terms/viewterm.html)

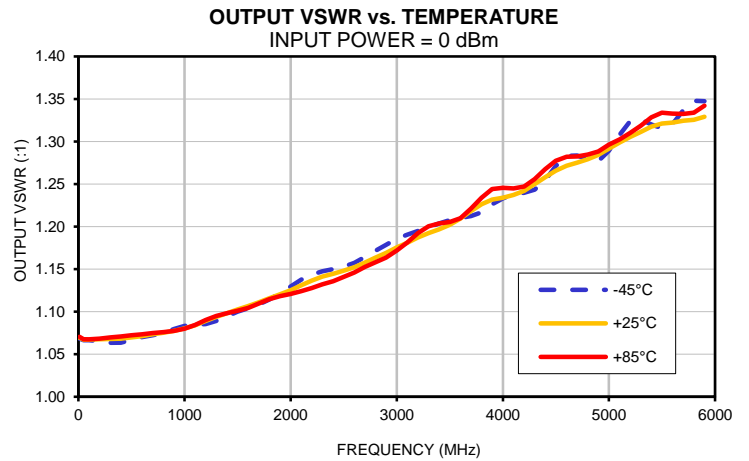
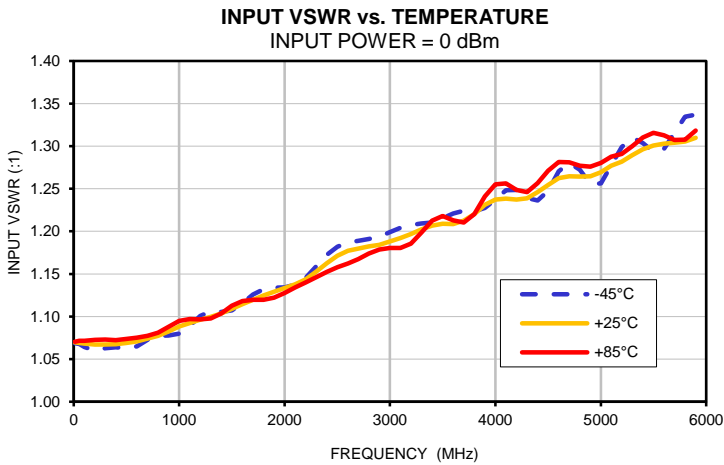
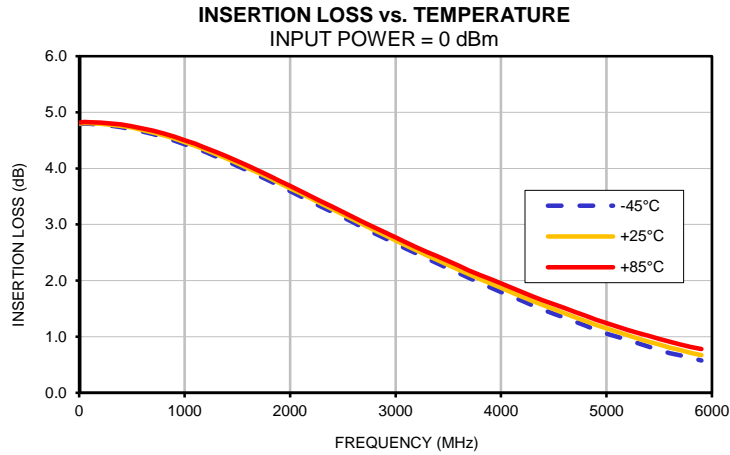


## Typical Performance Data

| FREQ.<br><br>(MHz) | INSERTION LOSS |       |        | INPUT VSWR |       |        | OUTPUT VSWR |       |        |
|--------------------|----------------|-------|--------|------------|-------|--------|-------------|-------|--------|
|                    | (dB)           |       |        | (:1)       |       |        | (:1)        |       |        |
|                    | @-45°C         | @25°C | @+85°C | @-45°C     | @25°C | @+85°C | @-45°C      | @25°C | @+85°C |
| 10                 | 4.79           | 4.80  | 4.81   | 1.07       | 1.07  | 1.07   | 1.07        | 1.07  | 1.07   |
| 50                 | 4.80           | 4.81  | 4.83   | 1.07       | 1.07  | 1.07   | 1.07        | 1.07  | 1.07   |
| 100                | 4.79           | 4.81  | 4.82   | 1.06       | 1.07  | 1.07   | 1.07        | 1.07  | 1.07   |
| 200                | 4.78           | 4.80  | 4.82   | 1.06       | 1.07  | 1.07   | 1.07        | 1.07  | 1.07   |
| 300                | 4.76           | 4.78  | 4.80   | 1.06       | 1.07  | 1.07   | 1.06        | 1.07  | 1.07   |
| 400                | 4.73           | 4.76  | 4.78   | 1.06       | 1.07  | 1.07   | 1.06        | 1.07  | 1.07   |
| 500                | 4.70           | 4.73  | 4.75   | 1.06       | 1.07  | 1.07   | 1.07        | 1.07  | 1.07   |
| 600                | 4.66           | 4.69  | 4.71   | 1.07       | 1.07  | 1.08   | 1.07        | 1.07  | 1.07   |
| 700                | 4.61           | 4.64  | 4.67   | 1.07       | 1.07  | 1.08   | 1.07        | 1.07  | 1.07   |
| 800                | 4.56           | 4.59  | 4.62   | 1.08       | 1.08  | 1.08   | 1.08        | 1.08  | 1.08   |
| 900                | 4.50           | 4.53  | 4.57   | 1.08       | 1.08  | 1.09   | 1.08        | 1.08  | 1.08   |
| 1000               | 4.43           | 4.47  | 4.50   | 1.08       | 1.09  | 1.09   | 1.08        | 1.08  | 1.08   |
| 1100               | 4.36           | 4.40  | 4.44   | 1.09       | 1.09  | 1.10   | 1.08        | 1.08  | 1.08   |
| 1200               | 4.29           | 4.33  | 4.37   | 1.10       | 1.10  | 1.10   | 1.09        | 1.09  | 1.09   |
| 1300               | 4.21           | 4.25  | 4.29   | 1.11       | 1.10  | 1.10   | 1.09        | 1.09  | 1.10   |
| 1400               | 4.13           | 4.17  | 4.21   | 1.11       | 1.10  | 1.10   | 1.09        | 1.10  | 1.10   |
| 1500               | 4.04           | 4.09  | 4.13   | 1.11       | 1.11  | 1.11   | 1.10        | 1.10  | 1.10   |
| 1600               | 3.96           | 4.01  | 4.05   | 1.12       | 1.11  | 1.12   | 1.10        | 1.11  | 1.10   |
| 1700               | 3.87           | 3.92  | 3.96   | 1.13       | 1.12  | 1.12   | 1.11        | 1.11  | 1.11   |
| 1800               | 3.78           | 3.83  | 3.87   | 1.13       | 1.12  | 1.12   | 1.11        | 1.12  | 1.11   |
| 1900               | 3.69           | 3.74  | 3.78   | 1.13       | 1.13  | 1.12   | 1.12        | 1.12  | 1.12   |
| 2000               | 3.59           | 3.65  | 3.69   | 1.13       | 1.13  | 1.13   | 1.13        | 1.13  | 1.12   |
| 2100               | 3.50           | 3.55  | 3.60   | 1.14       | 1.14  | 1.13   | 1.14        | 1.13  | 1.12   |
| 2200               | 3.41           | 3.46  | 3.50   | 1.15       | 1.14  | 1.14   | 1.14        | 1.14  | 1.13   |
| 2300               | 3.31           | 3.37  | 3.41   | 1.16       | 1.15  | 1.15   | 1.15        | 1.14  | 1.13   |
| 2400               | 3.22           | 3.27  | 3.32   | 1.17       | 1.16  | 1.15   | 1.15        | 1.14  | 1.14   |
| 2500               | 3.13           | 3.18  | 3.22   | 1.18       | 1.17  | 1.16   | 1.15        | 1.15  | 1.14   |
| 2600               | 3.03           | 3.09  | 3.13   | 1.19       | 1.18  | 1.16   | 1.16        | 1.15  | 1.15   |
| 2700               | 2.94           | 2.99  | 3.04   | 1.19       | 1.18  | 1.17   | 1.16        | 1.16  | 1.15   |
| 2800               | 2.84           | 2.90  | 2.95   | 1.19       | 1.18  | 1.17   | 1.17        | 1.16  | 1.16   |
| 2900               | 2.75           | 2.81  | 2.86   | 1.19       | 1.18  | 1.18   | 1.18        | 1.17  | 1.16   |
| 3000               | 2.66           | 2.72  | 2.77   | 1.20       | 1.19  | 1.18   | 1.19        | 1.18  | 1.17   |
| 3100               | 2.57           | 2.63  | 2.68   | 1.20       | 1.19  | 1.18   | 1.19        | 1.18  | 1.18   |
| 3200               | 2.48           | 2.54  | 2.59   | 1.21       | 1.20  | 1.19   | 1.19        | 1.19  | 1.19   |
| 3300               | 2.39           | 2.45  | 2.51   | 1.21       | 1.20  | 1.20   | 1.20        | 1.19  | 1.20   |
| 3400               | 2.30           | 2.36  | 2.43   | 1.21       | 1.21  | 1.21   | 1.20        | 1.20  | 1.20   |
| 3500               | 2.22           | 2.28  | 2.35   | 1.22       | 1.21  | 1.22   | 1.21        | 1.20  | 1.21   |
| 3600               | 2.13           | 2.19  | 2.26   | 1.22       | 1.21  | 1.21   | 1.21        | 1.21  | 1.21   |
| 3700               | 2.04           | 2.11  | 2.18   | 1.22       | 1.21  | 1.21   | 1.21        | 1.22  | 1.22   |
| 3800               | 1.96           | 2.03  | 2.10   | 1.22       | 1.22  | 1.22   | 1.22        | 1.23  | 1.23   |
| 3900               | 1.88           | 1.95  | 2.03   | 1.23       | 1.23  | 1.24   | 1.23        | 1.23  | 1.24   |
| 4000               | 1.80           | 1.87  | 1.95   | 1.24       | 1.24  | 1.26   | 1.23        | 1.23  | 1.25   |
| 4100               | 1.72           | 1.79  | 1.87   | 1.25       | 1.24  | 1.26   | 1.24        | 1.24  | 1.24   |
| 4200               | 1.64           | 1.71  | 1.79   | 1.25       | 1.24  | 1.25   | 1.24        | 1.24  | 1.25   |
| 4300               | 1.56           | 1.64  | 1.72   | 1.24       | 1.24  | 1.25   | 1.24        | 1.25  | 1.26   |
| 4400               | 1.48           | 1.56  | 1.65   | 1.24       | 1.25  | 1.26   | 1.25        | 1.26  | 1.27   |
| 4500               | 1.41           | 1.49  | 1.58   | 1.25       | 1.25  | 1.27   | 1.27        | 1.27  | 1.28   |
| 4600               | 1.34           | 1.42  | 1.51   | 1.27       | 1.26  | 1.28   | 1.28        | 1.27  | 1.28   |
| 4700               | 1.27           | 1.35  | 1.44   | 1.28       | 1.26  | 1.28   | 1.28        | 1.28  | 1.28   |
| 4800               | 1.20           | 1.28  | 1.37   | 1.27       | 1.26  | 1.28   | 1.28        | 1.28  | 1.28   |
| 4900               | 1.12           | 1.21  | 1.30   | 1.26       | 1.26  | 1.28   | 1.28        | 1.28  | 1.29   |
| 5000               | 1.06           | 1.15  | 1.24   | 1.26       | 1.27  | 1.28   | 1.29        | 1.29  | 1.30   |
| 5100               | 1.00           | 1.09  | 1.18   | 1.28       | 1.28  | 1.29   | 1.31        | 1.30  | 1.30   |
| 5200               | 0.94           | 1.03  | 1.12   | 1.30       | 1.28  | 1.29   | 1.32        | 1.31  | 1.31   |
| 5300               | 0.89           | 0.97  | 1.07   | 1.31       | 1.29  | 1.30   | 1.33        | 1.31  | 1.32   |
| 5400               | 0.82           | 0.91  | 1.02   | 1.30       | 1.30  | 1.31   | 1.32        | 1.32  | 1.33   |
| 5500               | 0.76           | 0.86  | 0.96   | 1.29       | 1.30  | 1.32   | 1.32        | 1.32  | 1.33   |
| 5600               | 0.71           | 0.81  | 0.91   | 1.30       | 1.30  | 1.31   | 1.32        | 1.32  | 1.33   |
| 5700               | 0.66           | 0.76  | 0.86   | 1.32       | 1.30  | 1.31   | 1.34        | 1.32  | 1.33   |
| 5800               | 0.62           | 0.71  | 0.82   | 1.33       | 1.31  | 1.31   | 1.35        | 1.33  | 1.33   |
| 5900               | 0.58           | 0.67  | 0.78   | 1.34       | 1.31  | 1.32   | 1.35        | 1.33  | 1.34   |
| 6000               | 0.53           | 0.63  | 0.75   | 1.32       | 1.31  | 1.33   | 1.34        | 1.33  | 1.35   |

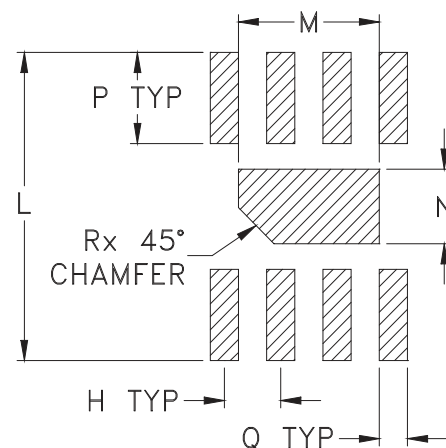
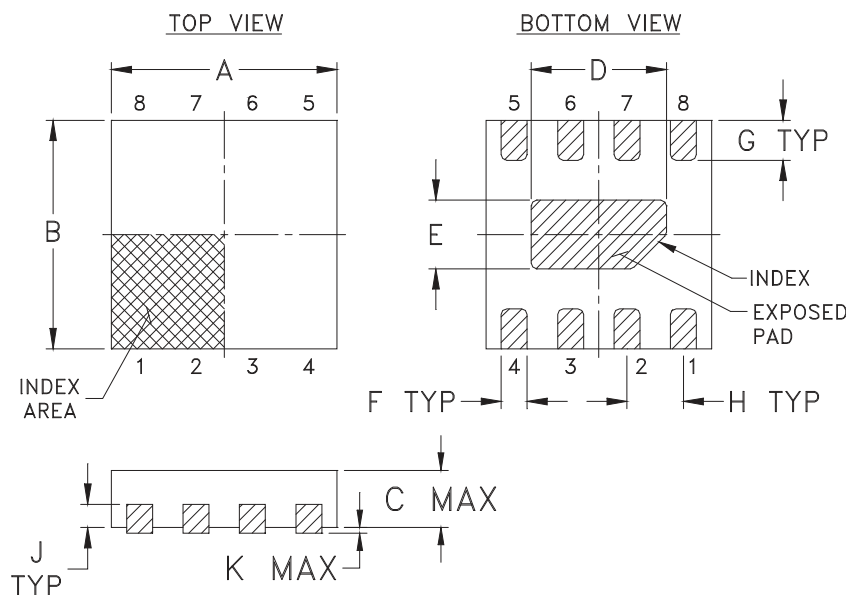


## Typical Performance Curves



### Outline Dimensions

### PCB Land Pattern



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

| SE #.    | A              | B              | C              | D              | E             | F             | G             | H             | J             | K             | L              | M              | N             | P             |
|----------|----------------|----------------|----------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|----------------|---------------|---------------|
| MC1631-1 | .079<br>(2.00) | .079<br>(2.00) | .039<br>(1.00) | .047<br>(1.20) | .024<br>(.60) | .009<br>(.23) | .014<br>(.35) | .020<br>(.50) | .008<br>(.20) | .002<br>(.05) | .106<br>(2.70) | .049<br>(1.25) | .026<br>(.65) | .031<br>(.80) |

| CASE #.  | Q             | R             | WT, GRAM |
|----------|---------------|---------------|----------|
| MC1631-1 | .010<br>(.25) | .012<br>(.30) | .006     |

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

#### Notes:

- Case material: Plastic.
- Termination finish:  
For RoHS Case Styles: Tin-Silver over Nickel plated or Matte-Tin Plated (See Data sheet).  
All models, (+) suffix.
- Lead #1 identifier shall be located in the cross-hatched area shown.  
Identifier may be either a molded or marked feature.



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

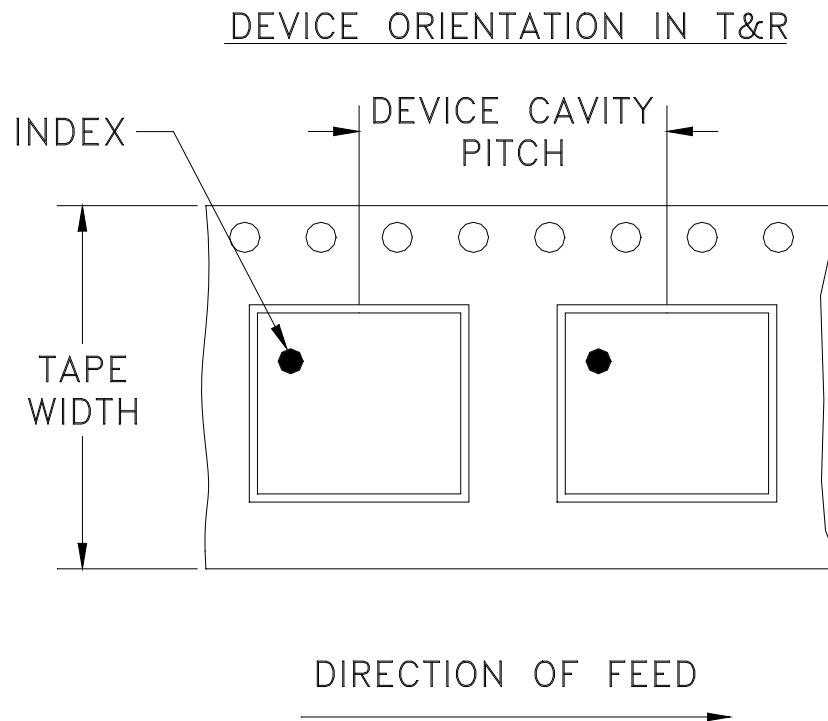


The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: [www.minicircuits.com](http://www.minicircuits.com)

RF/IF MICROWAVE COMPONENTS



# Tape & Reel Packaging TR-F66



| Tape Width, mm | Device Cavity Pitch, mm | Reel Size, inches | Devices per Reel<br>see note |                  |
|----------------|-------------------------|-------------------|------------------------------|------------------|
| 8              | 4                       | 7                 | Small quantity standard      | 20               |
|                |                         |                   |                              | 50               |
|                |                         |                   |                              | 100              |
|                |                         |                   |                              | 200              |
|                |                         |                   |                              | 500              |
|                |                         | 7                 | Standard                     | 1000, 2000, 3000 |

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](http://www.minicircuits.com/pages/pdfs/tape.pdf)

**Mini-Circuits®**

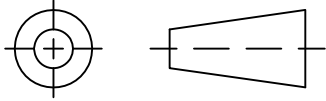
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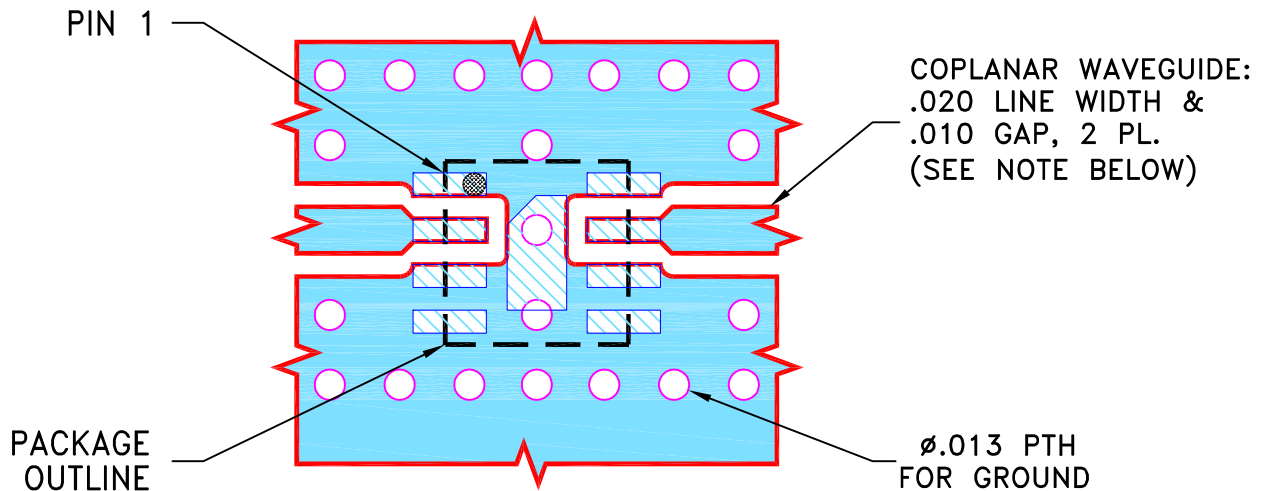
THIRD ANGLE PROJECTION



REVISIONS

| REV | ECN No. | DESCRIPTION | DATE     | DR  | AUTH |
|-----|---------|-------------|----------|-----|------|
| OR  | M167264 | NEW RELEASE | 04/09/18 | ITG | RS   |
|     |         |             |          |     |      |
|     |         |             |          |     |      |

SUGGESTED MOUNTING CONFIGURATION  
FOR MC1631-1 CASE STYLE, "08EQ01" PIN CODE

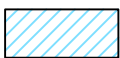


NOTES:

1. LINE WIDTH & GAP PARAMETERS ARE SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS  $.010 \pm .001$ . COPPER: 1/2 OZ. EACH SIDE.  
FOR OTHER MATERIALS LINE WIDTH & GAP MAY NEED TO BE MODIFIED.
3. 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<br>TOLERANCES ON:<br>2 PL DECIMALS ±<br>3 PL DECIMALS ± .005<br>ANGLES ±<br>FRACTIONS ± | DRAWN    | ITG | 04/06/18 |
|  | CHECKED  | GF  | 04/09/18 |
|  | APPROVED | RS  | 04/09/18 |



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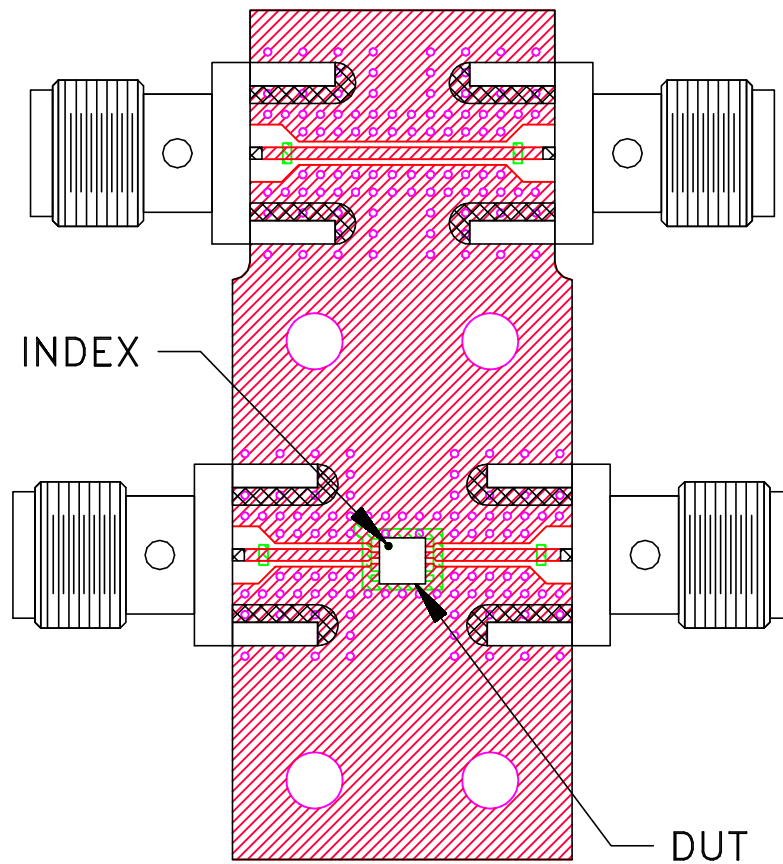
13 Neptune Avenue  
Brooklyn NY 11235

PL, 08EQ01, MC1631-1, TB-1041-N-63+

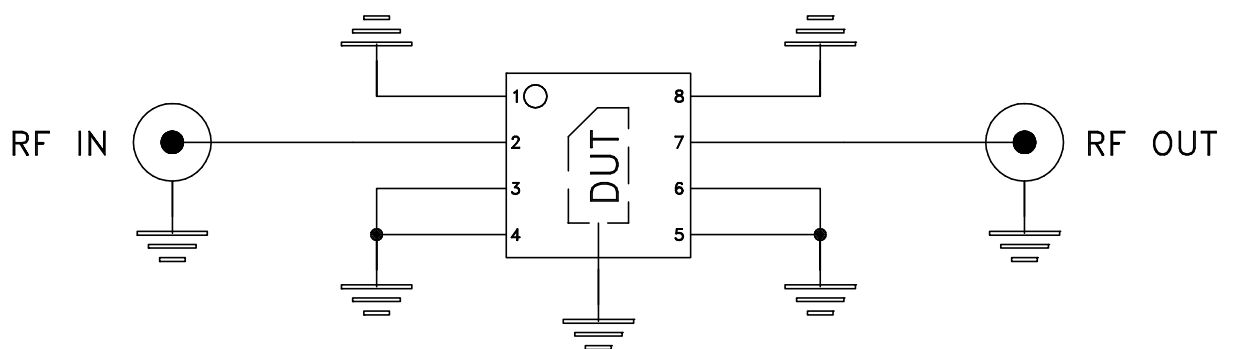
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| SIZE  | CODE IDENT | DRAWING NO: | REV:          |
|-------|------------|-------------|---------------|
| A     | 15542      | 98-PL-576   | OR            |
| FILE: | 98PL576    | SCALE: 12:1 | SHEET: 1 OF 1 |

# Evaluation Board and Circuit




TB-1041-4-63+



Schematic Diagram

## Notes:

1. 50 Ohm SMA Female connectors.
2. PCB Material: R04350 or equivalent,  
Dielectric Constant=3.5, Thickness=.010 inch.

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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 or -45° to 85°C<br>Ambient Environment  | Individual Model Data Sheet                                     |
| Storage Temperature            | -55° to 100° C or -65° to 150°<br>Ambient Environment  | Individual Model Data Sheet                                     |
| Thermal Shock                  | -55° to 100°C, 100 cycles  | MIL-STD-202, Method 107, Condition A-3, except +100°C           |
| Mechanical Shock               | 1.5Kg, 0.5 ms, 5 shock pulses, Y1 direction only   | MIL-STD-883, Method 2002, Condition B, except Y1 direction only |
| Vibration (Variable Frequency) | 50g peak   | MIL-STD-883, Method 2007, Condition B                           |
| Autoclave                      | 15 psig, 100% RH, 121°C, 96 hours  | JESD22-A102, Condition C  |
| HAST                           | 130°C, 85% RH, 96 hours  | JESD22-A110   |
| Solderability                  | 10X Magnification  | J-STD-002, Para 4.2.5, Test S, 95% Coverage                     |
| Solder Reflow Heat             | Sn-Pb Eutetic Process: 240°C peak<br>Pb-Free Process: 260°C peak   | J-STD-020, Table 4-1, 4-2 and 5-2; Figure 5-1                   |
| Moisture Sensitivity: Level 1  | Bake at 125°C for 24 hours<br>Soak at 85°C/85% RH for 168 hours, Reflow 3 cycles at 260°C peak                                 | J-STD-020   |
| Marking Resistance to Solvents | Isopropyl alcohol + mineral spirits at 25°C; terpene defluxer at 25°C;<br>distilled water + proylene glycol monomethyl ether + | MIL-STD-202, Method 215   |



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| <b>Specification</b> | <b>Test/Inspection Condition</b> | <b>Reference/Spec</b> |
|----------------------|----------------------------------|-----------------------|
|                      | monoethanolamine at 63°C to 70°C |                       |