

Surface Mount

# Power Splitter/Combiner

SCQA-4-162+

4 Way Quadrifilar 50Ω 1200 to 1600 MHz

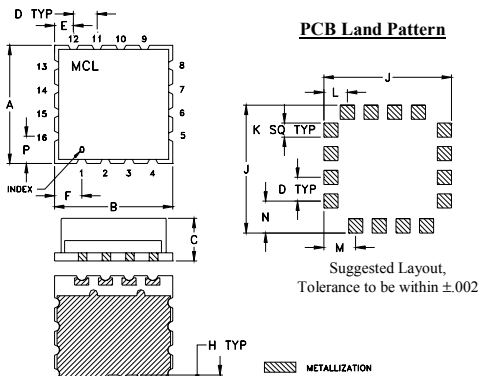
## Maximum Ratings

|                                                                 |                |
|-----------------------------------------------------------------|----------------|
| Operating Temperature                                           | -40°C to 85°C  |
| Storage Temperature                                             | -55°C to 100°C |
| Power Input (as a splitter)                                     | 1W max.        |
| Internal Dissipation                                            | 0.20W max.     |
| Permanent damage may occur if any of these limits are exceeded. |                |

## Pin Connections

|               |                 |
|---------------|-----------------|
| SUM PORT      | 10              |
| PORT 1 (0°)   | 1               |
| PORT 2 (90°)  | 2               |
| PORT 3 (180°) | 3               |
| PORT 4 (270°) | 4               |
| GROUND        | 5,6,7,8,9,11,12 |

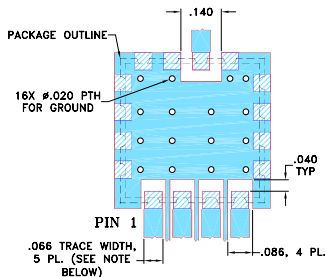
## Outline Drawing



## Outline Dimensions (inch/mm)

| A     | B     | C    | D    | E    | F    | G    | H     | J     |
|-------|-------|------|------|------|------|------|-------|-------|
| .500  | .500  | .180 | .100 | .080 | .115 | .060 | .040  | .540  |
| 12.70 | 12.70 | 4.57 | 2.54 | 2.03 | 2.92 | 1.52 | 1.02  | 13.72 |
| K     | L     | M    | N    | P    | Q    | T    | wt.   |       |
| .060  | .100  | .135 | .135 | .115 | .140 | .080 | grams |       |
| 1.52  | 2.54  | 3.43 | 3.43 | 2.92 | 3.56 | 2.03 | 1.0   |       |

## Demo Board MCL P/N: TB-652+ Suggested PCB Layout (PL-368+)



- 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

## 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)

## Features

- good isolation, 22 dB typ.
- good phase unbalance, 3 deg.
- good matching VSWR, 1.15:1 typ.

## Applications

- GPS phase array antenna



Generic photo used for illustration purposes only

CASE STYLE: CK1704

## +RoHS Compliant

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

## Electrical Specifications at 25°C

| Parameter                   | Frequency (MHz) | Min. | Typ. | Max. | Unit   |
|-----------------------------|-----------------|------|------|------|--------|
| Frequency Range             |                 | 1200 | —    | 1600 | MHz    |
| Insertion Loss Above 6.0 dB | 1200-1600       | —    | 1.5  | 2.8  | dB     |
| Isolation                   | 1200-1600       | 18   | 22   | —    | dB     |
| Phase Unbalance             | 1200-1600       | —    | 3.0  | 10   | Degree |
| Amplitude Unbalance         | 1200-1600       | —    | 0.6  | 1.0  | dB     |
| VSWR (Port S)               | 1200-1600       | —    | 1.2  | —    | :1     |
| VSWR (Port 1-4)             | 1200-1600       | —    | 1.4  | —    | :1     |

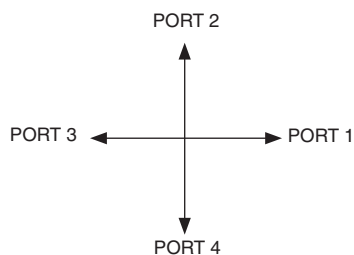
\*Phase Unbalance is referenced insertion phase at 0° port.

## Typical Performance Data

| Freq. (MHz) | Total Loss <sup>1</sup> (dB) | Amp. Unbal. (dB) | Insertion Phase (deg) | Phase Unbalance (deg.) |       |        |        | Isolation (dB) |       |       | VSWR S | VSWR 1 | VSWR 2 | VSWR 3 | VSWR 4 |
|-------------|------------------------------|------------------|-----------------------|------------------------|-------|--------|--------|----------------|-------|-------|--------|--------|--------|--------|--------|
|             |                              |                  |                       | 0°                     | 90°   | 180°   | 270°   | 1-2            | 2-3   | 3-4   |        |        |        |        |        |
| 1150.00     | 6.98                         | 0.32             | 160.79                | 0.00                   | 88.03 | 179.66 | 267.65 | 22.35          | 31.34 | 25.42 | 1.09   | 1.03   | 1.04   | 1.07   | 1.02   |
| 1200.00     | 7.10                         | 0.18             | 144.77                | 0.00                   | 88.25 | 179.80 | 267.68 | 22.07          | 30.71 | 25.20 | 1.10   | 1.03   | 1.06   | 1.07   | 1.02   |
| 1225.00     | 7.16                         | 0.26             | 136.76                | 0.00                   | 88.37 | 179.89 | 267.72 | 21.94          | 30.39 | 25.11 | 1.11   | 1.03   | 1.06   | 1.07   | 1.03   |
| 1250.00     | 7.21                         | 0.33             | 128.75                | 0.00                   | 88.49 | 179.96 | 267.76 | 21.82          | 30.06 | 25.02 | 1.11   | 1.03   | 1.07   | 1.07   | 1.03   |
| 1275.00     | 7.26                         | 0.38             | 120.75                | 0.00                   | 88.62 | 180.02 | 267.82 | 21.72          | 29.69 | 24.95 | 1.11   | 1.03   | 1.07   | 1.08   | 1.04   |
| 1300.00     | 7.31                         | 0.43             | 112.75                | 0.00                   | 88.76 | 180.07 | 267.88 | 21.65          | 29.32 | 24.90 | 1.11   | 1.04   | 1.08   | 1.08   | 1.04   |
| 1350.00     | 7.38                         | 0.51             | 96.73                 | 0.00                   | 89.04 | 180.18 | 268.04 | 21.54          | 28.55 | 24.88 | 1.11   | 1.04   | 1.09   | 1.09   | 1.05   |
| 1400.00     | 7.44                         | 0.54             | 80.72                 | 0.00                   | 89.32 | 180.28 | 268.21 | 21.52          | 27.81 | 24.98 | 1.12   | 1.05   | 1.10   | 1.10   | 1.06   |
| 1450.00     | 7.48                         | 0.54             | 64.73                 | 0.00                   | 89.60 | 180.32 | 268.38 | 21.59          | 27.08 | 25.19 | 1.12   | 1.06   | 1.10   | 1.11   | 1.07   |
| 1500.00     | 7.50                         | 0.53             | 48.73                 | 0.00                   | 89.83 | 180.35 | 268.57 | 21.73          | 26.33 | 25.50 | 1.14   | 1.06   | 1.11   | 1.12   | 1.07   |
| 1525.00     | 7.50                         | 0.51             | 40.73                 | 0.00                   | 89.96 | 180.35 | 268.67 | 21.83          | 26.00 | 25.70 | 1.15   | 1.07   | 1.11   | 1.13   | 1.08   |
| 1550.00     | 7.50                         | 0.48             | 32.73                 | 0.00                   | 90.07 | 180.33 | 268.76 | 21.94          | 25.67 | 25.91 | 1.16   | 1.07   | 1.11   | 1.13   | 1.08   |
| 1575.00     | 7.49                         | 0.44             | 24.73                 | 0.00                   | 90.18 | 180.30 | 268.87 | 22.07          | 25.33 | 26.16 | 1.18   | 1.07   | 1.11   | 1.14   | 1.08   |
| 1600.00     | 7.48                         | 0.39             | 16.75                 | 0.00                   | 90.28 | 180.25 | 268.98 | 22.23          | 25.02 | 26.43 | 1.20   | 1.08   | 1.11   | 1.14   | 1.09   |
| 1650.00     | 7.46                         | 0.30             | 0.72                  | 0.00                   | 90.48 | 180.20 | 269.22 | 22.57          | 24.40 | 26.99 | 1.23   | 1.08   | 1.11   | 1.14   | 1.10   |

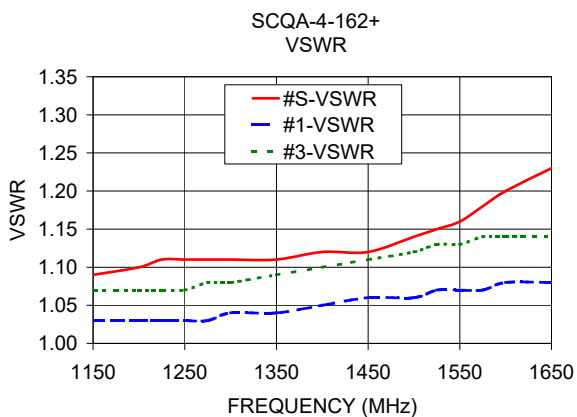
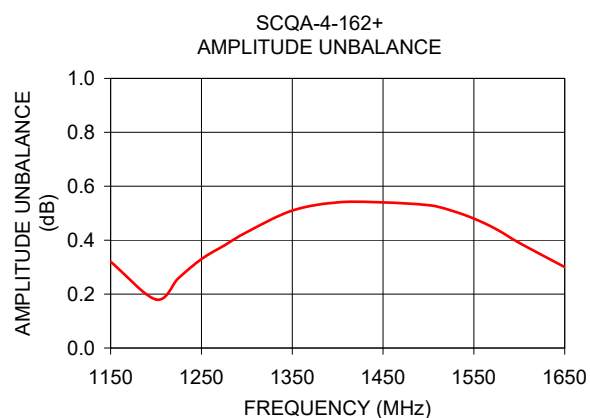
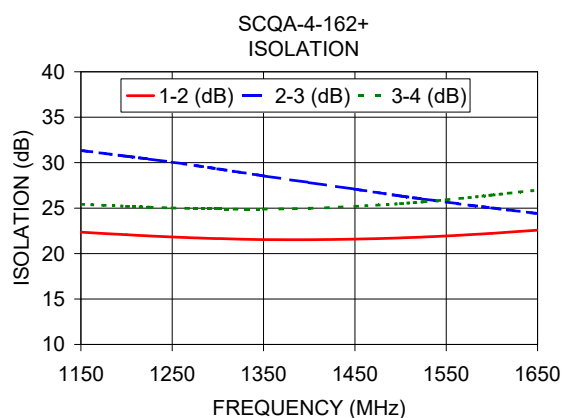
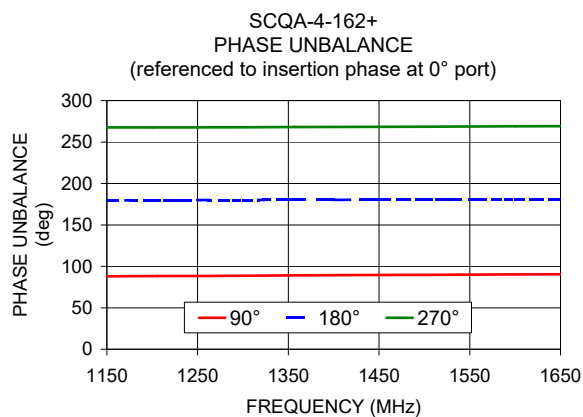
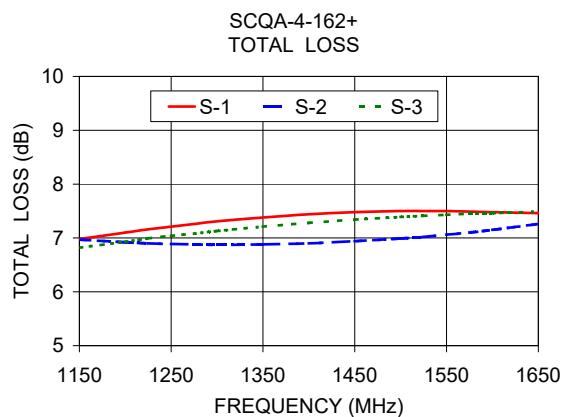
1. Total Loss = Insertion Loss + 6dB splitter loss.

## Phase Diagram



## Electrical Configuration





## 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.
- 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)



# 4 Way-Quadrifilar Power Splitter/Combiner

SCQA-4-162+

## Typical Performance Data

| FREQ.<br><br>(MHz) | TOTAL LOSS <sup>1</sup> |      |      |      | AMP.<br>UNBAL.<br><br>(dB) | INSERTION<br>PHASE<br><br>(Deg.) | ISOLATION |       |       | PHASE UNBALANCE |           |            |             | FREQ.<br><br>(MHz) | VSWR        |      |      |      |      |
|--------------------|-------------------------|------|------|------|----------------------------|----------------------------------|-----------|-------|-------|-----------------|-----------|------------|-------------|--------------------|-------------|------|------|------|------|
|                    | (dB)                    |      |      |      |                            |                                  | (dB)      |       |       | (Deg.)          |           |            |             |                    | (:1)        |      |      |      |      |
|                    | S-1                     | S-2  | S-3  | S-4  |                            |                                  |           | 1-2   | 2-3   | 3-4             | @ 0° Port | @ 90° Port | @ 180° Port |                    | @ 270° Port | S    | 1    | 2    | 3    |
| 1150.0             | 6.98                    | 6.97 | 6.82 | 7.14 | 0.32                       | 160.79                           | 22.35     | 31.34 | 25.42 | 0.00            | 88.03     | 179.66     | 267.65      | 1150.0             | 1.09        | 1.03 | 1.04 | 1.07 | 1.02 |
| 1200.0             | 7.10                    | 6.92 | 6.93 | 7.06 | 0.18                       | 144.77                           | 22.07     | 30.71 | 25.20 | 0.00            | 88.25     | 179.80     | 267.68      | 1200.0             | 1.10        | 1.03 | 1.06 | 1.07 | 1.02 |
| 1225.0             | 7.16                    | 6.90 | 6.99 | 7.03 | 0.26                       | 136.76                           | 21.94     | 30.39 | 25.11 | 0.00            | 88.37     | 179.89     | 267.72      | 1225.0             | 1.11        | 1.03 | 1.06 | 1.07 | 1.03 |
| 1250.0             | 7.21                    | 6.89 | 7.04 | 7.01 | 0.33                       | 128.75                           | 21.82     | 30.06 | 25.02 | 0.00            | 88.49     | 179.96     | 267.76      | 1250.0             | 1.11        | 1.03 | 1.07 | 1.07 | 1.03 |
| 1275.0             | 7.26                    | 6.88 | 7.08 | 6.98 | 0.38                       | 120.75                           | 21.72     | 29.69 | 24.95 | 0.00            | 88.62     | 180.02     | 267.82      | 1275.0             | 1.11        | 1.03 | 1.07 | 1.08 | 1.04 |
| 1300.0             | 7.31                    | 6.87 | 7.13 | 6.97 | 0.43                       | 112.75                           | 21.65     | 29.32 | 24.90 | 0.00            | 88.76     | 180.07     | 267.88      | 1300.0             | 1.11        | 1.04 | 1.08 | 1.08 | 1.04 |
| 1350.0             | 7.38                    | 6.88 | 7.21 | 6.94 | 0.51                       | 96.73                            | 21.54     | 28.55 | 24.88 | 0.00            | 89.04     | 180.18     | 268.04      | 1350.0             | 1.11        | 1.04 | 1.09 | 1.09 | 1.05 |
| 1400.0             | 7.44                    | 6.90 | 7.28 | 6.93 | 0.54                       | 80.72                            | 21.52     | 27.81 | 24.98 | 0.00            | 89.32     | 180.28     | 268.21      | 1400.0             | 1.12        | 1.05 | 1.10 | 1.10 | 1.06 |
| 1450.0             | 7.48                    | 6.94 | 7.34 | 6.94 | 0.54                       | 64.73                            | 21.59     | 27.08 | 25.19 | 0.00            | 89.60     | 180.32     | 268.38      | 1450.0             | 1.12        | 1.06 | 1.10 | 1.11 | 1.07 |
| 1500.0             | 7.50                    | 6.99 | 7.39 | 6.97 | 0.53                       | 48.73                            | 21.73     | 26.33 | 25.50 | 0.00            | 89.83     | 180.35     | 268.57      | 1500.0             | 1.14        | 1.06 | 1.11 | 1.12 | 1.07 |
| 1525.0             | 7.50                    | 7.02 | 7.41 | 6.99 | 0.51                       | 40.73                            | 21.83     | 26.00 | 25.70 | 0.00            | 89.96     | 180.35     | 268.67      | 1525.0             | 1.15        | 1.07 | 1.11 | 1.13 | 1.08 |
| 1550.0             | 7.50                    | 7.06 | 7.43 | 7.02 | 0.48                       | 32.73                            | 21.94     | 25.67 | 25.91 | 0.00            | 90.07     | 180.33     | 268.76      | 1550.0             | 1.16        | 1.07 | 1.11 | 1.13 | 1.08 |
| 1575.0             | 7.49                    | 7.10 | 7.45 | 7.05 | 0.44                       | 24.73                            | 22.07     | 25.33 | 26.16 | 0.00            | 90.18     | 180.30     | 268.87      | 1575.0             | 1.18        | 1.07 | 1.11 | 1.14 | 1.08 |
| 1600.0             | 7.48                    | 7.15 | 7.46 | 7.09 | 0.39                       | 16.75                            | 22.23     | 25.02 | 26.43 | 0.00            | 90.28     | 180.25     | 268.98      | 1600.0             | 1.20        | 1.08 | 1.11 | 1.14 | 1.09 |
| 1650.0             | 7.46                    | 7.26 | 7.49 | 7.19 | 0.30                       | 0.72                             | 22.57     | 24.40 | 26.99 | 0.00            | 90.48     | 180.20     | 269.22      | 1650.0             | 1.23        | 1.08 | 1.11 | 1.14 | 1.10 |

<sup>1</sup>Total Loss = Insertion Loss + 6dB Splitter Loss



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)

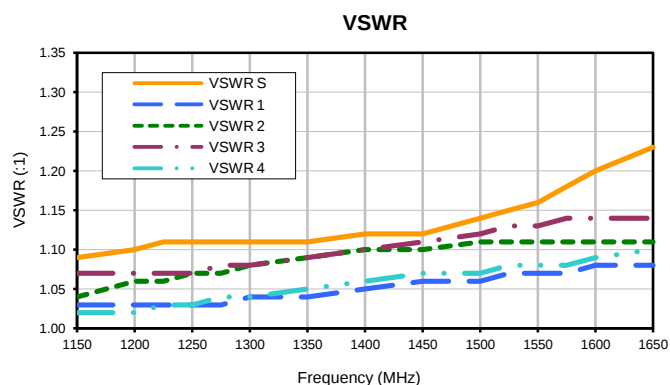
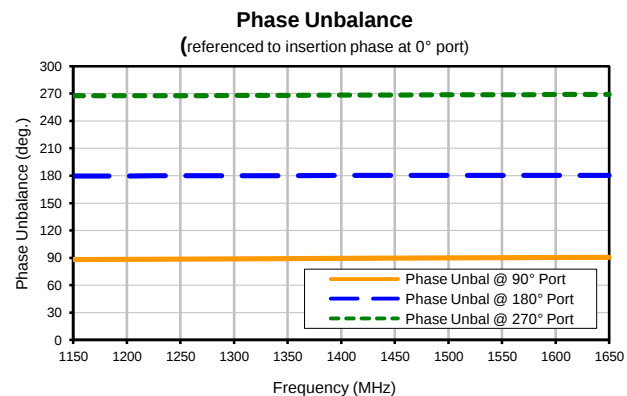
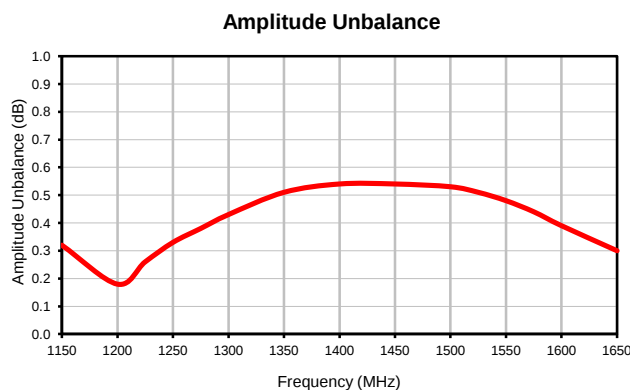
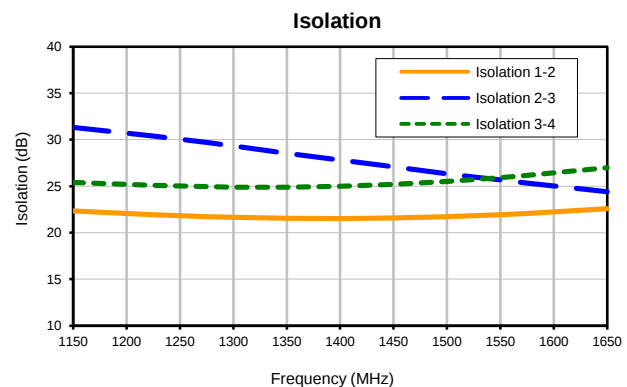
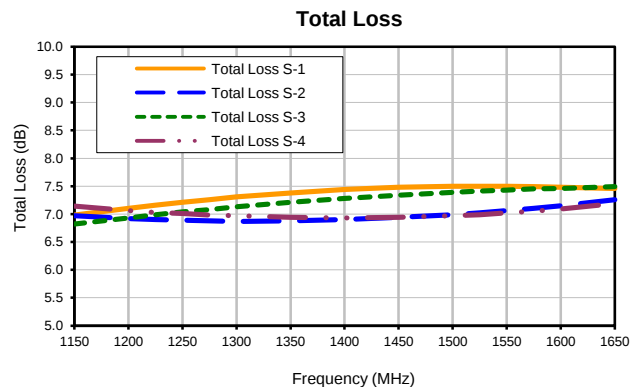
IF/RF MICROWAVE COMPONENTS

REV. OR  
 SCQA-4-162+  
 1/22/2013  
 Page 1 of 1

# 4 Way-Quadrifilar Power Splitter/Combiner

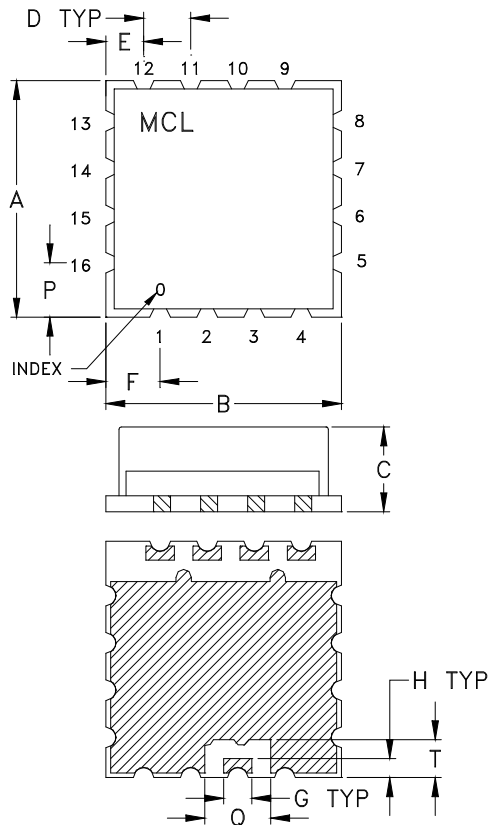
# SCQA-4-162+

## Typical Performance Curves

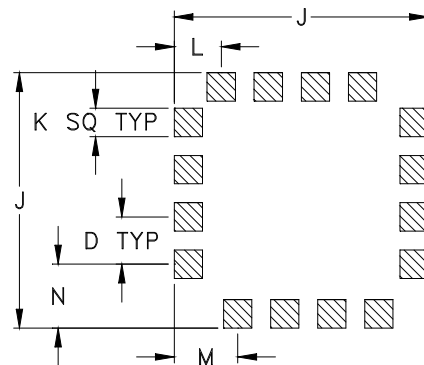


## Outline Dimensions

CK1704



## PCB Land Pattern



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

 METALLIZATION

| CASE # | A               | B               | C              | D              | E              | F              | G              | H              | J               | K              |
|--------|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|----------------|
| CK1704 | .500<br>(12.70) | .500<br>(12.70) | .180<br>(4.57) | .100<br>(2.54) | .080<br>(2.03) | .115<br>(2.92) | .060<br>(1.52) | .040<br>(1.02) | .540<br>(13.72) | .060<br>(1.52) |

| CASE # | L              | M              | N              | P              | Q              | R | S | T              | WT. GRAM |
|--------|----------------|----------------|----------------|----------------|----------------|---|---|----------------|----------|
| CK1704 | .100<br>(2.54) | .135<br>(3.43) | .135<br>(3.43) | .115<br>(2.92) | .140<br>(3.56) | - | - | .080<br>(2.03) | 1.0      |

Dimensions are in inches (mm). Tolerances: 2 Pl.  $\pm .03$ ; 3Pl.  $\pm .015$

### Notes:

- Case material: Nickel-Silver alloy.
- Base: Printed wiring laminate.
- Termination finish:  
For RoHS Case Styles: 3-5  $\mu$  inch (.08-.13 microns) Gold over 120-240  $\mu$  inch (3.05-6.10 microns) Nickel plate.  
All models, (+) suffix.

 **Mini-Circuits**<sup>®</sup>  
ISO 9001 ISO 14001 CERTIFIED

 **minicircuits.com**

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-F37



| Tape Width,<br>mm | Device Cavity<br>Pitch, mm | Reel Size,<br>inches | Devices per Reel                    |     |
|-------------------|----------------------------|----------------------|-------------------------------------|-----|
| 24                | 16                         | 7                    | Small quantity standards (see note) | 10  |
|                   |                            |                      |                                     | 20  |
|                   |                            |                      |                                     | 50  |
|                   |                            |                      |                                     | 100 |
|                   |                            | 13                   | Standard                            | 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.

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



INTERNET <http://www.minicircuits.com>

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661

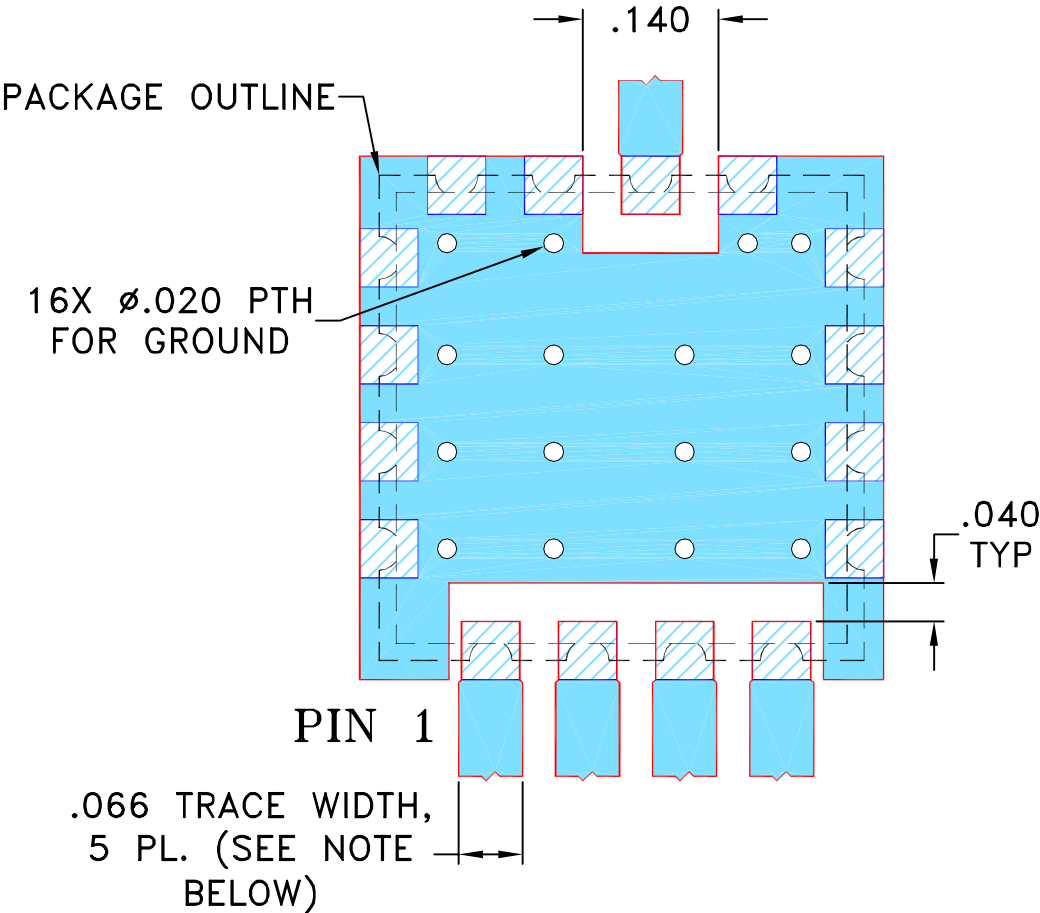
Distribution Centers NORTH AMERICA 800-654-7949 • 417-335-5935 • Fax 417-335-5945 • EUROPE 44-1252-832600 • Fax 44-1252-837010

Mini-Circuits ISO 9001 & ISO 14001 Certified

THIRD ANGLE PROJECTION

| REVISIONS |         |                     |          |    |      |
|-----------|---------|---------------------|----------|----|------|
| REV       | ECN No. | DESCRIPTION         | DATE     | DR | AUTH |
| OR        | M136731 | NEW RELEASE         | 05/14/12 | AV | ABD  |
| A         | M145165 | UPDATED PCB PATTERN | 02/28/14 | AV | JC   |
|           |         |                     |          |    |      |
|           |         |                     |          |    |      |

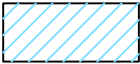
SUGGESTED MOUNTING CONFIGURATION FOR  
CK1704 CASE STYLE, "16SP01" PIN CONNECTION



- NOTES: 1. TRACE WIDTH IS SHOWN FOR ROGERS R04350B 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<br>TOLERANCES ON:<br>2 PL DECIMALS ±<br>3 PL DECIMALS ± .005<br>ANGLES ±<br>FRACTIONS ± | DRAWN    | AV  | 04/17/12 |
|                                                                                                                  | CHECKED  | IL  | 05/14/12 |
|                                                                                                                  | APPROVED | ABD | 05/14/12 |
|                                                                                                                  |          |     |          |



Mini-Circuits® 13 Neptune Avenue  
Brooklyn NY 11235

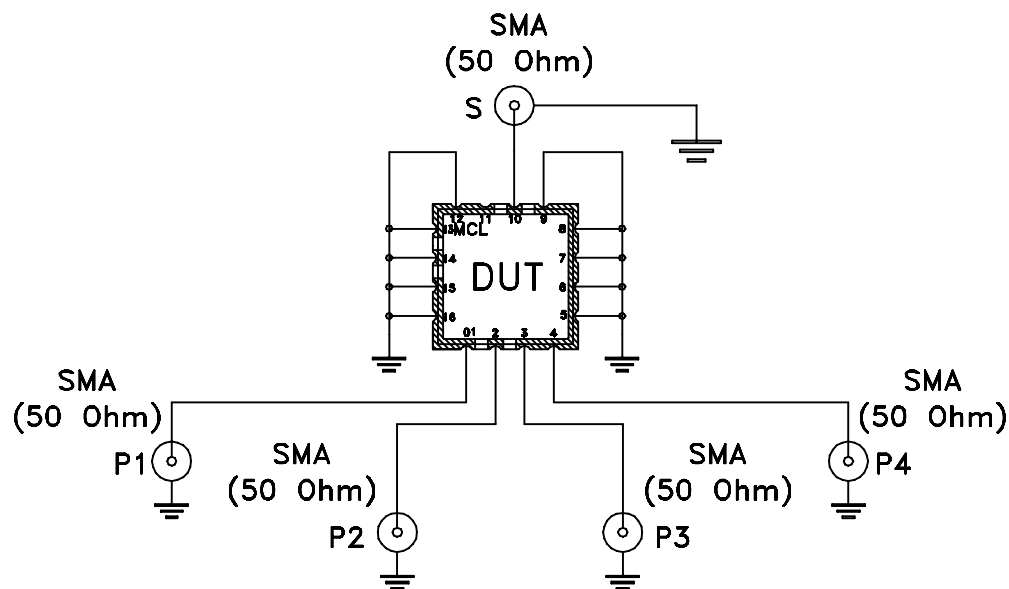
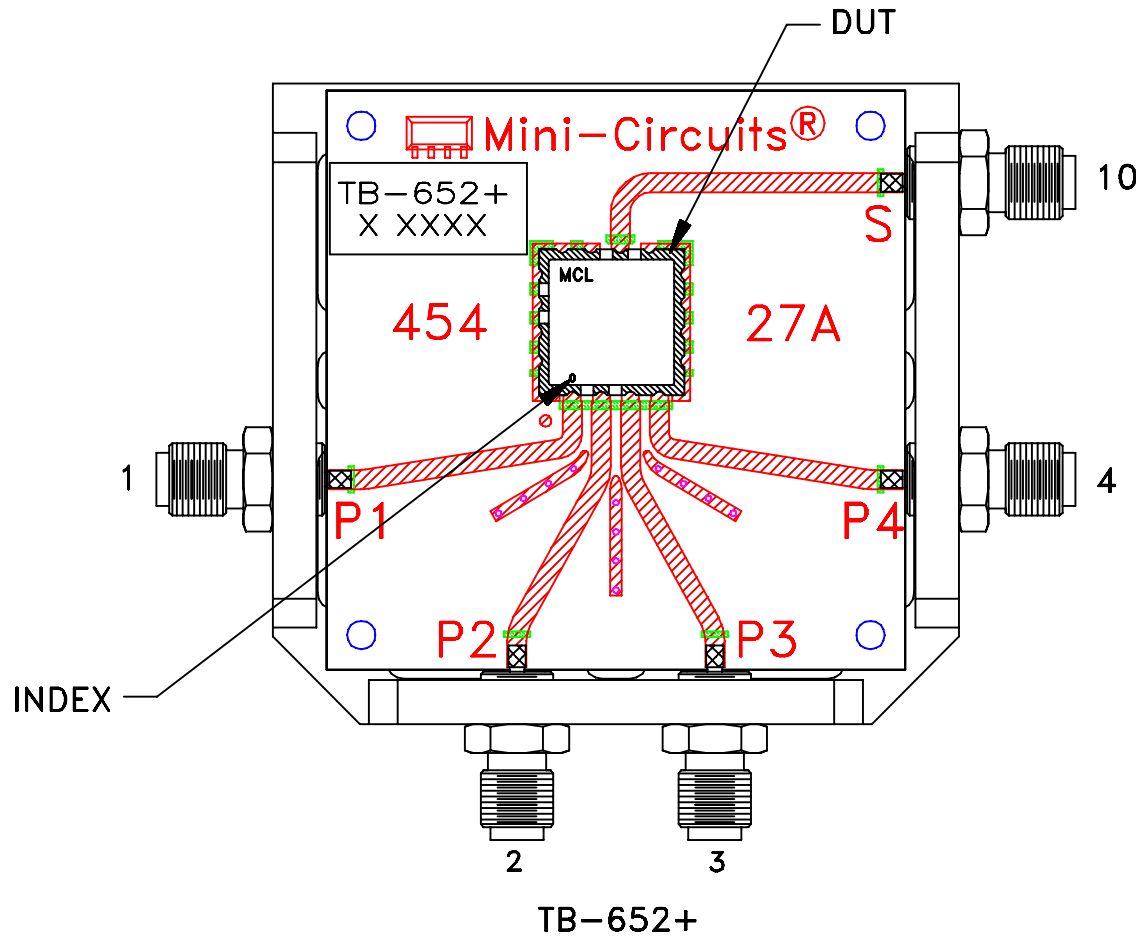
PL, 16SP01, CK1704, TB-652+

THIS DOCUMENT AND ITS CONTENTS ARE THE PROPERTY OF MINI-CIRCUITS. EXCEPT FOR USE EXPRESSLY GRANTED, IN WRITING, TO ITS VENDORS, VENDEE AND THE UNITED STATES GOVERNMENT, MINI-CIRCUITS RESERVES ALL PROPRIETARY DESIGN, USE, MANUFACTURING AND REPRODUCTION RIGHTS THERETO. THESE CONTENTS SHALL NOT BE USED, DUPLICATED OR DISCLOSED TO ANY OUTSIDE PARTY, IN WHOLE OR IN PART, WITHOUT WRITTEN PERMISSION OF MINI-CIRCUITS.

ASHEETA1.DWG REV:A    DATE:01/12/95

| SIZE  | CODE IDENT | DRAWING NO: | REV:   |
|-------|------------|-------------|--------|
| A     | 15542      | 98-PL-368   | A      |
| FILE: | 98PL368    | SCALE:      | SHEET: |
|       |            | 5:1         | 1 OF 1 |

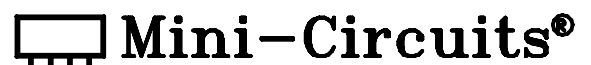
## Evaluation Board and Circuit



### Schematic Diagram

## Notes:

1. 50 Ohm SMA Female connectors.
2. PCB Material: R04350 or equivalent.  
Dielectric Constant=3.5, Thickness=.030 inch.





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          | -55° 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 Eutectic Process: 225°C peak<br>Pb-Free Process, 245°C peak                                                                                               | J-STD-020, Table 4-1, 4-2 and 5-2, Figure 5-1                                                        |
| Solderability                  | 10X Magnification                                                                                                                                               | J-STD-002, Para 4.2.5, Test S, 95% Coverage                                                          |
| Vibration (High Frequency)     | 20g peak, 20-2000 Hz, 4 times in each of three axes (total 12)                                                                                                  | MIL-STD-883, Method 2007.3, Condition A                                                              |
| 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                                                                              |