

50Ω Bi-Phase 2 to 400 MHz

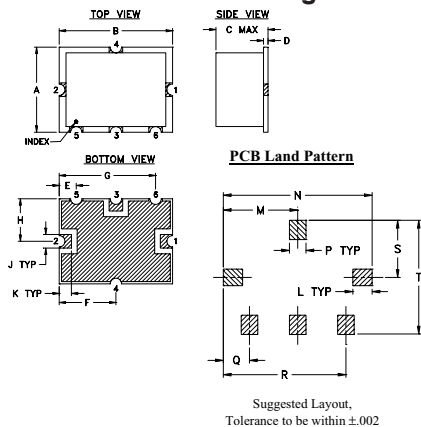
Maximum Ratings

Operating Temperature	-40°C to 85°C
Storage Temperature	-55°C to 100°C
Control Current	30mA
Permanent damage may occur if any of these limits are exceeded.	

Pin Connections

INPUT	1
OUTPUT	2
CONTROL	3
GROUND	4,5,6

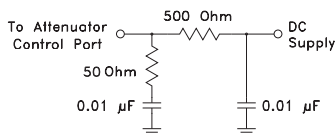
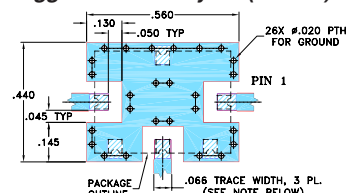
Outline Drawing



Outline Dimensions (inch)

A	B	C	D	E	F	G	H	J	K
.38	.50	.23	.020	.075	.250	.425	.187	.050	.050
9.65	12.70	5.84	0.51	1.91	6.35	10.80	4.75	1.27	1.27
L	M	N	P	Q	R	S	T	wt.	
.070	.270	.540	.060	.095	.445	.208	.415	grams	
1.78	6.86	13.72	1.52	2.41	11.30	5.28	10.54	0.8	

suggested control port biasing configuration

Demo Board MCL P/N: TB-12
Suggested PCB Layout (PL-079)

NOTE:

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. THE USE OF SOLDER MASK OVER THE GROUND AREA UNDER THE UNIT AS SHOWN IS RECOMMENDED TO PREVENT POTENTIAL SHORTING. IF USER CHOOSES TO EXPOSE METAL UNDER THE ENTIRE UNIT GROUND PAD FOR IMPROVED GROUNDING, IT IS RECOMMENDED A SOLDER MASK DAM BE APPLIED AROUND EACH GROUND PAD TO ENSURE TILLET AND CONNECTION AT GROUND PADS.
3. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.

■ DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER), SEE NOTE 2.

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-Circuits' 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

Features

- low conversion loss, 1.6 dB typ.
- excellent amplitude and phase unbalance

Applications

- electronic attenuator



CASE STYLE: TTT166

Attenuator/Switch Electrical Specifications

FREQUENCY (MHz)		INSERTION LOSS (dB) ±20 mA		MAX. INPUT PWR (dBm) ±20 mA		IN-OUT ISOLATION (dB) 0 mA		BI-PHASE X (±20 mA) Typ.	
IN	CON	Mid-Band m	Total Range	1 dB compr.	no damage	L	M	Δ AMP (dB)	Phase (deg.) deviation from 180°
f _L -f _U		Typ.	Max.	Typ.	Max.	Typ.	Min.	m	Total Range
2-400	DC-0.05	1.4	2.0	1.6	3.0	65	45	0.1	0.1
						45	33		1.0
						35	25		2.0

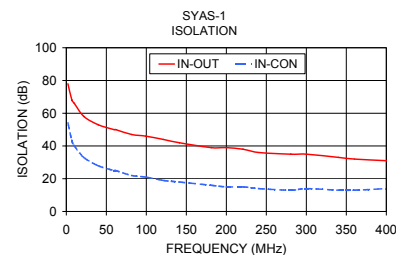
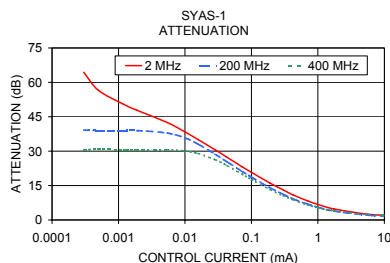
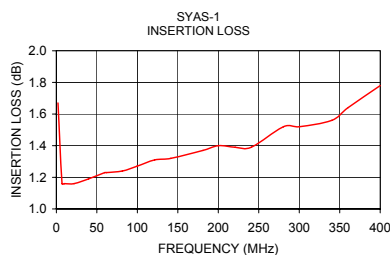
L = low range [f_L to 10 f_L] M = mid range [10 f_L to f_U/2] U = upper range [f_U/2 to f_U] m = [2 f_L to f_U/2]

* 15 dBm from 2-10 MHz.

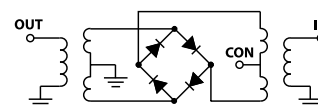
Performance specifications apply for input power up to 10 dB below stated 1 dB compression.

Typical Performance Data

Freq. (MHz)	I. Loss (dB) at 20mA		±Control ΔAMP (dB)	20mA ΔPhase (deg.)	Isolation (dB) (in-out) (in-con)		Input R. Loss (dB)	Control Current (mA)	Attenuation (dB)			Phase Δ ref at 15mA Ctrl			Input VSWR		
									2 MHz	200 MHz	400 MHz	2 MHz	200 MHz	400 MHz	2 MHz	200 MHz	400 MHz
	$\bar{x}$	σ	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$					deg.	deg.	deg.			
2.0	1.67	0.000	0.01	179.9	78	54	18.1	0.0000	72.7	39.0	30.6	27.2	-87.7	-95.3	7.7	7.2	4.4
7.0	1.16	0.001	0.00	180.0	68	43	15.4	0.0003	64.4	39.2	30.7	22.2	-86.0	-94.6	7.7	7.2	4.4
10.0	1.16	0.001	0.00	180.0	66	40	27.6	0.0005	56.5	39.0	30.8	28.6	-84.3	-93.7	7.6	7.2	4.4
21.9	1.16	0.001	0.00	180.0	58	33	31.0	0.0012	50.4	39.0	30.7	17.6	-80.5	-92.0	7.6	7.2	4.4
39.8	1.19	0.001	0.00	180.1	53	28	31.9	0.0019	47.8	39.0	30.7	14.1	-77.4	-90.3	7.5	7.2	4.4
59.7	1.23	0.001	0.00	180.1	50	25	32.1	0.0054	42.5	37.9	30.6	8.2	-56.2	-79.9	7.4	7.0	4.3
61.7	1.23	0.001	0.00	180.1	50	25	32.1	0.0100	38.4	35.8	30.1	7.6	-37.3	-67.6	7.2	6.9	4.3
81.6	1.24	0.001	0.00	180.2	47	22	32.2	0.0157	35.1	33.1	29.0	8.8	-25.3	-55.1	7.1	6.7	4.2
99.5	1.27	0.001	0.00	180.2	46	21	32.3	0.0284	30.6	28.7	26.3	8.8	-12.8	-37.6	6.7	6.3	4.0
121.4	1.31	0.001	0.01	180.3	44	19	32.4	0.0433	27.3	25.3	23.7	9.2	-7.2	-26.9	6.3	5.9	3.8
141.3	1.32	0.001	0.01	180.4	42	18	32.4	0.0722	23.2	21.2	20.0	9.3	-3.1	-17.7	5.6	5.3	3.5
181.1	1.37	0.001	0.01	180.6	39	16	32.2	0.1012	20.7	18.6	17.6	9.0	-1.4	-13.2	5.2	4.9	3.3
200.0	1.40	0.001	0.01	180.6	39	15	32.0	0.1898	16.1	14.1	13.3	8.2	0.4	-8.0	4.1	3.9	2.8
220.9	1.39	0.001	0.01	180.8	38	15	31.6	0.3008	13.1	11.2	10.6	7.4	0.9	-5.5	3.4	3.2	2.4
240.8	1.39	0.001	0.01	180.9	36	14	30.3	0.4259	10.9	9.2	8.8	6.7	1.1	-4.2	2.9	2.7	2.1
280.6	1.52	0.001	0.05	181.1	35	13	26.6	0.7017	8.3	6.9	6.6	5.4	1.1	-2.8	2.2	2.1	1.7
300.5	1.52	0.001	0.04	181.1	35	14	24.8	0.9968	6.8	5.6	5.4	4.4	0.9	-2.1	1.9	1.8	1.5
340.3	1.56	0.001	0.03	181.4	33	13	21.4	1.7486	4.8	3.9	4.0	3.0	0.7	-1.3	1.5	1.5	1.3
360.2	1.64	0.002	0.06	181.6	32	13	19.8	5.6920	2.5	2.1	2.3	0.9	0.2	-0.3	1.2	1.1	1.2
400.0	1.78	0.003	0.09	181.7	31	14	17.1	15.1258	1.8	1.5	1.8	0.0	0.0	0.1	1.3	1.1	1.3



electrical schematic



Attenuator/Switch

SYAS-1

Typical Performance Data

FREQ. (MHz)	INSERTION LOSS (dB) at 20mA Control Current	AMP. UNBAL. (dB) at ± 20 mA Control Current	PHASE UNBAL. (deg.) at ± 20 mA Control Current	ISOLATION at 0 mA Control Current (dB)		RETURN LOSS (dB) Input
				In-Out	In-Con	
2.0	1.67	0.01	179.9	78	54	18.1
7.0	1.16	0.00	180.0	68	43	15.4
10.0	1.16	0.00	180.0	66	40	27.6
21.9	1.16	0.00	180.0	58	33	31.0
39.8	1.19	0.00	180.1	53	28	31.9
59.7	1.23	0.00	180.1	50	25	32.1
61.7	1.23	0.00	180.1	50	25	32.1
81.6	1.24	0.00	180.2	47	22	32.2
99.5	1.27	0.00	180.2	46	21	32.3
121.4	1.31	0.01	180.3	44	19	32.4
141.3	1.32	0.01	180.4	42	18	32.4
181.1	1.37	0.01	180.6	39	16	32.2
200.0	1.40	0.01	180.6	39	15	32.0
220.9	1.39	0.01	180.8	38	15	31.6
240.8	1.39	0.01	180.9	36	14	30.3
280.6	1.52	0.05	181.1	35	13	26.6
300.5	1.52	0.04	181.1	35	14	24.8
340.3	1.56	0.03	181.4	33	13	21.4
360.2	1.64	0.06	181.6	32	13	19.8
400.0	1.78	0.09	181.7	31	14	17.1

CONTROL CURRENT (mA)	ATTENUATION (dB)			PHASE UNBALANCE REF AT 15 mA CONTROL (deg.)			INPUT VSWR (:1)		
	2 MHz	200 MHz	400 MHz	2 MHz	200 MHz	400 MHz	2 MHz	200 MHz	400 MHz
0.0000	72.7	39.0	30.6	27.2	-87.7	-95.3	7.7	7.2	4.4
0.0003	64.4	39.2	30.7	22.2	-86.0	-94.6	7.7	7.2	4.4
0.0005	56.5	39.0	30.8	28.6	-84.3	-93.7	7.6	7.2	4.4
0.0012	50.4	39.0	30.7	17.6	-80.5	-92.0	7.6	7.2	4.4
0.0019	47.8	39.0	30.7	14.1	-77.4	-90.3	7.5	7.2	4.4
0.0054	42.5	37.9	30.6	8.2	-56.2	-79.9	7.4	7.0	4.3
0.0100	38.4	35.8	30.1	7.6	-37.3	-67.6	7.2	6.9	4.3
0.0157	35.1	33.1	29.0	8.8	-25.3	-55.1	7.1	6.7	4.2
0.0284	30.6	28.7	26.3	8.8	-12.8	-37.6	6.7	6.3	4.0
0.0433	27.3	25.3	23.7	9.2	-7.2	-26.9	6.3	5.9	3.8
0.0722	23.2	21.2	20.0	9.3	-3.1	-17.7	5.6	5.3	3.5
0.1012	20.7	18.6	17.6	9.0	-1.4	-13.2	5.2	4.9	3.3
0.1898	16.1	14.1	13.3	8.2	0.4	-8.0	4.1	3.9	2.8
0.3008	13.1	11.2	10.6	7.4	0.9	-5.5	3.4	3.2	2.4
0.4259	10.9	9.2	8.8	6.7	1.1	-4.2	2.9	2.7	2.1
0.7017	8.3	6.9	6.6	5.4	1.1	-2.8	2.2	2.1	1.7
0.9968	6.8	5.6	5.4	4.4	0.9	-2.1	1.9	1.8	1.5
1.7486	4.8	3.9	4.0	3.0	0.7	-1.3	1.5	1.5	1.3
5.6920	2.5	2.1	2.3	0.9	0.2	-0.3	1.2	1.1	1.2
15.1258	1.8	1.5	1.8	0.0	0.0	0.1	1.3	1.1	1.3

REV. X1

SYAS-1

061203

Page 1 of 1



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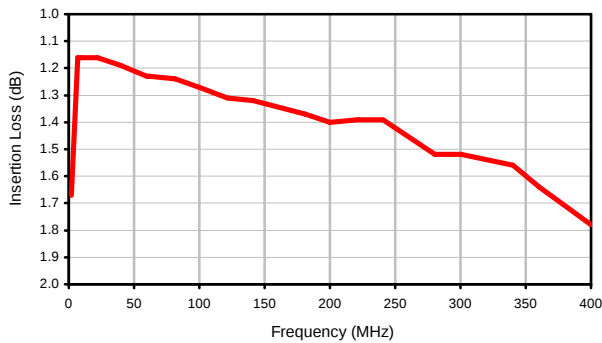


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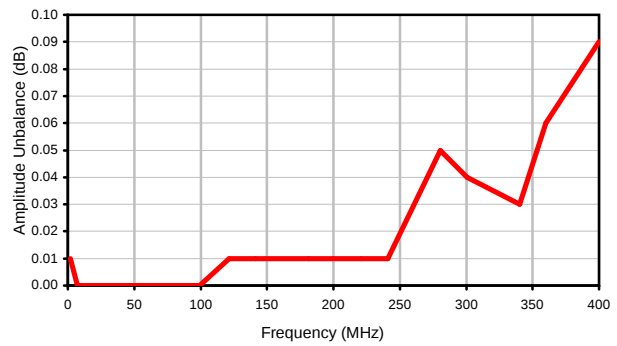


Typical Performance Curves

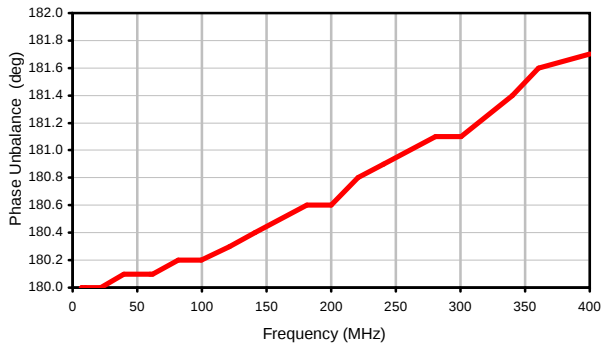
Insertion Loss @ 20 mA



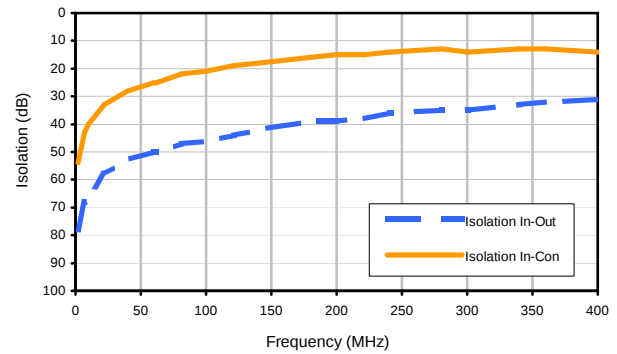
Amplitude Unbalance @ ± 20 mA



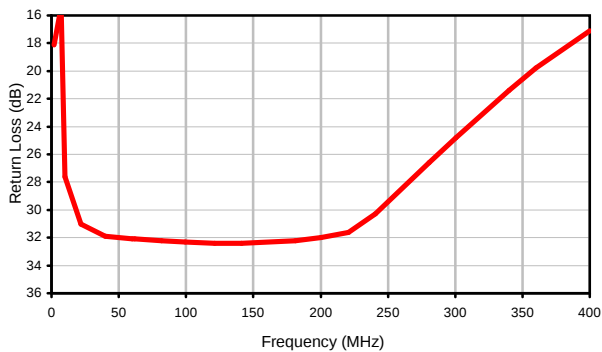
Phase Unbalance @ ± 20 mA



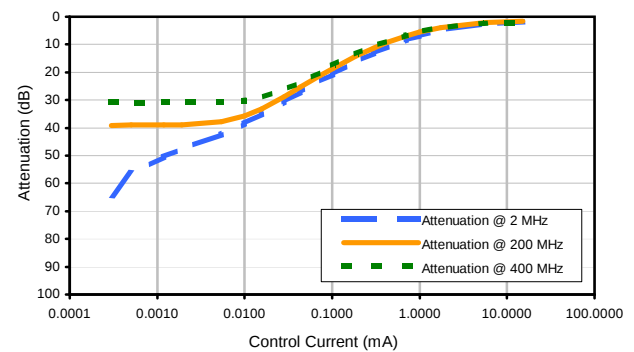
Isolation @ 0 mA



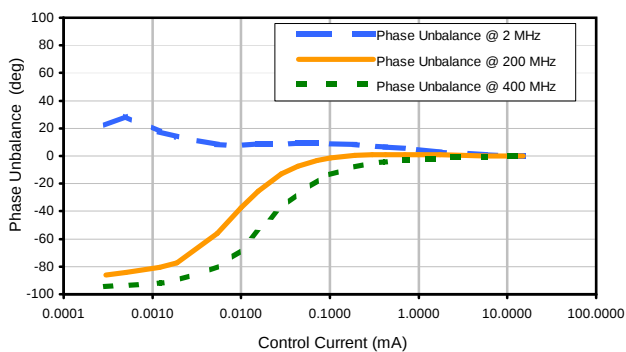
Return Loss Input



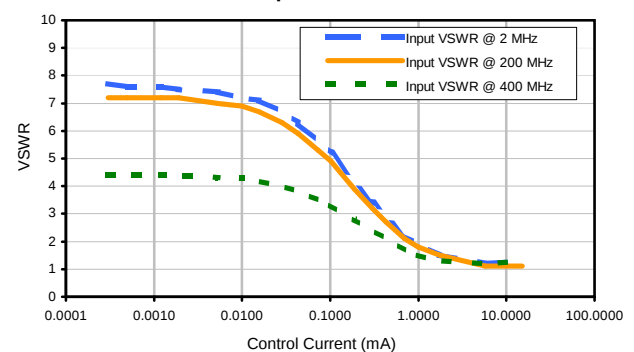
Attenuation



Phase Unbalance ref @ 15 mA

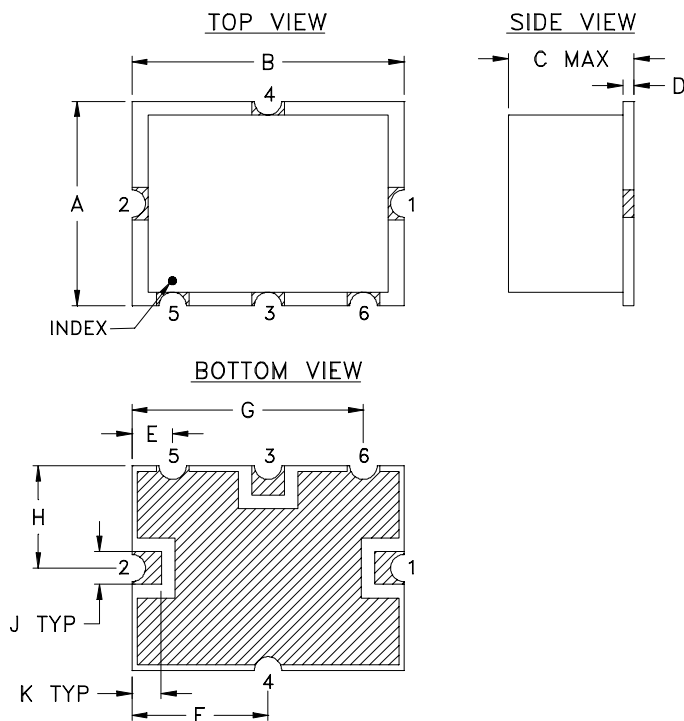


Input VSWR

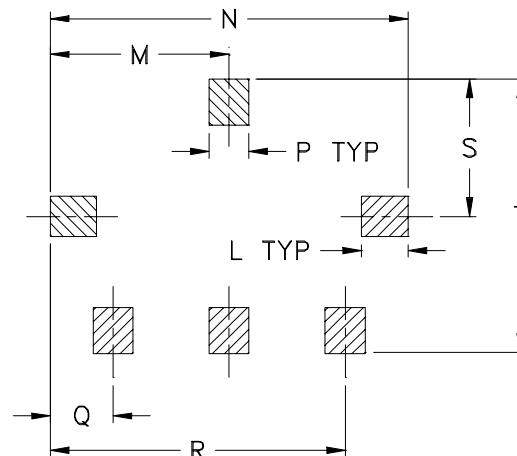


Outline Dimensions

TTT166
TTT167



PCB Land Pattern



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

CASE #	A	B	C	D	E	F	G	H	J	K	L	M	N
TTT166	.38 (9.65)	.50 (12.70)	.15 (3.81)	.020 (0.51)	.075 (1.91)	.250 (6.35)	.425 (10.80)	.187 (4.75)	.050 (1.27)	.050 (1.27)	.070 (1.78)	.270 (6.86)	.540 (13.72)
TTT167			.23 (5.84)										

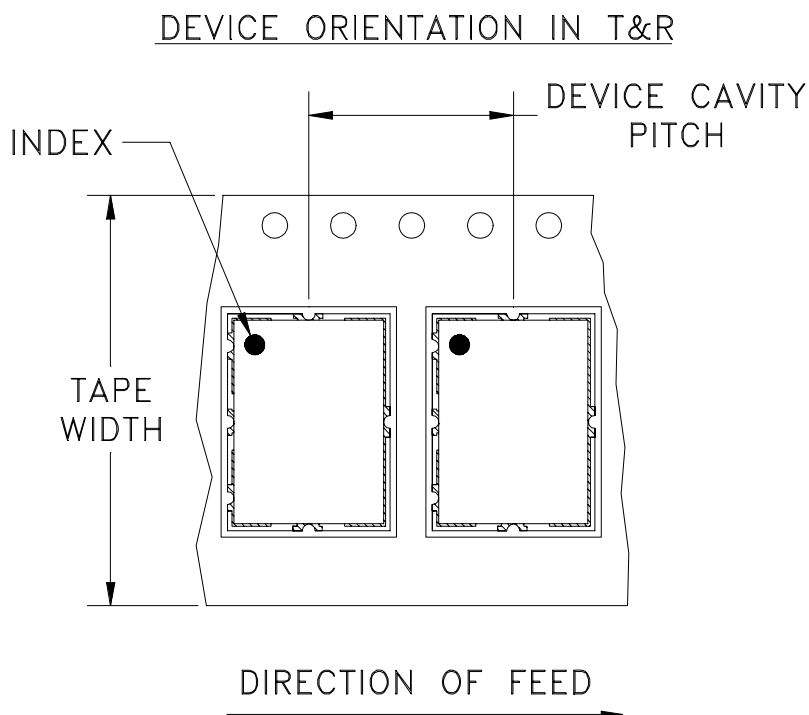
CASE #	P	Q	R	S	T	WT. GRAM
TTT166	.060 (1.52)	.095 (2.41)	.445 (11.30)	.208 (5.28)	.415 (10.54)	.8
TTT167						.8

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

Note:

- Case material: Plastic.
- Base material: Printed wiring laminate.
- Termination finish:
 - For RoHS Case Styles: 3-5 μ inch (.08-.13 microns) Gold over 120-240 μ inch (3.05-6.10 microns) Nickel plate. All models, (+) suffix.
 - For RoHS-5 Case Styles: Tin-Lead plate. All models, no (+) suffix.

Tape & Reel Packaging TR-F12



Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel	
24	12	7	Small quantity standards (see note)	10
				20
				50
				100
				200
		13	Standard	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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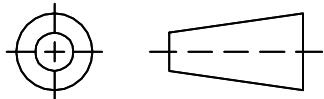
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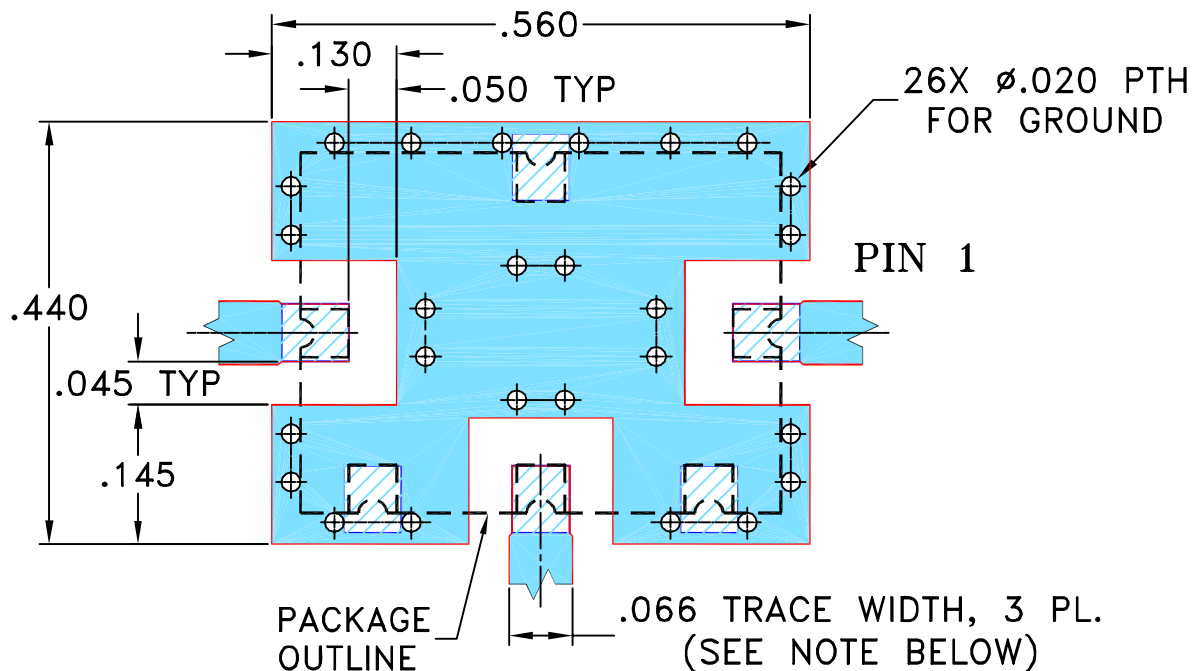
THIRD ANGLE PROJECTION



REVISIONS

REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
A	M86762	ADDED CONNECTIONS "lp & lq"	05/23/03	MMG	WL
B	M94598	ADDED CONNECTION "hk"	10/08/04	MMG	HY
C	M102713	UPDATED NOTES & DESCRIPTION	01/14/06	GF	IL
D	M132989	UPDATED NOTE 2	08/24/11	GF	DJ

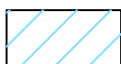
**SUGGESTED MOUNTING CONFIGURATION FOR
TTT166/167 CASE STYLE, "hk"/"lp"/"lq"
"x"/"ck"/"ec" PIN CONNECTIONS**

**NOTE:**

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. THE USE OF SOLDER MASK OVER THE GROUND AREA UNDER THE UNIT AS SHOWN IS RECOMMENDED TO PREVENT POTENTIAL SHORTING. IF USER CHOOSES TO EXPOSE METAL UNDER THE ENTIRE UNIT GROUND PAD FOR IMPROVED GROUNDING, IT IS RECOMMENDED A SOLDER MASK DAM BE APPLIED AROUND EACH GROUND PAD TO ENSURE FILLET AND CONNECTION AT GROUND PADS.
3. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.



DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER), SEE NOTE 2.



DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK

UNLESS OTHERWISE SPECIFIED

INITIALS

DATE

DIMENSIONS ARE IN INCHES

TOLERANCES ON:

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

DRAWN

GF

03/18/03

CHECKED

IL

04/15/03

APPROVED

DJ

04/15/03



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Brooklyn NY 11235

PL, hk/lp/lq/x/ck/ec, TTT166/167,
SYM/HJK/SYAS/SYPD, TB-12

SIZE
A

CODE IDENT
15542

DRAWING NO:
98-PL-079

REV:
D

FILE: 98PL079

SCALE: 5:1

SHEET: 1 OF 1

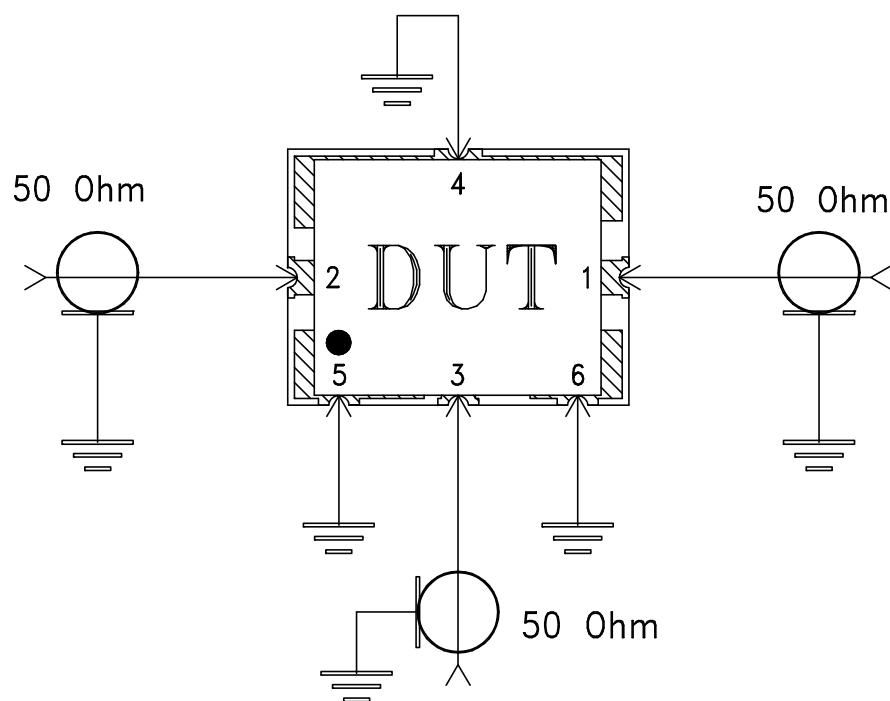
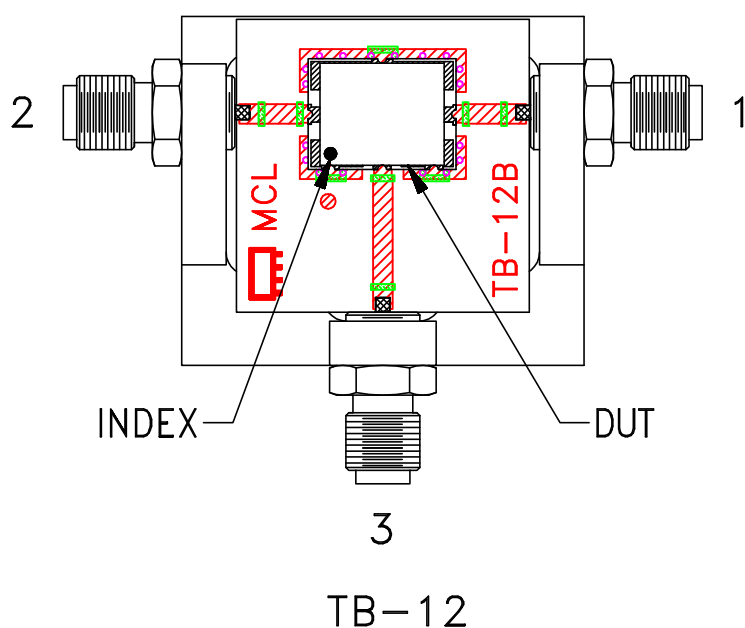
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ASHEETA1.DWG REV:A DATE:01/12/95

Evaluation Board and Circuit

For Pin Connections Refer to Data Sheet of the DUT



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 Ambient Environment	Individual Model Data Sheet
Storage Temperature	-55° to 100° C 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 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; distilled water + proylene glycol monomethyl ether + monoethanolamine at 63°C to 70°C	MIL-STD-202, Method 215