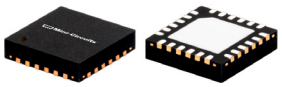
MMIC SURFACE MOUNT

Power Splitter/Combiner EPQ-133+

2 Way-90° 50Ω 6000 to 1400 MHz

THE BIG DEAL

- Wideband (6-14 GHz)
- Good Isolation and Return Loss
- Highly repeatable performance (GaAs based design)
- No external termination required
- High power handling (>30dBm)
- Small Size MCLP 4x4mm



Generic photo used for illustration purposes only

CASE STYLE: DG1847

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

APPLICATIONS

- Balanced amplifiers
- Modulators
- Attenuator
- Point to Point
- Military

PRODUCT OVERVIEW

Mini-Circuits' EPQ-133+ is a wideband 6-14 GHz, 90° hybrid. It splits an input signal into two output signals with quadrature phase shift between them. It provides low loss, wideband in a small layout size and handles high power with good VSWR.

KEY FEATURES

Feature	Advantages
Small Size	The EPQ-133+ offers an industry leading combination of size, bandwidth and frequency. The small footprint (4mm x4 mm) allows for reduced parasitics in systems with improved performance and simplified layout.
Low Phase and Amplitude Unbalance	3.4 deg. and 0.5 dB unbalance make this 90° hybrid applicable for use in higher level integrated components such as image reject mixers, single sideband modulators, phase shifters, variable attenuators, and balance amplifiers.
High Power Handling	Capable of operating up to 32 dBm, MMIC structure of EPQ-133+ makes this 90° hybrid a robust, rugged product that can be used effectively in either the transmit or receive paths.

Power Splitter/Combiner EPQ-133+

2 Way-90° 50Ω 6000 to 1400 MHz

ELECTRICAL SPECIFICATIONS AT +25°C

Parameter	Frequency (MHz)	Min.	Typ.	Max.	Unit
Frequency Range		6000		14000	MHz
Insertion Loss, (Avg. of Mainline & Coupled) above 3dB	6000 - 8000	—	0.6	1.1	dB
	8000 - 10000	—	0.6	1.2	
	10000 - 12000	—	0.8	1.5	
	12000 - 14000	—	1.0	2.0	
Isolation	6000 - 8000	16	20	—	dB
	8000 - 10000	16	20	—	
	10000 - 12000	14	18	—	
	12000 - 14000	13	16	—	
Amplitude Unbalance	6000 - 8000	—	0.5	1.7	dB
	8000 - 10000	—	0.5	1.2	
	10000 - 12000	—	0.6	1.2	
	12000 - 14000	—	0.4	1.6	
Phase Unbalance (Deviation from 90°)	6000 - 8000	—	2.9	5.7	Degree
	8000 - 10000	—	3.4	7.0	
	10000 - 12000	—	4.1	8.8	
	12000 - 14000	—	4.4	—	
Input VSWR	6000 - 8000		1.2		:1
	8000 - 10000		1.2		
	10000 - 12000		1.4		
	12000 - 14000		1.6		
Output VSWR (0°&90°)	6000 - 8000		1.2		:1
	8000 - 10000		1.1		
	10000 - 12000		1.3		
	12000 - 14000		1.5		

ABSOLUTE MAXIMUM RATINGS

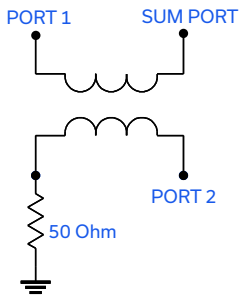
Parameter	Ratings
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
Power Input (as a splitter)	+32 dBm
Internal Dissipation	+30 dBm

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

Power Splitter/Combiner EPQ-133+

2 Way-90° 50Ω 6000 to 1400 MHz

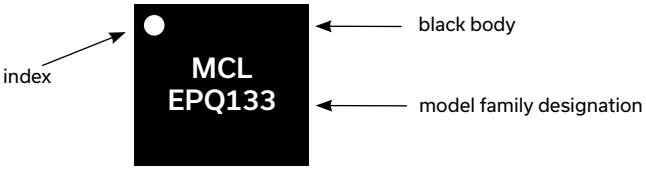
SIMPLIFIED ELECTRICAL SCHEMATIC



PAD CONNECTIONS

Function	Pad Number
SUM PORT	1
PORT 1 (0°)	9
PORT 2 (+90°)	22
NC	2-8, 10-21, 23,24

PRODUCT MARKING



Marking may contain other features or characters for internal lot control

Power Splitter/Combiner EPQ-133+

2 Way-90° 50Ω 6000 to 1400 MHz

ADDITIONAL DETAILED TECHNICAL INFORMATION IS AVAILABLE ON OUR DASH BOARD. TO ACCESS CLICK HERE

Performance Data	Data Table Swept Graphs S-Parameter (S2P Files) Data Set (.zip file)
Case Style	DG1847 Plastic package, exposed paddle; lead finish: Matte Tin
Tape & Reel **Standard quantities available on reel**	F68 7" reels with 20, 50, 100, 200, 500, 1000 devices 13" reels with 2000, 3000, 4000 devices
Suggested Layout for PCB Design	PL-520
Evaluation Board	TB-961-133+
Environmental Ratings	ENV82

ESD RATING

Human Body Model (HBM): Class 1A (250 to <500 V) in accordance with ANSI/ESD STM 5.1 - 2001

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

2 Way-90° Power Splitter/Combiner EPQ-133+

Typical Performance Data

TEST CONDITIONS: INPUT POWER = -10 dBm @Temperature = +25°C

FREQ. (GHz)	TOTAL LOSS[1] (dB)		AMP. UNBAL. (dB)	PHASE UNBAL. (deg.)	ISOLATION (dB)	VSWR (:1)		
	S-1	S-2			1-2	S	1	2
3.0	1.25	7.30	6.05	90.51	25.98	1.09	1.08	1.02
3.5	1.54	6.37	4.83	90.61	24.21	1.10	1.06	1.04
4.0	1.84	5.65	3.80	90.69	22.53	1.13	1.02	1.09
4.5	2.14	5.08	2.93	90.73	21.57	1.16	1.05	1.13
5.0	2.43	4.64	2.21	90.72	20.92	1.20	1.09	1.16
5.5	2.71	4.29	1.59	90.80	20.18	1.24	1.10	1.19
6.0	2.96	4.01	1.05	90.86	19.89	1.26	1.16	1.20
6.5	3.18	3.81	0.63	90.91	19.90	1.27	1.18	1.21
7.0	3.38	3.63	0.25	90.99	19.62	1.27	1.17	1.23
7.5	3.53	3.50	0.04	91.08	19.75	1.24	1.19	1.24
8.0	3.64	3.38	0.26	91.35	20.31	1.17	1.17	1.22
8.5	3.73	3.29	0.44	91.67	20.32	1.13	1.16	1.20
9.0	3.81	3.23	0.58	91.98	20.02	1.13	1.16	1.16
9.5	3.86	3.17	0.70	92.43	19.91	1.12	1.12	1.10
10.0	3.92	3.15	0.77	92.54	19.17	1.18	1.12	1.02
10.5	4.00	3.17	0.83	92.57	17.85	1.31	1.11	1.09
11.0	4.10	3.33	0.78	92.80	16.48	1.46	1.19	1.19
11.5	4.17	3.49	0.68	92.61	15.80	1.58	1.29	1.23
12.0	4.24	3.72	0.52	92.45	15.04	1.72	1.40	1.24
12.5	4.26	4.00	0.26	92.30	14.45	1.86	1.58	1.18
13.0	4.08	4.15	0.06	92.48	14.41	1.81	1.56	1.08
13.5	3.75	4.19	0.44	92.68	15.86	1.52	1.53	1.17
14.0	3.54	4.45	0.91	93.75	16.08	1.49	1.46	1.31
14.5	3.32	4.66	1.34	94.49	17.23	1.35	1.39	1.47
15.0	3.12	5.01	1.88	95.38	17.68	1.30	1.29	1.55
15.5	2.95	5.38	2.43	96.32	18.54	1.22	1.26	1.57
16.0	2.76	5.80	3.04	96.73	18.98	1.17	1.19	1.50

[1]Total Loss = Insertion Loss + 3dB Splitter Loss

2 Way-90° Power Splitter/Combiner EPQ-133+

Typical Performance Data

TEST CONDITIONS: INPUT POWER = -10 dBm @Temperature = -45 °C

FREQ. (GHz)	TOTAL LOSS[1] (dB)		AMP. UNBAL. (dB)	PHASE UNBAL. (deg.)	ISOLATION (dB)	VSWR (:1)		
	S-1	S-2			1-2	S	1	2
3.0	1.11	7.23	6.11	90.19	26.49	1.09	1.07	1.04
3.5	1.40	6.28	4.88	90.28	24.67	1.10	1.07	1.02
4.0	1.69	5.53	3.84	90.28	22.80	1.14	1.04	1.08
4.5	1.98	4.94	2.96	90.22	21.45	1.17	1.05	1.14
5.0	2.26	4.49	2.23	90.12	20.51	1.22	1.10	1.17
5.5	2.52	4.12	1.60	90.14	19.95	1.26	1.14	1.17
6.0	2.75	3.83	1.08	90.13	19.98	1.28	1.19	1.17
6.5	2.94	3.59	0.65	90.13	20.37	1.26	1.16	1.19
7.0	3.14	3.39	0.25	90.02	19.99	1.26	1.15	1.24
7.5	3.31	3.28	0.02	90.06	19.17	1.31	1.16	1.31
8.0	3.40	3.14	0.26	90.15	19.94	1.22	1.17	1.32
8.5	3.48	3.04	0.44	90.49	19.88	1.17	1.21	1.27
9.0	3.53	2.95	0.58	90.73	19.59	1.16	1.21	1.20
9.5	3.59	2.88	0.71	91.10	20.06	1.12	1.19	1.14
10.0	3.62	2.83	0.79	91.34	19.78	1.17	1.15	1.08
10.5	3.70	2.85	0.85	91.09	16.80	1.38	1.14	1.07
11.0	3.70	2.90	0.80	91.44	17.03	1.34	1.14	1.08
11.5	3.82	3.07	0.75	91.14	16.30	1.51	1.31	1.17
12.0	3.90	3.28	0.62	90.96	15.13	1.72	1.34	1.29
12.5	3.95	3.57	0.39	90.43	14.39	1.90	1.54	1.28
13.0	3.80	3.72	0.09	90.69	14.07	1.90	1.57	1.17
13.5	3.55	3.90	0.34	90.43	13.73	1.92	1.62	1.20
14.0	3.41	4.25	0.84	91.87	14.32	1.85	1.70	1.35
14.5	3.13	4.27	1.14	93.16	15.85	1.49	1.62	1.57
15.0	2.86	4.50	1.65	93.57	17.37	1.37	1.36	1.69
15.5	2.59	4.71	2.13	93.98	19.86	1.15	1.35	1.61
16.0	2.33	5.12	2.80	93.81	17.99	1.14	1.21	1.48

[1]Total Loss = Insertion Loss + 3dB Splitter Loss

2 Way-90° Power Splitter/Combiner EPQ-133+

Typical Performance Data

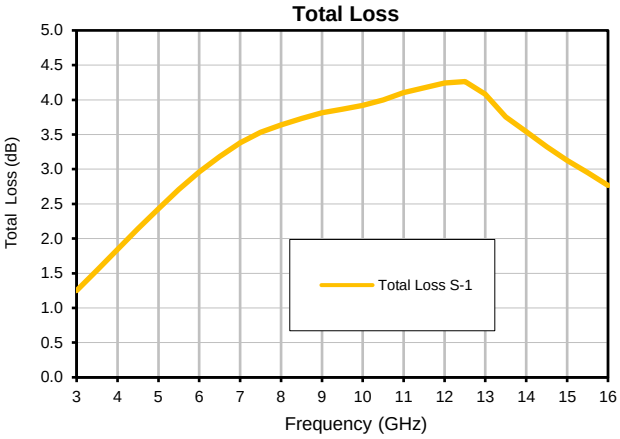
TEST CONDITIONS: INPUT POWER = -10 dBm @Temperature = +85 °C

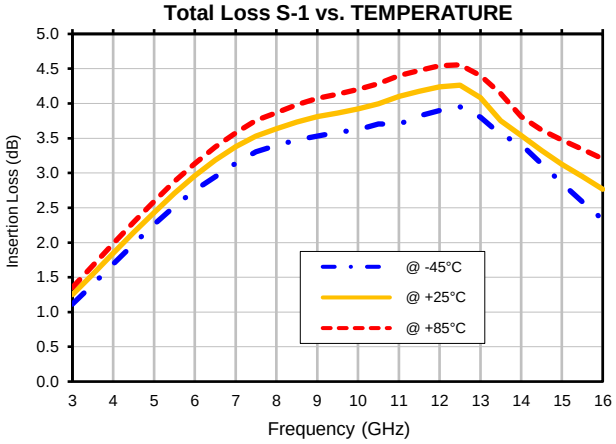
FREQ. (GHz)	TOTAL LOSS[1] (dB)		AMP. UNBAL. (dB)	PHASE UNBAL. (deg.)	ISOLATION (dB)	VSWR (:1)		
	S-1	S-2			1-2	S	1	2
3.0	1.35	7.34	5.99	90.42	25.47	1.09	1.08	1.01
3.5	1.67	6.43	4.77	90.46	23.39	1.10	1.04	1.08
4.0	1.98	5.74	3.76	90.50	22.18	1.14	1.03	1.13
4.5	2.29	5.19	2.90	90.59	21.47	1.17	1.07	1.15
5.0	2.59	4.77	2.18	90.61	21.00	1.20	1.10	1.17
5.5	2.88	4.44	1.56	90.76	20.33	1.23	1.11	1.19
6.0	3.14	4.17	1.03	90.81	20.03	1.24	1.14	1.19
6.5	3.37	3.97	0.60	90.89	19.92	1.25	1.17	1.18
7.0	3.58	3.81	0.23	91.04	19.50	1.25	1.14	1.18
7.5	3.75	3.69	0.06	91.06	19.77	1.21	1.19	1.18
8.0	3.86	3.58	0.29	91.37	20.56	1.13	1.15	1.14
8.5	3.98	3.51	0.48	91.64	20.51	1.12	1.13	1.12
9.0	4.08	3.47	0.60	91.90	20.19	1.14	1.15	1.09
9.5	4.14	3.42	0.71	92.23	20.08	1.13	1.10	1.04
10.0	4.20	3.43	0.78	92.31	19.16	1.21	1.14	1.04
10.5	4.28	3.46	0.82	92.35	18.43	1.32	1.09	1.15
11.0	4.40	3.65	0.75	92.44	16.46	1.49	1.20	1.22
11.5	4.47	3.84	0.63	92.35	15.58	1.61	1.27	1.25
12.0	4.54	4.10	0.44	92.16	14.96	1.74	1.44	1.19
12.5	4.56	4.39	0.16	92.26	14.53	1.85	1.60	1.10
13.0	4.40	4.55	0.15	92.44	14.65	1.79	1.57	1.04
13.5	4.14	4.66	0.51	93.22	16.75	1.53	1.46	1.23
14.0	3.81	4.75	0.94	93.88	17.41	1.29	1.36	1.24
14.5	3.62	5.04	1.42	94.50	17.98	1.27	1.27	1.37
15.0	3.47	5.46	1.99	95.45	17.84	1.28	1.28	1.40
15.5	3.34	5.90	2.56	96.51	18.38	1.26	1.29	1.45
16.0	3.20	6.41	3.21	97.26	19.16	1.26	1.22	1.48

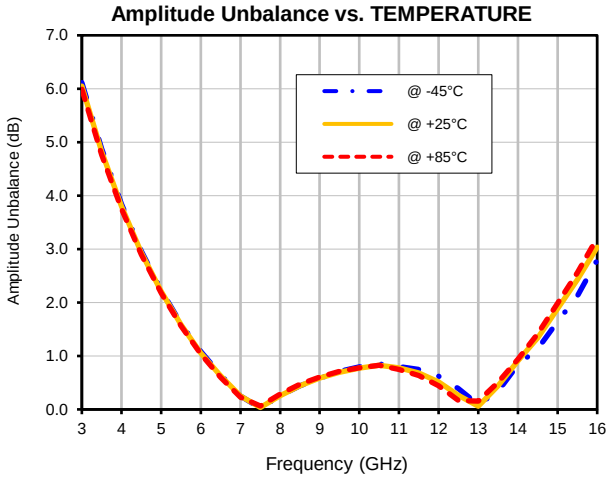
[1]Total Loss = Insertion Loss + 3dB Splitter Loss

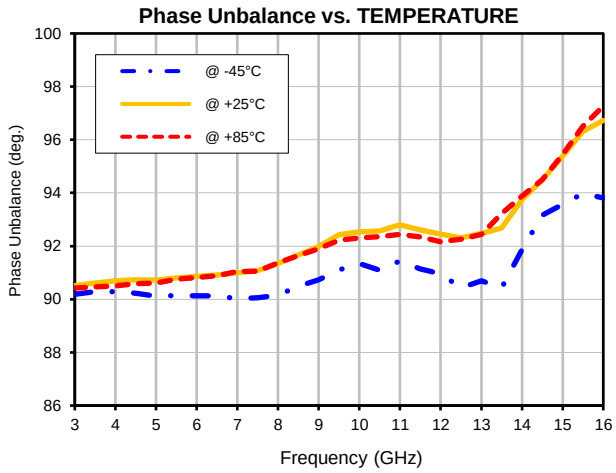
2 Way-90° Power Splitter/Combiner EPQ-133+

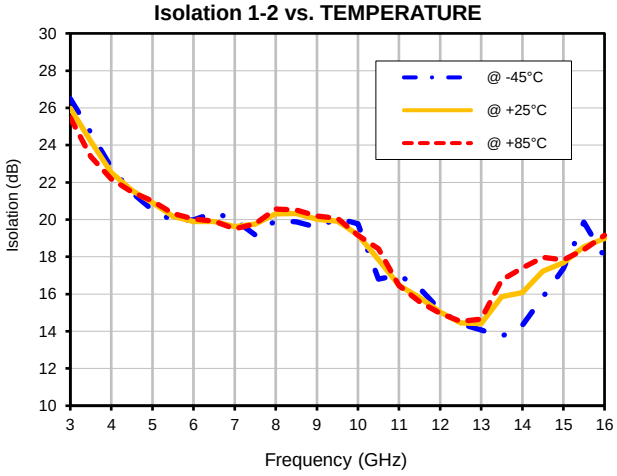
Typical Performance Curves



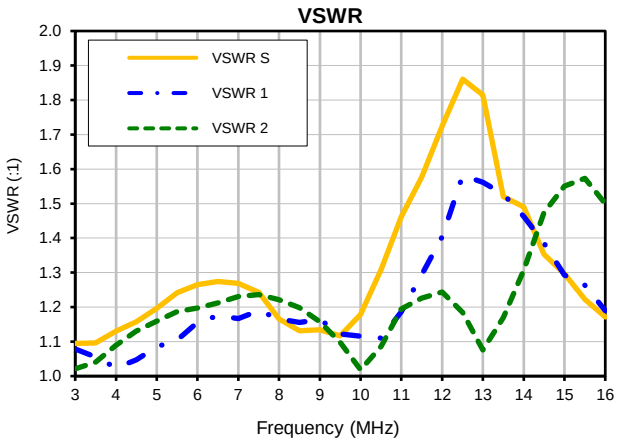


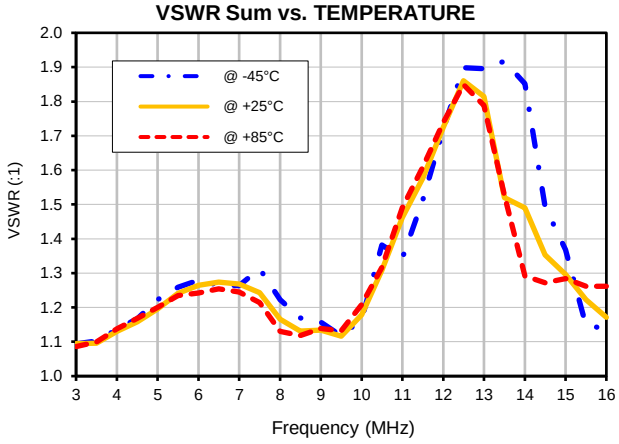


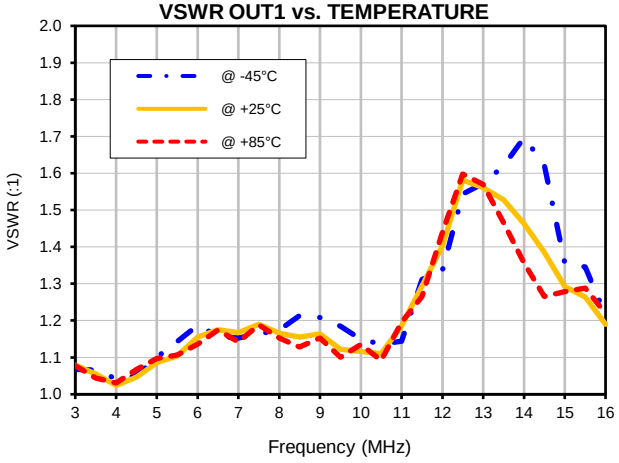




Typical Performance Curves



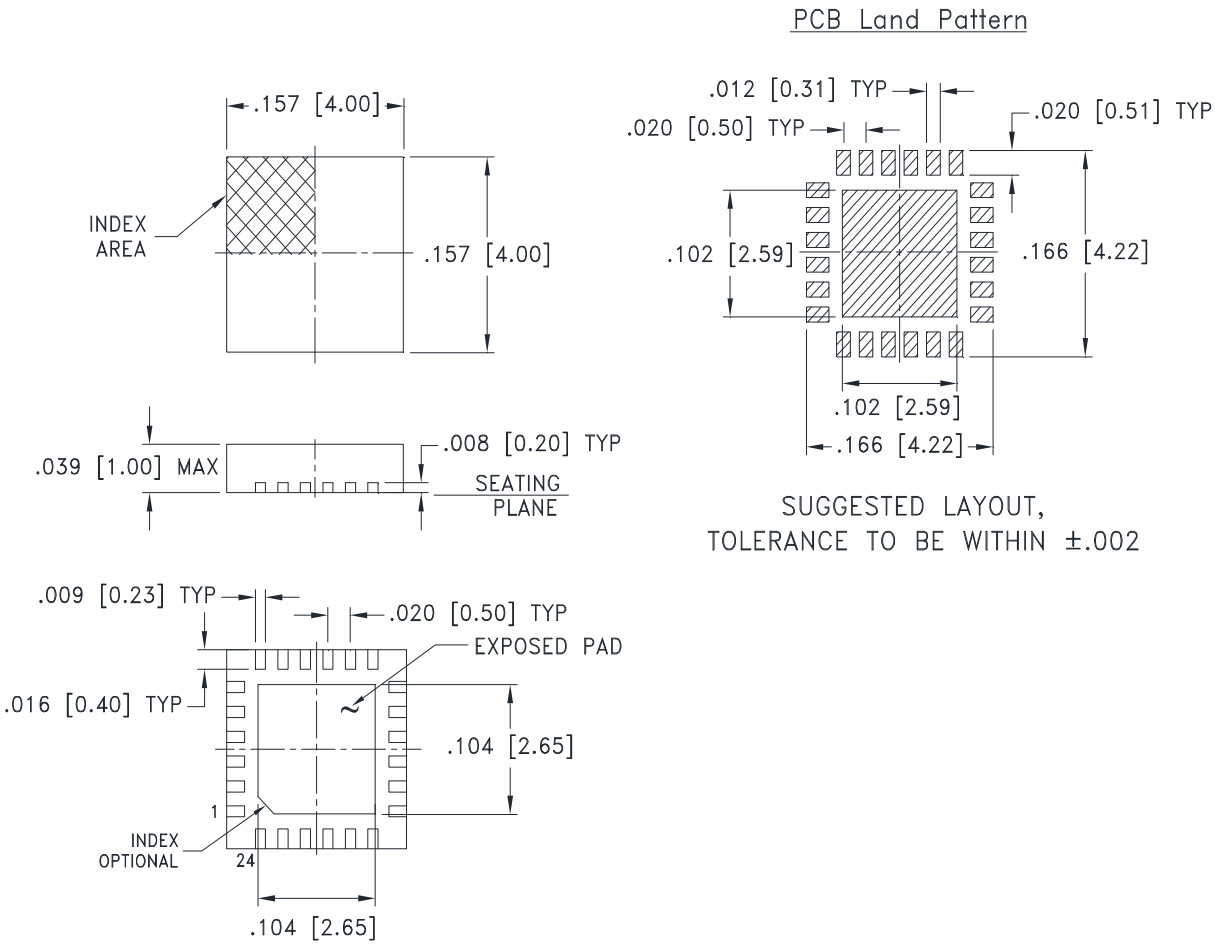




Case Style DG

DG1847

Outline Dimensions



Weight: .04 Grams

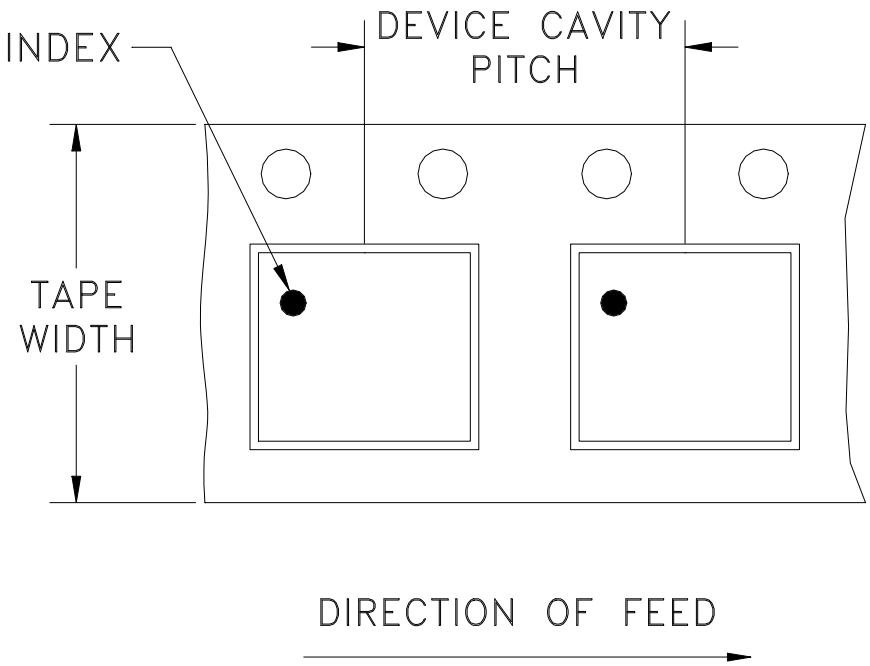
Dimensions are in inches (mm). Tolerances: 2 Pl. ± .01; 3 Pl. ± .005

Notes:

1. Case material: Plastic.
2. Termination finish:
   For RoHS Case Styles: Tin-Silver alloy plate over Nickel barrier or Matte-Tin. All models, (+) suffix. See model Data sheet.
   For RoHS-5 Case Styles: Tin-Lead plate. All models, no (+) suffix.

Tape & Reel Packaging TR-F68

DEVICE ORIENTATION IN T&R



Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel see note	
12	8	7	Small quantity standard	20
				50
				100
				200
				500
		7	Standard	1000
		13	Standard	2000
				3000
				4000

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

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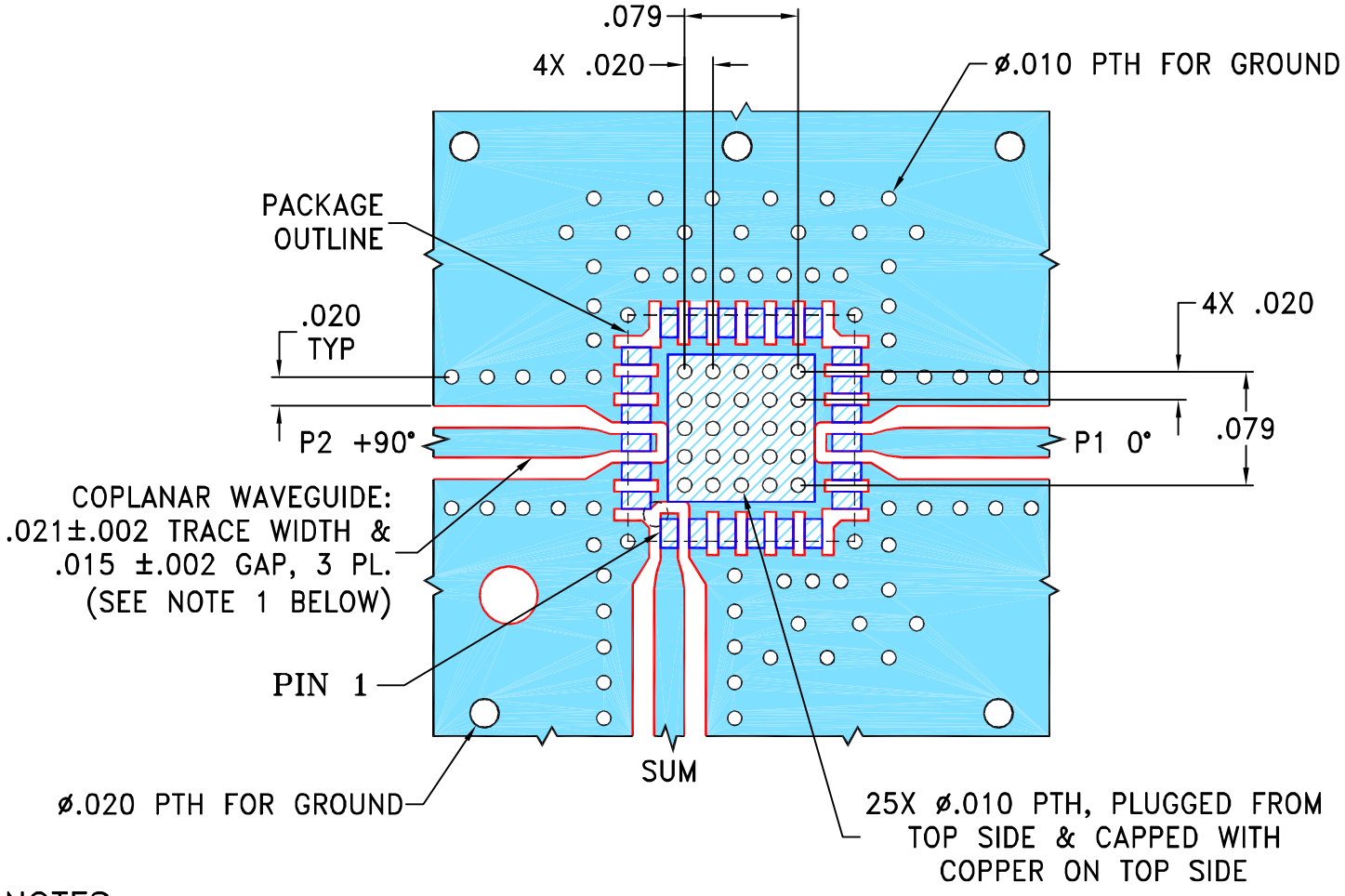
THIRD ANGLE PROJECTION

REVISIONS

REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	M162448	NEW RELEASE	07/19/17	CA	RS

SUGGESTED MOUNTING CONFIGURATION FOR DG1847 CASE STYLE, "24SP06" PIN CONNECTION



NOTES:

1. TRACE WIDTH AND GAP PARAMETERS ARE SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS .010" ±001; COPPER: 1/2 OZ. EACH SIDE. FOR OTHER MATERIALS TRACE WIDTH AND GAP MAY NEED TO BE MODIFIED.
2. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.

DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER)

DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK

UNLESS OTHERWISE SPECIFIED		INITIALS	DATE
DIMENSIONS ARE IN INCHES	DRAWN	CA	07/07/17
TOLERANCES ON:	CHECKED	GF	07/12/17
2 PL DECIMALS ±	APPROVED	RS	07/19/17
3 PL DECIMALS ± .005			
ANGLES ±			
FRACTIONS ±			

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

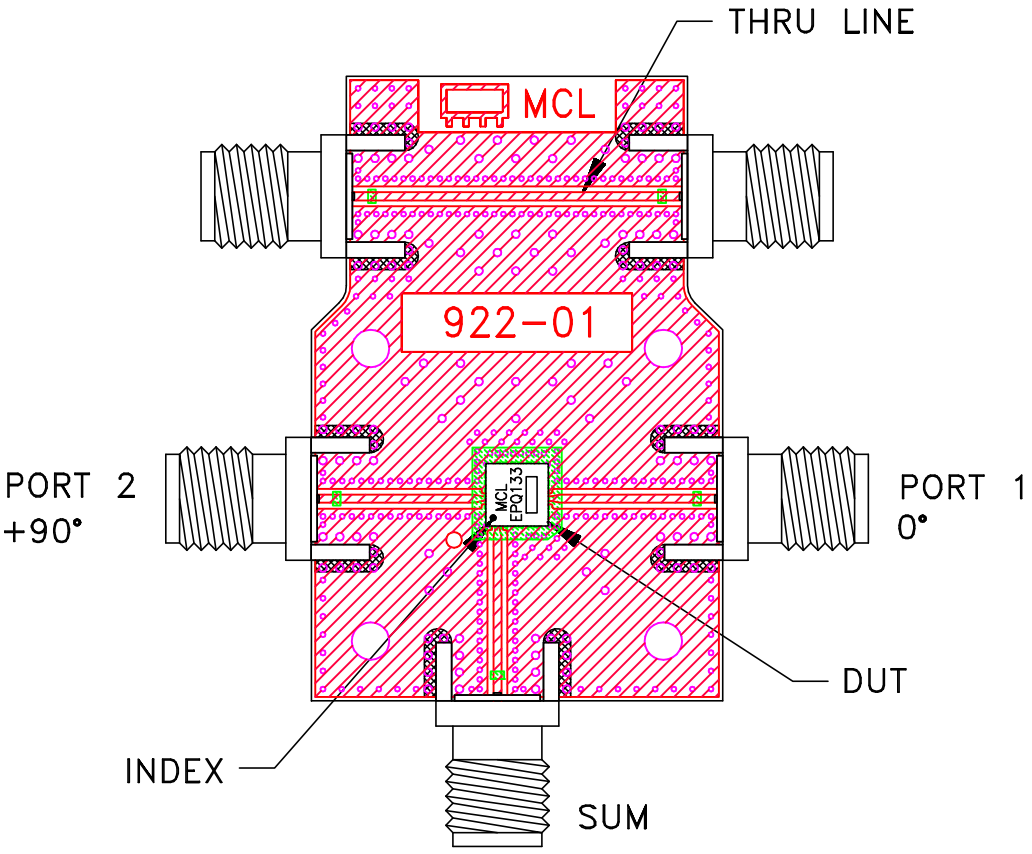
Mini-Circuits® 13 Neptune Avenue Brooklyn NY 11235

PL, 24SP06, DG1847, TB-961-133+

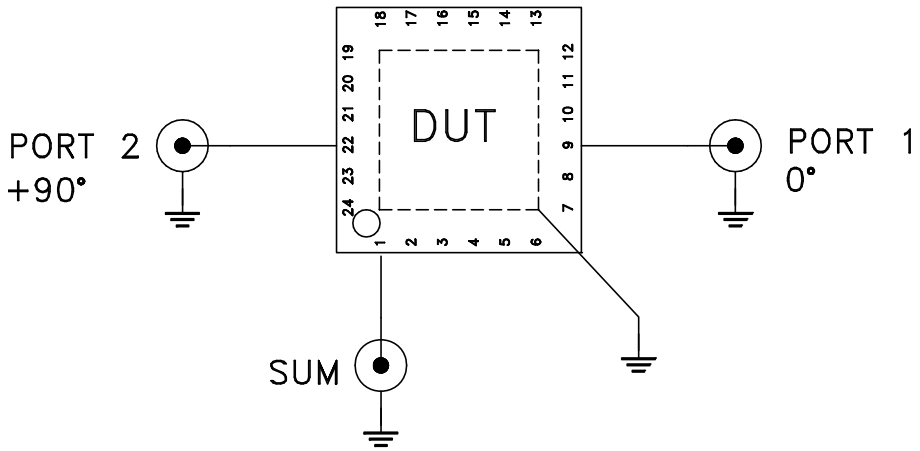
SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-520	OR

FILE:	SCALE:	SHEET:
98PL520	8:1	1 OF 1

Evaluation Board and Circuit



TB-961-133+



PINS 2-8,10-21,23,24 - NOT CONNECTED INTERNALLY
(GROUNDED ON PCB)

Schematic Diagram

Notes:

1. 50 Ohm SMA Female connectors.
2. PCB Material: RO4350 or equivalent,
   Dielectric Constant=3.5, Thickness=.010 inch.

Mini-Circuits®

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Environmental Specifications **ENV08T2**

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	-45° to 85°C or -40° to 85°C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-65° to 150° C 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 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 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; distilled water + proylene glycol monomethyl ether +	MIL-STD-202, Method 215

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
	monoethanolamine at 63°C to 70°C	