



Mini-Circuits

MMIC SURFACE MOUNT

Power Splitter/Combiner

EPQ-113+

2 Way-90° 50Ω 5 to 11 GHz

THE BIG DEAL

- Wideband (5-11 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-113+ is a wideband 5-11 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-113+ 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	3.7 deg. and 0.8 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-113+ makes this 90° hybrid a robust, rugged product that can be used effectively in either the transmit or receive paths.





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ELECTRICAL SPECIFICATIONS AT +25°C

Parameter	Frequency (MHz)	Min.	Typ.	Max.	Unit
Frequency Range		5000		11000	MHz
Insertion Loss, (Avg. of Mainline & Coupled) above 3dB	5000 - 6000	—	0.5	1.1	dB
	6000 - 7000	—	0.6	1.2	
	7000 - 9000	—	0.6	1.4	
	9000 - 10000	—	0.7	1.5	
	10000 - 11000	—	0.8	1.8	
Isolation	5000 - 6000	16	19	—	dB
	6000 - 7000	16	19	—	
	7000 - 9000	16	19	—	
	9000 - 10000	16	19	—	
	10000 - 11000	14	18	—	
Amplitude Unbalance	5000 - 6000	—	0.4	1.4	dB
	6000 - 7000	—	0.4	1.2	
	7000 - 9000	—	0.8	1.5	
	9000 - 10000	—	0.7	1.4	
	10000 - 11000	—	0.2	1.1	
Phase Unbalance (Deviation from 90°)	5000 - 6000	—	1.9	6.6	Degree
	6000 - 7000	—	2.4	7.6	
	7000 - 9000	—	3.7	8.8	
	9000 - 10000	—	4.1	9.7	
	10000 - 11000	—	4.2	—	
Input VSWR	5000 - 6000	—	1.2	—	:1
	6000 - 7000	—	1.2	—	
	7000 - 9000	—	1.2	—	
	9000 - 10000	—	1.2	—	
	10000 - 11000	—	1.3	—	
Output VSWR (0°&90°)	5000 - 6000	—	1.2	—	:1
	6000 - 7000	—	1.2	—	
	7000 - 9000	—	1.1	—	
	9000 - 10000	—	1.1	—	
	10000 - 11000	—	1.2	—	

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 (5 minutes max.) + 30 dBm (continuous)
Internal Dissipation	+30 dBm

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





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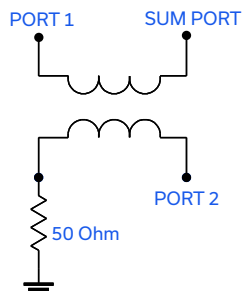
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Power Splitter/Combiner

EPQ-113+

2 Way-90° 50Ω 5 to 11 GHz

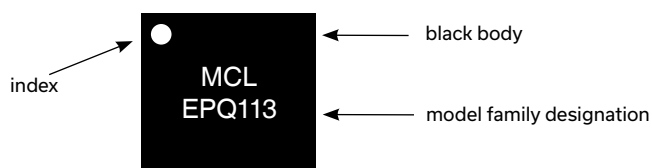
SIMPLIFIED ELECTRICAL SCHEMATIC



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





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EPQ-113+

2 Way-90° 50Ω 5 to 11 GHz

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-961-113+
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

- 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



2 Way-90° Power Splitter

EPQ-113+

Typical Performance Data

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

FREQ. (MHz)	TOTAL LOSS ⁽¹⁾ (dB)		AMP. UNBAL. (dB)	PHASE UNBAL. (deg.)	ISOLATION (dB)	VSWR (:1)		
	S-1	S-2				S	1	2
5000	3.10	3.85	0.75	88.72	19.87	1.22	1.11	1.27
5200	3.20	3.73	0.54	88.64	19.71	1.22	1.13	1.26
5400	3.30	3.66	0.36	88.69	19.64	1.23	1.13	1.26
5600	3.40	3.58	0.18	88.57	19.23	1.26	1.15	1.29
5800	3.47	3.51	0.04	88.69	19.30	1.24	1.15	1.26
6000	3.56	3.47	0.10	88.72	19.10	1.25	1.17	1.23
6200	3.66	3.42	0.24	88.78	19.11	1.25	1.16	1.22
6400	3.74	3.39	0.35	88.91	19.22	1.24	1.15	1.18
6600	3.78	3.34	0.45	88.81	19.31	1.23	1.16	1.21
6800	3.81	3.28	0.53	89.15	19.38	1.20	1.13	1.16
7000	3.86	3.25	0.62	89.13	19.23	1.22	1.15	1.15
7200	3.89	3.21	0.69	89.29	19.23	1.19	1.12	1.13
7400	3.93	3.19	0.74	89.35	19.33	1.18	1.11	1.11
7600	3.97	3.17	0.80	89.44	19.15	1.19	1.11	1.08
7800	3.99	3.15	0.84	89.50	19.24	1.16	1.06	1.09
8000	4.02	3.16	0.86	89.64	19.08	1.19	1.11	1.02
8200	4.07	3.17	0.90	89.60	19.01	1.20	1.06	1.11
8400	4.05	3.18	0.87	89.63	18.84	1.18	1.07	1.07
8600	4.06	3.19	0.87	89.69	18.74	1.18	1.06	1.07
8800	4.04	3.19	0.85	89.74	18.96	1.13	1.02	1.03
9000	4.06	3.24	0.82	89.80	18.52	1.20	1.06	1.07
9200	4.03	3.25	0.78	89.78	18.65	1.15	1.01	1.05
9400	4.03	3.29	0.74	89.90	18.49	1.18	1.01	1.09
9600	3.99	3.34	0.66	89.76	18.39	1.18	1.04	1.09
9800	3.96	3.39	0.57	89.66	18.31	1.17	1.03	1.13
10000	3.90	3.44	0.46	89.89	18.19	1.18	1.05	1.05
10200	3.88	3.50	0.38	89.80	18.23	1.19	1.06	1.13
10400	3.83	3.59	0.23	89.55	18.03	1.21	1.06	1.15
10600	3.75	3.70	0.04	89.63	17.86	1.21	1.10	1.13
10800	3.70	3.78	0.07	89.86	17.80	1.22	1.10	1.11
11000	3.65	3.92	0.27	89.55	17.71	1.23	1.14	1.15

⁽¹⁾Total Loss = Insertion Loss + 3dB Splitter Loss



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2 Way-90° Power Splitter

EPQ-113+

Typical Performance Data

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

FREQ. (MHz)	TOTAL LOSS ⁽¹⁾ (dB)		AMP. UNBAL. (dB)	PHASE UNBAL. (deg.)	ISOLATION (dB)	VSWR (:1)		
	S-1	S-2				S	1	2
5000	2.74	3.53	0.79	91.68	19.03	1.25	1.19	1.29
5200	2.82	3.38	0.56	91.75	19.57	1.20	1.18	1.23
5400	2.92	3.33	0.41	91.91	19.16	1.29	1.23	1.23
5600	3.00	3.23	0.23	91.88	18.88	1.31	1.22	1.27
5800	3.03	3.13	0.09	92.28	19.75	1.22	1.20	1.21
6000	3.12	3.06	0.06	92.46	19.57	1.27	1.17	1.20
6200	3.17	2.97	0.19	92.69	19.96	1.22	1.09	1.23
6400	3.24	2.92	0.32	92.83	20.06	1.21	1.11	1.21
6600	3.31	2.89	0.42	93.21	19.98	1.28	1.05	1.25
6800	3.36	2.82	0.54	93.41	20.15	1.19	1.05	1.23
7000	3.43	2.80	0.63	93.48	19.31	1.28	1.02	1.26
7200	3.45	2.74	0.71	93.75	19.34	1.24	1.06	1.25
7400	3.49	2.71	0.77	93.74	18.40	1.24	1.11	1.24
7600	3.54	2.72	0.81	93.79	17.73	1.33	1.10	1.22
7800	3.53	2.69	0.84	94.06	18.24	1.21	1.23	1.22
8000	3.59	2.73	0.86	94.27	16.96	1.37	1.22	1.12
8200	3.61	2.75	0.86	94.65	17.02	1.38	1.30	1.10
8400	3.61	2.76	0.84	94.90	16.96	1.38	1.29	1.05
8600	3.58	2.73	0.85	95.15	17.48	1.31	1.23	1.02
8800	3.59	2.73	0.85	95.75	17.94	1.28	1.26	1.09
9000	3.63	2.78	0.85	95.61	17.15	1.42	1.22	1.10
9200	3.55	2.67	0.88	96.26	18.74	1.15	1.20	1.09
9400	3.49	2.66	0.83	95.73	19.22	1.13	1.09	1.08
9600	3.47	2.72	0.75	95.72	18.33	1.23	1.05	1.10
9800	3.39	2.69	0.70	95.91	20.65	1.05	1.18	1.03
10000	3.35	2.72	0.63	95.83	20.60	1.01	1.18	1.11
10200	3.31	2.78	0.53	95.69	19.25	1.20	1.16	1.21
10400	3.22	2.85	0.37	95.56	19.04	1.12	1.18	1.23
10600	3.20	2.96	0.24	95.37	18.89	1.14	1.20	1.27
10800	3.14	3.08	0.06	95.62	17.45	1.31	1.14	1.21
11000	3.10	3.29	0.19	95.09	16.84	1.33	1.30	1.49

⁽¹⁾Total Loss = Insertion Loss + 3dB Splitter Loss



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2 Way-90° Power Splitter

EPQ-113+

Typical Performance Data

TEST CONDITIONS: INPUT POWER = 0 dBm @Temperature = +85 °C

FREQ. (MHz)	TOTAL LOSS ⁽¹⁾ (dB)		AMP. UNBAL. (dB)	PHASE UNBAL. (deg.)	ISOLATION (dB)	VSWR (:1)		
	S-1	S-2				S	1	2
5000	3.37	4.08	0.71	84.71	20.13	1.23	1.09	1.24
5200	3.48	3.98	0.50	84.50	19.96	1.22	1.11	1.27
5400	3.58	3.89	0.31	84.36	19.90	1.22	1.07	1.26
5600	3.69	3.82	0.13	84.17	19.60	1.25	1.13	1.27
5800	3.78	3.76	0.02	84.01	19.57	1.22	1.13	1.28
6000	3.88	3.71	0.17	83.90	19.09	1.24	1.14	1.24
6200	3.98	3.68	0.29	83.78	19.18	1.24	1.21	1.21
6400	4.03	3.64	0.39	83.75	19.07	1.22	1.15	1.19
6600	4.12	3.61	0.51	83.56	18.95	1.23	1.19	1.18
6800	4.16	3.60	0.56	83.54	19.25	1.20	1.24	1.13
7000	4.23	3.57	0.66	83.58	19.18	1.20	1.18	1.10
7200	4.28	3.55	0.73	83.57	19.31	1.19	1.20	1.07
7400	4.33	3.56	0.77	83.43	19.81	1.16	1.19	1.06
7600	4.37	3.51	0.86	83.48	19.78	1.14	1.09	1.02
7800	4.42	3.52	0.90	83.22	20.31	1.11	1.16	1.01
8000	4.45	3.52	0.93	83.36	20.22	1.12	1.07	1.06
8200	4.50	3.50	1.00	82.86	20.38	1.13	1.13	1.13
8400	4.49	3.55	0.94	82.73	20.70	1.13	1.13	1.09
8600	4.51	3.54	0.97	82.47	19.61	1.14	1.09	1.11
8800	4.50	3.57	0.93	82.18	19.88	1.17	1.18	1.14
9000	4.49	3.62	0.87	82.21	19.70	1.14	1.03	1.14
9200	4.49	3.64	0.86	81.25	18.88	1.16	1.20	1.14
9400	4.46	3.74	0.72	82.00	18.41	1.23	1.05	1.14
9600	4.44	3.78	0.65	81.45	18.59	1.17	1.15	1.14
9800	4.40	3.87	0.53	81.28	17.67	1.26	1.05	1.13
10000	4.36	3.98	0.39	81.57	17.30	1.29	1.20	1.12
10200	4.37	4.05	0.32	81.21	17.41	1.32	1.20	1.12
10400	4.33	4.16	0.17	81.40	17.10	1.36	1.15	1.06
10600	4.26	4.30	0.04	80.97	17.08	1.35	1.28	1.10
10800	4.24	4.38	0.14	81.47	17.21	1.36	1.11	1.14
11000	4.25	4.57	0.33	81.41	16.83	1.49	1.24	1.12

⁽¹⁾Total Loss = Insertion Loss + 3dB Splitter Loss



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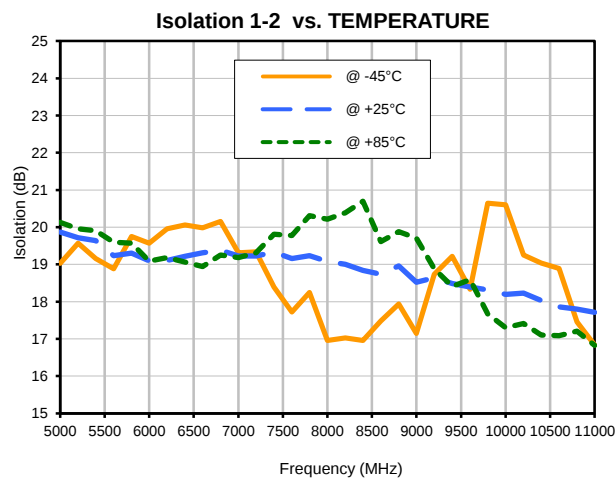
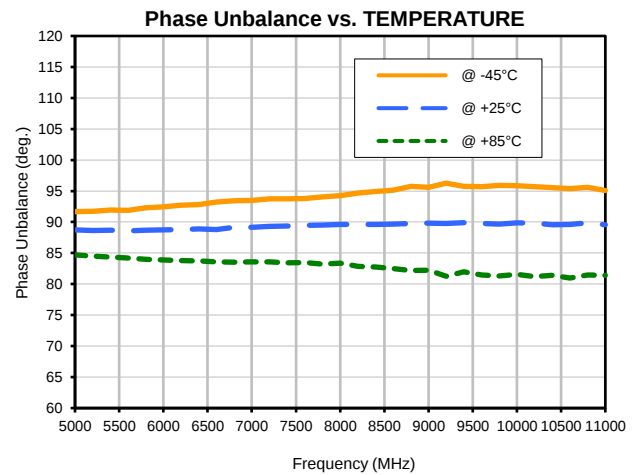
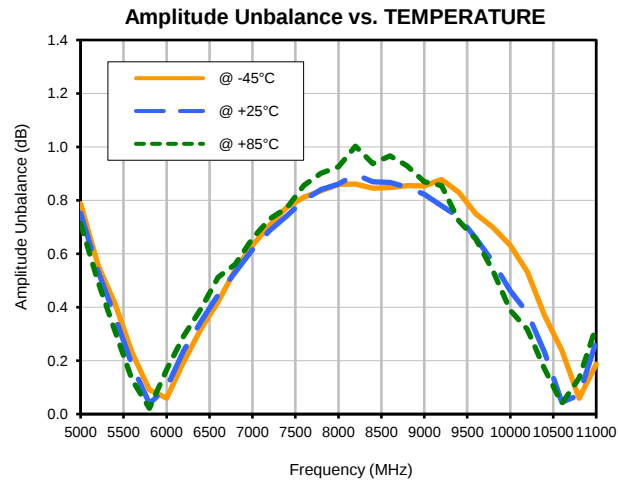
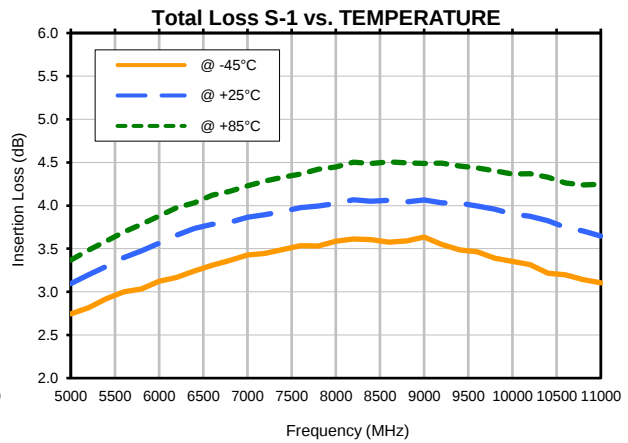
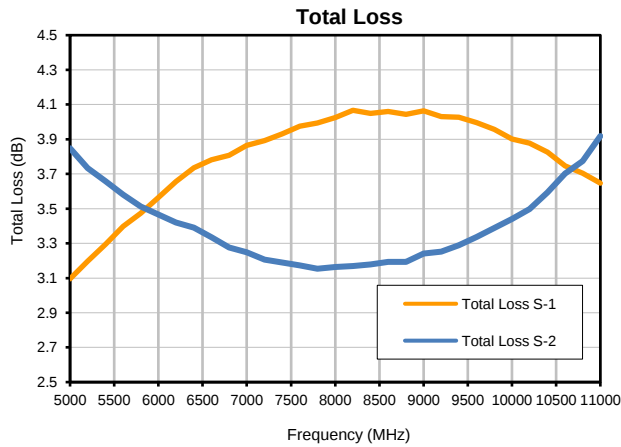


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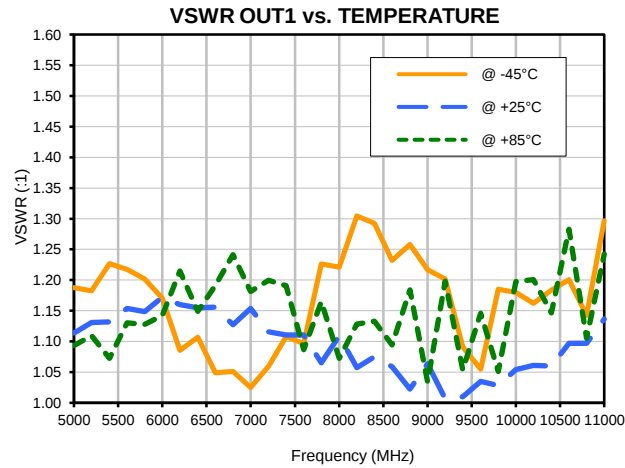
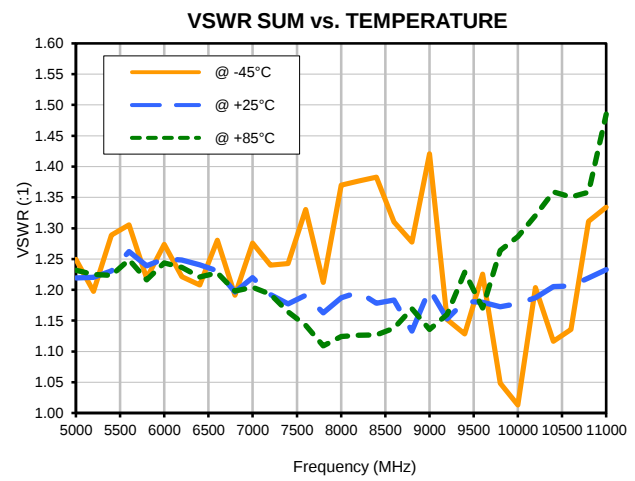
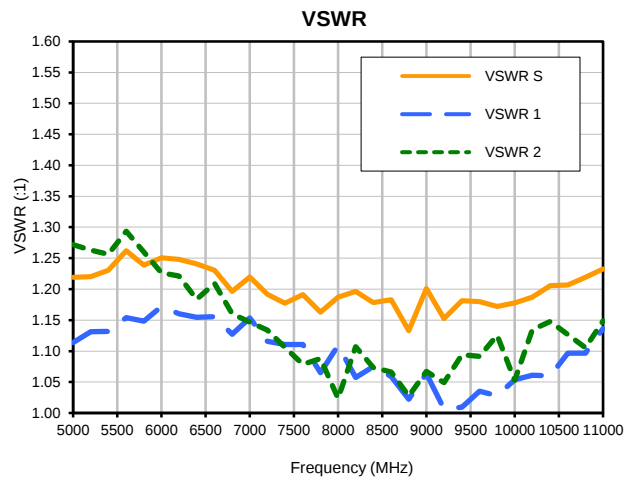


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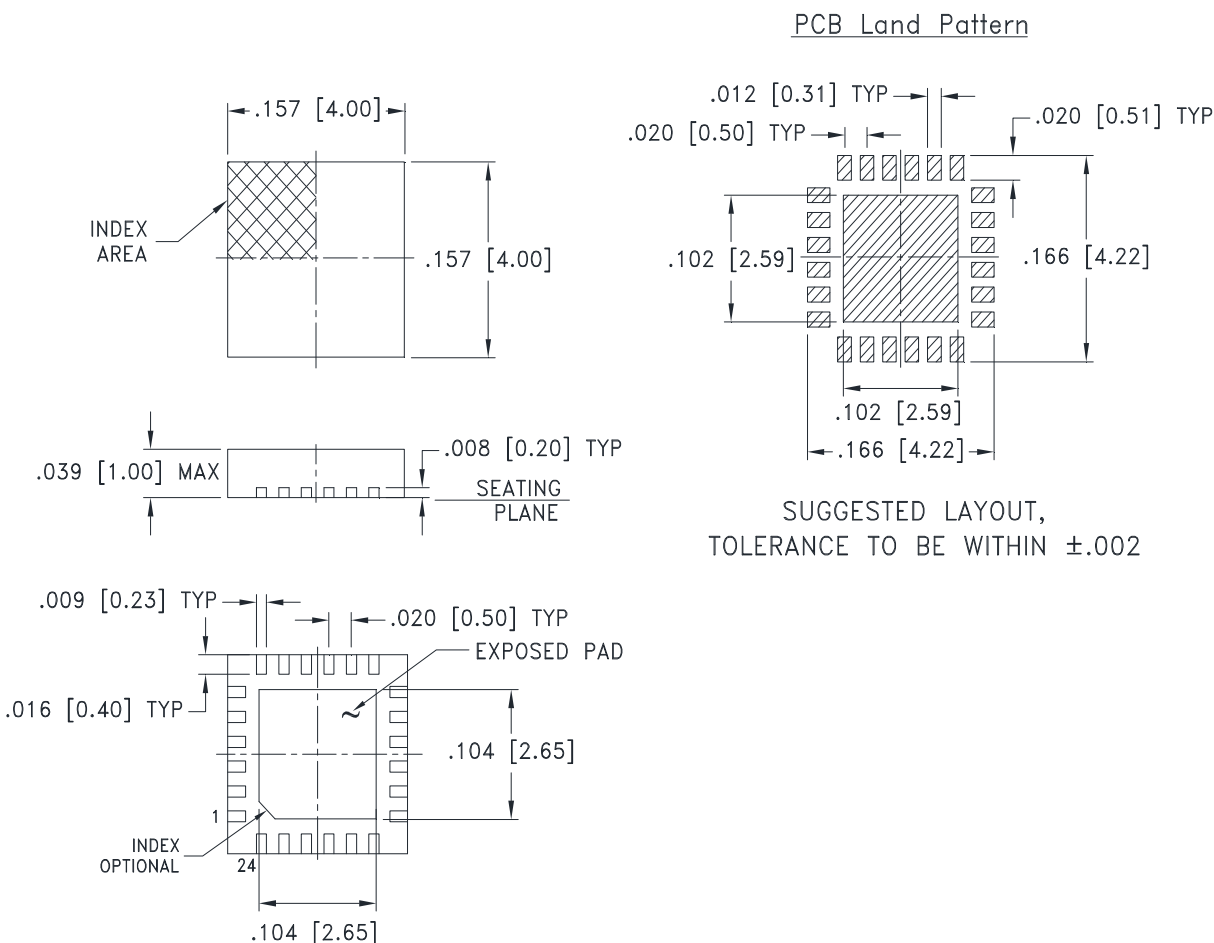
Typical Performance Curves



Typical Performance Curves



Outline Dimensions



Weight: .04 Grams

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

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.

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ISO 9001 ISO 14001 CERTIFIED

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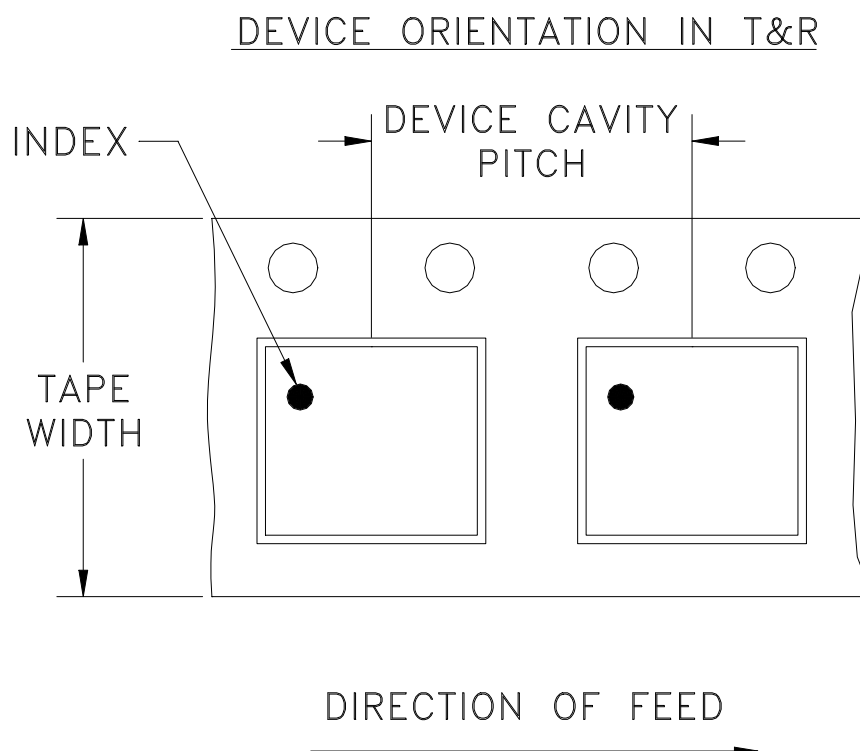
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DG1847 Rev.: AH (16 FEB 23) ECO-016811 File: DG1847

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Tape & Reel Packaging TR-F68



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

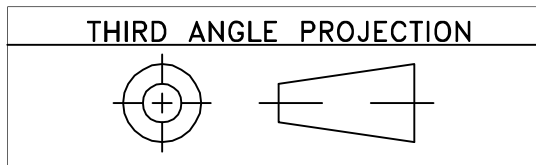


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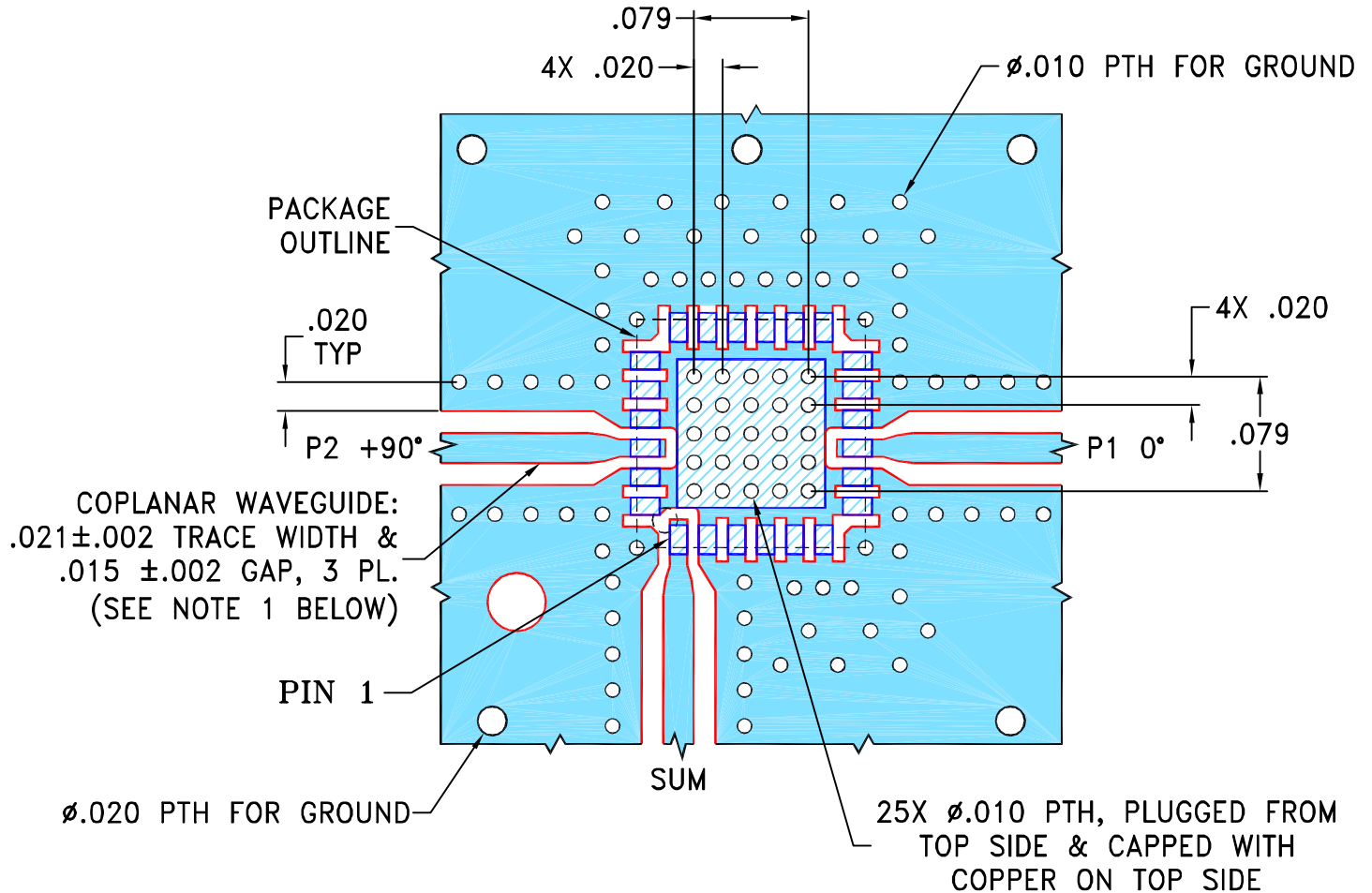
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REVISIONS					
REV OR	ECN No.	DESCRIPTION	DATE	DR	AUTH
	M162448	NEW RELEASE	07/19/17	CA	RS

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



NOTES:

1. TRACE WIDTH AND GAP PARAMETERS ARE SHOWN FOR ROGERS R04350B 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 TOLERANCES ON: 2 PL DECIMALS ± 3 PL DECIMALS ± .005 ANGLES ± FRACTIONS ±	DRAWN	CA	07/07/17
	CHECKED	GF	07/12/17
	APPROVED	RS	07/19/17



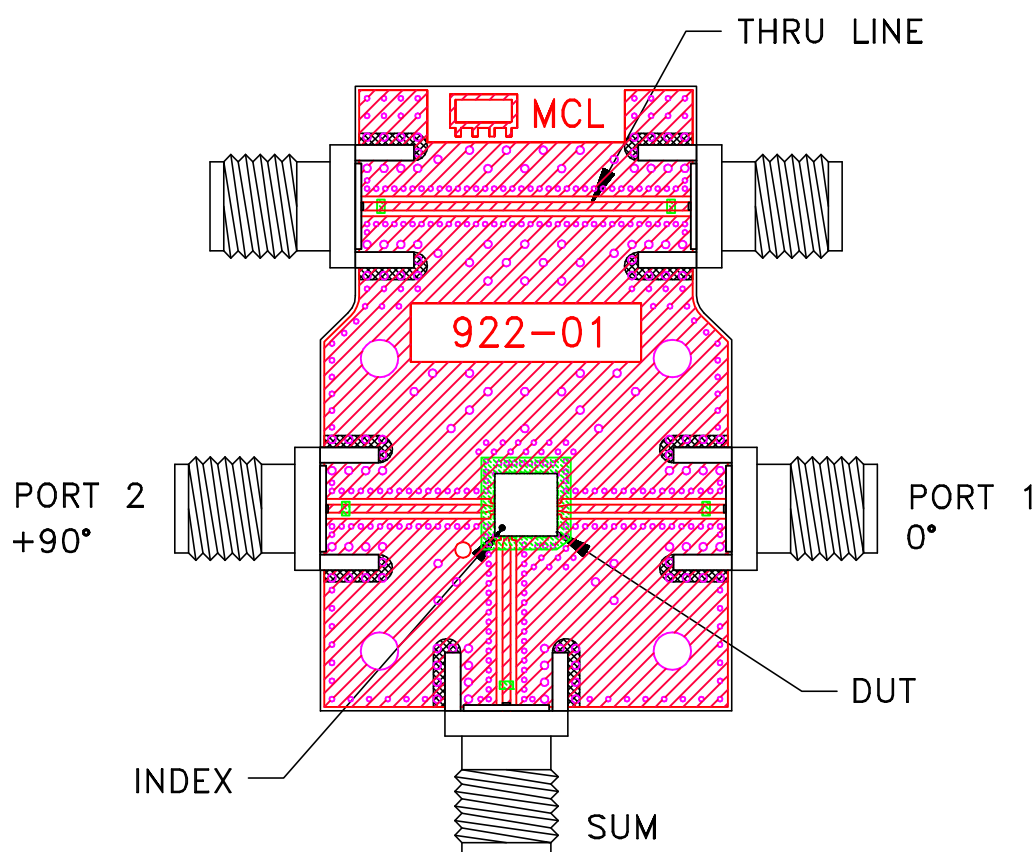
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PL, 24SP06, DG1847, TB-961-133+

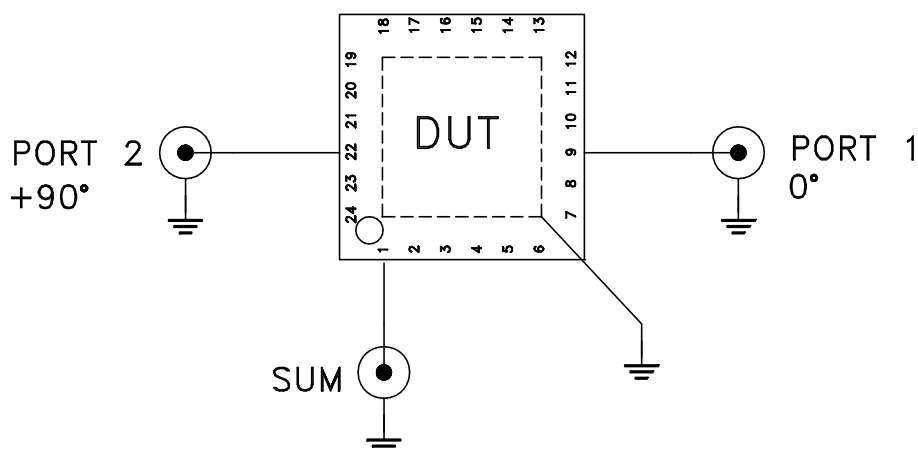
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SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-520	OR
FILE:	98PL520	SCALE:	8:1
SHEET:	1	OF	1

Evaluation Board and Circuit



TB-961-113+



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: 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	-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



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Specification	Test/Inspection Condition	Reference/Spec
	monoethanolamine at 63°C to 70°C	