



KEY FEATURES

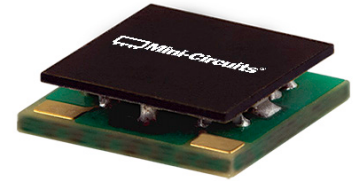
- Low Insertion Loss, 1.5 dB Typ.
- High Rejection, 45 dB Typ.
- Good Return Loss, 16.54 dB Typ.
- Sharp Insertion Loss Roll-off
- Ultra Miniature Surface Mount Package

APPLICATIONS

- Wireless Communications
- Receivers / Transformers
- Lab Use

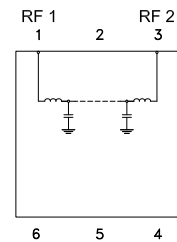
PRODUCT OVERVIEW

The ULP-288+ is a low pass filter in a top hat package (size of 0.25" x 0.25") fabricated using SMT technology. Covering DC to 288 MHz band width, these units offer good matching within the passband and high rejection. This model uses a miniature high Q capacitors and chip inductors for high reliability. In addition it has repeatable performance across production lots and consistent performance across temperature.



Generic photo used for illustration purposes only

FUNCTIONAL DIAGRAM



ELECTRICAL SPECIFICATIONS^{1,2,3} AT +25°C

Parameter	F#	Frequency (MHz)	Min.	Typ.	Max.	Units	
Passband	Insertion Loss	DC-F1	DC - 288	—	1.5	2	dB
	Freq. Cut-Off	Fc	310	—	3.0	—	dB
	Return Loss	DC-F1	DC - 288	—	16.54	—	dB
Stopband	Rejection	F2-F3	390 - 700	20	27	—	dB
		F3-F4	700 - 1500	40	45	—	dB

1. Tested in Evaluation Board P/N TB-ULP-288+

2. This filter is bi-directional RF1 and RF2 ports may be interchanged, see S-Parameters for actual performance.

3. In applications where DC voltage and/or current is present at either the input or output ports, external DC blocking capacitors are required.

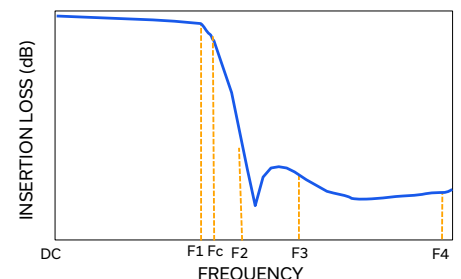
ABSOLUTE MAXIMUM RATINGS⁴

Parameter	Ratings
Operating Temperature	-40°C to + 85°C
Storage Temperature	-55°C to +100°C
Input Power ⁵	1 W max.

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

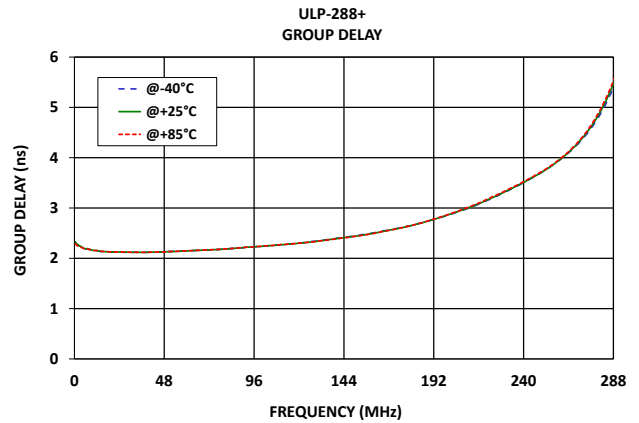
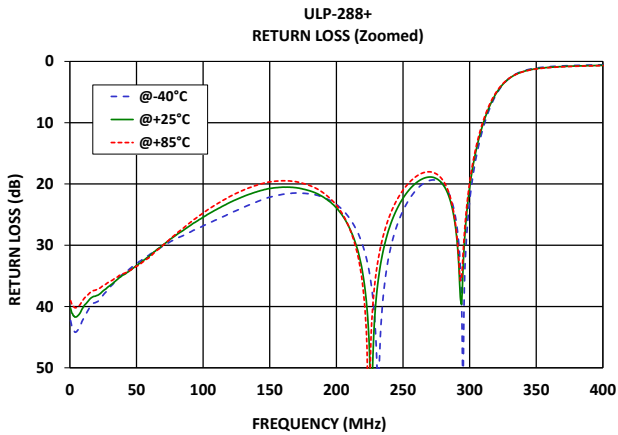
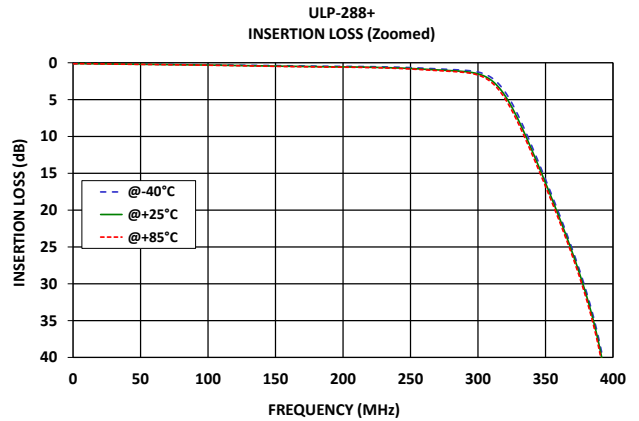
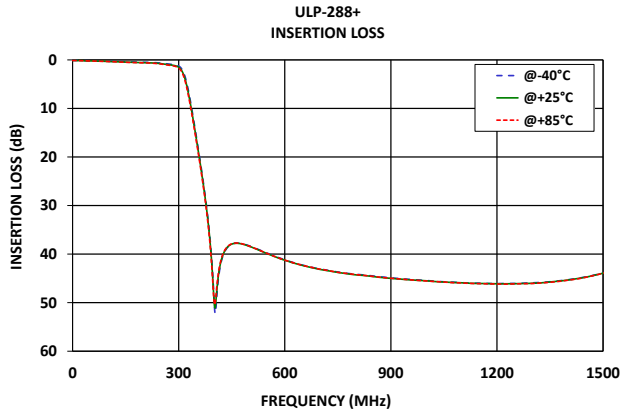
5. Power rating applies only to signals within the passband.

TYPICAL FREQUENCY RESPONSE AT +25°C





TYPICAL PERFORMANCE GRAPHS





FUNCTIONAL DIAGRAM

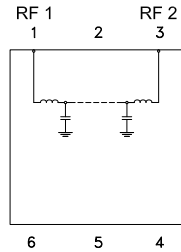


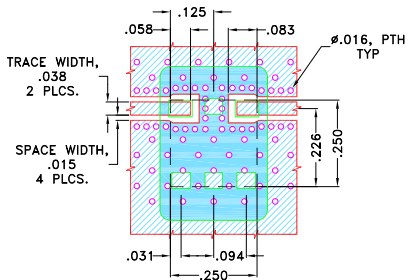
Figure 1. ULP-288+ Functional Diagram

PAD DESCRIPTION

Function	Pad Number	Description
RF ₁ (Note 2)	1	Connects to RF Input Port
RF ₂ (Note 2)	3	Connects to RF Output Port
GROUND	2,4,5,6	Connects to Ground on PCB, (See drawing PL-484)
NC	—	No connection, not used internally. See drawing PL-484 for connection to PCB

SUGGESTED PCB LAYOUT (PL-484)

SUGGESTED MOUNTING CONFIGURATION FOR QA2224 CASE STYLE "06FL09" PIN CODE



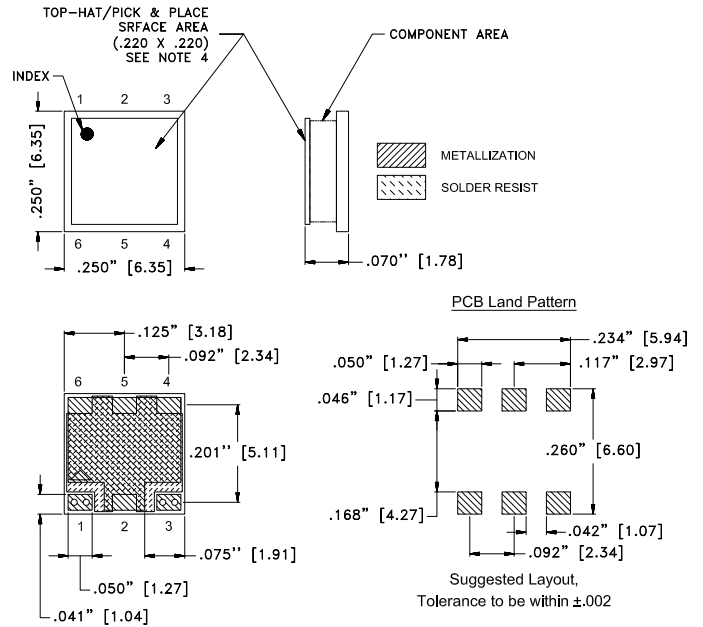
NOTES:

- TRACE WIDTH IS SHOWN FOR ROGERS (R04350B) WITH DIELECTRIC THICKNESS .020"±.0015". COPPER: 1/2 OZ. EACH SIDE. FOR OTHER MATERIALS TRACE WIDTH MAY NEED TO BE MODIFIED.
- 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 SOLDERMASK

Figure 2. Suggested PCB Layout PL-484

CASE STYLE DRAWING



Weight: .25 gram

Dimensions are in inches (mm). Tolerances: 2PI. ± .03; 3PI. ± .015

PRODUCT MARKING*: ULP-288

*Marking may contain other features or characters for internal lot control.



LUMPED LC SURFACE MOUNT ^{top hat}

Low Pass Filter

ULP-288+

50Ω

DC to 288 MHz

ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASH BOARD.

[CLICK HERE](#)

Performance Data and Graphs	Data
	Graphs
	S-Parameter (S2P Files) Data Set (.zip file) De-embedded to device pads
Case Style	QA2224 Lead Finish: Gold over Nickel Plate
RoHS Status	Compliant
Tape and Reel	TR-F34
Suggested Layout for PCB Design	PL-484
Evaluation Board	TB-ULP-288+
	Gerber File
Environmental Rating	ENV03T2

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/terms/viewterm.html



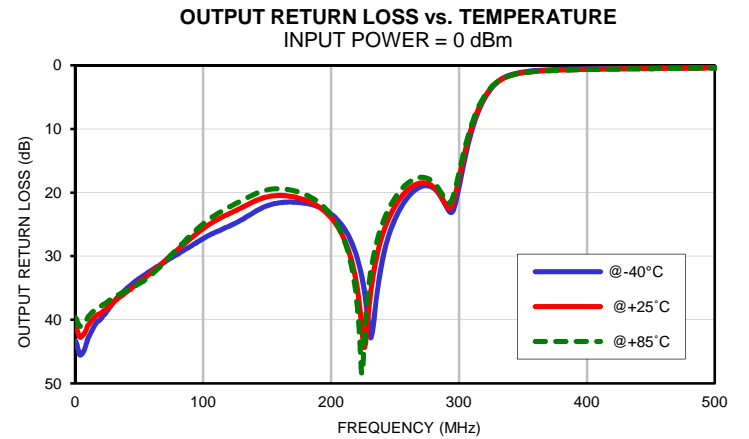
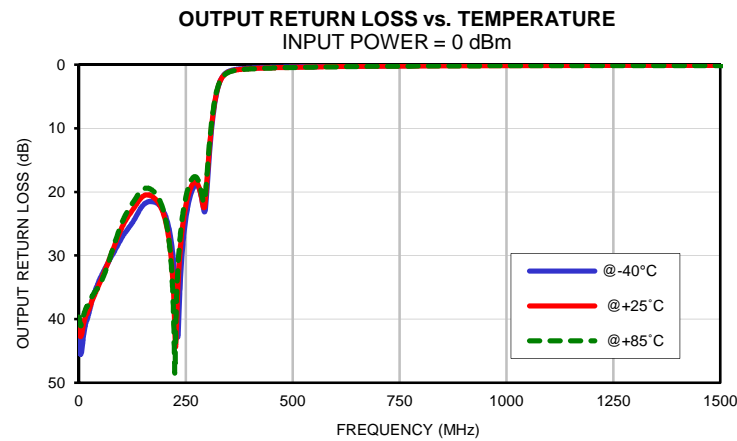
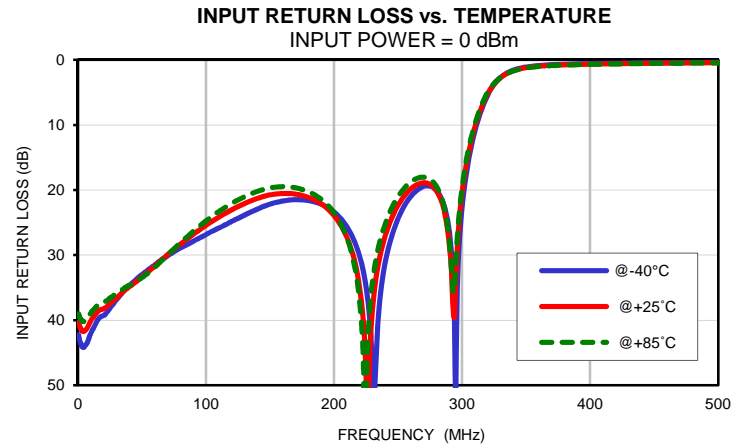
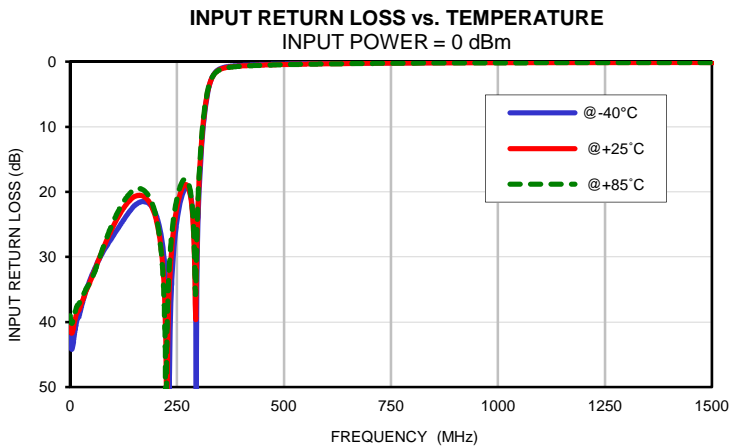
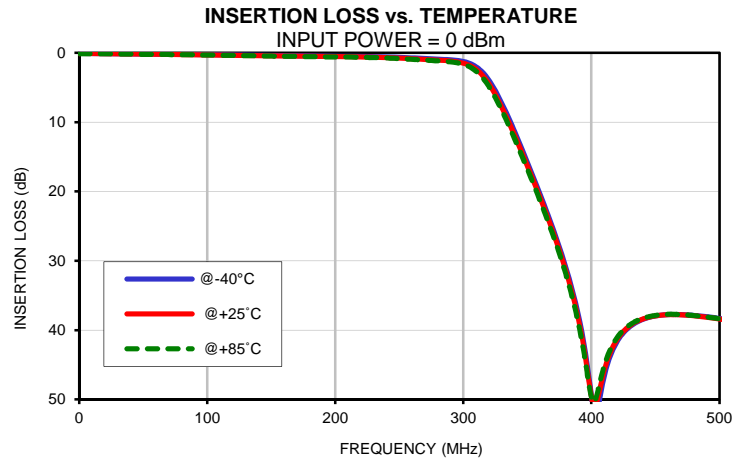
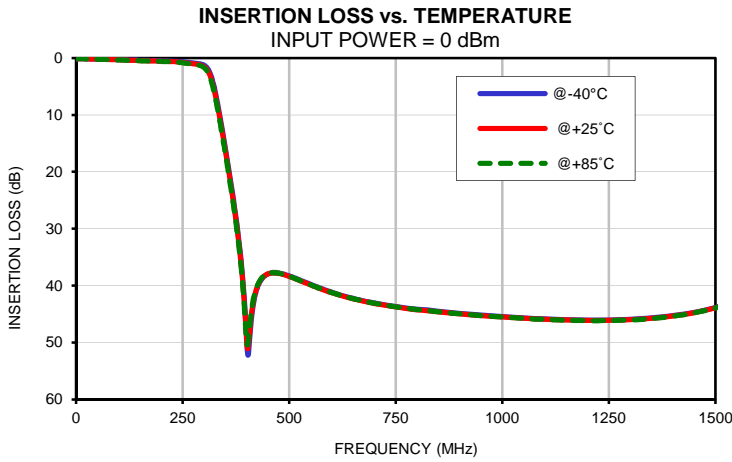
Typical Performance Data

FREQ. (MHz)	INSERTION LOSS			INPUT RETURN LOSS			OUTPUT RETURN LOSS		
	(dB)			(dB)			(dB)		
	@-40°C	@+25°C	@+85°C	@-40°C	@+25°C	@+85°C	@-40°C	@+25°C	@+85°C
1	0.11	0.12	0.14	42.77	40.69	39.33	43.62	41.30	39.84
2	0.10	0.12	0.13	43.45	41.17	39.75	44.41	41.89	40.35
5	0.10	0.12	0.13	44.11	41.68	40.16	45.43	42.63	40.99
10	0.10	0.12	0.13	42.06	40.14	38.90	42.97	40.92	39.59
15	0.12	0.13	0.14	40.09	38.77	37.76	40.99	39.68	38.52
20	0.13	0.14	0.16	39.26	38.22	37.25	39.89	39.00	37.91
25	0.14	0.16	0.17	38.13	37.44	36.58	38.62	38.15	37.21
50	0.19	0.21	0.22	32.97	33.31	33.42	33.52	34.12	34.35
100	0.28	0.31	0.33	26.84	25.43	24.73	27.25	25.68	24.94
150	0.39	0.45	0.49	22.14	20.72	19.65	22.09	20.68	19.59
200	0.49	0.56	0.60	23.34	23.90	23.46	23.35	23.93	23.51
225	0.54	0.63	0.68	34.73	48.47	53.22	34.21	43.26	47.02
250	0.66	0.78	0.85	24.37	22.33	21.01	24.18	22.16	20.84
275	0.88	1.02	1.12	19.41	19.12	18.36	18.91	18.52	17.72
280	0.92	1.07	1.17	20.05	20.09	19.42	19.27	19.11	18.37
285	0.96	1.13	1.23	21.82	22.38	21.80	20.32	20.36	19.65
288	1.00	1.17	1.28	23.93	25.08	24.56	21.35	21.41	20.67
290	1.02	1.20	1.32	26.23	28.13	27.62	22.15	22.10	21.31
295	1.11	1.31	1.45	52.18	34.16	31.71	22.95	21.79	20.84
300	1.26	1.50	1.67	22.81	20.58	19.77	19.18	17.69	16.89
310	2.02	2.40	2.67	10.98	10.26	9.84	10.40	9.70	9.25
312	2.29	2.70	3.00	9.54	8.96	8.59	9.09	8.51	8.11
314	2.62	3.06	3.38	8.29	7.82	7.50	7.92	7.45	7.11
315	2.80	3.26	3.60	7.72	7.30	7.01	7.38	6.97	6.65
320	3.94	4.47	4.87	5.39	5.19	5.00	5.18	4.96	4.76
325	5.44	6.00	6.45	3.78	3.72	3.62	3.63	3.56	3.45
330	7.24	7.81	8.29	2.71	2.74	2.70	2.60	2.62	2.57
340	11.37	11.90	12.39	1.57	1.67	1.69	1.50	1.59	1.60
350	15.83	16.31	16.78	1.08	1.19	1.23	1.03	1.14	1.17
360	20.46	20.91	21.36	0.85	0.96	1.01	0.81	0.92	0.96
370	25.37	25.82	26.28	0.73	0.83	0.88	0.69	0.79	0.83
378	29.72	30.20	30.68	0.66	0.76	0.80	0.63	0.73	0.77
380	30.90	31.40	31.89	0.65	0.75	0.79	0.62	0.72	0.76
390	37.92	38.56	39.18	0.60	0.69	0.73	0.56	0.66	0.70
400	49.31	49.62	49.67	0.55	0.65	0.68	0.53	0.61	0.65
420	41.65	41.35	41.10	0.49	0.58	0.61	0.47	0.55	0.59
450	37.95	37.94	37.87	0.43	0.50	0.54	0.40	0.48	0.51
475	37.80	37.86	37.81	0.39	0.46	0.49	0.36	0.43	0.47
500	38.30	38.40	38.37	0.35	0.42	0.45	0.33	0.39	0.43
525	39.02	39.13	39.10	0.31	0.38	0.41	0.30	0.36	0.39
550	39.78	39.89	39.86	0.29	0.35	0.38	0.27	0.33	0.36
600	41.18	41.27	41.23	0.24	0.30	0.33	0.22	0.29	0.31
650	42.26	42.33	42.30	0.20	0.26	0.29	0.19	0.25	0.27
700	43.05	43.16	43.10	0.17	0.23	0.25	0.16	0.22	0.24
750	43.69	43.77	43.75	0.15	0.21	0.23	0.13	0.19	0.21
800	44.15	44.27	44.21	0.13	0.19	0.21	0.12	0.18	0.20
850	44.51	44.63	44.59	0.12	0.17	0.19	0.10	0.16	0.18
900	44.88	44.99	44.97	0.11	0.17	0.18	0.09	0.15	0.17
950	45.19	45.28	45.28	0.09	0.15	0.17	0.07	0.13	0.15
1000	45.43	45.49	45.53	0.08	0.14	0.16	0.06	0.12	0.14
1050	45.70	45.75	45.75	0.07	0.14	0.15	0.06	0.12	0.14
1100	45.88	45.91	45.94	0.06	0.13	0.14	0.04	0.11	0.13
1150	45.99	46.05	46.08	0.06	0.12	0.14	0.04	0.11	0.13
1200	46.08	46.11	46.16	0.06	0.13	0.15	0.04	0.11	0.13
1300	45.91	46.01	46.05	0.05	0.12	0.14	0.03	0.10	0.12
1400	45.28	45.35	45.38	0.04	0.12	0.14	0.02	0.10	0.12
1425	45.02	45.06	45.14	0.05	0.12	0.14	0.02	0.10	0.12
1450	44.71	44.77	44.79	0.05	0.12	0.14	0.02	0.10	0.13
1475	44.33	44.36	44.39	0.05	0.13	0.15	0.02	0.11	0.13
1500	43.86	43.92	43.93	0.05	0.12	0.15	0.02	0.11	0.13

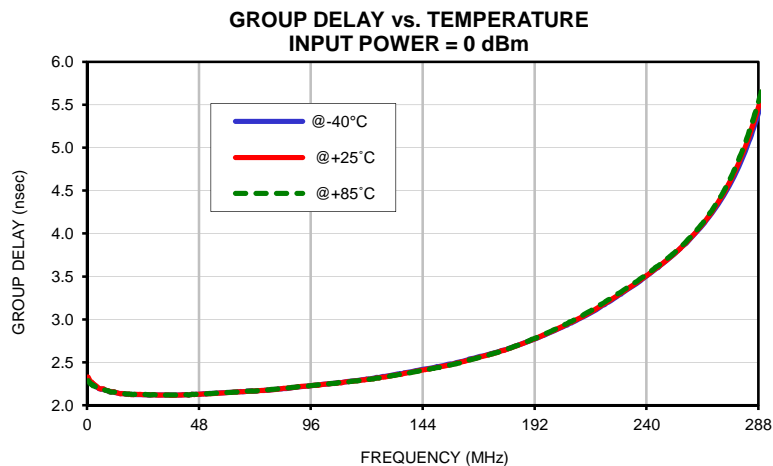
Typical Performance Data

FREQ. (MHz)	GROUP DELAY		
	(nsec)		
	@-40°C	@+25°C	@+85°C
1	2.28	2.30	2.27
2	2.26	2.27	2.25
3	2.24	2.25	2.23
4	2.22	2.22	2.21
5	2.20	2.20	2.19
10	2.15	2.16	2.16
15	2.14	2.14	2.14
20	2.13	2.13	2.13
25	2.13	2.12	2.13
30	2.12	2.12	2.12
35	2.12	2.12	2.12
40	2.12	2.12	2.12
45	2.13	2.13	2.13
50	2.14	2.13	2.13
55	2.14	2.14	2.14
60	2.15	2.15	2.15
65	2.16	2.16	2.16
70	2.17	2.16	2.17
75	2.17	2.17	2.17
80	2.18	2.18	2.19
85	2.19	2.20	2.20
90	2.21	2.21	2.21
100	2.24	2.24	2.24
110	2.27	2.27	2.27
120	2.31	2.30	2.30
130	2.35	2.34	2.34
140	2.40	2.39	2.39
150	2.45	2.44	2.44
160	2.51	2.50	2.49
165	2.54	2.54	2.53
170	2.58	2.57	2.57
175	2.61	2.61	2.61
180	2.65	2.65	2.65
185	2.70	2.70	2.70
190	2.75	2.75	2.76
195	2.81	2.81	2.81
200	2.86	2.87	2.88
205	2.92	2.93	2.94
210	2.99	3.00	3.01
215	3.06	3.07	3.08
225	3.22	3.23	3.25
230	3.31	3.32	3.34
235	3.40	3.41	3.43
240	3.50	3.51	3.52
245	3.60	3.61	3.62
250	3.72	3.72	3.73
255	3.84	3.84	3.85
260	3.98	3.98	3.99
265	4.13	4.14	4.15
270	4.31	4.33	4.35
275	4.53	4.56	4.59
280	4.80	4.85	4.89
281	4.87	4.91	4.96
282	4.93	4.98	5.03
283	5.00	5.06	5.11
284	5.07	5.13	5.18
285	5.15	5.21	5.26
286	5.23	5.29	5.35
287	5.31	5.38	5.44
288	5.40	5.47	5.53

Typical Performance Curves

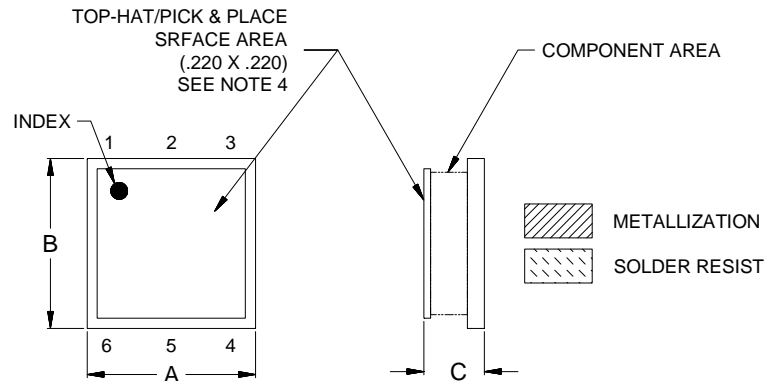


Typical Performance Curves

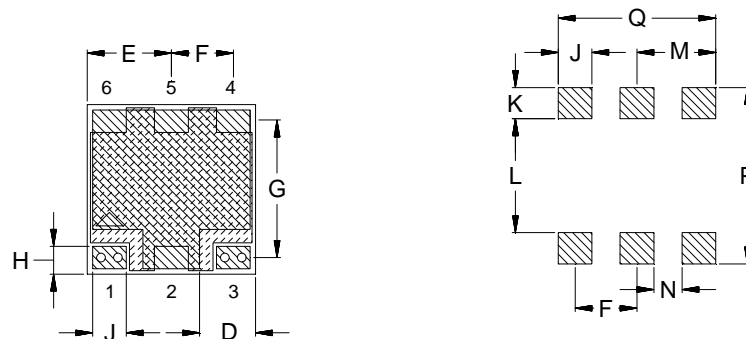


Outline Dimensions

QA2224



PCB Land Pattern



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

CASE#	A	B	C	D	E	F	G	H	J	K	L	M
QA2224	.250 (6.35)	.250 (6.35)	.070 (1.78)	.075 (1.91)	.125 (3.18)	.092 (2.34)	.201 (5.11)	.041 (1.04)	.050 (1.27)	.046 (1.17)	.168 (4.27)	.117 (2.97)

CASE#	N	P	Q	WT. GRAM
QA2224	.042 (1.07)	.260 (6.60)	.234 (5.94)	0.25

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

Notes:

- Case material: Ceramic base.
- Base: Printed wiring laminate.
- Termination finish:
For RoHS Case Styles: 3-5 μ inch Gold over 120-240 μ inch Nickel plate.
For RoHS-5 Case Styles: Tin-Lead plate.
- Top-Hat total thickness: .013 inches MAX



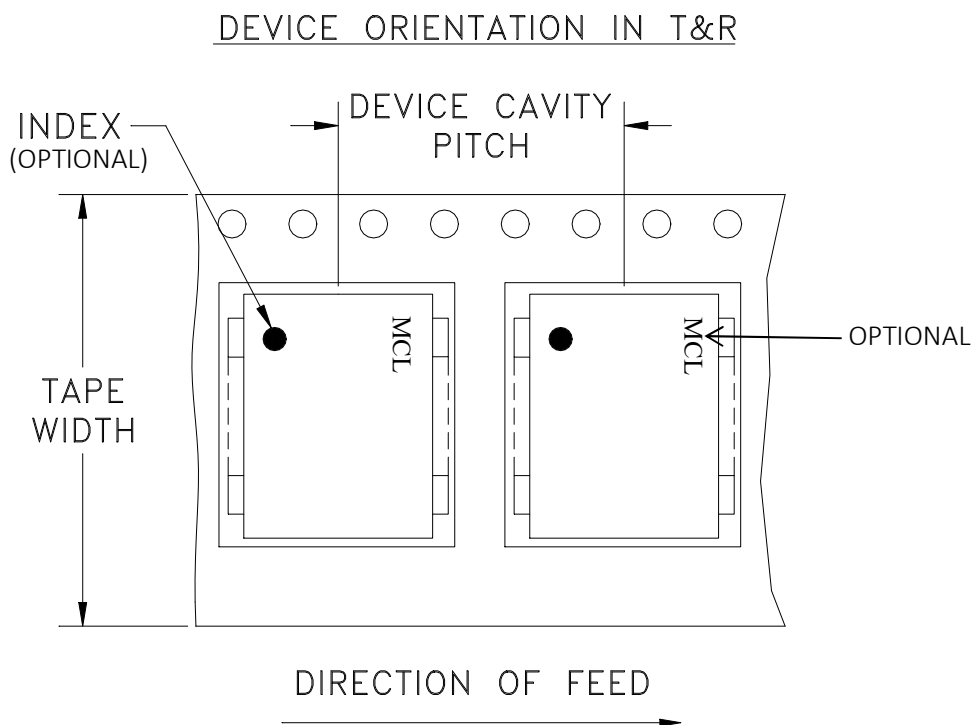
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site



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RF/IF MICROWAVE COMPONENTS

Tape & Reel Packaging TR-F34



Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel see note	
16	12	7	Small quantity standard (see note)	20
				50
			Standard	100
				200
		13	Standard	500
				1000

Note: Availability of small reel quantity varies by model.
Refer to pricing and availability on individual model dashboard.

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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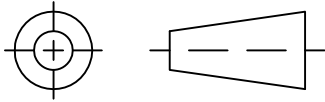
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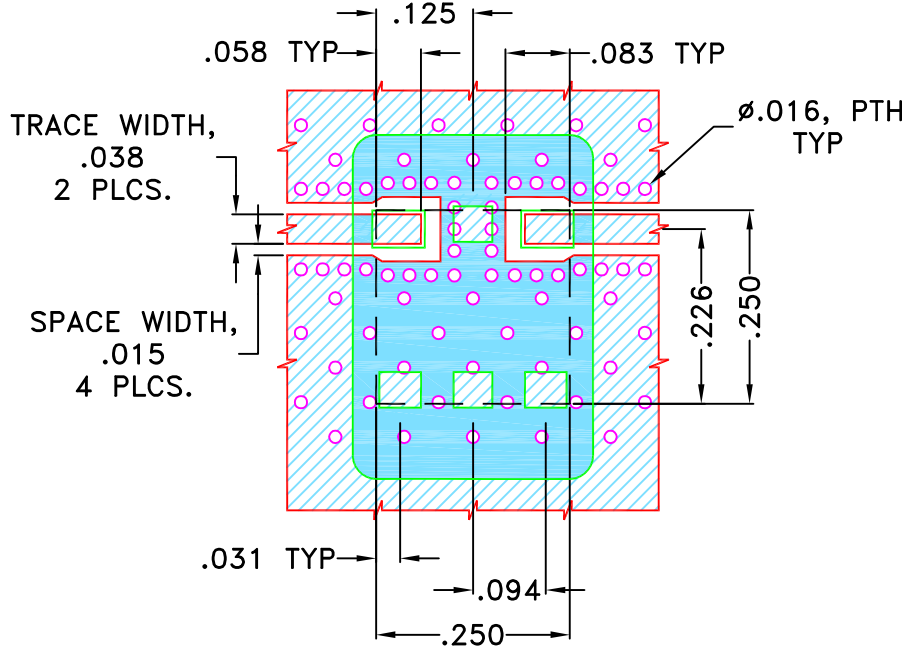
THIRD ANGLE PROJECTION



REVISIONS

REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	M156213	NEW RELEASE	MAY 16	TM	MD
A	M161508	COPPER LAND PATTERN UPDATED	APR 17	EJ	MD

SUGGESTED MOUNTING CONFIGURATION FOR QA2224 CASE STYLE "06FL09" PIN CODE



NOTES:

1. TRACE WIDTH IS SHOWN FOR ROGERS (R04350B) WITH DIELECTRIC THICKNESS .020"±.0015". 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 SOLDERMASK

UNLESS OTHERWISE SPECIFIED	INITIALS	DATE
DIMENSIONS ARE IN INCHES TOLERANCES ON: 2 PL DECIMALS ± 3 PL DECIMALS ± .005" ANGLES ± FRACTIONS ±	DRAWN	TM 02 MAY 16
	CHECKED	MD 02 MAY 16
	APPROVED	MD 02 MAY 16



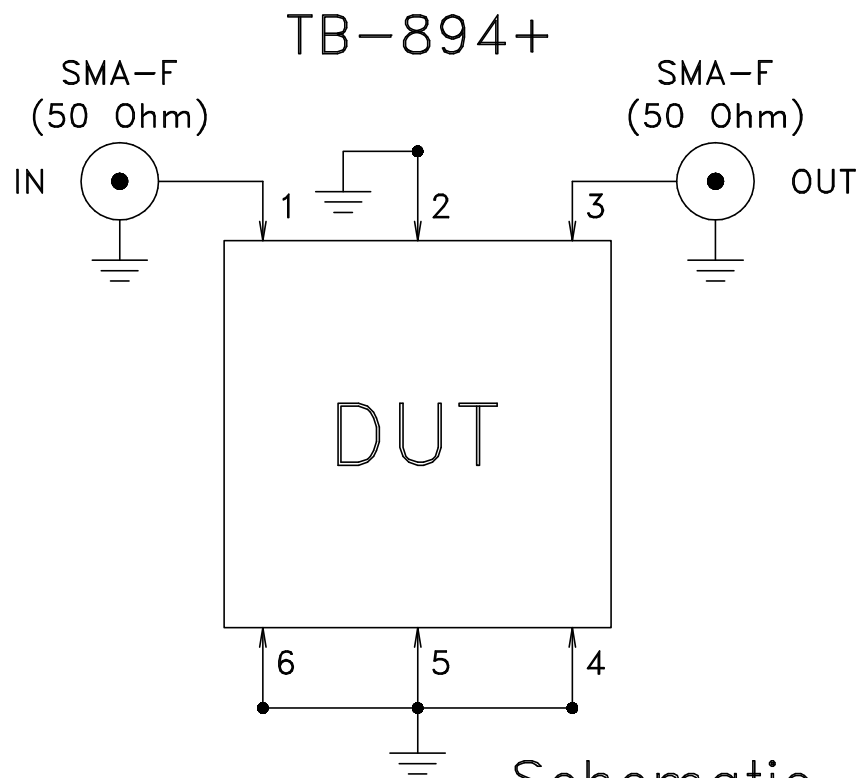
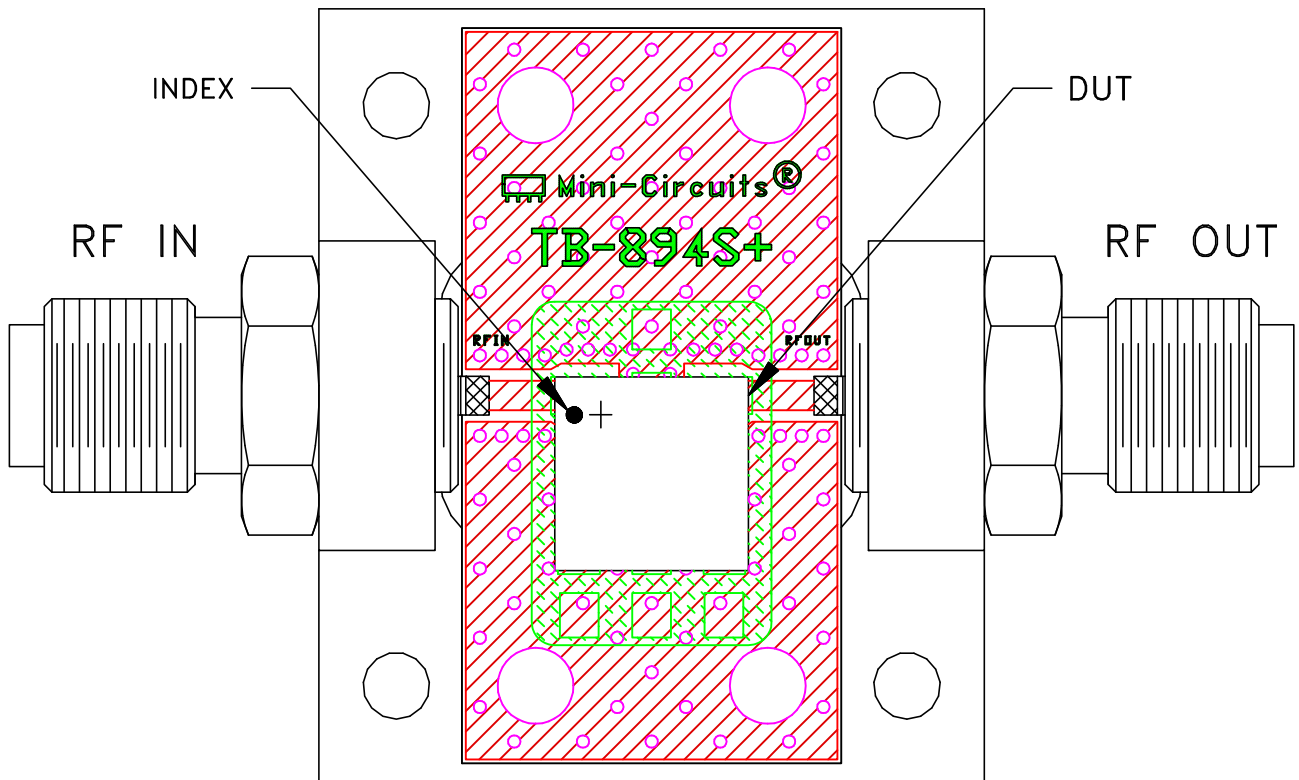
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Brooklyn NY 11235

PL, 06FL09, QA2224, ULP,
TB-894+, 50 Ohm

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SIZE A	CODE IDENT 15542	DRAWING NO: 98-PL-484	REV: A
FILE: 98PL484	SCALE: 4:1	SHEET: 1 OF 1	


Evaluation Board and Circuit



NOTES:

1. 50 Ohm SMA Female connectors.
2. PCB Material: ROGERS (RO4350B) OR Equivalent
Dielectric Constant=3.48±.05, Thickness=.020 inch.

Schematic Diagram

 **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
HAST	130°C, 85% RH, 96 hours	JESD22-A110
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 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; distilled water + proylene glycol monomethyl ether + monoethanolamine at 63°C to 70°C	MIL-STD-202, Method 215