

Surface Mount ®

# Low Pass Filter

ULP-288+

50Ω DC to 288 MHz



CASE STYLE: QA2224

## The Big Deal

- Low Insertion loss, 1.5dB Typ.
- High rejection, > 40dB
- Sharp insertion loss roll-off
- Good VSWR
- Ultra miniature surface mount package

## Product Overview

The ULP-288+ is a lowpass 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.

## Key Features

Feature	Advantages
Low passband insertion loss	Passband insertion loss 1.5dB typical ensures low signal loss throughout the passband
Excellent stopband rejection	Rejection of 40 dB ensures unwanted spurious are eliminated
Excellent return loss at DC-288 MHz	This makes signal transmission with very less reflections and well-matched with the adjacent component used in the system
Small size, 0.25" x 0.25"	The Ultra miniature surface mount package enables the ULP-288+ to be used in compact designs.

### 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.  
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50Ω

DC to 288 MHz

**ULP-288+**

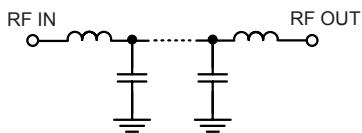
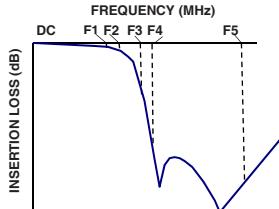
CASE STYLE: QA2224

**Features**

- High rejection
- Sharp insertion loss roll-off
- Good VSWR, 1.35:1 typ. at passband
- Ultra miniature surface mount package

**Applications**

- Wireless communications
- Receivers / Transformers
- Lab use

**Functional Schematic****Typical Frequency Response****Electrical Specifications at 25°C**

	Parameter	F#	Frequency (MHz)	Min.	Typ.	Max.	Unit
Pass Band	Insertion Loss	DC-F1	DC-288	—	1.5	2.0	dB
	Freq. Cut-Off	F2	310	—	3.0	—	dB
	VSWR	DC-F1	DC-288	—	1.35	—	:1
Stop Band	Rejection Loss	F3-F4	390-700	20	27	—	dB
		F4-F5	700-1500	40	45	—	dB
	VSWR	F3-F5	390-1500	—	20	—	:1

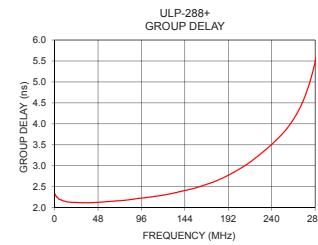
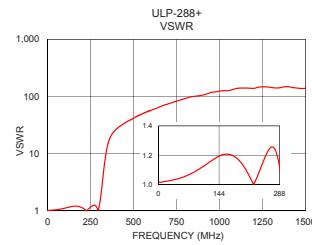
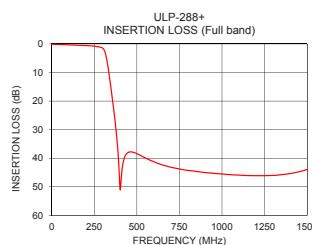
**Maximum Ratings**

Operating Temperature	-40°C to 85°C
Storage Temperature	-55°C to 100°C
RF Power Input	1W max.

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

**Typical Performance Data at 25°C**

Frequency (MHz)	Insertion Loss (dB)	VSWR (:1)	Frequency (MHz)	Group Delay (nsec)
1	0.12	1.02	1	2.30
50	0.21	1.04	10	2.16
100	0.31	1.11	20	2.13
200	0.56	1.14	30	2.12
288	1.17	1.12	40	2.12
310	2.40	1.89	50	2.13
315	3.26	2.52	60	2.15
330	7.81	6.40	75	2.17
340	11.90	10.45	100	2.24
360	20.91	18.06	125	2.32
378	30.20	22.83	150	2.44
390	38.56	25.14	175	2.61
500	38.40	41.67	200	2.87
700	43.16	74.07	225	3.23
800	44.27	92.03	250	3.72
900	44.99	105.22	260	3.98
1000	45.49	124.15	270	4.33
1200	46.11	138.49	275	4.56
1300	46.01	143.56	280	4.85
1500	43.92	139.19	288	5.47

**+RoHS Compliant**

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

**Notes**

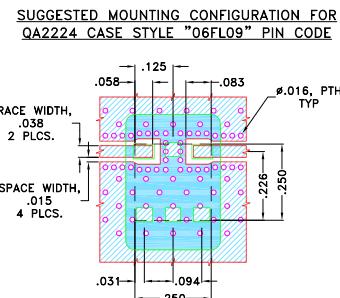
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**Pad Connections**

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

**Demo Board MCL P/N: TB-894+  
Suggested PCB Layout (PL-484)**

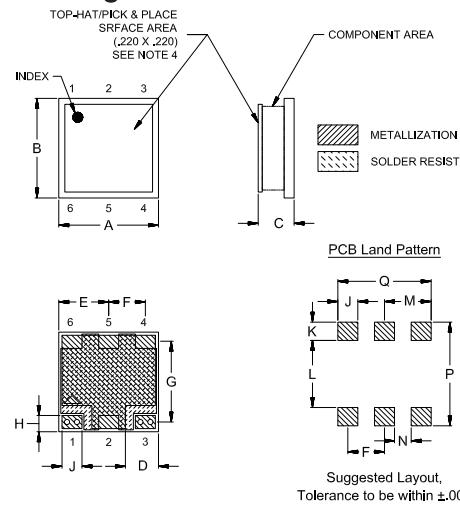


## NOTES:

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 SODERMASK

**Outline Drawing****Outline Dimensions ( inch mm )**

A	B	C	D	E	F	G	H	J	K
-	-	Min Max	-	-	-	-	-	-	-
.250	.250	.075 .100	.075	.125	.092	.201	.041	.050	.046
6.35	6.35	1.91 2.54	1.91	3.18	2.34	5.11	1.04	1.27	1.17

L	M	N	P	Q	Wt. grams
.168	.117	.042	.260	.234	0.25
4.27	2.97	1.07	6.60	5.94	

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# Low Pass Filter

**ULP-288+**

## Typical Performance Data

FREQ. (MHz)	INSERTION LOSS (dB)			INPUT RETURN LOSS (dB)			OUTPUT RETURN LOSS (dB)		
	@-40°C	@+25°C	@+85°C	@-40°C	@+25°C	@+85°C	@-40°C	@+25°C	@+85°C
	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



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IF/RF MICROWAVE COMPONENTS



REV. OR

ULP-288+

170510

Page 1 of 2

## 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

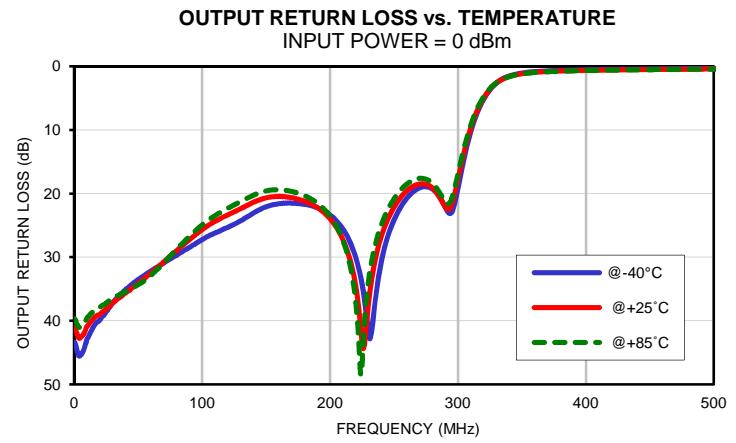
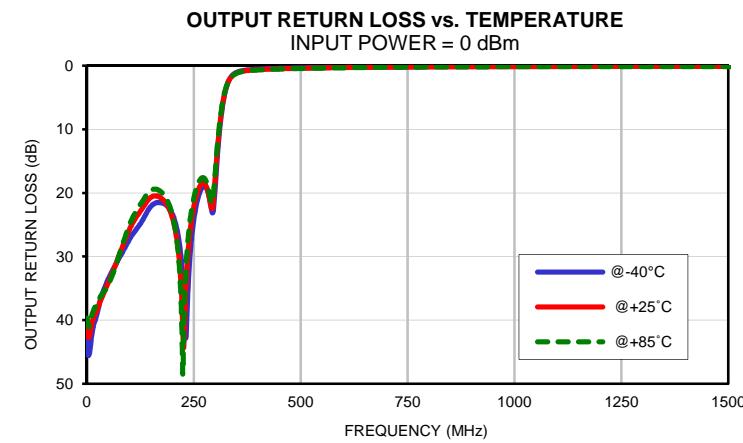
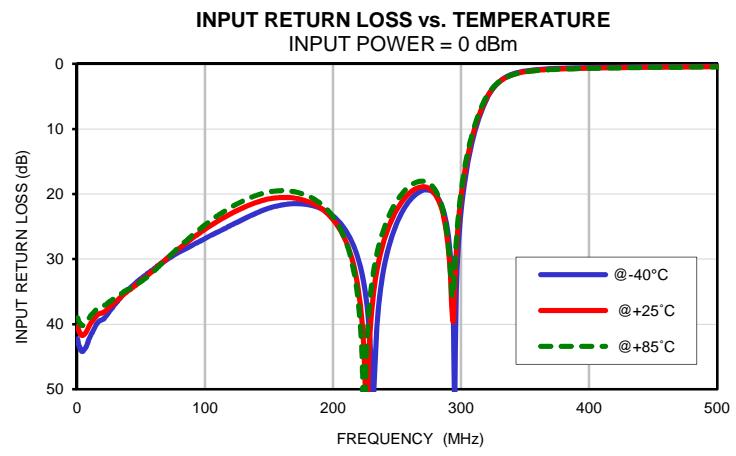
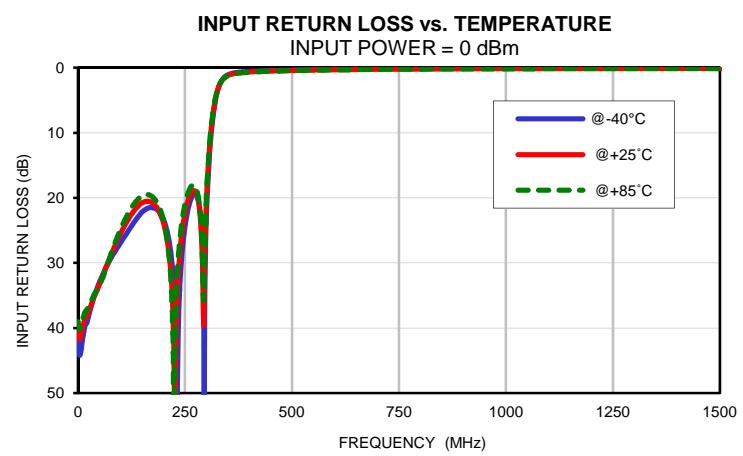
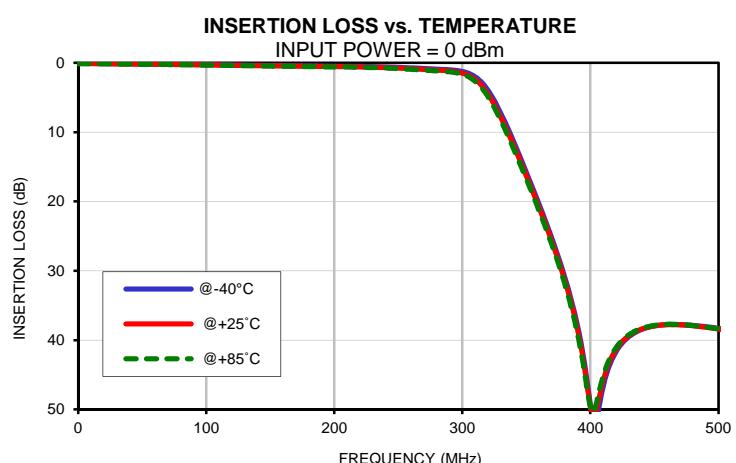
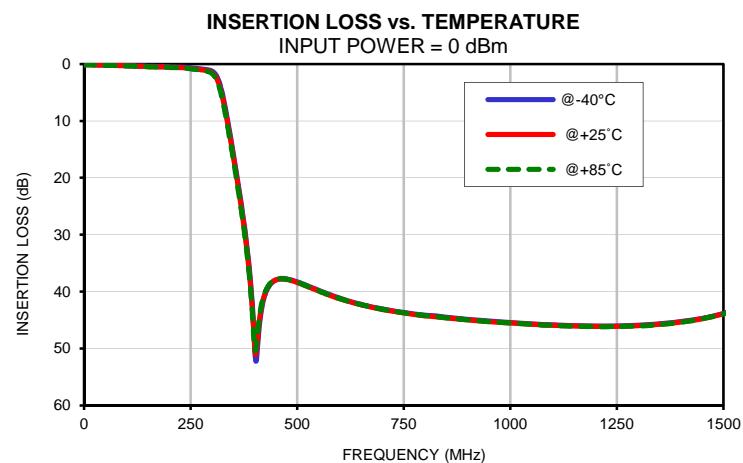


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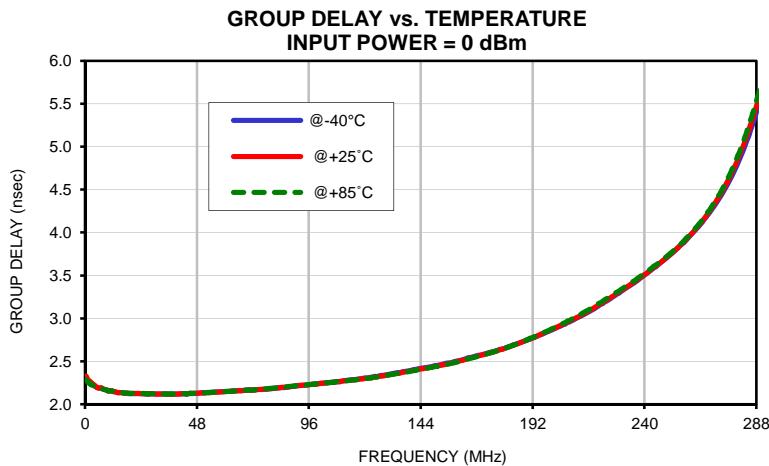
IF/RF MICROWAVE COMPONENTS



## Typical Performance Curves



## Typical Performance Curves

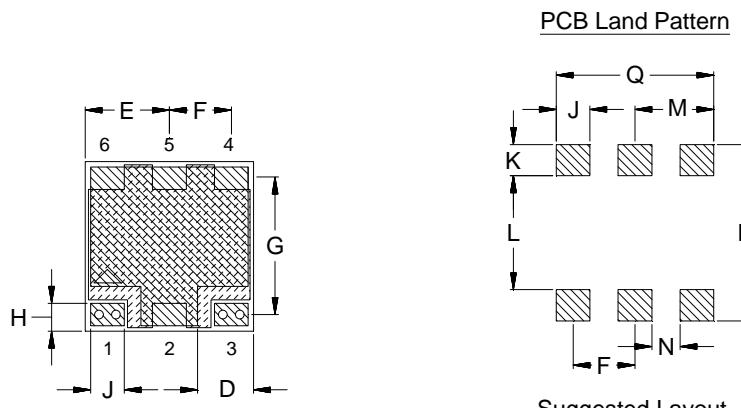
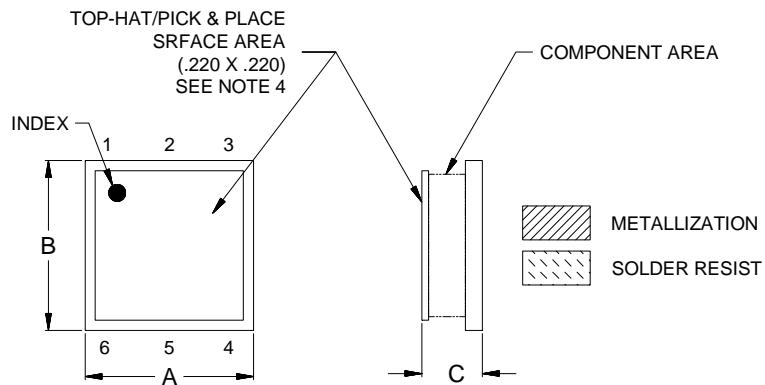


# Case Style

QA

## Outline Dimensions

QA2224



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:

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

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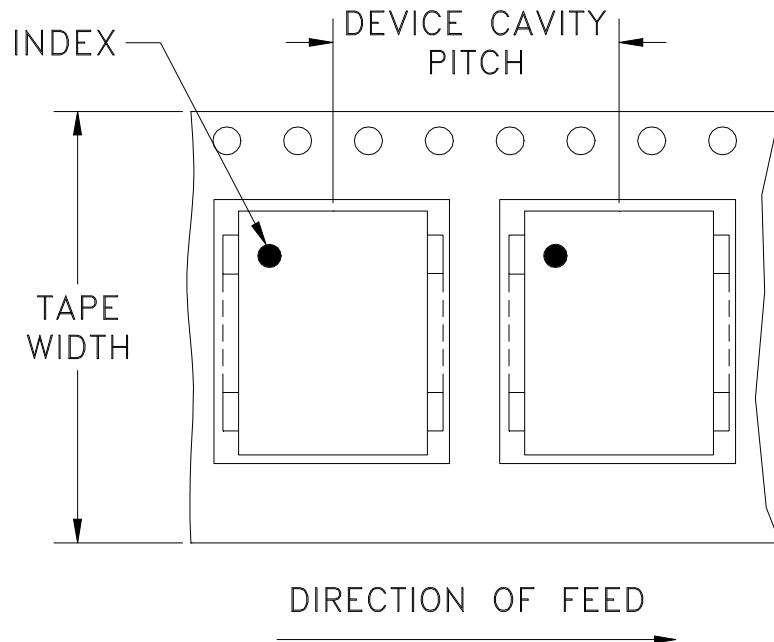


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RF/F MICROWAVE COMPONENTS

# Tape & Reel Packaging TR-F34

## DEVICE ORIENTATION IN T&R



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	50
			100	100
			200	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.

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



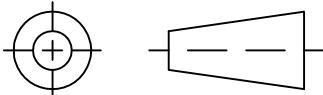
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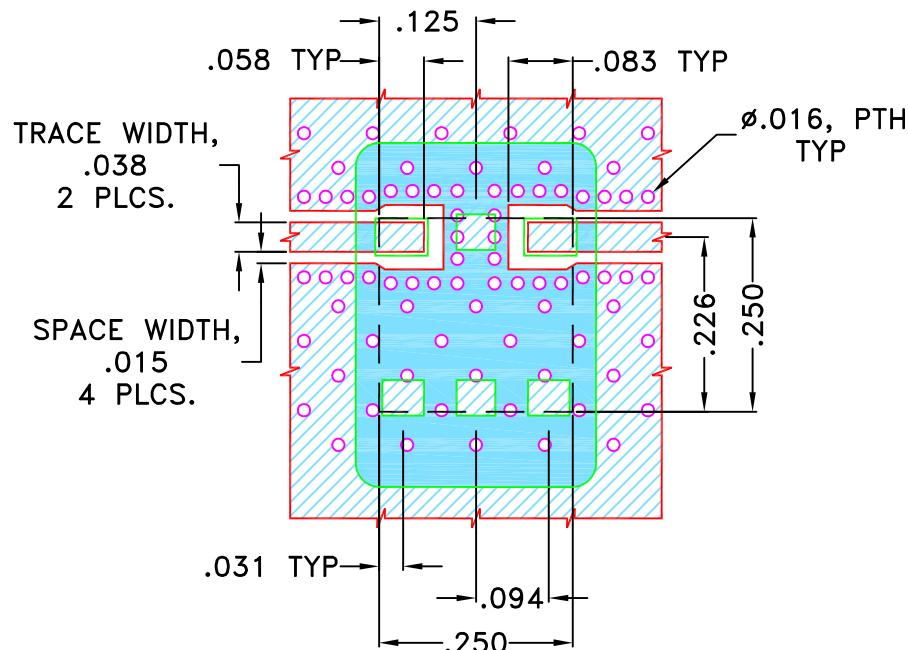
## THIRD ANGLE PROJECTION



## REVISONS

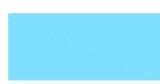
REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	M156213	NEW RELEASE	MAY 16	TM	MD
A	M161508	COPPER LAND PATTERN UPDATED	APR 17	EJ	MD

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

DIMENSIONS ARE IN INCHES

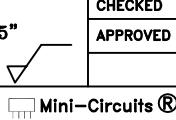
TOLERANCES ON:

2 PL DECIMALS ±

3 PL DECIMALS ± .005"

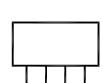
ANGLES ±

FRACTIONS ±



INITIALS

DATE

DRAWN  TM 02 MAY 16CHECKED  MD 02 MAY 16APPROVED  MD 02 MAY 16

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Brooklyn NY 11235

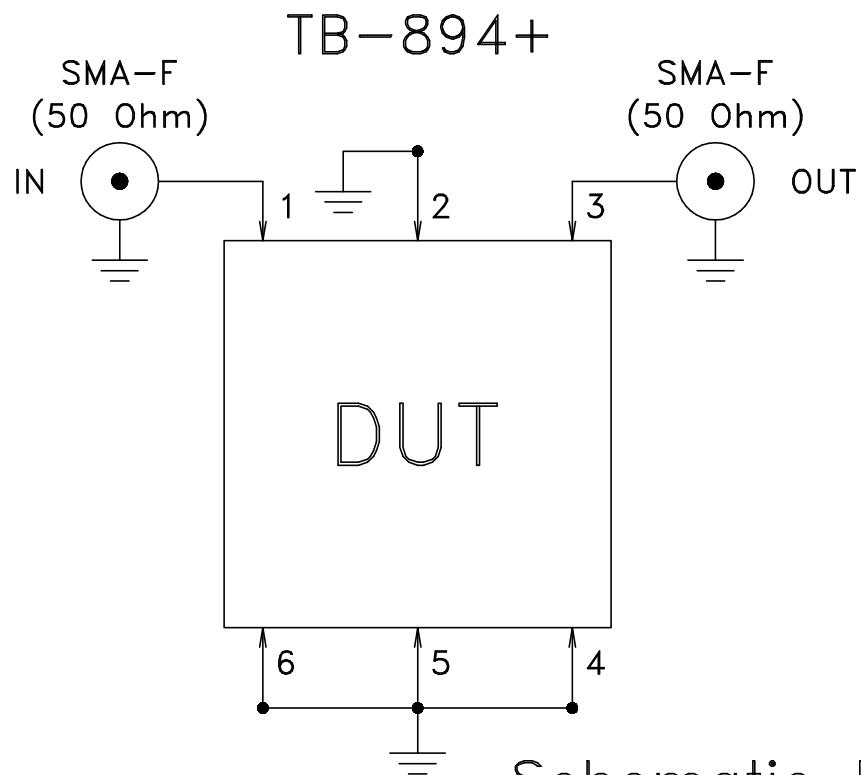
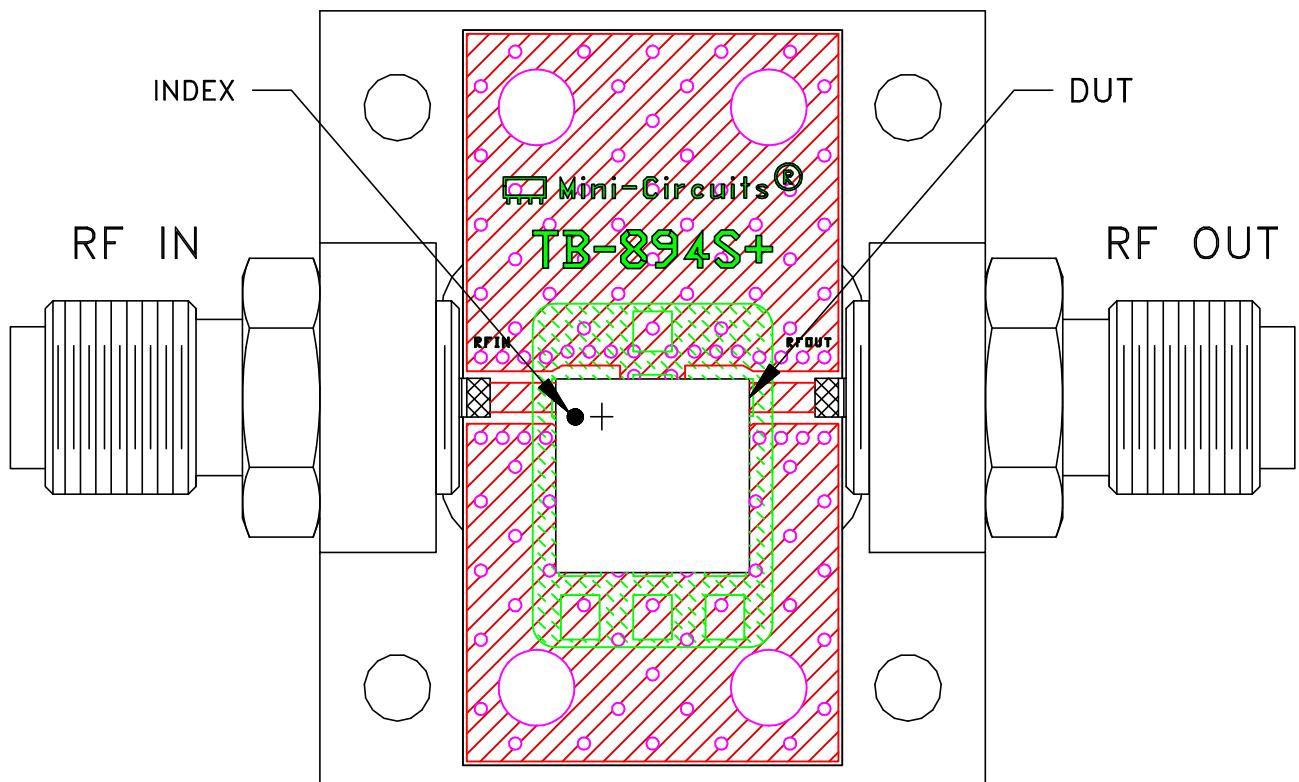
PL, 06FL09, QA2224, ULP,  
TB-894+, 50 Ohm

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

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

# Evaluation Board and Circuit



NOTES:

1. 50 Ohm SMA Female connectors.
2. PCB Material: ROGERS (R04350B) OR Equivalent  
Dielectric Constant= $3.48 \pm 0.05$ , Thickness=.020 inch.

Schematic Diagram



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## Environmental Specifications

## ENV03T2

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 + propylene glycol monomethyl ether + monoethanolamine at 63°C to 70°C	MIL-STD-202, Method 215