

# Surface Mount <sup>top hat®</sup> Low Pass Filter

## ULP-320+

50Ω DC to 320 MHz

### The Big Deal

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



CASE STYLE: QA2224

### Product Overview

The ULP-320+ is a lowpass filter in a top hat package (size of 0.25" x 0.25") fabricated using SMT technology. Covering DC to 320 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-320 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-320+ to be used in compact designs.

#### Notes

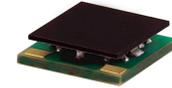
- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.  
B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's 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](http://www.minicircuits.com/MCLStore/terms.jsp)



# Surface Mount <sup>top hat®</sup> Low Pass Filter

## ULP-320+

50Ω DC to 320 MHz



CASE STYLE: QA2224

### Features

- High rejection
- Sharp insertion loss roll-off
- Ultra miniature surface mount package

### Applications

- Wireless communications
- Receivers / Transformers
- Lab use

### Electrical Specifications at 25°C

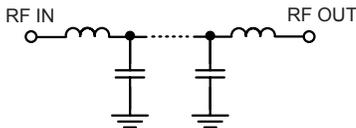
Parameter	F#	Frequency (MHz)	Min.	Typ.	Max.	Unit	
Pass Band	Insertion Loss	DC-F1	DC-320	—	1.5	2.0	dB
	Freq. Cut-Off	F2	345	—	3.0	—	dB
	VSWR	DC-F1	DC-320	—	1.4	—	:1
Stop Band	Rejection Loss	F3-F4	440-700	20	27	—	dB
		F4-F5	700-1600	40	47	—	dB
	VSWR	F3-F5	440-1600	—	20	—	:1

### Maximum Ratings

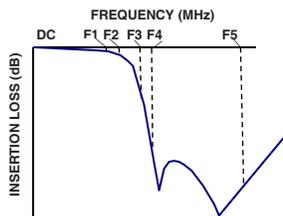
Operating Temperature	-40°C to 85°C
Storage Temperature	-55°C to 100°C
RF Power Input	1.6 W max.

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

### Functional Schematic



### Typical Frequency Response

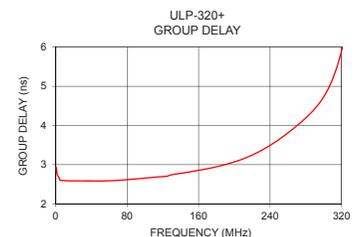
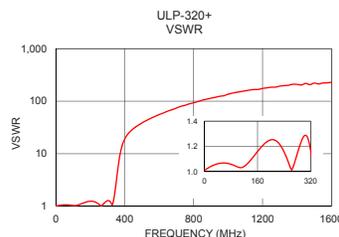


### Typical Performance Data at 25°C

Frequency (MHz)	Insertion Loss (dB)	VSWR (:1)	Frequency (MHz)	Group Delay (nsec)
1	0.11	1.02	1	2.42
10	0.13	1.03	2	2.25
100	0.31	1.04	5	2.10
150	0.43	1.13	10	2.09
320	1.26	1.17	50	2.08
345	2.92	2.14	80	2.12
346	3.10	2.27	100	2.16
375	12.67	10.73	120	2.19
395	20.88	17.81	140	2.28
416	30.08	23.24	160	2.35
440	44.90	28.17	180	2.45
450	55.27	29.97	200	2.57
475	44.06	34.32	210	2.65
510	41.61	40.34	230	2.86
600	43.55	55.67	250	3.14
700	46.26	73.86	270	3.49
1000	49.86	135.66	300	4.23
1250	50.81	184.02	310	4.69
1500	49.99	220.58	318	5.23
1600	48.82	227.43	320	5.40

### +RoHS Compliant

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



### 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-Circuits' 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](http://www.minicircuits.com/MCLStore/terms.jsp)



[www.minicircuits.com](http://www.minicircuits.com) P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

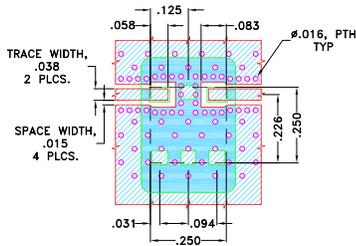
REV.A  
M161927  
ULP-320+  
EDU2395  
URJ  
170513  
Page 2 of 3

## Pad Connections

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

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

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

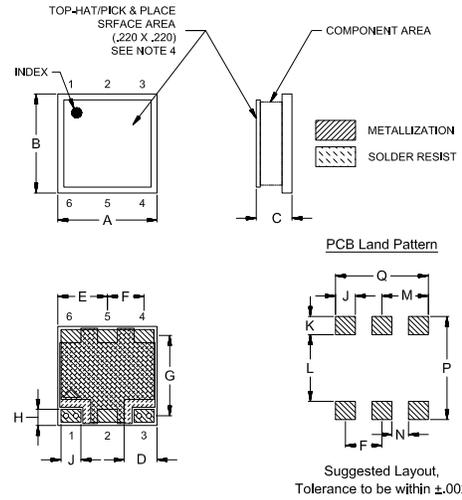


**NOTES:**

- 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

## 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
6.35	6.35	1.91	2.54	1.91	3.18	2.34	5.11	1.04	1.27
L	M	N	P	Q					
-	-	-	-	-					Wt.
.168	.117	.042	.260	.234					grams
4.27	2.97	1.07	6.60	5.94					0.25

**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](http://www.minicircuits.com/MCLStore/terms.jsp)



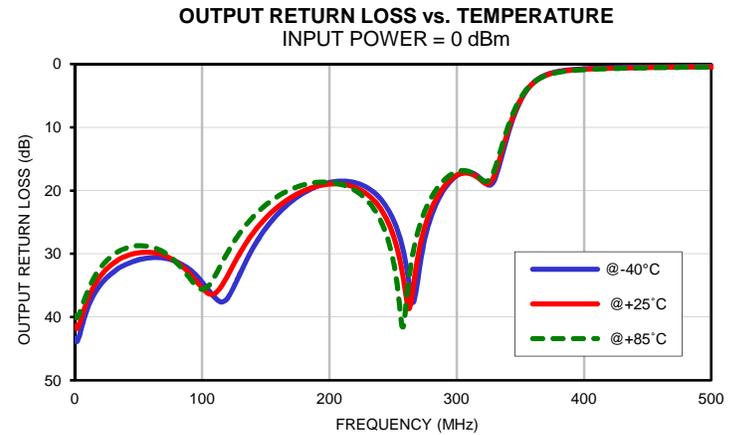
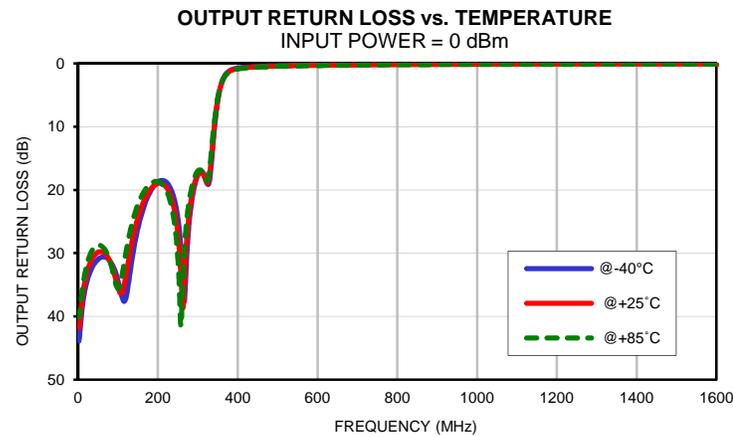
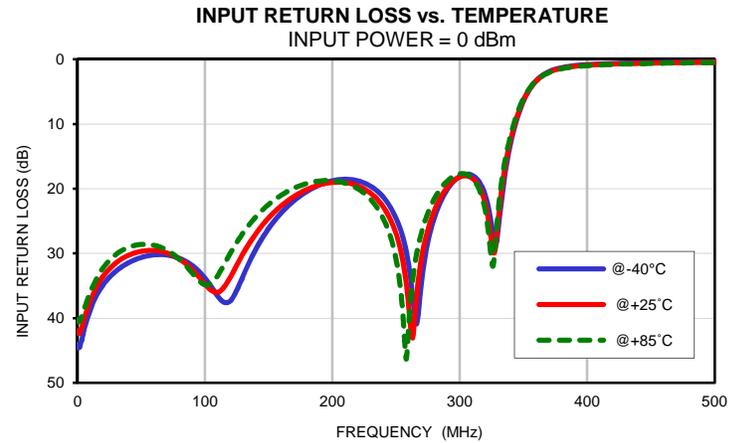
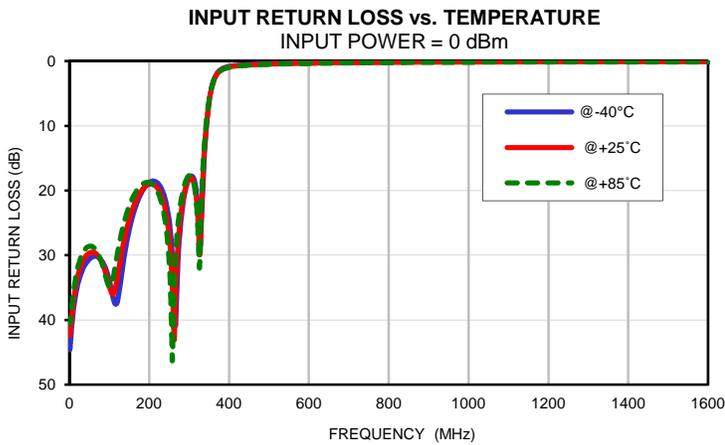
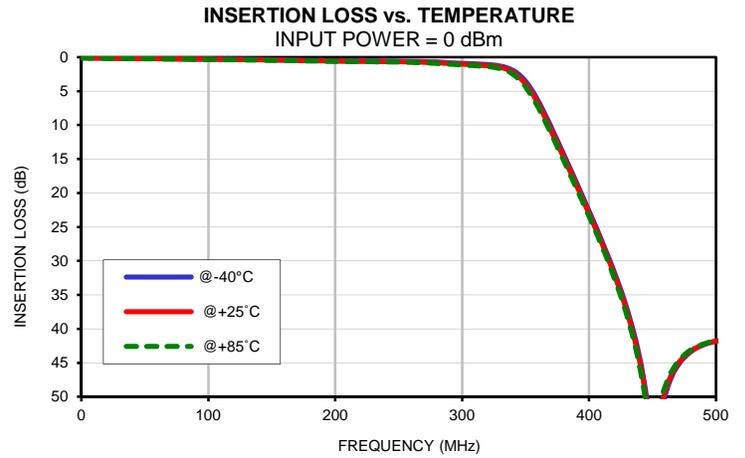
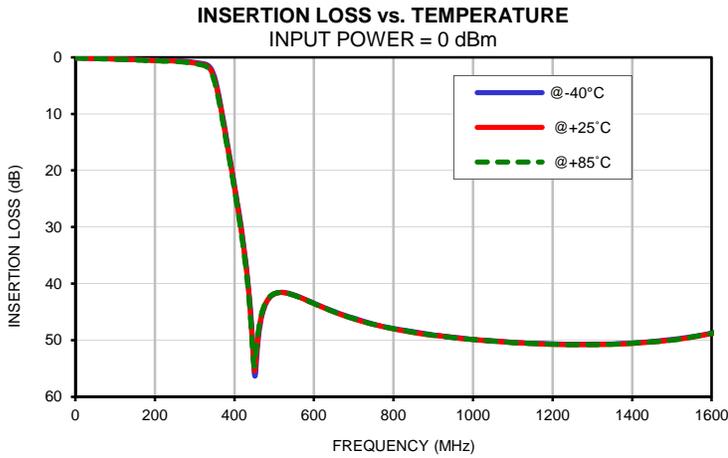
Typical Performance Data

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	0.09	0.11	0.13	43.95	41.88	40.14	43.73	41.72	39.99
2	0.10	0.12	0.14	44.25	42.14	40.35	43.84	41.79	40.08
5	0.11	0.12	0.14	41.87	40.22	38.70	41.95	40.29	38.78
10	0.12	0.13	0.15	38.65	37.31	35.99	38.71	37.34	36.01
15	0.13	0.15	0.16	36.46	35.15	33.87	36.47	35.13	33.85
20	0.15	0.16	0.17	34.85	33.54	32.25	34.97	33.60	32.29
25	0.16	0.17	0.19	33.68	32.39	31.08	33.81	32.42	31.10
50	0.21	0.23	0.24	30.63	29.67	28.61	30.94	29.82	28.70
100	0.29	0.31	0.33	33.82	34.72	34.84	34.42	35.38	35.62
150	0.38	0.43	0.47	26.12	24.48	22.41	25.97	24.34	22.27
200	0.53	0.58	0.63	18.76	19.02	18.75	18.72	18.96	18.68
250	0.60	0.67	0.73	24.54	26.96	30.89	24.45	26.89	30.92
300	0.91	1.03	1.14	18.10	18.16	17.69	17.65	17.58	17.00
320	1.11	1.26	1.39	21.01	22.33	23.42	18.32	18.52	18.35
330	1.30	1.50	1.69	26.78	25.37	23.81	18.18	17.38	16.49
345	2.57	2.92	3.28	9.12	8.80	8.37	8.22	7.87	7.43
346	2.74	3.10	3.48	8.51	8.23	7.84	7.69	7.38	6.98
350	3.55	3.95	4.38	6.43	6.29	6.04	5.86	5.69	5.42
355	4.87	5.30	5.77	4.56	4.53	4.41	4.15	4.10	3.96
360	6.49	6.92	7.41	3.28	3.33	3.29	2.98	3.00	2.95
370	10.26	10.67	11.16	1.89	1.99	2.03	1.69	1.78	1.81
375	12.27	12.67	13.15	1.52	1.62	1.68	1.35	1.45	1.49
380	14.31	14.70	15.16	1.27	1.37	1.44	1.13	1.23	1.28
385	16.37	16.75	17.20	1.10	1.20	1.27	0.97	1.07	1.13
390	18.44	18.81	19.24	0.97	1.07	1.14	0.86	0.96	1.01
395	20.52	20.88	21.31	0.88	0.98	1.04	0.78	0.87	0.93
400	22.62	22.98	23.41	0.81	0.90	0.97	0.72	0.81	0.87
410	26.94	27.31	27.76	0.71	0.79	0.86	0.63	0.71	0.77
415	29.22	29.60	30.06	0.67	0.76	0.81	0.60	0.68	0.73
417	30.16	30.55	31.02	0.66	0.74	0.80	0.59	0.67	0.72
420	31.61	32.02	32.50	0.64	0.72	0.78	0.57	0.65	0.70
425	34.19	34.63	35.14	0.61	0.69	0.74	0.55	0.62	0.67
430	37.03	37.52	38.10	0.59	0.66	0.72	0.53	0.60	0.65
440	44.27	44.90	45.69	0.54	0.62	0.67	0.49	0.56	0.61
450	55.69	55.27	54.64	0.51	0.58	0.63	0.46	0.53	0.57
475	44.22	44.06	43.89	0.44	0.51	0.55	0.40	0.46	0.50
500	41.83	41.83	41.81	0.39	0.45	0.49	0.36	0.42	0.45
510	41.61	41.61	41.62	0.37	0.43	0.47	0.34	0.40	0.43
520	41.55	41.58	41.59	0.35	0.41	0.45	0.33	0.38	0.42
525	41.57	41.62	41.63	0.35	0.41	0.44	0.32	0.38	0.41
550	42.01	42.07	42.09	0.31	0.37	0.41	0.29	0.34	0.37
600	43.47	43.55	43.54	0.26	0.31	0.35	0.24	0.29	0.32
650	44.93	45.00	44.99	0.21	0.27	0.30	0.20	0.25	0.28
700	46.14	46.26	46.19	0.18	0.24	0.26	0.16	0.22	0.24
750	47.16	47.24	47.22	0.15	0.21	0.24	0.14	0.19	0.22
800	47.97	48.07	47.99	0.13	0.19	0.21	0.12	0.17	0.19
850	48.52	48.60	48.61	0.10	0.17	0.19	0.10	0.15	0.17
900	49.08	49.15	49.11	0.09	0.15	0.18	0.08	0.14	0.16
950	49.49	49.52	49.55	0.08	0.14	0.16	0.07	0.13	0.15
1000	49.87	49.86	49.89	0.06	0.13	0.15	0.06	0.12	0.14
1050	50.12	50.18	50.16	0.05	0.12	0.15	0.05	0.12	0.13
1100	50.38	50.43	50.44	0.04	0.11	0.14	0.04	0.11	0.12
1150	50.60	50.62	50.56	0.03	0.10	0.13	0.03	0.10	0.12
1200	50.69	50.73	50.71	0.03	0.10	0.13	0.02	0.10	0.11
1300	50.69	50.80	50.82	0.01	0.09	0.12	0.01	0.09	0.11
1400	50.52	50.55	50.55	0.00	0.08	0.12	0.01	0.09	0.10
1450	50.22	50.33	50.30	0.00	0.08	0.11	0.00	0.08	0.10
1500	49.91	49.99	49.98	0.00	0.08	0.12	0.00	0.08	0.10
1550	49.40	49.48	49.46	0.00	0.08	0.11	0.00	0.08	0.10
1600	48.75	48.82	48.81	0.01	0.08	0.11	0.00	0.08	0.10

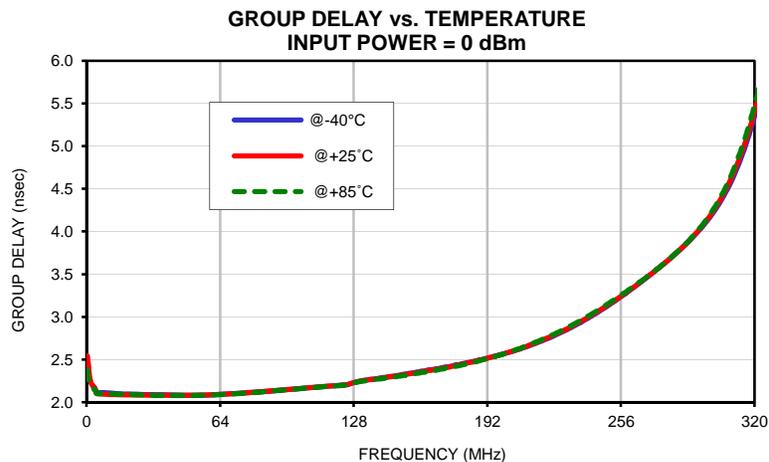
Typical Performance Data

FREQ.  (MHz)	GROUP DELAY		
	(nsec)		
	@-40°C	@+25°C	@+85°C
1	2.34	2.42	2.27
2	2.23	2.25	2.20
3	2.20	2.20	2.17
4	2.17	2.17	2.15
5	2.11	2.10	2.10
10	2.11	2.09	2.10
15	2.10	2.09	2.09
20	2.10	2.09	2.09
25	2.09	2.09	2.09
30	2.09	2.08	2.08
35	2.09	2.08	2.08
40	2.09	2.08	2.08
45	2.08	2.08	2.08
50	2.08	2.08	2.08
55	2.08	2.08	2.08
60	2.09	2.09	2.09
65	2.09	2.09	2.09
70	2.10	2.10	2.10
75	2.11	2.11	2.11
80	2.12	2.12	2.11
85	2.13	2.13	2.12
90	2.14	2.14	2.13
100	2.16	2.16	2.15
110	2.18	2.18	2.18
120	2.20	2.19	2.19
130	2.24	2.24	2.24
140	2.28	2.28	2.27
150	2.32	2.31	2.31
160	2.36	2.35	2.35
165	2.38	2.37	2.36
170	2.40	2.40	2.39
175	2.43	2.42	2.41
180	2.45	2.45	2.44
185	2.48	2.47	2.47
190	2.51	2.50	2.50
195	2.54	2.54	2.53
200	2.57	2.57	2.57
205	2.60	2.61	2.61
210	2.64	2.65	2.65
215	2.69	2.70	2.70
225	2.79	2.80	2.81
230	2.85	2.86	2.87
235	2.91	2.92	2.94
240	2.98	2.99	3.00
245	3.05	3.06	3.08
250	3.14	3.14	3.16
255	3.22	3.23	3.24
260	3.31	3.31	3.32
265	3.40	3.40	3.41
270	3.49	3.49	3.50
275	3.59	3.59	3.59
280	3.69	3.69	3.70
285	3.80	3.80	3.81
290	3.92	3.93	3.93
295	4.05	4.06	4.07
300	4.21	4.23	4.25
305	4.40	4.43	4.46
310	4.65	4.69	4.73
315	4.95	5.00	5.06
320	5.35	5.40	5.48

## Typical Performance Curves

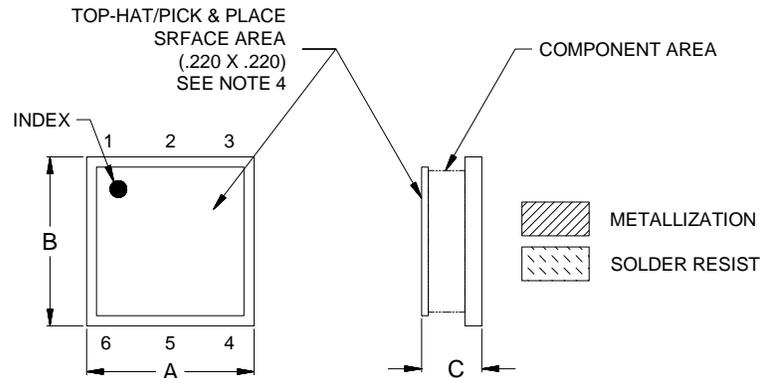


## Typical Performance Curves

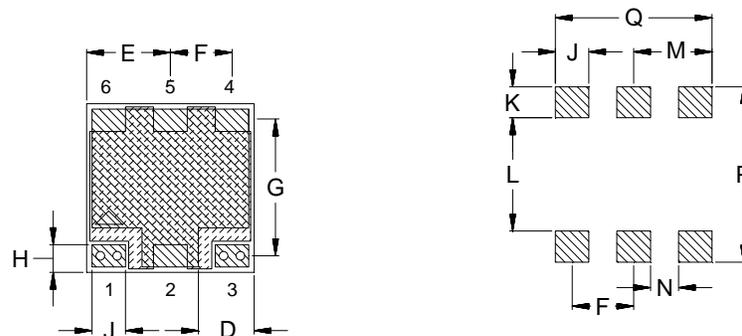


## Outline Dimensions

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  $\mu$  inch Gold over 120-240  $\mu$  inch Nickel plate.  
For RoHS-5 Case Styles: Tin-Lead plate.
- Top-Hat total thickness: .013 inches MAX



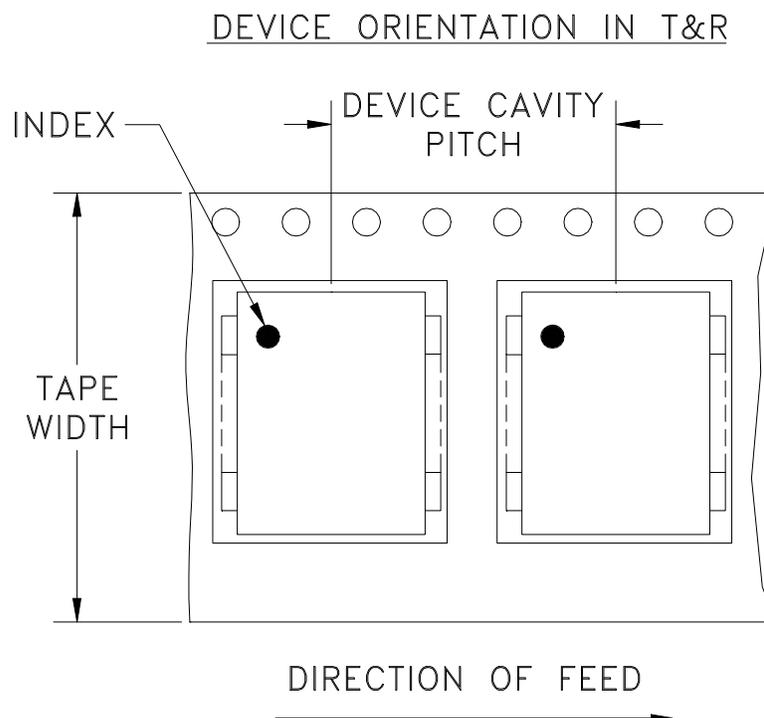
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: [www.minicircuits.com](http://www.minicircuits.com)

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
			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.

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



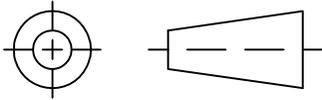
INTERNET <http://www.minicircuits.com>

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661

Distribution Centers NORTH AMERICA 800-654-7949 • 417-335-5935 • Fax 417-335-5945 • EUROPE 44-1252-832600 • Fax 44-1252-837010

Mini-Circuits ISO 9001 & ISO 14001 Certified

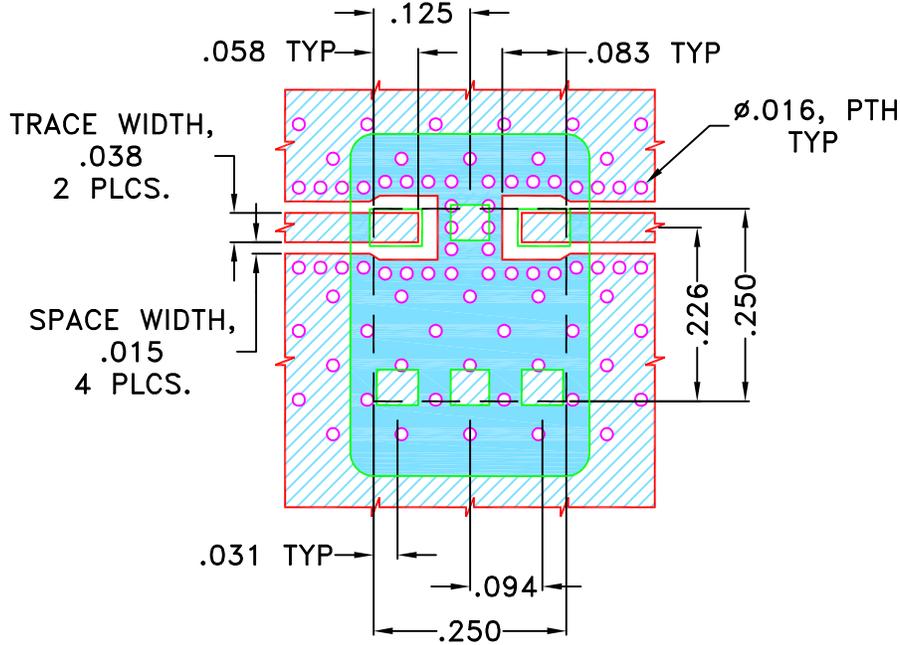
THIRD ANGLE PROJECTION



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



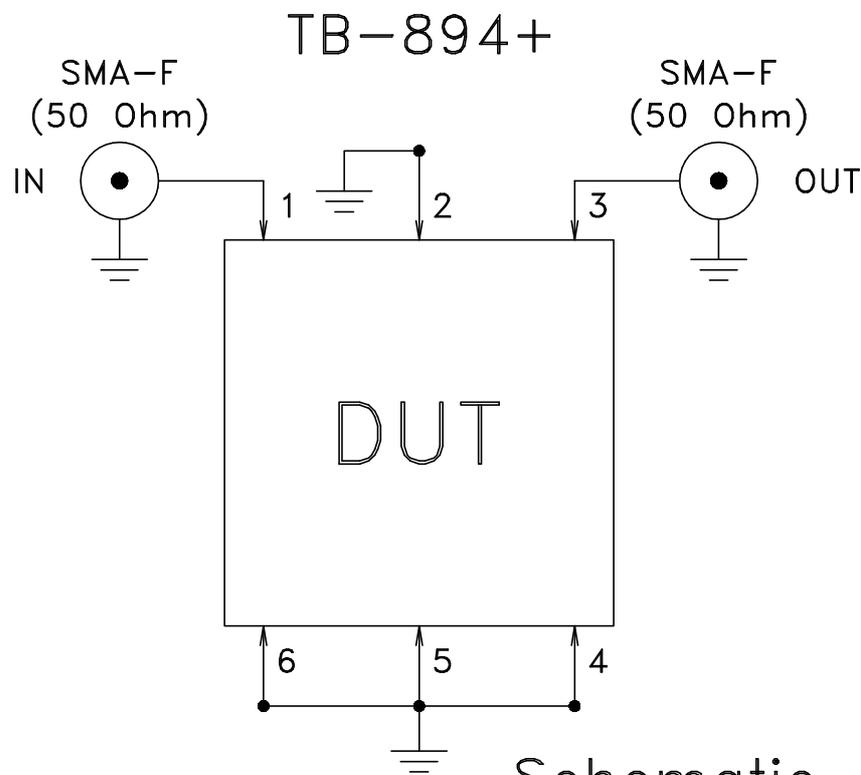
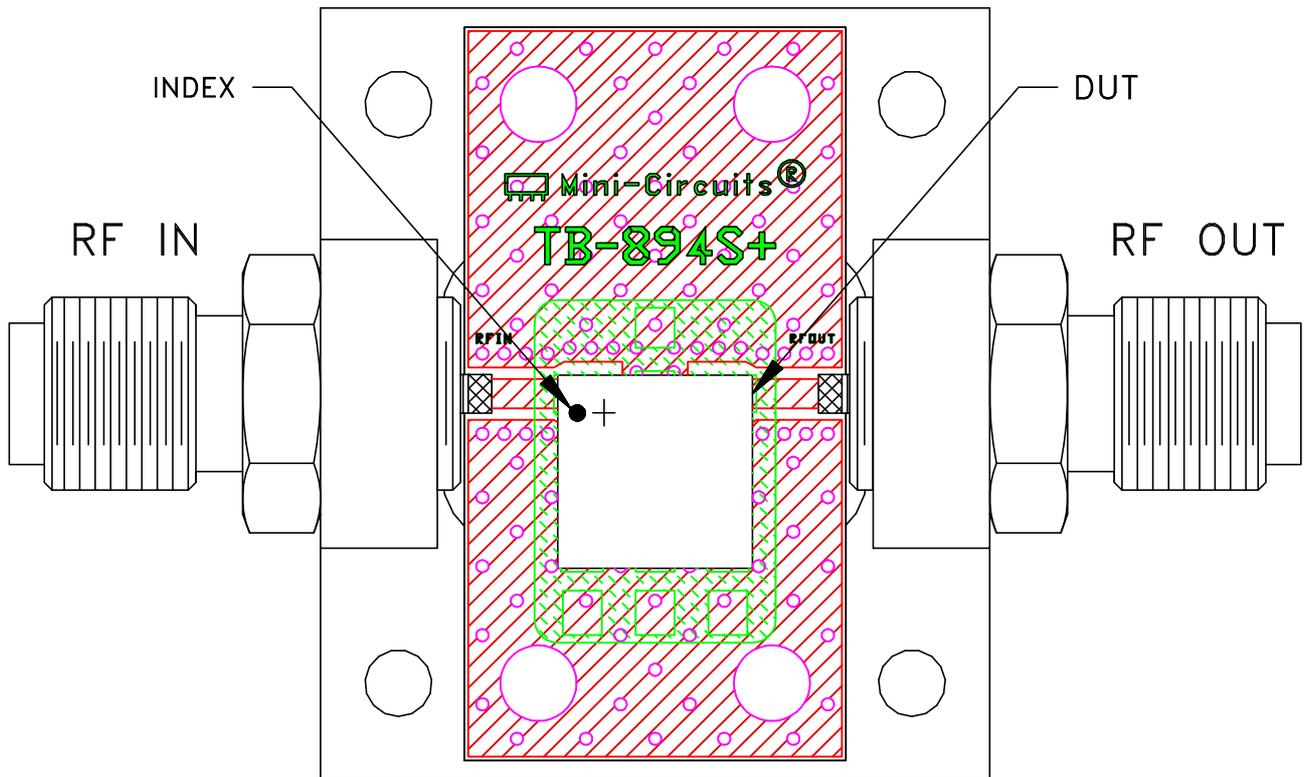
**Mini-Circuits®** 13 Neptune Avenue  
Brooklyn NY 11235

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

Mini-Circuits®  
THIS DOCUMENT AND ITS CONTENTS ARE THE PROPERTY OF MINI-CIRCUITS. EXCEPT FOR USE EXPRESSLY GRANTED, IN WRITING, TO ITS VENDORS, VENDEE AND THE UNITED STATES GOVERNMENT, MINI-CIRCUITS RESERVES ALL PROPRIETARY DESIGN, USE, MANUFACTURING AND REPRODUCTION RIGHTS THERETO. THESE CONTENTS SHALL NOT BE USED, DUPLICATED OR DISCLOSED TO ANY OUTSIDE PARTY, IN WHOLE OR IN PART, WITHOUT WRITTEN PERMISSION OF MINI-CIRCUITS.

SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-484	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