



LTCC SURFACE MOUNT

# Thru-Line

## TPCW-233+

50Ω DC to 23 GHz

### THE BIG DEAL

- Low Insertion Loss, 0.15dB Typ.
- Return Loss, 21dB Typ.
- 0603 Surface Mount Footprint
- Versatile "Place Holder" for Mini-Circuits LTCC Filters
- Power Handling: 7 Watts

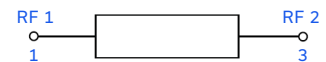


Generic photo used for illustration purposes only

### APPLICATIONS

- Test and Measurement Equipment
- Communication, EW, Radar and ECM Defense Systems
- 5G MIMO and Back Haul Radio Systems
- Satellite Communications

### FUNCTIONAL DIAGRAM



### PRODUCT OVERVIEW

TPCW-233+ is a miniature low temperature co-fired ceramic (LTCC) 50 Ohm transmission line with low insertion loss through 23 GHz acting as a place holder for Mini-Circuits HPF filters, on customer PCB. This model provides 0.15 dB typical insertion loss over a wide band due to its rugged monolithic construction. Housed in a tiny 0603 ceramic form factor with inspectable wrap-around terminations, the transmission line is ideal for dense signal chain PCB layouts where it complements MMIC size and performance. The LTCC fabrication process assures minimal RF performance variation while delivering a product that is well suited for environmental extremes of high humidity and temperature.

### KEY FEATURES

Features	Advantages
Footprint Compatible "Thru-Line" for Mini-Circuits, High Pass (HFCW series) filters in Case Style JC0603C with same pad connections as TPCW.	Enables system designers the flexibility to plan to add LTCC filters to the PCB layout at a later stage in the design process, after system test results are available.
Good power handling, 7W	This enables the device to be used in high power applications
LTCC Construction	Provides repeatable performance in a rugged, ceramic package well suited for tough environments such as high humidity and temperature extremes.
Tiny size, 0603	Saves space in dense circuit board layouts and minimizes the effects of parasitics.
Wrap-around terminations	Provides excellent solderability and easy visual inspection.
Rugged Power handling	Handles up to 7 Watts in a small 0603 package.



### ELECTRICAL SPECIFICATIONS<sup>1,2,3</sup> AT +25°C

Parameter		F#	Frequency (GHz)	Min.	Typ.	Max.	Units
Pass Band	Insertion Loss	DC-F1	DC - 10	—	0.15	0.4	dB
		F1-F2	10 - 16	—	0.5	1.0	
		F2-F3	16 - 23	—	0.9	—	
	Return Loss	DC-F1	DC - 10	—	21	—	dB
		F1-F2	10 - 16	—	14	—	
		F2-F3	16 - 23	—	10	—	
Group Delay	DC-F3	DC - 23	—	50	—	psec	

1. DC blocking capacitors are required in applications where DC voltage and/or current is present at either input or output ports. Please contact Mini-Circuits for alternatives if DC pass from IN-OUT is required.

2. Measured on Mini-Circuits Evaluation Board TB-TPCW-233+

3. Bi Directional, RF1 and RF2 ports can be interchanged, see S-parameters for actual performance

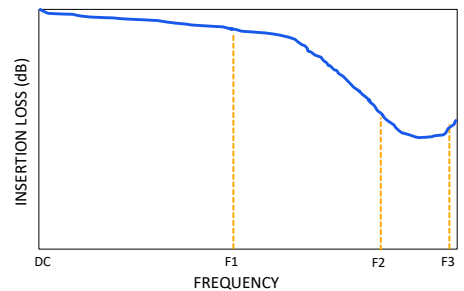
### ABSOLUTE MAXIMUM RATINGS<sup>4</sup>

Parameter	Ratings
Operating Temperature	-55 °C to +125 °C
Storage Temperature	-55 °C to +125 °C
Input Power <sup>5</sup>	7W @25°C

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

5. Power rating applies only to signals within the passband. Power rating above +25°C operating temperature decreases linearly to 2.3 W at +125°C.

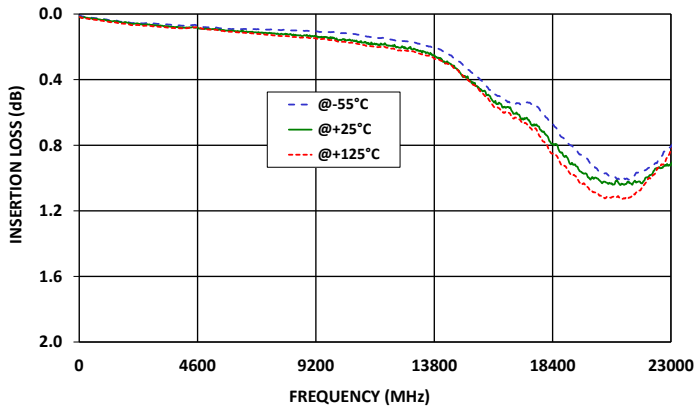
### TYPICAL FREQUENCY RESPONSE



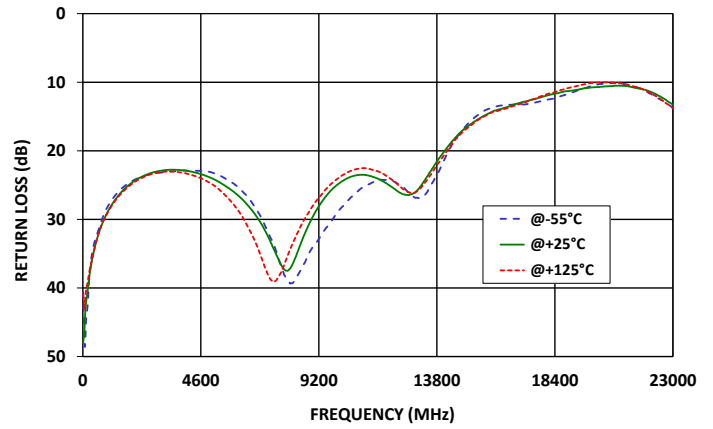


### TYPICAL PERFORMANCE GRAPHS

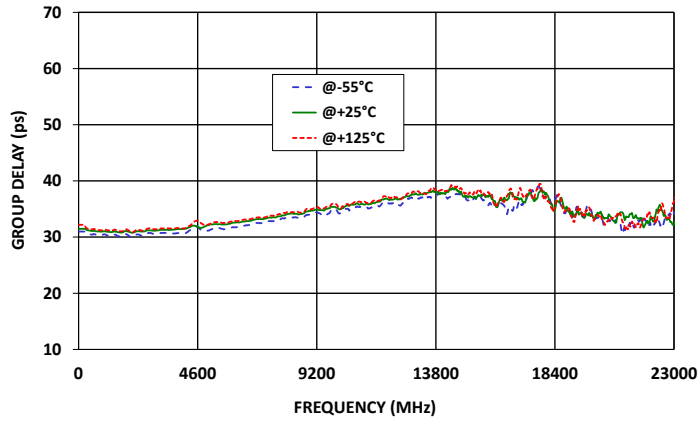
TPCW-233+  
INSERTION LOSS



TPCW-233+  
RETURN LOSS



TPCW-233+  
GROUP DELAY





### FUNCTIONAL DIAGRAM

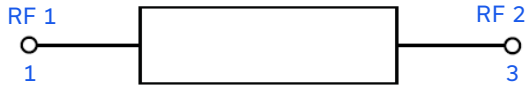
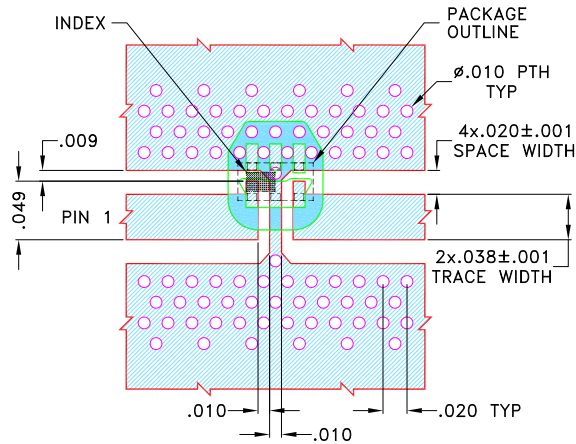


Figure 1. TPCW-233+ Functional Diagram

### PAD DESCRIPTION

Function	Pad Number	Description
RF1 <sup>(Note 2)</sup>	1	Connects to RF Input Port
RF2 <sup>(Note 2)</sup>	3	Connects to RF Output Port
GROUND	2,4,5,6	Connects to Ground on PCB, (See drawing PL-704)
NC	-	No connection, not used internally. See drawing PL-704 for connection to PCB

### SUGGESTED PCB LAYOUT (PL-704)



NOTES:



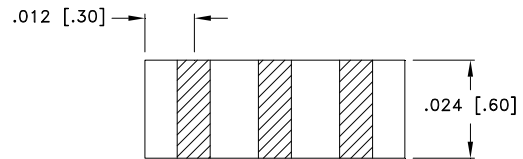
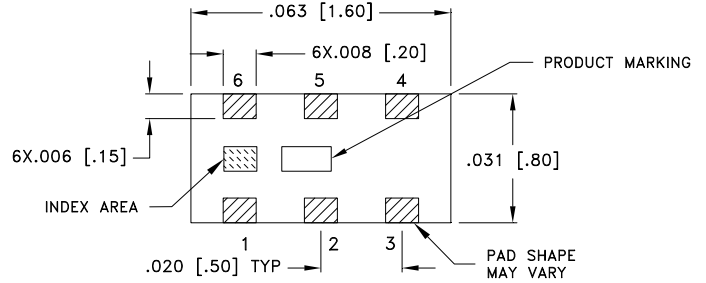
1. COPLANAR WAVEGUIDE PARAMETERS ARE SHOWN FOR ROGERS (R03003) WITH DIELECTRIC THICKNESS .020±.001 COPPER: 1/2 Oz. EACH SIDE. FOR OTHER MATERIALS TRACE WIDTH AND GAP MAY NEED TO BE MODIFIED.
  2. BOTTOM SIDE OF THE PCB IS CONTINUOUS GROUND PLANE.
-  DENOTES PCB COPPER PATTERN WITH SMOBC (SOLDER MASK OVER BARE COPPER)  
 DENOTES PCB COPPER PATTERN FREE OF SOLDERMASK

Figure 2. Suggested PCB Layout PL-704

### CASE STYLE DRAWING



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

### PRODUCT MARKING\*: VP

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



LTCC SURFACE MOUNT

# Thru-Line

## TPCW-233+

Mini-Circuits

50Ω DC to 23 GHz

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	JC0603C Lead Finish: Nickel-Tin
RoHS Status	Compliant
Tape and Reel	TR-F114
Suggested Layout for PCB Design	98-PL-704
Evaluation Board	TB-TPCW-233+
	Gerber File
Environmental Rating	ENV126

### 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](http://www.minicircuits.com/terms/viewterm.html)



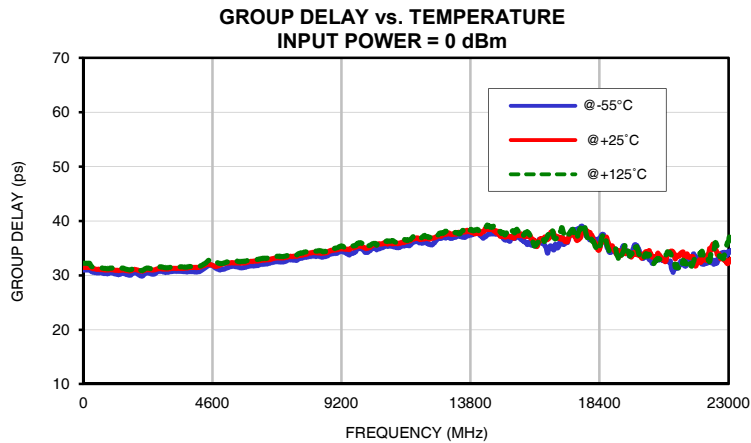
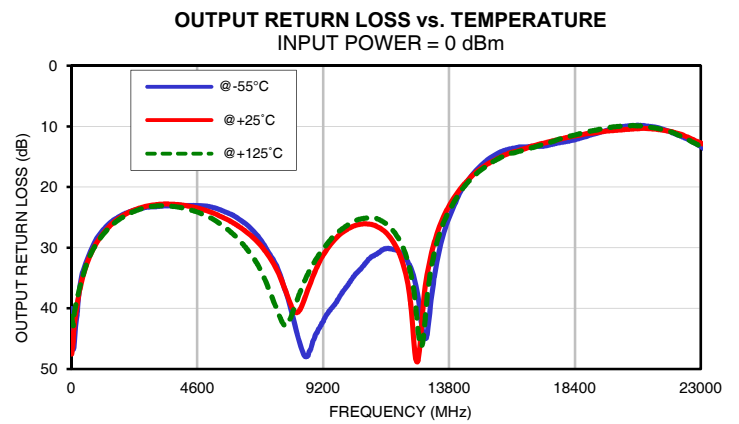
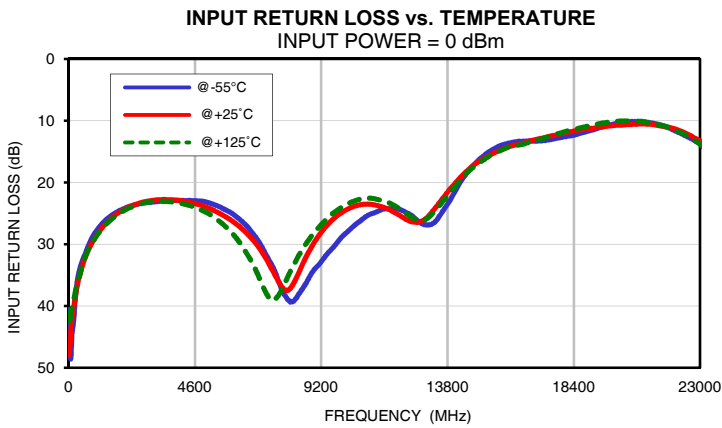
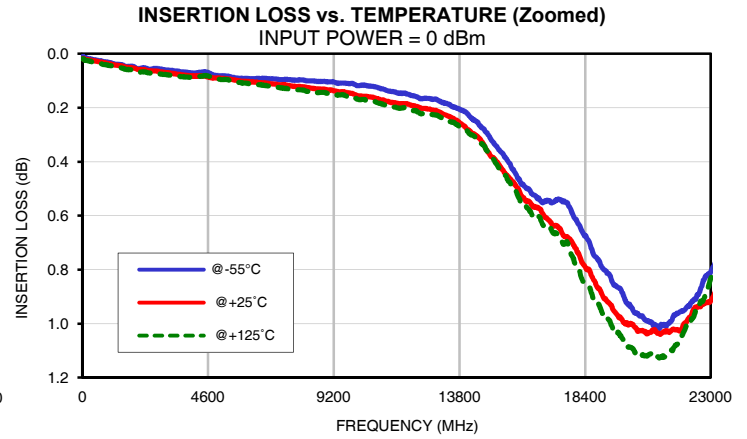
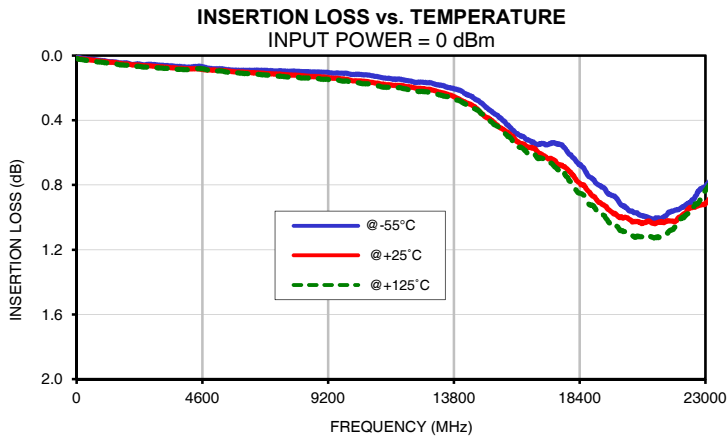
Typical Performance Data

FREQ. (MHz)	INSERTION LOSS			INPUT RETURN LOSS			OUTPUT RETURN LOSS		
	(dB)			(dB)			(dB)		
	@-55°C	@+25°C	@+125°C	@-55°C	@+25°C	@+125°C	@-55°C	@+25°C	@+125°C
10	0.01	0.02	0.02	40.59	48.03	40.87	40.04	47.54	41.32
100	0.02	0.02	0.02	47.51	43.14	41.06	45.94	42.93	40.99
200	0.02	0.02	0.03	41.90	39.98	38.89	41.33	39.83	38.78
250	0.02	0.02	0.03	38.74	38.45	37.69	38.62	38.33	37.62
300	0.02	0.02	0.03	36.75	37.19	36.81	36.71	37.08	36.71
350	0.02	0.03	0.03	35.21	36.10	35.94	35.33	36.02	35.88
400	0.02	0.03	0.03	34.16	35.16	35.11	34.28	35.10	35.05
500	0.02	0.03	0.03	32.76	33.57	33.51	32.87	33.53	33.49
550	0.02	0.03	0.03	32.20	32.89	32.81	32.29	32.86	32.79
600	0.03	0.03	0.04	31.66	32.27	32.16	31.74	32.24	32.17
650	0.03	0.03	0.04	31.08	31.70	31.59	31.16	31.67	31.60
700	0.03	0.03	0.04	30.51	31.17	31.09	30.60	31.14	31.11
750	0.03	0.03	0.04	29.95	30.68	30.63	30.05	30.65	30.66
800	0.03	0.03	0.04	29.45	30.22	30.22	29.54	30.19	30.24
850	0.03	0.04	0.04	29.01	29.80	29.85	29.09	29.77	29.86
900	0.03	0.04	0.04	28.62	29.40	29.49	28.67	29.37	29.48
950	0.03	0.04	0.04	28.27	29.03	29.14	28.31	28.99	29.12
1000	0.03	0.04	0.04	27.93	28.68	28.79	27.97	28.64	28.78
1050	0.03	0.04	0.04	27.63	28.35	28.47	27.67	28.31	28.46
1100	0.04	0.04	0.05	27.33	28.04	28.16	27.37	28.00	28.15
1150	0.04	0.04	0.05	27.06	27.74	27.87	27.10	27.70	27.86
1200	0.04	0.04	0.05	26.81	27.46	27.60	26.85	27.42	27.59
2000	0.05	0.06	0.07	24.25	24.41	24.59	24.30	24.40	24.62
2500	0.06	0.06	0.07	23.54	23.45	23.62	23.58	23.45	23.66
3000	0.06	0.07	0.08	23.19	22.93	23.14	23.27	22.95	23.18
3500	0.06	0.08	0.08	22.99	22.76	23.03	23.09	22.80	23.10
4000	0.07	0.08	0.09	22.89	22.88	23.28	23.01	22.94	23.37
4500	0.07	0.08	0.08	22.92	23.29	23.85	23.03	23.34	23.95
5000	0.08	0.09	0.09	23.13	23.97	24.80	23.17	23.98	24.88
5500	0.09	0.10	0.10	23.93	24.99	26.30	23.85	24.93	26.25
6000	0.09	0.10	0.11	25.13	26.34	28.42	24.89	26.13	28.13
6500	0.09	0.11	0.12	27.08	28.25	31.56	26.55	27.77	30.72
7000	0.09	0.11	0.12	30.09	30.94	35.99	29.23	30.06	34.51
7500	0.10	0.12	0.13	34.25	34.81	39.01	32.99	33.55	40.08
8000	0.10	0.12	0.13	39.02	37.45	35.13	39.71	39.19	41.71
8500	0.10	0.13	0.14	37.33	33.47	30.94	47.67	38.73	35.75
9000	0.10	0.13	0.15	33.86	29.35	27.83	43.77	32.95	31.47
9500	0.11	0.14	0.15	31.16	26.51	25.49	40.00	29.29	28.52
10000	0.12	0.15	0.17	28.61	24.72	23.87	36.79	27.20	26.57
10500	0.12	0.16	0.18	26.62	23.72	22.85	33.83	26.17	25.34
11000	0.13	0.17	0.19	25.12	23.51	22.53	31.40	26.19	25.01
11500	0.14	0.18	0.20	24.25	24.07	22.98	30.14	27.52	26.02
12000	0.15	0.19	0.21	24.30	25.18	24.09	30.72	31.13	28.85
12500	0.17	0.20	0.22	25.37	26.35	25.62	34.46	44.60	36.54
13000	0.17	0.21	0.23	26.83	25.88	25.97	44.31	34.43	38.16
13500	0.19	0.24	0.25	25.47	23.26	23.80	29.34	25.92	27.08
14000	0.22	0.27	0.28	22.05	20.52	21.07	22.96	21.66	22.36
14500	0.26	0.31	0.32	18.47	18.16	18.47	18.91	18.84	19.19
15000	0.32	0.38	0.39	16.09	16.44	16.65	16.33	16.84	17.09
15500	0.39	0.45	0.45	14.54	15.19	15.30	14.67	15.51	15.60
16000	0.47	0.51	0.54	13.65	14.21	14.31	13.74	14.40	14.54
16500	0.52	0.57	0.60	13.33	13.67	13.83	13.38	13.76	13.96
17000	0.54	0.61	0.63	13.28	13.05	13.22	13.29	13.07	13.29
17500	0.54	0.65	0.69	13.08	12.53	12.58	13.03	12.48	12.61
18000	0.61	0.71	0.77	12.65	12.04	11.85	12.57	11.94	11.84
18500	0.69	0.80	0.86	12.21	11.61	11.29	12.08	11.51	11.30
19000	0.79	0.89	0.95	11.55	11.24	10.77	11.36	11.11	10.75
20000	0.93	1.00	1.09	10.39	10.72	10.07	10.13	10.60	9.99
21000	1.01	1.03	1.12	10.20	10.50	10.17	9.93	10.32	10.00
23000	0.81	0.91	0.83	13.71	13.27	13.81	13.29	12.73	13.37

*Typical Performance Data*

FREQ.  (MHz)	GROUP DELAY		
	(psec)		
	@-55°C	@+25°C	@+125°C
10	30.98	31.47	32.18
500	30.45	31.10	31.40
1000	30.49	31.03	31.34
1500	30.23	30.88	31.15
2000	30.03	30.85	31.02
2500	30.19	30.99	31.13
3000	30.56	31.16	31.40
3500	30.71	31.27	31.54
4000	30.62	31.43	31.54
4500	31.86	32.01	32.82
5000	31.16	32.14	32.23
5500	31.51	32.26	32.59
6000	31.75	32.58	32.84
6500	32.13	32.85	33.12
7000	32.47	33.21	33.50
7500	32.84	33.52	33.82
8000	33.41	33.97	34.33
8500	33.34	34.03	34.43
9000	34.01	34.71	34.98
9500	33.83	34.78	35.16
10000	34.55	35.15	35.61
10500	34.95	35.76	35.80
11000	35.31	35.82	36.40
11500	35.49	36.22	36.47
12000	35.96	36.58	37.00
12500	35.99	36.91	36.93
13000	37.11	37.69	38.07
13500	37.04	37.91	38.14
14000	37.81	37.86	38.38
14500	37.62	38.44	38.87
15000	36.60	37.31	37.68
15500	37.25	37.36	38.13
16000	35.61	36.64	36.62
16500	35.09	36.64	36.71
17000	36.20	36.78	37.97
17500	38.03	37.20	37.38
18000	37.11	37.90	36.58
18500	37.52	36.41	37.13
20000	33.58	33.61	33.41
21000	30.90	34.42	32.86
23000	34.09	32.30	36.22

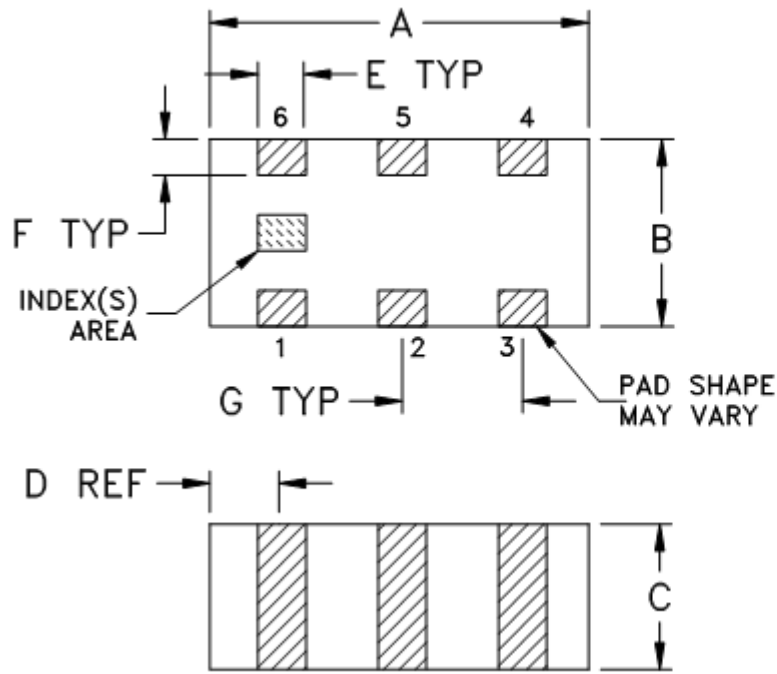
## Typical Performance Curves



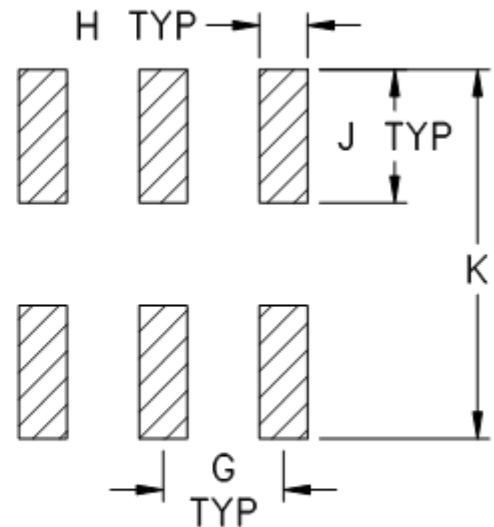


## Outline Dimensions

JC0603C



## PCB Land Pattern



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

CASE #	A	B	C	D	E	F	G	H	J	K	WT. GRAM
JC0603C	.063 (1.60)	.031 (0.80)	.024 (0.60)	.012 (0.30)	.008 (0.20)	.006 (0.15)	.020 (0.50)	.010 (0.25)	.022 (0.55)	0.053 (1.35)	.005

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

### Notes:

1. Open style, ceramic base.
2. Termination finish:  
For RoHS Case Styles: Tin plate over Nickel plate. All models, (+) suffix.



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-F114

## DEVICE ORIENTATION IN T&R

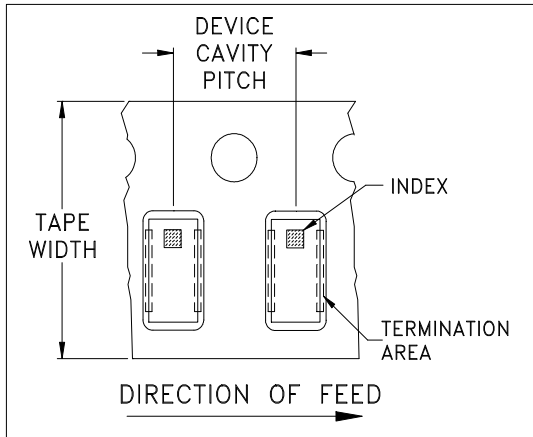


ILLUSTRATION 1

Applicable Case Styles	
GE0805C	JC0603C
GE0805C-1	JC0603C-4
GE0805C-1AP	JC0603C-6
GE0805C-7	
GE0805C-9	
GE0805C-10	
GE0805C-11	
GE0805C-12	

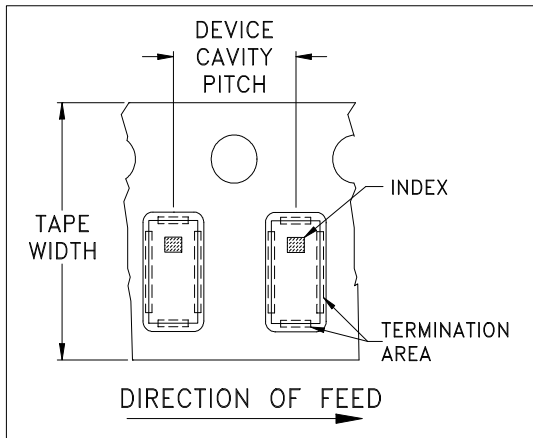


ILLUSTRATION 2

Applicable Case Styles	
GE0805C-2	JC0603C-1
GE0805C-3	JC0603C-2
GE0805C-4	JC0603C-3
GE0805C-5	JC0603C-5
GE0805C-6	JC0603C-7
GE0805C-8	JV1210C-1
GE0805C-15	

Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel	
8	4	7	Small quantity standards (see note)	20
				50
				100
				200
				500
				1000
			Standard	4000

Note: Please Consult individual model data sheet to determine device per reel availability.

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)



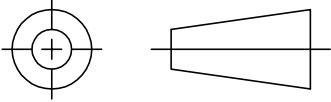
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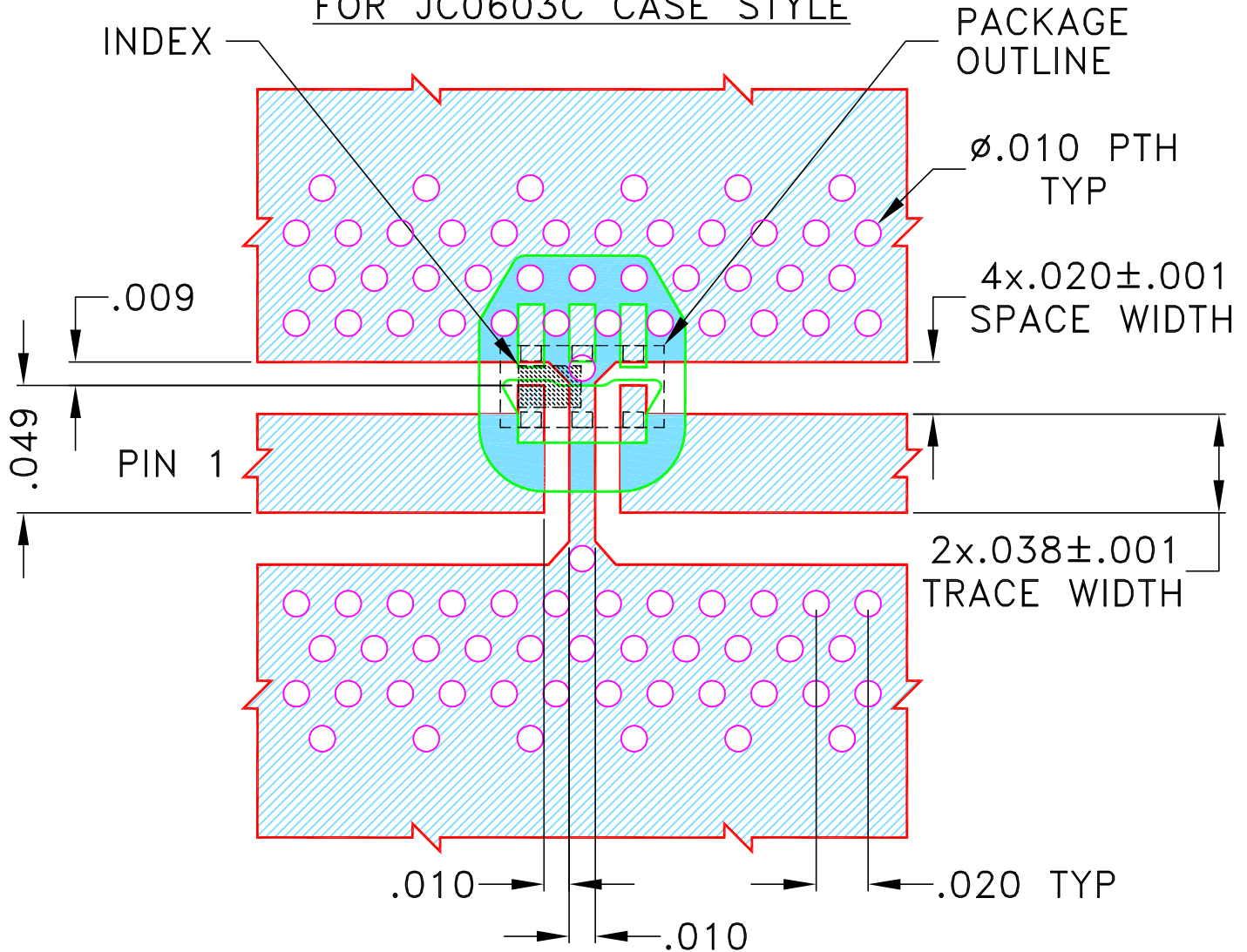
THIRD ANGLE PROJECTION



REVISIONS



REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	ECO-006344	NEW RELEASE	FEB 21	KKR	VC

SUGGESTED MOUNTING CONFIGURATION  
FOR JC0603C CASE STYLE



NOTES:

1. COPLANAR WAVEGUIDE PARAMETERS ARE SHOWN FOR ROGERS (R03003) WITH DIELECTRIC THICKNESS  $.020 \pm .001$  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 PATTERN WITH SMOBC (SOLDER MASK OVER BARE COPPER)  
 DENOTES PCB COPPER PATTERN FREE OF SOLDERMASK

UNLESS OTHERWISE SPECIFIED	INITIALS	DATE
DIMENSIONS ARE IN INCHES	DRAWN KKR	17 FEB 21
TOLERANCES ON:	CHECKED DDR	17 FEB 21
2 PL DECIMALS ±	APPROVED RV	17 FEB 21
3 PL DECIMALS ± .005		
ANGLES ±		
FRACTIONS ±		

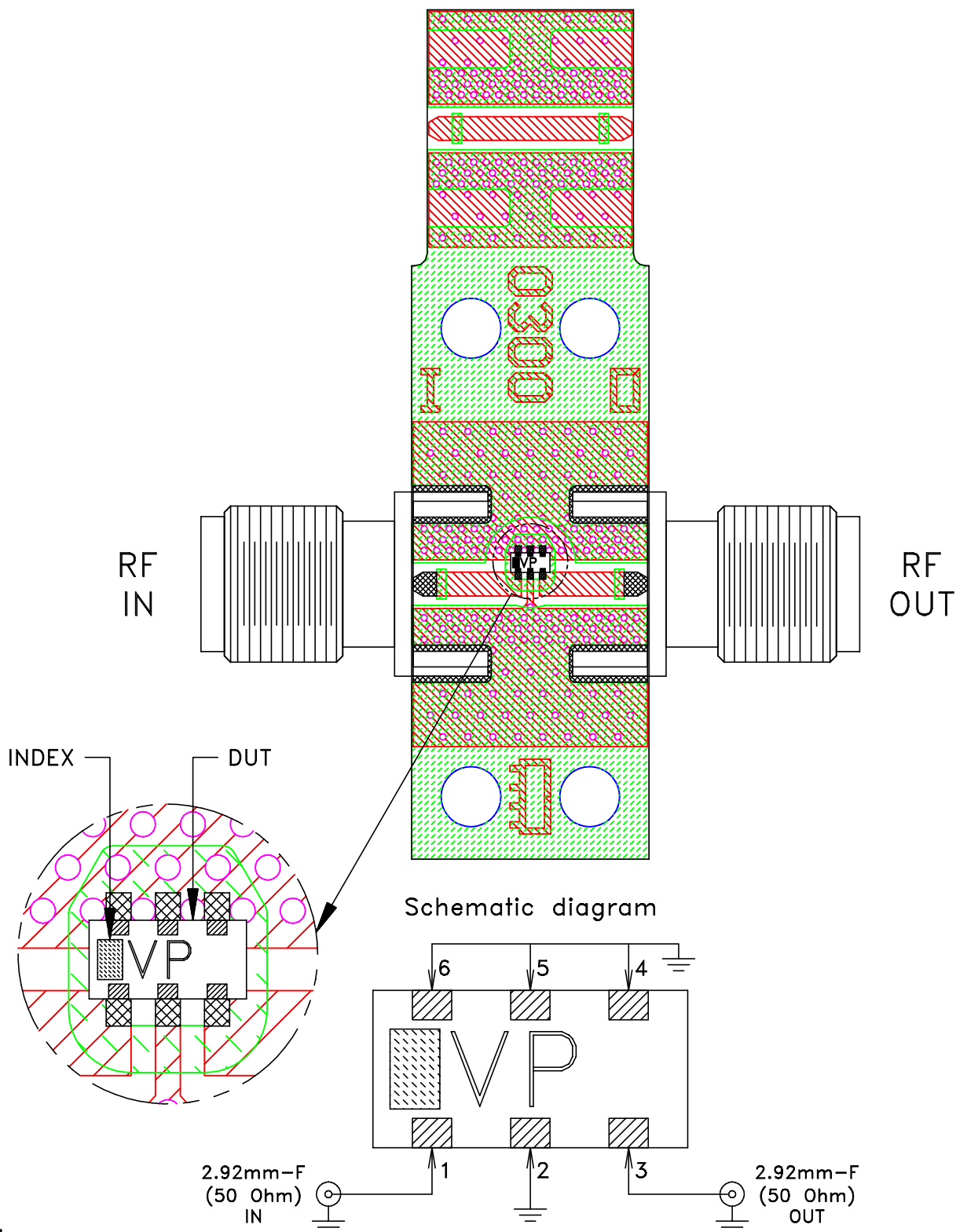
 **Mini-Circuits®** 13 Neptune Avenue  
Brooklyn NY 11235

PL DWG, JC0603C C.S, 50 OHM, HFCW

Mini-Circuits®		SIZE	CODE IDENT	DRAWING NO:	REV:
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ASHEETA1.DWG REV:A DATE:01/12/95	FILE:	98PL704	SCALE:	15:1	SHEET: 1 OF 1


# Evaluation Board and Circuit

TB-TPCW-233+



## Notes:

1. PCB Material: ROGERS (R03003) OR Equivalent, Dielectric Constant= $3.00 \pm 0.04$   
Dielectric Thickness:  $.020 \pm 0.001$
2. 50 Ohm 2.92mm Female Connectors.
3. Connectors on the test board shall not be subjected to temperature greater than 200°C to avoid permanent damage to the connectors.

 **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.

<b>Specification</b>	<b>Test/Inspection Condition</b>	<b>Reference/Spec</b>
Operating Temperature	-55° to 125° C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-55° to 125° C Ambient Environment	Individual Model Data Sheet
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
Solder Reflow Heat	Sn-Pb Eutectic Process 225°C peak Pb-Free Process 245° - 250°C peak	J-STD-020C, 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, 10-2000 Hz, 12 times in each of three perpendicular directions (total 36)	MIL-STD-202, Method 204, Condition D
Mechanical Shock	50g, 11 ms, 1/2-sine, 18 shocks: 3 each direction, each of 3 axes	MIL-STD-202, Method 213, Condition A