LTCC SURFACE MOUNT

Power Splitter/Combiner QCS-502+

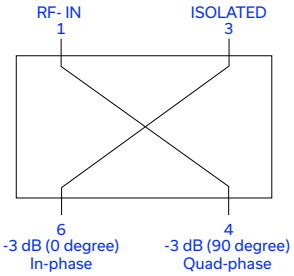
2 Way-90° 50Ω 2500 to 5000 MHz

THE BIG DEAL

- Compact 0805 Form Factor
- Broadband Quadrature Performance
- Wideband Accuracy and Isolation

Generic photo used for illustration purposes only

FUNCTIONAL DIAGRAM



APPLICATIONS

- 5G / Sub-6 GHz Infrastructure
- I/Q and Image Reject Architectures
- Balanced Amplifiers
- Phased Array Radars

PRODUCT OVERVIEW

Mini-Circuits' new 90° Power Splitter, model QCS-502+, offers an industry leading combination of operating bandwidth and size by supporting a full octave band in a miniature EIA-0805 form factor. The outstanding phase and amplitude unbalance make this component a versatile building block for use in a variety of systems and sub-system designs.

KEY FEATURES

Features	Advantages
Small Size	Offered in the EIA-0805 package size, the QCS-502+ offers an industry leading combination of size, bandwidth and frequency. The small footprint (2.0mm x1.25mm) allows for reduced parasitics in systems with improved performance and simplified layout
Low Phase and Amplitude Unbalance	Supporting 1.5 deg. and 0.7 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 balanced amplifiers.
High Power Handling	Capable of operating up to 8W, the LTCC construction of the QCS-502+ makes this 90° hybrid a robust, rugged product that can be used effectively in either the transmit or receive path

REV. OR
ECO-029654
QCS-502+
MCL NY
260521

Power Splitter/Combiner QCS-502+

2 Way-90° 50Ω 2500 to 5000 MHz

ELECTRICAL SPECIFICATIONS[1,2] AT +25 °C, Z_0 = 50Ω

Parameter	Frequency (MHz)	Min.	Typ.	Max.	Unit
Frequency Range		2500	-	5000	MHz
Average Insertion Loss, above 3.0 dB[3]	2500 – 3300	-	0.5	0.6	dB
	3300 – 3800	-	0.5	0.6	
	3800 – 4200	-	0.4	0.5	
	4200 – 5000	-	0.5	0.6	
Isolation	2500 – 3300	15	17	-	dB
	3300 – 3800	15	17	-	
	3800 – 4200	16	18	-	
	4200 – 5000	17	20	-	
Phase Unbalance (±)	2500 – 3300	-	1.8	3.5	Degree
	3300 – 3800	-	1.5	3.5	
	3800 – 4200	-	2	3.5	
	4200 – 5000	-	3.2	4.5	
Amplitude Unbalance (±)	2500 – 3300	-	1	1.3	dB
	3300 – 3800	-	0.7	1	
	3800 – 4200	-	0.7	1	
	4200 – 5000	-	0.7	1	
Return Loss (Input, -3 dB (0°), -3 dB (-90°), Isolated)	2500 – 3300	12.7	15.5	-	dB
	3300 – 3800	14	17.7	-	
	3800 – 4200	17.7	20.8	-	
	4200 – 5000	15.5	17.7	-	

1. Tested on Evaluation Board P/N TB-QCS-502C+ with the connector and feedline effects de-embedded using the 2X Thru IEEE P370 method
2. Symmetrical, all ports are interchangeable. See Pad Description table and S-parameters for actual performance.
3. See Page 3 for average insertion loss data vs. frequency

ABSOLUTE MAXIMUM RATINGS[4]

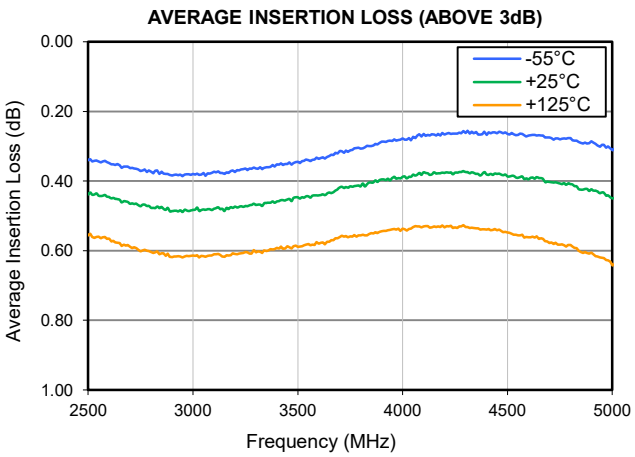
Parameter	Ratings
Operating Temperature	-55 °C to +125 °C
Storage Temperature	-55 °C to +125 °C
Power Input (as a splitter)[5]	8 W at +25 °C

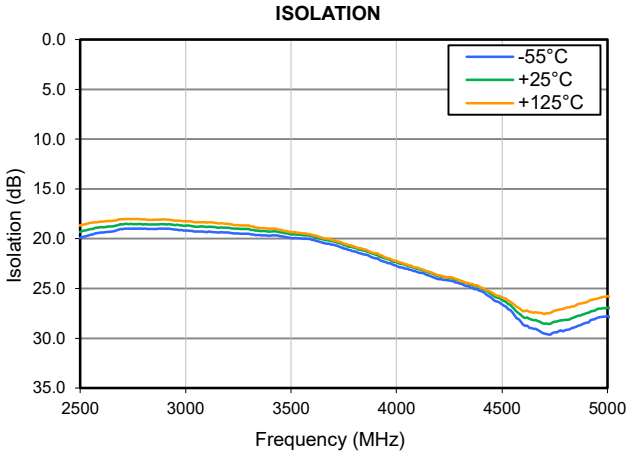
4. Permanent damage may occur if any of these limits are exceeded.
5. At +25 °C derate linearly to 2.25 W at +125 °C.

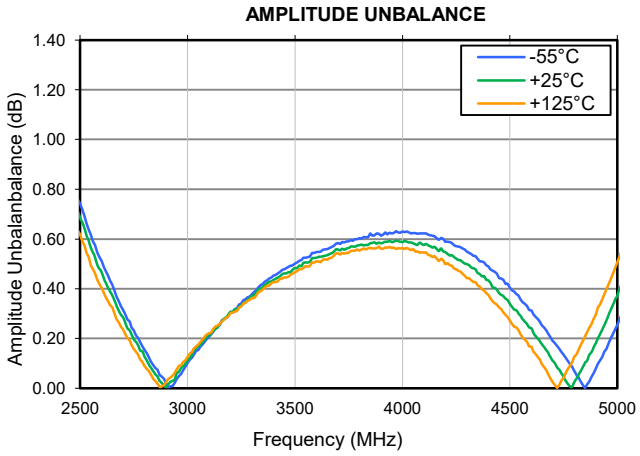
Power Splitter/Combiner QCS-502+

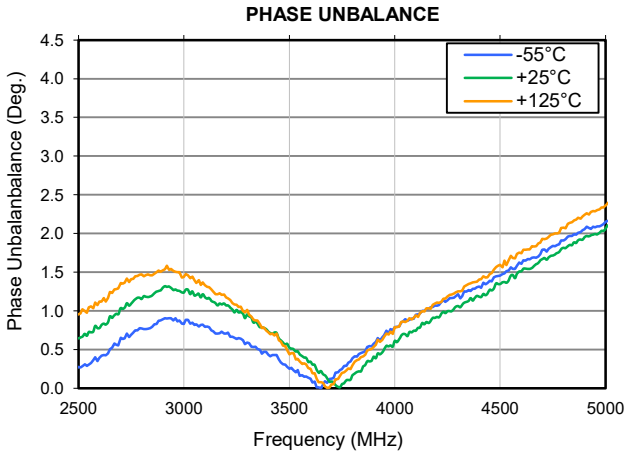
2 Way-90° 50Ω 2500 to 5000 MHz

TYPICAL PERFORMANCE GRAPHS







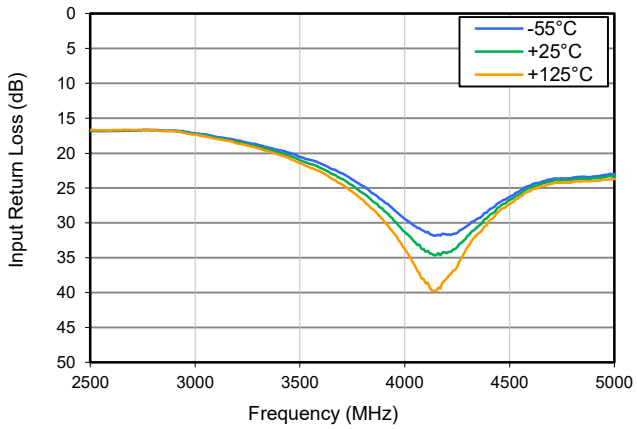


Power Splitter/Combiner QCS-502+

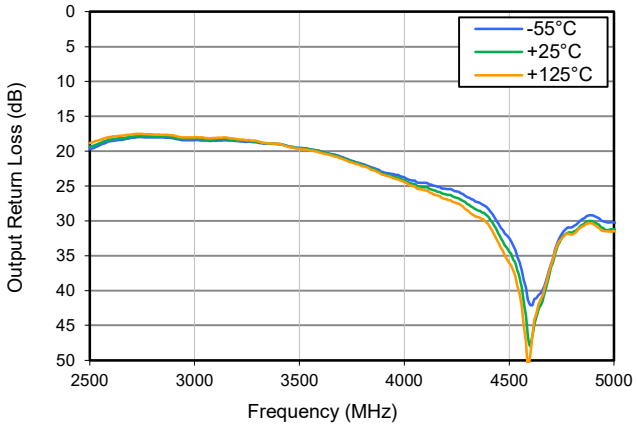
2 Way-90° 50Ω 2500 to 5000 MHz

TYPICAL PERFORMANCE GRAPHS

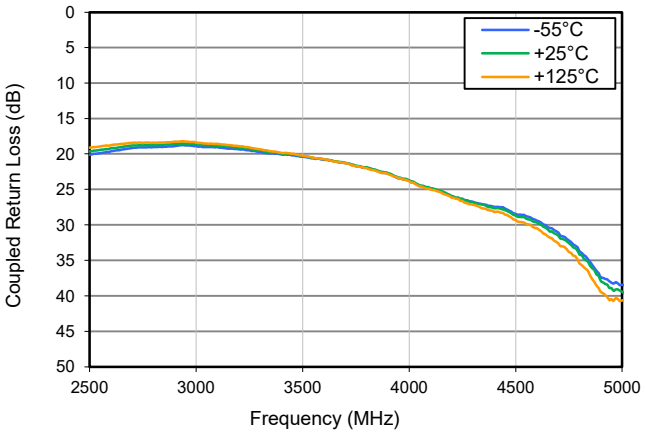
INPUT RETURN LOSS



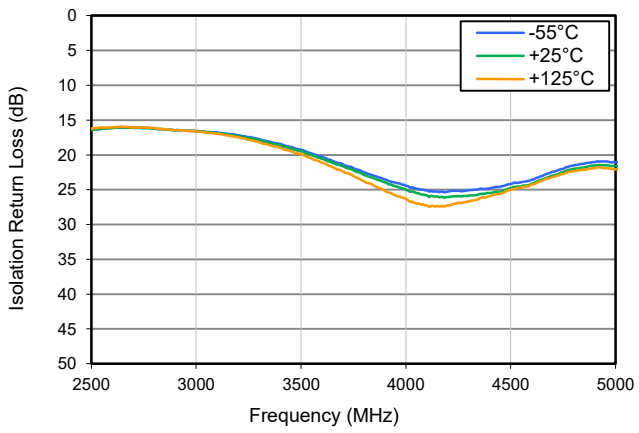
OUTPUT RETURN LOSS



COUPLED RETURN LOSS



ISOLATION RETURN LOSS



LTCC SURFACE MOUNT

Power Splitter/Combiner QCS-502+

2 Way-90° 50Ω 2500 to 5000 MHz

FUNCTIONAL DIAGRAM

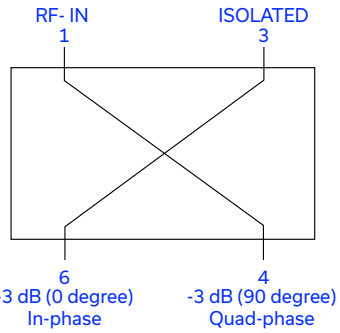
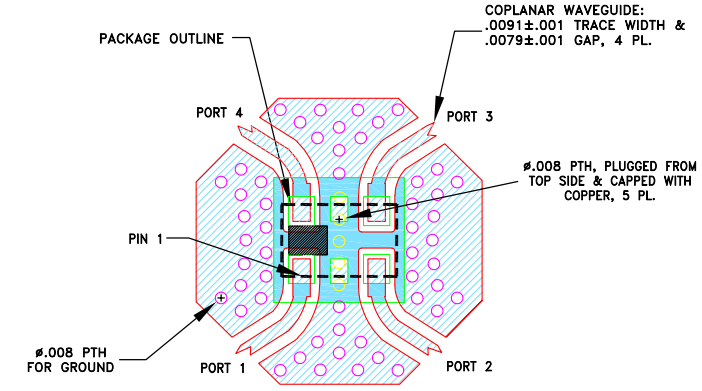


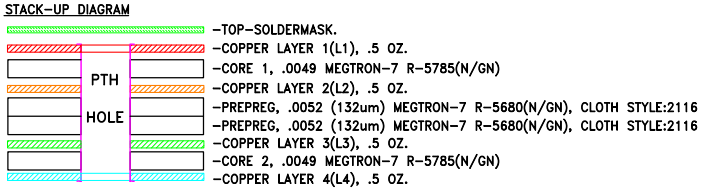
Figure 1. QCS-502+ Functional Diagram

PAD DESCRIPTION

Function	Pad Number	Description
RF Input	1	Connects to RF Input Port
Ground	2	Connects to Ground
Isolated	3	Connects to Isolated Port
-3 dB (-90°)	4	Connects to Quadrature Port
Ground	5	Connects to Ground
-3 dB (0°)	6	Connects to In-Phase Port

SUGGESTED PCB LAYOUT (PL-869)



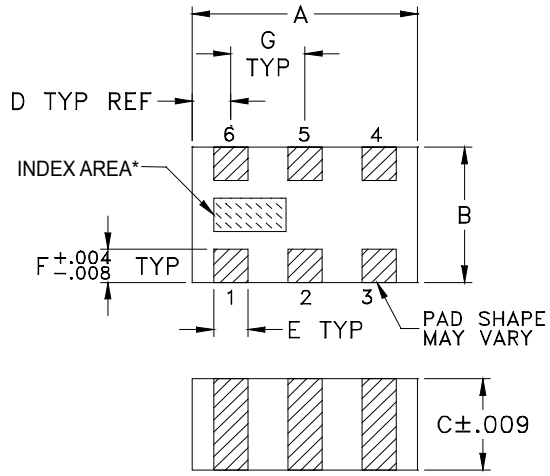


1. TOTAL FINISHED THICKNESS 0.0236±.004 .
2. PTH PRESENT FROM COPPER LAYER 1 TO COPPER LAYER 4.
3. INDICATED ON TOP VIEW PTH's ARE PLUGGED WITH EPOXY AND CAPPED WITH COPPER FROM TOP SIDE.
4. L2, L3 & L4 ARE CONTINUOUS GROUND PLANE.

NOTES:
1. TRACE WIDTH & GAP ARE SHOWN FOR MEGTRON-7 R-5785 WITH DIELECTRIC THICKNESS 0.0049±0.0005;COPPER 1/2 OZ.ON EACH SIDE.
   FOR OTHER MATERIALS TRACE WIDTH & GAP MAY NEED TO BE MODIFIED.
2. DENOTES PCB COPPER LAYOUT WITH SMOBC (SOLDER MASK OVER BARE COPPER).
3. DENOTES COPPER LAND PATTERN FREE OF SOLDER MASK.

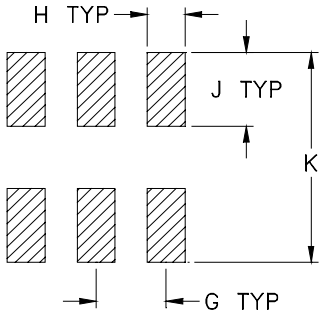
Figure 2. QCS-502+Suggested PCB Layout

OUTLINE DRAWING



*Shape of index marking may vary

PCB Land Pattern



Suggested Layout,
Tolerance to be within ±.002

OUTLINE DIMENSIONS (Inches / mm)

A	B	C	D	E	F
.079	.049	.033	.014	.012	.012
2.00	1.25	0.84	0.35	0.30	0.30

G	H	J	K		wt
.026	.014	.039	.110		grams
0.65	0.35	1.00	2.80		.008

Tolerances: 2Pl. + .01; 3 Pl. + .005

PRODUCT MARKING*: CP

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

Power Splitter/Combiner QCS-502+

2 Way-90° 50Ω 2500 to 5000 MHz

ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASHBOARD. CLICK HERE

Performance Data & Graphs	Data Graphs S-Parameter (S4P Files) Data Set (.zip file) De-embedded to device pads
Case Style	GE0805C-1 Lead Finish: Tin over Nickel Plating
RoHS Status	Compliant
Tape and Reel	F74
Suggested Layout for PCB Design	PL-869
Evaluation Board	TB-QCS-502C+ Gerber File
Environmental Rating	ENV06

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

LTCC 90 Degree Hybrid QCS-502+

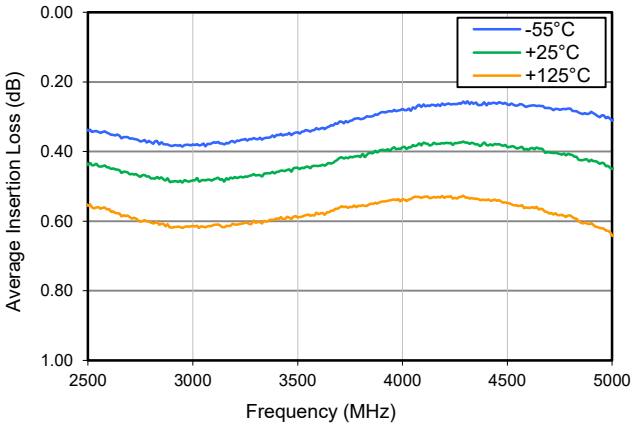
Typical Performance Data

FREQUENCY (GHz)	INSERTION LOSS (dB)			AMPLITUDE UNBALANCE (dB)			PHASE UNBALANCE (Degree)			ISOLATION (dB)		
	@+25°C	@-55°C	@+125°C	@+25°C	@-55°C	@+125°C	@+25°C	@-55°C	@+125°C	@+25°C	@-55°C	@+125°C
1000.00	1.67	1.62	1.73	7.58	7.66	7.49	0.87	0.65	0.95	23.85	24.21	23.60
1200.00	1.18	1.13	1.25	6.11	6.19	6.02	0.59	0.41	0.68	23.34	23.66	23.13
1400.00	0.85	0.79	0.92	4.88	4.95	4.78	0.45	0.25	0.51	22.95	23.30	22.69
1600.00	0.63	0.55	0.70	3.83	3.90	3.73	0.27	0.07	0.29	22.42	22.89	21.92
1800.00	0.50	0.42	0.58	2.93	3.01	2.84	0.14	0.10	0.19	21.87	22.39	21.24
2000.00	0.43	0.34	0.51	2.15	2.22	2.05	0.10	0.16	0.17	20.73	21.26	20.11
2500.00	0.44	0.34	0.56	0.69	0.74	0.62	0.64	0.28	0.95	19.32	19.92	18.67
2600.00	0.45	0.35	0.57	0.47	0.51	0.40	0.78	0.39	1.12	18.84	19.37	18.27
2700.00	0.47	0.36	0.59	0.29	0.32	0.24	1.03	0.65	1.36	18.57	19.05	18.07
2800.00	0.48	0.37	0.60	0.13	0.16	0.09	1.15	0.77	1.47	18.56	19.01	18.08
2900.00	0.49	0.38	0.62	0.00	0.02	0.02	1.30	0.89	1.53	18.56	19.01	18.08
3000.00	0.48	0.38	0.61	0.11	0.10	0.13	1.24	0.83	1.44	18.69	19.17	18.24
3100.00	0.48	0.37	0.61	0.21	0.21	0.22	1.18	0.80	1.33	18.81	19.31	18.38
3200.00	0.47	0.37	0.61	0.31	0.31	0.30	1.07	0.70	1.18	18.89	19.38	18.50
3300.00	0.47	0.36	0.60	0.37	0.38	0.36	0.95	0.59	1.01	19.03	19.50	18.70
3400.00	0.46	0.35	0.59	0.44	0.45	0.43	0.73	0.43	0.73	19.28	19.70	19.01
3500.00	0.45	0.34	0.59	0.48	0.50	0.47	0.52	0.25	0.44	19.58	19.94	19.35
3600.00	0.44	0.34	0.58	0.52	0.55	0.51	0.34	0.12	0.25	19.76	20.11	19.62
3700.00	0.42	0.31	0.56	0.56	0.58	0.54	0.09	0.13	0.05	20.25	20.59	20.15
3800.00	0.42	0.31	0.56	0.58	0.60	0.55	0.17	0.39	0.30	20.91	21.27	20.78
3900.00	0.40	0.29	0.54	0.58	0.61	0.56	0.41	0.57	0.53	21.58	21.98	21.47
4000.00	0.39	0.28	0.54	0.59	0.63	0.56	0.61	0.79	0.79	22.37	22.74	22.24
4100.00	0.37	0.27	0.53	0.58	0.62	0.55	0.74	0.95	0.94	23.02	23.37	22.93
4200.00	0.38	0.27	0.53	0.55	0.59	0.50	0.92	1.07	1.11	23.78	24.07	23.68
4300.00	0.37	0.26	0.53	0.50	0.55	0.44	1.06	1.22	1.25	24.23	24.51	24.19
4400.00	0.38	0.27	0.54	0.43	0.49	0.38	1.18	1.31	1.41	24.98	25.27	24.91
4500.00	0.39	0.26	0.55	0.34	0.41	0.27	1.35	1.46	1.60	26.17	26.61	25.91
4600.00	0.40	0.27	0.56	0.24	0.31	0.17	1.51	1.61	1.74	27.88	28.63	27.29
4700.00	0.40	0.27	0.58	0.11	0.19	0.02	1.67	1.79	1.93	28.55	29.53	27.56
4800.00	0.41	0.28	0.58	0.03	0.07	0.13	1.81	1.91	2.07	28.14	29.20	26.96
4900.00	0.42	0.29	0.61	0.18	0.08	0.30	1.95	2.06	2.24	27.48	28.43	26.37
5000.00	0.45	0.31	0.64	0.37	0.25	0.51	2.06	2.16	2.36	26.93	27.75	25.77
5500.00	0.63	0.45	0.87	1.73	1.54	1.97	2.91	2.88	3.40	25.67	26.84	24.30
6000.00	1.11	0.84	1.46	4.05	3.69	4.48	4.57	4.27	5.60	23.33	24.39	22.30
6500.00	2.48	1.99	3.11	8.15	7.45	9.05	7.89	6.59	10.35	21.11	22.07	20.39
7000.00	8.41	6.77	9.97	20.79	17.97	23.30	34.29	19.42	70.46	17.05	17.58	16.61
7500.00	3.62	3.94	3.40	8.91	10.36	7.42	22.52	21.63	23.37	13.16	13.10	13.27
8000.00	2.83	2.76	2.94	2.92	3.53	2.30	33.09	32.64	33.31	12.64	12.41	12.95

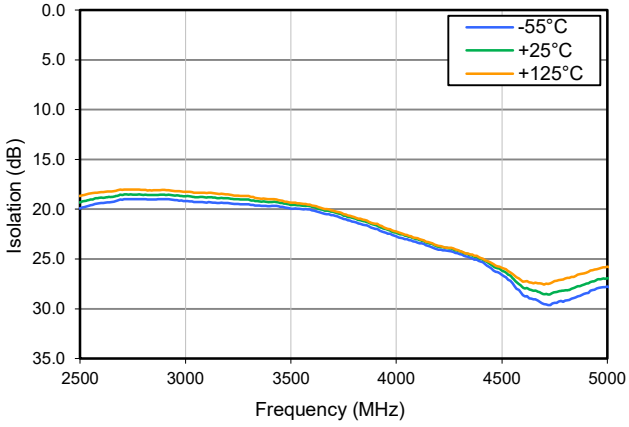
LTCC 2 Way-90° Power Splitter/Combiner QCS-502+

Typical Performance Data

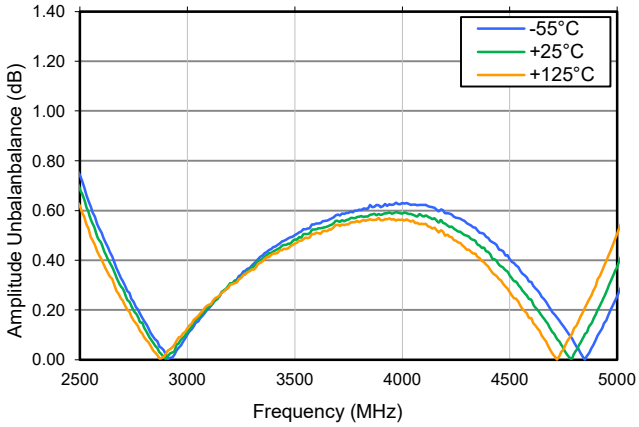
AVERAGE INSERTION LOSS (ABOVE 3dB)



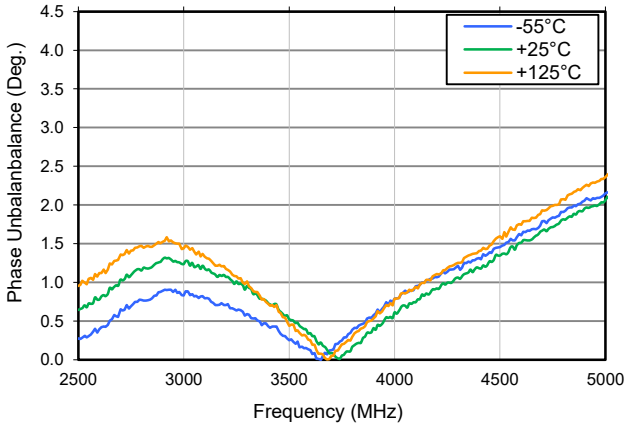
ISOLATION



AMPLITUDE UNBALANCE

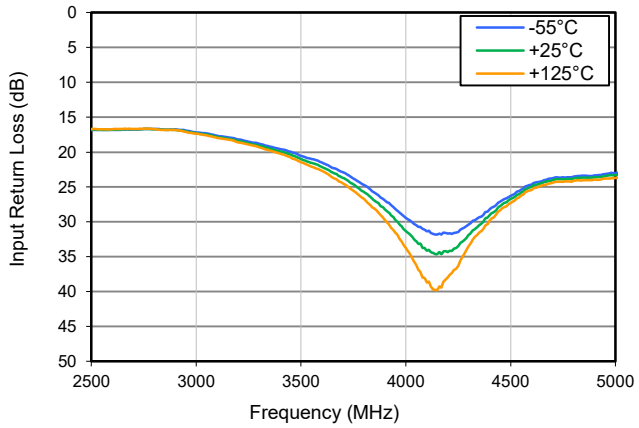


PHASE UNBALANCE

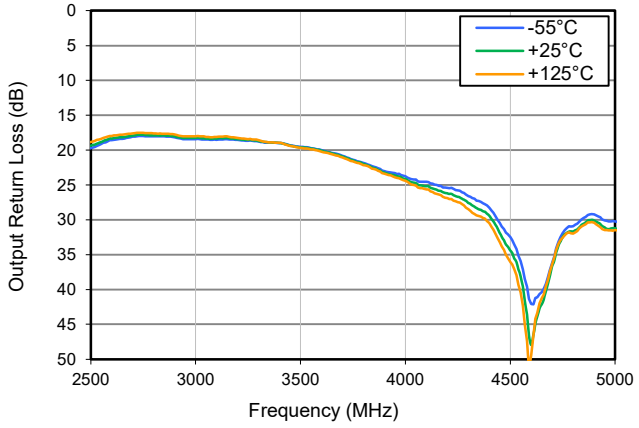


Typical Performance Data

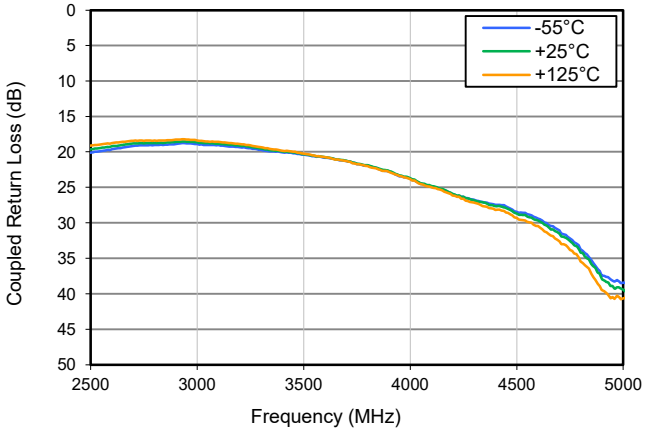
INPUT RETURN LOSS



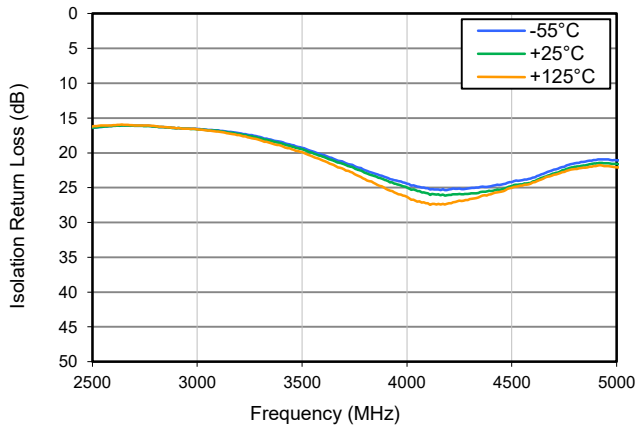
OUTPUT RETURN LOSS



COUPLED RETURN LOSS

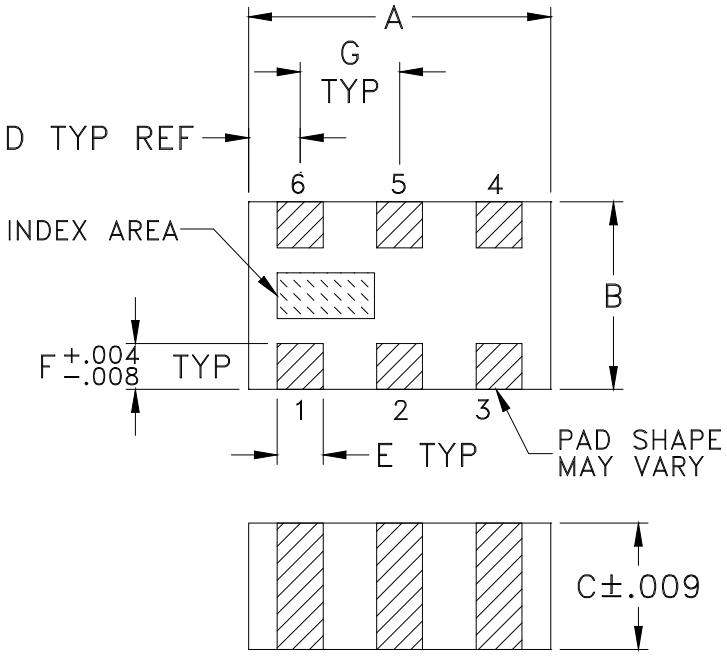


ISOLATION RETURN LOSS

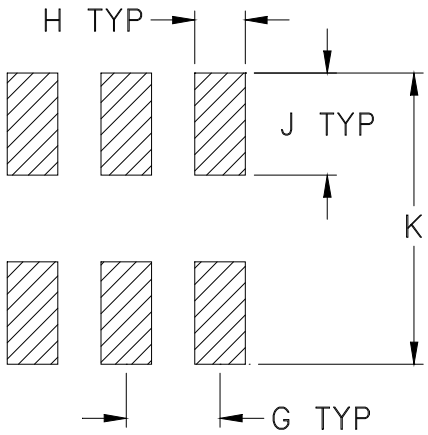


GE0805C-1

Outline Dimensions



PCB Land Pattern



Suggested Layout,
Tolerance to be within ±.002

CASE #	A	B	C	D	E	F	G	H	J	K	WT. GRAM
GE0805C-1	.079 (2.00)	.049 (1.25)	.033 (0.84)	.014 (0.35)	.012 (0.30)	.012 (0.30)	.026 (0.65)	.014 (0.35)	.039 (1.00)	.110 (2.80)	.008

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

Notes:

1. Open style, ceramic base.
2. Termination finish: For RoHS Case Styles: Tin plate over Nickel plate. All models, (+) suffix.
   For RoHS-5 Case Style: Tin-lead plate. All models, no (+) suffix.

Tape & Reel Packaging TR-F74

DEVICE ORIENTATION IN T&R

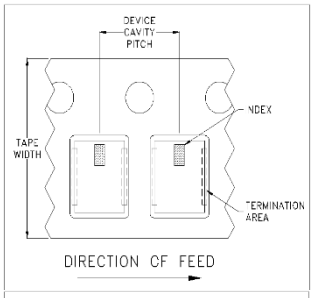


ILLUSTRATION 1

Applicable Case Styles
GE0805C-1
GE0805C-1AP
JV1210C-1
GU2939

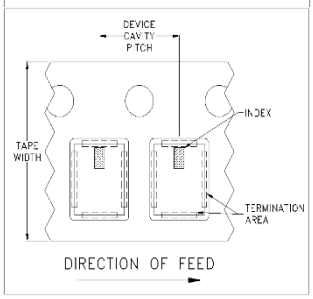


ILLUSTRATION 2

Applicable Case Styles
JV1210C
JV1210C-2
JV1210C-3
JV1210C-4
JV1210C-5
JV1210C-6
JV1210C-11

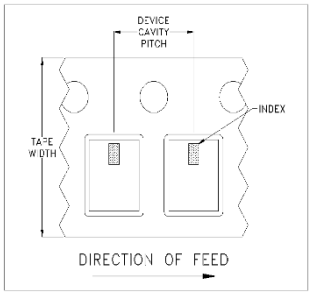


ILLUSTRATION 3

Applicable Case Styles
JC0603C-8
JC0603C-9
JV1210C-7
JV1210C-8
JV1210C-9
JV1210C-10
JV1210C-13
GE0805C-13
GE0805C-19
GE0805C-20

Tape Width, mm	Device Cavity Pitch, mm	Real Size, inches	Devices per Reel	
8	4	7	Small quantity standards **(see note)**	20
				50
				100
				200
				500
				1000
			Standard	2000
				4000

Note: Small reel availability 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

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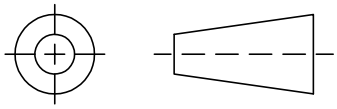
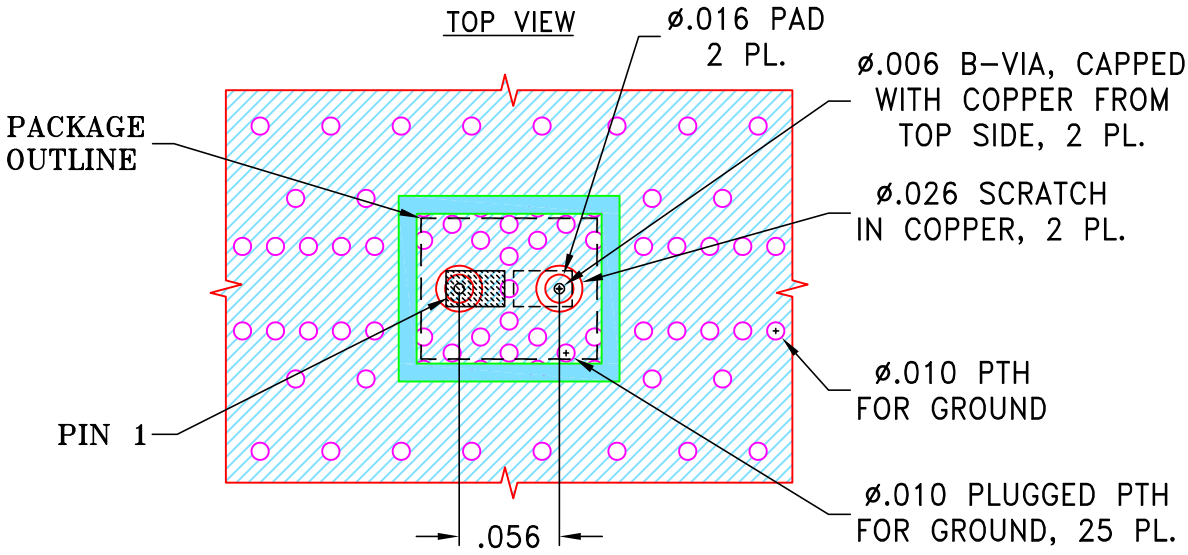
THIRD ANGLE PROJECTION

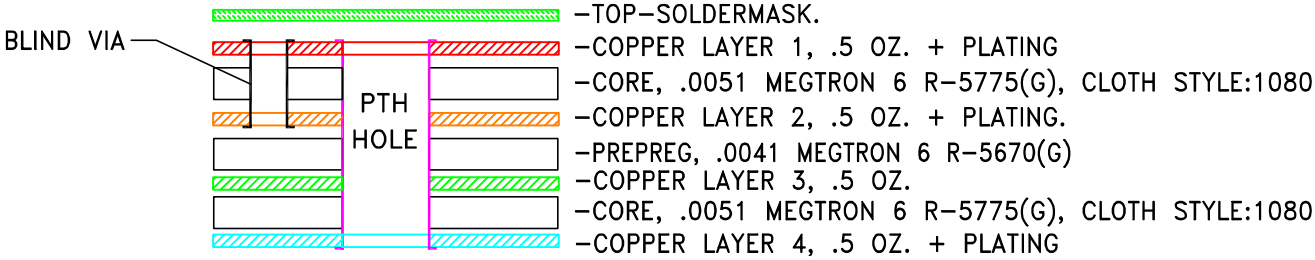


REVISIONS					
REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	ECO-023057	NEW RELEASE	SEP 24	AGS	GT

SUGGESTED MOUNTING CONFIGURATION FOR NL1008C-9 CASE STYLE



STACK-UP DIAGRAM



1. TOTAL FINISHED THICKNESS 0.0228±.004 .
2. B-VIA PRESENT FROM COPPER LAYER 1 TO COPPER LAYER 2.
3. PTH PRESENT FROM COPPER LAYER 1 TO COPPER LAYER 4.
4. INDICATED ON TOP VIEW PTH's ARE PLUGGED WITH EPOXY AND CAPPED WITH COPPER FROM TOP SIDE.
5. L4 IS CONTINUOUS GROUND PLANE.

NOTES:

1. PCB IS MULTILAYER, SEE STACK-UP DIAGRAM AND SHEET-2 FOR ILLUSTRATION.
2. TRACE WIDTH & GAP PARAMETERS ARE SHOWN FOR MEGTRON6 R-5775(G), CLOTH STYLE:1080 WITH DIELECTRIC THICKNESS .0051; COPPER: 1/2 OZ.+PLATING.
   FOR OTHER MATERIALS TRACE WIDTH AND GAP MAY NEED TO BE MODIFIED.
3. COPPER LAYER 4 OF THE PCB ARE 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	DRAWN	AGS	14 SEP 24
TOLERANCES ON:	CHECKED	MD	16 SEP 24
2 PL DECIMALS ±	APPROVED	GTP	17 SEP 24
3 PL DECIMALS ± .002			
ANGLES ±			
FRACTIONS ±			

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

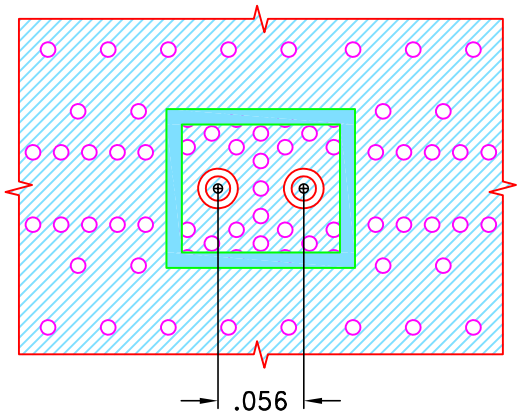
Mini-Circuits®
13 Neptune Avenue
Brooklyn NY 11235

PL, NL1008C-9, TB-LFHK-XXXX+

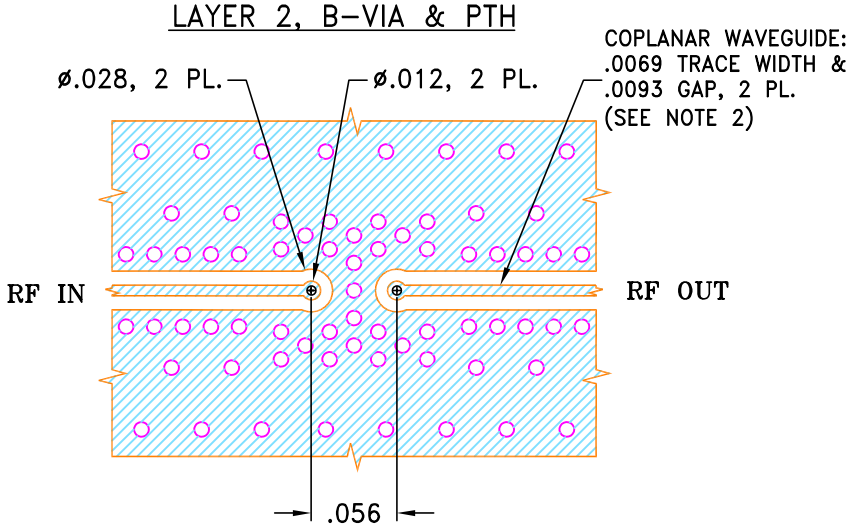
SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-798	OR

FILE:	SCALE:	SHEET:
98-PL-798	9:1	1 OF 2

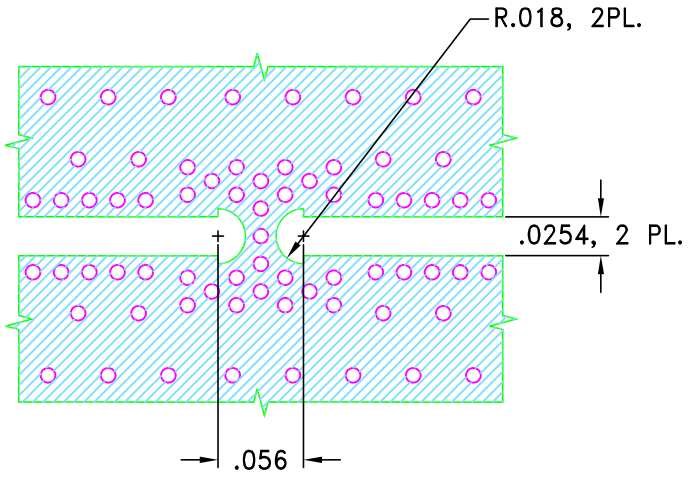
LAYER 1, SOLDER MASK & PTH



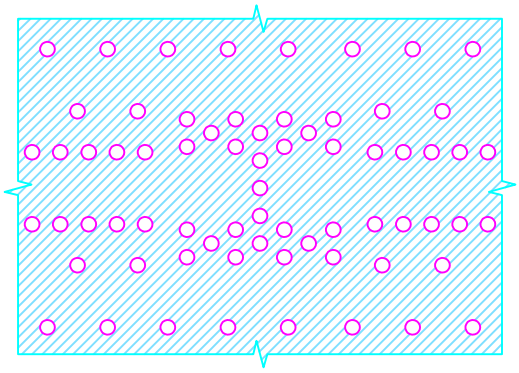
LAYER 2, B-VIA & PTH



LAYER 3 & PTH



LAYER 4 & PTH



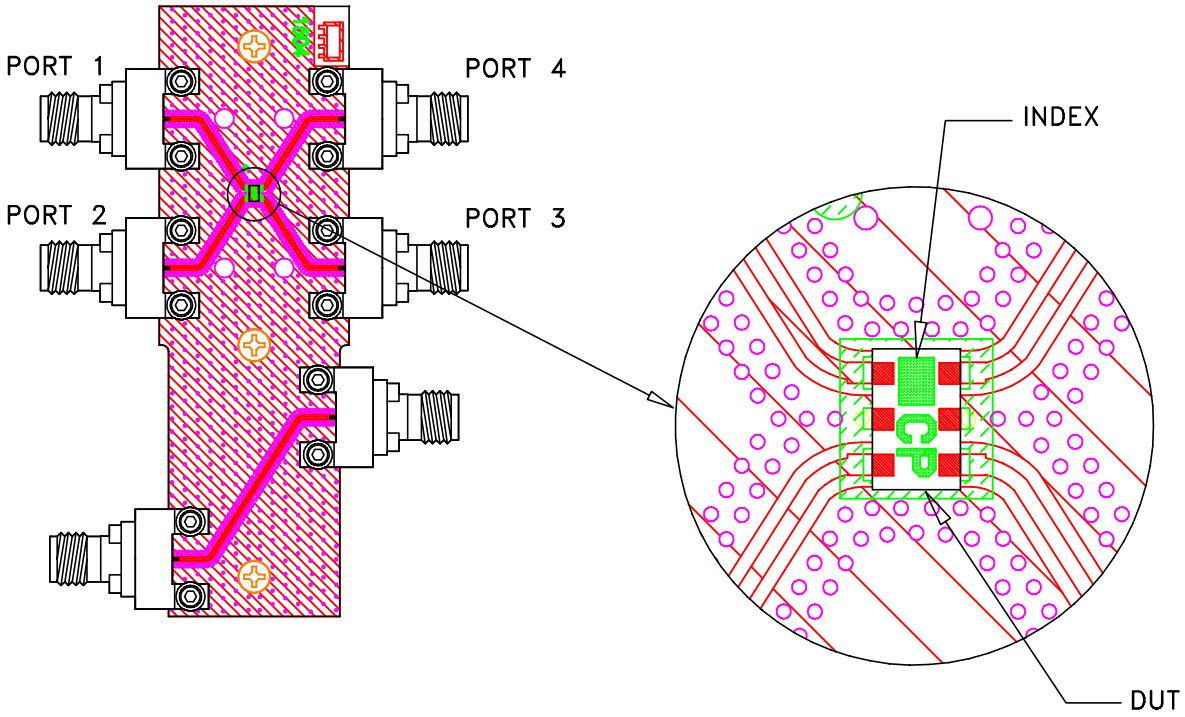
ASHEETA2.DWG REV:A DATE: 01/12/94

ALL DIMENSIONS ARE IN INCHES EXCEPT OTHERWISE SPECIFIED

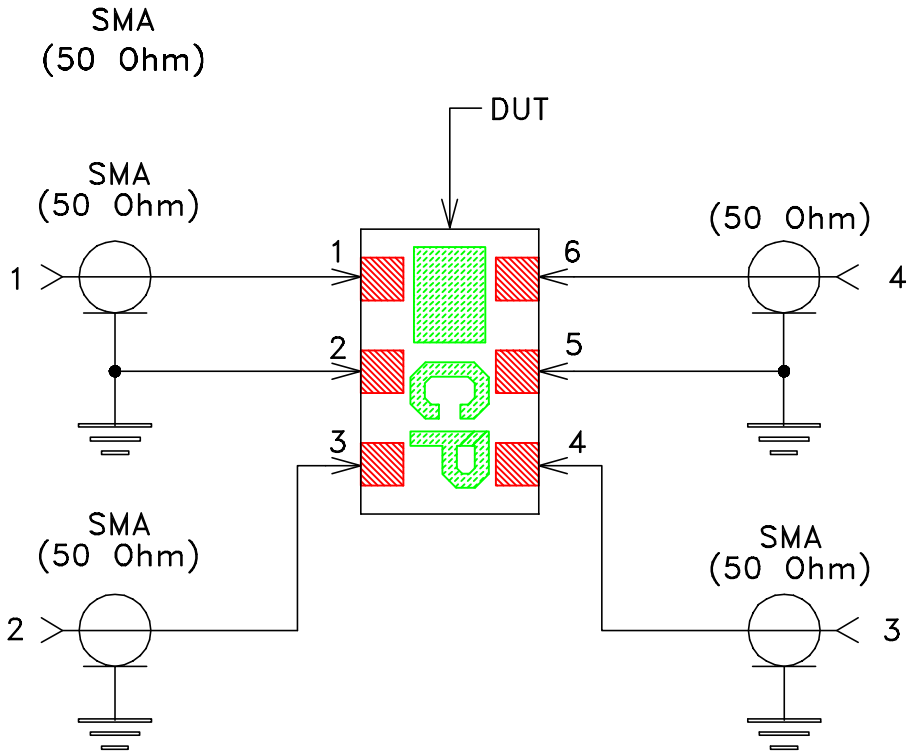
SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-798	OR

FILE:	SCALE:	SHEET:
98-PL-798	7.7:1	2 OF 2

Evaluation Board and Circuit



TB-QCS-502C+



Schematic Diagram

1. 50 Ohm 2.92 mm Female end Launch connectors.
2. PCB Material: MEGTRON-7 or equivalent,
   Dielectric Constant= 3.4 Thickness=.023 inch.

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Environmental Specifications ENV06

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	-55° to 100°C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-55° to 100° 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 Eutetic Process: 225°C peak Pb-Free Process 245° - 250°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, 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