

# Frequency Mixer

## TUF-2SM+

Level 7 (LO Power +7 dBm) 50 to 1000 MHz



Generic photo used for illustration purposes only  
CASE STYLE: NNN150

**+RoHS Compliant**

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

### Maximum Ratings

Operating Temperature	-55°C to 100°C
Storage Temperature	-55°C to 100°C
RF Power	50mW
IF Current	40mA

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

### Pin Connections

LO	4
RF	1
IF	2
GROUND	3
CASE GROUND	3

### Features

- low conversion loss, 5.85 dB typ.
- excellent L-R isolation, 47 dB typ.; L-I, 44 dB typ.
- wideband, 50 to 1000 MHz
- rugged welded construction

### Applications

- VHF/UHF
- cellular
- ISM/GSM

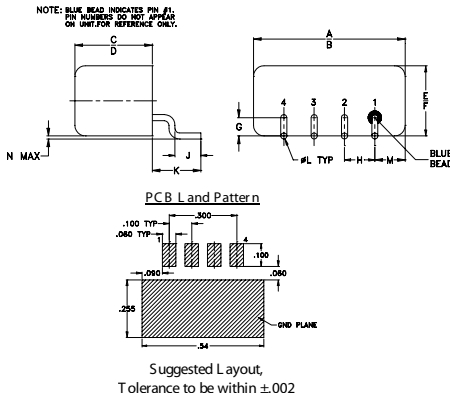
### Electrical Specifications

FREQUENCY (MHz)	CONVERSION LOSS (dB)	LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			IP3 @ CENTER BAND (dBm)										
		L	M	U	L	M	U											
50-1000	DC-1000	5.85	0.07	7.5	9.0	58	40	47	30	42	25	50	35	44	20	29	18	16

1 dB COMP: +1 dBm typ.

L = 50-100 MHz M = 100-500 MHz U = upper range [ $f_u/2$  to  $f_u$ ]  
m = mid band [ $2f_l$  to  $f_u/2$ ]

### Outline Drawing



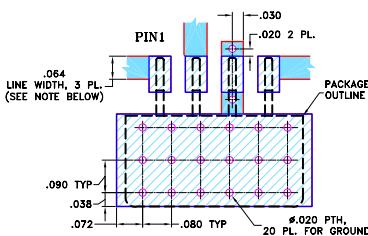
### Outline Dimensions (inch/mm)

A	B	C	D	E	F	G
.50	.48	.255	.240	.23	.21	.06
12.70	12.19	6.48	6.10	5.84	5.33	1.52

H	J	K	L	M	N	wt
.100	.09	.16	.020	.09	.005	grams
2.54	2.29	4.06	0.51	2.29	0.13	1.9

### Demo Board MCL PIN: TB-201 Suggested PCB Layout (PL-081)



- NOTES: 1. TRACE WIDTH IS SHOWN FOR ROGERS RO4350B WITH DIELECTRIC THICKNESS  $0.030 \pm 0.002$ ; 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 SOLDER MASK

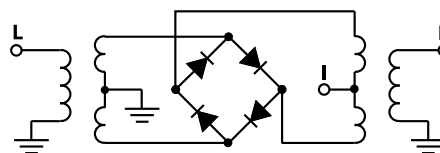
#### Notes

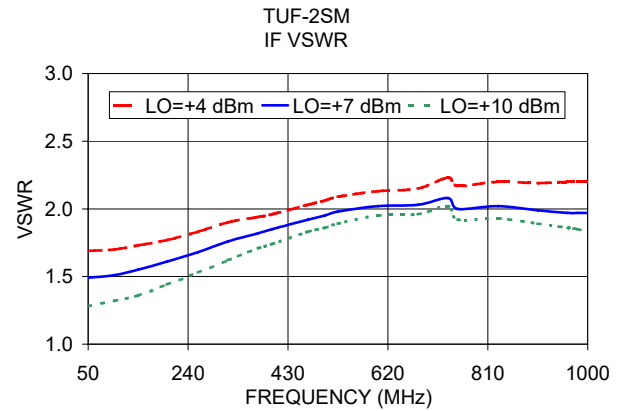
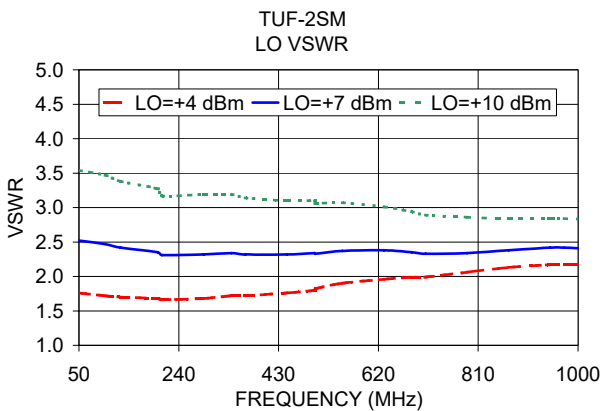
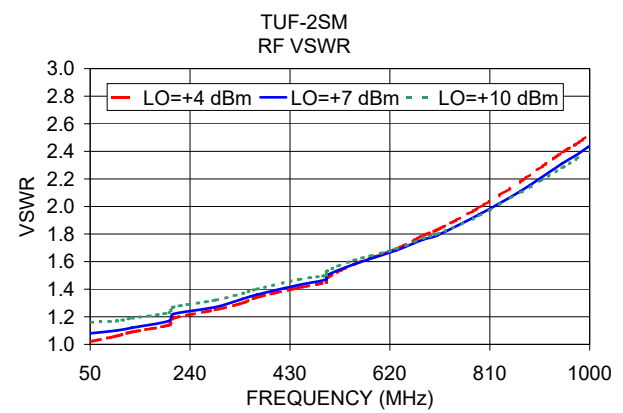
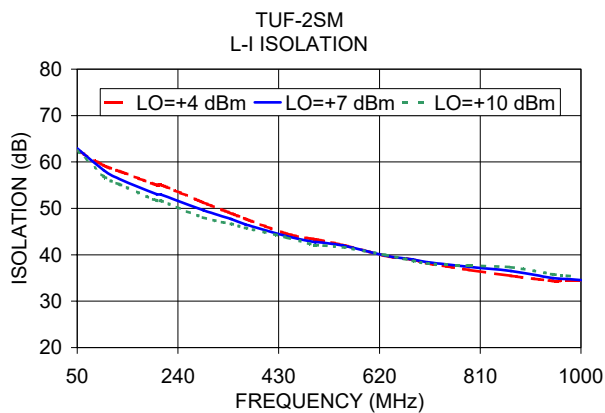
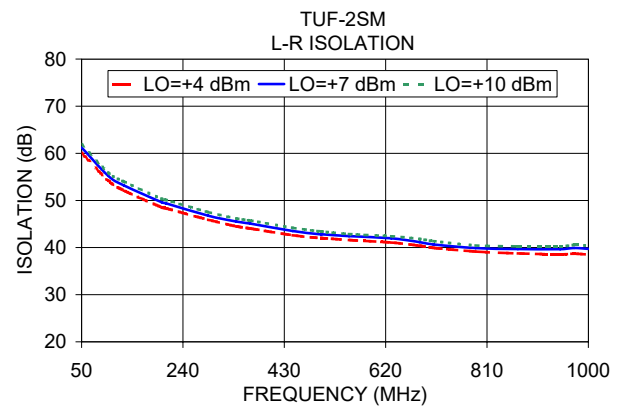
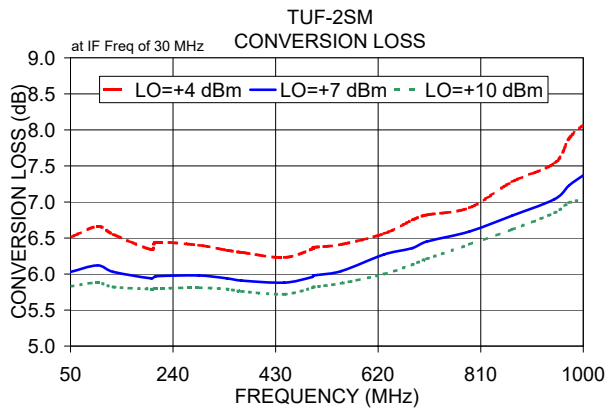
- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.  
B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.  
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### Typical Performance Data

Frequency (MHz)	Conversion Loss (dB)	Isolation L-R (dB)	Isolation L-I (dB)	VSWR RF Port (:1)	VSWR LO Port (:1)
50.00	80.00	6.03	61.24	1.08	2.52
100.00	70.00	6.12	55.20	1.10	2.47
129.17	99.17	6.03	53.19	1.12	2.42
200.00	170.00	5.94	49.63	1.17	2.35
208.33	178.33	5.97	49.40	1.22	2.31
287.50	257.50	5.98	46.76	1.27	2.32
340.28	310.28	5.94	45.51	1.33	2.34
366.67	336.67	5.91	45.07	1.36	2.32
445.83	415.83	5.88	43.51	1.43	2.32
498.61	468.61	5.96	42.80	1.47	2.34
500.00	470.00	5.98	42.81	1.50	2.33
551.39	521.39	6.04	42.43	1.58	2.37
630.56	600.56	6.27	41.96	1.68	2.38
683.33	653.33	6.36	41.15	1.76	2.35
709.72	679.72	6.45	40.66	1.79	2.33
788.89	758.89	6.59	39.89	1.94	2.34
868.06	838.06	6.81	39.69	2.11	2.38
947.22	917.22	7.04	39.66	2.31	2.42
973.61	943.61	7.23	39.91	2.37	2.42
1000.00	970.00	7.37	39.73	2.44	2.41

### Electrical Schematic





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# Frequency Mixer

# TUF-2SM+

## Typical Performance Data

RF (IN) (MHz)	LO (MHz)	CONVERSION LOSS IF FIXED @IF(OUT)=30MHz (dB)			RF (IN) (MHz)	LO (MHz)	IP3 INPUT (dBm)			RF (IN) (MHz)	LO (MHz)	COMPRESSION @RF IN=+1dBm (dB)		
		@LO (dBm)					@LO (dBm)					@LO (dBm)		
		+4	+7	+10			+4	+7	+10			+4	+7	+10
10.1	40.1	6.09	5.73	5.58	10.1	40.1	16.52	16.87	20.71	10.1	40.1	0.97	0.68	0.48
50.7	80.7	6.39	5.93	5.69	50.7	80.7	15.63	17.06	16.64	50.7	80.7	0.81	0.63	0.49
91.2	121.2	6.33	5.88	5.66	91.2	121.2	13.26	14.58	15.83	91.2	121.2	0.88	0.63	0.45
131.8	161.8	6.26	5.87	5.64	131.8	161.8	13.49	15.36	23.55	131.8	161.8	0.95	0.66	0.49
172.4	202.4	6.39	5.91	5.68	172.4	202.4	12.38	14.77	26.16	172.4	202.4	0.79	0.62	0.46
212.9	242.9	6.17	5.80	5.63	212.9	242.9	13.93	23.73	20.22	212.9	242.9	0.81	0.59	0.43
253.5	283.5	6.30	5.83	5.66	253.5	283.5	15.24	20.65	18.09	253.5	283.5	0.82	0.61	0.43
294.0	324.0	6.18	5.83	5.67	294.0	324.0	15.36	19.38	23.24	294.0	324.0	0.86	0.58	0.43
334.6	364.6	6.21	5.84	5.69	334.6	364.6	22.49	18.68	23.95	334.6	364.6	0.85	0.56	0.41
375.2	405.2	6.19	5.85	5.69	375.2	405.2	19.42	17.67	24.46	375.2	405.2	0.83	0.57	0.41
415.7	445.7	6.11	5.82	5.67	415.7	445.7	14.23	16.80	26.16	415.7	445.7	0.84	0.53	0.41
456.3	486.3	6.21	5.87	5.70	456.3	486.3	12.79	13.81	18.27	456.3	486.3	0.84	0.54	0.40
496.9	526.9	6.22	5.89	5.71	496.9	526.9	17.13	20.88	18.37	496.9	526.9	0.75	0.51	0.39
537.4	567.4	6.24	5.95	5.77	537.4	567.4	15.51	21.70	18.48	537.4	567.4	0.78	0.50	0.39
578.0	608.0	6.30	5.98	5.84	578.0	608.0	14.52	22.27	16.88	578.0	608.0	0.83	0.54	0.39
618.6	648.6	6.34	6.04	5.87	618.6	648.6	13.54	14.28	26.06	618.6	648.6	0.86	0.59	0.44
659.1	689.1	6.41	6.11	5.96	659.1	689.1	14.73	16.79	16.34	659.1	689.1	0.91	0.60	0.44
699.7	729.7	6.42	6.17	6.06	699.7	729.7	14.54	16.36	18.58	699.7	729.7	0.99	0.65	0.45
740.2	770.2	6.56	6.29	6.18	740.2	770.2	11.16	16.81	19.14	740.2	770.2	1.05	0.68	0.49
780.8	810.8	6.64	6.36	6.25	780.8	810.8	9.22	13.03	19.83	780.8	810.8	1.15	0.79	0.55
821.4	851.4	6.77	6.50	6.34	821.4	851.4	7.50	10.50	15.35	821.4	851.4	1.25	0.85	0.65
861.9	891.9	6.88	6.56	6.39	861.9	891.9	6.13	8.10	11.62	861.9	891.9	1.33	0.96	0.73
902.5	932.5	7.00	6.64	6.45	902.5	932.5	6.09	7.68	9.69	902.5	932.5	1.40	1.02	0.79
943.1	973.1	7.18	6.81	6.60	943.1	973.1	7.06	9.05	10.90	943.1	973.1	1.41	1.07	0.82
983.6	1013.6	7.29	6.81	6.55	983.6	1013.6	8.83	12.25	14.45	983.6	1013.6	1.46	1.10	0.87
1024.2	1054.2	7.36	6.84	6.59	1024.2	1054.2	11.50	17.31	20.61	1024.2	1054.2	1.47	1.11	0.88
1064.7	1094.7	7.52	6.89	6.63	1064.7	1094.7	15.08	17.76	15.83	1064.7	1094.7	1.47	1.13	0.88
1085.0	1115.0	7.65	6.98	6.69	1085.0	1115.0	13.98	15.98	15.82	1085.0	1115.0	1.46	1.12	0.86
1125.6	1155.6	7.86	7.13	6.80	1125.6	1155.6	13.40	16.93	15.98	1125.6	1155.6	1.37	1.11	0.84
1145.9	1175.9	8.04	7.26	6.91	1145.9	1175.9	13.86	15.26	15.57	1145.9	1175.9	1.26	1.03	0.78
1186.4	1216.4	8.35	7.50	7.09	1186.4	1216.4	11.25	15.98	13.63	1186.4	1216.4	1.19	1.01	0.78
1206.7	1236.7	8.47	7.66	7.22	1206.7	1236.7	11.57	14.32	14.52	1206.7	1236.7	1.08	0.96	0.75
1247.3	1277.3	8.85	7.93	7.40	1247.3	1277.3	10.81	12.75	14.50	1247.3	1277.3	0.96	0.93	0.75
1267.6	1297.6	9.04	8.10	7.55	1267.6	1297.6	10.50	12.37	13.58	1267.6	1297.6	0.92	0.89	0.75
1308.1	1338.1	9.52	8.54	7.91	1308.1	1338.1	9.56	11.65	13.10	1308.1	1338.1	0.83	0.87	0.80
1328.4	1358.4	9.72	8.74	8.09	1328.4	1358.4	9.50	11.53	12.53	1328.4	1358.4	0.77	0.83	0.81
1369.0	1399.0	10.25	9.32	8.60	1369.0	1399.0	9.27	11.29	13.72	1369.0	1399.0	0.63	0.76	0.81
1389.3	1419.3	10.49	9.60	8.90	1389.3	1419.3	9.20	11.72	12.56	1389.3	1419.3	0.58	0.74	0.83
1429.8	1459.8	11.15	10.41	9.67	1429.8	1459.8	9.65	10.67	13.40	1429.8	1459.8	0.35	0.55	0.72
1450.1	1480.1	11.39	10.70	10.08	1450.1	1480.1	9.24	10.59	13.41	1450.1	1480.1	0.26	0.43	0.58



# Frequency Mixer

# TUF-2SM+

## Typical Performance Data

IF (OUT) (MHz)	LO (MHz)	CONVERSION LOSS VS. IF FREQUENCY @RF(IN)=500.1MHz (dB)	IF (OUT) (MHz)	LO (MHz)	CONVERSION LOSS VS. IF FREQUENCY @RF(IN)=50.1MHz (dB)	IF (OUT) (MHz)	LO (MHz)	CONVERSION LOSS VS. IF FREQUENCY @RF(IN)=1000.1MHz (dB)
		@LO (dBm)			@LO (dBm)			@LO (dBm)
		+7			+7			+7
400.0	100.1	6.00	10.0	60.1	5.85	950.0	50.1	7.66
390.3	109.9	5.94	30.0	80.1	5.94	930.0	70.1	7.63
380.5	119.6	5.93	50.0	100.1	5.87	910.0	90.1	7.66
370.8	129.4	5.92	70.0	120.1	5.89	890.0	110.1	7.54
361.0	139.1	5.88	90.0	140.1	5.89	870.0	130.1	7.46
351.3	148.9	5.86	110.0	160.1	5.89	850.0	150.1	7.44
341.5	158.6	5.88	130.0	180.1	5.97	830.0	170.1	7.48
331.8	168.4	5.89	150.0	200.1	5.93	810.0	190.1	7.40
322.0	178.1	5.85	170.0	220.1	5.97	790.0	210.1	7.36
312.3	187.9	5.89	190.0	240.1	5.93	770.0	230.1	7.31
302.5	197.6	5.87	210.0	260.1	5.98	750.0	250.1	7.27
292.8	207.4	5.84	230.0	280.1	6.05	730.0	270.1	7.34
283.0	217.1	5.82	250.0	300.1	5.98	710.0	290.1	7.30
273.3	226.9	5.82	270.0	320.1	5.98	690.0	310.1	7.27
263.5	236.6	5.84	290.0	340.1	6.00	670.0	330.1	7.25
253.8	246.4	5.81	310.0	360.1	6.08	650.0	350.1	7.27
244.0	256.1	5.84	330.0	380.1	6.04	630.0	370.1	7.32
234.3	265.9	5.86	350.0	400.1	6.06	610.0	390.1	7.29
224.5	275.6	5.85	370.0	420.1	6.09	590.0	410.1	7.26
214.8	285.4	5.84	390.0	440.1	6.02	570.0	430.1	7.24
205.0	295.1	5.87	410.0	460.1	6.05	550.0	450.1	7.29
195.3	304.9	5.87	430.0	480.1	6.09	530.0	470.1	7.26
185.5	314.6	5.84	450.0	500.1	6.07	510.0	490.1	7.25
175.8	324.4	5.84	470.0	520.1	6.01	490.0	510.1	7.26
166.0	334.1	5.84	510.0	560.1	6.15	450.0	550.1	7.24
156.3	343.9	5.85	530.0	580.1	6.13	430.0	570.1	7.20
146.5	353.6	5.83	570.0	620.1	6.22	390.0	610.1	7.15
136.8	363.4	5.85	590.0	640.1	6.25	370.0	630.1	7.17
127.0	373.1	5.88	630.0	680.1	6.38	330.0	670.1	7.12
117.3	382.9	5.85	650.0	700.1	6.38	310.0	690.1	7.13
107.5	392.6	5.84	690.0	740.1	6.38	270.0	730.1	7.02
97.8	402.4	5.86	710.0	760.1	6.43	250.0	750.1	7.03
88.0	412.1	5.85	750.0	800.1	6.38	210.0	790.1	6.99
78.3	421.9	5.83	770.0	820.1	6.32	190.0	810.1	6.96
68.5	431.6	5.85	810.0	860.1	6.30	150.0	850.1	6.98
58.8	441.4	5.87	830.0	880.1	6.28	130.0	870.1	7.00
49.0	451.1	5.87	870.0	920.1	6.18	90.0	910.1	7.06
39.3	460.9	5.87	890.0	940.1	6.20	70.0	930.1	7.05
19.8	480.4	5.92	930.0	980.1	6.15	30.0	970.1	6.99
10.0	490.1	5.89	950.0	1000.1	6.11	10.0	990.1	6.87

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# TUF-2SM+

## Typical Performance Data

LO (MHz)	LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)		
	@LO (dBm)			@LO (dBm)		
	+4	+7	+10	+4	+7	+10
10.1	75.28	78.13	78.53	62.68	67.53	67.95
50.7	63.44	64.01	64.22	61.07	61.17	58.48
91.2	58.26	58.78	59.24	59.56	55.98	54.62
131.8	55.60	56.01	56.73	54.74	52.82	51.80
172.4	53.12	53.86	54.25	53.03	51.22	50.06
212.9	51.63	52.28	52.69	51.13	49.54	48.54
253.5	50.40	50.99	51.31	49.67	48.30	47.31
294.0	49.24	49.94	50.26	48.75	47.39	46.24
334.6	48.38	48.95	49.14	47.20	45.81	44.66
375.2	47.53	48.02	48.22	45.83	44.45	43.47
415.7	47.00	47.50	47.77	44.27	43.22	42.46
456.3	46.10	46.61	46.88	42.70	41.79	40.98
496.9	45.42	45.84	46.08	41.38	40.69	40.15
537.4	44.43	44.91	45.34	39.67	39.03	38.89
578.0	43.66	44.05	44.51	38.60	37.87	37.41
618.6	43.38	43.60	43.96	37.82	37.11	36.49
659.1	43.36	43.69	43.86	36.98	36.54	35.97
699.7	43.37	43.75	43.88	36.35	35.91	35.67
740.2	43.34	43.83	43.83	35.13	34.81	34.68
780.8	43.20	43.53	43.65	34.53	33.87	33.58
821.4	42.63	42.90	43.06	33.68	33.16	32.61
861.9	42.03	42.16	42.36	32.86	32.46	31.96
902.5	41.89	42.15	42.43	32.16	31.91	31.45
943.1	41.43	41.83	42.00	31.43	31.43	31.20
983.6	40.97	41.51	41.78	30.60	30.83	30.81
1024.2	40.41	41.10	41.46	29.81	30.06	30.22
1064.7	39.63	40.43	40.93	29.07	29.39	29.63
1085.0	39.37	40.21	40.82	28.68	28.99	29.30
1125.6	38.94	39.96	40.70	27.74	28.05	28.43
1145.9	38.66	39.76	40.61	27.39	27.58	27.99
1186.4	38.48	39.68	40.64	26.89	26.89	27.25
1206.7	38.25	39.55	40.62	26.59	26.57	26.89
1247.3	38.02	39.46	40.75	26.13	26.10	26.35
1267.6	37.81	39.34	40.71	25.92	25.83	26.08
1308.1	37.66	39.32	41.01	25.58	25.59	25.78
1328.4	37.51	39.33	41.22	25.34	25.36	25.58
1369.0	37.31	39.32	41.53	25.06	25.19	25.47
1389.3	37.30	39.36	41.79	24.91	25.06	25.37
1429.8	36.83	39.07	41.65	24.57	24.86	25.17
1450.1	36.73	39.09	41.81	24.44	24.76	25.16

RF (IN) (MHz)	LO (MHz)	RF-IF ISOLATION (dB)		
		@LO (dBm)		
		+4	+7	+10
10.1	40.1	45.17	45.18	53.39
50.7	80.7	36.62	35.93	36.34
91.2	121.2	31.86	31.71	31.88
131.8	161.8	29.05	29.17	29.29
172.4	202.4	27.36	27.53	27.69
212.9	242.9	26.29	26.46	26.50
253.5	283.5	25.53	25.82	26.08
294.0	324.0	25.43	25.58	25.79
334.6	364.6	25.58	25.90	26.03
375.2	405.2	25.70	26.31	26.75
415.7	445.7	25.87	26.57	27.13
456.3	486.3	26.36	26.73	27.02
496.9	526.9	27.22	27.27	27.33
537.4	567.4	27.66	28.03	28.35
578.0	608.0	26.62	27.46	28.27
618.6	648.6	24.41	25.12	25.93
659.1	689.1	22.07	22.44	22.90
699.7	729.7	20.36	20.35	20.46
740.2	770.2	19.09	18.89	18.83
780.8	810.8	17.94	17.70	17.56
821.4	851.4	17.15	16.85	16.66
861.9	891.9	16.58	16.30	16.06
902.5	932.5	15.97	15.67	15.45
943.1	973.1	15.52	15.24	15.04
983.6	1013.6	15.24	14.99	14.83
1024.2	1054.2	15.20	15.02	14.90
1064.7	1094.7	15.06	14.96	14.95
1085.0	1115.0	15.04	15.00	15.00
1125.6	1155.6	14.77	14.75	14.76
1145.9	1175.9	14.74	14.74	14.66
1186.4	1216.4	14.59	14.64	14.68
1206.7	1236.7	14.56	14.61	14.68
1247.3	1277.3	14.42	14.57	14.63
1267.6	1297.6	14.36	14.53	14.62
1308.1	1338.1	14.08	14.32	14.42
1328.4	1358.4	14.00	14.19	14.31
1369.0	1399.0	13.75	13.93	13.99
1389.3	1419.3	13.56	13.73	13.77
1429.8	1459.8	13.22	13.28	13.32
1450.1	1480.1	13.01	13.03	12.99

# Frequency Mixer

# TUF-2SM+

## Typical Performance Data

RF (IN) (MHz)	LO (MHz)	RF VSWR (:1)		
		@LO (dBm)		
		+4	+7	+10
10.1	40.1	1.10	1.09	1.13
50.7	80.7	1.09	1.03	1.08
91.2	121.2	1.10	1.06	1.11
131.8	161.8	1.10	1.09	1.14
172.4	202.4	1.12	1.11	1.17
212.9	242.9	1.12	1.15	1.20
253.5	283.5	1.15	1.17	1.23
294.0	324.0	1.17	1.20	1.25
334.6	364.6	1.19	1.24	1.29
375.2	405.2	1.21	1.26	1.31
415.7	445.7	1.23	1.28	1.33
456.3	486.3	1.25	1.28	1.32
496.9	526.9	1.27	1.30	1.33
537.4	567.4	1.29	1.32	1.36
578.0	608.0	1.30	1.35	1.40
618.6	648.6	1.32	1.37	1.42
659.1	689.1	1.34	1.40	1.44
699.7	729.7	1.34	1.40	1.45
740.2	770.2	1.32	1.38	1.43
780.8	810.8	1.28	1.32	1.36
821.4	851.4	1.24	1.26	1.29
861.9	891.9	1.23	1.24	1.26
902.5	932.5	1.25	1.25	1.25
943.1	973.1	1.31	1.29	1.29
983.6	1013.6	1.39	1.37	1.37
1024.2	1054.2	1.48	1.46	1.46
1064.7	1094.7	1.60	1.58	1.58
1085.0	1115.0	1.67	1.64	1.63
1125.6	1155.6	1.80	1.77	1.75
1145.9	1175.9	1.86	1.82	1.80
1186.4	1216.4	1.99	1.93	1.90
1206.7	1236.7	2.05	1.98	1.94
1247.3	1277.3	2.15	2.08	2.03
1267.6	1297.6	2.20	2.12	2.07
1308.1	1338.1	2.31	2.23	2.16
1328.4	1358.4	2.36	2.29	2.21
1369.0	1399.0	2.48	2.42	2.33
1389.3	1419.3	2.53	2.47	2.39
1429.8	1459.8	2.65	2.60	2.52
1450.1	1480.1	2.70	2.65	2.58

LO (MHz)	LO VSWR (:1)		
	@LO (dBm)		
	+4	+7	+10
10.1	1.79	2.75	3.91
50.7	1.92	2.79	4.01
91.2	1.79	2.52	3.53
131.8	1.87	2.72	3.84
172.4	1.80	2.54	3.55
212.9	1.82	2.59	3.62
253.5	1.82	2.59	3.61
294.0	1.79	2.52	3.48
334.6	1.84	2.60	3.61
375.2	1.79	2.50	3.44
415.7	1.83	2.56	3.52
456.3	1.81	2.52	3.45
496.9	1.81	2.50	3.40
537.4	1.84	2.54	3.45
578.0	1.81	2.48	3.34
618.6	1.85	2.52	3.40
659.1	1.85	2.49	3.33
699.7	1.85	2.48	3.31
740.2	1.88	2.49	3.29
780.8	1.88	2.48	3.25
821.4	1.89	2.50	3.27
861.9	1.90	2.48	3.22
902.5	1.92	2.49	3.23
943.1	1.91	2.46	3.17
983.6	1.92	2.44	3.13
1024.2	1.92	2.41	3.07
1064.7	1.93	2.39	3.03
1085.0	1.94	2.41	3.04
1125.6	1.97	2.42	3.03
1145.9	1.98	2.42	3.02
1186.4	2.01	2.45	3.04
1206.7	2.02	2.46	3.04
1247.3	2.01	2.45	3.00
1267.6	2.02	2.45	3.01
1308.1	2.03	2.46	3.00
1328.4	2.02	2.44	2.98
1369.0	2.02	2.44	2.98
1389.3	2.03	2.44	2.98
1429.8	2.02	2.42	2.93
1450.1	2.01	2.41	2.93

IF (OUT) (MHz)	IF VSWR @LO=1000.1MHz (:1)		
	@LO (dBm)		
	+4	+7	+10
10.0	1.62	1.40	1.25
30.2	1.64	1.43	1.31
50.4	1.75	1.55	1.41
70.6	1.83	1.61	1.48
90.8	1.75	1.54	1.42
111.0	1.71	1.51	1.40
131.2	1.80	1.59	1.48
151.4	1.84	1.64	1.53
171.6	1.80	1.60	1.49
191.8	1.80	1.60	1.49
212.0	1.82	1.63	1.54
232.2	1.80	1.63	1.54
252.4	1.83	1.65	1.56
272.7	1.89	1.71	1.62
292.9	1.89	1.71	1.64
313.1	1.86	1.69	1.63
333.3	1.92	1.75	1.69
353.5	2.00	1.84	1.77
373.7	1.99	1.83	1.77
393.9	1.98	1.82	1.76
434.3	2.03	1.89	1.85
454.5	2.00	1.87	1.83
494.9	2.12	1.99	1.95
515.1	2.07	1.95	1.93
555.5	2.11	1.99	1.97
575.7	2.12	2.02	2.00
616.1	2.19	2.07	2.04
636.3	2.18	2.07	2.05
676.7	2.13	2.02	2.00
696.9	2.22	2.10	2.08
737.3	2.15	2.02	1.99
757.6	2.14	2.01	1.97
798.0	2.12	2.00	1.97
818.2	2.17	2.03	1.98
858.6	2.08	1.93	1.88
878.8	2.04	1.89	1.83
919.2	2.12	1.96	1.89
939.4	2.08	1.91	1.82
979.8	2.04	1.85	1.76
1000.0	2.11	2.21	2.37

## Harmonics Tables

RF HARMONICS ORDER

	(-dBm)	(-dBc)										
0	-	-	13	25	20	40	36	45	39	38	34	52
1	-	21	+0	27	12	29	20	39	41	38	57	44
2	>100	74	58	74	59	76	57	74	70	>80	>80	68
3	>100	>80	70	>80	76	77	65	>80	>80	78	>80	71
4	>100	>80	>80	>80	>80	78	>80	>80	>80	>80	>80	>80
5	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
6	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
7	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
8	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
9	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
10	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
	RF CAL	0	1	2	3	4	5	6	7	8	9	10

### LO HARMONICS ORDER

Test conditions: RF IN: 500.1 MHz; -14.00 dBm.  
 LO IN: 530.01 MHz; +7.00 dBm  
 IF OUT: 29.91 MHz; -19.97 dBm

RF HARMONICS ORDER

	(-dBm)	(-dBc)										
0	-	-	22	35	32	52	47	56	51	54	51	69
1	-	21	+0	27	12	30	21	43	42	44	63	51
2	99	68	50	65	50	77	52	69	65	73	73	60
3	>100	59	46	58	48	55	41	57	47	56	63	53
4	>100	>90	79	84	70	89	67	81	63	78	76	>90
5	>100	80	69	76	60	72	58	68	58	71	65	81
6	>100	>90	>90	>90	89	>90	84	>90	84	>90	>90	>90
7	>100	88	>90	>90	80	>90	89	>90	82	86	75	>90
8	>100	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90
9	>100	>90	>90	>90	>90	>90	>90	>90	89	>90	86	>90
10	>100	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90
	RF CAL	0	1	2	3	4	5	6	7	8	9	10

### LO HARMONICS ORDER

Test conditions: RF IN: 500.1 MHz; -4.00 dBm.  
 LO IN: 530.01 MHz; +7.00 dBm  
 IF OUT: 29.91 MHz; -10.06 dBm

- Notes: 1. All Harmonics are in (dBc) relative to IF OUTPUT.  
 2. + entry denotes harmonics are in (dBc) above IF OUTPUT.  
 3. RF Cal represent the Harmonics level of the RF input signal to the mixer.

REV. X2  
 TUF-2SM+  
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 Page 5 of 5



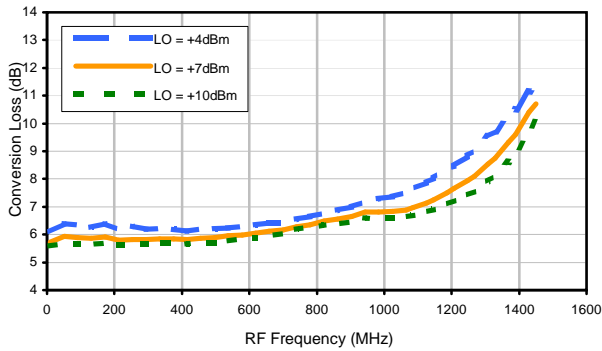
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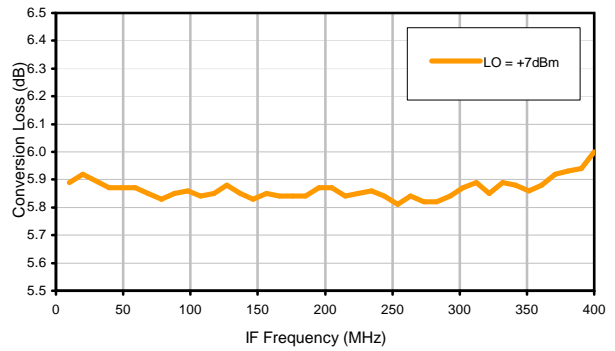
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## Typical Performance Curves

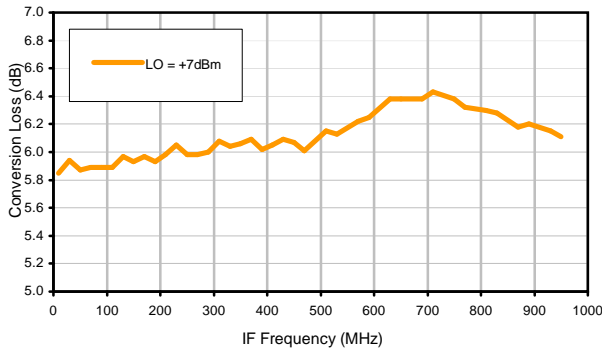
Conversion Loss @ IF=30MHz



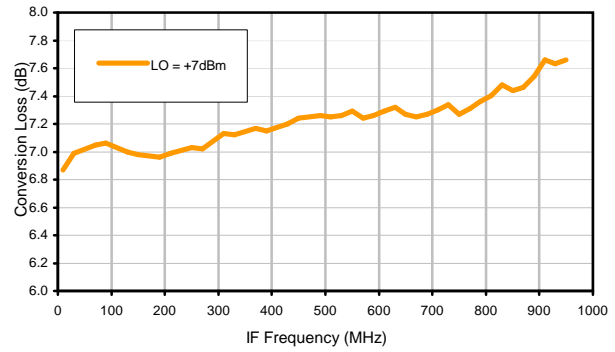
Conversion Loss vs. IF @ RF=500.1MHz



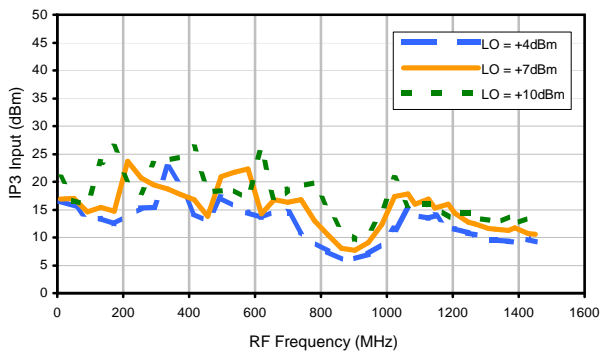
Conversion Loss vs. IF @ RF=50.1MHz



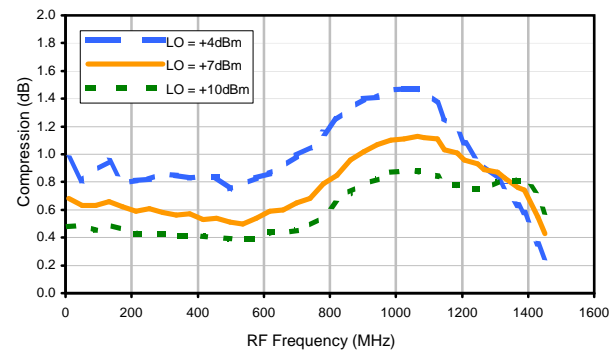
Conversion Loss vs. IF @ RF=1000.1MHz



IP3 Input

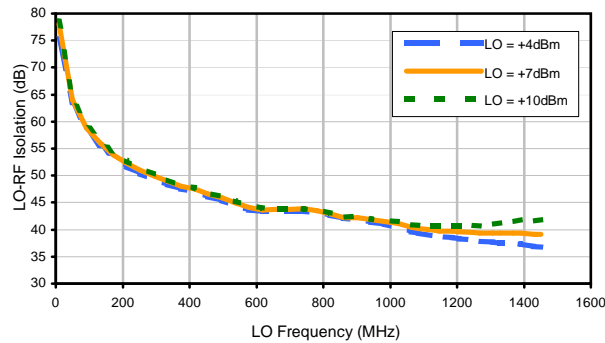


Compression @ RF IN=+1dBm

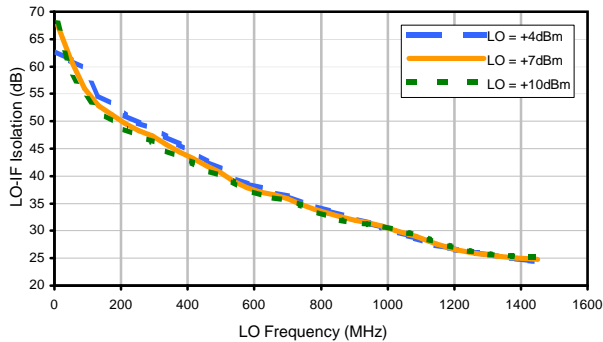


## Typical Performance Curves

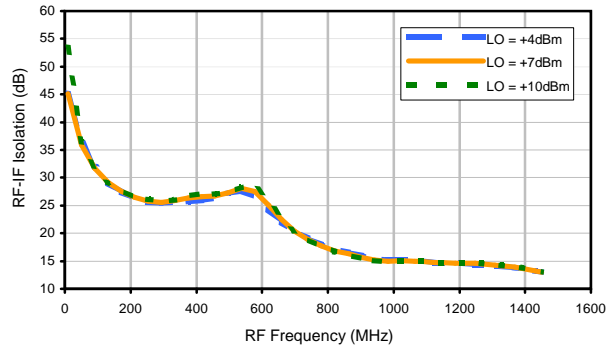
LO-RF Isolation



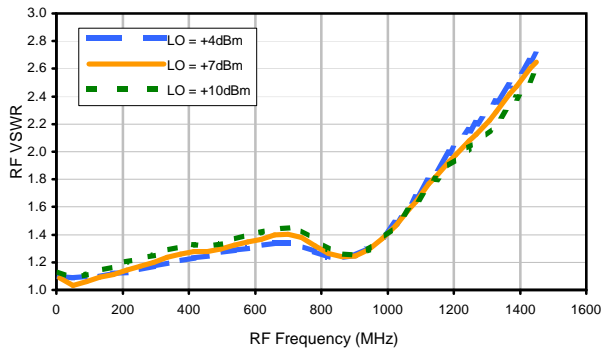
LO-IF Isolation



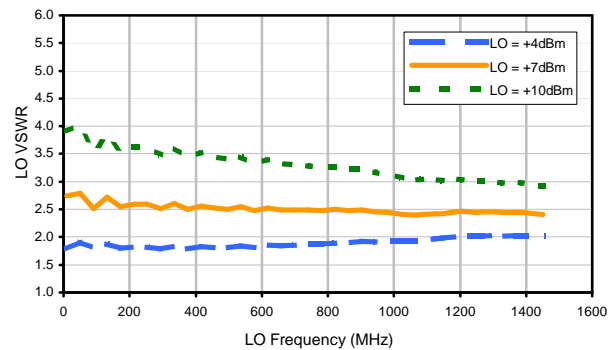
RF-IF Isolation



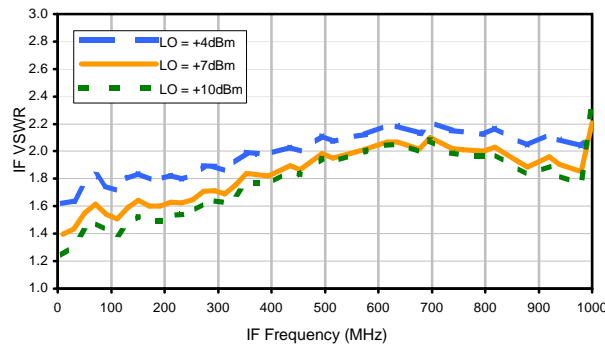
RF VSWR



LO VSWR



IF VSWR



## Harmonics Tables

RF HARMONICS ORDER

	(-dBm)	(-dBc)										
0	-	-	13	25	20	40	36	45	39	38	34	52
1	-	21	+0	27	12	29	20	39	41	38	57	44
2	>100	74	58	74	59	76	57	74	70	>80	>80	68
3	>100	>80	70	>80	76	77	65	>80	>80	78	>80	71
4	>100	>80	>80	>80	>80	78	>80	>80	>80	>80	>80	>80
5	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
6	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
7	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
8	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
9	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
10	>100	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
	RF CAL	0	1	2	3	4	5	6	7	8	9	10

### LO HARMONICS ORDER

Test conditions: RF IN: 500.1 MHz; -14.00 dBm.  
 LO IN: 530.01 MHz; +7.00 dBm  
 IF OUT: 29.91 MHz; -19.97 dBm

RF HARMONICS ORDER

	(-dBm)	(-dBc)										
0	-	-	22	35	32	52	47	56	51	54	51	69
1	-	21	+0	27	12	30	21	43	42	44	63	51
2	99	68	50	65	50	77	52	69	65	73	73	60
3	>100	59	46	58	48	55	41	57	47	56	63	53
4	>100	>90	79	84	70	89	67	81	63	78	76	>90
5	>100	80	69	76	60	72	58	68	58	71	65	81
6	>100	>90	>90	>90	89	>90	84	>90	84	>90	>90	>90
7	>100	88	>90	>90	80	>90	89	>90	82	86	75	>90
8	>100	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90
9	>100	>90	>90	>90	>90	>90	>90	>90	89	>90	86	>90
10	>100	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90
	RF CAL	0	1	2	3	4	5	6	7	8	9	10

### LO HARMONICS ORDER

Test conditions: RF IN: 500.1 MHz; -4.00 dBm.  
 LO IN: 530.01 MHz; +7.00 dBm  
 IF OUT: 29.91 MHz; -10.06 dBm

- Notes: 1. All Harmonics are in (dBc) relative to IF OUTPUT.  
 2. + entry denotes harmonics are in (dBc) above IF OUTPUT.  
 3. RF Cal represent the Harmonics level of the RF input signal to the mixer.

REV. X2  
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 Page 3 of 3



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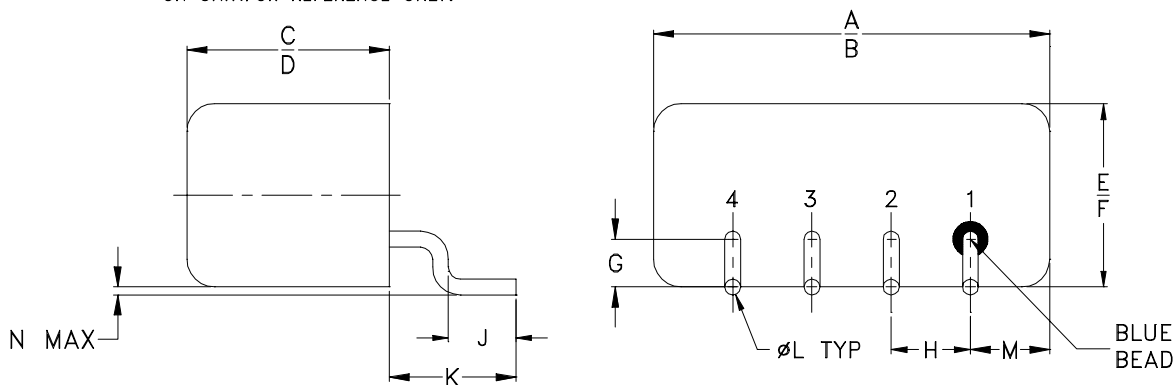


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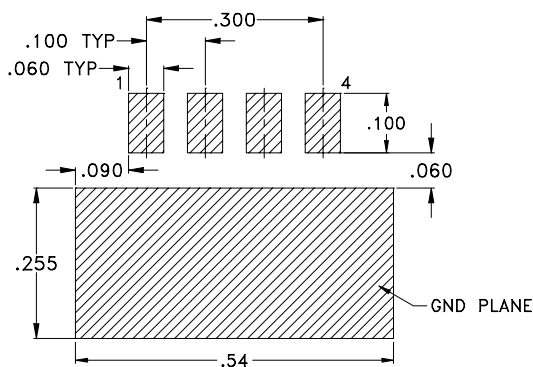
## Outline Dimensions

### NNN150

NOTE: BLUE BEAD INDICATES PIN #1.  
PIN NUMBERS DO NOT APPEAR  
ON UNIT.FOR REFERENCE ONLY.



### PCB Land Pattern



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

CASE #.	A	B	C	D	E	F	G	H	J	K	L	M	N	WT, GRAM
NNN150	.50 (12.70)	.48 (12.19)	.255 (6.48)	.240 (6.10)	.23 (5.84)	.21 (5.33)	.06 (1.52)	.100 (2.54)	.09 (2.29)	.16 (4.06)	.020 (0.51)	.09 (2.29)	.005 (0.13)	1.9

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

#### Notes:

- Header material C.R.S. Pin material #52 alloy.
- Finish: Electro-Tin, hot-oil flowed or electro-Tin-Silver.
- Cover material: Cupro-Nickel.
- Pin's meniscus 0.015 inch max.
- Special Tolerances: Pin diameter  $\pm .005$  inch.



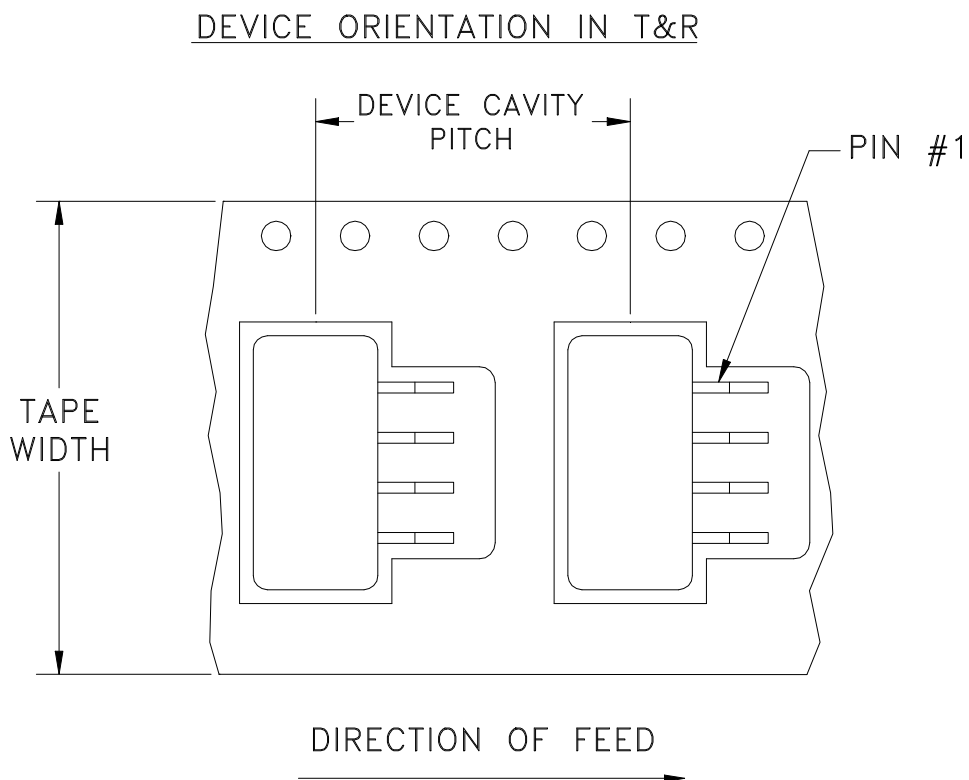
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# Tape & Reel Packaging TR-F9



Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel
24	16	13	500

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)



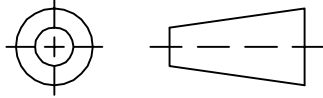
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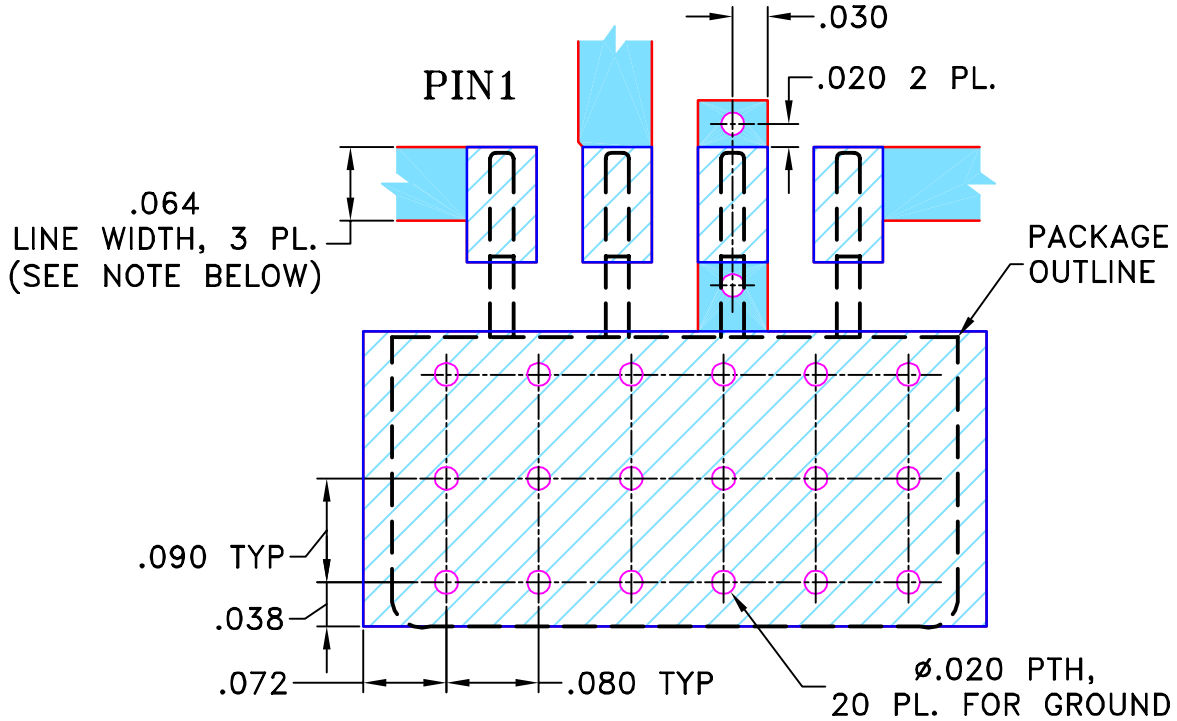
THIRD ANGLE PROJECTION



REVISIONS

REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	M86549	NEW RELEASE	04/15/03	GF	DJ
A	M102713	UPDATED NOTES & DISCRPTION	01/14/06	GF	IL

**SUGGESTED MOUNTING CONFIGURATION  
FOR NNN150 CASE STYLE, "z"/"cm" PIN CONNECTIONS.**



NOTES: 1. TRACE WIDTH IS SHOWN FOR ROGERS R04350B WITH DIELECTRIC THICKNESS 0.030" ± 0.002"; 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 SOLDER MASK

UNLESS OTHERWISE SPECIFIED	INITIALS		DATE
DIMENSIONS ARE IN INCHES TOLERANCES ON: 2 PL DECIMALS ± 3 PL DECIMALS ± .005 ANGLES ± FRACTIONS ±	DRAWN	GF	04/11/03
	CHECKED	AV	04/15/03
	APPROVED	DJ	04/15/03

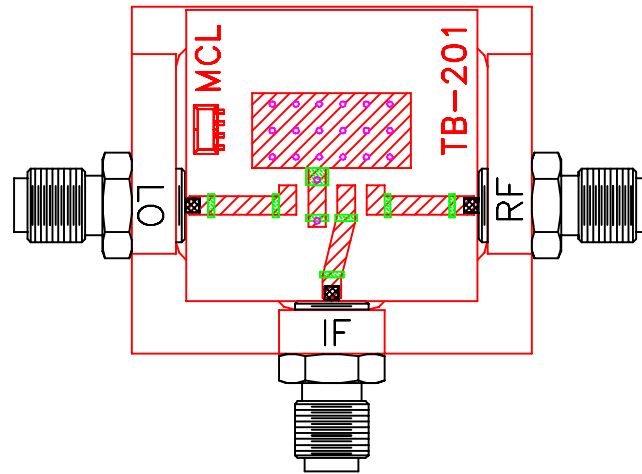
**Mini-Circuits<sup>®</sup>** 13 Neptune Avenue  
Brooklyn NY 11235

PL, z/cm NNN150, TUF/TFAS-SM, TB-201

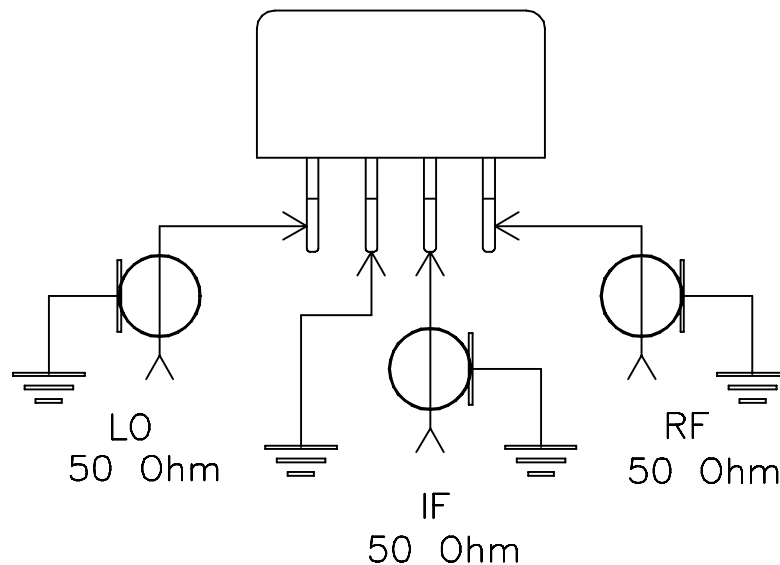
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SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-081	A
FILE:	98PL081	SCALE:	SHEET:
		6:1	1 OF 1

# Evaluation Board and Circuit




TB-201



Schematic Diagram

## Notes:

1. SMA Female connectors.
2. PCB Material: Rogers R04350 or equivalent,  
Dielectric Constant=3.5, Thickness=.030 inch.

 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	-55° to 100°C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-55° to 100° C Ambient Environment	Individual Model Data Sheet
Thermal Shock	-55° to 100°C, 100 cycles	MIL-STD-202, Method 107, Condition A-3, except +100°C
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
Moisture Resistance	10 cycles, 24 hours per cycle	MIL-STD-202, Method 106, Condition A, except 50°C and end point electrical test done within 12 hours
Solderability	10X Magnification	J-STD-002, 95% Coverage
Resistance to Solder Heat	260°C for 10 seconds	MIL-STD-202, Method 210, Condition B
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
Terminal Strength	4 1/2 Pound Pull	MIL-STD-202, Method 211, Condition A



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Specification	Test/Inspection Condition	Reference/Spec
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Barometric Pressure

100,000 Feet

MIL-STD-202, Method 105, Condition D