Surface Mount

Voltage Variable Equalizer

VAEQ-2150R+

50Ω 950 to 2150 MHz

The Big Deal

- Adjustable attenuation slope
- Supply voltage from +3V to +5V
- IP3 +55 dBm typical
- Minimal deviation from linear loss, ± 0.05dB

CASE STYLE: HE1354

Product Overview

The VAEQ-2150R+ is a 50Ω Voltage Variable Equalizer built into a shielded case (size of .394”x.394”x.150”). This model offers excellent performance over a wide frequency range of 950 to 2150 MHz with the variable slope providing great flexibility in a small 10mm package.
The VAEQ-2150R+ is often used to compensate RF chain gain flatness or cable loss versus frequency.

Key Features

Feature	Advantages
Low power consumption: • Supply voltage +3-5V_{DC} at max 15mA • Control voltage 0-5V at max 10 mA	Allows for high layout density of circuit boards, while minimizing affects of parasitics.
Adjustable attenuation slope (Control voltage of 0V to 5V)	Allows adjusting the slope to compensate for the precise loses encountered.
High linearity (IP3 +55 dBm typ.)	Low distortion enabling improved system performance.
Minimal deviation from linear loss over frequency range: ±0.05dB	Provides low signal distortion over the passband.

Surface Mount

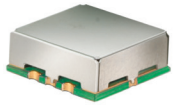
Voltage Variable Equalizer

VAEQ-2150R+

50Ω 950 to 2150 MHz

Features

- Wide bandwidth
- Low deviation from linear loss, ± 0.05 dB typ.
- High IP3 +55 dBm typ.
- Shielded case
- Aqueous washable



CASE STYLE: HE1354

Applications

- Cable loss compensation
- Instrumentation
- Satellite L band

+RoHS Compliant

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

Electrical Specifications at 25°C, unless otherwise noted

Parameter	Condition	V+=3V			V+=5V			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Frequency Range		950		2150	950		2150	MHz
Insertion Loss	950 MHz, Control Voltage, 0 - 5V 2150 MHz, Control Voltage, 0 - 5V		12.6 - 3.2 5.9 - 6.3			12.6 - 6.6 6.1 - 7.7		dB
Deviation from Linear Loss	950 - 2150 MHz, Control Voltage 0 - 5V		± 0.1			± 0.05		dB
IP3	950 - 2150 MHz, Control Voltage: 2 - 5V	+45	+55		+45	+55		dBm
1 dB Compression	950 - 2150 MHz, Control Voltage, 0 - 5V		+30			+30		dBm
Input Return Loss	950 - 2150 MHz, Control Voltage, 0 - 5V		15			16		dB
Output Return Loss	950 - 2150 MHz, Control Voltage, 0 - 5V		12			13		dB
Supply Current	950 - 2150 MHz, Control Voltage, 5V, 950 - 2150 MHz, Control Voltage, 0V		0 4	 8		3 7	 15	mA
Control Current	950 - 2150 MHz, Control Voltage, 5V 950 - 2150 MHz, Control Voltage, Low [1]		5 0.4	10		3.5 0.6	6.0	mA

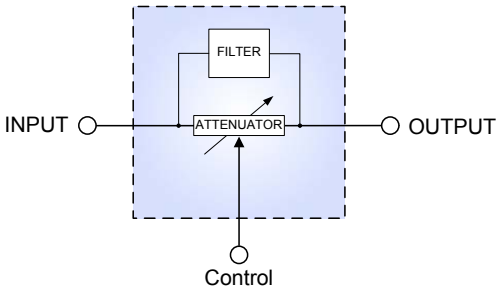
Note 1: Control Voltage Low is 3V for V+=5V and 2V for V+=3V.

Maximum Ratings

Parameter	Ratings
Operating Temperature	-40°C to 85°C
Storage Temperature	-55°C to 100°C
Input Power	+23 dBm
Control voltage	12 V
Supply Voltage (V+)	7 V

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

Simplified Functional Diagram



Pad Connections

Function	Pad Number
RF IN	1
RF OUT	6
V CONTROL	3
V+	4
GROUND	2,5

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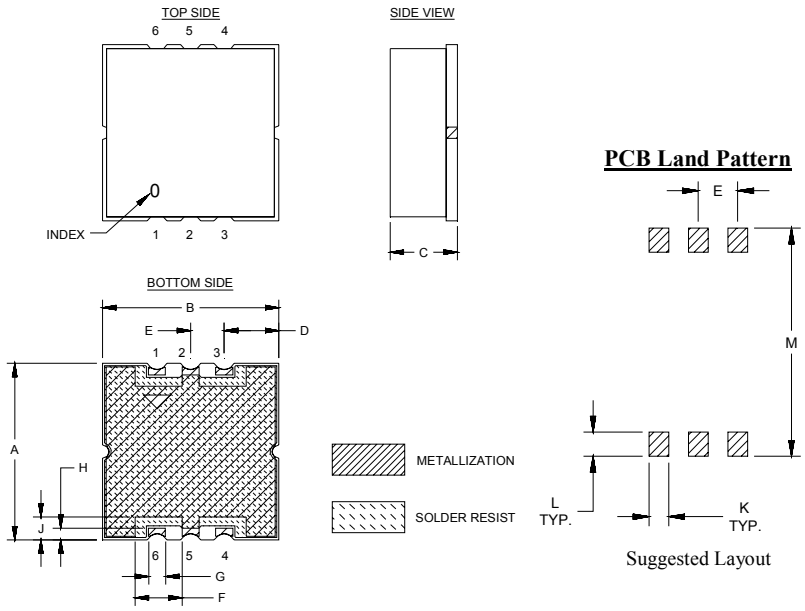
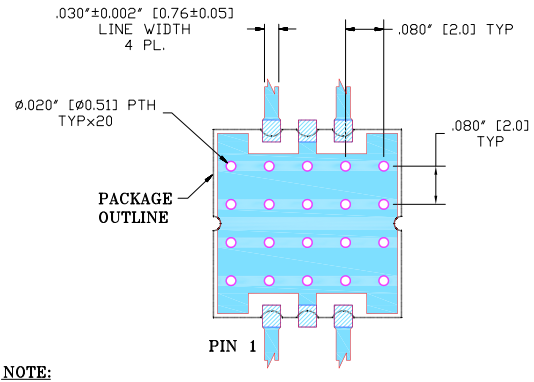
Outline Drawing



Outline Dimensions (inch / mm)

A	B	C	D	E	F	G	H	J	K	L	M	wt.
.394	.394	.150	.122	.075	.098	.038	.026	.051	.038	.046	.434	grams
10.01	10.01	3.81	3.10	1.90	2.49	0.97	0.66	1.29	0.97	1.17	11.02	0.7

Demo Board MCL P/N: TB-474+
Suggested PCB Layout (PL-285)



NOTE:

1. TRACE WIDTH IS SHOWN FOR RO4350 WITH DIELECTRIC THICKNESS. .030"±.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 SOLDERMASK

Pad Connections

Function	Pad Number
RF IN	1
RF OUT	6
V CONTROL	3
V+	4
GROUND	2,5

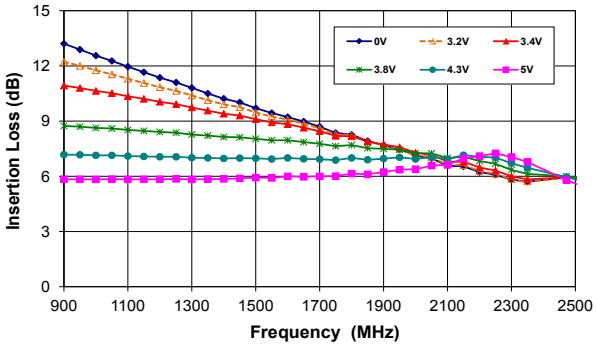
Frequency (MHz)	Insertion Loss (dB)		Input Return Loss (dB)		Output Return Loss (dB)		Deviation from Linear Loss (dB)		Insertion Phase (deg)	
	Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol	
	0V	3.2V	0V	3.2V	0V	3.2V	0V	3.2V	0V	3.2V
950	12.89	12.00	14.66	17.13	16.99	17.46	0.18	0.01	105.11	115.76
1000	12.56	11.76	14.43	16.81	16.64	17.10	0.12	0.00	112.64	122.97
1100	11.96	11.30	14.00	16.18	16.11	16.56	0.04	0.01	127.77	137.56
1150	11.66	11.07	13.75	15.83	15.94	16.39	0.01	0.01	135.40	144.89
1200	11.36	10.84	13.62	15.65	15.59	16.03	0.02	0.01	143.07	152.22
1300	10.81	10.39	13.12	14.96	15.08	15.51	0.05	0.01	159.10	167.62
1400	10.22	9.91	12.66	14.31	14.76	15.20	0.10	0.04	174.83	177.35
1450	10.02	9.75	12.35	13.91	14.50	14.92	0.04	0.03	176.88	169.28
1500	9.70	9.47	12.09	13.57	14.82	15.27	0.09	0.02	168.98	161.79
1600	9.22	9.08	11.68	13.02	14.18	14.62	0.04	0.04	152.72	146.13
1650	8.98	8.85	11.37	12.62	13.66	14.07	0.02	0.04	143.86	137.57
1700	8.70	8.61	11.10	12.28	13.49	13.90	0.03	0.02	135.24	129.30
1800	8.26	8.22	10.63	11.66	13.11	13.50	0.06	0.09	118.11	112.80
1850	7.92	7.89	10.35	11.30	12.84	13.23	0.02	0.01	109.19	104.30
1900	7.69	7.70	10.12	11.00	12.73	13.11	0.01	0.01	100.72	96.17
2000	7.13	7.16	9.53	10.24	12.41	12.76	0.03	0.07	82.56	78.79
2050	6.98	7.03	9.15	9.77	11.99	12.30	0.09	0.02	72.83	69.40
2100	6.58	6.64	8.98	9.52	12.06	12.37	0.04	0.15	63.66	60.71
2150	6.54	6.60	8.45	8.88	11.62	11.87	0.18	0.04	53.61	50.99

Frequency (MHz)	Insertion Loss (dB)		Input Return Loss (dB)		Output Return Loss (dB)		Deviation from Linear Loss (dB)		Insertion Phase (deg)		Input IP3 (dBm)
	Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol
	4.3V	5V	4.3V	5V	4.3V	5V	4.3V	5V	4.3V	5V	5V
950	7.17	5.84	20.12	17.47	20.43	18.87	0.09	0.20	142.51	146.41	54.03
1000	7.14	5.83	20.46	17.71	20.65	19.08	0.06	0.15	150.10	154.14	53.98
1100	7.10	5.83	21.02	18.16	20.94	19.38	0.03	0.09	165.34	169.72	53.80
1150	7.08	5.84	21.43	18.49	20.93	19.39	0.02	0.06	172.98	177.52	54.38
1200	7.06	5.84	21.62	18.64	21.22	19.70	0.01	0.03	179.45	174.74	54.95
1300	7.01	5.83	22.34	19.36	21.65	20.20	0.04	0.05	164.07	159.09	54.82
1400	6.97	5.86	22.68	19.93	22.12	20.71	0.06	0.10	148.94	143.62	55.08
1450	6.99	5.89	22.79	20.43	21.24	20.06	0.04	0.10	140.75	135.24	54.67
1500	6.98	5.93	22.89	20.82	22.33	20.79	0.04	0.09	133.58	127.91	54.26
1600	7.00	6.00	22.58	21.54	21.37	20.32	0.01	0.09	117.97	111.88	54.91
1650	6.95	5.97	22.22	22.12	21.04	20.47	0.06	0.15	109.82	103.64	54.50
1700	6.93	6.00	21.71	22.50	20.91	20.50	0.07	0.16	102.03	95.68	54.08
1800	7.00	6.15	20.05	21.99	20.11	20.11	0.01	0.08	86.32	79.53	53.81
1850	6.90	6.11	19.24	21.77	20.38	20.93	0.08	0.16	78.75	71.88	54.58
1900	6.96	6.23	18.29	20.95	19.75	20.30	0.02	0.07	71.31	64.13	55.35
2000	6.94	6.39	16.11	18.64	19.37	20.74	0.03	0.02	56.26	48.83	54.76
2050	7.05	6.58	14.74	16.93	18.02	19.53	0.09	0.18	48.09	40.37	54.21
2100	6.94	6.63	13.87	15.84	18.31	20.35	0.02	0.19	41.53	33.82	53.65
2150	7.15	6.98	12.26	13.77	16.81	18.80	0.20	0.51	33.60	25.84	53.22

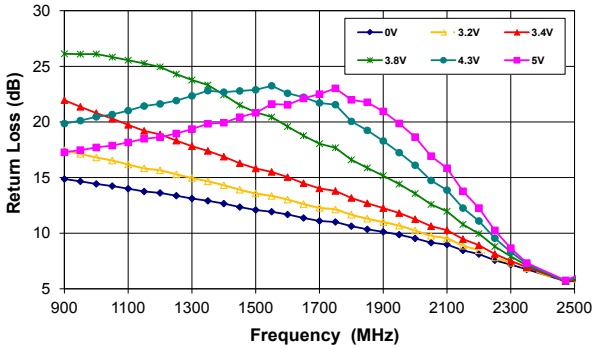
Frequency (MHz)	Insertion Loss (dB)		Input Return Loss (dB)		Output Return Loss (dB)		Deviation from Linear Loss (dB)		Insertion Phase (deg)	
	Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol	
	0V	2.1V	0V	2.1V	0V	2.1V	0V	2.1V	0V	2.1V
950	12.84	12.04	12.96	14.29	15.84	13.03	0.16	0.00	105.88	114.75
1000	12.51	11.79	12.81	14.09	15.55	12.87	0.10	0.02	113.34	121.89
1100	11.92	11.32	12.49	13.69	15.13	12.66	0.04	0.01	128.37	136.43
1150	11.62	11.08	12.31	13.48	14.99	12.61	0.01	0.01	135.96	143.75
1200	11.33	10.84	12.23	13.37	14.70	12.43	0.02	0.01	143.57	151.06
1300	10.77	10.36	11.86	12.90	14.27	12.20	0.04	0.01	159.50	166.43
1400	10.19	9.86	11.52	12.49	14.00	12.11	0.09	0.03	175.14	178.57
1450	9.99	9.69	11.28	12.20	13.81	11.99	0.03	0.03	176.59	170.48
1500	9.66	9.40	11.08	11.96	14.09	12.32	0.09	0.02	168.74	163.03
1600	9.18	8.98	10.79	11.60	13.58	12.01	0.03	0.04	152.53	147.27
1650	8.93	8.73	10.53	11.30	13.11	11.66	0.02	0.04	143.69	138.68
1700	8.65	8.47	10.32	11.05	12.97	11.61	0.03	0.01	135.08	130.35
1800	8.21	8.06	9.96	10.61	12.67	11.49	0.06	0.08	117.96	113.68
1850	7.87	7.72	9.74	10.35	12.42	11.32	0.02	0.02	109.03	105.08
1900	7.63	7.51	9.57	10.13	12.43	11.40	0.00	0.00	100.69	96.95
2000	7.06	6.95	9.08	9.56	12.02	11.20	0.03	0.09	82.26	79.11
2050	6.92	6.81	8.77	9.19	11.70	10.99	0.09	0.02	72.59	69.58
2100	6.51	6.41	8.66	9.04	11.80	11.14	0.05	0.15	63.40	60.76
2150	6.48	6.38	8.19	8.51	11.40	10.86	0.18	0.07	53.30	50.78

Frequency (MHz)	Insertion Loss (dB)		Input Return Loss (dB)		Output Return Loss (dB)		Deviation from Linear Loss (dB)		Insertion Phase (deg)		Input IP3 (dBm)
	Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol
	3V	5V	3V	5V	3V	5V	3V	5V	3V	5V	5V
950	6.31	2.31	25.92	20.38	18.11	20.45	0.02	0.35	146.43	154.48	53.16
1000	6.32	2.34	25.45	20.20	17.87	20.21	0.03	0.28	154.07	162.55	51.67
1100	6.35	2.41	24.28	19.58	17.51	19.82	0.03	0.15	169.45	178.89	49.78
1150	6.37	2.45	23.75	19.23	17.46	19.74	0.03	0.10	177.11	172.91	49.76
1200	6.40	2.50	23.44	19.22	17.16	19.42	0.01	0.05	175.29	164.75	49.73
1300	6.42	2.58	22.30	18.59	16.82	19.24	0.03	0.06	159.98	148.49	50.67
1400	6.47	2.72	21.26	18.13	16.73	19.41	0.01	0.12	145.00	132.20	51.49
1450	6.50	2.75	20.41	17.35	16.54	18.96	0.00	0.19	136.80	123.38	51.48
1500	6.56	2.91	19.95	17.19	17.10	20.17	0.04	0.13	129.81	115.58	51.46
1600	6.64	3.06	18.94	16.52	16.62	19.46	0.09	0.17	114.39	98.58	51.91
1650	6.59	3.06	18.24	16.02	16.04	18.87	0.03	0.27	106.47	90.19	52.93
1700	6.59	3.15	17.64	15.60	15.97	18.97	0.01	0.28	98.89	81.89	53.94
1800	6.69	3.41	16.39	14.70	15.67	18.66	0.08	0.22	83.53	64.56	55.24
1850	6.60	3.47	15.78	14.38	15.39	18.88	0.03	0.25	76.37	56.79	55.86
1900	6.66	3.68	15.12	13.82	15.39	18.96	0.01	0.14	69.14	48.39	56.47
2000	6.61	4.05	13.64	12.70	14.96	19.17	0.07	0.04	54.65	31.91	55.24
2050	6.68	4.36	12.64	11.66	14.44	18.43	0.02	0.25	46.54	22.43	54.56
2100	6.52	4.65	12.07	11.23	14.45	19.30	0.19	0.44	40.31	15.56	53.88
2150	6.68	5.22	10.85	9.91	13.83	18.38	0.06	0.92	32.17	6.01	53.88

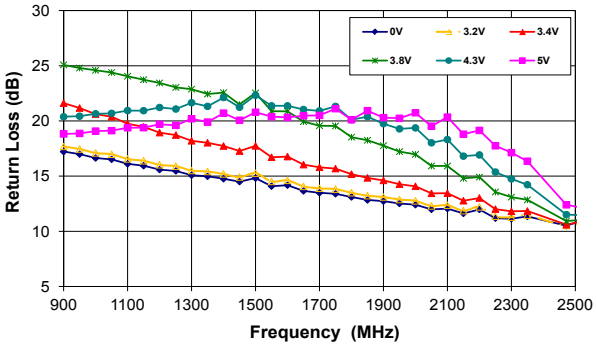
VAEQ-2150R+
INSERTION LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



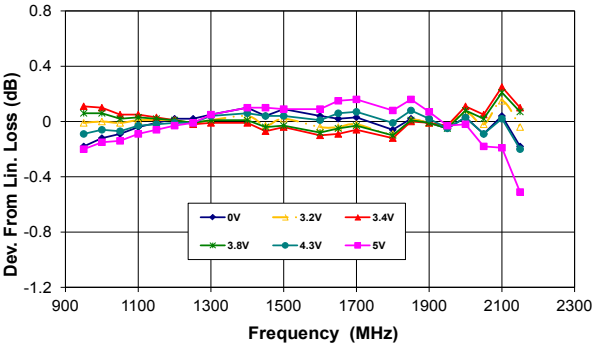
VAEQ-2150R+
INPUT RETURN LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



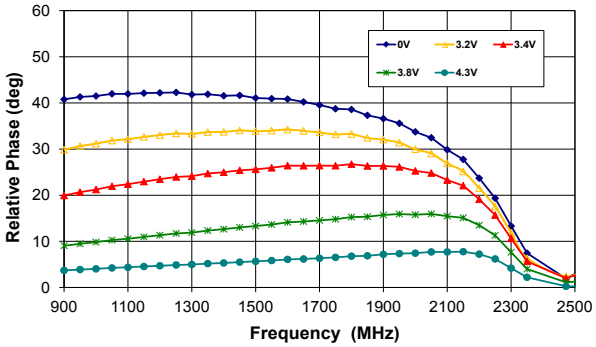
VAEQ-2150R+
OUTPUT RETURN LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



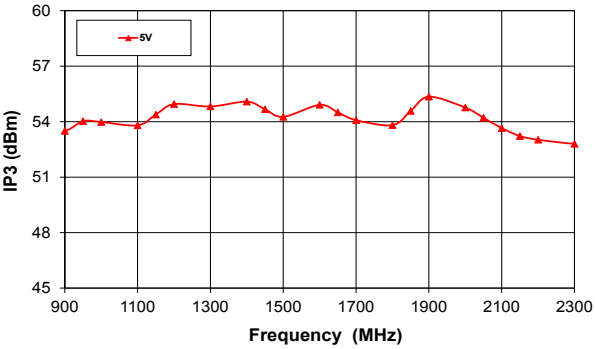
VAEQ-2150R+
DEVIATION FROM LINEAR LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



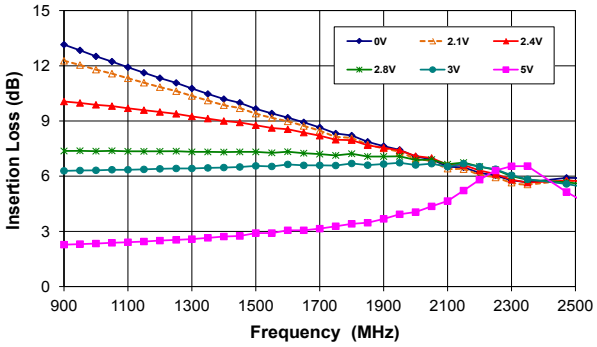
VAEQ-2150R+
PHASE UNBALANCE Vs. FREQUENCY
OVER CONTROL VOLTAGES



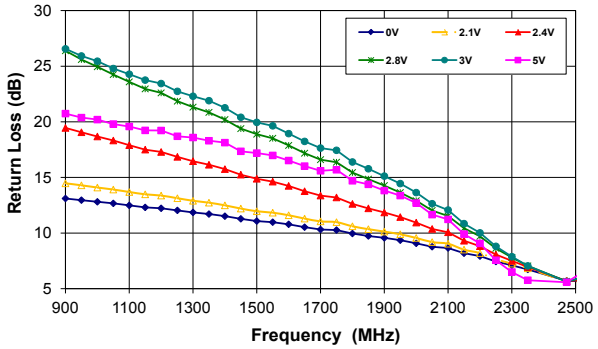
VAEQ-2150R+
IP3 Vs. FREQUENCY
OVER CONTROL VOLTAGES



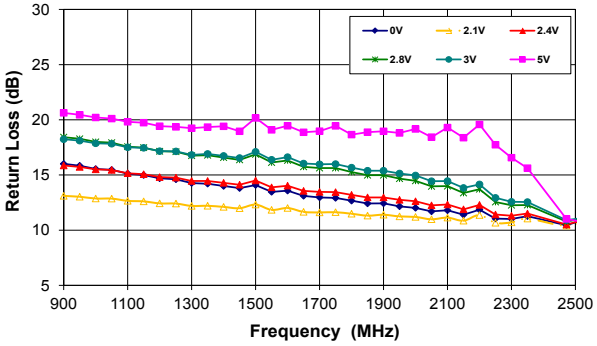
VAEQ-2150R+
INSERTION LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



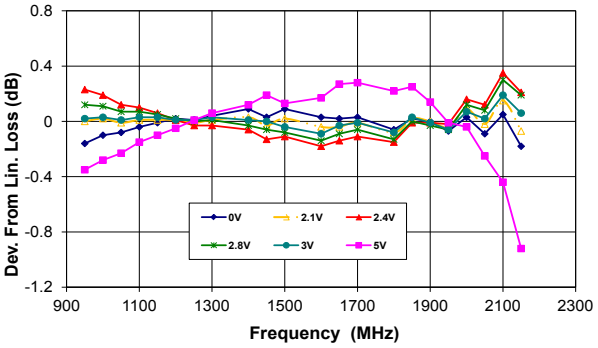
VAEQ-2150R+
INPUT RETURN LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



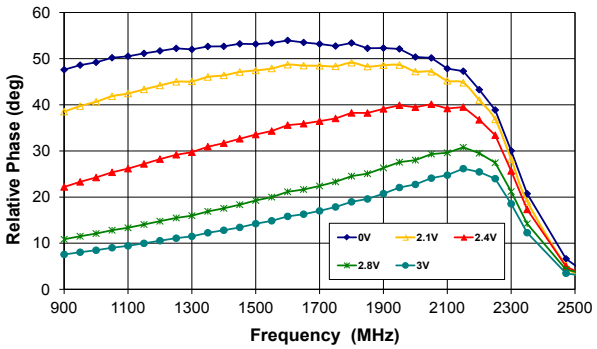
VAEQ-2150R+
OUTPUT RETURN LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



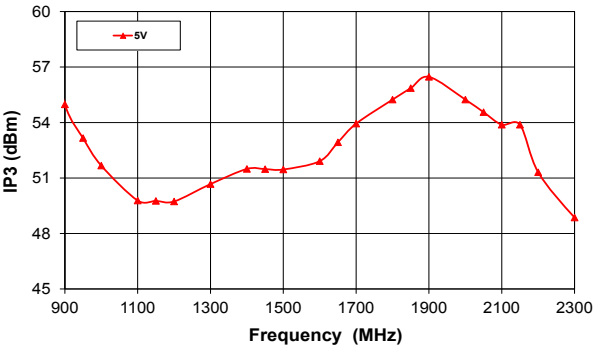
VAEQ-2150R+
DEVIATION FROM LINEAR LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



VAEQ-2150R+
PHASE UNBALANCE Vs. FREQUENCY
OVER CONTROL VOLTAGES



VAEQ-2150R+
IP3 Vs. FREQUENCY
OVER CONTROL VOLTAGES



Additional 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

Voltage Variable Equalizer, 50Ω VAEQ-2150R+

Typical Performance Data @ V+=5V

Frequency (MHz)	Insertion Loss (dB) Vcontrol		Input Return Loss (dB) Vcontrol		Output Return Loss (dB) Vcontrol		Deviation from Linear (dB) Vcontrol		Insertion Phase (deg) Vcontrol	
	0V	3.2V	0V	3.2V	0V	3.2V	0V	3.2V	0V	3.2V
900	13.21	12.22	14.87	17.46	17.22	17.69	-	-	-97.85	-108.77
920	13.08	12.14	14.80	17.35	17.09	17.55	-	-	-100.72	-111.52
940	12.95	12.04	14.69	17.19	17.01	17.47	-	-	-103.69	-114.41
950	12.89	12.00	14.66	17.13	16.99	17.46	51.62	26.34	-105.11	-115.76
970	12.72	11.87	14.58	17.03	16.93	17.40	19.47	9.73	-108.05	-118.54
990	12.62	11.80	14.51	16.91	16.68	17.15	10.29	3.06	-111.05	-121.44
1010	12.51	11.72	14.39	16.75	16.62	17.07	5.27	-1.20	-114.11	-124.43
1030	12.39	11.63	14.31	16.63	16.56	17.02	1.77	-4.57	-117.03	-127.24
1050	12.27	11.54	14.24	16.53	16.52	16.98	-1.06	-7.52	-119.97	-130.10
1070	12.08	11.40	14.18	16.43	16.51	16.98	-3.55	-10.27	-122.86	-132.77
1090	12.01	11.34	14.03	16.23	16.13	16.58	-5.81	-12.83	-126.29	-136.11
1110	11.91	11.26	13.97	16.13	16.09	16.54	-8.03	-15.40	-129.21	-138.94
1130	11.78	11.18	13.93	16.08	16.03	16.47	-10.18	-17.88	-132.13	-141.76
1150	11.66	11.07	13.75	15.83	15.94	16.39	-12.25	-20.32	-135.40	-144.89
1170	11.55	11.00	13.70	15.76	16.04	16.49	-14.33	-22.75	-138.29	-147.69
1190	11.41	10.87	13.63	15.66	15.60	16.04	-16.41	-25.17	-141.60	-150.79
1210	11.26	10.75	13.54	15.55	15.55	16.00	-18.59	-27.63	-144.76	-153.80
1230	11.20	10.71	13.42	15.37	15.49	15.93	-20.67	-30.04	-147.88	-156.87
1270	10.98	10.55	13.35	15.25	15.55	16.00	-25.03	-34.92	-153.69	-162.47
1300	10.81	10.39	13.12	14.96	15.08	15.51	-28.24	-38.53	-159.10	-167.62
1325	10.70	10.31	13.05	14.84	15.05	15.48	-30.95	-41.46	-162.81	-171.20
1350	10.50	10.14	12.91	14.66	14.98	15.42	-33.92	-44.69	-166.78	-174.98
1375	10.43	10.09	12.75	14.45	14.98	15.41	-36.65	-47.61	-170.68	-178.79
1400	10.22	9.91	12.66	14.31	14.76	15.20	-39.66	-50.80	-174.83	177.35
1425	10.10	9.81	12.47	14.08	14.55	14.98	-42.58	-53.86	-179.00	173.29
1450	10.02	9.75	12.35	13.91	14.50	14.92	-45.71	-57.10	176.88	169.28
1475	9.90	9.66	12.31	13.84	14.57	15.00	-48.61	-60.12	173.37	165.90
1500	9.70	9.47	12.09	13.57	14.82	15.27	-51.90	-63.48	168.98	161.79
1525	9.61	9.40	11.98	13.41	14.13	14.55	-54.87	-66.49	164.78	157.68
1550	9.44	9.25	11.93	13.35	14.09	14.52	-58.20	-69.86	160.85	153.93
1575	9.38	9.20	11.71	13.07	14.02	14.44	-61.37	-73.01	156.54	149.73
1600	9.22	9.08	11.68	13.02	14.18	14.62	-64.71	-76.38	152.72	146.13
1625	9.05	8.90	11.49	12.78	13.83	14.25	-67.82	-79.48	148.10	141.69
1650	8.98	8.85	11.37	12.62	13.66	14.07	-71.50	-83.06	143.86	137.57
1675	8.83	8.73	11.36	12.58	13.68	14.10	-74.67	-86.23	140.15	134.03
1700	8.70	8.61	11.10	12.28	13.49	13.90	-78.11	-89.58	135.24	129.30
1725	8.63	8.55	11.01	12.15	13.58	13.99	-81.69	-93.04	131.50	125.70
1750	8.36	8.30	11.01	12.13	13.40	13.82	-85.20	-96.52	127.24	121.69
1775	8.32	8.26	10.74	11.80	13.09	13.48	-88.70	-99.85	122.35	116.91
1800	8.26	8.22	10.63	11.66	13.11	13.50	-92.42	-103.50	118.11	112.80
1825	8.06	8.04	10.59	11.59	13.46	13.88	-95.77	-106.74	114.46	109.40
1850	7.92	7.89	10.35	11.30	12.84	13.23	-99.58	-110.41	109.19	104.30
1900	7.69	7.70	10.12	11.00	12.73	13.11	-106.50	-117.11	100.72	96.17
1950	7.47	7.49	9.87	10.67	12.52	12.88	-114.11	-124.43	92.01	87.80
2000	7.13	7.16	9.53	10.24	12.41	12.76	-121.36	-131.43	82.56	78.79
2050	6.98	7.03	9.15	9.77	11.99	12.30	-129.21	-138.94	72.83	69.40
2100	6.58	6.64	8.98	9.52	12.06	12.37	-136.89	-146.33	63.66	60.71
2150	6.54	6.60	8.45	8.88	11.62	11.87	-144.76	-153.80	53.61	50.99
2200	6.23	6.29	8.12	8.46	11.98	12.21	-	-	44.11	41.95
2250	6.09	6.13	7.57	7.82	11.19	11.37	-	-	32.54	30.72
2300	5.82	5.85	7.17	7.34	11.14	11.28	-	-	21.36	19.93
2350	5.71	5.72	6.76	6.85	11.35	11.45	-	-	10.98	9.88

Voltage Variable Equalizer, 50Ω VAEQ-2150R+

Typical Performance Data @ V+=5V

Frequency (MHz)	Insertion Loss (dB) Vcontrol		Input Return Loss (dB) Vcontrol		Output Return Loss (dB) Vcontrol		Deviation from Linear (dB) Vcontrol		Insertion Phase (deg) Vcontrol	
	4.3V	5V	4.3V	5V	4.3V	5V	4.3V	5V	4.3V	5V
900	7.18	5.84	19.85	17.27	20.38	18.82	-	-	-134.91	-138.62
920	7.18	5.84	19.94	17.33	20.40	18.85	-	-	-137.94	-141.72
940	7.17	5.84	20.10	17.45	20.42	18.87	-	-	-140.99	-144.84
950	7.17	5.84	20.12	17.47	20.43	18.87	4.55	3.03	-142.51	-146.41
970	7.16	5.85	20.18	17.49	20.99	19.30	-1.85	-2.95	-145.36	-149.32
990	7.14	5.83	20.35	17.62	20.65	19.07	-5.84	-6.76	-148.52	-152.54
1010	7.14	5.83	20.49	17.74	20.64	19.07	-9.32	-10.20	-151.64	-155.71
1030	7.14	5.84	20.59	17.81	20.65	19.08	-12.60	-13.49	-154.65	-158.82
1050	7.14	5.85	20.67	17.88	20.69	19.12	-15.77	-16.70	-157.70	-161.94
1070	7.12	5.85	20.90	18.03	20.98	19.30	-18.90	-19.89	-160.47	-164.79
1090	7.10	5.83	20.98	18.12	21.02	19.44	-21.96	-23.00	-163.80	-168.12
1110	7.10	5.84	21.06	18.19	20.92	19.37	-25.02	-26.11	-166.84	-171.25
1130	7.11	5.85	21.17	18.27	20.88	19.33	-28.08	-29.24	-169.88	-174.38
1150	7.08	5.84	21.43	18.49	20.93	19.39	-31.13	-32.36	-172.98	-177.52
1170	7.11	5.87	21.42	18.50	20.92	19.34	-34.17	-35.46	-176.03	179.32
1190	7.05	5.83	21.56	18.59	21.48	19.92	-37.18	-38.56	-178.93	176.42
1210	7.03	5.82	22.00	18.93	21.24	19.70	-40.22	-41.65	177.98	173.25
1230	7.05	5.84	21.88	18.91	21.14	19.66	-43.24	-44.74	174.77	169.98
1270	7.08	5.89	21.97	19.00	21.01	19.49	-49.30	-50.95	168.82	163.82
1300	7.01	5.83	22.34	19.36	21.65	20.20	-53.83	-55.59	164.07	159.09
1325	7.03	5.86	22.36	19.44	21.29	19.90	-57.43	-59.28	160.26	155.16
1350	7.00	5.85	22.81	19.84	21.32	19.90	-61.36	-63.29	156.52	151.34
1375	7.03	5.89	22.53	19.79	21.10	19.74	-64.96	-66.99	152.52	147.23
1400	6.97	5.86	22.68	19.93	22.12	20.71	-68.87	-71.00	148.94	143.62
1425	6.95	5.84	23.00	20.41	21.51	20.26	-72.50	-74.71	144.92	139.53
1450	6.99	5.89	22.79	20.43	21.24	20.06	-76.41	-78.71	140.75	135.24
1475	7.02	5.94	22.80	20.51	21.11	19.89	-80.02	-82.42	137.24	131.59
1500	6.98	5.93	22.89	20.82	22.33	20.79	-83.96	-86.45	133.58	127.91
1525	6.95	5.89	22.89	21.11	21.55	20.58	-87.55	-90.13	129.41	123.69
1550	6.94	5.91	23.25	21.61	21.37	20.39	-91.45	-94.13	125.76	119.92
1575	6.97	5.94	22.66	21.53	21.12	20.23	-95.09	-97.86	121.55	115.62
1600	7.00	6.00	22.58	21.54	21.37	20.32	-98.99	-101.85	117.97	111.88
1625	6.90	5.92	22.72	22.28	21.58	20.86	-102.57	-105.53	114.07	108.04
1650	6.95	5.97	22.22	22.12	21.04	20.47	-106.54	-109.57	109.82	103.64
1675	6.96	6.01	22.26	22.36	21.02	20.40	-110.15	-113.29	106.41	100.09
1700	6.93	6.00	21.71	22.50	20.91	20.50	-113.99	-117.24	102.03	95.68
1725	6.99	6.08	21.25	22.20	20.72	20.28	-117.71	-121.01	98.40	91.92
1750	6.88	6.01	21.55	23.02	21.32	21.11	-121.60	-125.01	95.04	88.51
1775	6.91	6.04	20.62	22.48	20.53	20.59	-125.24	-128.72	90.37	83.77
1800	7.00	6.15	20.05	21.99	20.11	20.11	-129.16	-132.73	86.32	79.53
1825	6.99	6.19	19.95	22.17	20.68	20.43	-132.77	-136.44	83.39	76.47
1850	6.90	6.11	19.24	21.77	20.38	20.93	-136.72	-140.47	78.75	71.88
1900	6.96	6.23	18.29	20.95	19.75	20.30	-144.02	-147.96	71.31	64.13
1950	7.03	6.36	17.24	19.87	19.28	20.24	-151.64	-155.71	63.78	56.43
2000	6.94	6.39	16.11	18.64	19.37	20.74	-159.15	-163.44	56.26	48.83
2050	7.05	6.58	14.74	16.93	18.02	19.53	-166.84	-171.25	48.09	40.37
2100	6.94	6.63	13.87	15.84	18.31	20.35	-174.56	-179.15	41.53	33.82
2150	7.15	6.98	12.26	13.77	16.81	18.80	177.98	173.25	33.60	25.84
2200	7.06	7.10	11.10	12.26	16.92	19.14	-	-	27.65	20.42
2250	7.02	7.25	9.55	10.25	15.37	17.75	-	-	19.38	13.19
2300	6.71	7.05	8.32	8.66	14.75	17.13	-	-	12.24	8.04
2350	6.46	6.78	7.24	7.32	14.22	16.35	-	-	5.75	3.53

Frequency (MHz)	Input IP3 (dBm) Vcontrol
	5V
900	53.50
950	54.03
1000	53.98
1100	53.80
1150	54.38
1200	54.95
1300	54.82
1400	55.08
1450	54.67
1500	54.26
1600	54.91
1650	54.50
1700	54.08
1800	53.81
1850	54.58
1900	55.35
2000	54.76
2050	54.21
2100	53.65
2150	53.22
2200	53.02
2300	52.80

Voltage Variable Equalizer, 50Ω VAEQ-2150R+

Typical Performance Data @ V+=3V

Frequency (MHz)	Insertion Loss (dB) Vcontrol		Input Return Loss (dB) Vcontrol		Output Return Loss (dB) Vcontrol		Deviation from Linear (dB) Vcontrol		Insertion Phase (deg) Vcontrol	
	0V	2.1V	0V	2.1V	0V	2.1V	0V	2.1V	0V	2.1V
900	13.15	12.27	13.11	14.47	16.01	13.11	-	-	-98.68	-107.76
920	13.03	12.18	13.06	14.41	15.90	13.05	-	-	-101.52	-110.50
940	12.89	12.08	12.98	14.32	15.85	13.03	-	-	-104.47	-113.37
950	12.84	12.04	12.96	14.29	15.84	13.03	51.20	30.95	-105.88	-114.75
970	12.67	11.91	12.90	14.22	15.72	12.99	18.75	11.08	-108.82	-117.46
990	12.57	11.84	12.86	14.16	15.59	12.89	9.58	3.84	-111.76	-120.41
1010	12.46	11.75	12.77	14.04	15.53	12.87	4.53	-0.64	-114.81	-123.33
1030	12.34	11.66	12.72	13.98	15.49	12.86	0.98	-4.14	-117.71	-126.18
1050	12.23	11.57	12.67	13.91	15.47	12.86	-1.90	-7.16	-120.64	-128.99
1070	12.04	11.43	12.63	13.87	15.47	12.89	-4.45	-9.94	-123.46	-131.63
1090	11.97	11.36	12.51	13.72	15.14	12.65	-6.76	-12.51	-126.90	-134.97
1110	11.87	11.28	12.47	13.67	15.11	12.65	-9.02	-15.09	-129.81	-137.84
1130	11.75	11.19	12.45	13.64	15.06	12.64	-11.21	-17.56	-132.71	-140.62
1150	11.62	11.08	12.31	13.48	14.99	12.61	-13.32	-20.00	-135.96	-143.75
1170	11.52	11.01	12.28	13.43	15.10	12.70	-15.43	-22.40	-138.83	-146.53
1190	11.37	10.87	12.23	13.37	14.70	12.43	-17.53	-24.81	-142.09	-149.62
1210	11.23	10.75	12.17	13.29	14.67	12.42	-19.71	-27.22	-145.22	-152.57
1230	11.17	10.70	12.07	13.18	14.62	12.40	-21.82	-29.63	-148.35	-155.70
1270	10.95	10.54	12.04	13.12	14.70	12.51	-26.19	-34.44	-154.12	-161.29
1300	10.77	10.36	11.86	12.90	14.27	12.20	-29.43	-37.99	-159.50	-166.43
1325	10.66	10.28	11.81	12.84	14.26	12.22	-32.13	-40.92	-163.20	-169.99
1350	10.47	10.11	11.71	12.73	14.21	12.21	-35.10	-44.10	-167.13	-173.75
1375	10.40	10.06	11.58	12.57	14.23	12.25	-37.84	-46.99	-171.03	-177.58
1400	10.19	9.86	11.52	12.49	14.00	12.11	-40.85	-50.19	-175.14	178.57
1425	10.07	9.75	11.37	12.32	13.84	12.00	-43.74	-53.18	-179.28	174.54
1450	9.99	9.69	11.28	12.20	13.81	11.99	-46.87	-56.40	176.59	170.48
1475	9.87	9.60	11.27	12.18	13.89	12.09	-49.75	-59.41	173.10	167.09
1500	9.66	9.40	11.08	11.96	14.09	12.32	-53.02	-62.70	168.74	163.03
1525	9.58	9.32	11.00	11.86	13.49	11.82	-56.00	-65.74	164.55	158.87
1550	9.41	9.17	10.98	11.83	13.47	11.84	-59.29	-69.05	160.65	155.14
1575	9.34	9.11	10.79	11.61	13.42	11.83	-62.44	-72.19	156.33	150.89
1600	9.18	8.98	10.79	11.60	13.58	12.01	-65.77	-75.56	152.53	147.27
1625	9.01	8.79	10.63	11.41	13.25	11.75	-68.87	-78.60	147.93	142.85
1650	8.93	8.73	10.53	11.30	13.11	11.66	-72.51	-82.19	143.69	138.68
1675	8.78	8.60	10.54	11.30	13.16	11.74	-75.67	-85.34	140.02	135.15
1700	8.65	8.47	10.32	11.05	12.97	11.61	-79.07	-88.63	135.08	130.35
1725	8.58	8.42	10.25	10.96	13.06	11.73	-82.63	-92.14	131.33	126.68
1750	8.32	8.15	10.27	10.98	12.92	11.63	-86.12	-95.56	127.12	122.73
1775	8.27	8.10	10.04	10.71	12.63	11.40	-89.58	-98.87	122.21	117.86
1800	8.21	8.06	9.96	10.61	12.67	11.49	-93.28	-102.51	117.96	113.68
1825	7.99	7.87	9.95	10.58	13.03	11.87	-96.61	-105.72	114.36	110.32
1850	7.87	7.72	9.74	10.35	12.42	11.32	-100.39	-109.41	109.03	105.08
1900	7.63	7.51	9.57	10.13	12.43	11.40	-107.26	-116.06	100.69	96.95
1950	7.43	7.31	9.36	9.89	12.16	11.25	-114.81	-123.33	91.85	88.36
2000	7.06	6.95	9.08	9.56	12.02	11.20	-122.01	-130.34	82.26	79.11
2050	6.92	6.81	8.77	9.19	11.70	10.99	-129.81	-137.84	72.59	69.58
2100	6.51	6.41	8.66	9.04	11.80	11.14	-137.44	-145.19	63.40	60.76
2150	6.48	6.38	8.19	8.51	11.40	10.86	-145.22	-152.57	53.30	50.78
2200	6.18	6.08	7.93	8.20	11.86	11.37	-	-	43.92	41.67
2250	6.04	5.93	7.44	7.65	11.05	10.67	-	-	32.19	30.13
2300	5.77	5.65	7.10	7.25	11.02	10.71	-	-	21.00	19.17
2350	5.67	5.55	6.73	6.83	11.27	11.05	-	-	10.69	9.04

Voltage Variable Equalizer, 50Ω VAEQ-2150R+

Typical Performance Data @ V+=3V

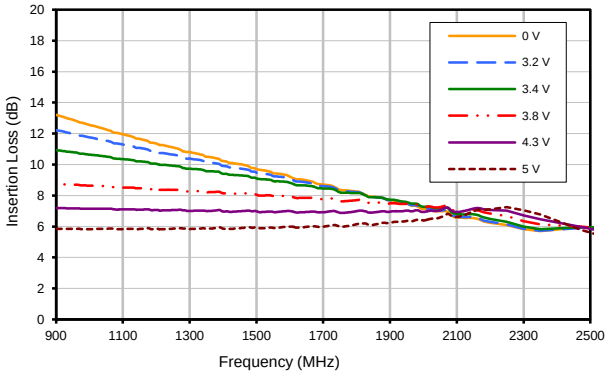
Frequency (MHz)	Insertion Loss (dB) Vcontrol		Input Return Loss (dB) Vcontrol		Output Return Loss (dB) Vcontrol		Deviation from Linear (dB) Vcontrol		Insertion Phase (deg) Vcontrol	
	3V	5V	3V	5V	3V	5V	3V	5V	3V	5V
900	6.29	2.28	26.56	20.74	18.24	20.63	-	-	-138.71	-146.28
920	6.29	2.29	26.33	20.64	18.14	20.49	-	-	-141.79	-149.54
940	6.30	2.30	26.09	20.48	18.11	20.47	-	-	-144.88	-152.82
950	6.31	2.31	25.92	20.38	18.11	20.45	5.01	2.55	-146.43	-154.48
970	6.33	2.36	25.70	20.31	18.09	20.62	-2.00	-3.63	-149.32	-157.62
990	6.32	2.33	25.61	20.31	17.88	20.20	-6.12	-7.48	-152.49	-160.90
1010	6.32	2.34	25.27	20.10	17.86	20.18	-9.72	-11.01	-155.64	-164.21
1030	6.34	2.36	25.02	19.95	17.84	20.13	-13.10	-14.44	-158.71	-167.50
1050	6.35	2.38	24.79	19.80	17.83	20.11	-16.39	-17.80	-161.82	-170.84
1070	6.37	2.43	24.87	19.82	17.95	20.38	-19.62	-21.14	-164.60	-173.97
1090	6.34	2.40	24.38	19.66	17.52	19.86	-22.78	-24.41	-167.87	-177.18
1110	6.36	2.42	24.18	19.52	17.51	19.78	-25.95	-27.70	-170.96	179.48
1130	6.38	2.44	24.09	19.46	17.49	19.71	-29.11	-31.00	-174.07	176.08
1150	6.37	2.45	23.75	19.23	17.46	19.74	-32.25	-34.28	-177.11	172.91
1170	6.41	2.49	23.47	19.03	17.61	19.89	-35.39	-37.55	179.72	169.41
1190	6.38	2.49	23.48	19.28	17.16	19.52	-38.51	-40.81	176.96	166.60
1210	6.38	2.51	23.52	19.23	17.21	19.55	-41.64	-44.07	173.88	163.23
1230	6.40	2.51	22.95	18.85	17.13	19.41	-44.75	-47.34	170.63	159.82
1270	6.47	2.59	22.65	18.63	17.31	19.52	-50.98	-53.87	164.55	153.03
1300	6.42	2.58	22.30	18.59	16.82	19.24	-55.65	-58.75	159.98	148.49
1325	6.45	2.61	22.01	18.35	16.84	19.14	-59.36	-62.65	156.13	144.24
1350	6.45	2.65	21.90	18.30	16.91	19.34	-63.40	-66.88	152.48	140.22
1375	6.49	2.68	21.27	17.82	16.94	19.27	-67.13	-70.80	148.39	135.82
1400	6.47	2.72	21.26	18.13	16.73	19.41	-71.15	-75.03	145.00	132.20
1425	6.45	2.71	20.87	17.75	16.58	19.13	-74.87	-78.93	141.04	128.02
1450	6.50	2.75	20.41	17.35	16.54	18.96	-78.88	-83.14	136.80	123.38
1475	6.57	2.84	20.29	17.27	16.71	19.10	-82.60	-87.07	133.26	119.26
1500	6.56	2.91	19.95	17.19	17.10	20.17	-86.63	-91.29	129.81	115.58
1525	6.52	2.84	19.67	16.99	16.28	18.92	-90.33	-95.19	125.71	111.35
1550	6.53	2.91	19.64	16.98	16.38	19.09	-94.33	-99.41	122.13	107.27
1575	6.57	2.94	19.00	16.43	16.31	18.94	-98.06	-103.32	117.89	102.73
1600	6.64	3.06	18.94	16.52	16.62	19.46	-102.07	-107.56	114.39	98.58
1625	6.53	3.01	18.64	16.36	16.22	19.25	-105.76	-111.49	110.73	94.99
1650	6.59	3.06	18.24	16.02	16.04	18.87	-109.77	-115.67	106.47	90.19
1675	6.63	3.16	18.22	16.09	16.18	19.11	-113.49	-119.61	103.16	86.29
1700	6.59	3.15	17.64	15.60	15.97	18.97	-117.44	-123.86	98.89	81.89
1725	6.68	3.27	17.34	15.39	16.14	19.11	-121.19	-127.71	95.29	77.59
1750	6.58	3.28	17.44	15.69	15.99	19.45	-125.19	-131.96	92.24	74.39
1775	6.59	3.27	16.73	14.98	15.58	18.72	-128.86	-135.87	87.58	69.39
1800	6.69	3.41	16.39	14.70	15.67	18.66	-132.85	-140.06	83.53	64.56
1825	6.71	3.57	16.30	14.82	16.30	19.90	-136.55	-144.00	80.84	61.29
1850	6.60	3.47	15.78	14.38	15.39	18.88	-140.55	-148.22	76.37	56.79
1900	6.66	3.68	15.12	13.82	15.39	18.96	-147.98	-156.16	69.14	48.39
1950	6.73	3.93	14.45	13.37	15.14	18.81	-155.64	-164.21	61.81	39.74
2000	6.61	4.05	13.64	12.70	14.96	19.17	-163.31	-172.49	54.65	31.91
2050	6.68	4.36	12.64	11.66	14.44	18.43	-170.96	179.48	46.54	22.43
2100	6.52	4.65	12.07	11.23	14.45	19.30	-178.74	171.14	40.31	15.56
2150	6.68	5.22	10.85	9.91	13.83	18.38	173.88	163.23	32.17	6.01
2200	6.52	5.81	10.02	9.07	14.15	19.58	-	-	26.10	0.65
2250	6.38	6.31	8.81	7.56	12.93	17.74	-	-	17.30	-6.69
2300	6.05	6.54	7.88	6.50	12.57	16.57	-	-	9.49	-9.04
2350	5.83	6.55	7.05	5.76	12.55	15.62	-	-	2.24	-10.04

Frequency (MHz)	Input IP3 (dBm) Vcontrol
	5V
900	54.98
950	53.16
1000	51.67
1100	49.78
1150	49.76
1200	49.73
1300	50.67
1400	51.49
1450	51.48
1500	51.46
1600	51.91
1650	52.93
1700	53.94
1800	55.24
1850	55.86
1900	56.47
2000	55.24
2050	54.56
2100	53.88
2150	53.88
2200	51.31
2300	48.86

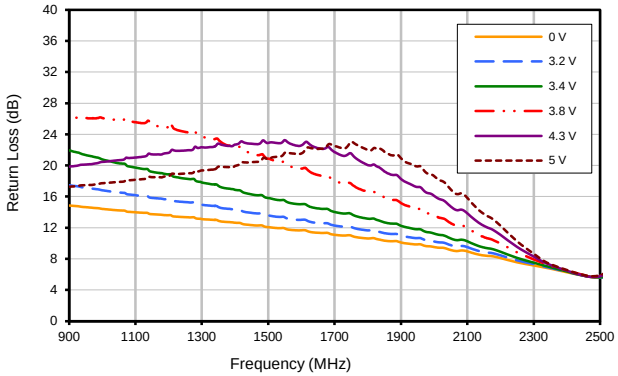
Voltage Variable Equalizer, 50Ω VAEQ-2150R+

Typical Performance Curves @ V+=5V

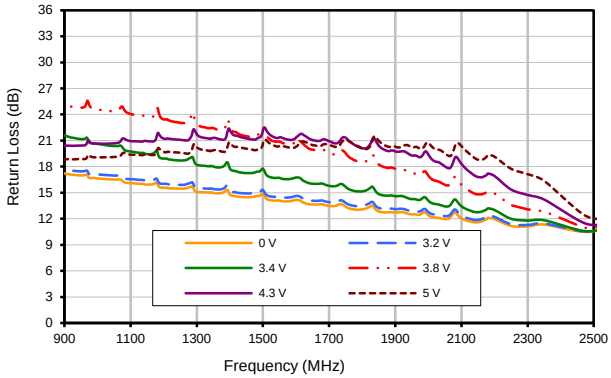
INSERTION LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



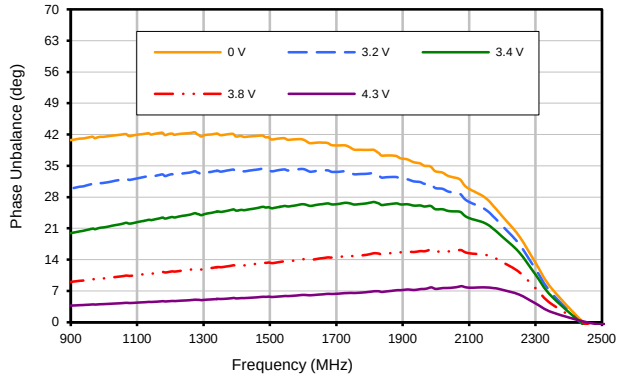
INPUT RETURN LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



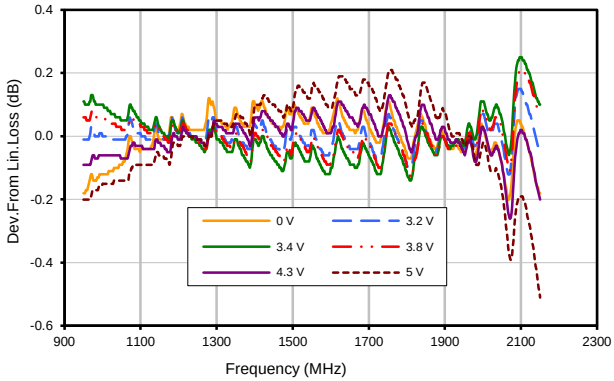
OUTPUT RETURN LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



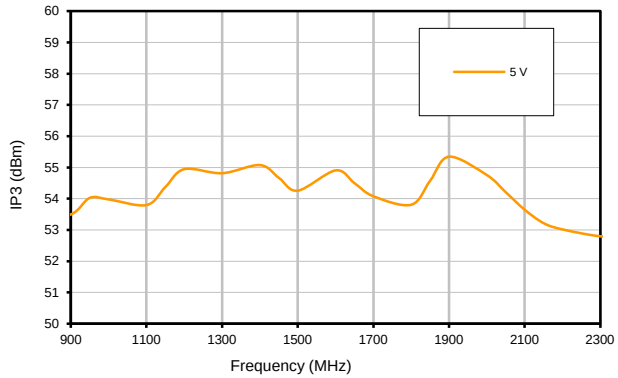
PHASE UNBALANCE
Vs.FREQUENCY OVER CONTROL VOLTAGES



DEVIATION FROM LINEAR LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES

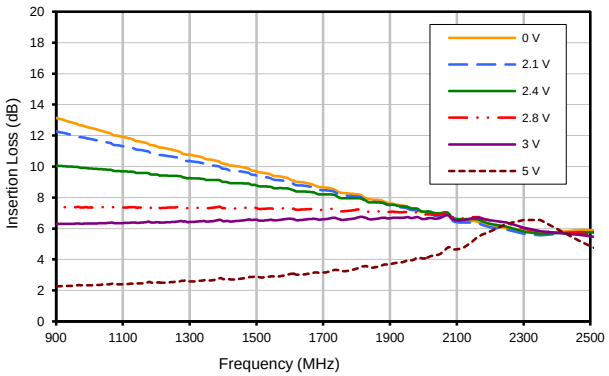


IP3
Vs.FREQUENCY OVER CONTROL VOLTAGES

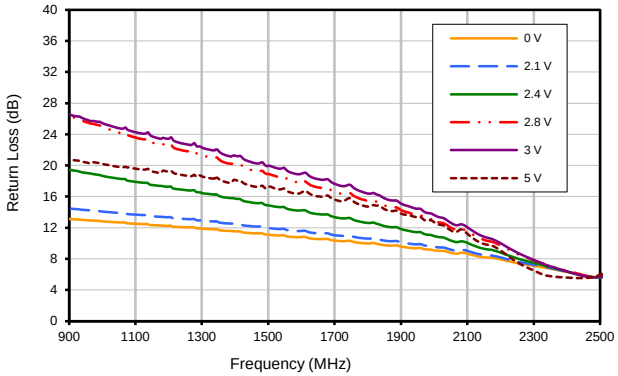


Typical Performance Curves @ V+=3V

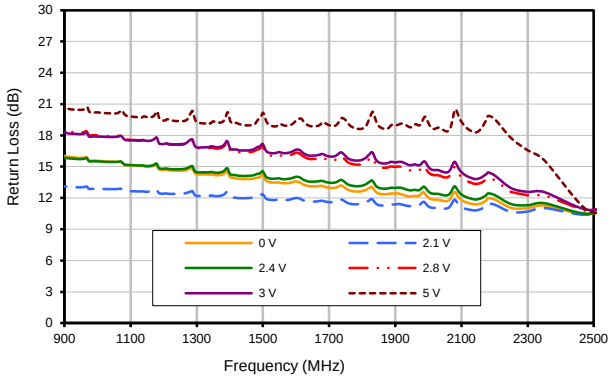
INSERTION LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



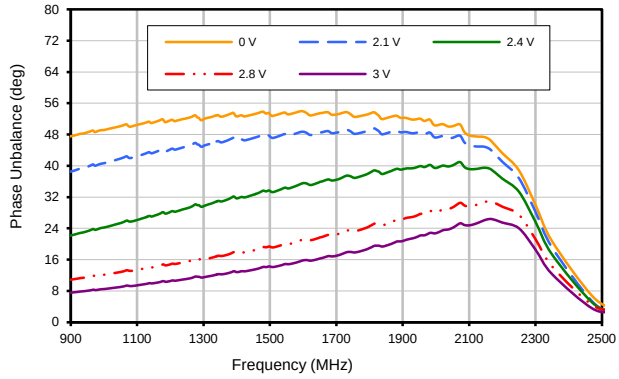
INPUT RETURN LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



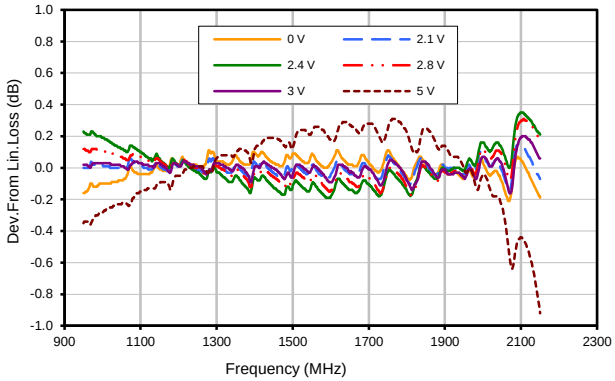
OUTPUT RETURN LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



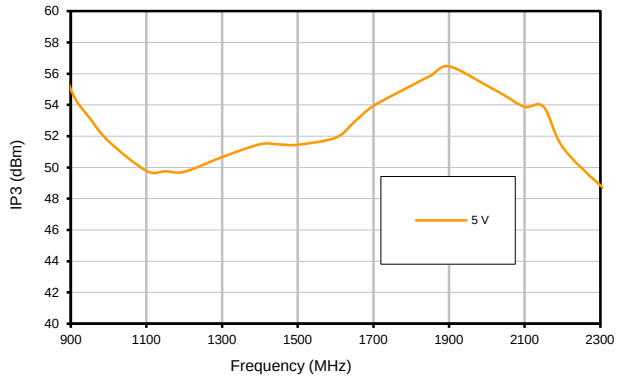
PHASE UNBALANCE
Vs.FREQUENCY OVER CONTROL VOLTAGES



DEVIATION FROM LINEAR LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



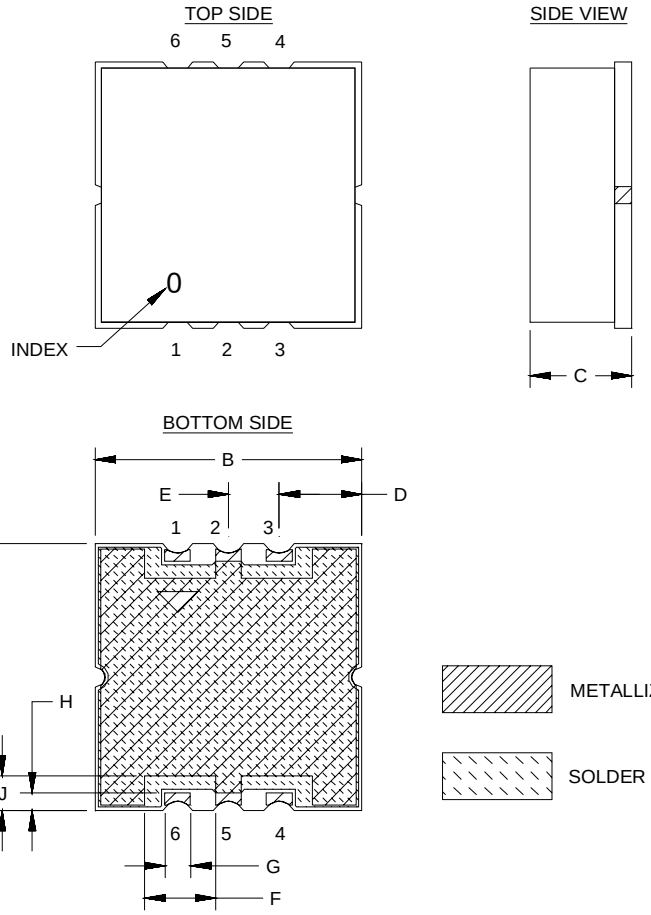
IP3
Vs.FREQUENCY OVER CONTROL VOLTAGES



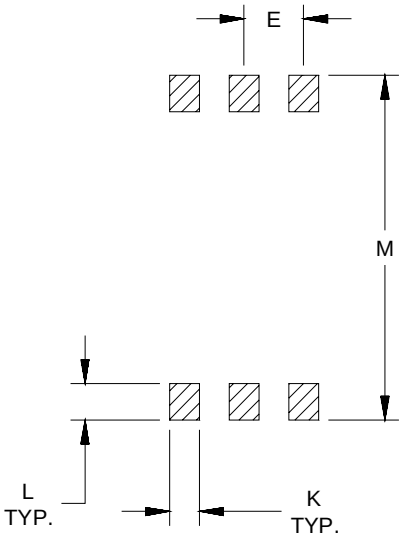
Case Style HE

HE1354

Outline Dimensions



PCB Land Pattern



Suggested Layout

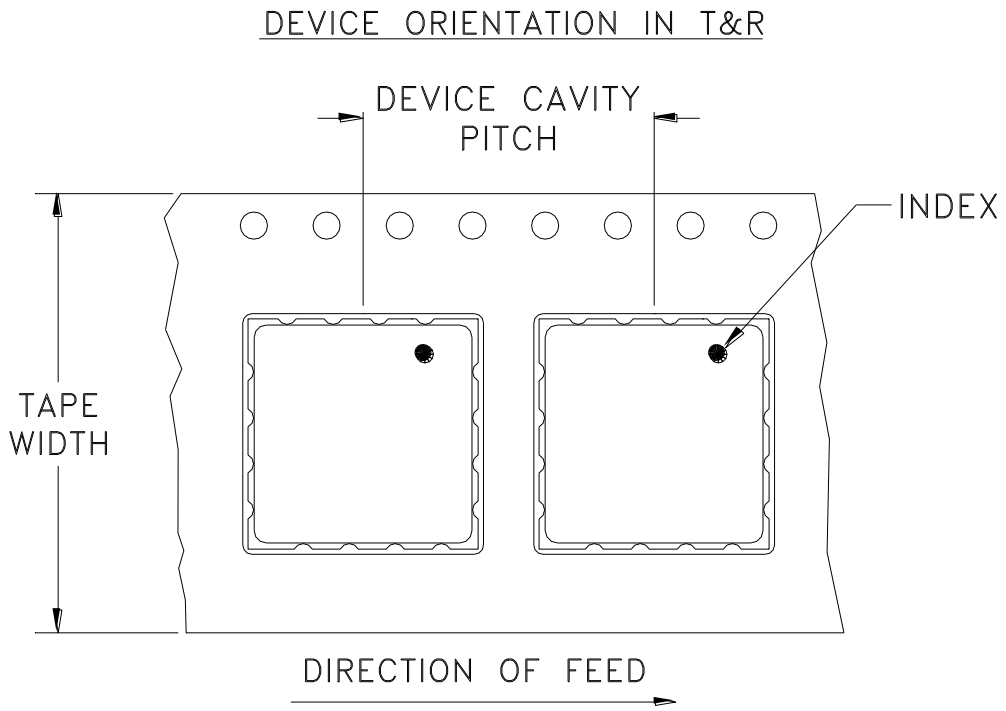
CASE #	A	B	C	D	E	F	G	H	J	K	L	M	WT. GRAMS
HE1354	.394 (10.01)	.394 (10.01)	.150 (3.81)	.122 (3.10)	.075 (1.90)	.098 (2.49)	.038 (0.97)	.026 (0.66)	.051 (1.29)	.038 (0.97)	.046 (1.17)	.434 (11.02)	0.7

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

Notes:

1. Case material: Nickel-Silver alloy.
2. Base: Printed wiring laminate.
3. Termination finish:
   For RoHS Case Styles: 3-5 µ inch (.08-.13 microns) Gold over 120-240 µ inch (3.05-6.10 microns) Nickel plate.
   For RoHS-5 Case Styles: Tin-Lead plate.

Tape & Reel Packaging TR-F37



Tape Width, mm	Device Cavity Pitch, mm	Reel Size, inches	Devices per Reel	
24	16	7	Small quantity standards (see note)	10
				20
				50
				100
		13	Standard	200
				500

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

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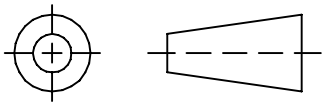
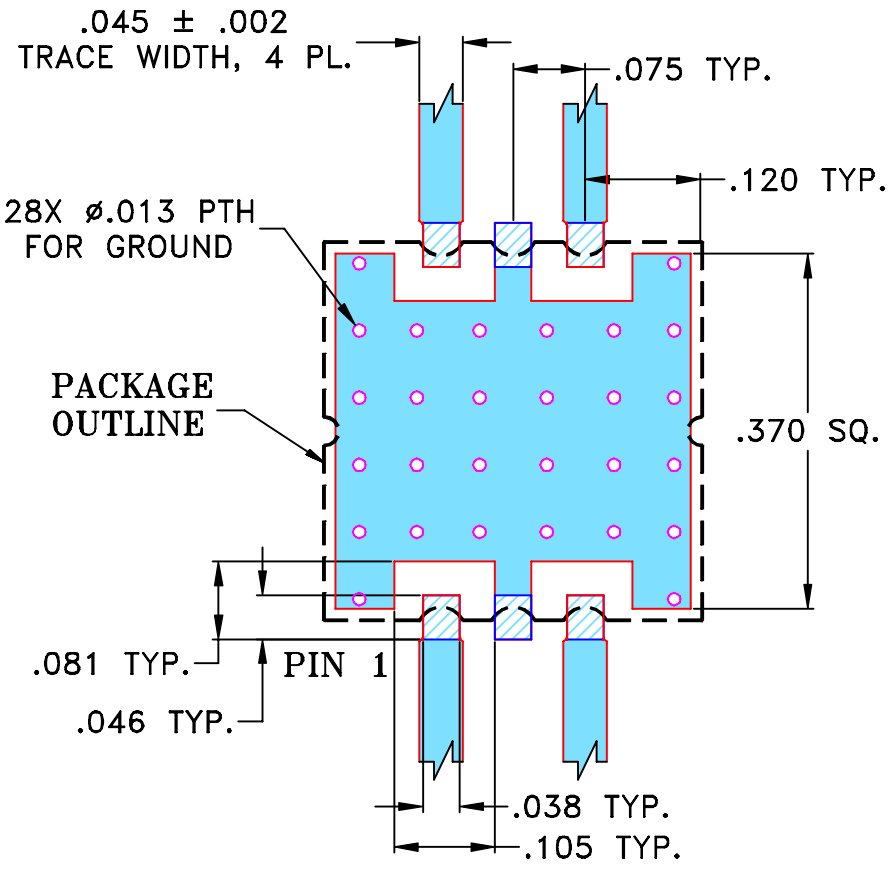
THIRD ANGLE PROJECTION



REVISIONS					
REV	ECN No.	DESCRIPTION	DATE	DR	AUTH
OR	M116338	NEW RELEASE (FROM RAVON)	03/08	DK	HH
OR	R72078	NEW RELEASE (FROM RAVON)	03/08	DK	HH

SUGGESTED MOUNTING CONFIGURATION FOR HE1354 CASE STYLE, "qg" PIN CONNECTION, 50 Ω



NOTE:

1. TRACE WIDTH IS SHOWN FOR FR4 WITH DIELECTRIC THICKNESS .025"±.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	DRAWN	DK (RAVON)	16 MAR 08
TOLERANCES ON:	CHECKED	RZ (RAVON)	16 MAR 08
2 PL DECIMALS ±	APPROVED	HH (RAVON)	16 MAR 08
3 PL DECIMALS ± .005			
ANGLES ±			
FRACTIONS ±			

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

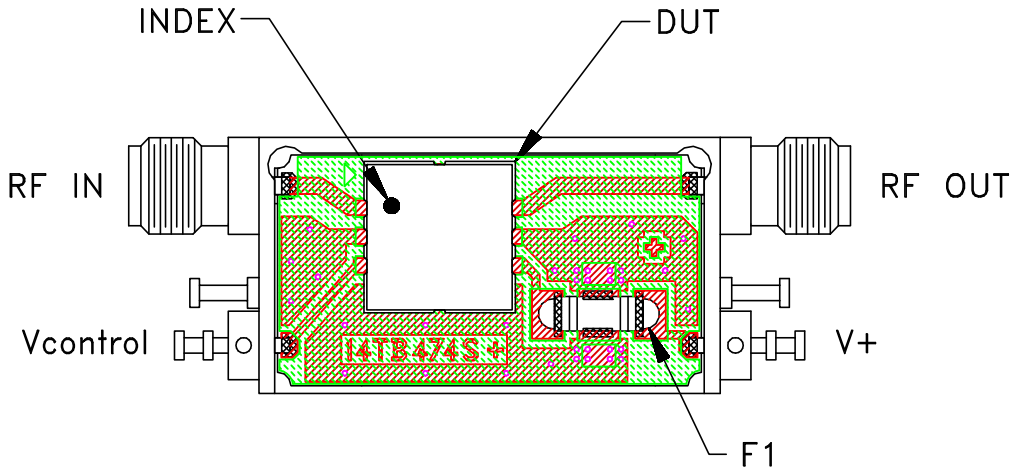
Mini-Circuits® 13 Neptune Avenue Brooklyn NY 11235

PL, qg, HE1354, TB-474+

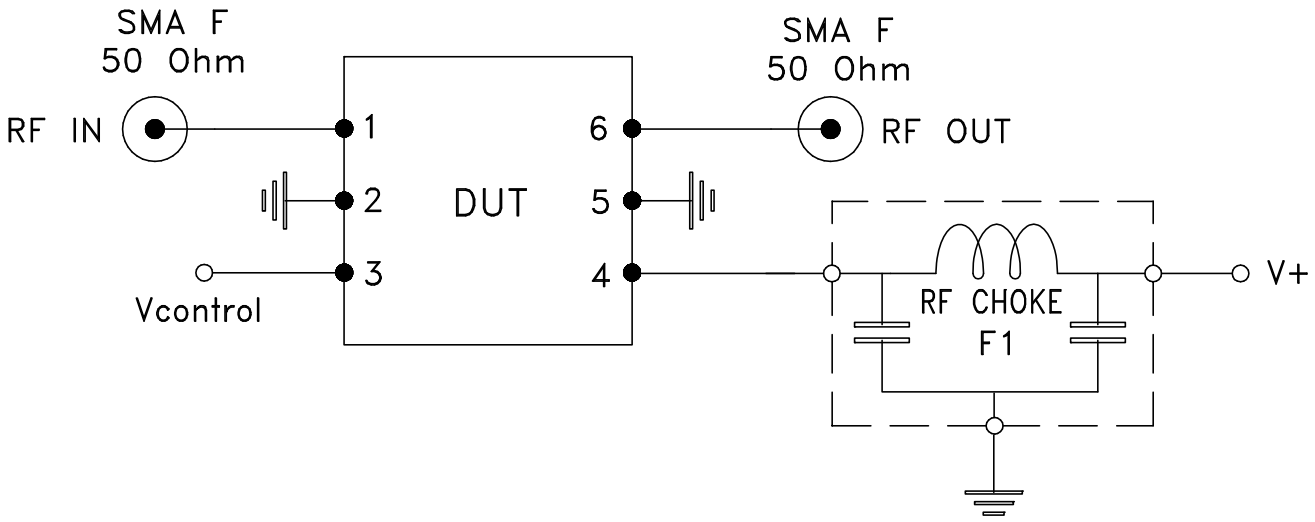
SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-285	OR

FILE:	SCALE:	SHEET:
98PL285	5:1	1 OF 1

Evaluation Board and Circuit



TB-474+



Schematic Diagram

Notes:
1. SMA Female connectors.
2. PCB Material: FR4 GRADE IT-180TC (ITEQ CORPORATION)
   Dielectric Constant=4.5, Thickness=.025 inch.

Mini-Circuits®

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Environmental Specifications ENV03T2

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-40° to 85° C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-55° to 100° C Ambient Environment	Individual Model Data Sheet
HAST	130°C, 85% RH, 96 hours	JESD22-A110
Humidity	90 to 95% RH, 240 hours, 50°C	MIL-STD-202, Method 103, Condition A, Except 50°C and end-point electrical test done within 12 hours
Thermal Shock	-55° to 100°C, 100 cycles	MIL-STD-202, Method 107, Condition A-3, except +100°C
Solder Reflow Heat	Sn-Pb Eutectic Process: 225°C peak Pb-Free Process, 245°C peak	J-STD-020, Table 4-1, 4-2 and 5-2, Figure 5-1
Solderability	10X Magnification	J-STD-002, Para 4.2.5, Test S, 95% Coverage
Vibration (High Frequency)	20g peak, 20-2000 Hz, 4 times in each of three axes (total 12)	MIL-STD-883, Method 2007.3, Condition A
Mechanical Shock	50g, 11 ms, 1/2-sine, 18 shocks: 3 each direction, each of 3 axes	MIL-STD-202, Method 213, Condition A
Marking Resistance to Solvents	Isopropyl alcohol + mineral spirits at 25°C; terpene defluxer at 25°C; distilled water + proylene glycol monomethyl ether + monoethanolamine at 63°C to 70°C	MIL-STD-202, Method 215