Surface Mount

Voltage Variable Equalizer

VAEQ-1000+

50Ω **50 to 1000 MHz**

The Big Deal

- Adjustable attenuation slope
- IP3 +45 dBm typical
- Minimal deviation from linear loss, ± 0.4dB

CASE STYLE: HE1354

Product Overview

The VAEQ-1000+ 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 50 to 1000 MHz with the variable slope providing great flexibility in a small 10mm package.
The VAEQ-1000+ is often used to compensate RF chain gain flatness or cable loss versus frequency.

Key Features

Feature	Advantages
Low power consumption: • Supply voltage +5V_{DC} at max 4mA • Control voltage 0-10V at max 40mA	Allows for high layout density of circuit boards, while minimizing affects of parasitics.
Adjustable attenuation slope (Control voltage of 0V to 10V)	Allows adjusting the slope to compensate for the precise loses encountered.
High linearity (IP3 +45 dBm typ.)	Low distortion enabling improved system performance.
Minimal deviation from linear loss over frequency range: ±0.4dB	Provides low signal distortion over the passband.

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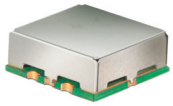
Voltage Variable Equalizer

VAEQ-1000+

50Ω 50 to 1000 MHz

Features

- Wide bandwidth
- Low insertion loss
- Low deviation from linear loss, ± 0.4 dB typ.
- High IP3 +45 dBm typ.
- Shielded case
- Aqueous washable



CASE STYLE: HE1354

Applications

- Cable loss compensation
- Instrumentation

+RoHS Compliant

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

Electrical Specifications at 25°C, V+=5V$_{DC}$ unless otherwise noted

Parameter	Condition	Min.	Typ.	Max.	Units
Frequency Range		50		1000	MHz
Insertion Loss	50 MHz, Control Voltage, 0 - 10V 1000 MHz, Control Voltage, 0 - 10V		15.2 - 2.2 1.7 - 1.6		dB
Deviation from Linear Loss	50 - 1000 MHz, Control Voltage 0 - 10V		± 0.4		dB
IP3	50 - 1000 MHz, Control Voltage, 1 - 10V	+33	+45		dBm
1 dB Compression	50 - 1000 MHz, Control Voltage, 0 - 10V		+30		dBm
Input Return Loss [1]	50 - 1000 MHz, Control Voltage, 0 - 10V		17.5		dB
Output Return Loss [1]	50 - 1000 MHz, Control Voltage, 0 - 10V		17.5		dB
Supply Voltage (V+) [1]	50 - 1000 MHz, Control Voltage, 0 - 10V	3.5	5	5.5	V
Supply Current	50 - 1000 MHz, Control Voltage 10V, 50 - 1000 MHz, Control Voltage 0V,		0 2	 4	mA
Control Current	50 - 1000 MHz, Control Voltage 10V 50 - 1000 MHz, Control Voltage 1V		32 0	40	mA

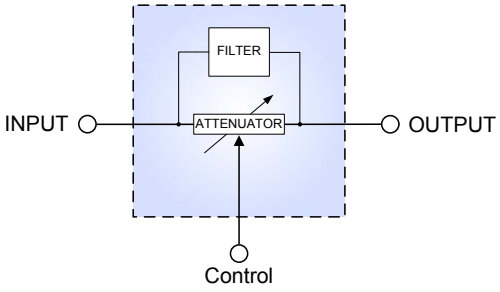
[1] Return Loss may degrade at V+ under 5V .

Maximum Ratings

Parameter	Ratings
Operating Temperature	0°C to 85°C
Storage Temperature	-55°C to 100°C
Input Power	+23 dBm
Control voltage	11 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

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

Notes

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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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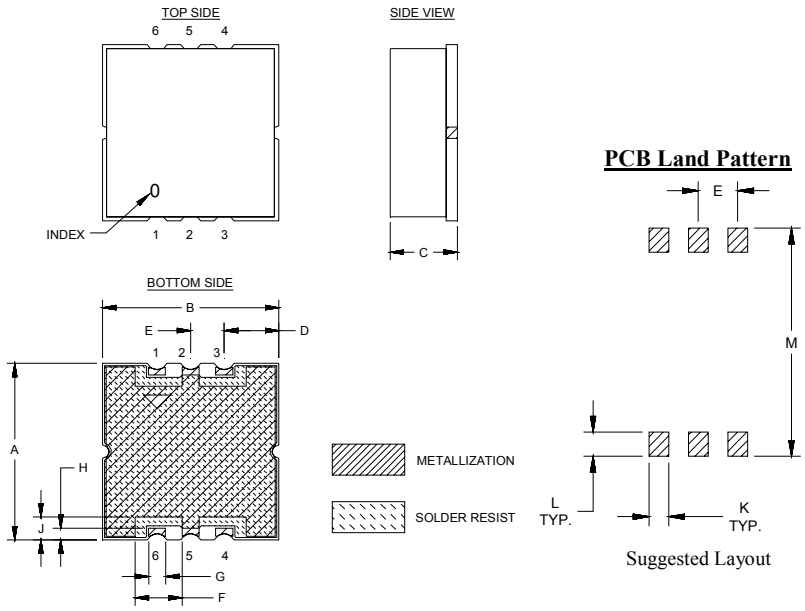
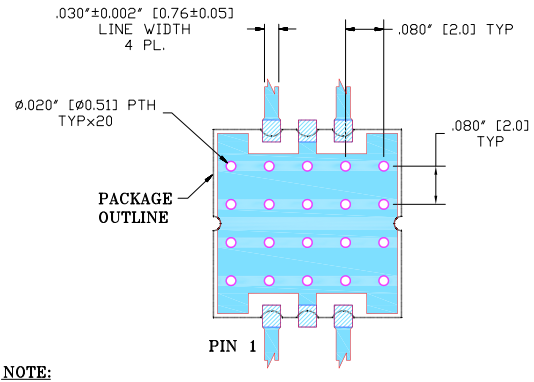
Outline Drawing



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

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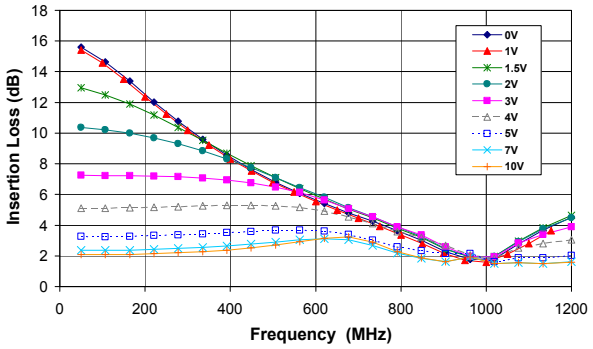
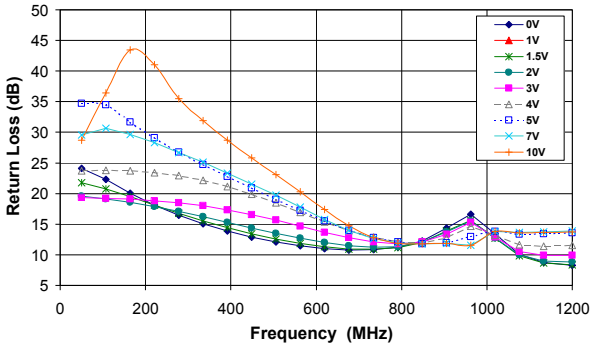
Frequency (MHz)	Insertion Loss (dB)		Input Return Loss (dB)		Output Return Loss (dB)		Deviation from Linear Loss (dB)		Insertion Phase (deg)		Input IP3 (dBm)	
	Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol	
	1V	4V	1V	4V	1V	4V	1V	4V	1V	4V	1V	4V
50	15.41	5.11	23.76	23.75	23.68	23.80	0.94	0.89	12.99	-3.65	36.73	45.55
100	14.57	5.11	22.02	23.81	21.89	23.88	0.55	0.73	11.96	-10.63	43.32	44.47
150	13.50	5.13	19.86	23.77	19.68	23.77	0.14	0.55	11.01	-16.83	-	-
200	12.35	5.15	18.02	23.54	17.84	23.49	0.21	0.37	8.33	-22.77	48.87	47.40
250	11.23	5.19	16.44	23.14	16.29	22.99	0.50	0.17	3.88	-28.56	-	-
300	10.17	5.22	15.18	22.65	15.05	22.37	0.66	-0.02	-1.74	-34.16	49.29	45.01
350	9.21	5.26	14.12	21.92	13.97	21.61	0.78	-0.22	-8.58	-39.66	-	-
400	8.33	5.29	13.25	21.00	13.14	20.66	0.78	-0.40	-15.85	-44.83	45.80	45.70
450	7.54	5.30	12.55	19.89	12.41	19.58	0.76	-0.57	-24.03	-49.90	-	-
500	6.80	5.27	12.01	18.65	11.86	18.42	0.63	-0.71	-32.20	-54.56	43.01	44.22
550	6.16	5.19	11.59	17.30	11.46	17.19	0.50	-0.78	-41.09	-59.11	-	-
600	5.54	5.02	11.34	15.93	11.19	15.92	0.30	-0.77	-49.87	-63.47	44.56	48.98
650	4.98	4.75	11.22	14.61	11.14	14.69	0.10	-0.67	-59.08	-68.00	-	-
700	4.44	4.36	11.31	13.45	11.21	13.63	0.10	-0.43	-68.37	-73.10	42.19	44.52
750	3.91	3.96	11.60	12.56	11.64	12.84	0.28	-0.20	-77.81	-78.85	-	-
800	3.37	3.51	12.27	12.05	12.32	12.42	0.40	0.10	-87.66	-85.55	45.44	45.81
850	2.79	3.19	13.42	11.98	13.61	12.46	0.58	0.26	-98.04	-92.48	-	-
900	2.18	2.72	15.28	12.60	15.87	13.20	1.00	0.57	-109.81	-99.58	46.64	47.10
1000	1.60	1.77	14.51	14.10	15.74	14.96	0.00	1.20	-138.90	-119.98	45.32	48.95

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	
	7V	10V	7V	10V	7V	10V	7V	10V	7V	10V	7V	10V
50	2.38	2.10	29.54	28.70	29.41	28.76	0.36	0.36	-3.66	-3.28	41.08	46.48
100	2.36	2.08	30.69	35.57	30.28	35.64	0.35	0.35	-11.56	-11.54	48.68	47.18
150	2.37	2.10	29.99	42.01	29.55	41.01	0.31	0.31	-18.55	-18.73	-	-
200	2.41	2.13	28.88	43.40	28.35	40.52	0.25	0.25	-25.27	-25.63	52.89	46.63
250	2.45	2.17	27.49	37.92	27.11	36.57	0.18	0.18	-31.89	-32.41	-	-
300	2.50	2.22	26.05	33.99	25.73	33.10	0.10	0.10	-38.39	-39.12	53.19	47.62
350	2.57	2.29	24.64	31.00	24.26	30.15	0.00	0.00	-44.83	-45.78	-	-
400	2.67	2.39	23.10	28.28	22.81	27.68	-0.12	-0.12	-51.11	-52.33	54.90	46.51
450	2.76	2.51	21.53	25.79	21.22	25.20	-0.24	-0.24	-57.22	-58.78	-	-
500	2.89	2.68	19.92	23.40	19.61	22.83	-0.40	-0.40	-63.06	-65.00	49.93	45.87
550	3.01	2.86	18.22	20.93	18.01	20.53	-0.54	-0.54	-68.49	-70.83	-	-
600	3.11	3.08	16.49	18.42	16.42	18.23	-0.67	-0.67	-73.32	-75.91	52.74	46.33
650	3.11	3.24	14.81	15.97	14.87	15.97	-0.70	-0.70	-77.60	-79.93	-	-
700	2.90	3.15	13.36	13.87	13.54	14.03	-0.52	-0.52	-81.58	-82.85	48.43	46.04
750	2.55	2.75	12.35	12.44	12.66	12.75	-0.19	-0.19	-86.62	-86.77	-	-
800	2.09	2.18	11.89	11.85	12.26	12.23	0.25	0.25	-93.01	-92.77	51.32	45.98
850	1.83	1.85	11.79	11.77	12.26	12.25	0.48	0.48	-100.90	-100.76	-	-
900	1.62	1.63	11.88	11.89	12.36	12.38	0.66	0.66	-108.80	-108.77	54.44	46.90
1000	1.64	1.64	13.74	13.72	14.42	14.40	0.59	0.59	-121.27	-121.24	51.88	48.86

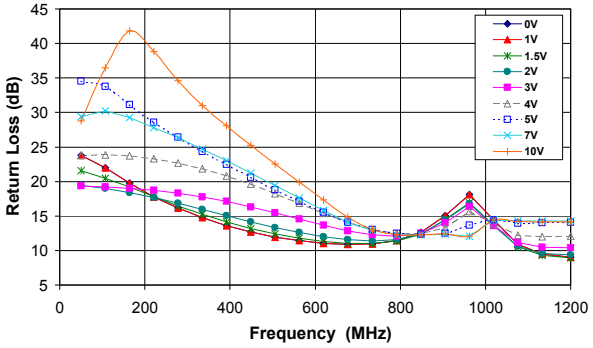
VAEQ-1000+
INSERTION LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



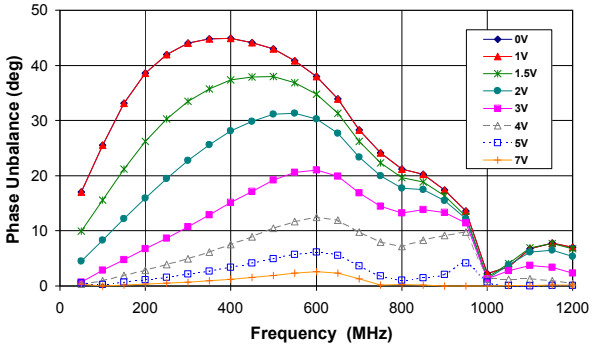
VAEQ-1000+
INPUT RETURN LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



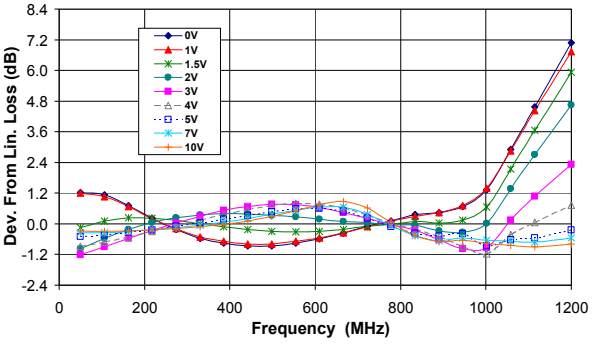
VAEQ-1000+
OUTPUT RETURN LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



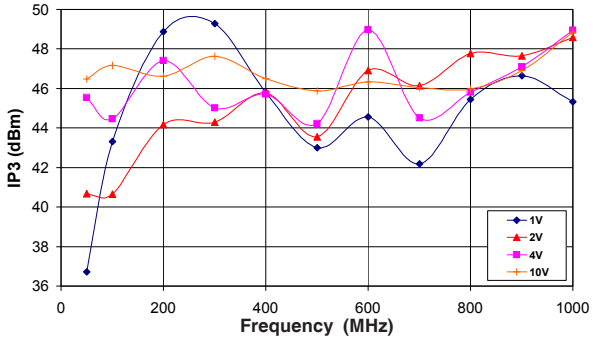
VAEQ-1000+
PHASE UNBALANCE Vs. FREQUENCY
OVER CONTROL VOLTAGES



VAEQ-1000+
DEVIATION FROM LINEAR LOSS Vs. FREQUENCY
OVER CONTROL VOLTAGES



VAEQ-1000+
IP3 Vs. FREQUENCY
OVER CONTROL VOLTAGES



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Voltage Variable Equalizer, 50Ω VAEQ-1000+

Typical Performance Data

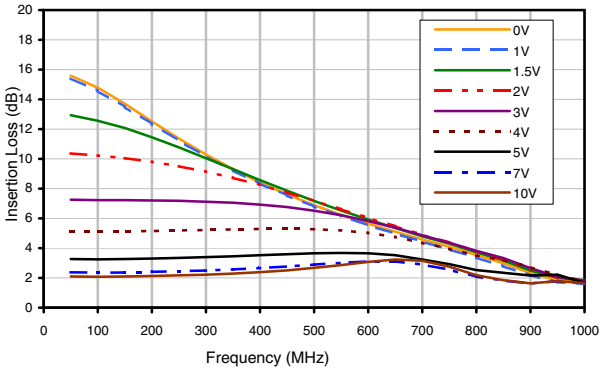
Frequency (MHz)	Insertion Loss (dB) Vcontrol		Input Return Loss (dB) Vcontrol		Output Return Loss (dB) Vcontrol		Deviation from Linear (dB) Vcontrol		Insertion Phase (deg) Vcontrol	
	1V	10V	1V	10V	1V	10V	1V	10V	1V	10V
50	15.41	2.10	23.76	28.70	-23.68	28.76	1.20	-0.27	12.99	-3.28
60	15.26	2.09	23.61	30.29	-23.50	30.38	1.20	-0.28	12.43	-5.13
70	15.11	2.08	23.31	31.70	-23.18	31.82	1.20	-0.29	12.17	-6.85
80	14.94	2.08	22.92	33.05	-22.78	33.15	1.18	-0.29	12.06	-8.47
90	14.76	2.08	22.48	34.31	-22.34	34.43	1.14	-0.29	12.00	-10.03
100	14.57	2.08	22.02	35.57	-21.89	35.64	1.10	-0.29	11.96	-11.54
120	14.16	2.08	21.11	38.12	-20.97	37.96	0.98	-0.29	11.76	-14.47
140	13.72	2.09	20.26	40.65	-20.09	40.12	0.84	-0.28	11.33	-17.32
150	13.50	2.10	19.86	42.01	-19.68	41.01	0.76	-0.27	11.01	-18.73
180	12.81	2.11	18.73	44.27	-18.54	41.75	0.51	-0.26	9.63	-22.89
190	12.58	2.12	18.37	44.06	-18.18	41.29	0.43	-0.25	9.02	-24.26
200	12.35	2.13	18.02	43.40	-17.84	40.52	0.35	-0.24	8.33	-25.63
220	11.89	2.14	17.34	41.20	-17.18	38.86	0.18	-0.23	6.72	-28.35
240	11.45	2.16	16.73	38.93	-16.57	37.36	0.04	-0.21	4.87	-31.06
250	11.23	2.17	16.44	37.92	-16.29	36.57	-0.04	-0.20	3.88	-32.41
280	10.59	2.20	15.66	35.37	-15.52	34.47	-0.24	-0.17	0.67	-36.44
300	10.17	2.22	15.18	33.99	-15.05	33.10	-0.36	-0.15	-1.74	-39.12
320	9.77	2.25	14.73	32.79	-14.60	31.85	-0.47	-0.12	-4.38	-41.78
340	9.39	2.28	14.31	31.59	-14.17	30.70	-0.55	-0.09	-7.17	-44.45
350	9.21	2.29	14.12	31.00	-13.97	30.15	-0.59	-0.08	-8.58	-45.78
380	8.68	2.35	13.58	29.32	-13.44	28.66	-0.68	-0.02	-12.85	-49.73
400	8.33	2.39	13.25	28.28	-13.14	27.68	-0.73	0.02	-15.85	-52.33
420	7.99	2.44	12.95	27.28	-12.84	26.68	-0.78	0.07	-19.06	-54.92
440	7.68	2.49	12.68	26.22	-12.55	25.69	-0.79	0.12	-22.38	-57.49
450	7.54	2.51	12.55	25.79	-12.41	25.20	-0.79	0.14	-24.03	-58.78
480	7.10	2.61	12.21	24.35	-12.04	23.75	-0.79	0.24	-28.85	-62.56
500	6.80	2.68	12.01	23.40	-11.86	22.83	-0.79	0.31	-32.20	-65.00
520	6.52	2.75	11.82	22.44	-11.70	21.90	-0.78	0.38	-35.76	-67.38
540	6.28	2.82	11.66	21.41	-11.54	20.98	-0.72	0.45	-39.34	-69.70
550	6.16	2.86	11.59	20.93	-11.46	20.53	-0.70	0.49	-41.09	-70.83
580	5.79	3.00	11.42	19.42	-11.26	19.15	-0.63	0.63	-46.27	-74.00
600	5.54	3.08	11.34	18.42	-11.19	18.23	-0.58	0.71	-49.87	-75.91
620	5.30	3.16	11.27	17.40	-11.17	17.32	-0.53	0.79	-53.57	-77.65
640	5.09	3.22	11.22	16.44	-11.15	16.41	-0.44	0.85	-57.25	-79.23
650	4.98	3.24	11.22	15.97	-11.14	15.97	-0.41	0.87	-59.08	-79.93
680	4.65	3.24	11.25	14.66	-11.15	14.74	-0.30	0.87	-64.60	-81.67
700	4.44	3.15	11.31	13.87	-11.21	14.03	-0.21	0.78	-68.37	-82.85
720	4.23	3.01	11.41	13.22	-11.35	13.42	-0.13	0.64	-72.14	-84.27
740	4.02	2.85	11.52	12.66	-11.53	12.94	-0.04	0.48	-75.90	-85.88
750	3.91	2.75	11.60	12.44	-11.64	12.75	-0.01	0.38	-77.81	-86.77
780	3.59	2.41	11.96	12.00	-12.02	12.35	0.11	0.04	-83.66	-89.95
800	3.37	2.18	12.27	11.85	-12.32	12.23	0.19	-0.19	-87.66	-92.77
820	3.14	2.00	12.67	11.77	-12.72	12.21	0.25	-0.37	-91.71	-95.94
840	2.91	1.90	13.14	11.76	-13.27	12.23	0.32	-0.47	-95.89	-99.20
850	2.79	1.85	13.42	11.77	-13.61	12.25	0.34	-0.53	-98.04	-100.76
880	2.42	1.72	14.47	11.86	-14.88	12.34	0.41	-0.66	-104.85	-105.42
900	2.18	1.63	15.28	11.89	-15.87	12.38	0.47	-0.75	-109.81	-108.77
920	1.96	1.61	16.14	11.87	-16.86	12.38	0.54	-0.77	-115.06	-112.47
940	1.78	1.69	16.70	11.79	-17.65	12.28	0.66	-0.69	-120.63	-116.09
950	1.71	1.78	16.76	11.71	-17.81	12.18	0.73	-0.60	-123.52	-117.69
980	1.58	2.05	15.76	12.43	-17.03	13.05	1.05	-0.33	-132.60	-119.08
1000	1.60	1.64	14.51	13.72	-15.74	14.40	1.36	-0.74	-138.90	-121.24

Frequency (MHz)	Input IP3 (dBm) Vcontrol	
	1V	10V
50	36.73	46.48
100	43.32	47.18
200	48.87	46.63
300	49.29	47.62
400	45.80	46.51
500	43.01	45.87
600	44.56	46.33
700	42.19	46.04
800	45.44	45.98
900	46.64	46.9
1000	45.32	48.86

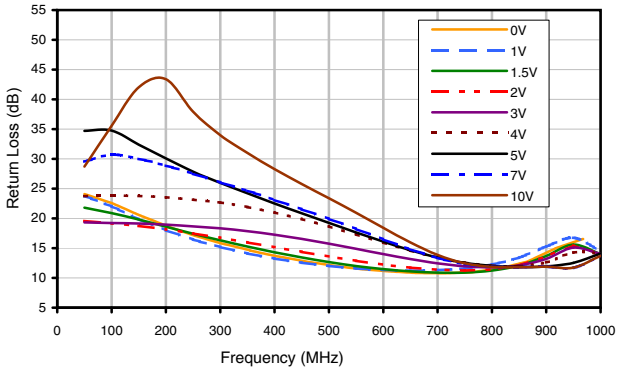
Voltage Variable Equalizer, 50Ω VAEQ-1000+

Typical Performance Curves

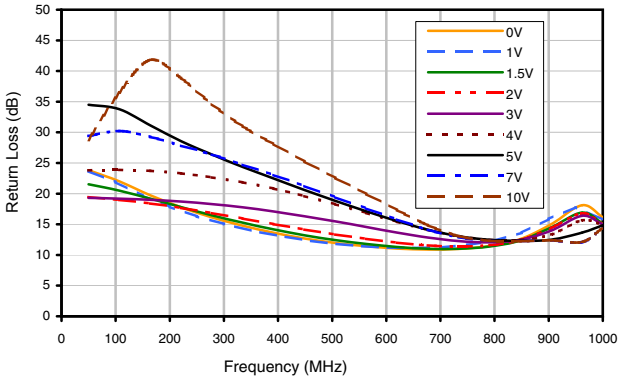
INSERTION LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



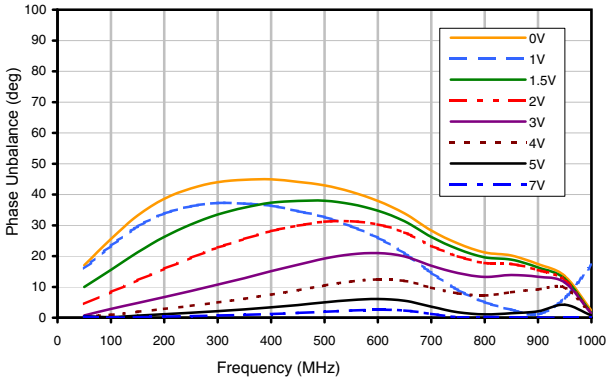
INPUT RETURN LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



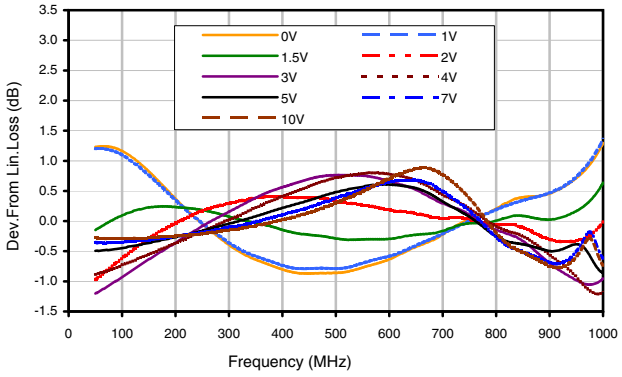
OUTPUT RETURN LOSS
Vs.FREQUENCY OVER CONTROL VOLTAGES



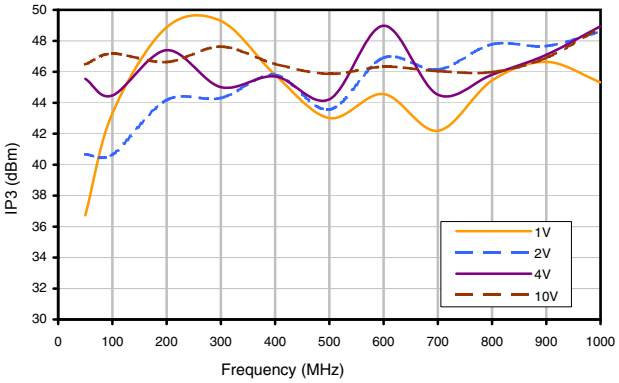
PHASE UNBALANCE
Vs.FREQUENCY OVER CONTROL VOLTAGES



DEVIATION FROM LINEAR LOSS Vs.FREQUENCY
OVER CONTROL VOLTAGES



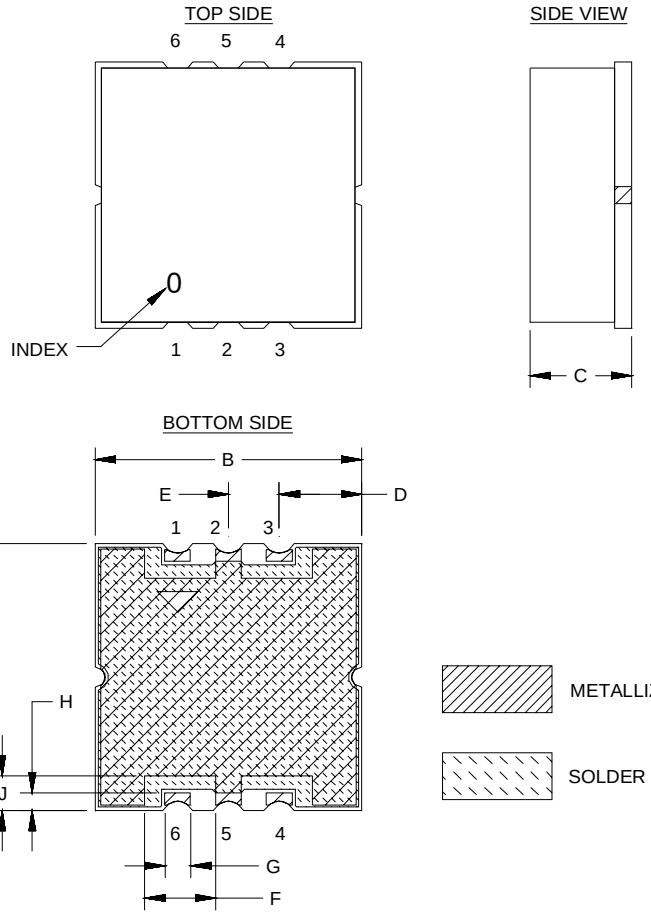
IP3
Vs.FREQUENCY OVER CONTROL VOLTAGES



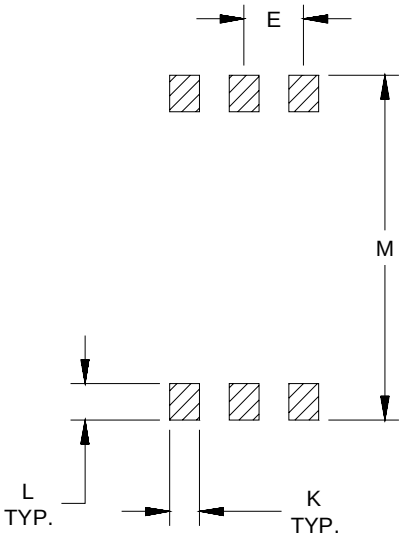
Case Style HE

HE1354

Outline Dimensions



PCB Land Pattern



Suggested Layout

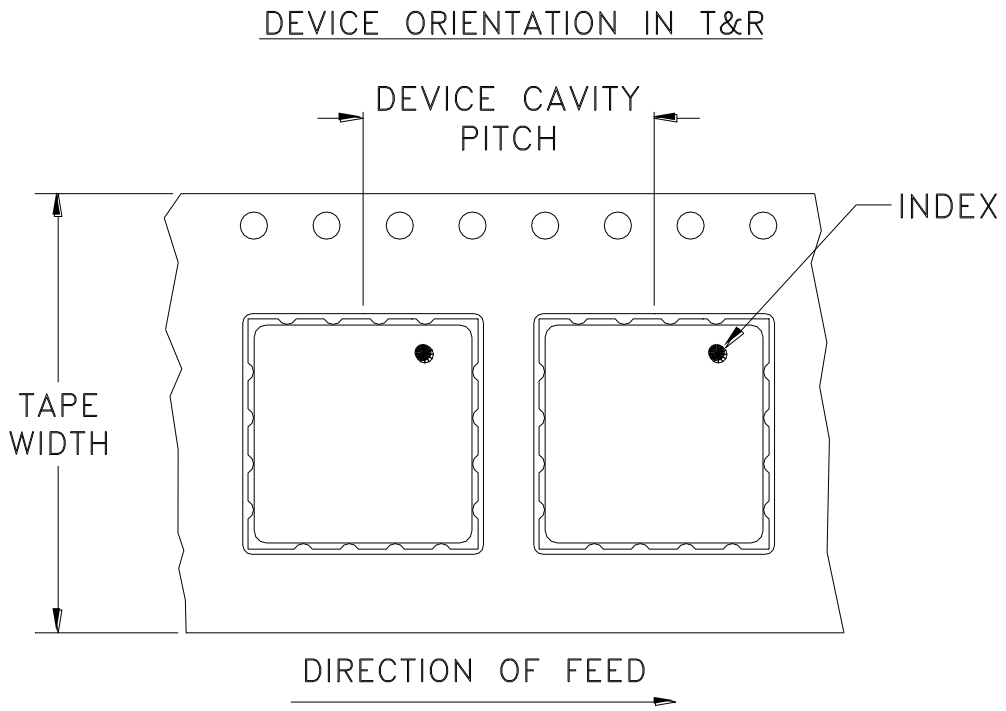
CASE #	A	B	C	D	E	F	G	H	J	K	L	M	WT. GRAMS
HE1354	.394 (10.01)	.394 (10.01)	.150 (3.81)	.122 (3.10)	.075 (1.90)	.098 (2.49)	.038 (0.97)	.026 (0.66)	.051 (1.29)	.038 (0.97)	.046 (1.17)	.434 (11.02)	0.7

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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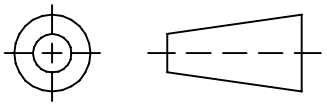
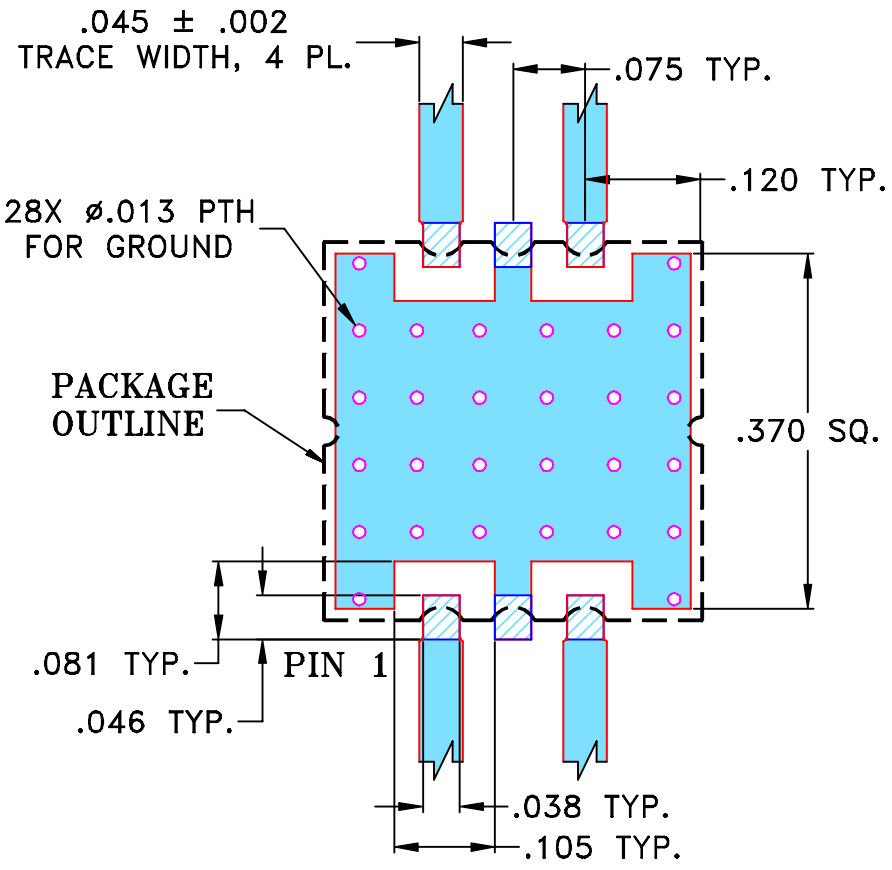
THIRD ANGLE PROJECTION



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

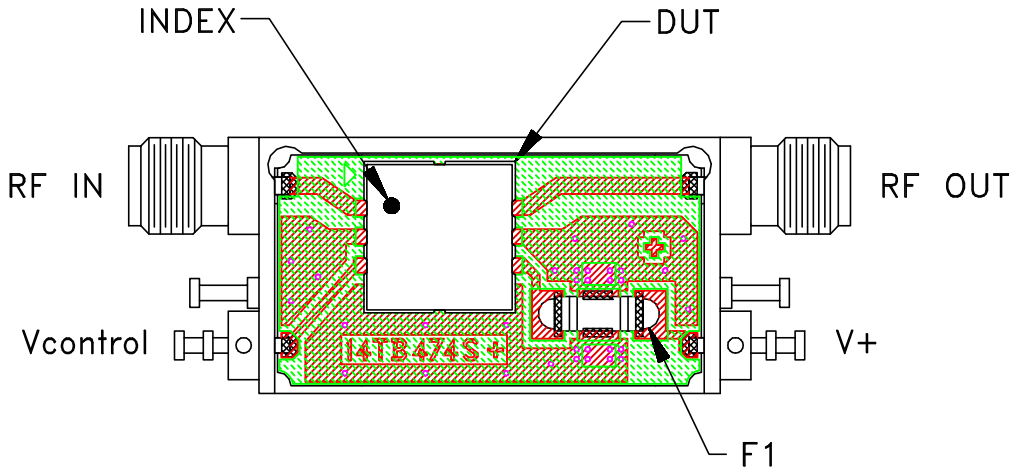
Mini-Circuits® 13 Neptune Avenue Brooklyn NY 11235

PL, qg, HE1354, TB-474+

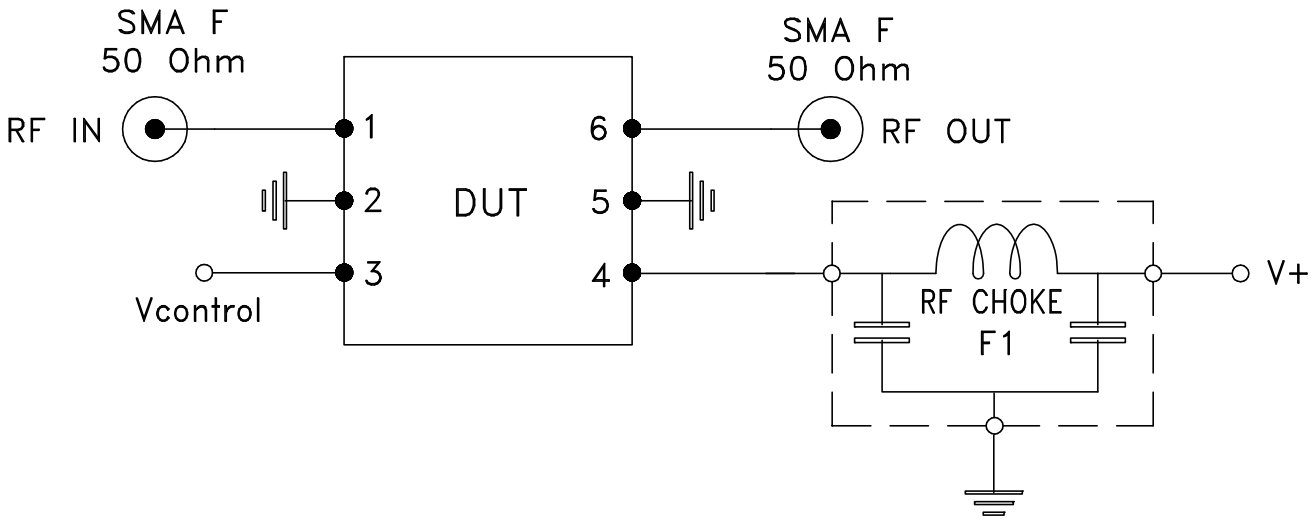
SIZE	CODE IDENT	DRAWING NO:	REV:
A	15542	98-PL-285	OR

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.

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Environmental Specifications ENV03T6

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	0° 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