

Surface Mount

Voltage Variable Equalizer

VAEQ-2150+

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, $\pm 0.05\text{dB}$



CASE STYLE: HE1354

Product Overview

The VAEQ-2150+ 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-2150+ 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: $\pm 0.05\text{dB}$	Provides low signal distortion over the passband.

Notes

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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		12.6 - 3.2			12.6 - 6.6		dB
	2150 MHz, Control Voltage, 0 - 5V		5.9 - 6.3			6.1 - 7.7		
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		10			11		dB
Supply Current	950 - 2150 MHz, Control Voltage, 5V,		0			3		mA
	950 - 2150 MHz, Control Voltage, 0V		4	8		7	15	
Control Current	950 - 2150 MHz, Control Voltage, 5V		5	10		3.5	6.0	mA
	950 - 2150 MHz, Control Voltage, Low ¹		0.4			0.6		

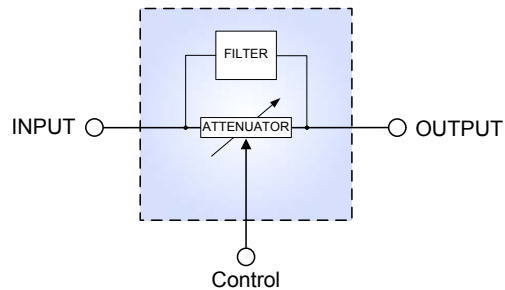
Note 1: Control Voltage Low is 3V for V+=5V and 2V for V+=3V.

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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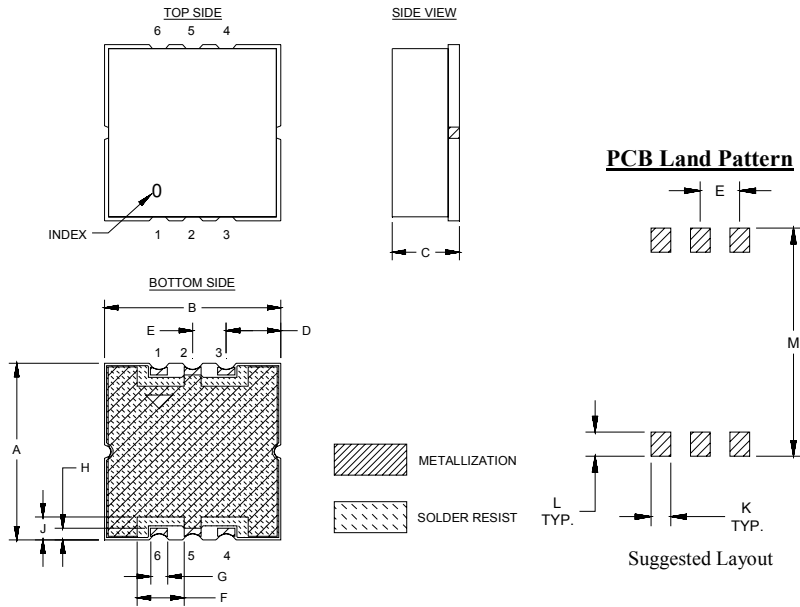
REV. B
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VAEQ-2150+
EDR-10990
RAV
190402
Page 2 of 7



Voltage Variable Equalizer

VAEQ-2150+

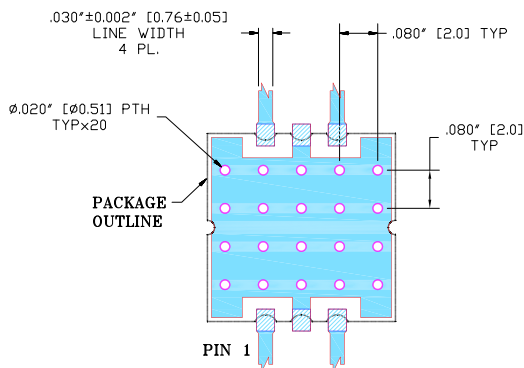
Outline Drawing



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:

- TRACE WIDTH IS SHOWN FOR R04350 WITH DIELECTRIC THICKNESS. $.030 \pm 0.002$ ". COPPER: 1/2 OZ. EACH SIDE. FOR OTHER MATERIALS TRACE WIDTH MAY NEED TO BE MODIFIED.
 - 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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NON-CATALOG

Typical Performance Data @V+=5V

VAEQ-2150+

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	
	0V	3V	0V	3V	0V	3V	0V	3V	0V	3V	0V	3V
950	12.62	12.48	11.88	12.16	10.12	9.71	0.07	0.04	99.45	101.50	52.07	53.70
1000	12.32	12.19	11.75	12.02	9.84	9.46	0.03	0.01	106.39	108.36	52.97	55.09
1100	11.77	11.67	11.49	11.75	9.35	9.01	0.00	0.00	120.47	122.27	53.01	54.45
1150	11.54	11.45	11.34	11.59	9.11	8.80	0.03	0.03	127.73	129.44	52.89	54.36
1200	11.24	11.15	11.25	11.50	8.91	8.61	0.01	0.00	134.83	136.45	53.30	54.67
1300	10.69	10.62	11.12	11.36	8.56	8.30	0.03	0.02	149.29	150.75	52.53	54.10
1400	10.16	10.10	11.09	11.32	8.27	8.05	0.03	0.02	164.14	165.46	53.03	53.97
1450	9.95	9.89	11.09	11.32	8.16	7.95	0.01	0.02	172.15	173.41	53.43	53.73
1500	9.61	9.56	11.11	11.35	8.05	7.86	0.05	0.04	179.45	179.37	53.53	53.75
1600	9.10	9.06	11.25	11.48	7.85	7.69	0.05	0.04	164.93	163.87	54.64	53.00
1650	8.86	8.81	11.31	11.54	7.75	7.61	0.03	0.02	156.52	155.51	53.98	52.86
1700	8.56	8.52	11.41	11.64	7.70	7.57	0.06	0.06	148.88	147.93	53.85	52.55
1800	8.07	8.04	11.62	11.85	7.56	7.46	0.02	0.02	132.30	131.47	52.01	52.45
1850	7.79	7.76	11.66	11.88	7.41	7.33	0.05	0.05	123.50	122.73	52.18	52.66
1900	7.56	7.53	11.87	12.10	7.45	7.38	0.02	0.02	115.47	114.75	52.23	52.39
2000	7.10	7.08	11.79	12.00	7.27	7.23	0.05	0.04	97.57	96.98	52.69	53.29
2050	6.79	6.77	11.65	11.84	7.14	7.11	0.01	0.01	88.87	88.36	52.99	53.64
2100	6.64	6.62	11.45	11.64	7.20	7.18	0.09	0.08	79.63	79.18	53.30	54.03
2150	6.29	6.28	11.04	11.20	7.04	7.04	0.02	0.01	70.46	70.09	53.60	54.33

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	
	4.4V	5V	4.4V	5V	4.4V	5V	4.4V	5V	4.4V	5V	4V	5V
950	7.60	6.62	30.06	26.56	16.59	17.49	0.05	0.05	135.26	138.73	52.81	55.71
1000	7.58	6.61	31.24	28.17	16.44	17.58	0.03	0.03	142.52	146.20	53.31	59.05
1100	7.55	6.62	31.47	32.71	16.08	17.65	0.01	0.01	156.98	161.05	53.33	58.83
1150	7.55	6.64	30.24	35.93	15.86	17.59	0.02	0.02	164.23	168.48	53.23	57.74
1200	7.52	6.64	29.39	39.94	15.70	17.61	0.01	0.02	171.50	175.96	53.13	56.15
1300	7.49	6.67	27.32	34.81	15.39	17.57	0.03	0.03	174.07	169.22	52.93	54.46
1400	7.48	6.72	25.79	29.89	15.09	17.46	0.04	0.04	159.47	154.26	53.32	53.63
1450	7.49	6.76	25.17	28.53	14.91	17.34	0.02	0.02	151.98	146.66	54.53	54.75
1500	7.45	6.76	24.43	26.70	14.79	17.27	0.06	0.15	144.83	139.31	56.06	55.26
1600	7.45	6.86	23.70	24.95	14.46	16.91	0.04	0.04	130.14	124.33	58.16	58.10
1650	7.46	6.91	23.40	24.46	14.22	16.63	0.04	0.15	122.60	116.71	56.74	57.45
1700	7.45	6.95	22.96	23.58	14.07	16.44	0.04	0.04	115.57	109.52	54.32	57.14
1800	7.48	7.10	22.80	23.18	13.56	15.73	0.00	0.10	100.90	94.67	52.48	55.51
1850	7.47	7.16	22.56	23.14	13.23	15.27	0.00	0.00	93.47	87.23	52.58	55.23
1900	7.52	7.29	22.57	22.95	12.96	14.87	0.05	0.05	86.73	80.42	52.59	54.41
2000	7.54	7.48	21.73	23.09	12.12	13.71	0.08	0.08	72.29	66.13	52.87	54.38
2050	7.50	7.55	20.77	22.58	11.66	13.08	0.04	0.04	65.76	59.83	53.37	54.48
2100	7.53	7.68	19.56	21.47	11.28	12.54	0.08	0.22	59.03	53.49	53.91	55.13
2150	7.38	7.66	17.70	19.42	10.66	11.70	0.07	0.07	52.70	47.81	54.38	54.67

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NON-CATALOG

Typical Performance Data @V+=3V

VAEQ-2150+

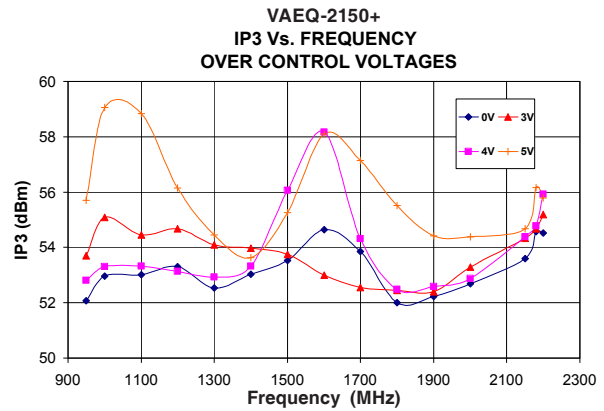
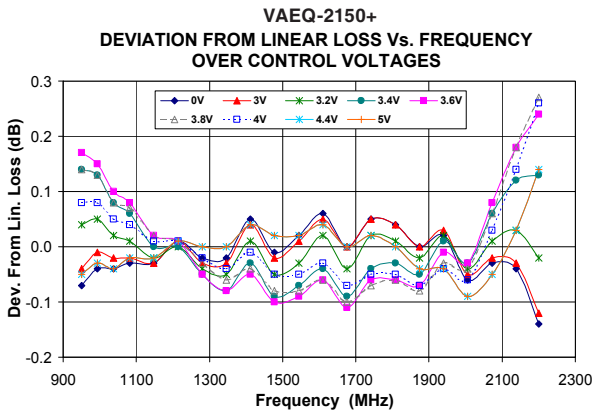
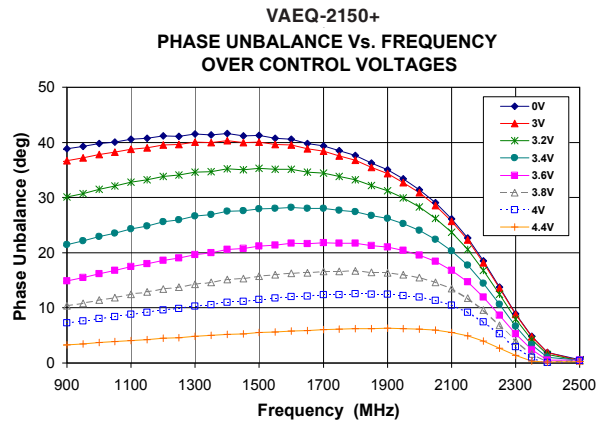
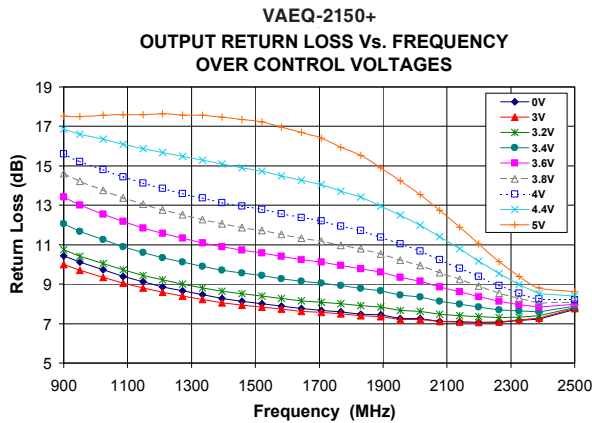
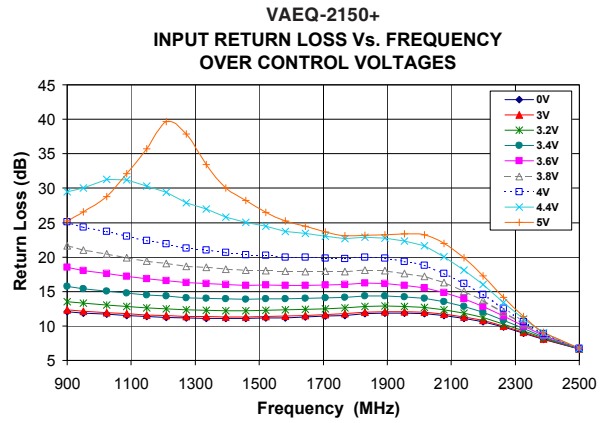
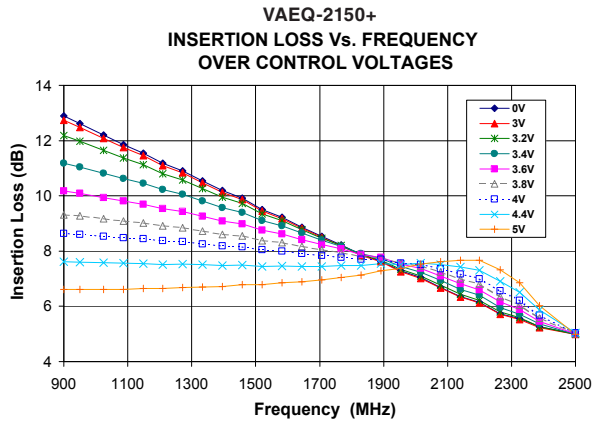
Frequency (MHz)	Insertion Loss (dB)		Input Return Loss (dB)		Output Return Loss (dB)		Deviation from Linear Loss (dB)		Insertion Phase (deg)		Input IP3 (dBm)	
	Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol	
	0V	2V	0V	2V	0V	2V	0V	2V	0V	2V	0V	2V
950	12.58	12.29	10.51	10.93	9.46	8.64	0.02	0.04	99.74	103.77	51.59	52.13
1000	12.28	12.02	10.43	10.84	9.22	8.45	0.00	0.05	106.56	110.40	52.74	53.65
1100	11.74	11.53	10.24	10.64	8.79	8.10	0.01	0.02	120.39	123.88	52.25	53.62
1150	11.51	11.32	10.12	10.51	8.59	7.94	0.04	0.03	127.53	130.90	52.13	53.44
1200	11.20	11.03	10.06	10.44	8.40	7.78	0.00	0.00	134.48	137.67	52.14	53.53
1300	10.64	10.50	9.96	10.34	8.09	7.55	0.01	0.00	148.71	151.58	51.78	52.90
1400	10.10	9.97	9.95	10.32	7.85	7.37	0.02	0.01	163.38	165.96	52.31	53.31
1450	9.87	9.76	9.97	10.33	7.75	7.31	0.03	0.05	171.32	173.79	52.65	53.22
1500	9.52	9.42	10.00	10.37	7.67	7.26	0.05	0.02	178.53	179.15	52.97	53.43
1600	8.99	8.89	10.15	10.52	7.52	7.17	0.04	0.02	165.97	163.88	53.68	52.96
1650	8.73	8.64	10.21	10.58	7.45	7.12	0.02	0.01	157.63	155.65	53.26	52.65
1700	8.43	8.35	10.31	10.67	7.43	7.13	0.06	0.04	150.01	148.16	52.66	52.20
1800	7.91	7.84	10.56	10.92	7.38	7.15	0.03	0.02	133.49	131.85	51.99	51.70
1850	7.62	7.55	10.64	11.00	7.17	6.97	0.05	0.05	124.74	123.21	52.10	52.01
1900	7.37	7.30	10.87	11.23	7.35	7.17	0.03	0.03	116.64	115.24	51.90	51.90
2000	6.88	6.82	10.94	11.29	7.23	7.10	0.03	0.02	98.74	97.57	52.43	52.94
2050	6.57	6.51	10.87	11.20	6.99	6.90	0.02	0.03	89.89	88.85	52.75	53.21
2100	6.41	6.35	10.84	11.16	7.19	7.12	0.10	0.07	80.64	79.72	53.45	53.73
2150	6.06	6.00	10.56	10.86	6.99	6.95	0.02	0.01	71.41	70.65	53.39	53.74

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	3V	5V
950	7.87	3.18	20.26	17.32	13.59	12.97	0.20	0.20	134.78	149.07	52.20	53.03
1000	7.85	3.23	20.01	17.57	13.35	12.85	0.17	0.15	141.80	156.72	52.99	54.16
1100	7.85	3.38	19.40	17.83	12.89	12.63	0.09	0.08	155.78	172.04	52.90	53.79
1150	7.86	3.48	19.01	17.87	12.65	12.54	0.04	0.07	162.80	179.75	52.77	53.44
1200	7.83	3.53	18.72	17.91	12.45	12.42	0.03	0.01	169.73	172.73	52.82	53.31
1300	7.79	3.70	18.21	17.93	12.15	12.28	0.02	0.04	176.43	157.61	52.39	52.40
1400	7.75	3.87	17.87	17.72	11.91	12.16	0.06	0.09	162.43	142.41	52.76	52.21
1450	7.75	3.99	17.73	17.57	11.80	12.10	0.10	0.09	155.13	134.50	54.24	53.22
1500	7.67	4.06	17.56	17.24	11.73	12.03	0.06	0.13	148.37	127.26	55.39	53.26
1600	7.62	4.28	17.44	16.63	11.56	11.89	0.10	0.14	134.21	112.05	58.68	56.24
1650	7.59	4.40	17.37	16.32	11.44	11.75	0.11	0.14	126.89	104.26	57.15	55.91
1700	7.53	4.54	17.27	15.83	11.42	11.71	0.09	0.13	120.13	97.06	53.83	60.73
1800	7.46	4.85	17.26	15.06	11.27	11.48	0.11	0.08	105.91	82.15	52.55	54.92
1850	7.39	4.98	17.18	14.71	10.89	11.12	0.08	0.08	98.67	74.74	52.55	54.40
1900	7.35	5.23	17.24	14.30	11.05	11.17	0.08	0.01	92.07	67.84	52.13	53.61
2000	7.21	5.62	16.86	13.43	10.57	10.54	0.02	0.10	77.75	53.96	52.53	52.85
2050	7.07	5.83	16.41	13.00	10.07	10.11	0.07	0.13	70.98	47.99	53.04	52.83
2100	7.01	6.10	15.93	12.44	10.07	9.87	0.09	0.21	64.01	41.98	53.72	54.18
2150	6.76	6.22	14.98	11.74	9.57	9.40	0.30	0.13	57.28	37.41	54.05	52.78

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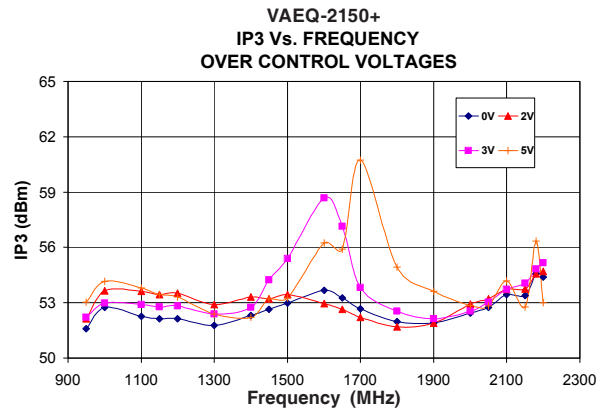
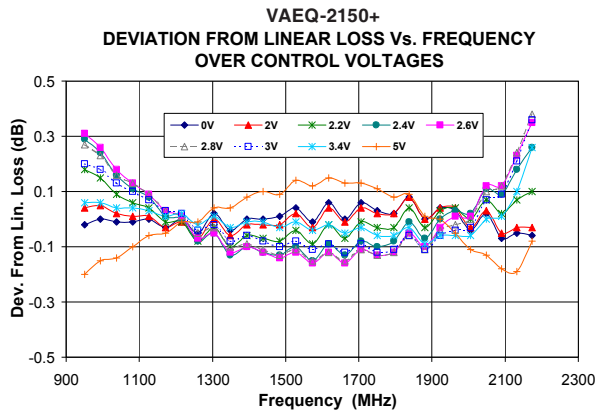
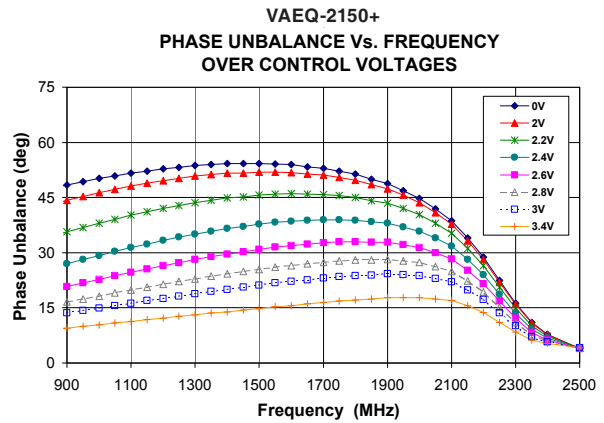
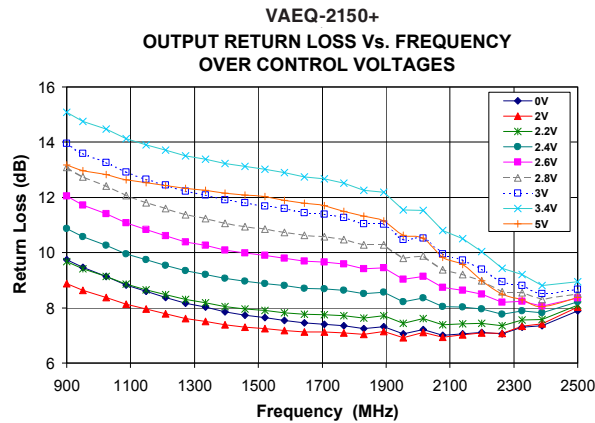
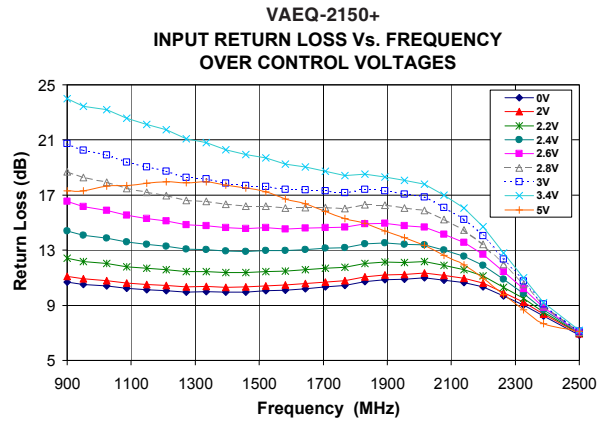
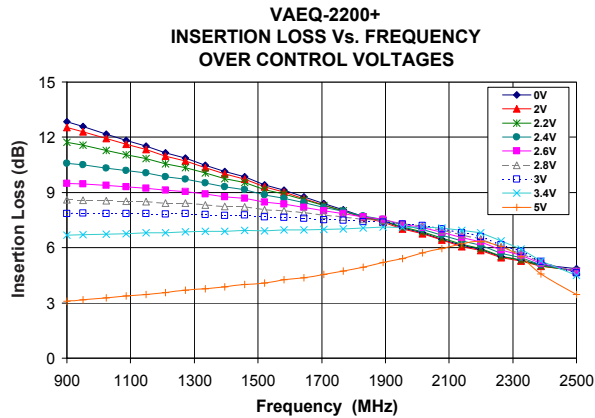




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Notes

- 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

