

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,  $\pm 0.05\text{dB}$



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: <ul style="list-style-type: none"><li>• Supply voltage +3-5V<sub>DC</sub> at max 15mA</li><li>• Control voltage 0-5V at max 10 mA</li></ul>	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.

# Surface Mount Voltage Variable Equalizer

## VAEQ-2150R+

50Ω

950 to 2150 MHz

### Features

- Wide bandwidth
- Low deviation from linear loss,  $\pm 0.05$  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		$\pm 0.1$			$\pm 0.05$		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,		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 <sup>1</sup>		0.4			0.6		

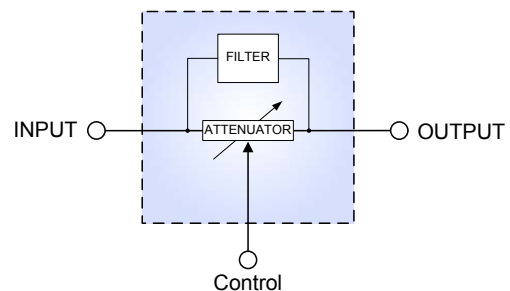
Note 1: Control Voltage Low is 3V for V+=5V and 2V for V+=3V.

### 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.

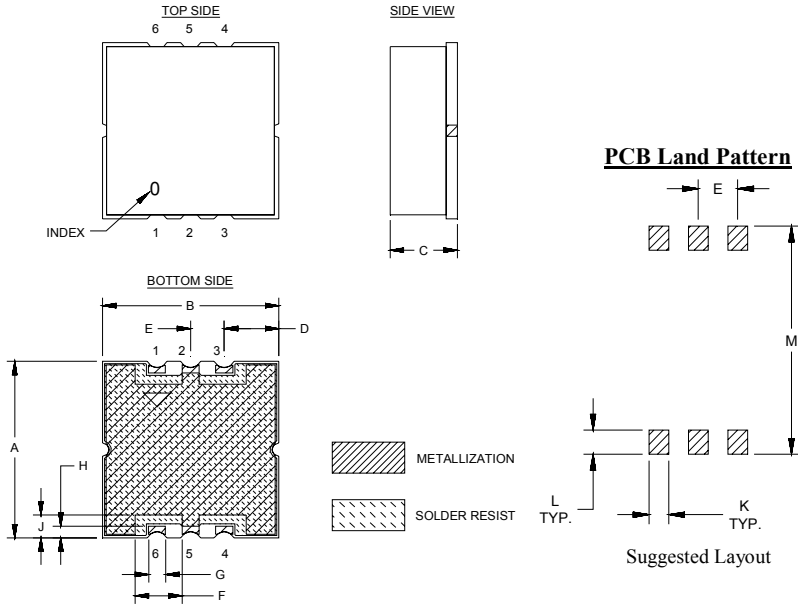
### Simplified Functional Diagram



### Pad Connections

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

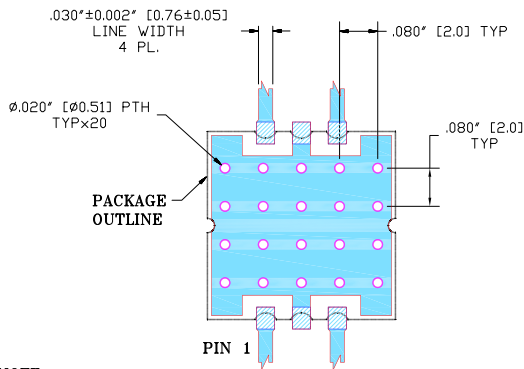
## Outline Drawing



## Outline Dimensions (inch/mm)

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

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



### NOTE:

- TRACE WIDTH IS SHOWN FOR R04350 WITH DIELECTRIC THICKNESS.  $.030 \pm .002$ ". 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

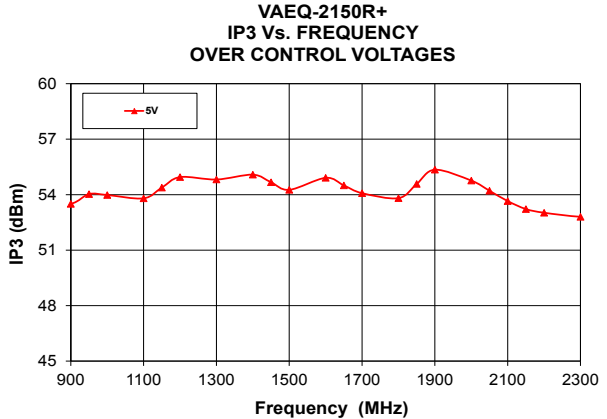
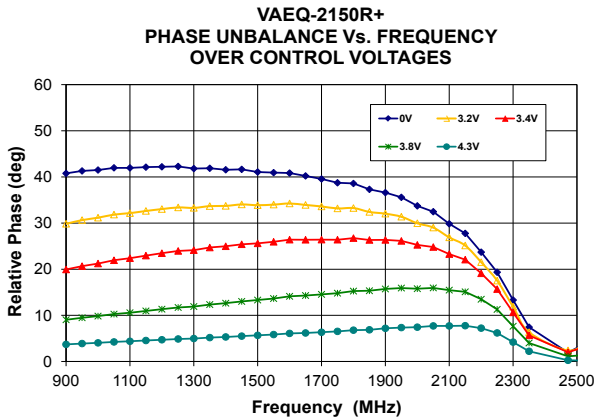
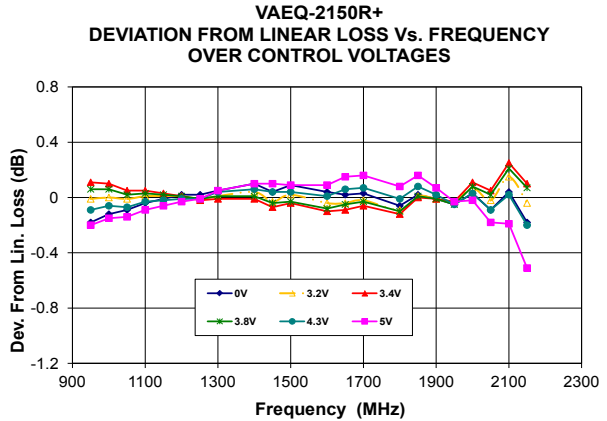
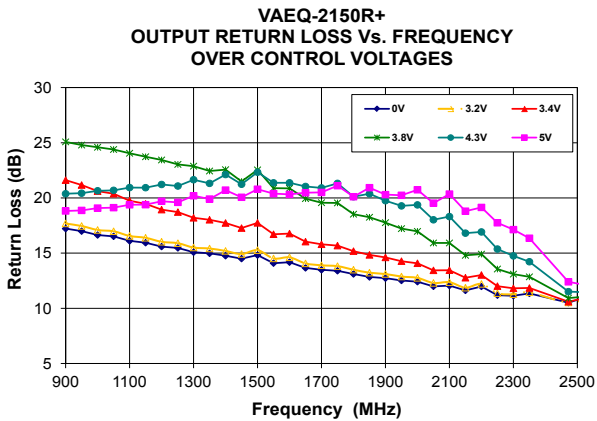
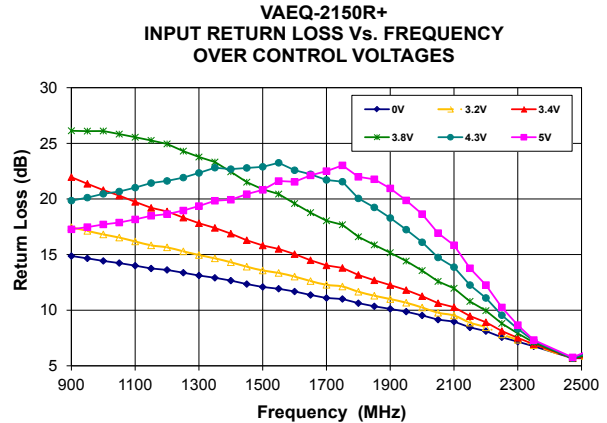
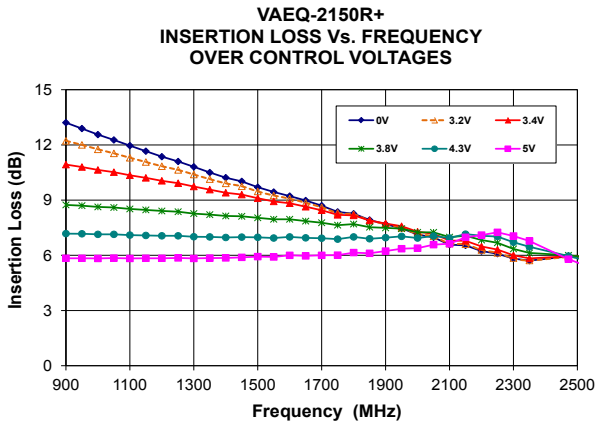
Function	Pad Number
RF IN	1
RF OUT	6
V CONTROL	3
V+	4
GROUND	2,5

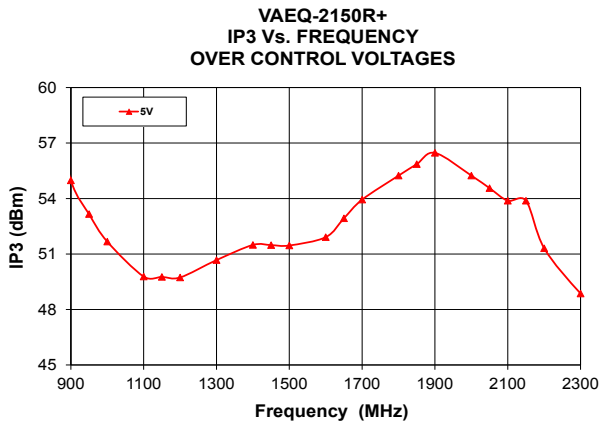
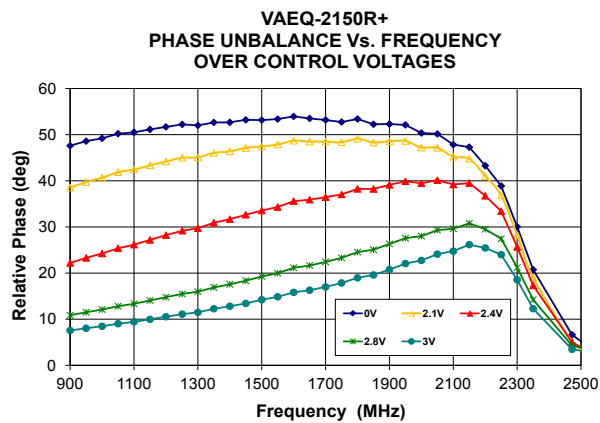
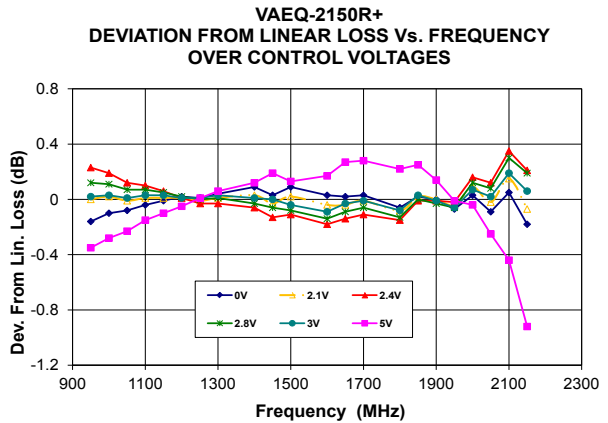
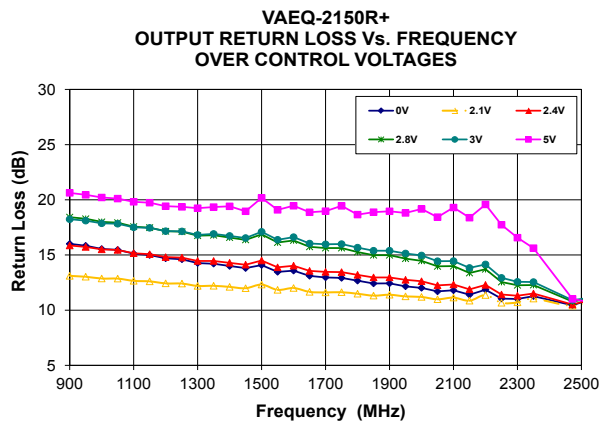
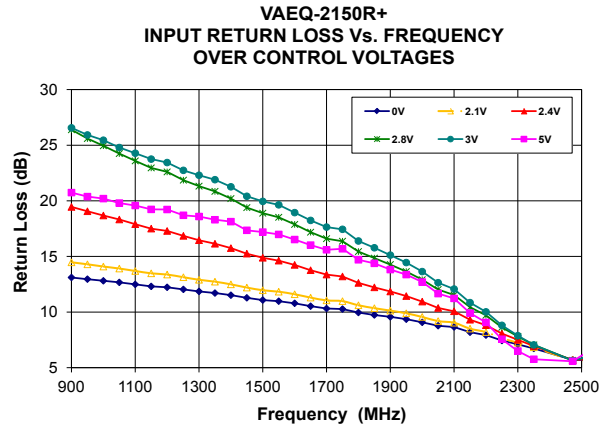
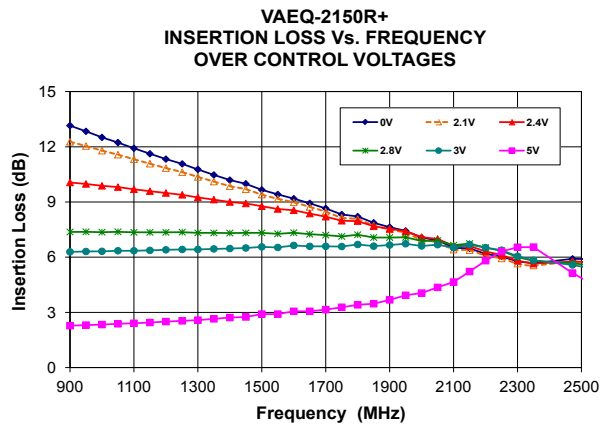
Frequency (MHz)	Insertion Loss (dB)		Input Return Loss (dB)		Output Return Loss (dB)		Deviation from Linear Loss (dB)		Insertion Phase (deg)	
	Vcontrol		Vcontrol		Vcontrol		Vcontrol		Vcontrol	
	0V	3.2V	0V	3.2V	0V	3.2V	0V	3.2V	0V	3.2V
950	12.89	12.00	14.66	17.13	16.99	17.46	0.18	0.01	105.11	115.76
1000	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		
	3V	5V	3V	5V	3V	5V	3V	5V	3V	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





**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.
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