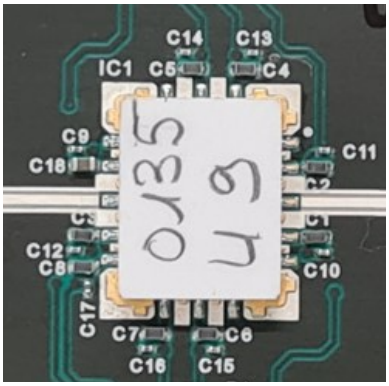
VRFC0135-SG

7.8-8.6 GHz GaAs Digital Attenuator MMIC

Preliminary Datasheet v5

Features



- Integrated 7-bit digitally controlled attenuator
- Frequency range: 7.8 GHz to 8.6 GHz
- LSB 0.5 dB, dynamic range 31.5 dB
- 50 Ω matched RF ports
- Control voltage 0 V / -3 V
- Available as bare die or package
- Package dimensions: 9.76 x 11.71 x 1.91 mm (including leads)
- Package type metal ceramic, hermetic

Description

The VRFC0135-SG is an X-band digitally controlled attenuator MMIC (DCA). The MMIC is designed according to ECSS-Q-ST-30-11C on a European space-evaluated technology, and is built into a high reliability hermetic metal/ceramic package. It demonstrates an insertion loss of 6.4 dB and a dynamic range of 31.5 dB. A supplemental 0.5 dB LSB is implemented on the circuit, to ensure higher resolution coverage where required. The RF ports are DC grounded and matched to 50 Ω. Typical applications include X Band transmit channels for payload satellite communications.

Note: conditions Vss = -3V, Baseplate temperature = 25 °C

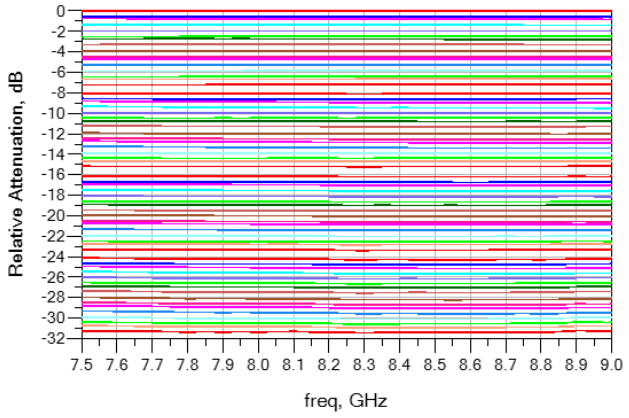
Electrical Characteristics

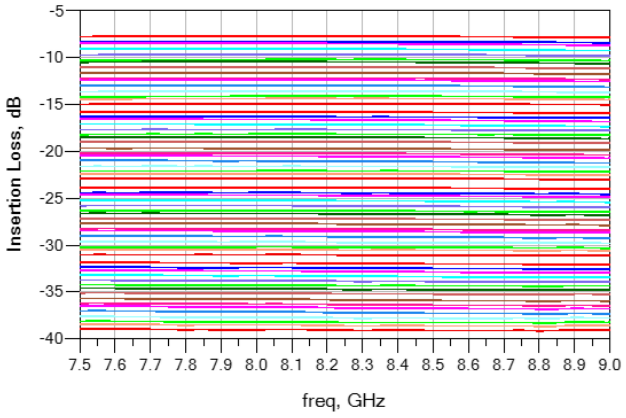
Parameter	Specification			Unit
	Min.	Typ.	Max.	
Operating Frequency	7.8	8.2	8.6	GHz
Insertion Loss (Ref. state)		6.5		dB
Bit Values		0.5, 0.5, 1, 2 4, 8, 16		dB
Dynamic Range		31.5		dB
Absolute Attenuation Error		-0.4 / +0.3		dB
Phase Shift across Dynamic Range		±8		°
I/P Return Loss		-10.5		dB
O/P Return Loss		-9.5		dB
Control Voltage: High Control Voltage: Low	-0.2	0 -3	0.2 -1.2	V V
Threshold Voltage	-1.2		-0.2	V
Operating temperature range	-20		50	°C
Hermeticity (typical)	10^{-9} Pa·m^3/s (10^{-8} ccHe/sec.) at 10^5 Pa (1atm) differential			

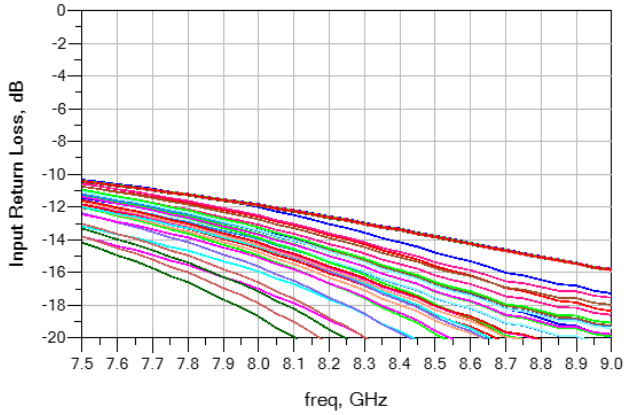
Note: a dedicated control line introduces a secondary 0.5dB attenuation bit. This may be used in case of attenuation inaccuracy and improved phase performance on selected states. However, this feature has not been characterised to date, please contact VIPER RF for further information.

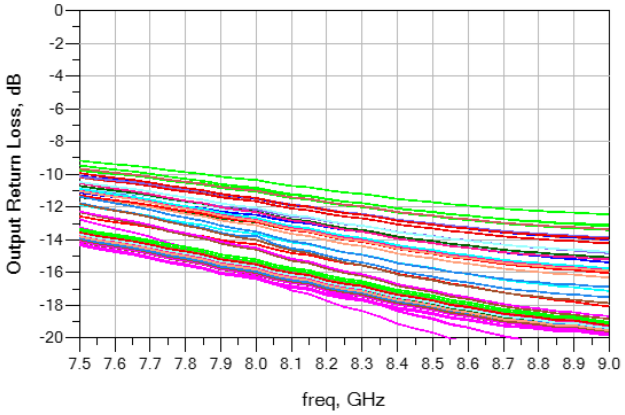
Measured Performance

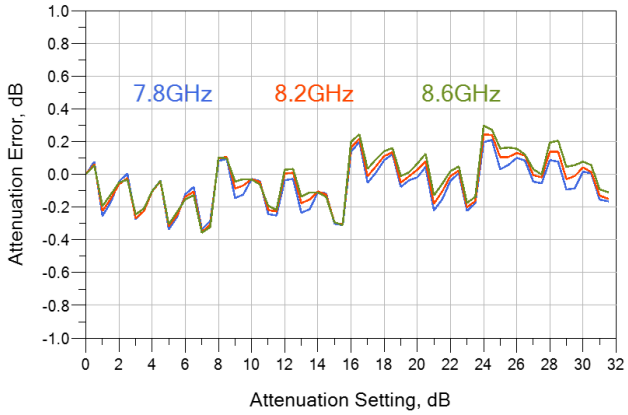
Vss = -3V, Baseplate temperature = 25 °C, Control voltages = 0V / -3V, Vctl_0.5dB_2 = 0V :

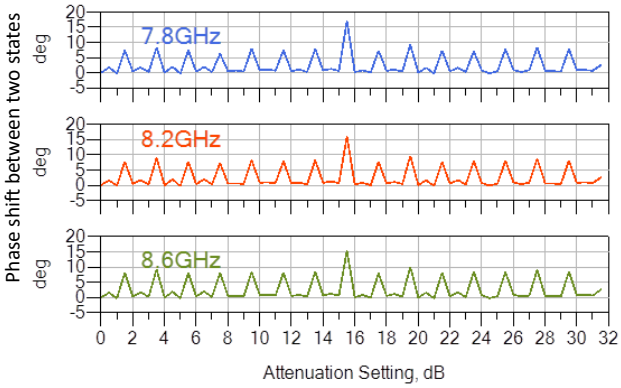






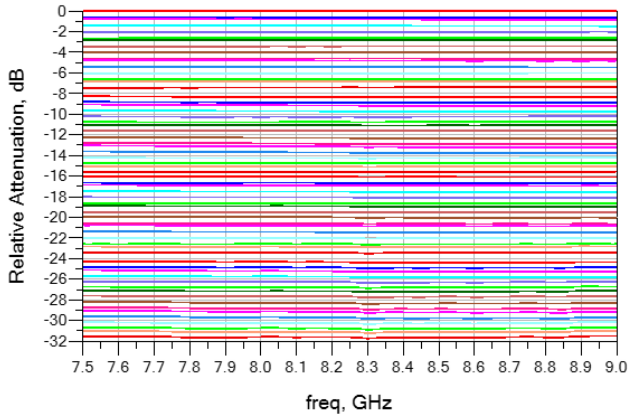


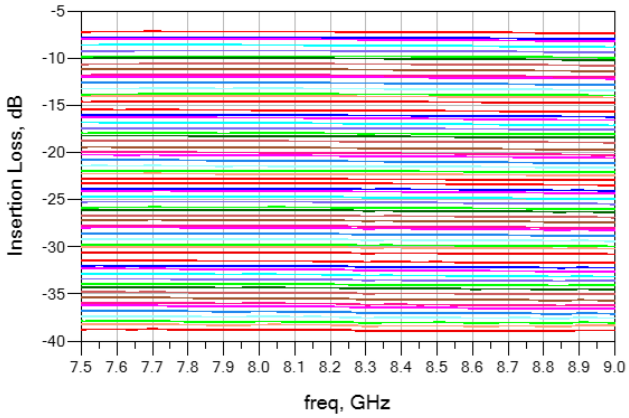


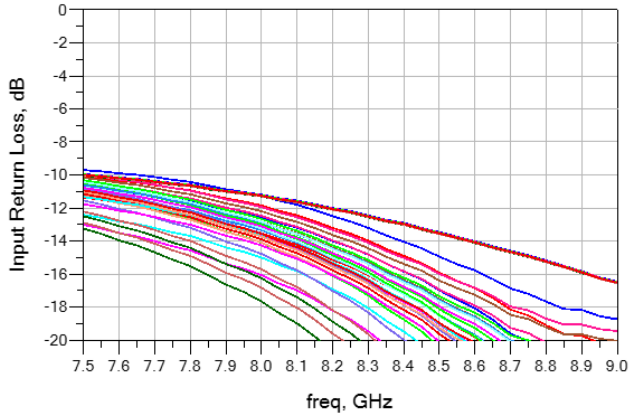


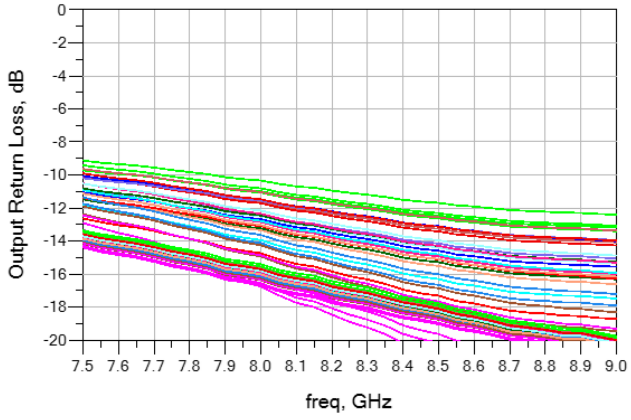
Note: the reference plane for all graphs is the PCB evaluation fixture RF connectors (fixture total loss = 1dB at the operating range, return loss better than –22dB)

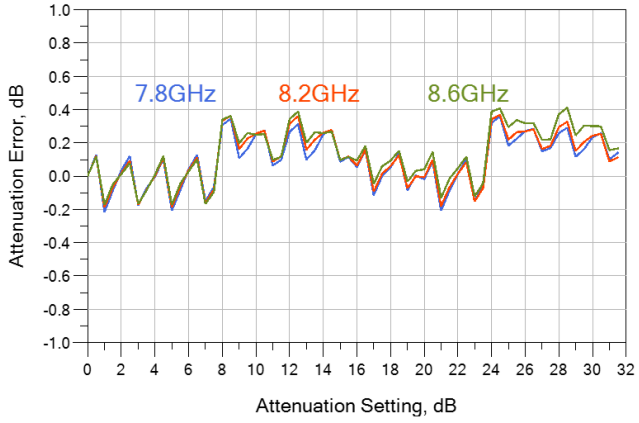
Vss = -3V, Baseplate temperature = -20 °C, Control voltages = 0V / -3V, Vctl_0.5dB_2 = 0V :

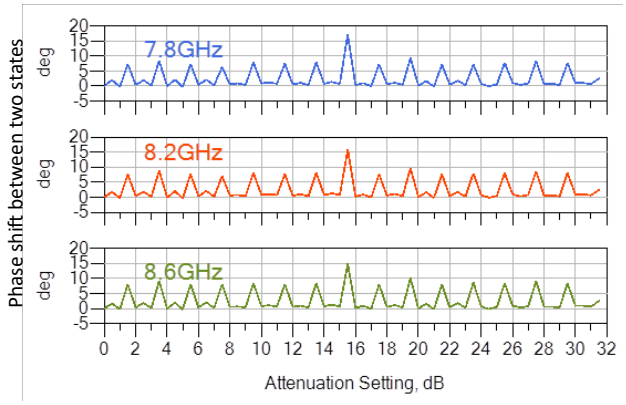






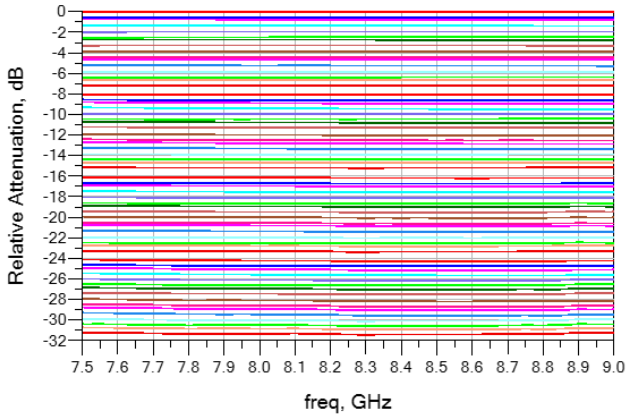


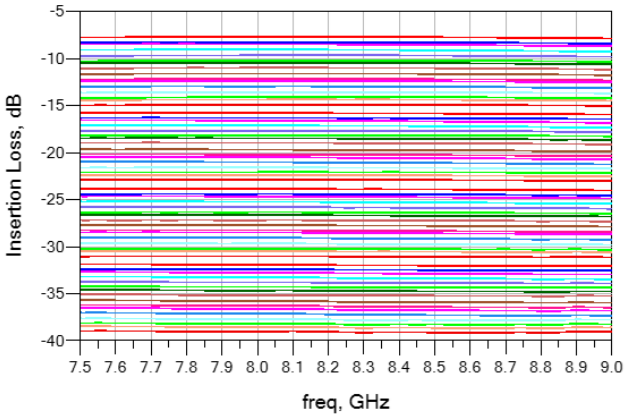


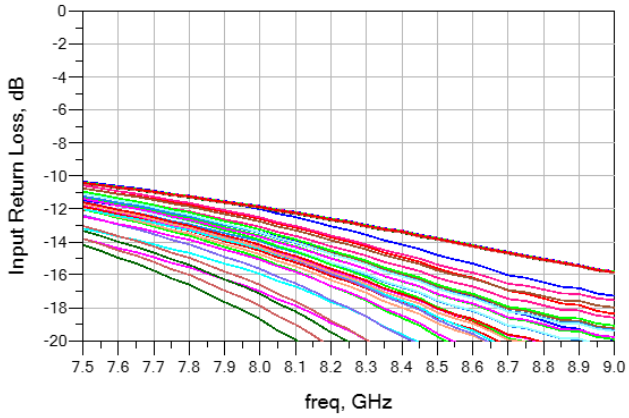


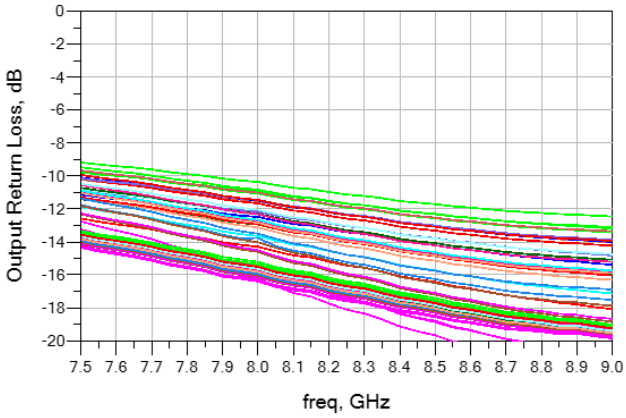
Note: the reference plane for all graphs is the PCB evaluation fixture RF connectors (fixture total loss = 1dB at the operating range, return loss better than –22dB)

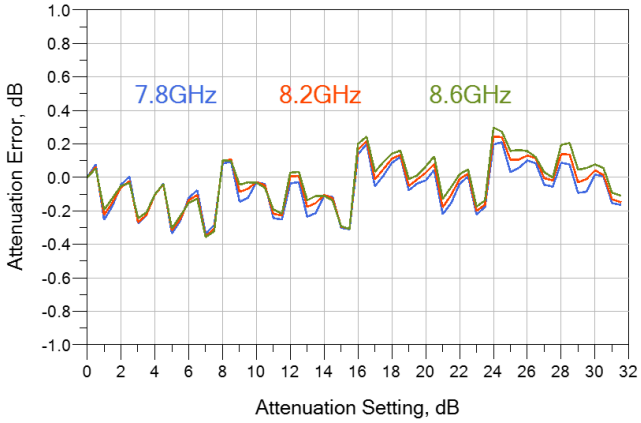
Vss = -3V, Baseplate temperature = 50 °C, Control voltages = 0V / -3V, Vctl_0.5dB_2 = 0V :

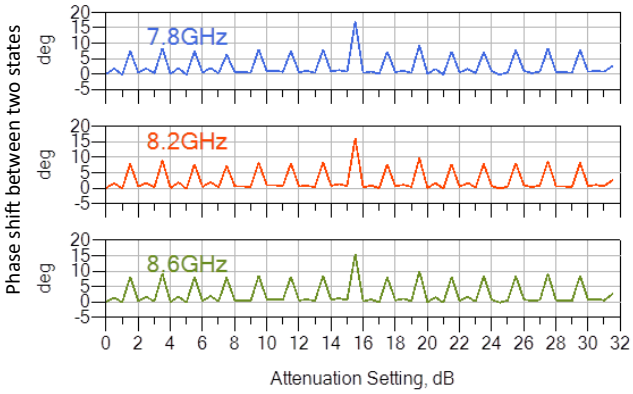












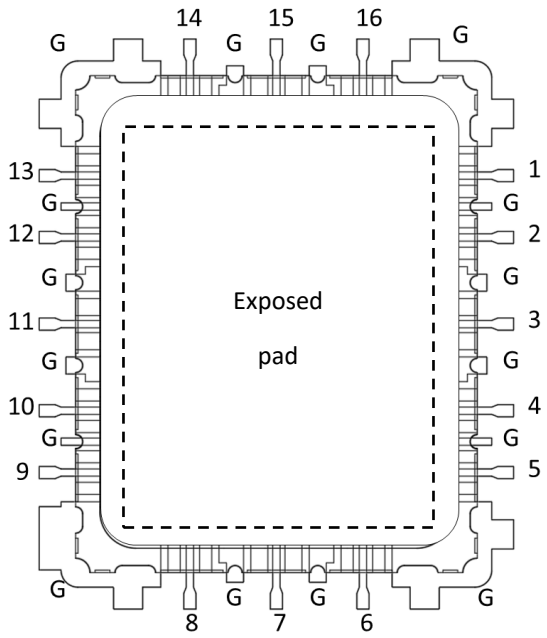
Note: the reference plane for all graphs is the PCB evaluation fixture RF connectors (fixture total loss = 1dB at the operating range, return loss better than –22dB)

Recommended Absolute Maximum Ratings [1]

Parameter	Symbol	Value	Notes
Control voltage	Vctl	Max = 0.3V	
RF input power	RFin	>15dBm	
Junction Temperature	T_j	115°C	For maximum median device lifetime, T_j should be minimised
Storage Temperature	$T_{storage}$	-55 to 150°C	

[1] Operation outside these conditions may cause permanent damage to the device. Combination of maximum rating conditions may reduce the values. Device performance at these ratings is not implied.

Device Pinout



Pin	Function	Typical DC Operating Voltage
12	Vss	-3V
1, 5, 6, 13, 14	NC	
15	Vctl_2dB	0/-3 V
16	Vctl_4dB	0/-3 V
2	$\overline{\text{Vctl\_16dB}}$	-3/0 V
3	RF OUT	
4	Vctl_16dB	0/-3 V
7	Vctl_1dB	0/-3 V
8	Vctl_0.5dB_1	0/-3 V
9	Vctl_0.5dB_2	0/-3 V
10	Vctl_8dB	0/-3 V
11	RF IN	
G	Ground	
Exposed Pad	Ground	

Note 1: All G pins and features should be connected to the ground net; exposed pad denotes the exposed area under the package, it should also be connected to the ground net and provide a low thermal resistance path. The thermal resistance specified between the transistor junction and the package (table page 1) is referenced to the Exposed Pad.
Note 2: Pin 2 should be the complementary signal of Pin 4

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Truth Table

Vctl_0.5dB_1	Vctl_1dB	Vctl_2dB	Vctl_4dB	Vctl_8dB	Vctl_16dB	$\overline{\text{Vctl\_16dB}}$	Attenuation
0V	0V	0V	0V	0V	0V	-3V	0 dB
-3V	0V	0V	0V	0V	0V	-3V	0.5 dB
0V	-3V	0V	0V	0V	0V	-3V	1 dB
-3V	-3V	0V	0V	0V	0V	-3V	1.5 dB
0V	0V	-3V	0V	0V	0V	-3V	2 dB
-3V	0V	-3V	0V	0V	0V	-3V	2.5 dB
0V	-3V	-3V	0V	0V	0V	-3V	3 dB
-3V	-3V	-3V	0V	0V	0V	-3V	3.5 dB
0V	0V	0V	-3V	0V	0V	-3V	4 dB
-3V	0V	0V	-3V	0V	0V	-3V	4.5 dB
0V	-3V	0V	-3V	0V	0V	-3V	5 dB
-3V	-3V	0V	-3V	0V	0V	-3V	5.5 dB
0V	0V	-3V	-3V	0V	0V	-3V	6 dB
-3V	0V	-3V	-3V	0V	0V	-3V	6.5 dB
0V	-3V	-3V	-3V	0V	0V	-3V	7 dB
-3V	-3V	-3V	-3V	0V	0V	-3V	7.5 dB
0V	0V	0V	0V	-3V	0V	-3V	8 dB
-3V	0V	0V	0V	-3V	0V	-3V	8.5 dB
0V	-3V	0V	0V	-3V	0V	-3V	9 dB
-3V	-3V	0V	0V	-3V	0V	-3V	9.5 dB
0V	0V	-3V	0V	-3V	0V	-3V	10 dB
-3V	0V	-3V	0V	-3V	0V	-3V	10.5 dB
0V	-3V	-3V	0V	-3V	0V	-3V	11 dB
-3V	-3V	-3V	0V	-3V	0V	-3V	11.5 dB
0V	0V	0V	-3V	-3V	0V	-3V	12 dB
-3V	0V	0V	-3V	-3V	0V	-3V	12.5 dB
0V	-3V	0V	-3V	-3V	0V	-3V	13 dB
-3V	-3V	0V	-3V	-3V	0V	-3V	13.5 dB
0V	0V	-3V	-3V	-3V	0V	-3V	14 dB
-3V	0V	-3V	-3V	-3V	0V	-3V	14.5 dB
0V	-3V	-3V	-3V	-3V	0V	-3V	15 dB
-3V	-3V	-3V	-3V	-3V	0V	-3V	15.5 dB
0V	0V	0V	0V	0V	-3V	0V	16 dB
-3V	0V	0V	0V	0V	-3V	0V	16.5 dB
0V	-3V	0V	0V	0V	-3V	0V	17 dB
-3V	-3V	0V	0V	0V	-3V	0V	17.5 dB
0V	0V	-3V	0V	0V	-3V	0V	18 dB
-3V	0V	-3V	0V	0V	-3V	0V	18.5 dB
0V	-3V	-3V	0V	0V	-3V	0V	19 dB
-3V	-3V	-3V	0V	0V	-3V	0V	19.5 dB
0V	0V	0V	-3V	0V	-3V	0V	20 dB
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0V	-3V	0V	-3V	0V	-3V	0V	21 dB
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0V	0V	-3V	-3V	0V	-3V	0V	22 dB
-3V	0V	-3V	-3V	0V	-3V	0V	22.5 dB
0V	-3V	-3V	-3V	0V	-3V	0V	23 dB
-3V	-3V	-3V	-3V	0V	-3V	0V	23.5 dB
0V	0V	0V	0V	-3V	-3V	0V	24 dB
-3V	0V	0V	0V	-3V	-3V	0V	24.5 dB
0V	-3V	0V	0V	-3V	-3V	0V	25 dB
-3V	-3V	0V	0V	-3V	-3V	0V	25.5 dB
0V	0V	-3V	0V	-3V	-3V	0V	26 dB
-3V	0V	-3V	0V	-3V	-3V	0V	26.5 dB
0V	-3V	-3V	0V	-3V	-3V	0V	27 dB
-3V	-3V	-3V	0V	-3V	-3V	0V	27.5 dB
0V	0V	0V	-3V	-3V	-3V	0V	28 dB
-3V	0V	0V	-3V	-3V	-3V	0V	28.5 dB
0V	-3V	0V	-3V	-3V	-3V	0V	29 dB
-3V	-3V	0V	-3V	-3V	-3V	0V	29.5 dB
0V	0V	-3V	-3V	-3V	-3V	0V	30 dB
-3V	0V	-3V	-3V	-3V	-3V	0V	30.5 dB
0V	-3V	-3V	-3V	-3V	-3V	0V	31 dB
-3V	-3V	-3V	-3V	-3V	-3V	0V	31.5 dB

The above table is valid for Vctl_0.5dB_2 = 0V.
For each of the attenuation states above, setting the control line Vctl_0.5dB_2 = -3V introduces a supplemental 0.5dB attenuation. This may be used in case of attenuation inaccuracy on selected states.

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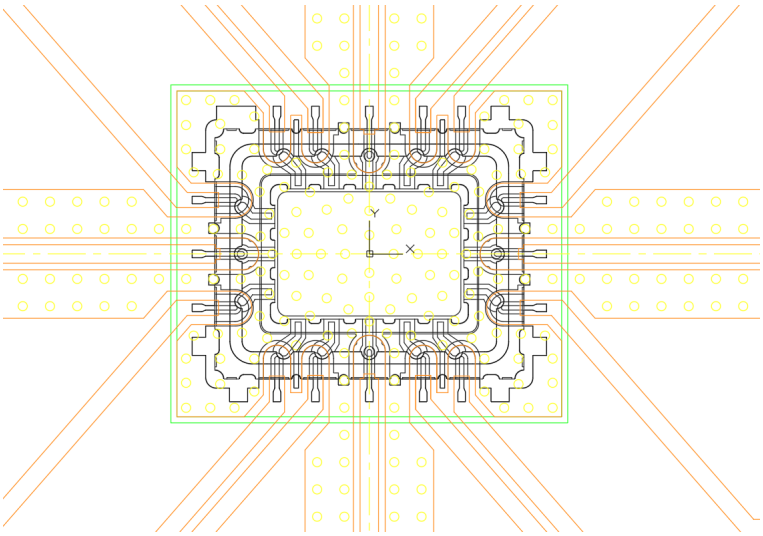
Specific Bias Circuit Information

The Vss and Control Lines are implemented on-chip with broadband 5kΩ series resistance to provide isolation between the bias circuit and the gate of the MMIC switches. Therefore bias decoupling is optional on the PCB. It should be noted that an external decoupling capacitor may reduce the switching speed of the MMIC.
No specific sequencing is required. However the user should ensure fast switching between states, to ensure the attenuator remains in a defined configuration.

Recommended Application Circuit - PCB Layout

A generic PCB layout for the package footprint is available from VIPER RF. Please consult the factory for the DXF file template.



Package Information

Package drawing is available from the factory, please consult VIPER RF for further information.

Parameter	Value
Type	Leaded
Body	Al_2O_3, white
Leads	Fe-Ni-Co Alloy
Lid	Al_2O_3
Exposed Pad	Cu-Mo alloy
Pin 1	Index mark, circle, Gold
Finish (on leads)	Au plating 0.8µm min Ni plating 2µm to 8µm

Recommended Handling and Assembly

VIPER RF advises the assembly process and reflow profiles should conform to JEDEC J-STD-020.

GaAs devices are ESD sensitive and precautions should be observed during storage, handling, assembly and testing.

ESD protection is implemented on the device (DC grounded RF ports, diode-clamped DC ports) however the level of protection is not guaranteed.