VRFC0136-SG

25.5-27 GHz Double-Balanced Upconverter MMIC

Preliminary Datasheet v6

Features

- Conversion gain: 27 dB typical
- Input IF power: -30 dBm typical
- RF Frequency range: 25.5 to 27 GHz
- IF Frequency Range: 7.8 to 8.6 GHz
- LO Frequency range: 17 to 17.5 GHz
- High-side LO injection mode with Integrated LO frequency doubler
- 50 Ω matched RF ports
- 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 VRFC0136-SG is a Ka-band GaAs upconverter MMIC in a high reliability hermetic leaded metal-ceramic package. The device provides a small-signal conversion gain of 29 dB with 60 dBc in-band rejection. The upconverter uses an integrated IF amplifier operating between 7.8 and 8.6 GHz. The mixer is driven by a multiplied (x2) LO at 0 dBm ranging 17 to 17.5 GHz. The output RF product ranges from 25.5 to 27 GHz. The mixer output is filtered for out-of-band spur rejection and amplified by an integrated RF amplifier. The LO chain includes a 2-bit digital attenuator to control the LO amplifier saturation level while ensuring reliable operation.

All RF ports and DC pads are ESD protected. The MMIC design is compliant with ECSS-Q-ST-30-11C Rev 1 and is manufactured on a technology successfully evaluated for Space use and referenced in the European Preferred Part List.

Electrical Specifications

condition V_{DD} = +4.5V, Baseplate temperature = 25 °C

Parameter	Specification						Unit
	Low-band			High-band			
	Min.	Typ.	Max.	Min.	Typ.	Max.	
Frequency Range RF IF LO[1]	 25.5 7.8 	 17	 26.25 8.6 17.6	 26.25 7.8 	 17.4	 27 8.6 18.4	GHz
Input RF Signals LO Drive Range IF input power	 -2 -40	 0 -30	 +2 -20	 -2 -40	 0 -30	 +2 -20	 dBm (Pcw) dBm (Pavg)
Return Loss RF IF LO		 -8 -15 -12			 -8 -15 -12		dB
Conversion Gain		27			27		dB
Inband Rejection		60			60		dBc
Output-referred P1dB		7			8		dBm
2xLO leakage at: RF output		 -20			 -25		dBc
DC Bias Voltages VD1, VD2, VD3 and VD4 [1] VG1, VG2, VG3 and VG4 [1] VG_MIXER [1] V_x2 [1] V_REF [1]	 -1 -7 	 +4.5 -0.7 +0.8 -5 -3	 +6 -0.45 -3 	 -1 -7 	 +4.5 -0.7 +0.8 -5 -3	 +6 -0.45 -3 	V
DC Currents Total I_D [2] I_x2 I_REF		 140 8 7.2	 16 10		 140 8 7.2	 16 10	mA
LO DCA control voltage	-0.2	0 -3	+0.3 -1.2	-0.2	0 -3	+0.3 -1.2	V (H) V (L)
Operating temperature range	-20 to 50						°C
Hermeticity (typical)	10^{-9} Pa·m^3/s (10^{-8} ccHe/sec.) at 10^5 Pa (1atm) differential						

[1] Gate voltage should be adjusted to achieve ID_Q = 140mA.
[2] At typical bias voltages; 140mA (23.5mA from VD1, 38.8mA from VD2, 57.6mA from VD3, 19.9mA from VD4)

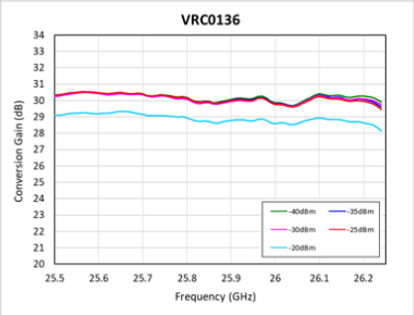
Note: the reference planes for all graphs are the PCB evaluation fixture RF connectors:

- Feedline loss at X band = 0.5dB
- Feedline loss at Ka band = 0.6dB
- Return loss better than –16dB

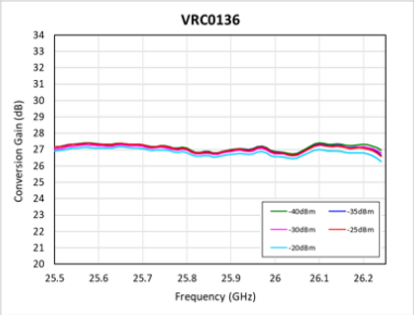
Conversion Gain versus IF Power and Temperature:

LO = 17.05 GHz, 0 dBm; IF = 7.8 to 8.6 GHz, -40 to –20 dBm:

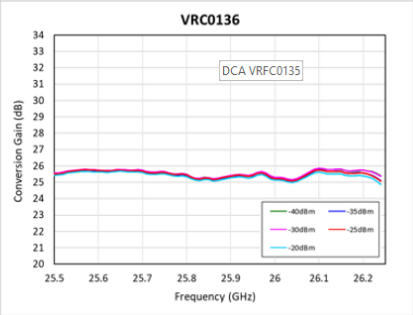
-20°C



25°C

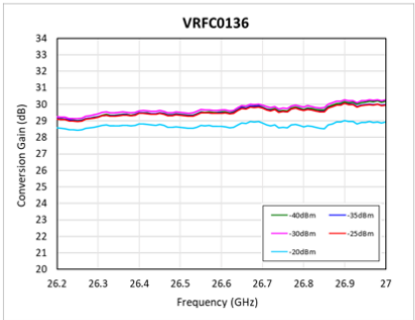


50°C

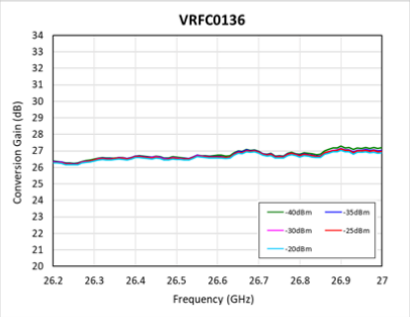


LO = 17.4 GHz, 0 dBm; IF = 7.8 to 8.6 GHz, -40 to –20 dBm:

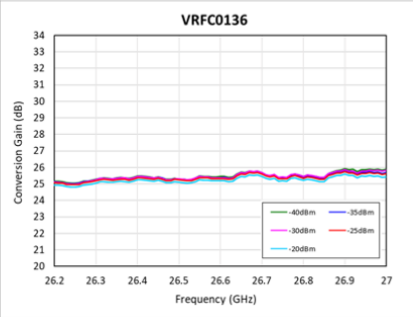
-20°C



25°C



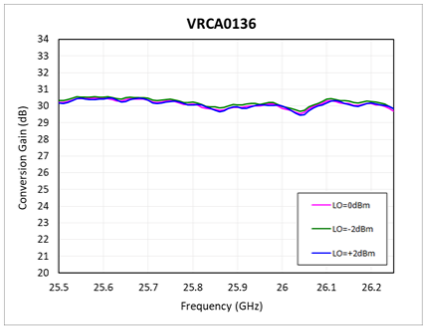
50°C



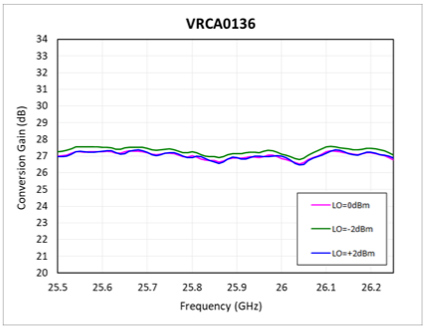
Conversion Gain versus LO Power and Temperature:

LO = 17.05 GHz, -2 to 2 dBm; IF = 7.8 to 8.6 GHz, -30 dBm:

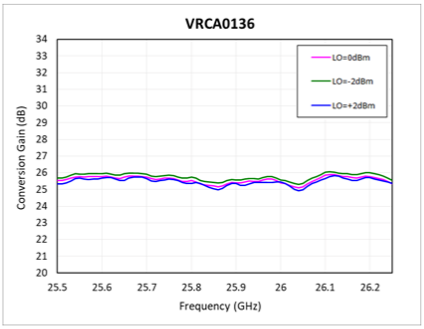
-20°C



25°C

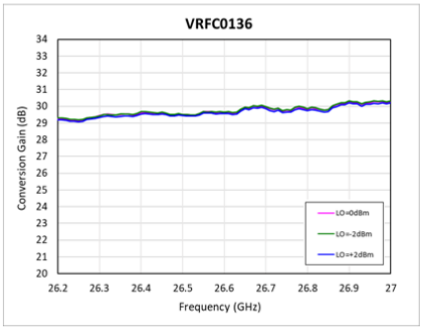


50°C

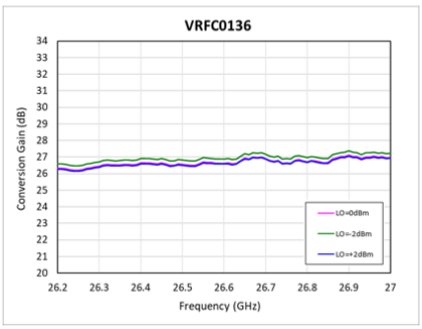


LO = 17.4 GHz, -2 to 2 dBm; IF = 7.8 to 8.6 GHz, -30 dBm:

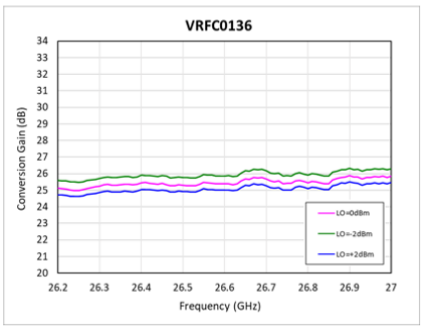
-20°C



25°C



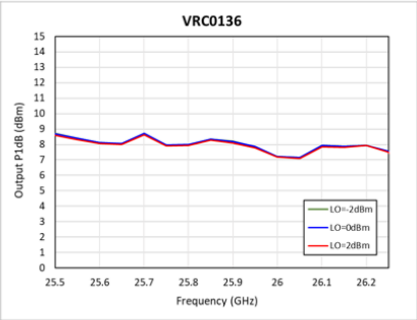
50°C



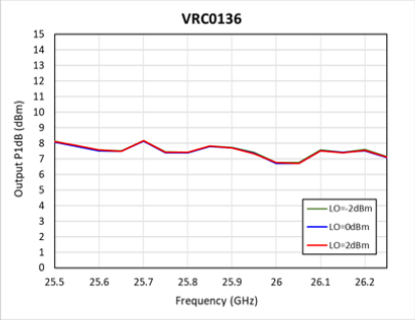
Output P1dB versus LO Power and Temperature:

LO = 17.05 GHz, -2 to 2 dBm; IF = 7.8 to 8.6 GHz:

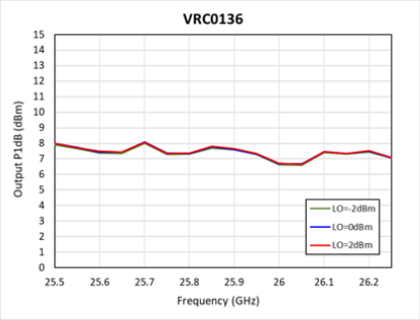
-20°C



25°C

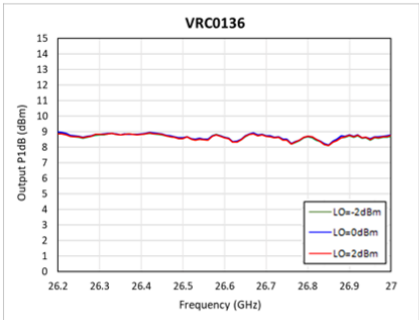


50°C

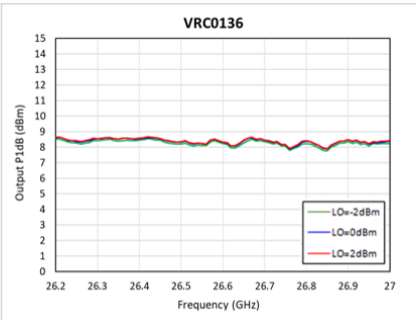


LO = 17.4 GHz, -2 to 2 dBm; IF = 7.8 to 8.6 GHz:

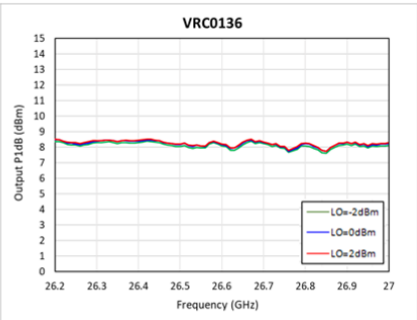
-20°C



25°C



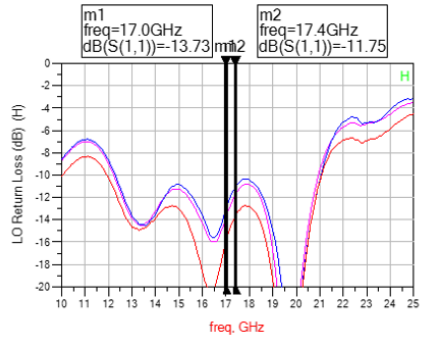
50°C

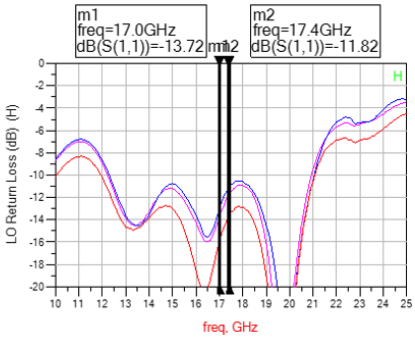


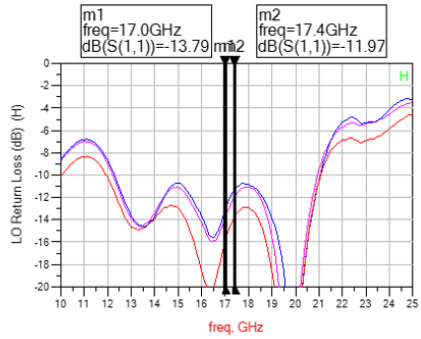
LO Return Loss versus LO Power and Temperature:

LO = -2 dBm (left), 0 dBm (centre), 2 dBm (right)

Baseplate temperature = -20°C (blue), 25°C (pink), 50°C (red)

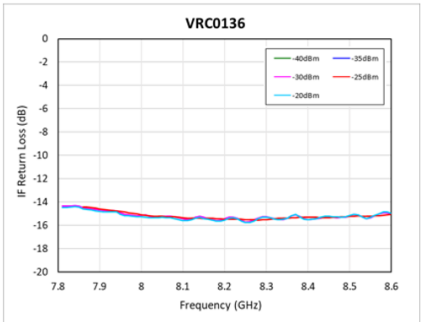




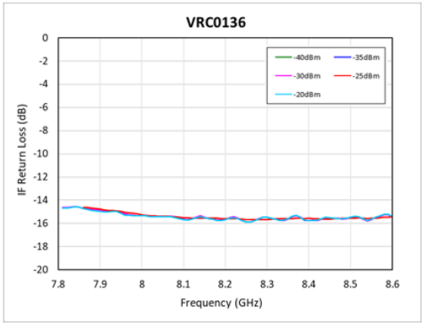


IF Return Loss versus IF Power and Temperature:

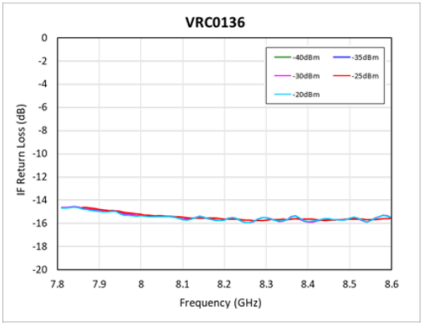
-20°C



25°C



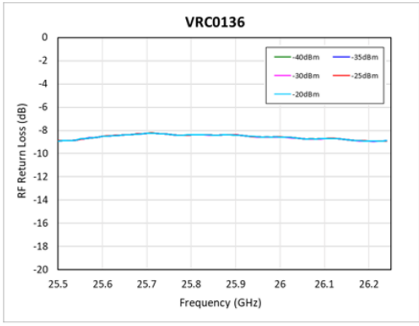
50°C



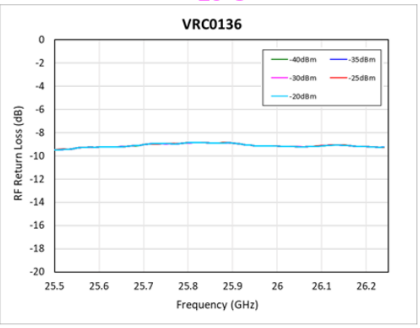
RF Return Loss versus IF Power and Temperature:

LO = 17.05 GHz, 0 dBm; IF = 7.8 to 8.6 GHz, -40 to –20 dBm:

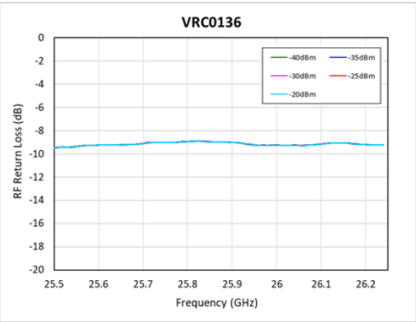
-20°C



25°C

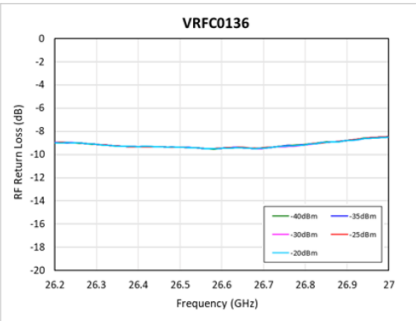


50°C

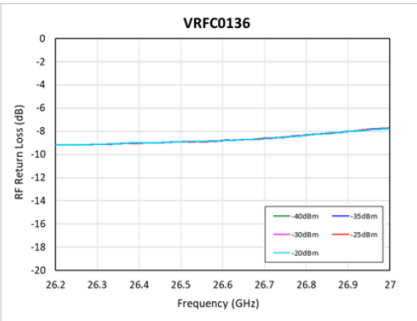


LO = 17.4 GHz, 0 dBm; IF = 7.8 to 8.6 GHz, -40 to –20 dBm:

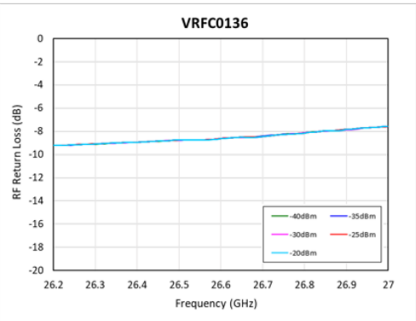
-20°C



25°C

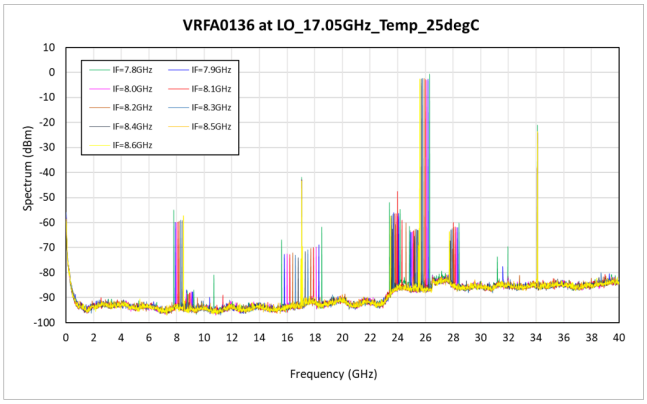


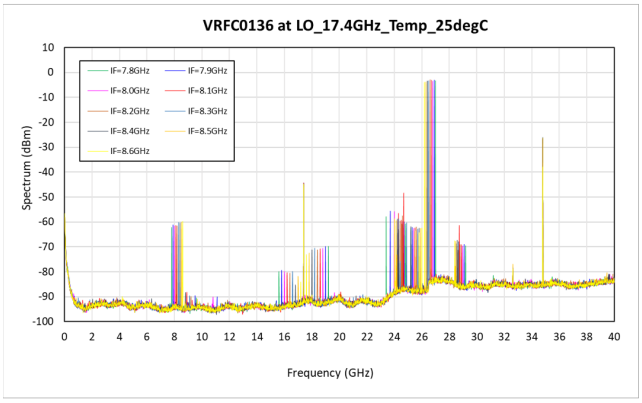
50°C



Broadband Spurious Output versus LO and IF Frequency:

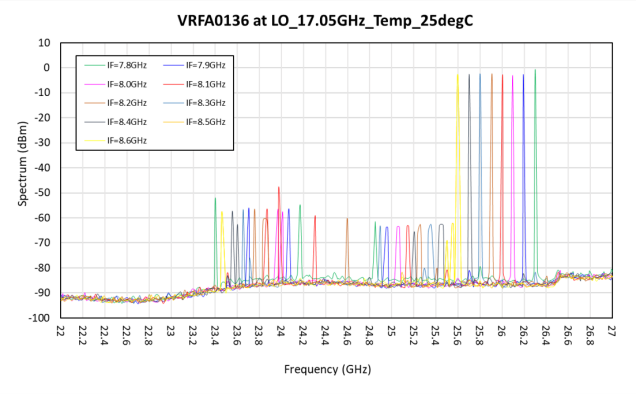
LO = 17.05 GHz (left) , 14.4 GHz (right); IF = 7.8 to 8.6 GHz, -30 dBm; Temperature = 25°C:

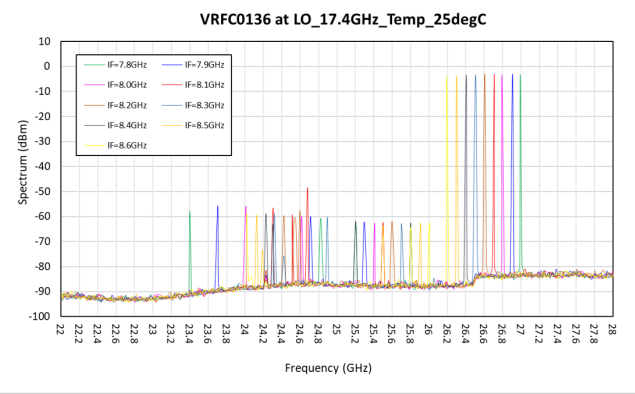




Narrowband Spurious Output versus LO and IF Frequency:

LO = 17.05 GHz (left) , 14.4 GHz (right); IF = 7.8 to 8.6 GHz, -30 dBm; Temperature = 25°C:





Recommended DCA control over temperature (preliminary guideline):

The LO DCA is implemented as two attenuator bits, 2dB and 4dB to cover a 6dB attenuation range. The user should provide an external attenuation control as follows, dependent on the operating temperature, in order to ensure suitable operation of the internal LO circuits.

Typical Temperature Range (°C)	B0 (V)	B1 (V)	Applied Attenuation (dB)
-20 to –10	0	0	6
-10 to +15	-3	0	4
+15 to +35	0	-3	2
+35 to +50	-3	-3	0

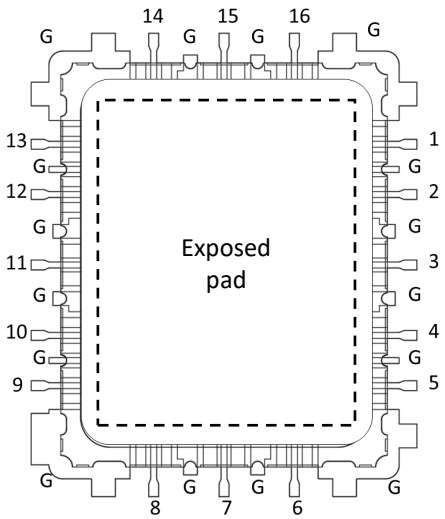
Recommended Maximum Ratings [1]

Parameter	Symbol	Value	Notes
Drain Bias Voltage	V_d	+8V	
Minimum gate Bias Voltage	V_g	-2V	
Gate Current	I_g	1mA/finger	4mA gate current for VG1 and 2mA gate current for VG2, VG3 and VG4
Mixer V_{SG} Bias Voltage	$V_{g,mixer}$	+3	
DCA control voltage	B	Max: +0.3V Min: -3V	
LO Input Power	P_{LO}	+13dBm	
Junction Temperature	T_j	115°C	For maximum median device lifetime, T_j should be minimised
Storage Temperature Range	$T_{storage}$	-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.*

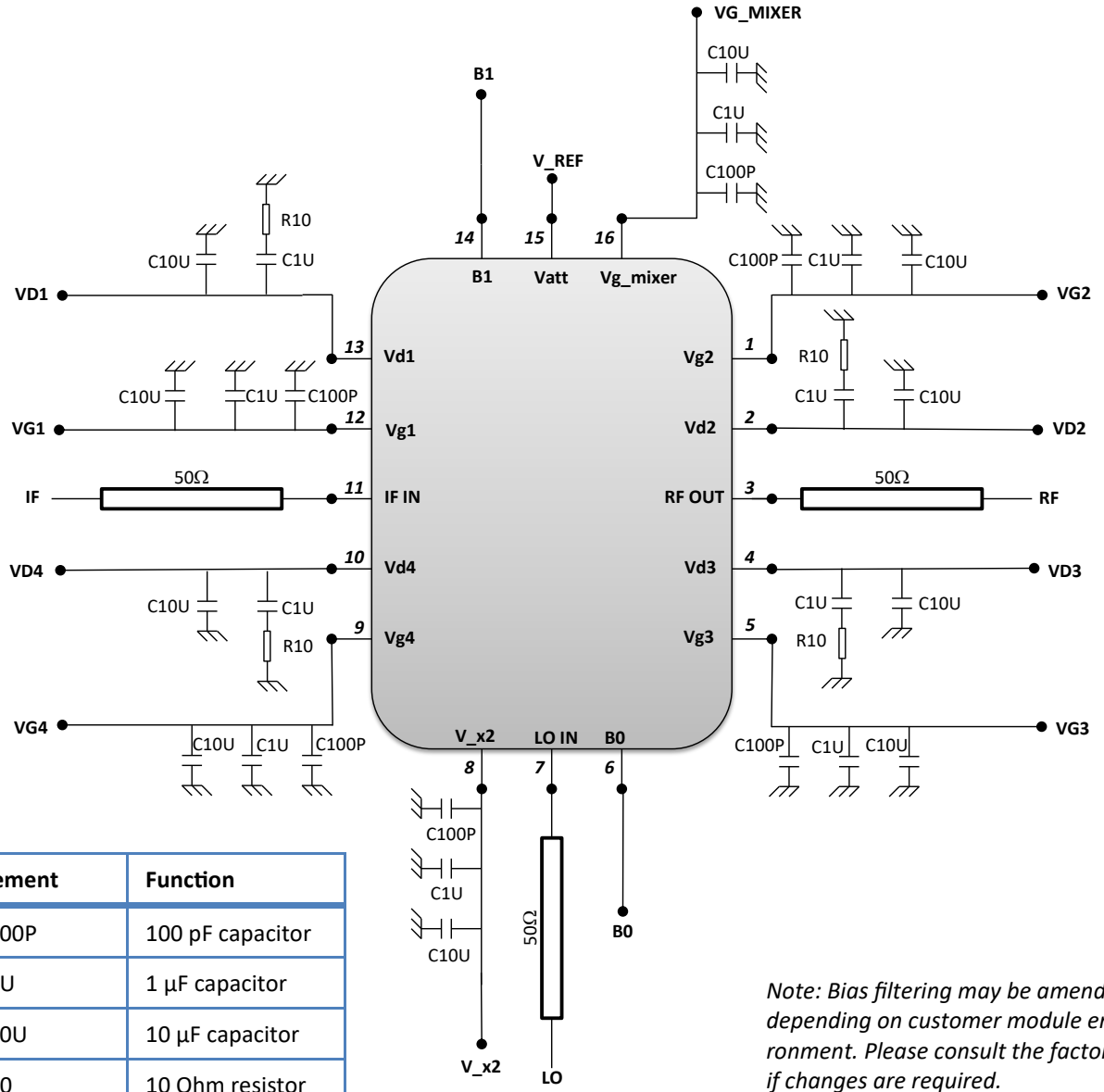
Device Pinout

Note: 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 is referenced to the ground Pad.



Pin	Function	Typical Voltage	Description
1	VG2	-0.7V	Gate Voltage for RF Amplifier
2	VD2	+4.5V	Drain Voltage for RF Amplifier
3	RF OUT	0V	RF output
4	VD3	+4.5V	Drain Voltage for Ku-band LO Amplifier
5	VG3	-0.7V	Gate Voltage for Ku-band LO Amplifier
6	B0	-3/0 V	Control bit 0 for LO DCA
7	LO IN	0V	LO input
8	V_x2	-5 V	Voltage Bias for LO Frequency Doubler
9	VG4	-0.7V	Gate Voltage for Ka-band LO Amplifier
10	VD4	+4.5V	Drain Voltage for Ka-band LO Amplifier
11	IF IN	0V	IF input
12	VG1	-0.7V	Gate Voltage IF Amp.
13	VD1	+4.5V	Drain Voltage IF Amp.
14	B1	-3/0 V	Control bit 1 for LO DCA
15	V_REF	-3 V	Fixed voltage for LO DCA
16	VG_MIXER	+0.8V	Gate Voltage Mixer switches
G	Ground		
EP	Ground		Exposed Pad

Recommended Application Circuit - Bias Circuits



Element	Function
C100P	100 pF capacitor
C1U	1 µF capacitor
C10U	10 µF capacitor
R10	10 Ohm resistor

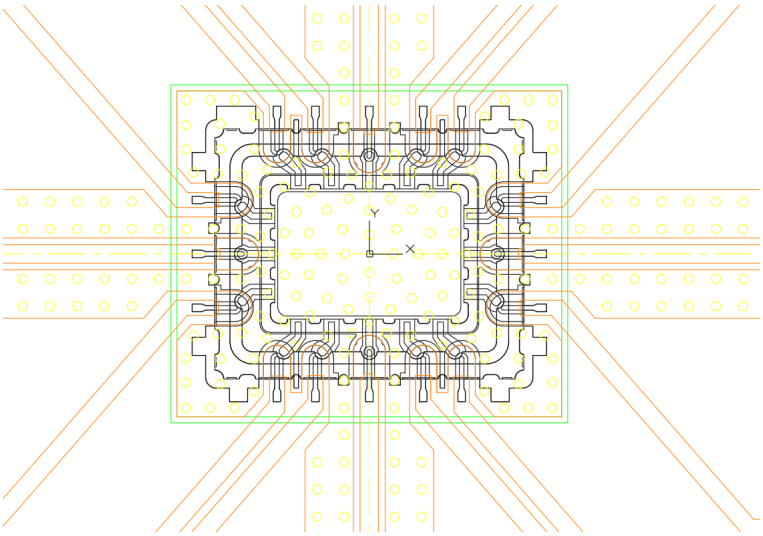
Note: Bias filtering may be amended depending on customer module environment. Please consult the factory if changes are required.

Specific Biasing Requirements

- *The amplifier stages on the various MMIC subfunctions may be biased up and down in any order*
- *Nominal bias is obtained by first applying a gate voltage of –0.7V, followed by a drain voltage of 4.5V (Note sequence). Minor adjustment of the gate voltage may be necessary to obtain the specified quiescent drain current.*
- *Sequence for turning off an amplifier stage is first disabling the drain voltage, followed by the gate voltage.*

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	Al2O3, white
Leads	Fe-Ni-Co Alloy
Lid	Al2O3
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.