VG111

PCS/UMTS-band Variable Gain Amplifier

The Communications Edge ™

Product Information

Product Features

- 1800 – 2200 MHz bandwidth
- 26.6 dB Attenuation Range
- +39.5 dBm Output IP3
- +22 dBm P1dB
- Constant IP3 & P1dB over attenuation range
- Single voltage supply
- Pb-free 6mm 28-pin QFN package
- MTTF > 1000 years

Applications

- Xmit & Rcv AGC circuitry for mobile infrastructure

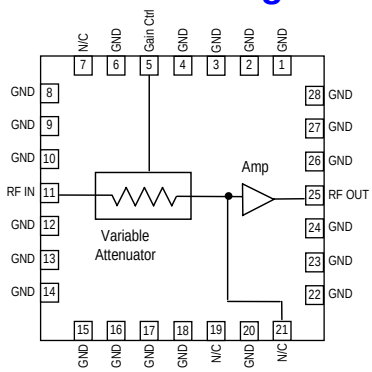
Product Description

The VG111 is a PCS / UMTS-band high dynamic range variable gain amplifier (VGA) packaged in a low profile Pb-free / RoHS-compliant surface-mount leadless package that measures 6 x 6 mm square.

The +22 dBm output compression point and +39.5 dBm output intercept point of the amplifier are maintained over the entire attenuation range, making the VG111 ideal for use in transmitter and receiver AGC circuits and as a variable gain stage following an LNA in high dynamic range receiver front ends.

Superior thermal design allows the product to have a minimum MTTF rating of 1000 years at a mounting temperature of +85º C. All devices are 100% RF & DC tested and packaged on tape and reel for automated surface-mount assembly.

Functional Diagram



Function	Pin No
Gain Control	5
No Connect	7, 19, 21
RF Input	11
RF Output / DC bias	25
Ground	All other pins Backside copper

Specifications (1)

Parameter	Units	Min	Typ	Max	Conditions
Operational Bandwidth	MHz	1800		2200	
Test Frequency	MHz		1900		See note 1
Gain at min. attenuation	dB	12	14		
Input Return Loss	dB		12		
Output Return Loss	dB		11		
Output P1dB	dBm		+22		
Output IP3	dBm	+37	+39.5		See note 2
Noise Figure at min. attenuation	dB		3.5		V_{CTRL} = 0 V
Test Frequency	MHz		2140		See note 1
Gain at min. attenuation	dB		13.3		
Input Return Loss	dB		14		
Output Return Loss	dB		14		
Output P1dB	dBm		+22		
Output IP3	dBm		+39.5		See note 2
Noise Figure at min. attenuation	dB		4.1		V_{CTRL} = 0 V
Gain Variation Range	dB	23.5	26.6	32.5	See note 3
Gain Variation Control Voltage, V_{CTRL}	V	0		4.5	See note 1
Group Delay	ns		0.6		
Supply Voltage	V		+5		
Operating Amplifier Current Range	mA	120	150	180	Pin 25
Gain Control Pin Current	mA			20	V_{CTRL} = 4.5 V. See note 1.

1. Test conditions unless otherwise noted: 25ºC, Vdd = +5 V in a tuned application circuit. Vctrl is the control voltage through a BJT transistor and a 100 Ω dropping resistor as shown in the same application circuit.
2. 3OIP measured with two tones at an output power of +5 dBm/tone separated by 10 MHz. The suppression on the largest IM3 product is used to calculate the 3OIP using a 2:1 rule.
3. The gain variation range is measured as the difference in gain with Vctrl = 0V and Vctrl = 4.5V at 1.9 GHz.

Absolute Maximum Rating

Parameter	Rating
Operating Case Temperature	-40 to +85 °C
Storage Temperature	-55 to +125 °C
Amplifier Supply Voltage (pin 25)	+6 V
Pin 5 (Gain Control) Current	30 mA
RF Input Power (continuous)	+12 dBm
Junction Temperature	+220° C

Operation of this device above any of these parameters may cause permanent damage.

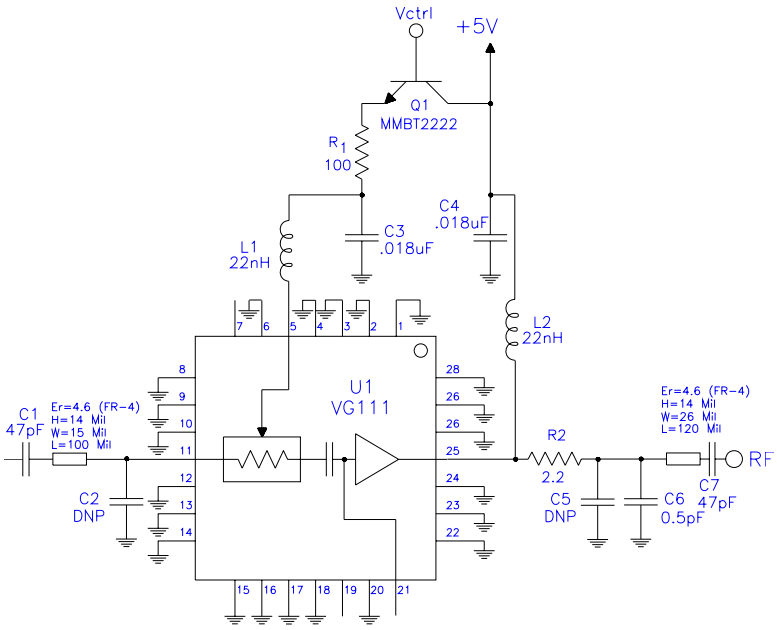
Ordering Information

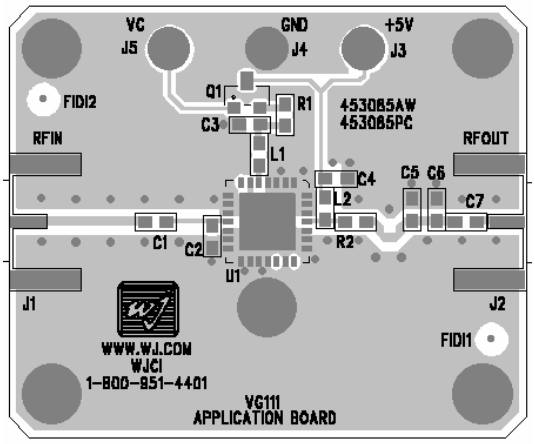
Part No.	Description
VG111*	PCS/UMTS-band Variable Gain Amplifier (Leaded QFN Pkg)
VG111-F	PCS/UMTS-band Variable Gain Amplifier (lead-free/RoHS-compliant QFN Pkg)
VG111-PCB1900	1.8 – 2.0 GHz Fully Assembled Application Board
VG111-PCB2100	2.0 – 2.2 GHz Fully Assembled Application Board

* This package is being phased out in favor of the lead-free package type which is backward compatible for existing designs.

Specifications and information are subject to change without notice

Application Circuit: 1.8 – 2.0 GHz (VG111-PCB1900)



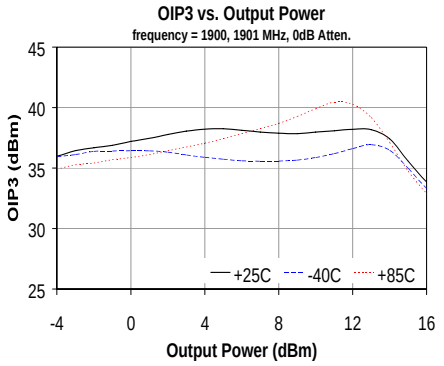


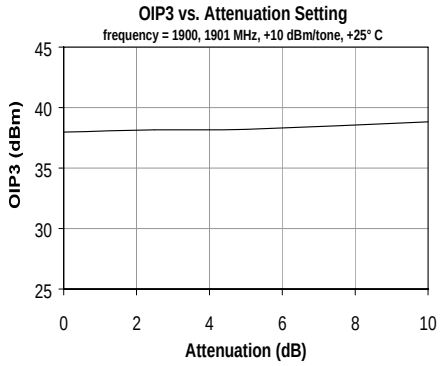
Circuit Board Material: .014" FR-4, 4 layers, .062" total thickness

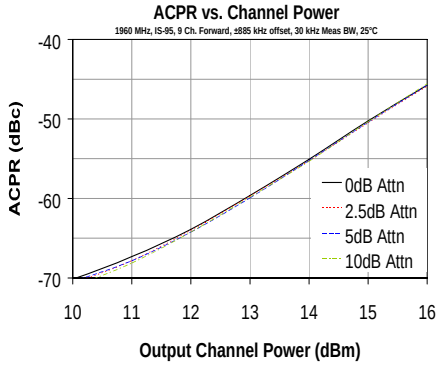
- Pins 7, 19, and 21 should not be connected.
- The amplifier is biased through Pin 25 and should be connected directly into a voltage regulator.
- DNP represents Do Not Place.
- Distances are shown from the edge-to-edge for the land pattern.

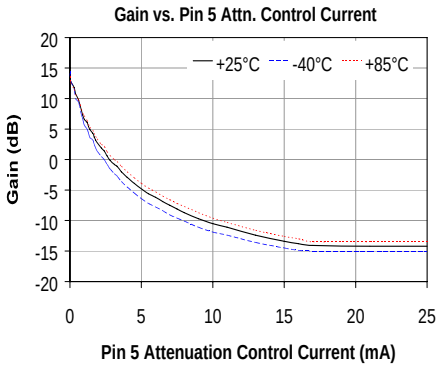
Bill of Materials

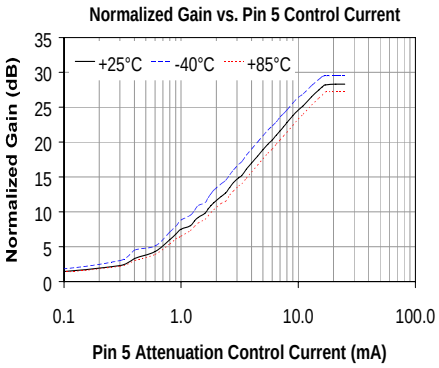
Ref. Des.	Description	Size
C1, C7	47 pF Chip Capacitor	0603
C2, C5	Do Not Place	
C3, C4	0.01 µF Chip Capacitor	0603
C6	0.5 pF Chip Capacitor	0603
L1, L2	22 nH Chip Inductor	0603
R1	100 Ω Chip Resistor	0603
R2	2.2 Ω Chip Resistor	0603
Q1	MMBT2222 Motorola Transistor	SOT-23
U1	VG111 Variable Gain Amplifier	QFN 6x6



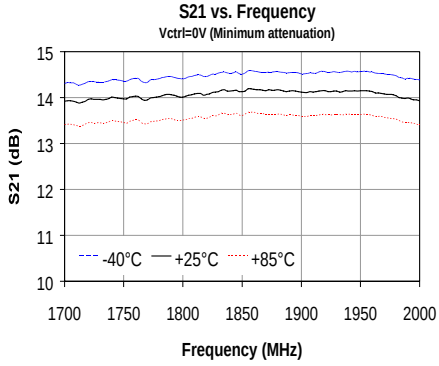


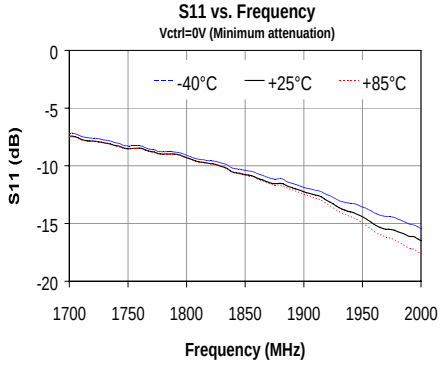


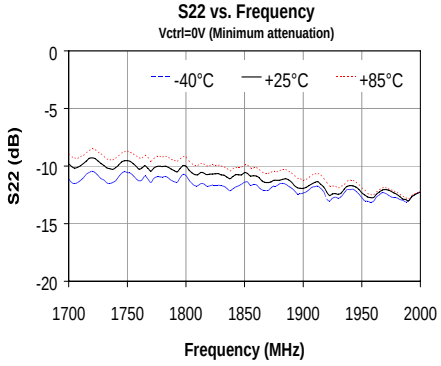


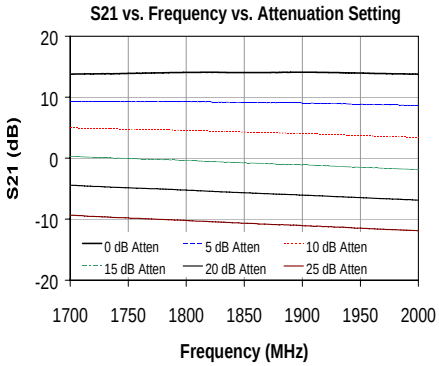


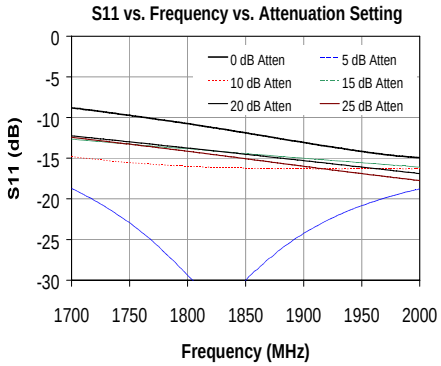
VG111-PCB1900 Application Circuit Performance (cont'd)

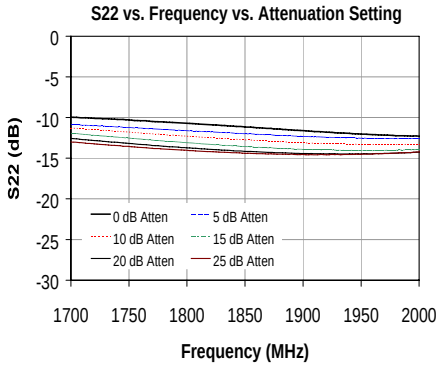


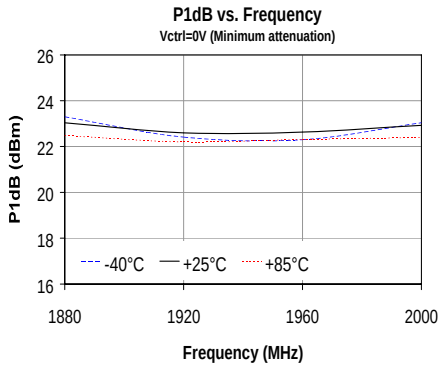


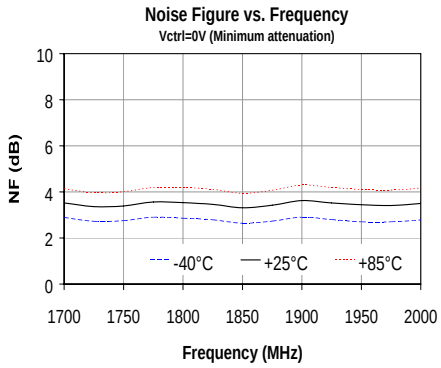




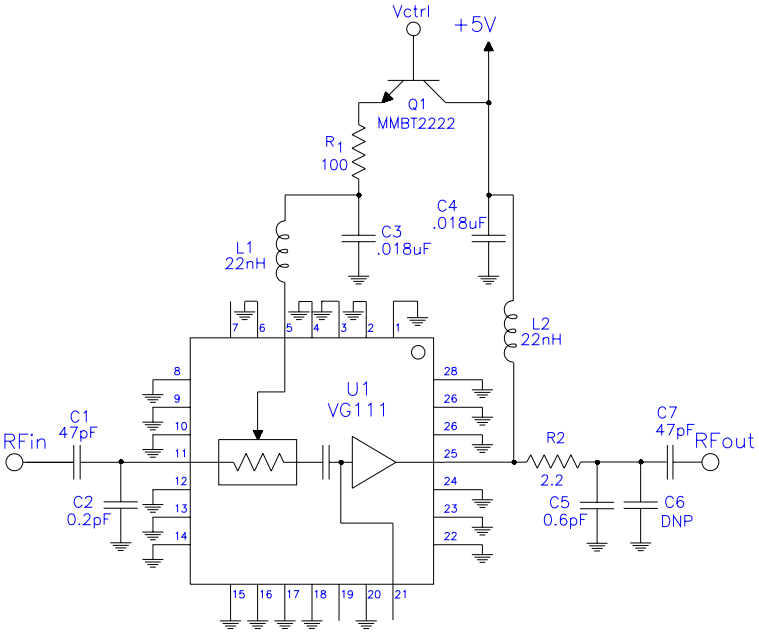


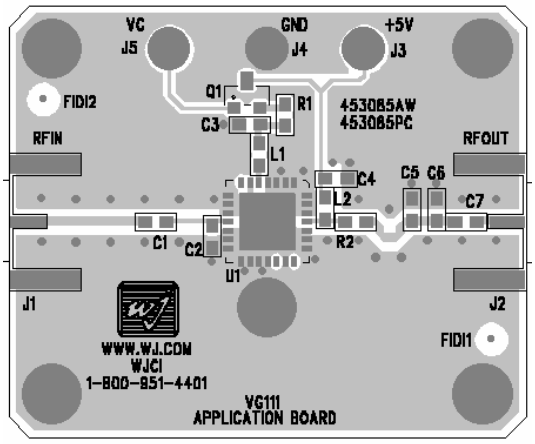






Application Circuit: 2.0 – 2.2 GHz (VG111-PCB2100)





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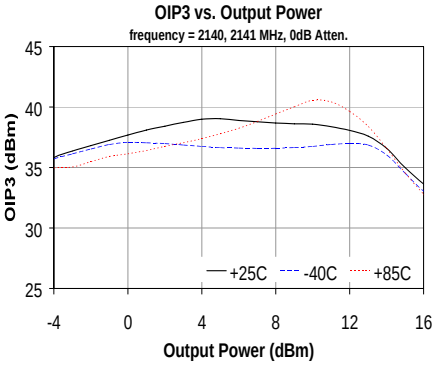
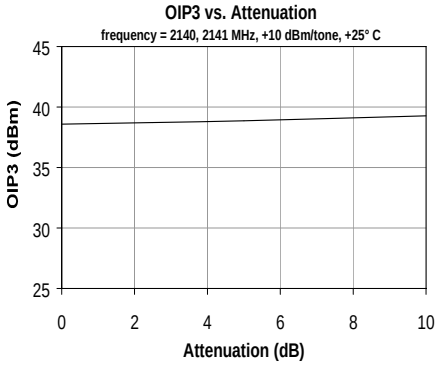
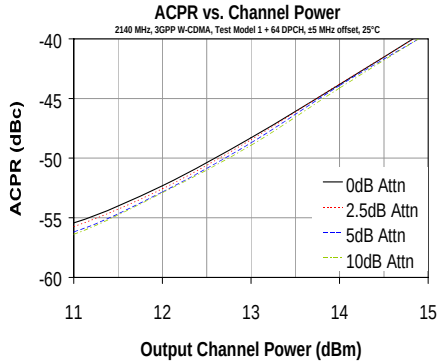
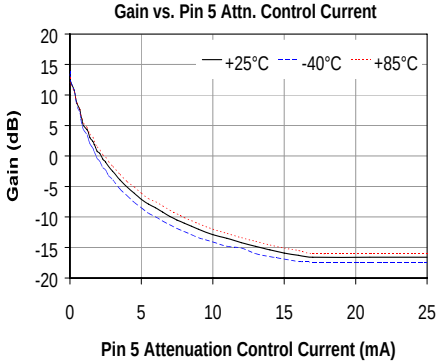
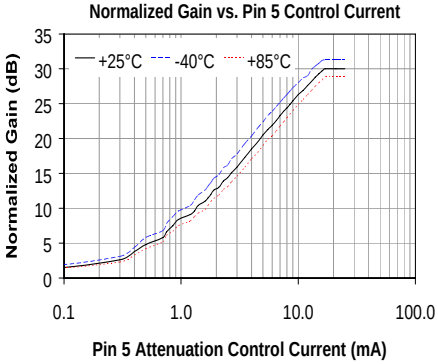


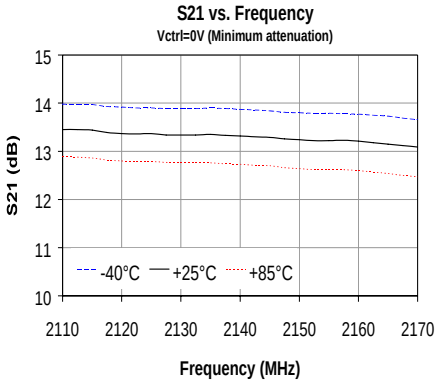


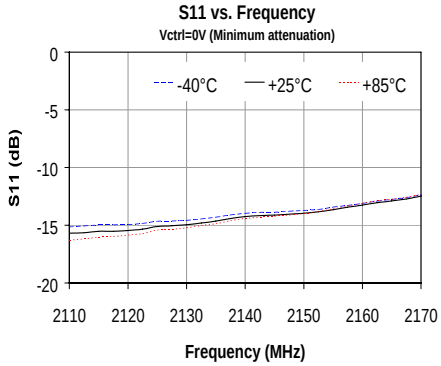


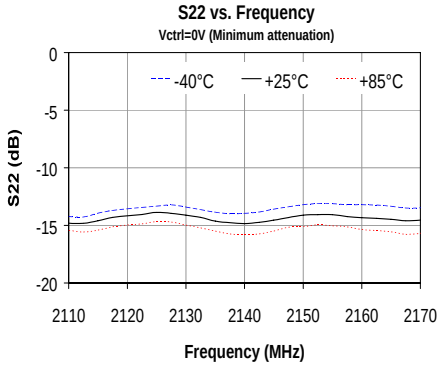


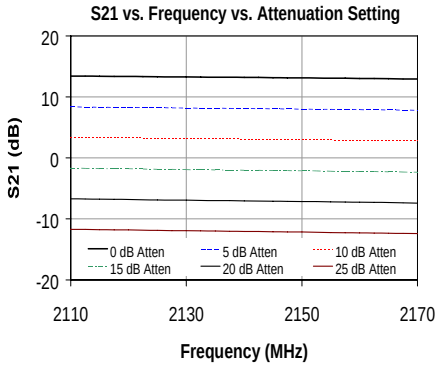


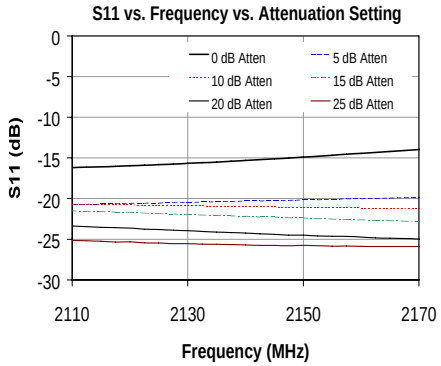
VG111-PCB2100 Application Circuit Performance (cont'd)

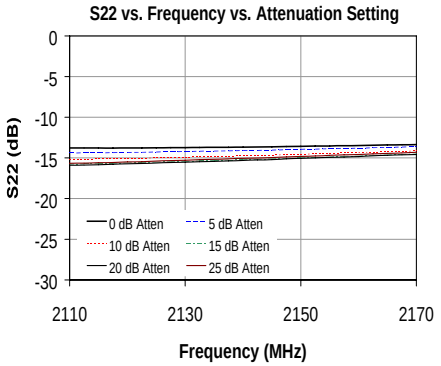


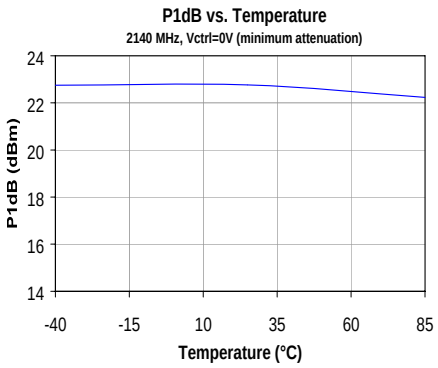


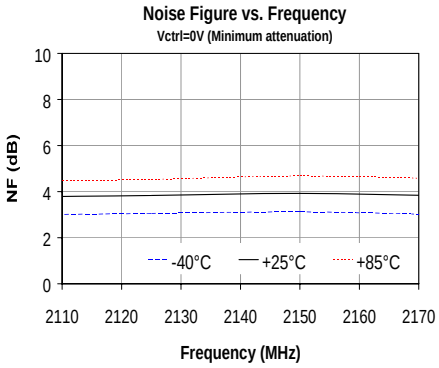








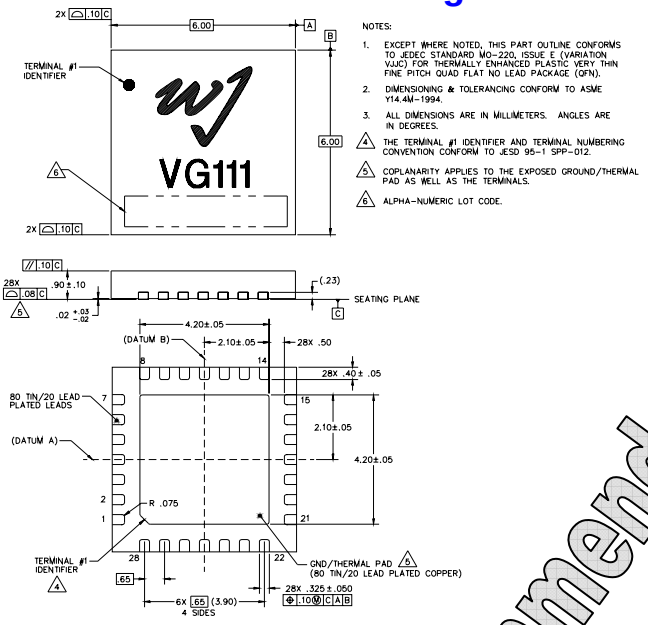




VG111 Mechanical Information

This package may contain lead-bearing materials. The plating material on the pins is SnPb.

Outline Drawing



Product Marking

The component will be laser marked with a "VG111" designator with an alphanumeric lot code on the top surface of the package.

Tape and reel specifications for this part will be located on the website in the "Application Notes" section.

ESD / MSL Information

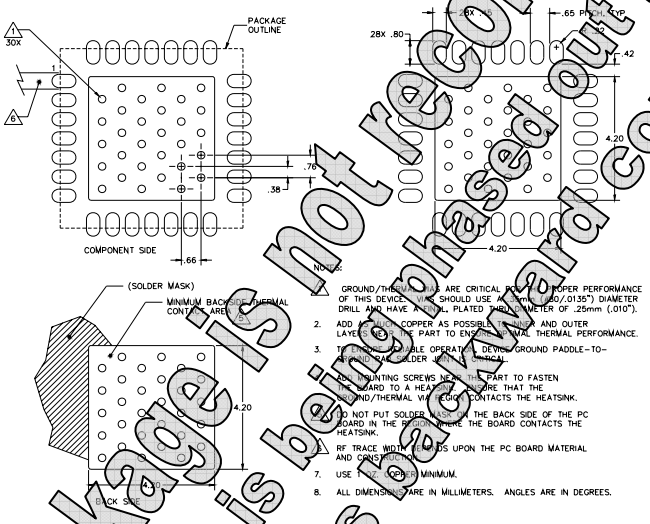
Caution: ESD sensitive device.

ESD Rating: Class 2B
Value: Passes ≥ 500V to <1000V
Test: Human Body Model (HBM)
Standard: JEDEC Standard JESD22-A114

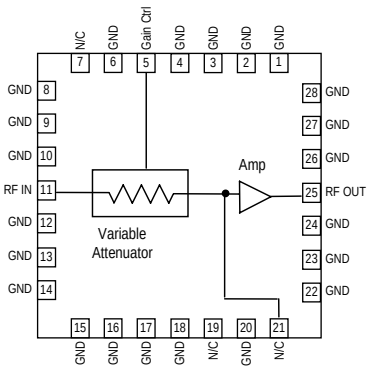
ESD Rating: Class IV
Value: Passes ≥ 1000V to <2000V
Test: Charged Device Model (CDM)
Standard: JEDEC Standard JESD22-C101

MSL: Level 1 at +250 °C convection reflow
Standard: JEDEC Standard J-STD-020

Mounting Configuration / Land Pattern



Functional Pin Layout

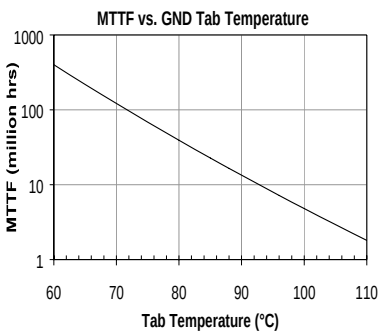


Pin	FUNCTION	Pin	FUNCTION
1	GND	15	GND
2	GND	16	GND
3	GND	17	GND
4	GND	18	GND
5	Gain control pin	19	N/C
6	GND	20	GND
7	N/C	21	N/C
8	GND	22	GND
9	GND	23	GND
10	GND	24	GND
11	RF Input	25	RF Output / Bias
12	GND	26	GND
13	GND	27	GND
14	GND	28	GND

Thermal Specifications

Parameter	Rating
Operating Case Temperature	-40 to +85° C
Thermal Resistance, Rθjc	30° C / W
Junction Temperature Tjc (2)	129° C

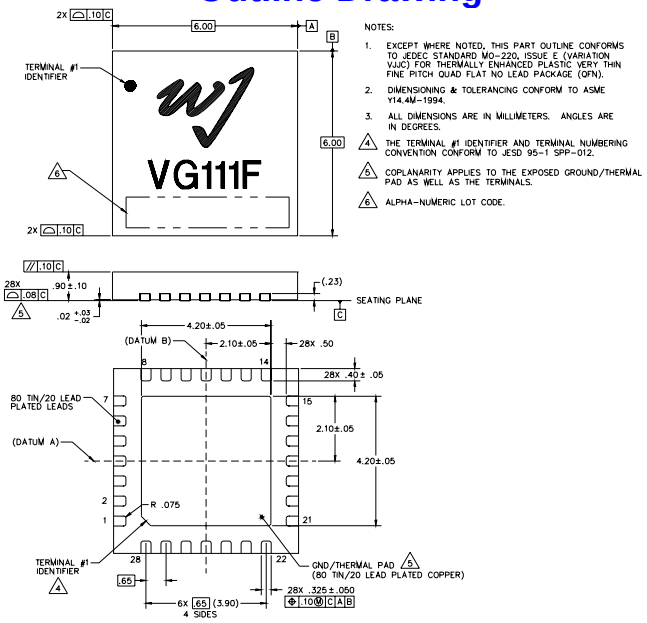
1. The thermal resistance is referenced from the hottest part of the junction to the ground tab (pin 4).
2. This corresponds to the typical biasing condition of +5V, 150 mA at an 85° C case temperature. A minimum MTTF of 1 million hours is achieved for junction temperatures below 160° C.



VG111-F Mechanical Information

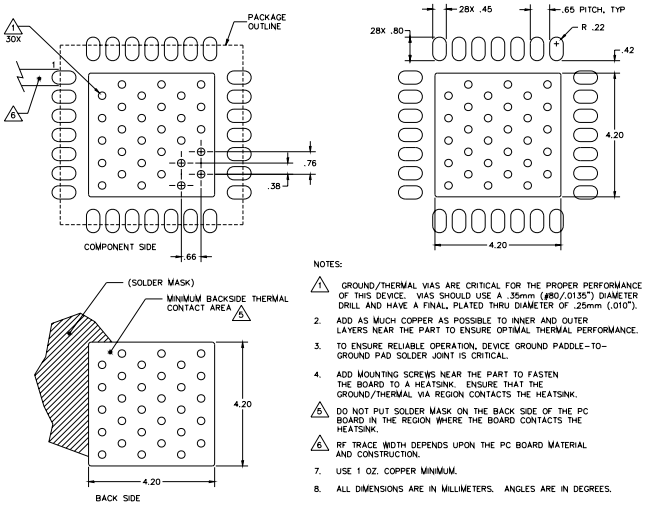
This package is lead-free/RoHS-compliant. It is compatible with both lead-free (maximum 260°C reflow temperature) and leaded (maximum 245°C reflow temperature) soldering processes. The plating material on the pins is annealed matte tin over copper.

Outline Drawing



NOTES:
1. EXCEPT WHERE NOTED, THIS PART OUTLINE CONFORMS TO JEDEC STANDARD MO-220, ISSUE E (VARIATION VJJC) FOR THERMALLY ENHANCED PLASTIC VERY THIN FINE PITCH QUAD FLAT NO LEAD PACKAGE (QFN).
2. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.4M-1994.
3. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION CONFORM TO JESD 95-1 SPP-012.
5. COPLANARITY APPLIES TO THE EXPOSED GROUND/THERMAL PAD AS WELL AS THE TERMINALS.
6. ALPHA-NUMERIC LOT CODE.

Mounting Configuration / Land Pattern

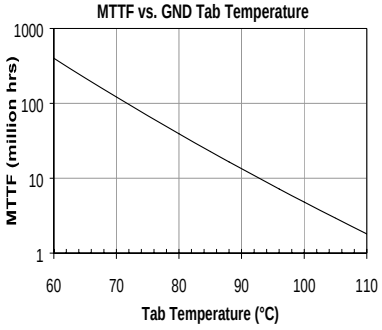


NOTES:
1. GROUND/THERMAL VIAS ARE CRITICAL FOR THE PROPER PERFORMANCE OF THIS DEVICE. VIAS SHOULD USE A .35mm (#80/.0135") DIAMETER DRILL AND HAVE A FINAL PLATED THRU DIAMETER OF .25mm (.010").
2. ADD AS MUCH COPPER AS POSSIBLE TO INNER AND OUTER LAYERS NEAR THE PART TO ENSURE OPTIMAL THERMAL PERFORMANCE.
3. TO ENSURE RELIABLE OPERATION, DEVICE GROUND PADDLE-TO-GROUND PAD SOLDER JOINT IS CRITICAL.
4. ADD MOUNTING SCREWS NEAR THE PART TO FASTEN THE BOARD TO A HEATSINK. ENSURE THAT THE GROUND/THERMAL VIA REGION CONTACTS THE HEATSINK.
5. DO NOT PUT SOLDER MASK ON THE BACK SIDE OF THE PC BOARD IN THE REGION WHERE THE BOARD CONTACTS THE HEATSINK.
6. RF TRACE WIDTH DEPENDS UPON THE PC BOARD MATERIAL AND CONSTRUCTION.
7. USE 1 OZ. COPPER MINIMUM.
8. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.

Thermal Specifications

Parameter	Rating
Operating Case Temperature	-40 to +85° C
Thermal Resistance, Rth (1)	59° C / W
Junction Temperature, Tjc (2)	129° C

1. The thermal resistance is referenced from the hottest part of the junction to the ground tab (pin 4).
2. This corresponds to the typical biasing condition of +5V, 150 mA at an 85° C case temperature. A minimum MTTF of 1 million hours is achieved for junction temperatures below 160° C.



Product Marking

The component will be lasermarked with a "VG111F" designator with an alphanumeric lot code on the top surface of the package.

Tape and reel specifications for this part will be located on the website in the "Application Notes" section.

ESD / MSL Information

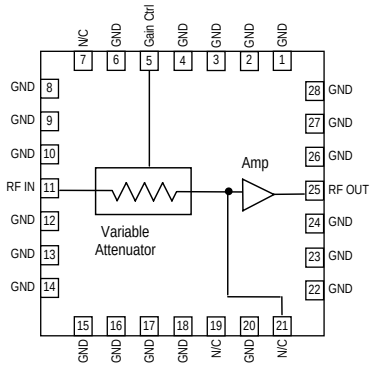
Caution! ESD sensitive device.

ESD Rating: Class 1B
Value: Passes ⩾500V to <1000V
Test: Human Body Model (HBM)
Standard: JEDEC Standard JESD22-A114

ESD Rating: Class IV
Value: Passes ⩾1000V to <2000V
Test: Charged Device Model (CDM)
Standard: JEDEC Standard JESD22-C101

MSL Rating: Level 2 at +260°C convection reflow
Standard: JEDEC Standard J-STD-020

Functional Pin Layout



Pin	FUNCTION	Pin	FUNCTION
1	GND	15	GND
2	GND	16	GND
3	GND	17	GND
4	GND	18	GND
5	Gain control pin	19	N/C
6	GND	20	GND
7	N/C	21	N/C
8	GND	22	GND
9	GND	23	GND
10	GND	24	GND
11	RF Input	25	RF Output / Bias
12	GND	26	GND
13	GND	27	GND
14	GND	28	GND

Specifications and information are subject to change without notice