Preliminary

GRF2013

High Linearity Gain Block; 0.05 – 3.8 GHz

Package: 1.5 x 1.5 mm DFN-6

Features

- 0.2 GHz to 2.7 GHz (Single Match)
- Gain: 17.5 dB @ 2.5 GHz
- OIP3: +38.8 dBm @ 2.5 GHz
- OP1dB: +22.5 dBm @ 2.5 GHz
- Psat: > +25.5 dBm @ 8.0 volts
- NF: 2.4 dB @ 2.5 GHz
- Operation to +105C Ambient
- Flexible Bias Voltage and Current
- Internally Matched to 50 Ω

Applications

- Linear Driver Amp for High PAR waveforms such as LTE and WCDMA
- Small Cells and Cellular Repeaters
- General Purpose Linear Amplifier
- Saturated, Broadband Driver Amplifier

Product Description

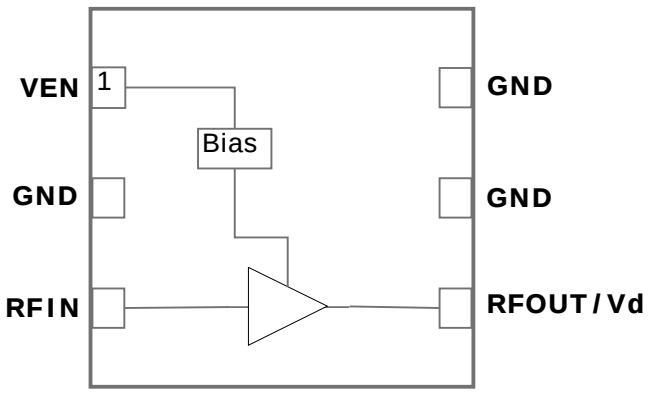
The GRF2013 is a broadband gain block with low noise figure and industry leading linearity designed for small cell, wireless infrastructure and other high performance applications. It exhibits outstanding broadband NF, linearity and return losses over 200 to 2700 MHz with a single match.

Configured as a linear driver or cascaded gain block, GRF2013 offers high levels of reuse both within a design and across platforms. The device is operated from a supply voltage of 2.7 to 8.0 V with a selectable Iddq range of 30 to 100 mA for optimal efficiency and linearity.

GRF2013 is internally matched to 50 Ω at the input and output ports, needing only external DC blocks and a bias choke on the output.

Consult with the GRF applications engineering team for custom tuning/evaluation board data and device s-parameters

Functional Block Diagram



Absolute Ratings

Parameter	Symbol	Min.	Max.	Unit
Drain Voltage	Vd	0	9.0	V
RF Input Power: (Load VSWR < 2:1; V_D: 5.0 volts)	$P_{IN\ MAX}$		+20	dBm
Operating Temperature (Package Heat Sink)	T_{AMB}	-40	+105	°C
Storage Temperature	T_{STG}	-40	+150	°C
Maximum Channel Temperature (MTTF > 10^6 Hours)	Tmax		+160	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		850	mW
Electrostatic Discharge:				
Charged Device Model: (TBD)	CDM	Class 4: 1000		V
Human Body Model: (TBD)	HBM	Class 1B: 500		V
Machine Model: (TBD)	MM	Class A: 50		V

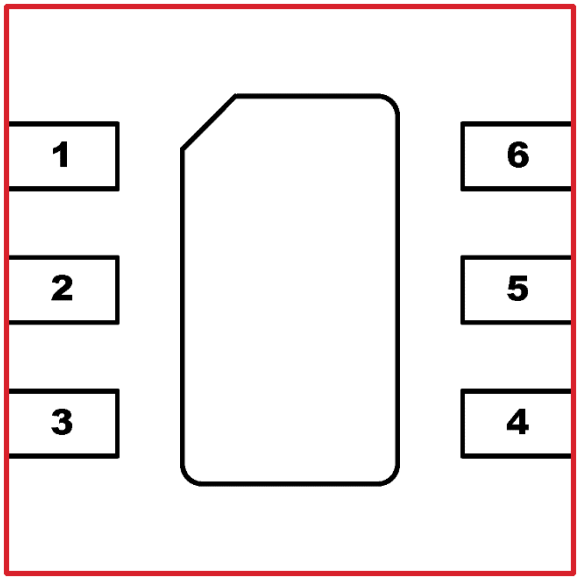
Caution! ESD Sensitive Device

Exceeding Absolute Maximum Rating conditions may cause permanent damage to the device.

Nominal Operating Parameters

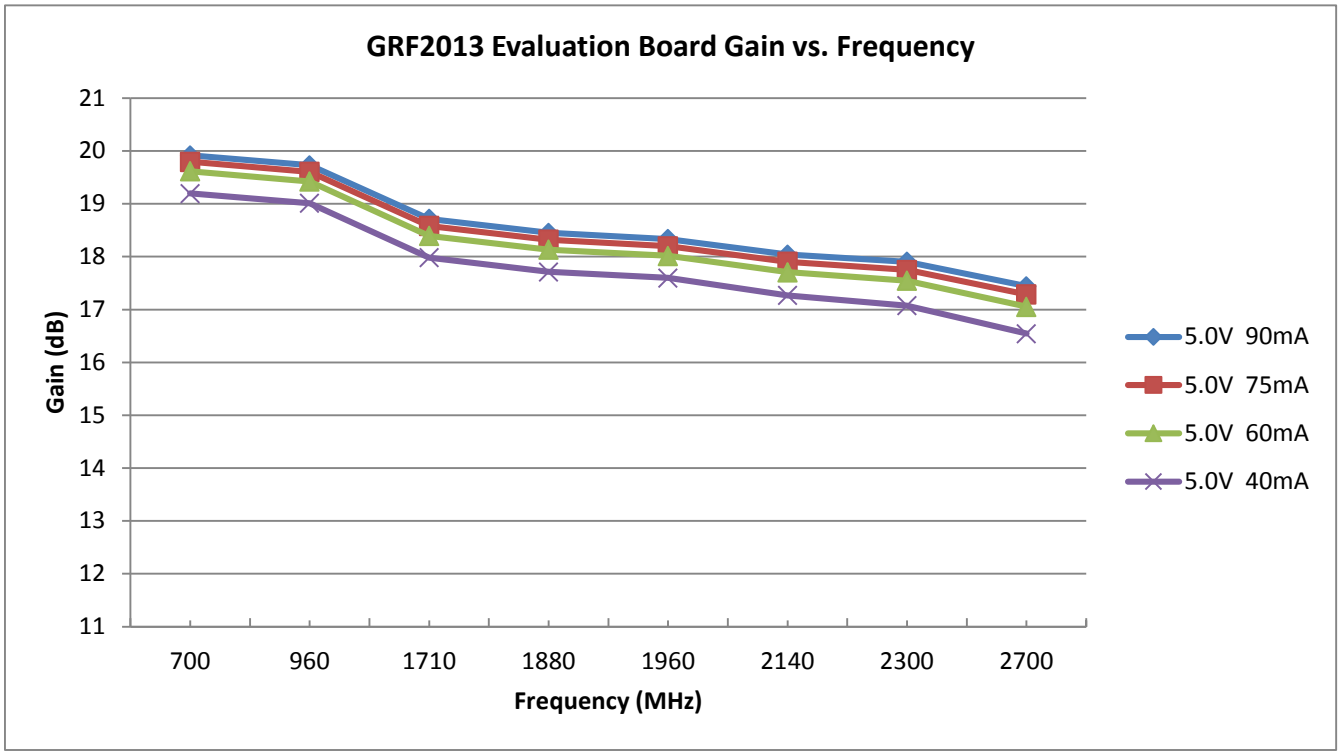
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain Mode (Venable high)						Vdd: 5.0 V, T_A = 25°C
Test Frequency	F_{TEST}		2500		MHz	
Gain	S21		17.5		dB	
Input Return Loss	S11		-15		dB	
Output Return Loss	S22		-11		dB	
Noise Figure	NF		2.4		dB	Input trace losses de-embedded
Output 3rd Order Intercept	OIP3		+38.8		dBm	+7.0 dBm P_{OUT} per tone at 2 MHz Spacing (2499 and 2501 MHz)
Output 1dB Compression Power	OP1dB		+22.5		dBm	
Switching Rise Time	T_{RISE}		300		ns	
Switching Fall Time	T_{FALL}		300		ns	
Supply Current	Idd		90		mA	Adjustable for optimal IP3
Enable Current	Ienable		2		mA	
Thermal Data						
Thermal Resistance (measured via IR scan)	Θjc		55		°C/W	On standard evaluation board
Channel Temperature @ +85 C Reference (Package Heat Sink)	Tchannel		+126		°C	Vd: 8.0 V; Iddq: 90 mA; No RF; Pdiss: 750 mW

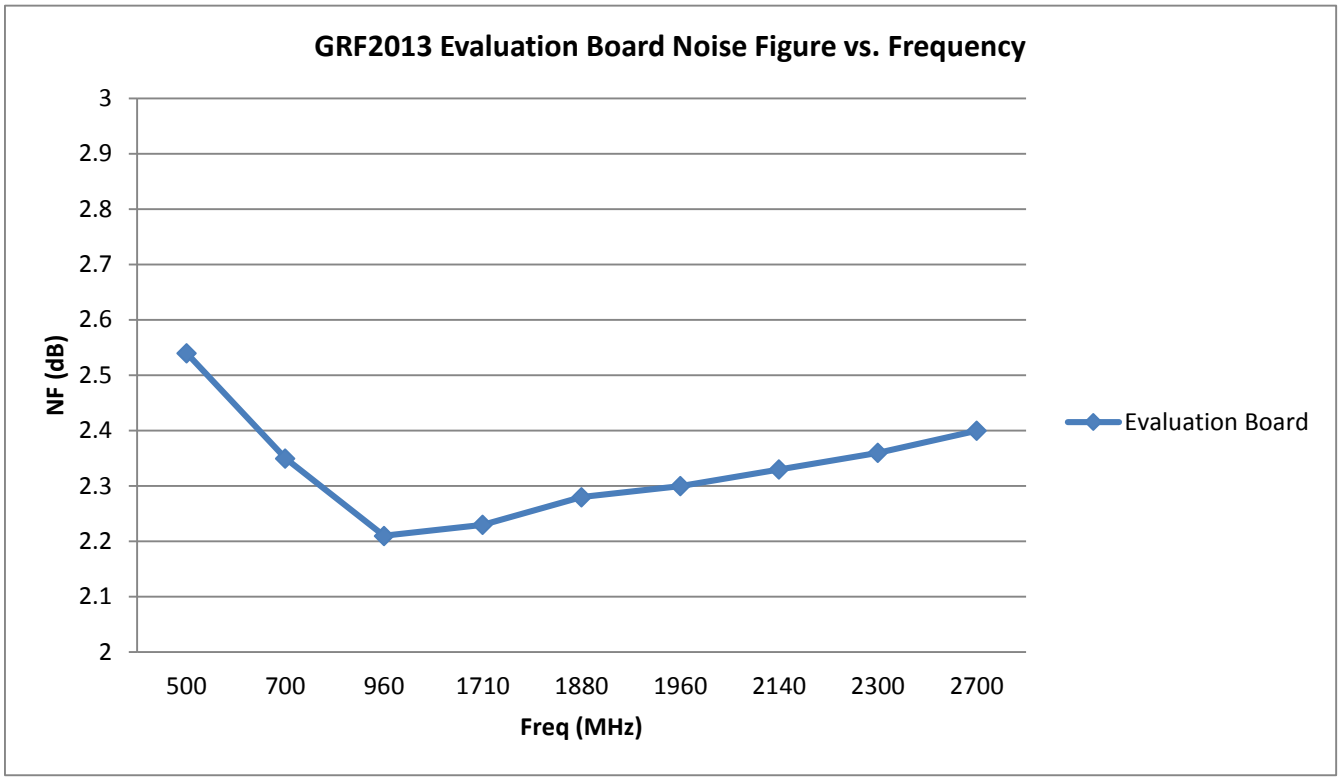
Pin Out (Top View)

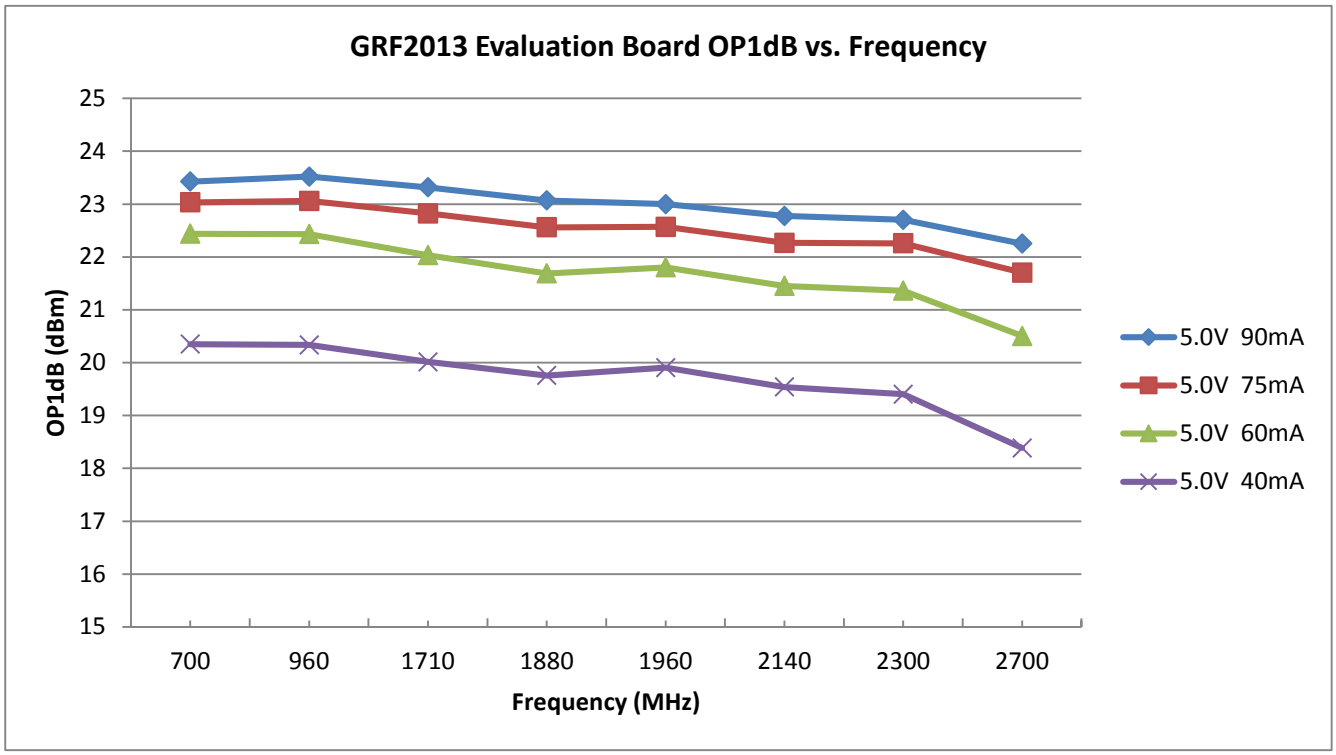


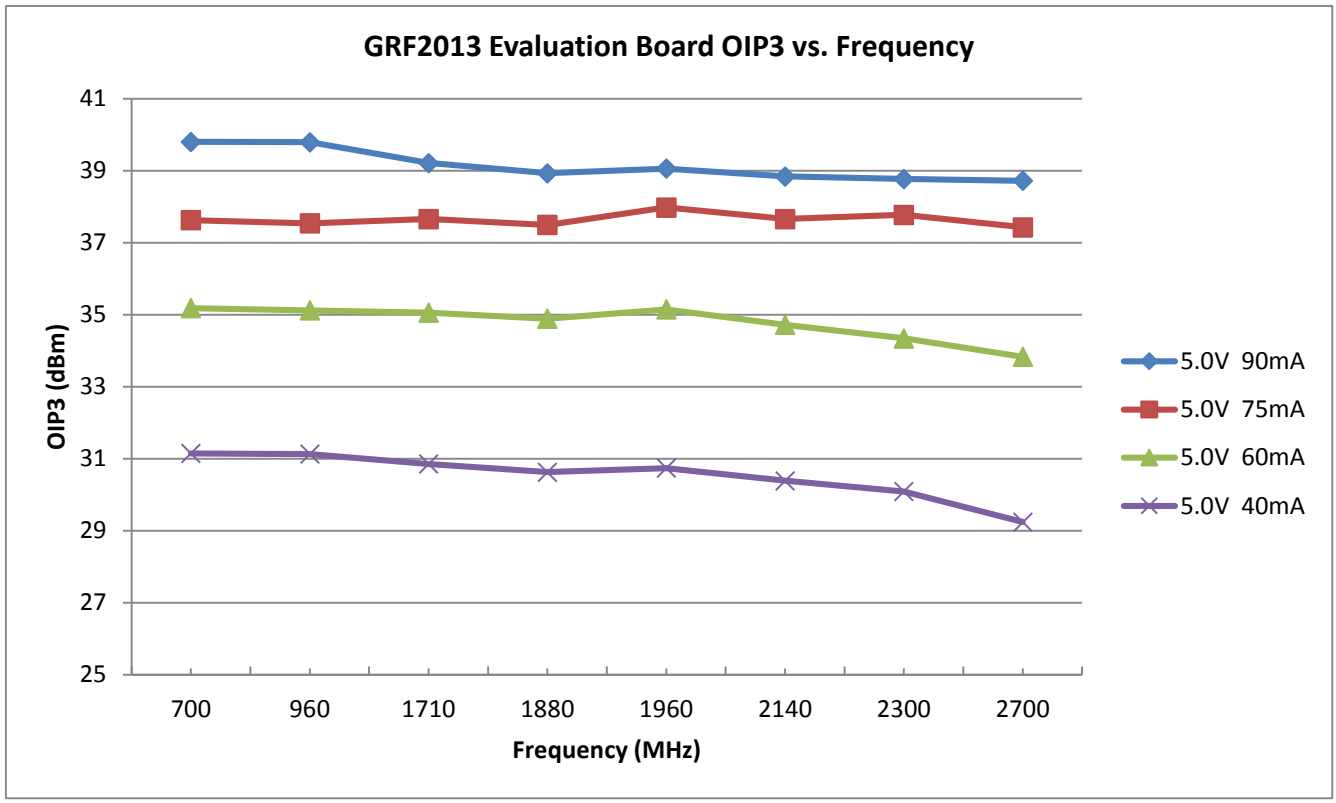
Pin Assignments

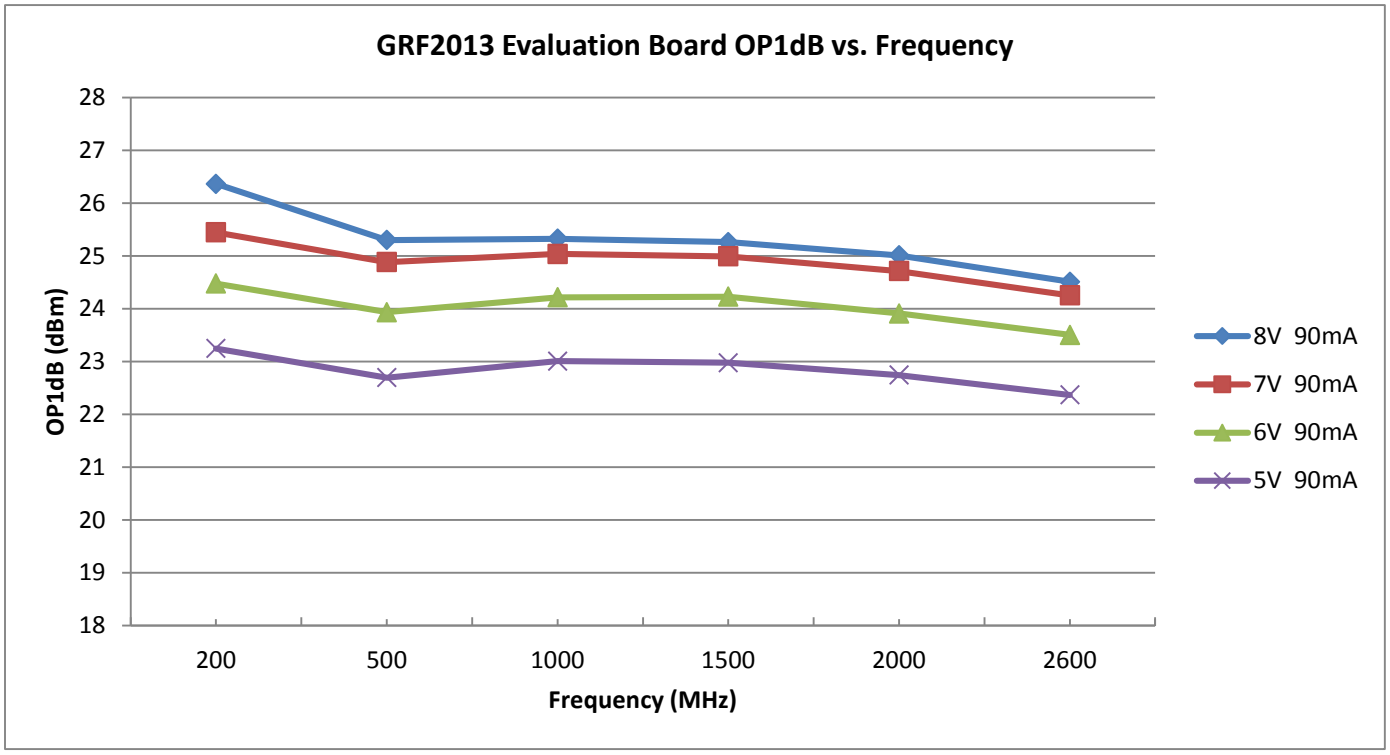
Pin	Name	Description	Note
1	V_{ENABLE}	Enable Voltage Input	Venable < 0.2 volts turns the device off. Venable and series resistor M3 control the device Iddq.
2	GND	Ground	Connect to ground for maximum RF performance.
3	RF_{IN}	LNA RF input	Internally matched 50 Ω. Requires external DC block.
4	RF_{OUT}	LNA RF output	Internally matched 50 Ω. V_{DD} must be applied through a choke to this pin.
5	GND	Ground	Connect to ground for maximum RF performance.
6	GND	Ground	Connect to ground for maximum RF performance.
PKG BASE	GND	Ground	Provides DC and RF ground for LNA, as well as thermal heat sink. Use multiple ground vias beneath the package for optimal RF and thermal performance.

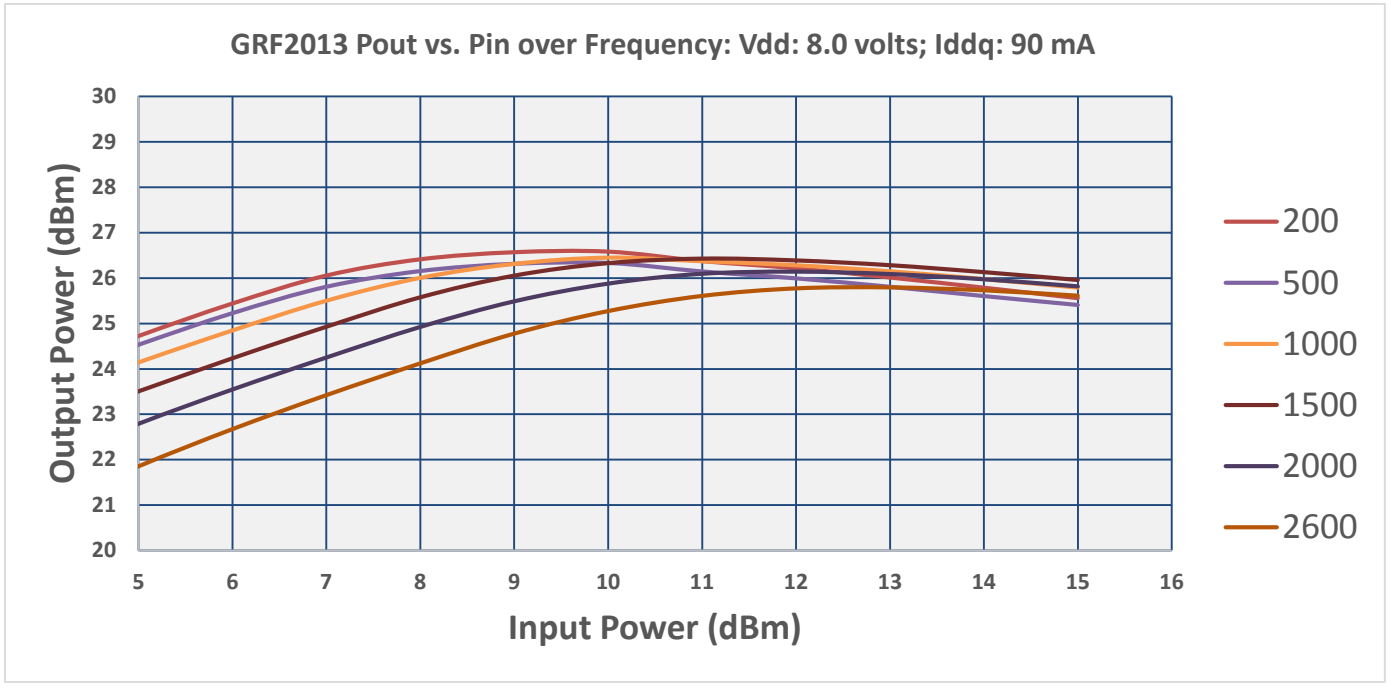

GRF2013 Evaluation Board Gain vs. Frequency
Gain (dB)
21
20
19
18
17
16
15
14
13
12
11
700
960
1710
1880
1960
2140
2300
2700
Frequency (MHz)
5.0V 90mA
5.0V 75mA
5.0V 60mA
5.0V 40mA


GRF2013 Evaluation Board Noise Figure vs. Frequency
NF (dB)
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
500
700
960
1710
1880
1960
2140
2300
2700
Freq (MHz)
Evaluation Board

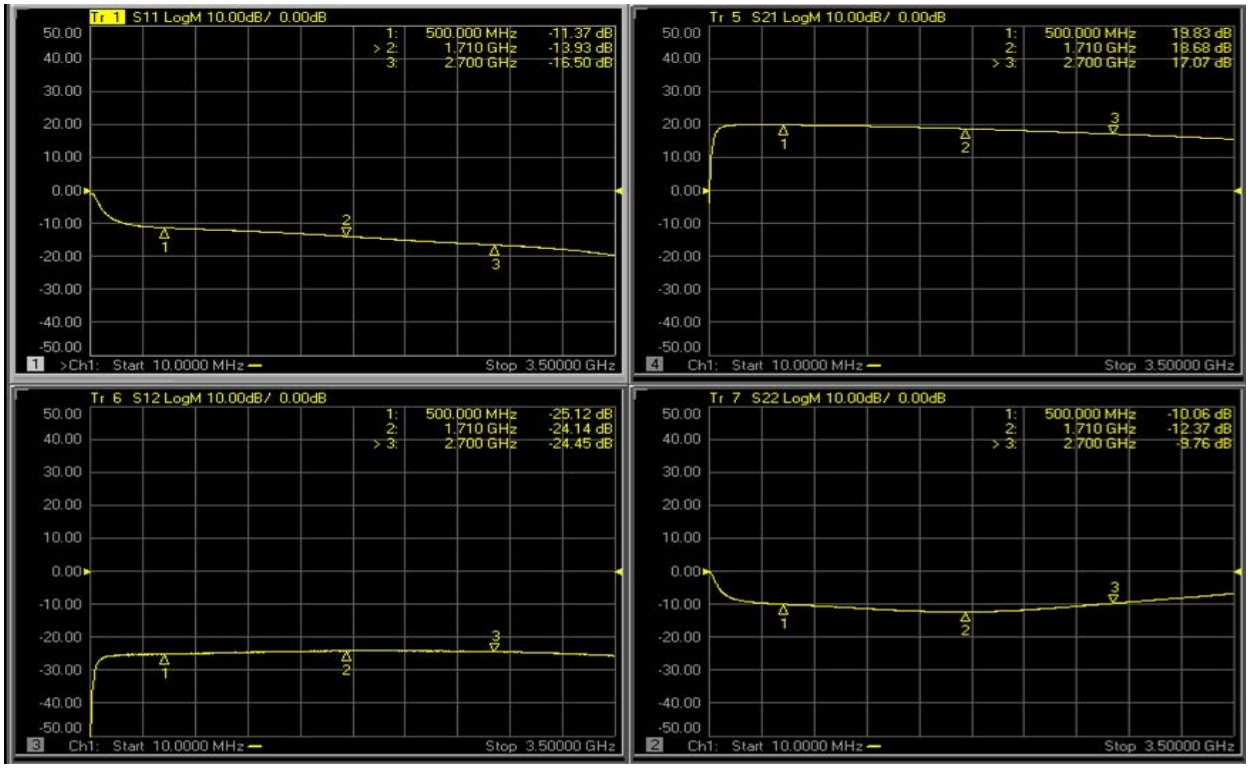

GRF2013 Evaluation Board OP1dB vs. Frequency
OP1dB (dBm)
25
24
23
22
21
20
19
18
17
16
15
700
960
1710
1880
1960
2140
2300
2700
Frequency (MHz)
5.0V 90mA
5.0V 75mA
5.0V 60mA
5.0V 40mA

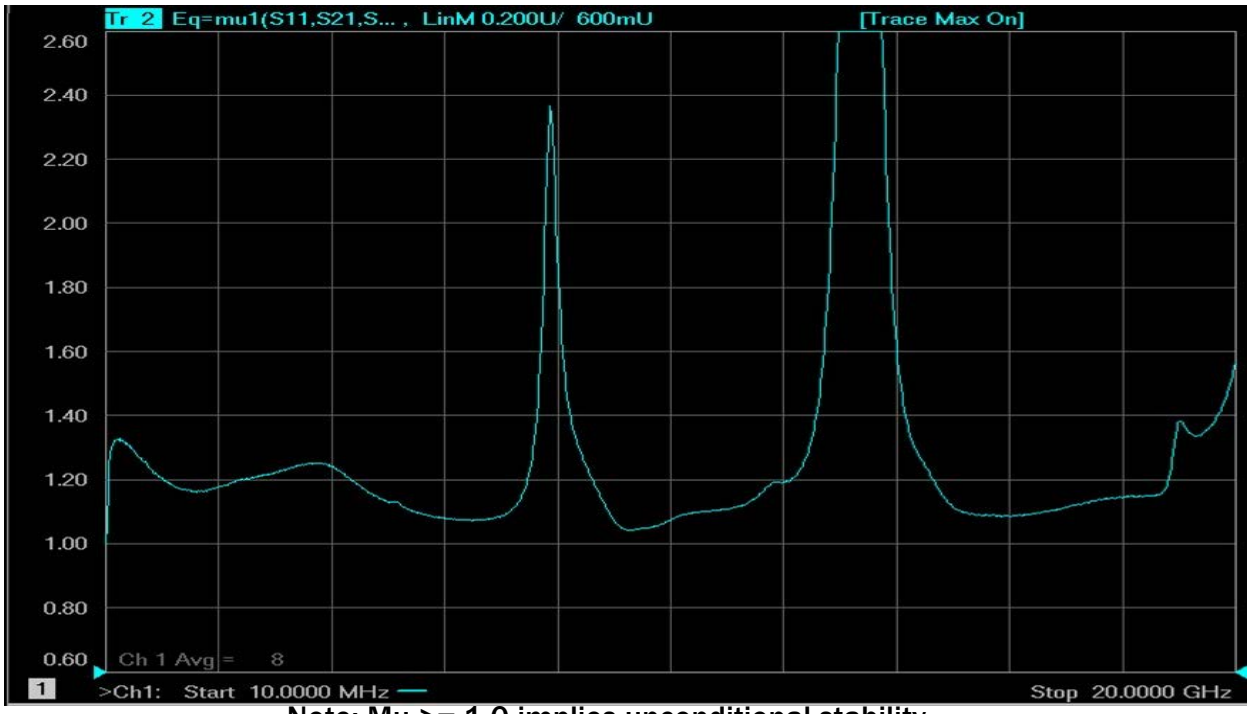

GRF2013 Evaluation Board OIP3 vs. Frequency
OIP3 (dBm)
41
39
37
35
33
31
29
27
25
700
960
1710
1880
1960
2140
2300
2700
Frequency (MHz)
5.0V 90mA
5.0V 75mA
5.0V 60mA
5.0V 40mA


GRF2013 Evaluation Board OP1dB vs. Frequency
OP1dB (dBm)
28
27
26
25
24
23
22
21
20
19
18
200
500
1000
1500
2000
2600
Frequency (MHz)
8V 90mA
7V 90mA
6V 90mA
5V 90mA


GRF2013 Pout vs. Pin over Frequency: Vdd: 8.0 volts; Iddq: 90 mA
Output Power (dBm)
30
29
28
27
26
25
24
23
22
21
20
5
6
7
8
9
10
11
12
13
14
15
16
Input Power (dBm)
200
500
1000
1500
2000
2600

GRF2013 Evaluation Board S-Parameters and Stability Mu Factor (500 - 2700 MHz Match)





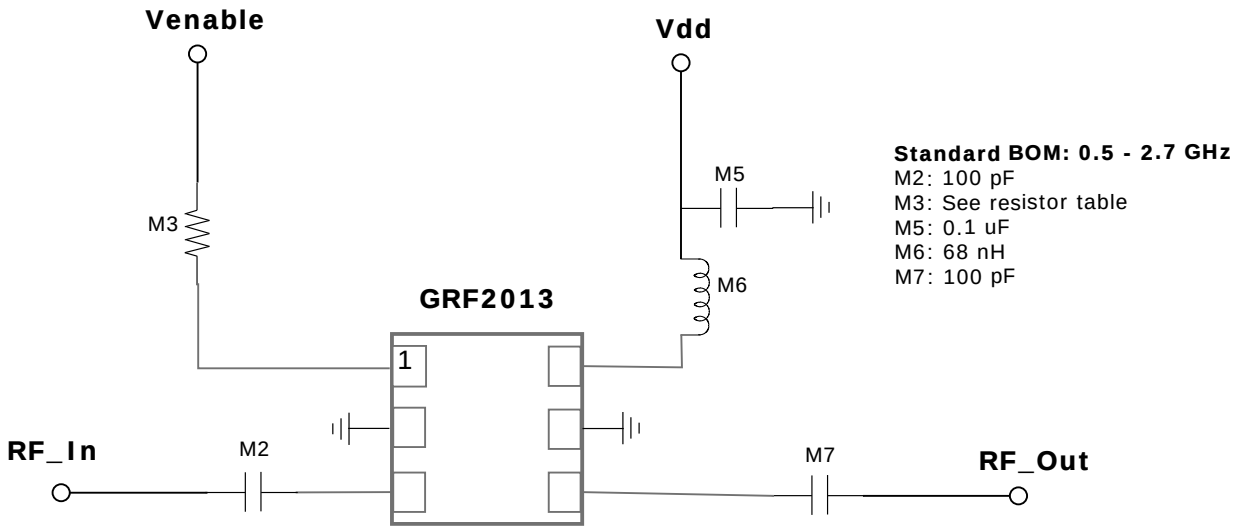
Note: Mu >= 1.0 implies unconditional stability

GRF2013 Theory of Operation:

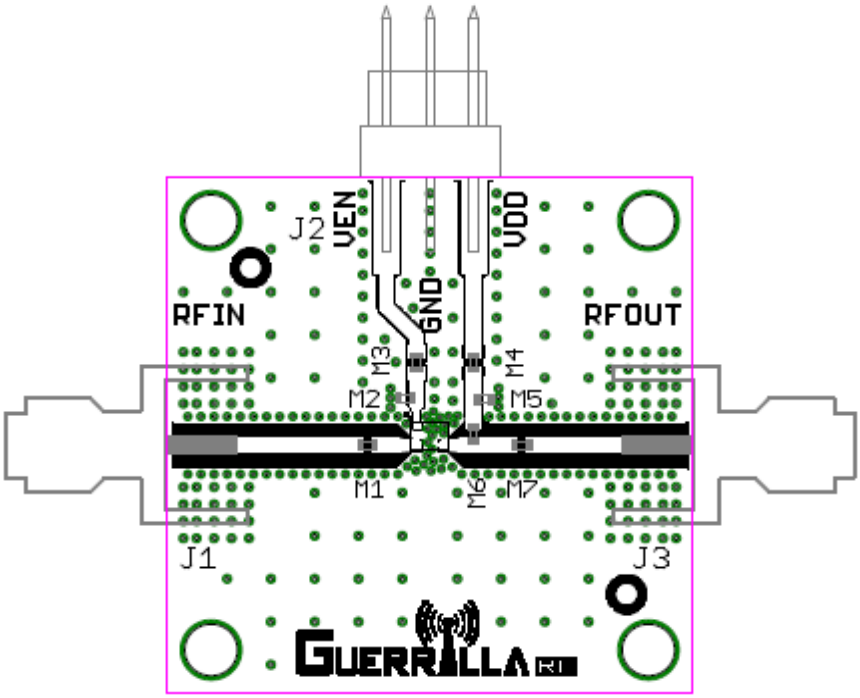
The GRF2013 is a high gain, ultra linear gain block that is suitable for a wide range of applications. The device is internally matched to 50 ohms and covers 200 - 2700 MHz with a single set of DC blocking caps (M1) and (M7) and bias inductor (M6).

The device Iddq can be set independently from the drain voltage Vdd via the resistor M3 in series with Venable. This allows the device Iddq to be optimized to meet a given linearity requirement with the highest possible efficiency. For a given Venable, increasing M3 will result in lower Iddq. As shown in the data sheet plots, GRF2013 exhibits excellent gain and linearity over a wide range of Vdd values from 2.7 V up to 8.0 V. The tables on the following page show bias resistor M3 values and resulting Iddq for a wide range of Venable and Vdd settings. The standard evaluation board is populated with a 350 Ohm resistor at M3 for evaluation purposes. With this resistor in place, the Venable voltage can be varied to achieve the desired Iddq to meet the target linearity requirements. The GRF applications team sees little performance benefit from GRF2013 Iddq values greater than 100 mA.

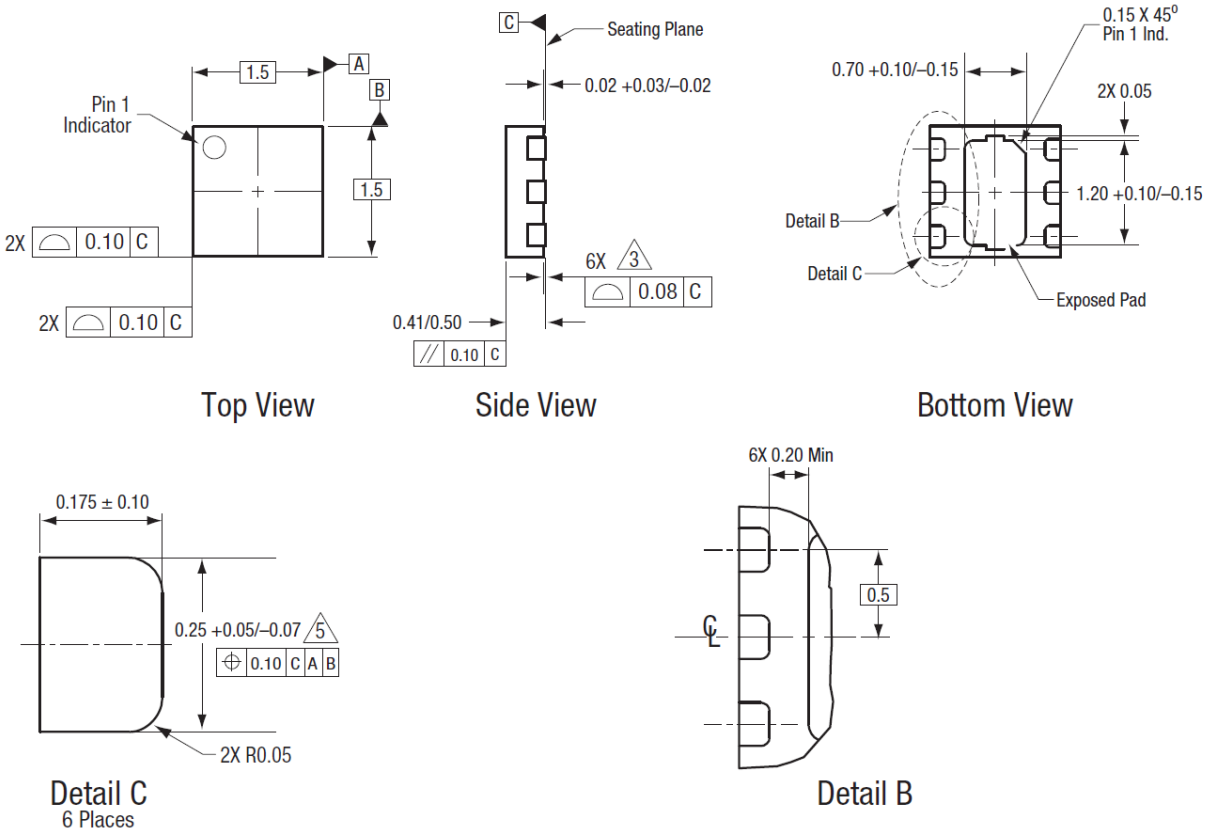
GRF2013 Bias Resistor vs. Iddq Table: (TBD)



GRF2013 Evaluation Board Application Schematic

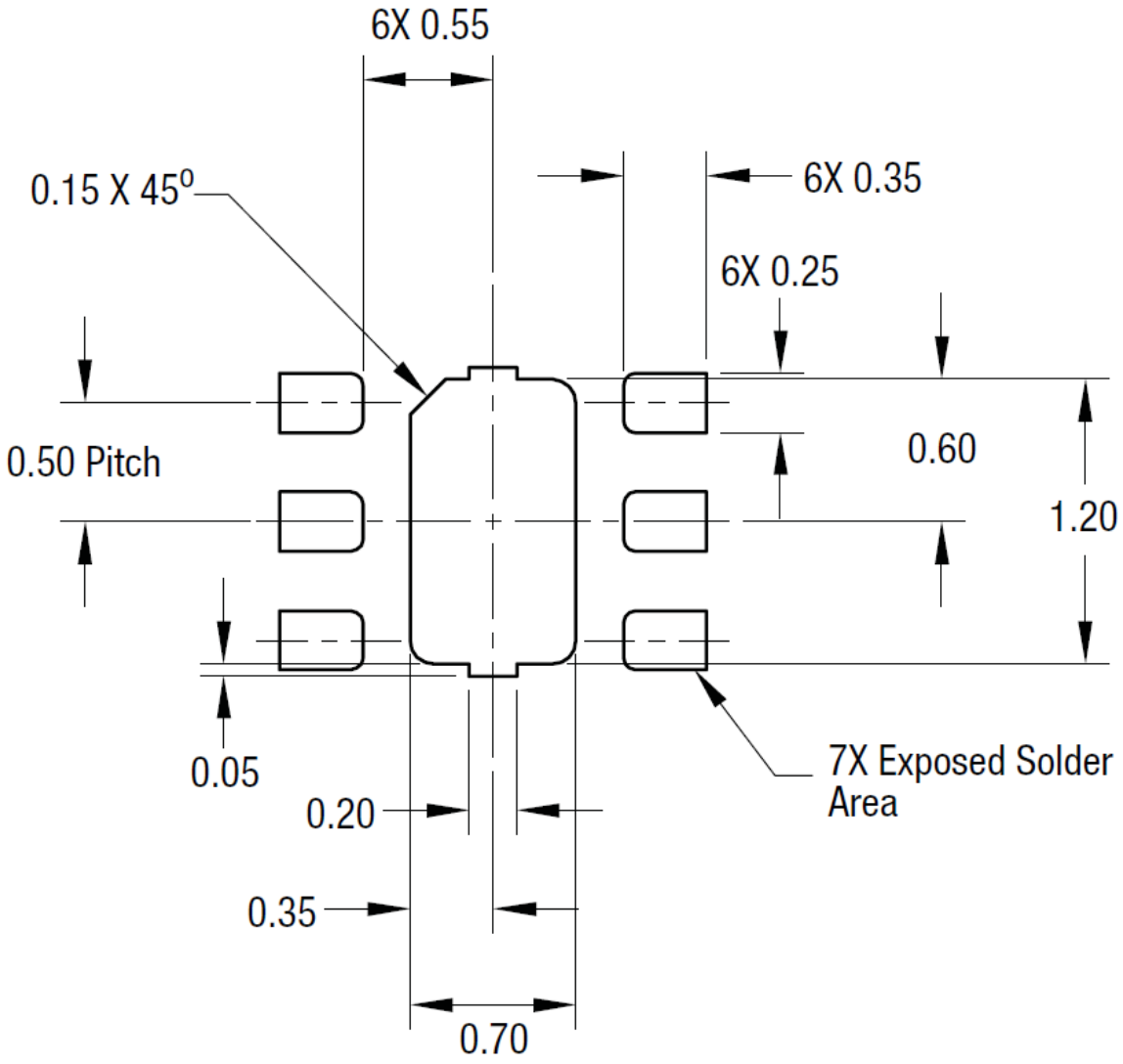


GRF2013 Evaluation Board Assembly Diagram



All measurements are in millimeters.
Dimensioning and tolerancing according to ASME Y14.5M-1994.
Coplanarity applies to the exposed heat sink slug as well as the terminals..
Plating requirement per source control drawing (SCD) 2504.
Dimension applies to metalized terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.

GRF2013 6-Pin DFN Package Dimensions



GRF2013 1.5 x 1.5 mm 6-Pin DFN PCB Layout Footprint

Data Sheet Release Status:	Notes
Advance	S-parameter and NF data based on EM simulations for the fully packaged device using foundry supplied transistor s-parameters. Linearity estimates based on device size, bias condition and experience with related devices.
Preliminary	All data based on evaluation board measurements in the Guerrilla RF Applications Lab.
Released	All data based on device qualification data. Typically, this data is nearly identical to the data found in the preliminary version. Max and min values for key RF parameters are included.