GRF2505

Preliminary

Linear PA Driver/Ultra-low Noise Amplifier; 4.0 - 6.0 GHz

Package: 6-Pin DFN

Features

- Broadband: 4.0 GHz to 6.0 GHz
- 0.80 dB Noise Figure at 5.5 GHz
- 13.2 dB gain, +33 dBm OIP3 and +20.5 dBm OP1dB at 5.5 GHz (5V/50 mA)
- Flexible Bias Voltage: 1.8 V to 5.0 V
- Adjustable Bias Current
- Internally Matched to 50 Ω
- Unconditionally Stable

Applications

- PA Driver for 5 GHz LTE Backhaul and 802.11a/n/ac
- Ultra-Low Noise Amplifier for 4 – 6 GHz Wireless Backhaul and 802.11a/n/ac
- Vehicle Information Systems
- Automated Toll Reader
- Low Voltage Transceivers

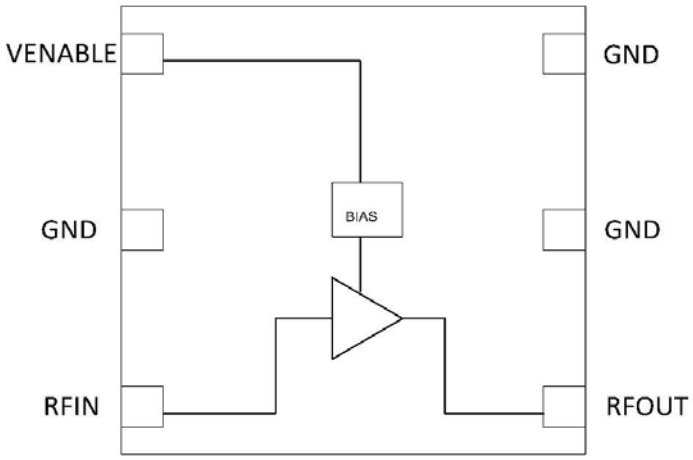
Product Description

The GRF2505 is a broadband, ultra-low noise, linear amplifier offering the highest levels of performance for demanding 802.11ac and wireless backhaul LNA and PA driver applications. This amplifier exhibits outstanding broadband NF, linearity and return losses over 4.0 to 6.0 GHz with a single match. It is operated from a single positive supply of 1.8 V to 5.0 V with a selectable Iddq range of 20 to 70 mA for optimal efficiency and linearity.

GRF2505 is housed in a 1.5 x 1.5 x 0.5 mm 6-pin plastic DFN package and is internally matched to 50 Ω at the input and output ports, requiring only 6 external RLC components.

Functional Block Diagram

1.5mm X 1.5mm 6-Pin DFN Package



Absolute Ratings

Parameter	Symbol	Min.	Max.	Unit
Drain Voltage	Vd	0	6.0	V
RF Input Power: (Load VSWR < 2:1; Vd: 5.0 volts)	$P_{IN\ MAX}$		+15	dBm
Operating Temperature	T_{AMB}	-40	+105	°C
Storage Temperature	T_{STG}	-40	+150	°C
Maximum Channel Temperature	T_{MAX}		+160	°C
Maximum Disspated Power (Note: De-rate 5 mW/°C for T_{AMB} > +85C.	$P_{DISS\ MAX}$		300	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

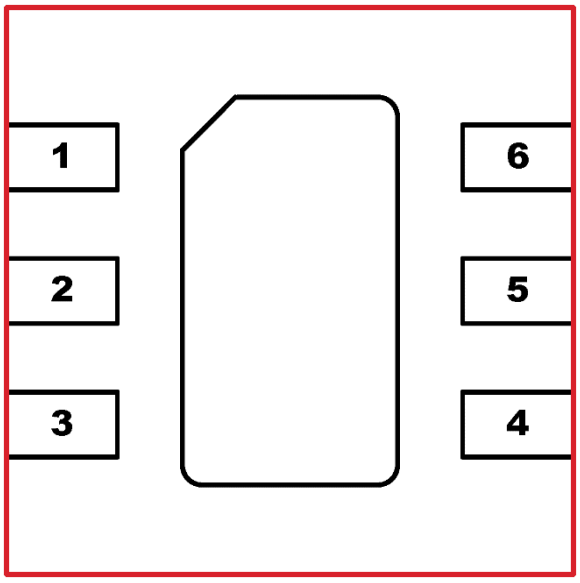
Caution! ESD Sensitive Device

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

Nominal Operating Parameters

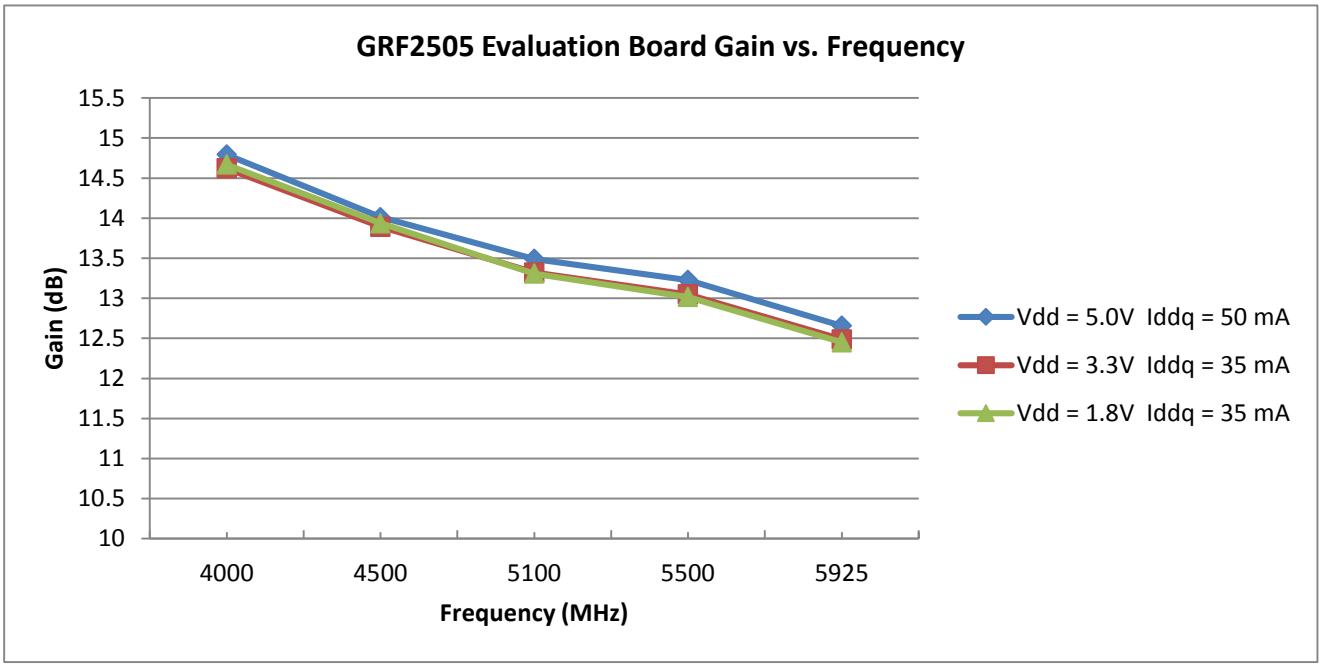
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain Mode (Venable high)						Vd = 5.0 V, T_A = 25°C
Test Frequency	F_{TEST}		5.5		GHz	
Gain	S21		13.2		dB	
Input Return Loss	S11		-15		dB	
Output Return Loss	S22		-20		dB	
Noise Figure	NF		0.80		dB	Input trace losses de-embedded
Output 3rd Order Intercept	OIP3		+33		dBm	
Output 1dB Compression Power	OP1dB		+20.5		dBm	
Switching Rise Time	T_{RISE}		300		ns	No added capacitance on Venable line (M2 not needed)
Switching Fall Time	T_{FALL}		300		ns	No added capacitance on Venable line (M2 not needed)
Supply Current	I_{DD}		50		mA	Adjustable for optimal IP3
Thermal Data						
Thermal Resistance: (Infra-Red Scan)	Θjc		225		°C/W	On standard Evaluation Board
Channel Temperature @ +85 C Reference (Package heat sink)	Tchannel		+141		°C	Vdd: 5.0 V; Iddq: 50 mA; No RF; Pdiss: 250 mW

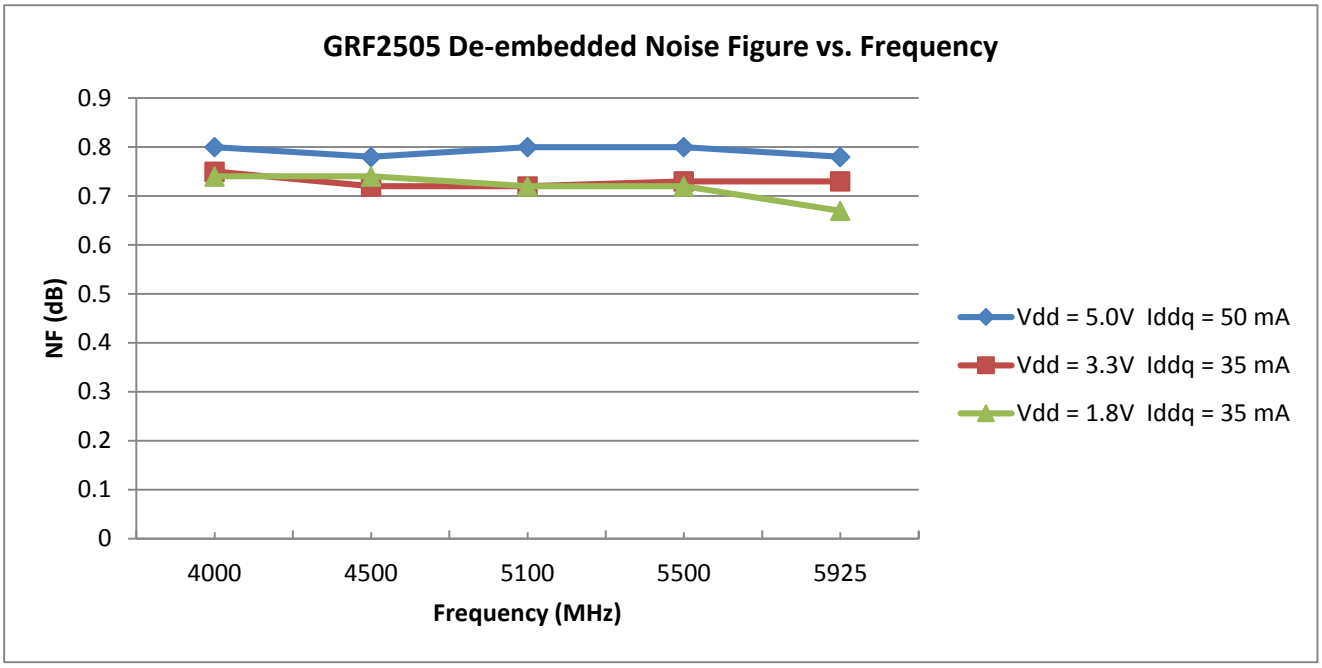
Pin Out (Top View)

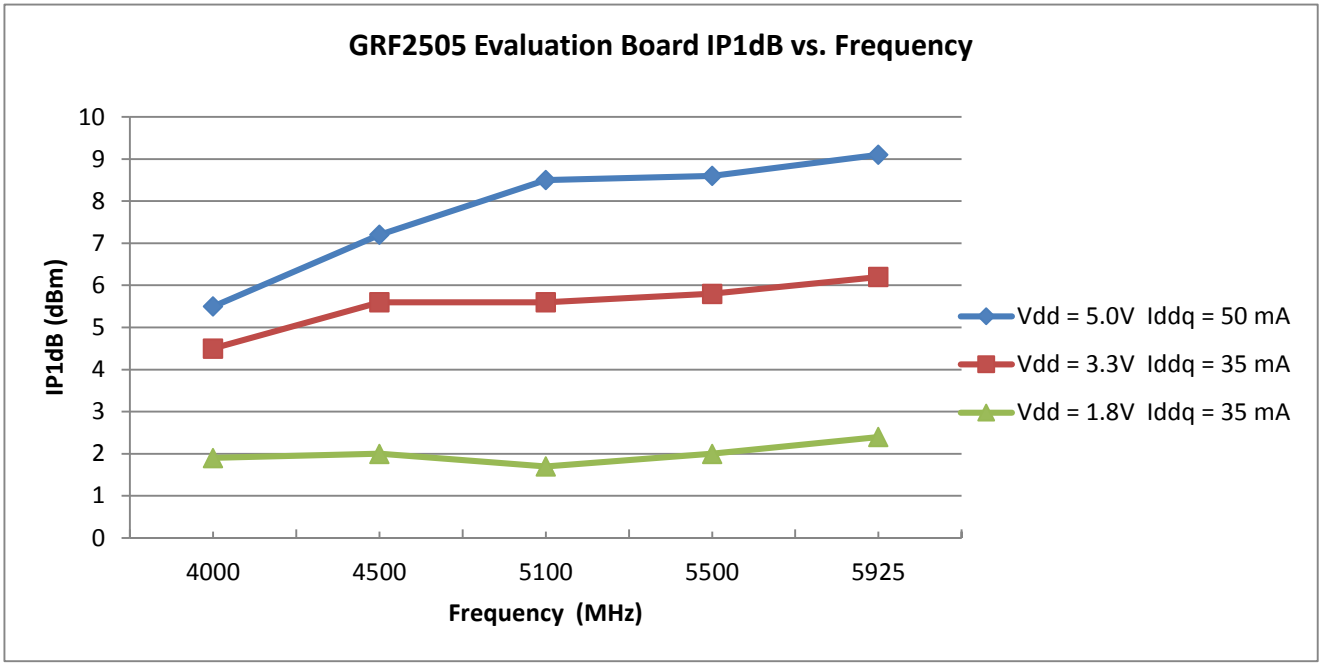


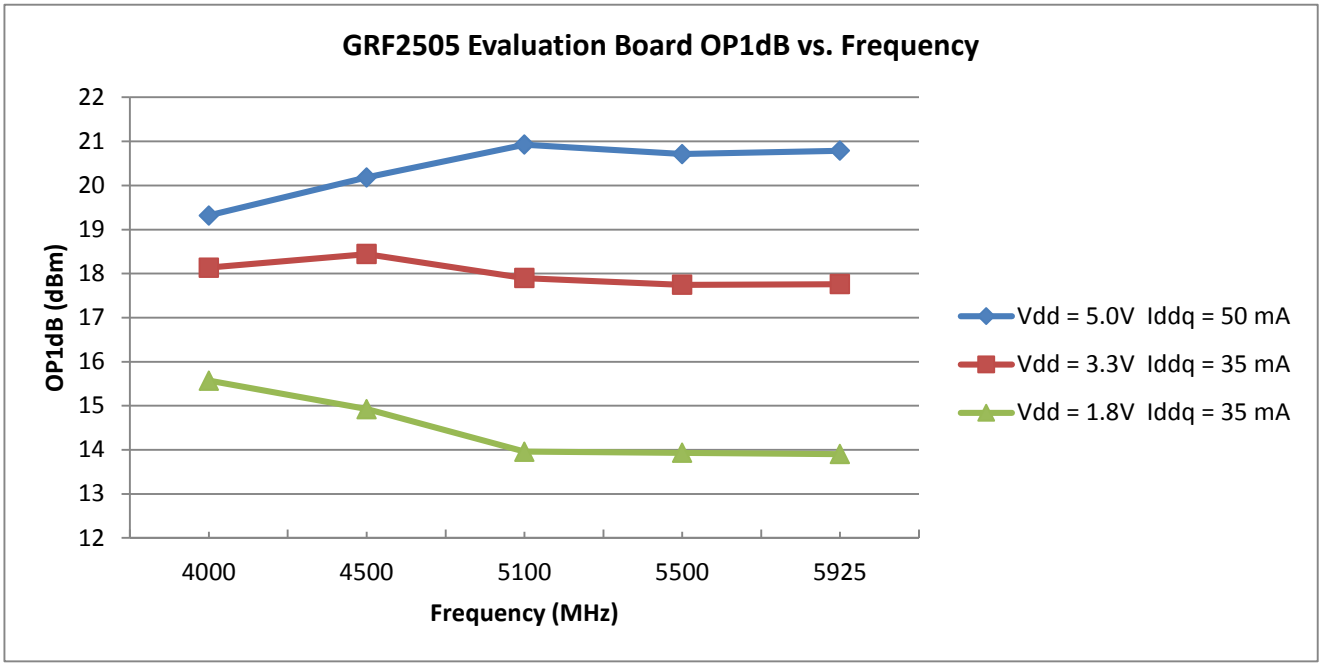
Pin Assignments

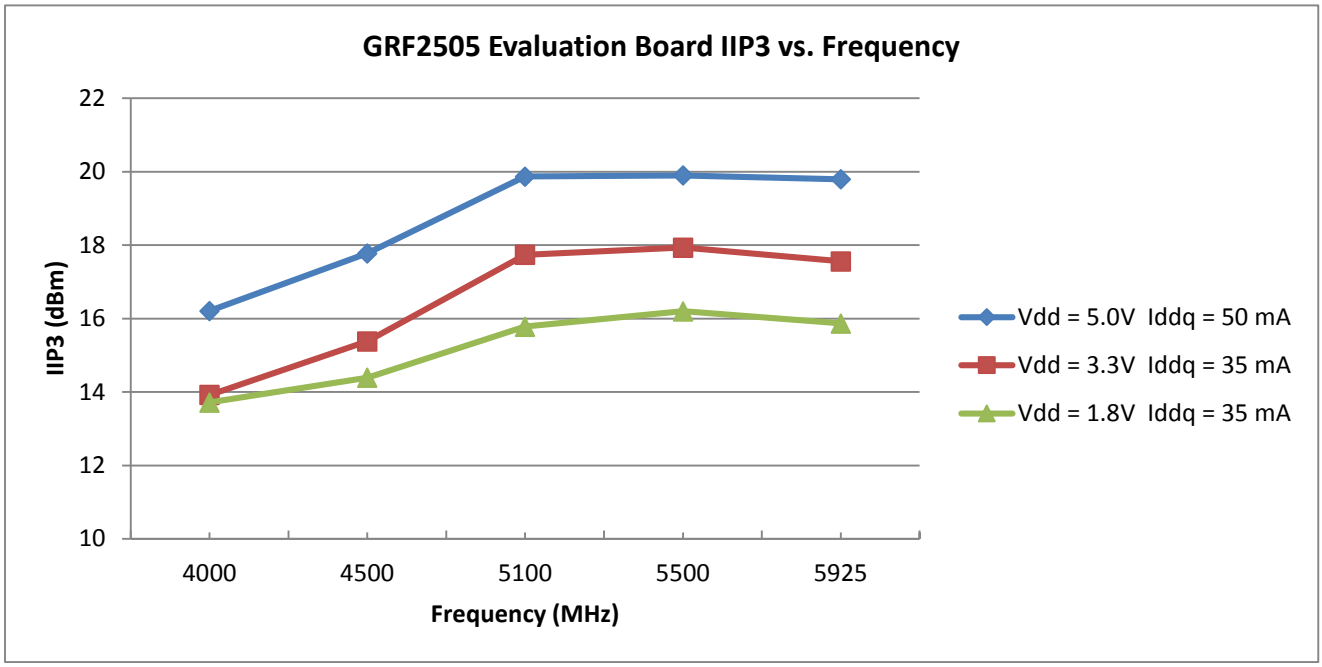
Pin	Name	Description	Note
1	**Venable**	Enable Voltage	Venable < 0.2 volts turns the device off. Venable and series resistor M3 control the device Iddq.
2	**GND**	Ground	Connect to ground for maximum RF performance
3	**RF_In**	LNA RF input	Internally matched 50Ω.
4	**RF_Out**	LNA RF output	Internally matched 50Ω. 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

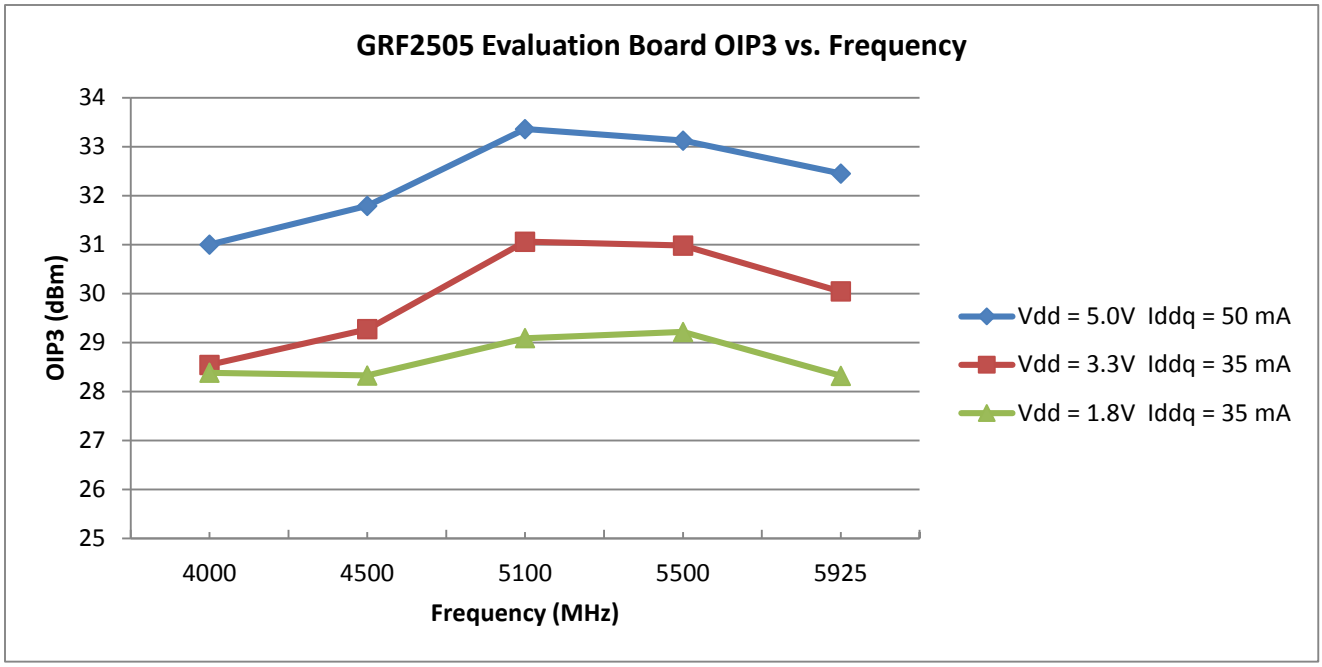

GRF2505 Evaluation Board Gain vs. Frequency
Gain (dB)
15.5
15
14.5
14
13.5
13
12.5
12
11.5
11
10.5
10
4000
4500
5100
5500
5925
Frequency (MHz)
Vdd = 5.0V Iddq = 50 mA
Vdd = 3.3V Iddq = 35 mA
Vdd = 1.8V Iddq = 35 mA

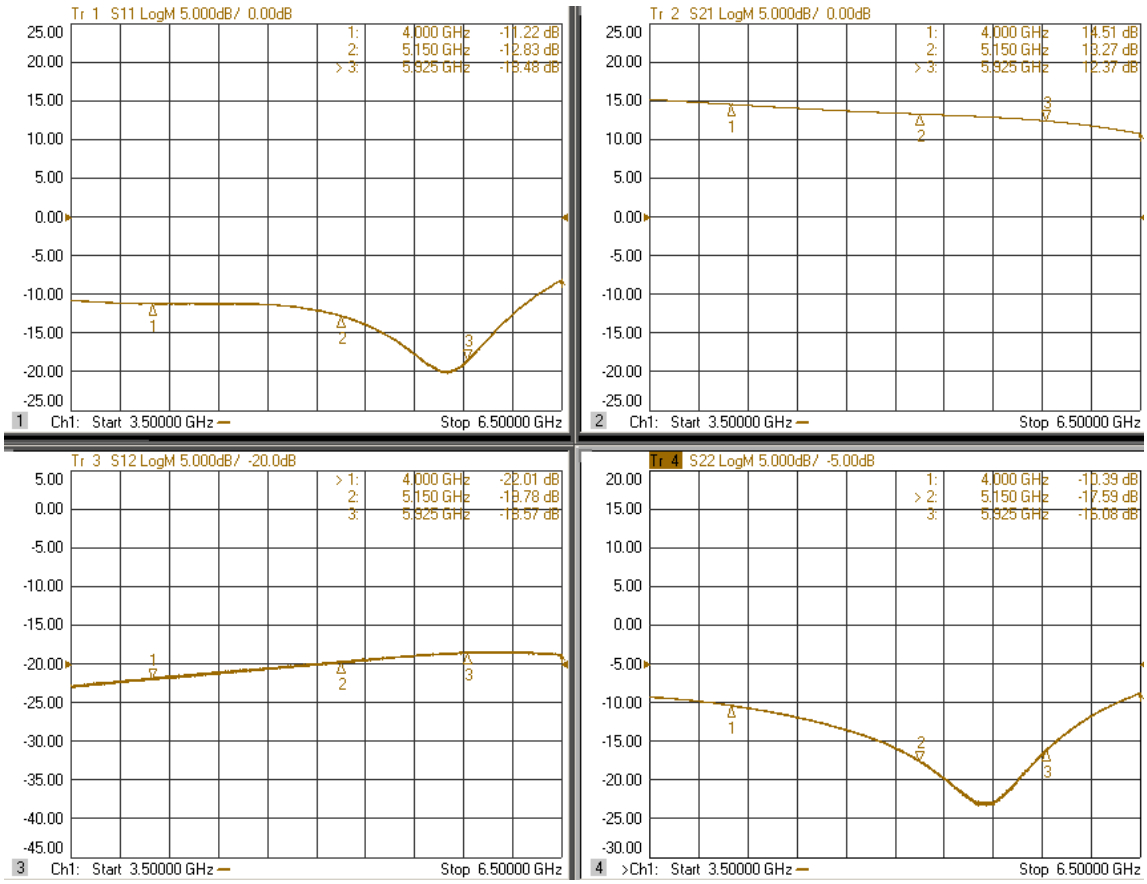

GRF2505 De-embedded Noise Figure vs. Frequency
NF (dB)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4000
4500
5100
5500
5925
Frequency (MHz)
Vdd = 5.0V Iddq = 50 mA
Vdd = 3.3V Iddq = 35 mA
Vdd = 1.8V Iddq = 35 mA


GRF2505 Evaluation Board IP1dB vs. Frequency
IP1dB (dBm)
10
9
8
7
6
5
4
3
2
1
0
4000
4500
5100
5500
5925
Frequency (MHz)
Vdd = 5.0V Iddq = 50 mA
Vdd = 3.3V Iddq = 35 mA
Vdd = 1.8V Iddq = 35 mA

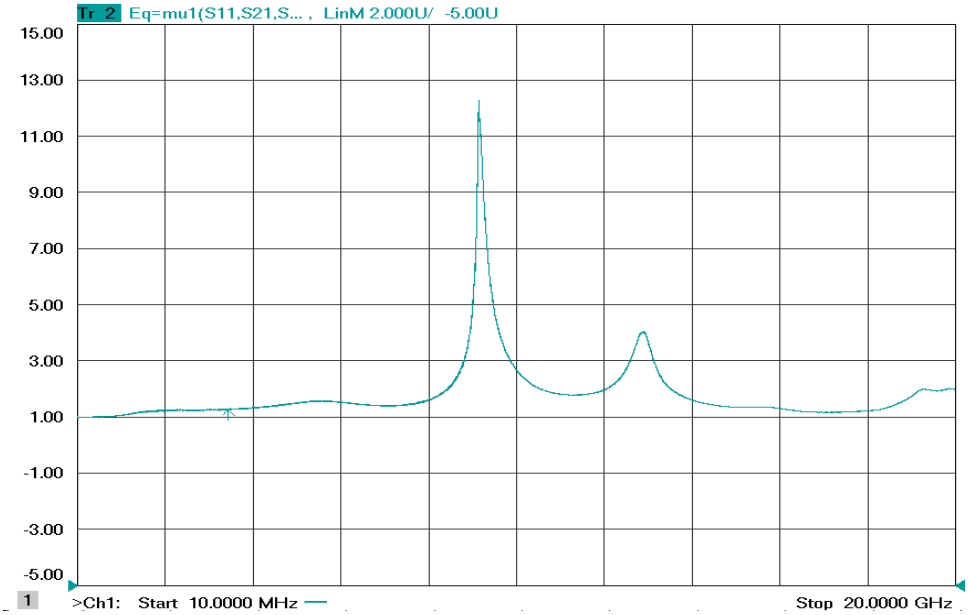

GRF2505 Evaluation Board OP1dB vs. Frequency
OP1dB (dBm)
22
21
20
19
18
17
16
15
14
13
12
4000
4500
5100
5500
5925
Frequency (MHz)
Vdd = 5.0V Iddq = 50 mA
Vdd = 3.3V Iddq = 35 mA
Vdd = 1.8V Iddq = 35 mA


GRF2505 Evaluation Board IIP3 vs. Frequency
IIP3 (dBm)
22
20
18
16
14
12
10
4000
4500
5100
5500
5925
Frequency (MHz)
Vdd = 5.0V Iddq = 50 mA
Vdd = 3.3V Iddq = 35 mA
Vdd = 1.8V Iddq = 35 mA


GRF2505 Evaluation Board OIP3 vs. Frequency
OIP3 (dBm)
34
33
32
31
30
29
28
27
26
25
4000
4500
5100
5500
5925
Frequency (MHz)
Vdd = 5.0V Iddq = 50 mA
Vdd = 3.3V Iddq = 35 mA
Vdd = 1.8V Iddq = 35 mA



GRF2505 Evaluation Board S-Parameters: 5.0 volts and 50 mA



GRF2505 Evaluation Board Stability Mu Factor

GRF2505 Theory of Operation:

The GRF2505 is a single-stage, high-performance, low noise linear amplifier that is suitable for a wide range of applications. The device is internally matched to 50 ohms and covers 4 to 6 GHz with a single set of DC blocking caps (M1 and M7) and bias inductor (M6).

The device Iddq can be set independently from the Vdd via the resistor M3 in series with Venable. This allows the device 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, GRF2505 exhibits excellent gain, NF and linearity over a wide range of Vdd values from 1.8 V up to 5.0 V.

The tables on the following page show bias resistor values for a wide range of Venable and Vdd settings. The GRF Applications Team sees no performance benefit from Iddq values greater than 70 mA.

GRF2505 Bias Resistor vs. Iddq Tables

Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2505	5	5	500	80
GRF2505	5	5	750	72
GRF2505	5	5	1000	65
GRF2505	5	5	1500	56
GRF2505	5	5	2000	49
GRF2505	5	5	2500	44
GRF2505	5	5	3000	40
GRF2505	5	5	4000	35
GRF2505	5	5	5000	31
GRF2505	5	5	6000	28
GRF2505	5	5	7000	25
GRF2505	5	5	10000	21

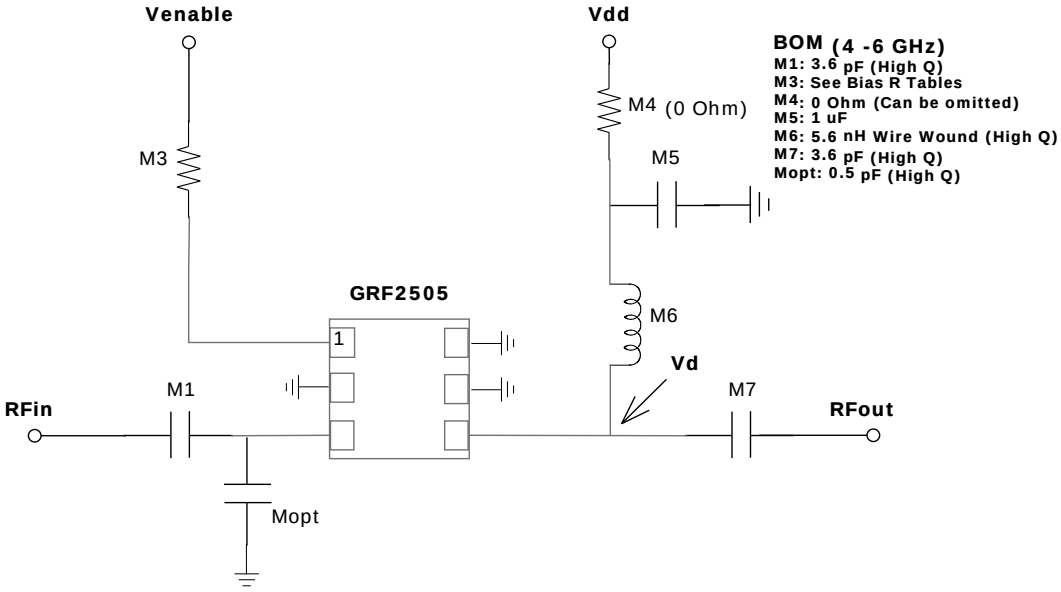
Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2505	4.5	4.5	300	80
GRF2505	4.5	4.5	400	76
GRF2505	4.5	4.5	500	72
GRF2505	4.5	4.5	750	64
GRF2505	4.5	4.5	1000	58
GRF2505	4.5	4.5	1500	50
GRF2505	4.5	4.5	2000	43
GRF2505	4.5	4.5	2500	39
GRF2505	4.5	4.5	3000	36
GRF2505	4.5	4.5	5000	27
GRF2505	4.5	4.5	6000	24
GRF2505	4.5	4.5	8000	20

Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2505	4.0	4.0	100	81
GRF2505	4.0	4.0	300	70
GRF2505	4.0	4.0	600	59
GRF2505	4.0	4.0	1000	50
GRF2505	4.0	4.0	1500	42
GRF2505	4.0	4.0	2000	36
GRF2505	4.0	4.0	2500	32
GRF2505	4.0	4.0	3000	29
GRF2505	4.0	4.0	3500	27
GRF2505	4.0	4.0	4500	23
GRF2505	4.0	4.0	6000	19

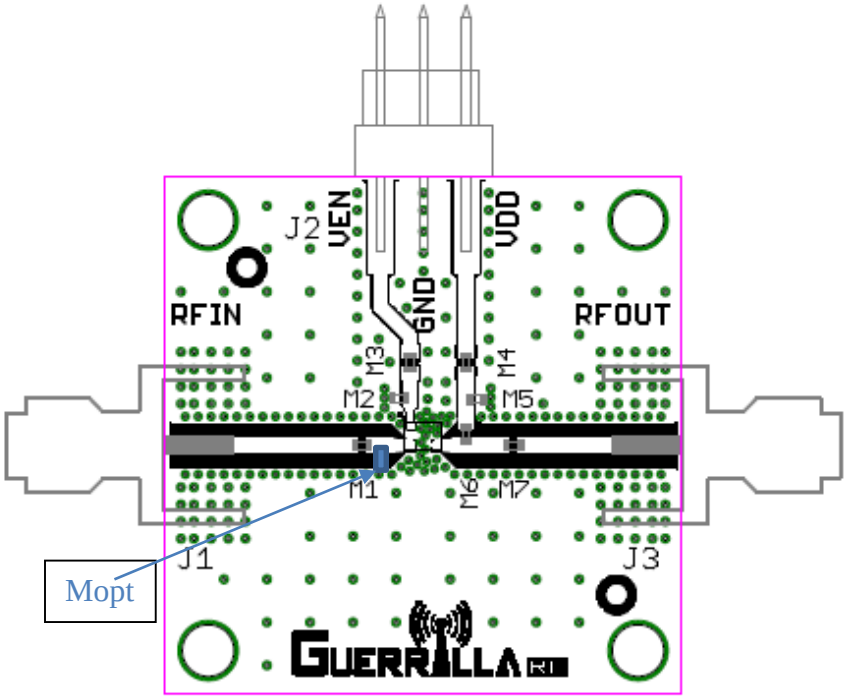
Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2505	3.3	3.3	0	74
GRF2505	3.3	3.3	100	68
GRF2505	3.3	3.3	200	63
GRF2505	3.3	3.3	300	59
GRF2505	3.3	3.3	500	53
GRF2505	3.3	3.3	750	46
GRF2505	3.3	3.3	1000	42
GRF2505	3.3	3.3	1500	35
GRF2505	3.3	3.3	2000	31
GRF2505	3.3	3.3	3000	25
GRF2505	3.3	3.3	4000	21

Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2505	3	3	0	67
GRF2505	3	3	100	61
GRF2505	3	3	200	57
GRF2505	3	3	300	53
GRF2505	3	3	500	47
GRF2505	3	3	750	42
GRF2505	3	3	1000	38
GRF2505	3	3	1500	32
GRF2505	3	3	2000	27
GRF2505	3	3	3000	22

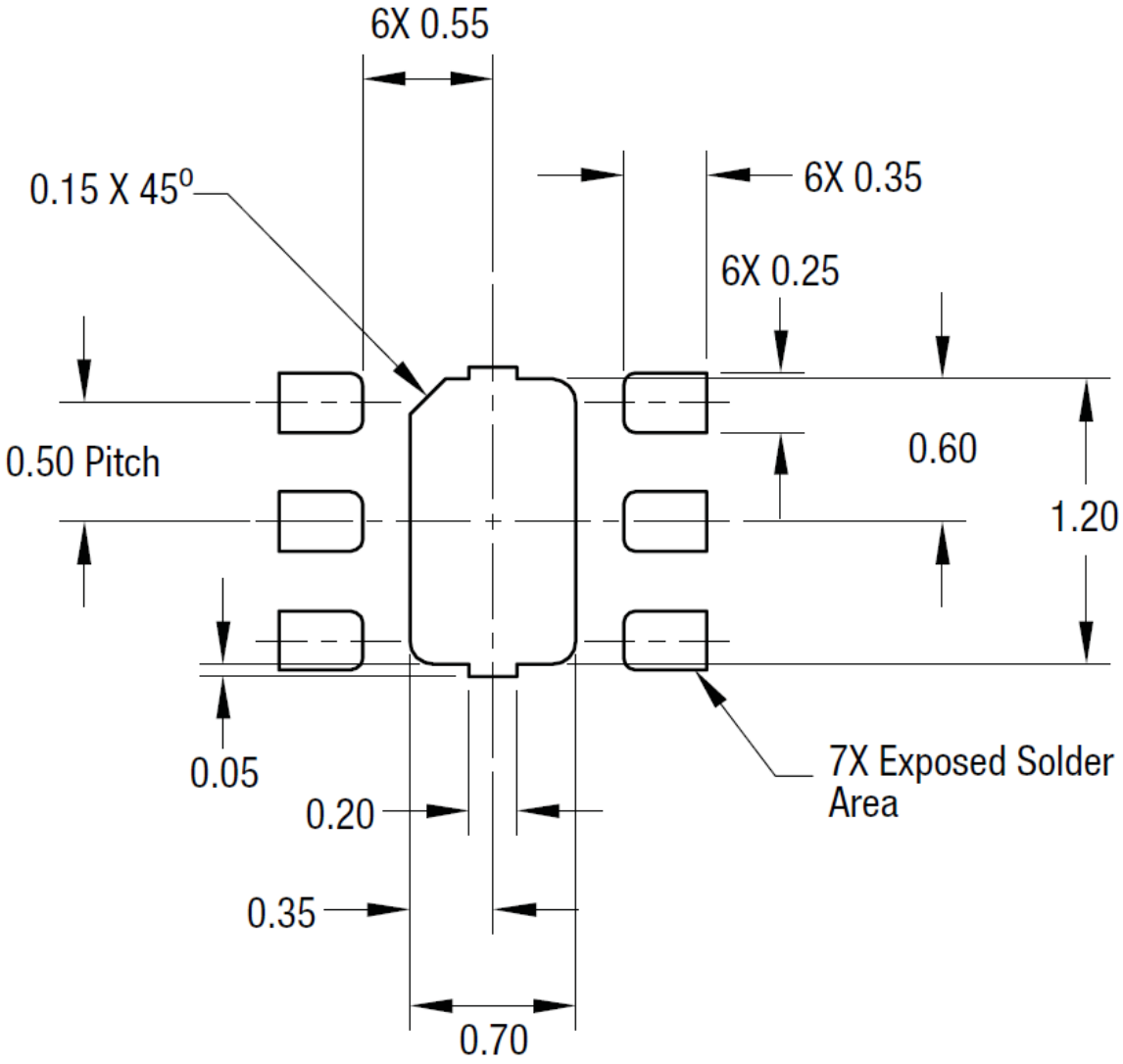
Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2505	1.8	1.8	0	35
GRF2505	1.8	1.8	100	32
GRF2505	1.8	1.8	200	30
GRF2505	1.8	1.8	400	26
GRF2505	1.8	1.8	600	23
GRF2505	1.8	1.8	900	20



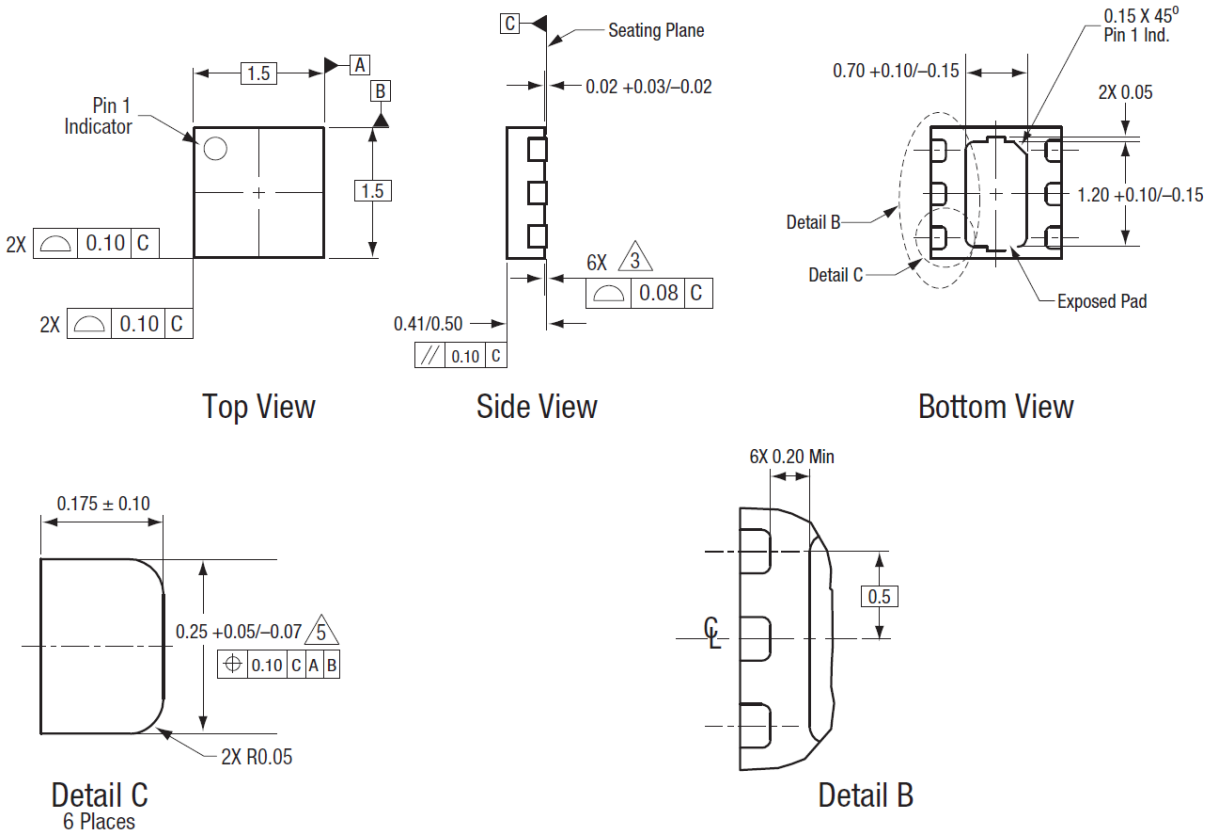
GRF2505 Evaluation Board Application Schematic



GRF2505 Evaluation Board Assembly Diagram



GRF2505 1.5 x 1.5mm 6-Pin DFN PCB Layout Footprint



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.

GRF2505 6-Pin DFN Package Dimensions

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.