



Preliminary

GRF2505

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

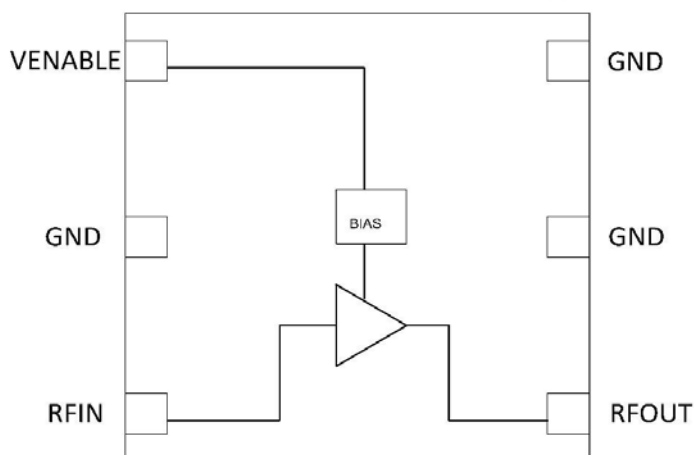
Product Description

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	V _d	0	6.0	V
RF Input Power: (Load VSWR < 2:1; V _d : 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 Dissipated 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



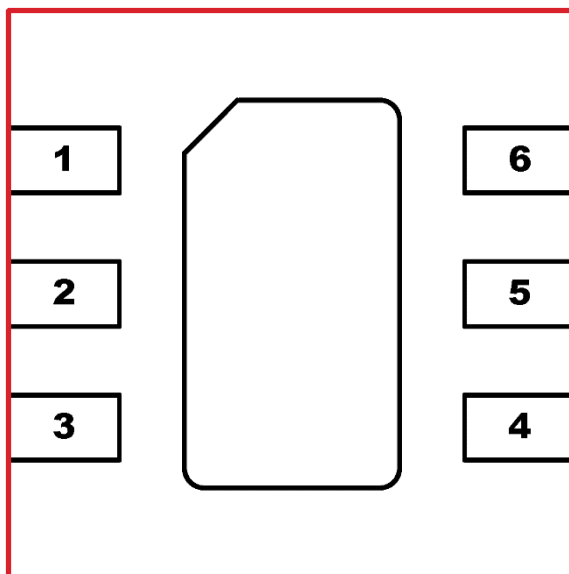
Caution! ESD Sensitive Device

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)						V _d = 5.0 V, T _A = 25 °C
Test Frequency	F _{TEST}		5.5		GHz	
Gain	S ₂₁		13.2		dB	
Input Return Loss	S ₁₁		-15		dB	
Output Return Loss	S ₂₂		-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)	Θ _{jc}		225		°C/W	On standard Evaluation Board
Channel Temperature @ +85 C Reference (Package heat sink)	T _{channel}		+141		°C	V _{dd} : 5.0 V; I _{ddq} : 50 mA; No RF; P _{diss} : 250 mW

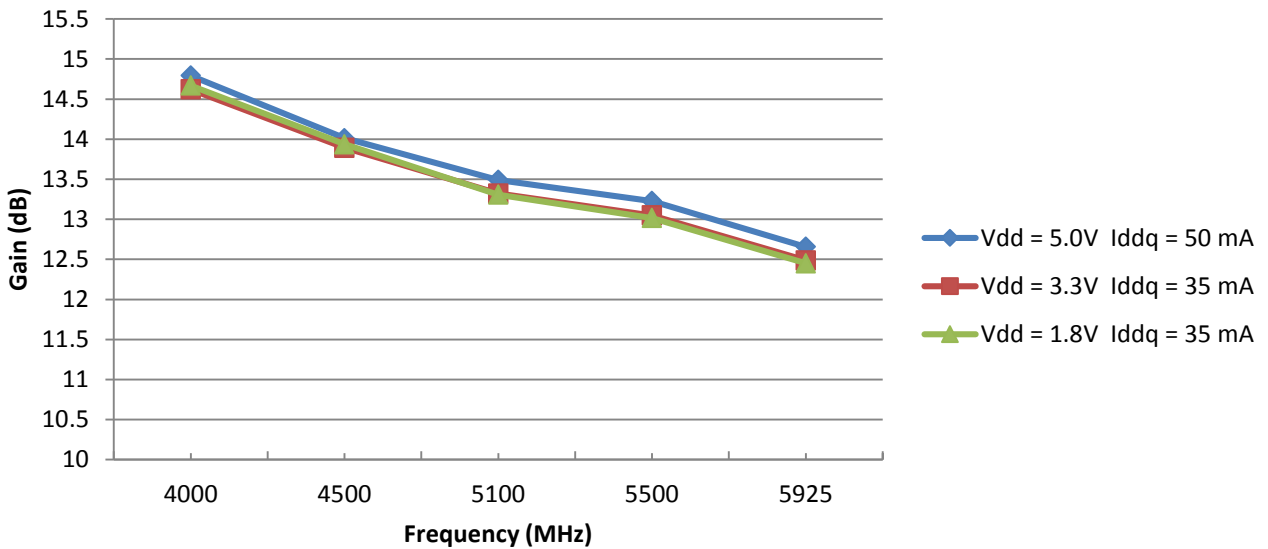
Pin Out (Top View)



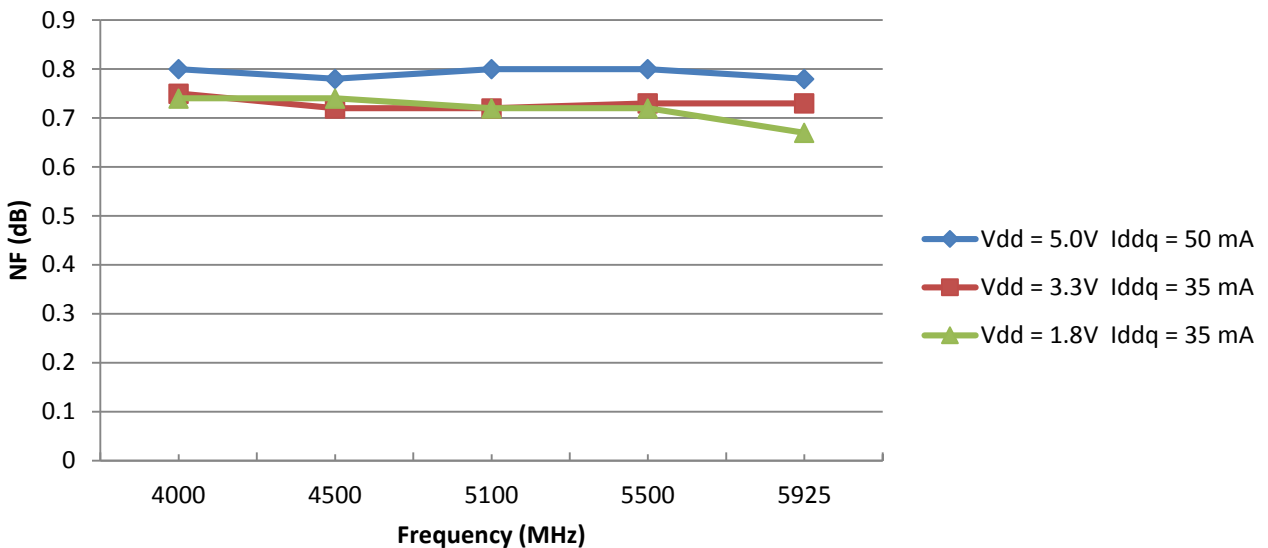
Pin Assignments

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. VDD 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

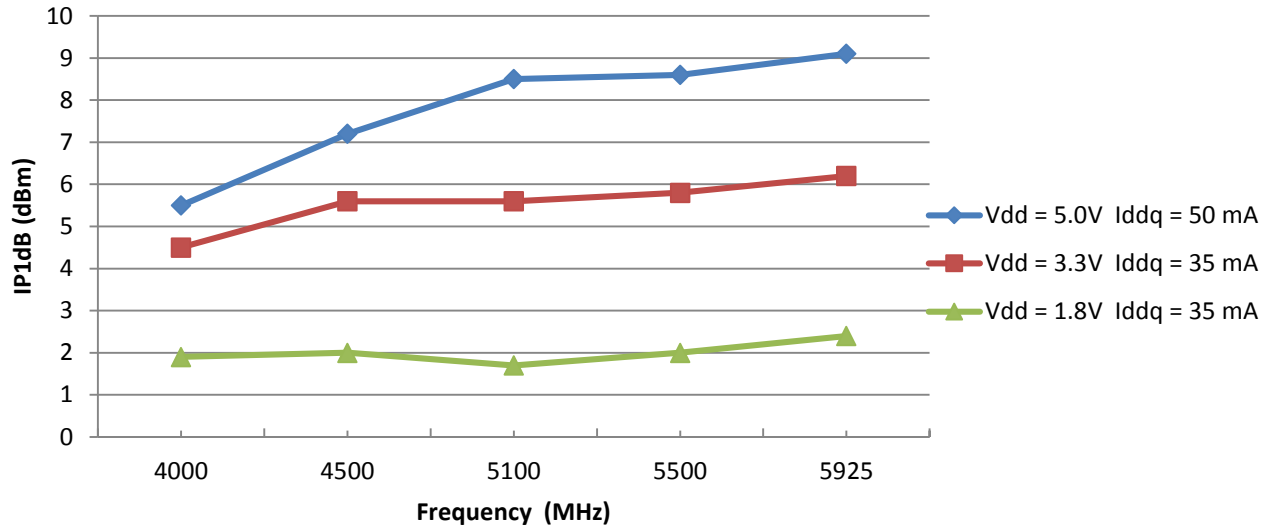
GRF2505 Evaluation Board Gain vs. Frequency



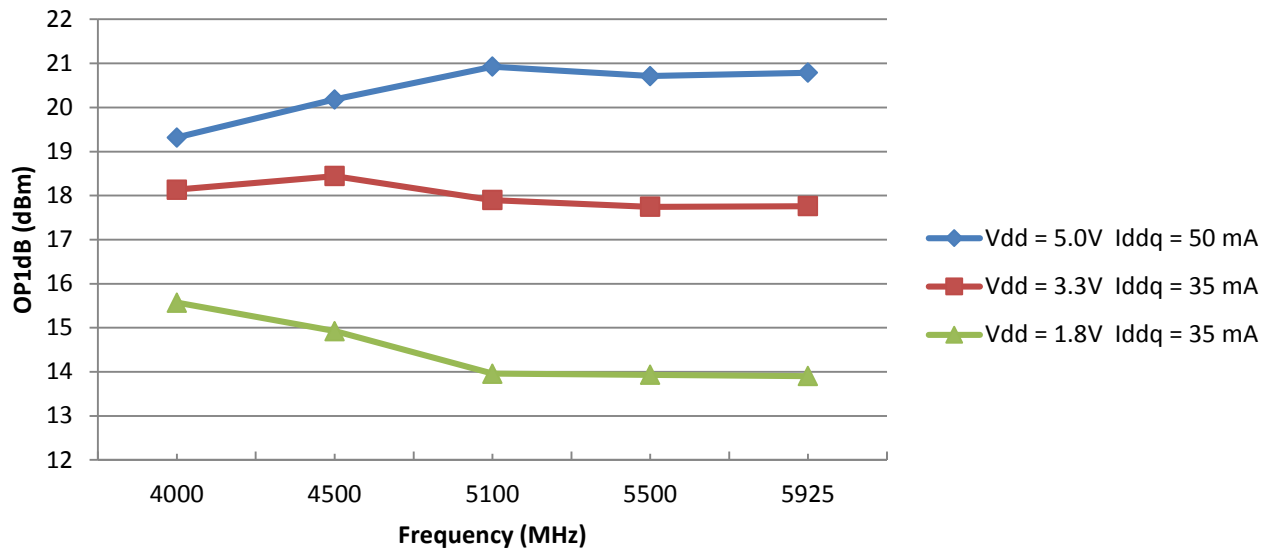
GRF2505 De-embedded Noise Figure vs. Frequency



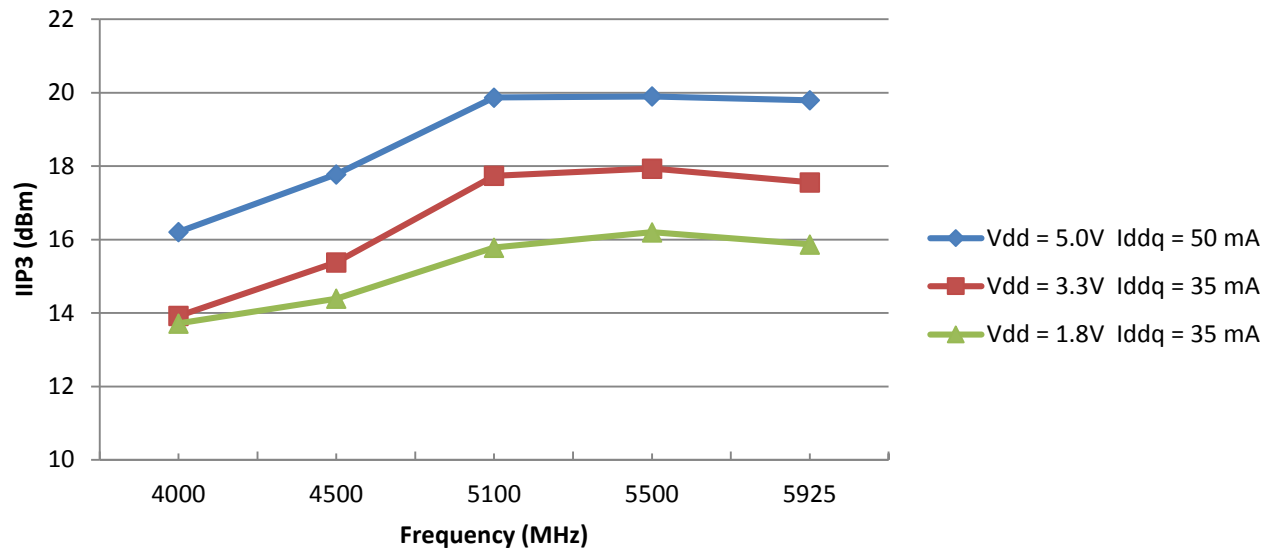
GRF2505 Evaluation Board IP1dB vs. Frequency



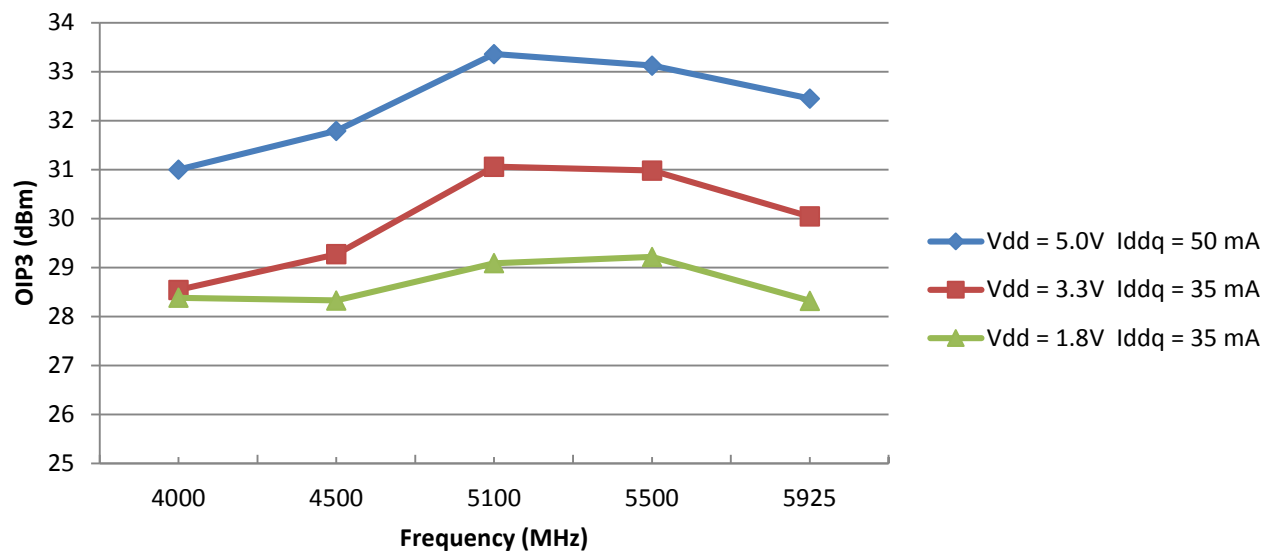
GRF2505 Evaluation Board OP1dB vs. Frequency

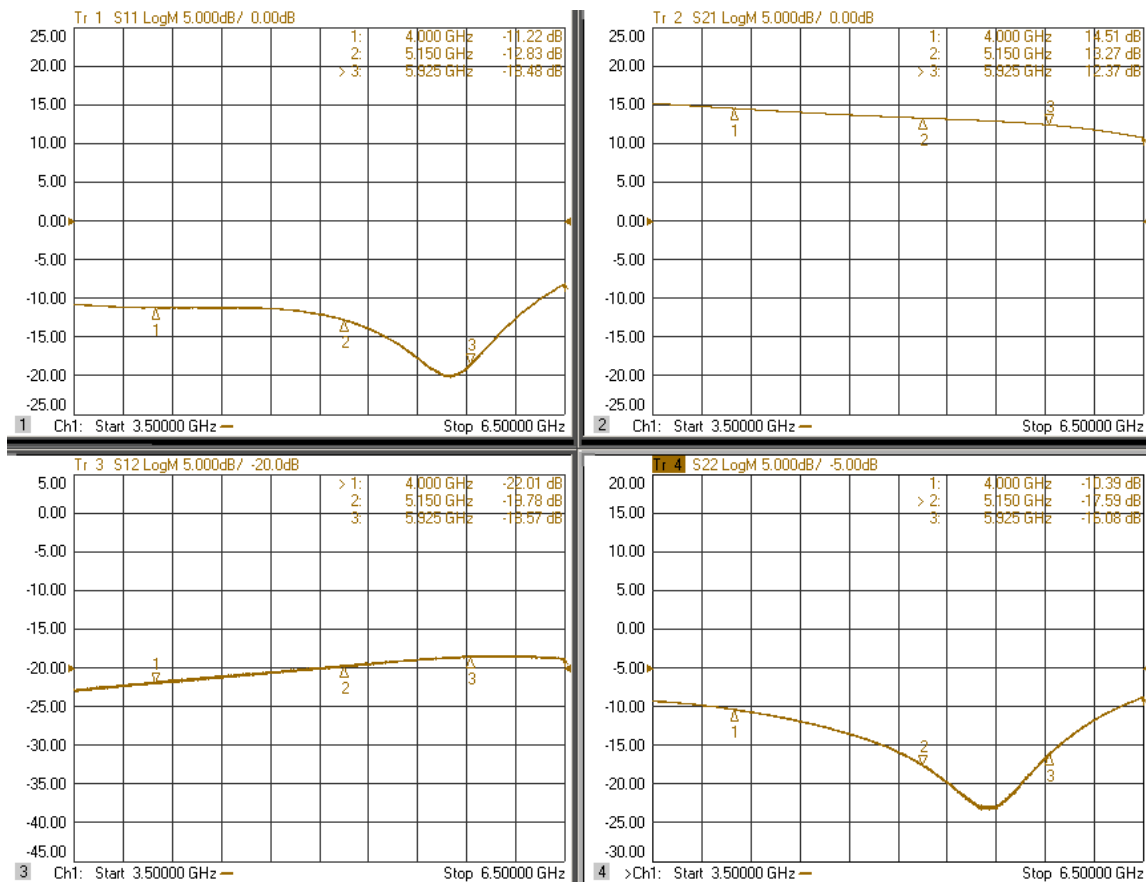


GRF2505 Evaluation Board IIP3 vs. Frequency

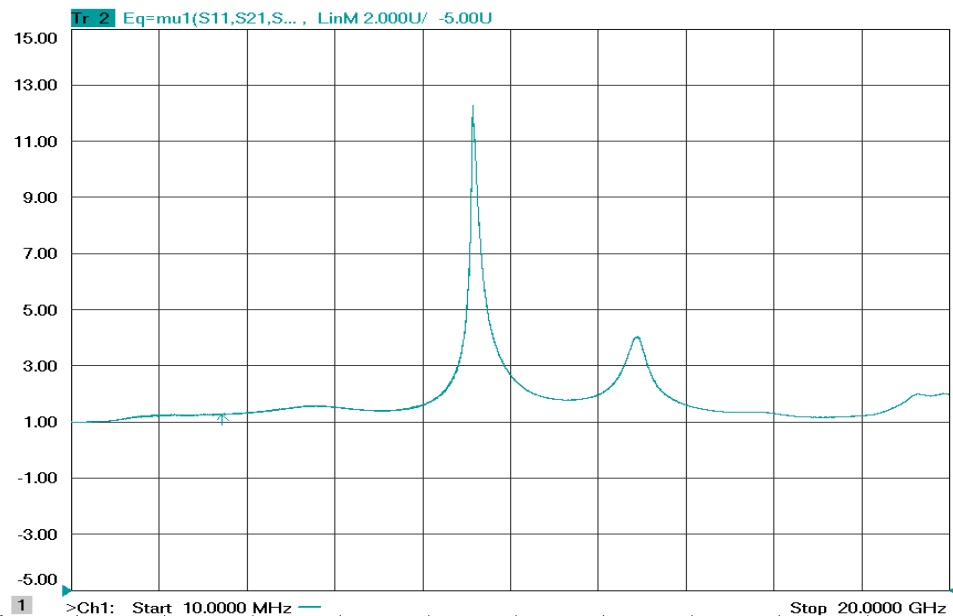


GRF2505 Evaluation Board OIP3 vs. Frequency





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



GRF2505 Evaluation Board Stability Mu Factor

GRF2505 Theory of Operation:

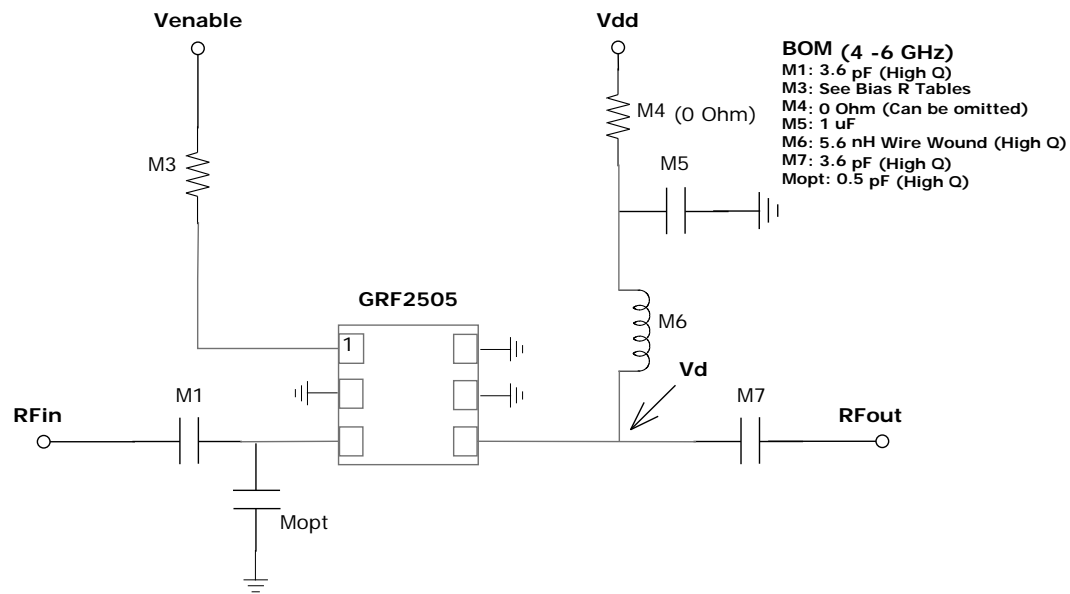
The GRF2505 is a single-stage, high-performance, low noise linear amplifier that is suitable for a wide range of applications. The device is internally matched to 50 ohms and covers 4 to 6 GHz with a single set of DC blocking caps (M1 and M7) and bias inductor (M6).

The device I_{ddq} can be set independently from the V_{dd} via the resistor M3 in series with V_{enable} . This allows the device to be optimized to meet a given linearity requirement with the highest possible efficiency. For a given V_{enable} , increasing M3 will result in lower I_{ddq} . As shown in the data sheet plots, GRF2505 exhibits excellent gain, NF and linearity over a wide range of V_{dd} values from 1.8 V up to 5.0 V.

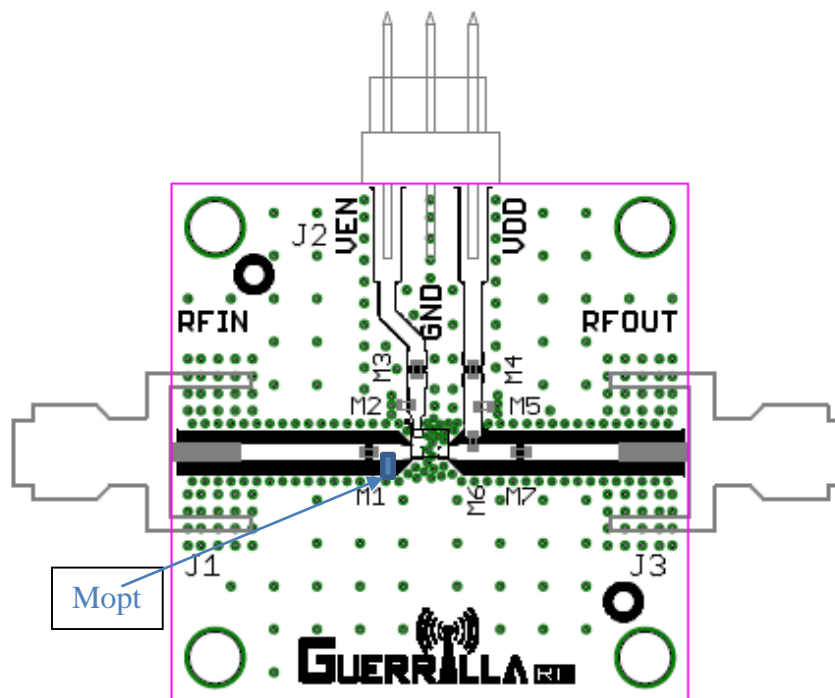
The tables on the following page show bias resistor values for a wide range of V_{enable} and V_{dd} settings. The GRF Applications Team sees no performance benefit from I_{ddq} values greater than 70 mA.

GRF2505 Bias Resistor vs. Iddq Tables

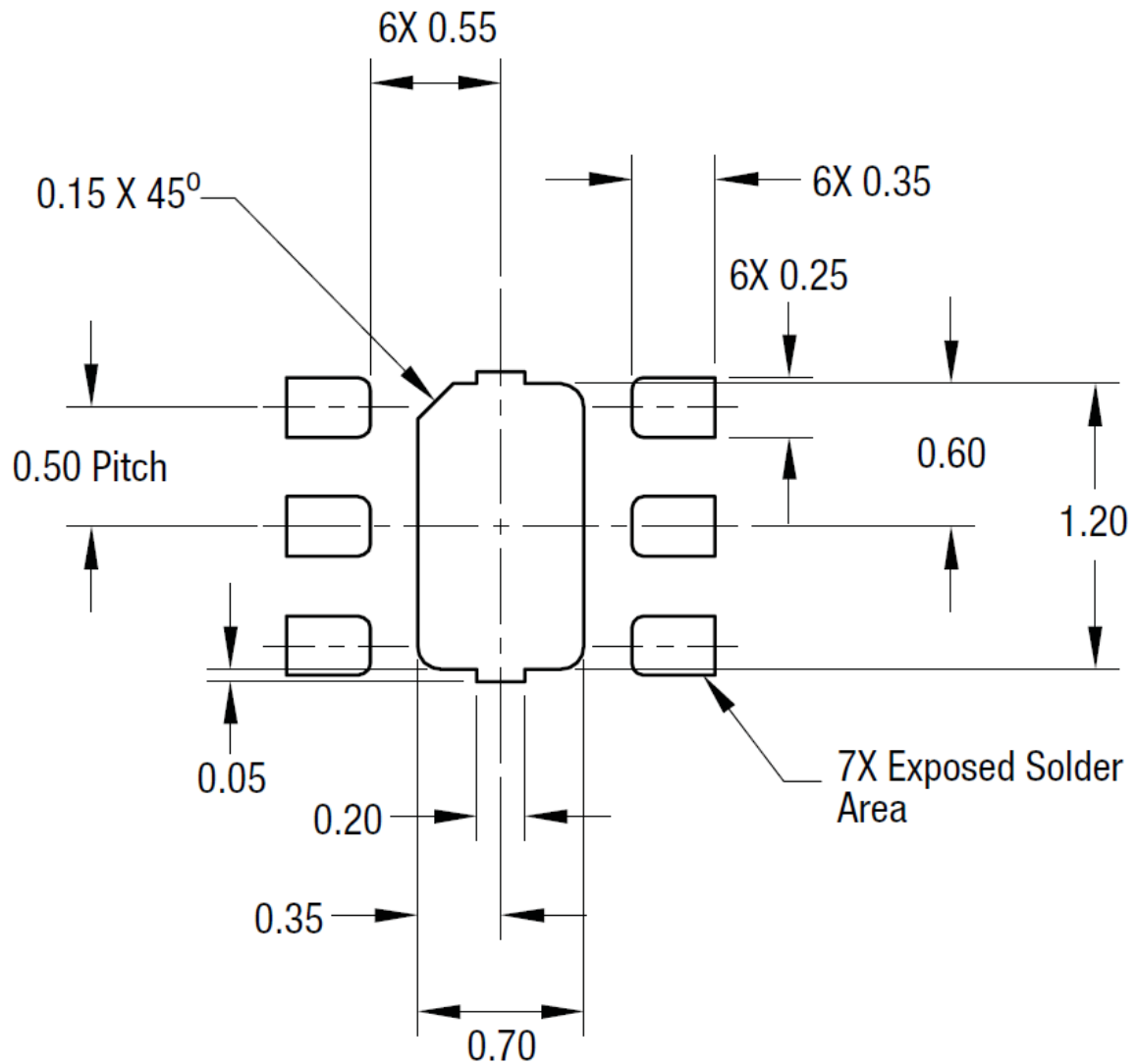
Device	Vdd	Venable	M3 (ohms)	Iddq (mA)		Device	Vdd	Venable	M3 (ohms)	Iddq (mA)		Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2505	5	5	500	80		GRF2505	4.5	4.5	300	80		GRF2505	4.0	4.0	100	81
GRF2505	5	5	750	72		GRF2505	4.5	4.5	400	76		GRF2505	4.0	4.0	300	70
GRF2505	5	5	1000	65		GRF2505	4.5	4.5	500	72		GRF2505	4.0	4.0	600	59
GRF2505	5	5	1500	56		GRF2505	4.5	4.5	750	64		GRF2505	4.0	4.0	1000	50
GRF2505	5	5	2000	49		GRF2505	4.5	4.5	1000	58		GRF2505	4.0	4.0	1500	42
GRF2505	5	5	2500	44		GRF2505	4.5	4.5	1500	50		GRF2505	4.0	4.0	2000	36
GRF2505	5	5	3000	40		GRF2505	4.5	4.5	2000	43		GRF2505	4.0	4.0	2500	32
GRF2505	5	5	4000	35		GRF2505	4.5	4.5	2500	39		GRF2505	4.0	4.0	3000	29
GRF2505	5	5	5000	31		GRF2505	4.5	4.5	3000	36		GRF2505	4.0	4.0	3500	27
GRF2505	5	5	6000	28		GRF2505	4.5	4.5	5000	27		GRF2505	4.0	4.0	4500	23
GRF2505	5	5	7000	25		GRF2505	4.5	4.5	6000	24		GRF2505	4.0	4.0	6000	19
GRF2505	5	5	10000	21		GRF2505	4.5	4.5	8000	20						
Device	Vdd	Venable	M3 (ohms)	Iddq (mA)		Device	Vdd	Venable	M3 (ohms)	Iddq (mA)		Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2505	3.3	3.3	0	74		GRF2505	3	3	0	67		GRF2505	1.8	1.8	0	35
GRF2505	3.3	3.3	100	68		GRF2505	3	3	100	61		GRF2505	1.8	1.8	100	32
GRF2505	3.3	3.3	200	63		GRF2505	3	3	200	57		GRF2505	1.8	1.8	200	30
GRF2505	3.3	3.3	300	59		GRF2505	3	3	300	53		GRF2505	1.8	1.8	400	26
GRF2505	3.3	3.3	500	53		GRF2505	3	3	500	47		GRF2505	1.8	1.8	600	23
GRF2505	3.3	3.3	750	46		GRF2505	3	3	750	42		GRF2505	1.8	1.8	900	20
GRF2505	3.3	3.3	1000	42		GRF2505	3	3	1000	38						
GRF2505	3.3	3.3	1500	35		GRF2505	3	3	1500	32						
GRF2505	3.3	3.3	2000	31		GRF2505	3	3	2000	27						
GRF2505	3.3	3.3	3000	25		GRF2505	3	3	3000	22						
GRF2505	3.3	3.3	4000	21												



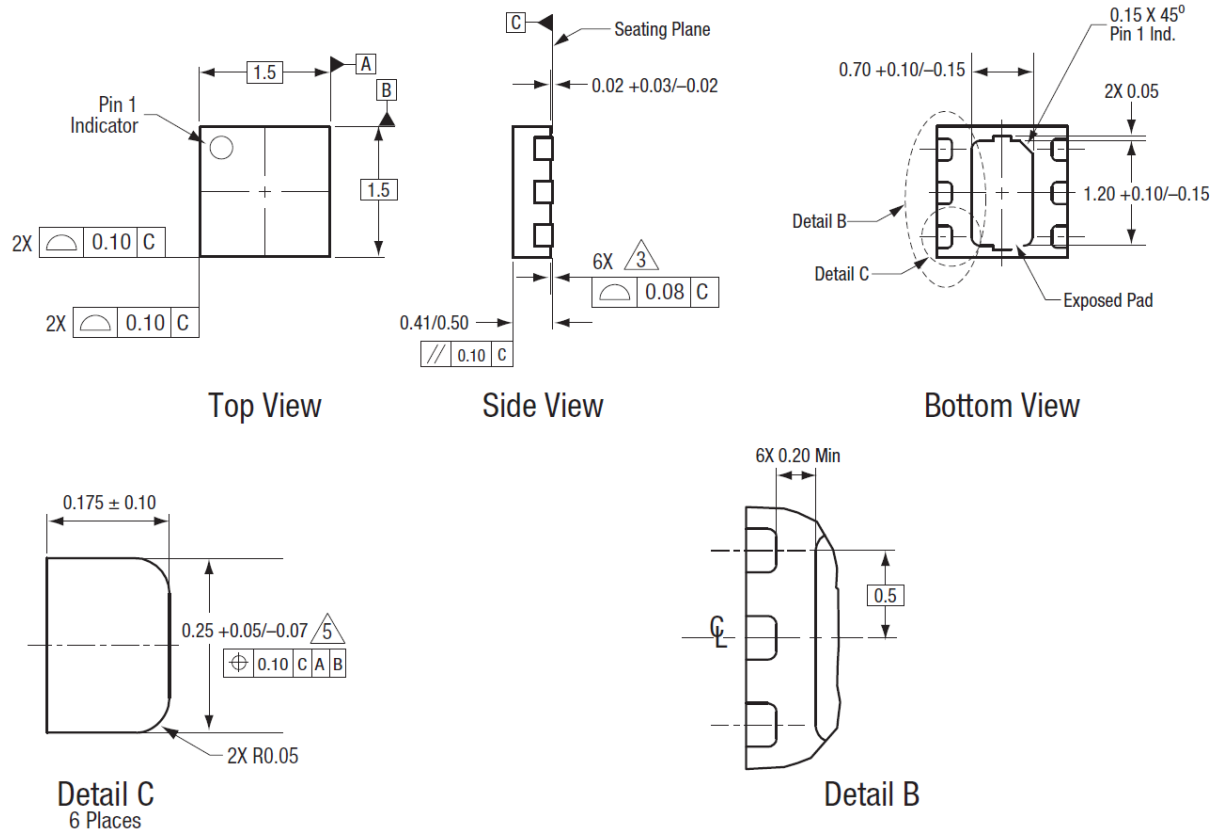
GRF2505 Evaluation Board Application Schematic



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.

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