



Preliminary

# GRF2501

## High Gain, Ultra-Low Noise Amplifier

### 802.11 a/n/ac 4.9 - 6.0 GHz

Package: 1.5 x 1.5 mm DFN-6



## Product Description

The GRF2501 is an ultra-low noise amplifier (LNA) designed for IEEE 802.11a/n/ac/p applications (5.1 GHz to 5.925 GHz). Over this band, the device exhibits outstanding de-embedded noise figure (NF) of 0.80 dB along with excellent gain flatness and high linearity. The high gain, superior NF and directivity of its design allows designers to create receiver architectures with outstanding cascaded NF and unconditional stability.

The LNA is operated from a single positive supply of 2.7 to 5.0 V with a typical bias condition of 3.3 V and 12 mA. GRF2501 is internally matched to 50  $\Omega$  at the input and output ports.

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

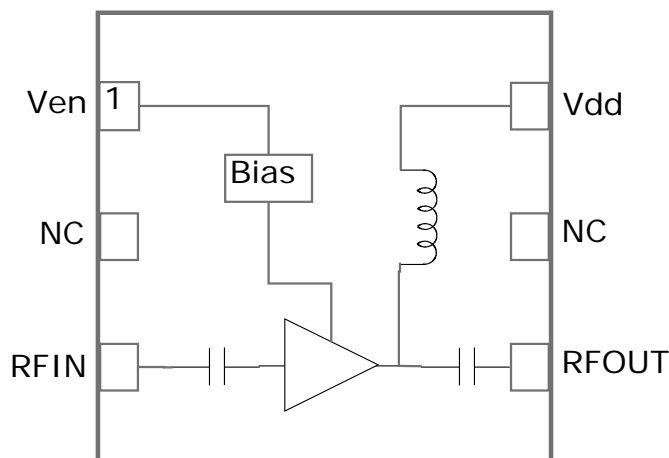
## Features

- 4.9 GHz to 6 GHz Operation
- Measurement Reference: 3.3V and 12 mA at 5.5 GHz
- 0.80 dB Noise Figure (De-embedded)
- 16.9 dB Gain
- 2.7 V to 5.0 V Single Supply
- Internally Matched to 50  $\Omega$
- Process: GaAs pHEMT

## Applications

- WiFi Access Points
- Mobile WiFi Devices
- Microwave Backhaul
- 802.11p Vehicle Communications

## Functional Block Diagram



## Absolute Ratings:

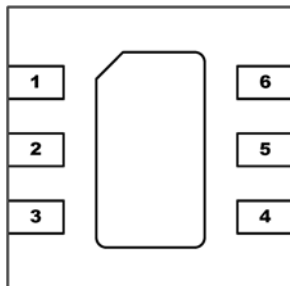
Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	V <sub>DD</sub>	0	6.0	V
DC Voltage at Control Port (Pin 1)	V <sub>ENABLE</sub>	0	5.0	V
RF CW Power into LNA Input	P <sub>IN MAX</sub>		+15	dBm
Operating Temperature (package heat sink)	T <sub>AMB</sub>	-40	+105	°C
Storage Temperature	T <sub>STG</sub>	-40	+150	°C
Maximum Channel Temperature	T <sub>MAX</sub>		+170	°C
Maximum Dissipated Power	P <sub>DISS MAX</sub>		200	mW
Electro Static 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.

Pin Out (Top View)



## Pin Assignments:

Pin	Name	Description	Note
1	V <sub>ENABLE</sub>	LNA Enable Input	Venable and series resistor M1 set the device Iddq
2	NC	No Connect or Ground	No internal connection to die
3	RF_In	LNA RF input	Internally matched to 50 Ω. These ports may be DC connected to ground externally but no DC > 0.2 volts should be applied to these ports.
4	RF_Out	LNA RF output	
5	NC	No Connect or Ground	No internal connection to die
6	V <sub>DD</sub>	Supply Voltage for the LNA	Requires bypass capacitance as close as possible to pin on PCB
PKG BASE	GND	Ground	Provides DC and RF ground for LNA, as well as thermal heat sink. Please see evaluation board assembly diagram for reference.

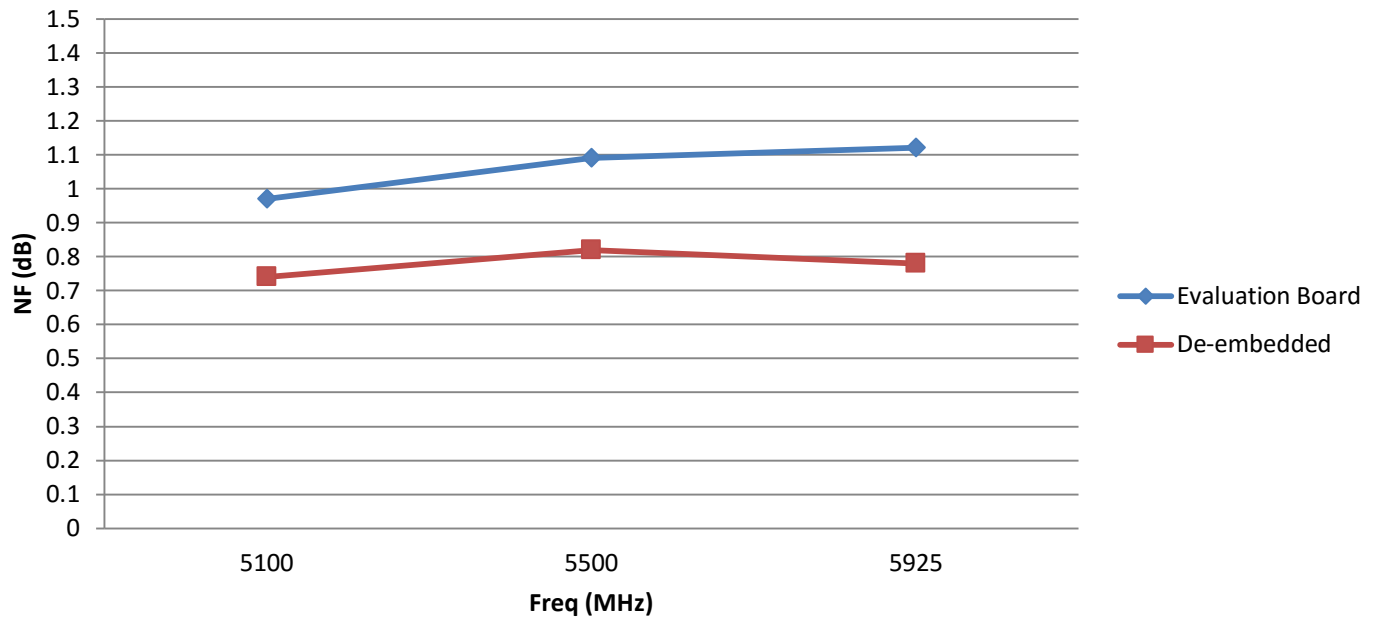
## V<sub>ENABLE</sub> Truth Table

V <sub>ENABLE</sub>	Mode
>=1.8 V	LNA On
<0.5 V	LNA Off

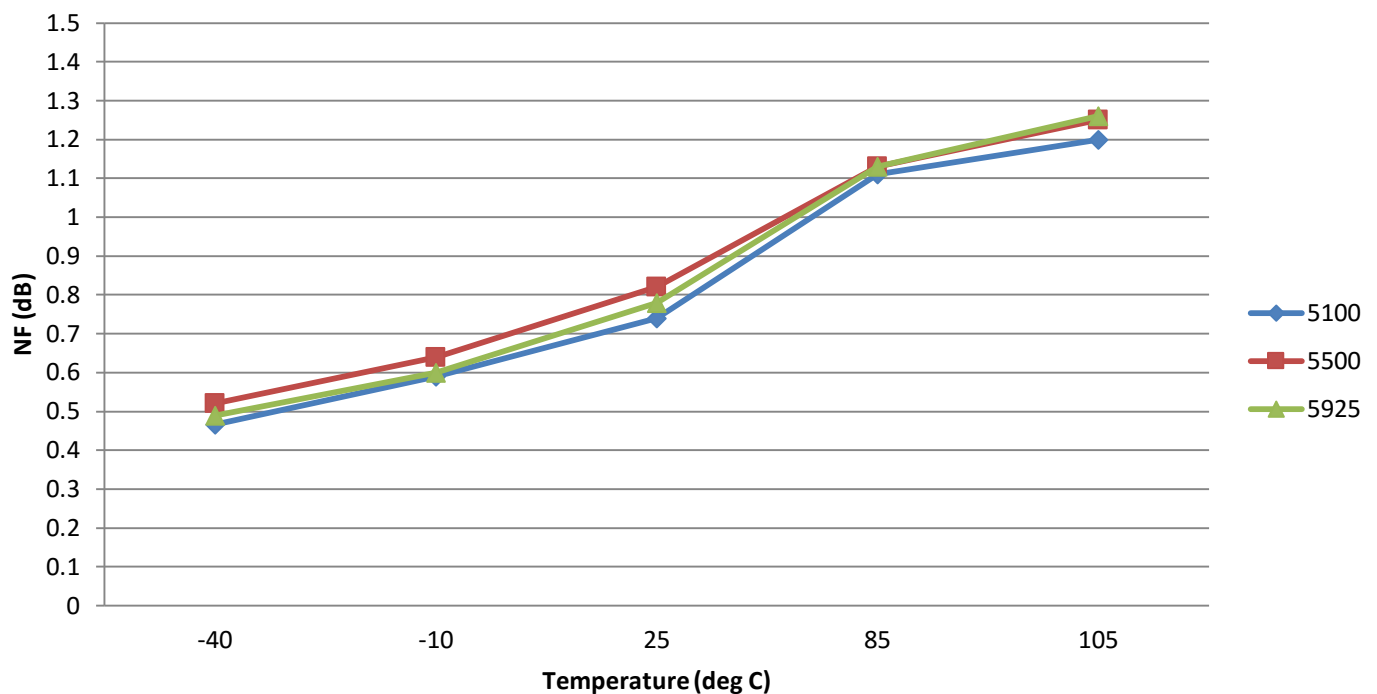
## Nominal Operating Parameters:

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
<b>High Gain Mode</b>						$V_{DD} = 3.3\text{ V}$ , $V_{ENABLE} = 3.3\text{ V}$ , $T_A = 25^\circ\text{C}$
Test Frequency	$F_{TEST}$		5500		MHz	
Gain	$S_{21}$	15.5	16.9		dB	
Gain Flatness	$\Delta S_{21}$		+/- 0.5		dB	Across 5.1 to 5.825 GHz
Input Return Loss	$S_{11}$		-9.6		dB	
Output Return Loss	$S_{22}$		-14.4		dB	
Noise Figure	NF		0.80	1.0	dB	(Board Losses De-embedded)
Input Power at 1% EVM	EVM	-21	-19.0		dBm	802.11a modulation
Input 1dB Compression	IP1dB	-10	-8.0		dBm	
Supply Current (Quiescent)	$I_{DDQ}$		12		mA	
Enable Current	$I_{enable}$		1.2		mA	
<b>Disabled Mode</b>						$V_{DD} = 3.3\text{ V}$ , $V_{ENABLE} = 0.0\text{V}$
Supply Current (Leakage)	$I_{DD}$		250		$\mu\text{A}$	
Enable Current	$I_{enable}$		0.01		$\mu\text{A}$	
<b>Thermal Data</b>						
Thermal Resistance (Infra-Red Scan)	$\Theta_{jc}$		141		$^\circ\text{C/W}$	
Channel Temperature @ +85 C reference (Package heat sink)	$T_{CHANNEL}$		+91		$^\circ\text{C}$	$V_{dd} = 3.3\text{ V}$ ; $I_{ddq} = 12\text{ mA}$ ; No RF; Dissipated Power: 40 mW

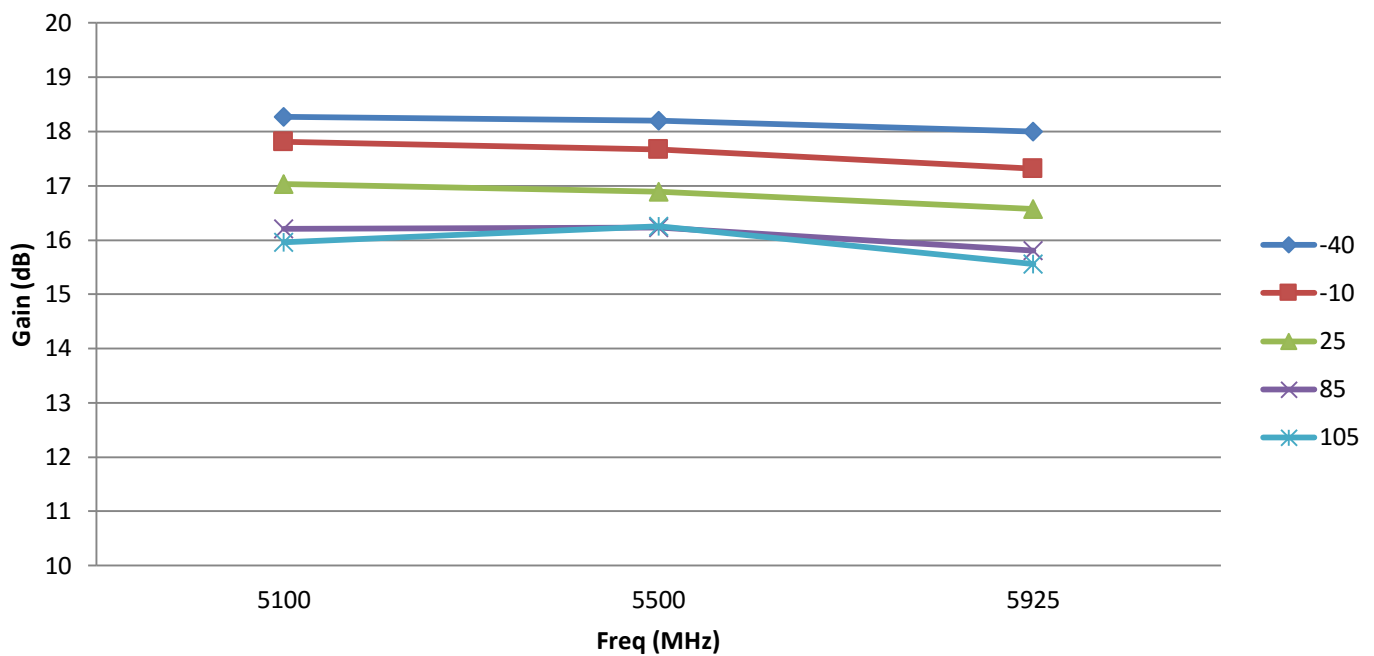
GRF2501 Noise Figure vs. Frequency



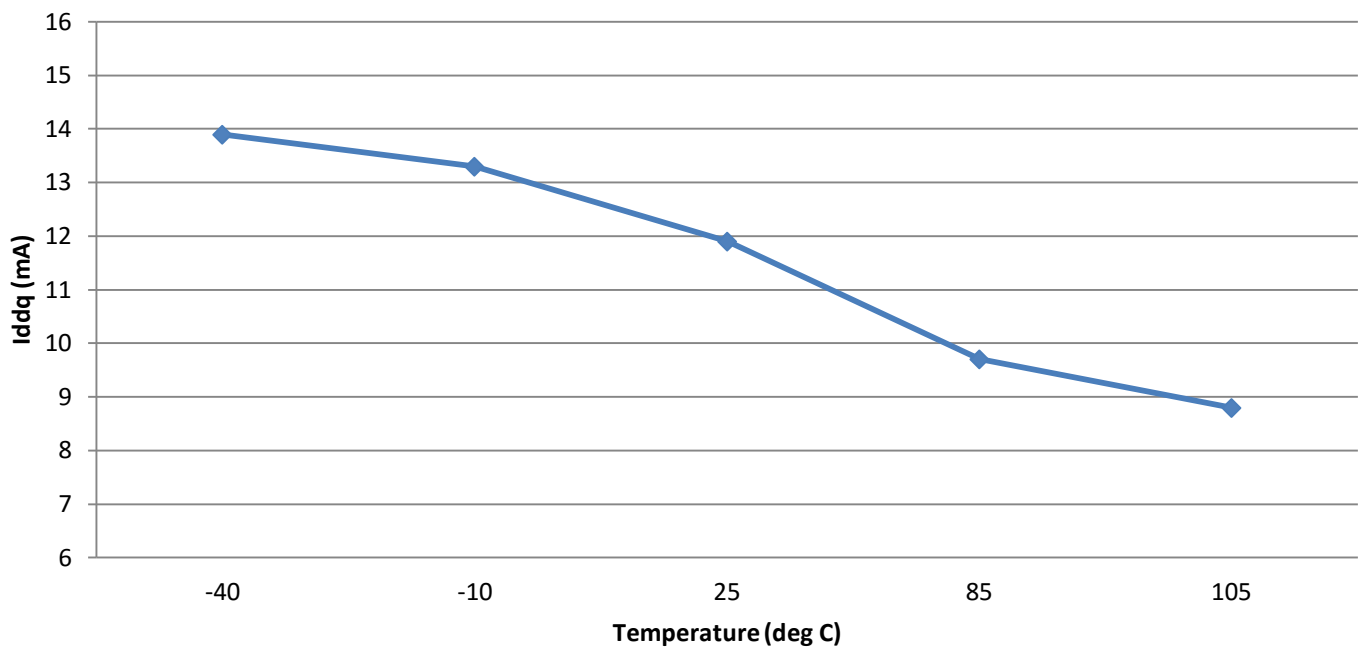
GRF2501 De-embedded Noise Figure vs. Temperature



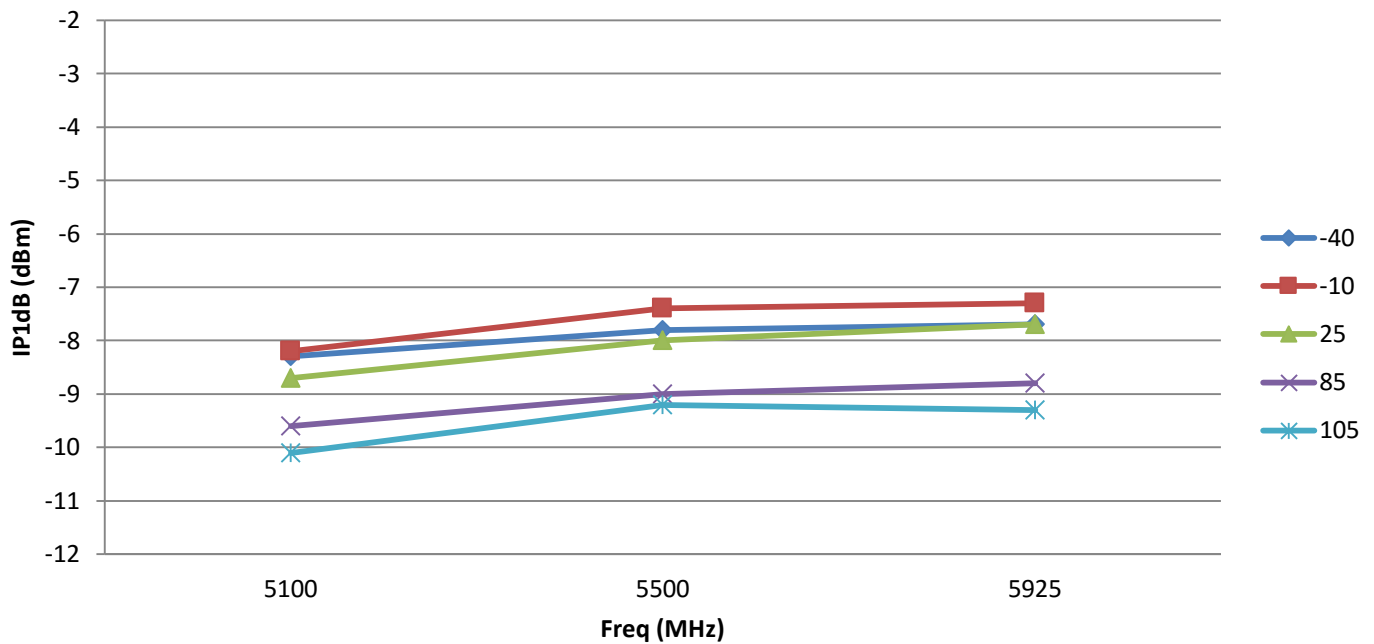
GRF2501 Gain vs. Temperature and Frequency



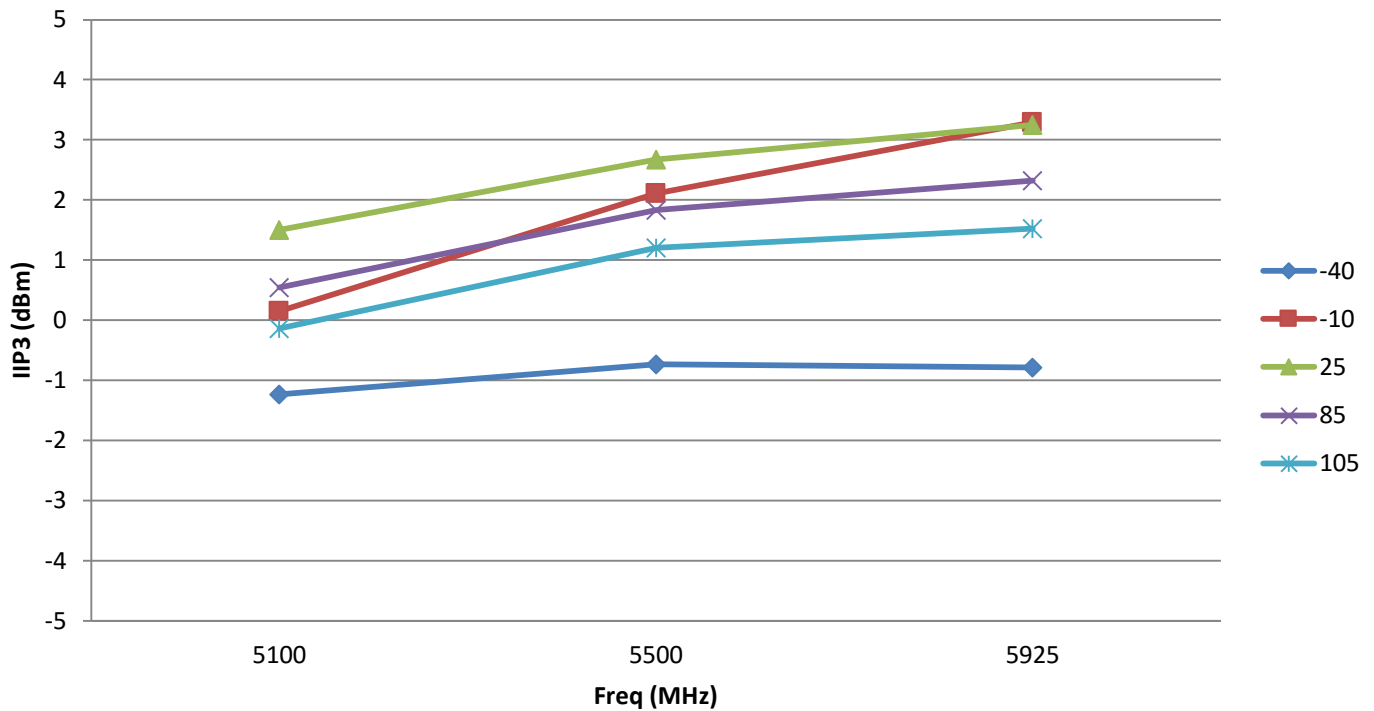
GRF2501 Iddq vs. Temperature



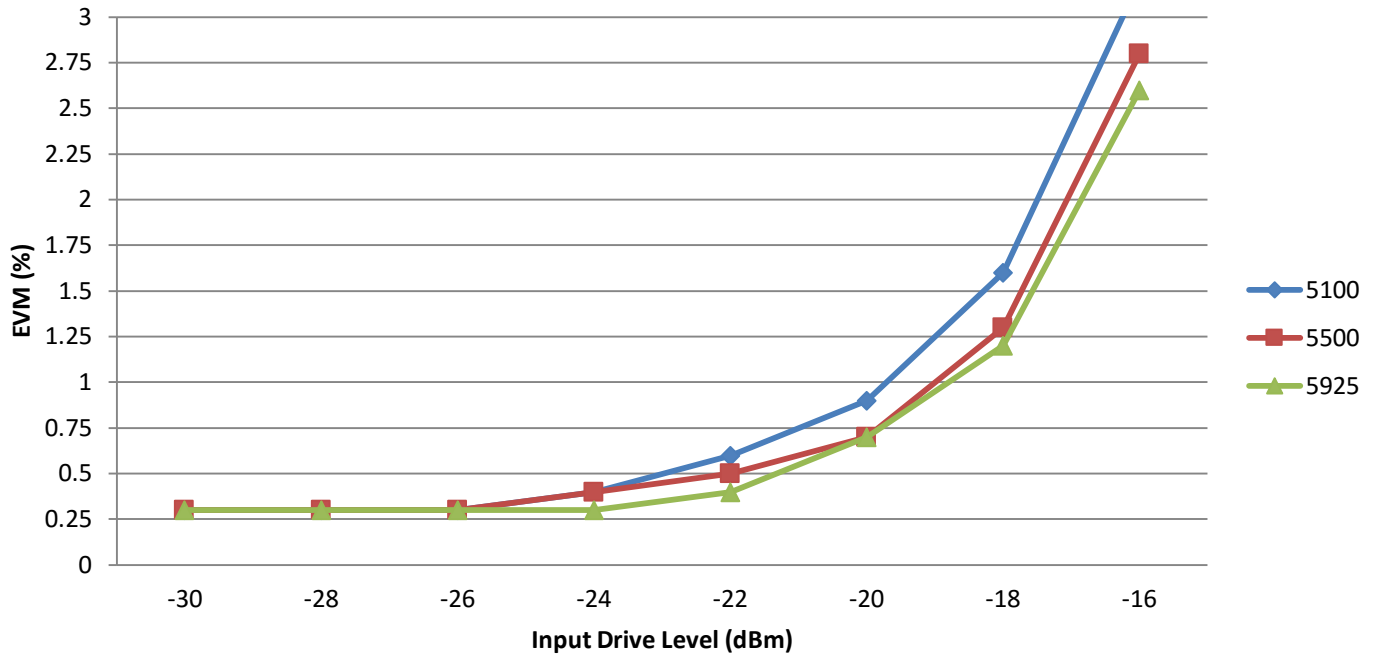
GRF2501 IP1dB vs. Temperature and Frequency; 3.3V/12mA



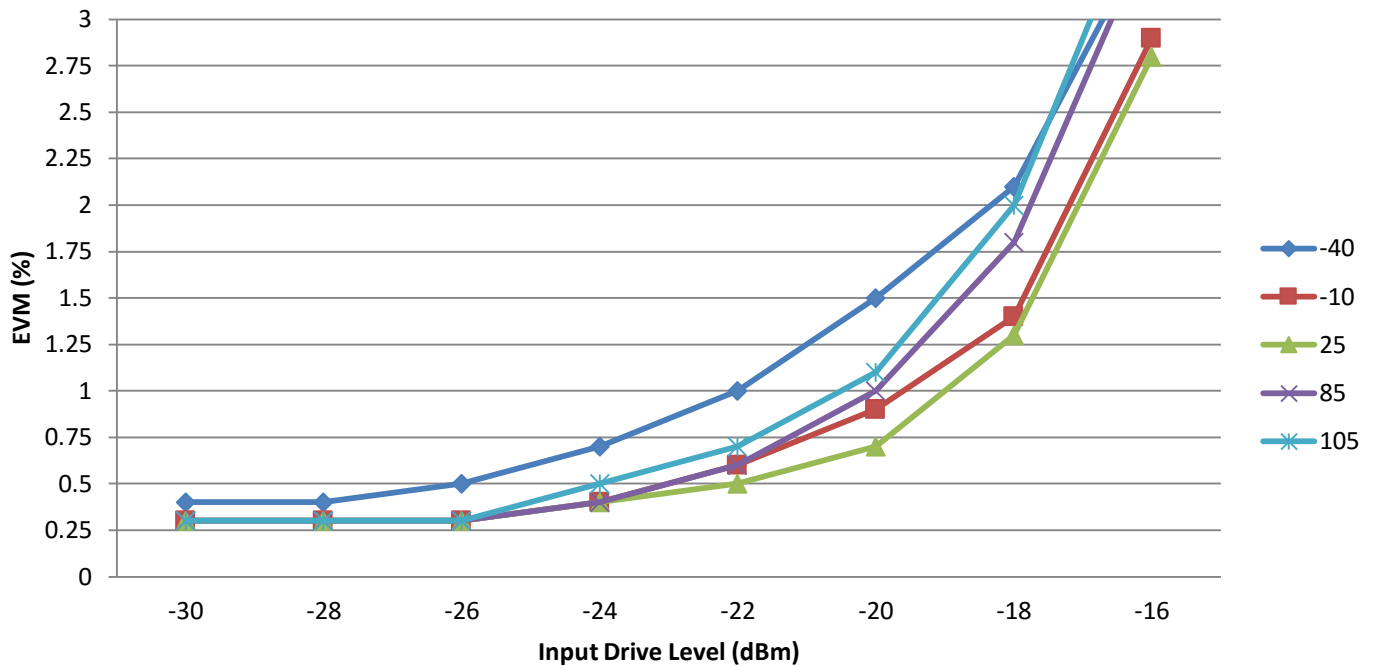
GRF2501 IIP3 vs. Temperature and Frequency; 3.3V/12mA



GRF2501 802.11 a/g EVM vs. Input Drive Level vs. Freq: 3.3V/12mA

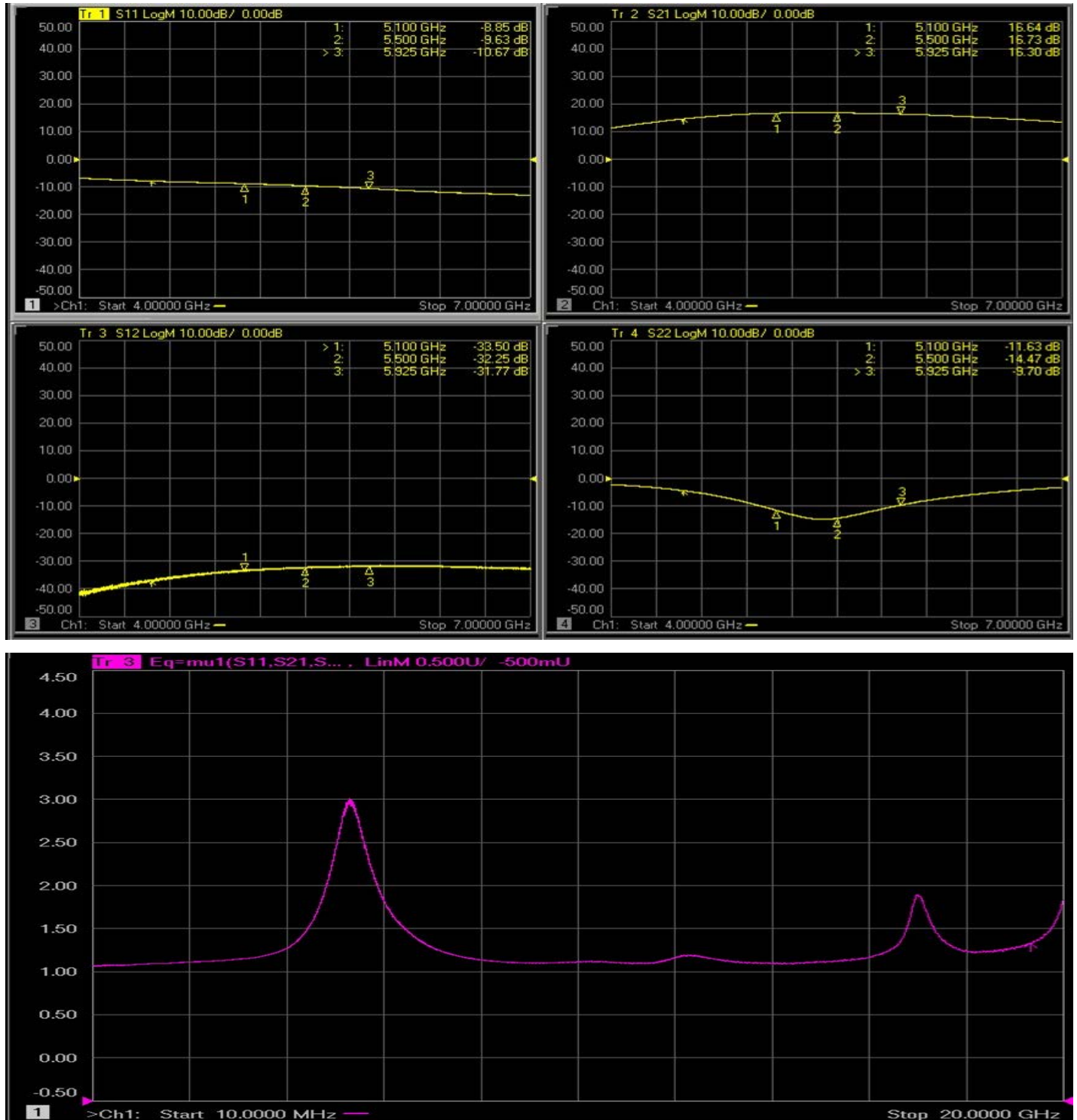


GRF2501 802.11 a/g EVM vs. Input Drive Level vs. Temperature: 3.3V/12mA; 5.5 GHz





## GRF2501 Evaluation Board S-Pars and Stability Mu Factor:



Note:  $\mu \geq 1.0$  implies unconditional stability

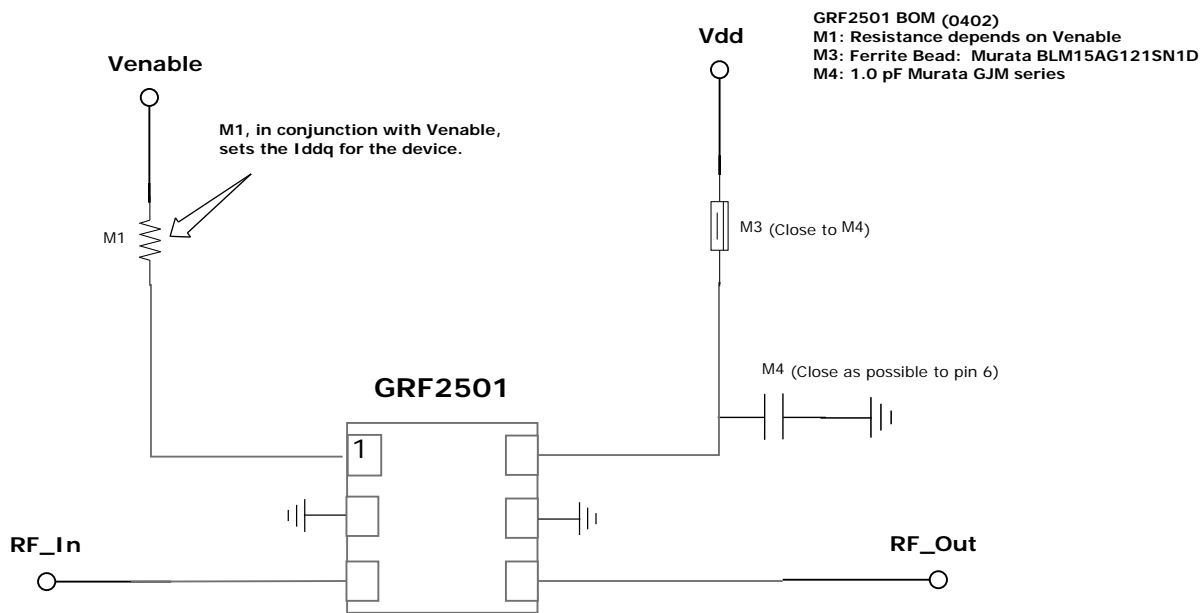
## GRF2501 Theory of Operation:

The device is internally matched with internal DC blocking caps. However, no DC voltage  $>0.2$  volts should be applied externally to the RF input and output ports of the device.

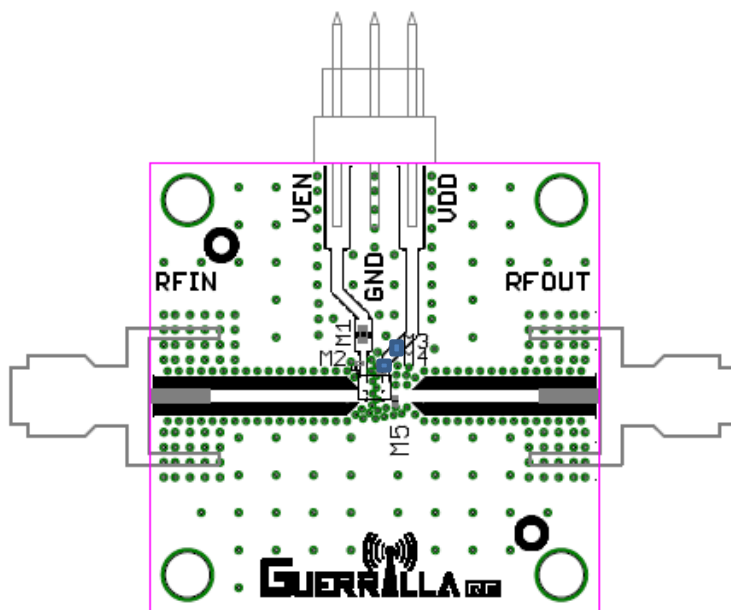
A key element of the application circuit is the low cost ferrite bead in series with the Vdd supply. This ferrite effectively isolates the application circuit so that transmission lines and terminations above it do not affect the device performance. Use of the ferrite also results in improved gain and NF and its use is strongly recommended.

The 1.0 pF external cap to ground at pin 6 should be placed as close as practical to the device for optimal performance. Likewise, the series ferrite bead should be placed close to the 1.0 pF cap to ground so that a compact layout can be achieved.

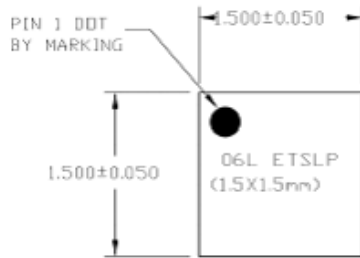
Iddq is set by the Venable voltage and the external resistor in series with it. For  $V_{dd} = V_{enable} = 3.3$  volts, a resistor value of 1.3k ohms will result in an Iddq of approximately 12 mA.



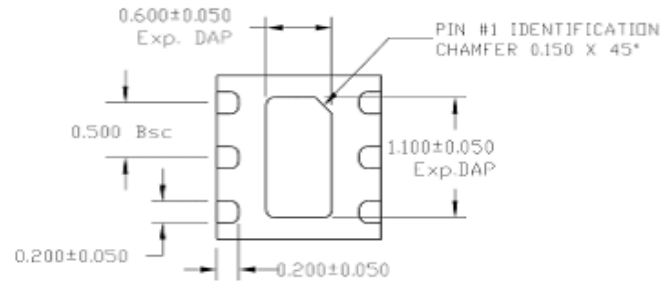
GRF2501 Evaluation Board Application Schematic



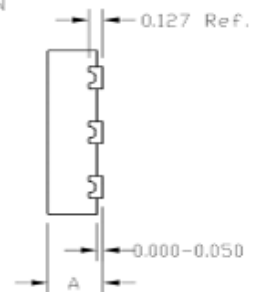
GRF2501 Evaluation Board Assembly Diagram



TOP VIEW



BOTTOM VIEW

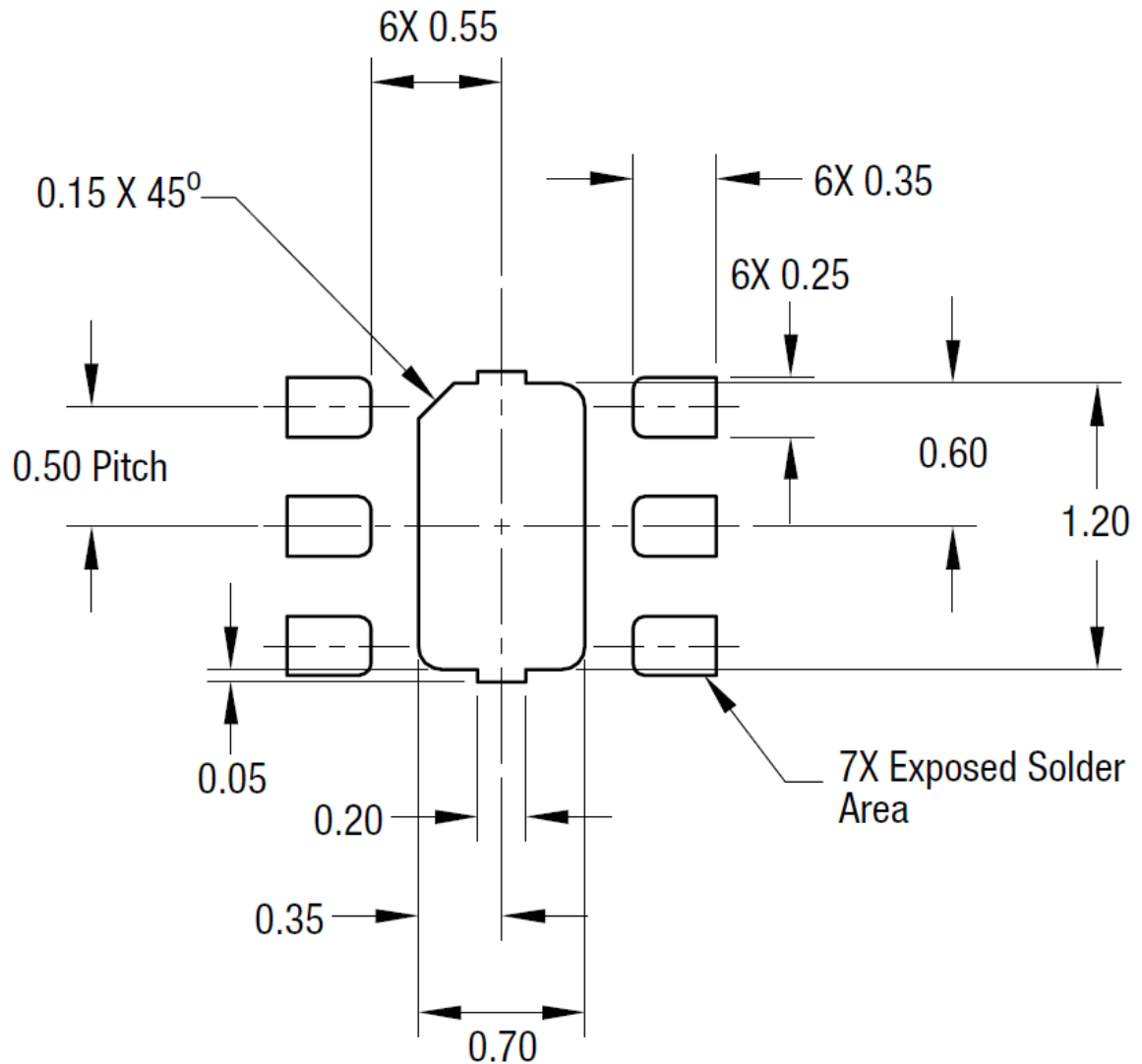


SIDE VIEW

A	ETSLP	
	MAX.	0.500
	NOM.	0.450
	MIN.	0.400

				TOLERANCES REFER TO SPECIFICATION ABOVE	UNIT: MM SCALE: NTS SYMBOL:		DATE:	06L (ETSLP) 1.5X1.5 mm (PACKAGE OUTLINE)
							DATE:	
							DATE:	
							DATE:	
							DATE:	
DESCRIPTION	DATE	BY	APPD			REV: 00		SHEET NO: 1 OF 1

## GRF2501 DFN-6 Package Dimensions



**GRF2501 1.5mm x 1.5mm 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.

Information in this datasheet is specific to the Guerrilla RF, LLC ("Guerrilla RF") product identified.

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