GRF2501

Preliminary **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

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 Ω
- Process: GaAs pHEMT

Applications

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

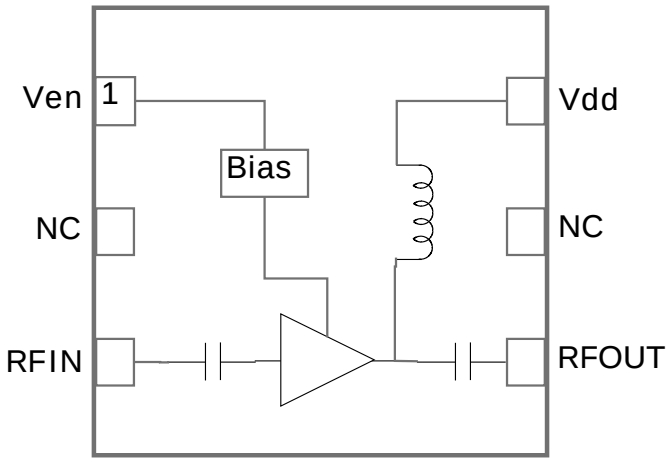
Product Description

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 Ω at the input and output ports.

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

Functional Block Diagram



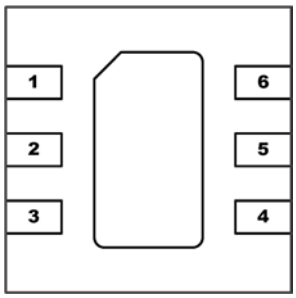
Absolute Ratings:

Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	V_{DD}	0	6.0	V
DC Voltage at Control Port (Pin 1)	V_{ENABLE}	0	5.0	V
RF CW Power into LNA Input	$P_{IN\ MAX}$		+15	dBm
Operating Temperature (package heat sink)	T_{AMB}	-40	+105	°C
Storage Temperature	T_{STG}	-40	+150	°C
Maximum Channel Temperature	T_{MAX}		+170	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		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:

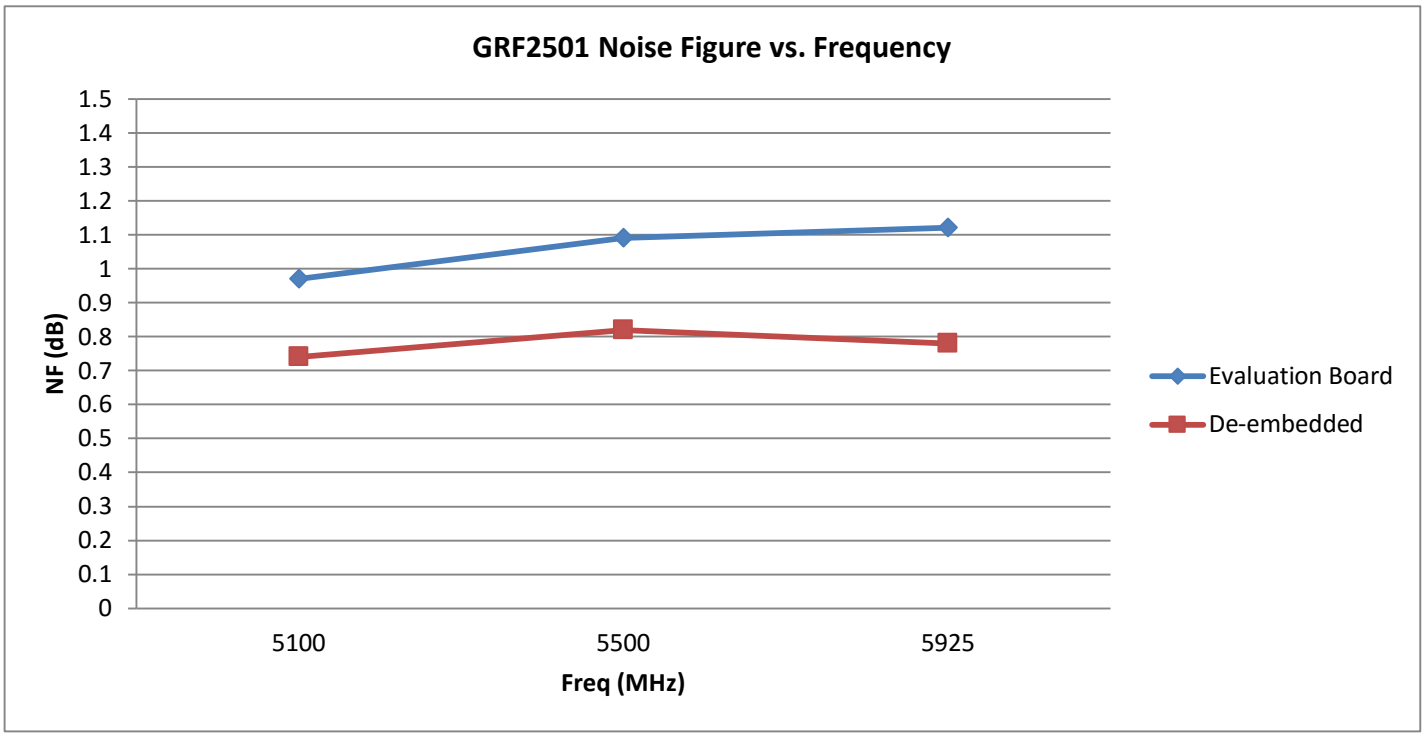
Pin	Name	Description	Note
1	V_{ENABLE}	LNA Enable Input	Venable and series resistor M1 set the device Iddq
2	NC	No Connect or Ground	No internal connection to die
3	RF_In	LNA RF input	Internally matched to 50 Ω. These ports may be DC connected to ground externally but no DC > 0.2 volts should be applied to these ports.
4	RF_Out	LNA RF output	
5	NC	No Connect or Ground	No internal connection to die
6	V_{DD}	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.

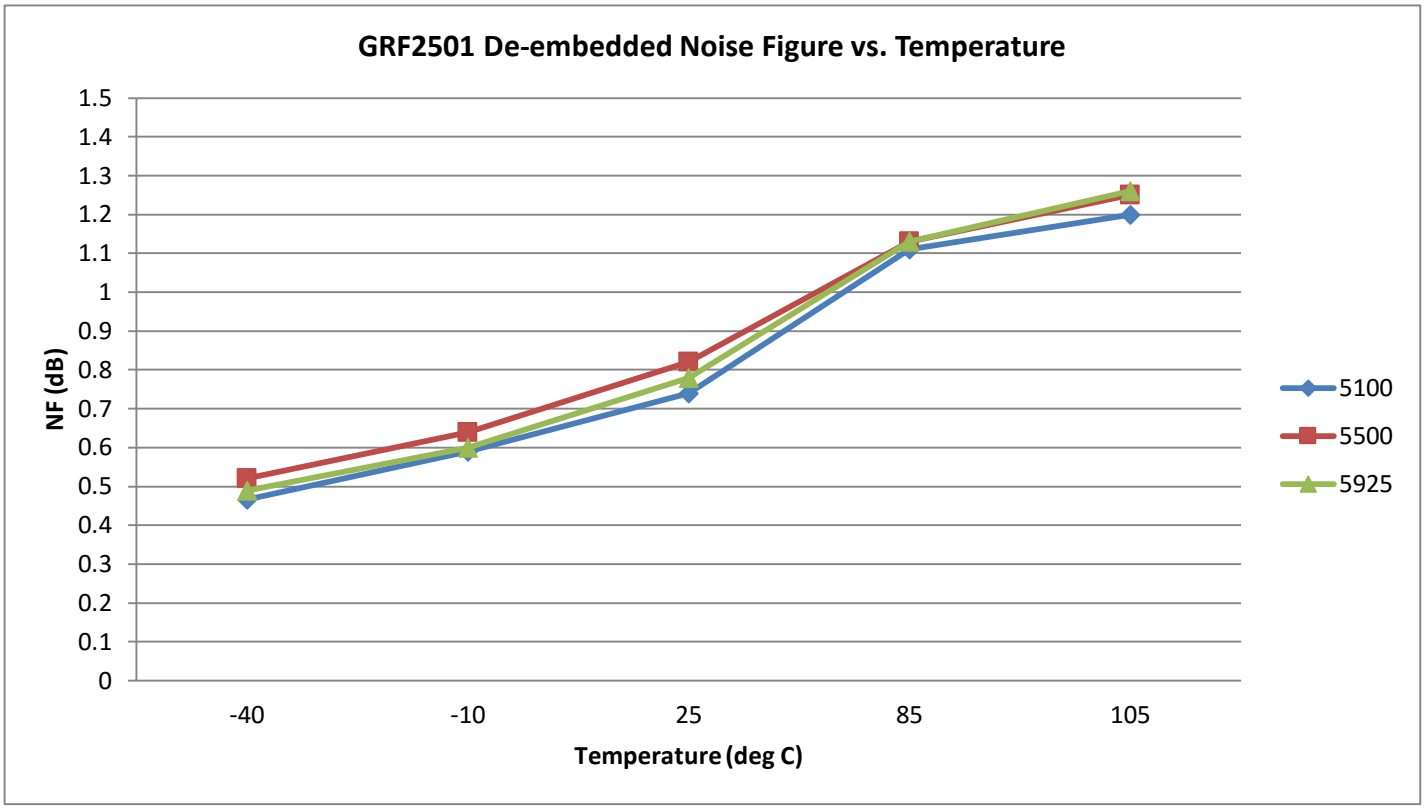
V_{ENABLE} Truth Table

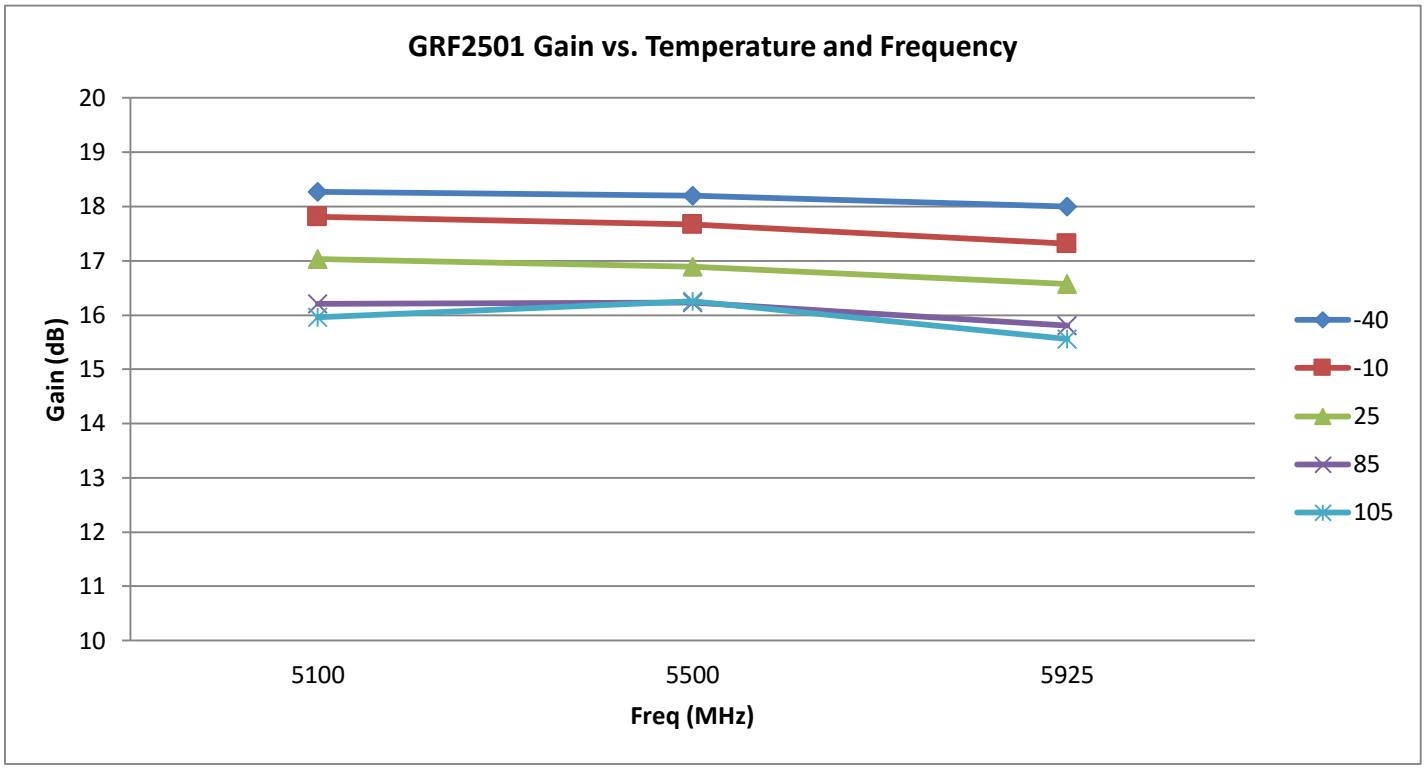
V_{ENABLE}	Mode
>=1.8 V	LNA On
<0.5 V	LNA Off

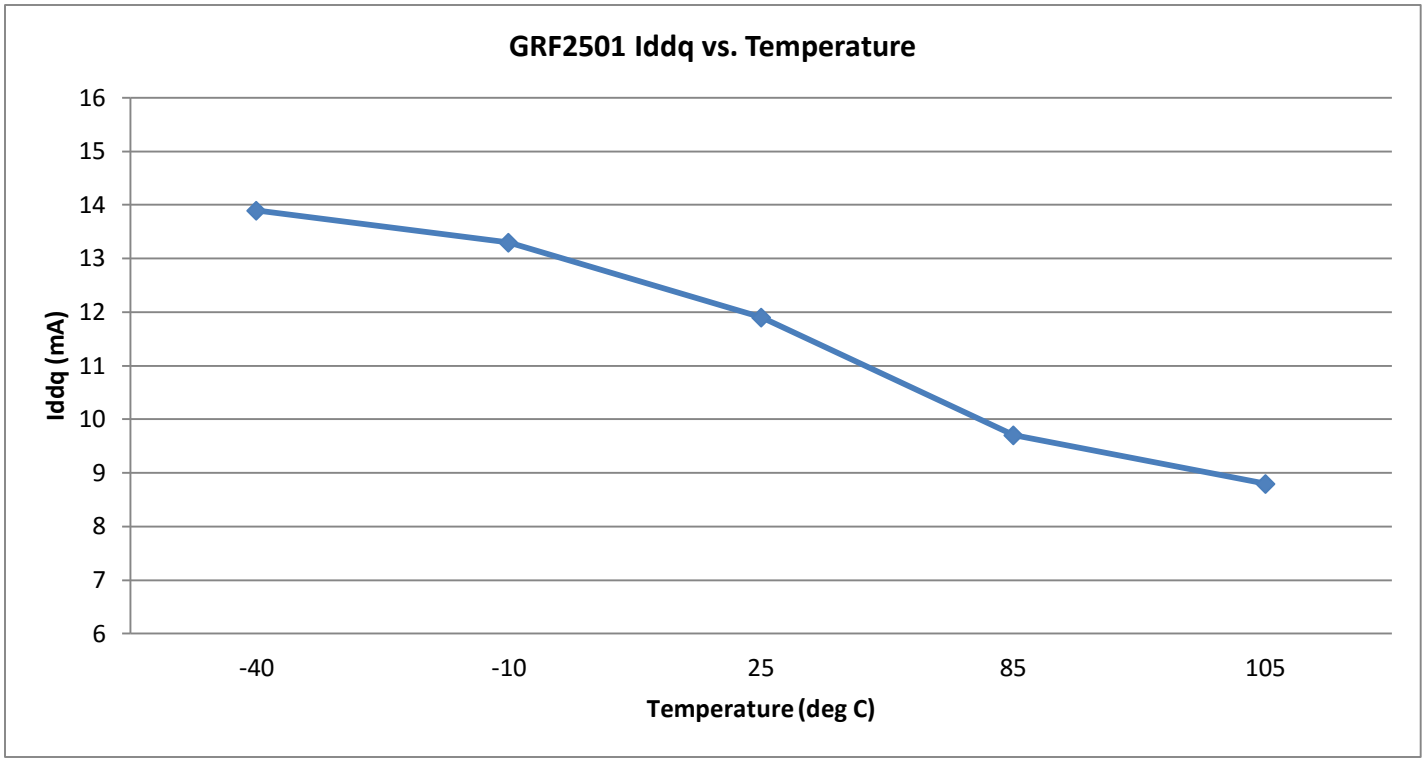
Nominal Operating Parameters:

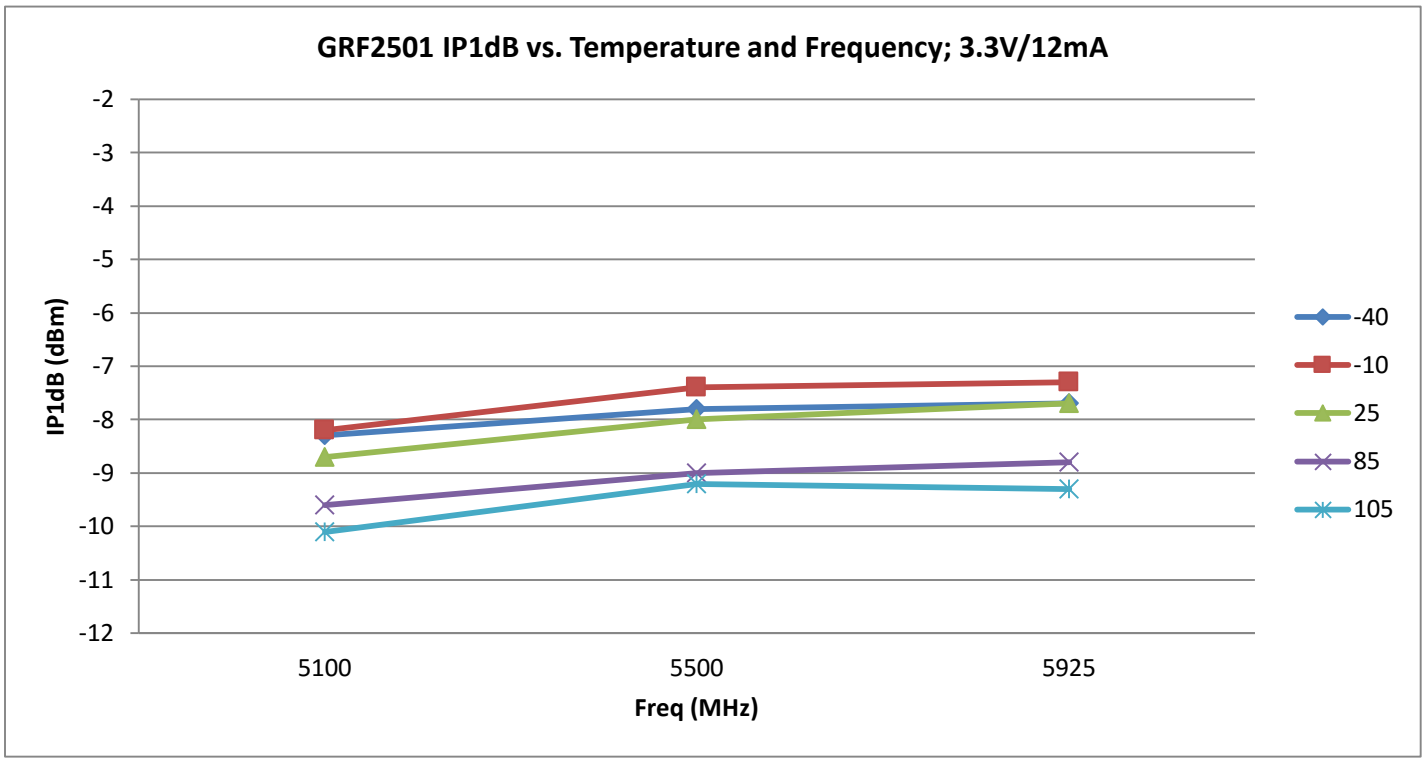
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
High Gain Mode						V_{DD} = 3.3 V, V_{ENABLE} = 3.3 V, T_A = 25°C
Test Frequency	F_{TEST}		5500		MHz	
Gain	S21	15.5	16.9		dB	
Gain Flatness	ΔS21		+/- 0.5		dB	Across 5.1 to 5.825 GHz
Input Return Loss	S11		-9.6		dB	
Output Return Loss	S22		-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	
Disabled Mode						V_{DD} = 3.3 V, V_{ENABLE} = 0.0V
Supply Current (Leakage)	I_{DD}		250		µA	
Enable Current	I_{enable}		0.01		µA	
Thermal Data						
Thermal Resistance (Infra-Red Scan)	Θjc		141		°C/W	
Channel Temperature @ +85 C reference (Package heat sink)	$T_{CHANNEL}$		+91		°C	Vdd: 3.3 V; Iddq: 12 mA; No RF; Dissipated Power: 40 mW

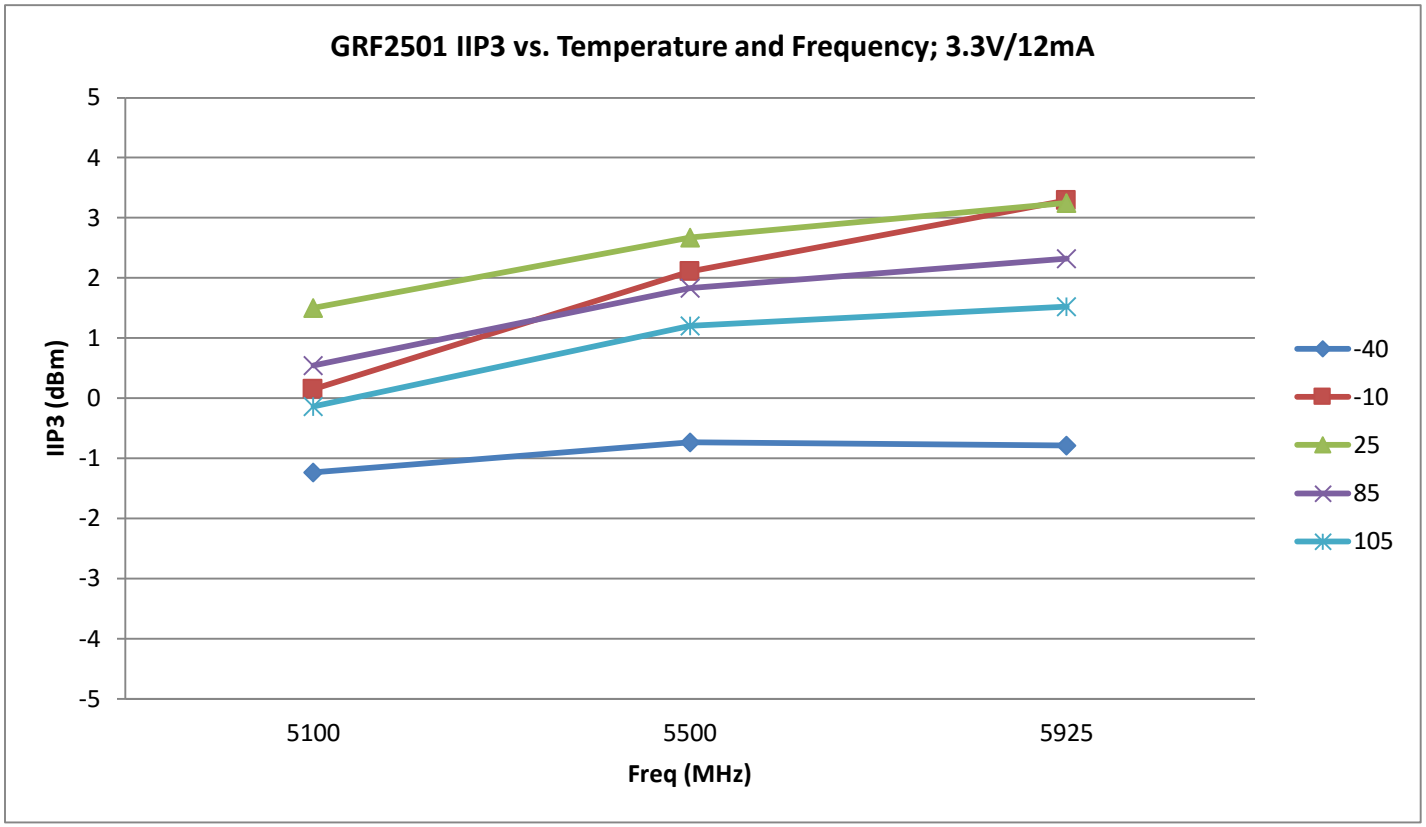

GRF2501 Noise Figure vs. Frequency
NF (dB)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5100
5500
5925
Freq (MHz)
Evaluation Board
De-embedded

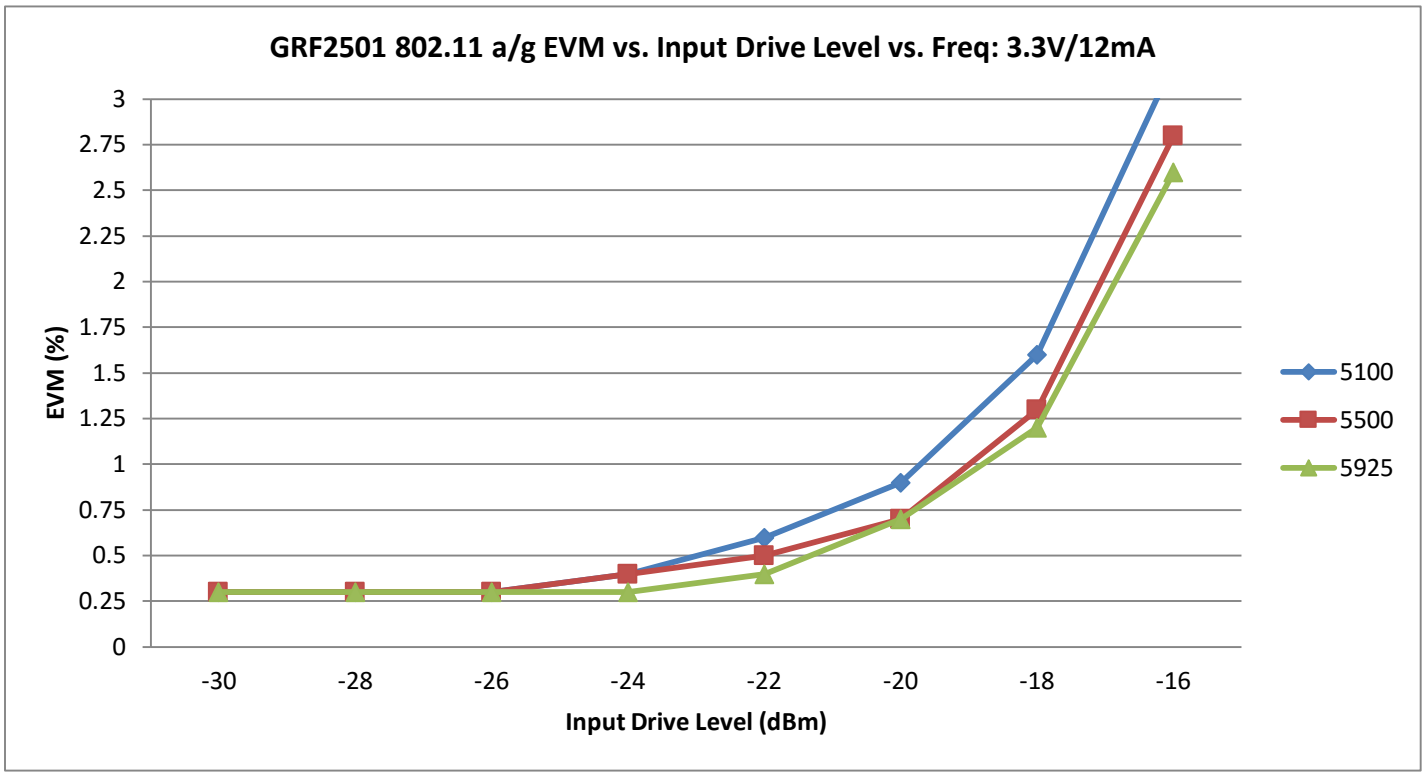

GRF2501 De-embedded Noise Figure vs. Temperature
NF (dB)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-40
-10
25
85
105
Temperature (deg C)
5100
5500
5925

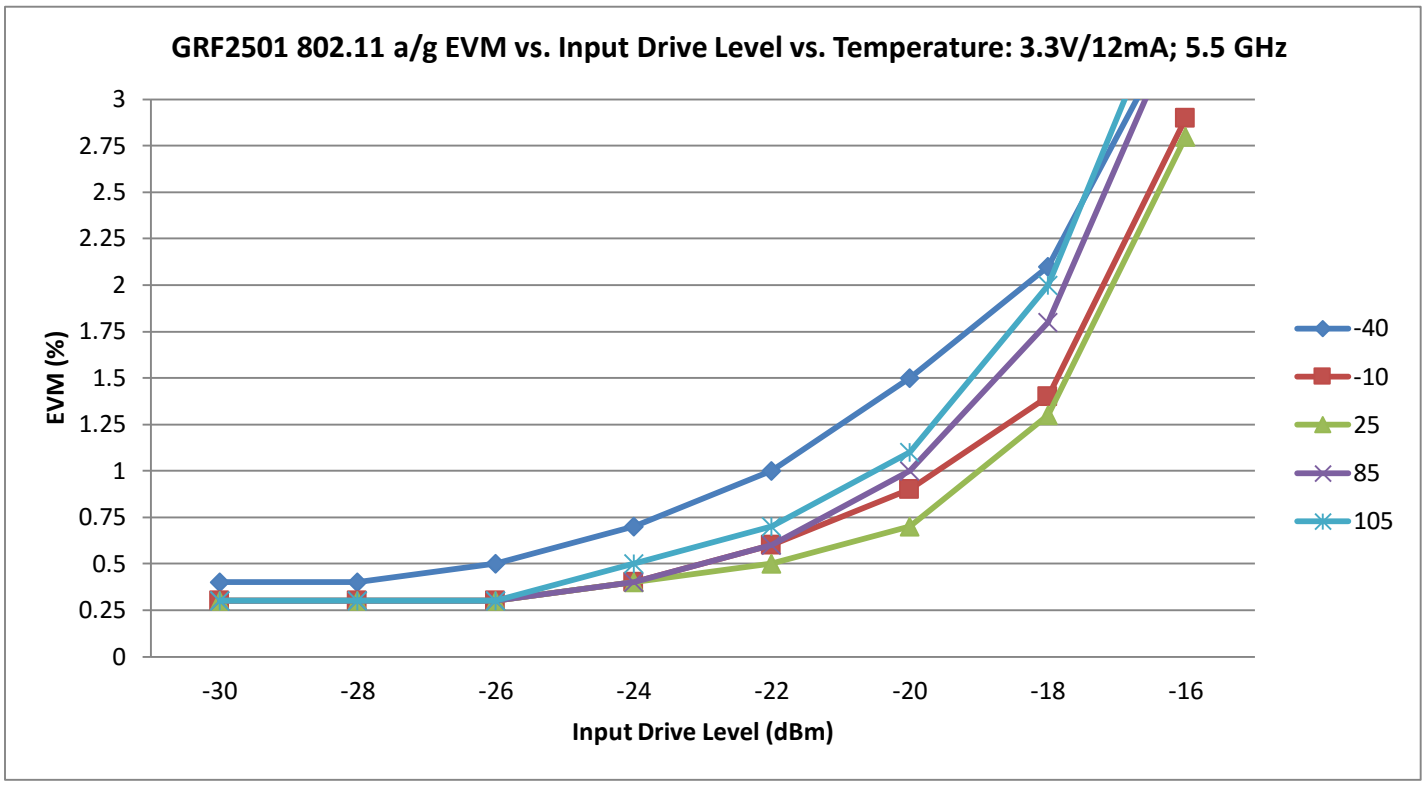

GRF2501 Gain vs. Temperature and Frequency
Gain (dB)
20
19
18
17
16
15
14
13
12
11
10
5100
5500
5925
Freq (MHz)
-40
-10
25
85
105


GRF2501 Iddq vs. Temperature
Iddq (mA)
16
15
14
13
12
11
10
9
8
7
6
-40
-10
25
85
105
Temperature (deg C)

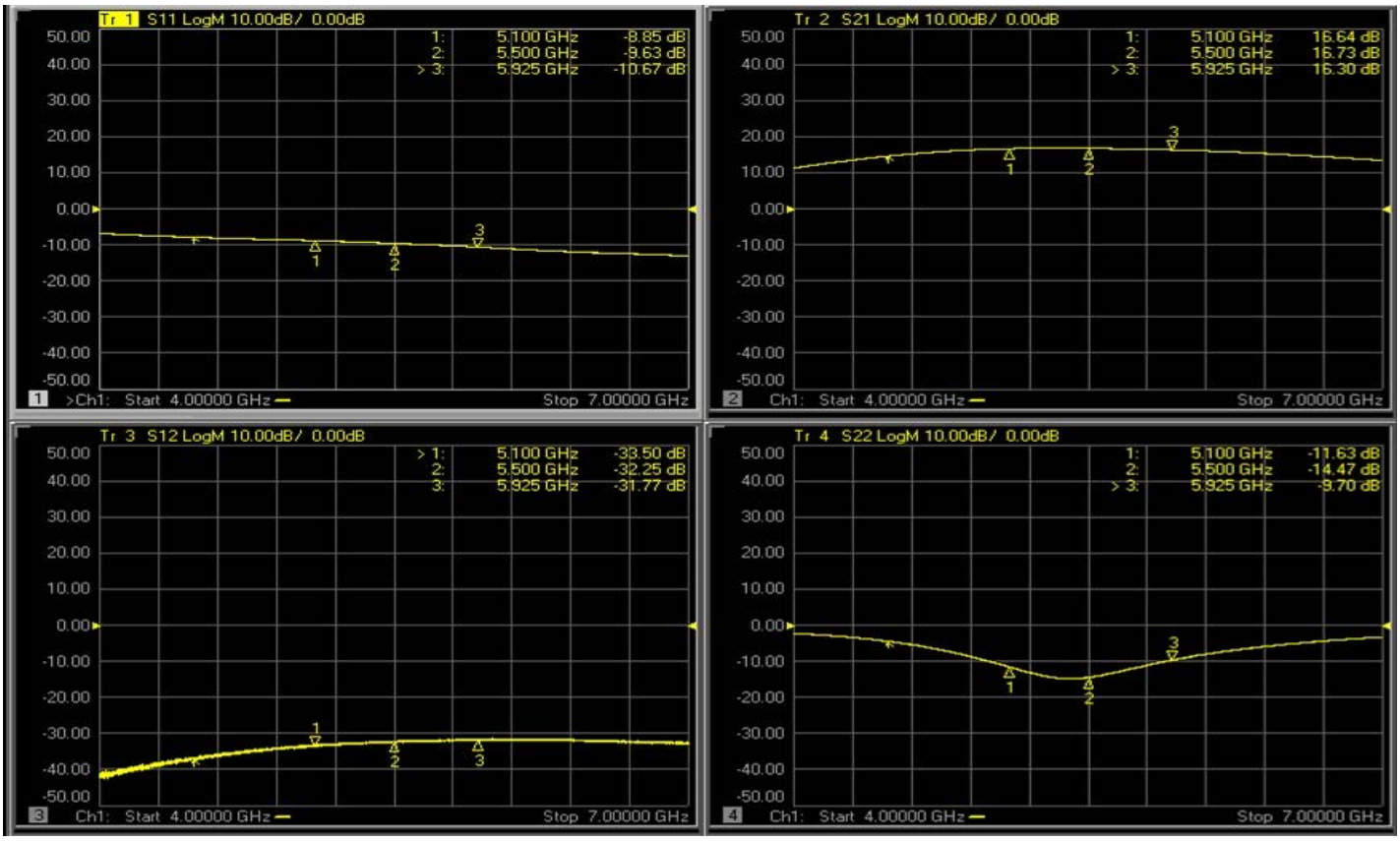

GRF2501 IP1dB vs. Temperature and Frequency; 3.3V/12mA
IP1dB (dBm)
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
5100
5500
5925
Freq (MHz)
-40
-10
25
85
105

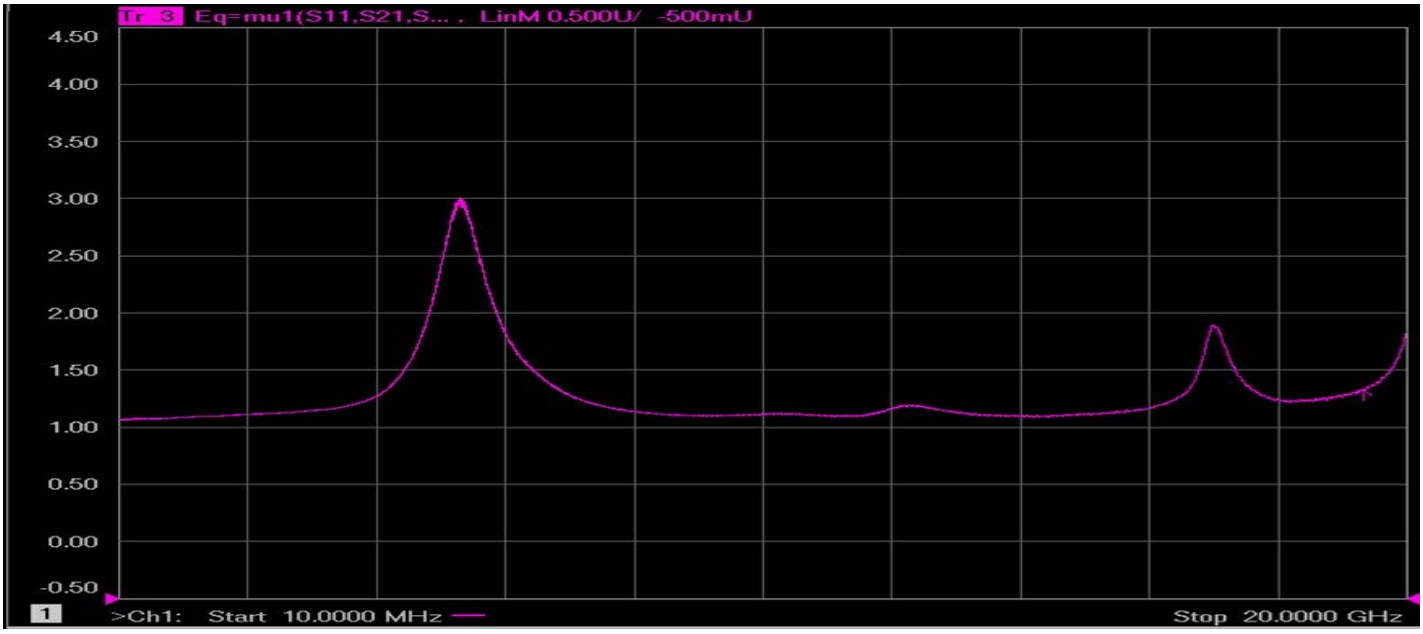

GRF2501 IIP3 vs. Temperature and Frequency; 3.3V/12mA
IIP3 (dBm)
5
4
3
2
1
0
-1
-2
-3
-4
-5
5100
5500
5925
Freq (MHz)
-40
-10
25
85
105


GRF2501 802.11 a/g EVM vs. Input Drive Level vs. Freq: 3.3V/12mA
EVM (%)
3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
-30
-28
-26
-24
-22
-20
-18
-16
Input Drive Level (dBm)
5100
5500
5925


GRF2501 802.11 a/g EVM vs. Input Drive Level vs. Temperature: 3.3V/12mA; 5.5 GHz
EVM (%)
3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
-30
-28
-26
-24
-22
-20
-18
-16
Input Drive Level (dBm)
-40
-10
25
85
105

GRF2501 Evaluation Board S-Pars and Stability Mu Factor:





Note: Mu >= 1.0 implies unconditional stability

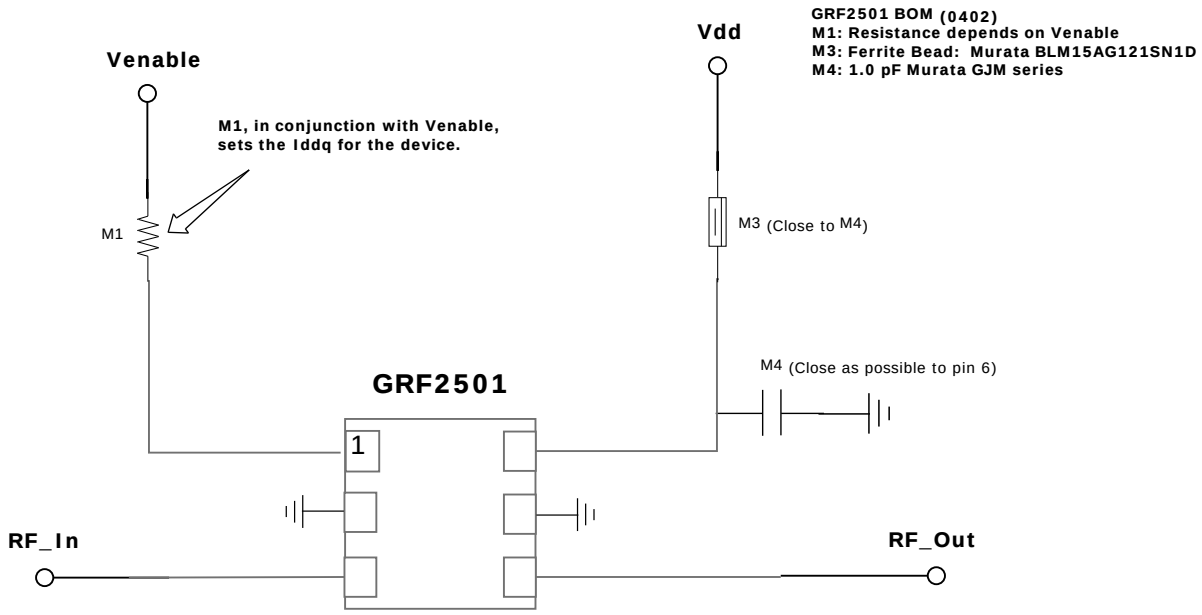
GRF2501 Theory of Operation:

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.

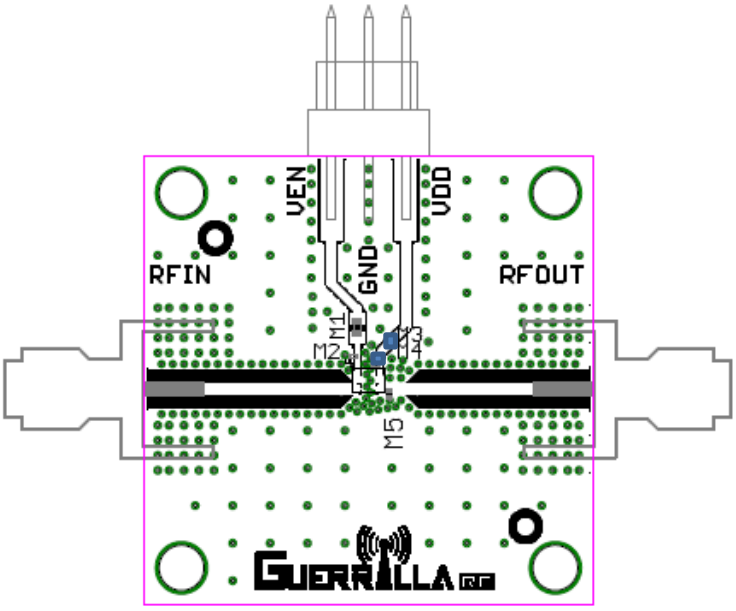
A key element of the application circuit is the low cost ferrite bead in series with the Vdd supply. This ferrite effectively isolates the application circuit so that transmission lines and terminations above it do not affect the device performance. Use of the ferrite also results in improved gain and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

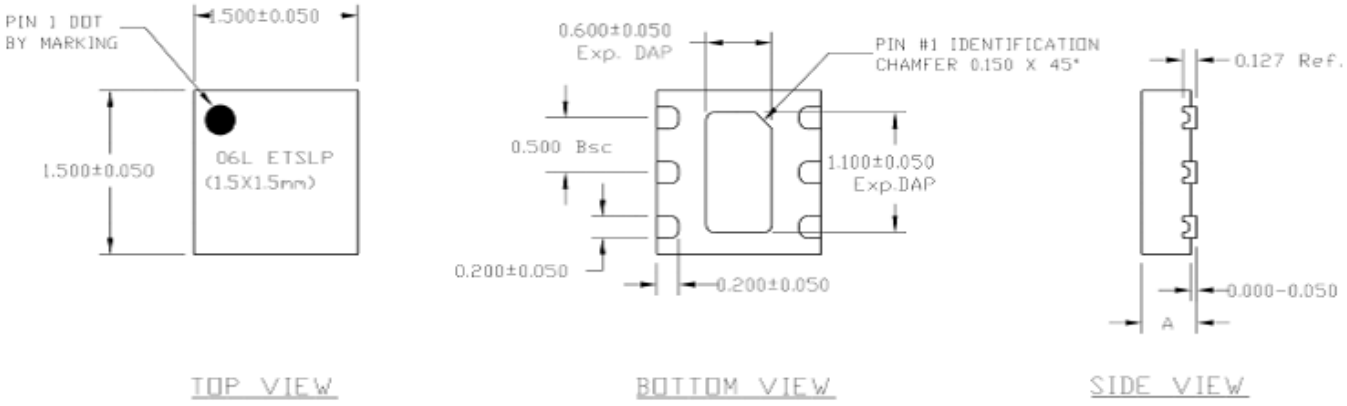
Iddq is set by the Venable voltage and the external resistor in series with it. For Vdd = Venable = 3.3 volts, a resistor value of 1.3k ohms will result in an Iddq of approximately 12 mA.



GRF2501 Evaluation Board Application Schematic



GRF2501 Evaluation Board Assembly Diagram



		ETSLP
A	MAX.	0.500
	NOM.	0.450
	MIN.	0.400

DESCRIPTION	DATE	BY	APPD

TOLERANCES: REFER TO SPECIFICATION ABOVE

UNIT: MM | SCALE: NTS

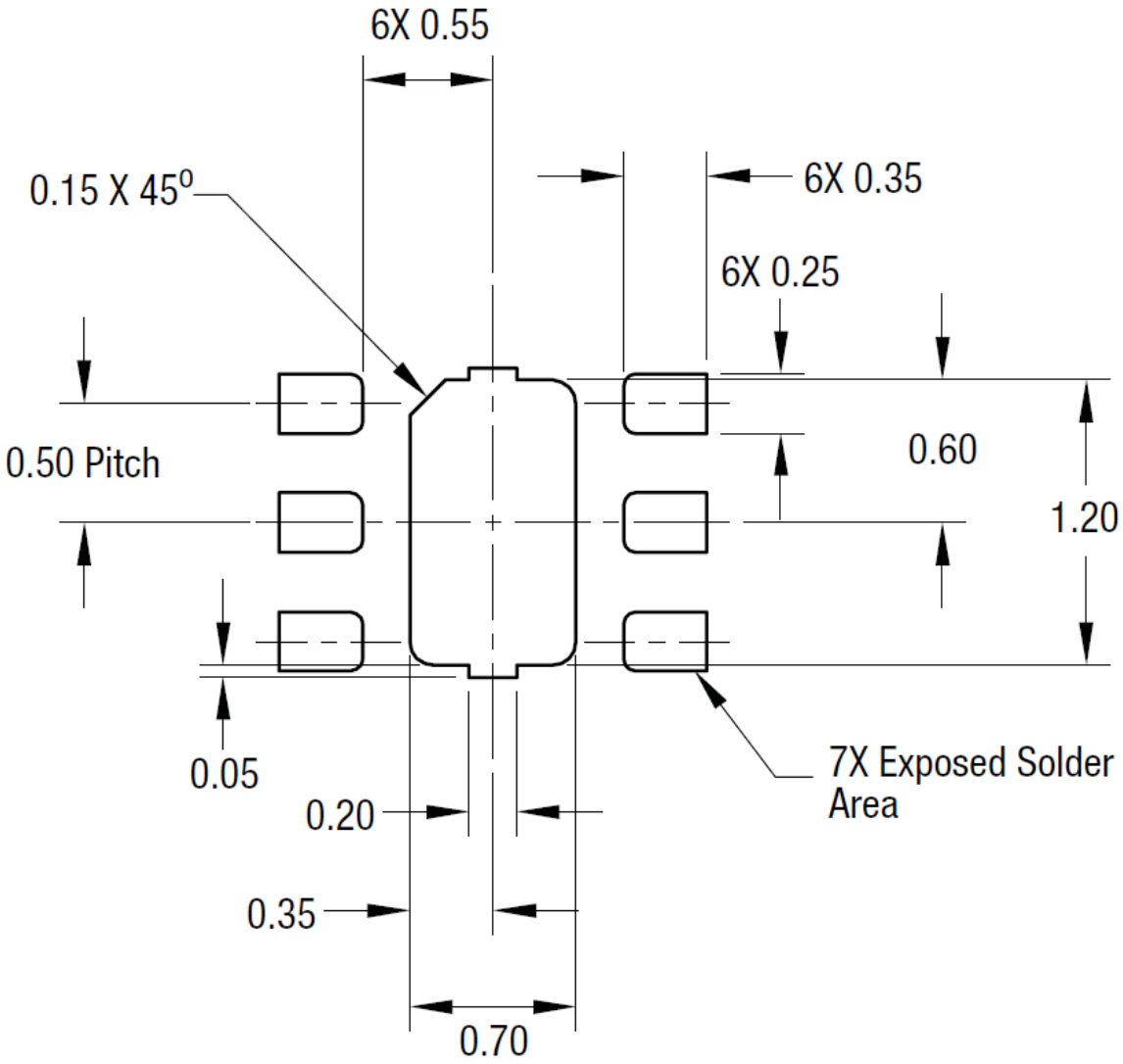
SYMBOL

DATE:
DATE:
DATE:
DATE:
DATE:
REV.: 00

06L (ETSLP) 1.5X1.5 mm
(PACKAGE OUTLINE)

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.