Preliminary

GRF2004

Broadband Gain Block with Low NF; 0.05 – 10.0 GHz

Package: 1.5 x 1.5 mm DFN-6

Features

- Bandwidth: 0.05 to 10.0 GHz
- Gain: 19.5 dB @ 2.0 GHz
- Gain: 10.2 dB @ 10.0 GHz
- OP1dB: +19.7 dBm @ 2.0 GHz
- OP1dB: +11.1 dBm @ 10.0 GHz
- OIP3: +33.0 dBm @ 2.0 GHz
- NF: 1.3 dB @ 2.0 GHz
- Flexible Bias Voltage and Current

Applications

- Microwave Backhaul
- Multi-stage Cascaded Amplifiers
- C and X-Band Amplifiers
- Fast Switching TDD Systems
- General Purpose Amplifier

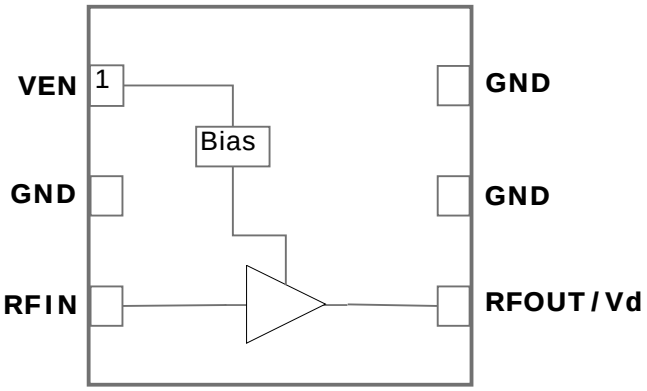
Product Description

The GRF2004 is a broadband, low noise linear gain block designed for small cell, wireless infrastructure and other high performance RF applications. Internally matched to 50 ohms, it exhibits low NF, with good linearity and gain flatness over 0.05 to 10.0 GHz.

Due to its flexible biasing capability, GRF2004 offers high levels of reuse both within a design and across platforms. The device can be operated over a range of supply voltages from 2.7 to 5.5 V with a typical Iddq range of 50 to 120 mA for optimal efficiency and linearity.

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	5.5	V
RF Input Power: (Load VSWR < 2:1; V_D: 5.0 volts)	$P_{IN\ MAX}$		+15	dBm
Operating Temperature (Package Heat Sink)	T_{AMB}	-40	+105	°C
Storage Temperature	T_{STG}	-40	+150	°C
Maximum Channel Temperature (MTTF > 10^6 Hours)	Tmax		+160	°C
Maximum Dissipated Power (Note: De-rate 8 mW/°C for T_{AMB} > +85C.	$P_{DISS\ MAX}$		600	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

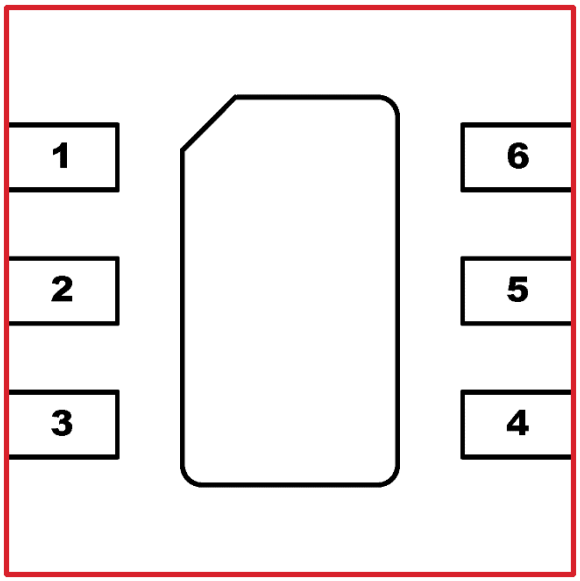
Caution! ESD Sensitive Device

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

Nominal Operating Parameters

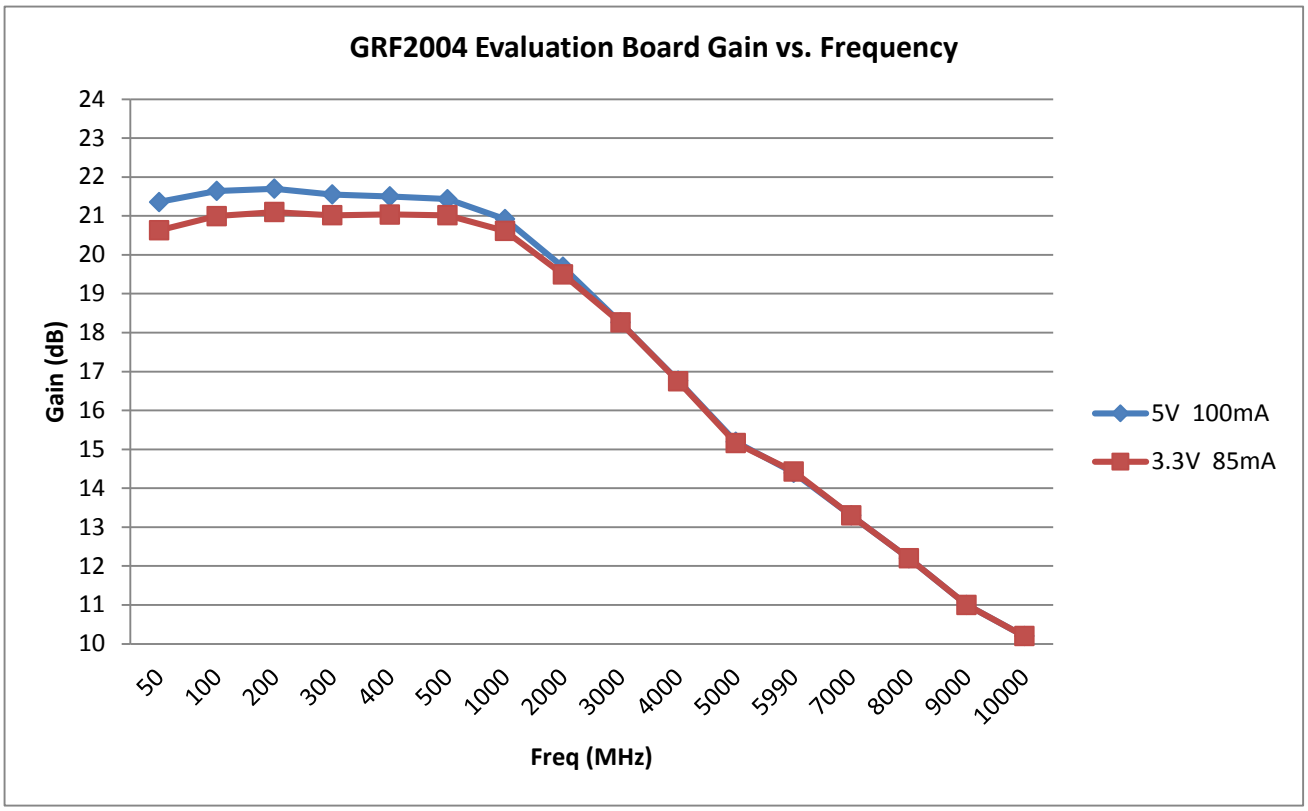
Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Gain Mode (Venable high)						Vdd = 5.0 V, T_A = 25°C
Test Frequency	F_{test}		2.0		GHz	
Gain	S21		19.5		dB	
Input Return Loss	S11		-15		dB	
Output Return Loss	S22		-15		dB	
Noise Figure (De-embedded)	NF		1.3		dB	
Output 3rd Order Intercept	OIP3		+33.0		dBm	+2 dBm P_{OUT} per tone at 2 MHz Spacing (2599 and 2601 MHz)
Ouput 1dB Compression Power	OP1dB		+19.7		dBm	
Switching Rise Time	T_{RISE}		300		ns	
Switching Fall Time	T_{FALL}		300		ns	
Supply Current	Idd		100		mA	Adjustable for optimal IP3
Enable Current	Ienable		3		mA	
Thermal Data						
Thermal Resistance (measured via IR scan)	Θjc		104		°C/W	On standard evaluation board
Channel Temperature @ +85 C Reference (Package Heat Sink)	Tchannel		137		°C	Vdd: 5.0 V; Iddq: 100 mA; No RF; Pdiss: 500 mW

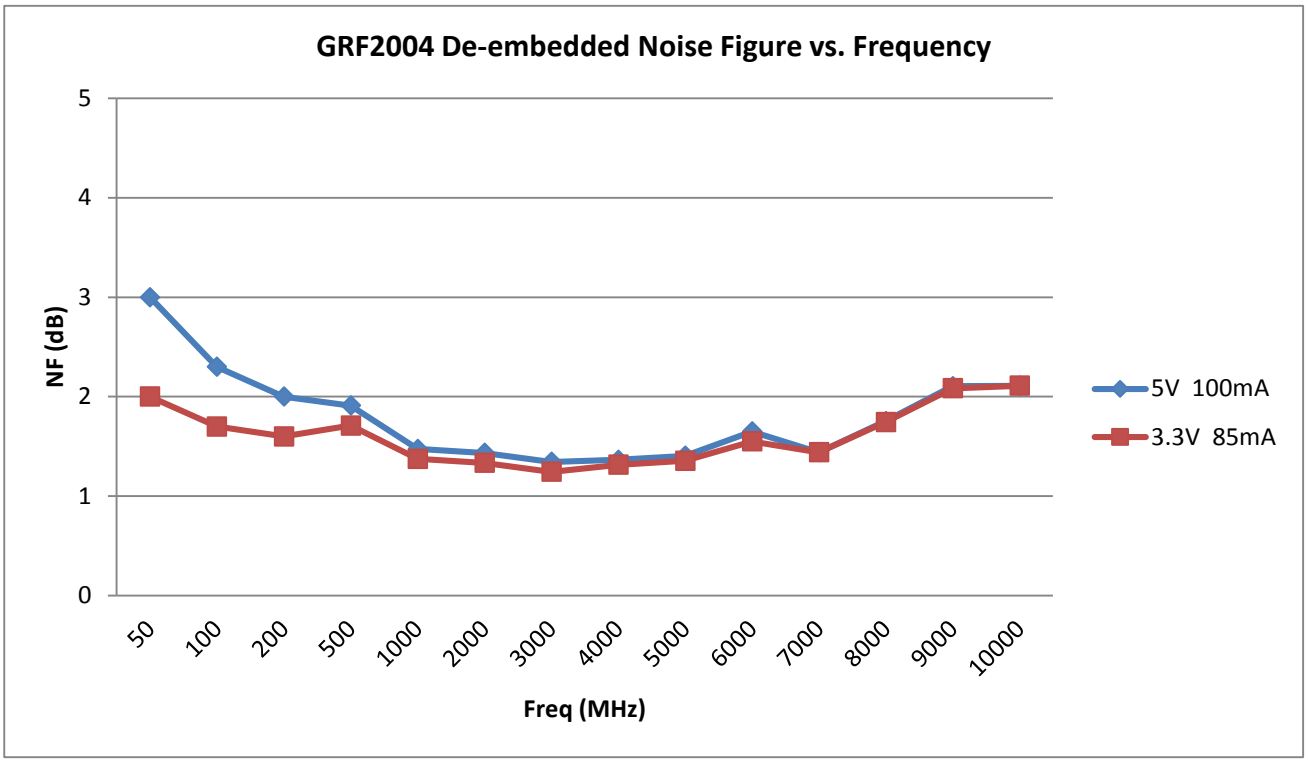
Pin Out

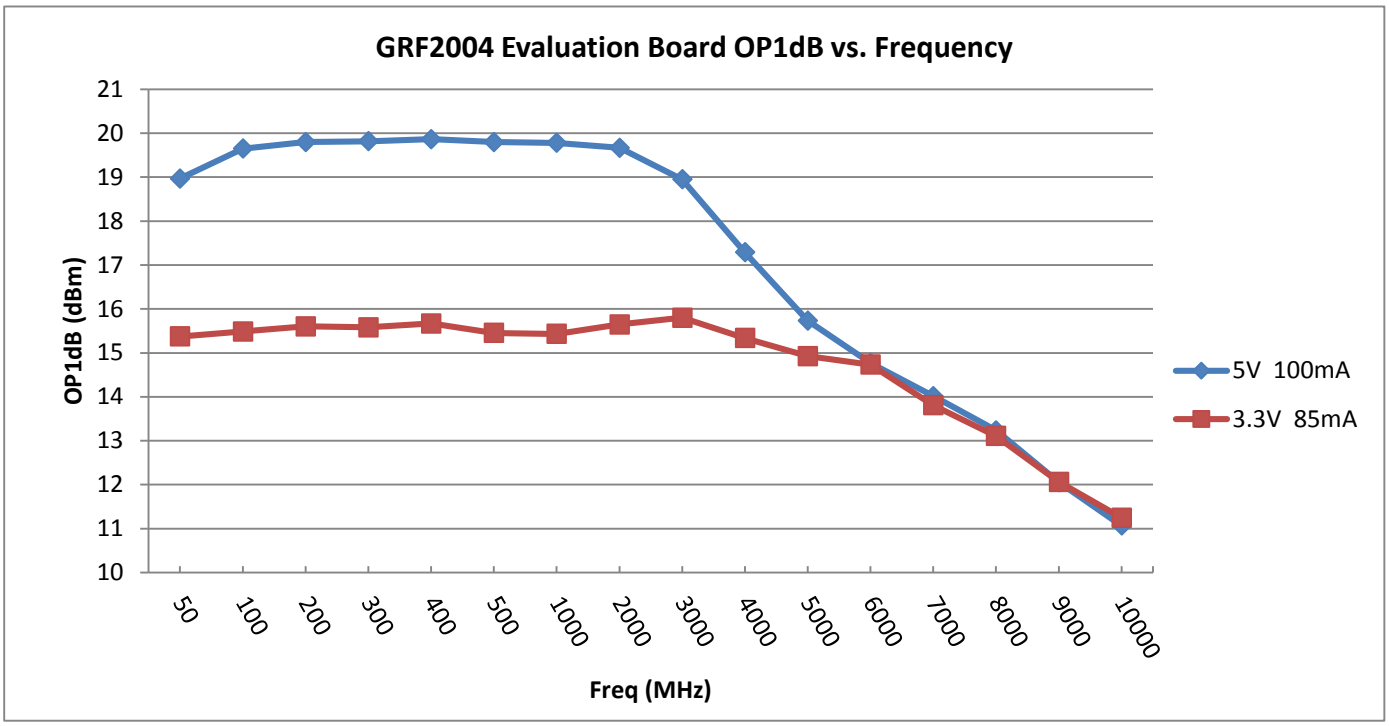


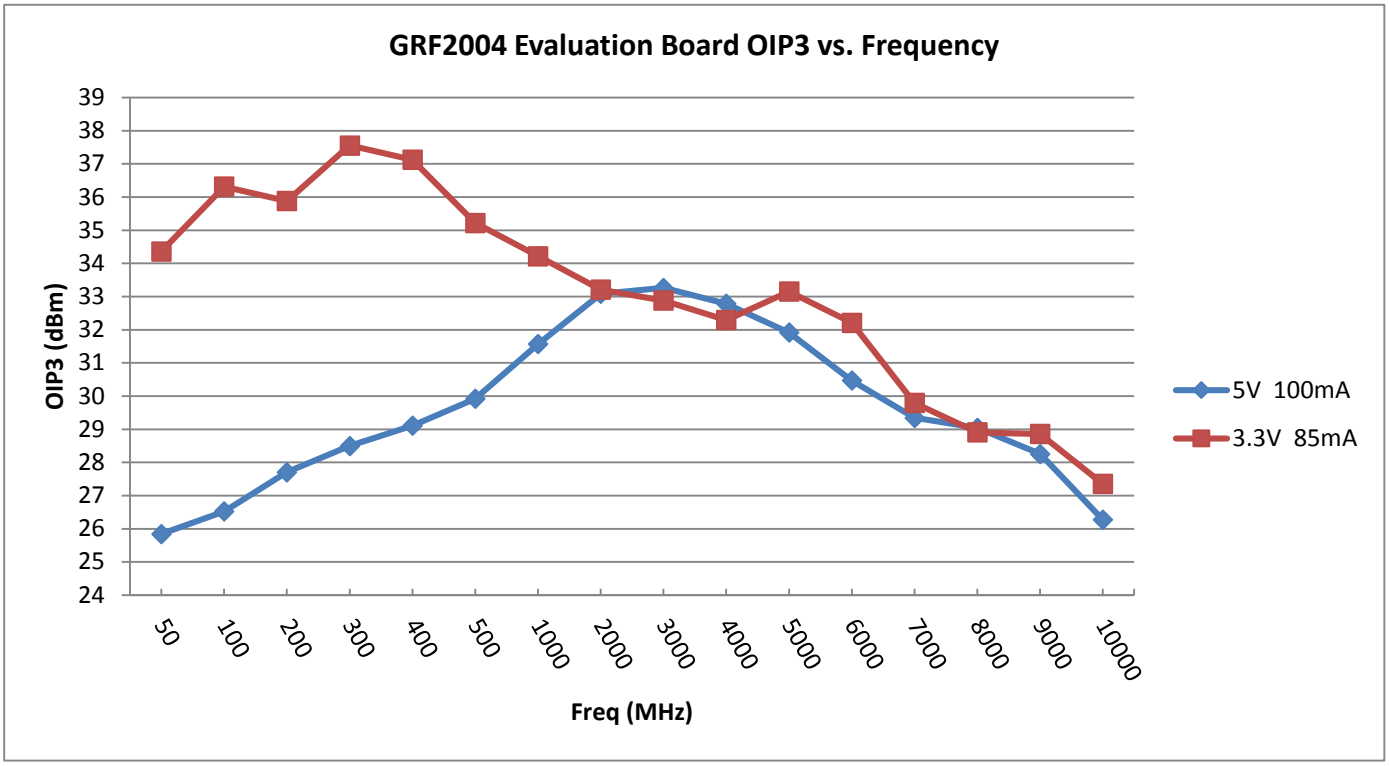
Pin Assignments

Pin	Name	Description	Note
1	V_{ENABLE}	Enable Voltage Input	Venable < 0.2 volts turns the device off. Venable and series resistor control the device Iddq.
2	GND	Ground	Connect to ground for maximum RF performance.
3	RF_{IN}	LNA RF input	Internally matched 50 Ω. This pin must be DC blocked.
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.

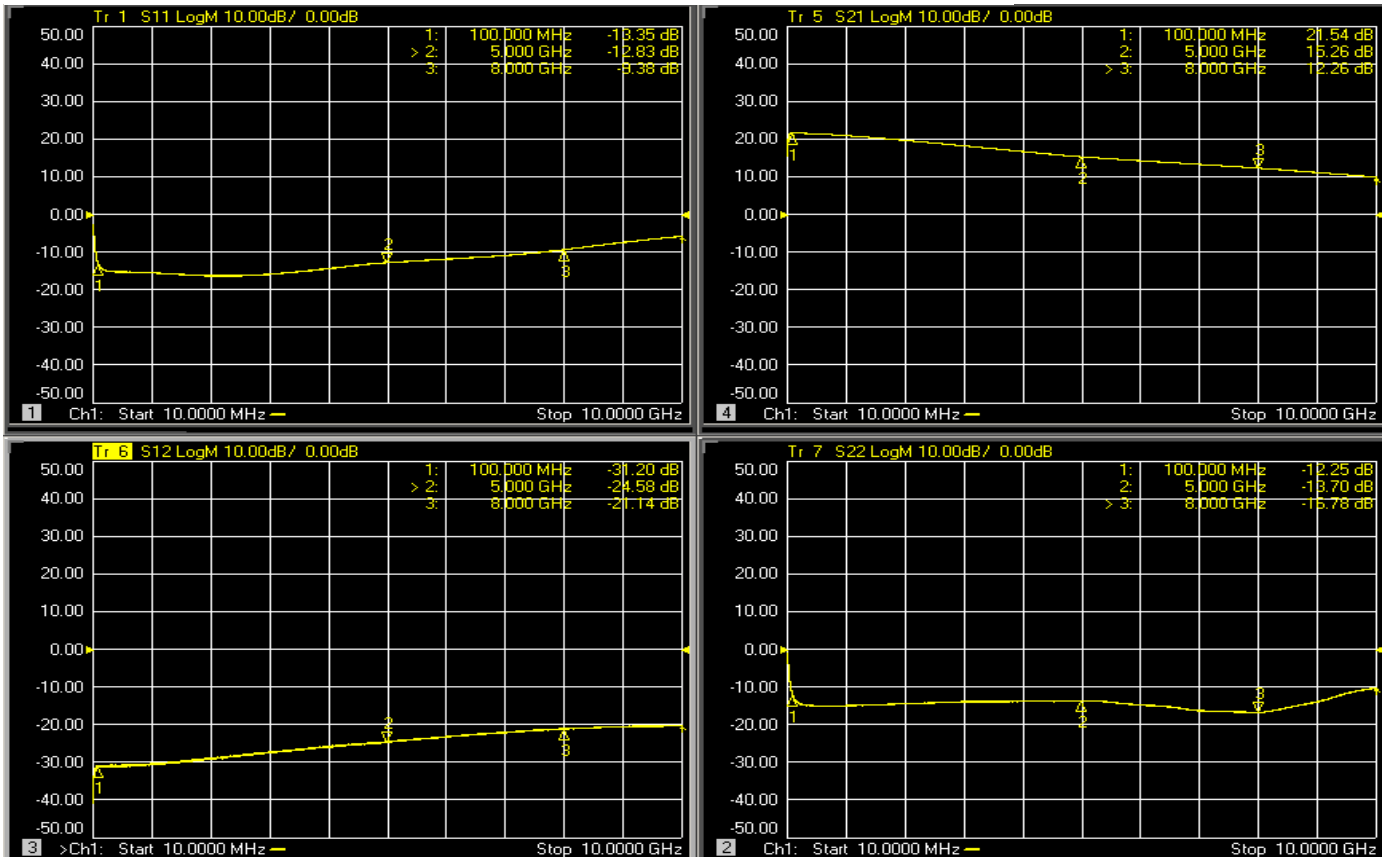

GRF2004 Evaluation Board Gain vs. Frequency
Gain (dB)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
50
100
200
300
400
500
1000
2000
3000
4000
5000
5990
7000
8000
9000
10000
Freq (MHz)
5V 100mA
3.3V 85mA

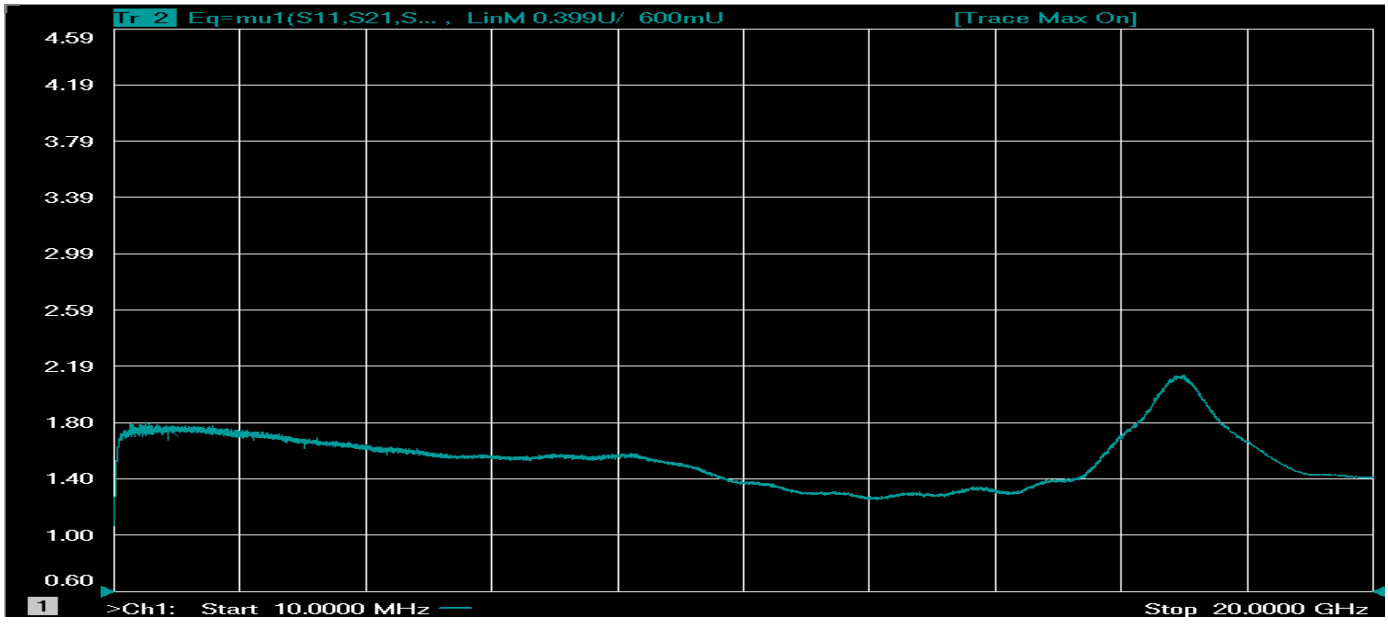

GRF2004 De-embedded Noise Figure vs. Frequency
NF (dB)
5
4
3
2
1
0
50
100
200
500
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Freq (MHz)
5V 100mA
3.3V 85mA


GRF2004 Evaluation Board OP1dB vs. Frequency
OP1dB (dBm)
21
20
19
18
17
16
15
14
13
12
11
10
50
100
200
300
400
500
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Freq (MHz)
5V 100mA
3.3V 85mA

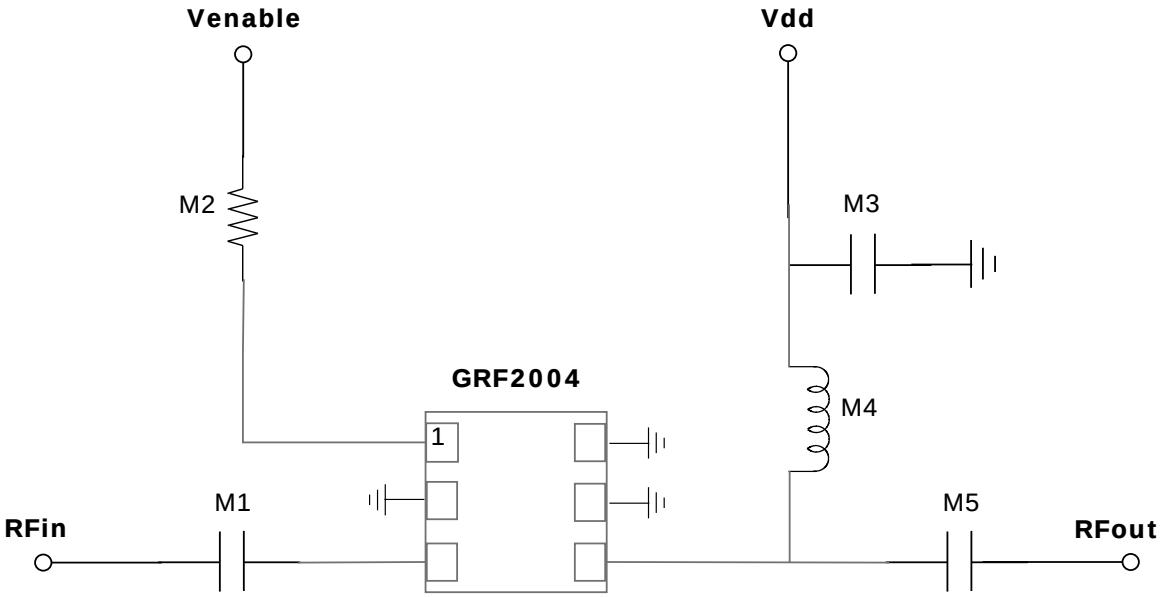

GRF2004 Evaluation Board OIP3 vs. Frequency
OIP3 (dBm)
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
50
100
200
300
400
500
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Freq (MHz)
5V 100mA
3.3V 85mA

GRF2004 Evaluation Board S-Parameters and Stability Mu Factor





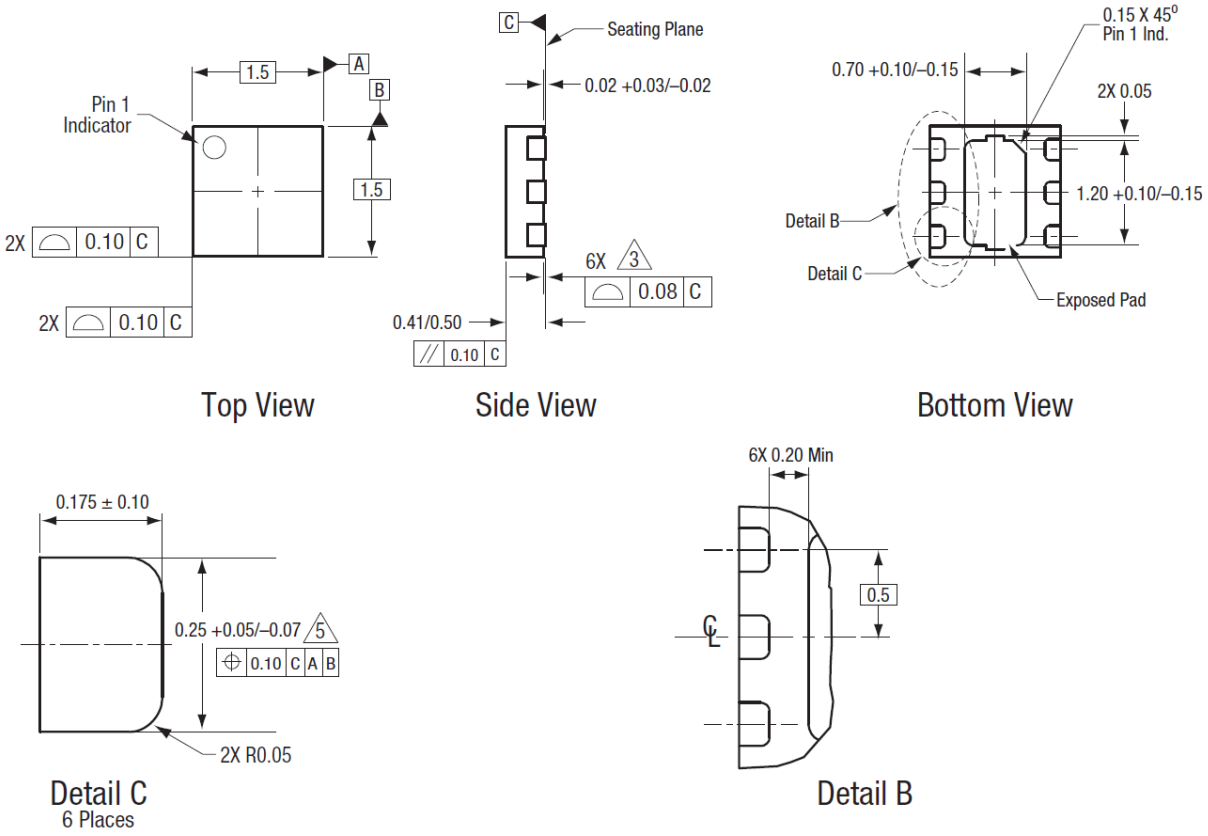
Note: Mu >= 1.0 implies unconditional stability



GRF2004 Application Schematic

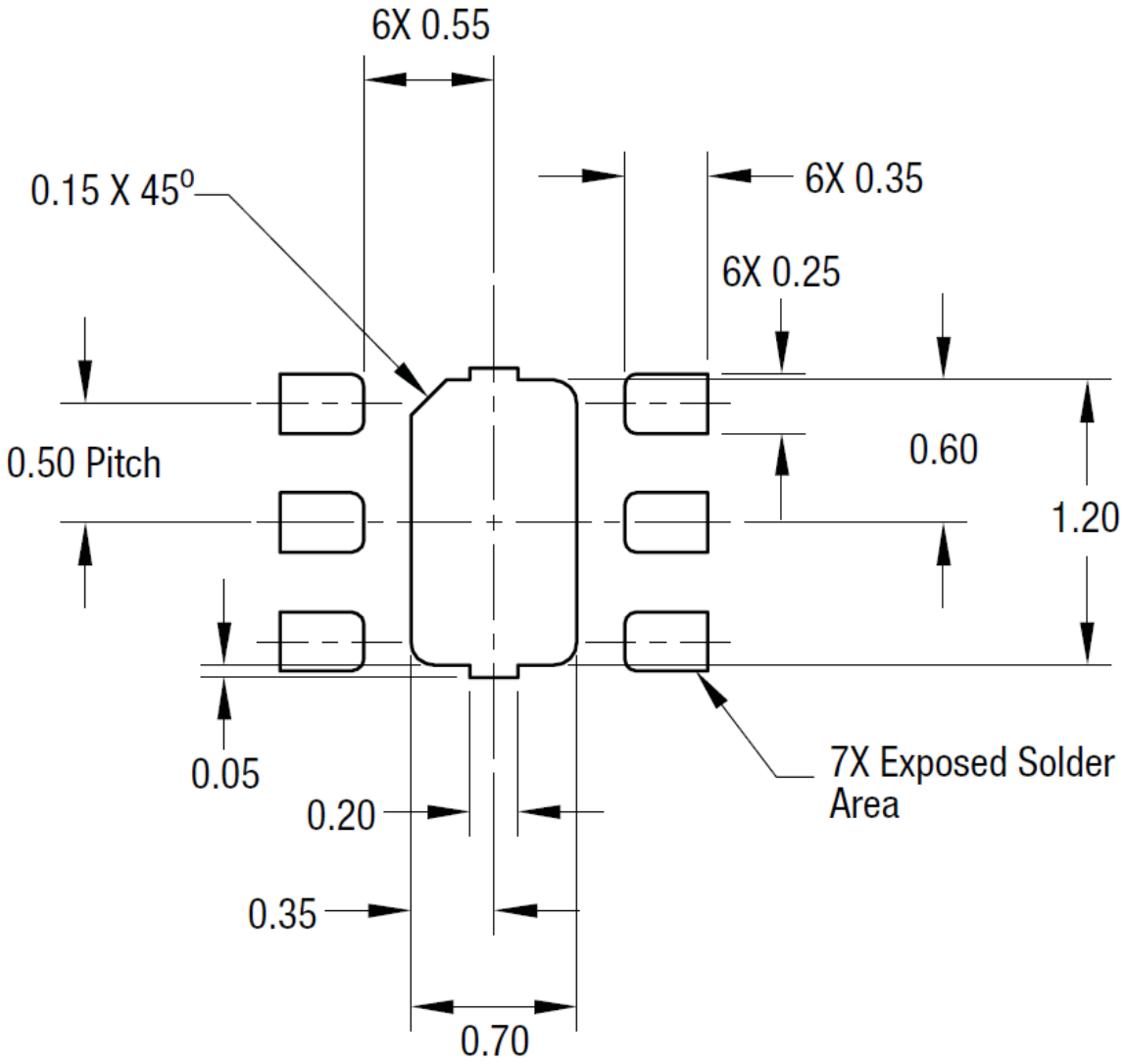
Device	Vdd	Venable	M3 (ohms)	Iddq (mA)		Device	Vdd	Venable	M3 (ohms)	Iddq (mA)		Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2004	5.0	5.0	2000	130		GRF2004	4.5	4.5	1200	123		GRF2004	4.0	4.0	1000	104
GRF2004	5.0	5.0	2500	122		GRF2004	4.5	4.5	2500	102		GRF2004	4.0	4.0	2500	82
GRF2004	5.0	5.0	3000	114		GRF2004	4.5	4.5	3000	95		GRF2004	4.0	4.0	3000	77
GRF2004	5.0	5.0	3500	108		GRF2004	4.5	4.5	3500	89		GRF2004	4.0	4.0	3500	72
GRF2004	5.0	5.0	4000	102		GRF2004	4.5	4.5	4000	85		GRF2004	4.0	4.0	4000	68
GRF2004	5.0	5.0	7000	77		GRF2004	4.5	4.5	7000	63		GRF2004	4.0	4.0	7000	50
GRF2004	5.0	5.0	10000	63		GRF2004	4.5	4.5	10000	51		GRF2004	4.0	4.0	10000	40
GRF2004	5.0	5.0	15000	48		GRF2004	4.5	4.5	15000	39		GRF2004	4.0	4.0	15000	31
GRF2004	5.0	5.0	20000	39		GRF2004	4.5	4.5	20000	31		GRF2004	4.0	4.0	20000	26
GRF2004	5.0	5.0	30000	29		GRF2004	4.5	4.5	30000	24		GRF2004	4.0	4.0	30000	21
GRF2004	5.0	5.0	40000	24		GRF2004	4.5	4.5	40000	20		GRF2004	4.0	4.0	40000	15
GRF2004	5.0	5.0	50000	22		GRF2004	4.5	4.5	50000	18		GRF2004	4.0	4.0	50000	13
Device	Vdd	Venable	M3 (ohms)	Iddq (mA)		Device	Vdd	Venable	M3 (ohms)	Iddq (mA)		Device	Vdd	Venable	M3 (ohms)	Iddq (mA)
GRF2004	3.6	3.6	1000	86		GRF2004	3.3	3.3	0	90		GRF2004	3.0	3.0	0	74
GRF2004	3.6	3.6	2000	73		GRF2004	3.3	3.3	1000	73		GRF2004	3.0	3.0	1000	60
GRF2004	3.6	3.6	3000	63		GRF2004	3.3	3.3	2000	62		GRF2004	3.0	3.0	2000	51
GRF2004	3.6	3.6	4000	55		GRF2004	3.3	3.3	3000	53		GRF2004	3.0	3.0	3000	44
GRF2004	3.6	3.6	6000	45		GRF2004	3.3	3.3	4000	47		GRF2004	3.0	3.0	4000	39
GRF2004	3.6	3.6	7000	41		GRF2004	3.3	3.3	6000	38		GRF2004	3.0	3.0	6000	32
GRF2004	3.6	3.6	10000	33		GRF2004	3.3	3.3	7000	35		GRF2004	3.0	3.0	7000	29
GRF2004	3.6	3.6	15000	26		GRF2004	3.3	3.3	10000	28		GRF2004	3.0	3.0	10000	24
GRF2004	3.6	3.6	20000	22		GRF2004	3.3	3.3	15000	23		GRF2004	3.0	3.0	15000	21
GRF2004	3.6	3.6	30000	15		GRF2004	3.3	3.3	20000	20		GRF2004	3.0	3.0	20000	18

Note: For a given Venable voltage and desired Iddq, use the above table to determine the required M2 resistor value. Vdd higher than Venable will result in a slight increase in Iddq compared to Vdd = Venable.



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.

GRF2004 6-Pin DFN Package Dimensions



GRF2004 1.5 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.