RF5188

3V 1950MHZ W-CDMA LINEAR POWER AMPLIFIER MODULE

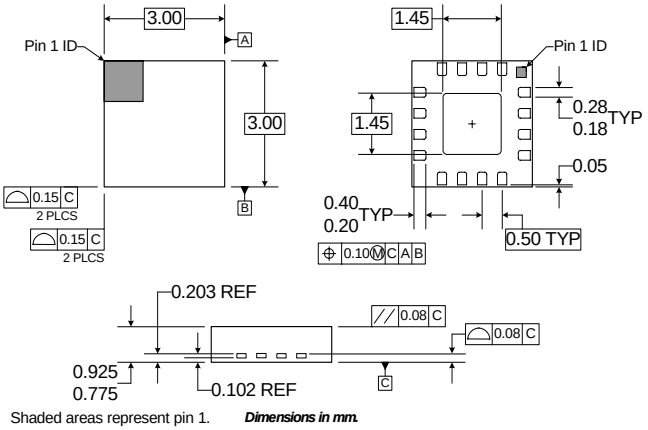
RoHS Compliant & Pb-Free Product

Typical Applications

- 3V W-CDMA Band 1 Handsets
- Multi-Mode W-CDMA 3G Handsets
- 3V TD-SCDMA Handsets
- Spread-Spectrum Systems

Product Description

The RF5188 is a high-power, high-efficiency linear amplifier module specifically designed for 3V handheld systems. The device is manufactured on an advanced third generation GaAs HBT process, and was designed for use as the final RF amplifier in 3V W-CDMA handheld digital cellular equipment, spread-spectrum systems, and other applications in the 1920MHz to 1980MHz band (Band 1). The RF5188 has a digital control line for low power applications to lower quiescent current. The RF5188 is assembled in at 16-pin, 3mmx3mm, QFN package.

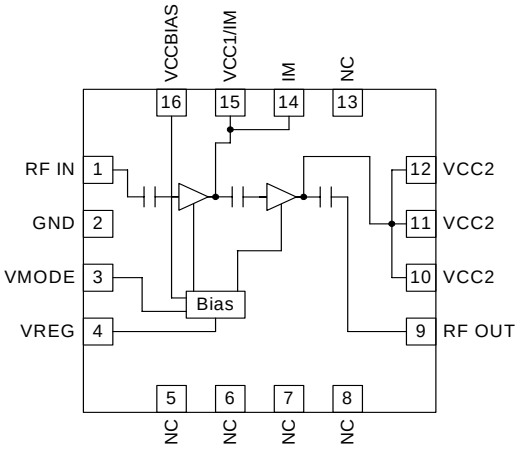


Shaded areas represent pin 1. ***Dimensions in mm.***

Optimum Technology Matching® Applied

- ☐ Si BJT
- ☑ GaAs HBT
- ☐ GaAs MESFET
- ☐ Si Bi-CMOS
- ☐ SiGe HBT
- ☐ Si CMOS
- ☐ InGaP/HBT
- ☐ GaN HEMT
- ☐ SiGe Bi-CMOS

Package Style: QFN, 16-Pin, 3x3



Functional Block Diagram

Features

- Input/Output Internally Matched@50Ω
- 27.5dBm Linear Output Power
- 42% Peak Linear Efficiency
- 28dB Linear Gain
- -42dBc ACLR @ ±5MHz
- HSDPA Capable

Ordering Information

RF5188	3V 1950MHz W-CDMA Linear Power Amplifier Module
RF5188PCBA-41X	Fully Assembled Evaluation Board

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Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage (RF off)	+8.0	V
Supply Voltage ($P_{OUT} \leq 31$dBm)	+5.2	V
Control Voltage (V_{REG})	+3.9	V
Input RF Power	+10	dBm
Mode Voltage (V_{MODE})	+3.9	V
Operating Temperature	-30 to +110	°C
Storage Temperature	-40 to +150	°C
Moisture Sensitivity Level (IPC/JEDEC J-STD-20)	MSL 2 @ 260	°C

Caution! ESD sensitive device.

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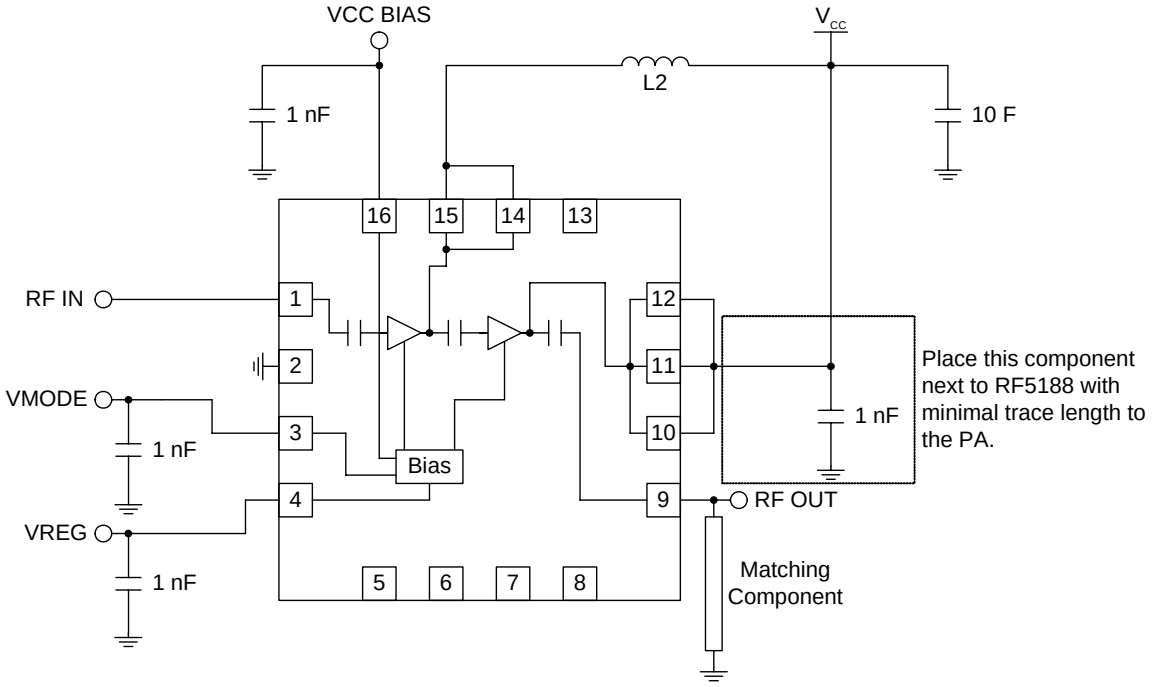
Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
High Gain Mode (V_{MODE} Low)					T=25°C Ambient, V_{CCBIAS}=3.4V, V_{CC}=3.4V, V_{REG}=2.8V, V_{MODE}=0V, and P_{OUT}=27.5dBm for all parameters (unless otherwise specified). Modulation is 3GPP 3.2 03-00 DPCCH+1DPDCH.
Operating Frequency Range	1920		1980	MHz	
Linear Gain	26	28.5	32	dB	
Harmonics			-10	dBm	f=2fo, 3fo
Maximum Linear Output	27.5			dBm	
Linear Efficiency	38	42	47	%	
Maximum I_{CC}	352	394	435	mA	
ACLR1 @ ±5MHz		-42	-37	dBc	
ACLR2 @ ±10MHz		-53	-48	dBc	
Input VSWR		1.7:1			
Output VSWR Stability			6:1		No oscillation>-70dBc
Ruggedness			10:1		No damage
Noise Power		-150		dBm/Hz	-50≤P_{OUT}≤+27.5dBm, RX=925MHz to 960MHz (EGSM)
		-133		dBm/Hz	-50≤P_{OUT}≤+27.5dBm, RX=1805MHz to 1880MHz (DCS)
		-140		dBm/Hz	-50≤P_{OUT}≤+27.5dBm, RX=2110MHz to 2170MHz (W-CDMA), TX/RX Offset=130MHz
		-143		dBm/Hz	-50≤P_{OUT}≤+27.5dBm, RX=2110MHz to 2170MHz (W-CDMA), TX/RX Offset=190MHz
		-147		dBm/Hz	-50≤P_{OUT}≤+27.5dBm, RX=2400MHz to 2480MHz (Bluetooth)
		-107		dBm/Hz	-50≤P_{OUT}≤+27.5dBm, TX=1932.3MHz to 1980MHz, RX=1893.5MHz to 1919.6MHz (PHS)
IM Products					
IM 5MHz			-31	dBc	IF offset f_O+5MHz with CW signal=-40dBc
IM 10MHz			-41	dBc	IF offset f_O+10MHz with CW signal=-40dBc

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Low Gain Mode (V_{MODE} High)					T=25°C Ambient, V_{CCBIAS}=3.4V, V_{CC}=1.5V, V_{REG}=2.8V, V_{MODE}=2.8V, and P_{OUT}=16dBm for all parameters (unless otherwise specified). Modulation is 3GPP 3.2 03-00 DPCCH+1DPDCH.
Operating Frequency Range	1920		1980	MHz	
Linear Gain	22	26	31	dB	
Maximum Linear Output	16			dBm	
Linear Efficiency	18.3	21.0	25.3	%	
ACLR @ ±5MHz		-41	-37	dBc	
ACLR @ ±10MHz		-54	-48	dBc	
Maximum I_{CC}	105	125	145	mA	
Input VSWR		2:1			
Output VSWR Stability			6:1		No oscillation>-65dBc
Ruggedness			10:1		No damage
IM Products					
IM 5MHz			-31	dBc	IF offset f_O+5MHz with CW signal=-40dBc
IM 10MHz			-41	dBc	IF offset f_O+10MHz with CW signal=-40dBc
Power Supply					
Supply Voltage (V_{CC1} and V_{CC2})	3.2	3.4	4.2	V	
	0.6			V	Low power with DC to DC Converter
V_{CC} Bias	1.5		4.2	V	
High Gain Idle Current (I_{CC1}/I_{CC2}/I_{CCBIAS})		70	93	mA	V_{MODE}=low and V_{REG}=2.8V, V_{CC}=3.4V
Low Gain Idle Current (I_{CC1}/I_{CC2}/I_{CCBIAS})		60	83	mA	V_{MODE}=high and V_{REG}=2.8V, V_{CC}=1.5V
V_{REG} Current		1	3	mA	
V_{MODE} Current		250		uA	
RF Turn On/Off Time		1.2	6	uS	
DC Turn On/Off Time		2	25	uS	
Total Current (Power Down)		0.2	0.5	uA	
V_{REG} Low Voltage (Power Down)	0		0.5	V	
V_{REG} High Voltage (Recommended)	2.75	2.8	2.95	V	
V_{REG} High Voltage (Operational)	2.7		3.0	V	
V_{MODE} Voltage	0		0.5	V	High Gain Mode
V_{MODE} Voltage	2.0		3.0	V	Low Gain Mode

Pin	Function	Description	Interface Schematic
1	RF IN	RF input internally matched to 50Ω. This input is internally AC-coupled.	
2	GND	Ground connection.	
3	VMODE	For nominal operation (High Power mode), V_{MODE} is set LOW. When set HIGH, devices are biased lower to improve efficiency at lower output levels.	
4	VREG	Regulated voltage supply for amplifier bias circuit. In power down mode, both V_{REG} and V_{MODE} need to be LOW (<0.5V).	
5	NC	No connection. Do not connect this pin to any external circuit.	
6	NC	No connection. Do not connect this pin to any external circuit.	
7	NC	No connection. Do not connect this pin to any external circuit.	
8	NC	No connection. Do not connect this pin to any external circuit.	
9	RF OUT	RF output. Internally AC-coupled.	
10	VCC2	Output stage collector supply. Please see the schematic for required external components.	
11	VCC2	Same as pin 10.	
12	VCC2	Same as pin 10.	
13	NC	No connection. Do not connect this pin to any external circuit.	
14	IM	Interstage matching. Connect to pin 15.	
15	VCC1/IM	First stage collector supply and interstage matching. A 4.7μF decoupling capacitor may be required. Connect to pin 14.	
16	VCCBIAS	Power supply input for the DC bias circuitry.	
Pkg Base	GND	Ground connection. The backside of the package should be soldered to a top side ground pad which is connected to the ground plane with multiple vias. The pad should have a short thermal path to the ground plane.	

Application Schematic



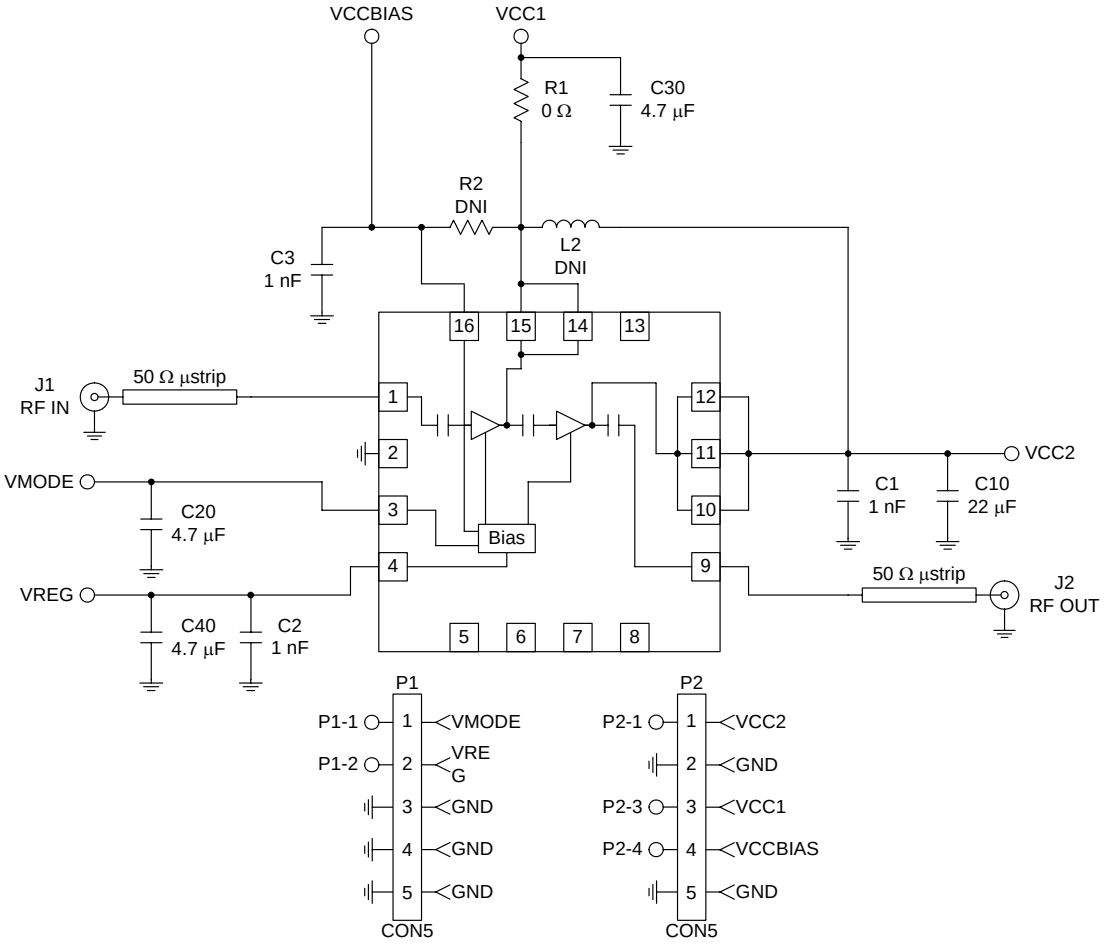
VCC BIAS can be connected to VCC; however, VCC must be maintained above 1.5 V.

L2 = 8.2 nH and may be needed to provide isolation between VCC1 and VCC2 depending on layout.

Circuit Optimization for Various Output Power Requirements

Output Power (dBm)	Matching Component	Sample Part Number	Typical Efficiency (%)
28	12nH	LQG15HN12NJ02D (Murata)	41
27.5	N/A		42
26.5	0.5pF	GRM1555C1HR50BZ01E (Murata)	42
26	1.0pF	GRM1555C1H1R0BZ01E (Murata)	42
25	1.5pF	GRM1555C1H1R5BZ01E (Murata)	41

Evaluation Board Schematic



PCB Design Requirements

PCB Surface Finish

The PCB surface finish used for RFMD's qualification process is electroless nickel, immersion gold. Typical thickness is 3μinch to 8μinch gold over 180μinch nickel.

PCB Land Pattern Recommendation

PCB land patterns for RFMD components are based on IPC-7351 standards and RFMD empirical data. The pad pattern shown has been developed and tested for optimized assembly at RFMD. The PCB land pattern has been developed to accommodate lead and package tolerances. Since surface mount processes vary from company to company, careful process development is recommended.

PCB Metal Land Pattern

A = 0.64 x 0.28 (mm) Typ.
B = 0.28 x 0.64 (mm) Typ.
C = 0.78 x 0.64 (mm)
D = 0.64 x 1.28 (mm)
E = 1.50 (mm) Sq.

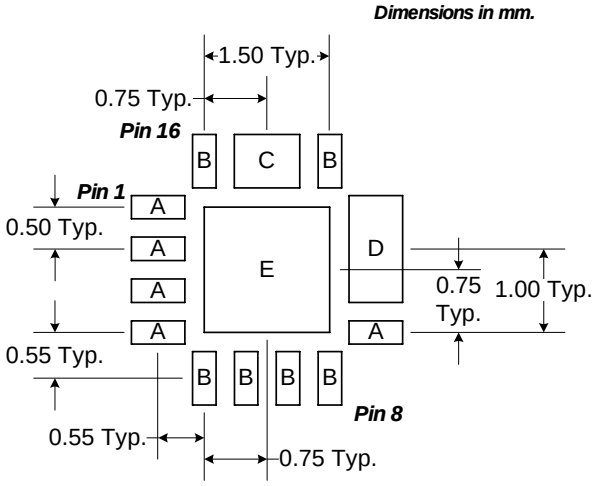


Figure 1. PCB Metal Land Pattern (Top View)

PCB Solder Mask Pattern

Liquid Photo-Imageable (LPI) solder mask is recommended. The solder mask footprint will match what is shown for the PCB metal land pattern with a 2mil to 3mil expansion to accommodate solder mask registration clearance around all pads. The center-grounding pad shall also have a solder mask clearance. Expansion of the pads to create solder mask clearance can be provided in the master data or requested from the PCB fabrication supplier.

A = 0.74 x 0.38 (mm) Typ.
B = 0.38 x 0.74 (mm) Typ.
C = 1.60 (mm) Sq.

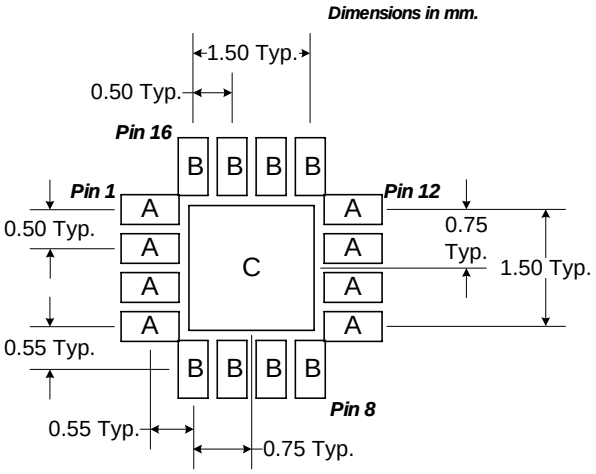


Figure 2. PCB Solder Mask Pattern (Top View)

Thermal Pad and Via Design

The PCB land pattern has been designed with a thermal pad that matches the die paddle size on the bottom of the device.

Thermal vias are required in the PCB layout to effectively conduct heat away from the package. The via pattern has been designed to address thermal, power dissipation and electrical requirements of the device as well as accommodating routing strategies.

The via pattern used for the RFMD qualification is based on thru-hole vias with 0.203mm to 0.330mm finished hole size on a 0.5mm to 1.2mm grid pattern with 0.025mm plating on via walls. If micro vias are used in a design, it is suggested that the quantity of vias be increased by a 4:1 ratio to achieve similar results.