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RF6281

3V MULTI-BAND UMTS LINEAR POWER AMPLIFIER MODULE

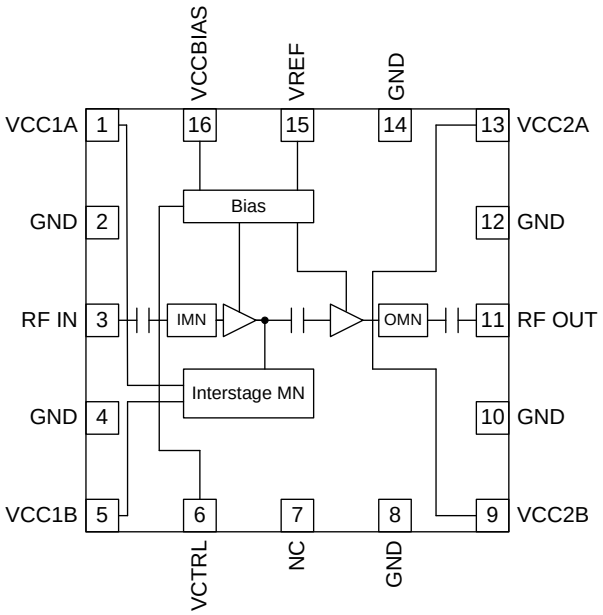
RoHS Compliant & Pb-Free Product
Package Style: Module, 16-Pin, 4 x 4

Features

- Multiple Band Coverage (Bands I, II, III, IV, IX)
- Input/Output Internally Matched@50Ω
- 27dBm Linear Output Power (HSDPA)
- 35% Peak Linear Efficiency (ULRMC 12.2Kbps)
- 24% Linear Efficiency at 16dBm
- -40dBc ACLR @ ±5MHz
- Analog Bias Control
- Load Insensitive

Applications

- 3V UMTS Band I Handsets
- Multi-Mode UMTS Handsets
- 3V TD-SCDMA Handsets
- Spread-Spectrum Systems



Functional Block Diagram

Product Description

The RF6281 is a high-power, high-efficiency linear amplifier module specifically designed for 3V handheld systems. This amplifier uses a balanced architecture which makes the PA load insensitive and therefore eliminates the need for an isolator. The device is manufactured on an advanced eighth generation GaAs HBT process, and was designed for use as the final RF amplifier in 3V UMTS handheld digital cellular equipment, spread-spectrum systems, and other applications in the 1710MHz to 1980MHz band (Bands I, II, III, IV, IX). The RF6281 has an analog bias control pin to reduce idle current at low power levels. The RF6281 is assembled in 16-pin, 4mmx4mm, laminate package.

Ordering Information

RF6281	3V Multi-Band UMTS Linear Power Amplifier Module
RF6281PCBA-41X	Fully Assembled Evaluation Board

Optimum Technology Matching® Applied

☑ GaAs HBT	☐ SiGe BiCMOS	☐ GaAs pHEMT	☐ GaN HEMT
☐ GaAs MESFET	☐ Si BiCMOS	☐ Si CMOS	
☐ InGaP HBT	☐ SiGe HBT	☐ Si BJT	

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Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage (RF off)	+7.0	V
Supply Voltage (P_{OUT}≤29dBm)	+4.3	V
Reference Voltage (V_{REF})	+3.6	V
Input RF Power	+6.0	dBm
ABC Voltage (V_{CTRL})	+2.3	V
Operating Temperature	-30 to +100	°C
Storage Temperature	-40 to +150	°C
Moisture Sensitivity Level (IPC/JEDEC J-STD-20)	MSL3@260	°C

Caution! ESD sensitive device.

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

RoHS status based on EUDirective2002/95/EC (at time of this document revision).

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Band I High Power					T=25°C Ambient, V_{CC}=3.1V, V_{CCBIAS}=3.1V, V_{REF}=2.85V, V_{CTRL}=1.95V, R_L=50Ω, and P_{OUT}=27dBm for all parameters (unless otherwise specified). Modulation is HSDPA.
Operating Frequency Range	1920		1980	MHz	
Linear Gain		28		dB	
Gain Variation into Mismatch		-1		dB	VSWR is 1:1 out to 3:1, all phase angles
Harmonics		-19	-10	dBm	f=$2f_o$, $3f_o$
Maximum Linear Output	27			dBm	
Linear Efficiency		36		%	UL RMC, 12.2Kbps, V_{CC}=2.8V
Maximum I_{CC}		505		mA	
ACLR1 @ ±5MHz		-39		dBc	
ACLR2 @ ±10MHz		-55		dBc	
ACLR @ ±5MHz into Mismatch		-36		dBc	VSWR is 1:1 out to 3:1, all phase angles
ACLR @ ±10MHz into Mismatch		-46		dBc	VSWR is 1:1 out to 3:1, all phase angles
Return Loss			-12	dB	
Output Load VSWR Stability (Spurious Emissions)			-46	dBc	VSWR=6:1
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=10:1
Noise Power		-145		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=470MHz to 770MHz
		-148		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=869MHz to 960MHz (Band V, VI, VIII)
		-137		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=1570MHz to 1580MHz (GPS)
		-126		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=1805MHz to 1880MHz (Band III and IX)
		-138		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=2110MHz to 2170MHz (Band I), TX/RX offset=130MHz to 190MHz
		-146		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=2400MHz to 2480MHz (Bluetooth)
		-120		dBm/Hz	-50≤P_{OUT}≤+27dBm, TX=1932.3MHz to 1980MHz, RX=1893.5MHz to 1919.6MHz (PHS)

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Band I High Power, cont.					
Reverse 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
Band I Medium Power					T=25°C Ambient, V_{CC}=1.2V, V_{CCBIAS}=3.1V, V_{REF}=2.85V, V_{CTRL}=1.6V, R_L=50Ω, and P_{OUT}=16dBm for all parameters (unless otherwise specified). Modulation is HSDPA.
Linear Gain		22		dB	
Maximum Linear Output	16			dBm	
Linear Efficiency		20		%	
Maximum I_{CC}		150		mA	
ACLR @ ±5MHz		-40		dBc	
ACLR @ ±10MHz		-55		dBc	
Input Return Loss			-12	dB	
Output Load VSWR Stability (Spurious Emissions)			-46	dBc	VSWR=6:1
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=10:1
Reverse 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
Band I Low Power					T=25°C Ambient, V_{CC}=0.6V, V_{CCBIAS}=3.1V, V_{REF}=2.85V, V_{CTRL}=1.42V, R_L=50Ω, and P_{OUT}=5dBm for all parameters (unless otherwise specified). Modulation is HSDPA.
Linear Gain		15		dB	
Maximum Linear Output	5			dBm	
Linear Efficiency		10		%	
ACLR @ ±5MHz		-40		dBc	
ACLR @ ±10MHz		-58		dBc	
Band II High Power					T=25°C Ambient, V_{CC}=3.1V, V_{CCBIAS}=3.1V, V_{REF}=2.85V, V_{CTRL}=1.95V, R_L=50Ω, and P_{OUT}=27dBm for all parameters (unless otherwise specified). Modulation is HSDPA.
Operating Frequency Range	1850		1910	MHz	
Linear Gain		28		dB	
Gain Variation into Mismatch		-1, +0.5		dB	VSWR is 1:1 out to 3:1, all phase angles
Harmonics		-19	-10	dBm	f=$2f_o$, $3f_o$
Maximum Linear Output	27			dBm	
Linear Efficiency		36		%	UL RMC, 12.2Kbps, V_{CC}=2.8V
Maximum I_{CC}		505		mA	
ACLR1 @ ±5MHz		-39		dBc	
ACLR2 @ ±10MHz		-55		dBc	
ACLR @ ±5MHz into Mismatch		-36		dBc	VSWR is 1:1 out to 3:1, all phase angles
ACLR @ ±10MHz into Mismatch		-46		dBc	VSWR is 1:1 out to 3:1, all phase angles
Input Return Loss			-12	dB	

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Band II High Power, cont.					
Output Load VSWR Stability (Spurious Emissions)			-46	dBc	VSWR=6:1
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=10:1
Noise Power		-145		dBm/Hz	$-50 \le P_{OUT} \le +27$dBm, RX=470MHz to 770MHz
		-150		dBm/Hz	$-50 \le P_{OUT} \le +27$dBm, RX=869MHz to 960MHz (Band V, VI, VIII)
		-133		dBm/Hz	$-50 \le P_{OUT} \le +27$dBm, RX=1570MHz to 1580MHz (GPS)
		-134		dBm/Hz	$-50 \le P_{OUT} \le +27$dBm, RX=1930MHz to 1990MHz (Band II), TX/RX Offset=80MHz
		-137		dBm/Hz	$-50 \le P_{OUT} \le +27$dBm, RX=2110MHz to 2170MHz (Band I)
		-143		dBm/Hz	$-50 \le P_{OUT} \le +27$dBm, RX=2400MHz to 2480MHz (Bluetooth)
Reverse 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
Band II Medium Power					T=25°C Ambient, V_{CC}=1.2V, V_{CCBIAS}=3.1V, V_{REF}=2.85V, V_{CTRL}=1.6V, R_L=50Ω, and P_{OUT}=16dBm for all parameters (unless otherwise specified). Modulation is HSDPA.
Linear Gain		22		dB	
Maximum Linear Output	16			dBm	
Linear Efficiency		22		%	
Maximum I_{CC}		150		mA	
ACLR @ ±5MHz		-40		dBc	
ACLR @ ±10MHz		-57		dBc	
Input Return Loss			-12	dB	
Output Load VSWR Stability (Spurious Emissions)			-46	dBc	VSWR=6:1
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=10:1
Reverse 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
Band II Low Power					T=25°C Ambient, V_{CC}=0.6V, V_{CCBIAS}=3.1V, V_{REF}=2.85V, V_{CTRL}=1.42V, R_L=50Ω, and P_{OUT}=5dBm for all parameters (unless otherwise specified). Modulation is HSDPA.
Linear Gain		15		dB	
Maximum Linear Output	5			dBm	
Linear Efficiency		10		%	
ACLR @ ±5MHz		-43		dBc	
ACLR @ ±10MHz		-58		dBc	

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Band III, IV High Power					T=25°C Ambient, V_{CC}=3.1V, V_{CCBIAS}=3.1V, V_{REF}=2.85V, V_{CTRL}=2.1V, R_L=50Ω, and P_{OUT}=27dBm for all parameters (unless otherwise specified). Modulation is HSDPA.
Operating Frequency Range	1710		1785	MHz	
Linear Gain		28		dB	
Gain Variation into Mismatch		-2, +0.5		dB	VSWR is 1:1 out to 3:1, all phase angles
Harmonics		-19	-10	dBm	f=2f_o, 3f_o
Maximum Linear Output	27			dBm	
Linear Efficiency		33		%	UL RMC, 12.2Kbps, V_{CC}=2.8V
Maximum I_{CC}		542		mA	
ACLR1 @ ±5MHz		-39		dBc	
ACLR2 @ ±10MHz		-57		dBc	
ACLR @ ±5MHz into Mismatch		-34		dBc	VSWR is 1:1 out to 3:1, all phase angles
ACLR @ ±10MHz into Mismatch		-46		dBc	VSWR is 1:1 out to 3:1, all phase angles
Input Return Loss			-12	dB	
Output Load VSWR Stability (Spurious Emissions)			-46	dBc	VSWR=6:1
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=10:1
Noise Power		-140		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=470MHz to 770MHz
		-140		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=869MHz to 960MHz (Band V)
		-131		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=1570MHz to 1580MHz (GPS)
		-134		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=1805MHz to 1880MHz (Band III and IX), TX/RX offset=95MHz
		-135		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=1930MHz to 1990MHz (Band II)
		-141		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=2110MHz to 2170MHz (Band I & IV)
		-146		dBm/Hz	-50≤P_{OUT}≤+27dBm, RX=2400MHz to 2480MHz (Bluetooth)
Reverse 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
Band III, IV Medium Power					T=25°C Ambient, V_{CC}=1.2V, V_{CCBIAS}=3.1V, V_{REF}=2.85V, V_{CTRL}=1.6V, R_L=50Ω, and P_{OUT}=16dBm for all parameters (unless otherwise specified). Modulation is HSDPA.
Linear Gain		22		dB	
Maximum Linear Output	16			dBm	
Linear Efficiency		21		%	
Maximum I_{CC}		158		mA	
ACLR @ ±5MHz		-40		dBc	
ACLR @ ±10MHz		-56		dBc	
Input Return Loss			-12	dB	

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Band III, IV Medium Power, cont.					
Output Load VSWR Stability (Spurious Emissions)			-46	dBc	VSWR=6:1
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=10:1
Reverse 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
Band III, IV Low Power					T=25°C Ambient, V_{CC}=0.6V, V_{CCBIAS}=3.1V, V_{REF}=2.85V, V_{CTRL}=1.44V, R_L=50Ω, and P_{OUT}=5dBm for all parameters (unless otherwise specified). Modulation is HSDPA.
Linear Gain		15		dB	
Maximum Linear Output	5			dBm	
Linear Efficiency		9		%	
ACLR @ ±5MHz		-40		dBc	
ACLR @ ±10MHz		-58		dBc	
Power Supply					
Supply Voltage (V_{CC1} and V_{CC2})	3.1	3.4	4.3	V	Full rated power.
	0.6			V	Low power with DC to DC Converter
V_{CC} Bias	2.9		4.3	V	
High Power Idle Current (I_{CC1}/I_{CC2}/I_{CCBIAS})		130		mA	V_{CC}=3.1V, V_{CTRL}=1.95V and V_{REF}=2.85V
Low Power Idle Current (I_{CC1}/I_{CC2}/I_{CCBIAS})		35		mA	V_{CC}=0.6V, V_{CTRL}=1.42V and V_{REF}=2.85V
V_{REF} Current		2		mA	
V_{CTRL} Current		300		uA	
RF Turn On/Off Time		1.2		uS	
DC Turn On/Off Time		2		uS	
Total Current (Power Down)		0.2		uA	
V_{REF} Low Voltage (Power Down)	0		0.5	V	
V_{REF} High Voltage (Recommended)	2.75	2.85	2.95	V	
V_{CTRL} Voltage Range	1.0		2.3	V	Higher output power requires higher V_{CTRL} voltage

HSDPA Set-up: β_{HS}/β_C=24/15, β_C/β_D=12/15	Settings	
1 DPCCH @ 15ksps	Spread Code=0	Relative Power=-7.095dB
1 DPDCH @ 60ksps	Spread Code=16	Relative Power=-5.157dB
1 DPCCH @ 15ksps	Spread Code=64	Relative Power=-3.012dB

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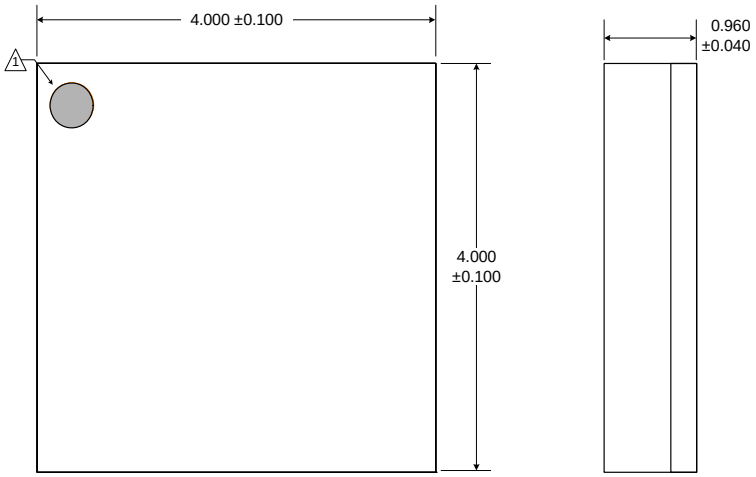
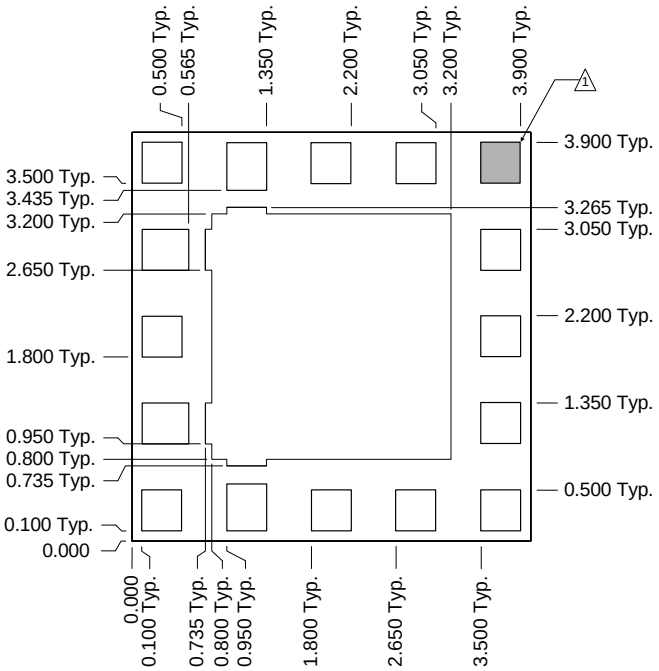
Pin	Function	Description
1	VCC1A	First stage collector supply.
2	GND	Ground connection.
3	RF IN	RF input internally matched to 50Ω. This input is internally AC-coupled.
4	GND	Ground connection.
5	VCC1B	First stage collector supply.
6	VCTRL	Analog Bias Control used to reduce idle current and therefore improve efficiency at lower output power levels.
7	NC	No connection.
8	GND	Ground connection.
9	VCC2B	Output stage collector supply. Please see the schematic for required external components.
10	GND	Ground connection.
11	RF OUT	RF output. Internally AC-coupled.
12	GND	Ground connection.
13	VCC2A	Same as pin 9.
14	GND	Ground connection.
15	VREF	Regulated voltage supply for amplifier bias circuit. In power down mode, both V_{REF} and V_{CTRL} need to be LOW (<0.5V).
16	VCCBIAS	Power supply input for the DC bias circuitry. Must be $\geq$ 3.0V.
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.

Package Drawing



Shaded areas represent pin 1.

Dimensions in mm.



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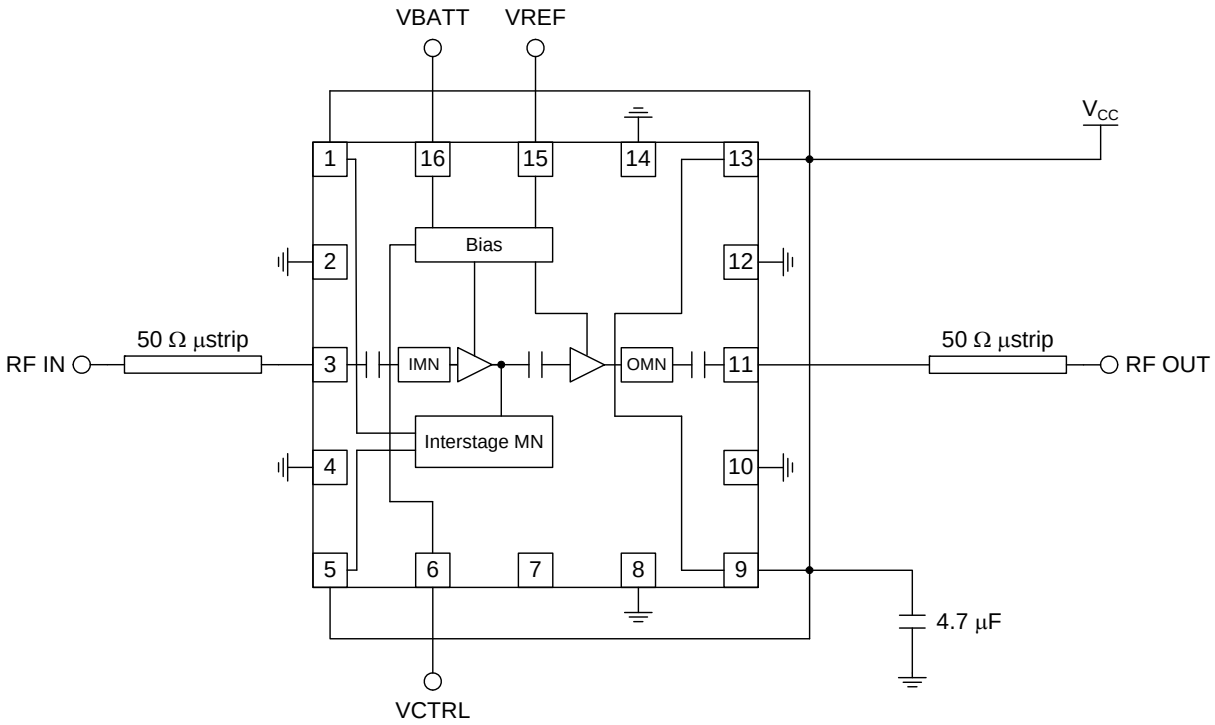
Application Schematic



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PCB Design Requirements

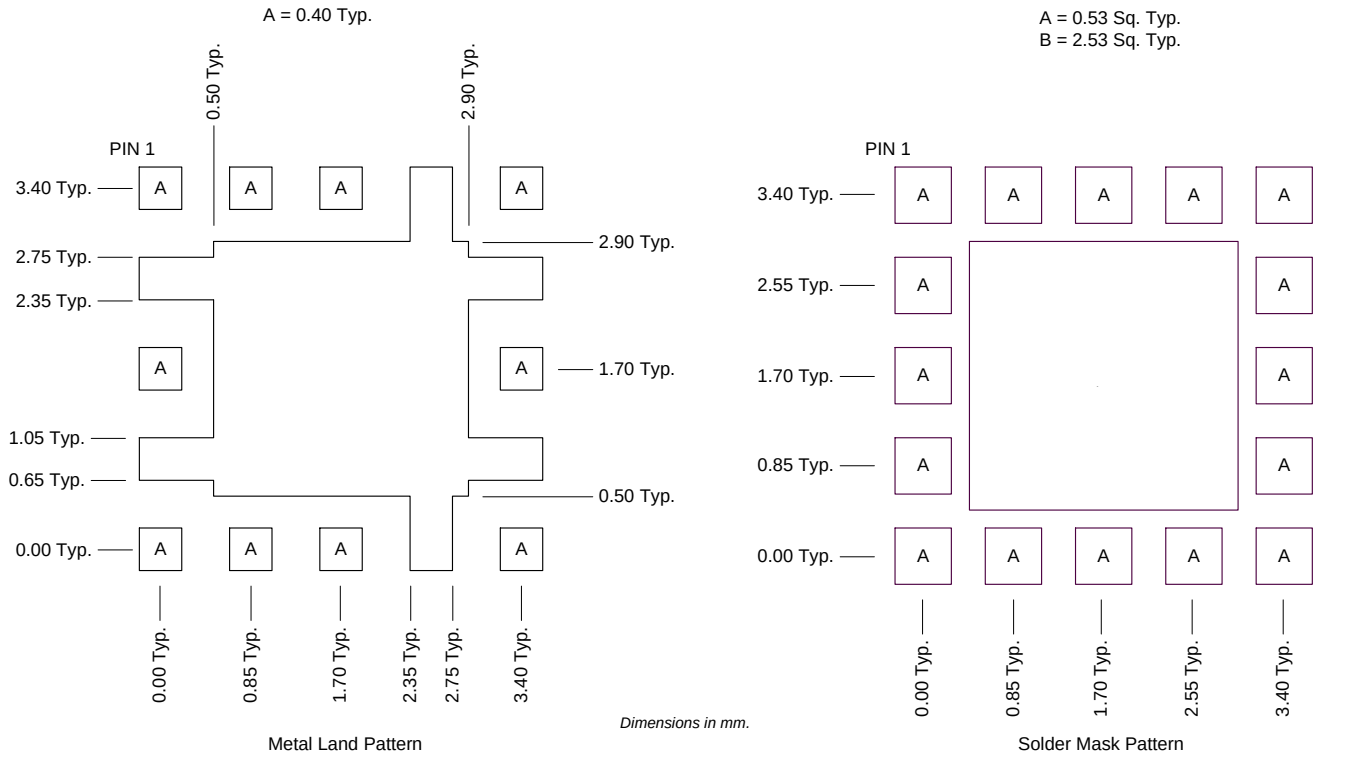
PCB Surface Finish

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



Thermal Pad and Via Design

The PCB land pattern has been designed with a thermal pad that matches the exposed 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.

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