RFFM6904

3.0V TO 4.2V, ISM BAND TRANSMIT/RECEIVE MODULE WITH DIVERSITY TRANSFER SWITCH

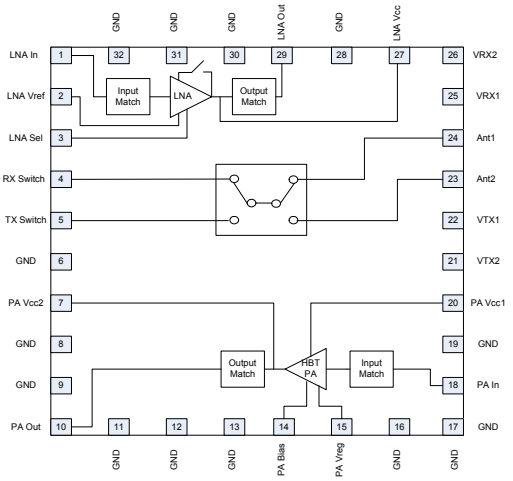
Package: LGA, 32-pin, 8mm x 8mm x 1.2mm

Features

- Integrated LNA, PA, and Transfer Switch
- Small Form Factor 8.0mm x 8.0mm x 1.2mm
- 50Ω Inputs and Outputs
- Low Insertion Loss, High Isolation Transfer Switch
- 33.5dBm PA Output Power
- Low PA Harmonic Content

Applications

- 868MHz/900MHz ISM Band Application
- Single Chip RF Front End Module
- Portable Battery Powered Equipment
- Wireless Automatic Metering Applications



Functional Block Diagram

Product Description

The RFFM6904 is a single-chip front-end module (FEM) for applications in the 868MHz/900MHz ISM Band. The RFFM6904 addresses the need for aggressive size reduction for typical portable equipment RF front-end design and greatly reduces the number of components outside of the core chipset thus minimizing the footprint and assembly cost of the overall solution. The RFFM6904 contains an integrated 2 Watt PA, TX/RX transfer switch, LNA with bypass mode, and matching components. The RFFM6904 is packaged in a 32-pin, 8.0mm x 8.0mm x 1.2mm over-molded laminate package with backside ground which greatly minimizes next level board space and allows for simplified integration.

Optimum Technology Matching® Applied

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

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Absolute Maximum Ratings

Parameter	Rating	Unit
Overall		
DC Supply Voltage	+5.0	V
Operating Ambient Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C
Low Noise Amplifier		
DC Supply Current	32	mA
Input RF Power	5	dBm
Power Amplifier		
DC Supply Current	1200	mA
Input RF Power	10	dBm
Transmit/Receive Switch		
Input RF Power	33	dBm

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 (Restriction of Hazardous Substances): Compliant per EU Directive 2002/95/EC.

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Low Noise Amplifier					
Frequency Range	868	902 to 928		MHz	
High Gain Mode					Gain Select < 0.8V
Gain	17	21	23.5	dB	Over LNA V_{CC}, LNA V_{REF}, Temperature, and Frequency
Noise Figure		1.3	1.5	dB	LNA V_{REF} = LNA V_{CC} = 3.3V
Input IP3	-4.5	-1		dBm	T_{AMB} = +25°C, LNA V_{CC} = 3.3V
Input Gain Compression	-15			dBm	
Input Return Loss		-8	-5	dB	
Output Return Loss		-8	-6	dB	
LNA Operating Current			15	mA	LNA V_{REF} = LNA V_{CC} = 3.3V
LNA Enable			1	mA	
Stability, Input VSWR	10:1				All phase angles
Output Spurious			-70	dBc	
Low Gain Mode					Gain Select > 1.8V
Gain	-7	-6		dB	
Input IP3	15.5	17		dBm	T_{AMB} = +25°C, LNA V_{CC} = 3.3V
Current Drain		1.5	3	mA	
Power Amplifier					
Frequency Range	868	902 to 928		MHz	
PA V_{CC1} = PA V_{CC2} = PA BIAS	3.2	4.0	4.5	V	
PA V_{REG}	2.75	2.85	2.95	V	
P_{OUT}	32.5	33.5		dBm	Saturated power output
Gain	27	30		dB	PA V_{CC1} = PA V_{CC2} = PA BIAS = 4V, over temperature and frequency
Output Harmonic Levels					
2nd			-42.5	dBc	
3rd through 10th			-72.5	dBc	PA V_{CC1} = PA V_{CC2} = PA BIAS = 4V, over temperature and frequency

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Power Amplifier, cont.					
Efficiency	40			%	33.5dBm output, PA V_{CC1} = PA V_{CC2} = PA BIAS = 4.0V, 2.85V V_{REG}
Input Return Loss	9			dB	
Output Spurious			-70	dBc	
Stability		10:1			All phase angles
		7:1			All phase angles, -40°C
Current					
Operating		750	1000	mA	33.5dBm output, PA V_{CC1} = PA V_{CC2} = PA BIAS = 4.0V, 2.85V V_{REG}
Bias Only			200	mA	Idle current, no RF at input
I_{REG}		2	6	mA	
Leakage Current		0.1	0.9	µA	Over V_{CC}, Frequency, and Temperature
Transmit/Receive Switch					
Frequency Range	868	902 to 928		MHz	
Insertion Loss					
TX to ANT1 or ANT2		0.85	1.4	dB	
RX to ANT1 or ANT2		0.95	1.4	dB	
Any Path (1800MHz to 1860MHz)	2			dB	
Any Path (2700MHz to 2790MHz)	2			dB	
Any Path (>3600MHz)	15			dB	
Isolation (All Paths)	18			dB	
Input IP3	55			dBm	
Thermal Resistance		47.8		°C/W	4V V_{CC}, 2.85V V_{REG}, 31dBm P_{OUT}, T_{REF} = 85°C
Output Harmonic Levels					
2nd			-60	dBc	
3rd through 10th			-80	dBc	
Input 1dB Gain Compression	30	32		dBm	
Return Loss (All Ports)	18			dB	Active ports only
Switch Control Logic HIGH	2.6		3.5	V	
Switch Control Logic LOW	0		0.2	V	
Switch Control Current			5	µA	VTX2, VRX1, and VRX2
			40	µA	VTX1
Transition Time			2	µA	Settle to 0.25dB of final value

Connected Path	RX SW to ANT1	RX SW to ANT2	TX SW to ANT1	TX SW to ANT2
VRX1	High	Low	Low	Low
VRX2	Low	High	Low	Low
VTX1	Low	Low	High	Low
VTX2	Low	Low	Low	High

*Switch Control Logic High = Min 2.6V to Max 3.5V
*Switch Control Logic Low = Min 0.0V to Max 0.2V

Pin Names and Description

Pin	Name	Description
1	LNA IN	RF Input to the low noise amplifier, 50Ω nominal impedance.
2	LNA VREF	Voltage to set the bias level to the LNA, 3.0V nominal, can be used to shut the LNA off or to adjust the quiescent current.
3	LNA SELECT	A logic low selects the high gain mode of the LNA, logic high selects the low gain mode.
4	RX SWITCH INPUT	RF port from the Switch going to the LNA input, 50Ω nominal impedance.
5	TX SWITCH INPUT	RF port from the Switch going to the PA output, 50Ω nominal impedance.
6	GND	Ground.
7	PA VCC2	Voltage supply for the Power Amplifier, nominal voltage is 3.6V.
8	GND	Ground.
9	GND	Ground.
10	PA OUT	RF output from the Power Amplifier, 50Ω nominal impedance and DC blocked.
11	GND	Ground.
12	GND	Ground.
13	GND	Ground.
14	PA BIAS	Voltage supply for the Power Amplifier bias network, nominal voltage is 3.6V.
15	PA VREG	Voltage to set the bias level of the Power Amplifier, nominal voltage is 2.85V.
16	GND	Ground.
17	GND	Ground.
18	PA IN	RF Input to the Power Amplifier, 50Ω nominal impedance.
19	GND	Ground.
20	PA VCC1	Voltage supply for the Power Amplifier, nominal voltage is 3.6V.
21	VTX2	Logic input to the Switch, see Logic Table below.
22	VTX1	Logic input to the Switch, see Logic Table below.
23	ANT2	RF port from the Switch going to Antenna 1, 50Ω nominal impedance.
24	ANT1	RF port from the Switch going to Antenna 2, 50Ω nominal impedance.
25	VRX1	Logic input to the Switch, see Logic Table below.
26	VRX2	Logic input to the Switch, see Logic Table below.
27	LNA VCC	LNA Collector Voltage, nominal voltage is 3.0V.
28	GND	Ground.
29	LNA OUT	RF Output from the low noise amplifier, 50Ω nominal impedance and DC blocked.
30	GND	Ground.
31	GND	Ground.
32	GND	Ground.
Pkg Base	GND	The central metal base of package provides DC and RF GND as well as heat sink for the amplifier.

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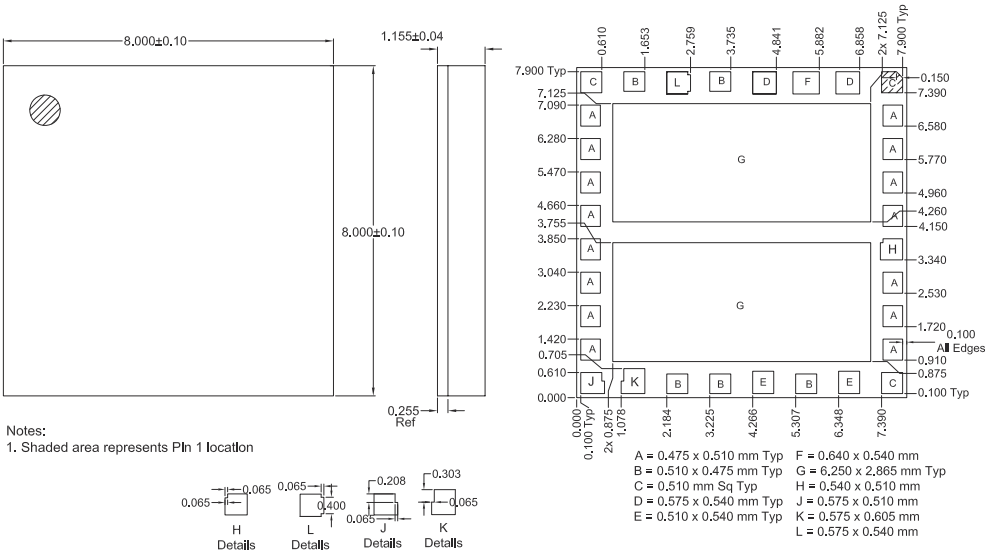
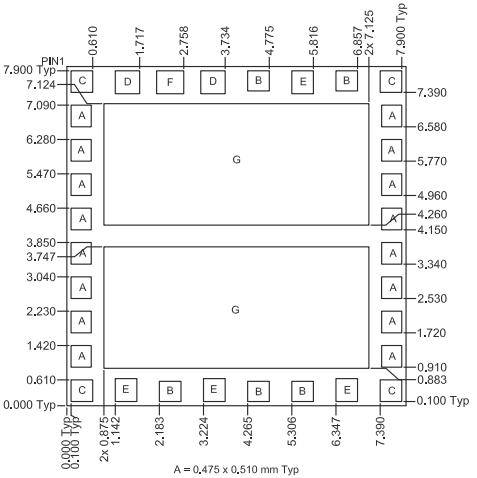
Package Drawing

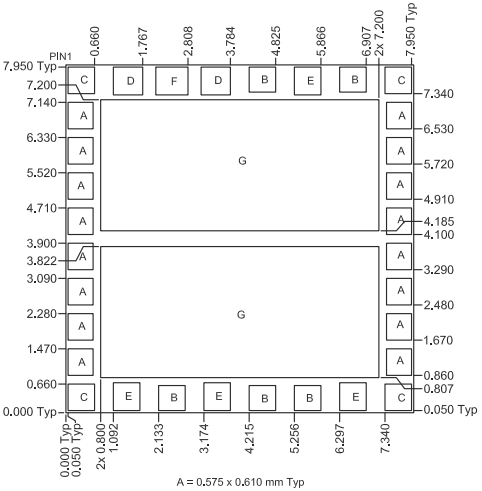


All units in μm.
Pin A = 510 x 475
Pin B = 510 x 510
Pin C = 475 x 510

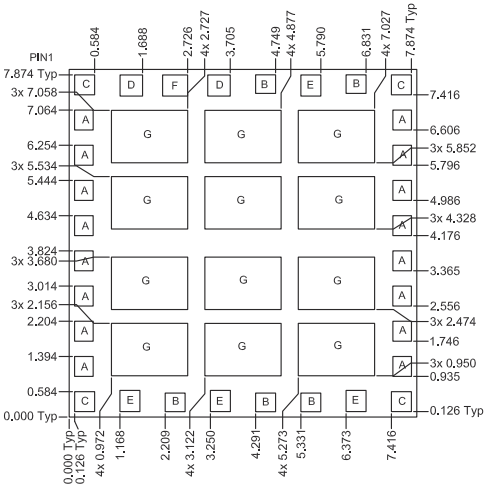
PCB Patterns



PCB MET/ L LAND PATTERN



PCB SOLDER MASK PATTERN



PCB STENCIL PATTERN

Thermal vias for center slug “G” should be incorporated into the PCB design. The number and size of thermal vias will depend on the application. Example of the number and size of vias can be found on the RFMD evaluation board layout.

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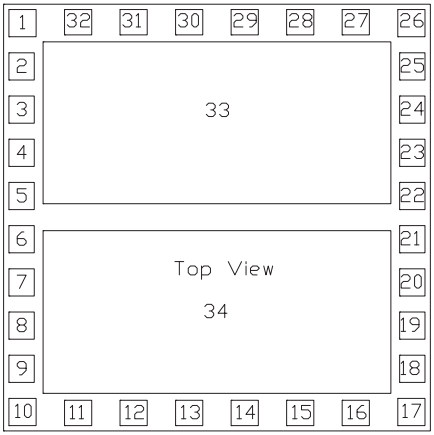
Pin Out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Top View
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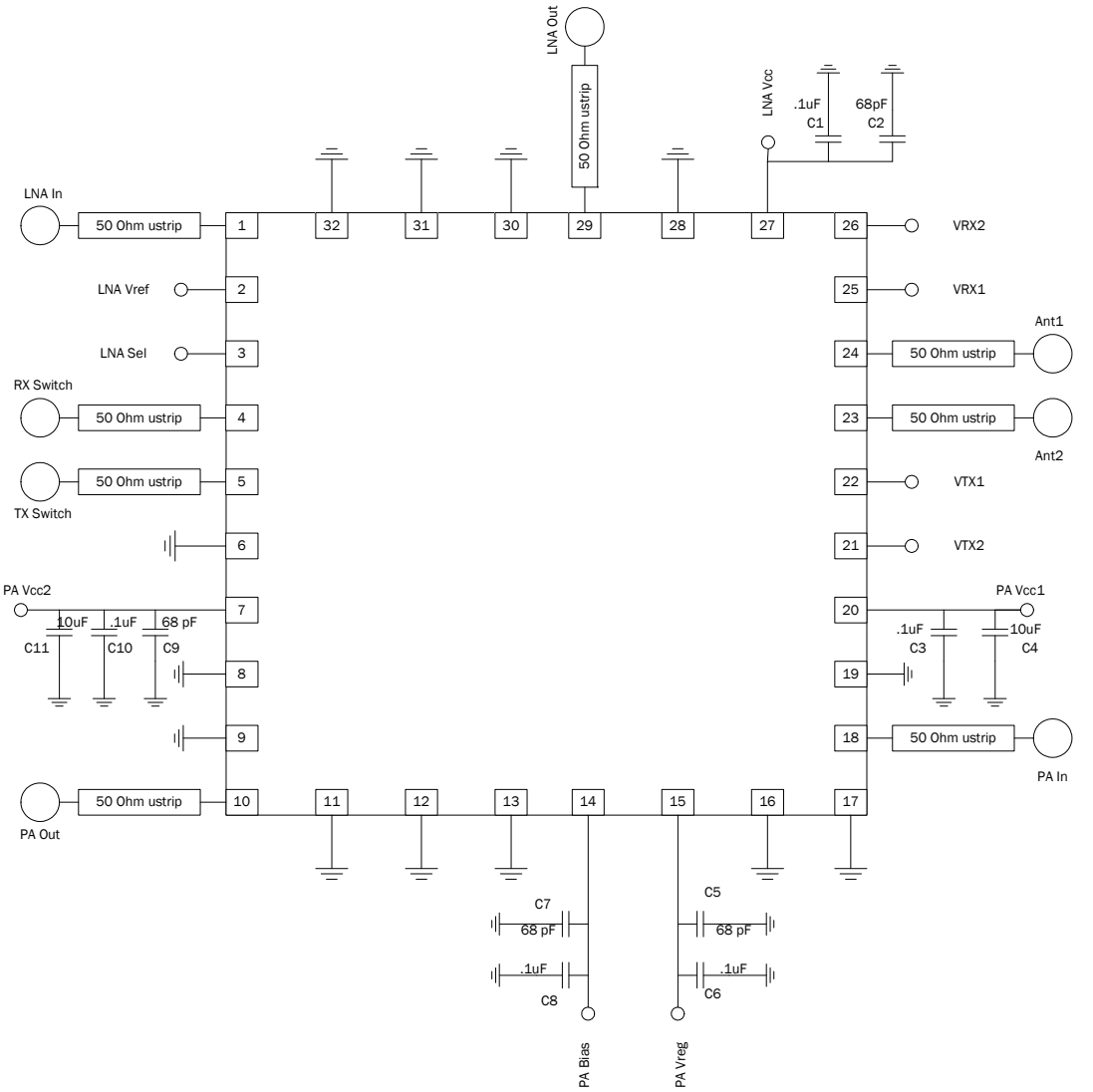
Application Schematic



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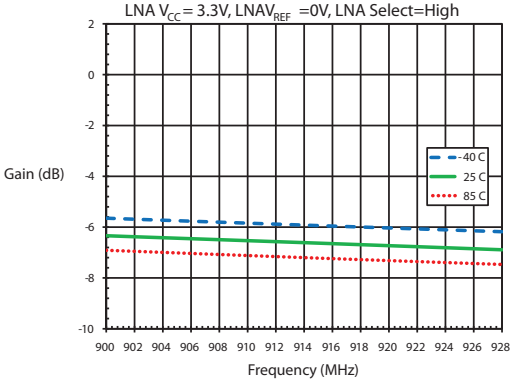
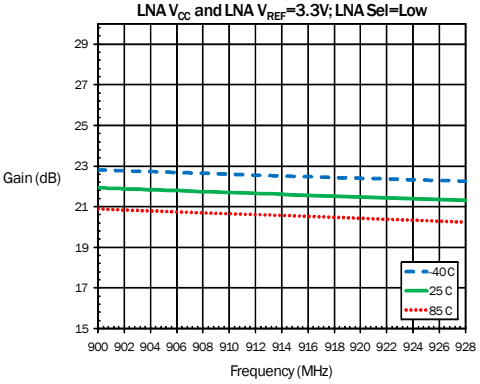
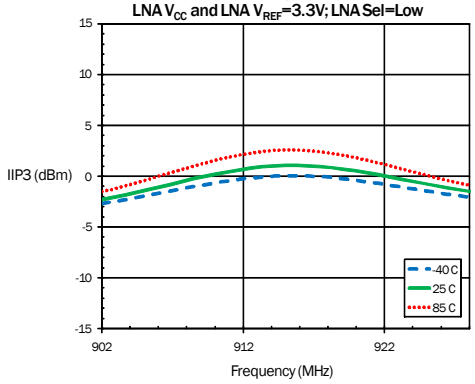
LNA Gain versus Frequency (Low Gain Mode)
Over Temperature
LNA V_{CC} = 3.3V, LNAV_{REF} =0V, LNA Select=High



LNA Gain versus Frequency (High Gain Mode)
Over Temperature
LNA V_{CC} and LNA V_{REF}=3.3V; LNA Sel=Low



LNA IIP3 versus Frequency (In High Gain Mode)
(Over Tempreture)
LNA V_{CC} and LNA V_{REF}=3.3V; LNA Sel=Low



LNA IIP3 Vs Frequency (Low Gain Mode)
(Over Temperature)
LNA VCC & LNA Vref = 3.3V; LNA Sel = High