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RF7161

QUAD-BAND GSM850/EGSM900/DCS1800/ PCS1900 TRANSMIT MODULE

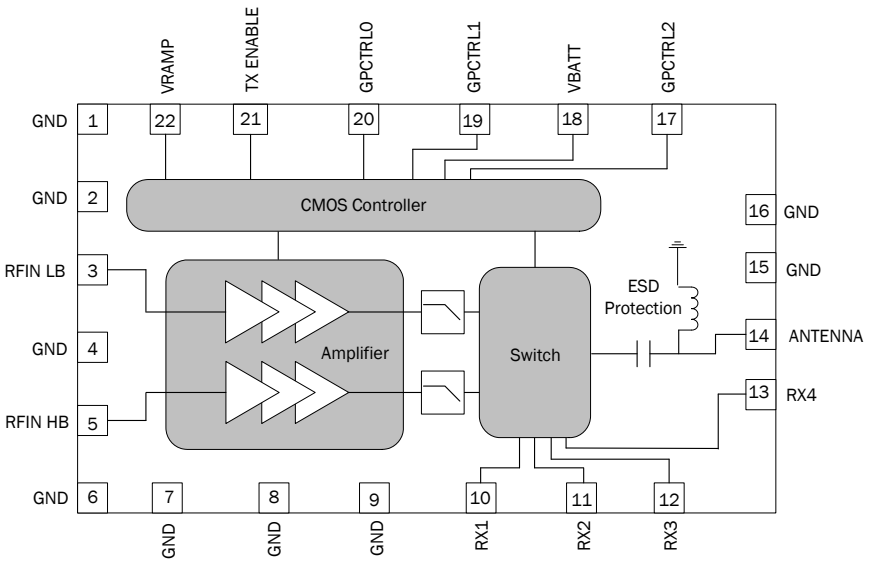
Package: Module 6.63mm x 5.24mm 1.0mm

Features

- Enhanced Performance Transmit Module
- No External Routing
- High Efficiency at Rated P_{OUT}
  V_{BATT}=3.5V
  GSM850/EGSM900=40%
  DCS1800/PCS1900=37%
- Low RX Insertion Loss
- Four Symmetrical RX Ports
- 0dBm to 6dBm Drive Level, >50dB of Dynamic Range
- Integrated Power Flattening Circuit
- V_{BATT} Tracking Circuit

Applications

- 3V Quad-Band GSM/GPRS Handsets
- GSM850/EGSM900/DCS1800/PCS1900 Products
- GPRS Class 12 Compliant
- Portable Battery-Powered Equipment



Functional Block Diagram

Product Description

The RF7161 is a quad-band (GSM850/EGSM900/DCS1800/PCS1900) GSM/GPRS, Class 12 compliant transmit module with four interchangeable receive ports. This transmit module builds upon RFMD's leading power amplifier with PowerStar® integrated power control technology, pHEMT switch technology, and integrated transmit filtering for best-in-class harmonic performance. The results are high performance, reduced solution size, and ease of implementation. The device is designed for use as the final portion of the transmitter section in a GSM850/EGSM900/DCS1800/PCS1900 handset and eliminates the need for a PA-to-antenna switch module matching network.

The RF7161 features RFMD's latest integrated power-flattening circuit which significantly reduces current and power variation into load mismatch. Additionally, a V_{BATT} tracking feature is incorporated to maintain switching performance as supply voltage decreases. The RF7161 also integrates an ESD filter to provide excellent ESD protection at the antenna port. The RF7161 is designed to provide maximum efficiency at rated P_{OUT}.

Ordering Information

RF7161	Quad-Band GSM850/EGSM900/DCS1800/PCS1900 Transmit Module
RF7161SB	Transmit Module 5-Piece Sample Pack
RF7161PCBA-41X	Fully Assembled Evaluation Board

Optimum Technology Matching® Applied

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

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Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	-0.3 to +6.0	V
Power Control Voltage (V_{RAMP})	-0.3 to +1.8	V
Input RF Power	+10	dBm
Max Duty Cycle	50	%
Output Load VSWR	20:1	
Operating Case Temperature	-20 to +85	°C
Storage Temperature	-55 to +150	°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.		
ESD					
ESD RF Ports			1000	V	HBM, JESD22-A114
			1000	V	CDM, JEDEC JESD22-C101
ESD Antenna Port			8	kV	IEC 61000-4-2
ESD Any Other Port			1000	V	HBM, JESD22-A114
			1000	V	CDM, JEDEC JESD22-C101
Overall Power Control V_{RAMP}					
Power Control “ON”			1.8	V	Max. P_{OUT}
Power Control “OFF”		0.25		V	Min. P_{OUT}
V_{RAMP} Input Capacitance		15	20	pF	DC to 200kHz
V_{RAMP} Input Current			10	µA	$V_{RAMP}=V_{RAMP, MAX}$
Power Control Range		50		dB	$V_{RAMP}=0.25V$ to $V_{RAMP, MAX}$
Overall Power Supply					
Power Supply Voltage	3.0	3.5	4.8	V	Operating Limits
Power Supply Current		40	80	µA	P_{IN}<-30dBm, TX Enable=Low, $V_{RAMP}=0.25V$, Temp=-20°C to +85°C, $V_{BATT}=4.8V$.
Overall Control Signals					
GpCtrl0/1/2 “Low”	0	0	0.5	V	
GpCtrl0/1/2 “High”	1.25	2.0	V_{BATT}	V	
GpCtrl0/1/2 “High Current”		1	2	µA	
TX Enable “Low”	0	0	0.5	V	
TX Enable “High”	1.25	2.0	V_{BATT}	V	
TX Enable “High Current”		1	2	µA	
RF Port Input and Output Impedance		50		Ω	

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
GSM850 Band					Nominal conditions unless otherwise stated. All unused ports are terminated. V_{BATT}=3.5V, P_{IN}=3dBm, Temp=+25°C, TX Enable=High, VRAMP=1.8V. TX Mode: GpCtrl2=Low, GpCtrl1=High, GpCtrl0=Low, Duty Cycle=25%, Pulse Width=1154µS
Operating Frequency Range	824		849	MHz	
Input Power	0	3	6	dBm	Full P_{OUT} guaranteed at minimum drive level.
Input VSWR		2:1	2.5:1		Over P_{OUT} range (5dBm to 33dBm)
Maximum Output Power	33	33.7		dBm	Nominal conditions.
	31	33.7		dBm	V_{BATT}=3.1V to 4.8V, P_{IN}=0dBm to 6dBm, Temp=-20°C to +85°C, Duty Cycle=50%, Pulse Width=2308mS, V_{RAMP}≤1.8V.
Minimum Power Into 3:1 VSWR	30	31.5		dBm	The measured delivered output power to the load with the mismatch loss already taken into account with 1dB variation margin.
Efficiency	36	40		%	Set V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm
2nd Harmonic		-40*	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm. *Typical value measured from worst case harmonic frequency across the band.
3rd Harmonic		-40*	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm. *Typical value measured from worst case harmonic frequency across the band.
All other harmonics up to 12.75GHz		-40	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm.
Non-harmonic Spurious up to 12.75GHz		-	-36	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, also over all power levels (5dBm to 33dBm).
Forward Isolation 1		-57	-41	dBm	TX Enable Low, P_{IN}=6dBm, V_{RAMP}=0.25V.
Forward Isolation 2		-27	-15	dBm	TX Enable High, P_{IN}=6dBm, V_{RAMP}=0.25V.
Output Noise Power		-87.5	-82	dBm	869MHz to 894MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, RBW=100kHz.
		-118	-74	dBm	1930MHz to 1990MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, RBW=100kHz.
Output Load VSWR Stability (Spurious Emissions)			-36	dBm	VSWR=12:1, all phase angles (Set $V_{RAMP=VRAMP\ RATED}$ for P_{OUT}≤33dBm into 50Ω load; load switched to VSWR=12:1).
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=20:1, all phase angles (Set $V_{RAMP=VRAMP\ RATED}$ for P_{OUT}≤33dBm into 50Ω load; load switched to VSWR=20:1).

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
EGSM900 Band					Nominal conditions unless otherwise stated. All unused ports are terminated. V_{BATT}=3.5V, P_{IN}=3dBm, Temp=+25°C, TX Enable=High, VRAMP=1.8V. TX Mode: GpCtrl2=Low, GpCtrl1=High, GpCtrl0=Low, Duty Cycle=25%, Pulse Width=1154µS
Operating Frequency Range	880		915	MHz	
Input Power	0	3	6	dBm	Full P_{OUT} guaranteed at minimum drive level.
Input VSWR		2:1	2.5:1		Over P_{OUT} range (5dBm to 33dBm).
Maximum Output Power	33	33.7		dBm	Nominal conditions.
	31	33.7		dBm	V_{BATT}=3.1V to 4.8V, P_{IN}=0dBm to 6dBm, Temp=-20°C to +85°C, Duty Cycle=50%, Pulse Width=2308mS, V_{RAMP}≤1.8V.
Minimum Power Into 3:1 VSWR	30	31.5		dBm	The measured delivered output power to the load with the mismatch loss already taken into account with 1dB variation margin.
Efficiency	36	40		%	Set V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm
2nd Harmonic		-40*	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm. *Typical value measured from worst case harmonic frequency across the band.
3rd Harmonic		-40*	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm. *Typical value measured from worst case harmonic frequency across the band.
All other harmonics up to 12.75GHz		-40	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm.
Non-harmonic Spurious up to 12.75GHz			-36	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, also over all power levels (5dBm to 33dBm).
Forward Isolation 1		-60	-41	dBm	TX Enable Low, P_{IN}=6dBm, V_{RAMP}=0.25V.
Forward Isolation 2		-27	-15	dBm	TX Enable High, P_{IN}=6dBm, V_{RAMP}=0.25V.
Output Noise Power		-86	-77	dBm	925MHz to 935MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, RBW=100kHz.
		-86	-83	dBm	935MHz to 960MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, RBW=100kHz.
		-118	-87	dBm	1805MHz to 1880MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, RBW=100kHz.
Output Load VSWR Stability (Spurious Emissions)			-36	dBm	VSWR=12:1, all phase angles (Set $V_{RAMP=VRAMP\ RATED}$ for P_{OUT}≤33dBm into 50Ω load; load switched to VSWR=12:1).
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=20:1, all phase angles (Set $V_{RAMP=VRAMP\ RATED}$ for P_{OUT}≤33dBm into 50Ω load; load switched to VSWR=20:1).

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
DCS1800 Band					Nominal conditions unless otherwise stated. All unused ports are terminated. V_{BATT}=3.5V, P_{IN}=3dBm, Temp=+25°C, TX Enable=High, VRAMP=1.8V. TX Mode: GpCtrl2=Low, GpCtrl1=High, GpCtrl0=High, Duty Cycle=25%, Pulse Width=1154µS
Operating Frequency Range	1710		1785	MHz	
Input Power	0	3	6	dBm	Full P_{OUT} guaranteed at minimum drive level.
Input VSWR		1.5:1	2.5:1		Over P_{OUT} range (0dBm to 30dBm).
Maximum Output Power	30	31.5		dBm	Nominal conditions.
	28	31.5		dBm	V_{BATT}=3.0V to 4.8V, P_{IN}=0dBm to 6dBm, Temp=-20°C to +85°C, Duty Cycle=50%, Pulse Width=2308mS, V_{RAMP}≤1.8V.
Minimum Power Into 3:1 VSWR	27	28.5		dBm	The measured delivered output power to the load with the mismatch loss already taken into account with 1dB variation margin.
Efficiency	32	37		%	Set V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm
2nd Harmonic		-40*	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm. *Typical value measured from worst case harmonic frequency across the band.
3rd Harmonic		-40*	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm. *Typical value measured from worst case harmonic frequency across the band.
4th Harmonic		-36*	-28	dBm	V_{RAMP}=$V_{RAMP\ RATED}$. *Typical value measured from worst case harmonic frequency across the band. External low pass filter can be used to attenuate the higher order harmonics. (See Application Schematic for suggested filter.)
All other harmonics up to 12.75GHz		-40	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm.
Non-harmonic Spurious up to 12.75GHz			-36	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm, also over all power levels (5dBm to 33dBm).
Forward Isolation 1		-62	-53	dBm	TX Enable Low, P_{IN}=6dBm, V_{RAMP}=0.25V.
Forward Isolation 2		-27	-15	dBm	TX Enable High, P_{IN}=6dBm, V_{RAMP}=0.25V.
Output Noise Power		-101	-77	dBm	925MHz to 935MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, RBW=100kHz.
		-100	-83	dBm	935MHz to 960MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, RBW=100kHz.
		-93	-79	dBm	1805MHz to 1880MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=33dBm, RBW=100kHz.
Output Load VSWR Stability (Spurious Emissions)			-36	dBm	VSWR=12:1, all phase angles (Set $V_{RAMP=VRAMP\ RATED}$ for P_{OUT}≤30dBm into 50Ω load; load switched to VSWR=12:1).
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=20:1, all phase angles (Set $V_{RAMP=VRAMP\ RATED}$ for P_{OUT}≤30dBm into 50Ω load; load switched to VSWR=20:1).

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
PCS1900 Band					Nominal conditions unless otherwise stated. All unused ports are terminated. V_{BATT}=3.5V, P_{IN}=3dBm, Temp=+25°C, TX Enable=High, VRAMP=1.8V. TX Mode: GpCtrl2=Low, GpCtrl1=High, GpCtrl0=High, Duty Cycle=25%, Pulse Width=1154μS
Operating Frequency Range	1850		1910	MHz	
Input Power	0	3	6	dBm	Full P_{OUT} guaranteed at minimum drive level.
Input VSWR		1.5:1	2.5:1		Over P_{OUT} range (5dBm to 30dBm).
Maximum Output Power	30	31.5		dBm	Nominal conditions.
	28	31.5		dBm	V_{BATT}=3.0V to 4.8V, P_{IN}=0dBm to 6dBm, Temp=-20°C to +85°C, Duty Cycle=50%, Pulse Width=2308mS, V_{RAMP}≤1.8V.
Minimum Power Into 3:1 VSWR	27	28.5		dBm	The measured delivered output power to the load with the mismatch loss already taken into account with 1dB variation margin.
Efficiency	32	37		%	Set V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm
2nd Harmonic		-40*	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm. *Typical value measured from worst case harmonic frequency across the band.
3rd Harmonic		-40*	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm. *Typical value measured from worst case harmonic frequency across the band.
4th Harmonic		-36*	-28	dBm	V_{RAMP}=$V_{RAMP\ RATED}$. *Typical value measured from worst case harmonic frequency across the band. External low pass filter can be used to attenuate the higher order harmonics. (See Application Schematic for suggested filter.)
All other harmonics up to 12.75GHz		-40	-33	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm.
Non-harmonic Spurious up to 12.75GHz			-36	dBm	V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm, also over all power levels (5dBm to 30dBm).
Forward Isolation 1		-61	-53	dBm	TX Enable Low, P_{IN}=6dBm, V_{RAMP}=0.25V.
Forward Isolation 2		-27	-15	dBm	TX Enable High, P_{IN}=6dBm, V_{RAMP}=0.25V.
Output Noise Power		-101	-82	dBm	869MHz to 894MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm, RBW=100kHz.
		-94	-74	dBm	1930MHz to 1990MHz. V_{RAMP}=$V_{RAMP\ RATED}$ for P_{OUT}=30dBm, RBW=100kHz.
Output Load VSWR Stability (Spurious Emissions)			-36	dBm	VSWR=12:1, all phase angles (Set $V_{RAMP=VRAMP\ RATED}$ for P_{OUT}≤30dBm into 50Ω load; load switched to VSWR=12:1).
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR=20:1, all phase angles (Set $V_{RAMP=VRAMP\ RATED}$ for P_{OUT}≤30dBm into 50Ω load; load switched to VSWR=20:1).

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
RX Section					Nominal conditions unless otherwise stated. VBATT=3.5V, PIN=-10dBm, Temp=+25°C, TX Enable=Low, VRAMP=0.2V, RX1 Mode: GpCtrl2=High, GpCtrl1=Low, GpCtrl0=Low RX2 Mode: GpCtrl2=Low, GpCtrl1=High, GpCtrll0=Low RX3 Mode: GpCtrl2=Low, GpCtrl1=High, GpCtrl0=High RX4 Mode: GpCtrl2=Low, GpCtrl1=Low, GpCtrl0=High RX Frequencies: GSM850=869MHz to 894MHz EGSM900=925MHz to 960MHz DCS1800=1805MHz to 1880MHz PCS1900=1930MHz to 1990MHz
Insertion Loss GSM850/EGSM900 ANT-RX1/2/3/4		1.0	1.3	dB	See Note 1.
In-Band Ripple GSM850/EGSM900 ANT-RX1/2/3/4		0.03	0.05	dB	
Input VSWR GSM850/EGSM900 ANT-RX1/2/3/4		1.3:1			
Insertion Loss DCS1800/PCS1900 ANT-RX1/2/3/4		1.4	1.7	dB	See Note 1.
In-Band Ripple DCS1800/PCS1900 ANT-RX1/2/3/4		0.05	0.1	dB	
Input VSWR DCS1800/PCS1900 ANT-RX1/2/3/4		1.9:1			
TX Section					
Switch Leakage P_{OUT} at RX Port GSM850, ANT-RX1/2/3/4		-10	6	dBm	GSM850 TX Mode: Freq=869MHz to 894MHz, GpCtrl2=Low, GpCtrl1=High. GpCtrl0=Low, $V_{RAMP}=V_{RAMP\ RATED}$ for P_{OUT}=33dBm at antenna port. See Note 2.
Switch Leakage P_{OUT} at RX Port EGSM900, ANT-RX1/2/3/4		-10	6	dBm	EGSM900 TX Mode: Freq=925MHz to 960MHz, GpCtrl2=Low, GpCtrl1=High. GpCtrl0=Low, $V_{RAMP}=V_{RAMP\ RATED}$ for P_{OUT}=33dBm at antenna port. See Note 2.
Switch Leakage P_{OUT} at RX Port DCS1800, ANT-RX1/2/3		-15	-5	dBm	GSM850 TX Mode: Freq=1805MHz to 1880MHz, GpCtrl2=Low, GpCtrl1=High. GpCtrl0=High, $V_{RAMP}=V_{RAMP\ RATED}$ for P_{OUT}=30dBm at antenna port. See Note 2.
Switch Leakage P_{OUT} at RX Port PCS1900, ANT-RX1/2/3		-15	-5	dBm	GSM TX Mode: Freq=1930MHz to 1990MHz, GpCtrl2=Low, GpCtrl1=High. GpCtrl0=High, $V_{RAMP}=V_{RAMP\ RATED}$ for P_{OUT}=30dBm at antenna port. See Note 2.

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
TX Section (cont.)					
Switch Leakage P_{OUT} at RX Port DCS1800, ANT-RX4		-3	5	dBm	
Switch Leakage P_{OUT} at RX Port PCS1900, ANT-RX4		-3	5	dBm	

Note 1: The insertion loss values listed take board resistive losses into account and are the upper limits of performance assuming an ideal match. A suggested matching network is supplied in the Application Schematic on page 14. PCS performance may vary up to 0.6dB from listed values without matching.

Note 2: Isolation specification set to ensure at least the following isolation at rated power. Calculation example: Switch Leakage=P_{OUT} at Antenna - P_{OUT} at RX Port. LB switch leakage=33-(-10)=43dB, HB switch leakage=30-(-15)=45dB.

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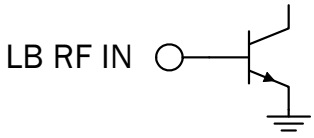
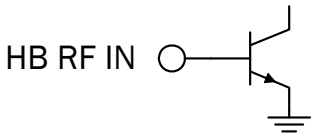
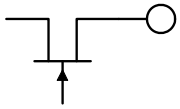
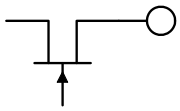
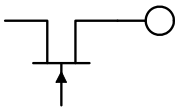
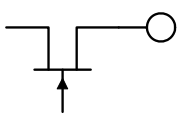
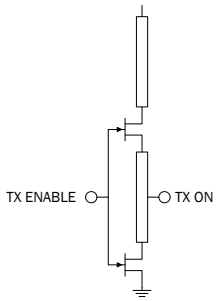
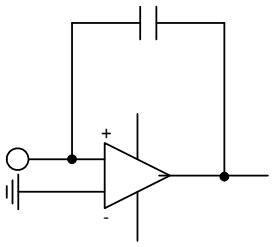
TX ENABLE	GpCtrl2	GpCtrl1	GpCtrl0	TX Module Mode
0	0	0	0	Low Power Mode (Standby)
0	1	0	0	RX1
0	0	1	0	RX2
0	0	1	1	RX3
0	0	0	1	RX4
1	0	1	0	GSM850/900 TX Mode
1	0	1	1	DCS1800/PCS1900 TX Mode

Pin	Function	Description	Interface Schematic
1	GND	Ground.	
2	GND	Ground.	
3	RF IN LB	RF input to the GSM850/EGSM900 bands. This is a 50Ω input.	
4	GND	Ground.	
5	RF IN HB	RF input to the DCS1800/PCS1900 bands. This is a 50Ω input.	
6	GND	Ground.	
7	GND	Ground.	
8	GND	Ground.	
9	GND	Ground.	
10	RX1	RX1 of antenna switch. This is a 50Ω output. This port is interchangeable with any other RX port.	
11	RX2	RX2 of antenna switch. This is a 50Ω output. This port is interchangeable with any other RX port.	
12	RX3	RX3 of antenna switch. This is a 50Ω output. This port is interchangeable with any other RX port.	
13	RX4	RX4 of antenna switch. This is a 50Ω output. This port is interchangeable with any other RX port.	

Pin	Function	Description	Interface Schematic
14	Antenna	Antenna port. This is a 50Ω output.	
15	GND	Ground.	
16	GND	Ground.	
17	GPCTRL2	Control pin that together with GpCtrl0 and GpCtrl1 selects the band of operation.	
18	VBATT	Power supply for the module. This should be connected to the battery terminal using as wide a trace as possible.	
19	GPCTRL1	Control pin that together with GpCtrl0 and GpCtrl2 selects the band of operation.	
20	GPCTRL0	Control pin that together with GpCtrl1 and GpCtrl2 selects the band of operation.	
21	TX ENABLE	This signal enables the PA module for operation with a logic high. The switch is put in TX mode determined by GpCtrl0, GpCtrl1, and GpCtrl2.	
22	VRAMP	VRAMP ramping signal from DAC. A simple RC filter is integrated into the RF7161 module. VRAMP may or may not require additional filtering depending on the baseband selected.	

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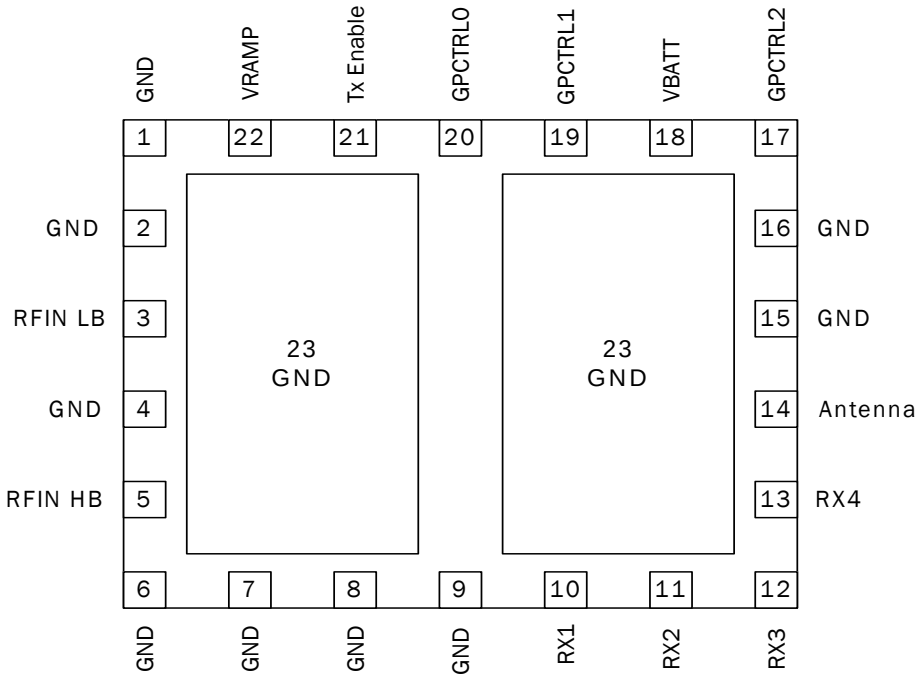
Pin Out


GND
VRAMP
Tx Enable
GPCTRL0
GPCTRL1
VBATT
GPCTRL2
1
22
21
20
19
18
17
GND 2
RFIN LB 3
GND 4
RFIN HB 5
16 GND
15 GND
14 Antenna
13 RX4
23
GND
23
GND
6
7
8
9
10
11
12
GND
GND
GND
GND
RX1
RX2
RX3

Theory of Operation

Product Description

The RF7161 is a quad-band transmit module (TXM) with fully-integrated power control functionality, harmonic filtering, band selectivity, and TX/RX switching. The TXM is self-contained, having 50Ω I/O terminals and four interchangeable RX ports allowing quad-band operation. The power control function eliminates all power control circuitry, including directional couplers, diode detectors, and power control ASICs, etc. The power control capability provides 50dB of continuous control range and 70dB of total control range, using a DAC-compatible, analog voltage input. The TX Enable feature provides for PA activation (TX mode) or RX mode/standby. Internal switching provides a low-loss, low-distortion path from the antenna port to the TX path (or RX port) while maintaining proper isolation.

Overview

The RF7161 simplifies the phone design by eliminating the need for the complicated control loop, harmonic filters, and TX/RX switch along with their associated matching components. The power control loop can be driven directly from the DAC output in the baseband circuit. The module has four RX ports for GSM850/EGSM900/DCS1800/PCS1900 operation. The four RX ports can be used interchangeably. To control the mode of operation there are four logic control signals: TX Enable, GpCtrl0, GpCtrl1, and GpCtrl2. RF7161 offers high efficiency at the rated P_{OUT} as backed-off efficiency is improved in this TXM.

Power Ramping and Timing

The RF7161 should be powered on according to the power-on sequence below. It is designed to prevent operation of the amplifier under conditions that could cause damage to the device or erratic operation.

There are some setup times associated with the control signals of the RF7161. The most important of these is the settling time between TXEN going high and when VRAMP can begin to increase. This time is often referred to as the “pedestal” and is required so that the internal power control loop and bias circuitry can settle after being turned on. The RF7161 requires at least 2 μs or two quarter-bit times for proper settling of the power control loop.

The power-down sequence is in opposite order of the power-on sequence. As described in the figure below, VBATT is applied first to provide bias to the silicon control chip. Then the RF drive is applied. Finally, when TXEN is high, The VRAMP signal is held at a constant 0.25V, and 2 μs later, VRAMP begins to ramp up. The shape of VRAMP is important for maintaining the switching transients. The basic shape of the ramping function should be raised cosine to achieve best transient performance.

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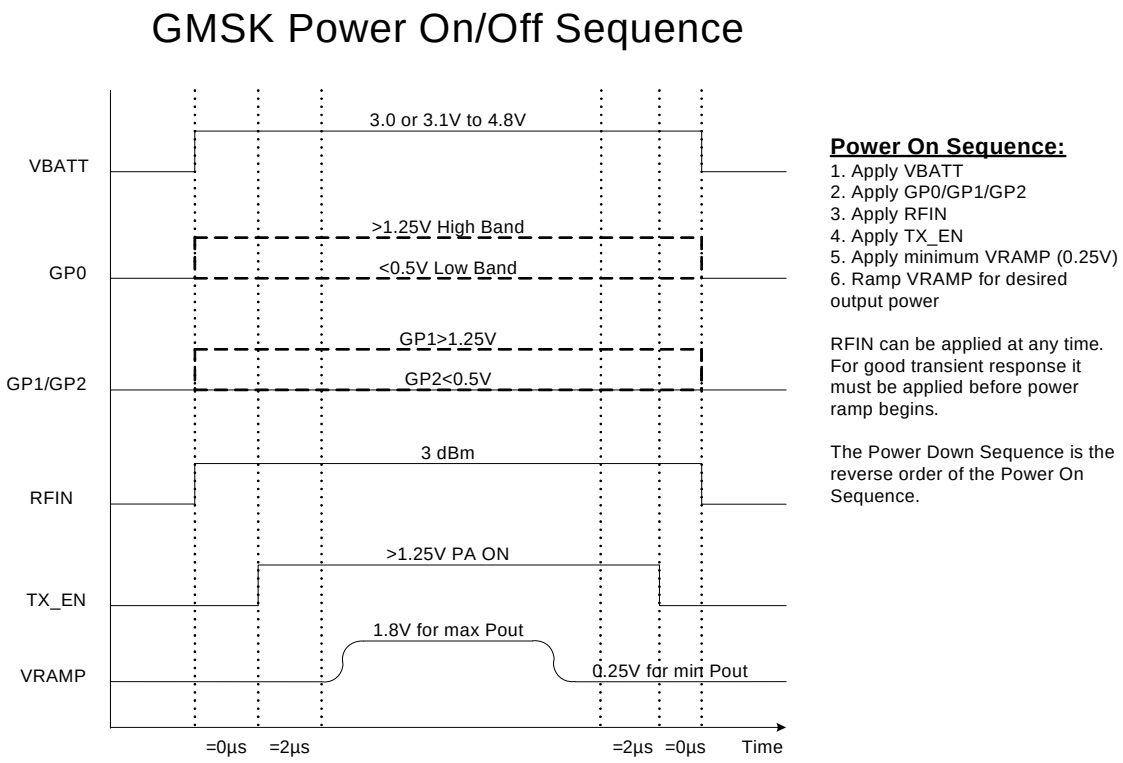
Power On Sequence



RF7161 Timing Diagram

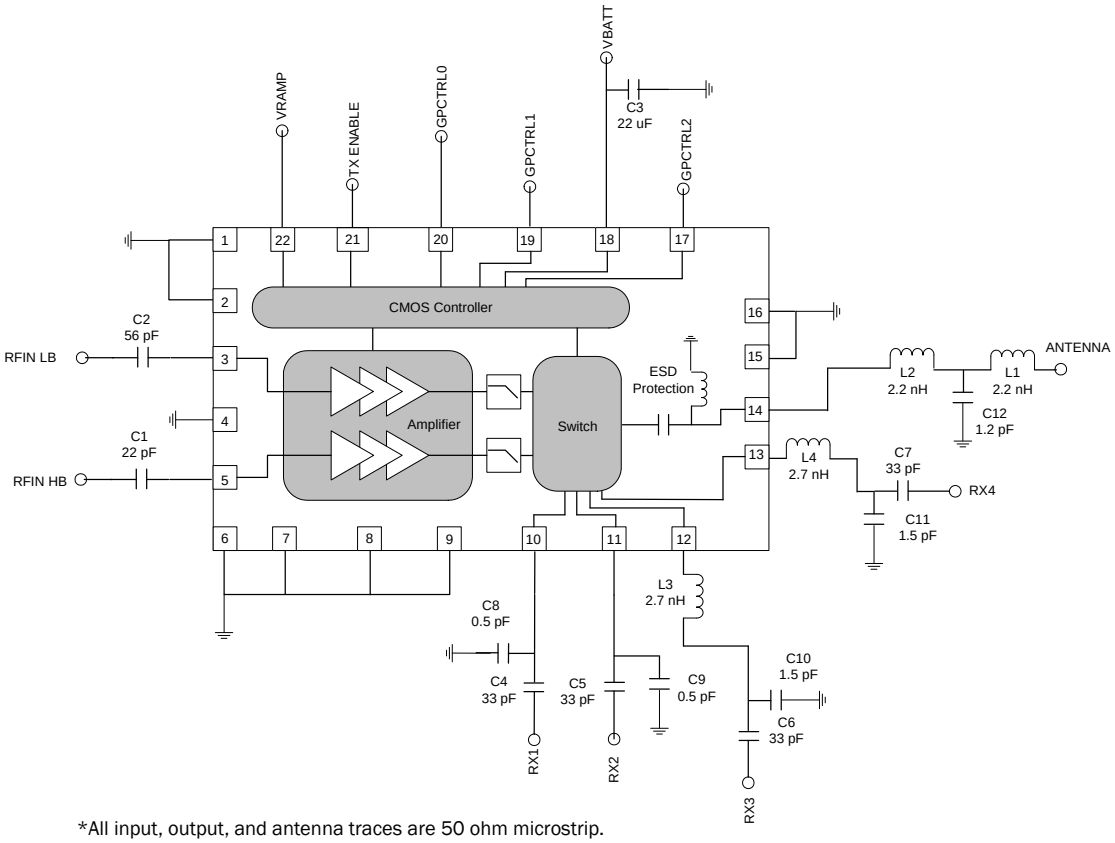
Power Flattening and VBATT Tracking

The RF7161 has an integrated power flattening circuit that reduces the amount of current variation when a mismatch is presented to the output of the PA. When a mismatch is presented to the output of the PA its output impedance is varied and could present a load that will increase output power. As the output power increases so does the current consumption. The current consumption can become very high if not monitored and limited. The power flattening circuit is integrated onto the CMOS controller and requires no input from user.

Into a mismatch, the current varies as the phase changes. The power flattening circuit monitors current through an internal sense resistor. As the current changes the loop is adjusted in order to maintain current. The result is flatter power and reduced current into mismatch.

The RF7161 also incorporates a VBATT tracking feature that eliminates the need for the transceiver/baseband to regulate the ramping signal as the supply voltage decreases. The internal circuit monitors the supply voltage and adjusts the ramping signal such that the switching spectrum is minimally impacted.

Application Schematic



*All input, output, and antenna traces are 50 ohm microstrip.

**VBATT capacitor value may change depending on application.

***RX ports usually connect to SAW filters. It is highly recommended to place shunt capacitors C8 – C11 and inductors L3 and L4 to provide the most flexibility for optimally matching the RX ports to the SAW filter for best RX performance. The series-L/shunt C networks are used on RX3 and RX4 which are recommended for high-band operation and give a greater degree of freedom in finding the correct match. The values shown for these components may not be ideal for each application, therefore, some experimentation may be warranted to find the correct values. Series capacitors C4 – C7 are required to block the DC voltage that is present on the RX pins.

****The recommended ordering of the RX ports for transceiver layout compatibility and isolation requirements is as follows: RX1=GSM850, RX2=EGSM900, RX3=DCS1800, and RX4=PCS1900.

*****If placing an attenuation network on the input to the power amplifier, ensure that it is positioned on the transceiver side of the capacitor C1 (or C2) to prevent adversely affecting the base biasing of the power amplifier.

******For control of higher order high-band harmonics, a low-pass filter is required on the ANT output. The values listed in this application schematic are suggested only and depend on the particular application, as they are heavily dependent on the phone circuit layout.

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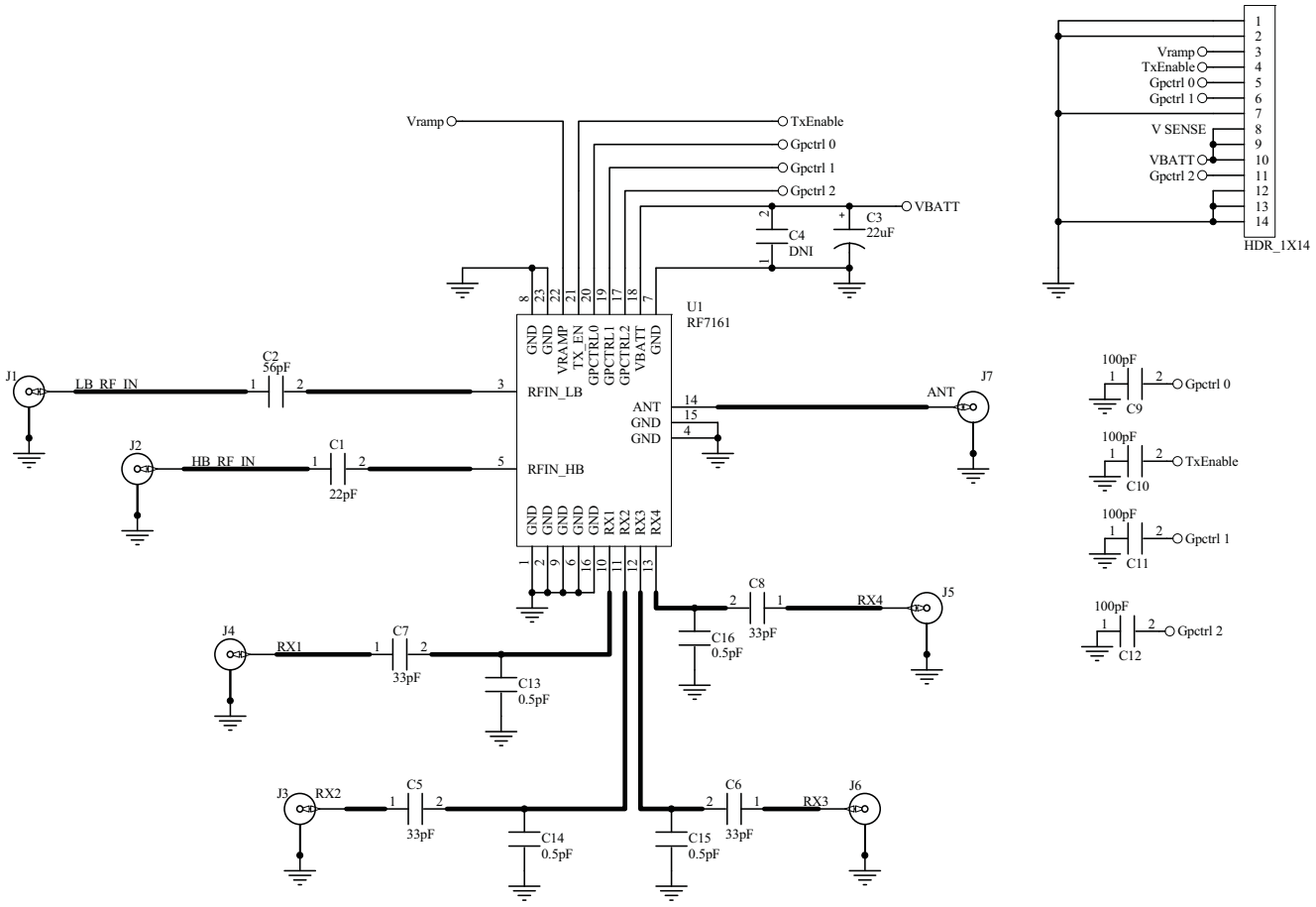
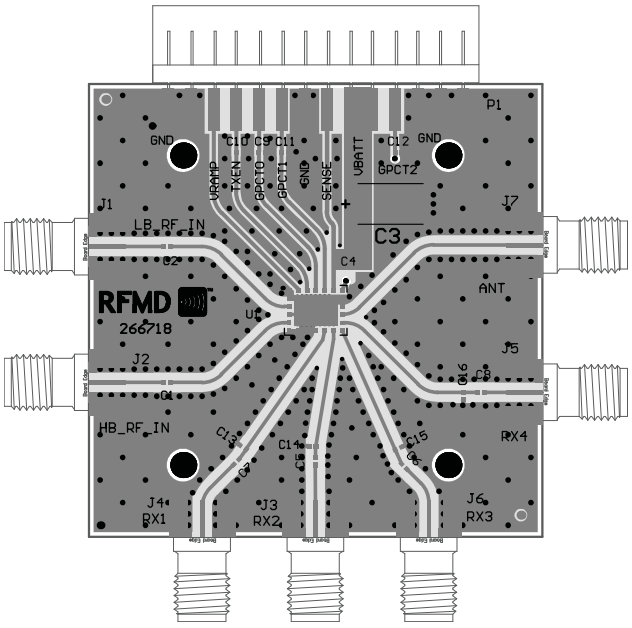
Evaluation Board Schematic

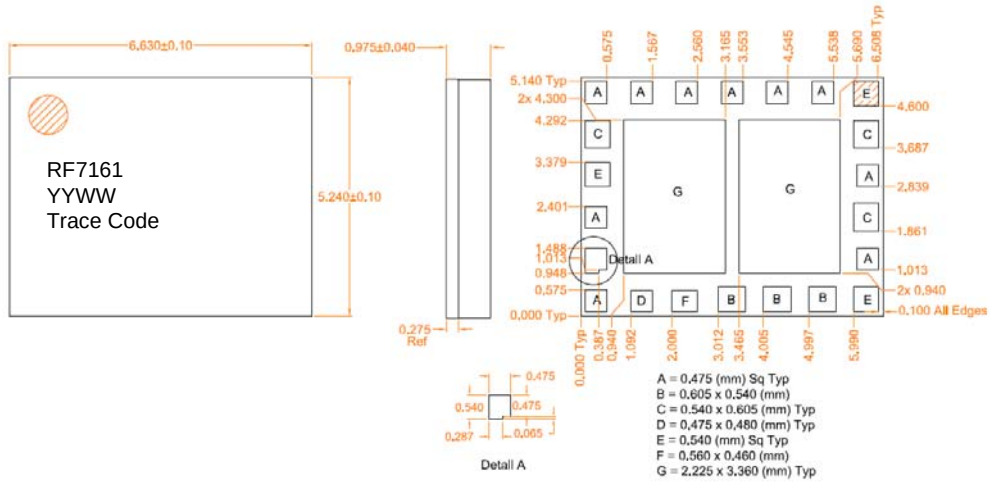


Notes: C9, C10, C11, and C12 are optional decoupling capacitors which may not be needed in the application. RX1, RX2, RX3, and RX4 usually connect to SAW filters. C5, C6, C7, and C8 are used to block the DC voltage present on RX pins. C13, C14, C15, and C16 are used to match the RX pins to a 50Ω filter.

Evaluation Board Layout



Package Drawing



Notes:
YY indicates year, WW indicates work week, and Trace Code is a sequential number assigned at device assembly.
Shaded areas represent Pin 1 location.

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PCB Design Requirements

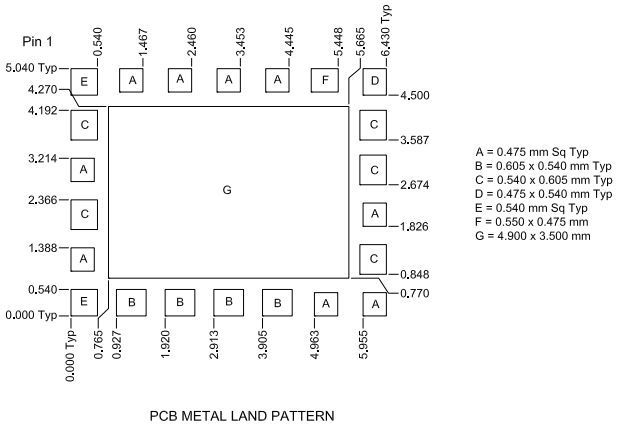
PCB Surface Finish

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

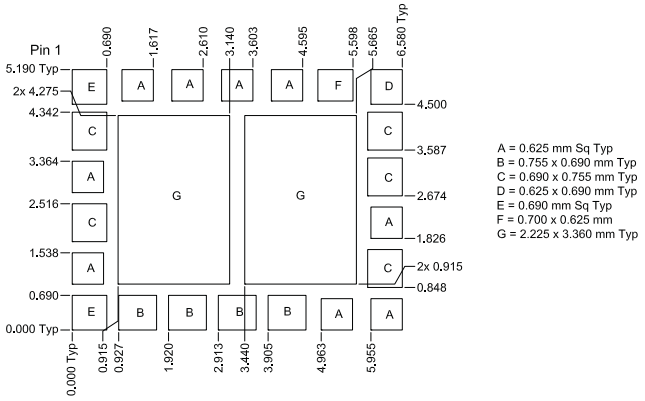
PCB Land Pattern Recommendation

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.

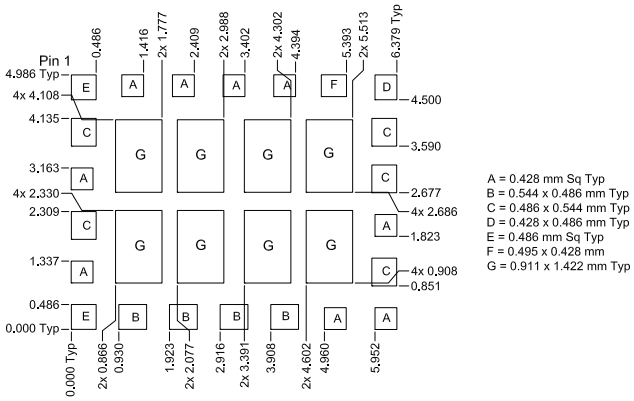
PCB Metal Land and Solder Mask Pattern



PCB METAL LAND PATTERN



PCB SOLDER MASK PATTERN



PCB STENCIL PATTERN

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Tape and Reel

Carrier tape basic dimensions are based on EIA 481. The pocket is designed to hold the part for shipping and loading onto SMT manufacturing equipment, while protecting the body and the solder terminals from damaging stresses. The individual pocket design can vary from vendor to vendor, but width and pitch will be consistent.

Carrier tape is wound or placed onto a shipping reel either 330mm (13 inches) in diameter or 178mm (7 inches) in diameter. The center hub design is large enough to ensure the radius formed by the carrier tape around it does not put unnecessary stress on the parts.

Prior to shipping, moisture sensitive parts (MSL level 2a-5a) are baked and placed into the pockets of the carrier tape. A cover tape is sealed over the top of the entire length of the carrier tape. The reel is sealed in a moisture barrier ESD bag with the appropriate units of desiccant and a humidity indicator card, which is placed in a cardboard shipping box. It is important to note that unused moisture sensitive parts need to be resealed in the moisture barrier bag. If the reels exceed the exposure limit and need to be rebaked, most carrier tape and shipping reels are not rated as bakeable at 125°C. If baking is required, devices may be baked according to section 4, table 4-1, of Joint Industry Standard IPC/JEDEC J-STD-033.

The table below provides information for carrier tape and reels used for shipping the devices described in this document.

Tape and Reel

RFMD Part Number	Reel Diameter Inch (mm)	Hub Diameter Inch (mm)	Width (mm)	Pocket Pitch (mm)	Feed	Units per Reel
RF7161TR13	13 (330)	4 (102)	12	8	Single	2500
RF7161TR7	7 (178)	2.4 (61)	12	8	Single	750

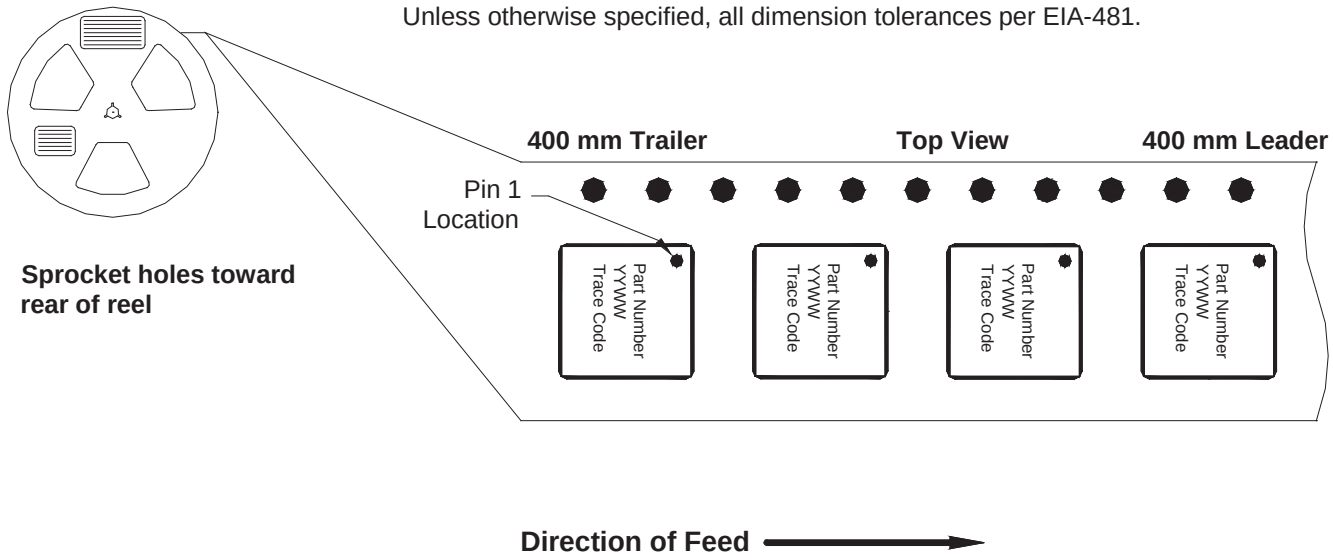

Figure 1. 5.24mm x 6.63mm (Carrier Tape Drawing with Part Orientation)

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RoHS* Banned Material Content

RoHS Compliant:	Yes
Package total weight in grams (g):	0.121
Compliance Date Code:	-
Bill of Materials Revision:	-
Pb Free Category:	e4

Bill of Materials	Parts Per Million (PPM)					
	Pb	Cd	Hg	Cr VI	PBB	PBDE
Die	0	0	0	0	0	0
Molding Compound	0	0	0	0	0	0
Lead Frame	0	0	0	0	0	0
Die Attach Epoxy	0	0	0	0	0	0
Wire	0	0	0	0	0	0
Solder Plating	0	0	0	0	0	0

This RoHS banned material content declaration was prepared solely on information, including analytical data, provided to RFMD by its suppliers, and applies to the Bill of Materials (BOM) revision noted above.

* DIRECTIVE 2002/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment

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