QUADRATURE DEMODUL

Typical Applications

- UHF Digital and Analog Receivers
- Digital Communication Systems
- Spread Spectrum Communication Systems
 General Purpose Frequency Conversion
- Commercial and Consumer Systems
- Portable Battery Powered Equipment

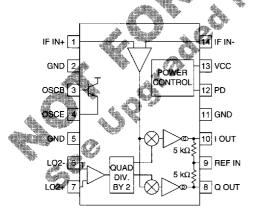
Product Description

The RF2701 is a monolithic integrated quadrature demodulator intended for use in digital mobile radio receivers. In this application it is used to recover the Inphase and Quadrature baseband signals from the amplified and filtered IF. The RF2701 is intended for IF systems where the IF frequency ranges from 100kHz to 70MHz, and the LO frequency is two times the IF. The IC contains all of the required components to implement the demodulation function of the receiver and contains a digital divider type 90° phase shifter, two double balanced mixers, and baseband amplifiers designed to interface with Analog to Digital Converters. The output DC offset may be slaved to the reference of the ADCs to maintain DC accuracy.

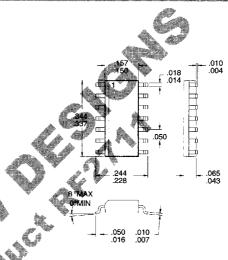
Optimum Technology Matching™ Applied

Si BJT Si Bi-CMOS ☐ GaAs HBT

GaAs MESFET



Functional Block Diagram



Package Style: SOP-14

Features

- 5V Power Supply
- On-Chip Active Device for Oscillator
- ADC Compatible Outputs
- Low LO Power Requirement
- Digitally Controlled Power Down Mode
- 100kHz to 70MHz IF Operation

Ordering Information

RF2701 RE2701 PCBA Quadrature Demodulator

Fully Assembled Evaluation Board

RF Micro Devices, Inc. 7625 Thorndike Road Greensboro, NC 27409, USA

Tel (910) 664 1233 Fax (910) 664 0454 http://www.rfmd.com

Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	-0.5 to +7.0	V_{DC}
Power Down Voltage (V _{PD})	-0.5 to $V_{\rm CC}$	V_{DC}
IF Input Level	2.0	V_{PP}
LO Input Power	+10	dBm
Operating Ambient Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C



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		Specification			
Parameter	Min.	Тур.	Max.	Unit	Condition
Overall IF Frequency Range Baseband Frequency Range Baseband Frequency Range Input Impedance Output Impedance Maximum Output Gain I/Q Amplitude Balance I/Q Phase Accuracy Reference Voltage DC Offset	13	0.1 to 70 DC to >10 DC to 1 1000-j1300 5000 >1.25 14 0.1 ±1 1.5 to 3.5	0.5 ±5	MHz MHz Ω Ω Ven alb elb V	T=25°C, V_{CB} =5.0 V Load Impedance > 5kΩ, C_{SHUNT} < 1pF Load Impedance > 5kΩ, C_{SHUNT} < 10pF At 50MHz, each input With 250mV input Small-signal, 100mV input The reference voltage input should provide a low impedance at the I/Q frequency. The voltage sets the DC level seen on the I and Q ports. I to Q
DC Offset LO Oscillator Frequency Level Input Impedance		0.1-1 400-j1200	60	mV V _{PP} Ω	Use provided transistor or external LO Twice (2x) the IF frequency At 100MHz
Power Down Turn On/Off Time PD Input Resistance Power Down "ON" Power Down "OFF	Q.5	<100 >50 2.5 0.8	3.0	ns kΩ V V	Threshold voltage Threshold voltage
Power Supply Voltage Current		5 4.5 to 5.5 4.5 300	7.2 500	V V mA μA	Specifications Operating limits Operating Power Down

Pin	Function	Description	Interface Schematic
1	IF IN+	Balanced IF input. An input level of 400 mV _{PP} gives full output swing; a level of maximum 250 mV _{PP} is recommended for linear operation. This pin has no internal DC block and an external capacitor of 100 nF is needed if connected to a DC path.	IF IN- 1500 Ω 350 Ω 350 Ω 350 Ω 350 Ω
2	GND	Ground connection. Keep traces physically short and connect immedi-	•
3	OSCB	ately to ground plane for best performance. Base of the LO transistor. This pin is not connected to anything else.	
3		This transistor can be used for an oscillator. The collector of the transistor is connected to V_{CC} .	OSCB — VCC
4	OSCE	Emitter of the LO transistor. This pin is not connected to anything else Maximum collector current of this device is $1\text{mA}_rt_T=4.5\text{GHz}$, $h_{\text{fe}}=100$	See pin 3.
5	GND	Same as pin 2.	
6	LO2-	Balanced input for the doubled LO. An internal divide-by-2 network generates the actual LO for the mixers. The divided signal is not accessible. When the LO is driven single ended this pin should be connected to a 100 nF capacitor to ground. This pin has an internal pull-up resistor to V _{CC} and an external DC blocking capacitor of 10 nF is recommended.	V _C V _C
7	LO2+	Balanced input for the doubled LO. The input frequency should be twice (2x) the IF frequency. An internal divide-by-2 network generates the actual LO for the mixers. This pin has an internal pull-up resistor to V _{CC} , and an external DC blocking capacitor of 100nF is recommended. LO frequencies below 100kHz are acceptable, providing that the LO signal is square wave. Above 100kHz a sine wave signal is acceptable. The quadrature accuracy of the LO/2 frequency into the mixers is affected by the duty cycle of the LO input signal. Square wave signals with other than 50% duty cycle will degrade the quadrature accuracy of the LO signal, thereby adversely affecting the I and Q quadrature accuracy. Since the LO input is AC coupled, asymmetric sine waves and sine waves dipped on either the top or bottom half will not have 50% duty cycles relative to the internal DC reference point. For this reason, distorted LO sine wave signals will degrade performance in a fashion similar to non-50% duty cycle square waves. A sine wave input with oven harmonics less than -15dBc is recommended. The internal limiting buffer amplifier ensures the amplitude stability of the demodulator.	See pin 6.
8	QOUT	Demodulated baseband Q output. The reference DC level of this pin is set by the voltage of pin 9 (REF IN), which is connected to this pin through a $5k\Omega$ resistor to the collectors of this push-pull output. This results in an output impedance of $5k\Omega$ if the REF IN pin is connected to a low impedance source. The capacitance of the load determines the maximum baseband frequency. A very low capacitive load may stretch the 3dB bandwidth over 10MHz. Another way to increase bandwidth is by connecting a shunt resistor. This will trade-off gain for bandwidth.	5 kΩ REF IN I/Q OUT
9	REF IN	Reference voltage input for the baseband outputs. This pin can be connected to the reference voltage source of the Analog to Digital Converter. It is connected to the I and Q outputs through $5\mathrm{k}\Omega$ resistors. This pin should have an external decoupling capacitor large enough to decouple the lowest baseband frequency.	See pin 8.

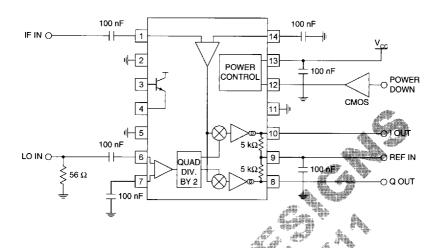
10	I OUT	Demodulated baseband I output. The reference DC level of this pin is set by the voltage of pin 9 (REF IN), which is connected to this pin through a $5 \mathrm{k}\Omega$ resistor to the collectors of this push-pull output. This results in an output impedance of $5 \mathrm{k}\Omega$ if the REF IN pin is connected to a low impedance source. The capacitance of the load determines the maximum baseband frequency. A very low capacitive load may stretch the 3dB bandwidth over 10MHz. Another way to increase bandwidth is by connecting a shunt resistor. This will trade gain for bandwidth.	See pin 8.
11	GND	Same as pin 2.	
12	PD	Power Down control. When this pin is "low", all circuits are shut off. A "low" is typically 0.8V or less at room temperature. When this pin is "high", all circuits are operating normally.	vcc
13	VCC	Power supply pin. An external 100nF bypass capacitor is recommended if no other bypass capacitor is nearby.	
14	IF IN-	Balanced IF input. An input level of 400 mV _{PP} gives full output swing, a level of maximum 250 mV _{PP} is recommended for linear operation. This pin has no internal DC block and an external capacitor of 100 m is needed if connected to a DC path. If the IF is driven by a single-ended source, connect this pin to an 100 nF capacitor to ground.	See pin 1.

Spice model for oscillator transistor:

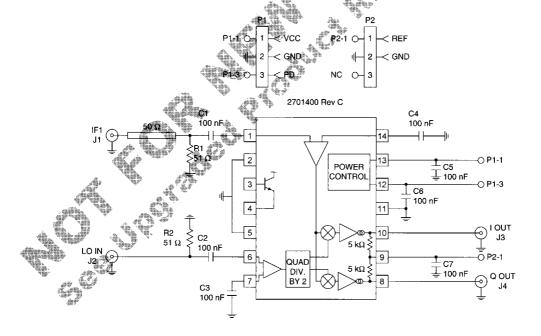
.MODEL RFM2 npn (BF=115.5 VAF=40 IS=.00722 F RE=12.1 RC=77.20 RB=1082.6 RBM=295.0 BR=0.6593 CJE=36.7F TF=24.485p CJC=38.75F CJS=161.1F)



Application Schematic



Evaluation Board Schematic 1.5" x 1.5"





PACKAGE DRAWINGS

Package Drawing Dimension Typical Tolerance		·	T	Mossur	amont (mm)	1 14	
A	Package Drav	ving	Dimension				
B 6.35 ±0.20 0.250 ±0.008	QLCC-16		<u> </u>				
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B 0.41 ±0.05 0.016 ±0.002 C 1.27		н	1.41	±0.09	0.063	+0.004, -0.003
8 0° to 8°	n - - - -		0.18	+0.07, -0.08	0.007	±0.003
SOP-20 A 7.50 ±0.10 0.295 ±0.004 ±0.002 B 0.41 ±0.05 0.016 ±0.002 C 1.27 0.050 D 10.31 ±0.20 0.406 ±0.008 ±0.008 F 0.76 ±0.25 0.030 ±0.010 ±0.002 H 2.34 0.092 J 0.20 ±0.10 0.008 ±0.004 O° to 8° PSOP-8 A 3.91 +0.08, -0.10 0.154 +0.003, -0.00 ±0.003 C 1.27 D 6.02 ±0.18 0.237 ±0.007 F 0.64 +0.25, -0.23 0.025 +0.010, -0.00 ±0.003 F 0.64 +0.25, -0.23 0.025 ±0.010, -0.00 ±0.003 F 0.64 +0.25, -0.23 0.025 ±0.010, -0.00 ±0.003 F 0.64 ±0.25, -0.23 0.025 ±0.010, -0.00 ±0.003 F 0.64 ±0.25, -0.23 0.025 ±0.010, -0.00 ±0.003 F 0.68 ±0.003 ±0.003 ±0.007 ±0.003 ±0.003 F 0.68 ±0.003 ±0.003 ±0.003 ±0.003 ±0.003 F 0.69 ±0.008 ±0.003 ±		θ	0° to 8°		0° to 8°	
SOP-20 A 7.50	00					
B	, G					
B 0.41 ±0.05 0.016 ±0.002 C 1.27 0.050 D 10.31 ±0.20 0.406 ±0.008 ±0.008 E 12.75 ±0.10 0.502 ±0.004 F 0.76 ±0.25 0.030 ±0.010 H 2.34 0.092 J 0.20 ±0.10 0.008 ±0.004 0° to 8° PSOP-8 A 3.91 +0.08, -0.10 0.154 +0.003, -0.00 0° to 8° D 6.02 ±0.18 0.237 ±0.007 E 4.90 +0.08, -0.10 0.193 +0.003, -0.00 F 0.64 +0.25, -0.23 0.025 +0.010, -0.00 F 0.65 ±0.003 ±0.003 F 0.66 ±0.005 ±0.003 ±0.003 F 0.66 ±0.005 ±0.003 ±0.003 F 0.67 ±0.005 ±0.003 F 0.69 ±0.005 ±0.003 F 0.09 ±0.005 ±0.003 F 0.005 ±0.005 F 0.005 ±0.	SOP-20	Α	7.50	±0.10	0.295	±0.004
C 1.27		В	0.41	±0.05	0.016	±0.002
PSOP-8 A 3.91 +0.08, -0.10 0.154 ±0.003, -0.004 B 0.41 ±0.08 0.016 ±0.003 C 1.27 0.64 ±0.23 ±0.003 B 0.41 ±0.08 0.016 ±0.003 C 1.27 0.050 B 40.003 ±0.007 ±0.003 C 1.27 0.050 B 40.003 ±0.007 ±0.003 C 1.27 0.050 C 1.27	B B	1	1.27		0.050	
E 12.75 ±0.10 0.502 ±0.004		D	10.31	±0.20	0.406	±0.008
PSOP-8 A 3.91 +0.08, -0.10 0.154 +0.003, -0.00 B 0.050		E	12.75	±0.10	0.502	±0.004
G 0.27 ±0.05 0.011 ±0.002 0.092 ±0.004 0.092 ±0.004 0.092 ±0.004 0.092 ±0.004 0.092 ±0.004 0.008 0.008 ±0.004 0.008 0.0		F	0.76	±0.25	0.030	±0.010
H 2.34 0.20 ±0.10 0.008 ±0.004 0° to 8° 0° to 8		G	0.27	±0.05	0.011	±0.002
PSOP-8 A 3.91 +0.08, -0.10 0.154 +0.003, -0.00 B 0.41 ±0.08 0.016 ±0.003 C 1.27 0.050 D 6.02 ±0.18 0.237 ±0.007 E 4.90 +0.08, -0.10 0.193 +0.003, -0.00 F 0.64 +0.25, -0.23 0.025 +0.010, -0.00 HEATSINK H 1.47 ±0.08 0.058 ±0.003 HEATSINK J 0.18 ±0.08 0.007 ±0.003 HEATSINK J 0.18 ±0.08 0.007 ±0.003 HEATSINK L 2.92 ±0.20 0.115 ±0.008 B 0.008 ±0.008 D 0.008 ±0.008 D 0.008 ±0.008 D 0.008 ±0.008		н	2.34		0.092	
PSOP-8 A 3.91 +0.08, -0.10 0.154 +0.003, -0.00 B 0.41 ±0.08 0.016 ±0.003 C 1.27 0.050 D 6.02 ±0.18 0.237 ±0.007 E 4.90 +0.08, -0.10 0.193 +0.003, -0.00 F 0.64 +0.25, -0.23 0.025 +0.010, -0.00 EXPOSED H 1.47 ±0.08 0.058 ±0.003 HEATSINK J 0.18 ±0.08 0.007 ±0.003 K 2.92 ±0.20 0.115 ±0.008 B 0.41 ±0.08 0.007 ±0.003 C 1.27 0.000 ±0.20 0.079 ±0.003		J	0.20	±0.10	0.008	±0.004
PSOP-8 A 3.91 +0.08, -0.10 0.154 +0.003, -0.00 B 0.41 ±0.08 0.016 ±0.003 C 1.27 0.050 D 6.02 ±0.18 0.237 ±0.007 E 4.90 +0.08, -0.10 0.193 +0.003, -0.00 F 0.64 +0.25, -0.23 0.025 +0.010, -0.00 F 0.64 +0.25, -0.23 0.025 +0.010, -0.00 HEATSINK J 0.18 ±0.08 0.058 ±0.003 H 1.47 ±0.08 0.058 ±0.003 H 1.47 ±0.08 0.058 ±0.003 K 2.92 ±0.20 0.115 ±0.008 C 1.27 0.003 ±0.003 F 0.64 +0.25, -0.23 0.025 +0.010, -0.003 F 0.64 ±0.08 0.058 ±0.003 F 0.65 ±0.08 0.058 ±0.08 0.058 ±0.003 F 0.65 ±0.08 0	н — п	θ	0° to 8°		0° to 8°	
B 0.41 ±0.08 0.016 ±0.003 C 1.27 0.050 D 6.02 ±0.18 0.237 ±0.007 E 4.90 +0.08, -0.10 0.193 +0.003, -0.00 F 0.64 +0.25, -0.23 0.025 +0.010, -0.00 HEATSINK J 0.18 ±0.08 0.058 ±0.003 HEATSINK J 0.18 ±0.08 0.007 ±0.003 K 2.92 ±0.20 0.115 ±0.008 D 6.02 ±0.20 0.079 ±0.008 O 0 to 8 0 0 to 8 0 0 to 8 0						
C 1.27	PSOP-8	A	3.91	+0.08, -0.10	1	
C 1.27	A - B	В	0.41	±0.08		±0.003
D 6.02 ±0.18 0.237 ±0.007 E 4.90 +0.08, -0.10 0.193 +0.003, -0.00 F 0.64 +0.25, -0.23 0.025 +0.010, -0.00 HEATSINK J 0.18 ±0.08 0.058 ±0.003 HEATSINK J 0.18 ±0.08 0.007 ±0.003 K 2.92 ±0.20 0.115 ±0.008 D 6.02 ±0.20 0.79 ±0.007 ±0.007 D 6.02 ±0.007 ±0.007 ±0.008 D 6.02 ±0.20 0.79 ±0.008 D 6.02 ±0.007 ±0.007 D 6.02 ±0.007 ±0.007 D 6.02 ±0.007 ±0.007 D 6.02 ±0.008 D 6.02 ±0.007 ±0.007 D 6.02 ±0		C	1		1	
E 4.90 +0.08, -0.10 0.193 +0.003, -0.00				i		
F 0.64 +0.25, -0.23 0.025 +0.010, -0.00		E			1	+0.003, -0.004
EXPOSED HEATSINK H 1.47 ±0.08 0.058 ±0.003 ±0.003 ±0.003 ±0.003 ±0.008 EXPOSED HEATSINK J 0.18 ±0.08 0.007 ±0.008 ±0.008 0.007 ±0.008 ±0.008 0.007 ±0.008		F	0.64	+0.25, -0.23	1	1
HEATSINK J 0.18 ±0.08 0.007 ±0.003 ±0.008 L 2.00 ±0.20 0° to 8° 0° to 8° Divided to the control of		G	0.23	1 1		+0.001, -0.002
θ° K 2.92 ±0.20 0.115 ±0.008 L 2.00 ±0.20 0.079 ±0.008 θ 0° to 8° 0° to 8° 0° to 8°	EXPOSED HEATSINK	Н	1.47			
L 2.00 ±0.20 0.079 ±0.008 θ 0° to 8°	φ.	J	0.18	1	Į.	1
C C C C C C C C C C C C C C C C C C C	11	κ	2.92	±0.20		1
θ 0° to 8° 0° to 8°	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1	L	2.00	±0.20	1	±0.008
		θ	0° to 8°		0° to 8°	

Package Draw	vina .	Dimension	Measure	ement (mm)	Measurer	nent (inches)
		Difficilision	Typical	Tolerance	Typical	Tolerance
SSOP-16		Α	3.90	±0.09	0.154	±0.003
A	- - J	В	0.26	±0.05	0.010	±0.002
B	r j	С	0.64		0.025	
E 38 E		D	6.00	±0.20	0.236	±0.008
E III C	<u>'</u> 	E	4.89	±0.09	0.192	±0.003
		F	0.84	±0.43	0.033	±0.017
D	! H !	G	0.22	±0.03	0.009	+0.001, -0.002
		н	1.55	±0.20	0.061	+0.007, -0.008
6° √ − − − − − − − − − − − − − − − − − −		J	0.18	+0.07, -0.08	0.007	±0.003
		θ	0° to 8°		0° to 8°	
SSOP-24		Α	3.90	±0.09	0.154	±0.003
A	- - J	В	0.26	±0.05	0.010	±0.002
В	LT-J	С	0.64		0.025	
	∄	D	6.00	±0.20	0.236	±0.008
		E	8.60	±0.09	0.340	±0.003
		F	0.84	±0.43	0.033	±0.017
		G	0.22	±0.03	0.009	+0.001, -0.002
		н	1.55	±0.20	0.061	+0.007, -0.008
	' H 	J	0.18	+0.07, -0.08	0.007	±0.003
		θ	0° to 8°		0° to 8°	
e° F G						
SSOP-28		Α	3.90	±0.09	0.154	±0.003
├ ─ A -	- - J	В	0.26	±0.05	0.010	±0.002
B		С	0.64		0.025	
		D	6.00	±0.20	0.236	±0.008
		E	9.89	±0.09	0.340	+0.003, -0.004
E 8 HH LC		F	0.84	±0.43	0.033	±0.017
C		G	0.22	±0.03	0.009	+0.001, -0.002
		н	1.55	±0.20	0.061	+0.007, -0.008
	_H	J	0.18	+0.07, -0.08	0.007	±0.003
		θ	0° to 8°		0° to 8°	
e° G						

		Measure	ment (mm)	Measurem	ent (inches)
Package Drawing	Dimension	Typical	Tolerance	Typical	Tolerance
SOP-8-C	Α	7.87	±0.13	0.310	±0.005
 	В	4.22	Square	0.166	Square
B J	С	0.38	±0.05	0.015	±0.002
l c	D	4.57	Max	0.180	Max
	E	1.27		0.050	
	F	0.38	±0.05	0.015	±0.002
- D	G	0.13	±0.03	0.005	±0.001
	н	1.45	Max	0.057	Max
00	J	0 to 0.10		0 to 0.004	
	θ	0° to 4°		0° to 4°	
-i⊢F G-					
SOP-16 Batwing	A	3.91	±0.10	0.154	±0.004
- A - - - -	В	0.43	±0.08	0.017	±0.003
B F	С	1.27		0.050	
	D	6.02	±0.18	0.237	±0.007
	E	9.88	±0.08	0.389	±0.003
	F	0.64	+0.25, -0.23	0.025	+0.010, -0.009
	G	0.23	±0.03	0.009	±0.001
F-C	H	1.45	+0.05, -0.08	0.057	+0.002, -0.003
	J	0.17	+0.06, -0.08	0.007	+0.002, -0.003
D H	K	1.69	+0.06, -0.07	0.067	+0.002, -0.003
	θ	0° to 8°		0° to 8°	
\\F G					
SOP-16 QBW1	Α	3.91	±0.10	0.154	±0.004
	В	0.43	±0.08	0.017	±0.003
В	С	1.27		0.050	
	D	6.02	±0.18	0.237	±0.007
	E	9.88	±0.08	0.389	±0.003
	F	0.64	+0.25, -0.23	0.025	+0.010, -0.009
	G	0.23	±0.03	0.009	±0.001
	н	1.45	+0.05, -0.08	0.057	+0.002, -0.003
	J	0.17	+0.06, -0.08	0.007	+0.002, -0.003
D :H	к	1.69	+0.06, -0.07	0.067	+0.002, -0.003
	θ	0° to 8°		0° to 8°	
e° f					
F G					
		1		<u> </u>	<u> </u>

Package Drawing	Dimension	Measure	Measurement (mm)		Measurement (inches)	
	Diriension	Typical	Tolerance	Typical	Tolerance	
TQFP-48	Α	8.99	±0.20	0.354	±0.008	
A	J- - B	8.99	±0.20	0.354	±0.008	
AAAAAAAAA T	d c	7.01	+0.18, -0.20	0.276	+0.007, -0.008	
B B C C	D E F	7.01	+0.18, -0.20	0.276	+0.007, -0.008	
	E	0.23	±0.05	0.009	±0.002	
	F	0.51		0.020		
F	G	0.13	Max	0.005	Max	
	<u> </u>	0.99	±0.05	0.039	±0.002	
	J	0.05 to 0.15		0.002 to 0.006		
θ°	θ	0° to 7°		0° to 7°		
F G						