RFFC5071/5072

WIDEBAND SYNTHESIZER/VCO WITH INTEGRATED 6GHz MIXER

Package: QFN, 32-Pin, 5mmx5mm

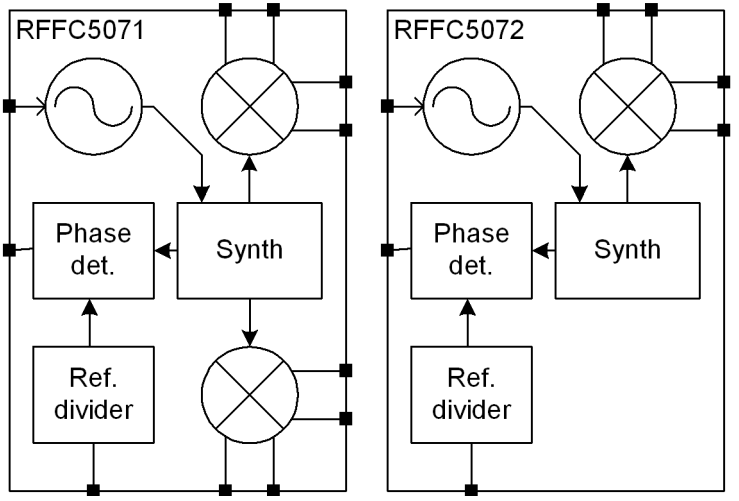
RFMD RFFC507x

Features

- 85MHz to 4200MHz LO Frequency Range
- Fractional-N Synthesizer with Very Low Spurious Levels
- Typical Step Size 1.5Hz
- Fully Integrated Low Phase Noise VCO and LO Buffers
- High Linearity RF Mixer(s)
- 30MHz to 6000MHz Mixer Frequency Range
- Input IP3 +23dBm
- Mixer Bias Adjustable for Low Power Operation
- Full Duplex Mode (RFFC5071)
- 2.7V to 3.3V Power Supply
- Low Current Consumption
- 3- or 4-Wire Serial Interface

Applications

- Diversity Receivers
- Software Defined Radios
- Wideband Radios
- Frequency Band Shifters
- Point-to-Point Radios
- WiMax/LTE Infrastructure
- Satellite Communications



Functional Block Diagram

Product Description

The RFFC5071 and RFFC5072 are reconfigurable frequency conversion devices with integrated fractional-N phased locked loop (PLL) synthesizer, voltage controlled oscillator (VCO) and either one or two high linearity mixers. The fractional-N synthesizer takes advantage of an advanced sigma-delta modulator that delivers ultra-fine step sizes and low spurious products. The PLL/VCO engine combined with an external loop filter allows the user to generate local oscillator (LO) signals from 85MHz to 4200MHz. The LO signal is buffered and routed to the integrated RF mixers which are used to convert frequencies ranging from 30MHz to 6000MHz. The mixer bias current is programmable and can be reduced for applications requiring lower power consumption.

Both devices can be configured to work as signal sources by bypassing the integrated mixers. Device programming is achieved via a simple 3-wire serial interface. In addition, a unique programming mode allows up to four devices to be controlled from a common serial bus. This eliminates the need for separate chip-select control lines between each device and the host controller. Up to six general purpose outputs are provided, which can be used to access internal signals (e.g. the LOCK signal) or to control front end components. Both devices operate with a 2.7V to 3.3V power supply.

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
Supply Voltage (V_{DD})	-0.5 to +3.6	V
Input Voltage (V_{IN}) any pin	-0.3 to V_{DD}+0.3	V
RF/IF mixer input power	+15	dBm
Operating Temperature Range	-40 to +85	°C
Storage Temperature Range	-40 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 Requirementsl					
Human Body Model	2000			V	General
	1000			V	RF Pins
Machine Model	200			V	General
	100			V	RF Pins
Operating Conditions					
Supply voltage (V_{DD})	2.7	3.0	3.3	V	
Temperature (T_{OP})	-40		+85	°C	
Logic Inputs/Outputs (V_{DD}=Supply to DIG_VDD pin)					
Input low voltage	-0.3		+0.5	V	
Input high voltage	1.5		V_{DD}	V	
Input low current	-10		+10	µA	Input=0V
Input high current	-10		+10	µA	Input=V_{DD}
Output low voltage	0		0.2*V_{DD}	V	
Output high voltage	0.8*V_{DD}		V_{DD}	V	
Load resistance	10			kΩ	
Load capacitance			20	pF	
Static					
Supply Current (I_{DD}) with 1GHz LO		100		mA	Low current, MIX_IDD=1, one mixer enabled.
		125		mA	High linearity, MIX_IDD=6, one mixer enabled.
Standby			2	mA	Reference oscillator and bandgap only.
Power Down Current			300	µA	ENBL=0 and REF_STBY=0
Mixer 1/2 (Mixer output driving 4:1 balun)					
Gain		-2		dB	Not including balun losses
Noise Figure		10		dB	Low current setting
		13		dB	High linearity setting
IIP3		+10		dBm	Low current setting
		+23		dBm	High linearity setting
Input port frequency range	30		6000	MHz	
Mixer input return loss		10		dB	100Ω differential
Output port frequency range	30		4500	MHz	
Reference Oscillator					
External reference frequency	10		104	MHz	
Reference divider ratio	1		7		
External reference input level	500	800	1500	mVp-p	AC-coupled

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Synthesizer (Loop bandwidth of 200KHz, 52MHz reference)					
Synthesizer output frequency	85		4200	MHz	
Phase detector frequency			52	MHz	
Phase noise (LO=1GHz)		-108		dBc/Hz	10kHz offset
		-108		dBc/Hz	100kHz offset
		-135		dBc/Hz	1MHz offset
		0.19		°	RMS integrated from 1kHz to 40MHz
Phase noise (LO=2GHz)		-102		dBc/Hz	10kHz offset
		-102		dBc/Hz	100kHz offset
		-130		dBc/Hz	1MHz offset
		0.32		°	RMS integrated from 1kHz to 40MHz
Normalized phase noise floor		-214		dBc/Hz	Measured at 20kHz to 30kHz offset

Pin	Function	Description
1	ENBL/GPO5	Device Enable pin. See note 1 and 2.
2	EXT_LO	External local oscillator input.
3	EXT_LO_DEC	Decoupling pin for external local oscillator.
4	REXT	External bandgap bias resistor. See note 3.
5	ANA_VDD1	Analog supply. Use good RF decoupling.
6	LFILT1	Phase detector output. Low-frequency noise-sensitive node.
7	LFILT2	Loop filter op-amp output. Low-frequency noise-sensitive node.
8	LFILT3	VCO control input. Low-frequency noise-sensitive node.
9	MODE/GPO6	Mode select pin. See note 1 and 2.
10	REF_IN	Reference input. Use AC coupling capacitor.
11	NC	
12	TM	Connect to ground.
13	MIX1_IPN	Differential input 1 (see note 4). On RFFC5072 this pin is NC.
14	MIX1_IPP	Differential input 1 (see note 4). On RFFC5072 this pin is NC.
15	GPO1/ADD1	General purpose output / MultiSlice address bit.
16	GPO2/ADD2	General purpose output / MultiSlice address bit.
17	MIX1_OPN	Differential output 1 (see note 5). On RFFC5072 this pin is NC.
18	MIX1_OPP	Differential output 1 (see note 5). On RFFC5072 this pin is NC.
19	DIG_VDD	Digital supply. Should be decoupled as close to the pin as possible.
20	NC	
21	NC	
22	ANA_VDD2	Analog supply. Use good RF decoupling.
23	MIX2_IPP	Differential input 2 (see note 4).
24	MIX2_IPN	Differential input 2 (see note 4).
25	GPO3/FM	General purpose output / frequency control input.
26	GPO4/LD/DO	General purpose output / Lock detect output / serial data out.
27	MIX2_OPN	Differential output 2 (see note 5).
28	MIX2_OPP	Differential output 2 (see note 5).
29	RESETX	Chip reset (active low). Connect to DIG_VDD if asynchronous reset is not required.
30	ENX	Serial interface select (active low). See note 1.
31	SCLK	Serial interface clock. See note 1.
32	SDATA	Serial interface data. See note 1.
Exposed paddle		Ground reference, should be connected to PCB ground through a low impedance path.

Note 1: An RC low-pass filter could be used on this line to reduce digital noise.

Note 2: If the device is under software control this input can be configured as a general purpose output (GPO).

Note 3: Connect a 51KΩ resistor from this pin to ground. This pin is sensitive to low frequency noise injection.

Note 4: DC voltage should not be applied to this pin. Use either an AC coupling capacitor as part of lumped element matching network or a transformer (see evaluation board schematic).

Note 5: This pin must be connected to ANA_VDD2 using an RF choke or center-tapped transformer (see evaluation board schematic).

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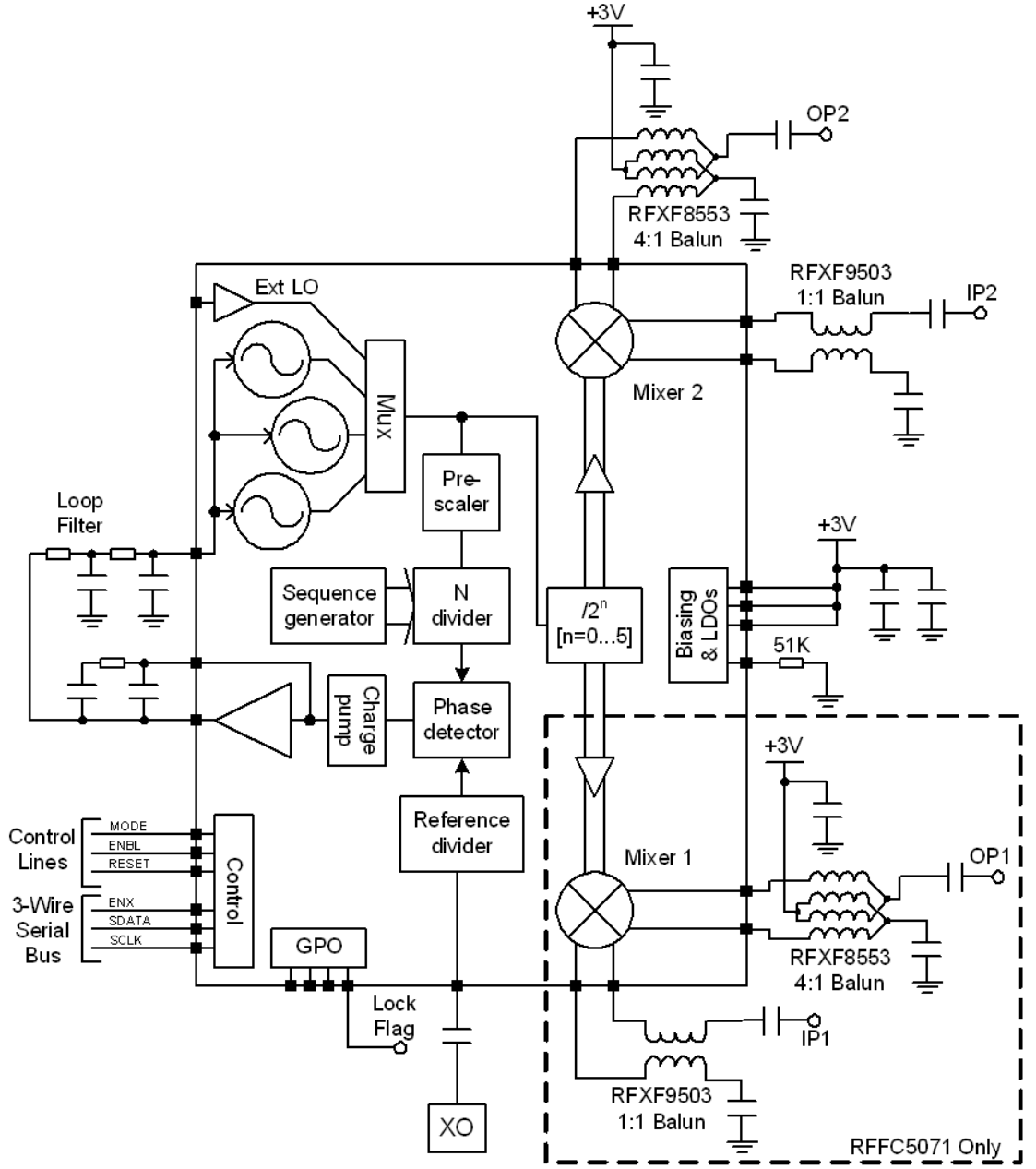
Detailed Functional Block Diagram



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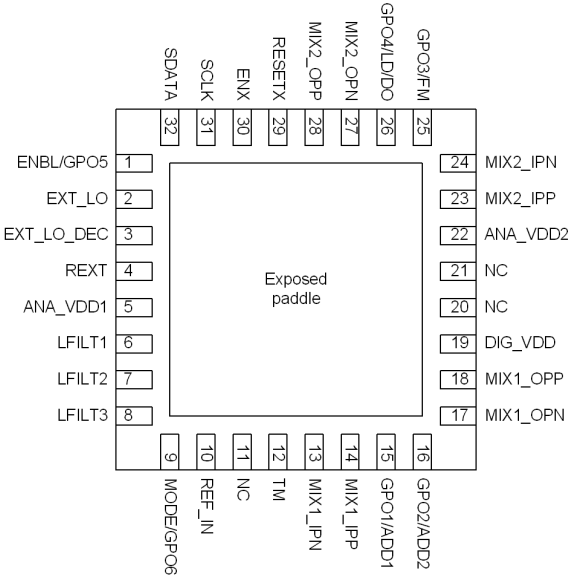
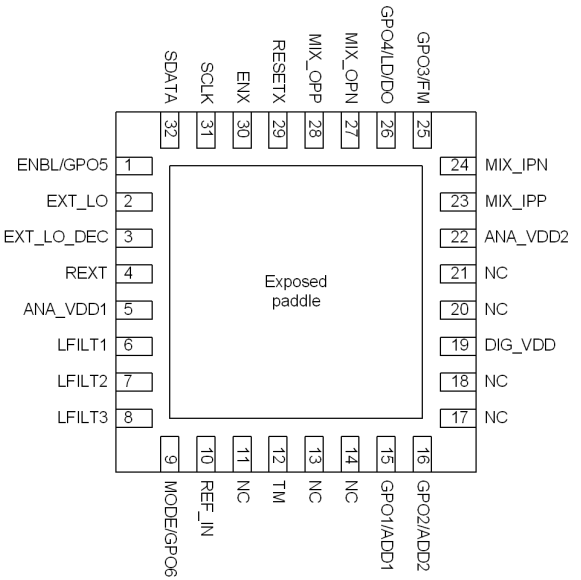
RFFC5071 Pin Out



RFFC5072 Pin Out



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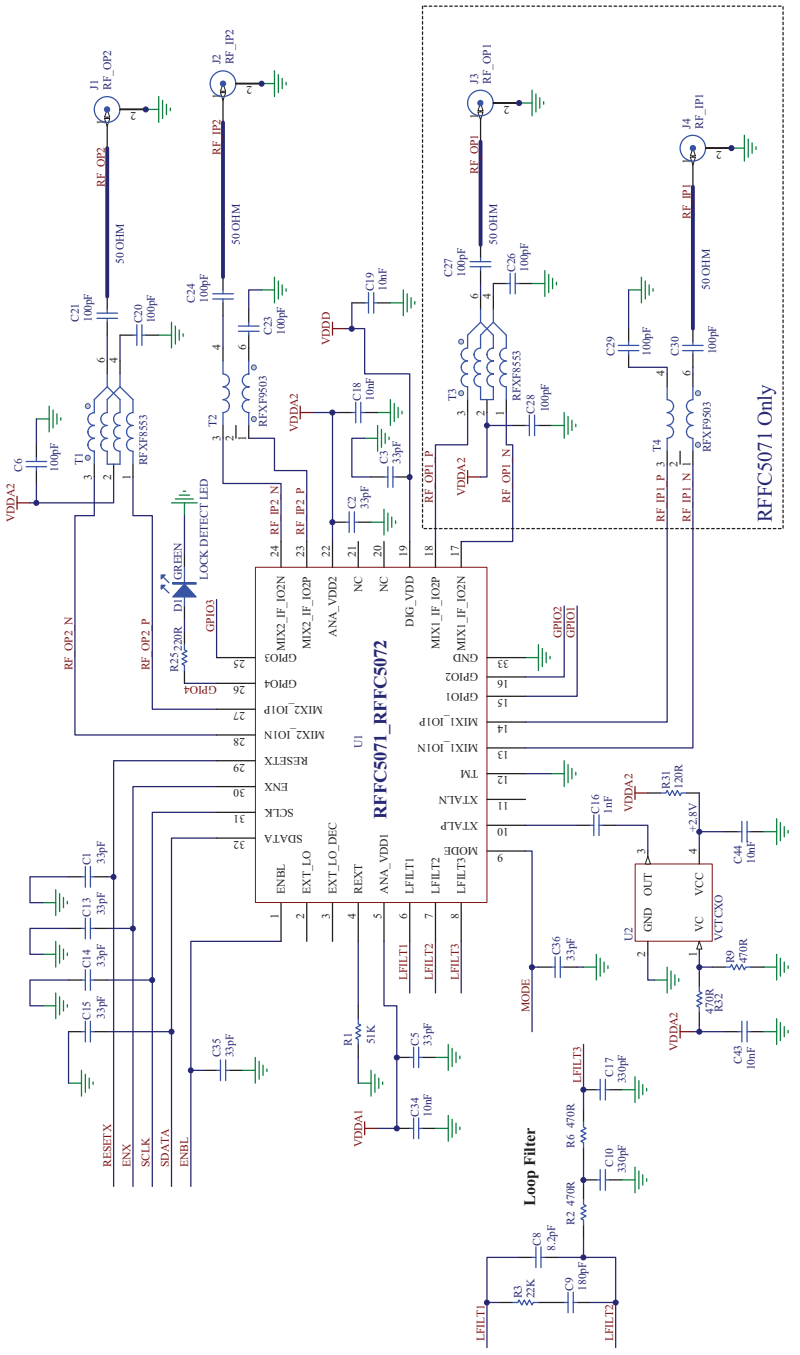
Wideband Application Schematic



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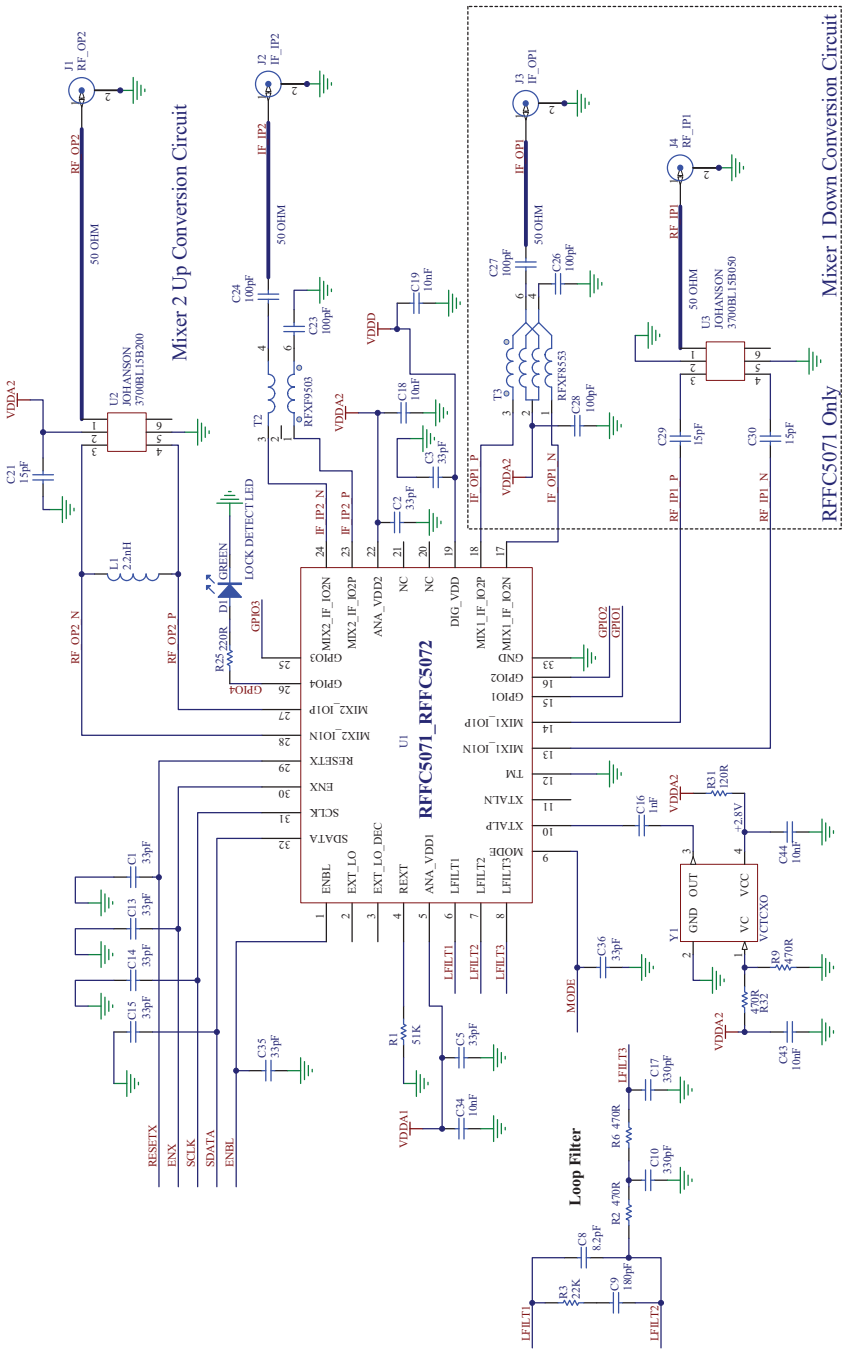
Narrowband 3.7 GHz Application Schematic



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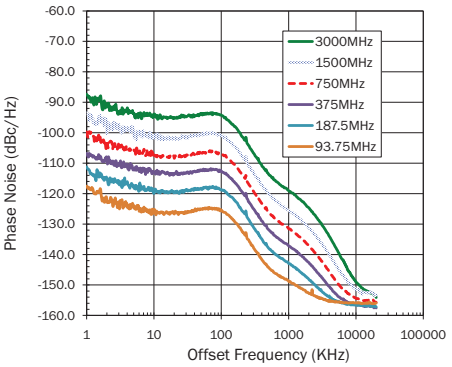
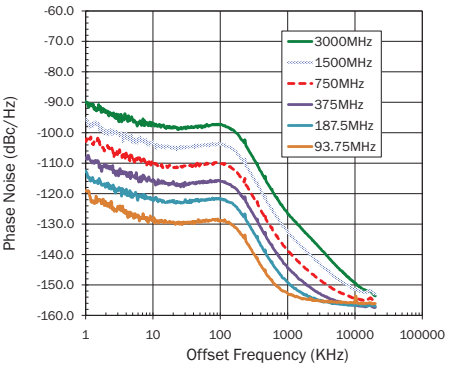
Typical Performance Characteristics: Synthesizer

V_{DD}=+3V and T_A=+27 °C unless stated.

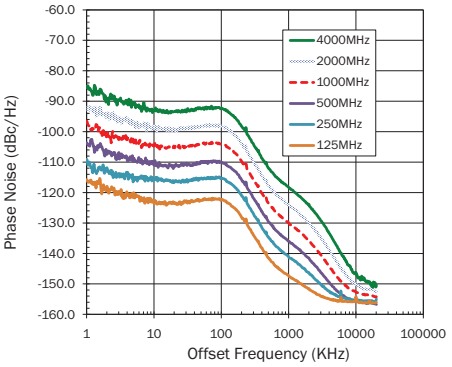
Synthesizer Phase Noise
3000MHz VCO Frequency, 26MHz Crystal Oscillator



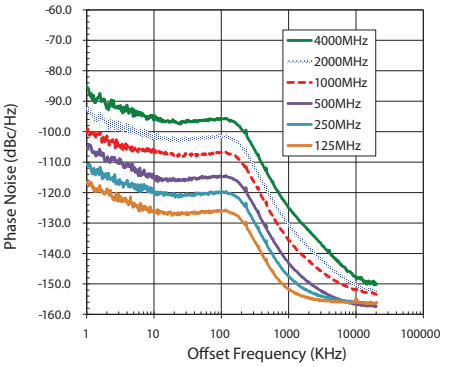
Synthesizer Phase Noise
3000MHz VCO Frequency, 52MHz Crystal Oscillator



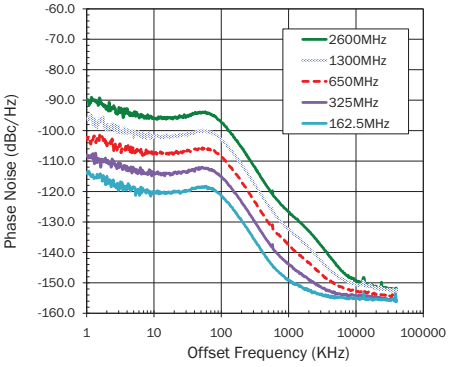
Synthesizer Phase Noise
4000MHz VCO Frequency, 26MHz Crystal Oscillator



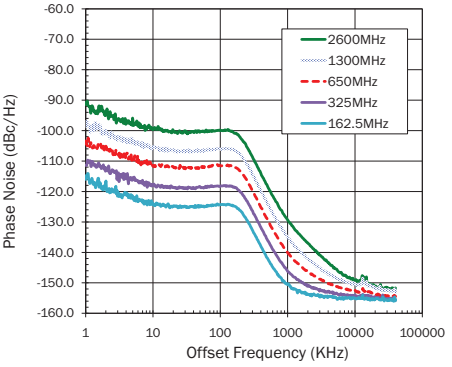
Synthesizer Phase Noise
4000MHz VCO Frequency, 52MHz Crystal Oscillator



Synthesizer Phase Noise
5200MHz VCO Frequency, 26MHz Crystal Oscillator

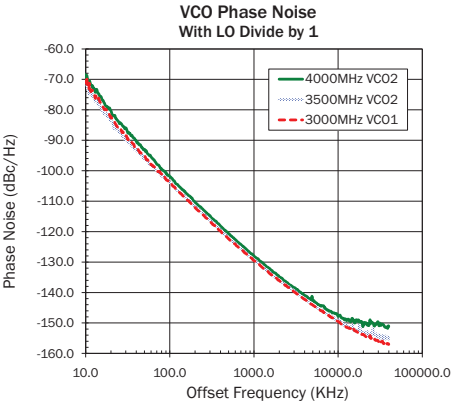


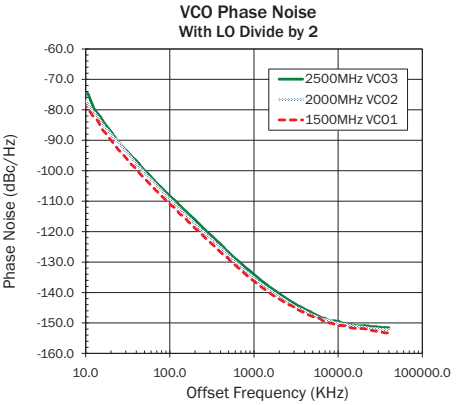
Synthesizer Phase Noise
5200MHz VCO Frequency, 52MHz Crystal Oscillator

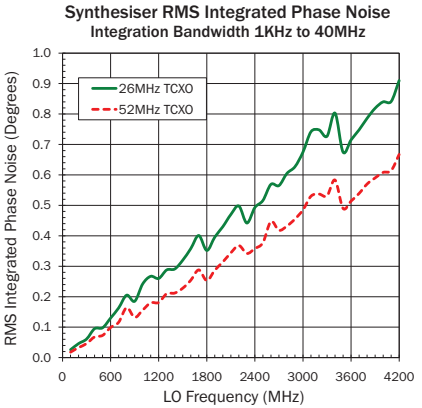


Typical Performance Characteristics: Synthesizer and VCO

V_{DD}=+3V and T_A=+27 °C unless stated.







Note:

- 26MHz Crystal Oscillator: NDK ENA3523A
- 52MHz Crystal Oscillator: NDK ENA3560A

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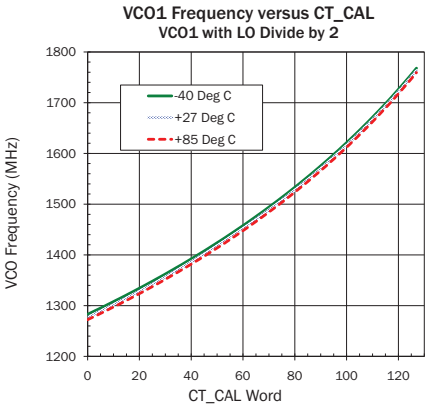
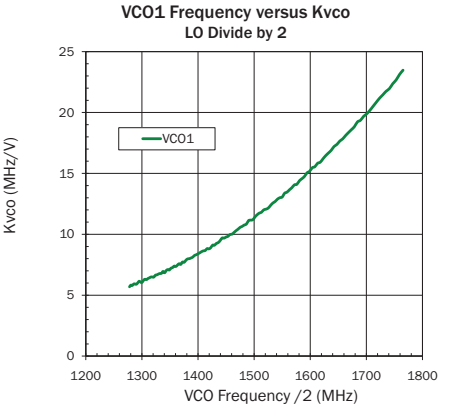
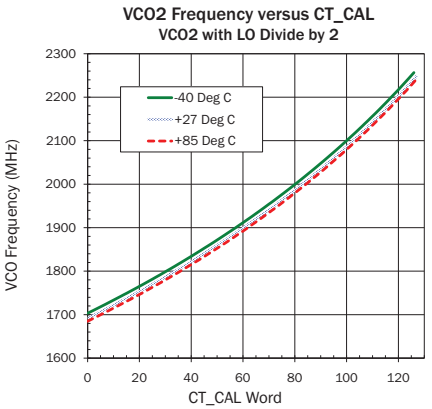
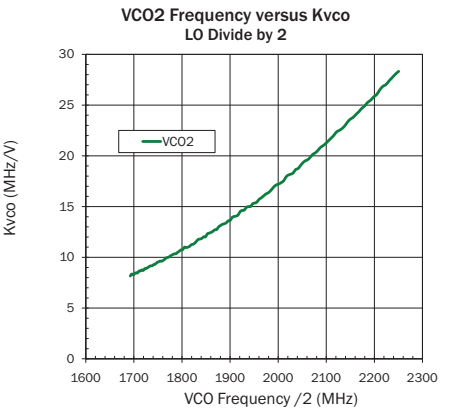
Typical Performance Characteristics: VCO

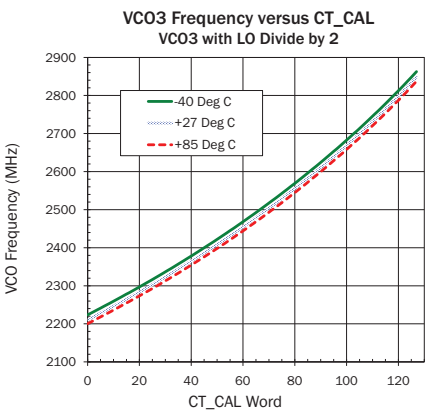
V_{DD}=+3V and T_A=+27 °C unless stated.

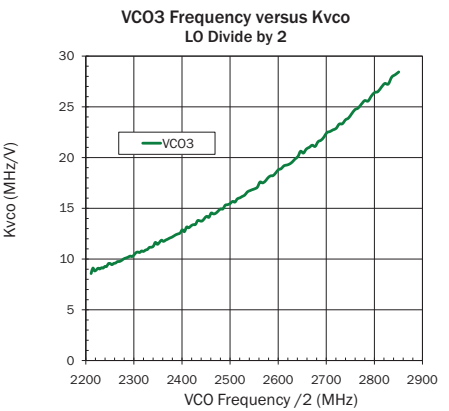








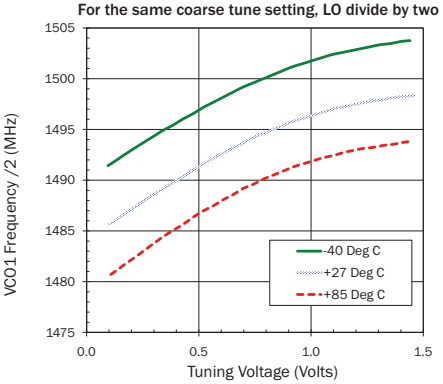




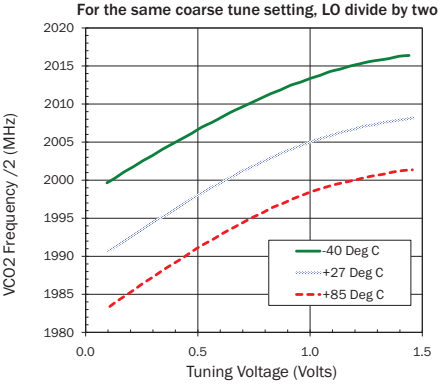
Typical Performance Characteristics: VCO

V_{DD}=+3V and T_A=+27 °C unless stated.

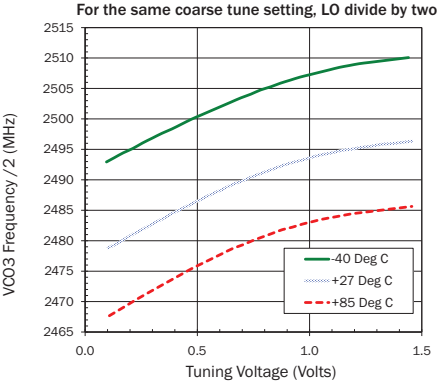
VCO1 Frequency versus Tuning Voltage
For the same coarse tune setting, LO divide by two



VCO2 Frequency versus Tuning Voltage
For the same coarse tune setting, LO divide by two



VCO3 Frequency versus Tuning Voltage
For the same coarse tune setting, LO divide by two



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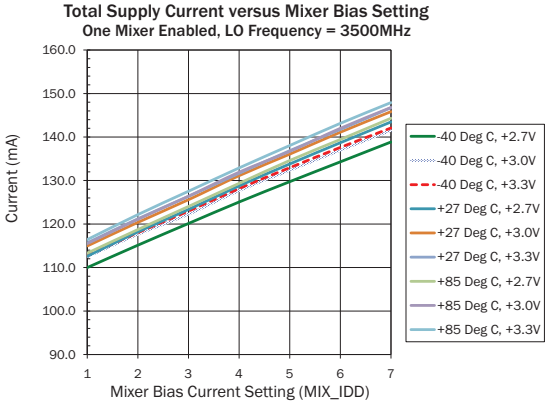
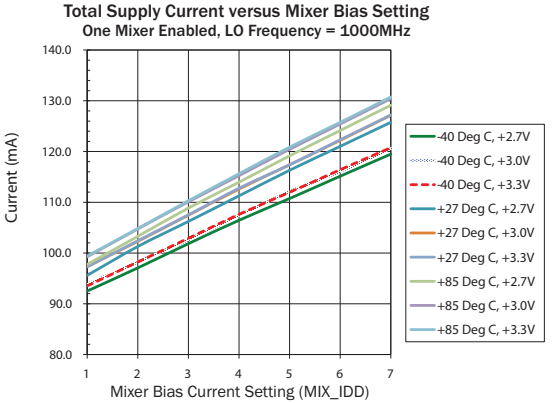
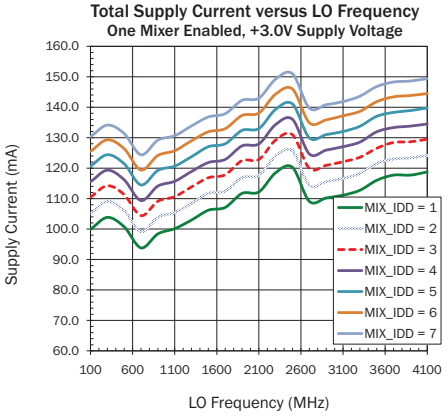
Typical Performance Characteristics: Supply Current

V_{DD}=+3V and T_A=+27 °C unless stated.Typical Performance Characteristics: RFMixer 2, RFFC5071 and RFFC5072







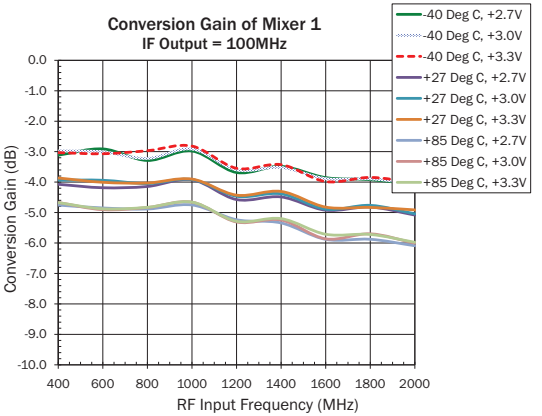
RFFC5071 Typical Operating Current in mA
in Full Duplex Mode (both mixers enabled) with +3V supply.

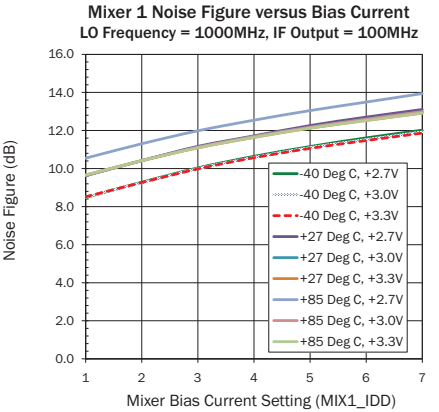
MIX2_IDD	MIX1_IDD						
	1	2	3	4	5	6	7
1	121	126	131	136	142	146	151
2	126	131	136	141	147	151	156
3	131	136	141	147	152	156	161
4	136	141	147	152	157	162	167
5	141	146	152	157	162	167	172
6	146	151	156	161	167	171	176
7	151	156	161	166	171	176	181

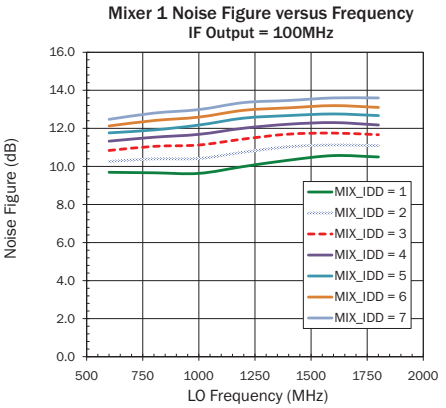
Typical Performance Characteristics: RF Mixer 1, RFFC5071 only

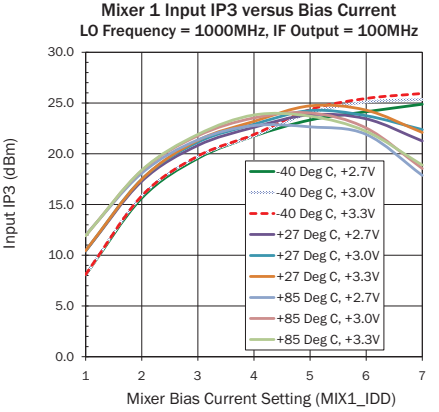
V_{DD}=+3V and T_A=+27 °C unless stated. As measured on RFFC5071 wideband evaluation board.

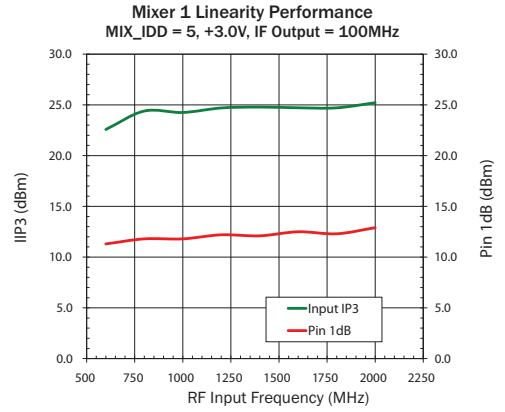
See application schematic on page 7.

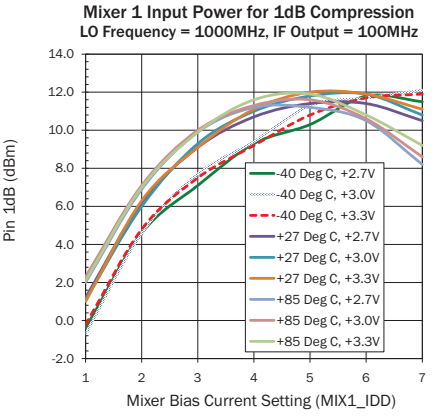












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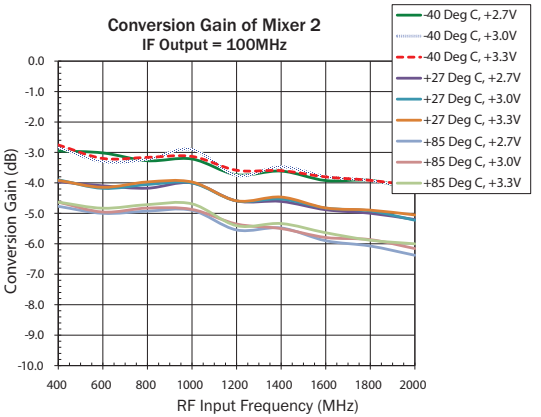
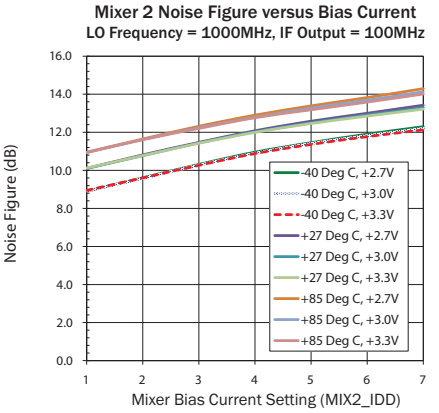
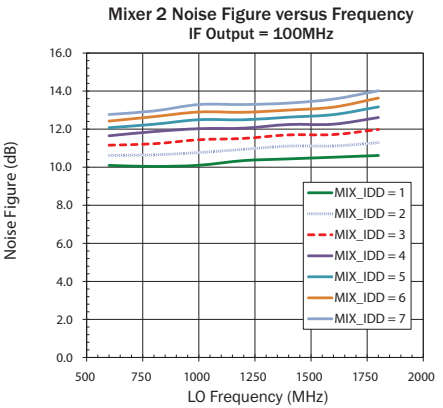
Typical Performance Characteristics: RF Mixer 2, RFFC5071 and RFFC5072

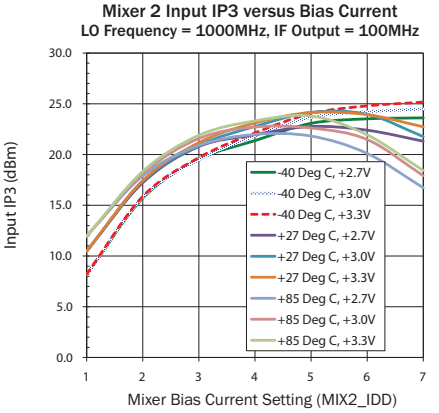
V_{DD}=+3V and T_A=+27 °C unless stated. As measured on RFFC5071/5072 wideband evaluation board.

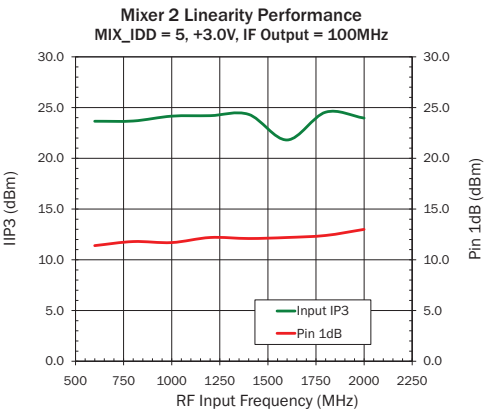
See application schematic on page 7.

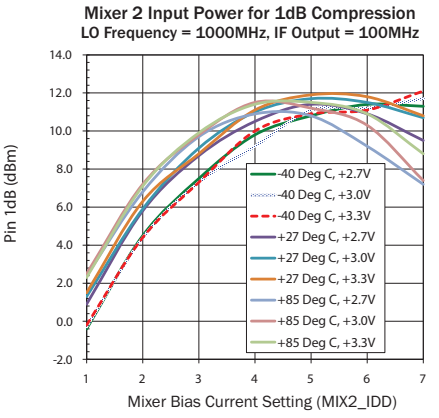












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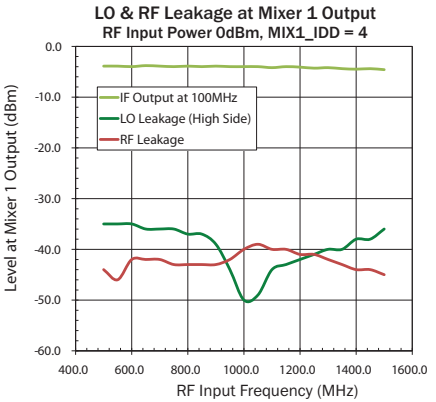
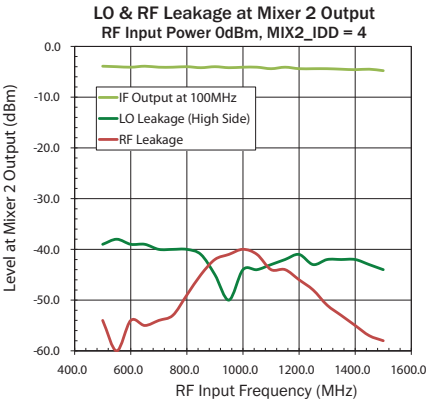
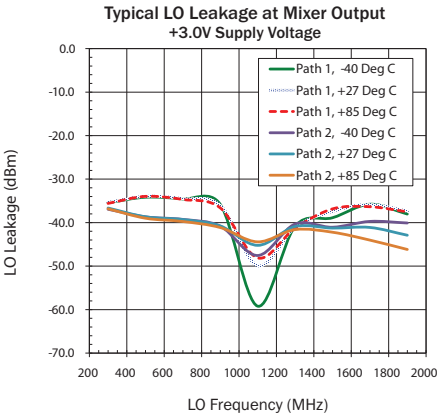
Typical Performance Characteristics: RF Mixers, RFFC5071 and RFFC5072

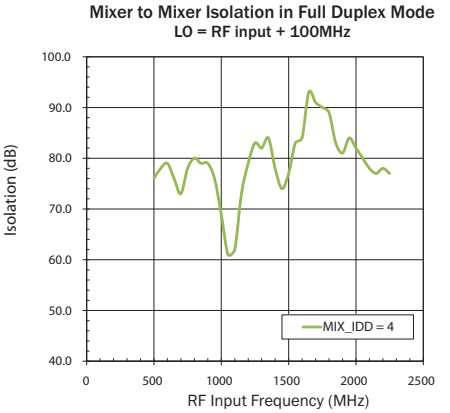
V_{DD}=+3V and T_A=+27 °C unless stated. As measured on RFFC5071 wideband evaluation board.

See application schematic on page 7. Note: Mixer 1 plots only apply to RFFC5071.









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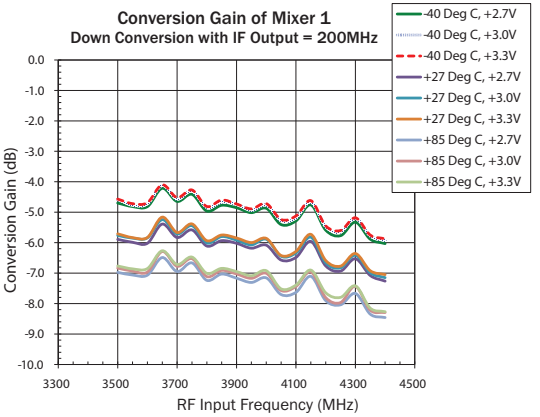
Typical Performance Characteristics: RF Mixers at 3.7GHz

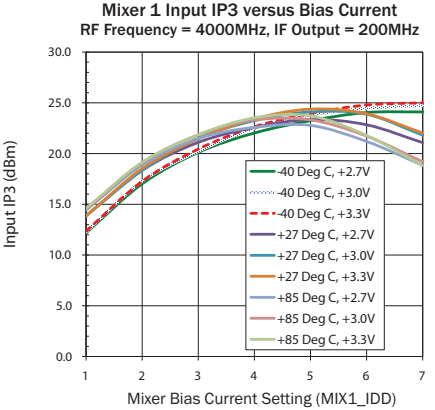
V_{DD} = +3V and T_A = +27 °C unless stated. As measured on 3.7GHz narrowband evaluation board.

See application schematic on page 8.

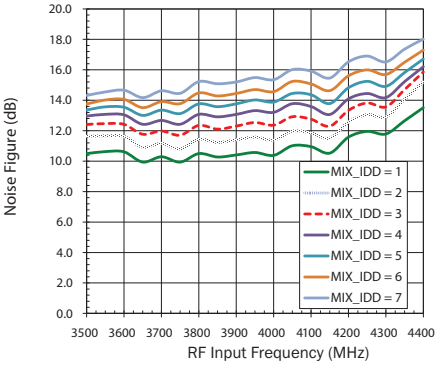
Conversion Gain of Mixer 1
Down Conversion with IF Output = 200MHz



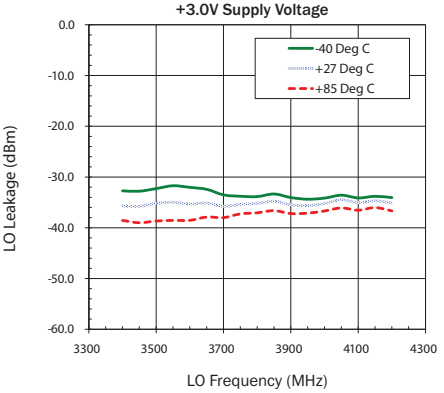
Mixer 1 Input IP3 versus Bias Current
RF Frequency = 4000MHz, IF Output = 200MHz



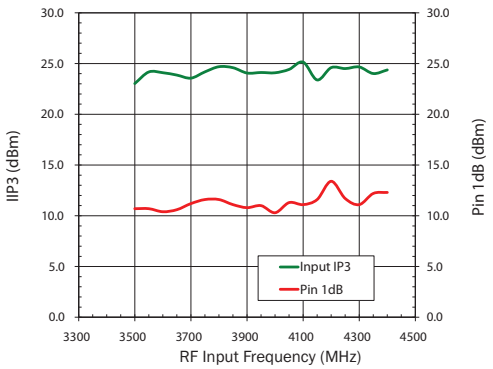
Mixer 1 Noise Figure versus Frequency
IF Output = 200MHz



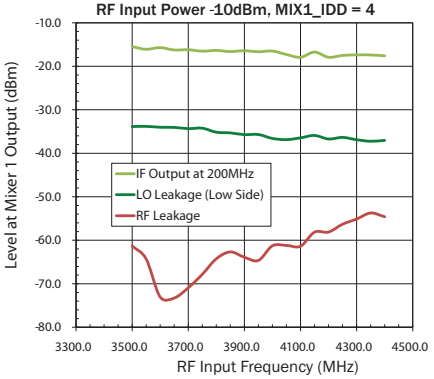
Typical LO Leakage at Mixer 1 Output
+3.0V Supply Voltage



Mixer 1 Linearity Performance
MIX_IDD = 5, +3.0V, IF Output = 200MHz



LO & RF Leakage at Mixer 1 Output
RF Input Power -10dBm, MIX1_IDD = 4



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Programming Information

The RFFC5071 and RFFC5072 share a common serial interface and control block. Please refer to the following documents for further details on programming and control:

Slice2 Register Map and Programming Guide
Slice2 Mixer Programming Guide

These documents are available for download from the RFMD web-site following the link below:

http://rfmd.com/products/IntSynthMixer/

Evaluation Boards

The evaluation boards for the RFFC5071 and RFFC5072 are provided as part of a design kit, along with the necessary cables and programming software tool to enable full evaluation of the device. The standard evaluation boards are configured with 3.7 GHz ceramic baluns on the RF ports, and wideband transformers on the IF ports.The design kits can be ordered from www.rfmd.com or from local RFMD sales offices and authorized sales channels. For ordering codes please refer to page 20.

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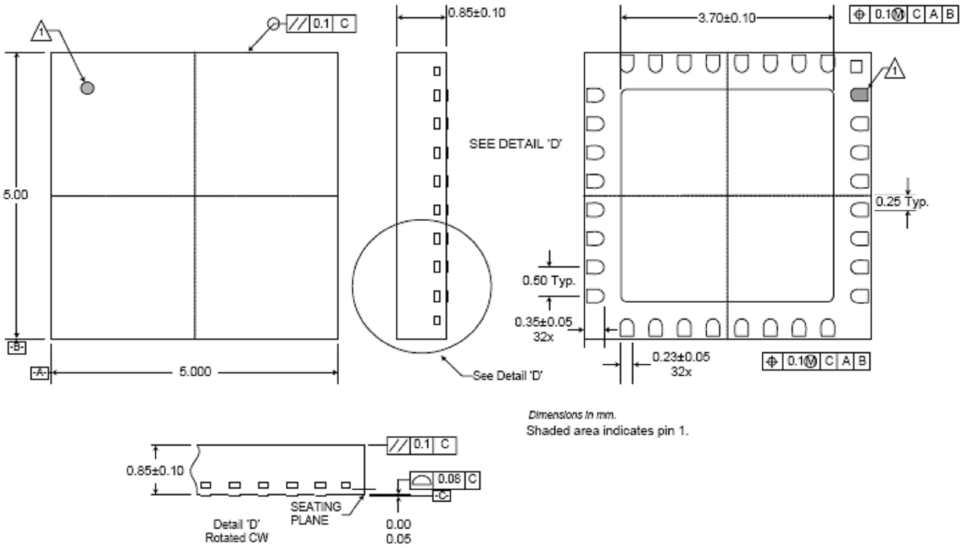
Package Drawing
QFN, 32-pin, 5mm x 5mm



Ordering Information

RFFC5071

Part Number	Description	Devices/Container
RFFC5071SB	32-pin QFN	5-piece sample bag
RFFC5071SQ	32-pin QFN	25-piece sample bag
RFFC5071SR	32-pin QFN	100-piece reel
RFFC5071TR7	32-pin QFN	750-piece reel
RFFC5071TR13	32-pin QFN	2500-piece reel
DKFC5071	Complete Design Kit	1 box

RFFC5072

Part Number	Description	Devices/Container
RFFC5072SB	32-pin QFN	5-piece sample bag
RFFC5072SQ	32-pin QFN	25-piece sample bag
RFFC5072SR	32-pin QFN	100-piece reel
RFFC5072TR7	32-pin QFN	750-piece reel
RFFC5072TR13	32-pin QFN	2500-piece reel
DKFC5072	Complete Design Kit	1 box

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