

Voltage gain 5-99dB (RF0-32dB; BB 0-62dB)
P1dB=-37dBm @RFATT0dB
100ohm impedance

RX level analysis

TX level analysis

Noise floor ca. -109dBm-48dB=-157+att dBm

dynamic ca. |-157dBm+15.1dB|=141.9-att dB

1V fullscale

DAC/ADC
MAX5864

Wimax TRX
MAX2837

2.3-2.7 GHz

RFSwitch
BGS12SL6

2.3-2.7 GHz

Pmin=-89dBm for fullscale
Pmax=5 dBm for fullscale

Fullscale 0.4 V
@ 100ohm impedance =-1 dBm

0.001-6 GHz

0.02-6 GHz

2.3-2.7 GHz

RFSwitch
BGS12SL6

0.02-6 GHz

Mixer
LTC5510

1.5 dB conversion gain

0.02-6 GHz

RFSwitch
BGS12SL6

RFSwitch
BGS12SL6

For Lowpass 2,3-0,3 Ghz
(measured frequency=0-2.4 GHz)

For Highpass 0.3-3.3 Ghz
(measured frequency=2.6-6 GHz)

Bypass 2.3-2.7 Ghz
(measured frequency=2.3-2.7 GHz)

0.02-6 GHz

RFSwitch
BGS12SL6

2.3-2.7 GHz

RFSwitch
BGS12SL6

2.3-2.7 GHz

Gain 18.6 dB

0.02-6 GHz

Pmin=-109.1+att dBm for fullscale
Pmax=-15.1+att dBm for fullscale

LNA
MAX2616

0.02-6 GHz

Attenuation switch
att=9x0.25dB=2.5dB @1GHz
att=5x0.35dB=1.8dB @2.5GHz
att=9x1.5dB=13.5dB @6GHz

RFSwitch
BGS12SL6

0.02-2.6 GHz

Lowpass
LP0603A
1880ANTR

0.02-2.6 GHz

2.4-6 GHz

DEA16
2400HT
-8004B1

2.4-6 GHz



0.02-6 GHz

0.02-6 GHz

Pmax=21.1 dBm for fullscale
!!! LNA in compression

LNA
MAX2616

0.02-6 GHz

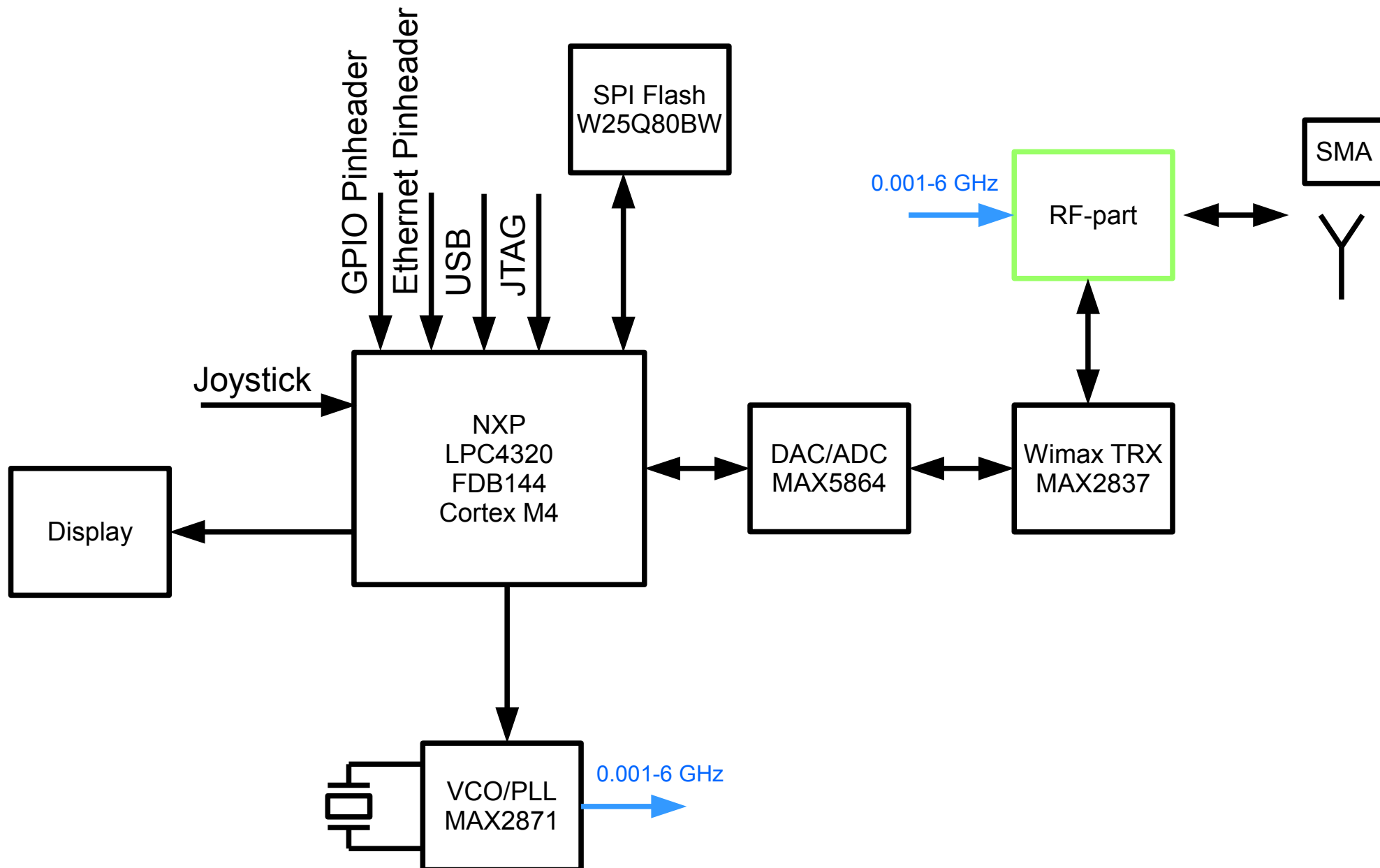
Pmin=-90.5dBm for fullscale
Pmax=3.5 dBm for fullscale

Pmax=2.5 dBm

2x
RFSwitch
BGS12SL6

RFSwitch
BGS12SL6

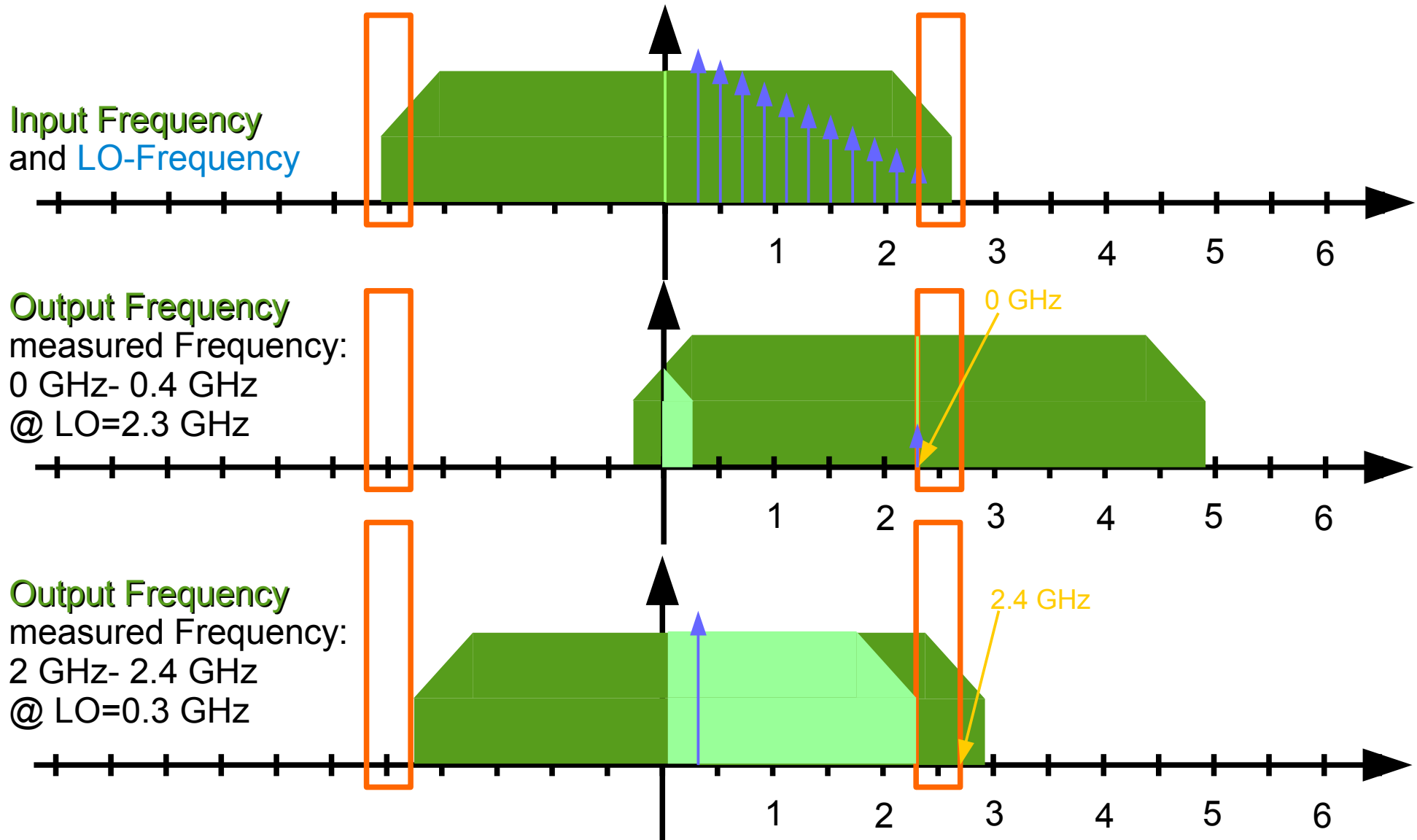
RFSwitch
BGS12SL6



Low pass Filter active 0-2.4 GHz

Wimax TRX receiving frequency 2.3 GHz- 2.7 GHz

LO Frequency

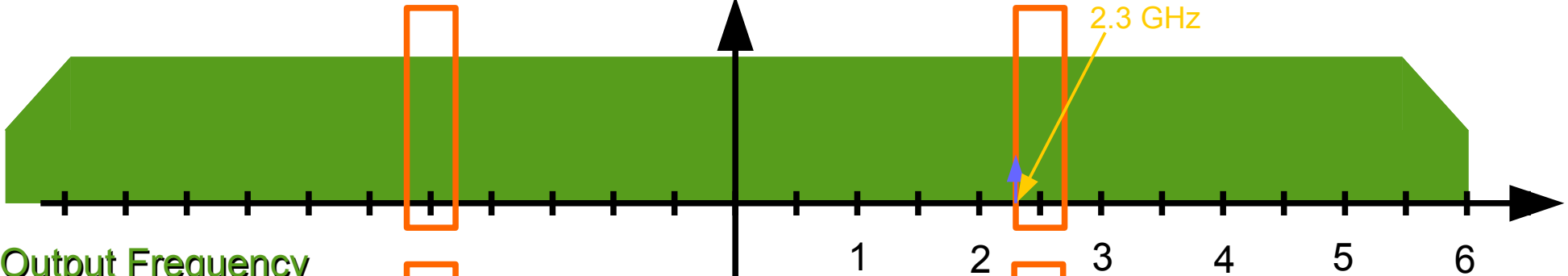
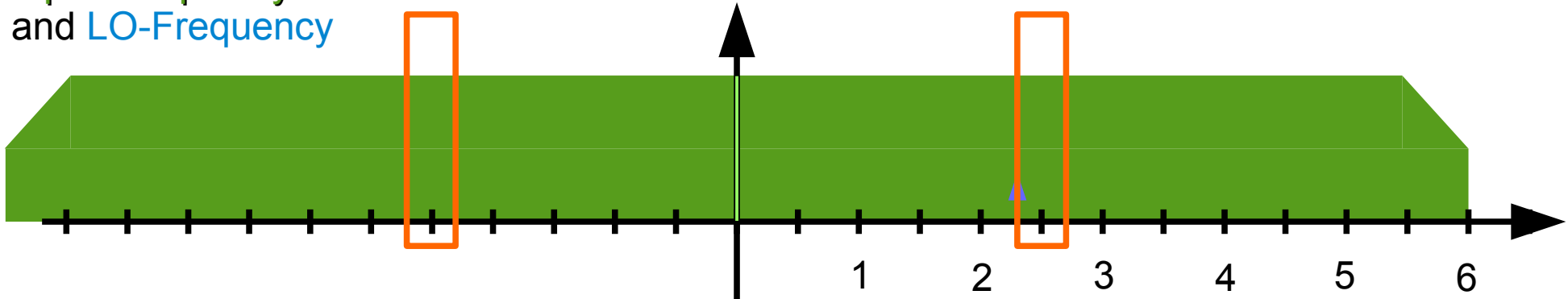


Byepass active 2.3-2.7 GHz

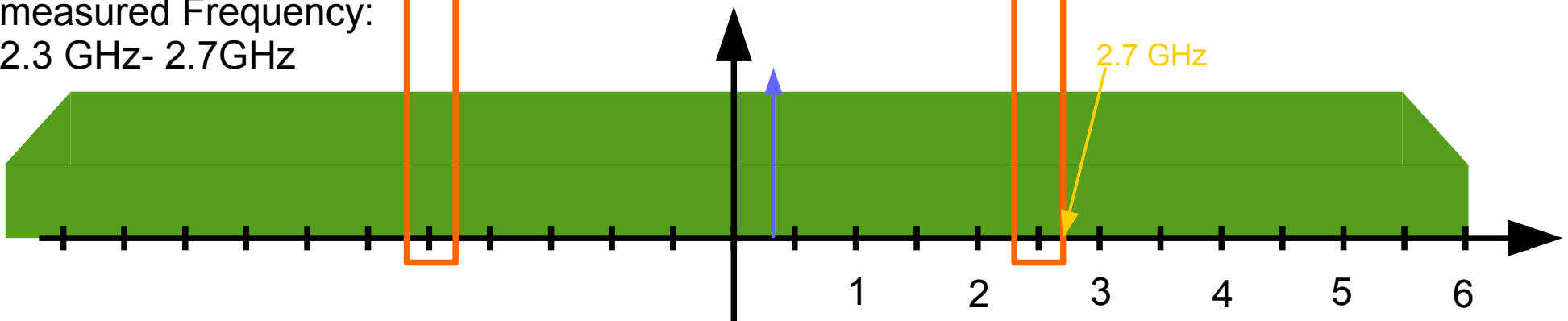
Wimax TRX receiving frequency 2.3 GHz- 2.7 GHz

LO Frequency

Input Frequency
and LO-Frequency



Output Frequency
measured Frequency:
2.3 GHz- 2.7GHz



High pass Filter active 2.6-6 GHz

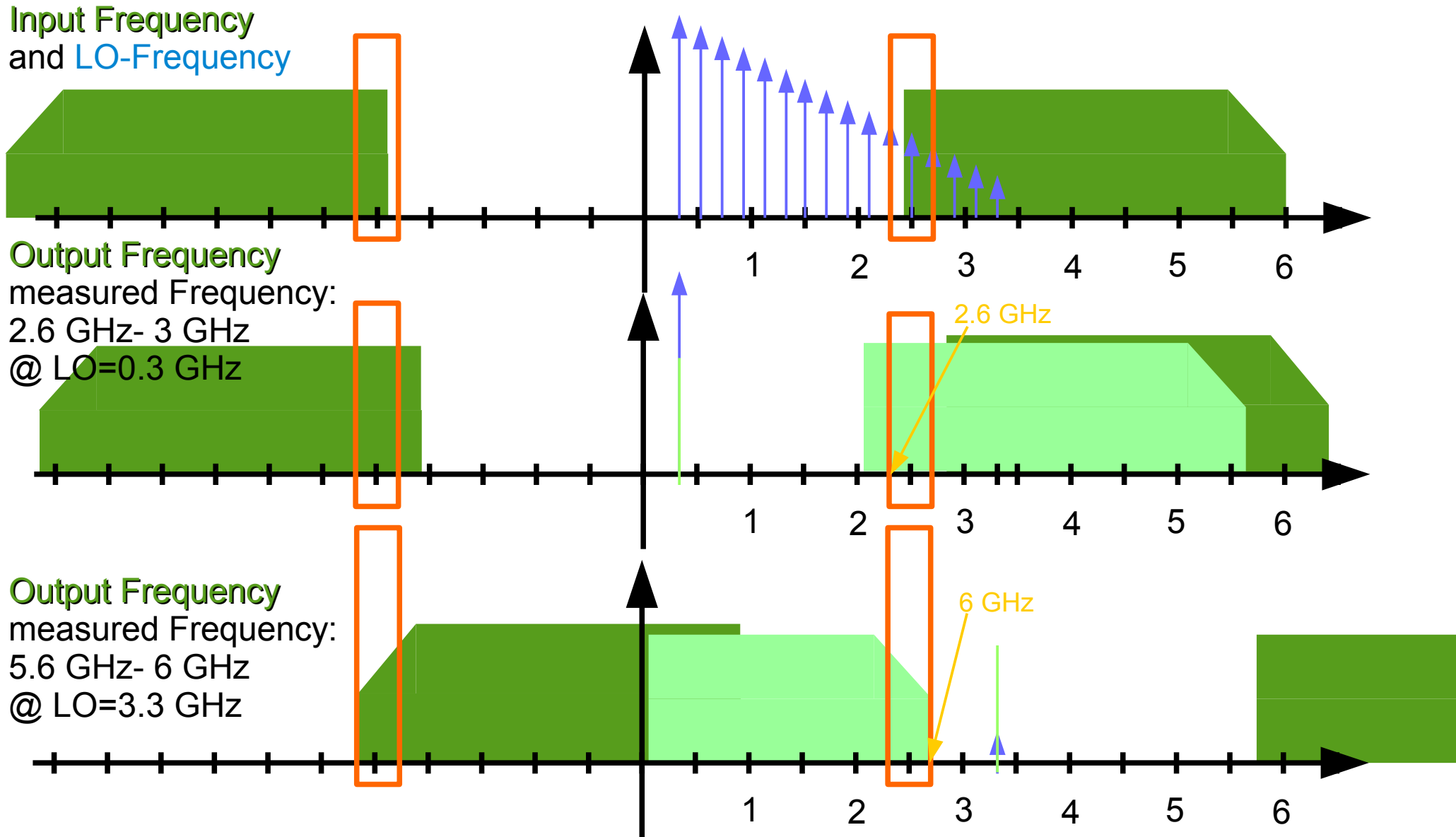
Wimax TRX receiving frequency 2.3 GHz- 2.7 GHz

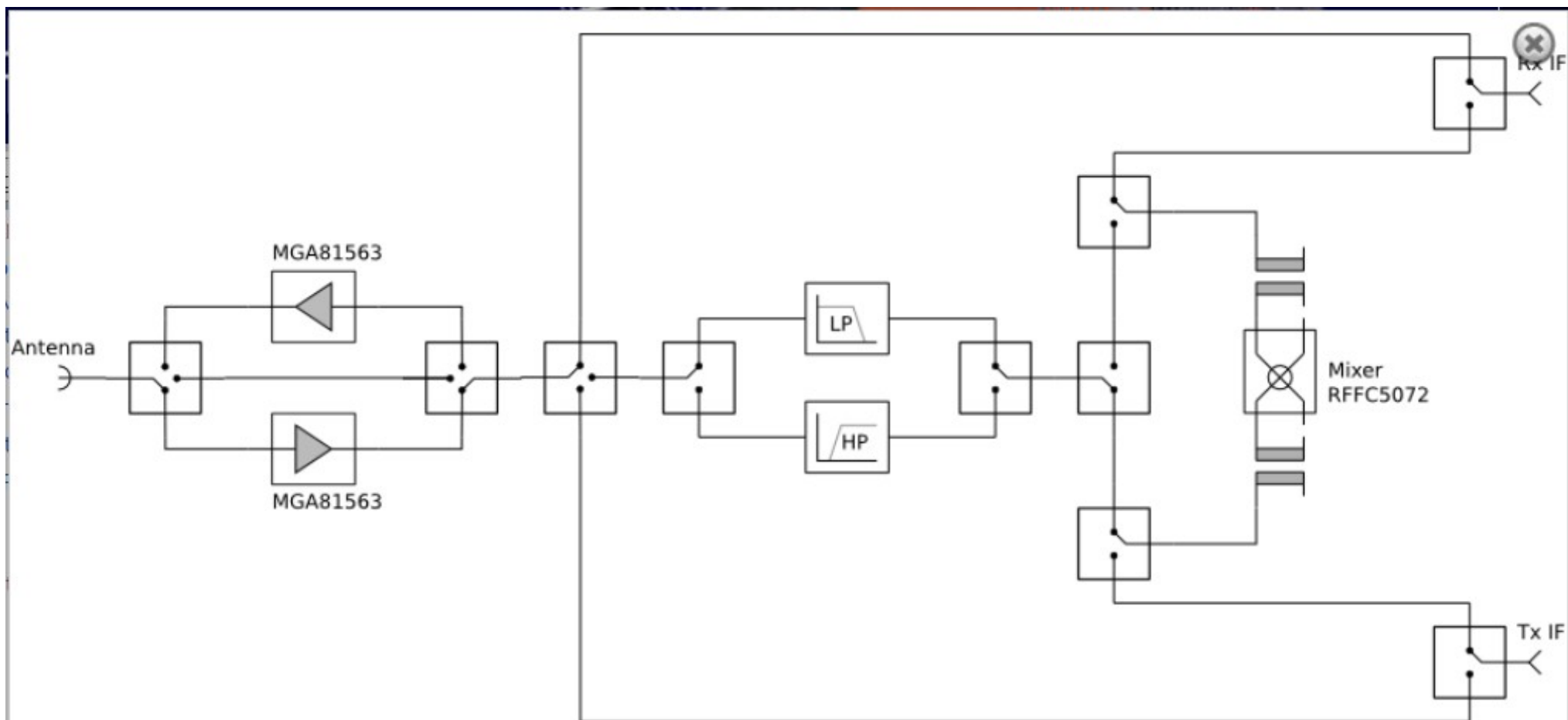
LO Frequency

Input Frequency
and LO-Frequency

Output Frequency
measured Frequency:
2.6 GHz- 3 GHz
@ LO=0.3 GHz

Output Frequency
measured Frequency:
5.6 GHz- 6 GHz
@ LO=3.3 GHz





HackRF One Frontend Block diagram

based on frontend schema dated 13. Feb. 2014

(C) Ekki Plicht, DF4OR WiMo

Current consumption

	mA	V
Mixer	105	3.3/5
LNA	2x81	3-5.5
Tranceiver	RX110 TX170	2.7-3.6
ADC	14	1.8-3.3
LPC4300	100	3.3
Switch	-	3.3/5
SUMRX	410mA	
SUMTX	470mA	

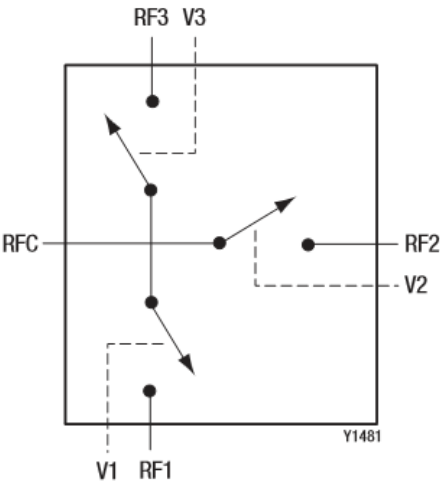
SKY13317-373LF: 20 MHz to 6.0 GHz pHEMT GaAs SP3T Switch

Applications

- 802.11 a/b/g/n WLAN networks
- Bluetooth® systems

Features

- Positive low voltage control: 0/1.8 to 5.0 V
- Low insertion loss: 0.5 dB @ 2.5 GHz, 0.9 dB @ 6 GHz
- High isolation: 25 dB up to 6 GHz
- Excellent linearity performance: P1dB = +29 dBm
- Miniature, ultra-thin MLP (8-pin, 1.5 x 1.5 mm) package (MSL1, 260 °C per JEDEC J-STD-020)



3 rd Order Input Intercept Point	IIP3	900 to 2450 MHz, $\Delta F = 1\text{ MHz}$, $P_{IN} = +17\text{ dBm/tone}$ $V_{LOW} = 0\text{ V}$, $V_{HIGH} = 2.1\text{ V}$ $V_{LOW} = 0\text{ V}$, $V_{HIGH} = 3.3\text{ V}$		+33 +50		dBm dBm
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Table 4. SKY13317-373LF Truth Table

Low Insertion Loss Path	V1 (Pin 3)	V2 (Pin 6)	V3 (Pin 7)
RFC to RF1	High	Low	Low
RFC to RF2	Low	High	Low
RFC to RF3	Low	Low	High

Note: "High" = 1.8 to 5.0 V. "Low" = 0 to 0.25 V. Any state other than described in this Table places the switch into an undefined state. An undefined state will not damage the device.



2.3GHz to 2.7GHz Wireless Broadband RF Transceiver

MAX2837

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Features

- ◆ 2.3GHz to 2.7GHz Wideband Operation
- ◆ Complete RF Transceiver, PA Driver, and Crystal Oscillator
 - 0dBm Linear OFDM Transmit Power
 - 70dBm Tx Spectral Emission Mask
 - 2.3dB Rx Noise Figure
 - Tx/Rx I/Q Error and LO Leakage Detection
 - Monolithic Low-Noise VCO with -39dBc Integrated Phase Noise
 - Programmable Tx I/Q Lowpass
 - Anti-Aliasing Filter
 - Sigma-Delta Fractional-N PLL with 20Hz Step Size
 - 45dB Tx Gain-Control Range
 - 94dB Receive Gain-Control Range
 - 60dB Analog RSSI Instantaneous Dynamic Range
 - 4-Wire SPI™ Digital Interface
 - I/Q Analog Baseband Interface
 - Digitally Tuned Crystal Oscillator
 - On-Chip Digital Temperature Sensor Read-Out
- ◆ +2.7V to +3.6V Transceiver Supply
- ◆ Low-Power Shutdown Current
- ◆ Small 48-Pin Thin QFN Package (6mm x 6mm x 0.8mm)

Lowpass

Thin-Film Low Pass Filter

LP0603 Lead-Free LGA Type

GENERAL DESCRIPTION

The LP0603 ITF (Integrated Thin Film) Lead-Free LGA Low Pass Filter is based on thin-film multilayer technology. The technology provides a miniature part with excellent high frequency performance and rugged construction for reliable automatic assembly.

The ITF Low Pass Filters are offered in a variety of frequency bands compatible with various types of high frequency wireless systems.

FEATURES

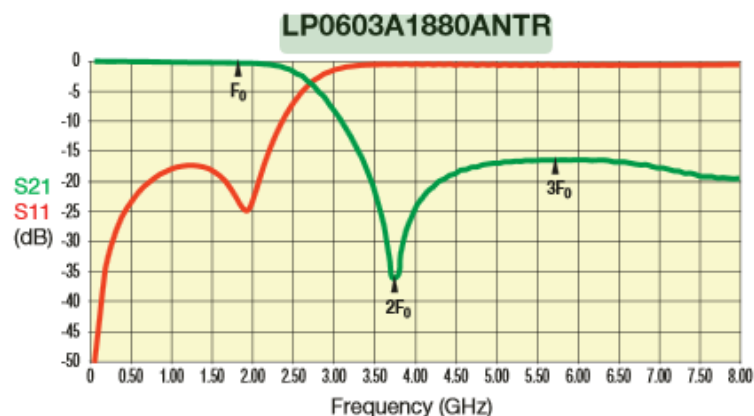
- Miniature Size: 0603
- Frequency Range: 900MHz-5.5GHz
- Characteristic Impedance: 50 Ohm
- Operating/Storage Temperature: -40°C to +85°C
- Power Rating: 3W Continuous
- Low Profile
- Rugged Construction
- Lead Free
- Taped and Reeled

APPL

- Mobil
- Satelli
- GPS
- Vehicl
- Wirel
- RFID

LANC

- Inhere
- Self A
- Excell
- Low F
- Better

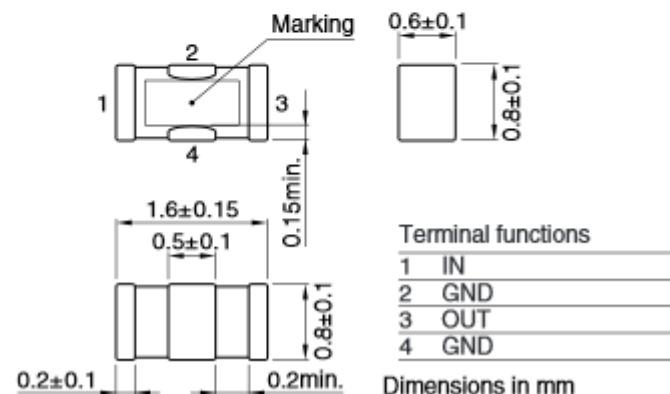


Highpass

Multilayer Chip High Pass Filters For Bluetooth & 2.4GHz W-LAN

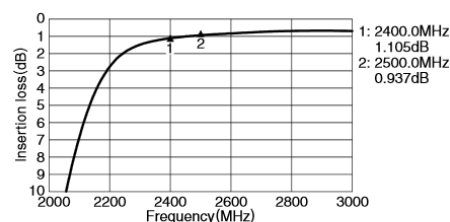
DEA Series DEA162400HT-8004B1

SHAPES AND DIMENSIONS

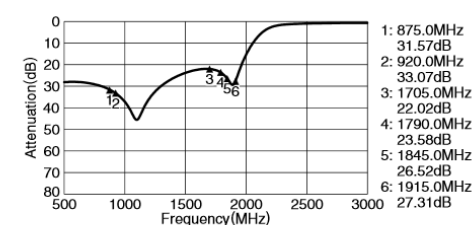


FREQUENCY CHARACTERISTICS

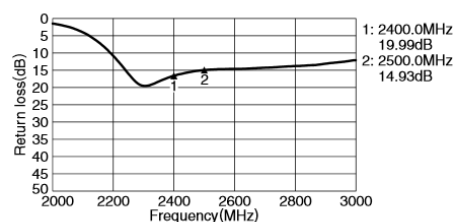
INSERTION LOSS



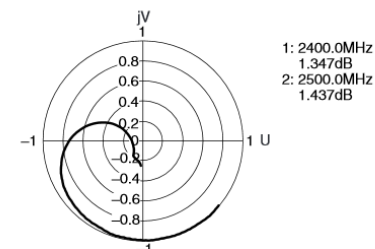
ATTENUATION



RETURN LOSS



VSWR



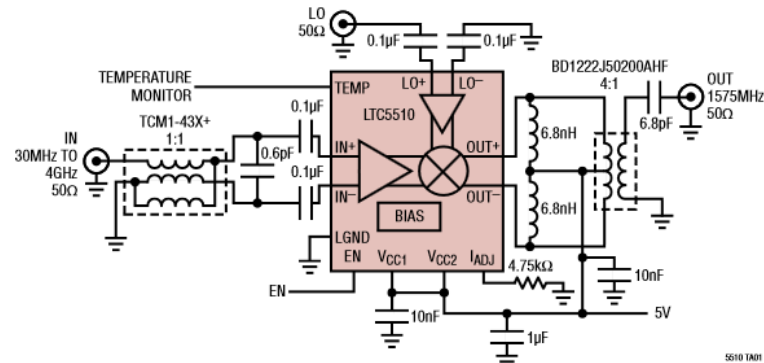
LTC5510

1MHz to 6GHz Wideband High Linearity Active Mixer

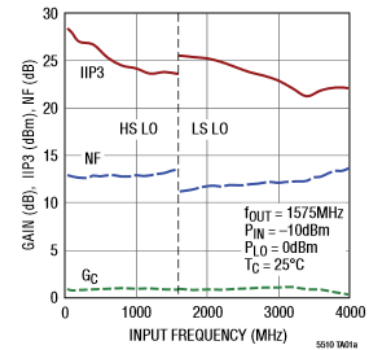
FEATURES

- Input/LO Frequency Range to 6GHz
- 50Ω Matched Input from 30MHz to >3GHz
- Capable of Up- or Down-Conversion
- **OIP3: 27dBm at $f_{OUT} = 1575\text{MHz}$**
- **1.5dB Conversion Gain**
- **Noise Figure: 11.6dB at $f_{OUT} = 1575\text{MHz}$**
- **High Input P1dB: 11dBm at 5V**
- **5V or 3.3V Supply at 105mA**
- Shutdown Control
- LO Input Impedance Always Matched
- 0dBm LO Drive Level
- On-Chip Temperature Monitor
- -40°C to 105°C Operation (T_C)
- 16-Lead (4mm × 4mm) QFN Package

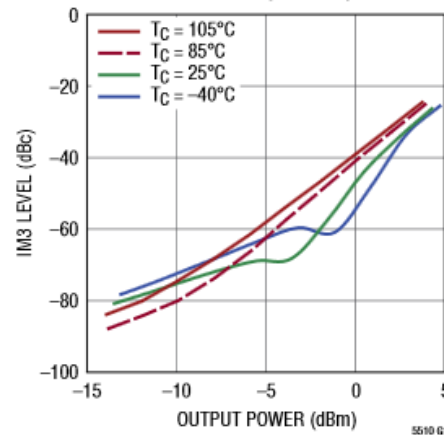
30MHz to 4GHz Up/Down Mixer for Wideband Receiver



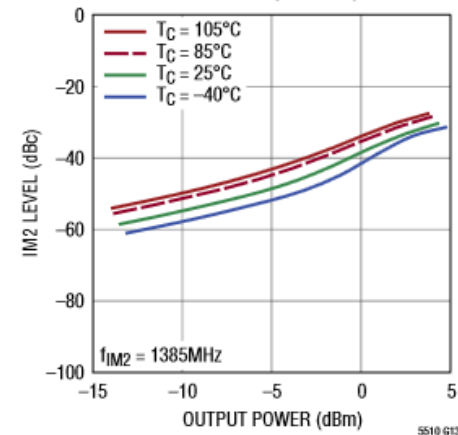
Conversion Gain, IIP3 and NF vs Input Frequency



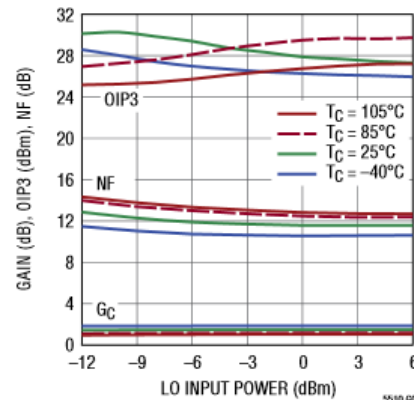
IM3 Level vs Output Power (2-Tone)



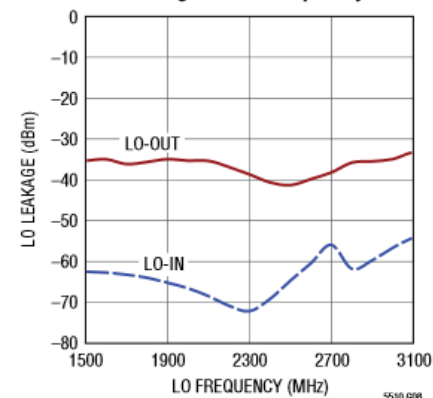
IM2 Level vs Output Power (2-Tone)



Conversion Gain, OIP3 and NF vs LO Power



LO Leakage vs LO Frequency



MAX2612-MAX2616

40MHz to 4GHz Linear Broadband Amplifiers

General Description

MAX2616 is a family of high-performance in blocks designed for use as a PA predriver amplifier, or as a cascadable 50Ω amplifier 9.5dBm output power. These devices are ry applications that include cellular infrate or commercial microwave radios, and modems. The operating frequency range 10MHz to 4000MHz. The amplifier operates +5.25V supply with input and output ports shed to 50Ω. The device family is available compatible, compact 2mm x 3mm TDFN tage.

Applications

Infrastructure
ave Radio
s LAN
d Measurement

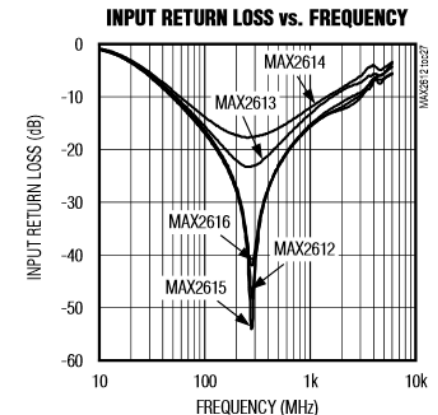
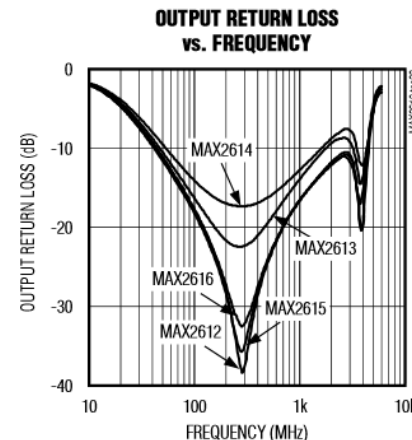
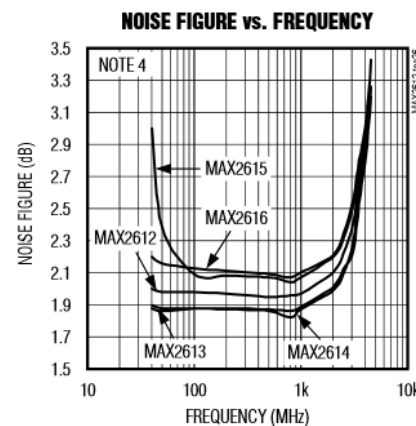
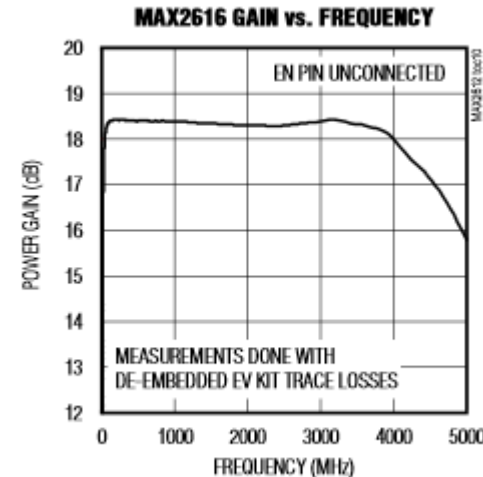
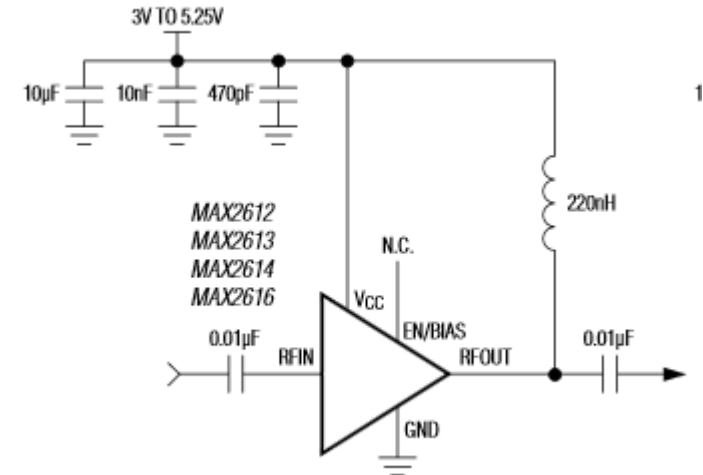
[nation](#) appears at end of data sheet.

and recommended products to use with this part,
[imintegrated.com/MAX2612.related](#).

Current 80.6 mA

Features

- Extremely Flat Frequency Response
◇ < 0.5dB, 1GHz to 4GHz
- Low Noise Figure: 2.0dB at $f_{RFIN} = 2.0GHz$
- 40MHz to 4000MHz Frequency Range
- Industry's Highest Max P_{IN} Rating
- Large OIP3 Ranges
◇ MAX2615/MAX2616: +37dBm
◇ MAX2612: +35.2dBm
◇ MAX2613: +31.2dBm
◇ MAX2614: +30dBm
- Output P1dB: +19.5dBm (MAX2615/MAX2616)
- High Gain: 18.6dB
- Shutdown Mode (MAX2612/MAX2613/
MAX2614/MAX2616)
- Adjustable Bias Current for Improved OIP3
(MAX2615)
- 3.0V to 5.25V Supply Range
- Compact 2mm x 3mm TDFN Package
- Industry-High ESD Rating: 2.5kV HBM





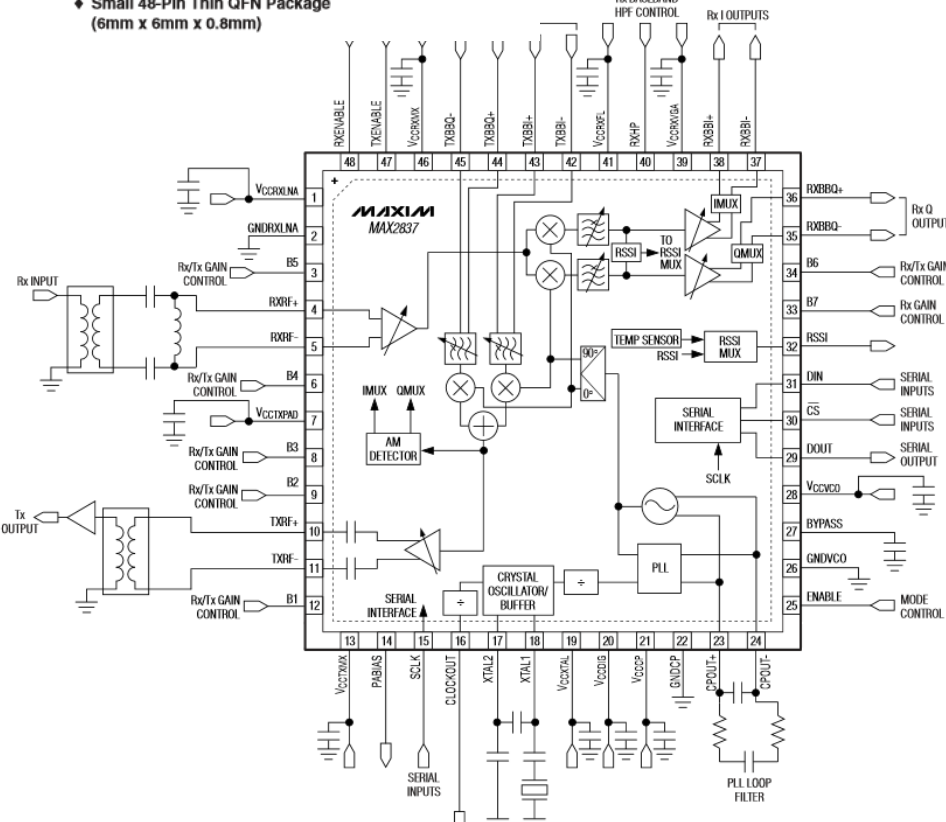
2.3GHz to 2.7GHz Wireless Broadband RF Transceiver

on Features

- ◆ 2.3GHz to 2.7GHz Wideband Operation
- ◆ Complete RF Transceiver, PA Driver, and Crystal Oscillator
- ◆ 0dBm Linear OFDM Transmit Power
- ◆ -70dB Tx Spectral Emission Mask
- ◆ 2.3dB Rx Noise Figure
- ◆ Tx/Rx I/Q Error and LO Leakage Detection
- ◆ Monolithic Low-Noise VCO with -39dBc Integrated Phase Noise
- ◆ Programmable Tx I/Q Lowpass Anti-Aliasing Filter
- ◆ Sigma-Delta Fractional-N PLL with 20Hz Step Size
- ◆ 45dB Tx Gain-Control Range
- ◆ 94dB Receive Gain-Control Range
- ◆ 60dB Analog RSSI Instantaneous Dynamic Range
- ◆ 4-Wire SPI™ Digital Interface
- ◆ I/Q Analog Baseband Interface
- ◆ Digitally Tuned Crystal Oscillator
- ◆ On-Chip Digital Temperature Sensor Read-Out
- ◆ +2.7V to +3.6V Transceiver Supply
- ◆ Low-Power Shutdown Current
- ◆ Small 48-Pin Thin QFN Package (6mm x 6mm x 0.8mm)

MAX2837

ns



PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	VCC_	2.7		3.6	V
Supply Current	Shutdown mode, T _A = +25°C		10		μA
	Standby mode		35	45	
	Rx mode		91	110	
	Tx mode, T _A = +25°C		145	170	mA
	Rx calibration mode		135	160	
	Tx calibration mode		110	135	
Rx I/Q Output Common-Mode Voltage	D9:D8 = 00 in A4:A0 = 00100	0.85	1.0	1.20	V
	D9:D8 = 01 in A4:A0 = 00100		1.1		
	D9:D8 = 10 in A4:A0 = 00100		1.2		
	D9:D8 = 11 in A4:A0 = 00100		1.35		
Tx Baseband Input Common-Mode Voltage Operating Range	DC-coupled	0.5		1.2	V
Tx Baseband Input Bias Current	Source current		10	20	μA
LOGIC INPUTS: ENABLE, TXENABLE, RXENABLE, SCLK, DIN, CS, B7:B1, RXHP					
Digital Input-Voltage High, V _{IH}		V _{CC} - 0.4			V
Digital Input-Voltage Low, V _{IL}			0.4		V
Digital Input-Current High, I _{IH}		-1		+1	μA
Digital Input-Current Low, I _{IL}		-1		+1	μA

AC ELECTRICAL CHARACTERISTICS—Rx MODE

(MAX2837 evaluation kit: VCC_ = 2.8V, f_{RF} = 2.502GHz, f_{LO} = 2.5GHz; receiver baseband I/Q outputs at 90mV_{RMS} (-21dBV), f_{REF} = 40MHz, ENABLE = RXENABLE = CS = high, TXENABLE = SCLK = DIN = low, with power matching for the differential RF pins using the typical applications and registers set to default settings and corresponding test mode, T_A = +25°C, unless otherwise noted. Lowpass filter is set to 10MHz RF channel BW. Unmodulated single-tone RF input signal is used, unless otherwise indicated.) (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
RECEIVER SECTION: LNA RF INPUT TO BASEBAND I/Q OUTPUTS					
RF Input Frequency Range		2.3		2.7	GHz
Peak-to-Peak Gain Variation over RF Input Frequency Range	Tested at band edges and band center		0.8		dB
RF Input Return Loss	All LNA gain settings		13		dB
Total Voltage Gain	T _A = -40°C to +85°C				dB
	Maximum gain, B7:B1 = 0000000	90	99		
	Minimum gain, B7:B1 = 1111111		5	13	
RF Gain Steps	From max RF gain to max RF gain - 8dB		8		dB
	From max RF gain to max RF gain - 16dB		16		
	From max RF gain to max RF gain - 32dB		32		
Gain Change Settling Time	Any RF or baseband gain change; gain settling to within ±1dB of steady state; RXHP = 1		0.2		μs
	Any RF or baseband gain change; gain settling to within ±0.1dB of steady state; RXHP = 1		2		
Baseband Gain Range	From maximum baseband gain (B5:B1 = 00000) to minimum baseband gain (B5:B1 = 11111), T _A = -40°C to +85°C	58	62	66	dB
Baseband Gain Minimum Step Size			2		dB
DSB Noise Figure	Voltage gain ≥ 65dB with max RF gain (B7:B6 = 00)		2.3		dB
	Voltage gain = 50dB with max RF gain - 8dB (B7:B6 = 01)		5.5		
	Voltage gain = 45dB with max RF gain - 16dB (B7:B6 = 10)		17		
	Voltage gain = 15dB with max RF gain - 32dB (B7:B6 = 11)		27		



Ultra-Low-Power, High-Dynamic-Performance, 22Msps Analog Front End

General Description

low-power, highly integrated analog portable communication equipment PDAs, WLAN, and 3G wireless terminals integrates dual 8-bit receive ADCs and dual 10-bit transmit DACs while providing the high-dynamic range at ultra-low power. The ADCs' input amplifiers are fully differential and provide excellent scale signals. Typical I-Q channel gain is $\pm 0.1^\circ$ and amplitude matching is $\pm 0.05\text{dB}$. The DACs' analog I-Q outputs are fully differential with 1.4V typical full-scale output, and 1.4V typical I-Q channel phase match is $\pm 0.05\text{dB}$. The DACs also provide resolution with 71.7dBc SFDR, and 2.2MHz and $f_{\text{CLK}} = 22\text{MHz}$.

operate simultaneously or independently in division duplex (FDD) and time-division duplex (TDD) modes. A 3-wire serial interface and transceiver modes of operation. Operating power is 42mW at $f_{\text{CLK}} = 22\text{MHz}$.

ELECTRICAL CHARACTERISTICS

($V_{\text{DD}} = 3\text{V}$, $\text{OV}_{\text{DD}} = 1.8\text{V}$, internal reference (1.024V), $C_{\text{L}} = 10\text{pF}$ on all digital outputs, $f_{\text{CLK}} = 22\text{MHz}$, ADC input amplitude = -0.5dBFS , DAC output amplitude = 0dBFS , differential ADC input, differential DAC output, $C_{\text{REFP}} = C_{\text{REFN}} = C_{\text{COM}} = 0.33\mu\text{F}$, Xcvr mode, unless otherwise noted. Typical values are at $T_{\text{A}} = +25^\circ\text{C}$, unless otherwise noted.) (Note 1)

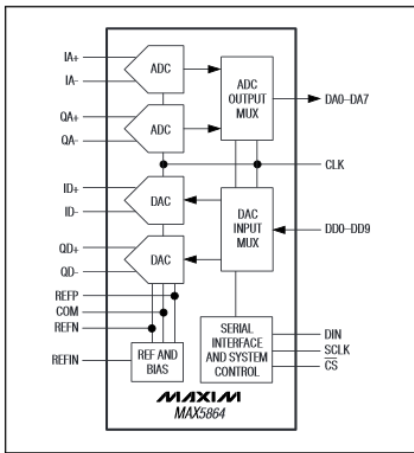
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER REQUIREMENTS						
Analog Supply Voltage	V_{DD}		2.7	3.0	3.3	V
Output Supply Voltage	OV_{DD}		1.8		V_{DD}	V
V_{DD} Supply Current		ADC operating mode, $f_{\text{IN}} = 5.5\text{MHz}$, $f_{\text{CLK}} = 22\text{MHz}$, DAC operating mode, $f_{\text{OUT}} = 2.2\text{MHz}$		14	16.5	mA
		ADC operating mode, $f_{\text{IN}} = 5.5\text{MHz}$, $f_{\text{CLK}} = 15.36\text{MHz}$, DAC operating mode, $f_{\text{OUT}} = 2.2\text{MHz}$		11.4		
		ADC operating mode (Rx), $f_{\text{IN}} = 5.5\text{MHz}$, $f_{\text{CLK}} = 15.36\text{MHz}$, DAC off, DAC digital inputs at zero or OV_{DD}		8.25		
		DAC operating mode (Tx), $f_{\text{OUT}} = 2.2\text{MHz}$, $f_{\text{CLK}} = 15.36\text{MHz}$, ADC off		8		
		Standby mode, DAC digital inputs and CLK at zero or OV_{DD}		2.0		
		Idle mode, DAC digital inputs at zero or OV_{DD} , $f_{\text{CLK}} = 22\text{MHz}$		6.7		
OV_{DD} Supply Current		Shutdown mode, digital inputs and CLK at zero or OV_{DD} , $\text{CS} = \text{OV}_{\text{DD}}$		1		μA
		ADC operating mode, $f_{\text{IN}} = 5.5\text{MHz}$, $f_{\text{CLK}} = 22\text{MHz}$, DAC operating mode, $f_{\text{OUT}} = 2.2\text{MHz}$		2.3		mA
		Idle mode, DAC digital inputs at zero or OV_{DD} , $f_{\text{CLK}} = 22\text{MHz}$		20.6		
		Shutdown mode, DAC digital inputs and CLK at zero or OV_{DD} , $\text{CS} = \text{OV}_{\text{DD}}$		1		μA

Features

- Integrated Dual 8-Bit ADCs and Dual 10-Bit DACs
- Ultra-Low Power
 - 42mW at $f_{\text{CLK}} = 22\text{MHz}$ (Transceiver Mode)
 - 34mW at $f_{\text{CLK}} = 15.36\text{MHz}$ (Transceiver Mode)
 - Low-Current Idle and Shutdown Modes
- Excellent Dynamic Performance
 - 48.5dB SINAD at $f_{\text{IN}} = 5.5\text{MHz}$ (ADC)
 - 71.7dB SFDR at $f_{\text{OUT}} = 2.2\text{MHz}$ (DAC)
- Excellent Gain/Phase Match
 - $\pm 0.1^\circ$ Phase, $\pm 0.03\text{dB}$ Gain at $f_{\text{IN}} = 5.5\text{MHz}$ (ADC)
- Internal/External Reference Option
- +1.8V to +3.3V Digital Output Level (TTL/CMOS Compatible)
- Multiplexed Parallel Digital Input/Output for ADCs/DACs
- Miniature 48-Pin Thin QFN Package (7mm x 7mm)
- Evaluation Kit Available (Order MAX5865EVKIT)

MAX5864

Functional Diagram



Bit-Dynamik $20 \cdot \log(2^8) = 48\text{dB}$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
ADC DC ACCURACY						
Resolution			8			Bits
Integral Nonlinearity	INL			±0.15		LSB
Differential Nonlinearity	DNL	No missing codes over temperature		±0.15		LSB
Offset Error		Residual DC offset error		±0.24	±5	%FS
Gain Error		Includes reference error		±0.77	±5	%FS
DC Gain Matching				±0.03	±0.25	dB
Offset Matching				±3		LSB
Gain Temperature Coefficient				±59		ppm/°C
Power-Supply Rejection	PSRR	Offset error (V _{DD} ±5%)		±0.2		LSB
		Gain error (V _{DD} ±5%)		±0.07		
ADC ANALOG INPUT						
Input Differential Range	V _{ID}	Differential or single-ended inputs		±0.512		V
Input Common-Mode Voltage Range				V _{DD} / 2		V
Input Impedance	R _{IN}	Switched capacitor load		245		kΩ
	C _{IN}			5		pF
ADC CONVERSION RATE						
Maximum Clock Frequency	f _{CLK}	(Note 2)		22		MHz
Data Latency		Channel I		5		Clock cycles
		Channel Q		5.5		
ADC DYNAMIC CHARACTERISTICS (Note 3)						
Signal-to-Noise Ratio	SNR	f _{IN} = 5.5MHz	47	48.6		dB
		f _{IN} = 11MHz		48.6		
Signal-to-Noise and Distortion Ratio	SINAD	f _{IN} = 5.5MHz	46.5	48.5		dB
		f _{IN} = 11MHz		48.5		
Spurious-Free Dynamic Range	SFDR	f _{IN} = 5.5MHz	58	69		dBc
		f _{IN} = 11MHz		71.5		
Third-Harmonic Distortion	HD3	f _{IN} = 5.5MHz		-70.3		dBc
		f _{IN} = 11MHz		-75.5		
Intermodulation Distortion	IMD	f ₁ = 2MHz, -7dBFS; f ₂ = 2.01MHz, -7dBFS		-64		dBc
Third-Order Intermodulation Distortion	IM3	f ₁ = 2MHz, -7dBFS; f ₂ = 2.01MHz, -7dBFS		-67		dBc
Total Harmonic Distortion	THD	f _{IN} = 5.5MHz		-68.2	-57	dBc
		f _{IN} = 11MHz		-68.2	-57	