



400 to 6000MHz Quadrature Demodulator

ADL5380

Preliminary Technical Data

FEATURES

I/Q Demodulator

RF frequency

400 MHz to 6000MHz

IIP3 +31 dBm

IIP2 +60dBm

Input P1dB +12dBm

NF 13.2 dB @ 2.5GHz

Voltage Conversion Gain of 4dB

Quadrature demodulation accuracy

Phase accuracy <0.5°

Amplitude balance <0.25 dB

LO Input -10 to +6 dBm

Demodulation Bandwidth ~500 MHz

I/Q Drive 2V_{pp} into 200Ω

APPLICATIONS

QAM/QPSK demodulator

W-CDMA/CDMA/CDMA2000/GSM

Point-to-(Multi)Point Radio

WiMax/LTE

GENERAL DESCRIPTION

The ADL5380 is a high performance quadrature I-Q demodulator that covers an RF input frequency range from 400 MHz to 6 GHz. With a NF = 13dB, IP1dB = 12dBm and IIP3 = 31dBm at 2.5GHz, the demodulator offers good dynamic range suitable for the demanding infrastructure direct-conversion requirements. The differential RF inputs provide a well-behaved broad-band input impedance of 50Ω and should be driven from a 1:1 balun for best performance.

Excellent quadrature accuracy is achieved using on-chip poly-phase filters for LO quadrature generation. Over a wide range of local oscillator (LO) levels, excellent demodulation accuracy is achieved with phase and amplitude balances < 0.25 dB and < 0.5°, respectively. The demodulated in-phase (I) and quadrature (Q) differential outputs are fully buffered. The ADL5380 provides a typical voltage conversion gain of 4dB

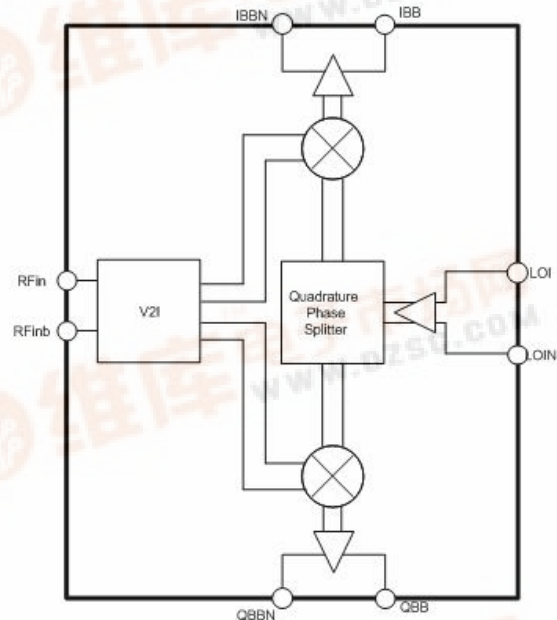


Figure 1. Functional Block Diagram

independent of differential load impedances as low as 100 Ω with a drive capability exceeding 2V_{pp} in to 200 Ω.

The fully balanced design minimizes effects from 2nd order distortion. The leakage from the LO port to the RF port is <- 60dBc. Differential DC-offsets at the I and Q outputs are <10mV. Both of these factors contribute to the excellent IIP2 of >60dBm.

The ADL5380 operates off a 4.75V to 5.25V supply with a typical supply current of 200mA. The ADL5380 is fabricated using Analog Devices' advanced Silicon-Germanium bipolar process and is available in a 24-lead exposed paddle LFCSP package. Performance is specified over a -40°C to +85°C temperature range.

SPECIFICATIONS

Table 1. $V_S = 5\text{ V}$, $T_A = 25^\circ\text{C}$, $R_{BIAS} = 1.5\text{k}\Omega$ for $R_F \leq 3\text{GHz}$, $R_{BIAS} = 200\Omega$ for $R_F \geq 3\text{GHz}$, $Z_0 = 50\Omega$ unless otherwise noted. I & Q are loaded to 50Ω using a 9:1 balun. Loss of RF input balun de-embedded from measurements. M/A COM ETC1-1-13 used for $R_F \leq 3\text{GHz}$. Johanson 3600BL14M050 used for $3\text{GHz} \leq R_F \leq 4\text{GHz}$.

Parameter	Condition	Min	Typ	Max	Unit
OPERATING CONDITIONS					
LO Frequency Range		0.4		6	GHz
RF input Impedance			50		Ω
RF Frequency Range		0.4		6	GHz
RF INPUT @ 700MHz					
Input P1dB	RFIP, RFIN		11.2		dBm
Voltage Conversion Gain	450 Ω load on QHI, QLO, IHI, ILO		4.3		dB
Second Order Input Intercept (IIP2)	-5 dBm Each Tone		72		dBm
Third Order Input Intercept (IIP3)	-5 dBm Each Tone		28		dBm
Noise Figure			11.5		dB
	With a -4dBm interferer 5MHz away		TBD		dB
RF INPUT @ 1900MHz					
Input P1dB	RFIP, RFIN		11		dBm
Voltage Conversion Gain	450 Ω load on QHI, QLO, IHI, ILO		3.5		dB
Second Order Input Intercept (IIP2)	-5 dBm Each Tone		67		dBm
Third Order Input Intercept (IIP3)	-5 dBm Each Tone		27		dBm
Noise Figure			12.8		dB
	With a -4dBm interferer 5MHz away		TBD		dB
RF INPUT @ 2500MHz					
Input P1dB	RFIP, RFIN		12		dBm
Voltage Conversion Gain	450 Ω load on QHI, QLO, IHI, ILO		2.9		dB
Second Order Input Intercept (IIP2)	-5 dBm Each Tone		60		dBm
Third Order Input Intercept (IIP3)	-5 dBm Each Tone		31		dBm
Noise Figure			13.2		dB
	With a -4dBm interferer 5MHz away		TBD		dB
RF INPUT @ 3500MHz					
Input P1dB	RFIP, RFIN		11		dBm
Voltage Conversion Gain	450 Ω load on QHI, QLO, IHI, ILO		4.5		dB
Second Order Input Intercept (IIP2)	-5 dBm Each Tone		54		dBm
Third Order Input Intercept (IIP3)	-5 dBm Each Tone		22		dBm
Noise Figure			14.7		dB
	With a -4dBm interferer 5MHz away		TBD		dB
LO INPUT					
Input Return Loss	LOIP, LOIN		9		dB
LO input level	AC-coupled into LOIP with LOIN bypassed, measured at 2GHz	-10		5	dBm
LO-RF Leakage	RFIN,RFIP terminated in 50 Ω , LO Power= 0dBm		-57		dBm

I/Q BASEBAND OUTPUTS	QHI, QLO, IHI, ILO			
Voltage Conversion Gain	450Ω load on QHI, QLO, IHI, ILO @ 1900MHz	4.3		dB
Demodulation Bandwidth	200Ω load Small Signal 3 dB Bandwidth	TBD		dB
Quadrature Phase Error	1Vp-p Signal 3 dB Bandwidth 400 Mhz to 6000 Mhz	500		MHz
I/Q Amplitude Imbalance		TBD		MHz
Output DC Offset (Differential)		TBD		deg
Output Common-Mode	0dBm LO input	TBD		dB
Group Delay Flatness	Any 20 MHz	10		mV
Gain Flatness	Any 20 MHz	Vpos-3		V
Output Swing	Differential 200 Ω load	TBD		ns p-p
Peak Output Current	1kΩ load	TBD		dB p-p
	Each pin	2		Vp-p
		TBD		Vp-p
		10		mA
POWER SUPPLIES	VPOS			
Voltage		4.75	5.25	V
Current	With RAdj = 1.5kΩ	240		mA
Current	With RAdj = 200Ω	250		mA

ABSOLUTE MAXIMUM RATINGS

Parameter	Rating
Supply Voltage VPOS1, VPOS2, VPOS3	5.5 V
LO Input Power	10 dBm (re: 50 Ω)
RF/IF Input Power	TBD dBm (re: 50 Ω)
Internal Max Power Dissipation	TBD mW
θ_{JA}	TBD $^{\circ}\text{C}/\text{W}$
Maximum Junction Temperature	TBD $^{\circ}\text{C}$
Operating Temperature Range	-40 $^{\circ}\text{C}$ to +85 $^{\circ}\text{C}$
Storage Temperature Range	-65 $^{\circ}\text{C}$ to +125 $^{\circ}\text{C}$
Lead Temperature (Soldering, 60 sec)	300 $^{\circ}\text{C}$

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD CAUTION



ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

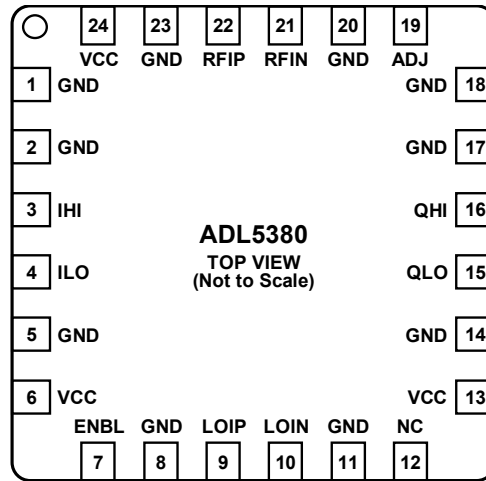


Figure 2. Pin Configuration

Table 2. Pin Function Descriptions

Pin No.	Mnemonic	Description
1,2,5,8,11,14,17,18,20,23	GND	Ground Connect.
6, 13, 24	VCC	Supply. Positive supply for LO, IF, biasing, and baseband sections. These pins should be decoupled to the board ground using appropriate-sized capacitors. o a low impedance ground plane.
12,	NC	Do not connect these pins.
7	ENBL	Enable Control. current. The default setting for this pin is open.
9,10	LOIP, LOIN	Local Oscillator Input. Pins must be ac-coupled. A differential drive through a balun (recommended balun is the M/A-COM ETC1-1-13 for lower frequencies and Johanson xxxx for higher frequencies) is necessary to achieve optimal performance.
3,4,15,16	IHI, ILO, QLO, QHI	I Channel and Q Channel Mixer Baseband Outputs. These outputs have a 50 Ω differential output impedance (25 Ω per pin). Each output pair can swing 2 V p-p (differential) into a load of 200 Ω. Output 3 dB bandwidth is ~ 500 MHz.
19	ADJ	A resistor to VPOS that optimizes third order intercept. For operation < 3GHz, R _{ADJ} = 1.5 kΩ. For operation from 3GHz to 4GHz, R _{ADJ} = 200Ω.
21, 22	RFIN, RFIP	RF Input. A single-ended 50 Ω signal can be applied to the RF inputs through a 1:1 balun (recommended balun is the M/A-COM ETC1-1-13 for lower frequencies and Johanson xxxx for higher frequencies).
	EP	Exposed Paddle. Connect to a low impedance thermal and electrical ground plane.

TYPICAL PERFORMANCE CHARACTERISTICS

$V_S = 5\text{ V}$, $T = 25^\circ\text{C}$, $R_{ADJ} = 1.5\text{ k}\Omega$, $Z_O = 50\ \Omega$, ETC1-1-13 balun on RF input. Balun loss de-embedded.

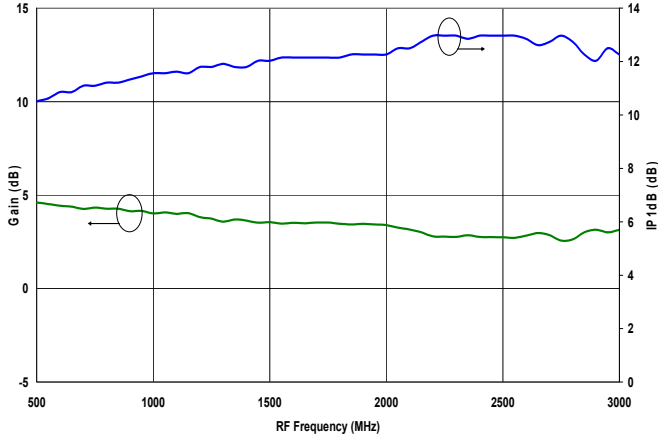


Figure 3. Gain & IP1 dB vs. Frequency

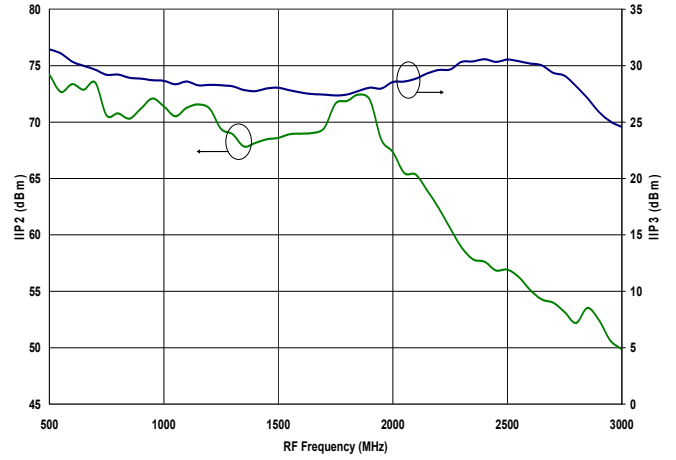


Figure 6 IIP3 and IIP2 vs. Frequency

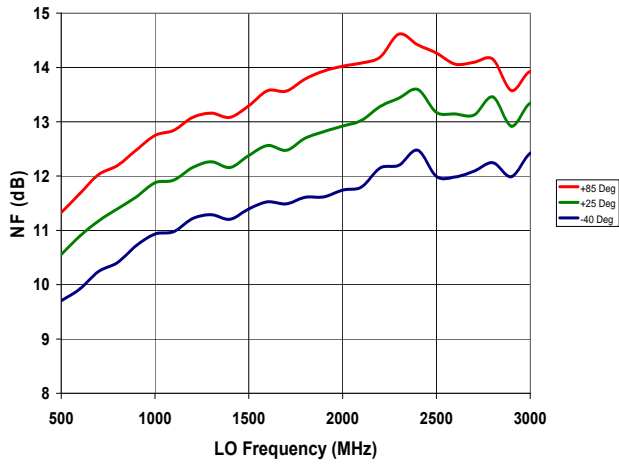


Figure 4. Noise Figure vs. Frequency

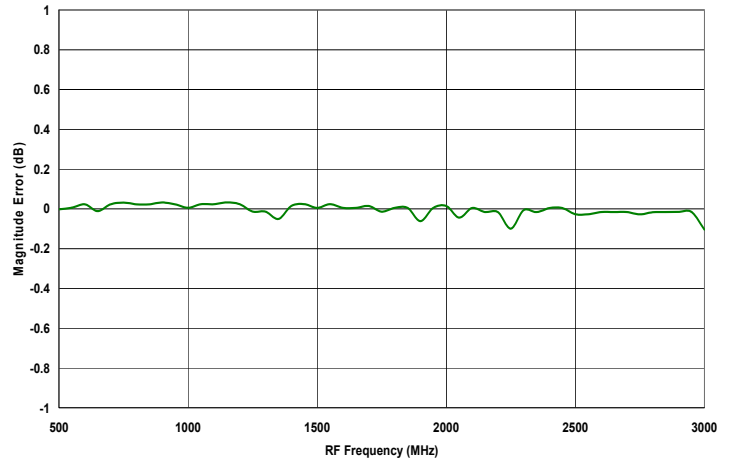


Figure 7. Magnitude Imbalance vs. Frequency

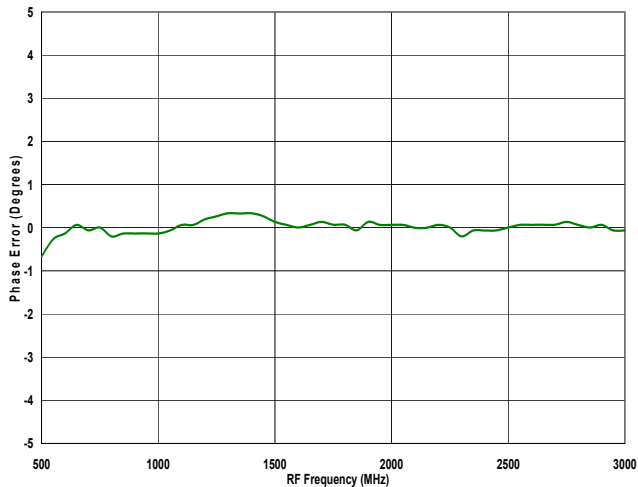


Figure 5. Phase Imbalance vs. Frequency

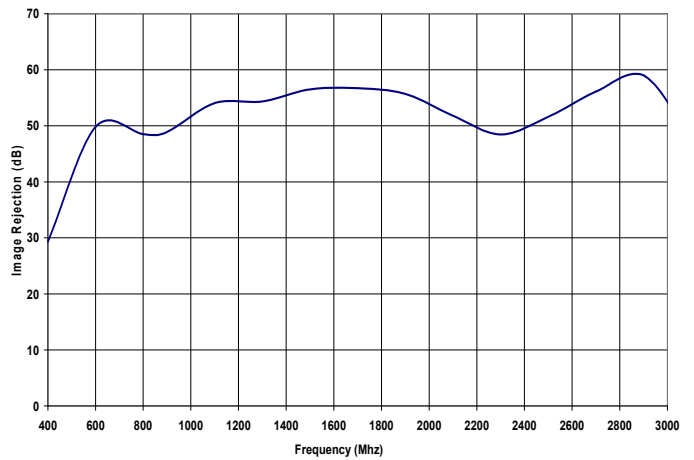


Figure 8. Image Rejection vs. Frequency

$V_S = 5\text{ V}$, $T = 25^\circ\text{C}$, $R_{ADJ} = 200\ \Omega$, $Z_O = 50\ \Omega$, Johanson 3600BL14M050 balun used on RF input. Balun loss de-embedded.

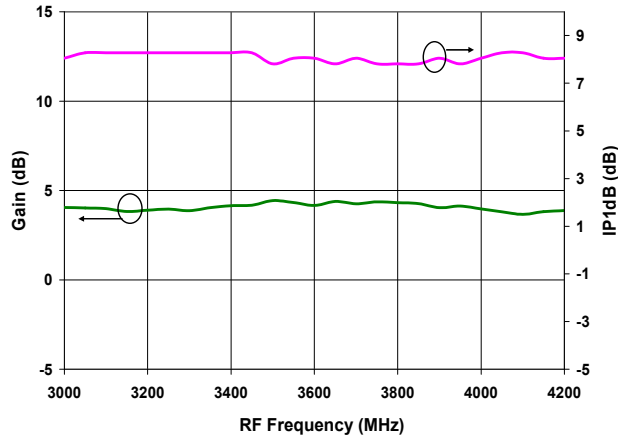


Figure 9. Gain & IP1dB vs. Frequency

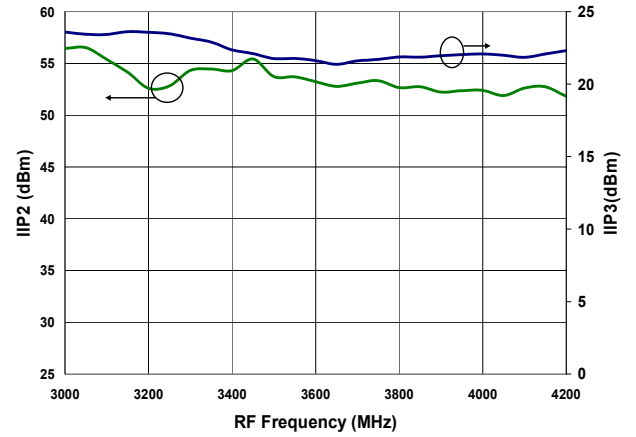


Figure 12 IIP2 and IIP3 vs. Frequency

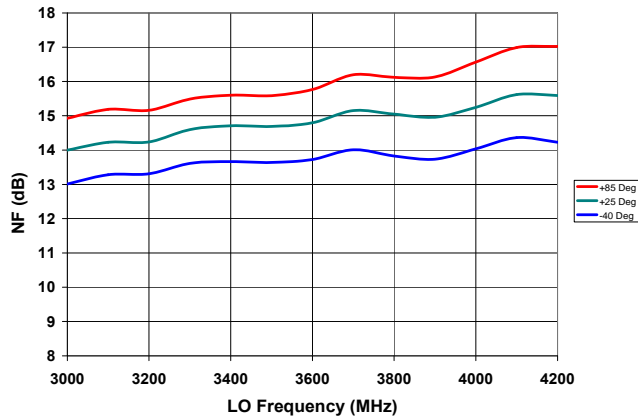


Figure 10. Noise Figure vs. Frequency

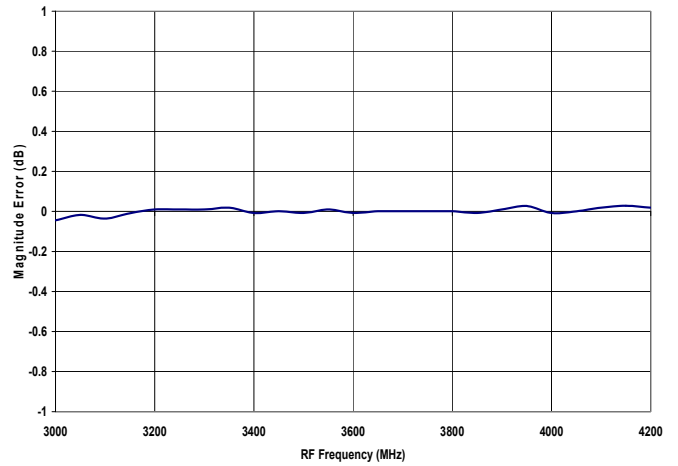


Figure 13. Magnitude Imbalance vs. Frequency

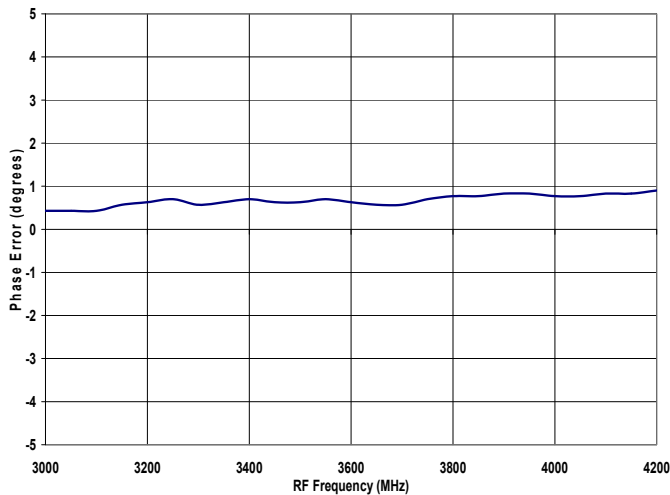


Figure 11. Phase Balance vs. Frequency

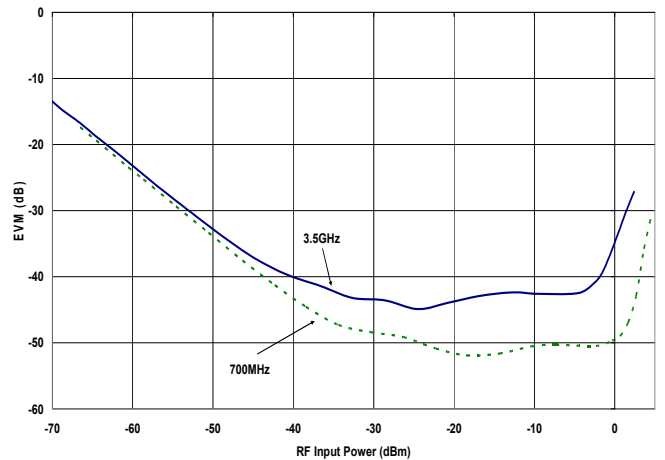


Figure 14. WiMAX EVM vs. RF Input Power for a 16QAM, 10MHz BW signal at 700MHz and 3.5GHz

EVALUATION BOARD

The ADL5382 evaluation board is available. There are two versions of the board, optimized for performance for separate frequency ranges. For operation < 3GHz, an FR4 material based board with the ETC1-1-13 balun footprint is available. For operation between 3GHz to 4GHz, a Rogers material based board with the Johanson 3600BL14M050 balun footprint is available.

The board can be used for single-ended or differential baseband analysis. The default configuration of the board is for single-ended baseband analysis.

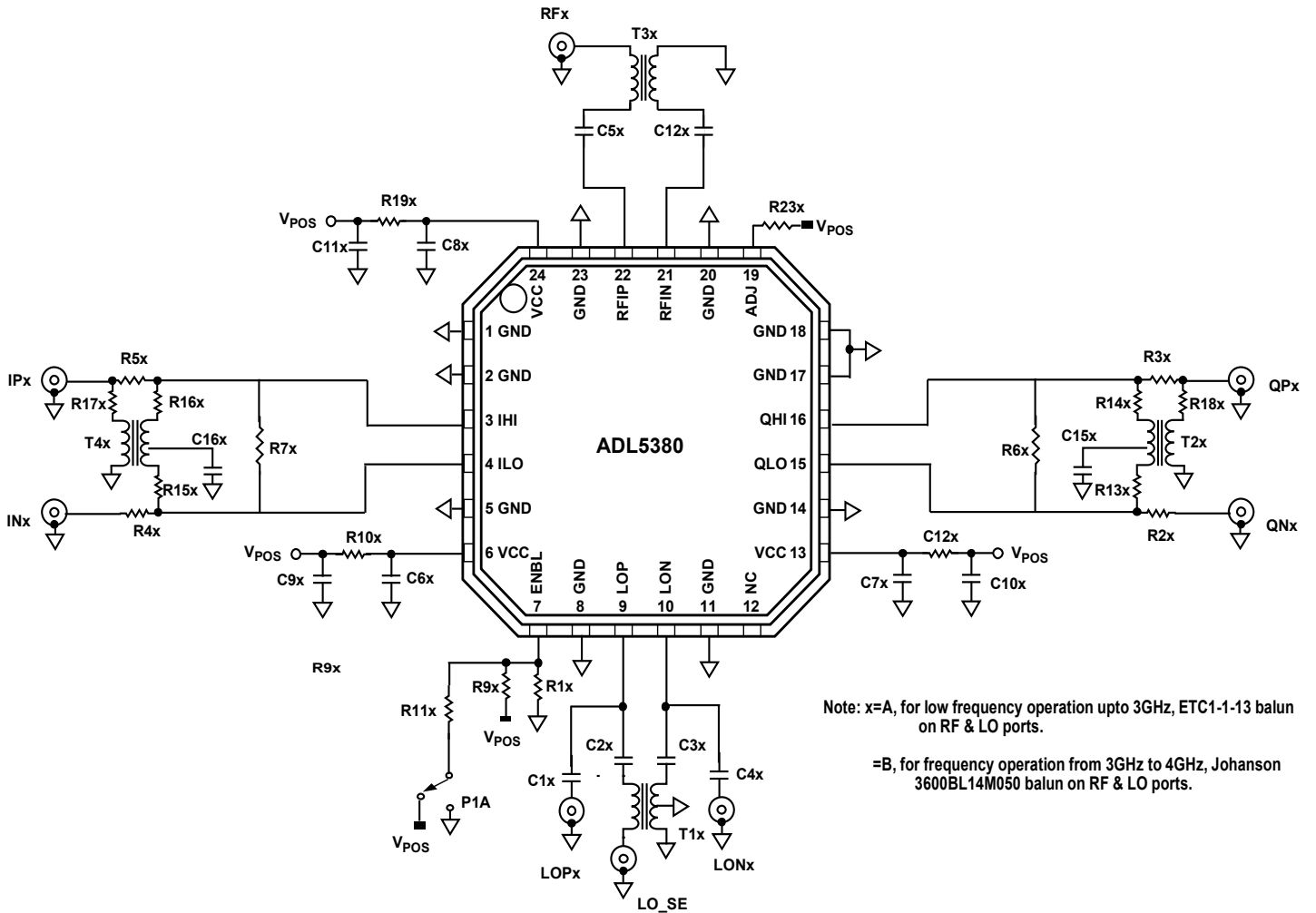


Figure 16. Evaluation Board Schematic

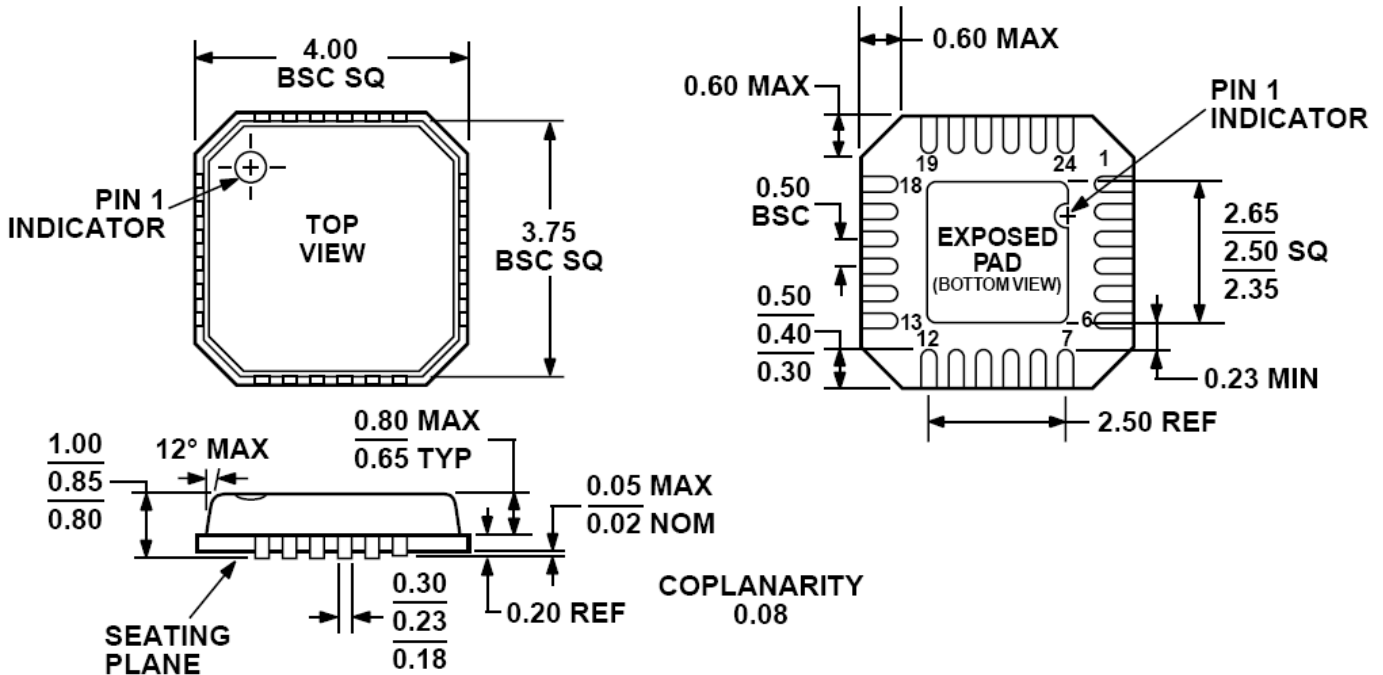
Table 3. Evaluation Board Configuration Options

Component	Function	Default Condition
VPOS, GND	Power Supply and Ground Vector Pins.	Not Applicable
R10x, R12x, R19x	Power Supply Decoupling. Shorts or power supply decoupling resistors.	R10x, R12x, R19x = 0 Ω (0603)
C6x to C10x	The capacitors provide the required dc coupling up to 6 GHz.	C6x, C7x, C8x = 100 pF (0402) C9x, C10x, C11x = 0.1 μ F (0603)
P1x, R11x, R9x, R1x	Device Enable. When connected to VPOS, the device is active.	P1A, R9x=DNI, R1x= DNI, R11x= 0 Ω .
R23x	Adjust Pin. Resistor value here sets the bias voltage at this pin and optimizes third order distortion.	R23A= 1.5k Ω (0603) R23B= 200 Ω (0603)
C1x to C5x, C12x	AC Coupling Capacitors. These capacitors provide the required ac coupling from 400MHz to 4GHz.	C2x, C3x, C5x, C12x = 100 pF (0402), C1x, C4x = DNI
R2x to R7x, R13x to R18x	Single-Ended Baseband Output Path. This is the default configuration of the evaluation board. R13x to R18x are populated for appropriate balun interface. R2x to R5x are not populated. Baseband outputs are taken from QHI and IHI. The user can reconfigure the board to use full differential baseband outputs. R2x to R5x provide a means to bypass the 9:1 TCM9-1 transformer to allow for differential baseband outputs. Access the differential baseband signals by populating R2x to R5x with 0 Ω and not populating R13x to R18x. This way the transformer does not need to be removed. The baseband outputs are taken from the SMAs of Q_HI, Q_LO, I_HI, and I_LO. R6x and R7x are provisions for applying a specific differential load across the baseband outputs	R13x to R18x = 0 Ω (0402), R2x to R7x = Open
T2x, T4x	IF Output Interface. TCM9-1 converts a differential high impedance IF output to a single-ended output. When loaded with 50 Ω , this balun presents a 450 Ω load to the device. The center tap can be decoupled through a capacitor to ground.	T2x, T4x = TCM9-1, 9:1 (Mini-Circuits)
C15x, C16x	Decoupling Capacitors. C15x and C16x are the decoupling capacitors used to reject noise on the center tap of the TCM9-1.	C15x, C16x = 0.1 μ F (0402)
T1x	LO Input Interface. A 1:1 RF balun that converts the single-ended RF input to differential signal is used.	T1A = ETC1-1-13, 1:1 (M/A COM) for operation < 3GHz. T1B= Johanson 3600BL14M050 for operation from 3GHz to 4GHz.
T3x	RF Input Interface. A 1:1 RF balun that converts the single-ended RF input to differential signal is used.	T3A = ETC1-1-13, 1:1 (M/A COM) for operation < 3GHz. T3B= Johanson 3600BL14M050 for operation from 3GHz to 4GHz.

OUTLINE DIMENSIONS



24-Lead Lead Frame Chip Scale Package [LFCSP_VQ]
 4 x 4 mm Body, Very Thin Quad
 (CP-24-3)
 Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-220-VGGD-8

Figure 10. 24-Lead Lead Frame Chip Scale Package [LFCSP_VQ] 4 mm x 4 mm Body, Very Thin Quad (CP-24-2)

Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADL5380ACPZ-R7	-40°C to +85°C	7" Tape and Reel	
ADL5380ACPZ-WP	-40°C to +85°C	Waffle Pack	
ADL5380-30A-EVALZ		Evaluation Board for operation < 3GHz	
ADL5380-29A-EVALZ		Evaluation Board for operation from 3GHz to 4GHz	