

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

## General Description

The MAX2310/MAX2312/MAX2314/MAX2316 are IF receivers designed for dual-band, dual-mode, and single-mode N-CDMA and W-CDMA cellular phone systems. The signal path consists of a variable gain amplifier (VGA) and I/Q demodulator. The devices feature guaranteed +2.7V operation, a dynamic range of over 110dB, and high input IP3 (-33dBm at 35dB gain, 1.7dBm at -35dB).

Unlike similar devices, the MAX2310 family of receivers includes dual oscillators and synthesizers to form a self-contained IF subsystem. The synthesizer's reference and RF dividers are fully programmable through a 3-wire serial bus, enabling dual-band system architectures using any common reference and IF frequency. The differential baseband outputs have enough bandwidth to suit both N-CDMA and W-CDMA systems, and offer saturated output levels of 2.7Vp-p at a low +2.75V supply voltage. Including the low-noise voltage-controlled oscillator (VCO) and synthesizer, the MAX2310 draws only 26mA from a +2.75V supply in CDMA (differential IF) mode.

The MAX2310/MAX2312/MAX2314/MAX2316 are available in 28-pin QSOP packages.

## Applications

Single/Dual/Triple-Mode CDMA Handsets  
Globalstar Dual-Mode Handsets  
Wireless Data Links  
Tetra Direct-Conversion Receivers  
Wireless Local Loop (WLL)

## Features

- ◆ Complete IF Subsystem Includes VCO and Synthesizer
- ◆ Supports Dual-Band, Triple-Mode Operation
- ◆ VGA with >110dB Gain Control
- ◆ Quadrature Demodulator
- ◆ High Output Level (2.7V)
- ◆ Programmable Charge-Pump Current
- ◆ Supports Any IF Frequency Between 40MHz and 300MHz
- ◆ 3-Wire Programmable Interface
- ◆ Low Supply Voltage (+2.7V)

## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX2310EEI	-40°C to +85°C	28 QSOP
MAX2312EEI	-40°C to +85°C	28 QSOP
MAX2314EEI	-40°C to +85°C	28 QSOP
MAX2316EEI	-40°C to +85°C	28 QSOP

*Pin Configurations appear at end of data sheet.*

*Block Diagram appears at end of data sheet.*

## Selector Guide

PART	MODE	DESCRIPTION	INPUT RANGE
MAX2310	AMPS, Cellular CDMA, PCS CDMA	Dual Band, Triple Mode	40MHz to 300MHz
MAX2312	PCS CDMA	Single Band, Single Mode	67MHz to 300MHz
MAX2314	AMPS, Cellular CDMA	Single Band, Dual Mode	40MHz to 150MHz
MAX2316	Cellular CDMA	Single Band, Single Mode or Single Band, Dual Mode with External Discriminator	40MHz to 150MHz

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

## ABSOLUTE MAXIMUM RATINGS

V <sub>CC</sub> to GND .....	-0.3V, +6.0V	Digital Input Current $\overline{\text{SHDN}}$ , MODE, DIVSEL, BUFEN, DATA, CLK, EN, STBY .....	±10mA
SHDN to GND .....	-0.3V to (V <sub>CC</sub> + 0.3V)	Continuous Power Dissipation (T <sub>A</sub> = +70°C) 28-pin QSOP (derate 10mW/°C above T <sub>A</sub> = +70°C) .....	800mW
STBY, BUFEN, MODE, EN, DATA, CLK, DIVSEL .....	-0.3V to (V <sub>CC</sub> + 0.3V)	Operating Temperature Range .....	-40°C to +85°C
V <sub>GC</sub> to GND .....	-0.3V, the lesser of +4.2V or (V <sub>CC</sub> + 0.3V)	Junction Temperature .....	+150°C
AC Signals TankH ±, TankL ±, REF, FM ±, CDMA ± .....	1.0V peak	Storage Temperature Range .....	-65°C to +160°C
		Lead Temperature (soldering, 10s) .....	+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## DC ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = +2.7V to +5.5V, MODE = DIVSEL =  $\overline{\text{SHDN}}$  =  $\overline{\text{STBY}}$  =  $\overline{\text{BUFEN}}$  = high, differential output load = 10kΩ, T<sub>A</sub> = -40°C to +85°C, registers set to default power-up settings. Typical values are at V<sub>CC</sub> = +2.75V and T<sub>A</sub> = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Current (Note 1)	I <sub>CC</sub>	CDMA mode	T <sub>A</sub> = +25°C	25.9	37.5	mA
			T <sub>A</sub> = -40°C to +85°C		41.5	
		FM IQ mode	T <sub>A</sub> = +25°C	25.4	36.7	
			T <sub>A</sub> = -40°C to +85°C		40.6	
		FM I mode	T <sub>A</sub> = +25°C	24.7	35.7	
			T <sub>A</sub> = -40°C to +85°C		39.5	
		STANDBY (VCO_H)	T <sub>A</sub> = +25°C	12.3	18.8	
			T <sub>A</sub> = -40°C to +85°C		20.7	
STANDBY (VCO_L)	T <sub>A</sub> = +25°C	11.5	18.4			
	T <sub>A</sub> = -40°C to +85°C		20.3			
Addition for LO out ( $\overline{\text{BUFEN}}$ = low)			3.5			
Shutdown Current	I <sub>CC</sub>	$\overline{\text{SHDN}}$ = low		1.5	10	μA
Register Shutdown Current	I <sub>CC</sub>			3	5.8	mA
Logic High			2.0			V
Logic Low					0.5	V
Logic High Input Current	I <sub>IH</sub>		2			μA
Logic Low Input Current	I <sub>IL</sub>				2	μA
VGC Control Input Current		0.5V < V <sub>VGC</sub> < 2.3V	-5		5	μA
VGC Control Input Current During Shutdown		$\overline{\text{SHDN}}$ = low			1	μA
Lock Indicator High (locked)		50kΩ load	2.0			V
Lock Indicator Low (unlocked)		50kΩ load			0.5	V
DC Offset Voltage		I+ to I- and Q+ to Q-, PLL locked	-20	±1.5	+20	mV
Common-Mode Output Voltage		V <sub>CC</sub> = 2.75V		V <sub>CC</sub> - 1.4		V

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

MAX2310/MAX2312/MAX2314/MAX2316

## AC ELECTRICAL CHARACTERISTICS

(MAX2310/MAX2314 or MAX2312/MAX2316 EV kit,  $V_{CC} = +2.75V$ , registers set to default power-up states,  $f_{IN} = 210.88MHz$  for CDMA,  $f_{IN} = 85.88MHz$  for FM,  $f_{REF} = 19.68MHz$ , synthesizer locked with passive 2nd-order lead-lag loop filter,  $\overline{SHDN} = high$ , VGC set for +35dB voltage gain, differential output load = 10k $\Omega$ , all power levels referred to 50 $\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Frequency	$f_{IN}$	(Note 2)	40		300	MHz
Reference Frequency	$f_{REF}$	(Note 2)			39	MHz
Frequency Reference Signal Level	$V_{REF}$		0.2			Vp-p
<b>SIGNAL PATH, CDMA MODE</b>						
Input Third-Order Intercept	IIP3	Gain = -35dB (Note 3)		1.7		dBm
		Gain = +35dB (Note 4)		-33.2		
Input 1dB Compression	P1dB	Gain = -35dB	-9	-6.4		dBm
		Gain = +35dB	-44	-38.3		
Input 0.25dB Desensitization		(Note 5)	Gain = -35dB		-14.8	dBm
			Gain = +35dB		-49	
Minimum Voltage Gain	$A_V$	$V_{GC} = 0.5V$ (Note 6)		-54.8	-49	dB
Maximum Voltage Gain	$A_V$	$V_{GC} = 2.3V$ (Note 6)	56	61.3		dB
DSB Noise Figure	NF	Gain = -35dB		62.9		dB
		Gain = +35dB		6.36		
<b>SIGNAL PATH, FM_IQ MODE</b>						
Input Third-Order Intercept	IIP3	(Note 7)	Gain = -35dB		-6.0	dBm
			Gain = +35dB		-31	
Input 1dB Compression	P1dB	(Notes 6, 8)	Gain = -35dB	-20	-16.2	dBm
			Gain = +35dB	-44	-38.4	
Minimum Voltage Gain	$A_V$	$V_{GC} = 0.5V$ (Note 6)		-50.2	-47.4	dB
Maximum Voltage Gain	$A_V$	$V_{GC} = 2.3V$ (Note 6)	58.5	63.4		dB
<b>SIGNAL PATH, CDMA and FM_IQ MODE</b>						
Maximum Gain Variation Over Temperature		Normalized to +25 $^\circ C$		$\pm 2.5$		dB
Baseband 0.5dB Bandwidth				4.2		MHz
Quadrature Suppression		$T_A = T_{MIN}$ to $T_{MAX}$ (Note 6)	+28	+35		dB
LO to Baseband Leakage				1		mVp-p
Saturated Output Level	$V_{SAT}$	Differential		2.7		Vp-p
<b>PHASE-LOCKED LOOP</b>						
VCO Tune Range	$f_{VCO\_L}$	(Note 2)	80		300	MHz
	$f_{VCO\_H}$		135		600	
LOOUT Output Power	$P_{LO}$	$R_L = 50\Omega$ , $\overline{BUFEN} = low$		-13.7		dBm

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

## AC ELECTRICAL CHARACTERISTICS (continued)

(MAX2310/MAX2314 or MAX2312/MAX2316 EV kit,  $V_{CC} = +2.75V$ , registers set to default power-up states,  $f_{IN} = 210.88MHz$  for CDMA,  $f_{IN} = 85.88MHz$  for FM,  $f_{REF} = 19.68MHz$ , synthesizer locked with passive 2nd-order lead-lag loop filter,  $\overline{SHDN} = high$ , VGC set for +35dB voltage gain, differential output load =  $10k\Omega$ , all power levels referred to  $50\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
VCO Minimum Divide Ratio	M1, M2				256	
VCO Maximum Divide Ratio	M1, M2		16383			
REF Minimum Divide Ratio	R1, R2				2	
REF Maximum Divide Ratio	R1, R2		2047			
Minimum Phase Detector Comparison Frequency		(Note 6)			20	kHz
Maximum Phase Detector Comparison Frequency		(Note 6)	1500			kHz
Base Band Spurious due to PLL					-50	dBc
LOOUT at 85MHz, VCO_L Enabled (Note 9)		1kHz offset		-72		dBc/Hz
		12.5kHz offset		-100		
		30kHz offset		-110		
		120kHz offset		-119		
		900kHz offset		-125		
LOOUT at 210MHz, VCO_H Enabled (Note 9)		1kHz offset		-64		dBc/Hz
		12.5kHz offset		-91		
		30kHz offset		-105		
		120kHz offset		-115		
		900kHz offset		-125		
Charge-Pump Source/Sink Current		Acquisition, CPX = XX, TC = 1 (Note 10)	1480	2100	2650	$\mu A$
		Locked, CPX = 00	105	150	190	
		Locked, CPX = 01	150	210	265	
		Locked, CPX = 10	210	300	380	
		Locked, CPX = 11	300	425	530	
Charge-Pump Source/Sink Matching		Locked, all values of CPX, $0.5V < V_{CP} < V_{CC} - 0.5V$		0.2	10	%

**Note 1:** FM\_IQ and FM\_I modes are not available on MAX2312 and MAX2316.

**Note 2:** Recommended operating frequency range.

**Note 3:**  $f_1 = 210.88MHz$ ,  $f_2 = 210.89MHz$ ,  $P_{f1} = P_{f2} = -15dBm$ .

**Note 4:**  $f_1 = 210.88MHz$ ,  $f_2 = 210.89MHz$ ,  $P_{f1} = P_{f2} = -50dBm$ .

**Note 5:** Small-signal gain at 200kHz below the LO frequency will be reduced by less than 0.25dB when an interfering signal at 1.25MHz below the LO frequency is applied at the specified level.

**Note 6:** Guaranteed by design and characterization.

**Note 7:**  $f_1 = 85.88MHz$ ,  $f_2 = 85.98MHz$ ,  $P_{f1} = P_{f2} = -15dBm$ .

**Note 8:**  $f_1 = 85.88MHz$ ,  $f_2 = 85.98MHz$ ,  $P_{f1} = P_{f2} = -50dBm$ .

**Note 9:** Measured at LOOUT with BD = 0 (+2 selected).

**Note 10:** Not available on MAX2316.

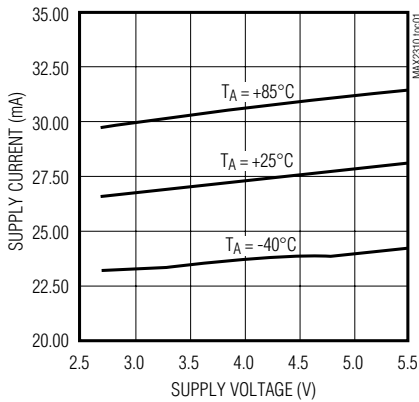
# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

## Typical Operating Characteristics

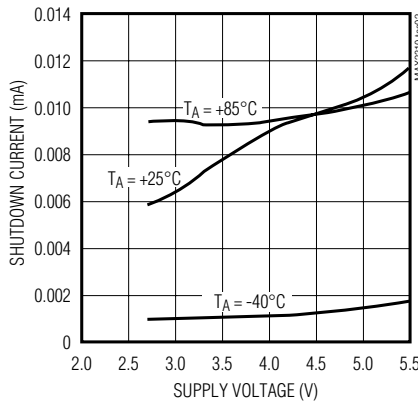
(MAX2310/MAX2314 or MAX2312/MAX2316 EV kit,  $V_{CC} = +2.75V$ , registers set to default power-up states,  $f_{IN} = 210.88MHz$  for CDMA,  $f_{IN} = 85.88MHz$  for FM,  $f_{REF} = 19.68MHz$ , synthesizer locked with passive 2nd-order lead-lag loop filter,  $\overline{SHDN} = high$ ,  $V_{GC}$  set for +35dB voltage gain, differential output load =  $10k\Omega$ , all power levels referred to  $50\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

MAX2310/MAX2312/MAX2314/MAX2316

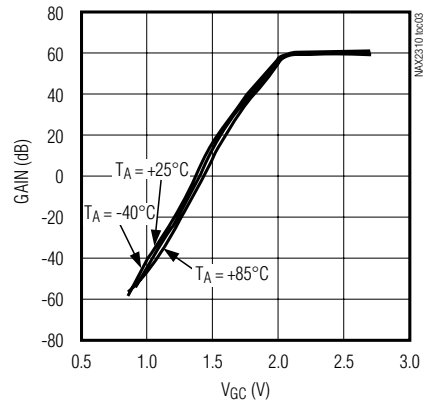
**RECEIVE SUPPLY CURRENT vs. SUPPLY VOLTAGE**



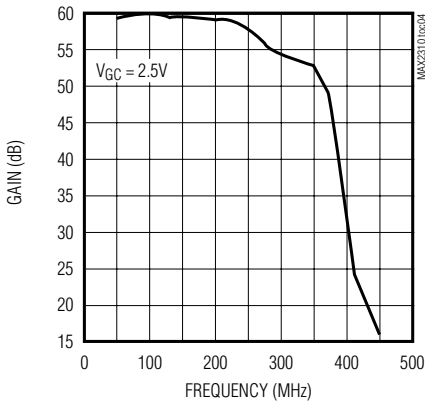
**RECEIVE SHUTDOWN CURRENT vs. SUPPLY VOLTAGE**



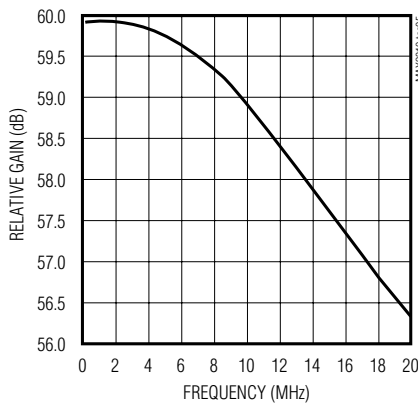
**GAIN vs. VGC**



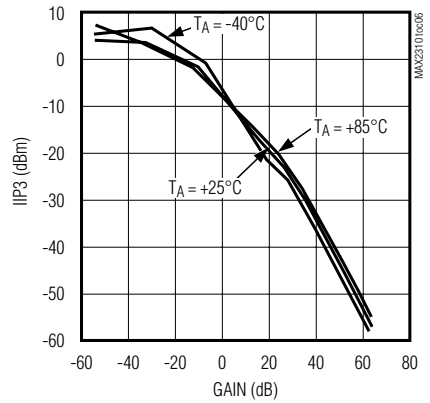
**GAIN vs. INPUT FREQUENCY**



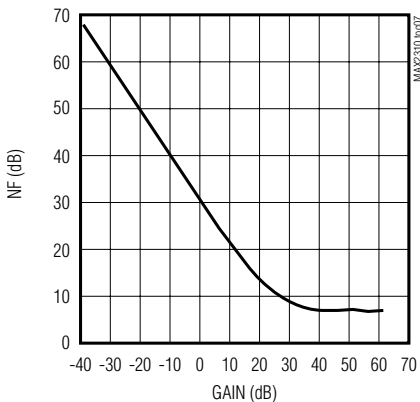
**GAIN vs. BASEBAND FREQUENCY**



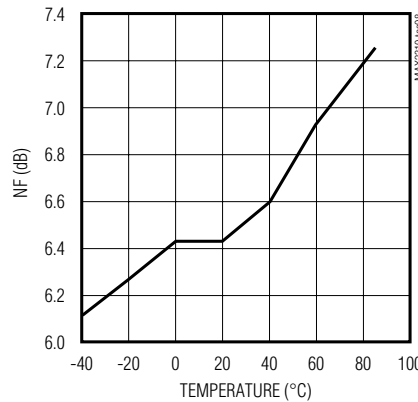
**THIRD-ORDER INPUT INTERCEPT vs. GAIN**



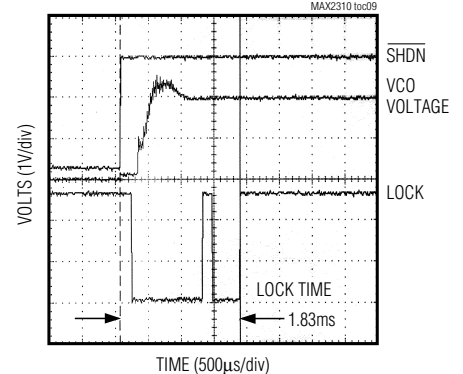
**NOISE FIGURE vs. GAIN**



**NOISE FIGURE vs. TEMPERATURE**



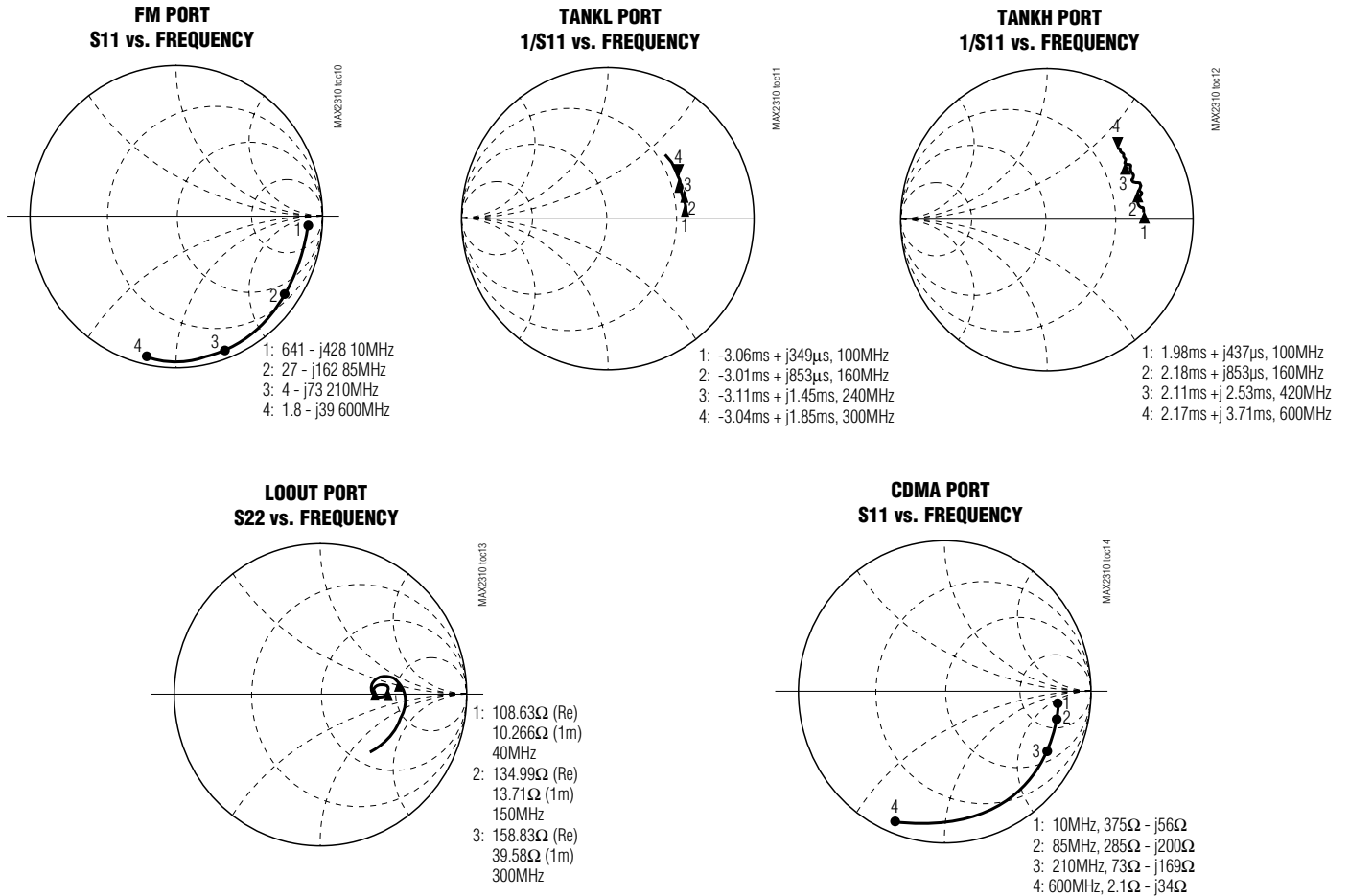
**VCO VOLTAGE vs. TIME**



# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

## Typical Operating Characteristics (continued)

(MAX2310/MAX2314 or MAX2312/MAX2316 EV kit,  $V_{CC} = +2.75V$ , registers set to default power-up states,  $f_{IN} = 210.88MHz$  for CDMA,  $f_{IN} = 85.88MHz$  for FM,  $f_{REF} = 19.68MHz$ , synthesizer locked with passive 2nd-order lead-lag loop filter,  $\overline{SHDN} = high$ , VGC set for +35dB voltage gain, differential output load =  $10k\Omega$ , all power levels referred to  $50\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



## Pin Description

PIN				NAME	FUNCTION
MAX2310	MAX2312	MAX2314	MAX2316		
1	1	1, 8	1	BYP	Bypass Node. Must be capacitively decoupled (bypassed) to analog ground.
2	2	2	2	CP_OUT	Charge-Pump Output
3	3	3	3	GND	Analog Ground Reference
4, 5	—	4, 5	5, 6	TANKL+, TANKL-	Differential Tank Input for Low-Frequency Oscillator
—	4	—	4	DIVSEL	High selects M1/R1; low selects M2/R2.

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

## Pin Description (continued)

PIN				NAME	FUNCTION
MAX2310	MAX2312	MAX2314	MAX2316		
6, 7	5, 6	—	—	TANKH+, TANKH-	Differential Tank Input for High-Frequency Oscillator
—	7	—	7	$\overline{\text{BUFEN}}$	LO Buffer Amplifier—active low
—	—	6, 7	—	N.C.	No Connection. Must be left open-circuit.
8	—	—	—	MODE	Mode Select. High selects CDMA mode; low selects FM mode.
—	8	—	8	LOOUT	Internal VCO Output. Depending on setting of BD bit, LOOUT is either the VCO frequency (twice the IF frequency) or one-half the VCO frequency (equal to the IF frequency).
9	9	9	9	V <sub>CC</sub>	+2.7V to +5.5V Supply for Digital Circuits
10	10	10	10	GND	Digital Ground
11	11	11	11	REF	Reference Frequency Input
12	12	12	12	$\overline{\text{SHDN}}$	Shutdown Input—active low. Low powers down entire device, including registers and serial interface.
13, 14	13, 14	13, 14	13, 14	IOUT+, IOUT-	Differential In-Phase Baseband Output, or FM signal output FM_I mode is selected.
15	15	15	15	LOCK	Lock Output—open-collector pin. Logic high indicates phase-locked condition.
16, 17	16, 17	16, 17	16, 17	QOUT-, QOUT+	Differential Quadrature-Phase Baseband Output. Disabled if FM_I mode is selected.
18	18	18	18	CLK	Clock input of the 3-wire serial bus
19	19	19	19	$\overline{\text{EN}}$	Enable Input. When low, input shift register is enabled.
20	20	20	20	DATA	Data input of the 3-wire serial bus.
21	21	21	21	V <sub>CC</sub>	2.7V to 5.5V Supply for Analog Circuits
22	22	22	22	VGC	VGA Gain Control Input. Control voltage range is 0.5V to 2.3V.
23, 24	23, 24	23, 24	23, 24	CDMA-, CDMA+	Differential CDMA Input. Active in CDMA mode.
25	—	25	—	FM+	Differential Positive Input. Active in FM mode.
—	25	—	25	N.C.	No Connection.
26	—	26	—	FM-	Differential Negative Input for FM signal. Bypass to GND for single-ended operation.
—	26	—	26	$\overline{\text{STBY}}$	Standby Input—active low. Low powers down VGA and demodulator while keeping VCO, PLL, and serial bus on.
27, 28	27, 28	27, 28	27, 28	BYP	Bypass Node. Must be capacitively decoupled (bypassed) to analog V <sub>CC</sub> .

MAX2310/MAX2312/MAX2314/MAX2316





# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

MAX2310/MAX2312/MAX2314/MAX2316

Table 1. MAX2310 Control Register States

OPERATIONAL MODE	ACTION RESULT	PINS		CONTROL REGISTER													LSB
		SHDN	MODE	TEST_MODE	CP POL	TEST_EN	TURBOCHARGE	DIVSEL	VCO_BYP	VCO_SEL	BUF_DIV	BUFEN	FM_TYPE	IN_SEL	STBY	SHDN	
SHUTDOWN	Shutdown pin completely powers down the chip	L	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SHUTDOWN	0 in shutdown register bit leaves serial port active	H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
STANDBY	0 in standby register bit turns off VGA and modulator only	H	X	X	X	0						X	X			0	1
CDMA	Mode pin overrides VCO_SEL, DIVSEL, and IN_SEL to high	H	H			0		X		X	X	X	X	X	1	1	
CDMA	Floating mode pin returns control to register	H	F			0		1		1	X	X	X	1	1	1	
FM_IQ	Mode pin overrides VCO_SEL, DIVSEL, and IN_SEL to low	H	L			0		X		X	X	X	0	X	1	1	
FM_IQ	Floating mode pin returns control to register	H	F			0					X	X	0	0	1	1	
FM_I	Mode pin overrides VCO_SEL, DIVSEL, and IN_SEL to low	H	L			0		X		X	X	X	1	X	1	1	
FM_I	Floating pins return control to register	H L	F			0					X	X	1	0	1	1	

Note: H = high, L = low, F = floating pin, X = don't care, Blank = independent parameter, 1 = logic high, 0 = logic low.

## MAX2312/MAX2316

The MAX2312/MAX2316 quadrature demodulators are simplified versions of the MAX2310 that can be used in single-mode CDMA or dual mode using an external FM discriminator (Figures 2a and 2b). The MAX2312 VCO is optimized for the 67MHz to 300MHz IF frequency range, while the MAX2316 VCO is optimized for the 40MHz to 150MHz IF frequency range.

Both devices include a buffered output for the VCO. The buffered VCO output can be used to support systems implementing traditional limiting IF stages for FM demodulation in dual-mode phones as well as for the transmit LO in TDD systems. This buffered output can

be configured for the VCO frequency (twice the IF frequency) or one-half the VCO frequency (IF frequency). The BUFEN pin enables this feature. A standby mode, in which only the VCO and synthesizer are operational, can be selected through the serial interface or the STBY pin. The MAX2312/MAX2316s' operational modes are described in Table 2. These modes are set by programming the control register and/or setting logic levels on control pins. If the control pins (STBY, BUFEN, DIVSEL) are left floating, the internal register controls the operational mode. If driven high or low, the control pins will override certain register bits, as shown in Table 2.

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

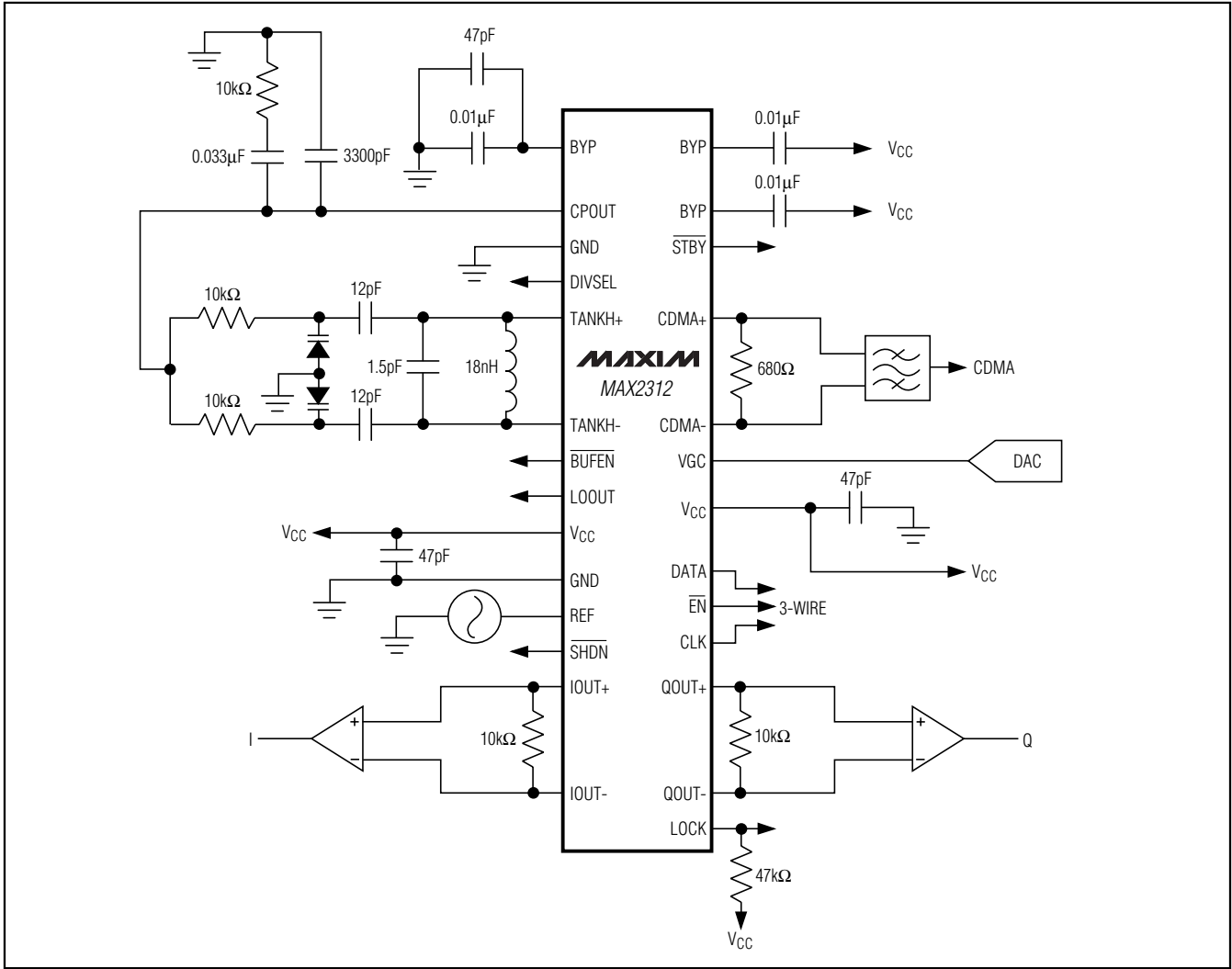


Figure 2a. MAX2312 Typical Operating Circuit

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

MAX2310/MAX2312/MAX2314/MAX2316

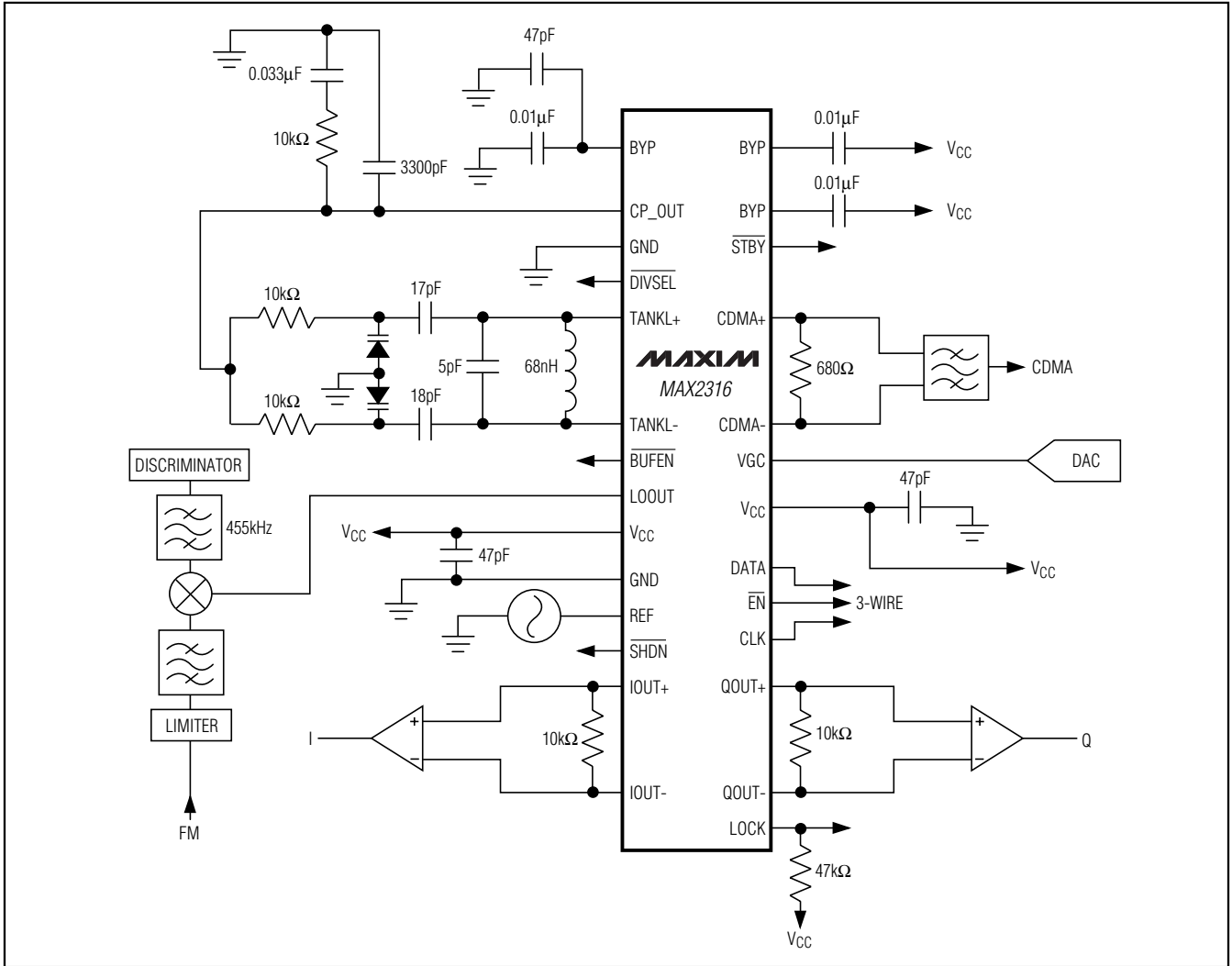


Figure 2b. MAX2316 Typical Operating Circuit

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

Table 2. MAX2312/MAX2316 Control Register States

OPERATIONAL MODE	ACTION RESULT	PINS				CONTROL REGISTER												L S B
		SHDN	DIVSEL	BUFEN	STBY	TEST_MODE	CP_POL	TES_TEN	TURBOCHARGE	DIVSEL	VCO_BYP	VCO_SEL	BUF_DIV	BUFEN	FM_TYPE	IN_SEL	STBY	
SHUTDOWN	Shutdown pin completely powers down the chip	L	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SHUTDOWN	0 in shutdown register bit leaves serial bus active	H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
STANDBY	0 in standby pin turns off VGA and modulator only	H			L			0				X					X	1
STANDBY	0 in standby register bit turns off VGA and modulator only	H	H/L	H				0				X					0	1
DIVIDER SELECT	DIV_SEL pin overrides DIV_SEL register bit	H	H/L		H			0		X		X						1
DIVIDER SELECT	If DIV_SEL pin is floated, then register bit selects divider	H	F		H			0		1/0		X						1
LO BUFFER ENABLE	BUFEN pin controls the LO buffer and overrides the bit	H/L		H				0				X		X				1
LO BUFFER ENABLE	If pin is floated, then BUFEN register bit controls buffer	H		F				0				X		1/0				1

Note: H = high, L = low, 1 = logic high, 0 = logic low, X = don't care, blank = independent parameter.

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

MAX2310/MAX2312/MAX2314/MAX2316

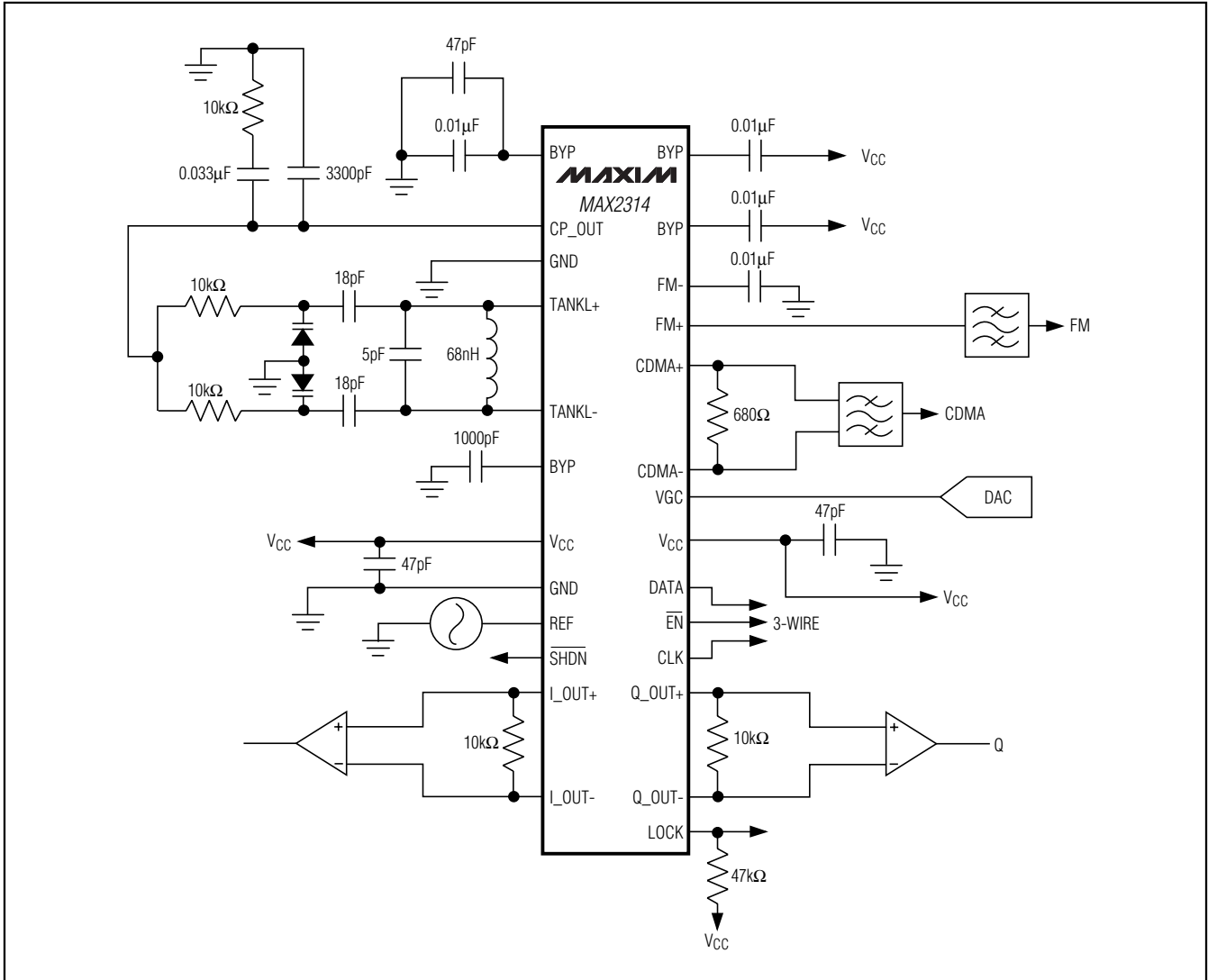


Figure 3. MAX2314 Typical Operating Circuit

## MAX2314

The MAX2314 supports CDMA cellular-band, dual-mode operation. As with the MAX2310, the FM mode can be configured for conversion to the I port or quadrature conversion to both the I and Q ports (Figure 3). The MAX2314's operational modes are described in Table 3. These modes are set by programming the control register and setting logic levels on control pins.

## Applications Information

### Variable-Gain Amplifier and Demodulator

The MAX2310 family provides a Variable-Gain Amplifier (VGA) with exceptional gain range. The MAX2310/MAX2314 support multimode applications with dual differential inputs, selectable with the IN\_SEL (IS) control bit. On the MAX2310 this function can be controlled with the MODE pin, which overrides the IS control bit. The VGA's gain is controlled over a 110dB range with

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Table 3. MAX2314 Control Register States

OPERATIONAL MODE	ACTION RESULT	PIN	CONTROL REGISTER												LSB	
		SHDN	TEST_MODE	CP_POL	TEST_EN	TURBOCHARGE	DIVSEL	VCO_BYP	VCO_SEL	BUF_DIV	BUFEN	FM_TYPE	IN_SEL	STBY	SHDN	
SHUTDOWN	Shutdown pin completely shuts down chip	L	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SHUTDOWN	0 in shutdown register bit leaves serial port active	H	X	X	X	X	X	X	X	X	X	X	X	X	X	L
STANDBY	0 in standby pin turns off VGA and modulator only	H			0				0	X	X			0	1	
CDMA	CDMA operation	H			0				0	X	X	X	1	1	1	
FM_IQ	FM IQ quadrature operation	H			0				0	X	X	0	0	1	1	
FM_I	FM I operation	H			0				0	X	X	1	0	1	1	

Note: H = high, L = low, 1 = logic high, 0 = logic low, X = don't care, blank = independent parameter

the VGC pin. The output of the VGA drives the RF ports of a quadrature demodulator. The MAX2310/MAX2314 provide two types of FM demodulation, controlled by the FM\_TYPE (FT) control bit. When FM\_TYPE is "1," the signal is passed through both the I and Q signal paths for subsequent lowpass filtering and A/D conversion at baseband. If FM\_TYPE is "0," the FM signal is passed through the I mixer only.

### Voltage-Controlled Oscillator, Buffers, and Quadrature Generation

The LO signal for downconversion is provided by a voltage-controlled oscillator (VCO) consisting of an on-chip differential oscillator, and an off-chip high-Q resonant network. Figure 4 shows a simplified schematic of the VCO oscillator. Multiband operation is supported by the MAX2310 with dual VCOs. VCO\_H and VCO\_L are selectable with the MODE pin or the VCO\_SEL (VS)

control bit. They oscillate at twice the desired LO frequency. For applications requiring an external LO, the VCOs can be bypassed with the VCO\_BYP (VB) control bit.

The MAX2312/MAX2316 buffer the output of the VCO and provide this signal at the LOOUT pin. This signal is enabled by the BUFEN (BE) control bit or by the BUFEN control pin. The frequency of this signal is selected by the BUF\_DIV (BD) control bit, and can be either the VCO frequency or half the VCO frequency.

Quadrature downconversion is realized by providing in-phase (I) and quadrature-phase (Q) components of the LO signal to the LO ports of the demodulator described above. The quadrature LO signals are generated by dividing the VCO output frequency using two latches. The appropriate latch outputs provide I and Q signals at the desired LO frequency.

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## Synthesizer

The VCO's output frequency is controlled by an internal phase-locked-loop (PLL) dual-modulus synthesizer. The loop filter is off-chip to simplify loop design for emerging applications. The tunable resonant network is also off-chip for maximum Q and for system design flexibility. The VCO output frequency is divided down to the desired comparison frequency with the M counter. The M counter consists of a 4-bit A swallow counter and a 10-bit P counter. A reference signal is provided from an external source and is divided down to the comparison frequency with the R counter. The two divided signals are compared with a three-state digital phase-frequency detector. The phase-detector output drives a charge pump as well as lock-detect logic and turbocharge control logic. The charge pump output (CP\_OUT) pin is processed by the loop filter and drives the tunable resonant network, altering the VCO frequency and closing the loop.

Multimode applications are supported by two independent programmable registers each for the M counter (M1, M2), the R counter (R1, R2), and the charge-pump output current magnitude (CP1, CP2). The DIVSEL (DS) bit selects which set of registers is used. It can be overridden by the MAX2310's MODE pin or the MAX2312/MAX2316's DIVSEL pin. Programming these registers is discussed in the *3-Wire Interface and Registers* section.

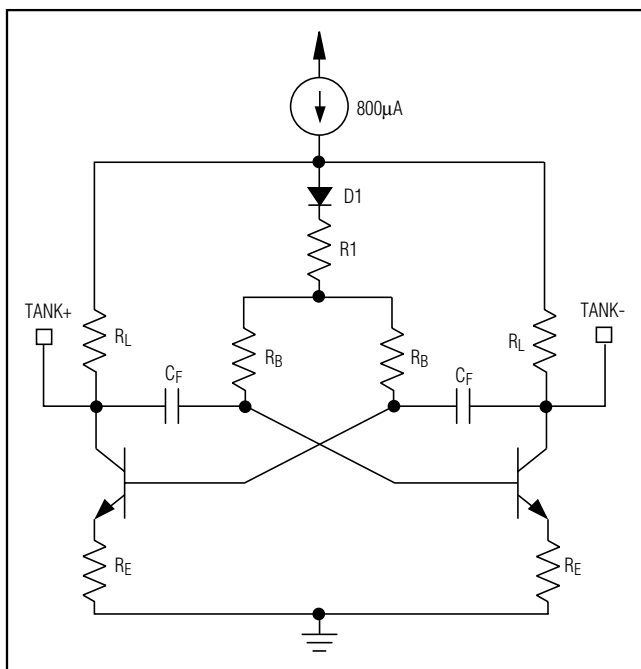


Figure 4. Voltage-Controlled Oscillators

When the part initially powers up or changes state, the synthesizer acquisition time can be reduced by using the Turbo feature, enabled by the TURBOCHARGE (TC) control bit. Turbo functionality provides a larger charge-pump current during acquisition mode. Once the VCO frequency is acquired, the charge-pump output current magnitude automatically returns to the pre-programmed state to maintain loop stability and minimize spurs in the VCO output signal.

The lock detect output indicates when the PLL is locked with a logic high.

## 3-Wire Interface and Registers

The MAX2310 family incorporates a 3-wire interface for synthesizer programming and device configuration (Figure 5). The 3-wire interface consists of a clock, data, and  $\overline{\text{ENABLE}}$ . It controls the VCO dividers (M1 and M2), reference frequency dividers (R1 and R2), and a 13-bit control register. The control register is used to set up the operational modes (Table 4). The input shift is 17 data bits long and requires a total of 18 clock bits (Figure 6). A single clock pulse is required before enable drops low to initialize the data bus.

Whenever the M or R divide register value is programmed and downloaded, the control register must also be subsequently updated. This prevents turbolock from going active when not desired.

The  $\overline{\text{SHDN}}$  control bit is notable because it differs from the SHDN pin. When the  $\overline{\text{SHDN}}$  control bit is low, the registers and serial interface are left active, retaining the values stored in the latches, while the rest of the device is shut off. In contrast, the SHDN pin, when low, shuts down everything, including the registers and serial interface. See the functional diagram in Figure 7.

## Registers

Figure 8 shows the programming logic. The 17-bit shift register is programmed by clocking in data at the rising edge of CLK. Before the shift register is able to accept data, it must be initialized by driving it with at least one full clock cycle at the CLK input with  $\overline{\text{EN}}$  high (see Figure 6). Pulling enable low will allow data to be clocked into the shift register; pulling enable high loads the register addressed by A0, A1, and A2, respectively (Figure 8). Table 5 lists the power-on default values of all registers. Table 6 lists the charge-pump current, depending on CP0 and CP1.

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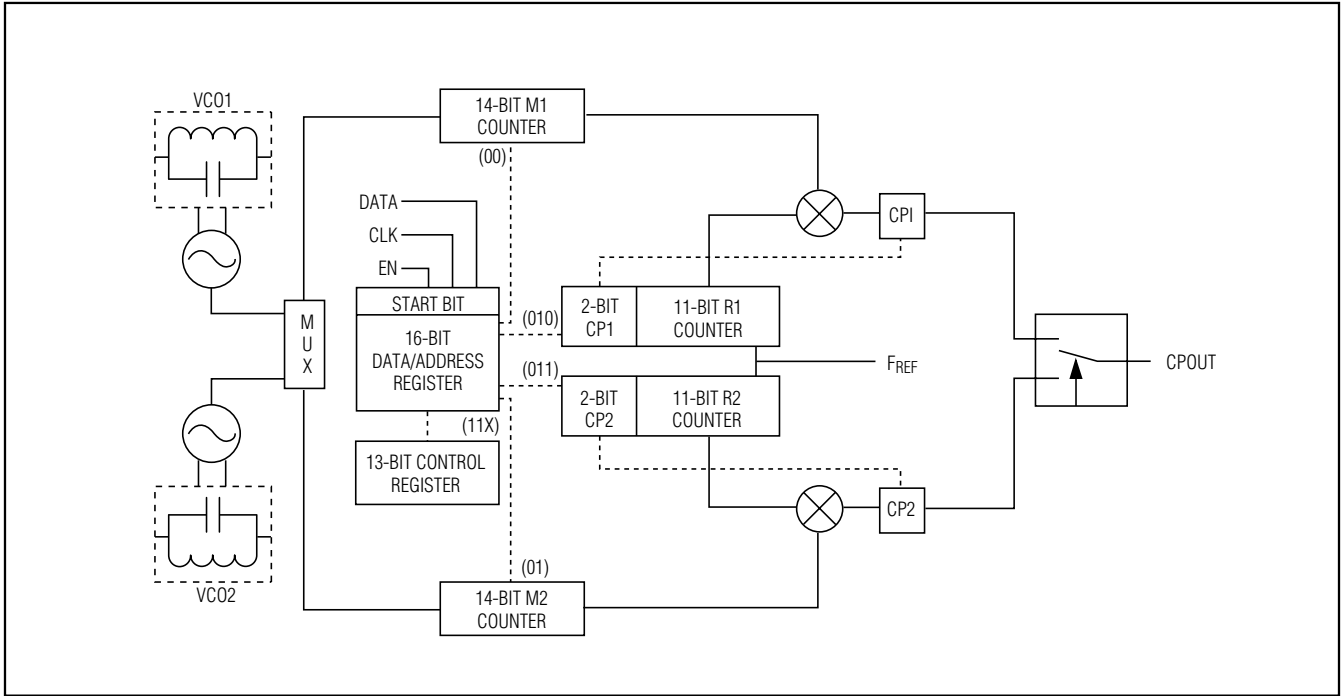


Figure 5. 3-Wire Control Block Diagram

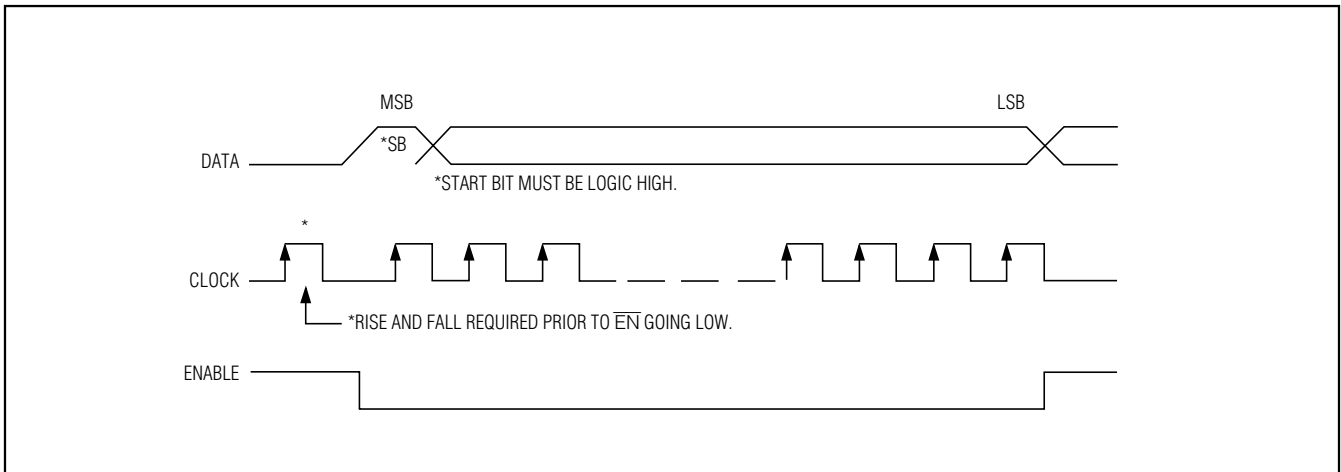


Figure 6. 3-Wire Interface Timing Diagram



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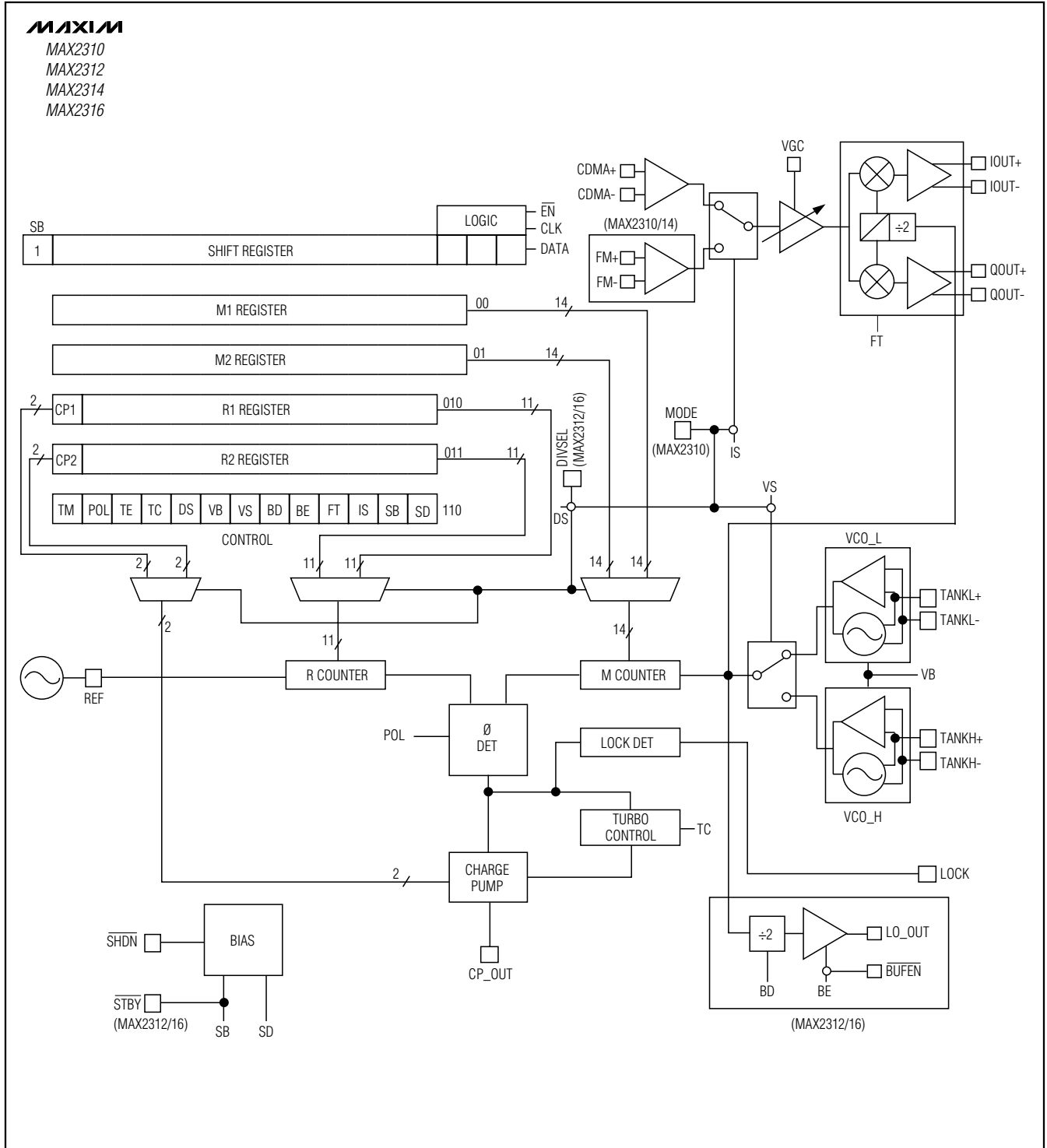


Figure 7. Functional Diagram

# CDMA IF VGAs and I/Q Demodulators with VCO and Synthesizer

**Table 4. Control Register, Default State: 0B57h, Address: 110b**

BIT ID	BIT NAME	POWER-UP STATE	BIT LOCATION 0 = LSB	FUNCTION
TM	TEST_MODE	0	12	Must be 0 for normal operation.
POL	CP_POL	1	11	Logic "1" causes the charge-pump output CP_OUT to source current when $f_{REF}/R > f_{VCO}/M$ . This state is used when the VCO tune polarity is such that increasing voltage produces increasing frequency. Logic "0" causes CP_OUT to source current when $f_{VCO}/M > f_{REF}/R$ . This state is used when increasing tune voltage causes the VCO frequency to decrease.
TE	TEST_ENABLE	0	10	Must be 0 for normal operation.
TC	TURBO_CHARGE	1	9	Logic "1" activates turbocharge mode, which provides rapid frequency acquisition in the PLL. Not available on MAX2316.
DS	DIV_SEL	1	8	Logic "1" selects M1/R1 divide ratios. Logic "0" selects M2/R2.
VB	VCO_BYP	0	7	Logic "1" bypasses the VCO inputs for external VCO operation.
VS	VCO_SEL	1	6	Logic "1" selects VCO_H. Logic "0" selects VCO_L.
BD	BUF_DIV	0	5	Logic "1" selects divide-by-2 on LOOUT port. Logic "0" bypasses divider.
BE	$\overline{\text{BUFEN}}$	1	4	Logic "1" disables LOOUT. Logic "0" enables LOOUT.
FT	FM_TYPE	0	3	Active in FM mode. Logic "0" selects quadrature demodulator for FM mode. Logic "1" selects downconversion to I port.
IS	IN_SEL	1	2	Logic "0" selects FM input port. Logic "1" selects CDMA input.
SB	$\overline{\text{STBY}}$	1	1	Logic "0" enables standby mode, which shuts down the VGA and demodulator stages, leaving the VCO locked and the registers active.
SD	$\overline{\text{SHDN}}$	1	0	Logic "0" enables register-based shutdown. This mode shuts down everything except the M and R latches and the serial bus.

**Table 5. Register Defaults**

REGISTER	DEFAULT
M1	10519DEC
M2	4269DEC
R1	492DEC
R2	492DEC
CTRL	0B57HEX
CP0	11 BIN
CP1	11 BIN

**Table 6. Charge-Pump Control Bits**

CP1	CP0	CHARGE-PUMP CURRENT AFTER ACQUISITION (μA)
0	0	150
0	1	210
1	0	300
1	1	425

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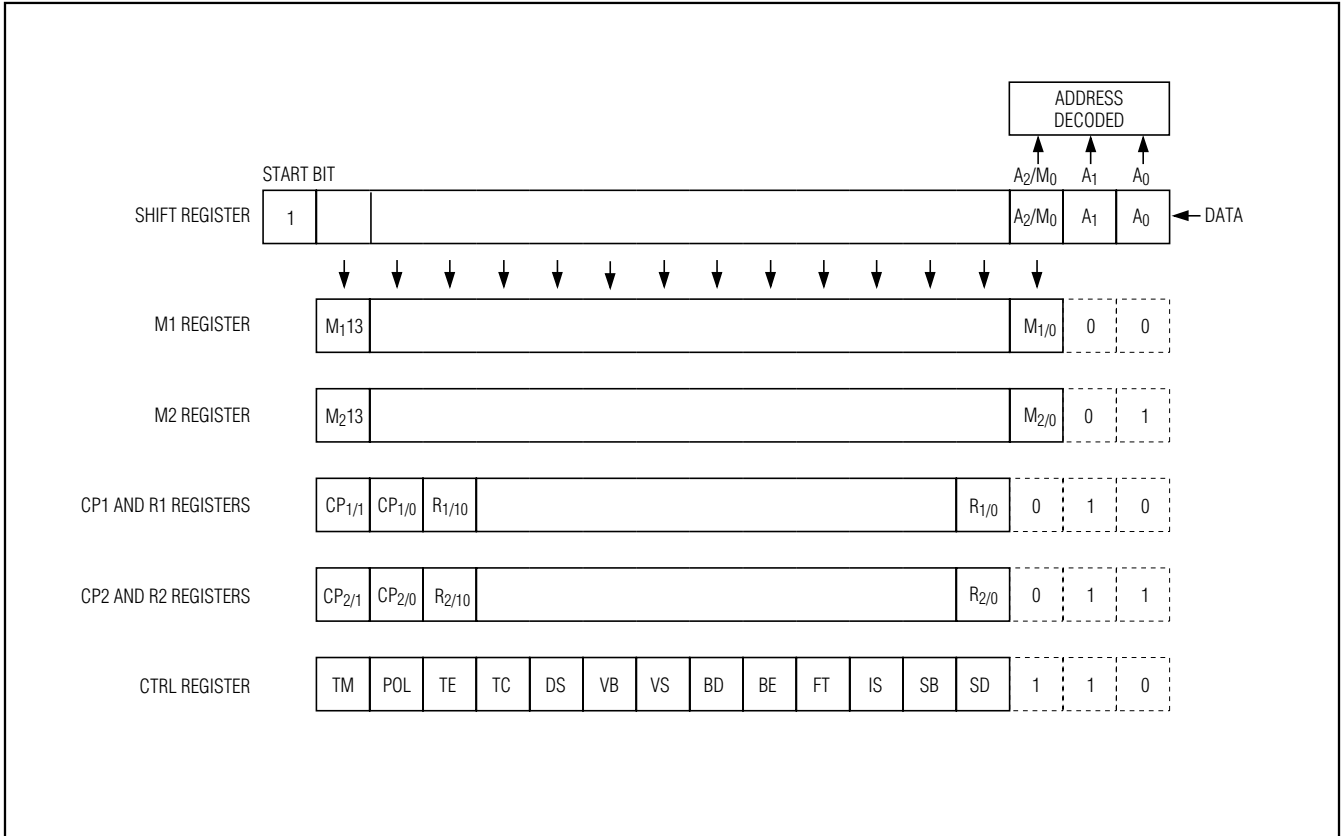
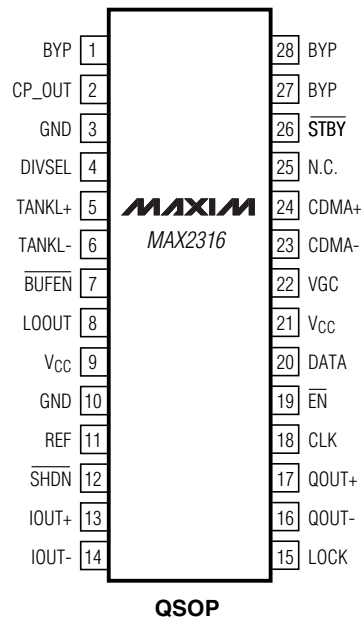
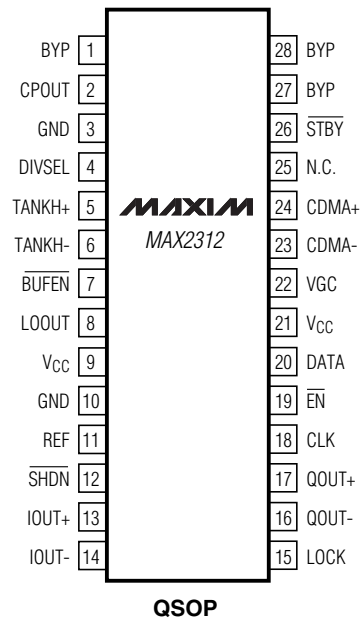
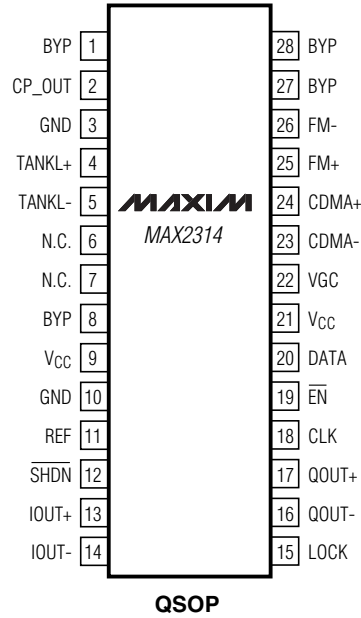
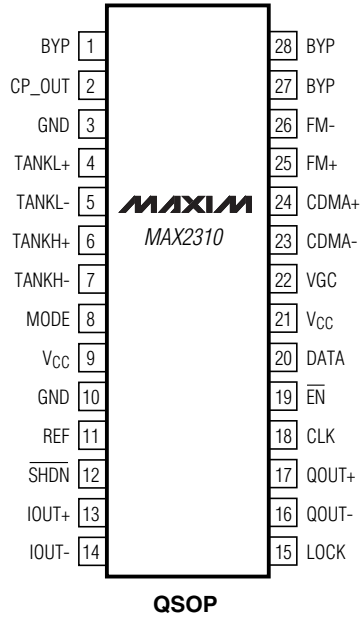


Figure 8. Programming Logic

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## Pin Configurations

TOP VIEW

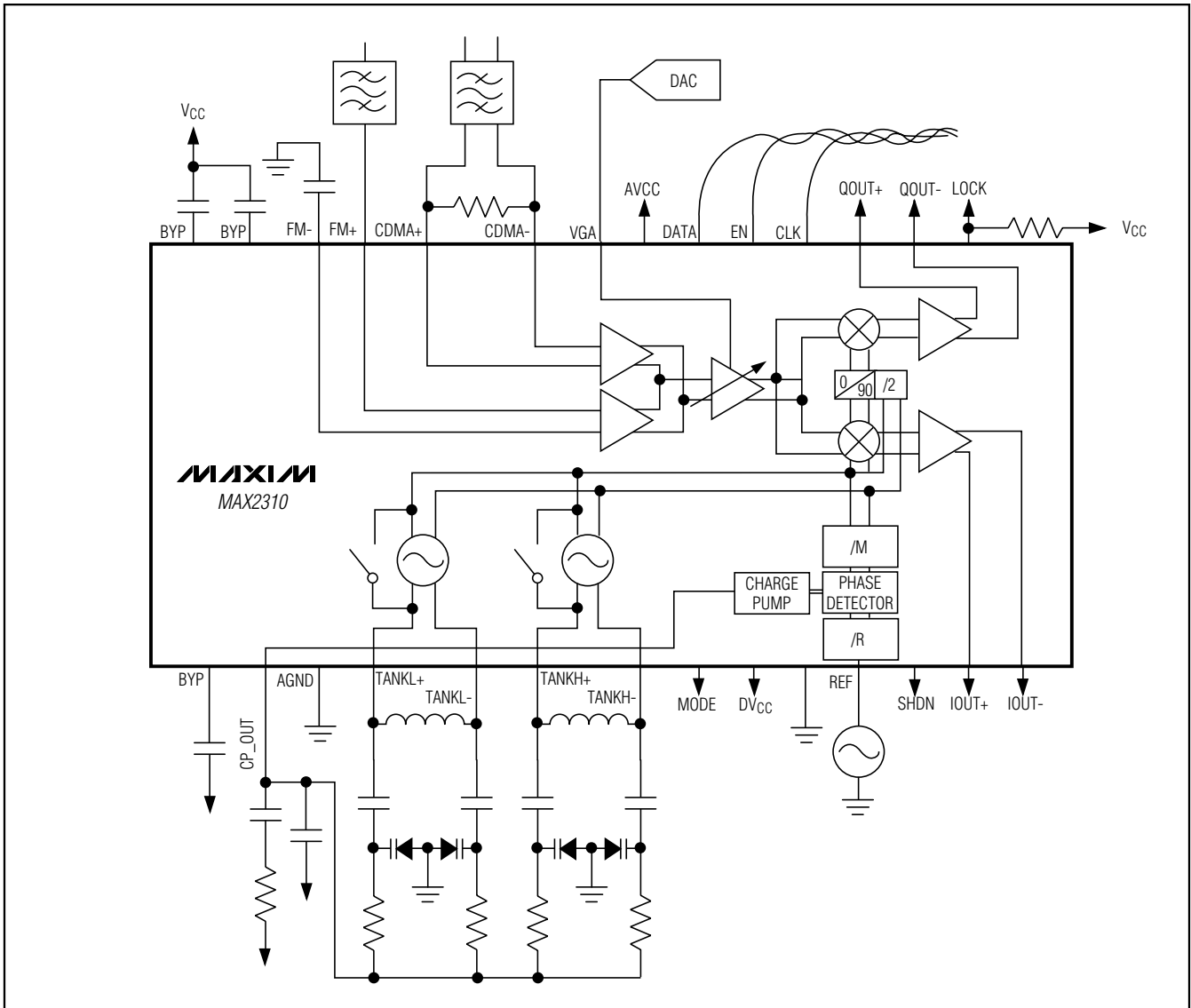


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## Chip Information

TRANSISTOR COUNT: 6422

## Block Diagram

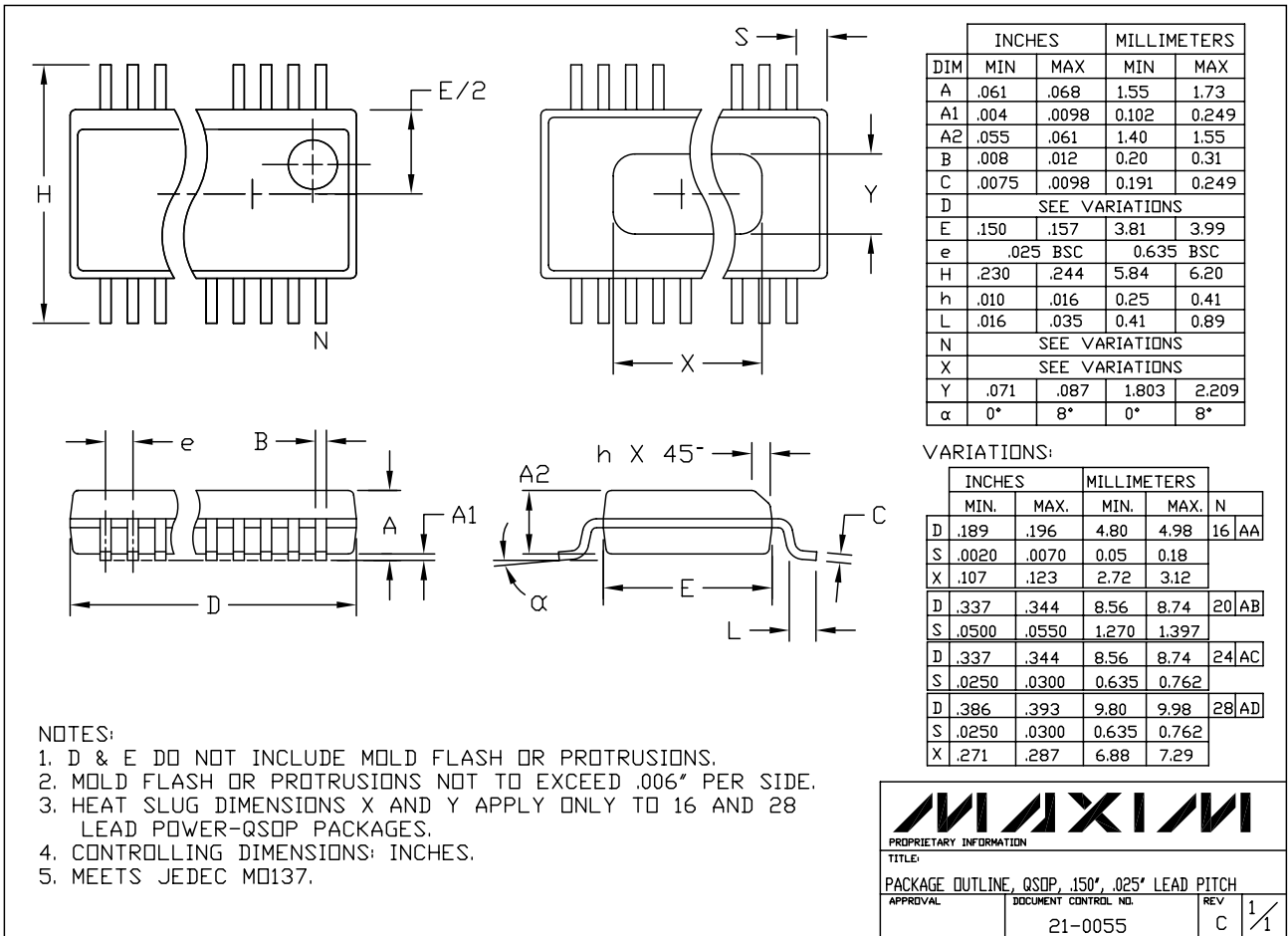


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## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



OSOPERS

## Revision History

Pages changed at Rev 2: 1, 4, 18, 22

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