#### **General Description**

The MAX2390–MAX2393/MAX2396/MAX2400 ("MAX2390 family") evaluation kits (EV kits) simplify the evaluation of these W-CDMA and TD-SCDMA receiver ICs. There are three different PC boards for the family: one for the MAX2391/MAX2392/MAX2393, one for the MAX2396, and one for the MAX2390/MAX2400. Each kit is fully assembled and tested at the factory. Standard 50 $\Omega$  SMA and BNC connectors, TCXOs and baseband buffers are included on the EV kits to allow quick and easy evaluation on the test bench.

For each of the six EV kits, this document provides a list of equipment required to evaluate each device, a straightforward test procedure to verify functionality, a circuit schematic, a bill of materials (BOM), and artwork for each layer of the PC board.

#### **Ordering Information**

PART*	TEMP RANGE	IC PACKAGE
MAX2390EVKIT	-40°C to +85°C	28 THIN QFN-EP**
MAX2391EVKIT	-40°C to +85°C	28 QFN-EP**
MAX2392EVKIT	-40°C to +85°C	28 QFN-EP**
MAX2393EVKIT	-40°C to +85°C	28 QFN-EP**
MAX2396EVKIT	-40°C to +85°C	28 QFN-EP**
MAX2400EVKIT	-40°C to +85°C	28 THIN QFN-EP**

\*Contact factory for pricing and availability.

\*\*EP = Exposed paddle.

#### **\_Features**

- Each EV Kit is Fully Assembled and Tested
- Fully Monolithic Direct-Conversion Receiver Include: PLL Synthesizer (All Except MAX2396/MAX2400) and VCO Eliminate: External IF SAW + IF AGC + I/Q Demodulator
- Meet All 3GPP Receiver's Standard Requirements with at Least 3dB Margin on Eb/No
- Operate from a Single +2.7V to +3.3V Supply
- Over 90dB of Gain-Control Range
- Channel Selectivity Fully On-Chip, with Superior ACS (>40dB)
- ♦ SPI<sup>™</sup>-/QSPI<sup>™</sup>-/MICROWIRE<sup>™</sup>-Compatible 3-Wire Serial Interface
- ♦ Receiver Current Consumption ≈ 32mA
- On-Chip DC Offset Cancellation
- Small 28-Pin QFN Leadless Package

PART	APPLICATION	CHIP RATE (Mcps)	RF BAND (MHz)	SYNTHESIZER
MAX2390	W-CDMA Band II (PCS)	3.84	1930 to 1990	On-Chip
MAX2391	IMT2000/UMTS	3.84	2110 to 2170	On-Chip
MAX2392	TD-SCDMA	1.28	2010 to 2025	On-Chip
MAX2393	W-TDD/TD-SCDMA	3.84 or 1.28	1900 to 1920	On-Chip
MAX2396	IMT2000/UMTS	3.84	2110 to 2170	External
MAX2400	W-CDMA Band II (PCS)	3.84	1930 to 1990	External

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Maxim Integrated Products 1

Selector Guide

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

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DESIGNATION	QTY	DESCRIPTION
C1, C7, C14, C16, C17	5	100pF capacitors (0402) Murata GRP1555C1H101J
C2, C32	2	10nF capacitors (0402) Murata GRP155R71C103K
C3, C18, C21, C22	4	1000pF capacitors (0402) Murata GRP155R71H102K
C4, C5	2	$0\Omega$ resistors (0402)
C6, C8, C27, C28, C33–C38, C40, C44, C45, C48	14	100nF capacitors (0402) Murata GRP155R61A104K
C9, C10–C13, C15, C20, C23, C31	9	Open capacitors (0402) (not installed)
C19	1	220pF capacitor (0402) Murata GRP1555C1H221J
C25	1	1.0pF capacitor (0402) Murata GRP1555C1H1R0B
C39, C43, C46, C47	4	10μF tantalum capacitors (2012) (R-code/case 0805-compatible) AVX TAJR106K006
C89	1	0.1µF capacitor (0805) Murata GRM21BR71E104K
C90	1	1.0µF capacitor (1206) Murata GRM31MR71C105K
C91	1	1.3pF capacitor (0402) Murata GRP1555C1H1R3B
C101	1	10µF capacitor (0805) Murata GRM216R71H103K
L1	1	3.3nH inductor (0402)
L2	1	Open inductor (0402)
L4	1	1.8nH inductor (0402)
R1	1	100k $\Omega$ resistor (0402)
R2, R3, R4, R10, R11, R16, R17	7	$0\Omega$ resistors (0402)
R5	1	27.4k $\Omega$ resistor (0402)
R6	1	6.8kΩ resistor (0402)
R7	1	Open resistor (0402)
R8	1	100 $\Omega$ resistor (0402)
R9, R18	2	10k $\Omega$ resistors (0402)
R12, R15	2	49.9Ω resistors (0402)
R13, R14	2	2.0pF capacitors (0402) Murata GRP1555C1H2R0B

#### Component List—MAX2391/MAX2392/MAX2393

DESIGNATION	QTY	DESCRIPTION
R19	1	1k $\Omega$ resistor (0402)
RBIAS	1	$12k\Omega \pm 1\%$ resistor (0402)
AGC, TCXO	2	10kΩ variable resistors (potentiometers)
BG, CSB, I+, I-, LOCK, Q+, Q-, TAGC, TUNE	9	Digi-Key 5000K-ND
FL1	1	2140MHz saw filter (2140MHz) Murata SAFSD2G14FA0T00R00
GND, GND2, GND3, JU37, JU38, VCC_EXT, VCC_IC	7	_
G_LNA, G_MXR, SHDNB	3	Open
I, Q	2	BNC (50Ω) PC board receptacles (jacks) Amphenol 31-5239-52RFX
J9	1	—
JU20, JVCO, VCC_BB, VCC_CP, VCC_DIG, VCC_LNA, VCC_LOGIC, VCC_MXR, VCC_REF, VCC_TCXO, VCC_VCO	11	Open
LD	1	—
LNA_IN, LNA_OUT, LO_TEST, MXR_IN, REF_IN	5	SMA end launch jack receptacles 0.031in Johnson Components 142-0701-881
U1	1	MAX2391EGI WCDMA receiver
U2	1	Open RF balun (not installed)
U3, U4	2	MAX4444 low-distortion, differential-to-single-ended line drivers
U9	1	MAX8867EUK28 linear regulator
Y1	1	19.2MHz voltage-controlled TCXO (19.2MHz) Kinseki VC-TCXO-208C3-19.2



DESIGNATION	ΟΤΥ	DESCRIPTION
DESIGNATION	QIY	DESCRIPTION
C1, C7, C14, C16, C17, C24, C41, C50, C51, C55, C56, C57, C59, C60	14	100pF capacitors (0402) Murata GRP1555C1H101J
C2, C32	2	10nF capacitors (0402) Murata GRP155R71C103K
C3, C22	2	1000pF capacitors (0402) Murata GRP155R71H102K
C4, C5	2	$0\Omega$ resistors (0402)
C6, C27, C28, C33–C38, C40, C42, C44, C45, C48, C54, C58	16	100nF capacitors (0402) Murata GRP155R61A104K
C10–C13, C15, C23, C29, C30, C31	9	Not installed
C26	1	1µF capacitor (0603) Taiyo Yuden JMK107BJ105MA-B
C39, C43, C46, C47	4	10μF tantalum capacitors (2012) (R-code/case 0805-compatible) AVX TAJR106K006
C49	1	47nF capacitor (0402) Murata GRP155R71A473K
C52	1	4.7nF capacitor (0402) Murata GRP155R71H472K
C53	1	39pF capacitor (0402) Murata GRP1555C1H390J
C89	1	0.1µF capacitor (0805) Murata GRM21BR71E104K
C90	1	1.0μF capacitor (1206) Murata GRM31MR71C105MA01L
C101	1	0.01µF capacitor (0805) Murata GRM216R71H103K
L1	1	3.3nH inductor (0402) Coilcraft 0402CS_3N3X
L2	1	Open inductor (0402) (not
L4	1	1.8nH inductor (0402) TOKO LL1005-FH1N8S
L5	1	1.3pF capacitor (0402) Murata GRP1555C1H1R3B
R2, R10, R11, R16, R17	5	$0\Omega$ resistors (0402)
R7, R22	2	Open resistors (0402) (not installed)
R8	1	$100\Omega$ resistor (0402)
R9, R18	2	10k $\Omega$ resistors (0402)

#### Component List—MAX2396

DECIONATION	-	DESODIBTION
DESIGNATION	QIY	DESCRIPTION
R12, R15	2	$50\Omega$ resistors (0402)
R13, R14	2	2.0pF capacitors (0402)
R19, R25	2	1k $Ω$ resistors (0402)
R23	1	$330\Omega$ resistor (0402)
RBIAS	1	$12k\Omega \pm 1\%$ resistor (0402)
AGC, TCXO	2	10k $\Omega$ variable resistors
BG, CSB, I+, I-, LOCK, Q+, Q-, TAGC, TUNE	9	Digi-Key 5000K-ND
FL1	1	2140MHz saw filter (2140MHz) Murata SAFSD2G14FA0T00R00
GND, GND2, GND3, JU37, JU38, VCC_EXT, VCC_IC	7	_
G_LNA, G_MXR, SHDNB	3	Open
I, Q	2	BNC (50Ω) PC board receptacles (jacks) Amphenol 31-5239-52RFX
J9	1	—
JU20, JVCO, VCC_BB, VCC_CP, VCC_DIG, VCC_LNA, VCC_LOGIC, VCC_MXR, VCC_REF, VCC_TCXO, VCC_VCO	11	Open
LD	1	
LNA_IN, LNA_OUT, LO_TEST, MXR_IN, REF_IN	5	SMA end launch jack receptacles 0.031in Johnson Components 142-0701-881
U1	1	MAX2396EGI WCDMA receiver
U2	1	Open broadband RF balun (not installed) TDK HHM1537
U3, U4	2	MAX4444 low-distortion, differential-to-single-ended line drivers
U5	1	Frac-N sigma delta synthesizer MAX2150EGI
U9	1	MAX8867EUK28 linear regulator
Y1	1	15.36MHz voltage-controlled TCXO (19.2MHz) Kinseki VC-TCXO-208C3-15.36

Evaluate: MAX2390-MAX2393/MAX2396/MAX2400

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DESIGNATION	QTY	DESCRIPTION
C1, C4, C5, C13, C23, C24, C26, C29, C30, C31, C41, C42, C50, C51, C53– C60	22	<b>Open, leave site open</b> 0402 capacitors
C2, C32	2	0.01µF ±10% 0402 capacitors Murata GRM155R71C103K
C3, C9, C22	3	1000pF ±10% 0402 capacitors Murata GRM155R71H102K
C6, C8, C27, C28, C33–C38, C40, C44, C45, C48	14	0.1µF ±10% 0402 capacitors Murata GRM155R61A104K
C7, C12, C14–C17	6	100pF ±5% 0402 capacitors Murata GRM1555C1H101J
C18	1	10pF ±0.1pF 0402 capacitor Murata GRM1555C1H100B
C39, C43, C46, C47	4	10µF ±10% tantalum capacitors R-case AVX TAJR106K006
C49	1	2200pF ±10% 0402 capacitor Murata GRM155R71H222K
C52	1	220pF ±5% 0402 capacitor Murata GRM1555C1H221J
C89	1	0.1µF ±10% 0805 capacitor Murata GRM21BR71E104K
C90	1	1.0μF ±10% 1206 capacitor Murata GRM31MR7C105K
C97, C99	2	2.0pF ±0.1pF 0402 capacitors Murata GRM1555C1H2R0B
C98	1	1.6pF±0.1pF0402 capacitor Murata GRM1555C1H1R6B
C101	1	0.01µF±10% 0805 capacitor Murata GRM216R71H103K
L1	1	10nH ±5% 0402 inductor Murata LQG15HN10NJ00
L2	1	<b>Open</b> 0402 inductor leave site open Coilcraft
L4	1	2.7nH ±0.3nH 0402 inductor TOKO LL1005-FH2N7S

#### Component List—MAX2390

DESIGNATION	QTY	DESCRIPTION
R1, R2, R3, R10, R11, R16, R17, R25	8	$0\Omega \pm 5\%$ 0402 resistors
R4, R7	2	<b>Open</b> 0402 resistors
R8	1	$100\Omega \pm 5\%$ 0402 resistor
R9, R18	2	10k $\Omega$ ±5% 0402 resistors
R12, R15	2	$49.9\Omega \pm 1\%$ 0402 resistors
R19	1	1k $\Omega$ ±5% 0402 resistor
R22	1	100k $\Omega$ ±5% 0402 resistor
R23	1	$6.8$ k $\Omega$ ±5% 0402 resistor
RBIAS	1	12.1k $\Omega$ ±1% 0402 resistor
AGC, TCXO	2	10kΩ variable resistors Bourns 3296W-103-ND
ĒN, BG, CSB, LD/IDLEB, LOCK, Q-, TAGC, TUNE, I+, I-, Q+	11	Test points Keystone 5000
FL1	1	Filter Infineon NWR190
G_LNA, G_MXR, SHDNB	3	<b>Do not install</b> 4-pin headers Sullins PTC36SAAN
I, Q	2	BNC connectors Amphenol 31-5329-52RFX
J9	1	2 x 10 header, dual in-line header, 100-mil center Sullins PTC36DAAN
JIDLEB	1	1 x 3 header, 3-pin in-line header, 100-mil center Sullins PTC36SAAN
JIDLEB	1	Shunt, shorting jumper Sullins STC02SYAN
JU20, JVCO, LD, VCC_BB, VCC_DIG, VCC_LNA, VCC_LOGIC, VCC_MXR, VCC_PLL, VCC_REF, VCC_TCXO, VCC_VCO	12	<b>Do not install</b> 1 x 2 headers, 2-pin in-line headers, 100-mil centers Sullins PTC36SAAN
GND2, GND3, VCC_EXT, VCC_IC	7	headers, 100-mil centers Sullins PTC36SDAAN



DESIGNATION	QTY	DESCRIPTION
LNA_IN, LNA_OUT, MXR_IN, REF_IN, LO_OUT/LO_TEST	5	SMA edge-mount connectors, round contacts Johnson 142-0701-801
U1	1	Maxim MAX2390EGI
U2	1	Balun TDK HHM1516
U3, U4	2	Maxim MAX4444ESE

#### \_Component List—MAX2390 (continued)

DESIGNATION	QTY	DESCRIPTION
U5	1	<b>Do not install</b> Maxim MAX2150ETI
U9	1	Maxim MAX8867EUK28
Y1	1	19.2MHz crystal Kenseki VC-TCXO-208C5-19P2
None	1	MAX2390/MAX2400 EV kit PC board, rev 2

#### DESIGNATION QTY DESCRIPTION Open C1, C4, C8, C9, C13, 9 Leave site open C18, C23, C29, C31 0402 capacitors 0.01µF ±10% 0402 capacitors C2, C32 2 Murata GRM155R71C103K 1000pF ±10% 0402 capacitors C3, C22 2 Murata GRM155R71H102K C5, C7, C12, C14-C17, C24, C30, 100pF ±5% 0402 capacitors 17 C41, C50, C51, C55, Murata GRM1555C1H101J C56, C57, C59, C60 C6, C27, C28, C33-C38, C40, 0.1µF ±10% 0402 capacitors 16 C42, C44, C45, Murata GRM155R61A104K C48, C54, C58 1.0µF ±10% 0603 capacitor C26 1 Murata GRM188R60J105K 10µF ±10% tantalum C39, C43, C46, C47 4 capacitors R-case AVX TAJR106K006 0.047µF ±10% 0402 capacitor C49 1 Murata GRM155R71A473K 4700pF ±10% 0402 capacitor C52 1 Murata GRM155R71H472K 39pF ±5% 0402 capacitor C53 1 Murata GRM1555C1H390J 0.1µF ±10% 0805 capacitor C89 1 Murata GRM21BR71E104K 1.0µF ±10% 1206 capacitor C90 1 Murata GRM31MR7C105K 2.0pF ±0.1pF 0402 capacitors 2 C97, C99 Murata GRM1555C1H2R0B

#### Component List—MAX2400

DESIGNATION	QTY	DESCRIPTION
C98	1	1.6pF ±0.1pF 0402 capacitor Murata GRM1555C1H1R6B
C101	1	0.01µF ±10% 0805 capacitor Murata GRM216R71H103K
L1	1	10nH ±5% 0402 inductor Murata LQG15HN10NJ00
L2	1	<b>Open</b> 0402 inductor leave site open Coilcraft
L4	1	2.7nH ±0.3nH 0402 inductor TOKO LL1005-FH2N7S
R1, R3, R7, R22	4	<b>Open</b> 0402 resistors
R2, R4, R10, R11, R16, R17	6	$0\Omega \pm 5\%$ 0402 resistors
R8	1	$100\Omega \pm 5\%$ 0402 resistor
R9, R18	2	10k $\Omega$ ±5% 0402 resistors
R12, R15	2	49.9 $\Omega$ ±1% 0402 resistors
R19, R25	2	1k $\Omega$ ±5% 0402 resistors
R23	1	$330\Omega \pm 5\%$ 0402 resistor
RBIAS	1	12.1k $\Omega$ ±1% 0402 resistor
AGC, TCXO	2	10kΩ variable resistors Bourns 3296W-103-ND
EN, BG, CSB, LD/IDLEB, LOCK, Q-, TAGC, TUNE, I+, I-, Q+	11	Test points Keystone 5000
FL1	1	Filter Infineon NWR190
G_LNA, G_MXR, SHDNB	3	<b>Do not install</b> 4-pin headers Sullins PTC36SAAN

Evaluate: MAX2390-MAX2393/MAX2396/MAX2400

DESIGNATION	QTY	DESCRIPTION
I, Q	2	BNC connectors Amphenol 31-5329-52RFX
J9	1	2 x 10 header, dual in-line header, 100-mil center Sullins PTC36DAAN
JIDLEB	1	1 x 3 header, 3-pin in-line header, 100-mil center Sullins PTC36SAAN
JIDLEB	1	Shunt, shorting jumper Sullins STC02SYAN
JU20, JVCO, LD, VCC_BB, VCC_DIG, VCC_LNA, VCC_LOGIC, VCC_MXR, VCC_PLL, VCC_REF, VCC_TCXO, VCC_VCO	12	<b>Do not install</b> 1 x 2 headers, 2-pin in-line headers, 100-mil centers Sullins PTC36SAAN

#### Component List—MAX2400 (continued)

DESIGNATION	QTY	DESCRIPTION
JU37, JU38, GND, GND2, GND3, VCC_EXT, VCC_IC	7	1 x 2 headers, 2-pin in-line headers, 100-mil centers Sullins PTC36SDAAN
LNA_IN, LNA_OUT, MXR_IN, REF_IN, LO_OUT/LO_TEST	5	SMA edge-mount connectors, round contacts Johnson 142-0701-801
U1	1	Maxim MAX2400EGI
U2	1	Balun TDK HHM1516
U3, U4	2	Maxim MAX4444ESE
U5	1	Maxim MAX2150ETI
U9	1	Maxim MAX8867EUK28
Y1	1	15.36MHz crystal Kinseki VC-TCXO-208C5-15.36
None	1	MAX2390/MAX2400 EV kit PC board, rev 2

#### **Component Suppliers**

SUPPLIER	PHONE	WEBSITE
Amhenol	203-265-8900	www.amphenolrf.com
Coilcraft	800-322-2645	www.coilcraft.com
Digi-Key	800-344-4539	www.digikey.com
Johnson	507-833-8822	www.johnsoncomponents.com
KSS Kinseki	(see website)	www.kinseki.co.jp/eng
Mini-Circuits	718-934-4500	www.minicircuits.com
Murata	770-436-1300	www.murata.com
Taiyo Yuden	800-322-2496	www.t-yuden.com
TDK	847-803-6100	www.component.tdk.com
ТОКО	(see website)	www.toko.com

Note: When contacting these suppliers, please indicate you are using the MAX2390-MAX2393/MAX2396/MAX2400.

#### Quick Start—MAX2391/ \_\_\_\_MAX2392/MAX2393

The MAX2391/MAX2392/MAX2393 EV kits are fully assembled and factory tested. Follow the instructions in the *Connections and Setup* section for proper device evaluation.

#### **Test Equipment Required**

This section lists the recommended test equipment to verify the operation of the MAX2391/MAX2392/MAX2393 EV kits. It is intended as a guide only, and some substitutions are possible.

- DC supply capable of delivering 200mA continuous current at +5.0V
- DC supply capable of delivering 200mA continuous current at -5.0V
- DC supply capable of delivering 50mA continuous current at +2.8V
- HP 34401 or equivalent DMM, to measure IC supply current
- HP 8648C or equivalent signal source capable of generating -30dBm up to 2.2GHz
- HP 8561E or equivalent RF spectrum analyzer (baseband spectrum only)
- TDS 3012 or equivalent digitizing oscilloscope
- Windows® 95/98/2000 PC with an available parallel port

#### **Connections and Setup**

This section provides a step-by-step guide to testing the basic functionality of the EV kits.

This procedure is specific to the MAX2391 in the UMTS band (reverse channel: 2110MHz to 2170MHz). Adapt the procedure for the MAX2392 or MAX2393 by changing the RF frequency of the test tone to suit the band of interest. The test tone at a 180kHz offset works well for all three parts.

- Install the MAX2391/MAX2392/MAX2393 control software on the PC. This software uses a 3rd-party DLL to allow communication through the parallel port: "DriverLINX" by Scientific Software Tools (www.sstnet.com). The Maxim installer installs this DLL automatically.
- 2) Connect the interface board and cable from the PC parallel port to the EV kit header. Pin 1 on the ribbon cable is indicated with a stripe, and pin 1 on the header is nearest to the corner of the board. The interface board is just populated with logic

Windows is a registered trademark of Microsoft.



buffers to protect the parallel port against accidental shorts, but be careful with these connections.

- Calibrate the power meter, with the low-power head, at 2140MHz. A rough interpolation of the cal factor does not introduce noticeable error, if reading the cal factor from a table.
- 4) Set the signal generator for a 2140.18MHz CW (demodulated) output at -27dBm, and connect a 3dB pad to the DUT side of the SMA cable. Use the power meter to set the input power to the DUT at -30dBm. Use measured attenuators and/or the signal generator's internal step attenuators (-40dB) to reduce the signal to -90dBm.
- 5) Connect the RF source's SMA cable and attenuators to the EV kit's LNA IN SMA input.
- 6) Connect the BNC cable from either I or Q to the spectrum analyzer. Connect the other output into the oscilloscope—be sure to set the oscilloscope's inputs to  $50\Omega$ , and not  $1M\Omega$ . Cable loss at 180kHz is negligible; as long as cables are about the same length, no calibration is required at the output to observe proper signal level as well as proper I/Q gain-and-phase balance.
- 7) Set one of the DC supplies to 2.8V and set a current limit of 100mA (if available). Connect this supply through the ammeter to VCC\_IC, and readjust the supply if necessary to get 2.8V at the IC when powered up. This supply connection only powers the IC on the EV kit—read the ammeter to watch IC supply current for the receiver. Connect another line directly from the 2.8V supply to VCC\_EXT to supply the external logic on the kit. Not having the voltage drop of the ammeter inline means the voltage is slightly higher than VCC\_IC, but this does not cause a problem.
- 8) Set the other supplies for ±5.0V with a current limit of about 100mA. Connect these supplies to the +5V, GND, and -5V on the opposite side of the kit. These are the bipolar supplies for the MAX4444 differential line drivers that buffer the I/Q outputs. Note that all GND test points are connected to the same ground plane—it is only necessary to use one of them.
- Set the spectrum analyzer to span from DC (minimum sweep) to 2MHz. Set the reference level to +10dBm.
- Set the oscilloscope for a sweep rate of about 1µs/div, DC-coupling, with an amplitude scale of about 100mV/div.

#### **Testing the W-CDMA Receiver**

The power-up default state of the MAX2391 receiver is for:

- LO midband (2140MHz)
- LNA high gain
- Mixer high gain, normal linearity
- Powered on (out of shutdown)
- 1) Verify that the IC itself is drawing about 32mA (from VCC\_IC). The two MAX4444 differential line drivers at the baseband outputs should draw about 80mA from each of their supplies.
- 2) Use the AGC adjust potentiometer on the board to set VAGC at +2.2V (maximum gain).
- 3) Spot-check the VCO tuning voltage (TUNE) to see that the synthesizer is locked. The voltage should be about midsupply with the RF LO running at its power-up default of 2140MHz. Disconnect any leads from this before continuing, as the noise pickup onto the tuning line directly frequency-modulates the VCO, and degrades LO phase noise.
- 4) Observe the 180kHz tone on the spectrum analyzer. Adjust AGC to achieve a -3.5dBm output level.
- 5) The on-board TCXO has a fine-tuning control—the other potentiometer on the EV kit allows for external temperature compensation of the TCXO to further decrease frequency error. Adjust the TCXO potentiometer if desired to bring the output tone exactly to 180kHz.
- 6) Observe the other output on the oscilloscope. At these input power levels, the SNR is typically much too low to see the output tone through the noise. If available, use the internal lowpass filter option (often 20MHz) and lots of averaging.
- 7) To make a gain/phase error measurement, connect both outputs to the scope. Increase the input power to about -50dBm, and back off the AGC until the outputs are swinging about 0.42VP-P. Again, use digital averaging to get both I and Q sinusoids visible on the scope. If automated measurements for phase and amplitude are not available, use the cursors to make the measurement. Calculate phase error in degrees and gain error in decibels, and verify that the results are better than 2 degrees and 0.6dB, respectively.

#### Quick Start—MAX2396

The MAX2396 EV kit is fully assembled and factory tested. Follow the instructions in the *Connections and Setup* section for proper device evaluation.

#### **Test Equipment Required**

This section lists the recommended test equipment to verify the operation of the MAX2396 EV kit. It is intended as a guide only, and substitutions are possible:

- DC supply capable of delivering 200mA continuous current at +5.0V
- DC supply capable of delivering 200mA continuous current at -5.0V
- DC supply capable of delivering 50mA continuous current at +2.8V
- DMM, to measure IC supply current
- HP 8648C or equivalent signal source capable of generating -30dBm up to 2.2GHz
- HP 8561E or equivalent RF spectrum analyzer
- TDS 3012 or equivalent digitizing oscilloscope
- Windows 95/98/2000 PC with an available parallel port

#### **Connections and Setup**

This section provides a step-by-step guide to testing the basic functionality of the EV kit:

- Install the MAX2396 control software on a PC. This software uses a 3rd-party DLL to allow communication through the parallel port: "DriverLINX" by Scientific Software Tools (<u>www.sstnet.com</u>). The Maxim installer installs this DLL automatically.
- 2) Connect the interface board and cable from the PC parallel port to the EV kit header. Pin 1 on the ribbon cable is indicated with a stripe, and pin 1 on the header is nearest to the corner of the board. The interface board is just populated with logic buffers to protect the parallel port against accidental shorts, but be careful with these connections.
- 3) Calibrate the power meter, with the low-power head, at 2140MHz. A rough interpolation of the cal factor does not introduce noticeable error if reading the cal factor from a table.
- 4) Set the signal generator for a 2140.18MHz CW (demodulated) output at -27dBm, and connect a 3dB pad to the DUT side of the SMA cable. Use the power meter to set the input power to the DUT at -30dBm. Use measured attenuators and/or the signal generator's internal step attenuators (-40dB) to reduce the signal to -90dBm.
- 5) Connect the RF source's SMA cable and attenuators to the EV kit's LNA IN SMA input.
- 6) Connect the BNC cable from either I or Q to the spectrum analyzer. Connect the other output into the oscilloscope—be sure to set the oscilloscope's inputs to  $50\Omega$ , and not  $1M\Omega$ . Cable loss at 180kHz



is negligible; as long as cables are about the same length, no calibration is required at the output to observe proper signal level, as well as proper I/Q gain-and-phase balance.

- 7) Set one of the DC supplies to 2.8V and set a current limit of 100mA (if available). Connect this supply through the ammeter to VCC\_IC, and readjust the supply, if necessary, to get 2.8V at the IC when powered up. This supply connection only powers the IC on the EV kit—read the ammeter to watch IC supply current for the receiver. Connect another line directly from the 2.8V supply to VCC\_EXT to supply the external logic on the kit. Not having the voltage drop of the ammeter in line means the voltage is slightly higher than VCC\_IC, but this does not cause a problem.
- 8) Set the other supplies for ±5.0V with a current limit of about 100mA. Connect these supplies to the +5V, GND, and -5V on the opposite side of the kit. These are the bipolar supplies for the MAX4444 differential line drivers that buffer the I/Q outputs. Note that all GND test points are connected to the same ground plane—it is only necessary to use one of them.
- Set the spectrum analyzer to span from DC (minimum sweep) to 2MHz. Set the reference level to +10dBm.
- Set the oscilloscope for a sweep rate of about 1µs/div, DC-coupling, with an amplitude scale of about 100mV/div.

#### **Testing the WCDMA Receiver**

The power-up default state of the MAX2396 receiver is for:

- LNA high gain
- Mixer high gain, normal linearity
- Powered on (out of shutdown)
- Verify that the IC itself is drawing about 31mA (from VCC\_IC). The two MAX4444 differential line drivers at the baseband outputs should draw about 80mA from each of their supplies.
- Use the AGC adjust potentiometer on the board to set VAGC at +2.2V (maximum gain).
- 3) Spot-check the VCO tuning voltage (TUNE) to see that the synthesizer on the MAX2150 is locked. The voltage should be about midsupply with the RFLO running at its power-up default of 2140MHz. Disconnect any leads from this before continuing, as the noise pickup onto the tuning line directly frequency modulates the VCO, and degrades LO phase noise.

- 4) Observe the 180kHz tone on the spectrum analyzer. Adjust AGC to achieve a -3.5dBm output level.
- 5) The on-board TCXO has a fine-tuning control—the other potentiometer on the EV kit allows for external temperature compensation of the TCXO to further decrease frequency error. Adjust the TCXO potentiometer if desired to bring the output tone exactly to 180kHz.
- 6) Observe the other output on the oscilloscope. At these input power levels, the SNR is typically much too low to see the output tone through the noise. If available, use the internal lowpass filter option (often 20MHz) and lots of averaging.
- 7) To make a gain/phase error measurement, connect both outputs to the scope. Increase the input power to about -50dBm, and back off the AGC until the outputs are swinging about 0.42Vp-p. Again, use digital averaging to get both I and Q sinusoids visible on the scope. If automated measurements for phase and amplitude are not available, use the cursors to make the measurement. Calculate phase error in degrees and gain error in decibels, and verify that the results are better than 2 degrees and 0.6dB, respectively.

#### Quick Start—MAX2390/ \_\_\_\_\_MAX2400

The MAX2390/MAX2400 EV kit is fully assembled and factory tested. Follow the instructions in the *Connections and Setup* section for proper device evaluation.

#### **Test Equipment Required**

This section lists the recommended test equipment to verify the operation of the MAX2390/MAX2400 EV kit. It is intended as a guide only, and substitutions are possible:

- DC supply capable of delivering 200mA continuous current at +5.0V
- DC supply capable of delivering 200mA continuous current at -5.0V
- DC supply capable of delivering 50mA continuous current at +2.8V
- DMM, to measure IC supply current
- HP 8648C or equivalent signal source capable of generating -30dBm up to 2.0GHz
- HP 8561E or equivalent RF spectrum analyzer
- TDS 3012 or equivalent digitizing oscilloscope
- Windows 95/98/2000 PC with an available parallel port

#### **Connections and Setup**

This section provides a step-by-step guide to testing the basic functionality of the EV kit:

- Install the MAX2391/MAX2392/MAX2393 and MAX2396 control software on a PC for MAX2390 and MAX2400, respectively. This software uses a 3rd-party DLL to allow communication through the parallel port: "DriverLINX" by Scientific Software Tools (<u>www.sstnet.com</u>). The Maxim installer installs this DLL automatically.
- 2) Connect the interface board and cable from the PC parallel port to the EV kit header. Pin 1 on the ribbon cable is indicated with a stripe, and pin 1 on the header is nearest to the corner of the board. The interface board is populated with logic buffers to protect the parallel port against accidental shorts, but be careful with these connections.
- Calibrate the power meter, with the low-power head, at 1960MHz. A rough interpolation of the cal factor does not introduce noticeable error if reading the cal factor from a table.
- 4) Set the signal generator for a 1960.18MHz CW (demodulated) output at -27dBm, and connect a 3dB pad to the DUT side of the SMA cable. Use the power meter to set the input power to the DUT at -30dBm. Use measured attenuators and/or the signal generator's internal step attenuators (-40dB) to reduce the signal to -90dBm.
- Connect the RF source's SMA cable and attenuators to the EV kit's LNA IN SMA input.
- 6) Connect the BNC cable from either I or Q to the spectrum analyzer. Connect the other output into

the oscilloscope—be sure to set the oscilloscope's inputs to  $50\Omega$ , and not  $1M\Omega$ . Cable loss at 180kHz is negligible; as long as cables are about the same length, no calibration is required at the output to observe proper signal level, as well as proper I/Q gain-and-phase balance.

- 7) Set one of the DC supplies to 2.8V and set a current limit of 100mA (if available). Connect this supply through the ammeter to VCC\_IC, and readjust the supply, if necessary, to get 2.8V at the IC when powered up. This supply connection only powers the IC on the EV kit. Read the ammeter to watch IC supply current for the receiver. Connect another line directly from the 2.8V supply to VCC\_EXT to supply the external logic on the kit. Not having the voltage drop of the ammeter in line means the voltage is slightly higher than VCC\_IC, but this does not cause a problem.
- 8) Set the other supplies for ±5.0V with a current limit of about 100mA. Connect these supplies to the +5V, GND, and -5V on the opposite side of the kit. These are the bipolar supplies for the MAX4444 differential line drivers that buffer the I/Q outputs. Note that all GND test points are connected to the same ground plane—it is only necessary to use one of them.
- Set the spectrum analyzer to span from DC (minimum sweep) to 2MHz. Set the reference level to +10dBm.
- Set the oscilloscope for a sweep rate of about 1µs/div, DC-coupling, with an amplitude scale of about 100mV/div.

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#### **Testing the WCDMA Receiver**

The power-up default state of the MAX2390/MAX2400 receivers is for:

- LO midband, 1960MHz (MAX2390 only)
- LNA high gain
- Mixer high gain, normal linearity
- Powered on (out of shutdown)

The MAX2390 uses the control s/w for the MAX2391/ MAX2392/MAX2393. Keep in mind that the s/w has different default states for the PLL counters than the IC's own power-up state. This means that the LO frequency needs to be programmed after the s/w is launched to be sure that the MAX2390 is tuned to 1960MHz.

Likewise, the MAX2400 uses the control s/w for the MAX2396. Again, the s/w assumes the same power-up defaults as the MAX2396, which are slightly different than the MAX2400. Be sure to go to the MAX2150 tab to program the synthesizer to 1960MHz.

- Verify that the IC itself is drawing about 31mA (from VCC\_IC). The two MAX4444 differential line drivers at the baseband outputs should draw about 80mA from each of their supplies.
- 2) Use the AGC adjust potentiometer on the board to set VAGC at +2.2V (maximum gain).
- Spot-check the VCO tuning voltage (TUNE) to see that the synthesizer (internal for the MAX2390, the MAX2400 uses the synthesizer on the MAX2150). The voltage should be about midsupply with the

RFLO running at center-of-band at 1960MHz. Reprogram the synthesizer registers if required. Disconnect any leads from this before continuing, as the noise pickup onto the tuning line directly frequency modulates the VCO, and degrades LO phase noise.

- 4) Observe the 180kHz tone on the spectrum analyzer. Adjust AGC to achieve a -3.5dBm output level.
- 5) The on-board TCXO has a fine-tuning control—the other potentiometer on the EV kit allows for external temperature compensation of the TCXO to further decrease frequency error. Adjust the TCXO potentiometer, if desired, to bring the output tone exactly to 180kHz.
- 6) Observe the other output on the oscilloscope. At these input power levels, the SNR is typically much too low to see the output tone through the noise. If available, use the internal lowpass filter option (often 20MHz) and lots of averaging.
- 7) To make a gain/phase error measurement, connect both outputs to the scope. Increase the input power to about -50dBm, and back off the AGC until the outputs are swinging about 0.42VP-P. Again, use digital averaging to get both I and Q sinusoids visible on the scope. If automated measurements for phase and amplitude are not available, use the cursors to make the measurement. Calculate phase error in degrees and gain error in decibels, and verify that the results are better than 2 degrees and 0.6dB, respectively.



Figure 1a. MAX2391 EV Kit Schematic—Main Circuit (Sheet 1 of 4)



Figure 1b. MAX2392 EV Kit Schematic—Main Circuit (Sheet 2 of 4)

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Figure 1c. MAX2393 EV Kit Schematic—Main Circuit (Sheet 3 of 4)





Figure 2a. MAX2396 EV Kit Schematic—Main Circuit (Sheet 1 of 3)



Figure 2b. MAX2396 EV Kit Schematic—Differential Line Drivers and Supplies (Sheet 2 of 3)



Figure 2c. MAX2396 EV Kit Schematic—MAX2150 Synthesizer (Sheet 3 of 3)





Figure 3a. MAX2390 EV Kit Schematic—Main Circuit (Sheet 1 of 3)



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Figure 3b. MAX2390 EV Kit Schematic—Differential Line Drivers and Supplies (Sheet 2 of 3)



Figure 3c. MAX2390 EV Kit Schematic—MAX2150 Synthesizer, Unused (Sheet 3 of 3)





Figure 3d. MAX2400 EV Kit Schematic—Main Circuit (Sheet 1 of 3)



Figure 3e. MAX2400 EV Kit Schematic—Differential Line Drivers and Supplies (Sheet 2 of 3)



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#### \_PC Board Artwork—MAX2391/MAX2392/MAX2393

Figure 4a. MAX2391/MAX2392/MAX2393 EV Kit Component Placement Guide—Top Silkscreen



Evaluate: MAX2390-MAX2393/MAX2396/MAX2400



Figure 4b. MAX2391/MAX2392/MAX2393 EV Kit Metal Layer 2—Top Solder Mask



Figure 4c. MAX2391/MAX2392/MAX2393 EV Kit PC Board Layout Metal Layer 2—Top Layer Metal



Figure 4d. MAX2391/MAX2392/MAX2393 EV Kit PC Board Layout—Metal Layer 2 (Ground)



Figure 4e. MAX2391/MAX2392/MAX2393 EV Kit PC Board Layout—Metal Layer 3 (Routes)



Figure 4f. MAX2391/MAX2392/MAX2393 EV Kit PC Board Layout—Bottom Layer Metal



Figure 4g. MAX2391/MAX2392/MAX2393 EV Kit PC Board Layout—Bottom Solder Mask



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#### \_PC Board Artwork—MAX2396

Figure 5a. MAX2391/MAX2392/MAX2393 EV Kit Component Placement Guide—Top Silkscreen

Evaluate: MAX2390-MAX2393/MAX2396/MAX2400



Figure 5b. MAX2391/MAX2392/MAX2393 EV Kit PC Board Layout Metal Layer 2—Top Layer Metal



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Evaluate: MAX2390-MAX2393/MAX2396/MAX2400



Figure 5d. MAX2391/MAX2392/MAX2393 EV Kit PC Board Layout—Metal Layer 3 (Routes)

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Evaluate: MAX2390-MAX2393/MAX2396/MAX2400



Figure 5e. MAX2391/MAX2392/MAX2393 EV Kit PC Board Layout—Bottom Layer Metal





#### \_PC Board Artwork—MAX2390/MAX2400

Figure 6a. MAX2390/MAX2400 EV Kit Component Placement Guide—Top Silkscreen

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Evaluate: MAX2390-MAX2393/MAX2396/MAX2400



Figure 6b. MAX2390/MAX2400 EV Kit PC Board Layout Metal Layer 2-Top Layer Metal



Figure 6c. MAX2390/MAX2400 EV Kit PC Board Layout—Metal Layer 2 (Ground)

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Evaluate: MAX2390-MAX2393/MAX2396/MAX2400



Figure 6d. MAX2390/MAX2400 EV Kit PC Board Layout—Metal Layer 3 (Routes)



Figure 6e. MAX2390/MAX2400 EV Kit PC Board Layout—Bottom Layer Metal

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Figure 6f. MAX2390/MAX2400 EV Kit PC Board Layout—Bottom Silkscreen

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