

## MAX2223 Evaluation Kit

Evaluates: MAX2223

### General Description

The MAX2223 evaluation kit (EV kit) simplifies evaluation of the MAX2223. The MAX2223 is a low-cost, direct-conversion tuner IC designed for satellite set-top and Very Small Aperture Terminal (VSAT) applications. The device directly converts the satellite signals from the LNB to baseband using a broadband I/Q down-converter. The operating frequency range extends from 925MHz to 2175MHz. The device supports an RF bandwidth of 1GHz.

This EV kit is a complete broadband satellite tuner DVB-S2 RF front-end solution. It enables testing of the device performance and requires no additional support circuitry. Standard 50Ω SMA connectors are included on the EV kit for the inputs and outputs to allow for quick and easy evaluation on the lab bench. The MAX2223 evaluation kit contains a microcontroller (MCU) that uses a 2-wire I<sup>2</sup>C-compatible serial interface to configure internal registers and modes. A Graphical User Interface (GUI) software running on a computer connected via USB makes it simple to program and control the device operation. The evaluation kit is fully assembled and tested at the factory.

This document provides a bill of materials, a list of equipment required to evaluate the device, a straightforward test procedure to verify functionality, a description of the EV kit circuit, the circuit schematic, and artwork for each layer of the printed circuit board (PCB).

### Features

- Easy Evaluation of the MAX2223 IC
- Single 3.3V ± 5% Supply for IC
- On-Board 5V ± 5% DAC for Gain Control
- 925MHz to 2175MHz Operating Frequency Range
- 50Ω SMA Connectors for the RF Ports and the Baseband Outputs
- All Critical Peripheral Components Included
- Micro USB Port for Interfacing with a PC
- PC Control Software (Available at [www.maximintegrated.com/evkitsoftware](http://www.maximintegrated.com/evkitsoftware))

Ordering Information appears at end of data sheet.

## Quick Start

### Required Equipment

This section lists the recommended test equipment to verify operation of the MAX2223. It is intended as a guide only and some substitutions are possible.

- One RF signal generator capable of delivering minimum -75dBm up to 3.0GHz (Keysight N5182B or equivalent)
- An RF spectrum analyzer with a range of 100kHz to 3.0GHz (Keysight N9020A or equivalent)
- A dual power supply capable of up to 250mA at 3.3V  $\pm 5\%$  on one channel, 15mA at 5V  $\pm 5\%$  on the other.
- One digital multi-meter for measuring the supply current (Keysight 34461A or equivalent) (optional).
- 50 $\Omega$  coaxial RF cables with SMA connectors.
- A user-supplied Windows 10 based PC.

### Procedure

This section provides a step-by-step guide to operating the EV kit and testing the device functions. The EV kit is fully assembled and tested. Follow the instructions in the Connections and Setup section for proper device evaluation.

**Caution: Do not turn on the DC power or RF signal generators until all connections are completed.**

## Detailed Description of Hardware and Software

The EV kit hosts a MAX32625 microcontroller platform, and also a MAX515 serial 10-Bit DAC along with the MAX2223. The purpose of microcontroller is to program the registers of MAX2223 and the DAC. The DAC is used to generate an on-board analog RF gain control voltage.

### Measurement Considerations

The EV kit includes on-board matching circuitry at the MAX2223 RF input to convert the 50 $\Omega$  source to a 75 $\Omega$  IC input. Note that the input power to the device must be adjusted to account for the 6dB power loss of the matching resistor network.

### Download the MAX2223 EV Kit Software

- Download the MAX2223 EV kit software from the link, run the installation file and install it.
- Run the MAX2223 EV kit software through the desktop icon to open the GUI.

**Note that the GUI will only run on Window 10 PCs.**

### Powering and Connecting the EV Kit

- Verify that all jumpers are in place. Jumper VCC\_VCO should be shorted. J2 should be shorted if one wants to use the on-board DAC to control the RF gain. In this case, one should not apply any voltage on the **EXT\_GC** pin. Pins 2-3 of J5 should be connected for default addressing.
- With its output disabled, connect a 3.3V power supply to the VCC and GND test points through an ammeter. If available, set the current limit to 200mA. One should account for the IR voltage drop through the ammeter and adjust the power supply to get 3.3V at the EV kit power supply test pins.
- If using an external power supply to provide the RF gain control voltage ( $V_{GC1}$ ), then also connect a power supply between the EXT\_GC and GND pins of the EV kit. Set the gain control voltage to 0.5V, but leave the supply powered off for now.
- Connect the MAX2223 EV kit to the PC running the GUI through the USB cable, and power on the EV kit (apply +3.3V power supply to the VCC and GND test points). A green LED on the MCU module should be blinking green about once per second. It will occasionally change momentarily to a blue color but will be blinking green most of the time.
- Double-click on the *Max2223 EVKIT GUI.exe* icon which will be on the desktop in order to start the GUI. One should see that the EV kit is connected by the *Connected* message at the bottom-right corner of the GUI display. See [Figure 1](#).
- After opening the GUI, there are two tabs: Block Diagram and Register View. The block diagram shows a block diagram of the IC. One can change various widgets such as the LO Frequency, and the corresponding registers will be automatically updated. The Register View allows one to read and write the register contents directly.
- The default LO frequency is 950MHz. After inputting a new value, press either the Tab key or the Enter key for the new value to take effect. Note that in the initial state, the PLL Lock box is not illuminated. This test procedure assumes the LO frequency is left at 950MHz.
- To see the lock status of the PLL, simply left mouse click on the *PLL Lock* box in order to enable it. A check mark will appear in the box if it is enabled. If everything is functioning normally, one should see the GUI change to resemble [Figure 1](#). Note that the *PLL Lock* widget is now illuminated green and one of

the four green bars in the center of the strip of ADC lock status indicators should be illuminated. The supply current from the 3.3V  $V_{CC}$  supply should read approximately 135mA.

- Using the *Register View* tab, program register 0x9 to have a value of 0x05.
- With its output disabled, set the RF signal generator to a 955MHz frequency at -69dBm to account for the 6dB resistive pad loss. When measuring noise figure, this 6dB must also be accounted for by subtracting 6dB from the measured noise figure.
- Connect the output of the RF signal generator to the SMA connector labeled RF\_IN on the EV kit.
- Connect one IF output among the four (IOUT+/IOUT-/QOUT/QOUT-) to a spectrum analyzer.
- Terminate the opposite polarity with a 50Ω SMA terminator (e.g., if observing IOUT+, terminate IOUT-).
- Enable the output of the RF signal generator.
- Observe the baseband output at 5MHz with a tone power of about -14dBm on spectrum analyzer.

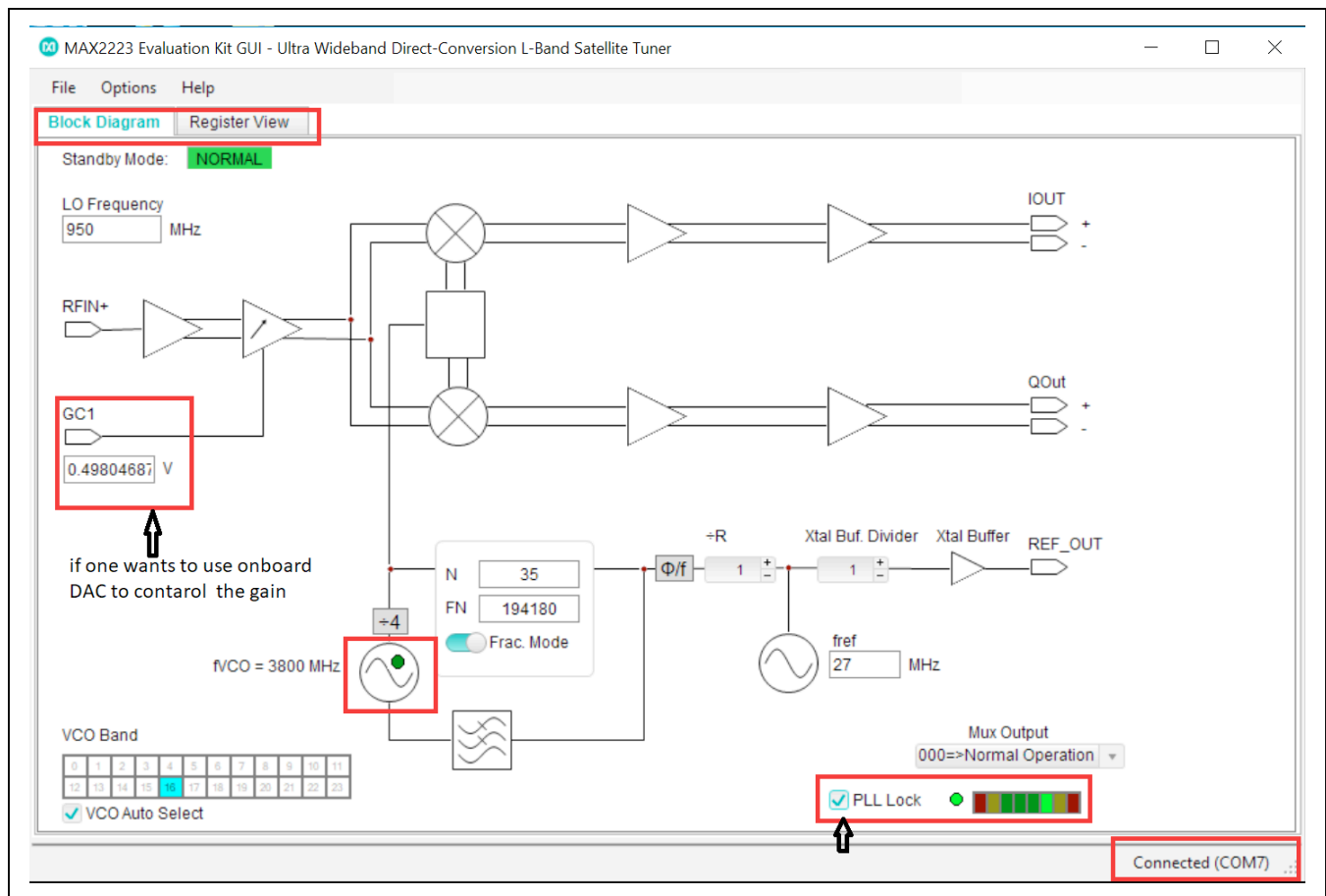


Figure 1. GUI View

**NOTE:** The RF gain control voltage ( $V_{GC1}$ ) can be set either by an external power supply or by using a DAC on the EV kit. If the on-board DAC is selected, then the voltage is set through the GC1 widget of the GUI Block Diagram window. Simply type in the desired voltage between 0.5V and 2.7V and hit Enter. It is recommended to probe the actual GC1 voltage with a multimeter and make small adjustments to the programmed voltage to compensate for any offsets that may exist.

## Layout Issues

A good PCB is an essential part of an RF circuit design. The EV kit PCB can serve as a guide for laying out a board using the devices. Keep traces carrying RF signals as short as possible to minimize radiation and insertion loss. Use impedance control on all RF signal traces. The exposed paddle must be soldered evenly to the board's ground plane for proper operation. Use abundant throughputs

beneath the exposed paddle and between RF traces to minimize undesired RF coupling. To minimize coupling between different sections of the IC, each VCC pin must have a bypass capacitor with low impedance to the closest ground at the frequency of interest. Do not share ground vias among multiple connections to the PCB ground plane. Refer to the *Layout Considerations* section of the MAX2223 IC data sheet for more information

## Component Suppliers

SUPPLIER	WEBSITE
Murata Mfg. Co., Ltd.	<a href="http://www.murata.com">www.murata.com</a>
Kemet Electronics Pvt Ltd	<a href="http://www.kemet.com">www.kemet.com</a>
Citizen America Corp.	<a href="http://www.citizencrystal.com">www.citizencrystal.com</a>
Keystone Electronics Corp	<a href="http://www.keyelco.com">www.keyelco.com</a>
Sullins Electronics Corp.	<a href="http://www.sullinselectronics.com">www.sullinselectronics.com</a>
Maxim Integrated	<a href="http://www.maximintegrated.com">www.maximintegrated.com</a>

## Ordering Information

PART	TYPE
MAX2223EVKIT#	EV Kit

#Denotes RoHS-compliant.

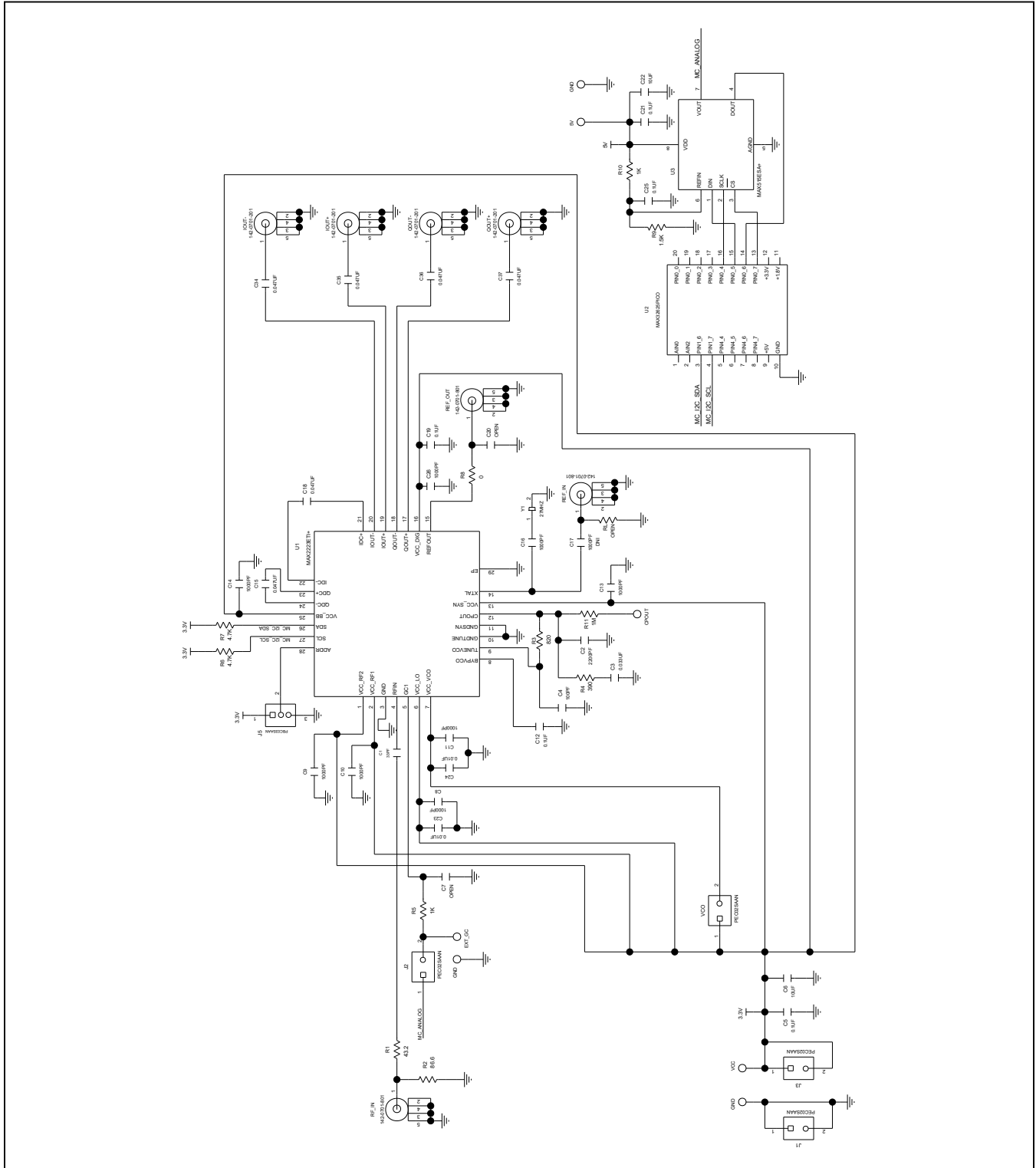
MAX2223 EV Kit Bill of Materials

ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION	COMMENTS
1	5V, EXT_GC	-	2	5005	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.35IN; BOARD HOLE=0.063IN; RED; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;	
2	C1	-	1	C1005C0G1H330J050BA; GRM1555C1H330JA01	TDK;MURATA	33PF	CAPACITOR; SMT; 0402; CERAMIC; 33pF; 50V; 5%; COG; -55degC to + 125degC; 0 +/-30PPM/degC	
3	C2	-	1	C0402X7R500-222KNE; GRM155R71H222KA01	VENKEL LTD.;MURATA	2200PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 2200PF; 50V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R	
4	C3	-	1	C0402C333K4RAC	KEMET	0.033UF	CAPACITOR; SMT; 0402; CERAMIC; 0.033uF; 16V; 10%; X7R; -55degC to + 125degC; 0 +/-15% degC	
5	C4	-	1	ECJ-0EB1H101K; CC0402KRX7R9BB101	PANASONIC;YAGEO PHYCOMP	100PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 100PF; 50V; TOL=10%; MODEL=ECJ SERIES; TG=-55 DEGC TO +125 DEGC; TC=X7R	
6	C5, C12, C19, C21, C25	-	5	CGA2B3X7R1H104K050BB; C1005X7R1H104K050BB; GRM155R71H104KE14; GCM155R71H104KE02; C1005X7R1H104K050BE; UMK105B7104KV-FR; CGA2B3X7R1H104K050BE	TDK;TDK;MURATA;MURATA; TDK;TAIYO YUDEN;TDK	0.1UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.1UF; 50V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R	
7	C6, C22	-	2	GRM155R60J106ME44; GRM155R60J106ME47; C1005X5R0J106M050BC; CL05A106MQ5NUN; C0402C106M9PAC	MURATA;MURATA;TDK; SAMSUNG ELECTRONICS;KEMET	10UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 10UF; 6.3V; TOL=20%; TG=-55 DEGC TO +85 DEGC; TC=X5R	
8	C8-C11, C13, C14, C16, C26	-	8	GRM155R71H102JA01	MURATA	1000PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 1000PF; 50V; TOL=5%; MODEL=GRM SERIES; TG=-55 DEGC TO +125 DEGC; TC=X7R	
9	C15, C18	-	2	C1005X7R1E473K050BC; GRM155R71E473K; GCM155R71E473KA55	TDK;MURATA;MURATA	0.047UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.047UF; 25V; TOL=10%; TG=-55 DEGC TO +125 DEGC	
10	C23, C24	-	2	C0402C103K5RAC; GRM155R71H103KA88; C1005X7R1H103K050BE; CL05B103KB5NNN	KEMET;MURATA;TDK; SAMSUNG ELECTRONIC	0.01UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.01UF; 50V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R	
11	C34-C37	-	4	C1005X7R1H473K; CGA2B3X7R1H473K050BB; GCM155R71H473KE02	TDK;TDK;MURATA	0.047UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.047UF; 50V; TOL=10%; MODEL=; TG=-55 DEGC TO +125 DEGC; TC=X7R	
12	CPOUT	-	1	5000	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; RED; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;	
13	GND, GND2, TP1	-	3	5011	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; BLACK; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;	
14	IOUT+, IOUT-, QOUT+, QOUT-	-	4	142-0701-201	JOHNSON COMPONENTS	142-0701-201	CONNECTOR; FEMALE THREADED; THROUGH HOLE; SMA; STRAIGHT THROUGH; 5PINS	
15	J1-J3, VCO	-	4	PEC02SAAN	SULLINS	PEC02SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 2PINS	
16	J5	-	1	PBC03SAAN	SULLINS	PBC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 3PINS; - 65 DEGC TO +125 DEGC	
17	MH1-MH4	-	4	9032	KEYSTONE	9032	MACHINE FABRICATED; ROUND-THRU HOLE SPACER; NO THREAD; M3.5; 5/8IN; NYLON	
18	R1	-	1	CRCW040243R2FK	VISHAY DALE	43.2	RESISTOR; 0402; 43.2 OHM; 1%; 100PPM; 0.0625W; THICK FILM	
19	R2	-	1	CRCW040286R6FK	VISHAY DALE	86.6	RESISTOR; 0402; 86.6 OHM; 1%; 100PPM; 0.0625W; THICK FILM	
20	R3	-	1	CRCW0402820RFK; RC0402FR-07820RL	VISHAY DALE;YAGEO PHICOMP	820	RESISTOR; 0402; 820 OHM, 1%, 100PPM, 0.0625W, THICK FILM	

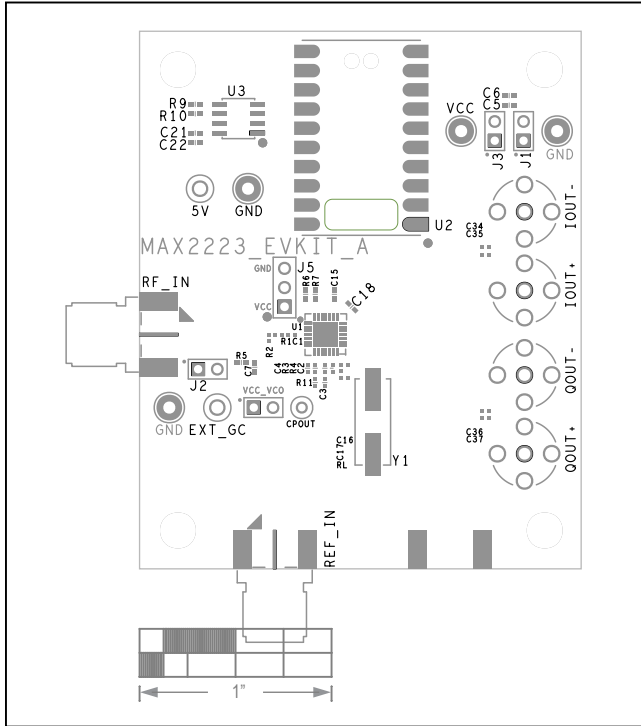
MAX2223 EV Kit Bill of Materials (continued)

ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION	COMMENTS
21	R4	-	1	CRCW0402390RFK	VISHAY DALE	390	RESISTOR, 0402, 390 OHM, 1%, 100PPM, 0.0625W, THICK FILM	
22	R5, R10	-	2	CRCW04021K00FK; RC0402FR-071KL; MCR01MZPF1001	VISHAY DALE;YAGEO PHICOMP; ROHM SEMI	1K	RESISTOR; 0402; 1K; 1%; 100PPM; 0.0625W; THICK FILM	
23	R6, R7	-	2	ERJ-2RKF4701	PANASONIC	4.7K	RESISTOR; 0402; 4.7K OHM; 1%; 100PPM; 0.10W; THICK FILM	
24	R8	-	1	ERJ-2GE0R00	PANASONIC	0	RESISTOR; 0402; 0 OHM; 0%; JUMPER; 0.10W; THICK FILM	
25	R9	-	1	CRCW04021K50FK	VISHAY DALE	1.5K	RESISTOR, 0402, 1.5K OHM, 1%, 100PPM, 0.0625W, THICK FILM	
26	R11	-	1	ERJ-2RKF1004	PANASONIC	1M	RESISTOR; 0402; 1M OHM; 1%; 100PPM; 0.10W; THICK FILM	
27	REF_IN, REF_OUT, RF_IN	-	3	142-0701-801	JOHNSON COMPONENTS	142-0701-801	CONNECTOR; FEMALE; BOARDMOUNT; END LAUNCH JACK RECEPTACLE- ROUND CONTACT; STRAIGHT; 2PINS	
28	SU1-SU5	-	5	S1100-B;SX1100-B; STC02SYAN	KYCON;KYCON;SULLINS ELECTRONICS CORP.	SX1100-B	TEST POINT; JUMPER; STR; TOTAL LENGTH=0.24IN; BLACK; INSULATION=PBT;PHOSPHOR BRONZE CONTACT=GOLD PLATED	
29	U1	-	1	MAX2223ETH+	MAXIM	MAX2223ETH+	EVKIT PART-IC; MAX2223ETH+; WG28 - COMPLETE DIRECT-CONVERSION L-BAND TUNER; TQFN28-EP; PACKAGE OUTLINE DRAWING: 21-0140; PACKAGE CODE: T2855+3; PACKAGE LAND PATTERN: 90-0023	
30	U2	-	1	MAX32625PICO	MAXIM	MAX32625PICO	MODULE; BOARD; MAX32625PICO BOARD DESIGN FOR MAX32625 ARM CORTEX-M4F; BOARD; LAMINATED PLASTIC WITH COPPER CLAD;	
31	U3	-	1	MAX515ESA+	MAXIM	MAX515ESA+	IC; DAC; 5V LOW-POWER VOLTAGE-OUTPUT SERIAL 10-BIT DIGITAL-TO-ANALOG CONVERTER; NSOIC8	
32	VCC	-	1	5010	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; RED; PHOSPHOR BRONZE WIRE SIL;	
33	Y1	-	1	HCM49-27.000MABJ-UT	CITIZEN	27MHZ	CRYSTAL; SMT; 10PF; 27MHZ; +/-30PPM; +/-5PPM	
34	PCB	-	1	MAX2223	MAXIM	PCB	PCB:MAX2223	-
35	KIT1	DNI	1	MAX32625PICO	MAXIM	MAX32625PICO	MODULE; BOARD; MAX32625PICO BOARD DESIGN FOR MAX32625 ARM CORTEX-M4F; BOARD; LAMINATED PLASTIC WITH COPPER CLAD;	
36	C17	DNP	0	GRM155R71H102JA01	MURATA	1000PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 1000PF; 50V; TOL=5%; MODEL=GRM SERIES; TG=-55 DEGC TO +125 DEGC; TC=X7R	
37	C7, C20	DNP	0	N/A	N/A	OPEN	PACKAGE OUTLINE 0402 NON-POLAR CAPACITOR	
38	RL	DNP	0	N/A	N/A	OPEN	PACKAGE OUTLINE 0402 RESISTOR	
TOTAL			72					

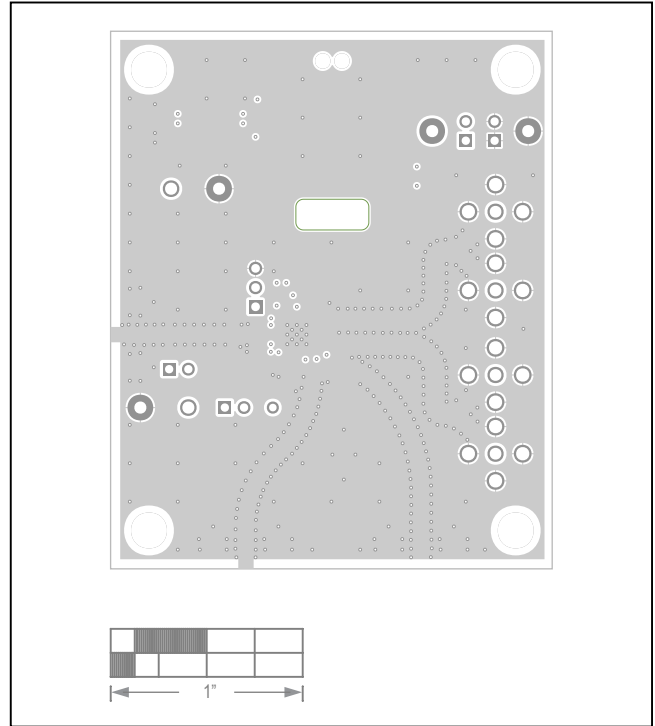
MAX2223 EV Kit Schematic



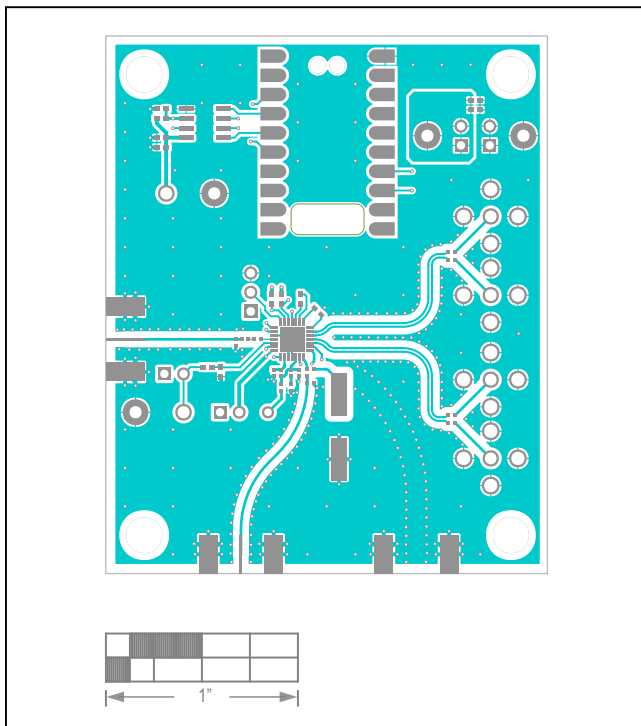
MAX2223 EV Kit PCB Layout Diagrams



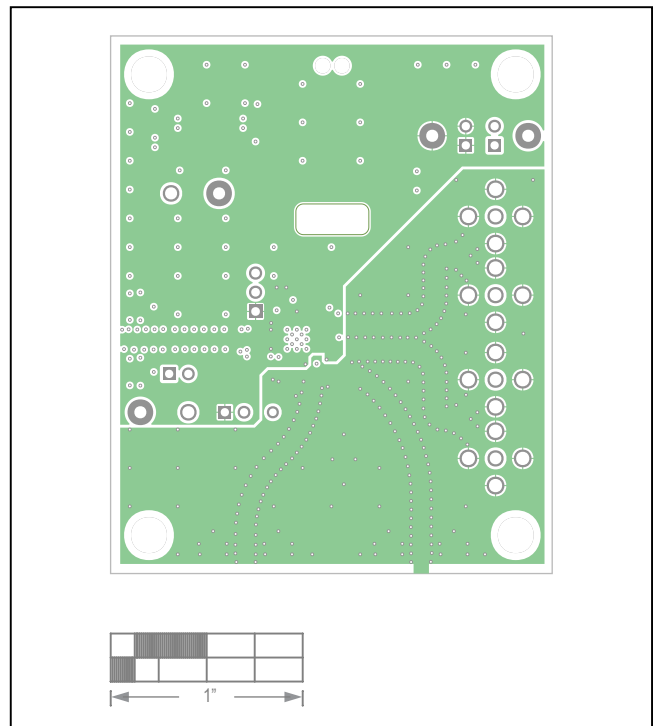
MAX2223 EV Kit—Top Silkscreen



MAX2223 EV Kit—Layer 2



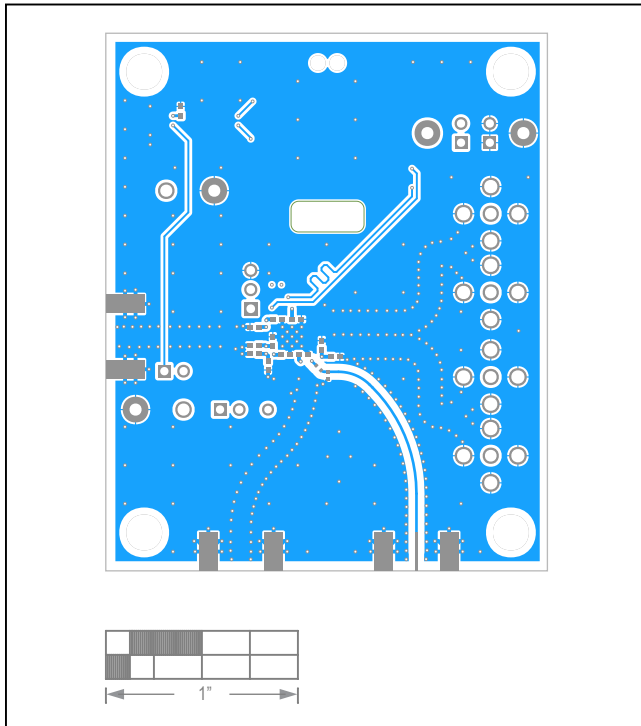
MAX2223 EV Kit—Top



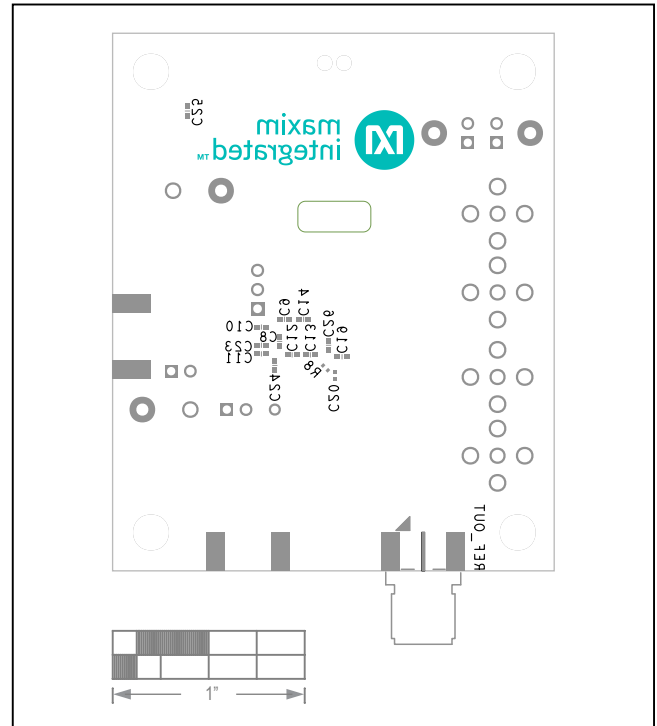
MAX2223 EV Kit—Layer 3



MAX2223 EV Kit PCB Layout Diagrams (continued)



MAX2223 EV Kit—Bottom



MAX2223 EV Kit—Bottom Silkscreen

## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	8/19	Initial release	—

For pricing, delivery, and ordering information, please visit Maxim Integrated's online storefront at <https://www.maximintegrated.com/en/storefront/storefront.html>.

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