



# MAX1416 Evaluation Kit/Evaluation System

## General Description

The MAX1416 evaluation kit (EV kit) is an assembled and tested printed-circuit board (PCB) that demonstrates the MAX1416 multichannel, 16-bit, sigma-delta data-acquisition system. Windows® 98/2000/XP-compatible software provides a convenient user interface to exercise the features of the MAX1416.

Order the complete evaluation system (EV system) (MAX1416EVC16) for a comprehensive evaluation of the MAX1416 using a personal computer. Order the EV kit (MAX1416EVKIT) if the 68HC16MODULE-DIP has been purchased with a previous Maxim EV system, or for custom use in other microcontroller ( $\mu$ C)-based systems.

To evaluate the MAX1415, request a free sample of the MAX1415EUE. To evaluate the MX7705, request a free sample of the MX7705EUE.

## Component Lists

### MAX1416 EV System

PART	QTY	DESCRIPTION
MAX1416EVKIT	1	MAX1416 evaluation kit
68HC16MODULE-DIP	1	68HC16 $\mu$ C module
USBTO232+	1	USB-to-COM port adapter board

+Denotes lead-free and RoHS-compliant.

DESIGNATION	QTY	DESCRIPTION
C1–C4, C10, C11	6	0.01 $\mu$ F, 10V X7R ceramic capacitors (radial leaded)
C5	1	0.01 $\mu$ F $\pm$ 10%, 50V X7R ceramic capacitor (0603) Taiyo Yuden UMK107B103KZ TDK C1608X7R1H103KT
C6	1	4.7 $\mu$ F $\pm$ 20%, 10V X5R ceramic capacitor (1206) Taiyo Yuden LMK316BJ475ML TDK C3216X5R1A475MT
C7, C8	2	22pF $\pm$ 5%, 50V C0G ceramic capacitors (0603) TDK C1608C0G1H220J
C9, C12, C13	3	0.1 $\mu$ F $\pm$ 10%, 50V X7R ceramic capacitors (0805) Taiyo Yuden UMK212BJ104KG TDK C2012X7R1H104KT
C14	1	1 $\mu$ F, 10V X7R ceramic capacitor (0805) TDK C2012X7R1A105K

Windows is a registered trademark of Microsoft Corp.

## Features

- ◆ Proven PCB Board Layout
- ◆ Complete Evaluation System
- ◆ Convenient On-Board Test Points
- ◆ Fully Assembled and Tested
- ◆ EV Kit Software Supports Windows 98/2000/XP with RS-232/COM Port
- ◆ EV Kit Software Supports Windows 2000/XP with USB Port

## Ordering Information

PART	TEMP RANGE	INTERFACE TYPE
MAX1416EVC16	0°C to +70°C*	Windows software
MAX1416EVKIT	0°C to +70°C*	User supplied

\*This limited temperature range applies to the EV kit PCB only. The MAX1416 IC temperature range is -45°C to +85°C.

**Note:** The MAX1416 software is designed for use with the complete EV system (MAX1416EVC16). It includes a 68HC16MODULE-DIP module, USBTO232, and a MAX1416EVKIT. If the MAX1416 evaluation software is not used, the MAX1416EVKIT board can be purchased by itself, without the  $\mu$ C.

### MAX1416 EV Kit

DESIGNATION	QTY	DESCRIPTION
H1	1	8-pin header
J1	1	2 x 20 right-angle socket
JU1	1	2-pin header
JU2	1	2-pin header
JU3	1	3-pin header
JU4	1	2-pin header
R1–R4	4	10 $\Omega$ $\pm$ 5% resistors (axial leaded)
R5, R6	2	10 $\Omega$ $\pm$ 5% resistors (1206)
TB1	1	0.200in 2-circuit screw terminal
TB2, TB3	2	0.200in 3-circuit screw terminal blocks
U1	1	MAX1416EUE (16-pin TSSOP)
U2	1	MAX873ACSA
U3, U4	2	MAX1840EUB
Y1	1	4.9152MHz crystal (HC49/US), parallel resonant, 20pF load ECS 49-20-4
—	4	Shunts (JU1–JU4)
—	1	PCB: MAX1416 Evaluation Kit

Evaluate: MAX1416/MAX1415/MX7705



# MAX1416 Evaluation Kit/Evaluation System

## Component Suppliers

SUPPLIER	PHONE	FAX	WEBSITE
Taiyo Yuden	800-348-2496	847-925-0899	www.t-yuden.com
TDK Corp.	847-803-6100	847-390-4405	www.component.tdk.com

**Note:** Indicate that you are using the MAX1416 when contacting these component suppliers.

## Quick Start

### Recommended Equipment (USB Port/PC Connection Option)

Before beginning, the following equipment is needed:

- MAX1416 EV system:  
MAX1416 EV kit  
68HC16MODULE-DIP  
USBTO232 (USB cable included)
- DC power supply, +7VDC to +12VDC at 0.25A
- DC power supply, +5VDC
- A user-supplied Windows 2000/XP computer with an available USB port to connect to the USBTO232 board

**Note:** In the following sections, software-related items are identified by bolding. Text in **bold** refers to items directly from the EV kit software. Text in **bold and underlined** refers to items from the Windows 2000/XP operating system.

### Procedure

The MAX1416 EV kit is fully assembled and tested. Follow the steps below to verify board operation.

**Caution:** Do not turn on the power until all connections are completed.

- 1) Visit the Maxim website (www.maxim-ic.com) to download the latest version of the USBTO232 User Guide. Follow the steps in the USBTO232 User Guide *Quick Start* section and return to step 2 of this *Quick Start* section when finished.
- 2) Ensure that jumpers JU1, JU2, and JU4 are closed and that jumper JU3 is in the 1-2 position (see Table 1 for jumper settings).
- 3) Carefully connect the boards by aligning the 40-pin header of the MAX1416 EV kit with the 40-pin connector of the 68HC16MODULE-DIP module. Gently press them together. The two boards should be flush against one another.
- 4) Connect the +5VDC power source to the MAX1416 EV kit at terminal block TB1. Observe the polarity marked on the board.

- 5) Connect the +7VDC to +20VDC power source to the  $\mu$ C module at the terminal block located next to the ON/OFF switch, along the top-edge of the  $\mu$ C module. Observe the polarity marked on the board.
- 6) Connect the USBTO232 board to the 68HC16MODULE-DIP module if you have not done so already.
- 7) The MAX1416 EV kit software should have already been downloaded and installed in the USBTO232 Quick Start.
- 8) Start the MAX1416 program by opening its icon in the **Start | Programs** menu.
- 9) Turn on the power supplies and slide SW1 to the ON position on the 68HC16MODULE-DIP module. Press the **OK** button to automatically connect and download the KIT1416.C16 file to the module.
- 10) When the main window appears (Figure 1), click **Initialize** and then **Calibrate**.
- 11) Apply input signals between AIN1+ and AIN1-. Tie the unused analog input (AIN2+ and AIN2-) to GND. Click **Read** or check **Auto Read**. Observe the code and voltage readout on the screen.

### Recommended Equipment (RS-232-to-COM Port/PC Connection Option)

Before beginning, the following equipment is needed:

- MAX1416 EV system:  
MAX1416 EV kit  
68HC16MODULE-DIP
- DC power supply, +7VDC to +12VDC at 0.25A
- DC power supply, +5VDC
- A user-supplied Windows 98/2000/XP computer with an available serial (COM) port
- 9-pin I/O extension cable

**Note:** In the following sections, software-related items are identified by bolding. Text in **bold** refers to items directly from the EV kit software. Text in **bold and underlined** refers to items from the Windows 98/2000/XP operating system.

# MAX1416 Evaluation Kit/Evaluation System

## Procedure

The MAX1416 EV kit is fully assembled and tested. Follow the steps below to verify board operation.

**Caution: Do not turn on the power until all connections are completed.**

- 1) Visit the Maxim website ([www.maxim-ic.com/evkitsoftware](http://www.maxim-ic.com/evkitsoftware)) to download the latest version of the EV kit software. Save the EV kit software to a temporary folder and uncompress the file (if it is a .zip file).
- 2) Install the MAX1416 EV kit software on your computer by running the INSTALL.EXE program. The program files are copied and icons are created for them in the Windows **Start | Programs** menu.
- 3) Ensure that jumpers JU1, JU2, and JU4 are closed and that jumper JU3 is in the 1-2 position (see Table 1 for jumper settings).
- 4) Carefully connect the boards by aligning the 40-pin header of the MAX1416 EV kit with the 40-pin connector of the 68HC16MODULE-DIP module. Gently press them together. The two boards should be flush against one another.
- 5) Connect the +5VDC power source to the MAX1416 EV kit at terminal block TB1. Observe the polarity marked on the board.
- 6) Connect the +7VDC to +20VDC power source to the  $\mu$ C module at the terminal block located next to the on/off switch, along the top-edge of the  $\mu$ C module. Observe the polarity marked on the board.
- 7) Connect a cable from the computer's serial port to the  $\mu$ C module. If using a 9-pin serial port, use a straight-through, 9-pin female-to-male cable. If the only available serial port uses a 25-pin connector, a standard 25-pin to 9-pin adapter is required. The EV kit software checks the modem status lines (CTS, DSR, and DCD) to confirm that the correct port has been selected.
- 8) Start the MAX1416 program by opening its icon in the **Start | Programs** menu.
- 9) Turn on the power supplies and slide SW1 to the ON position. Select the correct serial port and press the **OK** button. The program will automatically download KIT1416.C16 to the module.
- 10) When the main window appears (Figure 1), click **Initialize** and then **Calibrate**.
- 11) Apply input signals between AIN1+ and AIN1-. Tie the unused analog input (AIN2+ and AIN2-) to GND. Click **Read** or check **Auto Read**. Observe the code and voltage readout on the screen.

## Detailed Description of Software

The main window of the evaluation software controls the features of the MAX1416. The **Measurement** tab is used to initialize, calibrate, and read data. Prior to reading the MAX1416, select the appropriate MCLK master-clock input source and click **Initialize**. The FS1 and FS0 bits in the clock register determine the data rate.

The **Initialize** button writes the clock register INT, CLKDIS, CLKDIV, CLK, and FS bits, and then writes to the setup register with FSYNC = 1. The exact value written to the clock register depends on the **MCLK input** setting, and can be viewed by bringing up the **Clock** tab after initialization.

The **Calibrate** button first writes the setup register with FSYNC = 1, then writes setup with MD = 01 (self-calibration mode) and FSYNC = 0. After DRDY returns low, the MAX1416 setup register automatically returns to MD = 00 and FSYNC = 0.

The **Setup, Clock, Offset, and Gain** tabs provide read/write access to each of the registers. See Figures 2–5.

The **Comms and Data** (Figure 6) tab provides access to the **Standby** bit. The comms registers RS2, RS1, RS0, and R/W bits are automatically set by each register's read and write buttons. The channel select bits CH1 and CH0 are determined by which channel is selected on the **Measurement** tab.

### Sampling

To collect data, go to the **Measurement** tab and click **Sample**. Select the sample size and click **Begin Sampling**. After the samples have been collected, the data is automatically uploaded to the host and is graphed. Once displayed, the data can be saved to a file (optional).

### Saving Graphs to Disk

Data in the real-time graph and in the sampled data graphs can be saved to a file (Figures 7–8). Only the raw output codes are saved, but voltages can be inferred based on the reference voltage and the maximum code value.

### Evaluating Power-Down Mode

To enter standby mode, first make sure that **Auto Read** is not checked in the **Measurement** tab sheet. Then go to the **Comms and Data** tab and check **Power Down**, then click **Write**.

# MAX1416 Evaluation Kit/Evaluation System

## Reference Voltage

The evaluation software assumes a 2.500V reference voltage, unless otherwise specified. To override this value, go to the **Measurement** tab and type the new reference voltage next to **REF voltage**.

## Software Listing

The EV kit software disk contains the driver source and header file. Refer to DRV1416.cpp and DRV1416.h.

## Detailed Description of Hardware

The MAX1416 (U1) is a multichannel, 16-bit, sigma-delta data-acquisition system. Resistors R1–R4 and C1–C4 act as anti-aliasing filters. The MAX873 (U2) is a 2.5V reference. C14 ensures the MAX873's stability for arbitrary values of input capacitor C11. Level translators U3 and U4 allow the kit to support the 3V MAX1415, as well as the 5V MAX1416. The input signal can be applied directly to terminal blocks TB2 and TB3. C5 and C6 bypass the analog-to-digital converter's power supply. See Figure 9, and refer to the MAX1416 data sheet.

## Evaluating the MAX1415

To evaluate the MAX1415, request a free sample of the MAX1415EUE and replace U1. Follow the *Quick Start* procedure, with the following exceptions:

- In step 1, leave jumpers JU1 and JU2 open.
- In step 3, apply a +3VDC power supply (instead of +5V) to TB1. Apply an external +1.225VDC differential reference between TB3 pins 3 and 2.
- After step 10, go to the software's **Measurement** tab and type the new reference voltage of 1.225 next to **REF voltage**.

## Evaluating the MX7705

To evaluate the MX7705, request a free sample of the MX7705EUE and replace U1. The MX7705 is similar to the MAX1415/1416 except it does not support internal clock mode (INT must always be zero).

## Using an External Reference

To use an external reference, remove the shunts from JU1 and JU2, and connect a differential reference between TB3 pins 3 and 2. The evaluation software assumes a 2.500V reference voltage, unless otherwise specified. To override this value, go to the **Measurement** tab and type the new reference voltage next to **REF voltage**.

Table 1. Jumper Functions

JUMPER	SHUNT POSITION	FUNCTION
JU1	Closed*	U2 (MAX873) supplies REF+ reference voltage
	Open	REF+ must be externally connected
JU2	Closed*	REF- connects to ground at U2
	Open	REF- must be externally connected
JU3	1-2*	MCLKIN connects to crystal Y1
	Open	MCLKIN is not connected
	2-3	MCLKIN connects to ground (MAX1416/MAX1415 internal-oscillator mode only)
JU4	Closed*	MCLKOUT drives crystal Y1
	Open	MCLKOUT is not connected (MAX1416/MAX1415 internal-oscillator mode only)

\*Default position.

## Troubleshooting

### Problem: No output measurement. System seems to report zero voltage, or fails to make a measurement.

Check VDD supply voltage at TB1. The EV kit requires a separate supply in addition to the supply on the microcontroller module. Check the reference voltage using a digital voltmeter. Use an oscilloscope to verify that the  $\overline{CS}$ , SCLK, and DIN waveforms are correct. If the DRDY signal is pulsing, then the software has successfully initialized the MAX1416 and conversions have been triggered.

### Problem: Cannot see MCLK waveform on oscilloscope.

When using an external crystal, the MCLKIN and MCLKOUT nodes are very sensitive to extra load capacitance. Connecting a typical 10x scope probe effectively doubles the load capacitance from 20pF to 40pF, which can slow down or even halt oscillation. When using the internal oscillator (clock register INT = 1 and CLKDIS = 0), the oscillator signal is visible on the MCLKOUT pin. In this mode, MCLKOUT can be measured using a typical 10x scope probe.

QSPI is a trademark of Motorola, Inc.

# MAX1416 Evaluation Kit/Evaluation System

Evaluate: MAX1416/MAX1415/MX7705

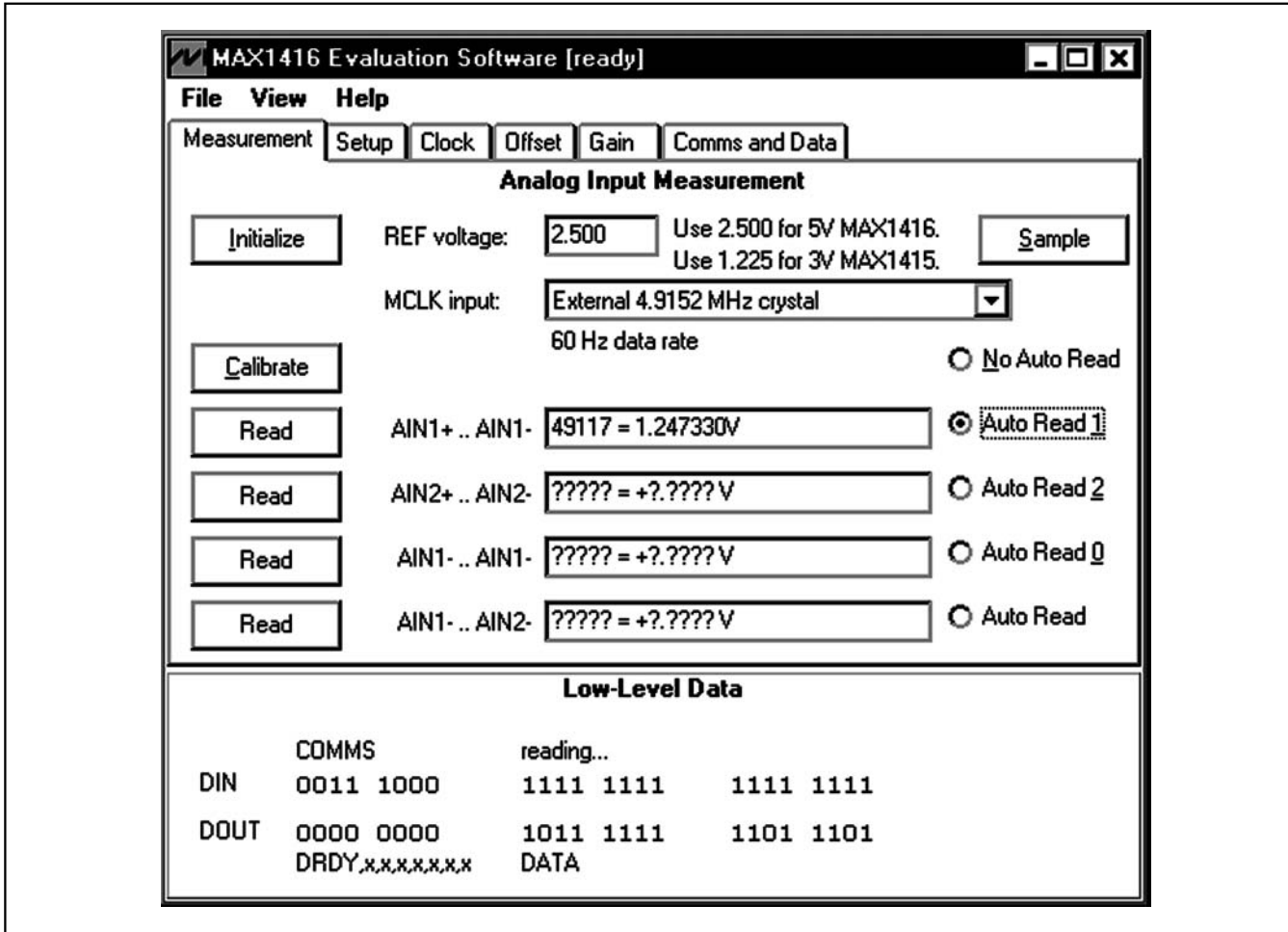


Figure 1. MAX1416 EV Kit Software Main Window (Measurement Tab)

**Problem: Internal oscillator does not work.**

The internal-oscillator mode is a feature of the MAX1416/MAX1415 only, and is not supported on the MX7705. The MX7705 requires an external clock, and can only be used with INT = 0. To observe the internal oscillator driving the MCLKOUT pin, U1 must be a MAX1416 or MAX1415, and the clock register must have INT = 1 and CLKDIS = 0.

**Problem: Measurements are erratic or unstable or there is poor accuracy.**

Check the reference voltage using a digital voltmeter. Use an oscilloscope to check for noise. When probing for noise, keep the oscilloscope ground-return lead as short as possible, preferably less than 1/2 in (10mm).

**Problem: Unacceptable errors when measuring a transducer.**

Although most signal sources can be connected directly to the MAX1416's analog input, some high-impedance signal sources may require using the internal input buffer (BUF = 1).

**Problem: PDA hot-sync software or other device software interferes with EV kit software.**

COM ports can only be used by one device at a time. Disable PDA hot-sync manager.

# MAX1416 Evaluation Kit/Evaluation System

Evaluate: MAX1416/MAX1415/MX7705

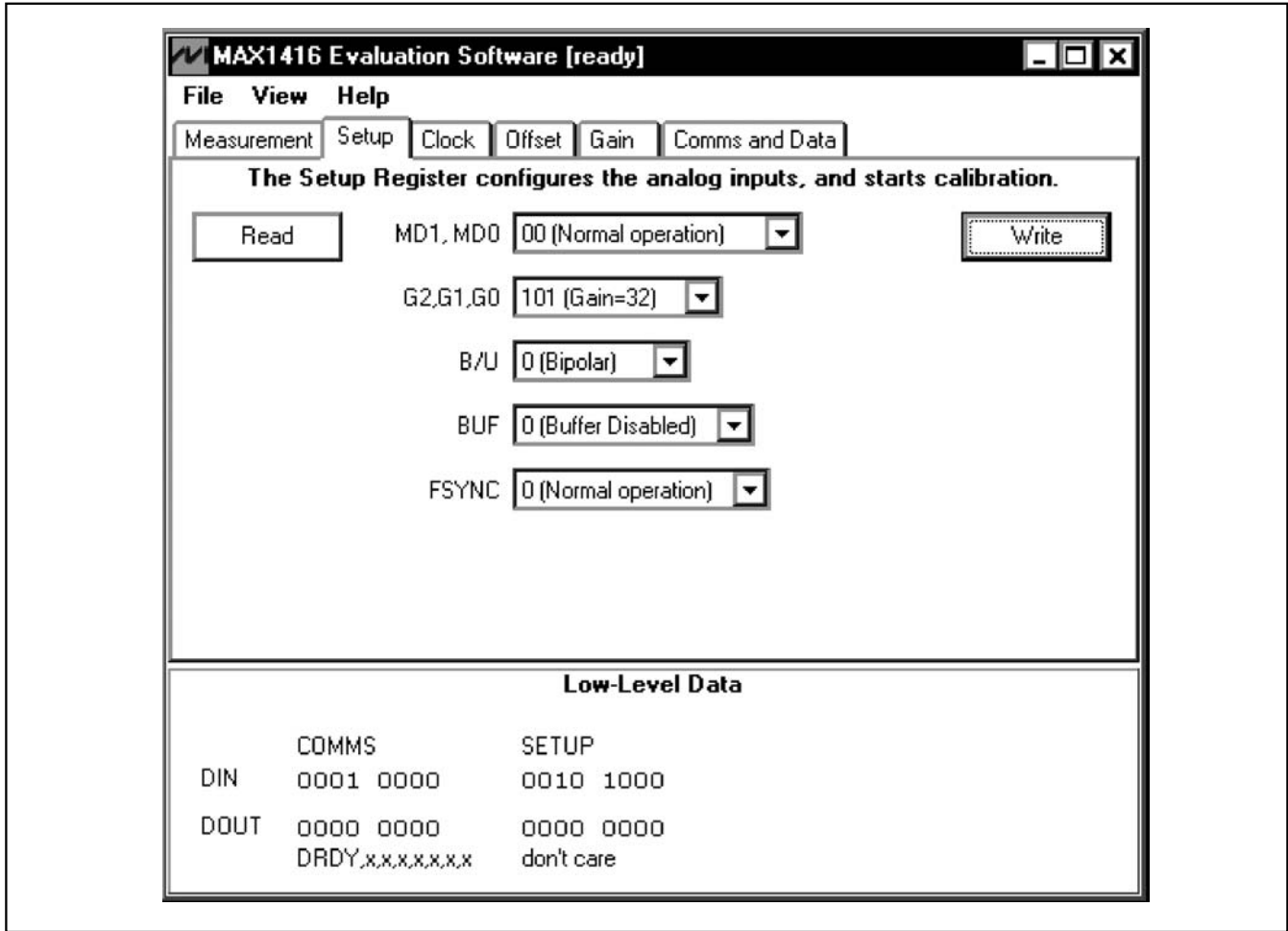


Figure 2. MAX1416 EV Kit Software Main Window (Setup Tab)

# MAX1416 Evaluation Kit/Evaluation System

Evaluate: MAX1416/MAX1415/MX7705

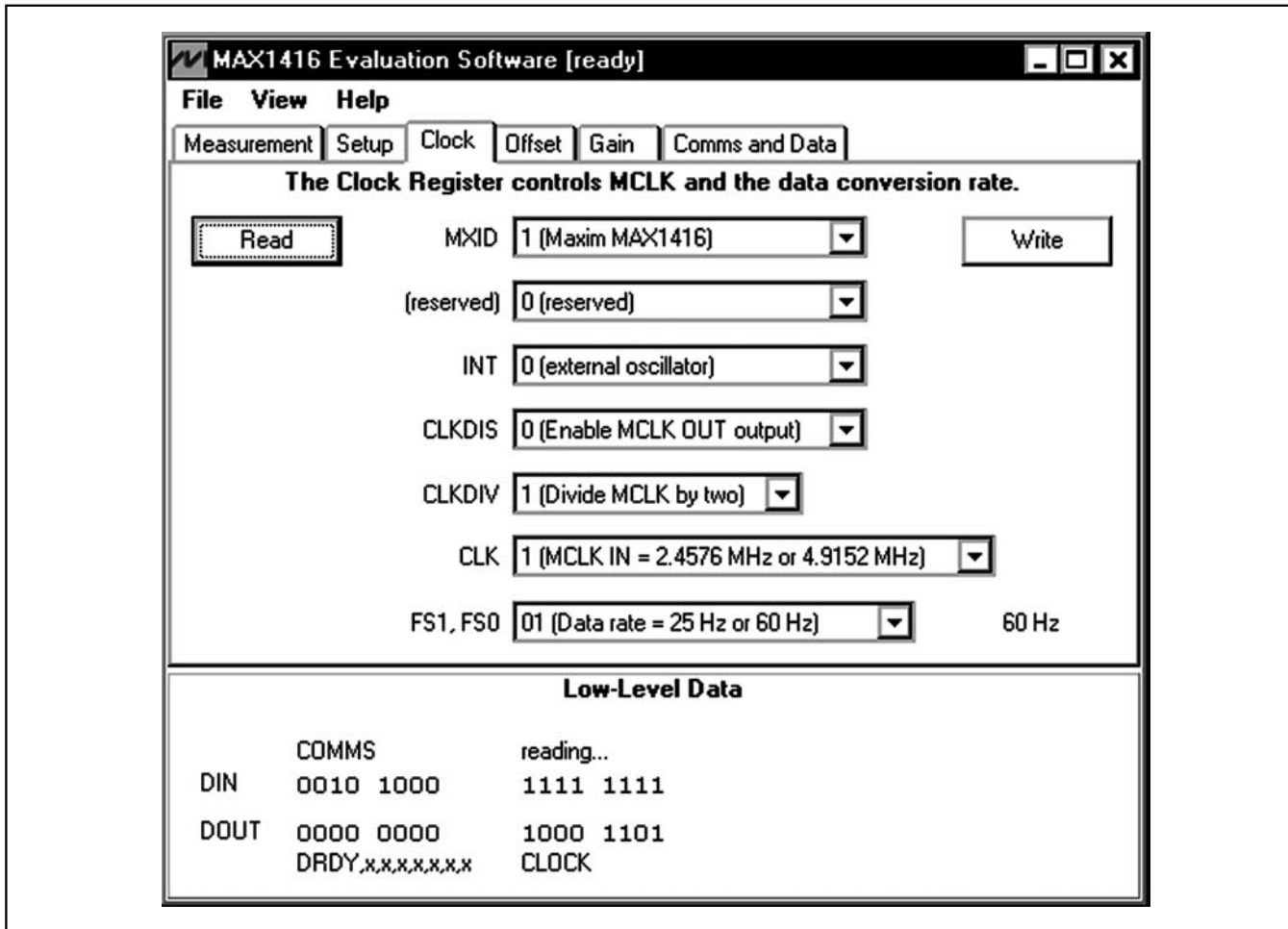


Figure 3. MAX1416 EV Kit Software Main Window (Clock Tab)

# MAX1416 Evaluation Kit/Evaluation System

Evaluate: MAX1416/MAX1415/MX7705

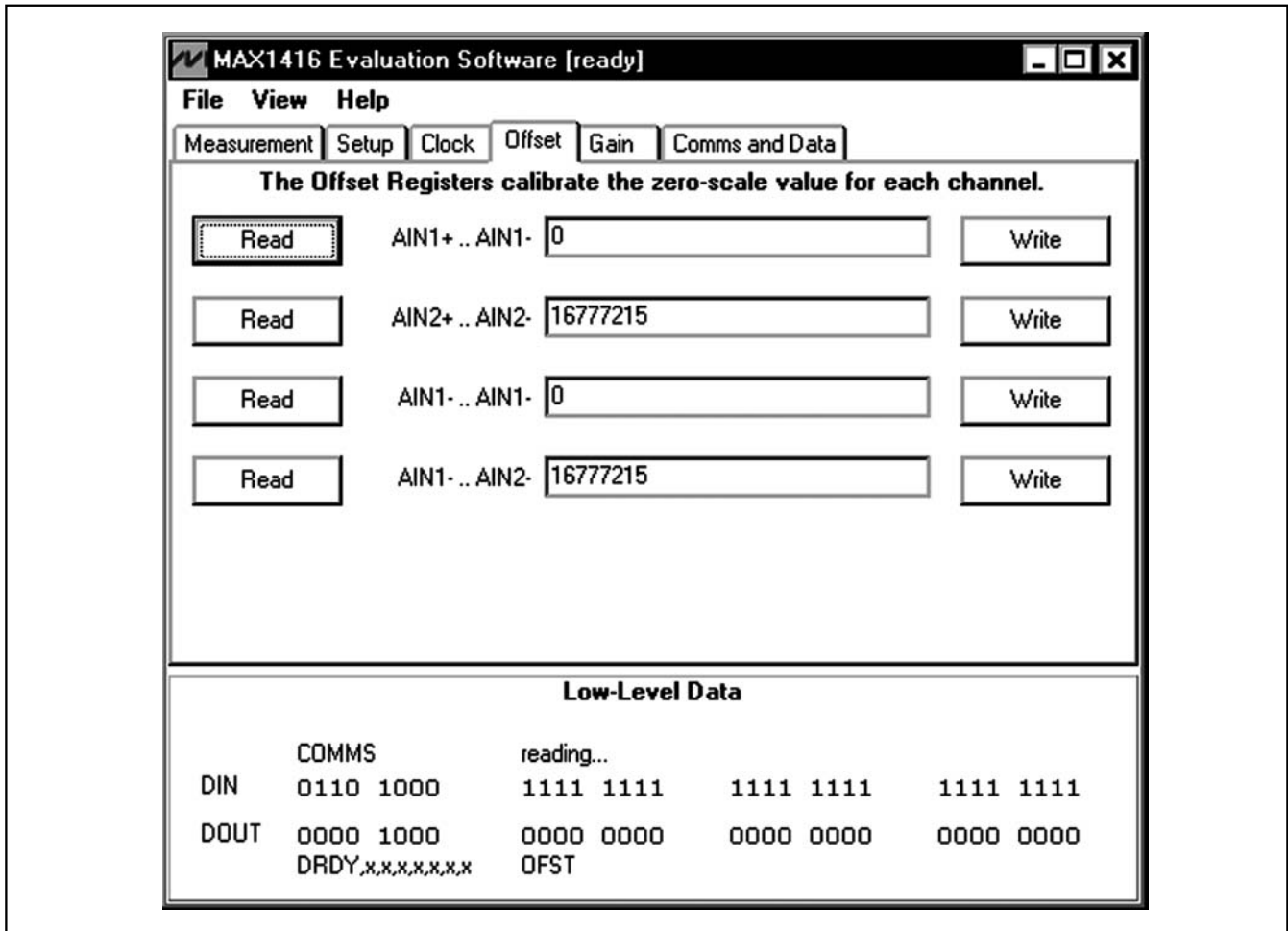


Figure 4. MAX1416 EV Kit Main Window (Offset Tab)

# MAX1416 Evaluation Kit/Evaluation System

Evaluate: MAX1416/MAX1415/MX7705

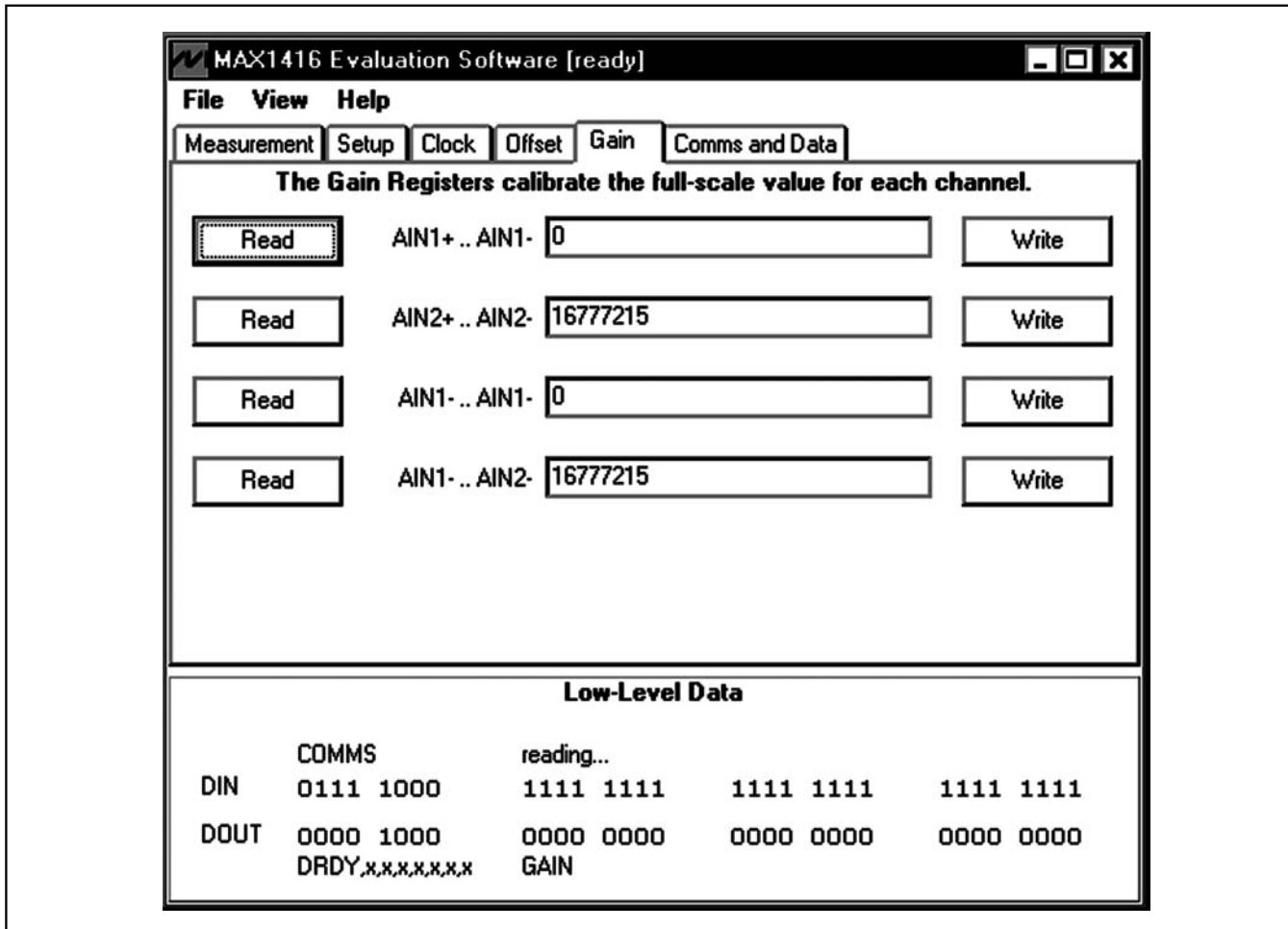


Figure 5. MAX1416 EV Kit Main Window (Gain Tab)

# MAX1416 Evaluation Kit/Evaluation System

Evaluate: MAX1416/MAX1415/MX7705

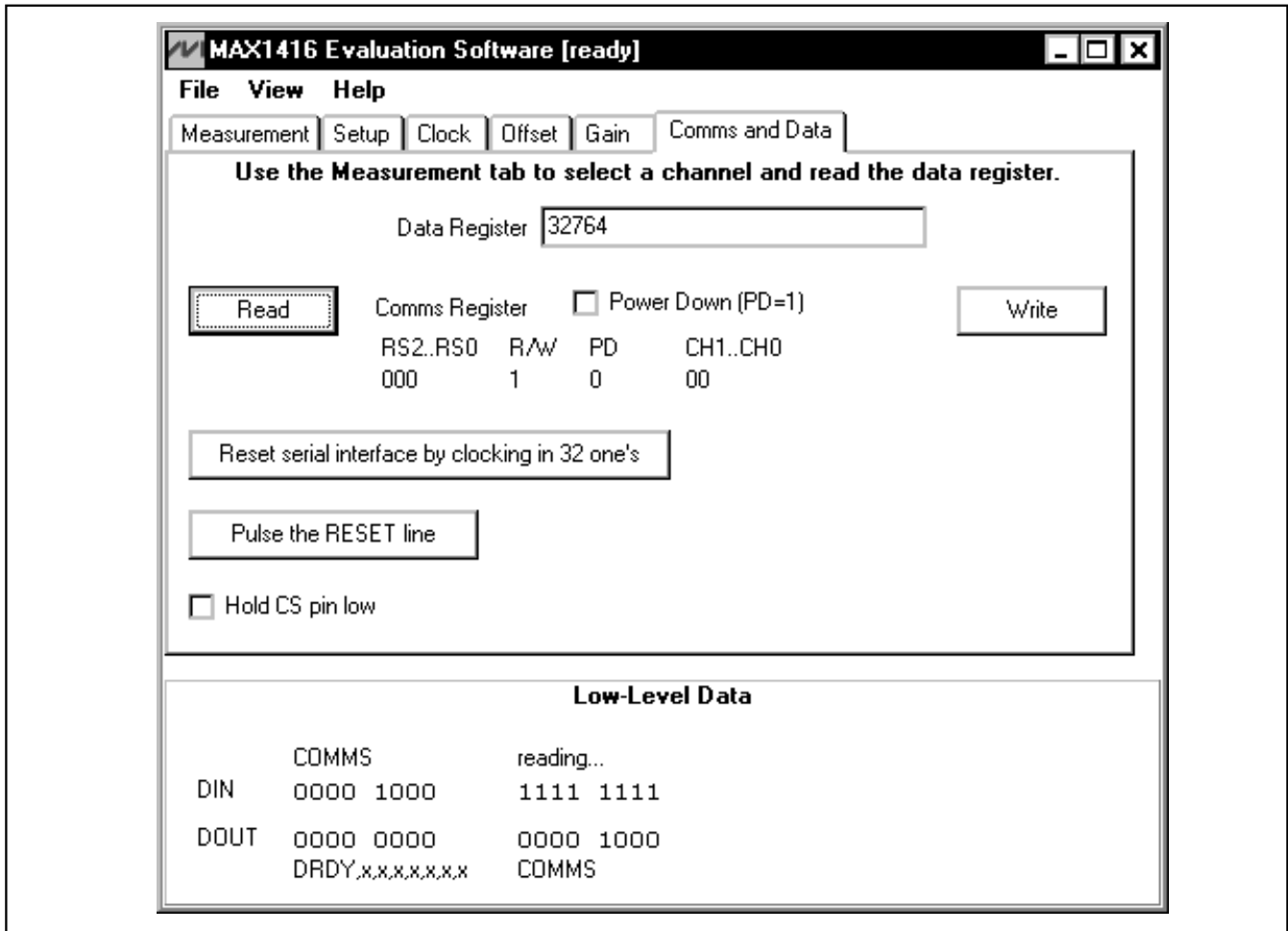


Figure 6. MAX1416 EV Kit Main Window (Comms and Data Tab)

# MAX1416 Evaluation Kit/Evaluation System

Evaluate: MAX1416/MAX1415/MX7705

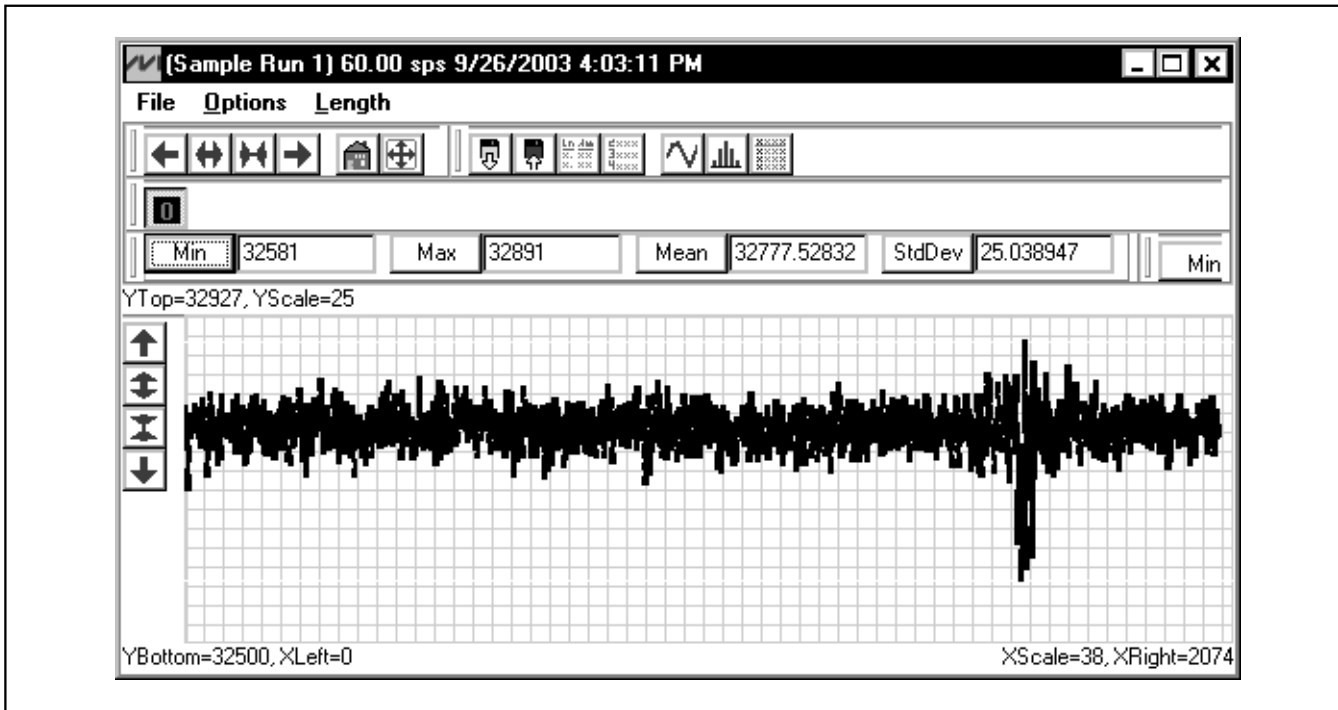


Figure 7. MAX1416—Saving Graphs to Disk

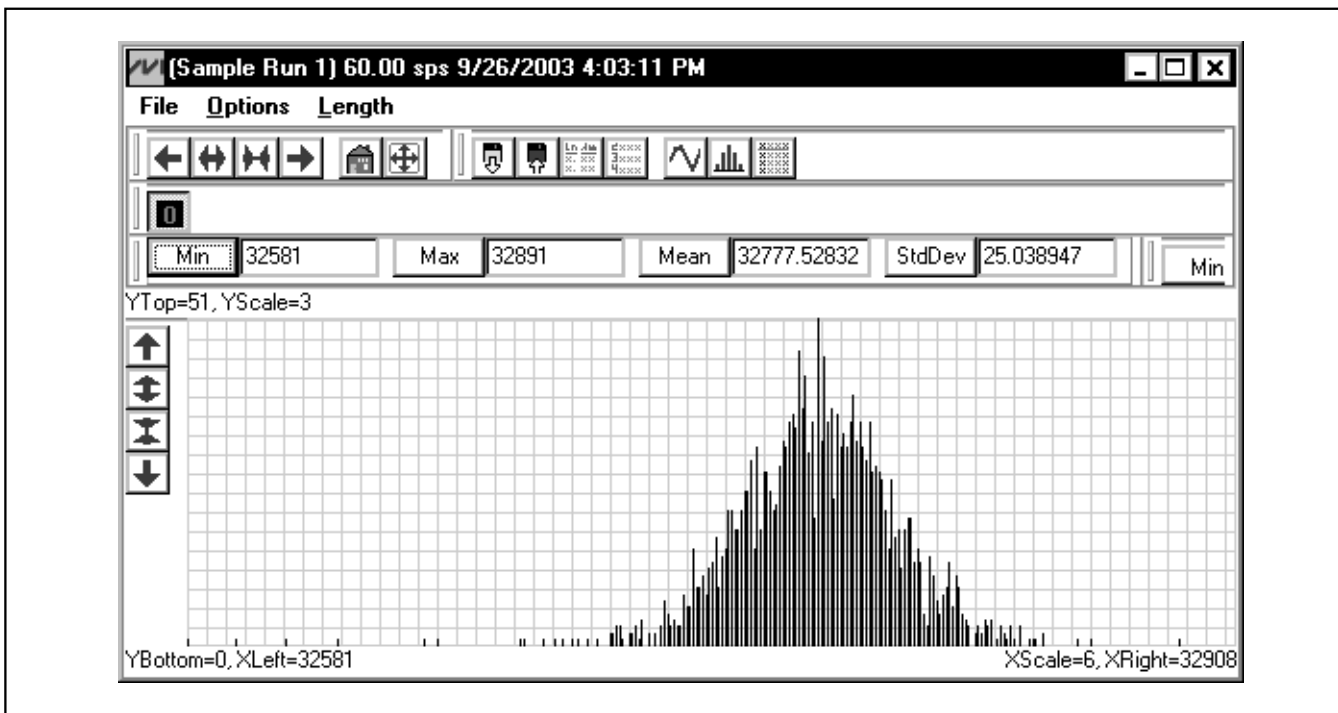


Figure 8. MAX1416—Saving Graphs to Disk

# MAX1416 Evaluation Kit/Evaluation System

Evaluate: MAX1416/MAX1415/MX7705

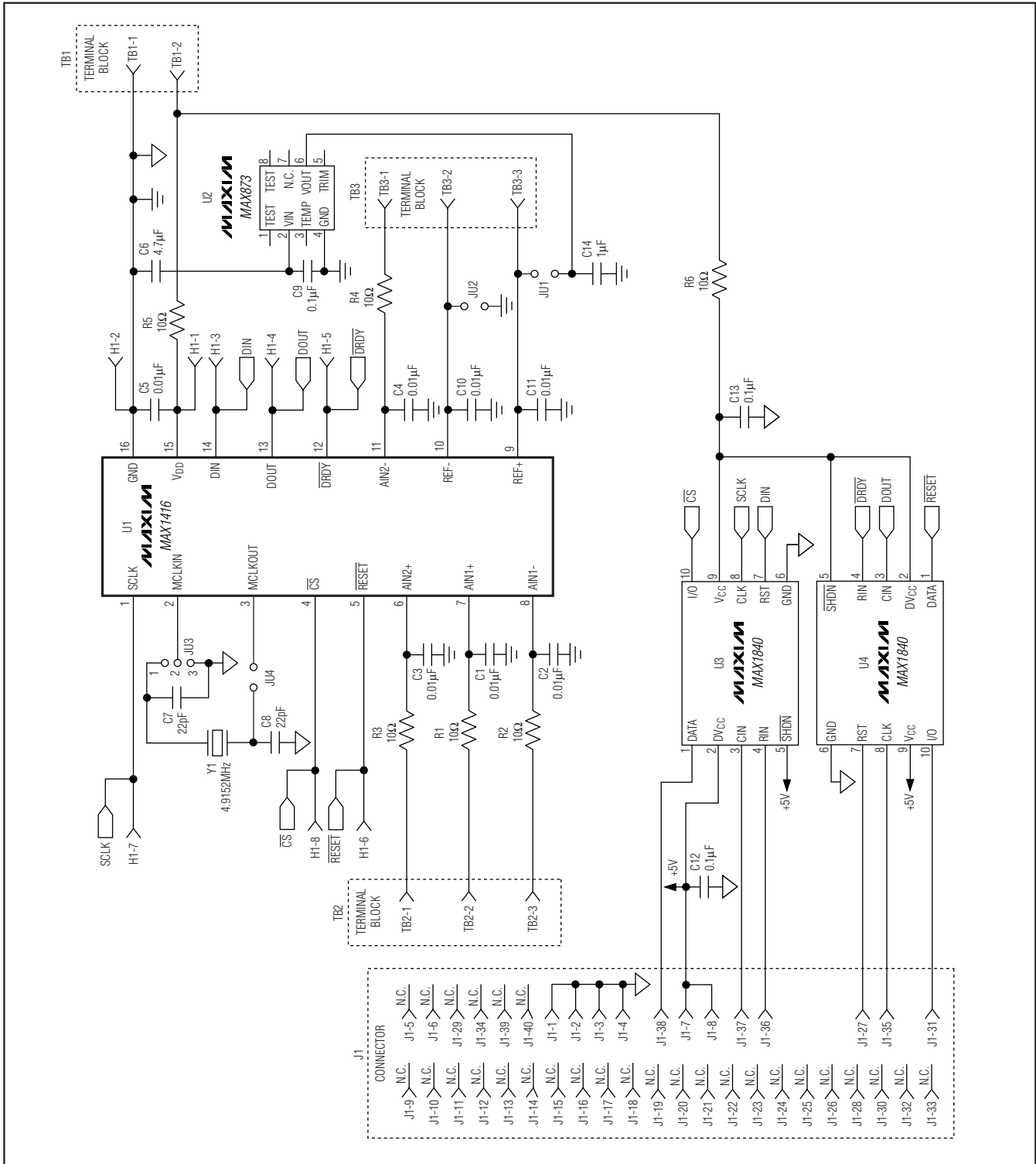


Figure 9. MAX1416 EV Kit Schematic

# MAX1416 Evaluation Kit/Evaluation System

Evaluate: MAX1416/MAX1415/MX7705

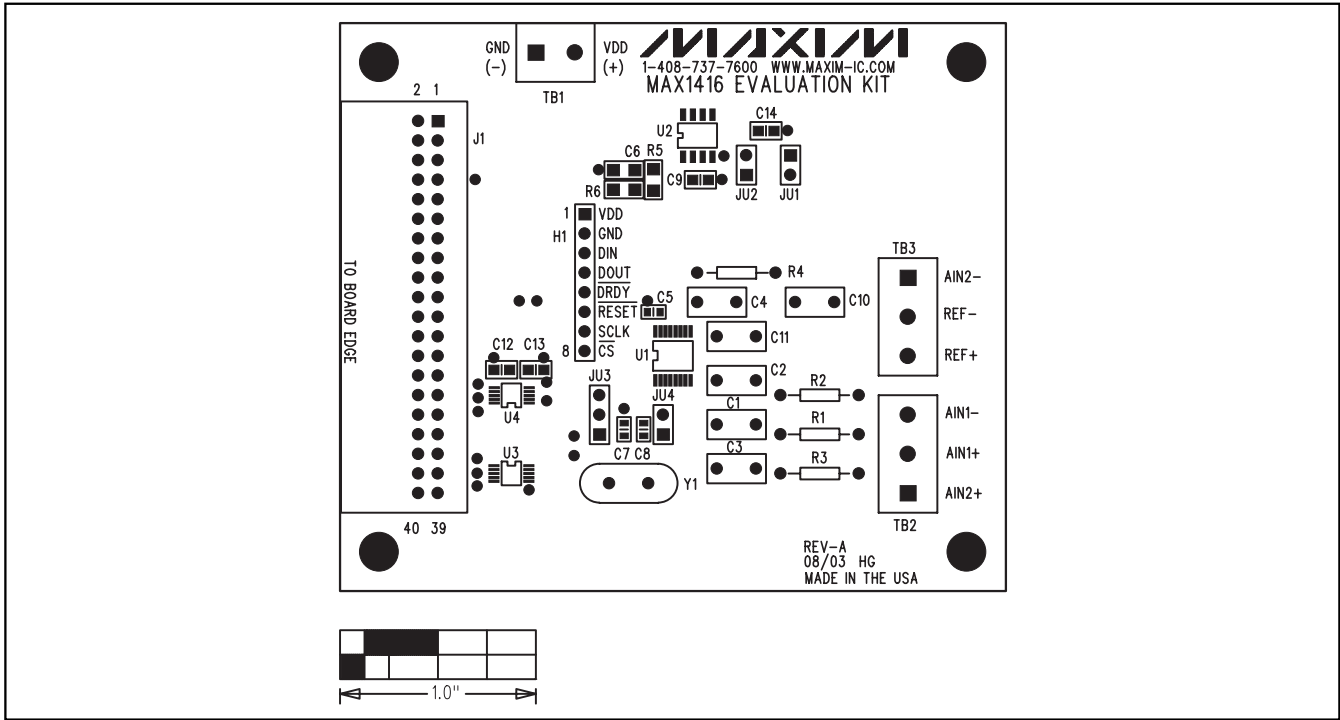


Figure 10. MAX1416 EV Kit Component Placement Guide—Component Side

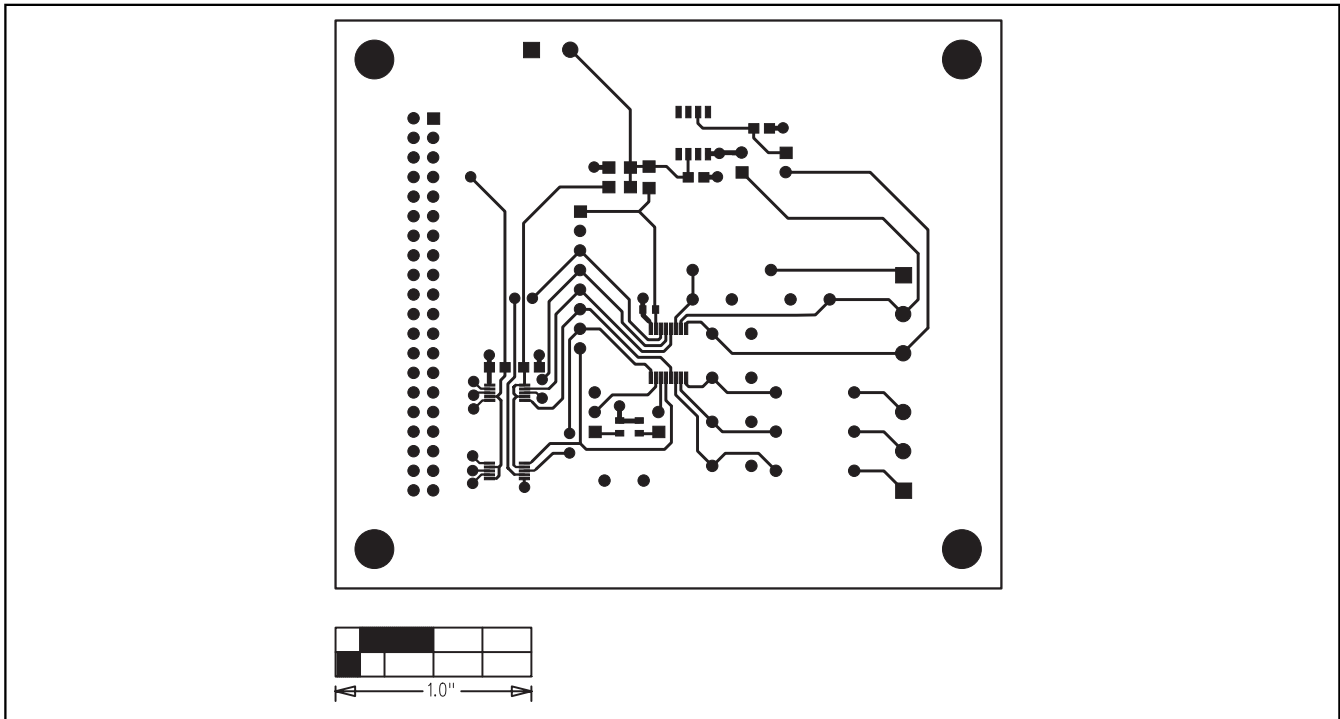


Figure 11. MAX1416 EV Kit PCB Layout—Component Side

# MAX1416 Evaluation Kit/Evaluation System

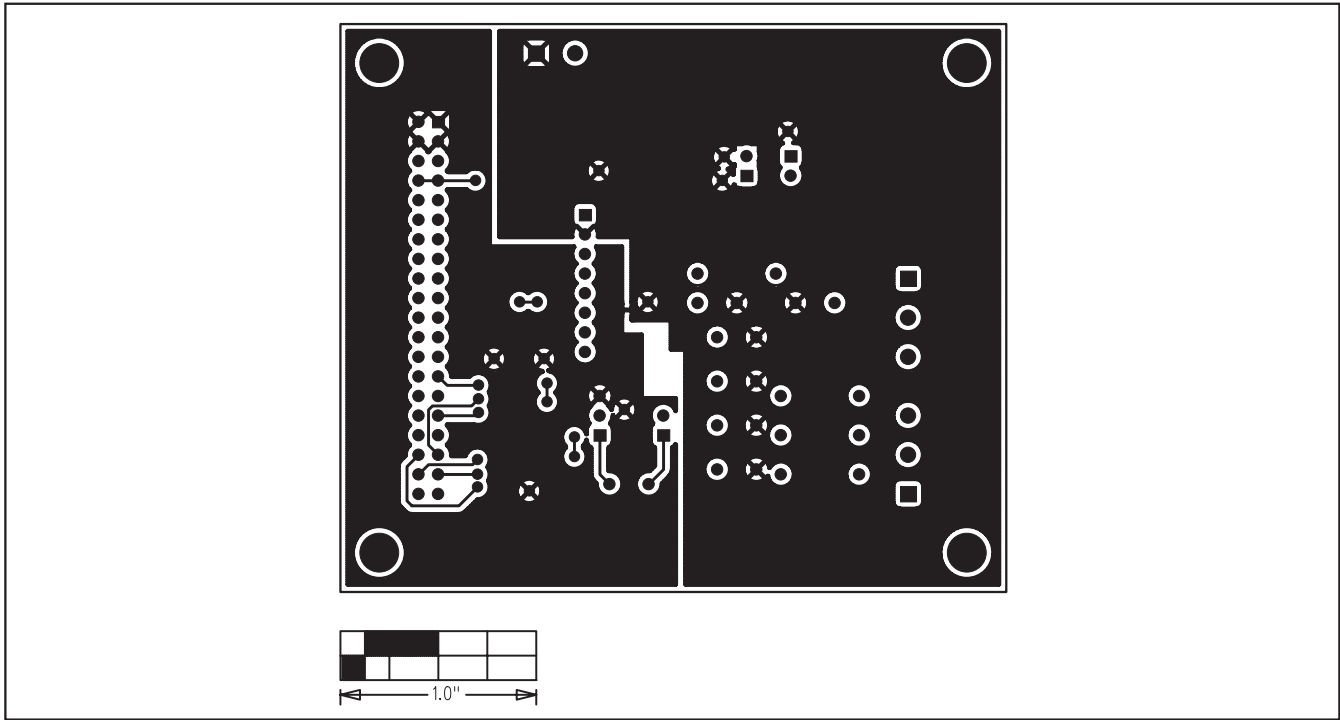


Figure 12. MAX1416 EV Kit PCB Layout —Solder Side

## Revision History

Pages changed at Rev 1: 1–10, 13, 14

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

14 **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600**