MAX1402 EV System

Evaluates: MAX1400/MAX1402

General Description

The MAX1402 evaluation system (EV system) is a complete, multichannel data-acquisition system consisting of a MAX1402 evaluation kit (EV kit) and a Maxim 68HC16 microcontroller (µC) module. The MAX1402 is a low-power, multichannel, serial-output analog to digital converter (ADC). Windows 95/98/2000™-compatible software provides a handy user interface to exercise the MAX1402's features. Source code in C++ and 68HC11 assembly language is provided for the low-level portion of the software.

Order the EV system for comprehensive evaluation of the MAX1402 using a personal computer. Order only the EV kit if the 68HC16 µC Module has already been purchased with a previous Maxim EV system, or for custom use in other µC-based systems.

The MAX1402 EV kit and EV system can also be used to evaluate the MAX1400. Simply order a free sample of the MAX1400CAI along with the MAX1402 EV kit.

MAX1402 Stand-Alone EV Kit

The MAX1402 EV kit provides a proven PC board layout to facilitate evaluation of the MAX1402 with user-provided software and hardware. It must be interfaced to appropriate timing signals for proper operation. Refer to the MAX1402 data sheet for timing requirements. See Table 2, *Jumper Functions*.

MAX1402 EV System

The MAX1402 EV system operates from a user-supplied +8V to +12V DC power supply.

MAX1402 EV System Component List

PART	QTY	DESCRIPTION
MAX1402EVKIT	1	MAX1402 Evaluation Kit
68HC16MODULE-DIP	1	68HC16 µC Module

Windows 95/98/2000 are trademarks of Microsoft Corp.

Features

♦ **Easy to Configure**

♦ **Collects Up to 8192 Samples at Full Speed**

♦ **Complete Evaluation System**

♦ **Proven PC Board Layout**

♦ **Fully Assembled and Tested**

Ordering Information

PART	TEMP RANGE	INTERFACE TYPE
MAX1402EVKIT	0°C to +70°C	User-Supplied
MAX1402EVC16	0°C to +70°C	Windows Software

Note: *The MAX1402 software can only be used with the complete evaluation system (MAX1402EVC16), which includes the 68HC16MODULE-DIP together with the MAX1402EVKIT.*

MAX1402 EV Kit Parts List

DESIGNATION	QTY	DESCRIPTION
C3–C8	6	100pF ceramic capacitors (1206) TDK C3216C0G2J101K
C9, C10, C11	3	0.1µF ceramic capacitors (1206) Murata GRM319R71H104K TDK C3216X7R1H104K
C12, C13	0	Not installed
C15	1	2.2µF, 25V X7R ceramic capacitor TDK C3216X7R1E225K
J1	1	2x20 right-angle socket
J2	1	Female SMA connector
JU1–JU8	0	Not installed
R1–R6	6	100Ω 5% resistors (1206)
R7, R8	2	10Ω 5% resistors (1206)
R9	0	Not installed
R10	0	Not installed
U1	1	Maxim MAX1402CAI
U2	1	Maxim MAX6025AEUR (SOT-23 voltage reference, 2.500V, 20ppm/°C max)
Y1	1	2.4576MHz ceramic resonator Murata CSTCC2M45G53-R0
—	1	3in x 4in PC board MAX1402 Evaluation Kit
—	1	3 1/2in software disk MAX1402 Evaluation Kit

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.

MAX1402 EV System

Component Suppliers

SUPPLIER	PHONE	FAX	WEBSITE
Murata	770-436-1300	770-436-3030	www.murata.com
TDK	847-803-6100	847-390-4405	www.component.tdk.com

Note: *Please indicate that you are using the MAX1402 when contacting these component suppliers.*

MAX1402 EV Kit Files

Windows Application Program Files

FILE	DESCRIPTION
MAX1402.EXE	Application program that runs under Windows 95/98.
MAX1402.HLP	Help file
KIT1402.C16	Software loaded into 68HC16 microcontroller.
MAX1402.INI	Program settings file

Example Source Code Files

FILE	DESCRIPTION
MAX1402.CPP	Source code module for driving the MAX1402, provided for reference. Includes definitions of the register names and low-level access routines. Compiled with Borland C++ 4.52. Maxim holds the copyright but allows customers to adapt the program for their own use without charge.
MAX1402.H	Header file for MAX1402.CPP, provided for reference.

68HC16 Source Code Files

FILE	DESCRIPTION
KIT1402.ASM	Main source code for the KIT1402.C16 program, provided for reference. Maxim holds the copyright but allows customers to adapt the program for their own use without charge.
EVKIT.ASM	Source code defining the program interface with the Maxim 68HC16 Module ROM (Rev. 2.0).

Quick Start

Recommended Equipment

Obtain the following equipment before you begin:

- A DC power supply that generates +8VDC to +12VDC at 30–50mA
- An IBM PC-compatible computer running Windows 95/98
- A spare serial communications port, preferably a 9-pin plug
- A serial cable to connect the computer's serial port to the Maxim 68HC16 Module

1) Before you begin, make sure your 68HC16 module has the Rev. 2.0 ROM. The software will not function with the Rev. 1.0 ROM.

2) Carefully connect the boards by aligning the 40-pin header of the MAX1402 EV kit with the 40-pin connector of the 68HC16MODULE module. Gently press them together. The two boards should be flush against one another.

3) Connect the DC power source to the µC module at terminal block J2, located next to the ON/OFF switch, along the top edge of the µC module. Observe the polarity marked on the board.

4) Connect a cable from the computer's serial port to the µC 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 will be required. The EV kit software checks the modem status lines (CTS, DSR, DCD) to confirm that the correct port has been selected.

5) Install the software on your computer by running the INSTALL.EXE program from the floppy disk. The program files are copied and icons are created for them in the Windows 95/98 Start Menu. The EV kit software evaluates both the MAX1402 and the MAX1400.

6) Start the MAX1402 program by opening its icon in the Start Menu.

Install/Uninstall Program Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer.
UNINST.INI	Database for uninstall program.
UNMAXIM.EXE	Removes the EV kit files from your computer. This file is automatically copied to C:\WINDOWS during installation.

7) The program will prompt you to connect the µC module and turn its power on. Slide SW1 to the "ON" position. Select the correct serial port, and click OK. The program will automatically download the file KIT1402.C16 to the module

8) When the software successfully establishes communication with the EV kit board, you will see a configuration tool and some other windows. Verify that the CLKIN and Reference Voltage settings are correct. Close or minimize this dialog box.

9) Apply input signals to the inputs labeled AIN1–AIN5, at the bottom edge of the MAX1402 EV kit board. AIN6 is analog common. Observe the readout on the screen.

Upgrading the 68HC16 Module
The MAX1402 Evaluation kit requires Rev. 2.0 of the Maxim 68HC16 Module ROM. Check the label on device U3 on the module; if its label says Rev. 1.0, contact the factory for a replacement.

To install the new ROM, use the following procedure. Use antistatic handling precautions. To reduce the risk of ESD damage, gather all required materials and perform the installation at one sitting:

1) Slide the ON/OFF switch to the OFF position.

2) Using a flat-blade screwdriver, gently pry U3, the REV 1.0 ROM, out of its socket.

3) Remove the REV 2.0 ROM from its antistatic packaging.

4) Align the REV 2.0 ROM in the U3 socket pins. Observe correct polarity (the notch at the top of the ROM). Verify that the pins are lined up with the socket, and gently press the ROM into place.

Proceed to the regular *Quick Start* instructions.

Detailed Description of Software

The MAX1402 digitizes up to seven inputs. The various program functions are grouped into windows, which are accessible from the Show menu on the main menu bar.

Main Display
The main display shows the calculated input voltage and raw A/D output code for each active channel. Although there are nine input channels, only certain configurations are allowed.

Select any single channel or one of the scanning sequences from the Inputs menu. AIN 1-6 designates an analog input between the AIN1 pin and the AIN6 pin. CALOFF designates the signal between the CALOFF+ and CALOFF- pins. CALGAIN designates the signal between the CALGAIN+ and CALGAIN- pins.

The EV kit software assumes that CALOFF+ and CALOFF- are grounded so that CALOFF measures zero volts. Similarly, the software assumes that CALGAIN+ is connected to REFIN+ and CALGAIN- is connected to REFIN- so that CALGAIN measures the reference voltage. These two points calibrate the code-to-voltage translation function performed in the software.

The MAX1400/MAX1402 automatically triggers its measurements, unless the FSYNC control bit is set. The evaluation kit software communicates with the MAX1400/MAX1402 at intervals determined by the Update Every combo box. To halt this automatic update, uncheck the Update Every checkbox or change the Update Every to a value between 100ms and 60000ms.

Normally, the microcontroller collects new data as soon as it becomes available, by using the $\overline{\text{INT}}$ pin to trigger an interrupt service routine. If the $\overline{\text{INT}}$ pin is not used as an interrupt, then the MAX1400 must not be operated in free-running mode. Check or uncheck the Use $\overline{\text{INT}}$ Interrupt checkbox to configure the evaluation kit software.

Configuration Tool
The Configuration Tool controls parameters that apply to the entire EV kit. Like the other windows, the Configuration Tool can be activated from the Show menu of the main menu bar. The CLK control should match the external ceramic resonator or crystal that sets the master clock frequency. The VREF Reference Voltage control tells the software what the reference voltage is. This is used to convert the raw A/D output codes into the corresponding input voltage to speed

user evaluation. The Data Rate control determines how often the MAX1402 performs a measurement. Some data rates provide 16-bit, noise-free resolution when used with the SINC3 filter (discussed below). The Filter Sync control can be used to inhibit the MAX1402 from performing its self-timed measurements. The Buffer Inputs checkbox enables the internal input buffers. The Burnout Test Currents checkbox enables two small (0.1µA) current sources to provide an input stimulus. When used with a transducer, these current sources can be used to verify that the transducer has not failed open or short circuit.

At the bottom of the window, there are input voltage range selection buttons. These buttons configure all input channels for the same input voltage range. Although the MAX1400/MAX1402 can be operated with three different input ranges at the same time, the evaluation kit software only supports a single range for all channels.

The digital filter on the MAX1402 can be configured for SINC^3 or SINC^1 operation, which affects the filter cutoff frequency. (SINC' means SIN(X) ÷ X, and SINC^3 means (SIN(X) ÷ X)^3.) The SINC^3 filter is required for 16-bit accuracy. The SINC^1 filter provides faster settling time with less accuracy. Alternatively, the raw modulator output can be driven out the DOUT pin; however, the EV kit software cannot read data from the MAX1402 in this mode.

Calibration Tool

The MAX1402 EV kit software can average the measurements from the calibration channels and use the measured values to correct the voltage displays. The calibration algorithm assumes that the CALOFF inputs are externally connected together, and that the CALGAIN inputs are externally connected to the reference voltage (VREF). View the calibration tool by selecting it from the Show menu.

The software automatically disables calibration if either of the calibration channels reports a code of 0 or 262143. This is to prevent erroneous calibration when using a transfer function that does not include both 0V and VREF.

When Use CALOFF and CALGAIN for Calibration is checked, the software averages the raw A/D codes for the CALOFF and CALGAIN channels. The average is calculated as a weighted sum of the new data and the old average value. The Slower/Faster slide bar controls the weight of the new data vs. the weight of the old average.

The EV kit software assumes that all three transfer function registers are set to the same value.

This calibration affects only the displayed voltage, not the raw code numbers. The average CALOFF and CALGAIN code values are used as the endpoints of a linear interpolation, with CALOFF measuring zero volts and CALGAIN measuring VREF.

The linear interpolation formula is as follows:

$$Voltage = \frac{VREF \cdot (Code - CALOFFcode)}{(CALGAINcode - CALOFFcode) \cdot PGAgain}$$

Sampling Tool

To sample data at full speed, select Sample from the main display menu, make your selections, and click on the Begin Sampling button. Sampling rate is controlled by the Configuration tool. Sample size is restricted to a power of two. Sample Size controls the number of samples collected on each selected channel. After the samples have been collected, the data is automatically uploaded to the host and is graphed. Once displayed, the data may be saved to a file.

While the Sampling tool is open, the other windows are locked out. Close the Sampling tool by clicking the Close icon in the upper corner.

Register Display Tool

This tool displays all of the internal registers of the MAX1400/MAX1402. Modify any bit value by checking or unchecking its box. (The START bit and the zero bits in the special function register (SFR) cannot be modified). The Read All Registers button causes the software to read all of the MAX1400/MAX1402's registers. (Not functional when the MDOUT or FULLPD bit is set.) Refer to Table 4, *Guide to Register Bit Functions*.

Communications Register (COMMS)

Setting the FSYNC control bit inhibits the MAX1400/MAX1402 from performing its self-timed measurements. If FSYNC = 1 when it is time to perform a measurement, the MAX1400/MAX1402 simply skips that measurement. Thus, power line frequency rejection is not affected by the FSYNC bit.

Setting the STDBY bit places the part in low-power standby mode. The serial interface and the CLK oscillator continue to operate. The part can be restored to normal operation by clearing the STDBY bit.

Special Function Register (SFR)

Setting the MDOUT bit causes the raw modulator output to be driven out the DOUT pin; however, the EV kit software cannot read data from the MAX1402 in this mode.

Setting the FULLPD bit in the SFR register places the part in full power-down mode. The master oscillator does not run. To restore normal operation, click on the

Reset menu item in the main display. This causes the 68HC16 software to pulse the MAX1402 $\overline{\text{RESET}}$ pin.

Transfer Function Registers (TF1, TF2, TF3)
The three Transfer Function registers (TF1, TF2, TF3) control how input voltage is mapped to code values. The transfer function registers control a programmable-gain amplifier (PGA) and an offset correction DAC.

If $U/\overline{B}$ = 1, the transfer function maps unipolar voltages between 0V and VREF. If $U/\overline{B}$ = 0, then the transfer function maps bipolar voltages between -VREF and +VREF. Next, the PGA increases the code-per-volt processing gain, reducing the full-scale voltage range by a factor of 1, 2, 4, 8, 16, 32, 64, or 128. Finally, the offset correction DAC offsets the voltage range by up to ±7/6 of the full-scale voltage range.

Input pins AIN1 and AIN2 are controlled by TF1. Input pins AIN3 and AIN4 are controlled by TF2. Input pin AIN5 is controlled by TF3. Input pin AIN6 is the analog common.

When SCAN = 1, the CALOFF and CALGAIN channels are controlled by TF3. When SCAN = 0, the CALOFF and CALGAIN channels are controlled by one of the transfer function registers, as selected by the A1 and A0 bits.

For simplicity, the EV kit software assumes that all three transfer functions are configured alike.

Detailed Description of Hardware

U1, the MAX1402, is a multichannel, high-resolution A/D converter (refer to the MAX1402 data sheet). U2, the MAX6025, is a 2.5V reference (refer to the MAX6025 data sheet). Y1 contains a ceramic resonator and its load capacitors. R1–R6 together with C3–C8 form anti-aliasing input filters. R8 and C11 filter the digital power supply. The analog supply comes through filter R7/C10.

Input Filtering
The EV kit has an RC filter on each input with a time constant of approximately 0.01µs = 10ns (R = 100Ω, C = 100pF). When scanning between channels, the RC filter's settling time may increase the acquisition time required for full accuracy.

Evaluating the MAX1400
The MAX1400 can be evaluated by shorting across jumpers JU6 and JU7. The MAX1400 is exactly like the MAX1402, except that the function of pins 5, 6, 7, and 8 is changed. Instead of the OUT1/OUT2 outputs and DS0/DS1 inputs, these pins are used to provide access to the analog signal between the multiplexer and the A/D converter. Tables 2 and 3 list the jumper functions and default settings. Refer to the MAX1400 data sheet for detailed information.

Measuring Supply Current
Supply current can be estimated by measuring the voltage across a series resistor. On the EV kit board, the MAX1402 draws all of its analog and digital power through R8, which is 10Ω. In addition, all analog supply current flows through R7, which is also 10Ω.

Troubleshooting
Problem: unacceptable amounts of noise in the signal.

Collect a sample of 1024 measurements at a 60Hz data rate. Observe whether the problem is caused by 60Hz noise.

Any AC-powered equipment connected to the analog signal ground can inject noise. Try replacing AC-powered DVMs with battery-powered DVMs.

MAX1402 EV System

Table 2. Jumper Functions

JUMPER	STATE	FUNCTION
JU1	Closed*	Use CalGain inputs for gain calibration (CALGAIN+ = REFIN+)
JU1	Open	Use CalGain inputs as general purpose signal inputs
JU2	Closed*	Use CalGain inputs for gain calibration (CALGAIN- = REFIN-)
JU2	Open	Use CalGain inputs as general purpose signal inputs
JU3	Closed*	Use CalOff inputs for offset calibration (CALOFF+ = GND)
JU3	Open	Use CalOff inputs as general purpose signal inputs
JU4	Closed*	Use CalOff inputs for offset calibration (CALOFF- = GND)
JU4	Open	Use CalOff inputs as general purpose signal inputs
JU5	Closed*	Use on-board reference U2 (REFIN- = GND)
JU5	Open	REFIN+ and REFIN- must be driven by an external reference
JU6	Closed	Connects pin 5 to pin 7 MAX1402: pin 5 = digital input DS1, pin 7 = current source MAX1400: normal operation
JU6	Open	Disconnects pin 5 from pin 7 MAX1402: pin 5 = digital input DS1, pin 7 = current source MAX1400: insert filter between mux and A/D
JU7	Closed	Connects pin 6 to pin 8 MAX1402: pin 6 = digital input DS0, pin 8 = current source MAX1400: normal operation
JU7	Open	Disconnects pin 6 from pin 8 MAX1402: pin 6 = digital input DS0, pin 8 = current source MAX1400: insert filter between mux and A/D
JU8	Closed*	Use on-board reference U2 (REFIN+ = 2.5V)
JU8	Open	REFIN+ and REFIN- must be driven by an external reference

Default trace on top layer of PC board

Table 3. Default Jumper Settings

JUMPER	STATE	FUNCTION
JU1	Closed*	Use CalGain inputs for gain calibration (CALGAIN+ = REFIN+)
JU2	Closed*	Use CalGain inputs for gain calibration (CALGAIN- = REFIN-)
JU3	Closed*	Use CalOff inputs for offset calibration (CALOFF+ = GND)
JU4	Closed*	Use CalOff inputs for offset calibration (CALOFF- = GND)
JU5	Closed*	Use on-board reference U2 (REFIN- = GND)
JU6	Open	Disconnects pin 5 from pin 7 MAX1402: pin 5 = digital input DS1, pin 7 = current source MAX1400: insert filter between mux and A/D
JU7	Open	Disconnects pin 6 from pin 8 MAX1402: pin 6 = digital input DS0, pin 8 = current source MAX1400: insert filter between mux and A/D
JU8	Closed*	Use on-board reference U2 (REFIN+ = 2.5V)

Default trace on top layer of PC board

Table 4. Guide to Register Bit Functions

| REGISTER	BIT NAME	DESCRIPTION
COMMS	0/DRDY	Start bit is zero; DIN pin must be 1 when idle
	RS2–RS0	Register select for subsequent operation
	R/$\overline{\text{W}}$	Selects subsequent read or write operation
	RESET	Causes software reset when set to 1
	STDBY	Activates standby power-down mode when set to 1
	FSYNC	Inhibits the A/D converter when set to 1
GS1	A1	Selects the active channel
	A0	Selects the active channel
	MF1	Selects the data output rate
	MF0	Selects the data output rate
	CLK	Selects the CLKIN frequency
	FS1	Select the data output rate
	FS0	Select the data output rate
	FAST	Selects SINC^1 filter instead of SINC^3
GS2	SCAN	Enables the scanning sequences
	M1	Enables the CalGain channel
	M0	Enables the CalOff channel
	BUFF	Enables the input buffers
	DIFF	Selects differential input pairs
	BOUT	Enables the transducer burn-out test currents
	IOUT	Enables the OUT1 and OUT2 current sources (MAX1402 only)
	X2CLK	Selects the CLKIN frequency
SFR	MDOUT	Changes the DOUT and $\overline{\text{INT}}$ pins to provide raw modulator output
	FULLPD	Activates full power-down mode. Use hardware reset to restore normal operation.
		All other bits in SFR must be zero
TF1, 2, 3	G2–G0	Select the PGA Gain
	U/$\overline{\text{B}}$	Selects unipolar or bipolar coding
	D3–D0	Select the offset correction DAC code; D3 = sign, D2–D0 = magnitude
DATA	D17–D0	Raw code value
	DS1	Value of the DS1 input pin (MAX1402 only)
	DS0	Value of the DS0 input pin (MAX1402 only)
	CID2–CID0	Channel identification tag

Evaluates: MAX1400/MAX1402
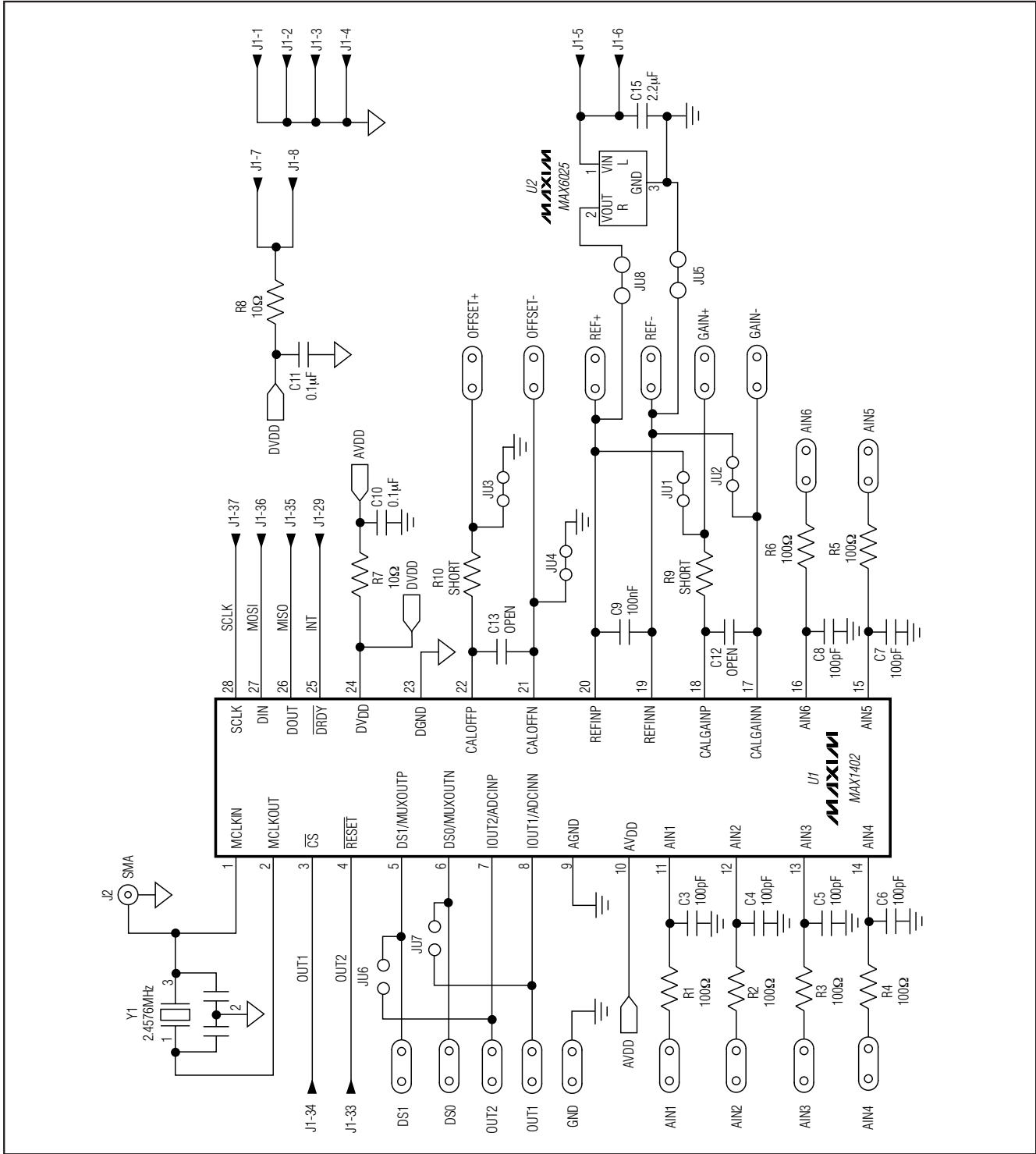
Figure 1. MAX1402 EV Kit Schematic

MAXIM
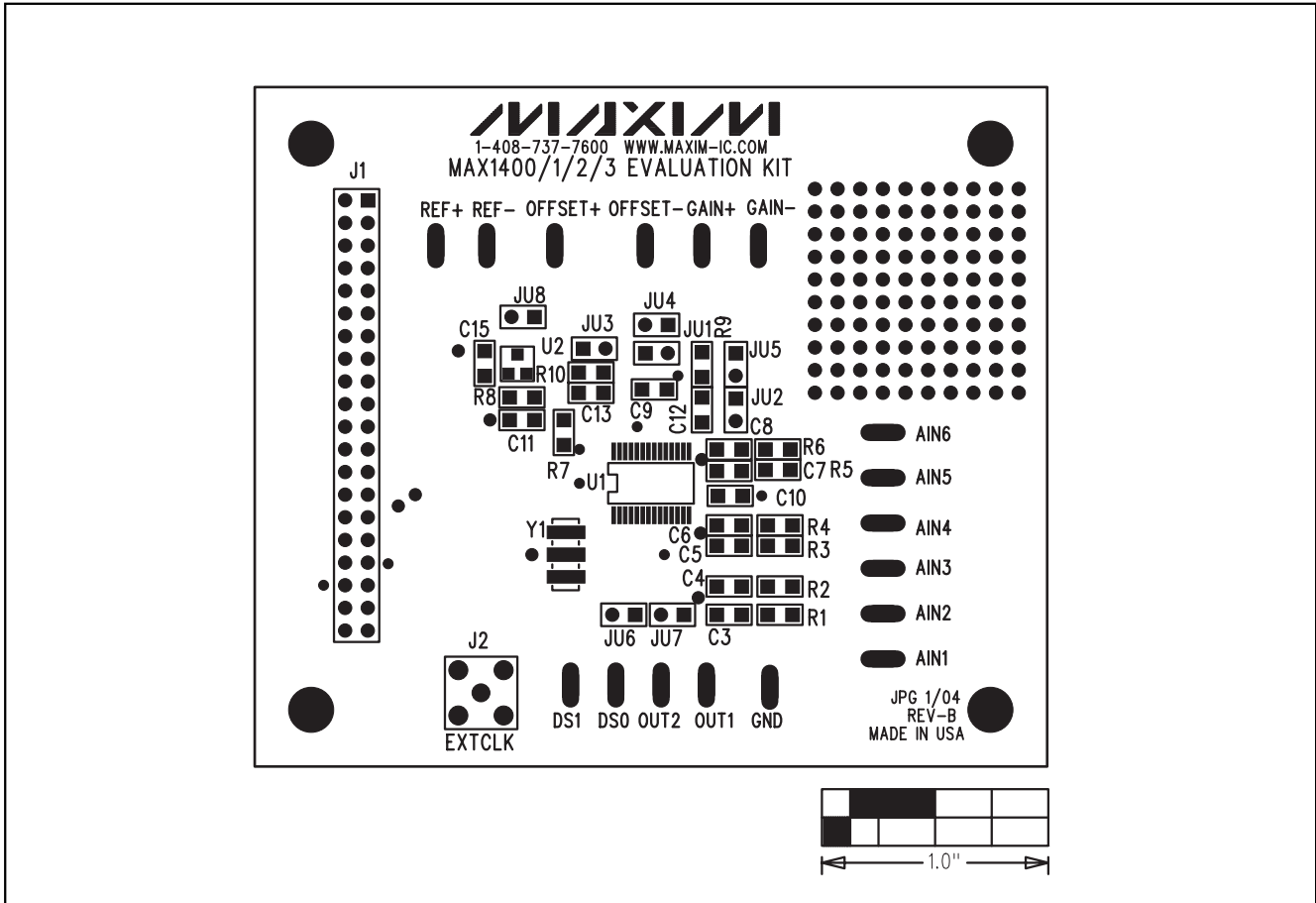
Figure 2. MAX1402 EV Kit Component Placement Guide—Component Side

Evaluates: MAX1400/MAX1402
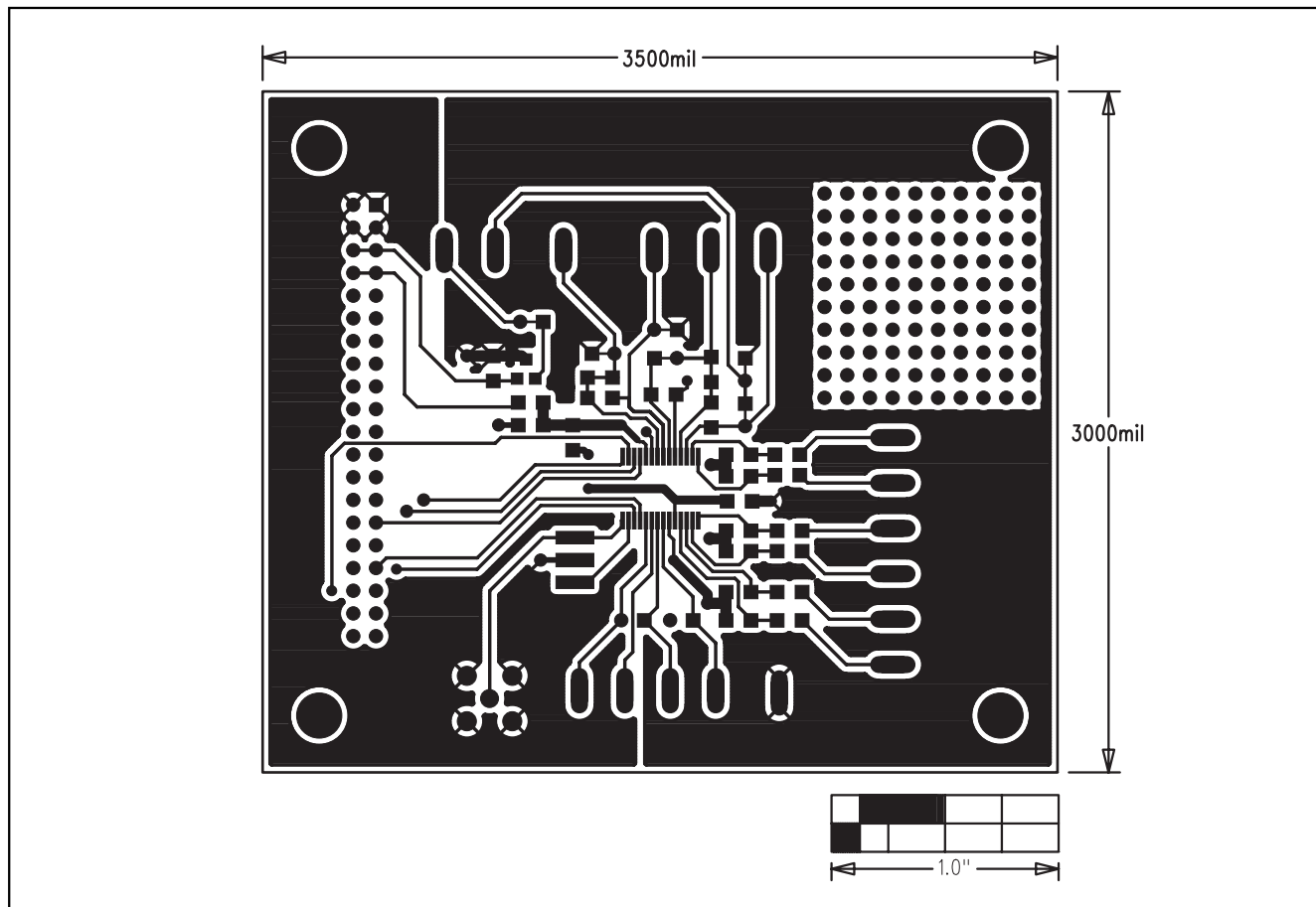
Figure 3. MAX1402 EV Kit PC Board Layout—Component Side

MAXIM

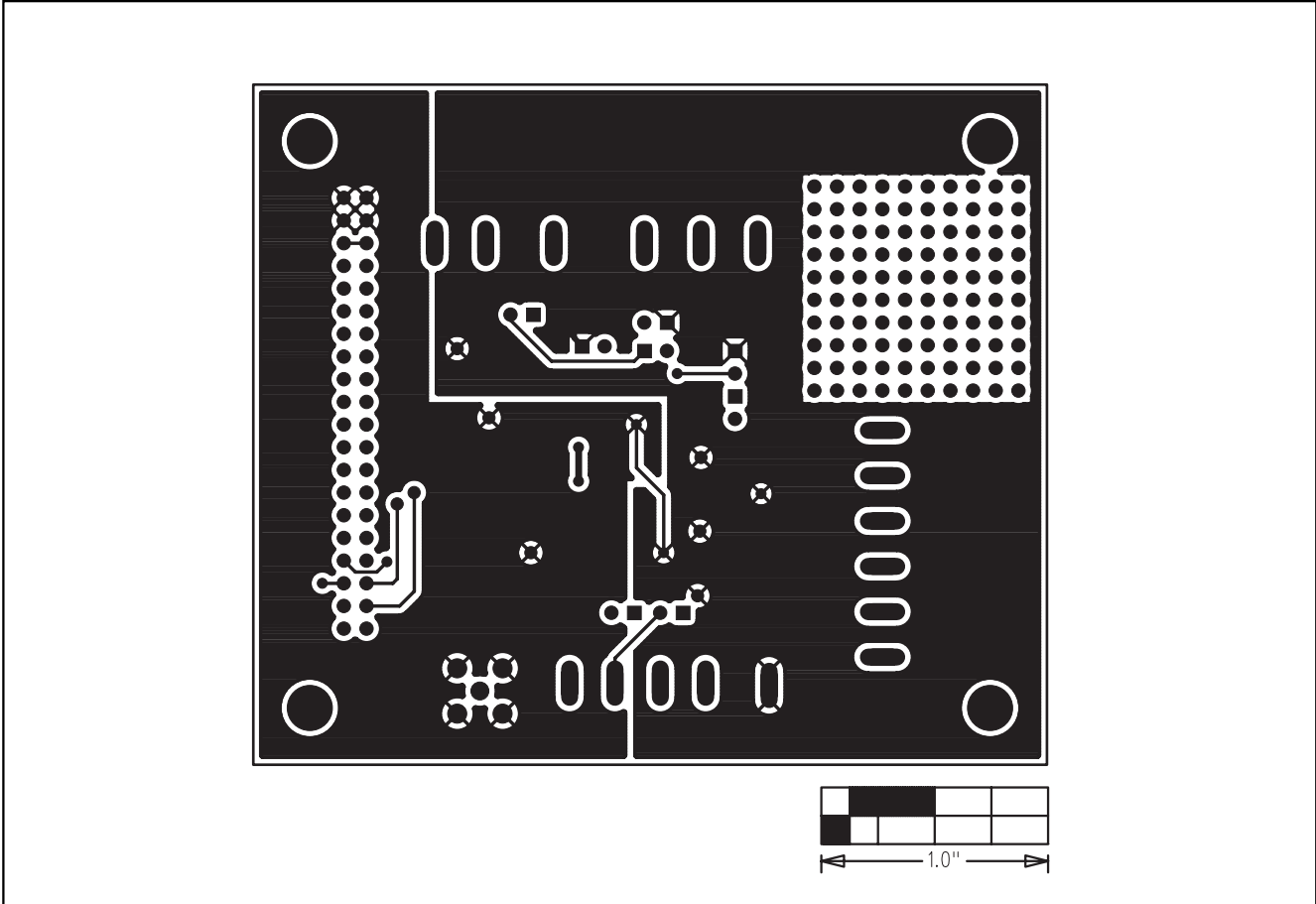Figure 4. MAX1402 EV Kit PC Board Layout—Solder Side

Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600 _____ **11**