19-4147; Rev 1; 9/08

# MAX11014 Evaluation Kit

Evaluates: MAX11014

## General Description

The MAX11014 evaluation kit (EV kit) provides a proven design to evaluate the MAX11014 automatic RF MESFET amplifier drain-current controller using an Altera complex programmable logic device (CPLD) containing the DI2CM™ IP core from Digital Core Design. The EV kit also includes Windows® 2000/XP/Vista®-compatible software that provides a simple graphical user interface (GUI) for exercising the features of the MAX11014.

Download the latest version of the MAX11014 IC data sheet from **www.maxim-ic.com**.

## Features

- ♦ **Demonstrates the Automatic Regulation of the MESFET Drain Current**
- ♦ **Supports Standard, Fast, and High-Speed I²C-Compatible Transfer Modes**
- ♦ **Windows 2000/XP/Vista (32-Bit)-Compatible Software**
- ♦ **USB-PC Connection (Cable Included)**
- ♦ **Lead-Free and RoHS Compliant**
- ♦ **Proven PCB Layout**
- ♦ **Fully Assembled and Tested**

## Ordering Information

| PART | TYPE |
|---|---|
| MAX11014EVKIT+ | EV Kit |

*+Denotes lead-free and RoHS compliant.*

## Component List

| DESIGNATION | QTY | DESCRIPTION |
|---|---|---|
| C1, C8, C11–C14, C18, C22, C23, C34–C43, C45, C51 | 21 | 1µF ±10%, 16V X7R ceramic capacitors (0603) TDK C1608X7R1C105K |
| C2, C7, C15, C16, C17, C21, C26, C27, C31, C33, C44, C46, C47, C48, C52, C53, C56 | 17 | 0.1µF ±10%, 16V X7R ceramic capacitors (0402) TDK C1005X7R1C104K |
| C3, C5 | 2 | 2pF ±0.25pF, 50V C0G ceramic capacitors (0402) TDK C1005C0G1H020J |
| C4, C6 | 2 | 150pF ±5%, 50V C0G ceramic capacitors (0402) TDK C1005C0G1H151J |
| C9, C10, C54, C55 | 0 | Not installed, ceramic capacitors (0402) |
| C19, C20 | 2 | 15000pF ±10%, 25V X7R ceramic capacitors (0402) TDK C1005X7R1E153K |
| C24, C25 | 2 | 15pF ±5%, 50V C0G ceramic capacitors (0402) TDK C1005C0G1H150J |
| C28, C29, C49, C50 | 4 | 100pF ±5%, 50V C0G ceramic capacitors (0402) TDK C1005C0G1H101J |
| C30, C32 | 2 | 100µF ±20%, 6.3V X5R ceramic capacitors (1210) TDK C3225X5R0J107M |
| D1 | 1 | Red LED (0603) |
| D2, D3 | 2 | Green LEDs (0603) |
| FB1, FB2, FB3 | 3 | 120Ω at 100MHz, 200mA ferrite beads (0603) Murata BLM18RK121SN1 |
| J1 | 1 | 4-pin, single-row header |
| J2 | 1 | 6-pin, single-row header |
| J5 | 1 | USB type-B right-angle female receptacle |
| J6 | 0 | Not installed, 10-pin dual-row header (2 x 5) |
| JU1, JU4, JU5 | 3 | 4-pin headers |
| JU2, JU3 | 2 | 3-pin headers |
| JU6–JU22 | 17 | 2-pin headers |
| Q1, Q2 | 2 | npn transistors Fairchild MMBT3904 |

*DI2CM is a trademark of Digital Core Design.*

*Windows and Windows Vista are registered trademarks of Microsoft Corp.*



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

# MAX11014 Evaluation Kit

## Component List (continued)

| DESIGNATION | QTY | DESCRIPTION |
|---|---|---|
| Q3, Q4 | 2 | RF power FETs<br>Excelics EFC240B-180F |
| R1, R2 | 2 | 1Ω ±1% current-sense resistors (2010) |
| R3, R4 | 2 | 100Ω ±5% resistors (0402) |
| R6, R7, R14 | 3 | 680Ω ±5% resistors (0402) |
| R8, R9 | 2 | 22Ω ±5%resistors (0402) |
| R10, R11 | 2 | 1kΩ ±1% resistors (0402) |
| R12, R13 | 2 | 1.5kΩ ±5% resistors (0402) |
| R15, R16 | 2 | 4.99kΩ ±1% resistors (0402) |
| R17, R18 | 2 | 510Ω ±5% resistors (1206) |
| TP1, TP2 | 0 | Not installed, test points |
| TP3, TP4 | 2 | Test points (red) |
| U1 | 1 | RF MESFET drain-current controller (48 TQFN-EP*)<br>Maxim MAX11014BGTM+ |
| U2 | 1 | 2.5V voltage reference (8 SO)<br>Maxim MAX6126AASA25+ |
| U3 | 1 | Microcontroller (64 QFN-EP*)<br>Atmel AT90USB1286-16MU |
| U4 | 1 | 3.3V LDO (16 TSSOP-EP*)<br>Maxim MAX8869EUE33+ |
| U5 | 1 | MAXII CPLD (100 TQFP)<br>Altera EPM570T100C5 |
| U6 | 1 | Tri-state logic buffer (5 SOT23) |
| Y1 | 1 | 8MHz crystal<br>Hong Kong X'tals<br>SSL8000000E18FAE |
| Y2 | 1 | 40MHz clock oscillator<br>Hong Kong X'tals<br>C437BM4000000AE00 |
| — | 22 | Shunts |
| — | 1 | USB high-speed A-to-B cable, 6ft |
| — | 1 | PCB: MAX11014 Evaluation Kit+ |

**EP = Exposed pad.*

## Component Suppliers

| SUPPLIER | PHONE | WEBSITE |
|---|---|---|
| Altera Corp. | 800-800-3753 | www.altera.com |
| Digital Core Design | 48-32-282-8266 | www.digitalcoredesign.com |
| Fairchild Semiconductor | 888-522-5372 | www.fairchildsemi.com |
| Hong Kong X'tals Ltd. | 852-35112388 | www.hongkongcrystal.com |
| Murata Electronics North America, Inc. | 770-436-1300 | www.murata-northamerica.com |
| TDK Corp. | 847-803-6100 | www.component.tdk.com |

***Note:*** *Indicate that you are using the MAX11014 when contacting these component suppliers.*

## MAX11014 EV Kit Files

| FILE | DESCRIPTION |
|---|---|
| INSTALL.EXE | Installs the EV kit files on your computer |
| MAX11014.EXE | Application program |
| ATUSBHID.DLL | USB software Library |
| UNINST.INI | Uninstalls the EV kit software |

## Quick Start

### Required Equipment

Before beginning, the following equipment is needed:

- MAX11014 EV kit (USB cable included)
- Windows 2000/XP/Vista PC with a spare USB port
- One +5V, 100mA power supply
- One -5V, 100mA power supply
- One +11V, 1A power supply

**Note 1:** The saturation current of the on-board MESFETs is approximately 450mA. During the evaluation process, limit the target drain current within 450mA to avoid permanent damage to the MESFETs.

**Note 2:** The channel temperature of the on-board MESFETs can be much higher than the measured temperature on Q1 and Q2 as the temperature-sensing diodes are not in contact with the MEFSETs. Raising the MESFETs' ambient temperature on Q1 and Q2 higher than +90°C could cause permanent damage to the MESFETs.

**Note 3:** 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 operating system.

### Procedure

The MAX11014 EV kit is fully assembled and tested. Follow the steps below to verify board operation:

1) Visit **www.maxim-ic.com/evkitsoftware** to download the latest version of the EV kit software, 11014Rxx.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file.
2) Install the MAX11014 EV kit software on your computer by running the INSTALL.EXE program inside the temporary folder. The program files are copied and icons are created in the Windows **Start | Programs** menu.
3) Verify that all jumpers are set in their default positions, as shown in Table 1.
4) Connect the +5V power supply to the AVDD and GND pads on the lower side of the EV board. Keep the power off.
5) Connect the -5V power supply to the AVSS and GND pads on the lower side of the EV board. Keep the power off.
6) Connect the +11V power supply positive terminal to the DRAIN1 and DRAIN2 pads. Connect the +11V power-supply negative terminal to the SOURCE1 and SORCE2 pads. Keep the power off.
7) Connect the USB cable from the PC to the EV kit board.
8) Turn on the power supplies.
9) Start the MAX11014 EV kit software by opening its icon in the **Start | Programs** menu. The EV kit software main window appears, as shown in Figure 1.
10) On the **Calibration & Regulation** tab sheet (Figure 6), press the **Run Current-sense Self-calibration Routine** button.
11) On the same tab sheet, move the **Target Current** track bars in the **Ch1 Current Regulation** and **Ch2 Current Regulation** group boxes to set the target current to 400mA.
12) Press the **Start** buttons in the **Ch1 Current Regulation** and **Ch2 Current Regulation** group boxes.
13) Increasing the target current can raise the channel temperature of the MESFETs quickly. Covering the EV board MESFETs' area can stop airflow, and the measured temperature is closer to the channel temperature.
14) Verify that the MAX11014 regulates the drain current to 400mA during temperature changes without TLUT and KLUT. Also observe the gate voltage changes when the temperature changes.

## Detailed Description of Software

The EV kit software contains six tab sheets. The MAX11014 configuration settings and parameters can be modified on the appropriate tab sheets. The status bar of the software window provides EV kit connection and data-transfer information.

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### Interface Control Tab

The **Interface Control** tab sheet shown in Figure 1 sets the I²C bus mode and the MAX11014 slave address. See Table 1 for the MAX11014 address pin configurations.

The **Interface Control** tab also provides low-level access to the MAX11014's registers. To read a register, select the register name in the **Reg** drop-down list in the **Read One Word From MAX11014** group box, then press the **Read** button. To write to a register, select the register name in the **Reg** drop-down list in the **Write One Word To MAX11014** group box and type in the value expected in the **Data: 0x** edit box, then press the **Write** button.

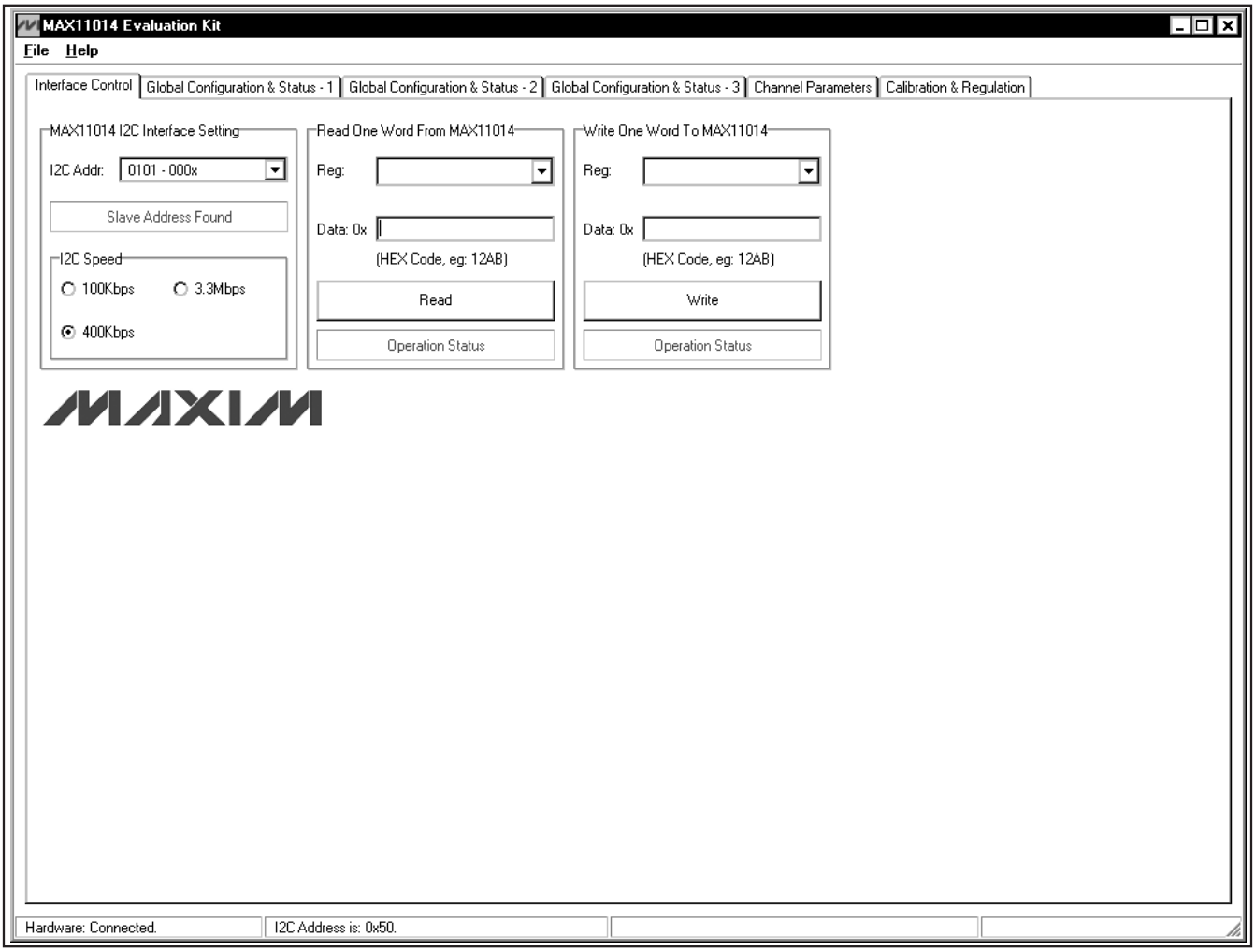



*Figure 1. MAX11014 EV Kit Software Main Window (Interface Control Tab)*

### Global Configuration & Status - 1 Tab

The **Global Configuration & Status - 1** tab sheet shown in Figure 2 provides read and/or write access to the FLAG, SHUT, ADCCON, HCFG, and SCFG registers.

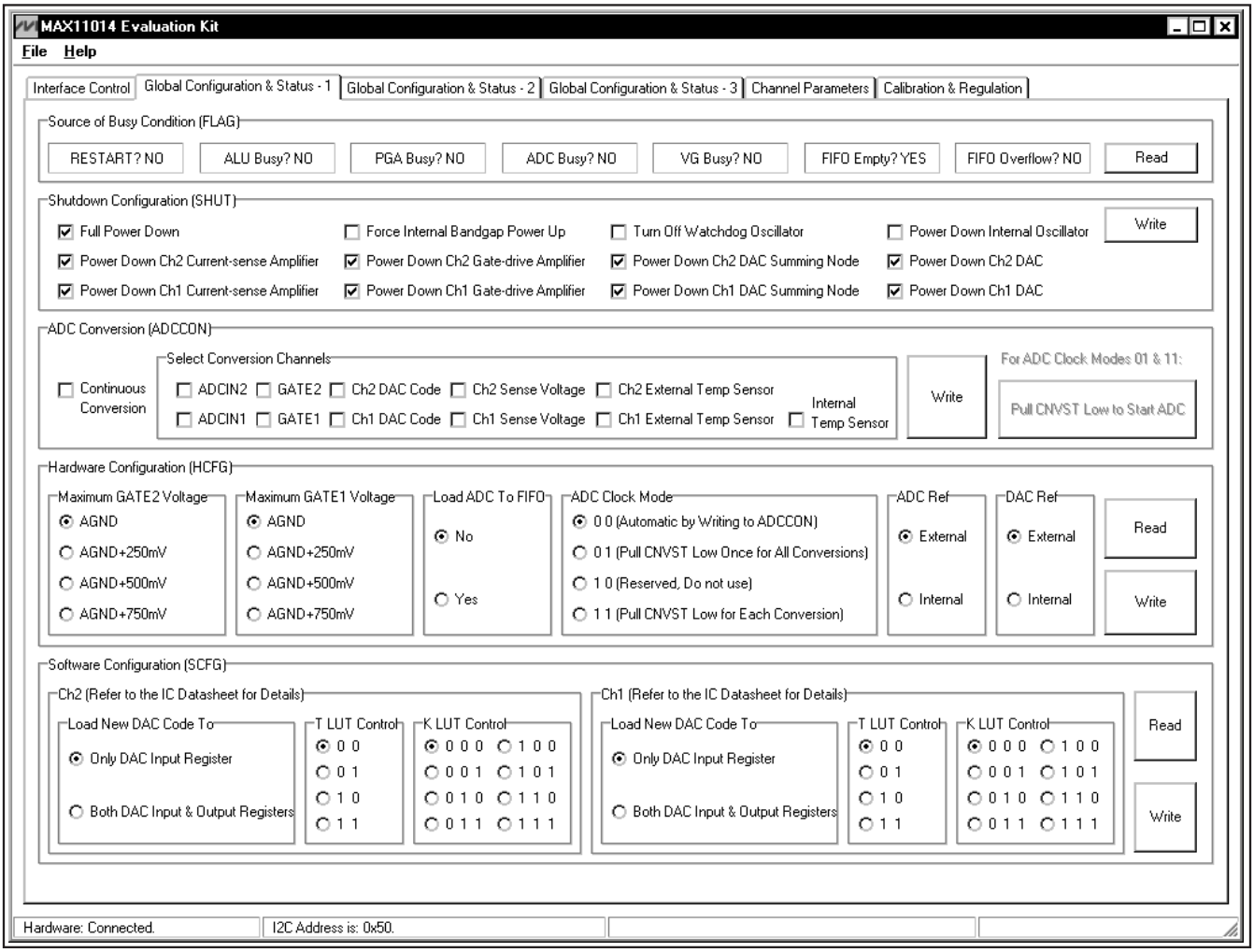



*Figure 2. MAX11014 EV Kit Software Main Window (Global Configuration & Status - 1 Tab)*

### Global Configuration & Status - 2 Tab

The **Global Configuration & Status - 2** tab sheet shown in Figure 3 provides read and/or write access to the ALMHCFG, ALMSCFG, and ALMFLAG registers.

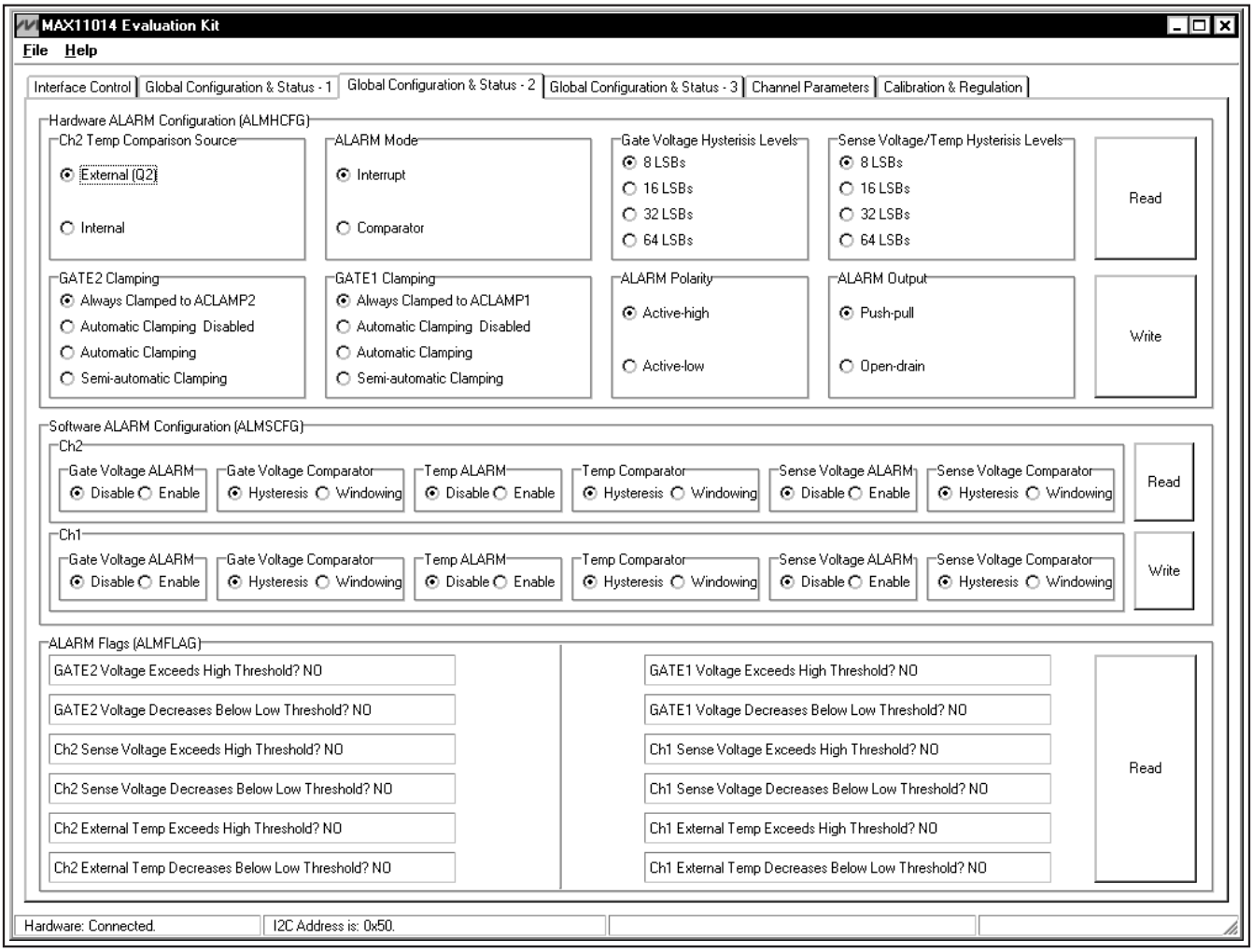



*Figure 3. MAX11014 EV Kit Software Main Window (Global Configuration & Status - 2 Tab)*

### *Global Configuration & Status - 3 Tab*

The **Global Configuration & Status - 3** tab sheet shown in Figure 4 provides access to the SCLR register. This register generates the following commands: reset all the internal registers, clear the internal ALU, and reset the FIFO. This register also resets the ALARM threshold registers, ALARM flag register, and the DAC registers.

The **Global Configuration & Status - 3** tab sheet also provides access to the LDAC register. Write to the LDAC register to load the values stored in the DAC input registers to their respective DAC output registers.

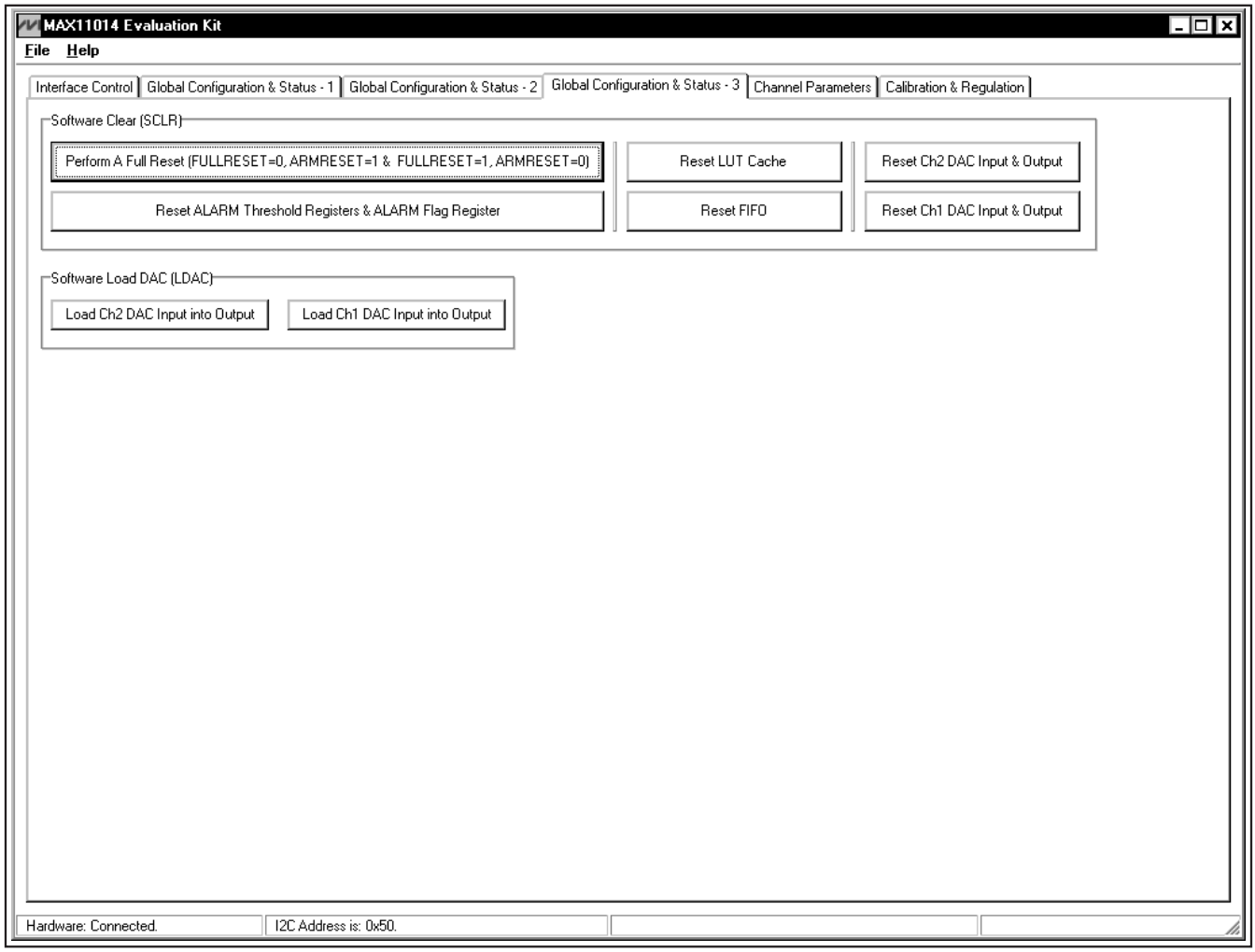



*Figure 4. MAX11014 EV Kit Software Main Window (Global Configuration & Status - 3 Tab)*

# MAX11014 Evaluation Kit

### Channel Parameters Tab

The **Channel Parameters** tab sheet shown in Figure 5 provides write access to the DAC input and output registers, $V_{SET}$ registers, and K parameter registers.

The **Channel Parameters** tab sheet also provides write and read access to the channel 1 and channel 2 threshold registers. They include sense voltage alarm, gate voltage alarm, and temperature alarm threshold registers.

To evaluate a different full-scale regulation current other than 625mA, a user can change the value of the on-board current-sense resistors, R1 and R2. The new value should be typed in the **Ch1 & Ch2 current sense resistor value (Ohm)** edit box for the software to work properly.

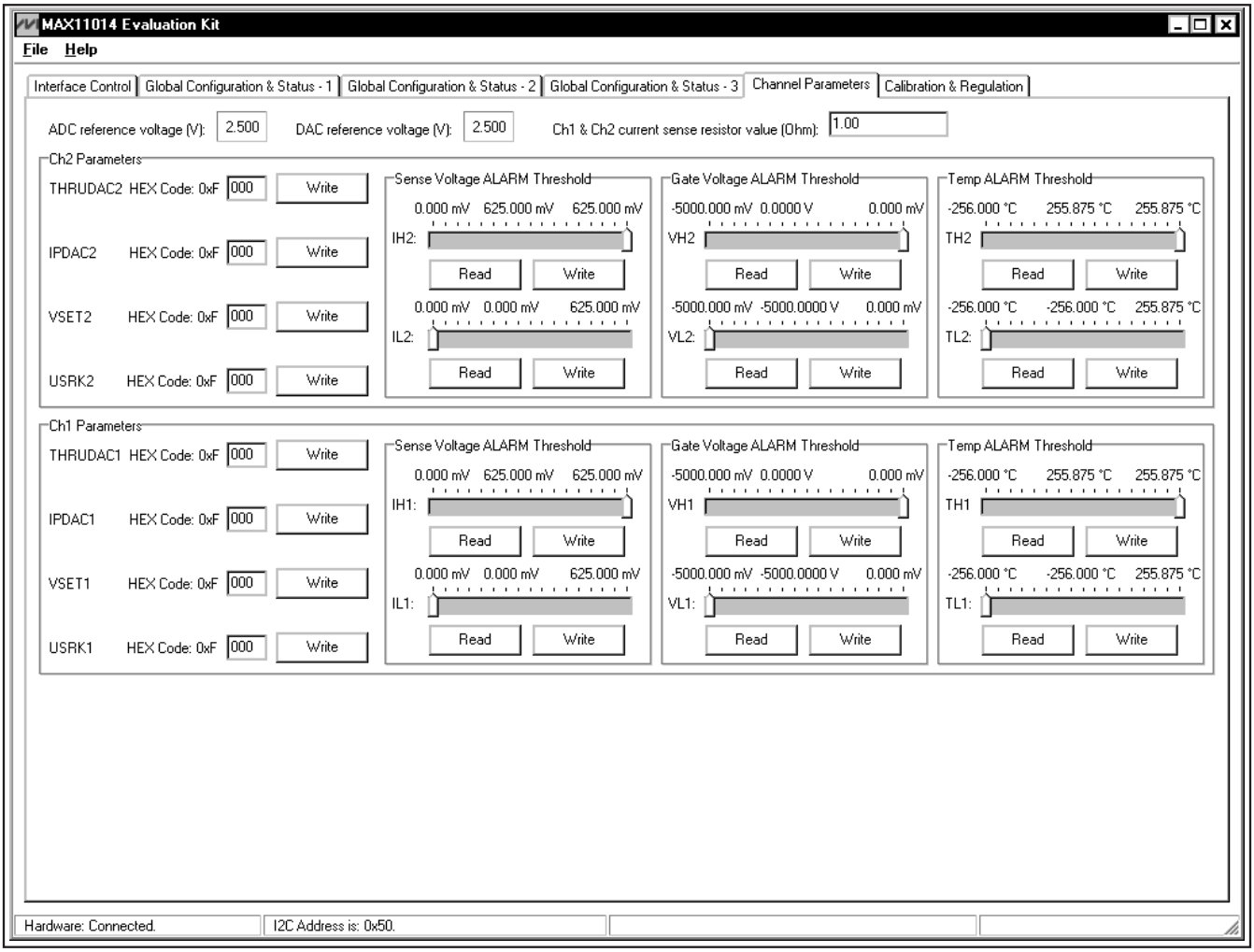



*Figure 5. MAX11014 EV Kit Software Main Window (Channel Parameters Tab)*

### Calibration & Regulation Tab

The **Calibration & Regulation** tab sheet shown in Figure 6 provides access to the PGACAL register. Write to this register to calibrate the channel 1 and channel 2 current-sense amplifiers.

To begin a calibration, set the PGACAL register bits first, then press the **Run Current-sense Self-calibration Routine** button. PGA offset is determined by setting the HVCAL_ bits and commanding a sense-voltage ADC conversion.

The **Calibration & Regulation** tab sheet includes a window to show the results of a regulated drain current without using the look-up tables.

The demo program calculates the ideal DAC code without PGA offset by the following equation:

$$DAC(CODE) = 4095 \times \frac{\text{Target Current}}{\text{Full-Scale Current}}$$

This DAC code is written to the DAC input and output register (THRUDAC_) to load the DAC code directly to the respective DAC output and bypass a DAC(CODE) calculation.

The demo window provides other information such as the MAX11014 internal temperature, the MESFET ambient temperature, etc. Refer to the MAX11014 IC data sheet for the conditions of a precise accuracy calculation.

Due to PCB limitations, sense accuracy cannot be accurately measured. Refer to the MAX11014 IC data sheet to see how full sense accuracy is measured.

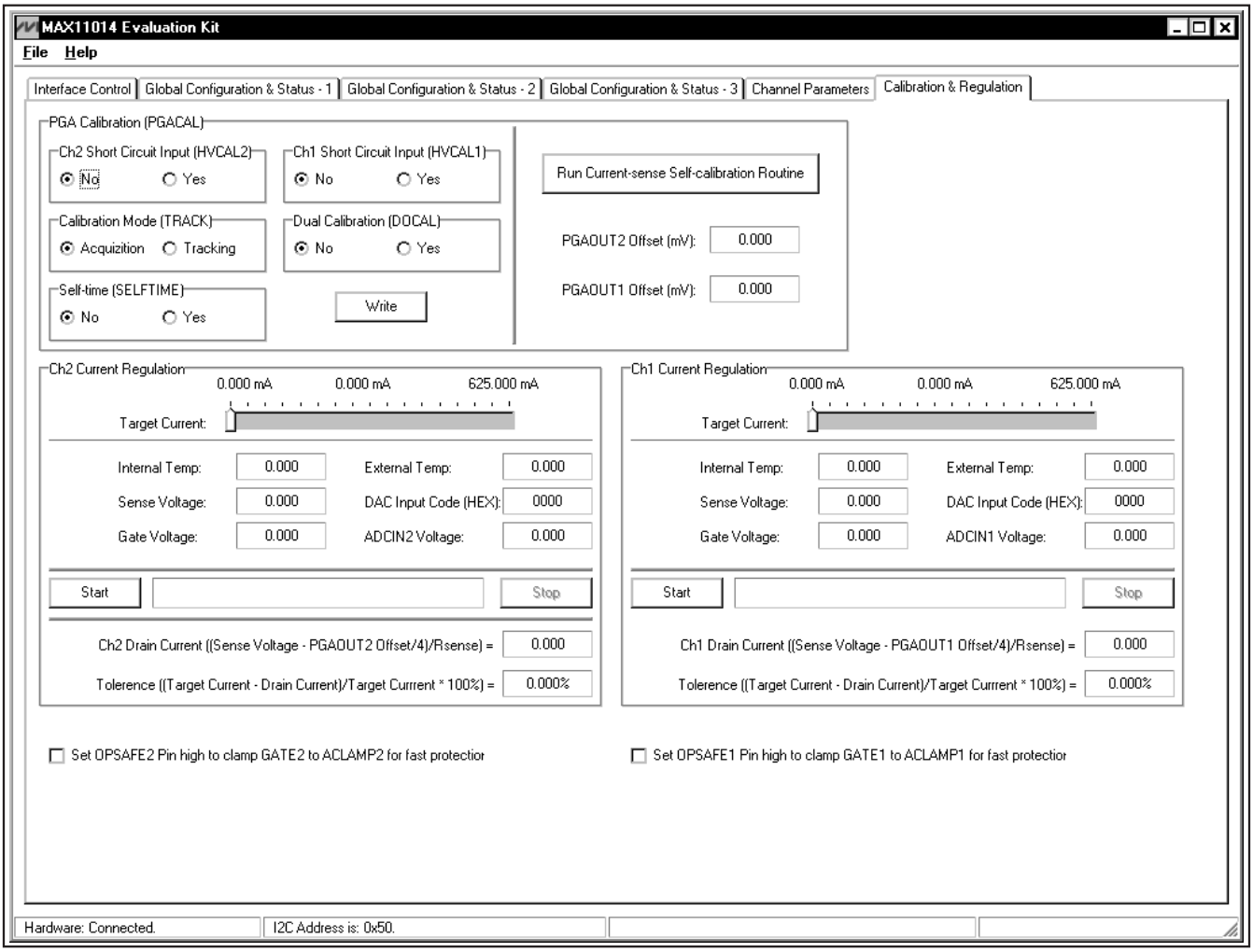



*Figure 6. Calibration & Regulation Tab*

The **Calibration & Regulation** tab sheet also includes the MAX11014 OPSAFE_ pin controls. Check the checkboxes to set the OPSAFE_ pins to clamp the gates to ACLAMP_ for fast protection of the MESFETs. Uncheck the checkboxes to clear the OPSAFE_ pins.

## _Detailed Description of Hardware

The MAX11014 EV kit is a complete evaluation system for the MAX11014 automatic RF MESFET amplifier drain-current controller. Check the EV kit schematic for detailed EV kit hardware.

### Power Supplies

The MAX11014's digital supply (DVDD) is provided by the on-board +3.3V LDO by default. To apply an external power supply for DVDD, remove the shunt on JU14 and connect the external power supply on the DVDD and DGND pads.

The MAX11014's analog supplies (AVDD and AVSS) are applied on the AVDD, AGND, and AVSS pads.

The on-board MESFETs are powered through the DRAIN1, DRAIN2 and SOURCE1, SOURCE2 pads. **The absolute maximum $V_{DS}$ is 15V and the maximum continuous $V_{DS}$ is 10V**.

### I²C Address

The MAX11014 has a 7-bit I²C slave address. The most-significant bits of the slave address are factory programmed to 0101. The logic state of address inputs A2, A1, and A0 determine the 3 least-significant bits of the device address. Connect A2, A1, and A0 to DVDD for a high logic state or DGND for a low logic state. See Table 1 for address pin configurations.

### ADC and DAC References

The MAX11014 has internal 2.5V ADC and DAC voltage references. An on-board MAX6126 device can also be used. A user can also apply external references on JU19/JU20.

External references are selected by default. To select the internal references, configure the ADCREF_ and DACREF_ bits in the HCFG register properly.

### Use SPI Interface Instead of I²C Interface

Although the EV kit is designed for an I²C-compatable interface, an SPI™-compatible interface can be used instead by changing the settings of JU1, JU3, and JU4. See Table 1 for details.

### Evaluate User-Supplied MESFETs

To evaluate user-supplied MESFETs, remove the shunts on JU6–JU9, JU15, and JU16 for channel 1 and the shunts on JU10–JU13, JU17, and JU18 for channel 2. Connect the MAX11014 pins to the target MESFETs, current-sense resistors, and remote npn transistors with the proper wires.

### DI2CM Core (Provided by Digital Core Design)

The DI2CM is an IP core that provides an interface between a microprocessor and an I²C bus. It can work as a master or slave device depending on the working mode determined by a microprocessor/microcontroller. The DI2CM core supports all the transmission modes required by the I²C specification: standard, fast, and high speed. Contact Digital Core Design for any questions relating to the DI2CM IP core. See the *Component Suppliers* section for contact information, or email Digital Core Design at info@dcd.pl for more information.

*SPI is a trademark of Motorola, Inc.*

## Table 1. EV Kit Jumper Settings (JU1–JU22)

| JUMPER | SETTING | DESCRIPTION |
|---|---|---|
| JU1 | 1-2 | SPI interface DOUT pin |
| | 1-3 | I²C A1 pin connected to DVDD |
| | 1-4* | I²C A1 pin connected to DGND |
| JU2 | 1-2 | I²C A2 pin connected to DVDD |
| | 2-3* | I²C A2 pin connected to DGND |
| JU3 | 1-2 | Select SPI mode |
| | 2-3* | Select I²C mode |
| JU4 | 1-2 | SPI interface $\overline{CS}$ pin |
| | 1-3 | I²C A0 pin connected to DVDD |
| | 1-4* | I²C A0 pin connected to DGND |
| JU5 | 1-2 | $\overline{CNVST}$ pin connected to microcontroller GPIO pin |
| | 1-3* | $\overline{CNVST}$ pin connected to DVDD |
| | 1-4 | $\overline{CNVST}$ pin connected to DGND |
| JU6, JU7 | 1-2* | Ch1 connected to the on-board current-sense circuit |
| | Open | Ch1 disconnected from the on-board current-sense circuit |
| JU8 | 1-2* | ADCIN1 connected to the on-board voltage-sense point |
| | Open | ADCIN1 disconnected from the on-board voltage-sense point |
| JU9 | 1-2* | GATE1 connected to the on-board MESFET gate |
| | Open | GATE1 disconnected from the on-board MESFET gate |
| JU10, JU11 | 1-2* | Ch2 connected to the on-board current-sense circuit |
| | Open | Ch2 disconnected from the on-board current-sense circuit |
| JU12 | 1-2* | ADCIN2 connected to the on-board voltage-sense point |
| | Open | ADCIN2 disconnected from the on-board voltage-sense point |
| JU13 | 1-2* | GATE2 connected to the on-board MESFET gate |
| | Open | GATE2 disconnected from the on-board MESFET gate |
| JU14 | 1-2* | DVDD connected to the on-board 3.3V LDO output |
| | Open | DVDD connected to an external power supply |
| JU15, JU16 | 1-2* | MAX11014 senses the on-board Q1 temperature |
| | Open | MAX11014 senses a remote npn transistor temperature |
| JU17, JU18 | 1-2* | MAX11014 senses the on-board Q2 temperature |
| | Open | MAX11014 senses a remote npn transistor temperature |
| JU19 | 1-2* | REFDAC connected to MAX6126 2.5V reference output |
| | Open | REFDAC connected externally |
| JU20 | 1-2* | REFADC connected to MAX6126 2.5V reference output |
| | Open | REFADC connected externally |
| JU21 | 1-2* | ACLAMP2 connected to AVSS |
| | Open | ACLAMP2 connected externally |
| JU22 | 1-2* | ACLAMP1 connected to AVSS |
| | Open | ACLAMP1 connected externally |

**Default position.*

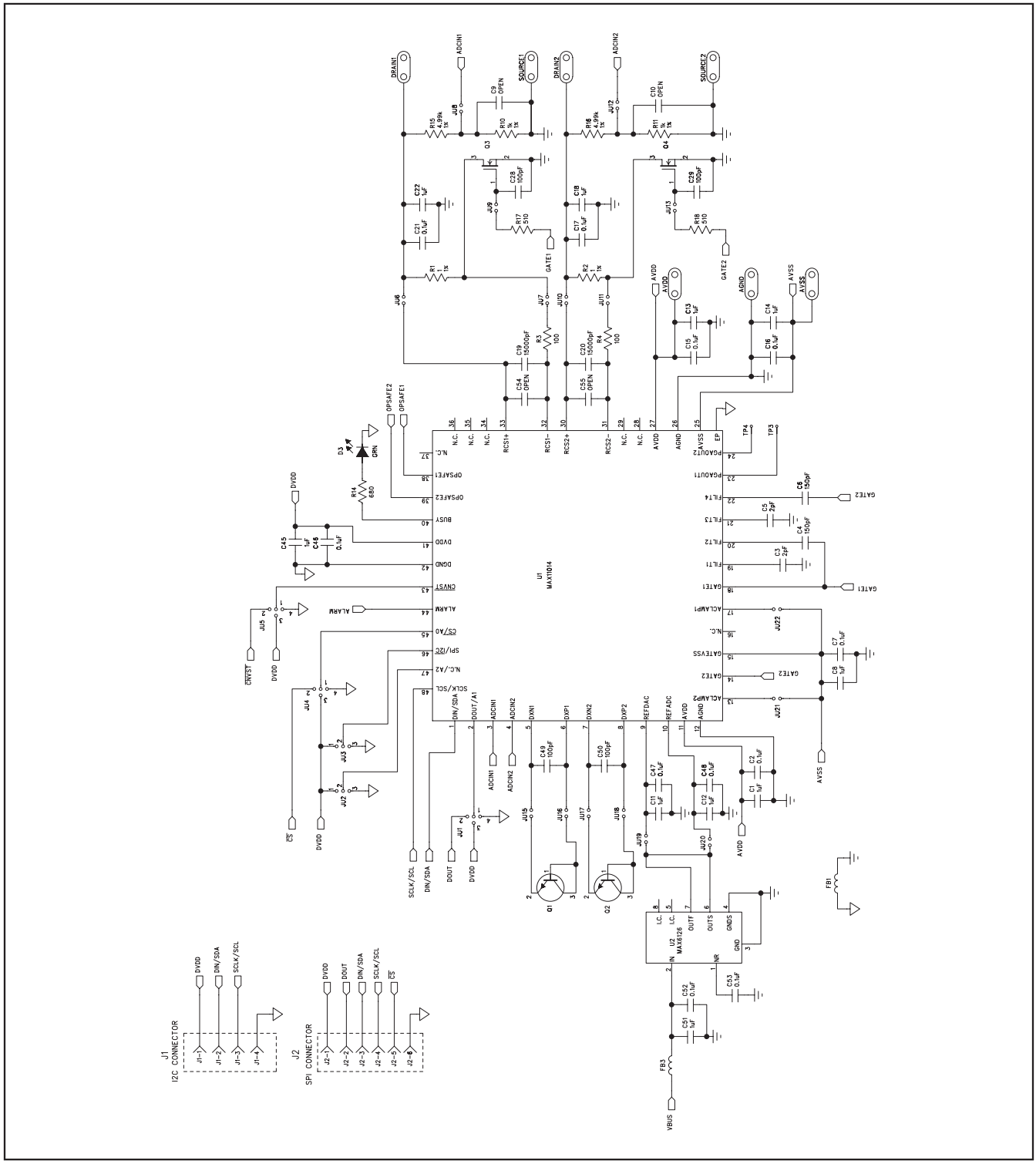



*Figure 7a. MAX11014 EV Kit Schematic (Sheet 1 of 3)*

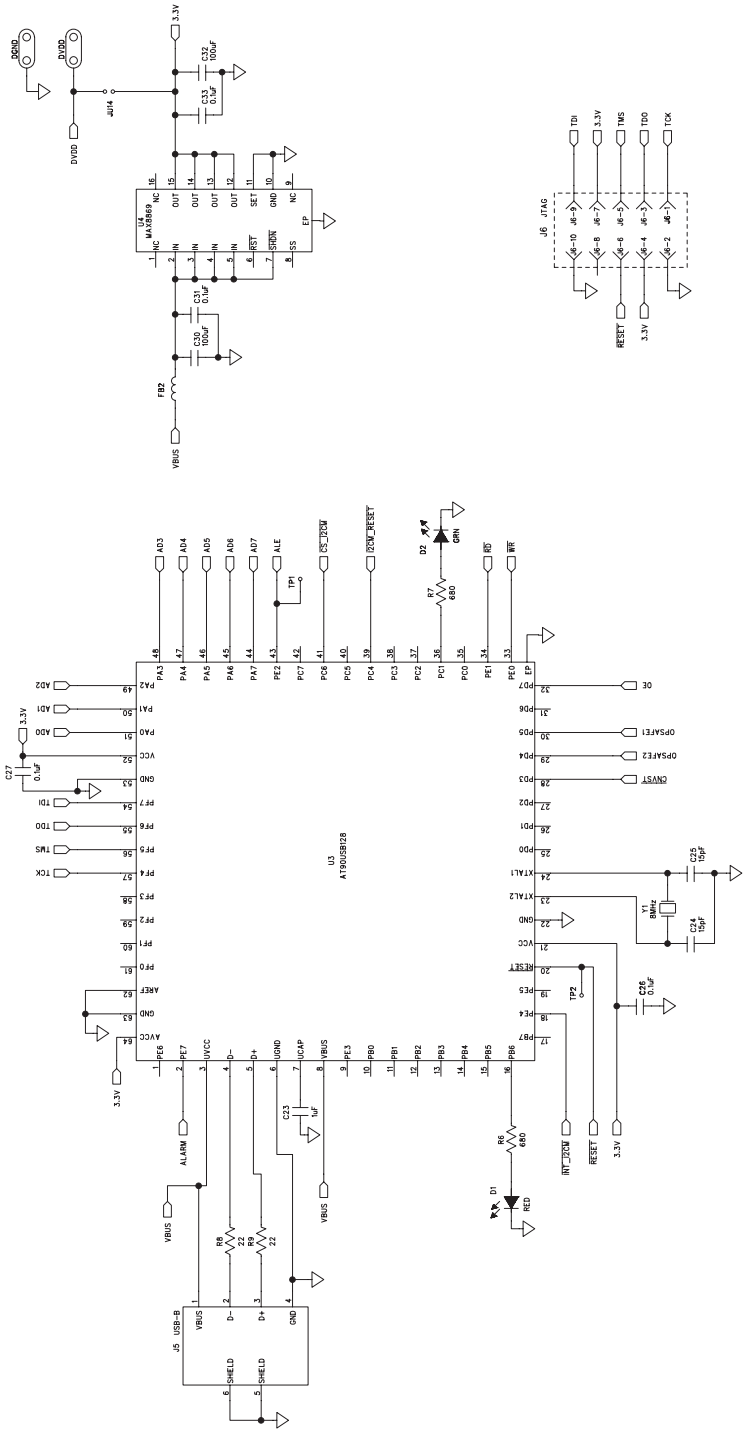



*Figure 7b. MAX11014 EV Kit Schematic (Sheet 2 of 3)*

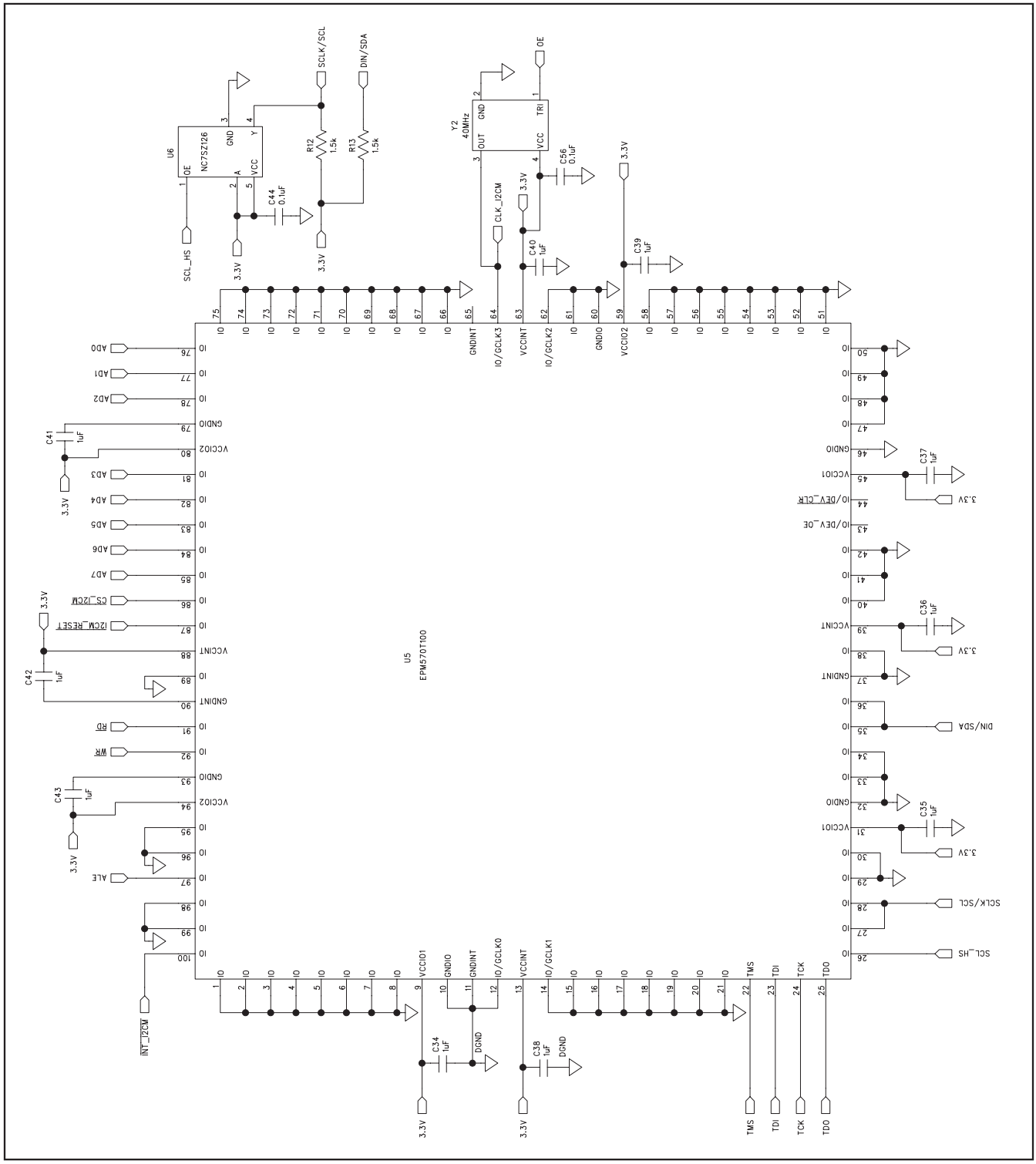



*Figure 7c. MAX11014 EV Kit Schematic (Sheet 3 of 3)*

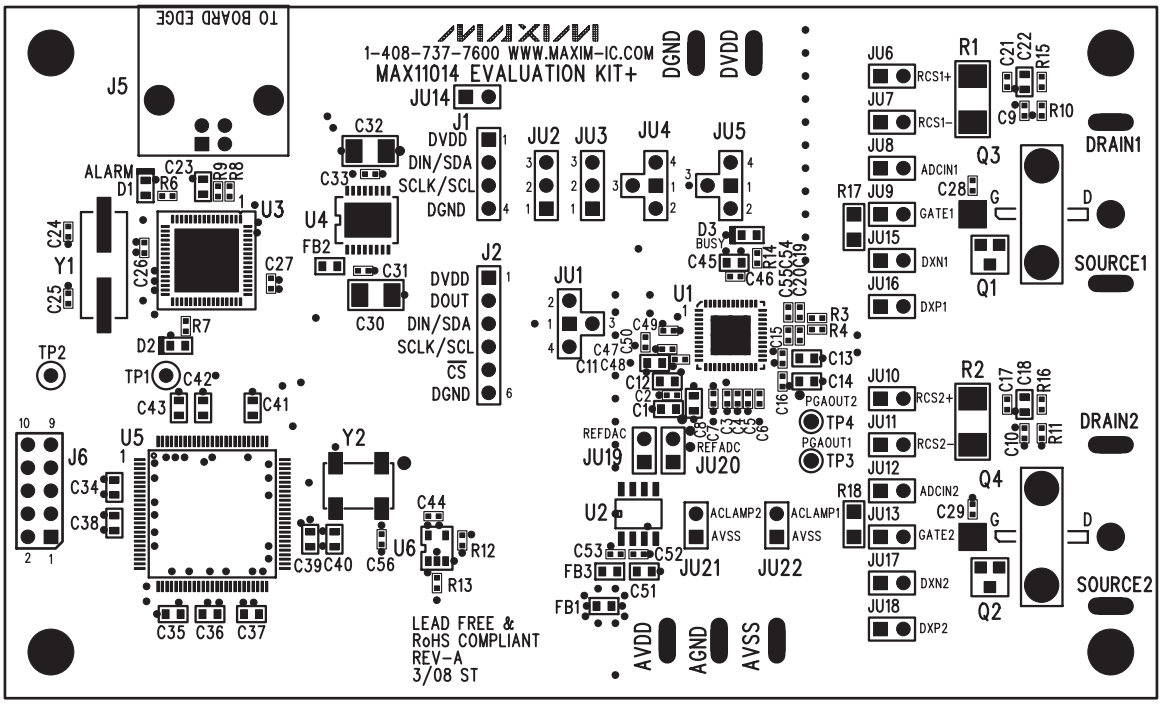



*Figure 8. MAX11014 EV Kit Component Placement Guide—Component Side*

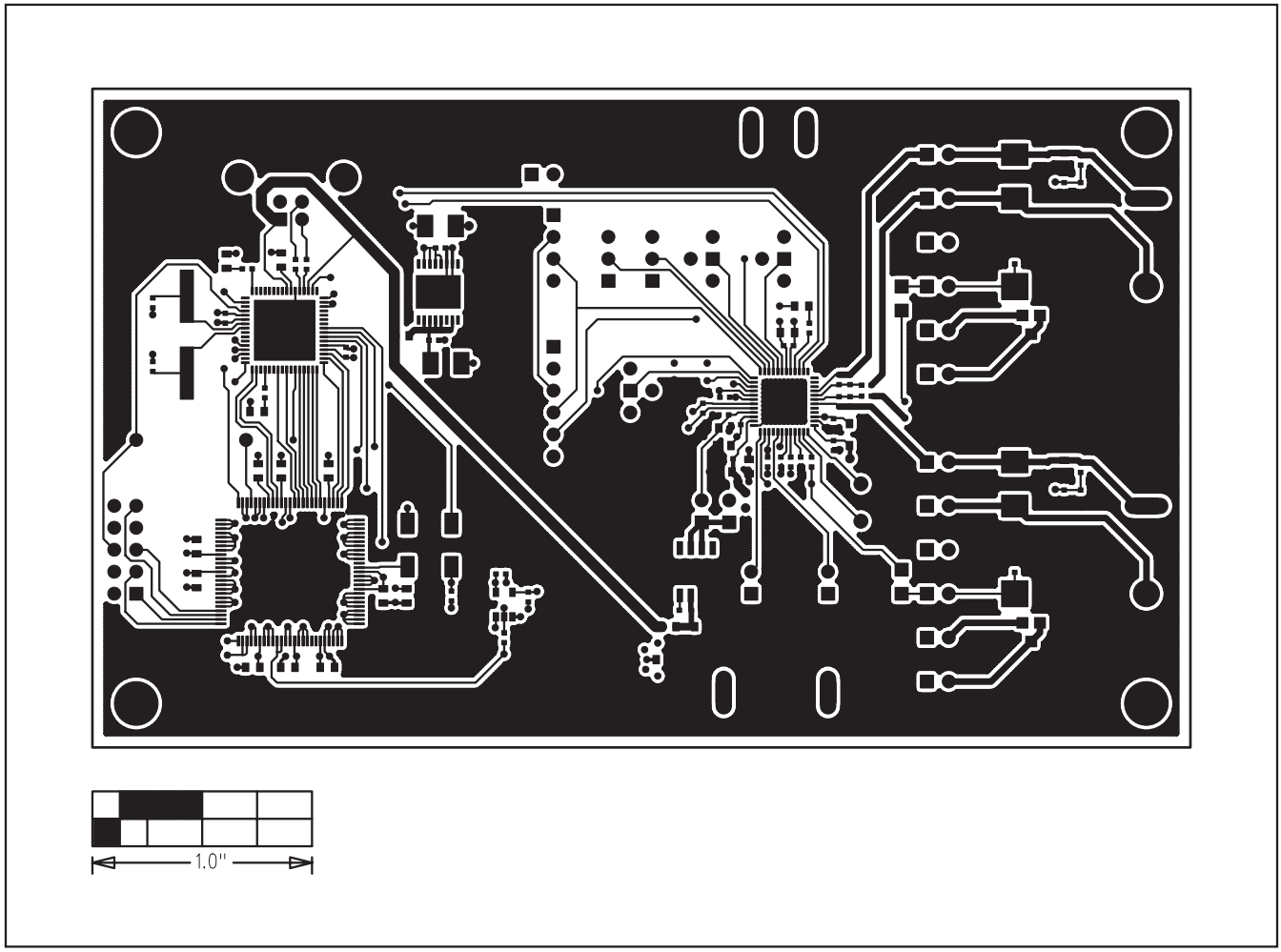



*Figure 9. MAX11014 EV Kit PCB Layout—Component Side*

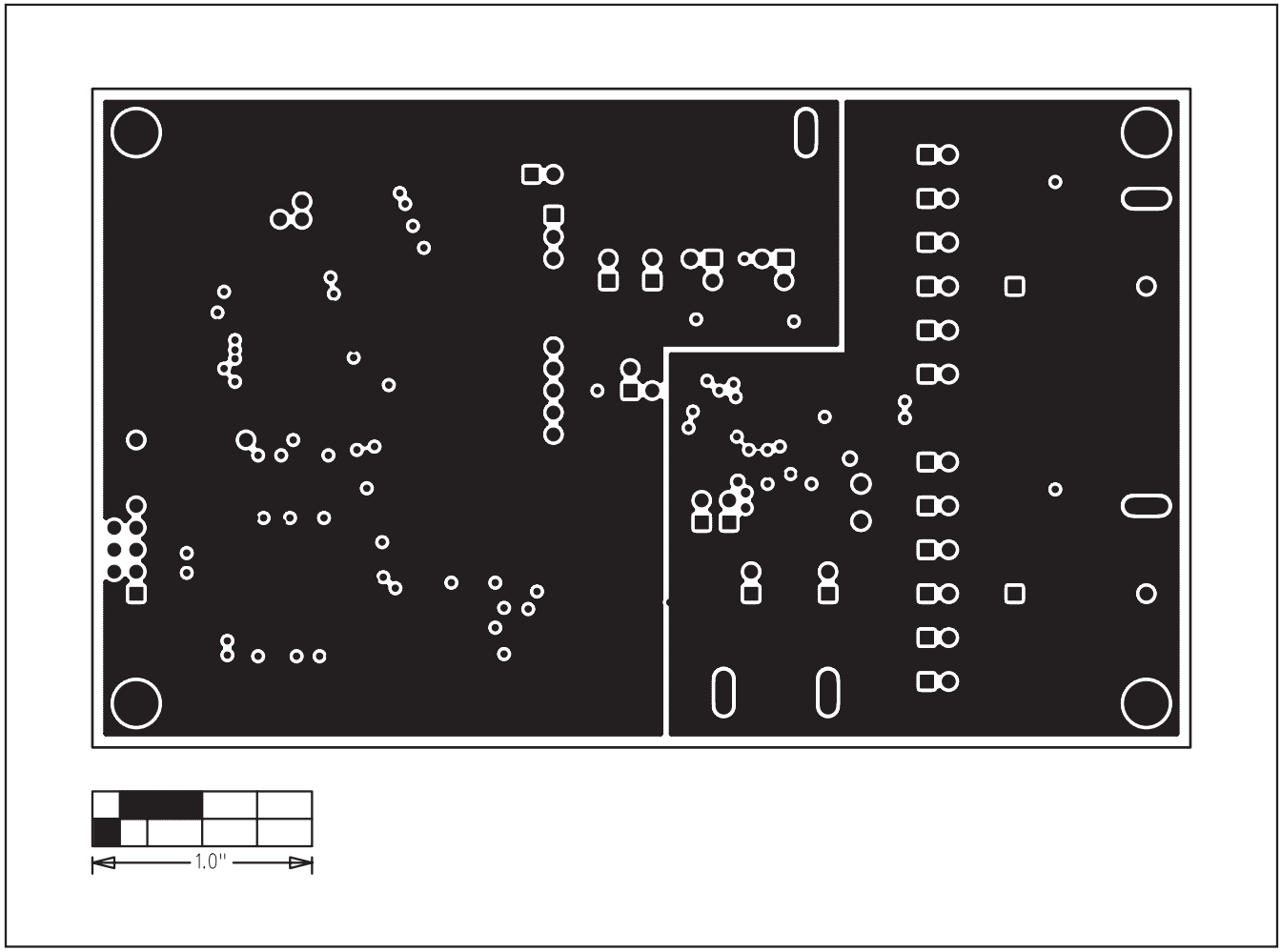



*Figure 10. MAX11014 EV Kit PCB Layout—Inner Layer 2*

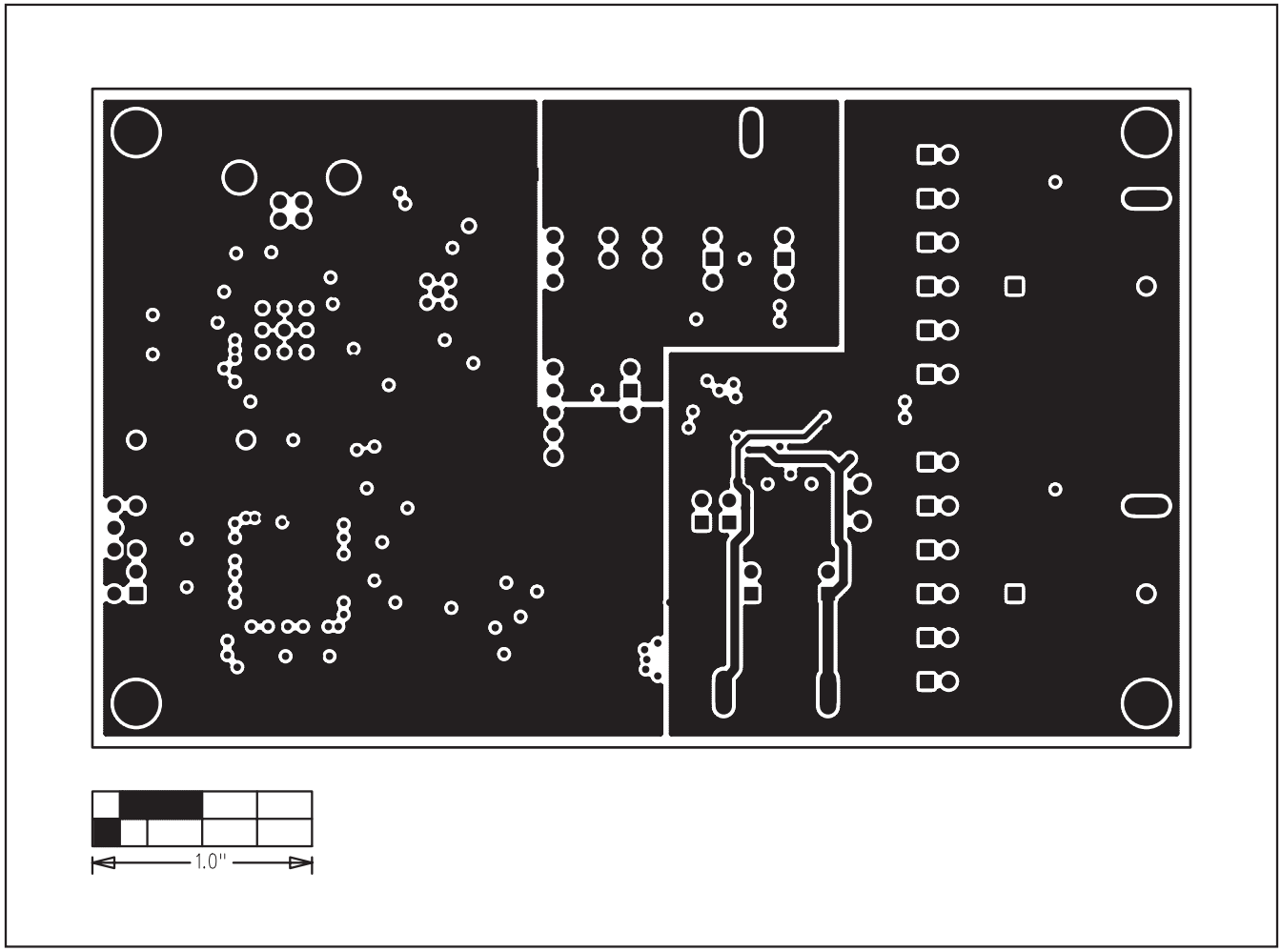



*Figure 11. MAX11014 EV Kit PCB Layout—Inner Layer 3*

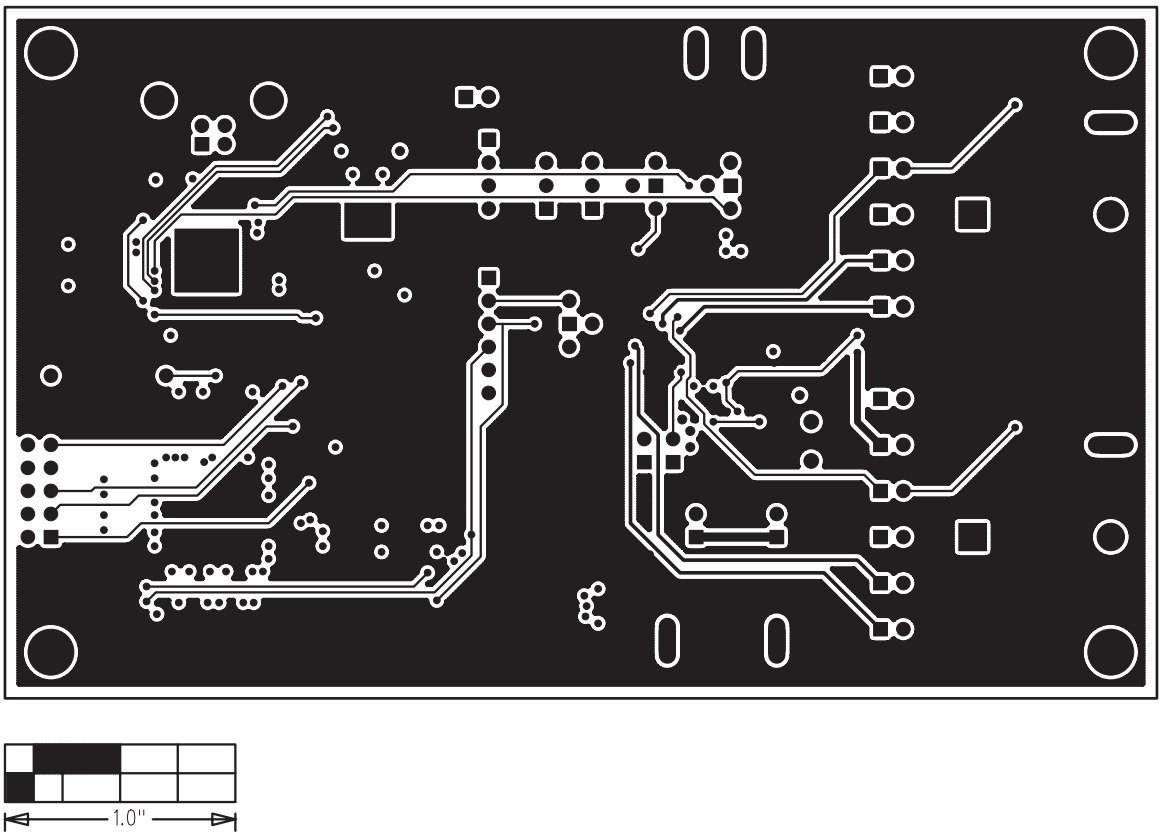



*Figure 12. MAX11014 EV Kit PCB Layout—Solder Side*

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 5/08 | Initial release | — |
| 1 | 9/08 | Corrected misspelling of three terms. | 3, 10 |

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