



MAX5898 Evaluation System/ Evaluation Kit

Evaluate: MAX5898

General Description

The MAX5898 evaluation kit (EV kit) is a fully assembled and tested circuit board that contains all the components necessary to evaluate the performance of the MAX5898 interpolating and modulating dual digital-to-analog converter (DAC). The EV kit board includes circuitry that converts the DAC differential output currents to single-ended voltages. The EV kit also includes circuitry that generates a clock signal from an AC sine-wave input signal.

The included evaluation software runs under Windows® 98/2000/XP, providing a graphical user interface (GUI) to exercise the features of the MAX5898 through the use of an SPI™ interface.

The MAX5898 EV kit provides a proven PC board layout to facilitate evaluation of the MAX5898. The EV kit must be interfaced to appropriate timing signals for proper operation. When using the EV kit without the CMOD232 command module, connect the system-side power (V_{MOD}), ground-return (GND), and interface (SCLK, CS, DIN, DOUT) signals to the pads on the PC board (see Figure 5). Refer to the MAX5898 data sheet for timing requirements.

The MAX5898 evaluation software runs under Windows 98/2000/XP on an IBM PC, interfacing to the EV system board (CMOD232) through the computer's serial communications port. See the *Quick Start* section for setup and operating instructions.

Order the complete EV system (MAX5898EVCMOD2) for comprehensive evaluation of the MAX5898 using a personal computer. Order the EV kit (MAX5898EVKIT) if the command module has already been purchased with another Maxim EV system, or for custom use in other microcontroller (μC)-based systems.

*Windows is a registered trademark of Microsoft Corp.
SPI is a trademark of Motorola, Inc.*

MAX5898 EV Kit Files

| PROGRAM | DESCRIPTION |
|---------------|--------------------------------|
| INSTALL.EXE | Installs the EV kit software |
| MAX5898.EXE | Application program |
| HELPPFILE.HTM | MAX5898 EV kit help file |
| UNINST.INI | Uninstalls the EV kit software |

Features

- ◆ Proven PC Board Layout
- ◆ SPI 4-Wire Serial Interface
- ◆ On-Board Reference Circuitry
- ◆ On-Board Reset Circuitry
- ◆ Assembled and Tested
- ◆ Includes Windows 98/2000/XP-Compatible Software

Ordering Information

| PART | TEMP RANGE* | IC PACKAGE | SPI INTERFACE TYPE |
|----------------|--------------|------------|--------------------|
| MAX5898EVKIT | 0°C to +70°C | 68 QFN | Not included |
| MAX5898EVCMOD2 | 0°C to +70°C | 68 QFN | CMOD232 |

* EV kit PC board temperature range only.

Note: The MAX5898 EV kit software is provided with the MAX5898 EV kit. The CMOD232 board is required to interface the EV kit to the computer when using the included software.

Component List

| DESIGNATION | QTY | DESCRIPTION |
|-----------------------------|-----|---|
| C1–C5 | 5 | 220μF ±20%, 6.3V tantalum capacitors (C-case) AVX TPSC227M006R0250 |
| C6–C10 | 0 | Not installed (C-case) |
| C11–C15 | 5 | 10μF ±20%, 10V X5R ceramic capacitors (1210) TDK C3225X5R1A106M |
| C16–C20, C37–C40, C48 | 10 | 1.0μF ±20%, 6.3V X5R ceramic capacitors (0402) TDK C1005X5R0J105M |
| C21–C32, C34, C35, C36 | 15 | 0.1μF ±20%, 16V X7R ceramic capacitors (0306) TDK C0816X7R1C104M |
| C41, C42 | 2 | 0.1μF ±20%, 10V X7R ceramic capacitors (0402) TDK C1005X7R1A104M |
| C43–C46 | 0 | Not installed (0603) |
| C47 | 0 | Not installed (0402) |

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Component List (continued)

| DESIGNATION | QTY | DESCRIPTION |
|----------------------------------|-----|---|
| J1 | 1 | 2 x 20 right-angle female connector |
| J2, J3 | 2 | Dual-row, right-angle, 40-pin headers |
| JU3, JU4 | 2 | Jumpers, 2-pin headers |
| L1–L5 | 5 | Ferrite bead cores (0805) |
| OUTI, OUTQ, CLK, DATACLKN, | 5 | SMA PC-mount connectors |
| OUTIN, OUTIP, OUTQN, OUTQP | 0 | Not installed |
| R1–R4 | 4 | 49.9Ω ±0.1% resistors (0603) IRC PFC-W0603R-03-49R9-B or equivalent |
| R5 | 1 | 2kΩ ±0.1% resistor (0603) Panasonic ERA-3YEB202V |
| R6, R7 | 2 | 24.9Ω ±0.1% resistors (0603) IRC PFC-W0603R-03-24R9-B or equivalent |
| R8, R9 | 2 | 100Ω ±0.1% resistors (0603) Panasonic ERA-3YEB101V |

| DESIGNATION | QTY | DESCRIPTION |
|-------------|-----|---|
| R10–R13 | 0 | Not installed (0603) |
| R14 | 1 | 174kΩ ±1% resistor (0603) |
| R15 | 1 | 100kΩ ±1% resistor (0603) |
| SW1 | 1 | Momentary pushbutton switch (NO) |
| T1, T2 | 2 | 1:1 RF balun transformers Coilcraft TTWB3010-1 |
| T3, T4, T5 | 3 | RF transformers Mini-Circuits ADTL1-12 |
| U1 | 1 | Maxim MAX5898EGK (68-pin QFN 10mm x 10mm) |
| U2 | 1 | Maxim MAX6161AESA (8-pin SO) or Maxim MAX6161BESA (8-pin SO) |
| U3 | 1 | Maxim MAX6392KA29 (SOT23-8) top mark = AAHV |
| U4, U5 | 2 | Maxim MAX1840EUB (10-pin μMAX®) |
| — | 2 | Shunts |
| — | 1 | MAX5898 PC board |
| — | 1 | MAX5898 EV kit software |

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Component Suppliers

| SUPPLIER | PHONE | FAX | WEBSITE |
|---------------|--------------|--------------|-----------------------|
| AVX | 843-946-0238 | 843-626-3123 | www.avxcorp.com |
| CoilCraft | 847-639-6400 | 847-639-1469 | www.coilcraft.com |
| IRC | 361-992-7900 | 361-992-3377 | www.irctt.com |
| Mini-Circuits | 718-934-4500 | 718-934-7092 | www.minicircuits.com |
| Panasonic | 714-373-7366 | 714-737-7323 | www.panasonic.com |
| TDK | 847-803-6100 | 847-390-4405 | www.component.tdk.com |

Note: Indicate that you are using the MAX5898 when contacting these component suppliers.

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Quick Start

Recommended Equipment

- Maxim MAX5898EVCMOD2 (contains MAX5898 EV kit board and CMOD232 module)
- DC power supply, 9VDC at 200mA (included with CMOD232 module)
- Computer running Windows 98, 2000, or XP with a spare serial (COM) port
- Standard 9-pin, **straight-through**, male-to-female cable (serial extension cable) to connect the computer's serial port to the Maxim command module interface board; use Mouser part number 172-0906 or equivalent
- Two DC power supplies, 1.8V at 750mA
- Three DC power supplies, 3.3V at 200mA
- Signal generator with low phase noise and low jitter for clock input signal (e.g., HP 8662A, HP 8644B)
- One digital data generator
- One spectrum analyzer

Procedure

The MAX5898 EV kit is fully assembled and tested. Follow the steps below to verify board operation. **Do not turn on the power supply until all connections are completed:**

Command Module Setup

- 1) Disable the pullup resistors on the command module by setting both switches (SW1) to the OFF position.
- 2) Set the command module working voltage to 5.0V by placing a shunt across pins 2-3 of the VDD select jumper (J1).
- 3) Connect a cable from the computer's serial port to the command module (CMOD232) interface board. Use a **straight-through** 9-pin male-to-female cable. To avoid damaging the EV kit or your computer, do not use a 9-pin null-modem cable or any other proprietary interface cable that is physically similar to the straight-through cable.
- 4) Connect the provided wall-cube power supply to the CMOD232 board.

EV Kit Software Setup

- 5) The MAX5898.EXE software program can be run from the CD-ROM or hard drive. Use the INSTALL.EXE program to copy the files and create icons in the Windows 98/2000/XP **Start** menu.

EV Kit Setup

- 6) Verify that shunts are installed in the following locations:
 - JU3 (installed) → On-board reference enabled
 - JU4 (installed) → On-board reference enabled
- 7) Connect a 1.8V DC power supply to the AVDD1.8 and GND pads.
- 8) Connect a 1.8V DC power supply to the DVDD1.8 and GND pads.
- 9) Connect a 3.3V DC power supply to the AVDD3.3 and GND pads.
- 10) Connect a 3.3V DC power supply to the DVDD3.3 and GND pads.
- 11) Connect a 3.3V DC power supply to the AVCLK and GND pads.
- 12) Connect the clock signal generator to the EV kit SMA connector labeled CLK.
- 13) Connect the digital data generator to headers J2 and J3 (see the *LVDS Input Data* section for connection details).
- 14) Connect the EV kit SMA connector labeled DATACLK to the data generator synchronization input.
- 15) Connect the OUTI or OUTQ connector to the spectrum analyzer.
- 16) Carefully align the 40-pin connector (J1) of the MAX5898 EV kit with the 40-pin header (P4) of the CMOD232 interface board. Gently press them together.
- 17) Plug the CMOD232 wall cube into an electrical outlet.
- 18) Turn on all of the DC power supplies.
- 19) Start the MAX5898 program by opening its icon in the **Start** menu.
- 20) Normal device operation can be verified by the "Status: MAX5898 Operational" text in the **Interface** box.

Detailed Description of Software

Main Window

The evaluation software's main window (Figure 1) consists of an **Interface** diagnostic box, the MAX5898 Control Tabs, and some system level controls.

The **Interface** box indicates the current **Device Type**, the **Register Address**, and the **Data Sent/Received** for the last read/write operation. Change the SPI SCLK frequency through the **SPI Clock Frequency** drop-down box. While the MAX5898 supports a maximum SPI clock frequency of 10MHz, the CMOD232 interface board is

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limited to 4MHz. To connect a faster SPI interface board to the EV kit, see the *Using an Alternative SPI Interface* section.

The MAX5898 EV kit software continuously polls the MAX5898 to make sure that the two boards have not become inadvertently disconnected. An undesired result of this polling is constant activity on the SPI bus. This feature may make it difficult to monitor the SPI bus for desired bit patterns. Disable this feature by checking the **Silence SPI Bus Activity** checkbox.

Return the EV kit to its power-on-reset state by clicking the **POR Reset** button.

IDAC Tab

The **IDAC** tab (Figure 1) configures the IDAC settings of the MAX5898. Adjust the **Coarse** and **Fine** gain by moving the sliders in the **IDAC Gain** box. For more precise control, enter the desired integer number in the edit box below each slider. Adjust the offset current and **Offset Direction** in the **IDAC Offset** box. Power down the IDAC by checking the **IDAC Power Down** checkbox.

QDAC Tab

The **QDAC** tab (Figure 2) configures the QDAC settings of the MAX5898. Adjust the **Coarse** and **Fine** gain by moving the sliders in the **QDAC Gain** box. For more precise control, enter the desired integer number in the edit box below each slider. Adjust the offset current and **Offset Direction** in the **QDAC Offset** box. Power down the QDAC by checking the **QDAC Power Down** checkbox.

Configuration Tab

The **Configuration** tab (Figure 3) configures the miscellaneous settings of the MAX5898. Select the desired **Latch Edge**, **Data Format**, and **Interleave** settings under the **Digital Input Data** controls. Select the desired **Interpolation Rate**, **Modulation Mode**, **Modulation Sign**, **Mixer Mode**, and **Filter Configuration** under the **Interpolators** controls. Select the data clock I/O pin and **Data Clock Output Enable** under the **Clock** section.

Note: Interleaved operation and DATACLK/B14 is only available when using the CMOS input versions of this DAC (MAX5893/MAX5894/MAX5895). Refer to the respective data sheet for details regarding these functions.

Simple SPI Commands

There are two methods for communicating with the MAX5898: through the normal user-interface panel or through the SPI commands available by selecting the **3-Wire Interface Diagnostic** item from the **Options** pull-down menu.

The SPI dialog boxes accept numeric data in hexadecimal format only. Hexadecimal numbers should be prefixed by "0x." See Figure 4 for an example of this tool.

Detailed Description of Hardware

The MAX5898 EV kit is designed to simplify the evaluation of the MAX5898 dual 16-bit, 500MSPS, interpolating and modulating current-output DAC. The MAX5898 operates with LVDS-compatible data inputs, a differential clock input signal, an internal 1.2V reference voltage, and 1.8V/3.3V power supplies for simple board operation.

The MAX5898 EV kit provides a header connector to easily interface with a pattern generator, circuitry that converts the differential current outputs to single-ended voltage signals, and circuitry to convert a user-supplied single-ended clock signal to a differential clock signal required by the MAX5898. The EV kit circuit includes multiple options for supplying a reference voltage to the DAC.

Power Supplies

The MAX5898 EV kit operates from 1.8V and 3.3V power supplies; however, two 1.8V power supplies and three 3.3V power supplies are recommended for optimum dynamic performance.

The EV kit board ground layout is divided into three sections: digital, analog, and clock. Using separate power supplies for each section reduces crosstalk and noise, and improves the integrity of the output signal.

LVDS Input Data

The MAX5898 EV kit provides two 0.1in, 2 x 20 headers (J2 and J3) to interface a 16-bit LVDS pattern generator to the EV kit. The header data pins are labeled on the board with their appropriate data bit designations. Table 1 details header connections for J2 and J3. Use the labels on the EV kit or Table 1 to match the data bits from the pattern generator to the corresponding data pins on headers J2 and J3.

Clock Signal

The MAX5898 requires a differential clock input signal with minimal jitter. The MAX5898 EV kit features single-ended-to-differential conversion circuitry. Supply a single-ended clock signal at the CLK SMA connector. The clock signal applied to the SMA should have a minimum amplitude of 10dBm when measured at the connector. Insertion loss due to the interconnecting cables decreases the amount of power seen at the EV kit input. Account for this loss when setting the signal-generator amplitude.

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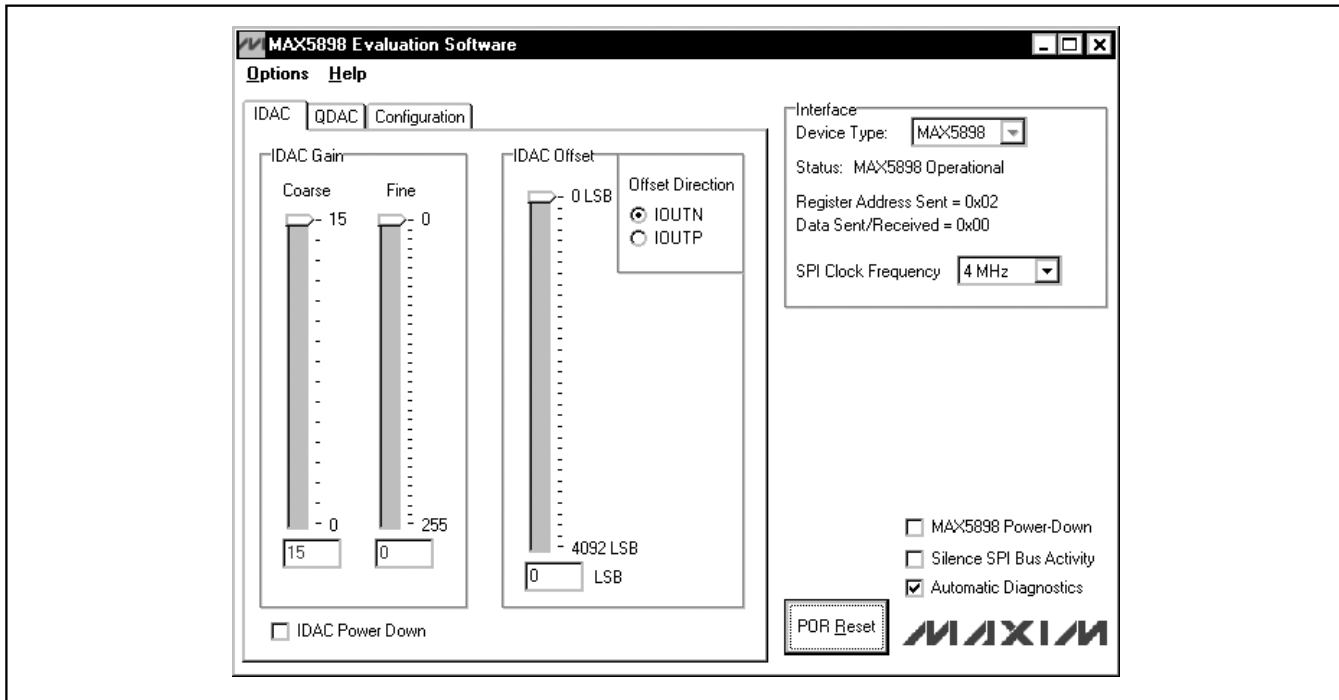


Figure 1. MAX5898 EV Kit Software Main Window (IDAC Tab)

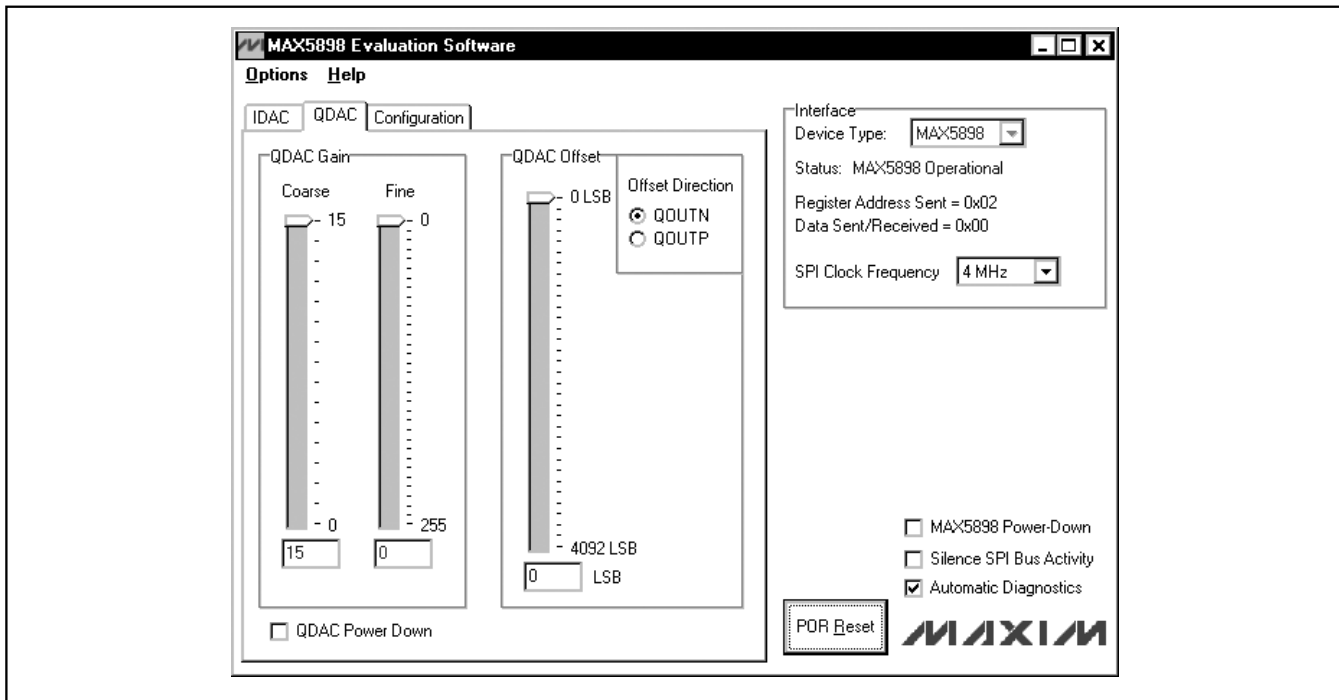


Figure 2. MAX5898 EV Kit Software Main Window (QDAC Tab)

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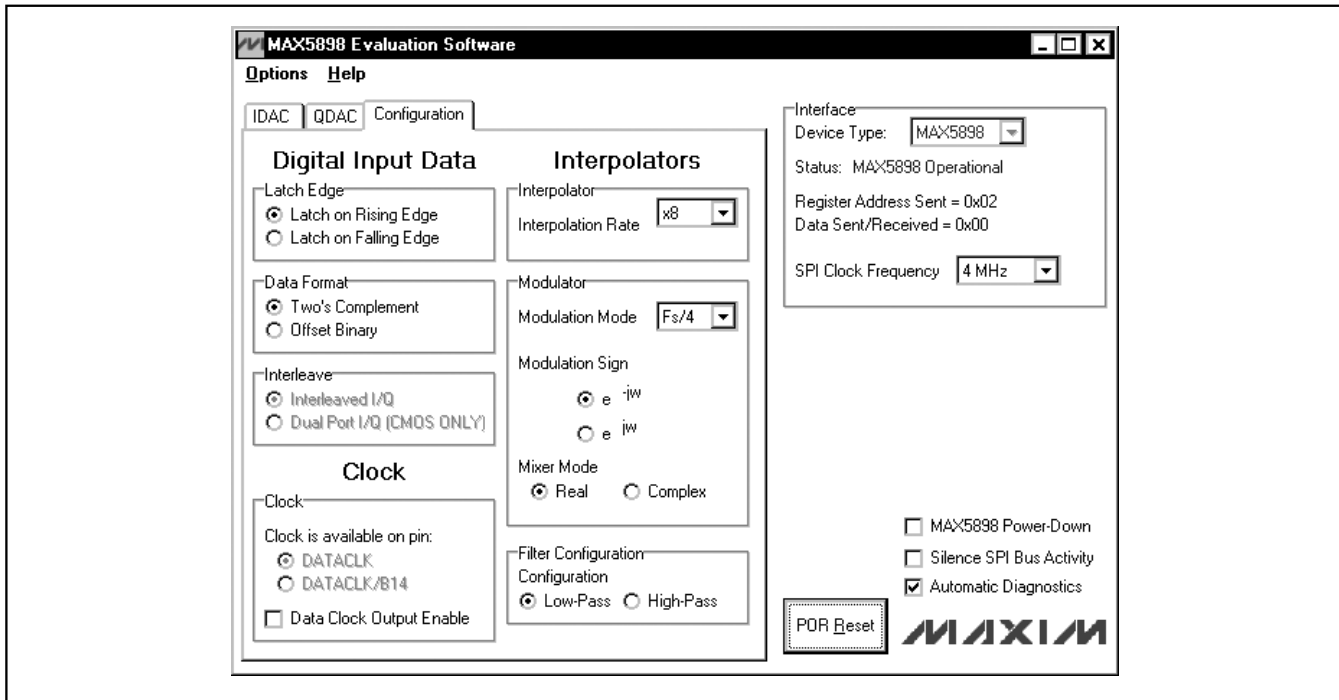


Figure 3. MAX5898 EV Kit Software Main Window (Configuration Tab)

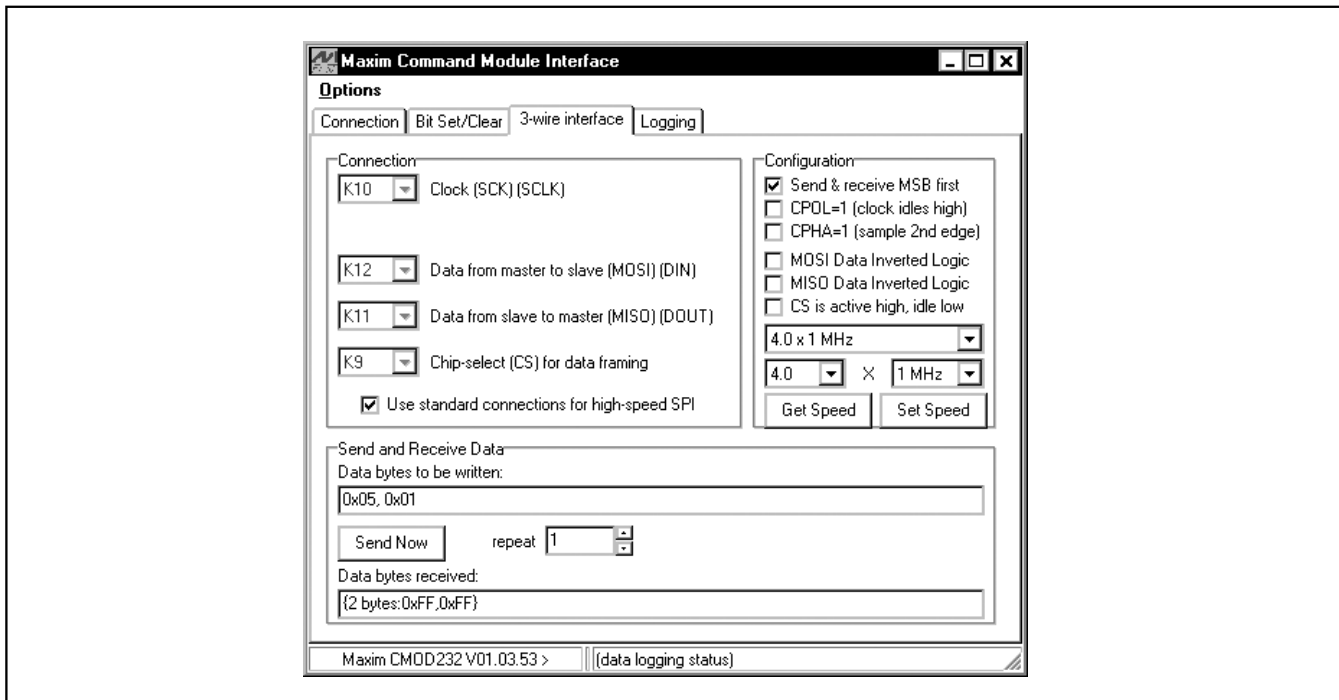


Figure 4. The above example shows a simple SPI transfer operation using the included 3-Wire Interface Diagnostics. In this example, the software is writing data (0x01h) to register address 0x05h. This sets the IDAC coarse gain to 1.

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Table 1. Digital Input Signals

| SIGNAL NAME | PIN | |
|-------------|-------|-------|
| | N | P |
| SELIQ | J2-39 | J2-37 |
| D15 | J2-35 | J2-33 |
| D14 | J2-31 | J2-29 |
| D13 | J2-27 | J2-25 |
| D12 | J2-23 | J2-21 |
| D11 | J2-19 | J2-17 |
| D10 | J2-15 | J2-13 |
| D9 | J2-11 | J2-9 |
| D8 | J2-7 | J2-5 |
| D7 | J2-3 | J2-1 |
| D6 | J3-39 | J3-37 |
| D5 | J3-35 | J3-33 |
| D4 | J3-31 | J3-29 |
| D3 | J3-27 | J3-25 |
| D2 | J3-23 | J3-21 |
| D1 | J3-19 | J3-17 |
| D0 | J3-15 | J3-13 |

Note: Pins J3-9, J3-7, J3-5, J3-3, and J3-1 are not connected. All other pins are connected to GND.

Reference Voltage Options

The MAX5898 requires a reference voltage to set the full-scale analog output current. The DAC contains a stable on-chip bandgap reference of 1.2V that is used by default. The internal reference can be overdriven by an external reference to enhance accuracy and drift performance or for gain control.

The MAX5898 EV kit features multiple reference options. Use the MAX5898 on-chip voltage reference by removing the shunts from jumpers JU3 and JU4. Use an external reference by removing the shunts from jumpers JU3 and JU4 and connecting a stable voltage reference at the REFIO pad. Install shunts on jumpers JU3 and JU4 to use the MAX5898 EV kit's on-board reference (MAX6161). See Table 2 to configure the shunts across jumpers JU3 and JU4 and select the source of the reference voltage.

Full-Scale Current

The MAX5898 requires an external resistor to set the full-scale output current. The MAX5898 EV kit's full-scale current is set to 20mA with resistor R5 (2.0k Ω).

Table 2. Reference Voltage Selection (JU3, JU4)

| SHUNT POSITIONS | VOLTAGE REFERENCE MODE |
|-----------------|---|
| Installed | External 1.25V reference (U2) connected to MAX5898 REFIO pin. |
| Not installed | MAX5898 internal 1.2V bandgap reference. |
| Not installed | User-supplied voltage reference at the REFIO pad (0.125V to 1.25V). |

Replace resistor R5 to adjust the full-scale output current. Refer to the *Reference Input/Output* section in the MAX5898 data sheet to select different values for resistor R5.

Differential Output

The MAX5898 complementary current outputs are terminated into a differential 50 Ω resistance to generate a voltage signal with a 1V_{p-p} differential amplitude. The positive and negative output signals of the differential signal can be measured at the OUTIP/OUTIN and OUTQP/OUTQN probe locations. The differential signal is converted into a 50 Ω single-ended signal with transformers T1 and T2 and can be measured at the OUTI/OUTQ SMA connectors.

Reset Circuitry

The MAX5898 EV kit features on-board reset circuitry that places the MAX5898 SPI registers in their default state after power-up. After power-up, the MAX5898 registers can be manually reset by pressing switch SW1. *If this button is pressed, click the **POR Reset** button on the MAX5898 EV kit software to synchronize the GUI with the hardware.*

Using an Alternative SPI Interface

The MAX5898 EV kit provides pads that allow an alternative SPI-compatible interface to be used. Connect the CMOS-compatible interface through the CS, DIN, DOUT, SCLK, and GND pads. The interface is connected to level translators that automatically translate the interface voltages to the MAX5898 system voltages. Apply the positive rail for the input side of the translators to the VMOD pad. Use the GND pad adjacent to DVDD3.3 as the ground reference.

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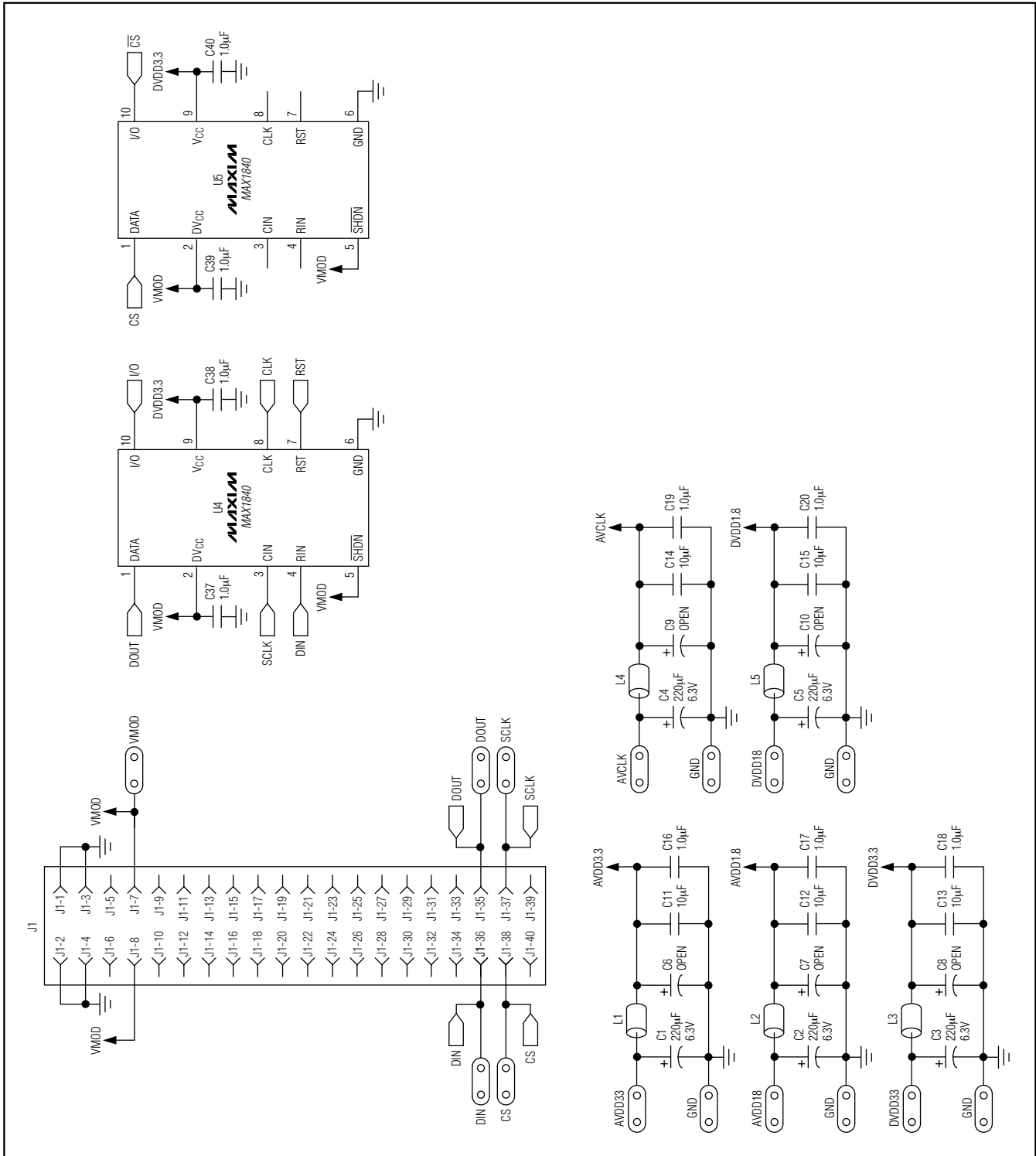


Figure 5b. MAX5898 EV Kit Schematic (Sheet 2 of 2)

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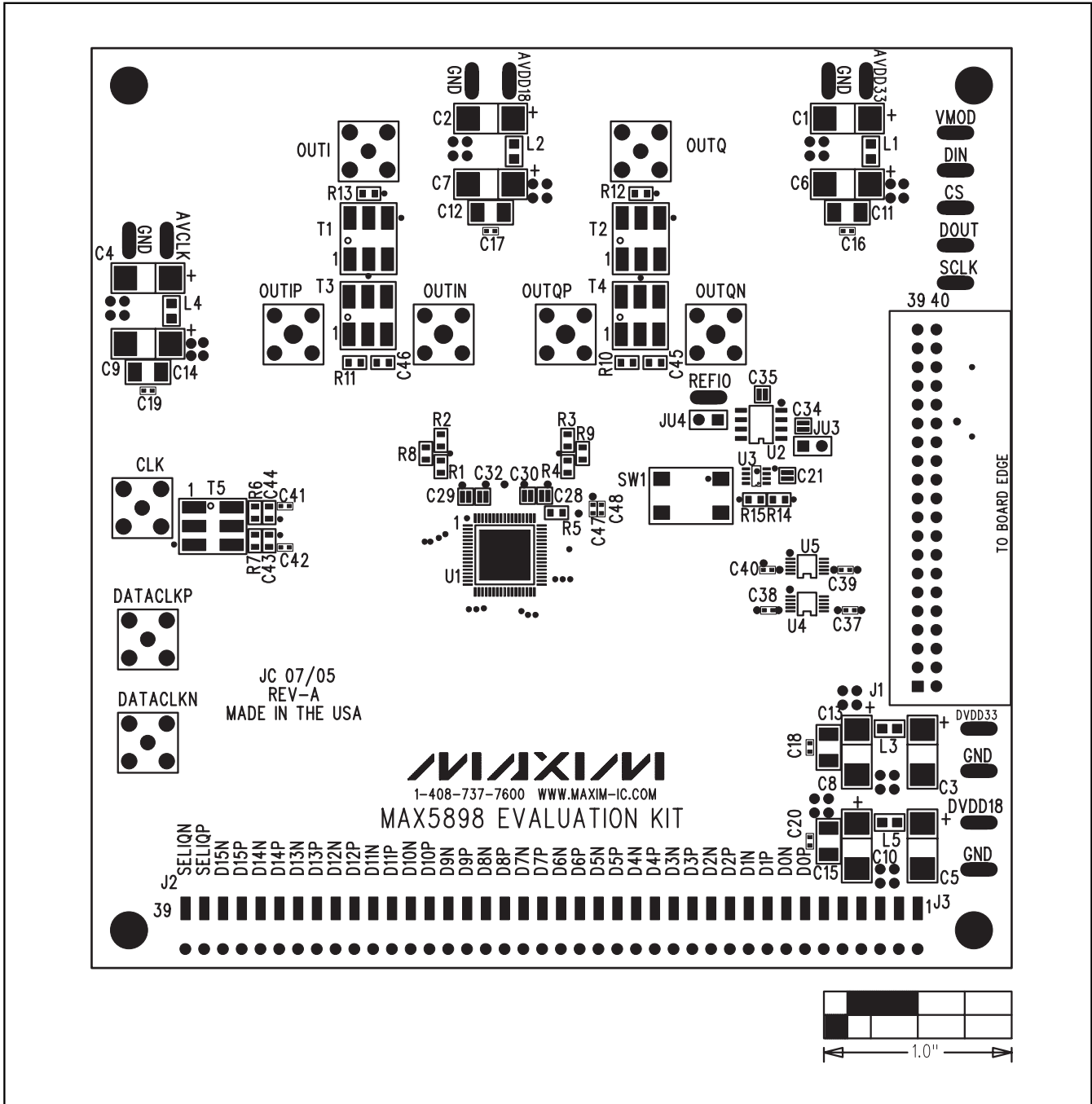


Figure 6. MAX5898 EV Kit Component Placement Guide—Component Side

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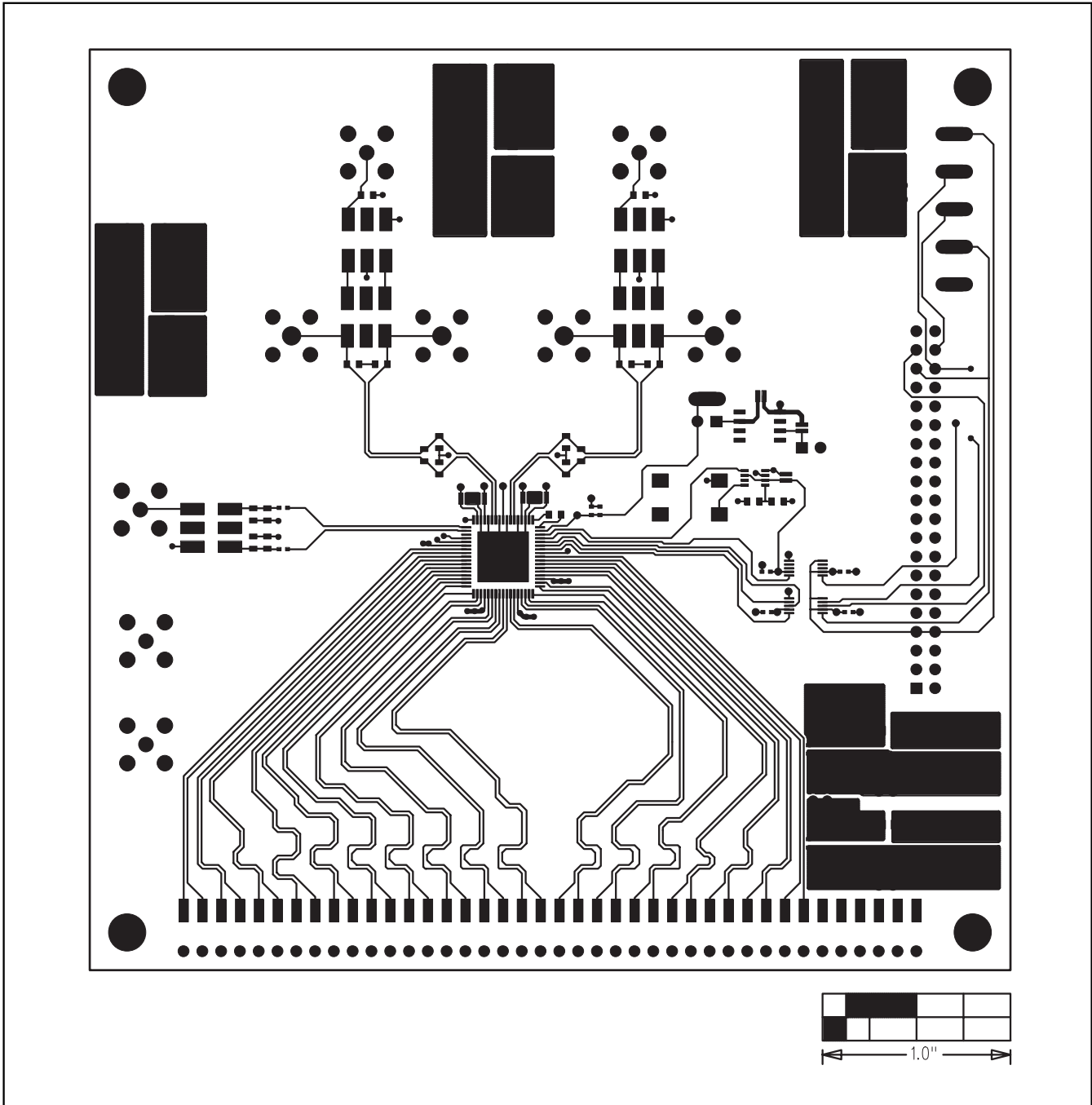


Figure 7. MAX5898 EV Kit PC Board Layout—Component Side

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Evaluate: MAX5898

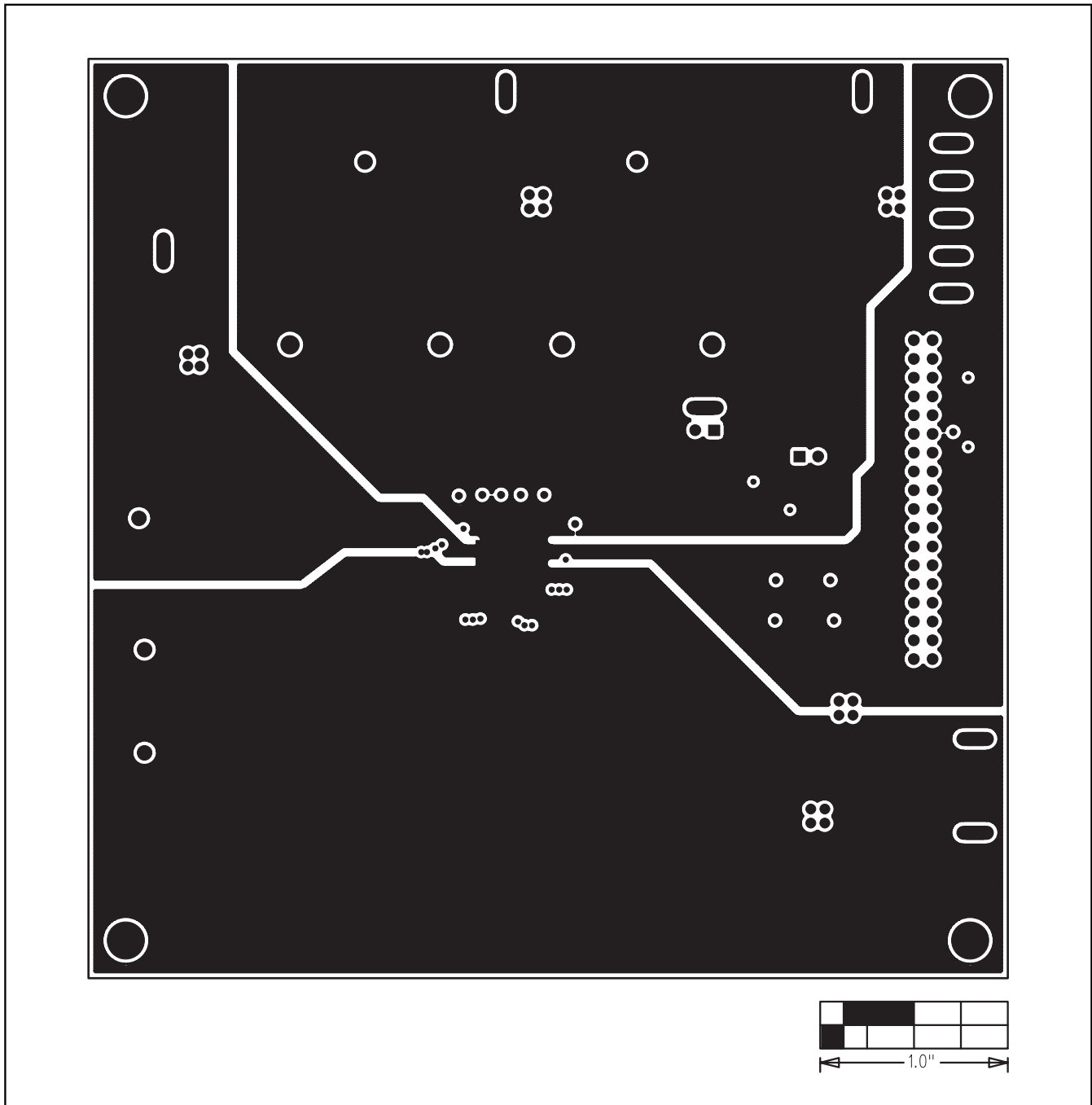


Figure 8. MAX5898 EV Kit PC Board Layout (Inner Layer 2)—Ground Planes

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Evaluate: MAX5898

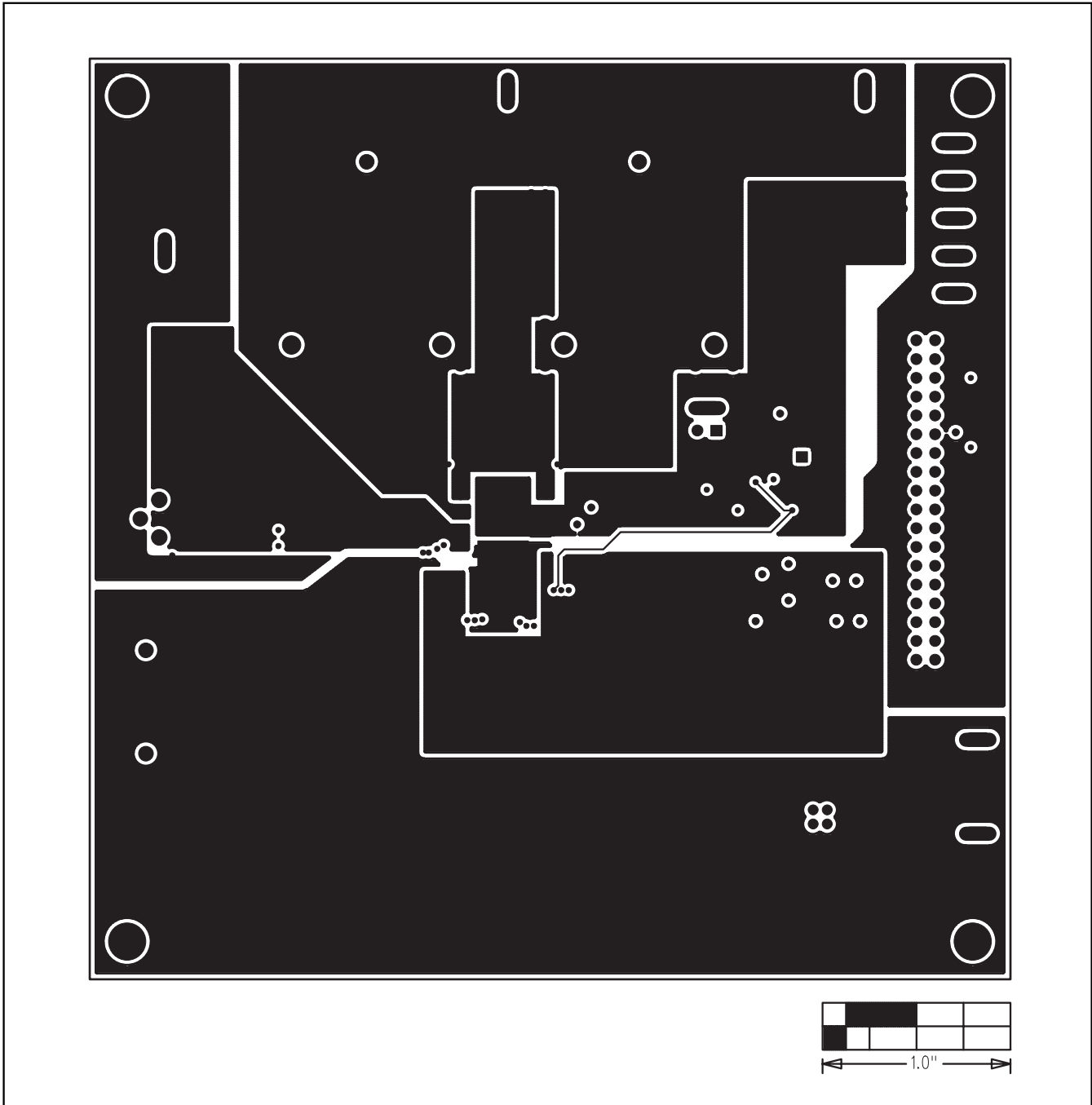


Figure 9. MAX5898 EV Kit PC Board Layout (Inner Layer 3)—Power Planes

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Evaluate: MAX5898

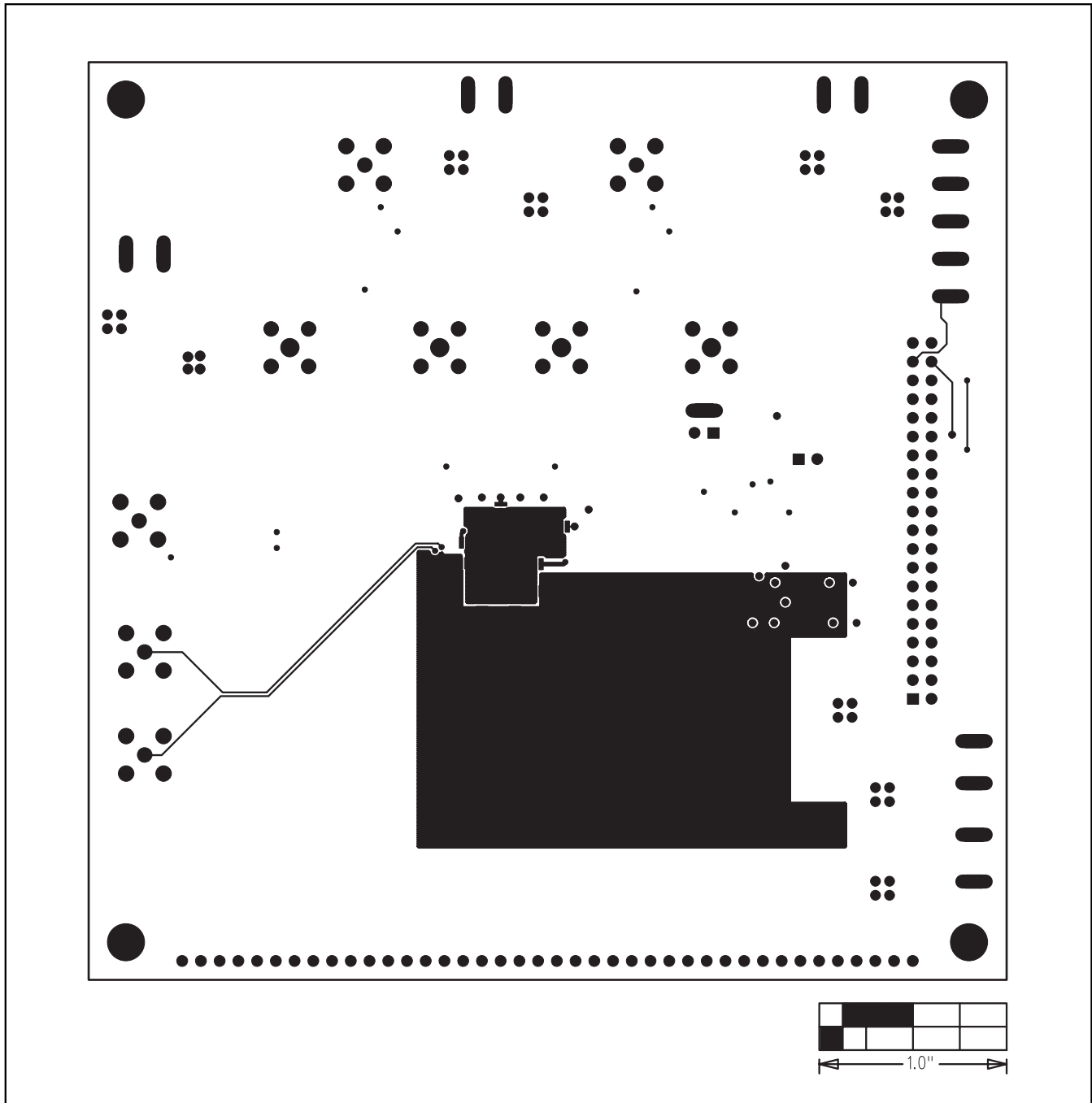


Figure 10. MAX5898 EV Kit PC Board Layout—Solder Side

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Evaluate: MAX5898

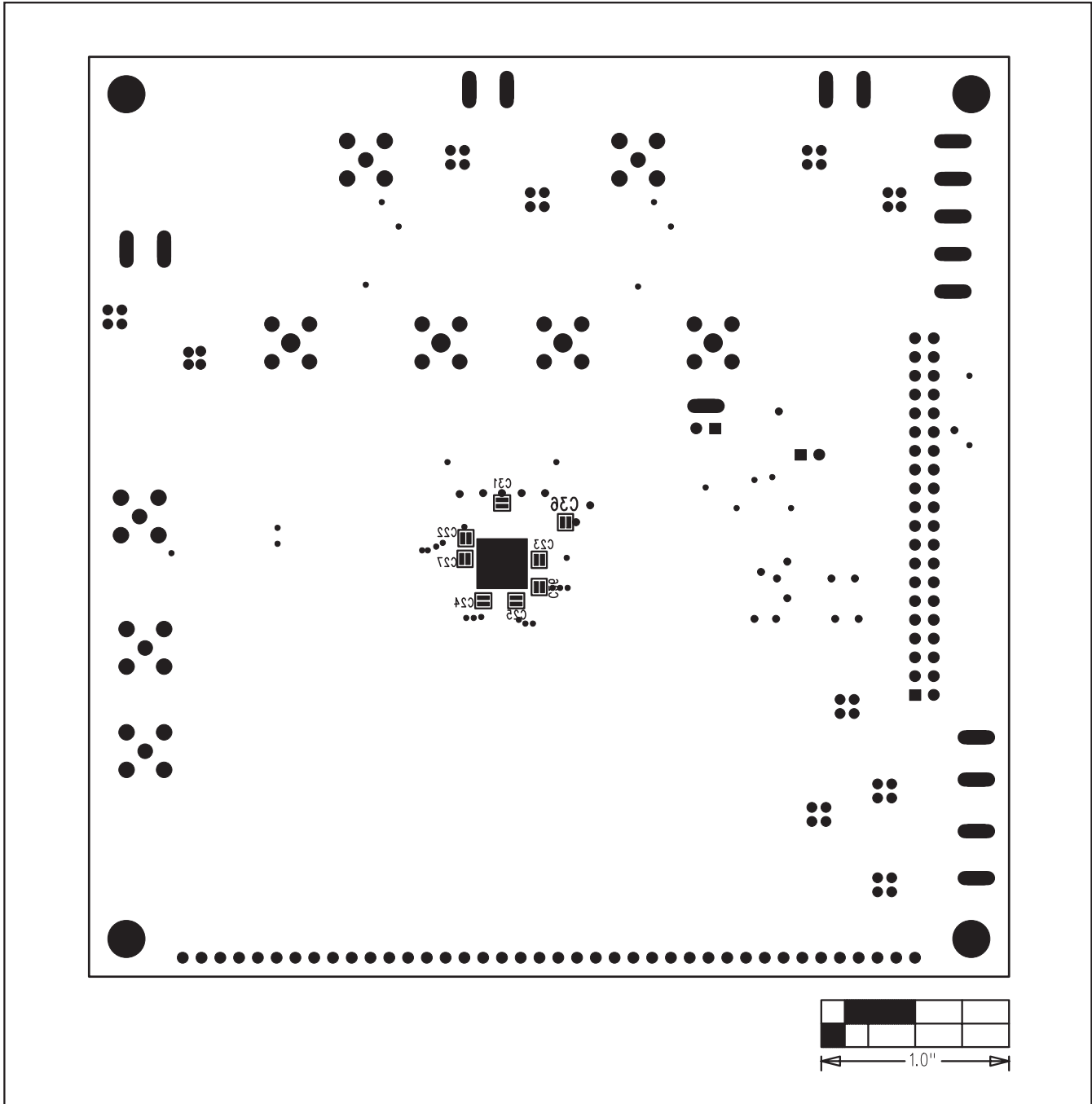


Figure 11. MAX5898 EV Kit Component Placement Guide—Solder Side

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