19-4258; Rev 0; 8/08

MAX9591 Evaluation Kit

General Description

The MAX9591 evaluation kit (EV kit) demonstrates the MAX9591 reference-voltage generator for gamma correction in TFT-LCD panels, such as those found in high-resolution TVs, high-end monitors, or for general industrial reference-voltage generation. The MAX9591 EV kit provides 14 programmable reference-voltage outputs (DAC outputs) and four static buffered reference-voltage outputs (reference outputs). The EV kit uses a 9V to 20V DC power supply for powering the application circuit.

The EV kit features a USB-to-I²C interface circuit. Windows® 2000/XP/Vista®-compatible software, with a graphical user interface (GUI), is available for exercising the MAX9591 features. The EV kit can also connect to a user-supplied I²C interface circuit for stand-alone MAX9591 operation.

The MAX9591 EV kit can also be used to evaluate the MAX9590ETU+.

Features

- **14 8-Bit Programmable Reference Voltages (DAC Outputs)**
- **Four Static Buffered Reference Voltages (Reference Outputs)**
- **400mA Peak Current on Reference Outputs and DAC Outputs 1, 7, 8, and 14**
- **200mA Peak Current on DAC Outputs 2–6 and 9–13**
- **9V to 20V DC Power-Supply Operation**
- **USB-Powered USB-to-I²C Interface Circuit**
- **Windows 2000/XP/Vista (32-Bit)-Compatible Software**
- **Lead-Free and RoHS Compliant**
- **Proven PCB Layout**
- **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX9591EVKIT+	EV Kit

+Denotes lead-free and RoHS compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C3–C10, C17, C21, C22, C24, C25	14	0.1µF ±10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C104K or TDK C1608X7R1C104K
C2, C13, C15	3	10µF ±10%, 10V X5R ceramic capacitors (0805) Murata GRM219R61A106K
C11, C12	2	10pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H100J or TDK C1608C0G1H100J
C14, C16, C23, C26	4	1µF ±10%, 10V X5R ceramic capacitors (0603) Murata GRM188R61A105K or TDK C1608X5R1A105K
C18, C19	2	22pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H220J or TDK C1608C0G1H220J
C20	1	3300pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H332K or TDK C1608X7R1H332K
C27–C44	0	Not installed, ceramic capacitors (0603)
C45, C48, C51	3	10µF ±20%, 25V X5R ceramic capacitors (1210) Murata GRM32DR61E106M

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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.

MAX9591 Evaluation Kit

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
C46, C47, C49, C50	4	0.1µF ±10%, 25V X7R ceramic capacitors (0603) Murata GRM188R71E104K or TDK C1608X7R1E104K
D1	1	Green LED (0603) Panasonic LNJ314G8TRA
FB1	0	Not installed, ferrite-bead inductor (0603)
J1	0	Not installed, 40-pin dual-row (2 x 20) header
JU1–JU4	0	Not installed, 2-pin headers
JU5	1	3-pin header
JU6	1	5-pin header
OUT_REFL_H, OUT_REFL_L, OUT_REFU_H, OUT_REFU_L, OUT1–OUT14	0	Not installed, small PCB test points
R1	1	0Ω ±5% resistor (0603)
R2	1	220Ω ±5% resistor (0603)
R3	1	10kΩ ±5% resistor (0603)
R4, R9–R12	5	2.2kΩ ±5% resistors (0603)
R5	1	1.5kΩ ±5% resistor (0603)
R6, R7	2	27Ω ±5% resistors (0603)
R8	0	Not installed, resistor (0402)
R13–R16, R17–R36, R44	0	Not installed, resistors (0603)
R37, R41	2	100Ω ±1% resistors (0603)
R38, R40	2	4.32kΩ ±1% resistors (0603)
R39	1	1.21kΩ ±1% resistor (0603)
R42, R43	2	1kΩ ±5% resistors (0603)
USB	1	USB type-B right-angle female receptacle
U1	1	Reference-voltage generator (38 TQFN-EP*) Maxim MAX9591ETU+
U2	1	Low-power 16-bit microcontroller (68 QFN-EP*) Maxim MAXQ2000-RAX+
U3	1	93C46 3-wire 16-bit EEPROM (8 SO)
U4	1	UART-to-USB converter (32 TQFP)
U5	1	3.3V regulator (5 SC70) Maxim MAX8511EXK33+T (Top Mark: AEI)
U6	1	2.5V regulator (5 SC70) Maxim MAX8511EXK25+T (Top Mark: ADV)
U7, U8	2	Dual bidirectional level translators (8 TDFN-EP*) Maxim MAX3394EETA+T (Top Mark: APE)
Y1	1	16MHz crystal
Y2	1	6MHz crystal
—	2	Shunts (JU5, JU6)
—	1	PCB: MAX9591 Evaluation Kit+

**EP = Exposed pad.*

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Panasonic Corp.	800-344-2112	www.panasonic.com
TDK Corp.	847-803-6100	www.component.tdk.com

Note: *Indicate that you are using the MAX9591 when contacting these component suppliers.*

MAX9591 EV Kit Files

FILES	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX9591.EXE	Application program
FTD2XX.INF	USB device driver file
UNINST.INI	Uninstalls the EV kit software
USB_Driver_Help.PDF	USB driver installation help file

Quick Start

Required Equipment

Before beginning, the following equipment is needed:

- MAX9591 EV kit (USB cable included)
- A user-supplied Windows 2000/XP/Vista PC with a spare USB port
- 9V to 20V DC power supply at 500mA
- One digital voltmeter (DVM)

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 operating system.

Procedure

The MAX9591 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, 9591Rxx.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file.
2) Install the 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) Connect the USB cable from the PC to the EV kit board. A **New Hardware Found** window pops up when installing the USB driver for the first time. If you do not see a window that is similar to the one described above after 30s, remove the USB cable from the board and reconnect it. Administrator privileges are required to install the USB device driver on Windows.
4) Follow the directions of the **Add New Hardware Wizard** to install the USB device driver. Choose the **Search for the best driver for your device** option. Specify the location of the device driver to be **C:\Program Files\MAX9591** (default installation directory) using the **Browse** button. During device driver installation, Windows might show a warning message indicating that the device driver Maxim uses does not contain a digital signature. This is not an error condition and it is safe to proceed with installation. Refer to the USB_Driver_Help.PDF document included with the software if there are any problems during this step.
5) Once the software and hardware installation is complete, disconnect the USB cable from the EV kit.
6) Verify that shunts are installed on:
   - Jumper JU5: Pins 1-2 (on-board 3.3V digital power supply)
   - Jumper JU6: Pins 1-2 (MAX9591 write address = 0xE8)
7) Connect the USB cable to the EV kit.
8) Connect the DVM negative terminal to the AGND PCB pad next to the REFL_L PCB pad.
9) Connect a voltage probe to the DVM positive terminal for later use.
10) Set the power supply to 15V and disable the power-supply output.
11) Connect the power-supply positive terminal to the AVDD PCB pad and the negative terminal to the AGND PCB pad next to AVDD.
12) Enable the power-supply output.
13) Start the MAX9591 EV kit software by opening its icon in the **Start | Programs** menu. The EV kit software main window appears, as shown in Figure 1.
14) Use the DVM voltage probe to measure the reference input voltages on the REFU_H, REFU_L, REFL_H and REFL_L PCB pads, and type those values into the corresponding edit boxes of the **Reference Voltages (V)** group box.
15) Press the **Quick Start** button.
16) Use the DVM voltage probe to verify that the DAC output voltages are close to the voltages shown in the **Output (V)** edit boxes for the respective channel.

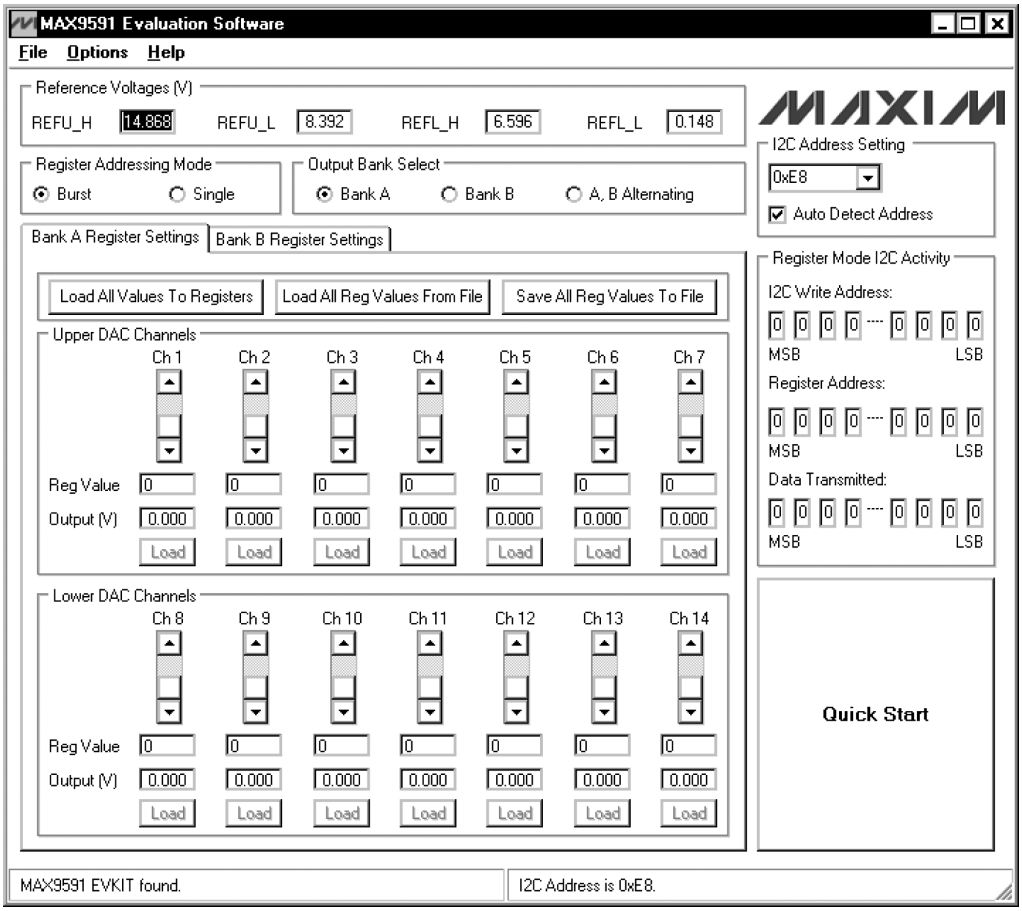


Figure 1. MAX9591 Evaluation Software Main Window

__Detailed Description of Software

The MAX9591 evaluation kit (EV kit) software main window is shown in Figure 1. The GUI software automatically detects the MAX9591 device address and displays it in the **I2C Address Setting** drop-down list and in the software status bar. The DAC output voltages in the **Upper DAC Channels**/**Lower DAC Channels** group boxes are calculated using the upper and lower reference input voltages on PCB pads REFU_H, REFU_L, REFL_H, and REFL_L. The reference input voltages MUST be measured at the appropriate PCB pads and the values entered in the respective **Reference Voltages (V)** edit boxes for the DAC output calculations to be correct.

Upon IC startup, the DAC outputs wake up in high-impedance mode. To exit high-impedance mode, click the **Quick Start** button or perform the following steps:

1) Select the **Bank A** radio button in the **Output Bank Select** group box. Select the **Bank A Register Settings** tab.
2) Select the **Burst** radio button in the **Register Addressing Mode** group box.
3) Modify any of the DAC channel's register values. See the *Output Register Values* section for more information.
4) Press the **Load All Values To Registers** button.
5) Select the **Bank B** radio button in the **Output Bank Select** group box. Select the **Bank B Register Settings** tab. Repeat steps 3 and 4.

The **Quick Start** button loads all bank A and bank B registers with a predefined set of values.

Register banks A and B are selectable using the radio buttons in the **Output Bank Select** group box. Register values are modified and loaded to registers using the buttons, edit boxes, and scrollbars of the **Bank _ Register Settings** tabs where _ is either **A** or **B**.

I²C Address Setting

The MAX9591's I²C slave address is displayed in the status bar of the software window and the **I2C Address Setting** drop-down list. If an address is manually selected in the drop-down list, the software verifies the address and changes the address displayed appropriately. If no acknowledge is received from the EV kit, a pop-up window is opened directing the user to properly set jumper JU6 on the EV kit. If the **Auto Detect Address** checkbox is checked, the software automatically detects the I²C address of the MAX9591.

Upper and Lower DAC Output Voltages

The upper and lower DAC output voltages are generated using an on-board resistor-divider network. The user can also apply external references to the REFU_H, REFU_L, REFL_H, and REFL_L, and AGND PCB pads. The voltages on these four pads MUST be captured and typed into the appropriate edit boxes in the **Reference Voltages (V)** group box for the calculated DAC output voltages shown in the **Upper DAC Channels/Lower DAC Channels** group boxes to be correct.

The transfer function for the upper DAC channels is:

$$V_{OUT} = REFU_L + \frac{D}{256} \times (REFU_H - REFU_L)$$

The transfer function for the lower DAC channels is:

$$V_{OUT} = REFL_L + \frac{D}{256} \times (REFL_H - REFL_L)$$

In both equations, D is the decimal register value. Refer to the MAX9591 IC data sheet for more details.

When the evaluation software is run for the first time, the reference input-voltage values in the **Reference Voltages (V)** group box are loaded from an initialization file (REF.INI). When the program is closed, the current values are logged in to the initialization file. The next time the program is run, the latest values are loaded automatically.

Output Bank Select

The **Bank A**, **Bank B**, and **A, B Alternating** radio buttons in the **Output Bank Select** group box choose the set of reference voltages buffered to the outputs between bank A, bank B, or alternating between banks A and B, with 1s hold time for each bank.

Output Register Values

Each DAC channel's register value can be set in three different ways within the **Upper DAC Channels**/**Lower DAC Channels** group boxes by:

1) Moving the channel's scrollbar.
2) Typing register values directly into the channel's **Reg Value** edit box (decimal 8-bit equivalent).
3) Typing the expected output voltage in the channel's **Output (V)** edit box. The software uses a register value that generates a voltage closest to the desired voltage value.

When a register value is changed, the corresponding field changes its color to red. A user should synchronize the GUI fields and actual device registers by pressing either the channel's **Load** button (in single mode) or the **Load All Values To Registers** button (in burst mode).

The **Load All Reg Values From File** button is used to load all the register values and reference voltages from a text file. The **Save All Reg Values To File** button is used to save all the register values and reference voltages on the current GUI to a user-named text file.

Register read/write operations can take place regardless of the output bank setting; for example, the user can change bank B registers when bank A is buffered to the outputs.

Register Addressing Mode

The **Burst** and **Single** radio buttons in the **Register Addressing Mode** group box set the MAX9591 software operation mode.

When the **Burst** radio button is selected, all registers for a single bank are updated using the **Load All Values To Registers** or **Load All Reg Values From File** buttons. The individual register's **Load** buttons are disabled.

When the **Single** radio button is selected, single register values are updated using the individual register's **Load** buttons. The **Load All Values To Registers** and **Load All Reg Values From File** buttons are disabled.

Register Mode I²C Activity

The **Register Mode I2C Activity** group box is used for the convenience of debugging when the **Single** radio button is selected. When an individual register is written, the bits sent to the MAX9591 through the I²C interface are displayed.

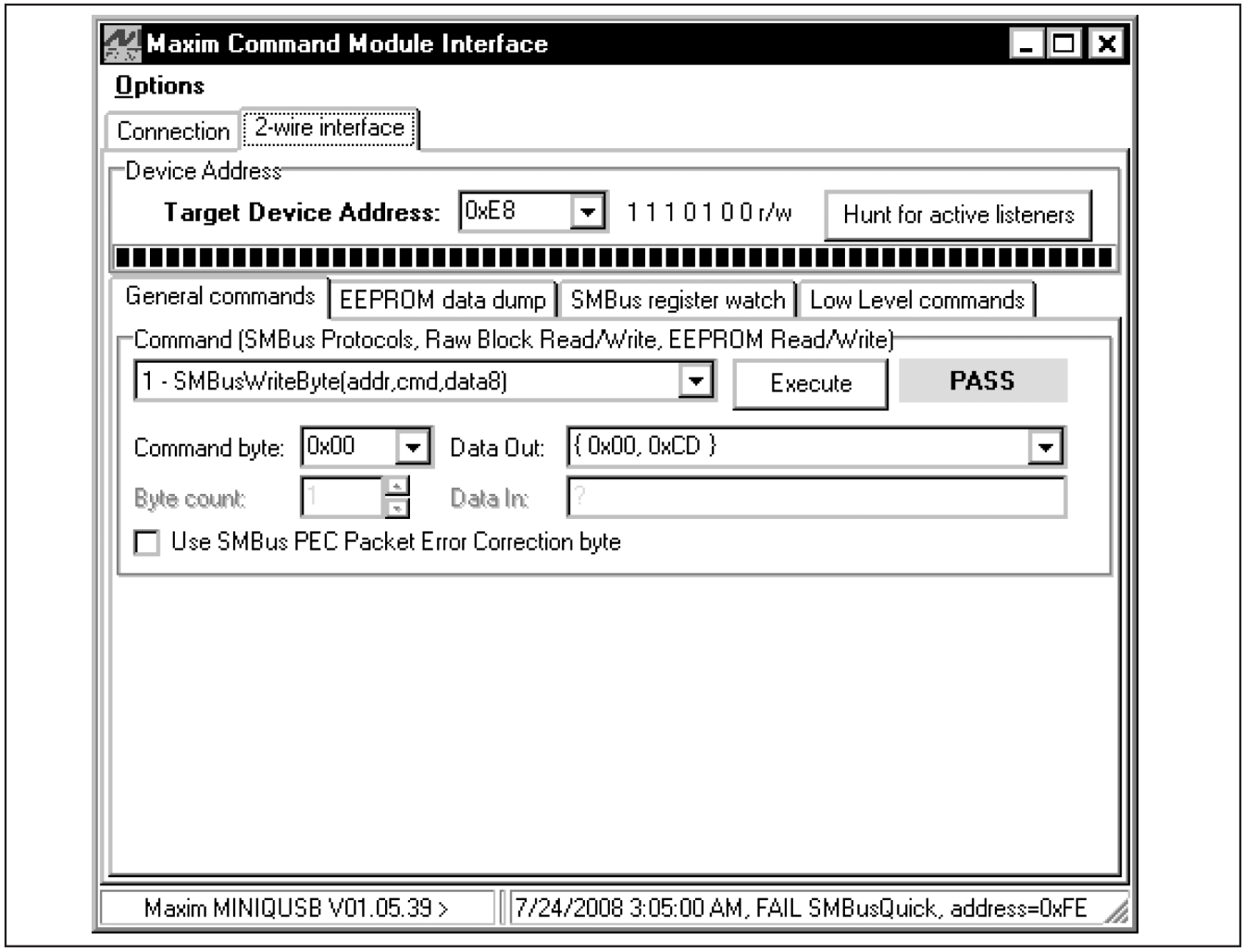


Figure 2. Advanced I²C Users Interface Window I 2-Wire Interface Tab

Advanced User Interface

A serial interface can be used by advanced users by selecting **Options I Interface (Advanced Users)** from the menu bar.

Click on the **2-wire interface** tab shown in Figure 2. Press the **Hunt for active listeners** button to obtain the current MAX9591 slave address in the **Target Device Address** combo box. In the **General commands** tab, select **1 – SMBusWriteByte(addr,cmd,data8)** from the **Command (SMBus Protocols, Raw Block Read/Write, EEPROM Read/Write)** drop-down list. Enter the desired values into the **Command byte** and **Data Out** combo boxes and then press the **Execute** button.

Detailed Description of Hardware

The MAX9591 evaluation kit (EV kit) demonstrates the MAX9591 reference-voltage generator in a 38-pin TQFN surface-mount package with an exposed pad. EV kit applications include gamma correction in TFT-LCD panels, such as those found in high-resolution TVs, high-end monitors, or for general industrial reference-voltage generation. The MAX9591 EV kit provides 14 programmable reference-voltage outputs (DAC outputs) and four static buffered reference-voltage outputs (DAC reference outputs) using four input reference voltages (DAC reference inputs).

To monitor the MAX9591 EV kit's 14 DAC outputs (OUT1–OUT14) and four reference outputs (OUT_REFU_H, OUT_REFU_L, OUT_REFL_H, and OUT_REFL_L), use

header J1 or the labeled test points. Reference outputs OUT_REFU_H, OUT_REFU_L, OUT_REFL_H, OUT_REFL_L, and DAC outputs OUT1, OUT7, OUT8, and OUT14 provide 400mA of peak current. DAC outputs OUT2–OUT6 and OUT9–OUT13 provide 200mA of peak current. Stay within the MAX9591 IC's power rating. Refer to the MAX9591 IC data sheet for more information.

The on-board resistor-divider network (R37–R41) generates the reference inputs (REFU_H, REFU_L, REFL_H, and REFL_L). The user can also apply external reference voltages to the REFU_H, REFU_L, REFL_H, and REFL_L PCB pads after removing R37–R41.

The EV kit uses a 9V to 20V DC power supply, connected across the AVDD and AGND PCB pads, for powering the EV kit application circuit. The EV kit might require up to 500mA of supply current depending on output loading.

Digital Supply Configuration

The MAX9591 EV kit provides two options to power the MAX9591 digital supply input (DVDD). DVDD can operate from the 3.3V supply generated by the USB-to-I²C interface circuit or from a user-supplied 2.7V to 5.5V DC power supply connected across the DVDD and DGND PCB pads. See Table 1 to configure DVDD using jumper JU5.

Caution: Always ensure that DVDD is powered before AVDD.

MAX9591 Slave Address Description

The MAX9591 I²C slave address can be set by jumper JU6. The slave address can be set to one of four different addresses. See Table 2 for slave address configuration.

Stand-Alone User-Supplied I²C Communication

The EV kit can be used in stand-alone operation to interface with a user's I²C system without using a PC. To use the MAX9591 EV kit with a user-supplied I²C interface, perform the following steps:

1) Viewing Figure 6, cut the SDA, SCL, STD_REG, and BANK_SEL traces immediately to the left of the corresponding PCB pad.
2) Disconnect the USB cable from the EV kit.
3) Move jumper JU5 shunt to pins 2-3.
4) Connect the positive terminal of a user-supplied 2.7V to 5.5V DC power supply to the DVDD PCB pad and the negative terminal to the nearby DGND PCB pad.
5) Install 2.2kΩ 0603 surface-mount resistors at locations R35 and R36 to pull up user-supplied signals SDA and SCL to DVDD if needed.
6) Connect the user-supplied I²C interface signals, general-purpose output (GPO) control signals, and signal ground return to the EV kit PCB pads, as shown in Table 3.

Table 1. Digital Supply Configuration (Jumper JU5)

SHUNT POSITION	DVDD PIN CONNECTION	DVDD POWER	I²C COMMUNICATION
1-2*	3.3V	On-board	On-board
2-3	DVDD PCB pad	User supplied (DVDD range: 3.3V to 5.5V**)	On-board
2-3	DVDD PCB pad	User supplied (DVDD range: 2.7V to 5.5V)	User supplied***

**Default position.*
***Minimum DVDD is limited to 3.3V by the USB-to-I²C interface circuit 3.3V logic level.*
****Disconnect the USB cable from the EV kit.*

Table 2. Slave Address Description (Jumper JU6)

SHUNT POSITION	A0 PIN CONNECTION	MAX9591 ADDRESS (HEX)	
		WRITE	READ
1-2*	GND	0xE8	0xE9
1-3	DVDD	0xEA	0xEB
1-4	SCL	0xEC	0xED
1-5	SDA	0xEE	0xEF

**Default position.*

Table 3. User-Supplied I²C Interface

USER-SUPPLIED SIGNAL	SIGNAL	EV KIT PCB PAD
SDA	I²C data	SDA
SCL	I²C clock	SCL
GPO	Control signal	STD_REG
GPO	Control signal	BANK_SEL
GND	Signal ground return	DGND

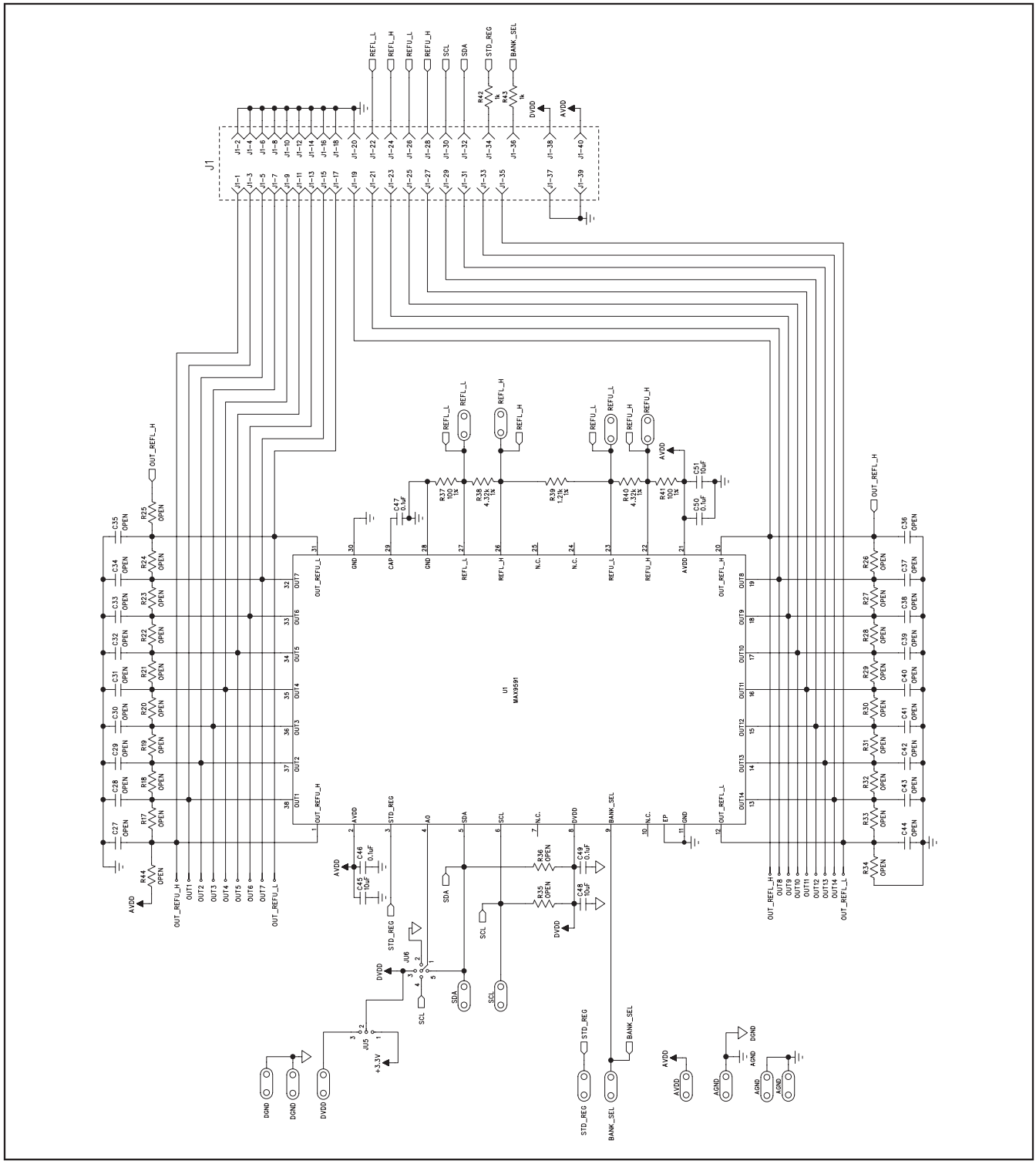


Figure 3a. MAX9591 EV Kit Schematic—Application Circuit (Sheet 1 of 2)

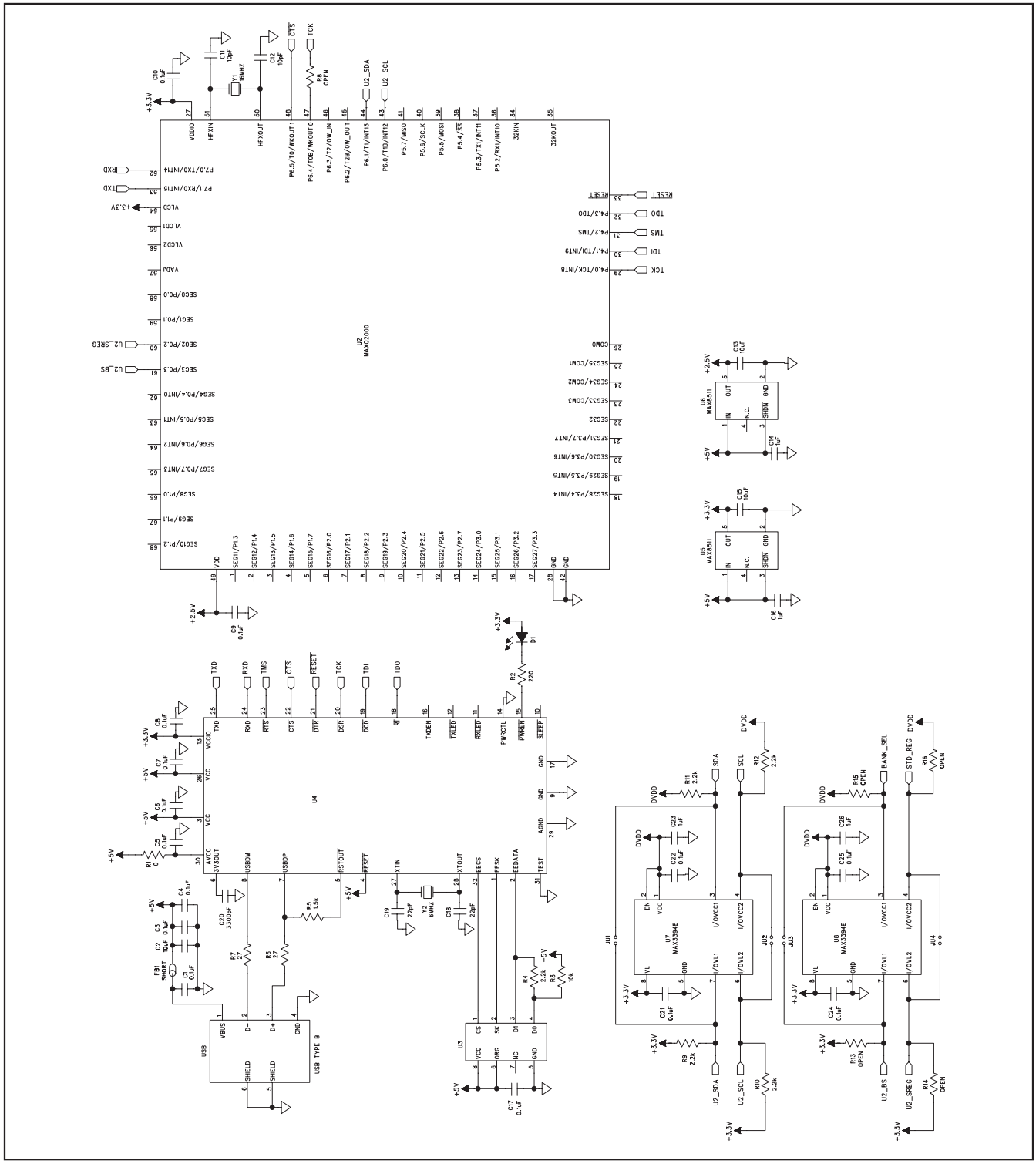


Figure 3b. MAX9591 EV Kit Schematic—USB-to-I²C Circuit (Sheet 2 of 2)

MAX9591 Evaluation Kit

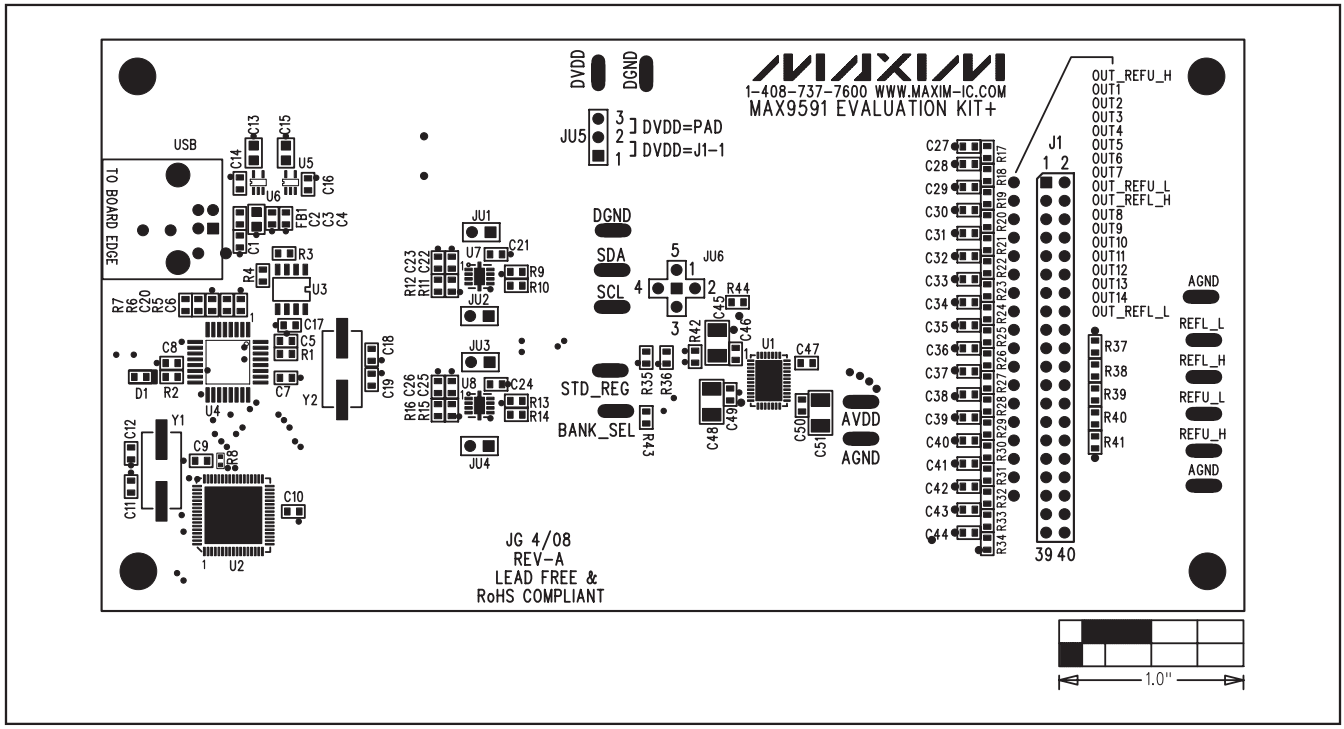


Figure 4. MAX9591 EV Kit Component Placement Guide—Component Side

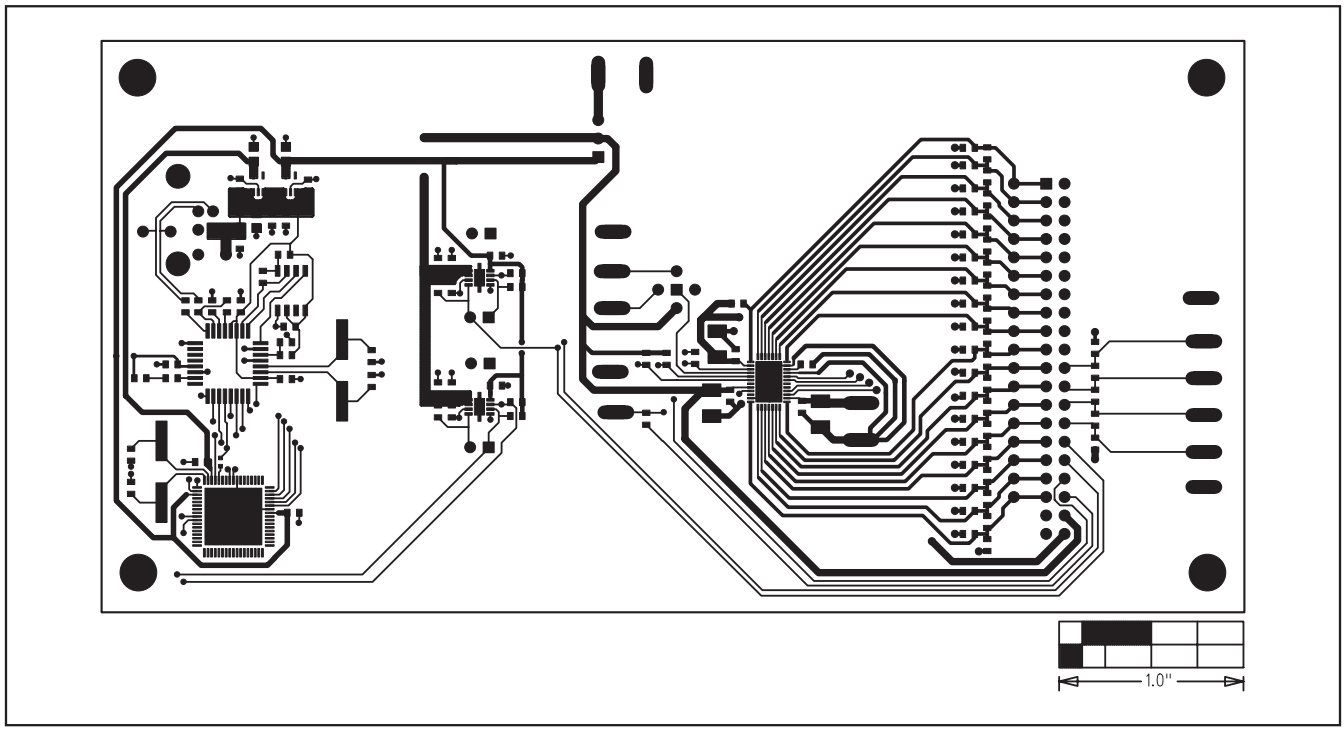


Figure 5. MAX9591 EV Kit PCB Layout—Component Side

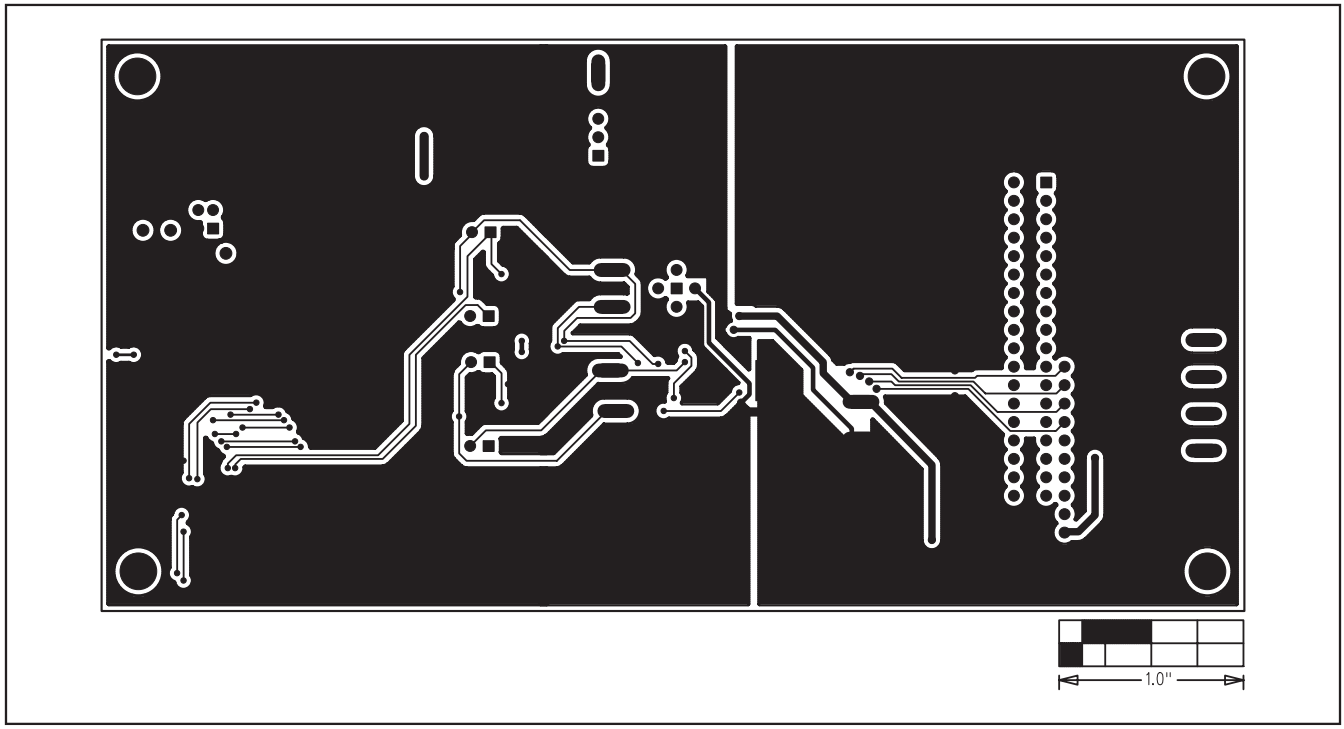


Figure 6. MAX9591 EV Kit PCB Layout—Solder Side

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