19-4050; Rev 1; 3/09

MAX16046 Evaluation Kit

Evaluates: MAX16046

General Description

The MAX16046 evaluation kit (EV kit) provides a proven printed-circuit board (PCB) layout that facilitates evaluation of the MAX16046 EEPROM-based sequencer/monitor/marginer with nonvolatile fault memory. This EV kit is a fully assembled and tested surface-mount board.

The EV kit includes an on-board USB-to-JTAG and I^2C interface facilitating communications between the host PC and the MAX16046. Two LDO regulators and two tracking FETs make it easy to evaluate the sequencing, monitoring, and margining functionality of the MAX16046. External connections are also provided to facilitate connection to an external application circuit.

This EV kit data sheet assumes basic familiarity with the MAX16046. Refer to the MAX16046/MAX16048 data sheet for more detailed information.

Features

- ♦ **USB Interface to Host PC**
- ♦ **Easy-to-Use GUI Software**
- ♦ **On-Board LDO Regulators and Tracking FETs**
- ♦ **Convenient Test Points and Headers for Easy Evaluation**

Ordering Information

PART	TYPE
MAX16046EVKIT+	EV Kit

+Denotes lead(Pb)-free and RoHS compliant.

Contents List

QTY	DESCRIPTION
1	Circuit board assembly: MAX16046EVKIT+
1	USB high-speed A-to-B cable, 5ft (1.5m)

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2	2	10µF ±10%, 16V tantalum capacitors AVX TAJA106K016R KEMET T494A106K010AS
C3	1	4.7µF ±20%, 16V X5R ceramic capacitor (1206) TDK C3216X5R1C475M Taiyo Yuden EMK316BJ475ML
C4, C6, C8, C10, C100, C108	6	1.0µF ±10%, 10V X5R ceramic capacitors (0805) TDK C2012X5R1A105K KEMET C0805C105K4PAC
C5, C9, C110	3	4.7µF ±20%, 6.3V X5R ceramic capacitors (0805) TDK C2012X5R0J475M Taiyo Yuden JMK212BJ475MG
C7	1	10µF ±20%, 16V X5R ceramic capacitor (1206) TDK C3216X5R1C106M Taiyo Yuden EMK316BJ106KL
C101, C102, C103	3	0.1µF ±10%, 25V X7R ceramic capacitors (0603) TDK C1608X7R1E104K Taiyo Yuden TMK107BJ104KA
C104–C107	4	18pF ±5%, 50V C0G ceramic capacitors (0603) TDK C1608C0G1H180J Taiyo Yuden UMK107CG180JZ
C111	1	0.01µF ±10%, 50V X7R ceramic capacitor (0603) TDK C1608X7R1H103K Taiyo Yuden UMK107B103KZ
C112, C113	2	2.2µF ±20%, 10V X5R ceramic capacitors (0805) TDK C2012X5R1A225M Taiyo Yuden LMK212BJ225MG
C114	1	33pF ±50V, C0G ceramic capacitor (0603) TDK C1608C0G1H330J Taiyo Yuden UMK107CG330JZ
EXT PWR	1	Test point, red
F100	1	500mA fast-acting fuse (2405)
GND	3	Test points, black
J1	1	8-pin header
J2, J3, J4, J7, J8	5	3-pin headers
J5, J6	2	2-pin headers
J100	1	2 x 3-pin header
LED1–LED7, LED100–LED103	11	Green LEDs (1206)
P1	1	5-pin header
P2	1	2 x 5-pin header
P3, P4, P9, P10	4	3-pin headers
P5, P7	2	9-pin headers

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.

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
P6	1	10-pin header
P8	1	11-pin header
P100	1	USB_B right-angle connector
P101, P102	0	Not installed
Q1, Q2	2	n-channel MOSFETs Fairchild FDC5612
R1, R3	2	84.5kΩ ±1% resistors (0805)
R2	1	133kΩ ±1% resistor (0805)
R4, R5, R19, R28	4	475Ω ±1% resistors (0805)
R6, R8, R9	3	78.7kΩ ±1% resistors (0805)
R7	1	66.5kΩ ±1% resistor (0805)
R10, R12, R13, R14	0	Not installed, resistors (0805)
R11	1	16.9kΩ ±1% resistor (0805)
R15, R17, R21, R24, R27, R29, R30, R100–R103	11	221Ω ±1% resistors (0805)
R16, R18, R20, R22, R23, R25, R26, R104	8	10kΩ ±1% resistors (0805)
R105, R106	2	33.2Ω ±1% resistors (0805)
R108, R109, R110	3	4.75kΩ ±1% resistors (0805)
R112	0	Not installed, resistor (0805)
S1–S4	4	8-row DIP switches
S5	1	SPDT slide switch
S6, S7	2	SPST pushbutton switches
U1, U2	2	Low-dropout linear regulators (8 SO) Maxim MAX1658ESA+
U3	1	EEPROM-programmable system manager (56 TQFN-EP*) Maxim MAX16046ETN+
U100	1	Dual, low-noise, low-dropout linear regulator (6 SOT23) Maxim MAX8882EUTAQ+
U101	1	USB peripheral controller (32 LQFP) Maxim MAX3420EECJ+
U102	1	Microcontroller (68 QFN-EP*) Maxim MAXQ2000-RAX+
Y100	1	12MHz crystal (HCM49) Citizen HCM49-12.000MABJ-UT
Y101	0	Not installed, 32kHz crystal
Y102	1	20MHz crystal (HCM49) Citizen HCM49-20.000MABJ-UT
—	9	Shunts
—	1	PCB: MAX16046 Evaluation Kit+

**EP = Exposed pad.*

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Diodes, Inc.	805-446-4800	www.diodes.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
KEMET Corp.	864-963-6300	www.kemet.com
Taiyo Yuden	800-348-2496	www.t-yuden.com
TDK Corp	847-390-4373	www.component.tdk.com

Note: *Indicate you are using the MAX16046 when contacting these component suppliers.*

Quick Start

Required Equipment

You need the following equipment to start using the MAX16046 EV kit:

- Maxim MAX16046 EV kit
- A PC with a spare USB port

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.

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Procedure

1) Ensure jumper J1 is set to LOW. Also ensure that jumpers J2, J3, and J4 are set to the 1-2 position, J5 and J6 are closed, J7 and J8 are in the 2-3 position, and J100 is in the 3.3V position. All switches in switch banks S1, S2, and S3 should be in the ON position.
2) Connect the MAX16046 EV kit to a PC using the provided USB cable. LED100 will light, indicating that the EV kit has power.
3) Install the MAX16046 EV kit software.
4) Launch MAX16046.exe.
5) Select **I2C** in the **Connect** dialog, and make sure **Address** is 0xA0. Click **OK**.
6) From the **File** menu, select **Open Configuration**.
7) Select the MAX16046 EV Kit Demo.xml file and click **OK**. This action loads the **Setup** tab with a configuration that matches the power supplies on the MAX16046 EV kit, as well as the register contents for the MAX16046.
8) Click the **Data Logging** tab. Move the enable switch, S5, to the ON position and note the monitored voltages.

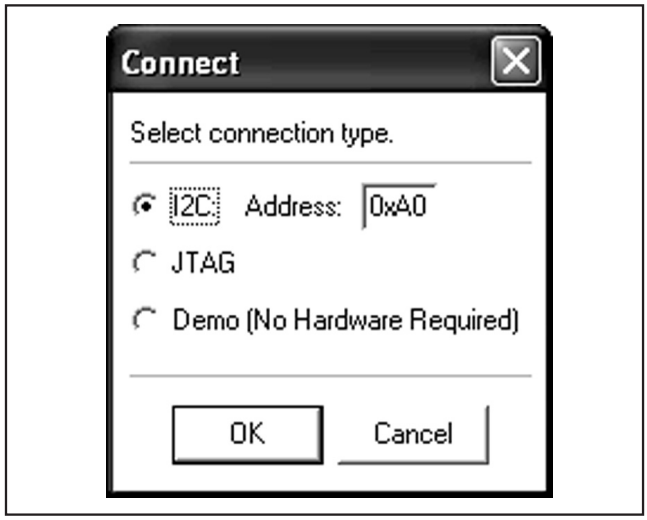


Figure 1. Connect Dialog

Detailed Description of Software

The MAX16046 EV kit software serves two purposes. One is to facilitate evaluation of the MAX16046 on the EV kit hardware. The other is to provide a convenient way to configure a MAX16046–MAX16049 in an application circuit.

Connecting to the MAX16046 EV Kit

Make sure the EV kit is connected to the PC by the USB cable. Launch the software, and in the **Connect** dialog, select **I2C** or **JTAG** and click **OK**. If the software is being used without the EV kit connected, select **Demo**.

The I^2C slave address may be specified. The default is 0xA0, but other values (depending on the settings of jumper J1; see Table 5) may be used.

Setup Tab

The **Setup** tab, shown in Figure 2, contains information about the power supplies connected to and monitored by the MAX16046. Each list item represents a power supply that is being controlled and monitored by the MAX16046. List items may have subitems, which are additional power-supply outputs that also require monitoring. For example, a dual-output DC-DC converter can have one subitem to monitor the extra DC-DC output. The contents of the **Setup** tab should match the schematic of the application circuit. In the case of the EV kit, the contents of the **Setup** tab should match the power supplies provided with the EV kit. Figure 2 shows the configuration for the four EV kit power supplies.

Table 1 describes the purpose of each column in the **Setup** tab.

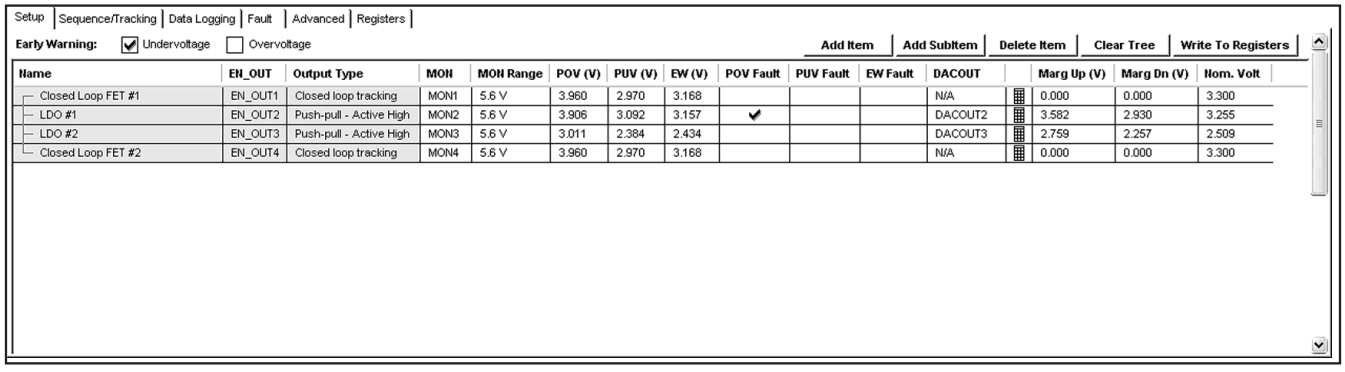


Figure 2. Setup Tab

Table 1. Setup Tab Column Descriptions

COLUMN NAME	DESCRIPTION
Name	The name of the power supply. This field is provided as a convenience and is not saved in the registers of the MAX16046, but it is stored in the configuration file.
EN_OUT	The selected EN_OUT enable output pin for the power supply. Choose the EN_OUT that is wired to the EN input of the power supply on the schematic.
Output Type	The output configuration for the selected EN_OUT. Choices range from push-pull/open-drain and active-high/active-low for logic-level outputs, and also charge pump and closed-loop tracking. Closed-loop tracking is for external n-channel MOSFETs and requires an additional GPIO to be configured as an INS_ sense line. See the *On-Board Tracking MOSFETs* section for more information.
MON	The monitoring input for this power supply. Choose the MON input that is wired to the power-supply output on the schematic. If more than one monitoring input is necessary for the power supply (such as for a multiple output supply), add a subitem by clicking **Add Subitem**.
MON Range	The input voltage range for the selected monitoring input. Choose a voltage range that encompasses the voltage to be monitored.
POV	Primary overvoltage and primary undervoltage monitoring thresholds. Choose the monitoring thresholds appropriate for this power supply. If a voltage is specified in the **Nom. Volt** field, clicking on the **POV** or **PUV** column header will display the thresholds as a percent over or percent under the nominal power-supply output voltage.
PUV	
EW	Early warning monitoring threshold. This threshold can be an overvoltage or an undervoltage depending on the **Early Warning** checkbox at the top of the **Setup** tab.
POV Fault	Fault-enable checkboxes. Placing a checkmark in one of these fields allows the associated fault condition to trigger an EEPROM fault log and turn off all the EN_OUTs.
PUV Fault	
EW Fault	
DACOUT	The margining DAC output for this power supply. If the power supply is wired for margining, select the DACOUT output that is connected through a resistor to the trim or feedback connection of the power supply on the schematic. If more than one DAC output is necessary for the power supply (such as for a multiple-output supply), add a subitem by clicking **Add Subitem**.
	Click the icon in the appropriate row to display the **Margining Calculator** dialog; additional margining DAC parameters are entered through this dialog, including the values of the feedback resistor, reference voltage, and several others.
Marg Up	Output voltages of the power supply during a margin up or margin down condition. Enter a value in each field to specify the voltage desired for each margin limit. Click the column headers to display the margin up and margin down values as a percentage of the nominal power-supply voltage (specified in the **Nom. Volt** column). Populate these fields initially using the margining calculator; afterwards, they can be edited directly.
Marg Dn	
Nom. Volt	Nominal power-supply output voltage. If the DACOUT is specified as N/A for this power supply, this value must be manually entered. If a DACOUT is specified, use the **Margining Calculator** dialog to modify this value. This value is provided to help with certain margining calculations as well as the percentage calculation for the voltage monitoring thresholds; it is not saved in the registers of the MAX16046 but it is stored in the configuration file.

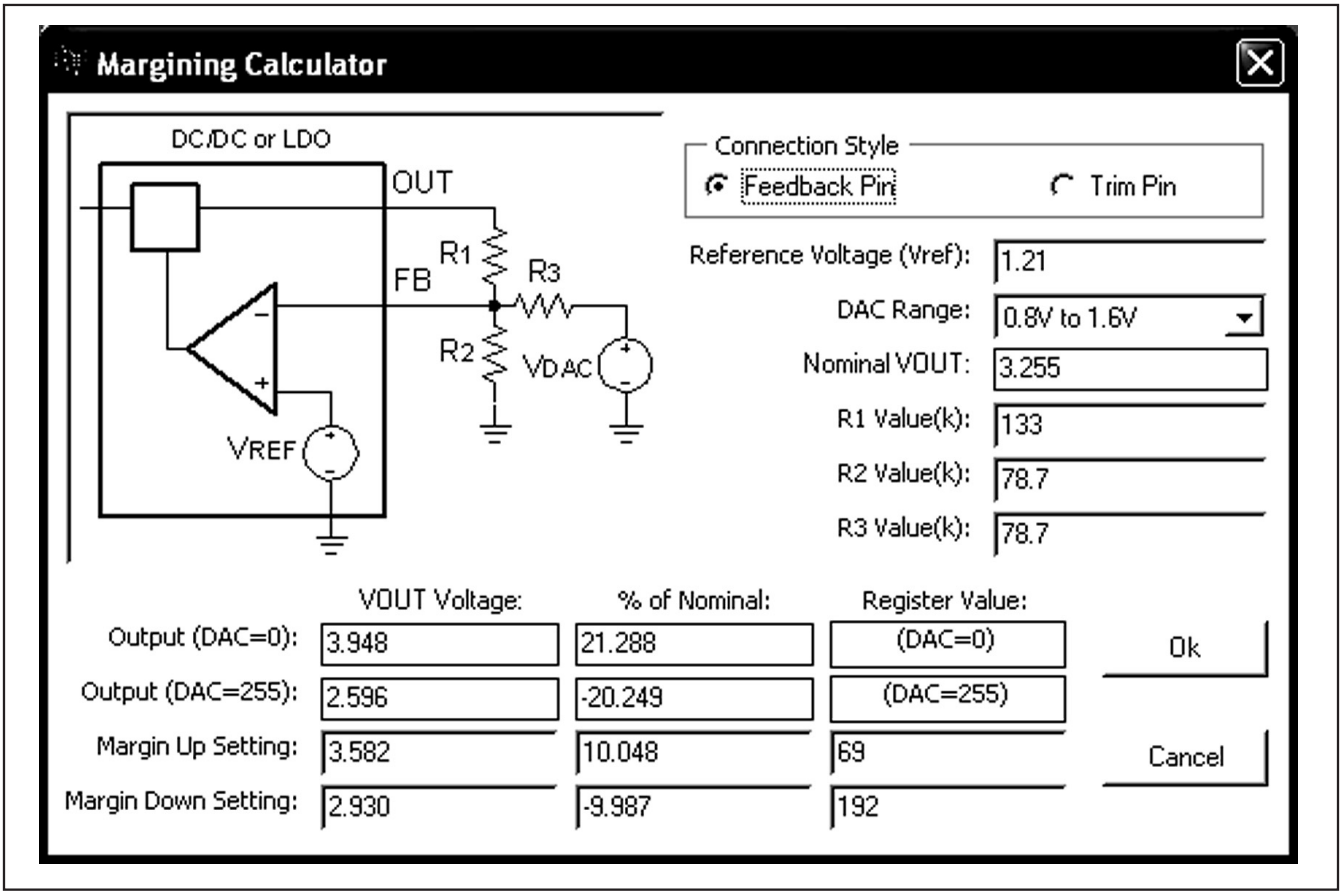


Figure 3. Margining Calculator

To add a power supply to the list, click **Add Item**. To add an additional monitoring input or margining DAC output to a power supply, as in the case of a multiple-output power supply, select the row representing the power supply and click **Add Subitem**. To remove a power supply or additional monitoring input/margining DAC output, select the row to be removed and click **Delete Item**. To remove all the power supplies, click **Clear Tree**.

The early warning thresholds (EW) can be configured as overvoltage thresholds or undervoltage thresholds. Click **Undervoltage** or **Overvoltage** as desired.

The contents of the **Setup** tab are not sent to the registers of the MAX16046 until the **Write To Registers** button is clicked. After making a change, click **Write To Registers** to update the device registers.

Margining Calculator

To facilitate resistor value calculation for designs using the margining DACs, the EV kit software provides a margining calculator. Access the margining calculator by clicking the icon for the desired DACOUT channel in the **Setup** tab.

Figure 3 shows the **Margining Calculator** dialog. This provides a convenient interface to the margining calculations listed in the *Applications Information* section of the MAX16046 data sheet.

To use the margining calculator, select the desired formulas using the **Connection Style** option buttons. The diagram on the left will update to reflect the wiring for that particular style. Enter the reference voltage used by the power supply under **Reference Voltage (Vref)**, and select the **DAC Range** so the reference voltage is approximately in the middle of the range. For the feed-

back pin style, **Nominal VOUT** is automatically calculated based on R1 and R2. For the trim pin style, enter the nominal output voltage. The **Nominal VOUT** value is identical to that of the field in the **Setup** tab, and can be changed from both places when the trim pin style is selected. Enter the three resistor values, **R1 Value(k)**, **R2 Value(k)**, **R3 Value(k)**.

After these values have been entered, values under the **VOUT Voltage**, **% of Nominal**, and **Register Value** columns update automatically. Rows **Output (DAC=0)** and **Output (DAC=255)** indicate the maximum and minimum limits of the output voltage, both as voltages and as percentages of the nominal output voltage.

Fields in the last two rows can each be modified manually, and the remaining fields in the same row will automatically be recalculated. For example, if a percentage is entered in the **% of Nominal** field of the **Margin Up Setting** row, the **VOUT Voltage** and **Register Value** for that row will be recalculated. Decimal values in the **Register Value** column are actual 8-bit DAC codes loaded into the MAX16046 registers. Values in the **% of Nominal** and **VOUT Voltage** fields are identical to those shown in the appropriate fields of the **Setup** tab and can be changed from both places.

Click **Ok** to save the changes to the **Setup** tab. Click **Cancel** and any changes will be lost. Changes will not be saved to the registers of the MAX16046 until **Write To Registers** (on the **Setup** tab) is clicked.

Table 2 provides the margining settings for LDO1 and LDO2 on the MAX16046 EV kit.

Table 2. Margining Settings

SETTING	CONNECTION STYLE	REFERENCE VOLTAGE	DAC RANGE (V)	R1 VALUE(k)	R2 VALUE(k)	R3 VALUE(k)
LDO1 (DACOUT2)	Feedback Pin	1.21	0.8 to 1.6	133	78.7	78.7
LDO2 (DACOUT3)	Feedback Pin	1.21	0.8 to 1.6	84.5	78.7	66.5

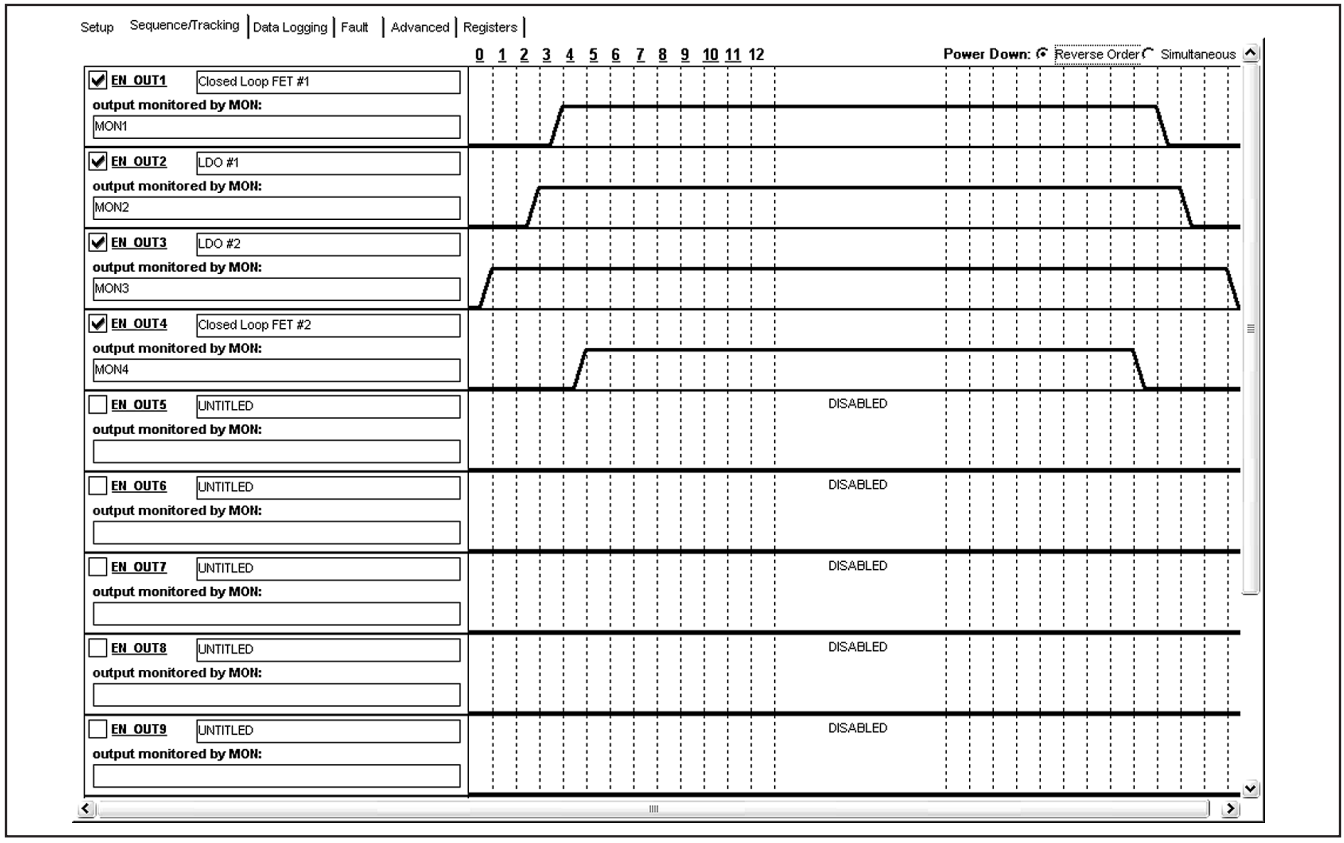


Figure 4. Sequence/Tracking Tab

Sequence/Tracking Tab

To set the sequence order of the power supplies, use the **Sequence/Tracking** tab, shown in Figure 4. Items changed on this tab are immediately written to the registers of the part.

Before a channel will correctly sequence, it must be enabled using the checkbox located to the left of the appropriate **EN_OUT_**. The name of the associated power supply (from the **Setup** tab) is just to the right of the text box. For convenience, the name(s) of all inputs monitored for this power supply is located below the checkbox, under **output monitored by MON**. Click the **EN_OUT_** labels to view the output type, which can only be modified from the **Setup** tab.

On the right side, the red sequence waveforms control the sequence order of the power supplies. Each column represents a sequencing time slot. The headings for each column indicate the slot number and can be clicked to change the slot delay for each time slot. Click and drag on the rising edge of each waveform to shift the sequence order. The MAX16046 EV kit software automatically calculates the MON_ and EN_OUT_ slot assignments and loads them to the registers of the MAX16046 immediately after any change.

To change the power-down order for all the channels, click the **Power Down** option button in the upper right. The red sequence waveforms will update to show the new configuration.

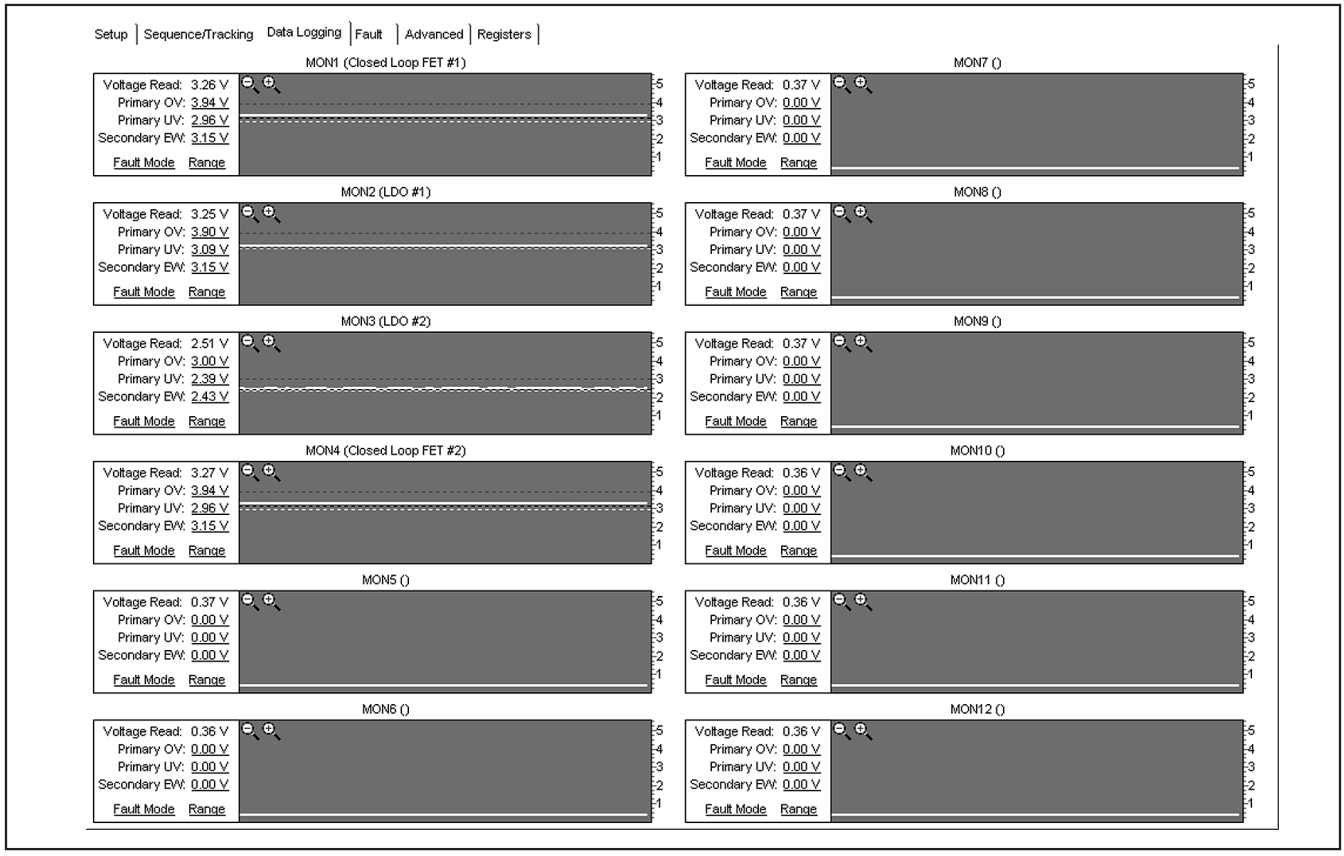


Figure 5. Data Logging Tab

Data Logging Tab

The **Data Logging** tab (Figure 5) monitors the voltage at each MON_ input on chart recorder graphs. Each graph shows the MON_ input being monitored, the name of any associated power supply, the primary overvoltage (OV) and undervoltage (UV) thresholds, and the configurable early warning (EW) threshold. The dotted lines represent the voltage thresholds, and the solid green line is the monitored voltage. Items changed on this tab are immediately written to the registers of the part.

To modify the primary OV, UV, or EW thresholds for a particular channel, click the appropriate underlined number next to that parameter. The thresholds can also be modified by dragging the dotted lines in the chart recorder view. The red dotted line represents the primary OV threshold, the yellow dotted line represents the primary UV threshold, and the blue dotted line represents the EW threshold. The **Range** link provides access to the input voltage range setting for that channel.

Each channel uses a fault flag indicator to signal if an undervoltage or overvoltage fault has occurred. The fault flag indicator turns red and remains so even after the original fault condition is removed. To clear a fault indicator, click the indicator and select **Clear Fault** or **Clear All Faults** on the menu that appears. The **Fault Mode** link provides access to the fault flag settings for each channel.

Any modifications to voltage thresholds, range settings, or fault modes are not propagated back to the **Setup** tab, and are lost when the **Write To Registers** button on the **Setup** tab is clicked.

Each chart recorder view shows the current voltage on the corresponding IN input with a solid green line. To zoom in and zoom out, click the magnifying glass icons in the upper left of the chart recorder view. Another way to zoom in and out is to click and “drag” a selection rectangle. Drag from upper left to lower right to zoom in, and drag from the lower right to the upper left to zoom out.

Setup | Sequence/Tracking | Data Logging | Fault | Advanced | Registers

Non-volatile Fault Register Content			
MON	Failed	Voltage	Code (hex)
MON1		0.000 V	00
MON2		0.000 V	00
MON3		0.000 V	00
MON4		0.000 V	00
MON5		0.000 V	00
MON6		0.000 V	00
MON7		0.000 V	00
MON8		0.000 V	00
MON9		0.000 V	00
MON10		0.000 V	00
MON11		0.000 V	00
MON12		0.000 V	00
Sequencer State		SLOT 0	

Tracker Fault on Channel	CH1	CH2	CH3	CH4

Clear Fault Registers

Figure 6. Fault Tab

Fault Tab

Observe the contents of the nonvolatile fault registers using the **Fault** tab (Figure 6). Each stored channel voltage is listed as both a hexadecimal code and as a voltage (calculated automatically using the input range selection).

The failed line is marked in the **Failed** column using a blue dot. If the fault occurred during sequencing, the **Sequencer State** row will indicate the power-up or power-down time slot where the fault occurred. If a tracking fault occurred on one or more tracking channels, that is indicated with a blue dot in the **Tracker Fault on Channel** row.

Click **Clear Fault Registers** to reset the contents of the nonvolatile fault registers. If the lock bits are set, a dialog box will allow you to clear them or to cancel the clear operation.

Advanced Tab

The **Advanced** tab (Figure 7) contains the settings for the programmable outputs as well as several other features of the MAX16046: the GPIO configuration, the RESET and FAULT pin configurations, the DAC outputs, the watchdog timer, and several miscellaneous timers. Items changed on this tab are immediately written to the registers of the part.

Setup | Sequence/Tracking | Data Logging | Fault | Advanced | Registers

OUTPUT	INPUT	Data	GPIO Configuration		Pull Down	PG Threshold
		GPIO #1	GPIO #1	INS1		95%
	●	GPIO #2	GPIO #2	Margin Up		95%
	●	GPIO #3	GPIO #3	Margin Down		95%
		GPIO #4	GPIO #4	INS4		95%
	●	GPIO #5	GPIO #5	Fault 1 OD		
	●	GPIO #6	GPIO #6	Fault 2 OD		

RESET Pin Configuration

Assert Pin On: Primary Undervoltage

MON: 1 2 3 4 5 6 7 8 9 10 11 12

Timeout: 25 us

Active High ● Push - pull

● Active Low Open Drain

FAULT1	FAULT2	FAULT Pin Dependencies
		Primary Over Voltage
✔	✔	Primary Under Voltage
		Early Warning
✔	✔	MON1
✔	✔	MON2
✔	✔	MON3
✔	✔	MON4
		MON5
		MON6
		MON7
		MON8
		MON9
		MON10
		MON11
		MON12
		Active High
●	●	Active Low

DAC Configuration	Enabled	Range	Output Code	Margin UP	Margin DN
DAC Control #1		Off	0	0	0
DAC Control #2		0.8 V to 1.6 V	0	69	192
DAC Control #3		0.8 V to 1.6 V	0	68	194
DAC Control #4		Off	0	0	0
DAC Control #5		Off	0	0	0
DAC Control #6		Off	0	0	0
DAC Control #7		Off	0	0	0
DAC Control #8		Off	0	0	0
DAC Control #9		Off	0	0	0
DAC Control #10		Off	0	0	0
DAC Control #11		Off	0	0	0
DAC Control #12		Off	0	0	0

Watchdog Timer

Enable ☐

Startup 25.6 s Timeout 1600 ms

Startup Timer ☐

Reset Output ☐

Mode Dependent

Miscellaneous Timers

Fault Up Timer 25 ms Deglitch Cycle 2 Cycle

Fault Down Timer 100 ms Slew Rate 800 V/s

Fault Behavior ○ Latch-Off

◉ Auto-Retry: 1600 ms

Figure 7. Advanced Tab

Table 3. GPIO Configuration Settings

NAME	AVAILABLE ON GPIO	DESCRIPTION
INS1–INS4	GPIO1–4	Voltage tracking sense connections. These are used to sense the output side (MOSFET source) of channels configured for closed-loop tracking.
Out. Port reg. PP	GPIO1–6	General-purpose output (open-drain or push-pull). The output state is controlled by the **OUTPUT** column.
Out. Port reg. OD		
Logic Input	GPIO1–6	General-purpose logic input. The logic state is shown in the **INPUT** column.
Any Fault PP	GPIO1–4	Fault output (open-drain or push-pull). Asserts low during any fault condition.
Any Fault OD		
Fault 1 PP	GPIO5	Configurable fault outputs (open-drain or push-pull). These are configured with the **FAULT Pin Dependencies** control.
Fault 1 OD		
Fault 2 PP	GPIO6	
Fault 2 OD		
Fault on Power-Up	GPIO6	Power-up fault. Asserts if a tracking fault occurs during power up.
MarginB	GPIO6	Margining control input. When pulled low externally, this disables threshold monitoring so margining can be performed.
Margin Up	GPIO2	Margin-up and margin-down control inputs. When asserted low externally, these enable the DAC outputs and load values from the **Margin UP** or **Margin DN** columns into the DAC registers.
Margin Down	GPIO3	
Manual Reset	GPIO4	Manual reset input. When asserted low externally, this triggers a reset pulse on RESET.
WDI	GPIO5	Watchdog input. Input to the internal watchdog timer.
WDO	GPIO6	Watchdog output. Dedicated watchdog timer output.

GPIO Configuration

The MAX16046 has six general-purpose input/output pins that can be configured for a variety of purposes.

The center column containing the drop-down list boxes control the configuration of each GPIO. Table 3 summarizes the different options.

The column on the left, **INPUT**, displays the current logic-high or logic-low state of each GPIO. A blue dot represents a logic-high, and the absence of a blue dot represents a logic-low. The **OUTPUT** column controls the state of GPIOs configured as general-purpose outputs. Click the boxes to set or clear the state of GPIOs configured as general-purpose outputs.

The **Pull Down** and **PG Threshold** settings are active only for GPIOs configured as INS_ (in sense) inputs. When the **Pull Down** checkbox is checked, the internal 100Ω pulldown is activated on that pin during power down. The **PG Threshold** setting controls the power-good threshold for closed-loop tracking. This determines what percentage of the input voltage the output voltage must achieve before the channel is considered powered up.

Fault 1, Fault 2, and RESET Outputs

GPIO5 and GPIO6 can be configured as Fault 1 and Fault 2 outputs. Each output can be configured to depend on overvoltage, undervoltage, or early warning conditions on one or more input channels; when a selected channel voltage exceeds the voltage of the selected threshold, the output asserts. The outputs can be configured as active high or active low. Click the boxes under the appropriate row and column to enable or disable each setting.

The early warning threshold can be configured as undervoltage or overvoltage depending on the **Early Warning** setting in the **Setup** tab.

RESET is a dedicated output that asserts when selected MON inputs exceed selected thresholds. It can be configured as open drain or push-pull as well as active high and active low. A reset timeout can also be chosen from the **Timeout** box. Thresholds that can be monitored are:

- Primary undervoltage only
- Early warning only
- Primary overvoltage only
- Primary overvoltage and primary undervoltage at the same time

DAC Configuration

The preferred method for configuring the margining DACs is through the **Setup** tab, but the DAC outputs can also be configured from the **Advanced** tab. Click the **Enabled** checkbox to turn a DAC on or off. For a DAC output to turn on, both the **Enabled** checkbox must be checked and the **Range** selection must be one of 0.4V to 0.8V, 0.6V to 1.2V, or 0.8V to 1.6V.

To set the DAC output voltage, enter a decimal number from 0 to 255 in the **Output Code** box. The new value will be written to the appropriate register and the DAC output will update immediately. The **Margin UP** and **Margin DN** boxes contain the decimal codes placed at all DAC outputs when the margin-up or margin-down inputs are asserted (see the *GPIO Configuration* section).

Any modifications to the DAC settings are not propagated back to the **Setup** tab, and are lost when the **Write To Registers** button on the **Setup** tab is clicked.

Watchdog Timer Configuration

The internal watchdog timer can be configured in this box. Check the **Enable** checkbox to turn on the watchdog timer. Click the blue link next to **Timeout** to change the watchdog timeout period.

If the watchdog timeout period needs to be extended during initial startup to allow for an external microprocessor to complete a boot-up sequence, check the **Startup Timer** checkbox and specify the startup timeout with the blue link next to **Startup**.

Normally, the watchdog timer asserts WDO (if GPIO6 is configured appropriately), but if desired, the watchdog timer can also assert RESET. Check the **Reset Output** checkbox to enable this behavior.

If **Mode** is set to **Dependent**, the watchdog timer turns on after power sequencing is complete and RESET deasserts. If **Mode** is set to **Independent**, the watchdog timer turns on immediately and remains on regardless of the power sequencing state.

Miscellaneous Timers

The **Fault Up Timer** controls the period of time allowed for a power supply to fall within its power-good thresholds from when it is turned on. Conversely, the **Fault Down Timer** setting controls the period allowed for a power-supply rail to turn off.

During a fault condition, the MAX16046 can either shut off or try to sequence again, depending on the **Fault Behavior** setting. Select **Latch-Off** to have the MAX16046 shut down and not attempt to restart power sequencing. Select **Auto-Retry** and select a delay period to have the MAX16046 attempt sequencing again after the delay occurs.

When a monitored voltage falls outside one of the programmable thresholds, the MAX16046's internal ADC will repeat several conversions on the same channel. To trigger a fault condition, the voltage must remain outside the threshold for a certain number of conversions. This number is controlled by the **Deglitch Cycle** setting. Allowable options are: 2, 4, 8, and 16 cycles.

The **Slew Rate** setting controls the tracking slew rate for channels configured in closed-loop tracking mode.

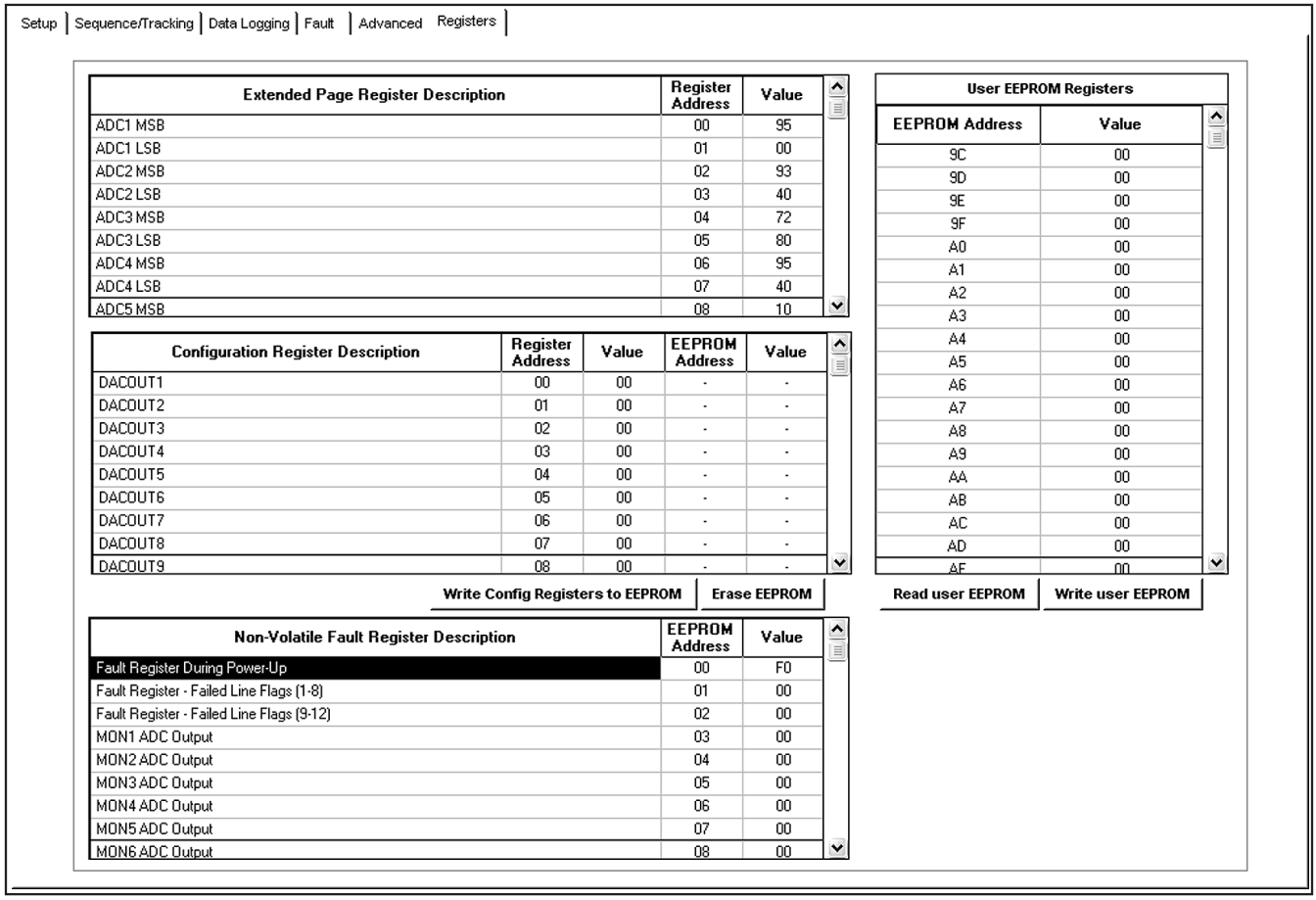


Figure 8. Registers Tab

Registers Tab

Besides the easy-to-use GUI controls, the MAX16046 can also be configured by directly modifying the registers and EEPROM. The **Registers** tab, seen in Figure 8, provides access to the registers and EEPROM. Modify a register by clicking the field under the **Value** column, entering the new value, and hitting enter or clicking in another field. After being edited, the register in the part is updated immediately.

Most configuration registers have a matching EEPROM location that is copied to the register when the MAX16046 powers up. The **Registers** tab places each pair on the same row. After experimenting with a particular register configuration, that configuration can be written to the EEPROM by clicking **Write Config Registers to EEPROM**.

Registers in the extended page, including the ADC conversion results and the fault flags, can be accessed from the **Extended Page Register Description** box. These values are volatile and not saved in EEPROM.

Values stored in the nonvolatile fault EEPROM can be accessed from the **Non-Volatile Fault Register Description** box.

The user EEPROM is also accessible from this tab. Separate read and write controls are provided. Read the user EEPROM from the part by clicking **Read user EEPROM**. After modifying a value in the **User EEPROM Registers** box, download the change to the part by clicking **Write user EEPROM**.

Menu Reference

File

Open Configuration and **Save Configuration As** load and save the contents of the setup tab (which are not saved to the MAX16046 registers), as well as the complete register contents to a standard XML file. **Tip:** XML files can be viewed in an indented, color-coded format in many web browsers.

Save as SVF writes the EEPROM configuration to an SVF file, which is a standard format used by JTAG device programmers for production programming.

System

Connect… directs the software to open a connection with a connected EV kit, and displays the **Connect** dialog (Figure 1) to select the connection type. Once connected, this menu item changes to **Disconnect**.

Fault Control changes the amount of information that the MAX16046 saves during a nonvolatile fault save event. This writes to register r47h.

Send REBOOT sends the reboot command to the MAX16046, which will then reload the configuration EEPROM into the configuration registers.

Trigger FAULT Save manually triggers a nonvolatile fault save event.

Save Configuration to EEPROM writes the contents of the configuration registers to the EEPROM.

Configuration Register Lock controls and displays the status of the register and configuration EEPROM lock bit, located in register r5Dh. The registers and the configuration EEPROM can be locked with this setting to prevent unintentional modification of configuration settings. The **lock icon** on the status bar also indicates and controls this lock bit.

Non-Volatile EEPROM Lock controls and displays the status of the nonvolatile EEPROM lock bit, located in register r5Dh. The fault EEPROM is locked automatically when a fault condition occurs, and it must be unlocked before any subsequent fault will get stored to EEPROM. A check mark will appear next to this item when the EEPROM is locked. Clear it by selecting the menu item.

Software Enable controls the MAX16046's sequencer. Click this menu item to enable or disable the MAX16046. A check mark appears next to this menu item when enabled. For power-up sequencing to occur, this menu item must be checked and the hardware enable switch on the MAX16046 EV kit must be switched on.

Device

This menu selects the target device. The EV kit uses the MAX16046 by default, but the EV kit software can also generate configuration files for and program the MAX16047/MAX16048/MAX16049.

Polling

On and **Off** turn register polling on and off. When polling is on, the controls in all the tabs are periodically refreshed from the physical registers. If polling is off, register contents can be read from the device by selecting **Read All Registers**.

Help

About launches the **About** dialog, which displays the software version and, if the EV kit is connected, the firmware revision of the USB interface.

_Detailed Description of Hardware

The MAX16046 monitors, sequences, and margins up to 12 power supplies. Seven configurable input/outputs indicate fault status information and control some functions of the IC. Figure 11 provides an overview of the major features of the EV kit PCB. Figure 12 is the MAX16046 EV kit schematic. Figure 13 shows the MAX16046 EV kit schematic—USB interface.

USB Host Interface

The MAX16046 EV kit includes a built-in USB-to-JTAG/I²C host interface. The host interface uses Maxim's MAX3420 USB peripheral controller along with a MAXQ2000 microcontroller to communicate with the host PC and generate the I²C/JTAG bus signals. Three indicators, LED101, LED102, and LED103, provide status information of the host interface. LED101 lights during EEPROM write operations, LED102 lights during I²C or JTAG bus activity, and LED103 lights when the software is connected to the EV kit.

To facilitate prototype development and programming, the host interface can be used to interface with a MAX16046 on another board by turning off switches 1–7 in switch bank S2. This disconnects the on-board MAX16046 from the JTAG and I²C buses. Connect to the other board using P1 and P2. The pinout of each connector is shown in Tables 6 and 7. Note that the I²C pullup resistors (R108, R109, and R110) are located on the EV kit host interface.

The on-board MAX16046 can be connected to an external JTAG or I²C interface by turning off switch bank S3 (switches 1–7) while keeping switch bank S2 (switches 1–7) on. Connect the external interface to P1 for I²C (Figure 9) or to P2 for JTAG (Figure 10). The MAX16046 can be completely disconnected from the on-board USB host interface by using this technique while providing external power to EXT PWR (J100 must be in the EXT position) and setting jumpers J7 and J8 to positions 1-2.

Each interface can be disconnected or connected separately. I²C uses switches 1, 2, and 3 on both S2 and S3, and JTAG uses switches 4–7 on both S2 and S3.

Power Source

The MAX16046 can be powered from one of three possible power supplies, controlled by jumper J100. To power directly from the USB 5.0V supply, place the jumper in the 5V position. To power from the on-board 3.3V regulator, place the jumper in the 3.3V position. When the jumper is in the EXT position, the MAX16046 can be powered from an external power supply connected to the EXT PWR test point. Do not supply a voltage higher than 14V.

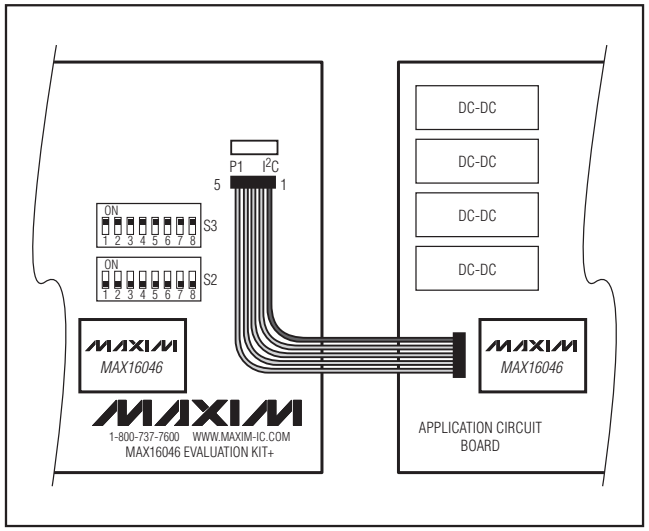


Figure 9. Connecting the EV Kit to an External Application Board Using I²C

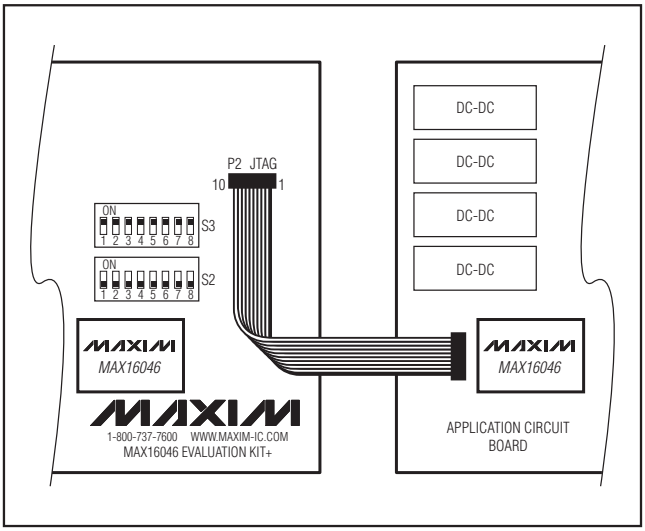


Figure 10. Connecting the EV Kit to an External Application Board Using JTAG

Serial Interfaces

The MAX16046 has both a JTAG interface and an I^2C serial interface. The slave address of the on-board MAX16046 can be set using J1 according to Table 5.

On-Board LDO Power Supplies

The MAX16046 EV kit includes two on-board LDO power supplies. LDO1 is connected to channel 2 (EN_OUT2/MON2/DACOUT2) and LDO2 is connected to channel 3 (EN_OUT3/MON3/DACOUT3).

LDO1 is a MAX1658 voltage regulator equipped with feedback resistors R2 and R8 to set the output voltage to 3.3V. A series resistor, R9, connects the LDO feedback node to DACOUT2 to facilitate margining. To completely disconnect LDO1 from EN_OUT2, MON2, and DACOUT2, remove R9 and cut the traces shorting R12 and R13. To modify the output voltage, calculate the new values for resistors R2 and R8 by either using the margining calculator feature of the MAX16046 EV kit software, or the following formulas:

$$V_{OUT1} = 1.21 \times \left(1 + \frac{R2}{R8}\right) (LDO1)$$

$$V_{OUT2} = 1.21 \times \left(1 + \frac{R1}{R6}\right) (LDO2)$$

LDO2 is identical to LDO1 except the output voltage is set using R1 and R6 to 2.5V. R7 connects LDO2 to DACOUT3 for margining. To disconnect LDO2 from EN_OUT3, MON3, and DACOUT3, remove R7 and cut the traces shorting R10 and R14.

The shutdown connection on LDO1 and LDO2, $\overline{SHDN}$, is active low. This is equivalent to an active-high enable connection. In the MAX16046 EV kit software, set the enable output type to active-high push-pull. The output must be push-pull since there is no pullup resistor.

Each LDO has a 475Ω load resistor: R5 for LDO1 and R4 for LDO2.

Headers P3 and P4 provide access to the EN_OUT_, MON_, and DACOUT_ connections for each LDO.

On-Board Tracking MOSFETs

The MAX16046 EV kit includes two tracking n-channel MOSFETs that facilitate evaluation of the MAX16046's closed-loop slew-rate-controlled tracking capability as well as the open-loop charge-pump capability. FET Q1 is connected to EN_OUT1, MON1, and INS1 (GPIO1), and FET Q2 is connected to EN_OUT4, MON4, and INS4 (GPIO4).

Power to FET Q1 is controlled by J8, and power to FET Q2 is controlled by J7. Position 1-2 connects the input (drain) side of the MOSFET to the V_{CC} supply set by J100, and position 2-3 connects to the USB interface's 3.3V regulator output. Remove the jumper to provide an external input voltage to the MON connection of headers P10 and P9.

Since the source side of each MOSFET is monitored by a GPIO configured as an INS (in sense) input in closed-loop tracking mode, the LED and pullup resistor normally associated with that GPIO must be disconnected. Jumpers J3 and J4, in position 1-2, disconnect the LED and pullup resistor and connect to the source sides of the FETs. In position 2-3, normal GPIO functionality is restored.

When using the MOSFETs in the open-loop charge-pump-output configuration, the INS_ (GPIO) connections can safely be disconnected by shifting jumper J3 or J4, as appropriate, to the 2-3 position, allowing the associated GPIO to be used for another function. In the 2-3 position, the MOSFET channel's output capacitor and load resistor are disconnected.

To disconnect the tracking MOSFETs entirely, remove jumpers J5 and J6. To disconnect the MOSFETs from MON1 and MON4, set jumpers J3 and J4 to their 2-3 positions.

Access to the MOSFET drain, gate, and source is provided through headers P10 and P9. MON_ connects to the drain, EN_OUT_ connects to the gate, and OP_ connects to the source. Connecting an oscilloscope probe to an OP_ connection will show the tracking output voltage for that MOSFET channel. A load can also be connected to OP_ to evaluate the behavior of closed-loop tracking under varying load conditions.

Monitoring Inputs, Enable Outputs, and DAC Outputs

Each of the MON_ inputs, EN_OUT_ outputs, and DACOUT_ outputs not used for the two on-board LDOs and two on-board tracking FETs can be accessed through headers P7 (EN_OUTs), P5 (MONs), and P8 (DACOUTs).

The switch bank, S1, allows EN_OUT5–EN_OUT12 to be connected to MON5–MON12 to help evaluate the MAX16046's sequencing feature. Configure the EN_OUT_s for active-high push-pull, and configure the voltage thresholds of the MON_s to correspond with the output logic levels.

General-Purpose Inputs and Outputs

Each GPIO has a separate indicator LED and pullup resistor, and each signal is brought out to a pin on P6. An LED will light to indicate that the associated output has gone to the logic-low state. The LEDs can be disabled by turning off switch 1 in switch bank S4. The pullup resistors are individually switched by S4; see Table 4 for the assignments of each switch in the switch bank. To use an external pullup voltage, connect J2 in the 2-3 position and connect the voltage source to the VPU pin of P6.

Margin Up and Margin Down

Through the MAX16046 EV kit software, GPIO2 and GPIO3 can be configured as margin-up and margin-down inputs, respectively. Switches S6 and S7 pull GPIO2 and GPIO3 to ground. It is not necessary to disable the LEDs or disconnect the pullup resistors for GPIO2 or GPIO3 to use this function.

Hardware Enable

The MAX16046 has an analog EN connection that can be used to trigger power-up or power-down sequencing. An on-board resistive divider formed by R3 and R11 set the falling threshold to 3.0V on V_{CC}; the threshold can be modified by changing R3 and R11 according to the following formulas:

$$V_{VCC_TH_RISING} = 0.525 \times \left(1 + \frac{R3}{R11}\right)$$

$$V_{VCC_TH_FALLING} = 0.500 \times \left(1 + \frac{R3}{R11}\right)$$

EN can be manually controlled using the hardware enable switch, S5. Set S5 to the OFF position to pull EN to 0V, and set S5 to the ON position to allow EN to respond to the V_{CC} voltage.

Margining

Two of the MAX16046's DACOUTs (DACOUT2 and DACOUT3) connect to the two LDO regulators on the EV kit, LDO1 and LDO2, respectively. The rest go to header P8. To evaluate the margining capabilities of the MAX16046, configure GPIO2 and GPIO3 as margin-up and margin-down inputs from the **Advanced** tab in the EV kit software. When the margin-down (S7) or margin-up (S6) pushbuttons are pressed, the DAC outputs are enabled and the DAC codes are loaded from the **Margin UP** or **Margin DN** columns in the **Advanced** tab, causing the LDO regulator output voltages to shift.

Jumper Function Tables

Table 4. Jumper Function Table (J100, J2–J8, S1–S4)

JUMPER	POSITION	FUNCTION
J100	5V*	MAX16046 (V_{CC}) powered from 5V USB power.
	3.3V	MAX16046 (V_{CC}) powered from 3.3V regulator.
	EXT	MAX16046 (V_{CC}) powered from EXT PWR test point.
J2	1-2*	Output pullup resistors connected to 3.3V.
	2-3	Output pullup resistors connected to VPU test point.
J3	1-2*	GPIO4 connected to tracking FET Q2 source.
	2-3	GPIO4 connected to LED/pullup resistor.
J4	1-2*	GPIO1 connected to tracking FET Q1 source.
	2-3	GPIO1 connected to LED/pullup resistor.
J5	Open	MON1 not connected to FET Q1 drain.
	Closed*	MON1 connected to FET Q1 drain.
J6	Open	MON4 not connected to FET Q2 drain.
	Closed*	MON4 connected to FET Q2 drain.
J7	1-2	FET Q2 tracking input voltage is V_{CC}.
	2-3*	FET Q2 tracking input voltage is 3.3V.
J8	1-2	FET Q1 tracking input voltage is V_{CC}.
	2-3*	FET Q1 tracking input voltage is 3.3V.
S1	1	Connects EN_OUT5 to MON5 when closed.
	2	Connects EN_OUT6 to MON6 when closed.
	3	Connects EN_OUT7 to MON7 when closed.
	4	Connects EN_OUT8 to MON8 when closed.
	5	Connects EN_OUT9 to MON9 when closed.
	6	Connects EN_OUT10 to MON10 when closed.
	7	Connects EN_OUT11 to MON11 when closed.
	8	Connects EN_OUT12 to MON12 when closed.
S2	1	Connect P1 (I^2C) to on-board MAX16046 when closed.
	2	
	3	
	4	Connect P2 (JTAG) to on-board MAX16046 when closed.
	5	
	6	
	7	
	8	Not used.

**Default configuration.*

Jumper Function Tables (continued)

Table 4. Jumper Function Table (J100, J2–J8, S1–S4) (continued)

JUMPER	POSITION	FUNCTION
S3	1	Connect I²C bus of host interface to P1 when closed.
	2	
	3	
	4	Connect JTAG bus of host interface to P2 when closed.
	5	
	6	
	7	
	8	Not used.
S4	1	Enables GPIO LEDs when closed.
	2	Enables RESET pullup when closed.
	3	Enables GPIO6 pullup when closed.
	4	Enables GPIO5 pullup when closed.
	5	Enables GPIO4 pullup when closed.
	6	Enables GPIO3 pullup when closed.
	7	Enables GPIO2 pullup when closed.
	8	Enables GPIO1 pullup when closed.

Table 5. Jumper Function Table (J1)

J1 SHUNT POSITION (A0)	I²C SLAVE ADDRESS
LOW*	1010 00XR (A0h)
HIGH	1010 01XR (A4h)
SCL	1010 10XR (A8h)
SDA	1010 11XR (ACh)

X = Don't care, R = read/write select bit.

**Default configuration.*

Table 6. I²C Connector Pinout

PIN	FUNCTION
1	3.3V (output only)
2	SDA
3	Ground
4	SCL
5	SMBALERT# (not used by MAX16046)

Table 7. JTAG Connector Pinout

PIN	FUNCTION
1	TCK
2	Ground
3	TDO
4	3.3V (output only)
5	TMS
6	—
7	— (Key)
8	—
9	TDI
10	Ground

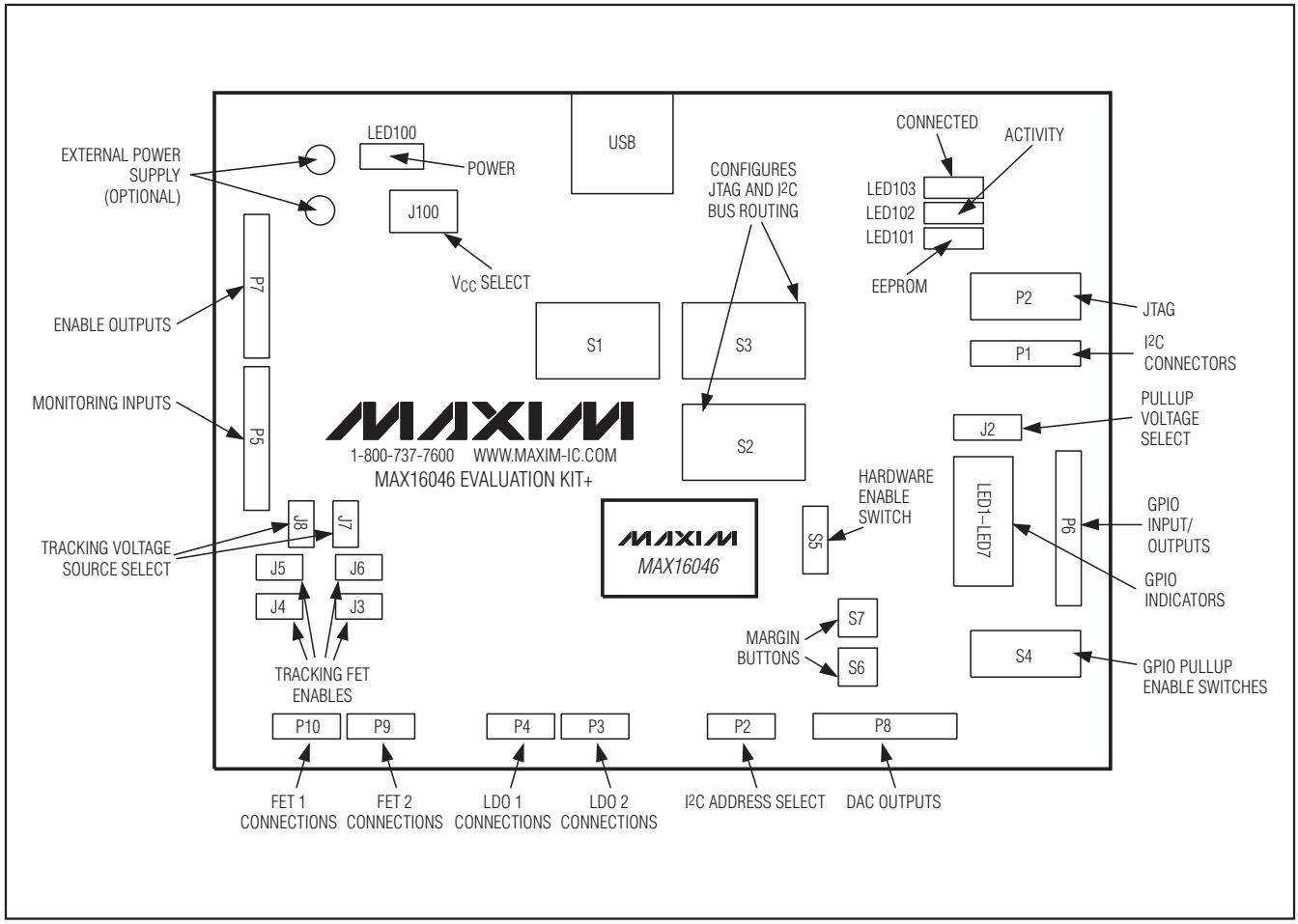


Figure 11. Evaluation Kit PCB Diagram

MAX16046 Evaluation Kit

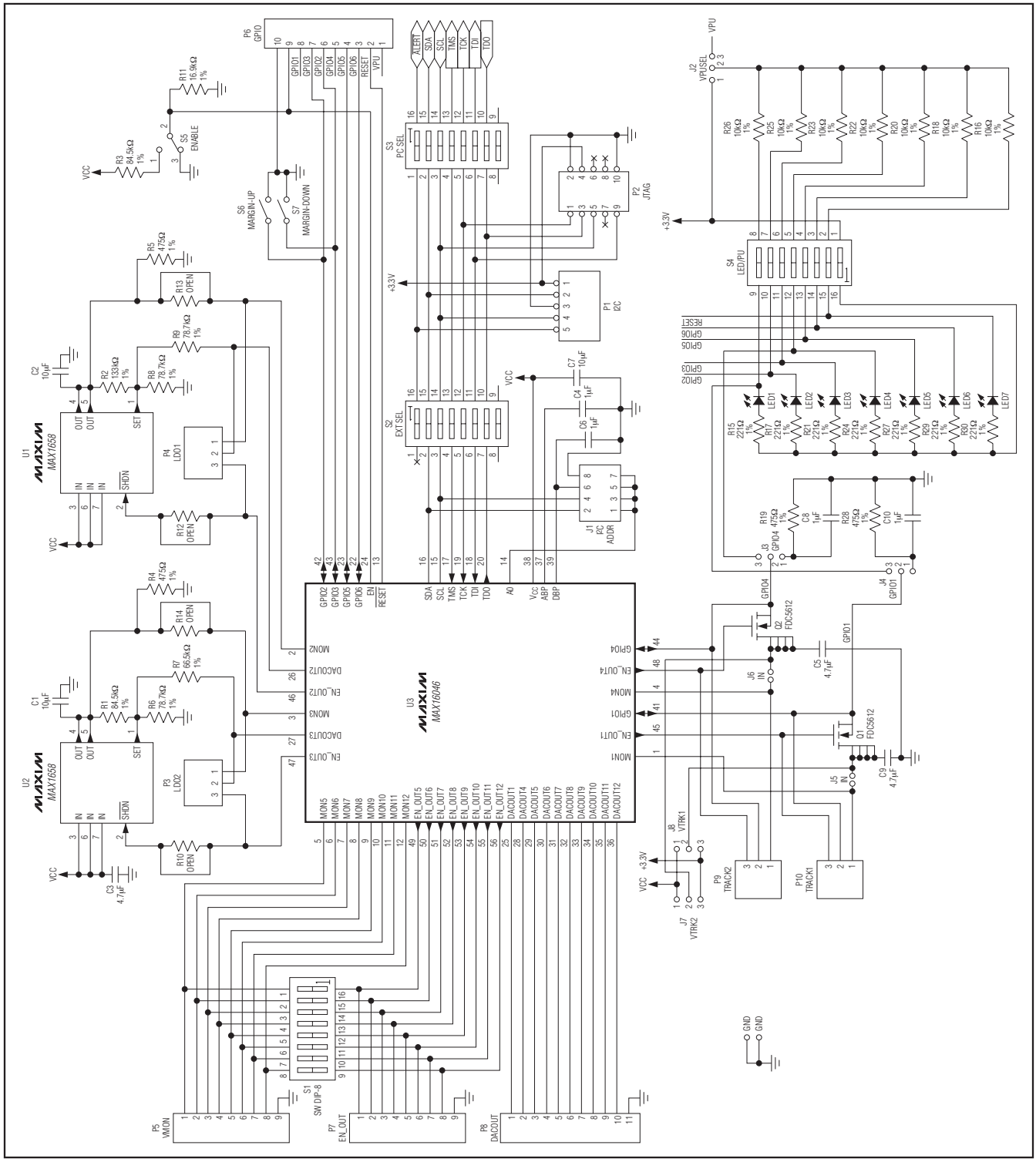


Figure 12. MAX16046 EV Kit Schematic

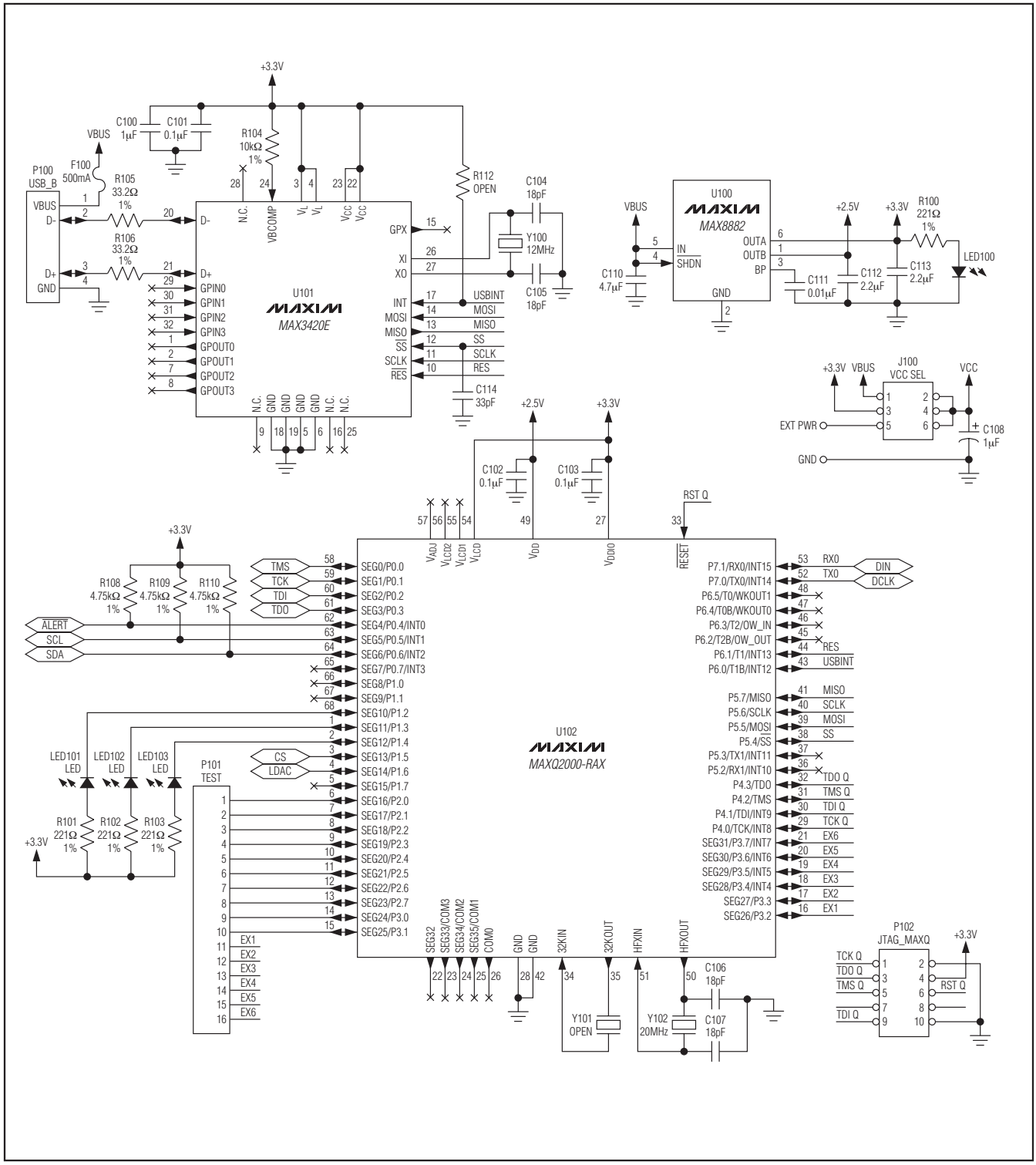


Figure 13. MAX16046 EV Kit Schematic—USB Interface

MAX16046 Evaluation Kit

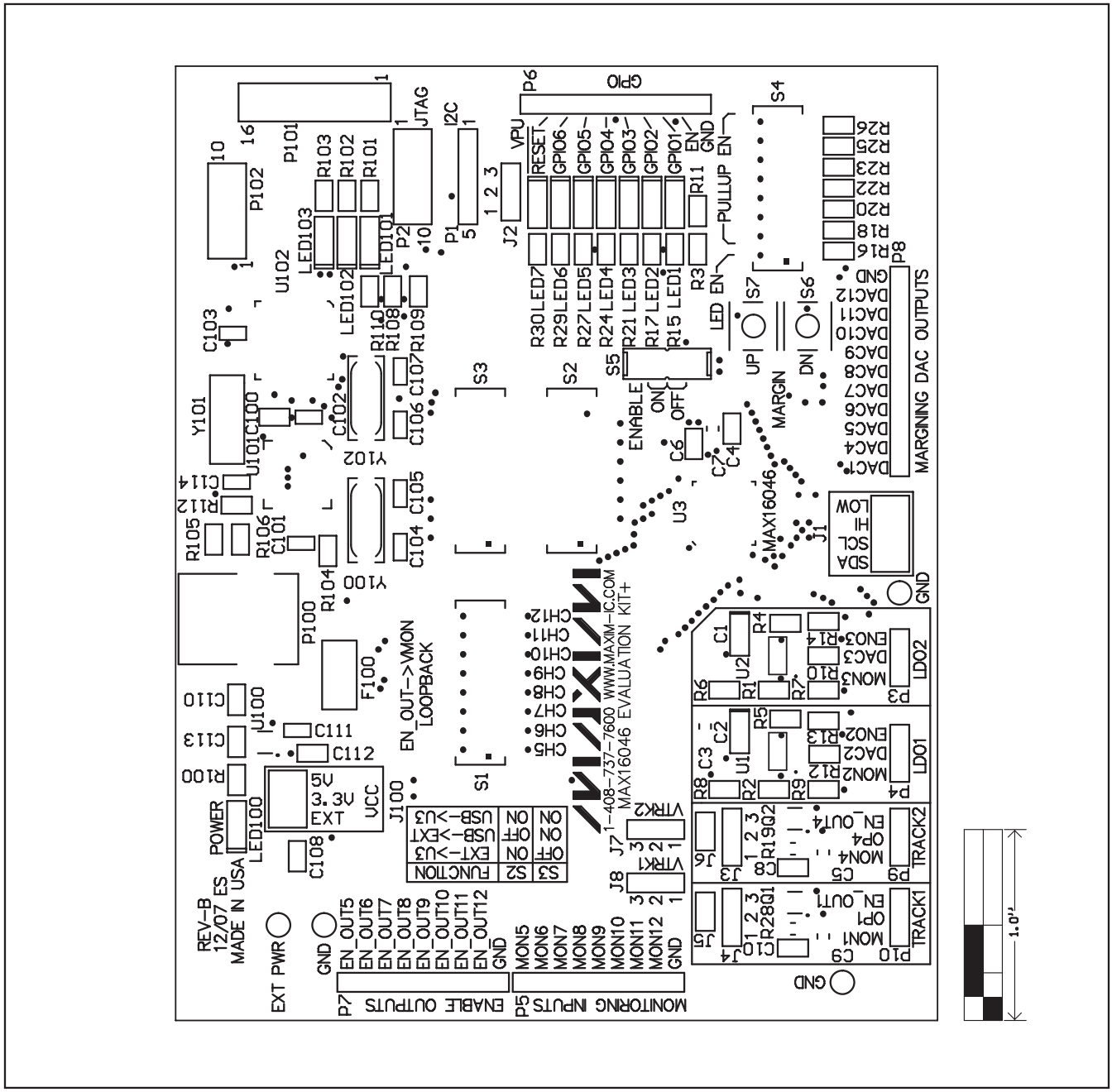


Figure 14. MAX16046 EV Kit Component Placement Guide—Component Side

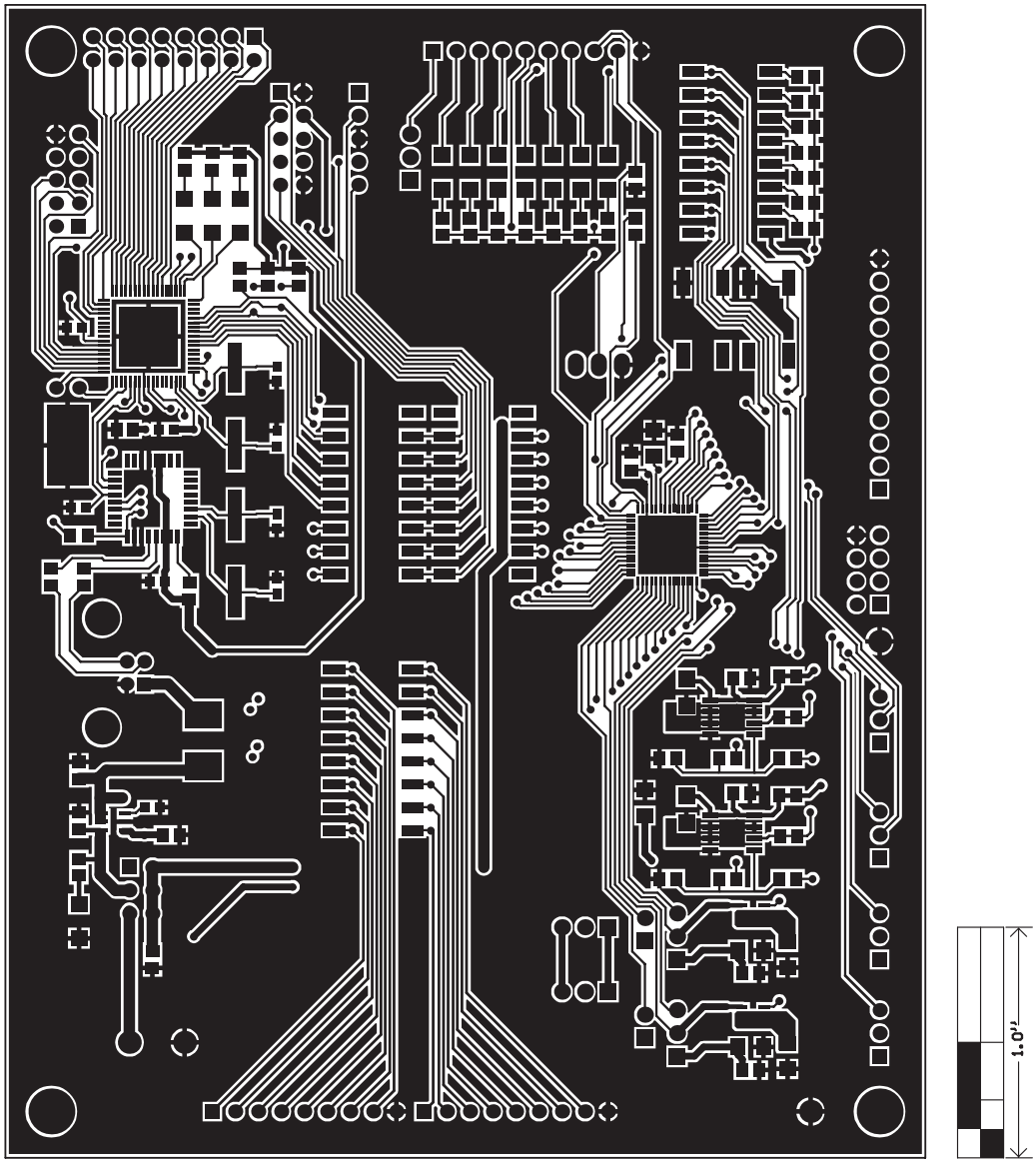


Figure 15. MAX16046 EV Kit PCB Layout—Component Side

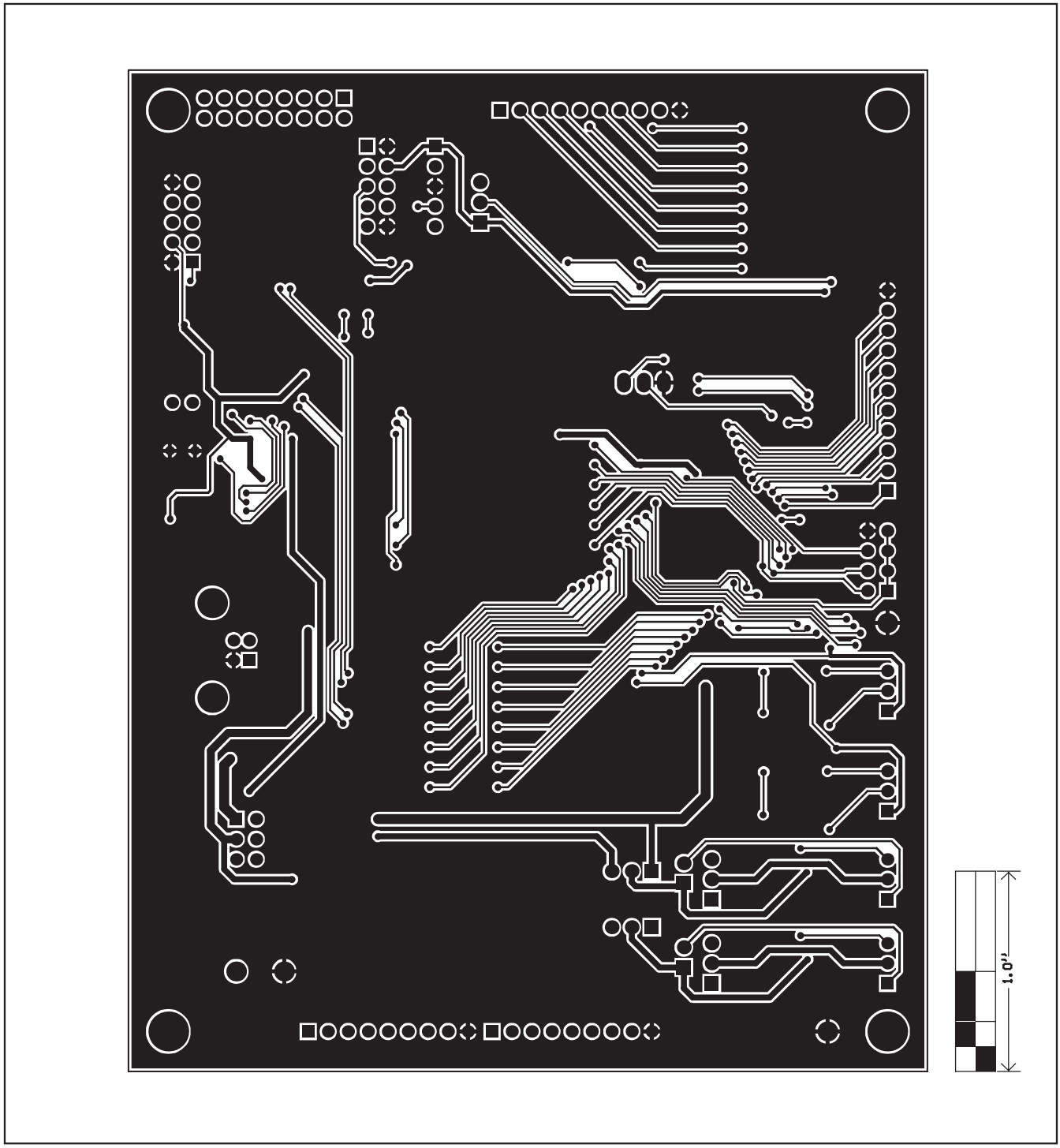


Figure 16. MAX16046 EV Kit PCB Layout—Solder Side

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/08	Initial release	—
1	3/09	Clarified I^2C addresses in Table 5.	18

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