



# MAX17061A Evaluation Kit/Evaluation System

## General Description

The MAX17061A evaluation system (EV system) consists of the MAX17061A evaluation kit (EV kit) and the Maxim CMAXQUSB+ command module. Windows® 2000-, Windows XP®, and Windows Vista®-compatible software are also available for use with the EV system (MAX17061AEVCMAXQU+) and can be downloaded from the Maxim website ([www.maxim-ic.com/evkitsoftware](http://www.maxim-ic.com/evkitsoftware)).

The MAX17061A EV kit (MAX17061AEVKIT+) is a fully assembled and tested surface-mount PCB that evaluates the high-efficiency MAX17061A white LED (WLED) driver. The MAX17061A EV kit utilizes a step-up DC-DC converter to generate the voltage required to drive up to eight strings of 10 surface-mount WLEDs. The EV kit is powered from dual supplies ( $V_{IN} = 5.5V$  to  $24V$  and  $V_{CC} = 4.5V$  to  $5.5V$ ) and can be configured to provide a fixed  $25mA$  or adjustable  $15mA$  to  $30mA$  full-scale LED current. As shipped, the MAX17061A EV kit is configured for evaluation with four strings of 10 WLEDs and includes an I<sup>2</sup>C/SMBus™-compatible interface that allows for software control of the brightness in 256 steps, backlight-controller operating mode, manufacturer and silicon revision detection, and fault detection.

The Maxim CMAXQUSB+ command module provides the I<sup>2</sup>C/SMBus interface and is connected to the computer through the universal serial bus (USB) port. The MAX17061A EV kit software provides a graphical user interface (GUI) for exercising the MAX17061A features.

## Features

- ◆ 7V to 21V Input Range
- ◆ WLED Drives Up to 30mA/String
- ◆ Drives Four Strings of 10 WLEDs (Capable of Driving Up to Eight Strings)
- ◆ Full-Scale LED Current Adjustable from 15mA to 30mA, or Preset 25mA
- ◆ 1MHz PWM Switching Frequency (Selectable: 500kHz or 750kHz, Component Change Required)
- ◆ All Components < 1.2mm Height
- ◆ Lead(Pb)-Free and RoHS Compliant
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TYPE
MAX17061AEVKIT+	EV Kit
MAX17061AEVCMAXQU+	EV System

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

**Note:** The Maxim CMAXQUSB+ command module is required when using the MAX17061A EV kit software.

## Component Lists

### MAX17061A EV System

PART	QTY	DESCRIPTION
MAX17061AEVKIT	1	MAX17061A EV kit
CMAXQUSB+	1	I <sup>2</sup> C/SMBus interface command module

### MAX17061A EV Kit

DESIGNATION	QTY	DESCRIPTION
C1	1	0.1μF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H104K TDK C1608X7R1H104K
C2	1	0.022μF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H223K TDK C1608X7R1H223K

DESIGNATION	QTY	DESCRIPTION
C3	1	4.7μF ±10%, 25V X5R ceramic capacitor (1206) Murata GRM319R61E475K
C4	0	Not installed, ceramic capacitor (1206)
C5, C6	2	1.0μF ±10%, 10V X7R ceramic capacitors (0603) Taiyo Yuden LMK107BJ105KA Murata GRM188R71A105K
C7–C12	6	0.33μF ±10%, 50V X7R ceramic capacitors (1206) Murata GRM319R71H334K TDK C3216JB1H334K
C13–C20, C22–C30	0	Not installed, ceramic capacitors (0603)

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# MAX17061A Evaluation Kit/Evaluation System

## Component Lists (continued)

### MAX17061A EV Kit (continued)

DESIGNATION	QTY	DESCRIPTION
C21	1	220pF $\pm 10\%$ , 50V X7R ceramic capacitor (0603) Murata GRM188R71H221K TDK C1608X7R1H221K
CCV	0	Not installed, test point
D1, D82	2	0.7A, 60V Schottky diodes (US-flat) Toshiba CUS04
D2–D41	40	White LEDs Nichia NSSW008CT-P1 OPTEK OVSRWACR6
D42–D81	0	Not installed, white LEDs
J1	1	2 x 10 right-angle receptacle
JU1–JU4, JU11, JU13	6	3-pin headers
JU5–JU8	0	Not installed, 3-pin headers—short (PC trace)
JU9	1	2-pin header

DESIGNATION	QTY	DESCRIPTION
L1	1	10 $\mu$ H, 1.2A power inductor Sumida CR6D09HPNP-100MC TDK VLP6810T-100M1R2
R1	0	Not installed, resistor—short (PC trace) (0603)
R2	1	2.21M $\Omega$ $\pm 1\%$ resistor (0603)
R3	1	61.9k $\Omega$ $\pm 1\%$ resistor (0603)
R4	1	130k $\Omega$ $\pm 5\%$ resistor (0603)
R5	1	200k $\Omega$ multiturn potentiometer
R6	1	41.2k $\Omega$ $\pm 1\%$ resistor (0603)
R7	1	500k $\Omega$ multiturn potentiometer
R8, R9	0	Not installed, resistors (0603)
R10	1	5.1k $\Omega$ $\pm 5\%$ resistor (0603)
R11	1	1M $\Omega$ resistor (0603)
U1	1	WLED driver (28 thin QFN) Maxim MAX17061AET1+
—	7	Shunts
—	1	PCB: MAX17061A EVALUATION KIT+

## Component Suppliers

SUPPLIER	PHONE	WEBSITE
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Nichia Corp.	248-352-6575	www.nichia.com
OPTEK Technologies	972-323-2200	www.optekinc.com
Sumida Corp.	847-545-6700	www.sumida.com
Taiyo Yuden	800-348-2496	www.t-yuden.com
TDK Corp.	847-803-6100	www.component.tdk.com
Toshiba America Electronic Components, Inc.	949-623-2900	www.toshiba.com/taec

**Note:** Indicate that you are using the MAX17061A when contacting these component suppliers.

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## MAX17061A EV Kit Files

PART	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX17061A.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

### Recommended Equipment

- MAX17061A EV system
  - MAX17061A EV kit
  - Maxim CMAXQUSB+ command module (USB cable included)
- 7V to 21V, 1A power supply (VIN)
- User-supplied Windows 2000, Windows XP, or Windows Vista PC
- Available 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.

### Procedure

The MAX17061A EV kit is fully assembled and tested. Follow the steps below to verify board operation.

**Caution: Do not turn on the power supply until all connections are completed.**

- 1) On the CMAXQUSB+ command module, ensure that the shunt on jumper JU1 is in the 5V (default) position.
- 2) On the MAX17061A EV kit, verify that the shunts are installed as follows:
 

JU1–JU4, JU13	1-2
JU9	Installed
JU11	2-3

- 3) Carefully connect the boards by aligning the 20-pin connector of the MAX17061A EV kit with the 20-pin header on the CMAXQUSB+ interface board. Gently press them together.
- 4) Connect the positive terminal of the VIN power supply to the VIN pad. Connect the ground terminal of the VIN power supply to the PGND pad.
- 5) Connect the positive terminal of the VCC power supply to the VCC pad. Connect the ground terminal of the VCC power supply to the GND pad.
- 6) Connect the USB cable from the computer's type-A USB port to the CMAXQUSB+ board's type-B USB port.
- 7) Visit [www.maxim-ic.com/evkitsoftware](http://www.maxim-ic.com/evkitsoftware) to obtain the latest version of the EV kit software, 17061ARxx.ZIP. Download and install it on your computer by running the INSTALL.EXE program. The program files are copied and icons are created in the Windows **Start** menu.
- 8) Set the VIN power supply to 12V and enable its output.
- 9) Set the VCC power supply to 5V and enable its output.
- 10) Start the MAX17061A program by opening its icon in the **Start** menu.
- 11) Normal device operation is verified when **CMAXQUSB HW: Connected. MAX17061A device connected.** is displayed at the bottom left of the MAX17061A EV kit window (Figure 1).

## Detailed Description of Software

### User-Interface Panel

The program's main window (Figure 1) is navigated by using a mouse or a combination of the keyboard's tab and arrow keys. The MAX17061A EV kit software provides controls for software-configurable features, such as **Brightness Control**, **Device Control**, **Faults/Status** detection, and **Manufacturer ID** and **Silicon Revision** detection. Changes to the controls result in a write operation that updates the appropriate registers of the MAX17061A. A status box is provided at the bottom of the program's main window and is used to verify command module and device connectivity. A **Device Search** option is located under the **Action** menu bar should the user want to switch from demo mode to normal operation.

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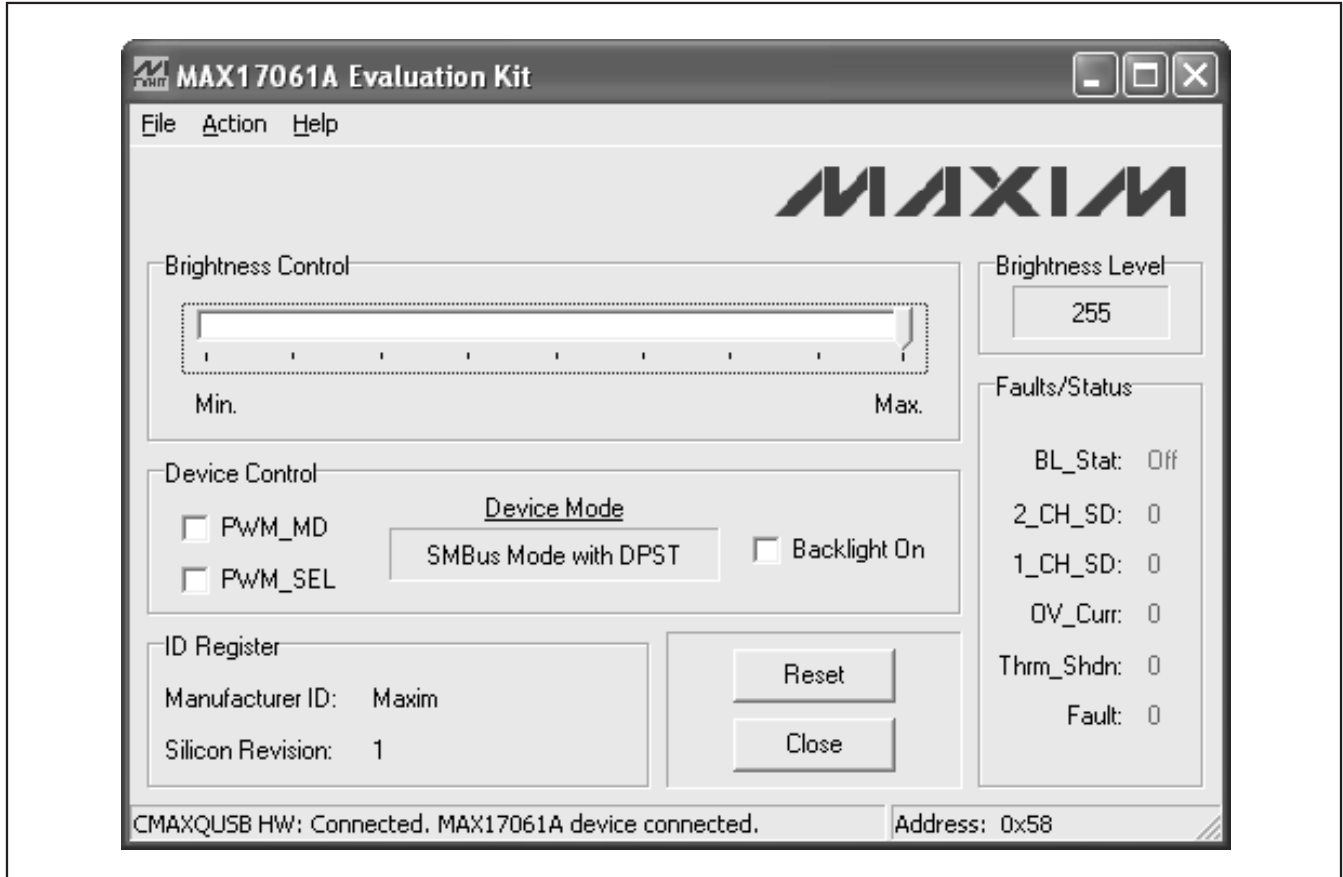


Figure 1. MAX17061A EV Kit Software Main Window

### Brightness Control and Level

The MAX17061A can be configured to one of any 256 steps of brightness control. To set the brightness, slide the **Brightness Control** track bar to the desired position, from 0 to 255. The track-bar position is then displayed in the **Brightness Level** group box.

### Device Control

The MAX17061A's device control register controls the operating mode of the backlight controller and backlight on/off states. The MAX17061A operating mode can be configured according to the bit settings shown in Table 1.

**Table 1. Operating Modes Selected by Device Control Register**

PWM_MD	PWM_SEL	OPERATING MODE
X	1	PWM mode
1	0	SMBus mode
0	0	SMBus mode with DPST

X = Don't care.

### Fault/Status Detection

The MAX17061A's fault/status read-only register monitors the backlight controller's operating state. This register detects the backlight on/off state, whether one or two LED output channels are shut down, overcurrent conditions, and thermal faults. When a fault is detected, the corresponding bit is changed from logic 0 to logic 1 and the font color is changed to red. Refer to the MAX17061A IC data sheet for more information regarding the fault/status register.

### Manufacturer/Silicon Revision Detection

The **ID Register** group box provides the manufacturer and silicon revision information for the MAX17061A IC. This information is read upon initial startup.

### Simple I<sup>2</sup>C/SMBus Commands

There are two methods for communicating with the MAX17061A, through the normal user interface (Figure 1), or through the SMBus commands available by selecting the **Interface Diagnostic Window** menu item

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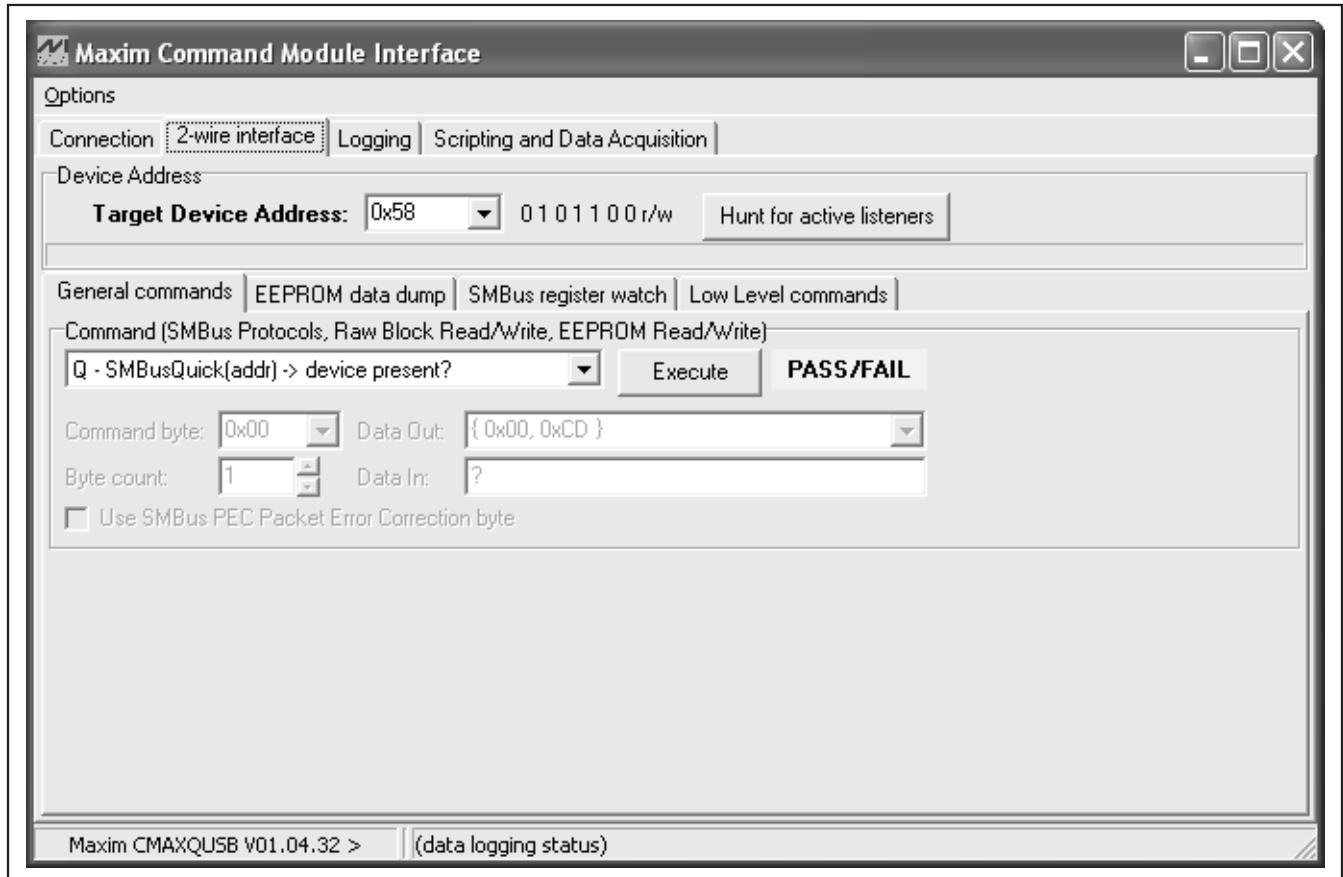


Figure 2. Interface Diagnostic Window

from the **Action** menu bar. The **Maxim Command Module Interface** window pops up (Figure 2) and includes a **2-wire interface** tab that allows for execution of simple I<sup>2</sup>C/SMBus commands.

The SMBus edit boxes in the **Command (SMBus Protocols, Raw Block Read/Write, EEPROM Read/Write)** group box accept numeric data in binary, decimal, or hexadecimal. Hexadecimal numbers should be prefixed by \$ or 0x. Binary numbers must be exactly eight digits. See Figure 2 for an illustration of this tool.

## **Detailed Description of Hardware**

The MAX17061A EV system (MAX17061AEVCMAXQU+) consists of the MAX17061A EV kit (MAX17061AEVKIT+) and the Maxim CMAXQUSB+ command module. The EV

kit evaluates the MAX17061A WLED driver and the CMAXQUSB+ provides the I<sup>2</sup>C/SMBus-compatible interface for software control of the LED brightness in 256 steps, backlight-controller operating mode, manufacturer and silicon revision detection, and fault detection.

The MAX17061A EV kit is powered from a 5.5V to 24V DC supply at VIN and a 4.5V to 5.5V DC supply at VCC. LED current can be configured to provide a fixed 25mA or adjustable 15mA to 30mA full-scale LED current through jumper JU11 and/or resistor R5.

The MAX17061A EV kit utilizes a step-up DC-DC converter to generate the voltage required to drive up to eight strings of 10 surface-mount WLEDs. As shipped, the MAX17061A EV kit is configured for evaluation with four strings of 10 WLEDs.

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## White LED String Configuration

As configured, the MAX17061A EV kit is assembled with four strings of 10 WLEDs (string 1–string 4), but can be reconfigured to drive up to eight strings of 10 WLEDs. Each string has an associated 3-pin header (JU1–JU8) and feedback pin (FB1–FB8). To evaluate additional strings (string 5–string 8), the EV kit must be reconfigured as follows:

- 1) Populate String\_ with either the WLED listed in the *Component List*, or its equivalent.
- 2) Cut the trace (solder side) between pins 2-3 of the string's associated header-footprint (JU5–JU8).
- 3) Install a 3-pin header (JU5–JU8) and configure its shunt according to Table 2.

To evaluate the EV kit with off-board WLED strings, see the *Off-Board White LED String Configuration* section.

## Off-Board White LED String Configuration

The MAX17061A EV kit can also be used to drive off-board WLED strings. To evaluate external WLED strings, remove the shunts from jumpers JU1–JU8. See Table 2 for jumpers JU1–JU8 configuration and Table 3 for jumper JU9 configuration. Removing these jumpers

**Table 2. Jumper JU1–JU8 Function**

SHUNT POSITION	FB_ PIN	STRING_
1-2	Connected to cathode of WLED string	Enabled
2-3	Connected to VCC	Disabled
Not installed	Connect to an external WLED string	On-board WLED string not used

**Table 3. Jumper JU9 Function**

SHUNT POSITION	VOUT
Installed*	Connected to anodes of on-board WLED strings
Not installed	Connect to anodes of off-board WLED strings

\*Default position.

effectively disconnects the on-board WLED strings between the output and feedback pins, allowing the connection of external WLED strings. For each external WLED string, connect the cathode terminal of the string to the corresponding feedback pad (FB1–FB8) and connect the anode terminal of the string to the VOUT pad. Once the external WLED strings are connected between the VOUT pad and the FB\_ pins, the EV kit can be evaluated in the same manner as the on-board WLED strings. Evaluating more than 10 WLEDs per string may require component changes. Refer to the MAX17061A IC data sheet for component selections.

## LED String Capacitance

In some LCD panel applications, a 0.1µF (typ) capacitor (CLED) is placed in parallel with each LED string to improve ESD immunity. As such, the MAX17061A EV kit provides a footprint across each LED string in addition to footprints for pullup resistors on each FB\_ pin. Refer to the *LCD Panel Capacitance* section in the MAX17061A IC data sheet for more detailed information.

## Setting Full-Scale LED Current (ILED(FS))

The full-scale current through each WLED string is configured by connecting the ISET pin (pin 24) to VCC or connecting it to GND through resistors R4 and R5. When ISET is connected to VCC, the full-scale current per string is set to 25mA; when pulled to GND, the full-scale current per string is adjustable from 15mA to 30mA:

$$I_{LED(FS)} = \left( 20 \times \frac{200k\Omega}{R4 + R5} \right) mA$$

where R4 is a 130kΩ resistor and R5 is a 200kΩ potentiometer. The ISET pin is configured through jumper

**Table 4. Jumper JU11 Function**

SHUNT POSITION	ISET PIN	ILED(FS)
1-2	Connected to VCC	25mA
2-3*	Connected to GND through R4 and R5	Adjustable from 15mA to 30mA

\*Default position.

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**Table 5. Jumper JU13 Function**

SHUNT POSITION	OSC PIN	OPERATING FREQUENCY
1-2*	Connected to VCC	1MHz
2-3	Connected to GND	500kHz
Not installed	Unconnected	750kHz

\*Default position.

JU11. See Table 4 for jumper JU11 settings.

### Switching-Frequency Selection (OSC)

The MAX17061A EV kit is configured to operate at 1MHz, but provides the option to set the switching frequency of the step-up DC-DC converter to 500kHz or 750kHz. The switching frequency is set by configuring JU13 to the shunt position, as shown in Table 5. Changing the switching frequency could require differ-

ent converter components (refer to the MAX17061A IC data sheet for proper component selections).

### Setting DPWM Frequency ( $f_{DPWM}$ )

The MAX17061A uses an internal DPWM signal to perform dimming control. The DPWM frequency is specified by an external resistor, connected from the FSET pin to GND:

$$f_{DPWM}[\text{Hz}] = \frac{10^9}{\alpha \times \text{RFSET} + \alpha \times \beta \times 1000} = \frac{10^9}{\alpha \times \text{RFSET} + \gamma}$$

where  $\alpha = 10.638$ ,  $\beta = 5.5$ ,  $\gamma = 58509$ .

The adjustable range for the FSET resistor (RFSET) is from 64k $\Omega$  to 465k $\Omega$ , corresponding to the DPWM frequency of 1350Hz to 200Hz. RFSET consists of resistors R6 and R7 on the EV kit, where R6 is a 41.2k $\Omega$  resistor and R7 is a 500k $\Omega$  potentiometer. If making adjustments, note that the minimum usable frequency results from a maximum resistance of 465k $\Omega$ .







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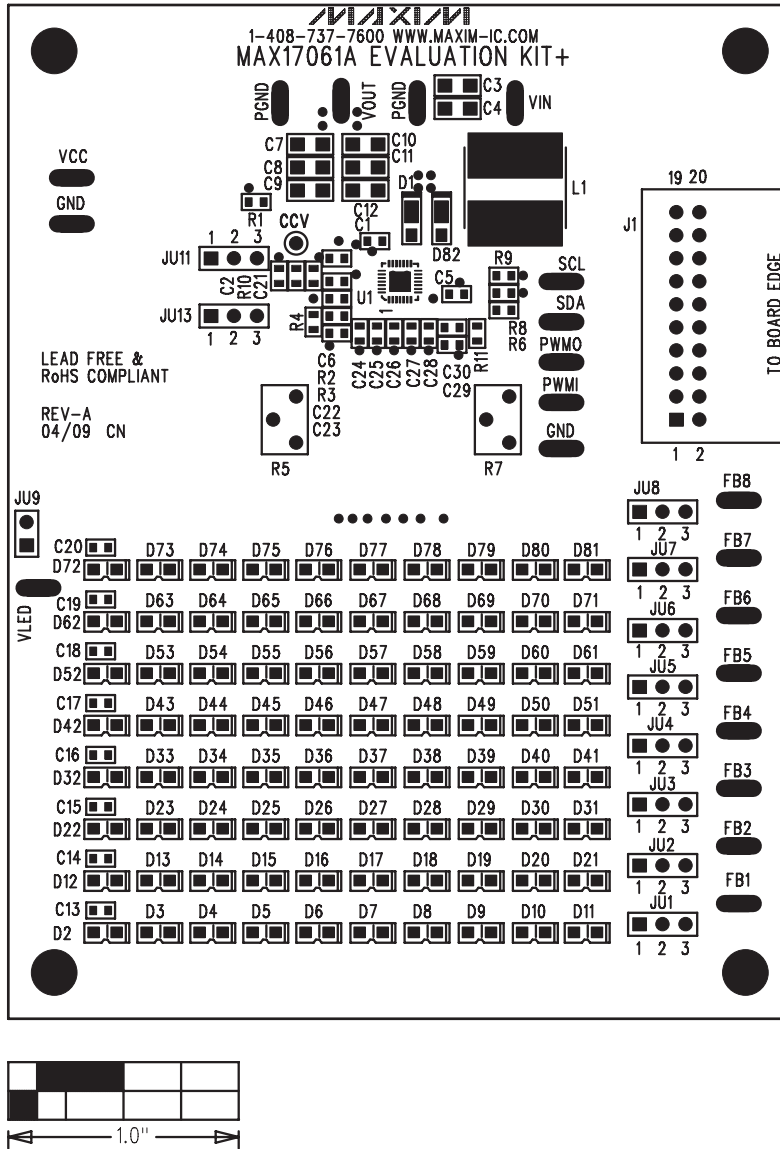


Figure 4. MAX17061A EV Kit Component Placement Guide—Component Side

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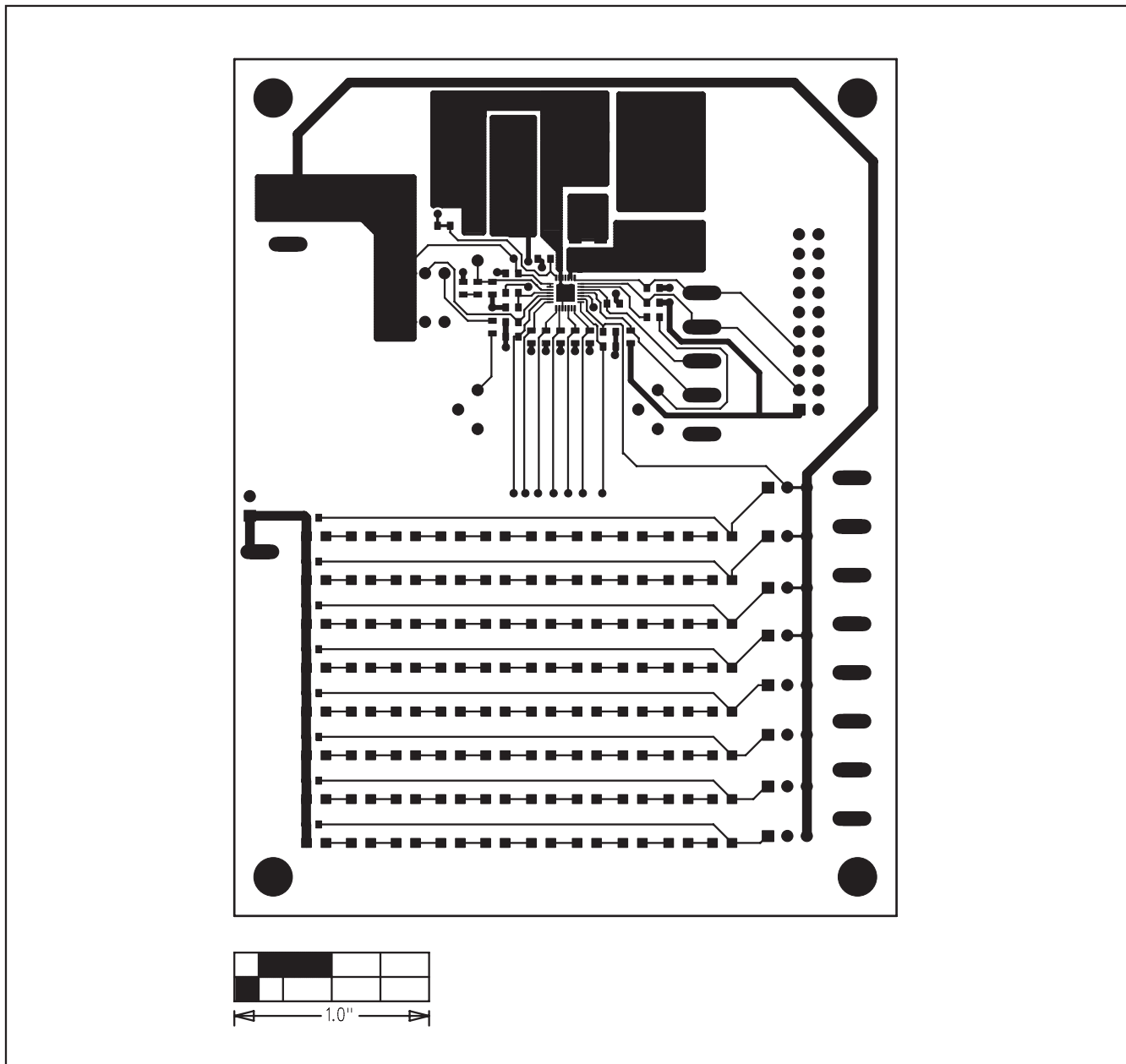


Figure 5. MAX17061A EV Kit PCB Layout—Component Side

# MAX17061 Evaluation Kit/Evaluation System

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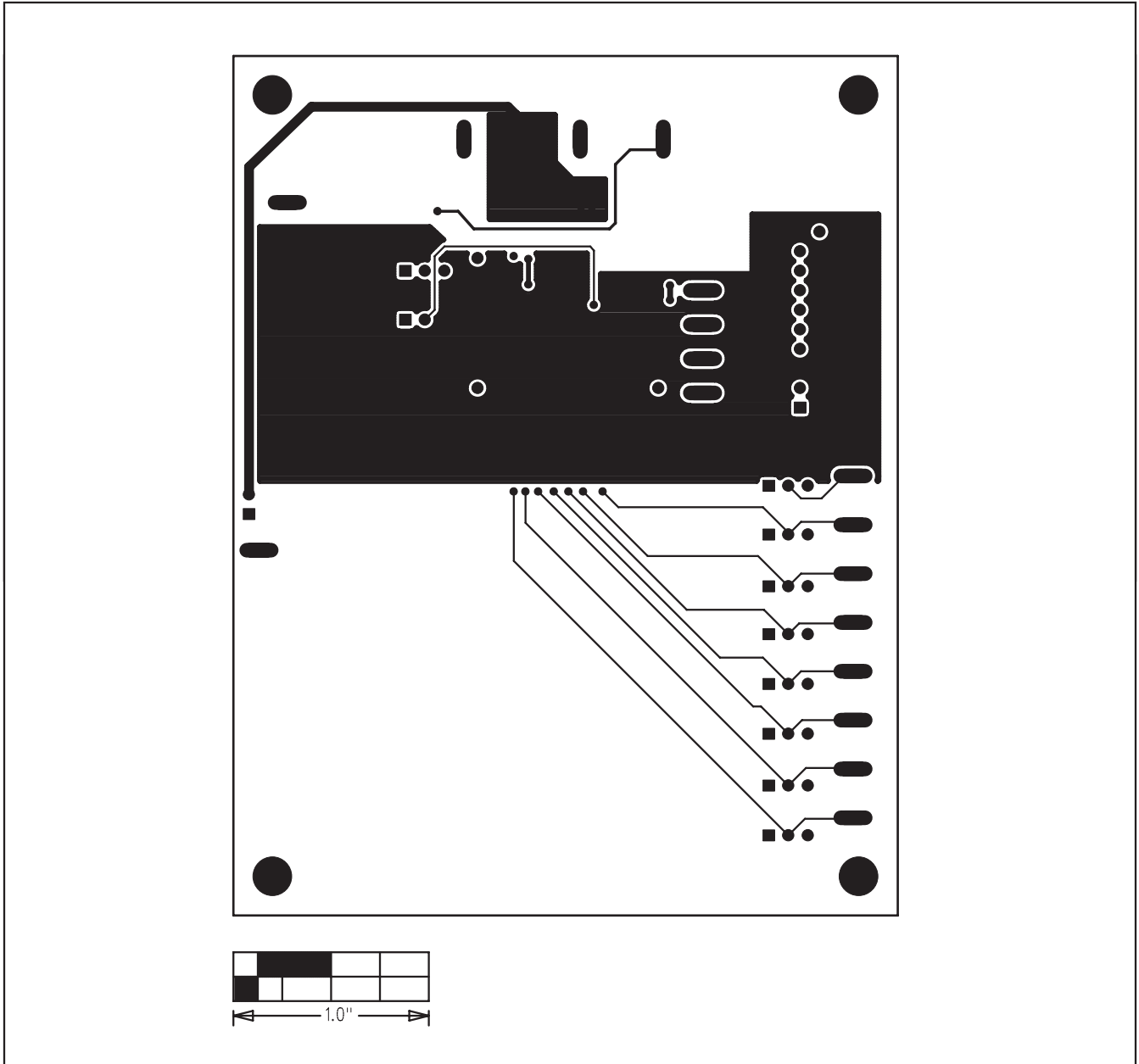


Figure 6. MAX17061A EV Kit PCB Layout—Solder Side

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