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# MAX17061 Evaluation Kit/Evaluation System

## General Description

The MAX17061 evaluation system (EV system) consists of the MAX17061 evaluation kit (EV kit) and the Maxim CMAXQUSB+ command module. Windows® 2000/XP- and Windows Vista®-compatible software is also available for use with the EV system (MAX17061EVC-MAXQU+) and can be downloaded from the Maxim website ([www.maxim-ic.com/evkitsoftware](http://www.maxim-ic.com/evkitsoftware)).

The MAX17061 EV kit (MAX17061EVKIT+) is a fully assembled and tested surface-mount printed-circuit board (PCB) that evaluates the high-efficiency MAX17061 white LED (WLED) driver. The MAX17061 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 uses a 7V to 21V input power supply (single-supply mode) and can be configured to provide a fixed 25mA or adjustable 15mA to 30mA full-scale LED current. As shipped, the MAX17061 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 MAX17061 EV kit software provides a graphical user interface (GUI) for exercising the MAX17061 features.

## Features

- ◆ 7V to 21V Input Range
- ◆ 87% Efficiency ( $V_{IN} = 12V$ , Load = 4 WLED Strings, Preset 25mA)
- ◆ 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 < 1mm Height
- ◆ Lead(Pb)-Free and RoHS Compliant
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TYPE
MAX17061EVKIT+	EV Kit
MAX17061EVCMAXQU+	EV System

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

**Note:** The Maxim CMAXQUSB+ command module is required when using the MAX17061 EV kit software.

## Component Lists

### MAX17061 EV System

PART	QTY	DESCRIPTION
MAX17061EVKIT+	1	MAX17061 EV kit
CMAXQUSB+	1	I <sup>2</sup> C/SMBus interface command module

### MAX17061 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 GRM319R61E475KA12D
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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# MAX17061 Evaluation Kit/Evaluation System

## Component Lists (continued)

### MAX17061 EV Kit (continued)

DESIGNATION	QTY	DESCRIPTION
C21	1	220pF ± 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 OVSRAWACR6
D42–D81	0	Not installed, white LEDs
J1	1	2 x 10 right-angle receptacle
JU1–JU4, JU10, JU11, JU13	7	3-pin headers
JU5–JU8	0	Not installed, 3-pin headers—short (PC trace)
JU9	1	2-pin header
L1	1	10µH, 1.2A power inductor Sumida CR6D09HPNP-100MC TDK VLP6810T-100M1R2

DESIGNATION	QTY	DESCRIPTION
R1	0	Not installed, resistor—short (PC trace) (0603)
R2	1	2.21MΩ ±1% resistor (0603)
R3	1	61.9kΩ ±1% resistor (0603)
R4	1	130kΩ ±5% resistor (0603)
R5	1	200kΩ multiterm potentiometer
R6	1	41.2kΩ ±1% resistor (0603)
R7	1	500kΩ multiterm potentiometer
R8, R9	0	Not installed, resistors (0603)
R10	1	5.1kΩ ±5% resistor (0603)
R11	1	1MΩ resistor (0603)
U1	1	8-string WLED driver (28-pin thin QFN, 4mm x 4mm x 0.8mm) Maxim MAX17061ETI+
—	8	Shunts
—	1	PCB: MAX17061 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 MAX17061 when contacting these component suppliers.

# MAX17061 Evaluation Kit/Evaluation System

## MAX17061 EV Kit Files

PART	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX17061.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

Before beginning, the following equipment is needed:

- MAX17061 EV system
  - MAX17061 EV kit
  - Maxim CMAXQUSB command module (USB cable included)
- 7V to 21V, 1A power supply (VIN)
- A user-supplied Windows 2000/XP/Vista-compatible 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 MAX17061 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 MAX17061 EV kit, verify that the shunts are installed as follows:

JU1–JU4, JU10, JU13	1-2
JU9	Installed
JU11	2-3

- 3) Carefully connect the boards by aligning the 20-pin connector of the MAX17061 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 USB cable from the computer's type-A USB port to the CMAXQUSB board's type-B USB port.
- 6) Visit [www.maxim-ic.com/evkitsoftware](http://www.maxim-ic.com/evkitsoftware) to obtain the latest version of the EV kit software, 17061Rxx.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.
- 7) Set the VIN power supply to 12V and enable its output.
- 8) Start the MAX17061 program by opening its icon in the **Start** menu.

Normal device operation is verified when **CMAXQUSB HW: Connected. MAX17061 device connected.** is displayed at the bottom left of the MAX17061 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 MAX17061 EV kit software provides controls for software-configurable features, such as **Brightness Control**, **Device Control**, **Fault/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 MAX17061. 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.

# MAX17061 Evaluation Kit/Evaluation System

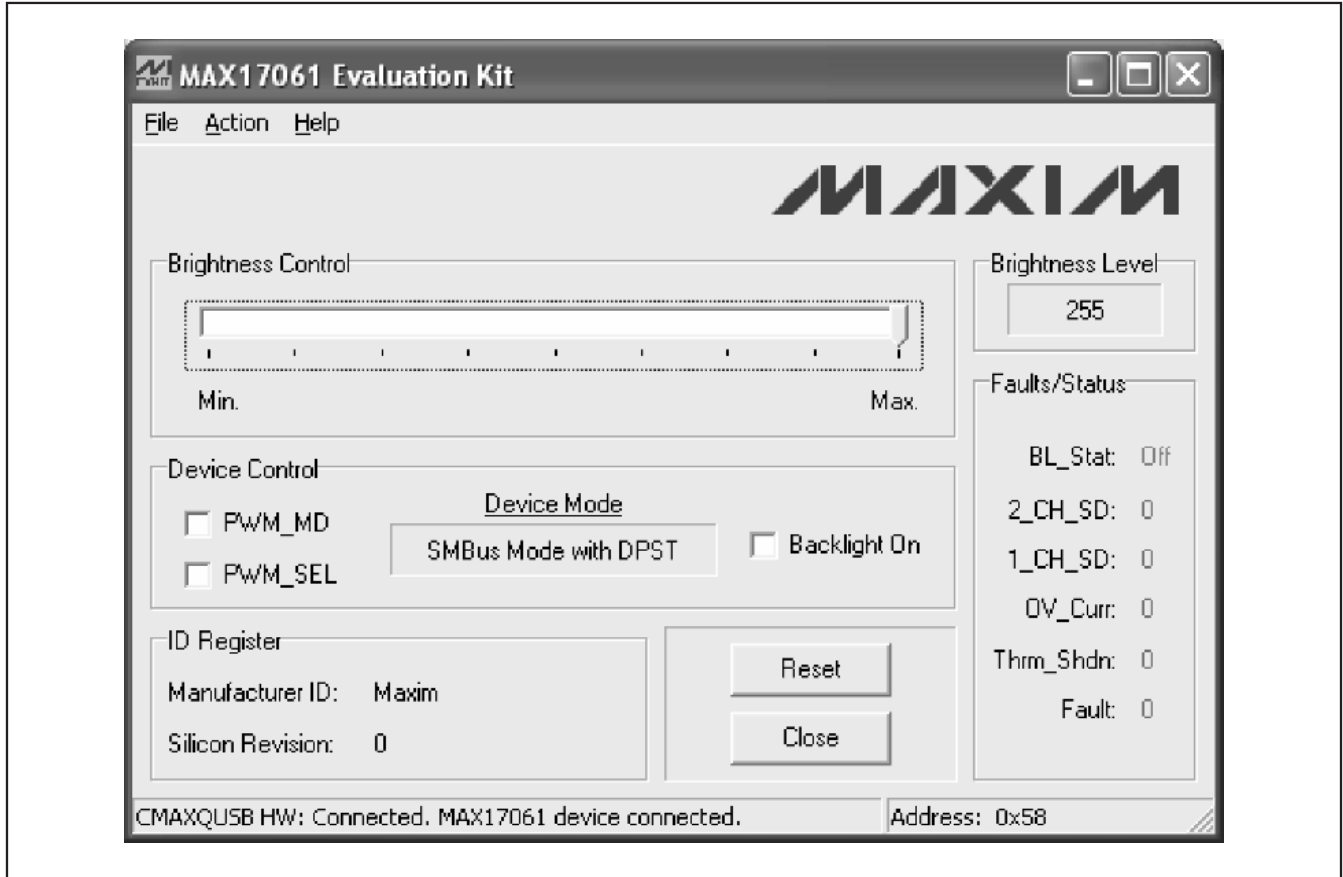


Figure 1. MAX17061 EV Kit Software Main Window

### Brightness Control and Level

The MAX17061 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 MAX17061's device control register controls the operating mode of the backlight controller and backlight on/off states. The MAX17061 operating modes 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 MAX17061'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 MAX17061 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 MAX17061 IC. This information is read upon initial startup.

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

There are two methods for communicating with the MAX17061, 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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Evaluate: MAX17061

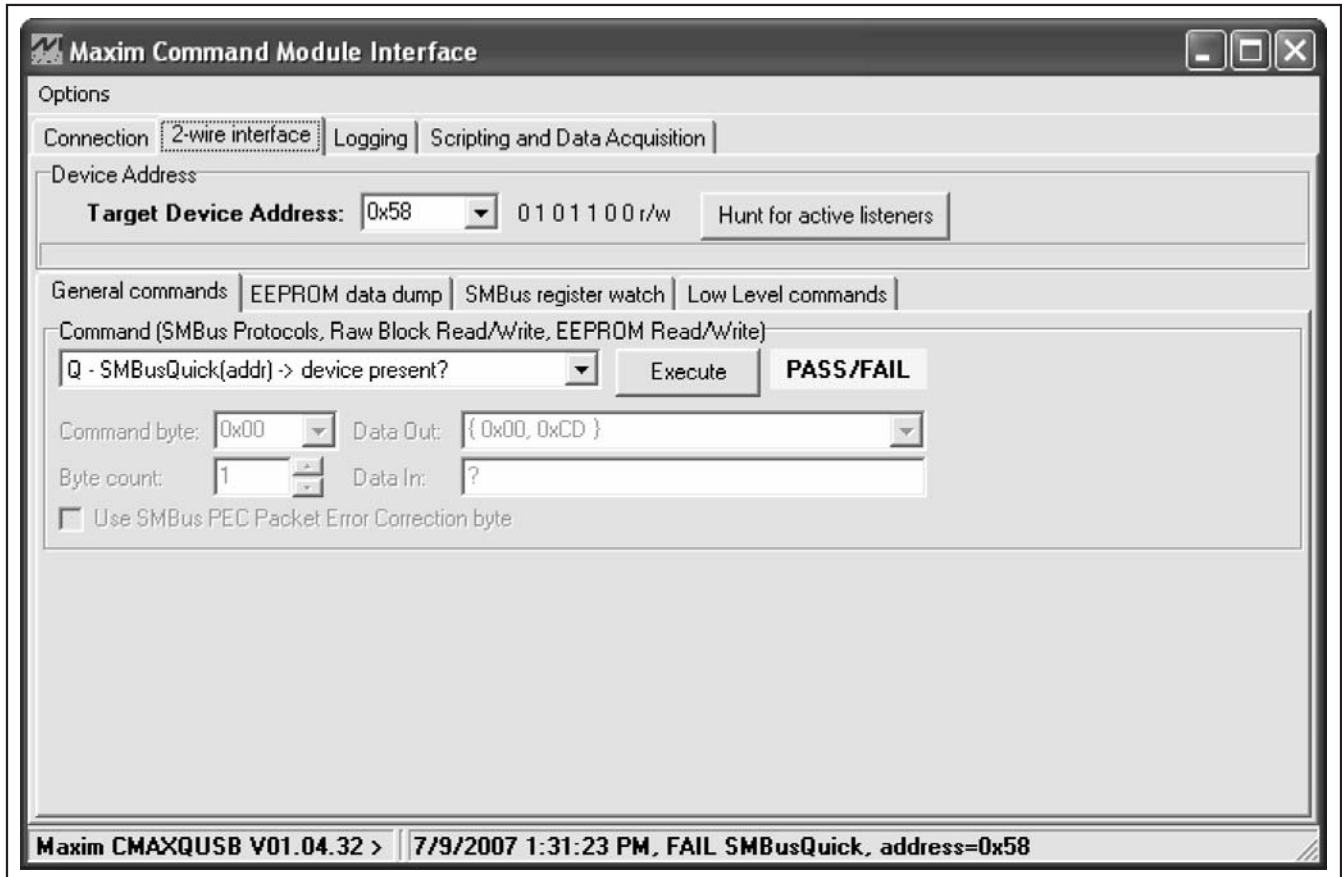


Figure 2. Interface Diagnostic Window

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 MAX17061 EV system (MAX17061EVCMAQU+) consists of the MAX17061 EV kit (MAX17061EVKIT+) and the Maxim CMAXQUSB+ command module. The EV kit evaluates the MAX17061 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 MAX17061 EV kit can be operated in single- ( $V_{IN} = 7V$  to  $21V$ ) or dual-supply ( $V_{IN} = 7V$  to  $21V$ ,  $V_{CC} = 4.5V$  to  $5.5V$ ) mode through selection of jumper JU10. 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 MAX17061 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 MAX17061 EV kit is configured for evaluation with four strings of 10 WLEDs.

# MAX17061 Evaluation Kit/Evaluation System

## White LED String Configuration

As configured, the MAX17061 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.

**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

## Off-Board White LED String Configuration

The MAX17061 EV kit can also be used to drive off-board WLED strings. To evaluate external WLED strings, reconfigure shunts from jumpers JU1–JU8. See Table 2 for jumpers JU1–JU8 configuration and Table 3 for jumper JU9 configuration. Removing these jumpers 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

**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.

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 MAX17061 IC data sheet for component selections.

## LED String Capacitance

In some LCD panel applications, a 0.1μF (typ) capacitor (C<sub>LED</sub>) is placed in parallel with each LED string to improve ESD immunity. As such, the MAX17061 EV kit provides a footprint across each LED string for optional C<sub>LED</sub>.

## Input Power Supply

The MAX17061 EV kit can be evaluated with one or two input power supplies. When using one input power supply, connect a 7V to 21V power supply to the VIN pad and configure jumper JU10 for single-supply operation (see Table 4). In single-supply operation, do not connect an external power supply or load to the VCC pad.

To utilize two input power supplies, configure jumper JU10 for dual-supply operation and connect a 4.5V to 5.5V power supply to the VCC pad and a 7V to 21V power supply to the VIN pad.

**Table 4. Jumper JU10 Function**

SHUNT POSITION	INPUT SUPPLY
1-2*	Single (7V to 21V)
2-3	Dual (VIN = 7V to 21V, VCC = 4.5V to 5.5V)

\*Default position.

The MAX17061 EV kit is also capable of single-supply operation in the 4.5V to 5.5V range. If this operation is desired, provide an external short between IN and VCC. Refer to the MAX17061 IC data sheet for component selection in this condition.

## Setting Full-Scale LED Current (I<sub>LED(FS)</sub>)

The full-scale current through each WLED string is configured by connecting the ISET pin to VCC or tying 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 JU11. See Table 5 for jumper JU11 settings.

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**Table 5. Jumper JU11 Function**

SHUNT POSITION	ISET PIN	I <sub>LED</sub> (FS)
1-2	Connected to VCC	25mA
2-3*	Connected to GND through R4 and R5	Adjustable from 15mA to 30mA

\*Default position.

### Switching-Frequency Selection (OSC)

The MAX17061 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 6. Changing the switching frequency could require different converter components (refer to the MAX17061 IC data sheet for proper component selections).

**Table 6. 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.

### Setting DPWM Frequency (f<sub>DPWM</sub>)

The MAX17061 uses an internal DPWM signal to perform dimming control. The DPWM frequency is specified by an external resistor, connected from 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 41kΩ to 465kΩ, corresponding to the DPWM frequency of 2000Hz to 200Hz. RFSET consists of resistors R6 and R7 on the EV kit, where R6 is a 41.2kΩ resistor and R7 is a 500kΩ potentiometer. If making adjustments, note that the minimum usable frequency results from a maximum resistance of 465kΩ.



# MAX17061 Evaluation Kit/Evaluation System

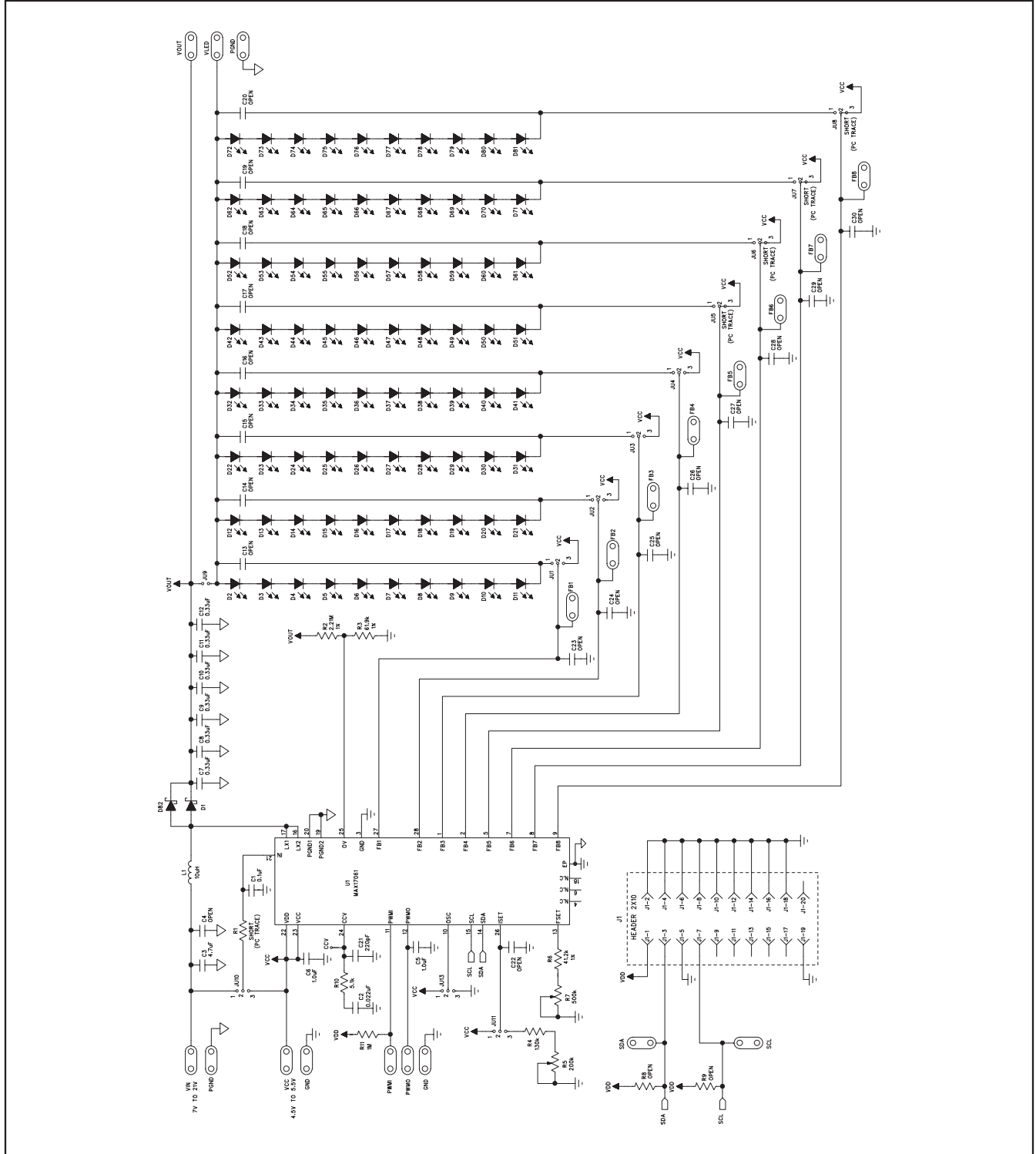


Figure 3. MAX17061 EV Kit Schematic

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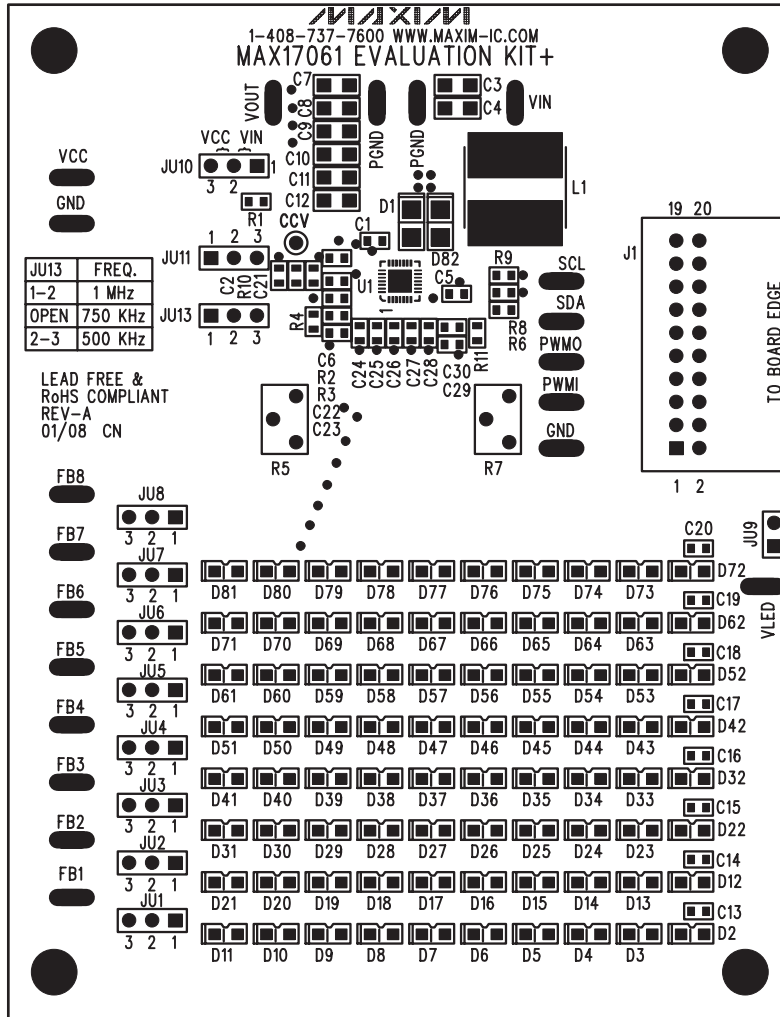


Figure 4. MAX17061 EV Kit Component Placement Guide—Component Side

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Evaluate: MAX17061

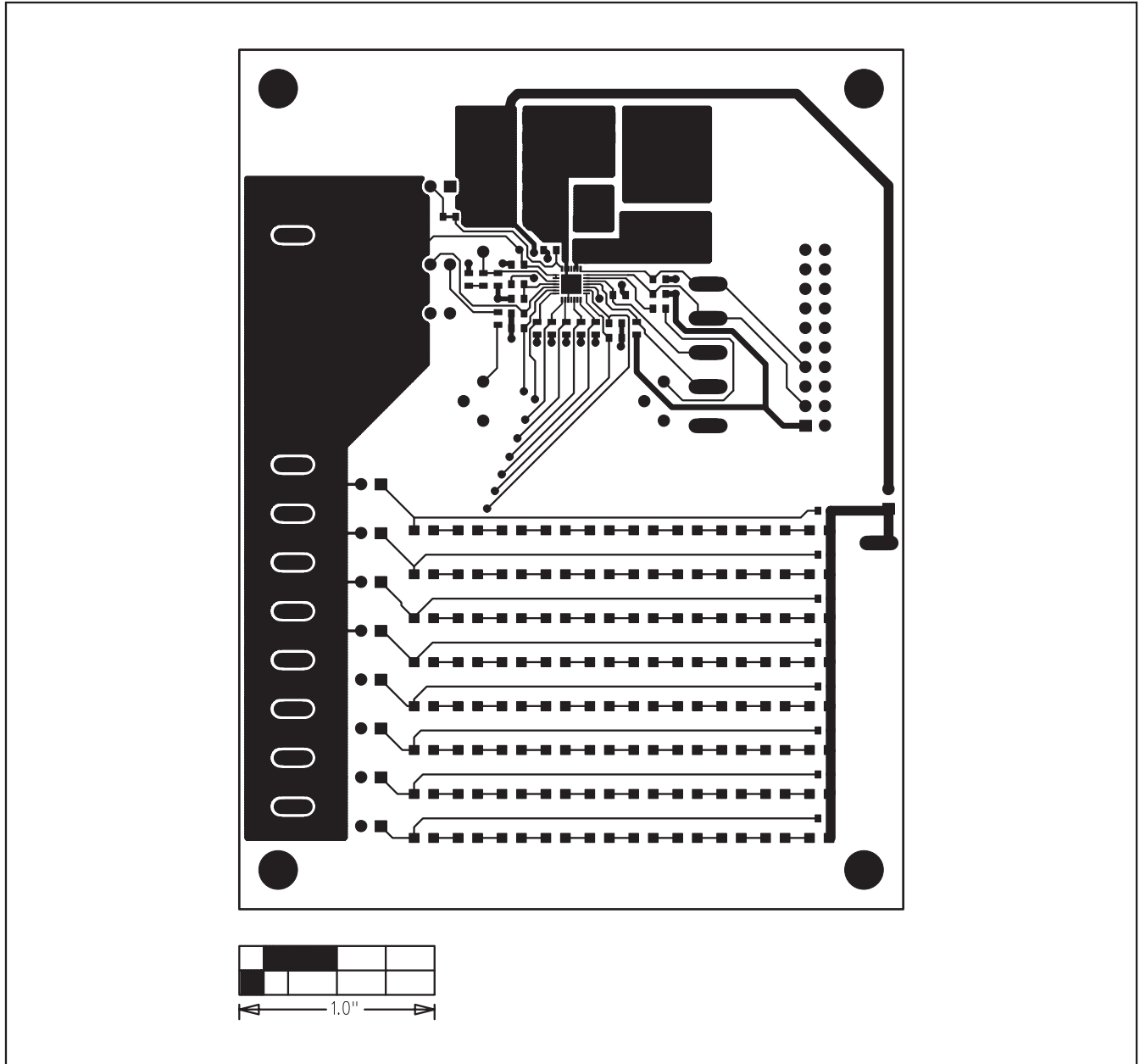


Figure 5. MAX17061 EV Kit PCB Layout—Component Side

# MAX17061 Evaluation Kit/Evaluation System

Evaluate: MAX17061

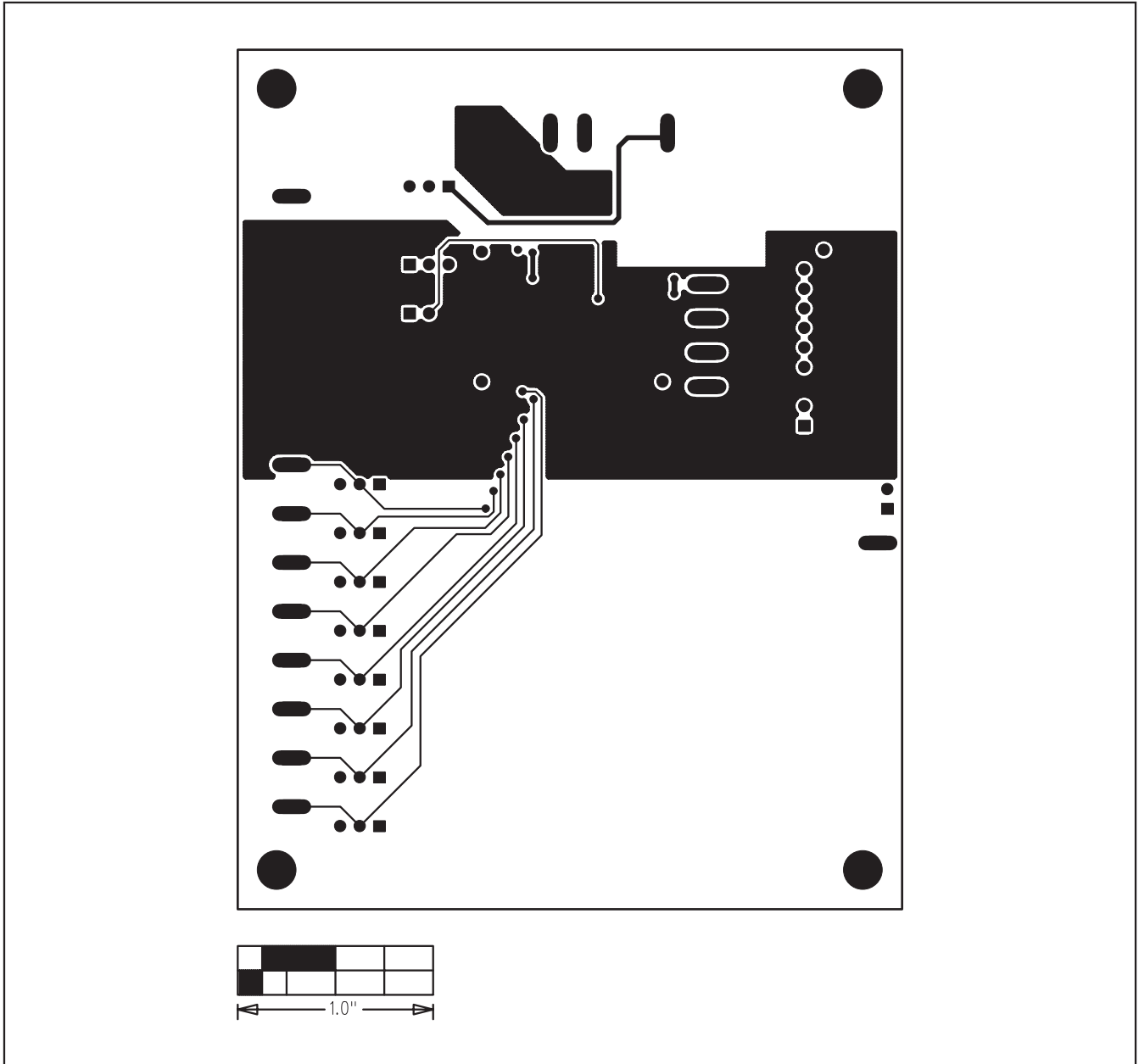


Figure 6. MAX17061 EV Kit PCB Layout—Solder Side

# **MAX17061 Evaluation Kit/Evaluation System**

## **Revision History**

<b>REVISION NUMBER</b>	<b>REVISION DATE</b>	<b>DESCRIPTION</b>	<b>PAGES CHANGED</b>
0	3/08	Initial release	—
1	10/08	Nichia part number updated for components D2–D41	2

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