General Description

The MAX1645B evaluation kit (EV kit) is an efficient, multichemistry battery charger. It uses the Intel System Management Bus (SMBus[™]) to control the battery regulation voltage, charger current output, and input current-limit set point.

The MAX1645B EV kit can charge one, two, three, or four series Li+ cells with a current up to 3A.

The MAX1645B evaluation system (EV system) consists of a MAX1645B EV kit and the Maxim SMBUSMON board. The MAX1645B EV kit includes Windows® 95-/98/ 2000-/XP-compatible software to provide a user-friendly interface.

Features

Charges Any Battery Chemistry: Li+, NiCd, NiMH, Lead Acid, etc.

MXXM

- SMBus-Compatible 2-Wire Serial Interface
- 3A (max) Battery Charge Current
- Up to 18.4V Battery Voltage
- Up to +28V Input Voltage
- Easy-to-Use Software Included
- Proven PC Board Layout
- Fully Assembled and Tested Surface-Mount Board

EV System

| DESIGNATION | QTY | DESCRIPTION |
|-------------|-----|--------------------|
| None | 1 | MAX1645B EV kit |
| None | 1 | SMBUSMON Interface |

| DESIGNATION | QTY | DESCRIPTION |
|----------------------|-----|---|
| C1, C2 | 2 | 22µF, 35V low-ESR tantalum caps AVX TPSE226M035R0300 |
| C3, C4 | 2 | 22µF, 25V low-ESR tantalum caps AVX TPSD226M025R0200 |
| C5, C19, C20 | 3 | 1µF, 50V ceramic capacitors (1210) Murata GRM42-2X7R105K050 |
| C6, C7, C12 | 3 | 1µF, 10V ceramic capacitors (0805) Taiyo Yuden LMK212BJ105MG |
| C8, C14, C15, C16 | 4 | 0.1µF, 16V ceramic capacitors (0603) Taiyo Yuden EMK107BJ104MA |
| C9, C10, C11 | 3 | 0.01µF ceramic capacitors (0603) |
| C13 1 | | 1500pF ceramic capacitor (0603) |
| C18, C23, C24 | 3 | 0.1µF, 50V ceramic capacitors (0805) Taiyo Yuden UMK212BJ104MG |
| D1, D2 | 2 | 40V, 2A Schottky diodes Central Semiconductor CMSH2-40 |
| D3, D4 | 2 | Schottky diodes (SOT23) Central Semiconductor CMPSH-3 |

SMBus is a registered trademark of Intel Corp.

Windows 95/98 are registered trademarks of Microsoft Corp.

| PART | TEMP RANGE | IC PACKAGE | |
|---------------|--------------|------------|--|
| MAX1645BEVKIT | 0°C to +70°C | 28 QSOP | |
| MAX1645BEVSYS | 0°C to +70°C | 28 QSOP | |
| | | | |

| DESIGNATION | QTY | DESCRIPTION | | | | |
|-------------------------|-----|--|--|--|--|--|
| H1 | 1 | 2x10 right-angle female header | | | | |
| H2 | 1 | 5-element terminal block | | | | |
| JU1, JU2, JU3 | 3 | 2-pin headers | | | | |
| L1 | 1 | 22µH, 3.6A inductor Sumida CDRH127-220 | | | | |
| LED1 | 1 | Red LED | | | | |
| N1 | 1 | 30V, 11.5A N-channel MOSFET Fairchild FDS6680 | | | | |
| N2 | 1 | 30V, 8.4A N-channel MOSFET Fairchild FDS6612A | | | | |
| P1, P2 | 2 | 30V, 11A P-channel MOSFETs Fairchild FDS6675 | | | | |
| R1 | 1 | 0.040Ω ±1%, 0.5W resistor Dale WSL-2010/0.040 $\Omega/1\%$ | | | | |
| R2 | 1 | $0.050\Omega \pm 1\%$, 0.5W resistor Dale WSL-2010/0.050 Ω /1% | | | | |
| R3, R4 | 2 | $100k\Omega \pm 1\%$ resistors (0603) | | | | |
| R5, R7, R9, R10, R17 | 5 | $10k\Omega \pm 5\%$ resistors (0603) | | | | |
| R6 | 1 | $10k\Omega \pm 1\%$ resistor (0603) | | | | |

EV Kit Component List

Ordering Information

Maxim Integrated Products 1

U valuate: MAX1645B

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

_EV Kit Component List (cont.)

| DESIGNATION | QTY | DESCRIPTION | | | |
|-------------|-----|------------------------------------|--|--|--|
| R8, R13 | 2 | 1k Ω ±5% resistors (0603) | | | |
| R11, R16 2 | | $1\Omega \pm 5\%$ resistors (0603) | | | |
| R12 | 1 | $33\Omega \pm 5\%$ resistor (0603) | | | |
| R14, R15 | 2 | 4.7Ω ±5% resistors (0603) | | | |
| U1 | 1 | MAX1645BEEI (28-pin QSOP) | | | |
| None | 3 | Shunts (JU1, JU2, JU3) | | | |
| None | 1 | MAX1645B EV kit software CD | | | |
| | | - | | | |

| | | in Suppliers | | |
|--------------------------|--------------|--------------|--|--|
| SUPPLIER | PHONE | FAX | | |
| AVX | 803-946-0690 | 803-626-3123 | | |
| Central Semiconductor | 516-435-1110 | 516-435-1824 | | |
| Dale | 402-564-3131 | 402-563-6418 | | |
| Fairchild | 408-822-2000 | 408-822-2102 | | |
| Murata | 814-237-1431 | 814-238-0490 | | |
| Sumida | 847-956-0666 | 847-956-0702 | | |
| Taiyo Yuden | 408-573-4150 | 408-573-4159 | | |

Note: Please indicate that you are using the MAX1645B when contacting the above component suppliers.

Quick Start

Recommended Equipment

Component Suppliers

- DC source to supply the input current to the charger. This source must be capable of supplying a voltage greater than the battery-voltage set point and have sufficient current rating.
- Voltmeter
- Smart battery
- Computer running Windows 95, 98, 2000, or XP
- 9-pin serial extension cable
- SMBUSMON board

Procedure

The MAX1645B EV kit is a fully assembled and tested board. Follow the steps below to verify board operation. **Do not turn on the power supply until all connections are completed. Observe all precautions on the battery manufacturer's data sheet.**

1) Set the VPP jumper on the SMBUSMON board to VCC5.

Table 1. Jumper Functions

| JUMPER | STATE | FUNCTION | | | |
|--------|---------|--|--|--|--|
| | Closed* | SCL pulled up to V _{DD} through a 10k Ω resistor. | | | |
| JU1 | Open | SCL not pulled up to V _{DD} ; SCL must be pulled up to external supply. | | | |
| | Closed* | SDA pulled up to V_{DD} through a 10k Ω resistor. | | | |
| JU2 | Open | SDA not pulled up to V _{DD} ; SDA must be pulled up to external supply. | | | |
| JU3 | Closed* | $10k\Omega$ resistor connected between thermistor and ground nodes, simulating the attach- ment of a smart battery. | | | |
| 303 | Open | $10k\Omega$ resistor disconnected; for use when an actual smart battery will be connected to the EV kit. | | | |

*Indicates default jumper setting

- 2) Carefully connect the boards by aligning the 20-pin connector of the MAX1645B EV kit with the 20-pin header of the SMBUSMON board. Gently press them together.
- Connect a cable from the computer's serial port to the SMBUSMON interface board. Use a straight-through 9-pin female-to-male cable.
- 4) Install the software by running the INSTALL.EXE program. The install program copies the files and creates icons for them in the Windows 95/98/2000/XP start menu. An uninstall program is included with the software. Click on the UNINSTALL icon to remove the EV kit software from the hard drive.
- 5) Connect power to the SMBUSMON board.
- 6) Connect the input-current supply across the ADAPTER_IN and PGND pads.
- 7) Connect a smart battery to connector H2.
- 8) Turn on the power supply.
- 9) Start the MAX1645B EV kit software.
- 10) Verify current is being delivered to the battery.



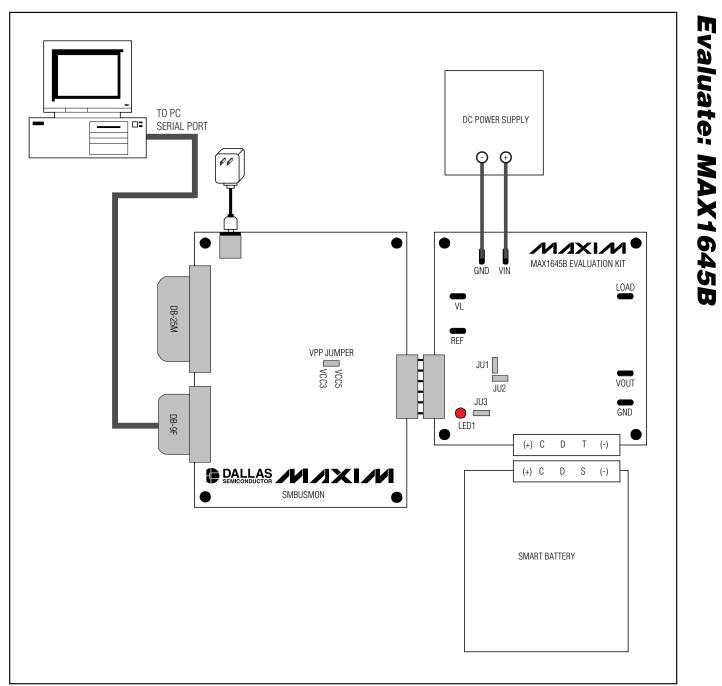


Figure 1. Block Diagram of MAX1645B EV System

_Detailed Description of Software

The MAX1645B program provides easy access to the MAX1645B registers. It is also capable of reading the registers of a smart battery and monitoring SMBus traffic.

Upon execution of the program, the software enables the MAX1645B smart-charger command panel (Figure 2), after which any of the allowed SMBus commands can be sent to the MAX1645B. Refer to the MAX1645B data sheet for more information regarding the allowed SMBus commands.

Smart-Charger Command Panel

ChargeVoltage()

To issue the ChargeVoltage() command to the MAX1645B, enter the desired voltage, in millivolts, into the Charging Voltage edit field and select the adjacent **Write** button.

ChargeCurrent()

To issue the ChargeCurrent() command to the MAX1645B, enter the desired current, in milliamps, into the Charging Current edit field and select the adjacent **Write** button.

| File Logging In | aluation Kit |
|---|---|
| 33 3 | System Overview Generic Smart Battery (0x16) MAX1645B Smart Charger (0x12) SMBus Interface SMBus Scripting SMBus Traffic |
| Timer Interval: 2 sec Set Interval Run Running Stop Stop if error Timer Action: • Active Read: • System • Battery • Charger • Passive | Smart Charger described in file: MAX1645B.INI Image: Charger Registers Other Bitmapped Charger Registers Outl 2 ChargerMode Image: Charger Registers Outl 3 ChargerStatus 0x12 ChargerMode Image: Charger Registers Outl 3 ChargerStatus 0x12 ChargerMode Image: Charger Registers Outl 3 ChargerStatus 0x12 ChargerMode Image: Charger Registers Image: Charger Registers 0x13 Charger Registers Image: Charger Registers Image: Charger Registers 0x13 Charger Registers Image: Charger Registers Image: Charger Registers 0x13 Charger Registers 1 Image: Charger Registers 0x12 Charger Registers 1 |
| SMBus traffic monitoring | (MSB) 0xE490 (MSB) 0x???? (MSB) 0x???? -0x14 ChargingCurrent 0x15 ChargingVoltage Other Numeric Charger Registers 1000 mA Write Item Numeric Charger Registers Auto Re-Write Auto Re-Write Read ??? -Data Refresh Read (3) passed Refresh |
| \\.\COM1 ready | 2/11/04 5:07:11 PM [0x12R 0x13 0xE490] Read Charger ChargerStatus 58512 0xE490 LEVEL_2 VOLTAGE_OR TF 🏑 |

Figure 2. MAX1645B Smart-Charger Command Panel

| ier j | System | Overview 🛛 Generic Sma | t Battery (0x1 | 6) MAX | (1645B Smart Charger (0x1) | 2) SMBu | s Interfac | e SMBus Scripting SM | Bus Traffi | ic |
|-----------------------|---------------------|---------------------------|----------------|-----------|----------------------------|----------|------------|---------------------------|------------|----------|
| er Interval: | | | | | | | -Other B | itmapped Charger Registe | rs | |
| sec | Sr | nart Charger described in | file: MAX16 | 458.INI | - | | 0x16:\ | W AlarmWarning | | T |
| et Interval | -0x13 C | hargerStatus | | C0x12 C | hargerMode | | 0x11:F | R ChargerSpecInfo | | |
| | (LSB) | | Read | (LSB) | N 1 | Write | (LSB) | V AlarmWarning | | |
| un Running | Bit O | CHARGE_INHIBITED | | Bit 0 | INHIBIT CHARGE | | Bit O | Not used | ? I | 1 |
| op | Bit 1 | MASTER_MODE | 0 | Bit 1 | Not Implemented | | Bit 1 | Not used | ? | 1 |
| <u> </u> | Bit 2 | Function disabled | 0 | Bit 2 | POR_RESET | | Bit 2 | Not used | | 1 |
| Stop if error | Bit 3 | Function disabled | 0 | Bit 3 | Not Implemented | | Bit 3 | Not used | ? | 1 |
| | Bit 4 | LEVEL_2 | 1 | Bit 4 | AC_PRESENT_MASK | | Bit 4 | Not used | ? I | 1 |
| | Bit 5 | LEVEL_3 | 0 | Bit 5 | BATT_PRESENT_MASK | | Bit 5 | Not used | ? | 1 |
| er Action: | Bit 6 | CURRENT_OR | 0 | Bit 6 | POWER_FAIL_MASK | | Bit 6 | Not used | | 1 |
| ler Action: | Bit 7 | VOLTAGE_OR | 1 | Bit 7 | Not Implemented | | Bit 7 | Not used | ? [| 1 |
| Active | Bit 8 | THERMISTOR OR | 0 | Bit 8 | Not Implemented | | Bit 8 | Not used | ? | 1 |
| Read: | Bit 9 | THERMISTOR COLD | 0 | Bit 9 | Not Implemented | | Bit 9 | Not used | ? | 1 |
| System | Bit 10 | THERMISTOR_HOT | 1 | Bit 10 | HOT_STOP | | Bit 10 | Reserved | ? | 1 |
| ✓ Battery ✓ Charger | Bit 11 | THERMISTOR_UR | 0 | Bit 11 | Not Implemented | | Bit 11 | Terminate Discharge | ? | 1 |
| | Bit 12 | ALARM_INHIBITED | 0 | Bit 12 | Not Implemented | | Bit 12 | Over Temperature | ? | 1 |
| | Bit 13 | POWER_FAIL | 1 | Bit 13 | Not Implemented | | Bit 13 | Other Alarm | ? | 1 |
| | Bit 14 | BATTERY_PRESENT | 1 | Bit 14 | Not Implemented | | Bit 14 | Terminate Charge | ? [| 1 |
| Passive | Bit 15 | AC_PRESENT | 1 | Bit 15 | Not Implemented | $\Box 1$ | Bit 15 | Over Chage Alarm | ? | 1 |
| SMBus | (MSB) | | 0xE490 | (MSB) | | 0x???? | (MSB) | | 0x | ???? |
| traffic monitoring | ⊏0x14 Ci | hargingCurrent | | -0x15 C | hargingVoltage | | -Other | Numeric Charger Registers | | |
| monikoning | 1000 | mA [| Write | 18000 | <u> </u> | Write | | | | * |
| | | Be-Write | | | D Re-Write | | | | | |
| | | offe-white | | | 5116-WIKe | | Rea | id ??? ??? | | Write |
| | | | | | | | L <u> </u> | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | ⊢ ^{Data} R | efresh | _ | | | | | | | |
| | | | F | lead (24) | passed | | | | Re | efresh |

Figure 3. MAX1645B Smart-Charger Command Panel Showing the Pulldown List For Charger Spec Info and Alarm Warning

Auto Rewrite Checkboxes

The MAX1645B needs to receive a ChargeVoltage() or ChargeCurrent() command every 175s (typ); otherwise, the MAX1645B times out and terminates charging. Usually, a smart battery sends these necessary commands. However, when not using a smart battery with the MAX1645B EV kit, select either (or both) of the Auto Rewrite checkboxes located directly under the Charging Current and Charging Voltage edit fields. This generates a ChargeVoltage() or ChargeCurrent() command at the selected time interval located on the Timer panel.

ChargerMode()

To issue the ChargerMode() command to the MAX1645B, select a combination of checkboxes in the Charger Mode panel of commands. Each checkbox represents a bit in the ChargerMode() command word. Select the checkboxes next to the bits for which the software should write a 1, unselect the checkboxes for a 0. Send the command by selecting the **Write** button.

Evaluate: MAX1645B



ChargerStatus()

Charger status is shown in the Charger Status panel. Each of the bits in the ChargerStatus() command word are shown individually with a short description of the bit.

By default, the status is automatically read once every two seconds. Disable this feature by unselecting the Active Read: Charger checkbox located on the Timer panel. Change the refresh time by entering a new value into the Timer Interval edit box and select the **Set Interval** button. When Auto Refresh is disabled, issue a ChargerStatus() command by selecting the **Read** button on the Charger Status panel.

ChargerSpecInfo()

ChargerSpecInfo() returns the Charger Specification (0x0009) from the MAX1645B. This command is available through the "Other Bitmapped Charger Registers..." panel. Select Charger Spec Info by picking it from the pulldown list located directly under the Other Bitmapped Charger Registers... label. Issue a ChargerSpecInfo() command by selecting the **Read** button. The returned hexadecimal value is shown at the bottom of the panel.

AlarmWarning()

Alarm Warning is shown on the Other Bitmapped Charger Registers... panel (Figure 3). Select Alarm Warning by picking it from the pulldown list located directly under the Other Bitmapped Charger Registers... label. Each of the bits in the AlarmWarning() command word are shown individually with a short description of the bit and a checkbox. Select the checkboxes next to the bits for which the software should write a 1; unselect the checkboxes for a 0. Send the command to the MAX1645B by selecting the **Write** button.

Smart-Battery Command Panel

The software is capable of reading the registers of a smart battery. The smart battery page of the software is shown in Figure 4. The software only reads the registers selected with checkmarks. By default, the registers are automatically read once every two seconds. Disable this feature by unselecting the Active Read: Battery checkbox located on the Timer panel. Change the refresh time by entering a new value into the Timer Interval edit box and select the **Set Interval** button. When Auto Refresh is disabled, read the battery by selecting the **Refresh** button.

Detailed Description ______of Hardware

Input Current Limiting

The MAX1645B EV kit is configured to regulate the battery current so that the total V_{IN} input current does not exceed 2.5A. If a load is connected across the LOAD

and GND pads (another system power supply, for example) that would cause the total current from V_{IN} to exceed 2.5A, the MAX1645B will automatically decrease its charging current to regulate the input current to 2.5A. Refer to the MAX1645B data sheet for more information regarding input current limiting.

Connecting a Smart Battery

The MAX1645B EV kit includes a five-element terminal block to facilitate connecting the EV kit to a smart battery. Refer to the smart battery specification to identify the type of smart battery connector suited to your application. Make sure that the EV kit power is turned off, and connect the (+), C, D, T, and (-) terminals from the EV kit board to the smart battery connector using no more than 2 inches of wire. Remove the JU3 shunt, attach a smart battery to the smart battery connector, and turn the EV kit power back on. See Figure 1 if necessary.

Connecting an Electronic Load

If a smart battery is unavailable, an electronic load can be connected across the BATT and GND pads on the MAX1645B EV kit board. Make sure that the EV kit power is turned off before connecting a load. Make sure that JU3 is shunted, making it appear to the MAX1645B as if a smart battery were connected. After the load is connected, program the load in voltage mode and set the electronic load to clamp at 5V. Turn on the power to the EV kit, and program the MAX1645B with a charging voltage of 12V at the maximum charging current. Verify that the MAX1645B is supplying the maximum current to the load. Increase the electronic load clamp voltage in 1V increments, and verify that as the electronic load voltage crosses 12V, the MAX1645B transitions from current regulation to voltage regulation; as the electronic load voltage increases beyond 12V, the BATT voltage should remain fixed at 12V.

Layout Considerations

The MAX1645B EV kit layout is optimized for fast switching and high currents. The traces connecting the power components must be able to carry at least 3A. Take care to ensure that C1 and C2 (the input capacitors), D2 and N2 (the synchronous rectifier), and C3 and C4 (the output capacitors) are all connected to GND at a common point, and to isolate the power GND from the quiet analog GND.

| limer | System Overview Generic Smart Ba | ttery (0x16) MAX16 | 645B Smart C | harger (0x12) SMBus Interface SI | MBus Scripting SMBus Traffic |
|--------------------|----------------------------------|-----------------------|--------------------------|----------------------------------|------------------------------|
| imer Interval: | | described in file: B/ | ATTERY.INI | ▼ | |
| 2 sec | Smart Battery Settings | | | | |
| Set Interval | 🔽 0x00 Manufacturer Access | 0xFF10 | | 🔽 0x10 Full Charge Capacity | 1770 mAh |
| Run Running | Ox01 Remaining Capacity Alarm | 300 mAh | | ☑ 0x11 Run Time to Empty | 2646 minutes |
| Stop | 🔽 0x02 Remaining Time Alarm | 10 minutes | | 0x12 Average Time to Empty | 2646 minutes |
| | 🔽 0x03 Battery Mode | 0x0000 | mAh | 🔽 0x13 Average Time to Full | 65535 minutes |
| Stop if error | 🔽 0x04 At Rate | -256 mA | | 🔽 0x14 Charging Current | 2000 mA |
| | Apply Selected Changes (0x00 | 00x04 writeable) | | 🔽 0x15 Charging Voltage | 65471 mV |
| imer Action: | ▼ 0x05 At Rate Time to Full | 65535 minutes | | 🔽 0x16 Battery Status | 0x00C0 |
| Active | Ox06 At Rate Time to Empty | 389 minutes | | 🔽 0x17 Cycle Count | 196 cycles |
| Read: | ▼ 0x07 At Rate OK | true | | 🔽 0x18 Design Capacity | 3000 mAh |
| ✓ System ✓ Battery | Ox08 Temperature | 294.2 K 21.1 C | | 🔽 0x19 Design Voltage | 14800 mV |
| Charger | v Ox09 Voltage | 16105 mV | | 🔽 0x1A Specification Info | 0x0010 |
| | V 0x0A Current | -43 mA | | 🔽 0x1B Manufacture Date | 5/13/1999 |
| | ✓ Ox0B AverageCurrent | -43 mA | | 🔽 0x1C Serial Number | 24127 |
| Passive | | 20 % | | 🔲 0x20 Manufacturer Name | |
| SMBus traffic | ♥ 0x0D Relative State of Charge | 93 % | | 0x21 Device Name | |
| monitoring | ♥ 0x0E Absolute State of Charge | 55 % | | 🔽 0x22 Device Chemistry | LION |
| | ♥ 0x0F Remaining Capacity | 1654 mAh | | | |
| | ♥ 0x23 Mfgr Data { 0x42 0x44 0x5 | 1 | | | |
| | Refresh Select All | | Erase old da Use PECs | a Open CSV Log Loggin | g On Logging Off Close Log |

Figure 4. MAX1645B Smart-Battery Command Panel

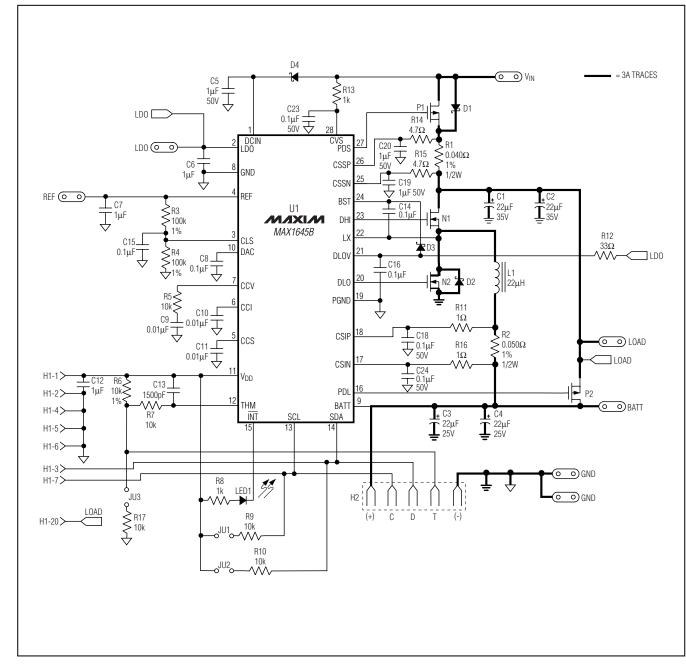


Figure 5. MAX1645B EV Kit Schematic

Evaluate: MAX1645B

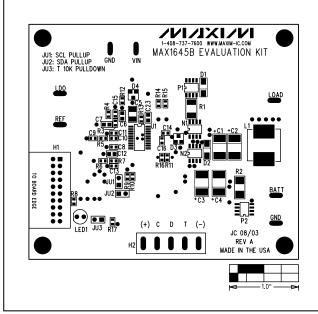


Figure 6. MAX1645B EV Kit Component Placement Guide— Component Side

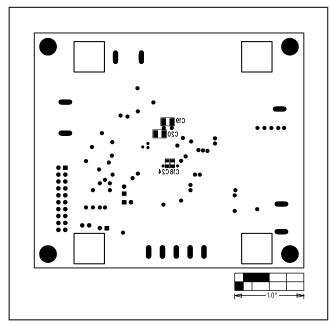


Figure 7. MAX1645B EV Kit Component Placement Guide— Solder Side

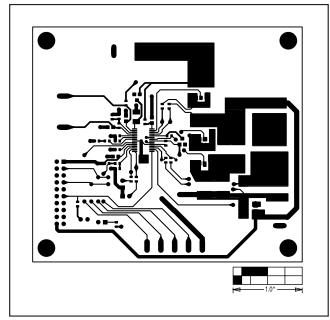


Figure 8. MAX1645B EV Kit PC Board Layout—Component Side

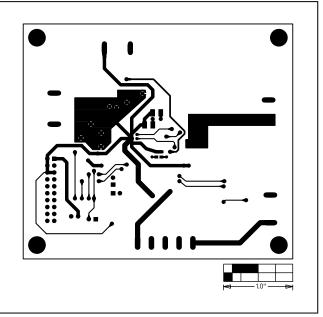


Figure 9. MAX1645B EV Kit PC Board Layout—Solder Side

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