

# MAX20094/MAX20095 Evaluation Kits/ MAX20094/MAX20095 Evaluation Systems

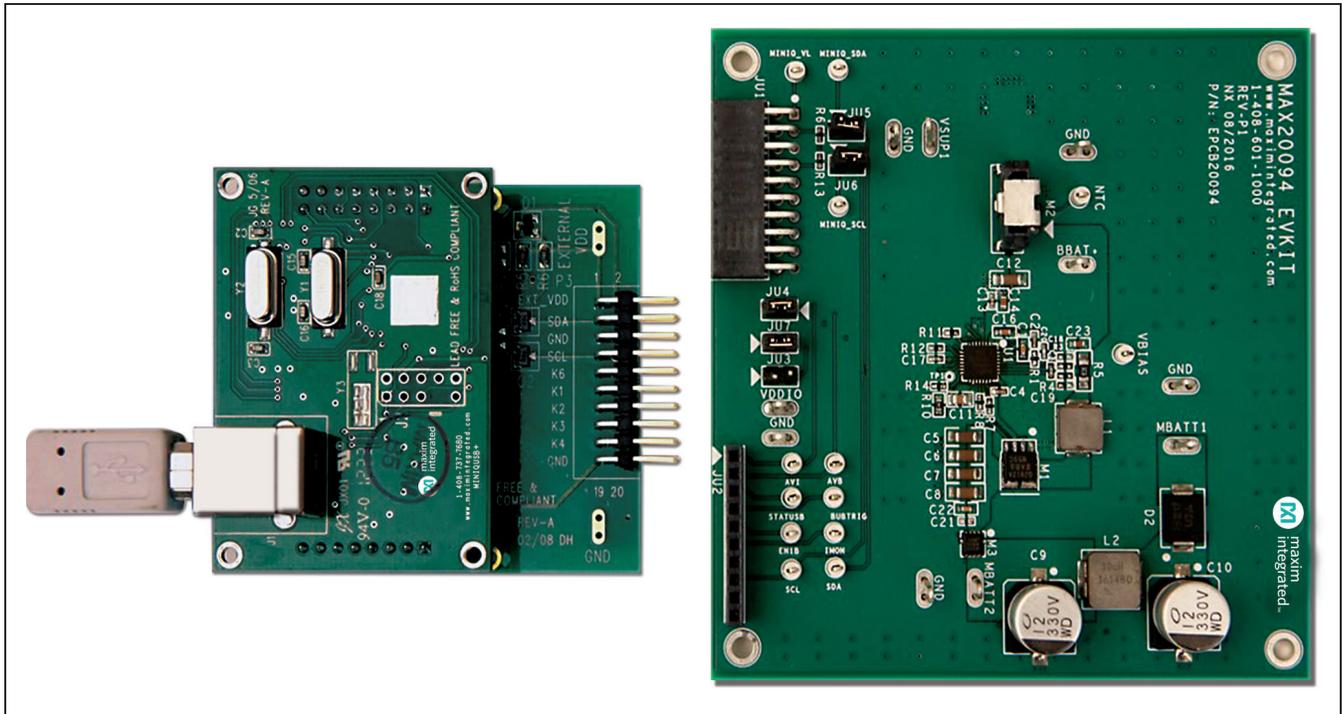
# Evaluate: MAX20094/MAX20095

## General Description

The MAX20094/MAX20095 evaluation kits (EV kits) are fully assembled and tested application circuits for the MAX20094/MAX20095 backup battery chargers and boost controllers with I<sup>2</sup>C capability. The EV kits are set up to provide the user with a convenient method to assess the constant-current/constant-voltage (CC/CV) battery charger, state-of-health (SOH) diagnostic features, and the boost controller.

Both EV kits are recommended for use with the free MAX20094 companion GUI and an I<sup>2</sup>C interface board, such as the Maxim Integrated command module (MINIUSB). The MINIUSB enables I<sup>2</sup>C communication through the USB port of a PC by emulating a 2-wire interface. The EV system includes both the EV kit and the MINIUSB command module. **Note:** The EV kit can also be used as a stand-alone board without these items. The EV kit can also evaluate the pin-compatible MAX20095 with IC replacement of U1.

## MAX20094 EV Kit Photo



**Note:** Photo shows the Maxim MINIUSB board on left and the MAX20094 EV kit board on right.

## Benefits and Features

- Easy Testing of CC/CV Charger, SOH Functions, and Boost Controller
- Free Downloadable EV Kit GUI
- MINIUSB for Simplified Control
- Jumpers and Pins for External I<sup>2</sup>C Controller
- Optimized Application Layout for Quick Implementation
- Both MAX20094 and MAX20095 EV Kits Can be Used to Evaluate Either of the Pin-Compatible ICs with Component Replacement of the U1 IC
- Proven PCB Layout
- Fully Assembled and Tested

Ordering Information appears at end of data sheet.

## Quick Start

### Required Equipment

- MAX20094 or MAX20095 EV kit
- Latest version of the MINIQUSB command module firmware (optional, USB cable included) available from [www.maximintegrated.com/evkitsoftware](http://www.maximintegrated.com/evkitsoftware)
- Latest version of the MAX20094 EV kit software, available from [www.maximintegrated.com/evkit-software](http://www.maximintegrated.com/evkit-software)
- Three adjustable DC power supplies (PS1, PS2, PS3)
- Digital multimeter (DMM)
- Power resistor, adjustable preferred (this can be omitted if power supply can sink current)
- Electronic load

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

- 1) Download the latest version of the EV kit software, and install to your PC using the .EXE setup file. The supported operating systems are Windows® 7, Windows 8, and Windows 10.
- 2) Connect the USB cable from the PC to the MINIQUSB board, and then plug it into JU1 on the EV kit.
- 3) If the firmware on the MINIQUSB board is not compatible with the GUI, the most recent version should be downloaded and the board updated. Refer to the MINIQUSB Firmware Update instructions in the downloaded file for further information.

- 4) Verify that all jumpers are in their default positions, as shown in [Table 1](#).

### Procedure for CC/CV Charging

To quickly test the CC/CV battery-charging functionality, power supplies and a variable power resistor are used instead of actual batteries:

- 1) Preset the PS1 power supply to 14V, then disable the supply. Connect the positive and negative terminals to the MBATT1 and the neighboring GND test pads, respectively, and turn on the supply.
- 2) Preset the PS2 power supply to 4V, then disable the supply. Connect the positive and negative terminals to the VSUP1 and the neighboring GND test pads, respectively, and turn on the supply.
- 3) Preset the PS3 power supply to 3.2V, then disable the supply.
- 4) Set a DMM to measure current. Connect the positive terminal of PS3 to the DMM's COM, and then connect the positive side of the DMM to the BBAT+ test pad. Close the current path by connecting the neighboring GND test pad to the supply's negative terminal and turn on PS3.
- 5) Connect a 60Ω power resistor across PS3, and optimize the value of the resistor to the charging current being tested.
- 6) Start the EV kit software on the PC and click the splash screen to bring up the main window.
- 7) Check **CHG\_EN** in the GUI ([Figure 1](#)) to enable the charger.
- 8) Verify that current through the DMM is approximately 50mA, from the board to the supply.

**Table 1. MAX20094/MAX20095 EV Kits Default Jumper Settings**

JUMPER	DEFAULT SHUNT POSITION	FUNCTION
JU1	—	MINIQUSB socket
JU2	—	—
JU3	Open	Disables (shorts EN1B to VDDIO)
JU4	Installed	Shorts MINIQUSB's VDD to VDDIO
JU5	Installed	Shorts SDA to MINIQUSB's SDA
JU6	Installed	Shorts SCL to MINIQUSB's SCL
JU7	Installed	Connects STATUSB to VDDIO through 10kΩ resistor

*Windows is a registered trademark and registered service mark of Microsoft Corporation.*

### Procedure for the State-of-Health (SOH)

To quickly test the SOH functionality, power supplies are used instead of actual batteries:

- 1) Preset PS1 to 14V, then disable the supply. Connect the positive and negative terminals to MBATT1 and the neighboring GND test pads, respectively, and turn on the supply.
- 2) Preset PS2 to 4V, then disable the supply. Connect the positive and negative terminals to VSUP1 and the neighboring GND test pads, respectively, and turn on the supply.
- 3) Preset PS3 to 3.2V, then disable the supply.
- 4) Set the DMM to measure current. Connect the positive terminal of PS3 to the DMM's COM, and then connect the positive side of the DMM to the BBAT+ test pad. Close the current path by connecting the neighboring GND test pad to the supply's negative terminal, then turn on PS3.
- 5) Start the EV kit software on the PC and click the splash screen to bring up the main window.
- 6) Check **SOH\_EN** in the GUI ([Figure 1](#)) to enable the SOH function.
- 7) Verify that the MAX20094/MAX20095 current through the DMM is approximately -500mA, flowing from the supply to the board.

### Procedure for the Boost Controller

To quickly test the boost-controller functionality, power supplies are used instead of actual batteries:

- 1) Preset PS1 to 14V, then disable the supply. Connect the positive and negative terminals to MBATT1 and the neighboring GND test pads, respectively, and turn on the supply.
- 2) Preset PS2 to 4V, then disable the supply. Connect the positive and negative terminals to VSUP1 and the neighboring GND test pads, respectively, and turn on the supply.
- 3) Preset PS3 to 3.2V, then disable the supply. Connect the positive and negative terminals to BBAT+ and the neighboring GND test pads, respectively, and turn on the supply.
- 4) Connect an electronic load's positive and negative terminals to MBATT2 and the neighboring GND test pads, respectively. Set the load to 100mA.
- 5) Start the EV kit software on the PC and click the splash screen to bring up the main window.
- 6) Check **BST\_EN** in the GUI to enable the boost controller.
- 7) Lower PS1 from 14V to 0V.
- 8) Verify that MBATT2 voltage is approximately 6.2V on the MAX20094 EV kit and 9V on the MAX20095 EV kit.

### Detailed Description Software

The GUI shown in [Figure 1](#) is the main window of MAX20094 EV kit software, and provides a convenient means to control both the MAX20094 and MAX20095 ICs. When the software is first opened, a splash screen appears. Click anywhere on the screen to proceed to the main window. Verify that the bottom-right corner of the status bar displays **EV Kit: Connected**. If there is a problem with the connection, reconnect the EV kit to the PC, power it up, and then click **Device > Connect**, or press F9 on the keyboard. Refer to the MAX20094/MAX20095 IC data sheet for a full description of each register and their bits.

### CC/CV Charging Details

The normal operating mode of the IC is to maintain charge on the backup battery of a system. Several key aspects of the charging function can be easily tested through the GUI.

### Switching Between Charging Modes

When the charger is enabled, the operation is governed by an internal state machine.

**Disabled:** The charger is in an OFF state if the CHG\_EN bit (register 0x04) = 0, or if the die temperature is above thermal-shutdown threshold.

**Prequal:** The prequalify state is a current-limited mode that occurs if BBAT+ voltage is less than an internal OTP threshold. To enter this mode, set BBAT+ to 0V before enabling the charger.

**Standby:** Once the charger is enabled, it remains in this state until a valid supply condition is met. To verify on EV kit, enable the charger and then enter SUP1 undervoltage lockout (UVLO) by reducing the V<sub>SUP1</sub> to below 3.5V.

**CC:** The continuous-current mode is used when the rechargeable battery needs a significant amount of charge. To enter this mode, follow the quick start [Procedure for CC/CV Charging](#) section.

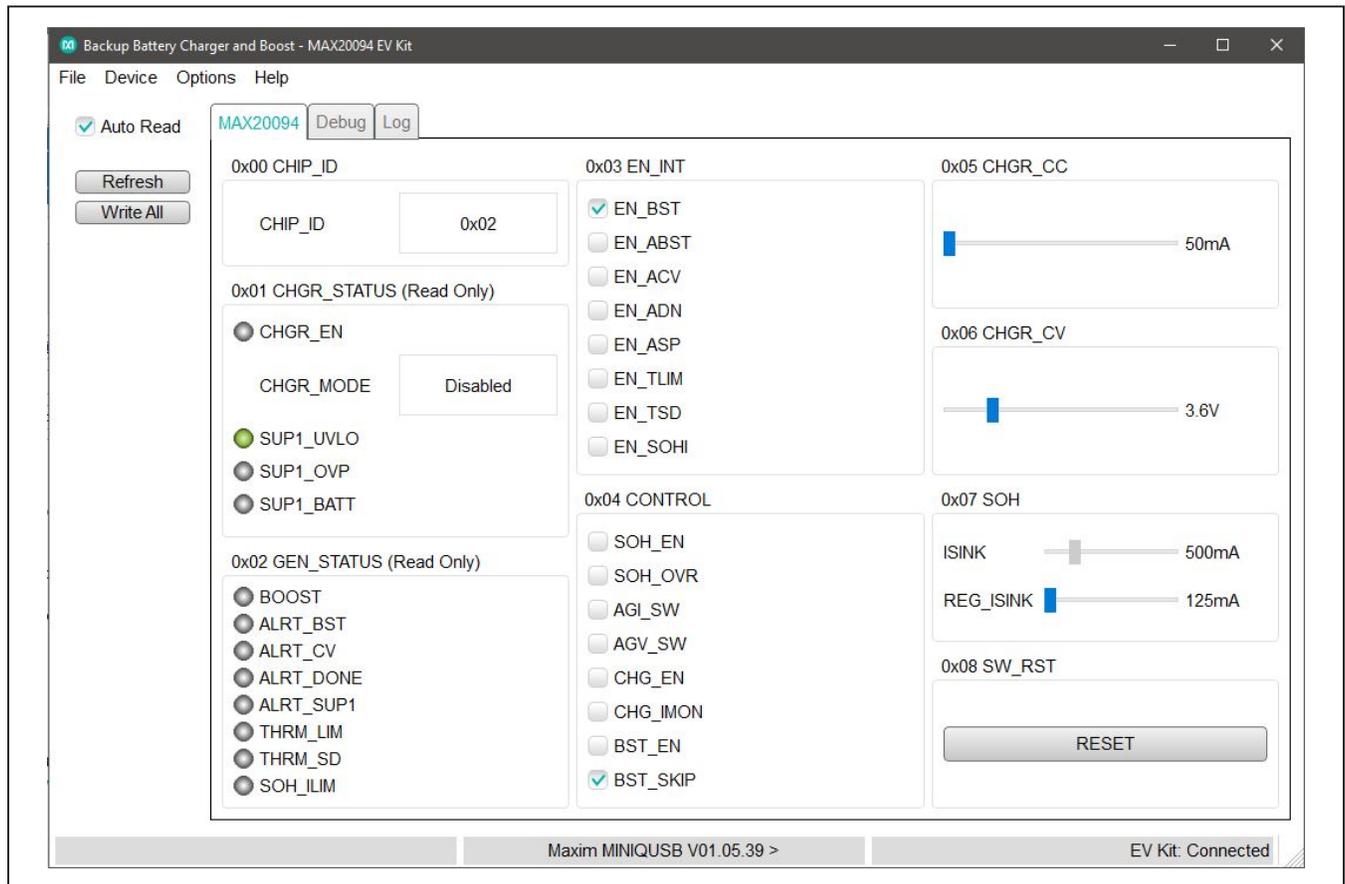


Figure 1. MAX20094 Evaluation Kit Software Main Window (also applies to the MAX20095 EV Kit)

**CV:** Continuous-voltage mode is triggered automatically if the rechargeable battery approaches full charge, set by 0x06 CHGR\_CV threshold. To test this from the [Quick Start](#) setup, slowly increase the BBAT+ voltage until it is just below the threshold.

**Done:** When the charger detects that battery voltage has surpassed 0x06 CHGR\_CV threshold, it enters the done state and no longer charges the battery. To quickly enter this state, lower the 0x06 slider in the GUI below BBAT+ voltage.

### Setting Charger CC Current

In constant-current mode, the fast-charging current can be adjusted based on system requirements. To adjust this on the EV kit, adjust the 0x05 CHGR\_CC slider in the GUI ([Figure 1](#)). If a power supply without sinking capability is used for BBAT+, a power resistor should be connected in parallel to the board to dissipate the charge current (flowing from board to supply). To prevent excess power from being drawn, the optimal resistor value is derived from:

$$I_{CHGR\_CC} = \frac{V_{BBAT+}}{R}$$

If the resistor value is too low, the charger may become current limited and will automatically switch to CV mode.

### State-of-Health (SOH) Details

The SOH function allows the IC to determine the condition of the backup battery based on the output impedance.

#### SOH Test Current

Test current used by the SOH system to determine the battery condition can be adjusted using the slider in the 0x07 SOH register box. The default for the EV kit is 500mA, which can be changed with the lower slider (REG\_ISINK). To set it in the IC, enable SOH\_OVR in the 0x04 CONTROL register box.

### SOH Current Limit

The SOH will report a current-limit error if SOH\_ILIM is operating in overcurrent condition, or BBAT+ is below 2.5V. When this occurs, SOH can no longer be enabled, so the SOH\_ILIM indicator in 0x02 GEN\_STATUS register blinks until the supply is increased again.

### Boost Controller Details

The boost controller allows the IC to maintain a regulated supply voltage on the MBATT2 pin using the backup battery in the event of a main battery failure. The IC includes a synchronous current-mode boost controller with factory-preset output. The standard switching frequency is 2.1MHz and operates in both FPWM and skip modes. When the SUP2 pin is above the regulation voltage, the boost block enters an ultra-low I<sub>Q</sub> standby mode.

### Mode of Operation

The default mode of operation for the MAX20094/MAX20095 is skip mode, which increases efficiency at light loads to reduce the power consumption of the backup battery. To operate in FPWM mode, uncheck BST\_SKIP in the 0x04 CONTROL register in the GUI. To guarantee FPWM operation across all load conditions, R4 should be switched to 250Ω. In addition, for IC options with boost output voltages greater than or equal to 8V, the inductor (L1) should be increased to accommodate the larger ripple current. A 2.2μH inductor is sufficient for the 12V option, which can be used for lower output voltages as well.

## Ordering Information

PART	TYPE
MAX20094EVKIT#	EV Kit
MAX20094EVSYS#	EV System
MAX20095EVKIT#	EV Kit
MAX20095EVSYS#	EV System

#Denotes RoHS compliant.

**Note:** The EV system includes both the EV kit and the MINIQUSB command module.

# MAX20094/MAX20095 Evaluation Kits/ MAX20094/MAX20095 Evaluation Systems

Evaluate: MAX20094/MAX20095

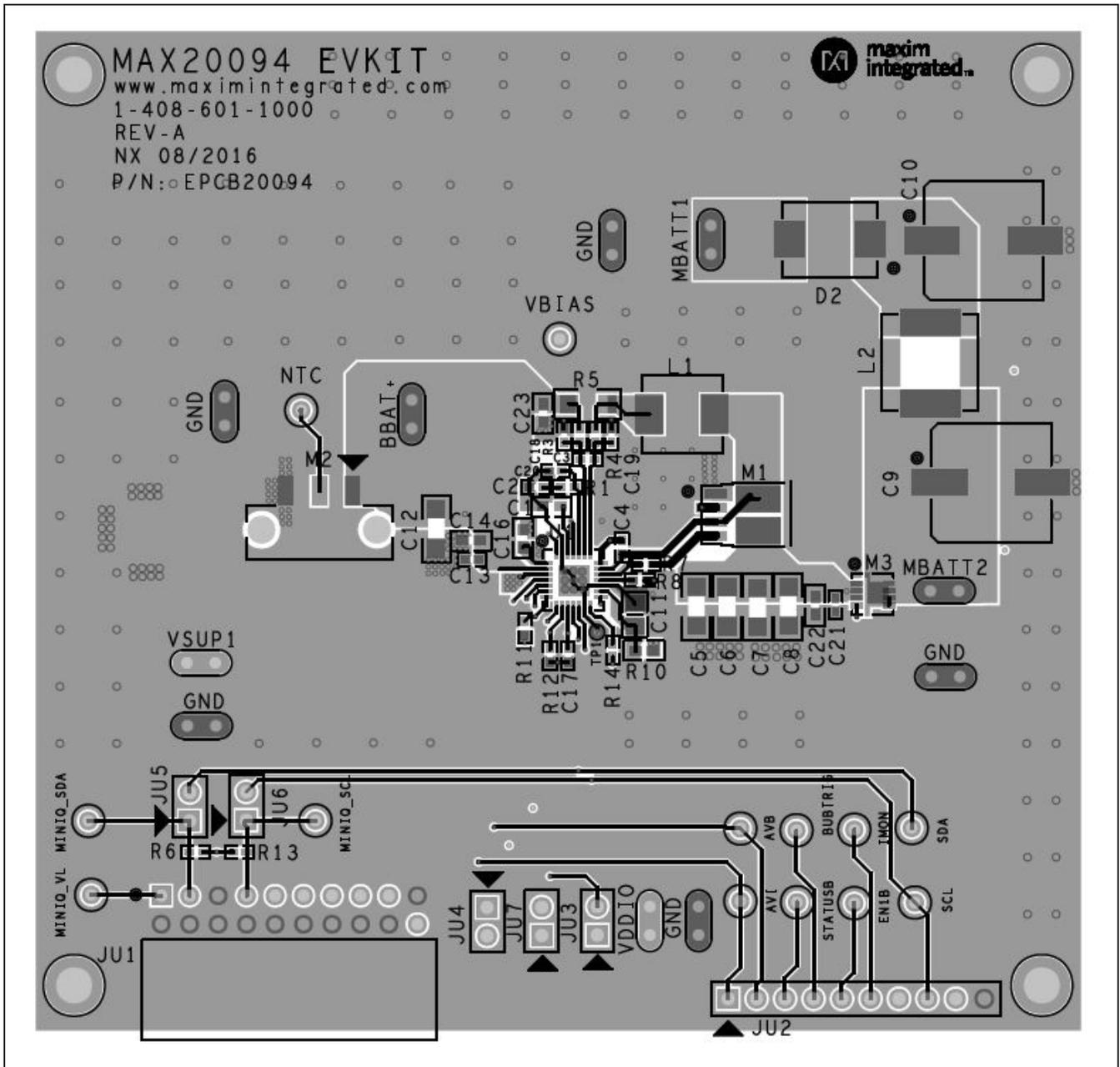
## MAX20094/MAX20095 EV Kits Bill of Materials

REF DESIGNATORS	QTY	VALUE	DESCRIPTION	MFG PART NO.
AVB, AVI, NTC, SCL, SDA, EN1B, IMON, VBIAS, BUBTRIG, STATUSB, MINIQ_VL, MINIQ_SCL, MINIQ_SDA	13	—	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; RED; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH; RECOMMENDED FOR BOARD THICKNESS=0.062IN; NOT FOR COLD TEST	5000
C1, C22	2	1.0UF	CAPACITOR; SMT (0603); CERAMIC; 1UF; 6.3V; TOL=10%; MODEL=GRM SERIES; TG=-55 DEGC TO +125 DEGC; TC=X7R; NOT RECOMMENDED FOR NEW DESIGN-USE 20-0001U-63	GRM188R70J105KA01; CL10B105KQ8NNNC
C2	1	3900PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 3900PF; 50V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R	C0402X7R500-392KNE; GRM155R71H392KA01
C3	1	100PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 100PF; 50V; TOL=2%; TG=-55 DEGC TO +125 DEGC; TC=C0G	C1005C0G1H101G050
C4, C13, C17, C21	4	0.1UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.1UF; 50V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R	CGA2B3X7R1H104K; C1005X7R1H104K050BB; GRM155R71H104KE14
C5-C8	4	4.7UF	CAPACITOR; SMT (1206); CERAMIC CHIP; 4.7UF; 50V; TOL=10%; MODEL=; TG=-55 DEGC TO +125 DEGC; TC=X7R	GRM31CR1H475KA12
C9,10	2	330UF	CAPACITOR; SMT; ALUMINUM-ELECTROLYTIC; 330UF; 35V; TOL=20%	EEE-FK1V331GP
C11	1	2.2UF	CAPACITOR; SMT (0805); CERAMIC CHIP; 2.2UF; 50V; TOL=10%; MODEL=; TG=-55 DEGC TO +125 DEGC; TC=X7R	C2012X7R1H225K
C12	1	10UF	CAPACITOR; SMT (1206); CERAMIC CHIP; 10UF; 16V; TOL=20%; MODEL=C SERIES; TG=-55 DEGC TO +125 DEGC; TC=X7R	C3216X7R1C106M160AC
C14, C23	1	2.2UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 2.2UF; 25V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7S	GRM188C71E225KE11
C15	1	Open	—	—
C16	1	2.2UF	CAPACITOR; SMT (0603); CERAMIC; 2.2UF; 6.3V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R; AUTO	GGA3E1X7R0J225K080AC
C18, C19	2	Open	—	—
C20	1	680PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 680PF; 50V; TOL=2%; TG=-55 DEGC TO +125 DEGC; TC=C0G	GRM1555C1H681GA01; C1005C0G1H681G050
D1	1	—	DIODE; SCH. SCHOTTKY DIODE; SMT (SOD-323); PIV=30V; IF=0.2A	BATS4H
D2	1	—	DIODE; RECT; SMC; PIV=600V; IF=4A	MURS360T3G
GND1-GND5, BBAT+, VDDIO, VSUP1, MBATT1, MBATT2	10	—	EVK KIT PARTS; MAXIM PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG	9020 BUSS
JU1	1	—	CONNECTOR; FEMALE; THROUGH HOLE; BREAKAWAY HEADER; RIGHT ANGLE; 20PINS	PPTC102LJBN-RC
JU2	1	—	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 10PINS; -65 DEGC TO +125 DEGC	PBC10SAAN
JU3-JU7	5	—	CONNECTOR; THROUGH HOLE; TSW SERIES; SINGLE ROW; STRAIGHT; 2PINS; -55 DEGC TO +105 DEGC	TSW-102-07-T-S
L1	1	680NH	INDUCTOR; SMT; SHIELDED; 680NH; TOL=+/-20%; 25A	IHLP2525ZERR68M01
L2	1	10UH	INDUCTOR; SMT; SHIELDED; 10UH; TOL=+/-20%; 5.4A	IHLP3232ZERR100M11
M1	1	—	TRAN; AUTOMOTIVE DUAL N-CHANNEL 40V (D-S) 175 DEGC MOSFET; NCH; SO-8L; PD-(48W); I(-30A); V(-40V)	SQJ912AEP-T1_GE3
M2	1	—	CONNECTOR; FEMALE; SMT; MICRO FIT 3.0 VERTICAL HEADER; 3MM PITCH; SINGLE ROW; WITH PCB PRESSFIT METAL RETENTION CLIP; STRAIGHT; 5PINS	43650-0322
M3	1	—	TRAN; AUTOMOTIVE P-CHANNEL TRENCHFET POWER MOSFET; PCH; POWERPAK1212-8; PD-(62.5W); I(-16A); V(-40V)	SQS401EN-T1-GE3
M4	1	—	TRAN; AUTOMOTIVE P-CHANNEL TRENCHFET POWER MOSFET; PCH; SO-8; PD-(83W); I(-40A); V(-40V)	SQ443EP-T1-GE3
R1	1	49.9k	RESISTOR; 0402; 49.9K; 1%; 100PPM; 0.0625W; THICK FILM	CRCW040249K9FK; 9C04021A4992FLH3
R2	1	499	RESISTOR; 0402; 499 OHM; 1%; 100PPM; 0.0625W; THICK FILM	CRCW0402499RFK
R3, R4	2	100	RESISTOR; 0402; 100 OHM; 0%; JUMPER; 0.2W; THICK FILM	CRCW0402100RFK; 9C04021A1000FL; RC0402FR-07100RL
R5	1	0.003	RESISTOR; 1206; 0.003 OHM; 1%; 150PPM; 1W; METAL FILM	WSP12063L000F
R6, R13	2	1K	RESISTOR; 0402; 1K; 1%; 100PPM; 0.0625W; THICK FILM	CRCW04021K00FK; RC0402FR-071KL
R7, R8, R14	3	0	RESISTOR; 0402; 0 OHM; 0%; JUMPER; 0.2W; THICK FILM	CRCW04020000Z0EDHP
R9	1	Open	—	—
R10	1	0.2	RESISTOR; 0603; 0.2 OHM; 1%; 200PPM; 0.10W; THICK FILM	CRL0603-FW-R200ELF
R11, R12	2	10K	RESISTOR; 0402; 10K OHM; 5%; 200PPM; 0.063W; THICK FILM	CRCW040210K0JN
U1	1	MAX20094	EVKIT PART-IC; CTRL.; BACKUP BATTERY CHARGER AND BOOST CONTROLLER; QFN28-EP; PACKAGE CODE: T2855Y-SC; 2.2MHz	MAX20094AT1A-VY+
U1	1	MAX20095	EVKIT PART-IC; CTRL.; BACKUP BATTERY CHARGER AND BOOST CONTROLLER; QFN28-EP; PACKAGE CODE: T2855Y-SC; 2.2MHz	MAX20095AT1C-VY+
—	1	—	PCB: MAX20094 EVKIT#	MAX20094EVKIT#



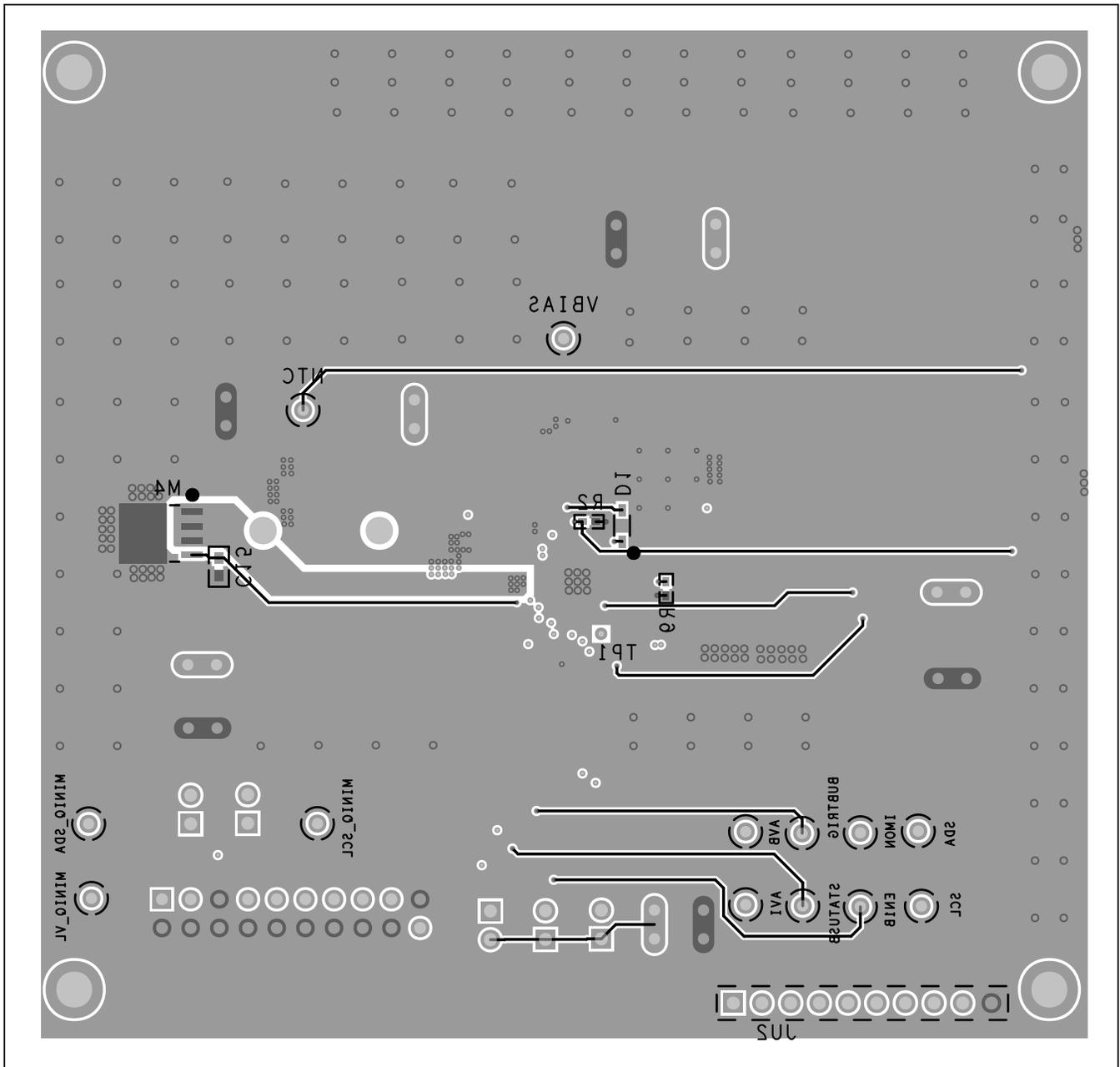


MAX20094/MAX20095 EV Kits PCB Layouts



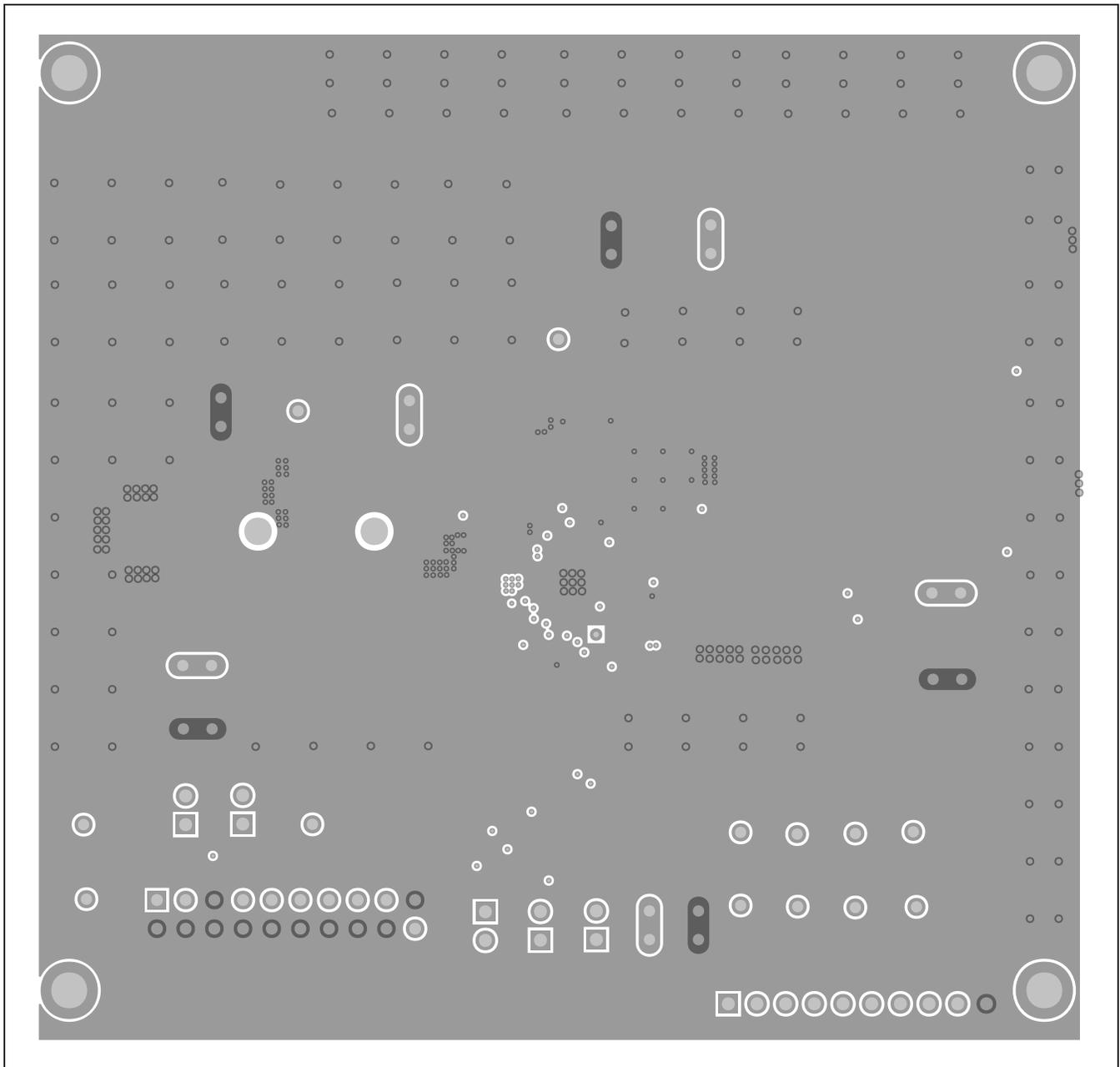
MAX20094 EV Kit Component Placement Guide—Top (also applies to the MAX20095 EV Kit)

MAX20094/MAX20095 EV Kits PCB Layouts (continued)



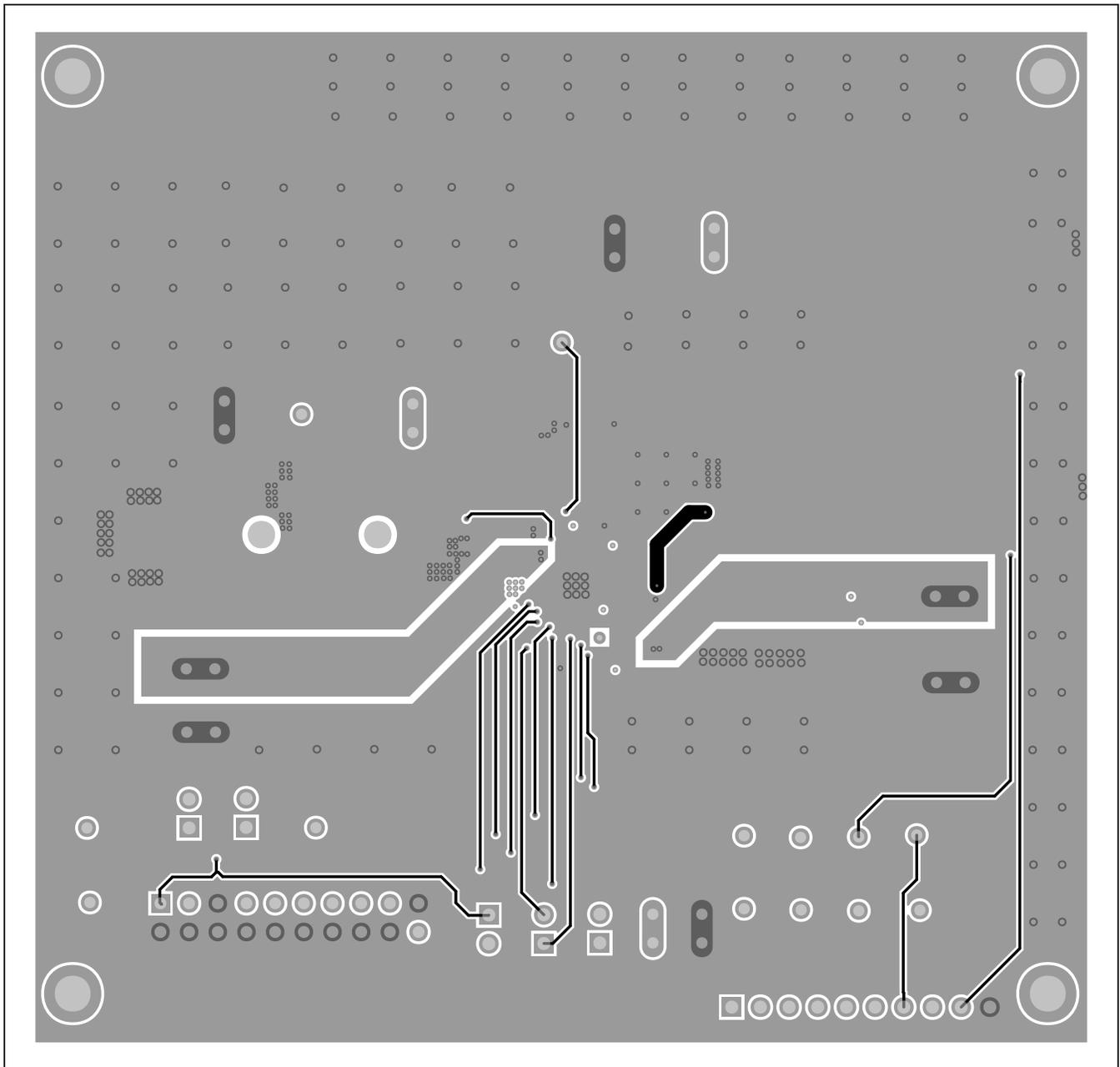
MAX20094 EV Kit Component Placement Guide—Bottom (also applies to the MAX20095 EV Kit)

**MAX20094/MAX20095 EV Kits PCB Layouts (continued)**



*MAX20094 EV Kit PCB Layout—Internal 2 (also applies to the MAX20095 EV Kit)*

**MAX20094/MAX20095 EV Kits PCB Layouts (continued)**



*MAX20094 EV Kit PCB Layout—Internal 3 (also applies to the MAX20095 EV Kit)*

## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	8/17	Initial release	—
1	8/17	Added missing <a href="#">Ordering Information</a> table	5
2	1/18	Added MAX20095EVKIT# and MAX20095EVSYS# to <a href="#">Ordering Information</a> table	5
3	1/18	Added MAX20095 EV kit and MAX20095 EV system to entire data sheet	1–13
4	3/18	Replaced MAX20094 and MAX20095 schematics	7, 8
5	3/18	Updated the <a href="#">Ordering Information</a> table	5

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at [www.maximintegrated.com](http://www.maximintegrated.com).

*Maxim Integrated cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim Integrated product. No circuit patent licenses are implied. Maxim Integrated reserves the right to change the circuitry and specifications without notice at any time.*