MAX17201G/MAX17201X/ E MAX17211G/MAX17211X

Evaluate: MAX17201/MAX17211

MAX17211G/MAX17211X Evaluation Kits

General Description

The MAX17201G/MAX17201X/MAX17211G/MAX17211X evaluation kits (EV kits) are fully assembled and tested surface-mount PCBs that evaluate the stand-alone ModelGauge™ m5 pack-side fuel-gauge ICs for lithiumion (Li+) batteries in handheld and portable equipment. The MAX17201 and MAX17211 are for single-cell applications. See the MAX17205 and MAX17215 for multicell applications.

The MAX17201G/MAX17201X/MAX17211G/MAX17211X EV kits include the Maxim DS91230+ USB interface, IC evaluation board, and RJ-11 connection cable. Windows[®] based graphical user interface (GUI) software is available for use with the EV kit and can be downloaded from Maxim's website at <u>http://www.maximintegrated.com/</u> <u>products/MAX17201</u> (under the *Design Resources* tab). Windows 7 or newer Windows operating system is required to use with the EV kit GUI software.

Benefits and Features

- ModelGauge m5 Algorithm
- Nonvolatile Memory Configured for Stand-Alone Operation
- Monitors 1S Cell Packs
- Battery Pack Input Voltage Range of +2.1V to +4.9V per Cell
- Thermistor Measurement Network
- Optional On-Board PCB Trace Sense Resistor
- Windows 7 or Newer Compatible Software
- Proven PCB Layout
- Fully Assembled and Tested

MAX17201G/MAX17201X/ MAX17211G/MAX17211X EV Kit Files

FILE	DECRIPTION
MAX17201_05_11_15K_	Installs all EV kit files
V2_0_0_0_Install.exe	on your computer

Ordering Information appears at end of data sheet.

Windows is a registered trademarks and registered service marks of Microsoft Corporation.

ModelGauge is a trademark of Maxim Integrated Products, Inc.

Quick Start

Required Equipment

- MAX17201G/MAX17201X/MAX17211G/MAX17211X EV kit
- Lithium battery pack of desired configuration
- Battery charger or power supply
- Load circuit
- DS91230+ USB adapter
- RJ-11 6pos reverse modular cord
- PC with Windows 7 or newer windows operating system and USB port

Procedure

The EV kits are fully assembled and tested. Follow the steps below to install the EV kit software, make required hardware connections, and start operation of the kits. The EV kit software can be run without hardware attached. It automatically locates the hardware when connections are made. Note that after communication is established the IC must still be configured correctly for the fuel gauge to be accurate. See the <u>Configuration Wizard</u> and <u>ModelGauge m5 EZ Configuration</u> sections of the GUI software description.

- Visit <u>http://www.maximintegrated.com/</u> products/MAX17201 under the *Design Resources* tab to download the latest version of the MAX17201_05_11_15K EV kit software. Save the EV kit software to a temporary folder and unpack the ZIP file.
- 2) Install the EV kit software on your computer by running the MAX17201_05_11_15K_Install.exe program inside the temporary folder. The program files are copied and icons are created in the Windows Start menu. The software requires the .NET Framework 4.5 or later. If you are connected to the internet, Windows automatically updates .NET framework as needed.
- 3) The EV kit software launches automatically after installation or alternatively it can be launched by clicking on its icon in the Windows **Start** menu.
- Connect the DS91230+ adapter to a USB port on the PC. The DS91230+ is a HID device and is located automatically by Windows without the need to install additional drivers.



- 5) Make connections to the EV kit board based on cell pack configuration as shown in <u>Figure 1</u>. The cell connects between the BAT- and BAT+ pads and the charger/load connect between the PACK- and PACK+ pads. The load or charger circuit can be connected at this time as well.
- 6) Connect the RJ-11 cable between the USB adapter and the EV kit board. The GUI software establishes communication automatically.
- 7) If the IC has not been configured, run the Configuration Wizard in the EV kit software to configure operation for the desired application circuit and lithium cell type. Configuration information is permanently saved inside the IC.

Detailed Description of Hardware

The MAX17201/MAX17211 EV kit boards provide a variety of features that highlight the functionality of the ICs. The following sections detail the most important aspects of the kit boards.

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Communication Connections

The RJ-11 connector provides all signal lines necessary for I²C, SMBus, 1-Wire, or 1-Wire overdrive communication between the IC and the software GUI interface. When developing code separately, connections to the communication lines can be made directly to the board. <u>Table 1</u> summarizes the connections that should be made. The user must apply the appropriate external pullup resistors to the communication lines when not using the DS91230+ communication interface.

External Thermistors

The MAX17201/MAX17211 can be configured to use up to two external thermistors. All EV kit boards come with these thermistors installed as surface mount components RT1 and RT2. If the application requires direct thermal contact to the cells, RT1 and RT2 can be removed and replaced with leaded thermistors connected between the RT1+/RT1- and RT2+/RT2- solder pads.

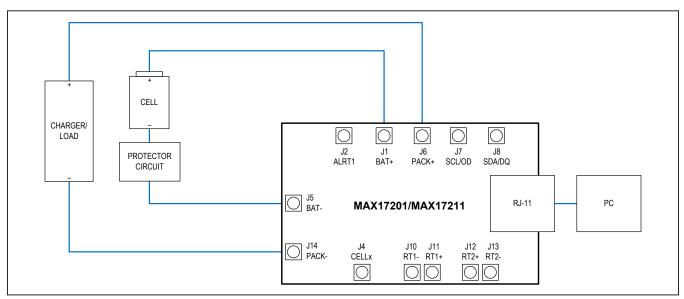


Figure 1. MAX17201/MAX17211 Board Connections

Table 1. Communication Line Solder Points

COMMUNICATION MODE	MAX17201 J7	MAX17201 J8	MAX17211 J7	MAX17211 J8
I ² C	SCL	SDA	N/A	N/A
1-Wire	N/A	N/A	Logic-low	DQ
1-Wire Overdrive	N/A	N/A	Logic-high	DQ

Sense Resistor Options

All EV kit boards are shipped with an 0805 size 0.010Ω chip sense resistor installed. Oversized land pattern pads allow for different size sense resistors to be used if desired. Also, each board contains an optional 0.003Ω copper trace sense resistor that can be enabled if desired. To do so, the chip sense resistor must be removed and 0Ω jumpers must be resoldered to change the circuit. Table 2 summarizes the changes for each board type. Note that the IC must be reconfigured to support the new resistor type. See the <u>Configuration Wizard</u> section for details.

Table 2. Sense Resistor Selection forMAX17201/MAX17211

COMPONENT	VALUE FOR CHIP SENSE	VALUE FOR BOARD TRACE SENSE
R13	0Ω	Not populated
R14	Not populated	0Ω
R15	Desired sense value	Not populated
R16	Not populated	0Ω (R17 is trace resistor)

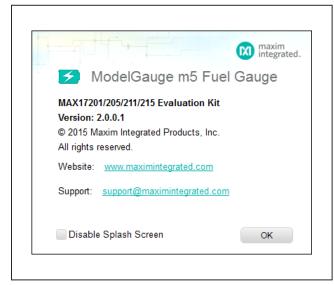


Figure 2. EV Kit Splash Screen

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Detailed Description of Software

The MAX17201G/MAX17201X/MAX17211G/MAX17211X evaluation kit software gives the user complete control of all functions of the MAX17201/MAX17211, as well as the ability to load a custom model into the ICs. It also comes with a sophisticated Configuration wizard to allow user to easily adjust fuel gauge settings. Separate control tabs allow the user access to view real-time updates of all monitored parameters. The software also incorporates a data-logging feature to monitor a cell over time.

Software Installation

The software requires Windows 7 or newer operating system. .NET version 4.5 is required for operation and is automatically installed if an older version of .NET framework is detected. To install the evaluation software, exit all programs currently running and unzip the provided MAX17201_05_11_15K Installation Package zipped file. Double click the MAX17201 05 11 15K V x x x x Install.exe icon and the installation process begins. Follow the prompts to complete the installation. The evaluation software can be uninstalled in the Add/Remove Programs tool in the Control Panel. After the installation is complete, open the Maxim Integrated/MAX17201_05_11_15K folder and run MAX17201 05 11 15K.exe or select it from the program menu. Figure 2 shows a splash screen containing information about the evaluation kit that appears as the program is being loaded.

Communication Port

The EV kit software automatically finds the DS91230+ adapter when connected to any USB port. Communication status is shown on the right-hand side of the bottom status bar. See <u>Figure 3</u>. If the adapter cannot be found, a "No USB Adapter" message is displayed. If the adapter is found, but the IC daughter board cannot be found, a "No Slave Device" message is displayed. Otherwise, if communication is valid, a green bar updates as the software continuously reads the IC registers.

If the DS91230+ is connected, the status bar should be active. The bottom status bar also displays information on data logging status, the communication mode, hibernation status, selected current-sense resistor value, device serial number, and the EVKIT GUI's version number.



Figure 3. EV Kit Bottom Status Bar

Program Tabs

All functions of the program are divided under eight tabs in the main program window. Click on the appropriate tab to move to the desired function page. Located on the ModelGauge m5 tab is the primary user information measured and calculated by the IC. The Graphs tab visually displays fuel gauge register changes over time. The Registers and SBS registers tabs allow the user to modify common fuel gauge registers one at a time. The **Commands** tab allows for special operations such as changing communication mode, initiate fuel gauge logging and performing fuel gauge reset. The Configuration tab displays the value of the nonvolatile registers as well as the remaining number of available writes. The Authentication tab displays SHA authentication-related information. The History tab allows the user to read out and save battery history information logged by the IC over its lifetime. All tabs are described in more detail in the following sections.

ModelGauge m5 Tab

The **ModelGauge m5** tab displays the important output information read from the IC. Figure 4 shows the format of the ModelGauge m5 Tab. Information is grouped by function and each is detailed separately.

State of Charge

The **State of Charge** group box displays the main output information from the fuel gauge: state of charge of the cell, remaining capacity, time to full, and time to empty.

Cell Information

The **Cell Information** group box displays information related to the health of the cell such as the cell's age, internal resistance, present capacity, number of equivalent full cycles, and change in capacity from when it was new.

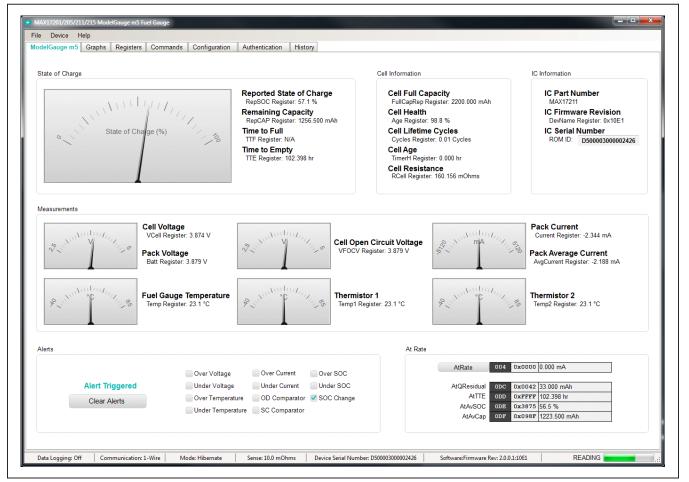


Figure 4. ModelGauge m5 Tab

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IC Information

The **IC Information** group box displays information related to IC itself. This includes the IC part number, IC unique ROM ID, and IC firmware revision.

Measurements

The **Measurements** group box displays ADC measurements that are used by the fuel gauge to determine state of charge.

Alerts

The **Alerts** group box tracks all eleven possible alert trigger conditions. If any alert occurs, the corresponding checkbox is checked for the user to see. The clear alerts button resets all alert flags.

At Rate

The At Rate group box allows user to input a hypothetical load current and the fuel gauge calculates the corresponding hypothetical Qresidual, TTE, AvSOC, and AvCap values.

Graphs Tab

The **Graphs** tab displays up to 20 ADC readings and fuel gauge outputs. Figure 5 shows the format of the **Graphs** Tab. Graph information is grouped into four categories: voltages, temperatures, capacities, and currents. The user can turn on or off any data series using the check boxes on the right-hand side of the tab. The graph visible viewing area can be adjusted from 10 minutes up to 1 week. The graphs remember up to 1 week worth of data. If the viewing area is smaller than the time range of the data already collected, the scroll bar below the graphs can be used to scroll through graph history. All graph history information is maintained by the program. Graph settings can be changed at any time without losing data.

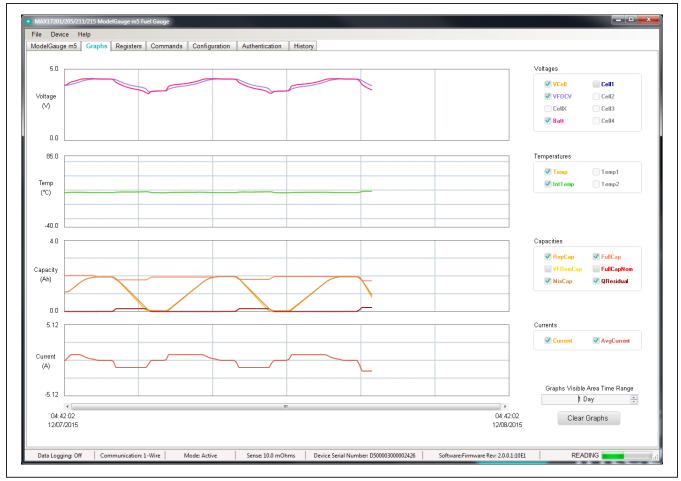


Figure 5. Graphs Tab

Registers Tab

The **Registers** tab allows the user access to all fuel gauge related registers of the IC. Figure 6 shows the format of the **Registers** tab. By using the two buttons on the left side of the tab, the user can sort the registers either by function or by their internal address. Each line of data contains the register name, register address, hexadecimal

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representation of the data stored in the register, and if applicable a conversion to application units. To write a register location click on the button containing the register name. A pop-up window allows the user to enter a new value in either hexadecimal units or application units. The main read loop temporarily pauses while the register updates.

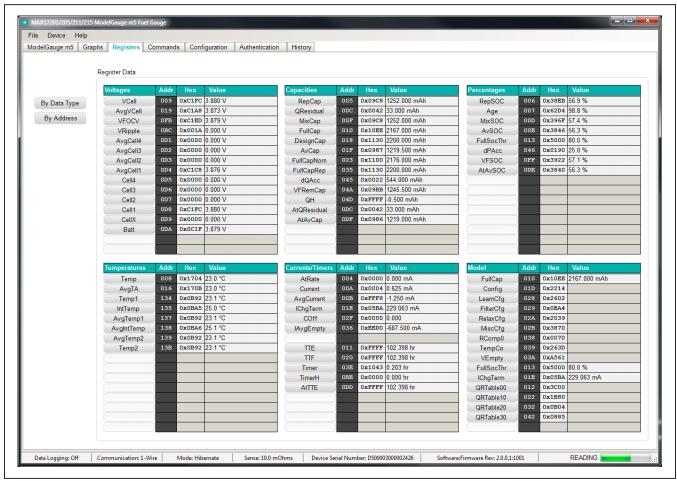


Figure 6. Registers Tab

SBS Registers Tab

The **SBS** registers tab is visible only if SBS functions of the IC are enabled. The **SBS** registers tab has the same formatting as the standard **Registers** tab as shown in <u>Figure</u> 7. By using the two buttons on the left side of the tab, the user can sort the registers either by function or by their internal address. Each line of data contains the register

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name, register address, hexadecimal representation of the data stored in the register, and if applicable a conversion to application units. To write a register location click on the button containing the register name. A pop-up window allows the user to enter a new value in either hexadecimal units or application units. The main read loop temporarily pauses while the register updates.

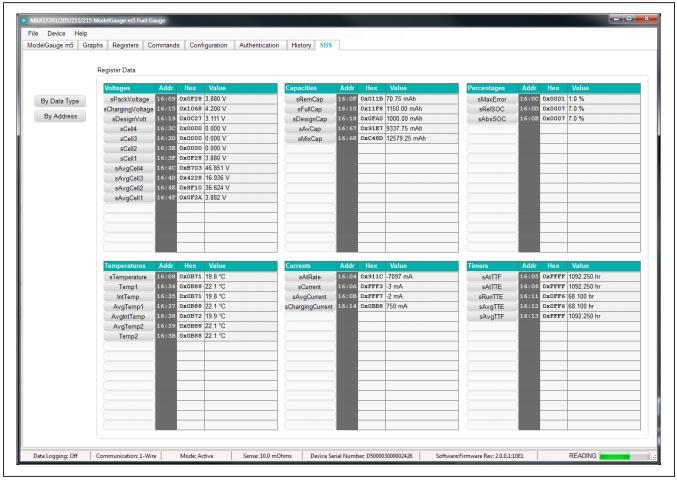


Figure 7. SBS Registers Tab

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Commands Tab

The **Commands** tab allows the user to access any general IC functions not related to normal writing and reading of register locations. Figure 8 shows the format of the **Commands** tab. Each group box of the **Commands** tab is described in detail in the following sections.

1-Wire Communication Speed (MAX1721x Only)	Reset IC
Vitre communication speed (WAX 172 ix Only) When communicating to a MAX1721x the EV kit controls 1-Wire communication speed through the SCL pin of the USB interface. Select the communication speed option below. Whenever communication speed is changed, the new state is automatically detected by the EV kit software. The status strip always reflects the detected (not expected) communication state. For external hardware control of communication speed, enable overdrive communication in the EV kit software and then drive the SCU/OD in hind or low as desired.	To reset the IC through software, first write 0x0000 to location 0x080, and then send the software Power-on-Reset (POR) command 0x000F to the Command Register. The result will be the same as the IC has been completely power cycled.
soltware and then drive the SCLOD pin high or low as desired. I-Wire Communication Mode	
1-Wire Overdrive Communication Mode	Burn Non-Volatile Memory Block
Read/Write Register	Burns a all non-volatile memory on pages 18 through 1D. This operation will also copy non-volatile settings into their corresponding register locations so that the new settings will take effect without the need to reset fuel gauge operation.
communication mode. Register 000 h Write Data 0082 h Read	Lock Register Blocks To lock any of the five memory blocks, click the corresponding button below. Note this is a permane operation that cannot be reversed.
	Set LOCK1 Non-Volatile Memory Pages 1A and 1B are Unlocked
Log Data to File IC registers will be stored in the selected logfile at the datalog interval using a .csv format. The datalog	Set LOCK2 ModelGauge Register Pages 00 to 04, 0B, and 0D are Unlocked
interval can be adjusted from 5 seconds to 5 minutes and can be changed while logging.	Set LOCK3 Non-Volatile Memory Pages 18 and 19 are Unlocked
	Set LOCK4 Non-Volatile Memory Page 1C is Unlocked
Start Log 15 📩 Datalog Interval (seconds) 🖉 Log Events	Set LOCK5 Non-Volatile Memory Page 1D is Unlocked

Figure 8. Commands Tab

1-Wire Communication Speed

This option affects 1-wire ICs only. The user can select either standard or overdrive communication speed. Communication speed is controlled by the EV kit software by driving the OD pin of the IC high or low. Regardless of the desired communication rate, the kit software communicates with any IC it discovers at either communication speed. The actual communication speed is displayed in the bottom status bar of the EV kit window.

Read/Write Register

The user can read a single register location by entering the address in hex and clicking the **Read** button. The user can write a single register location by entering the address and data in hex and clicking the **Write** button. The read loop is temporarily paused each time to complete this action.

Log Data to File

Data logging is always active when the kit software is started. The default data log storage location is the My Documents/Maxim Integrated/MAX17201_205_211_215/ Datalog.csv. The user can stop data logging by clicking the **Stop Log** button or change the data log file name by clicking the **Change Path** button. Whenever data logging is active, it is displayed on the bottom status bar of the EV kit window. All user available IC registers are logging in a .csv formatted file. The user can adjust the logging interval at any time. The user can also enable or disable the event logging at any time. When event logging is enabled, the data log also stores any IC write or reads that are not part of the normal read data loop and indicates any time communication to the IC is lost.

Burn Nonvolatile Memory Block

Clicking the **Burn NV Block** button sends the Copy NV Block command to the command register that causes all register locations from 180h to 1DFh to be stored to nonvolatile memory. Nonvolatile memory has a limited number of copies and the user is prompted to confirm prior to executing the copy.

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Reset IC

Clicking the **Full Reset** button sends the software POR command to the command register and sets the POR_CMD bit of the Config2 register to fully reset operation the same as if the IC had been power cycled. Note that resetting the IC when the cell is not relaxed causes fuel gauge error.

Lock Register Blocks

Clicking one of the five lock buttons locks a page or pages of memory as listed to the right of each button. This is a permanent operation so the user is prompted to confirm the operation prior to setting the lock.

Configuration Tab

The **Configuration** tab has similar formatting to the standard **Registers** tab as shown in <u>Figure 9</u>, but there are some major differences. When the user changes a register value on the **Configuration** tab, only the RAM value of that location is changed. The nonvolatile value remains unchanged. Register text changes to **BLUE** to indicate the RAM and nonvolatile values do not match. The user must complete a nonvolatile burn on the **Commands** tab or run the Configuration Wizard to change the nonvolatile value.

The nonvolatile memory has a limited number of updates that is shown in a box on the left-hand side of the tab. Maxim recommends using the Configuration Wizard to make any changes to nonvolatile memory instead of changing registers manually. The wizard can be launched through the **Device** drop-down menu at the top of the EV kit software window or by the button on the left-hand side of the **Configuration** tab. See the <u>Configuration Wizard</u> section for details.

Note any register information that is displayed in **RED** text indicates a nonvolatile burn error where the data read back after a burn does not match the expected value.

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		ommanu	is com	iguration Authentication	History						
	Register Data										
Configuration	Page 18h	Addr	Hex	Value	Page 1Ah	Addr	Hex	Value	Page 1Ch	Addr	Hex Value
Wizard	nXTable0	180	0x0000		nQRTable00	1A0	0x3C00		nVAlrtTh	1C0	0x0000
Launch	nXTable1	181	0x0000		nQRTable10	1A1	0x1B80		nTAIrtTh	1C1	0x0000
	nXTable2	182	0x0000		nQRTable20	1A2	0x0B04		nSAlrtTh	1C2	0x0000
There are this many	nXTable3	183	0x0000		nQRTable30	1A3	0x0885		nlAlrtTh	1C3	0x0000
updates remaining:	nXTable4	184	0x0000		nCycles	1A4		0.01 Cycles	nUser1C4	1C4	0x0000
6	nXTable5	185	0x0000		nFullCapNom	1A5	0x1130	2200.00 mAh	nUser1C5	1C5	0x0000
	nXTable6	186	0x0000		nRComp0	1A6	0x1070		nFullSOCThr	1C6	0x0000
	nXTable7	187	0x0000		nTempCo	1A7	0x263D		nTTFCfg	1C7	0x0000
	nXTable8	188	0x0000		nlAvgEmpty	1A8	0xEED0		nCGain	1C8	0x0000
	nXTable9	189	0x0000		nFullCapRep	1A9	0x1130		nTCurve	1C9	0x0025
	nXTable10	18A	0x0000		nVoltTemp	144	0x0000		nTGain	1CA	0x0000
	nXTable11	18B	0x0000		nMaxMinCurr	1AB	0x807F		nTOff	1CB 1CC	0x0000
	nUser18C	18C	0x0000		nMaxMinVolt	1AC	0x00FF		nManfctrName0	100 10D	0x0000
	nUser18D	18D 18E	0x0000 0x0000		nMaxMinTemp	1AD 1AE	0x807F 0x0000	0.0.9/	nManfctrName1	1CD 1CE	0x0000 0x0000
	nODSCTh	18E	0x0000		nSOC	1AE 1AF	0x0000		nManfctrName2	1CE	0x03E8 10.0 mOhms
	nODSCCfg	181	0x0000		nTimerH	IAP	0x0000	0.000 nr	nRSense	ICF	0x03£8 10.0 mOnms
	Page 19h	Addr	Hex	Value	Page 1Bh	Addr	Hex	Value	Page 1Dh	Addr	Hex Value
	nOCVTable0	190	0x0000		nConfig	1B0	0x0000		nUser1D0	1D0	0x0000
	nOCVTable1	191	0x0000		nRippleCfg	1B1	0x0204		nUser1D1	1D1	0x0000
	nOCVTable2	192	0x0000		nMiscCfg	182	0x0000		nAgeFcCfg	1D2	0xD5E3
	nOCVTable3	193	0x0000		nDesignCap	1B3	0x1130	2200.00 mAh	nDesignVoltage	1D3	0x0000 0.000 V
	nOCVTable4	194	0x0000		nHibCfg	1B4	0x0000		nUser1D4	1D4	0x0000
	nOCVTable5	195	0x0000		nPackCfg	185	0xBC01		nRFastVShdn	1D5	0x0000
	nOCVTable6	196	0x0000		nRelaxCfg	1B6	0x0000		nManfctrDate	1D6	0x0000
	nOCVTable7	197	0x0000		nConvgCfg	187	0x2241		nFirstUsed	1D7	0x0000
	nOCVTable8	198	0x0000		nNVCfg0	1B8	0x0100		nSerialNumber0	1D8	0x0000
	nOCVTable9	199	0x0000		nNVCfg1	1B9	0x0006		nSerialNumber1	1D9	0x0000
	nOCVTable10	19A	0x0000		nNVCfg2	1BA	0xFF0A		nSerialNumber2	1DA	0x0000
	nOCVTable11	19B	0x0000		nSBSCfg	188	0x0002		nDeviceName0	1DB	0x0000
	nlChgTerm	19C	0x0000	0 mA	nROMID0	1BC	0x2426		nDeviceName1	1DC	0x0000
	nFilterCfg	19D	0x0000		nROMID1	1BD	0x0000		nDeviceName2	1DD	0x0000
	nVEmpty	19E	0x0000		nROMID2	1BE	0x0030		nDeviceName3	1DE	0x0000
	nLearnCfg	19F	0x2602		nROMID3	1BF	0xD500		nDeviceName4	1DF	0x0000

Figure 9. Configuration Tab

Authentication Tab

The **Authentication** tab allows the user to perform any action related to the SHA 256 authentication feature of the IC. Figure 10 shows the format of the **Authentication** tab. Each group box of the **Authentication** tab is described in detail in the following sections.

SHA Challenge/ROM ID

Enter values into the challenge registers directly or click the **Randomize Challenge** button to fill the challenge registers with a completely random value. The challenge value is not written to the IC until one of the **Compute MAC** buttons is clicked. The ROM ID is used in some SHA calculations so it is displayed here for reference.

SHA Secret

Enter the secret value here to allow software to verify the SHA calculations of the IC. The EV kit software updates

these values after a compute next secret command to what it believes the secret value should be. The secret value cannot be written directly or read from the IC. The secret value has a limited number of updates that are displayed in the changes remaining box. Note that once the secret is locked or if the number of remaining updates reaches 0, it can no longer be changed.

SHA Authentication Results

After a SHA operation occurs, the output is displayed in the **Reported MAC** column. The EV kit software calculates its own hash and displays the result in the **Expected MAC** column. If the results match, the operation is a success. If the results do not match, it is most likely because the secret inside the IC does not match the secret value entered into the EV kit software.

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delGauge m5 Graphs Registers Commands Configuration	Authentication History			
SHA Challenge / ROM ID		SHA Secret		
The 160 bit Challenge value must be written prior to a SHA Compu Challenge registers directly or click the Randomize Challenge but registers with a completely random value. The challenge value is n the Compute MAC buttons below is clicked. The ROM ID is alway updated.	ton to fill the challenge not written to the IC until one of	allow software to verify th display the expected new	e SHA calculations of the IC v secret value after any Clear tored in non-volatile memory	IC. Enter the expected secret value here to EV kit software will also calculate and Secret or Compute Next Secret command. and therefore is limited to 5 total Compute
Challenge2 0x0020 0x0000 Challenge3 0x0020 0x00000 Challenge4 0x0020 0x0000 Challenge5 0x0020 0x0000 Challenge5 0x0020 0x0000 Challenge6 0x0020 ROM	MID2 N/A 0x0010	Secret0 Secret2 Secret3 Secret4 Secret5 Secret6 Secret6 Secret6 Secret9	N/A 0xC523 N/A 0xB2E1 N/A 0xCFBE N/A 0xFD11 N/A 0xFD15 N/A 0x1782 N/A 0x1782 N/A 0x3785 N/A 0x3745	Clear Secret Lock Secret Secret Changes Remaining
SHA Authentication Results			Generate Challenge F	Response Pairs
Addr Reported Expected MAC0 0x0c0 0x964B 0x964B MAC1 0x0c1 0x641B 0x641B MAC2 0x0c2 0x4861 0x4861 MAC3 0x0c3 0x089B 0x889B	The Challenge is written to Page 0C of the four SHA authentication option Secret is unknown, authentication re The Secret can be entered manually the Clear Secret command.	is is selected below. If the sults cannot be verified.	pairs for use by the above. Enter the nur	rate a text file of valid challenge response and application using the Secret value nber of pairs to be generated below then re the results to a file.
MAC4 0x0C4 0x88A5 0x88A5 MAC5 0x0C5 0x01C9 0x01C9	Compute MAC with F		Nu	mber of Pairs to Generate
MAC6 0x0C6 0xC19B 0xC19B MAC7 0x0C7 0xD0DB 0xD0DB MAC8 0x0C8 0xB5AD 0xB5AD	Compute MAC without Compute Next Secret wi			Generate Pairs
MAC9 0x0C9 0x0C5B 0x0C5B MAC10 0x0CA 0xFDC7 0xFDC7	Compute Next Secret with	out ROM ID		
MAC11 0x0CB 0x7861 0x7861 MAC12 0x0CC 0x599E 0x599E MAC13 0x0CD 0x778D 0x778D	AUTHENTIC	ATION		
MAC14 0x0CE 0xF88C 0xF88C	SUCCES	SS		

Figure 10. Authentication Tab

Generate Challenge/Response Pairs

Some applications use challenge-response pairs to confirm battery pack authenticity instead of maintaining the secret on the host side. The EV kit software can generate a file of any length of random challenge-response pairs for use by the application. Ensure to have the correct secret entered before generating the pairs.

History Tab

The **History** tab allows the user to see all battery history logging information stored inside the IC. When the EV kit software is loaded, this page is blank. History information is not automatically read from the IC. The user must click either the **Read Battery History** button to display history data or the **Read History and Save to File** button to store history data in a tab delimited .csv file and then display the data. After history data has been read from the IC,

it is displayed to the user starting with page 1. Figure 11 shows the history tab format.

Each history page has a status of "BLANK" if it has not yet been written, "WRITTEN" if it contains good history data, or "SKIPPED" if the IC experienced a write error while storing the data. Each history page contains 16 words of data. The user can click through each of the 203 history pages or enter a page number directly into the box to jump to a certain page.

If a page has been written, all page data is displayed as hexadecimal values. Some history information can be converted into application units. Those locations contain one or two additional boxes of information showing the converted values. Value boxes can display "User Data" if that location has been configured to store user data instead of history information or "A.F. Data" if that location is being used for cycle+ age forecasting information.

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Logging History									
Ма	x Temp (°C) Min Temp	(°C)		Page Status:	WRITT	ΈN			
85.00				Register	Hex		Valu	ie(s)	
-40.00		Pages	20	nQRTable10 nQRTable20 nQRTable30 nFullCapNom nTempCo nIAvgEmpty nFullCapRep nVoltTemp nMaxMinCurr nMaxMinCurr nMaxMinTemp nSOC nTimerH	0x1880 0x0804 0x0885 0x0000 0x0888 0x1070 0x263D 0x0000 0x0808 0x0000 0x807F 0x00FF 0x807F 0x0000 0x8000	Total Cycles: Nominal Capacity: Capacity: Voltage: Max Current: Max Voltage: Max Temperature: MixSOC: Elapsed Time:	0.00 1.500 Ah 1.500 Ah 0.00 V -5.120 A 0.00 V -128 °C 0 % 0.0 Hr	Temperature: Min Current: Min Voltage: Min Temperature: VFSOC:	0 °C 5.080 A 5.10 V 127 °C 0 %

Figure 11. History Tab

The history information is also displayed in a graph on the left side of the tab. The graph displays data only from history pages that have been written by the IC. Click on the corresponding register name button to change the data shown by the graph.

ModelGauge m5 EZ Configuration

Before the IC accurately fuel gauges the battery pack, it must be configured with characterization information. This can be accomplished two ways.

The first is through a custom characterization procedure that can be performed by Maxim under certain conditions. The result is an .INI summary file that contains information that can be programmed into the IC using the **Configuration Wizard** tool. Contact Maxim for details on this procedure.

The second method is ModelGauge m5 EZ configuration. This is the default characterization information shipped inside every IC. This default model produces accurate results for most applications under most operating conditions. It is the recommended method for new designs as it bypasses the custom cell characterization procedure. Some additional information is required from the user for EZ configuration initialization. The **Configuration Wizard** tool handles this as well.

Evaluate: MAX17201/MAX17211

Configuration Wizard

The EV kit software contains a fuel gauge Configuration Wizard that can be launched either on the **Configuration** tab or from the **Device** drop-down menu. The Configuration Wizard is the recommended way to change any nonvolatile settings inside the IC. The wizard allows user to:

- Open a custom INI file or generate a ModelGauge m5 EZ configuration.
- Make any adjustments specific to the application.
- Load the final configuration into the IC.
- Export the generated configuration to a new INI file.

The Configuration Wizard walks users through an 18 step process to configure the IC. Figure 12 shows the first page of the wizard. Each step is detailed below. The user

can click the previous button in the bottom left corner of any page to return to any previous step if desired. Once the last step is completed, the wizard closes, the IC is configured, and a new INI file is saved (if selected).

Step 1: Starting the Template

Choose between the existing nonvolatile memory data already inside the IC or revert back to the factory default values (ModelGauge m5 EZ).

Step 2: Cell Model Selection

Choose between existing model already in the IC's nonvolatile memory, the ModelGauge m5 EZ model, or a custom model from an INI file by using the **Select File** button. Note that ModelGauge m5 EZ is recommended if a custom model is not available.

-		nory settings or revert back to factory default settings.					
	th existing nonvolatile memory data						
 Start wi 	th factory default values						
Step 2: Cell Mode	el Selection						
		figuration options. Either use the existing model information already stored in an .INI file, or use the ModelGauge m5 EZ Model.					
🔵 Do not	change model						
🔵 Use Mo	odelGauge m5 EZ model						
	1000 Cell Size (mAH) *Contact Maxim for special cell chemistries: Pana						
	3.3 • Empty Voltage (V)	NCR/NCA, LiMnO2, LiNiO2, LiTiO3, or LiFePO4					
	Charge voltage is greater than 4.275V						
Use cu:	stom model from .INI file						
Path:	C:\Users\Mike.Mltchell\Desktop\BC15B0	C25 INI Files\1522_1_042114_MAX17201.INI.txt					
Title:	1373_1_112413_MAX17201						
	Select File						

Figure 12. Configuration Wizard Steps 1 and 2

Step 3: General Pack Configuration

Select the configuration that most closely resembles the application circuit. The choice made in step 3 determines which options are available in step 4 as certain functions and ADC channels are not available in certain pack configurations.

Step 4: Specific Pack Configuration Details

Select the number of series cells in the pack configuration as well as which ADC channels are used to measure pack voltages. If Multicell Inside Protector configuration was selected in step 3, cell balancing is possible. The cell balancing threshold can be selected from the drop-down box. If the application has more than 15 cells in series, contact Maxim about configuration options.

Step 5: Shutdown Mode

Select the checkbox if the user intends for the IC to enter shutdown mode any time the battery pack is removed from the application (communication lines low).

Step 6: SBS Compliant Functionality

Select the checkbox if user intends to use IC in smart battery system (SBS) compliant mode. If SBS mode is not used, these device registers are available for general-purpose data storage in step 16. If SBS mode is enabled, all SBS-related configuration settings can be adjusted here.

Step 7: Sense Resistor Selection

Choose the value of the sense resistor to be used in the application. Also, select the resistor temperature compensation. Maxim recommends disabling temperature compensation when using a chip sense resistor. If using a PCB signal trace as the sense resistor, the default temperature coefficient value of 0.4% per °C is ideal for copper.

Step 8: Current Measurement Calibration (Optional)

Current measurement gain calibration is not required for proper operation of the fuel gauge. Perform this operation calibration step only if the application requires it. To calibrate current, first force a known current of at least one half the full-scale value through the sense resistor and enter that value into the **Forced Current** text box. When the Current register and AvgCurrent register readings become stable, the **Auto Calibrate** button is enabled to allow calibration to occur. Alternatively, the user can adjust gain manually by entering a value into the **Gain Adjust** text box. The default value for gain adjust is 1.000 or 100%.

Step 9: Temperature Measurement Channels

Select which temperature measurements are used by the application. Die temperature measurement is recommended for all applications. Die temperature measurements are enabled by default if no other measurement channels are enabled..

Step 10: Temperature Measurement Details

Selections made in step 9 determine which options are available in this step. The user must select which temperature input is used by the fuel gauge. See the nPack-Cfg register definition for details. If a thermistor channel is enabled then gain, offset, and curve scaling values must be used to convert the ADC reading to temperature. If the application uses a common thermistor type found in the pulldown menu, select that thermistor and the scaling values are automatically populated. If the application does not use one of these common thermistors, select other and enter the scaling values manually.

Step 11: Alert Configuration

Enable the desired alert conditions and then select the desired alert thresholds. Note that the current related alert thresholds scale based on the sense resistor selection from step 7.

Step 12: Overcurrent Detection

Choose the over-discharge (OD) and short-circuit (SC) detection settings for the application. Each can be enabled independently of other alerts. The user then selects a threshold and delay setting. Threshold values scale depending on the sense resistor selection from step 7.

Step 13: ALRT Pin Polarity

Choose between active high and active low for the ALRT pin's polarity. ALRT pin polarity is forced to active low if either OD or SC comparators are enabled.

Step 14: Cycle+ Age Forecasting

Enable age forecasting here and then choose the DeadTargetRatio and CycleStart for the age forecasting function. Note that if age forecasting is enabled, the nVolt-Temp and nSOC registers are used to store age forecasting information and are not available in step 15.

Step 15: Battery Life Logging

Enable or disable any of the registers used for Battery Life Logging. Any unchecked registers not otherwise used by age forecasting are available for general-purpose data storage during step 16. The **Cycles Per Save** box sets the rate at which cell history information is data logged by the IC.

Step 16: General-Purpose Data Storage

Configuration choices in steps 1–15 determine which registers are available for general-purpose data storage. The user can now enter any data they wish into any nongrey register location.

Evaluate: MAX17201/MAX17211

Step 17: Summary of Changes

After all desired nonvolatile configuration settings have been entered by the user, the table in step 17 shows a color-coded summary of how the nonvolatile memory settings are changed by the new configuration. Note the **Configuration Wizard** automatically converts any memory location that matches its alternate default value into general-purpose data storage. This can cause changes to the nNVCfg0 to nNVCfg2 registers not selected by the user, but does not affect IC operation. <u>Figure 13</u> shows an example of the Configuration Wizard summary table.

Step 18: Update IC and Save New Configuration

In the final step, the user is given options of how to use the new configuration. Figure 14 shows step 18 of the configuration wizard. Option one is to discard all changes which has no effect on the IC. Option two is to write configura-

Evaluate: MAX17201/MAX17211

tion shadow RAM and then restart firmware so that those changes take effect. This allows the user to experience the new operation of the IC without using one of the limited nonvolatile copies. Finally, option three writes the new configuration to the IC, burns the configuration into nonvolatile memory, and then restarts the IC so those changes take effect. This option is not available if the IC already used up all of the available configuration copies. Additionally, the user can store the new configuration options into a new INI file for easy programming of additional units. Select the desired path name for the new INI file.

The Configuration Wizard completes once the user clicks the **Done** button below step 18. The desired actions from step 18 occur after **Done** is clicked and the wizard closes. Click the window close button in the upper right corner of the wizard to exit at any time without performing any of the actions from step 18.

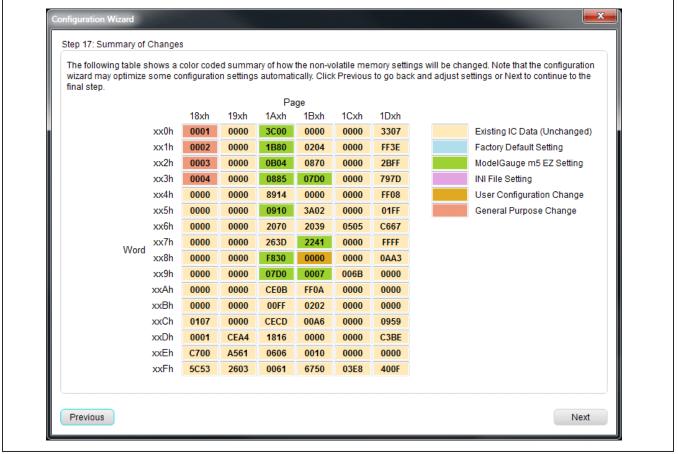


Figure 13. Configuration Wizard Step 17

Evaluate: MAX17201/MAX17211

non-volatile m non-volatile m	e new configuration is to be applied. Either discard the new configuration, write it to IC configuration RAM, or burn it to emory (if there are non-volatile writes remaining). Write to RAM only to test configuration settings without using up a emory write. Note that changing configuration settings will cause the fuel gauge to reset. The new configuration settings to a file regardless of programming option selected.
	configuration settings memory locations shown in blue have had their shadow RAM locations changed, but have not yet o non-volatile memory.
Memory locati burn that locat	ons shown in red indicate a NV burn failure. The data read back did not match the shadow RAM data before attempting to ion.
D	o not change configuration memory
w	rite configuration RAM and restart the fuel gauge so changes take effect. (Allows for testing configuration settings without using up a write cycle)
• W	rite new configuration to non-volatile memory and restart the fuel gauge. Configuration memory writes remaining: 6
🗸 Sa	ve new configuration settings to .INI file
	C:Wy New INI.INI
	Select Path

Figure 14. Configuration Wizard Step 18

Evaluate: MAX17201/MAX17211

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Murata Electronics North America, Inc.	770-436-1300	www.murata.com/en-us
TDK Corp.	847-803-6100	www.component.tdk.com
Vishay	402-563-6866	www.vishay.com

Note: Indicate that you are using the MAX17201/MAX17205/MAX17211/MAX17215 when contacting these component suppliers.

Ordering Information

PART	TYPE
MAX17201GEVKIT#	EV Kit
MAX17201XEVKIT#	EV Kit
MAX17211GEVKIT#	EV Kit
MAX17211XEVKIT#	EV Kit

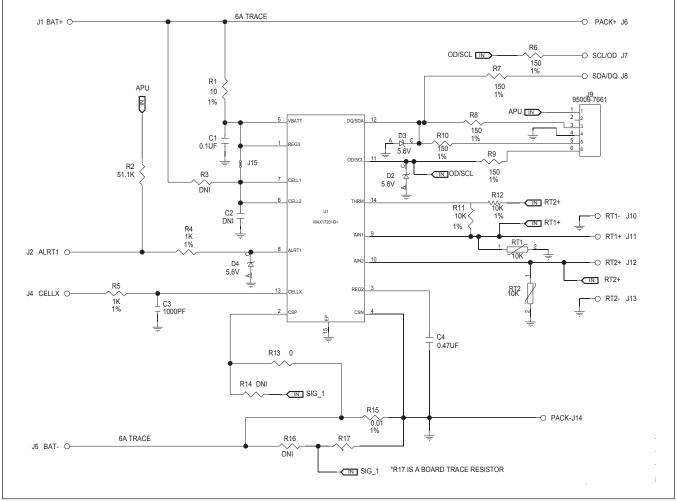
#Denotes RoHS compliant.

MAX17201G/MAX17211G Bill of Materials

PART	QTY	DESCRIPTION
C1	1	0.1uF ±10%, 50V X7R ceramic capacitor (0402)
C2	1	1000pF ±10%, 50V X7R ceramic capacitor (0402), not populated
C3	1	1000pF ±10%, 50V X7R ceramic capacitor (0402)
C4	1	0.47uF ±10%, 25V X5R ceramic capacitor (0402)
R1	1	10Ω ±1%, resistor (0402)
R2	1	51.1KΩ ±1%, resistor (0402)
R4, R5	2	1KΩ ±1%, resistor (0402)
R6-R10	5	150Ω ±1%, resistor (0402)
R11, R12	2	10kΩ ±1%, resistor (0402)
R13	1	0Ω resistor (0402)
R14	1	0Ω resistor (0402), not populated
R15	1	0.010Ω ±1%, resistor (0805)
R16	1	0Ω resistor (0805), not populated
RT1, RT2	2	Thermistor 10K NTC (0402) Murata NCP15XH103F03
D2-D4	2	5.6V Zener Diode (SOD323)
J1-J2, J4-J8, J10-J14	12	Plated through hole solder pad (16g wire)
19	1	RJ-11,R/A,6-POSITION/6-CONTACTS
J15	1	Exposed copper trace jumper
U1	1	MAX17201G/MAX17211G Li+ fuel gauge IC 3x3 TDFN 14 pin
	1	PCB: MAX17201EVKIT/MAX17211EVKIT
	1	USB-to-RJ11 board DS91230+
	1	RJ11 6pos-6pos reverse modular cord 6ft.

Evaluate: MAX17201/MAX17211

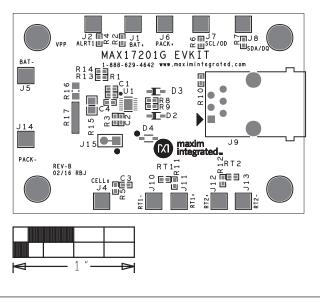
MAX17201G/MAX17211G Schematics

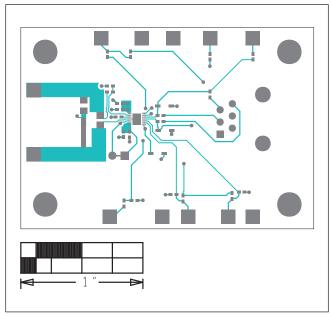


Note the schematic and layout are identical for the MAX17201G and MAX17211G EV kit boards. The only difference between boards is IC type and board name silkscreen. The MAX17201G is shown in the following figures.

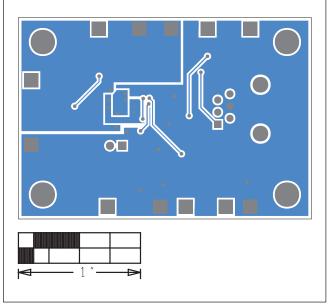
Evaluate: MAX17201/MAX17211

MAX17201G/MAX17211G PCB Layout





Component Placement



Bottom Layout

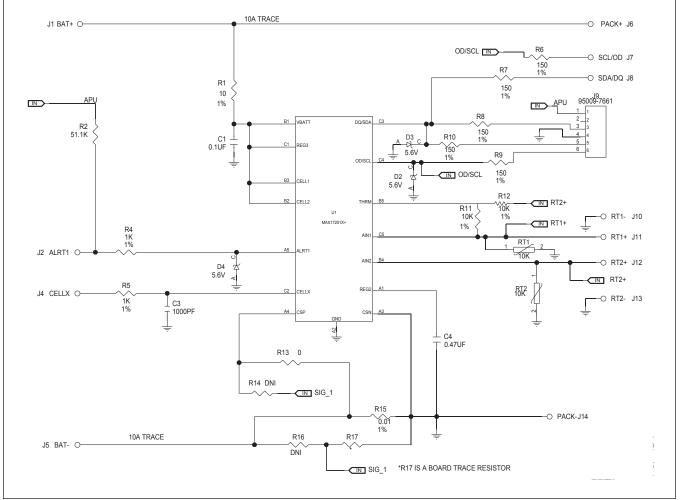
Top Layout

MAX17201X/MAX17211X Bill of Materials

PART	QTY	DESCRIPTION
C1	1	0.1uF ±10%, 50V X7R ceramic capacitor (0402)
C2	1	1000pF ±10%, 50V X7R ceramic capacitor (0402), not populated
C3	1	1000pF ±10%, 50V X7R ceramic capacitor (0402)
C4	1	0.47uF ±10%, 25V X5R ceramic capacitor (0402)
R1	1	10Ω ±1%, resistor (0402)
R2	1	51.1KΩ ±1%, resistor (0402)
R4, R5	2	1KΩ ±1%, resistor (0402)
R6-R10	5	150Ω ±1%, resistor (0402)
R11, R12	2	10kΩ ±1%, resistor (0402)
R13	1	0Ω resistor (0402)
R14	1	0Ω resistor (0402), not populated
R15	1	0.010Ω ±1%, resistor (0805)
R16	1	0Ω resistor (0805), not populated
RT1, RT2	2	Thermistor 10K NTC (0402) Murata NCP15XH103F03
D2-D4	2	5.6V Zener Diode (SOD323)
J1-J2, J4-J8, J10-J14	12	Plated through hole solder pad (16g wire)
19	1	RJ-11,R/A,6-POSITION/6-CONTACTS
J15	1	Exposed copper trace jumper
U1	1	MAX17201X/MAX17211X Li+ fuel gauge WLP 15 pin
	1	PCB: MAX17201XEVKIT/MAX17211XEVKIT
	1	USB-to-RJ11 board DS91230+
	1	RJ11 6pos-6pos reverse modular cord 6ft.

Evaluate: MAX17201/MAX17211

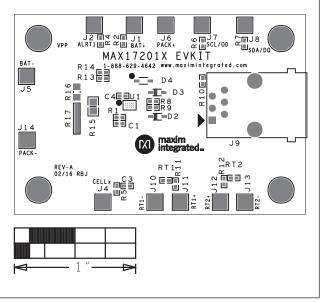
MAX17201X/MAX17211X Schematics

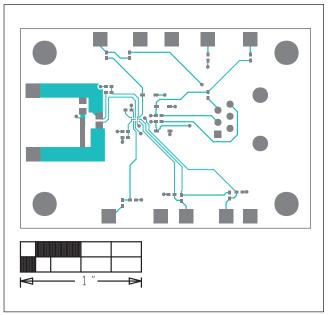


Note the schematic and layout are identical for the MAX17201X and MAX17211X EV kit boards. The only difference between boards is IC type and board name silkscreen. The MAX17201X is shown in the following figures.

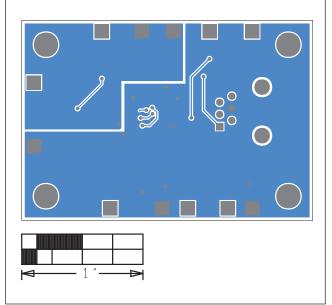
Evaluate: MAX17201/MAX17211

MAX17201X/MAX17211X PCB Layout





Component Placement



Bottom Layout

Top Layout

Evaluate: MAX17201/MAX17211

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/16	Initial release	—
1	4/16	Removed MAX17205/MAX17215 from EV kit	1–24

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.

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