Evaluate: MAX17201/MAX17211

MAX17201G/MAX17201X/ 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 <u>www.maximintegrated.com/evkitsoft-</u> <u>ware</u>. 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.

- 1) Visit <u>www.maximintegrated.com/evkitsoftware</u> 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
l 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 Figure 3. 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.

Data Logging: Off Communication: 1-Wire Mode: Hibernate Sense: 10.0 mOhms Device Serial Number: D50000300002426 Software:Firmware Rev: 2.0.0.1:10E1 READING

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

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.

File Device Help ModelGauge m5 Graphs rs Commands Configuration Authentication History Register Data 0xC1FC 3.880 V 0x09C8 1252.000 mAh 0x38EB 56.9 % VCell RepCap RepSOC By Data Type AvgVCell 0xC1A8 3.873 V QResidual 000 0x0042 33,000 mAh 0x62D4 98.8 % Age By Address VFOCV OFB 0xC1ED 3 879 V MixCap OOF 0x09C8 1252.000 mAh MixSOC 00D 0x396F 574% VRipple 0x001A 0.000 V FullCap 0x10EE 2167.000 mAh AvSOC 0x3846 56.3 % 0x1130 2200.000 mAh 0D1 0x0000 0.000 V 018 FullSocThr 013 0x5000 80.0 % AvaCell4 DesignCap AvgCell3 0D2 0x0000 0.000 V 01F 0x0987 1219.500 mAh 046 0x0190 25.0 % AvCap dPAcc 0x0000 0.000 V FullCapNom 0x1100 2176.000 mAh VFSOC 0x3922 57.1 % AvgCell2 0D3 023 OFF AvgCell1 0D4 0xC1C8 3.876 V FullCapRep 035 0x1130 2200.000 mAh AtAvSOC ODE 0x3840 56.3 % Cell4 0D5 0x0000 0.000 V dQAcc 045 0x0022 544.000 mAh 0D6 0x0000 0.000 V 04A 0x09BB 1245.500 mAh Cell3 VFRemCap Cell2 0D7 0x0000 0.000 V QH 04D OxFFFF -0.500 mAh Cell1 0D8 0xC1FC 3.880 V AtQResidual ODC 0x0042 33.000 mAh CellX 0D9 0x0000 0 000 V AtAvCap ODF 0x0986 1219.000 mAh Batt **ODA** 0x0C1F 3.879 V Temp 008 0x1704 23.0 °C AtRate 0x0000 0.000 mA FullCap 010 0x10EE 2167,000 mAh 0x170B 23.0 °C 00A 0x0004 0.625 mA 01D 0x2214 AvgTA Current Config 0x0B92 23.1 °C 134 0xFFF8 -1.250 mA 028 0x2602 Temp1 AvgCurrent OOE LearnCfg 135 0x0BA5 25.0 °C 01E 0x05BA 229.063 mA 0x0EA4 IntTemp IChgTerm FilterCfg 029 AvgTemp1 137 0x0B92 23.1 °C COff 02F 0x0000 0.000 RelaxCfg 02A 0x2039 0xEED0 -687.500 mA AvgIntTemp 138 0x0BA6 25.1 °C IAvgEmpty 036 MiscCfg 02B 0x3870 AvgTemp2 139 0x0B92 23.1 °C RComp0 038 0x0070 0x0B92 23.1 °C 0xFFFF 102.398 hr 13E TTE 0x263I Temp2 TempCo 039 0xFFFF 102.398 hr 0xA561 TTF 020 03A VEmpty Timer 03E 0x1043 0.203 hr FullSocThr 013 0x5000 80.0 % TimerH OBE 0x0000 0 000 hr IChgTerm 01E 0x05BA 229 063 mA ODD AtTTE 0xFFFF 102.398 hr QRTable00 0x3C00 0x1B8 QRTable10 022 0x0B04 QRTable20 032 042 0x0885 QRTable30 READING Sense: 10.0 mOhms Device Serial Number: D500003000002426 Data Logging: Off Communication: 1-Wire Mode: Hibernate Software:Firmware Rev: 2.0.0.1:10E1

Figure 6. Registers Tab

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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 Figure 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
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 SCUCOD in hind no 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 if the IC has been completely power cycled. Full Reset
1-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.
Reads or Writes a single register location. Valid register addresses are any location from 0 through 1FF. Use the full 9 bit address below and the software will automatically convert based on communication mode. Register 000 h Write	Burn NV Block
	Lock Register Blocks To lock any of the five memory blocks, click the corresponding button below. Note this is a permanent
Data 0082 h Read	operation that cannot be reversed.
Les Data to File	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 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 Figure 9, 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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odelGauge m5 🛛 Grap	hs Registers C	ommand	is Conf	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
here are this many	nXTable3	183	0x0000		nQRTable30	1A3	0x0885		nlAirtTh	1C3	0x0000
updates remaining:	nXTable4	184	0x0000		nCycles	1A4	0x0000	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	1AA	0x0000		nTGain	1CA	0x0000
	nXTable11	18B	0x0000		nMaxMinCurr	1AB	0x807F		nTOff	1CB	0x0000
	nUser18C	18C	0x0000		nMaxMinVolt	1AC	0x00FF		nManfctrName0	100	0x0000
	nUser18D	18D	0x0000		nMaxMinTemp	1AD	0x807F		nManfctrName1	1CD	0x0000
	nODSCTh	18E	0x0000		nSOC	1AE	0x0000		nManfctrName2	1CE	0x0000
	nODSCCfg	18F	0x0000		nTimerH	1AF	0x0000	0.000 hr	nRSense	1CF	0x03E8 10.0 mOhms
	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	184	0x0000		nUser1D4	1D4	0x0000
	nOCVTable5	195	0x0000		nPackCfg	185	0xBC01		nRFastVShdn	1D5	0x0000
	nOCVTable6	196	0x0000		nRelaxCfg	186	0x0000		nManfctrDate	1D6	0x0000
	nOCVTable7	197	0x0000		nConvgCfg	187	0x2241		nFirstUsed	1D7	0x0000
	nOCVTable8	198	0x0000		nNVCfg0	188	0x0100		nSerialNumber0	1D8	0x0000
	nOCVTable9	199	0x0000		nNVCfg1	189	0x0006		nSerialNumber1	1D9 1DA	0x0000
	nOCVTable10	19A	0x0000		nNVCfg2	1BA 1BB	0xFF0A		nSerialNumber2		0x0000
	nOCVTable11	19B	0x0000	0 -= 0	nSBSCfg	188 18C	0x0002		nDeviceName0	1DB 1DC	0x0000
	nlChgTerm	19C 19D	0x0000 0x0000	0 mA	nROMID0	1BC 1BD	0x2426 0x0000		nDeviceName1	1DC 1DD	0x0000 0x0000
	nFilterCfg	19D 19E	0x0000		nROMID1	1BD 1BE	0x0000		nDeviceName2	1DD 1DE	0x0000
	nVEmpty	19E	0x0000		nROMID2	1BE 1BF	0x0030		nDeviceName3	1DE 1DF	0x0000
	nLearnCfg	195	0X2002		nROMID3	TPL	0x0500		nDeviceName4	101	040000

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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	ands Configuration	Authentication History			
SHA Challenge / ROM ID			SHA Secret		
The 160 bit Challenge value must be writt Challenge registers directly or click the R registers with a completely random value the Compute MAC buttons below is click updated.	andomize Challenge but . The challenge value is	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. EV ki secret value after any Clear Secre	ter the expected secret value here to : software will also calculate and t or Compute Next Secret command. refore is limited to 5 total Compute
AddrHexChallenge00x0C00x0D1Challenge10x0C20x0D2Challenge20x0C20x0D2Challenge40x0C40x0C3Ox0D1Challenge50x0C50x0D1Challenge50x0C50x0D10x0D2Challenge60x0C50x0D10x0D2Challenge70x0C70x0D10x0D2Challenge80x0C60x0D10x0D2Challenge60x0C60x0D10x0D2	00 00 00 00 00 00 00 00 ROI 00 ROI 00 ROI 00 ROI 00 ROI 00 ROI 00 ROI 00 ROI 00 ROI 00 ROI 00 ROI 00 ROI 00 00 ROI 00 00 ROI 00 00 ROI 00 00 00 00 00 00 00 00 00 00 00 00 00	MID0 N/A 0x00A6 MID1 N/A 0x0000 MID1 N/A 0x0000 MID2 N/A 0x6750	Secret0 Secret2 Secret2 Secret3 Secret5 Secret5 Secret7 Secret8 Secret9	N/A 0xCFBE N/A 0xFD11 N/A 0x37BE N/A 0x1782 N/A 0x3785 Se N/A 0x57AB	Clear Secret Look Secret cret Changes Remaining 4
SHA Authentication Results				Generate Challenge Respor	se Pairs
Addr Report MAC0 0x0c0 0x96 MAC1 0x0c1 0x64 MAC2 0x0c2 0x42 MAC3 0x0c3 0x88	4B 0x964B 1B 0x641B 61 0x4E61	The Challenge is written to Page 0 of the four SHA authentication optic Secret is unknown, authentication i The Secret can be entered manual the Clear Secret command.	ons is selected below. If the results cannot be verified.	pairs for use by the end ap	ext file of valid challenge response plication using the Secret value pairs to be generated below then results to a file.
MAC3 0x0C3 0x88 MAC4 0x0C4 0x88 MAC5 0x0C5 0x01	A5 0x88A5	Compute MAC with	ROM ID	Number o	f Pairs to Generate
MAC6 0x0C6 0xC1 MAC7 0x0C7 0xD0		Compute MAC without			
MAC8 0x0C8 0xB5 MAC9 0x0C9 0x0C	5B 0x0C5B	Compute Next Secret w		Ge	nerate Pairs
MAC10 0x0CA 0xFD	61 0x7861	AUTHENTIC			
MAC11 0x0CB 0x78 MAC12 0x0CC 0x59	9E 0x599E				

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					
Max Temp (°C)	Min Temp (°C)	Page Sta	tus: WRITT	EN	
85.00		Register	Hex 00 0x3C00	V	/alue(s)
-40.00	Pages	nQRTable nQRTable nQRTable nQRTable nCycles nFullCapN nRComp nTempCa nNv0Emp nFullCapN nVoITem nMaxMinC nMaxMinTe nMaxMinTe nSOC 20 nTimerH	10 0x1800 20 0x0804 0x0805 0x0805 0x0000 0x0880 0x0000 0x1070 0x0263D 0x263D 0x0000 0x263D 0x0000 0x0000 uur 0x807F 0x807F 0x8070 0x8070 0x8070	Total Cycles: 0.00 Nominal Capacity: 1.500 Al Capacity: 1.500 Al Voltage: 0.000 A Voltage: 0.000 V Max Current: 5.120 A Max Current: -5.128 °C Max Voltage: 0.000 V Max Temperature: -128 °C MixSOC: 0 % Elapsed Time: 0.0 Hr	A Temperature: 0 °C A Min Current: 5.080 A Min Voltage: 5.10 V

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.

The configurato	r can begin with either the ex	isting IC memory setting	gs or revert back to factory default settings.				
Start w	th existing nonvolatile memo	ory data					
 Start with 	th factory default values						
Step 2: Cell Mod	el Selection						
			options. Either use the existing model information already s or use the ModelGauge m5 EZ Model.	tored in			
🔵 Do not	change model						
Use Mo	odelGauge m5 EZ model						
	1000 Cell Size (mAH) *Contact Maxim for special cell chemistries: Panason						
	3.3 v Empty Volta	age (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\Des	ktop\BC15BC25 INI File	es\1522_1_042114_MAX17201.INI.bt				
Title:	1373_1_112413_MAX1720)1					
	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.

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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. Figure 13 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

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non-volatile m non-volatile m	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 o 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 location 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.
Do	not change configuration memory
W	ite configuration RAM and restart the fuel gauge so changes take effect. (Allows for testing configuration settings without using up a write cycle)
💿 Wi	ite 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://y New INLINI
	Select Path

Figure 14. Configuration Wizard Step 18

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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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