Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

General Description

The MAX17201/MAX17205/MAX17211/MAX17215 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 and the MAX17205 and MAX17215 are for multicell applications.

The MAX17201/MAX17205/MAX17211/MAX17215 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/evkitsoftware</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 from 1S to More Than 15S 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

MAX17201/MAX17205/MAX17211/ MAX17215 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

- MAX17201/MAX17205/MAX17211/MAX17215 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) For the MAX17205/MAX17215 only: Set the on-board switch SW1 to the proper position based on cell stack size. For 2S to 4S cell stacks set the switch to "2S to 4S" as indicated on the board. For cell stacks of 4S or larger set the switch to "multicell" as indicated on the board. Warning: The EV kit board can be damaged when connecting cell stacks higher than 4S if SW1 is in "2S to 4S" position.
- 6) Make connections to the EV kit board based on cell pack configuration as shown in the following figures. The load or charger circuit can be connected at this time as well. Figure 1 shows the connections for a 1S cell pack. The cell connects between the BAT- and BAT+ pads and the charger/load connect between the PACK- and PACK+ pads.

Figure 2 shows the connections for a 2S cell pack with a high-side protector. The lower cell connects between the B1N and B1P/B2P pads and the upper cell connects between the B1P/B2P pads and the BxP pad. The charger/load connects between the PACK-and PACK+ pads. Note B1P and B2P should always be connected together in this configuration.

Figure 3 shows the connections for a 3S cell pack with high-side protector. The lower cell connects between the B1N and B1P pads, the middle cell connects between the B1P and B2P pads, and the upper cell connects between the B2P and BxP pads. The charger/ load connects between the PACK- and PACK+ pads.

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

Figure 4 shows the connections for a 2S to 4S cell pack with low side protector. In this case, the protector circuit prevents connections to individual cells. The entire cell stack connects between the B1N and BxP pads. The charger/load connects between the PACK-and PACK+ pads.

Figure 5 shows the connections for a 4S or larger cell pack. The cell stack connects between the B1N and BxP pads. The positive side of the cell stack also connects to one of the four resistive voltage divider network inputs: B4P for a 4S stack, B6P for a 6S stack, B10P for a 10S stack, B12P for a 12S stack. The charger/load connects between the PACK- and PACK+ pads. If the application cell configuration is not 4S, 6S, 10S, or 12S a custom resistive voltage divider must be created to properly divide the stack voltage for measurement. See the MAX17201/MAX17205/ MAX17211/MAX17215 data sheet for details.

- 7) Connect the RJ-11 cable between the USB adapter and the EV kit board. The GUI software establishes communication automatically.
- 8) 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.

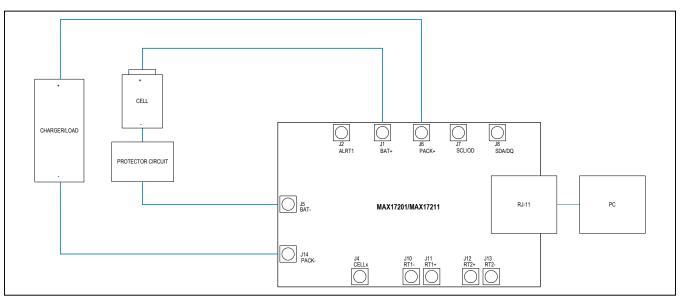


Figure 1. MAX17201/MAX17211 Board Connections

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

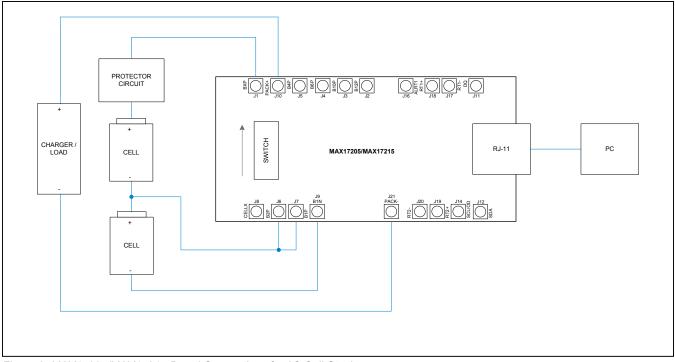


Figure 2. MAX17205/MAX17215 Board Connections for 2S Cell Stacks

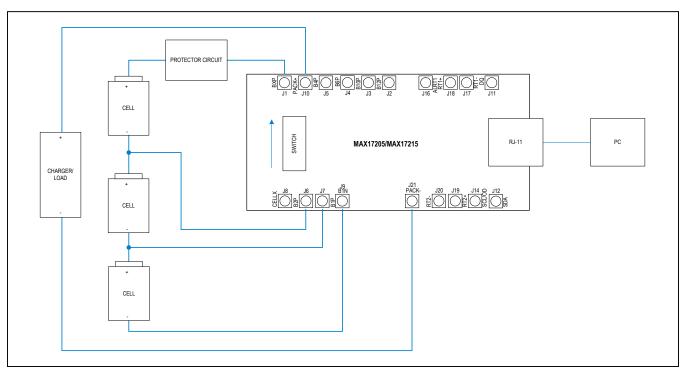


Figure 3. MAX17205/MAX17215 Board Connections for 3S Cell Stacks

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

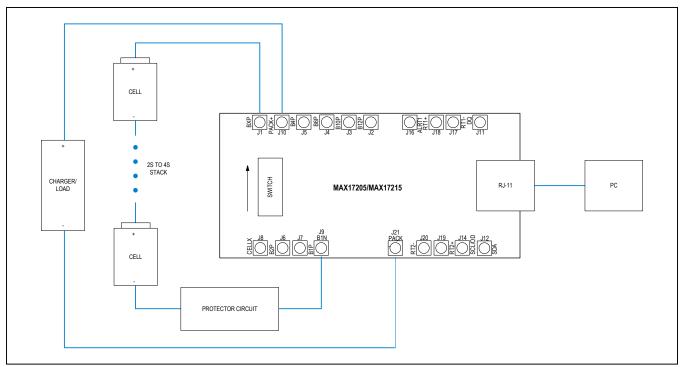


Figure 4. MAX17205/MAX17215 Board Connections for 2S to 4S Cell Stacks with Protector

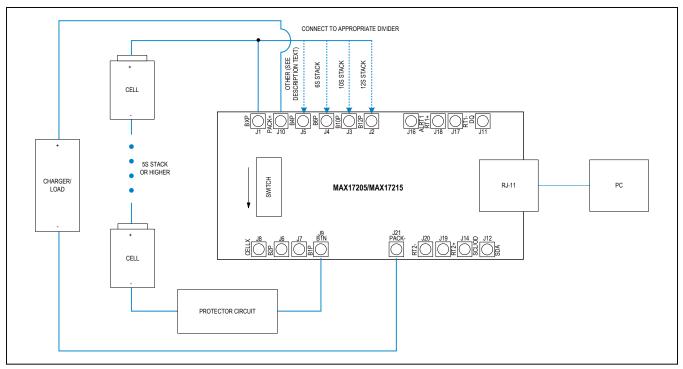


Figure 5. MAX17205/MAX17215 Board Connections for 5S or Larger Cell Stacks

Detailed Description of Hardware

The MAX17201/MAX17205/MAX17211/MAX17215 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.

Switch Setting (MAX17205/MAX17215 Only)

The mechanical switch labelled SW1 on MAX17205/ MAX17215 boards configures the voltage measurement inputs depending on the number of cells in the cell stack. When the switch is in the "2S to 4S" configuration, all voltage measurement pins are direct inputs to the IC. Resistors on CELL1 and CELL2 pins set the balancing current if cell balancing is enabled.

When SW1 is set to "multicell", the V_{BATT} pin voltage is limited to 18V maximum by an on-board regulator. The CELLx pin is connected to a resistive voltage divider to allow for the measurement of higher pack voltages. CELL2 controls the resistive voltage divider network to limit current and CELL1 is grounded and unused. <u>Table</u> <u>1</u> summarizes the settings for switch SW1. Note that regardless of switch setting, the IC must also be configured properly for the number of cells attached. See the *Configuration Wizard* section for details.

Regulator (MAX17205/MAX17215 Only)

When operating the board with a very high cell count (SW1 set to Multicell), a simple regulator circuit limits the voltage on the V_{BATT} pin to 18V. This regulator adds only a small amount of leakage current to the total circuit current load. The regulator can safely handle an input voltage of up to 60V.

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

Precision Resistive Voltage Divider (MAX17205/MAX17215 Only)

When operating the board with a very high cell count (SW1 set to multicell) the CELLx pin is connected to an external precision resistive voltage divider network to measure high voltage cell packs. The divider network has multiple connection points to properly divide the cell stack voltage for 4S, 6S, 10S, or 12S cell stacks. To measure other pack configurations, connect the cell stack to the B4P input and select a value for R5 using the following equation: $0.5M\Omega \times (N - 1)$ where N is the number of cells in the stack. 0.1% tolerance resistor are recommended.

The divider resistors have 0.1% tolerance ratings to have minimal impact on the accuracy of the CELLx measurement. The CELL2 pin controls an external FET to enable the resistor divider only during voltage measurement to limit current drain.

Cell Balancing Resistors (MAX17205/MAX17215 Only)

When operating the board with a 2S or 3S cell stack (SW1 set to 2S to 4S), the CELL1 and CELL2 pins provide direct input measurement of the middle voltage levels of the cell stack. CELL1 and CELL2 also shunt current to balance the cell's voltage levels if cell balancing is enabled. R10 and R11 control the balancing current in this mode. The default values of 100 Ω set the balancing current to ~40mA (~20mA for the middle cell of a 3S configuration). See the <u>Cell Balancing</u> section of the MAX17201/MAX17205/MAX17211/MAX17215 data sheet for further details.

Table 1. MAX17205/MAX17215 Switch Setting

SWITCH POSITION	V _{BATT} PIN	CELL1 PIN	CELL2 PIN	CELLX PIN
2S to 4S	Direct input	Direct input with balancing resistor	Direct input with balancing resistor	Direct input
Multicell	Regulated to 18V or lower	Ground	Resistive voltage divider control	Resistive voltage divider network

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

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 2</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/MAX17205/MAX17211/MAX17215 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

Table 2. Communication Line Solder Points

RT2 can be removed and replaced with leaded thermistors connected between the RT1+/RT1- and RT2+/RT2-solder pads.

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 3 and Table 4 summarize 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.

COMMUNICATION MODE	MAX17201 J7	MAX17201 J8	MAX17205 J14	MAX17205 J11	MAX17211 J7	MAX17211 J8	MAX17215 J14	MAX17215 J11
l ² C	SCL	SDA	SCL	SDA	N/A	N/A	N/A	N/A
1-Wire	N/A	N/A	N/A	N/A	Logic-low	DQ	Logic-low	DQ
1-Wire Overdrive	N/A	N/A	N/A	N/A	Logic-high	DQ	Logic-high	DQ

Table 3. 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)

Table 4. Sense Resistor Selection forMAX17205/MAX17215

COMPONENT	VALUE FOR CHIP SENSE	VALUE FOR BOARD TRACE SENSE
R23	0Ω	Not populated
R24	Not populated	0Ω
R20	Desired sense value	Not populated
R21	Not populated	0Ω (R22 is trace resistor)

Detailed Description of Software

The MAX17201/MAX17205/MAX17211/MAX17215 evaluation kit software gives the user complete control of all functions of the MAX17201/MAX17205/MAX17211/ MAX17215, 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

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

program menu. Figure 6 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 7. 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.

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.

maxim integrated.
💋 ModelGauge m5 Fuel Gauge
MAX17201/205/211/215 Evaluation Kit Version: 2.0.0.1 © 2015 Maxim Integrated Products, Inc. All rights reserved. Website: www.maximintegrated.com Support: support@maximintegrated.com
Disable Splash Screen OK

Figure 6. EV Kit Splash Screen

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 READING

Figure 7. EV Kit Bottom Status Bar

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 8 shows the format of the ModelGauge m5 Tab. Information is grouped by function and each is detailed separately.

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

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.

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.

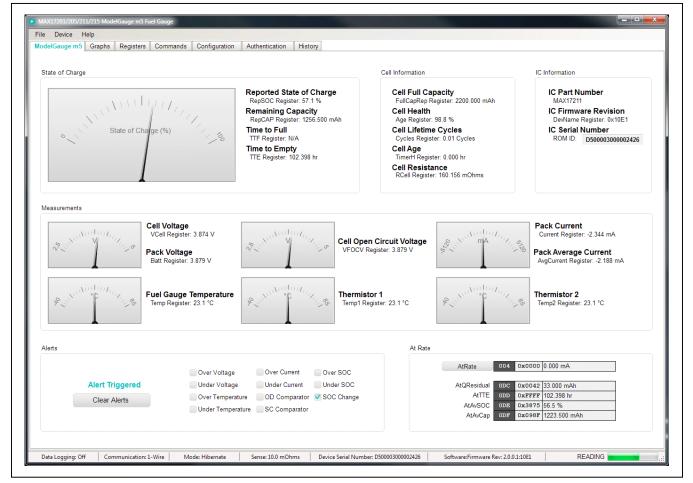


Figure 8. ModelGauge m5 Tab

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.

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

Graphs Tab

The **Graphs** tab displays up to 20 ADC readings and fuel gauge outputs. Figure 9 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.

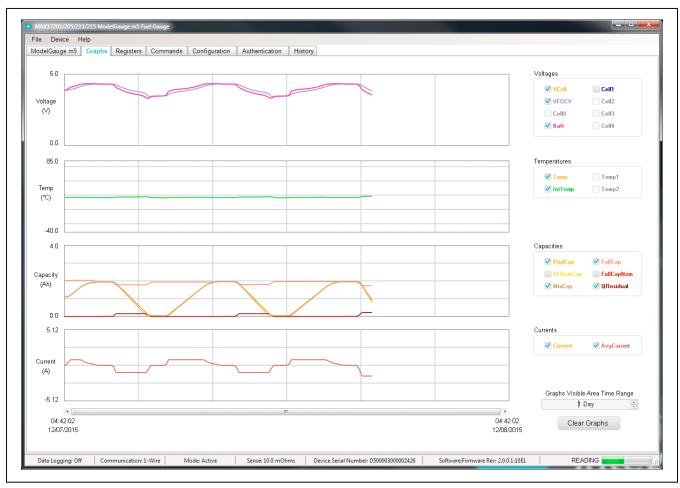


Figure 9. Graphs Tab

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

Registers Tab

The **Registers** tab allows the user access to all fuel gauge related registers of the IC. Figure 10 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.

e Device Help			10	1								
delGauge m5 Grap	ohs Registers C	ommand	s Confi	iguration Authentication	History							
	Register Data											
	Voltages	Addr	Hex	Value	Capacities	Addr	Hex	Value	Percentages	Addr	Hex	Value
By Data Type	VCell	009	0xC1FC		RepCap	005	0x09C8	1252.000 mAh	RepSOC	006	0x38EB	56.9 %
	AvgVCell	019	0xC1A8	3.873 V	QResidual	00C	0x0042	33.000 mAh	Age	007	0x62D4	98.8 %
By Address	VFOCV	OFB	0xC1ED	3.879 V	MixCap	00F	0x09C8	1252.000 mAh	MixSOC	00D	0x396F	57.4 %
	VRipple	0BC	0x001A	0.000 V	FullCap	010	0x10EE	2167.000 mAh	AvSOC	00E	0x3846	56.3 %
	AvgCell4	0D1	0x0000	0.000 V	DesignCap	018	0x1130	2200.000 mAh	FullSocThr	013	0x5000	80.0 %
	AvgCell3	0D2	0x0000	0.000 V	AvCap	01F	0x0987	1219.500 mAh	dPAcc	046	0x0190	25.0 %
	AvgCell2	0D3	0x0000	0.000 V	FullCapNom	023	0x1100	2176.000 mAh	VFSOC	OFF	0x3922	57.1 %
	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				
	Cell3	0D6	0x0000	0.000 V	VFRemCap	04A	0x09BB	1245.500 mAh				
	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	0DA	0x0C1F	3.879 V								
	Temperatures	Addr	Hex	Value	Currents/Timers	Addr	Hex	Value	Model	Addr	Hex	Value
	Temp	008		23.0 °C	AtRate	004		0.000 mA	FullCap	010	0x10EE	2167.000 mAh
	AvgTA	016	0x170B		Current	00A	0x0004	0.625 mA	Config	01D	0x2214	
	Temp1	134	0x0B92		AvgCurrent	00B	0xFFF8	-1.250 mA	LearnCfg	028	0x2602	
	IntTemp	135	0x0BA5		IChgTerm	01E			FilterCfg	029	0x0EA4	
	AvgTemp1	137	0x0B92		COff	02F	0x0000	0.000	RelaxCfg	02A	0x2039	
	AvgIntTemp	138	0x0BA6		IAvgEmpty	036	0xEED0	-687.500 mA	MiscCfg	02B	0x3870	
	AvgTemp2	139	0x0B92						RComp0	038	0x0070	
	Temp2	13B	0x0B92	23.1 °C	TTE	011		102.398 hr	TempCo	039	0x263D	
					TTF	020		102.398 hr	VEmpty	03A	0xA561	
					Timer	03E	0x1043		FullSocThr	013	0x5000	
					TimerH	OBE	0x0000		IChgTerm	01E	0x05BA	229.063 mA
					AtTTE	ODD	OxFFFF	102.398 hr	QRTable00	012	0x3C00	
									QRTable10	022	0x1B80	
									QRTable20	032	0x0B04	
									QRTable30	042	0x0885	

Figure 10. Registers Tab

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

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 11. 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.

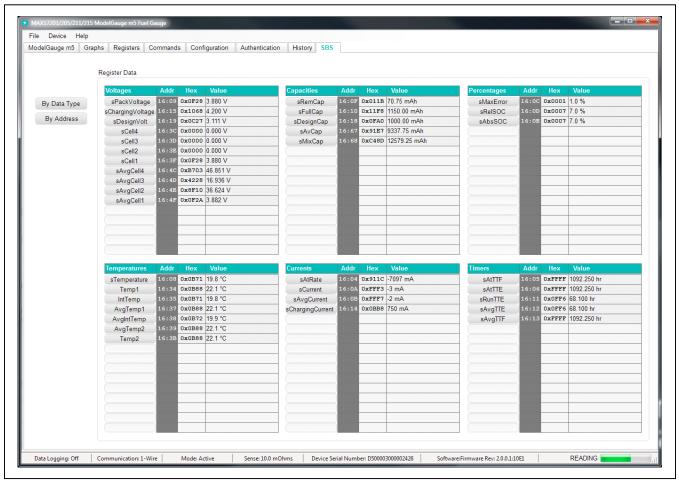


Figure 11. SBS Registers Tab

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

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 12 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 To reset the IC through software, first write 0x0000 to location 0x080, and then send the software
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	To reset the LC through software, first write voyout to location voyou, and then send the software Power-on-Reset (POR), command XoyOUF to the Command Register. The result will be the same as the IC has been completely power cycled. Full Reset
software and then drive the SCL/OD pin high or low as desired.	
I-Wire Communication Mode	Burn Non-Volatiile Memory Block
1-Wire Overdrive Communication Mode	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 th need to reset fuel gauge operation.
Read/Write Register	Burn NV Block
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.	Builling Block
Register 000 h Write	Lock Register Blocks
Data 0082 h Read	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	Set LOCK2 ModelGauge Register Pages 00 to 04, 0B, and 0D are Unlocked
IC registers will be stored in the selected logfile at the datalog interval using a .csv format. The datalog 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 12. 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

The user can log IC register information to file by clicking the **Start Log** button. The user is prompted to select a filename at this time. 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.

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 13</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.

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

	ohs Registers C	ommand	is Cont	figuration 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		nSAirtTh	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		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	0x000x0	
	nOCVTable1	191	0x0000		nRippleCfg	1B1	0x0204		nUser1D1	1D1	0x0000	
	nOCVTable2	192	0x0000		nMiscCfg	1B2	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	1B5	0xBC01		nRFastVShdn	1D5	0x0000	
	nOCVTable6	196	0x0000		nRelaxCfg	1B6	0x0000		nManfctrDate	1D6	0x0000	
	nOCVTable7	197	0x0000		nConvgCfg	1B7	0x2241		nFirstUsed	1D7	0x0000	
	nOCVTable8	198	0x0000		nNVCfg0	1B8	0x0100		nSerialNumber0	1D8	0x0000	
	nOCVTable9	199	0x0000		nNVCfg1	189	0x0006		nSerialNumber1	1D9	0x0000	
	nOCVTable10	19A	0x0000		nNVCfg2	1BA	0xFF0A		nSerialNumber2	1DA	0x0000	
	nOCVTable11	19B	0x0000		nSBSCfg	1BB	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 13. 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 14 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.

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

	nfiguration Authentication History			
SHA Challenge / ROM ID		SHA Secret		
The 160 bit Challenge value must be written prior to a Challenge registers directly or click the Randomize C registers with a completely random value. The challer the Compute MAC buttons below is clicked. The ROI updated.	Challenge button to fill the challenge nge value is not written to the IC until one of	allow software to verify the display the expected new	e SHA calculations of the secret value after any C	the IC. Enter the expected secret value here to IC. EV kit software will also calculate and ear Secret or Compute Next Secret command. $\eta\gamma$ and therefore is limited to 5 total Compute
Addr Hex Challenge1 0x000 0x0000 Challenge2 0x000 0x0000 Challenge3 0x000 0x0000 Challenge4 0x000 0x0000 Challenge4 0x000 0x0000 Challenge4 0x000 0x0000 Challenge5 0x000 0x0000 Challenge6 0x000 0x0000 Challenge7 0x0000 0x0000 Challenge8 0x000 0x0000	Randomize Challenge ROMID0 N/A 0x000A6 ROMID1 N/A 0x0000 ROMID2 N/A 0x0010 ROMID3 N/A 0x6750	Secret0 Secret1 Secret2 Secret3 Secret4 Secret5 Secret6 Secret6 Secret7 Secret8	N/A OxCFBE N/A 0xFD11 N/A 0x37BE N/A 0x1782 N/A 0x3785	Clear Secret Lock Secret Secret Changes Remaining
Challenge9 0x0C9 0x0000		Secret9	N/A 0x57AB N/A 0x37AB	
SHA Authentication Results		Secret9	N/A 0x37AB	le Response Pairs
SHA Authentication Results	xpected The Challenge is written to Pa		N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t	le Response Pairs enerate a text file of valid challenge response e end application using the Secret value
SHA Authentication Results Addr Reported E MAC0 0x0C0 0x964B 0	xpected The Challenge is written to Page 10x964B Oxfed1B Secret is unknown, authentication	ge 0Ch automatically when one options is selected below. If the tion results cannot be verified.	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response e end application using the Secret value number of pairs to be generated below then
SHA Authentication Results Addr Reported E MAC0 0x0c0 0x964B MAC1 0x0c1 0x641B	xpected The Challenge is written to Pagor 0x964B of the four SHA authentication 0x641B Secret is unknown, authentication 0x-secret The Secret can be entered ma	ge 0Ch automatically when one options is selected below. If the tion results cannot be verified.	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	le Response Pairs enerate a text file of valid challenge response e end application using the Secret value
Addr Reported E MAC0 0x000 0x964B 0x001 MAC1 0x001 0x641B 0x001 MAC2 0x002 0x4261 0x	xpected The Challenge is written to Page 0x964B of the four SHA authentication 0x641B The Secret is unknown, authenticate	ge 0Ch automatically when one options is selected below. If the tion results cannot be verified.	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response e end application using the Secret value number of pairs to be generated below then store the results to a file.
Addr Reported E MAC0 0x0c0 0x964B 0x0c1 0x641B 0x0c1 0x641B 0x0c2 0x4841B 0x0c2 0x4851 0x0c2 0x4892 0x0c2 0x8892 0x0c2 0x892 0x0c2 0x892 <t< td=""><td>xpected The Challenge is written to Pag 0x964B of the four SHA authentication 0x641B Secret is unknown, authentica 0x4B61 because the clear Secret command. 0x889A5 Compute MAC to the compute MAC to the clear Secret compute MAC</td><td>Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using</td><td>N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the</td><td>e Response Pairs enerate a text file of valid challenge response end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate</td></t<>	xpected The Challenge is written to Pag 0x964B of the four SHA authentication 0x641B Secret is unknown, authentica 0x4B61 because the clear Secret command. 0x889A5 Compute MAC to the compute MAC to the clear Secret compute MAC	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate
Addr Reported E MAC0 0x0C0 0x964B 0 MAC1 0x0C1 0x641B 0 MAC2 0x0c2 0x4851 0 MAC3 0x0c3 0x8895 0 MAC5 0x0c5 0x0129 0	xpected The Challenge is written to Pag 0x964B of the four SHA authentication 0x4851 Secret is unknown, authentica 0x889A5 The Secret can be entered ma 0x889A5 Corpute MAC to the M	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response e end application using the Secret value number of pairs to be generated below then store the results to a file.
Addr Reported E MAC0 0x0C0 0x964B E MAC1 0x0C1 0x641B E MAC2 0x0C2 0x481B E MAC3 0x0C2 0x4861 E MAC4 0x0C4 0x8885 E MAC4 0x0C5 0x0129 E MAC4 0x0C5 0x0129 E MAC6 0x0C6 0xC129B E	xpected The Challenge is written to Particle four SHA authentication 0x8964B of the four SHA authentication 0x4861 Secret is unknown, authentica 0x4861 The Secret can be entered mather 0x888A5 Compute MAC to 0x0129 0xc19B Compute MAC to 0x0129	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate
Authentication Results Addr Reported E MAC0 0x000 0x9643 0 MAC1 0x001 0x46418 0 MAC2 0x002 0x4851 0 MAC3 0x003 0x8892 0 MAC4 0x004 0x8845 0 MAC5 0x005 0x0109 0 MAC6 0x005 0x0109 0 MAC6 0x005 0x0198 0	xpected The Challenge is written to Pag of the four SHA authentication Secret is unknown, authentica Dx889E 0x4861 The Secret can be entered ma the Clear Secret command. 0x889E Compute MAC to Ox01C9 0xc19B Compute MAC to Ox10DB	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID thout ROM ID	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response ne end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate
Addr Reported E MAC0 0x000 0x964B 6 MAC1 0x001 0x641B 6 MAC2 0x002 0x4861 6 MAC2 0x002 0x4861 6 MAC2 0x002 0x8885 6 MAC4 0x002 0x012 6 MAC5 0x002 0x012 6 MAC5 0x002 0x012 6 MAC6 0x002 0x0012 6 MAC6 0x002 0x0012 6 MAC7 0x002 0x0012 6 MAC6 0x002 0x0012 6 MAC7 0x002 0x0012 6 MAC7 0x002 0x0012 6	xpected The Challenge is written to Particle 0x964B of the four SHA authentication 0x484E1 Secret is unknown, authentication 0x88950 Secret is unknown, authentication 0x88950 Compute Address 0x60205 Compute MAC with the Clear Secret Address 0x20026 Compute MAC with the Compute MAC with the Clear Secret Address 0x80450 Compute MAC with the Clear Secret Address	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID thout ROM ID	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate
Addr Reported E MAC0 0x000 0x964B 0 MAC1 0x001 0x641B 0 MAC2 0x002 0x4861 0 MAC3 0x002 0x4851 0 MAC4 0x004 0x8835 0 MAC5 0x005 0x0159 0 MAC6 0x005 0x0159 0 MAC6 0x005 0x0159 0 MAC6 0x005 0x0159 0 MAC6 0x005 0x0159 0 MAC8 0x005 0x0159 0 MAC8 0x005 0x0159 0	xpected The Challenge is written to Page 0x9564B of the four SHA authentication 0x641B Secret is unknown, authentica 0x4861 The Secret can be entered mather Clear Secret command. 0x889A5 Ox01C9 0x201C9 Compute MAC with Compute MAC with Compute MAC with Compute Next Secret Compute	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID thout ROM ID ret with ROM ID	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response ne end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate
Addr Reported E MAC0 0x00C0 0x964B 0x00C1 MAC1 0x00C1 0x641B 0x00C1 MAC2 0x00C2 0x484B 0x00C1 MAC3 0x00C3 0x8892 0x00C1 MAC4 0x00C4 0x088A5 0x00C9 MAC5 0x00C5 0x00C9 0x0129 0x00C9 MAC6 0x00C6 0x0129 0x00C9 0x00DB 0x00C9 MAC6 0x00C6 0x00C9 0x00C9 0x00C5B 0x00C9 0x00C5B 0x00C9 MAC10 0x00C4 0xx8D40 0x00C4 0x00C4 0x8D40 0x00C4 0x8D40 0x00C4 0x8D40 0x00C4 0x8D40 <td>xpected The Challenge is written to Page 0x8964B of the four SHA authentication 0x641B Secret is unknown, authentica 0x4861 The Secret can be entered mather 0x88845 Compute MAC to 0x00129 Compute MAC to 0x0025B Compute Next Secret 0x0025B Compute Next Secret</td> <td>Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID thout ROM ID ret with ROM ID</td> <td>N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the</td> <td>e Response Pairs enerate a text file of valid challenge response ne end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate</td>	xpected The Challenge is written to Page 0x8964B of the four SHA authentication 0x641B Secret is unknown, authentica 0x4861 The Secret can be entered mather 0x88845 Compute MAC to 0x00129 Compute MAC to 0x0025B Compute Next Secret 0x0025B Compute Next Secret	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID thout ROM ID ret with ROM ID	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response ne end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate
Authentication Results Addr Reported E MAC0 0x000 0x964B 0 MAC1 0x001 0x441B 0 MAC2 0x002 0x4851 0 MAC3 0x003 0x889E 0 MAC4 0x004 0x88451 0 MAC5 0x004 0x88451 0 MAC6 0x004 0x8845 0 MAC6 0x004 0x8845 0 MAC6 0x004 0x8845 0 MAC6 0x004 0x8845 0 MAC7 0x004 0x8540 0 MAC8 0x004 0x8540 0 MAC10 0x007 0x005 0x005 MAC10 0x00A 0x2650 0x005	xpected The Challenge is written to Pag of the four SHA authentication Secret is unknown, authentica 0x48845 0x48845 The Scret can be entered ma the Clear Secret command. 0x88945 Compute MAC to 0x0109 0x1019 Compute MAC to 0x0D0B 0x805AD Compute MAC to 0x000B 0x805AD Compute Next Secret 0x90761	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID thout ROM ID ret with ROM ID t without ROM ID	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response ne end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate
Addr Reported E MAC0 0x0C0 0x964B 0 MAC1 0x0c1 0x641B 0 MAC2 0x0c2 0x4861 0 MAC2 0x0c2 0x4861 0 MAC3 0x0c2 0x4861 0 MAC4 0x0c4 0x0c4 0x1c9 MAC5 0x0c5 0x01c9 0 MAC6 0x0c6 0x0c19 0 MAC6 0x0c7 0x0D0B 0 MAC6 0x0c6 0x0c5B 0 MAC6 0x0c6 0x0c5B 0 MAC10 0x0c9 0x0c5B 0 MAC11 0x0c9 0xc598 0 MAC12 0x0c0 0xc598 0	xpected The Challenge is written to Pag 0x964B othe four SHA authentication 0x484E1 The Scretz can be entered ma 0x8895 the Clear Secret command. 0x88045 Compute MAC to the Compute MAC to the Compute MAC to the Compute MAC to the Compute Next Secret Co	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID thout ROM ID ret with ROM ID t without ROM ID	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response ne end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate
Addr Reported E MAC0 0x0c0 0x964B E MAC1 0x0c1 0x641 E MAC2 0x0c1 0x641B E MAC3 0x0c2 0x4861 E MAC3 0x0c2 0x4851 E MAC4 0x0c4 0x8885 E MAC5 0x0c5 0x01c9 E MAC6 0x0c5 0x01c9 E MAC6 0x0c5 0x01c9 E MAC6 0x0c5 0x01c9 E MAC6 0x0c5 0x055 E MAC6 0x0c5 0x055 E MAC6 0x0c5 0x055 E MAC10 0x0c5 0x055 E MAC11 0x0c5 0x7861 E MAC13 0x0c5 0x780 E	xpected The Challenge is written to Pag of the four SHA authentication Secret is unknown, authentica 0x48845 0x48845 The Scret can be entered ma the Clear Secret command. 0x88945 Compute MAC to 0x0109 0x1019 Compute MAC to 0x0D0B 0x805AD Compute MAC to 0x000B 0x805AD Compute Next Secret 0x90761	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID thout ROM ID tet with ROM ID tt without ROM ID TICATION	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response ne end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate
Addr Reported E MAC0 0x0c0 0x964B E MAC1 0x0c1 0x641 E MAC2 0x0c2 0x481B E MAC3 0x0c2 0x481B E MAC4 0x0c4 0x8885 E MAC4 0x0c5 0x0c19 E MAC6 0x0c6 0xc19B E MAC6 0x0c6 0x259D E MAC6 0x0c6 0x0c55 E MAC710 0x0c7 0x0c599E E MAC11 0x0c7 0x7861 E MAC13 0x0c7 0x778D E	xpected The Challenge is written to Pag of the four SHA authentication Secret is unknown, authentica backaba 0x4861 The Secret can be entered ma the Clear Secret command. 0x8885 Compute MAC to 0x019B 0x203B Compute MAC to 0x005B 0x805C Compute Next Secret Compute Next Secret 0x7861 0x57861	Secret9 ge 0Ch automatically when one options is selected below. If the tion results cannot be verified. nually or reset to all 0's using with ROM ID thout ROM ID tet with ROM ID tt without ROM ID TICATION	N/A 0x37AB Generate Challeng The EV kit can g pairs for use by t above. Enter the	e Response Pairs enerate a text file of valid challenge response ne end application using the Secret value number of pairs to be generated below then store the results to a file. Number of Pairs to Generate

Figure 14. 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 15 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.

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

	Read Battery History	Read History and Save to File		Display His	story Data	a from Page:	1	* -
ogging His	story							
	Max Temp (°C) Min Temp (°C)		Page Status	: WRIT	EN		
85.00				Register	Hex		Valu	ue(s)
				nQRTable00	0x3C00		van	
				nQRTable10	0x1B80			
				nQRTable20	0x0B04			
				nQRTable30	0x0885			
				nCycles	0x0000	Total Cycles:	0.00]
				nFullCapNom	0x0BB8	Nominal Capacity:	1.500 Ah	1
				nRComp0	0x1070			
				nTempCo	0x263D			
				nlAvgEmpty	0x0000	Average Current:	0.000 A	
				nFullCapRep	0x0BB8	Capacity:	1.500 Ah	
				nVoltTemp	0x0000	Voltage:	0.00 V	Temperature: 0 °C
				nMaxMinCurr	0x807F	Max Current:	-5.120 A	Min Current: 5.080 A
				nMaxMinVolt	0x00FF	Max Voltage:	0.00 V	Min Voltage: 5.10 V
				nMaxMinTemp	0x807F	Max Temperature:	-128 °C	Min Temperature: 127 °C
-40.00	1	Pages	20	nSOC	0x0000	MixSOC:	0 %	VFSOC: 0 %
		rayes	20	nTimerH	0x0000	Elapsed Time:	0.0 Hr]

Figure 15. 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.

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

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 16 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.

Configuration Wizard		
		settings or revert back to factory default settings.
	h existing nonvolatile memory data	
 Start wit 	h factory default values	
Step 2: Cell Mode	I Selection	
the IC's non-vola	tile memory, load new model data from an .IN	ation options. Either use the existing model information already stored in Il file, or use the ModelGauge m5 EZ Model.
Do not c	hange model	
Use Mo	delGauge m5 EZ model	
	1000 Cell Size (mAH)	*Contact Maxim for special cell chemistries: Panasonic
	3.3 v Empty Voltage (V)	NCR/NCA, LiMnO2, LiNiO2, LiTiO3, or LiFePO4
	Charge voltage is greater than 4.275V	
 Use cus 	tom model from .INI file	
Path:	C:\Users\Mike.Mltchell\Desktop\BC15BC251	NI Files\1522_1_042114_MAX17201.INI.txt
Title:	1373_1_112413_MAX17201	
	Select File	
		Next

Figure 16. 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

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

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 forecast-ing 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.

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 17 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 18 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 the IC configuration shadow RAM only. This does not use one of the limited nonvolatile copies and does not change

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

the functional operation of the IC. Option three is to write configuration 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 four 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.

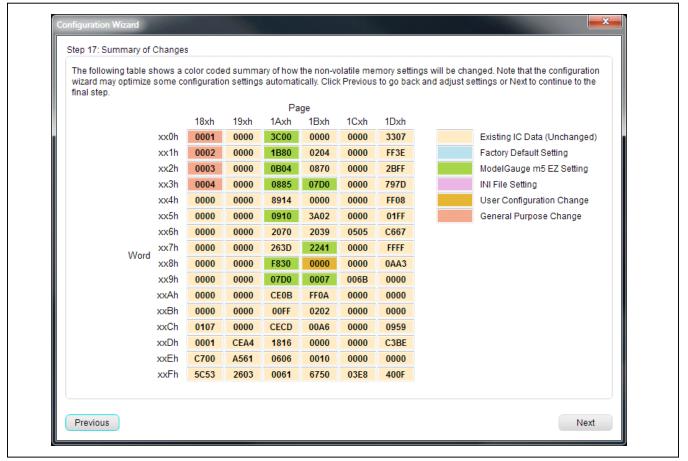


Figure 17. Configuration Wizard Step 17

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

non-volatile memoi non-volatile memoi	configuration is to be applied. Either discard the new configuration, write it to IC c y (if there are non-volatile writes remaining). Write to RAM only to test configuration y write. Note that changing configuration settings will cause the fuel gauge to rese le regardless of programming option selected.	n settings without using up a
After changing conf been burned to nor	iguration settings memory locations shown in blue have had their shadow RAM lo -volatile memory.	ocations changed, but have not yet
Memory locations s burn that location.	hown in red indicate a NV burn failure. The data read back did not match the shac	dow RAM data before attempting to
🔵 Do not	change configuration memory	
Write co	nfiguration RAM Only. Does not restart the fuel gauge.	
💿 Write co	nfiguration RAM and restart the fuel gauge so changes take effect.	
Write n	ew configuration to non-volatile memory and restart the fuel gauge.	
	Configuration memory writes remaining: 4	
🗸 Save ne	ew configuration settings to .INI file	
C	My new INLINI	
	Select Path	

Figure 18. Configuration Wizard Step 18

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

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.

Component List, Schematics, and PCBs

See the following links for the components, schematics, and PCBs.

Note the schematic and layout are identical for the MAX17201 and MAX17211 EV kit boards. The only difference between boards is IC type and board name silk-screen. The MAX17201 is shown in the following figures.

Note the schematic and layout are identical for the MAX17205 and MAX17215 EV kit boards. The only difference between boards is IC type and board name silk-screen. The MAX17205 is shown in the following figures.

- <u>MAX17201/MAX17211 BOM</u>
- MAX17201/MAX17211 schematics
- <u>MAX17201/MA17211 PCB</u>
- <u>MAX17205/MAX17215 BOM</u>
- MAX17205/MAX17215 schematics
- MAX17205/MAX17215 PCB

Ordering Information

PART	TYPE
MAX17201GEVKIT#	EV Kit
MAX17205GEVKIT#	EV Kit
MAX17211GEVKIT#	EV Kit
MAX17215GEVKIT#	EV Kit

#Denotes RoHS compliant.

Evaluates: MAX17201/MAX17205/ MAX17211/MAX17215

Revision History

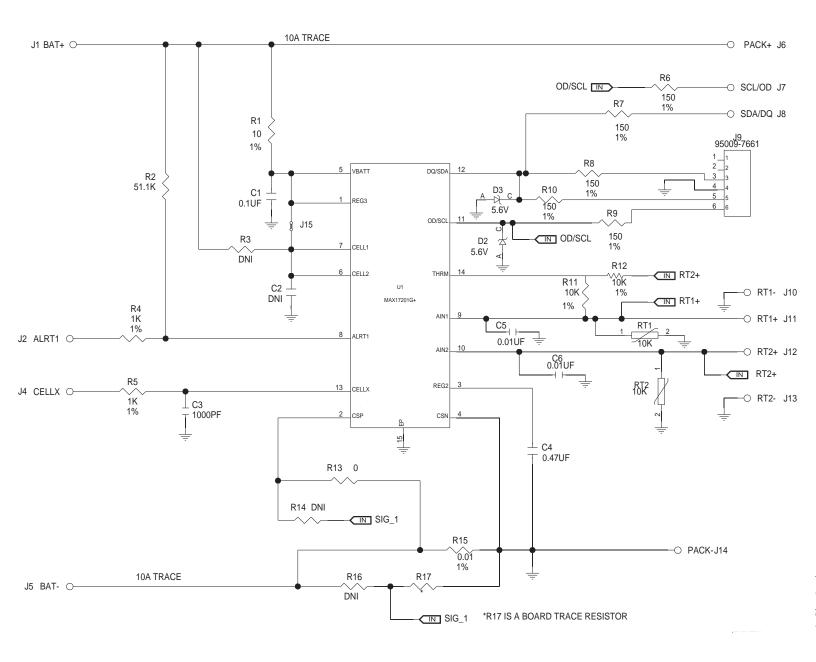
REVISION	REVISION	DESCRIPTION	PAGES
NUMBER	DATE		CHANGED
0	3/16	Initial release	—

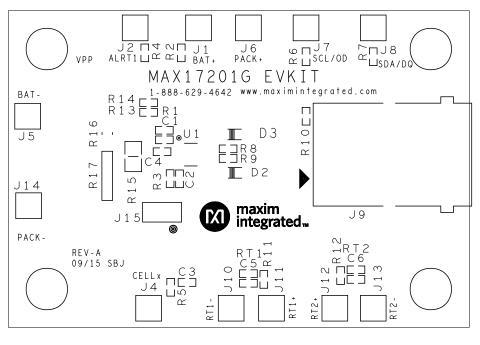
For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

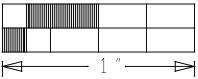
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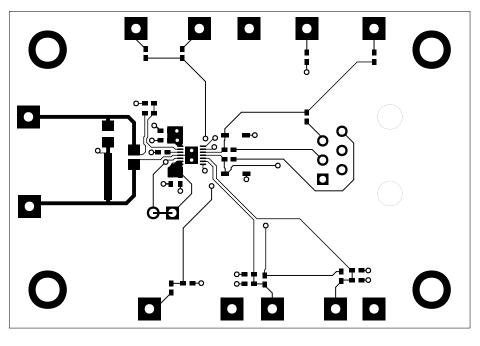
MAX17201 BILL OF MATERIALS REV 0; 2/16

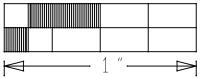
PART	QTY	DESCRIPTION
C1	1	0.1uF ±10%, 50V X7R ceramic capacitor (0402)
C2	1	1000pF ±10%, 50V X7R ceramic capacitor (0402), not populated
C3	1	1000pF ±10%, 50V X7R ceramic capacitor (0402)
C4	1	0.47uF ±10%, 25V X5R ceramic capacitor (0402)
C5, C6	2	0.01uF ±10%, 25V X7R ceramic capacitor (0402)
R1	1	10Ω ±1%, resistor (0402)
R2	1	51.1KΩ ±1%, resistor (0402)
R3	1	$50\Omega \pm 1\%$, resistor (0402), not populated
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, D3	2	5.6V Zener Diode (SOD323)
J1-J2, J4-J8, J10-J14	12	Plated through hole solder pad (16g wire)
J9	1	RJ-11,R/A,6-POSITION/6-CONTACTS
J15	1	Exposed copper trace jumper
U1	1	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.

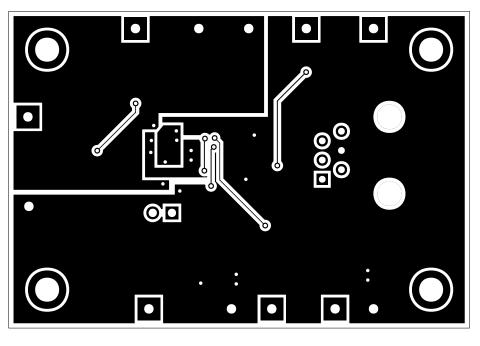


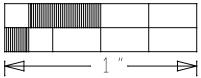






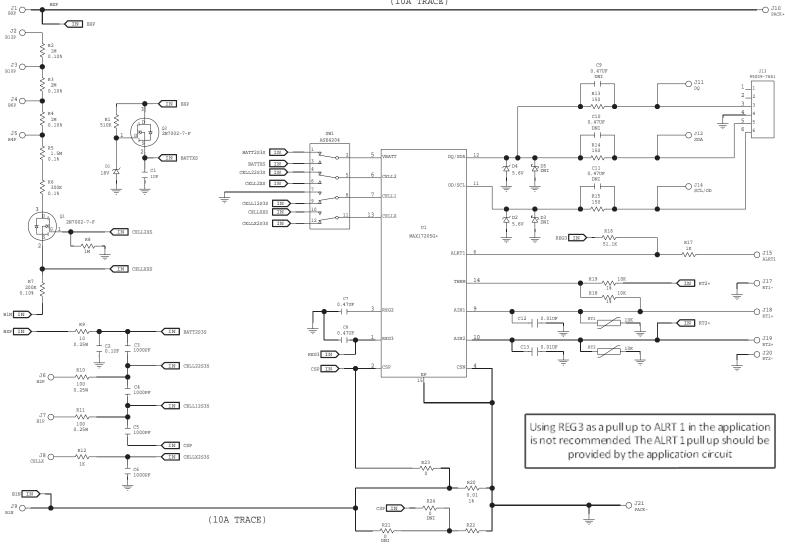




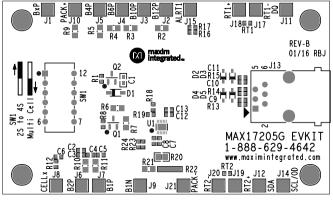


MAX172015 BILL OF MATERIALS REV 0; 2/16

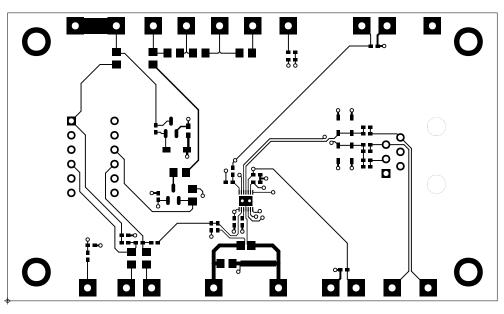
PART	QTY	DESCRIPTION
C1	1	1uF ±20%, 25V X5R ceramic capacitor (0603)
C2	1	0.1uF ±10%, 50V X7R ceramic capacitor (0402)
C3-C6	4	1000pF ±10%, 50V X7R ceramic capacitor (0402)
C7, C8	2	0.47uF ±10%, 25V X5R ceramic capacitor (0402)
C9-C11	3	0.47uF ±10%, 25V X5R ceramic capacitor (0402), not populated
C12, C13	2	0.01uF ±10%, 25V X7R ceramic capacitor (0402)
R1	1	510KΩ ±5%, resistor (0402)
R2, R4	2	1MΩ ±0.1%, resistor (0805)
R3	1	2MΩ ±0.1%, resistor (0805)
R5	1	1.5MΩ ±0.1%, resistor (0805)
R6	1	300KΩ ±0.1%, resistor (0805)
R7	1	200KΩ ±0.1%, resistor (0805)
R8	1	1MΩ ±1%, resistor (0402)
R9	1	10Ω ±5%, resistor (0805)
R10, R11	2	100Ω ±5%, resistor (0805)
R12, R17	2	1KΩ ±1%, resistor (0402)
R13-R15	3	150Ω ±1%, resistor (0402)
R16	1	51.1KΩ ±1%, resistor (0402)
R18, R19	2	10kΩ ±1%, resistor (0402)
R20	1	0.010Ω ±1%, resistor (0805)
R21	1	0Ω resistor (0805), not populated
R23	1	0Ω resistor (0402)
R24	1	0Ω resistor (0402), not populated
RT1, RT2	2	Thermistor 10K NTC (0402) Murata NCP15XH103F03
D1	1	18V Zener Diode (SOD123)
D2, D4	2	5.6V Zener Diode (SOD323)
D3, D5	2	Schottky Diode (SOD323), not populated
Q1, Q2	2	2N7002 FET (SOT-23)
SW1	1	Switch block 4PDT
J1-J12,J14,J16-J21	19	Plated through hole solder pad (16g wire)
J13	1	RJ-11,R/A,6-POSITION/6-CONTACTS
U1	1	Li+ fuel gauge IC 3x3 TDFN 14 pin
	1	PCB: MAX17205EVKIT/MAX17215EVKIT
	1	USB-to-RJ11 board DS91230+
	1	RJ11 6pos-6pos reverse modular cord 6ft.

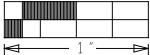


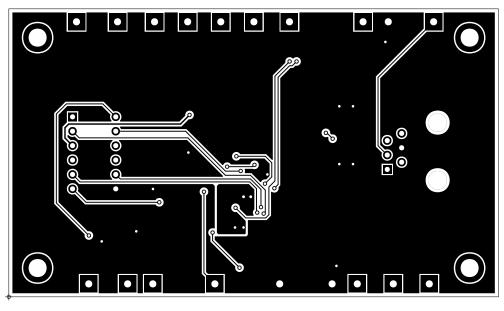
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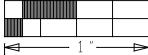














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