

# Evaluation Kit Description

Rev. 1.00 / February 2013

# ZSPM4521

High-Efficiency Photovoltaic Charger for Li-Ion Batteries



*Power and Precision*





### Restrictions:

Zentrum Mikroelektronik Dresden AG's ZSPM4521 Evaluation Kit is designed for evaluation of the ZSPM4521, laboratory setup, and module development only. This kit must not be used for module production and production test setups.

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For more information, contact ZMDI via [Analog@zmdi.com](mailto:Analog@zmdi.com).



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## 1 Kit Contents

- ZSPM4521 Evaluation Board (EVB)
- USB to I<sup>2</sup>C™\* Cable
- Startup Information

## 2 Introduction

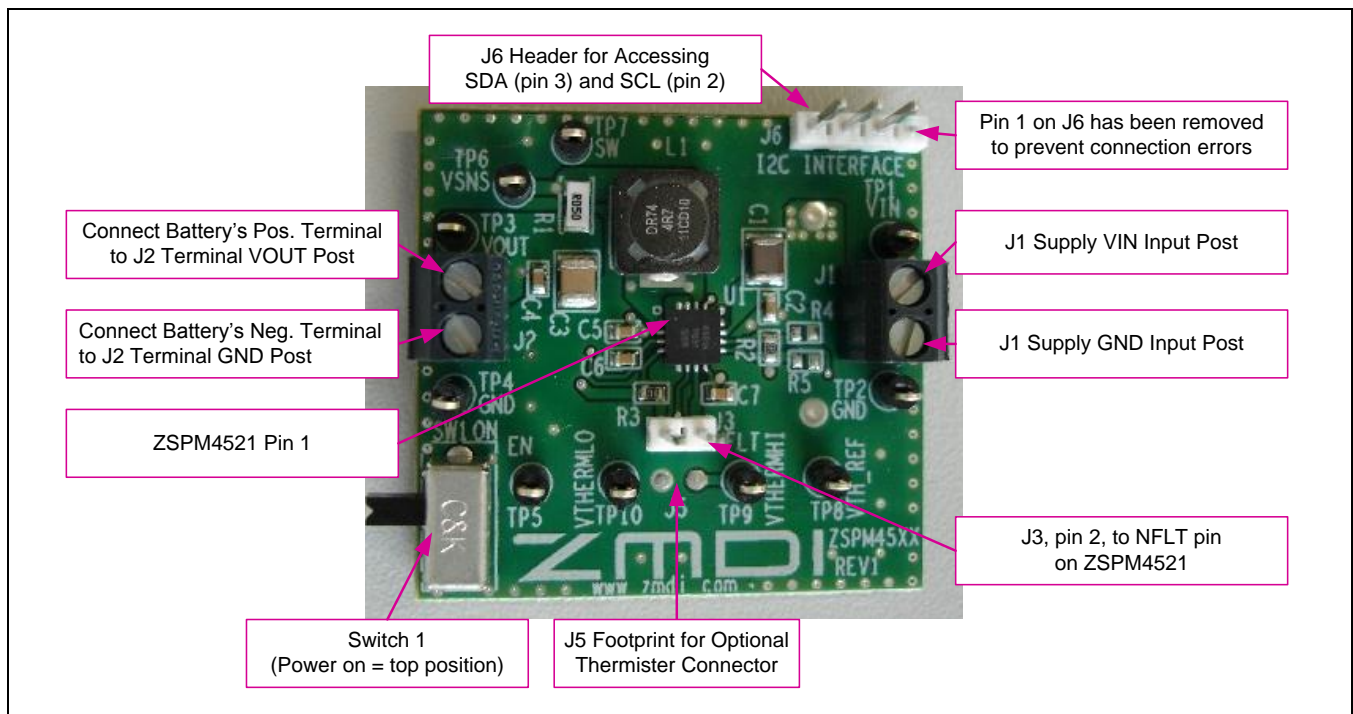
The ZSPM4521 Evaluation Board (EVB) contains the ZSPM4521 High-Efficiency Photovoltaic Battery Charger integrated circuit with recommended external components and test points (see Figure 2.1). The ZSPM4521 enables a complete battery charging system using a photovoltaic cell.

Key parameters of the battery charger are

- Battery: lithium ion or lithium polymer, 3.7V rated cell
- Photovoltaic voltage input: 4V to 7.2V

**Important:** Ensure that the power switch is in the off position (move to lower position when board is oriented as shown in Figure 2.1) when connecting hardware as labeled on the EVB.

**Figure 2.1 Overview of ZSPM4521 Evaluation Board**



\* I<sup>2</sup>C™ is a trademark of NXP.



### 3 General Overview

#### 3.1 Default Settings

The EVB is preset to have a 1.0A maximum charging current, 4.12V termination voltage, 100mA pre-charge current, and 100mA end-of-charge current. These parameters are adjustable and can be customized to a specific system optimization and stored in EEPROM memory through the I<sup>2</sup>C™\* interface. With the default settings, the charging current and termination voltage are independent of battery temperature. However, these parameters can be set via EEPROM settings to automatically adjust based on the battery temperature in order to meet the JEITA charging standard. Details of the I<sup>2</sup>C™ interface and register programming can be found in the ZSPM4521 datasheet.

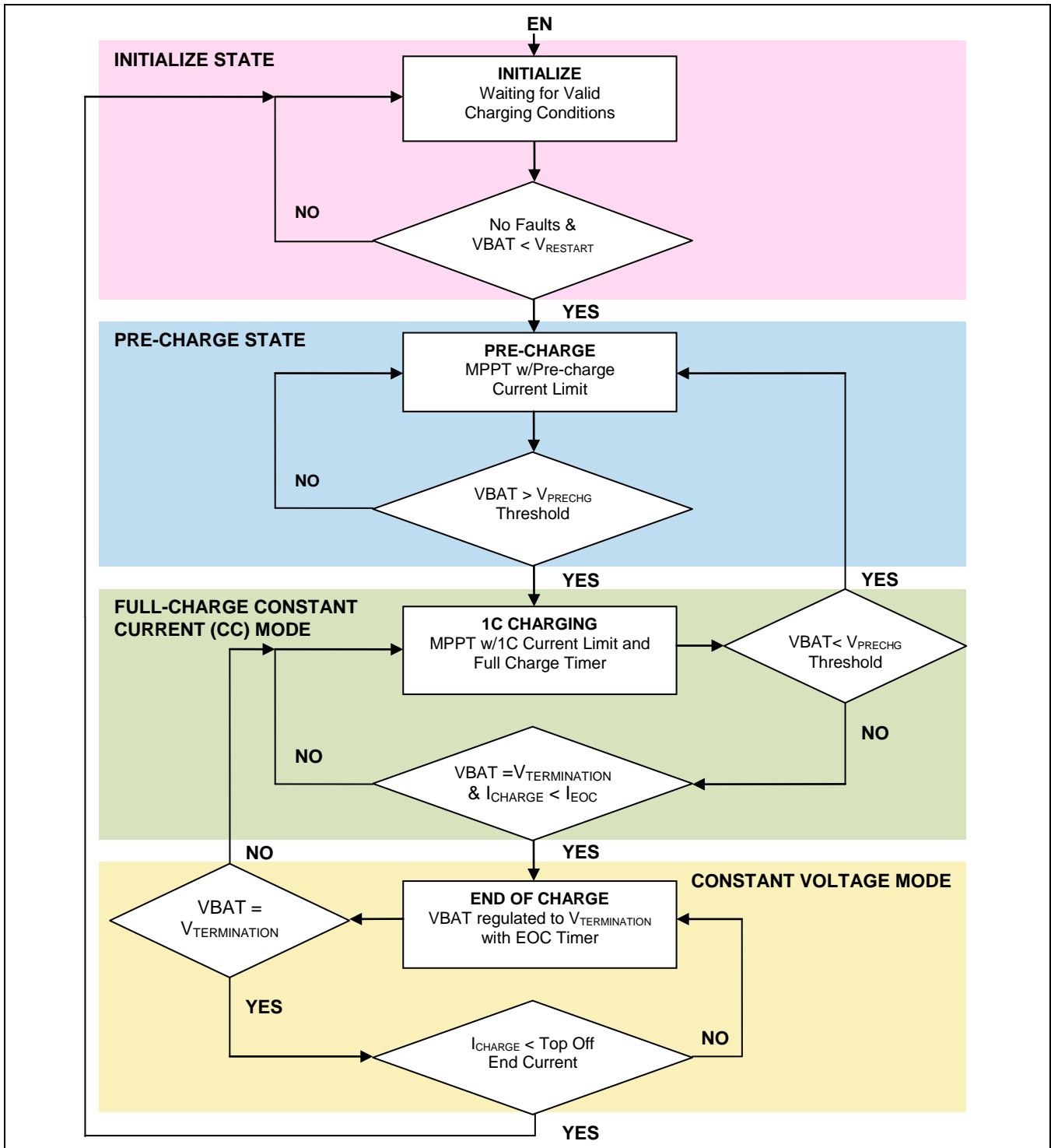
The SDA and SCL nodes for I<sup>2</sup>C™ communication are accessible via the J6 header pins (see Figure 2.1). If the EVB's default ZSPM4521 configuration settings are desired, no I<sup>2</sup>C™ operation is needed.

Operating the ZSPM4521 EVB is straightforward. Once the Li-ion battery and input voltage are properly connected as described in section 4.1, simply set switch SW1 to the ON position (see Figure 2.1), which starts the charging of the battery.

\* I<sup>2</sup>C™ is a trademark of NXP.



Figure 3.1 Charging State Diagram





## 4 Connectors and Test Points

### 4.1. Board Connectors

The board contains the following connectors for external signals and supplies:

- J1:** The input supply voltage for the board, which is controlled by the ZSPM4521 to charge the battery.
- J2:** Output voltage from the charger.
- J3:** **Pin 2** – Open drain output for the ZSPM4521's NFLT pin (see ZSPM4521 data sheet for details).
- J5:** Battery temperature sensor / thermistor input (optional).
- J6:** I<sup>2</sup>C™ connector. Pin 4 is next to "J6 I2C" on ZSPM4521 Evaluation Board (Figure 2.1)
- VDD** – pin 1 (Note this pin has been removed to avoid erroneous connections that could damage the board.)
- SCL** – pin 2
- SDA** – pin 3
- GND** – pin 4

### 4.2. Test and Probe Points

The board contains the following test/probe points:

- TP3 (VOUT):** Kelvin test point for VBAT+ (VOUT) to the positive battery terminal.
- TP4 (GND):** Kelvin test point for the negative battery terminal and ground for the EVB.
- TP7 (SW):** Switching node test point (SW pin on the ZSPM4521).
- TP6 (VSNS):** Sense voltage test point (VSENSE pin on the ZSPM4521).
- TP5 (EN):** Enable pin test point (EN pin on the ZSPM4521).
- TP8 (VTH\_REF):** VTH\_REF test point.
- TP9 (VTHERMHI) / TP10 (VTHERMLO):** Respectively, the positive and negative Kelvin connection test points for thermistor for measuring battery temperature.





## 5 Setup

Important: Follow these guidelines when connecting a DC input and battery to the ZSPM4521 Evaluation Board (see Figure 2.1).

- **Battery:** Connect the terminals of the battery to the EVB's J2 terminal so that the "+" battery terminal is connected to the J2 post marked "VOUT" and the "-" battery terminal is connected to GND of J2 (post nearest test point TP4).
- **Supply:** Connect the supply voltage to the Evaluation Board's J1 terminal so that the positive rail is connected to the J1 post marked "VIN" and the ground or negative rail is connected to GND of J1 (post nearest test point TP2).
- **Battery Thermistor:** The J5 connector is unpopulated by default so that the user can determine the type of connection if using the battery thermistor feature. Connect the positive terminal of the thermistor for sensing battery temperature to the Evaluation Board's V THERM HI connector on J5. Connect the negative terminal of the thermistor to the board's V THERM LO connector on J5, which is also the common ground on the board.
- **Important:** Be sure to apply power to the ZSPM4521 EVB and set the EVB power switch to the "ON" position prior to using the GUI.

## 6 Installing the Graphical User Interface (GUI) for the ZSPM4521

Follow these steps to create a user account on ZMDI's website and download the GUI:

- Go to [www.ZMDI.com](http://www.ZMDI.com), and create a user name and login following instructions given on the site.
- Place the cursor over the "PRODUCTS" tab, and select Smart Power Management from the drop-down menu.
- Click on ZSPM4521 on the secondary drop-down menu.
- Under the "SOFTWARE" heading, click on "ZSPM45xx Programmer" to download the GUI as a zip file.

Next, extract the files in the downloaded ZIP file, and click on *ZSPM45xx\_Programmer.exe*. Follow the installation wizard to complete the installation.

## 7 Installing Drivers for FTDI USB/ I<sup>2</sup>C™ Cable

If using Windows® 7 or later, install the drivers for the FTDI USB/ I<sup>2</sup>C™ cable by simply connecting the cable to the USB port on the computer and allowing the operating system to use Windows® Update to download and install the required drivers.

If using an older version of Windows® or if the method above is unsuccessful for automatically installing the drivers, refer to section 2.1 of the cable manufacturer's datasheet for supported drivers and download instructions:

[http://www.ftdichip.com/Support/Documents/DataSheets/Cables/DS\\_C232HM\\_MPSSE\\_CABLE.PDF](http://www.ftdichip.com/Support/Documents/DataSheets/Cables/DS_C232HM_MPSSE_CABLE.PDF). This document also provides a user guide for the cable.

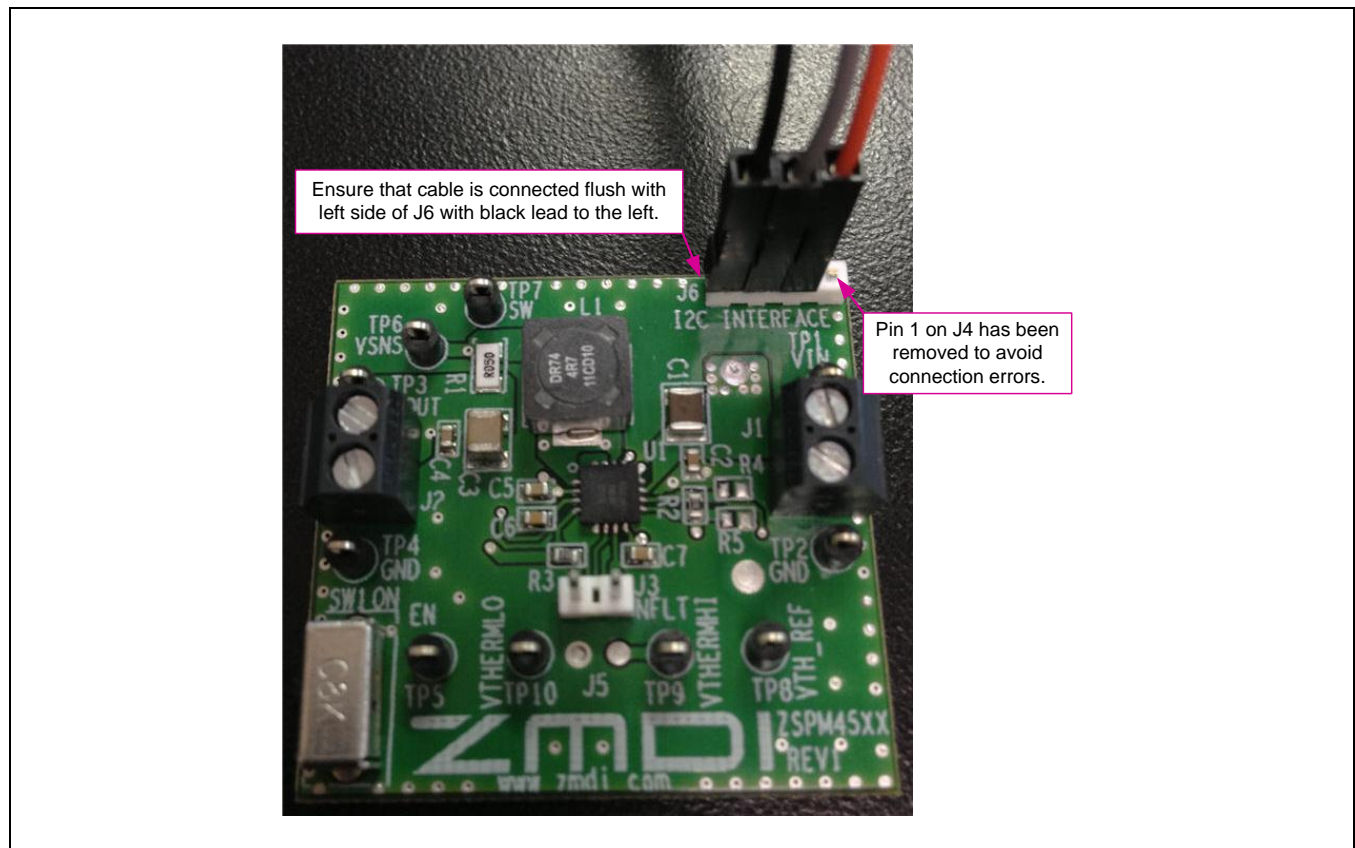




## 8 Connecting the FTDI Cable to ZSPM4521 Eval Board:

Connect the female connector of the FTDI USB/ I<sup>2</sup>C™ cable to J6 of ZSPM4521 Evaluation Board being careful to use the orientation shown in Figure 8.1. The order of the leads in the cable from left to right is black, gray, and then orange. Note that the last pin on the right on J6 has been removed to ensure that no accidental connections can be made, which would damage the board.

**Figure 8.1** Connecting the FTDI USB/ I<sup>2</sup>C™ Cable to J6





## 9 I<sup>2</sup>C™ Programming GUI Overview

ZSPM4521 GUI enables the user to communicate with the ZSPM4521 EVB, monitor status bits, and change settings. It is also designed to accommodate all ZSPM45xx family ICs.

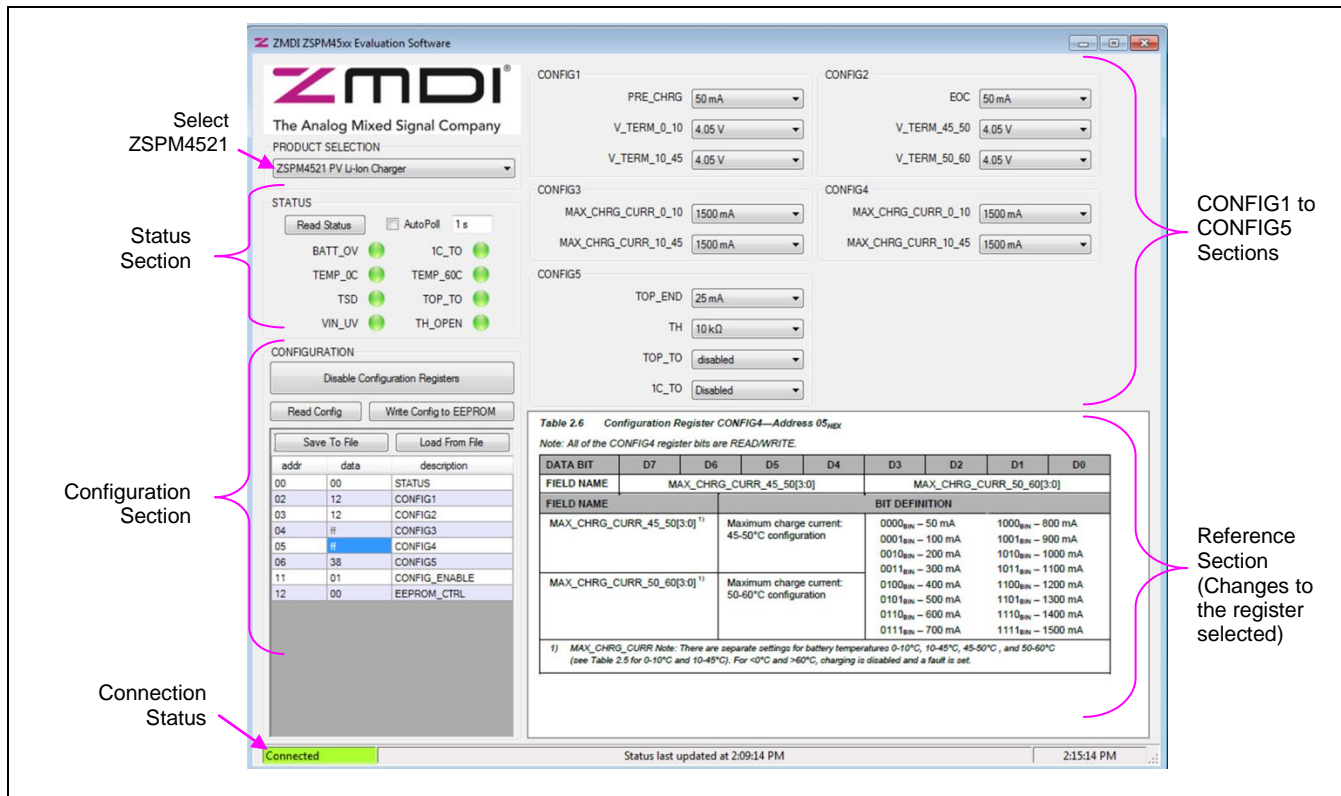
Upon activating the software, select “ZSPM4521 PV Li-Ion Charger” from the drop-down menu under “PRODUCT SELECTION” (see Figure 9.1).

This GUI is divided into sections as shown in Figure 9.1:

- The “Status” section allows reading the status registers for monitoring the ZSPM4521.
- The “Configuration” and “CONFIGx” sections allow programming different parameters in the ZSPM4521.
- The “Reference” section provides information from the datasheet showing definitions for programming values for configurable registers in “Configuration” section. See section 9.3 for an explanation of which register definitions will be displayed.

Note: At the bottom left of the GUI window, the status of communication of the USB to I<sup>2</sup>C™ interface is indicated. The status should indicate “Connected” as shown in Figure 9.1 if the cable is connected to the computer. If the GUI shows “Disconnected,” ensure that the I<sup>2</sup>C™/USB cable is connected to the computer and the driver is installed; then try again. If there is a problem reading values from the GUI, verify that ZSPM4521 EVB is powered on.

**Figure 9.1 The ZSPM4521 Graphic User Interface (GUI)**



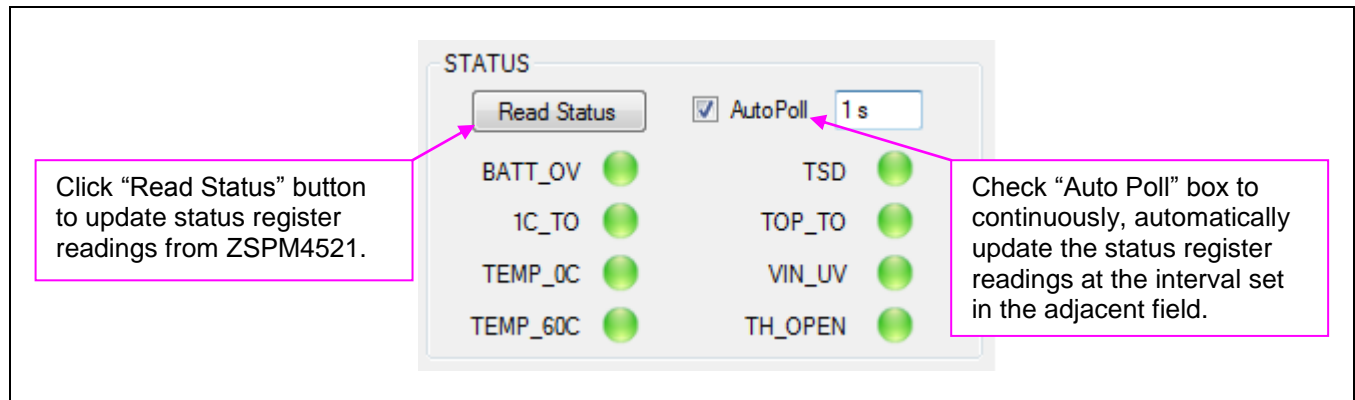


## 9.1. Status Section

Click on the “Read Status” button to read the current values of monitor registers of the ZSPM4521 on the EVB.

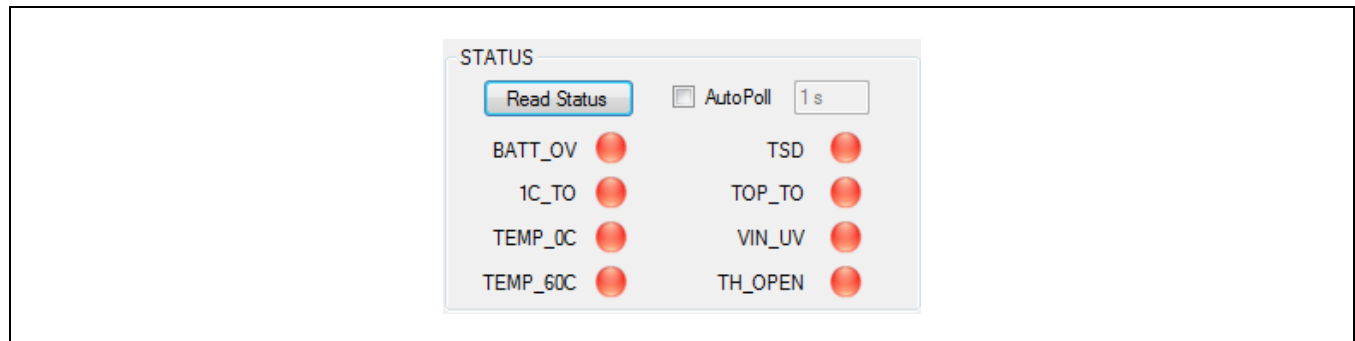
Enabling the “Auto Poll” feature will automatically read the status bits at the time interval specified in the adjacent field.

**Figure 9.2 Reading Status Registers**



Note: If any of the Status register bits shows a fault condition, the adjacent indicator is displayed as red as shown in the figure below.

**Figure 9.3 Fault Indication for Status Register Bits**





## 9.2. Configuration and CONFIGx Sections

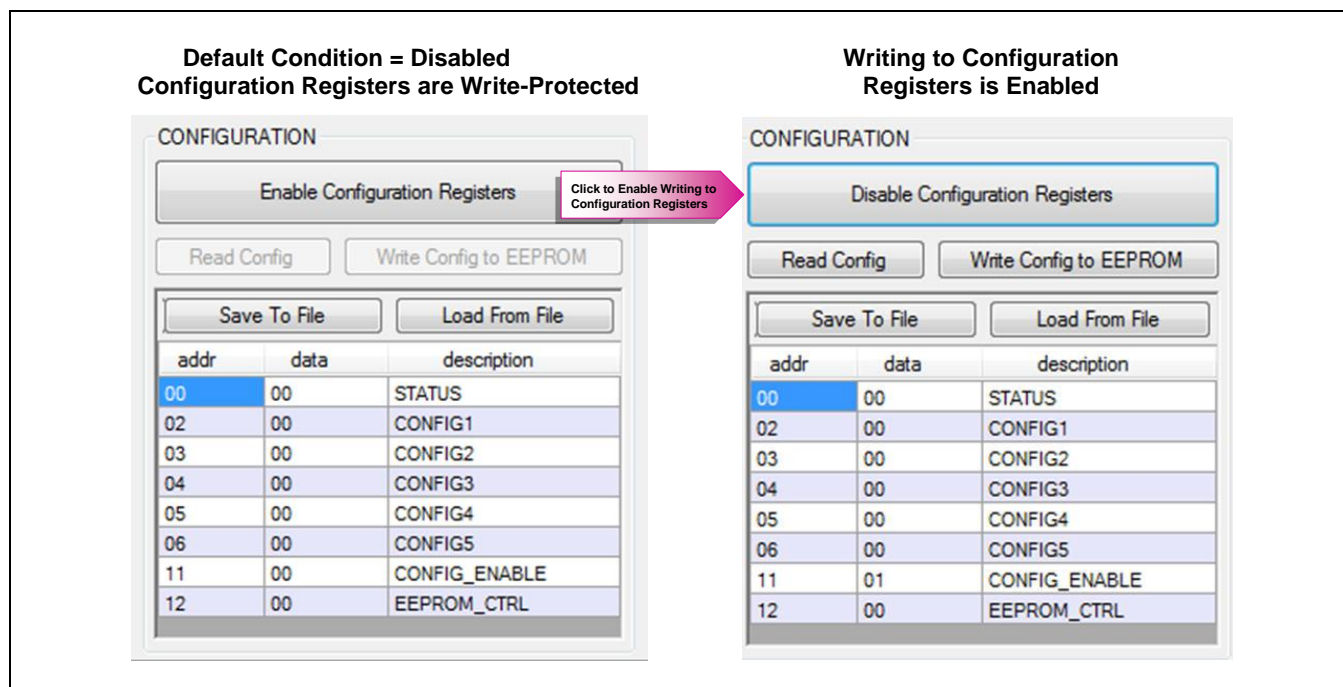
The recommended method for changing configuration settings is to select the required setting from each of the drop-down menus for each register in the “CONFIG1” through “CONFIG5” sections at the top right of the GUI shown in Figure 9.1. For advanced users who are knowledgeable in ZSPM4521 bit assignments (for details, refer to *ZSPM4521\_Data\_Sheet\_rev\_X\_xy.pdf*), settings can be changed manually using the “Configuration” section at the bottom left of the GUI.

The “Configuration” section of the GUI enables changing the hexadecimal data settings in the configurable registers of the ZSPM4521 (except STATUS, which is read-only). To change the registers, click on the “Enable Configuration Registers” button as shown in Figure 9.4. To prevent further changes to the configuration registers, click “Disable Configuration Registers.” After enabling configuration of the registers, click on the “Read Config” button to read the current configuration of the ZSPM4521.

Recommendation: Record the existing configuration register settings before changing any settings and writing the new configuration to the ZSPM4521. Refer to the “Reference” section (see section 9.3) for definitions for the register bits and valid settings.

Option: The “Load from File” button can be used to select a pre-defined set of values for the configuration registers from a previously saved configuration file (see Figure 9.5).

**Figure 9.4 Enabling/Disabling**



To change a register manually, click on the row for the register and enter the new value for the register in hexadecimal as illustrated in Figure 9.6.



Important: After changing the configuration of the registers as needed, the values entered will take effect immediately, but values will not be stored in the EEPROM. The values will be lost after a power cycle. In order to write the configuration to the EEPROM, click the “Write Config to EEPROM” button to write the new values to ZSPM4521’s EEPROM configuration registers.

The GUI provides the “Save to File” button for saving the current configuration to a file, so that the user has the option to load the file in the future using the “Load From File” button.

**Figure 9.5 Buttons for Saving Current Configuration Settings or Loading Previously Saved Configurations**



### 9.3. Reference Section

The right panel of the GUI provides a reference from the datasheet showing the definitions for register bits.

By default, the Status register definitions are shown as illustrated in Figure 9.1.

When access to the configuration registers has been enabled (see section 9.2), the “Reference” section provides defined values for configuration options for the register selected in the “Configuration” section.

**Figure 9.6 Using the Reference Section in Conjunction with the Configuration Section**

1. Click here if needed to display “Disable Configuration Registers” (enables writing to configurable registers).  
2. Then click “Read Config.”

Configuration Section

Reference Section (Changes to the register selected)

3. Click on the row of the register to be revised.

4. Refer to the data sheet definitions for the register bits in the selected row and enter the new hexadecimal value in the “data” column.





## 10 Board Options

Refer to the bill of materials in section 11.2 for recommended values and sources for the following optional components.

### 10.1. Schottky Diode

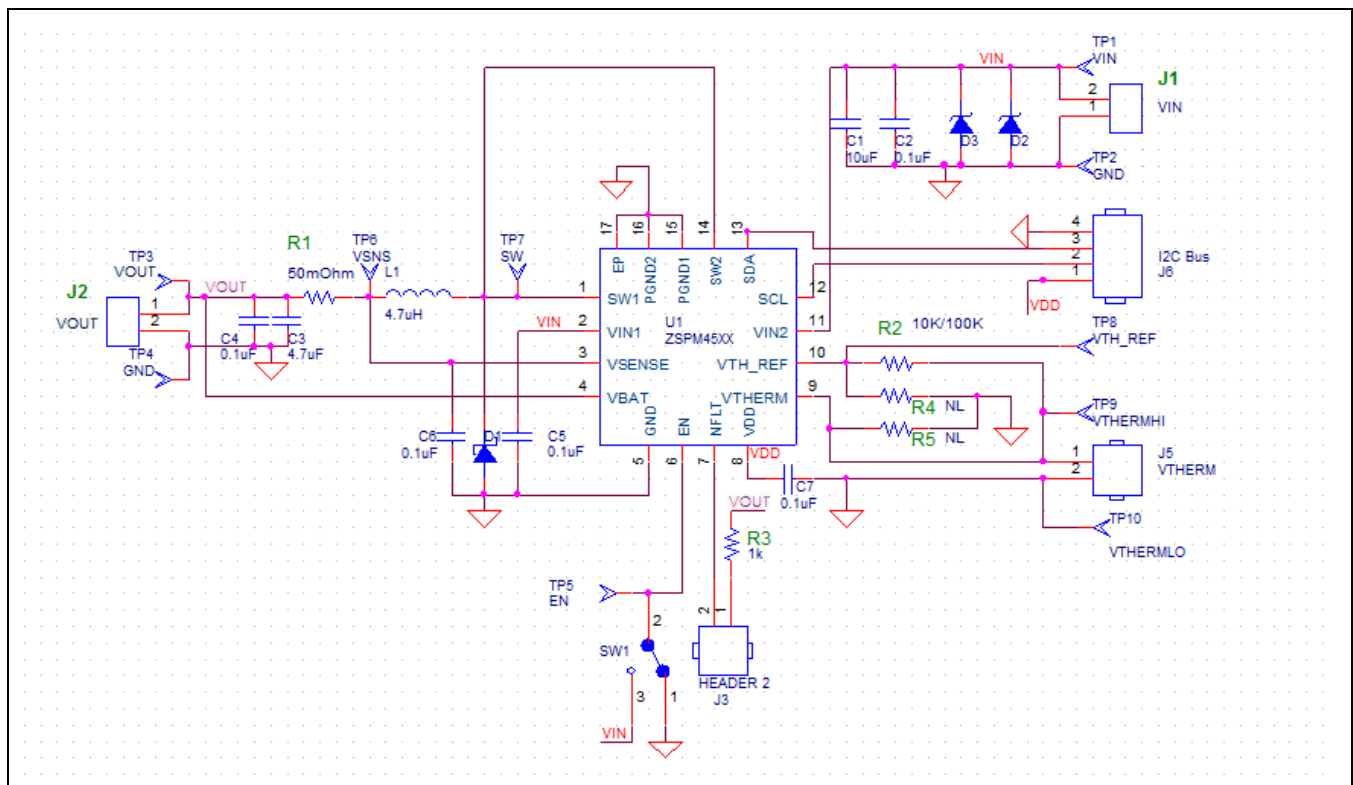
While D1 is not required, it can be populated to increase efficiency and provide a better load regulation. Care should be taken to select a diode that is rated to handle the output current supplied by the regulator.

### 10.2. Zener Diode

Zener diodes, D2 and D3, are not populated. However, adding D2 or D3 is highly recommended to protect the ZSPM4521 by clamping the input voltage to the maximum input voltage of 7.2V.

## 11 Evaluation Board Schematic and Layout

Figure 11.1 Schematic for the ZSPM4521 Evaluation Board Revision 1.0



# ZSPM4521

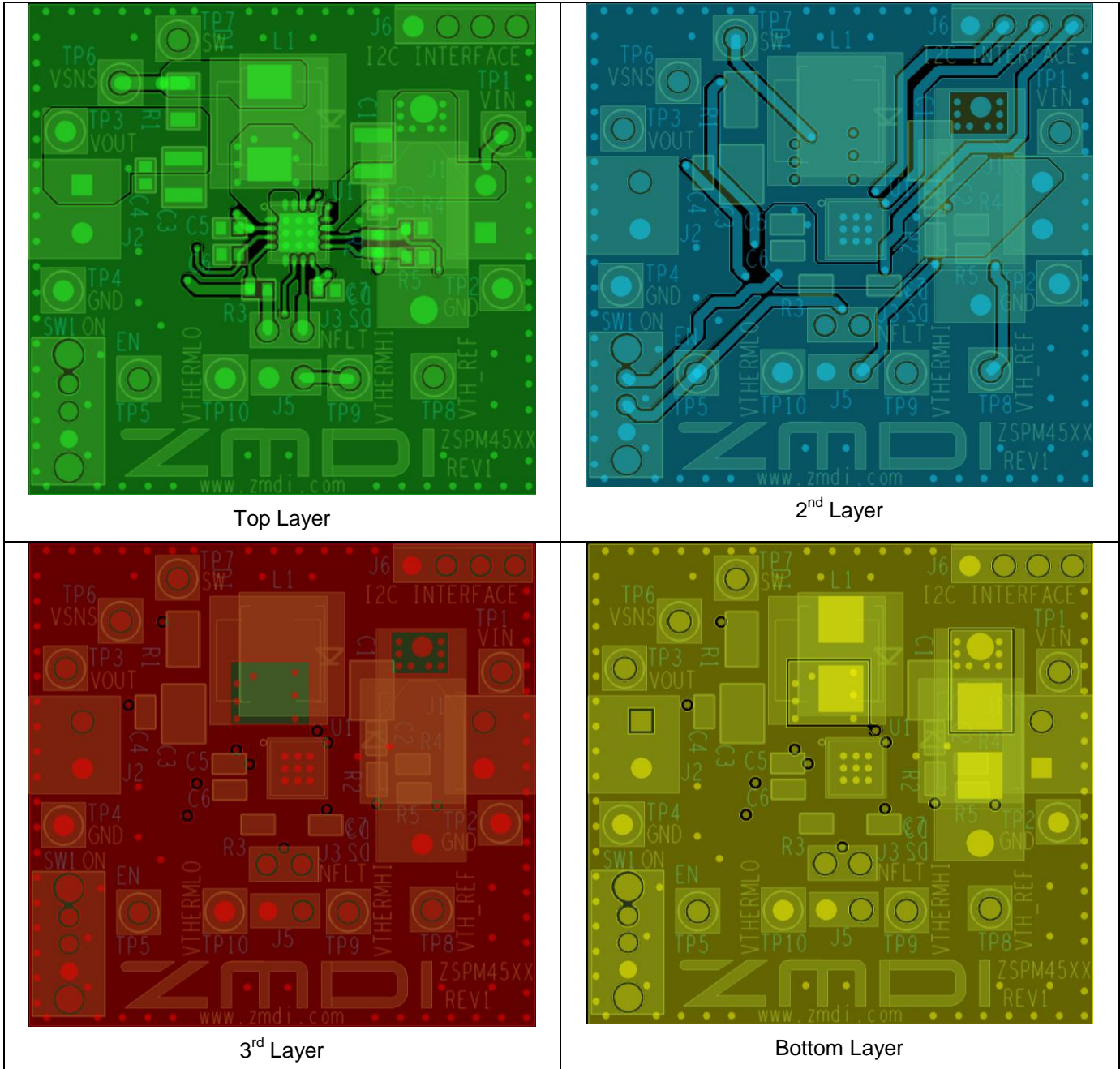
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## 11.1. Evaluation Board Layout



Top Layer

2<sup>nd</sup> Layer

3<sup>rd</sup> Layer

Bottom Layer



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The Analog Mixed Signal Company



## 11.2. ZSPM4521 Evaluation Board Bill of Materials

**Table 11.1 ZSPM4521 Evaluation Board Bill of Materials**

| Reference | Part                      | Footprint      | Manufacturer        | Manufacturer P/N    |
|-----------|---------------------------|----------------|---------------------|---------------------|
| C1        | 10 $\mu$ F/16V            | 1210           | TDK                 | C3225Y5V1C106Z/1.15 |
| C2        | 0.1 $\mu$ F/25V           | 603            | Murata              | GRM188R71C104KA01D  |
| C4        | 0.1 $\mu$ F/25V           | 603            |                     |                     |
| C5        | 0.1 $\mu$ F/25V           | 603            |                     |                     |
| C6        | 0.1 $\mu$ F/25V           | 603            |                     |                     |
| C7        | 0.1 $\mu$ F/25V           | 603            |                     |                     |
| C3        | 4.7 $\mu$ F/25V           | 1210           | TDK                 | C3225X7R1E475K      |
| D1        | DIODE SCHOTTKY            | smc_smb        | NL                  |                     |
| D2        | DIODE ZENER               | do201ad        | NL                  |                     |
| D3        | DIODE ZENER               | smc_smb        | NL                  |                     |
| J1        | VIN                       | OSTVQ021150    | On Shore Technology | ED555/2DS           |
| J2        | VOUT                      | OSTVQ021150    | On Shore Technology | ED555/2DS           |
| J3        | HEADER 2                  | jumper2        | TE Connectivity     | 3-644456-2          |
| J5        | VTHERM                    | jumper2        | NL                  |                     |
| J6        | I <sup>2</sup> C™ Bus     | jumper4        | TE Connectivity     | 3-644456-4          |
| L1        | 4.7 $\mu$ H               | ind            | Cooper Bussman      | DR74-4R7-R          |
| R1        | 50m $\Omega$ /1W/1%/50ppm | 1206           | Ohmite              | MCS1632R050FER      |
| R2        | 10K                       | 603            | Stackpole           | RMCF0603JT10K0      |
| R3        | 1k                        | 603            | Stackpole           | RMCF0603JT1K00      |
| R4        | NL                        | 603            | NL                  |                     |
| R5        | NL                        | 603            | NL                  |                     |
| SW1       | SW_T_SPDT                 | OS102011MA1QN1 | C&K                 | OS102011MA1QN1      |
| TP1       | VIN                       | TP             | Keystone            | 5001K-ND            |
| TP2       | GND                       | TP             | Keystone            | 5001K-ND            |
| TP4       | GND                       | TP             | Keystone            | 5001K-ND            |
| TP3       | VOUT                      | TP             | Keystone            | 5001K-ND            |
| TP5       | EN                        | TP             | Keystone            | 5001K-ND            |
| TP6       | VSNS                      | TP             | Keystone            | 5001K-ND            |
| TP7       | SW                        | TP             | Keystone            | 5001K-ND            |

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| Reference | Part     | Footprint | Manufacturer | Manufacturer P/N |
|-----------|----------|-----------|--------------|------------------|
| TP8       | VTH_REF  | TP        | Keystone     | 5001K-ND         |
| TP9       | VTHERMHI | TP        | Keystone     | 5001K-ND         |
| TP10      | VTHERMLO | TP        | Keystone     | 5001K-ND         |
| U1        | ZSPM4521 | pqfn-16   | ZMDI         | ZSPM4521         |

## 12 Ordering Information

| Product Sales Code | Description  |
|--------------------|--|
| ZSPM4521KIT        | ZSPM4521 Evaluation Kit for the ZSPM4521 High Efficiency Photovoltaic Charger for Li-ion Battery |

## 13 Related Documents

Note: X\_xy refers to the latest version of the document.

| File Name          | File Name                        |
|--------------------|----------------------------------|
| ZSPM4521 Datasheet | ZSPM4521_Data_Sheet_rev_X_xy.pdf |

Visit ZMDI's website [www.zmdi.com](http://www.zmdi.com) or contact your nearest sales office for the latest version of these documents.

## 14 Glossary

| Term  | Description   |
|-------|---|
| JEITA | Japan Electronics and Information Technology Industries Association |

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## Evaluation Kit Manual



## 15 Document Revision History

| Revision | Date              | Description    |
|----------|-------------------|----------------|
| 1.00     | February 12, 2013 | First release. |

| Sales and Further Information   |  | <a href="http://www.zmdi.com">www.zmdi.com</a>  | <a href="mailto:Analog@zmdi.com">Analog@zmdi.com</a>   |  |
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