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Evaluating the ADP5062 Linear Li-Ion Battery Charger with Power Path and USB Compatibility in LFCSP

FEATURES

Input voltage 4.0 V to 6.7 V
High current terminals for ADP5062 VINx, ISO_Sx, and ISO_Bx pins
ADP5062 operation configurable via I²C interface
Evaluation software included

EVALUATION KIT CONTENTS

ADP5062CP-EVALZ evaluation board

EQUIPMENT NEEDED

USB to serial input/output interface USB-SDP-CABLEZ
PC

SOFTWARE NEEDED

Analog Devices ADP5062 Evaluation and Design Software

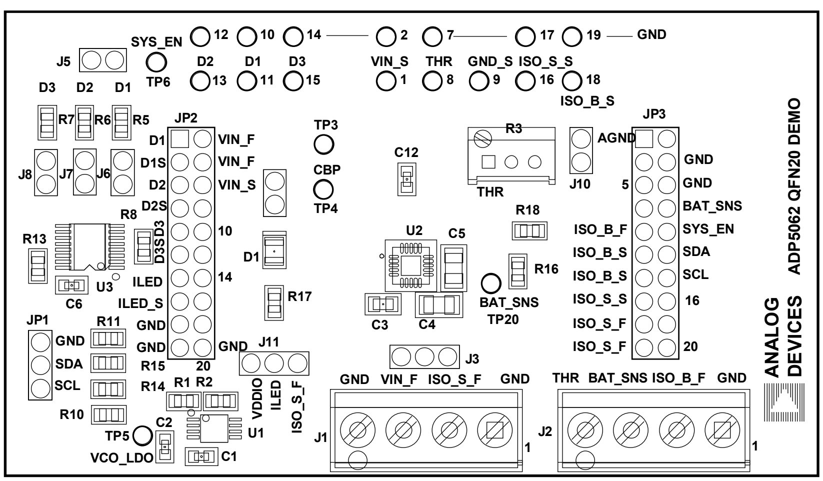
GENERAL DESCRIPTION

The ADP5062 charger evaluation system is composed of the ADP5062CP-EVALZ and a USB-to-serial-input/output interface (USB-SDP-CABLEZ). All ADP5062CP-EVALZ functions and circuits are controlled via one I²C bus connector. The I²C bus interfaces with the ADP5062 directly, and the digital input/output signals are controlled through an on-board input/output expander circuit on the I²C bus. The ADP5062CP-EVALZ also features a 3.4 V regulator for VDDIO generation. The ADP5062CP-EVALZ contains jumpers and numerous test points for easy evaluation.

The ADP5062 Evaluation and Design Software contains the ADP5062 graphical user interface (GUI) 3.0 installer. Use the GUI in conjunction with the USB-SDP-CABLEZ.

Full details on the ADP5062 are provided in the ADP5062 data sheet, which must be consulted in conjunction with this user guide when using the ADP5062CP-EVALZ.

EVALUATION BOARD PHOTOGRAPH



11190-001

Figure 1.

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REVISION HISTORY

11/2019—Rev. 0 to Rev. A

Changed Package Contents Section to Evaluation Kit Contents Section, Hardware Requirements Section to Equipment Needed Section, and Software Requirements Section to Software Needed Section ... 1
Changes to Features Section, Equipment Needed Section, Software Needed Section, and General Description Section ... 1
Changes to Installing ADP5062 Evaluation and Design Software Section ... 3
Changes to Figure 5 Caption and Typical Operation Section ... 6
Changed Measuring Total Input Current (I_{VIN}) Section to Measuring Total Input Current Section ... 7
Changes to Measuring Total Input Current Section and Trickle Charge Current Section ... 7
Changes to Fast Charge Current Section ... 8
Changes to THR Input and JEITA Settings Section ... 9
Changes to Table 1 ... 11

4/2013—Revision 0: Initial Version

EVALUATION BOARD SOFTWARE

INSTALLING THE ADP5062 EVALUATION AND DESIGN SOFTWARE

Before installing the ADP5062 Evaluation and Design Software, the drivers for the USB-SDP-CABLEZ must be installed. The software drivers are included with the ADP5062 Evaluation and Design Software. After proper installation of the USB-SDP-CABLEZ drivers, run the **setup.exe** file.

USING THE SOFTWARE GRAPHICAL USER INTERFACE (GUI)

The GUI operation controls and status tools include the following (see Figure 2):

- Operation parameter controls
- Functional enables
- Interrupt active register indicator (Register 0x0A)
- Charger status
- Battery status
- Fault indicators
- Watchdog control
- Digital input/output controls
- I²C communication status indicators

OPERATING THE ADP5062CP-EVALZ WITH THE GUI

To use the ADP5062CP-EVALZ, take the following steps:

1. Before running the ADP5062 Evaluation and Design Software, ensure that the USB-SDP-CABLEZ is plugged into the USB port of the PC.
2. Connect a 5 V power supply to the VIN_F input.
3. Click **START** > **All Programs** > **ADP506x GUI 3Vx SDP** > **ADP506x GUI SDP**. When this step is done, the ADP5062 Evaluation and Design Software is ready to use.

The V_{VIN} supply voltage must be above 2.5 V for the I²C communication of the ADP5062 to work. The VIN voltage level is monitored, and the indicators are shown in the charger status indicators (see Label 4 in Figure 2). The GUI automatically reads the content of the registers after every 0.3 seconds from the last action and updates the status of the registers on the screen.

If there is a problem in the I²C communication, the status indicators show an error message (see Label 9 in Figure 2). When I²C communication is operational, status indicators show **I2C_STATUS_OK** (see Figure 2).

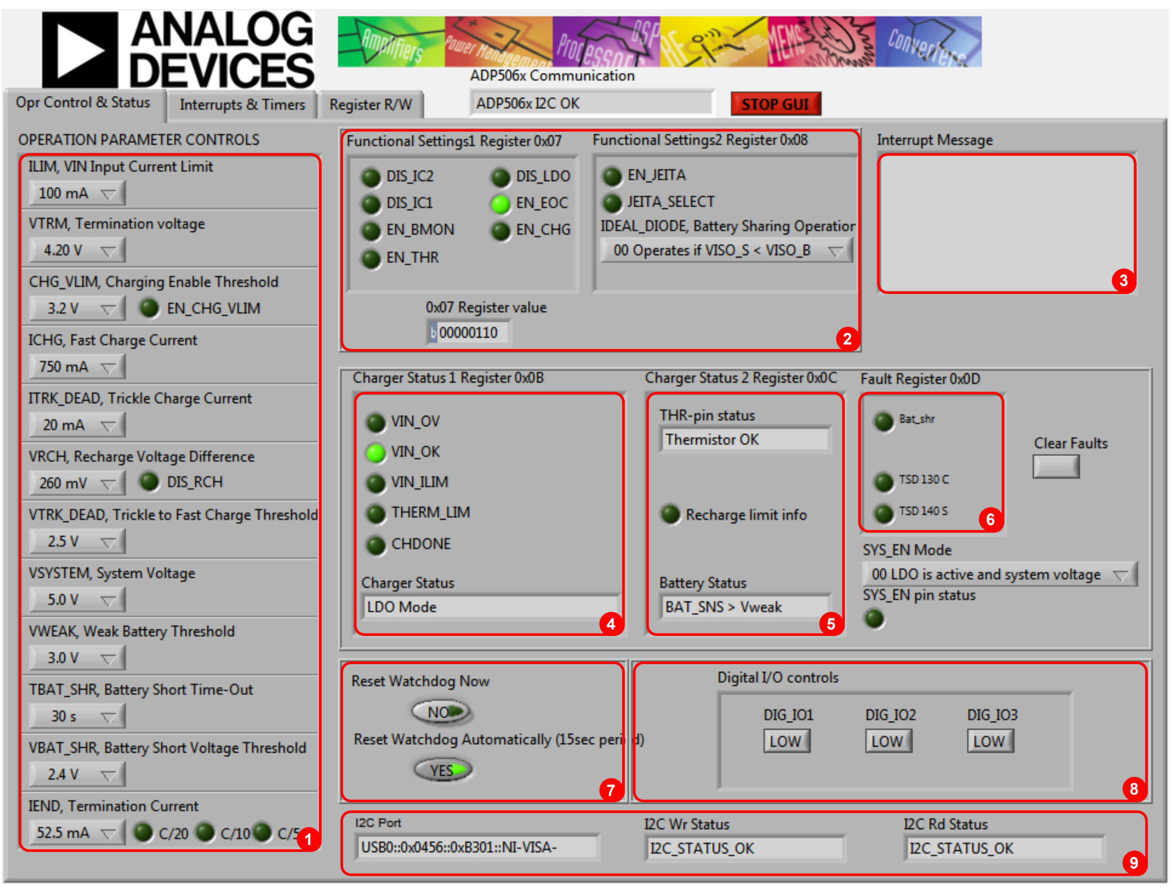

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Figure 2. ADP5062 GUI Operation Control and Status Tab

BASIC CHARGING PARAMETER SETTINGS

When the input power supply is connected and is between 4.0 V and 6.7 V, the ADP5062 is operational and capable of charging the battery. Charging starts with default operational parameter settings. It is possible to change settings using the controls on the left side of the **OPERATION PARAMETER CONTROLS** menu (Label 1 in Figure 2).

SETTING INTERRUPTS

The ADP5062 includes several interrupt flags to inform the system microcontroller of a status change in the corresponding charger function. All interrupts are disabled by default, and each interrupt can be separately enabled by issuing an I^2C write to Register 0x09.

The **Interrupts & Timers** tab (see Figure 3) in the GUI controls the register settings. Register 0x0A is automatically read after every 0.3 second timeout from the last user action involving the GUI. When a certain interrupt is enabled and there is a status change in the corresponding function during charging, an interrupt message is shown in the **Opr Control & Status** tab (see Label 3 in Figure 2).

SETTING TIMERS

The default settings of the timers are shown in Figure 3. To change the timer settings, click the items in the **Timer Settings (Write to Register 0x06)** box.

Register 0x09 controls the interrupt enables, and Register 0x06 controls the timer settings.

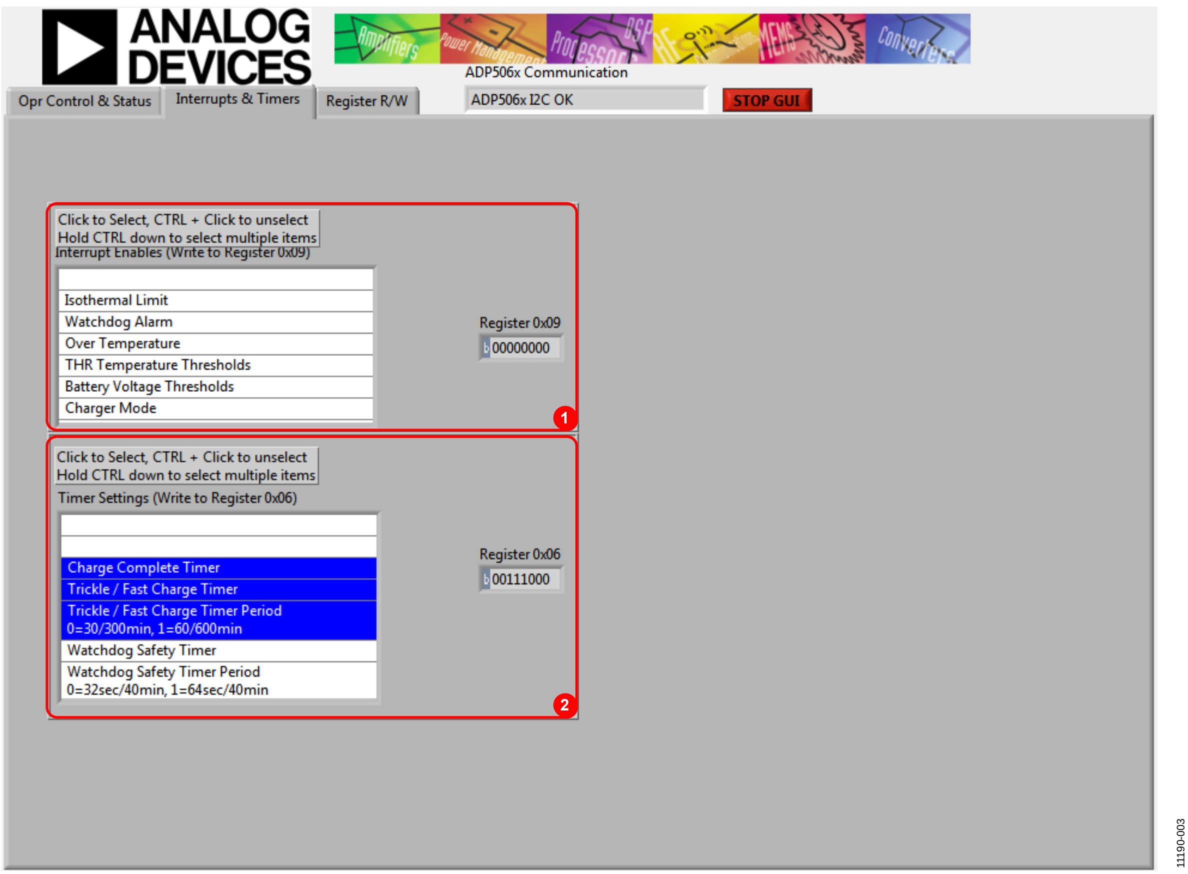

*Figure 3. ADP5062 Evaluation and Design Software GUI, **Interrupts & Timers** Tab*

DIRECT REGISTER READ AND WRITE

It is possible to read and write the content of each register using the **Register R/W** tab, as indicated in the GUI. Click **READ ALL** to update the contents of each register in the GUI. A single register read or write can be done using the controls on the right side of the **Register R/W** tab of the GUI (see Figure 4). Type the I^2C subaddress in the **Sub Address for READ or WRITE (0x00)** box, and then press the Enter key. Click **READ** to read the binary data, or click **WRITE** to write the binary data. Type the binary data for an I^2C write, and then press the Enter key. Note that some registers, such as Register 0x00 and Register 0x01, are read only registers and cannot be overwritten.

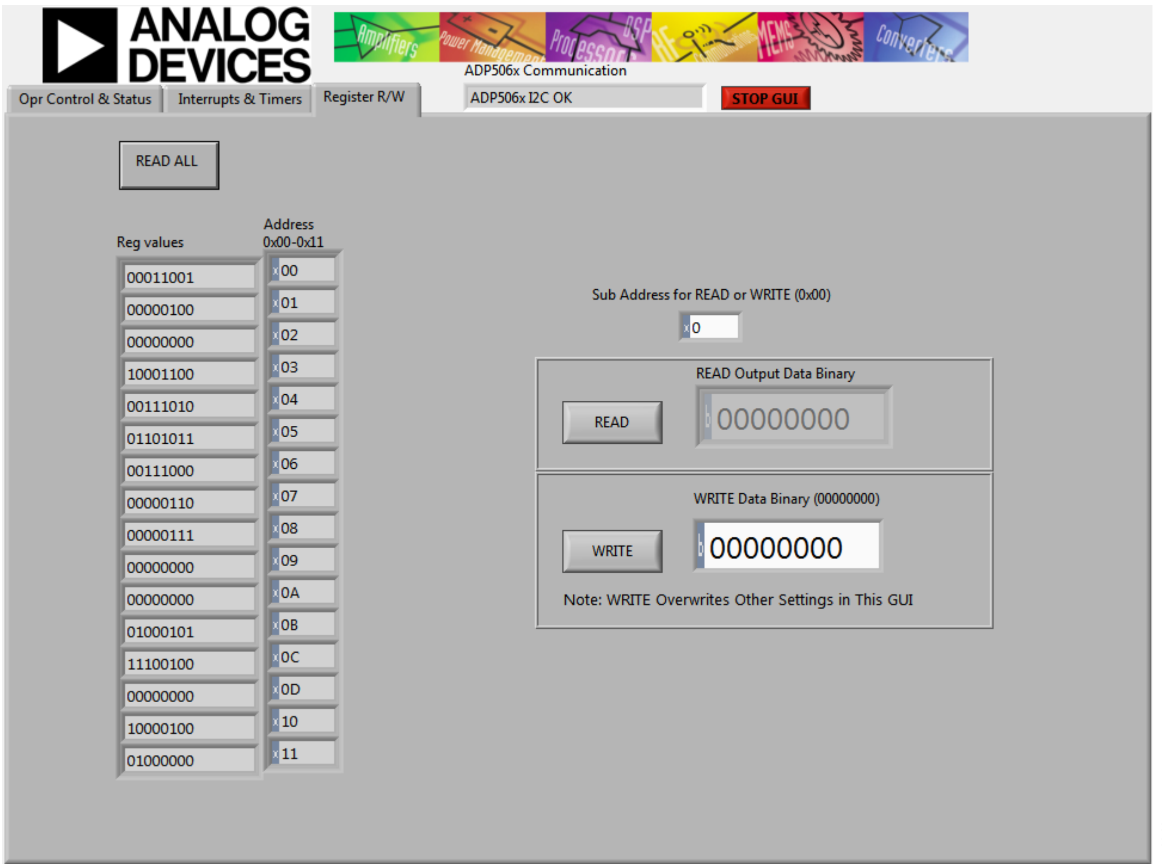

*Figure 4. ADP5062 Evaluation and Design Software GUI, **Register R/W** Tab*

EVALUATION BOARD OVERVIEW

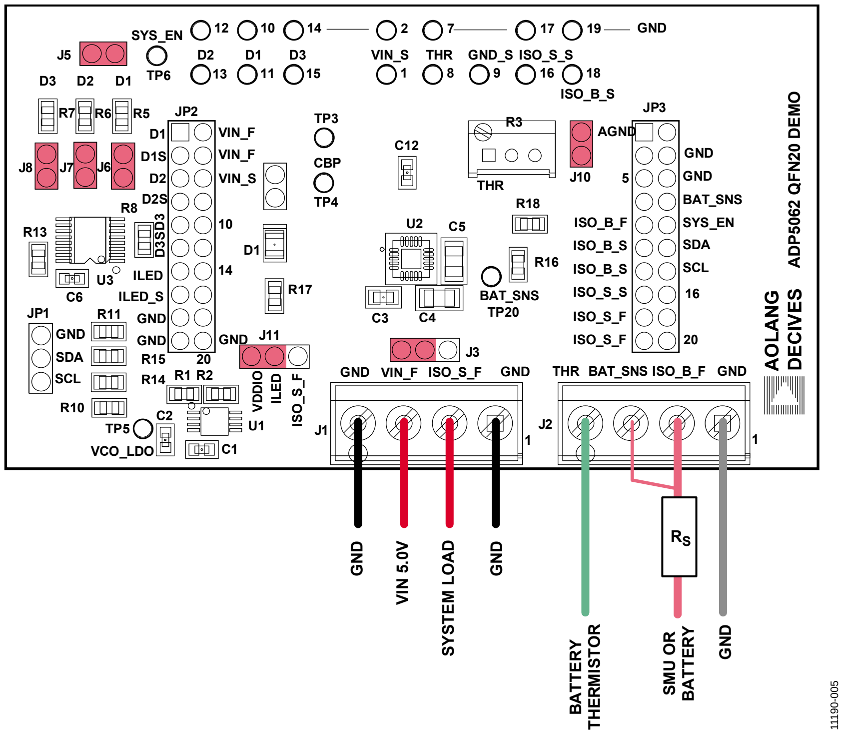

Figure 5. ADP5062CP-EVALZ Typical Operation Setup

TYPICAL OPERATION

The typical test setup for the ADP5062 charger consists of a dc power supply unit (PSU) for the VIN_F input, a source meter unit (SMU) or a battery simulator for the battery voltage (ISO_Bx) pins, and a variable power resistor or electronic load for the system voltage (ISO_Sx) pins.

The SMU at the ISO_B_F node must have a 100 mΩ to 250 mΩ resistor (R_S) in series with the positive lead (see Figure 5). The resistor emulates the equivalent series resistance of a real battery. Some SMU models that have been successfully used for the ISO_x_F nodes include the following:

- Keithley 2306 battery simulator
- Keithley 2602A SMU
- Agilent 6784A/6762A SMU

INPUT CURRENT

Measuring Total Input Current

When measuring power connection (VINx) input quiescent currents, take into account that the evaluation board includes a low dropout (LDO) regulator (U1) and I²C input/output expander (U3A in Figure 7). The LDO regulator generates a 3.4 V VDDIO voltage for the I²C bus and SYS_EN open-drain output pin, and the input/output expander controls the DIG_IO1, DIG_IO2, and DIG_IO3 digital inputs.

In the ADP5062CP-EVALZ typical setup, U1 and U3 are powered through the J3 pin header. The combined current consumption of the U1 and the U3A are typically in the range of 1 mA to 2 mA. To separate the ADP5062CP-EVALZ quiescent current from the ADP5062 VINx pins quiescent current, leave J3 open and connect a second dc power supply (3.5 V to 5.0 V) to the test point TP5 (see Figure 6).

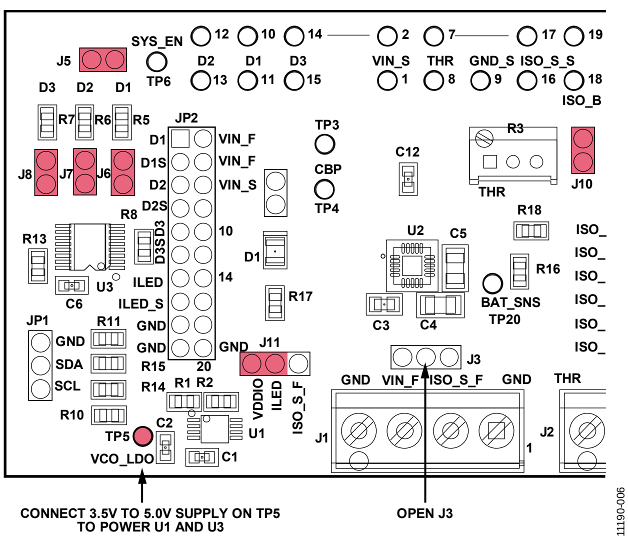

Figure 6. Board Setup for VINx Input Quiescent Current Measurement

VINx Input Current Limit

The VINx input current limit of the ADP5062 can be evaluated in charging mode. Note that the maximum programming for the charge current into the battery (ISO_Bx) is 1300 mA. For measuring the input current limit across the full programming range from 100 mA to 2100 mA, an additional system load has to be connected to the ISO_Sx pins.

To measure the VINx input current limit, take the following steps:

1. Set the VIN supply voltage to 5.0 V.
2. Set the ISO_Bx voltage (V_{ISO_B}) supply voltage to 3.6 V on SMU B.
3. Enable charging by setting Register 0x07, Bit D0 (EN_CHG), to 1 (high).
4. Confirm that the ADP5062 is in charging mode. To confirm the mode, take the following steps:
    1. The **Battery Status** indicator on the GUI must show **BAT_SNS > Vweak** (see Figure 2).
    2. The ADP5062 must start charging 80 mA to 90 mA current into the battery.
5. Measure the current on the VINx supply.
6. Use the GUI to change the input current limit programming and repeat the measurement.

A 1300 mA charge current into the battery may not be large enough to drive the input current up to the limit when the current limit programming values of 1200 mA or higher are used. Connect an additional load on the ISO_Sx node to evaluate the higher end of the input current limit programming range.

TRICKLE CHARGE CURRENT

Trickle charge can only be activated either during a battery charging start-up sequence, or if the voltage level at the ISO_Bx pins is lower than the dead battery trickle charge voltage threshold (V_{TRK_DEAD}) threshold (typically 2.5 V). When V_{VIN} is 5.0 V, initiate a charge start-up sequence by setting an I²C write of Register 0x07, Bit D0 (EN_CHG), to 1 (high). To measure the trickle charge current level, take the following steps:

1. Set the V_{ISO_B} voltage (SMU or battery simulator) to 2 V.
2. Set the V_{VIN} supply voltage to 5.0 V.
3. Ensure that the GUI **Charger Status** indicator shows **Trickle Charge**.
4. Check that the GUI **Battery Status** indicator shows **BAT_SNS < Vtrk**.
5. Check the battery short detection. To check the detection, take the following steps:
    1. Wait for a 30 second timeout to expire.
    2. Check that the GUI shows that the fault register (Register 0x0D, Bit D3) BAT_SHR flag is set.
    3. Use the GUI to change the battery short timeout setting from 1 second to 180 seconds.
6. Measure the trickle charge current level to the battery. The default value for the trickle mode current (I_{TRK_DEAD}) is 20 mA. It is possible to change the trickle charge current setting from 5 mA to 80 mA using the GUI.
7. Adjust the V_{ISO_B} voltage up until the **Battery Status** indicator shows **Vtrk < BAT_SNS < Vweak**. The **Charger Status** indicator on the GUI shows **Fast Charge (CC-Mode)**. The charge current (I_{CHG}) is now programmed $I_{CHG} + I_{TRK\_DEAD}$ if it is not limited by the input current limit.

FAST CHARGE CURRENT

To measure the fast charge current, take the following steps:

1. Set the V_{VIN} supply voltage to 5.0 V.
2. Set the V_{ISO_B} to 3.9 V.
3. Verify that the GUI **Battery Status** indicator shows **BAT_SNS** > **Vweak**.
4. Set the VINx input current limit to the maximum value (2100 mA).
5. Measure the charge current into the battery. The default value for the fast charge current is 750 mA. It is possible to change the fast charge current setting from 50 mA to 1300 mA using the GUI.

The fast charge current may be reduced because of the following conditions:

- The BAT_SNS voltage (V_{BAT_SNS}) level is close to the termination voltage (V_{TRM}) (default 4.20 V).
- The die temperature (T_J) exceeds the isothermal charging temperature (T_{LIM}) (typically 115°C).

TERMINATION VOLTAGE AND END OF CHARGE (EOC) CURRENT

Measuring Termination Voltage Using SMU or Battery Simulator

The ADP5062 fast charge constant voltage (CV) regulation is optimized for batteries with series resistance in the 100 mΩ to 250 mΩ range. When using an SMU or a battery simulator connected to the ISO_Bx input, set the R_S within this range.

Some battery simulators, such as the Keithley 2306, have programmable source resistance integrated into the instrument. For SMU units, use an external resistor to obtain accurate measurement results of the termination voltage.

To measure the termination voltage, take the following steps:

1. Set the V_{VIN} supply voltage to 5.0 V.
2. Set the termination voltage to 4.2 V using the GUI.
3. Disable the EOC by setting the EN_EOC bit (D2) to low in the Functional Settings 1 register, Register 0x07.
4. Disable the charge complete timer at Register 0x06 using the GUI (see Figure 3).
5. Sweep V_{ISO_B} up until the **Charger Status** indicator in the GUI shows **Fast Charge (CV-Mode)**.
6. Sweep V_{ISO_B} up until the charge current has dropped to 50 mA. In fast charge CV mode, 1 mV step up of V_{ISO_B} can reduce the charge current by several mA.
7. Measure termination voltage between the BAT_SNS (TP20) and GND_S (TP9) nodes.

Measuring EOC Current

To measure the EOC current, take the following steps:

1. Use the GUI to set the termination current to 52.5 mA.
2. Step V_{ISO_B} down 100 mV.
3. Enable the EOC by setting the EN_EOC bit (D2) to high in the Functional Settings 1 register, Register 0x07.
4. Step V_{ISO_B} up and monitor the charge current for each step until the **Charger Status** indicator in the GUI shows **Charge Complete**. The last charge current value before **Charge Complete** is the charge complete current threshold. Charging stops and there is no current flowing into the ISO_B_x node.

Measuring Recharge Voltage

To measure the recharge voltage, complete the following steps:

1. Step V_{ISO_B} down and monitor the voltage until the **Charger Status** indicator on the GUI shows **Fast Charge (CC-Mode)** and charge current flows to the ISO_B_x node. The last value before the charger status change is the recharge voltage level. With default settings, the recharge voltage threshold is 3.94 V.
2. Use the GUI to change the termination current and recharge voltage programming. Repeat Step 9 through Step 11 in the Measuring EOC Current section, and then Step 1 in this section to evaluate different settings.

THR INPUT AND JEITA SETTINGS

The thermistor (THR) input of the ADP5062CP-EVALZ is equipped with a 50 kΩ trimmer resistor (R3) and Jumper J10. When using an actual Li-Ion negative temperature coefficient (NTC) thermistor terminal, configure the board according to Figure 5 and take the following steps:

1. Remove Jumper J10.
2. Connect the Li-Ion battery NTC thermistor to the J2 screw terminal at Pin 4.

Evaluating THR Input Using Typical Board Setup

To evaluate the THR input using the typical board setup, complete the following steps:

1. Set the V_{VIN} supply voltage to 5.0 V.
2. Set V_{ISO_B} to 3.9 V.
3. Set the charge current setting to 750 mA using the GUI.
4. Set the VIN input current limit to 1500 mA.
5. Enable charging (EN_CHG = high).
6. Measure the current to the ISO_Bx input. The value must be 750 mA.
7. Adjust the trimmer resistor until the **THR-pin status** indicator on the GUI shows **BatCool**.
8. Enable JEITA by setting the EN_JEITA bit high in Functional Settings 2 register, Register 0x08.
9. Measure the current to the ISO_Bx node. The charging current must now be half of the fast charge current setting.
10. Change the trimmer resistor setting to evaluate the JEITA thresholds. The THR input resistance thresholds are specified in the ADP5062 data sheet.
11. The **THR-pin status** indicator in the GUI must show **BatCold**, **BatCool**, **Thermistor OK**, **BatWarm**, or **BatHot** when adjusting the trimmer resistance from 50 kΩ to 0 Ω.

EVALUATION BOARD SCHEMATIC

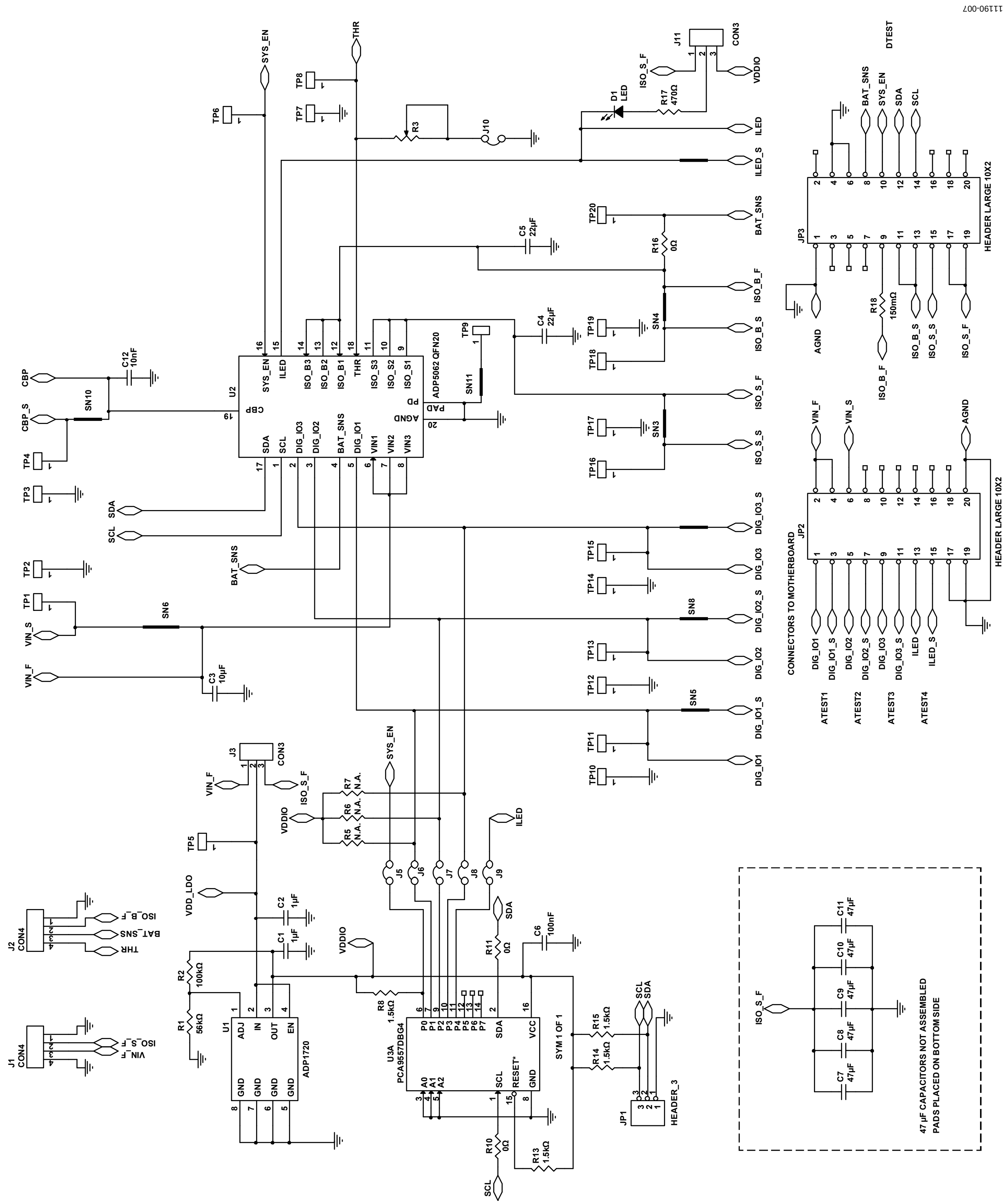

Figure 7. ADP5062 LFCSP Demo Board Schematic

ORDERING INFORMATION

BILL OF MATERIALS

Table 1.

Qty	Reference Designator	Description	Manufacturer/Vendor	Vendor P/N
2	C1, C2	Capacitors, multilayer ceramic capacitor (MLCC), 1 μF, 10 V, 0805, X7R	Murata	GRM21BR71A105KA01
1	C3	Capacitor, MLCC, 10 μF, 25 V, 0805, X5R	Murata	GRM21BR61E106MA73
2	C4, C5	Capacitors, MLCC, 22 μF, 6.3 V, 1206, X5R	Murata	GRM31CR60J226ME19
1	C6	Capacitor, MLCC, 100 nF, 16 V, 0402, X7R	Murata	GRM155R71C104KA88
1	C12	Capacitor, MLCC, 10 nF, 16 V, 0402, X7R	Murata	GRM15XR71C103KA86
5	C7, C8, C9, C10, C11	Capacitors, size 1206, 47 μF	Not assembled	Not assembled
1	D1	Red light emitting diode (LED) 2.2 mm × 1.4 mm	Toshiba or equivalent	TLRF1060(T18)
1	JP1	Connector header, 3 pins × 1 pin	Sullins Electronics	PEC36SAAN
2	JP2, JP3	Connector headers, 10 pins × 2 pins	Not assembled	Not assembled
2	J1, J2	Terminal block printed circuit board (PCB) connectors, 4-position	Tyco Electronics	282836-4
2	J3, J11	Connector headers, 3 pins × 1 pin	Sullins Electronics	PEC36SAAN
6	J5, J6, J7, J8, J9, J10	Connector headers, 2 pins × 1 pin	Sullins Electronics	PEC36SAAN
1	R1	Resistor, 56 kΩ, 1%, 0805, surface mount device (SMD)	Vishay or equivalent	CRCW080556K0FKEA
1	R2	Resistor, 100 kΩ, 1%, 0805, SMD	Panasonic	ERJ-6ENF1003V
1	R3	Resistor, 3296, 3/8" square trimming potentiometer 50 kΩ	Burns or equivalent	3296 W - 1 - 503 LF
3	R5, R6, R7	Resistors, 0805, SMD, no assembly	Not applicable	Not applicable
4	R8, R13, R14, R15	Resistors, 1.5 kΩ, 1%, 0805, SMD	Vishay or equivalent	CRCW08051K50FKEA
3	R10, R11, R16	Resistors, 0 Ω, 1%, 0805, SMD	Vishay or equivalent	CRCW08050000Z0EA
1	R17	Resistor, 470 Ω, 1%, 0805, SMD	Vishay or equivalent	CRCW0805470RFKEA
1	R18	Resistor, 0.150 mΩ, 1%, 0805, SMD	Rohm	MCR10EZHFLR150
20	TP1 to TP20	Test points, test headers, 1.0 mm hole	Vero Technologies	20-2137
1	U1	ADP1720 50 mA, high voltage, micropower linear regulator, 8-lead MSOP	Analog Devices, Inc.	ADP1720ARMZ-R7
1	U2	ADP5062 linear Li-Ion battery charger with power path and USB compatibility in LFCSP	Analog Devices, Inc.	ADP5062
1	U3A	8-bit I^2C bus input/output port with reset	NXP	PCA9557PW,112

NOTES

I^2C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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