One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

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 power connection (VINx), system voltage (ISO_Sx), and battery voltage (ISO_Bx) pins
- ADP5062 operation configurable via I²C interface
- Evaluation software included

PACKAGE CONTENTS

- ADP5062CP-EVALZ evaluation board
- Evaluation CD: ADP5062 evaluation software installer

HARDWARE REQUIREMENTS

- USB-to-serial-I/O interface USB-SDP-CABLEZ (USB-SDP-CABLEZ is not supplied in the evaluation kit and should be ordered separately from Analog Devices, Inc.)

SOFTWARE REQUIREMENTS

- Analog Devices ADP5062 SDP evaluation software

GENERAL DESCRIPTION

The ADP5062 charger evaluation system is composed of an evaluation board and a USB-to-serial-I/O interface (USB-SDP-CABLEZ). All evaluation board 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 evaluation board also features a 3.4 V regulator for VDDIO generation. The board contains jumpers and numerous test points for easy evaluation.

The ADP5062CP-EVALZ evaluation kit contains a CD with the ADP5062 graphical user interface (GUI) 3.0 installer. Use the GUI in conjunction with the USB-SDP-CABLEZ USB-to-serial-I/O interface.

Full performance details are provided in the ADP5062 data sheet, and the ADP5062 data sheet should be consulted in conjunction with this user guide.

ADP5062 EVALUATION BOARD

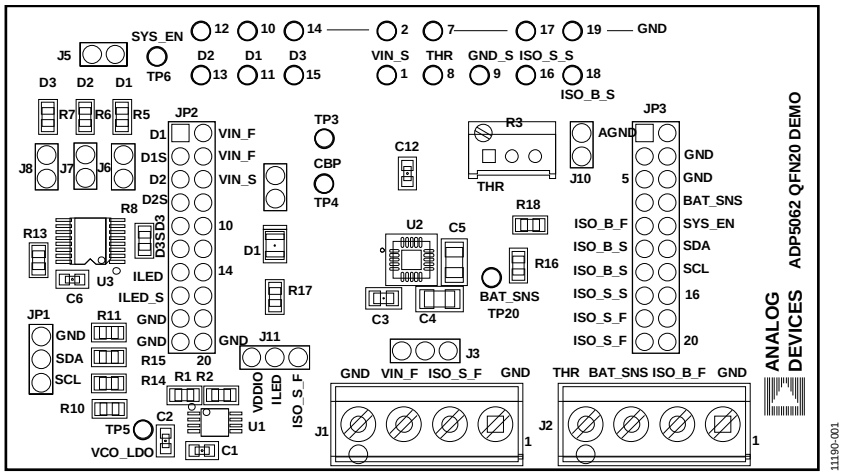

Figure 1.

TABLE OF CONTENTS

REVISION HISTORY

4/13—Revision 0: Initial Version

EVALUATION BOARD SOFTWARE

INSTALLING ADP5062 EVALUATION SOFTWARE

Before installing the ADP5062 evaluation software, the drivers for the USB-SDP-CABLEZ must be installed. The software drivers are included on the ADP5062CP-EVALZ setup CD and the instructions can be obtained from www.analog.com/usb-sdp-cablez. After proper installation of USB-SDP-CABLEZ drivers, insert the ADP5062CP-EVALZ setup CD and run the **Setup.exe** file.

USING THE SOFTWARE GRAPHICAL USER INTERFACE (GUI)

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

1. Operation parameter controls
2. Functional enables
3. Interrupt register indicator (Register 0x0A)
4. Charger status
5. Battery status
6. Fault indicators
7. Watchdog control
8. Digital I/O controls
9. I²C communication status indicators

OPERATING THE BOARD WITH THE GUI

Complete the following steps to use the board:

1. Before running the software, ensure that the Analog Devices USB-SDP-CABLEZ is plugged into the USB port of the PC.
2. Connect a 5 V power supply to VIN_F.
3. Click **START** > **All Programs** > **ADP506x GUI 3Vx SDP** > **ADP506x GUI SDP**. Once this step is done, the software is ready to use.

VIN must be above 2.5 V in order for the I²C communication of the ADP5062 to start working. The VIN voltage level is monitored, and the indicators are shown in the charger status indicators (see Number 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 screen.

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

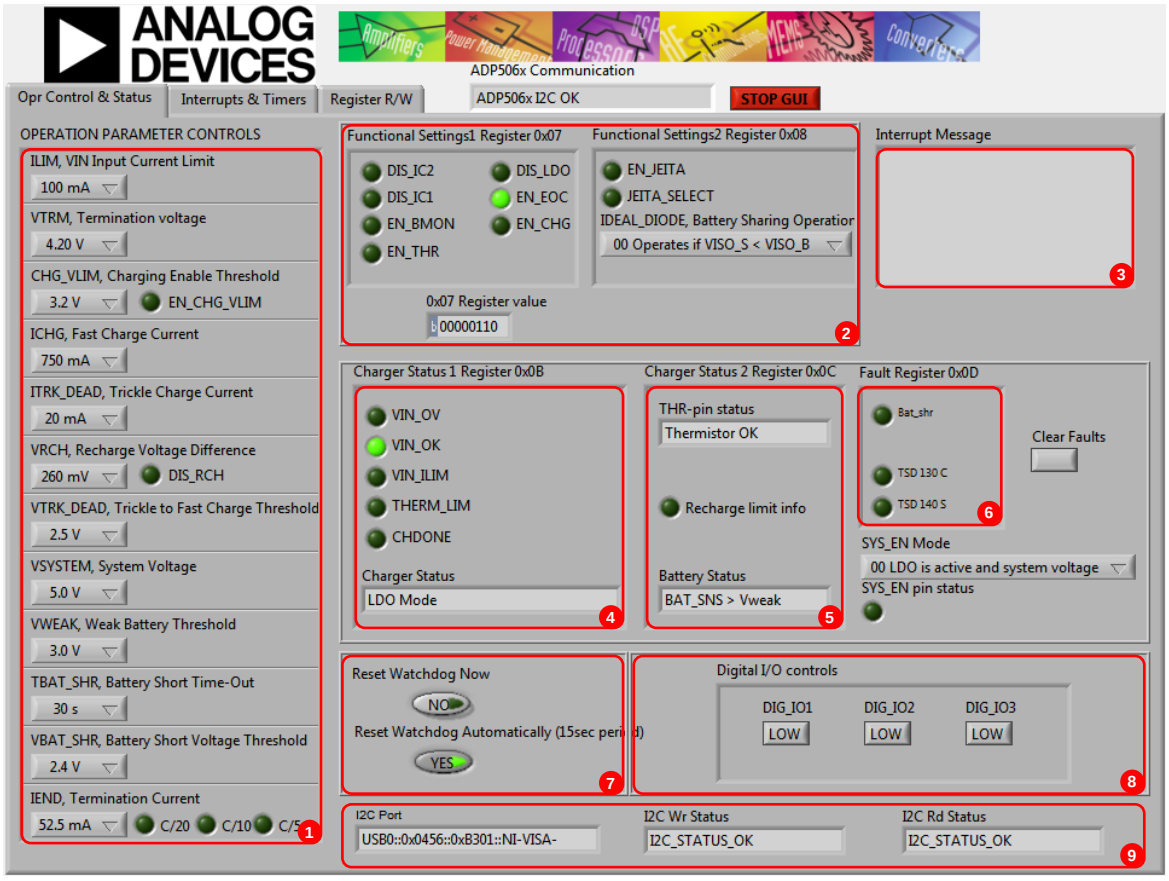

Figure 2. ADP5062 GUI Operation Control and Status Tab

BASIC CHARGING PARAMETER SETTINGS

After 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 **Opr Control & Status** tab.

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 I²C 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 Number 3 in Figure 2).

SETTING TIMERS

The default settings of the timers are shown in Figure 3. Changing the timer settings can be done by clicking items in the **Timer Settings (Write to Register 0x06)** box.

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

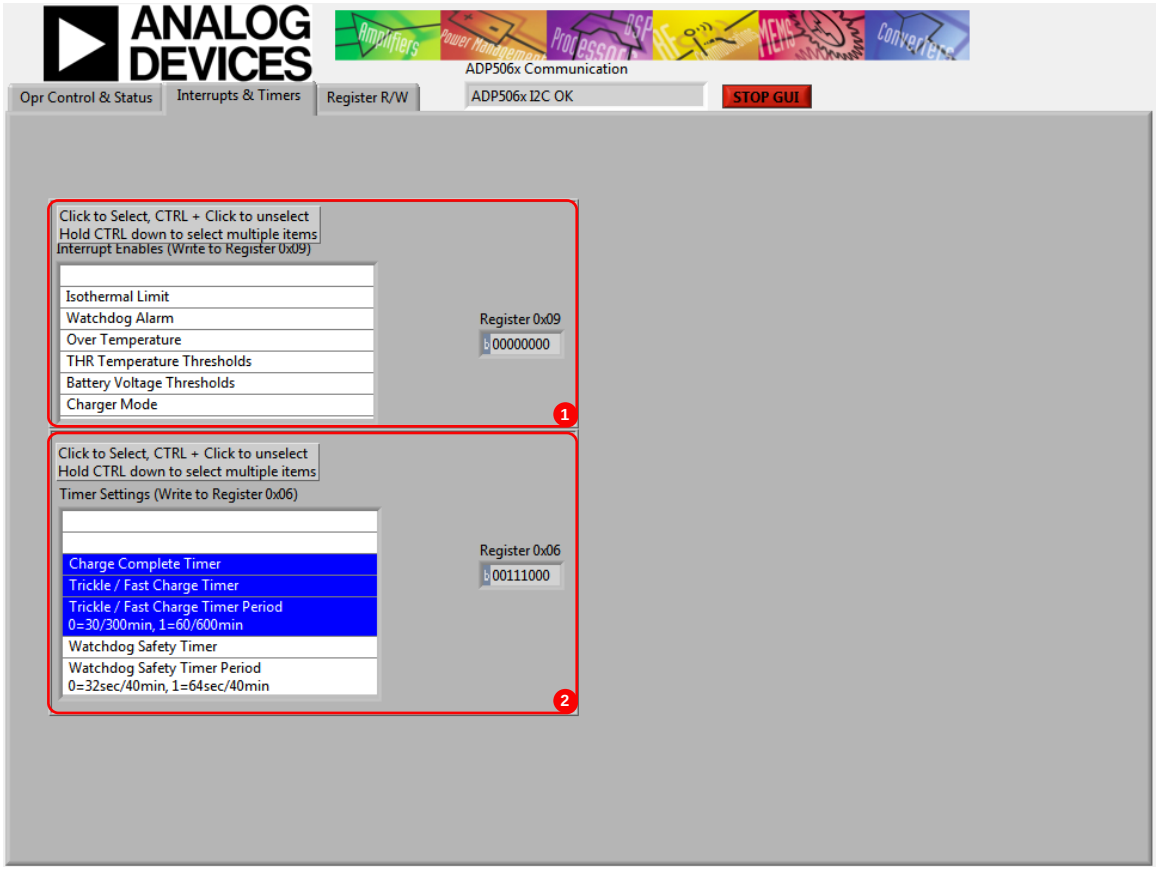

*Figure 3. ADP5062 Evaluation Software GUI, **Interrupts & Timers** Tab*

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. Type the I²C sub address 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 I²C 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.

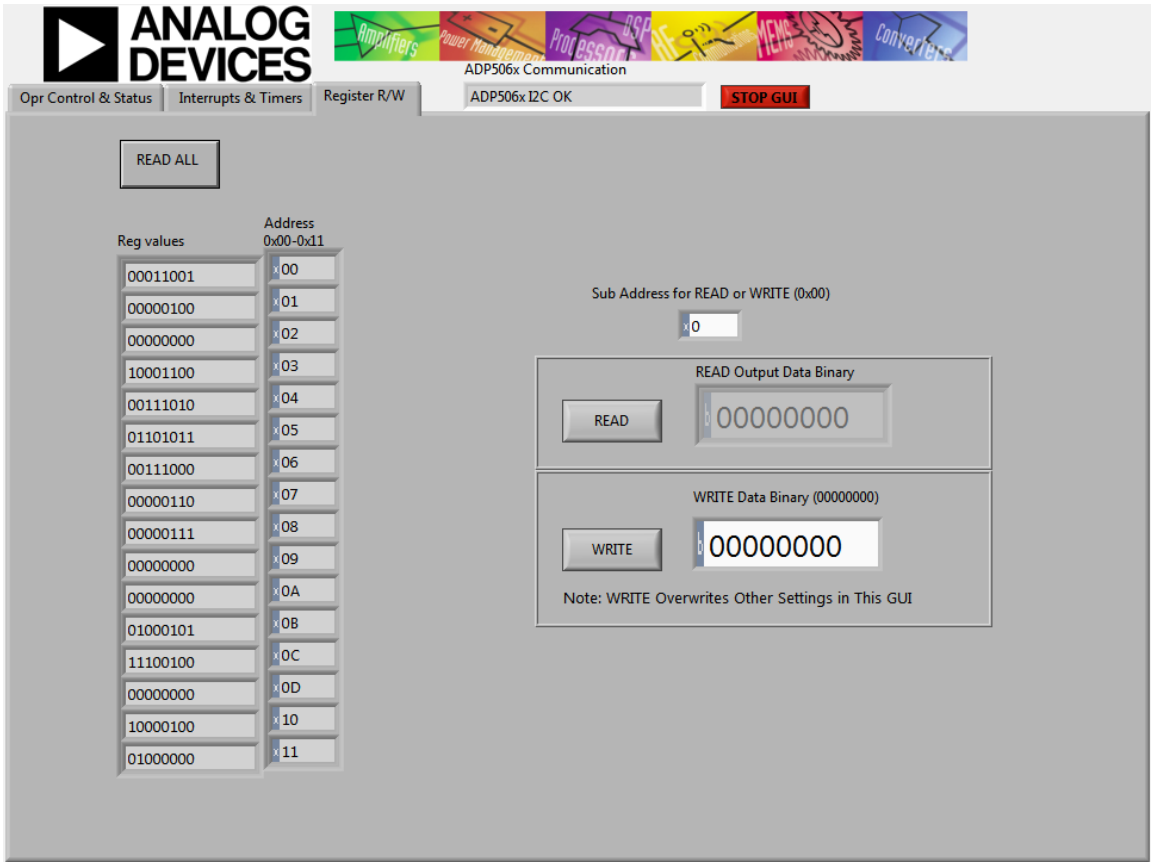

Figure 4. ADP5062 Evaluation Software GUI, Register R/W Tab

EVALUATION BOARD OVERVIEW

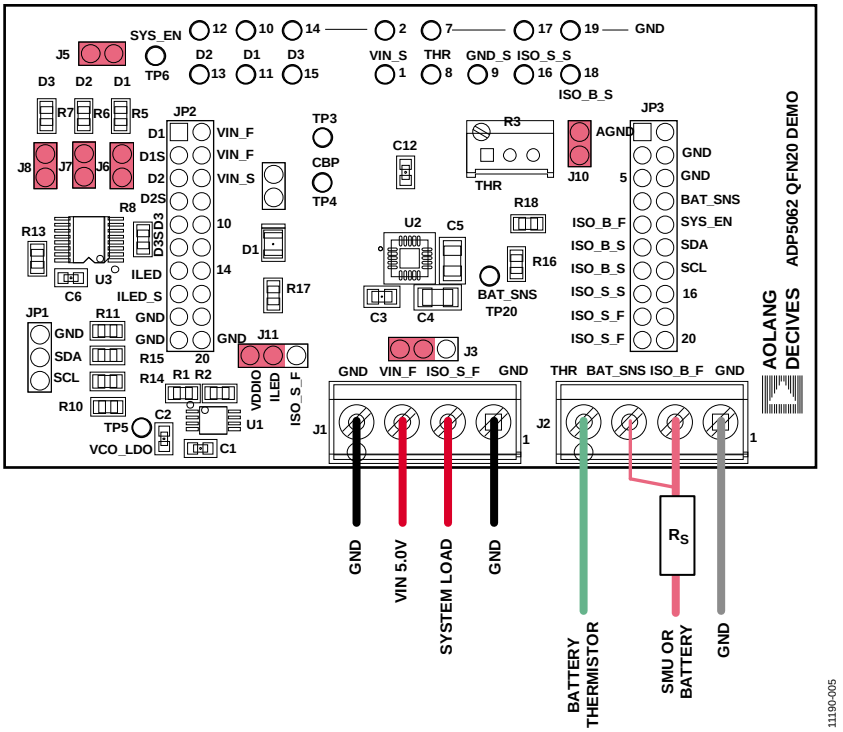

Figure 5. ADP5062 LFCSP Demo Board Typical Operation Setup

TYPICAL OPERATION

The typical test setup for the ADP5062 charger consists of a dc power supply unit (PSU) for VIN_F, a source meter unit (SMU) or a battery simulator for the ISO_Bx pins, and a variable power resistor or electronic load for the 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 its positive lead. The resistor emulates the equivalent series resistance of a real battery. Some SMU models that have been successfully used for the ISO_x_F node include the following:

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

INPUT CURRENT

Measuring Total Input Current (I_{VIN})

When measuring VINx input quiescent currents, take into account that the evaluation board includes an LDO (U1) and I²C input/output (I/O) expander (U2, U3A in Figure 7). The LDO generates a 3.4 V VDDIO voltage for the I²C bus and SYS_EN open-drain output, and the I/O expander controls digital inputs DIG_IO1, DIG_IO2, and DIG_IO3.

In the ADP5062 evaluation board typical setup, U1 and U3 are powered through a pin header, J3. Typically, the combined current consumption of the U1 and the U3 are in the range of 1 mA to 2 mA. To separate the evaluation board quiescent current from the ADP5062 VINx 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).

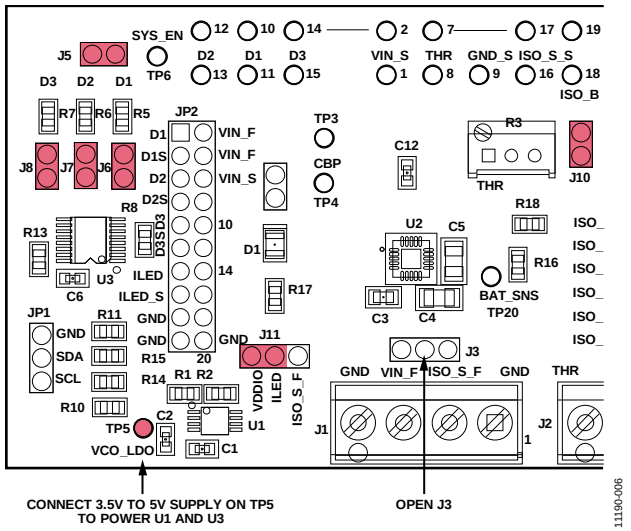

Figure 6. Board Setup for VINx Quiescent Current Measurement

VINx Current Limit

The VINx 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 current limit, complete the following steps:

1. Set the V_{VIN} supply voltage to 5.0 V.
2. Set the V_{ISO_B} voltage to 3.6 V on SMU B.
3. Enable charging by setting Register 0x07, Bit D0 (EN_CHG), high.
4. Confirm the ADP5062 charging mode:
   - The **Battery Status** indicator on the GUI must show **BAT_SNS > Vweak** (see Figure 2).
   - The ADP5062 must start charging 80 mA to 90 mA current into the battery.
5. Measure the current on 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 during a battery charging start-up sequence, if the voltage level at the ISO_Bx pins is lower than the 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), high. To measure the trickle charge current level, complete 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. Check 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:
   - Wait for a 30 second timeout to expire.
   - Check that the GUI shows that the I²C fault register (Register 0x0D, Bit D3) BAT_SHR flag is set.
   - Use the GUI to change the battery short timeout setting from 1 second to 180 second.
6. Measure the trickle charge current level to the battery. The default value for 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**.
8. The **Charger Status** indicator on the GUI should show **Fast Charge (CC-Mode)**. The charge current 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 change current, 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. 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.
6. The fast charge current may be reduced because of the following conditions:
   - The 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 a SMU or a battery simulator connected to the ISO_Bx, set the series resistance (R_S in Figure 5) within this range.

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

To measure the termination voltage, complete 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 register, Register 0x07.
4. Disable charge complete timer register, 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, complete the following steps:

8. Use the GUI to set the termination current to 52.5 mA.
9. Step V_{ISO_B} down 100 mV.
10. Enable the EOC by setting the EN_EOC bit (D2) to high in the functional settings register, Register 0x07.
11. 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:

12. 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 (V_{ISO_B}).
13. Use the GUI to change the termination current and recharge voltage programming. Repeat Step 9 to Step 12 to evaluate different settings.

THR INPUT AND JEITA SETTINGS

The THR input of the ADP5062 evaluation board is equipped with the 50 kΩ trimmer resistor (R3) and Jumper J10. When using an actual Li-Ion NTC thermistor terminal, configure the board according to Figure 5.

1. Remove Jumper J10.
2. Connect the Li-Ion battery NTC thermistor to the screw terminal, J2, 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 V_{VIN} input current limit to 1500 mA.
5. Enable charging (EN_CHG = high).
6. Measure current to ISO_Bx, value should 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 register, Register 0x08.
9. Measure current to ISO_Bx. 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.

SCHEMATIC DIAGRAM

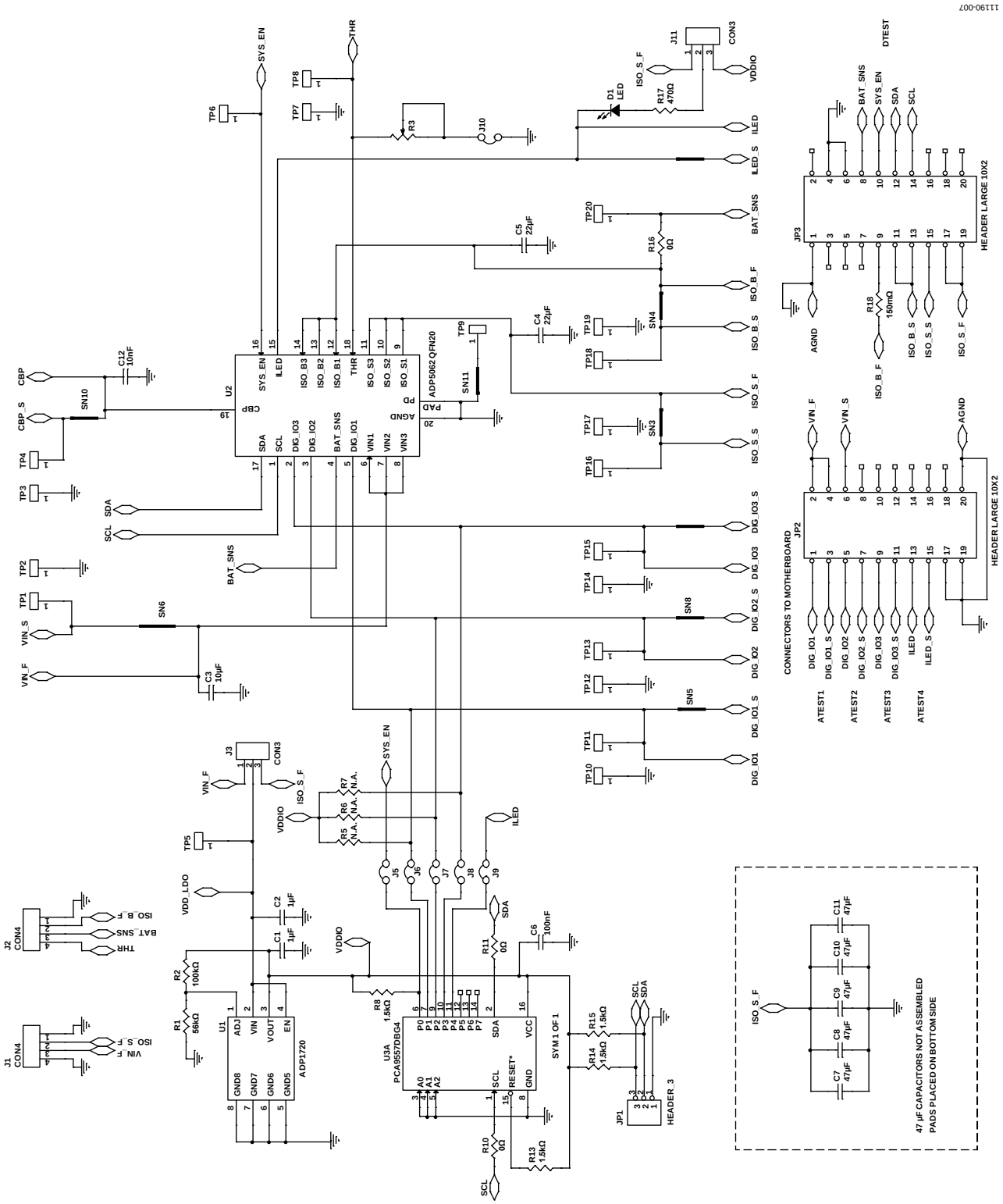

Figure 7. ADP5062 LFCSP Demo Board Schematic

ORDERING INFORMATION

BILL OF MATERIALS

Table 1.

Qty	Reference Designator	Description	Manufacturer/Vendor	Vendor P/N
2	C1, C2	Capacitors, 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	Not assembled	Not assembled
1	D1	Red 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 PCB connector, 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, 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 Ω, 1%, 0805, SMD	Rohm	MCR10EZHFLR150
20	TP1 to TP20	Test point, test header, 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 I/O port with reset	NXP	PCA9557PW,112

NOTES

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.

UG11190-0-4/13(0)

www.analog.com