

### FEATURES

- Input voltage: 2.3 V to 5.5 V**
- Evaluates backlight, individual sinks, and dual light sensing**
- Translates USB to I<sup>2</sup>C interface**
- Jumpers for measurement of the LEDs and input supply current**
- On-board reset push-button and interrupt indicator**
- Connector to interface external target hardware**
- On-board regulators**
- Individually selectable on-board LEDs for backlight and keypad light**

### GENERAL DESCRIPTION

The evaluation system is composed of a motherboard and a daughterboard. The motherboard provides the I<sup>2</sup>C signals from the computer USB port and generates the I/O voltages and digital high and low signals for the daughterboard.

The motherboard features a 3.3 V regulator (VBOARD), a 3.7 V regulator (VBATT), and a 2.7 V regulator (VDDIO). VBOARD

is the motherboard logic supply whereas VBATT provides power to the daughterboard. VDDIO is the digital I/O voltage supplying the I<sup>2</sup>C interface and the control pins. Jumper LK1 to Jumper LK3 on the motherboard define whether the internal regulators input voltage is supplied from the USB port or from external supplies connected to J29. The motherboard regulators are powered from the USB-VBUS line when Jumper LK1 to Jumper LK3 are in the USB position. External voltages can be applied to J29 to supply the motherboard and daughterboard, Jumpers LK1 to LK2 must be set to EXT position to use the external supply option.

The daughterboard contains numerous jumpers, LEDs, and test points for easy evaluation and monitoring of the board.

### EVALUATION KIT CONTENTS

- ADP8860 evaluation board**
- ADP8860 daughterboard**
- USB cable**
- Evaluation software**

### MOTHERBOARD AND DAUGHTERBOARD LAYOUT

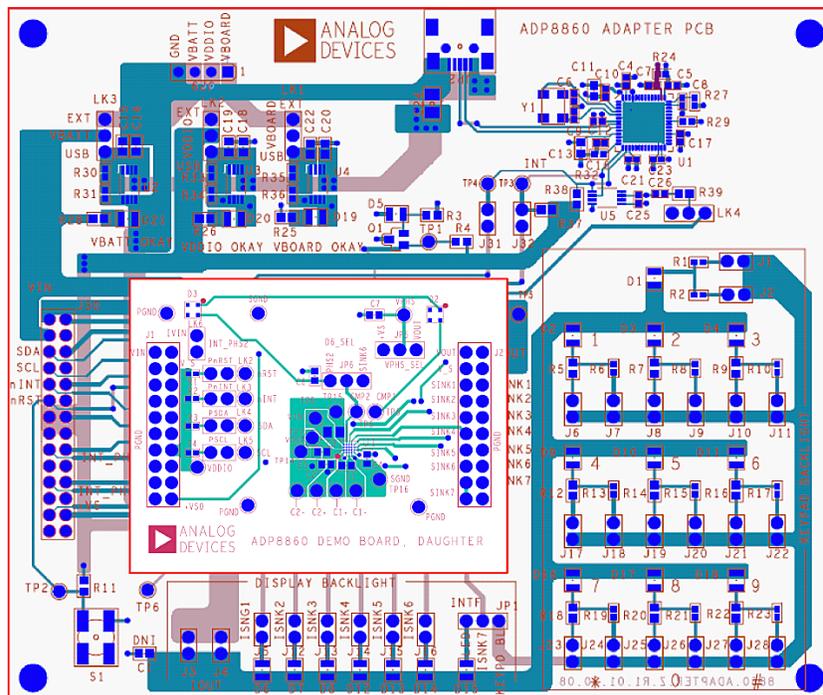


Figure 1.

### Rev. 0

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## REVISION HISTORY

7/09—Revision 0: Initial Version

## INSTALLING THE SOFTWARE

Before starting the software installation, make sure that the ADP8860 adapter board is not connected to the USB port of the PC.

Note: If the PC has LabVIEW™ already installed, this following step is not needed.

The application software is a compiled LabVIEW program requiring that the LabVIEW 8.5, or later version, run-time engine be installed on the PC. You can download the LabVIEW run-time engine on National Instrument’s website. A LabVIEW 8.5 run-time installation is available in the ADP8860 installation CD.

After installation, it may be necessary to reboot the PC to complete the operation.

1. Launch the **Setup.exe** file. When the dialog box shown in Figure 2 appears, click **Next>** to continue.

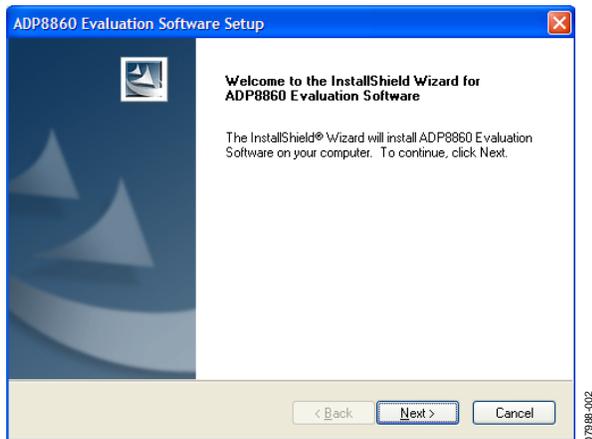


Figure 2. ADP8860 Evaluation Software Setup

2. Click **Yes** to accept the license agreement (see Figure 3).



Figure 3. License Agreement

3. Click **Next>** to install the files to the default destination folder or click **Browse...** to choose a different file (see Figure 4).

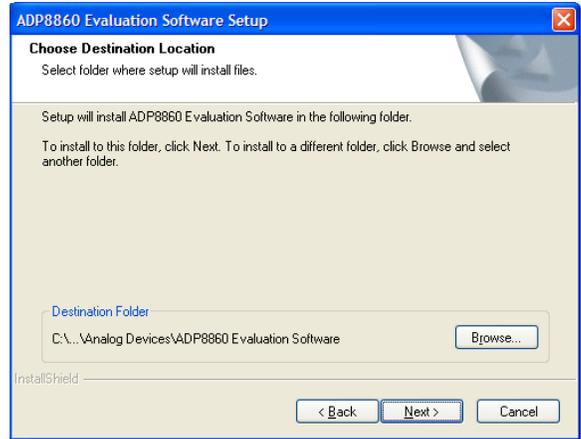


Figure 4. Choose Destination Location

4. Select the **Typical** set up type and click **Next>** to continue with the installation (see Figure 5).

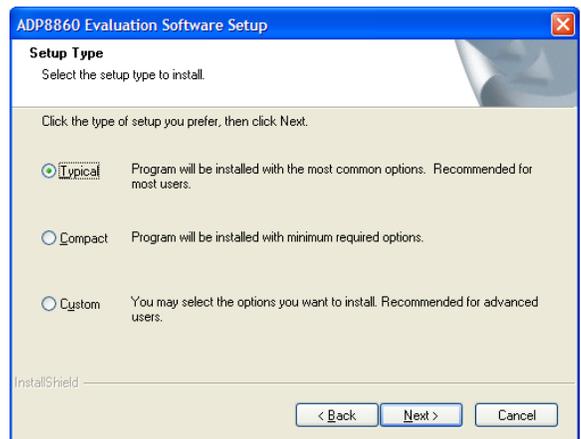


Figure 5. Setup Type

5. Click **Next**> to install the program to the default program folder (see Figure 6).

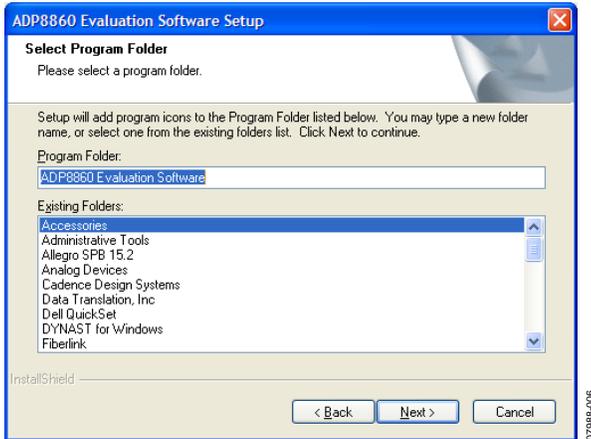


Figure 6. Select Program Folder

6. Click **Finish** to complete the installation (see Figure 7).

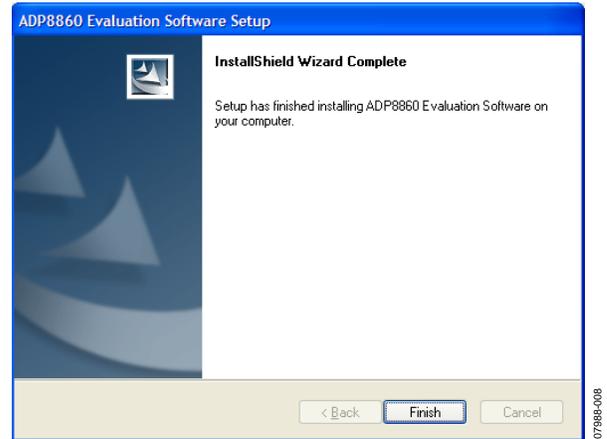


Figure 7. InstallShield Wizard Complete

## INSTALLING THE USB DRIVER

To install the USB driver, use the following steps:

1. Plug the ADP8860 board into the computer using the USB cable provided with the evaluation kit. When the system recognizes the board, the dialog box shown in Figure 8 appears.
2. Click **Next>** to install the driver.



Figure 8. Found New Hardware Wizard

3. When the dialog box in Figure 9 appears, click **Continue Anyway**.



Figure 9. Hardware Installation

4. Click **Finish** to complete the driver installation (see Figure 10).

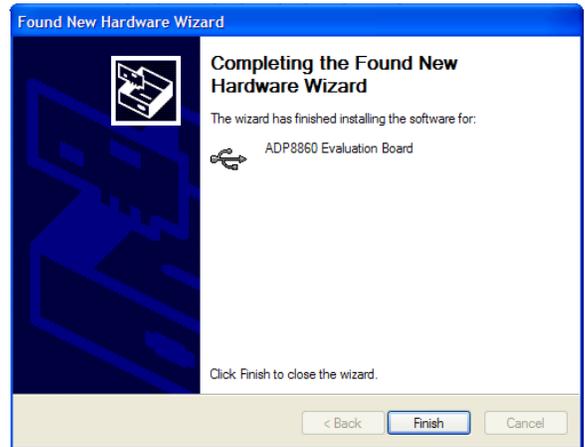


Figure 10. Driver Installation Complete

5. To check that the USB driver is installed properly, press **Start**. Then select **Control Panel > System** and open the **Device Manager** (see Figure 11).

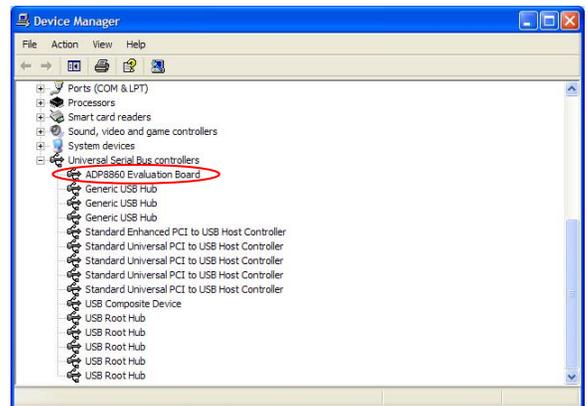


Figure 11. Check Driver Installation

When the USB cable is connected to a PC port different from the one used to install the driver, the PC device driver may ask you to install the driver again for that specific port. If this happens, repeat the first four steps listed in this section.

## QUICK START

### WARNING

Upon starting the ADP8860 application, a firmware is loaded into the adapter board processor (Cypress IC). This firmware is needed for the operation of the USB adapter and communication with the ADP8860 daughterboard. If the board is not connected through the USB cable, an error message appears on the screen (see Figure 12). This indicates that the firmware was not loaded into the adapter board. If this happens, check the USB connection, and ensure that Jumper LK10 is in the USB position. When the firmware is loaded, it resides in a volatile memory inside the Cypress processor. Therefore, if power is removed or the USB cable disconnected, the firmware is lost. If this happens, close the application, connect the adapter board, and then launch the ADP8860 application again to reload the firmware.



Figure 12. Board Detection Failure

It is recommended to always stop the program execution (press the EXIT button) before removing the USB cable.

Make sure that the software and USB driver are installed as described in the Installing the Software section. Connect the USB to a Mini-B cable (see Figure 13). Upon connecting the USB cable, the D19, D20, and D21 indicators light up, acknowledging that the supplies are ok.

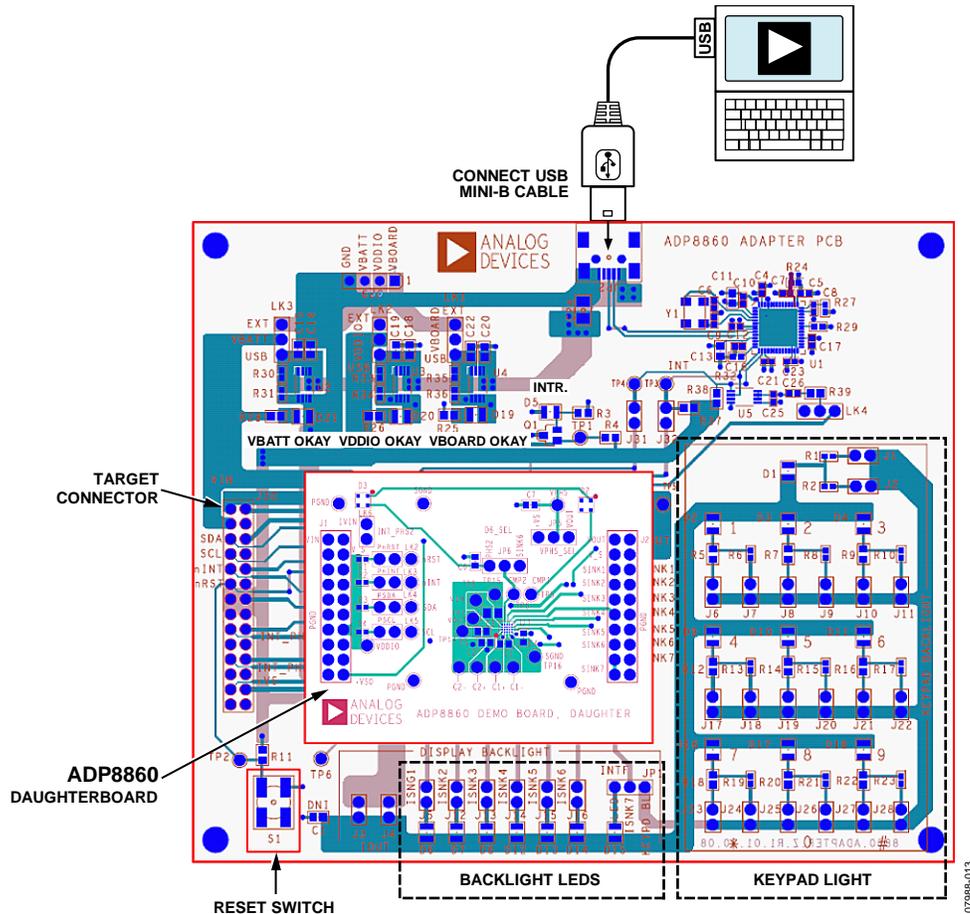


Figure 13. ADP8860 Board Connections

To run the ADP8860 GUI, click **Start > All Programs > Analog Devices > ADP8860 Evaluation Software 0\_x > ADP8860 Evaluation SW**. If the program starts correctly and the board is detected, the ADP8860 GUI appears as shown in Figure 14. The program default settings are as follows:

- All registers are initialized to zero.
- Comparators unit is in lux.
- **Enable History Log** is unchecked (data exchanged with the ADP8860 is not logged).

- **Read Refresh** option is unchecked (status registers are not read periodically).
- Refresh delay is 1000 ms.
- **Smart Update** option is checked (any change to the registers control triggers a write operation to the device).
- **Verify after Write** option is unchecked (a write operation is not verified).

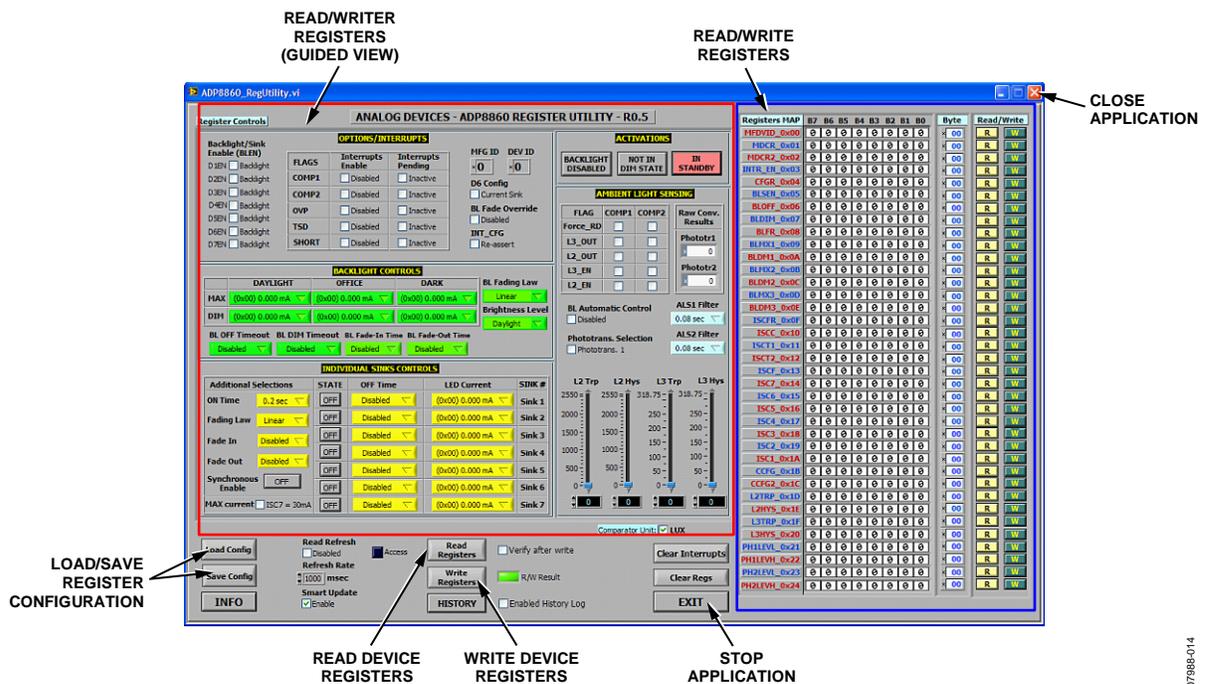
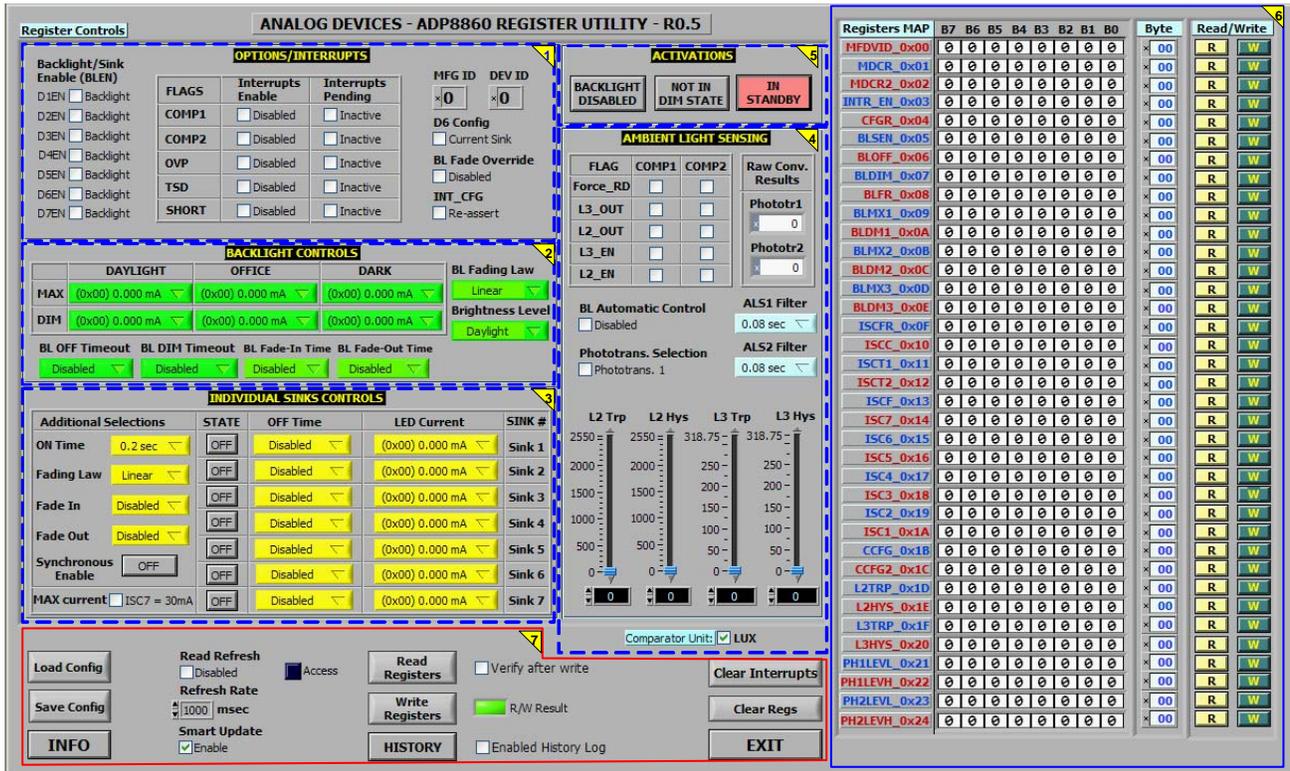


Figure 14. ADP8860 GUI

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## USING THE SOFTWARE



- 1 – VIEW/MODIFY OPTIONS AND INTERRUPTS
- 2 – VIEW/MODIFY BACKLIGHT PARAMETERS
- 3 – VIEW/MODIFY INDIVIDUAL SINKS PARAMETERS
- 4 – VIEW/MODIFY COMPARATORS PARAMETERS
- 5 – VIEW/MODIFY ACTIVATIONS
- 6 – VIEW/MODIFY REGISTERS (BIT/BYTE LEVEL)
- 7 – GUI COMMANDS AND CONTROLS

Figure 15. Evaluation Board Software

Before running the software, ensure that the board is connected to the computer USB port. You can verify this if the Vxxx-OKAY LEDs light up.

To run the ADP8860 GUI, click **Start > All Programs > Analog Devices > ADP8860 Evaluation Software 0\_x > ADP8860 Evaluation SW**. Failure to detect the adapter board prompts an error message as indicated in Figure 16. If this happens, check the connection and restart the program.

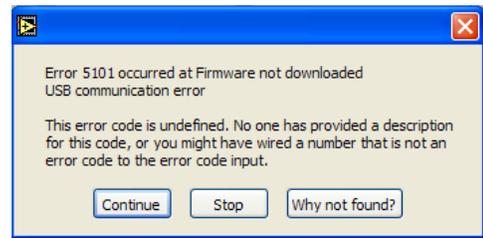


Figure 16. Board Detection Failure

## VIEW/MODIFY OPTIONS AND INTERRUPTS

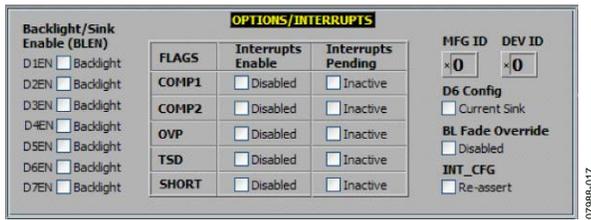


Figure 17. View/Modify Options and Interrupts

The view/modify options and interrupts block displays the ADP8860 general options and interrupts section (following a **Read Registers** operation) and allows modification of their current values (see Figure 17). The user just needs to select the desired value and then write to the device by clicking the **Write Registers** button (see Figure 25). If the option **Smart Update** is checked (default condition) as soon as a register value is changed, the application sends a programming command for that specific register without the need to press the **Write Registers** button. If **Smart Update** is unchecked, then data is programmed in the device registers when the **Write Registers** button is depressed.

The **Backlight/Sink Enable (BLEN)** control selects the current sinks used for the backlight (if the respective control is unchecked) or those treated as individual sinks (if the respective control is checked). This control corresponds to Register BLEN (Address 0x05).

Interrupts are enabled (if checked) or disabled (if unchecked) by the **Interrupts Enable** options. This control corresponds to Register INTR\_EN (Address 0x03). The interrupt pending flags are displayed in the **Interrupts Pending** section. This indicator corresponds to Register MDCR2 (Address 0x02). **Interrupts Pending** can be cleared by depressing the **Clear Interrupts** button (see Figure 25).

**MFG ID** is the manufacturer ID, Register MFDVID, Bit[7:4] (Address 0x00). **DEV ID** is the ADP8860 device revision, Register MFDVID, Bit[3:0]. This register is read-only.

The **D6 Config** checkbox selects D6 pin function. If unchecked, D6 is the sixth current sink. If checked, D6 is the input for the second phototransistor. This corresponds to Bit CMP2\_SEL in the CFGR register (Bit 5, Address 0x04). When D6 is selected as input for the second phototransistor, Jumper J16 must be removed.

The **BL Fade Override** checkbox enables fade override mode. If unchecked, fade override is disabled. If checked, fade override is enabled. This corresponds to Bit FOVR in the CFGR register (Bit 0, Address 0x04).

The **INT\_CFG** checkbox selects the interrupt reassertion mode. If unchecked, the interrupt is reasserted immediately, after clearing a pending interrupt, when the condition persists. If checked, the interrupt is deasserted at least 50  $\mu$ s after clearing the pending interrupt. This corresponds to Bit INT\_CFG in the MDCR register (Bit 6, Address 0x01).

## VIEW/MODIFY BACKLIGHT PARAMETERS



Figure 18. View/Modify Backlight Parameters

The controls in the view/modify backlight parameters block show the current parameters programmed for the backlight and allow modifications using the selections and drop-down controls.

The backlight brightness level is shown/changed for three levels: daylight, office, and dark. Each level has two operating states: maximum and dim. The first row shows/changes the maximum backlight brightness level, whereas the second row is for the dim level. The first column from the left shows/changes the **DAYLIGHT** levels, the second column shows/changes the **OFFICE** levels, and the third column shows/changes the **DARK** levels. The controls correspond to the following ADP8860 registers:

- Maximum daylight = Register BLMX1 (Address 0x09)
- Dim daylight = Register BLDM1 (Address 0x0A)
- Maximum office = Register BLMX2 (Address 0x0B)
- Dim office = Register BLDM2 (Address 0x0C)
- Maximum dark = Register BLMX3 (Address 0x0D)
- Dim dark = Register BLDM3 (Address 0x0E)

The control's values are automatically scaled according to the fading law programmed in the **BL Fading Law** drop-down control.

The backlight activation time at the maximum brightness level is shown/changed using the **BL DIM Timeout** drop-down control. This corresponds to Register BLDIM (Address 0x07). The backlight activation time at the dim brightness level is shown/changed using the **BL OFF Timeout**. This corresponds to Register BLOFF (Address 0x06).

The backlight fade-in time is shown/changed using the drop-down control **BL Fade-In Time**. This corresponds to Bit[3:0] in Register BLFR (Address 0x08). The backlight fade-out time is shown/changed using the drop-down control **BL Fade-Out Time**. This corresponds to Bit[7:4] in Register BLFR (Address 0x08).

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The backlight fading law is shown/changed using the drop-down control **BL Fading Law**. This corresponds to Bit[2:1] in Register CFGR (Address 0x04).

The backlight brightness state, when not automatically controlled by the ambient light sensing comparator, is shown/changed using the **Brightness Level** drop-down control. This corresponds to Bit[4:3] in Register CFGR (Address 0x04).

## VIEW/MODIFY INDIVIDUAL SINKS PARAMETERS



Figure 19. View/Modify Individual Sinks Parameters

The controls in the view/modify individual sinks parameters block show the current parameters programmed for the individual sinks and allow modifications using selections and drop-down controls.

Each individual sink has dedicated registers to program the brightness intensity, off time, and activation state. These controls are distributed in seven rows, one per individual sink. The brightness level controls for Sink 1 to Sink 7 correspond to Register ISC7 to Register ISC1 (Address 0x14 to Address 0x1A). The **MAX current** checkbox for Sink 7 shows/changes the full-scale range of the seventh individual sink (ISC7). If unchecked, the maximum current is 30 mA. If checked, the maximum current is 60 mA.

The **ON/OFF** activation selections correspond to Register ISCC, Bit[6:0] (Address 0x10). In the software, this button is off by default, and the respective individual sink is in the off state. If selected, the respective individual sink is in the on state (if the backlight is activated). The off times are shown/changed using the drop-down control in the **OFF Time** column for each individual sink. The controls correspond to the following ADP8860 registers:

- Sink 1 off time = Bit[1:0] in Register ISCT2 (Address 0x012)
- Sink 2 off time = Bit[3:2] in Register ISCT2 (Address 0x012)
- Sink 3 off time = Bit[5:3] in Register ISCT2 (Address 0x012)
- Sink 4 off time = Bit[7:6] in Register ISCT2 (Address 0x012)
- Sink 5 off time = Bit[1:0] in Register ISCT1 (Address 0x011)
- Sink 6 off time = Bit[3:2] in Register ISCT1 (Address 0x011)
- Sink 7 off time = Bit[5:3] in Register ISCT1 (Address 0x011)

Controls acting on parameters common to all the individual sinks are grouped on the left side of the block. These parameters are as follows:

- The **ON Time** drop-down control corresponds to Bit[7:6] in Register ISCT1 (Address 0x11).
- The **Fading Law** drop-down control corresponds to Bit[1:0] in Register ISCFR (Address 0x0F).
- The **Fade In** drop-down control corresponds to Bit[3:0] in Register ISCF (Address 0x13).
- The **Fade Out** drop-down control corresponds to Bit[7:4] in Register ISCF (Address 0x13).
- The **Synchronous Enable** selection corresponds to Bit[2] in Register MDCR (Address 0x01).

## VIEW/MODIFY COMPARATOR PARAMETERS

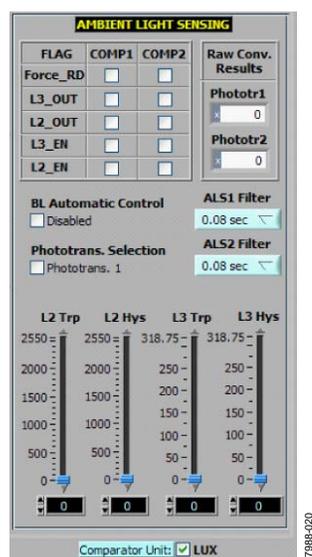


Figure 20. View/Modify Comparator Parameters

The controls in the view/modify comparator parameters block show the current parameters programmed for the light sensing comparators and allow modifications using selections and drop-down controls.

The **COMP1** column selections control the Comparator 1 operation. This corresponds to Bit[4:0] in Register CCFG (Address 0x1B).

The **COMP2** column selections control the Comparator 2 operation. This corresponds to Bit[4:0] in Register CCFG2 (Address 0x1C).

The pull-down controls **ALS1 Filter** and **ALS2 Filter** show/change the Comparator 1 and Comparator 2 filtering time constants. This corresponds to Bit[7:5] in Register CCFG (Address 0x1B) for Comparator 1 and Bit[7:5] in Register CCFG2 (Address 0x1C) for Comparator 2.

The **L2 Trp** slider shows/changes the Comparator 1 and Comparator 2 office/daylight tripping level and corresponds to Register L2\_TRP (Address 0x1D).

The **L2 Hys** slider shows/changes the Comparator 1 and Comparator 2 office/daylight hysteresis level and corresponds to Register L2\_HYS (Address 0x1E).

The **L3 Trp** slider shows/changes the Comparator 1 and Comparator 2 office/dark tripping level and corresponds to Register L3\_TRP (Address 0x1F).

The **L3 Hys** slider shows/changes the Comparator 1 and Comparator 2 office/dark hysteresis level and corresponds to Register L3\_HYS (Address 0x20).

The value shown for the comparator levels can be represented in lux or microamperes the selection is controlled by the **Comparator Unit** checkbox. One LSB is equivalent to 10 lux (or 4  $\mu$ A) for the L2 levels and 1.25 lux (or 0.5  $\mu$ A) for the L3 levels.

The **BL Automatic Control** selection corresponds to Bit 1 in Register MDCR (Address 0x01). When unchecked, the backlight brightness state is controlled by Bit[4:3] in Register CFGR (Address 0x04). When checked, the backlight brightness is automatically controlled by the ambient light sensors.

The **Phototrans. Selection** checkbox corresponds to Bit[6] in Register CFGR (Address 0x04). When the checkbox is not checked (as shown in Figure 20), **Phototrans. 1** is used to control the backlight brightness. When the checkbox is checked, **Phototrans. 2** is used.

The **Phototr1** and **Phototr2** indicators show the ambient light conversion level in raw format (as it comes out from the ADC). The value is aligned as a 13-bit number. Enable a comparator to display a value. The 13-bit value is calculated as follows:

$$Phototr1 = PH1LEVH \times 0x100 + PH1LEVL$$

$$Phototr2 = PH2LEVH \times 0x100 + PH2LEVL$$

Register PH1LEVL and Register PH1LEVH are mapped at Address 0x21 and Address 0x22.

Register PH2LEVL and Register PH2LEVH are mapped at Address 0x23 and Address 0x24.

## VIEW/MODIFY ACTIVATIONS



Figure 21. View/Modify Activations

The buttons in this block are used to control the backlight/individual activation. There are three buttons: **BACKLIGHT DISABLED**, **NOT IN DIM STATE**, and **IN STANDBY**.

- The **BACKLIGHT DISABLED** button corresponds to Bit[0] (BL\_EN) in Register MDCR (Address 0x01). When this button is depressed the backlight is activated according with the programmed parameters. If released, the backlight is turned off. This button can be reset automatically by the ADP8860.
- The **NOT IN DIM STATE** button corresponds to Bit[4] (DIM\_EN) in Register MDCR (Address 0x01). When this button is depressed and the backlight is enabled the backlight brightness is set at the dim level. This button can be set/reset automatically by the ADP8860.
- The **IN STANDBY** button corresponds to Bit[5] (nSTBY) in Register MDCR (Address 0x01). When this button is depressed, the device is not in standby mode. When released, the device is in standby mode.

## VIEW/MODIFY REGISTERS (BIT/BYTE LEVEL)

Registers MAP	B7	B6	B5	B4	B3	B2	B1	B0	Byte	Read/Write
MFDVID_0x00	0	0	0	0	0	0	0	0	x00	R W
MDCR_0x01	0	0	0	0	0	0	0	0	x00	R W
MDCR2_0x02	0	0	0	0	0	0	0	0	x00	R W
INTR_EN_0x03	0	1	0	0	0	0	0	0	x00	R W
CFGR_0x04	0	0	0	0	0	0	0	0	x00	R W
BLSEN_0x05	0	0	0	0	0	0	0	0	x00	R W
BLOFF_0x06	0	0	0	0	0	0	0	0	x00	R W
BLDIM_0x07	0	1	0	0	0	0	0	0	x00	R W
BLFR_0x08	0	0	0	0	0	0	0	0	x00	R W
BLMX1_0x09	0	0	0	0	0	0	0	0	x00	R W
BLDM1_0x0A	0	0	0	0	0	0	0	0	x00	R W
BLMX2_0x0B	0	1	0	0	0	0	0	0	x00	R W
BLDM2_0x0C	0	0	0	0	0	0	0	0	x00	R W
BLMX3_0x0D	0	0	0	0	0	0	0	0	x00	R W
BLDM3_0x0E	0	0	0	0	0	0	0	0	x00	R W
ISCFR_0x0F	0	1	0	0	0	0	0	0	x00	R W
ISCC_0x10	0	0	0	0	0	0	0	0	x00	R W
ISCT1_0x11	0	0	0	0	0	0	0	0	x00	R W
ISCT2_0x12	0	0	0	0	0	0	0	0	x00	R W
ISCF_0x13	0	1	0	0	0	0	0	0	x00	R W
ISC7_0x14	0	0	0	0	0	0	0	0	x00	R W
ISC6_0x15	0	0	0	0	0	0	0	0	x00	R W
ISC5_0x16	0	0	0	0	0	0	0	0	x00	R W
ISC4_0x17	0	0	0	0	0	0	0	0	x00	R W
ISC3_0x18	0	0	0	0	0	0	0	0	x00	R W
ISC2_0x19	0	0	0	0	0	0	0	0	x00	R W
ISC1_0x1A	0	0	0	0	0	0	0	0	x00	R W
CCFG_0x1B	0	0	0	0	0	0	0	0	x00	R W
CCFG2_0x1C	0	0	0	0	0	0	0	0	x00	R W
L2TRP_0x1D	0	0	0	0	0	0	0	0	x00	R W
L2HYS_0x1E	0	0	0	0	0	0	0	0	x00	R W
L3TRP_0x1F	0	0	0	0	0	0	0	0	x00	R W
L3HYS_0x20	0	0	0	0	0	0	0	0	x00	R W
PH1LEV_0x21	0	0	0	0	0	0	0	0	x00	R W
PH1LEVH_0x22	0	0	0	0	0	0	0	0	x00	R W
PH2LEV_0x23	0	0	0	0	0	0	0	0	x00	R W
PH2LEVH_0x24	0	0	0	0	0	0	0	0	x00	R W

Figure 22. View/Modify Registers (Bit/Byte Level)

In the view/modify registers (bit/byte level) block, all the ADP8860 registers are displayed according to their sequential address value. The registers content can be seen or modified in binary or numeric format.

The user has the choice to modify the registers bitwise by selecting the desired bit position. The bit value toggles from 0 to 1 or vice versa. It is not possible to change the values of the grayed bits. The register values can also be changed by entering a hex value in the desired register control. The **Hex/Dec** button (shown in the **Byte** column as an **x**) allows the user to change the data format of the register values from hexadecimal to decimal or vice versa. Binary and byte controls are intercommunicating and, therefore, a change to one control is automatically reflected in the other. The **R** and **W** buttons beside each register allow reading or writing a specific device address.

The smart update option is not active for this block Therefore, a new value is written into the ADP8860 only following a write operation by depressing **W** or the **Write Registers** button.

All the register values in the application window are always kept in synch. Changing the value in binary or numeric format also changes the corresponding control on the left side and vice versa.

## GUI COMMANDS AND CONTROLS

When selected, the **Read Registers** button reads all the ADP8860 internal registers (Address 0x00 to Address 0x24) and updates the controls with the new values.

When selected, the **Write Registers** button writes the current register values set in the control register into the ADP8860 volatile memory. If the **Verify after Write** option is checked, the program reads back the programmed registers comparing the device values with the set values (buffer). If one or more errors are detected, a message pops up indicating the registers at fault. Figure 23 shows a verification error example.

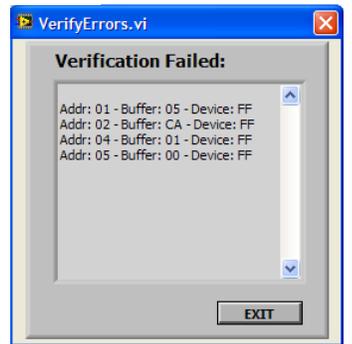


Figure 23. Verification Error

When selected, the **Clear Interrupts** button automatically clears all pending interrupts by writing all 1s in the MDCR2 register.

When selected, the **Clear Regs** button sets the user registers to 0. A message pops up requesting confirmation to continue with the operation or abort it, leaving the user registers unchanged (see Figure 24).

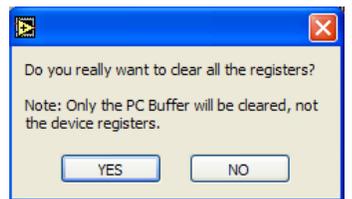


Figure 24. Register Clearing Confirmation



Figure 25. GUI Commands and Controls

The **Read Refresh** option enables the program to read the device status periodically. The refresh time is programmable in the **Refresh Rate** window from 100 ms to 5 sec. The registers read during the refresh are MFDVID (Address 0x00), MDCR (Address 0x01), CCFG (Address 0x1B), CCFG2 (Address 0x1C), PH1LEVL (Address 0x21), PH1LEVH (Address 0x22), PH2LEVL (Address 0x23), and PH2LEVH (Address 0x24), providing a real-time indication of the device functionality. When the blue **Access** indicator lights up, it indicates that the refresh operation is taking place.

The **Smart Update** option enables the program to automatically write an ADP8860 register when a value has been changed, which avoids selecting the **Write Registers** button every time a value is changed. The **Smart Update** option must be unchecked if the user wants to control the writing operations.

### LOAD/SAVE REGISTERS CONFIGURATION

The software program allows saving a specific registers configuration and loading it back in the **Register Controls and Registers MAP** window (see Figure 14). The **Save Config** button opens the file utility. Here, it is possible to specify a directory and filename to save. The default extension is **\*.dat** and it is suggested to maintain this convention. If the file does not exist, it is created. If the file already exists, it is overwritten.

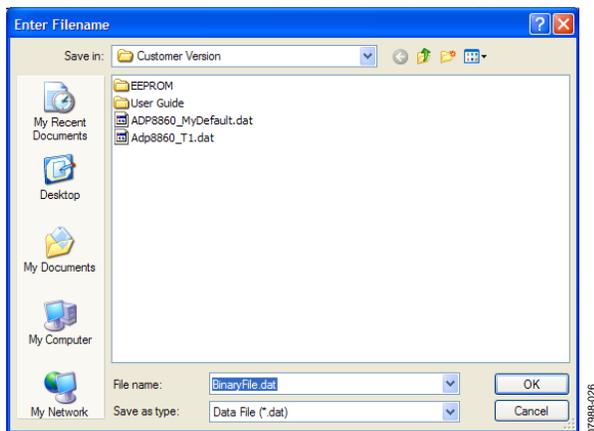


Figure 26. Save Configuration

The **Load Config** button opens the file utility where it is possible to specify a directory and filename to load. The default extension is **\*.dat**. Opting to cancel the operation prompts an error message. Press **Continue** to abort the operation (see Figure 27).

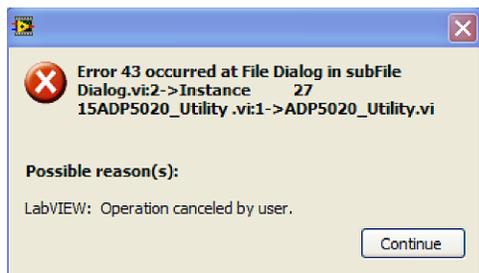


Figure 27. Load/Save Error Message

### ADDITIONAL COMMANDS

The **INFO** button provides information regarding the software revision number and other release notes (see Figure 25).

The **EXIT** button stops the program but leaves the window active (see Figure 25). To terminate the program completely, select the **X** button on the top right of the application window.

Online help is available by clicking **CTRL + H**. Hovering the mouse over a control or indicator displays information related to it in the context help window.

### HISTORY

Whenever issuing a command (both read and write), it is recorded in the **History** dialog box shown in Figure 28.

To display the **History** dialog box, click the **HISTORY** menu in the main software dialog box (see Figure 15) or the Windows® **History** tab on the bottom. To clear the history, click **Clear History**.

The window content can be copied and pasted into a text editor and then saved for future evaluation purposes.

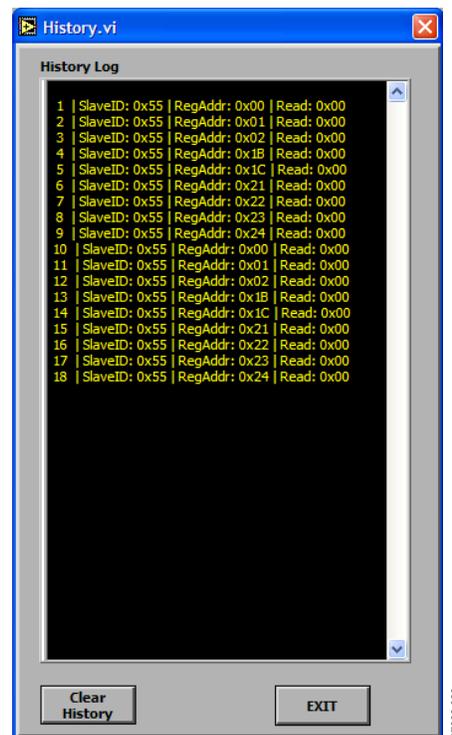


Figure 28. History

## EVALUATION BOARD OVERVIEW

### MOTHERBOARD

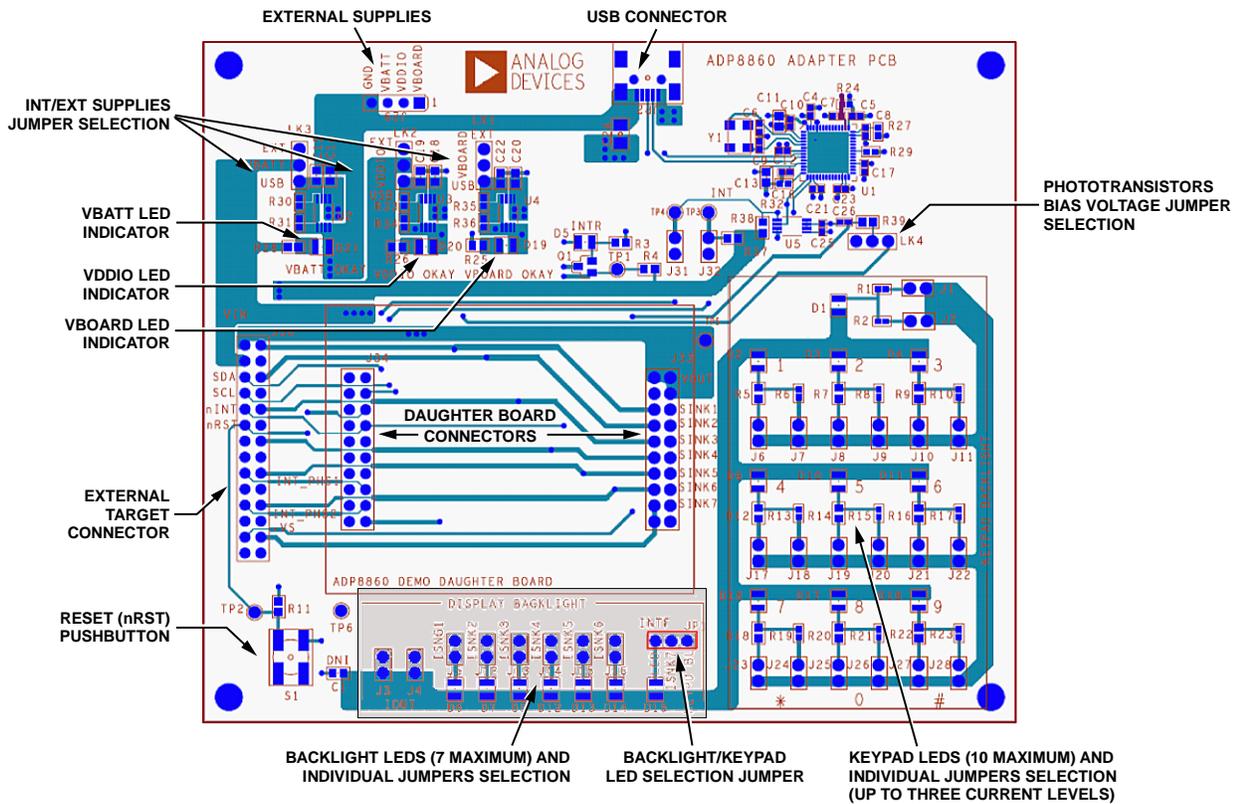


Figure 29. Motherboard

The EVAL-ADP8860 motherboard provides the interface signals to the ADP8860 parallel backlight IC. These include the SDA and SCL lines for I<sup>2</sup>C or the control line voltages for the hardware interface modes (nRST and nINT).

The CY68013A from Cypress Semiconductor Corporation provides the USB interface and I<sup>2</sup>C signals. The selected I<sup>2</sup>C frequency is 100 kHz. The M24C64R serial EEPROM provides the USB address of the board. The interface voltage is selected with the VBOARD header on the board and is set to 3.3 V by default.

Typically, the daughterboard is inserted directly into the 2 × 20 pin header of the motherboard. The 8-pin header, J29, on the top of the motherboard can be used to connect external supplies.

The VBATT OKAY, VDDIO OKAY, and VBOARD OKAY LEDs located at the top left of the board light up when the board is powered from the USB cable or external supplies are connected to J29 and the LK1 to LK3 jumpers are set in the EXT position. It is possible to choose several supply combinations. For example VBOARD, which supplies the motherboard ICs, can be provided from the USB while VDDIO and VBATT are provided externally. The motherboard contains three LDOs, generating the default supply voltage as indicated in Table 1.

Table 1. Power Supply Options

Supply Line	LK8 to LK10 in USB Position	LK8 to LK10 in EXT Position
VBATT	Internal: 3.7 V	External: 2.3 V to 5.5 V
VDDIO	Internal: 2.7 V	External: 1.7 V to 5.5 V
VBOARD	Internal: 3.3 V	External: 2.7 V to 3.6 V

Jumper LK4 selects the supply voltage for the daughterboard phototransistors. With the jumper in EXT\_VS position, the supply voltage +VS comes from the external target. With the jumper in VBOARD position, +VS is supplied by the VBOARD rail.

The VDDIO supply line determines the logic levels for nRST, nINT, SDA, and SCL.

When shunted, Jumper J31 and Jumper J32 connect the Cypress I<sup>2</sup>C interface to the daughterboard, which is the default setting for PC-to-adapter board communication. J31 and J32 must be removed if the I<sup>2</sup>C interface (master) is provided from the target (J30) to avoid bus contention.

JP1 selects the Sink 7 usage mode. If JP1 is in the **LED** position, Sink 7 is connected to the D15 LED and can be used as individual sink or as part of the backlight. If JP1 is in the **KEYPD BL** position, Sink 7 is connected to the keyboard light LED block.

For demonstration purposes the adapter board contains two LED lighting sections: the display backlight and the keypad backlight. The former can be configured, through jumper selection, to drive up to seven LEDs with up to 30 mA per LED. The second LED section contains up to 10 LEDs with a jumper-programmable current range. For example, D2 has two jumpers associated with it: J6 and J7. D2 is disabled by removing both jumpers. If only J6 is installed, D2 has a 100 Ω limiting (ballast) resistor. If only J7 is installed, D2 has a 50 Ω limiting resistor. If both jumpers are installed, the limiting resistor is the parallel of two resistors or 33.3 Ω. The lower is the limiting resistor; the higher is the driving capability per LED. The same applies for all the other LEDs used for the keypad backlight.

It is possible to measure the total LEDs current by removing the J1 and J2 jumpers and inserting a current meter across one of the jumpers. Each LED current can be measured by removing the individual LED selection (that is, J5 for D5, Sink 1 LED) and inserting an ammeter. The ADP8860 input current can be measured by removing Jumper LK6 in the daughterboard and inserting a current meter across the jumper.

An external target hardware can be connected to the adapter and daughterboard using a J30 connector. The signals available are indicated in Figure 30.

	J30		
CHARGE-PUMP OUTPUT VOLTAGE (VOUT)	1	2	SINK 1 – LED1 CATHODE
BATTERY VOLTAGE SUPPLY (VBATT)	3	4	SINK 1 – LED1 ANODE
I <sup>2</sup> C SERIAL DATA LINE (SDA)	5	6	SINK 2 – LED2 CATHODE
I <sup>2</sup> C SERIAL CLOCK LINE (SCL)	7	8	SINK 2 – LED2 ANODE
INTERRUPT OUTPUT (nINT)	9	10	SINK 3 – LED3 CATHODE
RESET INPUT (nRST)	11	12	SINK 3 – LED3 ANODE
LOGIC VOLTAGE LEVEL (VDDIO)	13	14	SINK 4 – LED4 CATHODE
GROUND (GND)	15	16	SINK 4 – LED4 ANODE
EXTERNAL PHOTOTRANSISTOR 1 (I_PHS1)	17	18	SINK 5 – LED5 CATHODE
GROUND (GND)	19	20	SINK 5 – LED5 ANODE
EXTERNAL PHOTOTRANSISTOR 2 (I_PHS2)	21	22	SINK 6 – LED6 CATHODE
GROUND (GND)	23	24	SINK 6 – LED6 ANODE
PHOTOTRANSISTOR SUPPLY VOLTAGE (+VS)	25	26	SINK 7 – LED7 CATHODE
GROUND (GND)	27	28	SINK 7 – LED7 ANODE

Figure 30. Target Connector J30

The target can either control the circuit in the adapter board or be driven by the daughterboard, such as when the LEDs reside on the target board. Also, I<sup>2</sup>C commands can be sent in either direction. When the target provides the I<sup>2</sup>C interface, however, the J31 and J32 jumpers must be removed.

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# EVAL-ADP8860

## DAUGHTERBOARD

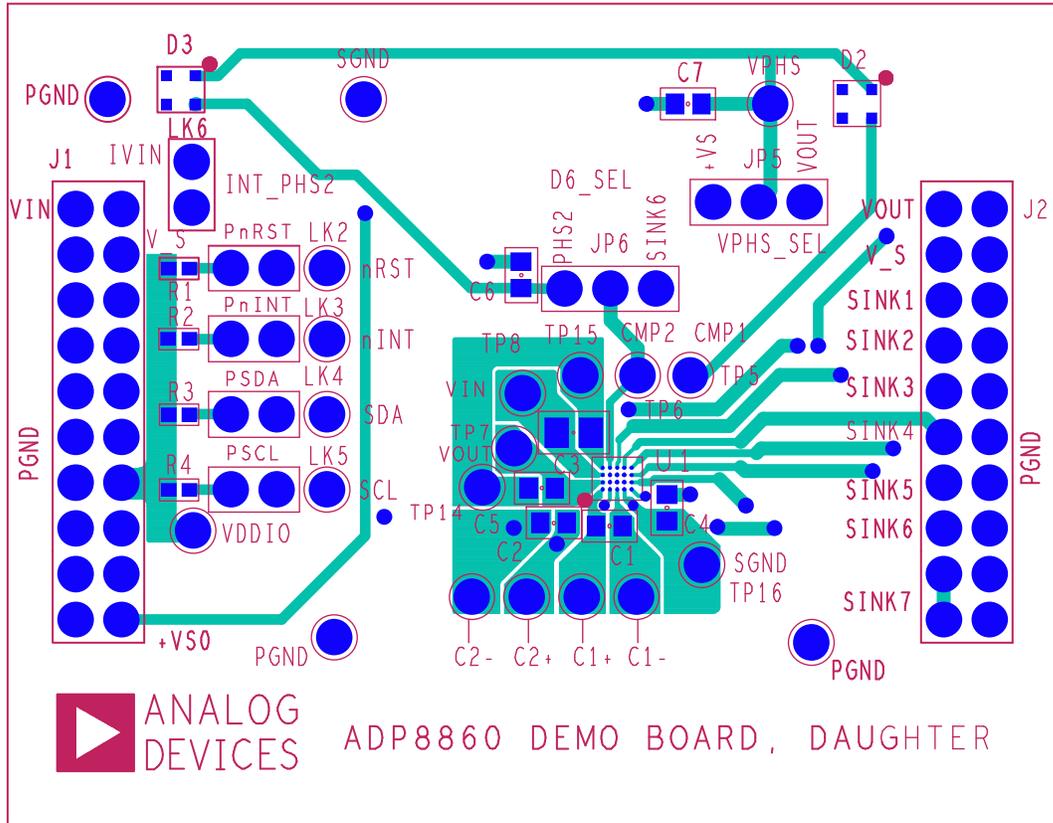


Figure 31. Daughterboard

The ADP8860 evaluation daughterboard is designed to quickly evaluate key parameters of the ADP8860 IC. The board layout footprint is extended so that parts can be exchanged easily, and headers are available to measure currents using a current probe or ammeter.

Connect a power supply or Li-Ion battery with 1 A maximum current capability to VBATT (see Figure 29). Short thick cables are recommended to minimize the IR drops. A high current can cause a big IR drop, and VBATT can be low enough to put the part into UVLO.

LK2, LK3, LK4, and LK5 enable 10 kΩ pull-ups on nRST, nINT, SDA, and SCL, respectively. The pull-ups are referred to as the VDDIO supply.

Jumper JP6 must be installed in the PHS2 position if both phototransistors are used. In addition, Jumper J16 in the motherboard must be removed to disconnect LED6 from the second comparator input. In this configuration, the ADP8860 supports only six LEDs. Make sure to set the **D6 Config** checkbox in the GUI to enable the second comparator (see Figure 15 and Figure 16).

### Quiescent Current Measurement

The ADP8860 has only one supply line (VIN) coming from the external supply. The input current can be measured by removing Jumper LK6 and inserting a current meter across the jumper.

**Kelvin Measurements**

The input and output voltages are routed to Connector J1 (VIN\_SENSE) and Connector J2 (VOUT\_SENSE) using Kelvin connections (the point of measurement is directly on the capacitor pads). This minimizes the measurement error due to the IR drop of the trace resistance. Table 2 and Table 3 show the signals available on Connector J1 and Connector J2.

**Table 2. Measurement Signals for J1**

Signal	Pin No.	Description
VIN	1, 2, 3	ADP8860 supply input
VIN_SENSE	4	Kelvin measurement at VIN
nRST	6	Reset line to ADP8860
nINT	8	Interrupt line from ADP8860
SDA	10	I <sup>2</sup> C bidirectional line
SCL	12	I <sup>2</sup> C clock line
VDDIO	14	Logic level reference voltage
I_PHS1	16	External Phototransistor 1
I_PHS2	18	External Phototransistor 2
+VS	20	Phototransistors supply voltage
GND	5, 7, 9, 11, 13, 15, 17, 19	Ground

**Table 3. Measurement Signals for J2**

Signal	Pin No.	Description
VOUT	1, 2, 4	Charge-pump output voltage
VOUT_SENSE	3	Kelvin measurement at VOUT
Sink 1	5	Output Sink 1
Sink 2	7	Output Sink 2
Sink 3	9	Output Sink 3
Sink 4	11	Output Sink 4
Sink 5	13	Output Sink 5
Sink 6	15	Output Sink 6
Sink 7	17, 19	Output Sink 7
GND	6, 8, 10, 12, 14, 16, 18, 20	Ground

**Power Board from USB Port Only**

To power the board via the USB without using an external supply, short Jumper LK1 to Jumper LK3 on the motherboard (USB position). Avoid exceeding the 500 mA current limit of the USB.

# EVAL-ADP8860

## EVALUATION BOARD SCHEMATICS AND ARTWORK

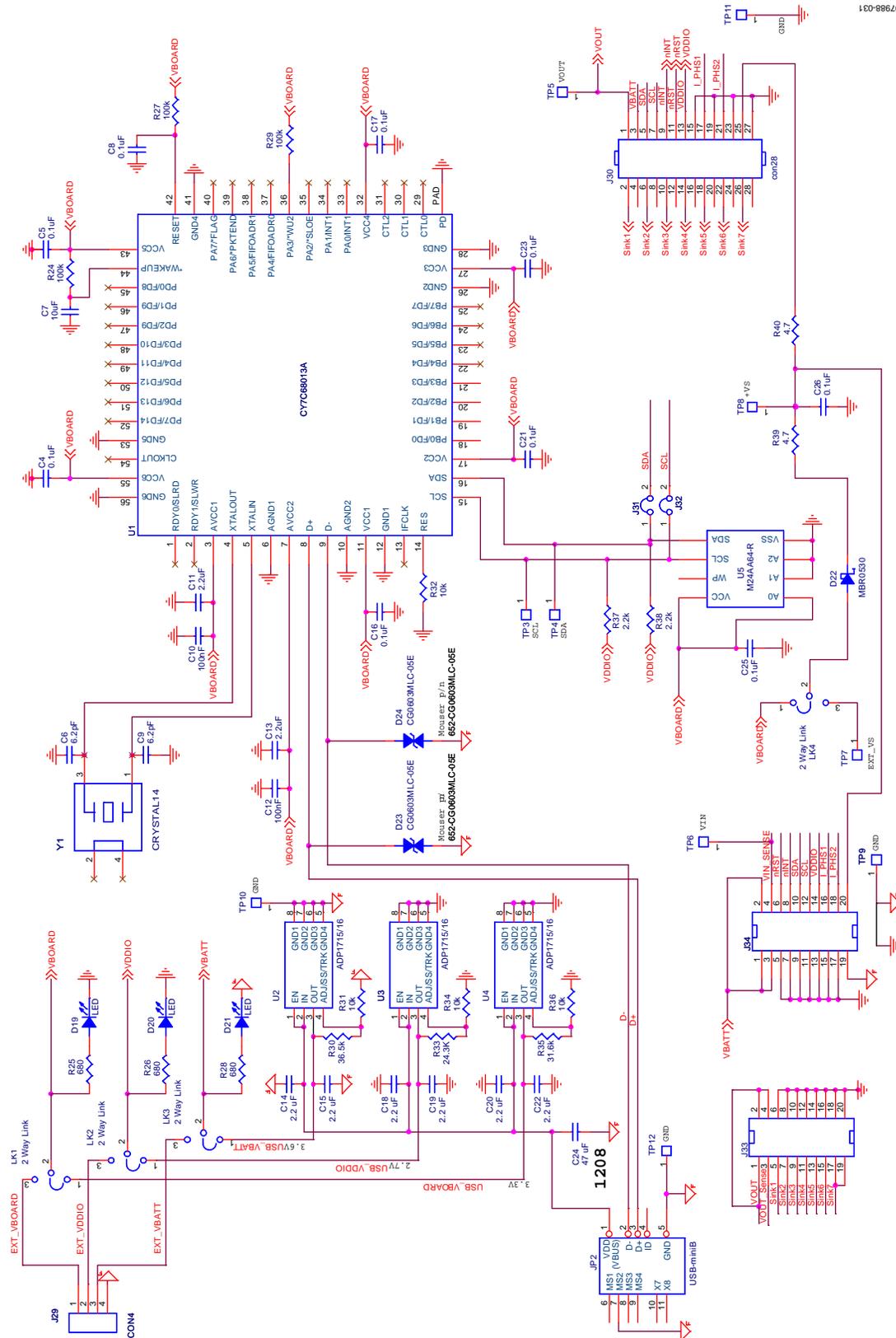


Figure 32. Motherboard Schematic—Main Section

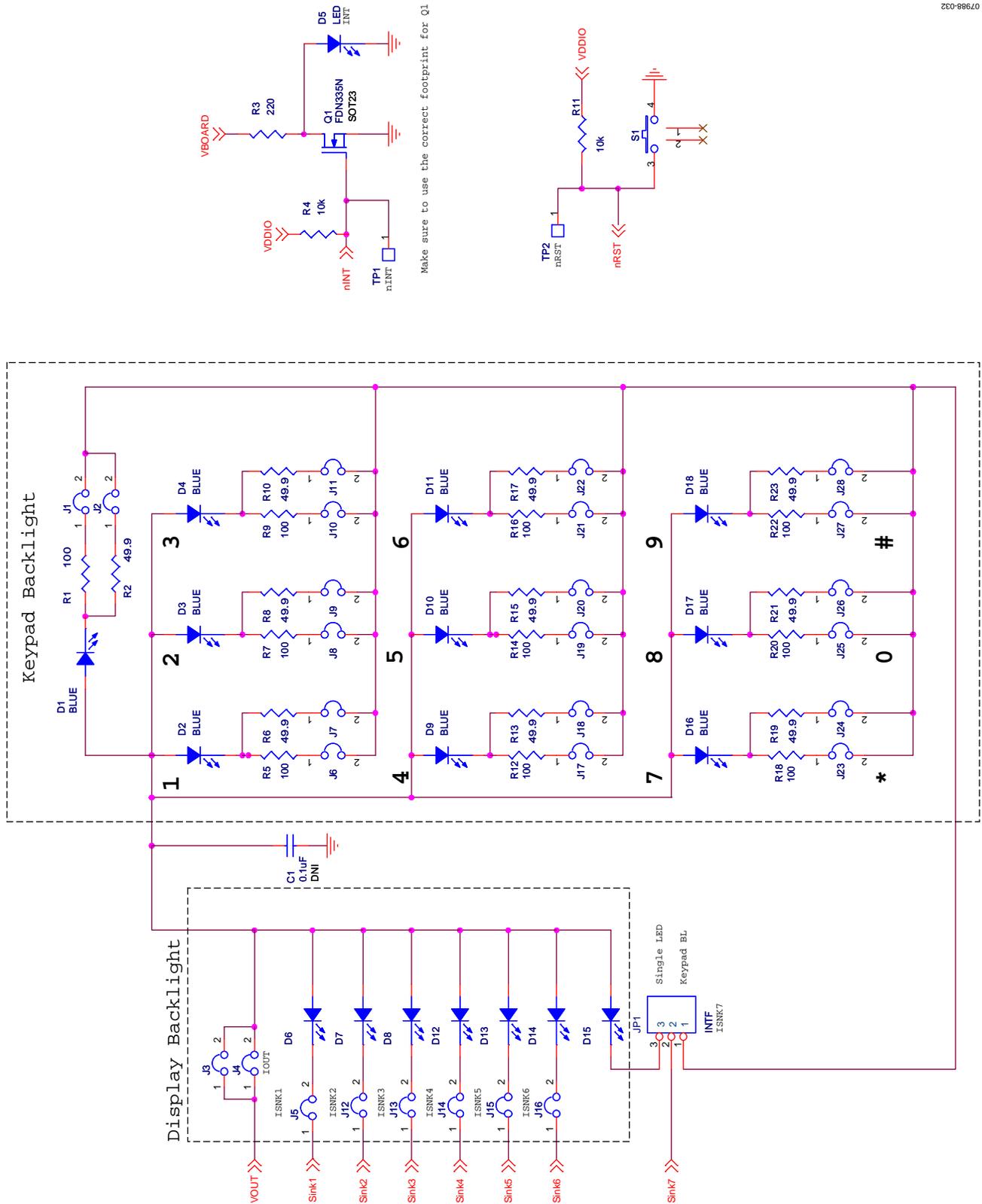


Figure 33. Motherboard Schematic—Interface Section



## PCB LAYOUT

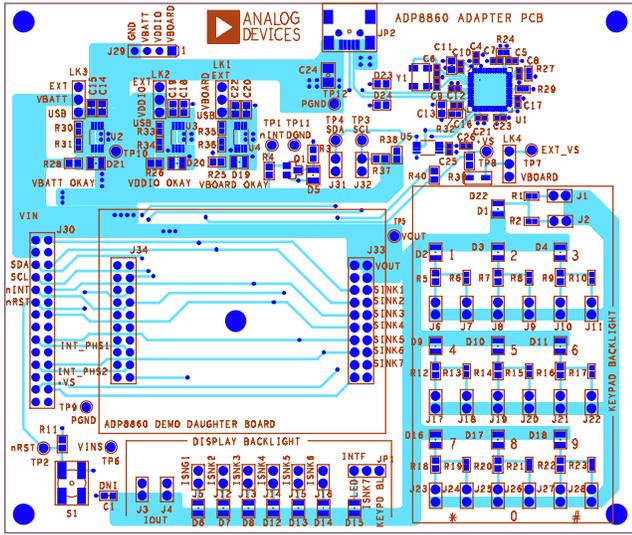


Figure 35. Motherboard, Top Layer

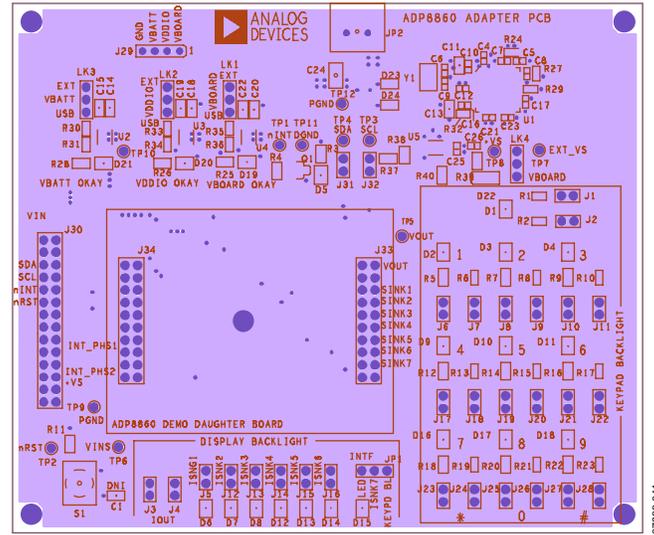


Figure 37. Motherboard, Inner Layer 2

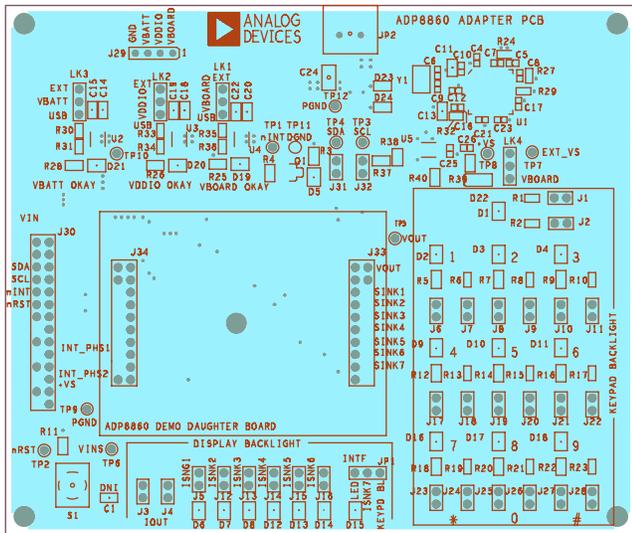


Figure 36. Motherboard, Inner Layer 1

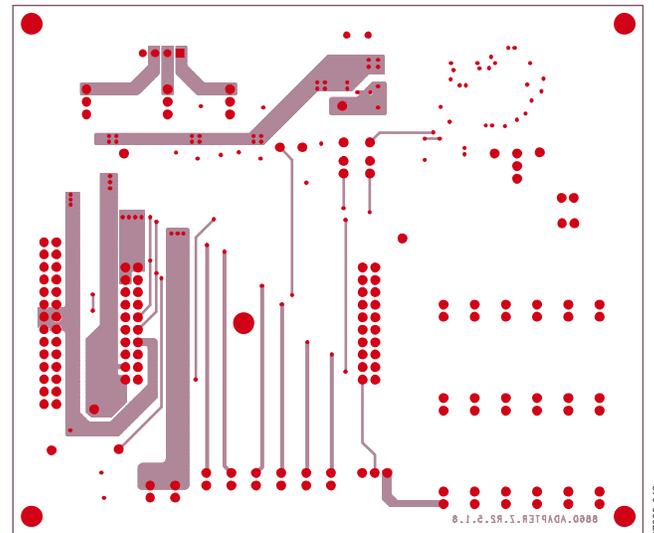


Figure 38. Motherboard, Bottom Layer

# EVAL-ADP8860

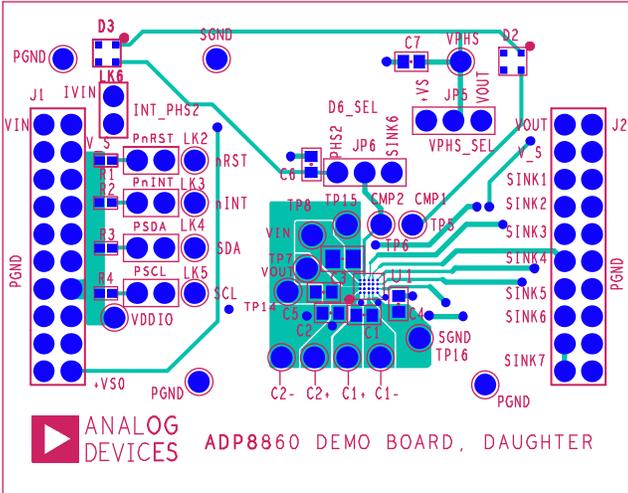


Figure 39. Daughterboard, Top Layer

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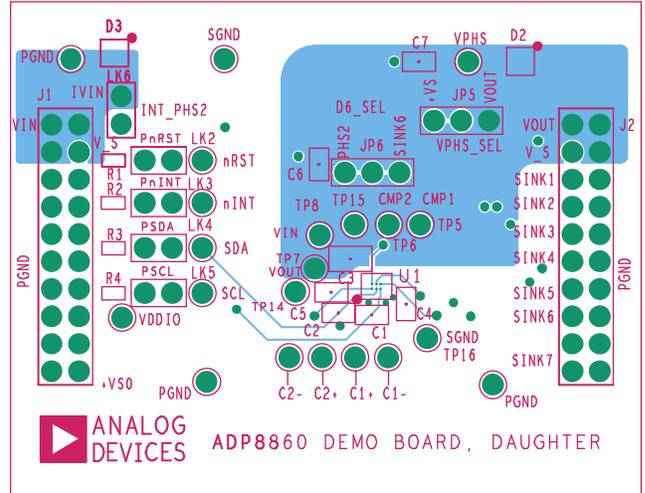
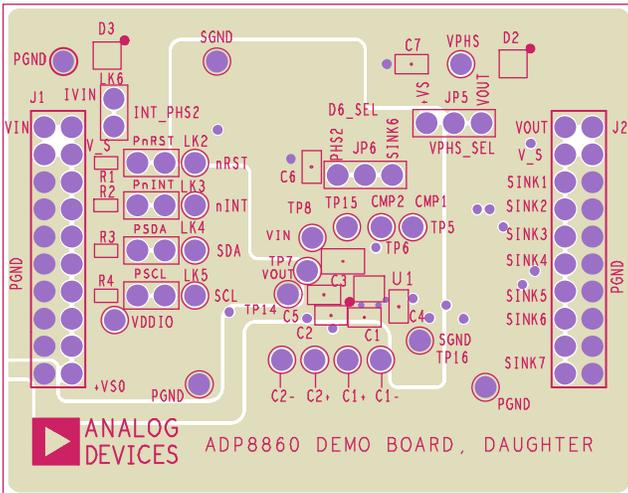


Figure 41. Daughterboard, Inner Layer 2

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## ORDERING INFORMATION

### BILL OF MATERIALS

Table 5. Motherboard

Qty	Reference Designator	Description	Manufacturer/Vendor	Part Number
12	C1, C4, C5, C8, C10, C12, C16, C17, C21, C23, C25, C26	100 nF, 10 V, 0402, X5R, MLCC capacitor	Murata Manufacturing Co., Ltd.	GRM155R61A104KA01B
2	C6, C9	6.0 pF, 0402, NP0, MLCC capacitor	Vishay/Panasonic	ECJ0EC1H060D
1	C7	10 $\mu$ F, 6.3 V, 0603, X5R, MLCC capacitor	Murata Manufacturing Co., Ltd.	GRM188R60J106ME
8	C11, C13, C14, C15, C18, C19, C20, C22	2.2 $\mu$ F, 10 V, 0603, X5R, MLCC capacitor	Murata Manufacturing Co., Ltd.	GRM188R61A225K
1	C24	47 $\mu$ F, 16 V, 1210 X5R, MLCC capacitor	Murata Manufacturing Co., Ltd.	GRM32ER61C476K
10	D1, D2, D3, D4, D9, D10, D11, D16, D17, D18	Blue 0805, SMD, LED	Lumex Inc.	SML-LX0805USBC-TR
1	D5	Red, 0805, SMD LED	Lumex Inc.	SML-LXT0805IW-TR
7	D6, D7, D8, D12, D13, D14, D15	White, 0805, SMD LED	Osram	LW M67C-S1T2-5K8L-Z
3	D19, D20, D21	Green, 0805, SMD LED	Lumex Inc.	SML-LXT0805GW-TR
1	D22	Schottky diode, SC70	ON Semiconductor	MBR0530T1G
2	D23, D24	USB ESD protector	Bourns	CG0603MLC-05E
10	R1, R5, R7, R9, R12, R14, R16, R18, R20, R22	100 $\Omega$ , 1%, 0603, SMD, resistor	Vishay Dale or equivalent	CRCW0603100RFKE
10	R2, R6, R8, R10, R13, R15, R17, R19, R21, R23	49.9 $\Omega$ , 1%, 0402, SMD resistor	Panasonic or equivalent	ERJ-2RKF49R9X
1	R3	220 $\Omega$ , 1%, 0603, SMD resistor	Vishay Dale or equivalent	CRCW0603220RFKE
6	R4, R11, R31, R32, R34, R36	10 k $\Omega$ , 1%, 0603, SMD resistor	Vishay Dale or equivalent	CRCW040210022F
3	R24, R27, R29	100 k $\Omega$ , 1%, 0402, SMD resistor	Vishay Dale or equivalent	CRCW04021003F
3	R25, R26, R28	680 $\Omega$ , 1%, 0603, SMD resistor	Vishay Dale or equivalent	CRCW04026810F
1	R35	31.6 k $\Omega$ , 1%, 0402, SMD resistor	Vishay Dale or equivalent	CRCW04023162F
2	R39, R40	4.75 $\Omega$ , 1%, 0603, SMD resistor	Vishay Dale or equivalent	CRCW06034R75FKTA
1	R30	36.5 k $\Omega$ , 1%, 0603, SMD resistor	Vishay Dale or equivalent	CRCW060336K5FKE
1	R33	24.3 $\Omega$ , 1%, 0402, SMD resistor	Vishay Dale or equivalent	CRCW040224K3FKE
2	R37, R38	2.21 k $\Omega$ , 1%, 0402, SMD resistor	Vishay Dale or equivalent	CRCW04022211FRT1
1	U1	IC MCU USB peripheral high SPD-56QFN	Cypress Semiconductor Corp	CY7C68013A
3	U2, U3, U4	IC LDO regulator, 500 mA, 8-Lead MSOP	Analog Devices, Inc.	ADP1715/ADP1716
1	U5	Microchip Serial EEPROM-64K, MSOP8	Microchip	M24LC64 or 24AA64
1	Y1	Crystal 24 MHz	CTS Corporation	CTX651CT
1	Q1	MOSFET N-channel, SOT23	Fairchild	FDN335N
1	JP2	USB Connector USB Mini-B, 5-pin	Delphi Corporation/Molex	15430262-110
30	J1 to J28, J31, J32	0.100, single, STR, 2-pin header	Sullins Connector Solutions	S1012-36-ND
1	J29	0.100, single, STR, 4-pin header	Sullins Electronics, Inc.	PEC36SAAN
1	J30	0.100, dual, STR, 28-pin header	Sullins Electronics, Inc.	PEC14DAAN
2	J33, J34	Male 0.100, dual, STR, 2 $\times$ 10 pin header	Sullins Connector Solutions	PTC10SAAN
5	LK1, LK2, LK3, LK4, JP1	0.100, single, STR, 3-pin header	Sullins Connector Solutions	PEC03SAAN
1	S1	Push-button switch, SMD	C & K Components	KSC321JLFS

# EVAL-ADP8860

Table 4. Daughterboard

Qty	Reference Designator	Description	Manufacturer/Vendor	Part Number
3	C1, C2, C5	1 $\mu$ F, 10 V, 0603, X5R, MLCC capacitor	Taiyo Yuden	LMK107BJ105KK-T
1	C3	10 $\mu$ F, 6.3 V, 0603, X5R, MLCC capacitor	Taiyo Yuden	JMK107BJ106MA
3	C4, C6, C7	100 nF, 10 V, 0402, X5R, MLCC capacitor	Murata Manufacturing Co., Ltd.	GRM155R61A104KA01B
4	R1, R2, R3, R4	10 k $\Omega$ , 1%, 0402 resistor	Vishay Dale	CRCW04021002F
2	D2, D3	6-pin chiptail phototransistor	Avago	APDS-9005-020
1	U1	20-ball, WLCSP ADP8860	Analog Devices	ADP8860ACBZ-R7
2	J1, J2	0.100, double-row 10-pin header	SAMTEC	SSW-110-03-G-D
5	LK2, LK3, LK4, LK5, LK6	0.100, single, STR, 2-pin header	Sullins Electronics, Inc./3M	S1012-36-ND
2	JP5, JP6	0.100, single, STR, 3-pin header	Sullins Electronics, Inc./3M	S1012-36-ND

## ORDERING GUIDE

Model	Description
ADP886XADAPT-EVALZ <sup>1</sup>	Motherboard
ADP8860DBCP-EVALZ <sup>1</sup>	Daughterboard—LFCSP Version
ADP8860DBCB-EVALZ <sup>1</sup>	Daughterboard—WLCSP Version

<sup>1</sup> Z = RoHS Compliant Part.

## 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.