



## Evaluating the **ADP8860/ADP8861** Charge Pump, 7-Channel Smart LED Driver with I<sup>2</sup>C Interface

### FEATURES

- Arduino compatible
- Backlight array
- Keypad backlight array
- Ambient light sensor
- Dedicated reset button
- Dedicated header for I<sup>2</sup>C communications

### EVALUATION KIT CONTENTS

The **ADP8860SHIELD-EVALZ** or the **ADP8861SHIELD-EVALZ**  
Connector jumpers

### EQUIPMENT NEEDED

- Micro USB to USB cable
- [EV-COG-AD3029LZ](#) and [EV-GEAR-EXPANDER1Z](#)
- Windows 7 or Windows 10 PC
- [EV-COG-BLEINTP1Z](#) (optional)

### GENERAL DESCRIPTION

The ADP8860SHIELD-EVALZ and the ADP8861SHIELD-EVALZ incorporate light emitting diodes (LEDs) for quick and easy evaluation of the ADP8860 and the ADP8861. Note that only the ADP8860SHIELD-EVALZ has dual light intensity sensors. The ADP8860SHIELD-EVALZ and the ADP8861SHIELD-EVALZ follow the form factor of a regular Arduino® shield to allow compatibility with microcontroller boards that use the same interface. These evaluation boards also incorporate a separate header dedicated to I<sup>2</sup>C communications.

The ADP8860 and the ADP8861 are 7-channel LED drivers that utilizes a charge pump with selective gain for maximum efficiency. The LEDs driven by either device are programmable for maximum current and fade in and out times via the I<sup>2</sup>C interface. Only the ADP8860 has a programmable light intensity threshold that can be set via the I<sup>2</sup>C interface of the device. Each channel can handle up to 30 mA (typical), except for the seventh channel, which can handle 60 mA (typical). Each channel can be unified to have the same fade in time and fade out time, or each channel can have an individual fade in time and fade out time for greater flexibility

For full details on the ADP8860 and the ADP8861, see the ADP8860 and the ADP8861 data sheets, which should be consulted in conjunction with this user guide when using these evaluation boards.

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## REVISION HISTORY

5/2021—Revision 0: Initial Version

## EVALUATION BOARD FUNCTIONAL BLOCK DIAGRAMS AND PHOTOGRAPH



Figure 1. Functional Block Diagram for Windows PC

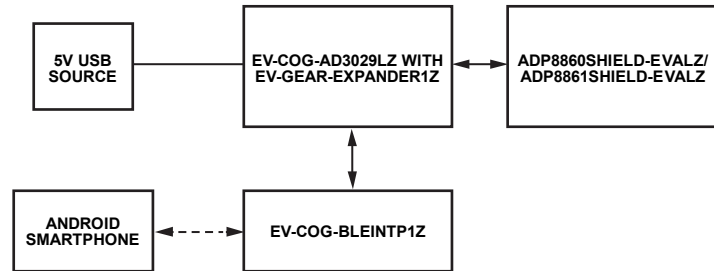


Figure 2. Functional Block Diagram for Android Smartphones

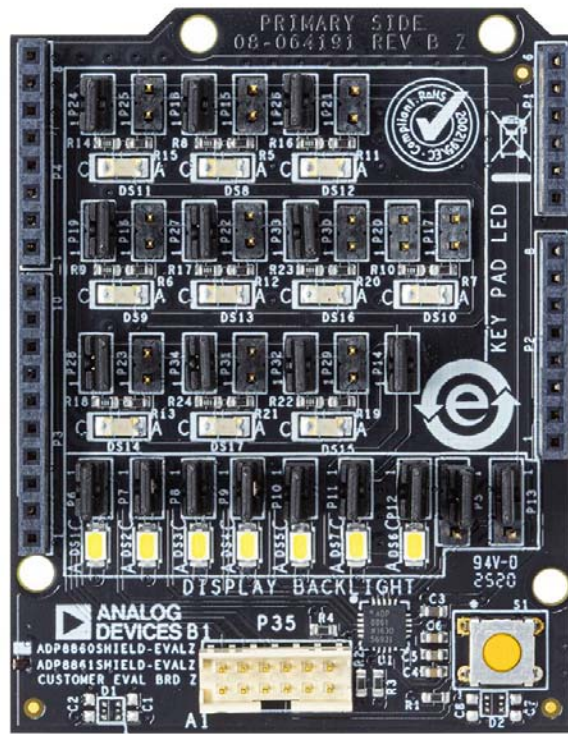


Figure 3. ADP8860SHIELD-EVALZ/ADP8861SHIELD-EVALZ Evaluation Board

## EVALUATION BOARD SETUP

### QUICK START PROCEDURE

The ADP8860SHIELD-EVALZ and the ADP8861SHIELD-EVALZ directly tie the input of the LEDs and the [ADP8860](#) or the [ADP8861](#) to the power rails of the host board ([EV-COG-AD3029LZ](#)), which eliminates the need for external power supplies in the evaluation. In addition, this evaluation incorporates graphical user interfaces (GUIs) for Windows® PC and Android® smartphones via Bluetooth®.

Based on the schematics (see Figure 25 and Figure 26), the ADP8860SHIELD-EVALZ and the ADP8861SHIELD-EVALZ have two LED groups: display backlight and keypad backlight. The display backlight LEDs include seven LEDs that can connect directly to the D1 to D7 pins of the ADP8860 or the ADP8861 via the P5 to P13 headers. The keypad backlight LEDs include 10 LEDs, and each of these LEDs has configurable series resistance. The keypad backlight LEDs are only tied to the D7 pin of either chip via the P13 header.

To enable the keypad backlight LEDs for either the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ, connect a jumper to P14 and between Pin 2 and Pin 3 of P13. When the keypad backlight LEDs are enabled, these LEDs disable one of the display backlight LEDs connected to Pin 1 of P13 for both the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ. The series resistance of each of the keypad backlight LEDs can be configured via the P15 to P34 headers

For the ADP8860SHIELD-EVALZ, light intensity sensing is implemented by using two ambient light photosensors, connect one sensor directly to Pin 18 of the ADP8860 and the other sensor through the P5 header. Sensing through P5 disables one of the display backlight LEDs connected to Pin 1 of the header.

To ensure proper operation, use the following sequence to power up the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ:

1. Connect the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ to the EV-COG-AD3029LZ via the [EV-GEAR-EXPANDER1Z](#).
2. Connect the EV-COG-AD3029LZ to the PC via the micro USB to USB cable.

# EVALUATING THE ADP8860SHIELD-EVALZ OR THE ADP8861SHIELD-EVALZ

## EVALUATION SUMMARY

All required software, such as the **CrossCore Serial Flash Programmer 1.5.0**, GUI installers for Windows and Android devices, and source code (hex file) for the embedded target are provided on the ADP8860SHIELD-EVALZ and the ADP8861SHIELD-EVALZ webpages. Before loading any new firmware to the **EV-COG-AD3029LZ**, clean and build the target and connect the EV-COG-AD3029LZ microcontroller to one of the ports on the Windows PC. Once the source code shown in Figure 6 loads, reset the EV-COG-AD3029LZ to ensure that the system, which includes the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ and the EV-COG-AD3029LZ, properly works. Once the source code is set up, open the GUI application on the specific machine being used.

Note that flashing the embedded target (EV-COG-AD3029LZ) can only be done using a Windows machine for this user guide.

## WINDOWS APPLICATION

Within the Windows application, users must take the following firmware, hardware, and GUI steps to evaluate the ADP8860SHEILD-EVALZ or the ADP8861SHEILD-EVALZ.

### Flashing Firmware

To flash the firmware, take the following steps:

1. Open the **CrossCore Serial Flash Programmer 1.5.0** app. If the programmer is not installed, download the installer from the [CrossCore Utilities](#) webpage.

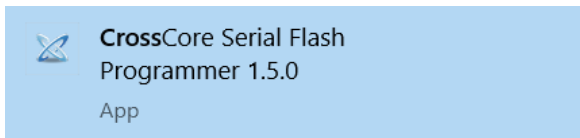


Figure 4. CrossCore Serial Flash Windows App

2. Ensure that the EV-COG-AD3029LZ is connected and select the following parameters (see Figure 5):
  - a. **Target:** ADuCM302x
  - b. **Serial Port:** (Port where the board is connected)
  - c. **Baudrate:** 115200
  - d. **Action:** Program

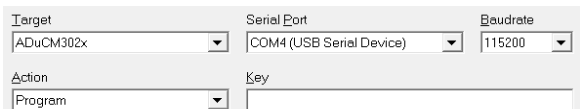


Figure 5. CrossCore Serial Flash Programmer Window

3. Under the **File to download** tab, browse and choose the source code (hex file) along with the downloaded files from the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ webpage.

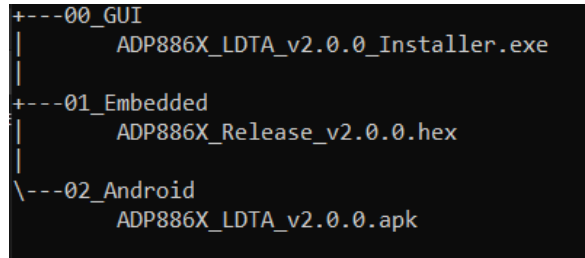


Figure 6. Package File Structure

4. Click **Start** to flash the programmer to the EV-COG-AD3029LZ.

## Hardware

To verify and reset the hardware, take the following steps:

1. Ensure that the GPIO28 pin on the **EV-GEAR-EXPANDER1Z** is not connected to GND. Remove any connection or jumpers if there is any.

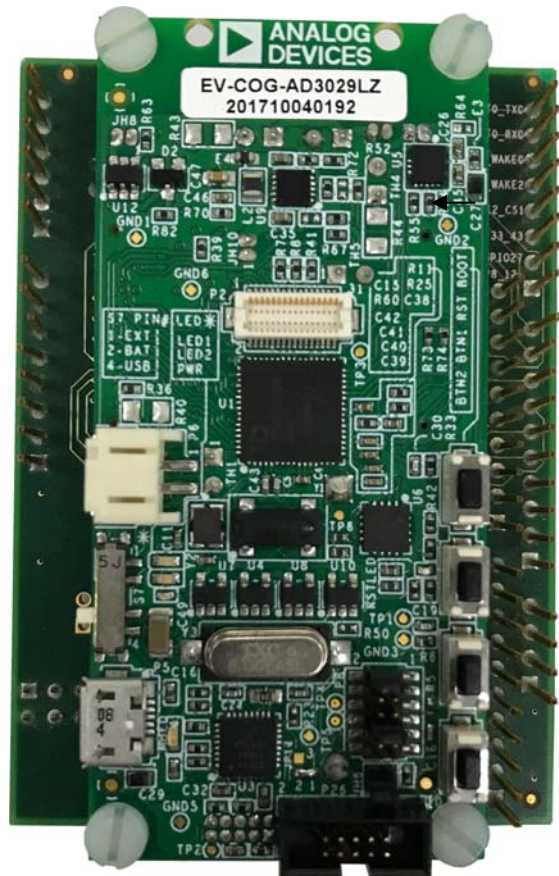


Figure 7. EV-COG-AD3029LZ with EV-GEAR-EXPANDER1Z Top View

2. Do a hardware reset on the ADP8860SHEILD-EVALZ or the ADP8861SHEILD-EVALZ and the EV-COG-AD3029LZ to reboot the flashing firmware.



**GUI**

To connect the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ to Windows, take the following steps:

1. Run and install the **ADP886X\_LDTA\_v2.0.0\_Installer.exe** file, which can be downloaded from the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ webpage.
2. After the installation completes, run the **ADP886X\_Release\_v2.0.0.exe** file that was installed during Step 1 to open the GUI window.
3. Click **Connect**. UART connect settings then prompt the user on the COM port (see Figure 8). Note that the default baud rate is 115200. Once UART connection is established, this automatically activates the **ADP8860** or the **ADP8861** device and reads what type of the device is connected. Users can use the four main functionalities: backlight, sink, interrupt, and ambient light sensing for the ADP8860, while the ADP8861 has no ambient light sensing.



Figure 8. Configure the COM Port

4. In the **BACKLIGHT** main tab for Windows, users can select the **BRIGHTNESS LEVEL** and type of **BACKLIGHT LAW** (see Figure 9). Under the **Bright** tab within this main tab, users can configure the maximum current for **Day Bright**, **Office Bright**, **Dark Bright**, and **Off Timeout Bright**.



Figure 9. BACKLIGHT Main Tab for Windows

5. Under the **Dim** tab within the **BACKLIGHT** main tab for Windows, users can configure the dim current for **Day Dim**, **Office Dim**, **Dark Dim**, and **Off Timeout Dim** (see Figure 10).



Figure 10. BACKLIGHT Dim Tab for Windows

6. Under the **Fade Override** tab within the **BACKLIGHT** main tab for Windows, users can configure the **Fade In** and **Fade Out** (see Figure 11).



Figure 11. BACKLIGHT Fade Tab for Windows

7. Under the **SINK** main tab for Windows, users can select sink independently and configure **Sink Law**, **Current**, **ON Time**, **OFF Time**, **Fade In**, and **Fade Out** (see Figure 12).



Figure 12. SINK Tab for Windows

8. In the **Interrupt** main tab for Windows, users can enable device protection as well as clear interrupts when triggered (see Figure 13).

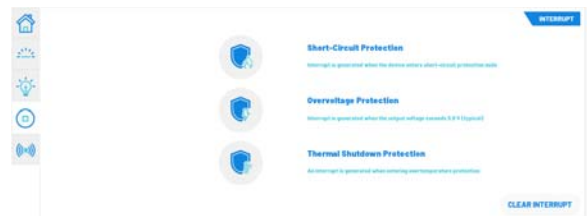


Figure 13. INTERRUPT Tab for Windows

- In the **A.L.S.** main tab for Windows, users can enable the photosensor and comparator with a threshold and hysteresis current configuration (see Figure 14). Note that this feature is only available for the **ADP8860**. To utilize the secondary photo sensor, move **P5** to the other position (see Figure 25 and Figure 26).



Figure 14. Ambient Light Sensing (**A.L.S.**) Tab for Windows

- Click **Switch** in Windows to enable the read and write of the registers directly (see Figure 15).

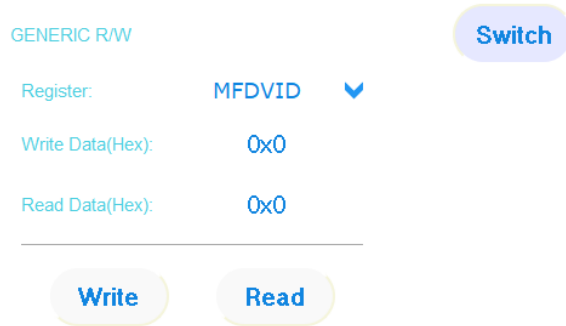


Figure 15. Generic Read and Write (**GENERIC R/W**) for Windows

- Note that all processes are logged in the **LOGS** box in Windows. Every log contains the time and date with the log category (**INFO**, **DEBUG**, and **ERROR**) and messages (see Figure 16). A **Clear Logs** options is also available.



Figure 16. **LOGS** Box for Windows

## ANDROID APP

Users must take the following flashing firmware, hardware, and Android app steps to connect the ADP8860SHEILD-EVALZ or the ADP8861SHEILD-EVALZ to the Android app.

### Flashing Firmware (Windows Only)

To flash the firmware, take the following steps:

- Open the **CrossCore Serial Flash Programmer 1.5.0** app (see Figure 4). If the programmer is not installed, download the installer from the [CrossCore Utilities](#) webpage.
- Ensure that the EV-COG-AD3029LZ is connected and select the following parameters (see Figure 5):
  - Target:** ADuCM302x
  - Serial Port:** (Port where the board is connected)
  - Baudrate:** 115200
  - Action:** Program
- Under the **File to download** tab, browse and choose the source code (hex file) along with the downloaded files from the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ webpage.
- Click **Start** to flash the programmer to the EV-COG-AD3029LZ.

### Hardware

To connect and reset the hardware, take the following steps:

- Connect the **EV-COG-BLEINTP1Z** to **EV-COG-AD3029LZ** via the Hirose connector.
- Connect the GPIO28 pin of the **EV-GEAR-EXPANDER1Z** to GND (see Figure 7).
- Do a hardware reset on the ADP8860SHEILD-EVALZ or the ADP8861SHEILD-EVALZ and the EV-COG-AD3029LZ to reboot the flashing firmware.

**Android App**

To use the Android app, take the following steps:

1. Install the **ADP886X\_LDTA\_v2.0.0.apk** file, which can be downloaded from the ADP8860SHIELD-EVALZ or the ADP8861SHIELD-EVALZ webpage) on an Android smartphone that has Bluetooth 4.3 or higher.
2. After installation completes, run the **ADP886X LED DRIVER TEST APP** (see Figure 17).

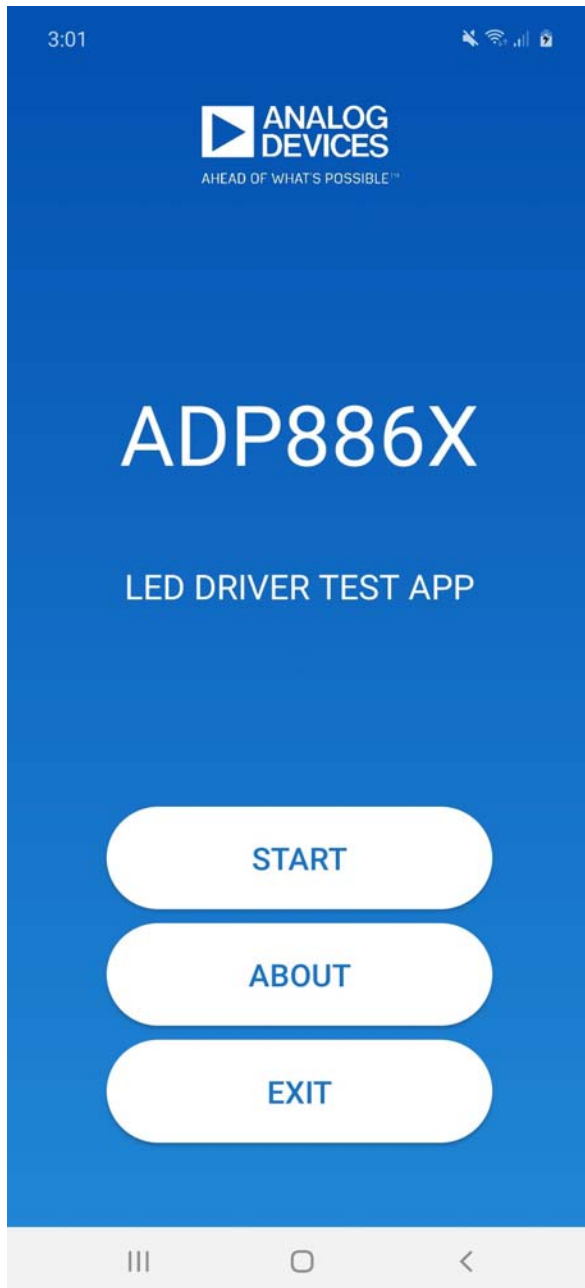


Figure 17. Title Page for the Android App

3. Click **START** and navigate to the side menu.

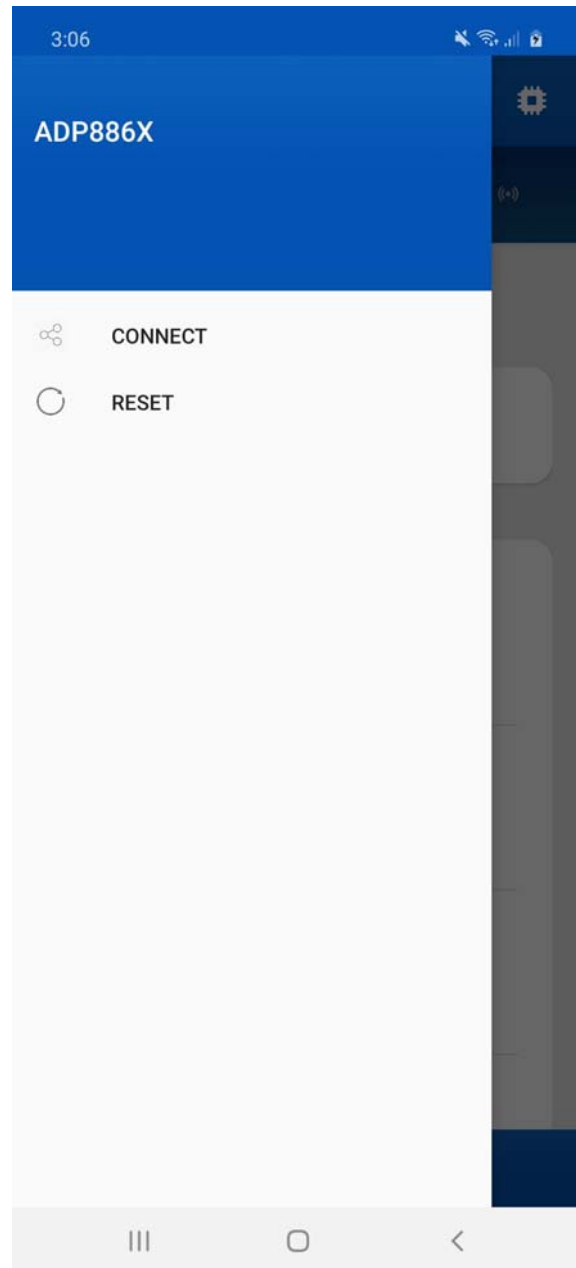


Figure 18. Side Menu for the Android App

4. Click **CONNECT** and turn on the Bluetooth and **Location** of the mobile devices, which then prompts Step 5.



5. Scan for the **ADP886X Demo** and reset on the ADP8860SHEILD-EVALZ or the ADP8861SHEILD-EVALZ and the [EV-COG-AD3029LZ](#) if none have scanned.

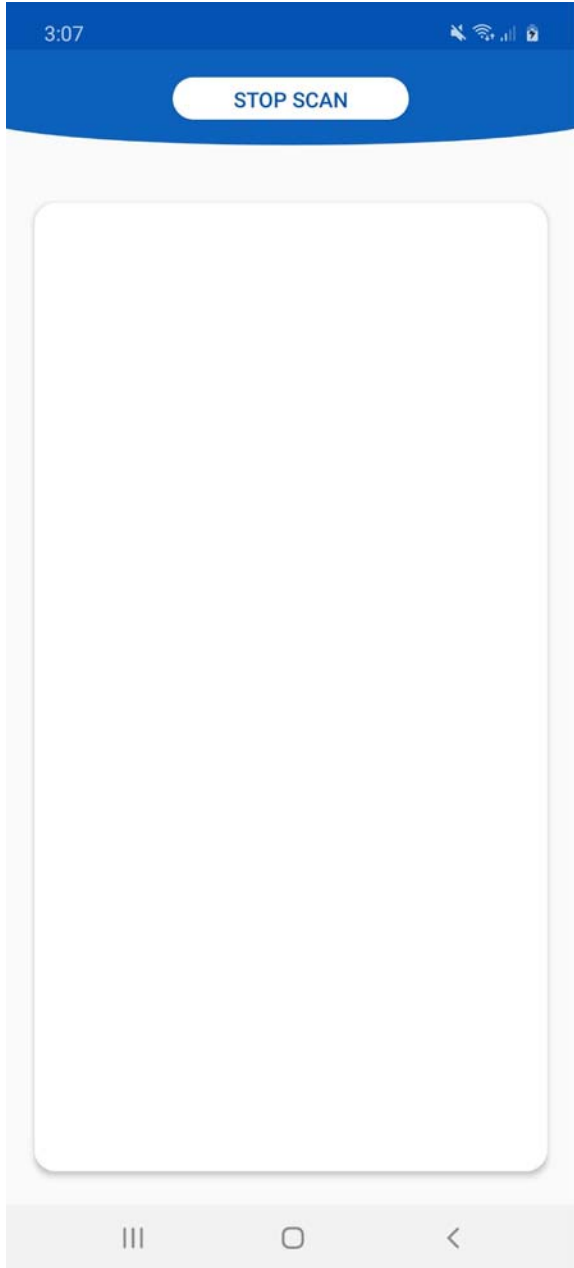


Figure 19. Device Scanning for the Android App

Once a Bluetooth connection is established, the [ADP8860](#) or [ADP8861](#) automatically activates and reads the device type. Users can use four main functionals: backlight, sink, interrupt, and ambient light sensing for the ADP8860, while the ADP8861 has no ambient light sensing.

6. In the **BACKLIGHT** tab, users can select the following (see Figure 20):
  - a. Brightness level and type of law
  - b. Maximum current for **Day**, **Office**, **Dark**, and **Off Timeout**
  - c. Dim current for **Day**, **Office**, **Dark**, and **Dim Timeout**
  - d. **Fade In** and **Fade Out**

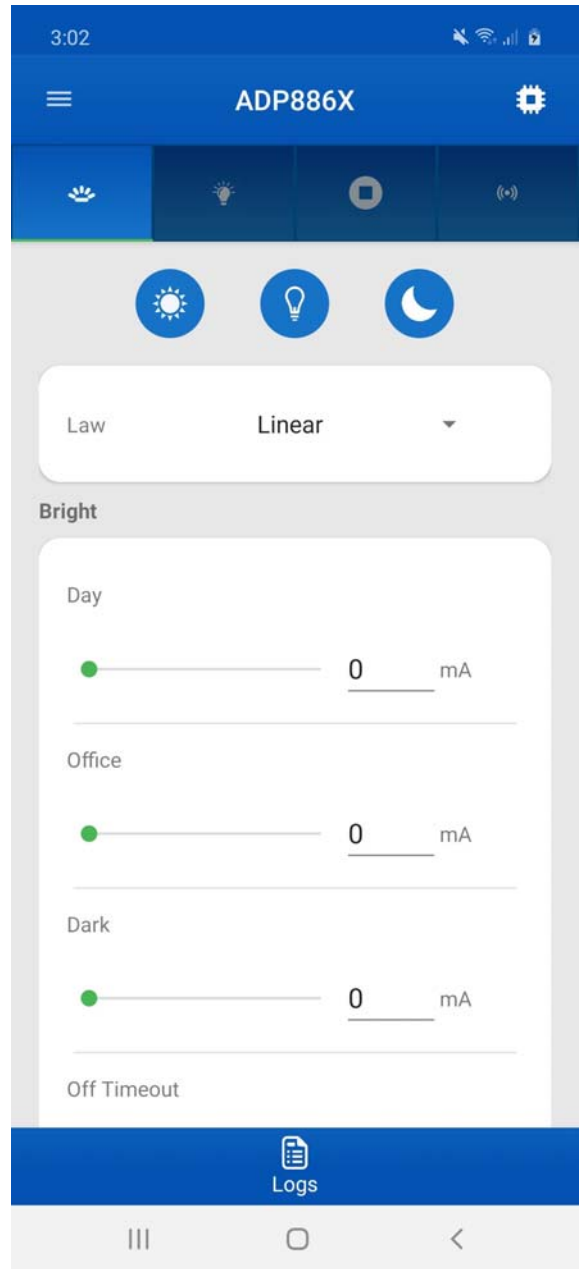


Figure 20. **BACKLIGHT** Tab for the Android App

- In the **Sink** main tab, users can select sink independently and can configure sink **Law**, **Current**, **On Time**, **Off Time**, **Fade In**, and **Fade Out** (see Figure 21).

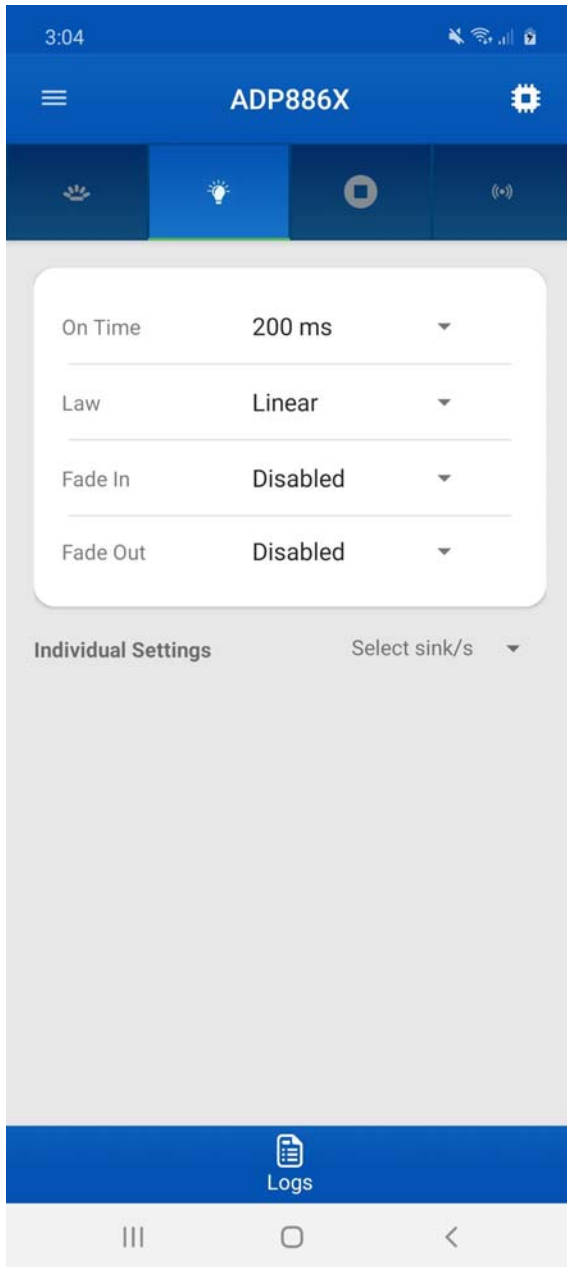


Figure 21. Sink Tab for the Android App

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- In the **Interrupt** main tab, users can enable device protection as well as clearing interrupts when triggered (see Figure 22).

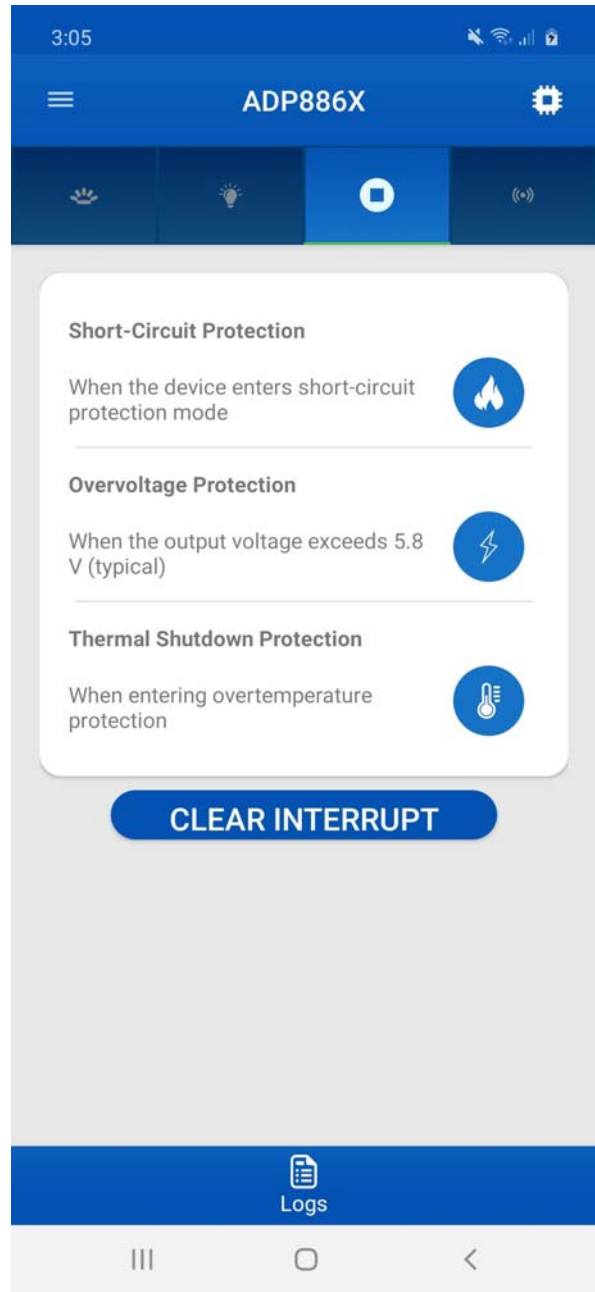


Figure 22. Interrupt Tab for the Android App

25186-023

- In the **A.L.S.** main tab, users can enable the photosensor and comparator with a threshold and hysteresis current configuration (see Figure 23). Note that this feature is only available for the **ADP8860**. To utilize the secondary photo sensor, move **P5** to the other position (see Figure 25 and Figure 26).

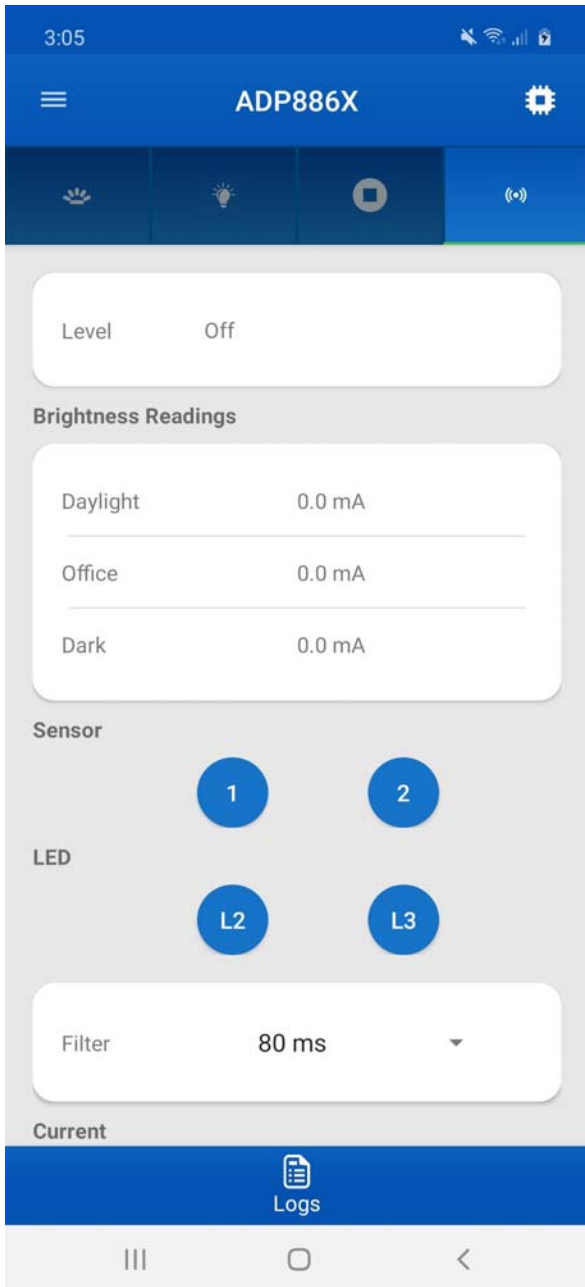


Figure 23. **A.L.S.** Tab for the Android App

- All processes log in the **Logs** box (see Figure 24).

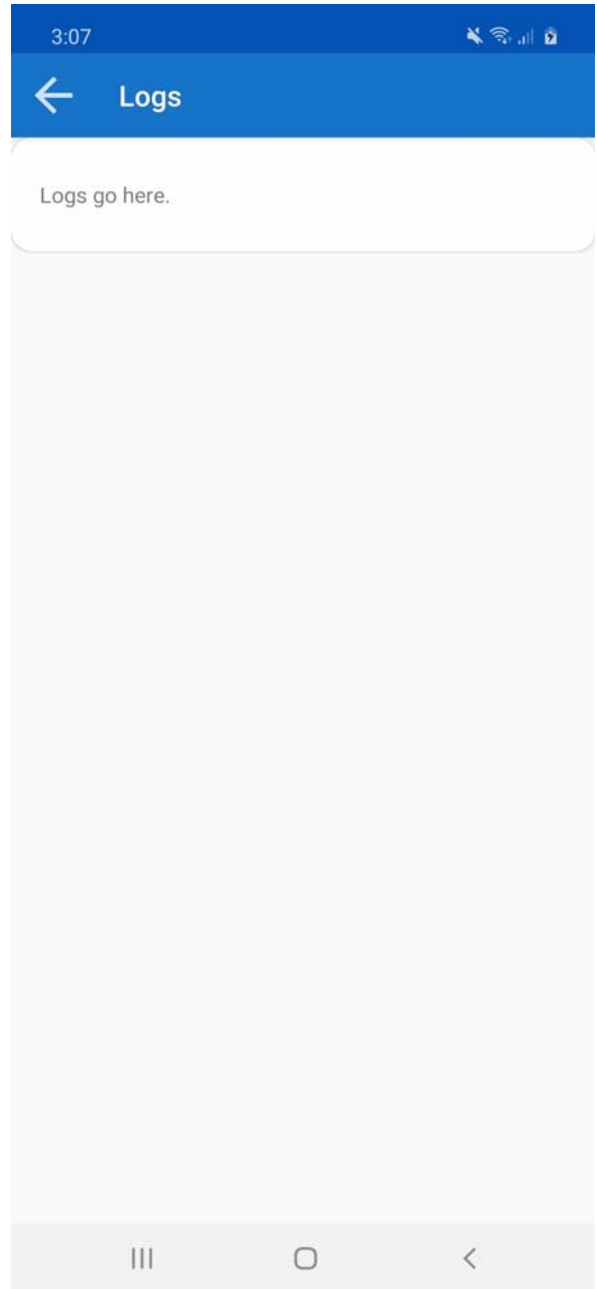


Figure 24. Log Box for the Android App

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EVALUATION BOARD SCHEMATICS AND LAYOUT

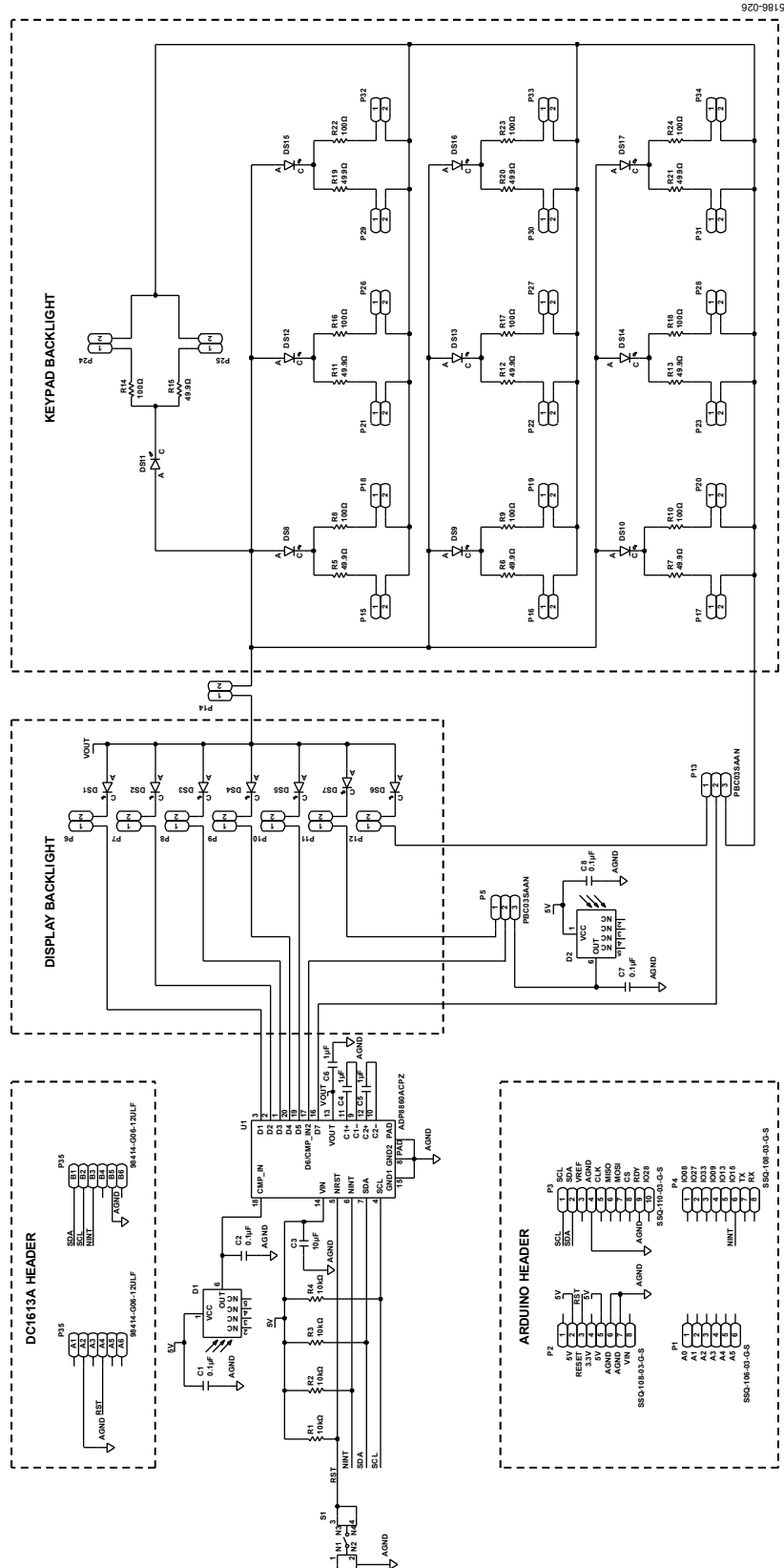


Figure 25. ADP8860SHIELD-EVALZ Schematic

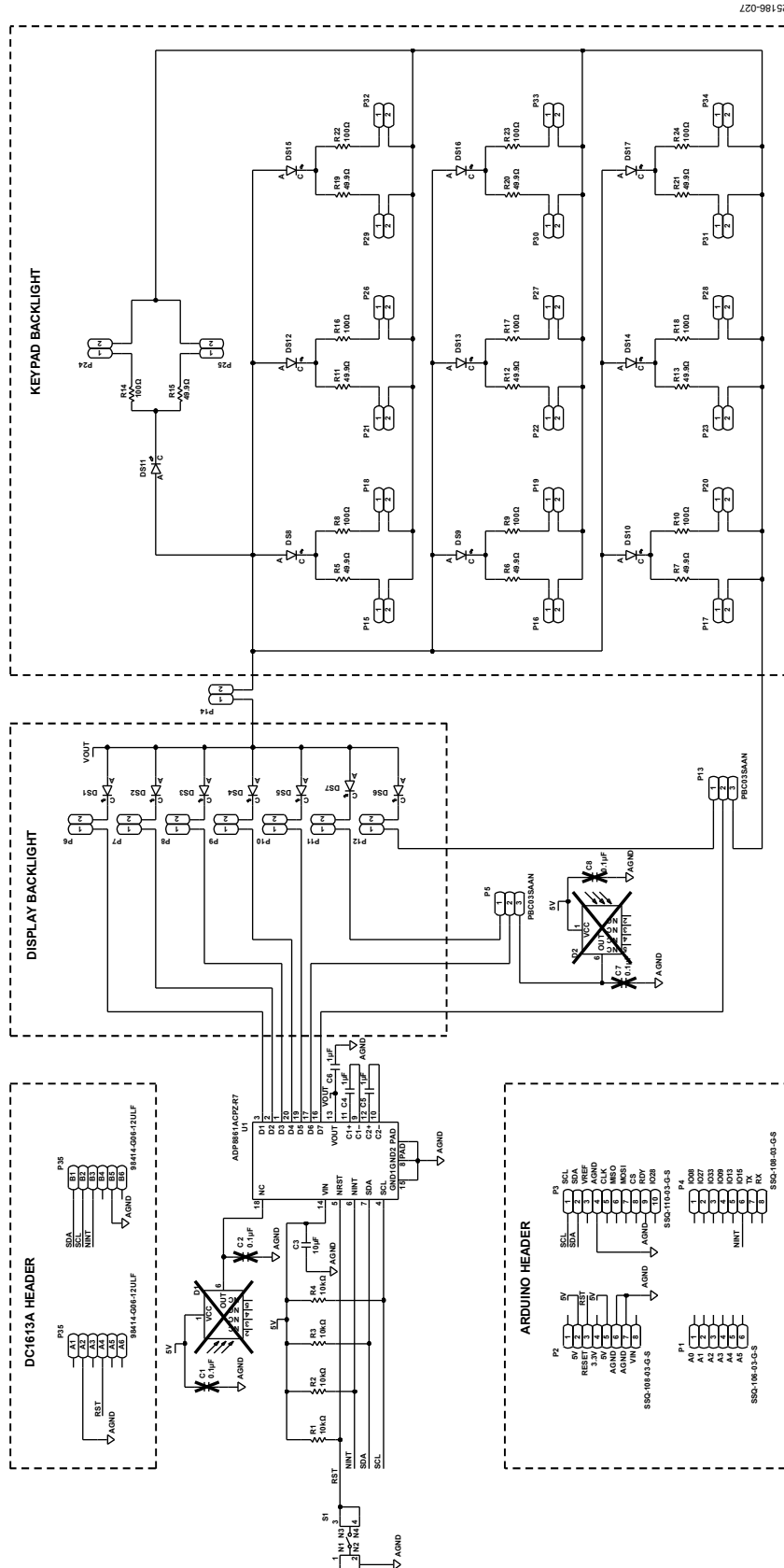
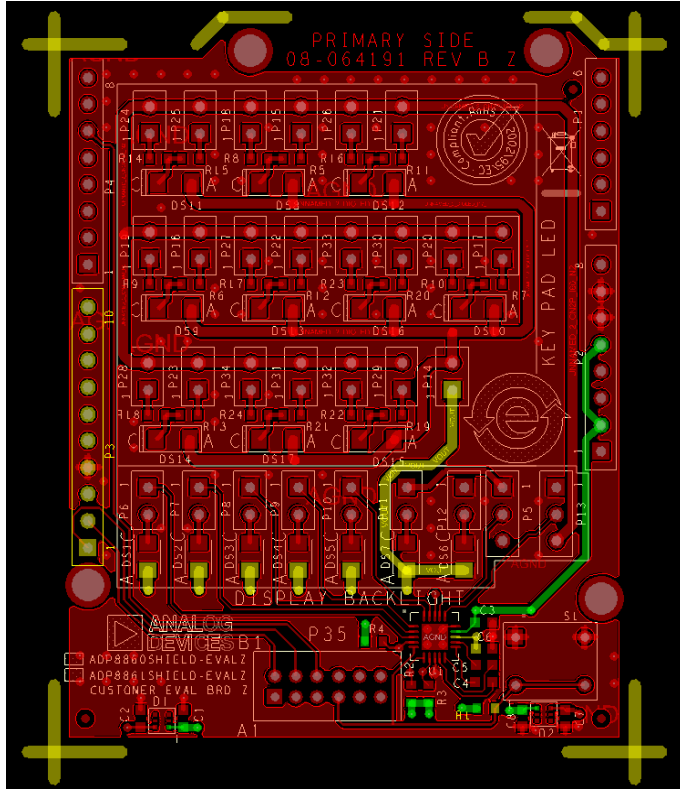
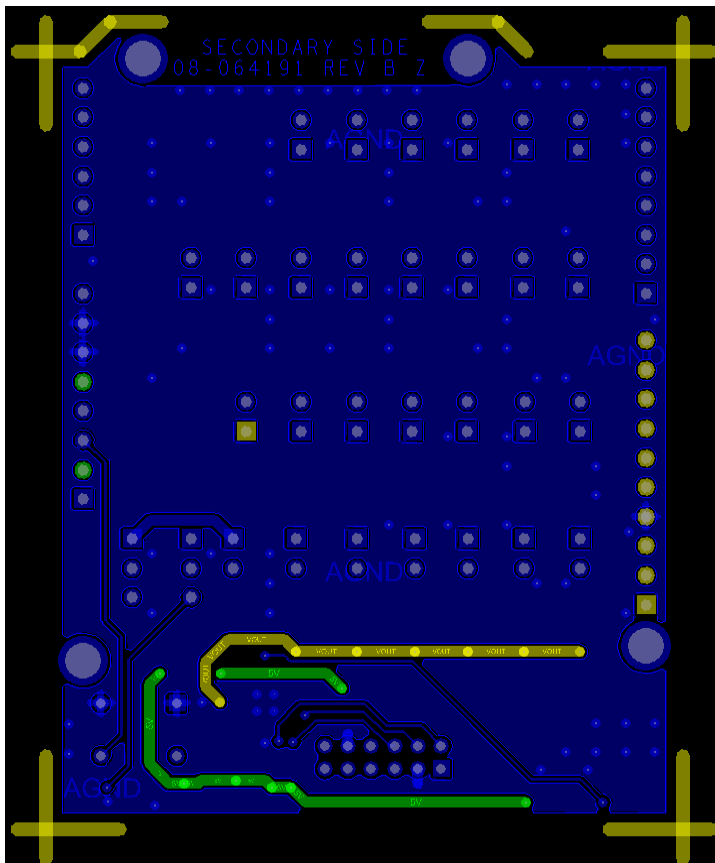


Figure 26. ADP8861SHIELD-EVALZ Schematic



25186-028

Figure 27. ADP8860/ADP8861 Evaluation Board Primary



25186-029

Figure 28. ADP8860/ADP8861 Evaluation Board Secondary



## ORDERING INFORMATION

### BILL OF MATERIALS

Table 1. Bill of Materials for the ADP8860SHIELD-EVALZ

Qty	Designators	Description	Part Number
4	C1, C2, C7, C8	0.1 $\mu$ F ceramic capacitors, 0603, X7R	C0603C104K4RAC
1	C3	10 $\mu$ F ceramic capacitor, X5R	C1608X5R1C106M080AB
3	C4 to C6	1 $\mu$ F ceramic capacitors, X7R	0603YC105KAT2A
7	DS1 to DS7	White LEDs, PLCC2, 1 in 1	CLM3C-WKW-CXAYA453
10	DS8 to DS17	565 nm, green, diffused LEDs, 1206, surface-mounted device (SMD)	SML-LX1206GW-TR
4	R1 to R4	10 k $\Omega$ resistors, 0603	ERJ-3EKF1002V
10	R8 to R10, R14, R16 to R18, R22 to R24	100 $\Omega$ resistors, 0603	ERA-3AEB101V
10	R5 to R7, R11 to R13, R15, R19 to R21	49.9 $\Omega$ resistors, 0603	ERJ-3EKF49R9V
1	S1	Tactile switch	B3W-1002
1	P1	6-position connector, receptacle, 0.1 gold, printed circuit board (PCB)	SSQ-106-03-G-S
28	P6 to P12, P14 to P34	2-pin male, 2.54 mm pitch headers	PBC02SAAN
2	P5, P13	3-pin male, 2.54 mm pitch headers	PBC03SAAN
2	P2, P4	8-pin receptacle, 2.54 mm pitch headers	SSQ-108-03-G-S
1	P3	10-pin receptacle, 2.54 mm pitch header	SSQ-110-03-G-S
1	P35	12-pin receptacle, 2.54 mm pitch header	98414-G06-12ULF
2	D1, D2	Diodes, ambient light photosensor	APDS-9005-020
1	U1	Charge pump, 7-channel smart LED driver with I <sup>2</sup> C interface	<a href="#">ADP8860ACPZ</a>

Table 2. Bill of Materials for the ADP8861SHIELD-EVALZ

Qty	Designators	Description	Part Number
1	C3	10 $\mu$ F ceramic capacitor, X5R	C1608X5R1C106M080AB
3	C4 to C6	1 $\mu$ F ceramic capacitors, X7R	0603YC105KAT2A
7	DS1 to DS7	White LEDs, PLCC2, 1 in 1	CLM3C-WKW-CXAYA453
10	DS8 to DS17	565 nm, green, diffused LEDs, 1206, SMD	SML-LX1206GW-TR
4	R1 to R4	10 k $\Omega$ resistors, 0603	ERJ-3EKF1002V
10	R8 to R10, R14, R16 to R18, R22 to R24	100 $\Omega$ resistors, 0603	ERA-3AEB101V
10	R5 to R7, R11 to R13, R15, R19 to R21	49.9 $\Omega$ resistors, 0603	ERJ-3EKF49R9V
1	S1	Tactile switch	B3W-1002
1	P1	6-position connector, receptacle, 0.1 gold, PCB	SSQ-106-03-G-S
28	P6 to P12, P14 to P34	2-pin male, 2.54 mm pitch headers	PBC02SAAN
2	P5, P13	3-pin male, 2.54 mm pitch headers	PBC03SAAN
2	P2, P4	8-pin receptacle, 2.54 mm pitch headers	SSQ-108-03-G-S
1	P3	10-pin receptacle, 2.54 mm pitch header	SSQ-110-03-G-S
1	P35	12-pin receptacle, 2.54 mm pitch header	98414-G06-12ULF
1	U1	Charge pump, 7-channel smart LED driver with I <sup>2</sup> C interface	<a href="#">ADP8861ACPZ</a>

## 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.

**Legal Terms and Conditions**

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.