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# Evaluating the ADT7516 SPI-/I²C-Compatible, Temperature Sensor, 4-Channel ADC and Quad Voltage Output DAC

## FEATURES

**Easy evaluation of the ADT7516**
**Evaluation software included**
**USB interface to PC**
**Powered from USB interface**

## APPLICATIONS

**Portable battery powered instruments**
**PCs**
**Smart battery chargers**
**Telecommunications systems**
**Electronic test equipment**
**Domestic appliances**
**Process controls**

## EQUIPMENT NEEDED

**USB A to Mini-B cable**
**ADT7516 evaluation board**

## DOCUMENTS NEEDED

**ADT7516 evaluation board data sheet**

## SOFTWARE NEEDED

**ADT7516 evaluation software on CD**

## GENERAL DESCRIPTION

The EVAL-ADT7516EBZ evaluation board allows the ADT7516 digital temperature sensor, 4-channel analog-to-digital converter (ADC) and quad digital-to-analog converter (DAC) to be quickly and easily evaluated using a PC. Using the evaluation board and its accompanying software, the ADT7516 evaluation board can interface with any PC via a USB port. The software works on 32-bit Windows® 7 machines and earlier versions like Windows XP.

The evaluation board allows all the input and output functions of the ADT7516 to be exercised without the need for external components. The software allows control and monitoring of the internal registers of the ADT7516.

# TABLE OF CONTENTS



## REVISION HISTORY

**2/16—Rev. A to Rev. B**

Update Format ..... Universal
Deleted ADT7517 and ADT7519 ..... Throughout
Changes to General Description ..... 1
Changes to Evaluation Board Hardware Section ..... 3
Changes to Evaluation Board Software Quick Start Procedures Section ..... 4
Changes to Configuration Section ..... 5
Changes to Figure 19 to Figure 21 ..... 12
Changes to Table 2 ..... 13

**2/07—Revision A: Initial Version**

# EVALUATION BOARD HARDWARE

The ADT7516 combines a 10-bit temperature to digital converter and a quad 12-bit DAC, respectively, in a 16-lead QSOP. These devices include a band gap temperature sensor and a 10-bit ADC to monitor and digitize the temperature reading to a resolution of 0.25°C. The ADT7516 operates from a single 2.7 V to 5.5 V supply. The input voltage range on the ADC channels is 0 V to 2.28 V, and the input bandwidth is dc. The reference for the ADC channels is derived internally. The output voltage of the DAC ranges from 0 V to $V_{DD}$, with an output voltage settling time of typically 7 ms.

The ADT7516 provides two serial interface options, a 4-wire serial interface that is compatible with SPI, QSPI™, MICROWIRE™, and DSP interface standards and a 2-wire SMBus/$I^2C$ interface. The ADT7516 features a standby mode that is controlled via the serial interface.

The EVAL-ADT7516EBZ evaluation board contains the following main components that can be identified from the printed circuit board (PCB) silkscreens and the schematic diagrams (see Figure 15 to Figure 21):

- ADT7516 IC (U1)
- USB microcontroller (U9)
- Interface buffers and analog switches
- Power LED, green (D1)
- Interrupt LED, red (D2)
- Temperature sensor (Q1)
- Photodiode sensor (U14)
- Bar graph driver and LED bar graph (U12/U8)
- Connector for USB interface (J1)
- DAC output connector (J2)
- VREF input connector (P1)
- AIN analog input connector (P2)
- LDAC push-button (S1)

## USING THE HARDWARE

The hardware is extremely simple to use. Before connecting the evaluation board to a USB port on the PC, using the USB A to Mini-B cable provided, make sure the software is installed. No external power supply is required.

## MINI-B USB CONNECTOR (J1)

The connections to J1 are shown in Table 1.

**Table 1. J1 Connections**

| J1 Pin | Mini-B Function |
|---|---|
| 1 | 5 V |
| 2 | −Data |
| 3 | +Data |
| 4 | Key (not used, connected to ground) |
| 5 | Ground |

The communication between the Mini-B plug and the rest of the evaluation board is handled by the USB microcontroller (U9).

## DAC OUTPUT CONNECTOR (J2)

The output of any one of the four DACs (selected by the software) is available on this connector.

## VREF INPUT CONNECTOR (P1)

The architecture of one DAC channel consists of a resistor string DAC followed by an output buffer amplifier. The reference voltage for the selected DAC is determined by the on-chip reference of 2.28 V or an external reference voltage, which may be connected to P1.

## AIN ANALOG INPUT CONNECTOR (P2)

The ADT7516 offer four single-ended analog input channels, which range from 0 V to 2.28 V, or 0 V to $V_{DD}$. This analog input may be connected using P1.

## TEST POINTS

Various system logic signals and the individual DAC outputs are available at the test points on the board.

# EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

The software allows control of the ADT7516 functions from a PC via an easy-to-use interface. The contents of the internal registers of the device can be read easily or altered through a user friendly interface, while the **Visual Display** dialog box gives a graphical display of the temperature and the voltage and allows the overtemperature limit to be altered using a slider control.

## INSTALLING THE SOFTWARE

To install the software, insert the supplied CD. Click **Start** > **Run**, and enter **X:ADT7516Eval.exe**, where **X:** is the letter of your CD drive, and then click **OK**.

Alternatively, run **Windows Explorer** or go to **My Computer**, select the CD drive, and double-click the **ADT7516 v2.0.2.exe** icon.

The installer extracts the files needed to install the software and starts the **InstallShield® Wizard**.

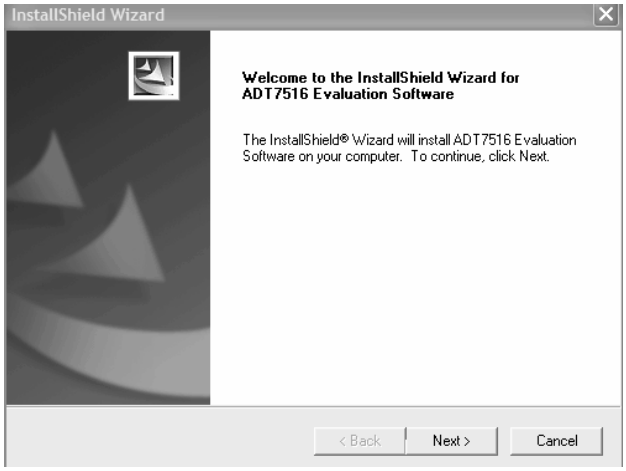


*Figure 1. **InstallShield Wizard** Startup Screen*

Click **Next >** to continue the installation. Various installation options are available, depending on whether a version of the software is already installed. A license agreement appears if this is a completely new installation. Click **Yes** to accept the agreement and continue with the installation.

If you want to install the software in the default folder shown, click **Next >**. Otherwise, click **Browse** and choose a different folder. Select the folder in which to install the program and click **OK**.

You are given the option of a **Typical**, **Compact**, or **Custom** installation of the software. Select the desired option and click **Next >**.

If **Custom** is selected, a window appears allowing individual components to be installed. Uncheck any components you do not wish to install, and click **Next >**.

If a **Typical** or **Compact** installation is selected, omit this step, and the **Select Program Folder** dialog box will appear. This box allows you to select the program folder to add the program icons to. Select the desired folder and click **Next >**.

**InstallShield** now installs the program files to the selected folders.

Click **Finish** to complete the installation.

If an existing version of the software is found during installation, you may modify the existing installation by adding or removing components, repair the installation by replacing existing files with ones from the CD (useful if a file has been corrupted), or uninstall the entire software package.

Select the desired option and click **Next >**. If **Modify** is selected, you may add or remove components. If **Repair** is selected, all of the installed files are replaced with the new files from the CD.

If **Remove** is selected, a prompt appears to confirm the complete removal of the software. Click **OK** to confirm removal of the software. During removal of the software, you may need to confirm removal of some files.

These files may be used by other Analog Devices, Inc. software. If no other Analog Devices software is installed on the system, it is safe to delete the files. To remove all shared files without further prompting, check **Don't display this message again** before clicking **Yes**.

Click **Finish** to complete the maintenance procedure.

## USING THE SOFTWARE

When using the software, first ensure that the evaluation board is connected to the USB port and the Power LED D1 is on.

To start the software, click **Start** > **All Programs** > **Analog Devices** > **ADT7516 Evaluation Software** > **ADT7516 Evaluation Software**.

The software searches for the evaluation board and initializes it.


*Figure 2. **EVAL-ADT7516EBZ Evaluation Software** Found*

If the evaluation board is not found, the message in Figure 3 appears. If this happens, check that the evaluation board is connected correctly, that D1 is lit, and then try again.

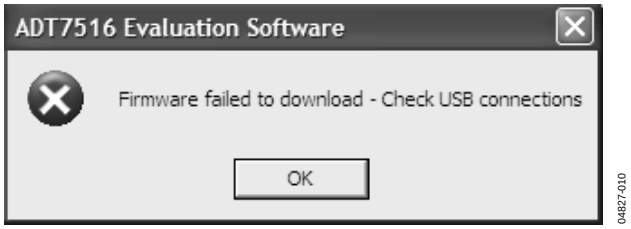


*Figure 3. **EVAL-ADT7516EBZ Evaluation Software** Not Found*

At the top of the program window is a series of drop-down menus and menu icons that can access the various functions of the software (see Figure 4), or you can use the **Settings** menu to select these functions.

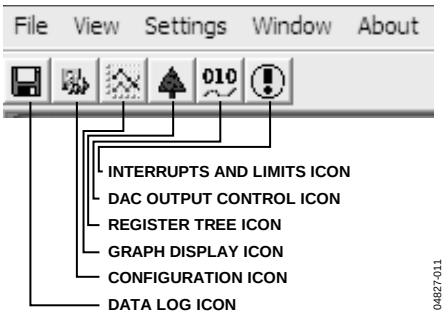


*Figure 4. Menu and Icon Bar*

The menu icons include the following:

- The **Interrupts and Limits** icon sets up interrupts and limits.
- The **DAC Output Control** icon allows adjustment of the DAC outputs. The **Settings** menu can also select these functions.
- The **Register Tree** icon displays a tree of the device registers.
- The **Graph Display** icon displays the temperature and voltage graphs. The **View** menu can also select these functions.
- The **Configuration** icon allows device configuration.
- The **Data Log** icon allows data to be logged and saved. The **File** menu can also be used.

Multiple windows for the previous software functions can be open and active simultaneously. The **Window** menu shows which window is on top and allows any window to come to the front.

### *Configuration*

Click the **Configuration** icon or use the **Device** menu to access the **Configuration** dialog box to set up the ADT7516. It consists of a set of four tabs that allows configuration of various functions of the device.

The **Devices Options** tab (see Figure 5) selects or enables/disables various options, such as monitoring, power down, averaging, interrupt, active low INT polarity, and SPI interface.

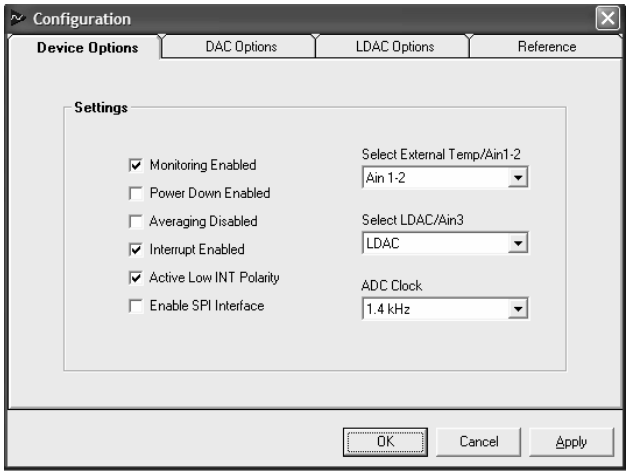


*Figure 5. **Device Options** Tab*

Note that if the ADT7516 SPI interface is enabled, it is necessary to exit the software, disconnect the board, and start again to switch back to the $I^2C$ interface.

Pin AIN1 to Pin AIN3 are multiplexed and their operation can also be toggled here.

The **DAC Options** tab (see Figure 6) selects the output range for each DAC (0V to VRef or 0V to 2VRef). It allows configuration of the thermal voltage function of the device, where the ADT7516 operates as a temperature to voltage converter, with DAC A controlled by the on-chip temperature sensor, and DAC B controlled by the external temperature sensor. To set the temperature corresponding to the 0 V output, adjust the analog offset for each channel. In addition, the resolution for the thermal voltage function can be set to 8 bits or 10 bits.

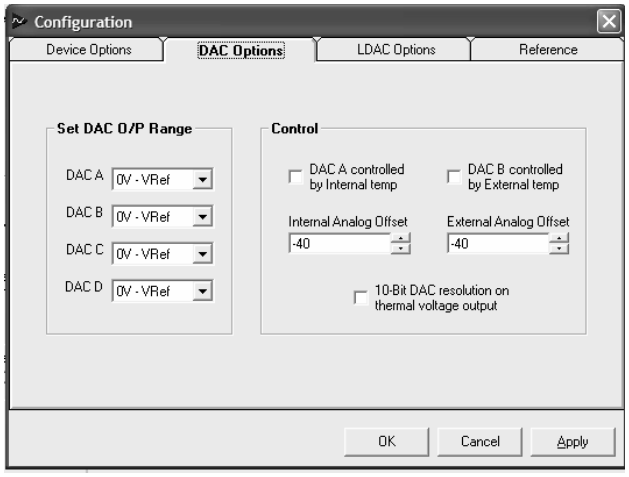


*Figure 6. **DAC Options** Tab*

The **LDAC Options** tab (see Figure 7) allows users to select how the DACs are updated. The DACs can be updated manually from the LDAC pin by pressing S1, when the MSBs are written to one of the DACs (three different options are available), or from the LDAC register. If the LDAC register is selected, the **LDAC Generation** buttons are active, and clicking one of the buttons updates the corresponding DAC.

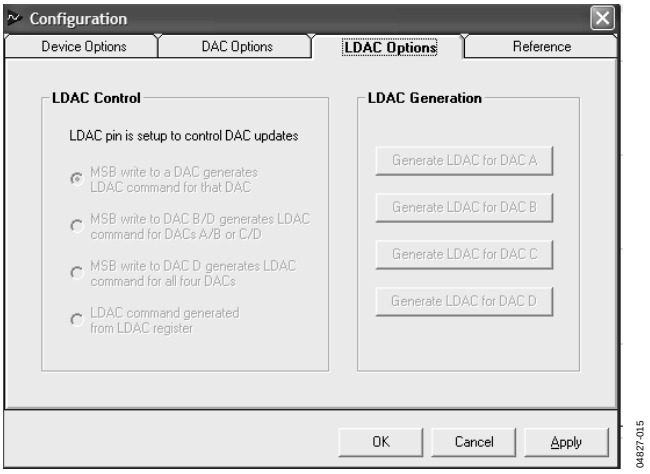


*Figure 7. **LDAC Options** Tab*

The **Reference** tab (see Figure 8) allows users to select the internal 2.28 V reference for DAC A and DAC B and DAC C and DAC D, or an external reference connected to P1. When using an external reference voltage, specify its value in the box provided to allow the DAC value to scale correctly.

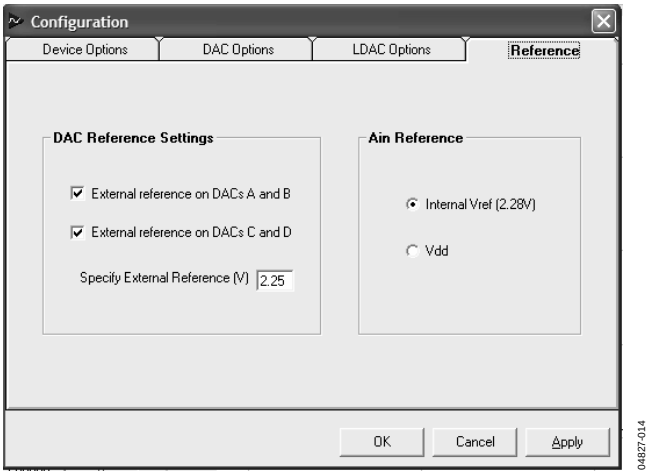


*Figure 8. **Reference** Options Tab*

### *Register Access*

Click the **Register Tree** icon or use the **View** menu to select the **Register Map Access** window.

The **Register Map Access** window (see Figure 9) allows viewing of the individual register's content, and this register that is read/write can have its content changed. The window on the left shows the registers arranged by function as a tree. The branches can expand or contract by double clicking the desired labels or the + or − symbols.

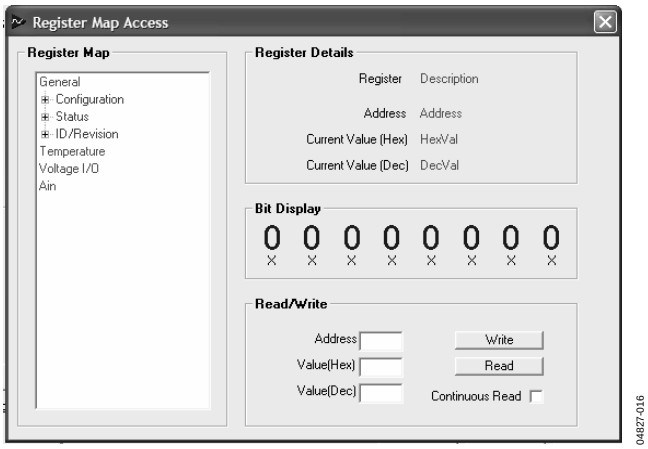


*Figure 9. **Register Map Access** Window*

The register name, its address, and its content in hexadecimal, decimal, and binary format are displayed. Click **Read** to read the register contents, or check off **Continuous Read** to set to continuous reading. To change content in the read/write registers, click on the individual bits of the binary display to toggle them, or enter a decimal or hexadecimal value in the **Read/Write** area and click **Write**.

### *Graphing*

Click the **Graph Display** icon or use the **View** menu to access the **Graphing** window (see Figure 10).

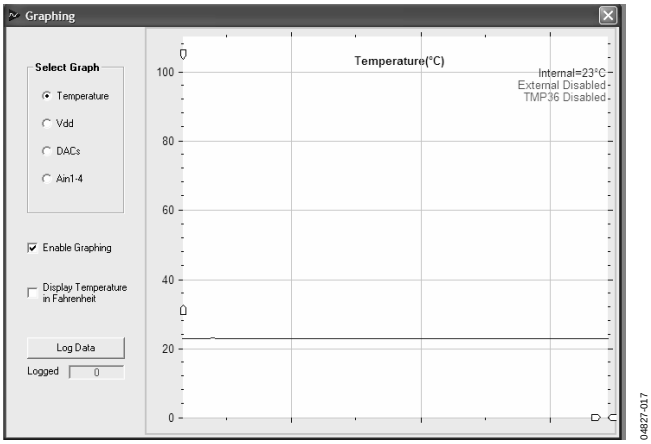


*Figure 10. **Graphing** Window*

The **Graphing** window allows the internal or external temperature, $V_{DD}$, the DAC outputs, or Pin AIN1 to Pin AIN4 to display as a rolling graph. Measurement limits can also be displayed. To view the graphic data in more or less detail, move the arrow pointers on the x-axis and y-axis to zoom in or zoom out.

### *DAC Control*

Click the **DAC Output Control** icon or use the **Device** menu to access the **DAC Control** window (see Figure 11).

The **DAC Control** window allows manually controlling the individual DACs without having to manipulate the DAC registers directly. To select and control a DAC, select a DAC (DAC A, DAC B, DAC C, or DAC D) and use the slider.

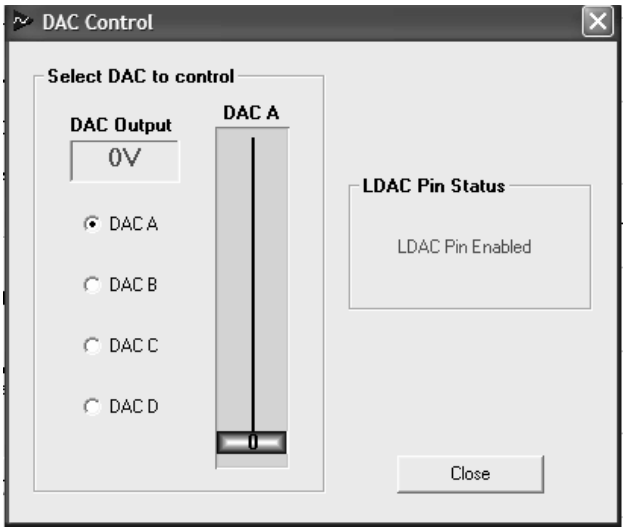


*Figure 11. **DAC Control** Window*

### *Setting Interrupts and Limits*

Click the **Interrupts and Limits** icon or use the **Device** menu to access the **Interrupt Settings** dialog box (see Figure 12).

The nine interrupt sources are shown on the left side of the window. When an interrupt asserts, the corresponding green status indicator turns red. To mask interrupts, check the box next to the name of the interrupt source. Use the slider controls to set the high and low limits for the measured parameters.

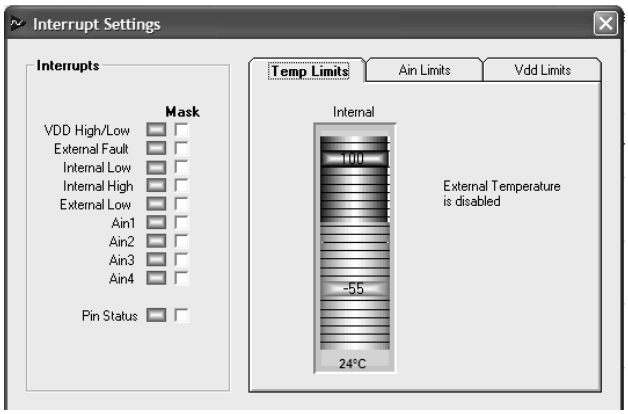


*Figure 12. **Interrupt Settings** Window*

### *Data Logging*

Click the **Data Log** icon or use the **File** menu to access the **Logging/Save/Recall** dialog box.

The **Logging/Save/Recall** window (see Figure 13) allows users to set the log inputs and the log intervals. Once this is set up, the window in Figure 14 appears.

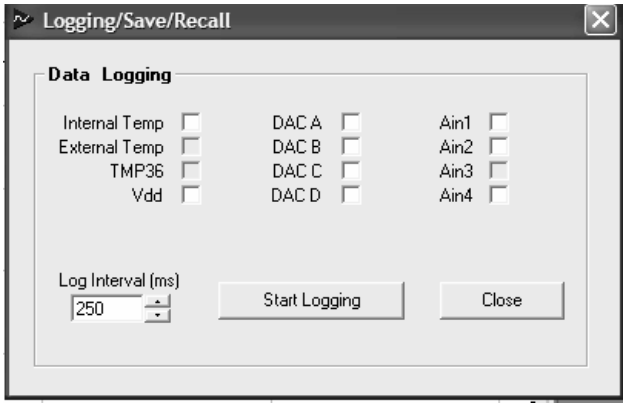


*Figure 13. **Logging/Save/Recall** Window*

To open an existing log file, use **Open** window (see Figure 14) or type in a new file name to create a new log file. When you select an existing file or type a new file name, click **Open** to begin data logging and then click **Start Logging**. To stop data logging, click **Stop Logging**. Note that the **Graphing** function must run during data logging or the data does not change.

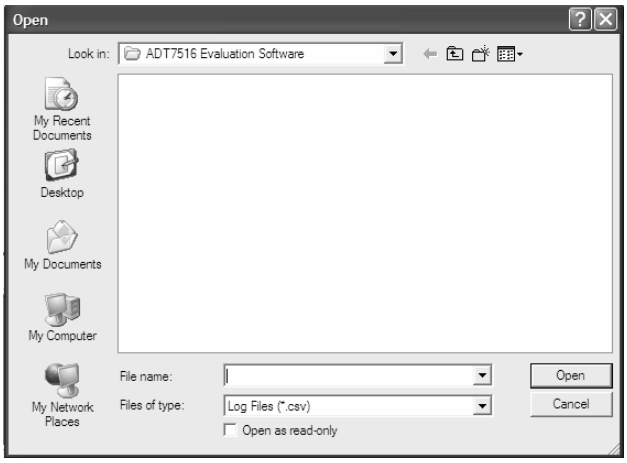


*Figure 14. Opening or Creating a Log File Window*

# EVALUATION BOARD SCHEMATICS AND ARTWORK

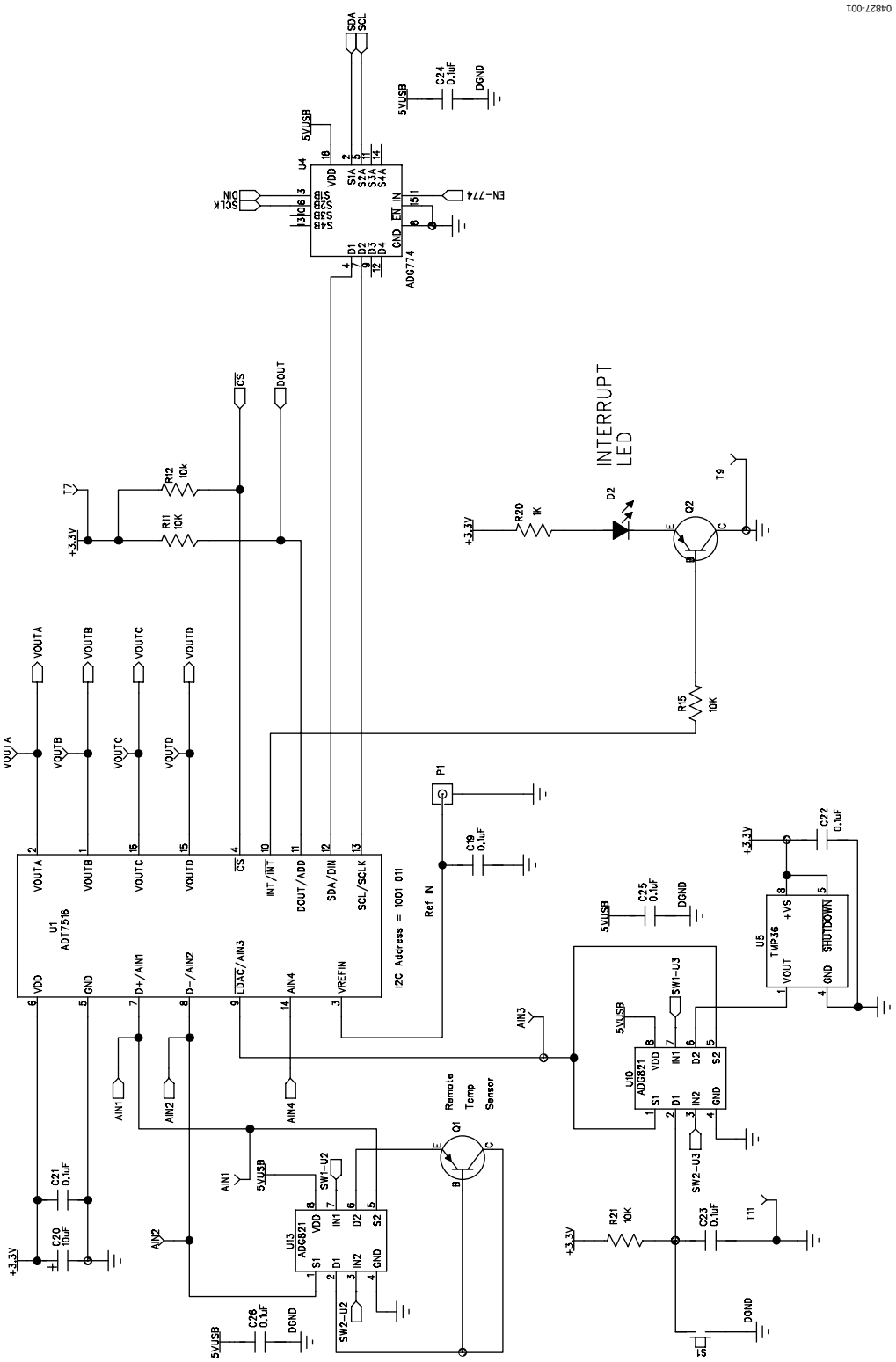


*Figure 15. EVAL-ADT7516EBZ Evaluation Board Schematic Part 1*

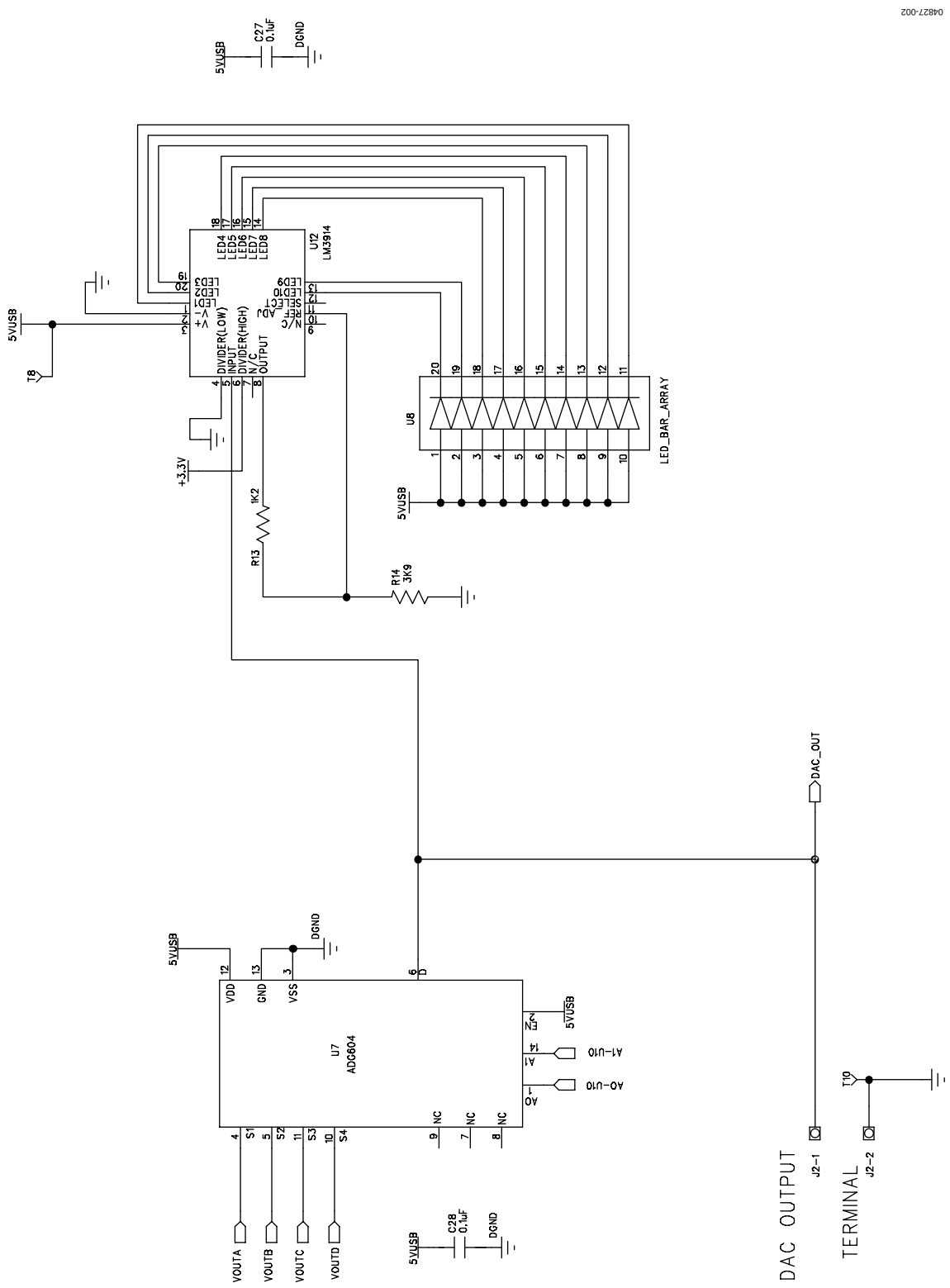


*Figure 16. EVAL-ADT7516EBZ Evaluation Board Schematic Part 2*

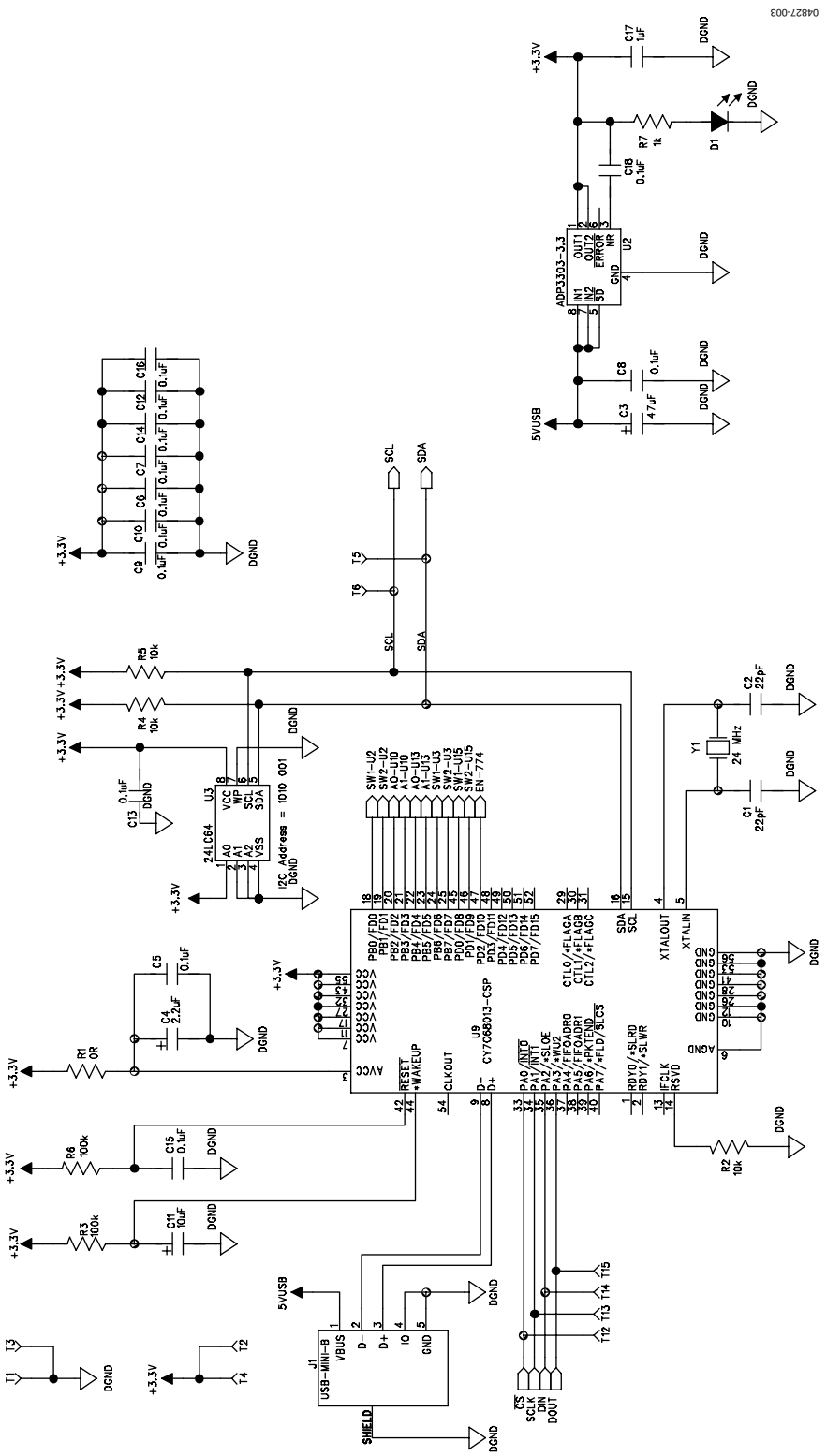

*Figure 17. EVAL-ADT7516EBZ Evaluation Board Schematic Part 3*

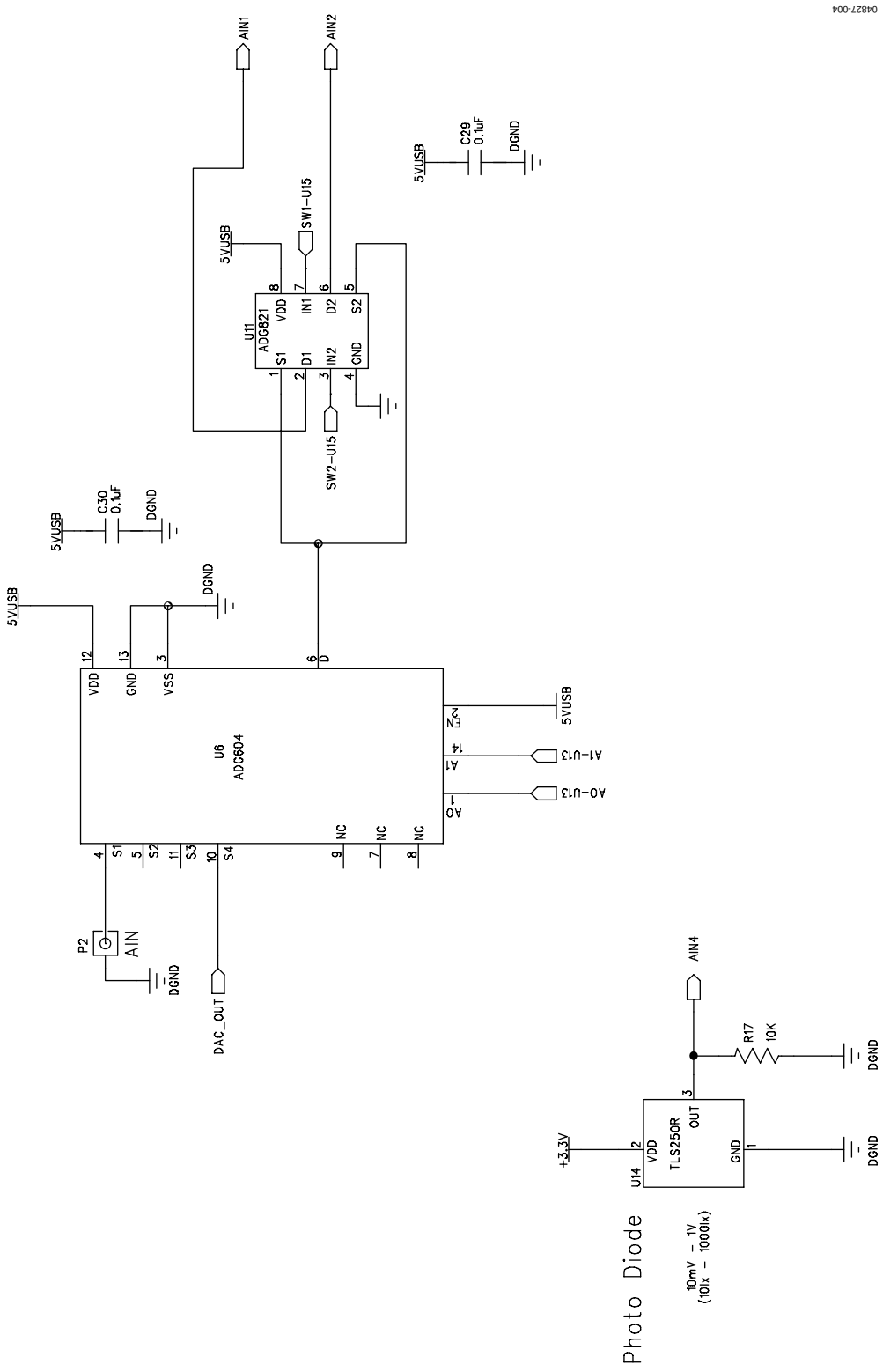


*Figure 18. EVAL-ADT7516EBZ Evaluation Board Schematic Part 4*

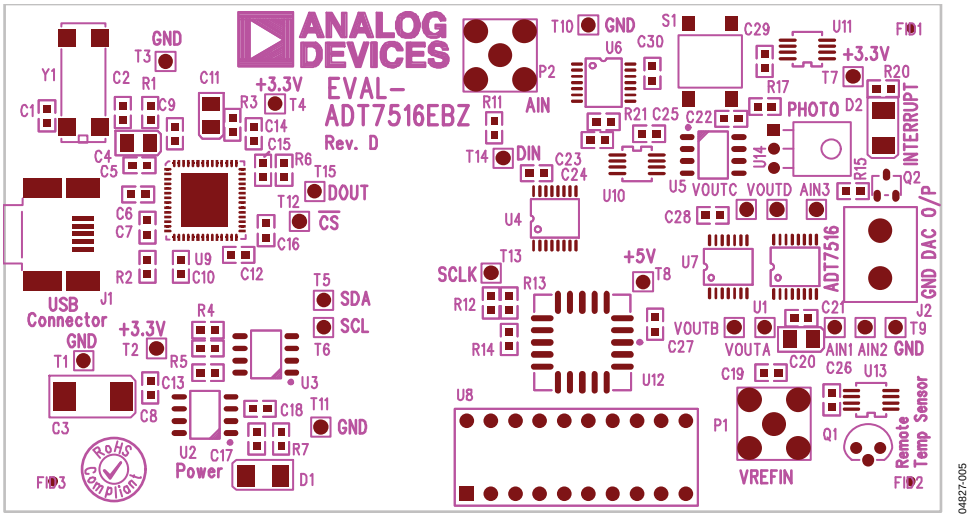


*Figure 19. EVAL-ADT7516EBZ Evaluation Board Silkscreen*

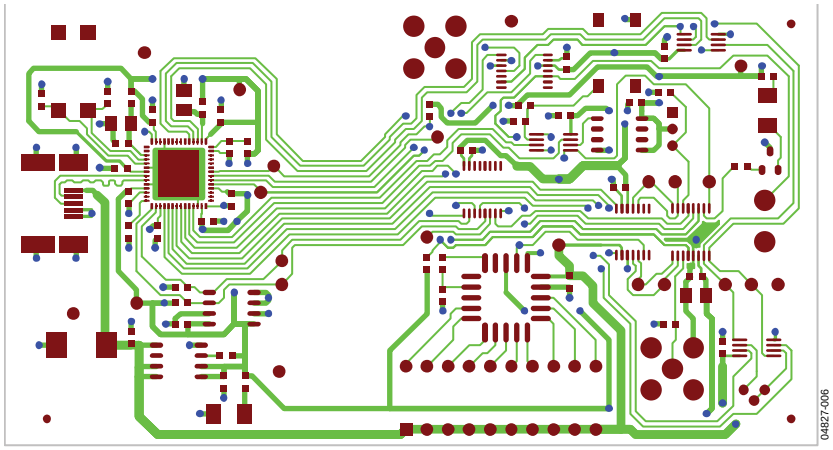


*Figure 20. EVAL-ADT7516EBZ Evaluation Board PCB Layout (Component Side)*

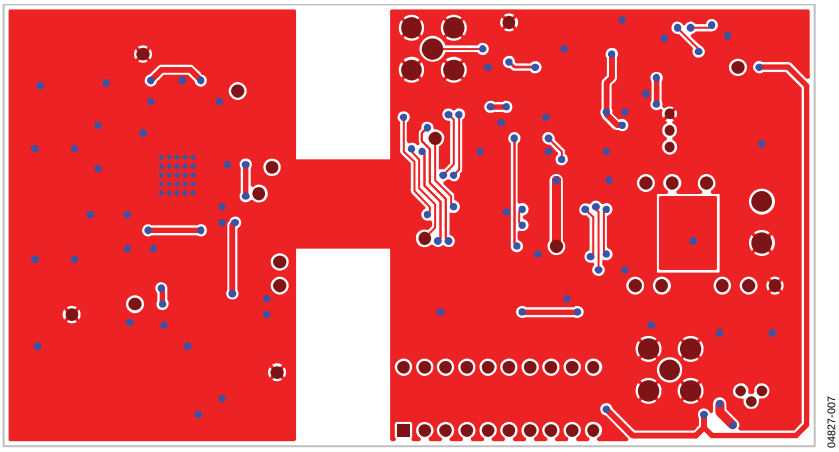


*Figure 21. EVAL-ADT7516EBZ Evaluation Board PCB Layout (Solder Side)*

# ORDERING INFORMATION

## BILL OF MATERIALS

**Table 2.**

| Component | Part Description |
|---|---|
| AIN1 to AIN3 | Red test points |
| C1, C2 | 22 pF, 50 V, NPO, SMD ceramic capacitors |
| C3 | 47 µF, 10 V, SMD, tantalum capacitor |
| C4 | 2.2 µF, 10 V, SMD, tantalum capacitor |
| C5 to C10, C12 to C16, C18, C19, C21 to C30 | 0.1 µF, 16 V, X7R, multilayer ceramic capacitors |
| C11 | 10 µF, 10 V, SMD, tantalum capacitor |
| C17 | 1 µF, 10 V, dc, Y5V, ceramic capacitor |
| C20 | 10 µF, 10 V, SMD, tantalum capacitor |
| D1 | Power light emitting diode (LED), green |
| D2 | Interrupt LED, red |
| J1 | USB Mini-B connector (USB-OTG) |
| J2 | 2-pin terminal block (5 mm pitch), CON\POWER |
| P1 | 50 Ω, SMB jack, output connector |
| P2 | 50 Ω, SMB jack, output connector |
| Q1 | PNP, bipolar transistor, 2N3906 |
| Q2 | Low power bipolar transistor, BC807-40LT1 |
| R1 | 0 Ω, 1% SMD resistor |
| R2, R4, R5, R11, R12, R15, R17, R21 | 10 kΩ, 1% SMD resistors |
| R3, R6 | 100 kΩ, 1% SMD resistors |
| R7, R20 | 1 kΩ, 1% SMD resistors |
| R13 | 1.2 kΩ, 1% SMD resistor |
| R14 | 3.9 kΩ, 1% SMD resistor |
| S1 | SMD push-button switch (sealed 6 mm x 6 mm) |
| T1 to T7, T9 to T11 | Black test points |
| T8, T12 to T15 | Red test points |
| U1 | ADT7516, 4-channel ADC and quad voltage output DAC |
| U2 | ADP3303-3.3, precision low dropout voltage regulator |
| U3 | 24LC64, 64 kΩ $I^2C$ serial EEPROM |
| U4 | ADG774, low voltage quad SPDT switch |
| U5 | TMP36, low voltage temperature sensor |
| U6, U7 | ADG604, CMOS 4-channel multiplexers |
| U8 | LED_BAR_ARRAY, LED bar graph |
| U9 | USB microcontroller, CY7C68013-CSP |
| U10, U11, U13 | ADG821, dual SPST switches |
| U12 | IC driver dot bar display, 20PLCC LM3914 |
| U14 | Photodiode sensor, L/V, TSL250R, TAOS |
| VOUTA to VOUTD | Red test points |
| Y1 | 24 MHz plastic SMD crystal, XTAL-CM309S |

# 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.



**UG04827-0-2/16(B)**


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