# ANALOG DEVICES

# Evaluation Board for 10-Bit ADCs with On-Chip Temperature Sensor
## EVAL-AD7816/7/8EB

## FEATURES

**10-bit ADC with 9 μs conversion time**
**1 (AD7818) and 4 (AD7817) single-ended analog input channels**
**The AD7816 is a temperature-measurement-only device**
**On-chip temperature sensor**
**Resolution of 0.25°C**
**±2°C error from −40°C to +85°C**
**−55°C to +125°C operating range**
**Wide operating supply range: 2.7 V to 5.5 V**
**Inherent track-and-hold functionality**
**On-chip reference (2.5 V ± 1%)**
**Overtemperature indicator**
**Automatic power-down at the end of a conversion**
**Low power operation**
    **4 μW at a throughput rate of 10 SPS**
    **40 μW at a throughput rate of 1 kSPS**
    **400 μW at a throughput rate of 10 kSPS**
**Flexible serial interface**

## APPLICATIONS

**Ambient temperature monitoring (AD7816)**
**Thermostat and fan control**
**High speed microprocessor**
**Temperature measurement and control**
**Data acquisition systems with ambient temperature**
**Monitoring (AD7817 and AD7818)**
**Industrial process control**
**Automotive**

## INTRODUCTION

The EVAL-AD7816/7/8EB evaluation board allows the AD7816, AD7817, and AD7818 10-bit ADCs with temperature sensors to be quickly and easily evaluated using a personal computer. Using the evaluation board and its accompanying software, the AD7816/AD7817/AD7818 can be interfaced to any personal computer running Windows® 95 or later, via the computer's parallel printer port.

The evaluation board allows all the input and output functions of the AD7816/AD7817/AD7818 to be exercised without external components. The software allows control and monitoring of the AD7816/AD7817/AD7818's internal registers.

## THE AD7816/AD7817/AD7818

This section gives a brief description of the AD7816/AD7817/ AD7818 and the system overview. For full information, see the AD7816/AD7817/AD7818 data sheet.

The AD7818 and AD7817 are 10-bit, single-channel and 4-channel ADCs with an on-chip temperature sensor that can operate from a single, 2.7 V to 5.5 V power supply. Each part contains a 9 μs successive-approximation converter based around a capacitor DAC, an on-chip temperature sensor with an accuracy of ±2°C, an on-chip clock oscillator, inherent track-and-hold functionality, and an on-chip reference (2.5 V). The AD7816 is a temperature-monitoring-only device that comes in a SOIC/MSOP package.

The on-chip temperature sensor of the AD7817 and AD7818 can be accessed via Channel 0. When Channel 0 is selected and a conversion is initiated, the resulting ADC code at the end of the conversion gives a measurement of the ambient temperature with a resolution of ±0.25°C. See the Temperature Measurement section of the AD7816/AD7817/AD7818 data sheet.

The AD7816/AD7817/AD7818 have a flexible serial interface that allows easy interfacing to most microcontrollers. The interface is compatible with the Intel® 8051, Motorola SPI®, and QSPI™ protocols, and National Semiconductor's MICROWIRE™ protocol. For more information, see the Serial Interface section of the AD7816/AD7817/AD7818 data sheet.

The AD7817 is available in a narrow body, 0.15″, 16-lead, small outline IC (SOIC) package and a 16-lead, thin shrink small outline package (TSSOP). The AD7816/AD7818 come in 8-lead SOIC and 8-lead MSOP packages.

## EVALUATION SYSTEM PACKAGE CONTENTS

The evaluation system package contains the following items:

- This document

- EVAL-AD7816/7/8EB evaluation board

- Evaluation software on a CD-ROM

# EVAL-AD7816/7/8EB

## TABLE OF CONTENTS

## REVISION HISTORY

**3/05—Rev. Sp0 to Rev. A**

**12/03—Revision Sp0: Initial Version**

# EVALUATION BOARD HARDWARE

The EVAL-AD7816/7/8EB evaluation board contains the following components, which can be identified from the block diagram, the printed circuit board silkscreen, and the schematic diagrams in Figure 8 to Figure 13:

- AD7816, AD7817, and AD7818 ICs

- Interface buffers and analog switches

- Three overtemperature LEDs and a power LED

- Connector for parallel interface, J1

- Input connectors SK1 and SK3

Selection of the AD7816, AD7817, or AD7818 is made under software control by ADG714 analog switches connected to form a 3-channel, 5-line data multiplexer. These are controlled via a separate serial interface.

## USING THE HARDWARE

The hardware is extremely simple to use. Make sure that your computer is switched off before connecting the evaluation board to a parallel printer port on the computer using the Centronics interface cable provided. No external power supply is required.

## CENTRONICS INTERFACE CONNECTOR, J1

The connections to J1 are listed in Table 1.

**Table 1. J1 Connections**

| J1 Pin | AD7816/AD7817/AD7818 Function |
|--------|-------------------------------|
| 2 | Serial Data In ($D_{IN}$) |
| 3 | Serial Data In (SDATA) |
| 4 | Start Conversion ($\overline{CONVST}$) |
| 5 | Serial Clock (SCLK) |
| 6 | Analog Switch $D_{IN}$ |
| 7 | Analog Switch SYNC |
| 8 | RESET IN |
| 10 | INT OUT |
| 12 | Analog Switch $D_{OUT}$ |
| 13 | Serial Data Output |
| 14 | Analog Switch $D_{IN}$ |

## INPUT CONNECTORS SK1 AND SK3

SK1 and SK3 allow analog input signals to be connected to the AD7817 and AD7818 (AD7816 measures temperature only). SK1 connects to the single analog input of the AD7818 and to $V_{IN}1$ and $V_{IN}2$ of the AD7817. SK3 connects to $V_{IN}3$ and VIN4 of the AD7817.

**Table 2. Indicators**

| LED | Color | Function |
|-----|-------|----------|
| D1 | Green | Power indicator |
| D6 | Red | AD7816 overtemperature indicator |
| D7 | Red | AD7818 overtemperature indicator |
| D8 | Red | AD7817 overtemperature indicator |

# EVALUATION SOFTWARE

The software allows you to control the functions of the AD7816/AD7817/AD7818 from a PC via an easy-to-use interface operating under Windows 95 or later. You can easily read or alter the contents of the device's internal registers through a user-friendly interface. The **Visual Display** (Figure 6) tab in the **AD7816/17/18 Evaluation Software** dialog box shows a graphical display of temperature and voltage, allowing you to alter the overtemperature limit using a slider.

## INSTALLING THE SOFTWARE

To install the software

1. Insert the CD-ROM into the CD-ROM drive.

2. Click **Start > Run**.

3. Type **X: AD7816_7_8Eval.exe**, where **X** is the letter of your CD-ROM drive.

4. Click **OK**.

Alternatively, run Windows Explorer, select the CD-ROM drive, and double-click **AD7816/17/18 Evaluation Software**.

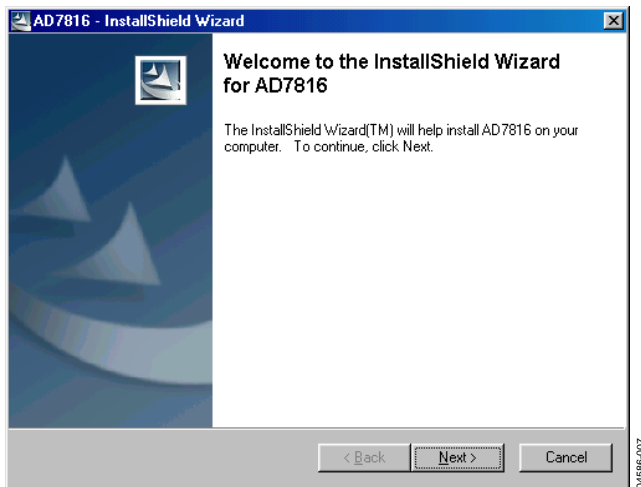The **InstallShield Wizard** is displayed.



Figure 1. InstallShield Wizard Start-Up Window

5. Click **Next** to continue the installation. InstallShield extracts the files from the CD-ROM and prepares for installation.

6. Click **Next** to continue the installation. Various installation options are available, depending on whether a version of the software is already installed. If this is a completely new installation, a license agreement appears.

7. Click **Yes** to accept the agreement and continue with the installation.

8. To install the software in the default folder shown, click **Next**. Otherwise, click **Browse** and choose a different folder.

9. Select the folder in which to install the program and click **OK**. You are now given the option of a typical, compact, or custom installation of the software.

10. Select the desired option, then click **Next**. If **Custom** is selected, a window allowing individual components to be installed appears. Uncheck any components you do not want to install, and click **Next**. If **Typical** or **Compact** installation is selected, this step is omitted and the **Select Program Folder** dialog box appears immediately. This allows you to select the program folder to which program icons are added.

11. Select the desired folder and click **Next**. InstallShield now installs the program files to the selected folders.

12. To use the software immediately, you must restart the computer so that Windows can update the setup files. To do this, select the **Yes** option. If you do not want to use the software immediately, select the **No** option.

13. Click **Finish** to complete the installation.

## MODIFYING THE INSTALLATION

If an existing version of the software is found during installation, you can modify the existing installation, repair the installation, or uninstall the entire software package.

1. Select the desired option and click **Next**. If you select **Modify**, you can add or remove components. If you select **Repair**, all the installed files are replaced with new files from the CD-ROM. If you select **Remove**, you are prompted to confirm the complete removal of the software.

2. Click **OK** to confirm removal of the software. During removal of the software, you might need to confirm removal of some files. These files might be used by other Analog Devices software. If no other Analog Devices software is installed on the system, it is safe to delete them. To remove all shared files without further prompting, select **Don't display this message again** before clicking **Yes**.

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

## USING THE SOFTWARE

When using the software, first ensure that the evaluation board is powered up and connected to the parallel printer port.

To start the software, click **Start** > **Programs** > **Analog Devices** > **AD7816 Evaluation Software** > **AD7816 Evaluation Software**. The **AD7816/17/18 Evaluation Software** dialog box appears with three tabs.

### Main Tab

The **Main** tab shows the software version. To obtain additional information about the software, click **About**.



*Figure 2. Main Tab*



*Figure 3. About the AD7414 Evaluation Software Dialog Box*

### Read/Write Tab

The **Read/Write** tab (see Figure 4) displays information about the AD7816/AD7817/AD7818's internal registers. From this dialog box, you can write to the overtemperature limit register, the only user-writeable register in the device. The **Read/Write** dialog box has five sections.
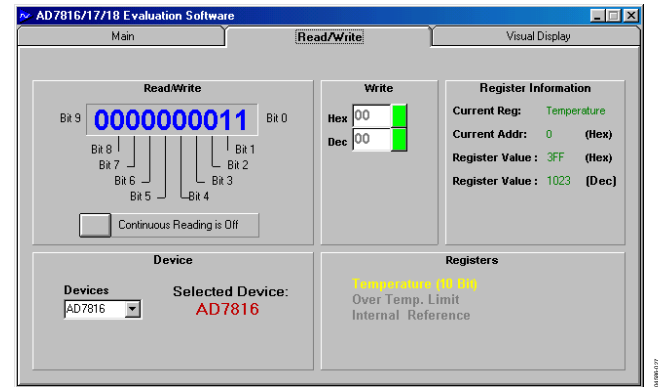


*Figure 4. Read/Write Tab*

The **Device** section allows you to select the device type.

The **Registers** section allows you to select a register in the device for display. The available registers vary with the selected device. The AD7816 has only temperature value and over-temperature limit registers. The AD7818 also has an $A_{IN}$ value register. The AD7817 has four $A_{IN}$ value registers.

The **Read/Write** section displays the data in the currently selected register in binary format. To set the device to continuous conversion and reading, toggle the button in the **Read/Write** section so that it reads **Continuous Reading is On**. When you toggle the button to **Continuous Reading is Off**, the registers are updated only when you select a new register.

The **Register Information** section displays the name of the register, its address, and its data contents in hexadecimal and decimal formats.

In the **Write** section, if you select the overtemperature limit register, you can change its value by clicking individual bits to toggle them. To change the register value, type a hexadecimal value in the **Hex** box or a decimal value in the **Dec** box and click the corresponding button. When you enter a new value, the button toggles from green to red; it toggles back to green when you click it and the new value is written to the overtemperature limit register.
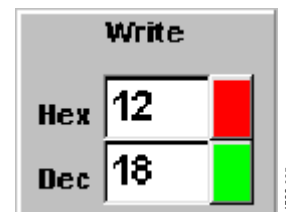


*Figure 5. Write Section*

The overtemperature limit register is only 8 bits, while the value registers are 10 bits. For limit comparison, only the 8 MSBs of the temperature value register are compared to the over-temperature limit register. The 2 MSBs are ignored. If the temperature exceeds the set limit, the device's OTI output goes low and the corresponding LED on the evaluation board lights up.

## Visual Display Tab

The **Visual Display** tab (see Figure 6) allows you to select a device and view all its channels in graphical format. Select a device from the list in the **Devices** box. For the AD7816, only temperature is displayed; for the AD7818, temperature and one analog channel are displayed; for the AD7817, temperature and four analog channels are displayed.

### Overtemperature Limit

Use the vertical slider to set the overtemperature limit. The temperature limit is shown on the slider, and the actual temperature is shown below the slider.
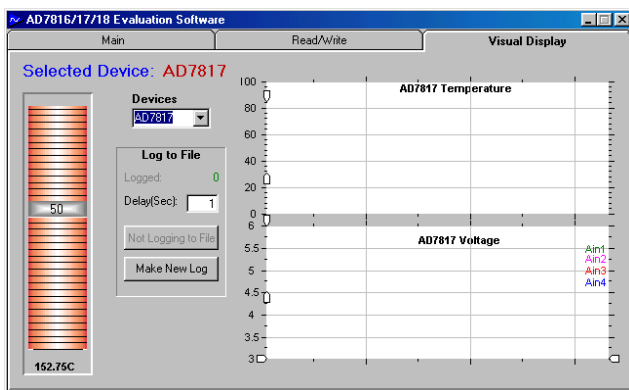


*Figure 6. Visual Display Tab for the AD7817*

**Log to File Section**

In the **Log to File** section, you can log output data from the device into an Excel spreadsheet. To enable this option

1.  Type the update interval (in seconds) in the **Delay (Sec)** box and click **Make New Log**. The **Open** dialog box is displayed (Figure 7).

2.  To select a folder in which to save the data, type a new file name or select an existing file name for the data, and click **Open**. If an existing log file is selected, the new data does not overwrite the existing data but is tagged onto the end.

3.  Once the data log file is opened, the evaluation software begins to write data to it. The **Logging to File** button is displayed in the **Visual Display** tab.
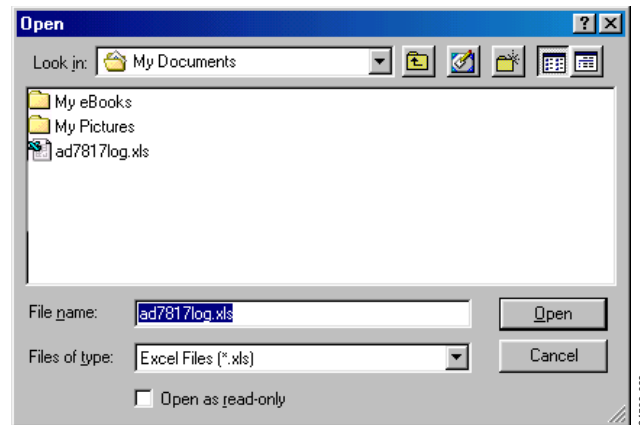


*Figure 7. Opening a Data Log File*

4.  To end logging, click **Logging to File**. The button toggles to **Not Logging to File**.

When the file is opened in Excel, it contains up to six columns of data, including

- Time at which each set of data was logged

- One column of temperature data

- Either zero, one, or four columns of analog data

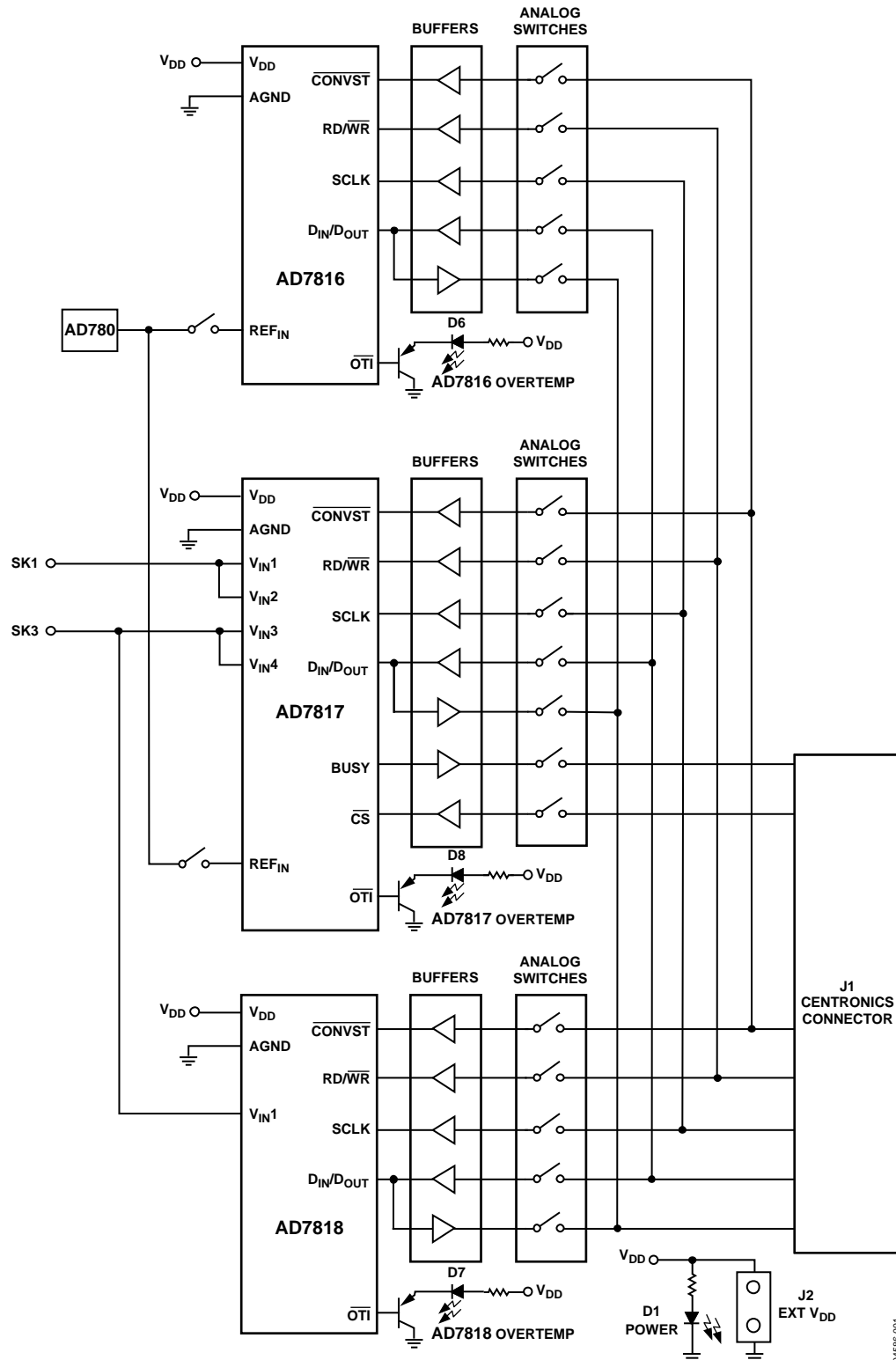# EVALUATION BOARD BLOCK DIAGRAM AND SCHEMATICS



*Figure 8. Evaluation Board Block Diagram*

*Figure 9. Evaluation Board Schematic*

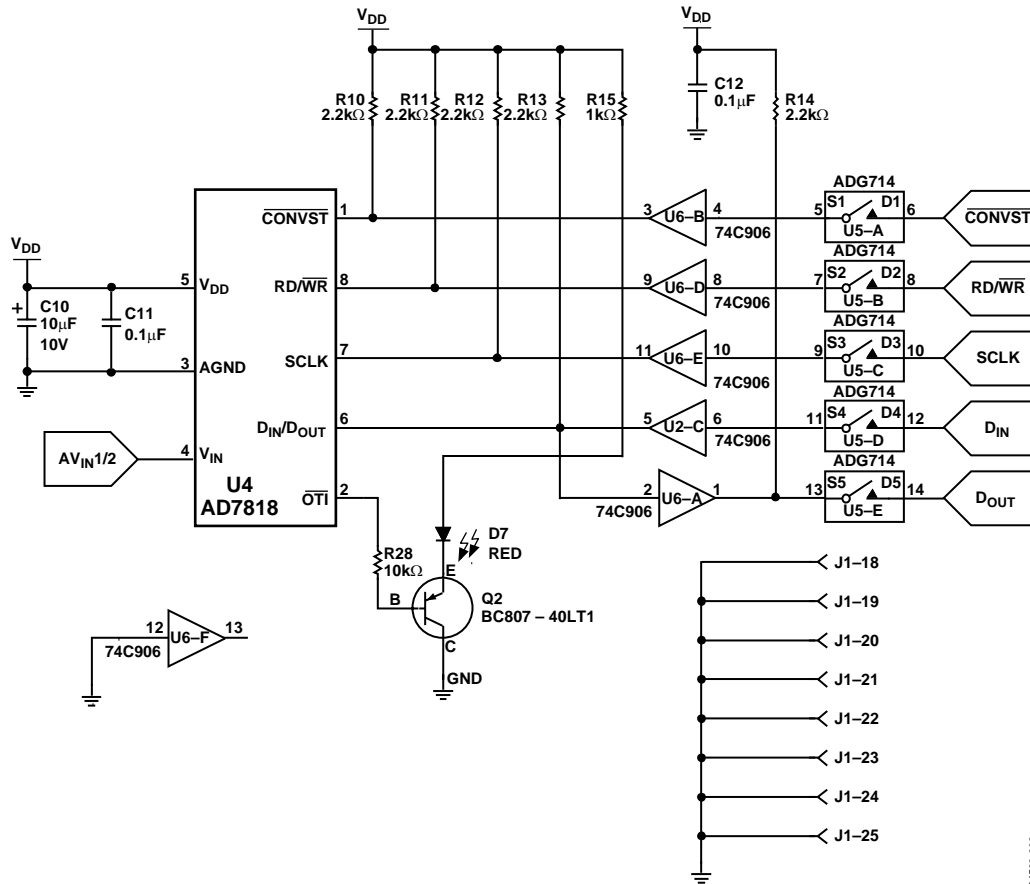Figure 10. Evaluation Board Schematic (Continued)

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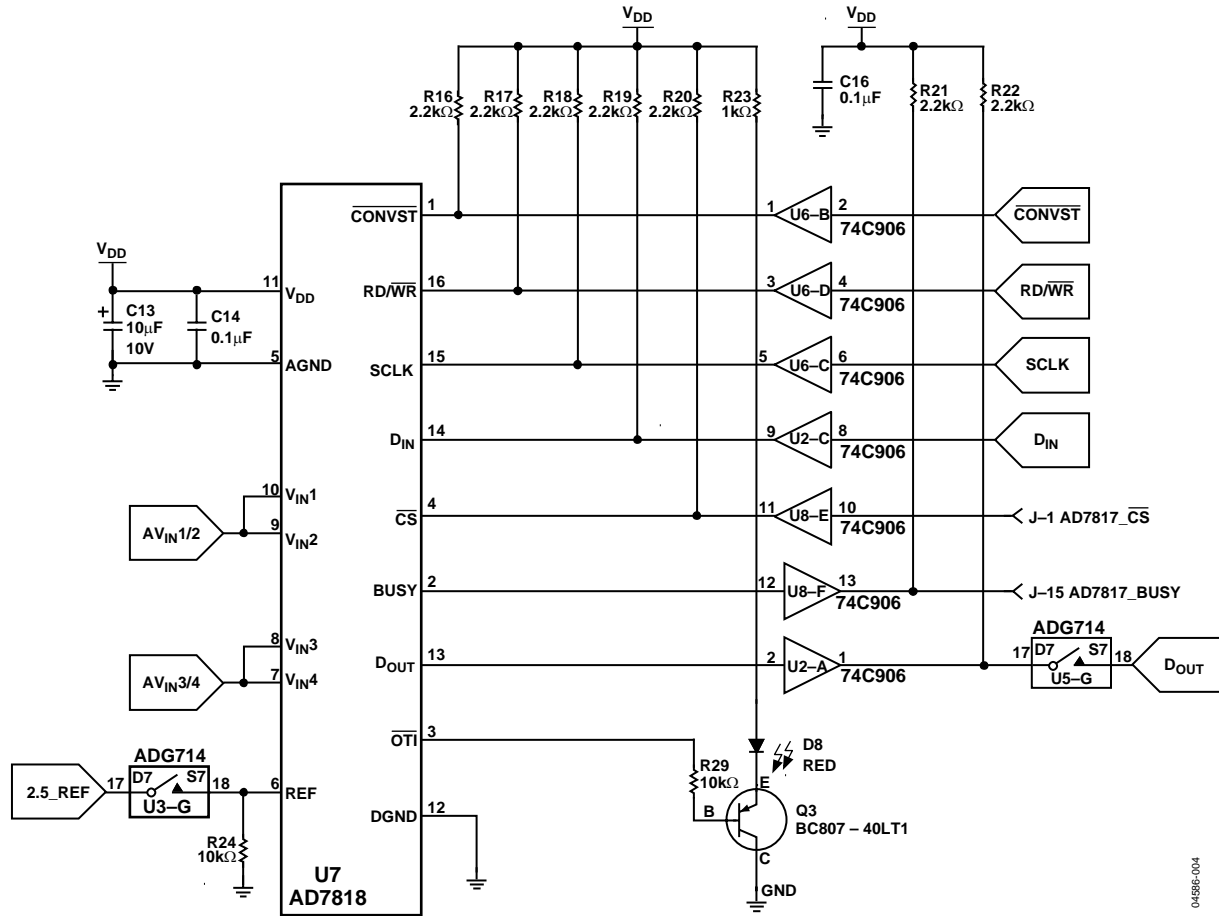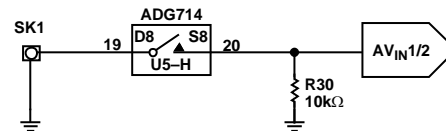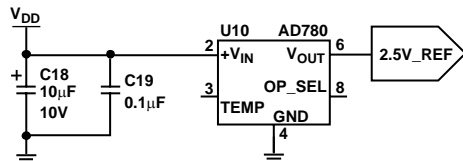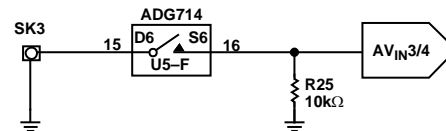Figure 11. Evaluation Board Schematic (Continued)



Figure 12. Evaluation Board Schematic (Continued)

Figure 13. Evaluation Board Silkscreen

## PARTS LIST

**Table 3.**

| Name | Part Type | Value | Tolerance | Description |
|------|-----------|-------|-----------|-------------|
| C1 | CAP+ | 10 µF | | 10 µF/10 V SMD Tantalum Capacitor |
| C2 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C3 | CAP+ | 47 µF | | 47 µF/10 V SMD Tantalum Capacitor |
| C4 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C5 | CAP+ | 47 µF | | 47 µF/10 V SMD Tantalum Capacitor |
| C6 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C7 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C8 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C9 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C10 | CAP+ | 10 µF | | 10 µF/10 V SMD Tantalum Capacitor |
| C11 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C12 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C13 | CAP+ | 10 µF | | 10 µF/10 V SMD Tantalum Capacitor |
| C14 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C15 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C16 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| C18 | CAP+ | 10 µF | | 10 µF/10 V SMD Tantalum Capacitor |
| C19 | CAP | 0.1 µF | | 100 nF/50 V X7R SMD Ceramic Capacitor |
| D1 | LED | | | Green SMD Light-Emitting Diode |
| D4 | DIODE | | | BAT41 Schottky Barrier Diode |
| D5 | DIODE | | | BAT41 Schottky Barrier Diode |
| D6 | LED | | | Red SMD Light-Emitting Diode |
| D7 | LED | | | Red SMD Light-Emitting Diode |
| D8 | LED | | | Red SMD Light-Emitting Diode |
| J1 | CENTRONICS | | | 36-Pin 90° Centronics Connector |
| Q1 | BC807-40LT1 | | | BC807-40LT1 PNP SMT Transistor |
| Q2 | BC807-40LT1 | | | BC807-40LT1 PNP SMT Transistor |
| Q3 | BC807-40LT1 | | | BC807-40LT1 PNP SMT Transistor |
| R1 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R2 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R3 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R4 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R5 | RES | 1 kΩ | 1% | 1 kΩ/1% SMD Resistor |
| R6 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R7 | RES | 10 kΩ | 1% | 10 kΩ/1% SMD Resistor |
| R8 | RES | 1 kΩ | 1% | 1 kΩ/1% SMD Resistor |
| R9 | RES | 20 kΩ | 1% | 20 kΩ/1% SMD Resistor |
| R10 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R11 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R12 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R13 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R14 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R15 | RES | 1 kΩ | 1% | 1 kΩ/1% SMD Resistor |
| R16 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R17 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R18 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R19 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R20 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R21 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R22 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |

| Name | Part Type | Value | Tolerance | Description |
|------|-----------|-------|-----------|-------------|
| R23 | RES | 1 kΩ | 1% | 1 kΩ/1% SMD Resistor |
| R24 | RES | 10 kΩ | 1% | 10 kΩ/1% SMD Resistor |
| R25 | RES | 10 kΩ | 1% | 10 kΩ/1% SMD Resistor |
| R26 | RES | 10 kΩ | 1% | 10 kΩ/1% SMD Resistor |
| R27 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| R28 | RES | 10 kΩ | 1% | 10 kΩ/1% SMD Resistor |
| R29 | RES | 10 kΩ | 1% | 10 kΩ/1% SMD Resistor |
| R30 | RES | 10 kΩ | 1% | 10 kΩ/1% SMD Resistor |
| R37 | RES | 2.2 kΩ | 1% | 2.2 kΩ/1% SMD Resistor |
| SK1 | SMB | | | 50 Ω SMB Jack |
| SK3 | SMB | | | 50 Ω SMB Jack |
| U1 | AD7816 | | | AD7816 ADC with Temperature Sensor |
| U2 | 74C906 | | | MM74C906 Hex Open Drain N-Channel Buffer |
| U3 | ADG714 | | | ADG714 Octal SPST Switch |
| U4 | AD7818 | | | AD7818 ADC with Temperature Sensor |
| U5 | ADG714 | | | ADG714 Octal SPST Switch |
| U6 | 74C906 | | | MM74C906 Hex Open Drain N-Channel Buffer |
| U7 | AD7817 | | | AD7817 ADC with Temperature Sensor |
| U8 | 74C906 | | | MM74C906 Hex Open Drain N-Channel Buffer |
| U10 | AD780 | | | AD780 2.5 V Reference |

# ORDERING INFORMATION

## ORDERING GUIDE

| Model | Description |
|---|---|
| EVAL-AD7816/7/8EB | Evaluation Board |

## ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

## NOTES

NOTES

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