FEATURES

Full-featured evaluation board for the AD7746
PC evaluation software for control and measurement
of the AD7746
USB interface and cable in kit

APPLICATIONS

Capacitive length sensor demo
AD7746 performance evaluation
Platform to integrate the AD7746 into system design

EVALUATION BOARD DESCRIPTION

This data sheet describes the evaluation board for the AD7746. The evaluation board interfaces to the USB port of a PC. Evaluation software is available with the evaluation board, which allows the user to easily communicate with the AD7746.

Note that the AD7746 evaluation board software should be installed before connecting the AD7746 evaluation board to the PC.

To properly use the evaluation board, see the AD7746 data sheet on the Analog Devices, Inc., website. You can download the data sheet from www.analog.com/AD7746.

AD7746 DEVICE DESCRIPTION

The AD7746 is a high resolution capacitance-to-digital converter (CDC). The capacitance to be measured is connected directly to the device inputs. The architecture features inherent high resolution (24 bits, no missing codes, up to 21-bit effective resolution), high linearity (0.01%), and high accuracy (±4 fF factory calibrated). The AD7746 capacitance input range is ±4 pF (changing); the AD7746 can accept up to 17 pF common-mode capacitance (not changing), which can be balanced by a programmable on-chip digital-to-capacitance converter (CAPDAC).

The AD7746 has two capacitive input channels. Each channel can be configured as single-ended or differential. The AD7746 is designed for floating capacitive sensors. For capacitive sensors with one plate connected to ground, the AD7747 is recommended.

The AD7746 has an on-chip temperature sensor with resolution of 0.1°C and accuracy of ±2°C. The on-chip voltage reference and the on-chip clock generator eliminate the need for any external components in most capacitive sensor applications. The part has a standard voltage input, which, together with the differential reference input, allows easy interface to an external temperature sensor such as an RTD or diode.

FUNCTIONAL BLOCK DIAGRAM

![Functional Block Diagram](image)

Figure 1.
## TABLE OF CONTENTS

Features .............................................................................................. 1  
Applications......................................................................................... 1  
Evaluation Board Description ......................................................... 1  
AD7746 Device Description ........................................................... 1  
Functional Block Diagram .............................................................. 1  
Revision History ............................................................................... 2  
Evaluation Board Software Installation ......................................... 3  
Evaluation Board Hardware ............................................................ 4  
Power Supplies .............................................................................. 4  
I²C Interface Configuration Options ......................................... 4  
USB Connector ............................................................................. 5  
Sockets ........................................................................................... 5  
Evaluation Board Software ...............................................................6  
Configuring the Evaluation Board..................................................6  
Getting Started with the Software ................................................. 6  
Setup Window ............................................................................... 8  
User Unit Setup ............................................................................ 9  
Performing a Noise Analysis......................................................... 10  
Saving and Reloading User Configurations................................... 10  
Schematics and Artwork ............................................................... 11  
Component ID ............................................................................ 12  
Ordering Information .................................................................... 13  
Bill of Materials ........................................................................... 13  
Ordering Guide .......................................................................... 13  
ESD Caution................................................................................ 13  

## REVISION HISTORY

11/11—Rev. 0 to Rev. A  
Changes to Evaluation Board Software Installation Section ...... 3  
Deleted Figure 2 ................................................................................ 3  
Added Figure 2, Figure 3, and Figure 4; Renumbered  
Figures Sequentially ................................................................. 3  
Renamed Evaluation Board Hardware and Interfacing Section  
to Evaluation Board Hardware Section ................................. 4  
Changes to Power Supplies Section.......................... 4  
Deleted Link Options Section, Figure 3, and Table 1 ....... 4  
Added I²C Interface Configuration Options Section,  
Figure 6, Figure 7, and Figure 8 ................................................... 4  

5/05—Revision 0: Initial Version  

Deleted Connecting the Board to the PC Section ............... 5  
Renamed Schematic Section to Schematics and Artwork  
Section; Changes to Figure 10 ...................................................... 11  
Renamed Layout Section to Component ID Section .......... 12  
Added Ordering Information Section, Bill of Materials  
Section, and Table 2 ................................................................. 13  
Changes to Ordering Guide ......................................................... 13  

Rev. A | Page 2 of 16
EVALUATION BOARD SOFTWARE INSTALLATION

Before connecting the AD7746 evaluation board to the PC, install the AD7746 evaluation board software by completing the following steps.

1. Insert the AD7746 evaluation kit CD into the CD-ROM drive of your PC.

The evaluation software installation wizard should start automatically (see Figure 3). If the wizard does not start, run Setup.exe from the AD7746 evaluation kit CD.

2. Follow the steps in the evaluation software installation wizard until the installation is completed.

3. Connect the AD7746 evaluation board to the USB connector of the PC using the USB cable included in the evaluation kit. The POWER LED on the evaluation board turns on, and the Found New Hardware Wizard starts automatically on the PC (see Figure 4).

4. Follow the steps in the Found New Hardware Wizard window. If a message that the software has not passed Windows® Logo testing appears, click Continue Anyway (see Figure 5).

5. Follow the steps in the Found New Hardware Wizard window until the installation is completed.
EVALUATION BOARD HARDWARE

POWER SUPPLIES
The board is powered via the 5 V supply from the USB connector, J1, indicated via LED D1 (POWER). The 5 V supply can be used to power the AD7746 directly. A 3.3 V regulated voltage from the on-board ADP3303 high precision, low power, 3.3 V output voltage regulator can also be used. Alternatively, the AD7746 can be powered using an external 3 V or 5 V power supply via J2.

I²C INTERFACE CONFIGURATION OPTIONS
The AD7746 evaluation board allows different digital interface configurations by redirecting the I²C signals, SDA and SCL, on LK2.

Default Configuration
Links in the SDA, SCL, and RDY positions of LK2 connect the USB microcontroller as the I²C bus master to the on-board AD7746, as shown in Figure 6. This configuration allows easy use of the evaluation board, together with the PC software.

External Connection—USB
The AD7746 evaluation board allows customers to connect their own specific AD7746 application board to Pin 4, Pin 6, and Pin 8 of LK2. Using the PC evaluation software, customers can evaluate their application hardware using the AD7746 evaluation board as a USB-to-I²C digital interface only, as shown in Figure 7.

External Connection—AD7746
The AD7746 evaluation board can be used for software development by connecting a customer-specific external microcontroller board to Pin 3, Pin 5, and Pin 7 of LK2, as shown in Figure 8. In this configuration, the AD7746 CDC on the evaluation board is used as the sensing device.
USB CONNECTOR
A standard USB connector, J1, is used to connect the evaluation board to the USB port of a PC. A standard USB connector cable is included with the AD7746 evaluation kit. Because the board is powered by the USB connector, an external power supply is not required, although one can be connected to J2.
Communication between the AD7746 evaluation board and the PC is over the USB interface. The on-board USB controller controls this communication.

SOCKETS
The AD7746 evaluation board has four populated sockets: EXCA (P1), EXCB (P2), CIN1− (P3), and CIN1+ (P4). The functions of these sockets are described in Table 1.
To interface to the AD7746 using the analog voltage input channel or the external temperature sensor and an external voltage reference, use the unpopulated through hole pads labeled AIN+, AIN−, REF+, and REF− located on the AD7746 evaluation board.

<table>
<thead>
<tr>
<th>Socket</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIN1+</td>
<td>Subminiature BNC (SMB) connector. The capacitive input signal for the CIN1(+) input of the AD7746 is applied to this socket.</td>
</tr>
<tr>
<td>CIN1−</td>
<td>Subminiature BNC (SMB) connector. The capacitive input signal for the CIN1(−) input of the AD7746 is applied to this socket.</td>
</tr>
<tr>
<td>CIN2+</td>
<td>Subminiature BNC (SMB) connector. The capacitive input signal for the CIN2(+) input of the AD7746 is applied to this socket. On this evaluation board, the positive terminal of the capacitive length sensor demo is connected to CIN2+.</td>
</tr>
<tr>
<td>CIN2−</td>
<td>Subminiature BNC (SMB) connector. The capacitive input signal for the CIN2(−) input of the AD7746 is applied to this socket.</td>
</tr>
<tr>
<td>EXCA</td>
<td>Subminiature BNC (SMB) connector. This socket is connected to the EXCA output of the AD7746. On this evaluation board, the negative terminal of the capacitive length sensor demo is connected to EXCA. This provides excitation to the on-board capacitive length sensor demo.</td>
</tr>
<tr>
<td>EXCB</td>
<td>Subminiature BNC (SMB) connector. This socket is connected to the EXCB output of the AD7746.</td>
</tr>
</tbody>
</table>

1 The CIN2− and CIN2+ sockets (P5 and P6, respectively) are unpopulated on the AD7746 evaluation board.
CONFIGURING THE EVALUATION BOARD

The evaluation board is initially configured to allow the user to interface any capacitive input directly to CIN1 of the AD7746 device. To do this, connect one end of the capacitive input to the SMB connector labeled CIN1+ or CIN1−. Then connect the other end of the capacitive input to the SMB connector labeled EXCB.

The AD7746 provides a second capacitive channel, CIN2. On the AD7746 evaluation board, the second capacitive channel is used with the on-board capacitive length sensor demo.

To disable the capacitive length sensor demo, disconnect the two 0 Ω SMD resistors, R1 and R2. Any capacitive sensor can then be directly interfaced to CIN2 of the AD7746 by connecting one end of the capacitive input to either of the SMB connectors labeled CIN2+ or CIN2− and the other end to one of the SMB connectors labeled EXCA or EXCB.

Note that after the capacitive length sensor demo is disabled, either of the excitation output pins (EXCA or EXCB) can be used as the excitation source, regardless of which capacitive channel is enabled. These settings are configurable using the evaluation board software.

GETTING STARTED WITH THE SOFTWARE

To run the AD7746 evaluation board software, follow these steps:

1. From the Start menu, select Program Files > Analog Devices > AD7746 Evaluation Software.

The AD7745/AD7746 Evaluation Software window appears (see Figure 9). By default, the application opens to the Real Time tab.

2. Click the Length Demo (CH2) button. This action enables continuous conversions on Capacitive Channel 2 in single-ended mode, enables EXCA as the excitation output pin, sets the update rate, and initializes CAPDAC A. The Capacitive Length Sensor Demo window appears (see Figure 10).

Figure 9. AD7745/AD7746 Evaluation Software Window
3. Slide the ruler on the evaluation board. This action is mirrored on the screen. The code, capacitance, and length (in inches or mm) appear on the right side of the window (see Figure 10). These values change as you slide the ruler on the evaluation board.

4. Remove the ruler completely by clicking the 0 mm/0 inch Cal button.

5. Place the ruler at the 51 mm/2 inch mark by clicking the 51 mm/2 inch Cal button. The part is now calibrated to the length of the ruler. Note that when the ruler length exceeds 80 mm, the demo can no longer measure the ruler length because the input capacitance range (±4 pF) has been exceeded.

6. Click BACK to return to the Real Time tab.

Figure 10. Capacitive Length Sensor Demo Window
SETUP WINDOW

After running the capacitive length sensor demo to check the settings and familiarize yourself with the software, follow these steps to set up the software.

1. On the Real Time tab, click Setup. The Setup window appears (see Figure 11).

   The Setup window allows you to configure the capacitive channel, the voltage/temperature channel, the output pin for the excitation source, the CAPDACs, and the AD7746 operating mode.

2. Click OK to return to the Real Time tab.

Note that the Setup window reflects the settings established during the capacitive length sensor demo, that is,

- Capacitive Channel 2 is enabled in single-ended mode.
- EXCA is enabled as the excitation output pin.
- CAPDAC A is set to a value determined by the demo calibration routine.
- The part is in continuous conversion mode.

![Figure 11. Setup Window](image-url)
USER UNIT SETUP
To set up the user unit, follow these steps.

1. On the Real Time tab, click User Unit Setup. The User Unit Setup window appears (see Figure 12). The User Unit Setup window allows you to configure a unit that reflects the nature and sensitivity of the capacitive sensor connected to the selected capacitive input. This configuration is then reflected in the Real Time tab and the Analysis tab. After the capacitive length sensor demo is run, the user unit reflects the capacitive length sensor by default.

2. Click OK to return to the Real Time tab.

3. Click START. Note that the Real Time tab reflects the settings established during the capacitive length sensor demo. The samples collected are displayed graphically in real time.

4. Click STOP to stop the display of data.

5. Click Quick Setup (CH1). This action enables Capacitive Channel 1, enables EXCB as the excitation output pin, and places the part in continuous conversion mode. In continuous conversion mode, the part directly measures any capacitance placed across the CIN1(+)/CIN1(−) and EXCB pins.

For complete information about this setup, click Setup. Alternatively, you can click Registers. This action displays a detailed register map of all available registers and reflects the current user settings. The Registers window can be used if a more detailed configuration of the AD7746 device is required.

The samples are also displayed in hexadecimal format and capacitance. When you move the ruler, the tab is updated in real time, and the input capacitance changes. Also, the User Unit field displays the length of the ruler in mm.

Figure 12. User Unit Setup Window
PERFORMING A NOISE ANALYSIS

With the quick setup for Capacitive Channel 1 still in place, click the Analysis tab. The Analysis window appears (see Figure 13). To perform a noise analysis, follow these steps.

1. Type the number of samples required and click START. After the samples are collected, they can be displayed as a waveform or as a histogram. The average, RMS noise, p-p noise, RMS resolution, and p-p resolution values relating to the collected set of samples appear in the Analysis (Codes) box on the right side of the window. These values can be displayed in code, in capacitance, or in the user configured unit.

2. To save this set of collected samples, select File > Save Binary Data.

3. Select the directory and file name where you want to save the data. The default file name is Binary Data.txt.

A summary of the current configuration as well as the data for the selected number of samples in hexadecimal format is saved to the file.

SAVING AND RELOADING USER CONFIGURATIONS

You can save a configuration and reload it at a later time. To save any configuration, follow these steps:

1. Select File > Save Settings.

2. Select the directory and file name where you want to save the current user configuration. The default file name is Settings.txt. The user unit, user offset, and user range are saved together with the complete register map as it appears in the Registers window.

To reload these settings at any time, select File > Load Settings. A prompt appears and points, by default, to the previously saved user configuration Settings.txt file.
SCHEMATICS AND ARTWORK

Figure 14. Evaluation Board Schematics
Figure 15. Evaluation Board Layout, Silkscreen
### ORDERING INFORMATION

#### BILL OF MATERIALS

<table>
<thead>
<tr>
<th>Qty</th>
<th>Designator</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part No.</th>
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<tbody>
<tr>
<td>3</td>
<td>U1, Sample1, Sample2</td>
<td>CDC for proximity sensing, 16-lead TSSOP</td>
<td>Analog Devices</td>
<td>AD7746RUZ</td>
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<td>1</td>
<td>U2</td>
<td>3.3 V voltage regulator, low I&lt;sub&gt;o&lt;/sub&gt;, 8-lead SOIC</td>
<td>Analog Devices</td>
<td>ADP3303ARZ-3.3</td>
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<td>Microchip</td>
<td>24LC64-I/SN</td>
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<td>Avago</td>
<td>HSMG-C170</td>
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<td>D2</td>
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<td>Avago</td>
<td>HSMS-C191</td>
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<td>S2A-E3/52T</td>
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<td>Yageo</td>
<td>CC0603ZRY5V6BB105</td>
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<td>Capacitor, ceramic, SMD, 12 pF, NPO, 50 V, 0603</td>
<td>Yageo</td>
<td>CC0603JRNP098N120</td>
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<td>Multicomp</td>
<td>MC 0.063W 0603 0R</td>
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<td>MC 0.063W 0603 1% 1R5</td>
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<td>Multicomp</td>
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<td>R9, R10</td>
<td>Resistor, SMD, 2.2 kΩ, 1%, 0603</td>
<td>Multicomp</td>
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<td>R12 to R14</td>
<td>Resistor, SMD, 100 kΩ, 1%, 0603</td>
<td>Multicomp</td>
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<td>L1</td>
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<td>Sigma Inductors</td>
<td>BMB2A0300AN1</td>
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<td>Y1</td>
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<td>ECS</td>
<td>ECS-240-12-20A-TR</td>
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<td>1</td>
<td>J1</td>
<td>Connector, USB type Mini-B</td>
<td>Molex</td>
<td>56579-0576</td>
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<tr>
<td>1</td>
<td>J2</td>
<td>Terminal block with screws, pitch 5 mm</td>
<td>Camden</td>
<td>CTB5000/2</td>
</tr>
<tr>
<td>4</td>
<td>P1 to P4</td>
<td>Connector, SMB, 50 Ω</td>
<td>Multicomp</td>
<td>24-14-2-TGG</td>
</tr>
<tr>
<td>1</td>
<td>LK1</td>
<td>Straight header, 2 × 3-pin, pitch 2.54 mm</td>
<td>Harwin</td>
<td>M20-9980346</td>
</tr>
<tr>
<td>1</td>
<td>LK2</td>
<td>Straight header, 2 × 5-pin, pitch 2.54 mm</td>
<td>Harwin</td>
<td>M20-9980546</td>
</tr>
<tr>
<td>4</td>
<td>Jumper socket</td>
<td>Jumper socket, red; insert in these locations: LK1 (5.0 V), LK2 (SDA, SCL, RDY)</td>
<td>Harwin</td>
<td>M7566-05</td>
</tr>
</tbody>
</table>

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### ORDERING GUIDE

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>EVAL-AD7746EBZ&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Evaluation Board</td>
</tr>
</tbody>
</table>

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

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### 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.