AD7746 Evaluation Board
EVAL-AD7746EB

Data Sheet

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.
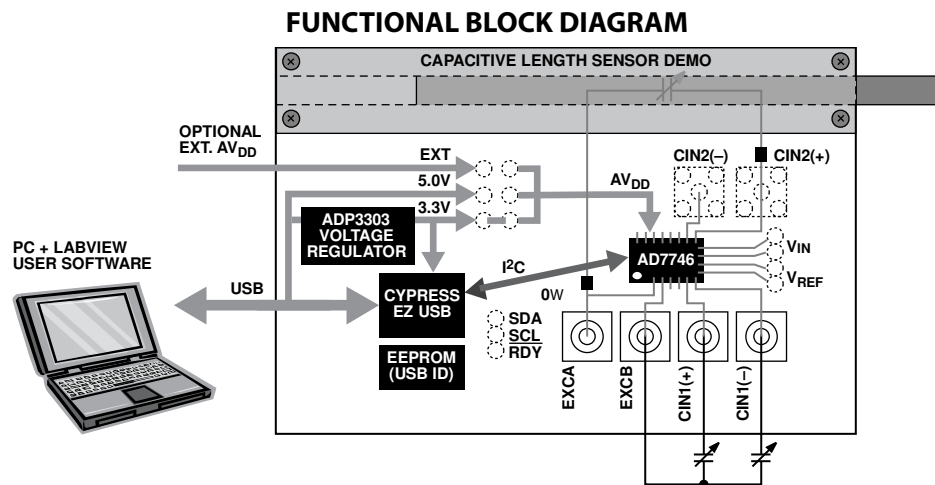
FUNCTIONAL BLOCK DIAGRAM

Figure 1.

Rev. A

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REVISION HISTORY

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.

Figure 2. AD7746 Evaluation Kit CD

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.
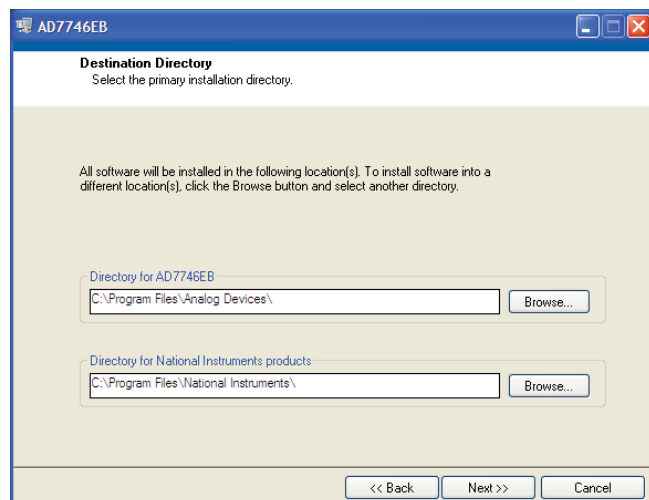
Figure 3. AD7746 Evaluation Software Installation Wizard

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).

Figure 4. Found New Hardware Wizard

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).

Figure 5. Windows Logo Warning

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

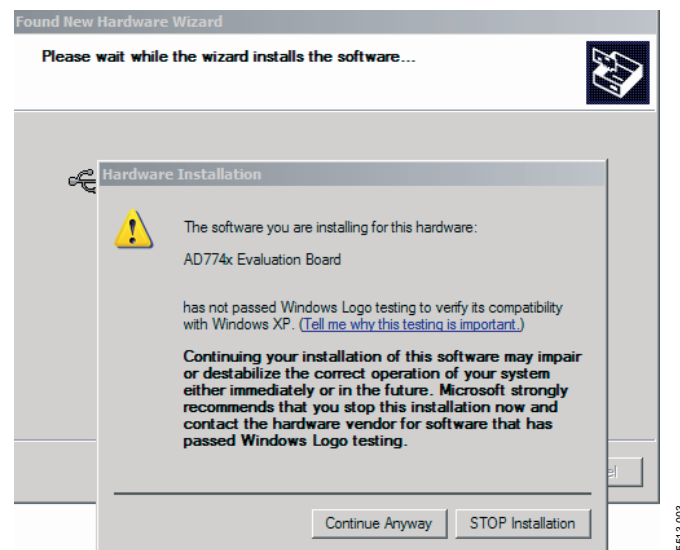The AD7746 evaluation board allows different digital interface configurations by redirecting the I²C signals, SDA and SCL, on LK2.

Default Configuration

Links in the SDA, SCL, and $\overline{RDY}$ 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.
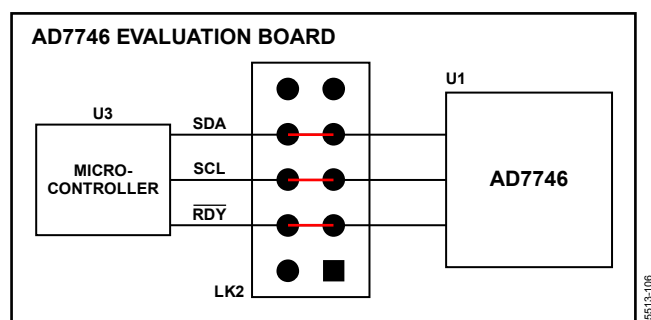
Figure 6. AD7746 Evaluation Board in Default Configuration

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.
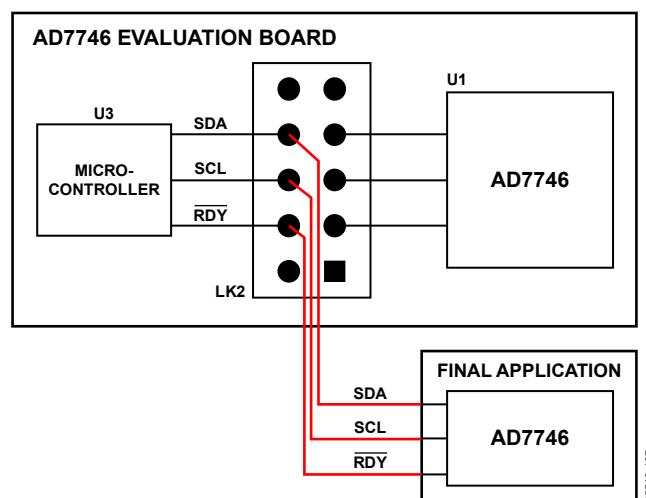
Figure 7. AD7746 Evaluation Board as USB-to-I²C Interface

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.
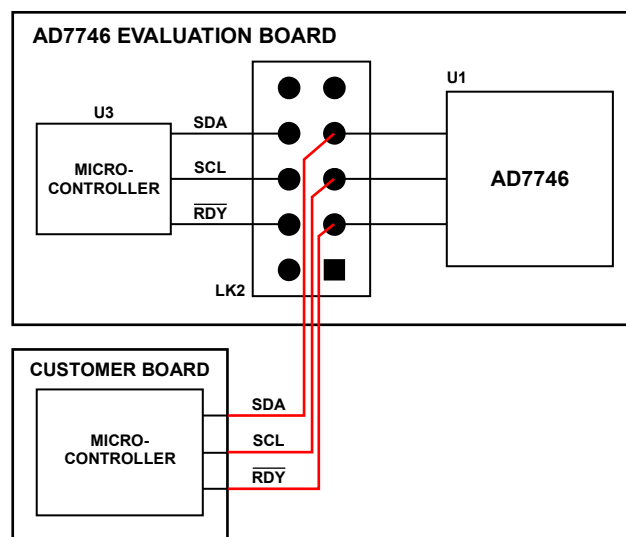
Figure 8. AD7746 Evaluation Board Software Development Platform

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 1. Socket Functions

Socket	Function
CIN1+	Subminiature BNC (SMB) connector. The capacitive input signal for the CIN1(+) input of the AD7746 is applied to this socket.
CIN1−	Subminiature BNC (SMB) connector. The capacitive input signal for the CIN1(−) input of the AD7746 is applied to this socket.
CIN2+[1]	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+.
CIN2−[1]	Subminiature BNC (SMB) connector. The capacitive input signal for the CIN2(−) input of the AD7746 is applied to this socket.
EXCA	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.
EXCB	Subminiature BNC (SMB) connector. This socket is connected to the EXCB output of the AD7746.

[1] The CIN2− and CIN2+ sockets (P5 and P6, respectively) are unpopulated on the AD7746 evaluation board.

EVALUATION BOARD SOFTWARE

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).
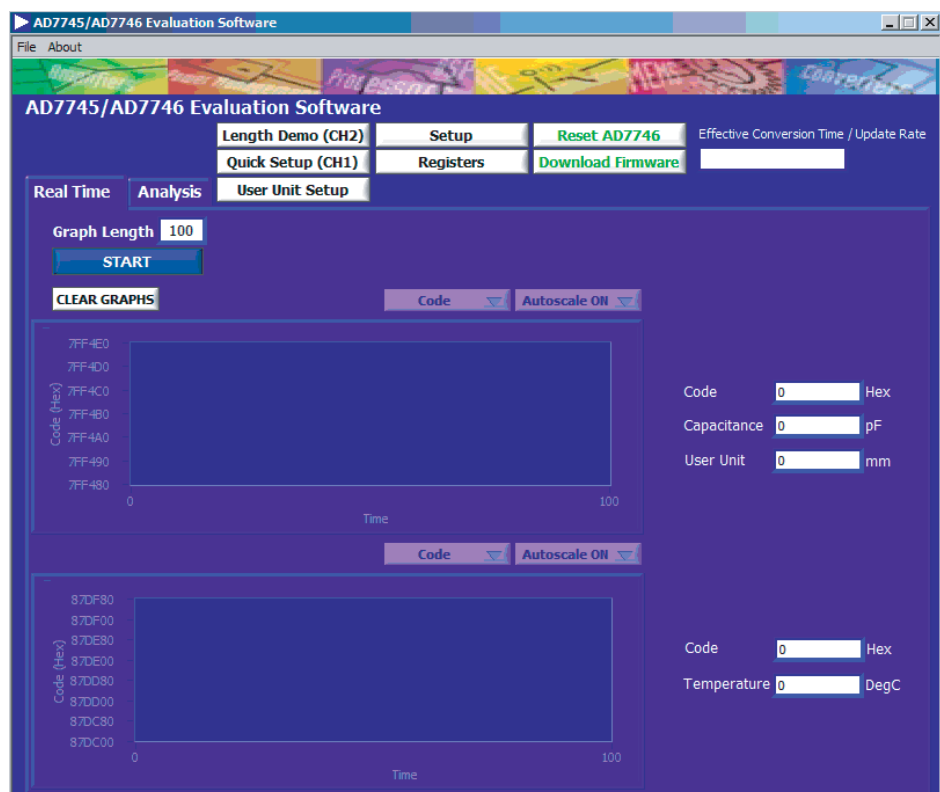
Figure 9. AD7745/AD7746 Evaluation Software Window

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.
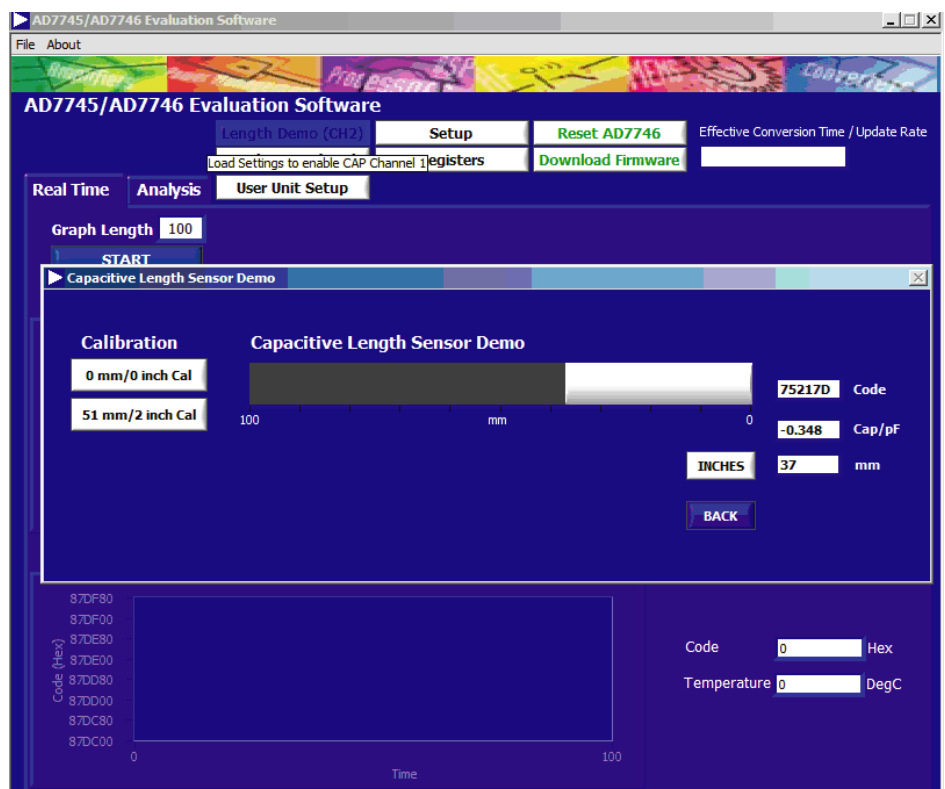
Figure 10. Capacitive Length Sensor Demo Window

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.

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.

2. Click **OK** to return to the **Real Time** tab.
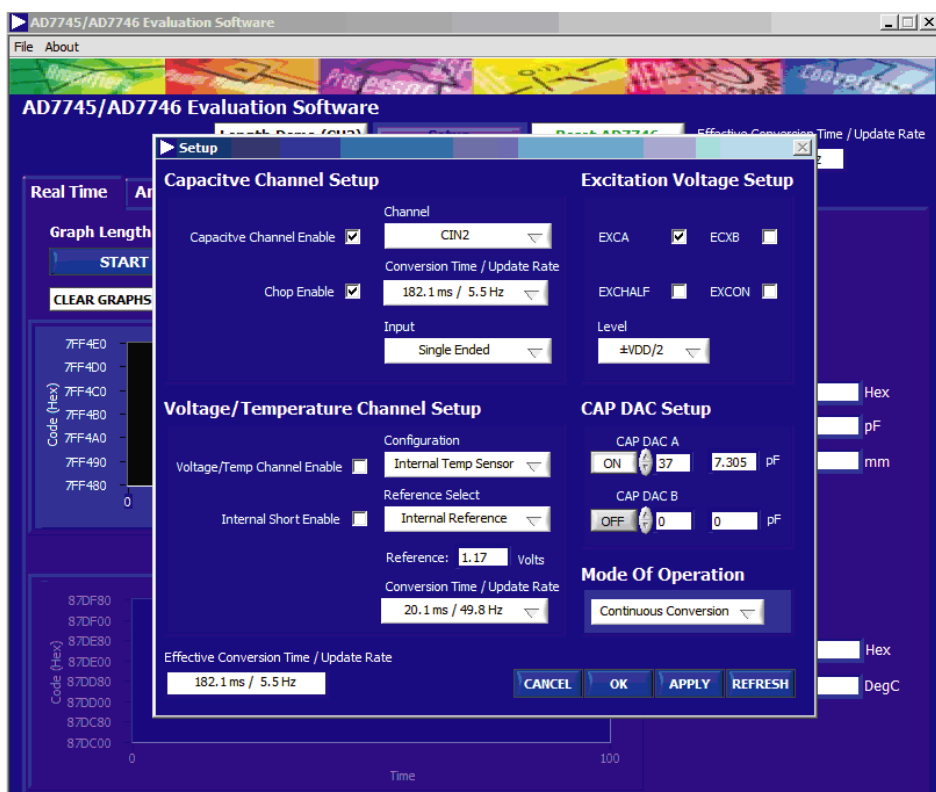
Figure 11. Setup Window

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.

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.

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.

Figure 12. User Unit Setup Window

PERFORMING A NOISE ANALYSIS

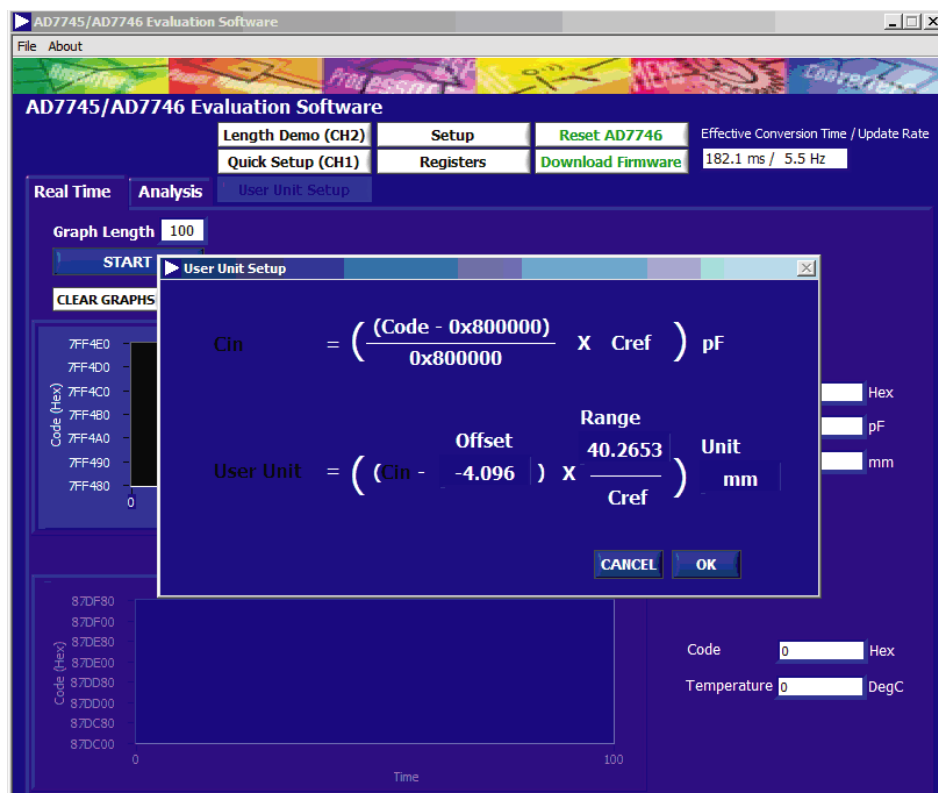With the quick setup for Capacitive Channel 1 still in place, click the **Analysis** tab. The **Analysis** window appears (see Figure 13). To perform a noise analysis, follow these steps.

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.
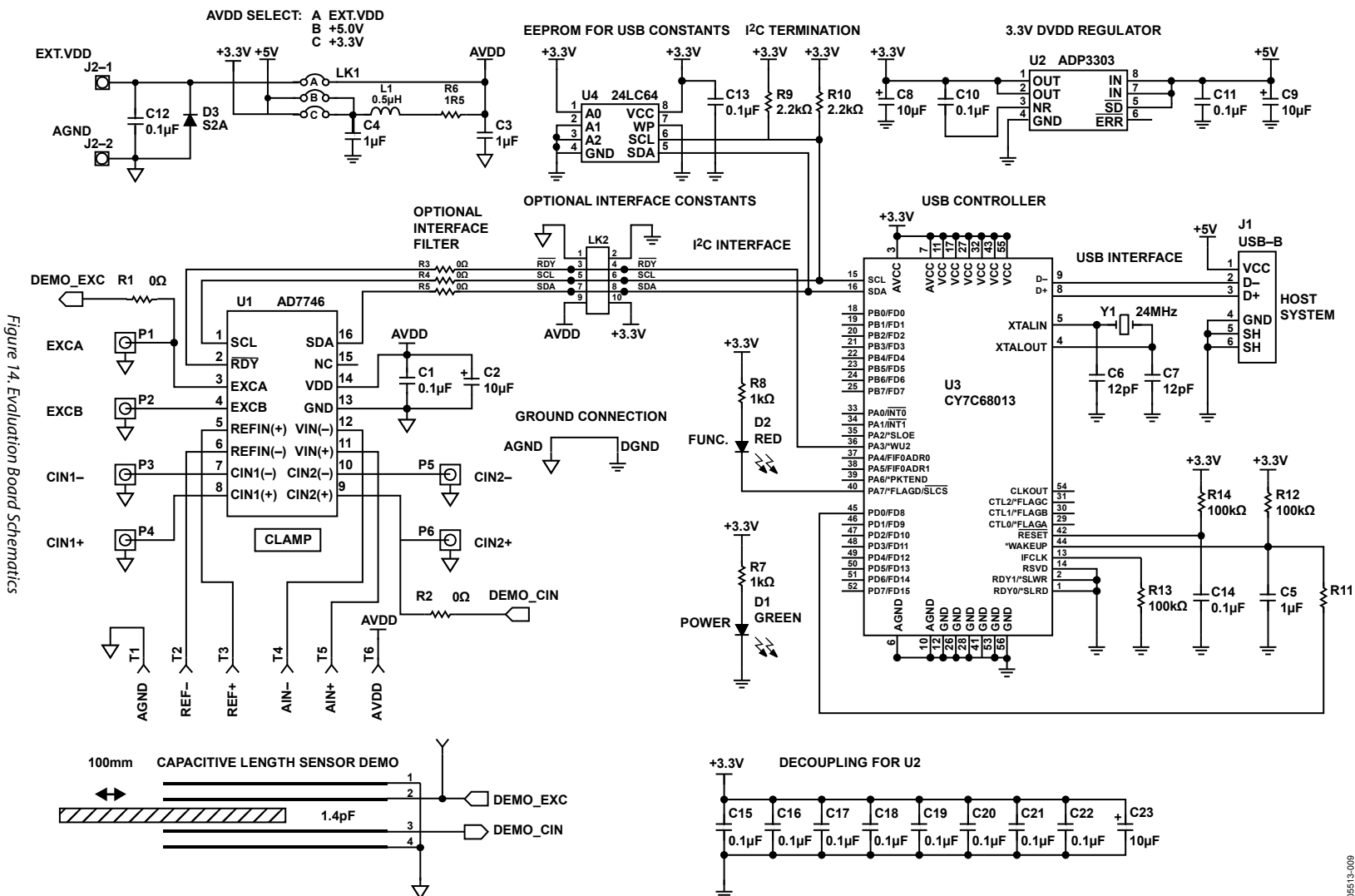

Figure 13. Analysis Window

SCHEMATICS AND ARTWORK

EVAL-AD7746EB

AVDD SELECT: A EXT.VDD
B +5.0V
C +3.3V

EXT.VDD
J2–1

AGND
J2–2

C12 0.1µF
D3 S2A

LK1
L1 0.5µH
R6 1R5
C4 1µF
C3 1µF

AVDD

+3.3V +5V

EEPROM FOR USB CONSTANTS
+3.3V
U4 24LC64
1 A0 VCC 8
2 A1 WP 7
3 A2 SCL 6
4 GND SDA 5
C13 0.1µF

I²C TERMINATION
+3.3V +3.3V +3.3V
R9 2.2kΩ
R10 2.2kΩ

3.3V DVDD REGULATOR
U2 ADP3303
1 OUT IN 8
2 OUT IN 7
3 NR SD 5
4 GND ERR 6
+5V
C8 10µF
C10 0.1µF
C11 0.1µF
C9 10µF

OPTIONAL INTERFACE FILTER

DEMO_EXC R1 0Ω

EXCA P1

EXCB P2

CIN1– P3

CIN1+ P4

U1 AD7746
1 SCL SDA 16
2 RDY NC 15
3 EXCA VDD 14
4 EXCB GND 13
5 REFIN(+) VIN(–) 12
6 REFIN(–) VIN(+) 11
7 CIN1(–) CIN2(–) 10
8 CIN1(+) CIN2(+) 9

CLAMP

AVDD
C1 0.1µF
C2 10µF

OPTIONAL INTERFACE CONSTANTS
LK2
R3 0Ω RDY
R4 0Ω SCL
R5 0Ω SDA
AVDD +3.3V

I²C INTERFACE

USB CONTROLLER
+3.3V
U3 CY7C68013

15 SCL AVCC
16 SDA AVCC

18 PB0/FD0
19 PB1/FD1
20 PB2/FD2
21 PB3/FD3
22 PB4/FD4
23 PB5/FD5
24 PB6/FD6
25 PB7/FD7

33 PA0/INT0
34 PA1/INT1
35 PA2/SLOE
36 PA3/WU2
37 PA4/FIFOADR0
38 PA5/FIFOADR1
39 PA6/PKTEND
40 PA7/FLAGD/SLCS

45 PD0/FD8
46 PD1/FD9
47 PD2/FD10
48 PD3/FD11
49 PD4/FD12
50 PD5/FD13
51 PD6/FD14
52 PD7/FD15

XTALIN
XTALOUT
Y1 24MHz
C6 12pF
C7 12pF

CLKOUT 54
CTL2/FLAGC 31
CTL1/FLAGB 30
CTL0/FLAGA 29
RESET 42
WAKEUP 44
IFCLK 13
RSVD 14
RDY1/SLWR
RDY0/SLRD

USB INTERFACE
+5V
J1 USB–B
1 VCC
2 D–
3 D+
4 GND
5 SH
6 SH
HOST SYSTEM

+3.3V R8 1kΩ
D2 RED
FUNC.

+3.3V R7 1kΩ
D1 GREEN
POWER

GROUND CONNECTION
AGND DGND

+3.3V R14 100kΩ
+3.3V R12 100kΩ
R13 100kΩ
C14 0.1µF
C5 1µF
R11

P5 CIN2–
P6 CIN2+
R2 0Ω DEMO_CIN

AVDD

T1 AGND
T2 REF–
T3 REF+
T4 AIN–
T5 AIN+
T6 AVDD

100mm CAPACITIVE LENGTH SENSOR DEMO
1
2
1.4pF
3
4
DEMO_EXC
DEMO_CIN

+3.3V DECOUPLING FOR U2
C15 0.1µF
C16 0.1µF
C17 0.1µF
C18 0.1µF
C19 0.1µF
C20 0.1µF
C21 0.1µF
C22 0.1µF
C23 10µF

AVCC AGND AGND GND GND GND GND GND GND

Figure 14. Evaluation Board Schematics

05513-009

Data Sheet

Figure 15. Evaluation Board Layout, Silkscreen

05513-010
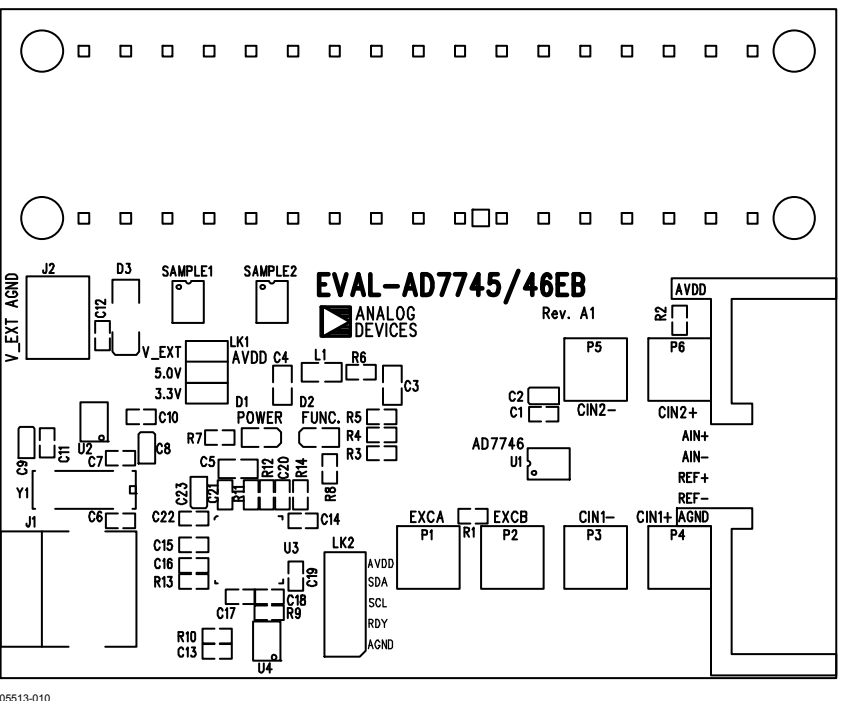
ORDERING INFORMATION

BILL OF MATERIALS

Table 2.

Qty	Designator	Description	Manufacturer	Part No.
3	U1, Sample1, Sample2	CDC for proximity sensing, 16-lead TSSOP	Analog Devices	AD7746RUZ
1	U2	3.3 V voltage regulator, low I_Q, 8-lead SOIC	Analog Devices	ADP3303ARZ-3.3
1	U3	Microcontroller, EZ-USB FX2LP, 56-lead QFN	Cypress	CY7C68013A-56LFXC
1	U4	EEPROM, I^2C, 64 kb, 8-lead SOIC	Microchip	24LC64-I/SN
1	D1	LED, green, 15 mcd, 572 nm, 0805	Avago	HSMG-C170
1	D2	LED, red, 10 mcd, 626 nm, 0805	Avago	HSMS-C191
1	D3	Diode, 50 V, 1.5 A, SMB	Vishay	S2A-E3/52T
14	C1, C10 to C22	Capacitor, ceramic, SMD, 100 nF, X7R, 16 V, 0603	AVX	CM105X7R104K16AT
4	C2, C8, C9, C23	Capacitor, tantalum, SMD, 10 µF, 6.3 V, TAJ-A	AVX	TAJA106K006RNJ
3	C3 to C5	Capacitor, ceramic, SMD, 1 µF, Y5V, 10 V, 0603	Yageo	CC0603ZRY5V6BB105
2	C6, C7	Capacitor, ceramic, SMD, 12 pF, NP0, 50 V, 0603	Yageo	CC0603JRNPO9BN120
5	R1 to R5	Resistor, SMD, 0 Ω, 0603	Multicomp	MC 0.063W 0603 0R
1	R6	Resistor, SMD, 1.5 Ω, 1%, 0603	Multicomp	MC 0.063W 0603 1% 1R5
2	R7, R8	Resistor, SMD, 1 kΩ, 1%, 0603	Multicomp	MC 0.063W 0603 1% 1k
2	R9, R10	Resistor, SMD, 2.2 kΩ, 1%, 0603	Multicomp	MC 0.063W 0603 1% 2k2
3	R12 to R14	Resistor, SMD, 100 kΩ, 1%, 0603	Multicomp	MC 0.063W 0603 1% 100k
1	L1	Ferrite bead, SMD, 300Z, 200 mA, 0805	Sigma Inductors	BMB2A0300AN1
1	Y1	Crystal, 24 MHz, 12 pF, CMS-8 series	ECS	ECS-240-12-20A-TR
1	J1	Connector, USB type Mini-B	Molex	56579-0576
1	J2	Terminal block with screws, pitch 5 mm	Camden	CTB5000/2
4	P1 to P4	Connector, SMB, 50 Ω	Multicomp	24-14-2-TGG
1	LK1	Straight header, 2 × 3-pin, pitch 2.54 mm	Harwin	M20-9980346
1	LK2	Straight header, 2 × 5-pin, pitch 2.54 mm	Harwin	M20-9980546
4	Jumper socket	Jumper socket, red; insert in these locations: LK1 (5.0 V), LK2 (SDA, SCL, RDY)	Harwin	M7566-05

ORDERING GUIDE

Model	Description
EVAL-AD7746EBZ[1]	Evaluation Board

[1] 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.

NOTES

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NOTES

I²C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors)

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