AN-1588
APPLICATION NOTE

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Sensing Low-*g* Acceleration Using the ADXL345 Digital Accelerometer Connected to the ADuC7024 Precision Analog Microcontroller

CIRCUIT FUNCTION AND BENEFITS

The ADXL345 is a small, thin, low power, 3-axis accelerometer with high resolution (13-bit) measurement up to ±16 *g*. Digital output data is formatted as 16-bit twos complement and is accessible through either a serial peripheral interface (SPI), 3-wire or 4-wire, or an I²C digital interface.

The ADXL345 is well suited for mobile device applications. The ADXL345 measures the static acceleration of gravity in tilt sensing applications, as well as dynamic acceleration resulting from motion or shock. The high resolution of the ADXL345 (4 m*g*/LSB) enables measurement of inclination changes of about 0.25°. Using a digital output accelerometer such as the ADXL345 eliminates the need for analog-to-digital conversion, reducing system cost and real estate. Additionally, the ADXL345 includes a variety of built in features. Activity detection or inactivity detection, tap detection or double tap detection, and free fall detection are all done internally with no need for the host processor to perform any calculations. A built in, 32-stage first in, first out (FIFO) memory buffer reduces the burden on the host processor, allowing algorithm simplification and power savings. Additional system level power savings can be implemented using the built in activity or inactivity detection and by using the ADXL345 as a motion switch to turn the whole system off when no activity is felt and on when activity is sensed again.

The ADXL345 communicates via an I²C interface or an SPI interface. The circuits described in this application note demonstrate how to implement communication via these protocols.

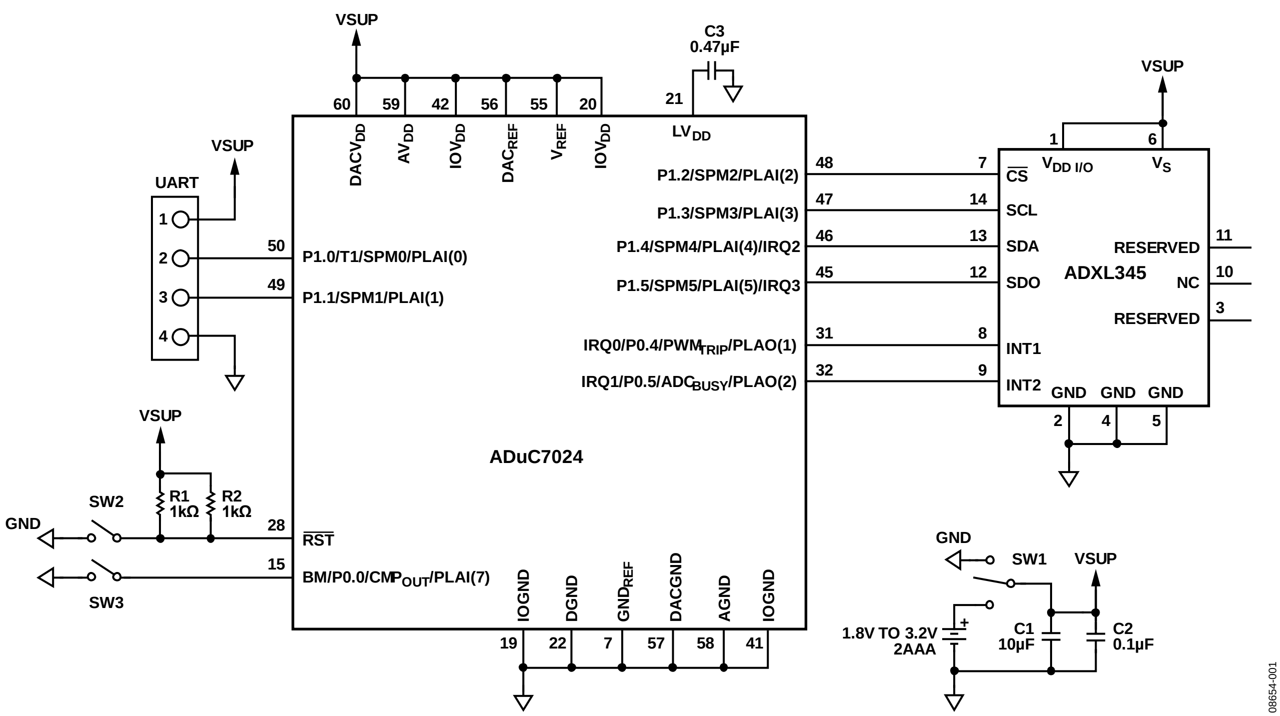

Figure 1. ADXL345 and ADuC7024 in 4-Wire SPI Configuration (Simplified Schematic: Decoupling and All Connections Not Shown)

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REVISION HISTORY

10/2018—Rev. 0 to Rev. A

Document Title Changed from CN0133 to AN-1588 ... Universal
Changes to Figure 1 1
Moved Revision History Section 2
Changes to Figure 3 and Common Variations Section 3
Deleted Data Sheets and Evaluation Boards Section 3
Deleted Learn More Section 4
Changes to Figure 4 4
Added Figure 5; Renumbered Sequentially 4

10/2009—Revision 0: Initial Version

CIRCUIT DESCRIPTION

This circuit uses an ADuC7024 precision analog microcontroller in conjunction with the ADXL345 digital accelerometer. Both are I²C ready and SPI ready. Figure 1 shows the ADXL345 and ADuC7024 in an SPI configuration, and Figure 3 shows the same devices in an I²C configuration. The $\overline{CS}$ pin (Pin 7 on the ADXL345) is used to select the desired interface. I²C mode is enabled if the $\overline{CS}$ pin is tied high to $V_{DD\ I/O}$ (Pin 1 on the ADXL345). In SPI mode, $\overline{CS}$ is toggled to signify the beginning and end of each transmission. Pulling $\overline{CS}$ high indicates that no SPI transmission is occurring or that an I²C transmission may occur.

Both schematics are simplified but required connections (for example, supplies and ground connections) are shown. In these schematics, the ADuC7024 is programmed via a universal asynchronous receiver-transmitter (UART) that connects to Pin 49 and Pin 50 of the ADuC7024. SW2 and SW3 are reset and download buttons, respectively, for programming the microcontroller. SW1 is an on or off power switch.

COMMON VARIATIONS

Figure 1 shows the ADXL345 in a 4-wire SPI configuration, and Figure 2 shows that the ADXL345 can also communicate via a 3-wire SPI.

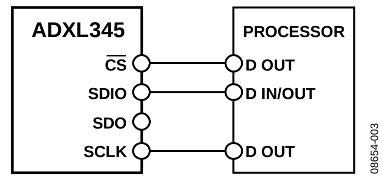

Figure 2. 3-Wire SPI Connection Diagram

The circuit described in Figure 1 and Figure 3 use the ADuC7024 microcontroller. The same configuration can be applied with any SPI capable or I²C capable microcontroller, as outlined in Figure 4 and Figure 5. The standard I²C connection and SPI connection are used. Pin functions for the two protocols are listed in Table 1.

For information on ADXL345 operation and register functions, refer to the ADXL345 data sheet.

For information on programming the ADuC7024, see the ADuC7024 data sheet.

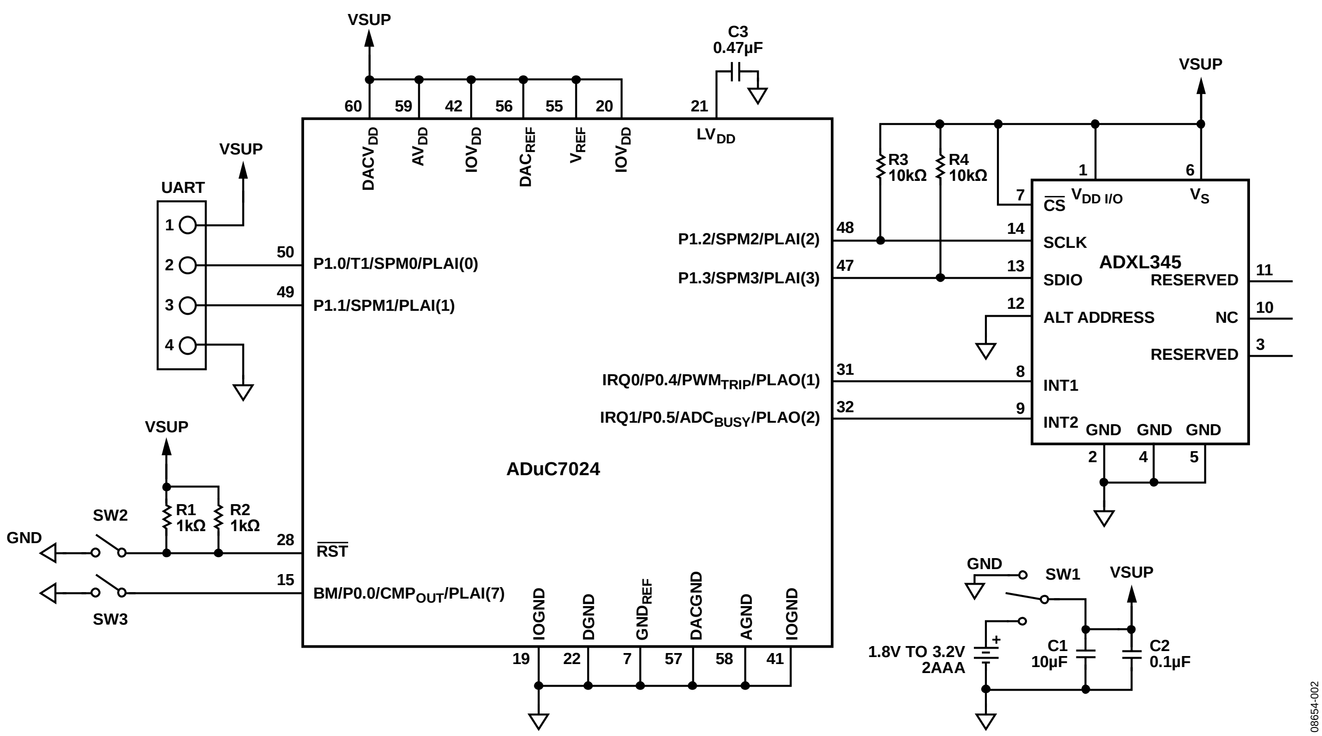

Figure 3. ADXL345 and ADuC7024 in I²C Configuration (Simplified Schematic: Decoupling and All Connections Not Shown)

Table 1. ADXL345 Pin Functionality in SPI and I²C Communication Modes

Pin Number	Pin Name	Functionality	
		I²C	SPI
7	$\overline{CS}$	Connect to $V_{DD\ I/O}$ for I²C	Chip select
12	SDO/ALT ADDRESS	Alternate address select	Serial data output
13	SDA/SDI/SDIO	Serial data	Serial data input (SPI 4-wire)/serial data input and output (SPI 2-wire)
14	SCL/SCLK	Serial communications clock	Serial communications clock

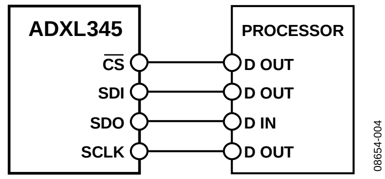

Figure 4. SPI Compatible Connection Diagram

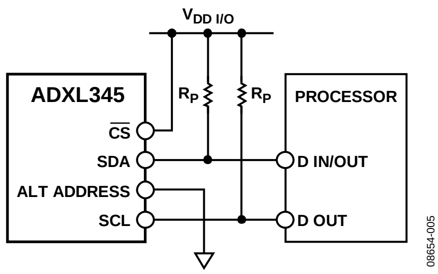

Figure 5. I²C Compatible Connection Diagram

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