User's Guide
SBOU056–March 2008

USB DAQ Platform

This user's guide describes the characteristics, operation, and use of the USB DAQ Platform. It provides a detailed description of the hardware design. The USB DAQ Platform is used as part of several of Texas Instruments evaluation module kits; this document supplements the documentation of those evaluation module kits.

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1 Overview

The USB DAQ Platform is a data acquisition system that generates digital and analog signals. Specifically, the system generates I^2C™, SPI™, One-Wire, and general-purpose digital I/O signals. The system also contains four 16-bit string digital-to-analog converters (DACs), and two 16-bit delta-sigma (ΔΣ) analog-to-digital converters (ADCs).

In general, the USB DAQ Platform is connected to a separate test board; these two components, along with the related cables and power supplies, form a complete evaluation module (EVM). An EVM facilitates the evaluation of a specific device. For example, the PGA308EVM contains the USB DAQ Platform, the PGA308 test board, a power supply, and a USB cable. This EVM allows customers to evaluate and understand all the features on the PGA308 integrated circuit.

1.1 Hardware Included with a Typical USB DAQ Platform

Figure 1 illustrates the typical hardware included the USB DAQ Platform.

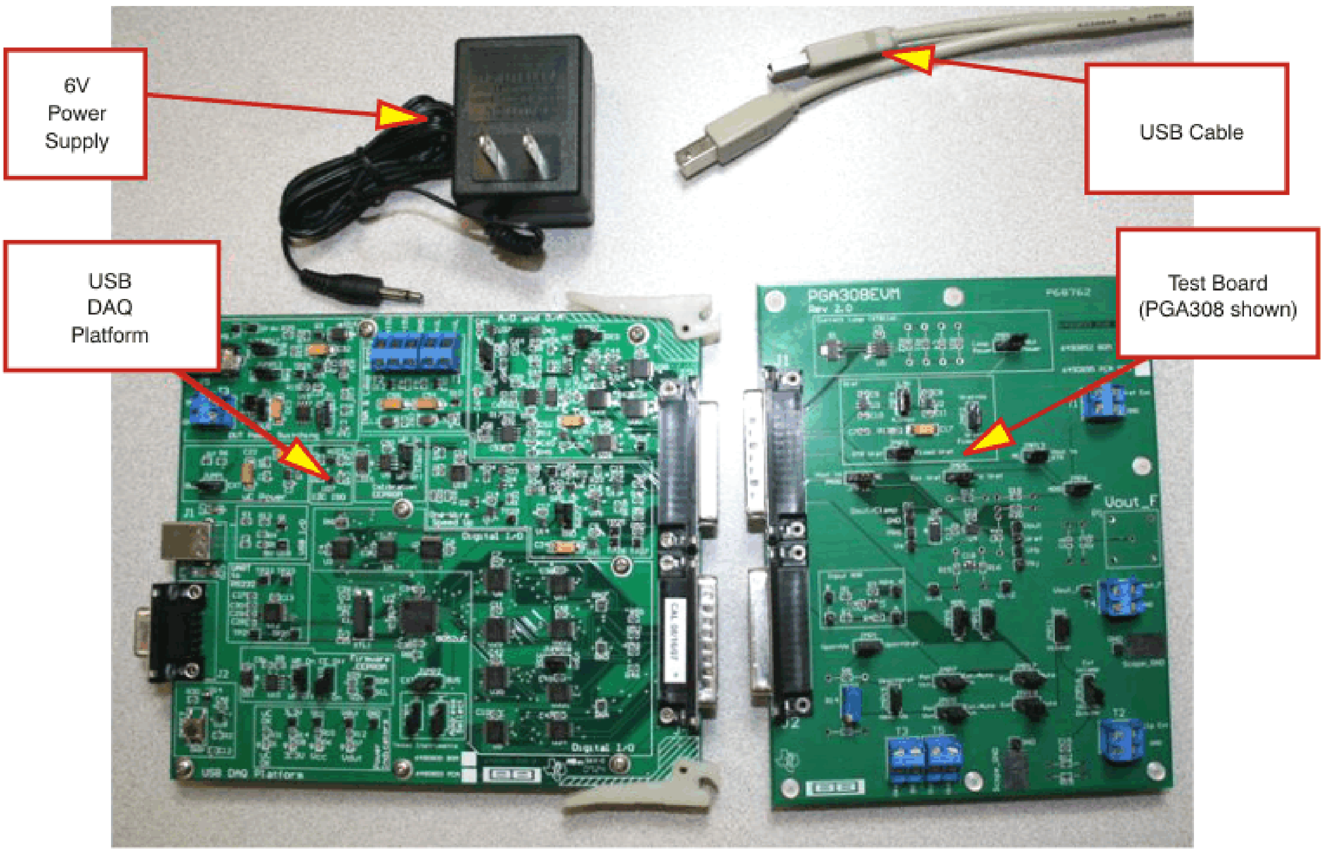

Figure 1. Typical Hardware Included with the USB DAQ Platform

1.2 Related Documentation from Texas Instruments

Current versions of all documentation can be obtained from the TI website at http://www.ti.com/, or by calling the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center (PIC) at (972) 644-5580. When ordering, identify the document by both title and literature number.

1.3 If You Need Assistance

If you have questions about the INA209 evaluation module, contact the Linear Amplifiers Applications Team at precisionamps@list.ti.com. Include *USB DAQ Platform* as the subject heading.

1.4 Information About Cautions and Warnings

This document contains caution statements.

CAUTION

This is an example of a caution statement. A caution statement describes a situation that could potentially damage your software or equipment.

The information in a caution or a warning is provided for your protection. Please read each caution and warning carefully.

1.5 FCC Warning

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense is required to take whatever measures may be required to correct this interference.

2 System Setup

Figure 2 shows the typical system setup for the USB DAQ Platform. The PC runs software that communicates with the USB DAQ Platform, while the USB DAQ Platform generates the digital signals used to communicate with the test board. Connectors on the test board are typically used to connect external signals to the device under test (DUT). Jumpers and other circuitry on the test board allow for different configurations of the DUT.

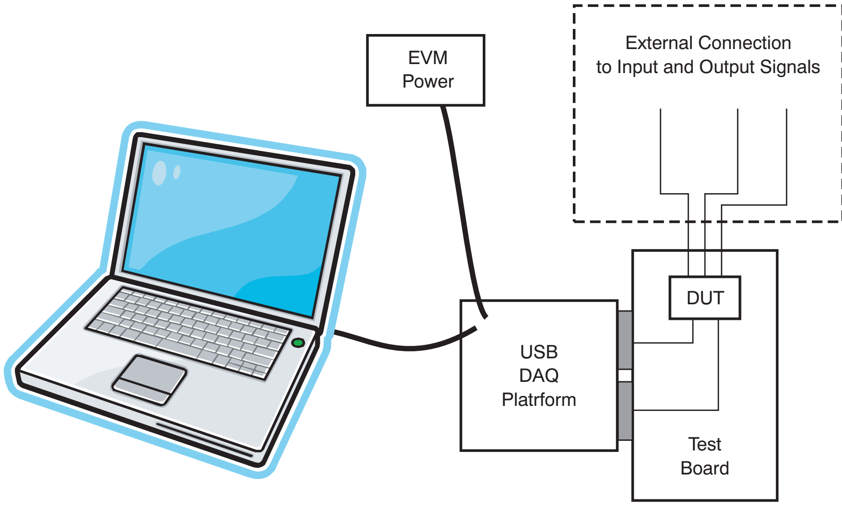

Figure 2. Hardware Setup for the USB DAQ Platform

Minimim PC operating requirements:

- Microsoft Windows® XP or higher
- Available USB port

NOTE: Works with either US or European regional settings.

3 Theory of Operation

The USB DAQ Platform is a general-purpose data acquisition system that is part of several different Texas Instruments EVMs. Figure 3 illustrates a block diagram of the platform.

The core of the USB DAQ Platform is the TUSB3210, an 8052 microcontroller (µC) that has a built-in USB interface. The microcontroller receives information from the host computer that it translates into I^2C, SPI, or other digital I/O patterns. During the digital I/O transaction, the microcontroller reads the response of any device connected to the I/O interface. The response from the device is then sent back to the PC where it is interpreted by the host computer.

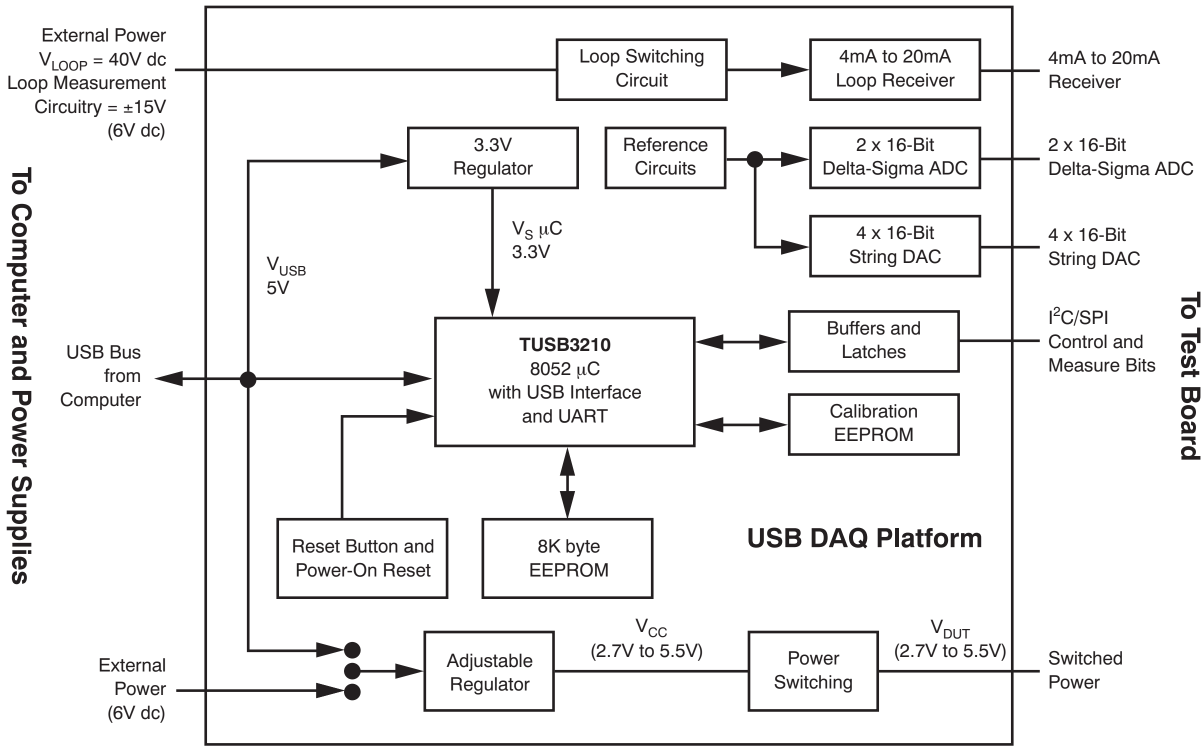

Figure 3. USB DAQ Platform Block Diagram

3.1 Digital I/O Area

The following subsections discuss the digital I/O areas that surround the microcontroller. Refer to SBOR001 (available for download from www.ti.com) for a detailed copy of the entire schematic.

3.1.1 Microcontroller

Figure 4 shows the detailed area surrounding the microcontroller. U2 is a TUSB3210 microcontroller—an 8052 core with a built-in USB interface. U2 converts information from the USB bus on the PC to I²C, SPI, and One-Wire digital transactions. U2 runs on 3.3V; the inputs are not 5V tolerant. As a result, all external input signals are level-translated. JUMP2 allows U2 to be powered from the USB bus or the external supply.

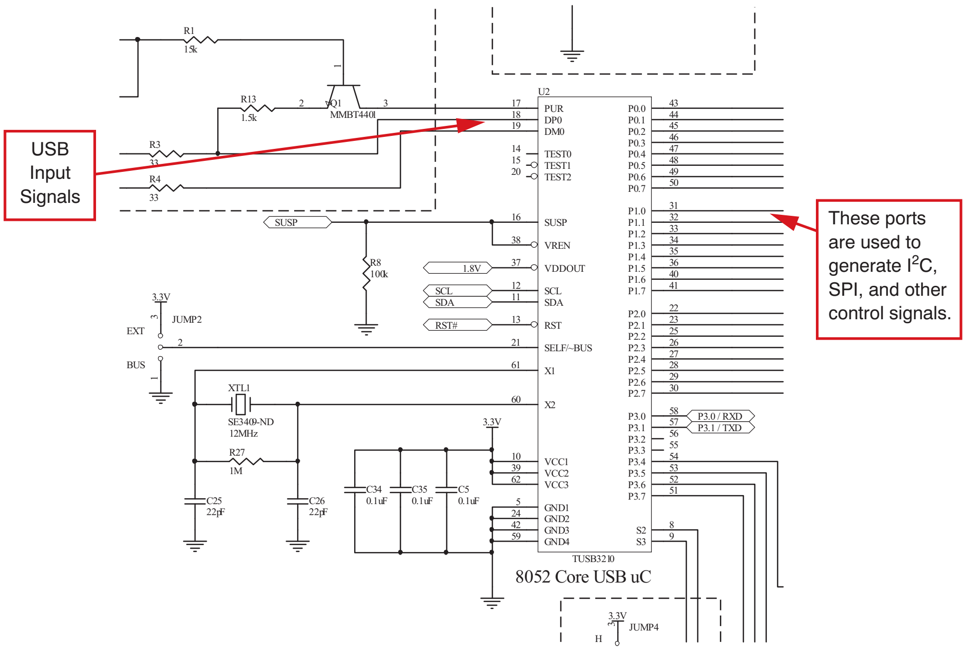

Figure 4. Digital I/O Area—Microcontroller

3.1.2 I^{2}C and SPI

Figure 5 shows the digital I/O area that manages I^{2}C and SPI communications. U3 and U4 are open collector drivers. These devices drive the I^{2}C and SPI output signals. Note that the input is 3.3V and the output follows V_{DUT} (that is, 3V or 5V). U7 is the input buffer. Note that the inputs are 5V tolerant. The outputs of U7 are compatible with the microcontroller (that is, 3.3V).

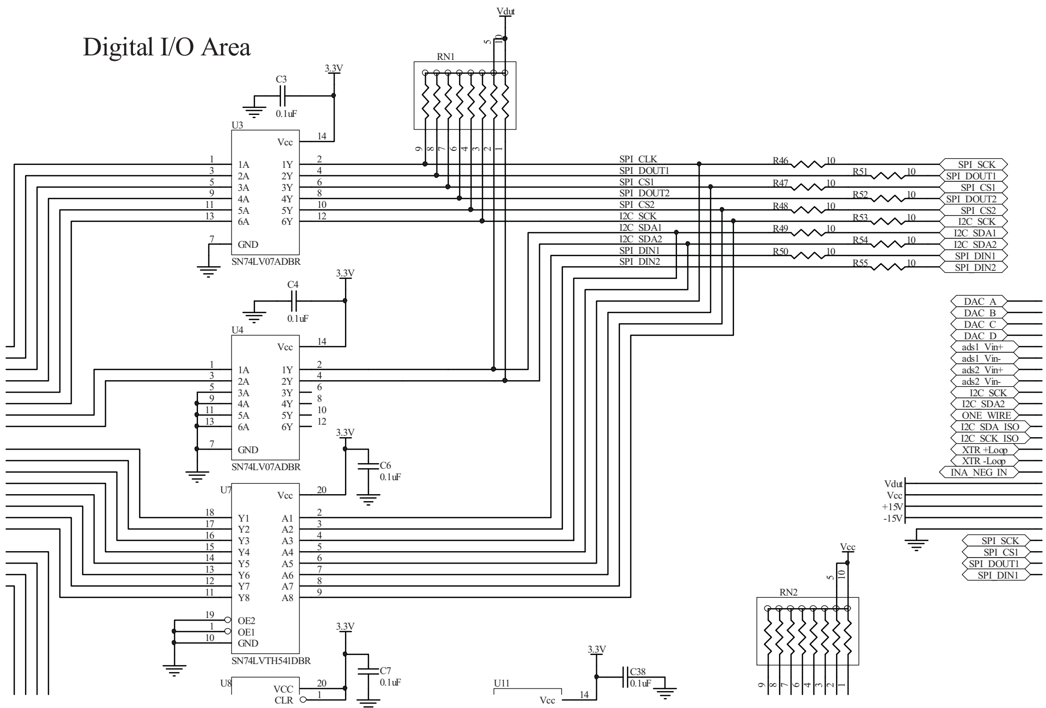

Figure 5. Digital I/O Area—I^{2}C and SPI

3.1.3 Internal Control Signals

Figure 6 shows the digital I/O area used for internal control (for example, calibration mux control). U8 is used to latch the internal control signals. A latch is required because microcontroller port 2 is used for multiple purposes. U11 is an open collector buffer that converts the control signals to V_{DUT} logic levels (that is, 3V or 5V). U25 and U22 perform the same function as U8 and U11, respectively.

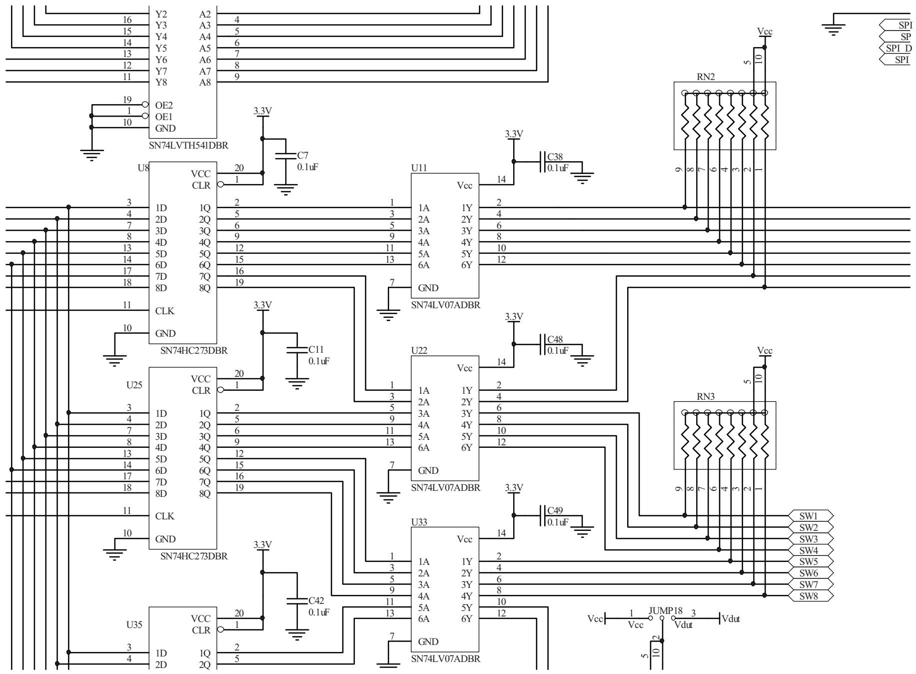

Figure 6. Digital I/O Area—Internal Control Signals

3.1.4 CTRL and MEAS

Figure 7 shows the connection of the CTRL and MEAS circuitry. U34 is the latch for the general-purpose output (CTRL1 to CTRL8). U5 is the buffer for the general-purpose input (MEAS1 to MEAS8).

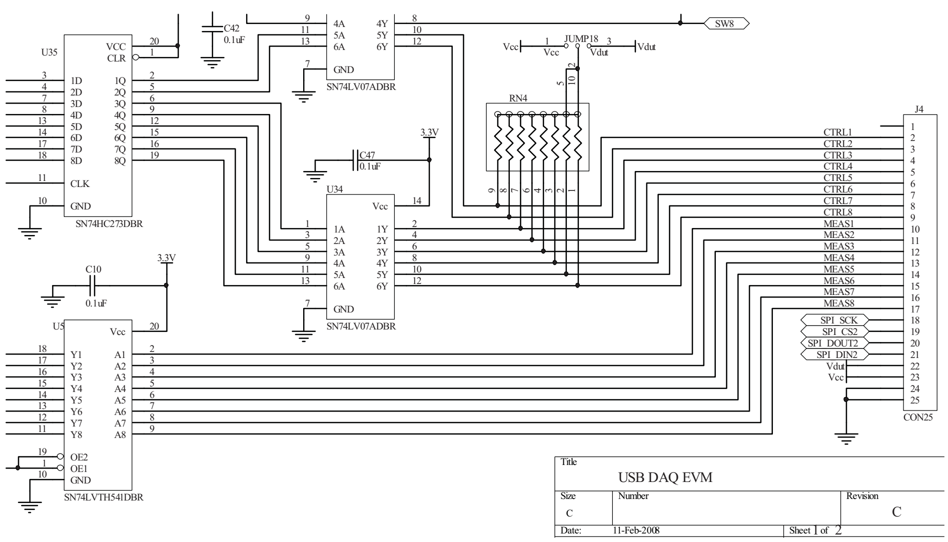

Figure 7. Digital I/O Area—CTRL and MEAS

3.1.5 Address Select

Figure 8 shows the jumper connections that set the USB address. JUMP4 and JUMP5 allow for different USB product IDs. The product IDs are called *addresses* because they effectively act as USB addresses.

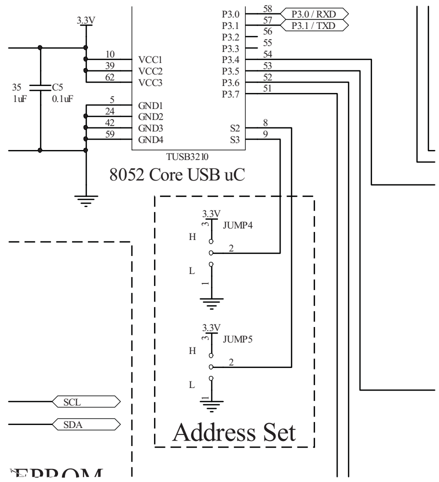

Figure 8. Digital I/O Area—Address Select

3.2 *Microcontroller Power*

Figure 9 shows the power connections to the microcontroller. U1 provides the 3.3V supply for the TUSB3210 microcontroller. JUMP1 selects the power source: EXT = External 9V dc power, BUS = 5V power from USB.

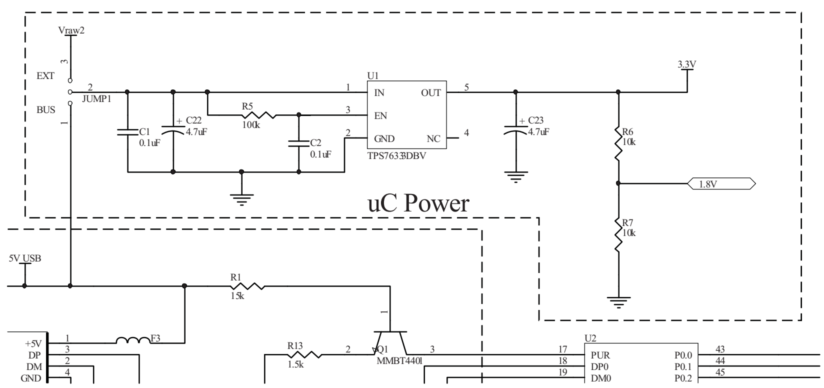

Figure 9. Microcontroller Power

3.3 USB I/O

Figure 10 shows the USB port connection to the microcontroller. J1 connects the USB bus to the TUSB3210 microcontroller. The transistor and resistors are standard support circuitry for this device. See the TUSB3210 data sheet (SLLS466F), available from www.ti.com, for more information.

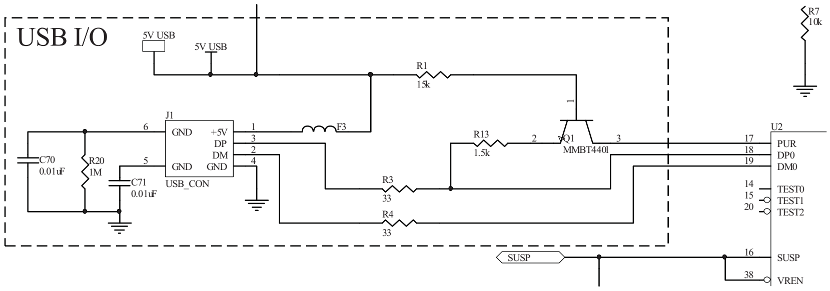

Figure 10. USB I/O

3.4 Firmware EEPROM

Figure 11 shows the firmware EEPROM area. U10 is the 8K-byte EEPROM that contains the firmware program used to run the microcontroller. JUMP3 allows the EEPROM to be disconnected from the microcontroller (EE OFF). The EE OFF feature is only used by the factory during EEPROM programming. This jumper must be in the EE ON position for normal operation.

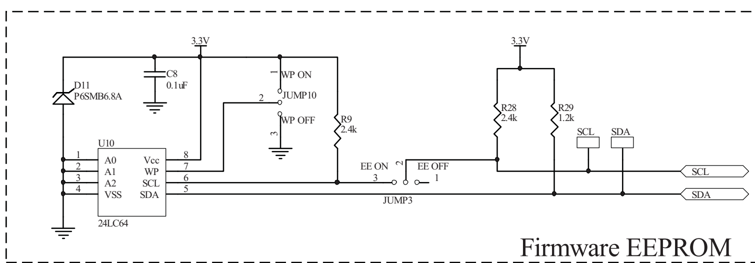

Figure 11. Firmware EEPROM

3.5 Power Indicators

Figure 12 shows the LED power indicators. The LEDs are used to indicate DUT power, 3V power, and microcontroller status. The LEDs labeled V_{CC}, *uC OK*, and *3.3V* should be on when the system is powered up. V_{DUT} is switched power and can be turned on and off with software.

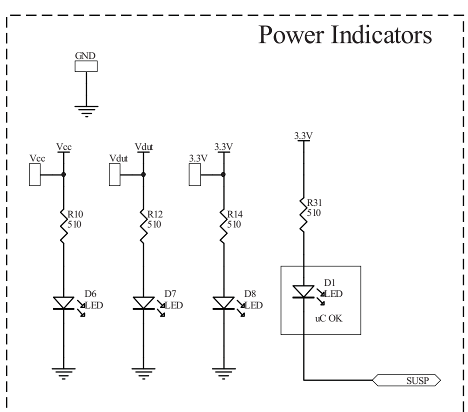

Figure 12. Power Indicators

3.6 Reset

Figure 13 shows the microcontroller reset circuitry. The reset circuit is connected to the $\overline{RST}$ pin on the microcontroller and resets the microcontroller upon power-up. U28 is a Schmitt buffer that is used to create a clean logic high or low (that is, the $\overline{RST}$ pin is connected to 3.3V or 0V and not to intermediate voltage levels).

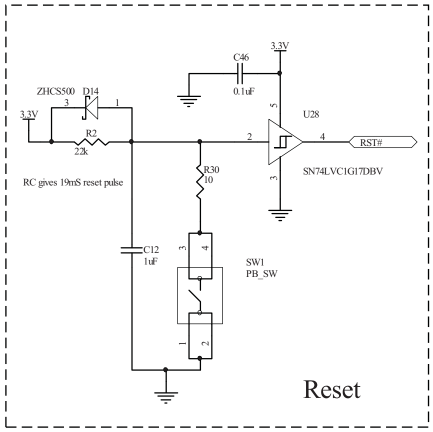

Figure 13. Reset

3.7 One-Wire Speed-Up Circuit

Figure 14 shows the One-Wire speed-up circuit. This circuit allows the UART signals to be connected on long lines (that is, lines with high capacitance). The key to the operation is capacitor C24 (10µF), which is used to speed up (boost) the rising edge of the UART signal. The one-shot component (U18) disconnects the boost capacitor shortly after the rising edge. JUMP8 can be used to enable or disable the speed-up circuit: SPD_UP = speed-up is enabled; GND = speed-up is disabled.

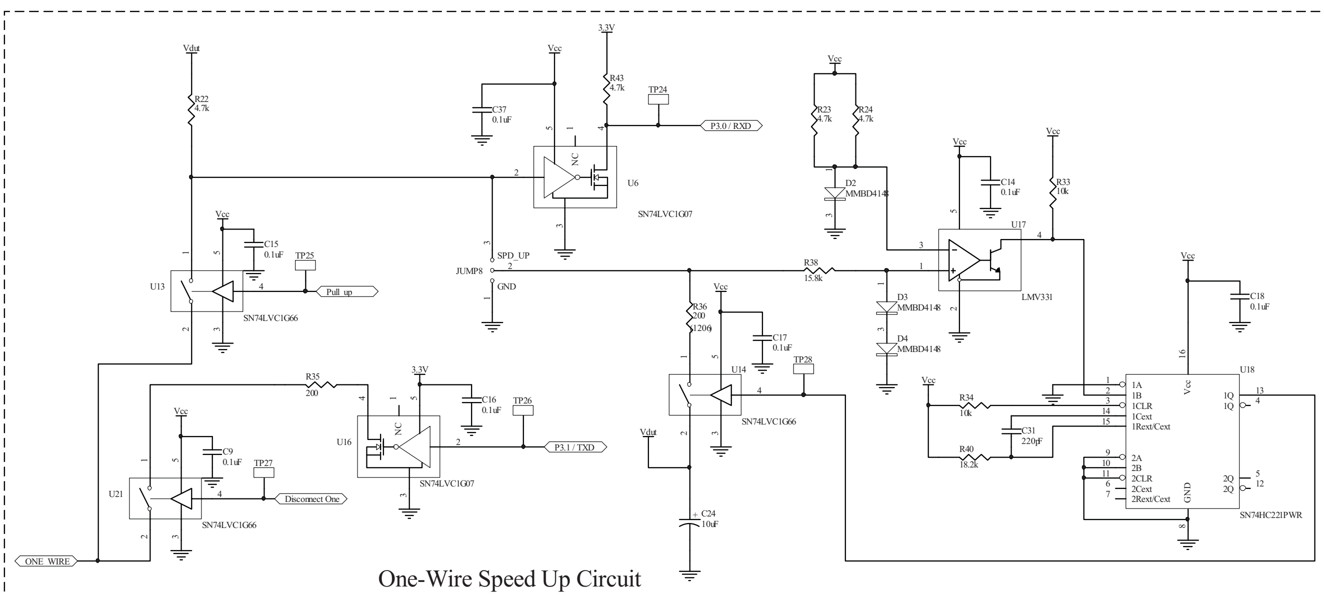

Figure 14. One-Wire Speed-Up Circuit

3.8 DUT Power Switching

Figure 15 shows the DUT power switching. U19 is an adjustable regulator. JUMP9 controls the output of U19; the output of U19 can be set to either 5V or 3V. Q3 switches the power on or off. The supply before the switch is called V_{CC}, and is a constant 3V or 5V. The supply after the switch is called V_{DUT} and is a switched 3V or 5V (that is, it can be disconnected). U15 is used to discharge any capacitance connected to V_{DUT} after it is disconnected.

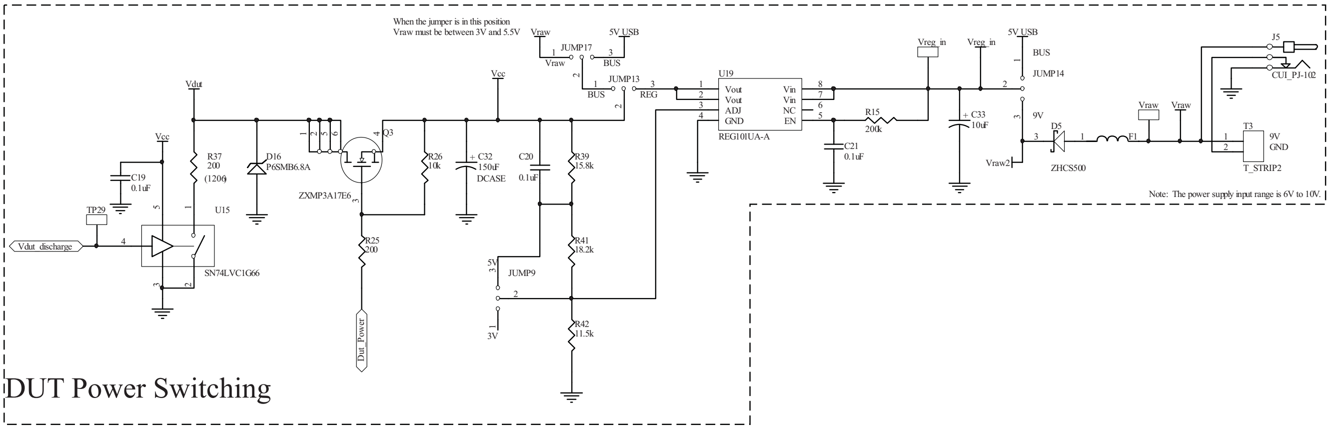

Figure 15. DUT Power Switching

3.9 Loop and INA Supplies

Figure 16 shows the loop and INA supplies, and current-loop receiver circuitry. This section provides the connection for ±15V supplies and the loop supply. Diodes prevent reverse connections. Capacitors C55 and C54 and inductors L2 and L3 provide filtering.

The instrumentation amplifier (U32) amplifies the current loop current across R18. The output of U32 is a voltage of 0V to 15V. The U32 output voltage is divided into 0V to 5V by R16 and R45. This voltage is connected to ADS1100_2 via U11. U11 can connect or disconnect the current loop output to ADS1100_2.

Photo-MOS-Relay U42 is used to connect and disconnect the loop supply from the loop. U12 provides the control signal to U42. Photo-MOS-Relay U43 is used to discharge any capacitance on the current loop after it has been disconnected. U44 provide the control signal to U43. U41 inverts the control signal.

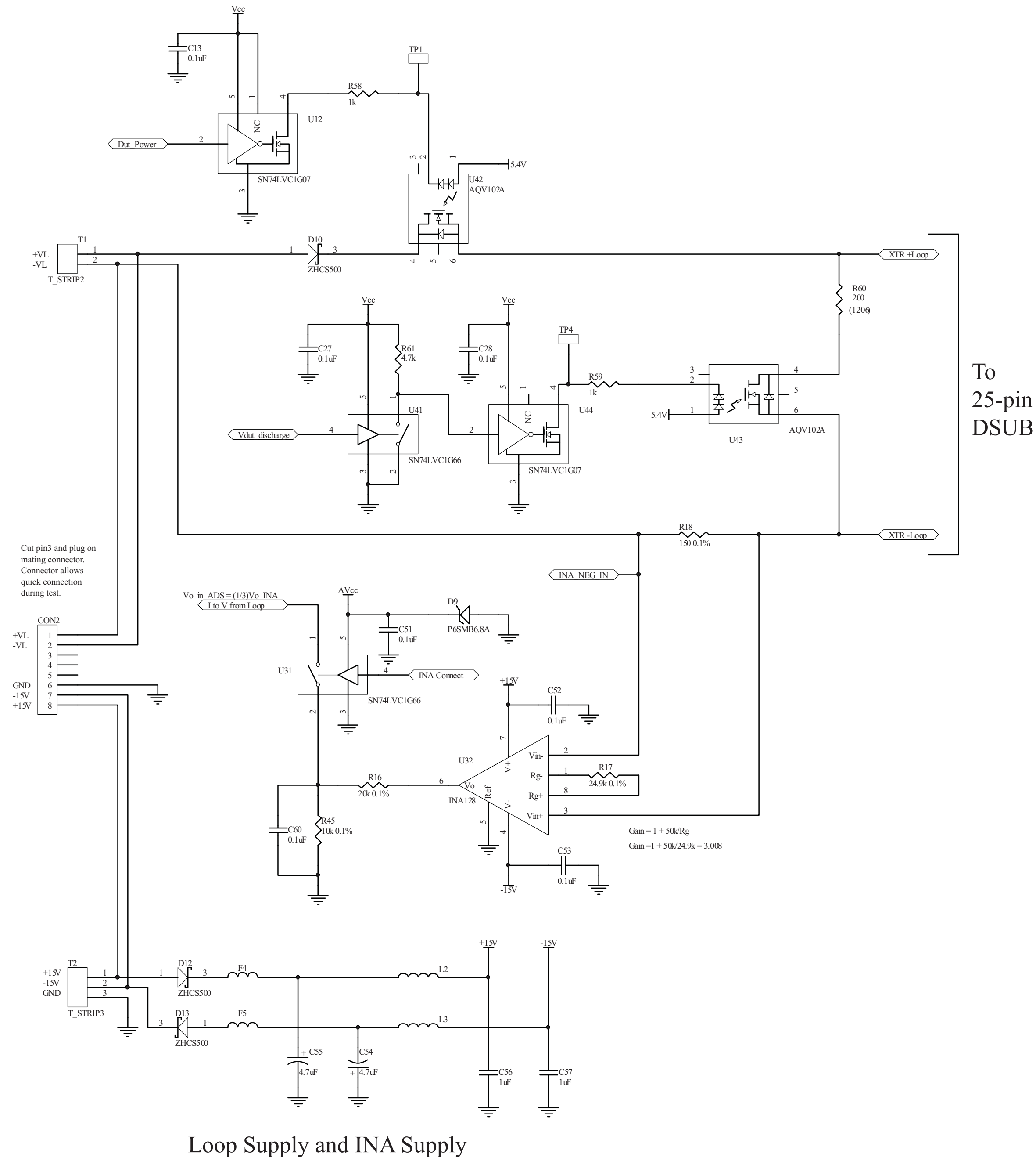

Figure 16. Loop and INA Supplies

3.10 I^{2}C Isolation

Figure 17 shows the switches that isolate the I^{2}C communication lines. U27 and U23 are used to connect or disconnect the I^{2}C bus.

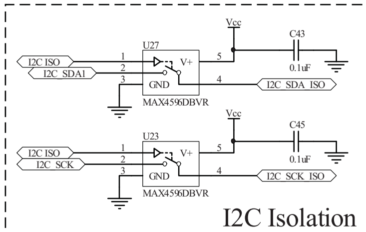

Figure 17. I^{2}C Isolation

3.11 Calibration EEPROM

Figure 18 shows the EEPROM that contains calibration information. U9 is a 8K-byte EEPROM. Calibration information (that is, slopes and offsets) for the DACs and ADCs is stored in U9. The USB DAQ Platform is calibrated at the factory. After calibration, JUMP11 is used to write-protect the EEPROM (that is, JUMP11 = WP ON).

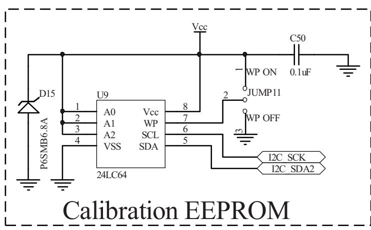

Figure 18. Calibration EEPROM

3.12 TUSB UART to RS232

Figure 19 shows the firmware debug connector. This connector can be used to connect an RS232 port to the TUSB3210 microcontroller. The RS232 port can be connected to a computer communication terminal and used to debug firmware.

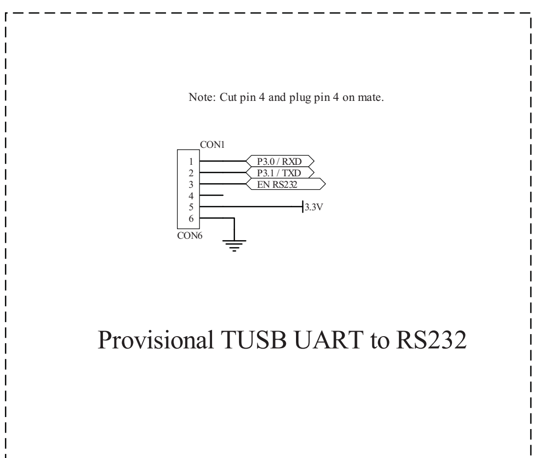

Figure 19. TUSB UART to RS232

3.13 DAC, ADC, and INA

3.13.1 Reference

Figure 20 shows the circuitry that generates the voltage reference for the DACs and ADCs. U37 and U39 are references connected in a stacked configuration to achieve a 3V or 5V reference. U36 generates a 5.4V supply for the OPA333 buffer. U40 is used to buffer the reference signal. Q2 and Q4 boost the current, but allow a close swing to the rail.

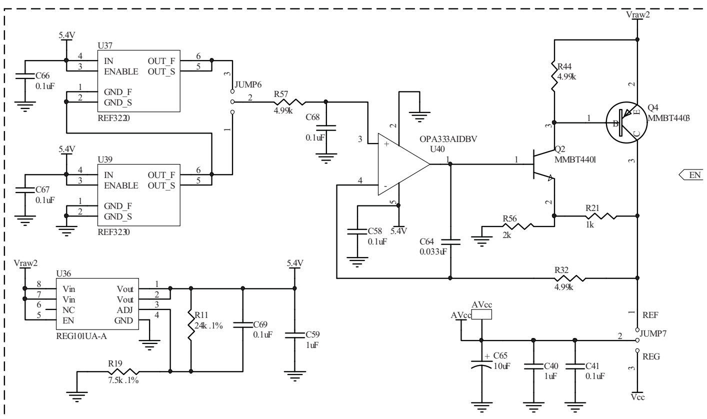

Figure 20. DAC, ADC, and INA—Reference

3.13.2 ADS1100 a1 Connections

Figure 21 shows the ADS1100 a1 external connections and self-calibration circuitry. U20 is a 16-bit delta-sigma ADC (ADS1100). U38 is a switch that allows the ADCs to be disconnected. U29 is a self-calibration/test switch that allows the ADC to be connected either to the DAC or to GND. Note that the USB DAQ Platform communicates to U24 using I²C channel 2.

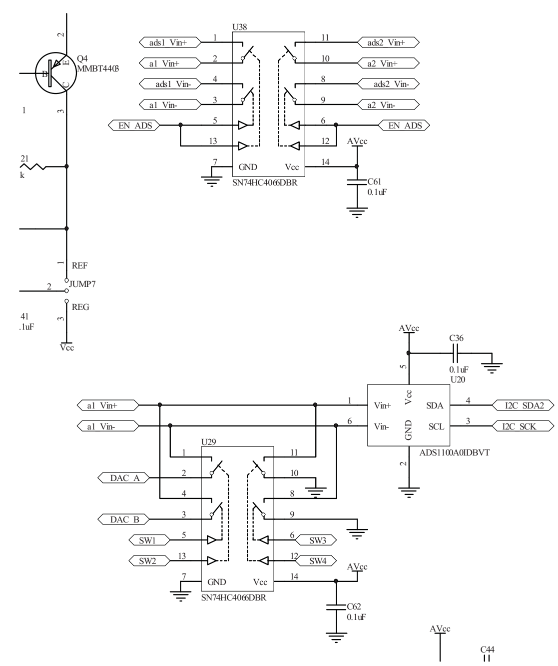

Figure 21. DAC, ADC, and INA—ADS1100 a1 Connections

3.13.3 ADS1100 a2 Connections

Figure 22 shows the ADS1100 a2 external connections and self-calibration circuitry. U23 is a 16-bit, delta-sigma ADC. U30 is a self-calibration/test switch that allows the ADC to be connected either to the DAC or to GND. Note that the a2_Vin+ input is connected to U11 in the *Loop and INA Supplies/4mA to 20mA Switching* section. Thus, U23 can be used to measure the 4mA to 20mA loop output.

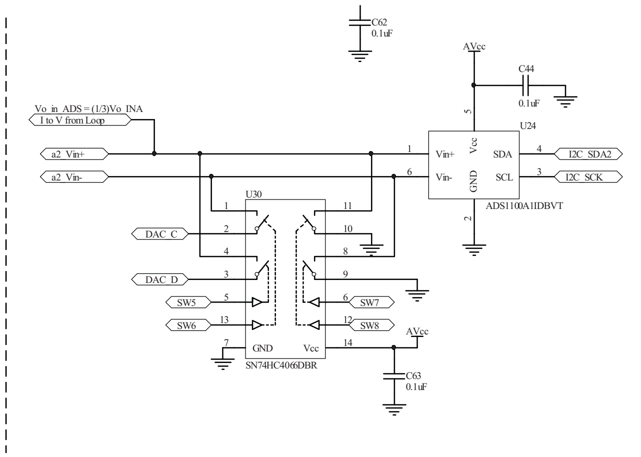

Figure 22. DAC, ADC, and INA—ADS1100 a2 Connections

3.13.4 DAC8574

Figure 23 shows the DAC8574 external connections. U26 is a 16-bit DAC (DAC8574) with four output channels. The USB DAQ Platform communicates to U26 using I^{2}C channel 2.

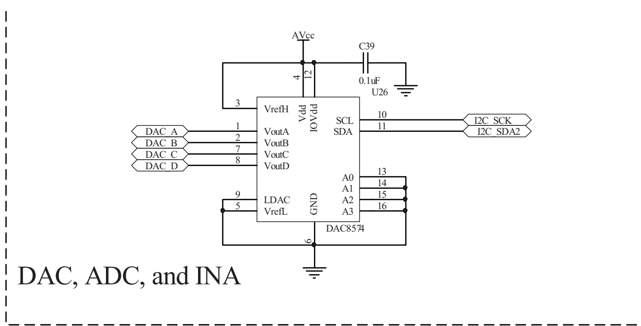

Figure 23. DAC, ADC, and INA—DAC8574

3.14 Default Jumper Settings

3.14.1 5V

Figure 24 shows the jumper settings for the most common USB DAQ Platform configuration. This setup is the jumper setting configuration that is shipped from the factory. In this configuration, the digital I/O, DACs, and ADCs are all referenced to 5V. This configuration also uses an external 6V dc supply to provide power for the digital I/O. It is possible to use the USB bus to power the USB DAQ Platform. However, it is not recommended because the USB bus power is noisier than the external power supply, has limited current, and does not have the headroom required to run the 5V reference.

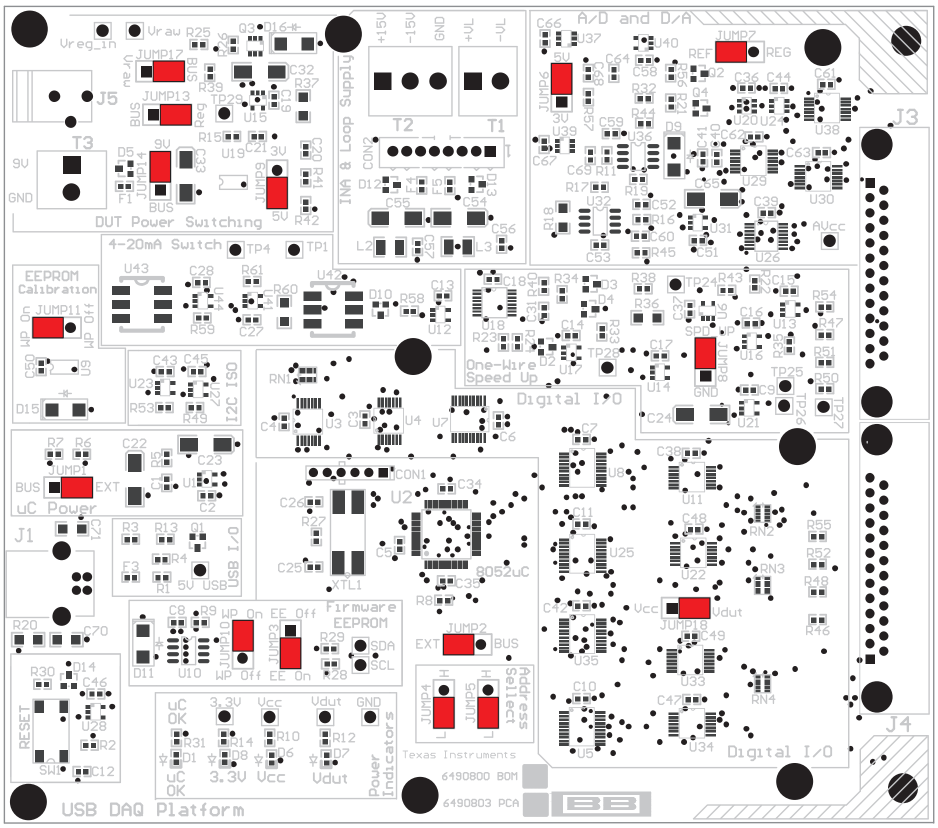

Figure 24. 5V Default Jumper Settings

3.14.2 3V

Figure 25 shows the jumper settings for another typical USB DAQ Platform configuration. In this configuration, the digital I/O has 3V levels and the DACs and ADCs are also referenced to 3V. This configuration uses an external 6V dc supply to provide power for the digital I/O. It is possible to use the USB bus to power the USB DAQ Platform. However, it is not recommended because the USB bus power is noisier than the external power supply, has limited current, and does not have the headroom required to run the 3V reference.

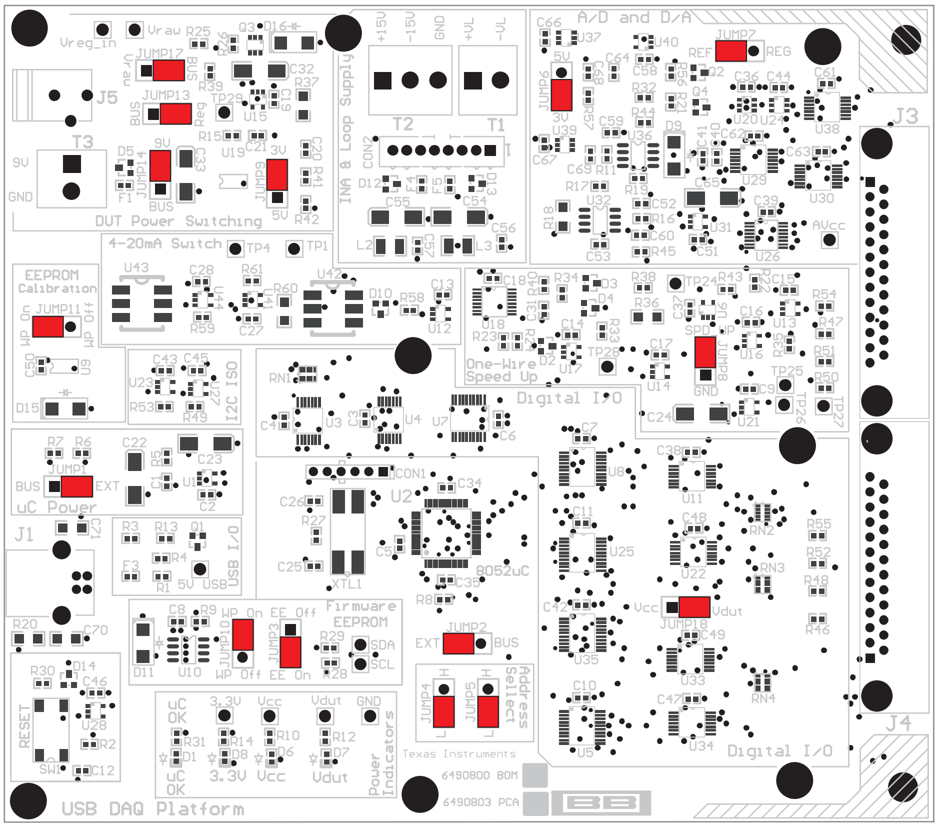

Figure 25. 3V Default Jumper Settings

4 Detailed Description of Jumper Settings

Table 1 to Table 7 show the detailed description of jumpers on the USB DAQ Platform. In most cases, it is easiest to use the typical setting described in Figure 24 or Figure 25. However, for some specific cases it may be useful to create a custom jumper setting using the information in Table 1 to Table 7.

Table 1. Power-Supply Jumper Configuration #1

Mode	Jumper	Comment
External Power—5V (default jumper settings)	JUMP17 = BUS (not used) JUMP13 = REG JUMP14 = 9V JUMP9 = 5V JUMP1 = EXT JUMP2 = EXT JUMP6 = 5V JUMP7 = REF	In this mode, all power is supplied to the EVM via J5 or T3. The external supply must be between 5.8V and 10.4V for proper operation. All digital I/Os are regulated to 5V using U19 (REG101). The ADCs and DACs have a separate 5V reference that is derived from U37 (REF1004). This configuration is the default setup.
External Power—3V (typical jumper settings)	JUMP17 = BUS (not used) JUMP13 = REG JUMP14 = 9V JUMP9 = 3.3V JUMP1 = EXT JUMP2 = EXT JUMP6 = 3V JUMP7 = REF	In this mode, all power is supplied to the EVM via J5 or T3. The external supply must be between 5.8V and 10.4V for proper operation. All digital I/Os are regulated to 3V using U19 (REG101). The ADCs and DACs have a separate 3V reference that is derived from U37 (REF1004). This configuration is very common. It is the same as the default, except that it uses a 3V supply and reference.
External Power—Variable Supply	JUMP17 = Vraw JUMP13 = BUS JUMP14 = 9V (not used) JUMP9 = 5V (not used) JUMP1 = EXT JUMP2 = EXT JUMP6 = 5V (not used) JUMP7 = REG (ratiometric mode)	In this mode, all the digital I/Os are referenced to the supply that is attached to either J5 or T3. **CAUTION** It is absolutely critical that the supply voltage does not exceed 5.5V in this mode. The supply is directly applied to devices with 5.5V absolute maximum ratings. This mode of operation is useful when a device supply other then 3.0V or 5.0V is required. Note that the ADCs and DACs for this case are configured in ratiometric mode only.

Table 2. Power-Supply Jumper Configuration #2

Mode	Jumper	Comment
Bus Power—5V	JUMP17 = BUS JUMP13 = BUS JUMP14 = 9V (not used) JUMP9 = 5V (not used) JUMP1 = BUS JUMP2 = BUS JUMP6 = 5V (not used) JUMP7 = REG (ratiometric mode, 5V supply)	In this mode, the USB bus completely powers the EVM. The USB bus is regulated by the master (computer) to be 5V. This mode relies upon external regulation. The ADCs and DACs also use 5V as the reference. This mode is recommended only when an external 9V supply is not available. If an external 9V supply is available, use either *External Power 5V* mode or *External Power 3V* mode.
Bus Power—3V	JUMP17 = BUS (not used) JUMP13 = REG JUMP14 = BUS JUMP9 = 3.3V JUMP1 = BUS JUMP2 = BUS JUMP6 = 3V JUMP7 = REG (ratiometric mode, 5V supply)	In this mode, the USB bus completely powers the EVM. The regulator (U19, REG101) is used to generate a 3V supply for all digital I/O. The ADCs and DACs also use 3V as the reference.

Table 3. Address Select

Address (Product ID or PID)	Jumper Setting	Comment
0x1234	JUMP4 = L JUMP5 = L	This address is the default.
0x1235	JUMP4 = L JUMP5 = L	
0x1236	JUMP4 = L JUMP5 = L	
0x1237	JUMP4 = L JUMP5 = L	

Table 4. EEPROM Jumpers

Jumper Setting	Comment
JUMP3 = EE On (default)	This position is the default setup for USB DAQ Platform users. This position allows the TUSB3210 microcontroller to load the USB DAQ Platform firmware upon power-up or reset. The other position (EE Off) is used for development or firmware update.
JUMP3 = EE Off	This position disconnects the EEPROM from the TUSB3210 microcontroller. This mode of operation allows new firmware to be loaded from the host computer to the USB DAQ Platform using the Texas Instruments Apploader driver (SLLC160). Note that this mode of operation is only used during firmware development.
JUMP10 = WP On	Prevents accidental overwrite of the firmware (normal position).
JUMP10 = WP Off	Allows for writing new firmware (normally done at factory).

EE On is the default position. This jumper is typically only used in factory EEPROM programming. In order to write new firmware into the EEPROM, the USB DAQ Platform must be connected to the host computer with the jumper in the *EE Off* position. Once the USB device has been detected, the jumper position must be changed to the *EE On* position. After the jumper position is changed, the EEPROM Burner software may be used to copy new firmware onto the USB DAQ Platform.

The following procedure describes the procedure for programming the EEPROM:

1. JUMP3 = EE Off, JUMP10 = WP Off.
   a. Connect power.
   b. Connect the USB cable.
   c. Press the reset button.
2. JUMP3 = EE On, JUMP10 = WP Off.
   a. Program the EEPROM.
3. JUMP3 = EE On, JUMP10 = WP On.
   a. Press the reset button.
   b. The programming procedure is complete. Test the module.

Table 5. One-Wire Speed-Up Jumper

Jumper Setting	Comment
JUMP8 = GND	One-Wire speed-up circuit disabled.
JUMP8 = SPD_UP (default)	One-Wire speed-up circuit enabled. The speed-up circuit connects a 10µF capacitor via a 200Ω pull-up resistor to the one-wire line when making a low-to-high transition. This connection helps shorten the rise time when talking across long communication lines. In general, this is the recommended operating mode and the default position.

Table 6. V_{CC}/V_{DUT} Jumper

Jumper Setting	Comment
JUMP18 = V_{DUT}	The digital output (CTRL1 to CTRL8) pull-up resistor is connected to V_{DUT}, a switched power supply of 3V or 5V. This mode of operation is most useful when the digital outputs are connected directly to the device under test (DUT). Thus, if the DUT power supply is turned off, the digital signals connected to the DUT are also turned off.
JUMP18 = V_{CC}	The digital output (CTRL1 to CTRL8) pull-up resistor is connected to V_{CC}, a constant power supply of 3V or 5V. This mode of operation is most useful when the digital outputs are connected to control circuitry that must remain configured regardless of the DUT supply status. For example, this mode would be used when an analog multiplexer is connected to the DUT, and the DUT power must be cycled without affecting the multiplexer configuration.

Table 7. Calibration EEPROM Jumper

Jumper Setting	Comment
JUMP11 = WP_On	Prevents accidental overwrite of calibration constants (default position).
JUMP11 = WP_Off	Allows rewriting of calibration constants (recalibration).

4.1 Connector Definition

Figure 26 gives a functional description of the different connectors on the USB DAQ Platform.

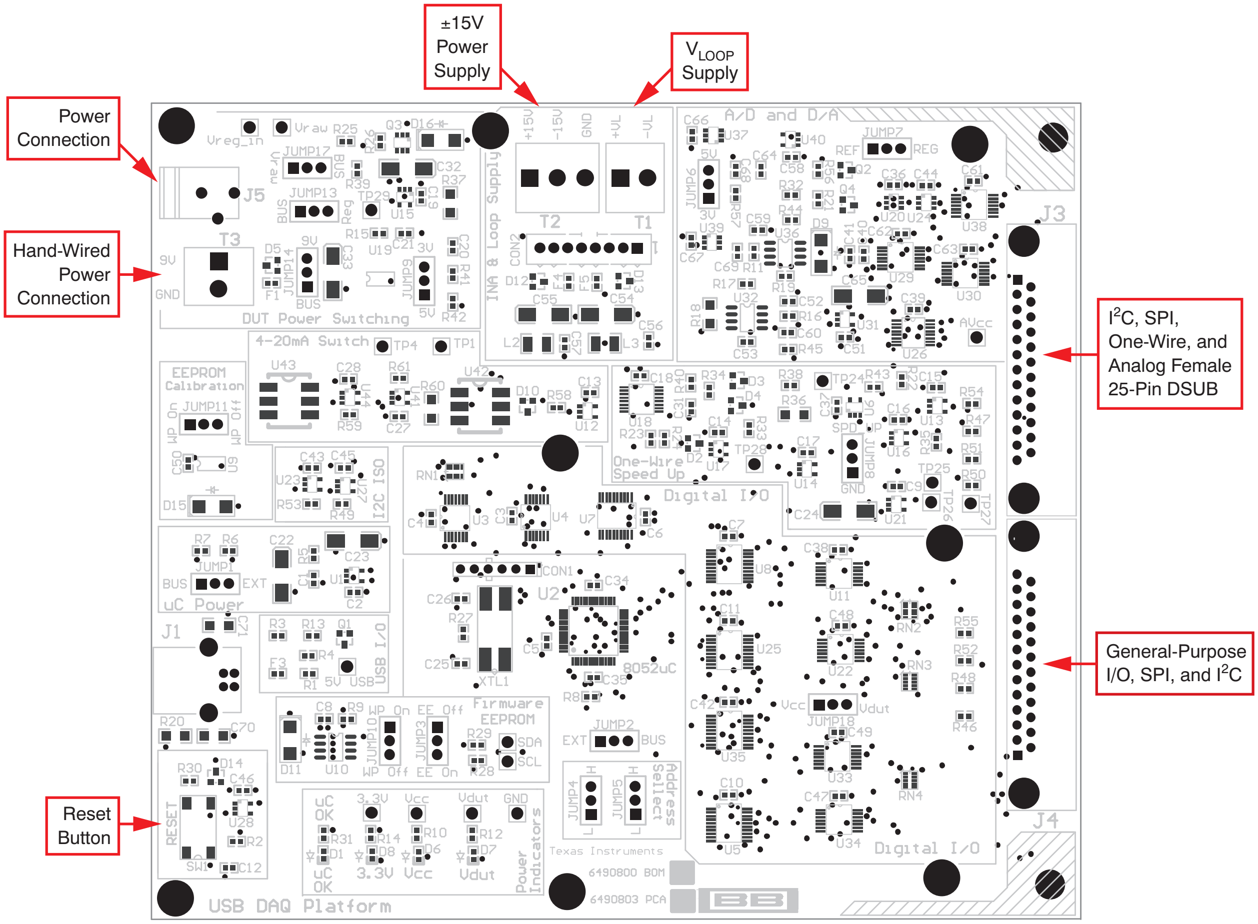

Figure 26. Connector Definition

4.2 Signal Definition of J3 (25-Pin Female DSUB)

Table 8 shows the different signals connected to J3 on the USB DAQ Platform, and gives a description of each signal.

Table 8. Signal Definition of J3 (25-Pin Female DSUB)

Pin on J1	Signal	Description
1	DAC A	16-bit string DAC output (1 of 4)
2	DAC B	16-bit string DAC output (2 of 4)
3	DAC C	16-bit string DAC output (3 of 4)
4	DAC D	16-bit string DAC output (4 of 4)
5	ADS1+	16-bit delta-sigma converter positive input (1 of 2)
6	ADS1–	16-bit delta-sigma converter negative input (1 of 2)
7	ADS2+	16-bit delta-sigma converter positive input (2 of 2)
8	ADS2–	16-bit delta-sigma converter negative input (2 of 2)
9	I2C_SCK	I^2C clock signal (SCL) channel 1
10	I2C_SDA2	I^2C data signal (SDA) channel 1
11	ONE_WIRE	One-Wire digital interface (UART-type interface)
12	I2C_SCK_ISO	I^2C clock signal (SCL) channel 1 – can be disconnected using a switch
13	I2C_SDA_ISO	I^2C data signal (SCL) channel 1 – can be disconnected using a switch
14	XTR_LOOP+	Supplies power for a 4mA to 20mA loop
15	XTR_LOOP–	Return for power for a 4mA to 20mA loop. Current is measured using an INA128.
16	INA–	Connection to negative input of INA128 for future use.
17	V_{DUT}	Switched 3V or 5V power. Note that when power is switched off, the digital I/O is also switched off.
18	V_{CC}	This supply is the same voltage as V_{DUT}, but is not switched. For example, if V_{DUT} = 3V, then V_{CC} =3V; however, V_{CC} does not change when V_{DUT} is turned off.
19	+15V	Supply for INA128. This device is only used to measure the 4mA to 20mA loop. If the 4mA to 20mA loop is not used, this supply is not required.
20	–15V	Supply for INA128. This device is only used to measure the 4mA to 20mA loop. If the 4mA to 20mA loop is not used, this supply is not required.
21	GND	Common or ground connection for power.
22	SPI_SCK	SPI clock signal for channel 1
23	SPI_CS1	SPI chip select for channel 1
24	SPI_DOUT	SPI data output for channel 1
25	SPI_DIN1	SPI data input for channel 1

4.3 Signal Definition of J4 (25-Pin Male DSUB)

Table 9 shows the different signals connected to J4 on the USB DAQ Platform and gives a description of each signal.

Table 9. Signal Definition of J4 (25-Pin Male DSUB)

Pin on J1	Signal	Description
1	NC	No connection
2	CTRL1	Digital output or control line (1 of 8)
3	CTRL2	Digital output or control line (2 of 8)
4	CTRL3	Digital output or control line (3 of 8)
5	CTRL4	Digital output or control line (4 of 8)
6	CTRL5	Digital output or control line (5 of 8)
7	CTRL6	Digital output or control line (6 of 8)
8	CTRL7	Digital output or control line (7 of 8)
9	CTRL8	Digital output or control line (8 of 8)
10	MEAS1	Digital input or measure line (1 of 8)
11	MEAS2	Digital input or measure line (2 of 8)
12	MEAS3	Digital input or measure line (3 of 8)
13	MEAS4	Digital input or measure line (4 of 8)
14	MEAS5	Digital input or measure line (5 of 8)
15	MEAS6	Digital input or measure line (6 of 8)
16	MEAS7	Digital input or measure line (7 of 8)
17	MEAS8	Digital input or measure line (8 of 8)
18	SPI_SCK	SPI clock for channel 2 (note this signal is shared for both channels)
19	SPI_CS2	SPI chip select for channel 2
20	SPI_DOUT2	SPI data output for channel 2
21	SPI_DIN2	SPI data input for channel 2
22	V_{DUT}	Switched 3V or 5V power. Note that when power is switched off, the digital I/O is also switched off.
23	V_{CC}	This supply is the same voltage as V_{DUT}, but is not switched. For example, if V_{DUT} = 3V, then V_{cc} =3V; however, V_{CC} does not change when V_{DUT} is turned off.
24	GND	Common or ground connection for power
25	GND	Common or ground connection for power

5 Bill of Materials

Table 10 shows the parts list.

Table 10. Bill of Materials

Qty	Value	Ref Des	Description	Vendor	Part Number
1	15kΩ	R1	RES 15.0K OHM 1/16W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF1502V
1	22kΩ	R2	RES 22.0K OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-0722KL
2	100kΩ	R5, R8	RES 100K OHM 1/16W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF1003V
5	10kΩ	R6, R7, R26, R33, R34	RES 10.0K OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-0710KL
2	33Ω	R3, R4	RES 33.0 OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-0733RL
1	1MΩ	R27	RES 1.00M OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-071ML
1	1.5kΩ	R13	RES 1.50K OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-071K5L
11	10Ω	R30, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55	RES 10.0 OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-0710RL
4	510Ω	R10, R12, R14, R31	RES 510 OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-07510RL
1	1.2kΩ	R29	RES 1.20K OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-071K2L
3	200Ω	R36, R37, R60	RES 200 OHM 1/4W 1% 1206 SMD	Yageo America	RC1206FR-07200RL
2	200Ω	R25, R35	RES 200 OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-07200RL
2	15.8kΩ	R38, R39	RES 15.8K OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-0715K8L
2	18.2kΩ	R40, R41	RES 18.2K OHM 1/10W 1% 0603 SMD	Vishay/Dale	CRCW060318K2FKEA
1	11.5kΩ	R42	RES 11.5K OHM 1/10W 1% 0603 SMD	Yageo Corporation	RC0603FR-0711K5L
1	200kΩ	R15	RES 200K OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-07200KL
2	2.4kΩ	R9, R28	RES 2.40K OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-072K4L
5	4.7kΩ	R22, R23, R24, R43, R61	RES 4.70K OHM 1/10W 1% 0603 SMD	Yageo America	RC0603FR-074K7L
1	24kΩ 0.1%	R11	RES 24K OHM 1/16W .1% 0603 SMD	Panasonic - ECG	ERA-3YEB243V
1	2kΩ	R56	RES 2.00K OHM 1/10W 1% 0603 SMD	Vishay/Dale	CRCW06032K00FKEA
3	4.99kΩ	R32, R44, R57	RES 4.99K OHM 1/10W 1% 0603 SMD	Vishay/Dale	CRCW06034K99FKEA
1	7.5kΩ 0.1%	R19	RES 7.5K OHM 1/16W .1% 0603 SMD	Vishay/Dale	ERA-3YEB752V
1	24.9kΩ 0.1%	R17	RES 24.9K OHM 1/10W .1% 0603 SMD	Rohm	RG1608P-2492-B-T5
1	150Ω 0.1%	R18	RES 150 OHM 1/4W 0.1% 1206	Yageo America	TNPW1206150RBEEA
1	20kΩ 0.1%	R16	RES 20K OHM 1/16W .1% 0603 SMD	Panasonic - ECG	ERA-3AEB203V
1	10kΩ 0.1%	R45	RES 10K OHM 1/16W .1% 0603 SMD	Panasonic - ECG	ERA-3AEB103V
3	1kΩ	R21, R59, R58	RES 1.00K OHM 1/10W 1% 0603 SMD	Vishay/Dale	CRCW06031K00FKEA
1	1MΩ	R20	RES 1.00M OHM 1/4W 1% 1206 SMD	Yageo America	RC1206FR-071ML
4	4.7kΩ	RN1, RN2, RN3, RN4	RES ARRAY 4.7KOHM 10TRM BUSS SMD	CTS Corporation	746X101472JP
4	4.7µF	C22, C23, C54, C55	CAPACITOR TANT 4.7UF 25V 10% SMD 6032-28 (EIA)	AVX Corporation	T491C475K025AT

Table 10. Bill of Materials (continued)

Qty	Value	Ref Des	Description	Vendor	Part Number
50	0.1µF	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C14, C15, C16, C17, C18, C19, C20, C21, C34, C35, C36, C37, C38, C39, C41, C42, C43, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C58, C60, C61, C66, C67, C68, C69, C27, C13, C28, C62, C63	CAP .10UF 25V CERAMIC Y5V 0603	Kemet	C0603C104M3VACTU
1	220pF	C31	CAP 220PF 50V CERAMIC X7R 0603 10%	Yageo America	CC0603KRX7R9BB221
5	1µF	C12, C40, C56, C57, C59	CAP 1UF 25V CERAMIC 0603 X5S	Panasonic - ECG	ECJ-1V41E105M
3	10µF	C24, C33, C65	CAP TANTALUM 10UF 25V 20% SMD	EPCOS Inc	B45196H5106M309
1	150µF	C32	CAP TANTALUM 150UF 10V 10% SMD	AVX Corporation	TAJC157K010R
1	0.033µF	C64	CAP 0.033uF 25V CERM X7R 0603	Panasonic - ECG	ECJ-1VB1E333K
2	22pF	C25, C26	CAP CERAMIC 22PF 50V NP0 0603	Yageo America	CC0603JRNPO9BN220
2	0.01µF	C70, C71	CAP CERAMIC .01UF 500V X7R 1206	Kemet	C1206C103KCRACTU
1		U1	IC 3.3V 150MA LDO REG SOT-23-5	Texas Instruments	TPS76333DBVT
1		U2	IC USB CNTRLR STORAGE 64-LQFP	Texas Instruments	TUSB3210PM
6		U3, U4, U11, U22, U33, U34	IC HEX BUFF/DRV W/OD 14-SSOP	Texas Instruments	SN74LV07ADBR
2		U9, U10	IC SERIAL EEPROM 64K 2.5V 8-SOIC	Texas Instruments	24LC64-I/SN
2		U5, U7	IC OCT BUFF/DRVR TRI-ST 20-SSOP	Texas Instruments	SN74LVTH541DBR
3		U8, U25, U35	IC OCT D-TYPE F-F W/CLR 20-SSOP	Texas Instruments	SN74HC273DBR
1		U20	IC 16BIT SELF-CALIB ADC SOT23-6	Texas Instruments	ADS1100A0IDBVT
1		U24	IC 16BIT SELF-CALIB ADC SOT23-6	Texas Instruments	ADS1100A1IDBVT
2		U19, U36	IC LDO REG ADJ 100MA 8-SOIC	Texas Instruments	REG101UA-A
1		U18	IC DUAL MULTIVIBRATR MON 16TSSOP	Texas Instruments	CD74HC221PWR
6		U13, U14, U15, U21, U31, U41	IC BILATERL ANALOG SWTCH SOT23-5	Texas Instruments	SN74LVC1G66DBVR
4		U16, U6, U12, U44	IC BUFF/DRVR W/OD OUT SOT-23-5	Texas Instruments	SN74LVC1G07DBVR
1		U17	IC GP LV COMPARATOR SOT-23-5	Texas Instruments	LMV331IDBVR
1		U26	IC DAC V-OUT QUAD LP 16-TSSOP	Texas Instruments	DAC8574IPW
2		U23, U27	IC ANALOG SWITCH 5V SOT23-5	Texas Instruments	MAX4596DBVR
1		U37	IC LDO VOLT REF 2.048V SOT23-6	Texas Instruments	REF3220AIDBVT
1		U39	IC LDO VOLT REF 3.0V SOT23-6	Texas Instruments	REF3230AIDBVT
2		U40	IC OPAMP 1.8V 0-DRIFT SOT23-5	Texas Instruments	OPA333AIDBVT

Table 10. Bill of Materials (continued)

Qty	Value	Ref Des	Description	Vendor	Part Number
3		U29, U30, U38	IC QUAD BI-LAT ANALOG SW 14-SSOP	Texas Instruments	SN74HC4066DBR
1		U28	IC SCHMITT-TRIG BUFF SOT-23-5	Texas Instruments	SN74LVC1G17DBVR
1		U32	IC LP INSTRUMENTATION AMP 8 SOIC	Texas Instruments	INA128U
2		U42, U43	RELAY OPTO DC 60V 600MA 6-SMD	Panasonic Electric Works	AQV102A
1	12MHz	XTL1	CRYSTAL 12.0000MHZ 18PF SMD	Epson Electronics America Inc	MA-505 12.0000M-C0:ROHS
1		J1	CONN SOCKET USB B-TYPE HORZ	Keystone Electronics	924
1		T2	3-Position Terminal Strip, Cage Clamp, 45°, 15A, Dove-tailed	On-Shore Technology Inc	ED300/3
2		T1, T3	2-Position Terminal Strip, Cage Clamp, 45°, 15A, Dove-tailed	On-Shore Technology Inc	ED300/2
1		J4	CONN D-SUB PLUG R/A 25POS 30GOLD (With Threaded Inserts and Board locks)	AMP/Tyco Electronics	5747842-4
1		J3	CONN D-SUB RCPT R/A 25POS 30GOLD (With Threaded Inserts and Board locks)	AMP/Tyco Electronics	5747846-4
1		J5	CONN AUDIO JACK 3.5MM MONO	CUI Inc	MJ-3536NG
4		D1, D7, D6, D8	Ultra Bright Red Diffused LED, 0603 pkg	Panasonic	LNJ208R8ARA
3		D2, D3, D4	SOT-23 Switching Diode, 300mS, 75V	Diodes Incorporated	MMBD4148-7-F
4		D9, D11, D15, D16	TVS ZENER UNIDIR 600W 6.8V SMB	ON Semiconductor	P6SMB6.8AT3G
5		D5, D10, D12, D13, D14	SOT-23 Schottky Diode, 500mA, 40V	Zetex Semiconductor	ZHCS500
2		Q1, Q2	TRANSISTOR GP NPN AMP SOT-23	Fairchild Semiconductor	MMBT4401
1		Q3	30V P-Channel Enhancement Mode MOSFET, SOT23-6	Zetex Semiconductor	ZXMP3A17E6
1		Q4	TRANS PNP 40V 350MW SMD SOT-23	Diodes Inc	MMBT4403-7-F
4		F1, F3, F4, F5	FERRITE 300MA 600 OHM 0603 SMD	Steward	HZ0603C601R-10
2		L2, L3	INDUCTOR MULTILAYER 150UH 1210, 85mA	Panasonic	NLCV32T-151K-PF
1		SW1	SWITCH TACT 6MM SMD GULL WING	Alcoswitch/Tyco Electronics	FSM2JSMA
19		TP1,TP4 TP24, TP25, TP26, TP27, TP28, TP29, Avcc, Vraw, Vreg_in, Vcc, Vdut, 3.3V, GND, 5V_USB, SDA, SCL, TP4	CONN HEADER .100 SNGL STR 36POS (cut into single position test points)	3M/ESD	929647-09-36-I
15		JUMP1, JUMP2, JUMP3, JUMP4, JUMP5, JUMP6, JUMP7, JUMP8, JUMP9, JUMP10, JUMP11, JUMP13, JUMP14, JUMP17, JUMP18	CONN HEADER .100 SNGL STR 36POS (cut into three position Jumpers)	3M/ESD	929647-09-36-I

Table 10. Bill of Materials (continued)

Qty	Value	Ref Des	Description	Vendor	Part Number
15		Jumpers for JUMP1, JUMP2, JUMP3, JUMP4, JUMP5, JUMP6, JUMP7, JUMP8, JUMP9, JUMP10, JUMP11, JUMP13, JUMP14, JUMP17, JUMP18	Jumper Shorting Units	AMP/Tyco Electronics	881545-2
7		NA	Standoffs, Hex , 4-40 Threaded, 0.500" length, 0.250" OD, Aluminum Iridite Finish	Keystone Electronics	2203K-ND
7		NA	SCREW MACHINE PHIL 4-40X1/4 SS	Building Fasteners	PMSSS 440 0025 PH
2		NA	PCB EXTRACTOR	Bivar	1001-062
2		NA	PIN FOR PCB EXTRACTOR	Bivar	RP-250

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