DATA TRANSLATION

UM-26000-G

DT7837
User's Manual

Radio and Television Interference

This equipment has been tested and found to comply with CISPR EN55022 Class A and EN61000-6-1 requirements and also with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Changes or modifications to this equipment not expressly approved by Data Translation could void your authority to operate the equipment under Part 15 of the FCC Rules.

Note: This product was verified to meet FCC requirements under test conditions that included use of shielded cables and connectors between system components. It is important that you use shielded cables and connectors to reduce the possibility of causing interference to radio, television, and other electronic devices.

Canadian Department of Communications Statement

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la class A prescrites dans le Règlement sur le brouillage radioélectrique édicté par le Ministère des Communications du Canada.

Table of Contents

About this Manual

The first part of this manual describes how to install and set up your DT7837 module and verify that your module is working properly.

The second part of this manual describes the features of the DT7837 module and how to program the DT7837 module using Linux system calls. Troubleshooting information is also provided.

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming a DT7837 module for data acquisition operations in the Linux operating system. It is assumed that you have some familiarity with data acquisition principles and that you understand your application.

How this Manual is Organized

This manual is organized as follows:

- Chapter 1, "Overview," describes the major features of the DT7837 module, as well as the supported software and accessories for the module.

- Chapter 2, "Principles of Operation," describes all of the features of the DT7837 module.

- Chapter 3, "Troubleshooting," provides information that you can use to resolve problems with the DT7837 module should they occur.

- Chapter 4, "Calibration," describes how to calibrate the analog circuitry of the DT7837 module.

- Appendix A, "Specifications," lists the specifications of the DT7837 module.

- Appendix B, "Connector Pin Assignments and LED Status Indicators," lists the pin assignments of the connectors on the DT7837 module, and describes the LED status indicators on the DT7837 module.

- An index completes this manual.

Conventions Used in this Manual

The following conventions are used in this manual:

- Notes provide useful information or information that requires special emphasis, cautions provide information to help you avoid losing data or damaging your equipment, and warnings provide information to help you avoid catastrophic damage to yourself or your equipment.

- Items that you select or type are shown in **bold**.

Related Information

Refer to the following documents, which can be found on the DT7837 web page on our website (http://www.datatranslation.com/Products/Sound-and-Vibration-ARM-DAQ/DT7837) for more information on using the DT7837 module:

- *DT7837 Getting Started* help file

- *DT7837 File I/O Programming Manual*

Refer to your Linux documentation for more information about Linux and Texas Instruments documentation for more information on the TI Sitara AM3352, 1 GHz, ARM® Cortex-A8 processor.

Where To Get Help

Should you run into problems installing or using a DT7837 module, the Data Translation Technical Support Department is available to provide technical assistance. Refer to Chapter 4 for more information. If you are outside the United States or Canada, call your local distributor, whose number is listed on our web site (www.datatranslation.com).

1

Overview

Hardware Features

The DT7837 module is an open-source Linux computing platform with a high-accuracy, dynamic signal analyzer front-end, making it ideal for embedded applications that require noise, vibration, and acoustic measurements.

As show in Figure 1, the module is composed of two boards that connect together: the ARM block (the bottom board) and the I/O block (the top board). Users can embed the module into their own enclosure and/or system, as needed.

Figure 1: DT7837 Module

The key features of the DT7837 module are as follows:

- Open-source computing platform featuring a TI Sitara AM3352, 1 GHz, ARM® Cortex-A8 processor.

- Linux distribution consisting of a Linux kernel, bootloader, and file system with a DT7837 device driver, USB device (client) driver, and USB host driver.

- Ethernet 10/100 Mbps connectivity to a host computer.

- USB 2.0 high-speed connectivity to a host computer.

- USB 2.0 host connection to external devices, such as an external memory stick or hub.

- Analog input subsystem:

  - Four, single-ended analog input channels available through SMA connectors.

  - Four simultaneous sampling, Delta-Sigma, 24-bit analog-to-digital converters (ADCs).

  - Support for IEPE (Integrated Electronic Piezoelectric) inputs, including use of a 4 mA current source with 20 V compliance voltage for AC or DC coupling.

  - Programmable throughput rate from 195.3125 Samples/s to 105.469 kSamples/s.

  - Input range of ±10 V with software-selectable gains of 1 and 10 for an effective input range of ±10 V and ±1 V.

  - Continuous acquisition from multiple analog input channels simultaneously.

- Supports the ability to return the value of the tachometer, measure counter, and/or digital input port in the analog input data stream, allowing you to measure a variety of signals synchronously with analog input measurements.

- Software-programmable trigger source (software trigger, external trigger, or threshold trigger using any analog input channel) to start acquisition.

- Accounts for analog input group delay in hardware.

- Analog output subsystem:

  - One stimulus analog output channel with a 24-bit D/A converter.

  - Single value and continuous streaming output.

  - Programmable output rate from 30 kSamples/s to 216 kSamples.

  - Output range of ±10 V.

  - Software-programmable trigger source (software trigger or external digital trigger) to start the analog output operation.

  - Supports the ability to update the digital output port synchronously with the analog output channels.

- Up to eight, TTL digital input lines using the eight general-purpose inputs. You can read the digital input port directly or you can return the value of the digital input port in the input data stream.

- Up to eight, TTL digital output lines using the eight general-purpose outputs. You can write a value to the digital output port directly.

- One, 32-bit, general-purpose counter/timer for performing event counting, rate generation, and non-retriggerable one-shot operations. You can use two general-purpose input signals for the C/T clock and gate inputs and one general-purpose output signal for the C/T clock output. You can read the value of the counter/timer directly through a synchronous read operation.

- One tachometer input signal. The value of the tachometer input signal can be returned in the input stream.

- One phase/measure counter. You can program the edge that starts the measurement and the edge that stops the measurement. Many edge types are supported. The data from the measure counter can be returned in the input stream.

- 2 GB embedded NAND flash memory that contains the Linux kernel, bootloader, and file system; this memory can also be used to store user files and data.

- 512 MB SDRAM (DDR3) memory.

- 8 kBytes EEPROM.

- Micro SD connector supports micro SD cards, which can be used as a boot source or for general-purpose file and data storage.

- 3.3 V UART, I^{2}C2, and an SPI (Serial Peripheral Interface) interfaces for embedded connectivity.

- Serial debug port.

- External power connectors (4-pin DIN or 3-pin Phoenix header) for connecting a +5 VDC power supply.

Board Layout Overview

The DT7837 module consists of an ARM block and a I/O block. Figure 2 shows the layout of the ARM block (the bottom board). Figure 3 shows the layout of the I/O block (the top board).
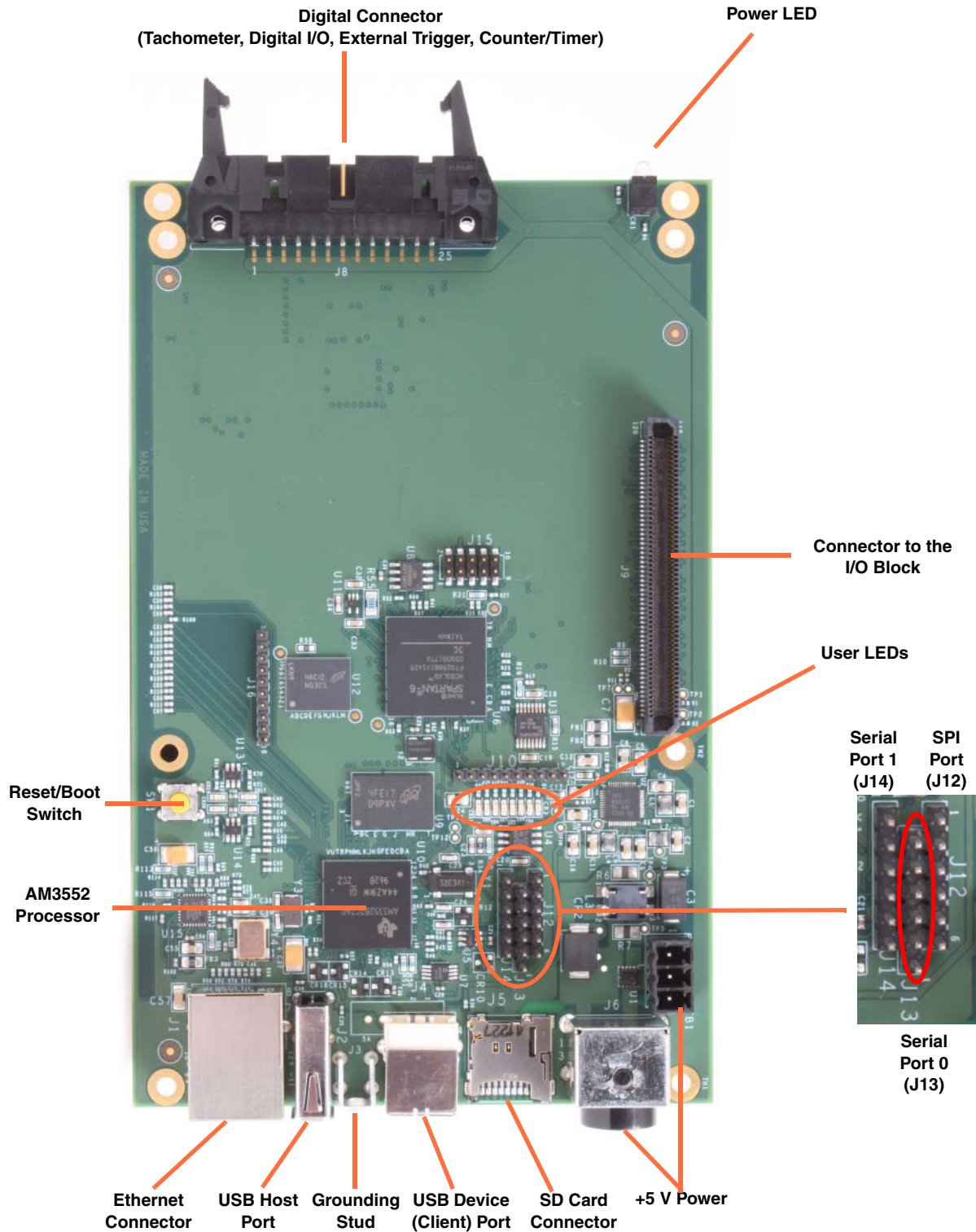
Figure 2: Layout of the ARM Block of the DT7837 Module
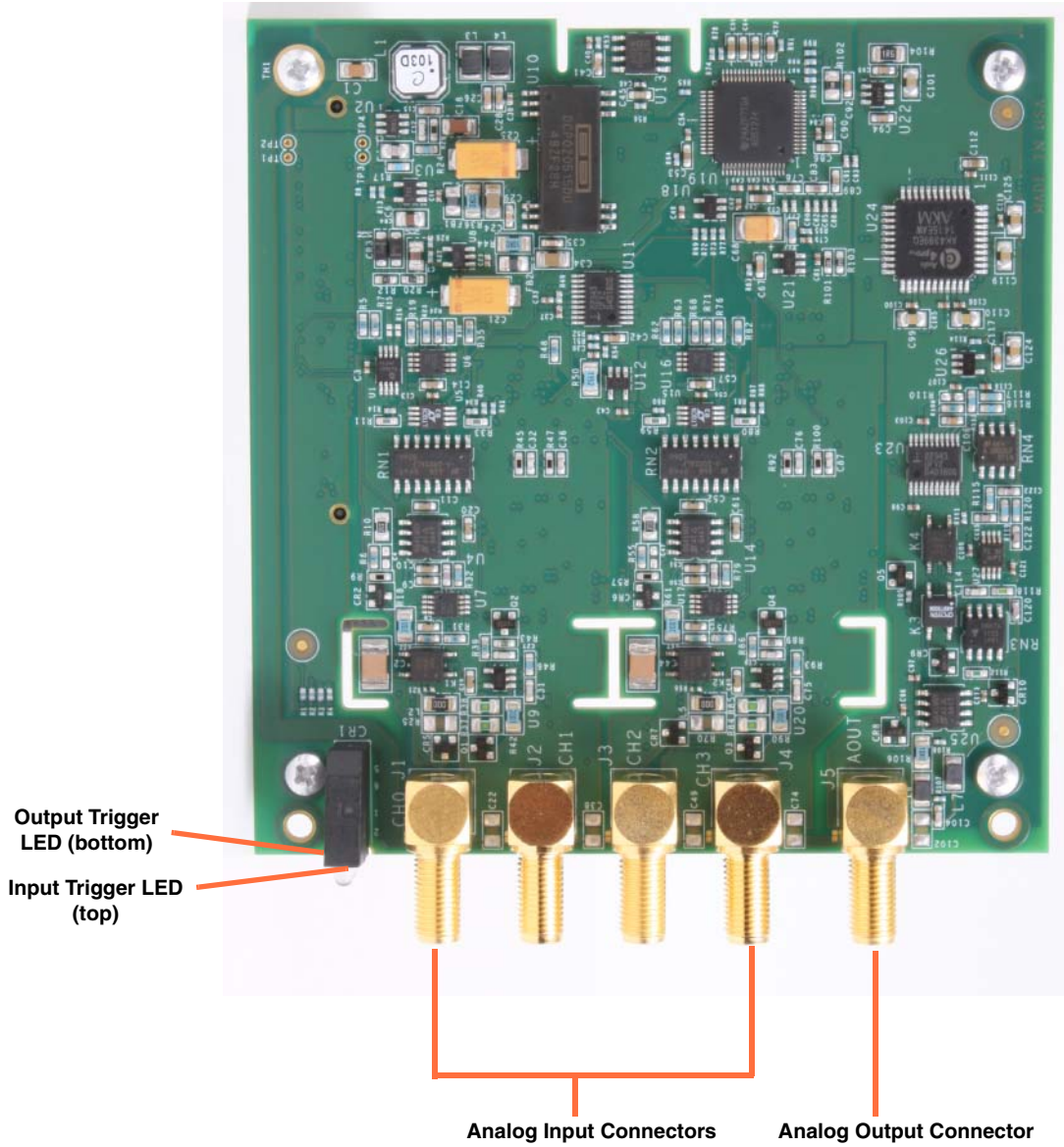
Figure 3: Layout of the I/O Block of the DT7837 Module

Supported Software

The DT7837 modules run Linux 3.12 (Debian distribution) with custom loadable kernel modules (LKM) or device drivers.

The DT7837 device drivers and numerous example application programs reside on the DT7837 module. The drivers are loaded when the DT7837 module is powered up. The example programs demonstrate the functionality of the hardware and how to use file I/O commands to write application programs for the module. A calibration utility is also provided for calibrating the analog circuitry of the DT7837 module. Refer to Chapter 4 for more information on the calibration utility.

The device drivers (DT78xx driver and DT78xx USB driver), shown in Figure 4, expose the functionality of the module to Linux user space applications using virtual file interfaces.
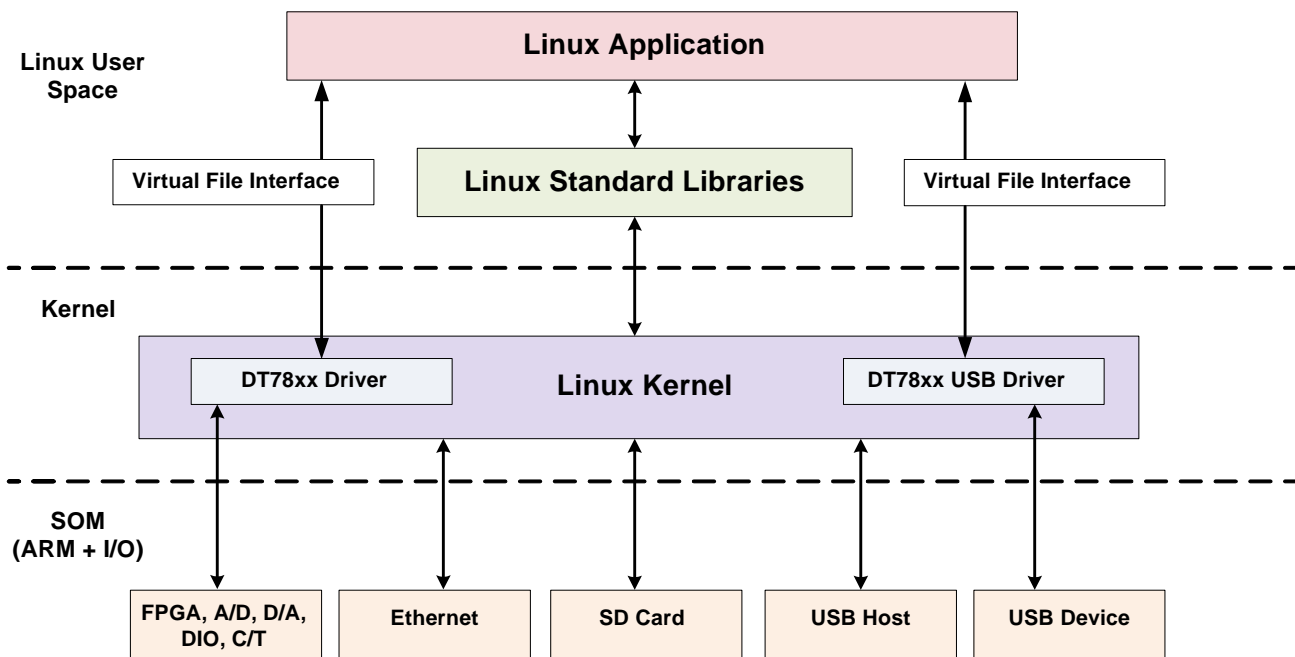
Figure 4: Software Architecture of the DT7837

For example, the DT7837 module uses the following files to access its subsystems:

- /dev/dt7837-ain – Analog input subsystem.
- /dev/dt7837-aout – Analog output subsystem.
- /dev/dt7837-din – Digital input subsystem.
- /dev/dt7837-dout – Digital output subsystem.
- /dev/dt7837-tach – Tachometer input subsystem.
- /dev/dt7837-measure – Measure counter subsystem.

- /dev/dt7837-ctr-tmr – Counter/timer subsystem.

- /dev/dt7837-stream-in – Input stream.

- /dev/dt7837-stream-out – Output stream.

The USB device functionality of the DT7837 is accessible to user-space embedded applications using the following files:

- /dev/dt7837-ep1in

- /dev/dt7837-ep1out

- /dev/dt7837-ep2in

- /dev/dt7837-ep2out

- /dev/dt7837-ep3out

- /dev/dt7837-ep4out

- /dev/dt7837-ep5out

User applications can perform standard file operations such as open, close, read, write, on the files to access and control the hardware. For instance, to access the digital input subsystem on the DT7837 module, the application uses the virtual file handle for the digital input subsystem (/dev/dt7837-din) as follows:

- Opens the file /dev/dt7837-din, thereby allowing access to the digital input subsystem.

- If supported, configures parameters for the digital input subsystem using IOCTL commands.

- Reads from the file, which in turn, reads the value of the digital input port and returns a value.

- Closes the file.

Refer to the *DT7837 File I/O Programming Manual* for more information about writing application programs for the DT7837 module using virtual file interfaces and file I/O commands**.**

Supported Accessories

The following optional accessories are available for a DT7837 module:

- **STP26 screw terminal panel** – This screw terminal panel accepts tachometer, digital input, C/T gate input, and C/T clock input signals from the Digital connector on the DT7837 module and provides digital output and C/T clock output signals from the Digital connector on the module.

  The 26-pin, 36-inch, EP406 cable is included with the STP26 screw terminal panel. The cable allows you to attach the STP26 screw terminal panel to the Digital connector on a DT7837 module.

  Figure 5 shows the STP26 and EP406 cable.
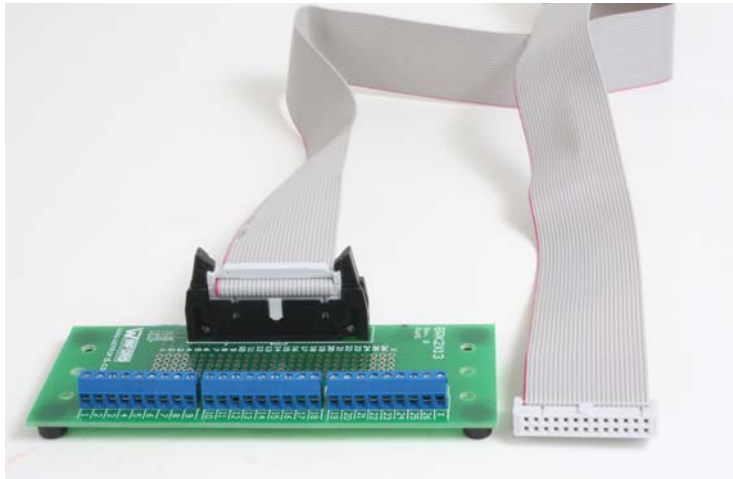
Figure 5: STP26 Screw Terminal Panel and EP406 Cable

- **EP405 USB to Serial TTL Debug Cable –** This 3Mbaud, 1.8 m cable, shown in Figure 6, connects the USB port of the host computer to serial UART connector J13 on the DT7837, allowing you to debug the DT7837 using a terminal interface.

Figure 6: EP405 USB to Serial TTL Debug Cable

• **EP361 External Power Supply** – This +5 VDC optional power supply and cable, shown in Figure 7, connects to the DIN power connector on the DT7837 module and to the wall power outlet.

Figure 7: EP361 +5 VDC External Power Supply

Getting Started Procedure

Refer to the *DT7837 Getting Started* help file on our web site
(http://www.datatranslation.com/Products/Sound-and-Vibration-ARM-DAQ/DT7837) for
getting started information.

2

Principles of Operation

Block Diagram

The DT7837 is an open-source Linux computing platform with a high-accuracy, dynamic signal analyzer front-end.

The DT7837 consists of two boards. The bottom board is the ARM block, which includes the ARM processor, PC and embedded connectivity options, and memory, as well as the digital I/O, counter/timer, measure counter, and tachometer circuitry.

The top board is the I/O block, which includes four 24-bit IEPE analog inputs and one 24-bit stimulus analog output.

Figure 8 shows a block diagram of the DT7837 module.

DT7837 Block Diagram
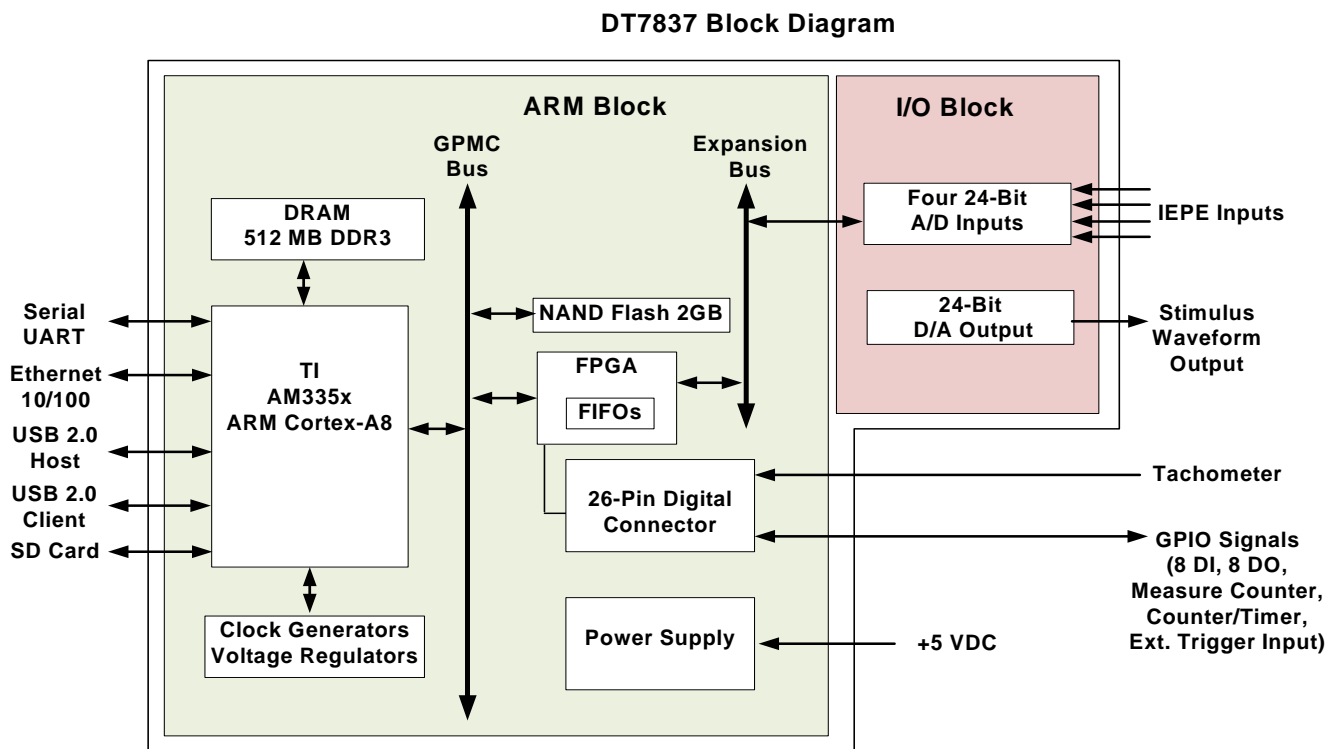
Figure 8: Block Diagram of the DT7837 Module

ARM Block

The ARM block of the DT7837 module uses the TI Sitara AM3352 processor and its associated peripherals to provide an open-source, single-board computer. The AM3352 supports many different interfaces, many of which are shared on the configurable I/O pins. In addition to the AM3352, the DT7837 module uses an embedded NAND flash and an FPGA.

This section describes the features of the ARM block in more detail.

ARM Processor

The AM3352 is based on the ARM Cortex-8 32-bit processor and is configured to run at 1 GHz.

Refer to the following web site for more information on this processor:
http://www.ti.com/product/am3352

Memory

A 512 MB, DDR3, SDRAM memory device is connected to the AM3352 processor through a dedicated DDR (Double Data Rate) memory interface.

Embedded NAND Flash

A 2 GB embedded NAND flash device is connected to the AM3352 processor through the 16-bit GPMC (General Purpose Memory Controller) bus, and can be accessed at the CS0 address space. The flash memory contains the Linux kernel, bootloader, and the file system.

You can also use the flash memory for general-purpose data and file storage as well as for input data and waveform storage.

EEPROM

An 8 kByte EEPROM device is connected to the I2C0, 2-wire, serial interface of the AM3352 processor. The EEPROM stores information about the device, including the calibration information.

Micro SD Card

A micro SD card slot is provided to support optional high-speed (up to 24 MB/s) micro SD cards. Micro SD cards (not provided with the module) communicate with the AM3352 processor using the MMC0 port in the 4-bit interface mode.

You can use a micro SD card as a boot source or for general-purpose file and data storage.

USB Device (Client) Port

The DT7837 module provides a USB 2.0 device (client) port on a type B receptacle. The device port connects to the USB port 0 controller of the AM3352 processor.

When connected to a host computer through this USB port, the host computer can identify the DT7837 module and load the appropriate drivers through the enumeration process.

USB Host Port

The DT7837 provides a high-speed USB 2.0 host port on a type A receptacle. The host port connects to the USB port 1 controller of the AM3352 processor. The USB host port supports any USB device, provided that the required software is installed on the Linux operating system.

If desired, you can connect USB devices, such as a memory stick or hub to this port.

Serial Port 0

Serial port 0 is a 3.3 V TTL serial interface provided on a 6-pin header. This port supports transmit and receive signals (no handshaking), and connects to the UART 0 interface of the AM3552 processor.

This port is particularly useful when you are debugging your applications. To use this port, use the EP405 USB to serial TTL adapter cable.

Serial Port 1 / I^{2}C2 Port

Serial port 1 and the I^{2}C2 port are provided on the same 6-pin header.

Serial port 1 is a 3.3 V TTL serial interface that supports transmit and receive signals, and connects to the UART1 interface of the AM3552 processor.

The bidirectional I^{2}C2 port connects to the I^{2}C port 2 interface of the AM3552 processor and is provided for embedded connectivity. It is possible to reconfigure the pins of the I^{2}C port 2 interface as the remaining UART 1 pins to provide the full functionality of serial port 1.

SPI Port

The SPI (Serial Peripheral Interface) is provided on an additional 6-pin header for embedded connectivity. This port connects to the SPI port 1 interface of the AM3552 processor.

GPMC Bus Interface

A 16-bit address/data multiplexed bus interface is supplied by the processor. In addition to the NAND flash, this bus also supports the FPGA. All control registers for the DT7837 are accessible in the CS1 address space. The CS3 address space provides access to the input FIFO.

Digital Connector

The Digital connector provides access to the tachometer input and GPIO (General Purpose Input and Output) signals of the DT7837 module. Refer to for the pin assignments of this connector.

Using software, you can specify a general-purpose input signal as the signal source for the following destinations:

- Digital input (the default signal for each general-purpose input pin)
- External A/D trigger input
- External D/A trigger input
- Gate input for the general-purpose counter/timer (C/T 0)
- Clock input for the general-purpose counter/timer (C/T 0)

Using software, you can specify a general-purpose (general-purpose) output signal as the signal source for one of these destinations:

- Digital output (the default signal for each general-purpose output pin)
- Clock output for the general-purpose counter/timer (C/T 0)

Note that a single general-purpose input may drive several destinations at the same time. However, a single general-purpose output can have only one driving source.

Analog Input Features

This section describes the following features of analog input (A/D) subsystem on the DT7837 module:

- Analog input channels, described on this page
- Input ranges and gains, described on this page
- IEPE functions, described on
- Input resolution, described on
- Continuous sampling mode, described on
- Input triggers, described on
- Input sample clock source and sampling frequency, described on
- Input FIFO and data format, described on
- Error conditions, described on

Analog Input Channels

The DT7837 module provides four analog input channels (channels 0 to 3). These are single-ended channels; you can connect IEPE sensors to these inputs, if desired; refer to for more information on IEPE functions. Refer to the *DT7837 Getting Started* help file for wiring information.

Note: To maintain simultaneous operation, all analog input connections on the DT7837 module must have the same lead lengths.

The DT7837 module uses four, Delta-Sigma, 24-bit ADCs that provide anti-aliasing filters based on the clock rate. These filters remove *aliasing*, which is a condition where high frequency input components erroneously appear as lower frequencies after sampling.

Using software, you can specify which analog input channels to sample by specifying bits 0 to 3 in the channel mask for the input stream.

Input Ranges and Gains

The DT7837 module provides an input range of ±10 V and software-selectable gains of 1 and 10. This provides effective input ranges of ±10 V (when the gain is 1) and ±1 V (when the gain is 10).

IEPE Functions

Applications that require accelerometer, vibration, noise, or sonar measurements often use IEPE sensors. IEPE conditioning is built-in to the analog input circuitry of the DT7837 module. The modules support the following software-programmable IEPE functions for each analog input channel:

- Excitation current source – The DT7837 module provides an internal excitation current source of 4 mA. You can turn the internal excitation current source on or off using software.

- Coupling type – You can select whether AC coupling or DC coupling is used.

DT7837 modules provide +20 V compliance voltage.

Note: If you enable the use of the internal excitation current source, it is recommended that you choose AC coupling.

Input Resolution

The resolution of the analog input channels is fixed at 24 bits; you cannot specify the resolution in software.

Continuous Sampling Mode

The DT7837 module supports continuous sampling mode on the input stream. This is an asynchronous I/O operation that is non-blocking so that your application can perform other operations while acquisition is being performed.

In continuous sampling mode, you can acquire data from the following channels in the input data stream: analog input channels 0 to 3, the tachometer input, the measure counter, and the digital input port. In software, you specify the channel mask for the input stream to determine which channels to sample. The bits of the channel mask are as follows:

- Channels (bits) 0 to 3 – Analog input channels 0 to 3

- Channel (bit) 8 – Tachometer; refer to for more information

- Channel (bit) 10 – Measure counter; refer to for more information

- Channel (bit) 11 – Digital input port; refer to for more information

The trigger that starts acquisition for the channels in the input stream can be any of the supported start trigger sources. Refer to for more information about the start trigger sources. However, the input stream of the module must be armed (using software) before the module can detect the trigger condition.

If a software trigger is specified as the start trigger, acquisition starts immediately when the software start command is executed. Otherwise, acquisition begins when the specified trigger signal is detected. When it detects the specified start trigger, the module simultaneously acquires data from all of the channels specified in the input stream. Acquisition repeats continuously until you stop the operation. The conversion rate is determined by the sampling frequency; refer to for more information.

When you stop the operation using software, the DMA engine stops and no further data is collected. It is the programmer's responsibility to clean up all inprocess control block resources. To restart the operation, the input stream of the module must be armed and started again.

Figure 9 illustrates continuous acquisition mode using three channels: analog input channels 0 and 1 and the digital input port. When the start trigger is detected, samples from the specified channels are acquired continuously.
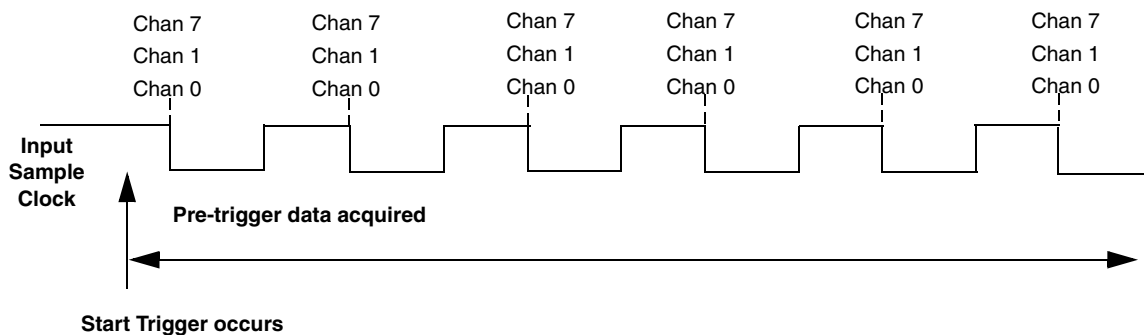
Figure 9: Continuous Sampling Mode on the DT7837 Module

Input Triggers

A trigger is an event that occurs based on a specified set of conditions. For continuous sampling mode of the channels in the input data stream, described on , you must specify a start trigger to start acquisition.

The DT7837 module supports the following sources for the start trigger; you configure the trigger source and its parameters using software:

- **Software trigger** – A software trigger event occurs when you start the analog input operation (the computer issues a write to the module to begin conversions). Using software, specify the start trigger source as a software trigger.

- **External digital (TTL) trigger** – An external digital (TTL) trigger event occurs when the module detects a rising- or falling-edge transition on the signal connected to a general-purpose input pin on the Digital connector. (Refer to for more the pin descriptions of the Digital connector.) You can specify which edge is active using software.

- **Threshold trigger** – The start trigger event occurs when the signal attached to a specified analog input channel rises above or falls below a user-specified threshold value. Using software, you specify the following parameters:

  – Edge – Specify a rising-edge threshold trigger if you want to trigger when the signal rises above a threshold level, or a falling-edge threshold trigger if you want to trigger when the signal falls below a threshold level.

  – Threshold channel – Specify any one of the analog input channels as the threshold input channel.

  – Threshold level – Specify a value between ±10 V for a gain of 1 or ±1 V for a gain of 10 as the threshold level. Note that in software, this value must be entered as counts.

    To convert volts to raw counts, use this formula:

    Gain of 1: $counts = ((volts/10.0f) * (1 << (24 - 1)))$

    Gain of 10: $counts = ((volts/1.0f) * (1 << (24 - 1)))$

    To convert raw counts to volts, use this formula:

    Gain of 1: $volts = ((counts * 10.0f)/(1 << (24 - 1)))$

    Gain of 10: $volts = ((counts * 1.0f)/(1 << (24 - 1)))$

Note: The DT7837 driver sets the threshold level as close as possible to the value that you specify. However, the value that you specify may not be the actual value that is set. You can return the actual threshold level that was set using software.

Input Clock Source and Sampling Frequency

The DT7837 module supports an internal A/D clock, which is derived from the 48 MHz reference clock. The reference clock is generated from the onboard oscillator.

Using software, you specify the frequency at which to pace input operations. The sampling frequency can range from 195.3125 Hz to 105.469 kHz.

Note: According to sampling theory (Nyquist Theorem), specify a frequency that is at least twice as fast as the input's highest frequency component. For example, to accurately sample a 20 kHz signal, specify a sampling frequency of at least 40 kHz to avoid aliasing.

The DT7837 driver sets the sampling frequency as close as possible to the value that you specify. However, the value that you specify may not be the actual value that is set. You can return the actual sampling frequency that was set using software.

Once the sample clock is started, the module requires 39 conversions before the first A/D sample is valid. The valid sample is aligned with the start trigger.

Note: After changing the A/D master clock, wait a few milliseconds for the master clock to settle before calibrating the module or performing an acquisition.

The DT7837 module has two power modes: low power mode and high power mode. Low power mode is used when you specify a sampling frequency less than 52.734 kHz. High power mode is used when you specify a sampling frequency greater than or equal to 52.734 kHz. If you change the power mode from low to high power or from high power to low power, and then configure the device, the module is self-calibrated. You may notice that it takes time after the device is configured to complete the calibration process.

Input FIFO and Data Format

The DT7837 has an input FIFO of 8 kSamples (32 kBytes) for storing input data. The driver moves the data from the input FIFO into user-allocated buffers. Refer to the *DT7837 File I/O Programming Manual* for details on user buffers.

The data that is returned in the input buffers is in the following order, assuming that all channels are enabled in the input stream:

- Analog input channels 0 through 3. Each analog input sample is a 32-bit, two's complement, raw A/D value.

- Tachometer. This is a 32-bit unsigned value.

- Counter/timer. This is a 32-bit unsigned value.

- Measure counter. This is a 32-bit unsigned value.

- Digital input port. This is a 32-bit unsigned value, where the digital input data is in the least significant eight bits.

If a channel is not enabled, the location in the input buffer is occupied by the data for next enabled channel in the input stream.

Error Conditions

The DT7837 module will detect an overrun error if the user buffers are not being sent to the module fast enough, and the A/D converters run out of user buffers to fill. To avoid this error, try one or more of the following:

- Reduce the clock rate of the A/D

- Increase the size of the buffers

- Increase the number of buffers

- Close any other applications that are running

Analog Output Features

This section describes the following features of analog output operations:

- Analog output channels, described below
- Output ranges and gains, described below
- Output resolution, described below
- Output clocks, described below
- Output conversion mode, described on
- Output triggers, described on
- Output FIFO and data format, described on
- Error conditions, described on

Analog Output Channels

The DT7837 module supports one analog output channel. You can also update the individual lines of the digital output port in the analog output stream, if desired. Using software, you can specify which channels to update by specifying bits 16 (the analog output channel) and bits 24 to 31 (the lines of the digital output port) in the channel mask for the output stream.

The DT7837 module provides a two-pole, 120 kHz Butterworth filter and quiet start circuitry to prevent noise from interfering with the output signal.

The analog output channel powers up to a value of 0 V ±10 mV.

Output Range and Gain

The DT7837 module can output bipolar analog output signals in the range of ±10 V using a gain of 1.

Output Resolution

The resolution of the analog output channel is fixed at 24 bits; you cannot specify the resolution in software.

Output Clocks

The DT7837 module supports an internal D/A clock, which is derived from the 48 MHz reference clock. The reference clock is generated from the onboard oscillator. The same internal 48 MHz clock signal is used for the both the analog input and analog output subsystems

Using software, you specify the frequency at which to update the channels in the output streams. The output frequency can range between 30 kHz and 216 kHz.

Note: The sample frequencies for the A/D and D/A subsystems are independently programmable and are derived from the same 48 MHz reference clock. Therefore, it is possible to establish a fixed relationship between the A/D and D/A sample frequencies, including setting them to the same frequency (30 kHz to 105.469 kHz). However, the subsystems are not designed to be synchronous with each other.

The DT7837 module requires 36 sample clock periods once the output subsystem has been triggered before the first D/A conversion is completed. The clock is always running.

Output Conversion Modes

The DT7837 module support single-value and continuous analog output operations.

Single-Value Mode

In single-value mode, use software to specify the analog output channel that you want to update, and the value to output from that channel. The value is output from the specified channel immediately.

You cannot specify a clock frequency, trigger source, or buffer for a single-value operation. Single-value operations stop automatically when finished; you cannot stop a single-value operation.

Continuous Analog Output Operations

Use continuous analog output mode to update the channels in the output stream.

Using software, you create a buffer with the values that you want to output to the analog output channels and/or the digital output port. When it detects a trigger, the module starts writing the values from the output buffer to the channels specified in the output stream at the specified clock frequency. The operation repeats continuously until all the data is output from the buffers or you stop the operation.

The DT7837 module supports the ability to start continuous operations on the input stream and output stream at the same time.

Note: Make sure that the data is transferred from the buffer to the output stream fast enough so that the channel does not run out of data; otherwise, an underrun error results.

To stop a continuously paced analog output operation, you can stop queuing buffers for the analog output system, letting the module stop when it runs out of data, or you issue a command to stop the continuous output operation.

Output Trigger

The DT7837 module supports the following trigger sources for starting analog output operations:

- **Software trigger** – A software trigger event occurs when you start the analog output operation (the computer issues a write to the module to begin conversions). Using software, specify the trigger source for the D/A subsystem as a software trigger.

- **External digital (TTL) trigger** – An external digital (TTL) trigger event occurs when the module detects a rising- or falling-edge transition on the signal connected to a general-purpose input pin on the Digital connector. (Refer to page 84 for more the pin descriptions of the Digital connector.) You can specify which edge is active using software.

  Using software, specify the trigger source for the D/A subsystem as an external, positive digital (TTL) trigger for a rising-edge external trigger or an external, negative digital (TTL) trigger for a falling-edge external trigger.

Output FIFO and Data Format

The DT7837 has an output FIFO of 4 kSamples (16 kBytes) for storing output data. The driver moves the data from user-allocated buffers into the output FIFO on the module. Refer to the *DT7837 File I/O Programming Manual* for details on user buffers.

The data in the output buffer must be in the following order, assuming that all channels are enabled in the output stream:

- Analog output channel 0. Each analog output sample is a 32-bit, two's complement, raw D/A value.

- Digital output port. This is a 32-bit unsigned value, where the digital output data is in the least significant eight bits.

If a channel is not enabled, the location in the output buffer is occupied by the data for next enabled channel in the output stream.

Error Conditions

The DT7837 module can detect underrun errors, where the D/A converter runs out of data when the data buffers are not being sent to the output stream fast enough. To avoid this error, try reducing the clock rate of the analog output operation.

Tachometer Input Features

You can connect a tachometer signal with a range of ±30 V to pin 23 of the Digital connector. Refer to page 84 for the pin descriptions of the Digital connector. Refer to the *DT7837 Getting Started* help file for wiring information.

The tachometer input accepts signals with a maximum frequency of 1 MHz and a minimum pulse width of 0.4 μs. The threshold voltage is fixed at +2 V with 0.5 V of hysteresis.

You can measure the frequency or period of the tachometer input signal to calculate the rotation speed for high-level (±30 V) tachometer input signals. An internal 12 MHz counter is used for the measurement, yielding a resolution of 83 ns (1/12 MHz).

You can read the number of counts between two consecutive starting edges of the tachometer input signal by specifying bit 8 in the channel mask for the input stream. The starting edge is programmable (either rising or falling).

Using software, you can also specify a flag (called Stale) that indicates whether or not the data is new. If the Stale flag is set as Used (the default value), the most significant bit (MSB) of the value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1. If the Stale flag is set to Not Used, the MSB is always set to 0.

When the input operation is started, the internal 12 MHz counter starts incrementing when it detects the first starting edge of the tachometer input and stops incrementing when it detects the next starting edge; at that point, the counter stores the count. The stored count is maintained until it is read as part of the input data stream or until a new count is stored. The next tachometer measurement operation is started automatically.

If the sample rate of the input subsystem is faster than the tachometer input frequency, then the stored count retains the current value when the count is read by the input subsystem. The operation of the Stale flag in this case is described as follows:

- If another input subsystem sample occurs before another measure completes and the Stale flag is enabled, then the Stale flag is set and the stale measure count is written into the input data stream.

- If another input subsystem sample occurs before another measure completes and the Stale flag is disabled, then the Stale flag is not set and the stale measure count is written into the input data stream.

If the input sample rate is slower than the tachometer input frequency, then as each period measurement completes, a new count value is stored. When the input subsystem sample occurs, the most recently stored measure count is written into the input data stream.

A data pipeline is used in the hardware to compensate for the A/D group delay and synchronizes the value of the tachometer input with the analog input measurements so that all measurements are correlated in time. The tachometer input is treated like any other channel in the analog input channel list; therefore, all the triggering and conversion modes supported for analog input channels are supported for the tachometer input.

When you read the value of the tachometer input as part of the analog input data stream, you might see results similar to the following:

Table 1: An Example of Reading the Tachometer Input as Part of the Analog Input Data Stream

Time	A/D Value	Tachometer Input Value	Status of Operation
10	5002	0	Operation started, but is not complete
20	5004	0	Operation not complete
30	5003	0	Operation not complete
40	5002	12373	Operation complete
50	5000	12373	Next operation started, but is not complete
60	5002	12373	Operation not complete
70	5004	12373	Operation not complete
80	5003	14503	Operation complete
90	5002	14503	Next operation started, but is not complete

Using the count that is returned from the tachometer input, you can determine the following:

- Frequency of a signal pulse (the number of periods per second). You can calculate the frequency as follows:

  - Frequency = 12 MHz/(Number of counts – 1)
    where 12 MHz is the internal counter/timer clock frequency

    For example, if the count is 21, the measured frequency is 600 kHz (12 MHz/20).

- Period of a signal pulse. You can calculate the period as follows:

  - Period = 1/Frequency

  - Period = (Number of counts – 1)/12 MHz
    where 12 MHz is the internal counter/timer clock frequency

General-Purpose Counter/Timer Features

This section describes the following features of counter/timer (C/T) operations:

- C/T channels, described below

- C/T clock sources, described on

- Gate types, described on

- Pulse output period and duty cycle, described on

- C/T operation modes, described on

Refer to the *DT7837 Getting Started* help file for wiring information.

C/T Channels

DT7837 modules provide one 32-bit, general-purpose counter/timer (C/T 0). As shown in Figure 10, the counter/timer accepts a clock input and gate input signal and outputs a pulse (clock output signal).
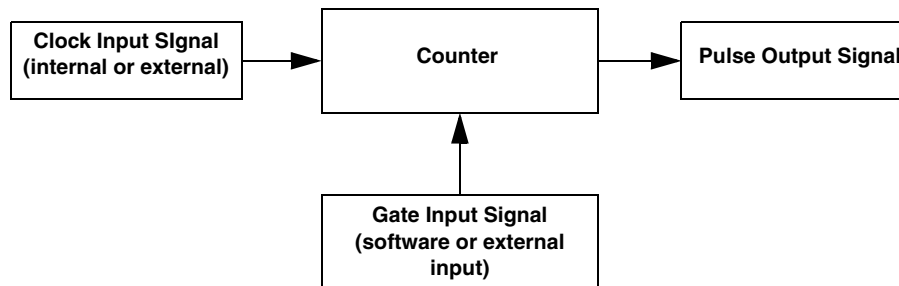
Figure 10: Counter/Timer Channel

Using software, you define general-purpose I/O pins on the Digital connector for the external C/T clock input, external C/T gate input, and C/T clock output signals.

C/T Clock Input Sources

The following clock input sources are available for the general-purpose counter/timer; you select the clock source through software:

- **Internal C/T clock** – The internal C/T clock uses a 48 MHz time base. This clock source is typically used for one-shot and rate generation operations.

- **External C/T clock** – An external C/T clock is useful when you want to pace counter/timer operations at rates not available with the internal C/T clock or if you want to pace at uneven intervals. The frequency of the external C/T clock can range from 0.0112 Hz to 10 MHz.

  This clock source is typically used for event counting and rate generation operations.

  Using software, specify one of the general-purpose input pins (1 to 8) of the Digital connector on the DT7837 module as the external C/T clock input. Then, physically connect the external clock signal to the selected pin. (Refer to page 84 for the pin descriptions of the Digital connector.) Counter/timer operations start on the rising edge of the clock input signal.

Note: If you specify a counter/timer in the input stream, the A/D clock determines how often you want to read the counter value. Refer to page 29 for more information about the A/D sample clock.

Gate Types

The edge or level of the counter gate signal determines when a counter/timer operation is enabled.

Unless you are using a software gate (no gate), define one of the general-purpose input pins of the Digital connector on the DT7837 module as the external C/T gate input using software. Then, physically connect the external gate signal to the selected pin. (Refer to page 84 for the pin descriptions of the Digital connector.)

DT7837 modules provide the following gate types; you select the gate type using software:

- **None** – A software start command enables any counter/timer operation immediately after execution. (No general-purpose input signal is required if a gate type of None is selected.)

- **Low external gate input** – Specifies a logic low or falling edge gate type. For event counting and rate generation mode, the operation is enabled when the counter's gate signal is low and is disabled when the counter's gate signal is high. For one-shot mode or repetitive one-shot mode, the operation is enabled when the counter's gate signal goes from a high to a low transition and is disabled when the counter's gate signal goes from a low to a high transition.

  You specify one of the general-purpose input pins (1 to 8) of the Digital connector on the DT7837 module as the external C/T gate input. Ensure that you physically connect the external gate signal to the selected pin. (Refer to page 84 for the pin descriptions of the Digital connector.)

- **High external gate input** – Specifies a logic high or rising edge gate type. For event counting and rate generation mode, the operation is enabled when the counter's gate signal is high and is disabled when the counter's gate signal is low. For one-shot mode or repetitive one-shot mode, the operation is enabled when the counter's gate signal goes from a low to a high transition and is disabled when the counter's gate signal goes from a high to a low transition.

You specify one of the general-purpose input pins (1 to 8) of the Digital connector on the DT7837 module as the external C/T gate input. Ensure that you physically connect the external gate signal to the selected pin. (Refer to page 84 for the pin descriptions of the Digital connector.)

Pulse Output Period, Pulse Width, and Polarity

If you want to perform a C/T output operation, define one of the general-purpose output pins (11 to 18) of the Digital connector on the DT7837 module as the external C/T output signal using software. Then, connect the external C/T output signal to the selected pin. (Refer to page 84 for the pin descriptions of the Digital connector.)

For the DT7837 module, you can program the polarity of the output pulse (active high or active low). For an active high pulse, the high portion of the total pulse output period is the active portion of the counter/timer pulse output signal. For an active low pulse, the low portion of the total pulse output period is the active portion of the counter/timer pulse output signal.

Using software, you can specify the number of input clock cycles that are used to create one period of the counter clock output signal. You can also specify the number of input clock cycles used to create the active pulse width (or duty cycle) of the C/T output signal.

For example, if you are using an external C/T clock running at 10000 Hz as the input clock source of the counter/timer, and you want to generate a output signal of 1000 Hz with a 20% duty cycle, specify a period of 10 (10000 Hz divided by 10 is 1000 Hz) and a pulse width of 2 (the period of 10 multiplied by 20%). This is illustrated in Figure 11.

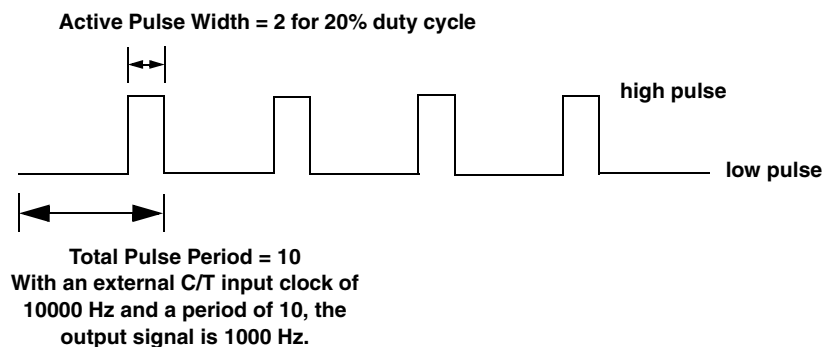**Active Pulse Width = 2 for 20% duty cycle**

high pulse

low pulse

**Total Pulse Period = 10
With an external C/T input clock of
10000 Hz and a period of 10, the
output signal is 1000 Hz.**

Figure 11: Example of a Pulse Output

Note: If you are using an internal C/T clock input source, you can output pulses using a maximum frequency of 24 MHz. Note, however, that the integrity of the signal degrades at frequencies greater than 10 MHz.

If you are using an external C/T clock input source, you can output pulses using a maximum frequency of 5 MHz.

Counter/Timer Operation Modes

The general-purpose counter/timer on the DT7837 module supports the following counter/timer operation modes:

- Event counting

- Rate generation

- Non-retriggerable one-shot

- Idle

The following subsections describe these modes in more detail.

Event Counting

Use event counting mode if you want to count the number of rising edges that occur on the counter's clock input when the counter's gate signal is active (low-level or high-level).

You can count a maximum of 4,294,967,296 events before the counter rolls over to 0 and starts counting again.

Using software, you must specify the following parameters for the event counting operation:

- Active gate type (external low level or external high level). Refer to page 37 for more information about the supported gate types.

- The general-purpose input pin to use for the external gate signal. Ensure that you physically connect the gate signal to this input pin. Refer to page 84 for the pin descriptions of the Digital connector.

- The C/T clock source (internal or external). Note that in event counting mode, the external C/T clock is more useful than an internal C/T clock; refer to page 37 for more information about the C/T clock sources.

- The general-purpose input pin to use for the external C/T clock input. Ensure that you physically connect the clock input signal to this input pin. Refer to page 84 for the pin descriptions of the Digital connector.

Using software, you can read the value of the counter/timer using a synchronous read operation.

Rate Generation

Use rate generation mode to generate a continuous pulse output signal from the counter's output signal. You can use this pulse output signal as an external clock to pace other operations, such as an analog input or other counter/timer operations.

The pulse output operation is enabled whenever the counter's gate signal is at the specified level. While the pulse output operation is enabled, the counter outputs a pulse of the specified type and frequency continuously. As soon as the operation is disabled, rate generation stops.

You can output pulses using a maximum frequency of 24 MHz (if using the internal C/T clock) or 5 MHz (if using the external C/T clock).


Note: The integrity of the signal degrades at frequencies greater than 10 MHz.

Using software, you must specify the following parameters for the rate generation operation:

- Active gate type (external low level or external high level). Refer to page 37 for more information about the supported gate types.

- The general-purpose input pin to use for the external gate signal. Ensure that you physically connect the gate signal to this input pin. Refer to page 84 for the pin descriptions of the Digital connector.

- The C/T clock source (internal or external). Refer to page 37 for more information about the C/T clock sources.

- If you are using an external C/T clock source, the general-purpose input pin to use for the external C/T clock input. Ensure that you physically connect the clock input signal to this input pin. Refer to page 84 for the pin descriptions of the Digital connector.

- The period of the output pulse. Refer to page 38 for more information about the period of the output pulse.

- The pulse width (duty cycle) of the active pulse. Refer to page 38 for more information about the pulse width of the output pulse.

- The general-purpose output signal to use for the C/T clock output signal. Ensure that you physically connect the C/T output signal to this output pin. Refer to page 84 for the pin descriptions of the Digital connector.

- The polarity of the output signal (active high or active low). Refer to page 38 for more information on the polarity of the output pulse.

Non-Retriggerable One-Shot

Use non-retriggerable one-shot mode to generate a single output pulse from the counter whenever the specified edge is detected on the counter's gate signal (after the pulse period from the previous output pulse expires). Any gate signals that occur while the pulse is being output are not detected by the module, as shown in Figure 12. The module continues to output a pulse when the specified gate edge is detected until you stop the operation. You can use this mode to clean up a poor clock input signal by changing its pulse width, and then outputting it.

Gate Signal is Ignored

Gate Input (High)
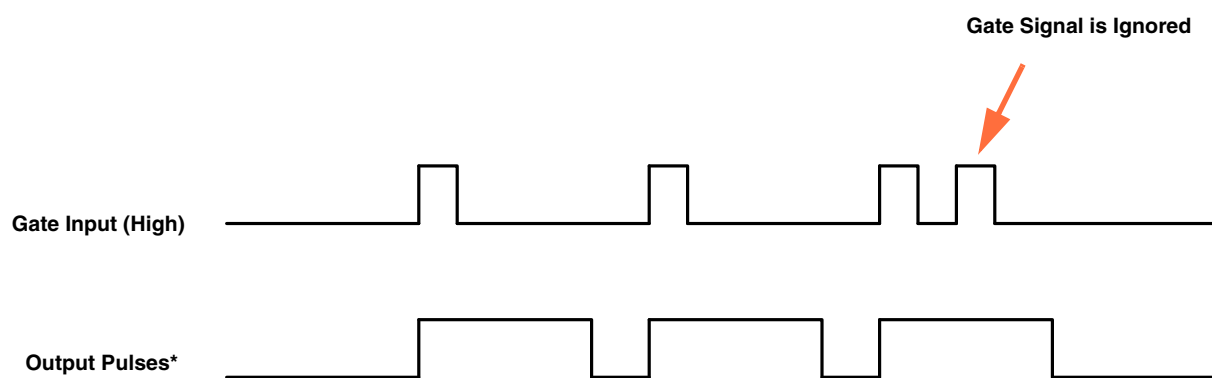
Output Pulses*

*You can determine period, pulse width, and polarity of the output pulse using software.

Figure 12: Non-Retriggerable One-Shot Mode

Using software, you must specify the following parameters for the non-retriggerable one-shot operation:

- Active gate type that enables the operation. Refer to page 37 for more information about the supported gate types.

- The general-purpose input pin to use for the external gate signal. Ensure that you physically connect the gate signal to this input pin. Refer to page 84 for the pin descriptions of the Digital connector.

- The C/T clock source (internal or external) that generates the pulse. Note that in one-shot mode, the internal C/T clock is more useful than an external C/T clock; refer to page 37 for more information about the C/T clock sources.

- The general-purpose input pin to use for the external C/T clock input. Ensure that you physically connect the clock input signal to this input pin. Refer to page 84 for the pin descriptions of the Digital connector.

- The period of the output pulse. Refer to page 38 for more information about the period of the output pulse.

- The pulse width (duty cycle) of the active pulse. Refer to page 38 for more information about the pulse width of the output pulse.

- The general-purpose output signal to use for the C/T clock output signal. Ensure that you physically connect the C/T output signal to this output pin. Refer to for the pin descriptions of the Digital connector.

- The polarity of the output signal (active high or active low). Refer to for more information on the polarity of the output pulse.

- Retriggerable setting of 0 for non-retriggerable one-shot.

Idle Mode

If you use idle mode, the counter no longer drives the clock output signal that is assigned to one of the general-purpose output signals (pins 11 to 18) of the Digital connector.

Note: The value of the counter output signal can also be overwritten by writing to the digital output subsystem.

If you assigned a general-purpose input signal as a counter clock or gate input (or external trigger), you can read the value of the signal as you would any other digital input signal. |

Refer to for more information on digital I/O operations.

Measure Counter Features

DT7837 modules provide one measure counter. Using this counter, you can measure the frequency, period, or pulse width of a single signal or the time period between two signals and return the value in the analog input stream. This is useful for correlating the analog input data with digital positional data, measuring the frequency of a signal, or as a tachometer. An internal 48 MHz counter is used for the measurement, yielding a resolution of 20.83 ns (1/48 MHz).

To read the value of measure counter in the input stream, specify bit 10 in the channel mask of the input stream.

Using software commands, you can configure the following parameters for the measure counter:

- The signals that start and stop the measurement. Refer to Table 2 for the supported start and stop signals.

Table 2: Possible Start and Stop Signals

Signal	Connection Required
A/D conversion complete	No connection required.
Tachometer input (falling edge or rising edge)	Connect to Tachometer input.
Digital input 0 (falling edge or rising edge)	Connect a digital input, external A/D trigger, C/T clock input, or C/T gate input to general-purpose input 0 (pin 1) of the Digital connector. By default, this is digital input 0.
Digital input 1 (falling edge or rising edge)	Connect a digital input, external A/D trigger, C/T clock input, or C/T gate input to general-purpose input 1 (pin 2) of the Digital connector. By default, this is digital input 1.
Digital input 2 (falling edge or rising edge)	Connect a digital input, external A/D trigger, C/T clock input, or C/T gate input to general-purpose input 2 (pin 3) of the Digital connector. By default, this is digital input 2.
Digital input 3 (falling edge or rising edge)	Connect a digital input, external A/D trigger, C/T clock input, or C/T gate input to general-purpose input 3 (pin 4) of the Digital connector. By default, this is digital input 3.
Digital input 4 (falling edge or rising edge)	Connect a digital input, external A/D trigger, C/T clock input, or C/T gate input to general-purpose input 4 (pin 5) of the Digital connector. By default, this is digital input 4.
Digital input 5 (falling edge or rising edge)	Connect a digital input, external A/D trigger, C/T clock input, or C/T gate input to general-purpose input 5 (pin 6) of the Digital connector. By default, this is digital input 5.
Digital input 6 (falling edge or rising edge)	Connect a digital input, external A/D trigger, C/T clock input, or C/T gate input to general-purpose input 6 (pin 7) of the Digital connector. By default, this is digital input 6.
Digital input 7 (falling edge or rising edge)	Connect a digital input, external A/D trigger, C/T clock input, or C/T gate input to general-purpose input 7 (pin 8) of the Digital connector. By default, this is digital input 7.

- A flag (called Stale) indicating whether or not the data is new. This flag is used only when the start edge and the stop edge is set to use the same pin and edge.

  If the Stale flag is set as Used (the default value), the most significant bit (MSB) of the value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1. If the Stale flag is set to Not Used, the MSB is always set to 0.

When the selected start edge is the same as the selected stop edge, the internal 48 MHz counter starts incrementing when it detects the first start edge of the selected input signal and stops incrementing when it detects the selected stop edge (which is the same as the start edge, in this case); at that point, the counter stores and resets the count. The stored count is maintained until it is read as part of the input data stream or until a new count is stored. Since the stop edge is the same as the start edge in this case, the stop edge for the current measurement is the start edge for the next measurement; therefore, no waveform periods are missed. The value of the measure count depends on the input subsystem sample frequency, described as follows:

- If the input subsystem sample frequency is faster than the selected input frequency, then the stored measure count retains the current value when it is read by the input subsystem. The operation of the Stale flag in this case is described as follows:

  - If another input subsystem sample occurs before another measure completes and the Stale flag is used, then the Stale flag is set and the stale measure count is written into the input data stream.

  - If another input subsystem sample occurs before another measure completes and the Stale flag is not used, then the Stale flag is not set and the stale measure count is written into the input data stream.

- If the input subsystem sample frequency is slower than the selected input frequency, then the new measure count value is stored as each period measurement completes. When an input subsystem sample occurs, then the most recently stored measure count is written into the input data stream.

When the selected start edge is not the same as the selected stop edge, the internal 48 MHz counter starts incrementing when it detects the selected start edge and stops incrementing when it detects the next selected stop edge; at that point, the counter stores and resets the count. The stored count is maintained until it is read as part of the input data stream or until a new count is stored. The value of the measure count depends on the input subsystem sample frequency, described as follows:

- If the input subsystem sample rate is faster than the selected measurement period, then the stored count retains the current value when the count is read by the input subsystem. The operation of the Stale flag in this case is described as follows:

  - If another input subsystem sample occurs before another measure completes and the Stale flag is used, then the Stale flag is set and the stale measure count is written into the input data stream.

  - If another input subsystem sample occurs before another measure completes and the Stale flag is not used, then the Stale flag is not set and the stale measure count is written into the input data stream.

- If the input subsystem sample rate is slower than the selected measurement period, then a new count value is stored as each period measurement completes. When an input subsystem sample occurs, the most recently stored measure count is written into the input data stream.

A data pipeline is used in the hardware to compensate for the A/D group delay and synchronizes the value of the measure counter with the analog input measurements, so that all measurements are correlated in time. The measure counter is treated like any other channel in the analog input channel list; therefore, all the triggering and conversion modes supported for analog input channels are supported for the measure counter.

When you read the value of the measure counter as part of the analog input data stream, you might see results similar to the following:

Table 3: An Example of Reading a Measure Counter as Part of the Analog Input Data Stream

Time	A/D Value	Measure Counter Values	Status of Operation
10	5002	0	Operation started, but is not complete
20	5004	0	Operation not complete
30	5003	0	Operation not complete
40	5002	12373	Operation complete
50	5000	12373	Next operation started, but is not complete
60	5002	12373	Operation not complete
70	5004	12373	Operation not complete
80	5003	14503	Operation complete
90	5002	14503	Next operation started, but is not complete

Using the count that is returned from the measure counter, you can determine the following:

- Frequency between the start and stop signals/edges. You can calculate the frequency as follows:

  – Frequency = 48 MHz/(Number of counts – 1)
    where 48 MHz is the internal measure counter frequency

  For example, if the count is 201, the measured frequency is 240 kHz (48 MHz/200).

- Period between the start and stop signals/edges. You can calculate the period as follows:

  – Period = 1/Frequency

  – Period = (Number of counts – 1)/48 MHz
    where 48 MHz is the internal measure counter frequency

- Pulse width of the start and stop signal/edges (rising to falling edge or falling edge to rising edge). You can calculate the period as follows:

    – Pulse width = 1/Frequency

    – Pulse width = (Number of counts – 1)/48 MHz
    where 48 MHz is the internal measure counter frequency

Digital I/O Features

This section describes the following features of digital I/O operations:

- Digital I/O lines
- Operation modes

Digital I/O Lines

DT7837 modules support one digital input port, consisting of up to 8 digital input lines (lines 0 to 7) and one digital output port, consisting of up to 8 digital output lines (lines 0 to 7). The resolution is fixed at 8 bits.

By default, general-purpose input pins 1 to 8 of the Digital connector on the DT7837 module correspond to digital input signals 0 to 7. Similarly, general-purpose output pins 11 to 18 of the Digital connector on the DT7837 module correspond to digital output signals 0 to 7.

Note: If you assigned a general-purpose input signal as a counter clock or gate input or as an external trigger, you can read the value of the signal as you would any other digital input signal, if desired.

If you want to write a value to a specific digital output line, ensure that the corresponding pin of the Digital connector is not configured for another use (such as the output of the counter/timer) or you could corrupt the signal on the pin.

A digital line is high if its value is 1; a digital line is low if its value is 0. On power up or reset, a low value (0) is output from each of the digital output lines and a high value (1) is read from each of the digital input lines if the lines are not connected.

Refer to the *DT7837 Getting Started* help file for wiring information.

Operation Modes

DT7837 modules support the following digital I/O operation modes:

- **Synchronous read and write operations** – Using software, you can read the value of the digital input port using a synchronous read operation or write a value to the digital output port using a synchronous write operation. The operation is blocking, in that it does not return until the value is read or written.

  You do not specify a trigger or clock for a synchronous read or write operation. The operation stops automatically once the value is read or written.

- **Continuous digital input** – Using software, specify the digital input port (all 8 digital input lines) as bit 11 of the channel mask in the input stream. You can specify the sampling frequency and trigger source for the input stream. The trigger starts the acquisition. The input sample clock paces the acquisition of data from the digital input port as well as the analog input channels, tachometer input, general-purpose counter/timer, and/or the measure counter.

- **Continuous digital output** – Using software, specify the individual lines of the digital output port as bits 24 to 31 of the channel mask in the output stream. You can specify the sampling frequency and trigger source for the output stream. The trigger starts the output operation. The output sample clock determines the rate at which the digital output port and the analog output channel are updated.

Triggering Acquisition on Multiple Modules

The internal clock on the DT7837 module is derived from the 48 MHz crystal oscillator and provides the timing for the analog input subsystem on the module.

You can start acquisition on multiple modules by connecting all modules to a shared external trigger input, as shown in Figure 13. Using software, you must define one of the general-purpose input pins on the Digital connector on each DT7837 module as the external trigger signal. Refer to the page 84 for the pin assignments of the Digital connector.

When triggered, the modules start acquiring data at the same time.

Using this connection scheme, the measurements of one module are not synchronous with the measurements of another module as they do not share the same reference clock.
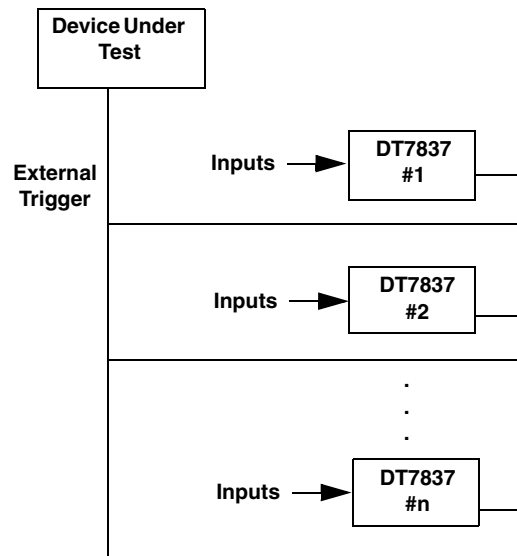
Figure 13: Triggering Multiple Modules Using an External Trigger Source

3

Troubleshooting

Technical Support

Should you experience problems using the DT7837 module, follow these steps:

1. Read all the appropriate sections of this manual and the *DT7837 File I/O Programming Manual*.

2. Refer to the supplied example programs for clarification.

3. Check that you have installed your hardware devices properly.

4. Check that you have installed the software properly.

If you are still having difficulty using the DT7837 module, Data Translation's Technical Support Department is available to provide technical assistance.

To request technical support, go to our web site at http://www.datatranslation.com and click on the Support link.

When requesting technical support, be prepared to provide the following information:

• Your product serial number

• The hardware/software product you need help on

If you are located outside the USA, contact your local distributor; see our web site (www.datatranslation.com) for the name and telephone number of your nearest distributor.

If Your Module Needs Factory Service

If your module must be returned to Data Translation, do the following:

1. Record the module's serial number, and then contact the Customer Service Department at (508) 481-3700, ext. 1323 (if you are in the USA) and obtain a Return Material Authorization (RMA).

   If you are located outside the USA, call your local distributor for authorization and shipping instructions; see our web site (www.datatranslation.com) for the name and telephone number of your nearest distributor. All return shipments to Data Translation must be marked with the correct RMA number to ensure proper processing.

2. Using the original packing materials, if available, package the module as follows:

   – Wrap the module in an electrically conductive plastic material. Handle with ground protection. A static discharge can destroy components on the module.

   – Place in a secure shipping container.

3. Return the module to the following address, making sure the RMA number is visible on the outside of the box.

   Customer Service Dept.
   Data Translation, Inc.
   100 Locke Drive
   Marlboro, MA 01752-1192

4

Calibration

Overview

DT7837 modules are calibrated at the factory and should not require calibration for initial use. We recommend that you check and, if necessary, readjust the calibration of the analog circuitry every six months using the DT7837 Calibration Utility.

The DT7837 Calibration Utility is provided as both a web application (**cal-server)** and a command-line program (**dt7837cal**).

This chapter describes how to calibrate the analog input subsystem of a DT7837 module using the command-line program, **dt7837cal**.

Using the Calibration Utility

To use the command-line DT7837 Calibration Utility, perform the following steps:

1. From the **/usr/local/bin/dt78xx-examples/dt7837-calibration** directory on the module, type **dt7837cal**, and press **Enter.**
   The main screen of the DT7837 Calibration Utility appears.

```
/dev/ttyUSB0 - PuTTY
              *** Analog Input Pots ***
     sampling rate:   -- low --       -- high --
                     Offset  Gain    Offset  Gain
     Ch 0: Gain= 1:    255    255      255    255
     Ch 0: Gain=10:    255    255      255    255
     Ch 1: Gain= 1:    255    255      255    255
     Ch 1: Gain=10:    255    255      255    255
     Ch 2: Gain= 1:    255    255      255    255
     Ch 2: Gain=10:    255    255      255    255
     Ch 3: Gain= 1:    255    255      255    255
     Ch 3: Gain=10:    255    255      255    255
              *** Analog Output Pots ***
     rate:     -- low --       -- mid --        -- high --
             Offset  Gain    Offset  Gain     Offset  Gain
     Ch 0:     111    255      255    255       255    255

Select one of the following:
1: Manually calibrate an analog input channel
2: Manually calibrate an analog output channel
3: Automatically calibrate an analog input channel
4: Restore all analog input factory calibration settings
5: Restore all analog output factory calibration settings
X: Exit
-->
```

2. Once the calibration utility is running, calibrate the analog input circuitry, as described on page 58, and/or calibrate the analog output circuitry, as described on page 61.

Calibrating the Analog Input Subsystem

This section describes how to use the DT7837 Calibration Utility to calibrate each analog input channel of the DT7837 module.

Warming up the Module

Before calibrating the analog input circuitry, ensure that the module has been powered on for at least one hour.

Connecting a Precision Voltage Source

To calibrate the analog input circuitry, you need to connect an external precision voltage source to the DT7837 module that is capable of generating 0.0000 V to +9.3750 V. Connect the precision voltage source to the first analog input channel that you want to calibrate (typically analog input channel 0).

Using the Auto-Calibration Procedure

Auto-calibration is the easiest to use and is the recommended calibration method. To auto-calibrate the analog input subsystem, do the following:

1. From the main menu of the program, select **3: Automatically calibrate an analog input channel**.

2. Enter the number (0 to 3) of the analog input channel that you want to calibrate, then enter **Y** to continue.

3. Verify that 0.0000 V (short) is applied to the channel that you want to calibrate, and enter **C** to continue.

4. Verify that +9.3750 V is applied to the channel that you want to calibrate, and then enter **C** to continue.

5. Verify that +0.9375 V is applied to the channel that you want to calibrate, and then enter **C** to continue.

6. Repeat steps 2 through 5 for the remaining analog input channels on the module.

7. When you have finished calibrating the module, press **X** from the main menu to exit from the program.

Using the Manual Calibration Procedure

The DT7837 has two gains (1 and 10) and two power modes: low power mode and high power mode. Low power mode is calibrated when you specify a sampling frequency less than 52.734 kHz. High power mode is calibrated when you specify a sampling frequency greater than 52.734 kHz. Ensure that you calibrate each analog input channel for gains of 1 and 10 if you are using both gains and for both high and low power mode if you are using sampling frequencies below and above 52.734 kHz. By default, this utility uses DC coupling with the current source disabled.

To manually calibrate the analog input circuitry, do the following for each channel:

1. From the main menu of the program, select **1: Manually calibrate an analog input channel**.

2. Enter the number (**0** to **3**) of the analog input channel that you want to calibrate.

3. Enter the gain value (**1** or **10**) to calibrate for the analog input channel.

4. Enter **0** to calibrate the offset potentiometer or **1** to calibrate the gain potentiometer.

5. Enter **0** to calibrate the selected potentiometer for sampling frequencies less than or equal to 52734 Hz or **1** to calibrate the selected potentiometer for sampling frequencies greater than 52734 Hz.
    The current calibration selections are displayed.

6. If the current selections are correct, enter **Y**. To fix an entry, enter **N** to repeat these steps.

7. If you chose to calibrate the offset potentiometer in step 4, adjust the potentiometer as follows:

    a. Verify that 0.0000 V (short) is applied to the channel that you want to calibrate, and then enter **C** to continue.

    b. Adjust the value as close as possible to 0.0000 V by typing a value between **0** and **255** or by pressing the **+** or **–** key.

    c. Press **Enter** to display the current information for the channel, including the value of the potentiometer and the current reading.

    d. Repeat steps 7b and 7c until the reading is calibrated to 0.0000 V.

    e. Once calibrated, press **x** to exit to the main menu.

8. If you chose to calibrate the gain potentiometer in step 4 and selected a gain of 1 in step 3, adjust the potentiometer as follows:

    a. Verify that +9.375 V is applied to the channel that you want to calibrate, and then enter **C** to continue.

    b. Adjust the value as close as possible to +9.375 V by typing a value between **0** and **255** or by pressing the **+** or **–** key.

    c. Press **Enter** to display the current information for the channel, including the value of the potentiometer and the current reading.

    d. Repeat steps 8b and 8c until the reading is calibrated to +9.375 V.

    e. Press **x** to exit to the main menu.

9. If you chose to calibrate the gain potentiometer in step 4 and selected a gain of 10 in step 3, adjust the potentiometer as follows:

   a. Verify that +0.9375 V is applied to the channel that you want to calibrate, and then enter **C** to continue.

   b. Adjust the value as close as possible to +0.9375 V by typing a value between **0** and **255** or by pressing the **+** or **–** key.

   c. Press **Enter** to display the current information for the channel, including the value of the potentiometer and the current reading.

   d. Repeat steps 9b and 9c until the reading is calibrated to +0.9375 V.

   e. Press **x** to exit to the main menu.

10. Repeat these steps for each gain and sampling frequency for the selected channel.

11. Repeat these steps for each analog input channel.

12. When you have finished calibrating the module, press **X** from the main menu to exit from the program.

Restoring Factory-Calibration Settings

If you wish, you can restore the analog input calibration values for each channel to their original factory settings by selecting **4: Restore all analog input factory calibration settings** from the main menu of the DT7837 Calibration Utility.

Calibrating the Analog Output Subsystem

To calibrate the analog output circuitry, you need to connect an external digital multimeter (DMM) to the analog output channel of the DT7837 module.

The analog output circuitry of the DT7837 module has calibration factors for three output frequency ranges:

- Low: 30 kHz and less than or equal to 54 kHz

- Mid: Greater than 54 kHz to less than or equal to 108 kHz.

- High: Greater than 108 kHz and less than or equal to 216 kHz

Ensure that you calibrate the analog input channel for each output frequency range that you are using.

Do the following to calibrate the analog output circuitry:

1. From the main menu of the program, select **2: Manually calibrate an analog output channel**.

2. Enter **0** to calibrate the offset potentiometer or **1** to calibrate the gain potentiometer.

3. Enter the output frequency that you want to calibrate, in Hertz.
   The current calibration selections are displayed.

4. If the current selections are correct, enter **Y**. To fix an entry, enter **N** to repeat these steps.

5. If you chose to calibrate the offset potentiometer in step 3, adjust the potentiometer as follows:

   a. Connect the DMM to analog output channel 0, and then enter **C** to continue.

   b. Adjust the value that is output to be as close as possible to 0.0000 V by typing a value between **0** and **255** or by pressing the **+** or **–** key.

   c. Press **Enter** to display the current information for the channel, including the value of the potentiometer and the current reading.

   d. Once calibrated, press **x** to exit to the main menu.

6. If you chose to calibrate the gain potentiometer in step 4, adjust the potentiometer as follows:

   a. Connect the DMM to analog output channel 0, and then enter **C** to continue.

   b. Adjust the value that is output to be as close as possible to +9.3750 V by typing a value between **0** and **255** or by pressing the **+** or **–** key.

   c. Press **Enter** to display the current information for the channel, including the value of the potentiometer and the current reading.

   d. Once calibrated, press **x** to exit to the main menu.

7. When you have finished calibrating the module, press **X** from the main menu to exit from the program.

Restoring Factory-Calibration Settings

If you wish, you can restore the analog output calibration values to their original factory settings by selecting **5: Restore all analog output factory calibration settings** from the main menu of the DT7837 Calibration Utility.

A

Specifications

Analog Input Specifications

Table 4 lists the specifications for the analog input subsystem on the DT7837 module. Unless otherwise noted, specifications are typical at 25° C.

Table 4: Analog Input Subsystem Specifications

Feature	DT7837 Specifications
Number of analog input channels	4, single-ended
Resolution	24 bits

Ranges and gains
  Gain of 1:
  Gain of 10:
	
	±10 V
	±1 V

A/D type	Delta Sigma
Data encoding	Two's complement
Input FIFO	8 kSamples
Maximum sample rate	105.469 kS/s
Minimum sample rate	195.3125 S/s
ADC master clock range Sampling frequency < 52.734 kHz: 52.734 kHz to 105.469 kHz:	100 kHz to 27 MHz 512 x sample frequency 256 x sample frequency
Group delay	39/sample rate, in seconds

ADC Delta Sigma filter[a]
  Passband, –3 dB:
  Passband ripple, ±0.005 dB:
  Stopband, –100 dB:
	
	0.49 x sample frequency, Hz
	0.453 x sample frequency, Hz
	0.547 x sample frequency, Hz

Analog filter[a]
  Low pass cutoff, –3 dB:
  High pass cutoff, –3 dB (AC coupling):
	
	400 kHz
	0.5 Hz

Channel-to-channel crosstalk[b] Input Signal = 1 kHz:	 ≤ –121 dB with 50 Ω termination
Input impedance	1 MΩ ‖ 20 pF[c]
Coupling	AC/DC (software-selectable per channel)
IEPE current source	4 mA ±0.5%
IEPE compliance voltage	20 V
IEPE current source noise DC to 1 kHz	 5 nARMS

Table 4: Analog Input Subsystem Specifications (cont.)

Feature	DT7837 Specifications	
DC Accuracy		
Offset error[d]	±1 mV	
Offset error temperature coefficient	±(7.2 µV/° C)/ Gain) ± 100 µV/° C	
Gain error Gain of 1: Gain of 10:	±0.02% ±0.5%	
Gain error temperature coefficient	50 ppm/° C	
ADC Integral Non-Linearity error, INL	±0.0006% of full-scale range	
ADC Differential Non-Linearity error, DNL	Monotonic to 24 bits	
Dynamic Performance[e]	**Gain of 1**	**Gain of 10**
Effective Number of Bits, ENOB[f] (1 kHz input, 105.5 kSPS) −1 dBFS input: −6 dBFS input:	 15 bits 16 bits	 15 bits 16 bits
Signal to Noise and Distortion Ratio, SINAD[g] (1 kHz input, 105.5 kSPS) −1 dBFS input: −6 dBFS input:	 93 dB 92 dB	 93 dB 92 dB
Signal to Noise Ratio, SNR[h] (1 kHz input, 105.5 kSPS) −1 dBFS input: −6 dBFS input:	 97 dB 96 dB	 97 dB 96 dB
Total Harmonic Distortion, THD[i] (1 kHz input, 105.5 kSPS) −1 dBFS input: −6 dBFS input:	 −102 dB −100 dB	 −102 dB −101 dB
Spurious Free Dynamic Range, SFDR[j] (1 kHz input, 105.5 kSPS) −1 dBFS input: −6 dBFS input:	 97 dBFS 103 dBFS	 98 dBFS 102 dBFS
Noise Floor (50 Ω input termination, 105.5 kSPS)	56 µVRMS	65 µVRMS
Overvoltage Protection		
Overvoltage protection Power on: Power off:	+40 V to −20 V ±40 V	
ESD protection Arc: Contact:	8 kV 4 kV	

a. The total frequency response is the combined frequency response of the ADC Delta Sigma filter and the analog filter.

b. Channel 0 is the reference channel with a 20 Vpp signal and a maximum sample rate of 105.469 kSamples/s.

c. Cable capacitance of 30 pF per foot (typical) must be added.

d. Offset errors are referred to the input.

    e. ENOB, SINAD, SNR, THD, and SFDR measurements were made with a 16384 point FFT with a minimum 4-term Blackman Harris window.

    f. Effective Number of Bits (ENOB) is calculated from the SINAD value with adjustment for level below full-scale of the input signal.

$$ENOB = \frac{(SINAD - 1.76 + IBFS)}{6.02}$$

where, IBFS is a positive value in dB, representing the ratio of a full-scale signal to the input signal.

    g. Signal to Noise and Distortion (SINAD) is the ratio of the RMS value of the input signal to the RMS sum of all other spectral components, excluding DC.

    h. Signal to Noise Ratio (SNR) is the ratio of the RMS value of the input signal to the RMS sum of all other spectral components, excluding harmonics and DC.

    i. Total Harmonic Distortion (THD) is the ratio of the RMS value of the input signal to the RMS sum of all harmonics.

    j. Spurious Free Dynamic Range (SFDR) is the ratio of the RMS full-scale range to the RMS value of the largest peak spurious component, including harmonics.

Analog Output Specifications

Table 5 lists the specifications for the analog output subsystem on the DT7837 module. Unless otherwise noted, specifications are typical at 25° C.

Table 5: Analog Output Subsystem Specifications

Feature	DT7837 Specifications
Number of analog output channels	1, single-ended
Resolution	24 bits
D/A type	Delta Sigma
Output range	±10 V
Data encoding	Two's complement
Minimum sample frequency	30 kHz
Maximum sample frequency	216 kHz

D/A master clock range
 	
Sampling Frequency
  30 kHz to 54 kHz:
  54 kHz to 108 kHz:
  108 kHz to 216 kHz:
	13.824 MHz to 27.648 MHz
	
	512 x sample frequency
	256 x sample frequency
	128 x sample frequency

Group delay (typical)	36/sample rate, in seconds

DAC Delta Sigma filter[a]
  Passband, −3 dB:
  Passband ripple, ±0.005 dB:
  Stopband
  Stopband attenuation, −100 dB:
  Stopband attenuation, −95 dB:
  Stopband attenuation, −90 dB:
	
	0.49 x sample frequency, Hz
	0.454 x sample frequency, Hz
	0.546 x sample frequency, Hz
	Sample frequency ≤ 44.1 kHz
	Sample frequency ≤ 96 kHz
	Sample frequency ≤192 kHz

Analog filter[a]	120 kHz, 2-pole, low-pass Butterworth
Output current	±3 mA maximum load (10 V across 3.3 kΩ)
Output FIFO	4 kSamples
Idle channel noise (216 kSPS)	 30 µVRMS

Total Harmonic Distortion, THD[b]
(216 kSPS
  −1 dBFS, 1 kHz output, 3.3 kΩ load:
  −6 dBFS, 1 kHz output, 3.3 kΩ load:
	
	−100 dB
	−110 dB

Spurious Free Dynamic Range, SFDR[b]
(216 kSPS)
  −1 dBFS, 1 kHz output, 1 kΩ load:
  −6 dBFS, 1 kHz output, 1 kΩ load:
	
	102 dB
	118 dB

Offset error	±0.5 mV

Table 5: Analog Output Subsystem Specifications (cont.)

Feature	DT7837 Specifications
Offset error temperature coefficient	130 µV/° C
Gain error	±0.03% of output
Gain error temperature coefficient	55 ppm/° C
ESD protection Arc: Contact:	 8 kV 4 kV

a. The total frequency response is the combined frequency response of the DAC Delta Sigma filter and the analog filter.

b. THD and SFDR measurements were made with a 16384 point FFT with a minimum 4-term Blackman Harris window.

Digital Input Specifications

Table 6 lists the specifications for the digital input signals available on the Digital connector of the DT7837 module.

Table 6: Digital Input Specifications

Feature	Specifications
Number of general-purpose inputs	8
Input type	3.3 V high-speed CMOS, Schmitt trigger, 5 V tolerant
Input termination	22.1 kΩ pull-up resistor to 3.3 V
+ Voltage threshold	2.0 V typical
– Voltage threshold	0.8 V typical
Clocked with sample clock:	Yes, if the digital input port is included in the input data stream (channel/bit 7)

Digital Output Specifications

Table 6 lists the specifications for the digital output signals available on the Digital connector of the DT7837 module.

Table 7: Digital Output Specifications

Feature	Specifications
Number of general-purpose outputs	8
Output type	LVTTL
Logic high output voltage	2.4 V minimum
Logic low output voltage	0.4 V maximum
Logic high output current	–10 mA maximum
Logic low output current	4 mA maximum
Short circuit current	50 mA maximum
Clocked with sample clock	Currently not supported

Tachometer Input Specifications

Table 8 lists the specifications for the tachometer input available on the Digital connector of the DT7837 module.

Table 8: Tachometer Input Specifications

Feature	Specifications
Number of channels	1
Resolution	31 bits per channel
Input voltage range	±30 V
Threshold voltage	+2 V with 0.5 V hysteresis
Input termination	None
Maximum input frequency	1 MHz[a]
Minimum pulse width high/low (minimum amount of time it takes a C/T to recognize an input pulse)	0.4 μs
Clock frequency for tachometer measurements	12 MHz (83 ns resolution)
Overvoltage protection	±30 V
Clocked with sample clock:	Yes, if the tachometer is included in the input data stream (channel/bit 4)

a. Limited by signal integrity and input signal conditioning.

Measure Counter Specifications

Table 9 lists the specifications for the measure counter on the DT7837 module.

Table 9: Measure Counter Specifications

Feature	Specifications
Number of measure counters	1
Resolution	31 bits per channel
Clock frequency for measurement counters	48 MHz (20.8 ns resolution)
Maximum input frequency	10 MHz[a]
Minimum pulse width high/low	50 ns (0.4 μs if the tachometer input is used for the starting edge and stopping edge)
Start and stop signals/edges	A/D conversion complete Tachometer input (falling or rising edge) Digital inputs 0 to 7 (falling or rising edge) C/T 0 Clock input (falling or rising edge) C/T 0 Gate input (falling or rising edge)
Clocked with sample clock:	Yes, if the measure counter is included in the input data stream (channel/bit 6)

a. Limited by signal integrity and input signal conditioning.

General-Purpose Counter/Timer Specifications

Table 8 lists the specifications for the general-purpose counter/timer (C/T 0) on the DT7837 module.

Table 10: General-Purpose Counter/Timer Specifications

Feature	Specifications
Number of general-purpose counter/timers	1

Clock sources
  Internal:
  External:
	
	48 MHz reference clock
	General-purpose inputs 0 to 7 on the Digital connector

Gate sources
  Internal:
  External:
	
	Software
	General-purpose inputs 0 to 7 on the Digital connector

Counter/timer outputs	General-purpose outputs 11 to 18 on the Digital connector
Resolution	32 bits per channel

Clock divider
  Minimum:
  Maximum:
	
	2
	4,294,967,296

Clock output
  Minimum:
  Maximum:
	
	0.0112 Hz
	24 MHz

Maximum clock or gate input frequency	24 MHz[a]
Minimum pulse width (minimum amount of time it takes a C/T to recognize an input pulse)	50 ns
Input voltage range	0 to 3.3 V (+5 V tolerance)

Inputs
  Input logic load:
  High input voltage:
  Low input voltage:
  Low input current:
  Input termination:
	
	1 LVTTL
	2.0 V minimum
	0.8 V maximum
	–0.8 mA maximum
	22 kΩ

Clocked with sample clock:	No

a. The integrity of the signal degrades at frequencies greater than 10 MHz.

Trigger Specifications

Table 11 lists the specifications for the triggers on the DT7837 module.

Table 11: Trigger Specifications

Feature	DT7837 Specifications

Trigger sources
   Internal software trigger:
   External digital trigger:
   Threshold trigger:
	Software-initiated
	Software-selectable, general-purpose inputs 0 to 7 on the Digital connector
	Software-selectable, analog inputs 0 to 3

External trigger (digital)
   Trigger type:
   Input type:
   Input termination:
   + Voltage threshold:
   – Voltage threshold:
   Minimum pulse width high/low:
   Overvoltage protection:
	Edge-sensitive, rising- or falling-edge trigger (software-selectable)
	3.3 V high-speed CMOS, Schmitt trigger, 5 V tolerant
	22.1 kΩ pull-up resistor to 3.3 V
	2.0 V
	0.8 V
	250 ns
	±30 V

Threshold trigger
   Trigger type:
 	
   Threshold level:
   Hysteresis:
	Rising- or falling-edge threshold trigger on any analog input channel
	(software-selectable)
	−10 V to +10 V @ gain of 1; ±1 V @ gain of 10
	100 mV

Trigger delay	1 conversion period maximum

Master Oscillator Specifications

Table 12 lists the specifications for the master oscillator on the DT7837 module.

Table 12: Master Oscillator Specifications

Feature	Specifications
Frequency	48 MHz
Frequency stability	±30 ppm[a]

a. Stability budget consists of initial tolerance, operating temperature range, rated power supply voltage change, load change, 10-year aging, shock, and vibration.

Power, Physical, and Environmental Specifications

Table 13 lists the power, physical, and environmental specifications for the DT7837 module.

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Table 13: Power, Physical, and Environmental Specifications

Feature	DT7837 Specifications
Power	+5 VDC @ 2 A maximum
Warm-up time	1 hour

Physical Dimensions
   Depth:
   Width:
   Height:
   Weight:
	
	6.28 in (159.5 mm)
	3.937 in (100 mm)
	1.30 in (33 mm)
	7.2 oz (204 g)

Environmental
   Operating temperature range:
   Storage temperature range:
   Relative humidity:
   Altitude:
	
	0° C to 55° C
	−25° C to 85° C
	To 95%, noncondensing
	To 10,000 feet

Regulatory Specifications

The DT7837 module is CE-compliant. Table 14 lists the regulatory specifications for the DT7837 module.

Table 14: Regulatory Specifications

Feature	DT7837 Specifications
Emissions (EMI)	FCC Part 15, Class A EN55011:2007 (Based on CISPR-11, 2003/A2, 2006)
Immunity	EN61326-1:2006 Electrical Equipment for Measurement, Control, and Laboratory Use EMC Requirements EN61000-4-2:2009 Electrostatic Discharge (ESD) 4 kV contact discharge, 8 kV air discharge, 4 kV horizontal and vertical coupling planes EN61000-4-3:2006 Radiated electromagnetic fields, 3 V/m, 80 to 1000 MHz; 3 V/m, 1.4 GHz to 2 GHz; 1 V/m, 2 GHz to 2.7 GHz EN61000-4-4:2004 Electrical Fast Transient/Burst (EFT) 1 kV on data cables EN61000-4-6:2009 Conducted immunity requirements, 3 Vrms on data cables 150 kHz to 80 MHz
RoHS (EU Directive 2002/95/EG)	Compliant (as of July 1st, 2006)

Connector Specifications

Table 15 lists the connector specifications for the DT7837 module.

Table 15: Connector Specifications

Connector	Board Reference Designator [a]	Part Number of Connector on Module	Part Number of Mating Connector
Analog input SMA connectors	J1-J5 on I/O block	Amphenol Connex 132203	–
Ethernet (RJ45) connector	J1 on ARM block	Bothhand LU1S041C-43 LF	–
USB host connector	J2 on ARM block	TE Connectivity 292336-1	–
USB device (client) connector	J4 on ARM block	TE Connectivity 292304-2	–
MicroSD connector	J5 on ARM block	Molex 503182-1853	–
External power supply DIN connector:	J6 on ARM block	Kycon KPJX-4S-S	Kycon KPPX-4P
3-Pin header:	TB1 on ARM block	Phoenix Contact 1707434	Phoenix Contact 1839610
Digital connector	J8 on ARM block	TE Connectivity 5499786-6	–
Serial connectors[b]	J12, J13, and J14 on ARM block	FCI 68000-406HLF	–

a. The reference designator indicates the location of the connector on the board. The ARM block is the bottom board and the I/O block is the top board.

b. The optional EP405 USB to Serial TTL cable attaches to connector J13 and the USB port of your computer.

External Power Supply Specifications

Table 16 lists the specifications for the option EP361 +5 V external power supply that is used with the DIN power connector on the DT7837 module.

Table 16: Specifications for the Optional EP361 External Power Supply
Used with the DIN Connector on the DT7837 Module

Feature	Specifications
Type	Total Power medical power supply (TPEMG24-S050400-7)
Input voltage	Typical 90 - 264 V AC
Input current	Typical 0.347 A at 115 V AC, 0.215 A at 230 V AC
Frequency	47 to 63 Hz
Inrush current	6.274 A RMS at 230 V AC
Output voltage	5 V DC
Output current	4.0 A
Output wattage	Typical 20 - 24 W
Noise and ripple	1% peak to peak
Regulatory specifications	UL, ITE, CE, FCC Class B, Energy Star compliant

Table 17 lists the specifications for the external power supply that is used with the 3-position header on the DT7837 module.

Table 17: Specifications for the External Power Supply
Used with the 3-Position Header on the DT7837 Module

Feature	Specifications
Output voltage	5 VDC to
Output current	2 A with 4 A surge capability
Noise and ripple	50 mVpp

B

Connector Pin Assignments and LED Status Indicators

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Analog Input Connectors

Figure 14 shows the layout of the analog input SMA connectors (connectors J1-J4) on the I/O block (top board) of the DT7837 module.

Channel n Analog In

Channel n Analog In Return
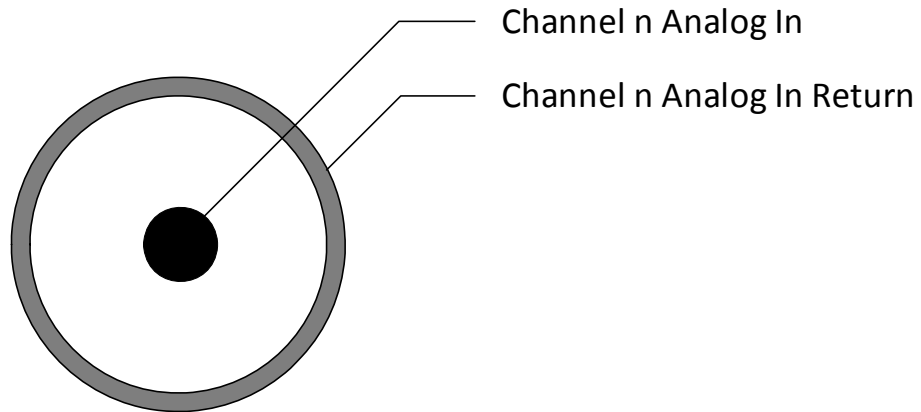
Figure 14: Analog Input Connectors

Analog Output Connectors

Figure 15 shows the layout of the analog output SMA connectors (connector J5) on the I/O block (top board) of the DT7837 module.

Channel n Analog Out

Channel n Analog Out Return
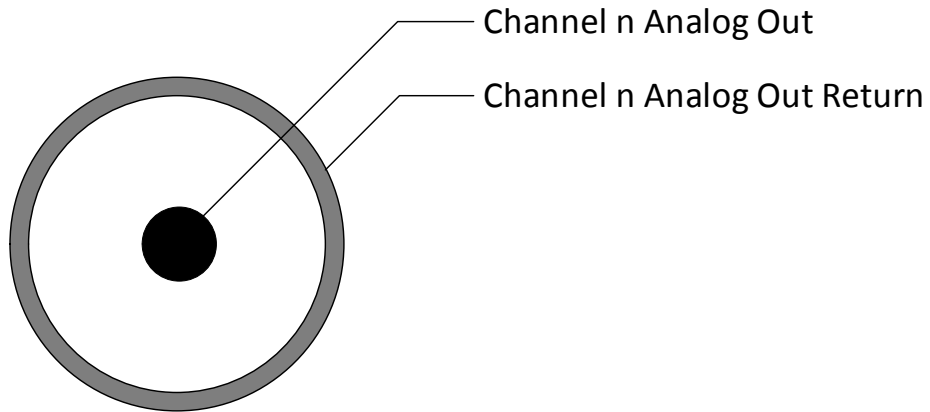
Figure 15: Analog Output Connector

Digital Connector

Figure 16 shows the layout of the 26-pin Digital connector (J8) on the ARM block (bottom board) of the DT7837 module. This connector brings out the tachometer, and GPIO signals for the module.
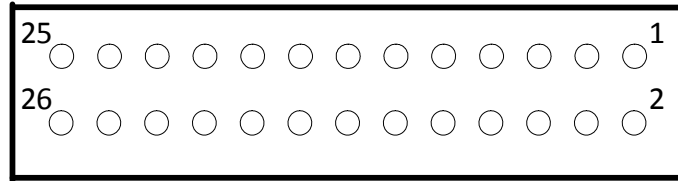
Figure 16: Layout of the Digital Connector

Table 18 lists the pin assignments for the Digital connector on the DT7837 module.

Table 18: Pin Assignments for the Digital Connector

Connector Pin Number	Signal Description	Connector Pin Number	Signal Description
1	General Purpose Input 0[a]	14	General Purpose Output 3[b]
2	General Purpose Input 1[a]	15	General Purpose Output 4[b]
3	General Purpose Input 2[a]	16	General Purpose Output 5[b]
4	General Purpose Input 3[a]	17	General Purpose Output 6[b]
5	General Purpose Input 4[a]	18	General Purpose Output 7[b]
6	General Purpose Input 5[a]	19	Digital Ground
7	General Purpose Input 6[a]	20	Digital Ground
8	General Purpose Input 7[a]	21	Reserved
9	Digital Ground	22	Digital Ground
10	Digital Ground	23	Tachometer input
11	General Purpose Output 0[b]	24	Digital Ground
12	General Purpose Output 1[b]	25	+5 V
13	General Purpose Output 2[b]	26	Digital Ground

a. The input signals are +5 V tolerant and 22 kΩ pull-ups are provided. By default, they are configured as digital input signals. By default, these signals are configured as digital input signals.

b. The output signals are driven by LVTTL buffers and are capable of providing up to ±24 mA of drive current at standard LVTTL levels. By default, they are configured as digital output signals.

Using software, you can specify a general-purpose input signal as the signal source for the following destinations:

- Digital input (the default signal for each general-purpose input pin)

- External A/D trigger input

- Gate input for the general-purpose counter/timer (C/T 0)

- Clock input for the general-purpose counter/timer (C/T 0)

Using software, you can specify a general-purpose output signal as the signal source for one of these destinations:

- Digital output (the default signal for each general-purpose output pin)

- Clock output for the general-purpose counter/timer (C/T 0)

Note that a single general-purpose input may drive several destinations at the same time. However, a single general-purpose output can have only one driving source.

USB Device (Client) Connector

Figure 17 shows the layout of the USB device (client) connector (J4) on the ARM block (bottom board) of the DT7837 module. This is a type B connector.
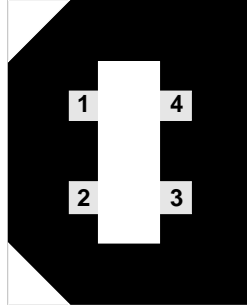
Figure 17: Layout of the USB Type B Connector for the USB Device (Client) Port

Table 19 lists the pin assignments for the USB type B connector on the DT7837 module for the USB device (client) port.

Table 19: Pin Assignments for the USB Type B Connector for the USB Device (Client) Port

Connector Pin Number	Signal Description	Connector Pin Number	Signal Description
1	USB +5 V	3	USB Data +
2	USB Data –	4	USB Ground

Note: The outer shell provides cable shield to chassis ground.

USB Host Connector

Figure 17 shows the layout of the USB host connector (J2) on the ARM block (bottom board) of the DT7837 module. This is a type A connector.
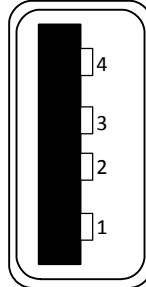
Figure 18: Layout of the USB Type A Connector for the USB Host Port

Table 20 lists the pin assignments for the USB type A connector on the DT7837 module for the USB host port.

Table 20: Pin Assignments for the USB Type B Connector for the USB Device (Client) Port

Connector Pin Number	Signal Description	Connector Pin Number	Signal Description
1	USB +5 V	3	USB Data +
2	USB Data –	4	USB Ground

Note: The outer shell provides cable shield to chassis ground.

Ethernet Connector

Figure 17 shows the layout of the Ethernet (RJ45) connector (J1) on the ARM block (bottom board) of the DT7837 module.
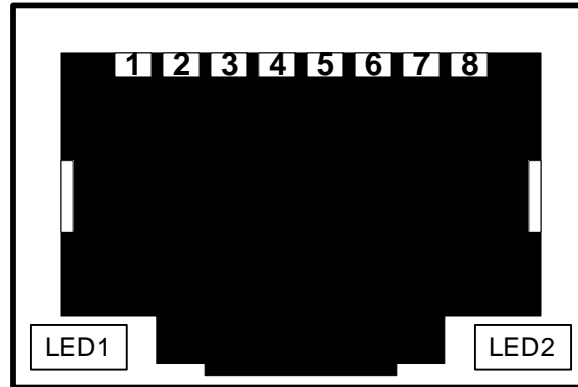
Figure 19: Layout of the Ethernet Connector

Table 21 lists the pin assignments for the Ethernet connector on the DT7837 module.

Table 21: Pin Assignments for the Ethernet Connector

Connector Pin Number	Signal Description	Connector Pin Number	Signal Description
1	Transmit+	5	Not connected
2	Transmit–	6	Receive–
3	Receive+	7	Not connected
4	Not connected	8	Not connected
LED1	Activity (green)	LED2	Link (yellow)

Note: The outer shell provides cable shield to chassis ground.

External +5 V Power Connector

The DT7837 module provides two connectors for attaching a +5 VDC external power supply: a DIN connector and a 3-position Phoenix header.

Figure 20 shows the layout of the DIN power connector (J6) on the ARM block (bottom board) of the DT7837.
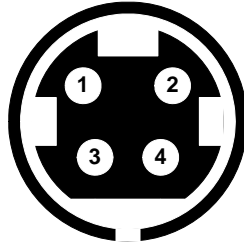
Figure 20: Layout of the DIN Power Connector

Table 22 lists the pin assignments for the external DIN power connector on the DT7837 module.

Table 22: Pin Assignments for the External Power Connector

Connector Pin Number	Signal Description	Connector Pin Number	Signal Description
1	+5 VDC	2	+5 VDC
3	Ground	4	Ground

You can connect the optional EP361 power supply to the DIN connector, if desired. Refer to page 78 and page 79 for detailed specifications of this power supply.

Figure 21 shows the layout of the 3-pin Phoenix header (TB1) on the ARM block (bottom board) of the DT7837 module.

Terminal 2

Terminal 1 | **Terminal 3**
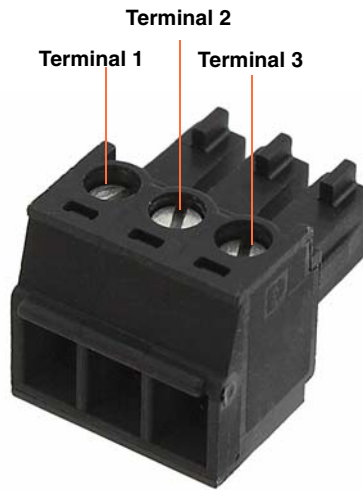
Figure 21: Layout of the 3-Position Phoenix Header

Table 23 lists the terminal assignments for the 3-position header on the DT7837 module.

Table 23: Terminal Assignments for the 3-Position Header (TB1) on the DT7837 Module

Terminal Number	Signal Description
1	+5 VDC
2	Digital Ground
3	Chassis Ground

Note that you must connect an external power supply to this header that meets the specifications described on page 80.

Serial Connectors

Figure 17 shows the layout of the 6-pin serial connectors (J12, J13, and J14) on the ARM block (bottom board) of the DT7837 module.
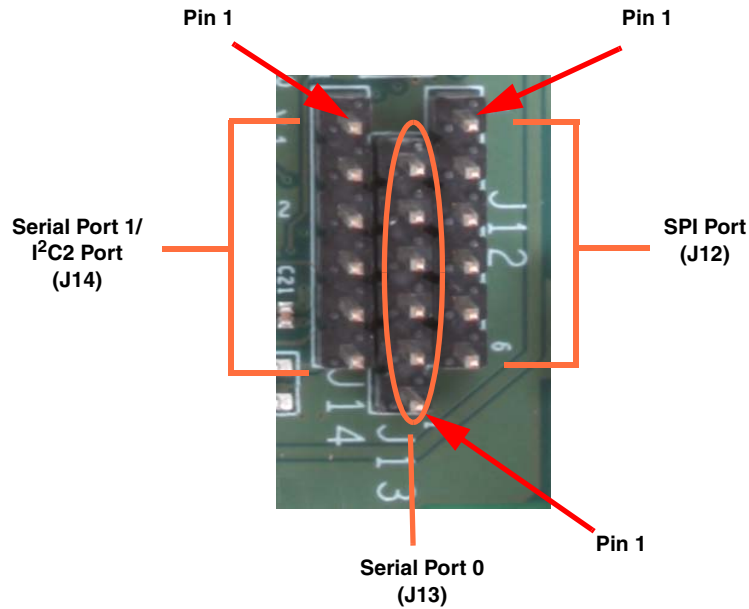
Figure 22: Layout of the Serial Connectors

These connectors are described in the sections that follow.

Serial Port 0 (UART 0)

Figure 17 shows the layout of the Serial port 0 (J13) on the ARM block (bottom board) of the DT7837 module.
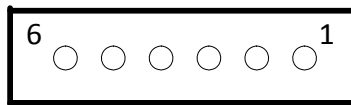
*Note that the pin order of connector J13 is reversed from connectors J12 and J14.

Figure 23: Layout of Serial Port 0 (J13)

Table 24 lists the pin assignments for serial port 0 on the DT7837 module.

Table 24: Pin Assignments for Serial Port 0 (J13) on the DT7837 Module

Connector Pin Number	Signal Description
1	DGND
2	Not Connected
3	Not Connected
4	UART0_RX
5	UART0_TX
6	Not Connected

SPI Connector

Figure 17 shows the layout of the SPI connector (J12) on the ARM block (bottom board) of the DT7837 module.
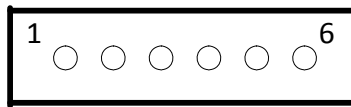
Figure 24: Layout of SPI Connector (J12)

Table 25 lists the pin assignments for the SPI connector on the DT7837 module.

Table 25: Pin Assignments for SPI Connector (J12) on the DT7837 Module

Pin Number	Signal Description
1	SPI1_D0
2	SPI1_SCLK
3	SPI1_CS0
4	SPI1_D1
5	DGND
6	+3.3 V

Serial Port 1 / I²C2 Connector

Figure 17 shows the layout of the Serial port 1/ I²C2 connector (J14) on the ARM block (bottom board) of the DT7837 module.
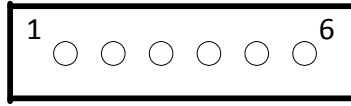
Figure 25: Layout of Serial Port 1 / I²C Port (J14)

Table 26 lists the pin assignments for the Serial port 1/ I²C connector on the DT7837 module.

Table 26: Pin Assignments for Serial Port 1 / I²C Connector (J14) on the DT7837 Module

Pin Number	Signal Description
1	UART1_RX
2	UART1_TX
3	I²C2_SDA
4	I²C2_SCL
5	DGND
6	+3.3 V

STP26 Screw Terminal Panel

The STP26 contains one 26-pin connector and a screw terminal block (TB1). The 26-pin connector provides access to the signals from the Digital connector on the DT7837 module.

Figure 26 shows the layout of the STP26 screw terminal panel.
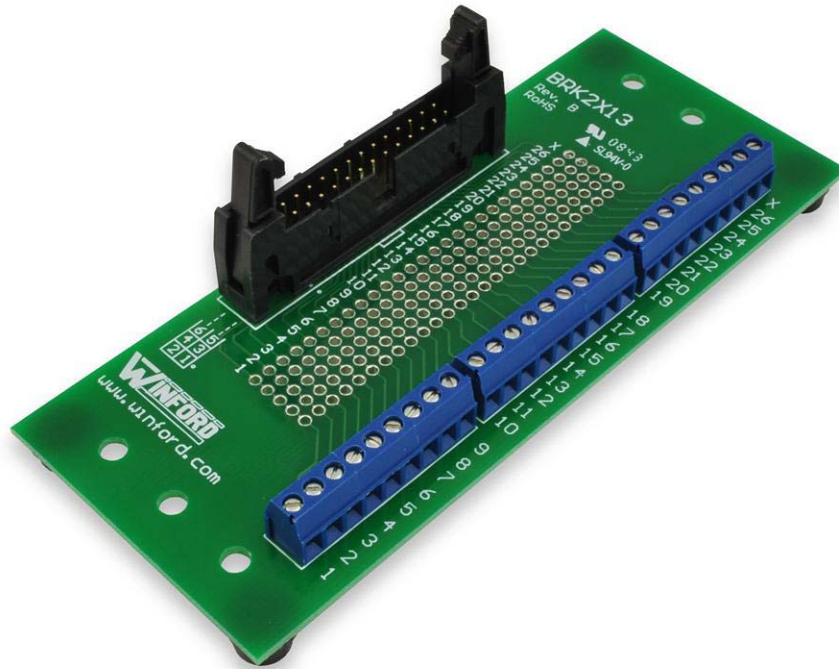
Figure 26: Layout of the STP26 Screw Terminal Panel

Table 27 lists the screw terminal assignments for the STP26 screw terminal panel.

Table 27: Screw Terminal Assignments for the STP26 Screw Terminal Panel

Screw Terminal	Signal Description
X	Shield
26	Digital Ground
25	+5 V
24	Digital Ground
23	Tachometer Input
22	Digital Ground
21	Reserved for future use
20	Digital Ground
19	Digital Ground
18	General-Purpose Output 7
17	General-Purpose Output 6
16	General-Purpose Output 5
15	General-Purpose Output 4
14	General-Purpose Output 3
13	General-Purpose Output 2
12	General-Purpose Output 1
11	General-Purpose Output 0
10	Digital Ground
9	Digital Ground
8	General-Purpose Input 7
7	General-Purpose Input 6
6	General-Purpose Input 5
5	General-Purpose Input 4
4	General-Purpose Input 3
3	General-Purpose Input 2
2	General-Purpose Input 1
1	General-Purpose Input 0

LED Status Indicators

The DT7837 module has a Power LED indicator on the ARM block (bottom board) and trigger LEDs on the I/O block (top board), as shown in Figure 27.

Input Trigger LED

Output Trigger LED
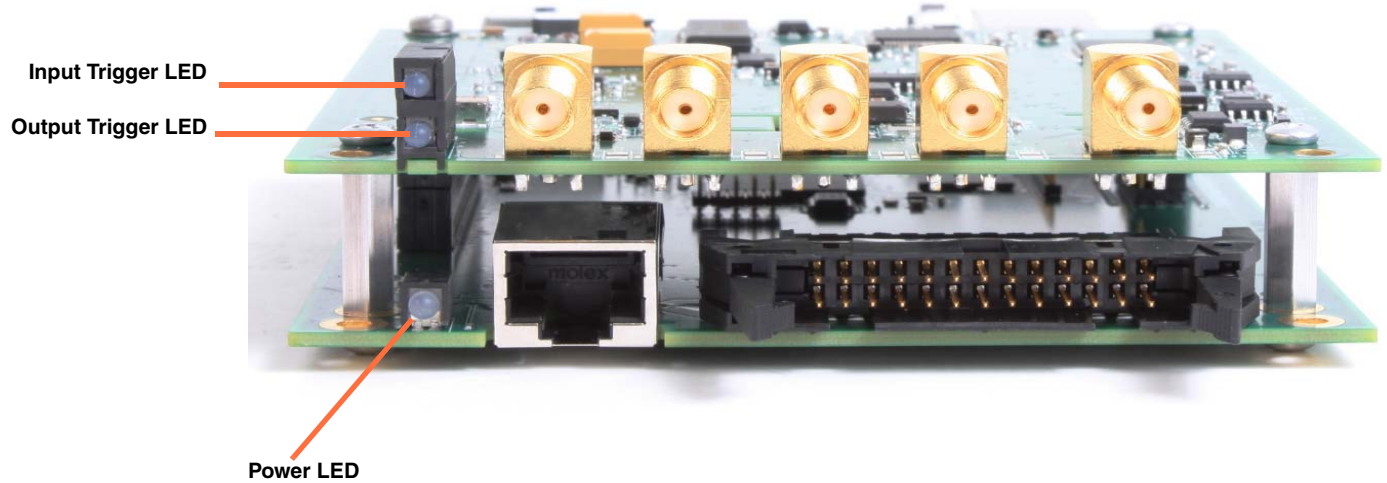
Power LED

Figure 27: Power LED on the DT7837 Module

The status LEDs are described in Table 28.

Table 28: LED Status Indicators on the DT7837 Module

LED	Color of the LED	Status Description
Input Trigger LED	Off	Idle.
	Solid amber	Input subsystem armed; it is waiting for an external digital trigger or threshold trigger (the module must have been configured for one of these trigger types).
	Solid green	Input subsystem has been triggered.
Output Trigger LED	Off	Idle.
	Solid amber	Output subsystem armed; it is waiting for an external digital trigger or threshold trigger (the module must have been configured for one of these trigger types).
	Solid green	Output subsystem has been triggered.
Power LED	Off	Power off.
	Solid green	Power on.

User LEDs

The DT7837 has eight user LEDs, shown in Figure 28, on the ARM block (bottom board). Header J10, also shown in Figure 28, provides debug pins that correspond to the user LEDs. The value of a debug pin reflects the state of the corresponding user LED, where the pin has a value of 0 if the LED is off or a value of 1 if the LED is on.

Debug Pins (Pin 10 is right-most; Pin 1 is left-most)

User LEDs (LED 0 is right-most; LED 7 is left-most)
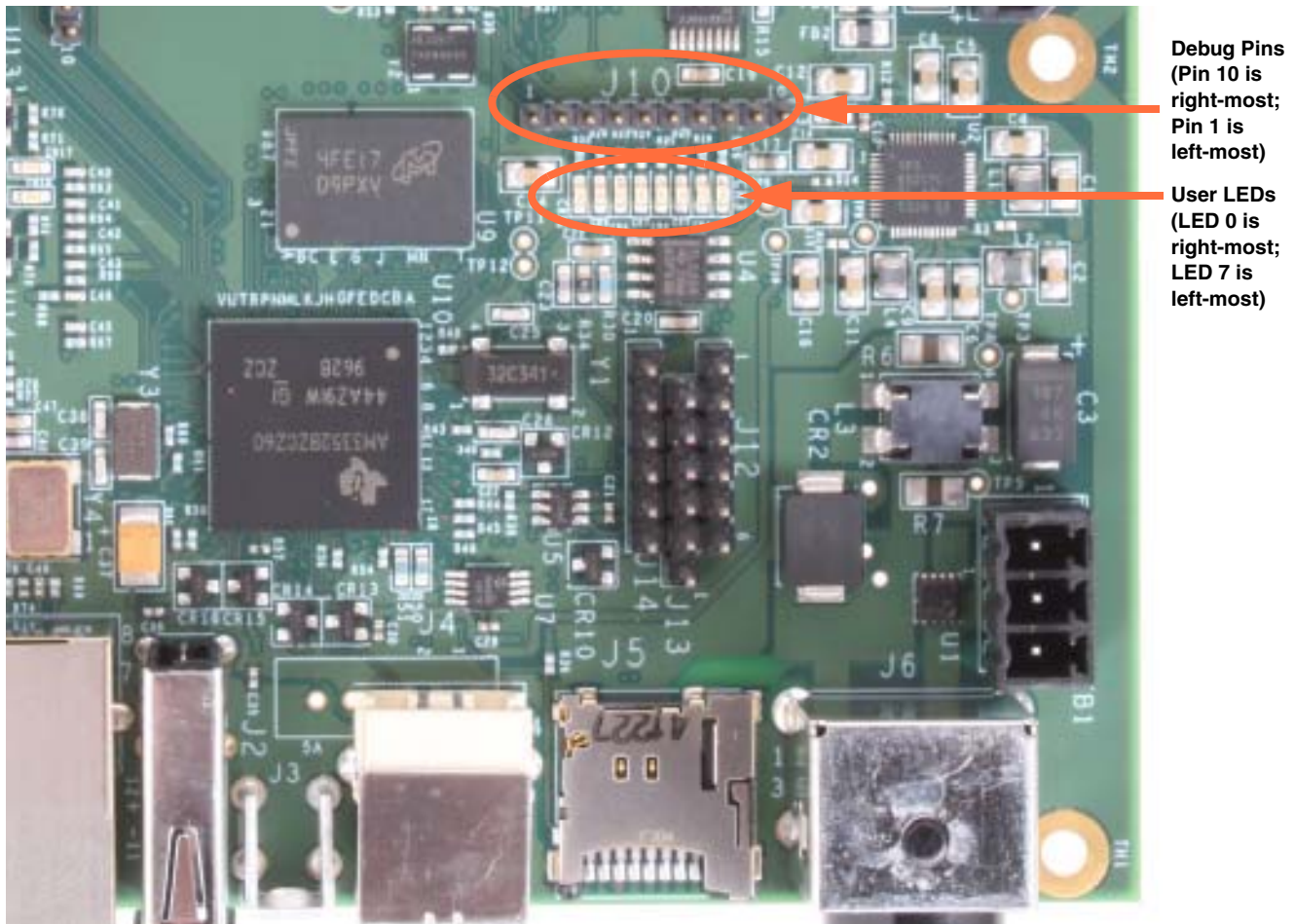
Figure 28: User LEDs and Debug Pins on the DT7837 Module

Table 29 lists the pin descriptions of header J10 on the DT7837.

Table 29: Debug Pins of Header J10

Pin	Pin Description
1	Debug_D7; corresponds to user LED 7.
2	Debug_D6; corresponds to user LED 6.
3	Debug_D5; corresponds to user LED 5.
4	Debug_D4; corresponds to user LED 4.
5	Debug_D3; corresponds to user LED 3.
6	Debug_D2; corresponds to user LED 2.
7	Debug_D1; corresponds to user LED 1.
8	Debug_D0; corresponds to user LED 0.
9	Digital Ground
10	Digital Ground

Using file I/O commands, you can turn the user LEDs either on or off. Refer to the *DT7837 File I/O Programming Manual* for more information.

Index

Symbols

Numerics

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