QUANSER
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Q8-USB Data Acquisition Board

User Manual

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1. Introduction

Quanser's Q8-USB Hardware-in-the-Loop (HIL) control board is a high-performance data acquisition and control solution. This robust single-board solution was developed as a portable solution and with a simple installation as an alternative to our equally powerful PCI and PCIe products. When combined with a Quanser Power Amplifier and the QUARC software, Q8-USB provides an ideal rapid prototyping and Hardware-in-the-Loop development environment. Key features include:

- Functions with QUARC or custom code
- No expensive or inflexible DSP used, all processing via CPU
- Quick-connect terminal board and cabling provided
- Robust metal case
- Watchdog timer for maximum safety and flexibility
- Multiple OS compatibility: Windows XP, Windows Vista, Windows 7

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

2. Specifications

The feature summary of the Q8-USB data acquisition board (DAQ) is listed below followed by the detailed specifications:

- USB 2.0 Hi-Speed Interface
- 8 digital inputs
- 8 digital outputs also configurable as 8 pulse-width modulated (PWM) outputs
- 8 16-bit analog to digital converters (ADC's) with configurable ranges
- 8 16-bit digital to analog converters (DAC's) with configurable ranges
- 8 single-ended encoder inputs with non-quadrature and 4X quadrature decoding with optional filtering, and hardware measured encoder velocities.
- Known state of analog outputs, PWM outputs and digital I/O on power-up or reset
- Configurable state of analog, PWM and digital outputs on watchdog expiry
- Duty cycle, frequency, period, one-shot, active pulse time, and encoder emulation PWM modes supported in unipolar, paired and complementary configurations.
- External interrupt, ADC conversion, watchdog lines with configurable polarities
- Target support for Quanser QUARC Windows target and NI LabVIEW
- OS Drivers: Microsoft Windows XP, Windows Vista, Windows 7
- API: C, C++, ActiveX, .NET (Visual Basic, C#, C++ and others), LabVIEW, MATLAB, and Simulink

Analog Input Specifications	*Value*
Number of channels	8
Resolution	16-bit
Conversion time for all 8 channels	4us†
Input impedance	1MΩ
Input range	±5 V, ±10 V
Max full scale range (FSR) error	±12 LSB, ±6 LSB
Input filter bandwidth (-3dB)	15 kHz, 23 kHz

Table 1: Q8-USB analog input specifications

† The effective conversion time will be limited by the USB communications at a 125µs clock rate

Analog Output Specifications	*Value*
Number of channels	8
Resolution	16-bit
Output voltage range	±10.8 V†, ±10 V, ±5 V, 10.8 V†, 10 V, 5 V.
Slew rate	3.5 V / µs
Integral non-linearity (INL)	± 1 LSB
Differential non-linearity (DNL)	± 16 LSB
Max full scale range (FSR) error	± 65 LSB
Conversion time (to within FSR error)	10 µs‡
Short-circuit current clamp	20 mA
Max load for specified performance	2 kΩ
Max capacitive load stability	4000 pF
DC output impedance	0.5 Ω

Table 2: Q8-USB analog output specifications

† NOTE: The maximum ADC input range is ±10V so do not connect the DAC's directly to the ADC's when this voltage range is used.

‡ The effective conversion time will be limited by the USB communications at a 125µs clock rate

Digital Input Specifications	*Value*
Number of digital input lines	8
Input low	1.50 V
Input high	3.50 V
Input leakage current	± 2 µA

Table 3: Q8-USB digital input specifications

Digital Output Specifications	*Value*
Number of digital I/O Lines	8
Output low (Max at max current)	0.55 V
Output high (Min at max current)	4.50 V
Maximum drive current per pin	± 32 mA
Maximum total drive current of all pins	± 100 mA

Table 4: Q8-USB digital output specifications

Encoder Input Specifications	*Value*
Number of encoder inputs	8
Input low	1.50 V
Input high	3.50 V
Input leakage current	± 2 µA
Max. A and B frequency in quadrature (no filtering)	24.883 MHz
Max. count frequency in 4X quadrature (no filtering)	99.532 MHz
5V total source current for all 8 encoders (shared with the 5V pin on the control header)	800 mA
Encoder velocities	99.532 MHz

Table 5: Q8-USB encoder input specifications

PWM Output Specifications	*Value*
Number of PWM outputs	8†
Minimum frequency	23.7309 Hz
Maximum frequency	49.766 MHz
Bits resolution	16 bits‡
Drive specifications	See digital output specifications

Table 6: Q8-USB PWM output specifications

† Shared with the digital outputs
‡ This is dependent on the frequency selected for the PWM

Control Header Specifications	*Value*
+5V source current (shared with with the 5V pins on the encoder connections)	800mA

Table 7: Q8-USB special feature specifications

3. Q8-USB Installation

3.1. Hardware Installation

The Q8-USB consists of the DAQ board, a USB 2.0 cable, a power supply, and a power cable.

1. Read all instructions before proceeding.
2. Install QUARC 2.1 or later (be sure to accept the installation of any drivers if the installer warns you that they are not signed).
3. **After** the installation of QUARC is complete, you can plug the DAQ into any USB 2.0 port. For the most consistent sample times, it is preferable to use a USB hub that is not occupied by any other USB devices.
4. Plug barrel connector of the power adapter into the Q8-USB, and the 120V/240V input into a wall outlet.
5. Follow the driver installation instructions for your operating system in sections 3.2. to 3.4.

Figure 1: Q8-USB DAQ board

Figure 2: USB 2.0 cable

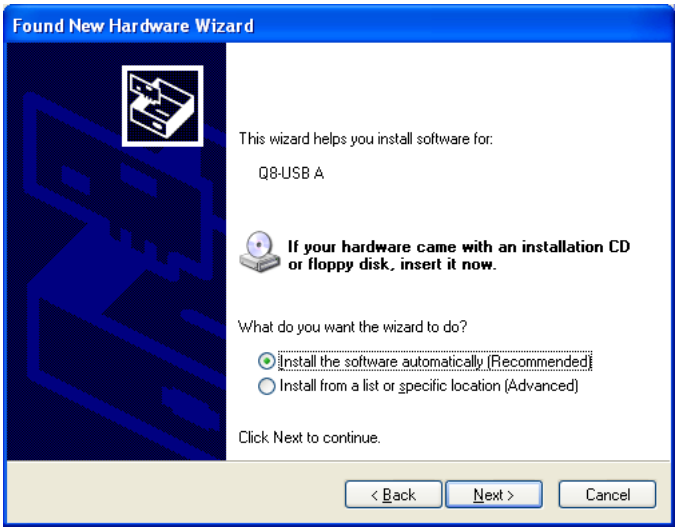
Figure 3: Power supply

Figure 4: Power cable

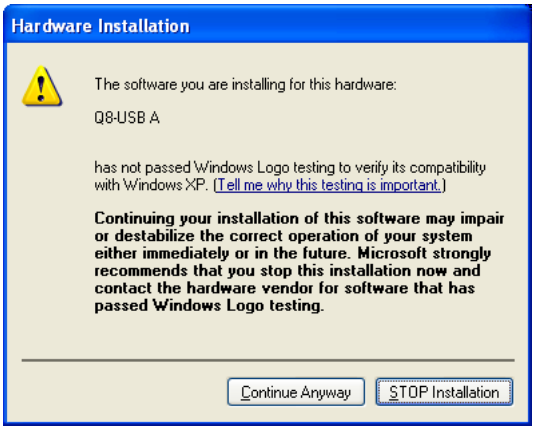
3.2. Driver Installation for Windows XP

After you plugging in the Q8-USB for the first time, the Found New Hardware Wizard should pop up. Select *No, not this time* and click Next.

On the next screen, select the option to Install the software automatically (Recommended) and click Next to start the installation.



The installation should automatically start and eventually identify the DAQ as a Q8-USB A. A window may pop up telling you that this driver has not been passed by the Windows Logo testing program. Click Continue Anyway.

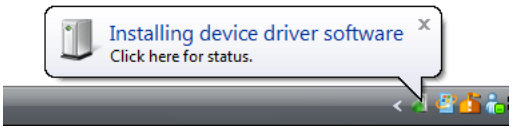


Finally, the installation process should say that it has finished installing the software for the Q8-USB A.

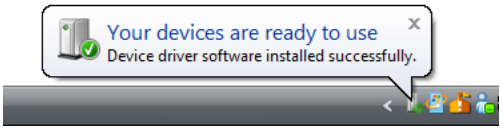
This process will then be repeated a **second** time for **Q8-USB B**. Follow the same procedure. Once the drivers for both Q8-USB A and B have been installed, your DAQ is ready for use.

3.3. Driver Installation for Windows Vista

The driver for the Q8-USB is preinstalled during the QUARC installation. After you plug in the device for the first time, a pop-up balloon will indicate that it is searching for the driver.

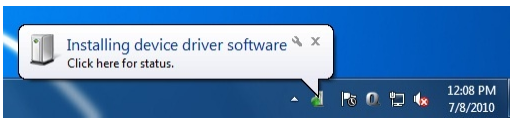


Upon completion, Vista will notify you that the device is ready for use.

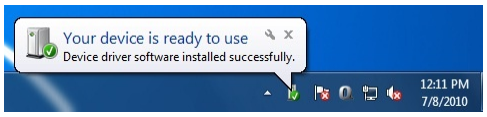


3.4. Driver Installation for Windows 7

The driver for the Q8-USB is preinstalled during the QUARC installation. After you plug in the device for the first time, a pop-up balloon will indicate that it is searching for the driver.



Upon completion, Windows will notify you that the device is ready for use.



3.5. The Q8-USB Interface

The components on the Q8-USB are depicted in Figure 5. Each component on the board has an identification number that corresponds to a short description given in Table 8.

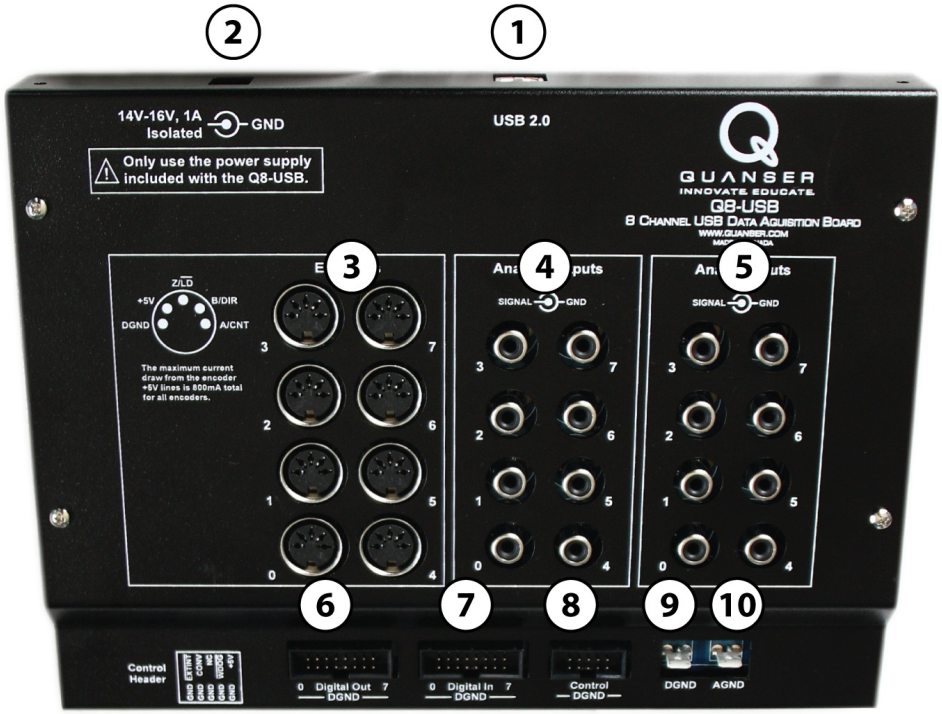


Figure 5: Q8-USB

ID #	*Description*	*ID #*	*Description*
1	USB connector	**6**	Digital output connector
2	Power connector	**7**	Digital input connector
3	Encoder input connectors	**8**	Control header
4	Analog output connectors	**9**	Digital ground lug
5	Analog input connectors	**10**	Analog ground lug

Table 8: Q8-USB Components.

A standard USB Type-B connection is used to connect from the Q8-USB port (ID #1) to a standard USB Type-A on a computer.

Power is connected using the barrel connector (ID #2). It is highly recommended that you only use the power adapter supplied with the Q8-USB. Please contact technical support if you need a replacement. The input is rated for 14V-16V at 1A. Only isolated power supplies such as the one included with the Q8-USB should be used. A non-isolated supply can result in ground loops that can damage the Q8-USB and/or the connected computer.

The pinout for the encoder DIN connectors (ID #3) is indicated on the case. The encoders plus the +5V on the control header can draw a collective total of current up to 800mA at 5V.

The analog outputs are standard RCA connectors (ID #4). The outputs can output up to +/-10V with the specified performance at a maximum of 5mA per channel. A 20mA short-circuit clamp is in place for circuit protection.

The analog inputs are standard RCA connectors (ID #5). The inputs can receive signals with a maximum +/-10V amplitude.

The digital output (DO) header (ID #6) has the pins on one side connected to digital ground, as indicated on the terminal board case. DO0-DO7 output 0V to 5V. Each pin can drive up to 32mA, but the maximum total current for all eight pins cannot exceed 100mA. The digital outputs can also be configured as PWM outputs.

The digital input (DI) header (ID #7) has the pins on one side connected to digital ground, as indicated on the terminal board case. DI0-DI7 can input 0V to 5V logic.

The control header (ID #8) provides access to the watchdog state, inputs for an external interrupt and to trigger conversions (see Figure 6 for pin locations). The details of the pin functions are outlined in Table 9.

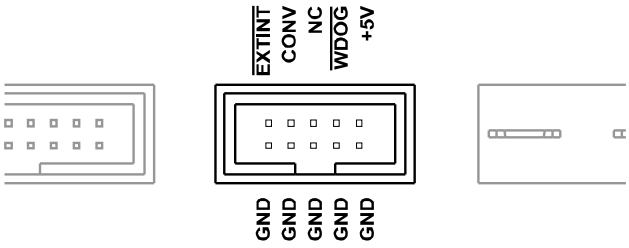


Figure 6: The control header pins.

Signal	*Full name*	*Description*
$\overline{\text{EXTINT}}$	External interrupt	Triggers an interrupt in the model when the configured edge change is detected.
CONV	Convert	Triggers a conversion to synchronize your sample with an external event or as a hardware timebase input depending on the configuration.
NC	No connect	This pin is not connected to any internal circuits.
$\overline{\text{WDOG}}$	Watchdog	When the watchdog timer expires, this line will go to the configured watchdog expiry state.
+5V	+5V source up to 800mA	This is a 5V source for user circuits. Note that the maximum current is shared with the current drawn by any attached encoders.

Table 9: The control header pin descriptions.

The digital ground lug (ID #9) is connected to the digital ground plane. It is provided as a digital ground reference for testing and rapid prototyping purposes.

The analog ground lug (ID #10) is connected to the analog ground plane. It is provided as an analog ground reference for testing and rapid prototyping purposes.

4. Using the Q8-USB

Refer to the MATLAB Help page under QUARC Targets/User's Guide/Accessing Hardware. In the HIL Initialize Block, the Board Type will be listed as q8_usb.

Refer to the MATLAB Help pages under QUARC Targets/User's Guide/QUARC Data Acquisition Card Support/Quanser Cards/Q8-USB.

LabVIEW Help pages are accessible from your Start Menu under Quanser/QUARC/Quanser LabVIEW VIs. Refer to the "Quanser Hardware-in-the-Loop for LabVIEW" section.

5. Obtaining Support

Note that a support contract may be required to obtain technical support. To obtain support from Quanser, go to http://www.quanser.com and click on the *Tech Support* link. Fill in the form with all requested software and hardware information and a description of the problem encountered. Be sure to include your email address and a telephone number where you can be reached. A qualified technical support person will contact you.

6. References

[1] QUARC User Manual (type `doc quarc` in MATLAB to access).