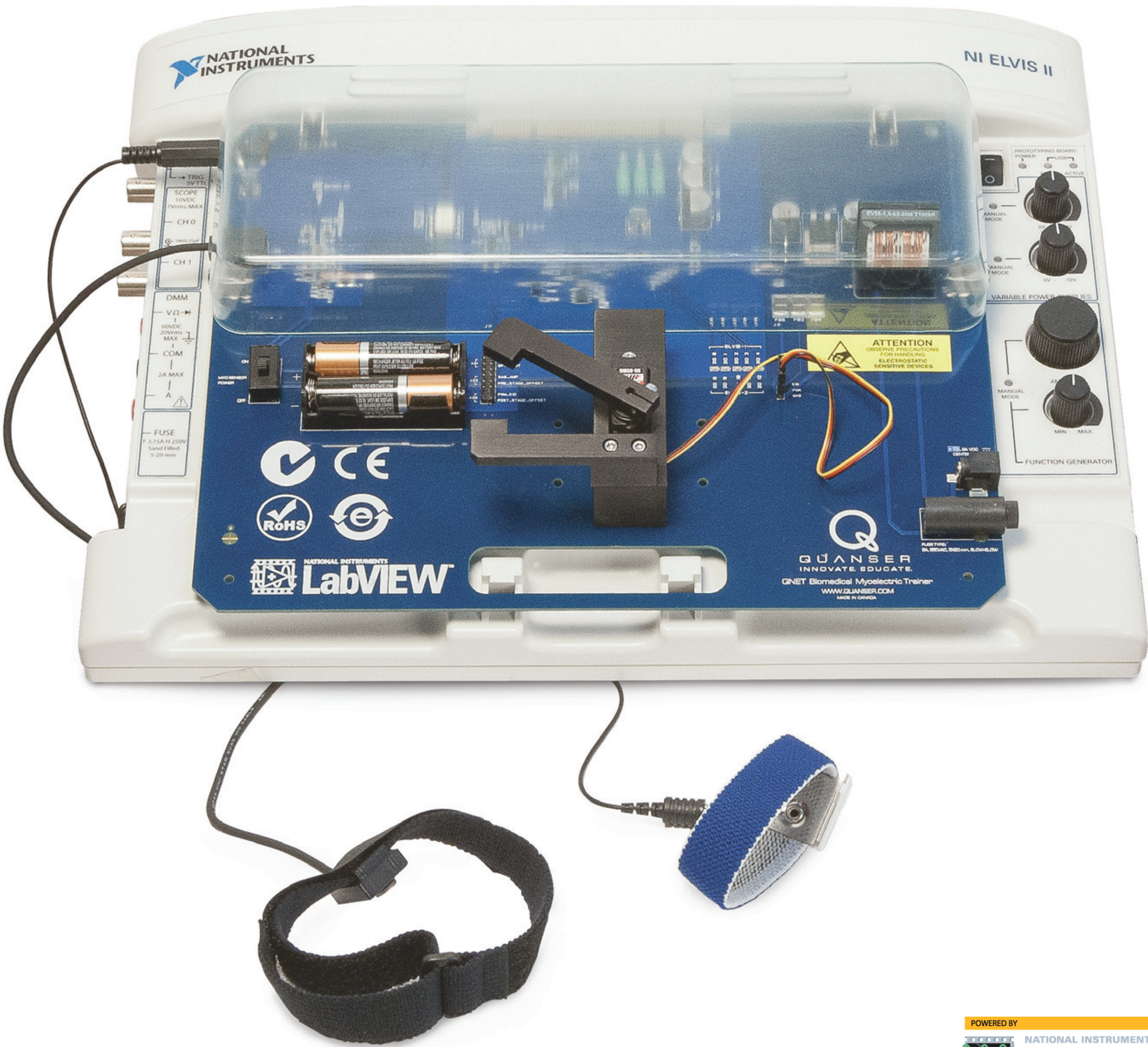
USER MANUAL

QNET Myoelectric Trainer for NI ELVIS

Set Up and Configuration



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Quanser Inc.
119 Spy Court
Markham, Ontario
L3R 5H6
Canada
info@quanser.com
Phone: 1-905-940-3575
Fax: 1-905-940-3576

Printed in Markham, Ontario.

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Contents

1 INTRODUCTION

The Myoelectric Trainer (MYOELECTRIC) is designed to teach and demonstrate the fundamentals of processing electromyographic signals. The system can be configured to utalize a veriety of filtering and control methods to process the muscular signals and control the position of the clamps on the servo. In particular, the system can be used to teach linear envelope filtering, zero-order hold, position control and the basics of LabVIEW coding. This is done using a PC with real-time control capabilities and the NI ELVIS II. The hardware of the MYOELECTRIC trainer is described in Section 2. A schematic of the hardware components is included in Section 3, and the specifications are listed in Section 4 and Section 5. Some helpful LabVIEW hints when using the QNET VIs are given in Section 7 along with a troubleshooting guide in Section 8.

Figure 1.1: QNET Myoelectric Trainer (MYOELECTRIC)

2 SYSTEM DESCRIPTION

2.1 MYOELECTRIC COMPONENTS

The components comprising the Myoelectric Trainer are labeled in Figure 2.2, and are described in Table 1.

■ **Caution:** Ensure the trainer is setup as dictated in the *QNET Setup Guide*. The trainer is susceptible to protection impairment if not used as specified.

ID#	Description	ID#	Description
1	Ground Strap Connector	9	+15V, -15V, +5V LEDs
2	EMG Sensor Connector	10	Servo Motor Connector
3	EMG Power On/Off SW2 Switch	11	Servo Motor
4	Battery Power Supply for EMG	12	Servo Clamps
5	PCI connector to NI ELVIS: for interfacing QNET module with DAC	13	15V QNET power jack
6	AD1 Jumper	14	EMG sensor strap
7	AD2 Jumper	15	Grounding strap
8	AD5 Jumper	16	Fuse

Table 1: Myoelectric component nomenclature

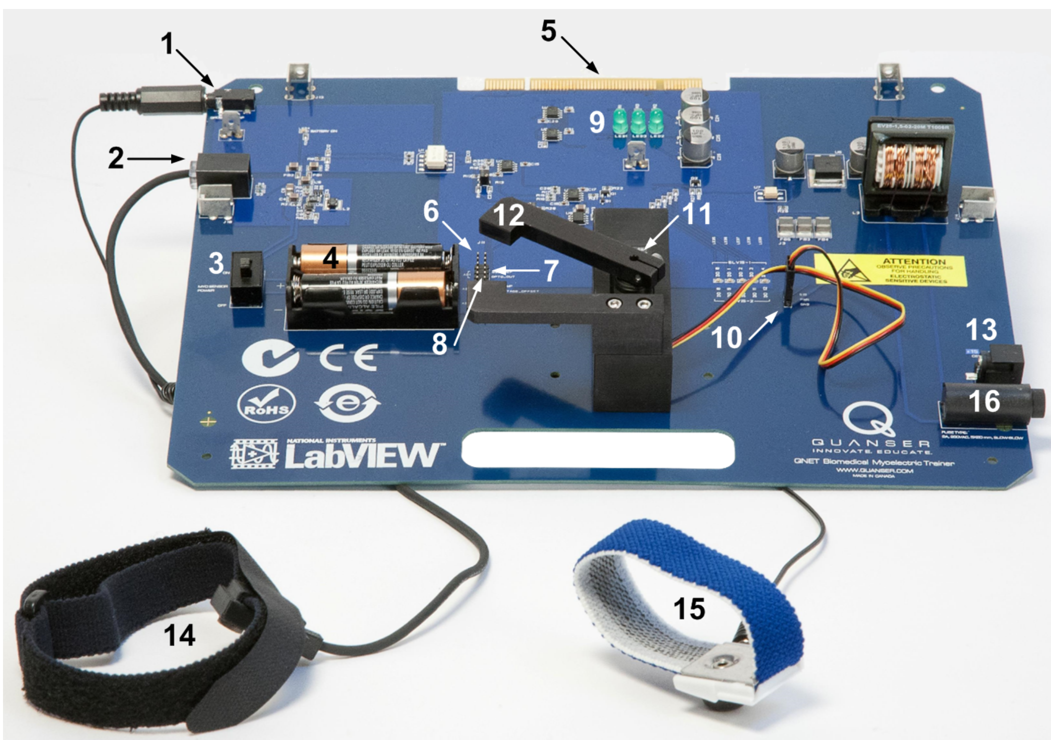

Figure 2.2: General layout of QNET MYOELECTRIC

2.1.1 Servo Motor

The servo motor supplied with the QNET Myoelectric trainer is controlled by a PWM signal and has an operating range of 4.8-6.0 V, as given in Table 2.

2.1.2 Isolation Amplifier

The HCPL-7800 optical isolation amplifier is used to amplify the electromyogram signal measured by the EMG electrode, remove noise, and isolate the power source from the user. See the Opto Isolation block in Figure 3.4. The amplifier has a gain of 8.0 V/V and its output voltage ranges between 1.29 V and 3.8 V. The output of the isolation amplifier can be measured on A/D #1 when the DIP switch is set to OPTO_OUT.

2.1.3 Muscle Contraction Measurement: EMG Sensor

The EMG Sensor consists of a two-electrode eletromyograph and a grounding strap with a ground electrode. It has an on-board gain of 300 V/V and a local band-pass filter with lower and upper cutoff frequencies of 25 Hz and 500 Hz, respectively. The electromyogram signal measured by the electromyograph relative to the ground terminal that is amplified by the isolation amplifier can be measured be measured on D/A #1 by setting the AD1 DIP switch to OPTO_OUT. The amplitude of the raw EMG signal is small and the signal is offset at around 2.5 V. As shown in Figure 3.4, the signal is then amplified to fit the $\pm$ 10 V range and biased to 0 V. This processed signal is available on A/D #0 and is used to measure the amount of muscle contraction.

■ **Caution:** Make sure that the two 1.5 V AA batteries that power the EMG sensor are inserted correctly.

2.1.4 DIP Switches

The AD1, AD2, and AD5 DIP Switches dictate what signals can be measured on the Digital-to-Analog lines 1, 2, and 5, respectively. The AD1 DIP switch, components #6 shown in Figure 3.3, is used to measure the 555 timer or the output of the optical isolation circuit on D/A #1. As shown in Figure 3.4, the OPTO_OUT is the electromyogram signal that is measured by the EMG sensor and amplifier and offset by the isolation amplifier. It is offset by about 2.5 V. The 555 Timer resembles a sawtooth wave, but is more like an integrated pulse signal.

Use the AD2 DIP switch, ID #7 in Figure 2.2, to view either DA0_AMP or PRE_STAGE_OFFSET on D/A #2. The DA0_AMP signal is the processed Digital-to-Analog #0 channel output, as illustrated in Figure 3.4. This is the A/D #0 signal, i.e. the analog output signal supplied to DAQ, that is scaled down and offset by the post stage offset value before getting passed to the comparator. The PRE_STAGE_OFFSET is a constant value. It is the offset used to bring the EMG signal to be around 0 V.

The AD5 DIP switch, component #8 shown in Figure 2.2, determines what signal can be viewed on D/A #5 - PWM_SIG or POST_STAGE_OFFSET. The PWM_SIG is the pulse-width modulated signal being sent to the servo. It is the result of passing the 555 Timer pulse and the processed A/D#0 signal through a comparator. The POST_STAGE_OFFSET is the offset used to regulated the attenuated A/D#0 signal to be about 0 V.

2.1.5 555 Timer

The National Semiconductor LM555CM-ND is a high-precision 555 timer integrated circuit that is used for the PWM cycles. It can be monitored on A/D#1 by setting AD1 DIP switch to 555_REF.

2.1.6 QNET Power Supply

The DCMCT module has a 15-Volt DC power jack to power the on-board ICs. It is called the QNET Myoelectric power supply.

■ **Caution:** Please make sure you use the correct type of wall transformer or you will damage the system. It should supply 15 VDC and be rated at 5.0 A. The QNET Myolectric does **NOT** use the same power supply as other QNET systems.

Note: The fuse is replaceable and is rated at 2A 250VAC, type slow-blow, size 5x20 mm.

3 SYSTEM SCHEMATIC

A schematic of the MYOELECTRIC system interfaced with a DAQ device is provided in Figure 3.3. The block diagram representing the circuit in the Myoelectric board is shown in Figure 3.4.

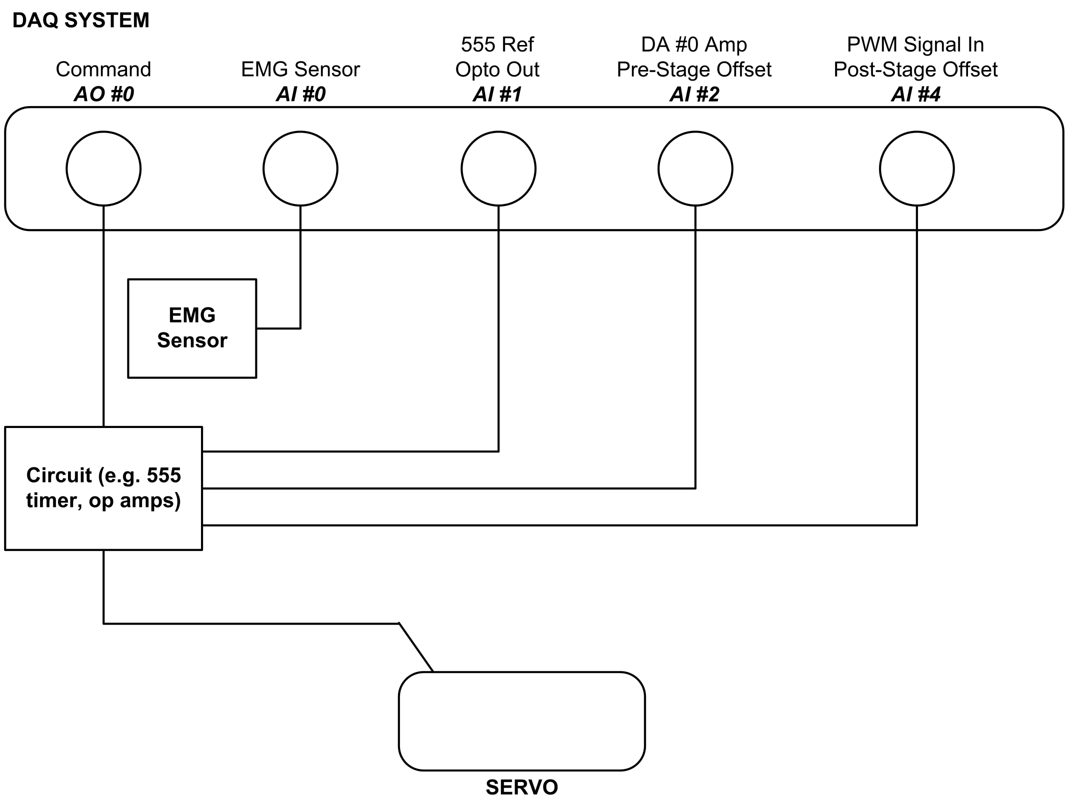

Figure 3.3: Schematic of QNET Myoelectric trainer

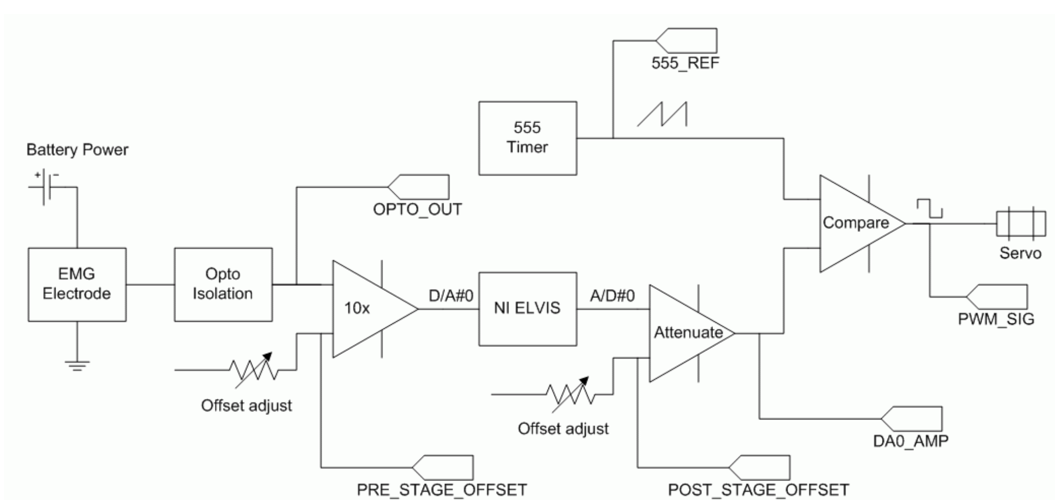

Figure 3.4: QNET Myolectric circuit block diagram

4 SPECIFICATIONS

The specifications of the MYOELECTRIC trainer are given in Table 2.

Symbol	Description	Value	Unit
	Servo Motor:		
	Operating Range	4.8-6.0	V
M_H	Stall torque	3	kg·cm
	Diemsions	29 x 13 x 30	mm^3
m_s	Weight	0.02	kg
	EMG Sensor:		
	Analog output range	± 5	V
	Gain	300	V/V
	Upper cut-off frequency	500	Hz
	Lower cut-off frequency	25	Hz
	Common mode rejection ratio	80	dB
	Supply voltage (typical)	5.00	V
	Isolation Amplifier:		
V_{MAX}	Recommended input voltage (accurate and linear)	± 0.200	V
$\|V_{IN}\|_{MAX}$	Maximum differential input voltage	0.308	V
G	Gain	8	V/V
V_{OL}	Output low voltage	1.29	V
V_{OH}	Output high voltage	3.8	V
	Bandwidth	100	kHz
	Supply Voltage	5.5	V

Table 2: MYOELECTRIC specifications

5 ENVIRONMENTAL

The Myoelectric Trainer environmental operating conditions are given in Table 3.

Description	Value	Unit
Operating temperature	15 to 35	°C
Humidity	20 to 90	%

Table 3: MYOELECTRIC environmental operating conditions

■ **Caution:** Ensure the unit is operated under the temperature and humidity conditions given in Table 3. Otherwise, there may be some issues with the heating and cooling results.

6 SETUP GUIDE

As illustrated in Figure 6.5, the QNET boards can easily be connected to an NI ELVIS system. The instructions in Section 6.1 detail the setup procedure for using a QNET with an NI ELVIS II.

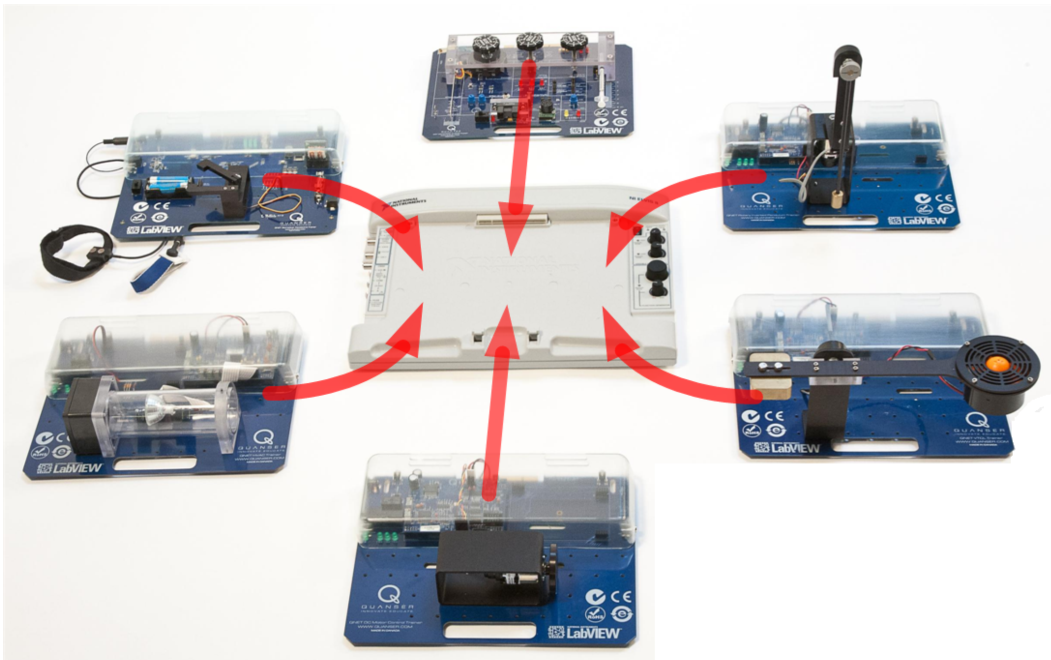

Figure 6.5: Connecting a QNET Trainer

■ **Caution: Do not position the ELVIS II so that it is difficult to disconnect the main power.**

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

6.1 QNET AND NI ELVIS II SETUP

The procedure to install a Quanser Engineering Trainer (QNET) module on the NI ELVIS II is detailed in this section. The NI ELVIS II components used in the installation procedure are located and marked by an ID number in Figure 6.6, and described in Table 4.

6.1.1 ELVIS II Components

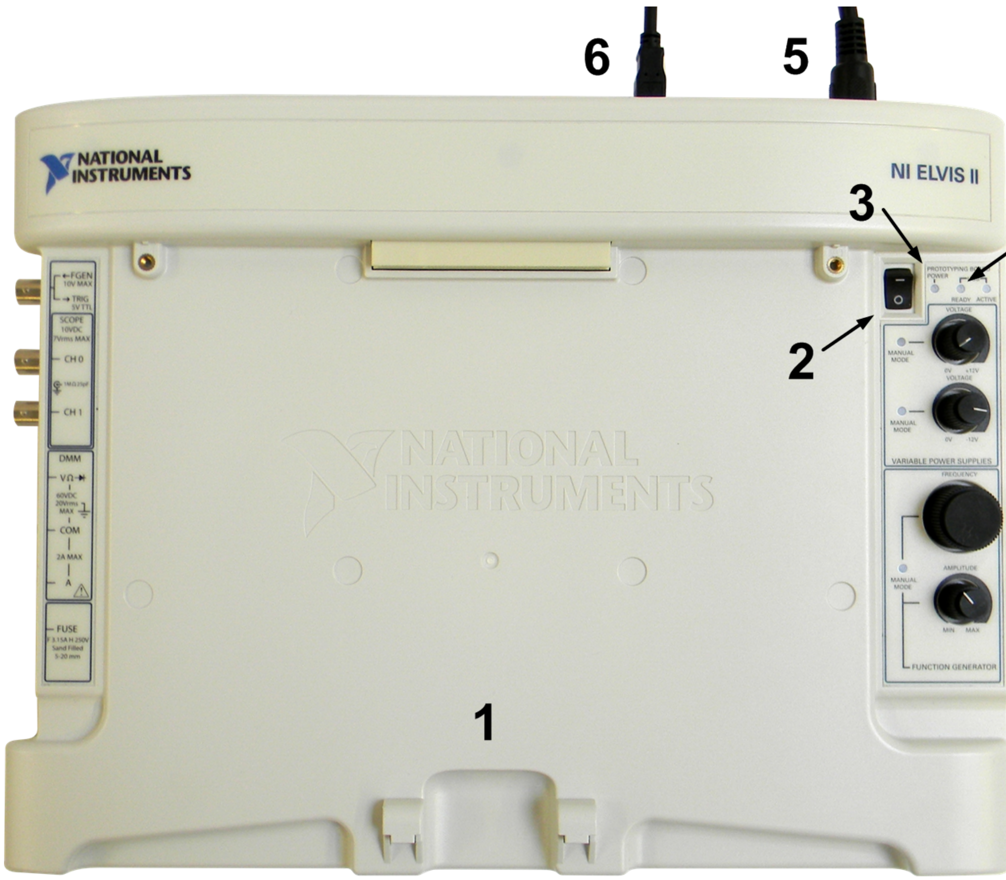

Figure 6.6: Components on ELVIS II

ID#	Description
1	NI ELVIS II
2	Prototyping board power switch
3	Power LED
4	Ready LED
5	Power Cable for ELVIS II
6	USB Connection between PC and ELVIS II

Table 4: ELVIS II components

6.1.2 ELVIS II Setup Procedure

Follow these instructions to setup a QNET board on an ELVIS II:

■ **Caution: Do NOT make the following connections while power is supplied to the hardware!**

■ **Caution: The unit is provided with a grounded cord to be used with a properly grounded outlet only, this is a safety feature, do not disable it**

1. Place the small opening on the front of the QNET board over the mounting bracket on the NI ELVIS II.
2. Slide the PCI connector of the QNET module end into the female connector on the NI ELVIS II. Make sure it is connected properly.
3. Connect the ELVIS II power cable.
4. Connect the ELVIS II USB cable to the PC.
5. Connect the supplied QNET transformer to the QNET power jack on the QNET module.
6. Connect the myoelectric sensor and grounding straps.
7. Power the NI ELVIS II by turning ON the *System Power Switch* on the rear panel.
8. Turn ON the *Prototyping Board Power* switch, ID #2 shown in Figure 6.6.

   ■ **Caution: Take extra care when powering the QNET module to avoid causing any damage!**
9. The *Power* and *Ready* LEDs of the NI ELVIS II unit should be lit as shown in Figure 6.7.

Figure 6.7: Ready and Power LEDs on NI ELVIS II

10. As pictured in Figure 6.8, verify that the *+15V*, *-15V*, and *+5V* LEDs on the QNET module are lit. They indicate that the board has been properly connected to the ELVIS unit.

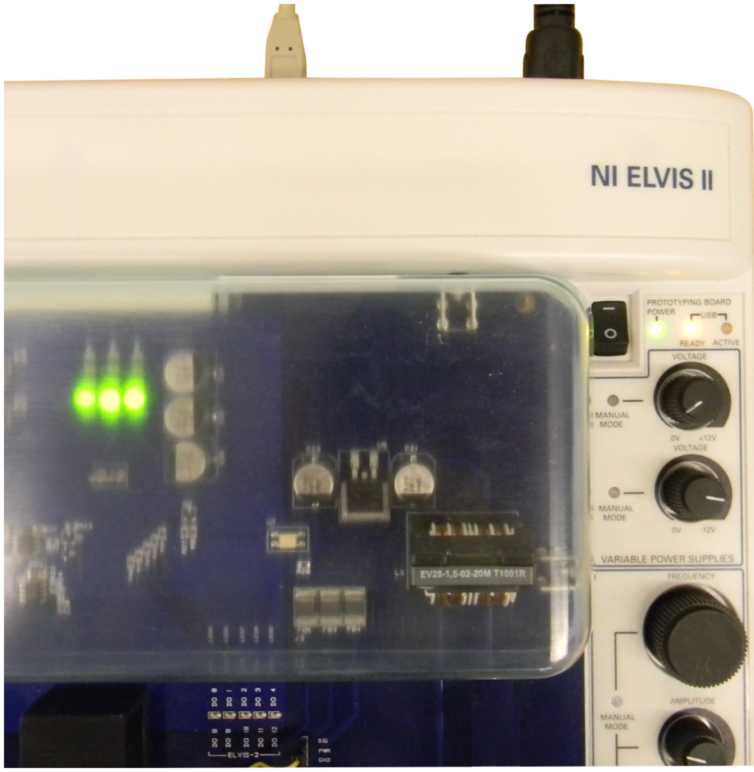

Figure 6.8: QNET LEDs should all be ON

11. Power ON the myoelectric sensor power.
12. Ensure that the *Battery ON* LED is lit, as shown in Figure 6.9.

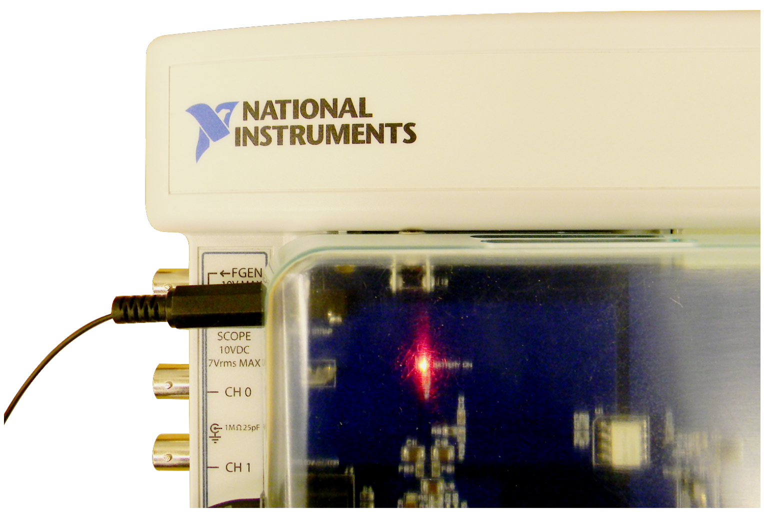

Figure 6.9: Battery LED should be ON

7 QNET LABVIEW HINTS

7.1 SCALING SCOPES

This section describes a handy method of changing the x or y axis in a LabVIEW scope using *QNET_DCMCT_Swing_Up_Control* VI as an example. Read the steps below to reduce the y-axis range of the Angle (deg) scope shown in Figure 7.10 in order to see the blue trace more up close.

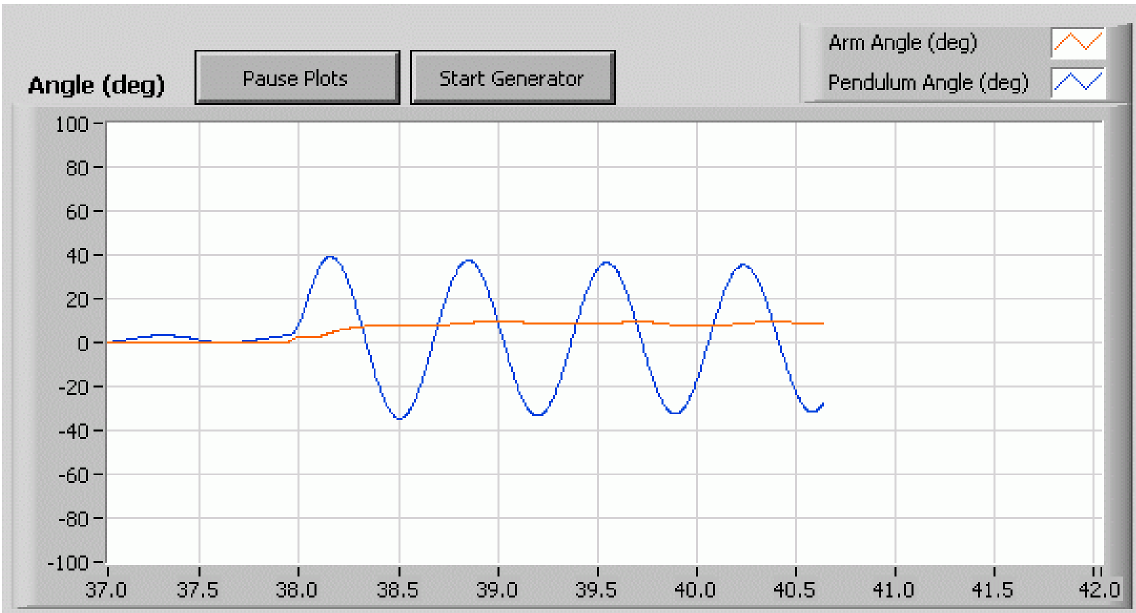

Figure 7.10: Scope needs to be scaled

1. As illustrated in Figure 7.11, to decrease the positive range of the scope down to 40, double-click on '100' in the y-axis, type in '40', and press ENTER.

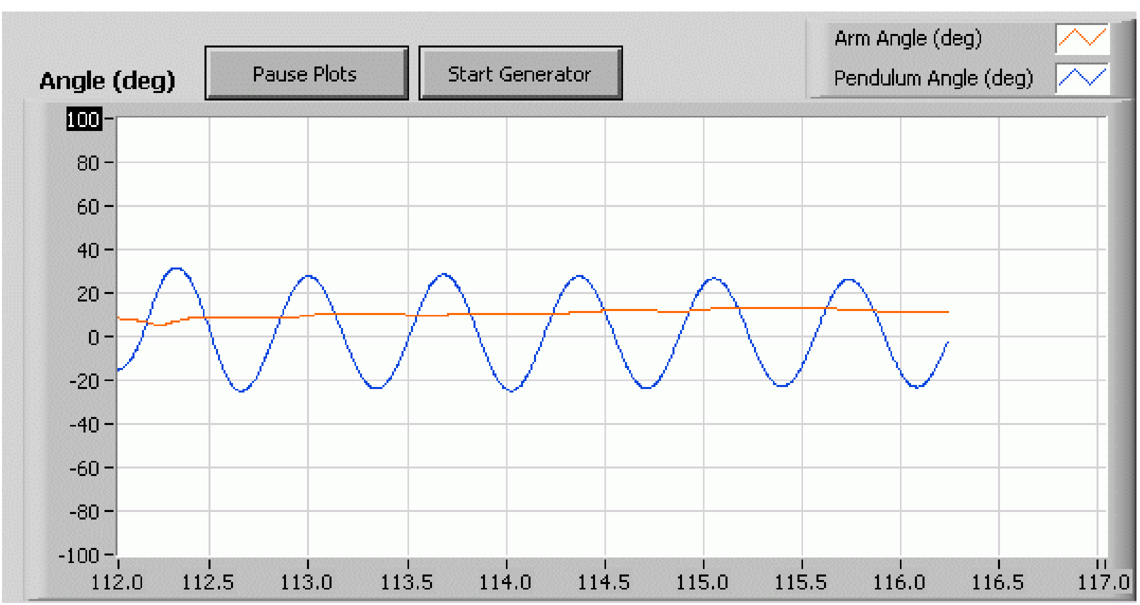

Figure 7.11: Scope needs to be scaled

2. The resulting scope is depicted in Figure 7.12. The blue trace is now more visible.

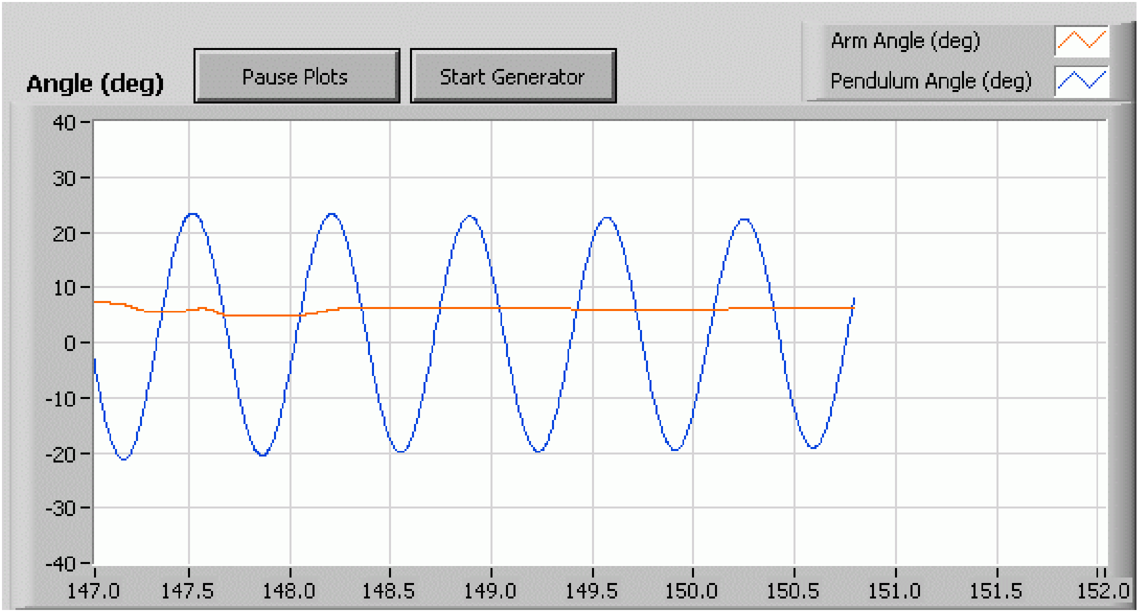

Figure 7.12: Y-axis of scope has been adjusted

Similarly, the minimum range of the y-axis can be changed as well as the range of the x-axis. For example, to see a time range of 10 seconds instead of 5 seconds the x-axis range can be changed from [0.0, 5.0] to [0.0, 10.0]. However, when changing the x -axis, i.e. the time-scale, it is recommended to do the following:

1. Pause the scopes or stop the VI and clear the chart (right-click on scope, select Data Operation || Clear Chart).
2. Apply the same scale change to both the output and input scopes. Otherwise, the data plotted in each scope will not be synchronized with each other.

7.2 SAVING RESPONSE

Read the following to save a scope response:

1. Right-click on the scope and select Export Simplified Image, as shown in Figure 7.13

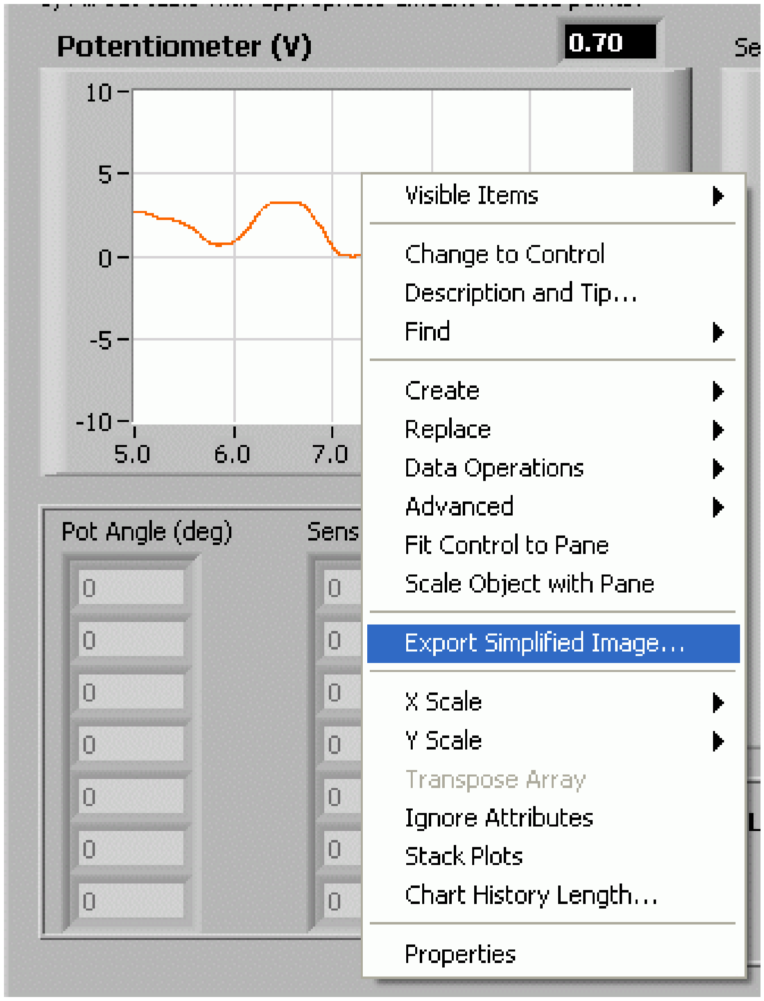

Figure 7.13: Right-click on scope and select Export Simplified Image

2. The dialog box shown in Figure 7.14 opens and gives various image export options. One way is to export the image to the clipboard as a bitmap. This can then be pasted in a graphical software (e.g MS Paint, Irfanview) and saved to a desired format (e.g. gif).

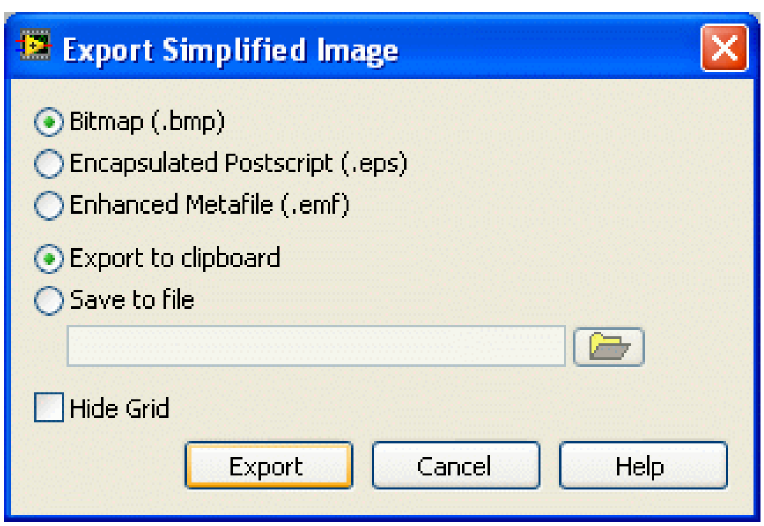

Figure 7.14: Export Simplified Image dialog box

3. The resulting image that is saved is shown in Figure 7.15.

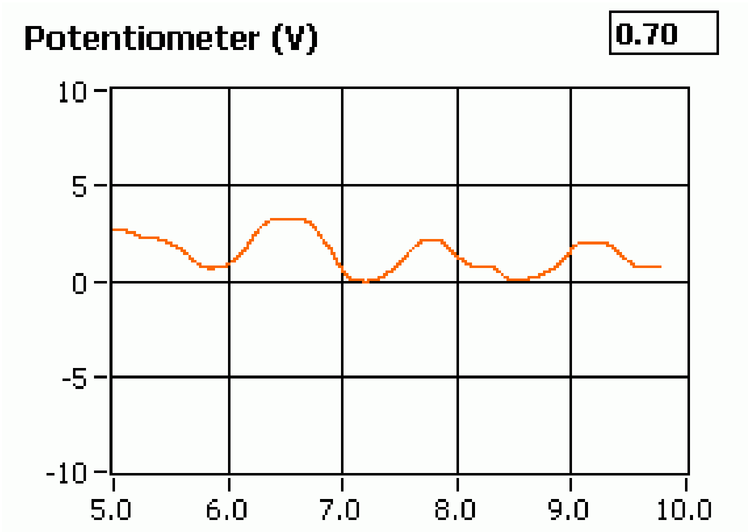

Figure 7.15: Sample saved response

The scope can be saved whether or not the VI is running. However, typically it is easier to stop the VI when the desired response is collected and then export the image as instructed above.

8 TROUBLESHOOTING

8.1 GENERAL SOFTWARE ISSUES

Q1 When I try to open a QNET VI, it says there are some missing VIs and they have a "CD" or "Sim" in the name?

The *LabVIEW Control Design and Simulation Toolkit* is not installed.

□□□

Q2 When I open a QNET VI a message prompts that a VI with "ELVIS" in the name cannot be found?

- ELVIS I: The QNET VIs use drivers that are installed from the ELVIS 3.0 or later CD. Make sure it is installed. If the folder "\National Instruments\NI ELVIS 3.0" does not exist then it is not installed (available for download at `www.ni.com` as well).
- ELVIS II: The QNET VIs use the ELVISmx drivers. Make sure you install the contents of the ELVIS II CD before attempting to open any of the QNET VIs (available for download at `www.ni.com` as well).

□□□

8.2 GENERAL HARDWARE ISSUES

Q1 None of the LEDs on the QNET board are lit?

Make sure both the *System Power* switch, which is located on the back of the ELVIS I and II units, and the *Prototyping Board Power* switch, which is situated on the front panel of the ELVIS I and on the top-right corner of the ELVIS II, are ON. See the QNET Setup Guide for more information.

□□□

Q2 On the QNET board, the +15V, -15V, and +5V LEDs are bright green but the +B LED is not lit?

Ensure the QNET power connector on the QNET board is connected with the supplied QNET power cable. See the QNET Setup Guide for more information.

□□□

Q3 At least one of the +B, +15V, -15V, and +5V LEDs on the QNET board is not lit?

See Q2 if only the +B is not lit.
If one or more of the +15V, -15V, and +5V LEDs is not lit then a +/-15V or +5V fuse(s) on the *Protection Board* of the NI-ELVIS I is burnt. Similarly, if the +B LED is still not lit after connecting the QNET power then the *Variable Power Supplies Fuses* on the ELVIS *Protection Board* are burnt. See the *Protection Board Fuses* in the NI ELVIS User Manual and replace the fuses as directed.

□□□

Q4 The *Ready LED* on the ELVIS II does not go on?

1. Go through the ELVIS II setup procedure outlined in the QNET Setup Guide
2. Once completed, launch the *Measurement & Automation Explorer* software.
3. As illustrated in Figure 8.16, expand the *Devices and Interfaces* and *NI-DAQmx Devices* items and select the NI ELVIS II device.
4. As shown in Figure 8.16, click on the *Reset Device* button.
5. Once successfully reset, click on the *Self-Test* button.
6. If the test passed, reset the ELVIS II (i.e. shut off the *Prototyping Board* switch and *System Power* switch and turn them back on again). The *Ready LED* on the ELVIS II should now be lit.

□□□

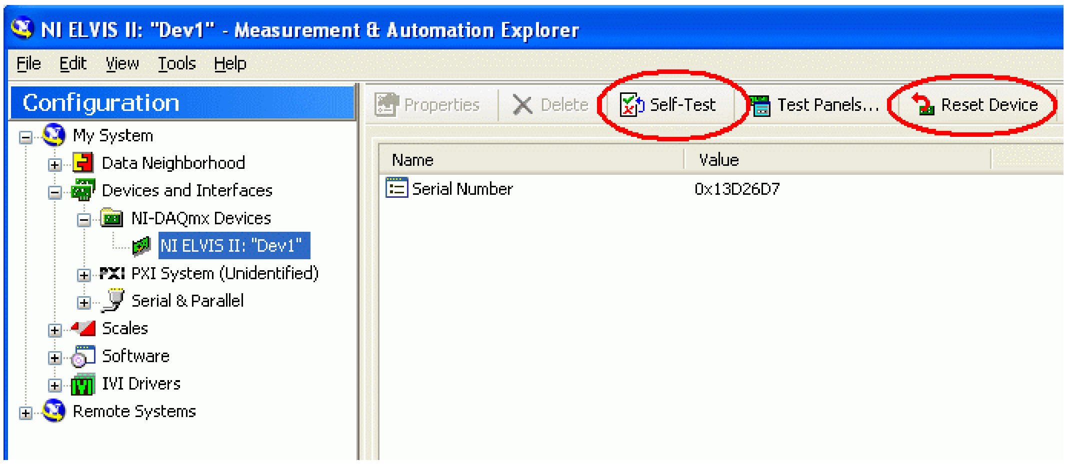

Figure 8.16: Reseting and performing the self-test on the ELVIS II

9 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 the requested software and hardware information as well as a description of the problem encountered. Also, make sure your e-mail address and telephone number are included. Submit the form and a technical support person will contact you.

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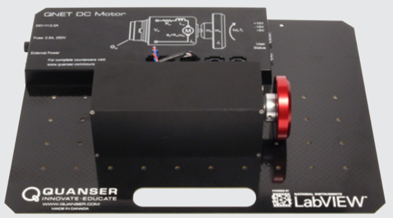
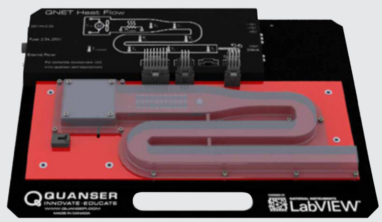
teaches fundamentals of DC motor control

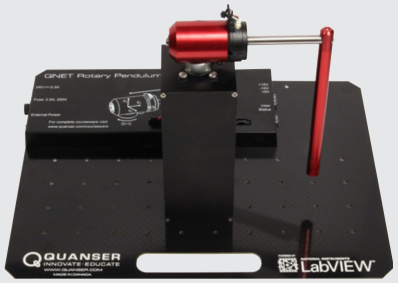


QNET 2.0 HVAC Board
teaches temperature (process) control



QNET Mechatronic Sensors Board
teaches functions of sensors

QNET 2.0 Rotary Pendulum Board
teaches classic pendulum control



QNET 2.0 VTOL Board
teaches basic flight dynamics and control

QNET Myoelectric Board
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