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Control in a MATLAB® Environment

Digital Pendulum

Installation and Commissioning

33-935/936-0V61

**(For 33-005, MATLAB 6.1 version
Windows 95, 98, NT, 2000)**



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Manual: 33-935/936-0V61 Ed01 06 2002 *Printed in England by FI Ltd, Crowborough*
Feedback Part No. 1160-3393560V61

Notes



DIGITAL PENDULUM SYSTEM INSTALLATION AND COMMISSIONING

Preface

THE HEALTH AND SAFETY AT WORK ACT 1974

We are required under the Health and Safety at Work Act 1974, to make available to users of this equipment certain information regarding its safe use.

The equipment, when used in normal or prescribed applications within the parameters set for its mechanical and electrical performance, should not cause any danger or hazard to health or safety if normal engineering practices are observed and they are used in accordance with the instructions supplied.

If, in specific cases, circumstances exist in which a potential hazard may be brought about by careless or improper use, these will be pointed out and the necessary precautions emphasised.

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This equipment should not be used by inexperienced users unless they are under supervision.

We are required by European Directives to indicate on our equipment panels certain areas and warnings that require attention by the user. These have been indicated in the specified way by yellow labels with black printing, the meaning of any labels that may be fixed to the instrument are shown below:



CAUTION -
RISK OF
DANGER

Refer to accompanying documents



CAUTION -
RISK OF
ELECTRIC SHOCK



CAUTION -
ELECTROSTATIC
SENSITIVE DEVICE

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All major changes are incorporated into up-dated editions of our manuals and this manual was believed to be correct at the time of printing. However, some product changes which do not affect the instructional capability of the equipment, may not be included until it is necessary to incorporate other significant changes.

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- | | |
|------------------------|----------------------------|
| 1. Equipment type | 2. Component value |
| 3. Component reference | 4. Equipment serial number |

Components can often be replaced by alternatives available locally, however we cannot therefore guarantee continued performance either to published specification or compliance with international standards.



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Should this equipment be used outside the classroom, laboratory study area or similar such place for which it is designed and sold then Feedback Instruments Ltd hereby states that conformity with the protection requirements of the European Community Electromagnetic Compatibility Directive (89/336/EEC) may be invalidated and could lead to prosecution.

This equipment, when operated in accordance with the supplied documentation, does not cause electromagnetic disturbance outside its immediate electromagnetic environment.

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DIGITAL PENDULUM SYSTEM INSTALLATION AND COMMISSIONING

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1 Introduction

This manual contains a description of the components of the Digital Pendulum System, assembly instructions and test procedures. It is intended to provide the means for validating the correct operation of the system, **before** proceeding to more advanced functions and demonstrations using control software with MATLAB / SIMULINK

The procedures described in this section of the Pendulum manual will ensure correct:

- Assembly of the system
- Setting up of the EISA or PCI Advantech Board
- Cable connections between the PC and the Pendulum

1.1 Required Equipment

- | | | | | | | | |
|-----------------|--|-----------|--|-----------------|---|-----------------|--------------------------------------|
| 1 | Software and PC system as described in the manual 33-000-0C - Introduction and Computer Systems Installation | | | | | | |
| 2 | Set of 3 "Control in a MATLAB Environment" Manuals: <table border="0" style="margin-left: 40px;"><tr><td>33-000-0C</td><td>Introduction and Software Installation</td></tr><tr><td>33-935/936-0V61</td><td>Digital Pendulum - Installation and Commissioning</td></tr><tr><td>33-935/936-1V61</td><td>Digital Pendulum Control Experiments</td></tr></table> | 33-000-0C | Introduction and Software Installation | 33-935/936-0V61 | Digital Pendulum - Installation and Commissioning | 33-935/936-1V61 | Digital Pendulum Control Experiments |
| 33-000-0C | Introduction and Software Installation | | | | | | |
| 33-935/936-0V61 | Digital Pendulum - Installation and Commissioning | | | | | | |
| 33-935/936-1V61 | Digital Pendulum Control Experiments | | | | | | |
| 3 | Feedback Supplied equipment as follows <table border="0" style="margin-left: 40px;"><tr><td>33-200</td><td>Digital Pendulum Mechanical Unit</td></tr><tr><td>33-201</td><td>Digital Pendulum Controller</td></tr></table> | 33-200 | Digital Pendulum Mechanical Unit | 33-201 | Digital Pendulum Controller | | |
| 33-200 | Digital Pendulum Mechanical Unit | | | | | | |
| 33-201 | Digital Pendulum Controller | | | | | | |



DIGITAL PENDULUM SYSTEM INSTALLATION AND COMMISSIONING

Chapter 1 Introduction

4 - For EISA Bus only	33-935	Digital Pendulum Control System Software pack including Advantech PCL 812PG card
	33-935I	Digital Pendulum Control System Software pack excluding Advantech PCL 812PG card
	33-005-EISA	Contains 33-200 , 33-201 , 33-935 (Composite product)
	33-005I-EISA	Contains 33-200 , 33-201 , 33-935I (Composite product)
4 - For PCI Bus only	33-936	Digital Pendulum Control System Software pack including Advantech PCI1711 card
	33-936I	Digital Pendulum Control System Software pack excluding Advantech PCI1711 card
	33-005-PCI	Contains 33-200 , 33-201 , 33-936 (Composite product)
	33-005I-PCI	Contains 33-200 , 33-201 , 33-936I (Composite product)



2 Mechanical Assembly

Carefully unpack the items, and remove all packaging and securing material. You should have the following items:

- 1) Track for the cart to move on, with motor attached, and toothed belt.
- 2) Pendulum cart with mounting points for the two pendulum arms and attached ribbon cable.
- 3) Two pendulum arms with weights attached.
- 4) Two legs each with two adjustable feet, with mounting plates for securing to the track.
- 5) 1 x 2 mm and 1 x 6 mm Allen keys.

Refer to Figure 2-1 below

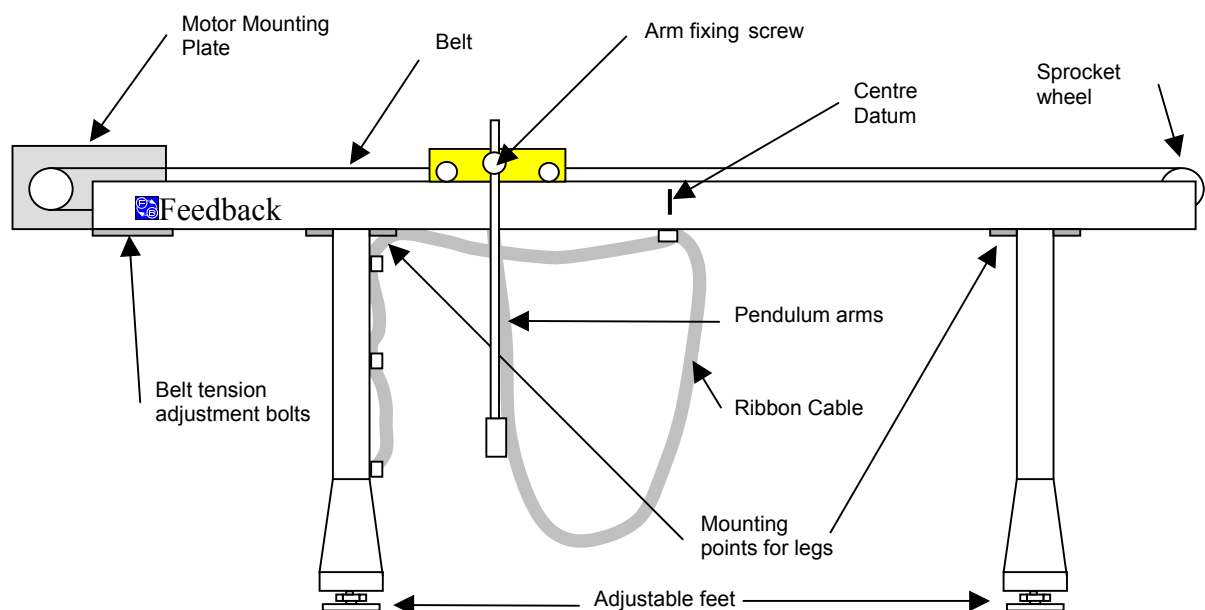


Fig 2.1: The pendulum system

Place the Digital Pendulum Mechanical Unit on a level surface with the motor on the left viewed from the front and allow sufficient room for the controller box, PC and mouse. Ensure that the pendulum is clear of any obstructions when executing a complete revolution, and is not able to make contact with any observers.

Using the 6 mm Allen key provided, remove the 8 bolts attached to the track at the leg mounting positions, and secure the legs to the track with these bolts.



Use the adjustable feet (it is only necessary to adjust one of the four) to ensure that the pendulum system is stable on the surface. Slacken off the adjustable foot locking nut and rotate the foot until the system is perfectly stable. Tighten the locking nut.

Insert one of the pendulum arms into one of the two mounting positions on the cart from the bottom and loosely tighten the securing screw on to the flat part of the pendulum arm with the 2 mm Allen key provided. Push the arm upwards until the end of the flat is reached and tighten the securing screw. Repeat for the other pendulum arm on the other side of the cart

Ensure the pendulum cart is free to move on the track and that the drive belt is attached to the cart at both ends and goes over the sprocket wheels at each end of the track. If the belt is slack, use the 6 mm Allen key to slacken off the belt tension adjustment bolts and move the motor mounting plate until the belt is taut. Tighten the adjustment bolts.

Finally, clip the ribbon cable to the pendulum left hand leg using the attached clips.



3 Connections to the Computer

Following the installation of the interface card into your PC, you are now ready to connect the ribbon cables to the 33-201 Digital Pendulum Controller.

Refer to Figures 3.1 and 3.2 below for details.

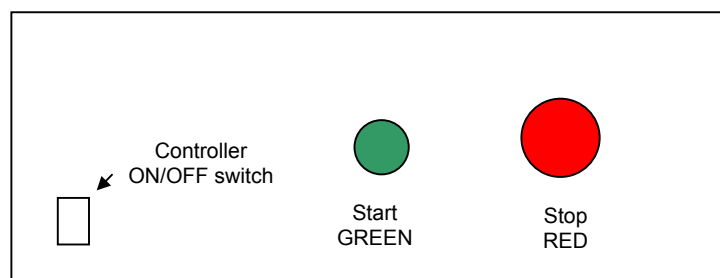


Figure 3-1: Front view of 33-201 controller

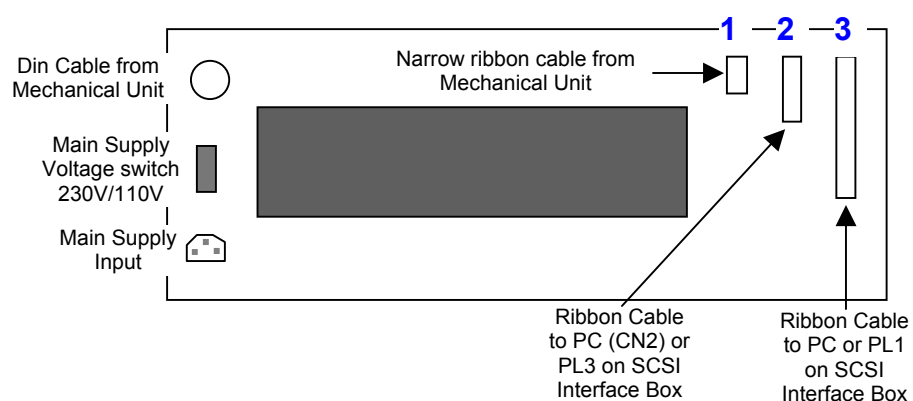


Figure 3-2: Rear view of 33-201 controller



PCL-812PG EISA

Refer to Figures 3.1 and 3.2.

Connect the **very** narrow ribbon cable from the Pendulum Mechanical Unit to connector **1** in Figure 3.2.

Connect the narrow ribbon cable from connector CN2 on the PCL-812PG board to connector **2** in Figure 3.2. Connector CN2 is the connector on the PCL 812PG board which is **nearest** to the motherboard.

Connect the wide ribbon cable from the PCL-812PG board to connector **3** in Figure 3.2.

See Figure 3.3 for connection details.

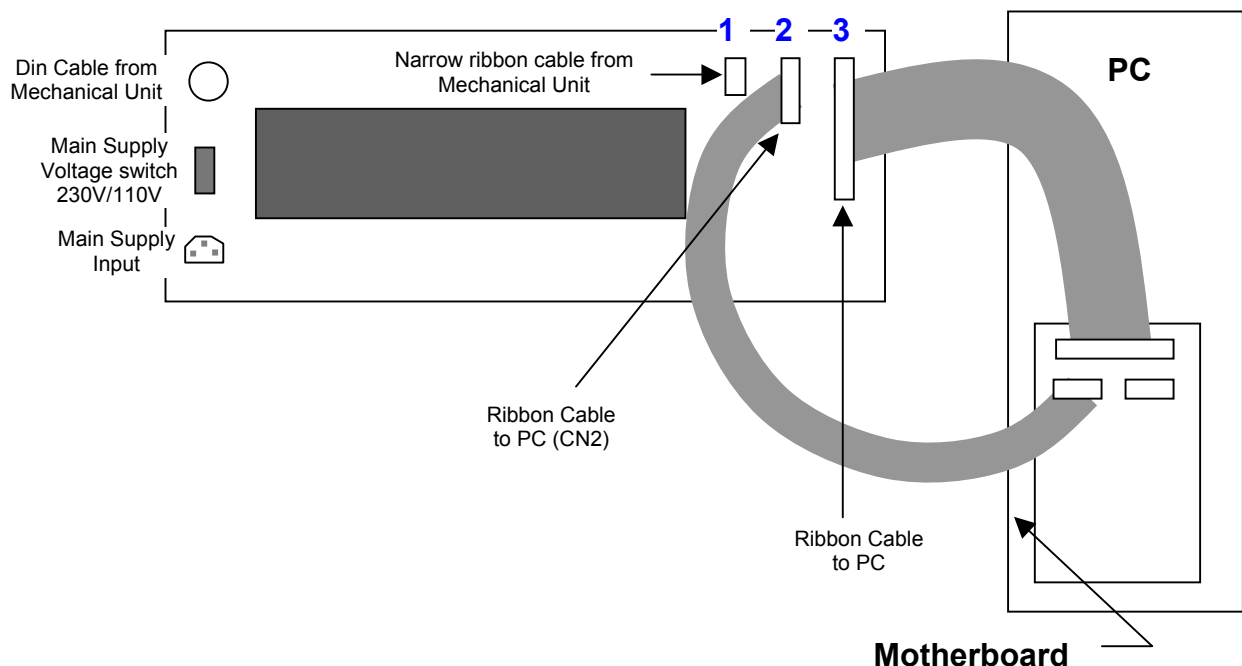


Figure 3-3: Cable connections for Advantech PCL 812PG board



PCI1711 PCI

Connect the **very** narrow ribbon cable from the Pendulum Mechanical Unit to connector 1 in Figure 3.4.

Connect the round SCSI cable from the PCI1711 board to the SCSI connector on the SCSI Adapter Box.

Connect the narrow ribbon cable from connector **PL3** on the SCSI Adapter Box to connector **2** in Figure 3.4. Connect the wide ribbon cable from connector **PL1** on the SCSI Adapter box to connector **3** in Figure 3.4.

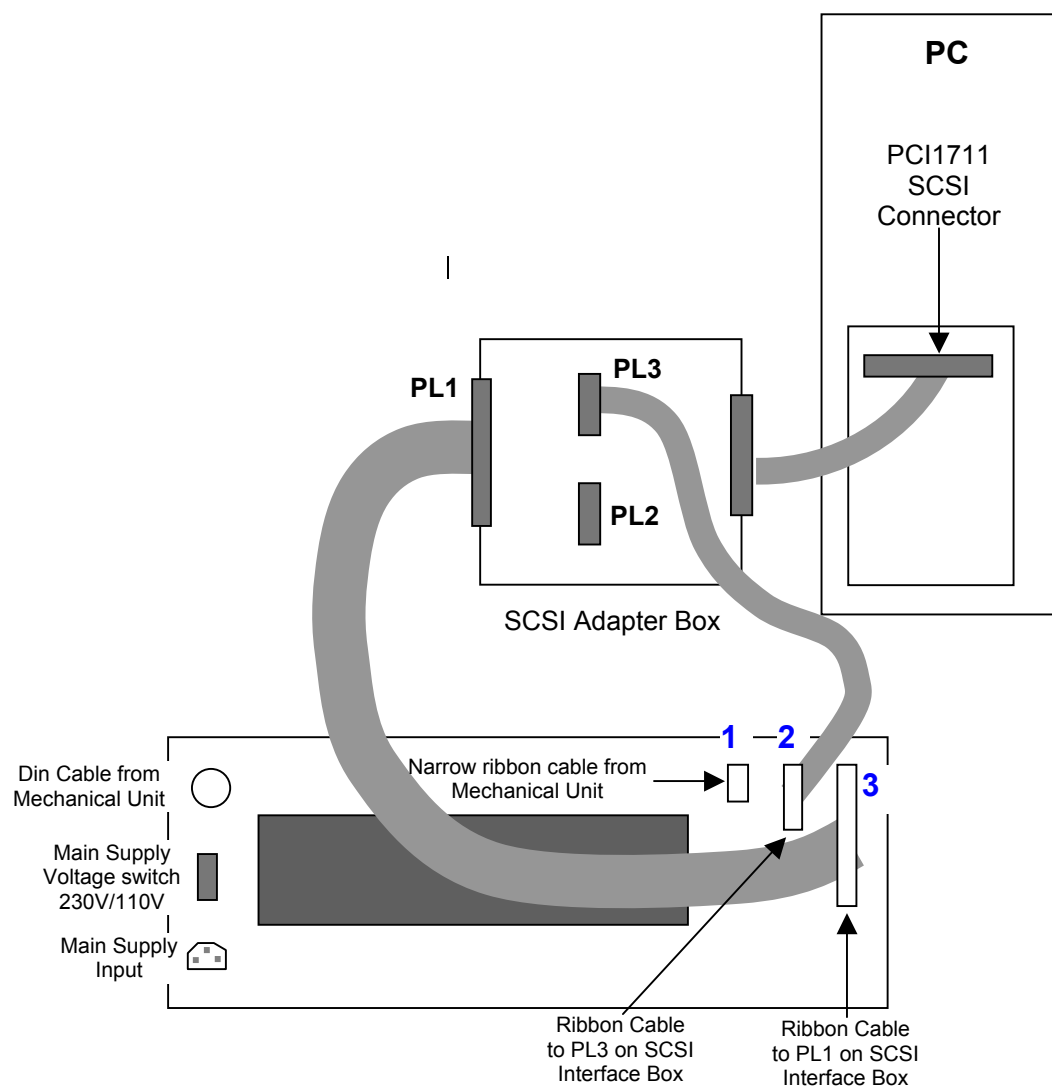


Figure 3-4: Cable connections to Advantech PCI1711 Board



- Voltage selector** Set the voltage selector for the correct voltage in your area.
- Mains power** Connect the mains power cable to the 33-201 and plug in to your mains supply.
- Switch on** Switch on your PC and the mains supply to the 33-201.
- Switch the 33-201 illuminated power switch on. If this switch does not light up check the mains power cable and mains power supply. Do not at this stage press the round green start button.



It is important that the area of operation is free of obstruction and that users and observers are warned to keep clear of the immediate vicinity of the system for safety reasons.



4 Commissioning and Test Software (Only for PCL 812PG Card)

4.1 Starting the Software

Commissioning/Test software is supplied to check the operation of the Pendulum System, before using the MATLAB driven control software. Note that this software is only available for the PCL 812PG card.

Windows 95 or 98 installation

Find the Pendulum Commissioning /Test software file on CD-ROM supplied:

From the Windows 95 or 98 **Start** menu click on **RUN** and use the browse feature to locate the **PENDTST.EXE** program on CD-ROM drive:

DOS installation

Insert the Pendulum Commissioning / Test software disk in drive A: Type in the following DOS commands.

>A:

>PENDTST

4.2 SOFTWARE OPERATION

After starting the Pendulum commissioning/test software you will see the following screen presented.



Figure 5.1: Start screen



- Click **OK**. The following screen appears, *only if the card is not found at the factory default Base address of 544.*

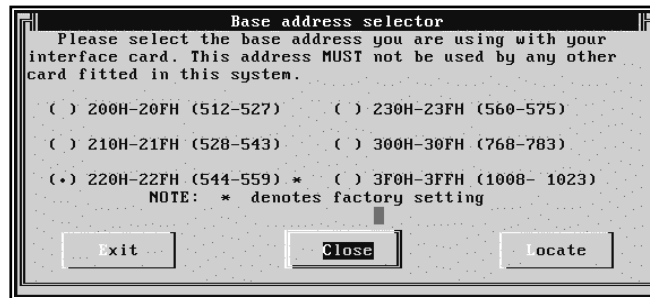


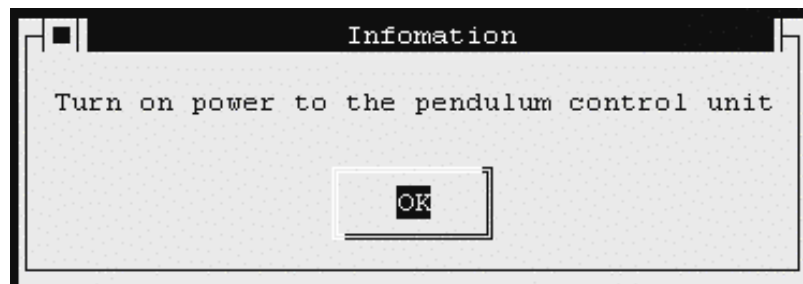
Figure 5.2: PCL-812 Base address Selection

- Use the mouse to select the base address of the PCL-812 interface card which has been set and checked in accordance with the procedure detailed in Chapter 3 of this manual.

If you do not know the Base Address, clicking on **Locate** will identify and set it automatically. (Note that **Locate** can only be used if there is only **one** PCL-812 board installed in your PC).

- Having selected the correct base Address, click on **Close**.

The following dialogue box appears.



- Remove the drive belt from the motor sprocket wheel.
- View the pendulum so that the motor is on the left side of the rail and the Feedback logo on the front.
- Turn on the power to the pendulum control unit and click OK.



The test of the motor must be done with the drive belt removed from the motor sprocket wheel to avoid the cart hitting the end stops.



DIGITAL PENDULUM SYSTEM INSTALLATION AND COMMISSIONING

Chapter 4 Commissioning and Test Software (only for PCL 812PG Card)

The following screen appears.

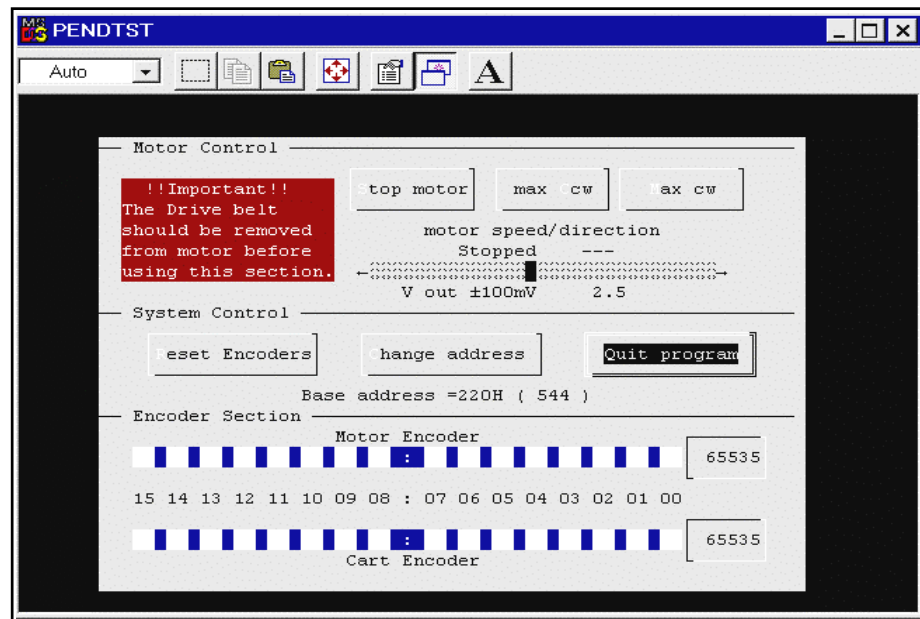


Figure 5.3: Main screen of PENDULUM Commissioning and Test Software



4.3 Description of Screen Controls and Displays

This screen allows you to interact with the PENDULUM System, change the speed or reverse direction of the motor by changing the applied voltage, and display the outputs from the two rotary encoders, which measure the angular displacement of the pendulum and the linear displacement of the cart.

Max cw

Clicking this button applies the maximum voltage to the motor to rotate it in a clockwise direction, from the viewpoint specified.

max Ccw

Clicking this button applies the maximum voltage to the motor to rotate it in a counter clockwise direction, from the viewpoint specified.

Stop motor

Clicking this button will stop the motor.

Change address

Locate the base address of the PCL-812 board or manually enter the known value into the software. The base address currently used is shown under this button in decimal format.

Reset encoders

Click on the reset encoders button sets the rotary encoders to zero. Subsequent encoder outputs are then angular deviations relative to the new set positions. The outputs for the motor and cart encoders, which measure the linear cart displacement and the pendulum angular displacement, are shown in binary format at the bottom of the screen

Quit Program

Exits the program.

Motor speed/direction

Dragging the slider bar to the left or right allows the motor speed to be varied in a clockwise or counter clockwise direction, in a number of discrete steps. When the slider bar is in the centre of the slider the motor is stopped, with an output voltage of $2.5 \pm 100\text{mv}$.



HOT KEYS

Note that as an alternative to using the mouse, the functions displayed on the screen can be activated by typing ALT + the highlighted letter displayed in reverse video on the screen. Thus, for example, to reset the encoders, press ALT + R



5 Test Sequence (Only for PCL 812PG Card)

When you have complete the system installation, execute the following test sequence to ensure that the system is functioning properly.

- Start PENDTST commissioning software, and check that the base address is correctly set.
- Switch on the mains power and the switch on the front of the 33-201 pendulum control unit.
- Click on **Stop motor**. Start the sequence in the table below.

ACTION	RESULT
<p>1. Disconnect the drive belt from the motor sprocket.</p> <p>Place the cart in the centre of the rail, lining up the positioning marks on the cart and the rail.</p> <p>Click Reset Encoders</p> <p>Slowly rotate the pendulum in a clockwise direction (as viewed from the specified viewpoint).</p>	<p>Observe the change in the cart encoder display in the bottom part of the screen. The encoder output is shown as a number.</p>
<p>2. Move the cart as far to the left as possible.</p> <p>Click Reset Encoders.</p> <p>Move the cart slowly as far to the right as possible.</p> <p>Move the cart slowly as far to the left as possible.</p>	<p>Observe the change in the motor encoder display in the bottom part of the screen. The encoder output is shown as a number. The encoder output should change from around zero to a value between 13000 and 14000</p> <p>The motor encoder output should return to a value close to zero.</p>



DIGITAL PENDULUM SYSTEM INSTALLATION AND COMMISSIONING

Chapter 5 Test Sequence (only for PCL 812PG Card)

ACTION	RESULT
<p>3. Click the Stop motor button</p> <p>Drag the Motor control slider at the top of the screen a small amount to the right.</p> <p>Repeat the above, dragging the Motor control slider the maximum amount to the right.</p>	<p>Establish that the motor is turning clockwise from the specified viewpoint.</p> <p>The motor is turning clockwise at its maximum rate.</p>
<p>4. Click the Stop motor button</p> <p>Drag the Motor control slider at the top of the screen a small amount to the left.</p> <p>Repeat the above, dragging the Motor control slider the maximum amount to the left.</p>	<p>Establish that the motor is turning counter clockwise from the specified viewpoint.</p> <p>The motor is turning counter clockwise at its maximum rate.</p>



Always be prepared to press the round red STOP button to cut the power to the pendulum if the system exhibits erratic or unexpected behaviour.