Control in a MATLAB Environment
Introduction and Computer Systems Installation
(MATLAB 6.5 Version)
33-000V65

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Control in a MATLAB® Environment

Introduction and Computer Systems Installation

33-000V65

(For use with MATLAB 6.5 Version and Windows 98, 2000, NT)

Feedback Instruments Limited

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Notes

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.

While we provide the fullest possible user information relating to the proper use of this equipment, if there is any doubt whatsoever about any aspect, the user should contact the Product Safety Officer at Feedback Instruments Limited, Crowborough.

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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

CAUTION - RISK OF ELECTRIC SHOCK

CAUTION - ELECTROSTATIC SENSITIVE DEVICE

Refer to accompanying documents

PRODUCT IMPROVEMENTS

We maintain a policy of continuous product improvement by incorporating the latest developments and components into our equipment, even up to the time of dispatch.

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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Where components are of a ‘Safety Critical’ nature, i.e. all components involved with the supply or carrying of voltages at supply potential or higher, these must be replaced with components of equal international safety approval in order to maintain full equipment safety.

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Any component may be ordered direct from Feedback or its agents by quoting the following information:

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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MATLAB, SIMULINK, REAL TIME WORKSHOP, REAL TIME WINDOWS TARGET ARE registered trademarkS of Mathworks Inc..

TABLE OF CONTENTS

Notes

1 Introduction

The material presented in these manuals is designed to demonstrate the operation of digital control in number of control situations. A complete system consists of a PC, MATLAB and associated toolboxes and utilities and one of a number of different hardware devices designed to show how control operates in real live situation physical situations.

The curriculum discusses the desired control objective, the device used to demonstrate it and the control methodology to be employed.

Examples are given showing how the controller is implemented graphically using MATLAB and Simulink.

Practical work is included which demonstrates the operation of the controller on the device and allows the student to change certain of the control parameters to allow for differences in hardware characteristics and improve the functioning of the controller.

The Environment

The controller is implemented on a PC using software tools from Mathworks Inc. These include:

MATLAB	
Simulink	
Real Time Workshop	RTW
Real Time Windows Target	RTWT
Visual C++ Professional	(from Microsoft)

all operating in a **Windows** environment.

MATLAB

MATLAB acts as the application Host environment in which the other Mathworks products run. It provides a sophisticated set of tools for solving mathematical problems. In addition there are specialised tool boxes which extend the Matlab functions in several different specific application areas.

Simulink

Simulink is a graphics based system for modelling processes (in our case **Control**), which takes the form of Blocks linked by connecting lines which show how output data from one block is fed as input into another block. Blocks perform specialised operations on the data and may be standard blocks from the Simulink Library or written by the user where no suitable library block exists. The Simulink model is then passed to Real Time Workshop.

Real Time Workshop - RTW

Real Time Workshop automatically builds a C++ source program from the Simulink model.

C++ Compiler

The C++ compiler compiles and links the code created by Real Time Workshop to produce an executable program. The program interfaces to the outside environment via a "Target", in our case Real Time Windows Target.

Real Time Windows Target

Real Time Windows Target communicates with the executable program acting as the Control program, and interfaces with the hardware device through an I/O board.

Real Time Windows Target controls the two way data or signal flow to and from the model (now an executable program), and to and from the I/O Board.

When the program is running, the user may change certain of the parameters in the Simulink model which are then passed, via Real Time Workshop, to the executable program. Any change in the structure of the model, however, will require Real Time Workshop to re-build the program.

Relationship between the elements of the environment

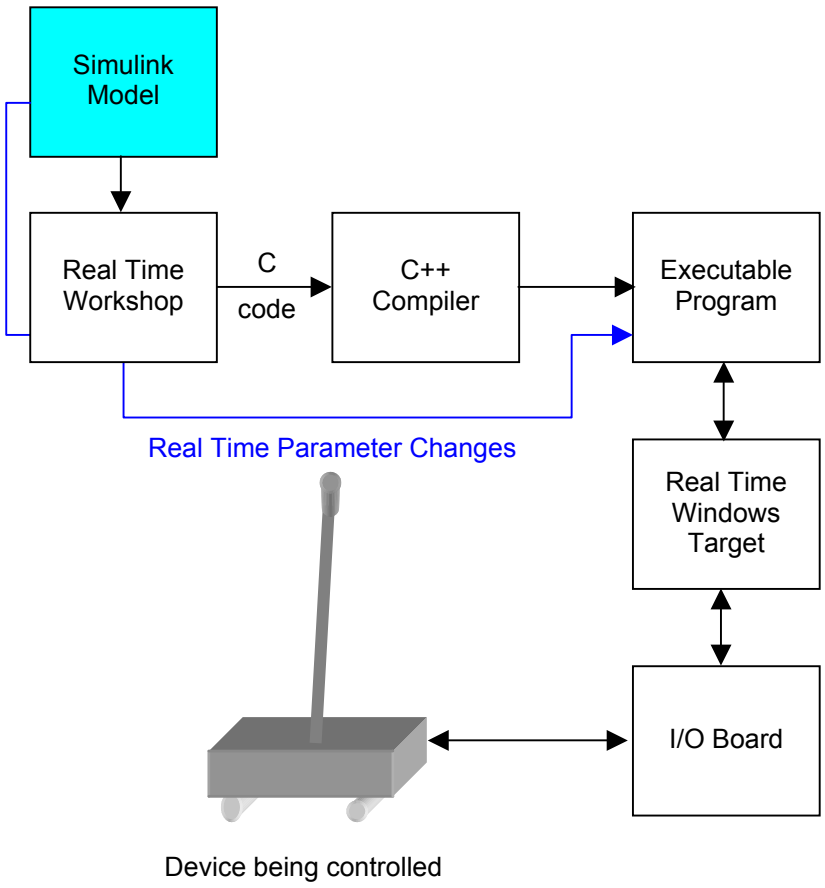


Figure 1-1: Control System Development Flow diagram

Figure 1-1 shows how the various elements of the MATLAB environment link together to provide an integrated set of tools for control system design and experimental validation.

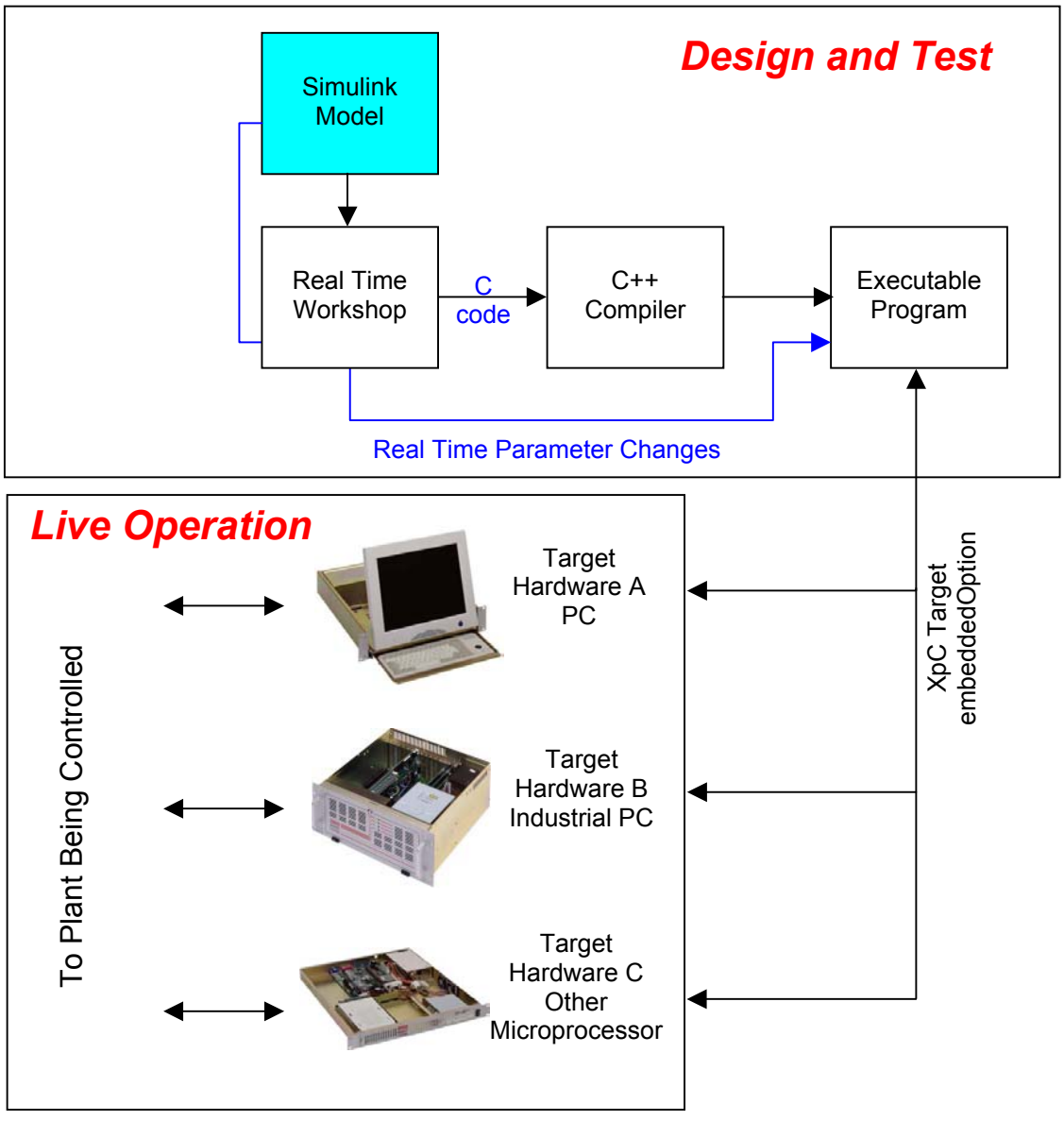


Figure 1-2

Advantages of this approach

The use of standard software tools means that, during the controller design stage, the designer only needs to model the process using the graphics tools available in Simulink (the shaded box in Figure 1-1), without being concerned with the mechanics of communication to and from the device under test.

The tools described above, produced by the Mathworks, are in very widespread use across a number of Industries for control system development. The control engineering student is very likely to meet them later during his or her career, so that familiarity with their use is a valuable addition to the student's skillset.

Figure 1-2 shows use of the tools to create an industrial controller. An additional product from Mathworks Inc, xPC, provides a mechanism for running the executable control code on a PC without Windows, thus avoiding unnecesssry software complexity and overhead.

These PC's can be either standard or industrial PC's depending on the application, environment and degree of redundancy required. In addition code can be generated for other hardware architectures than PC.

Feedback Control Products

Feedback Instruments manufacture a number of products for use within the MATLAB environment.

They are the following electromechanical plants:

Digital Pendulum

The Digital Pendulum is used to demonstrate control of a SIMO (Single Input Multiple Output) system. Consisting of a cart moving on an elevated track, and with two free swinging arms attached, it is used to demonstrate:

an inverted pendulum, which illustrates control of an unstable system. Unstable systems are found in controlling rockets at take off, and in humanoid robotics research.

a suspended pendulum which illustrates the sort of control a gantry crane might require when moving, for example, a container of molten steel with minimum oscillation of the load.

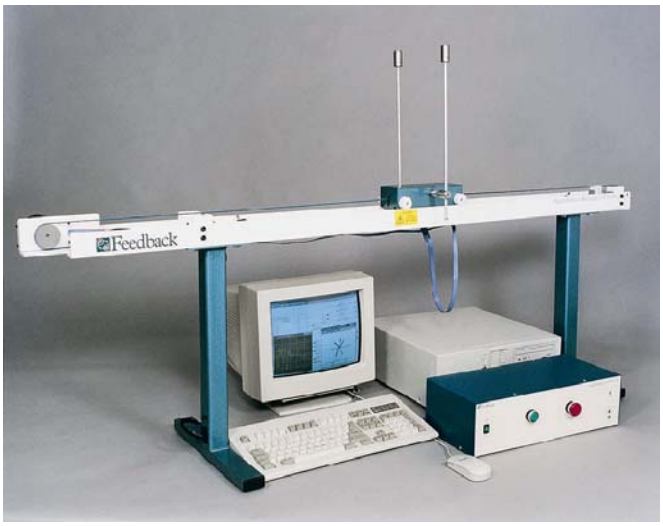


Figure 1-3: Digital Pendulum System

Twin Rotor MIMO System (Helicopter)

Figure 1-4: Twin Rotor MIMO System

The Twin Rotor Helicopter is used to demonstrate control of a MIMO (Multiple Input Multiple Output) system. It consists of a vertical and a horizontal rotor fixed to an arm which can rotate about both a vertical axis and a horizontal axis.

As in a real helicopter, two rotors are required for stable operation to counter the reaction on the helicopter body of changes in the angular momentum of the main rotor.

Magnetic Levitation System (Maglev)

Figure 1-5: Magnetic Levitation System

The Magnetic Levitation system demonstrates control of a metal sphere suspended in a magnetic field counteracting the force of gravity. It is an example of a system which is linear between only a small difference between the lower and upper limits of the sphere's vertical travel. Outside of these limits the system becomes highly non linear and impossible to control.

Modular Servo System

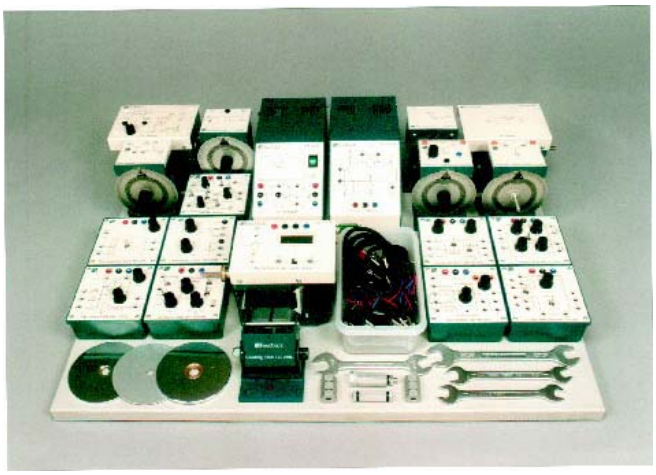


Figure 1-6: Modular Servo System

The Modular Servo system is a set of precision units which may be configured into a fully featured servo system.

Comprising power supply, dc motor, amplifiers, input and output potentiometers, digital encoder, tachometer, motor load unit and PC interface unit, the Modular Servo System provides an open architecture system for accurately demonstrating motor position and speed control.

Digital Servo System

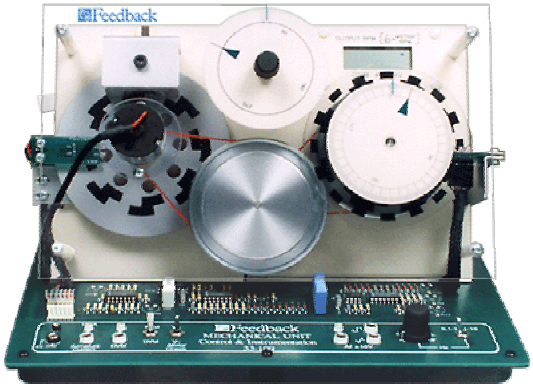


Figure 1-7: Digital Servo System

The Modular Servo system is a self contained dc servo motor system with control circuitry for the experimental study of servo motor behaviour and control. It comprises a Mechanical Unit and a Digital Unit.

The Mechanical Unit consists of a Power amplifier, dc motor, tacho-generator, absolute and incremental digital encoders, input and output analogue potentiometers, digital speed and voltage display, and a sine, square and sawtooth waveform generator.

The Digital Unit carries ADC and DAC for signal conversion, switching and multiplexing circuits, encoder output and display, linear and PWM motor drive and interface to the I/O card in the PC.

Process Control Trainer

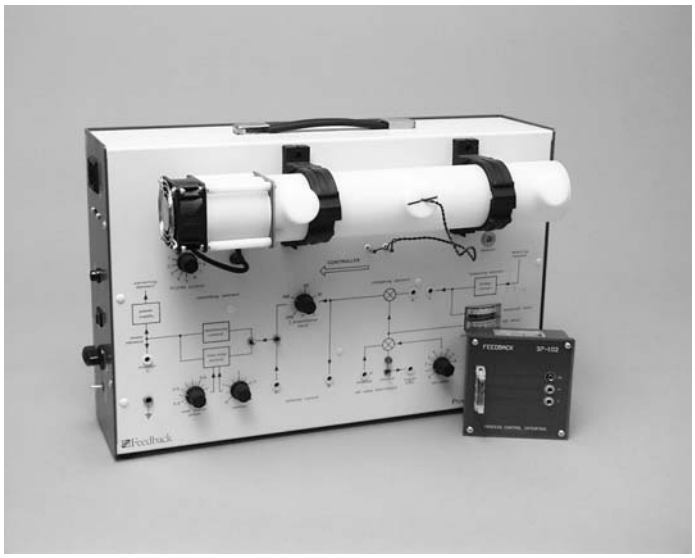


Figure 1-8: Process Control Trainer

The Process Control Trainer uses a tube equipped with a heating element at one end and a thermistor temperature detector, which can be placed in two positions in the tube. The control variable is the voltage to be applied to the heating element whilst the measured value is a voltage from the thermistor circuitry. The Process Control Trainer can be used to demonstrate and develop control techniques in a system with a transport delay.

Level and Flow Process Rig

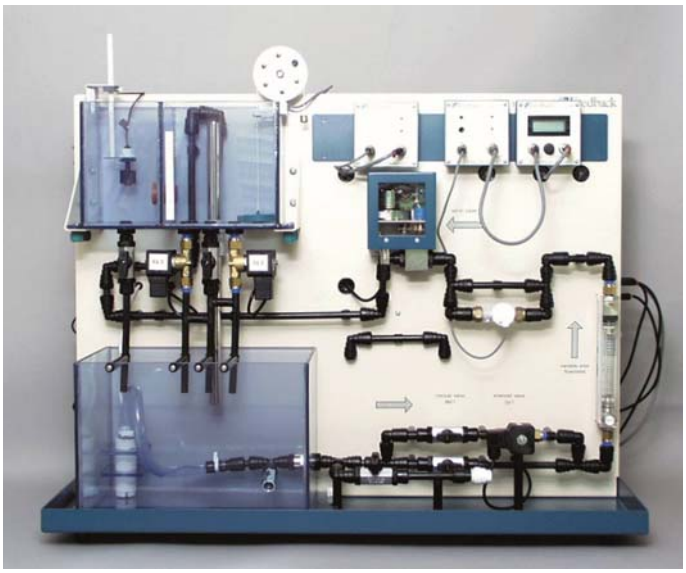


Figure 1-9: Level and Flow Process Rig

The Level and Flow Process Rig uses a pump to pump water from a reservoir tank to a header tank from where it may drain back into the reservoir tank. The flow into the header tank is controlled by a servo valve operating from a 4 - 20 ma range (fully closed - fully open) signal current. The header tank level transmitter consists of a float attached to a potentiometer which provides a 4-20 ma range (tank empty - tank full)input current. The 4-20 ma input and output currents are converted into 0-5V ranges using an adjustable interface unit supplied.

Temperature Rig with Forced Air Cooler

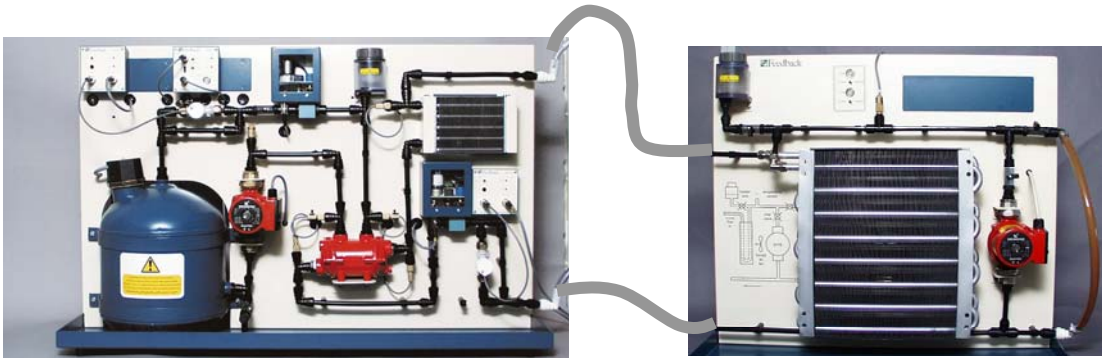


Figure 1-10: Temperature Rig with Forced Air Cooler

The Temperature Rig contains a primary pumped water circulating circuit, which is heated by an immersion heater in a tank. The water in the secondary flow circuit is heated in a heat exchanger through which the primary circuit passes.

Control of the secondary temperature may be exercised by connecting the secondary circuit to a source of running water and controlling the flow via the servo valve, or by connecting the Temperature Rig to the Level and Flow Rig (described above). In this case the Level and Flow Rig servo valve is used to control the flow and hence the temperature of the secondary circuit. However in these cases the degree of temperature control is limited and the Forced Air Cooler is used for optimum results.

The Forced Air Cooler provides two independent 4 – 20 mA circuits for control of cooling fan speed, and circulating pump speed.

Notes

2 System Requirements

Hardware

The hardware required for implementing the controllers described in the accompanying manuals includes as a minimum:

Pentium 700 MHz PC with 262 MB of main memory, CD ROM drive

PCI

For all apart from Digital Servo

Advantech PCI1711 I/O card and at least one free PCI slot on the motherboard.

This board has the following features

- Windows Plug and Play device
- 2 digital to analogue converter channels, 0-5V range
- 16 digital inputs (multiplexed to receive data from the control box)
- 16 analogue to digital converters (two used for tachometer inputs)

With the PCI1711 board a SCSI Adapter box is provided by Feedback to interface by ribbon cable to the Feedback plants.

Digital Servo only

Advantech PCI1751 I/O card and at least one free PCI slot on the motherboard.

This board has the following features

- Windows Plug and Play device
- 48 digital inputs / outputs

One or more of the Feedback Electromechanical plants previously described, with either external or built-in input/output electronics control box.

Software

Microsoft Windows 95, 98, NT, 2000	
Microsoft Visual C++ Professional Edition Version 6.0	
MATLAB Version 6.5	from Mathworks Inc.
Simulink Version 5.0	from Mathworks Inc
Real Time Workshop Version 5.0	from Mathworks Inc
Real Time Windows Target Version 2.2	from Mathworks Inc

Feedback PCI Software Pack for MATLAB (Advantech PCI1711 or PCI1751)

33-921V65	Digital Servo Workshop	PCI1751
33-927V65	Precision Modular Servo	PCI1711
33-936V65	Digital Pendulum	PCI1711
33-942V65	Magnetic Levitation System	PCI1711
33-949V65	Twin Rotor MIMO system	PCI1711
37-903V65	Process Control Trainer	PCI1711
38-906V65	Level and Flow Process Rig	PCI1711
38-908V65	Temperature Process Rig with Forced Air Cooler	PCI1711

3 Advantech PCI1711 Card

Introduction

If you have the Advantech PCI 1711 card, then follow the instructions given in this section. The PCI1711 uses the PCI bus and is therefore a Plug and Play device, which will be detected by the Windows Operating System when the computer is powered up.

Check

Check that you have the following items in the PCL-1711 Package

PCI-1711 card

CD-Rom disk

User manual

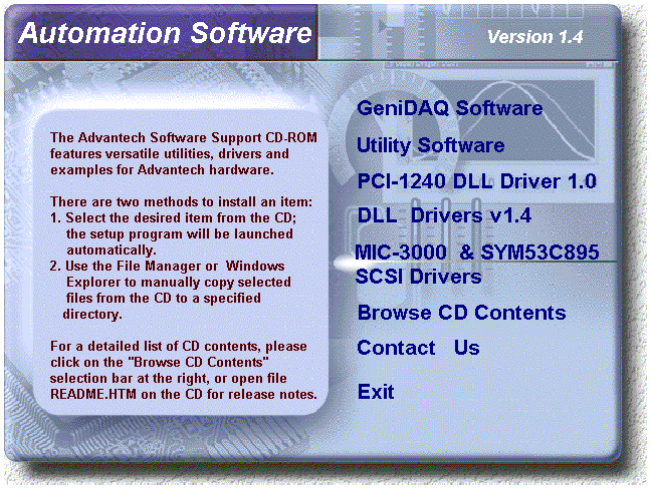
Quick start (single sheet instructions)

A) Driver Installation

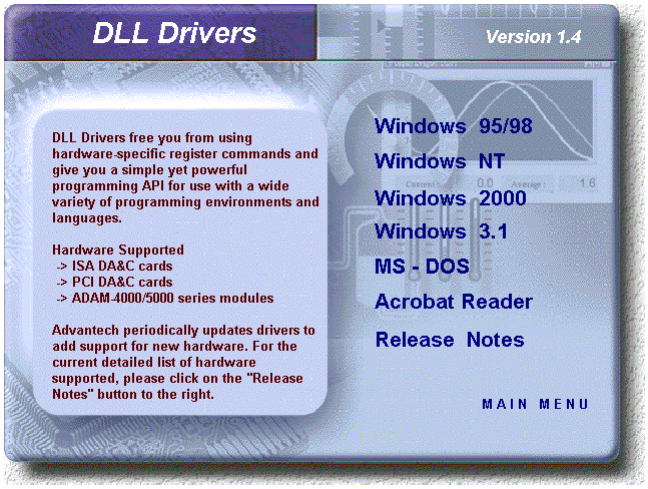
Step 1

Insert the companion CD disk into your CD-ROM drive

The `Setup` program will be launched automatically and you will see the following `Setup` screen

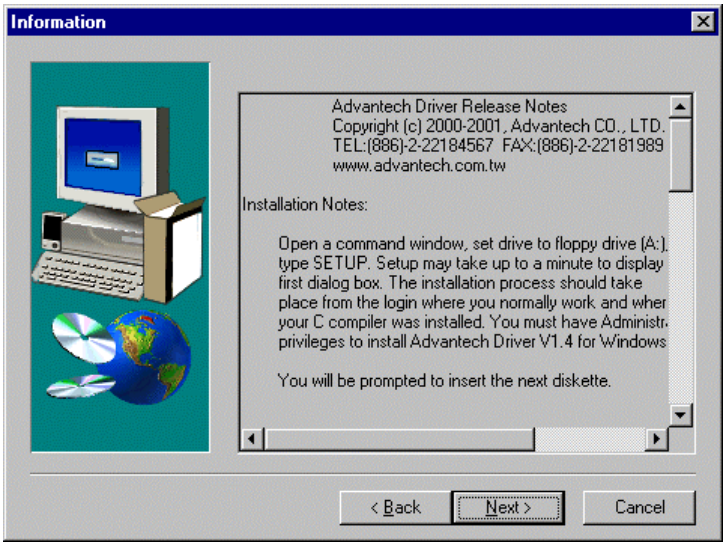


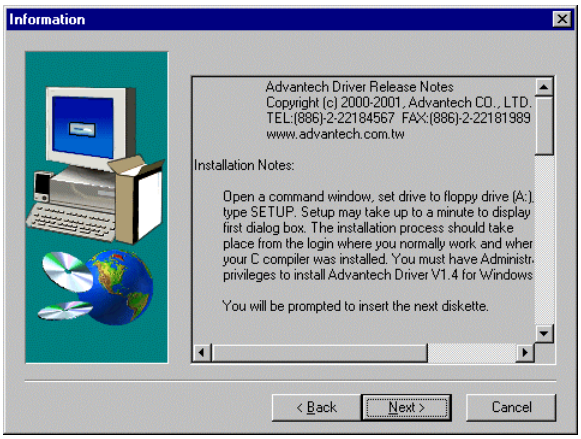
Step 2 Select the **`DLL Drivers`** installation option. (If `autoplay` is not enabled, use `Windows Explorer` or `Windows Run` command to execute `setup.exe` on CD-ROM).

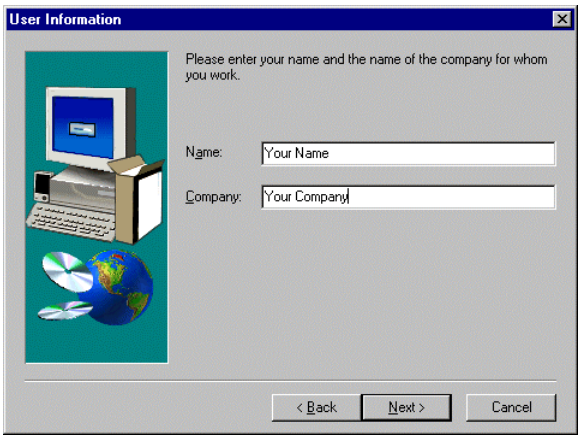


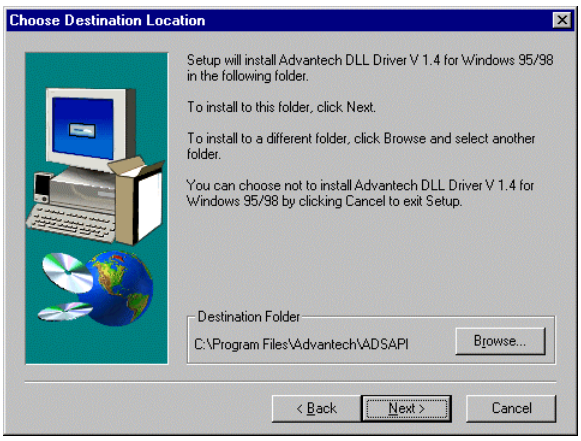
Step 3 Select your version of the **Windows** Operating System

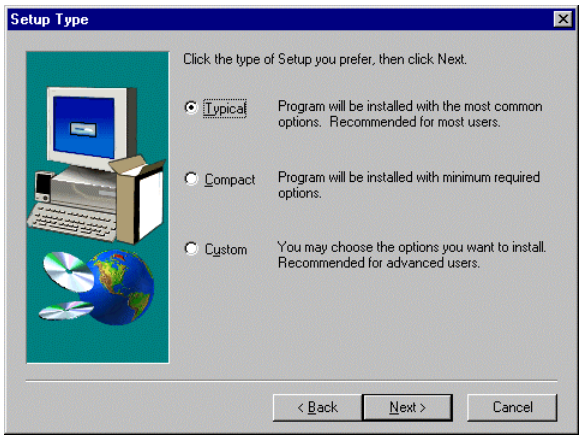
Step 4 Follow the installation instructions step by step to complete your DLL driver setup, as shown in the screen images below

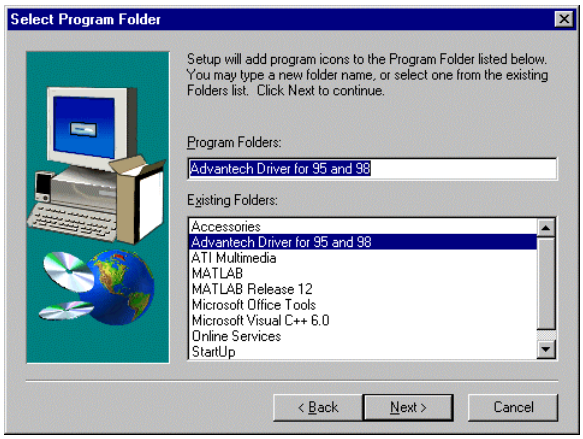


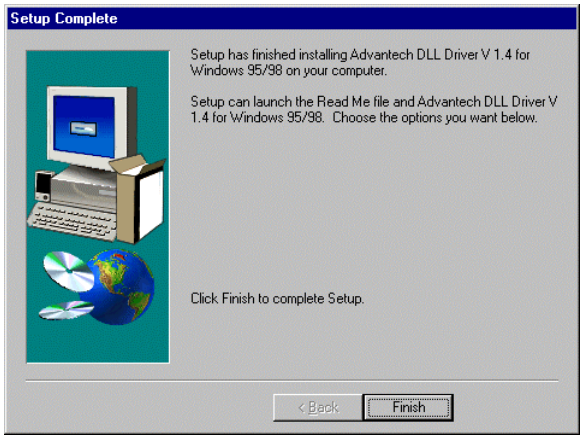

Information
Advantech Driver Release Notes
Copyright (c) 2000-2001, Advantech CO., LTD.
TEL:(886)-2-22184567 FAX:(886)-2-22181989
www.advantech.com.tw
Installation Notes:
Open a command window, set drive to floppy drive (A:)
type SETUP. Setup may take up to a minute to display
first dialog box. The installation process should take
place from the login where you normally work and wher
your C compiler was installed. You must have Administr
privileges to install Advantech Driver V1.4 for Windows
You will be prompted to insert the next diskette.
< Back
Next >
Cancel

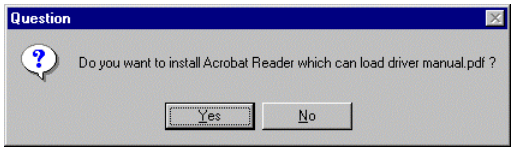

User Information
Please enter your name and the name of the company for whom you work.
Name:
Your Name
Company:
Your Company
< Back
Next >
Cancel


Choose Destination Location
Setup will install Advantech DLL Driver V 1.4 for Windows 95/98 in the following folder.
To install to this folder, click Next.
To install to a different folder, click Browse and select another folder.
You can choose not to install Advantech DLL Driver V 1.4 for Windows 95/98 by clicking Cancel to exit Setup.
Destination Folder
C:\Program Files\Advantech\ADSAPI
Browse...
< Back
Next >
Cancel


Setup Type
Click the type of Setup you prefer, then click Next.
Typical
Program will be installed with the most common options. Recommended for most users.
Compact
Program will be installed with minimum required options.
Custom
You may choose the options you want to install. Recommended for advanced users.
< Back
Next >
Cancel


Select Program Folder
Setup will add program icons to the Program Folder listed below. You may type a new folder name, or select one from the existing Folders list. Click Next to continue.
Program Folders:
Advantech Driver for 95 and 98
Existing Folders:
Accessories
Advantech Driver for 95 and 98
ATI Multimedia
MATLAB
MATLAB Release 12
Microsoft Office Tools
Microsoft Visual C++ 6.0
Online Services
StartUp
< Back
Next >
Cancel


Setup Complete
Setup has finished installing Advantech DLL Driver V 1.4 for Windows 95/98 on your computer.
Setup can launch the Read Me file and Advantech DLL Driver V 1.4 for Windows 95/98. Choose the options you want below.
Click Finish to complete Setup.
< Back
Finish


Question
Do you want to install Acrobat Reader which can load driver manual.pdf ?
Yes
No

B) Hardware Installation

Step 1	Turn off the computer and unplug the power cord and cables
Step 2	Remove the cover of the computer
Step 3	Remove the slot cover on the back panel of the computer
Step 4	Touch the metal part of your computer to discharge static electricity on your body
Step 5	Insert the PCI 1711 card into a PCI slot. Hold the card only by its edges and carefully align it with the slot, then insert the card firmly into place. Use of excessive force must be avoided otherwise the card may be damaged.
Step 6	Fasten the bracket of the PCI card on the back panel rail of the computer with screws
Step 7	Replace the computer cover, and re-connect the cables you removed in Step 2
Step 8	Connect the 68 pin SCSI connector on the PCI1711 board to the 68 pin connector on the Feedback SCSI Adapter box using the SCSI cable supplied. The other connectors on this box then connect to the Feedback equipment via the ribbon cables supplied

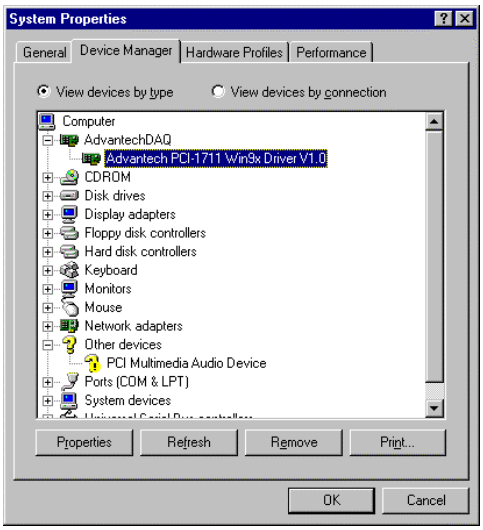
C) Verification

Step 1

Restart your Computer. Windows will detect the presence of the PCI1711 card and should find the driver, installed in steps **A)**

Step 2

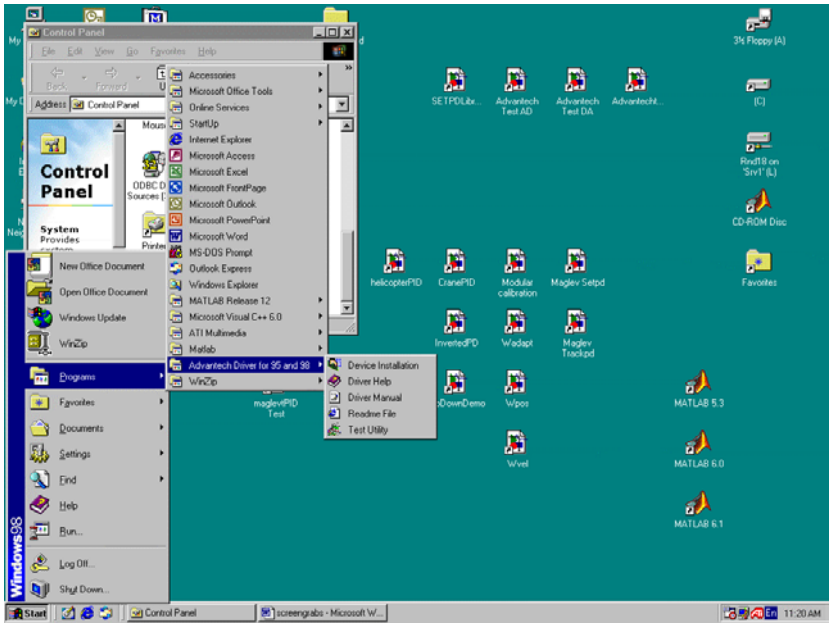
Access the `Device Manager` through the `Control Panel/System/Device Manager`. On the `Device Manager` tab of the `System Property` sheet you can see the `Device Name` of the PCI1711 listed on it.

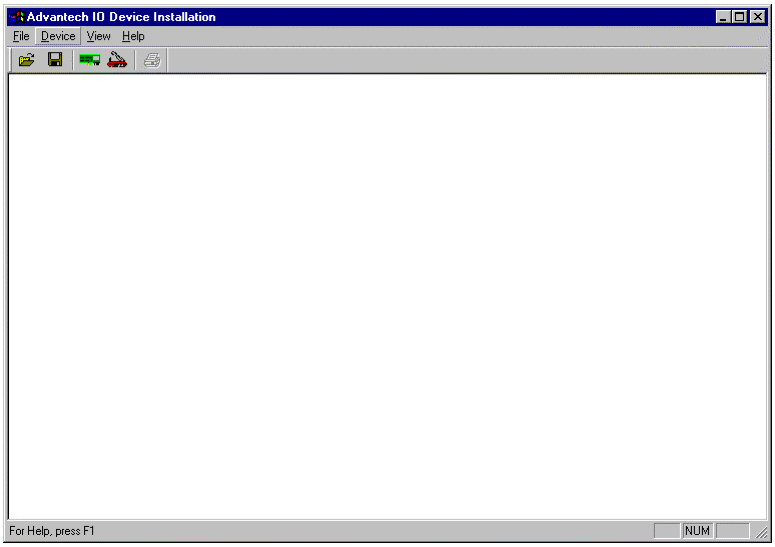


D) Device Installation

Step 1

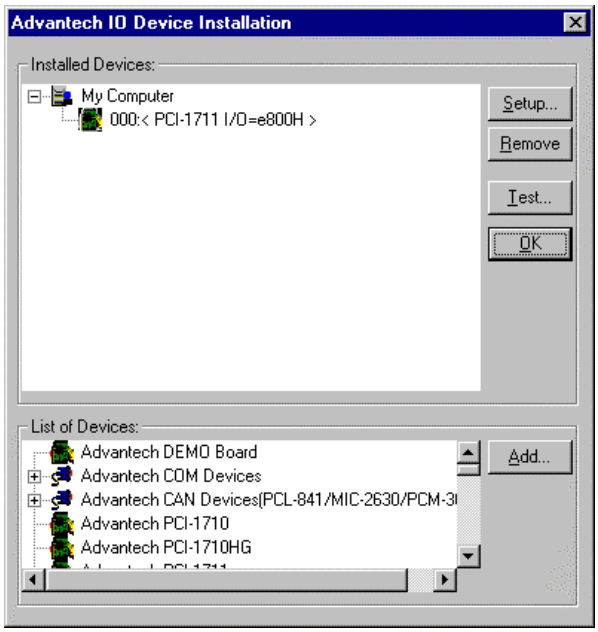
Run the `Device Installation` program by accessing `Start/Programs/Advantech Driver for 95 and 98`



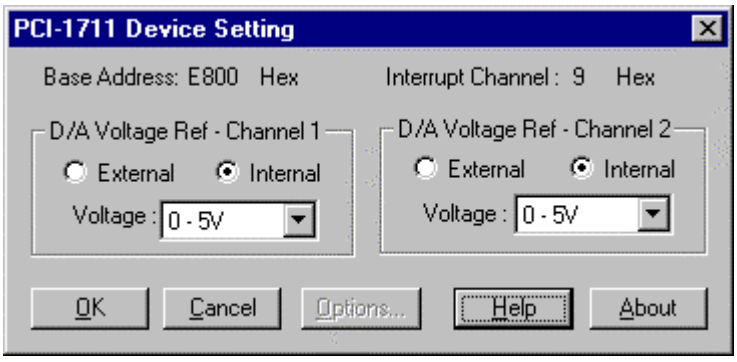


Step 2

On the `Device Installation` program Window, select the `Setup` menu item on the menu bar, and click the **`Device`** command to bring up the `I/O Device Installation` dialogue box as follows

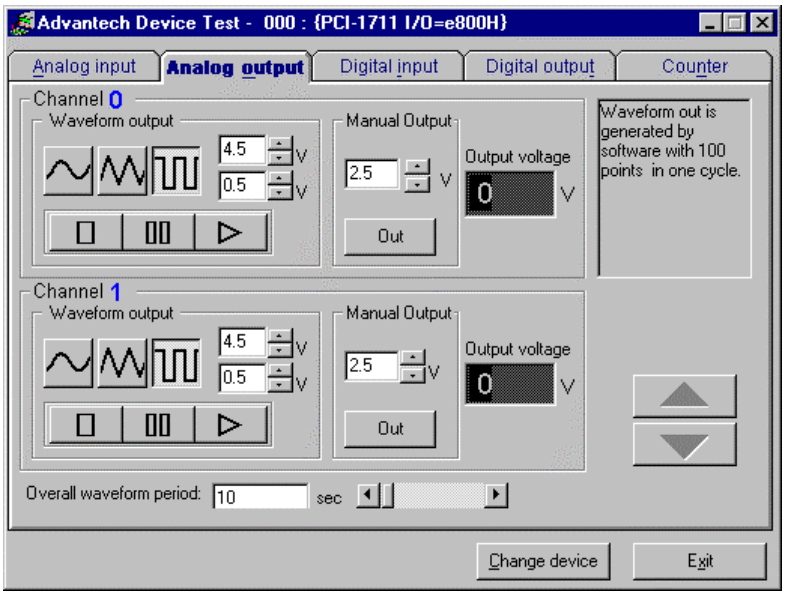


Step 3 Click the `Setup` tab. The `Device Setting` dialogue box will pop up



Step 4 Make sure the "`Internal`" radio button is set and that the D/A voltages are in the range 0-5V.

Step 5 Click the **Test** button on the Devices Installation window. The test utility window pops up which can be used to test the analogue and digital input and output.



Note

It is not necessary to make any on board adjustments to the PCI1711 board as its base address has automatically been configured by Windows during the Plug and play setup.

Notes

4 Advantech PCI 1751 Card (for Digital Servo 33-004 only)

Introduction

If you have the Advantech PCI 1751 card, then follow the instructions given in this section. The PCI1751 uses the PCI bus and is therefore a Plug and Play device, which will be detected by the Windows Operating System when the computer is powered up.

Check

Check that you have the following items in the PCL-1751 Package

PCI-1751 card

CD-Rom disk

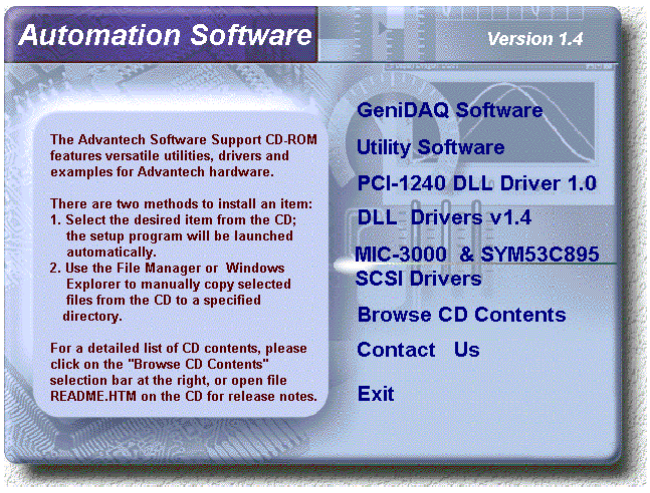
User manual

A) Driver Installation

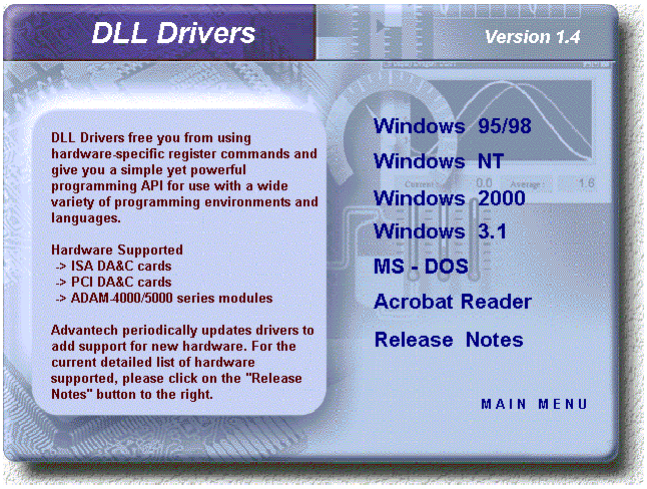
Step 1

Insert the companion CD disk into your CD-ROM drive

The `Setup` program will be launched automatically and you will see the following `Setup` screen

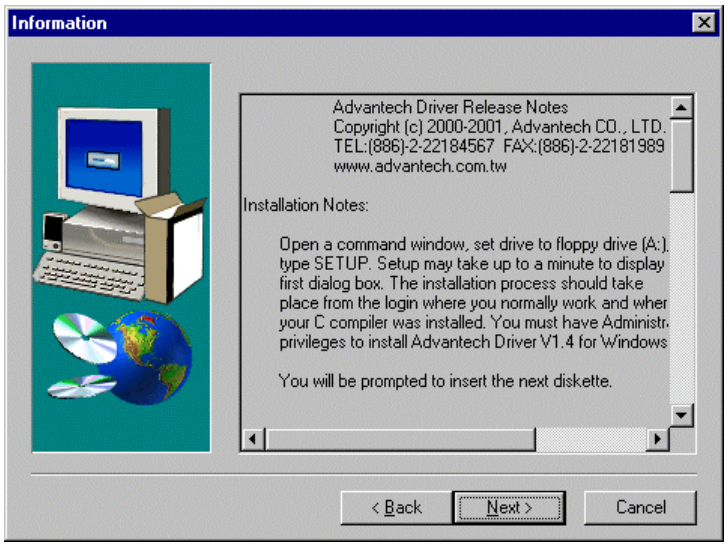


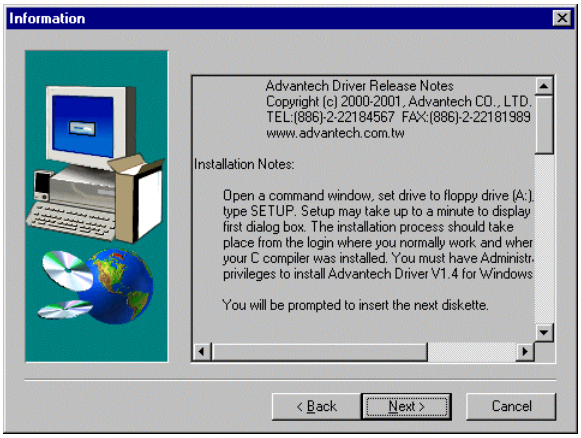
Step 2 Select the **`DLL Drivers`** installation option. (If `autoplay` is not enabled, use `Windows Explorer` or `Windows Run` command to execute `setup.exe` on CD-ROM).

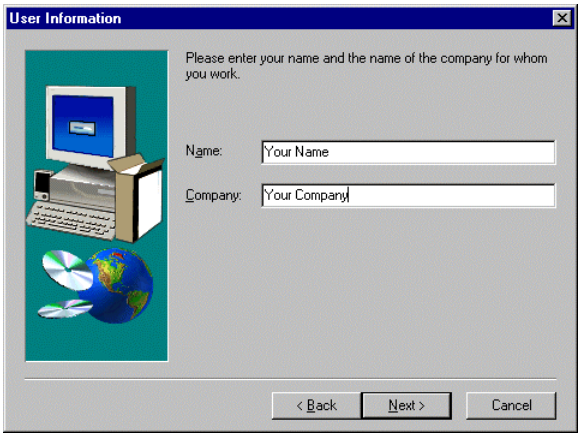


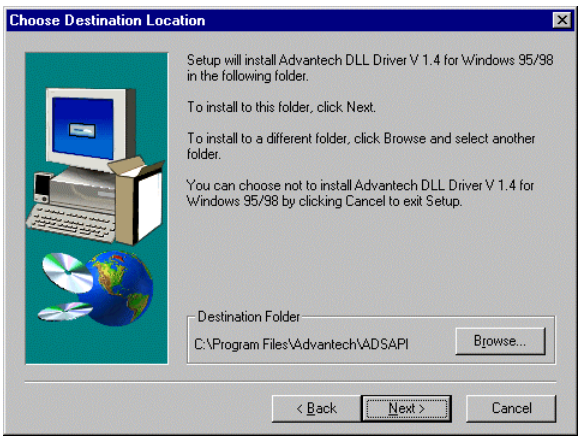
Step 3 Select the **Windows 95/98** or the option according to your operating system. **Windows NT**

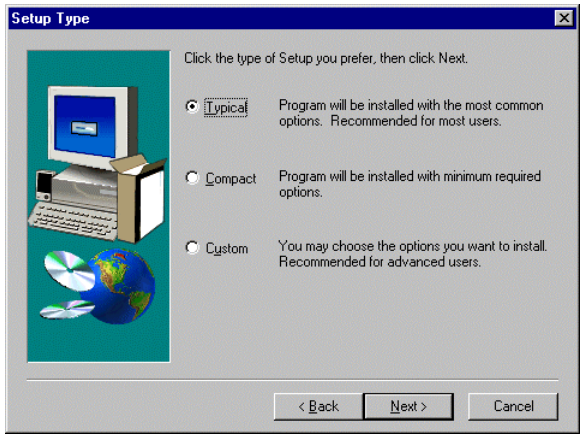
Step 4 Follow the installation instructions step by step to complete your DLL driver setup, as shown in the screen images below

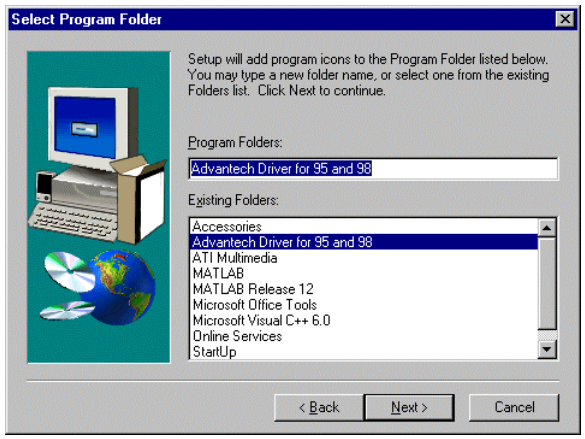


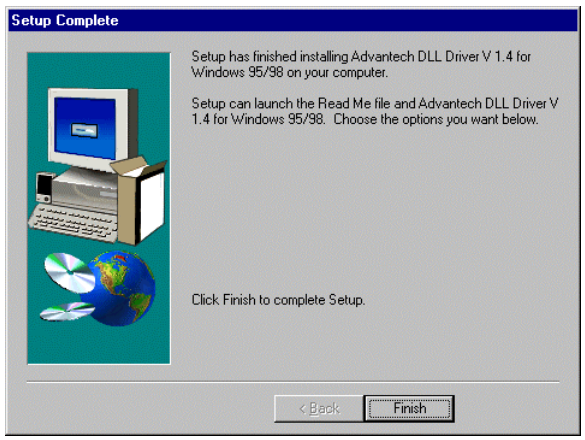

Information
Advantech Driver Release Notes
Copyright (c) 2000-2001, Advantech CO., LTD.
TEL:(886)-2-22184567 FAX:(886)-2-22181989
www.advantech.com.tw
Installation Notes:
Open a command window, set drive to floppy drive (A:),
type SETUP. Setup may take up to a minute to display
first dialog box. The installation process should take
place from the login where you normally work and wher
your C compiler was installed. You must have Administr
privileges to install Advantech Driver V1.4 for Windows
You will be prompted to insert the next diskette.
< Back
Next >
Cancel

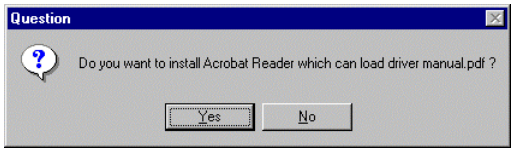

User Information
Please enter your name and the name of the company for whom you work.
Name:
Your Name
Company:
Your Company
< Back
Next >
Cancel


Choose Destination Location
Setup will install Advantech DLL Driver V 1.4 for Windows 95/98 in the following folder.
To install to this folder, click Next.
To install to a different folder, click Browse and select another folder.
You can choose not to install Advantech DLL Driver V 1.4 for Windows 95/98 by clicking Cancel to exit Setup.
Destination Folder
C:\Program Files\Advantech\ADSAPI
Browse...
< Back
Next >
Cancel


Setup Type
Click the type of Setup you prefer, then click Next.
Typical
Program will be installed with the most common options. Recommended for most users.
Compact
Program will be installed with minimum required options.
Custom
You may choose the options you want to install. Recommended for advanced users.
< Back
Next >
Cancel


Select Program Folder
Setup will add program icons to the Program Folder listed below. You may type a new folder name, or select one from the existing Folders list. Click Next to continue.
Program Folders:
Advantech Driver for 95 and 98
Existing Folders:
Accessories
Advantech Driver for 95 and 98
ATI Multimedia
MATLAB
MATLAB Release 12
Microsoft Office Tools
Microsoft Visual C++ 6.0
Online Services
StartUp
< Back
Next >
Cancel


Setup Complete
Setup has finished installing Advantech DLL Driver V 1.4 for Windows 95/98 on your computer.
Setup can launch the Read Me file and Advantech DLL Driver V 1.4 for Windows 95/98. Choose the options you want below.
Click Finish to complete Setup.
< Back
Finish


Question
Do you want to install Acrobat Reader which can load driver manual.pdf ?
Yes
No

B) Hardware Installation

Step 1	Turn off the computer and unplug the power cord and cables
Step 2	Remove the cover of the computer
Step 3	Remove the slot cover on the back panel of the computer
Step 4	Touch the metal part of your computer to discharge static electricity on your body
Step 5	Insert the PCI 1751 card into a PCI slot. Hold the card only by its edges and carefully align it with the slot, then insert the card firmly into place. Use of excessive force must be avoided otherwise the card may be damaged.
Step 6	Fasten the bracket of the PCI card on the back panel rail of the computer with screws
Step 7	Replace the computer cover, and re-connect the cables you removed in Step 2
Step 8	Connect the 68 pin SCSI connector on the PCI1751 board to the connector on the Digital Servo Digital Board using the special cable supplied by Feedback.

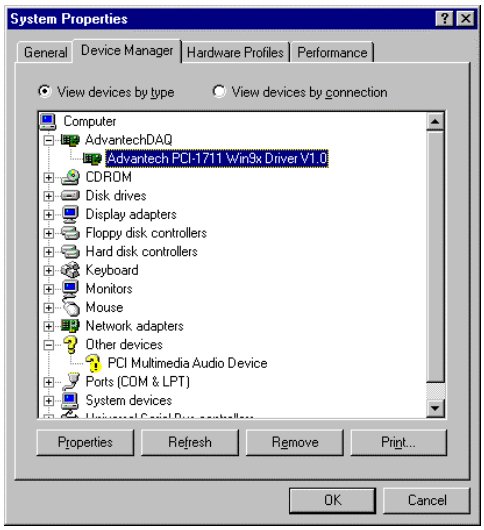
C) Verification

Step 1

Restart your Computer. Windows will detect the presence of the PCI1751 card and should find the driver, installed in steps **A)**

Step 2

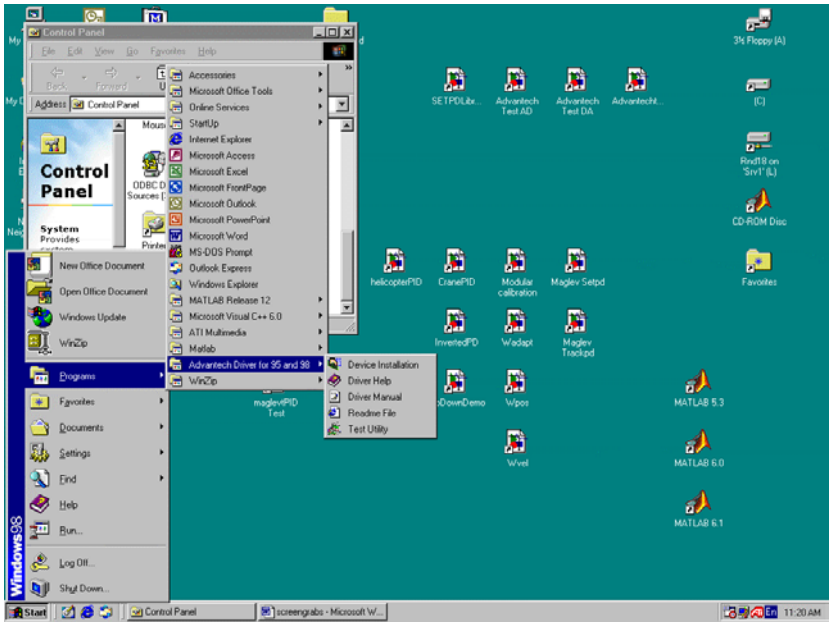
Access the `Device Manager` through the `Control Panel/System/Device Manager`. On the `Device Manager` tab of the `System Property` sheet you can see the `Device Name` of the PCI1751 listed on it.

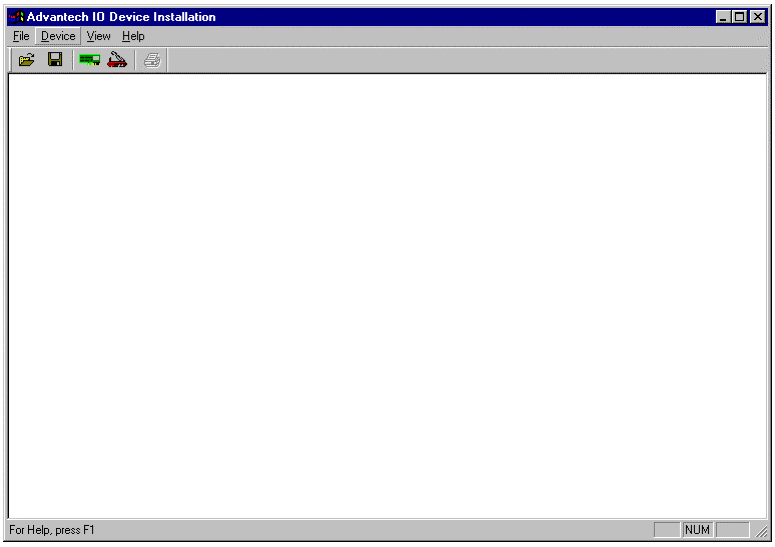


D) Device Installation

Step 1

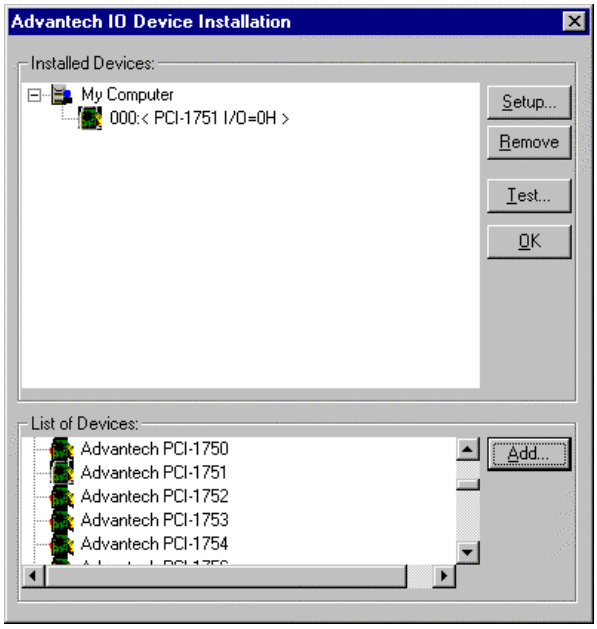
Run the `Device Installation` program by accessing `Start/Programs/Advantech Driver for 95 and 98`





Step 2

On the `Device Installation` program Window, select the `Setup` menu item on the menu bar, and click the **`Device`** command to bring up the `I/O Device Installation` dialogue box as follows



The window shown above shows that the board has been correctly installed.

Note

It is not necessary to make any on board adjustments to the PCI1751 board as its base address has automatically been configured by Windows during the Plug and play setup.

5 Software

Installation

Follow this sequence of instructions to install all the systems

Hardware

1 Assemble, commission and test the Feedback Electromechanical plant according to the instructions contained in the following Feedback Installation and Commissioning manuals. An Advantech I/O board should already have been installed as described in Chapter 3 (Advantech PCI1711) or Chapter 4 (Advantech PCL-812PG)

33-922-1	for the Digital Servo
33-936-0	for the Digital Pendulum
33-942-0	for Magnetic Levitation
33-949-0	for the Helicopter TRMS
33-927-0	for the Modular Servo
37-903-1	for the Process Trainer
38-906-1	for the Level and Flow Rig
38-908-1	for the Temperature Rig

MATLAB Software

2 Install MATLAB, Simulink, Real Time Workshop, Real Time Windows Target, and Microsoft Visual C++ according to the supplier's instructions.

3 Start MATLAB

4 To set up Real Time Windows Target; in the MATLAB Command Window type:

```
rtwintgt  -setup
```

Note space before the "-"

5 To inform MATLAB of the location of your Visual C++ compiler; in the MATLAB Command window type:

```
mex -setup
```

Note space before the "-"

MATLAB responds with

```
Would you like mex to locate installed
compilers [y]/n?
```

In the MATLAB Command window type `"y"`

MATLAB responds similarly to the following:

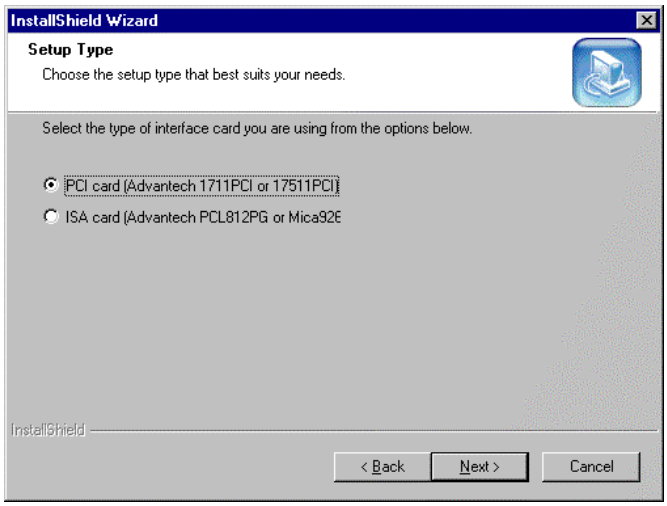
```
Please choose your compiler for building
external interface (MEX) files:

Select a compiler:

[1] Digital Visual Fortran version 6.0 in
C:\Program Files\Microsoft Visual Studio

[2] Lcc C version 2.4 in
C:\MATLABR12\sys\lcc

[3] Microsoft Visual C/C++ version 6.0 in
C:\Program Files\Microsoft Visual Studio
```

In the MATLAB Command window type "3" to select Visual C++

Feedback Software for MATLAB

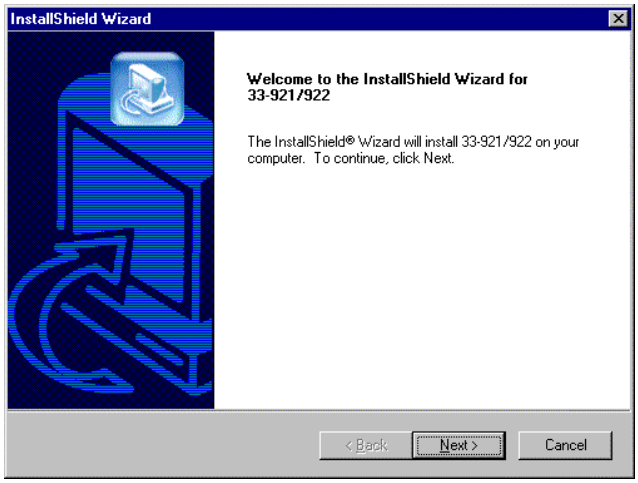
6. Insert the Feedback software CD for the particular Feedback plant you are installing.

   After some preliminary screens you will be asked to choose the type of I/O board. Select the correct one by clicking the radio button as shown in the figure below. The one shown is for the Digital Servo - other systems will have similar screens.



Click `Next`

The following screen is shown



Click `Next`

Your system is now installed

Note

If you have previously installed the model files and have made any changes to the Simulink models in the C:\MatlabR12\Feedback folder, you should first save the contents of C:\MatlabR12\Feedback to another folder, otherwise they will be overwritten.

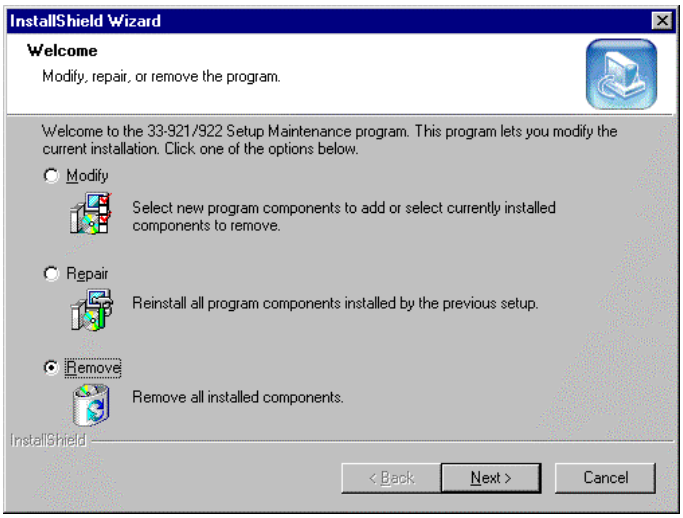
Un-installation

Feedback software for MATLAB un-installation

To uninstall all the Feedback base software files. follow the following sequence:

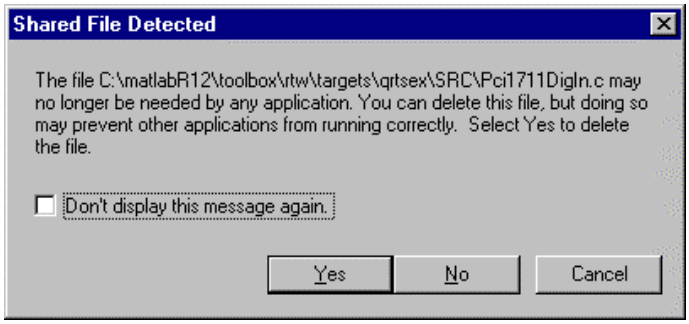
Insert the Feedback software CD for the particular Feedback plant you are un-installing.

You will see the following screen



Click on the `Remove all installed components` radio button.

The following screen will be shown



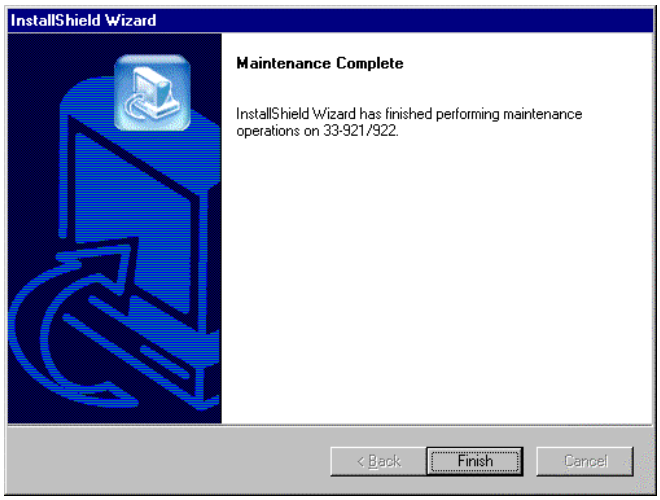
You will be asked to confirm the deletion as shown in the screen above.

Click on the `Yes` button if you wish to delete this file.

You will get a similar request for all other files which may be shared with other applications. Respond with `Yes` if you wish to delete them.

Note the contents of the above messages, these files may be shared and deletion may stop other programs from working

The following screen appears



.

Click on `Finish`

The Feedback software for MATLAB will be removed for this particular system.

Note

There are two other radio buttons shown on the installation screen marked `Modify` and `Repair`. It is recommended that you do not use these. Instead to re-install a system, first `Un-install` and then `Install`. Remember to first save any of your modified Simulink models.

Files placed on disk after software installation

Base software

After the software installation has been completed as described above, the following files should now be present on your computer.

Directory Name	Contents
matlabroot\toolbox\rtw\tarqets	Folder fbk
matlabroot\toolbox\rtw\targets\fbk	Folders fbk, src
matlabroot\toolbox\rtw\targets\fbk\src	All I/O drivers
matlabroot\toolbox\rtw\targets\fbk\fbk	Feedback I/O additions to Simulink Library
matlabroot\work	start.m - M file containing the Path statements for MATLAB including the Feedback special files

Table 5-1: Location of Feedback base software

The following paths will be added to the MATLAB Path Browser window.

```
matlabroot\toolbox\rtw\targets\fbk
matlabroot\too1box\rtw\targets\fbk\1ib
matlabroot\toolbox\rtw\targets\fbk\src
matlabroot\toolbox\rtw\targets\fbk\fbk
```

Applications software

After the applications software installation has been completed as described above, the following Simulink model files should now be present on your computer.

Directory Name	Contents
matlabroot\feedback\pendulum	CranePID.mdl InvertedPD.mdl UpDownDemo.mdl
matlabroot\feedback\helicopter	helicopterPID.mdl
matlabroot\feedback\maglev	calibration.mdl, Setpd.mdl Trackpd.mdl
matlabroot\feedback\modular	calibration.mdl, Wadapt.mdl Wpos.mdl Wvel.mdl
matlabroot\feedback\servotrainer	**EISA** - MicaServoIODemo.mdl MicaStMotor.mdl, ServoMicaPID.mdl **PCI** - ServoIODemo.mdl, StMotor.mdl, ServoPID.mdl
matlabroot\feedback\levelflow	levelflowcalib.mdl, levelflowonoff.mdl, levelflowpid

Directory Name	Contents
matlabroot\feedback\ptrainer	ptcalibration.mdl, ptraineronoff.mdl, ptrainerpid.mdl

Table 5-2: Location of Feedback Simulink Application models

Note

matlabroot is the general name of the directory, where you have chosen to locate your copy of Matlab

Note also that the Simulink applications modules in Table 5-2 are either EISA or PCI versions, but **not** both on the same PC

Notes

6 Trouble shooting and Installation Hints - MATLAB 6.5 version

This section is included to give guidance on the correct installation for the MATLAB software and the Feedback applications.

Matlab Installation

When you have installed MATLAB 6.5, Simulink, Real Time Workshop and Real Time Windows Target, execute the following command in the MATLAB command window

```
Ver
```

Matlab will respond similarly to the following

```
MATLAB Version 6.5.0.180913a (R13)

MATLAB License Number: xxxxxx

Operating System: Microsoft Windows 2000
Version 5.0 (Build 2195: Service Pack 1)

Java VM Version: Java 1.3.1_01 with Sun
Microsystems Inc. Java HotSpot(TM) Client VM

MATLAB                Version 6.5         (R13)

Simulink              Version 5.0         (R13)

Real-Time Windows Target Version 2.2      (R13)

Real-Time Workshop Version 5.0            (R13)
```

Check that your installation versions match the above

Feedback Installation

The Feedback Installation program will automatically detect where the MATLAB 6.5 system is installed and install the applications in the correct place.

The software packs supplied by Feedback for MATLAB applications comprise the following. They are however known to MATLAB by names which are more descriptive of the actual product. The following table shows the ordering or part number and the name of the relevant product.

	Part / Order Number	Product / MATLAB Name
Group 1	33-942-V65	**Maglev** (Magnetic Levitation)
	37-902-V65	**Ptrainer** (Process Trainer)
	38-906-V65	**LevelFlow** (Level and Flow Rig)
	38-908-V65	**Temperature** (Temperature Rig with Forced air Cooler)

Group 2	33-921-V65	**Servotrainer** (Digital Servo)
	33-927-V65	**Modular** (Precision Modular Servo)
	33-936-V65	**Pendulum** (Digital Pendulum)
	33-949-V65	**Helicopter** (Twin Rotor MIMO system)

The Feedback Installations for the Group 1 products in the above table are different from those for the Group 2 Products.

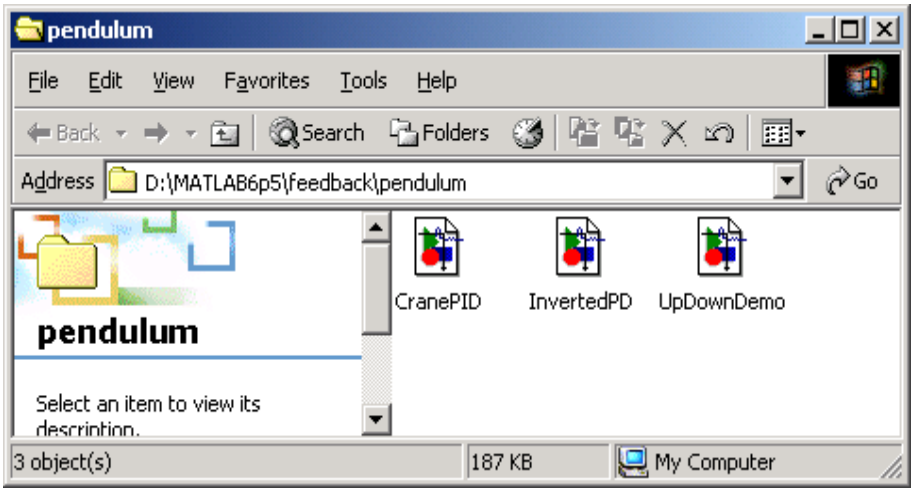
Group 1 Products are purely analogue devices and use only standard Real Time Windows Target Library Input / Output drivers for the Advantech PCI 1711 board. The Feedback Installation routines install only the Simulink Application models.

Group 2 Products are both analogue and digital devices and require special Feedback written drivers for the Advantech PCI 1711 and PCI 1751 boards. The Feedback Installation routines install both the Simulink Application models and the Input / Output drivers.

For all Products

Make the following checks after you have installed the Feedback Applications software

1. Check that the MATLAB 6.5 folder contains a folder named Feedback. This folder contains the Simulink models supplied by Feedback. For example if you have installed the Pendulum software this folder should contain a folder named **Pendulum** which should contain the following Simulink models



In this example the MATLAB 6.5 system is installed on to drive **D:,** but will normally be a drive you select when installing MATLAB, such as **C:, D:, E:** etc.

2. In order to be able to type the Simulink model name into the MATLAB command window, MATLAB requires that the Folder and File name path are known to MATLAB. When MATLAB is launched a MATLAB program (M file) is executed which contains the MATLAB **Path** statements. This program is

```
Matlabroot \ work \ startup.m
```

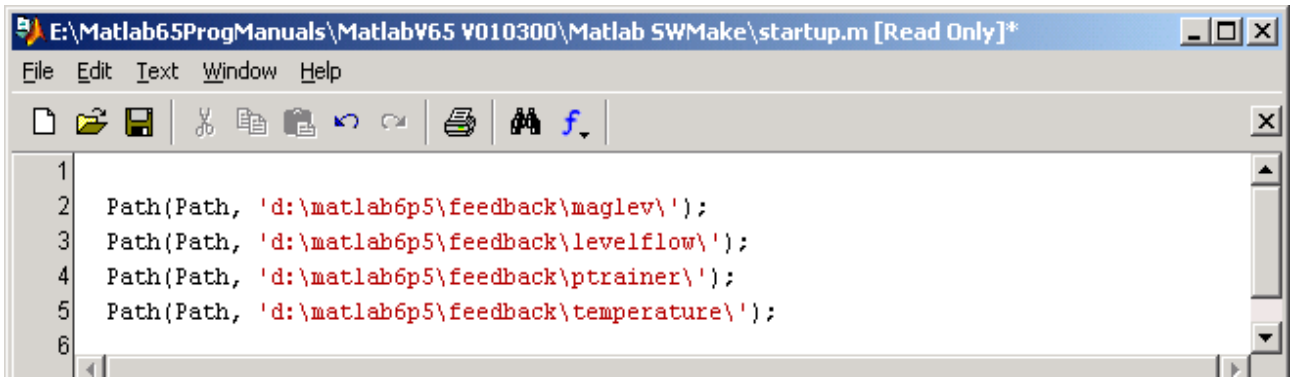
Where matlabroot is the location of your MATLAB system such as

```
C: \ Matlab6p5
```

The Feedback Installation will automatically set the proper entries in the `startup.m` file.

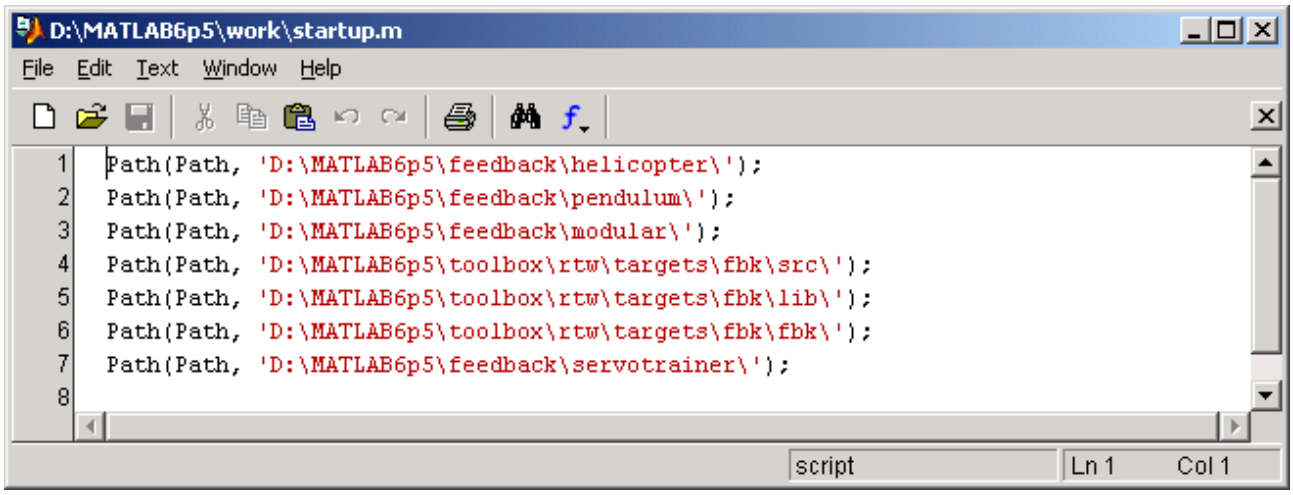
Group 1 products

The following screen dump shows the correct entries in the `Startup.m` file when all the Group 1 products have been installed.



Group 2 products

The following screen dump shows the correct entries in the `Startup.m` file when all the Group 2 products have been installed.



The following additional statements displayed above, place the special Feedback drivers for the analogue and digital products on the MATLAB path

```
Path(Path, D:\MATLAB6p5\toolbox\rtw\targets\fbk\src\');
Path(Path, D:\MATLAB6p5\toolbox\rtw\targets\fbk\lib\');
Path(Path, D:\MATLAB6p5\toolbox\rtw\targets\fbk\fbk\');
```

These statements should exist when **any one or more** Group 2 products are installed.

Check that the **fbk**, **src** and **lib** folders exist and are not empty

7 Hints and some common problems

Incorrect MATLAB system

Do not use a Student version of the MATLAB software. This will not function properly with the Feedback applications software.

Version Incompatibility

Unless you are **very** familiar with MATLAB it is strongly recommended that you do not have other versions of MATLAB such as MATLAB 6.0, 6.1 installed in the same disk partition as MATLAB 6.5.

Only one version of Real Time Workshop (RTW) and Real Time Windows Target (RTWT) can be active. If you have installed RTW for MATLAB 6.5, any attempt to use RTW to compile under another version of MATLAB will result in an error diagnostic, due to incompatible versions.

Starting MATLAB

Always re-start the computer when prompted to do so by MATLAB after making any change to the installation. Re-starting ensures that the correct software versions are properly entered into the Windows registry. If you do not then there is a risk of using old or incompatible versions.

Always restart MATLAB after any Feedback installation. The `Startup.m` file is executed at MATLAB launch, and if you do not you will not be able to run the Feedback applications.

System hanging when running Feedback Simulink models

A common cause of the system “hanging” are attempts to **move** or **re-size** windows (such as Simulink scopes), or **saving** the model during the execution of the program, after it has been compiled by RTW and Started using the External Mode Control Panel.

When the program is **Started** a Real Time Kernel program is launched which runs at a higher priority than some of the Windows operating system functions. This can lead to conflicts when attempting to use some Windows functions and cause a system hang, or loss of contact between the Real Time program and the device.

Failure to compile the Simulink model properly

If you make additional models using the Feedback models as a basis, or new models using the Simulink library you must check that the correct Template makefile is being used for the Target.

Matlab , RTW and RTWT comprise a suite of programs which may be used to download control programs to a wide variety of processor hardware or targets and the correct ones must be selected. The procedure for checking the correct Template makefile is shown below for Group 1 and Group 2 products.

Group 1 products

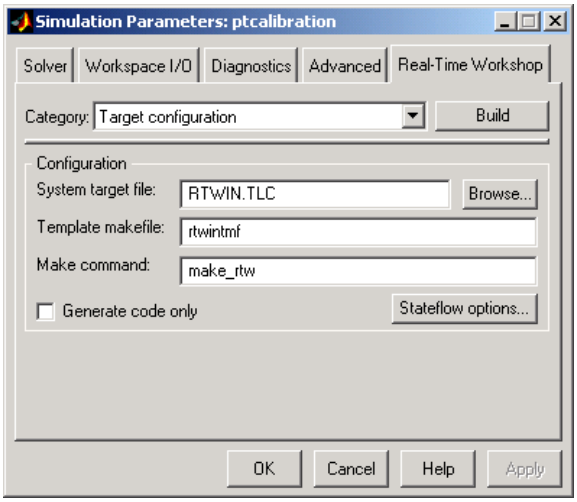
Open the Simulink model and select the menu item

Tools

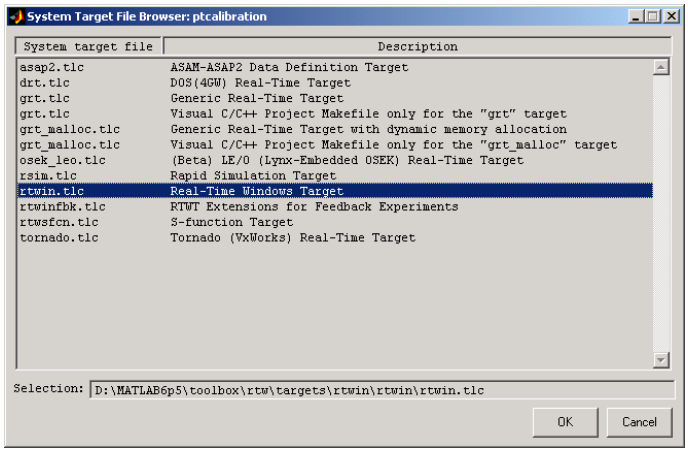
Real Time workshop

Options

A screen will be presented similar to that shown below



Ensure that the entries in the System target file, Template makefile and Make command are exactly as shown. If not select the Browse tab and highlight rtwin.tlc before OK and returning as shown below.



Group 2 products

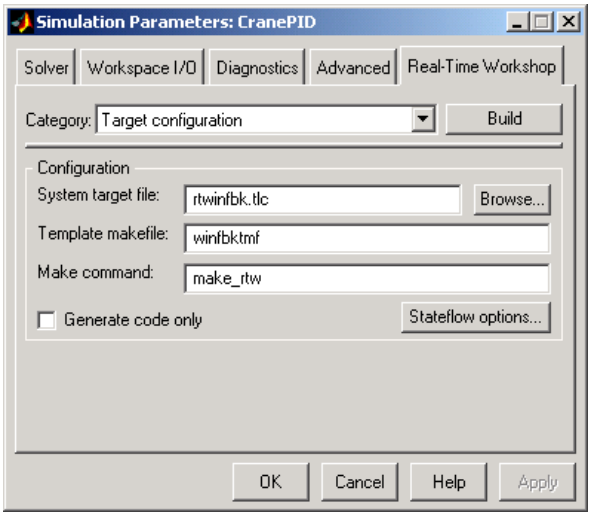
Open the Simulink model and select the menu item

Tools

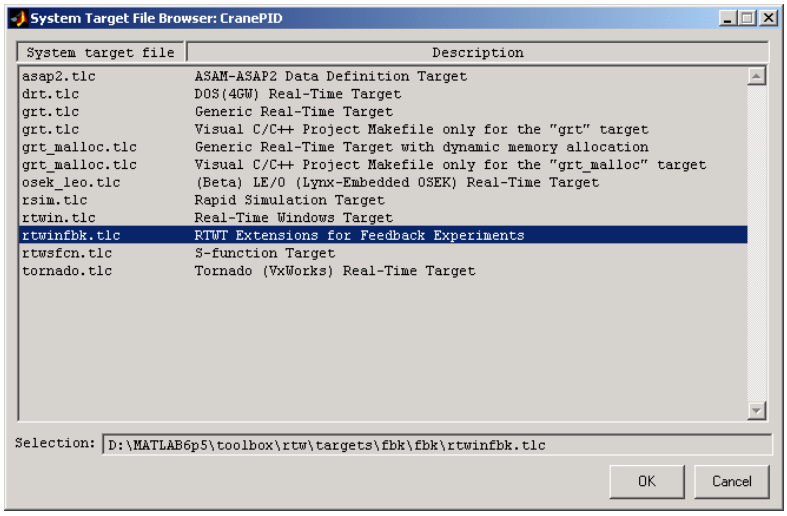
Real Time workshop

Options

A screen will be presented similar to that shown below



Ensure that the entries in the System target file, Template makefile and Make command are exactly as shown. If not select the Browse tab and highlight **rtwinfbk.tlc** before OK and returning as shown below.



8 Feedback Simulink Models – Hints and Tips

This section is included to assist the user in the understanding the operation of the Simulink® models provided by Feedback on the Installation CD Rom and, in particular, the operation of the input / output drivers provided by Mathworks® with Real Time Windows Target®.

The following products use **only** standard library software elements provided by Mathworks. Problems encountered with the operation of this software may be referred to Mathworks for resolution. Note that the Advantech PCI1711 board is used for all these products.

Magnetic Levitation

Level and Flow Rig

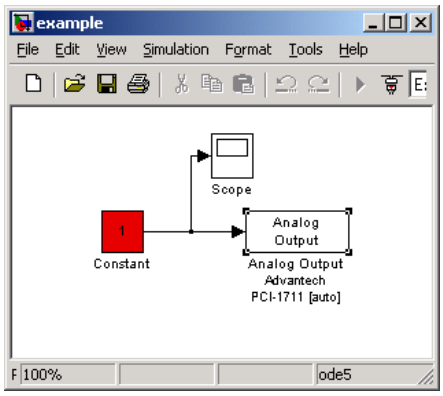
Process Trainer

Temperature Rig and Forced Air Cooler

8.1 User generated models for the products listed above

You can generate your own models for the products listed above using Simulink and Real Time Windows Target library elements as follows.

To generate and run the following simple model, follow the steps listed. Similar steps can be taken for a Simulink model with an Input block.



Select “New” and then Model from the Matlab File menu.

Select the “Library Browser” from the view menu on the Simulink window title bar .

Select a Constant block from the Sources section of the library browser and drag it to the Simulink Window

Select an Analogue Output block from the Real Time Windows Target section of the Library browser and drag it to the Simulink Window

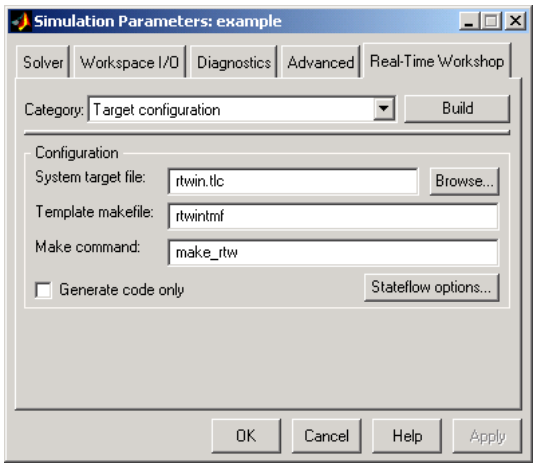
Double click the Analogue Output block on the Simulink Window and select the Advantech PCI 1711 board.

Set the Sample Time to 0.001 seconds and the Output Channel number to 1

Set the Stop time to whatever you want in seconds. The model stops after this time.

Go to the Simulation Parameters on the Simulink menu on the Simulink window and set the Solver Options to Fixed step. On this window click the Real Time Workshop tab. Select the configuration to exactly as shown below by using the Browse tab and selecting the Real Time Windows Target line

Your Simulation Parameters Window should look exactly as shown below

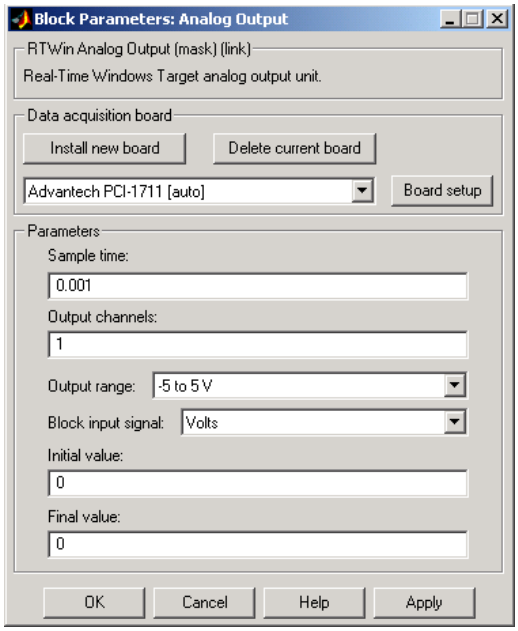


8.2 Settings of the Input/Output block

Double click the Input/Output block and select the Block input signal from the screen shown below

Case 1

Block Input Signal set to volts, output range to –5 to +5 volts



Input to Block	Block Output - volts
-5	0
0	2.5
5	5

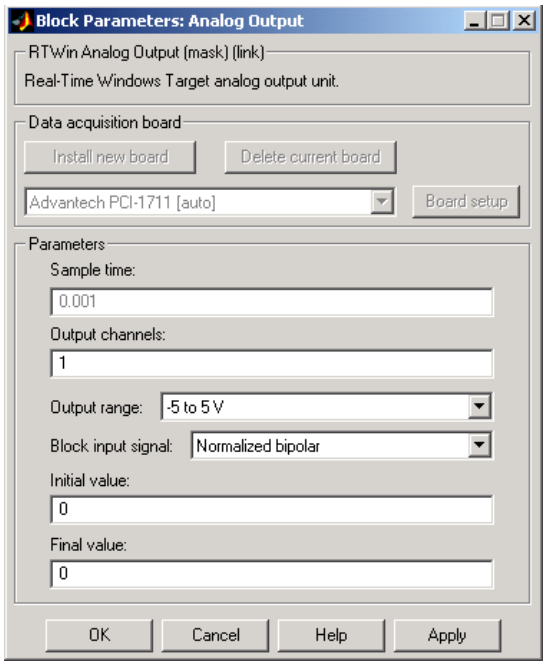
The Advantech board can only output a positive voltage – in this case 0 to 5 volts.

Therefore a block input of –5 to +5 is mapped to 0-5volts at the block output

The table above shows the output to the Feedback plant for given block inputs.

Case 2

Block Input Signal set to normalised bipolar, output range to –5 to +5 volts



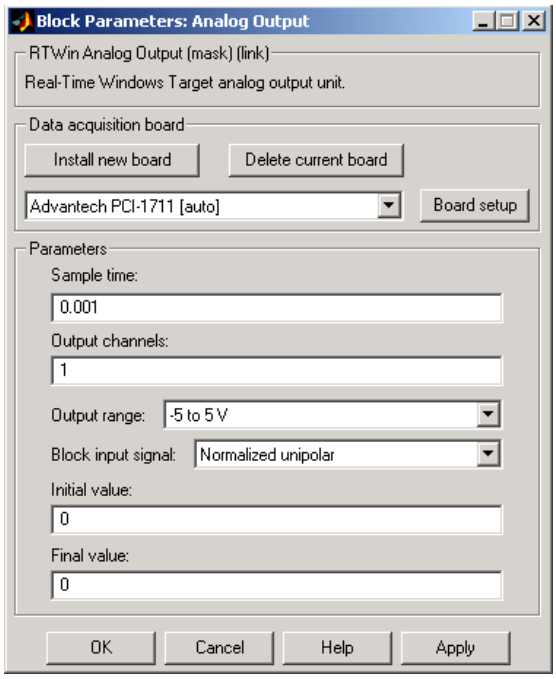
Input to Block	Block Output - volts
-1	0
0	2.5
1	5

In this case the block input range –1 to +1 is mapped to 0 to 5volts on the block output.

The table above shows the output to the Feedback plant for given block inputs.

Case 3

Block Input Signal set to normalise unipolar, output range to –5 to +5 volts



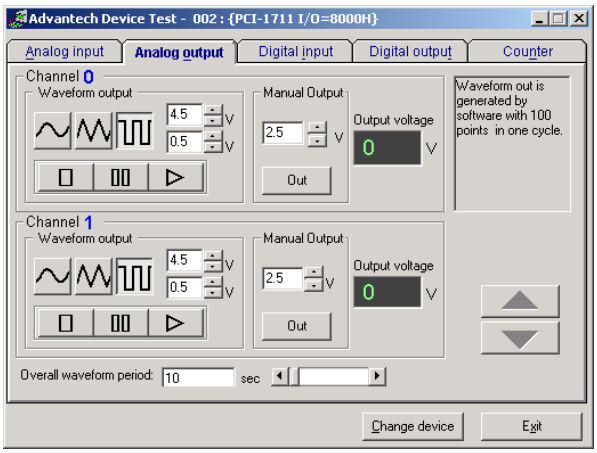
Input to Block	Block Output - volts
-1	0
0	2.5
1	5

8.3 Using the Advantech Test program

Analogue Output

If you wish to test the board independently of MATLAB, then select the Advantech driver from the Windows Program menu, and then Driver Test. Select the PCI-1711 board.

You will then get the following test window. Select Analogue Output



Select a voltage in the Manual Output section on channel 0 (the one used in the Simulink model) and click the “Out “ tab. An accurate voltage will then be output.

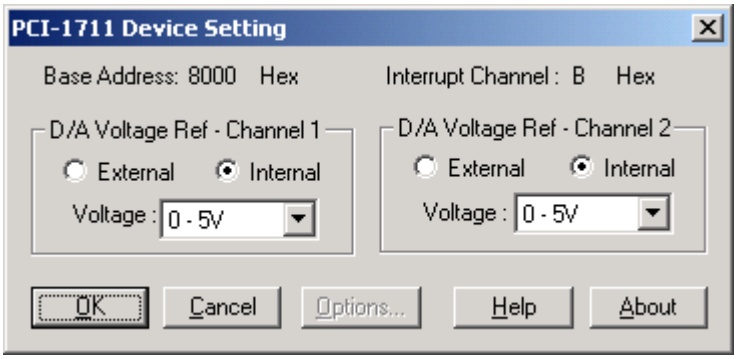
Note that the test channels 0 and 1 correspond to Simulink channels 1 and 2

Setting the PCI1711 correct output voltage

The PCI 1711 board must be set to the range 0-5 Volts for all Feedback Equipment

To set the Advantech voltage to 0-5 Volts range, go to the Windows Start Menu, and from the Programs menu select the Advantech Driver. Select Device installation. Select Device, then Setup. Select the Advantech PCI-1711 and then Setup.

Ensure that the screen which appears is exactly as shown below, otherwise reset it to that shown. You will have to re-boot for any change to be effective.

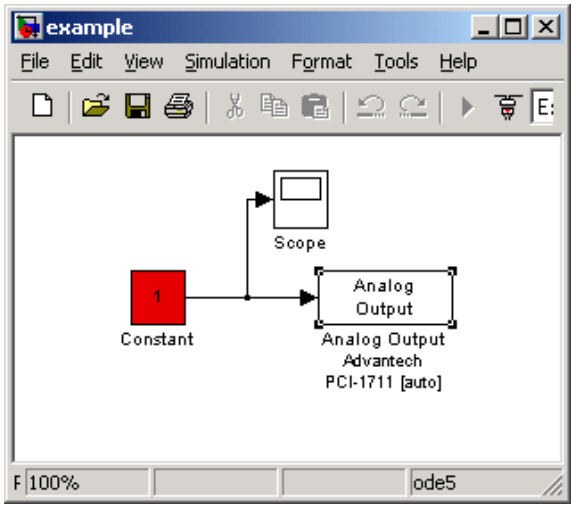


Analogue Input

A similar process may be undertaken to check Analogue Input operation.

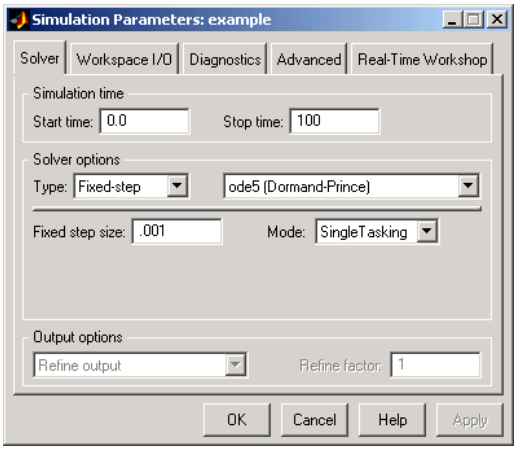
8.4 Simulink Scopes

The operation of Simulink scopes requires a little explanation.



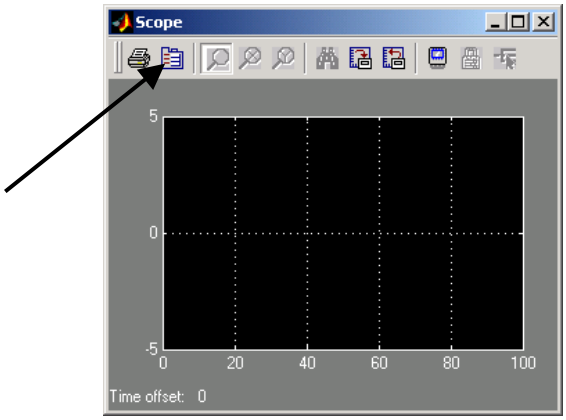
Consider the model shown above

You set the running time of the Simulation model in the Simulation parameters, as shown below

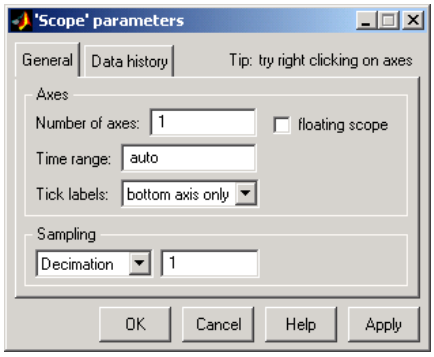


In this case the Simulation time is 100 seconds. Double click the scope block.

You will see the following



Click on the arrowed icon and you will get the scope parameters screen, as shown below

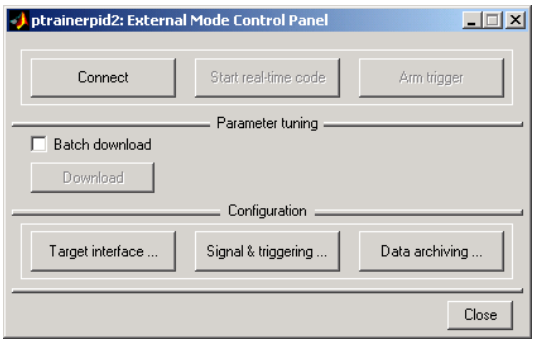


Note that the time range is set to auto. This sets the scope range to the total simulation time – in this case 100 seconds. If you want a different value then change the time range to another value in seconds.

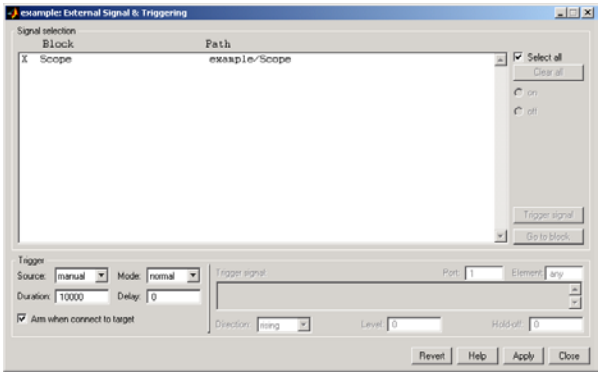
Note

If you have a problem getting the trace to completely fill the scope screen, for example if the scope range is set to 100 but the trace only goes to 10 and then resets, you must set the Signal and triggering from the External Mode Control Panel.

Start the External mode control panel



Click the Signal and triggering tab to show the following screen



Select the particular scope in the list (If your model contains several scopes they will all be listed – in this case there is only one) and set the duration to be the time range of the scope divided by the sample time. For example, if you sample time is one millisecond and your scope duration is 100 seconds, you will need to set the duration to 100000, to display the required number of data points.

Notes