The CED Power1401
Owners handbook

Version 1.2

March 2000

The CED Power1401 Owners Handbook

Table of contents

Typographic conventions

The following conventions apply to the text in this manual:

- Ordinary text is in Times New Roman.
- Titles of chapters, other manuals and other publications are in *italics*.
- Labels and identifiers appearing on the equipment described in this manual are in Arial.
- Menu items, buttons, and other contents of computer displays are in *Arial italics*.
- Dialogue that you type in at a keyboard is in `courier new lowercase`. Names of keyboard effector keys are enclosed in angular brackets, e.g.: `<esc>`, `<enter>`.
- Names of files, drives, paths and directories are in `Courier New`.
- Signal names are in Times New Roman, SMALL CAPS.

Use of symbols

Where applied, the following symbols have the meanings below:

This symbol declares that the equipment passes the relevant clauses of EU directives on safety and EMC emissions; see the certificate reproduced on page 66.

Attention, consult accompanying documents.

The DC symbol indicates that the Power1401 chassis is powered from a DC-only supply.

The earth symbol indicates a metallic contact at mains earth potential.

Potential for Radio/Television Interference
(USA only)

The Power1401 generates and uses radio frequency energy and may cause interference to radio and television reception. Your Power1401 complies with the Specification in Subpart J of Part 15 of the Federal Communications rules for a Class A computing device. These specifications provide reasonable protection against such interference in a residential installation. However there is no guarantee that interference will not occur in a particular installation. If the Power1401 does cause interference to radio or television reception, which can be determined by turning the Power1401 mains supply off and on, you can try to eliminate the interference problem by doing one or more of the following:

- Re-orient the receiving antenna
- Re-orient the position of the Power1401 with respect to the receiver
- Move the Power1401 away from the receiver
- Plug the Power1401 into a different outlet so that the Power1401 and the receiver are on different branch circuits

If necessary, consult CED or an experienced radio/television technician for additional suggestions. You may find the booklet, prepared by the Federal Communications Commission, helpful: *How to Identify and Resolve Radio/TV Interference Problems*. The booklet is available from the US Government Printing Office, Washington DC 20402, Stock no. 004-000-00345-4.

To comply with FCC rules, Part 15 B Class A Computing device, use only shielded interface cables.

Life support **CED products are not authorised for use as critical components in life support systems without the express written approval of the chairman of the board of directors of CED.**

Life support systems in this context are systems which support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided, can be reasonably expected to result in a significant injury to the user. A critical component in this context is any component of a life support system whose failure to perform can reasonably be expected to cause the failure of the life support system, or to affect its safety or effectiveness.

Fast installation guide for experienced users

USB

Power up & connect the Power1401

- Windows 98, Windows NT 2000

  Insert distribution disk when prompted

PCI

Plug the interface card into the computer

- Windows 9x, Windows NT 2000

  Plug'n'Play will autodetect – insert distribution disk when prompted

- Windows NT 4

  Install the driver – use *Start, Settings, Control panel, Add/remove programs*

ISA

Plug the interface card into the computer
Adjust jumpers as required

- Windows 9x, Windows NT 2000

  Use Add New Hardware Wizard

- Windows NT 4

  Install the driver – use *Start, Settings, Control panel, Add/remove programs*

Applications   Follow instructions supplied with disks

Introduction This manual will guide you through the initial check and installation of your Power1401. It introduces you to the external inputs and outputs. It also describes maintenance and diagnostic procedures. This manual does not cover 1401 programming or the use of application programs with the 1401.

Checklist The installation kit for your Power1401 comprises:

- A Power1401, with an optional rack-mount kit
- A power brick with attached DC supply cable
- A power brick mains cable, suitable for your country
- An interface card to adapt the Power1401 to your computer (unless you are using a USB port)
- A suitable data cable to connect Power1401 and computer
- An installation disk to allow you to install and check out your Power1401
- This owners manual

The power brick The power brick will run with no adjustment on any mains voltage from 100V to 240V, 47-63 Hz, drawing a maximum of 1.6 Amps. It has no switch, being controlled by plugging in and switching on at the mains socket.

The rear-panel switch controls input of DC power from the power brick to the Power1401. For complete electrical isolation, mains power must be disconnected from the power brick.
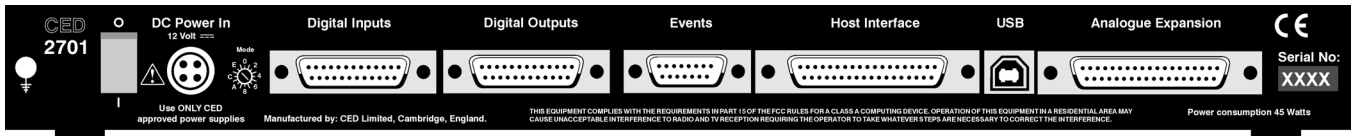
Confidence check

Your Power1401 was soak-tested at CED before shipping. To pass the test, a Power1401 must not generate a single error in at least 96 hours of testing. The next procedure checks that the 1401 hardware is in the same state as it left the factory.

Check that the DC switch on the back of the Power1401, marked O/I, is off (position O). Connect the power-brick output plug to the DC Power In socket. Check that the Mode selector is in position 2. Do not connect the data cable. Switch the Power1401 on. The green Power LED should light and stay on. The red Test LED should light for a few seconds while the yellow LEDs flicker. Test should then turn off. If this is not the case, turn to *Trouble shooting* on page 59.

Installing the Power1401

Once the Power1401 has passed the confidence check, you should turn to the section which deals with installation for your computer and interface. The remainder of this section deals with general topics. The section starting on page 39 describes the signal inputs and outputs. Following sections deal with maintenance and troubleshooting.

Storage and operating environment

The storage and operating environment for a Power1401 must not exceed the temperature range $-5°$ to $+50°$ Celsius, in conditions of non-condensing humidity. Humidity should not exceed 95% saturation. The Power1401 is suitable for continuous operation. The Power1401 is not protected against ingress of water or dust. There are no hazardous voltages inside the Power1401. The Power1401 complies with relevant EU and USA requirements for electromagnetic interference.

At some point you will choose a permanent position for your Power1401. It is happy in the same sort of environment that suits the host computer. The Power1401 normally stands on its base, but it will work on its side or upside down, if required.

Application software

The Power1401 requires application software to run it. Most customers will run CED application programs for the Power1401, such as Signal or Spike2, or products supplied by third parties. Alternatively, you may wish to write your own programs, with the help of the *1401 Language support for MS-DOS and Windows* library and your own computer programming manuals.

Operating platforms

We support the 1401 family (including the Power1401) under Windows 9x, Windows NT 2000 and Windows NT 4. Much of CED's old MS-DOS software will run in a DOS box. Macintosh installations require System 7 or System 8.

Installing CED application software

CED application software such as Spike2 or Signal is installed separately from the driver. Typically this is done by running *setup.exe* from a CD-ROM. The installation guide with the software will give more detailed instructions.

Information on application programs

Technical information required to use CED application programs is contained in the software manuals. Technical histories of some of our programs, upgrade information, and in many cases downloadable files, may be found on the CED Web site: `www.ced.co.uk`.

Information for programmers

The 1401 language support kit, for users who wish to program their Power1401 from their host computer, includes the *1401 family programming manual* for detailed descriptions of the 1401 standard command library. The Power1401 command development kit includes the *Power1401 technical manual*, which documents the Power1401's internal structure, and *Writing commands for the Power1401* which deals with writing commands in C to run on the StrongARM™ processor.

Circuit diagrams

Circuit diagrams for the Power1401 can be made available for a fee. Purchasers must sign a non-disclosure agreement.

Installation

Overview This section provides an overview on how to install a Power1401 in an IBM PC or compatible, or Macintosh.

To install the Power1401 you will need:
- A Power1401, power brick and mains cable
- A 1401 data cable, or else a USB cable
- A 1401 interface card (except for USB installations)
- Any tools needed to access the bus slots in your computer
- The CED 1401 installation disk

Organisation of sections The sections that follow deal with installing
- the PC USB interface
- the PC PCI interface
- the PC ISA interface and
- the Macintosh PCI interface

in that order. The instructions take you through the hardware part of the installation (making the physical connection between the Power1401 and your computer) and the software part (installing the 1401 device driver and utility programs). For PC interfaces, the three operating systems, Windows 9x, Windows NT 2000 and Windows NT 4 are covered in each section.

Drivers Having installed the hardware, you have to install the driver (the systems file that enables application software to communicate with the Power1401), and assign hardware resources (base address, interrupt and DMA settings). This process is largely automatic if your hardware is Plug'n'Play. ISA cards are not Plug'n'Play, and Windows NT 4 does not support Plug'n'Play. These cases require more care; in particular, clashes with other hardware have to be sorted out manually.

Test and diagnostic utilities A suite of test and diagnostic programs is available on the installation disk. They are of great use if something goes wrong, but not essential for normal operation. We describe the installation of these utilities after the sections on the hardware and drivers.

Hardware installation
Power1401s using the USB interface require a computer with a USB connector, but do not need an interface card. All you have to do is connect the USB cable between the computer and the Power1401. You must be running Windows 98 or Windows NT 2000 in order to use the USB interface.

Installing the driver
With the hardware installed, you now have to install the device driver. We describe installation under Windows 98 first, then Windows NT 2000. Note that USB is not supported under Windows 95, Windows NT 4, Windows 3.x or DOS.

Device drivers are supplied on the 1401 support for Windows disk. Drivers can also be found in CED software directories, e.g. `\Spike2\1401\Windrv`, if you have already installed application software.

Windows 98 After a Power1401 has been plugged into a USB port, it will be detected automatically as soon as PC and Power1401 are both powered up. Windows 98 will announce that it has detected a new USB device and is looking for its driver. Unless 1401 support has already been installed for an earlier system, it will not find it. The 'Add New Hardware Wizard' will be invoked. Read the wizard's messages, pressing the *Next* button as required. The wizard will ask you to insert the 1401 Support for Windows disk. The wizard will announce that it has found the CED 1401 USB software. Press the *Finish* button. When the USB driver has been installed, a *CED 1401* icon will appear in the Device Manager, but only when the Power1401 is plugged in and powered up.

System Properties,
Device Manager tab
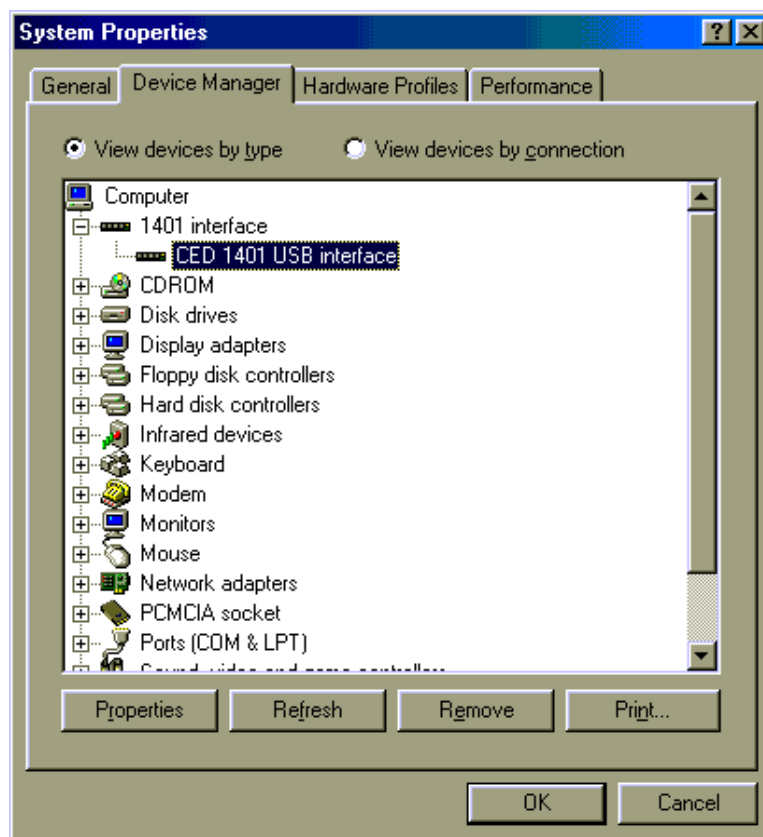
Tabs in *Properties* *General* provides overall device status, and allows for enabling/disabling the device. *Driver* lists device driver usage and version information. It has the *Change Driver* button, used to load device driver upgrades.

Windows NT 2000
The Power 1401 should be plugged into the USB port while both machines are powered up. The USB hardware will immediately detect the 1401 and Windows NT 2000 will announce that it has found a new USB device and is looking for its driver. Unless 1401 support has already been installed for an earlier system, the 'Update Device Driver Wizard' will be invoked. Read the wizard's messages, pressing the *Next* button as required. The wizard will ask you to insert the 1401 support for Windows disk. The wizard will announce that it has found the CED 1401 USB interface software. Press the *Finish* button. When the USB interface driver has been installed, the Power 1401 becomes a recognised USB device, and the *CED 1401* icon will appear in the Hardware Device Manager whenever the 1401 is plugged in and powered up.

USB interface properties sheet
You can view the 1401 USB settings by selecting *Start*, *Settings*, *Control panel*, and click on the *System* icon. Select the *Hardware* tab and press the *Device manager* button. This reveals the hardware devices tree. The "1401 interface" icon will be on a node with a boxed **+**, indicating that a device is present. Click on this to display the "CED 1401 USB interface" icon. Opening this reveals only three tabs of the properties window: *General*, *Settings*, and *Driver*. You can reset the Power1401 from the *Settings* tab.

PCI card installation
Remove power from your computer and clear a space round it; you will be taking off the cover in order to install the card. Follow the directions in your computer manual for installing option cards. Usually you will need to undo some screws and slide the cover off, to expose the slots where the interface card is fitted. Take precautions against static electricity: earth your computer to local mains earth, then earth yourself to your computer, preferably via a wrist strap.

Your interface card is the CED PCI interface (1401-60). See page 16 for technical details of this card.

1. Locate an unused slot. PCI cards need a (white) PCI slot.
2. Remove the blanking plate for your slot by undoing the securing screw. Keep the screw safe.
3. Offer the card to the slot and push it firmly home. Fix the metal bracket at the rear with the screw you saved, and replace the cover.
4. Now connect the 1401 data cable between the port at the rear of the interface card, and the Host interface connector at the rear of the Power1401. The cable is reversible end for end.
5. Plug the DC power cable into the rear of the Power1401.
6. Hardware installation is now complete.
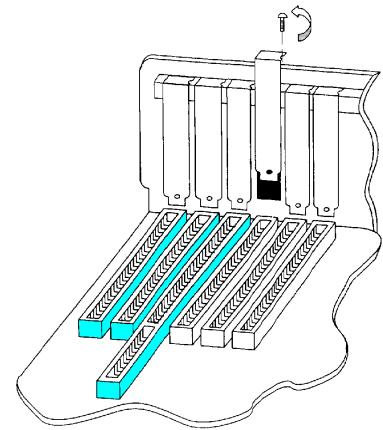
Installing the driver
With the hardware installed, you now have to install the device driver. We describe installation under Windows 9x first, followed by Windows NT 2000, then Windows NT 4. If you do need to install in Windows 3.x or DOS, please contact CED.

Device drivers are supplied on the 1401 support for Windows disk. Drivers can also be found in CED software directories, e.g. \Spike2\1401\Windrv, if you have already installed application software.

Windows 95
Windows 98
After a 1401 PCI interface card has been fitted, it is found automatically when the PC is next powered up. Windows 9x will announce that it has detected a new PCI card and is looking for its driver. Unless 1401 support has already been installed for an earlier system, it will not find it. The 'Install New Hardware Wizard' will be invoked. Read the wizard's messages, pressing the *Next* button as required. The wizard will ask you to insert the 1401 support for Windows disk. The wizard will announce that it has found the CED 1401 PCI interface software. Press the *Finish* button. When the PCI interface driver has been installed, a *CED 1401* icon will appear in the System Device Manager.

PCI interface settings
You can view the 1401 PCI interface settings by selecting

Start, *Settings*, *Control Panel*, *System*.

A window opens with four tabs; select *Device Manager*. The *1401* icon will be seen among the installed-devices tree. The boxed **+** on the 1401 node means a device is present: click on it to reveal *CED 1401 PCI interface*. Select this, then click on the *Properties* button at the bottom of the window. A new window opens, with more tabs; select *Resources* to view interrupt settings and I/O block usage. If there are hardware resource clashes they will be reported. You can then tell Windows 9x to edit values automatically, or else do it manually until the clash disappears.

System Properties, Device manager tab

PCI interface Properties, Resources tab ➢

System Properties   ? ✕

General | Device Manager | Hardware Profiles | Performance |

○ View devices by type   ○ View devices by connection

- 💻 Computer
  - ⊟ ▭▭▭ 1401 interface
    - ▭▭▭ CED 1401 PCI interface
  - ⊞ 💿 CDROM
  - ⊞ 💾 Disk drives
  - ⊞ 🖥 Display ada
  - ⊞ 💾 Floppy disk
  - ⊞ 💾 Hard disk c
  - ⊞ ⌨ Keyboard
  - ⊞ 📠 Modem
  - ⊞ 🖥 Monitor
  - ⊞ 🖱 Mouse
  - ⊞ 🖳 Network ad
  - ⊞ ❓ Other devic
  - ⊞ 🖭 Ports (COM
  - ⊞ 🔊 Sound, vide

Properties

CED 1401 PCI interface Properties   ? ✕

General | Settings | Driver | Resources |

▭▭▭▭ CED 1401 PCI interface

Resource settings:

Resource type	Setting
■ Interrupt Request	09
■ Input/Output Range	EF00 - EF3F
■ Input/Output Range	EE80 - EEBF

Setting based on: | Basic configuration 0000 |

Change Setting...   ☑ Use automatic settings

Conflicting device list:

No conflicts.

OK   Cancel

Other tabs in Properties You can reset the Power1401 from the *Settings* tab. *General* provides overall device status, and allows for enabling/ disabling the device. *Driver* lists device driver usage and version information. It has the *Change Driver* button, used to load device driver upgrades.

Windows NT 2000 A newly installed 1401 PCI interface card is detected automatically when the PC is next powered up. Windows NT 2000 will announce that it has detected a new PCI card and is looking for a driver. Unless 1401 support has already been installed for an earlier system, the 'Add New Hardware Wizard' will be invoked. Read the wizard's messages, pressing the *Next* button as required. The wizard will ask you to insert the 1401 support for Windows disk. The wizard will announce that it has found the CED 1401 PCI interface software. Press the *Finish* button. When the PCI interface driver has been installed, a *CED 1401* icon will appear in the Hardware Device Manager.

PCI driver properties sheet You can view the 1401 PCI interface settings by selecting *Start*, *Settings*, *Control panel*, and click on the *System* icon. Select the *Hardware* tab and press the *Device manager* button. This reveals the hardware devices tree. The "1401 interface" icon will be on a node with a boxed **+**, indicating that a device is present. Click on this to display the "CED 1401 PCI interface" icon. Opening this reveals the four tabs of the properties window, one of which is *Resources*. This lists the I/O blocks and interrupt use, and reports any clashes as each item is selected. There ought not to be any, since the PCI interface is Plug'n'Play. If there are, you can edit values with the scroll buttons until the clash disappears.

Windows NT 4 After a 1401 interface card has been fitted, switch the PC on. Windows NT 4 is not a Plug'n'Play operating system, so you should therefore proceed as follows:

Select *Start*, *Settings, Control Panel*. Double-click on the *Add/Remove Programs* icon. Press the *Install...* button and select the *Install/Uninstall* tab. Windows NT 4 will invite you to insert a disk with the new software. Insert the installation floppy/CD-ROM and press the *Next* button. Select *setup.exe*, browsing if necessary, then press *Finish*. If you prefer, you can start installation by selecting *Start*, *Run*, and typing

> `a:\setup.exe` or `d:\setup.exe`

depending on which drive you are installing from.

Add/Remove Programs, Install/Uninstall tab

Run Installation Program ➢
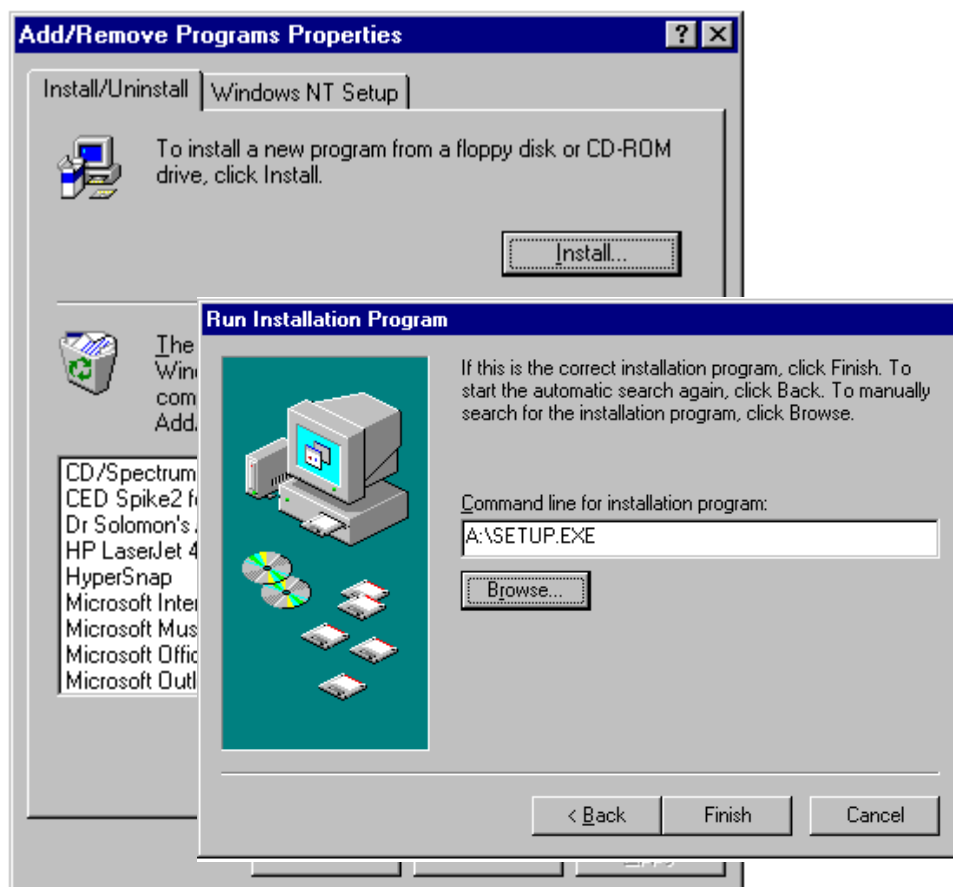
1401 control panel   Setup will install the 1401 driver and any application software, and a Control Panel applet that is automatically run on installation. You must now tell the system that your 140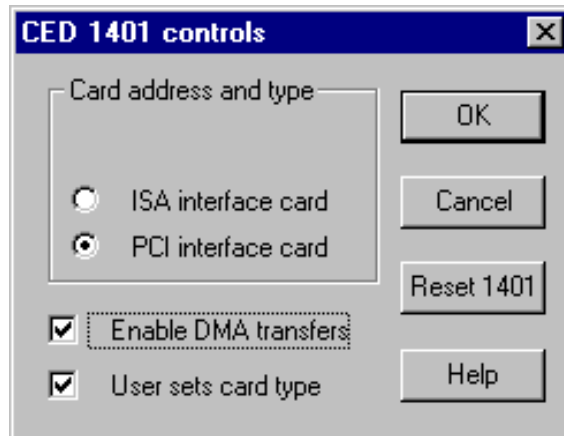1 interface is a PCI card: check the *User sets card type* box, then press the appropriate button. You can reset the Power1401 from the Control Panel.

1401 Control Panel Applet

Interface settings   To view the 1401 interface hardware settings, select

Start, *Programs, Administrative Tools, Windows NT Diagnostics*.

A window opens with nine tabs; select *Resources*. This displays the I/O usage, DMA, interrupts etc. grouped in various ways. Press the *Devices* button at the bottom of the window. Select *ced1401* from the list that is displayed, then press the *Properties* button, also at the bottom of the window. The resource usage of the 1401 interface card is displayed.

Windows NT Diagnostics

1401 Interface Resource Usage ➢

ced1401 Properties

General

Resource Owner: ced1401

Resource settings:

Resource Type	Bus	Setting
Interrupt Request	Isa	05
Direct Memory Access	Isa	01
Input/Output Range	Isa	0300 - 030F

OK   Cancel

Windows N

File   Help

Version
Services

Device
ced1401
PC Comp
i8042prt
Parport
Serial
Floppy
NE2000
Sermouse
atapi
s3
VgaSave

IRQ   I/O Port   DMA   Memory   Devices

Properties   Refresh   Print   OK

The PCI interface card The standard interface for the PCI bus is the 1401-60. This card has no hardware switches; its base address and interrupt are set up automatically by the device driver software.

CED 1401 60 A
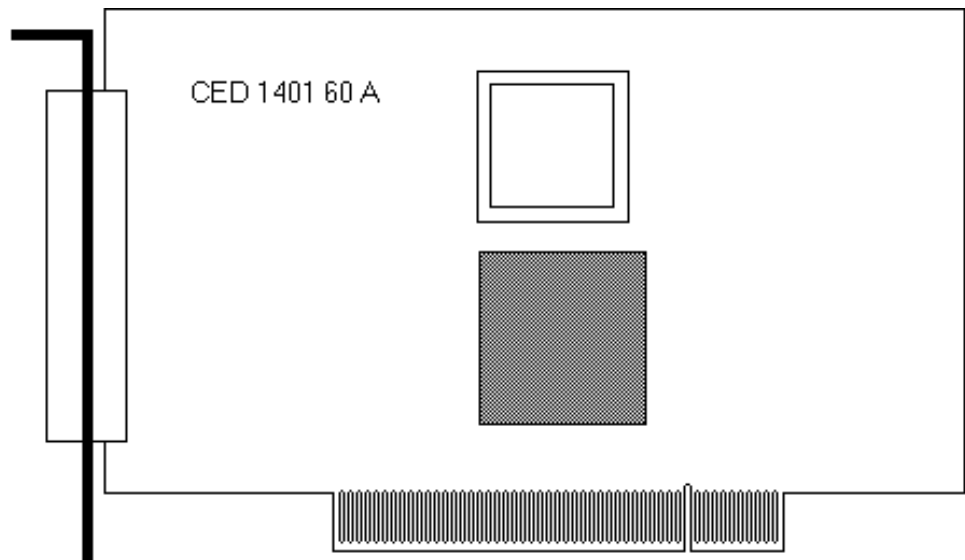
**ISA card installation** Remove power from your computer and clear a space round it; you will be taking off the cover in order to install the card. Follow the directions in your computer manual for installing option cards. Usually you will need to undo some screws and slide the cover off, to expose the slots where the interface card is fitted. Take precautions against static electricity: earth your computer to local mains earth, then earth yourself to your computer, preferably via a wrist strap.

Your interface card may be a standard ISA interface (1401-10), or a quad rate ISA interface (1401-50). See page 26 for technical details of these cards.

1. Locate an unused slot. ISA slots are black (as opposed to white PCI slots) and may be single, 8-bit connectors or double, 16-bit connectors. Either kind will do for our card.

2. Remove the blanking plate for your slot by undoing the securing screw. Keep the screw safe.

3. Check that the jumper settings are correct. Use the factory settings unless you know you need to change them. If you have changed an ISA card address, you must adjust the software; this is dealt with in the section describing installation of ISA interfaces. See page 28 for advice on checking jumper settings.

4. Offer the card to the slot and push it firmly home. Fix the metal bracket at the rear with the screw you saved, and replace the cover.

5. Now connect the 1401 data cable between the port at the rear of the interface card, and the Host interface connector at the rear of the Power1401. The cable is reversible end for end.

6. Plug the DC power cable into the rear of the Power1401.

7. Hardware installation is now complete.
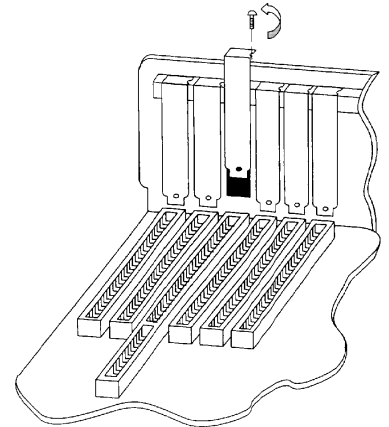
Installing the driver   With the hardware installed, you now have to install the device driver. We describe installation under Windows 9x first, followed by Windows NT 2000, then Windows NT 4. If you do need to install in Windows 3.x or DOS, please contact CED.

Device drivers are supplied on the 1401 support for Windows disk. Drivers can also be found in CED software directories, e.g. `\Spike2\1401\Windrv`, if you have already installed application software.

Windows 95
Windows 98 After a 1401 ISA interface card has been fitted, switch the PC on. Windows 9x will <u>not</u> detect the new hardware because ISA devices are not Plug'n'Play. You should therefore proceed as follows:

Select *Start*, *Settings*, *Control Panel*. Double-click on the *Add New Hardware* icon. Windows 9x will offer to search for the new hardware, but press *No* (and press the *Next* button as required.) A list of device types is displayed. Select *Other Devices*. A list of specific devices is displayed, but ignore it. Insert the 1401 support for Windows disk and press the *Have Disk* button.

Add New Hardware Wizard

Add New Hardware Wizard, cont. ➢
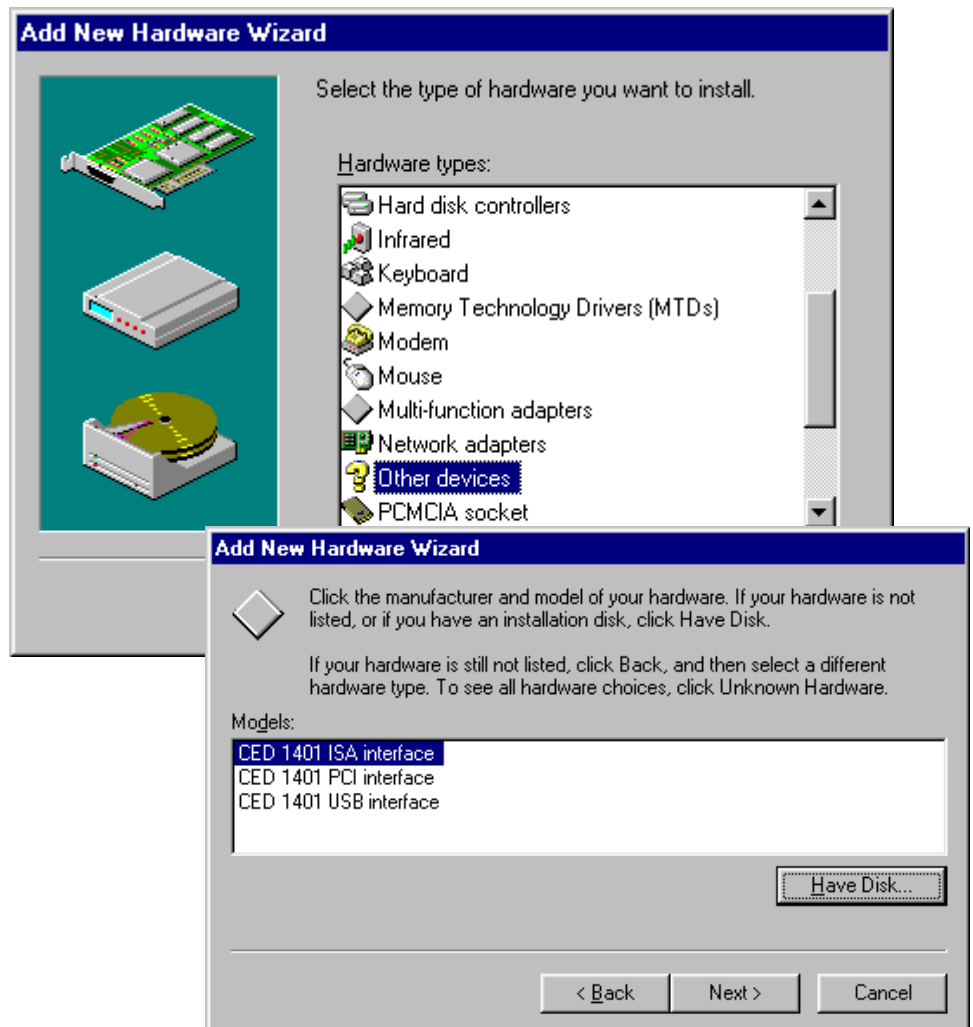
The following devices will be found and listed:

> *CED 1401 ISA interface*
> *CED 1401 PCI interface*
> *CED 1401 USB interface* (not in Windows 95)

Select the ISA device driver and press *Finish*.

ISA card jumpers There are jumpers on ISA interface cards that set the interrupt vector, DMA channel and 1401 address. If you have changed the address from the standard 300 (see page 29) you will also need to set the address in the Device Manager.

ISA interface settings You can view the 1401 ISA interface settings by selecting *Start*, *Settings*, *Control Panel*, *System*.

A window opens with four tabs; select *Device Manager*. The *1401* icon will be seen among the installed-devices tree. The boxed **+** on the 1401 node means a device is present: click on it to reveal *CED 1401 ISA interface*. Select this, then click on the *Properties* button at the bottom of the window. A new window opens, with more tabs; select *Resources* to view interrupt settings and I/O block usage. The *Settings* tab provides for editing the base address in case you have altered the interface-card address jumpers. There is no provision for manual editing of clashes in *Resources*.

Other tabs in Properties You can reset the Power1401 from the *Settings* tab. *General* provides overall device status, and allows for enabling/ disabling the device. *Driver* lists device driver usage and version information. It has the *Change Driver* button, used to load device driver upgrades.

Windows NT 2000 After the 1401 ISA interface card has been fitted, switch the PC on. Windows NT 2000 will <u>not</u> automatically detect the 1401 ISA card. This is how you proceed:

Select *Start, Settings, Control panel*, and double-click on the *Add New Hardware* icon. Select the "Add/troubleshoot device" button on the window that opens. Windows NT 2000 will now insist on searching for Plug'n'Play hardware, which the 1401 ISA interface is not. Press *Next* to start the search anyway. Having failed to find it, it will now give you the choice of its searching for "legacy hardware" or your choosing hardware from a list. Choose the list. From the list, select "Other devices", and press *Next*. Ignore the new list that opens, and press the *Have Disk* button.

Device drivers for CED hardware are stored in the 1401 support for Windows disk. Browse to an appropriate directory and press *Next*. Chose "CED 1401 ISA interface" from the list that is displayed. The software will now be installed.

ISA driver installation, Windows NT 2000

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The I/O base address The installer sets a default I/O base address of 300. This matches the default address set by links on the interface card (see page 28 for details.) If you are using this default address, simply press *Finish* to complete the installation. If your card's address has been altered, e.g. to avoid clashes, the software I/O address must be set to the correct range before installation. Changes to interrupt and DMA channel are dealt with automatically.

Editing I/O base address on installation If you have altered the I/O base address on the card, press the *Resources* button to inspect the base address. Now click on *Set configuration manually*. Select "Current configuration" from the drop-down list. This initially is empty; select "Input/Output range" and then press *Change Settings*. Using the scroll buttons, step the address range to the value set by the jumpers. Press *OK* as required, and *Finish* to complete the installation.

In case of failure If the device driver fails to install, it may be that there is a resource conflict, i.e. the resources assigned in software do not match the hardware, or else the hardware settings are already in use. You will need to check the link settings on your hardware (see details on page 26 onward) and your system resource settings, before adjusting the jumpers and changing the Input/Output address range as required.

Viewing resource settings in Windows NT 2000 You can view the 1401 ISA interface settings by selecting *Start*, *Settings*, *Control panel*, and clicking on the *System* icon. Select the *Hardware* tab and click on the *Device manager* button. This reveals the hardware devices tree. The "1401 interface" icon will be on a node with a boxed **+**, indicating that a device is present. Click on this to display the "CED 1401 ISA interface" icon. If the installation has failed, this icon will be marked with a yellow warning spot. Opening the icon reveals the four tabs of the properties window, one of which is *Resources*. *If this tab is empty, or displaying an error message, it may mean that there is a resource clash!* You should inspect the resource usage of other devices, especially other ISA devices, and figure out a base address and interrupt that do not clash.

Two devices sharing a DMA channel, though undesirable, is not regarded as a clash (see *DMA channel*, page 28.) Note also that, for historical reasons, interrupt *2*, one of the options on a CED ISA interface, is mapped onto and will be displayed as interrupt *request 9*.

ISA resources, Windows NT 2000
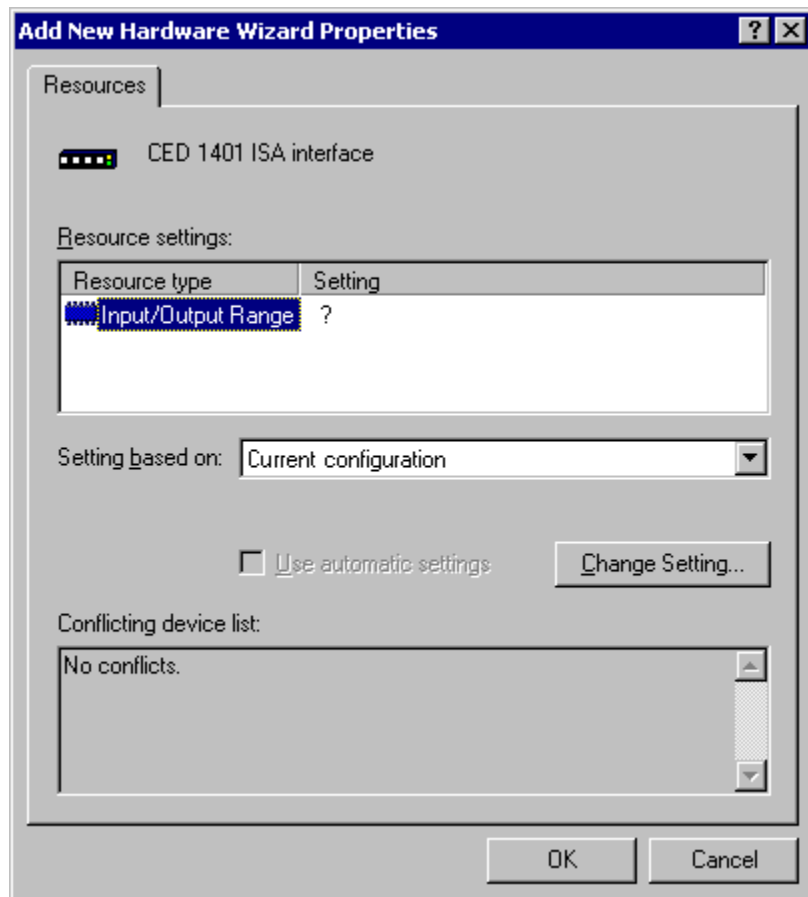
Resolving clashes Switch the computer off, and adjust the ISA interface hardware, following the advice given on page 28. As mentioned above, interrupt and DMA hardware settings are accommodated automatically, but alterations to the base address have to be set manually in "Current configuration". Go to Hardware Device Manager, 1401 Resources, as described above, and then proceed to "Set configuration manually" as described in *Editing I/O base address on installation*. All being well, the interface should immediately spring into life!

Windows NT 4 After a 1401 interface card has been fitted, switch the PC on. Windows NT 4 will <u>not</u> detect the new hardware. You should therefore proceed as follows:

Select *Start*, *Settings, Control Panel*. Double-click on the *Add/Remove Programs* icon. Press the *Install...* button and select the *Install/Uninstall* tab. Windows NT 4 will invite you to insert a disk with the new software. Insert the 1401 support for Windows disk and press the *Next* button. Select *setup.exe*, browsing if necessary, then press *Finish*. If you prefer, you can start installation by selecting *Start*, *Run*, and typing

```
a:\setup.exe   or   d:\setup.exe
```

depending on which drive you are installing from.

Add/Remove Programs, Install/Uninstall tab

Run Installation Program ➢
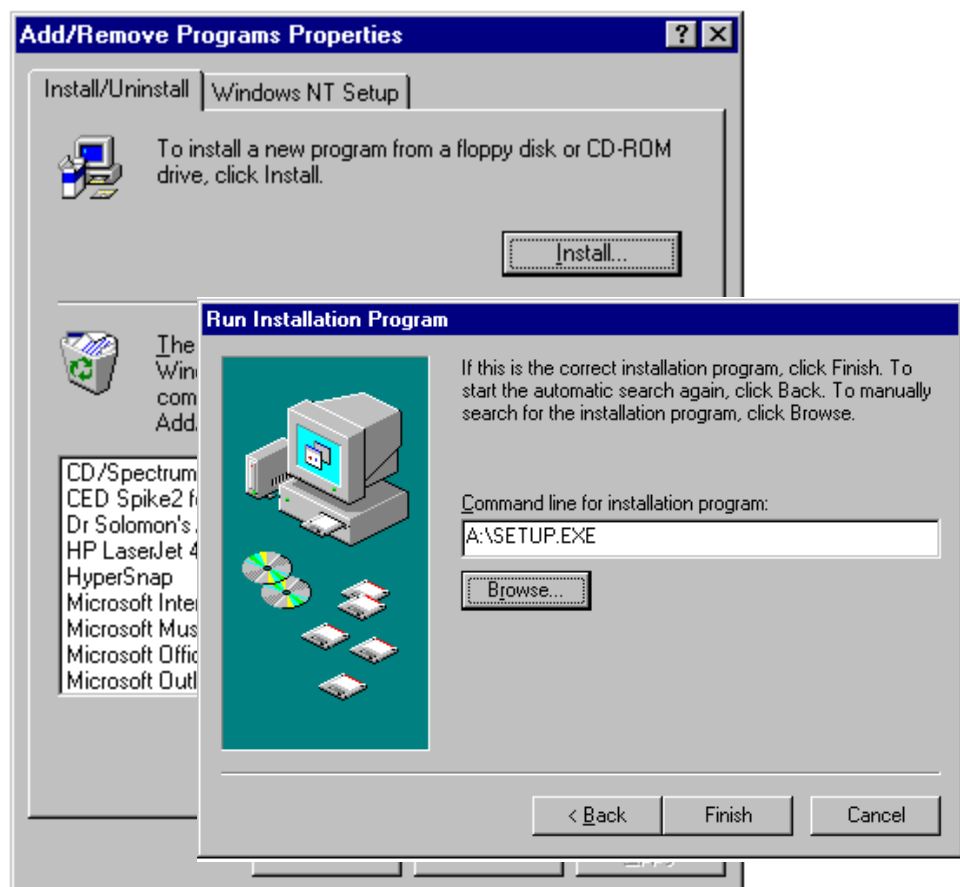
1401 control panel Setup will install the 1401 driver and any application software, and a Control Panel applet that is automatically run on installation. You must now tell the system that your 1401 interface is an ISA card: check the *User sets card type* box, then press the appropriate button. You can also set the base address if the address has been altered on the hardware. You can reset the Power1401 from the Control Panel.
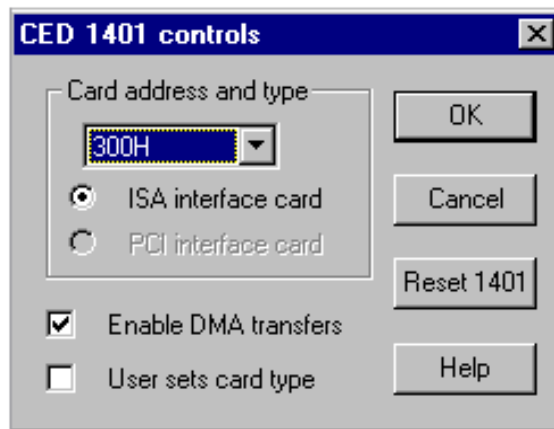
1401 Control Panel Applet

Interface settings To view the 1401 interface hardware settings, select

Start, *Programs, Administrative Tools, Windows NT Diagnostics*.

A window opens with nine tabs; select *Resources*. This displays the I/O usage, DMA, interrupts etc. grouped in various ways. Press the *Devices* button at the bottom of the window. Select *ced1401* from the list that is displayed, then press the *Properties* button, also at the bottom of the window. The resource usage of the 1401 interface card is displayed.

Types of ISA interface card The standard interface for the ISA bus is the 1401-10; for faster ISA performance the quad rate 1401-50 may be used.

1401-10L The standard 1401-10 ISA interface card is currently at issue L. It is compatible with all PCs including Pentiums. There have been significantly slower earlier issues. If you 'inherit' one from an older system it is likely to fail to work correctly with a fast modern computer.
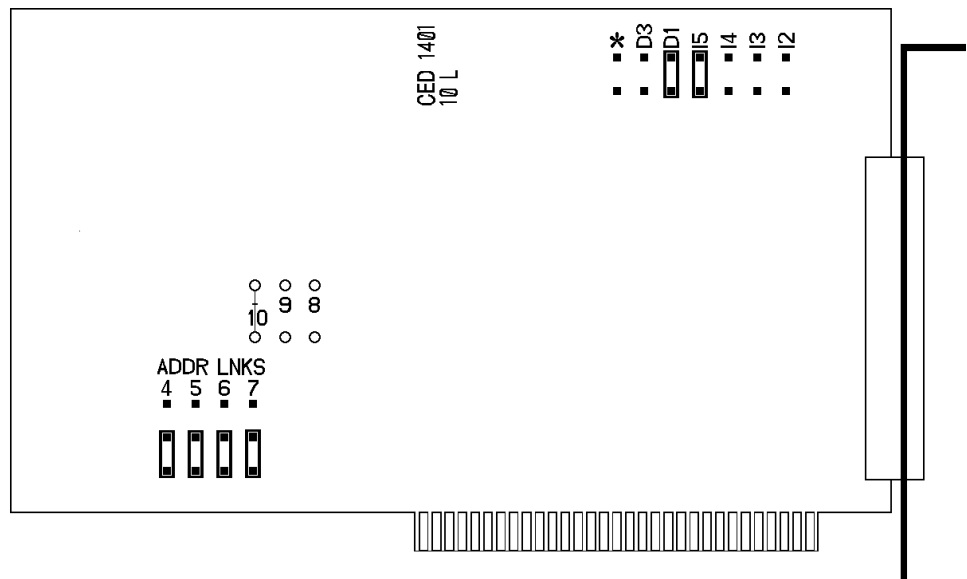
The interrupt vector and DMA channel are selected by jumpers at the top right of the card. A jumper in one of I2, I3, I4 or I5 selects an interrupt vector from 2 to 5. Similarly a jumper in one of D1, D3 or ✱ selects DMA channel 1, channel 3 or no DMA.

Bits 4 to 7 of the card address are set by jumpers on the ADDR LNKS field at lower left. The diagram shows jumpers set for address 300.

1401-50B The 1401-50 is a high-speed ISA interface card which can be used in place of the 1401-10. It makes use of the burst transfer Demand Mode available on the ISA bus.
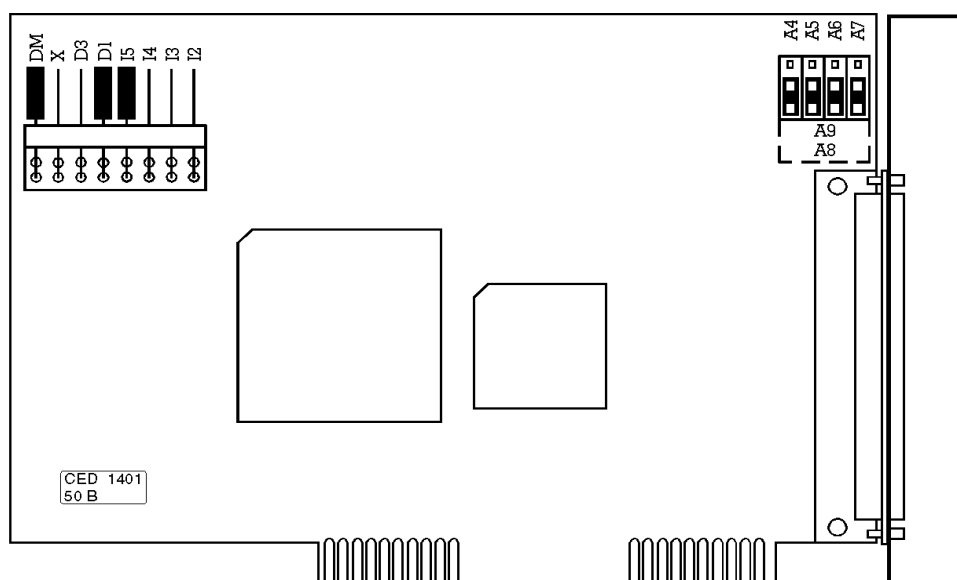
The interrupt vector and the DMA channel are set by jumpers at the top left of the card. A jumper in one of I2, I3, I4 or I5 selects a vector from 2 to 5. A jumper in one of D1, D3 or X selects DMA channel 1, channel 3 or no DMA.

The DM jumper, when inserted, selects the high-speed Demand Mode on the ISA bus. The jumper should be left in, unless there are problems with the high-speed mode on your PC.

Bits 4 to 7 of the card address are selected by the jumpers at the top right. When the jumpers are in the lower position, as in the diagram above, the card is set for address 300.

ISA interface hardware settings The ISA interface cards are set at the factory to interrupt vector 5, DMA channel 1 and base address 300. Many systems will work correctly with these standard settings. You only need to read the following notes if you suspect these settings have caused a hardware resources clash.

Interrupt vector The 1401 software uses a hardware interrupt to make servicing the Power1401 both fast and efficient. There are four vectors which can be used, numbered 2, 3, 4 and 5. The preferred vector is 5; see page 61 for advice if there are problems with this choice. Note that, for historical reasons, interrupt *2* is mapped onto and will be displayed as interrupt *request 9*.

DMA channel The 1401 device driver uses DMA transfers (Direct Memory Access) to move large blocks of data between Power1401 and the computer efficiently. You can disable DMA if you do not have a free DMA channel. However, some CED applications, for example CHART and Patch continuous sampling, will not work without DMA. Other applications, including Spike2, work more efficiently with DMA. You can disable DMA by moving a card jumper, see page 26 onward.

You can use DMA channel 1 or 3. No standard hardware uses either of these. If you have special hardware in your computer (for example a tape streamer), check if it uses DMA. It is possible for two devices to share DMA channels so long as they do not use the same channel at the same time.

The Power1401 only connects itself to the DMA logic in your computer when it transfers data, so it can share a DMA channel with the tape streamer so long as the tape streamer is also well-behaved. Ideally you should have a separate DMA channel for each device.

Card address It is unusual to need to change the address from the standard value of 300. The most common reason to change the address is to allow more than one 1401 to be connected to the same computer. Occasionally, an address clash with a different card can occur: beware of network cards and proprietary input cards.

Changing the card address
The 1401 device driver can be configured to any of the 16 addresses of the form 3n0 where n takes any value from 0 to f. (This is a hexadecimal number, in which 10 to 15 are represented by the letters a to f.) Jumpers determine what value is added to 300 to form the base address. In the default position, they each have a value of zero. In the other position, jumpers 4, 5, 6, and 7 have the values 10, 20, 40 and 80, respectively. So, to set address 3a0, for example, swap jumpers 5 and 7 from the default position to the other (300 + 20 + 80 = 3a0).

Bits 8, 9 and 10 can also be altered, by cutting tracks and soldering links, but this is not supported in software.

If you must change the card address or the DMA channel, you will need to make adjustments to the software. Refer to earlier sections of this chapter for advice on how to do this under the various operating systems.

Installing test & diagnostics

The Power1401 installation disk includes utilities that verify correct installation of your Power1401, assist in re-calibrating the analogue system, and diagnose hardware problems. You must install the 1401 driver before installing the diagnostic software.

CED provides you with 1401 support for Windows, either as a CDROM containing two folders called `Disk1` and `Disk2`, or as two floppy disks labelled Disk1 and Disk2.

If installing in Windows 9x or Windows NT 2000

- Insert either the CDROM or the floppy Disk1.
- Click on *Start*, *Run*, *Browse…* and choose the file `setup.exe` in Disk1.
- Click on *OK* and follow the screen instructions.

If installing in Windows NT 4

- The utilities were automatically installed at the same time as the driver.

If the 1401 drivers on the 1401 support disk are newer than those on your system, `setup.exe` will update them.

Location of software

You can choose where `setup.exe` copies the 1401 files. The usual destination is `c:\1401`. In this case, 1401 utilities are copied into the `\1401\utils` subdirectory together with a `readme.wri` file that lists all the new files. This manual assumes you have accepted that default. `\1401` itself is the directory where 1401 commands are installed.

Windows diagnostics The Windows installation copies several programs to `\1401\utils` that verify that your Power1401 has been installed correctly, and to run diagnostic procedures.

TRY1432 TRY1432 is the principal Windows 9x and Windows NT 2000 user test program. It is also installed as a utility in the program folders of CED applications such as Spike2 and Signal. It simulates a typical 1401 application program and exercises the host computer, interface card and Power1401 in the same way.

TRY1432 program screen
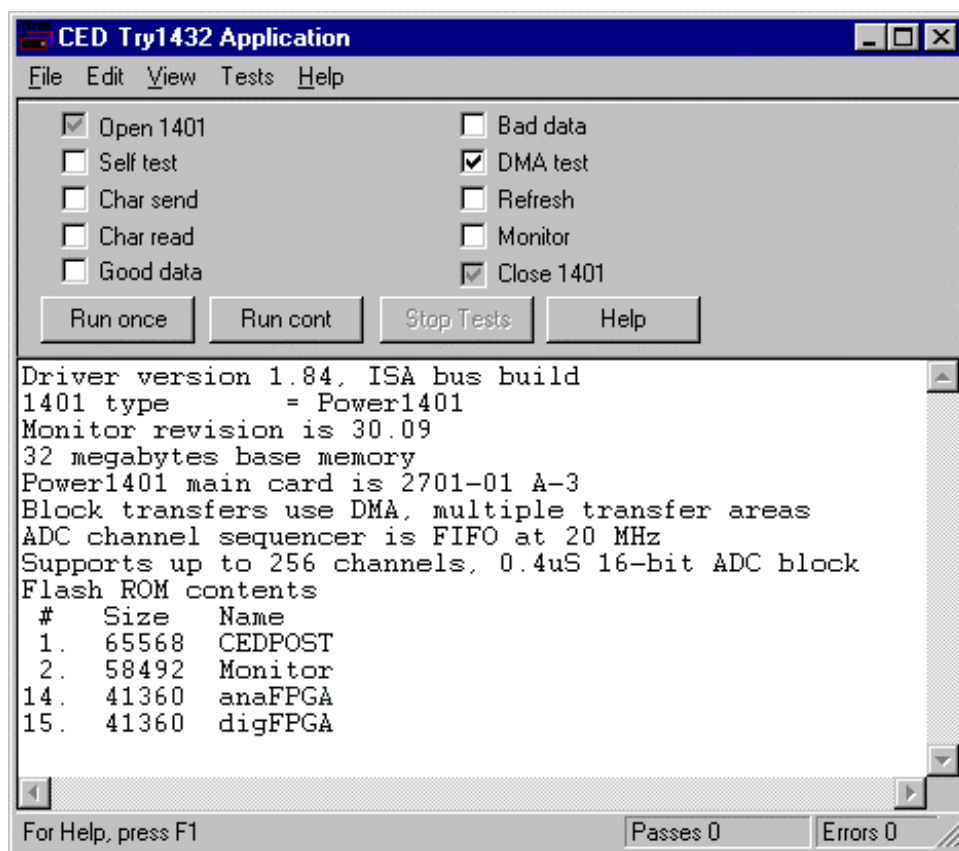
To run TRY1432, select

Start, Programs, Test1401, Try1432.

Running TRY1432 is self-explanatory. The check boxes allow different aspects of 1401 function to be tested separately. *Self test* causes the internal self-test hardware to run. Check this if the Test LED remains flashing after the Power1401 has been switched on. By clicking *Run cont*, the selected tests are run continuously, which can be useful for detecting intermittent faults.

TESTDAC TESTDAC enables you to re-calibrate the Power1401 analogue system and check the front panel connections, which the self-test cannot do. See page 58 for an overview of re-calibration.

DOS diagnostics

The following DOS mode programs are also copied to the `\1401\utils` directory. They are there in case of dire emergency, such as your system crashing to the point where you have to run in DOS mode! Unless a CED technician asks you to run these DOS utilities, you should never need them.

CEDMENU CEDMENU is a DOS utility for running 1401 DOS mode test programs. Run CEDMENU by typing

```
cd \1401\utils <enter>
cedmenu <enter>
```

CEDMENU screen

```
══════════════════════ System menu ══════════════════════
Dos version:  5.0         Free memory: 506496      Tue Aug 08 15:56:35 1995
┌──────────────────────────────────────────────────────────────────────────┐
│ 1401 INTERACT       : Display 1401 memory and exercise 1401 commands       │
│ 1401 REPORT         : Runs the 1401 self-test and describes faults found    │
│ 1401 Analogue setup : Checks and calibrates the ADCs and DACs               │
│ 1401 Quick check    : Confidence check on 1401 operation                    │
│                                                                            │
│                                                                            │
│                                                                            │
│                                                                            │
│                                                                            │
│                                                                            │
│                                                                            │
├──────────────────────────────────────────────────────────────────────────┤
│ Command   :METASHEL INTERACT                                               │
│ Directory:\1401\UTILS                                                       │
└──────────────────────────────────────────────────────────────────────────┘
Select a program with ↑↓, Enter to run or use Function keys
F1 Help  2        3        4 Commnd 5 Path  6 Title  7        8        9        10 Quit
```

REPORT *1401 REPORT* is the DOS mode equivalent of the *Self test* check box of the Windows TRY1432 application. To run REPORT, select it with the cursor keys and press <enter>. This program causes the Power1401 to run its self test and reports any failures. Satisfy yourself that the test runs several passes without error, then press <escape> to return to CEDMENU. If you encounter any problems, contact CED for advice.

TRY1401	Select *Quick check* to run TRY1401. This utility simulates a typical 1401 application program and exercises the host computer, 1401 interface card and Power1401 in much the same way.

Other diagnostic programs	The remaining programs on the disk, e.g. `testdig.exe` and `tevent.exe` are there to be run if CED asks you, to help diagnose any problems you may report.

Running 1401 software in the DOS box

This installation manual does not cover application software written to run in DOS-only mode, or to run under DOS itself.

The final versions of old CED software written for DOS can usually access the 1401 while running in the DOS box under Windows. They detect the Windows environment and use the Windows 1401 device driver rather than the DOS driver. If you wish to run such applications in the Windows DOS box you must first install the Windows driver appropriate to your hardware, as described in previous sections of this manual.

Earlier versions of CED DOS software will generally not work in the DOS box or will work erratically. CED advises users to upgrade to the final version (often for free!) or purchase a newer product. Consult CED for details, in particular the *Updates* page on our website. Some CED software such as CHART and Patch continuous sampling will not operate correctly from the DOS box under any circumstances.

Compared with running under DOS, programs generally run more slowly in the DOS box in full screen mode, and much more slowly when run in a window, particularly if the programs use graphics mode.

User programs in DOS

User-written DOS-mode programs that access the 1401 through CED standard libraries may operate in the Windows DOS box if they are rebuilt with the most recent library. Please contact CED for more information.

Installing DOS drivers

If you need to run programs in DOS itself, you will have to install the DOS mode drivers. The program that does this is `install.exe`, which is stored on 1401 support for Windows floppy Disk2, or the `Disk2` folder of the CDROM. This manual does not cover DOS applications; please contact CED if you need more information.

Installing the Macintosh interface

Introduction The CED Power1401 is supported on Power PCs with PCI slots by the 1401-60 PCI interface card. On members of the Macintosh family that have a NuBus interface and a 68020 or higher processor, for example the Macintosh II family, most Quadra or Centris Macintoshes, and PowerMacs equipped with NuBus, it uses the 1401-30 NuBus interface card. The 1401-30 will also work with certain Macintoshes which have a PDS slot which, by means of a NuBus adaptor card, can take a 7 inch NuBus card, for example the Centris 660 AV, the Quadra 610 and the PowerMac 6100/66. Macintosh applications communicate with the Power1401 through a device driver and the interface card.

Device driver The device driver takes care of the low-level control of the Power1401. It is provided in the file `Driver1401PCI` or for the NuBus, `Driver1401`.

1401 commands When a Power1401 is powered up it runs a control program in an on-board flash ROM. This holds some general purpose functions, called commands, which the host computer can tell the Power1401 to run. Additional commands are stored on the host and are downloaded to the Power1401 to provide new 1401 facilities, as required. The commands are stored in the host as Macintosh resources and are normally held in the file `1401Commands` in the system folder.

Hardware installation Turn off the Macintosh. Install the card. (Instructions can be found in the *Macintosh Owner's Guide* supplied with your computer.) Connect the 1401 data cable to the D-type connector on the back of the 1401 interface card. The other end of this cable plugs into the Host interface connector on the rear of the Power1401. Hardware installation is now complete.

Particular care should be taken when installing a 1401-30 card into a NuBus adaptor card in a PDS slot, for example in a Centris 660 AV, a Quadra 610 and a PowerMac 6100/66. Plug the 1401 data cable into the interface card before you put the top on the Macintosh, and then ensure that the interface card is properly connected to the NuBus adaptor card. It can happen that when you plug in the data cable, the interface card comes out of its socket in the NuBus adaptor card.

Software installation There are two files on the 1401 Installation Disk for Macintosh that you must copy into the system folder before you can use the Power1401. To install these files:

1. Insert the 1401 Installation Disk for Macintosh into the disk drive.

2. Drag the installation floppy disk icon to the icon of the hard disk containing the current System folder. This will copy all the files into a folder called `1401 driver` on your hard disk.

3. Open the hard disk icon, then open the `1401 driver` folder and the System folder.

4. Select the file `1401 commands` and drag it into the *open* System folder.

   - For PCI computers with the 1401-60 card, the driver is called `driver1401pci`. It must go in the `extensions` folder inside the System folder. Find the `extensions` folder and drag `driver1401pci` into it.

   - For NuBus computers with the 1401-30 card, the driver is called `driver1401`. It must go into the System folder. Drag the file into the System folder, NOT the System folder icon.

5. You must now re-start the Macintosh, which causes the driver to be loaded by the operating system, and makes it available to 1401 applications.

The `1401 Driver` folder should now contain a number of applications. You can double click the INTERACT icon to run your first 1401 application, to test the installation.

TEST1401 interface test This application performs low-level hardware checks on the 1401 interface card to isolate installation faults and also can run the Power1401 self-test to diagnose hardware problems. If you have a problem with your 1401 you may be asked to run this by our Hardware Help Desk to help them to isolate a fault.

TEST1401 in use
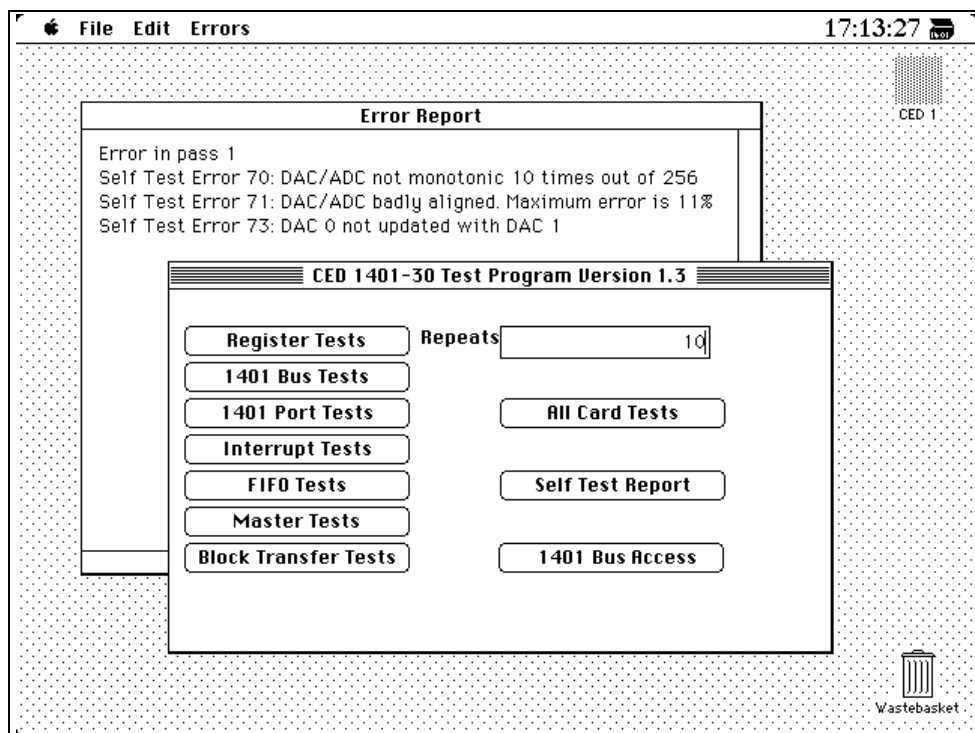
The program is intended to be self-explanatory. Select a test and run it. Any errors appear in the errors window. The picture shows the errors resulting from short-circuiting a DAC output to ground. These detailed error reports enable our staff to diagnose faults rapidly and accurately.

The TESTDAC application This application is used to calibrate the ADC inputs and to align the DAC with the ADC. The Power1401 needs to be opened to run this. See page 54 for information on opening a 1401.

The INTERACT application

This is a Macintosh application that allows you to load and run 1401 commands and to display Power1401 memory. Application programmers may use it to try out ideas before writing them into a 1401 application.

INTERACT in use
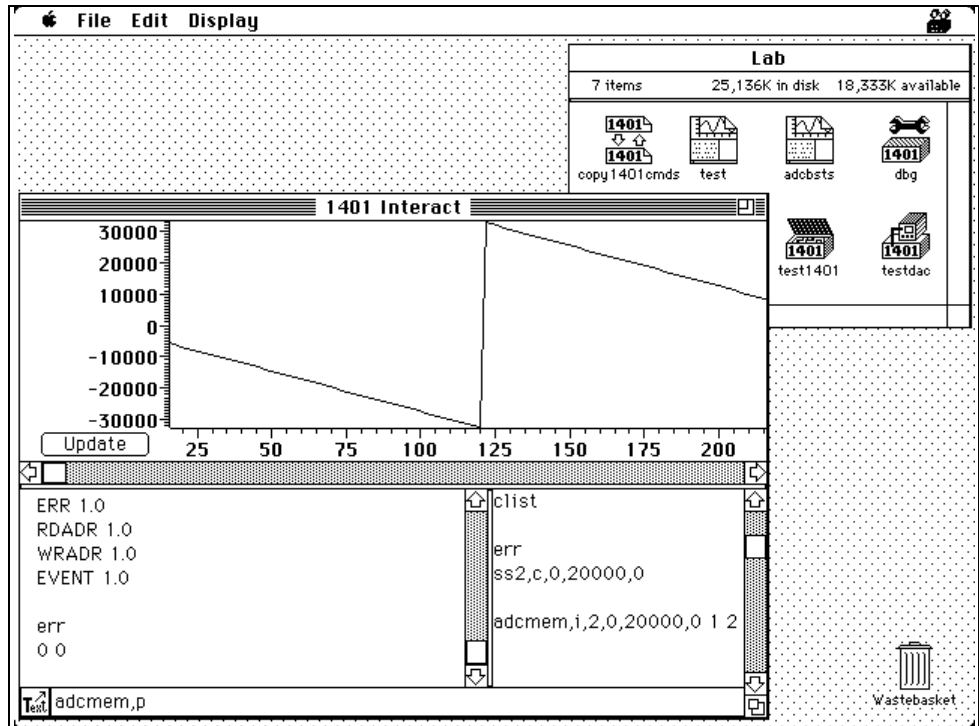
Text commands to Power1401 can be typed in the bottom window of the screen (where the text adcmem,p is located). Press the <enter> key to send the text to the Power1401. The window directly above this shows all text sent to the Power1401 (for example err), and all responses (for example 0 0).

The lower right-hand window is used to store commands to the Power1401; here it holds adcmem,i,2,0,20000,0 1 2. Drag the Text icon at the lower left into this window to copy a command line to the store. Double click on the store to send the command to Power1401.

Pull-down menu options allow you to configure the display of Power1401 memory and load 1401 commands from disk.

General These points relate to physical and electrical aspects of the Power1401 connectors, rather than their electronic function.

Mains earth The outer sleeves of the front-panel BNCs, and the metal shells of the various rear-panel connectors, are robustly connected to the metalwork of the case, and, via the DC-inlet earth pin and the earth lead of the power brick, to mains earth. All signal returns are tied to mains earth on the Power1401 PCB. Items of equipment connected to the Power1401 must not be regarded as isolated from mains earth, nor from each other.

Front panel LEDs All front-panel BNCs have adjacent yellow LEDs. These LEDs flash or blink to show appropriate activity, e.g. an ADC input LED lights when its channel is active; a DAC output LED flashes when its channel is updated; digital output LEDs will be lit when their bit is set. LEDs may light to prompt users to make connections. LEDs also flash in a characteristic manner on self test, see page 3.

The red Test LED lights to indicate self-test, and flashes if a hardware error has been detected. The green Power LED will turn off if any of the digital voltage rails drifts outside limits.

Socketed chips ICs connected directly to the outside world are susceptible to damage from electrostatic discharge or signal overload, though in practice this does not seem to happen very often. These ICs are fitted in sockets to allow you to replace them without recourse to unsoldering. All such chips are readily-available types; if ordering, remember to specify insertion, not surface-mount, style. See page 54 for opening the Power1401 and page 55 for the location and identification of socketed chips.

Connector diagrams On the following pages, all rear-panel connectors are drawn as the user sees them, i.e. viewed from the <u>outside</u>. This is also the view of their mating connectors as seen while wiring them up.
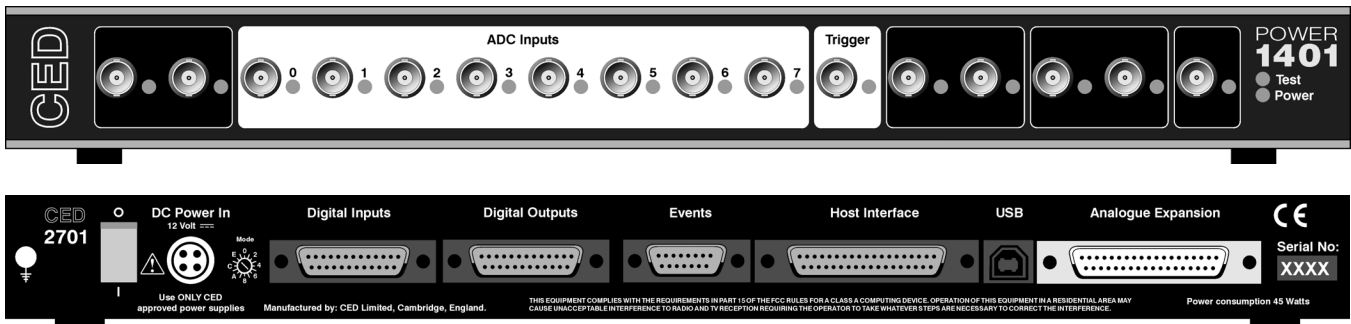
Waveform input   Waveform input channels are buffered through amplifiers. If the programmable-gain option is fitted, the gains are individually software-settable to unity, ×2, ×5 or ×10. Channels are then steered into the ADC (Analogue to Digital Converter) via multiplexers. The input sample-and-hold is part of the ADC chip. The ADC converts an input voltage to a 16-bit digital value in approximately 400ns for a single channel, 2.5µs if switching channel. Sampling is inherently sequential; two channels cannot be sampled simultaneously.

Waveform channels   There are 16 waveform input channels on a standard Power1401. Eight channels are available through front-panel BNC connectors, labelled ADC Inputs, and eight through the rear-panel Analogue Expansion D-socket. The normal working input range of these channels is ±5V, but can be altered to ±10V by cutting and soldering a pair of links.

Trigger   There is a front-panel input labelled Trigger. This can be set by software to be the external signal to start the ADC converting. The ADC external convert input is also permanently wired through pin 6 of the rear panel Events D-socket. Conversions are usually initiated by a high-to-low transition. External convert signals are used when the conversion time is determined by an external event, e.g. when synchronising conversions to the phases of a rotating machine. When operating in internally-triggered mode the ADC typically samples at a fixed rate set by one of the clocks.

ADC LEDs   The front-panel waveform input channels each have an associated yellow LED. They are controlled purely by software command and turn on when the channel is in use.

Trigger LED The trigger-input LED flashes on detection of an active-edge transition at the Trigger input. The LED can be set by software to be either on or off during its quiescent state.

Technical details: The input impedance of the waveform channels is typically
Analogue input 1 MOhm. The waveform inputs expect to be driven from a low-impedance source (100 Ohms or less); the output of most amplifiers is suitable. The maximum non-destructive input voltage range is ±15V. If you do overdrive the inputs, it is possible to damage the input buffer amplifiers. These chips are in sockets for easy replacement, see page 55.

Trigger input The front-panel Trigger input has in-line overvoltage protection and can accept signals in a ±40V range (absolute maximum). This input is held internally to +5V by a 100 kOhm resistor and has input hysteresis: the low-going threshold voltage is set at 0.95V and the high-going threshold at 1.2V. To pull this input low, the driving device must be able to sink 50μA. Pulses driving the trigger input should be 1μs or longer.

The rear-panel ADC external-convert input responds to TTL and switch closure signals, and is held internally at +5V via a 10 kOhm resistor. Input pulses should not be narrower than 1μs and must fall below 0.8V for guaranteed recognition. This input is protected by a 100 Ohm series resistor and diode clamps to +5V and ground; the safe range is 0 to 5V. Conversion is normally initiated on the high-to-low edge. Use of the other edge can be selected by switches, see page 54.

The ADC The input voltage is resolved into 65536 levels (16-bit precision); each step is approximately 150μV. Out-of-range voltages can cause incorrect output values and should be avoided.
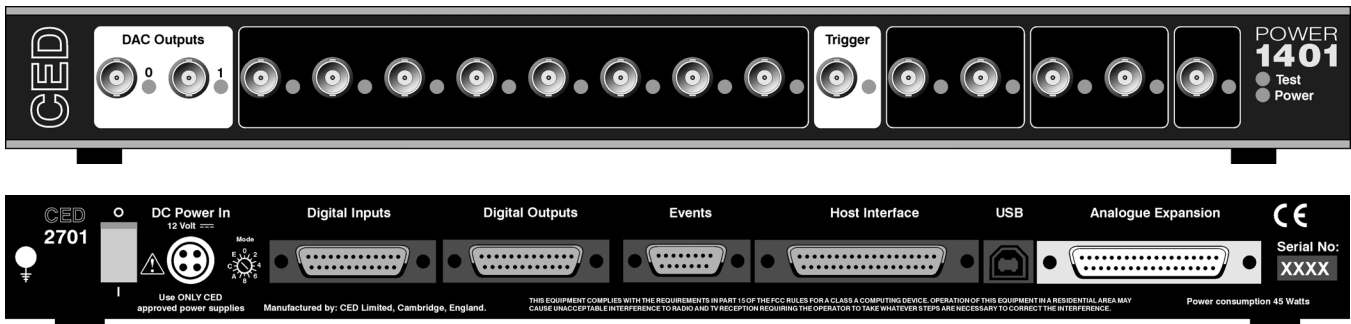
Waveform output   There are 4 waveform output channels on the Power1401. Two are available through BNC connectors on the front panel, labelled DAC Outputs (Digital to Analogue Converters), and two through the rear-panel Analogue Expansion D-socket.

The DAC waveform outputs produce voltages in the range ±5V, in steps of approximately 150μV. If the programmable gain option has been fitted, the output gain can be switched by software between unity and ×2. Alternatively, the range can be altered semi-permanently to ±10V, and 300μV resolution, by cutting a PCB track next to each DAC.

The DACs can be set by program to update in response to an external signal, either the rear panel Event Clock F input, see page 46, or the front panel Trigger input, to synchronise the update rate to external equipment. When multiple channels of waveform are output, the Power1401 can be programmed to update several DACs simultaneously. The maximum update rate is 400kHz.

DAC LEDs   The front-panel waveform output channels each have an associated yellow LED. The LED turns on when the channel is in use.

Technical details   The waveform outputs are designed for driving loads of 600 Ohms impedance or higher, and are short-circuit proof. For full accuracy, the load should not be less than 5 kOhm. The output amplifiers are fitted in sockets for easy replacement; see page 54.

The rear-panel analogue connector

The rear-panel analogue connector is a 37-way D-socket. It accommodates the top eight ADC input channels and DAC channels 2 and 3. These ten signals appear along one row of the D-socket, and each is provided with a separate return to GND on the other row. This is useful when wiring up mating plugs with twisted pairs or coaxial cables.

Rear-panel analogue socket
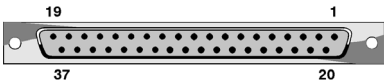
Pin	Function	Pin	Function
1-8	GND	20-27	No connection
9	GND	28	ADC_input_8
10	GND	29	ADC_input_9
11	GND	30	ADC_input_10
12	GND	31	ADC_input_11
13	GND	32	ADC_input_12
14	GND	33	ADC_input_13
15	GND	34	ADC_input_14
16	GND	35	ADC_input_15
17	GND	36	DAC_output_2
18	GND	37	DAC_output_3
19	GND		
Screen	Mains earth		
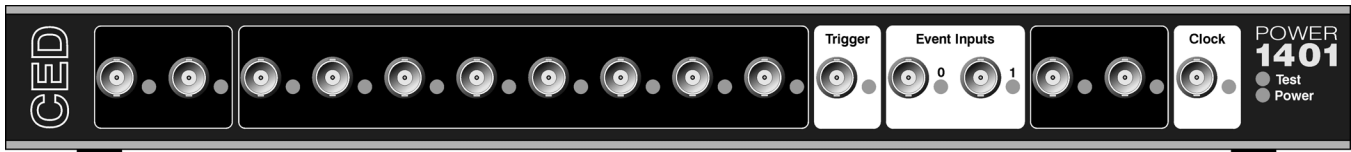
Clocks The Power1401 has five clocks, used for timing and counting external pulses (clocks 0 and 1), generating general purpose timing pulses (clock 2), controlling waveform output (clocks 3 and 4) and controlling the waveform input sampling rate (clock 4).

These clocks are managed automatically by the application software. You may need to drive a clock from an experiment, e.g. to trigger sweeps of waveform sampling. The front-panel Trigger input will be routed by software to the correct clock, to set it running on your signal.

You may require the application to generate pulses to drive an experiment. The output of Clock 2 is available from the front-panel Clock BNC connector. The application manual describes this where it is relevant.

Where external signal pulses are to be timed or counted, the application program may use the front-panel Event 0 and Event 1 inputs. Pulses must be 1µs or wider. If there are more than two such signals, the rear-panel Digital Inputs may be used, see page 49.

All clock frequencies are normally derived from an internal crystal oscillator. Users may sometimes need to take a timing source from outside the Power1401 instead. All the clocks can be driven from an external frequency source via the Clock F input, pin 7 on the rear-panel Events socket (see page 46.) When you need to synchronise two 1401 machines, connect the 4MHz Clock output from one to the F input of the other.

LEDs The trigger and event-input LEDs flash on detection of an active-edge transition. These LEDs can be either on or off in the quiescent state, as set by software command, to indicate that the input is armed and expects to be used. The clock output LED simply indicates that Clock 2 is running, turning on whenever Clock 2 is enabled.

Technical details Event 0 and Event 1 have in-line overvoltage protection and can accept signals in a ±40V range (absolute maximum). These inputs are held internally to +5V by 100 kOhm resistors and have input hysteresis: the low-going threshold voltage is set at 0.95V and the high-going threshold at 1.2V. To pull these inputs low, the driving device must be able to sink 50μA. Pulses driving these front panel inputs must be 1μs or longer. Clock is an output, driven by a 74HCT244 bus driver element which can source or sink 24mA; this chip is in a socket for easy replacement, see page 55.
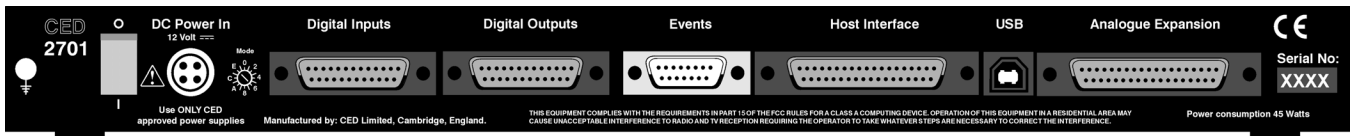
Event inputs More clock-related inputs, the Clock E series, are provided on the rear-panel Events D-socket. These inputs allow close control of the clocks for people writing their own software. Full details are given in the *1401 family programming manual,* and the *Power1401 technical manual.* The front panel BNCs Event 0 and Event 1 are often routed by software to the Clock E0 and E1 inputs.

Technical details Clock E and Clock F inputs respond to TTL or switch closure signals, and are held internally to +5V by 10 kOhm resistors. To pull these inputs low, the driving device must be able to sink at least 500μA; input pulses must fall below 0.8V to guarantee recognition. Clock E pulses should not be narrower than 100ns. Clock F frequency must not exceed 10MHz; pulses should be wider than 50ns. The working range of these inputs is 0 to +5V. They are protected by a 100 Ohm resistor in series with diode clamps to +5V and ground; the safe input range is ±10V. All chips associated with the Events I/O are in sockets for easy replacement, see page 55.

The 4MHz Clock output signal is buffered by a 74HCT14 Schmidt inverter element which can drive 10 LS TTL loads. 4 MHz Clock can be isolated from the rear-panel socket by a cuttable link, to help reduce EMI.

The sense of the Clock E and ADC external convert inputs may be inverted by a switch option, see page 54, but the inputs would all then be held active high if no input is connected.

Events socket
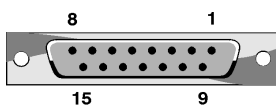
Pin	Function	Pin	Function
1	Clock E0 input	5	Clock E4 input
2	Clock E1 input	6	ADC external convert input
3	Clock E2 input	7	Clock F input for all clocks
4	Clock E3 input	8	4 MHz clock output
9 - 15	Ground	Screen	Mains earth
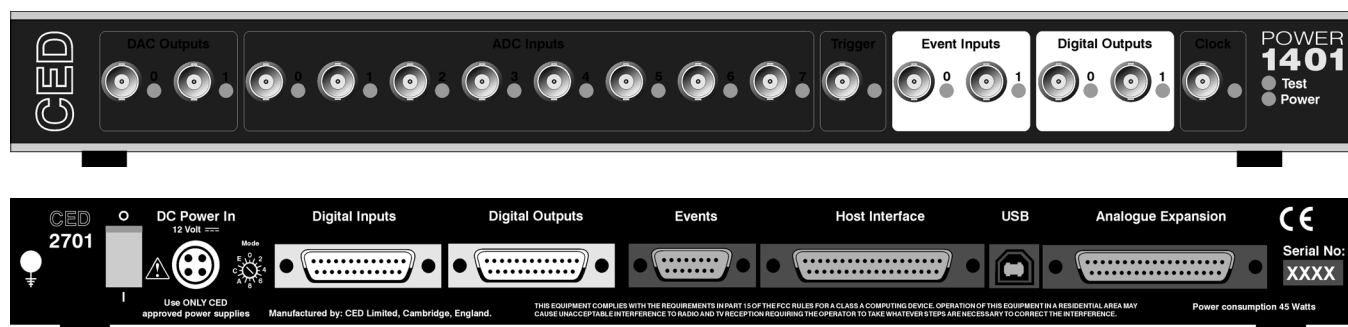
Digital input and output

The Power1401 has full 16-bit digital input and digital output available on rear-panel D-connectors marked Digital Inputs and Digital Outputs. Bits may be read or written singly, by low or high byte, or by the whole word. High-byte output bits 0 and 1 are also routed to the front-panel Digital Outputs, and, if enabled by software, high-byte inputs 0 and 1 are fed from the front-panel Event Inputs.

The input high byte can be programmed for detection and timing of change of state (i.e. any bit changing in either direction). Digital output can be gated with clock 2 so that it updates on clock 2 ticks. Digital output is normally permanently enabled, but either byte may be turned tristate-off by software. It can also be controlled by pin 11 of the output socket. If pin 11 is grounded, both bytes are disabled, i.e. tristate-off ; they are enabled if pin 11 is high or disconnected.

Digital I/O LEDs

Front-panel event-input LEDs flash on detection of active-edge transitions. The quiescent state is set by software command. Front-panel digital-output LEDs simply reflect the state of the bits, being lit whenever their bit is set (high).

Technical details

Front-panel digital I/O is routed through common-mode ferrite chokes to prevent radiation of EMI. Outputs are buffered through 74HCT244s, which can source or sink 24mA. All digital I/O chips are socketed for easy replacement, see page 55.

Unconnected digital inputs read 1, being pulled internally to +5V by 4k7 (rear panel) or 100k (front panel). Input voltages of more than 2.0V will always read as a logic 1. To appear as logic 0, the input must be pulled down to below 0.8V for at least 1µs, which takes approximately 1mA (rear), 50µA (front).

Digital I/O handshake protocol

Digital data transfer between the Power1401 and external equipment can optionally be synchronised by pairs of handshake signals. There are separate pairs for each byte. The polarities of all signals can be independently set by software. The example that follows is typical.
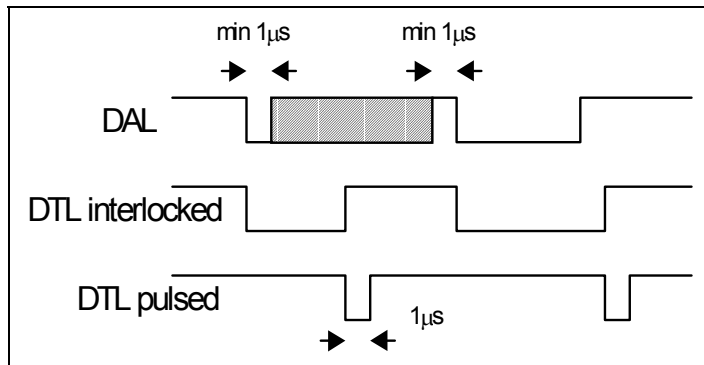
When presenting data, an external device sends a pulse at least 1µs wide to the DAL (data available 0-7) input. When the Power1401 reads the data the DTL (data transmitted 0-7) output line pulses for 1µs if in pulsed mode. If in interlocked mode, DTL is set by the Power1401 read and cleared by the next DAL.
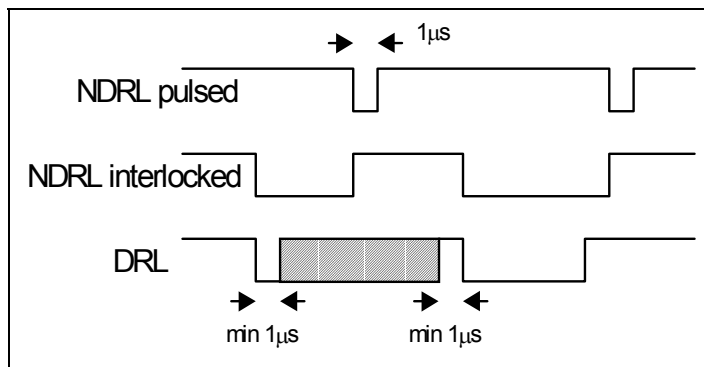
When Power1401 writes data to the digital output, the NDRL (new data ready 0-7) output pulses for 1µs if in pulsed mode. If in interlocked mode NDRL is set by the data write and cleared by the answering DRL (data read 0-7) pulse, at least 1µs wide, from the external device.

5 volt output and circuit breaker

There is a +5V output available on pin 25 of both the digital input and output ports. This output is internally protected by a 200mA circuit-breaker and is intended only to power one or two chips for interfacing purposes. The breaker is reset by removing power from the Power1401.
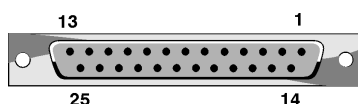
We have occasionally had problems with users who trip this protection very regularly. This is usually caused by a connector with a metal shroud being plugged into the digital input crookedly and the shroud touching pin 25, which causes overload. If you have this problem, the simple solution is to make this connection with Power1401 switched off, or to use a connector with a plastic shroud.

Digital I/O connectors

Digital Inputs
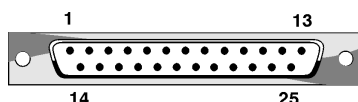
Digital Outputs

Pin	Output socket			Pin	Input plug		
1	High byte out 7		Word out 15	1	High byte in 7		Word in 15
14	6		14	14	6		14
2	5		13	2	5		13
15	4		12	15	4		12
3	3		11	3	3		11
16	2		10	16	2		10
4	1		9	4	1		9
17	0		8	17	0		8
5	Low byte out 7		Word out 7	5	Low byte in 7		Word in 7
18	6		6	18	6		6
6	5		5	6	5		5
19	4		4	19	4		4
7	3		3	7	3		3
20	2		2	20	2		2
8	1		1	8	1		1
21	0		0	21	0		0
9	DRH Data received 8-15		i/p	9	DTH Data transmitted 8-15 o/p		
22	User i/p (buffered, reserved)			22	not connected		
10	User o/p (buffered, reserved)			10	not connected		
23	NDRL New data ready 0-7		o/p	23	DAL Data available 0-7		i/p
11	Output enable		i/p	11	not connected		
24	DRL Data received 0-7		i/p	24	DTL Data transmitted 0-7 o/p		
12	NDRH New data ready 8-15		o/p	12	DAH Data available 8-15		i/p
25	+5V (200mA maximum)			25	+5V (200mA maximum)		
13	GND			13	GND		
Screen	Mains earth			Screen	Mains earth		

Host port If an ISA or a PCI interface card is being used, the Power1401 communicates with its host computer via a 37-way D-plug on the rear panel. Unidirectional signals are driven by 74HCT244s, bidirectional signals by a 74HCT245. All three host interface ICs are in sockets for easy replacement in the unlikely event of a chip being damaged; see page 55.

The host data cable is normally supplied in a length of 2 metres. It will still work satisfactorily if this is increased to 5 metres. The Power1401 is specified to meet European and US EMC regulations <u>only</u> if used with braid-screened cables supplied by CED.

Host interface plug
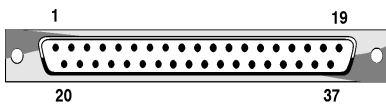
Pin	Function	Pin	Function
1	Host Address A0	11	Host D4
2	Host A1	12	Host D5
3	Host A2	13	Host D6
4	Host A3	14	Host D7
5	Host read/write	15	Host DA
6	Host DMA enable	16	Host strobe
7	Host Data D0	17	Host CTS
8	Host D1	18	Interrupt request
9	Host D2	19	Host reset
10	Host D3	20-37	GND
Screen	Mains earth		

USB port The USB port is for use with the USB serial-line protocol, and was first implemented by CED for hardware issue C of the Power1401, in 2000.

The USB port is a style B socket on the rear panel. USB_DATA+ and USB_DATA- transmit the serial data as a differential pair. USB_GND is connected to system ground via a choke. USB_+5V

USB socket
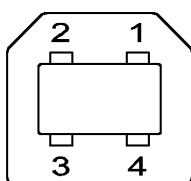
Pin	Function
1	USB_+5V (cable detect)
2	USB_DATA+
3	USB_DATA-
4	USB_GND (to system ground)
Screen	Mains earth

is used as a cable sense input; +5V applied to this pin indicates that the USB cable is inserted. The Power1401 is specified to meet European and US EMC regulations only if used with braid-screened cables supplied by CED.

DC power inlet The power brick is a switch-mode regulator that provides a nominal 12V DC. This is regulated to +5V inside the Power1401, and the other voltage rails (+3V3, +2V, ±15V) are generated from +5V. The internal 5V regulator will accept voltages in the range +9V to +18V, so the Power1401 will run off a car battery.

The rear-panel DC switch switches both +12V and 0V. When inserting the DC supply plug, initial contact is made by mains earth when the sleeve engages the DC inlet screen. Mains earth also makes contact via a pin at the same time that the +12V and 0V pins make contact.
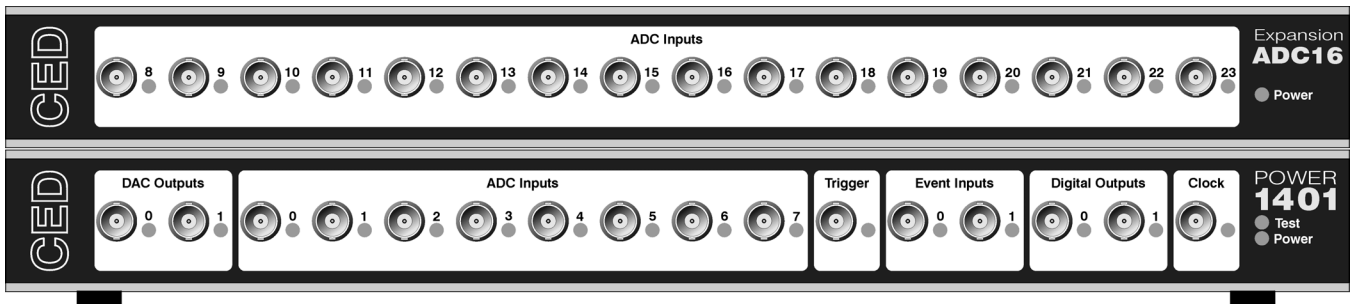
DC power socket
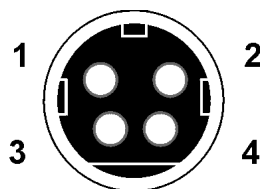
| Pin	Function
1	+12V
2	0V
3	SPARE
4	Mains earth
Screen	Mains earth

The Power1401 consumes approximately 3A at 12V.

Sets of 16 more waveform inputs

The set of waveform input channels may be expanded by adding an expansion box with sixteen extra channels, which are mapped onto ADC channels 9-23. Once the Power1401 is told about the extra channels by the installation program, the new ones may be freely used just like the basic set. Software that reads the extra channels will return undefined data values if the waveform expansion box is not installed.

The ADC inputs are of identical design to the ones on the main unit, with an input range of ±5V (optionally ±10V). The expansion box makes internal connections to the Power1401 motherboard. This card requires the Power1401 expanded mechanics (can and case) and is unsuitable for end-user installation.
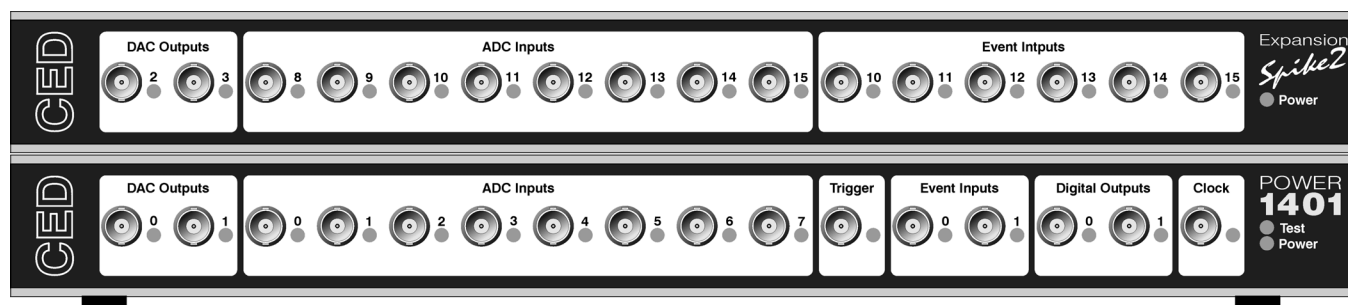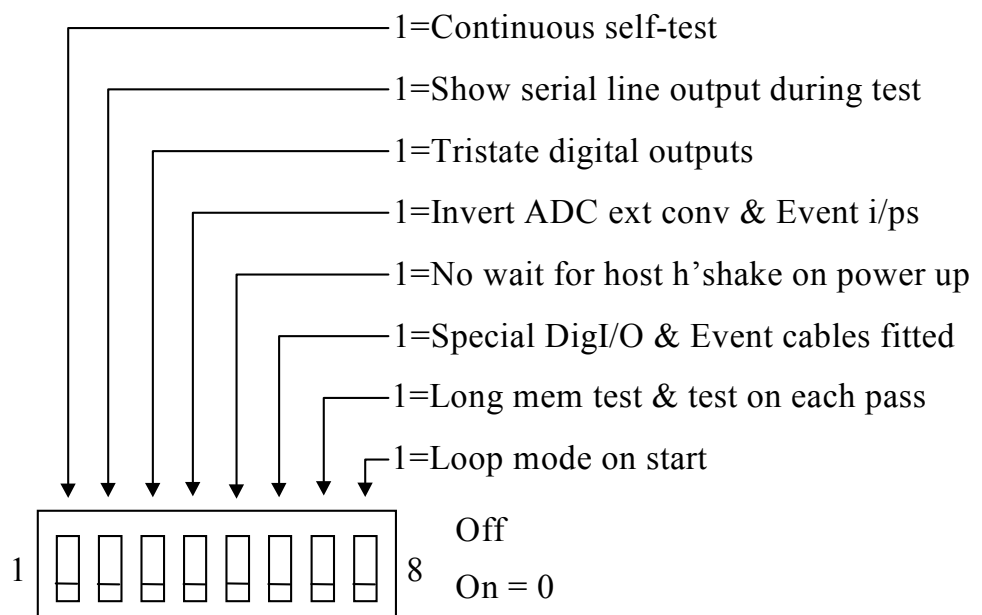
Digital BNC connections In some circumstances, such as in many Spike2 applications, the digital inputs and outputs are heavily used for signals. It is convenient to have more of these connectors available on the front panel as BNCs. The 2701-09 daughterboard provides six event inputs, mapped onto digital inputs 10-15, together with eight ADC inputs and a pair of DACs, mapped onto ADC 8-15 and DAC 2-3 respectively.

The safe working voltage range of the digital inputs is ±10V, and they present an impedance of 100 kOhm, as with the front panel Event and Trigger inputs. The expansion PCB makes internal connections to the Power1401 motherboard. This card requires the Power1401 expanded mechanics (can and case) and is unsuitable for end-user installation.

Introduction The Power1401 requires very little maintenance. This section covers simple operations that may occasionally require opening the case, such as setting the internal options switch or replacing damaged I/O chips. There is also a discussion on updating the flash ROM and re-calibrating the analogue system.
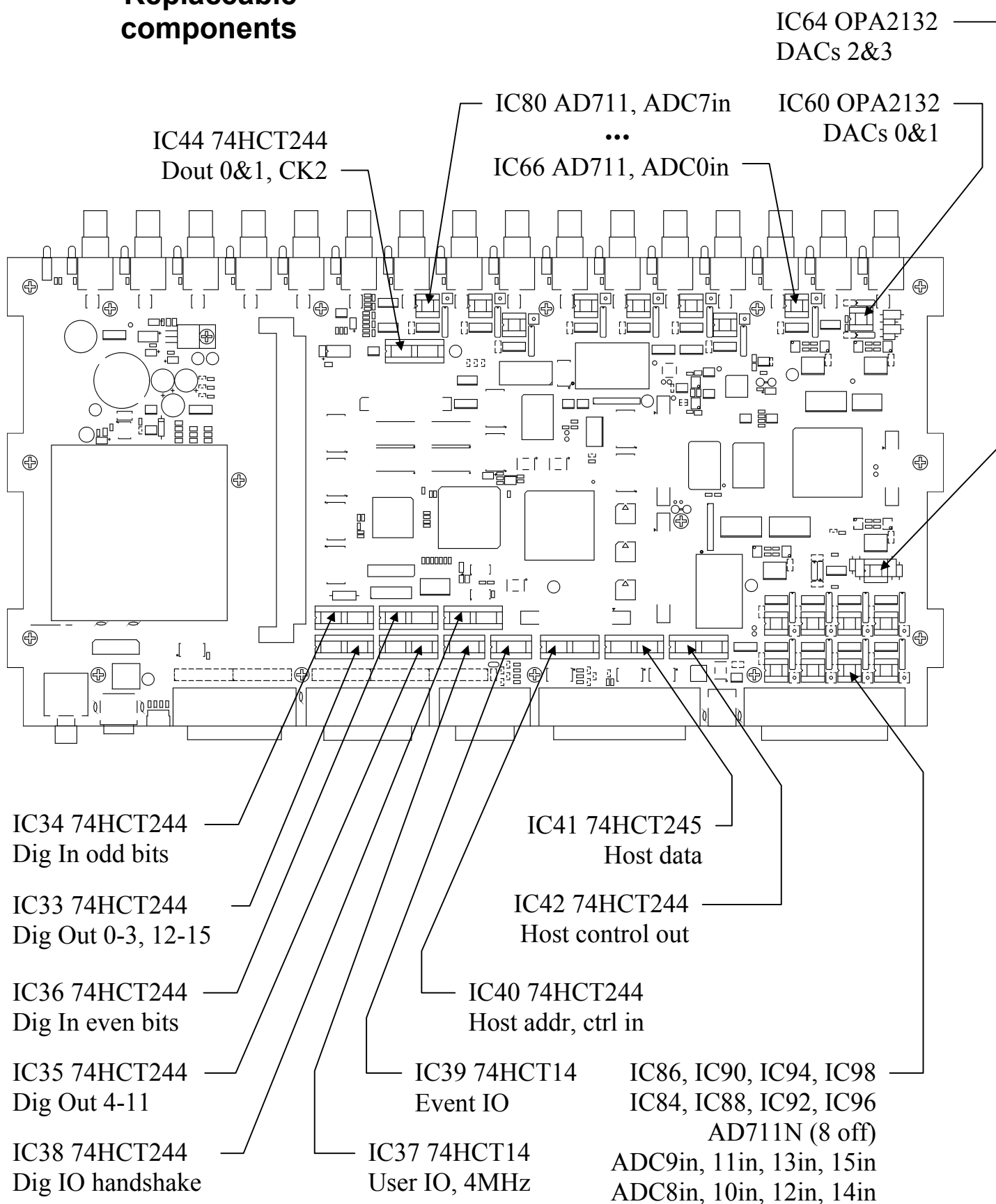
Taking the lid off The Power1401 top cover is held in place by the back panel. To free the back panel, unscrew the four M3 screws at the corners with a cross-point screwdriver. Swing the back panel away. There is no need to detach the green & yellow earth wire. Slide out the top cover. Be careful not to splay the sides; the case loses much of its rigidity once the back panel is off.
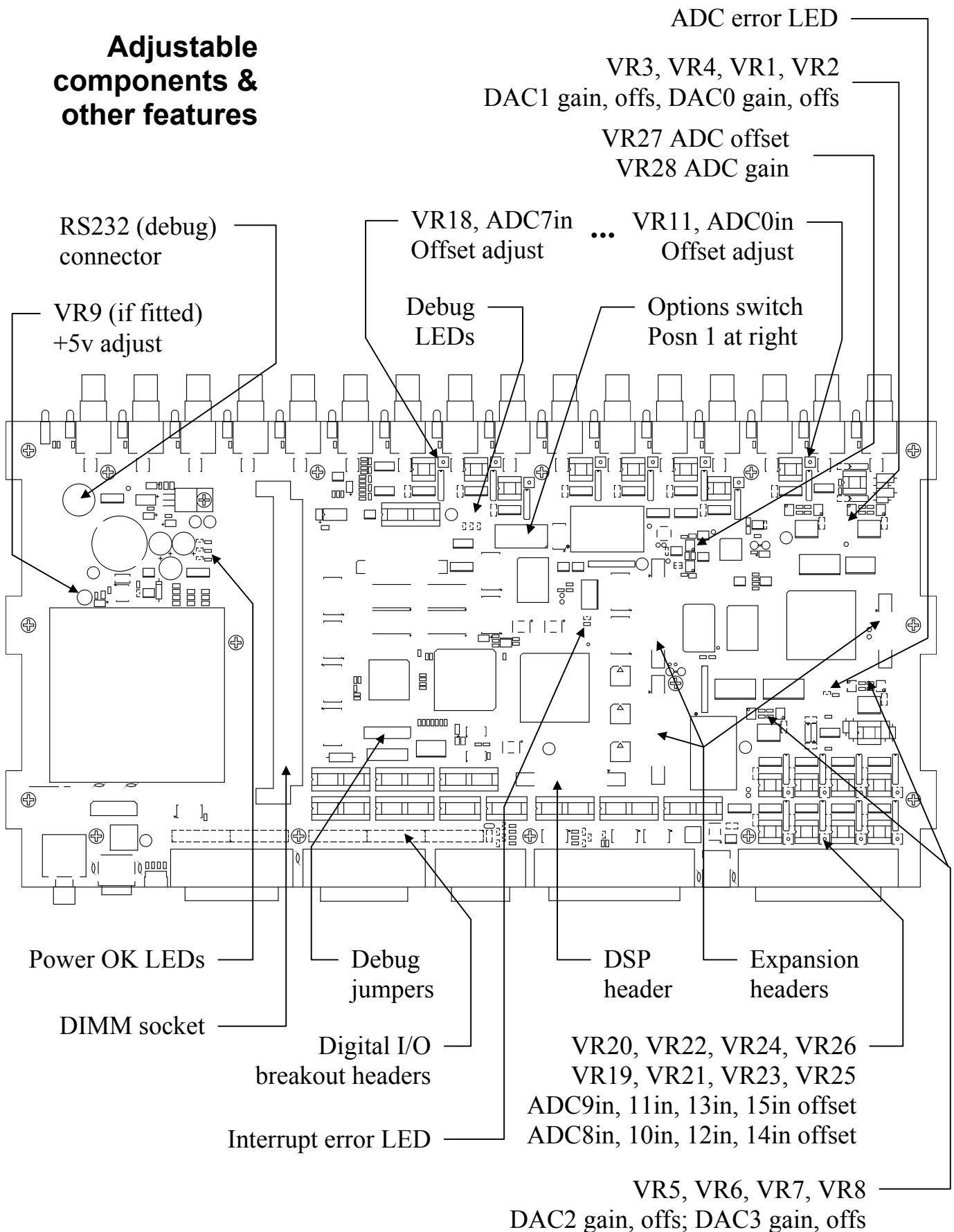
The inner EMC (electromagnetic compatibility) containment can is now visible. Slide the can out to the rear and undo the green & yellow earth wire that plugs in halfway along the side. Remove the lid of the can by unscrewing the six small screws and gently pulling the lid up and off.

Switch settings This diagram shows the internal options switch settings on the Power1401. In terms of logic, On counts as 0, Off counts as 1. Most options concern self-test and debug. For normal use, all switch positions must be On, physically towards the rear of the PCB, as shown.

1=Continuous self-test
1=Show serial line output during test
1=Tristate digital outputs
1=Invert ADC ext conv & Event i/ps
1=No wait for host h'shake on power up
1=Special DigI/O & Event cables fitted
1=Long mem test & test on each pass
1=Loop mode on start

1 8 Off
On = 0

Replaceable components

IC64 OPA2132
DACs 2&3

IC80 AD711, ADC7in

IC60 OPA2132
DACs 0&1

IC44 74HCT244
Dout 0&1, CK2

•••

IC66 AD711, ADC0in

IC34 74HCT244
Dig In odd bits

IC41 74HCT245
Host data

IC33 74HCT244
Dig Out 0-3, 12-15

IC42 74HCT244
Host control out

IC36 74HCT244
Dig In even bits

IC40 74HCT244
Host addr, ctrl in

IC35 74HCT244
Dig Out 4-11

IC39 74HCT14
Event IO

IC86, IC90, IC94, IC98
IC84, IC88, IC92, IC96
AD711N (8 off)
ADC9in, 11in, 13in, 15in
ADC8in, 10in, 12in, 14in

IC38 74HCT244
Dig IO handshake

IC37 74HCT14
User IO, 4MHz

55

Adjustable components & other features

ADC error LED

VR3, VR4, VR1, VR2
DAC1 gain, offs, DAC0 gain, offs

VR27 ADC offset
VR28 ADC gain

RS232 (debug) connector

VR18, ADC7in
Offset adjust   ...   VR11, ADC0in
Offset adjust

VR9 (if fitted)
+5v adjust

Debug
LEDs

Options switch
Posn 1 at right

Power OK LEDs

Debug
jumpers

DSP
header

Expansion
headers

DIMM socket

Digital I/O
breakout headers

VR20, VR22, VR24, VR26
VR19, VR21, VR23, VR25
ADC9in, 11in, 13in, 15in offset
ADC8in, 10in, 12in, 14in offset

Interrupt error LED

VR5, VR6, VR7, VR8
DAC2 gain, offs; DAC3 gain, offs

Flash ROM and the Power1401 Monitor

The Power1401 stores various items of software in its non-volatile, on-board flash ROM. FPGA configuration images are stored in memory blocks 14 and 15; the primary boot loader is stored in memory block 0, and the firmware for the power-on self-test in block 1. The monitor (the operating firmware) is stored in memory block 2. This monitor is automatically loaded on power-up, as long as the Mode switch is in position 2; this tells the primary boot loader to load block 2. You can implement monitor upgrades by writing a new one into flash ROM with the TRY1432 utility.

Memory block overwrite warning

Flash ROM contents ➢
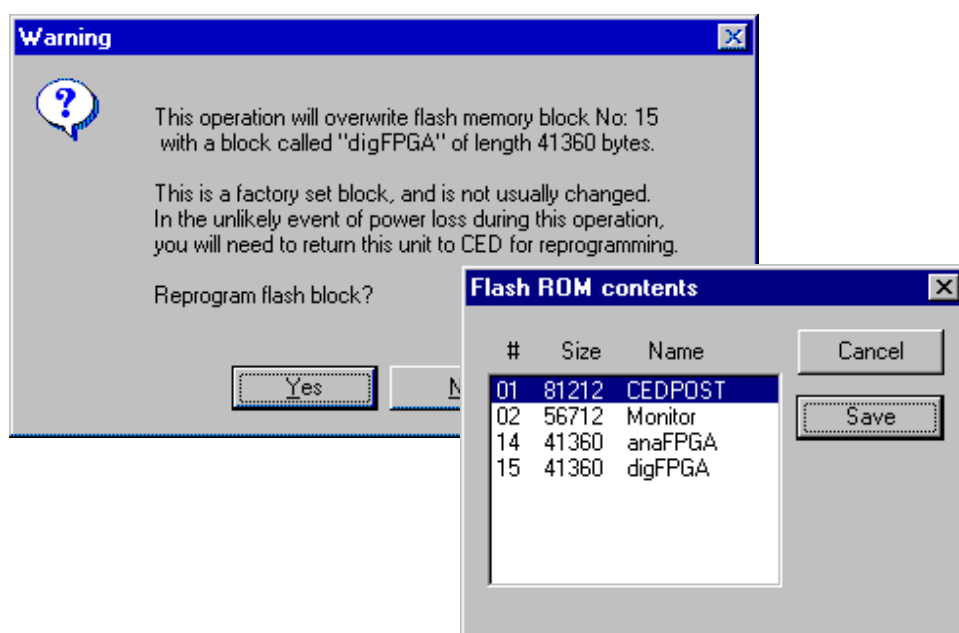
TRY1432 To upgrade the monitor, you need a valid flash image file with a `.fli` extension, typically downloaded from CED's website. Open TRY1432 (see page 31); from *File* select *Update Flash.* The new monitor's destination is set automatically to block 3, so the old monitor is still there in case of disaster, e.g. power failure during the few seconds taken writing the file. To use the new monitor, set Mode to 3 and switch 1401 DC off and on again. Blocks 0, 1, 2, 14 & 15 are pre-loaded; if you do write to them you are warned first. Afterwards the updated flash ROM contents are displayed.

Upgrades and the Internet Flash ROM monitor upgrades are available from CED's website, www.ced.co.uk. FPGA images will similarly be upgradable, to blocks 12 and 13, should this prove desirable.

Analogue calibration   A calibration program TESTDAC is provided for both the IBM and Macintosh systems, which is used to calibrate the ADC inputs. This involves opening the Power1401, since the main trimming controls are manually-adjusted potentiometers (see page 54 on taking the lid off.) Before we ship your unit, we run this program and set the waveform system to an accuracy of approximately 0.5mV, or three least significant bits (LSBs). On a ±5V range, one 16-bit LSB corresponds to only 150µV, which is of the same magnitude as the drift caused by the normal ageing of components. Therefore, if accurate voltage measurement is important to you, we suggest that you calibrate your Power1401 against a known standard as part of your experimental protocols, and check the absolute accuracy once every six months. We find that most units drift by less than 32 LSBs (0.05%) over this period.

To make use of this program you will need a 1.4mm flat-bladed jewellers screwdriver, a few BNC-to-BNC cables and a BNC tee-junction, and an accurate digital voltmeter (DVM) with a resolution of 10µV on the ±5V range. It is most important that you allow the Power1401 to warm up with power on for at least 30 minutes before you start the calibration, to allow the system to reach thermal equilibrium.

Alternatively, you may choose to return your Power1401 to CED for calibration. See page 62 for advice on sending it back.

Running TESTDAC   TESTDAC is a DOS utility stored in the folder `\1401\utils`. To run it, open a DOS box (preferably full-screen). Type

```
cd \1401\utils <enter>
testdac <enter>
```

and follow the screen instructions. The procedure involves calibrating the DACs against the DVM, then calibrating the ADC against DAC0.

Trouble shooting

Overview   The Power1401 has comprehensive built-in self-test capabilities which are backed up by a range of test and diagnostic programs to pin-point problems quickly. If you suspect that you have a hardware fault, you should follow the procedures below to obtain as much information as you can about the problem, then call the CED Hardware Help Desk for advice. Components in the Power1401 that are connected to the outside world are socketed for easy replacement, see the diagram on page 55. In many instances this avoids the need to return the Power1401 to CED.

Stand-alone test   The simplest test of a Power1401, which eliminates the possibility of a host computer or cable fault confusing the situation, is to disconnect the Power1401 from the host at the 1401 end of the data cable, remove all signal connections and then apply power to the Power1401. If all is well, the Power indicator should light and stay on. The Test indicator should flash for a few seconds, then turn off. The BNC LEDs will also flash. If the Power1401 behaves as expected it is likely that the fault lies in the interface cable, the 1401 interface card in the host, in the host computer hardware or the host computer software.

If the Test indicator remains flashing, the internal Power1401 power-up self-test has detected a problem. It is likely that one of the test programs will be able to diagnose the trouble. If you have not already installed the 1401 test and diagnostic programs, do so now (see page 30) and continue at the diagnostic section, below.

If the Power and Test indicators come on and stay on, the diagnostic programs may not be able to help. You should contact CED for advice.

Diagnostics If the Test indicator is flashing continuously, the most useful diagnostic program for Windows systems is the self-test option in TRY1432, (or TRY1401 in DOS) or the self-test report option of the TEST1401 application on the Macintosh. You will need to connect your Power1401 to the host computer before running the test. This program forces the Power1401 internal self-test to run repeatedly, and interprets any errors discovered. Make a note of any errors reported and contact CED for advice on correcting the problem.

Hardware resources clash Some problems are not due to a fault, but caused by a hardware incompatibility, or an address, interrupt or DMA channel clashing with another device. If you suspect you have this type of problem, you can do a first-line check yourself, before contacting CED for advice.

If another hardware device is using the same interrupt, DMA or base address as the 1401 interface card, symptoms can be 1401 commands refusing to load, or the Power1401 Test indicator turning on in the middle of an application. This can be checked by removing other cards one at a time, and re-trying the problematic operation.

Alternatively, run the various system diagnostics:

Windows 9x Select *Start, Settings, Control Panel* and double click on *System*. Select *Device Manager* and double click on *Computer* to see the IRQ (interrupt), DMA and address assignments. You can try to re-assign any clashes by double-clicking on the offender at the *Device Manager* level.

Windows NT 4 Select *Start, Programs, Administrative Tools, Windows NT Diagnostics*, and select the *Resources* tab. Press the *Devices* button. Select *ced1401* from the list that is displayed, then press the *Properties* button. The resource usage of the 1401 interface card is displayed. Clashes cannot be sorted out automatically, but must be resolved by editing values by hand.

Vector usage On AT class machines and above, interrupt 2 is actually interrupt request 9, redirected to 2. You do not have a free choice of interrupt since other devices in your system may be using vectors, which cannot be shared on the PC or AT bus. These are common vector usages:

Vector	Other users of this vector
2	May conflict with VGA frame interrupt on AT or above. VGA interrupt can usually be disabled without any performance penalty; see your VGA controller manual.
3	Serial port 2 (COM2). Will only conflict if you are using serial line software which uses interrupts on COM2.
4	Serial port 1 (COM1). Will only conflict if you are using serial line software which uses interrupts on COM1.
5	Parallel port 2 (LPT2) and some mice. It is extremely rare for the parallel port interrupt to be used.

The preferred setting is interrupt 5. If you have a VGA card and interrupt 2 fails, a common cause is that VGA interrupts are enabled. Very little software uses the VGA interrupt and it can usually be disabled by a jumper on the VGA controller card.

Calling the CED Help Desk If you cannot beat your Power1401 problems yourself, do call our Help Desk. Please email if possible; our email address is:

`info@ced.co.uk`

Otherwise, our phone and fax numbers are at the front of this manual. If your email has attached files, please ensure that they are less than 200Kb (zipped). To save yourself time, and improve the efficiency of the process:

- Please find the serial number of your Power1401, printed on the back.
- If the problem is with a program, please make a note of the version number, announced on entry.
- It is often useful for DOS users to have run TRY1401, for Windows users to have run TRY1432, or for Mac users to have run TEST1401, so you know about the hardware state.
- Print out your `config.sys` and `autoexec.bat` files, which are often the key to installation problems.

Sending it back If you need to send the Power1401 back to CED:

- Please get a returns number from CED.
- If you are despatching from outside the UK, please call us. We can advise you on speeding your machine through Customs, and save you money.
- Include a paper description of the problem with the unit.
- Make sure the packaging is adequate to avoid damage in transit!

Index

Specification

Waveform inputs	Input impedance	1	MOhm
	Active working voltage range	±5	Volts
		(±10	Volts with 10V option)
	Safe voltage range	±15	Volts
	Maximum conversion rate		
	single channel	2.5	megaHertz
	multi-channel	400	kiloHertz
	Resolution	16	bits
Waveform outputs	Active working voltage range	±5	Volts
		(±10	Volts with 10V option)
	Safe drive capability	600	Ohms
	Full accuracy drive	5	kOhms
	Maximum conversion rate	400	kiloHertz
	Resolution	16	bits
Front-panel digital inputs	Input impedance	100	kOhms
	Safe voltage range	±40	Volts
	Shortest pulse-width	100	nanoseconds
	Low voltage	0.8	Volts
	Low current	50	microAmps
Rear-panel digital and event inputs	Input impedance	4.7	kOhms minimum
	Safe voltage range	±10	Volts
	Shortest pulse-width	1	microsecond
	Low voltage	0.8	Volts
	Low current	1.5	milliAmps maximum
Digital outputs	Drive capability	±20	milliAmps
Mains Supply	Voltage range	100 to 240	Volts
	Frequency range	47 to 63	Hertz
	Current	0.8	Amps
Case size & weight	Power1401	88 × 219 × 428	millimetres
		3.0	kilograms
	Power brick	40 × 75 × 130	millimetres
		0.45	kilograms
Environment	Temperature range	−5 to +50	°Celsius
	Maximum humidity	95%	Non-condensing

CE

EC Declaration of Conformity

This is to certify that the:

CED Power1401

Manufactured by:

Cambridge Electronic Design Limited
Science Park, Milton Road, Cambridge CB4 0FE, UK
Tel +44 (0)1223 420186

conforms with the protection requirements of Council Directive 89/336/EEC,
relating to Electromagnetic Compatibility,
by the application of the following EMC standards:

Conducted and radiated emissions:

EN61326-1 (1997) Class B	-	COMPLIES
EN55022 (1998) Class B	-	COMPLIES
Vfg1046/1984	-	COMPLIES
FCC CFR47 (1997) Part 15 Subpart B Class A	-	COMPLIES

EN50082-1:1991 Immunity standards:

EN50082-1 (1997) (Generic immunity)	-	PASS
EN61000-4-2 (1995) (Electrostatic discharge)	-	PASS (8kV) Criterion A
EN61000-4-3 (1997) (RF field immunity)	-	PASS (3V/m) Criterion A
EN61000-4-4 (1995) (Electrical fast transients)	-	PASS (2kV - Heavy industrial) Criterion A
EN61000-4-5 (1995) (Surge immunity)	-	PASS Criterion A
EN61000-4-6 (1996) (Conducted immunity)	-	PASS Criterion A
EN61000-4-11 (1998) (Dips immunity)	-	PASS Criteria A&C

Signature   *Peter Rice*   Peter Rice
Technical Director

Date   11 AUGUST 1999   11 August 1999