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# The CED Power1401 Owners Handbook

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# Fast installation guide

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**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, including CDROMs, 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 symbols below have the following meanings:



This symbol declares that the equipment passes the relevant clauses of EU directives on safety and EMC emissions; see the certificate reproduced on page 65.



Observe precautions against electrostatic discharge.



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

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**1: Software**      Install software first: either your CED application or from the CED 1401 installation CDROM

**2: USB**

details on  
page 6

or

Power up & connect the Power1401

- Windows 98, Windows Me, Windows NT 2000, Windows XP

USB hardware is recognised & correct driver located automatically

**PCI**

details on  
page 9

or

Plug the interface card into the computer

- Windows 9x, Windows Me, Windows NT 2000, Windows XP

Windows automatically locates PCI driver

- Windows NT 4

Installation disk loads PCI driver. Use *CED 1401 controls* applet to set up interface

**ISA**

details on  
page 16

Plug the interface card into the computer

Adjust jumpers if required – usually not

- Windows 9x, Windows Me, Windows NT 2000, Windows XP

Use *Add New Hardware* dialog to install interface

- Windows NT 4

Installation disk loads ISA driver. Use *CED 1401 controls* applet to set up interface

**3: Check**

Run *Try1401*, set tests *All On*, select *Run Once*

Test should take ~15 seconds & give no errors

**4: Finish**

Your Power1401 is now ready for use

# Getting started with Power1401

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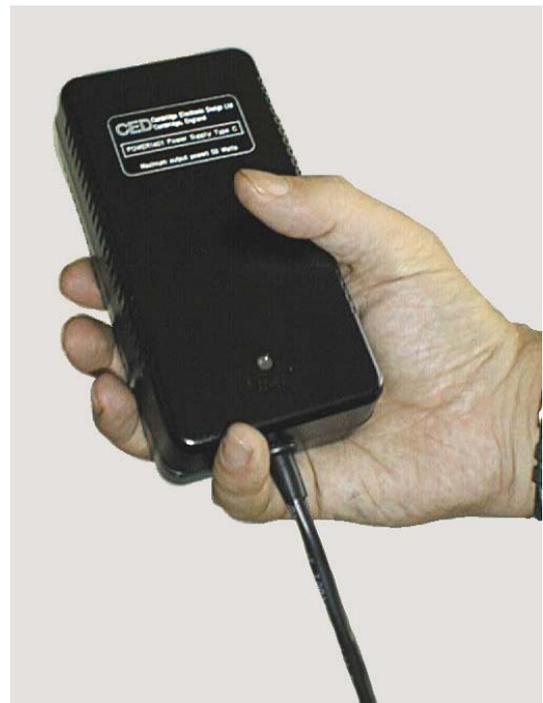


**Introduction** This manual will guide you through the initial check and installation of your Power1401. It introduces you to the external inputs and outputs. It also describes maintenance and diagnostic procedures. This manual does not cover 1401 programming or the use of application programs with 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 1.6 Amps maximum. It has no switch, being controlled by plugging in and switching on at the mains socket.

The rear-panel switch controls DC power input 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 57.

**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 31 describes the signal inputs and outputs. Following sections deal with expansion options, maintenance and troubleshooting.

**Storage and operating environment** The storage and operating environment for a Power1401 must not exceed the temperature range  $-5^{\circ}$  to  $+50^{\circ}$  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. The Power1401 can be recycled; please contact CED for further details.

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 95/98, Windows Me, Windows NT 2000, Windows XP and Windows NT 4. Much of CED's old MS-DOS software will run in a DOS box (see page 30).

**Installing CED application software** CED application software such as Spike2 or Signal is installed from a CDROM. Typically this will autorun, if it does not, run *setup.exe*. The installation program loads the 1401 drivers at the same time. 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](http://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 installing a Power1401 in an IBM PC or compatible.

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)
- The CED software application disk

**Organisation of sections** The sections that follow deal with installing:

- The PC USB interface
- The PC PCI interface
- The PC ISA interface

in that order. The instructions take you through the software part (installing the 1401 device driver and utility programs) and the hardware part of the installation (making the physical connection between the Power1401 and your computer).

**Windows variants** PC operating systems are treated as three groups:

- Windows 9x, which includes Windows 95, Windows 98, and Windows Me
- Windows NT 2000, which also applies to Windows XP
- Windows NT 4

The groups are covered in each section, in that order.

**Drivers** The device driver (the systems file used by application software to communicate with the Power1401) is installed along with the application software. Hardware resources (base address, interrupt and DMA settings) must now be assigned. 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 need more care; in particular, hardware clashes must be sorted out manually.

**Test and diagnostic utilities** A suite of test and diagnostic programs is available on the *CED 1401 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.

## Installing the USB interface

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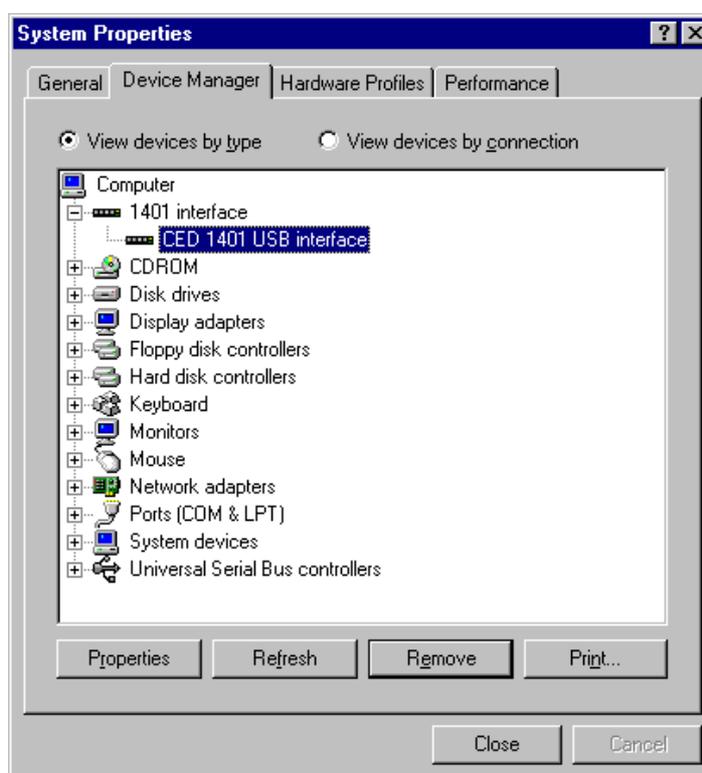
**The USB driver** You must be running Windows 98 (Second Edition) Windows Me, Windows NT 2000, or Windows XP in order to use the USB interface. USB is not supported under Windows 95 or Windows NT 4. We describe driver installation under Windows 98 first, then Windows NT 2000 and Windows XP.

Device drivers are supplied on CED applications disks and are loaded at the same time as the application. Drivers can also be found on the *CED 1401 installation* disk, and in CED software directories, e.g. \Spike2\1401\Windrv, if you have already installed application software.

**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.

**Windows 98, Windows Me** The Power 1401 should be plugged into the USB port while both machines are powered up. The USB hardware will detect the 1401, and a message window will briefly announce that Windows has detected a new USB device and is looking for its driver. Since this has been installed with the application, it will report that it has found the CED 1401 USB software, and disappear. With the USB interface driver installed, the Power 1401 becomes a recognised USB device, and the *CED 1401* icon will appear in the Device Manager whenever 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,  
Windows XP**

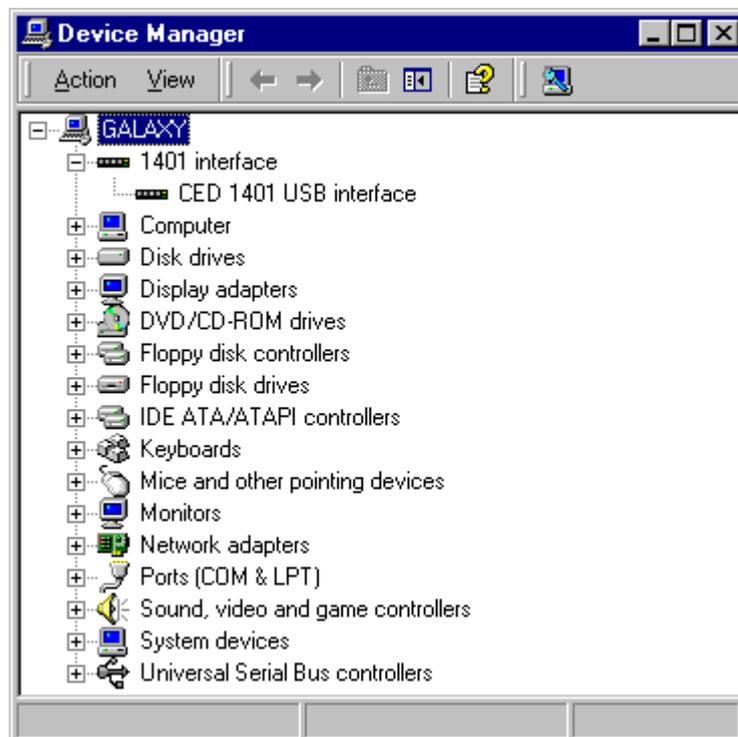
The Power 1401 should be plugged into the USB port while both machines are powered up. The USB hardware will detect the 1401, and a message window will briefly announce that Windows has detected a new USB device and is looking for its driver. Since this has been installed with the application, it will report that it has found the CED 1401 USB software, and disappear. With the USB interface driver 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, System*.

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.

**System Properties,  
Device Manager tab**



# Installing the PCI interface

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**The PCI driver** We describe driver installation under Windows 95/98 and Windows Me first, followed by Windows NT 2000 and Windows XP, then Windows NT 4. If you do need to install in Windows 3.x or DOS, please contact CED.

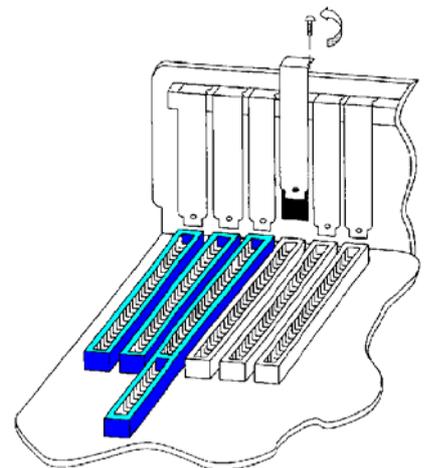
Device drivers are supplied on CED applications disks and are loaded with the application. This is done before the PCI card is inserted. Drivers are also found on the *CED 1401 installation* disk, and in CED directories, e.g. \Spike2\1401\Windrv, if you have already installed application software.

**PCI card insertion** 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 15 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.



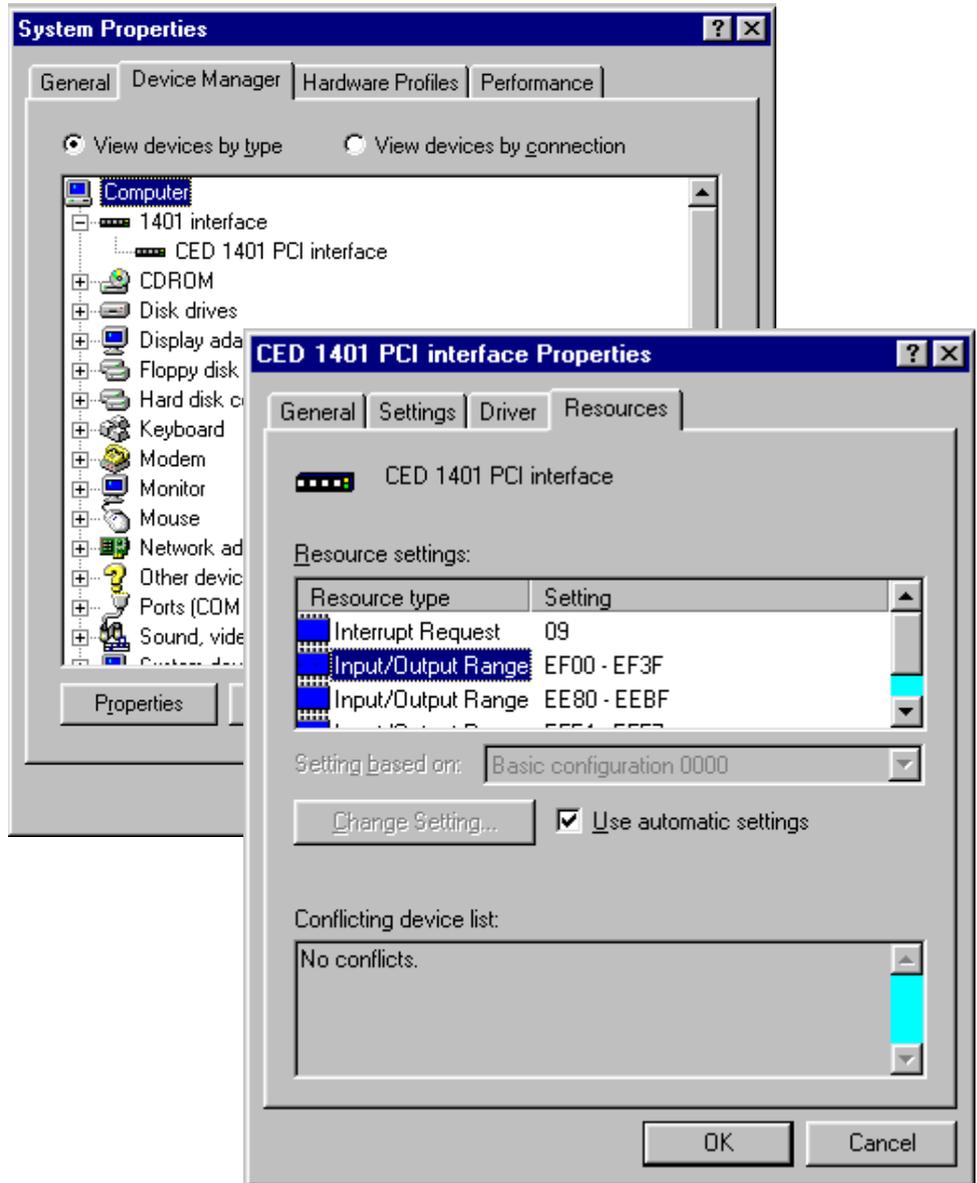
**Windows 95,**  
**Windows 98,**  
**Windows Me** After a 1401 PCI interface card has been fitted, Plug'n'Play finds it automatically when the PC is next powered up. A message window will briefly announce that Windows has detected a new PCI card and is looking for its driver. Since this has been installed with the application, it will report that it has found the CED 1401 PCI software, and disappear. 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 >



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, Windows XP** After a 1401 PCI interface card has been fitted, Plug'n'Play finds it automatically when the PC is next powered up. A message window will briefly announce that Windows has detected a new PCI card and is looking for its driver. Since this has been installed with the application, it will report that it has found the CED 1401 PCI software, and disappear. 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, System*.

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, but the installer on the CED application disk copies the drivers to the correct location and updates the registry. Consequently it is only necessary to check that the card type is properly set. You should therefore proceed as follows: select

*Start, Settings, Control Panel, CED 1401 controls.*

**1401 control panel** If the system does not think that your 1401 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*

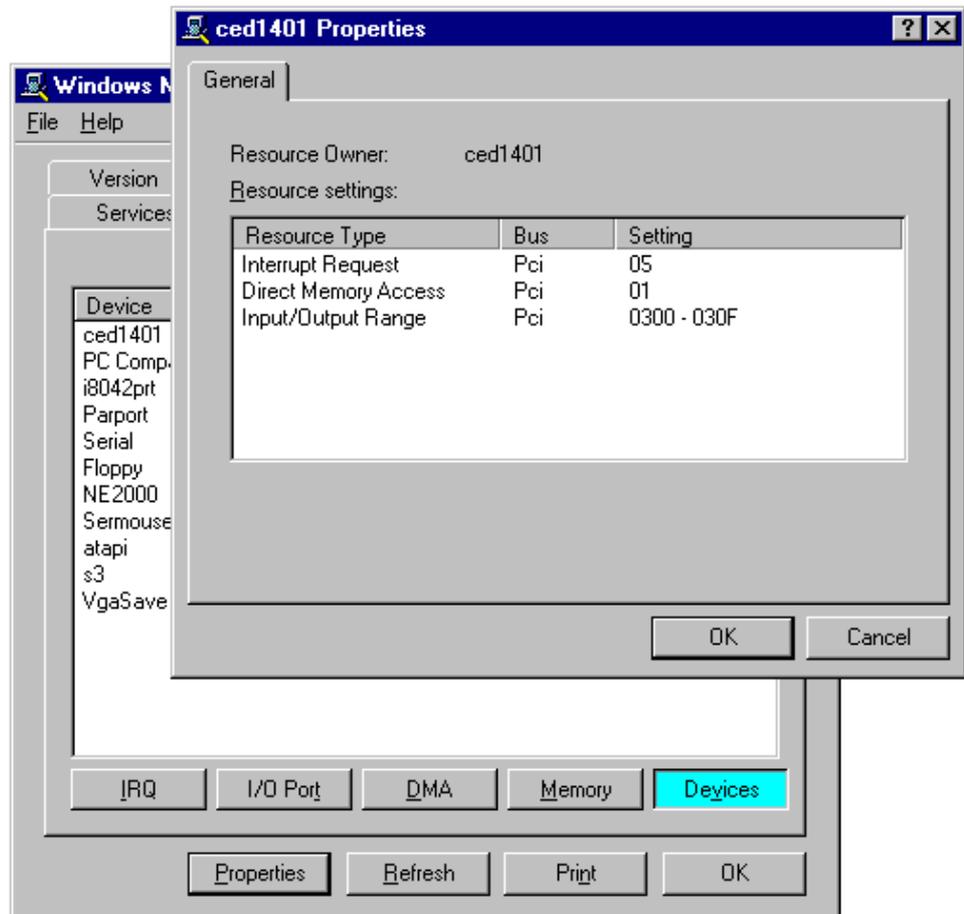


**Interface settings** To view the 1401 interface hardware settings, select *Start, Programs, Administrative Tools, Windows NT Diagnostics.*

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

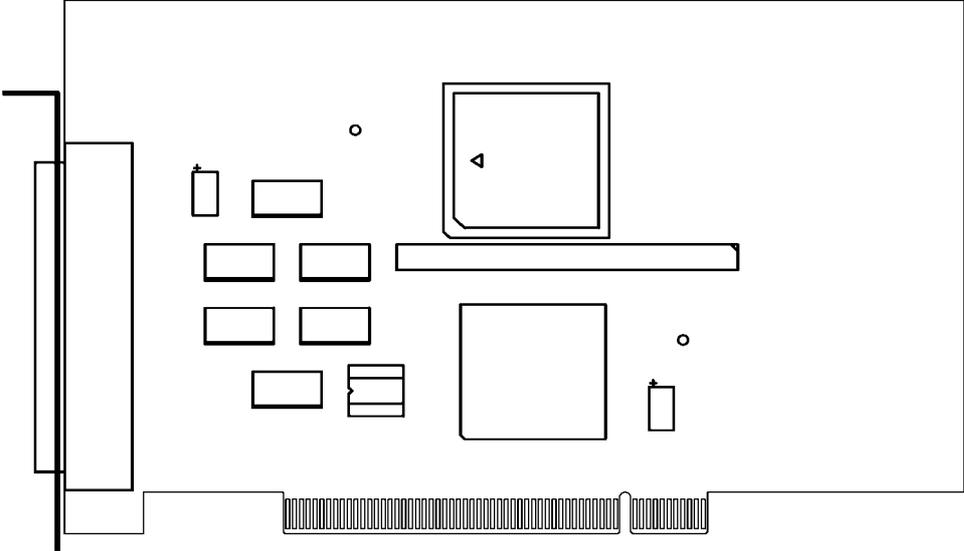
1401 Interface  
Resource Usage ➤



**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.

*The CED 1401-60 PCI interface card*



# Installing the ISA interface

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**The ISA driver** We describe driver installation under Windows 95/98 and Windows Me first, followed by Windows NT 2000 and Windows XP, then Windows NT 4. If you do need to install in Windows 3.x or DOS, please contact CED.

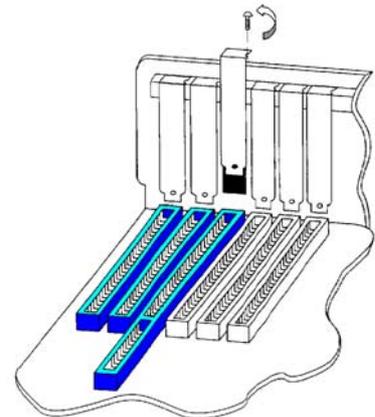
Device drivers are supplied on CED applications disks and are loaded with the application. This is done before the ISA card is inserted. Drivers are also found on the *CED 1401 installation* disk, and in CED directories, e.g. \Spike2\1401\Windrv, if you have already installed application software.

**ISA card insertion** Remove power from your computer and clear a space round it; you will be taking off the cover in order to insert the card. Follow the directions in your computer manual for inserting 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 23 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 25 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.

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

*Start, Settings, Control Panel, Add New Hardware.*

Windows 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 *1401 interface*. The following devices will be listed:

*CED 1401 ISA interface*

*CED 1401 PCI interface*

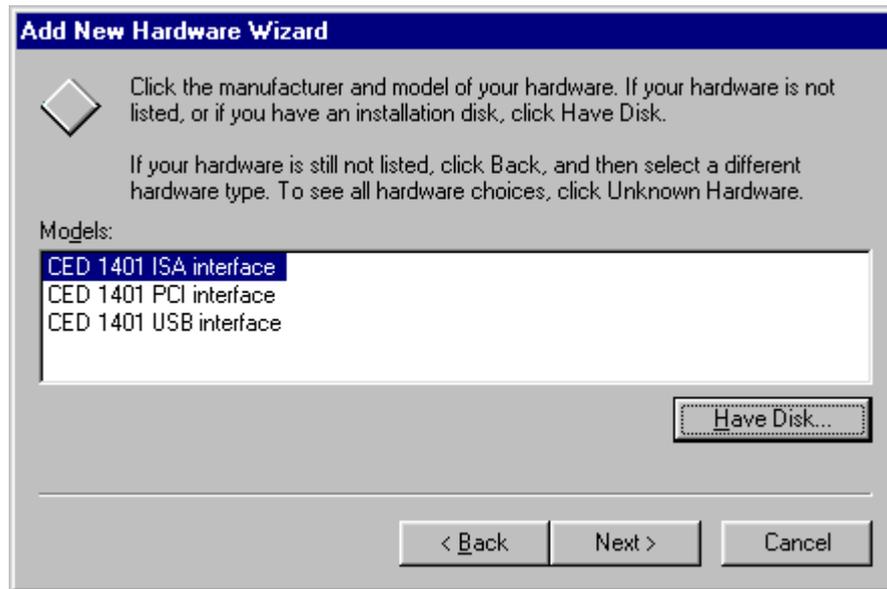
*CED 1401 USB interface* (not in Windows 95)

Select the ISA device driver and press *Next, Finish*.

### *Add New Hardware Wizard*



**Add New Hardware Wizard, cont.**



**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 26) 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,  
Windows XP**

After the 1401 ISA interface card has been fitted, switch the PC on. Windows NT 2000 or Windows XP will not automatically detect the 1401 ISA card. This is how you proceed. Select

*Start, Settings, Control Panel, Add New Hardware.*

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 “1401 interface”, and press *Next*. Choose “CED 1401 ISA interface” from the new list that opens. Press *Next, Finish*. The driver will now be installed.

**ISA driver installation,  
Windows NT 2000**



**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 25 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.

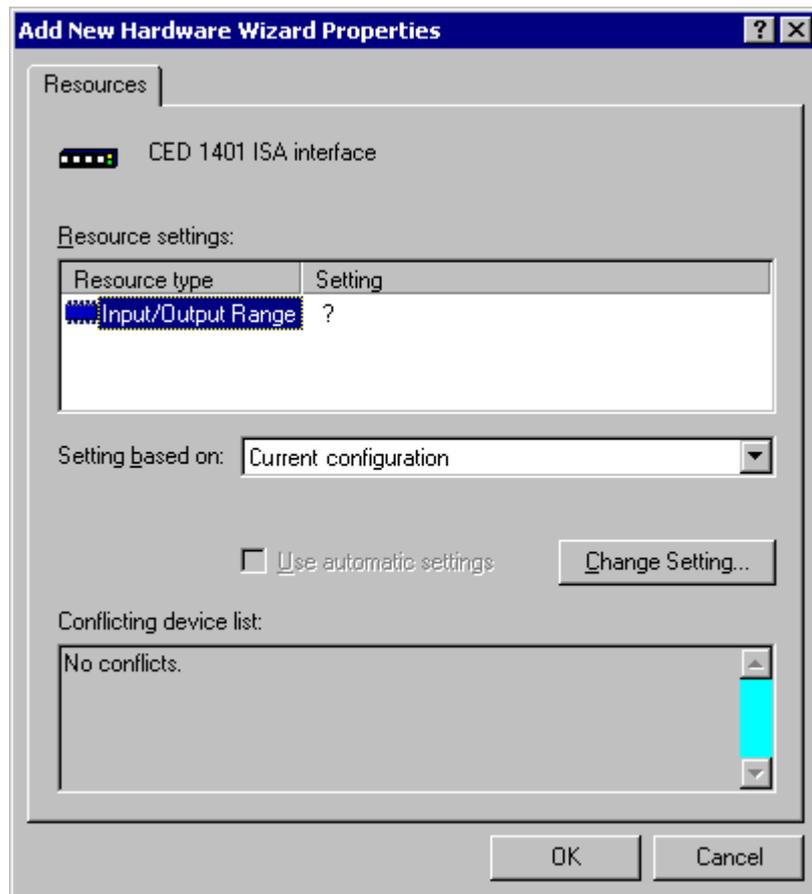
**In case of failure** If the device driver fails to install, it may be that there is a resource conflict, i.e. the resources assigned in software do not match the hardware, or else the hardware settings are already in use. You will need to check the link settings on your hardware (see details on page 23 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, System*.

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 25.) 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*

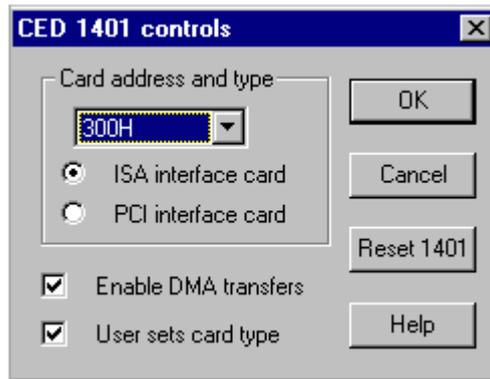


**Resolving clashes** Switch the computer off, and adjust the ISA interface hardware, following the advice given on page 25. As mentioned above, interrupt and DMA hardware settings are accommodated automatically, but alterations to the base address have to be set manually in “Current configuration”. 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* on page 20. 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 is not a Plug'n'Play operating system, but the installer on the CED application disk copies the drivers to the correct location and updates the registry. Consequently it is only necessary to check that the card type and card address are properly set. You should therefore proceed as follows. Select *Start, Settings, Control Panel, CED 1401 controls*.

**1401 control panel** If the system does not think 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*



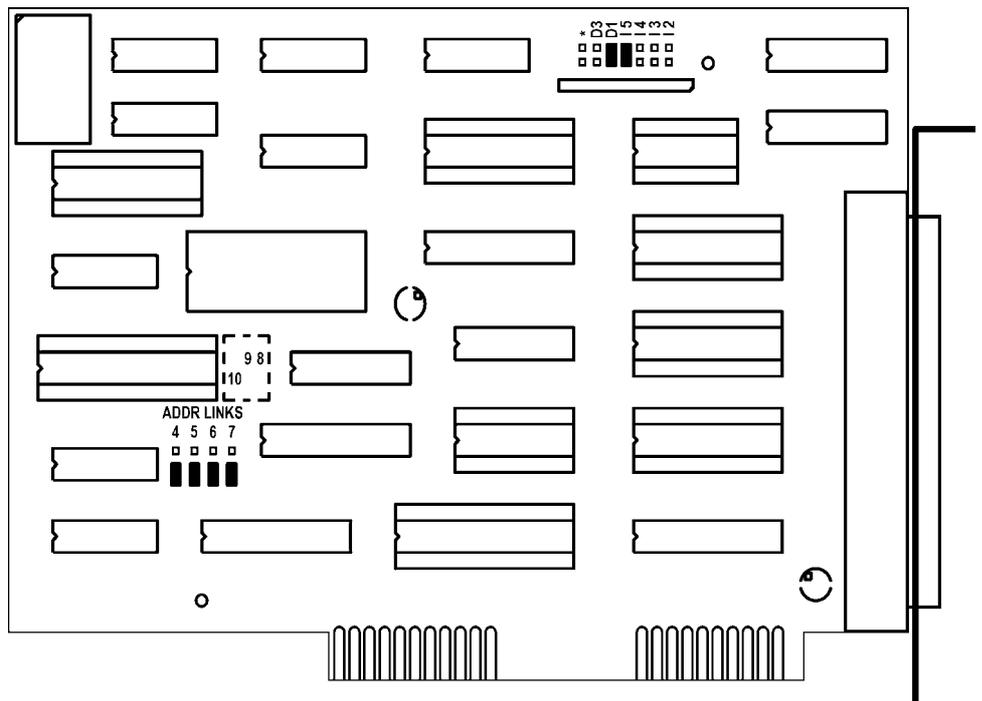
**Interface settings** To view the 1401 interface hardware settings, select *Start, Programs, Administrative Tools, Windows NT Diagnostics*.

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 CED 1401-10 ISA interface card**

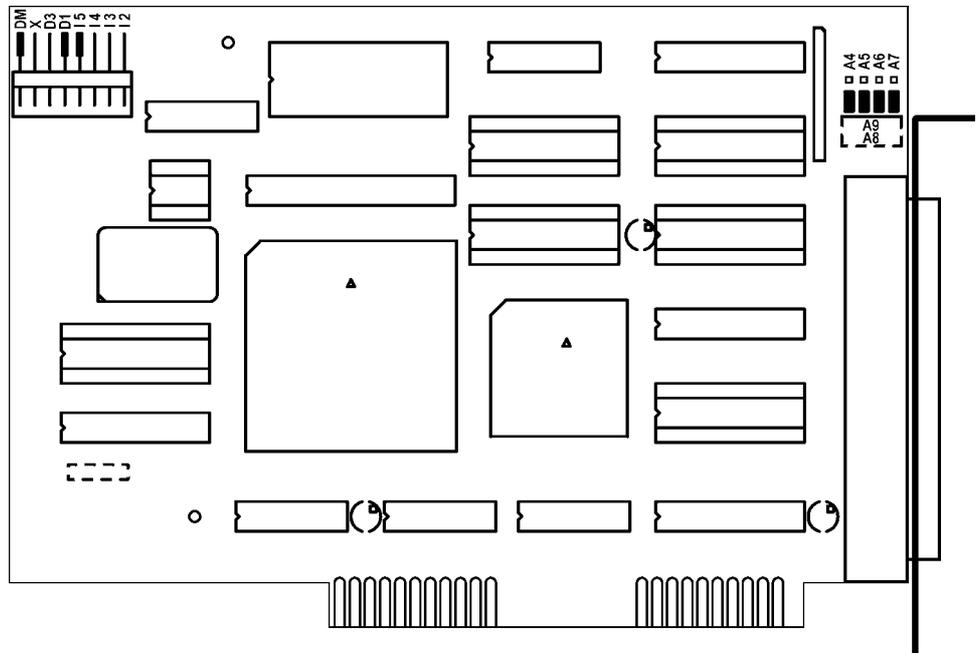


The interrupt vector and DMA channel are selected by jumpers at the top right of the card. A jumper in one of I2, I3, I4 or I5 selects an interrupt vector from 2 to 5 respectively. Similarly a jumper in one of D1, D3 or ★ selects DMA channel 1, channel 3 or no DMA.

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. See page 25 for more details.

**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 CED 1401-50 ISA interface card**



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. See page 25 for more details.

**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 59 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 23 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 a 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.

**Informing the 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.

## Test software

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**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 in a CDROM containing two folders called `Disk1` and `Disk2`.

If installing in Windows 9x, Windows Me, Windows NT 2000 or Windows XP

- Insert the CDROM.
- Select *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.

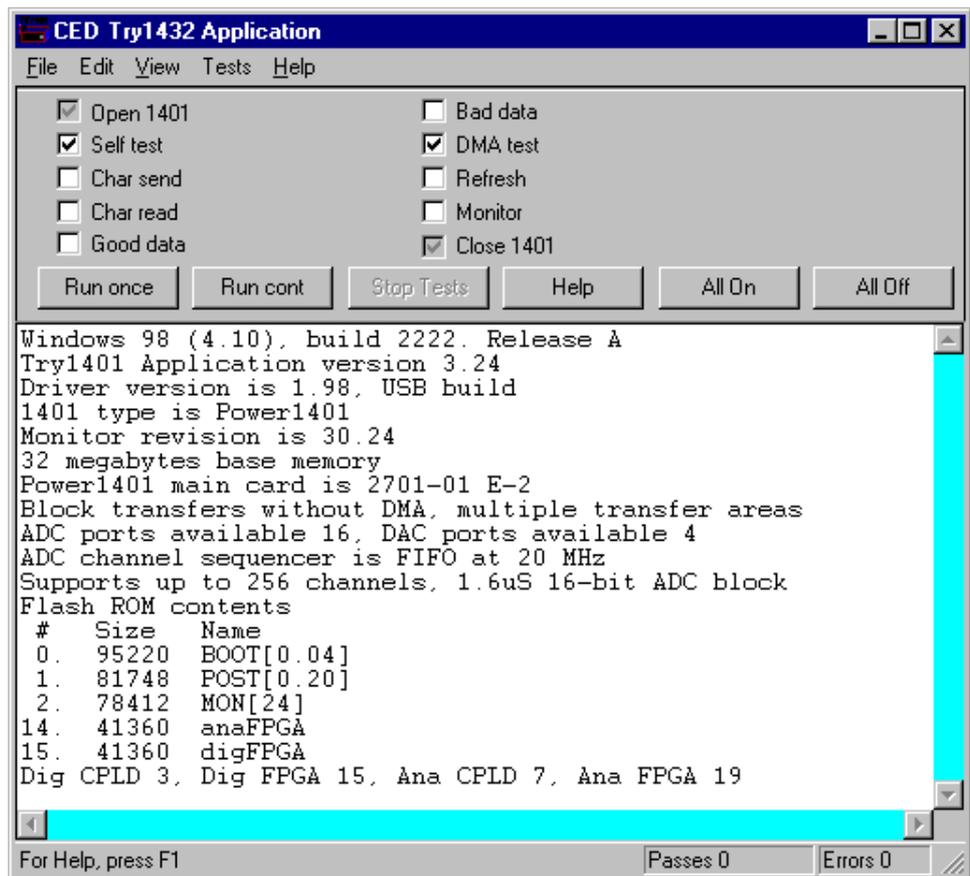
If the 1401 drivers on the *CED 1401 installation* disk are newer than those on your system, `setup.exe` will update them.

**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, Try1401.*

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.

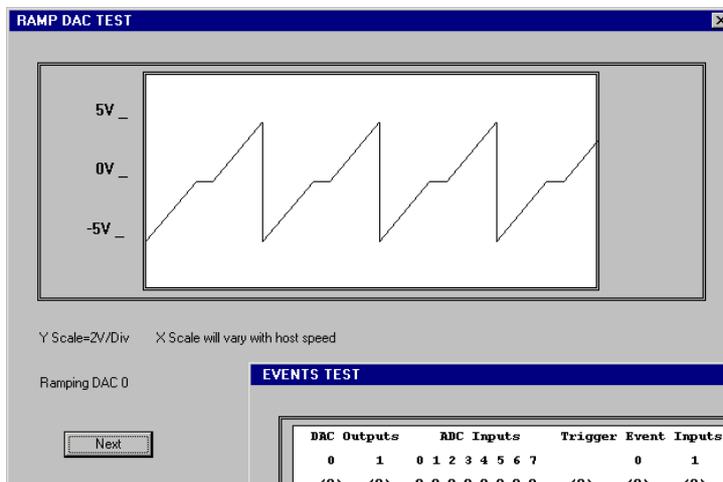
**1401 info...** To access the summary of hardware and firmware information shown on the TRY1432 screen on the previous page, select *File, 1401 info...* from inside TRY1432.

**ADC & DAC Test Event & Clock Test** If you wish to re-calibrate the analogue hardware, or test the functions of the Clocks and Events, select

*Tests, ADC & DAC Test* or *Tests, Event & Clock Test*

from inside TRY1432. These are tests that the machine cannot do by itself since they require cables to be routed between various connectors, voltages set, etc. The tests are interactive. At each step the user is instructed what equipment is needed, what to do, and what results to expect. Some tests can be carried out solely by connecting cables and digital voltmeters to the Power1401; others require the box to be opened in order to adjust pots. See page 51 for how to take the lid off, and page 53 for the location of adjustable components. Analogue calibration is discussed more fully on page 56.

**ADC & DAC Test,  
Ramp DAC test**



**Event & Clock Test,  
Events test** ➤

DAC Outputs		ADC Inputs								Trigger Event Inputs		Big Outputs		Clock P1401	
0	1	0	1	2	3	4	5	6	7	0	1	0	1	0	1
(0)	(0)	0	0	0	0	0	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)

Testing Event 0 input, high-going edge active  
Connect Digital Output 0 to Event input 0

Press <Execute> to run test or <Exit> to exit

## The DOS box

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**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.

# Inputs and outputs

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**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.

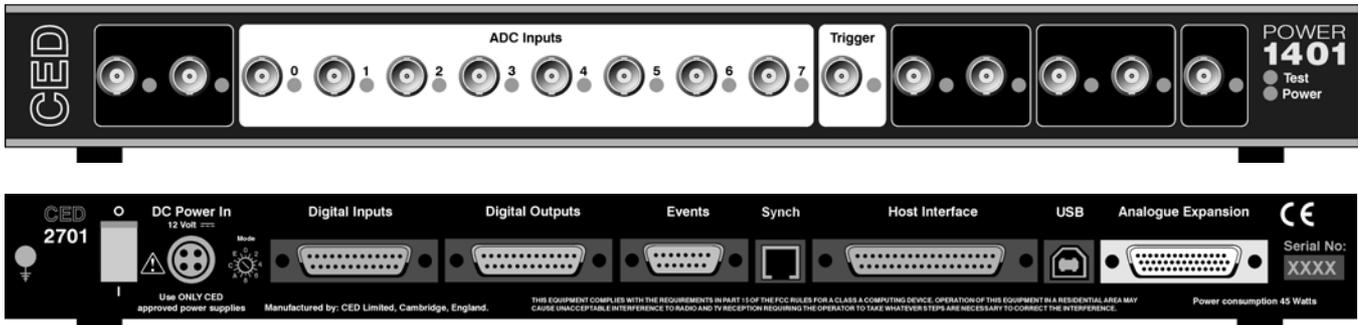
**Front panel LEDs** All front-panel BNCs have adjacent yellow LEDs. These LEDs flash or blink to show appropriate activity, e.g. an ADC input LED lights when its channel is active; a DAC output LED flashes when its channel is updated; digital output LEDs will be lit when their bit is set. LEDs may light 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. Whenever possible 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-mount, not surface-mount, style. See page 51 for opening the Power1401 and page 52 for the location and identification of socketed chips.

**MOSFET protection** Digital and event inputs are received by low-voltage chips that are only available in surface-mount style and so cannot be socketed. These chips are protected by MOSFET devices and are safe against moderate overloads of either polarity.

**Connector diagrams** On the following pages, all rear-panel connectors are drawn as the user sees them, i.e. viewed from the outside. This is also the view of their mating connectors as seen while wiring them up.



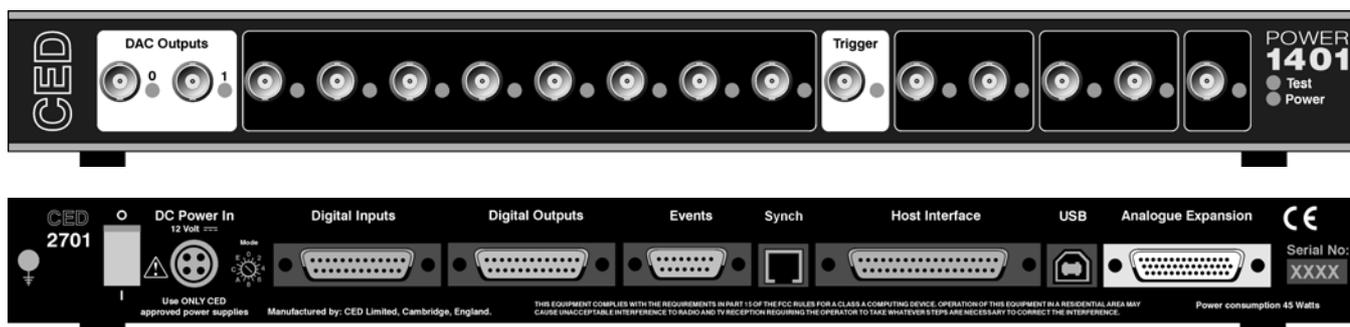
**Waveform input** Waveform input channels are buffered through amplifiers. If the programmable-gain option is fitted, the gains are individually software-settable to unity,  $\times 2$ ,  $\times 5$  or  $\times 10$ . Channels are then steered into the ADC (Analogue to Digital Converter) via multiplexers. The input sample-and-hold is part of the ADC chip. The ADC can convert an input signal to a 16-bit digital value at approximately 800kHz in single-channel mode, 625kHz if switching channel. Sampling is inherently sequential; two channels cannot be sampled simultaneously. If simultaneous sampling is required, you should consider the PGF8 expansion top box; see page 49.

**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  $\pm 5V$ , but this can be altered semi-permanently to  $\pm 10V$  by hardware modification at CED.

**Trigger** The front-panel input labelled Trigger can be set by software to be the external signal to start the clock that controls ADC conversions. The ADC external convert input is 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 by software command and typically 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 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. Front-panel waveform inputs are routed through common-mode ferrite chokes to prevent radiation of EMI. The maximum non-destructive input voltage range is  $\pm 15\text{V}$ . 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 52.
- Analogue input**
- Front-panel Trigger input** The front-panel Trigger input has a normal working voltage range of 0 to +5V. There is MOSFET circuit protection allowing a safe input range of  $\pm 10\text{V}$ , and a ferrite choke to prevent radiation of EMI. This input is held internally to +5V by a 100kOhm resistor and has input hysteresis: the low-going threshold voltage is set at 0.95V and the high-going threshold at 1.2V. Pulses driving the trigger input should be 1 $\mu\text{s}$  or longer. To pull this input low, the driving device must be able to sink 50 $\mu\text{A}$ .
- Rear-panel ADC external convert input** The rear-panel ADC external-convert input is on pin 6 of the Events D-socket. It responds to TTL and switch closure signals, and has a normal working voltage range of 0 to +5V. There is MOSFET circuit protection allowing a safe input range of  $\pm 10\text{V}$ . This input is held internally at +5V via a 10kOhm resistor. Input pulses should not be narrower than 1 $\mu\text{s}$  and must fall below 0.8V for guaranteed recognition. Conversion is normally initiated on the high-to-low edge. Use of the other edge can be selected by switches, see page 51.
- The ADC** The ADC input voltage is resolved into 65536 levels (16-bit precision); each step is approximately 150 $\mu\text{V}$ .



**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  $\pm 5V$ , in steps of approximately  $150\mu V$ . If the programmable gain option has been fitted, the output gain can be switched by software between unity and  $\times 2$ . Alternatively, the range can be altered semi-permanently to  $\pm 10V$  and  $300\mu V$  resolution, by hardware modification at CED.

**Update modes** 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 38, or the front panel Trigger input, to synchronise the update rate to external equipment. Alternatively, they can be updated at a fixed rate set by one of the internal clocks. When multiple channels of waveform are output, the Power1401 can be programmed to update several DACs simultaneously. The maximum update rate is 400kHz.

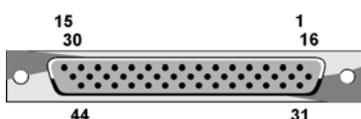
**DAC LEDs** The front-panel waveform output channels each have an associated yellow LED. The LED turns on when the channel is in use.

**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 5kOhm. There are common-mode ferrite chokes on the front-panel outputs to prevent radiation of EMI. The output amplifiers are fitted in sockets for easy replacement; see page 51.

### The rear-panel analogue connector

The rear-panel analogue connector is a 44-way high-density D-socket. It accommodates the top eight ADC input channels and DAC channels 2 and 3. These ten signals appear along the bottom row of the D-socket, and each is provided with a separate return to GND on the top row. This is useful when wiring up the mating plug with twisted pairs or coaxial cables. The middle row is entirely grounded.

Rear-panel analogue socket



Pin	Function	Pin	Function
1-2	No connection	31-32	No connection
3-10	GND	33	ADC input 8
11-12	No connection	34	ADC input 9
13-14	GND	35	ADC input 10
15	No connection	36	ADC input 11
		37	ADC input 12
16-30	GND	38	ADC input 13
		39	ADC input 14
		40	ADC input 15
		41-42	No connection
		43	DAC output 2
		44	DAC output 3
Screen	Mains earth		

### Rear-panel channel numbering

The rear-panel ADC inputs are always defined to be the last eight channels available. This means that, if the Power1401 is fitted with an 16-channel ADC expansion top-box (see page 45), the rear-panel inputs become ADC channels 24-31. If a Spike2 top-box has been fitted (see page 48), with 8 channels of ADC input, the rear-panel inputs become channels 16-23.

The rear-panel DAC outputs are similarly defined to be the last pair in use. If for instance the Signal top-box is fitted (see page 47), its DACs become 2-5, and the rear-panel DACs become 6 and 7.



**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.

**Trigger** 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.

**Clock output** 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. Frequencies between 500 kHz and 3.55 nHz (one pulse in 8.9 years!) can be generated. The application manual describes this where it is relevant.

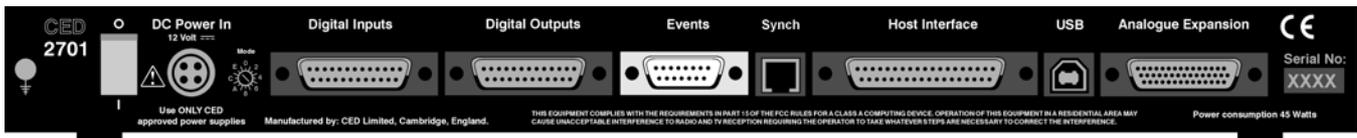
**Clock inputs** Where external signal pulses are to be timed or counted, the application program may use the front-panel Event 0 and Event 1 inputs. Pulses must be 1 $\mu$ s or wider. If there are more than two such signals, the rear-panel Digital Inputs may be used, see page 41.

**Frequency sources** All clock frequencies are normally derived from an internal crystal oscillator. Users may sometimes require a timing source from outside the Power1401 instead. All clocks can be driven from an external frequency source via the Clock F input, pin 7 on the rear-panel Events D-socket (see page 38). When you need to synchronise two 1401 machines, use the synchronisation port (see page 43).

**LEDs** The trigger and event-input LEDs flash on detection of an active-edge transition. These LEDs can be either off or on in the quiescent state, as set by software, the latter to show 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** The normal input range of Trigger, Event 0 and Event 1 is 0 to +5V. There is MOSFET circuit protection allowing a safe input range of  $\pm 10\text{V}$ . These inputs are held internally to +5V by 100kOhm 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 50 $\mu\text{A}$ . Pulses driving these front panel inputs must be 1 $\mu\text{s}$  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 52. Trigger, Event 0, Event 1 and Clock are routed through common-mode ferrite chokes to prevent radiation of EMI.



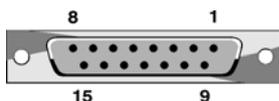
**Event inputs** More clock-related inputs, the Clock E series, are provided on the rear-panel Events D-socket. These inputs allow close control of the clocks for people writing their own software. Full details are given in the *1401 family programming manual*, and the *Power1401 technical manual*. The 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 10kOhm resistors. To pull these inputs low, the driving device must be able to sink at least 500 $\mu$ A; 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. There is MOSFET circuit protection allowing a safe input range of  $\pm 10$ V.

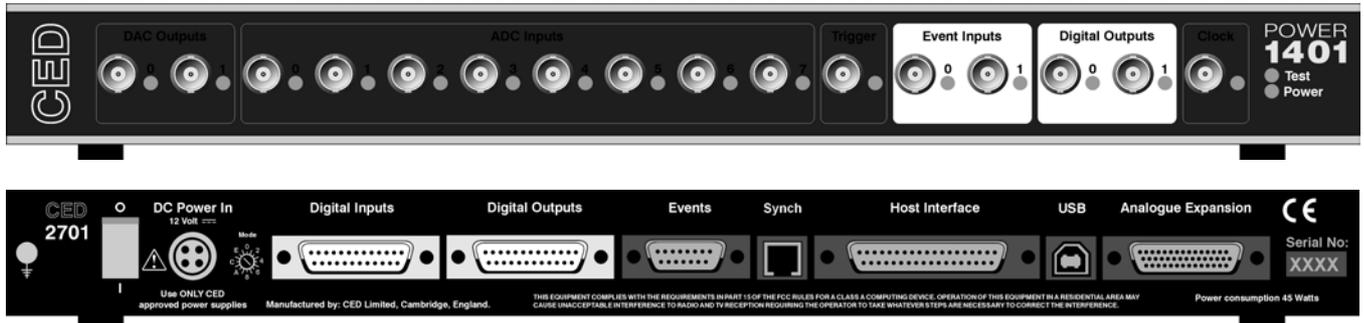
The 4MHz Clock output signal is buffered by a 74HCT14 Schmitt inverter element that can drive 10 LS TTL loads. This signal is normally isolated from the rear-panel socket and a jumper must be inserted on the motherboard to make it available (see page 53). This is to help reduce EMI.

The sense of the Clock E and ADC external convert inputs may be inverted by a switch option, see page 51, 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 I/O 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 either way). 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. Grounding pin 11 of the output socket also turns both bytes tristate-off; they are enabled if this pin is high or disconnected.

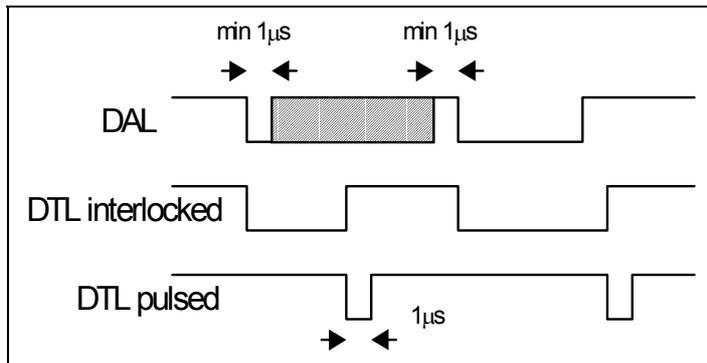
**Digital I/O LEDs** Front-panel event-input LEDs flash or blink on detection of active-edge transitions, the quiescent state being set by software command. Front-panel digital-output LEDs simply reflect the state of the bits, being lit whenever their bit is set (high).

**Technical details** Front-panel digital I/O is routed through common-mode ferrite chokes to prevent radiation of EMI. All digital inputs have MOSFET circuit protection. All outputs are buffered through 74HCT244s, which can source or sink 24mA. All output ICs are socketed for easy replacement, see page 52.

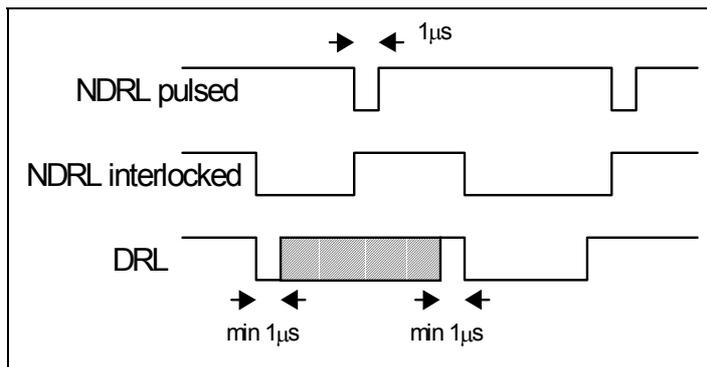
Unconnected digital inputs read 1, being pulled internally to +5V by 4k7 (rear panel) or 100k (front panel). Input voltages of more than 2.0V will always read as a logic 1. To appear as a logic 0, the input must be pulled down below 0.8V for at least 1µs (front) or 100ns (rear), which takes approximately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

**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.

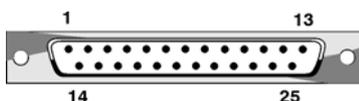
**5 volt output and circuit breaker**

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.

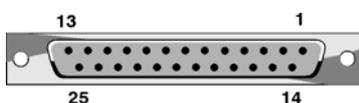
We have occasionally had problems with users who trip this protection very regularly. This is usually caused by a connector with a metal shroud being plugged into the digital input crookedly and the shroud touching pin 25, which causes overload. If you have this problem, the simple solution is to make this connection with Power1401 switched off, or to use a connector with a plastic shroud.

**Digital I/O connectors**

**Digital Input plug**



**Digital Output socket**

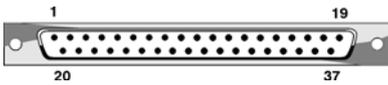


Pin	Output function		Pin	Input function	
1	High byte out 7	Word out 15	1	High byte in 7	Word in 15
14	6	14	14	6	14
2	5	13	2	5	13
15	4	12	15	4	12
3	3	11	3	3	11
16	2	10	16	2	10
4	1	9	4	1	9
17	0	8	17	0	8
5	Low byte out 7	Word out 7	5	Low byte in 7	Word in 7
18	6	6	18	6	6
6	5	5	6	5	5
19	4	4	19	4	4
7	3	3	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. Signals are driven and received by 74HCT244s. Receiver ICs have MOSFET circuit protection. Driver ICs are in sockets for easy replacement in the unlikely event of a chip being damaged; see page 52.

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 only if used with braid-screened cables supplied by CED.

Host interface plug

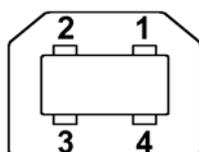


Pin	Function	Pin	Function
1	Host Address A0	11	Host D4
2	Host A1	12	Host D5
3	Host A2	13	Host D6
4	Host A3	14	Host D7
5	Host read/write	15	Host DA
6	Host DMA enable	16	Host strobe
7	Host Data D0	17	Host CTS
8	Host D1	18	Interrupt request
9	Host D2	19	Host reset
10	Host D3	20-37	GND
Screen	Mains earth		

**USB port** The USB port is for use with the USB protocol, and was first implemented by CED in Power1401s of serial no. P2000 onward. USB2 was implemented in Power1401s of serial no. P3000 onward. Data transfer rates are approximately 1.2 MBytes/sec for USB1, and 4.75 MBytes/sec for USB2.

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 is

USB socket



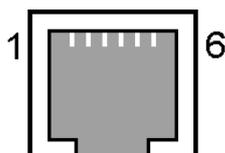
Pin	Function
1	USB +5V (USB cable detect)
2	USB_DATA+
3	USB_DATA-
4	USB_GND (to system ground)
Screen	Mains earth

used as a cable sense input, also via a choke; +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.

**Synchronisation port** The synchronisation port was implemented as a main board option in Power1401s of serial no. P3000, but is available as an add-on card for Power1401s of serial no. P2000. It enables two or more 1401s (Power or micro Mk2 in any mix) to be synchronised, so that there is absolutely no drift in timing between units.

The Synch socket is an RJ21 connector with 6 pins loaded. A screened cable is daisy-chained from unit to unit, and the “master” end of the cable determines which unit provides the

Synch socket



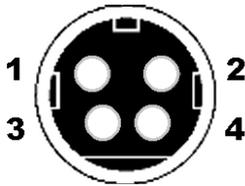
Pin	Function
1	No connection
2	MHZ20_IN-
3	MHZ20_IN+
4	MHZ20_OUT-
5	MHZ20_OUT+
6	No connection
Screen	Mains earth

clock frequency. Up to three 1401s may be slaved to the master. The units need to be in close physical proximity, side by side or stacked. If more than four 1401s need to be synchronised, the user should consider the CED 3301 external synchronisation unit.

**DC power inlet** The power brick is a switch-mode regulator that provides a nominal 12V DC. This is regulated to the required voltage rails inside the Power1401. The internal 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

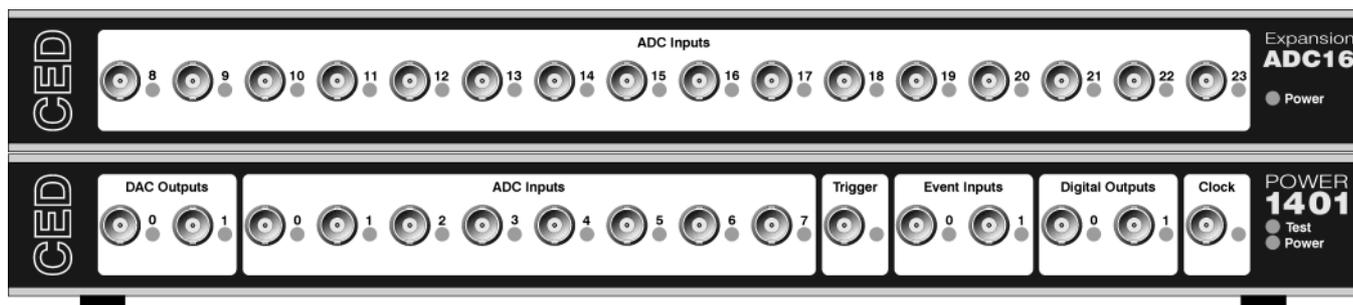


Pin	Function
1	+12V
2	0V
3	SPARE
4	Mains earth
Screen	Mains earth

The unexpanded Power1401 consumes approximately 1.8A at 12V. This can rise to up to 3.3A with top-boxes.

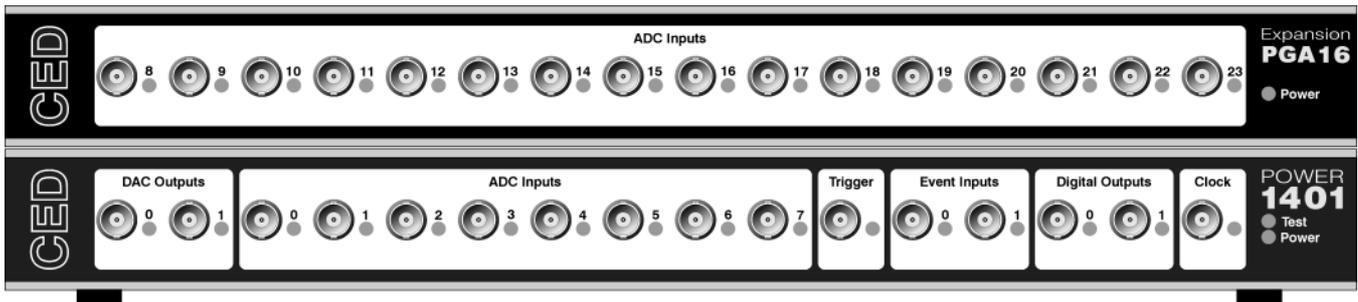
## Hardware expansion

---



**The ADC16 top-box: 16 waveform inputs** You may increase the number of waveform inputs by adding the ADC16 expansion top-box with sixteen extra channels, which are mapped onto ADC channels 8-23. 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. The rear-panel ADC inputs are mapped onto channels 24-31. Software that reads the extra channels will return undefined data values if the ADC16 is not installed.

The ADC inputs on the ADC16 are of identical design to the ones on the main board, with an input range of  $\pm 5V$  (optionally  $\pm 10V$ ). The top-box makes internal connections to the Power1401 motherboard. The daughterboard, designated the 2701-03, requires the Power1401 expanded mechanics (can and case) and it is usually more convenient to send an unexpanded unit back to CED for upgrading than for the end-user to install it.

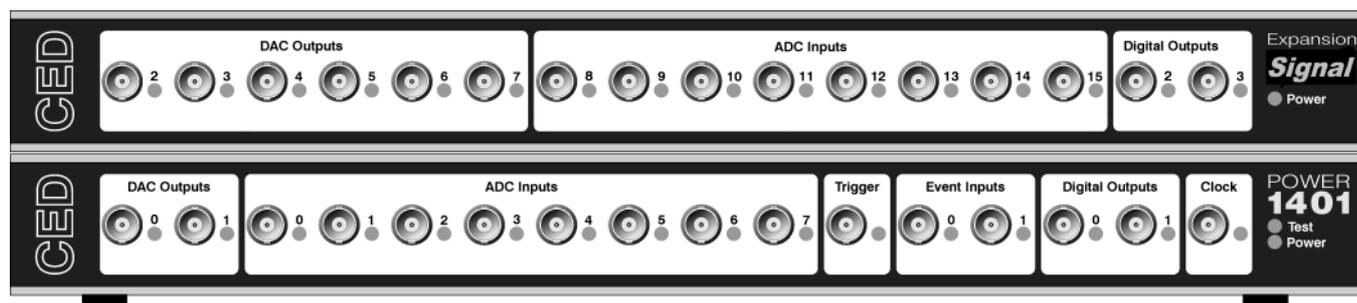


**The PGA16 top-box: 16 programmable-gain ADC inputs**

Like the ADC16, the PGA16 top-box provides 16 more ADC input channels mapped onto channels 8-23. In this case, however, each channel has individually programmable gain. Channels have two stages of gain; typically the first stage will have gains of unity,  $\times 2$ ,  $\times 5$  and  $\times 10$ , and the second, gains of unity,  $\times 10$  and  $\times 100$ . In this way gains of up to  $\times 1000$  are achievable.

Provision is made on the 2701-04 daughterboard for a USB interface, so that it can be built to operate as a stand-alone, 16-channel analogue amplifier in a 1U box.

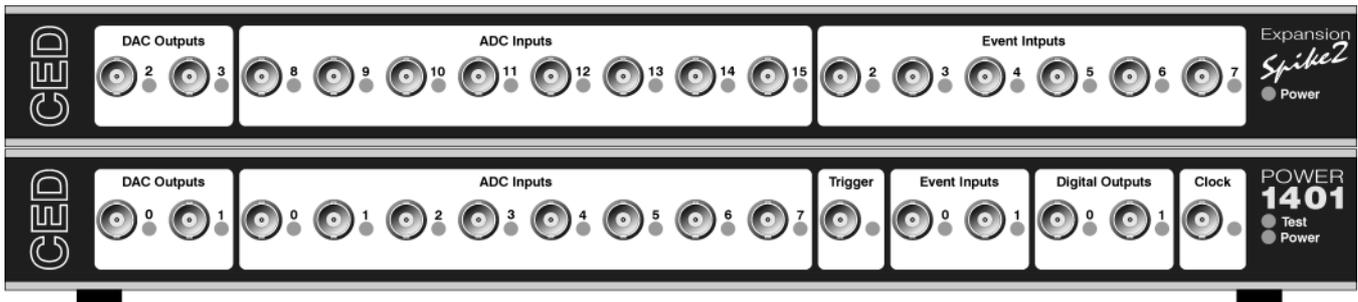
The ADC inputs are of identical design to the ones on the main unit, with an input range of  $\pm 5V$  (optionally  $\pm 10V$ ). When this card is installed, the rear-panel ADC inputs are mapped onto channels 24-31. The top-box makes internal connections to the Power1401 motherboard. The daughterboard, designated the 2701-04, requires the Power1401 expanded mechanics (can and case) and it is usually more convenient to send an unexpanded unit back to CED for upgrading than for the end-user to install it.



**The Signal top-box: 4 extra DACs** The Signal top-box is designed for customers who require a larger number of DACs than usual. It provides four more, which are mapped onto DAC output channels 2-5. Additionally, DACs 2 and 3 on the main board are brought out to BNCs on the top-box, and mapped as channels 6 and 7. Thus there are eight DACs in total, all available from front-panel BNCs.

The Signal top-box also provides eight channels of ADC input, mapped as channels 8-15. The inputs are of identical design to the ones on the main unit, with an input range of  $\pm 5V$  (optionally  $\pm 10V$ ). The rear-panel ADC inputs are mapped onto channels 16-23. The top-box also brings two more bits of digital output, bits 2 and 3 of the upper byte, to front-panel BNCs.

The top-box makes internal connections to the Power1401 motherboard. The daughterboard, designated the 2701-05, requires the Power1401 expanded mechanics (can and case) plus some hand-wiring, and it is usually more convenient to send an unexpanded unit back to CED for upgrading than for the end-user to install it.

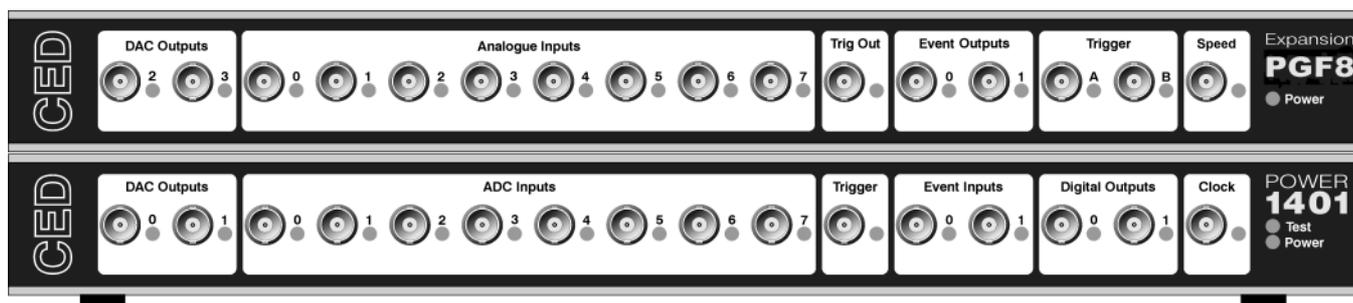


**The Spike2 top-box: digital BNC connections**

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 Spike2 top-box provides six event inputs, mapped onto bits 2-7 of the digital inputs high-byte, together with eight ADC inputs and a pair of DACs, mapped onto ADC 8-15 and DAC 2-3 respectively.

When this card is installed, the rear-panel ADC inputs are mapped onto channels 16-21, and the rear-panel DACs onto channels 4 and 5.

The normal input voltage range of the digital inputs is 0 to +5V. The safe range is  $\pm 10V$ , and they present an impedance of 100kOhm, as with the front panel Event and Trigger inputs. The top-box makes internal connections to the Power1401 motherboard. The daughterboard, designated the 2701-09, requires the Power1401 expanded mechanics (can and case) and it is usually more convenient to send an unexpanded unit back to CED for upgrading than for the end-user to install it.



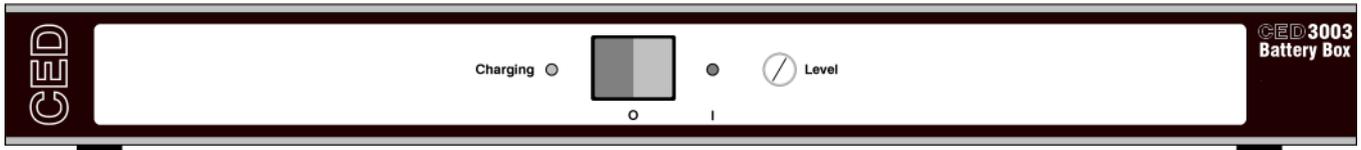
### The PGF8 top box: 8 programmable filter channels

The PGF8 is designed for researchers in vibration analysis and other systems generating periodic signals. It provides eight signal-processing channels plus auxiliary circuits. The heart of each channel is the switched-capacitor filter (SCF) and selectable gain, but there are also options for AC coupling, and sample-and-hold (S&H). The channels have individual control of gain level, and individual enabling of the SCF and the AC coupling. The SCF pass frequency and the S&H functions act equally on all channels. The channel outputs are multiplexed and connected directly to the motherboard ADC via an internal coaxial cable.

Auxiliary circuits include Trigger A and Trigger B inputs with programmable thresholds; a phase-locked loop (PLL); and a programmable frequency multiplication of the Trigger A frequency. The latter two functions are useful when triggering information comes from smoothly-varying systems such as rotating shafts.

The PGF8 generates three digital outputs, Event Outputs 0 and 1, and Trig Out, on BNCs handily positioned directly above the corresponding inputs on the Power1401. Front-panel access is provided for motherboard DACs 2 and 3. The frequency multiplier control voltage is brought out to a front-panel BNC labelled Speed.

The PGF8 can be fitted with a USB or an RS232 port and function as a stand-alone unit. As a top-box, it is driven by internal connections to the Power1401 motherboard. The daughterboard, designated the 2701-21, requires the Power1401 expanded mechanics (can and case) plus some hand-wiring, so an unexpanded unit must be sent back to CED for upgrading.



**The battery box** The CED 3003 Battery Box is a 1U box of identical size and matching style to the Power1401 hardware. It provides 12V DC and has a nominal capacity of 9.2 Amp-hours, enabling an unexpanded Power1401 to run for approximately four hours. The unit has two separate output sockets (cigar lighter style) and is supplied with an external, intelligent mains charger. The batteries are sealed, lead acid-gel type. The box weighs 6kg.

# Maintenance operations

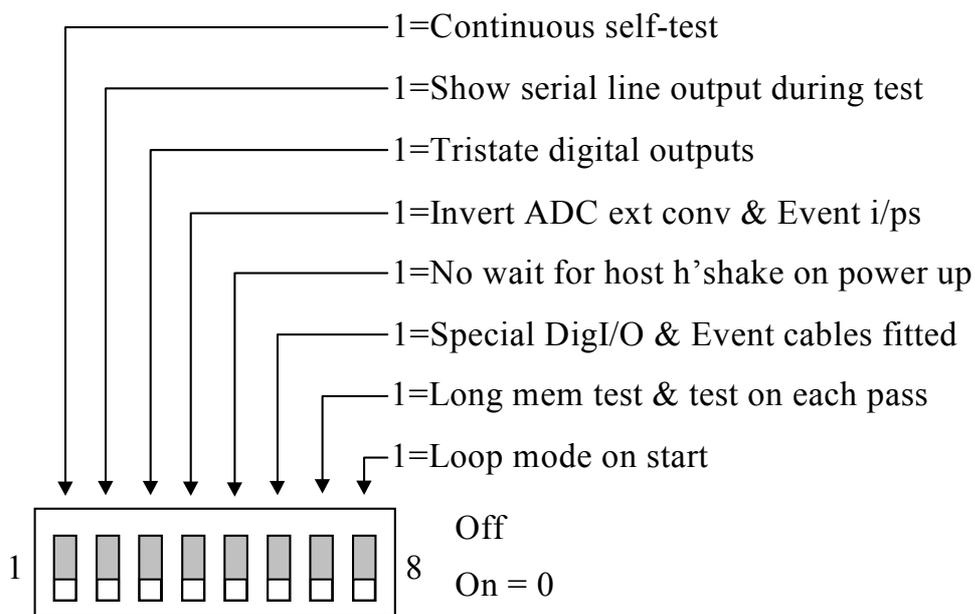
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**Introduction** The Power1401 requires very little maintenance. This section covers simple operations that may occasionally need the case opened, such as setting the internal options switch, replacing damaged I/O chips, upgrading memory, or re-calibrating the analogue system. We also describe updating the flash ROM.

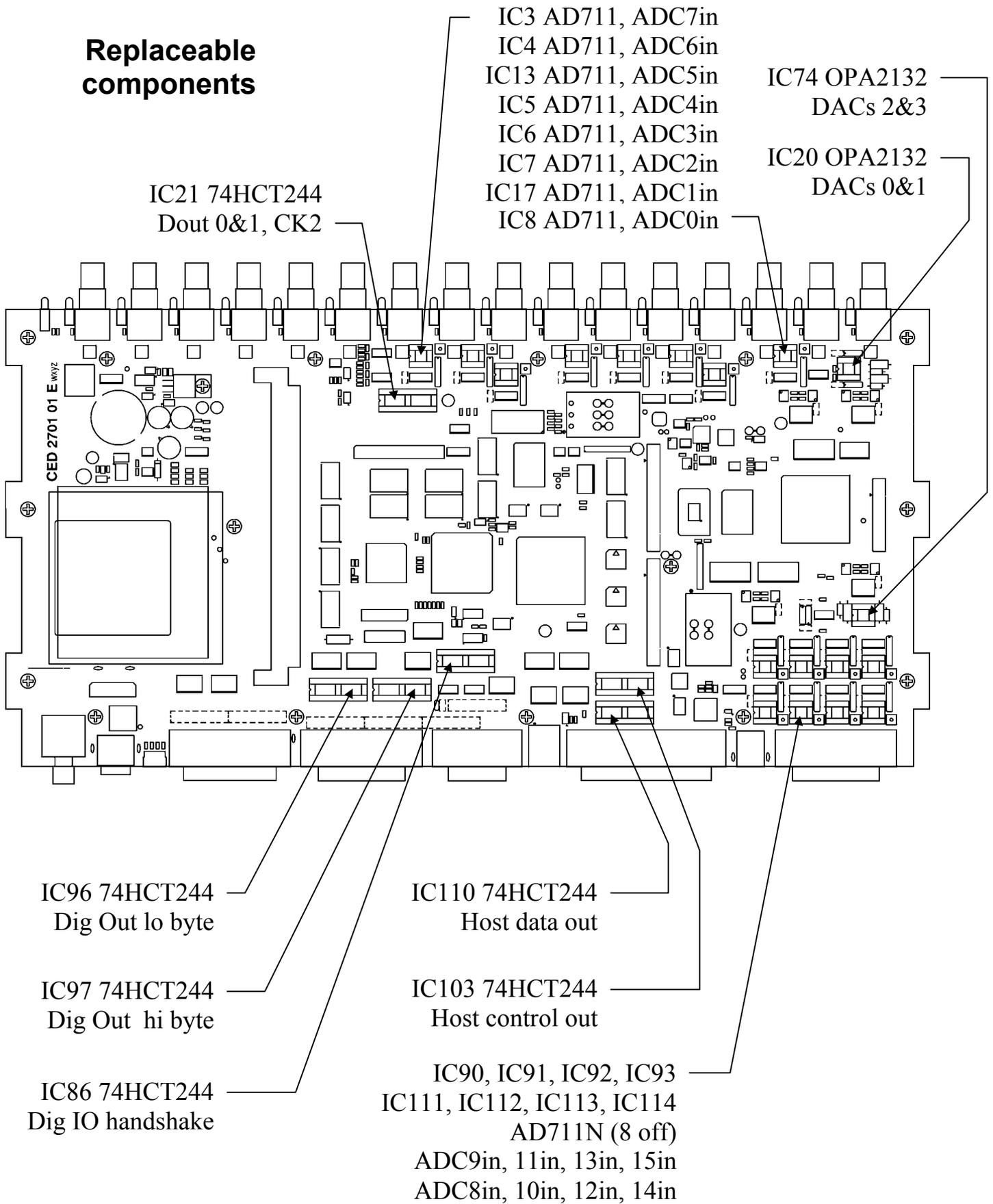
**Taking the lid off** The Power1401 top cover is held in place by the back panel. To free the back panel, unscrew the four M3 screws at the corners with a 2mm hex wrench. Swing the back panel away. There is no need to detach the green & yellow earth wire. Slide out the top cover. Be careful not to splay the sides; the case loses much of its rigidity once the back panel is off.

The inner 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 by unscrewing the six M3 screws with a 1-pt Pozidriv screwdriver and gently pulling it up and off. Note the graphite-impregnated gasket strips: store them somewhere safe, as they are quite delicate.

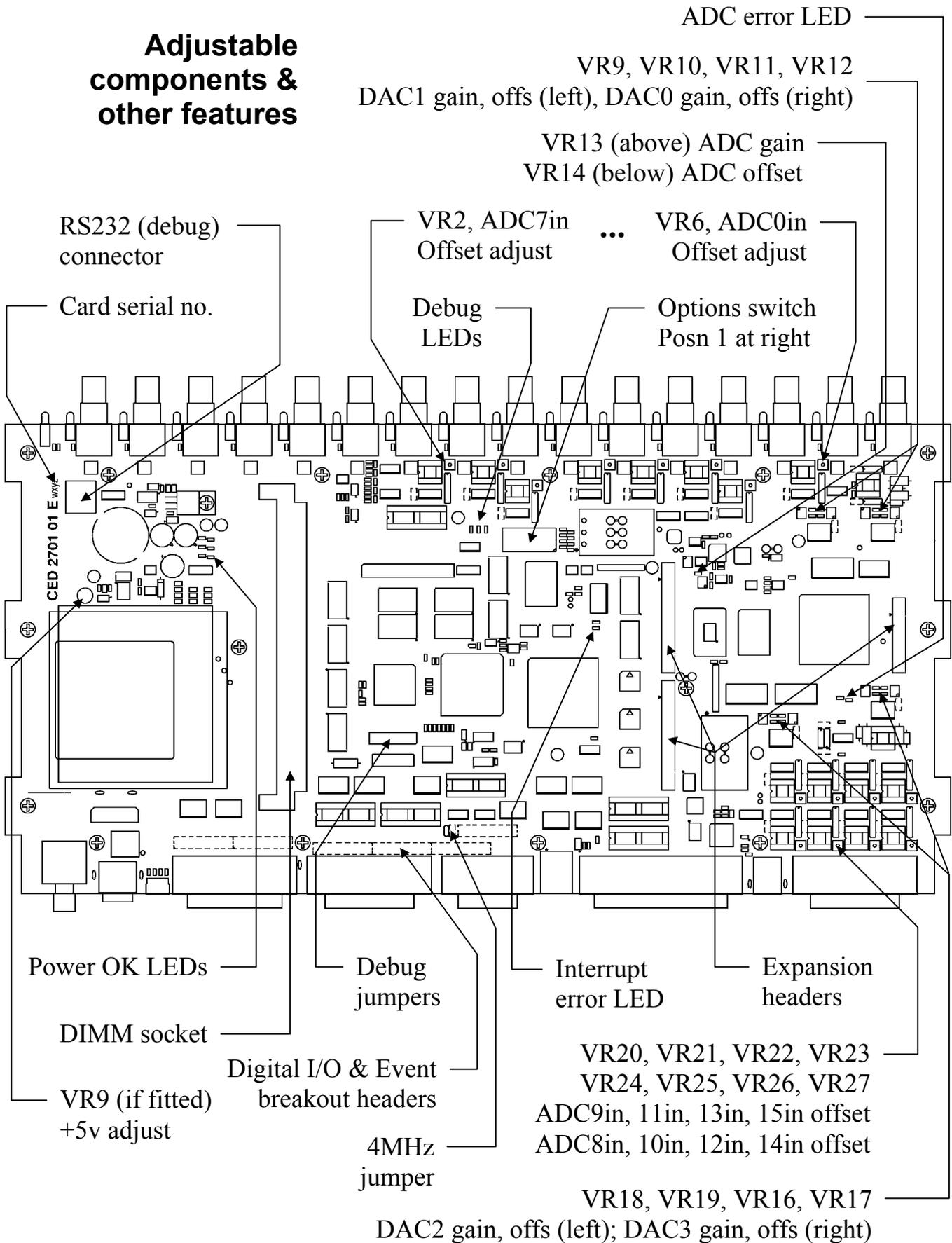
**Switch settings** This diagram shows the internal options switch settings on the Power1401. Logically, On counts as 0, Off as 1. Most options concern self-test and debug. Normally, all switches must be On, physically towards the rear of the PCB, as shown.



**Replaceable components**



**Adjustable components & other features**



**Memory upgrades** The base-level Power1401 is supplied with 32 MBytes of synchronous dynamic RAM (SDRAM) . This is packaged as a dual in-line memory module (DIMM) in a socket; you can upgrade your memory to up to 256 MBytes simply by exchanging the DIMM. See the diagram on page 53 for the location of the socket, and see page 51 on how to open a Power1401. The Power1401 automatically detects the size of the installed memory at power-on, so there is no need to alter any switches if the amount of memory is changed.

**Memory specification** Any memory you obtain should meet the following specification:

- Unbuffered SDRAM in 168-pin DIMM
- Speed: 66, 100 or 133 MHz
- Configured as 2 or 4 banks
- CS (chip strobes) control 64-bit rows, not 32-bit columns  
(This proviso is important for 256-MByte DIMMs)

*DIMM memory not meeting this specification will not work, but should not cause damage. The CED warranty on the Power1401 does not cover malfunctions caused by users attempting to upgrade their units.*

**Electrostatic precautions** When exchanging DIMMs, take precautions against static electricity. Earth the Power1401 case to mains earth, and yourself to the case, preferably via a wrist strap. Release the old DIMM by pushing the small ejection levers on either side of the socket. Ensure the new DIMM has no static charge by touching its conductive wrapping before handling it. Avoid touching metallic contacts on the DIMM; it is best to hold it by the short edges. DIMMs are polarised; you cannot insert one the wrong way round.



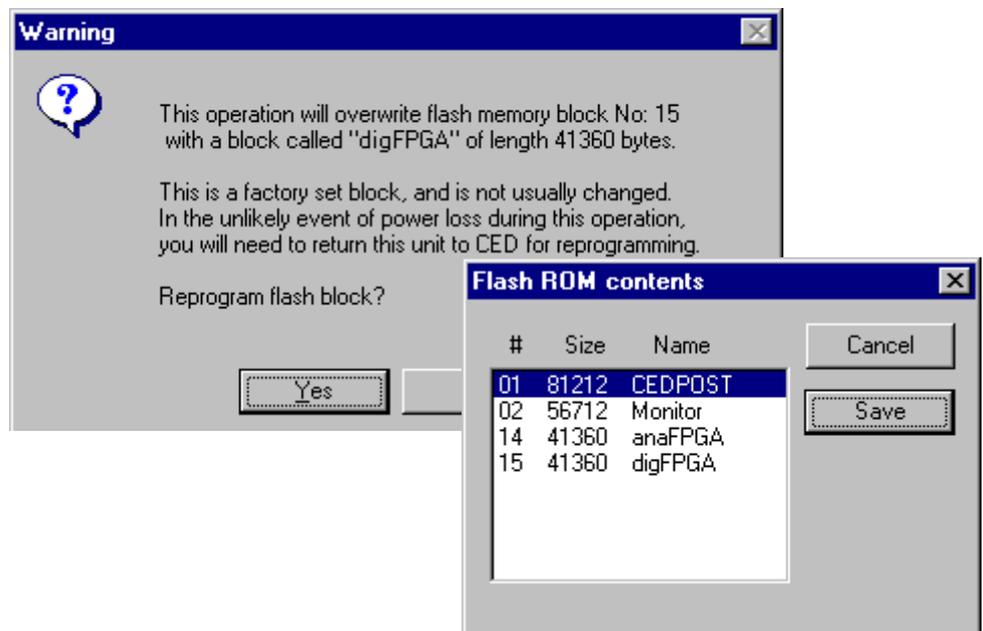
**Self-test** The time taken for the power-on self-test depends on the amount of memory. With 256 MBytes, the standard, short self-test will take about half a minute, the long test about 2 minutes.

## 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 28); from *File* select *Update Flash*. The destination for the new monitor 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](http://www.ced.co.uk). FPGA images will similarly be upgradable, to blocks 12 and 13, should this prove desirable.

## Analogue calibration

The ADC & DAC Test option inside TRY1432 is provided to calibrate the ADC inputs. This involves opening the Power1401, since the main trimming controls are manually adjusted potentiometers (see page 51 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  $\pm 5V$  range, one 16-bit LSB corresponds to only 150 $\mu V$ , 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 10 $\mu V$  on the  $\pm 5V$  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 60 for advice on sending it back.

**Running TRY1432** TRY1432 is a utility stored in the folder `\1401\utils`. To run it, select

*Start, Programs, Test 1401, Try1401.*

*ADC & DAC Test* is an option inside *Tests*. The screen instructions detail the equipment required and the actions taken at each step. The procedure involves calibrating the DACs against the DVM, then calibrating the ADC against DAC0.

## Electrostatic precautions



When working inside a Power1401 take precautions against static electricity. The case is connected to mains earth via the power cable; earth yourself to the case, preferably via a wrist strap.

## 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 help 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. Many of the components in the Power1401 that connect to the outside world are socketed for easy replacement; see the diagram on page 52. This often bypasses 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 27) 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. 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, 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 2000** Select *Start, Settings, Control Panel, System*. Select the *Hardware* tab, and click the *Device Manager* button. Expand the *1401* node and double-click on the *1401* icon. Select the *Resources* tab. Any clashes will be reported, and can be resolved automatically.

**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:

<b>Vector</b>	<b>Other users of this vector</b>
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 1 MByte (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 users to have run TRY1432, so that we know about the hardware state.

**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!

## 1

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## Specification

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<b>Waveform inputs</b>	Input impedance	1	MegOhm
	Active working voltage range	±5	Volts
		(±10	Volts with 10V option)
	Safe voltage range	±15	Volts
	Maximum conversion rate		
	single channel	800	kiloHertz
	multi-channel	625	kiloHertz
	Resolution	16	bits
	Crosstalk & noise	±2	LSBs up to 200kHz/chan
<b>Waveform outputs</b>	Active working voltage range	±5	Volts
		(±10	Volts with 10V option)
	Safe drive capability	600	Ohms
	Full accuracy drive	5	kilOhms
	Maximum update rate	400	kiloHertz
	Resolution	16	bits
<b>Front-panel digital inputs</b>	Input impedance	100	kilOhms to +5V
	Safe voltage range	±10	Volts
	Shortest pulse-width	1	microsecond
	Low voltage	0.8	Volts
<b>Clocks</b>	Accuracy & drift, 0-70°C	50	parts per million
<b>Rear-panel digital and event inputs</b>	Input impedance	4.7	kilOhms minimum
	Safe voltage range	±10	Volts
	Shortest pulse-width	100	nanoseconds
	Low voltage	0.8	Volts
	Low current	1.5	milliAmps maximum
<b>Digital outputs</b>	Drive capability	±20	milliAmps
<b>Mains Supply</b>	Voltage range	100 to 240	Volts
	Frequency range	47 to 63	Hertz
	Current	0.8	Amps
<b>Case size &amp; weight</b>	Power1401	88 × 219 × 428	millimetres
		3.0	kilograms
	Power brick	40 × 75 × 130	millimetres
		0.45	kilograms
<b>Environment</b>	Temperature range	-5 to +50	° Celsius
	Maximum humidity	95%	Non-condensing



## 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

Signature

Peter Rice

Technical Director

Date

11 AUGUST 1999

11 August 1999

EN61000-4-11 (1998) (Dips immunity) - PASS Criteria A & C