The CED Micro1401 mk II Owners Handbook

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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 are in *italics*.

- Labels and identifiers appearing on the equipment described in this manual are in Arial.

- Menu items, buttons, and other contents of computer displays are in *Arial italics*.

- Dialogue that you type in at a keyboard is in `Courier New lowercase`. Names of keyboard effector keys are enclosed in angular brackets, e.g.: `<esc>`, `<enter>`.

- Names of files, drives, paths and directories are in `Courier New`.

- Signal names are in Times New Roman, SMALL CAPS.

Use of symbols

Where applied, the following symbols have the meanings below:

This symbol declares that the equipment passes the relevant clauses of EU directives on safety and EMC emissions; see the certificate reproduced on page 61.

Observe precautions against electrostatic discharge.

The CED Micro1401 mk II is lead-free and conforms to the EU RoHS directive.

The CED Micro1401 mk II is subject to the EU WEEE regulations and may be returned to CED for recycling.

Attention, consult accompanying documents.

The DC symbol indicates that the Micro1401 chassis is powered from a DC-only supply.

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

Micro1401 mk II *vs* Micro1401

The Micro1401 mk II is an updated and enhanced version of the original Micro1401. Improvements include:

- 500 kHz, 16-bit ADC, as opposed to 333 kHz, 12-bit ADC
- 3× faster processor
- Firmware field-upgradable by download from website
- Synchronization port (from serial no. M2000 onwards)
- USB and standard CED host interface both built-in
- Improved mechanics for expansion units

'Micro1401' (or '1401' in brief) is always taken to mean 'Micro1401 mk II' unless specifically mentioned to the contrary.

Potential for Radio/Television Interference *(USA only)*

The Micro1401 generates and uses radio frequency energy and may cause interference to radio and television reception. Your Micro1401 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 Micro1401 does cause interference to radio or television reception, which can be determined by turning the Micro1401 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 Micro1401 with respect to the receiver
- Move the Micro1401 away from the receiver
- Plug the Micro1401 into a different outlet so that the Micro1401 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 authorized 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

Step1 Install the software first: either your CED application or the CED 1401 installation CD

Step 2 Set up your hardware, either for USB, or PCI interface, or ISA interface:

USB For Windows 98 SE, Windows Me, Windows NT 2000, Windows XP, and Vista

- Power-up the computer and the 1401
- Connect the USB cable
- USB is hardware is recognized & correct driver located automatically

PCI Plug the interface card into the computer

For Windows 9x, Windows Me, Windows NT 2000, Windows XP, and Vista

- Windows automatically locates PCI driver

For Windows NT 4

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

ISA Plug the interface card into the computer

Adjust jumpers as required – usually not

For Windows 9x, Windows Me, Windows NT 2000, Windows XP, and Vista

- Use *Add New Hardware* dialog to install interface

For Windows NT 4

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

Step 3 Check the installation

- Run *Try1401*, set tests *All On*, select *Run Once*
- Test should take ~20 seconds & give no errors

Step 4 Your Micro1401 is now ready for use
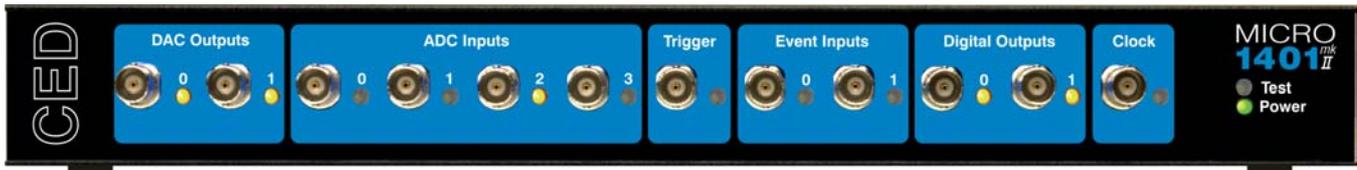
Introduction This manual will guide you through the initial check and installation of your Micro1401. It introduces you to the external inputs and outputs. It also describes maintenance and diagnostic procedures. This manual does not cover 1401 programming nor the use of application programs with the 1401.

Checklist The installation kit for your Micro1401 comprises:

- A Micro1401, 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 Micro1401 to your computer (unless you are using a USB port)
- A suitable data cable to connect Micro1401 and computer
- An installation disk to allow you to install and check out your Micro1401
- This owners manual

The power brick The power brick will run with no adjustment on any mains voltage from 100 V to 250 V, 50-60 Hz, drawing 0·7 Amps maximum. It has no switch, being controlled by plugging in and switching on at the mains socket.

The rear-panel switch controls input of DC power from the power brick to the Micro1401. For complete electrical isolation, you must disconnect the power brick from mains power.

Confidence check

Your Micro1401 was soak-tested at CED before shipping. To pass the test, a Micro1401 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.
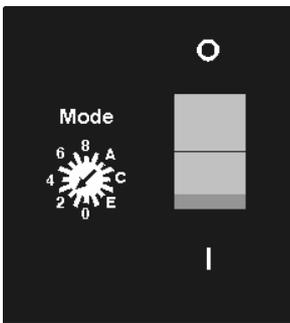
Check that the DC switch on the back of the Micro1401, marked O/I, is off (position O). Connect the power-brick output plug to the DC Power In socket. Check that the Mode selector is in position 2. Do not connect the data cable. Switch the Micro1401 on. The green Power LED should light and stay on. The 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 52.

Installing the Micro1401

Once the Micro1401 has passed the confidence check, you should turn to the section that 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 Micro1401 must not exceed the temperature range −5° to +50° Celsius, in conditions of non-condensing humidity. Humidity should not exceed 95% saturation. The Micro1401 is suitable for continuous operation. The Micro1401 is not protected against ingress of water or dust. There are no hazardous voltages inside the Micro1401. The Micro1401 complies with relevant EU and USA requirements for electromagnetic interference. The Micro1401 is subject to the EU WEEE regulations and may be returned to CED Ltd for recycling.

At some point you will choose a permanent position for your Micro1401. It is happy in the same sort of environment that suits the host computer. The Micro1401 normally stands on its base, but it will work on its side or upside down, if required.

Application software

The Micro1401 requires application software to run it. Most customers will run CED application programs 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 Micro1401) under Windows 95, Windows 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 separately from a CD-ROM. 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.

Information for programmers

The 1401 language support kit, for users who wish to program their Micro1401 from their host computer, includes the *1401 family programming manual* for detailed descriptions of the 1401 standard command library.

Circuit diagrams

Circuit diagrams for the Micro1401 can be made available for a fee. Purchasers must sign a non-disclosure agreement.

Installation

Overview This section provides an overview on installing a Micro1401 in an IBM PC or compatible.

To install the Micro1401 you will need:
- A Micro1401, power brick and mains cable
- A 1401 data cable, or else a USB cable
- A 1401 interface card (if not a USB installation)
- The CED application software disk

Organization of sections The sections that follow deal with installing
- the PC USB interface
- the PC PCI interface and
- 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 (making the physical connection between the Micro1401 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 and Vista
- Windows NT 4

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

Test and diagnostic utilities The *CED 1401 installation* disk includes test and diagnostic programs. They are of great use if something goes wrong, but not essential for normal operation. The are automatically installed at the same time as the device drivers. See page 27 onwards for details of these utilities.

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, Windows NT, Windows 3.x, or DOS. We describe installation under Windows 98/Windows Me first, then Windows NT 2000 and Windows XP.

Driver installation Device drivers are supplied on CED applications disks and are loaded at the same time as the application. This is done before the hardware is connected. 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 Micro1401s 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 Micro1401. Both machines should be powered up when you do this.

Windows 98, The Micro1401 should be plugged into a USB port while both
Windows Me machines are powered up. The USB hardware will detect the
1401, and a message 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 driver installed, the Micro1401 becomes recognized
USB device, and the a *1401 interface* icon will appear in the
System Device Manager whenever the Micro1401 is plugged in
and powered up.

System Properties,
Device Manager tab
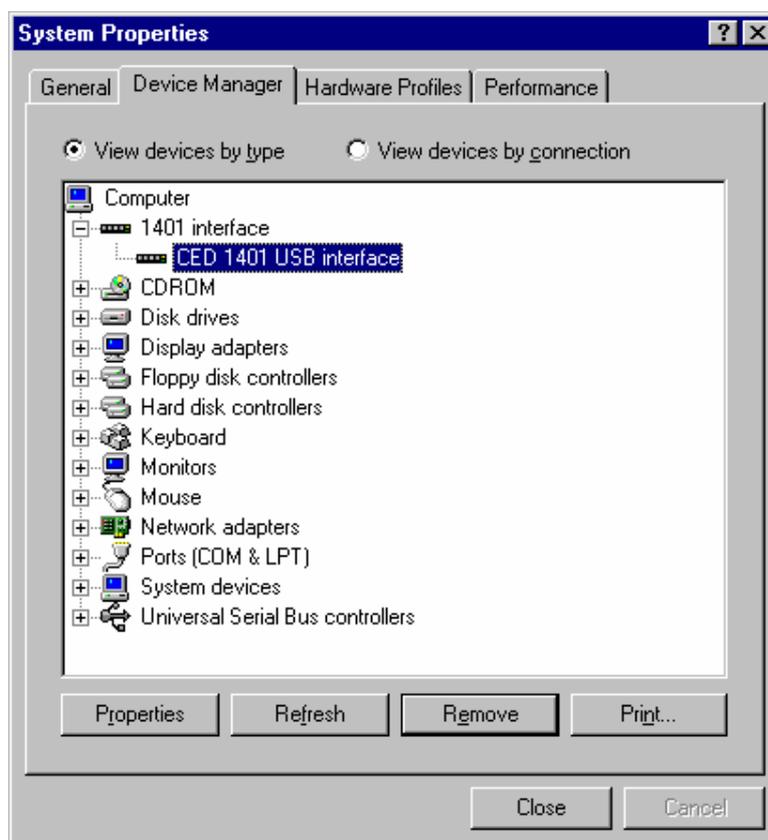
Tabs in *Properties* *General* provides overall device status, and allows for
enabling/disabling the device. *Driver* lists device driver usage
and version information. It has the *Change Driver* button, used
to load device driver upgrades. *Resources* details interrupt,
DMA and base address usage. From the *Settings* tab you can
set the device number of the Micro1401, if multiple 1401s are
connected. You can also reset the 1401 from here.

**Windows NT
2000,
Windows XP**

The Micro1401 should be plugged into the USB port while both machines are powered up. The USB hardware will detect the 1401, and a message 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 driver installed, the Micro1401 becomes recognized USB device, and the a *1401 interface* icon will appear in the Hardware Device Manager whenever the Micro1401 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. Click the boxed **+** by the *1401 interface* icon to display the *CED 1401 USB interface* icon. Opening this reveals the three tabs of the properties window: *General*, *Settings*, and *Driver*. From the *Settings* tab you can set the device number of the Micro1401, if multiple 1401s are connected. You can also reset the 1401 from here.

*System Properties,
Device Manager tab*

System Properties   **? X**

| General | Device Manager | Hardware Profiles | Performance |

○ View devices by type   ○ View devices by connection

- 🖥 Computer
  - 📟 1401 interface
    - 📟 **CED 1401 USB interface**
  - 💿 CDROM
  - 💾 Disk drives
  - 🖥 Display adapters
  - 📇 Floppy disk controllers
  - 📇 Hard disk controllers
  - ⌨ Keyboard
  - 🖥 Monitors
  - 🖱 Mouse
  - 🖧 Network adapters
  - 📜 Ports (COM & LPT)
  - 🖥 System devices
  - 🔌 Universal Serial Bus controllers

| Properties | Refresh | Remove | Print... |

Close   Cancel
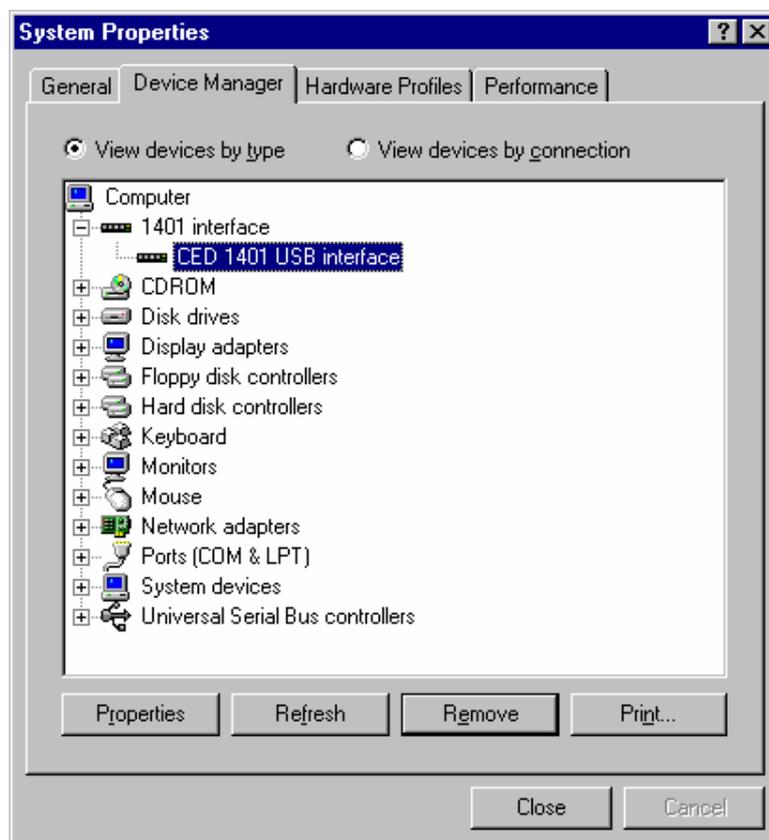
The PCI driver We describe driver installation under Windows 9x first, followed by Windows NT 2000, then Windows NT 4. If you do need to install in Windows 3.x or DOS, please contact CED.

Driver installation Device drivers are supplied on CED applications disks and are loaded at the same time as the application. This is done before the hardware is connected. 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.

PCI card installation

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

Your interface card is the CED PCI interface (1401-60). See page 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. 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 Micro1401. The cable is reversible end for end.
5. Plug the DC power cable into the rear of the Micro1401.
6. Hardware installation is now complete.
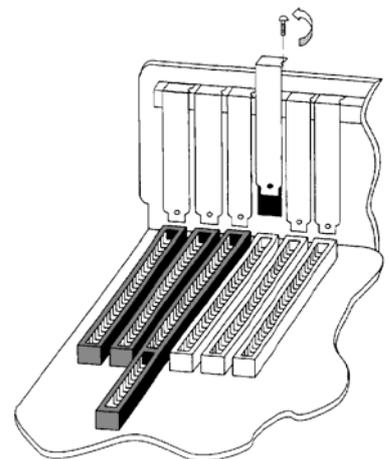
Windows 95, Windows 98, Windows Me
After a 1401 PCI interface card has been fitted, Windows finds it automatically when the PC is next powered up. A message will briefly announce that Windows has detected a new PCI card and is looking for its driver. Since this has been installed with the application, it will report that it has found the CED 1401 PCI software, and disappear. When the PCI driver has been installed, a *1401 interface* 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.

Other 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. From the *Settings* tab you can set the device number of the Micro1401, if multiple 1401s are installed. You can also reset the 1401 from here.

System Properties, Device manager tab

PCI interface Properties, Resources tab ➢

System Properties

General | Device Manager | Hardware Profiles | Performance

⦿ View devices by type   ○ View devices by connection

- 💻 Computer
  - 🔲 1401 interface
    - CED 1401 PCI interface
  - 💿 CDROM
  - 💾 Disk drives
  - 🖥 Display adapters
  - 💾 Floppy disk cont
  - 💾 Hard disk contro
  - ⌨ Keyboard
  - 📠 Modem
  - 🖥 Monitor
  - 🖱 Mouse
  - 🔌 Network adapter
  - ❓ Other devices
  - 🔌 Ports (COM & LP
  - 🔊 Sound, video an
  - 💻 System devices

Properties   R

CED 1401 PCI interface Properties

General | Settings | Driver | Resources

▭▭▭ CED 1401 PCI interface

Resource settings:

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

Setting based on: Basic configuration 0000

Change Setting...   ☑ Use automatic settings

Conflicting device list:

No conflicts.

OK   Cancel

11

Windows NT 2000, Windows XP After a 1401 PCI interface card has been fitted, Windows finds it automatically when the PC is next powered up. A message 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 driver has been installed, a *1401 interface* icon will appear in the System Device Manager.
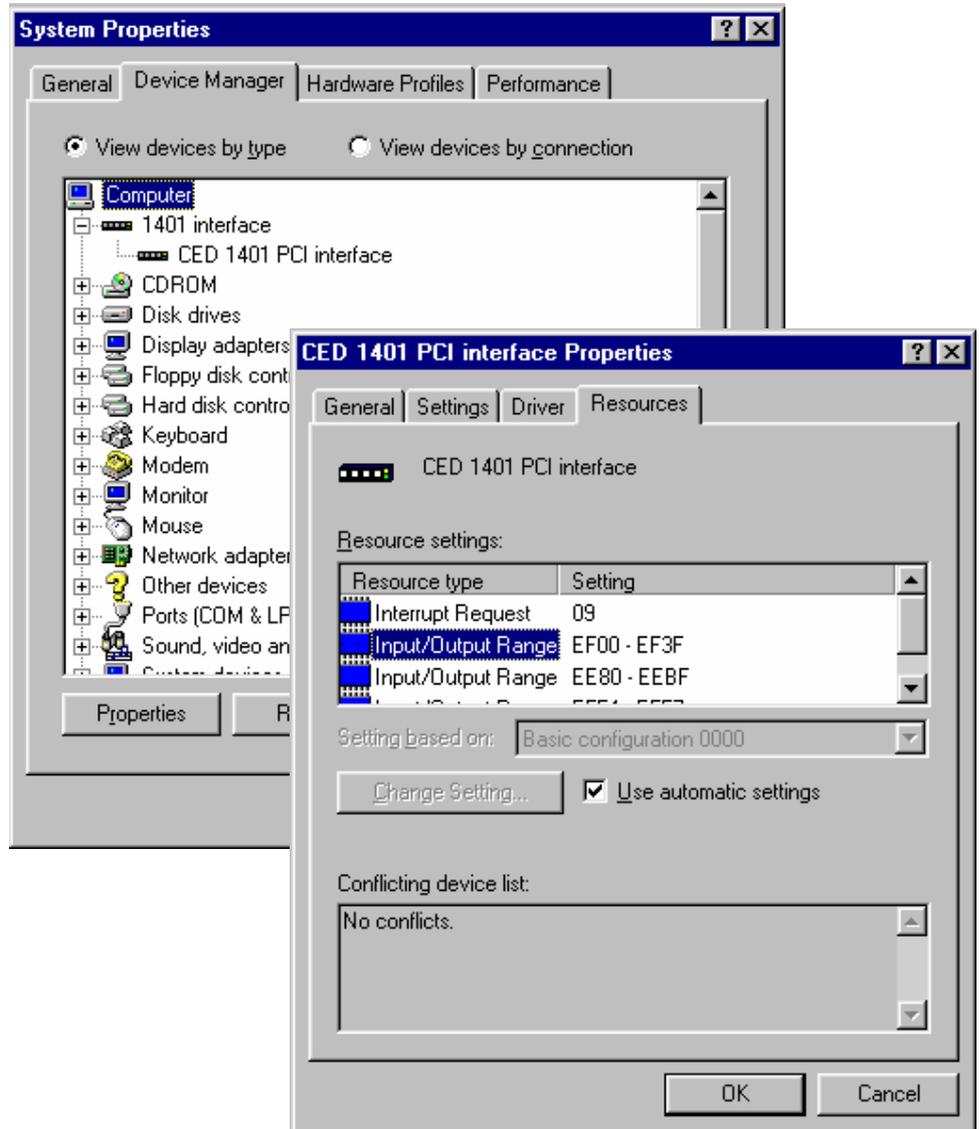
PCI driver properties sheet You can view the 1401 PCI interface settings by selecting *Start*, *Settings*, *Control Panel*, *System*.

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.

Other 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. From the *Settings* tab you can set the device number of the Micro1401, if multiple 1401s are installed. You can also reset the 1401 from here.

Windows NT 4 After a 1401 interface card has been fitted, switch the PC on. Windows NT 4 is not a Plug and Play operating system, but the installer on the CED applications 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 Micro1401 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.
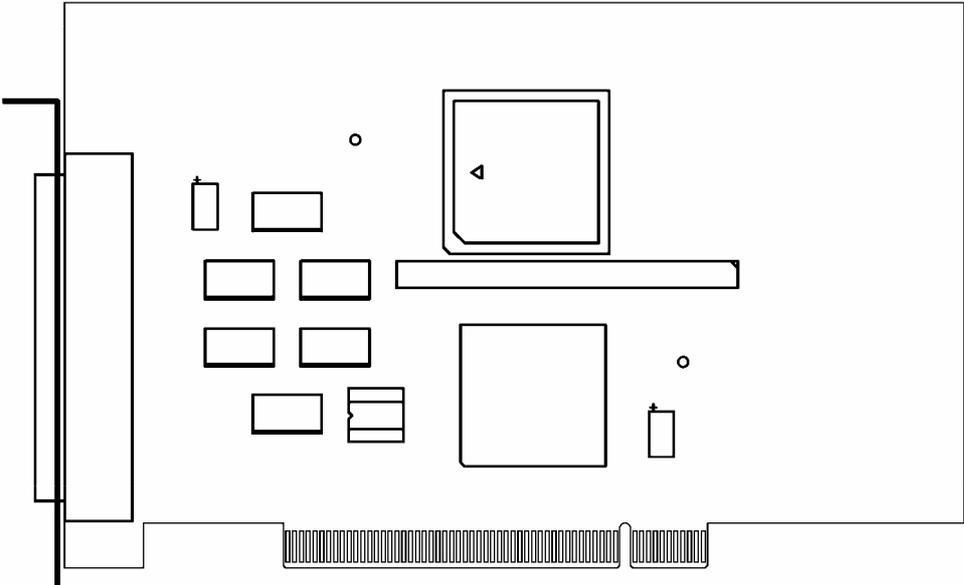
Windows NT Diagnostics

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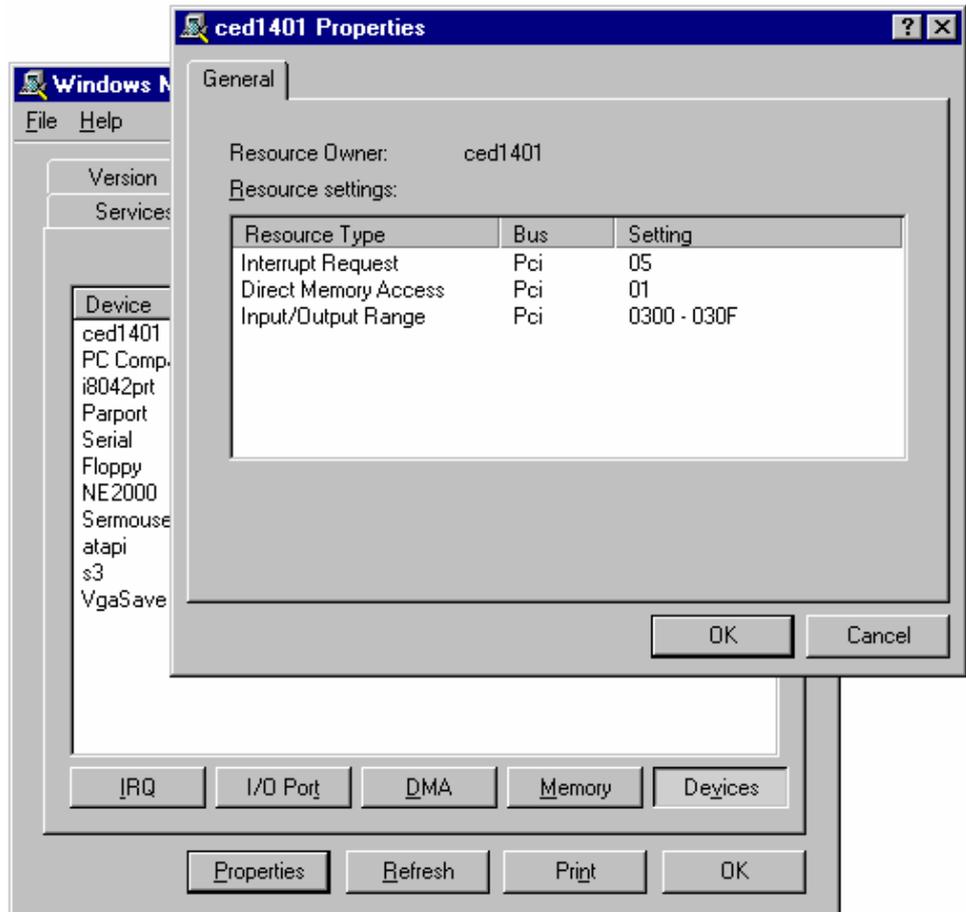
The PCI interface card The standard interface for the PCI bus is the 1401-60. This card has no hardware switches; its base address and interrupt are set up automatically by the device driver software.

The CED 1401-60 PCI interface card

The ISA driver We describe driver installation under Windows 9x first, followed by Windows NT 2000, then Windows NT 4. If you do need to install in Windows 3.x or DOS, please contact CED.

Driver installation Device drivers are supplied on CED applications disks and are loaded at the same time as the application. This is done before the hardware is connected. 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.

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

Your interface card may be a standard ISA interface (1401-10), or a quad rate ISA interface (1401-50). See page 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.
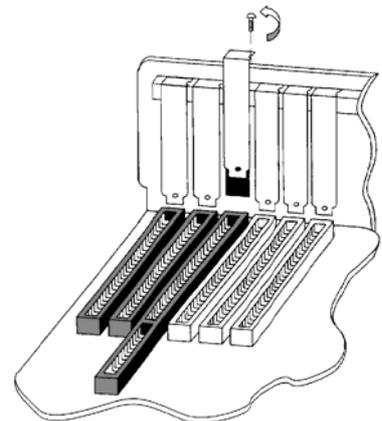
4. Offer the card to the slot and push it firmly home. Fix the metal bracket at the rear with the screw you saved, and replace the cover.

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 Micro1401. The cable is reversible end for end.

6. Plug the DC power cable into the rear of the Micro1401.

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 9x will <u>not</u> detect the new hardware because ISA devices are not Plug and 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.

Add New Hardware Wizard

Click the manufacturer and model of your hardware. If your hardware is not listed, or if you have an installation disk, click Have Disk.

If your hardware is still not listed, click Back, and then select a different hardware type. To see all hardware choices, click Unknown Hardware.

Mo_d_els:

CED 1401 ISA interface
CED 1401 PCI interface
CED 1401 USB interface

[_H_ave Disk...]

< _B_ack   Next >   Cancel

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 (hex) (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 interface* 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   *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. From the *Settings* tab you can set the device number of the Micro1401, if multiple 1401s are installed. You can also reset the 1401 from here.

Windows NT 2000, Windows XP

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

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

Select the "Add/troubleshoot device" button on the window that opens. Windows NT 2000 will now insist on searching for Plug and 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*. Chose *CED 1401 ISA interface* from the list that is displayed. The software 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.
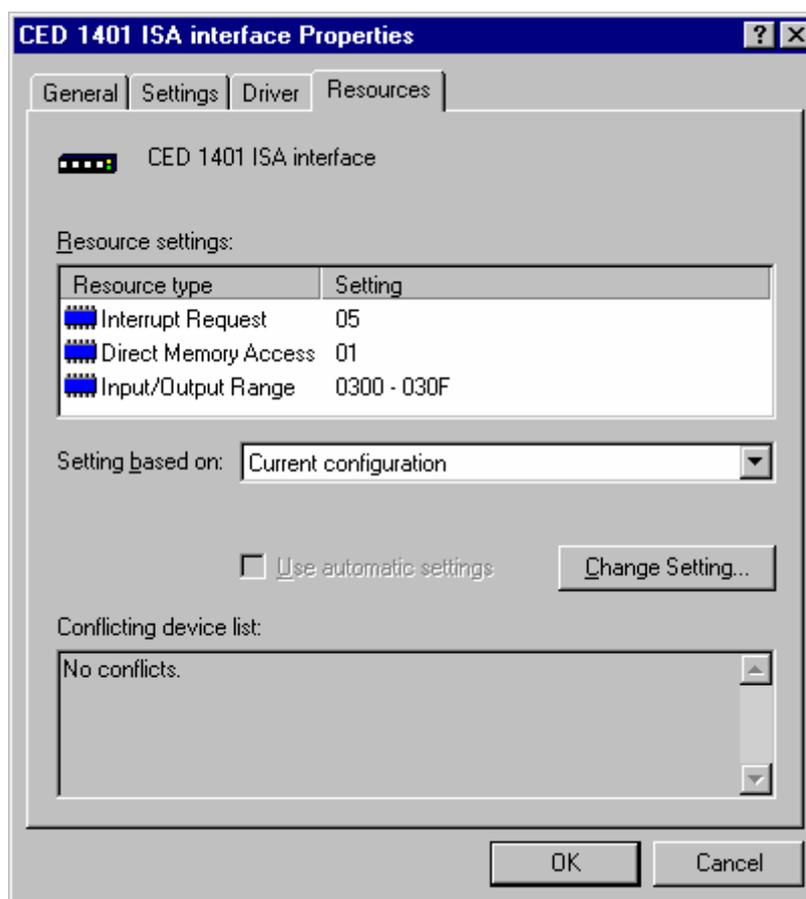
Editing I/O base address on installation If you have altered the I/O base address on the card, press the *Resources* button to inspect the base address. Now click on *Set configuration manually*. Select "Current configuration" from the drop-down list. This initially is empty; select "Input/Output range" 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 boxed + on the 1401 node means a device is present: click on it to reveal *CED 1401 ISA interface*. 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 obscure 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

CED 1401 ISA interface Properties

General | Settings | Driver | Resources

CED 1401 ISA interface

Resource settings:

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

Setting based on: Current configuration

☐ Use automatic settings   Change Setting...

Conflicting device list:

No conflicts.

OK   Cancel

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 going 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 and Play operating system, but the installer on the CED application disk copied the drivers to the correct location and updates the registry. Consequently it is only necessary to check that the card type and card address has been 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 1401 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.
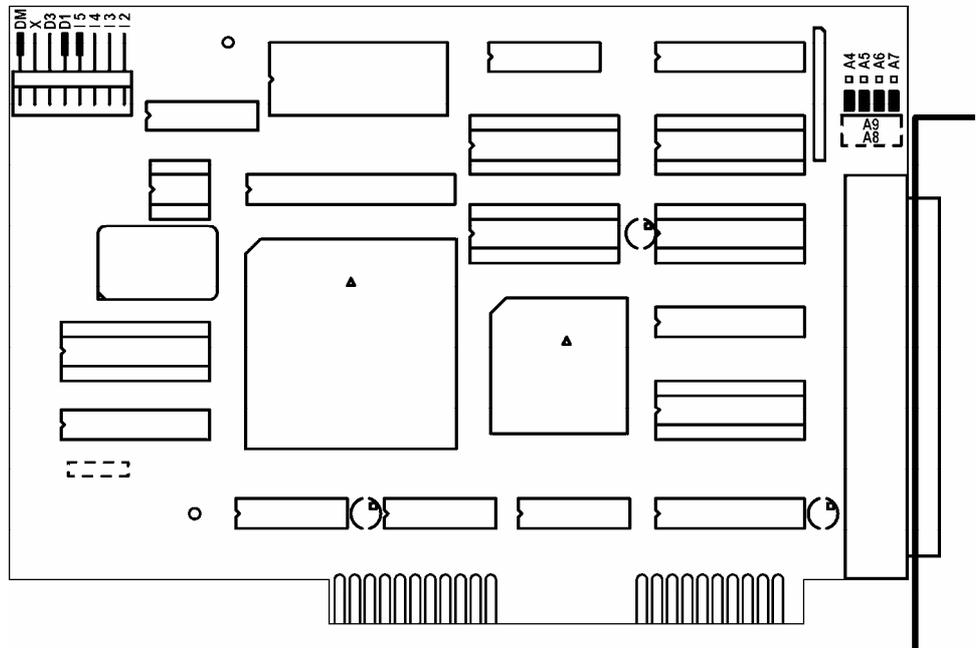
The CED 1401-10 ISA interface card
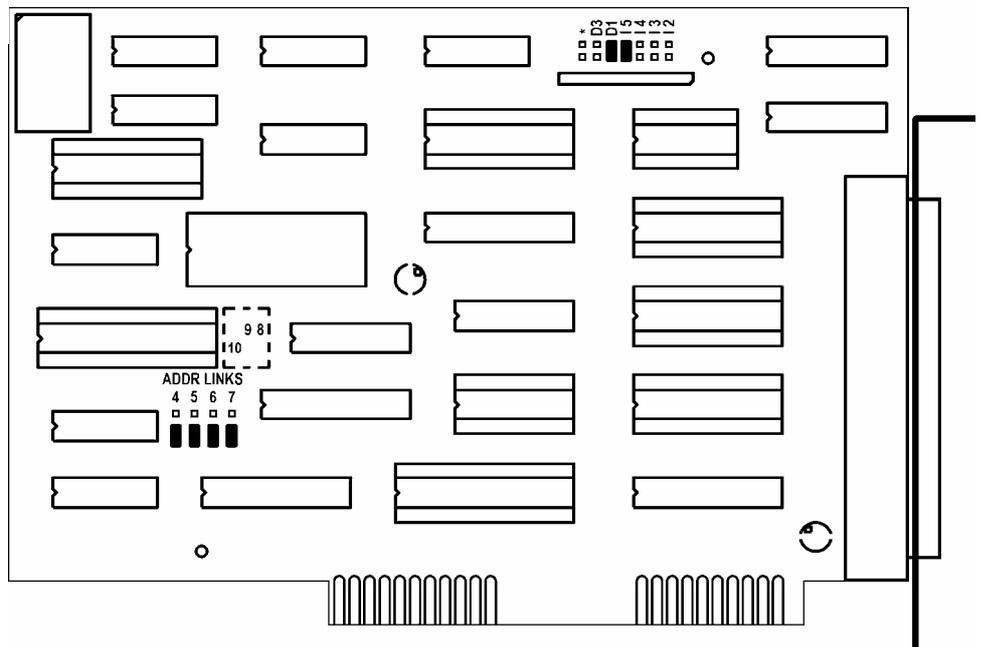
The interrupt vector and DMA channel are selected by jumpers at the top right of the card. A jumper in one of I2, I3, I4 or I5 selects an interrupt vector from 2 to 5. Similarly a jumper in one of D1, D3 or ✶ selects DMA channel 1, channel 3 or no DMA.

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 base address 300 (hex), with all jumpers in position 0 (lower). To set 310 (hex), move jumper 4 to position 1 (upper), and so on. See page 26 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 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. To set 310 (hex), move jumper 4 to the upper position, and so on. See page 26 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 (hex). 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 Micro1401 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 54 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 Micro1401 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 sound card), 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 Micro1401 only connects itself to the DMA logic in your computer when it transfers data, so it can share a DMA channel with the sound card so long as the sound card 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 (hex). The most common reason to change the address is because of a conflict with an ISA network card.

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

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

Installing test & diagnostics

CED application disks include test utilities, that verify correct installation of your Micro1401, assist in re-calibrating the analogue system, and diagnose hardware problems. These are installed automatically at the same time as the CED application.

If at a later date a *CED 1401 installation* disk is run, and it finds it has drivers or utilities that are newer than those on your system, it will update them.

These utilities are accessed through the *Try1401* icon, which may be found in any of the *Spike2*, *Signal*, or Test1401 program groups, which may be found via *Start*, *Programs*.

The Windows installation copies programs to `\1401\utils` that verify that your Micro1401 has been installed correctly, and to run diagnostic procedures.

TRY1401 TRY1401 is the principal Windows 9x and Windows NT 2000 user test program. It is also installed 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 Micro1401 in the same way.

TRY1401 program screen
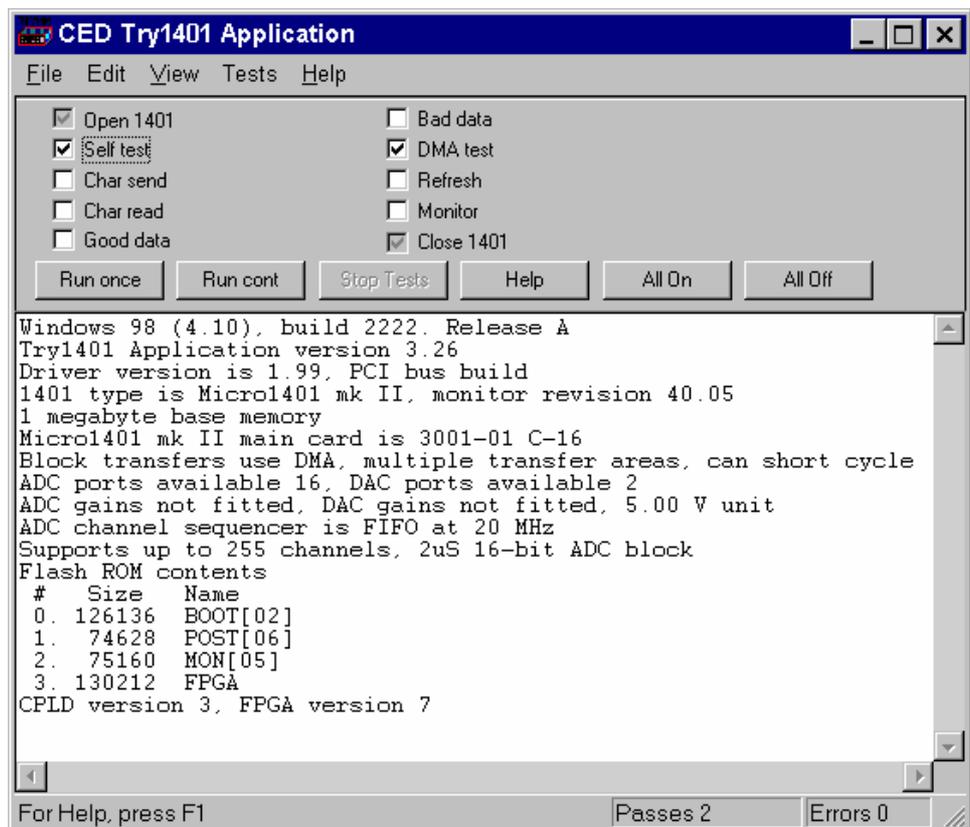
To run TRY1401, select

Start, Programs, Test1401, Try1401.

Running TRY1401 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 Micro1401 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 in the TRY1401 screen on the previous page, select

File, *1401 info…*

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

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

These are tests that the machine cannot do for 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 caried out solely by connecting cables and digital voltmeters to the Micro1401; others require the box to be opened in order to adjust pots. See page 47 for how to take the lid off, and page 49 for the location of adjustable components. Analogue calibration is discused more fully on page 51.

ADC & DAC Test,
Ramp DAC test
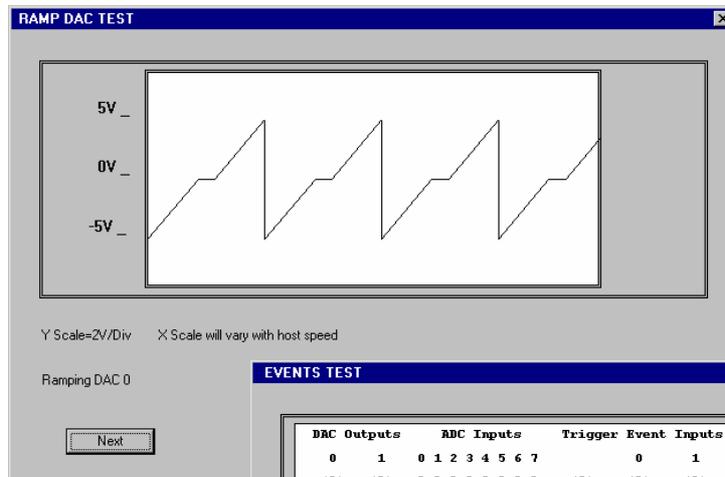
Clock & Event Test,
Events test ➢

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

General These points relate to physical and electrical aspects of the Micro1401 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 plug and the earth lead of the power brick, to mains earth. All signal returns are tied to mains earth on the Micro1401 printed circuit board. Items of equipment connected to the Micro1401 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 internal voltage rails fails or 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. See page 47 for opening the Micro1401 and page 48 for the location and identification of socketed chips. All such chips are readily-available types; if ordering, specify device codes exactly as detailed to ensure lead-free, insertion-mount parts.

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 <u>outside</u>. This is also the view of their mating connectors as seen while wiring them up!

Waveform input Waveform input channels are buffered through unity-gain amplifiers. Channels are then steered into the ADC (Analogue to Digital Converter) via a multiplexer. The input sample-and-hold is part of the ADC chip. The ADC converts an input voltage to a 16-bit digital value in approximately 2 µs. Optionally, a second sample-and-hold can be fitted to channel 3, which can then be sampled simultaneously with one of the other three channels.

Waveform channels There are four waveform input channels on a standard Micro1401, available through front-panel BNC connectors labelled ADC Inputs. The normal working input range of these channels is ±5 V, but can be altered to ±10 V 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 ADC converting. The ADC external convert input is also permanently wired through pin 6 of the rear panel Events D-socket. Conversions are usually initiated by a high-to-low transition. External convert signals are used when the conversion time is determined by an external event, e.g. when synchronizing conversions to the phases of a rotating machine. When operating in internally-triggered mode the ADC typically samples at a fixed rate set by one of the clocks.

ADC LEDs The front-panel waveform input channels each have an associated yellow LED. They are controlled purely by software command and typically are turned 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: Analogue input 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. Waveform inputs are routed through common-mode ferrite chokes to prevent radiation of EMI. The maximum non-destructive input voltage range is ±12 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 48.

Front-panel Trigger input The front-panel Trigger input has a normal working voltage range of 0 V to +5 V. There is MOSFET circuit protection allowing a safe input range of ±10 V, and a common-mode ferrite choke to prevent radiation of EMI. This input is held internally to +5 V by a 47 kOhm resistor and has input hysteresis: the low-going threshold voltage is set at 0.95 V and the high-going threshold at 1.2 V. Pulses driving the trigger input should be 1 µs or longer. To pull this input low, the driving device must be able to sink 100 µA.

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 of 0V to +5V. There is MOSFET circuit protection allowing a safe input range of ± 10V. This input is held internally at +5 V via a 10 kOhm resistor. Input pulses should not be narrower than 1µs and must fall below 0.8 V for guaranteed recognition. Conversion is normally initiated on the high-to-low edge. Use of the other edge can be selected by an internal switch; see page 47.

The ADC The ADC is a successive-approximation converter with integral sample-and-hold. The input voltage is resolved into 65536 levels (16-bit precision); each step is approximately 150 µV (or 300 µV on ±10 V range).

Waveform output There are two waveform output channels on the Micro1401, available through BNC connectors on the front panel labelled DAC Outputs (Digital to Analogue Converters).

The DAC waveform outputs produce voltages in the range ±5 V, in steps of approximately 2·44 mV. The range can be altered semi-permanently to ±10 V, and 4·88 mV 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 37), or the front-panel Trigger input, to synchronize the update rate to external equipment. Alternatively, they can be updated at a constant rate from one of the internal clocks; see page 35. When both channels of waveform are output, the Micro1401 can be programmed to update the DACs simultaneously. The maximum update rate is in excess of 400 kHz.

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

Technical details The waveform outputs are designed for driving loads of 600 Ohms impedance or higher, and are short-circuit proof. For full accuracy, the load should not be less than 5 kOhms. 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 47.

Clocks The Micro1401 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 μs or wider. If there are more than two such signals, the rear-panel Digital Inputs may be used; see page 40.

Frequency sources All clock frequencies are normally derived from an internal crystal oscillator. Users may sometimes need to take a timing source from outside the Micro1401 instead. All the 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 37.) When you need to synchronize two 1401 machines, use the synchronization port (see page 42.)

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

Technical details The normal working input range of Trigger, Event 0 and Event 1 is 0 V to +5 V. There is MOSFET circuit protection allowing a safe input range of ±10 V. These inputs are held internally to +5 V by 47 kOhm resistors and have input hysteresis: the low-going threshold voltage is set at 0·95 V and the high-going threshold at 1·2 V. To pull these inputs low, the driving device must be able to sink 100 μA. Pulses driving these front panel inputs must be 1 μs or longer.

Clock is an output, driven by a 74HCT125 element which can source or sink 8 mA; this chip is in a socket for easy replacement (see page 48.) Trigger, Event 0, Event 1 and Clock are routed through common-mode 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 *Micro1401 mk II 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 +5 V by 10 kOhm resistors. To pull these inputs low, the driving device must be able to sink at least 500 µA; input pulses must fall below 0·8 V to guarantee recognition. Clock E pulses should not be narrower than 100 ns. Clock F frequency must not exceed 10 MHz; pulses should be wider than 50 ns. The working range of these inputs is 0 to +5 V. There is MOSFET circuit protection allowing a safe input range of ±10 V.

The 4 MHz 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, to help reduce EMI; a jumper must be inserted to make it available (see page 49.)

The sense of the Clock E and ADC external convert inputs may be inverted by a switch option (see page 47), but the inputs would all then be held active high if no input is connected.

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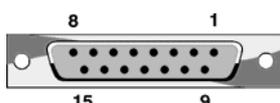
Pin	Function	Pin	Function
1	Clock E0 input	5	Clock E4 input
2	Clock E1 input	6	ADC external convert input
3	Clock E2 input	7	Clock F input for all clocks
4	Clock E3 input	8	4 MHz clock output
9 - 15	Ground	Screen	Mains earth
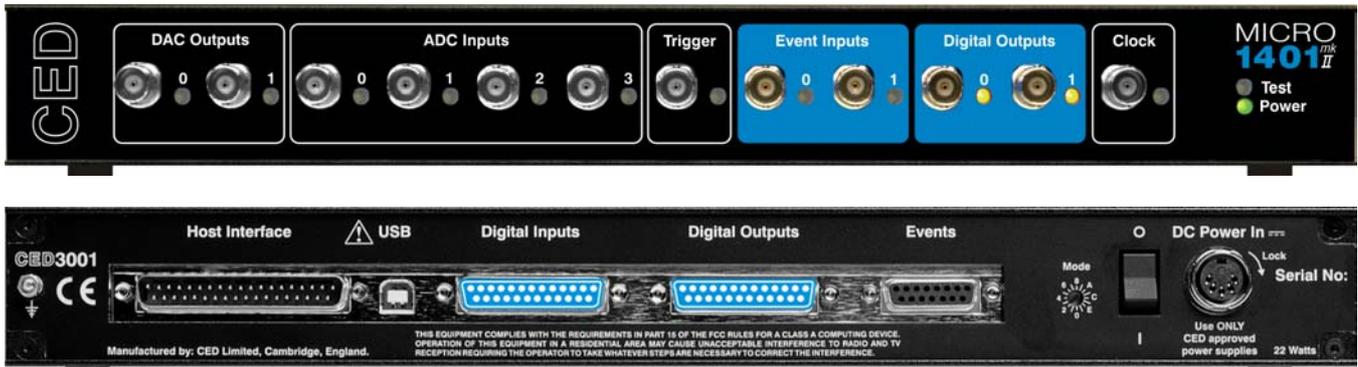
Digital input and output

The Micro1401 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 pin 11 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 is set by software command. Front-panel digital-output LEDs simply reflect the state of the bits, being lit whenever their bit is set (high).

Technical details

Front-panel digital I/O is routed through common-mode ferrite chokes to prevent radiation of EMI. All digital inputs have MOSFET circuit protection. All outputs are buffered through 74HCT244s, which can source or sink 24 mA. These chips are socketed for easy replacement; see page 48.

Unconnected digital inputs read 1, being pulled internally to +5 V by 4k7 (rear panel) or 47k (front panel). Input voltages of more than 2·0 V will always read as logic 1. To read as logic 0, the input must be pulled below 0·8 V for at least 1 μs, which takes 100 μA (front); or 100 ns, which takes 1 mA (rear).

Digital I/O handshake protocol Digital data transfer between the Micro1401 and external equipment can optionally be synchronized 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.
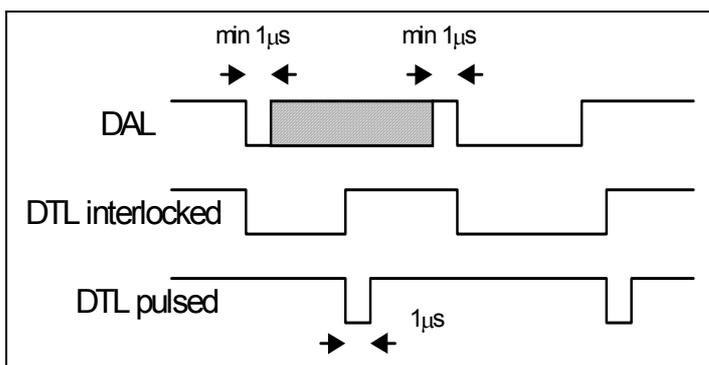
When presenting data, an external device sends a pulse at least 1 µs wide to the DAL (data available 0-7) input. When the Micro1401 reads the data the DTL (data transmitted 0-7) output line pulses for 1 µs if in pulsed mode. If in interlocked mode, DTL is set by the Micro1401 read and cleared by the next DAL.
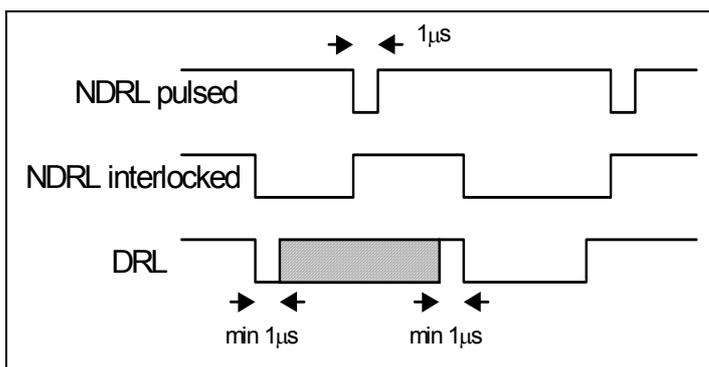
When Micro1401 writes data to the digital output, the NDRL (new data ready 0-7) output pulses for 1 µs if in pulsed mode. If in interlocked mode NDRL is set by the data write and cleared by the answering DRL (data read 0-7) pulse, which must be at least 1 µs wide, from the external device.

5 volt output and circuit breaker There is a +5 V output available on pin 25 of both the digital input and output ports. This output is internally protected by a 200 mA circuit-breaker and is intended only to power one or two chips for interfacing purposes. The breaker is reset by removing power from the Micro1401.

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 Micro1401 switched off, or to use a connector with a plastic shroud.

**Digital I/O connectors**

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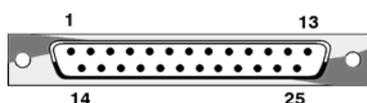
Digital output socket
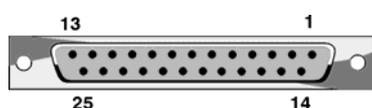
Pin	Output socket		Pin	Input plug	
1	High byte out 7	Word out 15	1	High byte in 7	Word in 15
14	6	14	14	6	14
2	5	13	2	5	13
15	4	12	15	4	12
3	3	11	3	3	11
16	2	10	16	2	10
4	1	9	4	1	9
17	0	8	17	0	8
5	Low byte out 7	Word out 7	5	Low byte in 7	Word in 7
18	6	6	18	6	6
6	5	5	6	5	5
19	4	4	19	4	4
7	3	3	7	3	3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

Host port If an ISA or a PCI interface card is being used, the Micro1401 communicates with its host computer via a 37-way D-plug on the rear panel. Signals are buffered by 74244s, of HCT type if driving out to the host, of LVC type if receiving from the host. The LVC ICs have diode-clamp circuit protection. The HCT ICs are in sockets for easy replacement in the unlikely event of a chip being damaged; see page 48.

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 Micro1401 is specified to meet European and US EMC regulations <u>only</u> if used with braid-screened cables supplied by CED.

Host interface plug
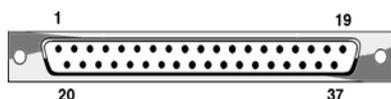
Pin	Function	Pin	Function
1	Host Address A0	11	Host D4
2	Host A1	12	Host D5
3	Host A2	13	Host D6
4	Host A3	14	Host D7
5	Host read/write	15	1401 DA
6	1401 DMA enable	16	Host strobe
7	Host Data D0	17	1401 CTS
8	Host D1	18	1401 interrupt request
9	Host D2	19	Host reset
10	Host D3	29	Cable detect
Screen	Mains earth	20-28, 30-37	GND

USB port The USB port is for use with the USB protocol, and, in the Micro1401 mk II, is part of the motherboard rather than being on a daughterboard. USB2 specification was implemented from serial no. M3000 onward. Data transfer rates are approximately 1 MByte/sec for USB1, and 5 MBytes/sec for USB2.

**USB socket** 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_+5 V is used as a cable sense input, also via a choke; +5 V applied to this pin indicates that the USB cable is inserted. The Micro1401 is specified to meet European and US EMC regulations only if used with braid-screened cables supplied by CED.
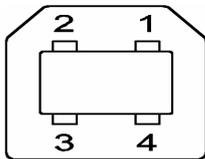
Pin	Function
1	USB_+5V (cable detect)
2	USB_DATA+
3	USB_DATA-
4	USB_GND (to system ground)
Screen	Mains earth

Synchronization port The synchronization port was implemented on Micro1401 mk IIs of serial no. M2000 onwards. It enables two or more 1401s (Power or Micro mk II in any mix) to be synchronized, so that there is absolutely no drift in timing between units.

Synch socket The Synch socket is an RJ21 connector with six pins loaded. A screened cable is daisy-chained from unit to unit, and the "master" end of the cable determines which unit provides the 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 synchronized, the user should consider the CED 3301 external synchronization unit.
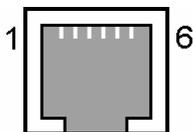
Pin	Function
1	No connection
2	MHZ20_IN-
3	MHZ20_IN+
4	MHZ20_OUT-
5	MHZ20_OUT+
6	No connection
Screen	Mains earth

DC power inlet The rear-panel DC inlet is a 5-pin 180° DIN socket with a locking ring. The DC switch switches the three power rails. All three rails are RF-filtered inside the Micro1401. The digital and analogue ground returns are carried by separate wires all the way to the power brick.

The power brick is a switch-mode device that provides regulated +5 V DC (digital) and ±12 V DC (analogue). The other digital voltages (+3V3 & +2V5) are generated internally from +5 V. The Micro1401 can optionally be built to run off a single external supply that can vary between 9 V and 38 V DC, e.g. a car or truck battery.

Using the power brick, the Micro1401 consumes approximately 2 A at 5 V, and 80 mA at ±12 V. Use only CED-approved power supplies.

DC power socket

Pin	Function
1	Digital ground
2	Analogue ground
3	Digital +5 V
4	Analogue –12 V
5	Analogue +12 V
Screen	Mains earth

The ADC12 top-box: 12 waveform inputs

The four waveform input channels may be expanded by adding the ADC12, an expansion card with twelve extra channels, which become ADC channels 4-15. Once the Micro1401 is told about the extra channels by the installation program, the new ones may be freely used just like the basic set. Attempts to read unimplemented channels either cause the software to report errors, or the ADC is mapped onto an internal ground point, depending on the program.

The ADC inputs are of identical design to the ones on the main unit, with an input range of ±5 V (optionally ±10 V), and a maximum non-destructive input range of ±12 V. All signals pass through common-mode ferrite chokes to reduce radiation of EMI. The expansion card makes internal connections to the Micro1401 motherboard and is housed in the same metal can. This card, designated the 3001-03, requires the Micro1401 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 *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* expansion card provides six event inputs mapped onto bits 2-7 of the digital input high-byte. Additionally, bits 2-7 of the digital output high-byte are brought out onto six front-panel BNCs.

The safe working voltage range of the digital inputs is ±10 V, and they present an impedance of 47 kOhm, as with the front-panel Event and Trigger inputs. They have input hysteresis: the low-going threshold voltage is set at 0·95 V and the high-going threshold at 1·2 V. All signals pass through common-mode ferrite chokes to reduce radiation of EMI. The expansion card makes internal connections to the Micro1401 motherboard and is housed in the same metal can. This card, designated the 3001-09, requires the Micro1401 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 Event Expander: 12 event inputs

The Micro1401 provides two front-panel inputs, Event 0 and Event 1, that are optimized for counting and timing pulses. There is MOSFET circuit protection allowing a safe input range of ±10 V. Signals are then conditioned by comparators and Schmitt triggers, so that sharp, unambiguous event pulses can be derived even from slow signals.

CED 2501-12, the Event Expander, provides event input on twelve BNCs labelled 00 to 0B, which are conditioned similarly to Event 0 and 1. They are processed quite differently, however: the Event Expander operates in conjunction with *Spike2* software. An event on any input generates an 8-bit encoded output that is routed to the Micro1401 rear-panel Digital Input, and recorded on a *Spike2* digital marker channel. Minimum time resolution between two events is about 1 μs; each event code takes about 10 μs to transmit. Inputs can be individually set to respond to positive-going or negative-going signals by means of switches accessible from the rear panel. A yellow LED next to each input will flash to indicate the detection of an event.

Event codes are transmitted to the Micro1401 via an external ribbon-cable from a rear-panel D-plug labelled To 1401 Dig In. There is a second D-plug, Dig In Expansion, allowing for the daisy-chaining of additional Event Expander units. The event BNCs on the second unit are labelled 0C to 17, and so on. Up to thirteen units may be daisy-chained, in which case the highest input would be 9B. The second digital input can also be used to accommodate ordinary digital input signals, so long as they are held tri-state off whenever the Event Expander is in use.

The Event Expander is supplied in a single-height unit uniform with the Micro1401, with its own power supply.

Introduction The Micro1401 requires very little maintenance. This section covers simple operations that may occasionally require opening the case, such as setting the internal options switch or replacing damaged I/O chips. There is also a discussion on updating the flash ROM and re-calibrating the analogue system.
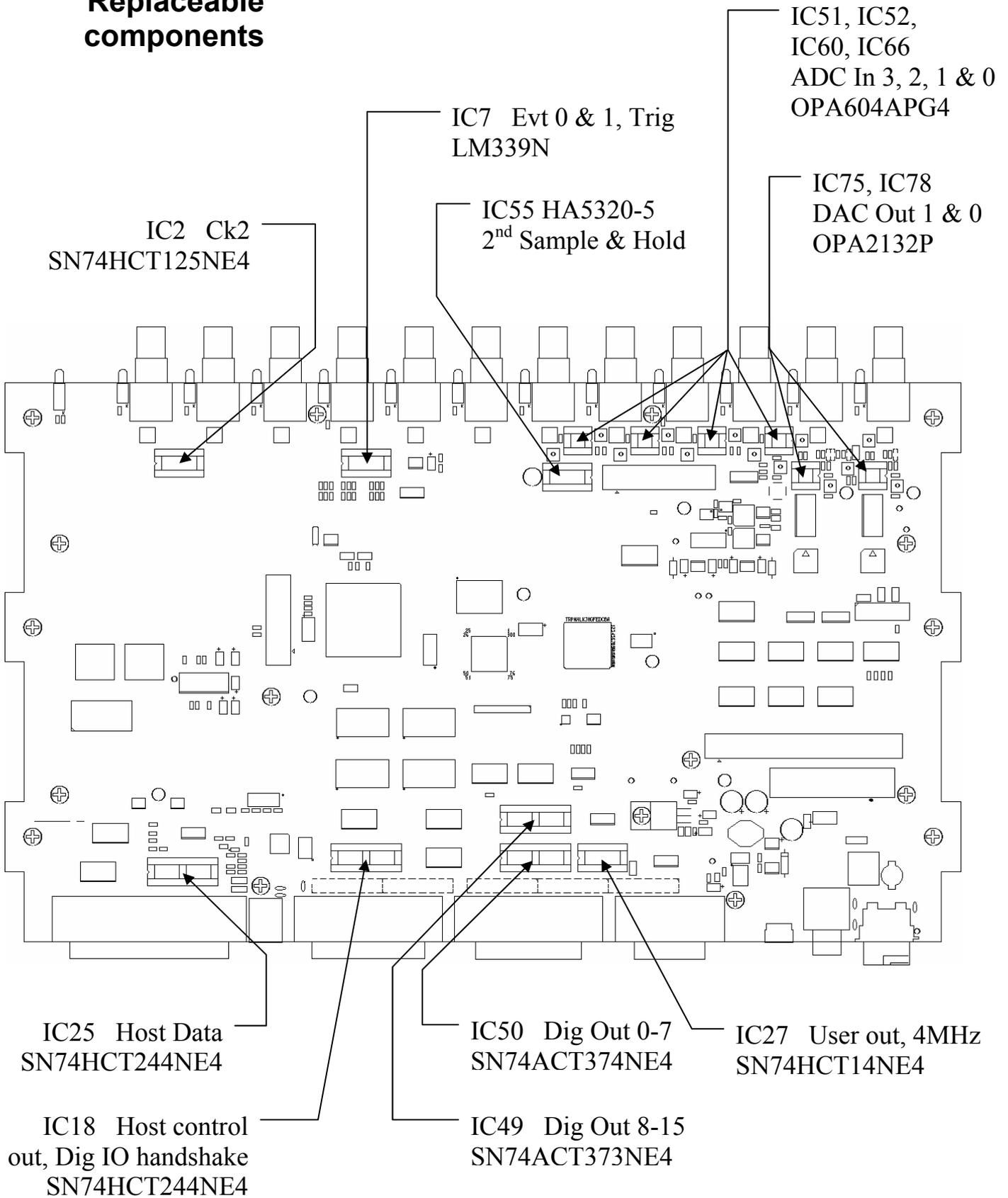
Taking the lid off The Micro1401 top cover is held in place by the back panel. To free the back panel, unscrew the four M3 screws at the corners with a 2 mm hex wrench. Swing the back panel away. There is no need to detach the green & yellow earth wire. Slide out the top cover. Be careful not to splay 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 unplug the green & yellow earth wire that plugs in a short distance along the side. Remove the lid by unscrewing the six small 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 Micro1401. Logically, On counts as 0, Off as 1. Most options concern self-test and debug. Normally, all switches must be On, physically towards the front of the PCB, as shown.

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

     1  [ ][ ][ ][ ][ ][ ][ ][ ]  8     On = 0
                                        Off
       SW1  O P T I O N S
```
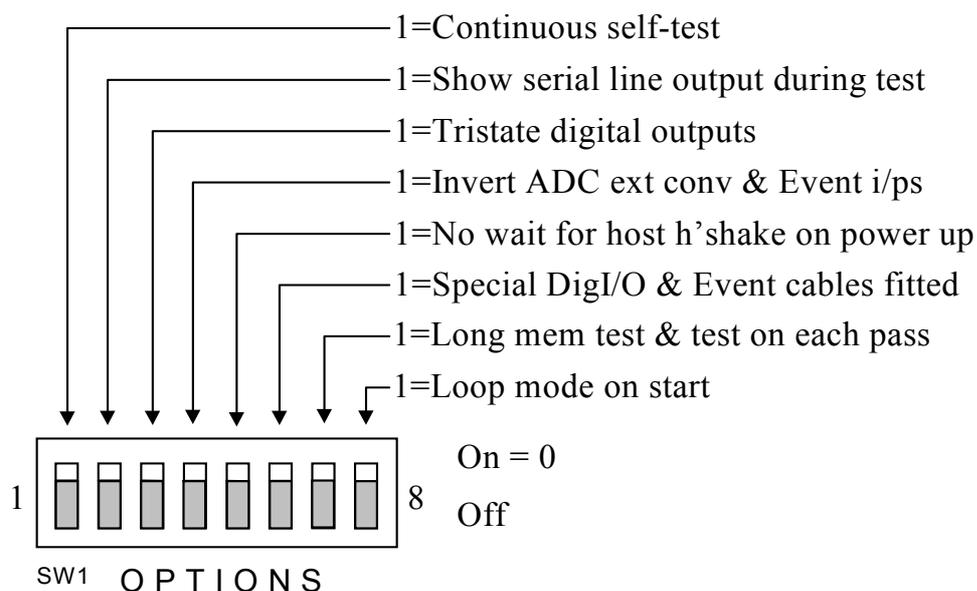
Replaceable components

IC51, IC52,
IC60, IC66
ADC In 3, 2, 1 & 0
OPA604APG4

IC7   Evt 0 & 1, Trig
LM339N

IC75, IC78
DAC Out 1 & 0
OPA2132P

IC55 HA5320-5
2nd Sample & Hold

IC2   Ck2
SN74HCT125NE4

IC25   Host Data
SN74HCT244NE4

IC50   Dig Out 0-7
SN74ACT374NE4

IC27   User out, 4MHz
SN74HCT14NE4

IC18   Host control
out, Dig IO handshake
SN74HCT244NE4

IC49   Dig Out 8-15
SN74ACT373NE4

**Adjustable
components &
other features**

Chan gain pots
(if fitted)
(3 left, 0 right)

DAC offset pots
(1 left, 0 right)

DAC gain pots
(1 left, 0 right)

UARTs 1 (left) &
2 (right)

Chan offset pots
(3 left, 0 right)

ICE debug

2nd S&H pot
(if fitted)

Patch
adjust
(if fitted)

Options switch
Position 1 at left

Analogue expansion
header

Digital expansion
header

Earth tag

Digital I/O
breakout headers

ADC offset (left) ADC gain (right)

Flash ROM and the Micro1401 Firmware

The Micro1401 stores its firmware in non-volatile flash ROM, which is organized into 16 blocks. The primary boot loader is stored in block 0, the power-on self-test (POST) in block 1, the monitor (the operating system) in block 2 and the FPGA configuration image in block 3. The primary boot loader loads this firmware on power-up, so long as the rear-panel Mode switch is in position 2. Alternative POST, monitor and FPGA firmware can be stored in blocks 4-6, and loaded by setting Mode to position 5.

Memory block update report
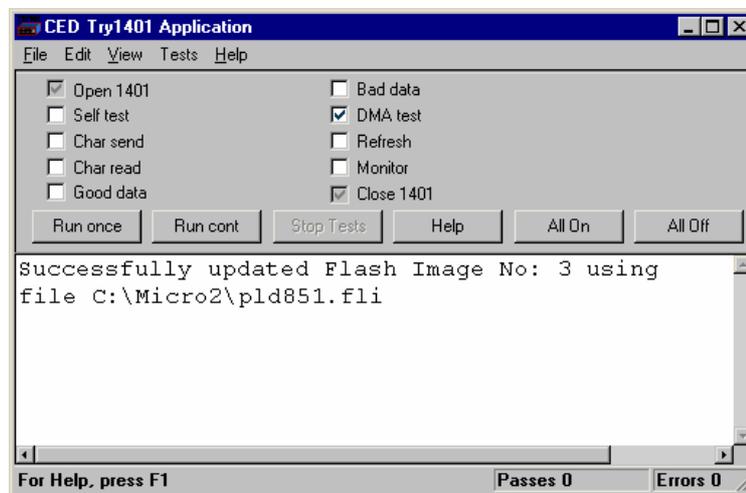
You can upgrade the firmware by writing new files into flash ROM with the TRY1401 utility. You will need valid flash image files with .fli extensions, typically downloaded from CED's website, www.ced.co.uk. Further information comes with the download; it is important to read this before upgrading.

Open TRY1401 (see page 28); from the *File* menu select *Update Flash*. The new firmware does not overwrite the old, so the original set is still there in case of disaster, e.g. power failure during the few seconds taken to write the file. The contents of the flash ROM can be viewed in TRY1401, via *File, 1401 info…*

Upgrading firmware with TRY1401

To use the new firmware, set Mode to 5 and switch the DC power off and on again.

Analogue calibration

ADC & DAC Test, a calibration utility built into the *Tests* menu of TRY1401, is used to calibrate the ADC inputs. This involves opening the Micro1401, since the main trimming controls are manually-adjusted potentiometers (see page 47 on taking the lid off.) Before we ship your unit, we run this program and set the waveform system to an accuracy of approximately 0·5 mV, or three least significant bits (LSBs). On a ±5 V range, one 16-bit LSB corresponds to only 150 µV, 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 Micro1401 ADC 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 1·4 mm 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 µV on the ±5 V range. It is most important that you allow the Micro1401 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 Micro1401 to CED for calibration. See page 55 for advice on sending it back.

Running ADC & DAC Test

ADC & DAC Test is an option inside the Tests menu of TRY1401. To run TRY1401, select

Start, *Programs*, *Test 1401*, *Try1401*.

ADC & DAC Test is a sequence of dialogue boxes. Each box lists the equipment required and the instructions for that stage of the calibration. Where cables have to be connected between BNCs, or potentiometers adjusted, this is indicated schematically. The aim of the task is to calibrate the DACs against the DVM, then calibrate the ADC against DAC0.

Electrostatic precautions

When working inside the Micro1401 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.

Overview The Micro1401 has comprehensive built-in self-test capabilities which are backed up by a range of test and diagnostic programs to pin-point problems quickly. If you suspect that you have a hardware fault, you should follow the procedures below to obtain as much information as you can about the problem, then call the CED Hardware Help Desk for advice. Components in the Micro1401 that are connected to the outside world are socketed for easy replacement whenever possible, see the diagram on page 48. In many instances this bypasses the need to return the Micro1401 to CED.

Stand-alone test The simplest test of a Micro1401, which eliminates the possibility of a host computer or cable fault confusing the situation, is to disconnect the 1401 from the host at the 1401 end of the cable, remove all signal connections and then power-up the 1401. If all is well, the green Power indicator should light and stay on. The red Test indicator should flash for a few seconds, then turn off. The yellow BNC LEDs will also flash. If the Micro1401 behaves like this it is likely that the fault lies in the interface cable, the 1401 interface card in the host (if present), the host computer hardware or the host computer software.

If the Test indicator remains flashing, the internal power-up self-test has detected a problem. It is likely that one of the test programs will be able to diagnose the trouble. See 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 TRY1401 (see page 28.) You will need to connect your Micro1401 to the host computer before running the test. This program forces the Micro1401 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 in the host PC. This is far more likely with ISA hardware, which is not Plug and Play. 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 Micro1401 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 Windows system diagnostics:

Windows 95, Windows 98, Windows Me 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, Windows XP Select *Start*, *Settings*, *Control Panel*, *System*. Select the *Hardware* tab and press the *Device Manager* button. Expand the *1401* node and double-click *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.

ISA hardware settings If you have resolved a hardware clash by reassigning the resources of an ISA device, remember to set the hardware to match! (See section starting on page 23.)

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

Vector	Other users of this vector
2	May conflict with VGA frame interrupt on AT or above. VGA interrupt can usually be disabled without any performance penalty; see your VGA controller manual.
3	Serial port 2 (COM2). Will only conflict if you are using serial line software which uses interrupts on COM2.
4	Serial port 1 (COM1). Will only conflict if you are using serial line software which uses interrupts on COM1.
5	Parallel port 2 (LPT2) and some mouses. 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 Micro1401 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 1MByte (zipped). To save yourself time, and improve the efficiency of the process:

- Please make a note of the serial number of your Micro1401, printed on the back.

- If the problem is with a program, please make a note of the version number, announced on entry, or in *Help*, *About*.

- Make a note of your computer's CPU type and speed, and how much memory you have, (e.g. Intel® Pentium® 4, 3·0 GHz, 1 GByte).

- It is often useful for users to have run TRY1401, so that we know about the hardware state.

Sending it back If you need to send the Micro1401 back to CED:

- You must first get a return authorization from CED.

- We advise you to dispatch the machine to us CIF. CED is not responsible for the safety of the equipment until it is inside our premises.

- If you are dispatching from outside the EU, it is essential to call us for advice on the documentation necessary to get your machine through Customs. If you do not provide the correct documentation, it may be subject to additional taxes or duties, be turned back, or even impounded.

- Include a paper description of the problem with the equipment.

- Make sure the packaging is adequate to avoid damage in transit.

Index

User notes

Specification

Waveform inputs	Input impedance	1	MegOhm
	Active working voltage range	±5	Volts
		(±10	Volts with 10V option)
	Safe voltage range	±15	Volts
	Maximum conversion rate	500	kiloHertz
	Resolution	16	bits
	Crosstalk & noise	±3	LSBs up to 200kHz/chan
Waveform outputs	Active working voltage range	±5	Volts
		(±10	Volts with 10V option)
	Safe drive capability	600	Ohms
	Full accuracy drive	5	kilOhms
	Resolution	12	bits
Clocks	Accuracy & drift, 0-70°C	50	parts per million
Front-panel digital inputs	Input impedance	47	kilOhms to +5V
	Safe voltage range	±10	Volts
	Shortest pulse-width	1	microsecond
	Low voltage	0·8	Volts
	Low current	100	microAmps
Rear-panel digital and event inputs	Input impedance	10	kilOhms to +5V
	Safe voltage range	±10	Volts
	Shortest pulse-width	100	nanoseconds
	Low voltage	0·8	Volts
	Low current	500	microAmps
Digital outputs	Drive capability	±20	milliAmps
Mains Supply	Voltage range	100 to 250	Volts
	Frequency range	50 to 60	Hertz
	Current	0.7	Amps
Case size & weight	Micro1401	44 × 217 × 366	millimetres
		2·9	kilograms
	Power brick	42 × 78 × 128	millimetres
		0·45	kilograms
Environment	Temperature range	−5 to +50	°Celsius
	Maximum humidity	95%	Non-condensing

CE

EC Declaration of Conformity

This is to certify that the:

CED Micro1401 mk II

Manufactured by:

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

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

Conducted and radiated emissions:

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

EN50082-1:1991 Immunity standards:

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

Signature   Peter Rice
                   Technical Director

Date   07 September 2001