The CED Power1401 mk II Owners Handbook

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Table of contents

Typographic conventions

The following conventions apply to the text in this manual:

- Ordinary text is in Times New Roman.
- Titles of chapters, other manuals and other publications, including CDs, 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 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 51.

Observe precautions against electrostatic discharge.

The CED Power1401 mk II is lead-free and conforms to the EU RoHS directive.

The CED Power1401 mk II is subject to the EU WEEE regulations and may be returned to CED Ltd for recycling.

Attention, consult accompanying documents.

The DC symbol indicates that the Power1401 mk II 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 mk II generates and uses radio frequency energy and may cause interference to radio and television reception. Your Power1401 mk II 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 mk II does cause interference to radio or television reception, which can be determined by turning the Power1401 mk II 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 mk II with respect to the receiver
- Move the Power1401 mk II away from the receiver
- Plug the Power1401 mk II into a different outlet so that the Power1401 mk II 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

Step 1 Install the software first: either your CED application or the CED 1401 installation CD

Step 2 Set up your hardware, either for USB or the High-speed Serial Link (HSL):

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

- Power-up the computer and the Power1401
- Connect the USB cable
- USB hardware is recognized and correct driver located automatically

For details, see page 7

HSL For Windows NT 2000, Windows XP, and Vista

- Plug the PCI interface into the host computer and power-up the computer
- PCI card is recognized and correct driver located automatically
- Connect the High-speed Serial Link cable and switch on the Power1401

For details, see page 10

Step 3 Check the installation

- Run *Test1401, Try1401*: set tests *All On*, select *Run Once*
- Test should take ~15 seconds and give no errors

Step 4 Your Power1401 is now ready for use

Introduction

This manual will guide you through the initial check and installation of your Power1401 mk II (hereafter referred to as the Power1401 except where it differs from the previous model). 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.

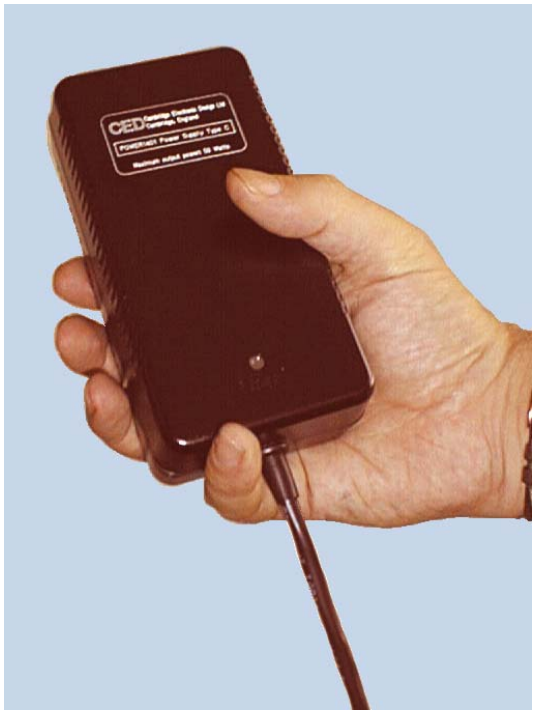
Checklist

The installation kit for your Power1401 comprises:

- A Power1401, with optional rack-mount kit
- A power brick with attached DC supply cable
- A power-brick mains cable suitable for your country
- A PCI interface card (if you have chosen the High-speed Serial Link option)
- A data cable, either USB or High-speed Serial Link
- An installation disk
- This owners manual

The power brick

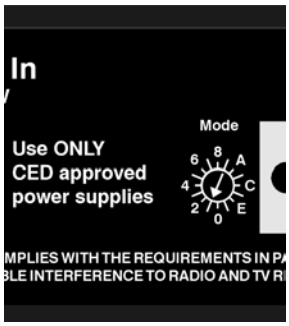
The power brick will run with no adjustment on any mains voltage from 100 V to 240 V, 47 Hz - 63 Hz, drawing a maximum of 1·6 Amps. It has no switch, being controlled by plugging in and switching on at the mains socket.



The front-panel push-switch actuates a relay inside the Power1401 that switches DC power to the rest of the circuitry. 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.



Ensure that the front-panel DC switch, marked Power/Test, is off (with the button protruding from the panel). Insert the power-brick output plug into the DC Power In socket. Check that the Mode selector is in position 1. Do not connect the data cable. Switch the Power1401 on. The switch button should light red for a few seconds while the yellow LEDs flicker. The button should then turn green and glow steadily. If this is not the case, turn to *Trouble shooting* on page 43.

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, starting on page 6. The remainder of this section deals with general topics. The section starting on page 16 describes the signal inputs and outputs. Following sections deal with expansion options, maintenance and troubleshooting.

Storage and operating environment

Storage and operating environment for a Power1401 must not exceed the temperature range −5° to +50° Celsius. Humidity should not exceed 95% saturation and must not be condensing. 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.

Position

When choosing a permanent position for your Power1401, note that it prefers the same sort of environment as suits the host computer. The Power1401 normally stands on its base, but it will work on its side or upside down, if required.

The fan

To deal with the heat generated by the microprocessor, the Power1401 mk II is equipped with a small fan. This runs continuously, venting to the rear. Be careful not to obstruct this. There should be a clear space at least 150 mm behind the case.

If the fan should fail or be obstructed, a temperature sensor inside the Power1401 will shut off power to the microprocessor. The LED in the power switch will turn off, while the eight ADC input LEDs and the two DAC output LEDs will all turn on. Remove the obstruction and switch the Power1401 off and on again to restore normal operation.

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* library (downloadable from the CED Web site: `www.ced.co.uk`, free of charge) and your own computer programming manuals.

Operating platforms

We support the 1401 family (including the Power1401 mk II) under Windows 98SE, Windows Me, Windows NT 2000, Windows XP, and Vista.

Installing CED application software

CED application software such as Spike2 or Signal is installed from a CD. 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 `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 Power1401's processor. Use of this kit is not recommended for any other than very experienced embedded software developers.

Circuit diagrams

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

Overview

This section provides an overview on installing a Power1401 mk II in a Windows PC.

To install the Power1401 you will need:

- A Power1401, power brick and mains cable
- A USB cable (for USB installations)
- Optionally, a 1401 PCI interface card and serial cable (for High-speed Serial Link installations)
- The CED software application disk

Organisation of sections

The sections that follow deal with installing:

- The PC USB interface
- The PC PCI interface for the High-speed Serial Link

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 two groups:

- Windows XP, which also applies to Windows NT 2000 and Vista
- Windows 98SE and Windows Me

The groups are covered in that order in the USB section; PCI installations can only be run on operating systems of the XP group.

Drivers

The device driver (the systems file used by application software to communicate with the Power1401) is installed along with the application software.

Test and diagnostic utilities

A suite of test and diagnostic programs is available on the *CED 1401 installation software* 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.

The USB driver

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

Install the Power1401 drivers by installing any CED application software (such as Spike2 or Signal), or else by running the standard *CED 1401 installation software* disk.

Hardware installation

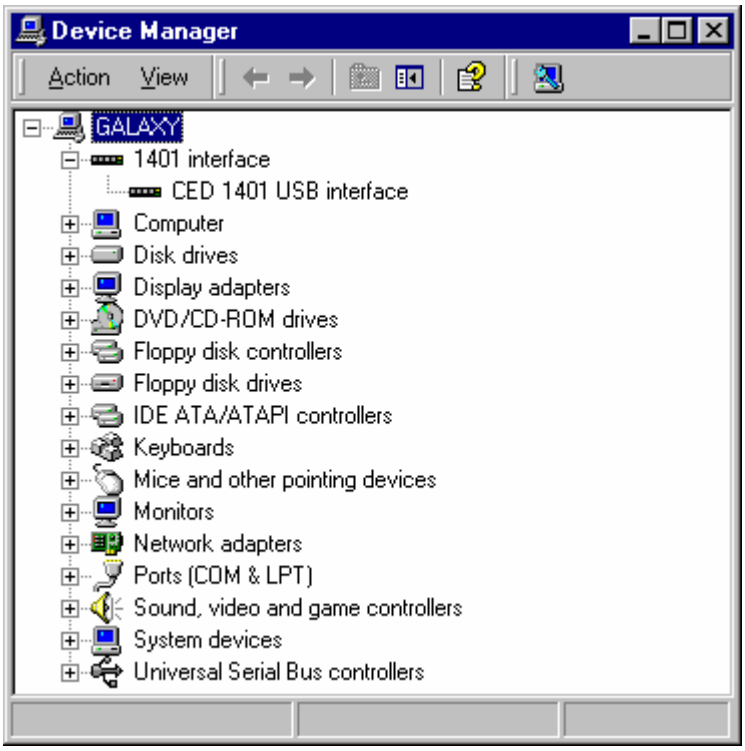
A Power1401 using the USB interface requires a computer with a USB connector, but does not need an interface card. All you have to do is connect the USB cable between the computer and the Power1401.

USB hardware is designed for "hot plugging": with the software installed, and both computer and Power1401 switched on, the USB cable is inserted. This causes the computer to recognize the presence of a new USB device and look for its device driver.

Windows NT 2000, Windows XP, Vista

The Power1401 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 already been installed, it will report that it has found the CED 1401 USB software, and disappear.

Device Manager, view devices by type



USB interface settings

With the driver installed, the Power1401 becomes a recognized USB device, and the *CED 1401* icon will appear in the Device Manager whenever the 1401 is plugged in and powered up. You can view the 1401 USB settings by selecting

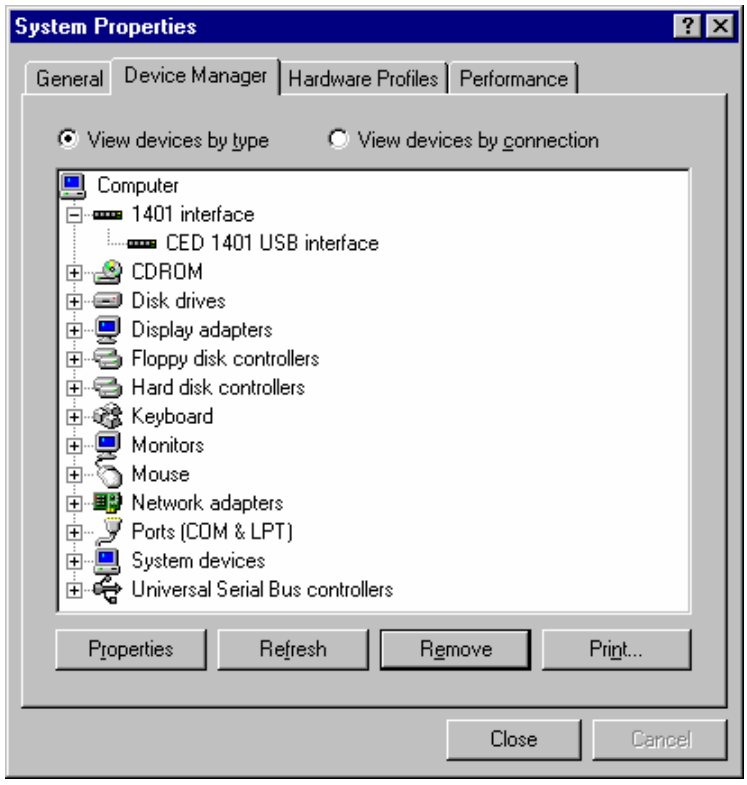
Start, *Control Panel*, *System*.

Open *System* by double-clicking, 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. Among the tabs revealed when this is opened, the *General* tab provides overall device status, and allows for enabling/disabling the device. The *Settings* tab allows you to set the 1401 device number if you have a multi-1401 installation.

Windows 98 SE, Windows Me

The Power1401 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 already been installed, it will report that it has found the CED 1401 USB software, and disappear.

System Properties, Device Manager tab



USB interface settings

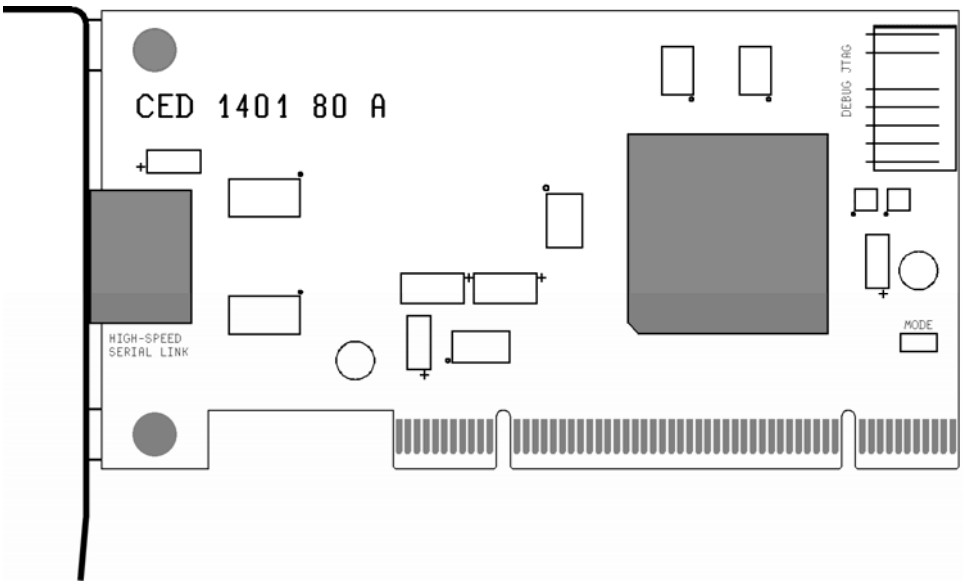
With the driver installed, the Power1401 becomes a recognized USB device, and the *CED 1401* icon will appear in the Device Manager whenever the 1401 is plugged in and powered up. You can view the 1401 USB settings by selecting

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

Open *System* by double-clicking and select the *Device Manager* tab. 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. Among the tabs revealed when this is opened, *General* provides overall device status, and allows for enabling/disabling the device. The *Settings* tab allows you to set the 1401 device number if you have a multi-1401 installation.

The High-speed Serial Link interface card

The CED 1401-80 card provides the interface between a PCI bus and a Power1401 mk II, via the High-speed Serial Link (see page 28). This is a low-profile card to the MD1 specification (120 mm × 64·4 mm), allowing it to fit either in the standard-height or the low-profile PCI chassis, using alternative card brackets. This card has no hardware switch options; its base address and interrupt are set up automatically by the device driver software.

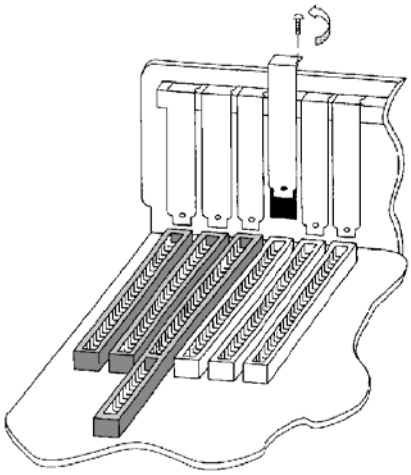


The CED 1401-80 PCI interface card (with low-profile bracket)

PCI card insertion

Remove power from your computer: actually unplug the mains cable. There may be standby voltages present on PCI bus slots even when the PC is switched off, and it is important that the machine is completely powered-down. Clear a space round it; you will be opening it to install the card. Consult the computer manual on fitting option-cards. Usually you need to undo some screws and slide the cover off, to expose the PCI expansion slots. 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 High-speed Serial Link PCI interface (CED 1401-80). Older CED 1401 interface cards cannot be used. See page 10 for technical details of this card.



1. Locate an unused slot. PCI slots are always white.
2. Remove the blanking plate for your slot by undoing the securing screw. Keep it 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 computer cover.
4. Now connect the High-speed Serial Link cable between the port at the rear of the interface card and the High speed Serial connector at the rear of the Power1401. This cable is reversible end for end.
5. Plug the DC power cable into the rear of the Power1401.
6. Hardware installation is now complete.

The PCI driver

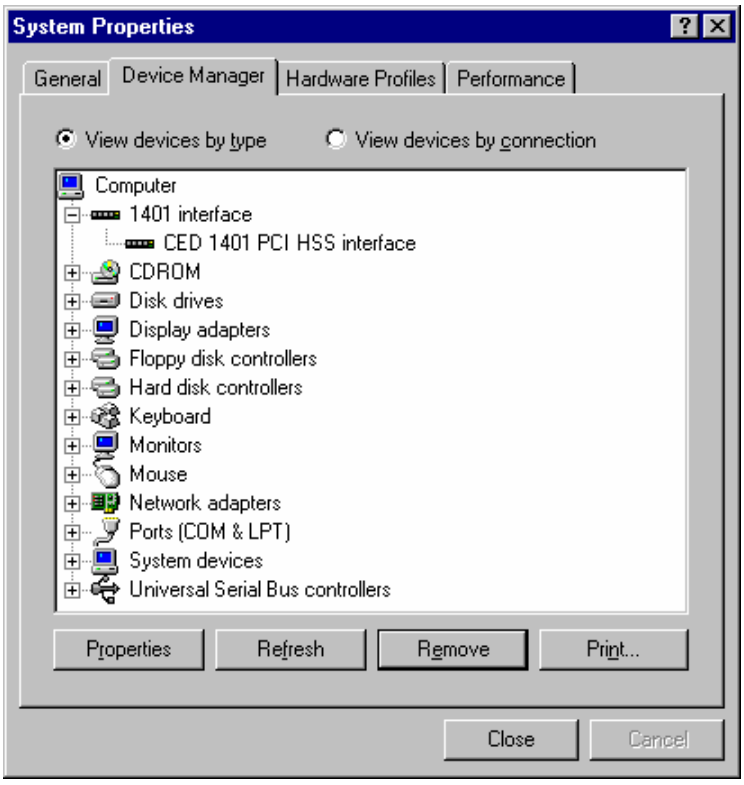
The High-speed Serial Link connects to the host computer via an interface card that is a PCI device. We describe PCI driver installation under Windows NT 2000, Windows XP and Vista only; it is not supported under Windows 98 or Windows Me.

Install the Power1401 drivers by installing any CED application software (such as Spike2 or Signal), or else by running the standard *CED 1401 installation software* disk.

Windows NT 2000, Windows XP, Vista

After a 1401 PCI interface card has been fitted, Windows 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.

Device Manager, view devices by type



PCI interface settings

With the driver installed, the Power1401 becomes a recognized PCI device, and the *CED 1401* icon will appear in the Device Manager. You can view the 1401 PCI interface settings by selecting

Start, Control panel, System.

Open *System* by double-clicking, 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 HSS interface" icon. Among the tabs revealed when this is opened, the *General* tab provides overall device status, and allows for enabling/disabling the device. The *Settings* tab allows you to set the 1401 device number if you have a multi-1401 installation.

Installing test & diagnostics

The Power1401 mk II 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 CD.

To install under any supported operating system:

- Insert the CD.
- The installation program should run automatically.
- If it does not, select *Start*, *Run*, *Browse…* , open the CD and choose the file `setup.exe`.
- Click on *OK* and follow the screen instructions.

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.

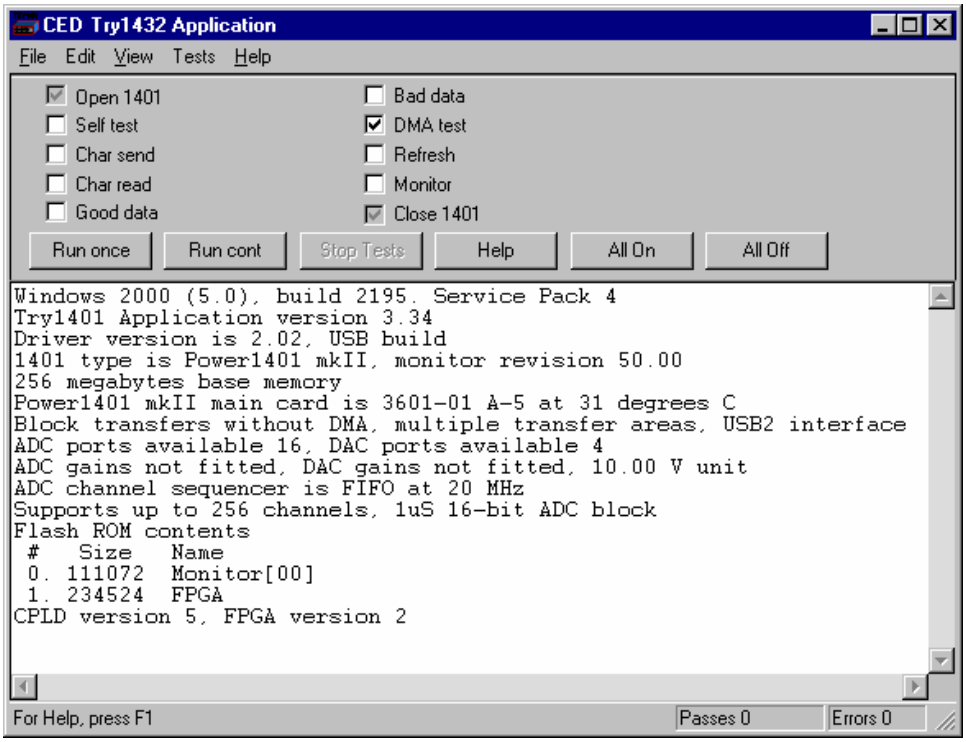
Windows diagnostics

The Windows installation includes the utility TRY1401, that verifies that your Power1401 has been installed correctly, and runs diagnostic procedures.

TRY1401

TRY1401 is the principal test program for users. 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.

TRY1401 program screen



TRY1401 is currently installed as the application `TRY1432.exe`. To run TRY1401, select

Start, *Programs*, *1401 support*, *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 Power/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 TRY1401 screen on the previous page, select

File, 1401 info…

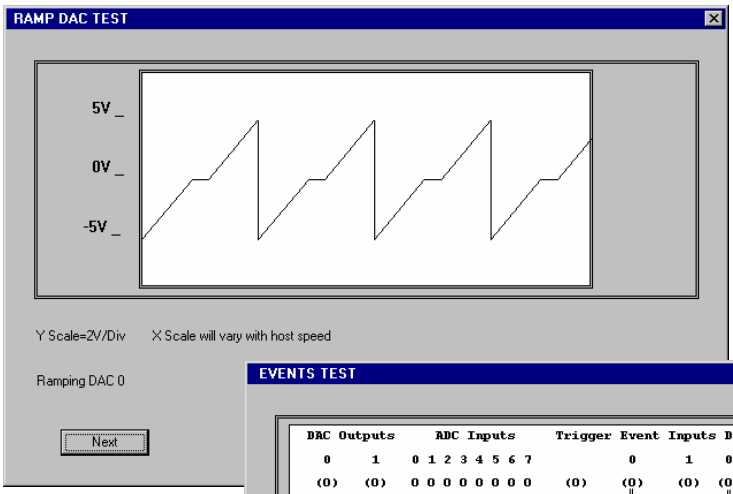
from inside TRY1401.

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

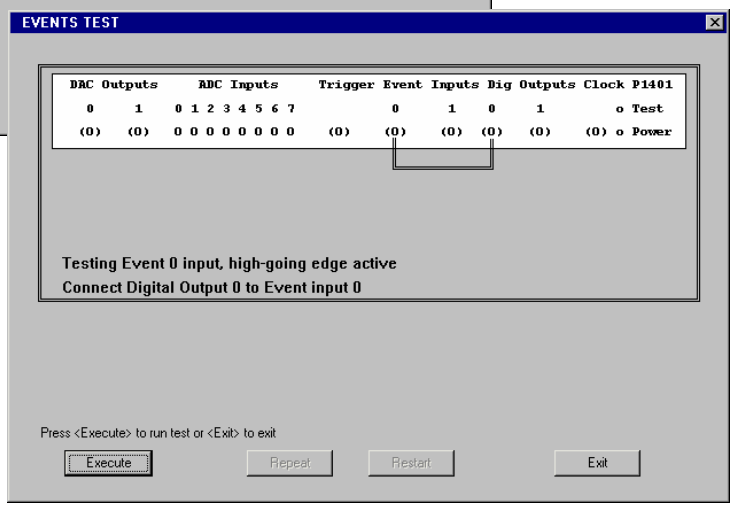
Tests, ADC & DAC Test or *Tests, Event & Clock Test*

from inside TRY1401. 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 potentiometers. See page 36 for how to take the lid off, and page 38 for the location of adjustable components. Analogue calibration is discussed more fully on page 42.

ADC & DAC Test, Ramp DAC test



Event & Clock Test, Events test ➢



General

The following points deal with physical and electrical aspects of 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 printed circuit board. Items of equipment connected to the Power1401 must not be treated as isolated from mains earth, nor from each other.

Front panel LEDs

All front-panel BNCs have adjacent yellow LEDs. These 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 light when their bit is set. LEDs may light to prompt users to make connections. LEDs flash in a characteristic manner on self test; see page 3. If all ADC and DAC LEDs turn on at once, and the Power/Test pushbutton LED turns off, the machine is overheating. Power/Test lights red to indicate self-test, and flashes red if a hardware error has been detected. Normally it glows green, indicating that none of the digital voltage rails has drifted outside limits.

Socketed chips

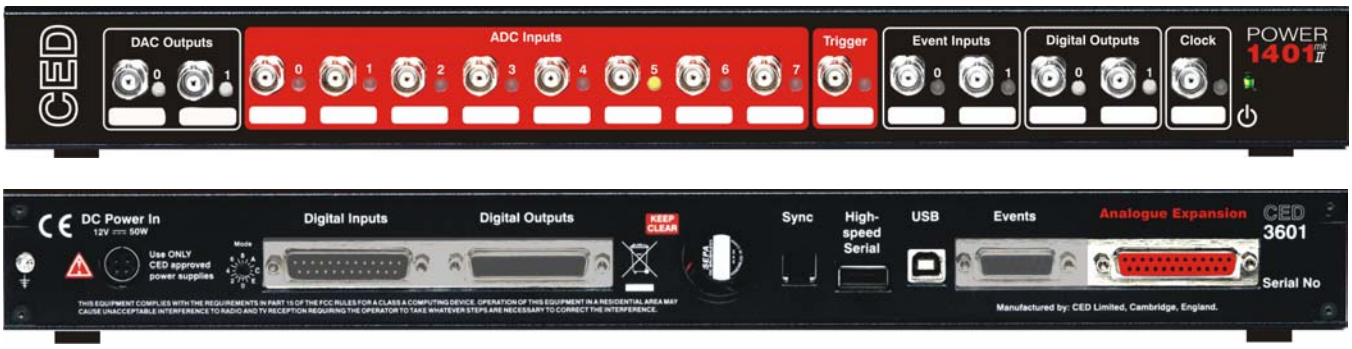
ICs connected directly to the outside world are susceptible to damage from electrostatic discharge or signal overload, though in practice this seems to happen only rarely. In the case of the ADC inputs and DAC outputs the ICs are in sockets, to allow their replacement without unsoldering. All such chips are readily-available types; if ordering, specify the exact part-code as on page 37 to ensure insertion-mount, lead-free parts. See page 36 for opening the Power1401 and page 37 for the location and identification of socketed chips.

MOSFET protection

Digital and event input signals pass through 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 overvoltages 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 amplifier gains are individually software-settable to unity, ×2, ×5 or ×10. Channels are then steered into the ADC (Analogue to Digital Converter) via multiplexers. The input sample-and-hold is part of the ADC chip. The ADC can convert an input signal to a 16-bit digital value at up to 2 MHz in single-channel mode, 1 MHz if switching channels. 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 34.

Waveform channels

There are sixteen 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 working input range of the ADC (and the DAC outputs) is ±5 V or ±10 V, as selected by setup software; the choice is retained in non-volatile EEPROM and survives power cycling. See page 40 for setting the ADC input range.

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. When operating in internally-triggered mode the ADC typically samples at a fixed rate set by one of the clocks.

External convert

The ADC external convert input is also permanently wired through pin 6 of the rear panel Events D-socket. Conversions are usually initiated by a high-to-low transition. External convert signals are used when the conversion time is determined by an external event, e.g. when synchronising conversions to the phases of a rotating machine.

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.

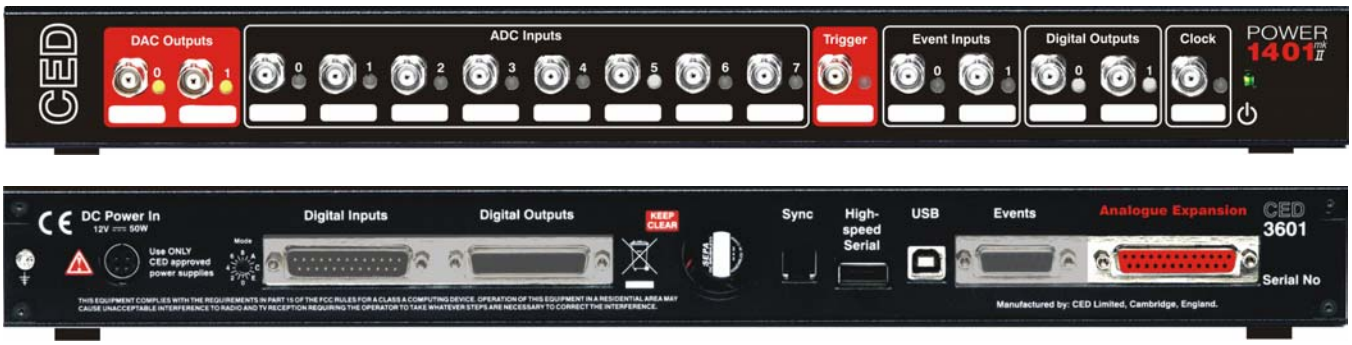
Trigger LED The trigger-input LED flashes or blinks on detection of an active-edge transition at the Trigger input. The LED can be set by software to be either on or off during the quiescent state.

Technical details: Analogue input The input impedance of the waveform channels is 1 MOhm. The waveform inputs expect to be driven from a low-impedance source (100 Ohms or less); the output of most amplifiers is suitable. The maximum non-destructive input voltage range is ±15 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 37.

Front-panel Trigger input The front-panel Trigger input has a normal working voltage range of 0 to +5 V. There is MOSFET circuit protection allowing a safe input range of ±10 V. This input is held internally to +5 V by a 100 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 50 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 range of 0 to +5 V. There is MOSFET circuit protection allowing a safe input range of ±10 V. This input is held internally at +5 V via a 10 kOhm resistor. Input pulses should not be narrower than 1 µs 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 switch; see page 36.

The ADC The ADC input voltage is resolved into 65536 levels (sixteen-bit precision); each step is approximately 150 µV with an input range of ±5 V or 300 µV with an input range of ±10 V.



Waveform output

There are four 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 generate voltages in the range ±5 V, in steps of approximately 150 µV, or ±10 V in 300 µV steps, as selected by software. The same range is applied to all four DACs (and also the ADC inputs). The choice is retained in non-volatile EEPROM and survives power cycling. See page 40 for setting the DAC output range.

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 23, or the front panel Trigger input, so as to synchronize the update rate with 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 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.

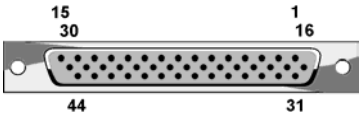
Technical details

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. The output amplifiers are fitted in sockets for easy replacement; see page 36.

The rear-panel analogue connector

The rear-panel analogue connector is a 44-way high-density D-socket. On an unexpanded Power1401 it accommodates ADC input channels 8 - 15 and DAC channels 2 and 3. (For rear-panel channel numbering on expanded units, see note below.) These ten signals occupy the bottom row of the D-socket, and each is provided with its own return to ground on the top row. This is convenient when wiring up the mating plug with twisted pairs or coaxial cables. The middle row is entirely unconnected.

Rear-panel analogue socket



Pin	Function	Pin	Function
1, 2	No connection	31, 32	No connection
3	ADC 8 return	33	ADC input 8
4	ADC 9 return	34	ADC input 9
5	ADC 10 return	35	ADC input 10
6	ADC 11 return	36	ADC input 11
7	ADC 12 return	37	ADC input 12
8	ADC 13 return	38	ADC input 13
9	ADC 14 return	39	ADC input 14
10	ADC 15 return	40	ADC input 15
11, 12	No connection	41, 42	No connection
13	DAC 2 return	43	DAC output 2
14	DAC 3 return	44	DAC output 3
15	No connection		
16 - 30	No connection	Shell	Mains earth to cable screen

The mating D-plug, with solder-bucket terminations, is ITW McMurdo part-number HDB44PTD. A suitable shroud is also required.

Rear-panel channel numbering

The rear-panel ADC inputs are defined always to be the last eight channels available. This means that, if for instance a sixteen-channel ADC expansion top-box is fitted (see page 30), the rear-panel inputs become ADC channels 24 - 31. If a Spike2 top-box is fitted, with eight channels of ADC input (see page 33), 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 32), 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 10 MHz 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 27.

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 23). When you need to synchronize two 1401 machines, use the synchronization port (see page 29).

LEDs

The trigger and event-input LEDs flash on detection of an active-edge transition. They 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 +5 V. There is MOSFET circuit protection allowing a safe input range of ±10 V. These inputs are held internally to +5 V by 100 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 50 μA. Pulses driving these front panel inputs must be 1 μs or longer.

Clock is an output, driven by an SN74HCT244 lead-free, surface-mount bus driver element which can source or sink 24 mA. Note that, since this is an output device, it cannot have MOSFET protection. If it is damaged, its replacement will involve unsoldering and resoldering.

Event inputs

More clock-related inputs, the Clock E series, are provided on the rear-panel Events D-socket. These allow close control of the clocks for 1401 programmers. Full details are given in the *1401 family programming manual*, and the *Power1401 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

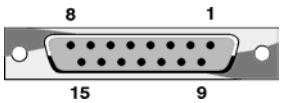
Clock E and Clock F inputs respond to TTL or switch closure signals, and are held internally to +5 V by 10 kOhm resistors. To pull these inputs low, a driving device must sink at least 500 µA; to guarantee recognition, input pulses must fall below 0·8 V. Clock E pulses should not be narrower than 100 ns. Clock F frequency must not exceed 10 MHz; pulses should be 50 ns or wider. The working range of these inputs is 0 to +5 V; MOSFET circuit protection allows a safe input range of ±10 V.

The sense of the Clock E and ADC external convert inputs may be inverted by a switch option, see page 36, but the inputs would all then be held active high if no input is connected.

Event Out

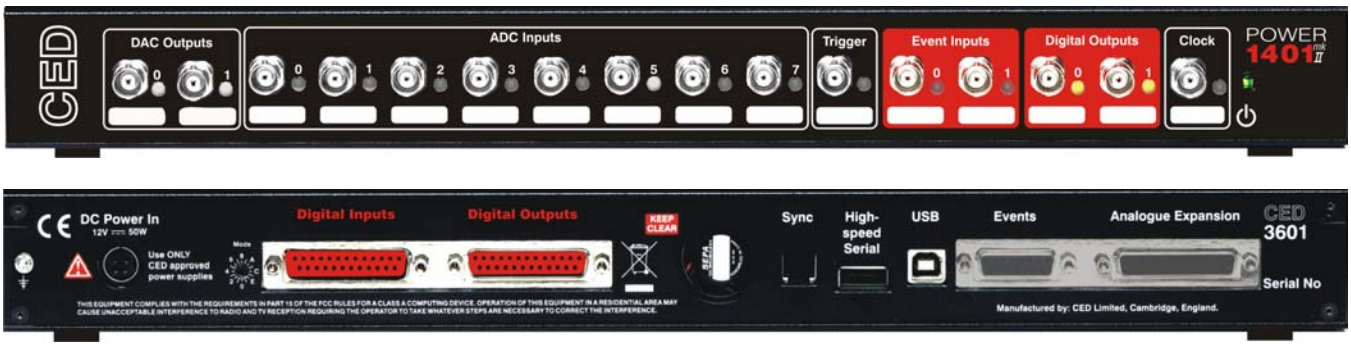
The Event Out output is buffered by an NC7SZ04 single-gate, lead-free, surface-mount inverter that can drive 10 LS TTL loads. Note that, since this is an output device, it cannot have MOSFET protection. If it is damaged, its replacement will involve resoldering. Event Out is normally isolated from the rear-panel socket and a motherboard jumper must be inserted to make it available (see page 38). This is to help reduce EMI.

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	Event Out output
9 - 15	Ground	Shell	Mains earth to cable screen

The mating D-plug, with solder-bucket terminations, is ITW McMurdo part-number DA15P. A shroud is also required.



Digital input and output

The Power1401 has full, sixteen-bit digital I/O available on the rear-panel D-connectors 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-in 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. Either or both bytes can also be turned tristate-off by grounding pin 11 of the output socket, if this has been enabled by software; those bytes are re-enabled when 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 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).

The 1-Wire port

The Power1401 mk II is provided with a 1-Wire port on pin 22 of the input connector, which was previously unused. This allows bidirectional communication down a single wire (plus ground) to one or more devices, which are also powered from the same wire. Devices currently available include temperature and humidity sensors, as well as “silicon serial numbers”.

The 1-Wire port is not currently (August 2007) supported in software.

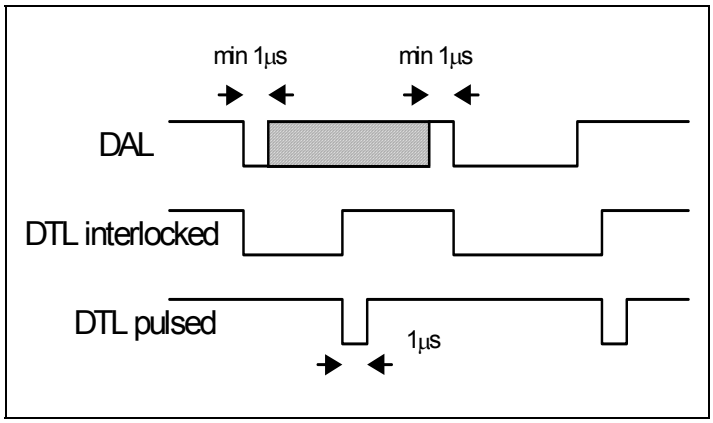
Technical details

All digital inputs have MOSFET circuit protection. All outputs are buffered through SN74ACT373 or SN74ACT374 lead-free, surface-mount devices, which can source or sink 24 mA. Note that, since these are output devices, they cannot have MOSFET protection. If any are damaged, their replacement will involve unsoldering and resoldering.

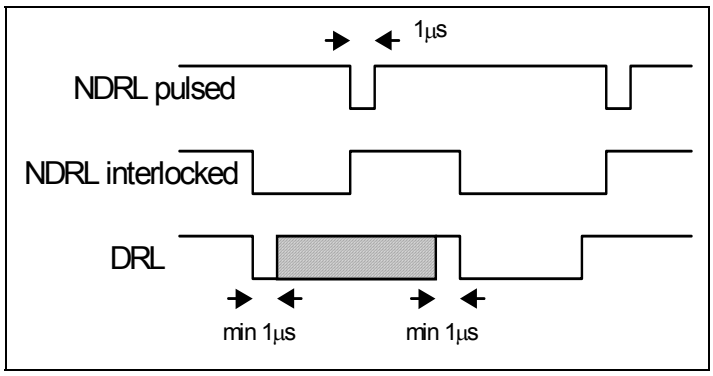
Unconnected digital inputs read 1, being pulled internally to +5 V by 4·7 kOhms (at the rear panel) or 100 kOhms (at the front panel). Input voltages of more than 2·0 V will always read as a logic 1. To appear as a logic 0, the input must be pulled down below 0·8 V for at least 1 μs, requiring approximately 50 μA, at the front panel; or 100 ns, requiring approximately 1 mA, at the rear panel.

Digital I/O handshake protocol

Digital data transfer between the Power1401 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 set independently 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 input (data available, 0 - 7). When the Power1401 reads the data the DTL output line (data transmitted, 0 - 7) pulses for 1 µs 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 output (new data ready, 0 - 7) 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, at least 1 µs wide, from the external device.

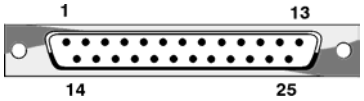
5 volt output and circuit breaker

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 circuit-breaker is reset by removing power from the Power1401.

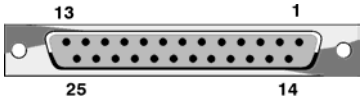
We have occasionally had problems with users who trip this protection very regularly. This is usually caused by a connector with a metal shroud being plugged into the digital input crookedly and the shroud shorting to pin 25, which causes overload. If you have this problem, the simple solution is to 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	1-wire port i/o
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 disable 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	Ground	13	Ground
Shell	Mains earth to cable screen	Shell	Mains earth to cable screen

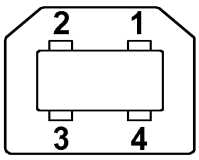
The mating connectors, with solder-bucket terminations, are ITW McMurdo part-numbers DB25P (25-way plug) and DB25S (25-way socket). Suitable shrouds are also required.

USB port

The USB port is for use with the USB protocol. Both USB1 and USB2 standards are supported. Data transfer rates are approximately 1·2 MBytes/sec for USB1, and up to 20 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 used as a cable sense input, also via a choke; +5 V 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.

USB socket



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

High-speed Serial Link

The High-speed Serial Link provides an alternative means for communicating with the host computer. A PCI interface card, the CED 1401-80 (see page 10), is required, and a PCI bus slot on the host motherboard.

High-speed Serial Link socket

Pin	Function
1	Ground
2	RX+
3	RX-
4	Ground
5	TX-
6	TX+
7	Ground
Shell	Mains earth to cable screen

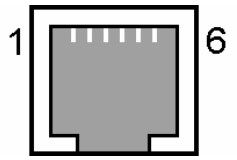
The High-speed Serial Link connects to the Power1401 via a socket in the rear panel. One differential pair transmits data in each direction. Pre-formed, shielded cable must be used in order to meet European and US EMC regulations. This can be supplied in lengths of 2 m (standard) or 5 m (by request).

Synchronization port

The synchronization port enables two or more 1401s (Power mkII, micro mkII or Power serial no. P3xxx onwards, in any mix) to be synchronized, 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, with the "master" end of the cable determining 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, either side by side or stacked. If more than four 1401s need to be synchronized, the user should consider the CED 3301 external synchronization unit.

Synch socket



Pin	Function
1	MHZ20_TRX−
2	MHZ20_IN−
3	MHZ20_IN+
4	MHZ20_OUT−
5	MHZ20_OUT+
6	MHZ20_TRX+
Shell	Mains earth to cable screen

DC power inlet

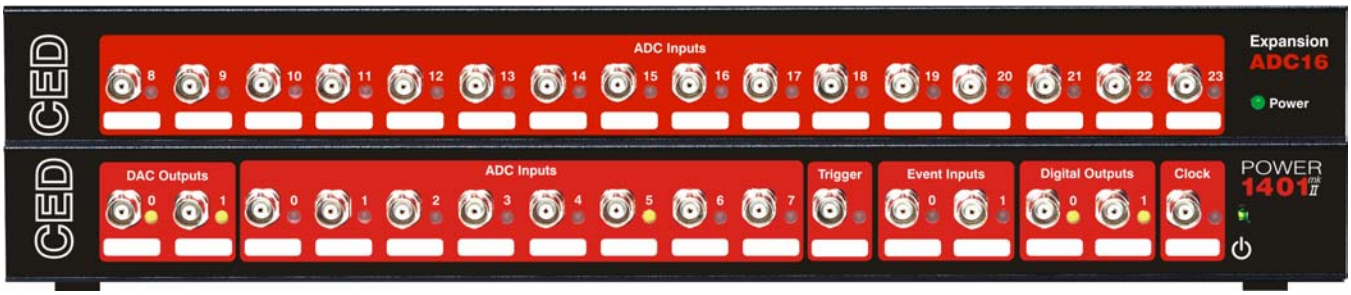
The power brick is a switch-mode regulator that provides a nominal 12V DC. This is regulated to the required voltage rails inside the Power1401. The internal regulator will accept voltages in the range +9 V to +18 V, so the Power1401 will run off a car battery. (See also the Battery Box, page 35.)

An internal relay controlled by the front-panel pushbutton switches both +12 V and 0 V. 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 as the +12 V and 0 V pins.

DC power socket

Pin	Function
1	+12 V
2	0 V
3	SPARE
4	Mains earth
Shell	Mains earth to cable screen

The unexpanded Power1401 will consume approximately 1·8 A at 12 V. This can rise to up to 3·3 A if the Power1401 is fitted with top-boxes.



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. The rear-panel ADC inputs are then mapped onto channels 24 - 31. Once the Power1401 has been told about the extra channels by the installation program, the new ones may be freely used just like the basic set. Software that attempts to read the extra channels will return undefined data values if the ADC16 is not installed.

Up to two ADC16s may be added to a Power1401, in which case the second maps onto channels 24 - 39 and the rear-panel ADC inputs onto channels 40 - 47.

The ADC inputs on the ADC16 are of identical design to the ones on the main board, with optional selectable gains of unity, ×2, ×5 or ×10. The input range will be ±5 V or ±10 V as set on the motherboard. The top-box makes internal connections to the Power1401 motherboard. The expansion board, designated the CED 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 sixteen more ADC input channels mapped onto channels 8 - 23 (and the rear-panel ADC inputs onto 24 - 31). In this case, however, each channel has two stages of individually-programmable gain. Typically the first stage will have gains of unity, ×2, ×5 and ×10, and the second stage gains of unity, ×10 and ×100. In this way gains of up to ×1000 are achievable.

Up to two PGA16s may be added to a Power1401, in which case the second maps onto channels 24 - 39 and the rear-panel ADC inputs map onto channels 40 - 47.

The ADC inputs are of similar design to the ones on the main unit, only with two cascaded gain stages. The input range will be ±5 V or ±10 V as set on the motherboard. 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 expansion board, designated the CED 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 another four, 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 onto 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 optional selectable gains of unity, ×2, ×5 or ×10, and input range of ±5 V or ±10 V as set on the motherboard. 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 expansion board, designated the CED 2701-05, 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.

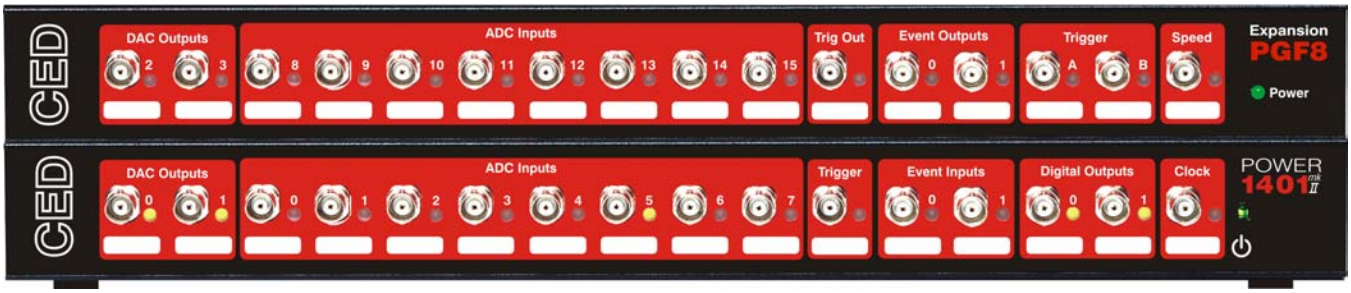
The *Spike2* top-box: digital BNC connections

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.

This expansion board also provides eight ADC inputs mapped onto ADC 8 - 15, of identical design to the ones on the main unit, with optional selectable gains of unity, ×2, ×5 or ×10, and input range of ±5 V or ±10 V as set on the motherboard. Finally there is a pair of DACs mapped onto DAC 2 - 3.

When this card is installed, the rear-panel ADC inputs are mapped onto channels 16 - 23, and the rear-panel DACs onto channels 4 and 5.

The normal input voltage range of the digital inputs is 0 to +5 V. The safe range is ±10 V, and they present an impedance of 100 kOhm, as with the front-panel Event and Trigger inputs. The top-box makes internal connections to the Power1401 motherboard. The expansion board, designated the CED 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 simultaneous 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 expansion board, designated the CED 2701-21, 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 battery box

The CED 3003 Battery Box is a 1U box of identical size and matching style to the Power1401 hardware. It provides 12 V DC and has a nominal capacity of 9·2 Amp-hours, enabling an unexpanded Power1401 mk II to run for three to 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 6 kg.

Recycling the CED 3003

Particular care must be taken when disposing of this unit. It may be returned to CED Ltd for recycling; otherwise, note that the electronic components are deemed to be lead-free with the obvious exception of the batteries themselves. These should be removed and disposed-of at a recycling facility competent to deal with such waste.

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.

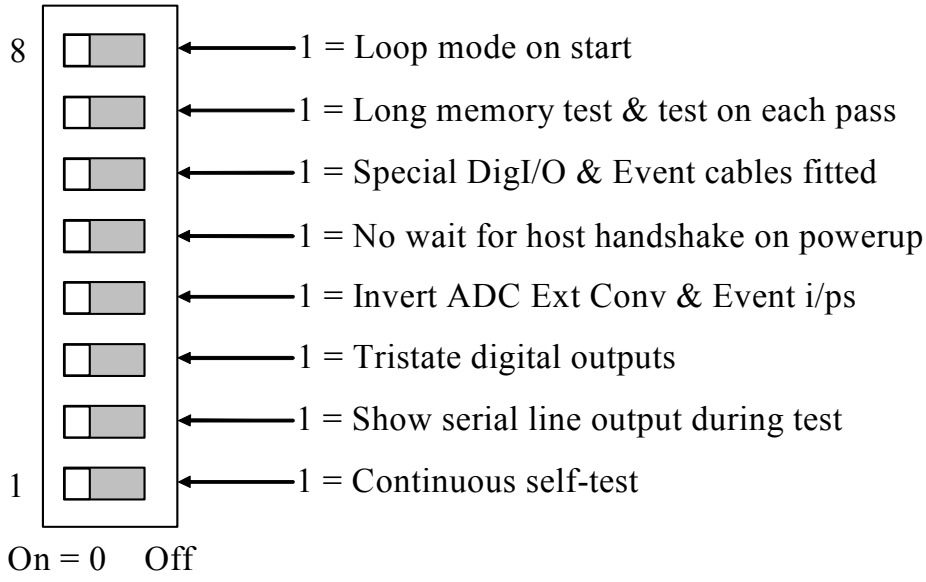
Taking the lid off

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 2 mm hex wrench. Swing the back panel away. There is no need to unscrew 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.

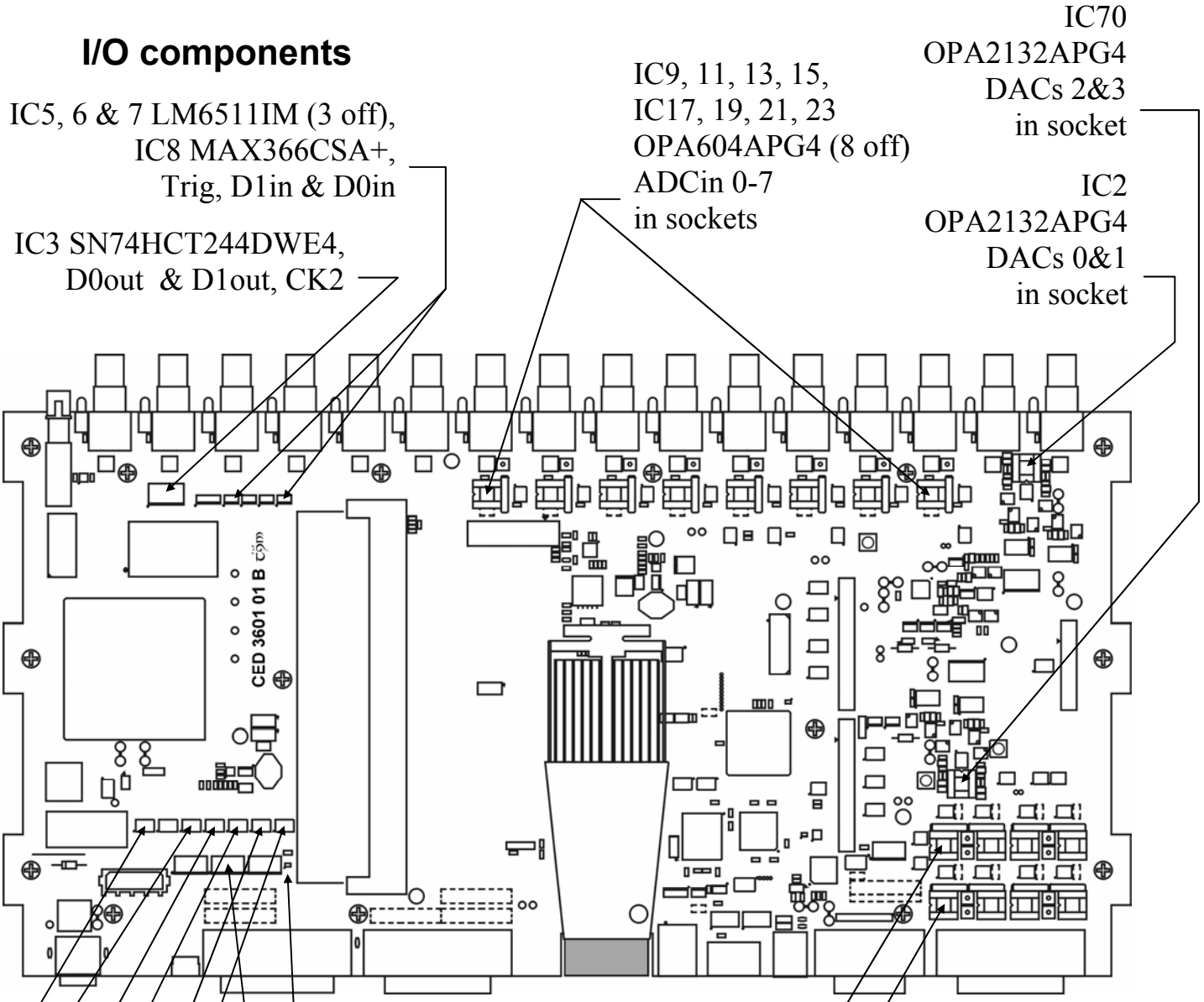
The inner can is now visible. Slide the can out to the rear, and unplug the green & yellow earth wire that plugs in at the side. Unscrew the six M3 screws with a 1-pt Pozidriv screwdriver (these are special screws with shakeproof washers permanently attached.) Remove the lid by gently pulling it up and off. Note the position of the graphite-impregnated gasket strips. Store these safely, since they are quite delicate.

Switch settings

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



I/O components



IC92 NC7SZ04M5X_NL, User out
IC93 NC7WZ14P6X_NL,
User in & Hi-byte output enable

IC89, 90, 91, MAX367CWN+
Input protection

IC80 SN74HCT244PWE4, Handshake out

IC79 74LCX244MTC, Handshake in

IC78 SN74ACT373PWE4, Dig Out hi byte

IC77 SN74ACT374PWE4, Dig Out lo byte

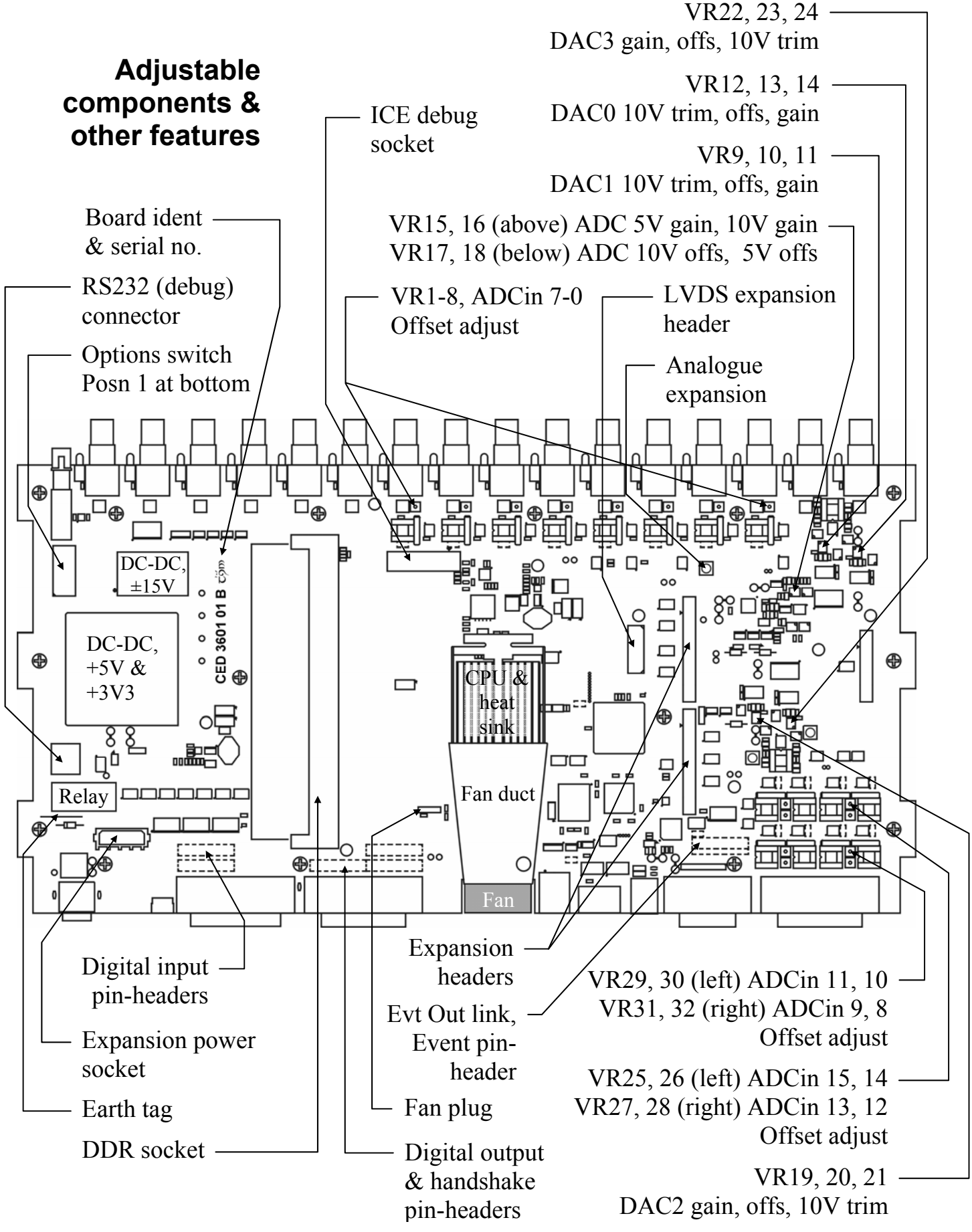
IC76 74LCX373MTC, Dig In lo byte

IC74 74LCX244MTC, Dig In hi byte

IC113, 114, 115, 116,
OPA604APG4 (4 off)
ADCin 11, 10, 9, 8
in sockets

IC100, 101, 102, 103,
OPA604APG4 (4 off)
ADCin 15, 14, 13, 12
in sockets

Adjustable components & other features



Memory upgrades

The base-level Power1401 mk II is supplied with 256 MBytes of double data-rate synchronous dynamic RAM (DDR SDRAM). This is packaged as a dual in-line memory module (DIMM) in a socket; you can upgrade your memory to up to 1 GByte simply by exchanging the DIMM. See the diagram on page 38 for the location of the socket, and see page 36 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:

- Registered ECC DDR-II SDRAM in 240-pin DIMM
- Speed: 400 MHz
- Standard: PC2-3200R
- Memory chips must be 8-bit or 16-bit devices, not 4-bit
- 1 GB memory must be 2-rank or 4-rank, not single-rank

DIMM memory not meeting this specification will not work. The CED warranty on the Power1401 mk II does not cover malfunctions caused by users attempting to upgrade their units.

Suitable memory DIMMs

512 MB	Micron	MT18HTF6472DY-40EB2
	Samsung	M393T6453xxx-CCC
	Samsung	M393T6553xxx-CCC
	Hynix	HYMP564R72BP8-E3
1 GB	Micron	MT18HTF12872DY-40EA1

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 mechanically polarized; 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 10 seconds, the long test about 2½ minutes.

Setting the ADC input range

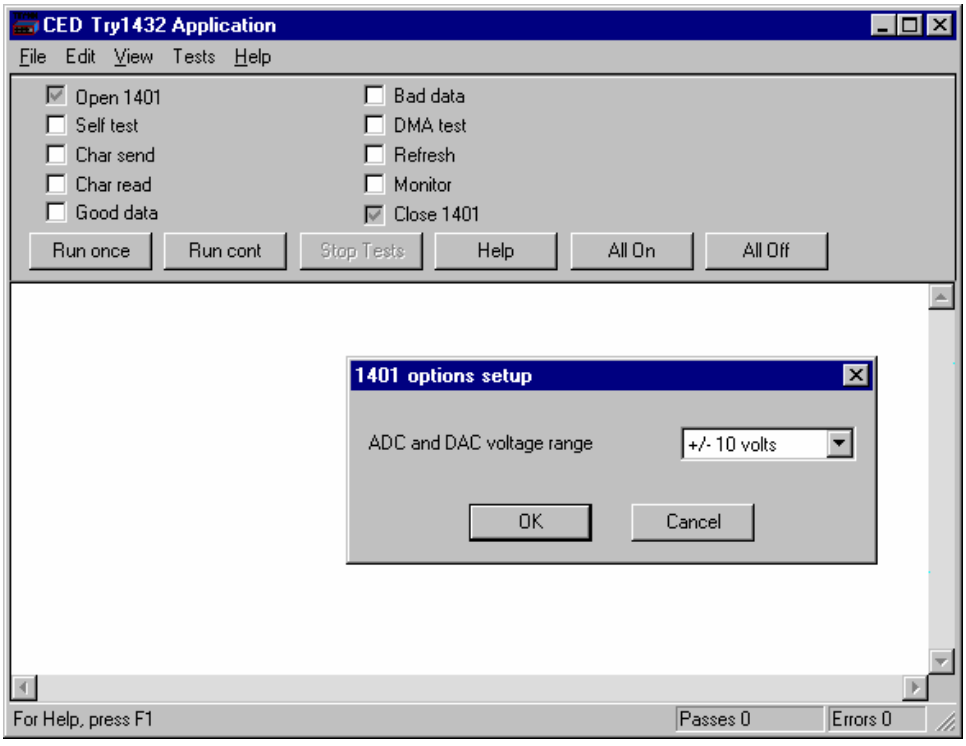
The ADC and DACs may together be set to a working range of either ±5 V or ±10 V. This is done in software through TRY1401 (version 3.35 or later). The setting is stored in non-volatile memory and is not affected by power cycling. The default setting is ±5 V; your Power1401 will be supplied set to this range.

To alter the voltage range, select

Start, *Programs*, *1401 support*, *Try1401*.

Inside the *File* menu, click on *1401 Options…* Select from the dropdown list to set ADC and DACs to your preferred working range. Hit *OK* to confirm the change, or *Cancel*, as appropriate. The change will take effect the next time the Power1401 is power cycled.

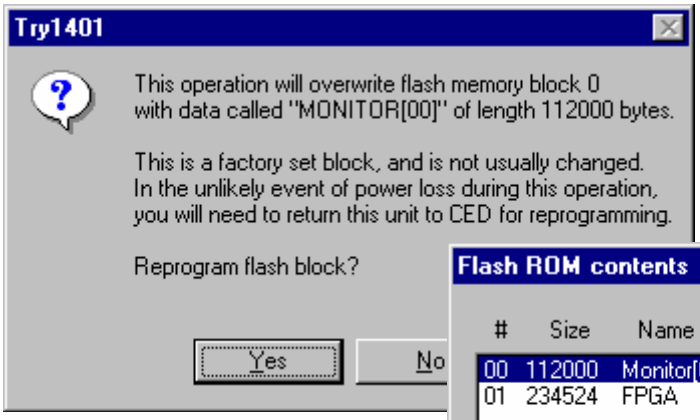
TRY1401, ADC and DAC range selection



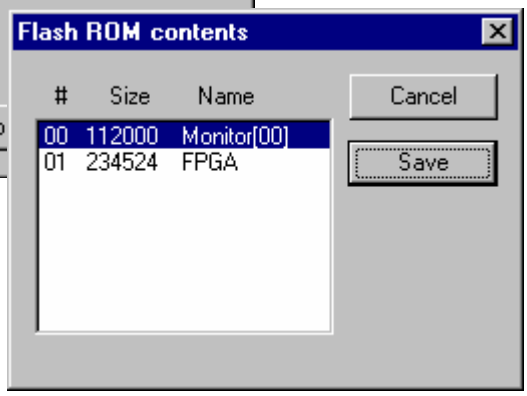
Flash ROM and the Power1401 mk II Monitor

The Power1401 stores various software items in its non-volatile flash ROM. The primary boot loader, the power-on self-test firmware, and the monitor (the operating firmware) are all stored in block 0. The FPGA configuration image is stored in block 1. Both blocks are automatically loaded on power-up, so long as the rear-panel Mode selector is in position 1; this tells the primary boot loader to load blocks 0 and 1.

Memory block overwrite warning



Flash ROM contents ➢



Upgrades and the Internet

Monitor and FPGA upgrades are available as `.fli` files from CED's website, `www.ced.co.uk`.

TRY1401

You can implement monitor and FPGA upgrades by updating the flash ROM using the TRY1401 utility. To open TRY1401, select

Start, *Programs*, *1401 support*, *Try1401*.

From *File* select *Update Flash.* The destination for the new monitor is set automatically to block 2, and the FPGA image to block 3, so the old monitor and FPGA images are still there in case of disaster, e.g. power failure during the few seconds taken writing the file. Blocks 0 and 1 are pre-loaded; if you do write to them you are warned first. To use the new monitor or FPGA image, set the rear-panel Mode selector to 2 and switch the 1401 DC off and on again. Check that the Power1401 is operating correctly.

Analogue calibration

The ADC & DAC Test option inside TRY1401 is provided to calibrate the ADC inputs. This involves opening the Power1401 mk II, since the main trimming controls are manually-adjusted potentiometers (see page 36 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 sixteen-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 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 substantially less than thirty-two LSBs (0·05%) over this period.

To make use of this program you will need a fine trimming tool or a 1·4 mm flat-bladed jeweller's 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 Power1401 to warm up with power on for at least thirty 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 44 for advice on sending it back.

Running TRY1401

To run TRY1401, select

Start, Programs, 1401 support, 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.

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. In the Power1401 mk II, the op-amp ICs that buffer ADC input and drive DAC output are socketed for easy replacement; see the diagram on page 37. This often bypasses the need to return the Power1401 to CED.

Stand-alone test

This is the simplest test of a Power1401; it eliminates the possibility of a host computer or cable fault confusing the situation. Disconnect the Power1401 from the host at the 1401 end of the host cable, remove all signal connections and then apply power to the Power1401. If all is well, the Power/Test indicator should turn on red. The BNC LEDs will flash in a characteristic pattern. The Power/Test indicator should then turn green and remain so. If the Power1401 behaves like this, yet exhibits a fault in operation, it is likely that the fault lies in the interface cable, the 1401 interface card in the host (if present), in the host computer hardware or the host computer software.

Running TRY1401

If the Power/Test indicator begins to flash red, the internal Power1401 power-up self-test has detected a problem. It is likely that TRY1401 will be able to provide details of the problem. You will need to connect your Power1401 to the host computer before running the test. Open TRY1401 by selecting

Start, *Programs*, *1401 support*, *Try1401*.

Check the *Self test* box, then click on *Run once*. If no errors are detected it may be worth running continuous self-test (*Run cont*) to pick up any intermittent fault. Inform CED of any reported errors: *File, Send Email* will create a new email with the report as an attachment (you can also copy and paste.) Our hardware help address is `hardhelp@ced.co.uk`.

If the Power/Test indicator remains steadily red after power-up, TRY1401 may not be able to help. You should contact CED for advice.

Calling the CED Help Desk

If you cannot diagnose your Power1401 problems yourself, do call our Hardware Help Desk. Please email if possible; our email address is:

`hardhelp@ced.co.uk`

We also have a direct phone line to the Hardware Help Desk:

+44 (0)1223 433477

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 machine, printed on the back, in the form P 4xxx.
- If the problem is with a program, please make a note of the version number, announced on entry, or from *Help, About….*
- 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 Power1401 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: your package may be dropped several metres!

Index

Waveform inputs	Input impedance	1	megohm
	Active working voltage range (software selectable)	±5 or ±10	volts
	Safe voltage range	±15	volts
	Maximum conversion rate		
	single channel	2.0	megahertz
	multi-channel	1	megahertz
	Resolution	16	bits
	Crosstalk & noise	±2	LSBs up to 200kHz/chan
Waveform outputs	Active working voltage range (software selectable)	±5 or ±10	volts
	Safe drive capability	600	ohms
	Full accuracy drive	5	kilohms
	Maximum update rate	400	kilohertz
	Resolution	16	bits
Front-panel digital inputs	Input impedance	100	kilohms to +5 V
	Safe voltage range	±10	volts
	Shortest pulse-width	1	microsecond
	Low voltage	0·8	volts
Clocks	Accuracy & drift, 0-70°C	50	parts per million
Rear-panel digital and event inputs	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
Digital outputs	Drive capability	±20	milliamps
Mains Supply	Voltage range	100 to 240	volts
	Frequency range	47 to 63	hertz
	Current	0·8	amps
Case size & weight	Power1401 mk II	88 × 219 × 428	millimetres
		3·0	kilograms
	Power brick	40 × 75 × 130	millimetres
		0·45	kilograms
Environment	Temperature range	–5 to +50	°Celsius
	Maximum humidity	95%	non-condensing

CE

EC Declaration of Conformity

This is to certify that the:

CED Power1401 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 2004/108/EC,
relating to Electromagnetic Compatibility,
by the application of the following harmonised EMC standard:

EN61326-1 (1997) Class B with Amendment 1 (1998)
Amendment 2 (2001)
Amendment 3 (2003) - COMPLIES

FCC CFR47 (2006) Part 15 Subpart B Class A - COMPLIES

Signature 

Peter Rice
Technical Director

Date 15 August 2007