# The CED Micro1401-4 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.*
- Names of files, drives, paths and directories, and keyboard entry by the user, 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:

CE

This symbol declares that the equipment passes the relevant clauses of EU directives on safety and EMC emissions; see the certificate reproduced on page 43.

Observe precautions against electrostatic discharge.


The CED Micro1401-4 is lead-free and conforms to the EU RoHS directive.

The CED Micro1401-4 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 Micro1401-4 chassis is powered from a DC-only supply.

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

## Micro1401-4 *v* earlier Micros

The Micro1401-4 is an updated and enhanced version of the previous Micro1401-3. Improvements include:

- New computational core, running at 400 MHz (was 90 MHz) with Arm® Cortex®-M7 microprocessor
- Internal memory increased to 32 MByte (from 4 MByte)
- 16-bit ADC throughput rate 1 MHz (was 500 kHz)
- Low-glitch (1·1 nV.s) 16-bit DACs, 1 µs settling time (was 5 µs); 2 DACs standard, option of fitting 4
- Both DACs & ADC electronically calibrated (no manual trim pots), reducing need to open case
- USB2 transfer rate from host 47 $MBs^{-1}$, to host 48 $MBs^{-1}$ (were 7·8 $MBs^{-1}$ & 14·5 $MBs^{-1}$)

### 1401 names

In this manual 'Micro4' is frequently used as an abbreviation for 'Micro1401-4'. '1401' by itself is used generically, to mean any member of the CED Micro1401 or Power1401 families.

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

The Micro1401-4 generates and uses radio frequency energy and may cause interference to radio and television reception. Your Micro4 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 Micro1401-4 does cause interference to radio or television reception, which can be determined by turning the Micro1401-4 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 Micro4 with respect to the receiver
- Move the Micro1401-4 away from the receiver
- Plug the Micro1401-4 into a different outlet so that the Micro1401-4 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

- CED's software is supported under Windows 7 and Windows 10
- Installation disk should run automatically

**Step 2** Set up your hardware for USB interface:

- Power-up both the computer and the Micro4
- Connect the USB cable
- USB hardware is recognized and the correct driver is located automatically

**Step 3** Check the installation

- Run Try1401, select *Self Test*, then *Run Once*
- Test should take less than 1 second and give no errors

**Step 4** Your Micro4 is now ready for use

**Recycling the box** The Micro4 is packed in a stout cardboard carton, with an inner cardboard accessory box with foamed-polyether liner, and internal spacers of expanded polystyrene and foamed polyethylene. You should dispose of these thoughtfully, and in accordance with best waste-recycling practice. Currently, cardboard is widely recycled. Foamed polyethylene can be included with LDPE. Expanded polystyrene can only be recycled by specialist recyclers. Polyether is not yet recyclable.

Should the Micro4 ever need returning to CED (see page 37), this packaging is the ideal container, so you may consider it worth saving.


## Introduction

This manual will guide you through the initial check and installation of your Micro4. It introduces you to the external inputs and outputs. It also describes maintenance and diagnostic procedures. This manual does not cover Micro4 programming, nor the use of application programs with the Micro4.

### Checklist

The installation kit for your Micro4 comprises:

- A Micro4, with optional rack-mount kit
- A power brick with attached DC supply cable
- A power brick mains cable, suitable for your country
- A USB data cable to connect Micro4 and computer
- An installation disk to allow you to install and check out your Micro4
- 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. It has no switch, being controlled by plugging in and switching on at the mains socket. The Micro4 consumes a maximum of 15 Watts.

The Micro4 front-panel push-switch actuates an internal dual-pole relay that switches DC power to the rest of the circuitry. For complete electrical isolation, mains power must be disconnected from the power brick.

***The power brick: PowerSolve PSE60-312 shown***


## Confidence check

Your Micro4 was soak-tested at CED before shipping. To pass the test, a Micro4 must not generate a single error in at least 96 hours of testing. The next procedure checks that the Micro4 hardware is in the same state as it left the factory.


Ensure that the front-panel DC power switch, marked ⏻, is <u>off</u> (with the button protruding from the panel). Plug the power-brick output cable into the DC Power In socket, but <u>do not</u> connect the data cable. Check that the Mode selector is in position 1. Switch the Micro4 on. The switch button should turn on red whilst yellow LEDs flicker. The button should then turn blue and glow steadily. If this is not the case, turn to *Trouble shooting* on page 36.

## Installing the Micro4

Once the Micro4 has passed the confidence check, you should turn to the section on page 5 that deals with installation on your computer. The rest of this section deals with general topics. Remaining sections describe the signal inputs and outputs, expansion options, and maintenance and troubleshooting.

## Storage and operating environment

The Micro4 should be stored and operated within a range of −5° and +50° Celsius, in non-condensing humidity. Humidity should not exceed 95% saturation. The Micro4 is suitable for continuous operation. The Micro4 is not protected against ingress of water or dust. There are no hazardous voltages inside the Micro4. The Micro4 complies with relevant EU and USA requirements for electromagnetic interference. The Micro4 complies with RoHS regulations on hazardous substances. The Micro4 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 Micro4. It is happy in the same sort of environment as suits the host computer. The Micro4 normally stands on its base, but it will work on its side or upside down, if required.

## Application software

The Micro4 requires application software to run it. Most customers will run CED application programs such as *Signal* or *Spike2*, or products supplied by third parties. See pages 11 and 12 for brief descriptions of *Spike2* and *Signal*. 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 Micro4) under Windows 7 and Windows 10.

### 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 Micro4 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 provided 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 Micro4 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 Micro1401-4 can be made available for a fee. Purchasers must sign a non-disclosure agreement. CED does not make information on the contents of programmable devices available.

## Overview

To install the Micro4 you will need:

- a Micro4, power brick and mains cable
- a USB cable
- the CED application software disk

The following section details the installation of the USB interface. The instructions take you through the software part (installing the Micro4 device driver and utility programs) and the hardware part (making the physical connection between the Micro4 and your computer).

### 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. They are automatically installed at the same time as the device drivers. See page 8 onwards for details of these utilities.

## The USB driver

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

Micro4s use the USB interface, and require a computer with a USB connector. All you have to do is connect the USB cable between the computer and the Micro4. The cable has a standard style A plug at the computer end and a standard style B plug at the 1401 end (this is often known as a 'printer cable'.) In order to comply with European and US EMC rules, the cable must be shielded with a braided screen. You should only use the cable supplied by CED.

### Hot plugging

USB hardware is designed for 'hot plugging': after the software has been installed, the USB cable is inserted with the computer and Micro4 both already switched on. This causes the computer to recognize the presence of a new USB device and look for its device driver.

### Windows 7 & Windows 10

Plug the Micro4 into the USB port with both 1401 and PC powered up. The USB hardware will detect the Micro4, 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.

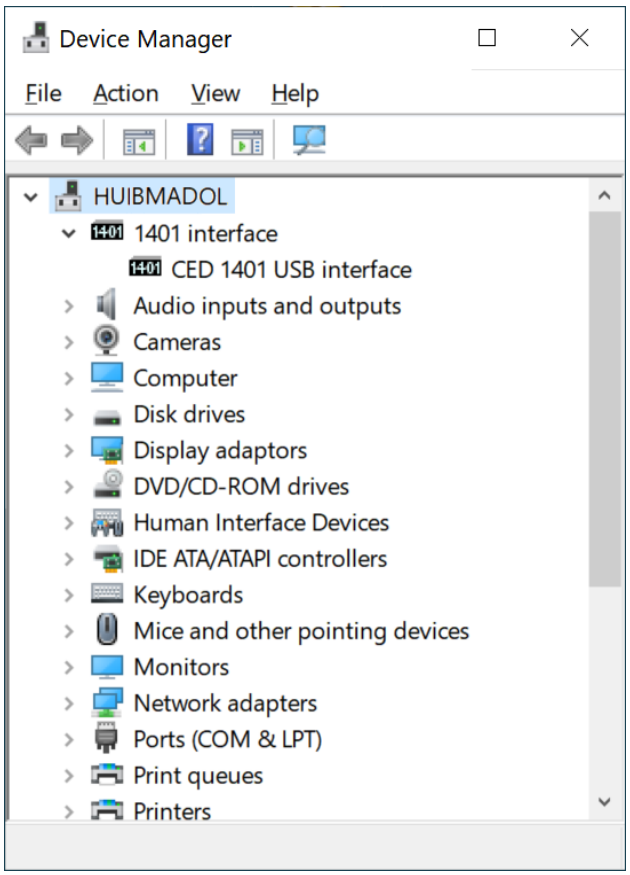
### USB interface settings

With the driver installed, the Micro4 becomes a recognized USB device, and the *1401 interface* icon will appear in the Hardware Device Manager whenever the Micro4 is plugged in and powered up.

### Windows 10

To view the Micro4 USB settings in Windows 10, press the Windows button in the bottom left-hand corner of the display. A window opens. *Device Manager*, and below it, *Control Panel*, appear in the right half of the window. Click on either; the Device Manager opens. If the Micro4 is powered up and the USB cable connected, *1401 Interface* will appear in the list of devices. Click on the **>** to its left. This reveals the *CED 1401 USB interface*. Right-click on this and select *Properties*. In the new window, among the tabs revealed, the *General* tab shows overall device status and the USB port & hub. The *Settings* tab allows you to set the device number of the Micro4 if multiple Micro4s are connected, and to reset the 1401. The *Driver* tab allows you to disable (and uninstall) the 1401.

***Device Manager, Windows 10 shown***




**Windows 7** To view the Micro4 USB settings in Windows 7, press the Windows button at the bottom left of the display. In the window that opens, select *Control Panel* from the column on the right. In the new window, type `Device Manager` in the search box at the top right of the display. *Device Manager* appears in a list on the left, under *Devices and Printers*. Select it. If the Micro4 is powered up and the USB cable connected, *1401 Interface* will appear in the list of devices. Click on the ▷ to its left. This reveals the *CED 1401 USB interface*. Right-click on this and select *Properties*. In the new window, among the tabs revealed, the *General* tab shows overall device status and the USB port & hub. The *Settings* tab allows you to set the device number of the Micro4 if multiple Micro4s are connected, and to reset the 1401. The *Driver* tab allows you to disable (and uninstall) the 1401.

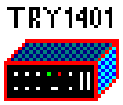
## Installing test & diagnostics

CED application disks include test utilities, that verify correct installation of your Micro4, assist in re-calibrating the analogue system, and diagnose hardware problems.

These utilities are installed automatically as a component of CED applications such as *Spike2* or *Signal*. For stand-alone users, they are installed as the Test1401 program group along with the 1401 commands by the *CED 1401 installation* disk.

### Try1401

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



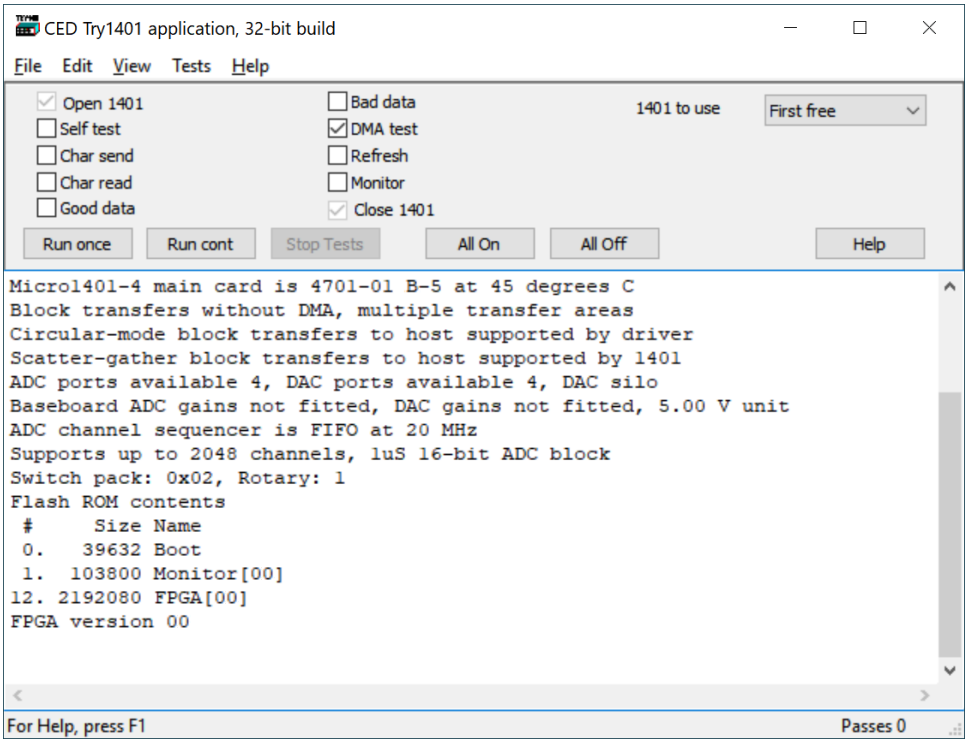

*Start, Programs, SpikeN, Try1401* or
*Start, Programs, SignalN, Try1401* or
*Start, Programs, Test1401, Try1401*

as appropriate. Here *'N'* is the version of the application: 9 for Spike2, 7 for Signal, at the time of writing. If at a later date a *CED 1401 installation* disk is run, and it finds that it has drivers or utilities that are newer than those on your system, it will update them.

**About Try1401**

Try1401 is the principal user test program. It simulates a typical Micro4 application program and exercises the host computer and Micro4 in the same way.

***Try1401 program screen***




Running Try1401 is self-explanatory. The check boxes allow different aspects of Micro4 function to be tested separately. *Self test* causes the internal self-test hardware to run. You should check this if the DC power switch remains flashing red after the Micro4 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 above, select

*File*, *1401 info…*

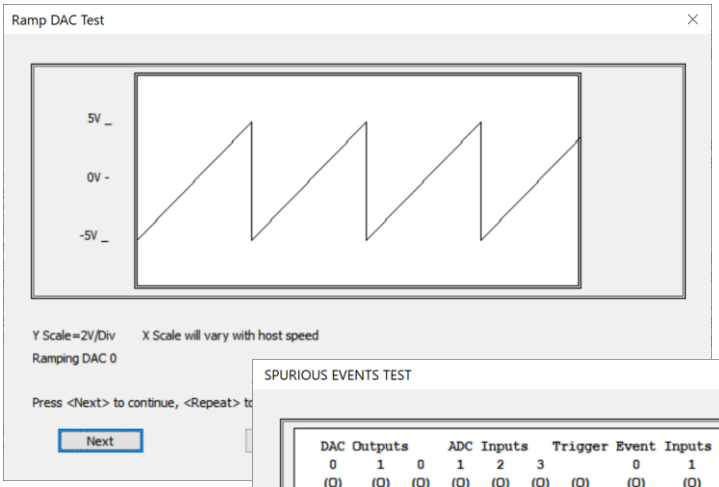
**DAC & ADC Test**
**Event & Clock Test**

If you wish to re-calibrate the analogue hardware, or test the functions of the Clocks or Events, select

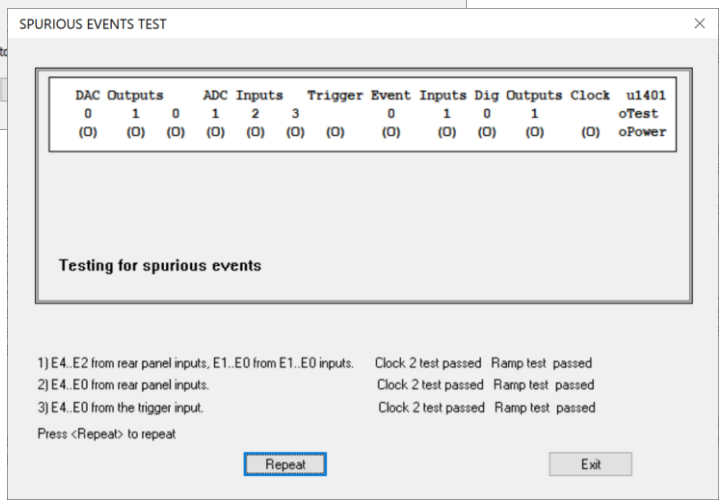
*Tests*, *ADC & DAC Test* or *Tests*, *Event & Clock Test*.

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. The box will probably not need to be opened, since the input amplifier voltage offset pots should remain in-range for the lifetime of the machine. ADC & DAC offset & gain pots are electronic and adjusted by software. The box need only be opened if the user has to replace an IC. See page 30 for how to take the lid off, and page 32 for the location of ICs susceptible to external damage. Analogue calibration is discused more fully on page 34.

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

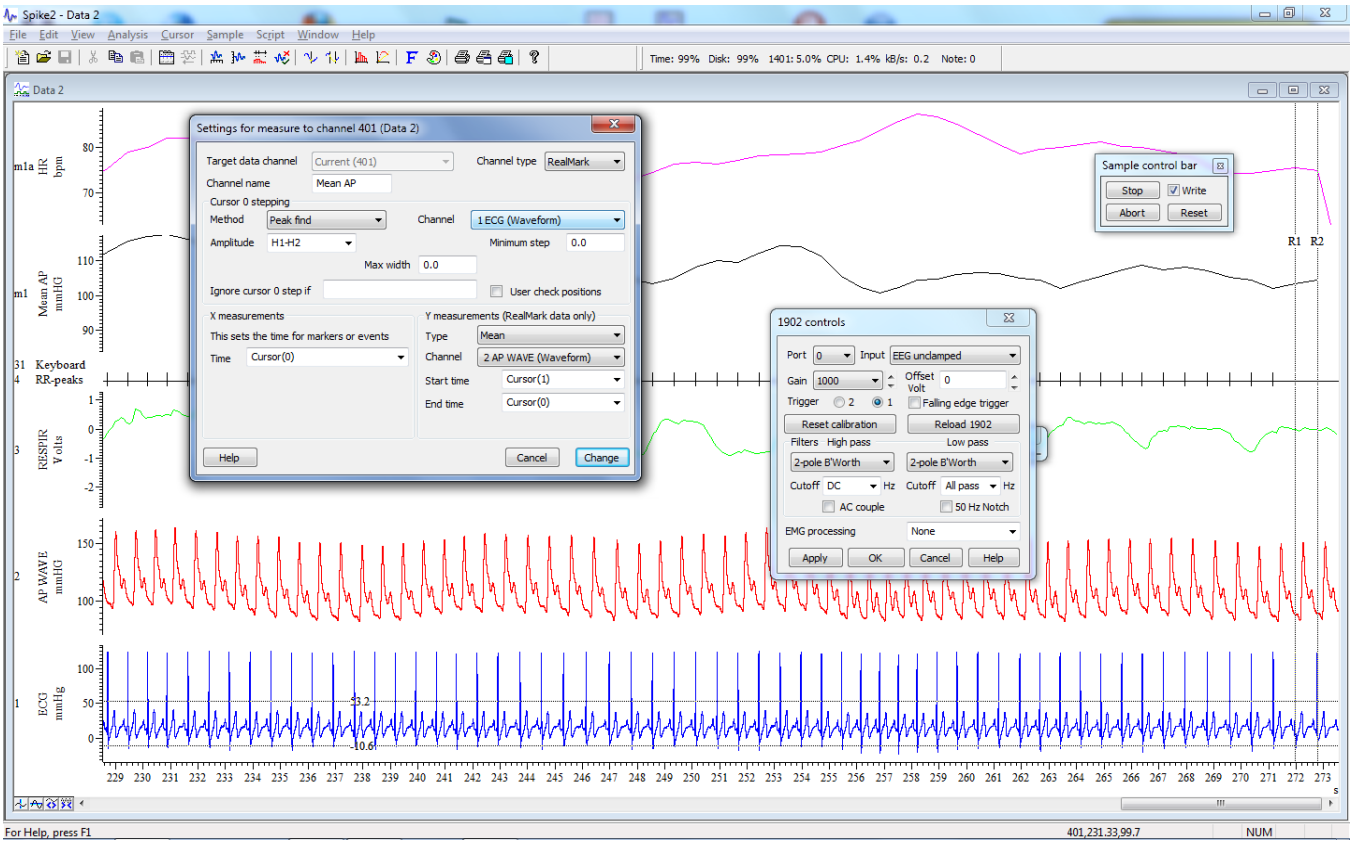



***Clock & Event Test, Events test ➢***



## Running the Micro1401 with Spike2

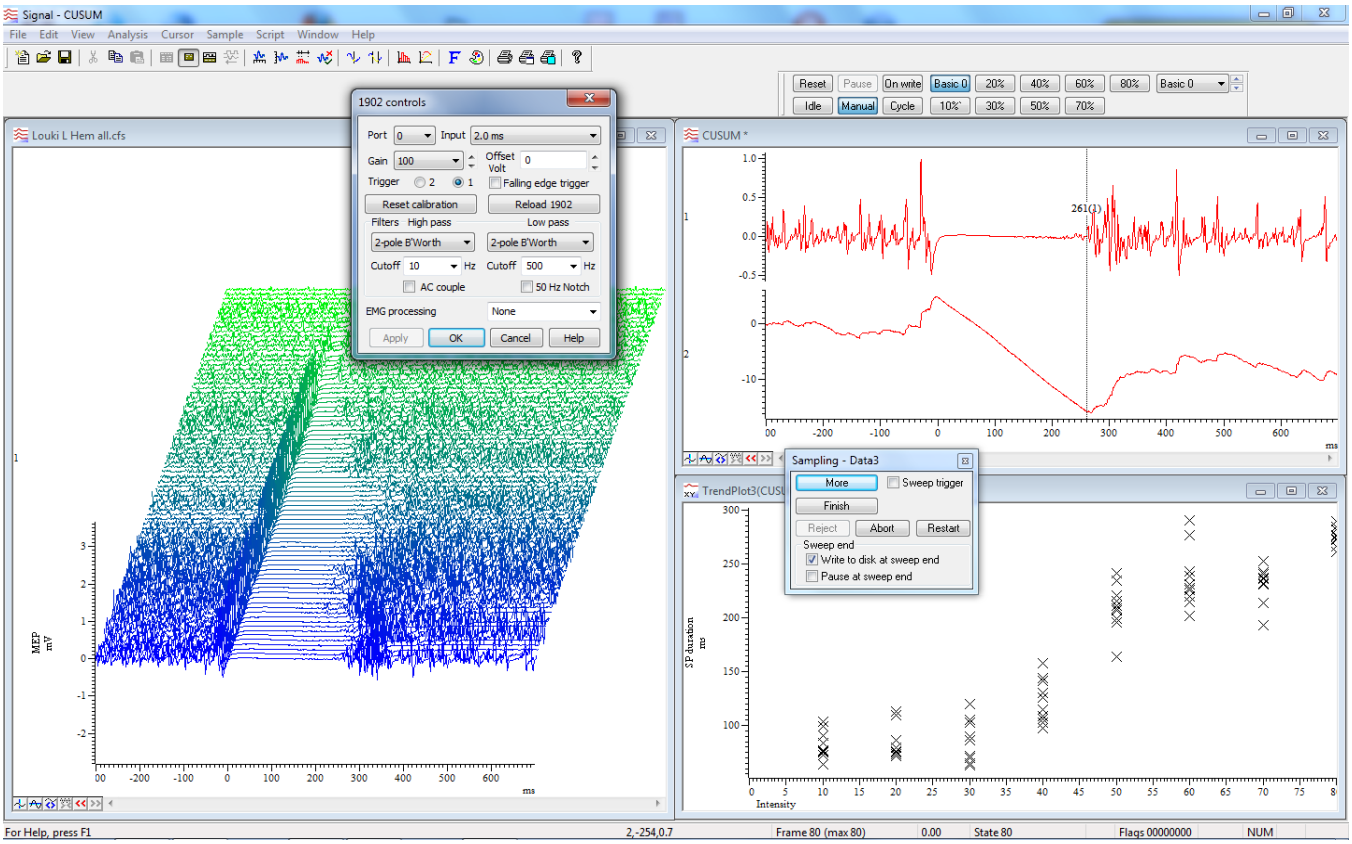
Spike2 is optimized for the analysis and recording of continuous data, possibly on many channels. Analysis of EEGs during sleep, or recording of cardiac output, blood pressure and respiration would be typical tasks. This application example, and the Signal application example below, make use of the CED 1902 isolated pre-amplifier.




**Spike2 *sampling ECG, with 1902 control panel***

## Running the Micro1401 with Signal

Signal is optimized for the analysis of sweep based information, where a sequence of data is recorded repetitively, often synchronized to a repeated stimulus. The classic example of this is evoked-response recording: here segments of brain activity are correlated with recurrent stimuli, in order to extract responses buried in the noise.




**Signal *controlling 1902s for multi-channel data acquisition***

## General

The following points relate to physical and electrical aspects of the Micro4 connectors, rather than to 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 Micro4 printed circuit board. Items of equipment connected to the Micro4 must not be treated as isolated from mains earth, nor from each other.

### Front panel LEDs

All front-panel BNCs have adjacent yellow LEDs. They flash or blink to show appropriate activity, e.g. an ADC LED lights when its channel is being sampled; a DAC LED flashes on channel update; digital output LEDs are 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.

### DC switch LED

On power-up, the DC power switch first lights red to indicate self-test, then turns blue to indicate normal operation. It starts flashing red if a hardware error has been identified, and glows steadily red if an undiagnosable fault has been detected.

### Externally-connected ICs


ICs connecting 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. If an IC is damaged, it will have to be unsoldered and replaced. See page 31 for the location and identification of susceptible ICs. Preferably, the Micro4 should be sent back to CED for repair; see page 37 for details. If you do have to replace an IC, note they are all readily-available types; order part numbers exactly as shown, to ensure lead-free, surface-mount parts.

### MOSFET & diode protection

Digital and event inputs are protected by MOSFET devices and are safe against moderate overloads of either polarity. ADC and DAC op-amps are diode-clamped to ±15 V, and digital outputs to 5 V & ground. The USB2 interface is diode-protected against voltage excursions and electrostatic discharge.

### 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 unity-gain amplifiers. Signals 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 1 µs.

**Waveform channels** There are four waveform input channels on a standard Micro4, available through front-panel BNC connectors labelled ADC Inputs. The working input range of these channels is ±5 V (the default setting) or ±10 V. You can change the input range using the Try1401 utility.

**Trigger** The front-panel input labelled Trigger can be set by software to be the external signal that starts 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 the ADC clock.

**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 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 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 ±15 V, at which voltage the input is clamped by diodes in series with a 200 ohm current-limiting resistor. If you do overdrive the inputs, it is possible to damage the input buffer amplifiers. The input amplifiers are lead-free, surface-mount devices, part number OPA604AU. See page 31 for the location of these ICs. Preferably the Micro4 should be sent back to CED for repair; see page 37 for details.

**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. It 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 socket. It responds to TTL and switch closure signals, and has a normal working voltage of 0 V 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 an internal switch; see page 30.

**The ADC**

The ADC is a successive-approximation switched-capacitor converter with integral sample-and-hold. The input voltage is resolved into 65536 levels (16-bit precision); each step is approximately 150 µV (300 µV on ±10 V range). Conversion time is nominally 1 µs.


## Waveform output

There are two, optionally four, waveform output channels on the Micro4. The standard pair, DACs 0 & 1, outputs through BNC connectors on the front panel labelled DAC Outputs. The optional DACs 2 & 3 may be routed to BNC connectors on the rear panel, or come out through an expansion top-box.

The DAC (digital to analogue converter) waveform outputs produce voltages in the range ±5 V in steps of approximately 150 µV or ±10 V in steps of approximately 300 µV (16-bit precision). ±5 V is the default setting; the output range is selected using the Try1401 utility. The DACs have low glitch energy, typically 10 nV.s, when crossing major transitions, in particular between 0x7fff and 0x8000, when all 16 bits change.

### 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 19), or the front-panel Trigger input, to synchronize the update rate to external equipment. Alternatively, they can be updated at a constant rate from the DAC clock or one of the other internal clocks; see page 17. When two or more channels of waveform are output, the Micro4 can be programmed to update the DACs simultaneously. The maximum useful update rate (allowing the output to settle) is in excess of 500 kHz.

### DAC LEDs

The front-panel waveform output channels each have an associated yellow LED. They are controlled purely by software command and typically turn on when their 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 op-amp outputs are diode-clamped at ±15 V. The DAC 0 & 1 output amplifiers are packaged in one lead-free, surface-mount device, part number OPA2132UAE4. See page 15 for technical details of the Trigger input. See page 31 for the location of these parts.


## Clocks

The Micro4 has four clocks. The event clock times and counts external pulses; the general-purpose clock generates timing pulses; the ADC clock controls waveform input sampling rate; the DAC clock controls waveform update rate, but DACs can also be updated by the ADC and general-purpose clocks. These clocks are managed automatically by the application.

### Trigger

You may need to control a clock from an experiment, e.g. to initiate event counting or trigger sweeps of waveform sampling. The application can route the front-panel Trigger input to set the appropriate clock running on your signal.

### Clock output

You may need to generate pulses to drive an experiment. The general-purpose clock output is available from the front-panel Clock BNC connector. Frequencies between 500 kHz and 710 nHz (one pulse in 16¼ days!) can be generated. The application manual describes this where it is relevant.

### Event inputs

Where external pulses need to be timed or counted, your application may use the front-panel Event 0 and Event 1 inputs. If there are more than two such signals, the rear-panel Digital Inputs may be used; see page 23.

### External frequency sources

All clock frequencies are normally derived from an internal crystal oscillator, of 50 ppm accuracy and drift. Users may sometimes need a timing source from outside the Micro4 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 19.) When you need to synchronize two 1401 machines, use the synchronization port (see page 24.)

### LEDs

The trigger and event-input LEDs flash or blink on detection of an active-edge transition; these LEDs can be set by software command to be on or off while quiescent, the former to indicate that the input is armed and expects to be used. The Clock LED simply turns on whenever the general-purpose clock is enabled.

**Clock names**

In earlier versions of the Micro1401, clocks were labelled by numbers that can be traced back to old MSI counter-timer chips in the earliest 1401s. The event clock used to be clocks 0 and 1, the general-purpose clock was clock 2, the DAC clock was clock 3, and the ADC clock was clock 4. In the Micro4, clocks 0 and 1 have been combined, and the opportunity taken to give the clocks more informative names.

**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. The inputs are pulled internally to +5 V by 47 kOhm resistors. Inputs are conditioned by a single LM339M/NOPB quad analogue comparator with 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 an SN74AHCT1G125DCK single-gate device that can source or sink 8 mA. Note that, since this is an output device, it cannot have MOSFET protection.

Trigger, Event 0, Event 1 and Clock are routed through common-mode chokes to prevent radiation of EMI.


Both the quad input comparator and the output driver are surface-mount, lead-free devices. If either is damaged, its replacement will involve unsoldering the defunct part. Preferably the Micro4 should be sent back to CED for repair; see page 37 for details.


## Event inputs

The rear-panel Events D-socket provides more clock-related inputs, the Clock E series and Clock F. These inputs allow 1401 programmers close control of the clocks. Details are given in the *1401 family programming manual*, and the *Micro1401-4 technical manual*. The front-panel BNCs Event 0 and Event 1 are often routed by software to the Clock E0 and E1 inputs.

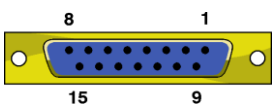
### Technical details

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 and pulses should be wider than 50 ns. The working range of these inputs is 0 V to +5 V. There is MOSFET circuit protection allowing a safe input range of ±10 V.

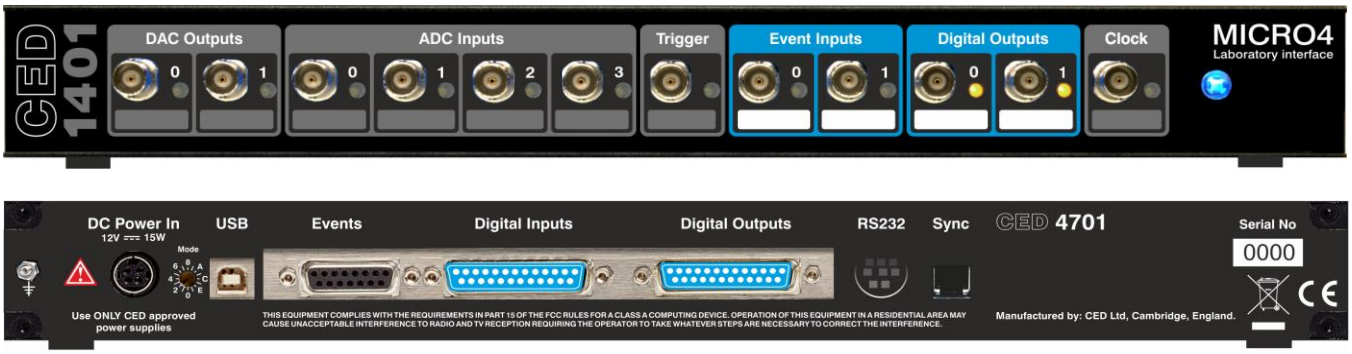
The Event Out signal is normally isolated from the rear-panel socket, to help reduce EMI; a jumper must be inserted to make it available (see page 32.) This output is buffered by an NC7SZ04M5X_NL, a lead-free, surface-mount IC that can source or sink 32 mA. Since this is an output device, it cannot have MOSFET protection. If it is damaged, its replacement will involve unsoldering the defunct part. Preferably the Micro4 should be sent back to CED for repair; see page 37 for details.

The sense of the Clock E and ADC external convert inputs may be inverted by a switch option (see page 30), but the inputs would all then be held active high if no input were 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 | Event Out output |
| 9 - 15 | Ground | Screen | Mains earth |




## Digital input and output

The Micro4 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 the general-purpose clock so that it updates on the clock's 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. Front-panel outputs are buffered through single-gate SN74AHCT1G125DCK parts, which can source or sink 8 mA, and rear-panel outputs through 8-channel SN74HCT244DWE4 parts which can source or sink 6 mA per channel. These are both lead-free, surface-mount devices. Note that, since they are output devices, they cannot have MOSFET protection. If they are damaged, their replacement will involve unsoldering and replacing the defunct part. Preferably the Micro4 should be sent back to CED for repair; see page 37 for details.

**Digital input requirements**

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, which for front-panel input takes 100 µA, for at least 1 µs; for rear-panel input it takes 1 mA, for least 100 ns.

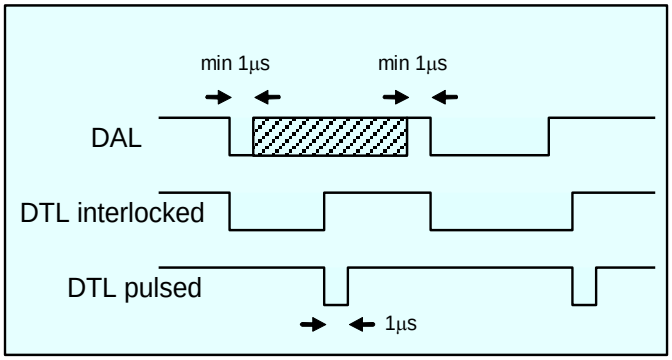
**5 volt output and circuit breaker**

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 ICs for interfacing purposes. The breaker is reset by removing power from the Micro4.

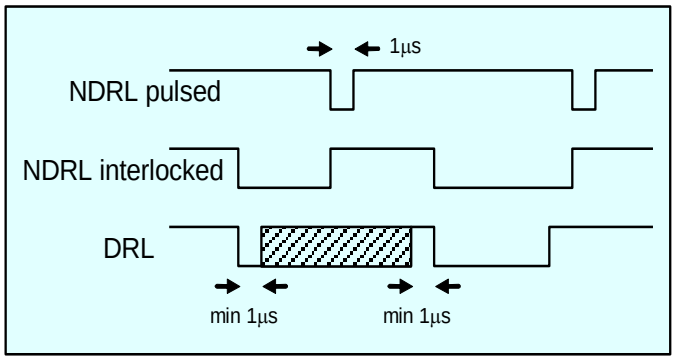
We have occasionally had problems with users who trip this protection very regularly. This is usually caused by a connector with a metal shroud being plugged into the digital input crookedly and the shroud touching pin 25, which causes overload. If you have this problem, the simple solution is to make this connection with Micro4 switched off, or to use a connector with a plastic shroud.

**Digital I/O handshake protocol**

Digital data transfer between the Micro4 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.



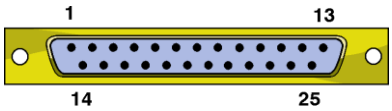

When presenting data, an external device sends a pulse at least 1 µs wide to the DAL (data available 0-7) input. When the Micro4 reads the data the DTL (data transmitted 0-7) output line pulses for 1 µs if in pulsed mode. If in interlocked mode, DTL is set by the Micro4 read and cleared by the next DAL.



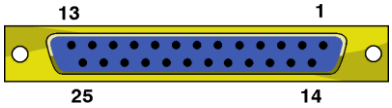

When Micro4 writes data to the digital output, the NDRL (new data ready 0-7) output pulses for 1 µs if in pulsed mode. If in interlocked mode NDRL is set by the data write and cleared by the answering DRL (data read 0-7) pulse, which must be at least 1 µs wide, from the external device.

**Digital I/O connectors**

**Digital input plug**




**Digital output socket**



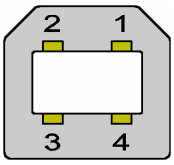

| Pin | Output socket | Pin | Input plug |
|---|---|---|---|
| 1 | High byte out 7 Word out 15 | 1 | High byte in 7 Word in 15 |
| 14 | 6 14 | 14 | 6 14 |
| 2 | 5 13 | 2 | 5 13 |
| 15 | 4 12 | 15 | 4 12 |
| 3 | 3 11 | 3 | 3 11 |
| 16 | 2 10 | 16 | 2 10 |
| 4 | 1 9 | 4 | 1 9 |
| 17 | 0 8 | 17 | 0 8 |
| 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 |
| Shell | Mains earth | Shell | Mains earth |

## USB port

The USB port is for use with the USB serial-data protocol. Data transfer rates are less than 1 MByte/sec for USB 1; for USB2, rates are up to 47 MByte/sec for transfers to the Micro4 and up to 48 MByte/sec for transfers from the Micro4.

### 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 detect input, also via a choke; +5 V applied to this pin indicates that the USB cable is inserted. There is diode protection against overvoltage and electrostatic discharge. The Micro4 is specified to meet European and US EMC regulations only if used with braid-screened cables supplied by CED.



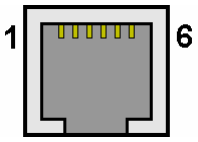

| Pin | Function |
|---|---|
| 1 | USB_+5V (cable detect) |
| 2 | USB_DATA+ |
| 3 | USB_DATA– |
| 4 | USB_GND (to system ground) |
| Shell | Mains earth to cable screen |

## Synchronization port

The synchronization port enables two or more 1401s (Power or Micro in any mix, so long as they have synchronization ports) 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.



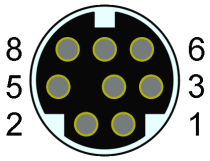

| Pin | Function |
|---|---|
| 1 | MHZ_$TR_X$– |
| 2 | MHZ20_IN– |
| 3 | MHZ20_IN+ |
| 4 | MHZ20_OUT– |
| 5 | MHZ20_OUT+ |
| 6 | MHZ_$TR_X$+ |
| Screen | Mains earth |

### Removing the synch cable

Owing to the depth of the rear panel metalwork, removal of the synch cable requires the use of a jeweller's screwdriver (or similar tool) to access the RJ21 release lever.

## RS232

**8-way mini-DIN**




| Pin | Function |
|---|---|
| 1 | CON_DTR |
| 2 | CON_CTS |
| 3 | CON_RX |
| 4 | Ground |
| 5 | CON_TX |
| 6,7 | No connection |
| 8 | Ground |
| Shell | Mains earth to cable screen |

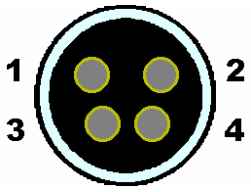
The RS232 port is only used during the initial setup and for debugging. Under working conditions the Micro4 cannot be programmed via RS232 so this port is not available for users. Its pinout is given here only for sake of completeness.

## DC power inlet

The power brick is a switch-mode regulator that provides a nominal 12V DC. Regulators in the Micro4 generate the required voltage rails from this. The regulators will accept voltages in the range +9 V to +18 V, so the Micro4 will run off a car battery.

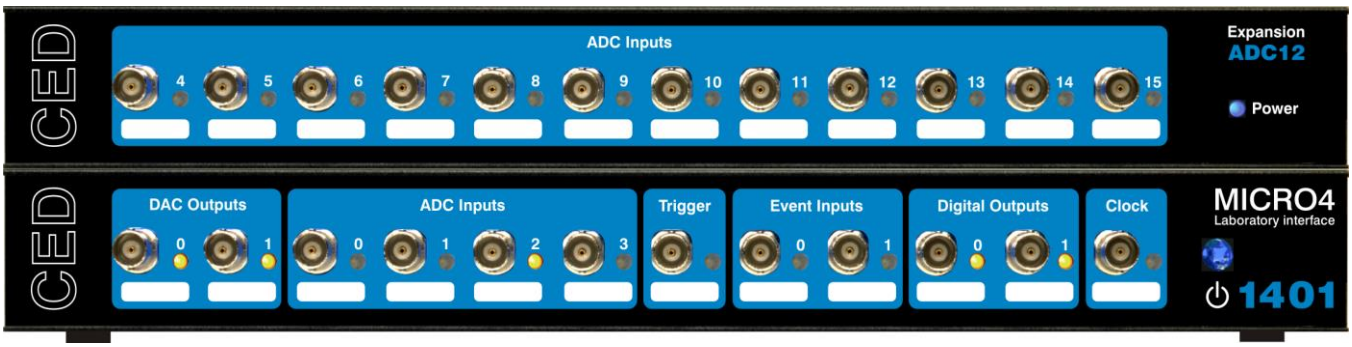
An internal relay controlled by the front-panel pushbutton switches both +12 V and 0 V. When inserting the DC supply plug, initial contact is made by mains earth when the sleeve engages the DC inlet screen. Mains earth also makes contact via a pin at the same time as the +12 V and 0 V pins.

**DC power socket**




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

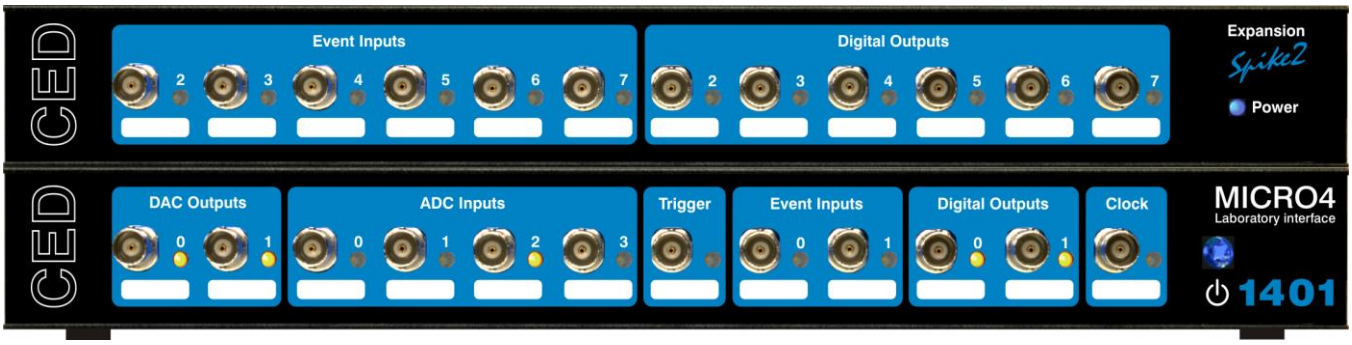
The unexpanded Micro4 will consume approximately 0·5 A at 12 V. This can rise to up to 1·0 A if the Micro4 is fitted with top-boxes.




## 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. A second expansion unit may be added, to provide channels 16-27. Once the Micro4 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.

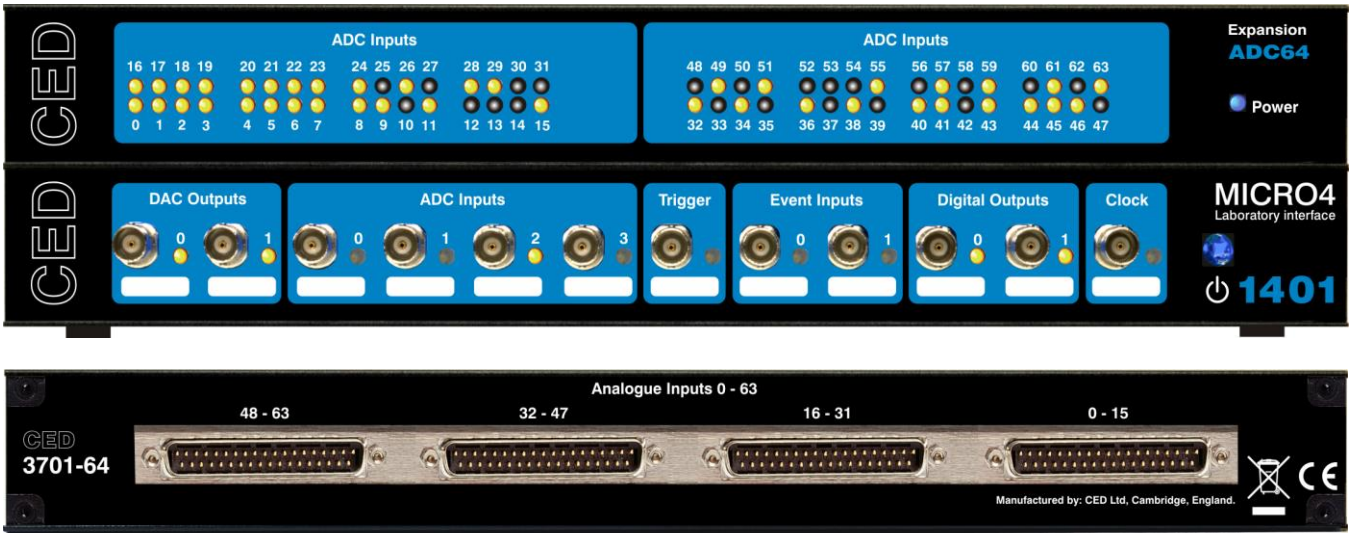
The ADC inputs are of identical design to the ones on the main unit, with an input range of ±5 V (optionally ±10 V), and a maximum non-destructive input range of ±15 V. All signals pass through common-mode ferrite chokes to reduce radiation of EMI. Each waveform input has a yellow LED that functions in identical manner to those on the motherboard. The expansion card makes internal connections to the Micro4 motherboard and is housed in the same metal can. This card, designated the 3001-03, requires the Micro4 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. The yellow LEDs by each BNC behave in identical manner to the front-panel event inputs and digital outputs. All signals pass through common-mode ferrite chokes to reduce radiation of EMI. The expansion card makes internal connections to the Micro4 motherboard and is housed in the same metal can. This card, designated the 3001-09, requires the Micro4 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 64-channel top-box: 64 differential inputs

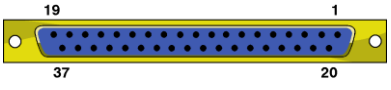
The ADC64 provides sixty-four channels of waveform input on one card, for users requiring many inputs. A Micro4 can accommodate two such cards, allowing 128 channels of waveform input to be sampled on one machine, if supported by the application. The base-unit ADC channels cannot be used at the same time as the ADC64.

The ADC64 uses instrumentation amplifiers, so the input is intrinsically differential; they can be operated in single-ended mode by grounding the inverting inputs. Channel gains are set by resistor during manufacture, typically between unity and ×10. The voltage input range is the same as is set for the original ADC inputs. Note that, because these channels are multiplexed and routed to the ADC on the motherboard, the maximum waveform conversion rate will be slower than in an unexpanded unit, on account of the extra capacitance; a full sweep of sixty-four channels will take on the order of 160 µs.

Input is by way of four 37-way D-type sockets mounted on the back panel. The front panel accommodates sixty-four LEDs that indicate the channels in use. The maximum non-destructive input range is ±15 V. All signals pass through ferrite chokes to reduce radiation of EMI. The expansion card makes internal connections to the Micro4 motherboard and is housed in the same metal can. This card, designated the 3701-64, requires the Micro4 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.

**16-channel waveform input connectors**

**Waveform input socket**




| Pin | 1st unit<br>2nd unit | 0-15<br>4-19<br>64-79<br>68-83 | 16-31<br>20-35<br>80-95<br>84-99 | 32-47<br>36-51<br>96-111<br>100-115 | 48-63<br>52-67<br>112-127<br>116-127* |
|---|---|---|---|---|---|
| 1 | A | | A | A | A |
| 2 | Ch 0– | | Ch 16– | Ch 32– | Ch 48– |
| 3 | Ch 1– | | Ch 17– | Ch 33– | Ch 49– |
| 4 | Ch 2– | | Ch 18– | Ch 34– | Ch 50– |
| 5 | Ch 3– | | Ch 19– | Ch 35– | Ch 51– |
| 6 | Ch 4– | | Ch 20– | Ch 36– | Ch 52– |
| 7 | Ch 5– | | Ch 21– | Ch 37– | Ch 53– |
| 8 | Ch 6– | | Ch 22– | Ch 38– | Ch 54– |
| 9 | Ch 7– | | Ch 23– | Ch 39– | Ch 55– |
| 10 | Ch 8– | | Ch 24– | Ch 40– | Ch 56– |
| 11 | Ch 9– | | Ch 25– | Ch 41– | Ch 57– |
| 12 | Ch 10– | | Ch 26– | Ch 42– | Ch 58– |
| 13 | Ch 11– | | Ch 27– | Ch 43– | Ch 59– |
| 14 | Ch 12– | | Ch 28– | Ch 44– | Ch 60– |
| 15 | Ch 13– | | Ch 29– | Ch 45– | Ch 61– |
| 16 | Ch 14– | | Ch 30– | Ch 47– | Ch 62– |
| 17 | Ch 15– | | Ch 31– | Ch 47– | Ch 63– |
| 18,19 | A | | A | A | A |
| 20 | Ch 0+ | | Ch 16+ | Ch 32+ | Ch 48+ |
| 21 | Ch 1+ | | Ch 17+ | Ch 33+ | Ch 49+ |
| 22 | Ch 2+ | | Ch 18+ | Ch 34+ | Ch 50+ |
| 23 | Ch 3+ | | Ch 19+ | Ch 35+ | Ch 51+ |
| 24 | Ch 4+ | | Ch 20+ | Ch 36+ | Ch 52+ |
| 25 | Ch 5+ | | Ch 21+ | Ch 37+ | Ch 53+ |
| 26 | Ch 6+ | | Ch 22+ | Ch 38+ | Ch 54+ |
| 27 | Ch 7+ | | Ch 23+ | Ch 39+ | Ch 55+ |
| 28 | Ch 8+ | | Ch 24+ | Ch 40+ | Ch 56+ |
| 29 | Ch 9+ | | Ch 25+ | Ch 41+ | Ch 57+ |
| 30 | Ch 10+ | | Ch 26+ | Ch 42+ | Ch 58+ |
| 31 | Ch 11+ | | Ch 27+ | Ch 43+ | Ch 59+ |
| 32 | Ch 12+ | | Ch 28+ | Ch 44+ | Ch 60+ |
| 33 | Ch 13+ | | Ch 29+ | Ch 45+ | Ch 61+ |
| 34 | Ch 14+ | | Ch 30+ | Ch 47+ | Ch 62+ |
| 35 | Ch 15+ | | Ch 31+ | Ch 47– | Ch 63+ |
| 36,37 | A | | A | A | A |
| Shell | Mains earth | | Mains earth | Mains earth | Mains earth |

A = analogue ground

* channel number cannot exceed 127

## Introduction

The Micro4 requires little maintenance. A few operations need the case to be opened, such as setting the internal options switch or replacing damaged ICs. This section also discusses updating the flash ROM and re-calibrating the analogue system.

## Taking the lid off

Take precautions against static electricity. The case is connected to mains earth by the power cable; switch power off at the mains but leave the cable plugged in. Earth yourself to the case by a wrist strap. Unscrew the four M3 screws on the back panel with a 2 mm hex wrench. Swing it aside, but leave the green & yellow earth wire attached. Slide out the top cover. Now you can slide out the inner can, unplugging the earth wire where it plugs in at the side. Take care not to splay the sides of the case; it loses its rigidity with the back panel off.

### Opening the can

To open the inner can, unscrew the three small 'combi' screws on each side with a 1-pt Pozidriv screwdriver. Gently pull the lid up and off. Note the graphite-impregnated gasket strips: store them carefully, since they are quite delicate.

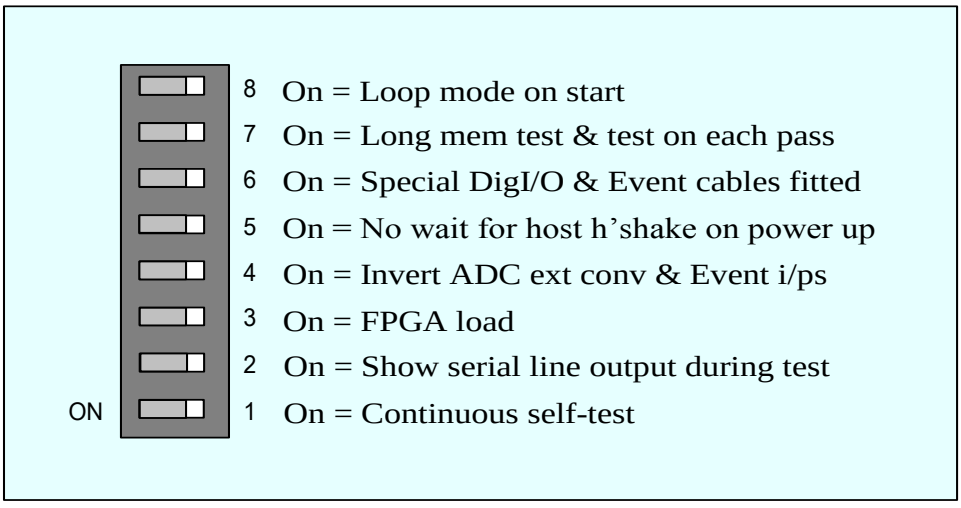
### Closing the Micro4

To close the Micro4, simply reverse this procedure.

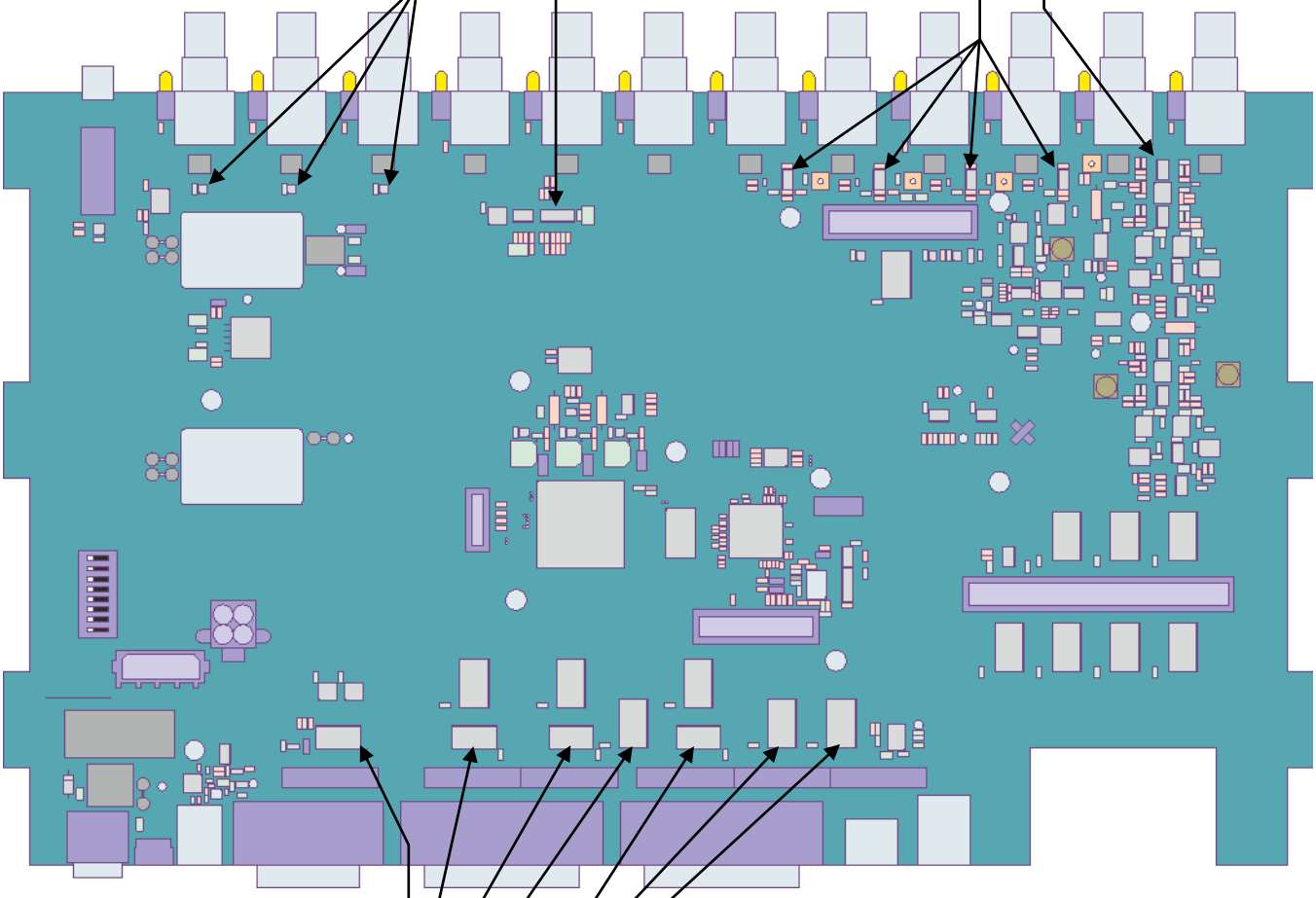
## Switch settings

This diagram shows the Micro4 internal options switch settings. Most concern self-test and debug and are only relevant to test engineers. Normally all switches are Off, physically towards the centre, as shown. Programmers can override switch settings, until the next power cycle, with the inbuilt INFO command.

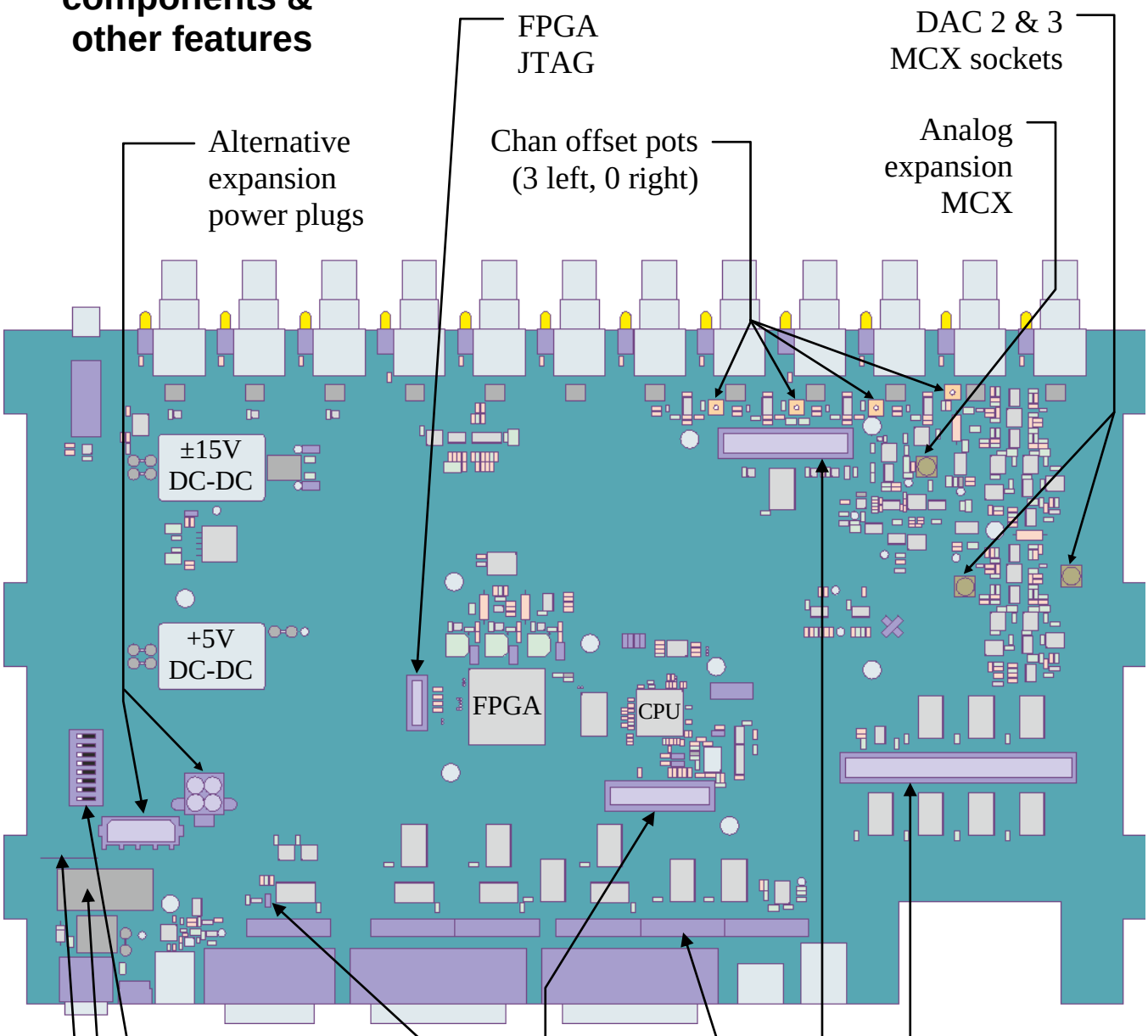
### *SW2 options*



## Location of I/O chips



## Adjustable components & other features




Options switch, position 1 at bottom

DC power relay

Earth tag

Clock out link

CPU JTAG/ debug

Event & digital I/O breakout headers (6 off) (if fitted)

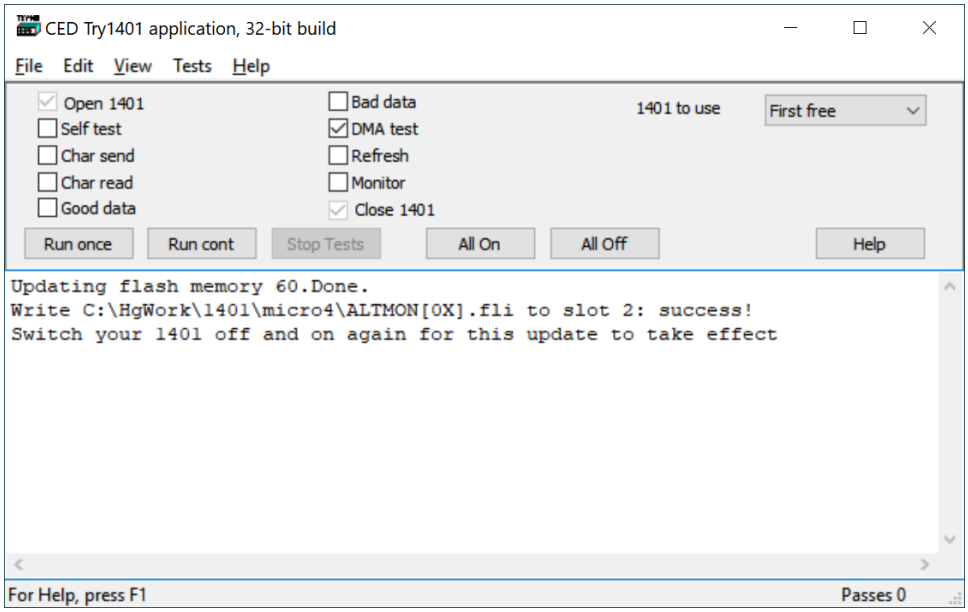
Analogue expansion header

Digital expansion header

## Flash ROM and the Micro4 Firmware

The Micro4 stores its firmware in non-volatile flash ROM. The primary boot loader is stored in block 0; the monitor (i.e. the operating system) and the power-on self-test (POST) are in block 1. These blocks are in the CPU itself. The FPGA configuration image is stored in block 12, in an external QSPI memory. The primary boot loader loads this firmware on power-up as long as the rear-panel Mode switch is in position 1. Alternative monitor and POST can be stored in block 2, and alternative FPGA firmware in block 13; to select these, set Mode to position 2.

***Memory block update report***




## Upgrading firmware with Try1401

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 9); 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…*

To use the new firmware, set the rear-panel Mode switch to 2 and switch the DC power off and on again.

## Analogue calibration

*ADC & DAC Test* is used to calibrate the ADC inputs. 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 Micro4 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.

### Running ADC & DAC Test

*ADC & DAC Test* is an option inside the *Tests* menu of Try1401. See page 10 for ways of entering this program. *ADC & DAC Test* is a sequence of dialogue boxes. Each box lists the equipment required and the instructions for that stage of the calibration. The aim of the task is to calibrate the DACs against the DVM, then calibrate the ADC against the DVM using voltages generated by DAC0.

### Equipment required

To make use of this program you will need 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 Micro4 to warm up with power on for at least 30 minutes before you start the calibration, to allow the system to reach thermal equilibrium.

### The lid stays on

The Micro4 should not need opening for calibration, since the only manual trim pots are for setting the ADC input-amplifier offset voltages, which are unlikely to drift significantly during the lifetime of the unit. All other trim pots are electronic.

### Caveat

It has to be said that calibration is a complex and tedious job. You may well prefer to return your Micro4 to CED for calibration. See page 37 for advice on sending it back.

## Cleaning the Micro1401

The Micro1401 needs regular cleaning to remain in good condition. Before cleaning, remove power and all cables from the Micro1401.

The exteriors of the Micro1401 case and the power supply should be cleaned annually to remove deposits of foreign matter, with a soft cloth moistened with a mild detergent solution. Avoid spilling drops of water or any other liquid on the Micro1401. Note: this product is not designed to withstand abrasive or caustic cleansing products.

Check the BNC connectors and rear-panel plugs and sockets for pieces of paper or fluff. If any are seen, remove them with a pin.

Check cables visually for fraying or other mechanical damage.

## Overview

The Micro4 has extensive built-in self-test capabilities, backed by a range of test and diagnostic programs to pin-point problems. If you suspect a hardware fault, follow the procedures below to obtain as much information as you can about the problem, then call the CED Hardware Help Desk for advice. If an IC has been damaged, we prefer to replace it at CED; however, you can do it yourself by opening the box, unsoldering the dead part and soldering-in a new one. See pages 30 & 31 for opening the box and locating ICs. An electronic technician should have no difficulty doing this, except maybe for the USB chip, which is a very small QFN32 device.

## Stand-alone test

The simplest Micro4 test, to rule out a host computer or cable fault confusing matters, is to disconnect the host cable at the Micro4 end, remove all signal connections, then power-up the Micro4. If all is well, the DC switch LED will turn on red. The BNC LEDs will flicker, then the DC switch LED will turn blue and remain so. If the Micro4 behaves like this, yet still is faulty in operation, the fault probably lies in the interface cable, the host computer hardware or the host computer software.

## Running Try1401

If the DC switch LED begins to flash red, the internal Micro4 power-up self-test has detected a problem. It is likely that Try1401 will be able to provide details. You will need to connect your Micro4 to the host computer before running the test. Open Try1401 by selecting

*Start, Programs, SpikeN, Try1401* or
*Start, Programs, SignalN, Try1401* or
*Start, Programs, Test1401, Try1401.*

('*N*' being the version number of the relevant application.)

Check the *Self test* box, then click on *Run once*. If no errors are found, try 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`.

### Steady red LED

If the DC switch LED remains steadily red after power-up, Try1401 may not be able to help. Contact CED for advice.

## Calling the CED Help Desk

If you cannot overcome your Micro4 problems yourself, do call our Help Desk. Please email if possible; our email address is:

`info@ced.co.uk`

Otherwise, our phone 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 Micro4, printed on the back, in the form M 6xxx.
- 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® Core™ i5-4690 ×4, 3·5 GHz, 16 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 Micro4 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. (Note that requirements are liable to change after Brexit.)
- Include a paper description of the problem with the equipment.
- Make sure the packaging is adequate to avoid damage in transit. Packages may fall *more than two metres* between conveyor belts! The original carton is ideal for this.

# Index

| | | | |
|---|---|---|---|
| **Waveform inputs** | Input impedance | 1 | MegOhm |
| | Active working range | ±5, ±10 | Volts |
| | Safe voltage range | ±15 | Volts |
| | Maximum conversion rate | 1 | MegaHertz |
| | Resolution | 16 | bits |
| | Crosstalk & noise | ±3 | LSBs up to 200kHz/chan |
| **Waveform outputs** | Active working range | ±5, ±10 | Volts |
| | Safe drive capability | 600 | Ohms |
| | Full accuracy drive | 5 | kilOhms |
| | Typ. major-carry glitch energy | 10 | nV.s |
| | Maximum update rate | >500 | kiloHertz |
| | Resolution | 16 | 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** | Micro4 | 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 Micro1401-4

Manufactured by:

Cambridge Electronic Design Limited
Technical Centre, 139 Cambridge Road, Milton, Cambridge CB24 6AZ
Tel +44 (0)1223 420186

Conforms with the protection requirements of Council Directive 2014/30/EU,
relating to Electromagnetic Compatibility,
by the application of the following harmonized EMC standard:

EN61326-1 (2013) Class B with Amendment 1 (2019) - COMPLIES

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

Signature 

Peter Rice
Technical Director

Date 03 September 2019