Digitimer

D400

Multi-channel 50/60Hz Mains Noise Eliminator

OPERATOR'S MANUAL

Two channel D400-2
Four channel D400-4

CE

For Research Use Only

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Product Registration

Please take time out to register your new product.

Details are included in the Introduction.

You can even do it online at:-

www.digitimer.com/register

D400 Intended Use & Description

Introduction

The Digitimer D400 is a multi-channel, standalone, mains noise eliminator designed for real-time removal of 50/60Hz mains noise interference from amplified biological and other signals prior to acquisition by digital data recording systems. The D400 is unique as the first commercially manufactured, multi-channel, standalone noise eliminator and does not need to be operated in conjunction with any particular brand of data acquisition system.

The Problem

Mains interference is a perennial problem in the field of electrophysiology, where low amplitude signals of interest need to be discriminated from background electrical noise generated by nearby electrical devices. While we would always recommend traditional noise removal techniques such as adequate grounding, positioning of equipment and the use of a Faraday cage before employing the D400, this device is ideally suited to situations where mains noise cannot be completely removed using the methods above or where the noise is intermittent. The D400 also has a role in mobile or temporary electrophysiological setups, such as in hospitals, classrooms or other environments where mains noise is likely to be a particular problem.

Theory of Operation

For those unfamiliar with the concept of operation of active noise eliminators, the D400 receives amplified analogue voltage signals from an amplifier or signal conditioner via its inputs and as these signals pass through the D400, the noise eliminator constructs and

continuously updates a phase-locked "mains noise template", subtracting this template from the original analogue signal. Noise removal occurs in real-time and as the noise template is constantly evolving, the D400 compensates for changes in amplitude or other characteristics of the noise.

While the method of noise removal employed by the D400 follows the principles of operation of other single channel devices, such as the Quest Scientific "Humbug", the hardware and software algorithms of the D400 have been developed wholly by Digitimer and are unique to this device.

Not only does the D400 remove mains noise in the 50Hz to 60Hz frequency, but it is also effective at removing associated harmonics of these frequencies. Importantly, and unlike standard 50/60Hz notch filters, this method of noise removal is not detrimental to signals of interest, even if they lie within the 50-60Hz frequency range.

Furthermore, the signal pathway through the D400 is analogue throughout, meaning that the input signals are not digitised at any point, thus preserving complete data integrity.

In normal use, the D400 would be incorporated into the signal processing pathway following any amplification and signal conditioning stages, but immediately prior to data acquisition or signal visualisation. Pre-amplification of the signals ensures that the input to the D400 is of an adequate amplitude to optimise the noise removal process.

Unpacking the D400

After unpacking the D400 and accessories from the shipping carton, please inspect each piece for any sign of shipping damage. Please contact the carrier and your distributor, or Digitimer Limited, immediately if there is any damage. Do NOT dispose of the shipping carton, as the carrier will want to examine it in order to process a damage claim. Digitimer Limited and their distributors insure all shipments to cover shipping damage.

It is also advisable to keep the shipping carton in the event that the instrument needs to be returned for service.

Supplied Accessories

The following items are included with the D400 Multi-channel Mains Noise Eliminator:

- Mains lead/Power cord
- USB Cable for host PC connection (**D-USBF**).
- D400 Operator's Manual (this document).
- 2 or 4 Channel Input Lead (female DB9 to multiple BNC): **D990-32** (for D400-2), **D990-34** (for D400-4).

- 2 or 4 Channel Output Lead (male DB9 to multiple BNC): **D990-33** (for D400-2) **D990-35** (for D400-4).

Optional Accessories

The following items are optional purchases available from Digitimer or our local representatives.

- **D990-17** 8 Channel Signal Link Cable (for use with Digitimer D360, D360R, D440-2 or D440-4 amplifiers).
- **NL951B-1m** or **NL951B-2m** 1m/2m Lemo to BNC cable.
- **D185-TC3** BNC to BNC cable (1m)
- **D185-TC3-2M** BNC to BNC cable (2m)

Precautions and Warnings

Operator's Manual

Carefully study this Operator's Manual before using the D400 Multi-channel Noise Eliminator.

Explosion and Fire

The D400 must not be used in an explosive or volatile atmosphere.

Damage

The D400 and/or any accessories must not be used if there are any signs of external damage.

Moisture

The D400 and/or any accessories must not be used if any parts are wet or damp.

Electrical Interference

This unit has been fully tested for European (CE) EMC conformity. This unit should NOT be used near radio transmitters. If any 'strange' behaviour of the unit is noted, discontinue use immediately and refer to a qualified EMC engineer.

Contact Addresses

Manufacturer

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E-mail: svalenti@digitimer.com

Please contact Digitimer for Representatives in other countries.

Servicing & Maintenance

This equipment does not require any regular maintenance but if you would like your D400 to be serviced we are happy to do so. Please contact us for a reference number and instructions before despatching the unit.

Before each use - The case and all interconnecting cables should be inspected for any damage. The equipment (or the lead) should be sent for repair if any damage is found.

Environmental Considerations

The European Union has adopted Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE), with requirements that went into effect August 13, 2005. WEEE is intended to reduce the disposal of waste from electrical and electronic equipment by establishing guidelines for prevention, reuse, recycling and recovery.

As part of our legal obligation, Digitimer Limited is a registered EEE producer. Our WEEE registration number is WEE/BJ0052TQ. For further information relating to the correct method of disposal of any of our equipment, which features this label  , please contact us.

Warranty Information

Limited Warranty

Digitimer Limited warrants to the first purchaser, for a period of one year from the date of purchase, that this Digitimer instrument (hereafter referred to as the "Product") will be free from defective workmanship and materials, and agrees that it will, at its option, either repair the defect or replace the defective Product or part thereof at no charge to the purchaser for parts and labour. The Product must be returned to Digitimer Limited, carriage paid and insured. Digitimer Limited will return the Product, carriage paid and insured, in the most appropriate method as determined by Digitimer Limited. If a faster shipping service is desired by the customer, any additional special delivery expenses must be paid by the customer.

This warranty does not apply to shipping damage. Digitimer Limited fully insures all shipments. Any claims of damage upon receipt must be filed with the carrier and Digitimer Limited immediately.

This warranty does not apply to any exterior appearance item of the Product which has been damaged or defaced, which has been subjected to misuse and abuse, abnormal service or handling, or which has been altered or modified in design or construction.

This warranty does not apply to any interconnection cables supplied with the Product.

This warranty does not apply if any unauthorised repairs, modifications or alterations have been made to the Product.

No sales organisations, other than Digitimer Limited itself, are authorised to make any warranties other than those described above, or to extend the duration of any warranties beyond the time period described above on the behalf of Digitimer Limited. If Digitimer Limited agrees to such a modification of this warranty, Digitimer will furnish a modified copy of this agreement, which must be presented if a claim is being made under these modified terms.

Obtaining Warranty Service

Warranty service of this Product can be obtained by returning the Product, carriage paid and insured, to Digitimer Limited, or the Distributor from whom the equipment was purchased. Prior authorisation before shipping the product is advised for the most expedient service.

Product change or discontinuation

Digitimer reserve the right to discontinue any instrument or to change its specification without notice, and without responsibility for incorporating changes in instruments already sold.

Register Your Purchase for a Warranty Extension

For a speedy response to all your questions now and in the future, please take time out to register your new D400 at www.digitimer.com/register now! Product registration permits us to quickly advise you of any safety matters or new product information. This web address is your point of contact for all questions regarding the D400. The site's contents are now growing rapidly, so please bookmark it so that you visit it regularly to check out the new items.

Why Register your purchase?

Digitimer Limited periodically offers enhancements and updates to our products. Without product registration, users of our products may miss out on announcements of important enhancements to the products that they are using

Digitimer Limited does not make our customer list available to anyone else. Any information that you provide to us is strictly confidential.

How to Register your purchase

Product registration can be accomplished in two ways. You may fill out and mail in the product registration/warranty card supplied with each Digitimer Limited product. You may also register on-line at our www.digitimer.com/register website.

Product announcement mailing list

Digitimer Limited has e-mailing lists which we use as our primary outlet for announcements of new products, product enhancements and product updates. We strongly recommend that all users of our products sign up for the list that is most appropriate to their area of interest. E-mail is kept to a minimum and list membership is kept in the strictest confidence. Only Digitimer Limited can send mail to members of our e-mailing lists.

You may join the D400 mailing list through our www.digitimer.com/register website.

Specifications

Number of Channels: 2 (D400-2), 4 (D400-4)

Working Input Voltage Range: ±10V

Maximum Noise Amplitude: ±1V (pk-pk)

Output Voltage Range: ±10V

Frequency Response: DC to 1MHz (-3dB)

Front Panel Controls:

- CLEAR - Erases existing noise templates
- HOLD - Freezes existing noise templates
- BYPASS - Pass-through of raw signals direct to outputs

Front Panel Indicators:

- Power (Green)
- Signal (Green) & Template (bi-colour Green or Amber)

Inputs/Outputs

- BNC input and output sockets (one pair per channel)
- Combined signal inputs/outputs via pair of DB9 connectors
- Potential Equalisation Connector (PEC)
- USB socket for connection to host PC
- IEC Mains power inlet socket

Operating Voltage Range: 100V - 240V

External Fuses:

- 100-120 V mains T 400 mA L 5 x 20 mm, 250 V
- 200-240 V mains T 200 mA L 5 x 20 mm, 250 V

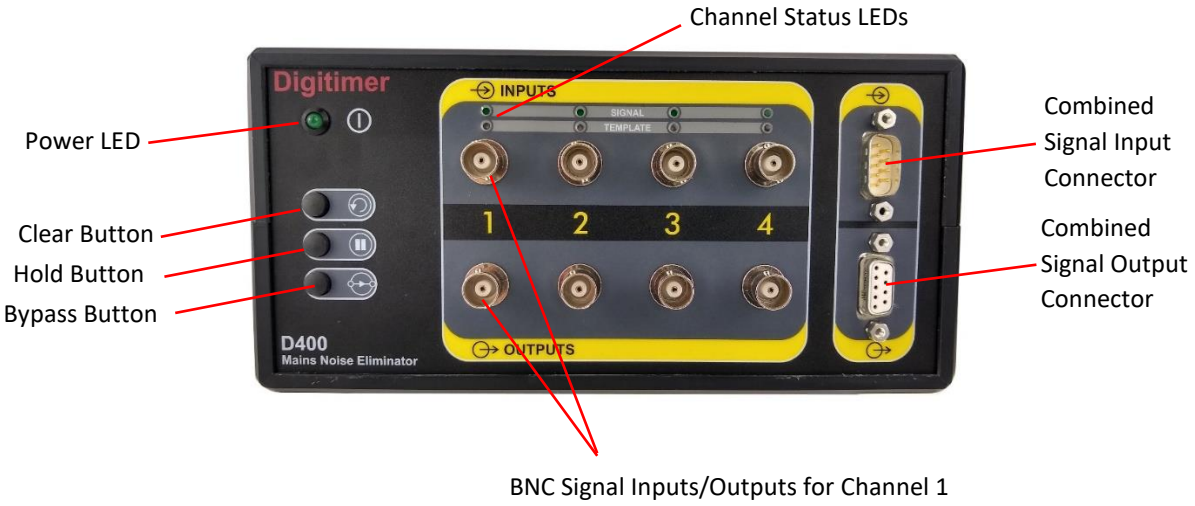
Unit Dimensions: 200mm (W) x 275mm (D) x 110mm (H)

Weight: 2.5kg (D400-4)

Hardware Overview

The D400 is designed for ease of use, has very few controls and is essentially "plug and play". There are three push buttons on the left of the front panel and to the right of these are multiple pairs of signal input and output connectors, as well as equivalent 9-way "D" connectors for all channels. Associated with the individual signal connectors are several LED indicators which show the status of each channel (see below).

D400 Front Panel Components



Power LED

Once powered on, the D400 will enter a start-up stabilisation phase signified by the front panel POWER LED flashing green for approximately 40 seconds. This LED will be permanently lit once the D400 is ready to use.

Signal Input/Output Connectors

The D400 offers the user two alternative methods for signal input and output connection. For each channel there is a pair of standard BNC connectors designated "Inputs" and "Outputs". In addition, two 9-way "D" connectors are available for combining input and/or output signals via the supplied signal input/output cables.

The operational signal range of the D400 is ±10V and amplifiers or signal conditioners providing voltages in excess of ±10V are not compatible with the D400.

Channel Status LED's

Above each BNC input socket are two LED's. When the D400 is actively removing noise from a signal, the SIGNAL LED is green and the bi-colour TEMPLATE LED is Green or Amber. The TEMPLATE LED's change colour or are extinguished when the D400 is in different operating modes (see below).

Front Panel Controls

The front panel of the D400 has three push buttons. These buttons have the following functions:-

CLEAR

A single press erases the existing noise template and the D400 begins to construct a new one. When this button is pressed and the template erased, any previously removed mains noise present in the signal will re-appear and gradually decrease in amplitude as a new noise template is constructed.

HOLD

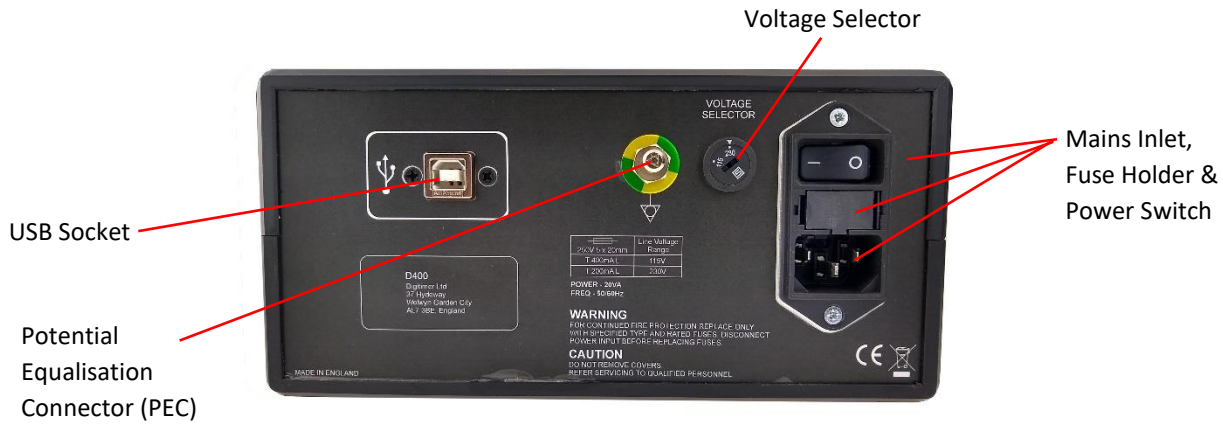
This freezes the noise template so it no longer evolves with changes in the noise level. This may be useful in situations where the user needs to adjust some recording equipment and expects to introduce briefly, some additional noise. Pressing HOLD again once the interruption has taken place, unfreezes the template, causing minimal disruption to the noise removal process. While the D400 is in the "Hold" mode, the TEMPLATE LED's are AMBER.

BYPASS

This allows the user to see what the raw signal passing through the D400 looks like without any noise cancellation. When the D400 is in "Bypass" mode, the TEMPLATE LED's are extinguished.

All three front panel buttons apply their actions globally (i.e. to every channel). For independent channel control, it is necessary to use the D400 Control Panel Software.

D400 Rear Panel Components



Mains Inlet, Fuse Holder & Power Switch

Accepts standard IEC mains lead (supplied). Operates over 100-120V and 200-240V.

The D440 is fitted with fuses appropriate for the voltage selector setting. These fuses should only be replaced by qualified personnel.

- 100-120 V mains T 400 mA L 5 x 20 mm, 250 V
- 200-240 V mains T 200 mA L 5 x 20 mm, 250 V

Voltage Selector

Check that the voltage selector on the back panel of the instrument is set correctly for your supply voltage. The factory setting is 230 volts and the alternative is 115 V.

- The 230 V setting allows use on supplies from 200 to 240 V.
- The 115 V setting allows use on supplies from 100 to 120 V.

Potential Equalisation Connector (PEC)

Earth/Ground reference for unit and bonding point. This is to be used when the earth/ground conductor in the mains lead cannot be relied upon.

USB Socket

Provides USB connection to host computer running Windows OS. USB connection allows:-

1. Software control of D400 settings via Control Panel.
2. Updates to firmware.
3. Recalibration of the D400.

Installation & Use of the D400

1. Check the D400 and accessories for any sign of damage before proceeding. Please contact Digitimer if any damage is present.

2. Confirm the rear panel voltage selector is correctly set and mains inlet fuses are of the appropriate rating for the local power supply voltage.

3. Connect the mains lead to the D400 rear panel mains inlet socket and power the unit on using the associated On/Off switch. If the D400 Control Panel Software is being used, double-click on the program shortcut to run it.

4. Once powered on, the D400 will enter a start-up stabilisation phase signified by the front panel POWER LED flashing green for approximately 40 seconds. This LED will become permanently lit once the D400 is ready to use.

5. Signal input and output cables may be connected via the BNC sockets or via the "D" connectors. It is normal for the D400 to be located in the signal pathway after any amplification or signal conditioning, but immediately before the data acquisition or visualisation stage.

6. This arrangement ensures the input signals are adequately amplified before noise subtraction takes place. The D400 accepts and outputs voltages in the range of ±10V.

7. Once signal input and output cables connected, the D400 will start to construct the noise template and a reduction in mains interference should become apparent within the observed/acquired signals.

8. The three front panel buttons provide global control of all channel settings, while the D400 Control Software permits individual channel control.

D400 Control Panel Software

The D400 is a standalone device and does not need any software, however, our Control Panel replicates the three physical front panel buttons on the D400 and also provides the following additional features:-

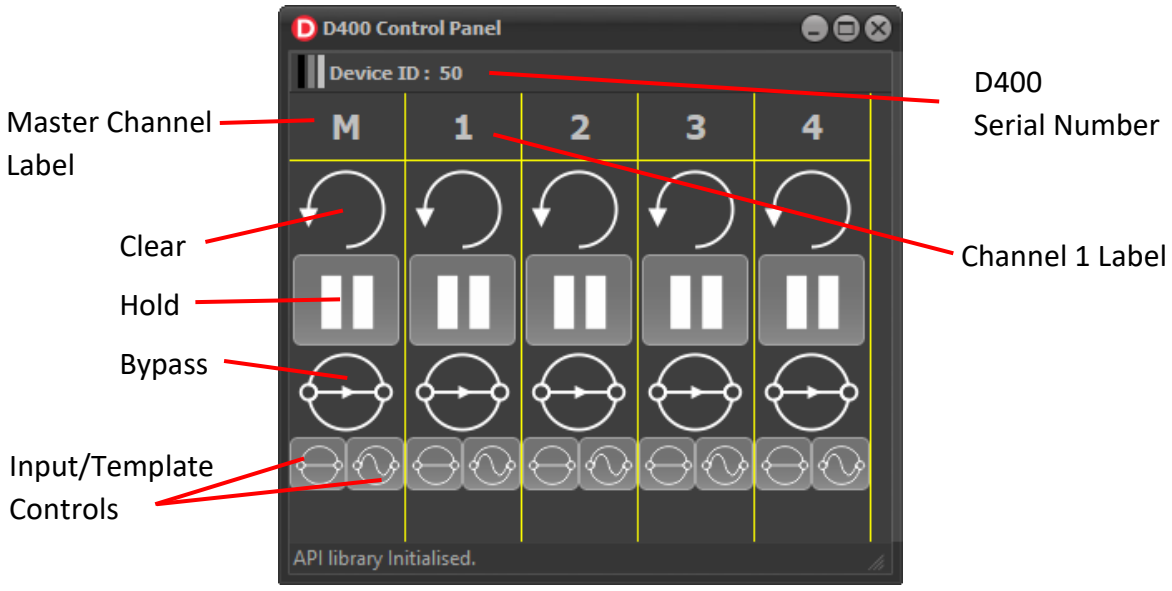
- Individual control of the Clear, Hold and Bypass functions for each channel.
- Ability to toggle the input signal on and off, allowing the noise template to be visualised in isolation from the signal of interest.

Software Installation

The D400 Control Panel software is available from the Digitimer website. The software is intended for use and is compatible with 32bit or 64bit Microsoft Windows 10 operating systems. Compatibility with earlier versions of Windows is not guaranteed.

1. Download the software installer and if necessary copy the file to a USB stick and insert into a USB port on the host PC.
2. Browse to the D400 Control Panel software installation file.
3. Double-click on the installation file and follow the installation instructions.
4. Following installation, a D400 shortcut will be placed on the Windows desktop.
5. Connect the D400 to the host PC using supplied USB cable and power it on.
6. Double-click on the D400 desktop shortcut to run the D400 Control Panel Software.

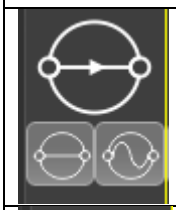
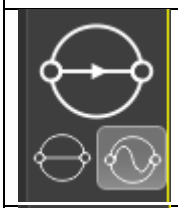
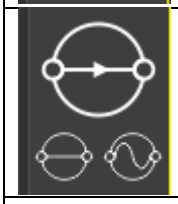
Software GUI Controls



The software controls of the D400 are laid out in a grid, with Master Control (M) on the left and individual channel control labelled 1 and 2 (D400-2) or 1 to 4 (D400-4) in the additional columns of the grid. Below the channel labels are three large "Clear", "Hold" and "Bypass" icons. Clicking on these icons replicates the actions of the hardware buttons, making settings changes that are global (Master channel) or on a per channel basis.

Below the "Clear", "Hold" and "Bypass" controls are a pair of smaller icons, associated with the Bypass feature, that allow the user to toggle the input signals (left icon) and template subtraction processes (right icon) on or off.

The table below summarises how these two controls influence the behaviour of the D400 and which signals are passed to the outputs.

Icon Status	Front Panel LED Status	Description of D400 Mode
	Signal: Green Template: Green or Amber*	**Normal Operating Mode (Bypass OFF)** The input signal is passing through the D400 to the output and template subtraction process is active i.e. normal noise subtracting state.
	Signal: Green Template: Extinguished	**Bypass Mode ON** The input signal is passing through the D400 to the output, but the template subtraction process is inactive i.e. the input signal = output signal and noise is not being actively removed.
	Signal: Extinguished Template: Green or Amber*	The input signal is not passing through the D400, but the template subtraction process is still active. The output signal is the inverted noise template and does not include the input signal.
	Signal: Extinguished Template: Extinguished	The input signal is not passing through the D400 and the template subtraction process is inactive. The output signal reflects the output noise from the D400.
* Template LEDs are Amber if Hold is active		

Third Party Software Control

The D400 Control Panel software incorporates a simple advanced programmer's interface (API), which is available for users who wish to control the D400 via their own or third party software, rather than use our own GUI. If you are interested in using the API, please contact us, providing details of the software you intend to use and what programming or scripting languages you typically employ.

References

As the D400 is a new product we do not have any publications that cite its use, however, if you publish research which has used the D400, please cite the Digitimer D400-2 or D400-4 in your methods section to help other researchers e.g. *D400-2 Mains Noise Eliminator (Digitimer Ltd., Welwyn Garden City, UK)*.

Digitimer would appreciate a copy of any relevant publications and could add details to this section of the manual.

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