

# Digitimer

# D188

## REMOTE ELECTRODE SELECTOR



## OPERATOR'S MANUAL



**For Research Use Only**

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# Section 1

## General Information



### D188 Intended Usage & Description

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The D188 Remote Electrode Selector can be used to direct electrical stimuli from a single stimulator to one of up to eight pairs of stimulation electrodes. It is particularly useful in applications where a stimulus needs to be presented to several stimulation sites, one site at a time, but only one stimulator is available.

Channel selection is controlled by **TTL compatible digital inputs** applied to the rear panel socket on the D188 or manually via **Windows compatible software** (supplied). A pair of stimulus inputs is provided for connection to a compatible electrical stimulator and there are eight pairs of stimulus outputs (channels), numbered from 1 to 8, each associated with a green LED to show when they are active. These LED's can be turned off for situations where it is important that the subject does not know which channel is active.

Although the D188 has been designed with human applications in mind, the D188 is not a medical device, so its use is limited to research applications. It should not be used for patient treatment or diagnostic purposes.

## Unpacking the D188

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After unpacking the D188 Remote Electrode Selector 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 should have been packed with your D188 Remote Electrode Selector:

- 12V Switched Mode Power Supply for 100V-240V input with plug adaptor(s).
- USB Cable for host PC connection.
- Quick Start Guide or Operator's Manual.
- Windows Compatible D188 Control App Software, including API for third party software control (supplied on USB Stick).
- Digital Communication Cable (1m long, 15-way "D" connector to 10 tinned wires).

## Optional Accessories

- D185-OC1 4mm Plugs (pair of 4mm touch proof plugs, compatible with the outputs on Digitimer DS5, DS7A, DS7AH Isolated Stimulators).
- NL844P Plugs (1.5mm DIN42802 plugs, available in red and black).
- D185-HB4 Output Extension Cable (4mm touch proof plugs to 1.5mm touch proof sockets).
- NL985P 2mm Plugs (pair of 2mm touch proof plugs for use with Digitimer DS2A, DS3 and DS4 Isolated Stimulators).
- Stimulator connection cables: D188-09 (female 1.5mm touch-proof, 2m), D188-10 (female 1.5mm touch-proof, 50cm), D188-11 (2mm male touch-proof to 1.5mm female touch-proof, 50cm) and D188-12 (4mm male touch-proof to 1.5mm female touch-proof, 50cm).
- Output Extension Cables: D188-13 (1m long) and D188-14 (2m long). Supplied in pairs for extending the length of electrode leads fitted with 1.5mm DIN42802 touch-proof connectors.

## Mains Connections

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The D188 is shipped with a 100V-240V input power supply and plug adaptor plates for UK, European (Schuko) or North American wall sockets. For countries that do not use one of these types of socket, we recommend obtaining a compatible travel adaptor.

## Specifications

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<b>Maximum Stimulus Input Voltage:</b>	400V.
<b>Maximum Stimulus Input Current:</b>	1A.
<b>Minimum Switching Interval:</b>	1ms.
<b>Digital Input Requirements:</b>	TTL Logic (5V).

### Front Panel Connections:

- Common (COM) Inputs: One red, one black 1.5mm DIN 42802 male sockets.
- Stimulus Outputs: 8 pairs of red and black 1.5mm DIN 42802 male sockets.

### Rear panel Connections:

- USB Input (Type B Socket) for Win PC software control/setup.
- Power Supply Input Socket
- Digital Communication Socket (15-way Female "D" Connector).

### Indicators:

- 8 Green LEDs – One per channel used to indicate the active channel.

### Control Software:

Supplied on USB drive. Compatible with Windows 7 or higher.

### Weight & Dimensions:

Size: 152 x 55 x 178 mm (w x h x d).

Weight: 500g (approx.).

### Environmental:

Operating Range 10°C to 40°C 30 to 75%, non-condensing.

Storage Range -40°C to 70°C 10 to 100%, non-condensing.

Transport Range -40°C to 70°C 10 to 100%, non-condensing.





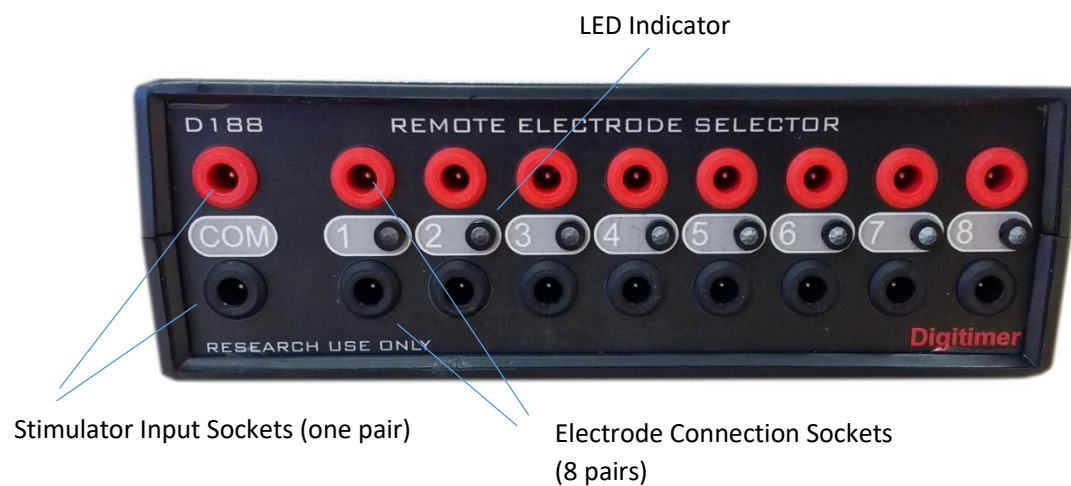
# Section 2

## D188 Installation

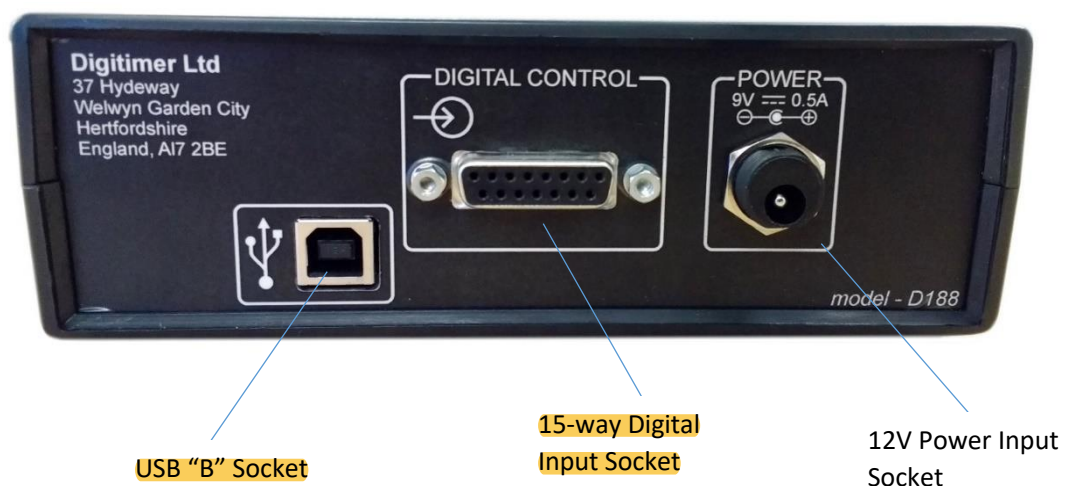
### Hardware Overview

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#### D188 Front Panel

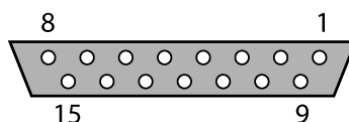


#### D188 Rear Panel



## D188 Digital Input Socket

The D188 is fitted with a 15-way female “D” connector which is used for digital control. Digitimer supplies a cable with the unit which has 10 tinned wires for user connection to a digital output device fitted with screw terminals. The wiring details for the socket and cable are given below.



Digital Input Connector  
Female Socket View

Pin	Function (Colour)	Pin	Function (Colour)
1	D0 (Black)	6	D5 (Green)
2	D1 Brown	7	D6 (Blue)
3	D2 (Red)	8	D7 (Violet)
4	D3 (Orange)	9	+5V (White)
5	D4 (Yellow)	10	GND/Cable Screen (Grey/Black)

Note that pins 11 to 15 are unused. A +5V pin is made available for anyone wishing to use this for button control of the D188 and is not needed for digital control.

## Installing the D188 Control Software

The D188 Control Software is supplied on a USB flash drive and is compatible with personal computers running Microsoft Windows 7 or higher.

1. Insert the USB stick and browse to the contents.
2. Double click on the D188 software installer file (\*.exe) and follow in the installation prompts to completion.

## Installing the D188 Remote Electrode Selector Hardware

Once the software has been installed on the host PC, the D188 can be connected to the computer.

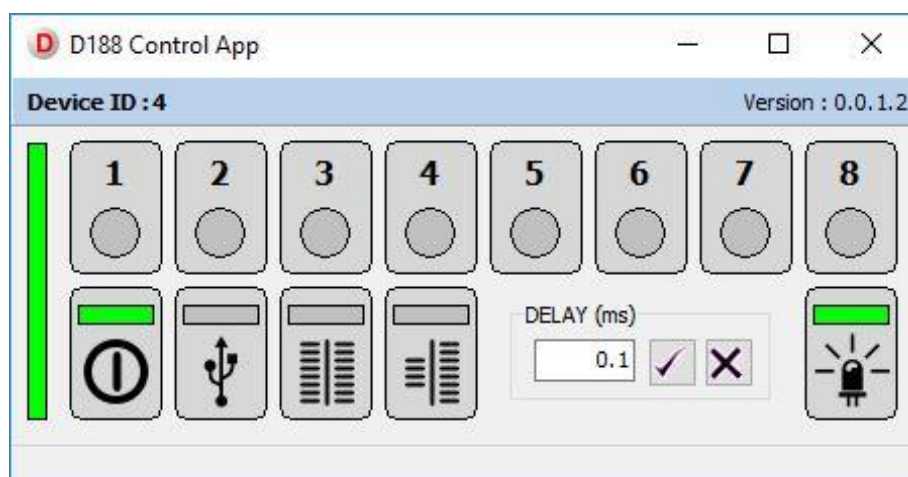
1. Connect the supplied USB cable between the D188 and a free USB port on the host PC.

2. Connect the 12V power supply adaptor to a powered wall socket the other end to the D188 rear panel power input.
3. There may be a delay of up to a minute as the D188 device drivers are detected and installed by the Windows operating system.
4. Once driver installation is complete, double click the *D188App* icon on the desktop to run the control software.
5. If the software detects one or more D188's, the device ID's (serial numbers) will be shown in the top left of each device's D188 software panel. D188's are always sorted with the lowest device number at the top and the highest at the bottom.
6. If a D188 is not detected, the software will display "Waiting...". If this happens, check the power supply and USB cables are connected or try a different USB port and/or wall socket.

# Section 3

## Software Overview

### Introduction



The D188 Control App Software is a virtual front panel for the D188 and allows the operator to manually switch channels using a left mouse click or keyboard number keys. The software also controls the operating modes of the D188, whether the LEDs associated with an active channel are illuminated and the **Delay/De-bounce setting**.

If multiple D188's are connected to the host PC, a narrow, vertical green bar moves between respective D188 panels to show which D188 is being managed (by the number keys) at a particular time.

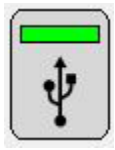
The D188 has three modes of operation and a standby setting. Modes are selected via a left mouse click on the mode button of choice. A green bar will highlight the active mode. Additional features and modes of operation are discussed in greater detail below.

#### Standby



When the D188 Control Software is first run, with a D188 connected to the PC via the USB cable, the software indicates the presence of a D188 by displaying the device ID (serial number) near the top left of the window and adding a green highlight to the Standby button icon, confirming the D188 is in standby. The D188 will not allow any stimuli to pass through it until one of the other operating modes below is selected.

## USB (Manual) Control Mode



The simplest control method is to use the USB connection to a host PC and the D188 Control Software to manually select which channel (electrode pair) is active. To use this mode, the operator needs to left mouse click on the button with the USB symbol to activate that mode, moving the green highlight to this button. It is then possible to activate individual channels by left clicking on each numbered button or using the 1 to 8 keys on the keyboard. The active channel is indicated by a green circular highlight within the software and a front panel LED on the D188 itself.

## 1:1 Digital Control Mode



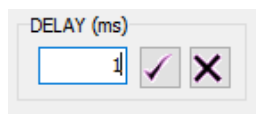
If the operator wishes to control the D188 using digital commands from a data acquisition board or other device, the D188 has the option to be controlled by 8 TTL compatible (5V) digital outputs in a 1:1 manner. See [1:1 Digital Control](#) for more detail.

## 4:8 Digital Control Mode



If eight digital outputs are not available, the operator can choose to use four digital outputs, defining a 4-bit binary string that the D188 receives through pins 1 – 4 (D0 – D3). See [4:8 Digital Control](#) for more detail.

## Delay/De-bounce Setting



The Delay/De-bounce setting allows the operator to introduce an adjustable delay in switching which can be **as long as 1000 milliseconds**. **This ensures that the voltage at any of the digital inputs has stabilised before the D188 makes changes to the active electrode pair**. See [Delay/De-bounce](#) for more detail.

## LED Control



In some applications it is important that the operator or subject of stimulation is unaware which channel is active. The D188 Control Software has a button that “cloaks” the unit, allowing the LED indicators of active channels to be toggled on or off. When the LED indicators are active, the LED Control button on the software window has a green highlight.

## Persistent Storage of Settings

Note that operating modes and other options are persistent when the D188 is powered off and back on. Any channels left active (on) in USB (Manual) mode are deactivated when power is removed. This reduces the risk of unintentional stimulation.

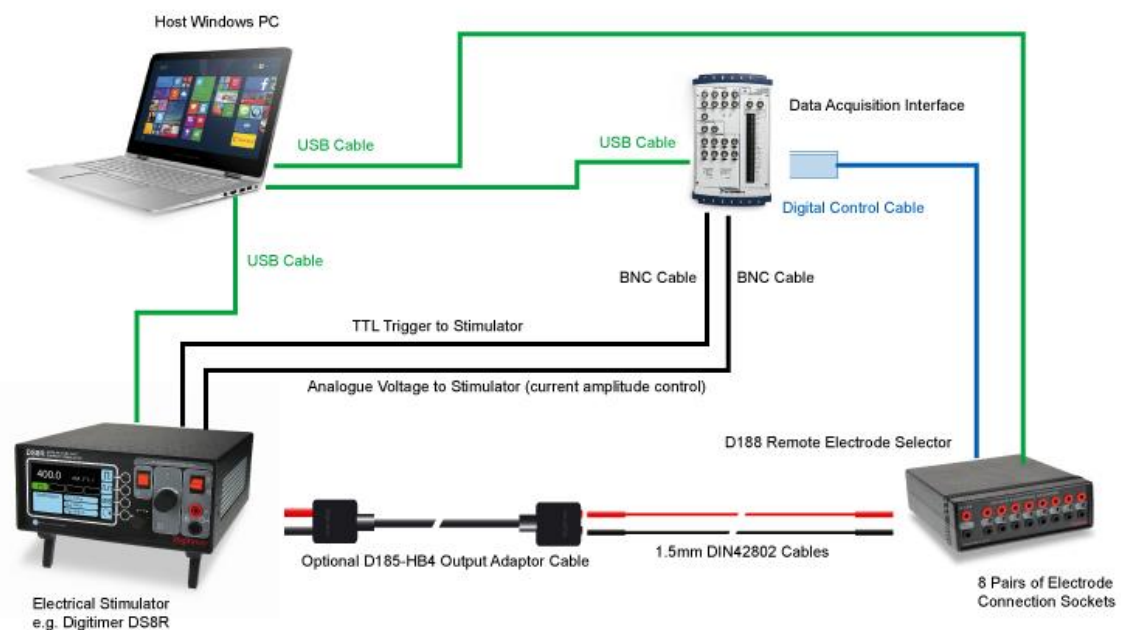


# Section 4

## System Operation

### Introduction

Once the operator is familiar with the D188 hardware and understands how the control software is operated, the next step is connection of the D188 to the source of stimulation, the stimulation electrodes and the digital trigger source. A schematic of a typical setup is given below.



The diagram above illustrates how a single PC and compatible DAQ hardware/software can be used to control the stimulation parameters of a Digitimer stimulator and direct electrical stimuli to one of up to eight pairs of electrodes, one pair at a time.

## Connecting the D188 to an Electrical Stimulator

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**The D188 is limited to a maximum input voltage of 400V and a maximum current of 1A. It should not be used with stimulators delivering higher levels than this.** The D188 is fitted with a pair of 1.5mm touch proof DIN 42802 sockets, labelled "COM" which are used to connect the stimulation source to the D188.

### Connecting to a Digitimer DS5, DS7A, DS7AH, DS7R or DS8R Stimulator

**D188-09** (2m long) or **D188-10** (50cm long) cables are required to attach the D188 input to our popular D185-HB4 Output Extension Cables.



If a D185-HB4 cable is not used, we offer the **D188-12**, which is a 50cm pair of cables with 4mm touch-proof connectors at the stimulator end and 1.5mm touch-proof female connectors at the D188 end.



### Connecting to a Digitimer DS2A, DS3 or DS4 Stimulator

As our non-human research stimulators are fitted with 2mm touch-proof sockets, so we offer the 50cm long **D188-11** cables to connect from this 2mm output to the 1.5mm input of the D188.



### Connecting to other Stimulators

If the stimulator to be used has an alternative type of output socket, the operator can remove plugs from one end of the cables above and re-solder with an alternative which is compatible with the stimulator. Digitimer supplies some plugs, but these are usually of a type compatible with our own clinical and research stimulators. Please contact us for details.

## Connecting the D188 to Stimulating Electrodes

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The D188 output connectors are also **1.5mm touch proof DIN 42802 sockets**, which are compatible with many of the electrodes Digitimer offers for human electrical stimulation, including **bar electrodes** and



**digital ring electrodes.** The operator has the option of connecting as many pairs of electrodes as needed, up to a maximum of eight.

If the electrode lead wires are too short, we offer pairs of output extension cables to increase the distance between the D188 front panel and the subject. These are available in 1m long (**D188-13**) or 2m long (**D188-14**) pairs.

## Using Multiple D188's with a Single Stimulus Source

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In order to use more than one D188 and a single stimulator, it will be necessary for the user to connect the stimulus source, in parallel, to the COM inputs of each D188. In this case, our D185-HB1 output adaptor cable would be a suitable alternative to our D185-HB4. Alternatively, the stimulus source can be connected to a single D188 and one output channel of that unit used to pass the stimulus to a second D188. In this way, multiple D188's can be "daisy chained" to one stimulator.

## Using Manual Control

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Manual control allows the operator to switch channels under mouse or keyboard control and is the best method of control when specifically timed digital control is not required. We recommend that there is a period of familiarisation, using the D188 in manual mode before any digital control protocols are commenced. This allows the operator to test and optimize the physical connections between stimulus source, computer, the D188 and the subject whilst also ensuring that the stimulator settings and electrodes are appropriate for the chosen application.

## Using External Digital Control

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Due to the nature of the device, digital control will require the D188 to be interfaced with other hardware which Digitimer may not supply or support. We therefore urge all users to take care when programming automated electrode switching processes and stimulus delivery protocols, to ensure that unexpected stimulation patterns are not delivered. All switching control protocols should be thoroughly tested before any electrical stimulation is undertaken.

### 1:1 Digital Control

If the operator wishes to control the D188 using digital commands from a data acquisition board or other device, the D188 has the option to be controlled by 8 TTL compatible (5V) digital outputs in a 1:1 manner. The D188 is supplied with a communication cable which connects to the rear of the D188 via the 15-way "D" connector input. The other end has tinned wires that can be soldered to a specific type of connector, wired into a break-out box or used with screw terminals on a data acquisition interface. In this operating mode, if Pin 1 (D0) is held TTL high, Channel 1 is active, if Pin 2 (D1) is held TTL high, Channel 2 is active etc.

**If more than one pin is set to TTL high, all outputs will be disabled**, to prevent stimulation through multiple channels.

## 4:8 Digital Control

If eight digital outputs are not available, the operator can choose to use four digital outputs, defining a 4-bit binary string that the D188 receives through pins 1 – 4 (D0 – D3). As with 1:1 mode, **channels remain active while the appropriate inputs are held TTL high.**

### Example Digital Input Configurations:

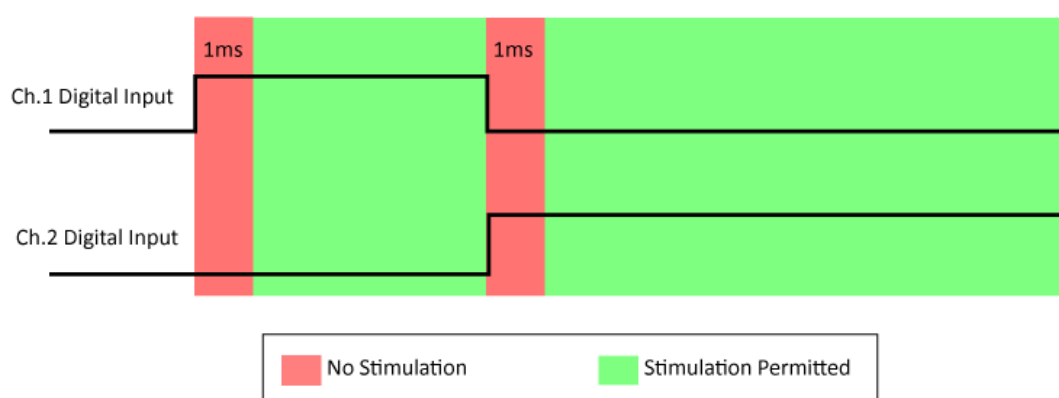
Channel 2 Active	Channel 4 Active	Channel 5 Active	Channel 8 Active
Pin 1 = 0 (TTL low)	Pin 1 = 0 (TTL low)	Pin 1 = 1 (TTL high)	Pin 1 = 0 (TTL low)
Pin 2 = 1 (TTL high)	Pin 2 = 0 (TTL low)	Pin 2 = 0 (TTL low)	Pin 2 = 0 (TTL low)
Pin 3 = 0 (TTL low)	Pin 3 = 1 (TTL high)	Pin 3 = 1 (TTL high)	Pin 3 = 0 (TTL low)
Pin 4 = 0 (TTL low)	Pin 4 = 0 (TTL low)	Pin 4 = 0 (TTL low)	Pin 4 = 1 (TTL high)

## Delay/De-bounce

The Delay/De-bounce setting allows the operator to introduce an adjustable delay in switching which can be as long as 1000 milliseconds. This ensures that the voltage at any of the digital inputs has stabilised before the D188 makes changes to the active electrode pair. **This may be of use if mechanical switches are used to control the D188, as “switch bounce” could be interpreted by the D188 as multiple rapid changes between TTL low and high, rather than a single state change.**

## Minimum Switching Times & Stimulus Pulse Duration

It is important to appreciate that the electrode switching process is not instantaneous. **It takes several hundred microseconds for the D188 to switch channels in response to a change in the TTL state of the digital inputs.** We recommend that stimulus delivery and digital switching protocols are devised which **allow for a 1ms pause in stimulation following a digital input state change.** If this pause is not adhered to, stimulation may occur in multiple channels during the 1ms transition period.



The recommended 1ms pause, following changes in the digital inputs, is indicated by the red blocks in the illustration above.

It is also important that the duration of an electrical stimulus is considered when programming a switching protocol. We recommend that any stimulus delivery events are bracketed by longer periods of D188 channel activation to ensure that the stimulation pulse has ceased and fully dissipated before the channel being stimulated through is changed.

### Digital Control Voltage Requirements

In the 1:1 mode the D188 requires +4V (@ 50µA), but when operated in 4:8 control mode, i.e. specifying the active channel using a 4-bit binary string rather than using 8 digital inputs, then the required voltage is lower and a device generating +3.3V would be adequate.

## Using the API for Third Party Software Control

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The D188 control software includes an API. While we recommend using digital control to switch channels for applications that require precise timing, it is possible to use third party software to switch channels via the USB connection.

During installation of the D188 software, the DGD18API.DLL is placed in the Windows System folders (System32 and SysWOW64).

To assist developers we provide a sample C++ example program within a zip file (D188-VS-C++Example.zip), located in C:\Users\<username>\Documents\Digitimer Limited

## Example Applications

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Below we include an example application which illustrates how the D188 has been used. We invite all D188 users to submit a brief summary of the application and list of hardware and software they are using, so we can add details to this section.

### Application 1: Tactile stimulation of multiple digits (sequentially) across both hands.

The aim was to develop a diagnostic test for somatosensory cortical reorganisation in patients with Complex Regional Pain Syndrome. Stimulation was applied no faster than 1Hz, with stimuli either repeating on the same digit or switching digits in a manner that appears random to the subject, but follows a pre-programmed sequence.

#### Hardware

Labjack U3-HV ([www.labjack.com](http://www.labjack.com)) sends instructions to the Digitimer D188 to change channel (digit stimulated) and to the Digitimer DS7A to stimulate via digital ring electrodes.

#### Software

Matlab (2015 version, [www.mathworks.com](http://www.mathworks.com)) programming creates stimulation sequences and instructions to the Labjack which time the digit changes and digit stimulations via the D188 and DS7A respectively. Control of the Labjack requires specific drivers and commands supplied by Labjack for use in Matlab.

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