

LIFE SCIENCE RESEARCH

Brief pulses of electricity are used in various biomedical research applications as a stimulus to excite nerve or muscle fibers. In order to minimise artifacts introduced into electrophysiological data, it is desirable that the stimulator (stimulus isolator) used should be electrically isolated both from ground and from the trigger device. The DS2A meets both of these requirements and will deliver a low noise, precisely controlled constant voltage stimulus of up to 100V, adjustable in pulse duration and amplitude. As with the DS3 Constant Current Stimulator the output comes from self-contained batteries. The DS2A can be triggered by a TTL compatible external device such as our DG2A Train/Delay Generator. The DS2A can be fitted into a 19" rack mounting frame (D121-11) which can hold up to two DS2A's, DS3's, DS4's or DG2A's.

FEATURES

- ✓ **Low noise battery power supply with up to 99V output**
- ✓ **Internal (20µs to 2s) or external TTL "gated" control of pulse duration**
- ✓ **Two voltage ranges (0-9V and 0-99V) allow precise reproducible control of stimulus output**
- ✓ **Polarity reversal switch**
- ✓ **Battery test sockets**
- ✓ **Single-shot trigger button**
- ✓ **In the case of low impedance preparations, current output is limited to 50mA by an overload protection circuit**
- ✓ **Current is only drawn from batteries when a stimulus is being delivered**



DS3 ISOLATED CURRENT STIMULATOR

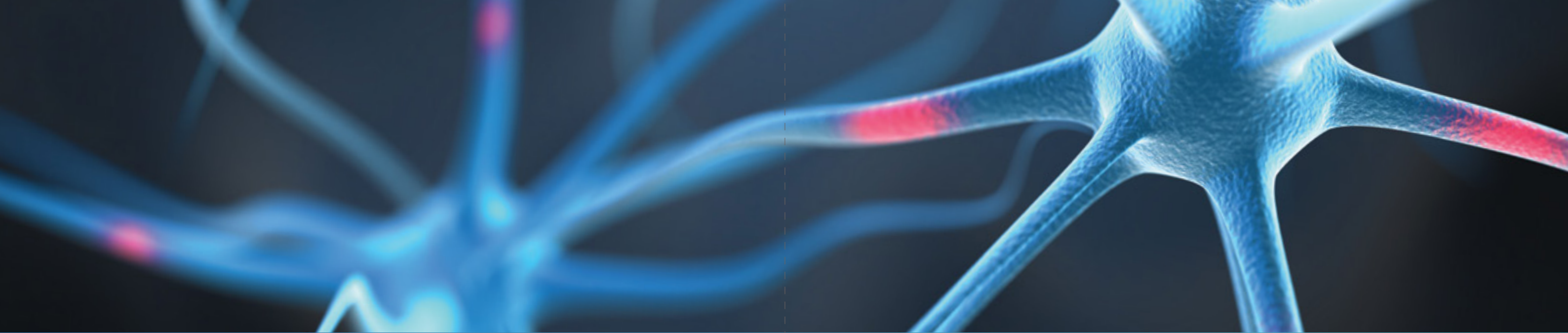
Brief pulses of electricity are used in various biomedical research applications as a stimulus to excite nerve or muscle fibers. In order to minimise artifacts introduced into electrophysiological data, it is desirable that the stimulator/stimulus isolator should be electrically isolated both from ground and from the trigger device. The voltage required to send current through tissues can vary greatly, making it important to have control over the stimulus driving force. Large impedance variations during an experiment can result in a lack or reproducibility or total loss of the stimulus. In these circumstances, a constant current stimulator like our DS3 would be recommended over our DS2A.

The DS3 provides a precise Constant Current stimulus (up to 32mA) controllable in Pulse Duration and Amplitude and as with the constant voltage DS2A this output comes from self-contained batteries. The DS3 also features a "clamp" or discharge circuit which discharges the output between stimuli, preventing a charge build up on the preparation. In other constant current devices this charge build up can lead to a loss of stimulus. The DS3 can be triggered by an external device such as our DG2A Train/Delay Generator. The DS3 can be fitted into a 19" rack mounting frame (D121-11) which can hold up to two DS2A's, DS3's, DS4's or DG2A's.

FEATURES

- ✓ **Low noise battery power supply with 90V compliance**
- ✓ **Internal (20µs to 2s) or external TTL "gated" control of pulse duration**
- ✓ **Four current ranges allow precise reproducible control of stimulus output between 2µA and 32mA**
- ✓ **Polarity reversal switch**
- ✓ **Battery test sockets**
- ✓ **Single-shot trigger button**
- ✓ **Output discharge (Clamp) circuit prevents charge build-up during stimulus trains, which is important to prevent stimulus loss**
- ✓ **Current is only drawn from batteries when a stimulus is being delivered**





LIFE SCIENCE RESEARCH

DS4 BI-PHASIC CURRENT STIMULATOR

The DS4 has been developed to meet the needs of life scientists who require a stimulus isolator that can output a bi-phasic isolated constant current stimulus in response to an external command voltage signal, provided by a computer DAC via software. Such a requirement is already met by our NeuroLog System in the form of the NL512 Biphasic Buffer and NL800A Stimulus Isolators, but the DS4 provides our first standalone device to meet this need.

The DS4 accepts a variety of voltage input ranges ($\pm 1V$, $\pm 2.5V$, $\pm 5V$ and $\pm 10V$) and produces a constant current stimulus output in 4 ranges ($\pm 10\mu A$, $\pm 100\mu A$, $\pm 1mA$ and $\pm 10mA$) from a compliance voltage of $\pm 48V$. In addition, the DS4 has a GATE input which allows multiple DS4's to be connected to a single analogue voltage source, with each DS4 being digitally enabled, separately.



FEATURES

- ✓ External voltage control permits software defined waveforms
- ✓ Isolated constant current output for low noise
- ✓ Minimal zero crossing distortion
- ✓ Inactivity sensor significantly reduces leak currents
- ✓ Battery test sockets

Unique "Inactivity Sensor" Prevents Unwanted DC Stimulation

One of the problems with stimulators that make use of an external voltage source to define a stimulus waveform is that small offsets or noisy baseline signals from the DAC's used to drive them can result in unwanted battery drain or perhaps worse, low amplitude stimulation. The DS4 uses a special "inactivity sensor" to monitor the input voltage and disable the DS4 output if this voltage falls within $0\pm 0.15\%$ of the full scale value for a user selectable time period of 100ms, 200ms, 1s or 2s. Unlike other devices which only produce an output when the input voltage exceeds a threshold value, this "inactivity sensor" reduces battery usage and damaging "leak currents" during infrequent stimulation, while at the same time maintaining low levels of zero crossing distortion for repetitive waveforms.

The DS4 uses an external DC power supply to power the input control circuitry and readily available/inexpensive batteries to provide the opto-isolated stimulus voltage source. The DS4 can be fitted into a 19" rack mounting frame (D121-11) which can hold up to two DS2A's, DS3's, DS4's or DG2A's.

DG2A TRAIN/DELAY GENERATOR

This small free-standing instrument has been designed for control of normal repetitive stimulation as well as for defining the Effective Refractory Period using a second, delayed pulse. The DG2A is especially useful as a frequency generator (as a TTL trigger source) for use with our DS2A, DS3 and DS7A isolated stimulators which have their own pulse duration controls. The basic features of its predecessor the DG2 Trigger Generator have been extended to allow trains of pulses to be generated in response to input signals from other devices. The DG2A Train/Delay Generator has four operating modes:-

- **Train** – In TRAIN mode, a regular button press or TTL compatible trigger received at the IN socket is translated into a SYNC pulse train with a pulse repetition rate and train duration determined by the REPETITION and DURATION settings. The DELAY dial allows the introduction of a delayed pulse after each SYNC pulse which can be detected at the OUT-1/OUT-2 output.



FEATURES

- ✓ Simple TTL trigger source for our range of stimulators
- ✓ Battery powered (single 9V, PP3)
- ✓ Four operating modes (Train, Gated, Free-run, Single)
- ✓ Delayed output for study of effective refractory period

- **Gated** – In GATED mode, the DG2A will output a train of pulses at the SYNC socket while the input at the IN socket is TTL high. This allows the operator to GATE the train of pulses on and off with an external device. The pulse repetition rate is determined by the REPETITION setting. The DURATION control has no function in this mode. The DELAY dial allows the introduction of a delayed pulse after each SYNC pulse, which can be detected at the OUT-1/OUT-2 output.
- **Free-run** – In FREE-RUN mode, the DG2A will continuously output SYNC pulses with a pulse repetition rate determined by the REPETITION setting while the unit is ON. The DURATION control has no function in this mode. The DELAY dial allows the introduction of a delayed pulse after each SYNC pulse which can be detected at the OUT-1/OUT-2 output.
- **Single** – In SINGLE mode, a single TTL compatible trigger received at the IN socket or push button press is translated into a single SYNC pulse. The REPETITION and DURATION controls have no function in this mode. The DELAY dial allows the introduction of a delayed pulse after each SYNC pulse which can be detected at the OUT-1/OUT-2 output.

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D121-11 MOUNTING FRAME

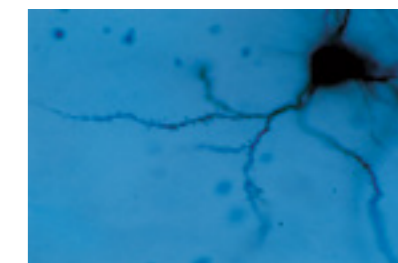
The D121-11 mounting frame is designed to allow one or two DS2A, DS3, DS4 or DG2A devices to be mounted on a standard 19" equipment rack. This arrangement permits units to be positioned at a suitable height within an instrumentation rack, providing easy access to all front panel controls. Each D121-11 is supplied with 4 replacement case screws to enable mounting of up to two DS2A, DS3, DS4 or DG2A units (two screws needed per unit).



D380 IONTOPHORETIC DYE MARKER

The D380 Iontophoretic Dye Marker provides an isolated, bipolar and constant current output intended for cell labelling or cell marking of individual neurons with charged dyes, such as Lucifer Yellow, via iontophoresis. Holding currents of up to $\pm 6\text{nA}$ and injection currents up to $\pm 12\text{nA}$ are possible and precisely set by single-turn panel mounted dials. A compliance voltage in excess of $\pm 6\text{V}$ allows the full injection current into electrodes with impedances up to 500Mohms . An LCD screen continuously displays the polarity and magnitude of the requested Injection and Holding currents as well as the electrode resistance and the voltage applied. The unit is powered from a single, standard, 9 Volt battery.

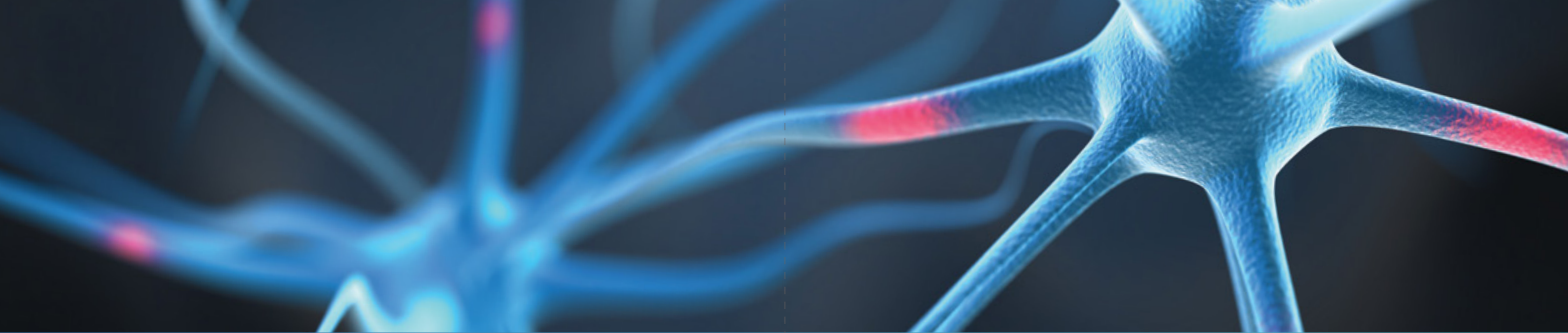
A novel feature of the unit is that the injection current polarity can be easily reversed by a push button switch to facilitate electrode de-blocking.



A neuron from rat Nucleus Accumbens stained using the D380 Dye Marker (courtesy of Gloria E. Meredith)

FEATURES

- ✓ Holding current of $\pm 6\text{nA}$
- ✓ Injection current of $\pm 12\text{nA}$
- ✓ Polarity reversal for de-blocking purposes
- ✓ For pipette resistances of up to 500Mohms .
- ✓ LCD Display screen



LIFE SCIENCE RESEARCH

QUEST SCIENTIFIC HUM BUG NOISE ELIMINATOR



The Problem

Signals recorded using biological sensors and other high impedance devices are often contaminated with 50 or 60 Hz noise corrupting the content of these signals and degrading the quality of subsequent data analysis.

Electrical interference is notoriously difficult to remove without altering the original signal embedded within the noise.

In theory, proper attention to ground and appropriate shielding can eliminate electrical interference. In practice, noise remains a frequent and distressing problem in many laboratories.

Noise may come and go for no apparent reason and may appear during critical phases of data collection. The effort required to maintain noise at an acceptable level is both time consuming and frustrating.

The Traditional Approach

Faraday cages decrease the magnitude of environmental noise sources but this protection is often incomplete. Notch or comb mains noise filters are occasionally used to suppress 50/60 Hz noise and harmonics but a line noise filter will distort the input waveform if the frequency components of the signal overlap with the filtered frequencies.

FEATURES

- ✓ **The Hum Bug is not a filter. It does not create phase delays, amplitude errors, DC shifts or waveform distortion.**
- ✓ **It effectively eliminates 50/60Hz noise and harmonics without altering the frequency characteristics of the input signal even when these frequencies overlap with noise components.**



A New Solution – 50 or 60Hz Noise Removal without Filtering

Quest Scientific has developed a powerful new technique – 50Hz noise removal or 60 Hz noise removal from analogue signals without filtering.

The Hum Bug constructs a noise replica in real time and continuously subtracts this replica from the input signal. It performs this function in the presence of biological activity even when noise characteristics evolve over time.

Even if the biological signal has 50Hz or 60Hz components, these will be untouched by the Hum Bug Noise Eliminator.

Simplicity

The Hum Bug is a real-time device. Simply connect it between your preamplifier and any analysis or recording equipment (oscilloscope etc.).

It will automatically eliminate electrical interference while it lets the signal of interest pass through unchanged. No settings or adjustments are required.

The front panel switches are only used if you wish to bypass noise cancellation (BYPASS), stop the adaptation process (HOLD), or clear the noise replica (CLEAR).



In the Red trace, 50Hz mains noise is clearly seen, however, passing the same response through a Hum Bug (Green) results in the removal of the mains interference with no damage to the biological signal.

NeuroLog SYSTEM

NEUROLOG SYSTEM

AN OVERVIEW

The NeuroLog System is now widely accepted throughout the world by scientists who demand high quality, dependability and innovation in their research instrumentation. Typical applications include: intracellular recording, extracellular recording, spike detection, electrical stimulation, pulse & train generation, multi-channel isolated EMG or EEG recording, pressure or other transducer recordings. NeuroLog System sales and service is available worldwide, through Digitimer Ltd. and its network of distributors.

Because the NeuroLog System is fully modular, it has the following well recognized advantages over non-modular "multi-purpose" instruments:

- **Greater Flexibility** Complex systems can be quickly assembled or modified.
- **Enhanced Efficiency** Modules can be shared among several set-ups, expanding capabilities without duplication. Only those modules required for a particular task are tied up and occupy rack space.
- **Wider Compatibility** Input & output levels, impedances, connectors, etc., of different modules in the system are compatible, minimizing the problems encountered in interconnecting pieces of equipment of diverse origin.
- **Cost Effective** Only those modules actually required are purchased. You do not pay for all those functions added to an instrument to make it "general purpose". Individual modules can be added to the system at any time, as the scope and orientation of your application changes.

FEATURES

- ✓ **Intracellular & Extracellular Recording**
- ✓ **Pressure or Force Measurement**
- ✓ **Multi-Channel Isolated Amplification**
- ✓ **Isolated Electrical Stimulation**
- ✓ **Trigger Pulse Generation**
- ✓ **Filtering & Signal Conditioning**

The NL900D Case & Power Supply unit allows up to thirteen modules to be installed. This means that a single NeuroLog System can be used to monitor several different parameters, such as extracellular spikes, intracellular potentials or even blood pressure, as well as produce outgoing trigger pulses to other pieces of equipment, electrically stimulate a preparation or carry out signal conditioning tasks.



This brochure, like any other, is a snap-shot of the product line at one particular time. When the product is in a continuous state of development, as in the case of the NeuroLog System, the brochure is out of date almost before it is printed. It is our practice to supplement this brochure with periodic product announcements to keep our customers (and potential customers) informed about new products as soon as they become available.

In addition, our web site (www.digitimer.com) contains a wealth of up to date information on the components of the NeuroLog System as well as downloadable support documents such as specific Application Notes and User's Manuals which can be invaluable when selecting the appropriate modules for a particular application. We are always happy to discuss your requirements if you are unsure what components you require.

The NeuroLog System Modules

The front panel of each module measures 30mm wide by 122mm high. The attached printed circuit board is 152mm long by 102mm high. Each module has a split ring handle attached to its front panel; this serves as a cable run as well as a handle for withdrawing or inserting the module into the case. All module outputs are short circuit proof. The extensive use of standard transistor-transistor logic (TTL) and standard linear



integrated circuits ensures the lowest possible cost and highest possible compatibility with other instruments. The output levels and impedances of the linear inputs and outputs are appropriate for general purpose oscilloscopes, low gain chart recorders and data acquisition interfaces. The NeuroLog System is also compatible with the components most frequently used in special circuitry built by individual investigators to meet their own particular needs. Undrilled front panels and special printed circuit

boards - assembled as the NL50 Blank Module are available to encourage the design and use of such special purpose modules with the NeuroLog System.

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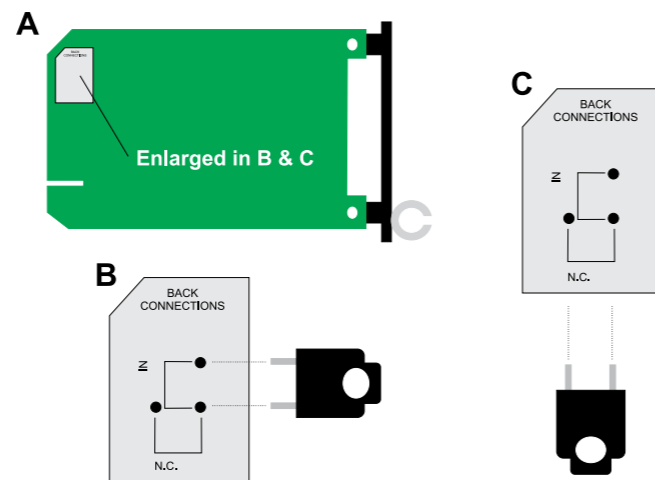
NL905 Compact NeuroLog System Rack & Power Supply (up to 4 modules)

The NL905 is a compact case & power supply unit for the NeuroLog System which is offered for users who require no more than 4 modules for their given application or are short of space. The case measures 130mm (high) x 164mm (wide) x 271mm (deep), has overload protection fuses, a front panel on/off switch, an LED power indicator as well as flip-out feet for bench placement. It is fully compatible with all NeuroLog System modules, either current or discontinued.

Module Interconnection

The general problem of module interconnection has been minimized in the NeuroLog System by a unique method of automatic connection of outputs and inputs of neighbouring modules through the case edge connectors. Thus, for many linear arrangements of modules, only the input and output cables connecting the system to the preparation and to output devices such as oscilloscopes, recorder or data acquisition interfaces are required. Front panel controls are therefore not obscured by cables which merely connect each module to the next. More complex module arrangements will, however,

require some front panel cable interconnection; between 5 and 10 cables of various length will be required for a typical 13 module system. No cables are supplied with the case. The diagram below shows how the shorting pin on a typical module printed circuit board is used to make the connection between the input of this module and the output of the module in the adjacent bay to its left. (A) shows the location of the jumper pin in the upper left hand corner of the p.c. board, while (B) shows the jumper position enabling connection via the rear of the module and (C) shows the position for no rear connection.



Some modules with more than one output have a similar jumper pin arrangement for selecting the output to be relayed through its edge connector to the input of the module in the bay to its right.

Cables & Accessories

Only micro-miniature coaxial connectors with a "snap-on" action are used in the NeuroLog System, eliminating the nuisances caused by connectors such as the BNC and UHF types which have a "twist-on" or "screw-on" action. All external connections between modules are made through miniature, screened coaxial cable, which reduces cross-talk and transient pick-up, as well as eliminating the "rat's nests" of fine, unscreened wires and 1mm, 2mm or 4mm plugs frequently used for patching in other modular systems.

A variety of assembled cables, plugs, sockets, BNC to NeuroLog adaptors and "T" connectors are available from Digitimer Ltd., and its agents for the NeuroLog System (see Accessories Section). The connectors are manufactured by Lemo (Switzerland) and were chosen for the NeuroLog System because they are the finest micro-miniature snap-action connectors available. Without these particular plugs and sockets, the front panels of the NeuroLog System would necessarily have been substantially larger. This would have reduced the number of modules which would fit into a standard 483mm (19") case, and increased the total system cost.



NL951-15



NL953K



NL951B-2m Lemo to BNC Cable

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TYPICAL APPLICATIONS

This brochure gives us the opportunity to illustrate some of the ways the NeuroLog System can be employed in your laboratory, however, this is by no means an exhaustive list of applications. As our module range continues to evolve and your requirements also change, new applications will arise and it is hoped that many of these will either find their way onto these pages in future editions or onto our web site (www.digitimer.com). The web site already contains a comprehensive range of application notes available for download in PDF format, including versions of those given below. If after consulting our application notes or browsing our web site you think the NeuroLog System may be suitable for your particular application, please contact us to discuss it further.

In each of the illustrated application notes, modules are either joined by solid lines, indicating cable connections or by dotted lines, indicating connections made through the rear of neighbouring modules. We generally recommend that you use the rear connections whenever possible as it saves on the number of cables you need to purchase and reduces clutter around the front panels of the modules, however, in some instances cables are required. We can supply cables of various types and lengths, please refer to the Accessories Section of this brochure. When using the rear connections, make sure that the jumpers on the printed circuit boards of the modules are correctly positioned (please refer to the users manual for each module for full details) and remember that communication through the rear connections ONLY occurs from left to right between immediately neighbouring modules.

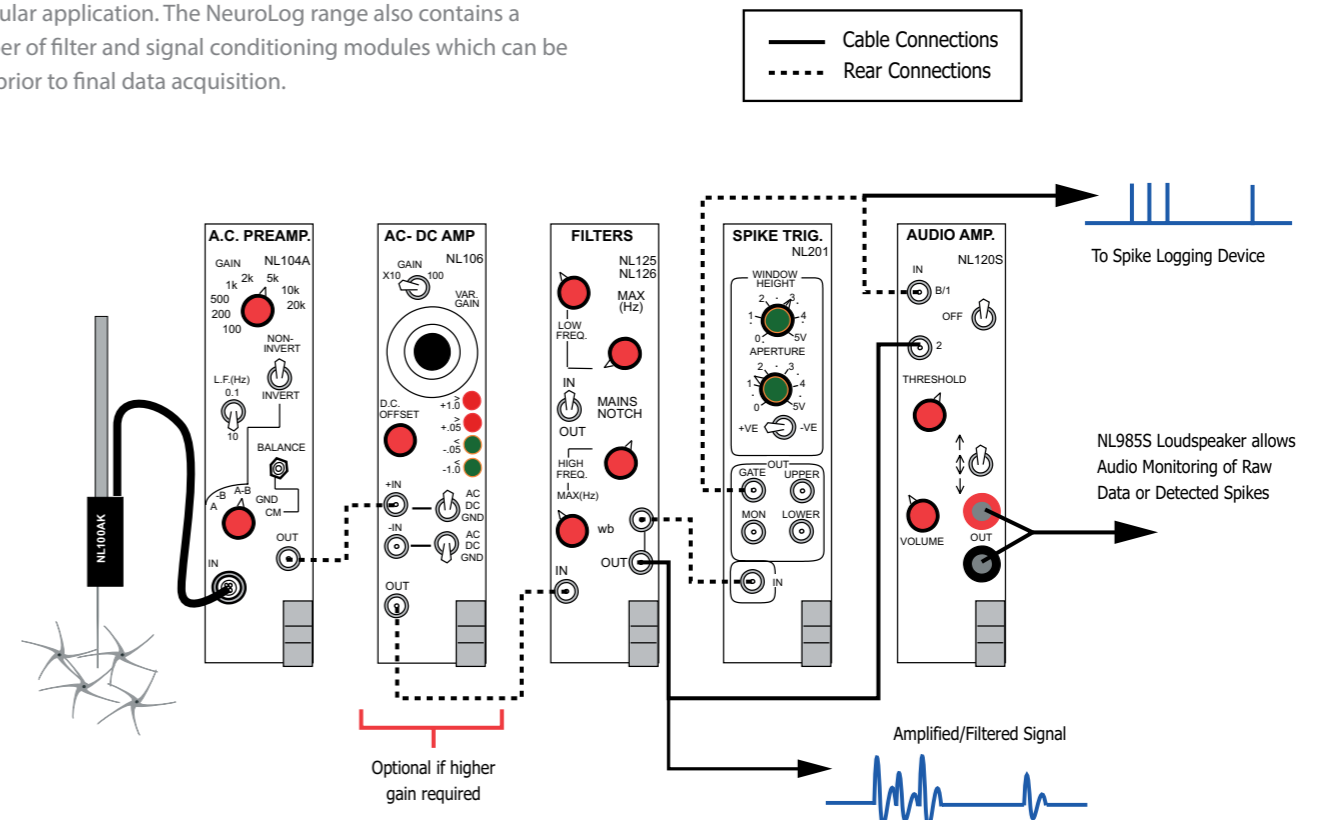


AMPLIFICATION & SIGNAL CONDITIONING

The NeuroLog System provides AC or DC coupled amplification of biological signals from transducers, single electrode or multi electrode configurations. DC coupled amplifiers output absolute voltage levels and are most commonly employed for intracellular or transducer recording where baseline membrane potentials or slower changes in parameters are of interest. With AC coupled amplifiers, the "DC baseline" is removed by low cut filtering. Such amplifiers are used for extracellular recording of action potentials in neuronal preparations, ECG, EMG or EEG waveforms. The variety of NeuroLog pre-amplification and amplification modules means that users can develop systems specifically suited to their particular application. The NeuroLog range also contains a number of filter and signal conditioning modules which can be used prior to final data acquisition.

Extracellular AC Recording

The NL100AK PRE-AMPLIFIER HEADSTAGE and NL104A AC PRE-AMPLIFIER combine to provide an excellent low noise amplification, impedance matched system for extracellular AC recording from *in vitro* preparations or *in vivo*. The NL104A can be used in differential or single ended modes and can amplify a signal by x100 to x20k. A 0.1Hz or 10Hz low frequency cut-off filter allows removal of DC components. If the signal of interest requires further amplification, the NL106 AC/DC AMPLIFIER can be used to boost the gain by up to x100.



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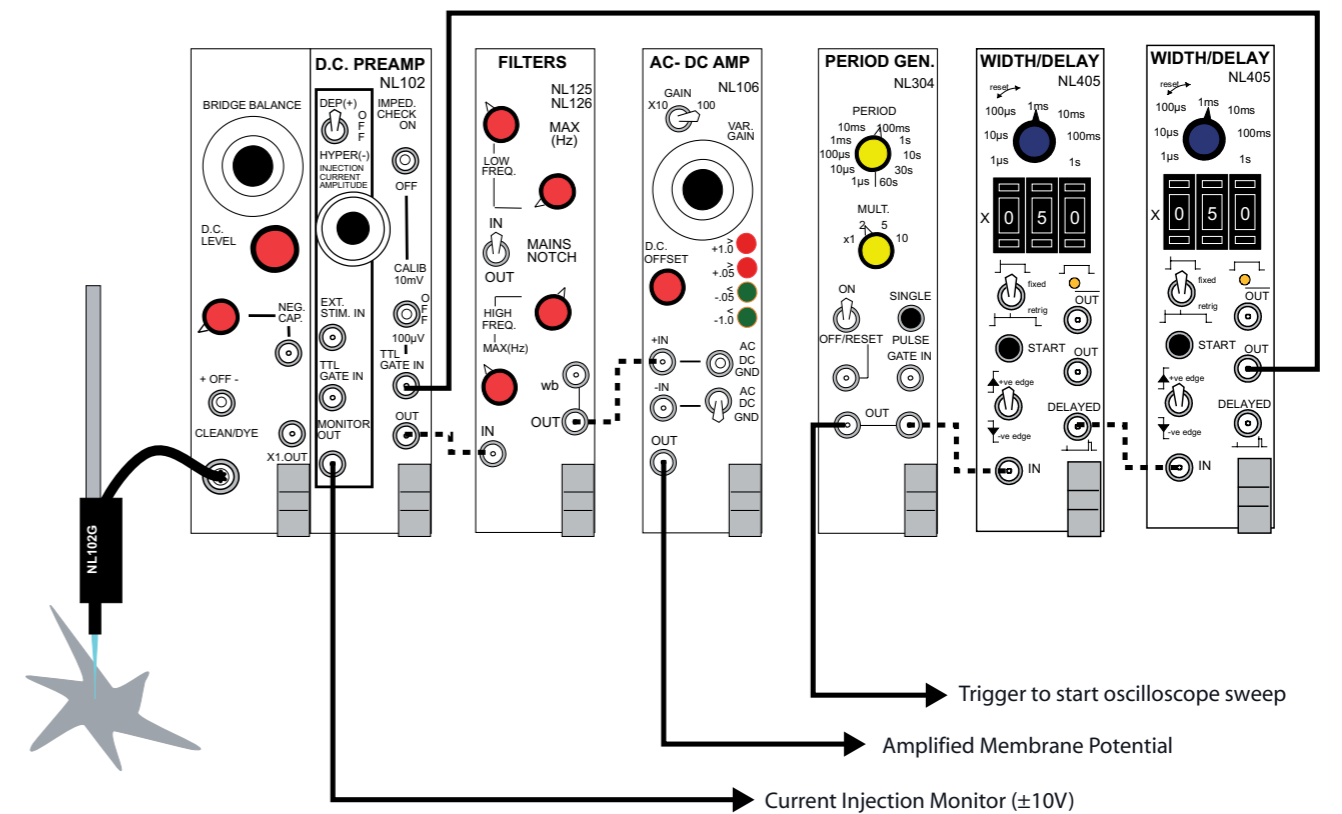
NEUROLOG SYSTEM

Notch (50 or 60Hz), low and high cut filtering is provided by the NL125/6 FILTER. The output from the NL125/6 can be fed into a computer via an ADC for acquisition, or alternatively, individual spikes can be discriminated using the NL201 SPIKE TRIGGER module. The aperture size, polarity and height of the discriminator window can be monitored on an oscilloscope with the raw data superimposed (MONITOR). The various outputs on the NL201 produce a TTL compatible pulse in response to a spike which crosses the lower threshold only (LOWER), upper threshold (UPPER) and lower but not upper thresholds (GATE). These pulses can be collected by a computer data acquisition system enabling spike frequency logging to be carried out alongside acquisition of the raw signal.

Intracellular DC Recording with Current Injection

The NL102G DC PRE-AMPLIFIER features capacity neutralization, current injection, low leakage current and low DC drift. It is particularly suitable for intracellular recording through fluid filled micro-electrodes. Electrode attachment to the dedicated compact pre-amplifier headstage is made via our range of ELECTRODE CHAMBERS. Features of the NL102G include electrode impedance check, calibrator, stimulus bridge balance DC level adjustment ($\pm 2V$) and current injection/monitor. A maximum current injection of up to $\pm 100nA$ is possible through the front panel control or from an external analogue input. Current injection occurs either when the toggle switch is moved to the DEP or HYPER positions or in response to an input at the TTL GATE IN socket and/or EXT. STIM. IN socket.

Electrode impedance checking and output calibration features can be easily accessed using the controls on the right hand side of the of the NL102G. The timing of these functions can be controlled by other modules or devices via the TTL GATE IN socket. In the setup illustrated, the impedance checking/calibration functions are controlled by a 50ms gating pulse which is generated by other NeuroLog modules once every 200ms. The first NL405 WIDTH/DELAY module delays the pulse from the NL304 PERIOD GENERATOR while the second NL405 gives the duration of the pulse. However, such pulses could possibly be provided by your chosen data acquisition interface/software, making these extra modules unnecessary.



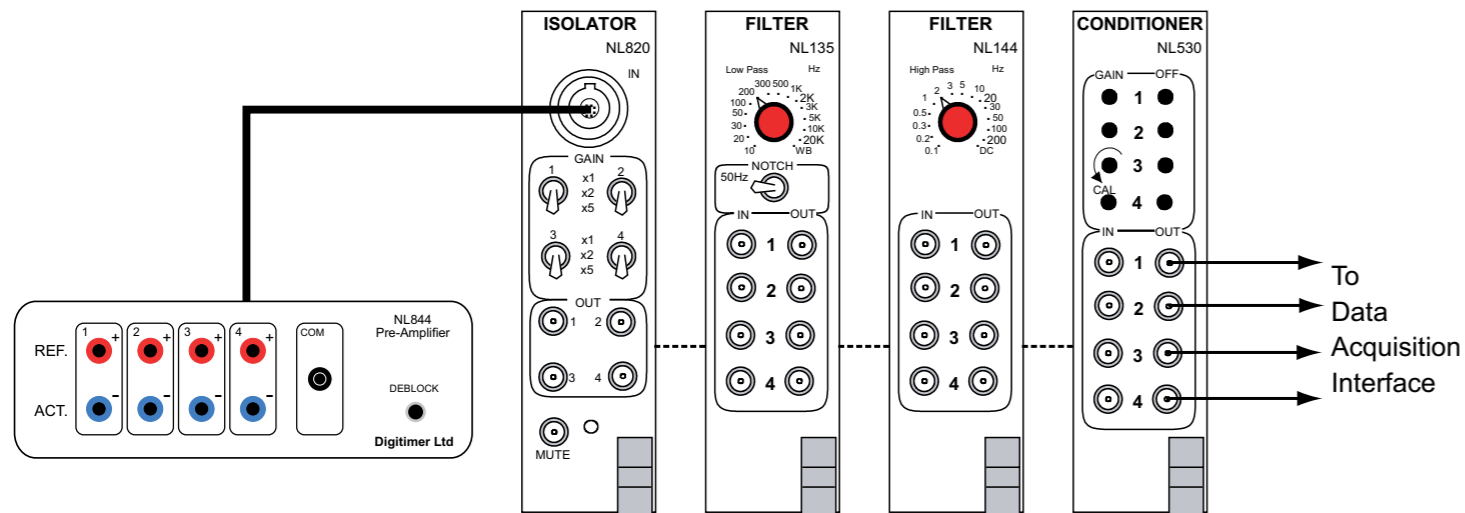
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Four Channel Isolated Amplification for EEG, EMG or ECG Recording

An ideal system for multi-channel isolated AC recording of physiological signals such as EEG, EMG or ECG in the non-diagnostic (research) environment. The system provides a widerange of amplification and filter settings. The NL844 4-CHANNEL AC PRE-AMPLIFIER can be positioned near the recording site, so reducing the length of the electrode cables and minimising interference. The outputs are connected to the a NL820A ISOLATOR (housed in an NL900D or NL905 NeuroLog

case), where further amplification of the signals can be selected on a channel by channel basis. Further filtering can be carried out by the various NL144 or NL134/5/6 FILTERS, which offer high pass, low pass and notch filter options. In addition, the signal can be conditioned prior to ADC input using the NL530 CONDITIONER which has facilities for signal gain, filtering and DC offset adjustment. Signals are passed between the modules through rear connections, thus reducing the number of additional cables required and improving the signal to noise ratio of the system.

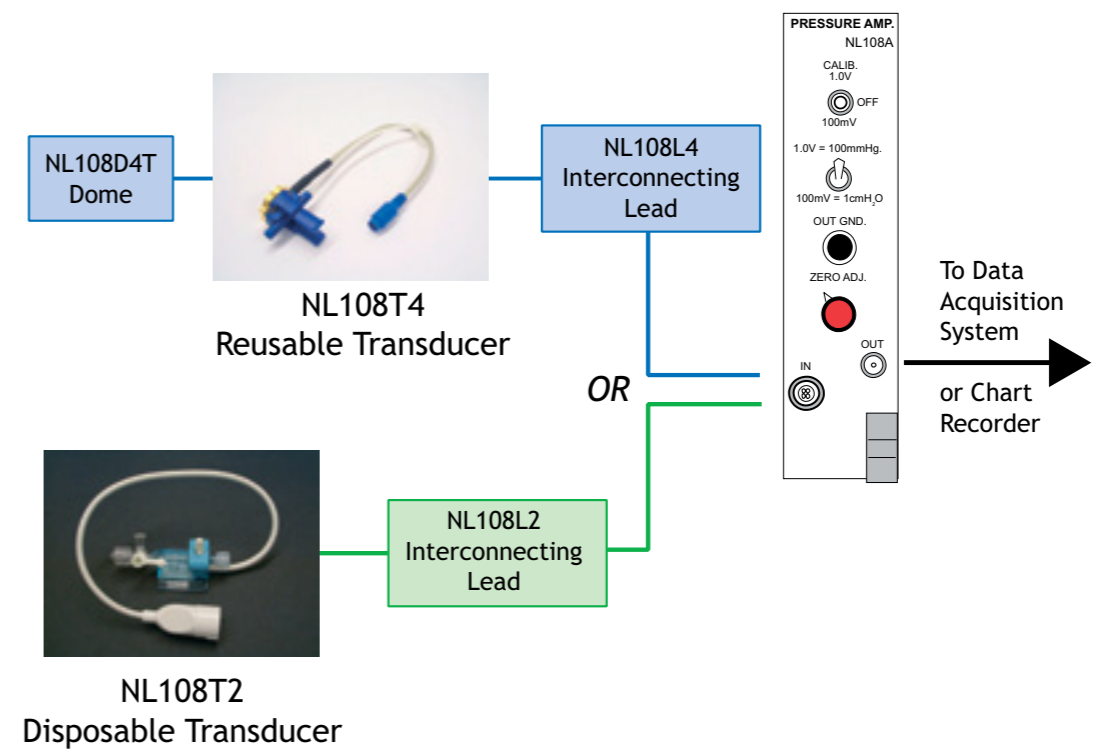


Physiological Pressure & Force Measurement

The NL108A PRESSURE AMPLIFIER provides an easy method of monitoring physiological pressure changes and can be used in combination with our disposable (NL108T2) or reusable (NL108T4) pressure transducers. The NL108A has two amplification ranges, making it suitable for measuring high pressures such as blood pressure as well as lower pressures including intra-tracheal pressure.

The NL108A PRESSURE AMPLIFIER can also be interfaced with isometric force transducers such as our NL61, NL62 and NL63.

As with pressure monitoring, the analogue output of the NL108A can be fed directly to a chart recorder or ADC interface for PC-based data acquisition. The module includes a calibrate button as well as a DC offset control allowing you to zero the baseline. Your chosen transducer is connected to the NL108A module via an interconnecting lead with the output from the NL108A feeding into a chart recorder or ADC interface.



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PULSE GENERATION & ELECTRICAL STIMULATION

The NeuroLog System includes a range of modules capable of pulse generation, timing control and electrical stimulation. Pulse patterns can be pre-defined in a variety of ways, allowing you to control other modules within the NeuroLog rack or send TTL compatible trigger pulses to external devices, such as stimulators or acquisition systems. The NeuroLog range includes the small, constant current NL800A STIMULUS ISOLATOR which can be controlled by other NeuroLog modules (e.g. NL510A PULSE BUFFER) or other compatible devices. Our new NL512 BIPHASIC BUFFER allows one or two NL800A's to be controlled by an analogue waveform, such as that generated by a computer controlled DAC. Used in this way, the NeuroLog System can become a multi-channel, computer controlled, biphasic, constant current, independently isolated stimulator.

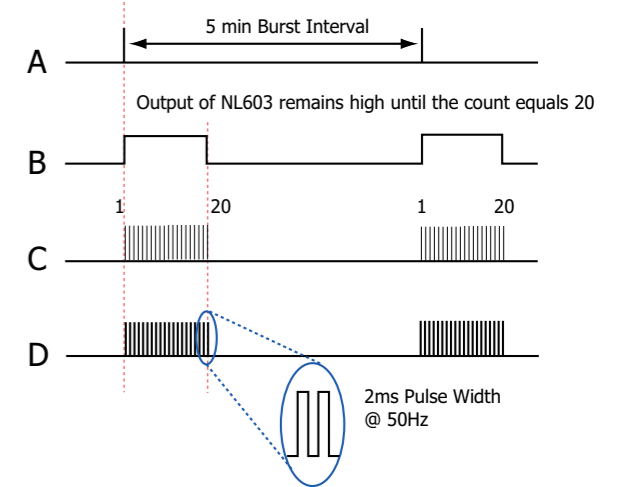
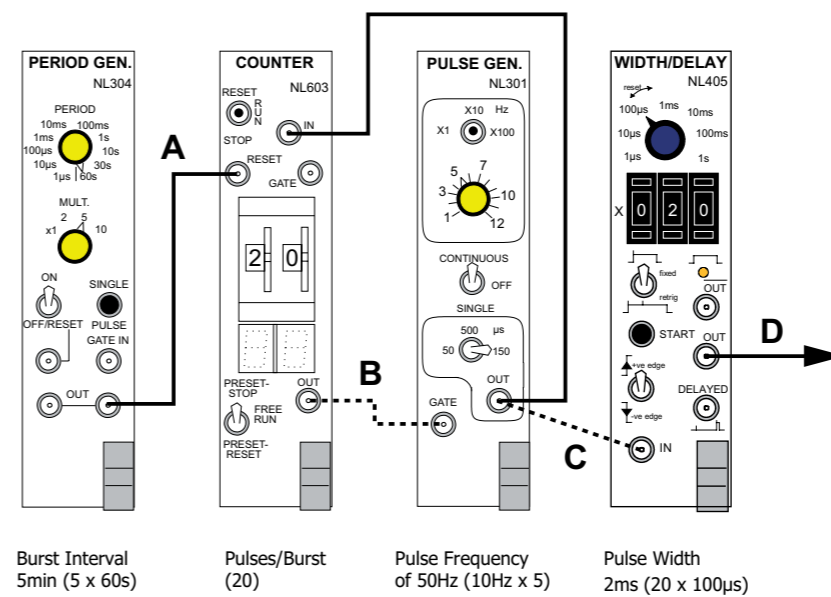
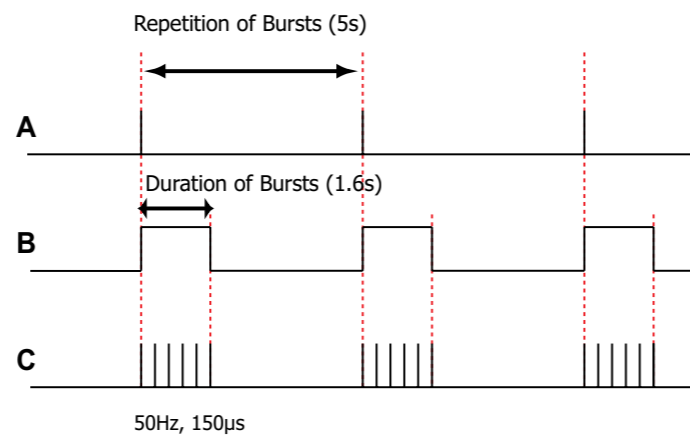
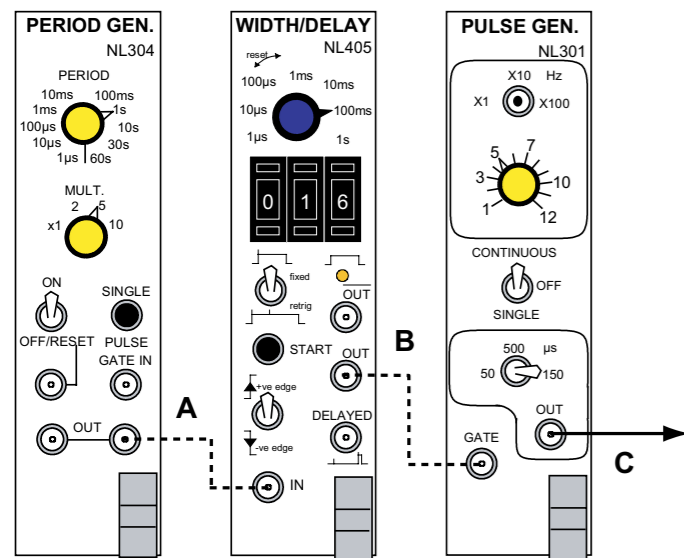
A Regular Burst of Pulses with Control of Burst Duration/ Repetition and Output Frequency/Width

This scheme provides a simple means of generating a repeating burst of pulses which can be used to trigger other NeuroLog modules or TTL compatible devices, such as electrical stimulators. These modules allow control over the duration and repetition of the burst as well as the duration and frequency of the individual output pulses. The NL304 PERIOD GENERATOR is used to set the repetition of the burst, while the NL405 WIDTH/DELAY module determines the duration of the burst. Note that older "Width" modules such as the NL401 DIGITAL WIDTH and NL403 DELAY/WIDTH can be used in place of the NL405. Finally, the NL301 PULSE GENERATOR sets the output pulse frequency and width (50, 150 or 500 μ s). If these pulse widths are too limiting, it is quite possible to add a further NL405 after the NL301 to provide greater flexibility, as demonstrated below.

A Regular Burst of Pulses with Control of Burst Frequency, Pulses per Burst & Pulse Frequency/Width

This application was designed to allow a NeuroLog user to deliver a burst of stimuli to a biological preparation every five minutes, with control over this interval, the number of pulses in the burst as well as control over the stimulus pulse width and frequency. Ultimately, the output at (D) was fed into the NL510A PULSE BUFFER and NL800A STIMULUS ISOLATOR in order to convert the 2ms output pulses from the NL405 WIDTH/DELAY in order to give them width and also fed back to the input of the counter module. Once the counter detects 20 pulses, the output goes "low" thereby ending the gating pulse at (B). This gating pulse remains "low" until the next reset pulse is sent by the period generator and a new burst is initiated.

Once in the "ON" position, the module sends a regular output pulse at the interval set on the front panel. This output resets and activates the NL603 COUNTER, sending it's output at (B) "high" until the count reaches the preset value of 20. But how is the counting done? The "high" output from the NL603 is used as a gate which allows the NL301 PULSE GENERATOR to pass a burst of pulses. The burst of pulses is fed into the NL405 WIDTH/DELAY in order to give them width and also fed back to the input of the counter module. Once the counter detects 20 pulses, the output goes "low" thereby ending the gating pulse at (B). This gating pulse remains "low" until the next reset pulse is sent by the period generator and a new burst is initiated.

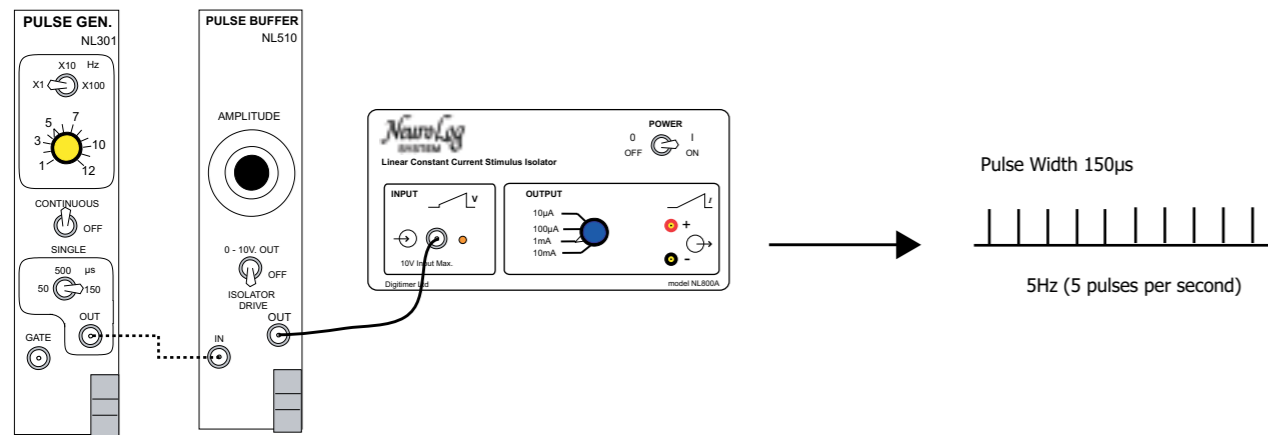


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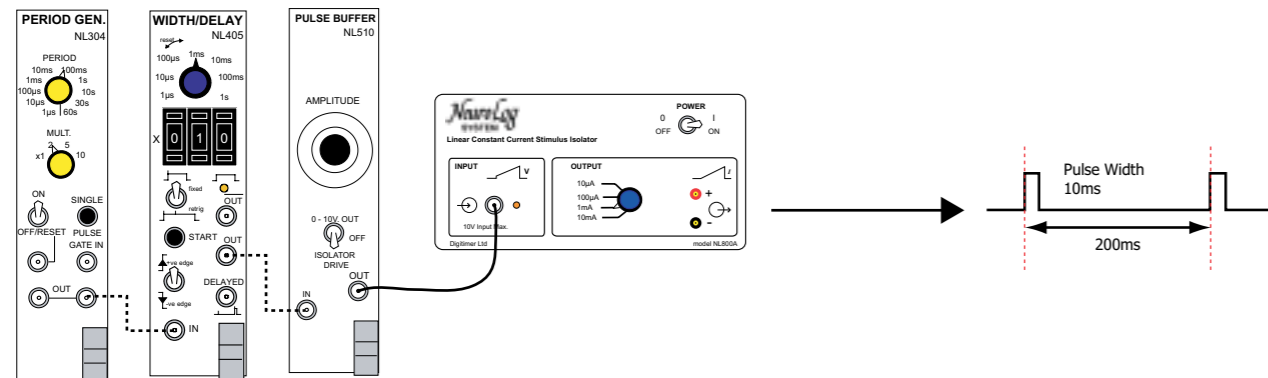
Basic Stimulation with Limited Pulse Duration Control

The arrangement below shows the simplest method by which single stimuli or continuous stimulation trains can be produced with the NeuroLog System. Pulse frequency is continuously variable from 1Hz to 1000Hz, three output pulse widths (50, 150, 500 μ s) are available and output amplitude is continuously variable over four ranges from 0 to 10mA, with an isolated stimulus output supplied by the NL800A STIMULUS ISOLATOR. Note that the NL510A PULSE BUFFER can be used without the NL800A to generate a 0-10V non-isolated output for low voltage stimulation applications.



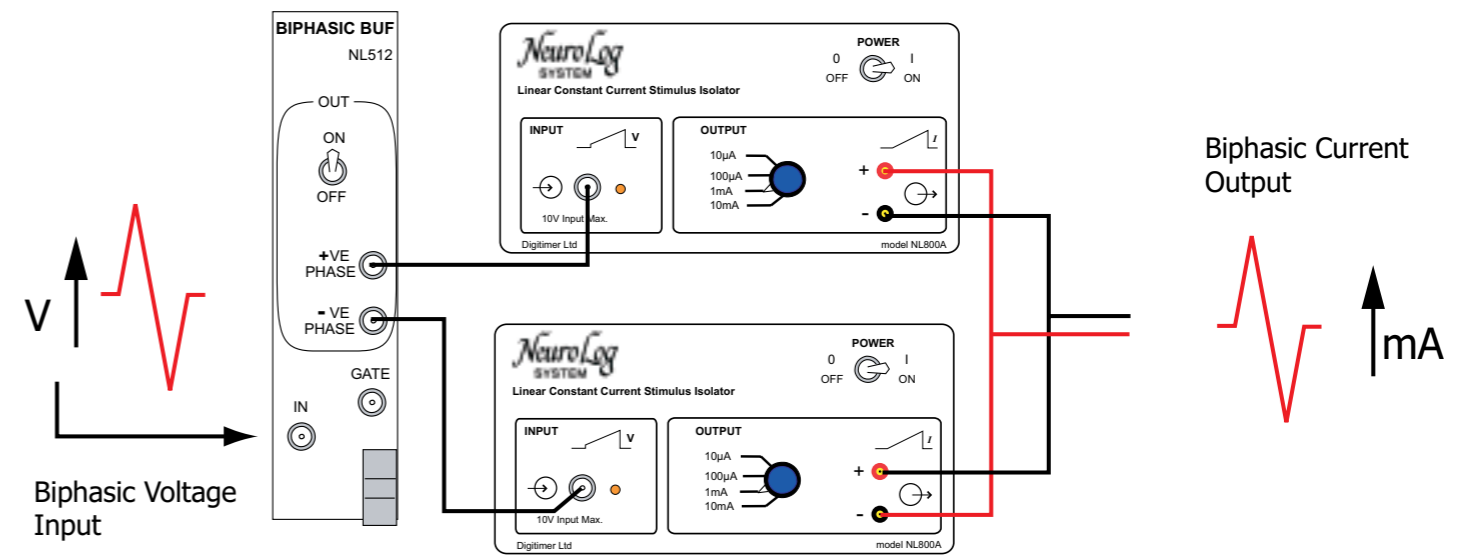
Repetitive Stimulation with Pulse Duration Control

By substituting the NL301 with an NL304 PERIOD GENERATOR, the pulse interval range can be greatly extended. In addition, because the NL304 only outputs a 0.5 μ s long pulse, the actual stimulus width can be more flexibly defined using the NL405 WIDTH/DELAY module. Amplitude is controlled in the same manner as above.



External Analogue Control of Biphasic Stimulation

The NL512 BIPHASIC BUFFER can be used in combination with two NL800A modules to allow a biphasic analogue signal to be converted into a constant current stimulus. The resulting configuration is "current out for voltage in", meaning that the amplitude of the analogue input is proportional to the amplitude of the resulting constant current stimulus. Biphasic stimulation has the advantages that the preparation does not suffer the deleterious effects of "charging-up" and electrodes do not become oxidised. The biphasic analogue signal can be generated by a PC controlled DAC or by other NeuroLog System modules. If you want to stimulate several preparations using multiple sets of the NL512/NL800A configuration at different times, the GATE input of the NL512 allows for digital output lines from a PC to enable each NL512 individually.



NeuroLog SYSTEM

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PRE-AMPLIFIERS & AMPLIFIERS

NL100AK AC PRE-AMPLIFIER HEADSTAGE

The NL100AK AC pre-amplifier headstage is a differential input, low noise, high impedance buffer amplifier suitable for extracellular recording. The headstage is supplied as standard with a removable 6.4mm diameter stainless steel manipulator mounting rod. Power is supplied by the NL104A AC pre-amplifier via a 4 way lemo plug and socket, however, this headstage can also be used in conjunction with older NeuroLog amplifiers (NL103, NL104, NL107), please specify with your order. Each headstage is supplied with an NL973A accessory kit which contains 1mm and 2mm plugs, a U-shaped input jumper and an allen key.

SPECIFICATIONS:

Input resistance: 100M Ω ; gain: x1; input noise: <2 μ V (peak to peak) with inputs shorted, <25 μ V for typical tungsten microelectrode in saline, <30 μ V with a 1M Ω resistor between

inputs (bandwidth in all three cases, 10Hz to 10kHz); dimensions: 35.6mm x 9.5mm diameter; cable length: 2m; connections: +IN (2mm socket) for non-inverting input (accepts plugs supplied and optional NL101 electrode chambers), -IN (1mm socket) for inverting

input connection to reference electrode or via U connector (supplied) to ground socket (GND). GND (1mm socket) connected to mains earth.



NL102G INTRACELLULAR DC PRE-AMPLIFIER

The NL102G is a direct coupled pre-amplifier designed specifically for biological recording. With features such as capacity neutralization, current injection, low leakage current and low DC drift, it is particularly suitable for intracellular measurements through high resistance fluid-filled electrodes. The high impedance headstage of the NL102G is fitted in a metal tube at the end of a 2m cable. The headstage is matched with the main amplifier module supplied with it and is not interchangeable with other NL102G DC pre-amplifier modules without recalibration

(the serial numbers on the headstage and module MUST match). The central 2mm input socket (IN) is the capacity-compensated signal input through which current can be injected. The shield socket (1mm) is the



x1 output and may be used as a capacitance ground or shield around the electrode and preparation. The third socket (1mm) is the system earth (ground) and connection should be made to the indifferent electrode only.

FEATURES INCLUDE:

Electrode impedance check • Calibrator • Four current injection ranges (\pm 100nA, \pm 50nA, \pm 20nA, \pm 10nA) with four corresponding bridge balance ranges (100M Ω , 200M Ω , 500M Ω and 1000M Ω) • External gating of above facilities • Bridge balance • Constant current capacitance compensation (neg. Cap.) which largely eliminates re-adjustment, due to changes in input source resistance, common with voltage feedback circuits. • Dye/clean (+ OFF -) toggle switch which can be used either for clearing blocked micro-electrodes or depositing dyes through extracellular pipettes (max. current \pm 1.0 μ A) • For low capacitance screening purposes the headstage has a driven shield output (x1 out) • x1 output amplifier has a \pm 10V dynamic input signal range

• Current injection monitor • Supplied NL412 Pulse Module provides "buzz" capability to ease micro-electrode impalement.

AMPLIFICATION - Two outputs are available:

- x1 OUT - voltage present at "+" input referred to GND including any potential dropped across electrode resistance by injection stimulus current applied. Max. voltage range of amplifier \pm 10V.
- x10 OUT - 10 times signal present at "+" input referred to GND less voltage generated across electrode resistance R_e when bridge balance control is correctly set for a value of R_e . BRIDGE BALANCE range \pm 10V corresponds to 100M Ω at 100nA, 200M Ω at 50nA, 500M Ω at 20nA and 1000M Ω at 10nA depending on the setting of the inject current selector, (printed circuit board mounted). DC LEVEL control enables x10 amplifier to back off up to \pm 2V at the input.

CURRENT INJECTION

Stimulus currents can be injected into the electrode system in either direction under the following conditions:

- Set by current inject control in magnitude, direction by front panel HYPER/DEP switch and gated ON or OFF by TTL gate pulses at front panel socket.
- Set in magnitude and direction by analogue voltage applied at front panel socket - signal range \pm 10V. Current injection can be a combination of both control systems.



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Full scale current injection conditions can be set by printed circuit board selector at 100nA, 50nA, 20nA or 10nA. The MONITOR OUT socket allows connection of an oscilloscope to monitor the injection current (+10V/ + full scale injection current).

Other injection current possibilities are:

Max. non-controlled current for dye injection to preparations or clearing of blocked electrodes. Current is dependent on electrode resistance and can be up to 1µA max. Repeated reversal of the selector switch will usually clean blocked electrodes.

Impedance check measurements selected by front panel switch injects a current (1nA) through the electrode giving a signal at the x1 output which is a pulse wave of amplitude 1mV/MΩ or 10mV/MΩ at the x10 output.

CAPACITY COMPENSATION

The NL102G has a front panel control to adjust the amplifier section to compensate for capacity to ground at the electrode. Adjustment is easily made by switching on the impedance check signal and setting the NEG CAP control for a fast risetime square wave without excessive overshoot at the output. The range is sufficient to compensate for capacities up to 30pF. The amplifier can be deliberately put into an oscillatory mode (buzzed) by pressing the push button located on the NL412 Pulse module which is supplied with the NL102G. This feature is designed to aid cell penetration when attempting intracellular recordings.

CALIBRATION

A square wave calibration signal is built into the NL102G for calibration through a complete system. This is selected by a front panel switch as one of two magnitudes: 10mV or 100µV or it can be gate controlled by a TTL signal applied to the front panel sockets. The signal (approx. 150Hz) is summed with the bridge balance signal at the input of the x10 amplifier section.

SPECIFICATIONS:

Input resistance: $10^{11}\Omega$; input voltage: $\pm 10V$; gate leakage current: adjustable to zero; risetime (zero source resistance): 1µs (20MΩ source resistance: 15µs); injection current/bridge balance (selectable ranges): 100nA/100MΩ - 50nA/200MΩ, 20nA/500MΩ & 10 nA/1000MΩ; zero stability: $\pm 100 \mu V/\text{Day}$; output impedance: 600Ω; maximum noise level at 10 kHz bandwidth, referred to input (zero source resistance): 20µV peak to peak/4µV RMS (10MΩ source resistance: 180µV peak-peak/36µV RMS); DC level range: $\pm 2V$; output voltage range: $\pm 11V$; calibrator: 10mV or 100µV, 150Hz square wave; external stimulus input range (referred to input): $\pm 10V$ corresponds to \pm full scale current, depending on range selected; voltage gains: x1, x10 fixed; absolute max. input voltage range: $\pm 14V$; capacity neutralization: 0-30pF; electrode impedance check: x1 out = 1 mV/MΩ, x10 out = 10 mV/MΩ; headstage dimensions: 35.6mm x 9.5mm diameter.

NL104A EXTRACELLULAR AC PRE-AMPLIFIER

The NL104A AC pre-amplifier is a low noise, high input impedance, differential preamplifier. It can be used alone for making recordings from low resistance (gross) electrodes, or with the NL100AK or NL100RK headstages for microelectrode recordings. The NL104A features a wide dynamic balance adjustment for asymmetrical inputs (useful for balancing out interference and shock artefacts), a choice of two input time constants, 8 gain ranges and 3 high frequency filter settings. An internal 50Hz oscillator is provided for precisely balancing the input (input switch in the CM position).



NL109 BRIDGE AMPLIFIER

The NL109 BRIDGE AMPLIFIER is DC coupled, differential amplifier intended for use with transducers which require a bridge excitation voltage, including our own force transducers (see NL61, NL62 and NL63). It can also accept our NL100AK Headstage for DC coupled microelectrode recordings. The output from the NL109 is the amplified and filtered difference between the +IN and -IN signals. An on board jumper allows the user to set the NL109 to a "Half Bridge" mode for single-ended inputs. The input socket mates with the NL963K plug, which is not included.

SPECIFICATIONS:

Input Voltage Range: $\pm 1.5V$ (Working), $\pm 15V$ Max.; Gain: x1 to x5,000; Calibration: Cal. control provides 0 to -40% gain reduction; High Frequency Cut: 0.3 to 30kHz ($\pm 10\%$); Low Frequency Cut: DC, 0.1 or 10Hz; Zero Button with bi-colour LED; Excitation Voltage: 1 to 15V; Output Voltage: $\pm 13.5V$; Common Mode Rejection Ratio: $>90\text{dB}$ @ 50Hz.



NeuroLog SYSTEM

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NL108A PRESSURE AMPLIFIER

The NL108A pressure amplifier module provides two gain settings, one appropriate for blood pressure measurement (1.0V at the output corresponds to 100mm Hg pressure at the

transducer) and the other for low pressure measurement such as intra-tracheal pressure (100mV at the output equals 1cm H₂O at the transducer port). An internal voltage calibrate provides the appropriate deflection (1.0V or 100mV) for these two ranges. Other features include excellent DC stability, a push button switch for setting the zero pressure baseline on the recorder instrument, and a sensitive zero offset control. Although the NL108A is designed to mate perfectly with our own pressure transducers (NL108T2 or NL108T4), due to its internally adjustable gain and bridge excitation voltage, it can be used with a variety of other standard pressure transducers. If

another transducer is being used an input plug type NL963K must be correctly wired to the particular pressure transducer to be used with the NL108A.

SPECIFICATIONS:

Input voltage range: $\pm 10V$; input impedance: $10^9\Omega$ (typical); gain: 1V/100mm Hg or 100mV/cm H₂O (for a pressure transducer having an output of 50 μ V/mm Hg); DC offset: ± 80 cm H₂O, ± 60 mm Hg (when switched to appropriate range); bandwidth: DC to 150Hz; output voltage range: $\pm 12V$; output impedance: 600 Ω (nominal) except "zero out", where output is short circuited to Ground.

NL108T2 DISPOSABLE PRESSURE TRANSDUCER

The NL108T2 disposable pressure transducers provide a straight-forward, cost effective and reliable means of monitoring physiological pressures. The transducers feature a large uniform lumen reducing the chance of incomplete filling, which can lead to bubble formation.

The transducer is fitted with a short lead which is to be connected via our 2.5m long NL108L2 cable to the NL108A pressure amplifier. Whilst these transducers are justifiably used on a disposable basis in the clinical environment, with careful use, their life-time in a non-human research laboratory can be extended further.

SPECIFICATIONS:

Pressure Range: -50mm Hg to +300mm Hg; over-pressure tolerance: 10000mm Hg; bridge resistance: 1000 Ω (input) nominal, 350 Ω (output) nominal; excitation voltage: up to 10V DC or AC maximum, up to 5kHz; zero offset: ± 40 mm Hg, maximum; maximum inaccuracy: $\pm 2\%$ of reading or 1mm Hg, whichever is greater.

NL108T4 PRESSURE TRANSDUCER

Suitable for both arterial and venous blood pressure monitoring, the NL108T4 is to be attached to the NL108A pressure amplifier via a 2.5m long NL108L4 cable, allowing continuous pressure monitoring. The NL108T4 is a highly accurate and rugged re-useable transducer, which is used in conjunction with disposable domes (NL108D4T). These disposable domes are easy to fill and attach to the transducer body and are available from Digitimer in packs of 10 or individually (one dome is included with each transducer). The components of the transducer are electrically isolated from the transducer housing, which is in turn isolated from the saline solution by the silicone membrane of the dome. The transducer is gold plated, making it easier to clean. The transducer is designed primarily for use during blood pressure monitoring, but equally well operates as a monitor for intracranial, gastrologic or intrauterine pressures, as well as urodynamic measurements.

SPECIFICATIONS:

Pressure range: -20 to 300mm Hg; max. overpressure: 10,000mm Hg; sensitivity: 50 μ V/V/cm Hg; resonance frequency: 300Hz typical (transducer and dome); max. electrical excitation: 15V DC or AC; input resistance: 700 Ω ; output resistance: 1000 Ω ; non-



linearity & hysteresis: max. 0.5% of full scale; zero balance: max. ± 30 mm Hg; thermal sensitivity: 0.15%/ $^{\circ}C$; thermal zero shift: max. 0.25mm Hg/ $^{\circ}C$; operating temperature range: +10 to +50 $^{\circ}C$; storage temperature range: -20 to +70 $^{\circ}C$; insulation resistance: min. 10M Ω ; leakage current: max. 1.5 μ A at 250V, 50Hz; high voltage resistance: 10kV between saline in dome & transducer leads; weight: 26g (without cable); length of cable: 0.3m.

NL120S AUDIO AMPLIFIER

The NL120S audio amplifier is a power amplifier for driving a 4 Ω or 8 Ω loudspeaker such as the NL985S. It has sufficient power

amplification to raise a ± 20 mV signal to a moderate sound level.

The module features an input selector for switching between two input signals, and the options of amplifying only positive or negative peaks (useful when baseline noise masks the sounds of nerve spikes of interest). The output is shaped to improve the low frequency response of small loudspeakers, and is power limited to minimize the nuisance caused by large transients such as shock artifacts.

SPECIFICATIONS:

Input impedance: 10k Ω ; bandwidth: 10Hz to >15kHz; output voltage range: $\pm 1.5V$; minimum load resistance across output: 3 Ω .

NL820A 4-CHANNEL ISOLATOR

The NL820A isolator provides four channels of high level signal isolation and a $\pm 13V$ (nominal) isolated supply to power separate pre-amplifier stages (e.g. NL822, NL824 or NL844). Connection of all four output channels to other four channel modules (NL134/5/6, NL144 and NL530) is provided via the mother board, without external cables being necessary.

SPECIFICATIONS:

Input signal: $\pm 1.2V$ maximum; gain: x1, x2, x5 with individual channel control; bandwidth: DC to 25kHz (-3dB); channel cross modulation: -60dB; auxiliary supply: $\pm 13V$ 40mA unregulated; power requirement: $\pm 15V$ 80mA (from NeuroLog System Case).

NL844 4-CHANNEL PRE-AMPLIFIER

The NL844 pre-amplifier is specifically designed to operate in conjunction with the NL820A Isolator. Its low noise and high impedance differential inputs make it particularly suitable for use as a headstage pre-amplifier close to the preparation, ideal for isolated EMG, EEG or ECG applications. It features 4 pairs of colour coded 1.5mm DIN "touch proof" sockets for electrode connection as well as a COM input.

The unit can be operated in 1,2,3 or 4 channel modes with unused

channels switched off using the rear panel toggle switches. This unit is particularly suited for use where there are very large stimulus artefacts, for example when used close to a magnetic stimulator coil. The input circuit automatically adjusts to the DC input conditions plus a non-linear filter modifies its time constant if the differential input signal exceeds its normal ± 20 mV working range. Therefore, fast, short artefacts do not block the subsequent stages. This results in an amplifier with a very fast recovery time from stimulus artefact pulses.

SPECIFICATIONS:

Gain: x100, x1000, x10,000 (operated in channel pairs); LF cut: 3, 10, 30Hz (operated in channel pairs); input impedance: 100M Ω ; input channels: 4; common mode: 10,000:1 (-80dB) (with NL820A -120dB); noise: 5 μ V RMS full bandwidth; lead length: 2.5m.



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FILTERS & SIGNAL CONDITIONERS



NL125/6 FILTER (HIGH & LOW PASS, 50/60Hz NOTCH)

The NL125/6 filter module employs two active sections to control the high and low pass characteristics. The low frequency cutoff point can be set continuously from 0.5Hz to 5kHz with a single turn potentiometer, in four switched ranges. Similarly the high frequency cutoff can be set continuously from 5Hz to 50kHz in four switched ranges. DC and WB (wide band) switch positions bypass the lower and upper filter sections, respectively. An active notch filter is provided for the rejection of line frequency interference; this can be operator set at 50Hz or 60Hz, with a 20Hz notch width (-3dB points).

SPECIFICATIONS:

Input voltage range: $\pm 10V$; input impedance: $56k\Omega$; low frequency cutoff range: DC, 0.5Hz - $>5kHz$ continuously adjustable; high frequency cutoff range: wide band ($>50kHz$), and 5Hz to 50kHz continuously adjustable; gain within passband: +1.0; attenuation beyond cutoff: 40dB/decade; notch attenuation: $>50dB$; notch width at -3dB points: 20Hz. Output voltage range: $\pm 10V$; output impedance: 600Ω .



($\pm 2\%$, $\pm 1.25Hz$ at $< 630Hz$) or ($\pm 2\%$, $\pm 62.5Hz$ at $> 630Hz$); gain before cut-off: +1.0; attn. beyond cut-off: 40dB/decade, 12dB/octave; notch attenuation: $>50dB$; notch width (-3dB): 20Hz; crosstalk: better than -60dB; noise: $<100\mu V$ rms; output DC offset: $<\pm 10mV$; output voltage range: $\pm 10V$; output impedance: $<600\Omega$.

NL144 SPECIFICATIONS:

As above except, filter settings (-6dB): 0.1, 0.2, 0.3, 0.5, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200 Hz and DC (no filter); gain after cut-off: +1.0; attn. below cut-off: 40dB/decade. Rear connections to the motherboard allow Input and Output interconnections between this and (newer) NL820A and NL530 modules without the need of front panel cables.



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ANALOGUE & A/D INTERFACE MODULES

SPECIFICATIONS:

Input voltage: $\pm 10V$ max.; input impedance: $1M\Omega$; input time constant: 0.2s or DC; lower range (height): 0 - 5V; aperture range: 0.2 - 5V; gain: x1 or x10 (internally); triggering: +ve or -ve slope; threshold calibration: $\pm 10\%$. OUTPUTS: upper: TTL, 230 μ s ($\pm 10\%$) pulse; lower: TTL, 200 μ s ($\pm 10\%$) pulse; gate: TTL, 15 μ s ($\pm 10\%$) pulse; monitor: input plus upper and lower levels.

Input: 0 - 5V (trigger); $\pm 15V$ (max.); Min. rate 0.1 ppm; Max. rate 999 pps. Output (OUT): 0 - 5V or 0 - 10V ($\pm 5\%$) proportional to rate; latency to output voltage $< 500\mu$ s. Output (LIMIT): TTL high (5V) if the rate is outside the window set by the user, otherwise TTL low; latency to limit $< 500\mu$ s. Mode Switch Control: 4 Position Rotary Switch determining frequency range: PPS 000 to 999 pps; LO PPS 00.0 to 99.9 pps; PPM 000 to 999 ppm; LO PPM 00.0 to 99.9 ppm. Level Control: Rotary dial used in conjunction with "Set Upper Limit", Set Lower Limit" and "Set Trigger Threshold" buttons. Set Limit Buttons: Three buttons allowing the Lower, Upper and Trigger Threshold levels to be set. Visual Indicators: 3 Digit Display (for rate and level values); Trigger (Green LED); Lower Rate Limit (Red LED, left); Upper Rate Limit (Red LED, right).

analogue switch. It also presets the internal Flip-Flop. In the mid position the IN/FF switch selects the control signal for the analogue switch. FLIP-FLOP: is preset by the SET/-RESET toggle switch and toggled by the negative (-ve) going edge of a logic input signal. INPUT: allowed signal: $\pm 15V$ max.; logic threshold: +1.4V approx. (suits TTL); impedance: $10k\Omega$ approx.



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DIGITAL MODULES



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PULSE GENERATOR & STIMULATOR MODULES



(x0.1; x1; x10 with alternative internal jumper setting); input: TTL compatible GATE input; output fan-out: 10 TTL inputs; output pulse widths: 50, 150 or 500 μ s (\pm 5%).

NL304 PERIOD GENERATOR

The NL304 period generator contains a crystal oscillator and frequency dividers for producing a precise, stable frequency standard. It can be externally gated (GATE IN) and synchronised with an external source (RESET input). The pulse train can be switched off and a single output pulse can be produced manually by a front panel push switch. The NL304 is the basic "clock" of the NeuroLog™ System as it provides the "fine grain" (1 μ s increments) necessary for digital control of pulse width, cycle duration, delay, etc using the NL603 Counters.

SPECIFICATIONS:

Output: TTL pulses; period accuracy: \pm 0.01%; period range: 1 μ s to 10 minutes by 1 μ s, 10 μ s, 100 μ s, 1ms, 100ms, 1s, 10s, 30s & 60s PERIOD switch and x1, x2, x5 and x10 MULT switch; output pulse width: 0.5 μ s.

durations of trains of pulses when the NL412 is combined with a Pulse Generator such as the NL301. When used with the NL102G (that incorporates external "Buzz" circuitry) the duration of the "Buzz" is set by the front panel control.

SPECIFICATIONS:

Pulse duration: 1 - 10ms with >20% accuracy at all settings; output level: 9V; rise and fall times: <100 μ s.

NL510A PULSE BUFFER

The NL510A pulse buffer converts TTL logic pulses into 0 to 10V pulses which can be used to drive the NL800A Stimulus Isolator. The output pulses in the ISOLATOR DRIVE mode are offset to match the input characteristics of the NL800A. Output amplitude is adjusted with a precision 10-turn potentiometer and turns counting dial. The mode switch has an OFF position, a useful feature when more than one stimulator is used. The NL510A can be used as a non-isolated voltage stimulator, relay driver, solenoid drive, oscilloscope beam brightener, etc.

SPECIFICATIONS:

Output voltage range: 0-10V; output resistance: < 10 Ω ; output current: 50mA; output rise and fall times: <1 μ s.



NeuroLog
SYSTEM

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SYSTEM ACCESSORIES



NL951-15



NL951B-2m



NL953K

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Extension Cables

NL950 - 10cm (1-way) cable with male connector one end and a female connector on the other end.

NL954 - 2m (4-way) extension cable for NL100A Preamplifier, first stage for NL103 AC Preamplifier [superceded], NL107 Recorder Amplifier.

NL954K - 2m (4-way) extension cable for NL100AK/NL104A/NL108A/NL850A.

NL955 - 2m (6-way) extension cable for NL102 Differential DC-Preamplifier [superceded] (with split socket).

NL955K - 2m (6-way) extension cable for NL102 Differential DC-Preamplifier [superceded] (standard keyway).

NL956K - 2m (6-way) extension cable for NL102G DC-Preamplifier.

NL958 - 824 - 5m (9-way) extension cable for connection between NL822/824 and NL820A Isolation Amplifier.

NL958 - 844 - 5m (9-way) extension cable for connection between NL844 and NL820A Isolation Amplifier.



NL954

NL950

NL956K

Headstage Accessory Kits

NL973A - NL100AK headstage accessory kit. As supplied with each NL100AK. Kit comprises: 3x 1mm gold stacking pins with wire attached, 1x 1mm stacking pin, 1x heat shrink tubing, 1x 2mm plug, 1x "U" shaped jumper with wire attached & 1x Allen key.

NL976 - NL102G headstage accessory kit. As supplied with each NL102G.



NL973A

NL976

Plugs (for Cable Mounting)

NL962 - The standard Lemo NeuroLog single-pole plug.

NL963 - Lemo 4-pole for NL103/NL107.

NL963K - Lemo 4-pole for NL104A/NL108A/NL109.

NL967K - Lemo 6-pole plug (matches NL102G).

NL968K - Lemo 2-pole plug. Mates with NL410 front panel socket.

NL969P - Lemo 9-pole insulated plug. (Mates with NL820A).

NL822P/10 - 2mm plugs with red (NL822P/10-Red) or black (NL822P/10-Blk) insulator. For use with NL822/824 preamplifiers or our D330 MultiStim System. Packet of 10.

NL844P/10 - 1.5mm touch proof plugs with blue (NL844P/10-Bu), black (NL844P/10-Bk) or red (NL844P/10-Rd) insulator. For use with our NL844 preamplifier. Packet of 10.

NL985P - Output connector plugs (pair) for user assembly. Used with NL120S Audio Amplifier, NL100C, DS2A or DS3.

NL970/10 - Gold plated 1mm stacking plug with heat shrinkable sleeve. Pack of 10. For use with NL100AK, NL102G and NL800A.

NL972/10 - Gold plated 2mm plugs. Pack of 10. For use with NL100A, NL100AK and NL102G.



NL963K

Sockets (for Panel Mounting)

NL944 - Lemo 4-pole as on NL103, NL107.

NL944K - Lemo 4-pole, as on NL104A, NL108A, NL109.

NL964 - The standard NeuroLog front panel socket.

NL969S - 9-pole insulated socket. (As used on the NL820A front panel).



NL964



NL965K



NL960



NL961



NL61-xxx



NL62-xxx



NL63-xxx



NL910



NL800-BATT

D330 MULTISTIM

OVERVIEW

The D330 MultiStim System is a modular and highly versatile multi-channel stimulator designed for accurate stimulation of multiple low impedance tissue preparations, using adjustable voltage or current. Typical applications include stimulating cells in culture or acute tissue preparations in organ baths or myographs.

The system provides a choice of modules for either constant current (D343, up to 500mA from a 100V source) or constant voltage (D333H, up to 100V at 1A) stimulation. The D335 Meter can be fitted into the system to allow precise voltage or current monitoring. Timing modules are available to generate pulses, variable in frequency and width, which can be controlled as trains using a gating waveform, variable in repetition rate and duration or pulse count. For ease of use, most modules have an error indicator to warn of incompatible settings or an overload condition. The D330 MultiStim System rack/case comes in a 19" rack-mountable unit that can house up to ten stimulation channels - along with the Pulse Train Generator and Gating modules.

As with many modular systems, some decisions have to be made prior to selection of the correct modules. In order to help with this we have a dedicated D330 MultiStim product brochure with a number of application diagrams that can aid system configuration.



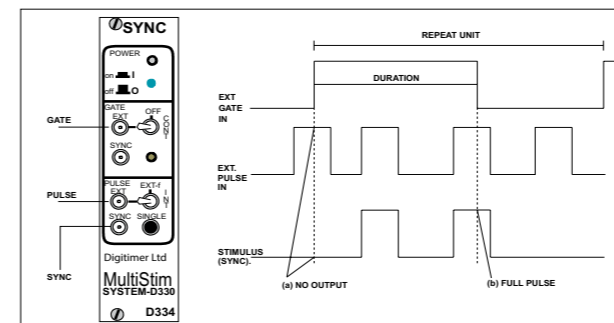
FEATURES

- ✓ **Powerful**
- ✓ **Accurate**
- ✓ **Easy to use**
- ✓ **Modular**
- ✓ **Multi-Channel**
- ✓ **Repeatable**
- ✓ **Self-Contained**
- ✓ **Expandable**

OPERATIONAL MODES

Simple External Control

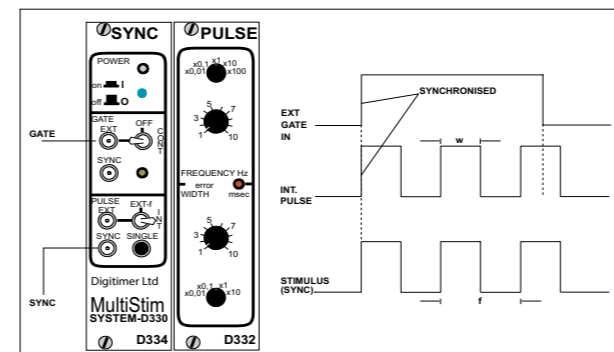
The figure shows the connections of the Gate and Pulse inputs in relation to the overall system. The waveforms show the function of the Gate and Pulse signals in relation to the stimulus output. If the external Pulse starts before the Gate is 'high' (both external



TTL signals in this example) no stimulus is produced (a). Similarly, if an external Pulse starts before the Gate has 'shut', the full pulse is produced as the stimulus output (b). In this way the Gate functions as an 'enabling' signal to 'whole-pulses' only.

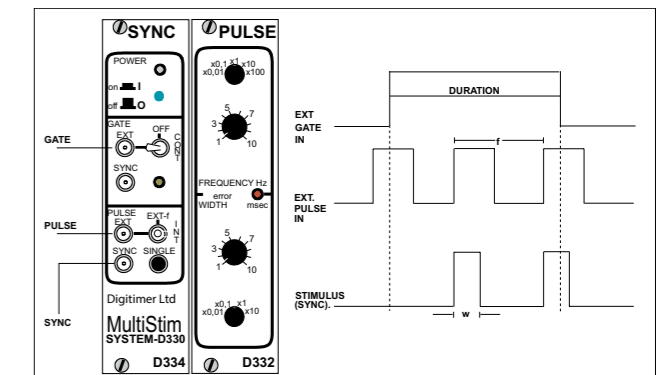
External Gating of Internal Pulses

Here the Width (w) and Frequency (f) are being controlled internally by the D332/D332T. Note that Pulse 1 starts synchronously with the start of the Gate 'opening'. Note also that, since pulse 3 starts before the Gate 'closes', the whole pulse is delivered to the preparation.



External Control with Internal Pulse Width

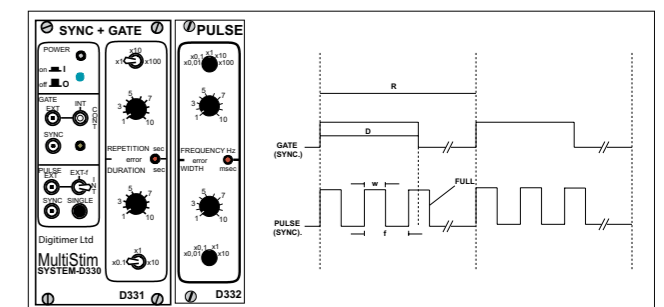
The situation here is similar to that shown above except that the pulse Frequency (f) is being controlled by the frequency of the external TTL input. The Width (w) of the stimuli, however, is still controlled by the D332/D332T module.



Internal Control of Gate and Pulse

The D331AT module allows the user to set the Repetition Interval (R) and Gate Duration (D) independently. The pulse Frequency (f) and Width (w) are both controlled by the D332/D332T module.

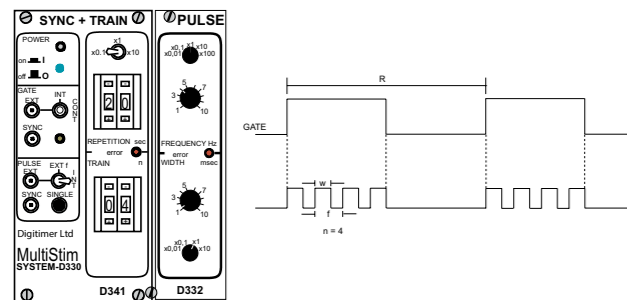
If no internal control of the Gate is required, then the D334B can be substituted for the D331AT.



D330 MULTISTIM

Internal Control of Train & Pulses

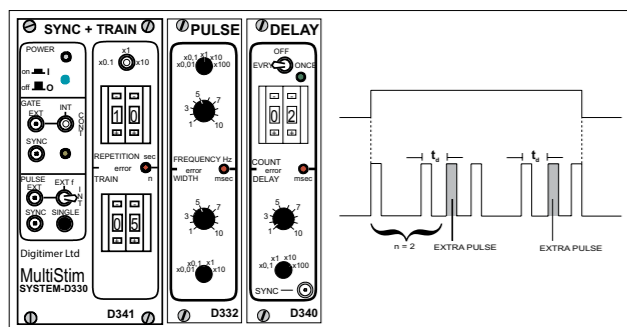
The D341A module allows the user to set a fixed Number of Pulses (n) within the gated Train. The pulse Frequency (f) and Width (w) are both controlled by the D332T module



(Additional) Delayed Pulse

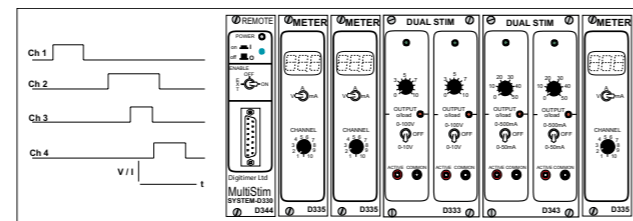
The addition of a D340 to the system enables a delayed extra pulse to be generated that can be used for determining Effective Refractory Period. In the example shown, $n_d = 2$, which means that an extra pulse is generated after every second pulse. t_d is the delay from the start of the second (02) pulse to the start of the additional pulse. The D340 module allows the extra pulse to be selected either after Every nth regular pulse within the gate (as shown) or just Once per Gate burst.

An internal jumper within the D340 allows the selection of just the delayed pulse being the stimulus.



Independent External Logic Control

The D344 module accepts external TTL inputs to independently control the timing of each stimulation channel using multiple D333H/D343.



Specific Requirements

The D330-MultiStim System can often be adapted to suit the user's own needs. For example, by factory modification, up to four D333H/D343 channels can be independently controlled by four separate D332T modules in the same rack.

Protection & Indicators

Particular attention has been paid in the design to protect the unit and warn the user of incompatible settings. This could be too great a Width for the set Frequency on the D332T, too long a Duration for the set Repetition Rate on the D331AT or a preparation that requires too great a current for the set Voltage on the D333H. Red LEDs are fitted to indicate an erroneous setting or overload, and orange LEDs indicate each Output channel that is producing a stimulus. The power supply lines are each monitored and if any go out of limits, possibly due to excessive total current from the stimulating channels, the LED on the left-hand module (D331AT/334B/341A/344) changes from green (OK) to red (FAULT).

D330 MULTISTIM SYSTEM COMPONENTS



SYSTEM CAPACITY

The left-hand bay will contain a double width D331AT or D341A unless internal Gate control is not required when the D334B or D344 would be fitted. The next bay will contain the D332T (unless D344 fitted). A D340 may be fitted (unless D344 fitted) if room is available in the left-hand 4 bays. Stimulation modules are fitted starting at bay 5 and one, or more, D335 - Meters may be fitted. D330-1/D330-2 blank front panels will be fitted to unused bays.

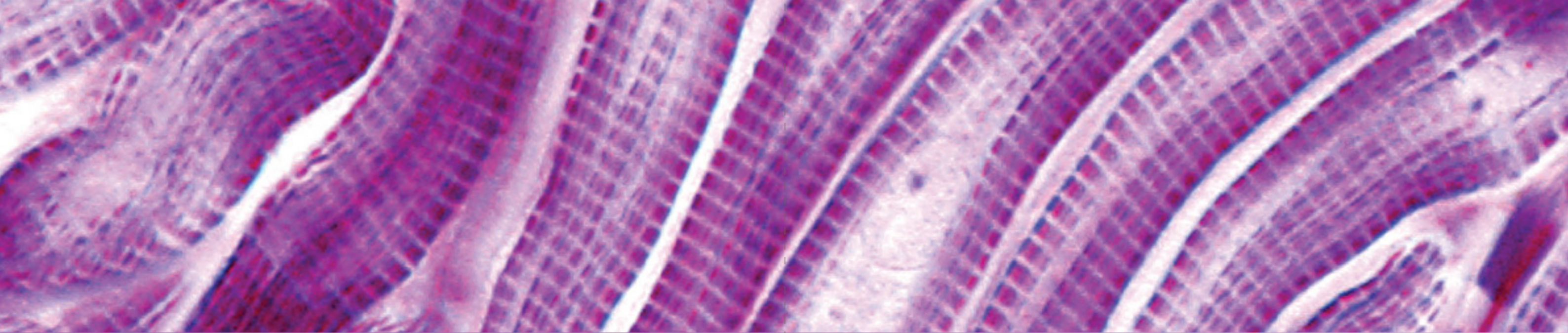
STIMULATORS & MONITORING MODULES

D333H - Dual Stimulator

This unit provides constant voltage stimuli from 0 to 100V in amplitude with currents up to 1A into loads as great as 0.01 μ F. The voltage of the two channels is independently controlled by single turn controls and range selector switches. Each channel has an on/off switch, stimulus indicator and an overload detector/indicator. The control and timing for the pulses is generated by selecting other modules from the D330-MultiStim System range. The D335 - Meter can be used to indicate either the voltage or current of the selected channel immediately before the end of the stimulation pulse.

SPECIFICATION SUMMARY (of each channel)

OUTPUT: **Range Selector:** 1) 0 - 100V, 2) OFF, 3) 0 - 10V; **Amplitude:** Single turn (270°) control marked 0 - 10, intermediary panel marks at each integer; **Accuracy:** $\pm 1\%$ at '1' and '10' marks on 100V range, $\pm 2\%$ at '1' and '10' marks on 10V range, $\pm 5\%$ at intermediary marks; **Minimum:** At '0' output: <100mV; **Current:** 1A max.; **Impedance:** On - 0.25 Ω , Off - 22 Ω ; **Rise/Fall time:** <5 μ s/20 μ s. **OVERLOAD CUT-OUT: Limit:** 1A per channel; **Function:** The output pulse duration is terminated; **Reset:** The overload cut-out is automatically reset after each pulse. **INDICATORS: Overload:** Red LED that illuminates after each overload; **Stimulus:** Amber LED that illuminates for each stimulus.



D330 MULTISTIM

D335 - Meter Module

This module provides retained digital indication of the measured voltage or current of the stimulating waveform, thus making oscilloscopes to measure these parameters unnecessary. The measurement channel is selected from the front panel and the measurement is shown on three 7-segment LEDs. The converter is commanded to sample the selected channel coincident with the end of the output pulse to remove errors due to the capacitance of the preparation. This is possible as the stimulus control logic is very quick and the stimulus itself takes a few microseconds to react.

SPECIFICATION SUMMARY

Display: 3 x 7-segment red LEDs - 0.3" high; **Range:** 00.0 - 99.9V, 0.00 - 9.99A, 000 - 999mA; **Timing:** Samples and converts selected channel coincident with the end of the output timing pulse; **Selector:** Ten-position rotary switch marked Channels 1 to 10.

CONTROL AND GATE MODULES

COMMON FEATURES (Gate only applies to D331AT, Train to D341A, Pulse to D331AT, D334B and D341A) **POWER:** **Switch:** Mounting for the rod that activates the switch in the PSU, push on - push off; Error/Power On: Red/Green LED. **EXTERNAL CONNECTORS:** **Type:** Lemo single pole (not D344); **Control Inputs:** TTL compatible, Triggers at +1.5V, maximum input $\pm 15V$, active high; Sync. **Outputs:** TTL compatible. **Optionally:** +15V pulse by on-board jumpers, active high. **GATE/TRAIN SELECTOR FUNCTIONS:** 1) 'EXT' - External control of Repetition and Duration, 2) 'INT' - Internal control of Repetition and Duration, 3) 'CONT' - Pulses continuously enabled. **PULSE SELECTOR FUNCTIONS:** 1) 'EXT' - External control of Frequency and Width, 2) 'EXT-f' - External control of Frequency, 3) 'INT' - Internal control of pulse Frequency and Width; Single (not D344): Push button to give a single output pulse irrespective of other settings. **NOTE:** The internal pulse frequency and width would be set by a D332T - Pulse module.



SPECIFICATION SUMMARY

TRAIN REPETITION: **Total Range:** 0.1 - 990 seconds; **Control:** 01 to 99 by a two-digit thumb-wheel switch; **Multiplier:** x0.1, x1, x10; **Ranges:** 0.1 - 9.9s in 0.1s increments, 1 - 99s in 1s increments, 10 - 990s in 10s increments; **Accuracy:** $\pm 1\%$. **COUNT:** **Total Range:** 01 - 99.

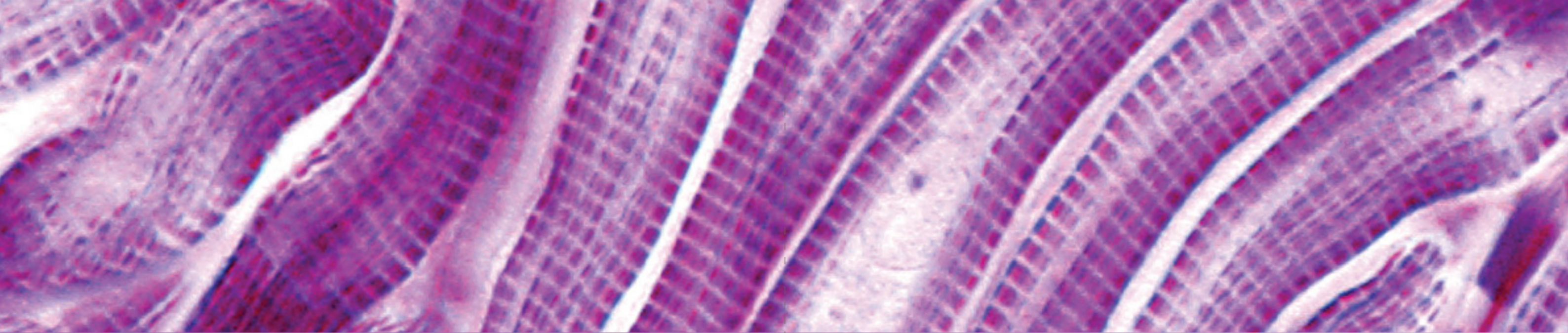
D344 - Remote

This module allows the user full (and only) external control of the timing for each independent channel. A toggle switch gives overall output control by :- a) allowing a single external Enable signal to control the system, b) permanent Enable or c) all channels OFF (for safety).

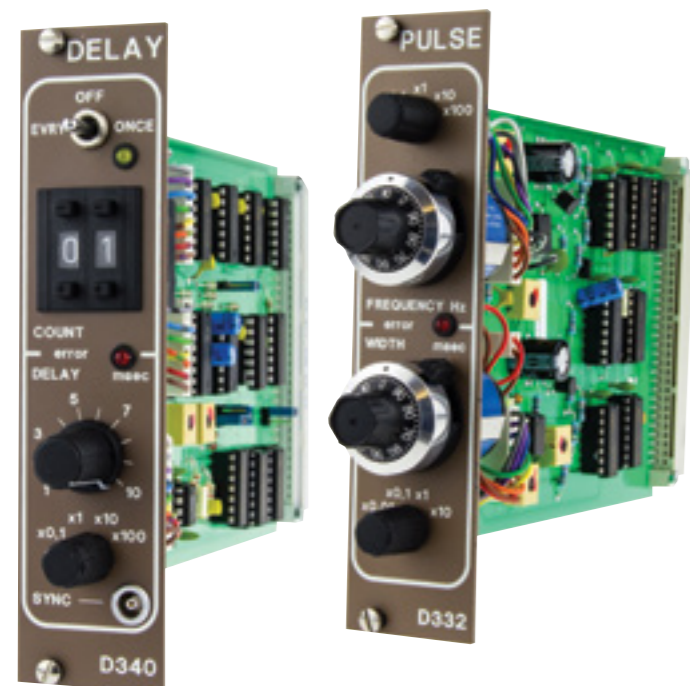
SPECIFICATION SUMMARY

INPUTS: **Channel:** Ten off, 1 per channel; **Enable:** Active high, when low disables all channels; **Connector:** 15-way male 'D' with hex-jack locking. **OUTPUTS:** **Power:** Ground and +5V limited to 20mA. **CONTROL:** **System Enable:** 1) 'EXT'-External control of Enable; 2) 'OFF'-No output from any stimulator; 3) 'ON'-External enable overridden.





D330 MULTISTIM



Plugs, Adapters and Leads

No leads or connectors (except for a Mains lead) are supplied with a D330-MultiStim System. In addition to the preparation leads at least one lead is usually required for external synchronisation or monitoring.

Lemo Connectors and cables for Synchronisation and External In sockets

NL951: Cable with a connector on both ends; available in 5 standard lengths (15cm, 30cm, 45cm, 1m and 2m) - please specify length when ordering; NL952: 2m cable with a connector at one end and tinned lead at the other; NL960: Adapter with BNC plug and Lemo socket that makes cables with BNC plugs at one end unnecessary; NL961: 'T' connector that is used to make branched connections at the front panel socket; NL962: Unassembled plug.

CLINICAL NEUROPHYSIOLOGY

DS5 ISOLATED BIPOLAR CURRENT STIMULATOR

The DS5 isolated bipolar stimulator allows computer control of stimulus amplitude and timing parameters and has a maximum constant current output of $\pm 50\text{mA}$. It has been designed to speed up and enhance human peripheral nerve diagnostics by facilitating semi-automated nerve excitability tests. It also has roles in wider aspects of clinical neurophysiology research, including psychological, vestibular system and nociceptive testing. The DS5 is a CE marked medical device under the European Medical Device Regulation.

The DS5 is controlled by an analogue voltage input which it translates into an isolated constant current stimulus (up to $\pm 50\text{mA}$), precisely replicating the shape of the input waveform. As a result the DS5 should be of interest to anyone wishing to control surface stimulation protocols via software/hardware combinations capable of producing a suitable command voltage waveform e.g semi-automated pain research or sensory threshold testing.

The DS5 was developed in collaboration with Prof. Hugh Bostock (UCL, London) for use with QtracW, a nerve excitability stimulus control, acquisition and data analysis software package.

FEATURES

- ✓ **Up to $\pm 50\text{mA}$ output from $\pm 120\text{V}$ compliance, in 3 output ranges.**
- ✓ **Isolated constant current output proportional to input “command” voltage.**
- ✓ **Compatible with DAQ’s capable of producing an analogue voltage output.**
- ✓ **Safety features ensure patient/human subject protection. CE marked medical device.**
- ✓ **Output connection accessories, including plugs and cables and electrodes are also available.**



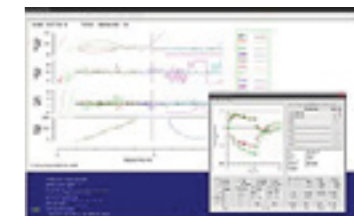
QTRACW THRESHOLD TRACKING SOFTWARE

QtracW is a flexible, stimulus response data acquisition program with averaging and threshold tracking facilities, for studies of human nerves in vivo and animal in vivo/in vitro preparations. It is best suited to situations when the excitability or response varies slowly with time, either due to changes in the stimulus parameters or to an externally initiated treatment, and the data of primary interest are the changes in selected parameters (threshold, amplitude, latency, etc.) of the response with time. Response waveforms can also be recorded, enabling the time course of additional response parameters to be calculated after the recording is finished. QtracW comprises separate stimulation and plotting programs, QtracS and QtracP. QtracW is a multi-channel program, in which the ‘channels’ (up to 16) may be associated with different physical inputs and outputs, or with different stimulation parameters or different operations on the response waveform. Flexibility comes from the ability to associate any combination of physical or operational parameters with any channel.

The Digitimer DS5 Bipolar Constant Current Stimulator was specifically designed to work with QtracW software for human studies of nerve excitability. The major components of a human nerve excitability setup include a PC running QtracW software, a nerve stimulator (e.g. Digitimer DS5), an isolated EMG amplifier (e.g. Digitimer D440-2) and a compatible DAQ interface. For animal studies we recommend our DS4 Stimulator.

Compatible DAQ Hardware

National Instruments DAQ interfaces (e.g. USB-6221-BNC or USB-6251-BNC) are recommended for use with QtracW software. Please consult the QtracW users manual for further details on specific models.



Obtaining QtracW

The most recent version of QtracW software can be freely downloaded from the QtracW FTP site (login details available from Digitimer upon request). After 50 days evaluation QtracW will only function through use of a USB hardware dongle/key which is provided once a licence has been purchased from Digitimer.

Installation Instructions

All the necessary files and installation instructions are available from the QtracW FTP site.

QtracW Training

A series of highly successful nerve excitability workshops has been held since 2009. Further workshops are organised when there is adequate demand. Please contact us if you are interested in attending a workshop.

Purchasing QtracW

New QtracW users need to purchase a 5 year licence pack from Digitimer. This pack consists of one QtracSP dongle (stimulation and analysis/plotting) and two QtracP (analysis/plotting only) dongles. Once a user becomes a registered QtracW licensee, further dongles can be purchased individually with variable lifetimes (one to five years) and capabilities (either QtracP or QtracSP). It is also possible to extend the lifetime of a dongle by paying the appropriate licence fee. Existing QtracW users can also transfer remaining licence time from a password on their computer to up to three USB dongles (only one QtracS) using “DongleExtend” software. Please contact Digitimer for further details.

CLINICAL NEUROPHYSIOLOGY

DS7A & DS7AH HIGH VOLTAGE CURRENT STIMULATOR

Suitable as a general purpose electrical nerve or muscle stimulator, the DS7A provides up to 100mA constant current high voltage pulses of brief duration for percutaneous stimulation during investigation of the electrical activity of nerve and muscle tissue. The DS7A is also commonly used in pain research applications. The output current is continuously variable over the range 0 to 100mA from a maximum compliance voltage of 400V. The DS7AH allows currents up to 1A with a reduced maximum pulse duration limit of 200µs. This model is offered to overcome the difficulties of stimulating deep peripheral nerves, or large muscles such as the quadriceps with large area electrodes.

The DS7A and DS7AH now include an alternating polarity mode to prevent polarization of the stimulation site and potentially harmful electrolytic effects of longer periods of stimulation.

The DS7A or DS7AH can be triggered by an external device such as our DG2A Train/Delay Generator. For applications that require a higher output, we recommend our D185 MultiPulse. The DS7A & DS7AH are CE marked medical devices and have been cleared by the FDA for marketing within the USA.

FEATURES

- ✓ Pulse durations from 50µs to 2ms (DS7A) and 50µs to 200µs (DS7AH).
- ✓ 100mA (DS7A) or 1A (DS7AH) constant current output from 400V.
- ✓ Flexible TTL compatible trigger options or front panel push button.
- ✓ NEW Alternating Polarity control – a toggle switch allows the stimulator to operate in +ve, -ve or alternating polarities during stimulation.
- ✓ Output connection accessories, including plugs and cables and electrodes are also available. (See D185 accessories)



DS8R ISOLATED BIPHASIC CONSTANT CURRENT STIMULATOR

The DS8R is a new constant current, multi-mode, discrete pulse stimulator for human research studies involving nerve and muscle stimulation via surface electrodes. It features a high compliance voltage and can be triggered by a TTL compatible input, contact closure foot/hand switch or front panel "single-shot" button. The DS8R can deliver pulses of up to 2ms duration and 0-1000mA (from 400V), however the actual current achieved will be restricted by a pulse energy limit of 300mJ per pulse and the skin/electrode resistance.

Biphasic Charge-balanced Output

The DS8R has two pulse modes, enabling stimulation using monophasic or biphasic rectangular pulses. Additionally, in biphasic mode the DS8R allows for both symmetric or asymmetric charge-balanced stimuli through implementation of an adjustable stimulus/recovery phase amplitude ratio. Biphasic charge-balanced stimulation offers certain advantages over monophasic stimulation, as it prevents the potentially harmful electrochemical changes which occur under stimulation sites and is reported to be more comfortable for the subject during long periods of stimulation.

External Control Capabilities – Software (via USB) and Analogue Voltage Input

Researchers often want to adjust stimulus settings (current and duration) during a stimulation protocol and with the arrival of the DS8R, such control becomes a reality. While the DS8R can operate as a standalone isolated stimulator with full control via the front panel, settings can also be modified using Windows PC control software (supplied) via a USB interface. This software provides a Virtual Front Panel for the stimulator, but more importantly incorporates an API allowing the operator to implement control from custom or commercially available software packages.

FEATURES

- ✓ Current range 0-1000mA from 400V
- ✓ Pulse duration range 50-2000µs
- ✓ Biphasic Output – Charge-balanced symmetric or asymmetric
- ✓ Adjustable inter phase interval (0-50ms)
- ✓ External control via PC software/USB connection (includes API)
- ✓ Analogue Control of Stimulus current
- ✓ PC log of stimulus parameters stored in CSV format
- ✓ Output connection accessories, including plugs and cables and electrodes are also available.



CLINICAL NEUROPHYSIOLOGY

D188 REMOTE ELECTRODE SELECTOR

The D188 Remote Electrode Selector gives you the ability to direct a stimulus from a single stimulator to one of up to eight pairs of electrodes. The D188 is supplied with PC software which acts as a virtual front panel, allowing manual switching between stimulation sites, but is ideally suited to situations where stimulation needs to be rapidly and silently switched between multiple sites under remote digital control. The D188 is not a certified medical device and use is restricted to human research applications.



D185 MULTIPULSE CORTICAL STIMULATOR

Now used worldwide as an effective tool for intra operative monitoring (IOM) of the spinal cord, the D185 is the ONLY standalone surgical stimulator with FDA clearance for this technique. The D185 transcranial stimulator allows transcranial motor evoked potentials (MEPs) to be used in surgical procedures such as scoliosis correction, spinal tumour resection and thoraco-abdominal aortic aneurysm (TAAA) repair. The 1000V power source means that MEPs can even be evoked in patients with pre-existing neuropathologies.



FEATURES

- ✓ 1000V maximum voltage output (set by user).
- ✓ 1.5A maximum current output (LCD monitor).
- ✓ Risetime of 0.1A per μ s.
- ✓ 50 μ s pulse duration.
- ✓ 1 to 9 pulses with user defined interpulse interval.
- ✓ Reversible output polarity switch.
- ✓ Interfaces with standard intra operative monitoring equipment.
- ✓ User defined trigger facilities permit integration with popular EMG recording equipment.

The D185 is a CE marked medical device and has been cleared by the FDA for marketing in the USA.

The D185 MultiPulse is also useful for peripheral nerve stimulation. Although the D185 was designed for transcranial cortical stimulation during intra operative monitoring, the brief high voltage output also makes it suitable for use as a spinal root stimulator during differential diagnosis of peripheral nerve disorders, such as multifocal motor neuropathy and motor neuron disease. The high voltage allows effectively stimulation of deep nerve roots as they exit the spinal column, while the very short pulse duration minimizes patient discomfort.

CLINICAL NEUROPHYSIOLOGY

D185 MULTIPULSE CORTICAL STIMULATOR ACCESSORIES



The D185 MultiPulse Cortical Stimulator can be supplied with a range of accessories to facilitate integration with operating theatre equipment and stimulation preferences. The current range includes electrode extension leads, stimulator output plugs, a footswitch and a range of electrode connection head boxes and electrode holders/handles for peripheral nerve stimulation applications.

Miscellaneous Items



D185-TC3
Trigger cable (BNC - BNC) - 1m. For connection between your EP system and the D185.



D185-TC4
Trigger polarity inverter. For connection between your EP system and the D185.



D185-TC5
Trigger cable (BNC socket - 3.5mm) - 0.6m. For connection between your EP system and the D185.



D185-FS1
Foot switch to IP68. Allows foot switch control of the D185.



D185-OC1
Output connector plugs for user assembly (pair). Also suitable for use with the DS7A peripheral nerve/muscle stimulator.

Electrode Connection Headboxes



D185-HB1
Electrode connection headbox (5m cable). This extension headbox provides 5 linked pairs of 1.5mm DIN sockets for connection to MEP electrodes closer to the site of stimulation.



D185-HB3
Electrode connection headbox with stimulus reversal and SEP electrode disconnection (inc. D185-CB1) - 5m. Ideal for those using SEP monitoring who want to avoid saturating their SEP amplifier during MEP stimulation.



D185-HB4
Electrode extension cable - 4.5m. Straight forward extension of the output sockets of the D185, terminating in a moulded pair of 1.5mm DIN sockets. Other lengths are available.

Trigger Cables*



D185-TC1
Trigger cable (BNC - 3.5mm) - 1.5m. For connection between your EP system and the D185.



D185-TC2
Trigger cable (BNC - SMB) - 1.5m. For connection between your EP system and the D185.

Electrode Holders/Handles



D185-OL1
Output lead - moulded connector on 5m cable for user assembly. Also suitable for use with the DS7A peripheral nerve/muscle stimulator.



D180-PADS
Pack of 10 felt pads for D180 and D185 Electrode holders.



D185-EH2
Depth Electrode - One cathode and three anodes for deep peripheral nerve stimulation.



D185-EH3
Compact Standard Electrode - Single anode and single cathode (with 50mm spacing).



D185-EH4
D180ES Style Electrode - Single anode and single cathode with long handle (with 60mm spacing).

*There are lots more trigger cables available, please contact us.

CLINICAL NEUROPHYSIOLOGY

D360 8-CHANNEL PATIENT AMPLIFIER

The D360 is a computer-controlled 8-channel patient-isolated AC-coupled biological amplifier and analogue filter system, CE marked according to the European Medical Device Directive. The system comprises a main amplifier unit, a remote active head-box and dedicated Windows compatible control software.

Multiple D360 systems can be connected to a single computer (via a single serial port) to allow multiples of 8 channels to be controlled through a single software interface.



FEATURES

- ✓ **Individual or grouped control of the gain and filtering characteristics of amplifier channels.**
- ✓ **Impedance checking feature allows tri-colour LEDs to indicate problems with any electrodes.**
- ✓ **Notch filter (factory set to 50Hz or 60Hz). Large range of low-cut and high-cut band-pass filter settings.**
- ✓ **Overall gain of x100 to x2,000,000 with outputs at the front (BNC) or rear (D-type) of the main unit.**
- ✓ **Includes software control of amplifier settings.**
- ✓ **Typically used as a multi-channel EEG amplifier or multi-channel EMG amplifier.**
- ✓ **Compatible with our D175 Electrode resistance meter.**
- ✓ **Support for control by CED Signal and Spike2 software (32bit CED installations only).**
- ✓ **Windows XP (SP2), Vista, Win7 and Win8.1 (32 bit and 64 bit) compatible control software included.**

The D360 is ideally suited to research or diagnostic use, as an electroencephalography amplifier (EEG), electromyography amplifier (EMG) or evoked potential amplifier (EP).

Analogue signal outputs mean that the D360 can be used with the majority of commercially available data acquisition systems, so you aren't restricted to any particular data acquisition and analysis software.

The D360-AIS gives the operator a tool to select which channel to listen to or feedback to the subject. This is particularly useful during TMS studies where muscle relaxation is easily monitored with the D360-AIS. The unit plugs into the Signal Channel Output socket on the rear of the Digitimer D360 Amplifier and the LINE-IN socket of the PC (via a supplied cable). A rotary switch allows the operator to select the channel number to monitor.

As serial ports become less widely available on desktop and laptop computers, this adaptor makes it possible to connect the Digitimer D360 Amplifier via a standard USB port. It is important to note that although there are many types of USB to serial adaptors available, not all of them will work with the D360. Digitimer has ensured that the adaptors we offer are compatible with the D360 amplifier.

FEATURES

- ✓ **Switchable from channels 1 to 8.**
- ✓ **Adjustable Volume Control.**
- ✓ **Compatible with PC Soundcards.**
- ✓ **Connects to D360 Amplifier via rear "D" connector.**



CLINICAL NEUROPHYSIOLOGY

D440 2 OR 4 CHANNEL ISOLATED AMPLIFIER

The Digitimer D440 Isolated Amplifier is a low noise solution for human EMG studies, specifically those related to nerve excitability. Low noise performance is significantly enhanced through the use of a Driven Right Leg (DRL) circuit which reduces Common-mode interference. The D440 features an amplification range of x100 to x20k. The gain, filter and mode settings for individual channels are adjusted using Digitimer's "virtual front panel" software or other software via a COM interface. The D440 is available in two versions, the D440-2 (two channels) and the D440-4 (four channels). Each channel features a pair of 1.5mm touch proof sockets for active and reference electrode connection, but provision is also made for shielded leads with 5-pin DIN connectors. Each amplifier is supplied with a signal output cable (D connector to multiple BNC) and electrode connection cable (1.2m long with 3x 1.5mm DIN42802 sockets for electrode connection and 270 degree 5-pin DIN plug for amplifier connection).

FEATURES

- ✓ Portable, standalone design
- ✓ Extremely low noise
- ✓ Rapid recovery from stimulus artifacts e.g magnetic or electrical stimulation
- ✓ AC and DC operating modes
- ✓ Analogue signal output for ultimate compatibility with data acquisition systems
- ✓ Computer control through dedicated Digitimer software or external programs (via COM interface)
- ✓ Designed for human research applications, including nerve excitability testing



D175 ELECTRODE IMPEDANCE METER

The D175 Impedance Meter is a compact battery powered device designed to allow checking of electrode impedances prior to recording or stimulating through surface electrodes attached to the skin. In the case of electrical stimulation, high electrode impedance can reduce the amount of current that can pass through the target tissue, resulting in lower than expected stimulation and a poor evoked response. Likewise, high impedances can reduce the quality of recordings, such as ECG, EEG and EMG that rely on surface electrodes.

FEATURES

- ✓ Portable
- ✓ Battery powered
- ✓ Easy to use
- ✓ Wide impedance range
- ✓ Low/high LED indicators



The D175 is a tool that allows suitably trained operators to rapidly assess surface electrode impedances in order to decide if they are low enough for the procedure being undertaken. It features green/red bi-colour LEDs allowing the operator to set a threshold impedance at which an LED will light as red rather than green. This facilitates electrode impedance checking, by providing the operator with an easily visible indication of "good" (green) or "bad" (red) electrode impedances. The impedance values that the D175 can display are 0, 0.5, 2, 3, 5, 7, 12, 20, 30, 50 kohm. For display purposes, measured impedances are rounded up to the next highest displayable value, i.e 4 kohm lights up the 5 kohm LED. By pressing and holding the Power Button for longer than 4 seconds, the D175 will enter the SETUP MODE and allow the operator to change the level at which the LEDs illuminate green or red. In SETUP MODE, the LED corresponding to the highest "good" (green) level will flash green. The D175 preserves battery power by switching off if a button is not pressed for a period of greater than one minute.

CLINICAL NEUROPHYSIOLOGY

D179 PERFORMANCE CHECKER

The Association of Neurophysiological Scientists (ANS, formerly known as EPTA) have transferred the manufacture of their model 1179 Performance Checker to Digitimer Ltd. As a result, we are now able to offer the updated 1179A unit (model D179) with or without the required function generator.

Guidelines drawn up by the ANS urge clinical neurophysiology departments to carry out certain routine checks on their equipment to ensure that it is operating within specified standards. While many instruments offer internal calibration functions, these checks do not of course provide any independent verification that the equipment is functioning correctly. Only by use of an independent external device to carry out EMG amplifier calibration (or EEG amplifier calibration) can such checks be conducted with complete confidence.



FEATURES

- ✓ Improved version of the EPTA 1179 Unit
- ✓ More accurate than the original 1179
- ✓ Uses fewer leads
- ✓ Single-handed operation

The D179 Performance Checker is designed to be used in conjunction with a suitable signal source. The recommended signal source for those departments wishing to calibrate EEG amplifiers only is the TG315 Function Generator. For those departments needing to check Evoked Potential and EMG/Nerve Conduction systems as well as EEG, a signal source with a trigger input is needed. Here, the TG1010A is suggested, which is a digital function generator. Both devices are available from Digitimer and are supplied with a calibration certificate.

The 1179A Performance Checker accepts the output from either of the above sources, attenuates it by 100,000:1 (100dB) and presents it simultaneously to 32 outputs via standard 1.5mm touch-proof sockets on the top of the box. There are in addition a GROUND/COMMON socket and two REFERENCE/NEUTRAL sockets.

D177 BIOFEEDBACK UNIT

Designed to Improve the Reproducibility of Neurophysiological Testing

The Digitimer D177 Bio-Feedback Unit has been developed to improve reproducibility of the Vestibular Evoked Myogenic Potential (VEMP) test, however, it may be employed for any neurophysiological evaluation that requires repetitive voluntary input from the subject. The D177 provides a visual indication of the effort being exerted and this helps the subject maintain the same level of tonic activation during each successive trial.

Easily Incorporated into Standard EP/EMG Systems.

The D177 has a 2.8m long cable, terminating with a 3.5mm mono audio jack, to facilitate connection to the audio output of an EMG amplifier. The D177 converts this signal into visual feedback for the subject, in the form of needle movement on an analogue level meter. The subject is instructed to make an initial movement under the direction of the operator and the 'volume' is then adjusted until the needle is in the centre of the display. No further adjustments are necessary until the test is complete for that person. All the operator need do, is ask the subject to exert enough voluntary effort to direct the needle to the centre of the display and maintain it there, during each trial.

FEATURES

- ✓ More Reproducible VEMP Testing
- ✓ Portable & Lightweight
- ✓ Easy to Setup & Use

Inexpensive and Suitable for Subjects with Large or Small EMG Responses.

The D177 Biofeedback Unit is a simple, inexpensive device which improves the reproducibility of neurophysiological tests including VEMPs. It is suitable for subjects with small or large EMG output, as the device is easily calibrated to an effort that each person can withstand and repeat comfortably.



NEURODIAGNOSTIC ACCESSORIES

Disposable Concentric Needle Electrodes (EMG)

For use with the DCNE extension cable. For single use only.
Packing: 25 individually packed electrodes per box, pre-sterilized.
Sterilization: ETO. 36 month shelf life.

BENEFITS

- ✓ **Optimal signal quality and excellent noise reduction**
- ✓ **Painless skin penetration and less bleeding**
- ✓ **Easy maneuvering**
- ✓ **“Hands free” disposal of the needle from the cable**
- ✓ **Friction reduction during insertion**
- ✓ **Reduces patient discomfort during muscle contraction**
- ✓ **Easy recognition during usage**
- ✓ **Less shelf space and reduction in shipping cost**

FEATURES

- ✓ **Matching material properties of cannula and core wire**
- ✓ **Machine sharpened tip**
- ✓ **Coaxial, orientation free gold-plated connector**
- ✓ **Recording area indicator**
- ✓ **Changed cannula structure**
- ✓ **Optimized material flexibility**
- ✓ **Colour coded hub according to market standard.**
- ✓ **New improved smaller box and pouch**

Needle Length	Needle Diameter	Recording Area	Hub Colour	Part Number
25mm 0.30mm	(30 Gauge)	0.021mm ²	Red	E.B50600-001
25mm 0.40mm	(27 Gauge)	0.021mm ²	Yellow	E.B50600-002
30mm 0.3mm	(30 Gauge)	0.021mm ²	Pink	E.B50600-006
37mm 0.45mm	(26 Gauge)	0.068mm ²	Green	E.B50600-003
50mm 0.45mm	(26 Gauge)	0.068mm ²	Blue	E.B50600-004
75mm 0.60mm	(23 Gauge)	0.068mm ²	Violet/Purple	E.B50600-005

Goldline DCNE Electrodes

An enhanced version of the Silverline Electrodes which feature a platinum-iridium electrode wire and gold-plated cannula.

Needle Length	Needle Diameter	Recording Area	Hub Colour	Part Number
25mm 0.30mm	(30 Gauge)	0.021mm ²	Red	E.B50035-001
25mm 0.40mm	(27 Gauge)	0.021mm ²	Yellow	E.B50035-002
37mm 0.45mm	(26 Gauge)	0.068mm ²	Green	E.B50035-003
50mm 0.45mm	(26 Gauge)	0.068mm ²	Blue	E.B50035-004
75mm 0.60mm	(23 Gauge)	0.068mm ²	Violet/Purple	E.B50035-005

Reusable Concentric Needle Electrodes (EMG)

Our reusable concentric needle electrodes feature a platinum-iridium electrode core wire located in a stainless steel cannula. The electrode head is designed as a sub-miniature coaxial plug, permitting quick connection that requires no orientation.

Packing: 1 piece per package

Needle Length	Needle Diameter	Recording Area	Hub Colour	Part Number
20mm 0.40mm	(27 Gauge)	0.021mm ²	Red	E.RN147/20
25mm 0.30mm	(30 Gauge)	0.021mm ²	Yellow	E.RN140/35
30mm 0.40mm	(27 Gauge)	0.021mm ²	White	E.RN147/30
40mm 0.50mm	(25 Gauge)	0.068mm ²	Green	E.RN145/40
50mm 0.45mm	(26 Gauge)	0.068mm ²	Brown	E.RN146/50
60mm 0.60mm	(23 Gauge)	0.068mm ²	Blue	E.RN143/60



NEURODIAGNOSTIC ACCESSORIES

Reusable Single Fibre Needle Electrodes (EMG)

A platinum-iridium recording surface is presented through a side port opposite to the cutting edge bevel, close to the needle tip. The position of the recording electrode is indicated by a white dot on the needle hub. The core of the electrode has a diameter of 25µm.

Packing: 1 piece per package.

Requires appropriate Reusable Cable for electrode headbox connection.

Needle Length	Needle Diameter	Hub Colour	Part Number
25mm 0.40mm	(27 Gauge)	Brown	E.RN167/25
40mm 0.45mm	(26 Gauge)	Black	E.RN166/40



Reusable Cables (EMG, NCS, EP)

Required for use with our Disposable and Reusable Concentric, Single Fibre Needle electrodes.

Our shielded reusable cables 1.25m or 2m long and available with a 5-pole DIN connector.

Packing: 1 piece per package.

Connector Type	Wire	Part Number
5-pole DIN connector	Flexible (1.25m)	E.A0011/125/DIN
5-pole DIN connector	Flexible (2m)	E.A0011/200/DIN



Sharpening Kit for Reusable Needle Electrodes (EMG)

Designed for accurate and uniform sharpening of reusable concentric and single fibre needle electrodes. Needle holder consists of two blocks bolted together at their sides. A 15 degree angle matches that of the needle's point and a 27 degree angle is for sharpening the facets of the needle tip.

The kit contains a clear plastic needle holder, a magnifying lens and an Arkansas whetstone.

Kit	Part Number
Sharpening Kit	E.A0070



Disposable Monopolar Needle Electrodes (EMG)

Our disposable monopolar needle electrodes of stainless steel are PTFE coated for low friction during insertion. The needle point is conically sharpened and the needle tip serves as the recording area. The 1 metre PVC wire terminates in a safety DIN 42 802 connector. The hub is a firm-grip and is colour coded for easy identification. We have two versions, a Detachable and a Prewired Needle Electrode.

The Detachable Monopolar comes with a gold-plated orientation free coaxial connector.

The Prewired Monopolar has a 0.75m PVC wire, terminating into a safety DIN 42 802 connector.

For single use only.

Packing: 25 individually packed electrodes per box, presterilized.

Sterilization: EtO.



Needle Length	Needle Diameter	Wire Colour	Part Number Detachable	Part Number Prewired
25mm 0.35mm	(28 Gauge)	Red	E.RN068/25	E.RN058/25
25mm 0.45mm	(26 Gauge)	Yellow	E.RN066/25	E.RN056/25
37mm 0.35mm	(28 Gauge)	Orange	E.RN068/37	E.RN058/37
37mm 0.45mm	(26 Gauge)	Green	E.RN066/37	E.RN056/37
50mm 0.45mm	(26 Gauge)	Blue	E.RN066/50	E.RN056/50
75mm 0.45mm	(26 Gauge)	Violet	E.RN066/75	E.RN056/75

Reusable Cables (EMG)

Required for use with our Detachable Disposable Monopolar Needle Electrodes (above).

They come with moulded connector ends and are available in two versions.

- Shielded (with 5-pole DIN connector, 1m)
- Unshielded (with safety DIN 42 802 connector, 60cm)Packing: 1 piece per package.

Cable Type	Part Number
Shielded (1m)	E.A0015/DIN
Unshielded (60cm)	E.A0015

NEURODIAGNOSTIC ACCESSORIES

Disposable Hypodermic Needle Electrodes (EMG)

The Disposable Hypodermic Needle Electrode is a high quality product developed for simultaneous Botulinum Toxin (or other medicine) injection and EMG recordings or electrical stimulation.

The six different sizes enable you to cover all treatment areas.

Needle Length	Needle Diameter	Hub Colour	Part Number
25mm 0.30mm	(30 Gauge)	Red	E.HN010/25
25mm 0.40mm	(27 Gauge)	Yellow	E.HN017/25
37mm 0.40mm	(27 Gauge)	Orange	E.HN017/37
37mm 0.45mm	(26 Gauge)	Green	E.HN016/37
50mm 0.50mm	(25 Gauge)	Blue	E.HN015/50
75mm 0.70mm	(22 Gauge)	Violet	E.HN012/75



Packing: 10 electrodes per box, presterilized.

Sterilization: EtO.

The Disposable Hypodermic Needle Electrode is designed to meet your expectations:

- Easy skin penetration.
- Minimal patient discomfort.
- Very smooth "sliding" behaviour.
- Excellent signal quality.
- Comfortable "feel in the hand".
- Leak-free, very secure slip-tip and Luer Lock syringe connection.
- Minimum dead volume medication.

Made from medical grade stainless steel with an ultra-smooth coating, sharpened with micro-precision to a facet bevel, the Disposable Hypodermic Needle Electrode guarantees multiple insertions without any degradation of its characteristics. During the design much attention has been given to the ergonomic aspect of a good, secure feel in the hand and the aspect of dead-volume of medication. With the Disposable Hypodermic Needle Electrode, the dead-volume has been minimized to just the lumen volume of the needle itself.

Furthermore, the smart hub design with colour coding and recording area indicator facilitates improved control during a procedure. The clear colour coding, selected wire length (75 cm / 30 inch) and safety DIN 42 802 connector allow easy selection of the right needle for the procedure and comfortable and reliable connection to all EMG equipment.

Box, pouch and packaging method allow quick and hassle free preparation of the procedure.

Bar Electrodes (NCS, EP)

This product consists of two durable stainless steel disk electrodes of a 8mm diameter with 30mm spacing. The electrode holder features a feedthrough for the fixation of the Velcro strap.

The electrode is coded for polarity. One adjustable Velcro strap is included. The 1m cable terminates in two safety DIN 42 802 connectors or one 5-pole DIN connector.

Packing: 1 piece per package.

Connector Type	Part Number
2x DIN 42 802 connector	E.SB010
2x 4mm touch proof connector*	E.SB010/4mm
5-pole DIN connector	E.SB010/DIN



* Allows direct connection to the Digitimer range of Clinical Stimulators.

NEURODIAGNOSTIC ACCESSORIES

Bipolar Felt Pad Electrodes (NCS, EP)

Our bipolar felt pad electrode is available with an adjustable Velcro strap.

The product consists of two versatile and convenient stimulating electrodes. The surface stimulating electrode consists of two 8mm felt pads in a stainless steel holder. The spacing between the tips is 25mm. Each electrode is coded for polarity.

Four felt pads are included in the electrode package. The 1m cable terminates in two safety DIN 42 802 connectors or one 5-pole DIN connector.

Packing: 1 piece per package.

Connector Type	Part Number
2x DIN 42 802 connector	E.SB020
2x 4mm touch proof connector*	E.SB020/4mm
5-pole DIN connector	E.SB020/DIN

* Allows direct connection to the Digitimer range of Clinical Stimulators.



Replacement Felt Pads (NCS, EP)

Replacement felt pads for the Bipolar Felt Pad Electrodes are supplied in packs of 10.

Product	Part Number
Replacement Felt Pads	E.A0060



Velcro Straps (NCS, EP)

Straps may be attached to each other for large limb applications. The size is 55cm x 2cm.

Packing: 3 straps per package.

Product	Part Number
Velcro Straps	E.A0080



Product	Part Number
Small Stimulating Electrodes	E.SP010



Material	Size	Connection Type	Part Number
Stainless Steel	Adult	2x DIN 42 802	E.SR020
Stainless Steel	Adult	5-pole DIN	E.SR020/DIN
Gold-plated	Adult	2x DIN 42 802	E.SR010
Gold-plated	Adult	5-pole DIN	E.SR010/DIN



Connector Type	Part Number
2x DIN 42 802 connector	E.SD010
5-pole DIN connector	E.SD010/DIN



NEURODIAGNOSTIC ACCESSORIES

Alligator Clips (NCS, EP)

Easy to use in combination with tab electrodes. The red and black silicone wires of 1m length terminate in two safety DIN 42 802 connectors or one 5-pole DIN connector.
Packing: 1 piece per package



Connector Type	Part Number
2x DIN 42 802 Connector	E.A0090
5-pole DIN connector	E.A0090/DIN

Grounding Electrodes (NCS, EP)

Grounding "wrap-around" style electrode, 20mm wide. The wire terminates into a safety DIN 42 802 connector.
Packing: 1 piece per package.



Colour	Length	Size	Part Number
Green	1.5m	Adult (55cm)	E.RG010/150
Green	1.5m	Pediatric (25cm)	E.RG011/150
Green	2m	Adult	E.RG010/200
Green	2m	Pediatric	E.RG011/200
Red	1.5m	Adult (55cm)	E.RG020/150
Red	1.5m	Pediatric (25cm)	E.RG021/150

Grounding Plate Electrode

with a long lasting 30mm x 30mm polished stainless steel plate. The 1.5m wire terminates into a safety DIN 42 802 connector.
Packing: 1 piece per package.



Product	Part Number
Grounding Plate Electrode	E.RG030

Grounding Alligator Clip

with a 1m green silicone wire, terminating into a safety DIN 42 802 connector.
Packing: 1 piece per package.



Product	Part Number
Grounding Alligator Clip	E.RG040

Disposable Subdermal Needle Electrodes (Stainless Steel) (EP, IOM, EEG)

Standard single stainless steel needle electrode, 13mm in length and 0.4mm (27G) in diameter. Suitable for use with the Lectromed Cerebral Function Monitor (CFM).
The multi colour (5 or 6) PVC wires terminate into a safety DIN 42 802 connector and are available in a 0.5m, 1m, 1.5m, 2m or 2.5m length.
Packing: Individually packed electrodes, 24 or 25 per box, presterilized.
Sterilization: EtO.
For single use only.

Wire Length	5 x 5 colours (25pcs) Part Number	4 x 6 colours (24pcs) Part Number
0.5m (for CFM use)	E.RN017/050	
1m	E.RN017/100	E.S50716-001
1.5m	E.RN017/150	E.S50716-002
1. 2m	E.RN017/200	E.S50716-003
1. 2.5m	E.RN017/250	E.S50716-004



Disposable Subdermal Needle Electrodes (Pt/Ir) (EP, IOM, EEG)

Standard single: Platinum-Iridium needle, 13 mm in length and 0.4 mm (27G) in diameter. The multi-color (5) PVC wires connect into a safety DIN 42 802 connector and are available in a 1.5 meter length. 5x5 colors (Red, Green, White, Yellow, Blue)

Wire Length	Packing	Part Number
1.5m	25 pieces	E.S46-638

NEURODIAGNOSTIC ACCESSORIES

Extra Small Disposable Subdermal Needle Electrodes (EP, IOM, EEG)

7 x 0.30mm (30 gauge), stainless steel 1m PVC wire, packaged in 4 x 6 colours. Terminating with single DIN 42 802 connector. 24 per package.

Wire Length	Part Number
1.5m	E.S50718-001
2m	E.S50718-002
2.5m	E.S50718-003

Disposable Subdermal Hooked Needle Electrodes (EP, IOM, EEG)

These electrodes are especially designed to better stay in place during usage. The item consists of a 26 gauge (0.45mm x 12mm) stainless steel bent needle with a 1.5m or 2m multi colour (5) PVC wire, terminating in a safety DIN 42 802 connector. Packing: 24 packaged in 4 x 6 colours , presterilized. Sterilization: EtO. For single use only.

Wire Length	Part Number
1.5m	E.S50719-001
2m	E.S50719-002
2.5m	E.S50719-003



Disposable Subdermal Curved Needle Electrodes (EP, IOM, EEG)

The curved needle is especially designed to better stay in place during usage. The item consists of a stainless steel bent needle with a 1.5 or 2 meter PVC wire and connects into a safety DIN 42 802 connector. Shelf life for unopened pouches is 36 months. Sterilization: EtO
5 x 5 colors (Red, Green, White, Yellow, Blue)

Wire Length	Part Number
1.5m	E.RN020/150
2m	E.RN020/150



Twisted Disposable Subdermal Needle Electrodes (EP, IOM, EEG)

A twisted pair version with a 1.5m or 2m PVC wire in 10 colour combinations, terminating in safety DIN 42 802 connectors. Packing: 20 individually packed pairs per box, presterilized. Sterilization: EtO. For single use only.

Wire Length	Part Number
1.5m	E.RN030/150
2m	E.RN030/200



Reusable Subdermal Needle Electrodes (EP, IOM, EEG)

This product is available in two needle materials: stainless steel or platinum-iridium. Each needle is 13mm in length, 0.4mm (27G) in diameter. The selected multi coloured (6) silicone wires, 1m or 1.5m, terminate into a safety DIN 42 802 connector. Packing: 12 pieces per package.

Material	Wire Length	Part Number
Stainless Steel	1m	E.DN010/100
Stainless Steel	1.5m	E.DN010/150



Disposable Subdermal Corkscrew Electrodes (IOM, EEG, EP)

During surgical procedures where brain activity needs to be monitored, such as carotid artery or spinal surgery, it is very important that EEG/EP electrodes stay in place. Our corkscrew electrodes were developed for exactly this purpose. Made from stainless steel, the electrodes are easy and reliable to position, safe and offer a high signal quality. PVC wire (120cm long), 4x6 colours and terminates in a safety DIN 42 802 connector which connects to our range of D185 Electrode Connection Headboxes. Packing: 24 pieces individually sterile packed.

Product	Part Number
Disposable Subdermal Corkscrew Electrodes	E.CS010/120



NEURODIAGNOSTIC ACCESSORIES

Disposable Cup Electrodes (EP, IOM, EEG)

Our disposable Silver/Silver Chloride cup electrodes are one of our latest additions to our product programme. The diameter of the cups is 10mm and they are made of silver-chlorided plastic. The PVC wires are multi coloured (5) and available in the following lengths: 1m, 1.5m or 2m, with DIN 42 802 connectors. For single use only. Packing: 25 pieces per package.

Wire Length	Part Number
1m	E.DC010/100
1.5m	E.DC010/150
2m	E.DC010/200



IMPROVED - Reusable Cup Electrodes (EP, IOM, EEG)

Our reusable cup electrodes have been designed to withstand long-term use by medical technicians. Our cup electrodes now feature a “no-lift” adjustable cup neck, which can be angled to contour the head, which improving effectiveness, ease of use and reliability. The precision stamped cups are available in two diameters: the paediatric, 6mm or the adult, 10mm size. They are made out of 99.9% pure silver. The silver cups are silver-chlorided, covered with a heavy gold-plate, or kept silver. The flexible silicone wires are standard in multi colour (6) and available in the following lengths: 1m, 1.5m, 2m or 2.5m, with DIN 42 802 connectors. Packing: 12 pieces per package.

Colour	Length	Size	Part Number
Silver (Ag)	1m	Adult	E.DC030/100
Silver (Ag)	1.5m	Adult	E.DC030/150
Silver (Ag)	2m	Adult	E.DC030/200
Silver (Ag)	2.5m	Adult	E.C22-934
Silver-Silver Chloride (Ag-AgCl)	1m	Adult	E.DC020/100
Silver-Silver Chloride (Ag-AgCl)	1.5m	Adult	E.DC020/150
Silver-Silver Chloride (Ag-AgCl)	2m	Adult	E.DC020/200
Silver-Silver Chloride (Ag-AgCl)	2.5m	Adult	E.C22-434
Gold-plated (Au)	1m	Adult	E.DC070/100
Gold-plated (Au)	1.5m	Adult	E.DC070/150
Gold-plated (Au)	2m	Adult	E.DC070/200
Gold-plated (Au)	2.5m	Adult	E.C32-934



Ear Clip Electrodes (IOM, EEG)

This product consists of two EEG cup electrodes mounted as an ear clip. Available in three different surface options: silver, silver-chloride or gold-plated. The cups themselves come in two diameters, either 10mm (adult) or 6mm (paediatric). All electrodes are attached to a 1m or 1.5m colour coded silicone wire, terminating in a safety DIN 42 802 connector. Packing: 1 pair per package.

Material	Size	1m Long Part Number	1.5m Long Part Number
Silver (Ag)	Adult	E.DC040/100	E.DC040/150
Silver-Silver Chloride (Ag-AgCl)	Adult	E.DC050/100	E.DC041/150
Gold-plated (Au)	Adult	E.DC060/100	E.DC060/150



Nasopharyngeal Electrodes (IOM, EEG)

Thin, semi-rigid coated wire (adult: 15cm; paediatric: 10cm). The 3mm diameter gold-plated, silver-chlorided or plain silver recording tip is combined with a 1.5m silicone wire with a safety DIN 42 802 connector. Packing: 1 piece per package.

Colour	Size	Part Number
Silver (Ag)	Adult	E.DW010
Silver (Ag)	Paediatric	E.DW011
Silver-Silver Chloride (Ag-AgCl)	Adult	E.DW020
Silver-Silver Chloride (Ag-AgCl)	Paediatric	E.DW021
Gold-plated (Au)	Adult	E.DW030
Gold-plated (Au)	Paediatric	E.DW031



Complex Motor Point Pen Electrode

Helps you to place your electrodes correctly in order to improve stimulation comfort and effectiveness. The Motor Point Pen features a 4mm diameter stainless-steel ball stimulation tip and works with Snap connectors or cables wired with 2mm pins. The motor point pen can be interfaced with the Digitimer stimulators using the D185-HB4 output extension cable and our DS7A-M338 adaptor leads (see Touch Proof Plugs, Adaptors & Electrode Linkers).

Product	Part Number
Complex Motor Point Pen Electrode	G.MPPE



NEURODIAGNOSTIC ACCESSORIES

Plaquette Disposable Adhesive Surface Electrodes (DASE)

Plaquette™, a high quality range of pre-wired Disposable Adhesive Surface Electrodes, specifically designed and approved for cutaneous recording and stimulation purposes. This brand new product line is available in 10 different models, to cover all treatment areas.

- Pre-gelled and engineered for single patient use.
- Light weight colour coded flexible PVC wires with safety 1.5mm DIN 42 802 connectors.
- Silver / silverchloride conductive layer for optimal signal recording.
- Soft and flexible electrode pad material for minimum patient discomfort.
- Smart little gel free tab for easy, multiple electrode repositioning without touching the gel.
- Special formula gel for a very sticky electrode, yet easy to remove leaving no residu on the patient.
- Two year electrode shelf life.



All these features guarantee, that Plaquette™ Disposable Adhesive Surface Electrodes provide perfect signal quality and optimal patient and user comfort.

Disposable 20mm Disk Electrodes (4 pack):	Part Number
20mm diameter disk x 4; 1m leads: red, blue, green, black; 10 sets of 4 / box	E.K50430-001
20mm diameter disk x 4; 2m leads: red, blue, green, black; 10 sets of 4/ box	E.K50430-002

Disposable Ground Electrodes:	Part Number
40 x 50mm surface; 1m lead; 20 pieces per box	E.K50431-002
40 x 50mm surface; 2m lead; 20 pieces per box	E.K50431-003

As long as the pouches are unopened, the electrode shelf life is two years.

Axelgaard PALS® Platinum Self Adhesive Stimulation Electrodes

Designed for all FES and TENS applications, Axelgaard PALS Platinum neuro-stimulation electrodes combine a patented stainless steel knit cloth, a patented hydrogel, and an exclusive impedance compensation system. Fitted with 2mm sockets*

Code	Dimensions	Quantity per Case
A.J10R00	2.5 cm, round	10 packs of 4
A.879100	3.2 cm, round	10 packs of 4
A.879200	5.0 cm, round	10 packs of 4
A.879300	7.0 cm, round	10 packs of 4
A.891200	3 x 5cm, rectangle	10 packs of 4
A.895220	5 x 5 cm, square	10 packs of 4
A.895240	5 x 9 cm, rectangle	10 packs of 4
A.895250	5 x 13 cm, rectangle	10 packs of 4
A.895340	8 x 10 cm, rectangle	10 packs of 4
A.896230	4 x 6 cm, oval	10 packs of 4
A.896240	5 x 10 cm, oval	10 packs of 4
A.896350	8 x 13 cm, oval	10 packs of 4

Axelgaard PALS® Platinum Blue Self Adhesive Stimulation Electrodes

Code	Dimensions	Quantity per Case
A.901220	5 x 5 cm, square	10 packs of 4
A.901240	4 x 9 cm, rectangular	10 packs of 4

Designed for all FES and TENS applications, Axelgaard PALS Platinum Blue neurostimulation electrodes combine a patented stainless steel knit cloth and hydrogel construction with our exclusive impedance compensation system. Fitted with 2mm sockets*

- The gel of choice for extremely sensitive skin.
- Adheres through body hair.
- Patented stainless steel fabric for optimum conductivity and conformity.
- Designed for TENS and muscle stimulation applications.

- Patented conductive cloth provides the ultimate in flexibility and conformity.
- The impedance compensation system ensures optimal current distribution.
- Patented dual layer MultiStick hydrogel provides comfort and optimizes multiple applications to the skin.



NEURODIAGNOSTIC ACCESSORIES

Axelgaard Valutrode® Fabric Top Self Adhesive Stimulation Electrodes

Axelgaard ValuTrode electrodes with white cloth top and conductive film provide an all purpose economy electrode. Fitted with 2mm sockets*

- Available in a variety of shapes and sizes.
- Each lead wire interface is customized for each electrode to optimize current distribution for every shape and size.
- MultiStick hydrogel is optimized for durability and multiple applications to the skin.



Code	Dimensions	Quantity per Case
A.CF3200	3.2 cm, round	10 packs of 4
A.CF5000	5.0 cm, round	10 packs of 4
A.CF7000	7.0 cm, round	10 packs of 4
A.CF5050	5 x 5 cm, square	10 packs of 4
A.CF4090	4 x 9 cm, rectangle	10 packs of 4
A.CF5090	5 x 9 cm, rectangle	10 packs of 4
A.CF7515	8x13 cm, rectangle	10 packs of 2
A.CF4065	4 x 6 cm, oval	10 packs of 4
A.CF5010	5 x 10 cm, oval	10 packs of 4

* Important Note: The Axelgaard electrodes terminate in short leads fitted with 2mm sockets, so we recommend our D185-HB4 Electrode Extension Cable (available in 2m, 4.5m, 6m, 8m or 12m lengths) combined with shorter adaptor cables (DS7A-M338, supplied as a pair, 30cm or 90cm long) to connect between these electrodes and our clinical stimulators.

Part Description	Dimensions	Part Number
Collodion Adhesive		
High Viscosity	15ml tube, 36 off	E.A0031
High Viscosity	60 ml tube, 18 off	E.A0032
Collodion Remover		
Non acetone	0.51 bottle	E.A0100
Non acetone	3.51 container	E.A0101
Nuprep Skin Abrasive		
10-30	113g, 4oz tube, 3 off	E.A0040
Ten 20 Conductive Adhesive Paste		
10-20-4T	113g, 4oz tube, 3 off	E.A0050
10-20-4	113g, 4oz jar, 3 off	E.A0051
10-20-8	226g, 8oz jar, 3 off	E.A0052

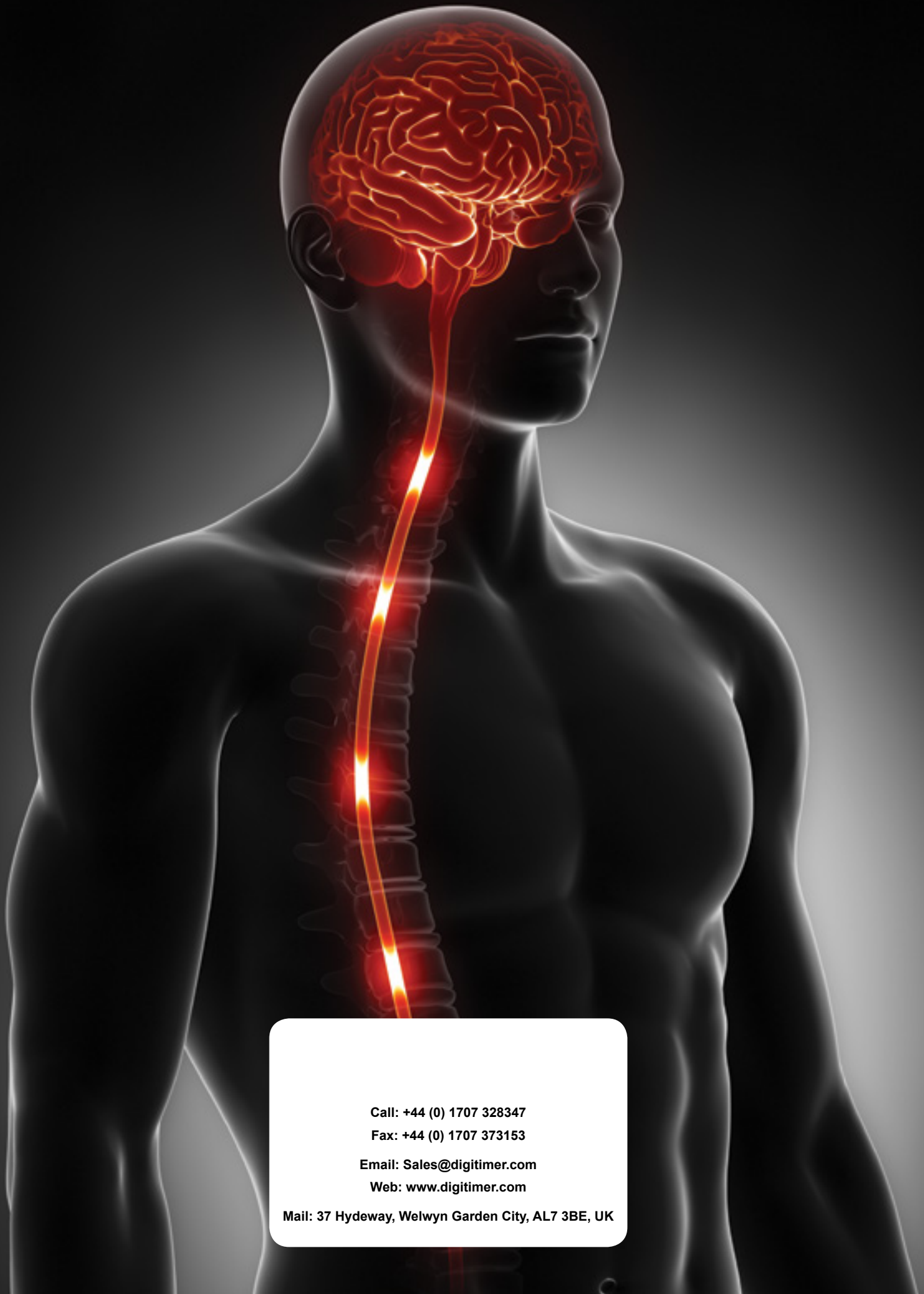
Collodion, Preps and Pastes (IOM, EEG)

Collodion (medical adhesive) and Collodion Remover (non acetone) Mavidon. Weaver's Nuprep abrasive is useful whenever a reduction of skin impedance would enhance a test result. Ten 20 Conductive Adhesive Paste by Weaver. White, opaque, water-soluble medical adhesive paste designed to be used with EEG cup electrodes.



Touch Proof Plugs, Adaptors & Electrode Linkers (EMG, NCS, EP, IOM, EEG)

Part Description	Part Number
Pair (one red, one black) of 4mm Touch proof plugs for user assembly. Provide direct connection to Digitimer DS5, DS7A and D185 stimulator output sockets. (See D185 Multipulse accessories page)	D185-OC1
1.5mm (DIN 42 802) Touch proof plugs (per 10 pieces). Compatible with Digitimer D360, D440 and NeuroLog System NL844 input sockets as well as output sockets on D185 electrode connection headboxes (e.g D185-HB4 below).	NL844P/10-Bu (BLUE) NL844P/10-Bk (BLACK) NL844P/10-Rd (RED)
Electrode Extension Cable. For use with Digitimer DS5, DS7A, DS8 and D185 stimulators when electrode leads are fitted with 1.5mm touch proof DIN 42 802 plugs. Moulded touch proof 4mm output connector at the stimulator end and a moulded pair of DIN 42 802 sockets at the patient end. The standard length is 4.5m, but it is also available in three other lengths to suit various applications. (See D185 Multipulse accessories page)	D185-HB4-2m D185-HB4 D185-HB4-6m D185-HB4-12m
Electrode adaptor leads. 1.5mm (DIN 42 802) Touch proof plug at one end (for connection to D185-HB4) and 2mm pin at the other (for electrode connection).	DS7A-M338CM (30cm, pair, red & black) DS7A-M338-90CM (90cm, pair, red & black)
Snap Electrode Connection cable terminated with a 1.5mm (DIN 42802) touch-proof connector. Supplied as individual cables (150cm long) in RED, GREEN or BLACK.	G.SNAP-RD (Red) G.SNAP-GN (Green) G.SNAP-BK (Black)



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