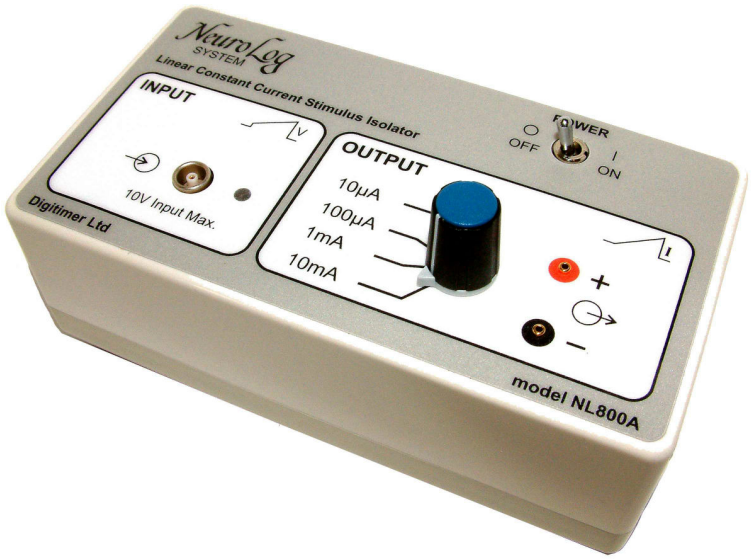
NL800A - Stimulus Isolator



Introduction

The **NL800A STIMULUS ISOLATOR** is a battery powered, opto-coupled isolator. It has a constant current output, with very high output impedance, making it suitable for stimulation through microelectrodes as well as with gross electrodes. Normally driven from the NL510A PULSE BUFFER, its output current is set by the 10-turn AMPLITUDE control on the NL510A, within the output range set by the switch on the **NL800A**; output pulses have the same timing as the input pulses (2 microseconds to 30 seconds output pulse width). Features of the **NL800A** are its very small physical size (for mounting close to the preparation), low battery consumption, excellent isolation (<1pF output to input or ground coupling), and fast pulse risetime.

The **NL800A** is a replacement for the NL800 which used different batteries but had the same electronic circuit.

Please refer to the correct section of this Users Manual for the NL800 details.

Operation

In the normal operating mode, an NL510A PULSE BUFFER produces the appropriate input pulses. The **NL800A** Power switch is turned on, the output range is selected and the desired output amplitude is produced at the two output terminals by adjusting the amplitude (10 turn) dial on the NL510A. The output can be checked by measuring the voltage across a 1kohm resistor, connected between the output terminals, with an oscilloscope or voltmeter (1V = 1mA).

Driving the NL800A with something other than the NL510A

The **NL800A** requires an input that varies between approximately +1.4V and +10V, 0 to +30mA, corresponding to **NL800A** outputs of 0 to full scale.

Bipolar Stimulation

The NL512 Biphasic Pulse Buffer has been designed to allow two (2) NL800A's to be used to produce a bipolar stimulation signal. Please refer to the NL512 section of the Users Manual for details.

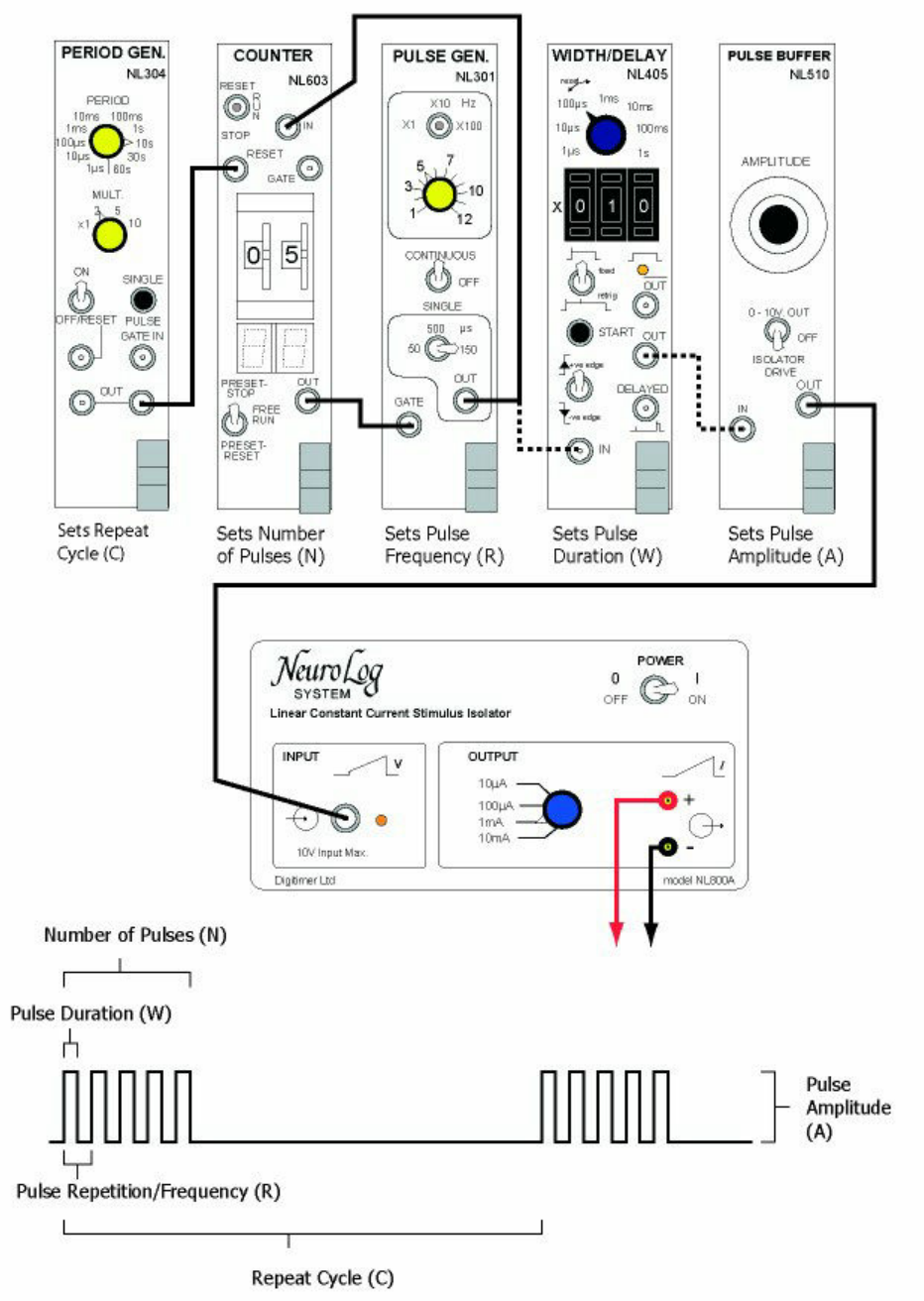


Fig. NL800A-1

A Typical Stimulus Channel Arrangement Providing Comprehensive Pulse train Facilities.

- - - - connections shown thus, are made by rear motherboard links.

Output Characteristics - Load Restrictions

The maximum voltage which can appear across the output terminals is limited by the internal battery supply to about 44V. This voltage determines the maximum output current for a given load resistance, according to Ohm's Law (V=IR). For example, if the load resistance across the output terminals is 10,000 ohms, the maximum current which can be delivered by the **NL800A** is approximately 44/10,000 = 4.4mA, in spite of the fact that the Output Range switch may be set for 10mA and the NL510A set for an amplitude of 10.00. The shaded region of Fig. NL800A-2 shows realisable output currents for 5 decades of load resistance.

Bear in mind when considering Fig. NL800A-2 that electrodes in tissues do not behave as resistors - they may have much lower effective series resistance for narrow pulses than for DC inputs, due to polarisation (most metal electrodes polarise with DC inputs). A typical tungsten microelectrode, for example, has a DC resistance of about 200Mohms, an 'impedance' of 1Mohm for 1kHz sine input, and an impedance of perhaps only 100kohm for a 100µs pulse, a 2000:1 ratio. Fig. NL800A-2 predicts that this electrode will pass about 400µA for short pulses, but only about 0.2µA for very long pulses.

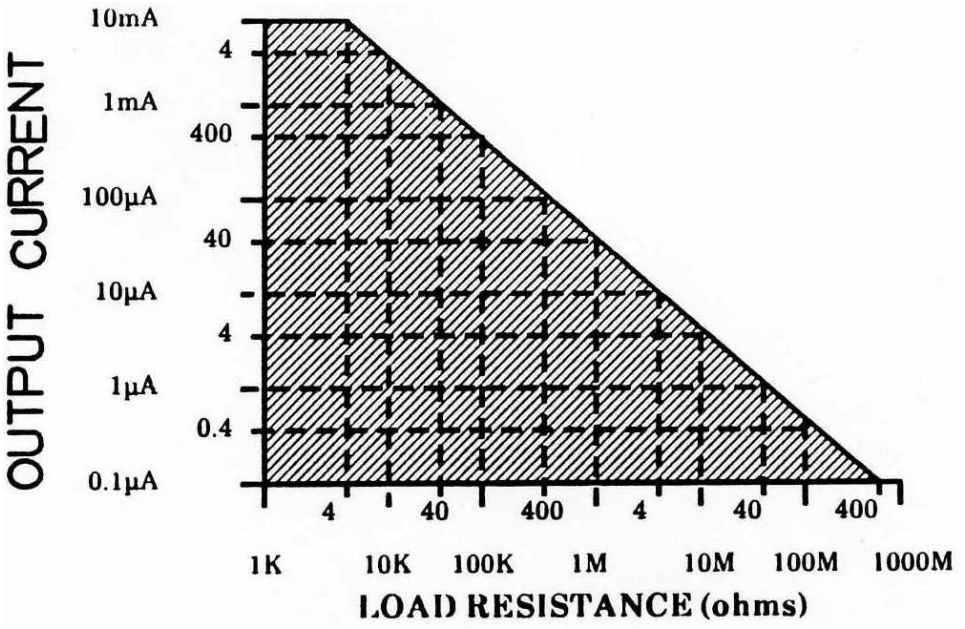


Fig. NL800A-2
Graph showing the Current that can be delivered dependant on the load Resistance.
Currents **can be** delivered to loads within the hatched area.

Output Characteristics - Checking Actual Output Current

If there is some doubt that the load resistance is low enough to allow operation within the shaded portion of Fig. NL800A-2, the actual output current can be monitored with the arrangement shown in Fig. NL800A-3. Note that the 1kohm monitoring resistor is connected directly to the preparation ground; this obviously reduces the effective isolation of the **NL800A** output, which is not normally desirable. All of the output current must however pass through both the 1kohm resistor and the electrode (load resistance), giving an accurate measure on the oscilloscope of the actual output current. The oscilloscope input cannot be put directly across the isolator output because it would then shunt the electrode. The 1kohm series resistor does not contribute appreciably to the total load resistance for high impedance electrodes such as microelectrodes; gross electrodes (e.g. EEG electrode, silver hooks, etc.) may require a smaller series resistor (e.g. 10 ohms) when high output currents are used.

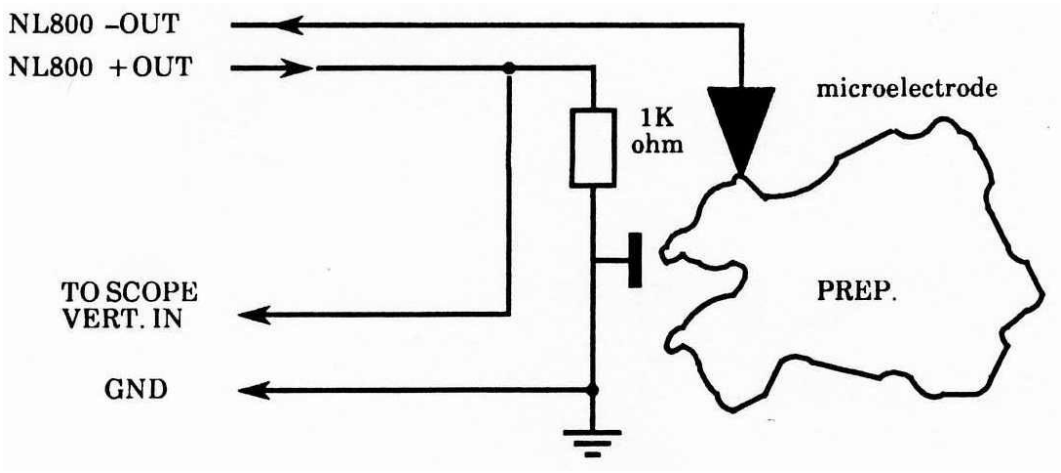


Fig. NL800A-3
Method to monitor current actually delivered.

Output Characteristics - Output Capacitance and Risetime

The **NL800A** has a total output capacitance of approximately 40pF. Thus a 1Mohm resistor across the output will limit the output risetime to about 40µs. As discussed above, however, metal microelectrodes which are nominally characterised as having an impedance of 1Mohm (at 1kHz) behave more like 100kohms resistors for short pulses and therefore usually produce risetimes of the order of 10 to 15µs. Non-polarisable electrodes (chlorided silver electrodes, micropipettes) behave more like resistors than ordinary metal microelectrodes do; i.e. their impedance is more constant as a function of frequency. Thus, a 10Mohms micropipette acts like a 10Mohms resistor for short pulses as well as long ones. The risetime may therefore be quite long for these electrodes (approximately = 40µs electrode DC resistance in Meg-Ohms).

Output Characteristics - How Constant is the Constant Current Output?

The **NL800A** has more than 900Mohms output resistance at its output terminals. Thus, load resistance variations from a short circuit (0 ohms) to 100Mohms will result in only approximately a 10% variation in output current (assuming that the voltage drop through the load does not exceed the 44V limit discussed above). Obviously few load situations will vary to this extent, and for all practical purposes, the output is constant.

Battery Life

The five (5) equal batteries in the **NL800A** discharge only when a pulse is applied at the input; battery drain between pulses is restricted to leakage currents of the order of hundredths of a micro-ampere, and is therefore negligible. These five batteries are split into a single (1) "Control" battery and four (4) "Stimulus" batteries. The life of the "Control" battery is determined solely by the amplitude and duration of the input pulses and not the output amplitude: continuous operation with high duty cycles* at the maximum input amplitude (i.e. with the NL510A amplitude dial at 10.00), produces greater battery drain than low duty cycles at low input amplitudes. The drain on this battery is the same for each output range.

The table below (Table NL800A-1) is an approximate guide to the life of the "Control" battery.

NL510A Dial	Duty Cycle	Life (hours)
10.0	50%	25
10.0	10%	125
10.0	1%	1,250
5.0	50%	50
5.0	10%	250
5.0	1%	2,500
1.0	50%	250
1.0	10%	1,250
1.0	1%	12,500

Table NL800A-1. Expected "Control" battery life

The four "Stimulus" batteries are simultaneously discharge at a rate that depends only on the magnitudes of the output pulses. The table below gives a rough guide to the service life for these batteries.

Pulse Amplitude	Duty Cycle	Life to 80% (~34.4V Output)	Life to 50% (~22V Output)
10mA	50%	8 hours	16 hours
10mA	10%	40 hours	80 hours
10mA	1%	400 hours	800 hours
1mA	50%	80 hours	160 hours
1mA	10%	400 hours	800 hours
1mA	1%	4000 hours	8000 hours

Table NL800A-2. Expected "Stimulus" battery life

As the "Stimulus" batteries discharge, their output voltage decreases. The first number in the Life entries above indicate the service at which the battery voltage in each battery has fallen to 80% (giving a total output voltage available of about 34.4V); the second number indicates the hours of service to battery voltages of about 50% (total output voltage available of about 22V).

Thus, with fresh batteries, the **NL800A** will be able to deliver 10mA through any load resistance less than 4.4kohms (see Fig. NL800A-2), but after 8 hours of continuous service with a 50% duty cycle at the maximum amplitude setting on the 10mA output range, only 7.8mA can be delivered through the 4.4kohms load (i.e. 34.4V/4,400 = 0.0078A). In situations where high currents are required and load resistance are near the limits shown in Fig. NL800A-2 careful attention must be paid to battery checks and replacement.

In most applications, the entire set has a life of several months, perhaps even approaching the battery shelf life.

As the cost of these batteries is relatively low, it is wise to replace all 5 at the same time.

Battery Fitting

The five batteries are accessed via the panel in base of the unit. Removal of the two screws will give access.

It is imperative that the batteries are fitted with the correct polarity orientation. This is marked on the batteries and the holders. The symbols must match.

It is recommended that all five batteries are replaced at the same time.

Battery Checks

The battery can be easily checked by putting a voltmeter across the ends of each battery in turn. Batteries which show only 11V, with no load, are beginning to fail. The best test, however, is to check battery voltages under the appropriate load conditions. This can be accomplished with the NL510A connected, NL800A Power switched on, and the output terminals of the **NL800A** shorted. Each battery is checked at the test points with an oscilloscope. Seriously discharged batteries will show a marked fall in voltage during each “Stimulus” pulse (which should be at least 1 second duration, if a meter is being used).

Whether this voltage drop will affect the output current depends on the desired output current and load resistance, as discussed in the previous section.

Calibration and Set-up

Fig. NL800A-4 shows three output calibration curves for the **NL800A**, driven by an NL510A Pulse Buffer. The NL510A contains on its printed circuit board an adjustable trim-pot (the one with the knob) for setting the output offset. The three curves in Fig. NL800A-4 were obtained with three settings of the NL510A trimmer. The NL510A can be adjusted so that the **NL800A** is maximally linear (curve A) but has a small output pulse (3% of the full scale output) when the NL510A AMPLITUDE dial reads 0.00. Curve B shows the output relation if the NL510A trimmer is adjusted for a zero **NL800A** output with a dial reading of 0.00. Some applications favour the maximally linear calibration, others the zero-in zero-out adjustment.

Curve C if Fig. NL800A-4 shows incorrect adjustment of the NL510A trim-pot. It is recommended that the user plot a calibration curve for the NL510A-**NL800A** combination by measuring the voltage induced in a 1kohms resistor placed across the **NL800A** output. (With the **NL800A** RANGE switch on the 100µA range, 100µA will correspond to 100mV across the resistor).

Because the **NL800A** is an isolated current source, **NL800A**'s can be operated in parallel (never in series). Thus current stimuli can be summed, either with the same sign or with the opposite sign, if bipolar stimuli are desired. A single NL510A will drive up to two **NL800A**'s in parallel if stimuli with identical timing are desired.

See the NL512 Biphasic Pulse Buffer module for using two **NL800A** to produce Bipolar Stimulation.

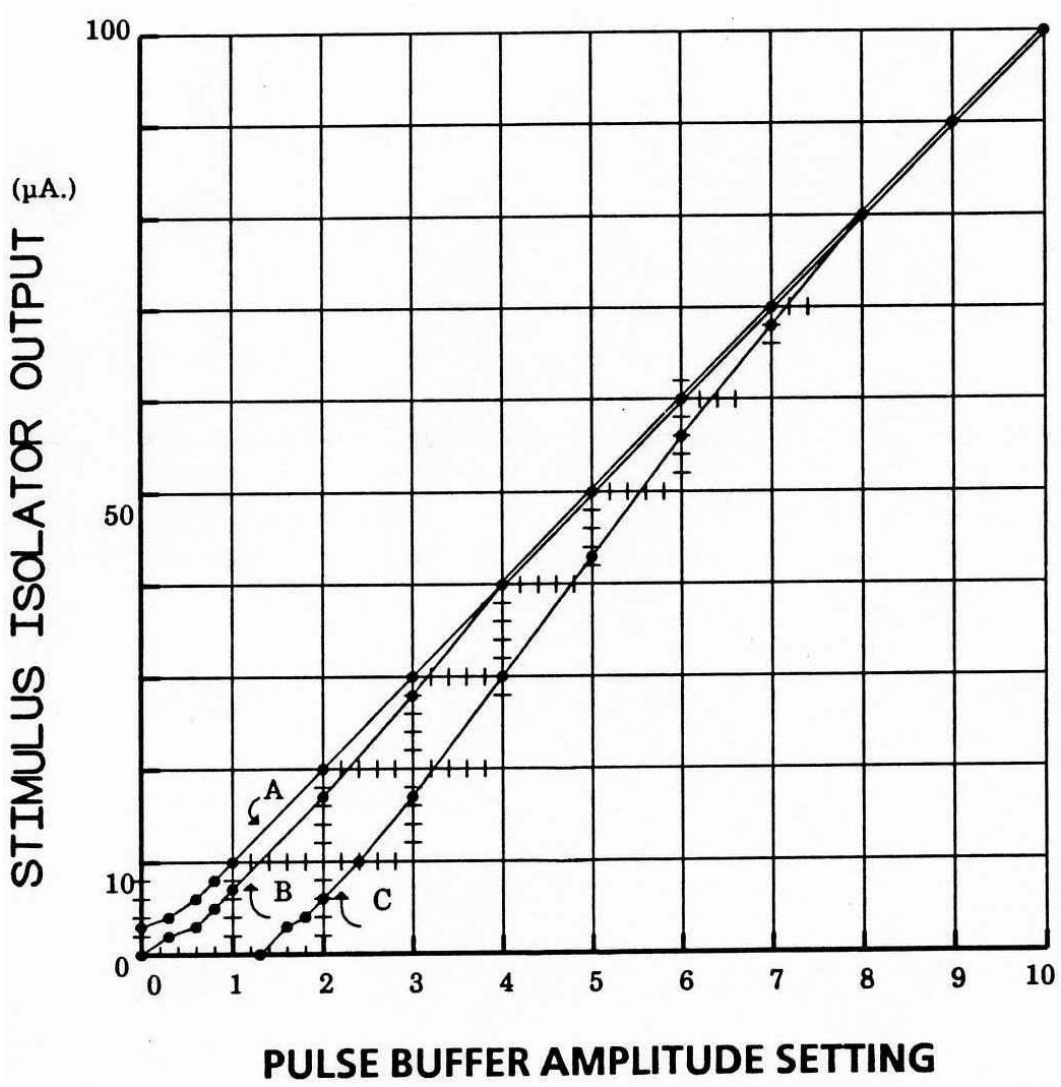


Fig. NL800A-4
Graph showing the NL800A Output Current verses NL510A setting.

Specification

Input requirements	:	10V at 30mA (nominal) for full scale output
Input Connector	:	Standard 1-pole ***NeuroLog*** Lemo socket
Output current range	:	0 to 10mA in 4 overlapping decade ranges
Output Connectors	:	1mm gold sockets
Output risetime	:	<5µs (1kohm load) <20µs (typical tungsten microelectrode load) <40µs (1Mohms resistor load)
Output resistance	:	>900Mohms
Input-output capacitive coupling	:	<1pF
Accuracy and linearity	:	±3% of full scale output for each output range
Dimensions	:	120 x 65 x 40 mm (4.7 x 2.6 x 1.6"), excl. knob and removable feet.
Weight	:	220g including batteries.
Accessories Supplied	:	Batteries are fitted 2 x 1mm gold plugs with heatshrink sleeving for insulation.

Accessories Available

		Digitimer Part Number
Batteries	:	**NL800A-BATT**
Output Plugs	:	**NL970/10** - 1mm Gold stacking plugs (10 pieces)
Input Plug	:	**NL962** - Standard ***NeuroLog*** Lemo Plug
Input Leads	:	**NL951-xx** - Double ended Lemo plug lead where **xx = 15, 30, 45 cm** or **1m, 2m**
	:	**NL951B-xx** - Double ended lead with Lemo plug at one end and BNC at other; where **xx = 1m** or **2m**
	:	**NL952** - Single ended lead with Lemo plug on one end. Tinned wires at other end. Length is 2m.

We reserve the right to alter specifications and price without prior notification.

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