NL100AK - Headstage

The NL100AK is supplied with several fittings and accessories.

1) A 6.35mm diameter (0.25") metal mounting rod which fits into the hole at the rear of the NL100AK, next to the output cable, and is secured by a small grub screw. This rod can be used to secure the NL100AK to a micro-manipulator or clamp etc.

2) Three input cables are supplied two with a stackable 1mm pin connector each and one with a short U-shaped link (see below for application).

3) A 1mm stacking plug and a 2mm pin. These are used to make connections with microelectrodes, as described below.

Electrode Connections

Where possible, it is recommended that microelectrodes are attached directly to the NL100AK input so that the lead length between the NL100AK input and the electrode is minimised; even a few centimetres of lead may result in substantial mains interference (pick-up).

Fluid Filled Pipette Electrodes

When using fluid filled pipette electrodes it is recommended that an electrode chamber (part no: NL101) is used.

Metal Electrodes

Metal microelectrodes may be connected by using an electrode holder (part no: NL04). Alternatively the user can adapt the 2mm connector (supplied) to suit the particular electrode used. A common solution is to use a short length (5-10mm) of hypodermic needle tubing soldered to the pin (keep this connection as short as possible for low interference).

When the NL100AK HEADSTAGE is used in conjunction with the NL104A AC PREAMPLIFIER it is important that the "A-B" position is selected on the NL104A input selector switch. This will reduce interference from external sources and match offset components inherent to the low noise, high input impedance stage in the NL100AK.

Single ended recordings can be accomplished by grounding the "B" input of the NL100AK with the input cable having the "U" shaped 1mm jumper (supplied); the "U" shaped plug is pushed into the "B" and "GND" inputs and the flying lead is used to provide the ONLY ground connection for the preparation. (See catalogue application note entitled 'Avoiding Ground Loops'). In this way any common-mode interference picked up at both the "A" and "B" inputs of the NL100AK can be summed out by the NL104A.
A DC path must be provided from each input of the NL100AK to the system ground. This DC path may of course be through a high resistance microelectrode. It is also essential, for the best noise performance, to make the ground connection to the biological preparation through the GND terminal of the NL100AK. If the NL100AK is used differentially, with both A and B inputs connected through electrodes to the preparation, a connection to the NL100AK GND should still be made to the preparation.

Differential Recordings

Although the NL100AK Headstage is most frequently used with high resistance microelectrodes, its very low noise allows it to be used with low resistance electrodes (eg for differential recordings of action potential through gross electrodes).

WARNING - It should be pointed out that if the input device of, or cable to, the Headstage should fail there is a possibility of current flowing though the preparation to ground causing an inadvertent lesion[1]. This is limited by the design to approximately 650μA. Should this be a problem (and it is a remote possibility) please contact Digitimer for advice.

ALSO - make certain that the NL900 power switch is on before connecting the preparation to the active inputs of the NL100AK (or NL104A). Do NOT switch the NL900A power on or off while a preparation is connected to the NeuroLog™ System.

Do NOT attempt to use oversize plugs with the headstage sockets, as pins greater then 1.00/2.00mm diameter will damage the socket.

NOTE: if the NL100AK is required to plug into the NL103 amplifier which is fitted with an input socket without locating keyway, the NL100A (first stage) should be ordered to ensure that the correct mating plug is fitted to the connecting cable.

(1) - Recording of Brain Potentials with FET-Circuits: Hazard of Inadvertent Lesions, by **J. A. W. M. Weijnen** and **N. Chedhade** in *Brain Research Bulletin*, **Vol. 18**, pp617-618.

Specification

Input resistance	10^8ohms
Gain	:+1.0
Input noise	:<2 μV (peak to peak) with inputs shorted
	<25 μV for a typical tungsten microelectrode in saline
	<30 μV with a 1 Megohm resistor between inputs
	(bandwidth in all three cases, 10Hz to 10kHz)

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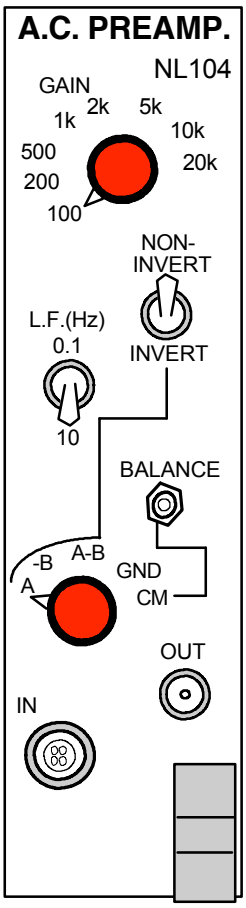
File Reference: - N:\DOCS\COMPANY\MANUALS\NEUROLOG \ NL100AK.SAM

NL104A - AC Pre-Amplifier

Introduction



The NL104A AC Preamplifier is a low noise AC coupled differential amplifier. It can be used alone for making recordings from low resistance electrodes (see below) or with the NL100AK headstage for microelectrode recordings. It can be operated in single ended (inverting or non-inverting), or differential modes. It has a wide dynamic balance adjustment for asymmetrical inputs (useful for balancing out interference and short artefacts), a choice of two input time constants and a choice of eight gains. The NL104A has provision for limiting the high frequency response (a jumper on the printed circuit board, with -3dB limits indicated) eliminating the need for subsequent filtering in some applications.

Balancing the NL104A

An internal 50Hz oscillator is provided for precisely balancing the input.

Set the input switch to the CM position, the rotary gain switch to x1000 and adjust the BALANCE potentiometer until the 50Hz signal at the output is minimal. A 3.5mV signal will be present when the common mode rejection is 80dB (or 10,000 to 1). Better rejection ratios are possible with careful adjustment of the BALANCE control, but assessment is difficult without filtering the output signal since the typical output noise will be 5mV (5µV x1000) with 10kHz BW.

When the NL104A is used to make differential recordings (input switch in the A-B position), the BALANCE control is adjusted to minimise common mode signals such as mains interference or shock artefacts present in the recording. The adjustment will differ from one situation to another, depending on the relative magnitudes of the interference signals at the two inputs and on differences in input electrode resistance, etc. The internal common mode oscillator makes it possible to quickly return the NL104A to a balance after such adjustments.

The colours indicated in Fig. NL104A-1 refer to the insulated wires of the assembled cable, NL953K. The +15V and -15V pins in the input socket supply power to the NL100AK headstage; 4mA @ 15V is available at these pins for input preamplifiers of the user's own design if the NL100AK is unsuitable.

If the NL104A is connected directly to the biological preparation through a long miniature screened cable, it must be borne in mind that the frequency response of the NL104A may be substantially reduced. 1.5m (5ft) of miniature 4 conductor screened cable will have approximately 150pF capacitance between each conductor and the screen. If connection is made through 1Mohm electrodes, frequency response will begin to fall off above 10kHz. For lower resistance electrodes, the frequency response is of course affected to a lesser extent.

CAUTION: When using the NL104A AC Pre-Amplifier, either with or without the NL100AK headstage, do not switch the NL900A POWER switch on or off while the biological preparation is connected to the inputs. Switch the power on before these connections are made and disconnect the preparation before the power is switched off during an experiment. This routine will reduce the risk of damage to the FET input transistors and avoid the possibility of injecting micro-amp currents into the preparation during the supply settling period.

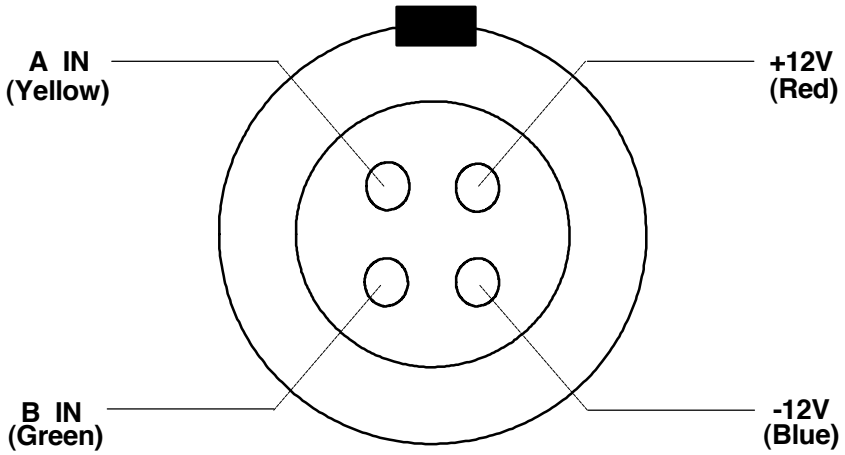


FIG. NL104A-1 shows the pin arrangement for the NL104A input connector. The NL104A can be used without the NL100AK for low source resistance measurements. (Assembled input cables and un-assembled input plugs are available separately for this purpose).

Specifications

Gain	: 100, 200, 500, 1K, 2K, 5K, 10K, or 20K
Input resistance	: 10Mohms
High frequency cut off	: 100, 700, 6K or WB (>40K) Hz selectable
Low frequency cut off	: 0.1Hz or 10Hz
Common mode rejection ratio	: 10,000:1 at 50Hz (80dB)
Input noise	: <10μV (peak to peak) with input grounded and bandwidth 0.1Hz to 10kHz
Dynamic balance adjustment	: gain for one input can be varied ±25% with respect to the other
Output voltage range	: ±12V (max)

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Last Revision: August 22, 1996

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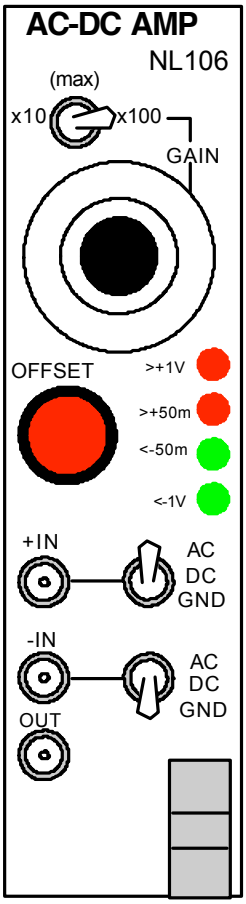
NL106 - AC-DC Amplifier



Introduction

The **NL106 AC-DC** differential Amplifier features continually adjustable amplification and DC offset with output level indication.

The amplification (or attenuation) is adjusted using a calibrated, locking, ten-turn control where the range is set by a switch which gives the two gain ranges of 0 and x10 or 0 and x100.

The input controls are similar to those of conventional oscilloscope vertical amplifiers allowing operation in AC or DC coupled, single-ended (inverting or non-inverting) or differential modes. Up to ±2V DC at either input can be zeroed using the ten-turn DC OFFSET adjustment.

The output voltage is shown by 4 light-emitting diodes: two red LED's show outputs in excess of +50mV and +1V and two green LED's show corresponding negative outputs. Thus, adjustment of gain and DC offset can be accomplished without an oscilloscope monitor.

Low drift, low noise and moderate input impedance make the **NL106** suitable either as an amplifier for low impedance sources, or as a variable gain stage following a preamplifier.

Each input of the amplifier is accessible through a single pole socket and separate control of AC or DC operation, with the option of amplifier grounding to remove the signal, is provided by a toggle switch adjacent to each input socket.

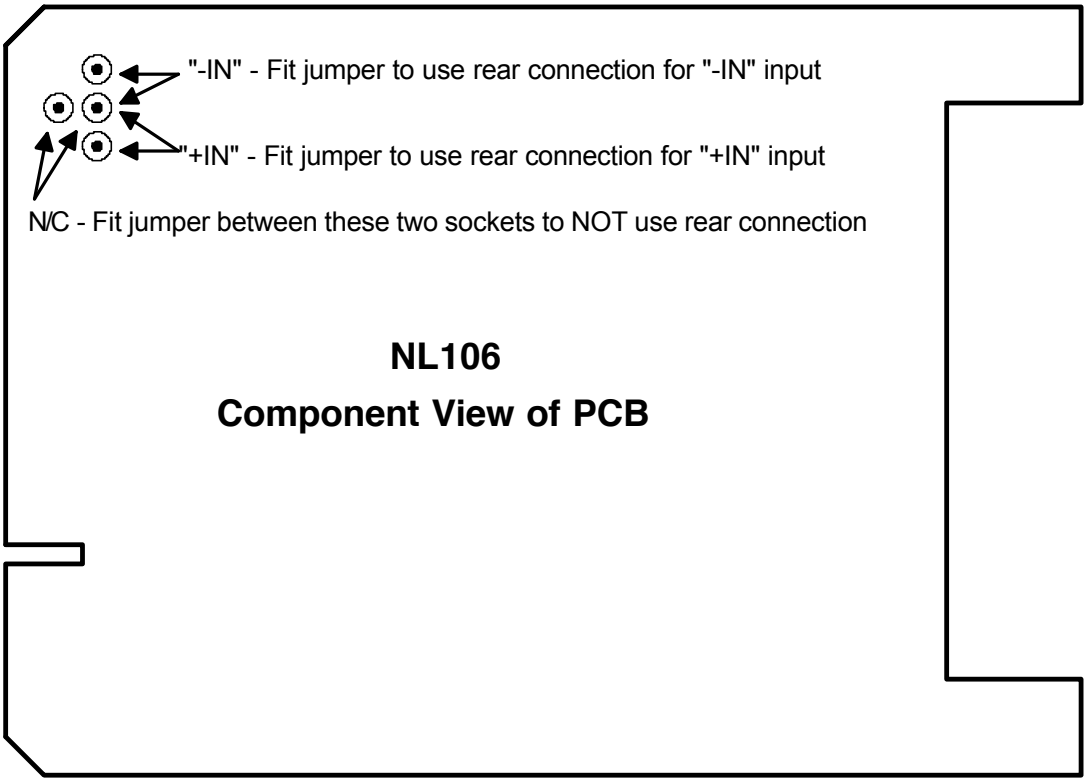
A single time constant of 0.1 seconds applies to the AC operation condition and the input impedance is 1Mohms for each input.

Output limiting will occur with input signal exceeding ±2.5V differentially or single-ended regardless of gain setting and common mode levels of up to ±3V can be handled. Within these limitations the **NL106** can be used to provide an output proportional to the difference between two DC signal levels.

Specification Summary

Input voltage range	:	±3V (working):±15V (overload)
Input impedance	:	1Mohm
Gain	:	0 to x10 or 0 to x100 continuously variable by ten-turn potentiometer
Small signal frequency response	:	(±1V out) : >30kHz
Low frequency cut-off in AC mode	:	2Hz
Output voltage range	:	±12V
Output Impedance	:	600ohms
DC offset range	:	±2V at either input, ten-turn potentiometer adjustment
CMRR	:	>2500:1 at 50Hz

Rear connections to the motherboard allow Input and Output interconnections between this module and other analogue modules without the need of front panel cables.



Rear Connections

The rear edge connector in the NL900 rack allows adjacent modules to connected together without the need of front panel leads.

Output Signal - This module has the output signal permanently connected to the rear connector for automatic routing to the module on the immediate right.

Input Signals - The output signal from the module to the immediate left can be routed to either the "+IN" or "-IN" inputs, or left open. This is done by removing jumper, in the upper rear corner of the PCB, and placing it in the appropriate pair of holes.

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File Reference: N:\DOCS\COMPANY\MANUALS\NEUROLOG\ NL106.SAM

NL107 - Recorder Amplifier

Introduction

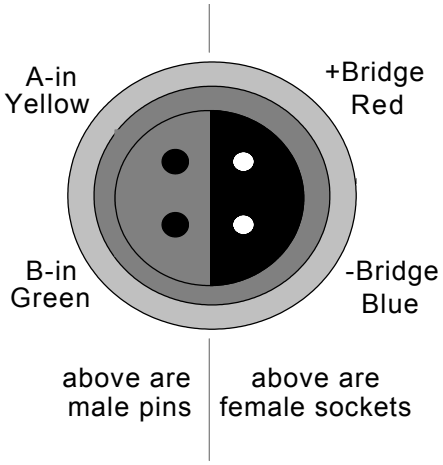
The NL107 Recorder Amplifier is a DC coupled differential Amplifier intended for use as a bridge amplifier or as a recorder matching amplifier. Some of the NL107's features include:-

a) wide gain range
b) an integral power supply for bridge excitation
c) excellent DC stability
d) selectable input time constants
e) a wide DC offset adjustment

The +Bridge and -Bridge supply are approximately ±15V with a source impedance of 1k2ohms. When using a 600ohm bridge this gives an excitation voltage of 10V. Other excitation voltages (up to ±14.5V) can be obtained by changing the resistors on the board to suit the particular bridge employed. A front panel switch grounds the output for recorder baseline adjustments.

The figure below, shows the pin arrangement for the NL107 input connector. The colours indicated refer to the insulated wires of the assembled cable, NL953.

Setting	x1		x50	
	Sens.	Gain	Sens.	Gain
1	1mV/V	x1000	50mV/V	x20
2	2mV/V	x500	100mV/V	x10
5	5mV/V	x200	200mV/V	x4
10	10mV/V	x100	500mV/V	x2
20	20mV/V	x50	1000mV/V	x1



Specification Summary

Input voltage range	:	±15V
Input impedance	:	1 Mohm
Input time constant (AC mode)	:	10sec (0.02Hz)
Input sensitivity (gain)	:	x1 to x1000 switched in 1-2-5 sequence (1mV to 1V input for 1V output)
DC offset	:	±1V at input, 10 turn potentiometer adjustment
Output high frequency cut-offs	:	20kHz (WB), 50Hz, or 0.5Hz (Mn)
CMRR	:	2500:1 at 50Hz
Output voltage range	:	±10V
Output impedance	:	600 ohms
Bridge supply	:	approximately 10V for 600 ohm bridge. Can be adapted to suit most strain gauge transducers.

Rear connection to the motherboard allows Output interconnection between this and the Input of an analogue module, placed to the immediate right, without the need of a front panel cable.

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

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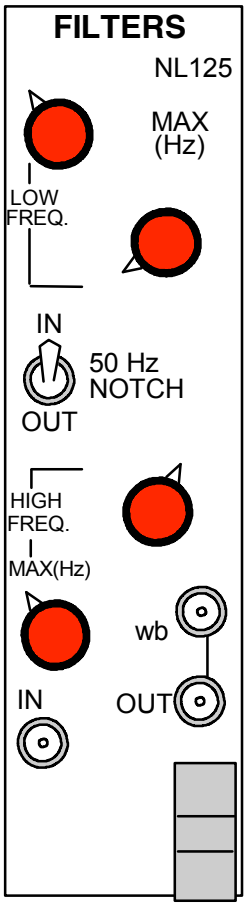
File Reference: N:\Docs\Company\Manuals\NeuroLog \ NL107.lwp

E-mail: sales@digitimer.com **Tel:**+44 (0)1707 328347; **Fax:**...373153 **Website:** www.digitimer.com

NL125/NL126 - Filters

Introduction



The NL125 and NL126 Filter modules employ 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 by-pass the lower and upper filter sections, respectively. An active notch filter is provided for the rejection of line frequency interference; this is set at the factory to 50Hz (NL125) or 60Hz (NL126), with a 20Hz notch width (-3dB points).

Specification Summary

Input voltage range	: ±10V
Input impedance	: 56Kohms
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	: ±10V
Output impedance	: 600ohms

First Issued: before July 1984
Last Revision: July 11, 1995

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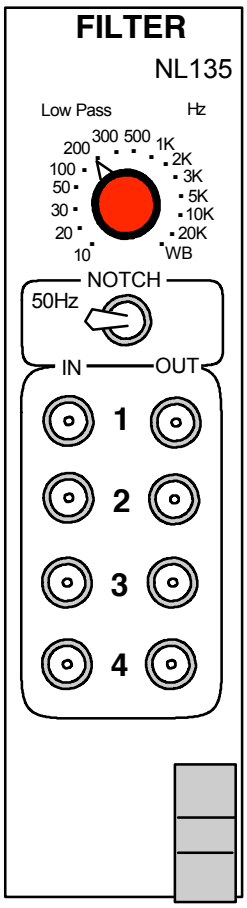
NL134/135/136 - Filters (4-channel)



Introduction

The NL134/5/6 FILTERS are 4-channel, second order (two-pole) low-pass with mains frequency Notch reject (NL135/6 only) filter modules. They are ideal partners for the NL820 Isolated Amplifier system with its 2/4-channel AC (NL822/824) or DC (NL832/834) pre-amplifiers and the NL530 4-channel Conditioner module.

The filter settings have been selected for most Electrophysiological and Clinical protocols but other frequencies can be factory set to order. The design is implemented using low noise active linear circuitry and does not suffer any of the aliasing problems that are encountered when cheaper methods are used. A rotary switch selects the 14 frequency settings giving repeatability over a wide range with 12dB/octave [40dB/decade] attenuation above the selected frequency value. The 'WB' (wide-band) switch position by-passes the filter sections completely (both LP and Notch).

The active Notch filter provides rejection of line frequency [50Hz (NL135) or 60Hz (NL136)] interference when switched in. (No switch is fitted on the NL134).

Specification Summary

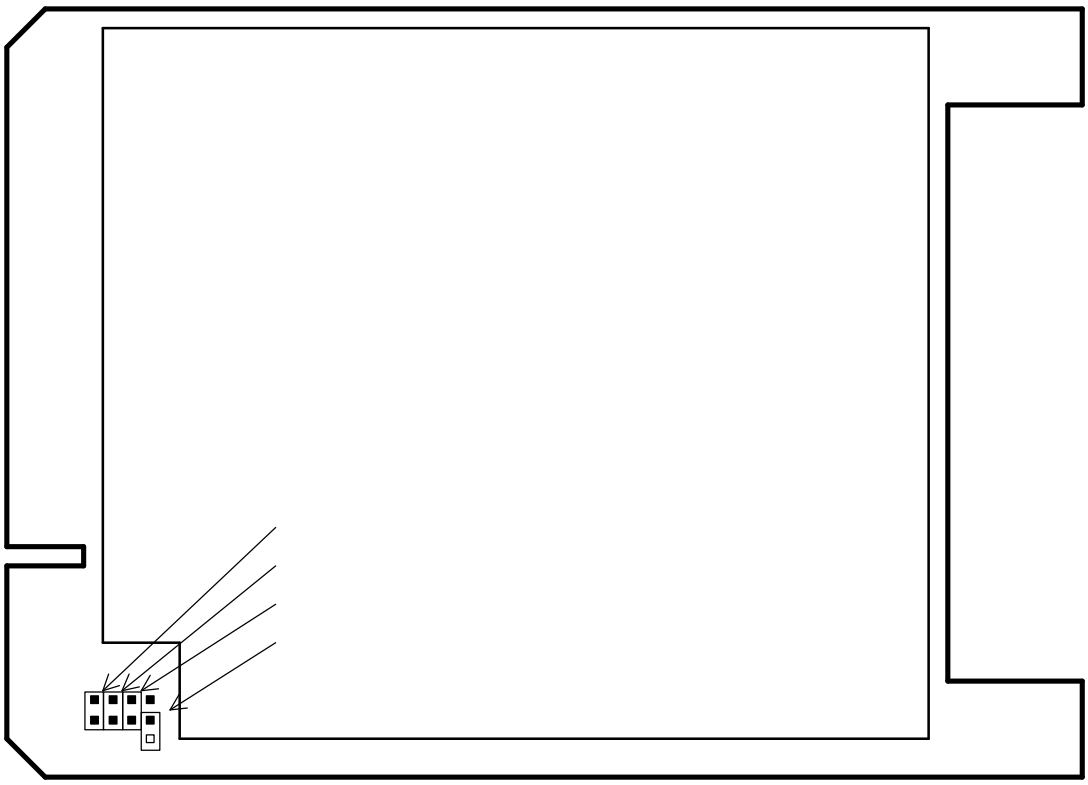
Input voltage range:	±15V max. >±10V operating
Input impedance	1MΩ
Filter settings (-6dB)	10, 20, 30, 50, 100, 200, 300, 500,1k, 2k, 3k, 5k, 10k, 20k - Hz and WB
Cut-off accuracy	±2% + ±1.25Hz <630Hz ±2% + ±62.5Hz >630Hz
Gain before cut-off	+1.0
Attn. beyond cut-off	40dB/decade, 12dB/octave
Notch Attenuation	>50dB
Notch Width (-3dB)	20Hz
Crosstalk	better than -60dB
Noise	<100µV rms.
Output DC offset	<±10mV
Output voltage range	±10V
Output impedance	<600Ω

Rear connections to the motherboard allow Input and Output interconnections of all four channels between this and (newer) NL820 and NL530 modules without the need of front panel cables.

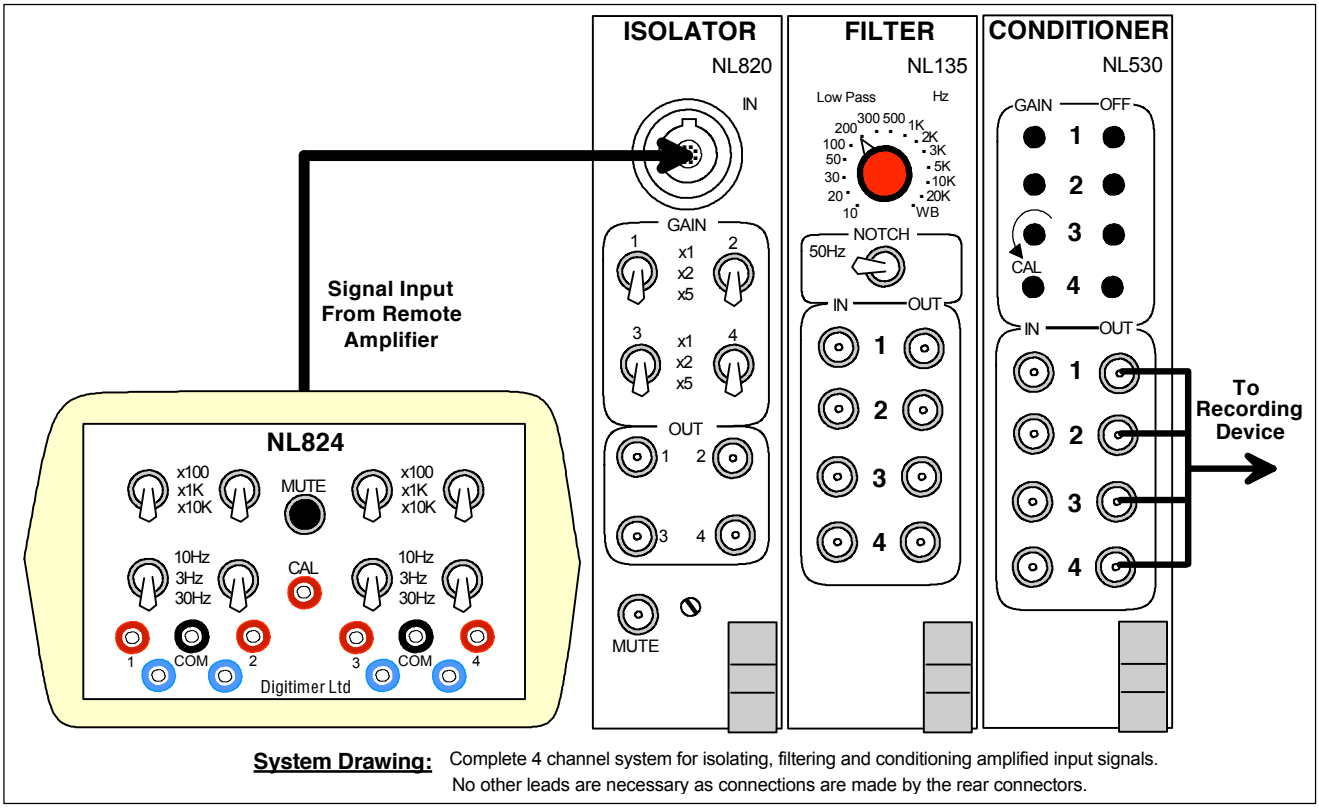
NB: This module must NOT be placed adjacent to a Counter module in the **NeuroLog ™** rack.

Rear Connections and jumpers

The rear edge connector in the NL900 rack allows adjacent modules to connected together without the need of front panel leads. This module has the output signals permanently connected to the rear connector for automatic routing to the module on the immediate right. The input signals can be disconnected from the outputs of the module on the immediate left if they are inappropriate. This is done by removing one of the jumpers, in the lower rear corner of the PCB, for each channel to be disconnected. The jumpers can be 'parked', so that they are not lost, by placing them on just one of the pins (as shown for channel 1).



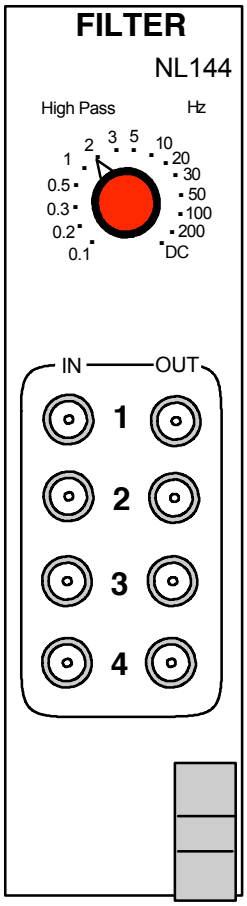
We reserve the right to alter specifications and price without prior notification.



System Drawing: Complete 4 channel system for isolating, filtering and conditioning amplified input signals. No other leads are necessary as connections are made by the rear connectors.

Last Revision: March 4, 1998
File Reference: N:\DOCS\COMPANY\MANUALS\NEUROLOG \ NL134-6.SAM

NL144 - Filter (4-channel)



Introduction

The NL144 FILTER is a 4-channel, second order (two-pole) high-pass filter module. It is an ideal partner for the NL820A Isolated Amplifier system with its 2/4-channel AC (NL822/824) or DC (NL832/834) pre-amplifiers and the NL530 4-channel Conditioner module. In combination with either the NL135/136 or NL134 Filters, a full 4 channel low frequency and high frequency cut-off system is provided.

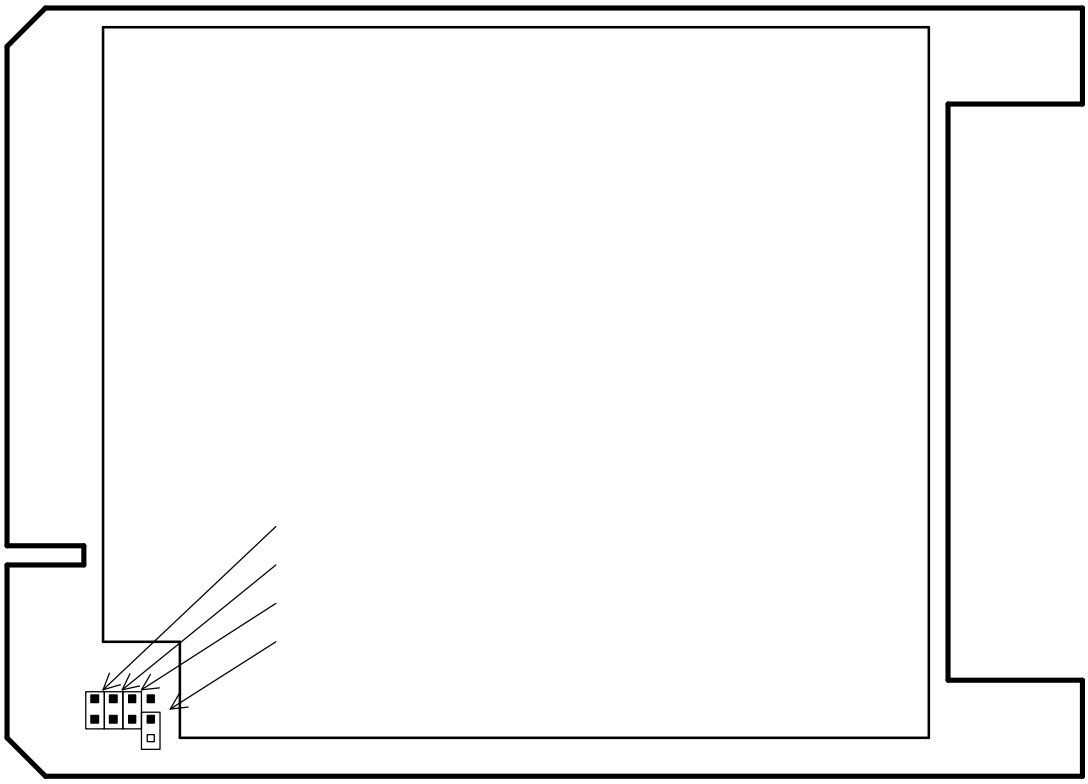
The filter settings have been selected for most Electrophysiological and Clinical protocols but other frequencies can be factory set to order. The design is implemented using low noise active linear circuitry and does not suffer any of the aliasing problems that are encountered when cheaper methods are used. A rotary switch selects the 14 frequency settings giving repeatability over a wide range with 12dB/octave [40dB/decade] attenuation below the selected frequency value. The 'DC' switch position by-passes the filter sections completely.

Specification Summary

Input voltage range:	±15V max. >±10V operating
Input impedance	120kΩ
Filter settings (-6dB)	0.1, 0.2, 0.3, 0.5, 1, 2, 3, 5,10, 20, 30, 50, 100, 200 - Hz and DC
Cut-off accuracy	±3% + ±0.01Hz <6.3Hz ±3% + ±0.63Hz >6.3Hz
Gain after cut-off	+1.0
Attn. below cut-off	40dB/decade, 12dB/octave
Crosstalk	better than -60dB
Noise	<100µV rms.
Output DC offset	<±10mV
Output voltage range	±10V
Output impedance	<600Ω

Rear connections to the motherboard allow Input and Output interconnections between this and (newer) NL820A, NL134/135/136 and NL530 modules without the need of front panel cables.

NB: This module must NOT be placed adjacent to a Counter module in the **NeuroLog™** rack.

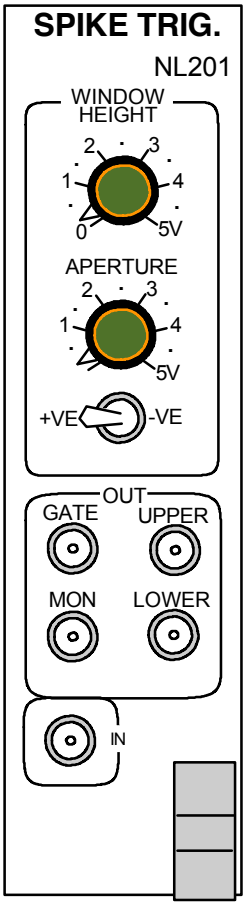


Rear Connections and jumpers

The rear edge connector in the NL900 rack allows adjacent modules to connected together without the need of front panel leads. This module has the output signals permanently connected to the rear connector for automatic routing to the module on the immediate right. The input signals can be disconnected from the outputs of the module on the immediate left if they are inappropriate. This is done by removing one of the jumpers, in the lower rear corner of the PCB, for each channel to be disconnected. The jumpers can be 'parked', so that they are not lost, by placing them on just one of the pins (as shown for channel 1).

Last Revision: October 21, 1998
File Reference N:\DOCS\COMPANY\MANUALS\NEUROLOG\ NL144.SAM

NL201 - Spike Trigger



Introduction

The **NL201 SPIKE TRIGGER** is a gated amplitude discriminator for nerve spikes and other events which produces separate output pulse trains for spikes which:-

(a) cross the Upper voltage threshold
(b) cross the Lower voltage threshold
(c) cross the Lower threshold but not the Upper threshold

The WINDOW HEIGHT potentiometer sets the DC level of the "window" and the APERTURE potentiometer sets the separation between the two voltage thresholds of this window. Thus, slight changes in signal amplitude require adjustments of only one setting, and it is impossible to set the Upper voltage threshold lower than the Lower voltage threshold.

A front panel switch selects either positive (+VE) or negative (-VE) slope and level triggering and there is an choice of two internally selected input voltage ranges.

The MONITOR output socket provides a display of the input signal with the Lower and Upper levels super-imposed on it to enable easy setting of the discrimination levels.

This module is essential for converting spike trains (which are analogue signals) into trains of digital pulses; these can be analysed using other modules (such as the **NL700 LOG DISPLAY**) or used to synchronise displays, trigger averaging, etc. An internal jumper allows the input to be DC coupled or have a time-constant which is appropriate for nerve spikes with rise times less than 200µs - modifications for longer rise times are available by special order.

To line up with the front panel markings the input signal should be externally amplified so that the required Lower threshold is in the range ±1 to ±5 Volts with the "window" 200mV to 5V wide. If this can not be accomplished the internal gain of x10 may be selected so that signals requiring a Lower threshold of 0 to ±500mV and a "window" of 20 to 500mV can be accommodated.

Although the **NL201 SPIKE TRIGGER** is specifically designed for spike amplitude discrimination, it can be used for events with much longer rise times if amplitude gating is not essential. For example, pulses can be triggered by QRS complexes in electrocardiograms, either at the upper or lower thresholds.

It is anticipated that the NL201 would be used with an standard, low specification Analogue oscilloscope not a Digital Storage Oscilloscope (DSO). Should a DSO be used, the user may wish to modify the speed of the multiplexer (see page 4) so that the discrimination levels are displayed more distinctly to the detriment of the display of the signal. Alternatively, the discrimination levels could be disabled completely (see page 6).

Level detection:

Fig. NL201-1

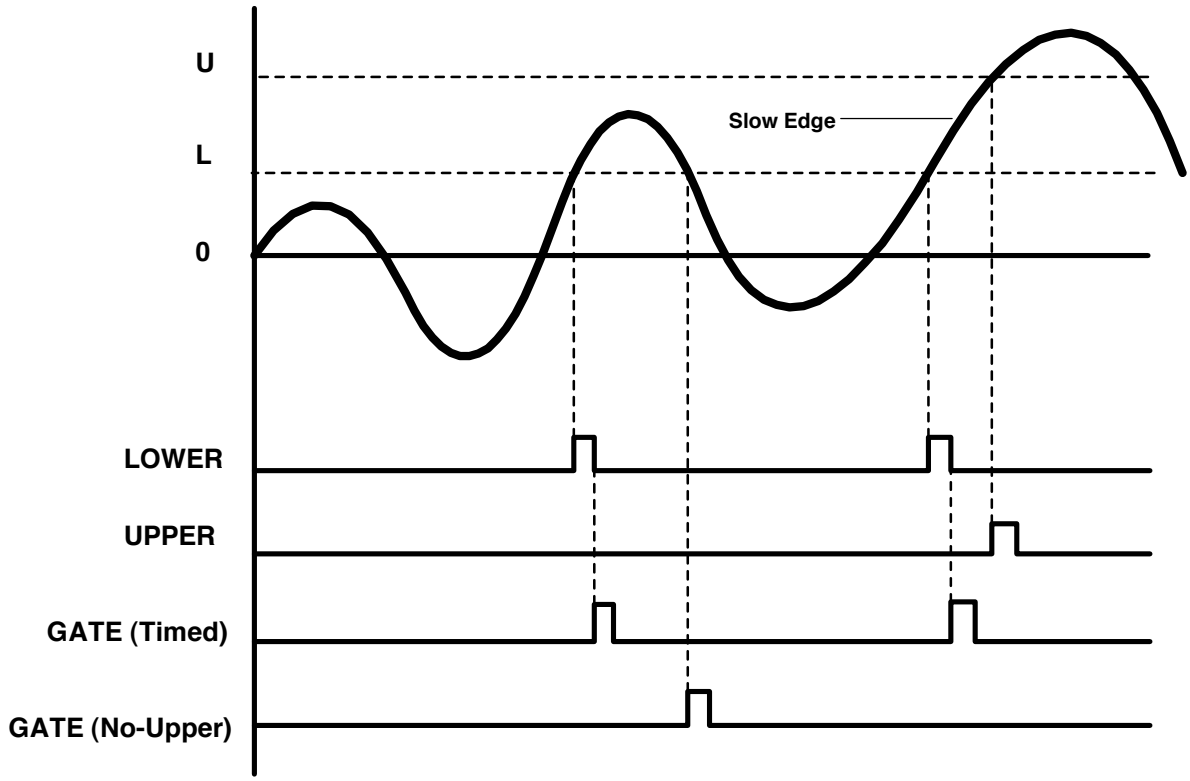


Fig. NL201-1 : Level detection

The thresholds are adjusted with the two potentiometers mounted on the front panel. The dial markings for the WINDOW HEIGHT potentiometer show the Lower threshold (see Fig. NL201-1) in volts; the Upper threshold, however, is equal to the WINDOW HEIGHT + APERTURE settings. The values of this arrangement are twofold:-

Firstly, the separation between the two thresholds (i.e. the APERTURE) can be kept constant and the position of this amplitude window can be shifted with respect to the baseline with a single potentiometer (WINDOW HEIGHT).

Secondly, it is impossible to incorrectly adjust the two thresholds, as would easily be possible if each was adjusted independently (e.g. the Upper threshold cannot be lower than the Lower threshold).

Input signals used to drive the **NL201** may have appreciable DC components (e.g. the vertical output signal of an oscilloscope will have a DC level which depends on the setting of the oscilloscope's vertical position knob), but the spike amplitudes are measured with respect to the baseline. The input of the NL201 is normally AC coupled for that reason (low frequency response approximately 0.8Hz) to simplify threshold adjustments. (An internal jumper allows the coupling capacitor to be shorted if DC discriminations are required). The WINDOW HEIGHT, APERTURE and INPUT RANGE labelling are therefore AC amplitudes.

The spike at the left in Fig. NL201-1 does not cross either threshold and therefore, no output pulses are produced. The middle spike crosses only the Lower threshold (i.e. its peak is within the "window" bounded by the two thresholds) and it triggers both LOWER and GATE pulses. The peak of the third spike is above the window and it triggers LOWER and UPPER pulses, but not a GATE pulse in 'No-Upper mode'. It does, however, produce a GATE in 'Timed' mode as the transition between the Lower and Upper level took longer than the 200µs (nom.) of the Lower-Output-Pulse, this is not typical of nerve spike activity. In this example, pulses are triggered by positive going slopes; if the POLARITY switch was towards the right (-ve) position, the threshold would have been arranged in a mirror-image position about the baseline.

Threshold setting

Fig. NL201-2

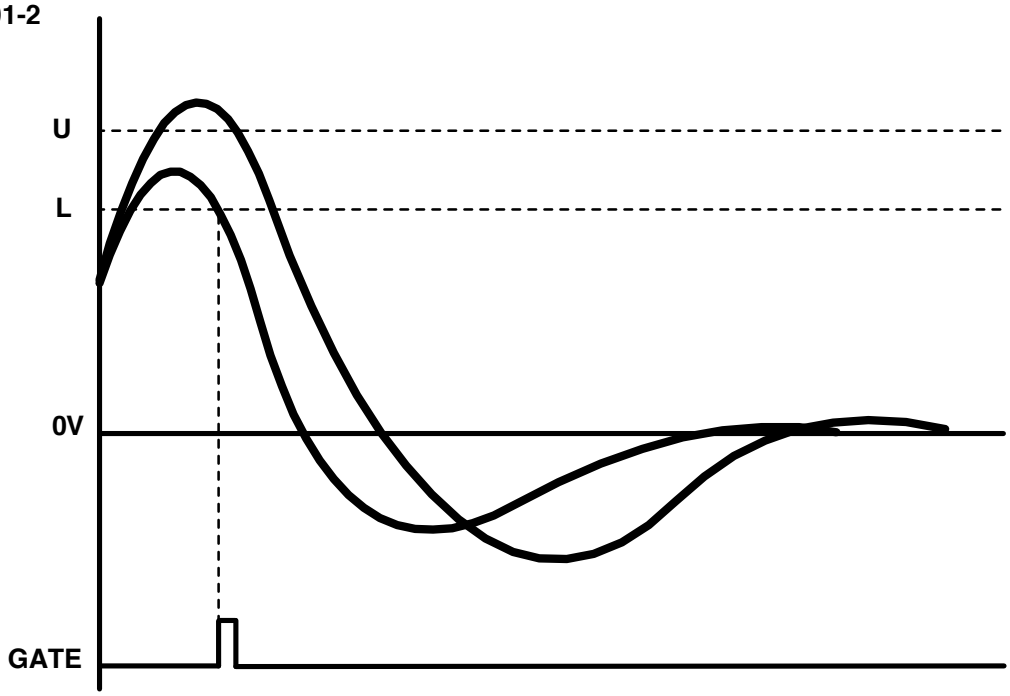


Fig. NL201-2 : Threshold setting

The NL201 thresholds can be set several ways; Fig. NL201-2 shows one method. The monitoring oscilloscope is triggered externally with the positive-going edges of the NL201 LOWER output pulses, with a moderately fast sweep speed (50 or 100 micro-second per division). All spikes which cross the lower threshold will appear on the 'scope face; the vertical origin at the left indicates precisely the actual threshold. Two super-imposed spikes are shown in Fig. NL201-2; one which crossed only the lower threshold and one larger spike which exceeded both thresholds.

The **first** method is to use the second channel of an oscilloscope to display GATE pulses (in 'No-Upper' mode) where there is no doubt about which spikes have peaks in the window. This method forces an awareness of each spike waveform and makes it less likely that different spikes with similar peak amplitude will be confused (spikes with the same amplitude produced by neighbouring cells, are simultaneously recorded more often than one might suppose).

The **second** method of setting the NL201's thresholds is simply to measure spike amplitudes at the NL201 input with a monitoring oscilloscope, and to set the thresholds from the dials. This may be the only method possible if the spike firing rate is low and somewhat unpredictable. The display shown in Fig. NL201-2 is useful when the spikes of interest occur more frequently than a few per second.

The **third** method is purely displaying the MONITOR signal on an oscilloscope and setting the levels appropriately

Perhaps the best method, however, for visualising the spike discrimination process is to use the **NL201 SPIKE TRIGGER** with the **NL741 ANALOG DELAY** or **NL202 AC DELAY** module. By delaying the spike signal, and triggering the oscilloscope time base with the GATE pulse, only those spikes which initiate GATE pulses will be displayed; these will be seen in their entirety, including portions of their waveform which precede the trigger thresholds.

The GATE output can be internally selected to occur under one of two conditions. In both cases it would occur after the input signal had passed through the Lower level and:-

a) 'Timed' mode - If it had not passed through the Upper level by the end of the LOWER output pulse (200 micro-second).
b) 'No-Upper' mode - Passes back through Lower without crossing the Upper level - this is without time constraint. [Normal position]

Rear Connections and Jumpers

The rear edge connector in the NL900 rack allows adjacent modules to be connected together without the need of front panel leads. Full details are giving the Jumpers section.

INPUT: The input signal can be disconnected from the output of the module on the immediate left if it is inappropriate.

OUTPUT: The user has the choice of one of three output signals that can be connected to the rear connector for automatic routing to the module on the immediate right.

Multiplexer Frequency

The internal multiplexer oscillator runs at a frequency of approximately 150kHz (a 6.67µs cycle) and can be measured at pin 2 of IC9. This oscillator is used to switch between the display of the Upper level, Signal, Lower level and Signal again in a 1:7:1:7 (6.67µs : 46.7µs : 6.67µs : 46.7µs) time-frame. If it is required to slow down this oscillator the value of C19 should be increased proportionally (see Fig, 201-3).

The standard value of C19 is 0.015µF (15nF) and a value of 0.1µF (100nF) would give an oscillation frequency of around one sixth the standard value, that is 25kHz (a 40µs cycle).

Output Pulse Widths

The duration (width) of the LOWER, GATE and UPPER pulses is set by the timing components fitted to three monostables. If the factory set values are not consistent with your needs, these may be changed. The position of these on the circuit board is shown in Fig. NL201-3.

Function	Capacitor / Value	Resistor / Value	Standard Width
LOWER	C26 / 0.01µF	R39 / 27k	200µs
GATE	C25 / 1000pF	R38 / 20k	15µs
UPPER	C20 / 0.01µF	R33 / 33k	230µs

The one point that must be considered is the fact that the GATE output, when set to the 'Timed' mode, uses the LOWER pulse width to determine the existence of a signal that lies within the GATE voltage window.

The calculation of the Resistor and Capacitor to be used come from the following, approximate, equation:-

Width = 0.7 x Capacitor x Resistor

Note that the values used in the equation are in Farads and ohms and the circuit has the limitation on values given below:-

Component	Minimum value	Maximum value
Capacitor	1000pF	10µF
Resistor for Lower and Upper	2k ohms	100k ohms
Resistor for Gate	1500 ohms	40k ohms

Example:-
Using the factory UPPER pulse width. UPPER = 0.7 x 0.01E-6 x 33E3 = 231E-6 or 231µs.

Specification Summary

Input:

Voltage range	±10V
Impedance	1MΩ
Protection	±100 Volts maximum
Time constant	0.2 second or DC (internal jumper)
Gain	x1 or x10 (internal jumper) -NB: after AC coupling

Thresholds:

Lower range (HEIGHT)	0 to 5 Volts (positive or negative)
Aperture range (WINDOW)	0.2 to 5 Volts (positive or negative)
Triggering (and levels)	positive or negative slope
Calibration	±10%

Outputs:

UPPER	TTL, 230 micro-second (±10%) pulse
LOWER	TTL, 200 micro-second (±10%) pulse
GATE	TTL, 15 micro-second (±10%) pulse
MONITOR	Input signal (x Gain) plus Upper and Lower levels

Internal Jumpers:

AC/DC Coupling	Input is DC coupled or a 0.2 second time-constant
GAIN	x1 or x10 on input signal
MONITOR OUT	Purely input signal or signal plus levels
GATE Pulse occurs:-	

a) LOWER pulse-width after signal goes through Lower if it has not crossed the Upper.
b) As signal re-passes Lower (towards zero) without having crossed the Upper.

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

Jumpers

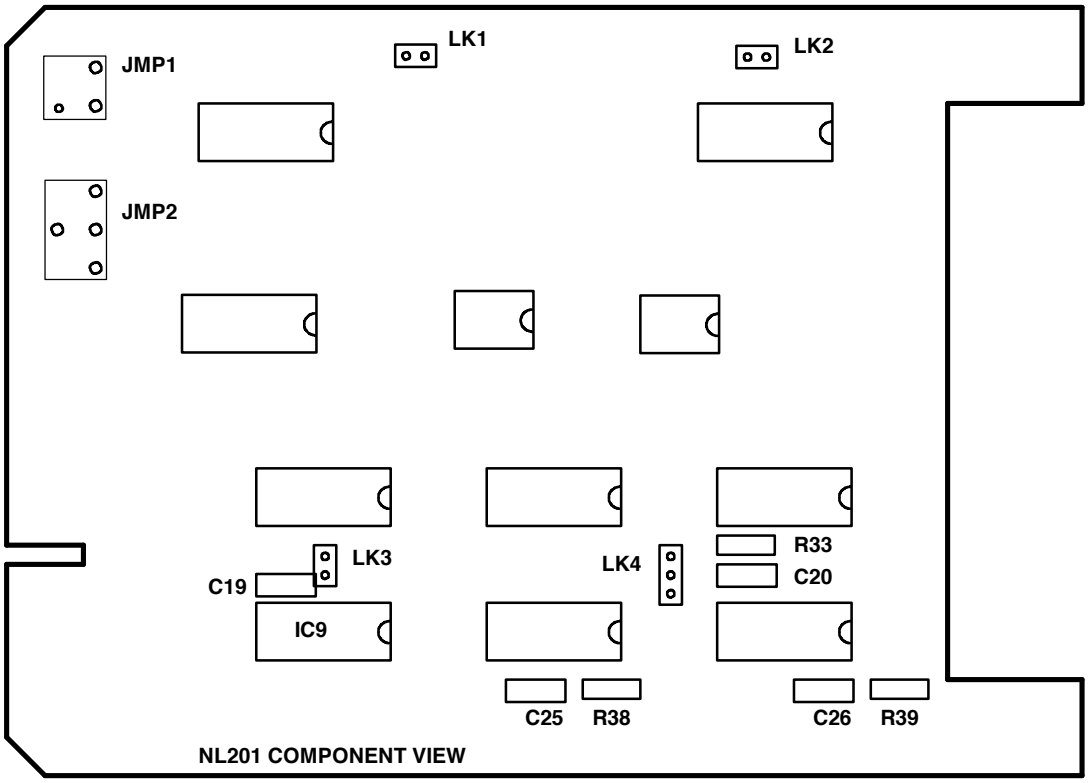


Fig. NL201-3 : On-board jumpers

LK1 - Input Coupling Jumper the pins together for DC coupling
LK2 - Signal Input Gain Jumper the pins together for an input gain of x10
LK3 - Multiplexer display Jumper the pins together for a display of the threshold levels with the signal at the 'MONITOR' socket.
LK4 - Gate pulse occurrence

The GATE pulse will occur after the input signal has passed through the Lower level (from 0V) and:-

'Timed' mode - (Jumper lower two pins of link LK4):- If it had not passed through the Upper level by the end of the LOWER output pulse (200 micro-second).

'No-Upper' mode - (Jumper upper two pins of link LK4):- Passes back through Lower without crossing the Upper level - this is without time constraint. [Normal position]

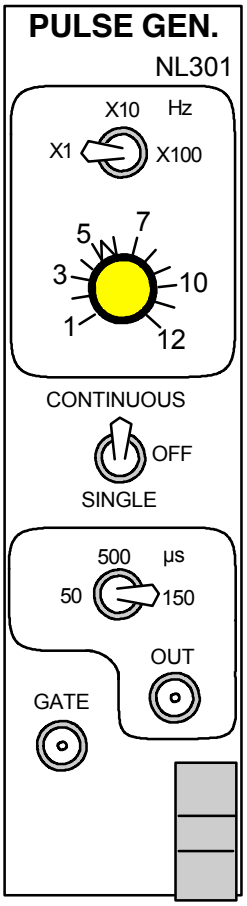
JMP1 - Rear Input Jumper the two gold sockets to source the INPUT signal from the output of the module on the immediate left.

JMP2 - Rear Output This selects the OUTPUT of this module for rear connection to the input of the module to the immediate right.

Jumper one of the following to the central socket as follows:-

Upper socket	for	LOWER signal
Middle socket	for	UPPER signal
Lower socket	for	GATE signal

NL301 - Pulse Generator



Introduction

The **NL301 PULSE GENERATOR** is a low cost module for producing trains of uniform TTL pulses. It can be operated continuously, switched off, or a single pulse can be triggered manually. It is the successor to the NL300.

A GATE input socket is provided to allow synchronous trains of pulses to be gated-on by an externally applied TTL high logic level. An internal jumper either excludes (as with the NL300) or produces an output pulse coincident with the start of the GATE signal.

Pulse frequency is continuously variable over more than three decades using a single 12:1 control and a three position decade switch. Three fixed output pulse widths are available.

The frequency range and pulse widths were chosen to make this module suitable as a timing source for electrical stimulation of the nervous system, without the necessity of additional modules for determining the pulse width.

The **NL301** is also useful for a variety of other timing purposes where a widely variable rate is desirable, and precision is important but not critical.

Frequency Range

The front panel control is marked in integer marks between 1 and 12 and is calibrated to be within 1% accuracy at the '1' and '10' marks. At the other marks it will be within 5% accurate.

Even though the scale is not marked below '1' the **NL301** will produce an output frequency down to '0.5'. This gives a 0.5-12 (or 24:1) range on a single control. With the three decade toggle switch the total range of 0.5 Hz to 1200 Hz can be covered in three over-lapping ranges.

An internal jumper is fitted to change the 0.5-1200 range to 0.05-120 Hz by changing the board jumper. When this jumper (LK2) is fitted the range will be 0.05-120 and when removed it will be the marked 0.5-1200 Hz. -see diagram that follows.

Single/Off/Continuous

This three way toggle switch allows a single output pulse at the set pulse width when it is pressed into the 'SINGLE' position. The switch is biased so that it will not stay in this position. In the 'OFF' position there is no output. In 'CONTINUOUS' the output can be gated - see diagram that follows.

Gate Function

The Front Panel socket allows the **NL301** output train to be gated on and off.

In CONTINUOUS mode the output pulse train will start in synchronism with the positive going edge of the GATE signal and continue until the GATE signal is taken low or the toggle switch is switched out of 'CONTINUOUS'.

When there is no connection to the 'GATE' socket, the NL301 will give a continuous train of pulses when switched to 'CONTINUOUS'.

First Pulse Option

An internal jumper exists that can enable an output pulse coincident with the positive edge of the GATE signal. The alternative is for the first output pulse to be one period of the selected frequency after the start of the GATE signal (as was the case with the NL300). -see Fig. 301-1.

The on-board jumper (LK3) is fitted to join the two pins or not.

Pins joined	No pulse coincident with the start of GATE
Pins not joined	First pulse will be coincident with the start of GATE

Specifications

Frequency		
	Total range	<1 to 1200 Hz
	Control	Single turn (270°) control marked 1 - 12 Hz with intermediary integer panel marks. Maximum range > 0.5 - 12
	Accuracy	±1% at '1' and '12' marks ±5% at other scale marks
	Multiplier	x1 ; x10 ; x100
	Internal Jumper (LK2)	x0.1 multiplier giving:- <0.1 to 120Hz on the front panel controls
Gate		
	Control	TTL 'high' (or socket open circuit) enable oscillator TTL 'low' inhibits oscillator
	Internal Jumper (LK3)	Pins Joined - No pulse coincident with GATE start Pins Open - First pulse coincident with GATE start
	Input	TTL compatible, 1 TTL load maximum +15V
Output pulse widths		50, 150 or 500 µs (±5%)
Output fan-out		10 TTL inputs

Fig. NL301-1 : GATE / OUTPUT relationships

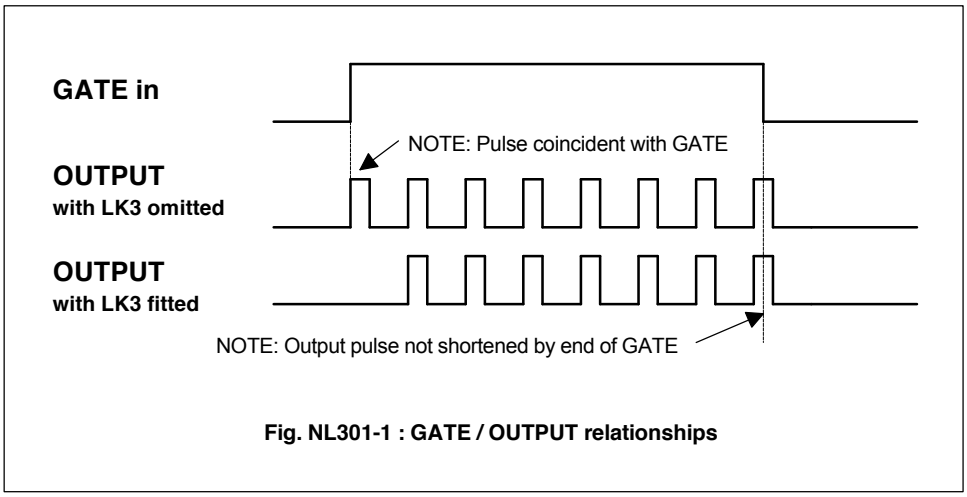


Fig. NL301-1 : GATE / OUTPUT relationships

Jumpers

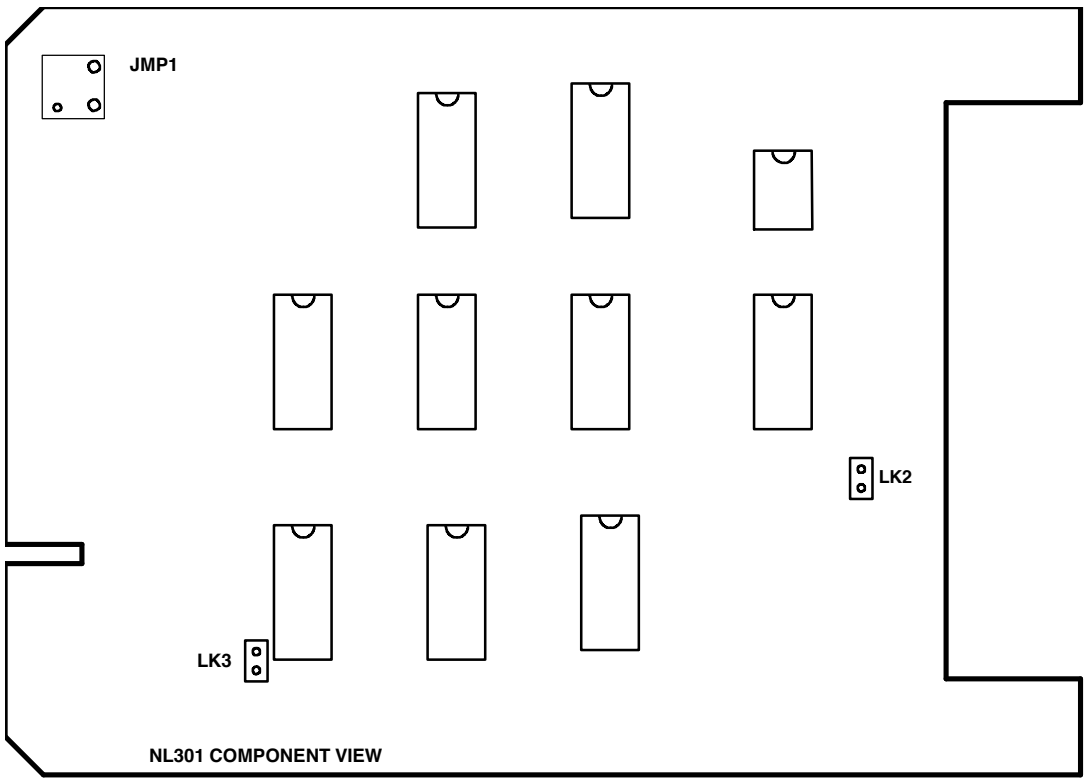
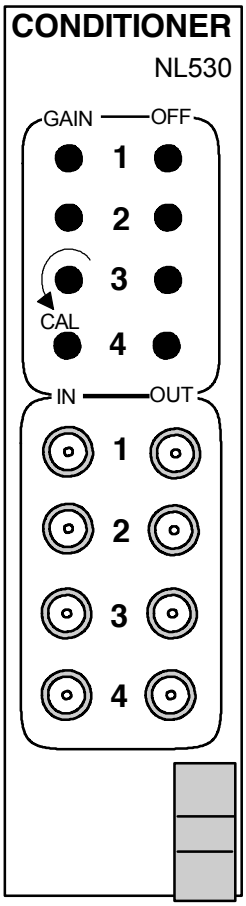


Fig. NL301-2 : On-board jumpers

LK2 - Range Select Jumper these pins together to reduce the front panel range by a factor of 10.
LK3 - First Gate Pulse Jumper these pins together to enable a pulse coincident with the start of the Gate.
JMP1 - Rear Input Jumper the two gold sockets to source the GATE signal from the output of the module on the immediate left.

Last Revision:	March 4, 1998
File Reference:	N:\DOCS\COMPANY\MANUALS\NEUROLOG \ NL301.SAM

NL530 - Conditioner (4-channel)



Introduction

A single width module designed to give Gain and Offset set-up controls when interfacing signals to the Analog-to-Digital Converters (ADCs) of PCs.

The module contains four channels each with independently adjustable Filter settings and front panel Gain and Offsets presets. There is also a Master ADC offset control to allow Unipolar ADCs to be used with Bipolar signals.

As ADC boards have a precise input range (outside of which damage may occur) the module features on-board preset controls to set all channels to 'CLIP' (or limit) at independently set positive and negative (or zero) levels.

Specifications of each independent channel

Input:	Front panel Lemo socket
Abs. Max. Input:	±100V
Input Impedance:	20k ohms
* Gain:	Off; x0.1; x0.2; x0.5; x1; x2; x5; x10
ø Variable Gain:	x1 (cal.) to x2.5 (nom.)
ø Offset control:	±1V or ±5V
* Offset range:	±1V or ±5V
* Filters:	100Hz, 1kHz, 10kHz, none
Bandwidth:	DC - 100kHz
Crosstalk:	less than -56dB between channels
Output:	Front Panel Lemo socket
Output range:	±11V minimum
Output impedance:	<5 ohms (for up to 10mA load)

Output = (Input * Gain) + (ADC + Variable) Offsets

Specifications common to all channels

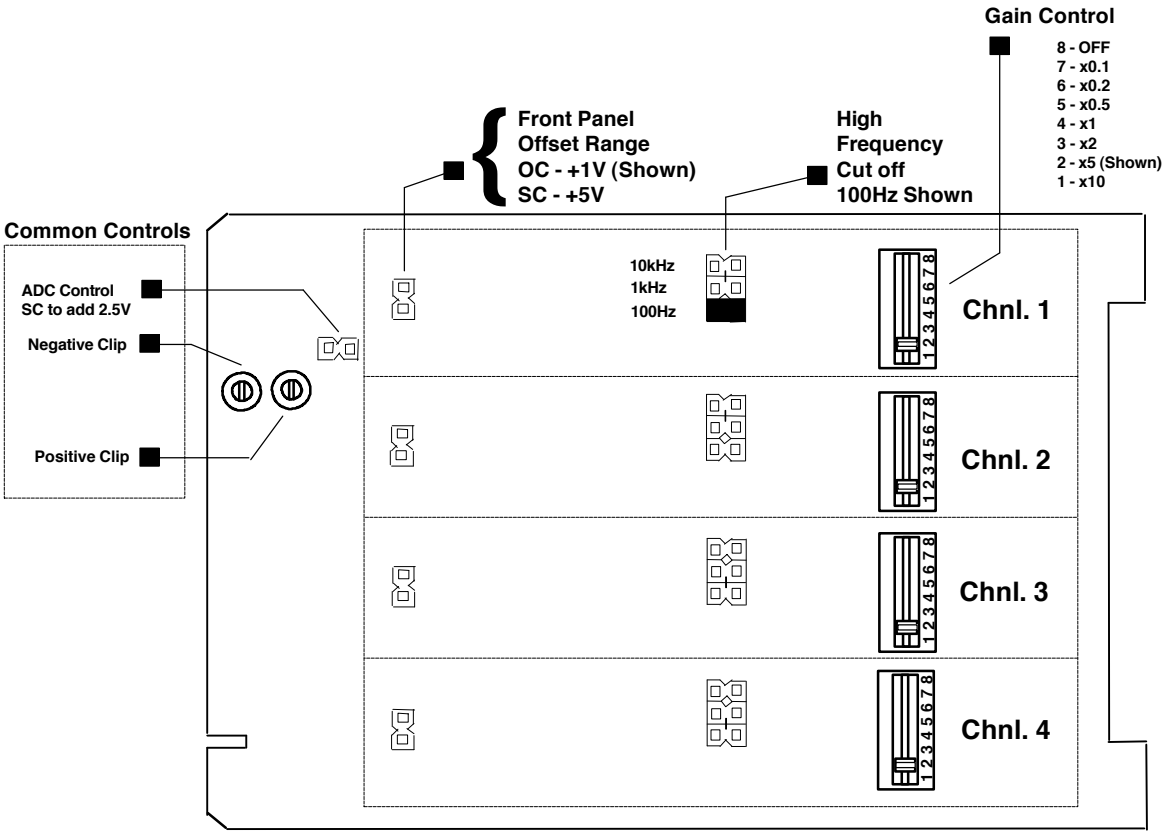
* Clip limits:	Positive: +4V to +11V min. Negative: -11V min to 0V
* ADC Offset:	Zero (0 volts) or +2.5V

ø = screwdriver adjustable single turn front panel preset

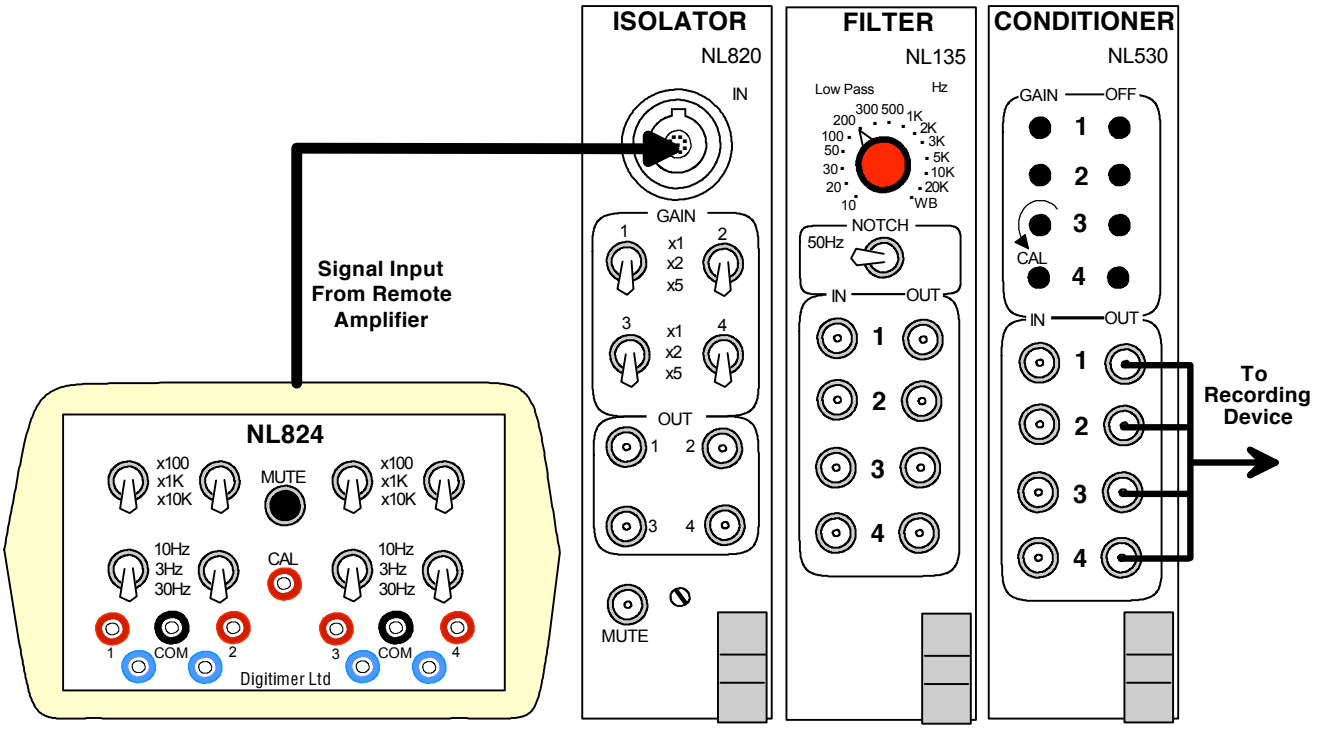
* = on-board controls

Board Presets, Switches and Jumpers

The figure below, shows the Presets, Switches and Jumpers that alter the parameters of independent channels or all channels.



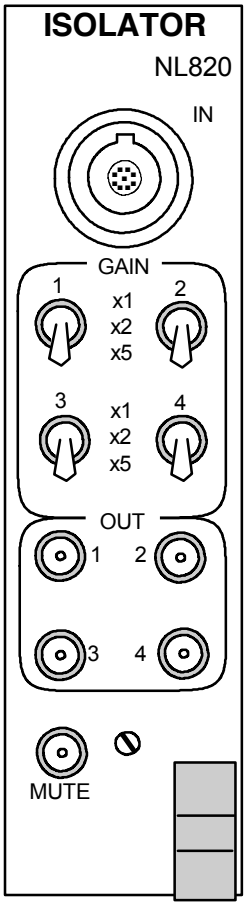
NOTE: The NL530 conditioner will automatically receive input from the module placed directly to the left of it through the rear connectors. There are no jumpers present on the NL530 to prevent this.



System Drawing: Complete 4 channel system for isolating, filtering and conditioning amplified input signals. No other leads are necessary as connections are made by the rear connectors.

Last Revision: March 4, 1998
File Reference: N:\DOCS\COMPANY\MANUALS\NEUROLOG \ NL530.SAM

NL820A - Isolator (4-channel)



Introduction

The **NL820A ISOLATOR** is the module at the heart of the **NeuroLog™ System** Isolated Amplifier range of components that meet, or exceed, the BS5724 and IEC601-1 patient leakage specifications.

The NL822 and NL824 miniature, low-noise pre-amplifiers and **NL134/135/136/144 FILTERS** and **NL530 CONDITIONER** complete the system (see system drawing on page 5).

General Description

The NL820A is a four channel analogue signal isolation module designed to plug into the **NeuroLog™** rack system. Opto-isolator and transformer techniques are employed to provide signal and power supply isolation from the power supply ground. The leakage current between amplifier inputs and ground is less than the limit specified in IEC 601-1 for class CF equipment.

Refer to Fig. NL820A-2 for a module overview.

Four single-ended inputs with a common isolated terminal are provided together with positive and negative isolated supplies for powering external pre-amplifiers or control devices. Each channel has adjustment of sensitivity by a three step switch to provide x1, x2 and x5 amplification. Input signals in the range DC to higher than 10kHz and amplitudes up to ±1 volt can be handled by the module. Multiple NL820A isolators can be operated in the same NL900 rack to provide higher numbers of channels.

The NL820A is fitted with an insulated multi-way input socket providing connections to the four signal channels and the isolated power source. The optional NL822 and NL824 Pre-amplifiers are supplied complete with connecting cable and matching plug.

Fig. NL820A-1 identifies the pin numbers of the matching plug that is available as Part Number NL969P should you wish to use your own front-end Pre-Amplifier.

Pin No	Function
1	Channel 1
2	Channel 2
3	Common
4	+13V to Pre-Amp
5	-13V to Pre-Amp
6	Common
7	Channel 3
8	Channel 4
9	Mute to Pre-Amp

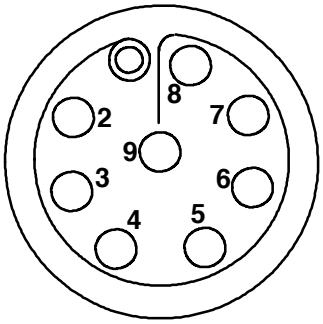


Fig. NL820A-1 Outside view of socket & wiring view of plug

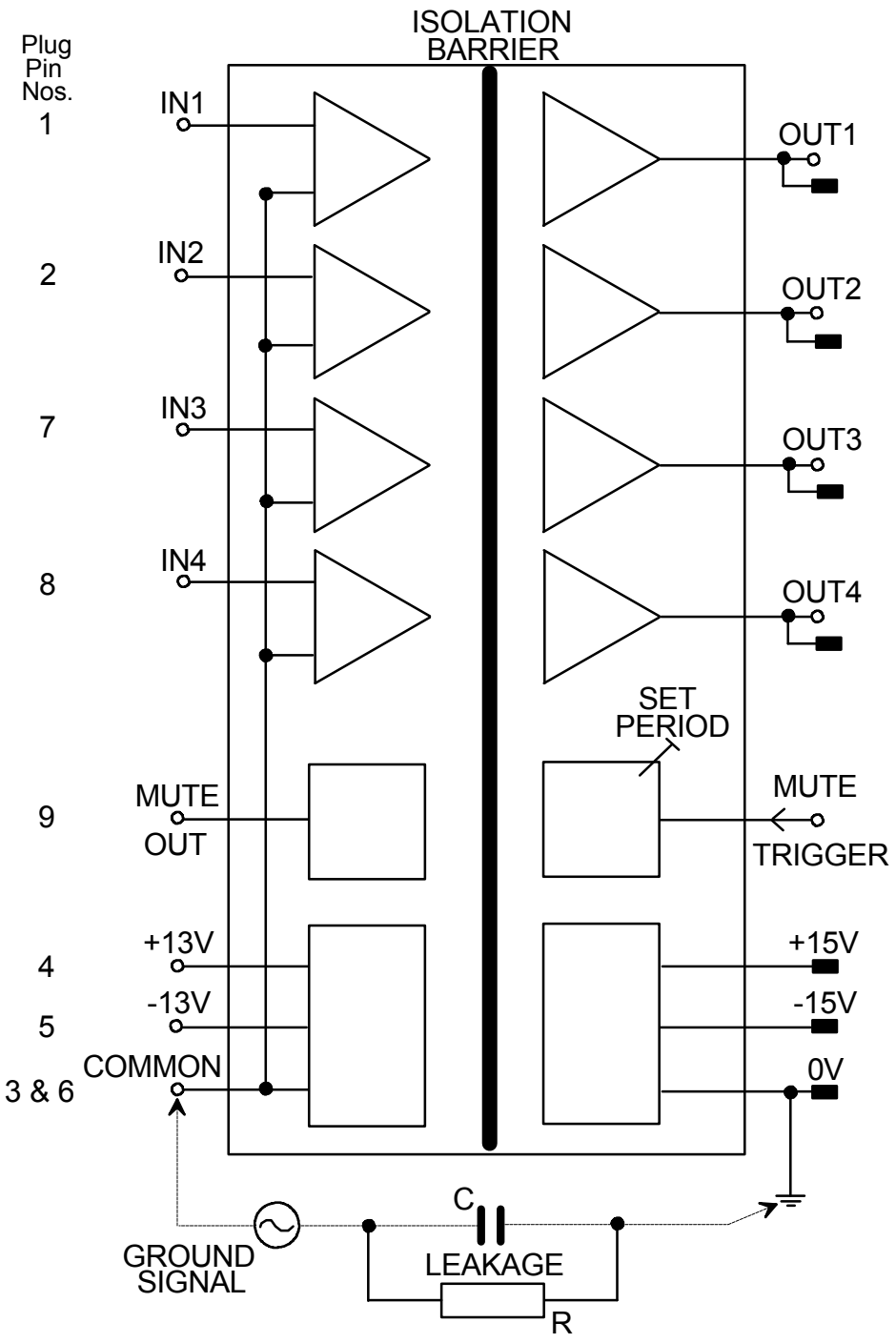


Fig. NL820A-2
NL820A SYSTEM DIAGRAM

Mute Facility

When used with NL822 and NL824 AC signal pre-amplifiers large artefact signals present at the inputs which would lead to "blocking" of the system can be reduced or removed by the use of a mute control. In order to provide operation of this mute control without bridging the isolation barrier, a logic trigger signal applied to the front panel socket on the NL820A generates a pulse of adjustable width which is coupled via an opto-isolator and the connection cable to the pre-amplifier.

The mute period may be adjusted via the trimmer control mounted behind the front panel over the range of approximately 1 to 10 milliseconds timed from the positive going edge of the applied trigger signal.

Longer mute periods can be achieved by using a logic signal of the required period to override the internal pulse width generator.

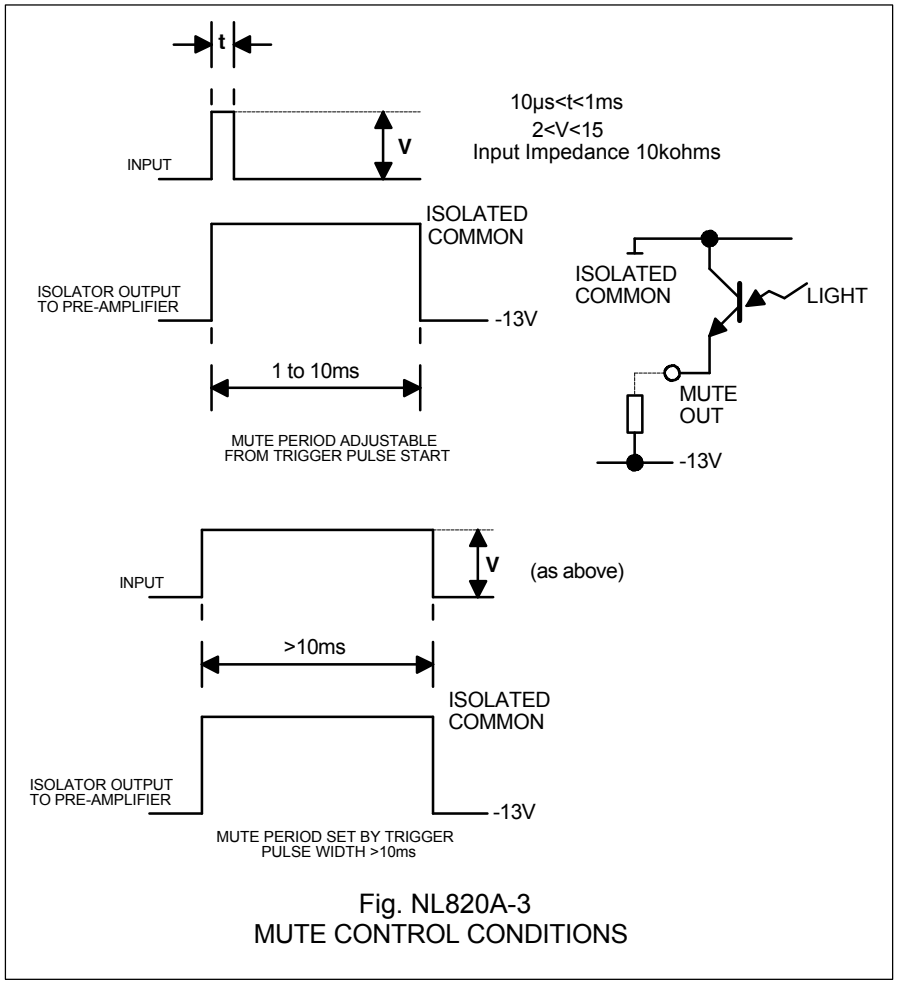


Fig. NL820A-3
MUTE CONTROL CONDITIONS

Fig. NL820A-3 illustrates the mute control requirements.

Safety

It should be self evident that by ensuring that a high impedance path is presented to any earth return current that could be present under fault conditions, the NL820A will provide a higher order of electrical safety than conventional amplifier components.

Care should therefore be taken to preserve the isolation barrier created within the NL820A module by avoiding any unintentional ground connection to the amplifier inputs or isolated power supply. At 50/60Hz power line frequency the impedance present between the input circuit common terminal and supply ground is of the order of 100M ohms due to the leakage capacity specified at less than 35 pF.

NL820A Edge Connector

No.	Function
1	not used on NL820A
2	channel 1 out
3	channel 2 out
4	not used on NL820A
5	channel 3 out
6	not used on NL820A
7	+15V
8	keyway
9	0V
10	not used on NL820A
11	channel 4 out
12	+5V
13	-15V

Specification

Isolation:	Voltage	- ±2,500 volts DC or DC plus peak AC
	Capacitance	- 35pf
	Resistance	- 10k Mohms (10^{10} ohms)
	Ground signal attenuation	- 2 x signal frequency Hz/10^{6} (approx.)
	See Fig NL820A-2 for definition of isolation measurements.	
Gain:	x1, x2, x5 - accuracy ±3%	
Input:	Amplitude	- ±1 volt linear range; ±10 volts absolute
	Impedance	- 10k ohms
	Bias current	- less than 50 nA
	Noise	- less than 4 mV at 150 kHz
	Offset	- less than 10 mV
Output:	Amplitude	- ±5 volts maximum, dependant on gain setting
	Frequency response	- DC to 15kHz (-3dB point)

Isolated Power: ±13 volts nominal un-regulated, current maximum ±40 mA, output impedance 35 ohms nominal

Input Power: +15 volts regulated at 45 mA, -15 volts at 40 mA, +5V at 100µA (from NL900). Add 1.2mA for each 1mA of Isolated power used. +15V @ 93 mA, -15V @ 88 mA, +5V @ 100µA for max. isolated power specified

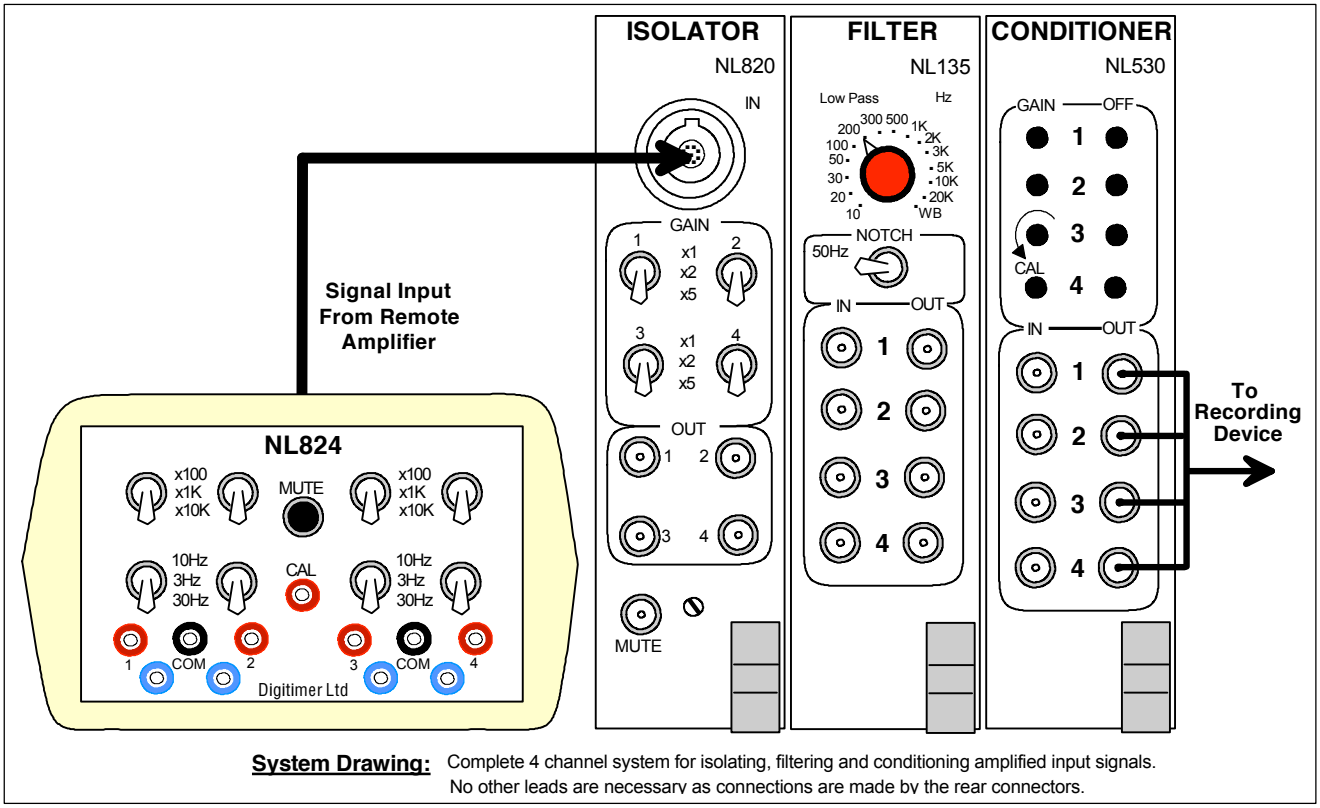
Refer to NL822 and NL824 data sheets for suitable pre-amplifier modules.

Optional Accessories

NL969P 9-way plug to mate with NL820A. (As used on NL822 and NL824 leads)

NL969S 9-way socket to mate with NL822 and NL824. (As used on NL820A front panel)

NL969T "T" adaptor connects 2 x NL822 into a NL820A for 4-channel use.



System Drawing: Complete 4 channel system for isolating, filtering and conditioning amplified input signals. No other leads are necessary as connections are made by the rear connectors.

Last Revision: March 4, 1998
File Reference: N:\DOCS\COMPANY\MANUALS\NEUROLOG \ NL820A.SAM

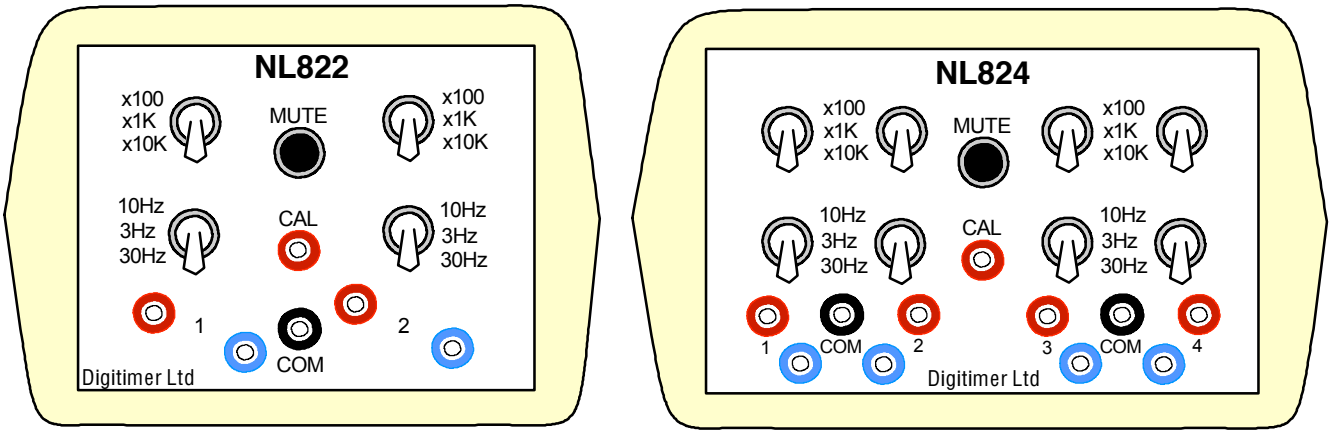
NL822 - 2-Channel AC Pre-Amplifier
NL824 - 4-Channel AC Pre-Amplifier
Multi-Channel, AC coupled, Miniature Low Noise Amplifiers

Introduction

The **NL820A ISOLATOR** is the module at the heart of the **NeuroLog™ System** Isolated Amplifier range of components that meet, or exceed, the BS5724 and IEC601-1 patient leakage specifications.

The **NL822** and **NL824** miniature, low-noise, AC coupled (or NL832/834 DC) pre-amplifiers complete the system.

General Description



The NL822 and NL824 units are low noise differential AC pre-amplifiers with simple three step control of gain and low frequency cut-off point. High frequency response extends to 30kHz and no control of cut-off point is provided. The designs provide high common mode rejection of signals from DC to frequencies in excess of 1kHz.

The **NL822 AC Pre-Amplifier** provides two differential amplifier channels with a common terminal and a built-in 100 microvolt calibration signal.

The **NL824 AC Pre-Amplifier** has four differential amplifier channels referenced to a common terminal with 100 microvolt calibration facility.

Both units have a mute facility for suppression or reduction of overload artefact signals. This can either be operated by a push button on the front panel or, when used with the NL820A ISOLATOR, triggered from an electrical signal to provide an automatic mute feature.

Power supply to either unit will normally be provided by an isolated supply system within the **NeuroLog** NL820A ISOLATOR module from supply rails of ±13 volts nominal. A 9-way plug fitted to a three metre length of cable provides for supplies, channel outputs and remote mute control.

Stand-alone use

The NL822 and NL824 will operate from DC supplies in the range ±10V to ±15V but it must be remembered that the unit will not isolate the signals unless a specific isolation stage is used.

Specification

Gain

x100, x1000, x10,000 selected by 3 position toggle switch each channel separately adjustable. When used with the NL820A module with its 1:2:5 sequence gain control the full range covered will be x100 to x50,000 in 9 steps i.e. 10mV/V to 20µV/V.

Low Frequency

These amplifiers are AC coupled to remove electrode potentials and selection by 3 position toggle switch provides 3Hz, 10Hz and 30Hz cut-off frequencies. The amplifiers will operate with dc input differential voltages up to 200mV from the electrodes and common mode voltages in excess of 1 volt without affecting their AC performance.

Input Impedance

100M ohms each input to common.

Common Mode

The differential inputs provide a rejection ratio greater than -80dB (10,000:1) for frequencies up to 1kHz. Note when used with the NL820A ISOLATOR module signals present between mains ground and the NL822/824 input system are further reduced to give common mode rejection ratios greater than -120dB.

High Frequency

No adjustment of high frequency range is provided, the -3dB point is greater than 30kHz. When used with the NL820A module the overall system response reduces, but the -3dB is still greater than 10kHz. For adjustable bandwidth control the NL125/126 filters can be connected to the NL820A outputs.

Noise

When operated with inputs short circuited, over the full 30kHz bandwidth the noise is less than 5µV RMS. The low frequency noise from 3-100Hz is less than 1.5µV peak to peak.

Deblock/Mute

Operated by manual push button or remote logic trigger control through the NL820A. May be used to inhibit stimulus artefact effects - mute time adjustable over the range 1-10 milliseconds.

Calibrate

A square wave pulse is available from a front panel socket of 100µV amplitude at approximately 160Hz.

Connection

The amplifier channel inputs are 2mm sockets coloured red and blue to indicate relationship between input and output as follows. A positive input at the red socket will produce a positive output, a signal at the blue input will be inverted. The common signal return socket is coded black. Where a single ended input signal is to be amplified, then the un-used input (red or blue) socket should be linked to the common black socket.

Calibration

The 100 microvolt calibrate signal can be connected to any amplifier channel by linking from the calibrate socket to the appropriate red or blue input socket. The other input should be connected to the COMMON socket.

Connection

Fig. NL822-1 illustrates the output and supply connections provided via the 9-way plug to a matching socket. Normally when used with the NL820A ISOLATOR module the correct connections are made by inserting the plug into the socket.

The NL824 provides channels through to outputs 1-4 on the NL820A.

The NL822 connects channels 1 and 2 to outputs 1-2. A "T" adaptor (Part No. NL969T) is available for connecting two NL822 amplifiers to a single NL820A to drive outputs 1-4.

The information provided on Fig. NL822-1 will therefore only be required if an NL822 or NL824 is to be used without the NL820A in which case one, or more, matching socket(s) must be ordered (Part No. NL969S).

Pin No.	Function
1	Channel 1
2	Channel 2
3	Common
4	+13V
5	-13V
6	Common
7	Channel 3
8	Channel 4
9	Mute

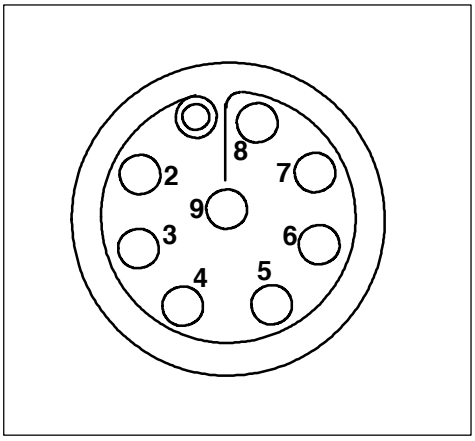


Fig. NL822-1

Operation

The NL822 and NL824 amplifiers are suitable for amplifying low level AC signals in the presence of large interference potentials from mains supply sources and DC potentials generated by electro-chemical action at electrode interface connections. They are particularly suitable for electro-physiological measurements, however it is still important that care is taken over input connections and wiring layout.

When recording differentially, electrode leads should be run close together and where possible twisted. Connection impedances should be as low as possible since although the amplifiers present a high input impedance, both noise and common mode rejection of power source interference will deteriorate with increased signal source impedance.

Similarly although the amplifiers are AC coupled there is a limit to the magnitude of any DC potential which can be applied to the input terminals without producing limiting effects on the signal. Accordingly good quality matched electrodes should be used to minimise these potentials.

Switch setting of gain and low frequency cut-off point are clearly marked on the front panel and can be adjusted by the user as required to suit the application. The sensitivity of any channel can easily be checked by connecting either input socket to the 100 microvolt calibrate socket whilst linking the un-used input socket to common.

When used with the NL820A ISOLATOR module the amplifier inputs are separated from ground by the isolation barrier existing within the NL820A. It is therefore important if this safety feature is to be preserved that accidental grounding of the input circuit is avoided.

The mute push button on the front panel provides for rapid resetting of the amplifier coupling components to minimise blocking effects following large "artefact" signals. It can also be operated immediately prior to any expected disturbance or external stimulus and will suppress the output whilst the button is held depressed.

Electrical operation of the mute facility is available via the NL820A module to maintain isolation of the amplifier inputs from the logic signal and ground. See the NL820A section of this manual for further details.

Some applications will require reduction of the amplifier bandwidth to enhance the signal/noise ratio. Generally this requirement will be satisfied by reducing the high frequency response of the system. The filtering required will vary with application and has not been included in the NL822 or NL824 amplifiers in order to maintain small size. Where the system includes the NL820A and the **NeuroLog™** rack, the NL125 or NL126 can be used to give comprehensive continuous control of upper and lower frequency cut-off points. Low frequency cut-off is not usually required to be finely adjustable over such a large range and therefore in most applications the three step control switches provided for each channel will be adequate.

Multiple System

Two channel and four channel amplification requirements are covered by NL822 and NL824 units provided the input signals are relative to a common point with less than 1 volt common mode potential. If measurements are to be made from differing potential points then isolation will be required between these points and an NL820A signal and supply isolator will be required to operate amplifiers from each point. For example two channels referenced to point A and four channels referenced to point B. Potential between common points A and B 240V 50Hz.

Solution - One NL822 and one NL820A for point A system
- One NL824 and one NL820A for point B system

Where more than four channels are required, even though all are referenced to the same point, multiples of NL822 and NL824 units will be required and if isolation is required then one NL820A will be required for each group of four channels.

Dimensions

Size: NL822- 70 x 60 x 110 mm (W x H x D)
NL824- 90 x 60 x 155 mm (W x H x D)

Lead length: 2.5m (nominally)

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File Reference: N:\DOCS\COMPANY\MANUALS\NEUROLOG \ NL822824.SAM

NL900D - Case and Power Unit

The NL900 NeuroLog module frame and power supply are housed in a fully finished, enclosed case. The case has carrying handles and is supplied with bolt-on rack mounting hardware so that it can be located either in the rack or on the bench top. The base is fitted with rubberised feet and the front pair may be extended so as to raise the front of the unit. These are easily removed, if required, for rack-mounting.

The NeuroLog case has an integral module retention system, consisting of a simple, slide action lever on the power supply panel. Thus fittings such as retained screws, D-Locks, etc., on individual module front panels are unnecessary; this simplifies the modules mechanical design, reduces their cost and greatly improves the ease with which rapid changes in module arrangements can be made.

The NeuroLog power supply produces three voltages (+15V, +5V and -15V), stabilised against line and load variations. The voltage outputs are rated at 650mA, 3.0A and 650mA respectively. All three supplies have internal "fold-over" current limiting; the 15V supplies, in addition, are protected with series fuses. Each supply has less than 15mV line ripple at maximum load. The power supply transformer employs sectionalised Winding former for additional safety and complies with the safety requirements of BS EN 60601-1 but is NOT listed as a Medical Device. The power supply provides sufficient power for any mix of single width NeuroLog modules, plus up to 2 NL750 Averagers.

A unique feature of the NeuroLog power supply is a built-in monitoring circuit which indicates (by extinguishing the power supply indicator on the front panel) excessive loading of one or more of the three supply outputs. While it is expected that a power supply failure will never occur using NeuroLog modules, the fault indication is invaluable when testing custom circuits built in the NL50 Blank Module.

The NL900 is the heart of the NeuroLog system being the rack to house the modules as well as providing the power for them to function. It also has a unique interconnection system that allows adjacent modules, in most cases, to pass signals between each other without the need for external cables.

The NL900D is the latest in a long line of NL900's. The design changes over the years have been due to obsolescence of parts or specification changes - BUT, all modules ever made will fit and work in all racks produced.

Unpacking Your NL900D

Your NeuroLog™ System was delivered in a carton which was carefully designed to protect the NL900D case against damage in shipment. It would be advisable to keep your carton in case you need to relocate or return your NeuroLog™ System some time in the future.

Mains Connection

The power lead should be connected to a suitable plug. The power lead is colour coded in line with international standards and must be connected as follows:

Insulation Colour	Function
Green/Yellow	Earth
Brown	Live / Line / Hot
Blue	Neutral

The Earth connection MUST be made.

Before the power unit is plugged into the mains, check that the voltage selector on the back of the case is set for the correct mains voltage. The appropriate voltage should be opposite the arrow. If incorrectly set, use a coin of appropriate size to rotate the centre of the voltage selector to align the arrow head with the correct voltage setting.

Supply range	Fuse Value and speed
100-120 V ac	T 2A L
200- 240 V ac	T 1A L

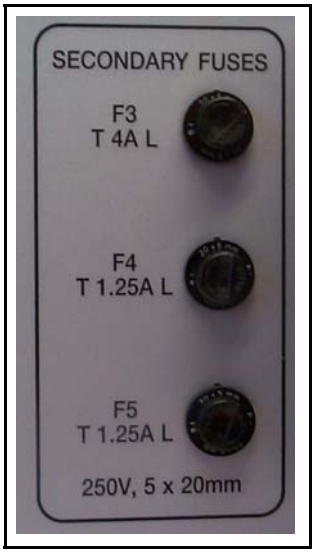
Changing the mains voltage will also require you to change the two fuses in the mains inlet. They must be “5 x 20 mm” in size and the value and speed shown here.

Grounding

The Earth or Ground connection in the mains lead is continuous with the ground points on all module connectors and with the case. No provision is made for opening the connection between the case ground system and the mains earth lead.

Power Unit Protection

The power unit supplies three stabilised voltages, +5V, +15V and -15V each of which is completely protected against excessive load with its own internal 'current fold-over' circuit which can sustain an indefinitely long short circuit.



Each of the supplies is also protected by fuses, fitted to the rear panel, which protect the power transformer against a gradually applied overload. A suddenly applied overload may not blow a fuse before the fold-over protection circuit acts.

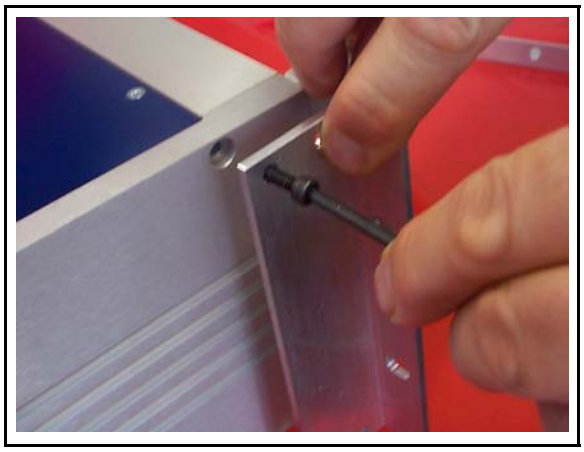
Fuse Ref:	Supply Protected	Fuse Value and speed
F3	+5V	T 4A L
F4 & F5	±15V	T 1.25A L

The indicator light on the case front panel is illuminated when all three power supplies in the power unit are operating with correct output voltages. If the indicator does not light when the mains power is switched on (POWER switch on the front panel), either one of the supplies is faulty or an overload condition exists.

A module malfunction or faulty circuits constructed on the BLANK MODULES (NL50) may be the source of the excessive power unit load. Identify and remove the overload; if the indicator is still unlit, check the fuses.

Rack Mounting Brackets.

A pair of rack mounting brackets are supplied, as standard, with each NL900D. These need only be fitted to the NL900D if you wish to mount the unit in a 19" rack.



To fit these brackets you should locate the two recessed screws on each side of the rack, near the front. You should now decide which bracket is going on each side by offering up the bracket to the two screws to see if they align.

The existing screws should be used to retain the bracket and an "Allan-key" is supplied with the brackets to remove and refit the screws.

When the brackets are fitted, ensure that the screws are fully tightened as they carry the weight of the whole unit when it is in the rack.

You may find that you also have to remove the feet if you need to place the unit close to another unit in your rack. This is done by pulling out the rubber foot from the plastic moulding and then undoing the screw that holds the moulding to the case bottom plate.

Support Feet

To raise the front of the unit when it is mounted on a bench-top, the front feet can be lowered. This is done by lifting the front of the case up by about 75mm and pulling down the leg.

When fitted into a 19" rack, you may wish to remove these feet totally. This is done by removing the rubber feet that would normally rest on a bench, then removing the screw that is fitted into the recess. The nut is fixed to the bottom plate and will not become loose. The feet should be kept safely in case they are needed later.

Module Lock and Module Insertion

The case is fitted with a sliding bar for retaining the modules. This retaining lock is operated by the knob at the top of the case front panel. A module is inserted into its guides until its front panel is within about 10mm of the front of the case. The locking knob is pushed sideways to the right (towards the UNLOCK position) about 5mm.
The module can then be pushed the rest of the way into the case and the locking knob returned to the LOCK position. If each module is not pushed firmly home, the movement of the locking slide will be impeded. Do not use excessive force in pushing the locking knob against its mechanical stops. Do not try to force the modules into or out of the case without operating the lock.

IMPORTANT: Do not put heavy objects on top of the NeuroLog™ case since this will bend the case frame, making the insertion and withdrawal of modules difficult. Even slight distortion of the case results in impaired operation of the module retention bar.

Switching the Mains Power On

The NL900D power switch should be switched on BEFORE connections are made to biological preparations. Failure to disconnect the preparation before switch-on may result in some ground current flow (of the order of a few micro-amps) through the preparation while the supplies settle.

Analogue Versus Logic Modules

NeuroLog™ modules can be grouped together according to the kinds of inputs and outputs they require. Some require analogue voltages, varying from micro volts to volts. Others are designed for standard TTL (Transistor-Transistor Logic) signals.

Examples are -

Modules Requiring Analogue Voltages	Modules Designed for Standard TTL Signals
NL100AK Headstage	NL301 Pulse Generator
NL102G DC Pre-amplifier	NL304 Period Generator
NL104A AC Pre-amplifier	NL401 Digital Width
NL125-126 Filters	NL501 Logic Gate
NL800 Stimulus Isolator	NL603 Counter

The NL201 Spike Trigger and the NL515 Interface modules, for example, provide analogue to logic interfaces, converting analogue inputs into TTL pulses which can be utilised by other modules. Other modules convert in the opposite direction (e.g. the NL510 Pulse Buffer converts TTL pulses into 'analogue' pulses which can be used to drive relays, provide voltage stimulation, etc.).

Logic Signals

As TTL is a binary system, each TTL input or output must be within one of two narrowly defined voltage ranges - unlike analogue inputs or outputs which can vary continuously between specified limits. A binary 1 (or logic high) in TTL has a voltage range between +2.4V and +5.0V; a binary 0 (or logic low) occupies the range between 0.0V and +0.8V.

A TTL output provides a low resistance shunt to ground, typically 220 to 300 ohms when it is at logic low (i.e. 0 to +0.8V) level. Other pulse sources, such as non-TTL signal generators may not provide this current sinking path to ground and therefore may require some modification in order to be used to drive TTL inputs. The scheme illustrated below will work for a variety of positive pulse trains:

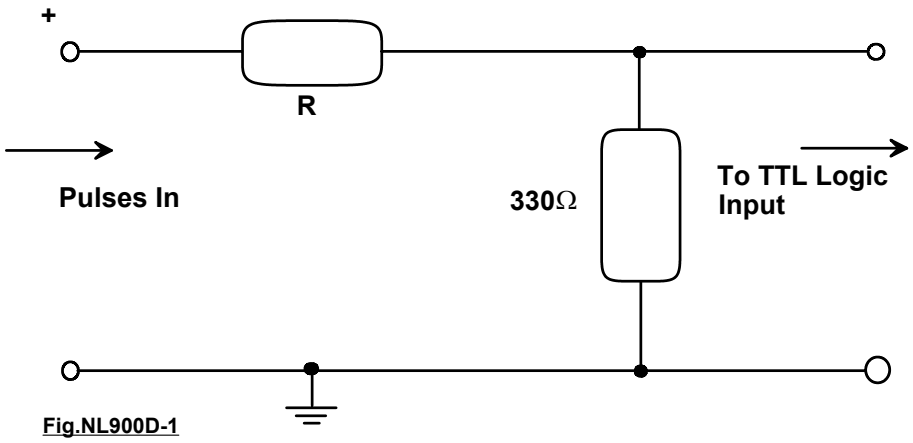


Fig.NL900D-1

The value of 'R' depends on the nature of the circuit or instruments providing the positive pulses. The maximum voltage at the TTL input must not exceed +5.5V, but must be at least +2.4V at logic high levels, and the rise times of the pulses at the TTL input must be fast (typically less than 100nsec). Thus if the positive pulses have a 12V amplitude,

$$R = \frac{(12-5.5)}{5.5} \times 330\ ohm = 390\ ohm$$

or 1kohm maximum for +3V logic level. Check that the resistor network is not loading the pulse generator by examining the pulse amplitude at the TTL input. 'R' may require adjustment accordingly. Some pulse sources may not be able to supply sufficient current to achieve the +2.4V high logic level into 330ohm.

Logic inputs should not have negative voltages or positive voltages greater than +5.5V applied to them. Although the input circuits may not necessarily be damaged by exceeding these limits, every effort should be made not to connect analogue outputs to logic inputs (e.g. the NL104A AC Pre-amp output, which can vary between ±13V should not be connected to the NL603 Counter input). Similarly, TTL outputs are intended to drive TTL inputs, either those of NeuroLog™ logic modules or inputs of other equipment which accept standard TTL signals. The logic modules should not be used to drive high capacity loads (e.g. connecting a logic output to a remote piece of equipment through a long piece of screened cable is a high capacity load) or used to drive apparatus not specifically designed for TTL levels (e.g. the NL301 Pulse Generator should not be connected directly to a preparation for voltage stimulation, or be used to drive large relays, etc.).

Any NeuroLog™ TTL output will, in general, drive any 10 NeuroLog™ TTL inputs in parallel.

Module Interconnection : Internal Interconnection

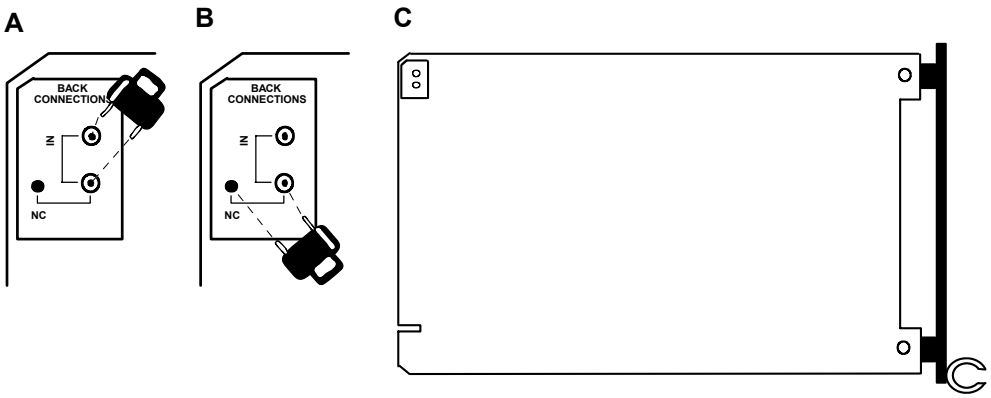


Fig. NL900D-2 shows the input jumper arrangement for a typical module. In A the jumper is being placed so that the input of this module will be connected to the OUTPUT of the module in the adjacent bay at its left. In B, the jumper is being placed in the 'no connection' or NC position so that its input is NOT connected to the output of the module at the left.

The printed circuit board at the back of the module bay in the case contains edge connectors which supply power to each module. These connectors also link the inputs and outputs of adjacent modules via conductor tracks on the printed circuit board. This arrangement reduces the number of external cable connections required (e.g. many simple system configurations only require cable connections to the preparation and monitoring instruments). Internal interconnection can only be made between adjacent modules - internal interconnections cannot be made, for example, between the output of the first module and the input of a module in the 5th bay.

Some inputs and outputs have not been brought back to the module edge connector because these would not normally be connected to other modules (e.g. the output of the NL120 Audio Amp is intended to drive a loudspeaker; the NL104A AC Pre-amp input is normally connected either to the NL100AK Headstage or directly to a biological preparation, etc.).

Because many modules have multiple inputs and outputs, internal interconnections must be 'programmed'. Inputs which are to be connected through the edge connector are selected (or programmed) by making electrical connection between pairs of 1mm sockets on module printed circuit boards. These sockets are located at the back top corner of the board. To effect connection, two sockets are bridged by the black 'jumper' plug supplied. The pin sockets are labelled (in some modules on the conductor side, in others on the component side of the PCB) to indicate the associated input or output. (Input sockets and jumper always form the top group when both input and output jumpers are present). Each jumper can also be placed in a neutral position with one of its pins in a PCB hole lacking a socket, so that no connection is completed through the edge connector.

Many NeuroLog™ modules have jumpers for outputs as well as inputs if they have more than one output (e.g. GATE, UPPER and LOWER outputs for the NL201 Spike Trigger). The jumper is used to select which (if any) of these outputs are relayed to the neighbouring modules. If there is only one output in a particular module available for connection through the edge connector, it is usually connected directly to the edge connector. Such outputs will automatically be connected to the inputs of the right adjacent modules, unless the input jumpers on the right adjacent modules are open-circuited by placing them in their neutral position. See Fig. NL900D-2.

If the output of one module is connected internally (back-connected) to the input of the module in the next bay to the right, two front panel sockets become available for additional parallel connection. Each of these (the output socket of the left module and the input socket of the right module) are connected together internally. External cable connections can be made to these, either for joining the output to more than one input, in parallel (e.g. the output of the NL304 Period Generator might be connected to the inputs of 2 or more NL403 Delay Width modules), or for making connection to monitoring equipment such as oscilloscopes or recorders.

IMPORTANT: Some caution is necessary with this back connection system due to the ease with which two outputs can be connected together at a single input. If the input drive for one module is supplied through a cable connection to the input socket on the front panel and the module bay to the left has a module in it, the possibility exists that two outputs (one through the cable, the other via a back connection) will be joined. This can be avoided by putting the input jumper of the module receiving the external input drive in its NC (no connection) position. Permanent damage is unlikely to result from the accidental parallel connection of outputs, but the system, so connected, will not operate correctly. When assembling a system, exercise care that only one output is connected to each input (though, of course, up to ten inputs can be connected to a single output).

WARNING: If some modules in an assembly operate incorrectly, check to see that the back connections are the intended ones; failure to correctly set back connection jumpers is the most frequent cause of NeuroLog™ Systems not 'doing what they are supposed to do'. When there appears to be a malfunction in the new arrangement of modules, check each back jumper.

Front Panel Connections

Connections through the coaxial sockets on module front panels should be made with screened coaxial cables fitted with appropriate mating male plugs. These plugs are high quality, precision components and are therefore relatively costly.

The particular connectors chosen for the NeuroLog™ System are standard in new nuclear instruments (the CAMAC module system), replacing the BNC connector. It is expected that connectors like those used in the NeuroLog™ System will eventually become standard on other instrument ranges. By providing the internal connection system, the total number of cables necessary in a typical system arrangement has been reduced to a minimum.
It is vital that the cables used to make external connections in the NeuroLog™ System are made with high quality screened wire. This will minimise interference and pick-up. The rise times of TTL pulses are much faster (a few nanoseconds) than those produced by equipment found in the past in Physiology Laboratories and greater care must be taken to preserve clean signals. Patching with fine, unscreened wire pushed into input and output sockets, for example, is unsatisfactory.

Rear Panel Connections - Non-counter modules.

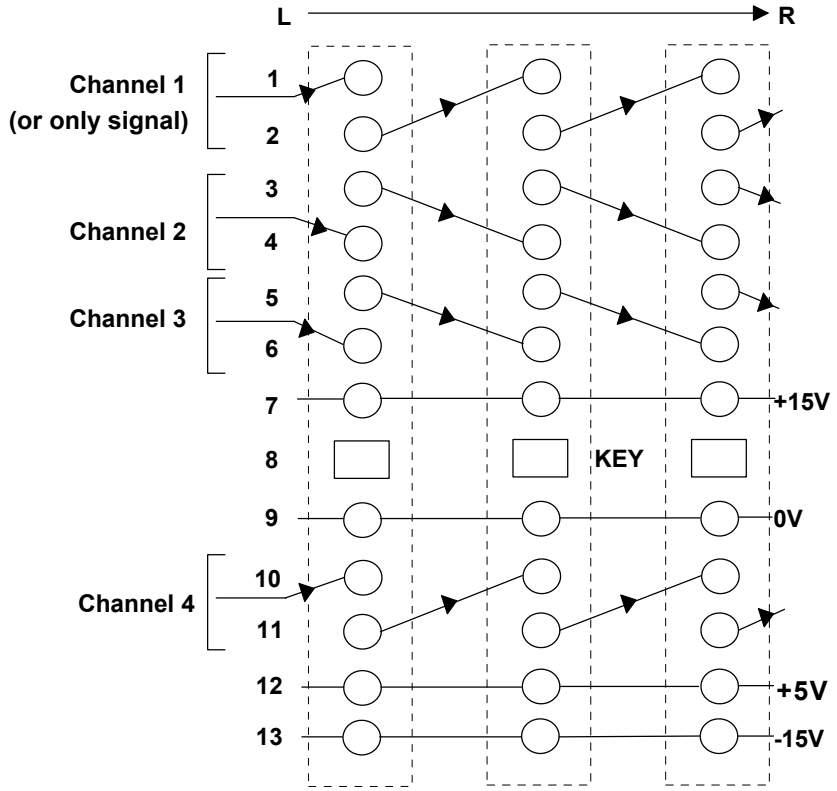


Fig. NL900D-3a. NeuroLog™ Module Edge Connector System, as used for non-counters. View from front.

Rear Panel Connections - Counter modules.

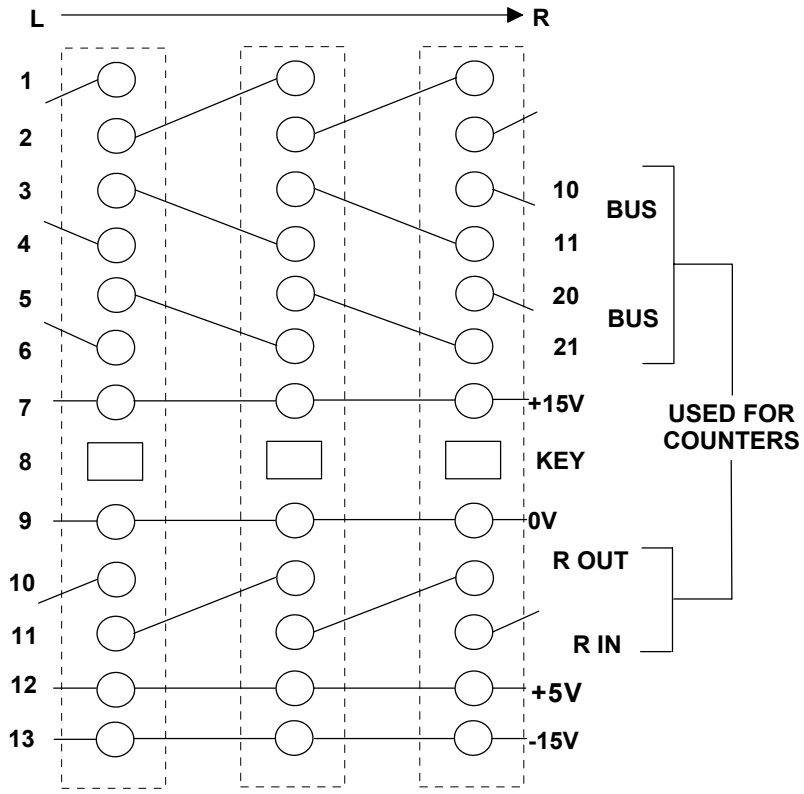


Fig. NL900D-3b. NeuroLog™ Module Edge Connector System, as used for counters. View from front.

History

The NL900D is the latest in a long line of NL900 models. The design changes over the years have been due to unavailability of parts or specification changes - BUT, all modules ever made will fit and work in all racks ever produced.

The different models can be identified from the Serial Number label and (usually) the printing on the rear panel.

Model	Case style.	+5V Power Supply
NL900	Original design with a pale blue top cover retained by four screws.	5A and regulated by transistors.
NL900A	Same case as above.	Regulated by 5A regulators.
NL900B	Same case as above.	Regulated by 3A regulators
NL900C	Second design of case. The top cover was a light grey colour with pale blue insert strips. Access from the top is NOT possible. The rack-mounting brackets fold flat to the side plates when not required.	Regulated by 3A regulators
NL900D	Third design of case. The top cover is royal blue with four retaining screws. This case has removable rack-mounting brackets.	Regulated by 3A regulators

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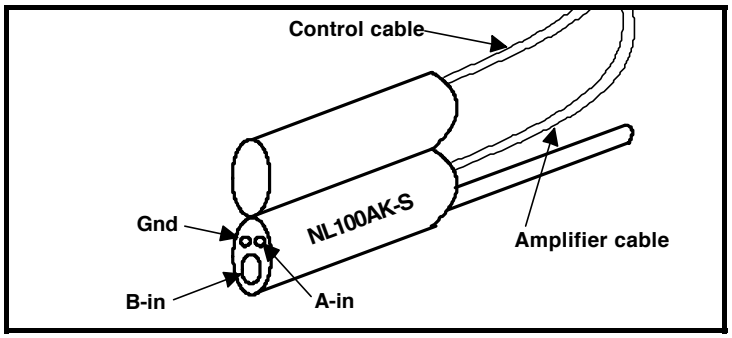
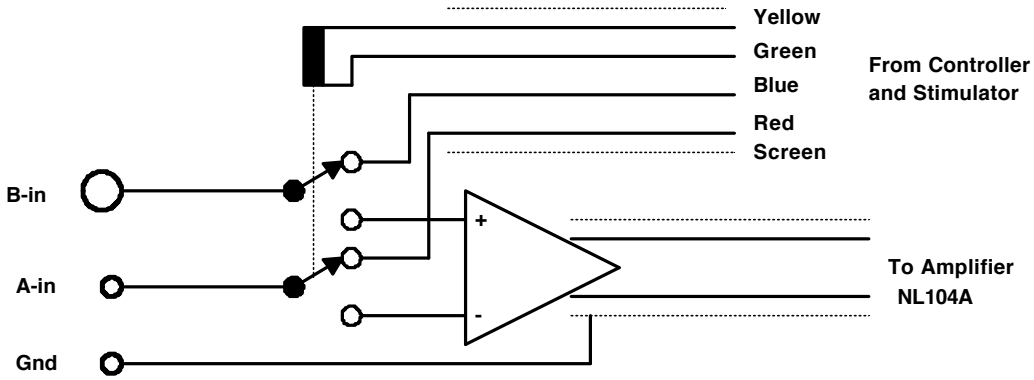
NL100AK-S

Introduction

The **NL100AK-S** is a standard NL100AK with the ability to stimulate through the recording electrodes. This is possible when an electrical signal is used to 'switch' the electrode connections from Amplifier input to Stimulator output. The circuit has been designed so that the switching only takes around 2ms.

This function is made possible with a change-over relay fitted in a second tubular housing mounted alongside the standard one.





NOTE: Relay shown energised

For more details of the Amplifier side of the NL100AK-S, please see the NL100AK section of this manual.

Control

The relay has a coil impedance of 98 ohms and should be controlled by a 6V signal (61mA) - the polarity is un-important and the relay will work between 4.25V (43mA) and 8V (82mA). The *NeuroLog* NL510 (set for 6V) is a suitable choice of controller. In the above drawing the circuit is shown with the relay energised. The screen of the control/stimulus cable should be grounded at the controller, as it is not connected at the headstage to reduce interference.

Stimulus

Due to the small size of the relay used, the Stimulus MUST NOT be active whilst the relay is switching. The range of stimuli should be limited to currents less than 1A and voltages less than 100V. The relay has a very low capacitance and a low contact resistance of 100 milli-ohms.

Last Revision: June 5, 1996
File Reference: NL100AKS.SAM

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