

X-1 HIGH SPEED DVM

Non-Linear Systems, Inc., Del Mar, Calif.

The information in this manual supplements the information received with each X-1 Digital Voltmeter.



Originator of the Digital Voltmeter

.005% Accuracy

Multifunction DC volts,
AC volts, Millivolts,
Ratio and Ohms

23 Millisecond readings

Five digits with a sixth digit
20% over-range

All Solid-State Reliability

Floating Input with High CMR

High Input Impedance

Manual and Automatic

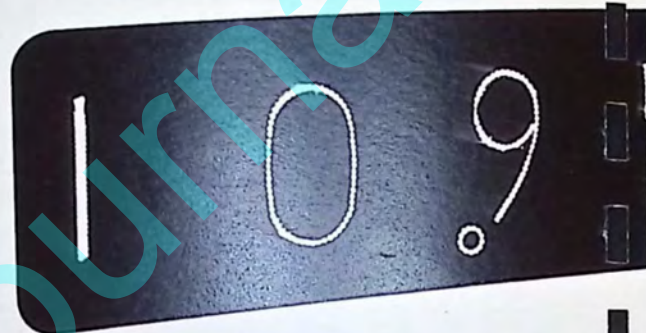
Remote Programming

High Resolution

Active Filter

Eight Range Ohmmeter

digital voltmeter



threshold



non-linear systems, inc.



digital

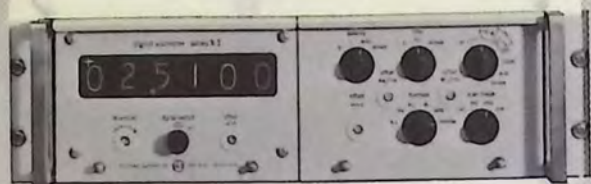
High Accuracy

**Multifunction
Capability**

Extremely High Speed

Over-Range

Reliability



**Exclusive Threshold
Control**

Range Hysteresis

**Range & Polarity
Memory Logic**

Scan Memory

High Common Mode

Low Cost Best Buy

$\pm (.001\% \text{ of Full Scale} + .005\% \text{ Reading})$

DC volts, AC volts, Millivolts, K Ohms, Filter, and Ratio, are all remotely programmable.

23 Millisecond readings as high as 43 readings per second.

Five digits, with sixth digit 20% over-range.

All solid-state, chopper-free circuitry, glass epoxy circuit boards, and the highest quality components available, assure the ultimate in trouble-free operation.

Features

Bobble or jitter in the readout, due to noisy signals, is eliminated in the X-1 by an exclusive *Threshold Control*. This unique feature maintains the error amplifier gain, and the accuracy of the instrument, yet eliminates bobble as effectively as if the amplifier gain were reduced. The *Threshold Control* allows the instrument to make a reading but inhibits a different reading until the input voltage differs from the first reading by a controlled number of digits. This number of digits may be varied from 0 to 10 by the operator, as required.

When measuring voltages close to the range change points there is no transfer indecision.

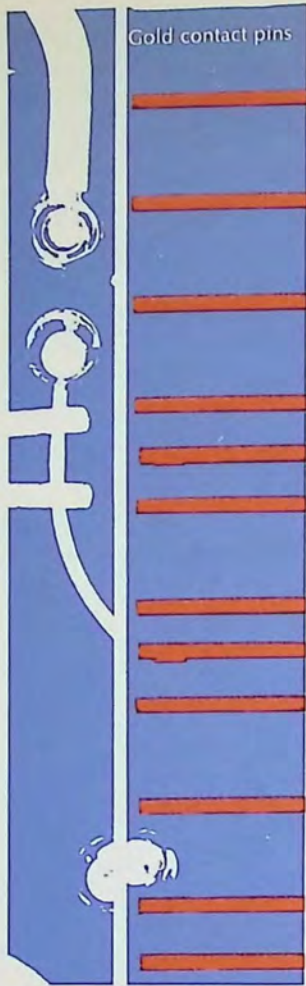
After each reading, range and polarity information is stored. If the same range and polarity applies to the next reading no time is lost in searching.

A circuit called the Scan Counter limits the number of range and/or polarity changes to four, preventing indefinite hunting in the presence of noisy input signals.

Greater than 140 db.

\$2,450.

The exceptionally low price of the basic X-1 Digital Voltmeter is the result of innovation in circuit design and packaging.



Gold contact pins



P.C. Department



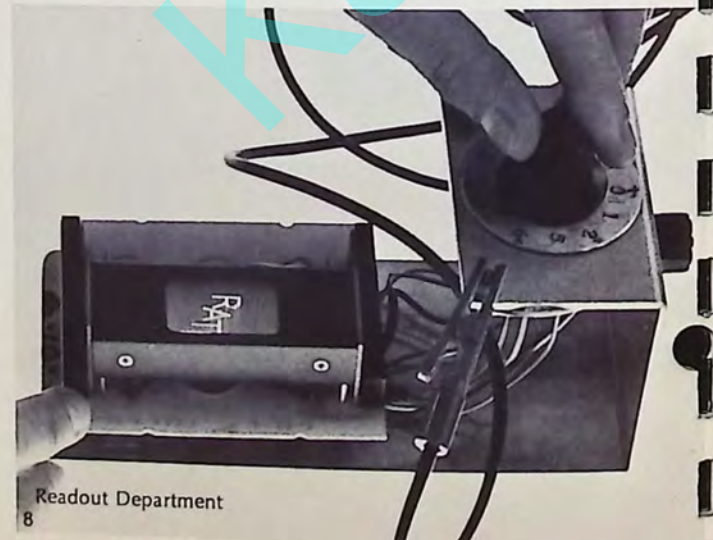
P.C. Department



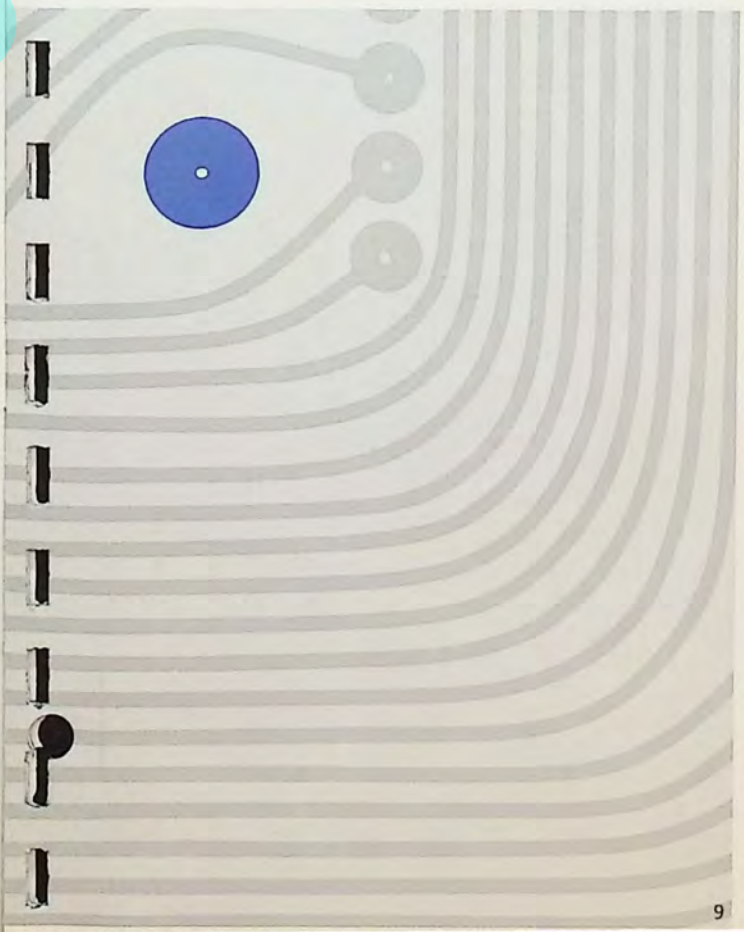
Components



P.C. Department

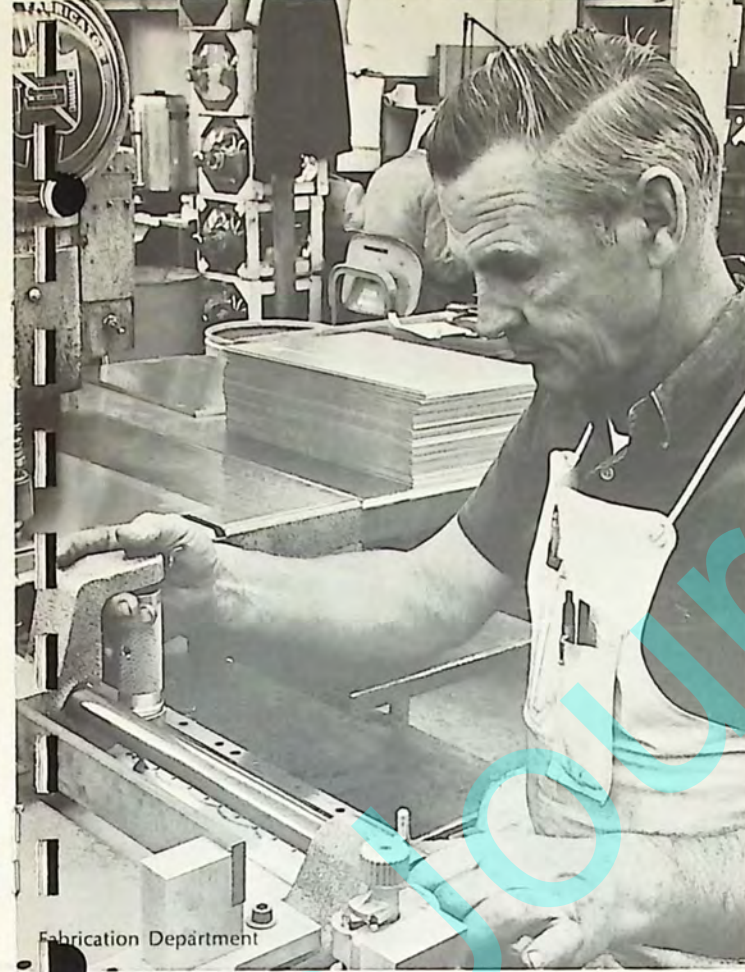


Readout Department





Transformer Department



Fabrication Department

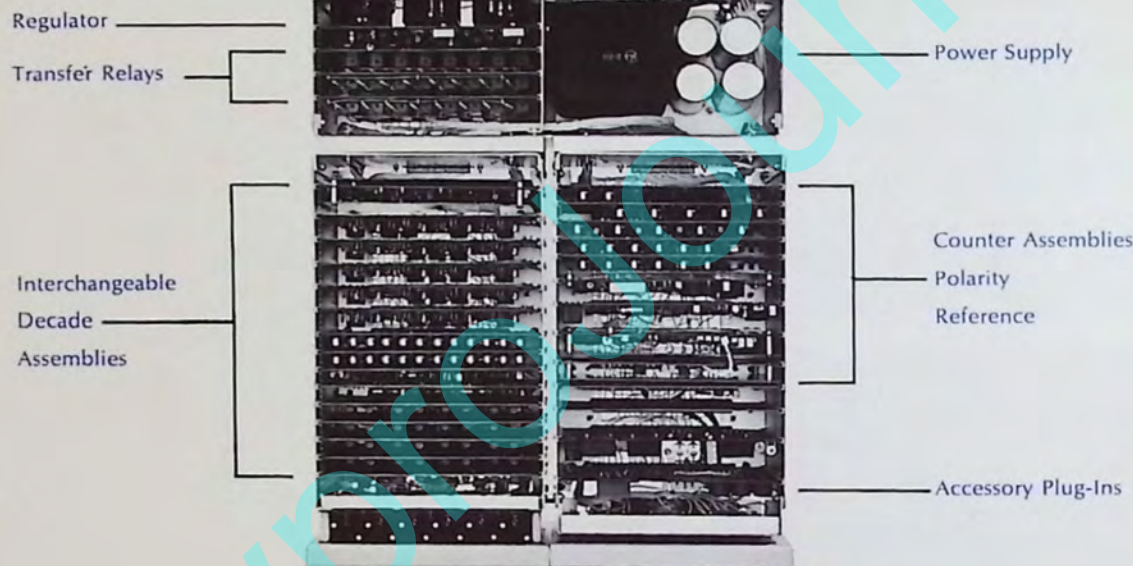


Precision Resistor Dept.

Non-Linear Systems fabricates all materials that are used in the manufacture of their digital instruments, with the exception of raw stock and standard components. Especially, the critical components such as *shielded power transformers*, *precision wire-wound resistors*, and reed relays are fabricated at NLS. Most important, their *precision voltage references* receive meticulous testing and aging to assure the user of a state-of-the-art digital voltmeter.

Non-Linear Systems in-plant capabilities not only insure high quality construction and performance, but provide instruments at the lowest possible investment. Reduced middleman cost makes it possible to produce the X-1 to sell at two-thirds the cost of competing instruments.

Three Drawer Modular Construction



The operational assemblies of the X-1 are housed in three separate, easily removed, slide-out drawers. The components within these drawers are mounted on plug-in circuit boards for easiest access and replacement. It is possible to keep the instrument operative with a minimum of downtime. Many plug-in boards are interchangeable. For example, logic and feedback voltage generator cir-



cuits, common to any one decade (readout window), are mounted on a separate board and four of the five decade boards, decade counters, decode assemblies and program counters are interchangeable. An NLS packaging innovation makes it possible to retain full guard shielding while eliminating the "thermos bottle" effects resulting from conventional box-within-a-box construction.

NLS designed the X-1 controls to meet a wide variety of needs and applications. Note that a number of controls are not combined on one knob! Each control is clearly defined, permitting the user to take full advantage of the instrument's inherent flexibility and accuracy.

Maximum Flexibility & Control

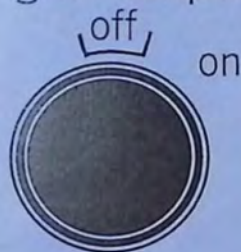
threshold



Threshold Control

Advancing the threshold control introduces "deadband" and provides immunity to noisy or unstable signals. This eliminates bobble in the righthand readout window. With this unique and exclusive control you can dial in up to ten digits of stability in the least significant decade, the extreme righthand readout.

digital output



Digital Output Control

Turning this control to the OFF position prevents acquisition of unwanted data in systems applications, while continuing to monitor the readout visually.

polarity



Polarity Control

MANUAL, AUTOMATIC, and REMOTE polarity can be selected. It enables the operator to match versatility and reading speed to the particular application (see Systems Applications Section).



Range Control

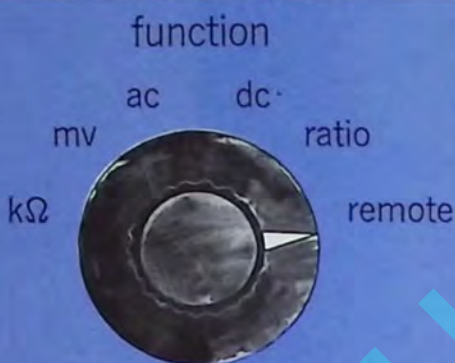
MANUAL, AUTOMATIC, and REMOTE ranging features also permit maximum flexibility and faster reading speeds. Unique RANGE MEMORY logic decreases over-all measuring time by eliminating needless ranging. Ranges and polarity do not reset to an arbitrary state but await the next input (see Systems Applications Section).

Maximum Flexibility & Control



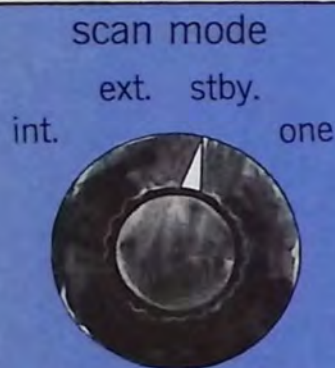
Filter Control

The filter attenuates excessive noise on the input signal *without impairing accuracy*. If high speed rejection is required, the NLS Active Filter option may be substituted.



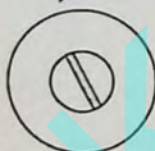
Function Control

DC volts, AC volts, Millivolts, K Ohms, and Ratio functions are manually or remotely selected.



Scan Mode Control is a result of NLS' 15 years experience in DVM design. On **INTERNAL** position, an internal clock causes continuous signal input sampling. In **EXTERNAL** position, readings are initiated by releasing the Trigger Hold—OFF. In **STANDBY**, the DVM is powered but cannot be triggered internally or externally. The last measurement remains stored in the display. The **ONE** position is spring-loaded and may be used to manually initiate a single measurement. Data record pulses are issued in **EXTERNAL** and **ONE** position.

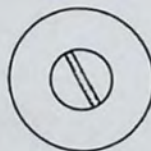
offset
ac / mv



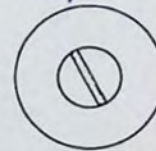
offset
plus



offset
minus



offset
kΩ / mv



Offset Controls

Screwdriver, front panel offset controls are zero adjustments provided to *cancel* out unwanted offset voltages caused by external ground loops, thermals, or transducers that do not reference at zero voltage. This is a much more practical approach than the use of external "bucking" voltages. For system applications requiring programmed offset control to reference unlike transducers to zero, contact our sales engineering group.

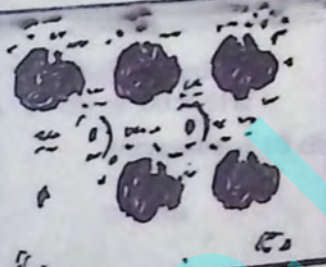
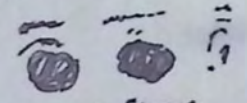


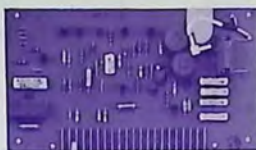
1
247



Speeds Available

068052





New NLS Active Filter For the X-1 DVM

CUTS READING TIME IN HALF
ELIMINATES FILTER "KICK-BACK" and
DOES NOT AFFECT ACCURACY OR INPUT IMPEDANCE
Two Speeds Available

The NLS 3-pole Active Filter is an operational amplifier circuit that shunts noise to ground without impairing signal accuracy. It is an optional replacement for the standard passive filter P/C card supplied on all meters, and is remotely or locally switchable as is the passive filter. It provides greater Normal Mode Rejection and increases reading speed by a factor of two. It also prevents filter "kick-back."

Normal Mode Rejection

High Speed	Low Speed
37 db @ $60 \pm .5\text{Hz}$	76 db @ $60 \pm .5\text{Hz}$
Increases at 18 db per Octave	

Settling Time

170 ms	750 ms
--------	--------

Configuration

3-Pole

The NLS Model X-1 Digital Voltmeter, using the Active Filter, exceeds the noise rejection capabilities of integrating DVM's when presented with transient noise or the normal slight variations in line voltage frequency. Using the NLS Active Filter, the X-1 faithfully measures DC voltages while very effectively rejecting both transient noise and line voltage ripple (even with frequency variations).

The two NLS Active Filters were specifically designed to maintain the X-1's great accuracy and to fill the need for combining fast response to DC voltages with high rejection of unwanted noise, regardless of whether the noise varies in frequency, is erratic, transient, or exceeds the peak limitations which are imposed by integrating DVMs.

Low Speed Filter

	NLS X-1	TYPICAL INTEGRATOR
Attenuation at $60 \pm .5\text{Hz}$	76 db	40.3 db
Attenuation at $300 \pm .5\text{Hz}$	120 db	56 db
Settling Time	750 ms	1000 ms

High Speed Filter

Attenuation at $60 \pm .5\text{Hz}$	37 db	26 db
Attenuation at $300 \pm .5\text{Hz}$	78 db	57 db
Settling Time	170 ms	167 ms

SPECIFICATIONS

AC Converter, Type I & II

RANGES: including
20% over-range

FREQUENCY RESPONSE:

ACCURACY: Type I

Type II

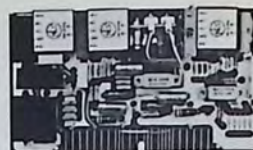
RESPONSE TIME:

COMMON MODE REJECTION:

INPUT IMPEDANCE:

RANGING:

Five Digit X-1
1.19999/11.9999
119.999 & 500.00 VAC



Type I



Type II

Type I: 50 Hz to 10KHz
Type II: 50 Hz to 100KHz

Lower frequency converters are available on special order.
The Type I converter is useable to 30KHz in the manual ranging mode.

0.05% reading or 0.02% FS, 200Hz to 3KHz
0.1% reading and 0.05% FS, 50 Hz to 200Hz
and 3 KHz to 10KHz. 30Hz accuracy is typically 0.3%.

Same as Type I, plus:
0.3% reading and 0.1% FS, 10KHz to 30KHz, 250 VAC
0.5% reading and 0.1% FS, 30KHz to 100Hz, 150 VAC

600 milliseconds to 0.1% of final value

120 db with up to 100 ohms in either lead, dc to 60Hz

One megohm, shunted by 100 pf

Automatic manual and remote ranging

SPECIFICATIONS

Preamplifier

RANGES:
(automatic, manual
& remote)

ACCURACY:

STABILITY:

**COMMON MODE
REJECTION:**

DC

AC (60. $\pm$ 5 Hz)

ZERO STABILITY:

INPUT RESISTANCE:

RESPONSE TIME:

x10 $\pm$ 0000.01 mv to $\pm$ 1199.99 mv
x100 $\pm$ 000.001 mv to $\pm$ 119.999 mv

Short Term $\pm$ (0.01% of reading + .01% FS)
Six Months $\pm$ (0.03% of reading + .01% FS)

Short Term $\pm$.01% FS
Long Term (see rated accuracy)

(with 100 ohms in either lead)

x10 Range 140 db
x100 Range 140 db

x10 Range 120 db
x100 Range 130 db

Not to exceed $\pm$ 5 μ v or $\pm$ 1 digit per week, whichever is greater

100 megohms, minimum, steady state
20K ohms, minimum, dynamic

1 second (to .01% of final value)
Range change (to 0.01% of final value)
1 second. Response increased by signal source resistance
greater than 10K ohms.



SPECIFICATIONS

Ratio

RANGES:
ACCURACY:

$\pm$ 1.19999/ $\pm$ 11.9999/ $\pm$ 99.999

0.001% of FS + 0.002% of reading
(short term, ASA Reference conditions)

Systems Applications

Remote Control (J-3) Remote control of the X-1 is performed by applying a nominal 12 volts at 9 ma to the appropriate pin of J-3 (see opposite page). A single scan is commanded by release of the TRIGGER HOLD-OFF RELAY, (A), for a minimum of 500 microseconds to a maximum of 7 milliseconds.

Data Output (J-4) Connector J-4 furnishes access to the data output, *Record and Read Command*. Function, Polarity, Range, and Digital output are presented by 1-2-4-8 BCD voltage levels or contact closures (as shown), as standard options. Different plug-in boards are used in the output section, depending upon the option, but the data is taken from the same pins in either case.

The voltage levels appears as: zero volts = true, -13 volts = false and are part of the floating circuitry. The contact closures are isolated and should be chosen if high common mode rejection is required.

Signal Input (J-1)

Sense Hi (Red Input Cable) Input connection for AC volts, DC volts, millivolts, ratio test voltage and signal lead of 4-wire K Ω function.

Sense Lo (Black Input Cable) Input connector for AC volts, DC volts, millivolts, ratio test voltage, ratio reference voltage (positive), signal lead of K Ω function.

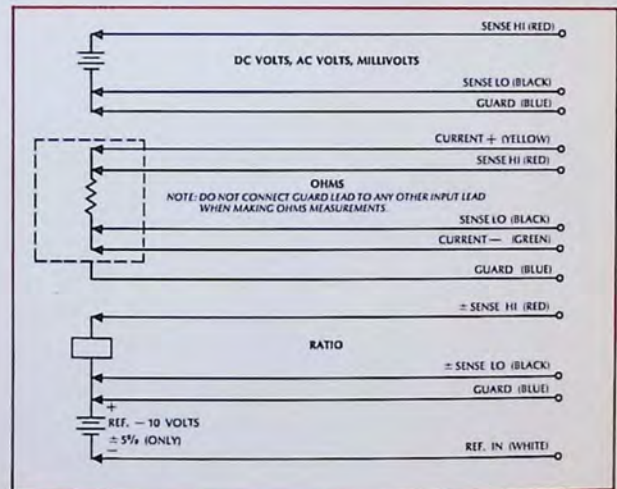
Current + (Yellow Input Cable)
- (Green Input Cable)

Ref. In (White Input Cable)
Ratio reference voltage (-10 volts $\pm 5\%$, only)

Guard (Blue Input Cable)
Connects to internal isolated shield.
For best CMR, connect as follows:

The contact closures require approximately one millisecond to settle; however, the *Record Command* (b) is normally delayed for seven milliseconds to assure dry closure. If speed is of prime importance, this time can be reduced to three milliseconds. The specification on the contact closure is as follows:

Power Capability	10 Millivolt @ .1A minimum 50 Volt @ .5A maximum Inrush .8A for 6 microseconds
Resistance	100 Milliohm, maximum
Insulation Resistance	5 x 10,000 megohms
Breakdown	300 volt peak

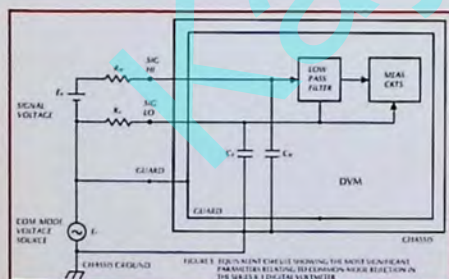


cont'd

NLS X-1 Specifications

Ranges:	DC Volts ± 11.9999 ± 119.999 ± 999.99 Including sixth digit, 20% over-range on two lowest ranges. Range and polarity may be controlled automatically, manually or remotely.
Resolution:	One digit
Absolute Accuracy:	Short Term: $\pm (.001\% \text{ FS} + .005\% \text{ of reading})$ Long Term: $\pm (.001\% \text{ FS} + .01\% \text{ of reading})$ (Six months)
Temperature Range:	12°C to 50°C (operative) -65°C to 70°C (storage)
Temperature Coefficient:	.0003%/°C
Response Time:	Input Buffer Response Time 10 Millisec Digitizing Time 6 Millisec Incremental Response Time 6 Millisec Full Scale Step Response Time 16 Millisec Range Response Time 30 Millisec Polarity Response Time 30 Millisec (Range and Polarity can change simultaneously) Data Transfer Time: Voltage levels 0 Millisec Relay closures 7 Millisec
Common Mode Rejection:	With 100 Ohm in Either Lead DC CMR Greater than 140 db AC CMR (60 Hz and below): Without Input Filter: Greater than 100 db With Input Filter: Greater than 100 db plus the attenuation ratio of the filter expressed in db

FORMULAS FOR CALCULATING AC COMMON MODE REJECTION OF DIGITAL VOLTMETERS



$$\text{AC CMR} = \left| \frac{A_F}{(R_L C_L - R_H C_H)} \right|$$

- A_F = attenuation ratio of input filter (unity for no filter)
 ω = 2π times the frequency of the common mode voltage
 C_L = effective capacitance between "Signal Low" and chassis ground (160 PF, max).
 C_H = effective capacitance between "Signal High" and chassis ground (2 PF, max).
 R_L = resistance in series with "Signal Low"
 R_H = resistance in series with "Signal High"

In decibels

$$\text{AC CMR db} = 20 \log \left| \omega \frac{1}{(R_L C_L - R_H C_H)} \right| + 20 \log A_F$$

attenuation
ratio of
filter in db

Normal Mode Rejection:

Passive Filter—37 db @ 60 Hz
 Active Filter, fast—37 db @ 60 Hz
 Active Filter, slow—76 db @ 60 Hz

Input Impedance:

10,000 Megohms, constant, 10 volt range
 10 Megohms, constant, 100 volt & 1000 volt range
 (in shunt w. 100 PF)

Warm-Up Time:

15 minutes to rated accuracy.

Barometric Pressure Range:

Operative to 10,000 feet (522 mm Hg)
 Storage to 50,000 feet (87.5 mm Hg)
 Tested per MIL-E-4970A (USAF)

Shock Resistance:

No damage when tested for Service Shock Test and Shipping Shock Test per MIL-E-4970A (USAF) referencing MIL-STD 202B.

High-Potential Resistance:

No damage when tested with 1000 volts DC between all inputs and outer case.

Radio Frequency Interference:

Conforms to the requirements of MIL-I-6181 for conduction, and susceptibility.

Power Requirements:

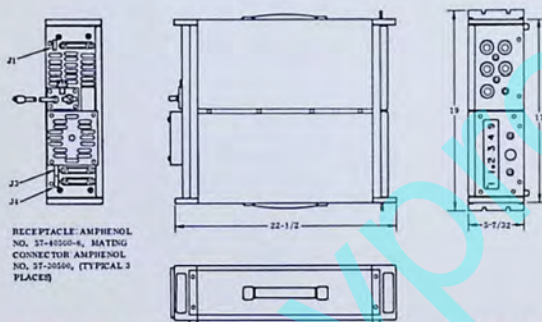
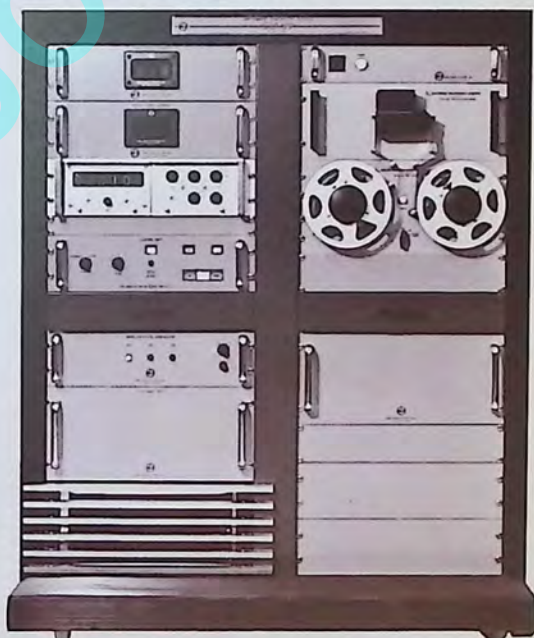
105 to 125 VAC, 50 to 60 Hz
 240 VAC and 400 Hz optional

Weight:

40 lbs, net—55 lbs, shipping

Accessories:

Rack mount adapters and Cables N/C

**Basic X-1****\$2450.00**

**For System applications, laboratory applications, accessory prices, and detailed assistance
 call your local NLS Applications Engineer**

Call collect or write



Non-Linear Systems, Inc.
 Del Mar, California 92014
 (714) 755-1134/TWX 910-322-1132

Represented by

Manual Polarity & Range
Remote Polarity & Range
Manual Polarity & Auto Range

Remote Polarity & Auto Range

Manual Range & Auto Polarity

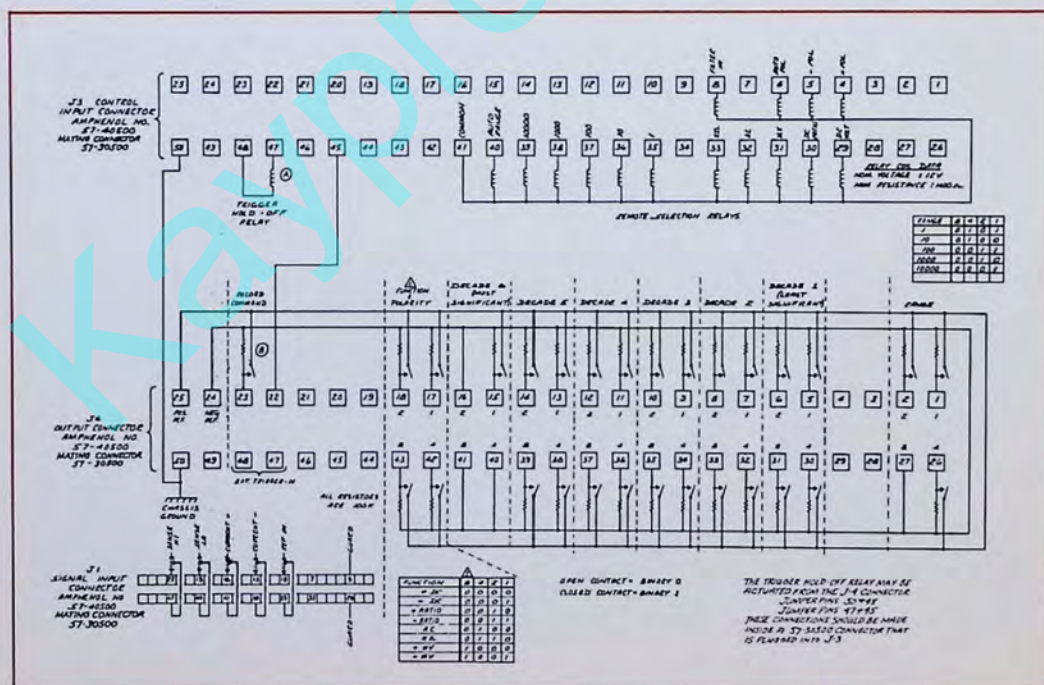
Remote Range & Auto Polarity

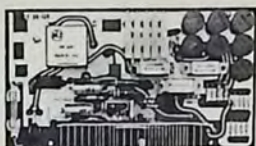
Automatic Range & Polarity

The averages shown above are the statistical means of time consumed for all possibilities.

The times above are those for a voltage level code to appear at J-4. When output closures are utilized, the relays will require an additional one to two milliseconds to settle.

When normal mode or common mode interference requires use of either of the three filters, their settling time must also be considered.





STANDARD OHMS CONVERTER

The Ohms Converter transforms the X-1 into a very accurate, very fast ohmmeter for measuring resistances between .01 ohms and 11.9999 megohm, with five-digit display from 100.000 ohms to 11.9999 megohm, with sixth digit 20% overrange.

Specifications

RANGE	ACCURACY	MAX CURRENT*
1.19999K Ω	$\pm (0.001\% \text{ FS} + 0.01\% \text{ of reading})$	10 ma
11.9999K Ω		1 ma
119.999K Ω		100 μ a
1.19999M Ω	$\pm (0.001\% \text{ FS} + 0.03\% \text{ of reading})$	10 μ a
11.9999M Ω		1 μ a
STABILITY	0.01% full scale for at least 90 days, except 0.05% full scale on 10 megohm range.	
RESPONSE TIME	100 milliseconds for step response. 200 milliseconds for step response with range change. 700 milliseconds on 10 megohm range.	
RANGING	Automatic, manual, and remote ranging.	
INPUT CONFIGURATION	Four-wire Kelvin, with voltage protection	MAXIMUM TEST VOLTAGE 16 volts

(*) Lower test currents available on special order.

SPECIAL EIGHT RANGE OHM/VOLTMETER .1 Milliohm to 100 Megohm Industry's First

No other instrument can give you X-1 high speed and accuracy, with this range of resistance measurements. This special instrument includes an Active Filter, a preamplifier, and the very special ohms conversion P.C. board, therefore, the instrument may be used for DC volts, millivolts, and ohms measurements and all with the high noise rejection advantages of the Active Filter. The AC converter may also be used.

Specifications

RANGE	ACCURACY	STABILITY (90 day period)	TEST* CURRENT	READING TIME	% of FINAL
11.9999Ω	± (0.001% FS + 0.05% of reading)	±0.02% of FS	10 ma	200 ms	.01%
119.999Ω	± (0.001% FS + 0.03% of reading)	±0.02% of FS	10 ma	100 ms	.01%
1.19999KΩ	± (0.001% FS + 0.01% of reading)	±0.005% of FS	10 ma	100 ms	.01%
11.9999KΩ			1 ma	100 ms	.01%
119.999KΩ			.1 ma		
1.19999MΩ	± (0.001% FS + 0.03% of reading)	±0.005% of FS	.01 ma	100 ms	.01%
11.9999MΩ	± (0.001% FS + 0.1% of reading)	±0.05% of FS	1 μa	700 ms	.01%
119.999MΩ		±0.05% of FS	.1 μa	5 sec	0.1%
RANGING	Automatic, manual, and remote ranging.				
INPUT CONFIGURATION	FOUR-WIRE with voltage protection.		MAXIMUM TEST VOLTAGE 16 volts		

(*) Lower test currents available on special order.