

## DATA SHEET

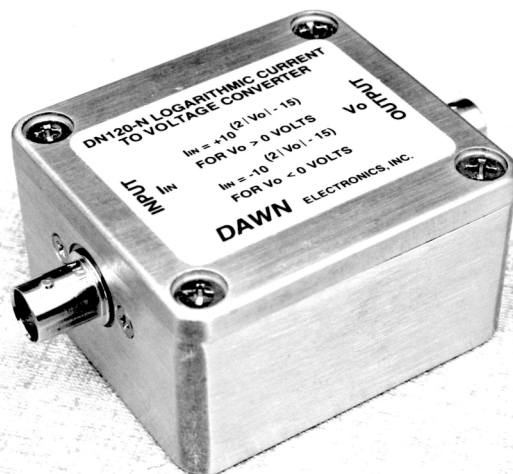
DN120N

### LOGARITHMIC CURRENT TO VOLTAGE CONVERTER WITH 220 dB DYNAMIC RANGE

The DN120N is a Logarithmic Current to Voltage Converter capable of measuring current from 1.0fA to 100µA without the need of changing ranges. This feature makes it possible to continuously measure current that changes many orders of magnitude in a short period of time. Loss of data during autoranging makes comparable measurements difficult in conventional instruments. The large dynamic range of the DN120N is made possible by an oven controlled matched pair of silicon diodes that make up the log element in this converter.

The output of the DN120N increases 0.500 Volts per decade increase in the input current. The equations relating the output voltage to input current are shown below. The resolution of the DN120N output is  $\pm 1\text{mV}$  which is 0.5% of the current being measured. An output voltage of 1.500 volt, for example, results from one pico ampere of input current. A variation of  $\pm 1\text{mV}$  in this 1.500 Volt output, therefore, indicates a  $\pm 5\text{fA}$  change in input current. The input offset voltage drop of the DN120N is less than  $200\mu\text{V}$ . This makes it possible to make accurate current measurements from circuits with very low voltage sources.

An offset current  $I_{\text{OFF}}$  can be programmed into the virtual ground input of the DN120N. This is illustrated in the block diagram for the device. This current is added to the input and is used to null or offset the input current when measuring very low current in the femtoampere range.



The DN120N is ideally suited for measuring the output of photodiodes, ion chambers, biological reactions of other applications where a large dynamic range of current must be measured. This device can be used in data acquisition systems where the output voltage of the DN120N is converted to a digital signal, processed, and displayed in accordance with the user's needs. Housed in a cast aluminum chassis, the DN120N operates from a single +5Volt power supply and has an operating case temperature range of  $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ .

### CONVERSION EQUATIONS

The equations relating the output voltage of the DN120N to the input current are shown below.

$$V_o = + \left\{ 7.5 + \frac{\log |I_T|}{2} \right\} \quad I_T = I_{\text{IN}} + I_{\text{OFF}}$$

$$\text{For } 10^{-4} > I_T > 10^{-15} \text{ A}$$

$$V_o = - \left\{ 7.5 + \frac{\log |I_T|}{2} \right\}$$

$$\text{For } -10^{-4} \geq I_T \geq -10^{-15} \text{ A}$$

Where  $I_{\text{OFF}}$  can be adjusted from zero to at least  $\pm 100\text{fA}$  by applying a voltage  $V_{\text{OFF}}$  from 0 to  $\pm 1$  Volts between Pin 4 and Ground (Pin 6).

$$I_T = +10 \quad (2 IV_o I - 15) \quad \text{For } 5.5\text{V} > V_o > 0$$

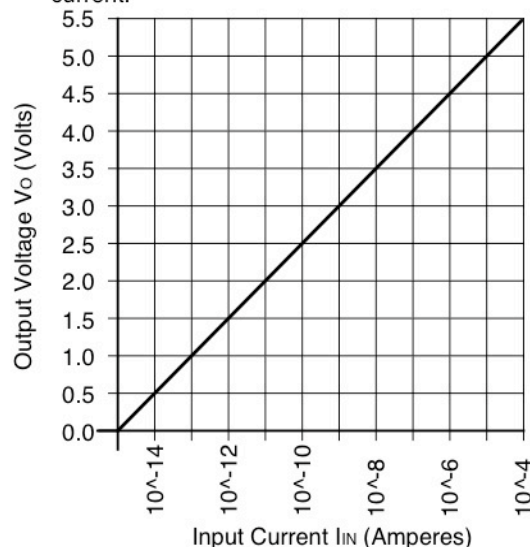
$$I_T = -10 \quad (2 IV_o I - 15) \quad \text{For } -5.5\text{V} < V_o < 0$$

### EXAMPLES

Measured Output Voltage ( $V_o$ )	Calculated Input Current $I_{\text{IN}}$ ( $I_{\text{OFF}} = 0$ )
+1.152 Volts	+201.4 fA
-3.725 Volts	-28.18 nA

### OUTPUT VOLTAGE ( $V_o$ ) vs INPUT CURRENT ( $I_{\text{IN}}$ )

This graph is shown for positive input current only. Negative output voltage occurs for negative input current.



The output voltage ( $V_o$ ) of the DN120N is zero when the input current ( $I_{\text{IN}}$ ) is less than  $\pm 1.0\text{fA}$ .

## SPECIFICATIONS FOR THE DN120N FROM +18°C TO +28°C

INPUT	OUTPUT	OUTPUT ACCURACY (± mV)	OUTPUT RESOLUTION	CALCULATED CURRENT ACCURACY	CURRENT RESOLUTION	RISE TIME (10% TO 90%)
10 fA	0.500 V	70 mV	1 mV	±4 fA	0.05 fA	30 sec.
100 fA	1.000 V	30 mV	1 mV	±15 fA	0.5 fA	5.0 sec.
1 pA	1.500 V	10 mV	1 mV	±50 fA	5 fA	1.0 sec.
10 pA	2.000 V	4 mV	1 mV	±200 fA	50 fA	150 msec.
100 pA	2.500 V	4 mV	1 mV	±2 pA	500 fA	15 msec.
1 nA	3.000 V	4 mV	1 mV	±20 pA	5 pA	1.5 msec.
10 nA	3.500 V	4 mV	1 mV	±200 pA	50 pA	150 µsec.
100 nA	4.000 V	4 mV	1 mV	±2 nA	500 pA	50 µsec.
1 µA	4.500 V	4 mV	1 mV	±20 nA	5 nA	50 µsec.
10 µA	5.000 V	4 mV	1 mV	±200 nA	50 nA	50 µsec.
100 µA	5.500 V	10 mV	1 mV	5 µA	500 nA	50 µsec.

The above measurements are made with a 20pF of shunt input capacitance.

**INPUT OFFSET VOLTAGE:** < 200µV

**OUTPUT IMPEDANCE:** < 100Ω From 0 TO 10KHz

**OUTPUT VOLTAGE:** 0 TO ± 5.5V with 5KΩ load

**MAXIMUM INPUT VOLTAGE WITHOUT DAMAGE:** ±40 VDC

**OPERATING TEMPERATURE RANGE:** 0°C to +50°C

**TEMPERATURE COEFFICIENT:** +18°C to 0°C and +28°C to +50°C (Increases the error of the above specifications by ± 0.1% per °C)

**OFFSET VOLTAGE ADJUSTMENT (V<sub>OFF</sub>):** A voltage

V<sub>OFF</sub> = ±1.0 Volts causes an output voltage of a least ±1.200 Volts an equivalent (I<sub>OFF</sub> = ± 250fA).

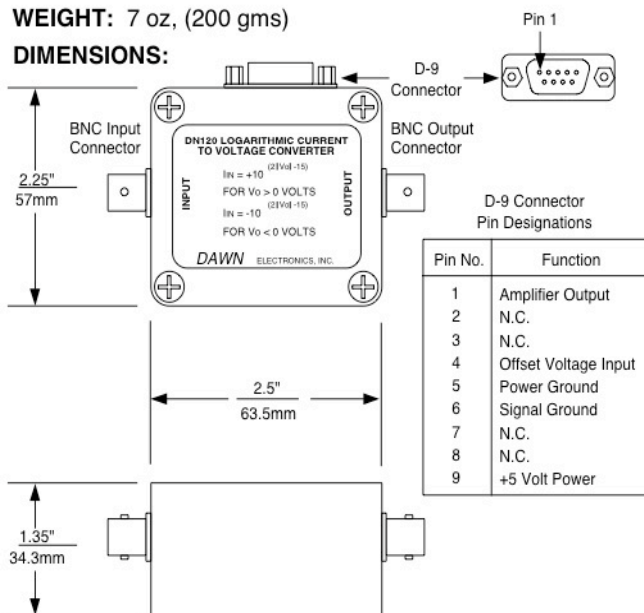
**POWER:** The DN120-N operates from a single 5VDC ±0.25V power supply capable of delivering 1.5A of current at turn-on. (DO NOT REVERSE THE INPUT SUPPLY VOLTAGE, OTHERWISE PERMANENT DAMAGE WILL OCCUR TO THE DN120N). This amount of current is required to regulate the temperature of the oven that houses the LOG element. The 5VDC is supplied from an external power source. There are many suppliers of 5 Volt modular power supplies that will work very well with the DN120N.

**WARM UP TIME:** Power must be applied to the DN120N for at least 10 minutes before the stated accuracies are met.

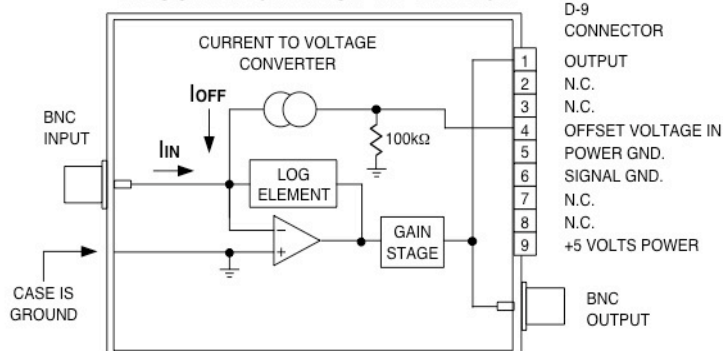
**CONNECTORS:** The input and output connectors are female BNC. All other connections, including an additional output, are made through a male D-9 connector. The pin outs are shown below.

**WEIGHT:** 7 oz, (200 gms)

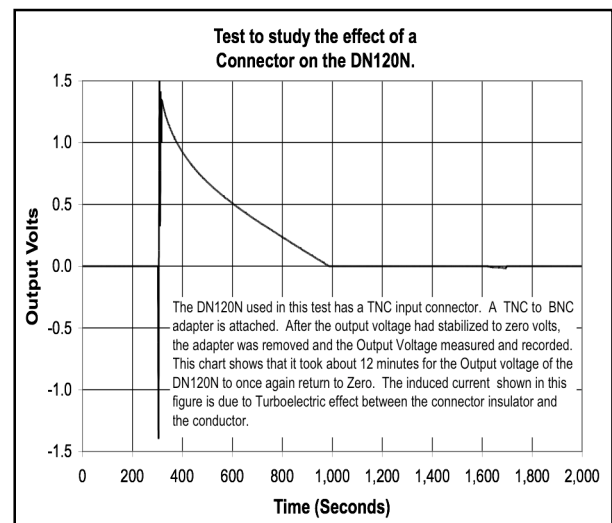
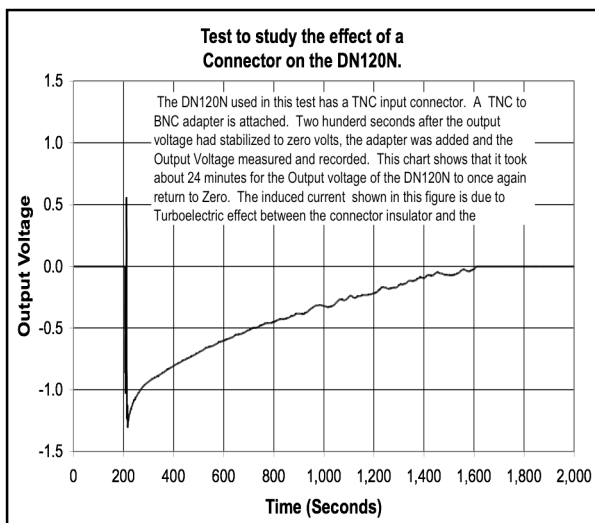
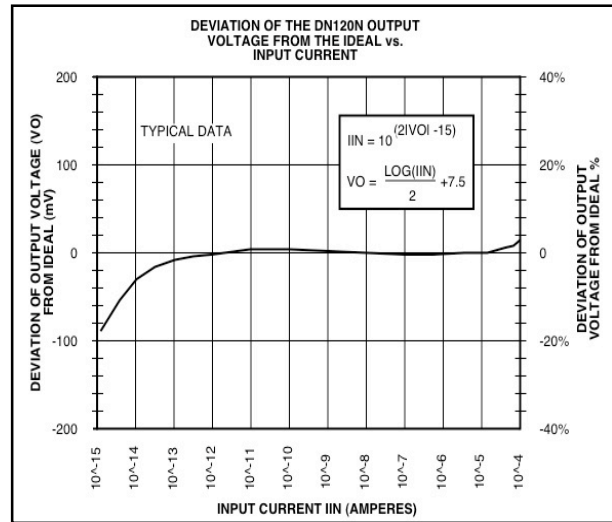
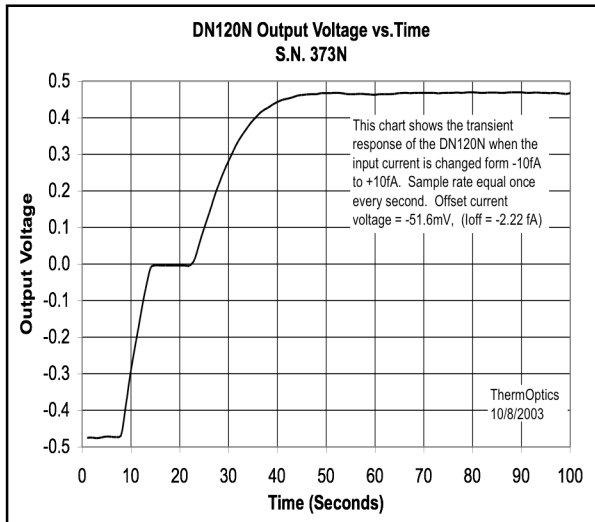
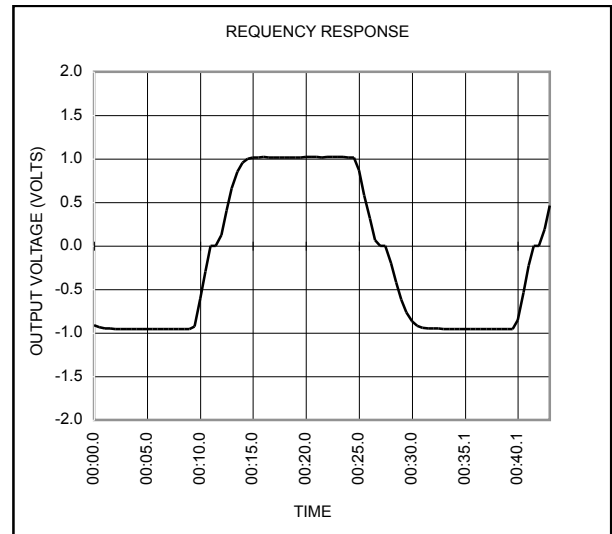
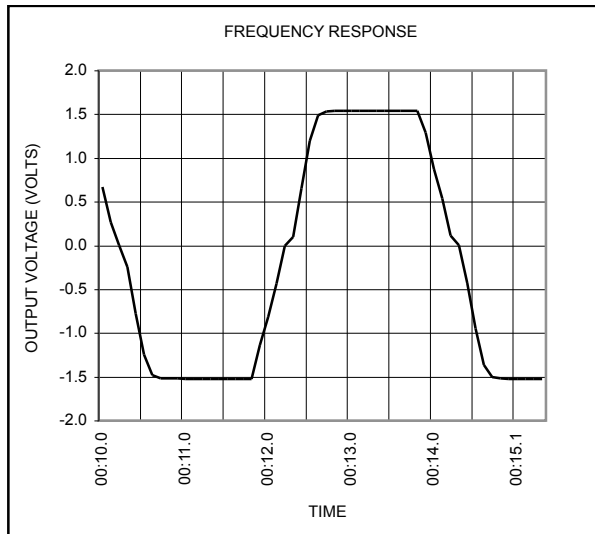
**DIMENSIONS:**



## BLOCK DIAGRAM OF THE DN120N

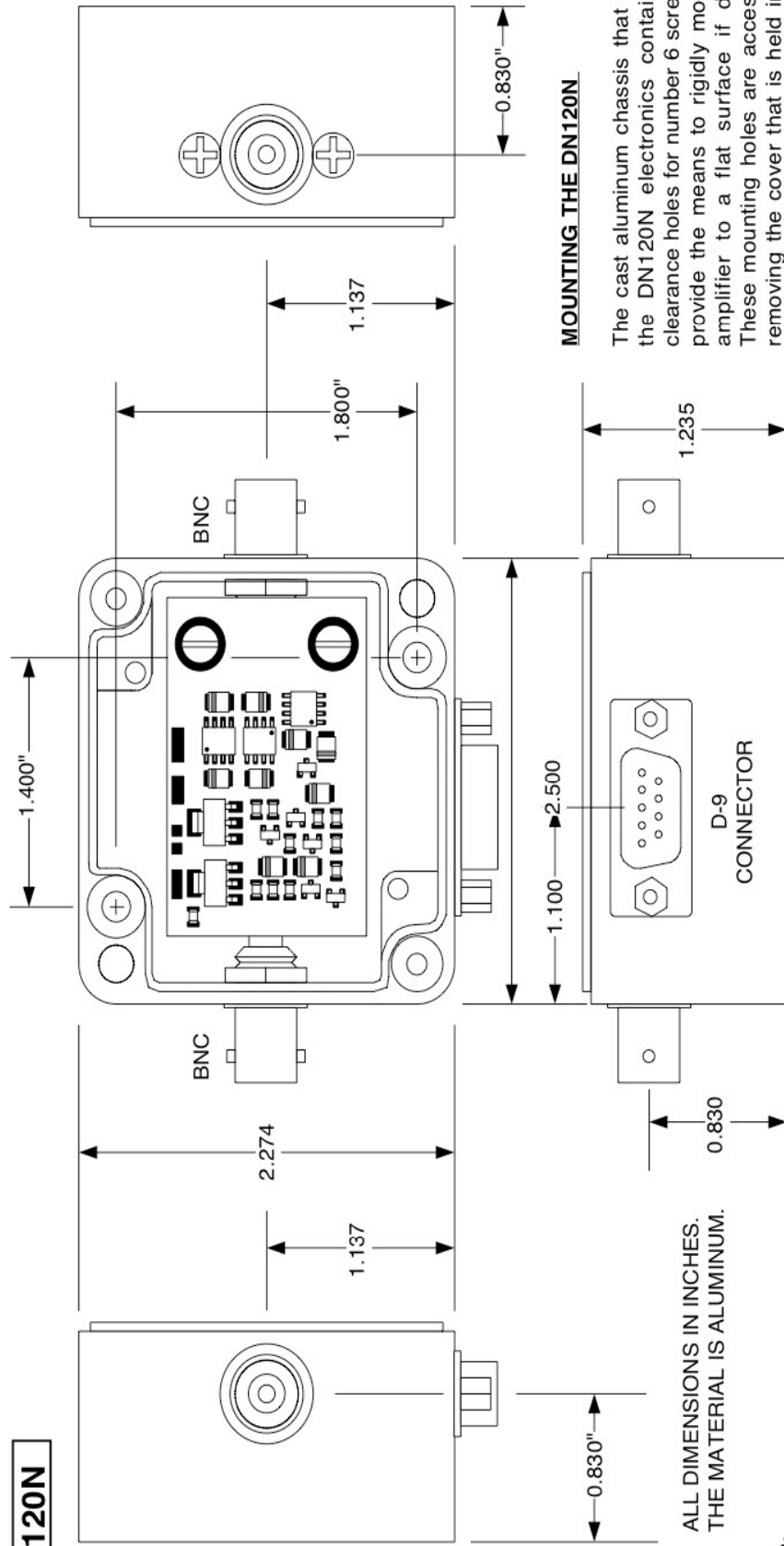


The DN120N allows the user to null or offset the input current by injecting a current into the virtual ground input of the log amplifier. This is illustrated in the figure to the right. The magnitude of this offset current is adjustable from zero to approximately ±100fA to ±250fA per Volt. This Voltage is applied between Pin 4 and Signal Ground (Pin 6) of the D-9 connector. In addition the DN120N has been scaled so that it can measure input currents down to 1fA. The I/O equations are shown on page 1.





## DN120N



ALL DIMENSIONS IN INCHES.  
THE MATERIAL IS ALUMINUM.

### POWER:

The DN120N operates from a single 5VDC  $\pm 0.25V$  power supply capable of delivering 1.5A of current at turn-on. This amount of current is required to regulate the temperature of the oven that houses the LOG element. The 5VDC is supplied from an external power source such as the ELPAC MI2005 tabletop model. This supply operates from 95 to 250 VAC at a frequency of 47 to 63Hz. **DO NOT REVERSE THE INPUT +5 VOLT POWER SUPPLY CONNECTIONS. PERMANENT DAMAGE TO THE UNIT WILL OCCUR TO THE UNIT IF THE POLARITY IS REVERSED.**

THE DN120 AND THE  
DN-120N WITH THE COVER  
REMOVED

2-10-2012

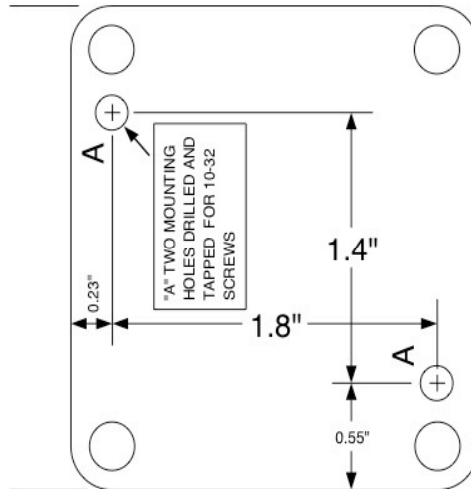
### MOUNTING THE DN120N

The cast aluminum chassis that houses the DN120N electronics contains two clearance holes for number 6 screws that provide the means to rigidly mount the amplifier to a flat surface if desired. These mounting holes are accessed by removing the cover that is held in place with four screws. This is illustrated in the mechanical drawing illustrated below. These two holes are also tapped for 10-32 screws and are accessible from the back of the DN120N. The cover does not need to be removed when mounting from the back of the amplifier.

### CONNECTORS

The DN120N is supplied with female BNC input and output connectors. All other connections are made through a male D-9 connector.

**READ THIS BEFORE APPLYING  
POWER TO THE DN120N**



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