

## Congratulations!

You are about to experiment with some of the world's most advanced clipping technology, using our patented **Nanolog Devices™** (NDs). These are a new class of component that use molecular electronics, where molecules act directly as elements in a circuit. Prepare yourself to experience greater dynamics, a warm rich frequency response, and new organic textures.

## Before You Get Started

Please take the time to understand that these components are different. Before we send our devices out, they are tested rigorously through a number of processes to ensure their functioning at the highest level, so please:

### **DO NOT:**

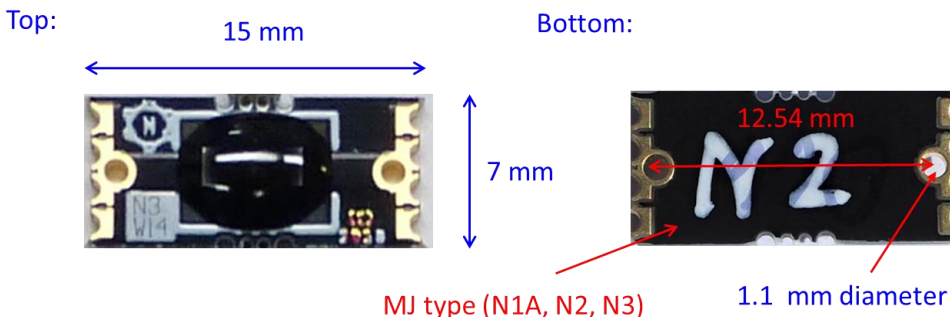
- **Use DC bias or AC signals above 1 V (or 1.5 V for N3)**
- **DC voltages imposed by electronic test equipment (e.g. multimeters) can cause permanent damage**

Our devices have been tested extensively, and have run continuously for months of operations at  $\pm 1$  V at audio frequencies. They are durable and will last a lifetime, but are susceptible to damage when used improperly. A document on Nanolog Devices test limits describes pulse and DC conditions tested to date. Please get in touch with us directly if you have any questions about testing.

## About The Devices

Not too long ago, Nanolog Devices™ were thought to be impossible to create: no way could we harness the potential of quantum physics and the power of molecules in a practical, mass scale setting. But, we've changed the game, and have accomplished just that.

These are our new "Chip on Board" designs. The devices are carbon-based two-terminal devices made from aromatic carbon. They bridge two conductors together with varying layers & depths of hexagonal carbon molecules. Figure 1 below shows their dimensions, and ID badge:



**Figure 1.** Photo of a Nanolog Device in a CoB (chip on board) format. N1A, N2, N3 are three versions, with the current/voltage responses shown in figure 2.

## It's All About The Curves

We have three different device versions (N1A, N2, N3), and each version conducts and responds differently from the other. They all have in common the non-linear electronic properties, and are symmetric with respect to polarity, as they conduct equally in both directions.

The conduction phase is where the magic happens. The NDs unique characteristics and benefits stem from the quantum tunneling process that creates smooth & continuous conduction curves, opposed to the rigid "stop/start" found in typical p-n Junctions (silicon or germanium).

The i-V curve of the two Nanolog Devices are plotted below in Figure 2, where the current flow is measured between the two terminals of the device as a function of the applied voltage. The i-V curve is important for determining the exact character of distortion or clipping that will result, and will have important consequences on the design of a circuit for a targeted application.

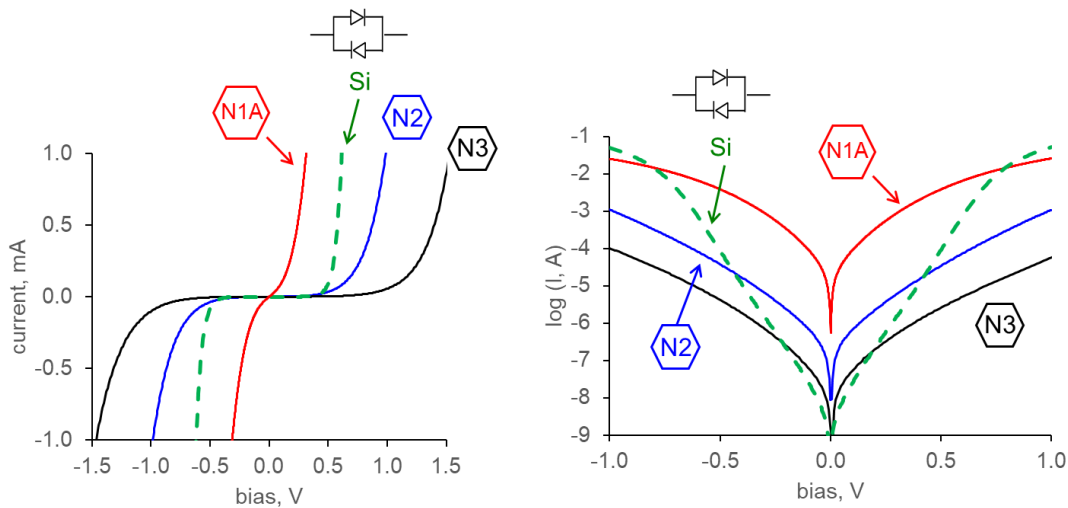
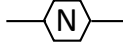
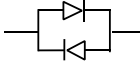


Figure 2: Current vs voltage responses of N1A, N2, and N3 compared to a pair of silicon diodes (1N4148), on both linear and log scales. Note that only one Nanolog device is necessary to replace two conventional diodes, since Nanolog Devices use quantum mechanical tunneling while conventional diodes are p-n junctions.

## Application

Most directly, Nanolog Devices can act as a drop-in replacement for an anti-parallel diode array. But in order to use the non-linear *i-V* curve of a Nanolog Device for clipping, some type of amplifier needs to be used.

Note: The electronic symbol for a ND is  and it can replace 

There are several proven options of how to get the most out of our NDs. Depending on the needs and intention of the circuit, this is where Nanolog Devices can really shine: by being incorporated into classic circuits to bring out a new element, or by serving as a design centre-point for unique sounds.

Contact to a ND can be made three different ways: with solder, optional through-hole pins, or surface mounting. The gold contacts extend to the bottom surface, and the active carbon device is protected under the black epoxy. The CoB package has been tested in operation for 10 minutes in boiling water, for billions of IV cycles run continuously for one month in air, and two days operation in 80 °C/80% humidity. They are designed to perform under even the most intense environmental factors.

## Circuits

The final page demonstrates some of the circuits that we have tested, and verified, where Nanolog Devices can operate and perform with significant results. However, there are a number of other circuits which could be investigated that will also work. So please, experiment!

In any application, it can be a good idea to rig a switch that allows direct comparison of the Nanolog Devices to a standard pair of clipping diodes, in order to fine-tune the circuit, or to provide for a quick contrast.

### Important Points

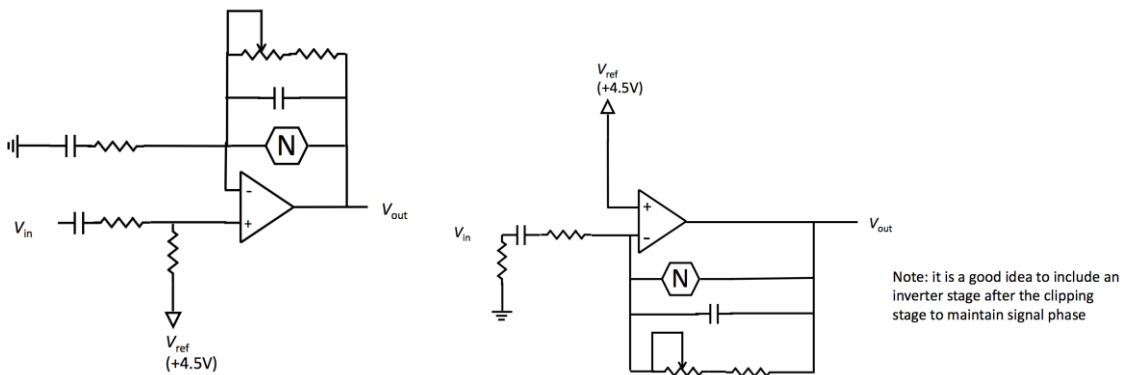
- Avoid designs where the NDs will be subjected to DC biases!
- NDs have been tested only in circuits using 9 VDC power supplies.
- While transient DC voltages and AC voltages are tolerated up to several volts, circuit design should assume and test only AC voltages in the audio frequency range.
  - We can advise designers on protection circuits if necessary.

## **Boldly Going Where No Man (or Woman) Has Gone Before!**

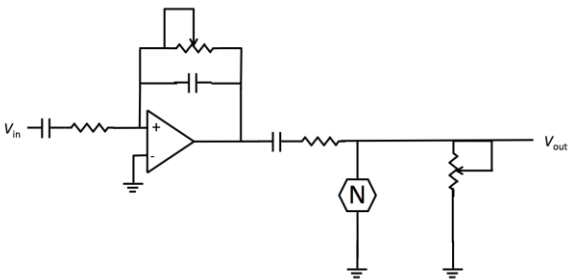
These devices pack a serious punch, and are at the forefront of innovation in analog technology. Whatever design you create will be one of the first footsteps into a new era of molecular electronics, so these are exciting times. Please contact us with any questions about our Nanolog Devices, testing processes, and potential circuit applications at:

Adam Bergren, PhD  
President & Co-Founder  
Nanolog Audio Inc.

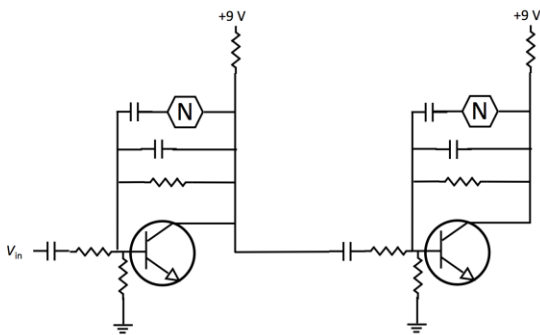
ajbergren@nanologaudio.com  
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www.nanologaudio.com



**Figure 3.** (Left) Non-Inverting op-amp soft-clipping stage, and (Right) inverting op-amp soft-clipping stage. These both utilize feedback-loop based clipping configurations where the non-linear Nanolog Devices shape the voltage waveform. The choices of R and C values will depend on the intent of the design, and are left blank.



**Figure 4.** Non-inverting op-amp with a hard-clipping shunt clipping stage. The choices of R and C values will depend on the intent of the design, and are left blank.



**Figure 5.** NPN transistor based hard clipping circuit with two series stages. The choices of R and C values will depend on the intent of the design, and are left blank.

## Nanolog Devices Tested Limits

The data below indicated environmental and electronic conditions in which Nanolog Devices N1A, N2, and N3 with “chip on board” packages were tested, with no significant change in current/voltage response observed after the test. Applications outside these limits are possible in many cases, and can be tested at Nanolog Audio on request. Contact Adam Brown ([awbrown@nanologaudio.com](mailto:awbrown@nanologaudio.com)) for details.

### Environmental:

1. AC waveform with zero DC bias: Eight months continuous operation at room temperature, >4 billion triangular IV cycles to  $\pm 1$  V ( $\pm 1.5$  V for N3)
2. Two days AC operation at 80 °C and 80% relative humidity
3. Immersion in boiling water for 10 minutes
4. Molten solder (350 °C) on contacts for > 10 seconds

### Electronic:

<b>N1A</b>			
200 Hz sine wave, $V_{DC}^a = 0$	$V_{pp}^b$	$I_{peak}$ , mA	duration, hrs
	2.0	20	>24
	3.0	75	>200
DC pulse from V=0 bias <sup>c</sup>	$V_{pulse}$ , V	$I_{pulse}$ , mA	duration, sec
	3.0	200	0.05
	3.0	200	1
	2.5	150	10
Triangle bias scans @ 2 V/sec	Bias range <sup>b</sup> , V	$I_{peak}$ , mA	
	$\pm 5.0$	500	
	$\pm 1.0$	25	
<b>N2</b>			
200 Hz sine wave, $V_{DC}^a = 0$	$V_{pp}^b$	$I_{peak}$ , mA	duration, hrs
	2.0	1.5	>4000
	3.0	10	>24
	4.0	25	>1
DC pulse from V=0 bias <sup>c</sup>	$V_{pulse}$ , V	$I_{pulse}$ , mA	duration, sec
	10	750	0.01
	5.0	280	0.10
	2.0	26	60
	1.5	6.5	300
Triangle bias scans @ 2 V/sec	Bias range <sup>b</sup> , V	$I_{peak}$ , mA	
	$\pm 5.0$	250	
	$\pm 1.5$	8.0	

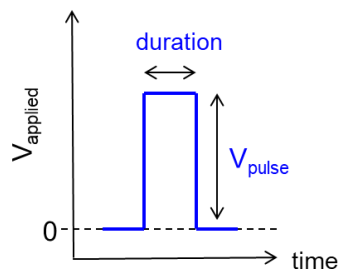
N3			
200 Hz sine wave, $V_{DC}^a = 0$	$V_{pp}^b$	$I_{peak}$ , mA	duration, hrs
	3.0	3.5	>50
	4.0	15	>1
DC pulse from $V=0$ bias <sup>c</sup>	$V_{pulse}$ , V	$I_{pulse}$ , mA	duration, sec
	3.25	150	0.01
	3.0	100	0.10
	2.5	25	1.0
Triangle bias scans @ 2 V/sec	Bias range <sup>b</sup> , V	$I_{peak}$ , mA	
	$\pm 2.5$	45	
	$\pm 1.5$	1.5	

- DC bias during AC operation
- peak to peak amplitude
- square pulse with indicated duration from 0 to  $V_{pulse}$  bias

Notes:

- IV curves are symmetric with respect to polarity. Positive and negative pulses yield currents with similar magnitude but opposite polarity
- Standard deviations of device current at fixed bias is  $\pm 15\%$  or less
- Sustained DC operation produces changes in device current which are faster for higher bias and longer duration. Constant DC bias should be avoided, but examples of tolerated DC biases are indicated in pulse results.
- Device current increases with temperature, typically 5% for 10 °C increase at room temperature. Device heating can cause similar increases during long pulses. Temperature effects are completely reversible over a range of -200 to +150 °C
- Pulse and triangle waveforms, with relevant parameters:

DC pulse:



Triangle scans:

