

**FCC Notice “Declaration of Conformity Information”**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna. Locate the antenna more than 30 feet away from the equipment and connect it to the receiver using a shield cable.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

**WARNING:** Only peripherals complying with the FCC class B limits may be attached to this equipment.

Changes or modifications made to this equipment, not expressly approved by us or parties authorized by us could void the user’s authority to operate the equipment. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**SAFETY INSTRUCTIONS**

There are two categories of Safety Instructions included in this manual:

Product Warnings, (i.e., what must never be done to assure avoiding those hazards that could cause bodily injury or property damage); and

User Directions (i.e., what must always be done to assure the safe use of your device).

The Safety Instructions contained in this manual have been categorized in accordance with the seriousness of the potential hazards through the use of Signal Words. Those Signal Words, and their intended meanings, are as follows:

**DANGER:** Indicates that a failure to observe the Safety Instructions could result in death or catastrophic bodily injury.

**WARNING:** Indicates that a failure to observe the Safety Instructions could result in serious bodily injury.

**CAUTION:** Indicates that a failure to observe the Safety Instructions could result in minor bodily injury or property damage.

**NOTE:** Designates important information that relates to activities and/or conditions that might result in loss of data and/or damage to your device.

**Safe Use and Operation of Your Device**

This equipment emits stray RF energy and will interfere with the reception of signals by airborne electronic navigational devices or medical devices. Do not operate this equipment near any medical devices (especially heart pacemaker).

**WARNING: Use only grounded AC power cords.**

**DANGER:** If NuForce equipment and all other equipments connected to it do not have AC ground, excessive amount of radio frequency emission could occur. This will interfere with medical devices (such as pacemaker), airborne electronic navigational devices and other radio frequency receivers.

Always immediately disconnect the power to the equipment in the event the device emits an unusual odor or sound or generates smoke.

**WARNING:** Never attempt to disassemble, repair or make any modification to your device. Disassembly, modification or any attempt at repair could cause bodily injury or property damage, as well as damage to the device itself.

**WARNING:** Your device is not a toy. Never allow children to play with your device. Misuse, rough or improper handling of your device by children could result in serious bodily injury for any of the enumerated safety warnings in this manual. In addition, always keep all accessories and components out of the reach of small children as small parts might present a choking hazard. Seek immediate medical attention if choking occurs or if any small part has been swallowed.

**CAUTION:** Never raise the sound volume level too high when using your device with earphones. An excessive sound volume level could cause damage to your hearing.

**WARNING:** To reduce the risk of fire or electric shock, do not expose the unit to moisture or water.

Do not allow foreign objects to get into the enclosure. If the unit is exposed to moisture, or a foreign object gets into the enclosure, immediately disconnect the power cord from the wall. Take the unit to a qualified service person for inspection and necessary repairs.

Read all the instructions before connecting or operating the component.

Keep this manual so you can refer to these safety instructions.

Heed all warnings and safety information in these instructions and on the product itself. Follow all operating instructions.

Do not use this unit near water.

You must allow a minimum 10 cm or 4 inches of unobstructed clearance around the unit. Do not place the unit on a bed, sofa, rug, or similar surface that could block the ventilation openings. If the unit is placed in a bookcase or cabinet, there must be ventilation of the cabinet to allow proper cooling. Keep the component away from radiators, heat registers, stoves, or any other appliance that produces heat.

The unit must be connected to a power supply only of the type and voltage specified on the rear panel. (USA: 115 V/60Hz, EC: 230V/50Hz)

Connect the component to the power outlet only with the supplied power supply cable or an exact equivalent. Do not modify the supplied cable.

Do not route the power cord where it will be crushed, pinched, bent, exposed to heat, or damaged in any way. Pay particular attention to the power cord at the plug and where the cord exits the back of the unit.

The power cord should be unplugged from the wall outlet during a lightning storm or if the unit is to be left unused for a long period of time.

Immediately stop using the component and have it inspected and/or serviced by a qualified service agency

if:

- The power supply cord or plug has been damaged.
- Objects have fallen or liquid has been spilled into the unit.
- The unit has been exposed to rain.
- The unit shows signs of improper operation
- The unit has been dropped or damaged in any way

## Read Me First

Thank you for purchasing the NuForce™ Reference series amplifier. The NuForce™ amplifier utilizes unique analog switching circuit topology. Before connecting and powering up the amplifier for the first time, please take a moment to study the following information in order to ensure proper operation and to avoid costly damage.

Serious audiophiles who want to enjoy the full potential of NuForce amplifier should allow it to “break-in” for roughly 75 hours (i.e., play music for about 75 hours before evaluating the amplifier).

**CAUTION: No-Load Condition** – Do not turn on the unit when there is no load on the speaker terminals (only turn on the unit after you have connected it to the speaker). Strong resonant currents could occur under a no-load condition that can overheat the passive components.

If the amplifier overheats due to a no-load accident, the overheat protection circuit will shut the amp down (the power LED light will remain lit) and restart after it has cooled down. Should this occur, it is good practice to switch the power OFF completely and let the amp cool down before powering it up again.

**WARNING: Do not connect NuForce speaker-level outputs to the line-level inputs of active devices such as active subwoofers or semi-active speakers with powered woofers.**

If you use semi-active speakers where the woofer is powered, or a subwoofer that accepts speaker-level signal from the NuForce, or sums the left and right input signals from the speaker outputs of *two* NuForce mono amplifiers, **please consult NuForce or your dealer before proceeding.**

**WARNING: Use only grounded AC power cords.**

**AC Input** – NuForce Reference amplifiers are designed to work with worldwide AC voltages (100VAC – 240VAC).

The speaker cable should be securely attached to the correct positive and negative speaker terminals and the RCA input cable should be connected prior to turning on the AC power. Do not disconnect the input or speaker cables when the AC power is switched to ON.

**WARNING: Check and set the RCA/XLR selector switch**

**RCA/XLR Selector Switch** – Make sure that the selector switch is correctly set – to the outside for Balanced XLR and to the inside (toward speaker posts) for RCA. Do not connect the RCA *and* XLR inputs *simultaneously*. The selector switch provides the correct grounding for either of the two configurations but is not meant to function as a signal selector. Running the RCA cable with the switch flipped to “XLR” may result in a loud noise that could damage the tweeters. (Running XLR cable but with the switch flipped to RCA does not cause the noise problem)

**Equipment Compatibility** – The NuForce amplifier has usable power bandwidth up to 100 kHz. As a result, the high-frequency noise and grounding flaws created by custom modification or by aging upstream components such as a CD player, D/A converter, or preamplifier could become audible as a loud hissing or buzzing noise.



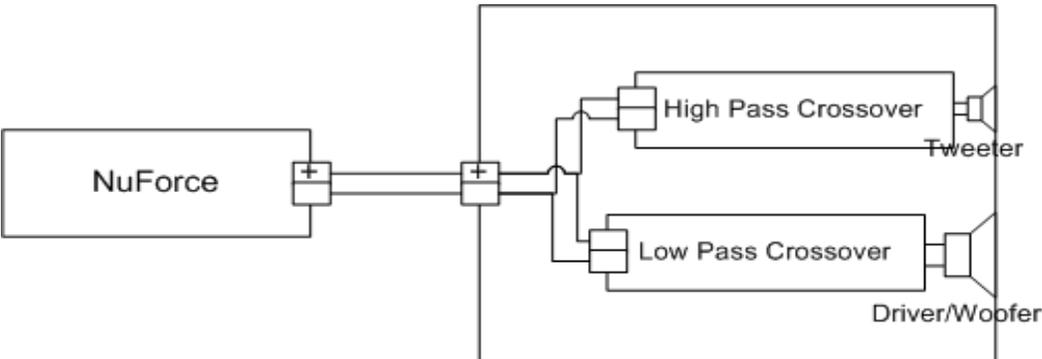
**Adjusting Speaker Toe-In and Listening Position** – The NuForce amplifier has a very wide and deep soundstage. To fine-tune its effect, try experimenting with the amount of speaker toe-in and also the listener's distance to the speakers. Be aware that these adjustments can affect the perceived high frequency balance/level.

**Floating Speaker Output** – The speaker output terminals are floating, with a 24VDC offset (DC across the speaker terminals is still 0V). Please consult NuForce Support ([support@nuforce.com](mailto:support@nuforce.com)) if your setup requires any of the following configurations:

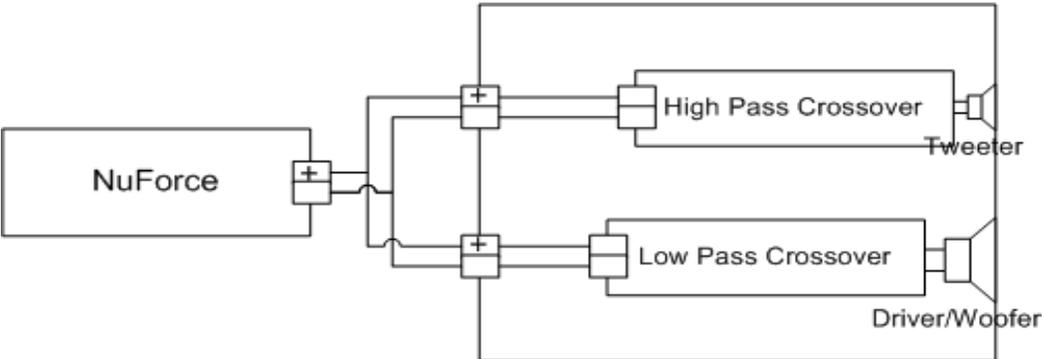
1. Multiple amplifiers to drive a single speaker driver (*Never do this!*)
2. Subwoofer that accepts and sums left and right input signals from *two* NuForce amplifiers' speaker terminals
3. Grounding other audio signal grounds to any of the speaker terminals on the NuForce amplifier
4. Using two amplifiers to drive a bi-amp, series-crossover speaker (uncommon setup)



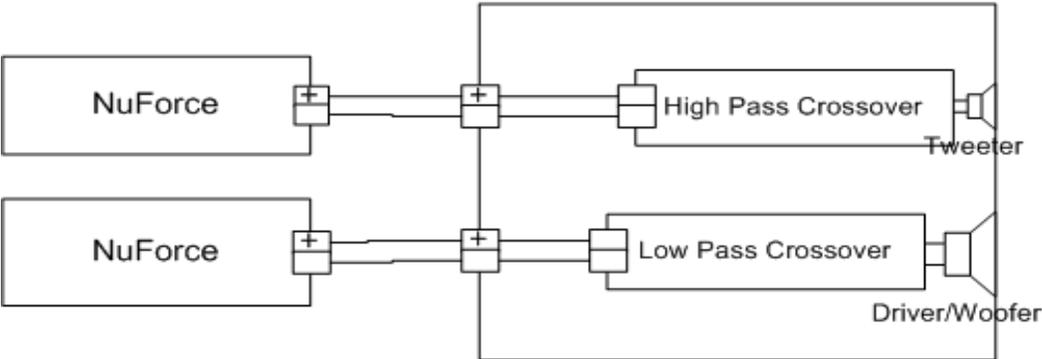
Acceptable Speaker Configurations



Single Amp., Single Wire (most common)



Single Amp., Bi-Wire (common in high-end speaker)



Bi-Amp., Bi-Wire (common in high-end speaker)

### Heat Dissipation

The internal heat sink is mounted to the chassis for maximum heat dissipation. The NuForce amplifier is very efficient and generates little heat. Its normal operating temperature is around 45 degrees Celsius. The chassis temperature can go up to as high as 60 degrees Celsius after many hours of maximum power usage and/or when kept in a confined space.

*The NuForce amplifier is capable of supplying high continuous current. To avoid possible damage to your loudspeakers, exercise common sense: DO NOT unplug the input or loudspeaker cables while the power remains ON.*

## Analog Switching Amplifier

NuForce™ amplifier technology is based upon the principle that a power oscillator can be modulated by an audio signal so that it produces an amplified audio signal obtained with a reconstruction filter, without the bandwidth limitation of a fixed frequency, carrier-based conventional PWM control. It uses a high-performance analog modulation technique and a closed-loop control system. Therefore NuForce refers to its audio amplifier as the Analog Switching Amplifier™. NuForce amplifiers offer ultra-wide bandwidth, with virtually no phase shift in the audible frequency range. The output stage is fully regulated and has an extremely high damping factor, which provides unprecedented control of the bass-frequency spectrum.

NuForce developed its revolutionary amplifier technology from the ground up to reassess and redefine faithful music reproduction. The first impressions of listening to NuForce amplifiers are those of pristine clarity, natural tonality, expansive imagery, and realistic proportions of the musicians and their instruments. Bass notes are well defined and articulate, with addictive rhythm and drive.

**In order to achieve our goal of flawless music reproduction, NuForce amplifiers are designed with the following characteristics:**

### High Bandwidth

The NuForce™ Analog Switching Amplifier provides near ruler-flat response from 20 Hz to 50 kHz with response out past 90 kHz. Only a handful of very expensive high-end linear amplifiers have a bandwidth exceeding 50 kHz. Most linear or digital switching amplifiers barely achieve a bandwidth of 20Hz-25 kHz.

### Low Distortion

The majority of today's amplifiers provide low distortion figures—typically less than 0.1% of Total Harmonic Distortion (THD) when measured at 1W using a 1000Hz sine wave. The manufacturers of these amplifiers fail to disclose that at full power the distortion may be 10 to 100 times greater, and at higher frequencies their distortion rises further. With NuForce's patent-pending technologies, harmonic distortion is effectively cancelled at every cycle of operation. As a result, the extremely low distortion of NuForce's analog switching amplifier remains extremely low regardless of the frequency of the signal or the output power level.

### Unique closed-loop design

Unlike the Class-D amplifier, NuForce's analog switching amplifier does not require a sawtooth waveform for modulation, but a proprietary, naturally-occurring modulating signal. In conjunction with referencing the signal at the loudspeaker terminals, thereby eliminating all distortions, NuForce's natural switching signal does not add noise into the system. The NuForce amplifier also does not suffer from the 180-degree phase shift caused by the output filter that plagues most Class-D amplifiers.

NuForce's high bandwidth and unique closed-loop design provide very high forward gain, well beyond the audio frequency range, at up to 1MHz. Therefore, all non-linearities are greatly reduced to achieve an operating power bandwidth as high as 100 kHz, while at the same time maintaining consistently low distortion across that frequency spectrum.

### Near Zero Phase Shift

By design, the NuForce amplifier has almost no phase shift. Most amps exhibit phase shift in excess of 45 degrees at 20 kHz, increasing rapidly toward 90 degrees as frequency ascends. Spatial information is skewed and inaccurate when there are phase shifts.

### High Damping Factor

To compute the damping factor of an amplifier, a reference input signal is applied and the output voltages without load ( $V_{no-load}$ ) and with 8-ohm speaker load ( $V_{load}$ ) are measured.

$$\text{Damping Factor} = V_{no-load} / (V_{no-load} - V_{load})$$

There are 2 issues with the above industry standard measurement: (1) Nuforce closed-loop response must include the speaker load for the PWM switching oscillation to take place; (2) Output without load on Nuforce speakers is basically irrelevant, and we are in fact measuring the output with an internal 100-ohm Zobel network. Using the standard measurement method, at the MOSFET output (after being filtered), we get a  $V_{load}$  almost identical to or slightly higher than  $V_{no-load}$ . This resulted in an *infinite* damping factor.

Since Nuforce requires a closed-loop response to oscillate for the PWM controller to function, and the closed-loop transfer function changes with different loads – therefore, Damping Factor measurement is irrelevant with Nuforce Circuit. In the production Nuforce amplifier, speaker lead out wires which form high-frequency common-mode chokes are added to the circuit board to suppress RF noise. When Damping Factor is taken at the speaker terminals, this number is 160, which reflects the impedance of the wirings and the output chokes.

## NuForce Reference 9 V2



### Specifications:

- Configuration: Mono; Inputs: RCA and true Balanced XLR
- Power Output

Power/Load	8 ohm	4 ohm	2 ohm
Peak Power (20msec hold time)	325W	650W	1300W
*RMS Power	190W	300W	300W

\* RMS power is the maximum continuous power. Peak power provides the required instantaneous power boost.

- Power bandwidth: 100 to 20 kHz +/- 0.8 db; 10 Hz -0.5 db; 60 kHz -3 db
- THD+N = 0.03%, 1kHz, 10 W
- Input Impedance: 45k-ohms
- Gain: 27 dB
- Signal/Noise Ratio: 100dB @ 100W
- Gold-Plated RCA Input Jack
- Speaker Binding Posts accept spade lugs or banana plugs
- Chassis is 100% high-grade, brushed and anodized aluminum to reduce audio resonance
- Dimensions: 8.5"W x 14"L x 1.8"H (height does not include feet)
- Worldwide AC-Voltage Compatibility: 84VAC to 264VAC
- Weight: 7 lbs.

## NuForce Reference 8.5 V2

Reference 8.5 V2 is identical to Reference 9 V2 in every way except the power supply.

### Specifications:

- Configuration: Mono; Inputs: RCA and true Balanced XLR
- Power output

Power/Load	8 ohm	4 ohm	2 ohm
Peak Power (20msec hold time)	288W	576W	1152W
RMS Power	160W	200W	200W

\* RMS power is the maximum continuous power. Peak power provides the required instantaneous power boost.

- Weight: 6 lbs.

## NuForce Reference 9 V2 Special Edition (SE)



Reference 9 V2 SE utilizes an improved power supply board with proprietary Nuforce low ESR capacitor matrix and high performance capacitors.

The Reference 9 V2 SE adds refinement and delicacy to the already excellent-sounding Ref 9 V2. The tonal balance remains unaltered, and when used in less than the most revealing and transparent systems, the advantages of the SE may not be fully realized.

As excellent as the Ref 9 V2 is, the Ref 9 SE V2 takes the strengths of the Ref 9 V2 to an even higher level. These include:

- Even sweeter highs, without any compromise in frequency extension.
- An even smoother and more palpable midrange, while preserving the natural harmonic structure that the Ref 9 V2 is famous for. The Ref 9 V2 SE is one of the few amplifiers in the world that do not impart its own signature on the music. This results in a more natural and more relaxed presentation.
- The bass remains a huge strength of the amp. The Ref 9 V2 SE has same tightness and texture of the standard Ref 9 V2, but with a little more weight.
- The stage is more coherent and deeper.

To put it in one sentence, the sound in general is more neutral, more liquid; with a more relaxed and more powerful presentation of the soundstage as well as individual instruments

## Amplifier FAQ

### **What is an Analog Switching Amplifier? What's the difference between NuForce's amplifier and other digital amplifiers?**

NuForce's switching amplifier is a drastic departure from conventional approaches to switching amplifier design. Most class-D amplifiers use a fixed sawtooth waveform to modulate an audio signal, and suffer from the 180-degree phase shift of the LC reconstruction filter which would normally cause a feedback from the load to the error amplifier to oscillate unless phase compensation is used. That compensation network drastically reduces the amplifier bandwidth to below the corner frequency of the LC reconstruction filter. Thus most class-D amplifiers have low bandwidth and high distortion due to limited gain of the phase-corrected error amplifier at audio frequencies.

NuForce's amplifier technology is based upon the principle that a power oscillator can be modulated by an audio signal so that it produces an amplified audio signal obtained with a reconstruction filter, without the bandwidth limitation of a fixed frequency carrier-based conventional PWM control. It uses analog modulation technique and close-loop control systems. Therefore NuForce refer to its audio amplifier as Analog Switching Amplifier.

### **What are the problems with traditional Class-A and A/B amplifiers?**

Traditional linear amplifiers such as Class-A and Class-A/B amplifiers are bulky and inefficient. The inefficiency compromises the reproduction of music signal's full dynamic range. Its resulting higher operating temperature also shortens the useful life of the electrolytic capacitors used in abundance in these amplifiers. To get around that problem, today's better amplifiers employ bulky heatsinks and costly linear power supplies to provide enough headroom to handle the full dynamics. These huge power supplies are unregulated and could add noise and ripples at low volume. Besides being inefficient, linear amplifier depends on transistors or MOSFET devices to generate power. Big (high-power) bipolar transistors or MOSFETs have inherently low bandwidth and do not provide adequate audio performance. Therefore, smaller (up to 20+) MOSFETs with decent audio bandwidth performance are paralleled to provide sufficient power. Each MOSFET has an inherent junction noise - actually worse audio low frequency noise than bipolar transistors - and the aggregated noise corrupts music reproduction. What you hear is haziness and a lack of clarity in music reproduction. MOSFETs are used in parallel because technically, they are easier to drive although they have inherently higher distortion than bipolar transistors, which are much harder to drive when they are paralleled. Class-AB amplifiers - the most popular amplifier circuit - have to overcome the inherent crossover distortion that occurs when the audio signal goes from negative to positive and vice-versa, crossing the zero region where gains of transistors are much reduced. They are actually down to zero when the transistors stop conducting current. Close-loop system designers know that lower gain means higher inaccuracy of the amplification loop.

### **What are the problems with Class-D digital switching amplifiers?**

Digital Switching Amplifiers (commonly known as Class-D) have been around for years. Nevertheless, it is nearly impossible to engineer a conventional Class-D amplifier that handles the full requirement, 20-20,000Hz, for full-bandwidth music reproduction. A Class-D amplifier works by utilizing a high-frequency sawtooth waveform to modulate the music signal (to learn more about how Class-D amplifier works, click [here](#)). The constant presence of the sawtooth waveform, which is very high in frequency spectrum and its inevitable frequency jittering, can mask or corrupt low-level music signal. The output filter designed to filter out noise and overtones caused by the sawtooth waveform adds a 180 degree phase shift to Class-D output stage, causing possible instability and adding distortion due to its own inherent non-

linearities. Additionally, the output filter presents frequency-variant output impedance that can interact with a speaker's complex impedance. Variants of Class-D amplifiers with the addition of Digital Signal Processor claim to improve music reproductions. However, because of their lack of close-loop design, especially from the speaker's terminals, spurious interaction between the speaker's complex impedance and back-EMF with the amplifier's resonant output filter can result in harsh sound reproduction. The fundamental flaws of conventional Class-D amplifiers remain unresolved.

### **Does NuForce's amplifier experience crowding-out phenomenon as in conventional audio amplifiers?**

Many audiophiles have observed that the main voices in a recording when produced by amplifiers that have impressive specification numbers are crowded out or submerged in the presence of strong basses. Yet these amplifiers boast about 100kHz bandwidth. Is this a human hearing characteristic or the amplifiers have something strange going on?

While it is true that human ears are highly non-linear vs. amplitude and frequencies, it is also true that no datasheet of transistors contain straight lines on any parameter such as gain (or rise time) vs. any other parameter such as drain/collector current (or the voltage across the transistor terminals). In particular, the current gain of a bipolar transistor or the transconductance of a MOSFET varies not only with the collector current or drain current but also the frequency of the input signal. For example it is well known that the transconductance of a bipolar transistor is at first approximation proportional to the collector current but on the other hand its current gain decreases with collector current. Therefore when a bass note appears during a continuous main voice, the gains of the transistors become actually lower than during the absence of the bass note, especially a strong one, because the transistor currents are higher during the vibration of the bass note, therefore its  $F_{sub.t}$  also go lower, causing the higher frequencies of the main voice to be actually less amplified.

Thus in conventional amplifiers, especially class-AB amplifiers using bipolar transistors, the crowding-out or submersion of high-frequency voices is real.

NuForce's amplifiers on the other hand do not suffer from this crowding-out phenomenon. This is because the output MOSFETs only switch between ON and OFF regardless of the amplitude of the audio input signal, the gain in such amplifiers is independent of the transistor current level. NuForce's amplifiers have exceptionally huge bandwidth exceeding 100kHz and very low phase shift in the same frequency range. Therefore all the audio frequencies and their pitch-defining harmonics are faithfully reproduced.

### **Why is switching amplifier better than linear amplifier in reproducing music? Music is a blend of sine waves, isn't it?**

While any waveform theoretically consists of sine waves, that mathematical decomposition assumes that the waveform is periodic, in other words, a repeating waveform. Musical instruments, on the other hand, produce waveforms with full sharp edges that even trained eyes have a difficult time figuring out what the fundamental frequency is, because even a single note produced by any instrument is full of attacks and decays (except for instruments that are based on natural resonance such as the pipe organ or the flute). A violin produces very complex waveforms full of high frequencies called harmonics. Harmonics are so named because their frequencies are multiples of the fundamental frequency of the note being played. Faithful reproduction of such complex waveforms requires an amplifier capable of very high bandwidth, and more importantly, with no crossover distortion. The most popular amplifiers use a class of amplifying circuit called class-AB amplifier. It is actually a compromise between the huge inefficiency of class-A amplifiers - the simplest circuit universally used in low power amplification - and the high distortion but higher efficiency of class-B amplifier. Class-A amplifiers theoretically have no crossover distortion. This is the main reason why audiophiles are willing to pay sky high prices for some class-A amplifiers. Likewise,

*NuForce's analog switching amplifier circuit has no crossover distortion. And while typical linear amplifiers have a bandwidth that is barely over 20 kHz - lower still in boomboxes and in conventional switching amplifiers - NuForce's analog switching amplifier uses proprietary technologies to achieve bandwidth up to ten times higher than typical linear amplifiers. Its huge bandwidth allows it to amplify complex music faithfully, much beyond the concept of high-fidelity. A good side effect of zero crossover distortion and huge bandwidth is a huge sound stage most music lovers never experienced before, because now spatial information contained in a stereo program is completely reproduced.*

### **NuForce amp uses a lot of Surface-mount components (SMD). Are SMD worse than traditional through-hole discrete components?**

SMD components are rated and performed as well and sometimes better than through-hole components in several ways: (1) The proximity of lead-less components reduces parasitic inductances, capacitances, and spurious induced noise, so the circuit performs closer to theoretical ideal even when operating at high speed/frequencies; (2) SMD manufacturing technology, driven by PC and telecommunication industries, are more reliable and consistent to produce quality circuit boards. Additionally, our rigorous component selection and scientific circuit design methodologies coupled with extensive computerized simulations and analyses, made possible by our deep insight of high-performance high-precision analog design, make very high fidelity a scientific reality and not marketing hypes of voodoo electronics. Using SMD with the resulting minimum parasitic inductances, capacitances, and minimum antenna effects, NuForce's analog switching amplifiers achieve the highest bandwidth at lowest distortion of a magnitude higher than that of linear and conventional switching amplifiers.

### **What is damping factor and how does it affect an amplifier's performance?**

We shall start with a simplified explanation for the less technical reader. The damping factor tells you how good the amplifier is at driving a speaker. The larger the number, the better it is. It is considered good above 100, poor below 20. Other factors that affect an amplifier's performance are frequency response, distortion, and phase shift etc.

One of the factors affecting how an amplifier drives a speaker system is the amplifier's output impedance. The lower it is, the better the amplifier can present needed current to the speaker system. The better the amplifier can provide varying amounts of current without changing the applied voltage to the speaker system, the more accurate the speaker's reproduction of music. The apparent impedance of the speaker system changes depending on the direction, moving speed and position of the speaker drivers when the voltage is applied. At one moment, it might appear to be 2 ohms, and a moment later, it might appear to be 40 ohms. The applied voltage waveform is, for all intents and purposes, an exact graph of the desired physical motion of the speaker.

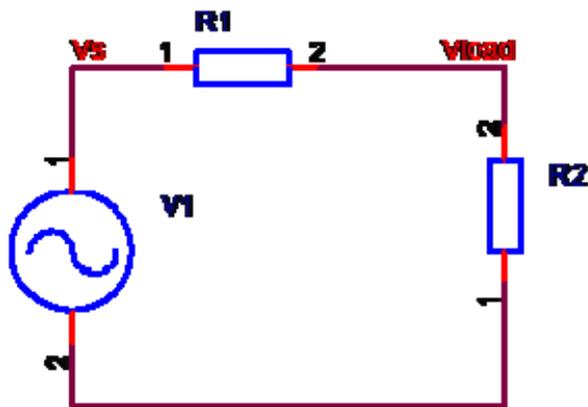
But because the speaker's load impedance will vary widely depending on what it was doing when particular voltage (say 15 volts) was applied, the amount of current that the speaker will draw with the applied 15 volts will vary widely as well. The amplifier needs to present the applied voltage correctly no matter what the speaker impedance is. If it can do that, the speaker's cone movements will produce the most accurate reproduction of the applied voltage changes - in other words, the least distortion will occur because the driver(s) will move to the desired position with the least amount of error in time and space.

Summing up, since music is comprised of a constantly changing set of applied voltages, except when silence is being reproduced, the speaker is always moving in some complex pattern of strokes in and out, and that in turn means that when the amplifier changes the applied voltage, the amount of current consumed by the speaker system in complying with that applied voltage will vary over a wide range. So the amplifier must, to the best of its ability, supply that current and not change the applied voltage as a result.

If the voltage changes in the process, the speaker will not reach the originally intended excursion, and distortion is the result.

Technical definition of the damping factor is the specified load impedance (in use, that'd be the speaker system) divided by the amplifier's output impedance.

In the following diagram, R1 is the source impedance, R2 the load impedance, and Damping Factor =  $R2/R1$



$$V_{load} = V_s \cdot \frac{R2}{(R1+R2)}$$

$$\frac{V_{load}}{V_s} = \frac{R2}{(R1+R2)}$$

$$V_{load}(V_s - V_{load}) = R2R1$$

$$R1 = \frac{R2 \cdot (V_s - V_{load})}{V_{load}}$$

$V_s$  is measured no-load voltage ( $R2 \gg \gg \gg$ )

$V_{load}$  is measured with  $R2$

If  $V_{load} = V_s$  then  $R1 = 0$

It is very important to note that the load impedance is very hard to measure and it is not constant as it consists of capacitive, resistive and inductive load. And the load impedance also changes with frequencies.

With NuForce amplifiers, measured  $V_{load}$  is equal to no-load output voltage (=  $V_s$ ) at any audio frequency, therefore its output impedance is practically zero, otherwise said, its damping factor is very high,  $DF \gg 1000$ . Output impedance is less than 10 milliohm (due to speaker cable and contact) within the entire frequency response.

There are 2 issues with the above industry standard measurement: (1) Nuforce closed-loop response must include the speaker load for the PWM switching oscillation to take place. (2) Output without load on Nuforce speakers is basically irrelevant, and we are in fact measuring the output with an internal 100-ohm Zobel network.

Using the standard measurement method, at the MOSFET output (after being filtered), we get an 'Infinite' damping factor with  $V_{load}$  (8-ohm) almost identical to or slightly higher than  $V_{no-load}$  (actually 100-ohm Zobel network). This resulted in an infinite damping factor.

Since Nuforce requires a closed-loop response to oscillate for the PWM controller to function, and the closed-loop transfer function changes with different loads – therefore, standard Damping Factor measurement is irrelevant with Nuforce Circuit.

In the production Nuforce amplifier, speaker lead out wires which form high-frequency common-mode chokes are added to the circuit board to suppress RF noise. When Damping Factor is taken at the speaker terminals, this number is 160, which reflects the impedance of the wirings and the output chokes when compare to the 100-ohm Zobel network.

## Power FAQ

### **NuForce's amplifier is so small and light, does it provide adequate performance?**

NuForce's amplifier utilizes high-performance switch-mode power supplies (SMPS). SMPS, as opposed to traditional huge and bulky linear power supplies, offers smaller size and higher efficiency. Most importantly, SMPS operates at much higher frequencies. These are thousands of times faster than linear power supplies operating at 50/60Hz. Therefore, they *respond faster to provide instantaneous power as required by high-performance music reproduction*. Transformers and capacitors are more efficient and smaller at higher frequency. Hence, even a very small SMPS is still several times more capable than a 50/60Hz linear power supply. SMPS also offers sophisticated over-current and short circuit protection, in addition to meeting all leading safety and industry reliability standard. *Running very cool*, the SMPS used in NuForce's amplifier provides an unequalled regulated output without the 100/120 Hz ripple voltage found in linear power supplies (even when huge cans of filter capacitors are used such as the case of high end amplifiers).

### **What are Peak and RMS (Root Mean Square) power ratings? What's the effect on audio output?**

RMS power is continuous power that the amplifier is capable of outputting over long periods. Peak power is short-term power that an amplifier is capable of briefly outputting when faced with sudden, high-energy signals.

Headroom is referred to an amplifier's ability to go beyond its rated average power (RMS or continuous power) for a short time in order to recreate loud or explosive audio signals that rise very quickly. In order to have high headroom (an ability to achieve loud peak levels without distorting), an amplifier must have a stiff power supply with a good amount of reserve energy on which it can call (stored in capacitors). The ability of the power supply to quickly recharge the capacitors is also very critical. A typical low frequency (50Hz for example) explosive sound consists of an attack followed by a series of rapidly decaying lobes of a 50Hz sine wave. Therefore, an amplifier with 300W peak power with 20ms holdtime is capable of providing 300W power to the 50Hz musical note (full cycle of 50 Hz is 20ms). A series of successive explosive sound might sounded very close to human ear, but their base notes are far apart enough (1 second = 1000 ms) for the amplifier to provide the required peak power. For most typical home listening, hardly more than 20W of power is consumed. Therefore, a good amplifier should provide sufficient RMS power and a high peak power with low distortion (NuForce's Amplifier is capable of generating the peak power at ultra low distortion of less than 0.05% THD+N).

### **Is NuForce's 300W amplifier less or more powerful than a linear solid state or tube amplifier rated for 300W?**

In terms of reproducing the dynamics and headrooms of music, the more power the better. The commonly accepted measurement is to rate the output power when the amplifier clips with a 1% THD. Now, what is clipping? Clipping occurs in a linear amplifier when its output signal tries to exceed the limits of its power supply voltage. In a linear amplifier using transistors and bulky a transformer/rectifier, the storage capacitor is recharged only once every 8.33 milliseconds, and its voltage is only slightly above the maximum output voltage, so it could clip rather easily. To put it simply, it has very little headroom. With tube amplifiers, the supply voltage is very high, typically 300 to 600V. Therefore even though tube amplifiers have higher overall distortion, perceptively, they sound more 'powerful'. NuForce's amplifier is a switching amplifier designed with lots of headroom, so that there is no clipping at its rated 300W. Its 300W is perceptively better sounding than a 300W linear amplifier.

## TERMS AND CONDITIONS OF SALE

**Scope.** These terms and conditions of sale (these “Terms”) apply to all sales of products (the “Products”) by NuForce Inc. (“NuForce”), a California corporation, to buyer of the Products (“Buyer”). These Terms (along with the specific terms of the attached purchase order) constitute the complete and entire agreement between the parties relating to the subject matter hereof, and supersede any and all prior and contemporaneous other terms or conditions, whether oral or written, including negotiations, prior quotations and purchase orders between the parties. These Terms may be modified only by a writing signed and approved by an authorized representative of NuForce. NuForce’ failure to object to any term or condition contained in any communication from Buyer (including in any purchase order) shall not be deemed a waiver or modification of these Terms. These Terms shall not be modified, supplemented, qualified or interpreted by any trade usage or prior course of dealing.

**Orders.** Subject to Section 0, a contract between NuForce and Buyer shall be formed only upon NuForce’ written acceptance of Buyer’s order or shipment of Products to Buyer pursuant to Buyer’s written purchase order. If NuForce accepts by shipment, then the acceptance shall only be for the quantity shipped.

**Title and Delivery.**

**Title and Risk of Loss.** Delivery is F.O.B. NuForce’ point of shipment (“Delivery”). NuForce may exercise NuForce’ own discretion in selecting the method of shipment. The risk of loss passes to Buyer upon delivery to the carrier at NuForce’ point of shipment. NuForce retains title to the Products until NuForce has received payment in full of all sums due in connection with the sale of Products to Buyer. NuForce hereby reserves and Buyer hereby grants to NuForce a purchase money security interest in the Products sold and the proceeds thereof, including accounts receivable, until Buyer pays NuForce the purchase price in full.

**Shipment and Delivery.** Any scheduled ship date quoted is approximate and not the essence of the contract. Claims of late delivery are barred unless made prior to receipt of Products. Buyer’s sole remedy for delay in or failure to deliver shall be cancellation of the applicable order.

**Pricing.** NuForce reserves the right to increase prices for any unshipped Products if the cost to NuForce for supplies, raw materials, labor or services is materially increased. The prices quoted on the attached purchase order shall be valid only for the period of time there indicated. All prices are exclusive of transportation, insurance, taxes, duties and other charges related thereto; unless NuForce receives a certified tax exemption from Buyer prior to shipment. Buyer agrees to indemnify, defend and hold NuForce harmless from any loss or expense arising out of or related to NuForce’ reliance on any tax exemption provided by Buyer.

**Payment.** Except as otherwise specifically designated on the invoice, payment shall be due and payable within 30 days from the date of the invoice. NuForce reserves the right at any time to modify or withdraw any credit extended to Buyer. If in NuForce’ sole discretion, NuForce may require full or partial payment in advance of any shipment of Product. If Buyer becomes delinquent in any payment to NuForce, NuForce has the right to suspend performance until such delinquency is corrected. Regardless of any statement appearing on a check in payment for Product, NuForce’ acceptance of such check shall not constitute a waiver of NuForce’ right to pursue the collection of any remaining balance. NuForce reserves the right to charge a late fee on late payments at the lesser of one and 1.5% per month or the maximum rate allowable by law, together with NuForce’ costs of collections including attorneys’ fees.

**Acceptance.** Use of the Products by Buyer or its agents, or the failure by Buyer to reject the Products within 5 days following Buyer’s delivery of such Products shall constitute acceptance by the Buyer.

**NuForce’ Limited Warranty and Limitation of Liabilities.**

**Full Refund Period.** For a period of 30 days after shipment (the “Refund Period”), Buyer may return the Products to NuForce for a full refund. To qualify for this refund, the Products must be returned in their original packaging and a 15% restocking fee will apply to damaged (including blemish on product’s surface) Products.

**Limited Warranty.** For a period (as specified in the Warranty Coverage section) after conclusion of the Refund Period, NuForce warrants (i) this product against defects in materials and workmanship, and (ii) that each Product, unmodified and under normal use and conditions, will substantially comply with NuForce’ applicable written technical documentation for the Product. NuForce reserves the right to make substitutions and modifications from time to time in the specifications of Products sold by NuForce, provided that such substitutions or modifications do not materially affect overall Product performance.

**Limitations.** EXCEPT FOR NUFORCE’ LIMITED WARRANTY SET FORTH IN SECTION 0 ABOVE, NUFORCE SPECIFICALLY DISCLAIMS ANY AND ALL EXPRESS, IMPLIED OR STATUTORY WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE, OF MERCHANTABILITY AND AGAINST INFRINGEMENT. THE EXPRESS WARRANTY IN SECTION 0 ABOVE SHALL EXTEND TO BUYER ONLY AND NOT TO BUYER’S CUSTOMERS OR ANY THIRD PARTY. NO PERSON IS AUTHORIZED TO MAKE ANY WARRANTY OR REPRESENTATION ON BEHALF OF NUFORCE CONCERNING THE PRODUCTS OTHER THAN THE LIMITED WARRANTY EXPRESSLY SET FORTH IN SECTION 0. BUYER WILL BE SOLELY RESPONSIBLE FOR AND WILL INDEMNIFY, DEFEND AND HOLD HARMLESS NUFORCE FROM AND AGAINST ANY AND ALL LIABILITIES, DAMAGES, COSTS AND EXPENSES RELATED TO ANY WARRANTIES WITH RESPECT TO THE PRODUCTS OTHER THAN THOSE SET FORTH IN SECTION 0 OR ANY USE OF THE PRODUCTS OR RESALE OF THE PRODUCTS.

**Liability.** With respect to any claims asserting breach of the limited warranty set forth in Section 0, NuForce’ exclusive liability and Buyer’s sole remedy, is at NuForce’ option, to replace or repair the defective Product or to issue credit to Buyer for the purchase price of the Product (without interest), provided that prior to any replacement, repair or credit the following conditions are satisfied:

(i) NuForce is promptly notified in writing by Buyer upon discovery of any such default; (ii) the defective Product is returned to NuForce, transportation charges prepaid by Buyer, accompanied by a brief statement explaining the alleged defect; and (iii) NuForce’ examination of such Product shall disclose to NuForce’ satisfaction that such failures did not arise as a result of misuse, abuse, improper installation or application, repair, alteration, or accident, or negligence in use, storage, transportation or handling by anyone

other than NuForce. Any replacement Product will be warranted for the remainder of the original warranty period or 30 days, whichever is longer. NuForce shall in no event be responsible for any labor costs, or otherwise, incurred by Buyer incident to the replacement of any defective Product. If NuForce determines that the returned Product conformed to the warranties, NuForce will return the Product to Buyer at Buyer's expense.

NUFORCE SHALL NOT BE LIABLE FOR INDIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES OF ANY NATURE INCLUDING WITHOUT LIMITATION LOSS OF PROFIT, PROMOTIONAL OR MANUFACTURING EXPENSES, OVERHEAD, DATA, INJURY TO REPUTATION OR LOSS TO CUSTOMERS, ARISING OUT OF OR IN CONNECTION WITH THE PURCHASE, SALE, USE, PERFORMANCE OR FAILURE OF THE PRODUCTS, WHETHER SUCH LIABILITY ARISES UNDER CONTRACT, TORT (INCLUDING NEGLIGENCE), STRICT PRODUCT LIABILITY OR OTHERWISE, EVEN IF NUFORCE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR IF SUCH DAMAGE COULD HAVE BEEN REASONABLY FORESEEN. IN NO EVENT WILL NUFORCE' LIABILITY TO BUYER ARISING OUT OF OR RELATING TO THESE TERMS EXCEED THE AMOUNT OF THE PURCHASE PRICE PAID TO NUFORCE BY BUYER FOR THE PRODUCT THAT GIVES RISE TO THE CLAIM.

Default. If Buyer becomes insolvent, bankrupt, makes an assignment for the benefit of its creditors or is otherwise unable to meet Buyer's obligations as they come due, NuForce may decline to make further shipments without in any way affecting NuForce' rights under these Terms. If, NuForce elects to continue to make shipments, NuForce' action shall not constitute a waiver of any default by Buyer or in any way affect NuForce' legal remedies of any such default.

Assignment. Buyer shall not assign Buyer's order or any interest in or any rights hereunder without the prior written consent of NuForce.

Confidentiality. Buyer acknowledges that Buyer may gain access to trade secrets and confidential information of NuForce. At all times Buyer agrees not to disclose NuForce' trade secrets or confidential information to any third party without the express written consent of NuForce. Buyer further agrees to undertake all steps necessary to maintain the secrecy of NuForce' trade secrets and confidential information.

Miscellaneous. All notices, authorizations, and requests shall be deemed given on receipt. These Terms shall be governed by the laws of the State of California without reference to that state's choice of law provisions. The California state courts of Santa Clara County, California or the United States District Court for the Northern District of California shall have exclusive jurisdiction and venue over any dispute arising out of this Agreement, and each party hereby consents to the jurisdiction and venue of such courts. All waivers of the exercise any remedy or option provided herein, or to require any performance by Buyer must be in a writing signed by NuForce. If any provision of these Terms is declared invalid, illegal or unenforceable, all remaining provisions shall continue in full force and effect. Nonperformance of either party, except for the making of payments, shall be excused to the extent that performance is delayed or rendered impossible by any reason where failure to perform is beyond the reasonable control of the non-performing party.



### **NuForce Three (3) Year Limited Warranty**

Reference 8.5 V2 and Reference 9 V2 have three year warranty.  
Reference 9 V2 SE has five year warranty.

#### **WARRANTY COVERAGE**

NuForce's warranty is specified in **NuForce Terms and Conditions of Sale**. If a defect exists, at its option NuForce will (1) repair the product at no charge, using new or refurbished replacement parts, (2) exchange the product with a product that is new or which has been manufactured from new or serviceable used parts and is at least functionally equivalent to the original product, or (3) refund the purchase price of the product. A replacement product/part assumes the remaining warranty of the original product or ninety (90) days from the date of replacement or repair, whichever provides longer coverage for you. When a product or part is exchanged, any replacement item becomes your property and the replaced item becomes NuForce's property. When a refund is given, your product becomes NuForce's property.

#### **OBTAINING WARRANTY SERVICE**

If you purchased the product in the U.S., deliver the product, at your expense, to any NuForce Service Center located in the U.S. If you purchased the product outside of the U.S., deliver the product to any NuForce Authorized Importer in the country where you purchased the product. Be aware, however, that not all countries have NuForce Authorized Service Providers and not all Authorized Service Providers outside the country of purchase have all parts or replacement units for the product. If the product cannot be repaired or replaced in the country it is in, it may need to be sent to a different country or returned to the country of purchase at your expense for repair or replacement. You can always deliver the product to NuForce's U.S. main service center for obtaining warranty service.

#### **EXCLUSIONS AND LIMITATIONS**

This Limited Warranty applies only to hardware products manufactured by or for NuForce that can be identified by the "NuForce" trademark, trade name, or logo affixed to them. The Limited Warranty does not apply to any non-NuForce hardware products or any accessories, even if packaged or sold with NuForce hardware. Non-NuForce manufacturers, suppliers, may provide their own warranties. Other accessories distributed by NuForce under the NuForce brand name are not covered under this Limited Warranty. This warranty does not apply: (a) to damage caused by accident, abuse, misuse, misapplication, or non-NuForce products; (b) to damage caused by service performed by anyone who is not an NuForce Authorized Service Provider; (c) to a product or a part that has been modified without the written permission of NuForce; or (d) if any NuForce serial number has been removed or defaced.

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