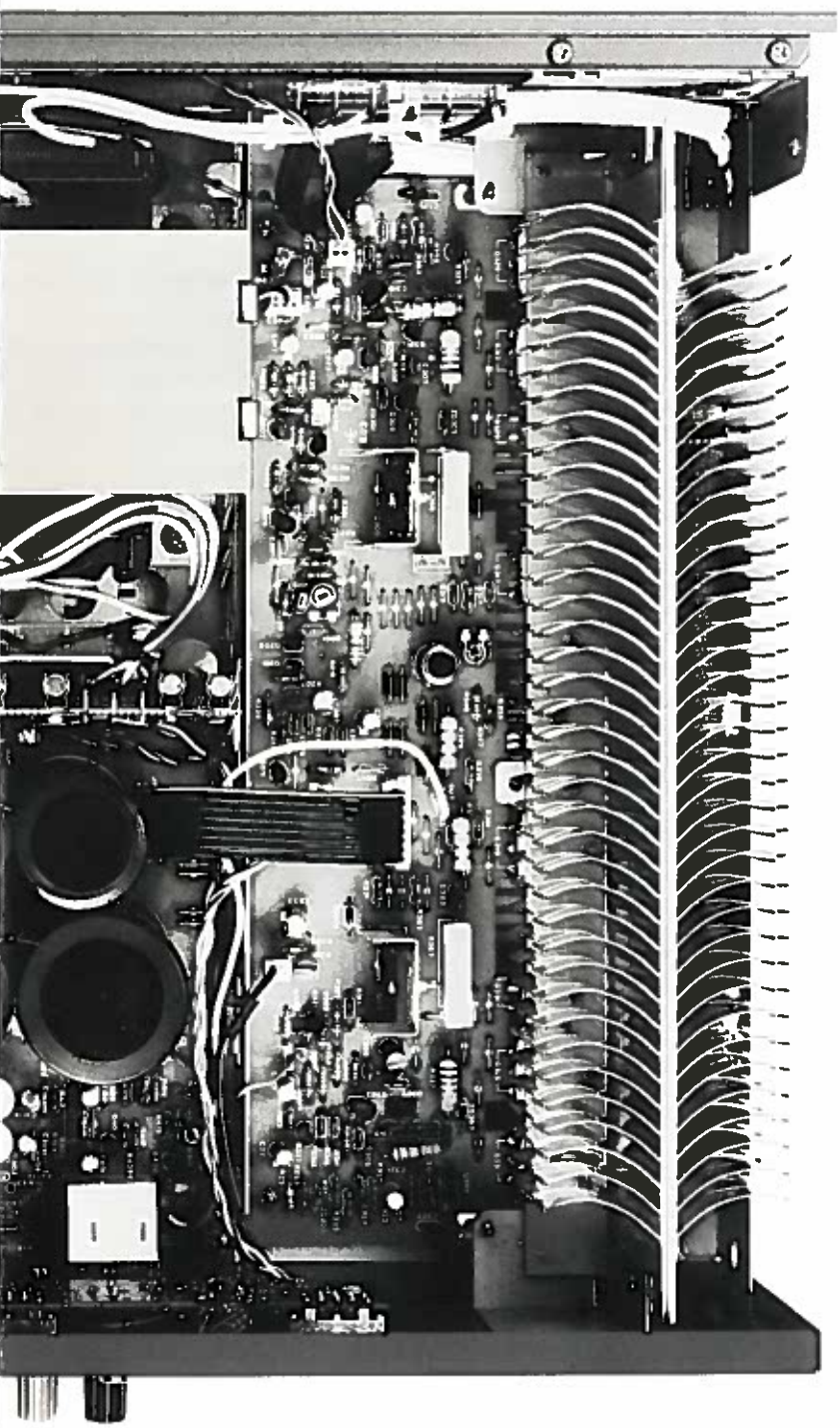
NAD

THE POWER ENVELOPE



A NEW GENERATION OF NAD AMPLIFIERS.

For several years NAD has led the industry in producing affordable stereo amplifiers that deliver unexpectedly large amounts of real speaker-driving power for the reproduction of music. NAD amplifiers have always employed massive power supplies and large transistors with high current capacity (to drive the low and complex impedances of loudspeakers), with an extra margin of dynamic headroom for musical transients. Now, as other manufacturers have begun to follow NAD's lead in these areas, NAD is launching a new generation of amplifiers that establish completely new standards for musically useful dynamic power.

The key to these new amplifiers, as with all NAD products, is that they go beyond conventional specifications and laboratory tests to provide optimum performance under the real conditions of everyday use. NAD amplifiers are designed, first and foremost, to reproduce the dynamically varying waveforms of music—not just sine-wave test tones.

THE DYNAMIC ENVELOPE OF MUSIC.

All amplifiers have a "continuous" or RMS power rating, measured with a constant-level test tone. But music is not a constant tone: it changes with each surging chord and pulsing beat. Music has a high "peak to average" ratio, meaning that in virtually every musical sound there are short-term peaks whose intensity is several decibels greater than the average level.

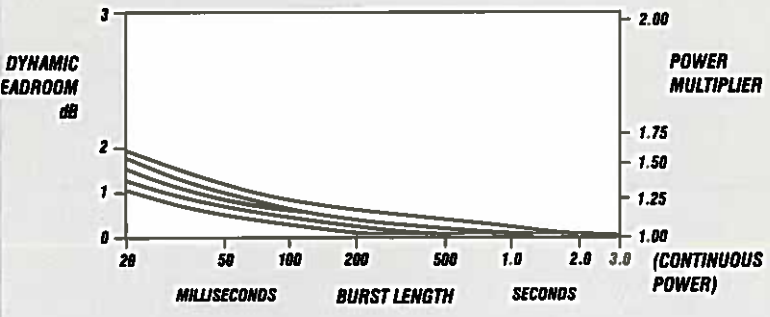
This can be seen in tape recorders: the flickering LEDs of a "peak-reading" display often register momentary bursts of sound that are several dB higher than the averaged level shown on a VU meter. This characteristic is obvious in the accompanying photographs, each showing the intensity of musical sound over a period of two seconds. For example in Figure 5, a two-second excerpt of a popular song played at high volume, bursts of high intensity (during each note and syllable) alternate with the brief near-silences between notes when only the reverberation of the previous note is heard. The average power may be no higher than 30 watts, but it consists of 100-watt bursts paired with intervals in which the power drops to 5 watts.

Similar patterns are seen in the other two-second samples of music shown here: an instrumental portion of the same song (Fig. 6), some loud rock music with a driving beat (Fig. 7), a solo piano (Fig. 8), and a symphony orchestra (Fig. 9). Even in Fig. 10 (a massive full chord played on a pipe organ), the signal level is not constant; the highest power levels occur in brief transients that last for only a few hundredths of a second.

Recognizing this fact, modern amplifiers are designed to deliver higher power for brief transients than for continuous tones. This is measured by the IHF "dynamic headroom" test, in which a tone is switched on for only 0.02 second (20 milliseconds). In specifications and test reports, the "continuous" RMS power represents the amplifier's ability to play constant test tones, while the "dynamic headroom" tells you how much extra power the amp can deliver in a short burst.

The very brief tone-bursts in the IHF headroom test are similar to the musical impulses seen in Fig. 6. What, then, is the amplifier's ability to deliver extra power not only for transients lasting a few thousandths of a second, but for the longer bursts seen in the other examples—for 100, 200, or 300 milliseconds, the duration of the notes in music? That is measured by the "dynamic power envelope", which shows an amplifier's maximum undistorted power *as a function of time.*

Figure 1.



Power Envelope Curves for several conventional amplifiers.

THE POWER ENVELOPE.

Figure 1 shows the power envelope curves for several fine amplifiers. The height of each curve at the left-hand edge of the graph is the amplifier's dynamic headroom as measured in the standard IHF test, with a 20-millisecond tone-burst. At the right-hand edge of the graph all of the curves approach the 0 dB reference level, which is the amplifier's maximum undistorted power for continuous test tones.

As the graph shows, in good amplifiers of conventional design the IHF dynamic headroom, as measured with a tone-burst only 20 milliseconds long, is typically about 1.5 dB (i.e. about 40 percent) higher than the maximum steady-state power. With a tone-burst that lasts for 200 or 300 milliseconds, the duration of a typical note of music, the dynamic headroom of a normal amplifier is no more than 0.5 dB, or 12 percent above the maximum steady-state power.

Compare that to Figure 2, the power envelope of a new NAD amplifier. The headroom for short 20-millisecond bursts is not just 40 percent but a full 300 percent higher than the continuous power. For the 300-millisecond duration of a long musical note, the headroom is not just 12 percent but 250 percent greater than the steady-state level!

Figure 2.

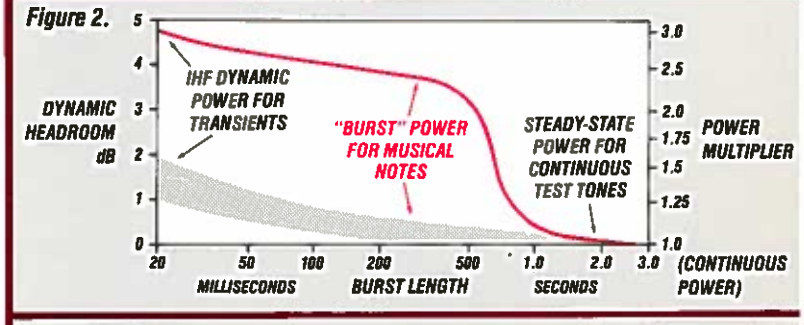
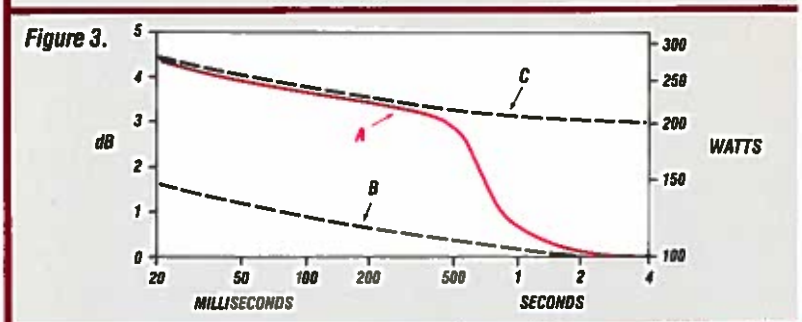


Figure 3.



The practical consequence of Power Envelope design is seen in Figure 3, which compares the power envelopes of a new NAD amplifier (A) and two competing amplifiers of conventional design. Amplifier B has the same continuous power output, and therefore costs about the same to manufacture, as the NAD amplifier; but it has only half as much useful power for the bursts in music. Amplifier C has the same musically useful power as the NAD amp. But in order to achieve that output, Amplifier C had to be designed with a high level of continuous power for test tones—expensive power that heats the amplifier, and raises its cost, but is never used for music. (With any amplifier, you will normally set your volume control so that the loudest musical bursts remain undistorted, and in all types of music the long-term average power is several dB lower than those peak levels.)

It may fairly be said that the new NAD Power Envelope amplifiers and receivers are the first line of audio electronics designed to play music rather than test tones.

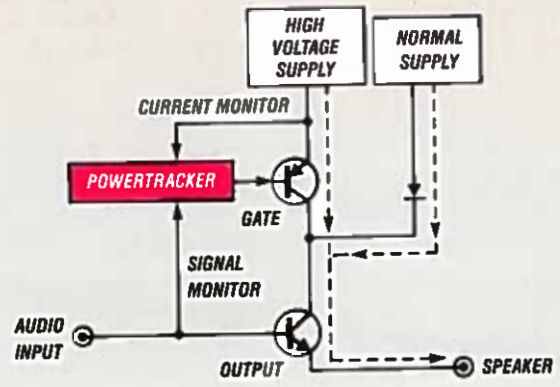
HOW IT WORKS: THE POWERTRACKER.

Any power amplifier consists of two parts: a power supply and an audio circuit. The audio circuit functions as an electronic valve, opening and closing to feed current from the power supply to the loudspeaker in accordance with the demands of the audio signal. Since power is the product of voltage and current, the amplifier's maximum output is determined by the voltage of the power supply and by the current-carrying capacity of the circuit. A genuinely powerful amplifier is one that operates at high voltage and can deliver high current.

If the amplifier were built for *continuous* operation at these high voltages and currents, it would require an enormous power transformer, special filter capacitors, plus an elaborate system of heat sink fins and ventilation to dissipate the resulting waste heat. The manufacturing cost of the amplifier would be doubled or tripled, for no purpose. But music is dynamic, requiring maximum power only in bursts—not continuously.

A NAD "Power Envelope" amplifier meets the dynamic needs of music by employing two power supplies: a lower-voltage supply that operates up to the amplifier's rated continuous power level (with normally modest heating and modest cost), plus a high-voltage supply that is used only when high power is needed. The key to its operation is the NAD PowerTracker control circuit, whose operation is illustrated in Fig. 4. At normal signal levels the lower-voltage supply provides all current to the output. When the audio signal rises above the amplifier's rated RMS power level, the PowerTracker's "gate" turns on, allowing maximum current to flow from the high-voltage supply.

Figure 4.



The PowerTracker control circuit.

The high-voltage supply contains a solid-state memory device that functions as an elegantly simple analog computer, monitoring both the heating of the power supply and the flow of current. If the output has been fluctuating up and down (i.e. playing music), then the average current is modest, and the high-voltage supply remains available to provide maximum current on demand. But if the average goes up, reflecting constantly high output for more than a few seconds, then the high-voltage supply shuts down and the amplifier reverts to the lower-voltage supply.

Thus, as long as the amplifier is playing normally dynamic music signals, it can provide the high voltage and high current of a very powerful amplifier. But if it is fed a continuous high-level test tone (or is constantly overdriven by a careless user), the amplifier automatically closes down to its rated power level to protect itself and avoid overheating.

GETTING THE DETAILS RIGHT:

In some amplifiers with switched power supplies, the switching transients can introduce distortion. The design of the PowerTracker circuit provides double insurance against this. First, no switching ever occurs at low signal levels, where even a small amount of distortion might be obtrusive. The lower-voltage supply produces all output up to, and including, the amplifier's rated continuous power level. The high-voltage supply is used only to produce bursts of power above the rated RMS output, in the top 6 dB of the music's dynamic range. Relative to this high level, a switching transient would introduce an inaudibly small percentage of distortion.

Second, there is no abrupt switching between supplies. The output stage is permanently connected to the lower-voltage supply, and an electronic gate opens to allow current to flow from the high-voltage supply when needed. It opens quickly enough to provide full power for high-level bursts of music, but smoothly enough that no false transients are added to the signal.

As a further bonus, the PowerTracker circuit is simple, elegant, foolproof, and adds very little to the amplifier's cost. Most important, these new "Power Envelope" amplifiers retain all of the sonic virtues and price/performance value that have made NAD a world-wide favorite.

Close-tracking Soft Clipping.™ NAD premiered the use of Soft Clipping in solid-state amplifiers, gently rounding off waveform corners to prevent harsh distortion when the demands of the musical signal exceed the amplifier's limit. The newly improved circuit accurately tracks the available peak power, regardless of speaker impedance, keeping the amplifier's sound clean and transparent right up to the maximum output level. So even if you manage to overdrive the amplifier at high volume levels, it will continue to sound musical.

High-current design. Current flowing through the voice-coil is what causes a speaker to produce sound, and NAD was the first manufacturer to emphasize the importance of high output current capacity, unrestricted by so-called protection circuits, to cope with the complex and reactive impedance that many speakers present. Even the smallest NAD amplifier can deliver peak currents in excess of 15 amperes, and larger models produce up to 50 amperes to drive any loudspeaker without distortion or limiting.

Ultra-low noise. Lifelike reproduction of musical sound requires delicacy to handle very small signals as well as power for the big moments. Every NAD amplifier is designed with low-impedance circuits so that no low-level hiss or hum can intrude on the quiet background of the music. A stereo system based on NAD electronics is a clear, transparent window through which the widest-range analog and digital recordings can be enjoyed.

Chief Engineer Peter Bath at the NAD Electronics Research Lab in London.

Bjørn-Erik Edvardsen, NAD's Directo Research and principal designer of t Power Envelope circuit.

Dynamic Envelopes Of Various Musical Signals.

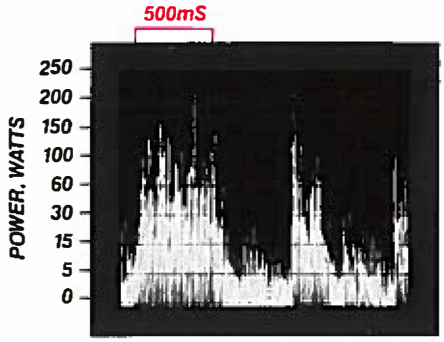


Figure 5. Bee Gees, "Paradise."

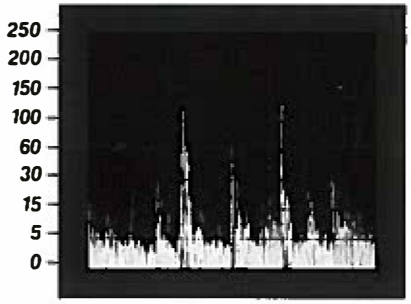


Figure 6. Bee Gees, "Paradise."

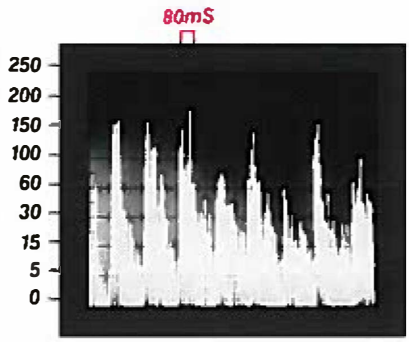


Figure 7. Genesis, "No Reply At All."

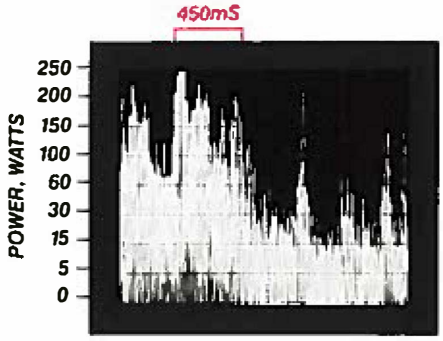


Figure 8. Chopin, "Polonaise."

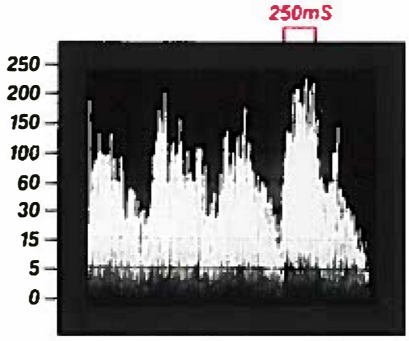


Figure 9. Bruckner, Symphony No. 4

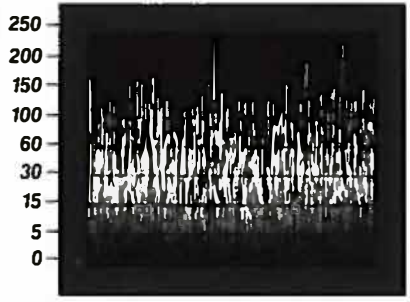


Figure 10. Bach, Toccata.

AN UNCOMMON COMPANY.

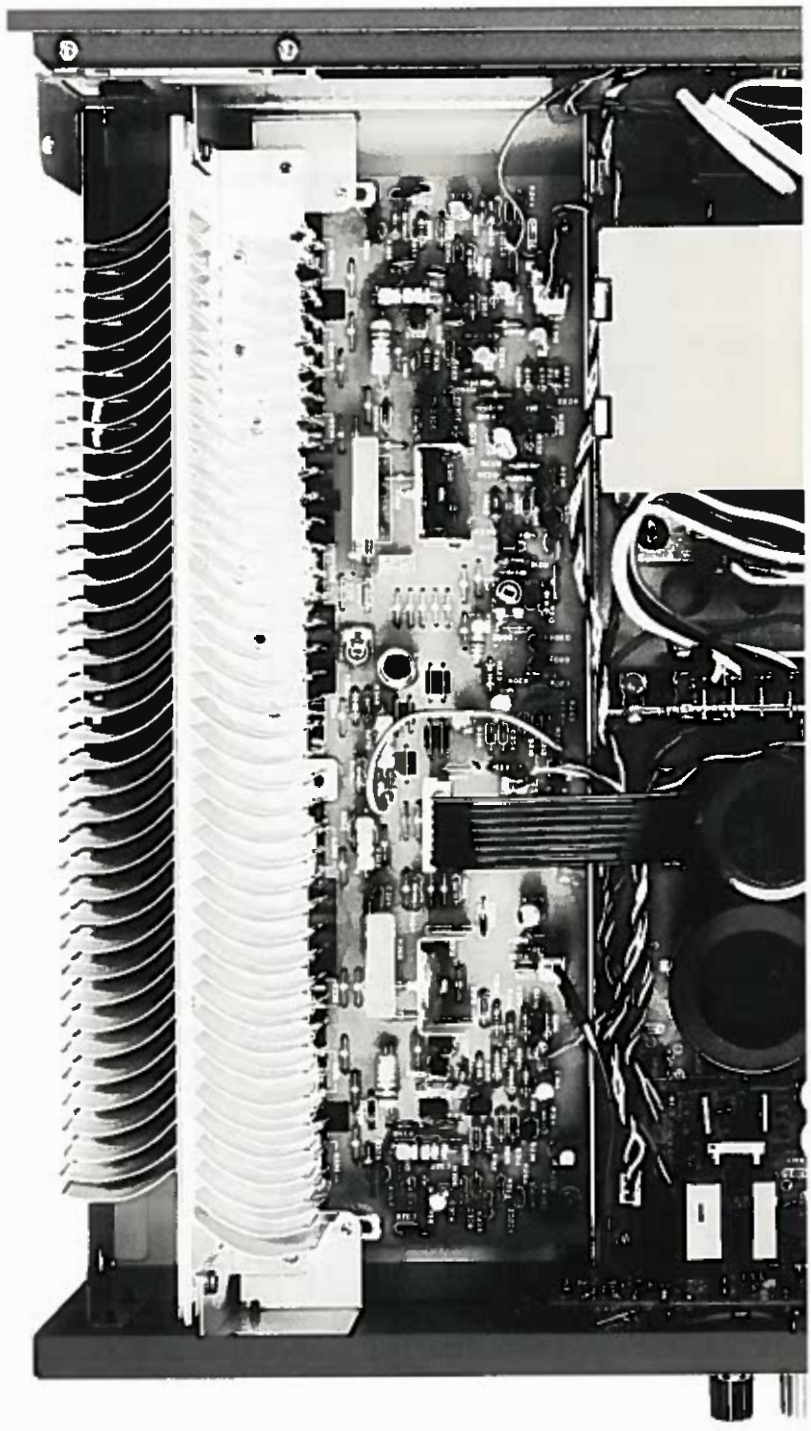
NAD, founded in 1972, is an international association of high fidelity specialists. Incorporating the most advanced engineering concepts available, NAD produces state-of-the-art components at affordable prices.

Our uncommonly rational approach to audio design and dedication to simplicity and value has brought critical acclaim from audio reviewers around the world.

We don't just try to make products with imposing specifications. Our engineers step outside of the laboratory to study actual listening environments and the effects of interaction between components in a complete audio system. No compromises whatsoever are made in the design areas which directly affect performance in real-use conditions. The circuits and features of every NAD component are designed for maximum efficiency and effectiveness, to offer the best possible sound quality regardless of power rating or price.

NAD's organization is as unconventional as its product philosophy. The people who sell and market the product are the people who have the closest association with the consumer, and therefore, the greatest understanding of his needs. NAD dealers and distributors from over 29 countries participate in planning sessions at local and international conferences. Working closely with NAD engineers and consultants, they develop the new products and concepts that make NAD components so unique.

From all over the world, NAD has invited the leading experts in each aspect of audio technology to participate in creating an NAD product. We believe it is this combination of an uncommon company with an uncommon philosophy which results in products that have become "classics" in their own time.



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BOSTON/LONDON