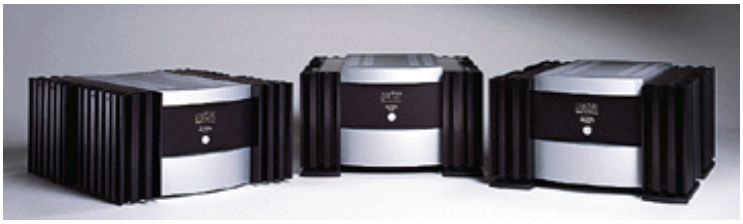
Mark Levinson 300-Series Dual Monaural Power Amplifiers

The ML Nº 333 is chosen product of the year by Italy's *Suono* magazine!

Some History

Mark Levinson power amplifiers enjoy a long and rich heritage. From 1977's legendary ML-2 Monaural Power Amplifiers to the awesome Nº33 Reference design, Mark Levinson products consistently have defined the state of the art. The Nº33, in particular, represents the culmination of over 20 years' experience designing and building the world's finest amplifiers. Hailed around the world as one of the most important products in audio today, the Nº33 combines unmatched power with unparalleled precision to reproduce music with a sense of effortless grace that must be heard to be appreciated.

The Nº331, Nº332, and Nº333 Dual Monaural Power Amplifiers derive in large part from the technological innovations contained within the Nº33. They deliver a significant portion of the excellence of the Nº33 in a more practical package that can be enjoyed by a wider range of music lovers. Like the Nº33 before them, the Mark Levinson 300-series Dual Monaural power amplifiers defy the accepted wisdom that it is impossible to design a large, powerful amplifier that also exhibits the finesse of the finest smaller amplifiers.



Design Overview

Power amplifiers are logically divided into two main functional areas: the power supply that provides a reservoir of clean, clear power for the instantaneous needs of the music; and the actual audio circuitry that uses that power to make music. Further, the audio circuitry is divided between the voltage gain circuits that literally amplify the signal (by increasing the incoming voltage by some predetermined multiplier) and the output stage which then must provide all of the current needed to support the amplified voltage as it is passed to the loudspeaker.

Mark Levinson power amplifiers address all three of these crucial functional areas (power supply, voltage gain, and output stage) with innovative solutions to the challenges presented by each.

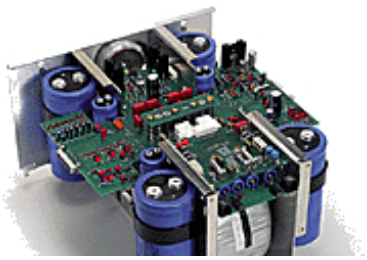
Massive Power Supplies

Each Mark Levinson 300-series amplifier includes two large, completely independent power supplies-one for each channel. Each supply includes a high capacity, low noise toroidal transformer, and two large, low ESR capacitors.

By contrast, traditional "stereo" amplifiers share a single, common power supply between both amplifier channels. Unfortunately, this means that the demands being placed on one channel can adversely influence the performance of the other.

While more costly to implement, the dual monaural design used by Mark Levinson amplifiers results in two separate amplifiers that share a single enclosure. This approach ensures that each channel is allowed to operate independently, delivering optimal performance at all times. The audible improvement in clarity, dynamics, and stereo imaging is obvious.

The two large power transformers within a 300-series amplifier are contained in a steel tunnel that runs from front to back down the center of the chassis. These Madrigal-designed, custom-made toroidal transformers radiate less electromagnetic interference (EMI) than other transformer designs. Moreover, the steel tunnel in which they are mounted is an effective shield, and the transformers themselves are oriented so as to minimize their potential adverse effects. This comprehensive approach to stopping EMI at its source is one reason for the seemingly effortless clarity exhibited by these amplifiers.



Heavy oxygen-free copper bus bars enhance the efficiency of power distribution within the amplifier and eliminate variances introduced by the wiring harnesses, etc. commonly found even in high performance amplifiers. This efficient power distribution system is further

supplemented by high frequency power supply "bypass" capacitors on individual PC boards. Critical circuitry use these "bypass caps" as local reservoirs of immediately accessible power. The resulting ready availability of power seen by the various circuits within the amplifier lays the foundation for both the pure power and the extraordinary finesse that characterizes the 300-series.

As with previous Mark Levinson amplifiers, the 300-series incorporates AC line filtering. Such filtering removes much of the electrical noise that might exist on your AC service before it can even reach the power supply, much less the amplifier circuitry itself. AC line filtering makes the amplifiers less sensitive to the varying quality of the AC mains service around the world than amplifiers lacking such filters, thereby assuring superior results under a wider range of circumstances.

All 300-series amplifiers also employ inrush limiting to protect and preserve the high quality of the expensive power supply components. When a 300-series amplifier is first plugged into the wall outlet, it is "off." A small power supply draws only a few watts, just enough for the protection and control circuitry to operate. When you first press the standby button, this protection and control circuitry moves the amplifier from "off" to "standby" during which time the inrush current is controlled, allowing the power supply to charge up slowly and gently. After the power supply is fully charged (about ten seconds), pressing the "standby" button a second time will advance the amplifier to "operate," at which time music may be enjoyed.

There are several benefits to having a true "standby" condition. When in standby, the power supply remains powered up, as does the sensitive voltage gain circuitry. Only the output stages are shut down in order to conserve energy (since they are the largest consumers of power in the amplifier). This way, the power supply components are never stressed through everyday charge/discharge cycles, and the voltage gain circuitry is always warmed up and sounding its best. Taking the amplifier from "standby" to "operate" brings the output stages on line. By virtue of their using more power than the other portions of the amplifier, they warm up faster and can be performing at their maximum potential within a short time. (In fact, without a true standby, you are probably better off leaving your power amplifier on at all times.) Lastly, standby operation allows remote-controlled turn-on and turn-off of the amplifiers from a Linked Mark Levinson preamplifier.

Optimized Power

The power supply provides the foundation for both the voltage gain and the output stage sections of the audio circuitry. Yet the requirements of the voltage gain and the output stage are quite dissimilar. Optimizing these stages for their unique requirements is one of the secrets to achieving the sonic benefits associated with smaller amplifiers, while retaining impressive output power capabilities.

Since the voltage gain stages actually magnify the signal, any flaws in the process are especially audible. In photographic terms, the voltage gain stages are like using a telephoto lens on a camera, enlarging an image that would otherwise be too small to be useful. In this context, the power supply serves as a rock-solid tripod that supports the camera. Even the smallest instability in this tripod will blur the details of the image being photographed. Similarly, even the smallest imperfections in the amplifier's power supply will limit the available detail and resolution of the musical signal. Thus, voltage gain stages require absolute precision and consistency above all else. For this reason, the portion of the power supply feeding the voltage gain stages is independently and fully regulated.

In the Nº333 and Nº332, voltage gain power supply regulation is performed by a two stage, discrete differential amplifier, whereas the Nº331 uses a monolithic regulator better suited to its lower operating voltages. In either case, these regulators are like using small, dedicated amplifiers to provide the cleanest possible power to the voltage gain circuitry.

In contrast with the voltage gain circuitry, the output stage requires a combination of precision and brute strength to be able to enforce the preamplifier's musical instructions with great accuracy. Rather than magnifying the signal, the output stage is supposed to pass on the voltage it is given without change, while at the same time providing the large electrical currents demanded by the speaker at those voltages. (For this reason, the output stage is sometimes called the "current gain stage.") The power supply must be able to provide these sometimes huge amounts of current with great precision, and without "running dry" under duress.

Voltage Gain

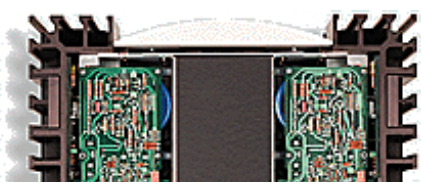
A preamplifier passes a relatively small signal to the power amplifier. The power amplifier must first receive this signal in a way that does not alter it at all, and then magnify it to a level commensurate with what a speaker might require. This is the task of the voltage gain circuitry.

As simple as it sounds, receiving the signal without altering it is difficult. The finest modern preamplifiers use balanced outputs to optimize the integrity of the signal transmission from preamp to amp. In order to achieve peak performance, this balanced signal must be received and handled in such as way as to preserve every iota of information contained therein.

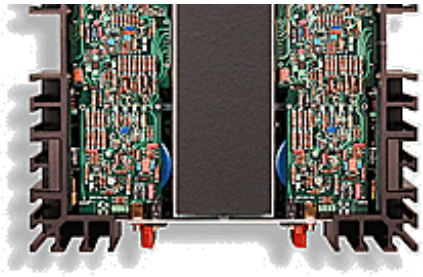
A new differential amplifier topology takes the receiving and amplification of balanced audio signals to a new level in the 300-series amplifiers. Uniquely, the fully balanced voltage gain section of the 300-series eliminates the need for an input buffer. This approach provides precise matching of impedances at the amplifier's input terminals and a truly balanced handling of balanced audio inputs. The result is vastly improved rejection of common mode noise (noise picked up between the preamp and the amp, for example) and greater low level detail than previously possible.

The input stage of the 300-series amplifiers also employs a new DC servo to correct and eliminate any residual DC offset that might come from the preamplifier. This servo can correct for as much as one full volt of DC offset. In the event of a catastrophic failure in the preamplifier resulting in DC offset even larger than a volt, the power amplifier will simply shut down to prevent potential damage to the loudspeaker.

Both the fully balanced voltage gain circuitry and the remarkable DC servo in the 300-series amplifiers derive directly from the groundbreaking Nº33 Reference Monaural Power Amplifier. The result is a "telephoto lens" of exceptional quality, yielding a larger version of the signal provided by the preamplifier that is unchanged in virtually all other respects. More musical information and detail is retained in the 300-series than in any previous Mark Levinson two channel amplifier.

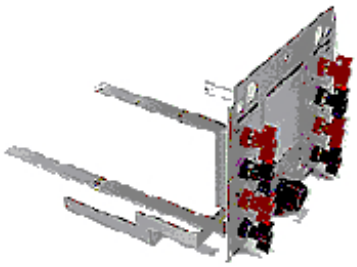


Output Stage



Once the music signal has been enlarged to an appropriate size, it must then be given the power required to move the loudspeaker. This is the task of the output stage of the amplifier: to maintain the same electrical pressure (voltage) it receives, while at the same time providing enough current to satisfy the needs of the loudspeaker.

To better understand this, it is helpful to think in terms of everyday plumbing. Imagine the amplifier represented by a high quality pump; that pump is designed to maintain a certain pressure (voltage, the music signal); the output stage must maintain precisely that pressure in the face of suddenly having to fill a rather large diameter pipe (whereas previously, the pipe may have been the size of a garden hose or less). Obviously, if either the supply of water (power supply) or the pump itself (the output stage) is not up to the task of filling that large pipe (the speaker), the pressure will dip. Any departure from the correct pressure, for any reason, represents an important form of distortion.



Just as heavy copper bars carry power from the power supply to the output stage, additional solid copper bus bars carry the high current signal from the output stage directly to the speaker terminals, without any intervening wires or relays (either of which would limit performance). This routing of power on heavy bus bars provides a lower-impedance path for the power to the speaker terminals than can be had with even extremely heavy gauge wire. It also eliminates the small unit-to-unit variations that might otherwise be expected from variations in the placement of flexible wires through the inside of the amplifier. These rigid bars offer no room for unwanted variations that could undermine performance.

Adaptive Biasing

Although a comprehensive discussion of the technical details of biasing of output stages is beyond the scope of this literature, there are one or two salient points that may be made here. (Technically-inclined readers interested in more detail on the nature of the Madrigal Adaptive Biasing System should ask their dealer for a copy of the Technical Discussion paper on the subject.)

Magazines and product literature have both contributed to a great deal of poorly-informed discussion of "class A" operation over the years. Unfortunately, the thermal management problems of true class A operation in a high-current output stage are severe, and introduce serious sonic compromises of their own. For this reason, the output stages of Mark Levinson 300-series amplifiers are not class-A biased in a traditional fashion. (All voltage gain stages of the 300-series amplifiers are biased to operate in a full class A mode in order to keep the active devices safely within their most linear, distortion-free range at all times.)

Proper biasing ensures that transistors always operate in their lowest-distortion region. Specifically, transistors generate distortions when they turn on and turn off. Bias keeps them at idle, much like the idle speed of your car's engine, so they are ready to do their job when called upon to do so.

At any instant, the ideal amount of output stage bias is determined by both the voltage and the current required by the output. Other variable bias systems fail to live up to their promise because they merely track the input signal in a more-or-less proportional fashion, failing to take into account the specific needs of the loudspeaker's impedance.

Rather than having only one fixed bias at which it operates (as with traditional Class A designs), or varying the bias level as a function of the input signal only (resulting in a system that spends most of its time either over- or under-biased), the proprietary adaptive biasing scheme developed by Madrigal looks at both the input and the output, to maintain the correct bias at all times. Introduced in the N°33 Reference Monaural Amplifiers, this adaptive biasing system has been hailed as a breakthrough in output stage design.

The 300-series amplifiers therefore enjoy the sonic advantages of a Class A output stage without incurring the substantial inefficiencies and consequent thermal problems of fixed-bias Class A operation. Uniquely, this continuously variable adaptive biasing scheme never allows the output devices themselves to be reverse-biased. This approach results in greatly reduced dynamic distortions, and a sweeter sound that exhibits a greater sense of ease at all volume levels.

Attending to the Details

Often, the difference between a fine product and a genuinely exceptional one lies in the details. Countless hours were spent during the development of the N°33 and the subsequent 300-series to ensure that these details were completely addressed.

A careful examination of "bottlenecks" in the routing of power from the AC mains through the power supply to the output of the amplifier resulted in several unique innovations. Simply put, any path along which significant currents must travel is constructed from solid copper bus bars rather than using the more traditional thin copper "traces" on a circuit board. For example, the power conducted from the power supply directly to the output devices travels on solid copper bus bars. These large, heavy bars run directly from the large filter capacitors in the power supply to the output transistors to provide the electrical equivalent of an eight lane superhighway for the movement of power. In this way, power moves from where it is stored to where it is needed freely and without practical limitation.

The physical layout of the amplifier keeps even these "superhighways" as short as possible. If you look inside the 300-series amplifiers, you will note that the power supply resides in the center with the amplifier proper wrapped tightly around it. The dense layout deliberately keeps the signal path as short as possible.

Further attention to detail is evidenced by the many brass fittings seen within the amplifiers. Wherever there is a mechanical connection through which electrical currents must flow (for example, the screws that both hold the output transistors in place and ground them to their heatsinks), brass fittings are used rather than the more common steel ones. This is because an electrochemical reaction takes place when electrical currents flow through a junction of dissimilar metals. The result of this reaction would be the creation of a white, powdery residue that actually inhibits electrical flow. By using brass, with its high copper content, we avoid the build-up of this residue and the resulting deterioration of performance over the

years seen in other designs.

While looking at the brass screws holding the output transistors in place, note that the transistors themselves have been color-coded (note the painted stripes on the metal cases). After purchasing the tightest-tolerance output devices Motorola sells, we further hand test and sort them to meet our own, more demanding specification. Only sets of transistors having carefully matched characteristics are used, to ensure that each carries its own share of the load-no more, no less. In this way they all run at the same temperature, and none are working harder than any others, yielding improvements in sound quality, reliability and longevity.

A close look at the printed circuit boards in these amplifiers also reveals an absence of any flux residue. Solder flux is a cleaning agent applied to the surfaces to be soldered together that is essential to good quality connections. It is corrosive by its nature. Flux residue left on the circuit boards after soldering must be cleaned off to avoid damage and to minimize unit to unit variations in sound quality based on the random placement of this corrosive (and mildly capacitive) material over the surface of the board. Surprisingly, many costly, hand-built products fail to meet minimum standards when it comes to this important (but easily overlooked) test.

The extensive attention to detail exhibited in all Mark Levinson products contributes to their excellent retained value: they simply sound better when new, and avoid the gradual deterioration so common in other designs.

Extensive Protection

Of course, with the vast amounts of power that can be delivered by such an amplifier, extensive protection against possible turn-on transients and various fault conditions is crucial. The 300-series power amplifiers shut themselves down if they sense any of a number of fault conditions that could damage either themselves or the loudspeakers. These fault conditions include:

- the presence of DC (direct current) at the output
- either over-voltage or under-voltage conditions on the AC mains (±10%)
- unsafe operating temperatures in any of several critical areas within the amplifier

If any of these fault conditions is sensed while the amplifier is in either standby or fully on, the amplifier will shut down completely ("off," not merely "standby"). It will not turn on again until the fault condition is corrected.

In addition, the AC input to each transformer is fused to protect against the possibility of sustained driving of a dead short circuit (as might happen if speaker wires were accidently crossed).

Finally, 300-series amplifiers incorporate a controlled clipping circuit that prevents the output devices from saturating. The harsh high frequency harmonics generated by hard-clipped output devices are avoided by the gentle waveshaping action of this controlled clip circuitry.

A True Voltage Source

The 300-series power amplifiers operate as virtually perfect textbook cases of a "voltage source." This is to say that they will maintain whatever the appropriate voltage might be at any moment (given the demands of the music, and within the rated voltage output of the amplifier) without any particular regard for the current demands of the loudspeaker.

Because of this "voltage source" characteristic, the 300-series amplifiers double their rated power output every time the loudspeaker impedance is cut by half. For example, the Nº333's continuous rated power (measured from 20Hz-20kHz, both channels driven, with less than 0.5% distortion) is 300 watts per channel at 8; 600 watts per channel at 4; 1200 watts per channel at 2-assuming the electrical circuit in the wall can support these extraordinary power levels. (Note that a continuous 2 test of the Nº333 at maximum power requires about 45 amperes at 120V; hence the necessarily heavy, captive power cord. The laws of physics refuse to be cheated. Long-term, you cannot deliver more power into the speaker the wall can supply.)

Thirty-two output transistors are distributed in the heatsinks of the Nº333 to conduct and control the flow of its remarkable power capabilities to the loudspeaker. There are eight matched, complementary pairs of output transistors in each channel of the amplifier. Similarly, the Nº332 uses twenty-four transistors in six matched, complementary pairs of output transistors for each channel, and the Nº331 uses sixteen output transistors in four matched, complementary pairs of output transistors for each channel.

No known high quality loudspeaker can absorb the continuous full power capability of the Nº333. (Nor would you want to be present in the room were you to find one that could do so.) However, many high quality loudspeakers may require rather extreme power levels on a short term basis when reproducing music at realistic levels. The 300-series amplifiers can answer these needs with impunity, without power supply "sag" and without altering their sonic performance in any way. The resultant imperturbable nature of these amplifiers is reflected in the authority and control with which they reproduce music.

With the introduction of the 300-series power amplifiers, the conventional wisdom is undone. The apparent tradeoffs between the qualities of small, "finesse" amplifiers and large, "powerhouse" amplifiers no longer apply. All three Mark Levinson dual monaural power amplifiers combine sophisti-cation and strength in an unprecedented way. As might be expected, the larger amplifiers have even greater strength, and exhibit superior dynamic capabilities as a result.

This literature has been designed to illuminate some of the concepts and features of the finest dual monaural amplifiers ever to bear the prestigious Mark Levinson trademark. Please use it as a guide to your understanding, and not as a substitute for the experience of auditioning these special products.

A limited group of dealers who specialize in creating high performance audio systems have purchased 300-series amplifiers for their showrooms. We encourage you to arrange a visit with one of them to see and hear these fine instruments firsthand.

All Mark Levinson products are hand built in limited quantities to exacting standards. The thoughtful, multi-disciplined design and engineering expertise contained in a Mark Levinson component can be appreciated fully only by personally examining the product thoroughly, both inside and out, in conjunction with a careful audition.

The unique performance and extraordinary build quality of Mark Levinson products are realized only when integrated into a properly designed system. Our worldwide network of authorized dealers and distributors has been trained in the details and operation of our products and others which together reproduce music in its finest expression. We recommend that you contact the representative in your area to evaluate and purchase these fine instruments.

300-Series Specifications

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