

MADRIGAL

N° 31 Reference CD Transport



The Mark Levinson No. 30 Reference Digital Processor set new standards for digital-to-analog conversion. Now the No. 31 Reference CD Transport enhances the process of recovering music from Compact Discs, bringing a new level of performance to this most popular digital medium.

Digital audio is a two-dimensional medium, containing information about amplitude and time. While much has been made of perfectly recovering the numbers corresponding to amplitude, Madrigal has led the effort to refine performance in the time dimension of digital audio.

By analog standards, even inexpensive CD players can recover time-domain information with astonishing accuracy (in the range of thousandths-of-a-millionth of a second). Prompted by controlled listening tests, however, research revealed the need for accuracy a thousand times more precise to fully recover the information contained in digital audio.

Time-domain accuracy in picoseconds (millionths-of-a-millionth of a second) within the current CD standard strains the capabilities of current technology. It requires painstaking attention to mechanical and electronic details, far beyond that needed for superior analog reproduction. The primary advantage of the N° 31's technical features is greater time-domain accuracy, and the listener benefits through a more complete musical experience.

MECHANICAL TECHNOLOGY

One benefit of the CD medium is its relative immunity to the mechanical constraints of analog record players. It's possible, for example, to play a CD in a car traveling on a bumpy road. Still, such conditions don't allow for the full sonic potential of the CD medium. The N° 31's extraordinary mechanical design contributes significantly; it's the foundation for its sonic performance.

VIBRATION ISOLATION

Vibration can affect the performance of any mechanical device. In a CD transport, reliability and durability are affected by vibration, but ultimately, musical performance is as well. The exceptional musical clarity of the N° 31 derives, in part, from measures taken to control unwanted vibrations in the rotating disc.

As the foundation of a building provides a firm base for everything built on top of it, a CD transport's supporting members must provide a mechanically inert and stable platform for top performance. To best match the surface on which it's placed, the N° 31's feet can be used in two different ways. Where the mechanical stability of supporting furniture suggests that the N° 31 should be isolated from it (rather than coupled to it), or when a fine finish might be marred by spikes, the machined-aluminum feet may be used. The feet's energy-absorbent pads generally prevent slipping (even on highly polished surfaces), but won't stick, rub off, or discolor. Alternatively, specially designed spikes (supplied with the N° 31) may replace the screws that hold the feet in place, mechanically coupling the chassis to an appropriate surface.

The N° 31's center section, which contains the laser and motor mechanisms, has a bottom plate constructed from an energy-absorbing material sandwiched between two different thicknesses of aluminum alloy. This extremely rigid platform also damps vibrational energy.

On top of the plinth established by the feet and bottom plate, approximately twelve pounds (5.44kg) of lead, sandwiched between aluminum plates, is suspended on tuned and vibrationally damped springs. (The lead is coated to prevent environmental contamination.) This assembly absorbs low-frequency energy, and its mass provides significant inertial damping of mechanical energy. The actual laser-and-motor assembly that reads the CD is further isolated from the lead-and-spring suspension by butyl rubber mounts and a spring-mounted frame, effective at damping higher-frequency energy.



When closed, the solid aluminum lid on the N° 31 seals against a rubber O-ring to prevent acoustic vibrations from reaching the CD during play. It also ensures that the only light on the CD comes from the laser itself. (Designs that allow you to see the spinning CD may be visually attractive, but they degrade performance by decreasing the optical signal-to-noise ratio.)

DAMPER DISC



While it spins, the CD itself tends to vibrate unless clamped over most of its surface. For several years, critical listeners have tried various dampers, weights, and innovative transport designs to audibly improve their CD system's performance - with limited success. Techniques developed at Madrigal allow us to objectively measure the effects of damping schemes and other vibration-reducing techniques. These measurements, confirmed by controlled listening tests, clearly demonstrate the effects of these mechanical adjustments.

Other designs' weighted clamps may effectively reduce the vibrations of the spinning disc, but they combine with the mass of the CD to greatly exceed the operating parameters of the transport's servo systems and motor bearings. This introduces time distortions more harmful to the music than those that are decreased, resulting in an audible change - for the

worse.

The damper designed for the N° 31 is made from carbon-fiber material, offering high rigidity with low mass. A carefully selected energy-absorbing material effectively couples the damper to the CD. The damper is startlingly low-mass (35 grams).

For adequate clamping force that doesn't exceed the mass specifications of the transport mechanism, a powerful neodymium magnet is attached to a precision-machined high-strength aluminum-alloy centering ring that positions the damper precisely on the motor hub. Magnetic force couples the damper to a disc better than a weighted damper with ten times the mass. A magnetic sensor in the N° 31's lid prevents play without the damper in place or when the lid is open.

The laser-and-motor assembly used in the N° 31 is the CDM-4 Industrial from Philips, chosen for durability and superior performance. Madrigal modifies it to reduce vibrations in its frame.

Four screws in the suspension assembly, accessible when the lid is open, may be easily adjusted to ensure that the CD suspension system is level. Although the sonic benefits may be subtle, proper leveling also helps ensure long-term performance by decreasing mechanical wear.

ELECTRONIC TECHNOLOGY

Matching the unprecedented care in the mechanical design of the N° 31 is a sophisticated electronic design for the control of the transport, recovery of the digital information contained on the CD, and transmission of this information to a processor.

POWER SUPPLIES

Care in the design of power supplies is essential for high-performance electronic circuits. The N° 31 not only filters and regulates AC mains power, but also provides "backward" filtering to prevent digital noise (arising in the N° 31) from returning to the AC mains and degrading the performance of other audio components.

The N° 31's towers contain the two master power supplies. The right tower contains the master supply for the microprocessor board (which controls the unit's operation), while the supply in the left tower powers the digital and analog circuits involved in the decoding process. AC enters through the right tower, where it's immediately filtered to remove unwanted noise. Two stages of filtering ensure optimal performance from the power supplies that follow. The supply in the left tower is powered by AC that's routed from the right tower through a special steel tunnel in the front of the chassis. The steel conduit provides the necessary shielding to prevent any AC noise from coupling onto nearby circuits. Both master supplies utilize active electronic regulation to purify the DC delivered to their respective circuits. After further passive filtering, separate electronic regulators in the left tower provide DC to the analog and digital sections of the decoder circuitry governing the sonic performance of this (or any) CD transport. Both towers may be easily opened and the power supplies removed for future upgrades, or in the unlikely event that service is required.

Although the separate power supplies isolated in the towers provide well-filtered and regulated DC, active electronic regulators are distributed throughout the N° 31's operational circuitry to provide a very low impedance immediately adjacent to the point of use, and to further isolate sections of the circuitry from each other.

DECODING

During CD playback, light reflected off of microscopic patterns on the CD generates an electrical signal in four photo diodes. The resulting analog signal contains a great deal of digital information: the description of a musical signal, sub-code information about contents of the disc and its unique serial number, and information needed for the positioning of the laser. Viewed on an oscilloscope, this EFM signal appears as overlapping sine waves in a distinctive pattern, often called an "eye pattern". This analog signal must be decoded into digital information, some of which is used to control additional analog servo circuitry guiding the laser, and some of which must be passed on to a digital processor for conversion back into an analog musical signal.

Unlike most high-end CD transports, the N° 31 uses entirely new and proprietary circuitry for decoding and for the laser servos. (Others use boards supplied by the laser's manufacturer, or simply lay out the laser manufacturer's circuit on their own board.) One of the N° 31's main performance advantages is the isolation of digital signals from analog signals that must exist on the same circuit board. By designing our own circuits, we prevent digital noise from interfering with the performance of the analog servo signals, and analog oscillations from introducing time distortions to the digital signals.

A result of this sophisticated design is more accurate control of the laser's position and focus. Distributed regulation of power to the servo circuitry also prevents current fluctuations (during demanding servo operation) from affecting the accuracy of the decoding of the musical signal.

While the shape of the eye pattern may change, research at Madrigal demonstrated that fluctuation or movement in the eye pattern indicates timing variations and reliably predicts sonic degradation. The N° 31's enhancements produce a remarkably stable eye pattern.

The timing accuracy of most digital transports is limited by the performance of a clocking crystal, a component of an integrated-circuit chip. The N° 31 employs a discrete, temperature-compensated, high-precision crystal, yielding better than 5.0 PPM accuracy of the DAS output. Since some processors achieve good performance only with transports meeting this Class 1 specification (due to limitations in their digital interface receivers), this ensures wide compatibility, plus top performance with the best processors.

OPTIMIZED DAS OUTPUTS

An aspect of digital audio performance not optimized in previous designs is the output transmitters and input receivers used to drive electrical or optical interconnect cables. (Perhaps because the accuracy of digital-data transmission between personal computers and printers appears perfect, it's easy to assume that digital audio is as simple. It isn't.) Many of the worst characteristics of what detractors call "digital sound" relate to poor implementation of digital interconnection. In the N° 31, each of the four types of interconnection currently used in digital audio is refined to an unprecedented level of performance.

The best method of digital interconnection is the standard developed by the Audio Engineering Society and the European Broadcasting Union (AES/EBU). It uses balanced interconnection via XLR connectors, providing noise reduction similar to balanced analog interconnection. At ten times the voltage of the consumer standard (5V versus 0.5V, nominal), it has a better intrinsic signal-to-noise ratio. The AES/EBU standard calls for 110 ohm output impedance, which is how the N° 31 is shipped. With some cables and receiver circuitry, however, better performance is achieved with low output impedances (<1 ohm); the N° 31 provides internal DIP-switches to lower its output impedance for compatibility with some other manufacturers' products.

We highly recommend Madrigal MDC-1 digital interconnect cable for use between Mark Levinson digital products, and with other products equipped with AES/EBU interconnection circuitry.

Most consumer digital products use the Sony/Philips Digital Interface Format (S/PDIF). With the enhancements designed into the N° 31, this interface is capable of quite excellent audio performance - in fact, when AES/EBU isn't available, we recommend using SPDIF. With the proper 75 ohm cable (such as [Madrigal MDC-2](#)) and receiver circuitry that provides adequate ground isolation, this interface can produce audio performance only slightly below the professional standard.

ST-optical digital interconnection was designed by AT&T for computer networking. Though not optimal for audio, it has certain advantages over digital interfaces found on some equipment. ST has a wider bandwidth than the more common EIAJ optical standard (often referred to by Toshiba's "Toslink®" trademark) and the coupling transformers used in most S/PDIF interfaces. It also provides ground-noise isolation often lacking in poorly designed electrical interfaces, and ST generally uses glass-fiber rather than plastic-fiber cables. ST is also recommended when digital-interconnection distances greater than fifty feet are required.

The ST implementation in the N° 31 uses Hewlett-Packard parts with twice the bandwidth of the AT&T parts, yet is fully compatible with AT&T receivers. This 100MHz bandwidth is less than half that of the AES/EBU and SPDIF circuitry on the N° 31, but it may perform better with processors with poorly implemented electrical inputs.

The N° 31 provides EIAJ output only for compatibility with equipment offering no other method of interconnection. Its limited bandwidth (less than 6MHz on the N° 31, and typically less than 4mhz) is inconsistent with high-quality audio performance. Where it must be used, glass-fiber cables may improve performance.

EASE OF USE

Not only has Madrigal engineered higher audio performance into the N° 31, we've also provided the most comprehensive selection of features to be found on any single-disc transport. This is made possible through our own unique hardware and software for digital control and communication. Years of development prepared Madrigal to offer Mark Levinson "30-Series" components with features that have been absent from other high-end products.

To complement the N° 31's elegant styling and to enhance its ease-of-use, great care and attention were given to the design of the IR remote control. Metal construction provides both durability and balance. The shapes, shades, and positions of the tactile-feedback buttons are simple, yet functional.

BASIC CONTROLS

The basic operating controls of the top-loading N° 31 are, logically, located on the top. Large aluminum buttons, with international symbols of their functions milled into their faces, provide easy control of Open/Close, Reverse Scan, Forward Scan, Stop, Play, Pause, Previous, and Next. Positive tactile feedback gives these switches a reassuringly solid feel. The large and legible display on the front panel uses LEDs (rather than a vacuum-fluorescent display) to avoid generating additional noise that might affect sonic performance. The brightness of the display adjusts to three levels (and off).

Four time-display modes may be selected during disc play: elapsed time on track, elapsed time on disc, time remaining on track, and time remaining on disc. Using the remote control, it's possible to directly access a specific time on a CD, interpreted in the context of the current time-display mode. (When elapsed time on disc is displayed, for example, entering "3:00" begins play three minutes into the disc. Making the same entry when time remaining on disc is displayed begins play three minutes before the end of the disc.)

When using some of the more advanced features, the N° 31's large display eases operation by providing clear status and instructions.

SOPHISTICATED PROGRAMMING

Simply playing a CD is easy using the top-panel controls. The N° 31 also offers a number of programming features to automate the playback of musical programs.

Tracks or indices are added to a program by displaying their number and pushing a + key. Up to 99 tracks and indices may be programmed, in any order. Alternatively, one or more selections may be "ignored" using a - key, leaving the unselected tracks or indices as the program. Either type of program can easily be reviewed and edited.

A program for custom playback of a particular CD, once created, may be saved with the push of a button. The next time that CD is played in the N° 31, it will play the same program - without the user having to re-enter it. Up to 1300 CDs' programs may be "remembered" in this way, and the N° 31 will remember these programs even if power is lost for as long as five years!

While limited versions of these features are available on some consumer transports, the N° 31 is the first to combine them on a high-performance unit.

INTELLIGENT INTERACTION WITH OTHER MARK LEVINSON PRODUCTS

The eight-pin data-communications ports on Mark Levinson 30-Series products allow them to "talk to each other," further simplifying their operation. When the N° 31 is linked to a Mark Levinson digital processor, for example, it selects the correct input of that processor when Play is selected on the transport. In a complex system with many digital sources, this prevents

frustrating moments of silence while seeking the proper input. If multiple N° 31s are connected to the same Mark Levinson processor, they will automatically be individually recognized. Similarly, adjusting the display intensity of a 30-Series component, via front-panel control or IR remote, carries out the same adjustment on all linked units.

In addition to track and index selections saved with a program, the N° 31 remembers the playback polarity for a linked Mark Levinson processor. Even if a particular program sequence isn't desired, discriminating listeners who had to mark their CDs with their preferred polarity settings (and had to remember to manually change their processors) will appreciate this convenience.

Ordinarily, the N° 31's forward and reverse scans allow a slightly muted signal to be heard. At the user's option, however, complete muting of a linked Mark Levinson processor may be automatically engaged for silent searches.

When the N° 31 is used with the N° 30 processor, and when the input to which the N° 31 is connected is selected for digital recording, an automatic record interlock on the N° 31 displays a warning, requiring a second confirming command to initiate any action that would disrupt the recording process. (This prevents that DAT copy you were making for your car from being accidentally altered.)

These features will enhance the musical experience for many people. On the other hand, we understand our sophisticated customers' right to exercise options. Therefore, the N° 31 provides the ability to customize its operation through software commands.

Moreover, being software-based on an easily replaceable (ZIF-socketed) EPROM, the N°31's features can be enhanced as technology evolves. In the N° 31, as in all Madrigal products, we make every effort to ensure enduring satisfaction for those who invest in our home-entertainment equipment.

[N° 31 Specifications](#)
