Spectral Audio, Inc.
442 Oakmead Parkway
Sunnyvale, California 94086
408.738.8521 Fax: 408.738.8524

Bulletin 0514

*Development Overview*

# The Spectral DMA-260 Series 2 Reference Amplifier

*Keith O. Johnson, Director of Engineering*

Audio components from Spectral have evolved for decades with a continuous research program that includes auditioning live music at recording sessions and careful listening trials though a variety of reference sound systems. The knowledge from this work has become an essential part of creating and evaluating promising technical concepts, new circuits and testing methods. The very best candidates, those with greatest potential to preserve a live music experience become parts of Spectral technology used to create new state-of-the-art audio products. This background work has substantiated the benefits of new semiconductors manufactured with recently developed manufacturing processes and their inclusion to make hybrid surface mount and through-hole amplifying circuits with exceptional performance. Our laboratory tests that correlate to human hearing and use music-like waveforms verify their technical advantage. The most promising circuits, those accurately conveying robust dynamics and transparency along with superlative detail and staging have become part of Spectral design and the creation of an exceptionally fine new audio amplifier, the Spectral DMA-260 Series 2 Reference.

## The Quest for Superior Amplification Devices

In developing new and advanced amplifier topologies, we are constantly researching available semiconductor transistors for premium devices which will be superior in Spectral high-speed analog applications, including a new generation of SMT transistors. Many of these surface mount semiconductors we could use for new designs have quicker responses and possess excellent amplification potential, yet their inclusion into carefully designed Spectral circuits would not live up to our expectations. Many were found to damage resolution and clarity. We believed that perhaps thermal stress and charge settling might be responsible since electronic evolution has favored smaller semiconductors whose junctions might respond to transient heating and produce thermally active errors. To explore this possibility we developed new sophisticated sampling tests at Spectral using simulated music waveforms to screen promising new semiconductor devices. A typical evaluation would create isolated transient events at semiconductor junctions so that heating would be similar to that from amplifying music and correction responses expected from loudspeaker loads. Such events require responses that demand brief energy bursts, which produce quick temperature surges. Then junction voltages, which should be constant might change to memorialize the event and to initiate error responses or thermal tails. Since most integrated circuit op-amp amplifiers have similar difficulties, the test methodology was made practical from working with these consumer devices. Performance limits became quantified to hearing acuity as well as human perceptual ability. These new test methodologies have now consistently verified the Spectral philosophy of inherently fast - low stress amplification to achieve ultimate resolution and accuracy. When instantaneous waveform accuracy is achieved at parts-per-million, the listening experience

can become most detailed, transparent and involving. Our search for superior amplification devices led us to recent discrete semiconductors intended for premium television and computer displays. Their hefty construction and advanced manufacturing processes create a substantial and very fast device that is free of thermal tail and memorialization of error issues. These new devices can be operated over a wide range of voltages and currents while being capable of excellent gain linearity, quickness and ability to amplifiy very high frequencies. The DMA-260 achieves its unmatched clarity and resolution from a combination of these breakthrough performances.

### Developing the SHHA Driver Technology

In the course of development work for the DMA-260, many different semiconductor technologies and manufacturing processes have been researched. Most promising were those featuring breakthrough manufacturing processes and computed chip geometries that produced excellent tests from both traditional tone tests and our recently developed music related test methodology. Best examples from this work often spawned unique or new circuits whose design integration required computed "re-designs" that would change many resistors and capacitors in the test amplifier. Each experiment might include new JFET, CMOS or Bipolar devices, but unlike traditional parts swapping, the test platform would be a well thought out optimum design prototype that could be realistically compared to a highly evolved Spectral reference component. The result of this research effort is the Spectral High-speed Hybrid Amplifier driver module, and ideally optimised topology using the finest available transistors from both SMT and traditional leaded component technologies.

In the new SHHA driver module, surface mount technologies are essential to fully utilize the new faster devices that have been successfully tested. The SHHA driver module provides greater parts density where needed and its layouts have become more purposeful than our previous drivers. Exemplary staging and quiet amplification are hallmarks of this technology as left and right channels are extremely well isolated and free of interferences. Inherent miniaturization makes room for more and better support circuits used to regulate the amplifier, its voltages and currents, as well as to cancel magnetic fields and block electrostatic interactions that might propagate from signal, power and speaker cables. All Spectral amplifiers employ similar environmental isolation strategies, but additional fine-tuning from the SHHA surface mount hybrid technology greatly improves this ability. It also provides tight thermal coupling to evenly distribute temperatures, allowing higher biasing currents that improve dynamic headroom. The important gain path from microvolt sensitive JFET devices to the powerful compact MOSFET output section is now direct and clean for effortless amplification. All combined, the new hybrid surface mount construction and advanced active devices of the SHHA driver improve accuracy, speed, power capability and provide greater stability margins that are necessary for supporting the DMA-260 'Focused Array' high-speed, high-current output.

### New Solutions to Old Interface Problems

All connections to the DMA-260 have internal interfaces to assure ideal conditioning as well as optimum transmission of audio signals and power. The crossing points or matching networks also remove interferences that would otherwise enter sensitive circuitry and create unwanted signal propagation and noise.

Traditional solid state amplifiers have always employed output terminating networks to provide an impedance or compliance to accomodate the load of the speaker cable and crossover in order to protect the amplifier. Unfortunately, the problems associated with using conventional output networks are severe, ranging from non-linear and unpredictable loading behavior to magnetic field propagation and noise. All these problems will degrade amplifier performance and sonics.
In Spectral amplifiers the sources of these distortions are eliminated. Stabilizing networks, resistors, chokes and inductors are replaced with tailored precision woven cables which eliminate non-linearities, noise propagation and magnetic fields. Now the signal from the output devices to the cable load is pristine, isolated and uncompromised by passive component problems.

`

## Unique Advantages of the High Speed Topology

Spectral amplifiers beginning with the first of its kind DMA-180 have unique timed or focused power architectures. Their circuitry, including choice of fast CMOS output semiconductors and construction layout assure responses from all power parts arrive equally to the speakers and the internal feedback components. To do this, each output device has its own isolated power supply source and field cancelling layout. Groups of these are placed for coincident timing so that responses can be precise and simultaneous. Their field cancelling design assures their actions do not propagate noise to the sensitive input circuitry and feedback components. Heavy shielding is unnecessary. Since these configurations operate so quick, our internal interface cables provide precise impedance and compliance to eliminate unpredictable loading behaviors. Old solid state designs use coils for this purpose but their magnetic field propagation degrades performance. Heroic massive machined chassis construction might improve the problem but is simply not necessary except for cosmetic decoration. The focused power architecture, woven and terminated interface cables along with sophisticated signal and routing of Spectral designs and contruction provide safety and extreme internal noise isolation. Crossover transitions between positive and negative FETS are smooth and small signal feedback circuits operate in a ultra-quiet environment to eliminate overcorrection responses typical in other high-end amplifier designs.

## Achieving Inner Peace

The DMA-260 uses sophisticated electrical and mechanical construction to achieve precise interface to the outside world while maintaining extreme internal isolation of sensitive signals and powering. Massive machined chassis contruction common in todays high-end amplifiers is inefficient and proven unnecessary to achieve state-of-the-art isolation and signal purity. The silent operating environment of the DMA-260 contributes to a level of transparency and signal purity which is unmatched by other high-end amplifier topologies.

## High resolution and the Listening Experience

Quick response and instantaneous accuracy to the original music waveforms of live signals are the hallmark of well crafted high resolution recordings. The same requirements are necessary for reproduction. A large inherent bandwidth that is not forced by excessive correction or feedback is an essential performance foundation as it can avoid having to confront many technical complications with negative sonic consequences. Transient intermodulation, cross modulation, group delay distortion, dispersion, reactive loading are a few of the difficult to decribe and understand errors that will not be found in the DMA-260. However, thermal settling associated with quickness (thermal tails) could have been an issue as it is with all fast circuits. Advanced testing and state-of-the-art semiconductors, exceptional layouts with much dedicated engineering has been necessary to address and eliminate these complex distortions. In a waveform or time sense, the output signal from the DMA-260 traverses from point “A” to “B” of a musical event with exactly the same waveform shape as its input signal. It does this with parts-per-million accuracy that is free of memorialized unnatural artifacts either before or after the input event. This requires extreme precision. Because Spectral circuits have high intrinsic speed and accuracy, the amplification from the DMA-260 is absolutely stress free and precise. This important performance aspect preserves clarity, transparency and resolution of the very highest order.

## The DMA-260 Optimized System

Circuits, devices, layouts and construction aspects of Spectral amplifiers are carefully engineered and structured to work together as a system capable of producing a highly refined level of performance. All assemblies and most components inside the DMA-260 are revised and improved to fully realize the virtues of the SHHA driver board and the fully balanced gain section. These improvments are necessary to fulfill the Spectral uncompromised design philosophy.

Along with the innovative new SHHA driver section, the DMA-260 features new power supply design and transformers. These larger transformers have exceptionally tight regulation and isolation with the ability to energize tough, low impedance loads. New high performance rectifiers improve peak power and speed. Remarkably, this greater level of performance can be met in an amplifier of compact size and weight.

The new generation amplifier systemboard of the DMA-260 features advanced RF layout techniques for ultra stable high frequency operation without ferrite stabilization or capacitors in the signal path. Our new "high plate" pc board technology offers three times the trace thickness for vastly improved current capability.

New generation custom Teflon capacitors improve signal purity in sensitive driver compensation positions.

All new signal cables and precision grounding system are designed to exploit the very high isolation capacity of the SHHA driver and balanced gain section. Audio paths are direct and short as possible with minimal filtering for the lowest possible noise and extreme quiet signal resolution and ultra-fast transient settling.

**The Result: Instantaneous Amplifer Accuracy**

In the DMA-260 Series 2 Spectral further develops the SHHA driver technology, a radically improved amplifier topology featuring double the speed and signal response of our previous drivers. At these elevated speeds, device energy storage and thermal memory can now be observed as significant signal distortions, bluring transient detail and smearing instrument decay and interplay. Sophisticated new testing methodology identifies these fast-moving, thermal tail artifacts and directs their elimination in the advanced new SHHA driver topology. Combined with the innovative push-pull, balanced gain section and sophisticated internal interfaces, the SHHA driver achieves parts-per-million waveform accuracy and extraordinary low distortion and noise. The long sought after ideal of 'instantaneous accuracy' with virtually no signal memory is significantly realized in the remarkable DMA-260 Series 2 Stereo Reference Amplifier.