

LINN

CHAKRA

WHITE PAPER

High-efficiency ultra-linear power amplifier technology

BACKGROUND

Linn strives for continuous improvement across every area of our business and product range. Technology used within any given Linn product is selected on the basis of what is most appropriate for the application. We have proven that what you do with the parts and technology is always much more important than how the technology is categorised. Two designs can use the same components, but achieve completely different results.



Throughout history, there have been many fine amplifier designs. Some use valves (tubes), some use bipolar transistors, some MOSFETs. Some manufacturers swear by Class A, others by Class AB, one or two by Class D, and many others are somewhere in between. At Linn we believe that different designs work best for different applications and illustrating this, our current power amplifier range contains MOSFET, monolithic, discrete and bipolar designs. By continuously refining and improving all the core technologies involved, our latest monolithic designs sound better than our previous discrete bipolar designs. Similarly our latest discrete bipolar designs have more power and sound better than our earlier monolithic and bipolar designs.

MONOLITHIC CIRCUITRY

Monolithic (single-chip) circuits are, in principle, the optimum way to design the direct signal path circuitry within a high-performance power amplifier. With a monolithic design all of the required audio circuitry is contained within a few square millimetres of silicon, minimising circuit area for the shortest possible signal path, making them inherently less susceptible to unwanted interference and enabling the amplifier to operate at higher speeds. They also accommodate circuit complexity which is not practical with a less dense discrete design, and offer high-performance through tightly controlled and matched device behaviours.

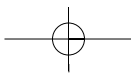
The investment required to design and manufacture these monolithic chips typically results in costs which are prohibitive to short-run specialist applications such as high-end audio. Consequently they are normally targeted at high-volume applications where audio performance is not the most important parameter. For a number of years, however, Linn has worked closely with trusted microchip manufacturers and as a result, exceptional capability has been designed into a high-volume chip, that now enables Linn to realise the full potential of this technology without requiring unfeasibly high production volumes.

This aside, monolithic topologies do present a number of other technical challenges, which, whilst not insurmountable, can compromise the potential of a design. The most significant of these is output current, which is limited due to both the compactness of the circuitry and the chip fabrication process, typically resulting in unwanted distortion at high listening levels. Monolithic designs also have a tendency to be less rugged than a well-crafted discrete design.

CHAKRA

Monolithic technology is used extensively throughout Linn's product range, both as single chips and paralleled devices to increase power output. The CHAKRA topology is the result of more than 5 years of continuous development of Linn's high-power monolithic amplifier audio circuits, and was initially conceived during development work for the Linn 328A professional monitoring loudspeaker. The Linn 328A required greater power, circuit density and performance than even our reference monolithic power amplifier, the KLIMAX 500 Twin, could offer, and so we began work on developing a solution which performed accurately and consistently in even the most demanding monitoring applications.

The CHAKRA topology we devised uses an array of large bi-polar transistors as 'boosters' around a single monolithic. This approach in itself is not a new idea, but Linn's execution of the monolithic to bi-polar transition is truly unique, and a patent application for the design has been submitted. When output current is less than a few amps, all of the power output comes from the monolithic, maximising the speed and linear properties of this design. At higher output currents the bi-polars provide the majority of the output current, leaving the monolithic to operate well within its capability and so able to correct any error instantaneously. Even under extreme overload conditions, like short circuit, the monolithic never delivers more than a fraction of its safe output, while separate circuitry protects the bi-polars. So with current output virtually unlimited, CHAKRA offers robust and powerful low-frequency response down to near DC. This is essential for the type of servo-controlled bass systems used throughout Linn's highest performance loudspeaker systems and benefits will extend across all future iterations and applications of the CHAKRA topology. The new topology is also very compact, actually reducing the circuit area and signal path length compared to our previous best paralleled topology and it is also highly efficient, running cooler than any previous Linn amplifier design.



POWER SUPPLIES

While the new CHAKRA topology represents a massive step forward in Linn's direct signal path circuitry, the overall performance of a power amplifier is equally dependent on its power supply. Linn's compact proprietary, audio-optimised Switch Mode Power Supply (SMPS) technology generates stable, low noise power rails for the audio circuitry, with higher mains noise isolation and efficiency than the very bulky and noisy conventional power supplies. The combination of SMPS and CHAKRA technologies creates a wealth of possibilities for new configurations of high-performance, high-efficiency Silent Power amplifiers.

LINN ACTIVE TECHNOLOGY

A key design consideration during development of the CHAKRA audio circuit technology was the ability to power loudspeakers in internally or externally active configurations. As a result, active modules can plug directly into the main CHAKRA amplifier for straightforward active system building. Each of these active modules filters the signal for one drive unit, with a separate module allowing simple and subtle optimisation of the system to suit the room, aiding the simple installation of active systems and optimising performance.

CONCLUSION

The Linn CHAKRA technology eliminates the weaknesses and maximises the strengths of monolithic linear amplifier technology. It combines the speed and precision of a high integration chip technology with the ruggedness and smoothness of discrete ultra-linear bipolar transistors and delivers precisely controlled Linn Silent Power at all listening levels.

APPENDIX: CLASS D AMPLIFIERS

CHAKRA is a linear (continuous time) amplifier technology with a switch mode (discrete time) power supply. There are now several products on the market based on switch mode amplifier technology commonly referred to as 'Digital' or 'Class D' amplifiers. This attempt to associate the well known attributes of digital systems with these products is, however, at best a slightly misleading premise.

A traditional amplifier audio circuit features a continuously variable (linear) output stage generating the required output by dissipating as heat the difference between the power supply voltage and the required output voltage. A Class D amplifier uses very high speed switches to send the entire voltage of the power supply, with minimal power loss, as a sequence of pulses to the output, where a filter averages the pulses before the loudspeaker terminals. The frequency, density and duty cycle of these pulses determine the average output voltage. This is exactly how a switch mode power supply works, except that instead of generating the system power supply, the Class D amplifier circuit is generating the final audio output.

Like SMPS, the concept of Class D amplifier audio circuit technology is not demanding; indeed Class D amplifiers have been around for 30 years, but have failed to penetrate the specialist high fidelity sound equipment market, primarily because they lack the subtlety of well executed linear amplifier technology. However, with the ever-more widespread adoption of multi-channel systems there is pressure on the industry to develop lighter, smaller and cheaper power amplification platforms which in turn has sparked renewed interest and research effort in Class D technology. The prospect of combining Linn's Switch Mode Power Supply technology with advanced Class D audio circuitry is an appealing one, but can only be considered when the technology is mature enough to offer a performance advantage - in other words, when it meets the standards Linn customers expect from our company. Our best guess is that it could be as much as ten years until we can achieve this level of reliability and performance. For all of these reasons we developed CHAKRA and envisage it will remain supreme in its segment for many years to come.

The above mentioned information is subject to change without prior notice.

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