DALI CALLISTO

WHITEPAPER

DALI®

IN ADMIRATION OF MUSIC

INTRODUCTION

The landscape for High End Audio has been changing for a number of years now, and the shift has been accelerating, with no signs of it slowing down. We refer to of course, the choice of convenience.

This ‘convenience’ has emerged in many shapes and forms, driven by the lure of ease of use, getting started and installation. These factors have begun to triumph over high-quality audio, with music lovers settling for lesser sound quality in order to get more convenience. This is not to say that good sound is not important to them, but simply because the wish for convenience left them with no alternative.

The trend is that first time buyers of high-end audio have little interest in the hassle with cables and multiple boxes of electronics. They want easy access to all their digitally stored music, be it online, on their phone or on a network connected hard drive - but they want it to sound great. In short, they long for the virtues of a traditional Hi-Fi product that matches the audio demands of the 21th century.

At DALI we recognised this dilemma of customers having to choose between high quality performance and convenience in ease of use, so we set out to develop a solution which brings together the best of both worlds. The challenge was to create a great sounding wireless speaker system that is easy to setup and use. A wireless speaker system that empowers the customers to easily access all their music in the best possible quality, and play it back without the need for complicated electronics.

With the DALI CALLISTO speakers, we deliver a speaker series that builds on all of the DALI audio traits. A speaker system made in Denmark, which has the possibility to easily playback, stream, beam, select, distribute and connect your music from any source, and conveniently send it wirelessly to the speaker!

Acting as the central hub for the CALLISTO speaker system, the DALI Sound Hub is what brings it all together. With built-in Bluetooth, inputs for Optical (x2), Analogue (x2), Coax and integration via dual Expansion Ports, you can connect anything to your CALLISTO speaker system, and, when you are done, forget all about them. The Sound Hub automatically detects which source is active and automatically selects the correct input, meaning the only thing the listener really need to do is adjust is the volume. Naturally, you can also select the input manually; either from the Bluetooth remote control or directly on the Sound Hub. The Sound Hub transmits the audio signal (I2S) wirelessly to the connected speakers in true HD audio quality (24 bit / 96 kHz) to ensure only the best possible reproduction.

The CALLISTO speakers are designed around a DALI manufactured 6½” wood fibre woofer with a brand new and advanced SMC magnet motor system, and a hybrid tweeter module. The drivers are fed by a powerful dual channel 250W Class-D amplifier connected directly to the drivers. This design enables us to setup each amplifier channel to match perfectly with the driver, and thereby maximize the performance of the drivers. Drivers which are designed with a detailed knowledge of the amplifier in mind can be taken well beyond the performance levels of conventional passive driver designs, to deliver you a transparent, detailed, coherent and well-timed audio experience.

DALI is truly proud to introduce the CALLISTO series - a contemporary take on traditional Hi-Fi.

In the following we will dive into all the technical details of this product. We welcome you to the world of the DALI CALLISTO audio experience.

PRODUCTS

The DALI CALLISTO systems consist of two stereo speaker configurations and an optional central Sound Hub.

CALLISTO SPEAKERS

The CALLISTO speaker series presents a unique opportunity for DALI to deliver the best of both worlds. Controlling the development of everything from the drivers to the amplifier, we can optimise every single component to match each other perfectly. This enables us to design the woofers to be more linear than would ever be possible in a similar priced traditional passive speaker system. Pushing the woofer design to new limits of performance is possible because we are in total control of the signal path, and can therefore ensure the control needed so not to overextend the drivers. Leveraging this potential, we elevated the audio performance to levels that surpass almost any speaker amplifier combinations in this price bracket.

CALLISTO 2 C

This is the compact stand mount solution in the CALLISTO system. Perfect for smaller spaces or rooms where the speakers' presence must be minimised, without giving up on performance. The combination of the 6½" low-loss wood fibre woofer, the hybrid tweeter module and the perfectly balanced internal volume of the cabinet, come together to form the base of a highly accurate audio experience.

CALLISTO 6 C

When truly deep bass performance and room filling sound-pressure is needed, the floor standing CALLISTO 6 C is the perfect choice. Gaining extra width and depth from the added woofer and internal cabinet volume, the CALLISTO 6 C can deliver a complete and highly detailed three-dimensional sound stage into even large rooms.

Both speaker models have an RCA input for volume controlled line level input. This enables you to connect an audio device directly to the speakers if desired, although we recommend using the DALI Sound Hub to obtain the full convenience of the CALLISTO speakers, including wireless audio transfer.

DALI SOUND HUB

The Sound Hub is the starting point when setting up you CALLISTO speaker system cable free, and where initiating the pairing process begins. It also controls all communication with the connected speakers and ensures that audio, volume and balance are synchronised across the speakers. It handles all audio inputs via the built in Bluetooth, (supporting AAC, Apt-X and Apt-X HD) or any of the multitude of external inputs (Optical, Coax, Analogue and the expansion ports). The wireless 24 bit / 96 kHz connection carries the line level signal from the Sound Hub to the speakers built-in amplifier.

The Sound Hub's auto source sensing system ensures that you only rarely need think about what input you are using. Just start playing music or turn on your TV and the Sound Hub will automatically activate the right input, and if in standby, also turn on the speakers. There truly is nothing more for you to do other than enjoy.

When the need for adjusting the volume arises it is easily done from the remote control, the Sound Hub or even directly on top of the speakers via the built-in touch panel. The Sound Hub transmit the volume change to the connected speakers and the volume is changed in the speaker amplifier.

The CALLISTO speaker system offers the ultimate in convenience, even letting you control the volume right on the speaker.

CABINET

When preparing the visual design for the CALLISTO series we especially had two things in mind. We were seeking a design that would allow for the introduction of the hybrid tweeter in the stand mount model, and a look that clearly showed that this series is something new, without losing the connection to the traditions of the passive speaker. With the use of a round front housing for the ribbon tweeter in combination with the distinctive tweeter front plate, and the elegant integration of the volume control and LED's, we believe that we succeeded, and then some!

Manufacturing the cabinet at our large and efficient woodworking facility in Denmark, we can keep complete control over the quality of the speaker, handling everything from cutting out the Medium Density Fibre board (MDF) cabinet to applying the vinyl. The mounting of the drivers and the final tests and approvals on each and every speaker is also handled directly at our own assembly lines in our Danish factory.

Constructed from 25mm MDF, the cabinets employ a very rigid construction with solid bracings across the inside of the cabinet for extra reinforcement. Together with the very solid MDF structure, this contributes to a stiffness and density that practically eliminates resonance within the cabinet. However, excessive internal bracing can disturb and hinder the crucial airflow inside a speaker cabinet, thereby adversely affecting sound quality. Therefore, great care is taken in the layout and application of internal bracing in order not to reduce the internal volume of the cabinet unnecessarily.

The high-grade vinyl is carefully selected among the finest available. Extensive testing is carried out to make sure that the surface and joints of the cabinet will stand the test of time. Through strict in-house control of every aspect of production, CALLISTO achieves a level of fit and finish typically found only in products well beyond its price point.

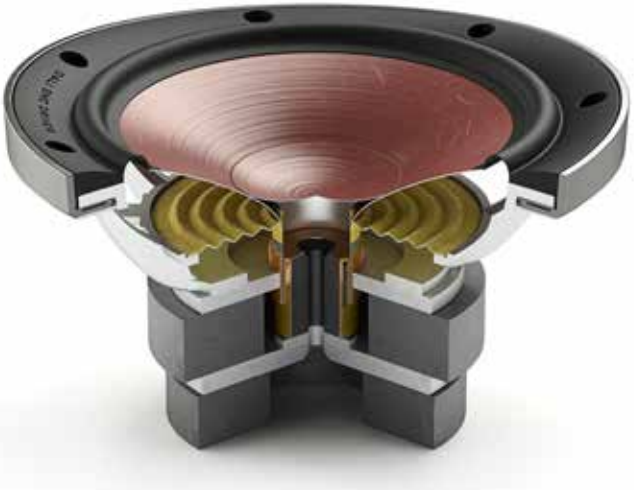
WOOFER

We knew from the outset that the woofer for the CALLISTO series would be something unique. Never before has the entire audio chain been in the hand of DALI's own R&D team. This intimate knowledge helped our acoustic team design and build a woofer that took low loss and linearity to a whole new level.

Working with well known elements from the OPTICON and RUBICON woofers, we used advanced computer simulation and a whole lot of listening hours, to optimise the magnet motor to deliver the ultimate in flux saturation and BI linearity within the voice coils excursion span. The rear membrane suspension (spider) geometry was likewise optimised to work in close harmony with the amplifier. Knowing that we controlled the maximum signal impulse, we could soften up the spider and obtain a very linear and perfectly symmetrical suspension within the working area of the voice coil and membrane, only taking control and slowing down the membrane movement at the outer most excursion points.

The extra linearity obtained both around the voice-coil and in the spider manifests itself in reduction in mechanical distortion and less strain on the amplifier, which leads to more detailing and a better defined sound stage.

The CALLISTO woofers also benefits from the use of SMC in the pole piece. Soft Magnetic Compound (SMC) is a coated magnet granule that can be shaped into any form that you would want. SMC has many advantages, and when used in a speaker magnet motor system, it results in a significant reduction of distortion from mechanical loss. SMC's unique ability to deliver a high magnetic conductivity and a very low electrical



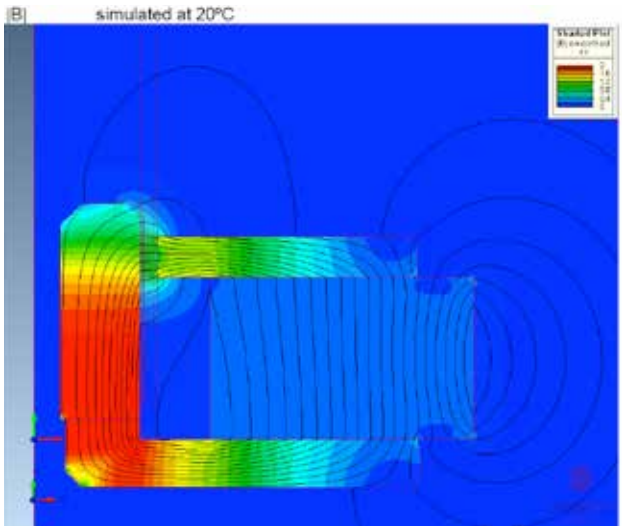
Every part of the CALLISTO woofer is optimised to work perfectly with the build in amplifier.

conductivity delivers all the wanted qualities of a really good speaker magnet without the traditional downsides.

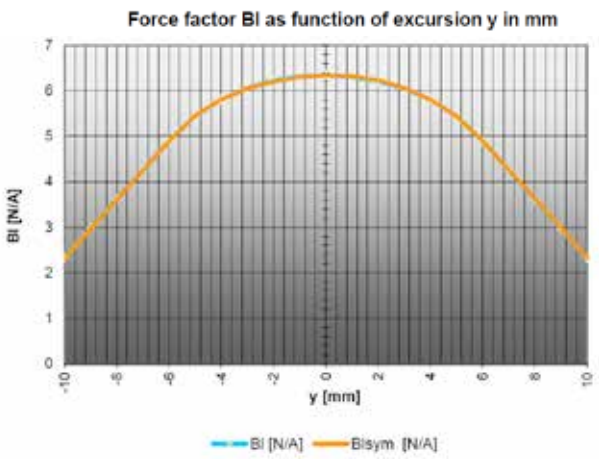
Like in the RUBICON magnet motor system, the CALLISTO's SMC pole piece is covered by a copper cap that helps focus the flux field surrounding the voice coil, and in conjunction with the SMC pole piece, the flux modulation is significantly less influenced by the current in the voice coil. As a result, we manage to reduce the distortion from current generated flux variations greatly. Furthermore by surrounding the SMC pole piece with a copper cap, and controlling the effect via small slits in the copper cap, we focus the effect of the SMC around the voice coil and linearise the inductance generated in the voice coil to a degree that it is seen as almost flat.

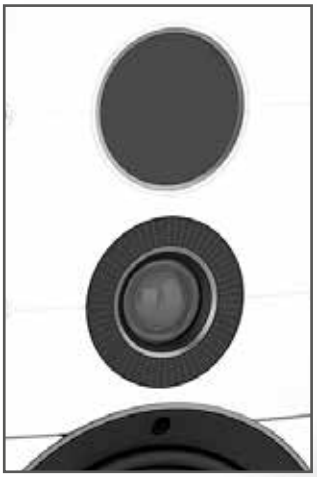
As a result of these optimisations and especially through use of SMC, the CALLISO series benefits from an extremely agile, well behaved and ultra low loss woofer, that when working in conjunction with the amplifier, is able to deliver a detail rich, time coherent and very powerful audio signal.

Computer simulation helped optimise the magnet system for optimal flux saturation



The BI in the CALLISTO woofer is not only very linear but perfectly symmetrical





The dome tweeter is constructed to match the CALLISTO amplifier and to works seamlessly with the ribbon tweeter.

HYBRID TWEETER

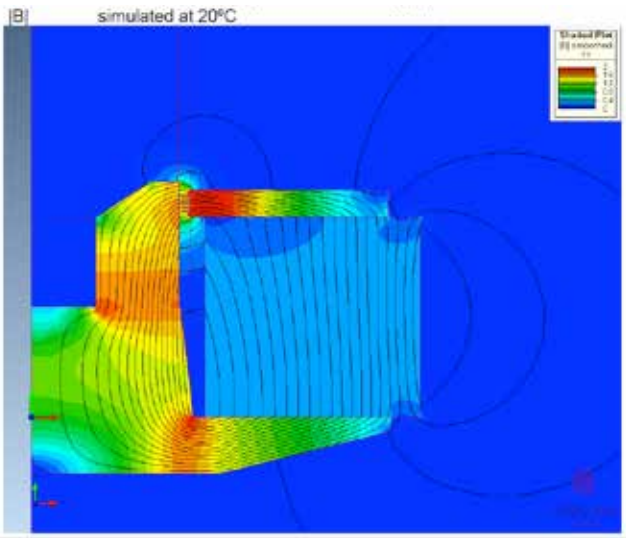
DALI's trademark hybrid tweeter module combines the dome tweeter with a ribbon tweeter for an amazing rendering of the high frequencies, and a dispersion of high frequency audio that outperforms all other tweeter technologies.

In the CALLISTO series, DALI makes use of the hybrid tweeter configuration in both the stand-mount and the floor-standing model, with a great deal of work carried out to optimise the module specifically for the CALLISTO series.

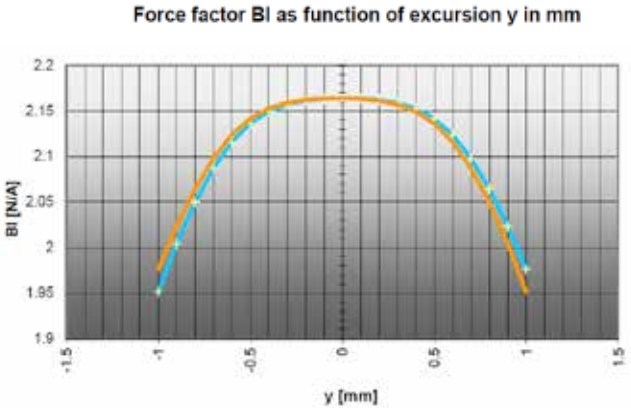
The dome membrane is very soft and ultra-lightweight, and actually so thin that a coating has to be applied to hold the material together and be uniform in construction. Using computer simulation we were able to optimise the magnet system and maximize flux saturation right at the voice coil area. This optimisation combined with the use of an ultra-thin magnetic fluid for cooling, enables the dome tweeter to deliver a very linear BL in the entire excursion range. This results in better control, power handling and greatly limits distortion.

The ribbon part of the hybrid module is a magneto-static type tweeter. Four bands of conductive material make up the active diaphragm that is controlled by a strong magnetic field formed around it. The ribbon tweeter is the master of wide dispersion, and combining it with the soft dome, we get a tweeter module that can be utilised as low as 2.0 KHz and continues to perform well above 30 KHz. This extreme bandwidth combined with the ultra wide dispersion is an important part of the DALI sonic definition.

Through the help of simulation the dimensions of the magnet was optimized for almost perfect flux saturation.



Like on the woofer the BI in the CALLISTO tweeter is very linear and very symmetrical.



DALI SOUND HUB

The elegantly designed Sound Hub is the central hub in the CALLISTO system. It houses all the potential connections, has built-in controls for Power On/Off, Volume control, Source select, Mute and Speaker pairing, and also visual indications for Volume, Source and Speaker placement. It is also the base of the distribution of the wireless audio signal.

Hidden away, but easily accessible on the back of the Sound Hub is the broad array of possible connections. This is also where the two expansions bays are placed, and the location of the Link button that initiates the pairing process.

The Sound Hub remote control is connected to the Sound Hub via Bluetooth ensuring the optimal in operating distance, stability and visual feedback from the Sound Hub. This also enables the user to place the Sound Hub anywhere in the same room as the speakers. Offering the possibility to place the Sound Hub in a central position, wherever it looks its best or hiding it away completely.

Hidden away on the back of the Sound Hub the link button, every input and output connector, and the expansion ports is readily accessible.

EXPANSION PORTS

One of the most innovative features of the DALI Sound Hub is actually hidden away from view. The two modular expansion ports on the back panel open the Sound Hub to a world of possibilities. Via the DALI designed open standard connector, any type of audio module can integrate 100% with the Sound Hub system. Supporting I2S audio transfer on up to 8 channels, and command transfer to control volume and other essential information. This enables a total seamless addition of extra functions to the Sound Hub, not only allowing for streaming, multi-room or even multi-channel expansions, but also future proofing the Sound Hub and any connected speakers by separating the quickly evolving music delivery technologies from the more robust and time durable speaker technology.

WIRELESS AUDIO TRANSFER

The wireless connection between the Sound Hub and the speakers, is an extremely stable digital connection, made on either the 2.4 GHz or the 5.8 GHz band depending on location and quality of the connection. The proprietary 30 bit protocol transfers an uncompressed I2S audio signal in 24 bit 96 kHz, utilising the remaining bits to control volume, speaker ID and other control data. Because it works on a less trafficked band, and the protocol is specially designed for transporting an audio signal, the connection is highly stable introducing next to no packet loss. The protocol uses forward error correction to remove the result of packet loss should they occur. The high bandwidth low latency protocol functions as a point to multipoint connection. This allows for multiple speakers to connect to the same stereo signal. With latency below 25 ms, sync between video and audio from a movie or TV source is obtained well within conventionally acceptable limits.

SOUND HUB INPUTS

Bluetooth
This proven and very well-known wireless technology is built-in as standard, offering the possibility to transfer sound to the CALLISTO system from almost any device. Even if the basis of Bluetooth is more than 20 years old, new advances in audio quality is still being made. DALI wants to enable you to listen to Bluetooth transferred music in the best possible quality, and have therefore added support for AAC and Apt-X HD in the Sound Hub.

AAC is an improved audio protocol that despite still being lossy, supports a larger amount of audio data to be transferred via the Bluetooth connection. AAC is supported by a host of mobile platforms, and is mainly used by Apple products as the highest quality of Bluetooth transfer.

Apt-X HD is an expansion of the well-known Apt-X audio protocol, allowing for compression of up to 24 bit 48 kHz audio streams and a wider bandwidth transfer than Apt-X. This allows for high quality playback of not just traditional audio files, but also HD quality music over Bluetooth, along with full backward compatibility with Apt-X.

Optical
The two optical inputs are controlled differently with a clear focus on TV and audio use.

The TV input is activated by the carrier signal. This enables the Sound Hub to power up the CALLISTO speaker system the second the TV is turned on, they are therefore ready to play as soon as there is sound from the TV, without any delay.

The audio input on the other hand, is activated by an audio signal. Since many audio units do not turn off the carrier signal when put into standby, a simple light detection is not enough. By analysing the audio signal, the Sound Hub can determine if audio is played back, and if not, will automatically power off the system, turning it back on again when a signal is detected.

The optical input accepts any data rate from 16 bit / 32 kHz to 24 bit / 192 kHz. The signal will be converted to work optimally with the 24 bit / 96 kHz wireless transfer audio protocol before being passed on to the connected speakers.

Coaxial RCA
For direct digital connection between an audio device and the Sound Hub. Like the optical input, it will accept from 16 bit / 32 kHz to 24 bit / 192 kHz.

Analogue (RCA and mini/jack)
The high-quality ADC samples the analogue signal in 24 bit / 96 kHz using the system master clock for optimal wireless transfer to the CALLISTO speakers.

SOUND HUB OUTPUTS

Sub-out
LFE type subwoofer output. When a subwoofer is connected, everything below 100 Hz is sent through this output to a connected subwoofer.

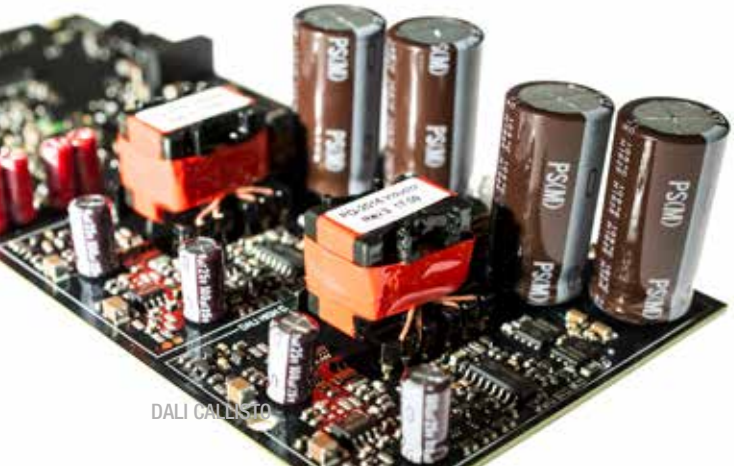
Pre-out
Line level RCA output. This output allows you to use the DALI Sound Hub as a pre-amplifier for your existing setup, making it possible to enjoy the benefits of the modular extensions and the auto source sensing capabilities. The Pre-out can also be used to connect to the CALLISTO speakers via a cable in cases where wireless transfer is not preferable.

USB Power
The built in USB A port delivers a 5V 1A output to power connected devices like a Google Chromecast Audio, or charge a mobile device whilst playing. It is also used to update the Sound Hub's firmware. The built in USB port does not offer the ability to playback audio stored on a connected device.

On the back of the speakers the mains power connector, link button, setup display, the line-in connector and USB port for firmware upgrades is located.

AMPLIFIER

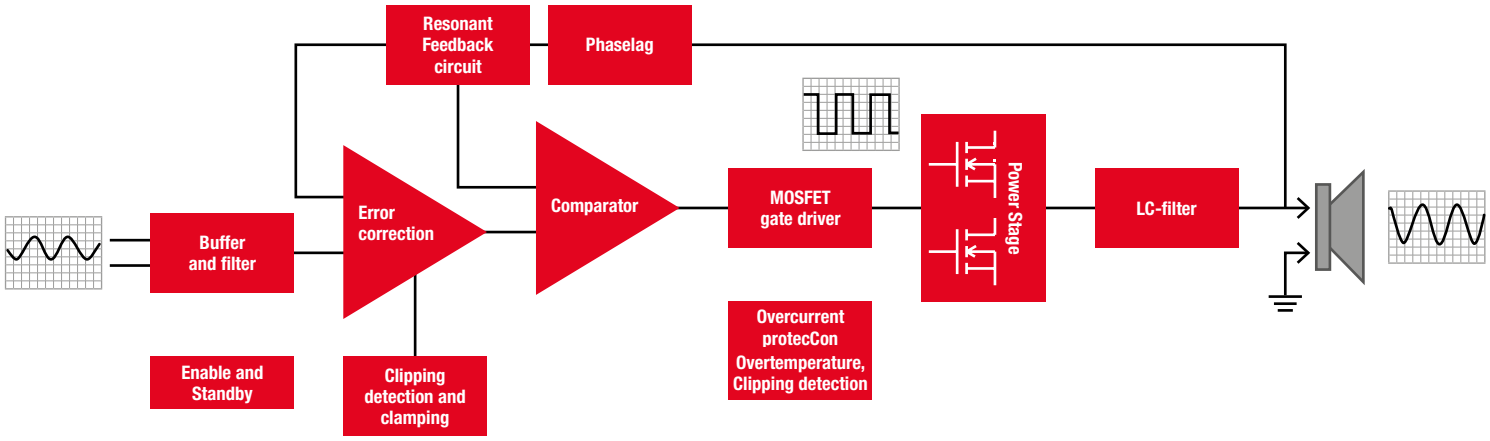
Designing a ‘best in class’ active speaker system is the sum of many parts. One truly important part is the amplifier, or more correctly the amplifier module. Any quality amplifier module consists of three equally important parts that need to be designed to work together in perfect harmony: the amplifier itself, the PSU and the signal processing. The delivery from the signal processing and the PSU to the amplifier circuitry must adhere precisely to the amplifiers needs and demands. Only in this way can you achieve an undistorted, uncoloured and coherent amplification.



The amplifier

The CALLISTO Class D amplifier is based on patented state-of-the-art technology with a global feedback, self-oscillating design chosen for its very musical properties. Being able to deliver 250 Watts for up to 5 seconds, there is plenty of power to ensure more than enough sound pressure even in complex musical passages or massive explosions in movies.

Simple diagram of the amplifier structure showing the self oscillating global feedback loop.

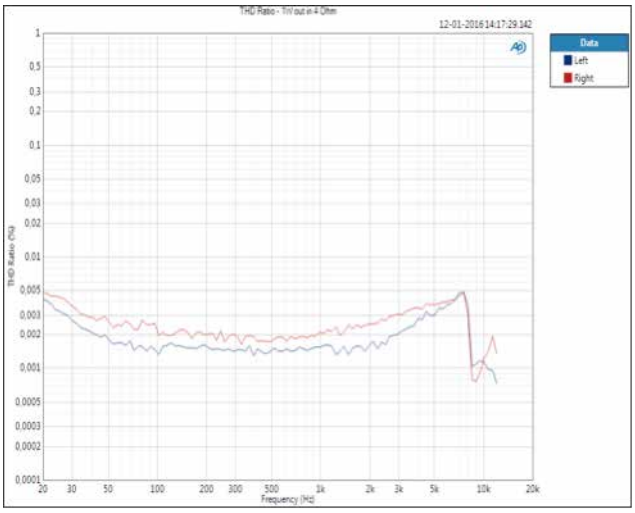


The self-oscillating loop PWM amplifier enjoys improved performance over conventional fixed-frequency triangle-based PWM amplifiers because the bandwidth of the feedback loop is higher than that of a conventional feedback loop which must obey conservative stability criteria. The post filter feedback reduces distortion and provides best in class load invariance. To keep control of the self-oscillating switching frequency and to ensure fast recovery after a clipping situation, the limiter circuit acts whenever the voltage difference between the input and output of the error amplifier exceeds a hardware defined threshold. This threshold is tuned so that THD levels will not exceed approximately 1% at the speaker output.

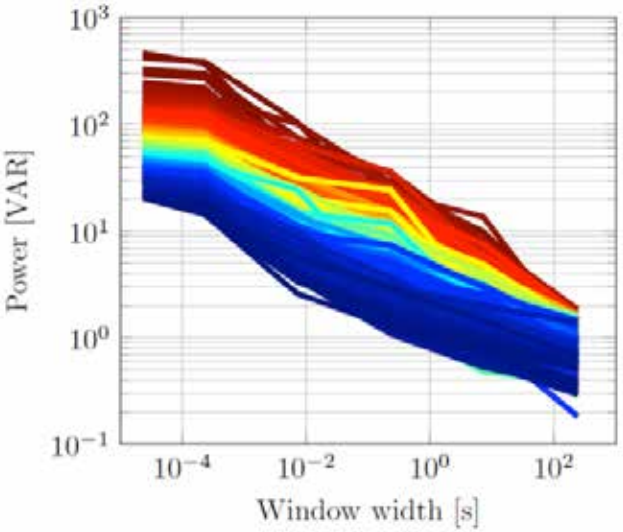
The Total Harmonic Distortion (THD) of the amplifier is below 0.005% across the audio bandwidth 20-20 kHz measured at 1W output power into 4Ω. At 30W output power the amplifier meets THD levels between 0.015% and 0.03% which is successfully independent of frequency. Traditional amplifiers typically show increasing levels of THD towards higher frequencies.

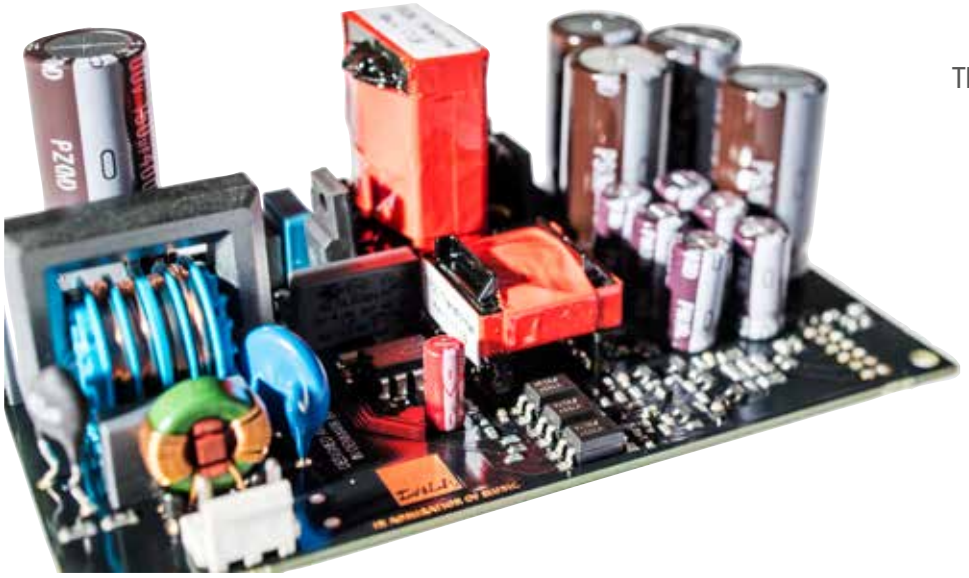
A large study presented in 2014 analysed more than 400 different musical tracks, and concluded that there needs to be a 10x peak-to-average power in an amplifier to ensure the dynamics of music without limiting and in worst case clipping. The amplifier in CALLISTO delivers 30 Watts continuous power, and up to 300 Watts power for very short bursts, delivering perfectly on the 10x peak-to-average power ratio. The obvious advantage of leveraging this knowledge is the amplifier design draws less running power, and thereby reduces the risk of introducing PSU noise leaks and shutdowns due to overheating.

Total Harmonic Distortion is below 0.005% across the entire frequency range.



There is a 10x peak to average power ratio for normal music, and with 250 Watts for up to 5 seconds the CALLISTO amplifier has more power than most amplifiers.



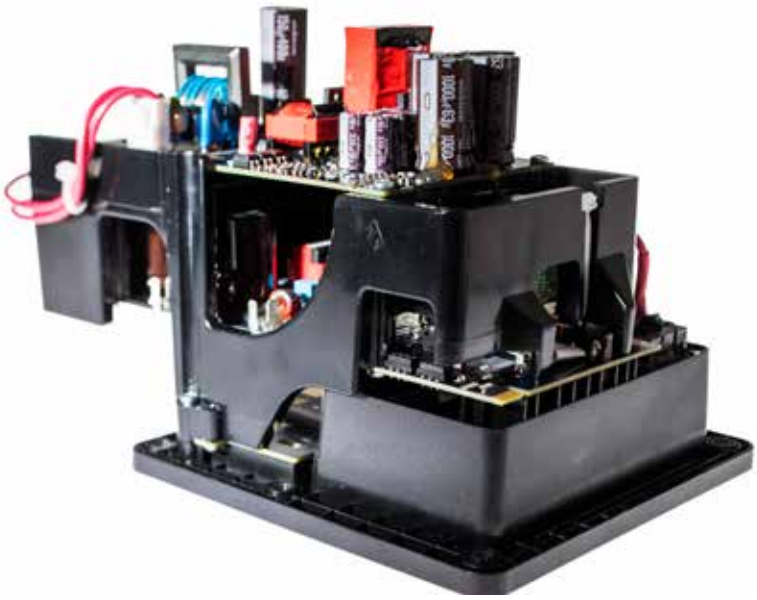


The compact but very powerful PSU is able to deliver up to 300 Watts peak power.

THE POWER SUPPLY UNIT

The power supply for the system is a universal mains input switch mode PSU, capable of delivering 50 Watts continuous and 250 Watts power for 5 seconds. The voltage regulation is done from both the negative and positive rail voltage to suppress uneven bus pumping on the rails through the half-bridge amplifier design.

The power supply is a 130 kHz switching fly-back type, making use of the alternating energy stored in the transformer. The size of the transformer is optimized for the power dynamics of the amplifier, maintaining stable operation from 300W down to less than 1 W.



Every part of the amplifier module is design and developed by DALI.

THE SIGNAL PROCESSING

The core of the signal processing is comprised of a 50MIPS Digital Signal Processor, and an audiophile 24bit Digital to Analogue Converter.

The DSP boasts an audio processor capable of up to 1024 instructions per cycle. On the output side, the DSP is connected through I2S to a Burr Brown DAC that makes use of advanced segment architecture to achieve excellent 123 dB dynamic range performance. Differential current outputs are provided to suppress common mode noise and, by nature of the analogue interface, clock jitter is eliminated on the audio interface to the class D power amplifier. The current to voltage conversion is done at the power amplifier input, securing the shortest possible signal path without the need of sound quality degrading AC-coupling capacitors.

The master volume control takes effect in the signal chain just before the analogue amplification stage, to ensure optimal Signal-to-Noise-Ratio, and true 24 bit HD resolution at all volume levels. This means that no matter which of the many possible volume controls is used for adjusting the master volume, the actual volume change is done at the very end of the signal chain.

The amplifier output is connected directly to the driver, with all of the crossover filtering done in DSP. Having complete control over every step of the audio handling has the clear benefit of being able to maximize the utilisation of every component in the audio chain. Optimising the crossover parameters with the knowledge of precisely how the driver is going to react, pushing the performance of the individual driver right to the limit without ever going beyond. Combined with the well-known DALI driver performance, this is a large part of the ‘best in class’ sound of the CALLISTO speakers.

CALLISTO IN PRACTICAL USE

The DALI CALLISTO speaker series is at the same time something brand new, never seen before, and something very familiar and well-known. This is precisely what sets it apart from every other speaker system in the market today. The CALLISTO speaker system speaks to a broader audience than traditional Hi-Fi, without ever loosing foothold with the current Hi-Fi customer.

Built on traditional virtues and technology, they sound every bit as good, and most likely better, than the best traditional combinations out there at the same price level. At the same time, they offer ease of use in both setup and operation to an extent not seen before. This combination is extremely powerful, and offers customers an exciting new option.

Since the CALLISTO speaker system is at heart a traditional Hi-Fi speaker system, the user scenarios is for the most part found in the normal primary listening setup. Both the CALLISTO 2 C and the CALLISTO 6 C have the ability to deliver a room filling audio experience, either from a musical source or if connected to the TV.

If you are looking for the best in audio quality, the best in connectivity, the most convenient audio system, a future proof modular audio system and a truly elegant looking audio system, then the answer is simple.....the all new DALI CALLISTO.