

X⁺ SERIES

WHITE PAPER



MILLER & KREISEL®

A Message from the Inventors of the Subwoofer

At M&K Sound, we design loudspeakers to sound inherently right, act as universal tools, and be equally adept with playing back any style of music or movie soundtrack, whether recorded in a stereo, surround, or an immersive object-based audio format. The fundamental rightness of our products – call it accuracy, precision, neutrality, naturalness, realism – breaks down the barriers that otherwise exist between professional and consumer audio. We create loudspeakers free from the analytical brutality of conventional studio monitors that make listening feel like work, and equally free from the euphonic colorations of typical domestic speakers that introduce a homogenized sameness to recorded sound, while veiling crucial details that are so essential to any rich, finely woven sonic tapestry.

Music, dialogue, and effects for many of the biggest Hollywood blockbuster hits in recent years have been mixed and edited using M&K Sound speakers. Sound designers, re-recording engineers and producers at Lucasfilm Ltd., Universal Pictures, 20th Century, Paramount Pictures, The Walt Disney Company, Sony Pictures, Danish Broadcasting DR, Mainstream, Danish National Film Academy and HBO, among others, trust the performance and reliability of M&K Sound's speakers. Our loudspeakers were originally chosen for the development and demonstration of the Dolby Digital 5.1 cinema and home surround format, the first public demonstration of the high-resolution Blu-ray disc format, for the entire sound production workflows on Star Wars Episodes I, II and III, and countless other award-winning music, film, and TV productions.

Our philosophy is that the only truly worthwhile listening experience is one that transports the audience to the site of the original acoustic event with absolutely minimal loss, addition, or distortion. Therefore, our speakers are designed as a conduit to allow the listener to hear exactly what the performers and recording engineers heard, no more and no less.

As a company founded equally on professional recording and high-end home entertainment, the basis for all M&K Sound design work over five decades has always been that a good loudspeaker must accurately and realistically reproduce the original acoustic event within its intended acoustical space. It doesn't matter whether the source is a voice, musical instrument, explosion or simply a gentle breeze caressing the leaves of a tree. Naturally, this must include the ambience of the space in which the source was recorded.

Because our emphasis has always been exclusively on accurate reproduction that maintains the full integrity of the original recorded signal, M&K Sound has developed a fiercely loyal following both among professional users and music and home cinema enthusiasts.

Why Every System Needs an M&K Sound X+ Series Subwoofer

For readers not deeply interested in technical product literature, here are some salient points up front.

Above and beyond the obvious, simplistic answer. More and better bass, the combination of a well-designed and conscientiously constructed subwoofer and main satellite speakers offers worthwhile performance advantages. These improve overall system performance in many critical areas that are equally relevant for stereo, surround, and object-based audio, for movie viewing and music listening.

Here's what happens when we physically separate reproduction of low frequency information from the upper and mid ranges:

- The most widely acknowledged benefit, of course, is improved deep bass extension, higher deep bass output levels and more control and authority, i.e., the system will play deeper, louder, cleaner, tighter bass.
- With an M&K Sound X+ Series subwoofer, bass is exclusively reproduced by a speaker created and optimized for that purpose only. Removing the burden of deep bass from the main speakers provides major improvements in essential parameters such as midrange purity and accuracy.
- Liberating main speakers from handling the tremendous demands of low bass also significantly increases their effective power handling capabilities, so that they can play louder without distortion.



The Miller & Kreisel X+ Series

- Removing deep bass from main speakers also ensures substantially reduced distortion. For example, keeping low bass out of main speakers works wonders for intermodulation phenomena of various kinds, including FM or Doppler distortion.
- Because the main amplifier no longer must handle deep bass, the amount of power needed to achieve a given sound pressure level from the main speakers is greatly reduced (typically -50%). This ensures that the amp remains well within its safe operating limits with considerable headroom readily available on demand.
- Independent placement of subwoofer and satellites allows the user to select an optimal position for each specific frequency range. The spot that delivers best bass is almost never the one that also delivers best upper/mid performance.
- With no bass vibrations or internal bass pressure waves in the main speaker enclosures, resonances are eliminated for cleaner, clearer mid and high frequencies.
- Since they no longer have to reproduce deep bass, main speaker cabinets can be more compact with enhanced structural integrity for natural, uncolored sound and a narrow front that eliminates baffle diffraction distortion, resulting in more open, natural, three-dimensional sound. No matter what some manufacturers may claim, and according to the immutable laws of physics, big bass requires a big box.
- M&K Sound invented the subwoofer nearly 50 years ago and continues to lead the way in low-frequency innovation and performance. "M&K is the granddaddy of subwoofer manufacturers" in Stereophile magazine's eloquent turn of phrase.
- Each M&K Sound X+ Series subwoofer is conceived as a complete system with drivers, amplifier and cabinet designed and optimized to work together as a unit for controlled, extended, natural, deep bass.
- M&K Sound X+ Series subwoofers employ a unique Push-Pull Dual Driver configuration to cancel harmonic distortion and provide an additional 6 dB of useable output for a more linear contour and more accurate bass.
- Subwoofer level, crossover and phase controls are optimized for fast, seamless integration of the subwoofer with the main speakers in any listening room.
- X+ Series subwoofers employ sealed enclosures exclusively, because this is the only way to achieve the finest transient response, impulse response and true deep bass extension with control and authority and none of the boomy, muddy sound that is inevitable with bass reflex designs with ports or passive radiators.
- THX Dominus, Ultra, and Select certification ensure independent quality assurance. You don't have to trust us, because our subs are independently measured and certified to adhere to the most stringent requirements of movie and music reproduction.



M&K Sound X+ Series Bass Drivers

The X+ subwoofers feature all-new bass drivers designed from the ground up to match the new amplifiers as a complete system. These drivers are tailored specifically to handle the increased power and achieve the best performance without sacrificing efficiency or adding distortion. They feature larger, longer voice coils to handle the increased power without adding distortion. New cones, dust caps, surrounds and spiders maintain low moving mass and extreme rigidity, and control the increased excursion. Furthermore, new cast aluminum woofer frames support the increased magnet structure and dissipate additional heat.

M&K Sound woofers are designed for high efficiency without sacrificing ultimate bottom end extension. Long voice coil windings ensure full control of impulse excursion even at the lowest frequencies. Coil length is an integral part of the drivers' specific tuning for optimal performance in sealed enclosures, which themselves have precisely calibrated cabinet volume and system Q tuning for ideal linear motion at large excursion.

The solid aluminum framework ensures improved heat dissipation from the motor system for reduced power compression. This phenomenon occurs in more conventionally constructed drivers when heat generated at the voice coil (as a consequence of extended operation at high output levels) causes impedance to rise, thereby reducing available output. The X+ Series woofers are, by design, immune to this undesirable effect and remain well within specified operating conditions, regardless of sound pressure level.

More About Distortion Killers

Major design features of the M&K sound X+ Series subwoofers include AC shorting rings in the magnet system and aluminum pole spacers above the pole piece. These devices make valuable contributions to the effortless bass transparency of the new line of subwoofers.

As an increasing proportion of modern program material contains more bass than ever before - and home audiences listen at higher levels than ever before - M&K Sound subwoofer drivers have evolved to keep up with these demands. Distorted sound reproduction is an all-too-familiar side effect when a signal is applied to a drive unit dedicated to work at large excursions. The best approach to the elimination of driver generated distortion is a preemptive strike before the problem arises. ('An ounce of prevention...', as the saying goes.)

One highly effective measure for distortion reduction is shorting rings placed in the driver magnet system to significantly reduce typical non-linear distortion types generated in the transducer. Placing an aluminum ring inside the magnet system minimizes impedance variations in the voice coil windings that would otherwise occur due to coil movement in the gap.

To provide the same effect for the voice coil windings above the gap, an aluminum spacer is mounted on top of the magnet system pole piece of the X+ Series woofers. This method of reducing impedance variation in the driver

is a proven and effective way to reduce system distortion, for more controlled, cleaner bass.

The distortion killer rings also act as an effective shunt for another source of deleterious non-linear distortion in the driver: voice coil generated AC magnetic field interference with the static magnetic field in the air gap.

With the shorting ring and pole spacer properly fitted in the magnet system to provide counter currents, the AC magnetic field of the coil is effectively shorted away from the permanent magnetic field in the driver's motor. This results in free and fast movement of the coil and attached cone in precise response to any incoming signal.

M&K Sound X+ Series shorting rings and pole spacers equalize the induction of extended voice coil windings and eliminate AC-generated eddy currents. This action makes a significant contribution to the subwoofers' ability to render extraordinary fine dynamic bass detail with high precision at all levels, as the drivers maintain full control and respond instantaneously to the incoming signal. The gain for the listener is represented by unparalleled accuracy and authority in the bottom octaves.

NBR and Conex Suspension

While previous generations of M&K Sound bass drivers used polymer-coated foam surrounds, X+ Series woofers take full advantage of the latest innovations in materials technologies with high quality, low-loss, thermally stable NBR rubber surrounds.

The half-roll suspension employed in the newly designed X+ Series drivers is designed to deliver extended long-stroke cone motion with no mechanical losses within the driver's linear excursion range.

The surround is also designed to provide a high

degree of damping of pressure build-up inside the cabinet to avoid collapse modes in the surround in the presence of large input voltage.

The critical specification of the hardness of the rubber is based on decades of experience in driver design, for unrivalled performance under even the most demanding operating conditions.

The X+ Series woofers feature advanced spider designs with suspensions made from Conex, a material that combines cotton and heat resistant Nomex to form a thermally stable center suspension ring for the driver.

Overhung Voice Coil on Aluminum ASV Former

The new X+ Series drivers use a non-inductive aluminum voice coil former to effectively eliminate mechanical damping in the moving coil. Aluminum formers offer key advantages, including mechanical rigidity and extreme thermal stability.

The voice coils are wound as overhung coils. Specifically, the X10+ and X12+ have a coil winding length of > 47 mm, operating within a 10 mm top plate, permitting up to +/- 18 mm of linear stroke. The X15+ has a winding length of 54 mm for a linear stroke of more than +/- 20 mm.

The potential of the long, overhung coil configuration is fully exploited in combination with the distortion killer ring that effectively reduces eddy currents caused by coil windings.

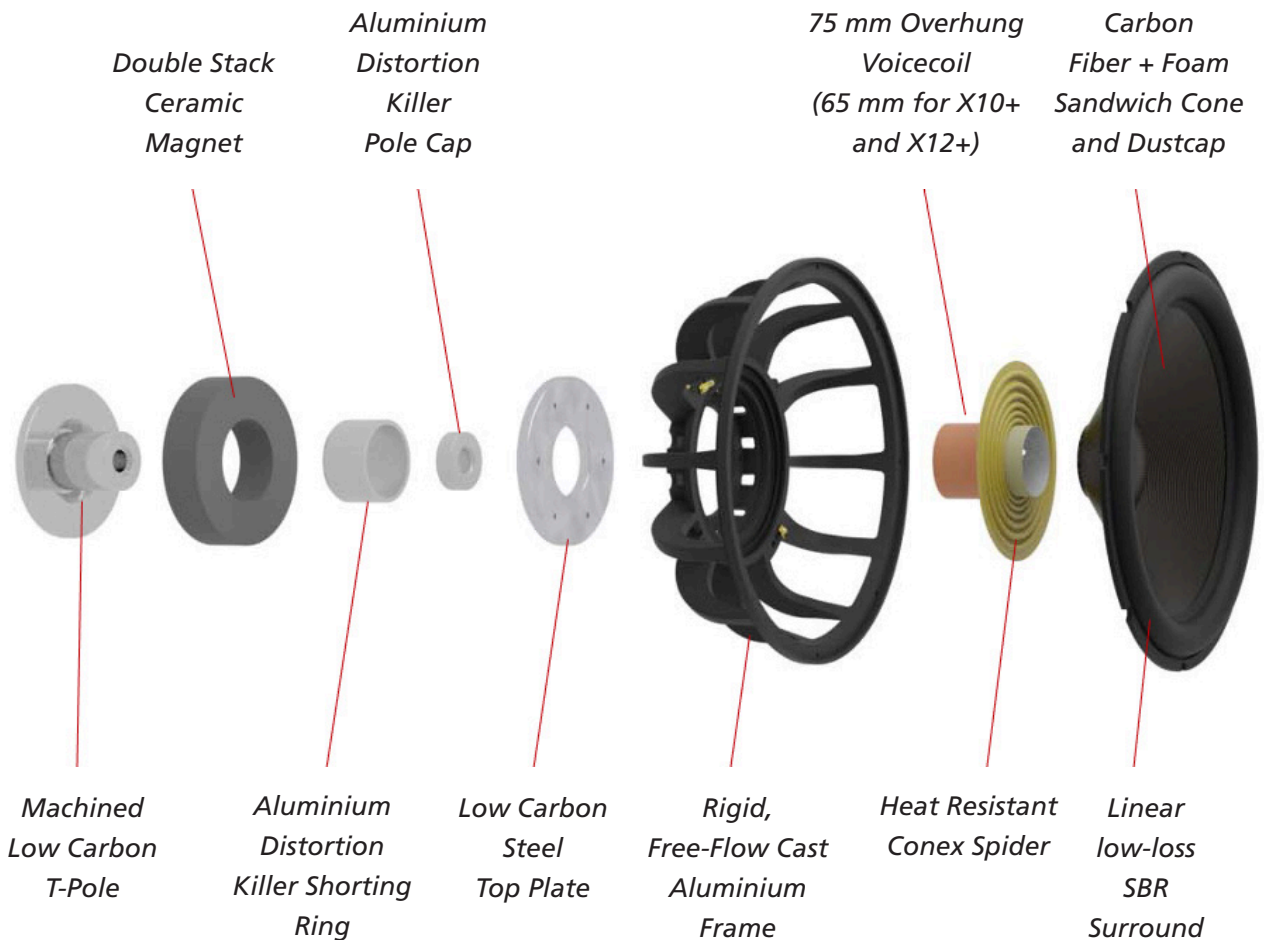
The X+ subwoofers have increased coil diameters of 65 mm for the X10+ and X12+, ensuring extraordinary power handling capabilities over 1000 Watts peak power handling. The massive 75 mm voice coil for the X15+ is, in turn, capable of handling over 1400 Watts.

All-New Carbon Fiber Foam Sandwich Woofer Cones

The woofer cones and dustcaps have been upgraded to an ultra-high strength and rigidity carbon fiber sandwich with a foam inner layer to ensure constant performance with all the extra power and excursion. Flexible, soft cone materials increase distortion through breakup modes and, by using carbon fiber, we eliminate this breakup mode distortion. As an added benefit, the new cones are stronger, stiffer, and lighter than previous versions resulting in louder, more accurate, and more dynamic, deep bass.

Woofer Caption Statement

The all-new X+ Series 10", 12" and 15" woofers have been tailored specifically to fulfill M&K Sound's ambitious performance requirements. They employ open baskets for free air circulation, resulting in minimal mechanical distortion by eliminating any captive compressed air mass behind the cone. Cast baskets also offer a very rigid attachment to the cabinet. And because the cast basket can withstand maximum torsion on screws, it provides a rock-solid transition between cabinet and driver.



M&K Sound X+ Series Amplification and Controls

While digital signal processing (DSP) and switch mode power amplifiers are definitely the buzz words du jour in subwoofer design, M&K Sound chose to take another long, hard look at all available technologies to create the new X+ Series subwoofers. After extensive experimentation and auditions, a combination of tried-and-true discrete analog technology and switch mode amplification was finally selected.

In our intensive testing, discrete analog input circuits consistently won out in terms of musicality, speed, and deep bass accuracy.

With precision EQ filters designed to complement driver specifications and cabinet tuning, discrete analog technology provided ideal measured target response curves, while preserving all the subtleties and ambient presence of analog deep bass.

The filter for extended low end response is custom designed based on Linkwitz-Riley transfer calculations and carefully optimized to provide filter flanks with shelving characteristics for smooth, extended low end frequency response.

The acclaimed bass impact of M&K Sound

- Classic M&K Sound analog input section for full-bodied bass with authority and weight
- Class D digital switching power amplifier for fast, precise bass
- Headroom Maximizer for strict control of peak excursions
- No servo controls to cause degrading signal delays
- Variable EQ/phase and crossover adjustments
- Flexible input/output options for use with active speakers with onboard filters

subwoofers is fully intact in the X Series with overall driver and cabinet tuning integrated with carefully adjusted filters for rock-solid bass below 20 Hz. This is a level of performance that is claimed by many but delivered by few.

To feed the driver clean, fast, efficient, and ample power, a switch mode power module has been selected. Capable of delivering up to 700 Watts continuously and up to 1400 Watts Peak (X15+), the module keeps a firm grip on the specially designed drivers at even the highest output levels.

Unlike manufacturers that are forced to utilize huge amplifiers to drive their under-designed, overweight drivers, M&K Sound integrates woofer and amplification from the earliest stages to achieve elegance and brute force in a high-tech, low-profile package. This arrangement also definitively proves that fast and accurate bass, and potent and muscular bass, need not be mutually exclusive.

Exclusive Headroom Maximizer

The use of M&K Sound's proprietary Headroom Maximizer to monitor the incoming signals has long been part of the secret behind the success of M&K Sound subwoofers.



Unlike traditional limiters implemented to protect speakers and prevent large driver excursions by brutally clipping peak voltage values above a fixed level, the Headroom Maximizer provides gentler, less invasive protection to handle high peak values by controlling dynamic variations in program material.

As low frequency program material from a given source can have dynamic characteristics that potentially drive any speaker to its outer linear excursion limits, the essential function of the Headroom Maximizer is to keep the driver within its linear stroke range to minimize distortion caused by extreme cone excursion.

The Headroom Maximizer monitors peak values in program material to detect dynamic changes that would require the amplifier to deliver full power. Before such levels are reached, the Headroom Maximizer gently and unnoticeably adjusts the

voltage from input section to output section appropriately, protecting the subwoofer without compromising dynamic integrity by keeping driver excursion within linear control.

By operating with settings for attack and release times in the Headroom Maximizer for subtle, incremental effects, X+ Series subwoofers are graced with exceptional dynamic capabilities.

Power Output vs. X-Series

The #1 upgrade from previous X Series subwoofers is the power increase. More power = cleaner and smoother high-output performance. At up to 1400 Watts Peak (X15+) these subs ensure considerable power without the need for dedicated circuit breakers or 20A circuits delivering maximum power from standard power sockets.

No Intrusive Servo Control

M&K Sound has consistently rejected servo control as a “quick fix” for what ails most subwoofers. The notion that additional electronic circuitry receiving direct feedback from an accelerometer attached to the driver cone can adequately detect errors and then calculate and apply corrective measures in real time with no detrimental effect on overall performance is unrealistic, to put it politely.

Rather than throw valuable resources at a complex solution to possible errors, M&K Sound X+ Series subwoofers are simply designed from the ground up to prevent such errors from occurring, through close scrutiny of the basic principles of dynamic loudspeakers and their fundamental behavior.

Class D Amplifiers

The audio power amplifier plays an essential role in every system that generates audible sound. For decades, amplifiers have been produced using analogue (Class A and AB) designs, which are very inefficient and result in voluminous, heavy and rather expensive products. The innovation cycle of analogue audio power conversion has matured, leaving little room for improvement.

On the other hand, switching or Class D amplification techniques are only at the beginning of their development. These technologies carry

a large potential for delivering much higher efficiency and audio performance, making products more reliable, higher quality, smaller in size, and costing less.

Instead of linear power regulation used in Class AB amplifiers, which leads to energy losses in power transistors, Class D amplifiers use switching transistors that operate at only two stages – “on” or “off”. Almost no energy loss occurs at the transistor and nearly all the power is carried to the transducer.

Class D technologies have been around for decades but, until the 1990s, their design and integration characteristics had not been developed to the level necessary for achieving high performance in quality audio and hi-fi applications. It was only as recently as the 1990s that semiconductor and digital technologies were developed to enable enhancement of Class D designs.

ICEpower pioneered new technologies to enhance Class D amplification and bring the audio quality to a level accepted by audiophiles. This allowed the subsequent introduction of Class D technologies into a wide range of audio applications.

Legacy X Series Subwoofers

X10 = 350 Watts RMS / 600 Watts Peak

X12 = 400 Watts RMS / 700 Watts Peak

New X+ Subwoofers

X10+ = 500 Watts RMS / 1000 Watts Peak

X12+ = 600 Watts RMS / 1200 Watts Peak

X15+ = 700 Watts RMS / 1400 Watts Peak

Advantages

ICEpower® Class D amplifiers have the following advantages:

- Audio performance on a level with, or better than, Class AB amplifiers
- Significantly higher energy efficiency of audio products
- Audio products can be made much smaller and lighter, and external heat sinks can be eliminated
- Significantly decreased manufacturing costs
- Higher integration of components made possible
- More design freedom and more attractive products
- The possibility of designing smaller products means more channels can be integrated into a single solution or audio product
- Higher quality of products
- The possibility of increasing the standard of existing products

- Numerous corresponding benefits to the environment makes Class D amplification a “green” technology

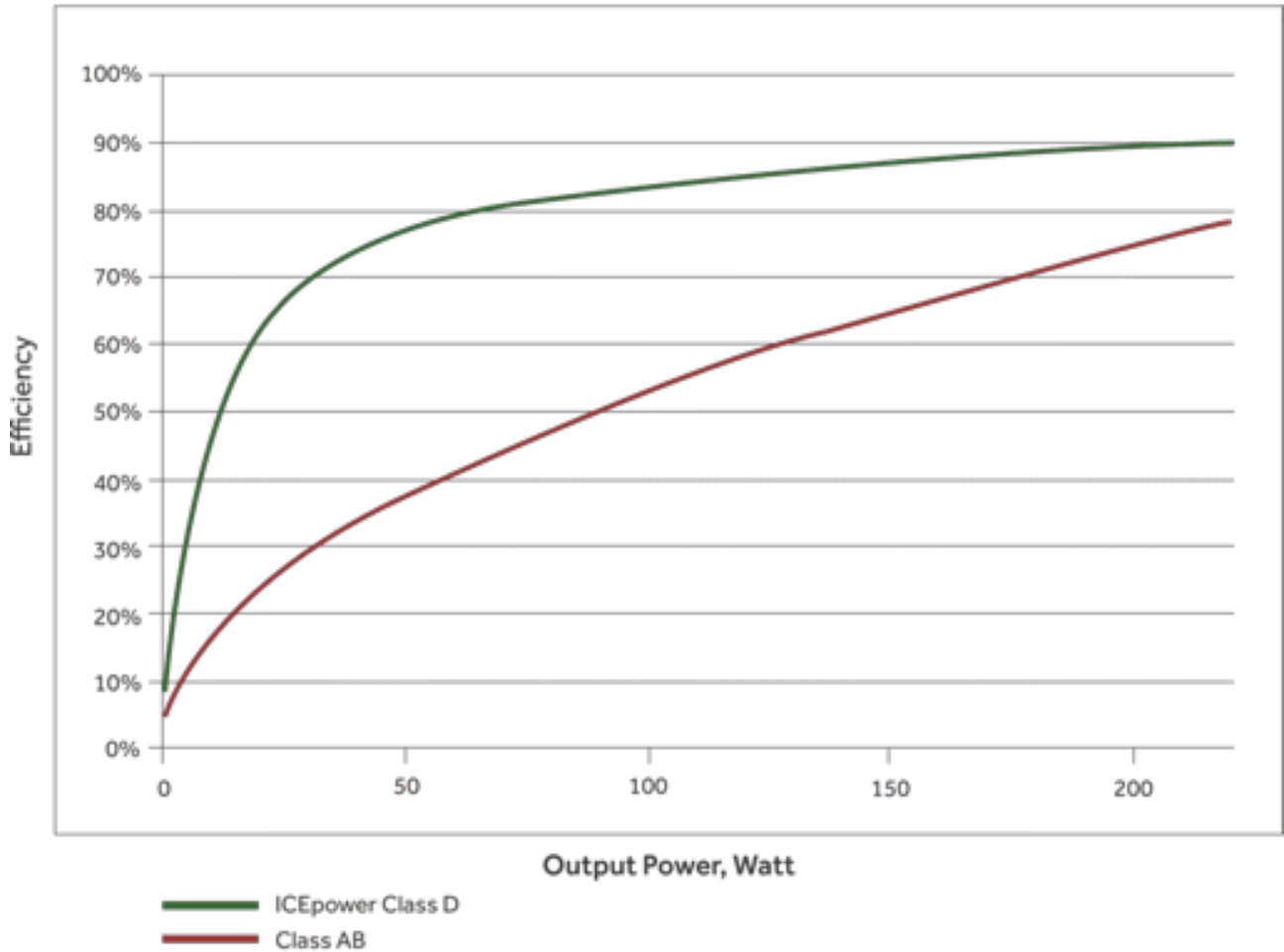
It is worth noting that the 10-channel solutions that ICEpower created for Pioneer Electronics' Susano AV receiver could not have been developed without applying switching technologies. Class AB amplifiers could not support this amount of channels in a single product and simultaneously produce high audio quality.

Efficiency

On the next page is a graph showing ICEpower amplifier efficiency compared to the highest theoretically possible efficiency of a Class AB amplifier (the latter calculated under ideal conditions which can never be achieved in reality).



Efficiency of an ICEpower Class D amplifier and best theoretically possible efficiency of a Class AB amplifier

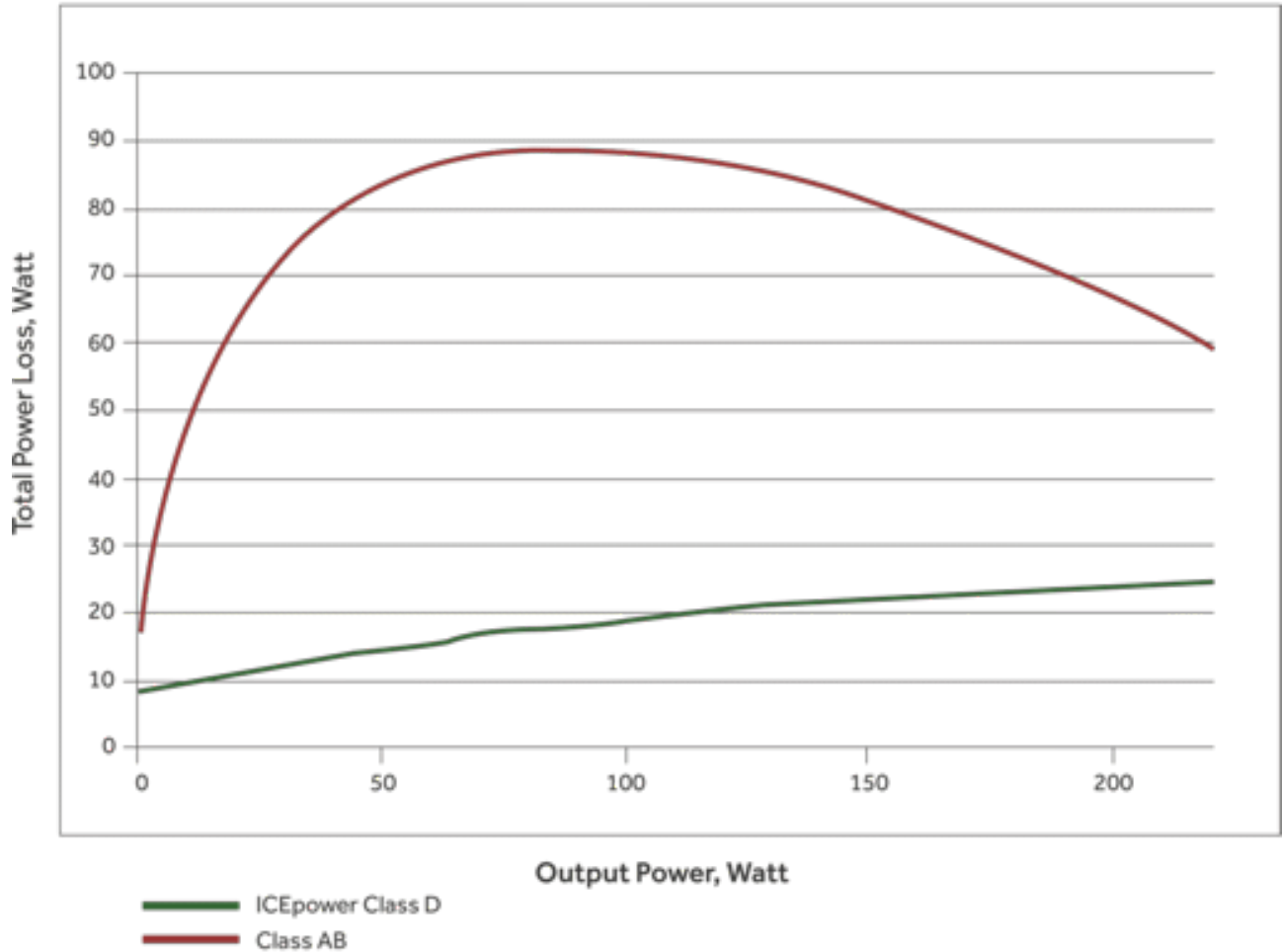


(Green graph: actual measured efficiency of the ICEpower Class D amplifier Conditions: mains 230V AC, load 8 Ohm, frequency 1 kHz sine, 1 channel driven.

Red graph: the best theoretically possible efficiency of a Class AB amplifier)

Inversely, below is the graph of energy loss in an ICEpower Class D amplifier vs. power loss in a Class AB amplifier with the best theoretically possible efficiency.

Power Loss of an ICEpower Class D amplifier and power loss of a Class AB amplifier with highest theoretically possible efficiency



(Green graph: power loss of an ICEpower Class D amplifier Conditions: mains 230V AC, load 8 Ohm, frequency 1 kHz sine, 1 channel driven.

Red graph: power loss in a Class AB amplifier with the best theoretically possible efficiency)

M&K Sound Cabinet and System Tuning

The M&K Deep Bass Concept

All M&K Sound subwoofers employ the company's Deep Bass™ concept based on careful matching of drivers, amplifiers, sealed enclosures and the exclusive Headroom Maximizer™ circuit. Headroom Maximizer allows the full, uncompressed dynamics of an audio signal to be heard, while preventing amplifier clipping and distortion. M&K's Deep Bass sealed box design reproduces bass frequencies below 20 Hz with exceptional transient response, accuracy and authority.

Deep Bass specifically refers to a subwoofer's ability to produce usable steady state and transient output below 20 Hz. M&K's Deep Bass design produces significant deep bass output on some models to frequencies below 10 Hz. This output is responsible for a major difference in subwoofer performance, producing what some have described as the "startle factor" or "awesome" bass.

Most conventional subwoofer designs (especially units with

passive radiators and vented cabinets) have an extremely sharp roll-off (24 dB/octave) below the lower limit of their "flat" response. But M&K subwoofers have a much shallower roll-off below their -3 dB anechoic response frequency. By reproducing bass frequencies well below 20 Hz, M&K subwoofers have a lifelike power and authority that other subwoofers cannot match.

The X+ Series subwoofers follow the proven M&K Sound concept of front and bottom mounted dual drivers operating in a sealed enclosure

push-pull configuration, which was introduced in 1988 with the legendary MX-1000 subwoofer. It has been continually refined over the ensuing decades. The unusual front and bottom driver configuration is a clever, non-invasive way to reduce harmonic distortion.

Push-Pull Dual Drive

M&K Sound subwoofers revolutionized the industry with innovative push-pull compound loading designs. This design allows for smaller cabinet volume, while providing faster, more powerful, and deeper bass than other designs,





along with far less distortion. The dual driver design creates a pistonic action with stable and constant air pressure inside the cabinet and, due to the phase and placement of the dual drivers, provides noise cancellation substantially superior to any servo-controlled system.

Measured third harmonics in dynamic transducers are undesirable side effects arising from the basic non-linear characteristics of mechanical suspension parts, such as the half-roll design typically used for driver surround and center spider suspension. Because these parts also provide the essential function of progressive braking at large excursion, trade-offs between basic driver design and mechanical control of moving parts in relation to distortion become inevitable in conventional driver configurations.

The M&K Sound X+ Series subwoofers employ a unique Push-Pull Dual Driver configuration to eliminate harmonic distortion and double the sound power per watt of amplifier power. This achieves 6 dB of additional output, along with major improvements in bass detail, articulation, authority, and impact.

Inside M&K Sound X+ Series subwoofers, one driver is mounted conventionally on the cabinet's front baffle, while the second driver is mounted inverted in the bottom panel. The front of its cone faces the inside of the cabinet, with the rear of the cone, magnet, and frame facing the outside.

Although both drivers fire into the room in pressure phase (one with the front side of its cone and the other with the rear), they operate mechanically out of phase relative to each other's magnetic structure. (They are driven electrically out of phase.) Therefore, regardless of position, each cone is always in the exact opposite position from the other in its travel, relative to its own magnet.

By mounting two identical drivers in opposite phase in a Push Pull configuration, the distortions generated by the drivers, one in-phase and one out-of-phase, effectively cancel each other for significant improvements in overall system harmonic distortion measurements. Essentially, two drivers become one and their non-linear distortion products are eliminated.

Even-order harmonic distortion in a conventional woofer is caused by different non-linearities in the cone's motion when the voice coil is moving deep into its magnet compared to when it is moving away from its magnet. In the X+ Series Push-Pull Dual Driver configuration, the two drivers operate in reverse phase, so that the even-order harmonics of both drivers are equal and opposite in time phase to each other.



Consequently, the even-order harmonic distortion products of the two drivers cancel each other acoustically, providing a worthwhile reduction of linear distortion types, such as second and fourth harmonics. This elegantly sidesteps what for other brands is an inevitable problem and transforms unacceptable non-linear driver behavior into ideal linear system behavior.

As important as the distortion cancellation, the push-pull configuration also doubles efficiency in comparison to a single 12" driver (equivalent to doubling amplifier power), as well as allowing twice the amplifier power to be used because power is distributed to two drivers. The total output improvement is four times (6 dB).

M&K Push-Pull Dual Driver designs deliver deep bass with very low distortion and tremendous articulation to produce a very natural and powerful bass reproduction.

Sealed vs. Vented?

Built from dense MDF panels up to 25 mm thick, the M&K Sound X+ Series offers an extreme level

of structural integrity in mechanical construction. Extensive internal bracing also contributes to the rigidity of the enclosure.

A sealed enclosure design is by far the most precise and accurate subwoofer principle if superior impulse and transient response are the goals. Compared to vented systems, a correctly tuned sealed enclosure system will always be twice as fast at bringing an impulse

ripple to a stop than a vented or passive radiator system.

By employing a Push-Pull Dual Driver configuration in sealed enclosures, M&K Sound X+ Series subwoofers minimize harmonic distortion and optimize transient/ impulse response to achieve an unparalleled level of low frequency authority and realism.

The fact that subwoofer/room interaction (with actual in-room bass response measured in real rooms, not in anechoic chambers) will be more predictable and smoother, is yet another useful advantage of sealed enclosures.

While vented systems, where the port artificially boosts the tuned resonant frequency, can easily excite unwanted room resonances, and if the tuning of driver and port is not completely accurate, a sealed enclosure exhibits a constant response slope at the lowest frequencies for a far more accurate rendering of the input signal.

Sealed Box Deep Bass Subwoofers

All M&K Sound X+ Series subwoofers are sealed-box designs, tightly packed with highly efficient sound absorbing material. This configuration delivers the best transient response and is the only design capable of producing true Deep Bass.

Good transient response means that the speaker responds quickly to input signals, with a quick start and a quick stop. Speakers with poor transient response have a blurred, muddy sound with little pitch definition. Deep Bass refers to the ability of the speaker to produce significant output down to frequencies below 20 Hz, which is needed to produce the “startle factor.”

M&K cabinets are very heavily braced to provide the most stable platform for the drivers and to avoid the resonances, buzzes and rattles that are surprisingly common in competitive subwoofers. Flimsy, unbraced cabinets produce an easily recognized sound. They sound cheap!

Weaknesses of Vented Designs (Reflex Ports and Passive Radiators)

Many subwoofers are vented designs, using ports or passive radiators. These designs have inherently poor transient response, producing a boomy, uncontrolled sound. They may play fairly loud, but good produce, a sound that quickly becomes fatiguing to listeners. Most produce audible air turbulence noise from their ports when producing certain frequencies. This noise can draw listeners’ attention to the subwoofer and make it easy to hear its location. Most of these subwoofers respond poorly or not at all to very rapid impulses, such as the stomping of flamenco dancers on a wooden floor.

Like a bottle filled with water that produces one particular frequency when air is blown across its opening, the sole purpose of a port or passive

radiator is to make a cabinet resonate at or near the tuned frequency of the port. This generates an added output (3 to 6 dB) at that frequency, but there is a price to pay for that poorly damped extra output, because internal damping material cannot be used with this type of design.

Remember that a speaker driver is radiating as much sound inside the cabinet as it is filling the room. This is why all M&K subs are tightly stuffed with highly efficient absorbing material to soak up much or all of the sound inside the cabinet. When a cabinet does not have this absorption, the sound in the room becomes muddy. In a ported speaker, stuffing cannot be used.

The other fatal flaw of vented designs is their extremely rapid roll-off below their tuned resonance frequency (usually well above 30 Hz). Below that frequency, the woofer’s response drops off so quickly it essentially disappears, making it unable to reproduce subsonic transients. Vented boxes roll off at twice the rate of sealed boxes (24 dB per octave), and their active driver and vent are actually out of phase with each other, so they cannot produce Deep Bass.

No Servo Feedback

Many customers ask about negative feedback in powered subwoofers. M&K does not currently manufacture subwoofers using servo feedback, although the original Volkwoofer did have a servo circuit. Feedback uses a sensor mounted on the speaker that detects the movement of the cone. The signal generated by this movement is sent from the speaker voice coil area back to the electrical input of the power amplifier and is compared to the subwoofer’s input signal. Any difference between the two represents distortion. The feedback circuit takes that difference (distortion) signal, inverts its phase, and applies it back to the amplifier’s input, theoretically canceling the distortion.

When an input signal is steady-state, like a sine wave, feedback can measure extremely well. Unfortunately, music is always changing. And since a musical signal has changed by the time the “correction” signal has been applied, the sound is not improved—it is actually made worse!

This is why designers of high-end amplifiers strive for minimum feedback. Even though greater feedback produces lower measured distortion, excessive feedback produces poorer sound due to a phenomenon known as Transient Intermodulation Distortion.

In loudspeakers, the same principle applies, but to a much greater degree, because the delay in applying the correction signal is greater as it is responding to the motion of the speaker, instead of the speed of electrons moving through an amplifier at nearly the speed of light.

In speakers, feedback also affects transient performance and dynamic range. Feedback systems can become unstable with sharp transients and high output levels, forcing designers to include amplifier limiting circuitry. This adversely affects sound quality by dulling transients and compressing dynamics.

It is M&K’s philosophy to strive for excellent reproduction of transients in real-world signals, not just artificial testbench sine wave measurements. Compare the sound of an M&K Sound X+ Series subwoofer to any subwoofer using servo feedback. The dynamic and transient performance of the M&K will deliver an audibly cleaner and more detailed musical sound.

Ease of Service

M&K X+ Series amplifiers and crossovers utilize modular printed circuit boards for maximum reliability, quality control testing and ease of service. Unlike M&K Sound, many speaker

crossovers are simply glued to a mounting panel or to the cabinet itself and they cannot be easily removed or tested.

Control of System Q

“Q” is a measure of quality that involves the speaker’s transient performance, with a low “Q” being optimal. Subwoofers with passive radiators, vented boxes (bass reflex) or bandpass designs use air in a chamber or port as a high Q resonator. The vent “tunes” the speaker to a given frequency, which then becomes essentially its low frequency limit.

The purpose of these ports or passive radiators is to resonate the cabinet at some frequency, which, if done properly, can increase the speaker’s output by 3 to 6 dB at that specific frequency.

But these high Q systems have an unavoidable tendency to resonate (or “ring”), much as a tuning fork continues to sound long after it is struck. M&K low Q sealed box designs, tightly stuffed with special sound-absorbing material (which cannot be used with a vented speaker), produce a solid output without ringing, down to frequencies below 20 Hz.

Every element of an M&K Sound X+ Series subwoofer, from the driver to the enclosure and the amplifier, is very tightly damped (low Q), so the combination achieves extremely tight and articulate musical bass.

Room-Ready

M&K Sound X+ Series subwoofers do not include onboard room correction because, by design, they interact well with any listening space with proper placement and adjustment. Many users will already have access to full-range room correction in a preamplifier, surround processor or a standalone unit. In any case, to be truly effective,

room correction should be applied not only at subwoofer frequencies, but across the full audible spectrum.

Updates from X Series

Increased Venting

To allow better transfer of all this extra output into the room, M&K has increased the cutout areas around the bottom woofer. With a new large rear vent and greatly increased front vent, distortion from air turbulence has been significantly reduced over the former X Series. In addition, these two vents work in tandem to provide a convenient handle for installation.

Full 25 mm MDF vs 22 mm MDF

The new X+ Subwoofers also include full 25 mm MDF construction. Dense, rigid construction with bracing ensures

no panel vibrations or cabinet resonances. The new X+ Series subwoofers are true home audio heavyweights, weighing 40, 46 and 61 kg, respectively. Their rock solid cabinets ensure minimum resonances or dynamic interference.

Cosmetic Upgrades

The new X+ Subwoofers now mirror the clean lines of M&K Sound's S 150 and S 300 satellite speakers. The X Series' recessed front baffle has been removed in favor of a more décor-conscious, smooth façade. Additionally, the former grille pegs of the X Series have been replaced with invisible and convenient magnetic grille attachments. Threaded inserts for subwoofer feet allow users the option to acquire after market spikes or vibration isolators.



Installing M&K Sound X+ Series Subwoofers

Ultimately, the amount and quality of bass in each room are dependent on the room itself and the location of the subwoofer in that room. Low frequency sounds are affected most by the size of the room, furnishings (hard or soft) and the method of construction (wood, brick, concrete) used to build it. All rooms are different when it comes to reproducing bass and the quantity and quality of that bass are highly dependent on the subwoofer's location.

A simple rule to remember is that bass levels increase when a subwoofer is moved towards any wall or corner. Moving it away from a wall or corner reduces bass output. Remember also that the floor loads the subwoofer, and that maximum bass is generated with the woofer on the floor and in a corner.

Our experience in measuring subwoofer performance (in hundreds of rooms) shows that, in most cases, the best location is either directly in, or very close to, a corner.

All our room measurement techniques correlate well to the time and frequency domain characteristics of the human ear and brain system. Third-octave techniques do not provide sufficient frequency resolution or time-domain selectivity needed for accurately determining ideal subwoofer placement.

Placing the subwoofer near or in a corner provides good loading to the room and is a good place to start when experimenting. Placing the subwoofer in a corner maximizes bass output, but in some rooms, it may negatively affect the quality of the bass. In these cases, placement away from the

corner is recommended. One room position will exhibit the flattest response, with no peaks and dips, and the highest output (room gain). Typically, this is the corner closest to the listening position.

Virtually every room has a set of frequencies that are either emphasized (response peaks) or canceled (response dips) because of the room's dimensions. When this happens, the sound is boomy and unclear - not just at those frequencies, but in general. The goal is to achieve a smooth sound quality, with the entire bass spectrum equally prominent.

M&K Sound subwoofers deliver excellent performance located virtually anywhere in a room. M&K Sound subwoofers they are designed so that their output is not localizable when used with proper bass management electronics and adjustment. Therefore, there is no need to place a subwoofer either between the main speakers or in a specific location, or any other than the one that offers the best spectral response. Determining which location works best for a particular application should be done according to the following guidelines.

The low frequency response and efficiency of a subwoofer are heavily influenced by the acoustics of the playback environment. More specifically, the response is influenced by the room's dimensional ratios, furnishings, building construction and location of the subwoofer within that environment. Subwoofer in-room response and efficiency can be significantly improved by experimenting with various room placements until the optimum location is found.

When placing the subwoofer, there are several general guidelines that should be kept in mind. These include:

- Every acoustic space is unique, and experimentation is an important key in finding the best possible location in a particular environment.
- A subwoofer becomes more acoustically efficient (delivering greater output) as it is moved closer to a room surface (e.g., against a wall or in a corner).
- A subwoofer will give maximum output and maximum acoustic excitement when it is in a corner.
- Under certain acoustic conditions, corner locations are optimum; in others they can excite multiple room modes, producing muddy or boomy sound.
- Multiple subwoofers are always better than a single subwoofer installation due to the elimination of small “sweet spots” and cancellation of room modes.

The following method has been found to work successfully under most conditions.

Subwoofer placement using a Real Time Analyzer

Place the subwoofer at the main listening position and connect the subwoofer to a pink noise source (a generator or test CD/DVD). Turn on the pink noise and make sure that the level of the subwoofer has been raised high enough so that low frequencies are not masked by background noise in the room. Now set the analyzer to real time mode and 1/12th octave resolution (or whichever setting provides the highest resolution) and begin to take measurements around the room. If the analyzer has the capabilities to do real time averaging, then use this function to better analyze the spectral response.

As measurements are taken at various positions throughout the room, careful attention should be paid to locations that yield smoothest spectral response and greatest low frequency extension. Pay special attention to the corners and along the walls. Remember, because the subwoofer is basically omnidirectional, the best spot for the subwoofer can be next to, or even behind, the main listening area.

After analyzing the data and finding the spot where the subwoofer has the best response in the room, place the subwoofer in that location. Now, take some additional measurements from the listening position and confirm that the subwoofer’s response remains the same as when the positions were reversed. If it is, then leave the subwoofer in that location. If not, continue to experiment with the subwoofer location until the smoothest and best response has been achieved.

It has been found that a subwoofer’s in-room response can sometimes be improved by facing the drivers towards a wall. Again, experimentation is the key to finding the best possible location.

M&K Sound subwoofers generate tremendous energy, so they may vibrate objects close to them. If buzzing or vibration is heard, eliminate the noise at its source. Rattling, buzzing and other sympathetic resonances can make the subwoofer localizable and therefore should be avoided. Using a sine wave generator or test CD/DVD with frequency sweeps can be helpful in locating these acoustic anomalies.

Using Multiple Subwoofers

While each X+ subwoofer is single-sub Certified for THX Select, Ultra, and Dominus (X10+, X12+, and X15+ respectively), there are considerable benefits to using multiple subwoofers in any installation.

Two (or more) subwoofers can be beneficial in a system, although one great sub correctly positioned and adjusted will always be better than two merely good subs. A second subwoofer significantly improves a system's total bass output, dynamic range, and headroom. The second unit doubles the amount of driver radiating area, which, depending on room placement, increases efficiency by as much as 3 dB (the same as doubling amplifier power). The second subwoofer then doubles available amplifier power for another 3 dB of output for a total increase of 6 dB!

The addition of a second woofer means that both woofers have to work up to 6 dB less hard (25% of the work) for a given output level, making for lower distortion (due to less cone motion) at all but the highest playback levels (which can be much higher with a second woofer).

As noted earlier, bass quality and peaks and dips in the frequency response of a subwoofer in each room are dependent on the location of the subwoofer. If you can find and use the optimum location (no response peaks or dips) for a subwoofer in a room, two subwoofers stacked at that single location would be best. However, two subs at different locations will help create a larger sweet spot and more even bass response across all seating locations.

Unfortunately, such an ideal location is generally not available so, in most cases, two subwoofers in different locations can complement each other. Stacking subs in a front corner boosts output, but will not address any room modes arising from that placement.

A second sub positioned approximately one-third of the way down a side wall, instead of atop a corner sub will not excite the same set of room modes. From two locations, different room modes are "driven", which can produce smoother response in the room. Listening and measurement tests can help determine the best dual subwoofer placement. The use of stereo subwoofers is subject to the same conditions.

Properly executed room correction may address some, but far from all, room mode issues. If the room generates peaks at some frequencies, then room correction can easily equalize them away. But if the room cancels a given frequency, creating a dip

in response, then asking any sub to compensate by producing an additional 10, 15 or 20 dB, or even more, at a specific sub frequency will quickly move it out of its comfort zone.

Unlike stacking, distributed sub placement prevents aggressive room modes, eliminating the need for a cure.

With multiple subs, there is also the theoretical possibility of using one for the dedicated LFE channel and the other for all additional channels. However, we strongly recommend that the bass content of all channels be fed to all subwoofers in a system.





The M&K Sound Satellite-Subwoofer System Concept

Unrivalled Sat/Sub Experience

M&K Sound is the only speaker manufacturer to produce exclusively satellite and subwoofer systems since 1974. The company manufactures satellite-subwoofer systems because it believes this is the optimum configuration for reproducing both music and film sound. Here is why:

Bass frequencies and Large Boxes

Basic laws of physics dictate that speakers reproducing true Deep Bass (down to 20 Hz and below) must be large. Therefore, M&K powered subwoofers, come in fairly large enclosures.

Mid and High Frequencies and Small Enclosures

But large enclosures, with their large front baffles, are not good for reproducing the rest of the audible spectrum. Mid-range and high frequencies produced from cabinets with large front baffles have a distinctive coloration known as baffle diffraction distortion. The small baffles of M&K satellites minimize this coloration, resulting in an open, natural, three-dimensional sound.

M&K Sound Optimized Powered Subwoofers

M&K subwoofers are designed as complete systems. Each model's performance is so much more than the high quality of the drivers, cabinet, and amplifier because these elements are optimized to work with each other in that specific product.

M&K's design allows the user to set the bass level anywhere from flat to grossly exaggerated. Built-in adjustable low-pass filters allow users to fine-tune the transition between the satellite and subwoofer speakers without a separate crossover. For use with surround processors, most models have a lowpass filter bypass to eliminate any phase problems associated with dual filters.

Incompatible Placement Demands

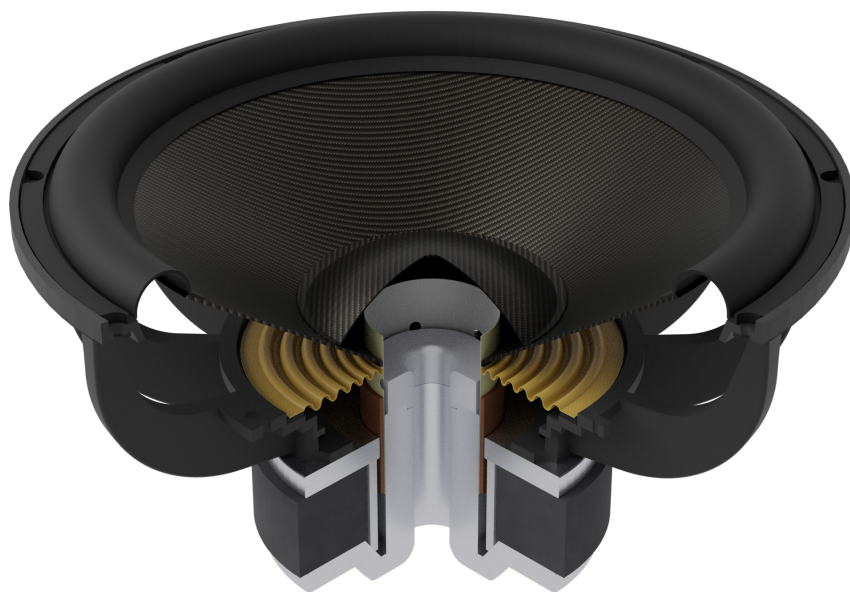
When speakers are set up in a room, they are usually located to produce the best imaging at the main listening position. Unfortunately, in virtually all rooms, that location does not give the deepest

and smoothest bass response. It usually means that the speaker's bass response will be disappointing because the speaker will not achieve its bass specifications in that room! This compromise is inherent in all speakers without a separate subwoofer.

With an M&K system, satellites are simply located for best imaging and the subwoofer(s) for best bass. Listening rooms have an enormous effect on sound quality, and only satellite-subwoofer systems provide the superior flexibility for achieving the best possible sound in any room.

Compact M&K Sound Satellite Speaker

The compact size of M&K satellites has been appreciated by music lovers for many years due to the speakers' great placement flexibility and unobtrusiveness. With the advent of home theater and music systems requiring 5.1, 6.1, 7.1 - or even 7.1.4 - channels and beyond, this advantage is appreciated even more!



Technical Features and Descriptions

M&K Sound X10+ Subwoofer

With dual 10" drive units, the X10+ provides 156 sq inches of cone area to move and control air.

M&K Sound X12+ Subwoofer

With dual 12" drive units, the X12+ provides 226 sq inches of cone area to move and control air, or 40% more surface area than the X10+.

M&K Sound X15+ Subwoofer

With dual 15" drive units, the X15+ provides 350 sq inches of cone area to move and control air, or 55% more surface area than the X12+, and 125% more surface area than the X10+.

There's no replacement for displacement

M&K Sound X+ Series Subwoofers possess the transparency, speed and resolution that let the most critical audio professionals hear exactly what's going on in the mix and listen for hours on end with no hint of fatigue. M&K Sound's seamless, integrated feel immerses the listener in sound with exceptional handling of dynamic changes in pace and volume.

Making the final choice to purchase X+ Series Subwoofers model will naturally depend on many factors including budget, room size, preferred listening levels, musical and cinematic tastes and, of course, exactly how dedicated the buyer is in his/her quest for ultimate audio realism.

Bass Integration Functions

The classic M&K Sound analog input section offers all the necessary adjustments and input options for perfect integration of X+ Series subwoofers in any listening environment and audio system.

Phase: Continuously variable phase adjustment for seamless subwoofer/satellite integration.

Low Pass: Filter options include fixed 80 Hz THX, continuously variable high-pass function, and a bypass mode for use with a surround processor with built-in bass management.

THX EQ: Processing shapes frequency response according to THX specifications for movie soundtracks and all forms of multi-channel surround and object-based audio program material.

M&K Anechoic: EQ processing provides a mildly attenuated low frequency output appropriate for most music program material.

Level: Fixed THX specified input level or continuously variable level.

Passthrough: Designed for professional setup options which do not require external bass management processing, such as M&K Sound professional monitors with onboard high pass filtering.

The Final Choice

Bass is so much more than explosive special effects, booming cannons in the 1812 Overture, the deafening roar of CGI monsters or even the most riveting, trouser-flapping, techno or R&B dance beat.

It is also the subtle, low-level ambient hum of a packed concert hall just before the first note is played, or the soft, ominous rumble of thunder miles away in the distance.

Deep bass is all of these things and so much more. The bottom end of the audio spectrum is a crucial

component to making the listening experience that much more real and visceral. Subwoofers with a substantial footprint are not just designed for playing content loud, but are required to ensure that you, the audience, has a chance to experience the entire audio spectrum without compromise.

With the new X+ Series of subwoofers, whether listening to movie or music sources, M&K Sound is proud to deliver that perfect experience to your home.



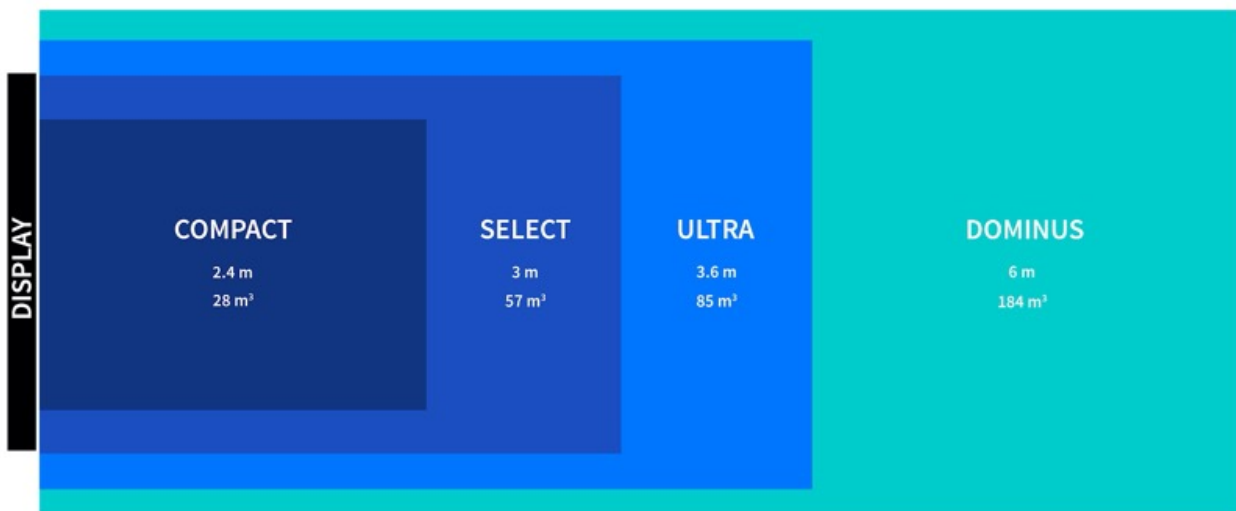
THX Certification

THX is a set of performance standards originally developed by Lucasfilm Ltd, the movie empire of Star Wars creator George Lucas, to lay out a set of criteria to ensure that the creations of cinematic artists are reproduced exactly as intended. For domestic installations, THX certification is the seal of approval that attests that the component has been thoroughly tested by a fully independent body and found to live up to the strictest quality requirements in the audio industry.

THX Certified Dominus

THX Certified Dominus is the newest and the largest performance class of THX Certification, meant to bridge the gap between large home theater speakers and those used in cinemas worldwide. Home theater owners with rooms up to 184 cubic meters of space and up to a 6-meter viewing distance (or up to 6500 cubic feet and up to 20 feet, respectively) can fill their entertainment space with the superior audio quality they expect from THX Certified products. That means quieter whispers, bigger explosions, and everything in-between, at a greater distance.

THX CERTIFIED PERFORMANCE CLASSES



The Miller & Kreisel X+ Series

The company developed the THX Certified Dominus performance class to fill the largest home theaters with sound, but the new speakers need to be more than just loud. During the rigorous testing process, THX pays special attention to distortion levels at high volumes. With Dominus, THX pushes this to the extreme, subjecting speakers to 120 dB sound pressure levels where they must keep distortion to a minimum. Dominus speakers must also be sensitive enough to reach the cinematic THX Reference Level when paired with THX Certified Dominus and certain THX Certified Ultra amplifiers.

The result of the THX Certified Dominus performance class is huge speakers that produce a massive wall of sound to immerse everyone in a home theater or hi-fi listening room, irrespective of seating location, with beautiful, distortion-free sound.

THX[®]
C E R T I F I E D

TM

D O M I N U S

M&K Sound X+ Series Specifications



X10+

Amplifier Power 500 Watts RMS / 1000 Watts Peak
 Frequency Response 20 - 200 Hz +/- 3 dB
 Total Harmonic Distortion < 0.5%, 300 Watts, 4 Ohm
 AC Power Consumption 0.5W standby, 100W average, 600W max
 AC Line Voltage 100-230 VAC 50/60 Hz 5A
 LFE Input L/R Line level RCA & L/R XLR balanced
 LFE Passthrough Output L/R Line level RCA & L/R XLR balanced
 Switchable Lowpass Filters Fixed 80 Hz / Variable / No lowpass
 Phase 0-180 degrees, continuously variable
 Switchable LFE Optional THX or MK EQ mode
 Dimensions WxHxD 40 x 64.7 x 34 cm / 15.7 x 25.5 x 13.4 Inch
 Weight 40 kg / 88.4 lbs



X12+

Amplifier Power 600 Watts RMS / 1200 Watts Peak
 Frequency Response 20 - 200 Hz +/- 3 dB
 Total Harmonic Distortion < 0.5%, 350 Watts, 4 Ohm
 AC Power Consumption 0.5W standby, 110W average, 700W max.
 AC Line Voltage 100-230 VAC 50/60 Hz 5A
 LFE Input L/R Line level RCA & L/R XLR balanced
 LFE Passthrough Output L/R Line level RCA & L/R XLR balanced
 Switchable Lowpass Filters Fixed 80 Hz / Variable / No lowpass
 Phase 0-180 degrees, continuously variable
 Switchable LFE Optional THX or MK EQ mode
 Dimensions WxHxD 45 x 72.8 x 38.5 cm / 17.7 x 28.7 x 15.2 Inch
 Weight 46 kg / 101.2 lbs



X15+

Amplifier Power 700 Watts RMS / 1400 Watts Peak
 Frequency Response 16 - 200 Hz +/- 3 dB
 Total Harmonic Distortion < 0.5%, 400 Watts, 4 Ohm
 AC Power Consumption 0.5W standby, 120W average, 800W max.
 AC Line Voltage 100-230 VAC 50/60 Hz 5A
 LFE Input L/R Line level RCA & L/R XLR balanced
 LFE Passthrough Output L/R Line level RCA & L/R XLR balanced
 Switchable Lowpass Filters Fixed 80 Hz / Variable / No lowpass
 Phase 0-180 degrees, continuously variable
 Switchable LFE Optional THX or MK EQ mode
 Dimensions WxHxD 51.5 x 83.3 x 46 cm / 20.3 x 32.8 x 18.1 Inch
 Weight 61 kg / 134.7 lbs

MILLER & KREISEL®

www.mksound.com

The Choice of Professionals®