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SS-AR1 Loudspeaker: Technical Background

Because You Care About Music™

Everybody says they "love music" and thanks to digital streaming and digital files, more people can access their music in more ways than ever. But greater access does not always mean greater satisfaction. Frequent playback does not always equal attentive listening.

Sony created the SS-AR1 loudspeaker for people who are focused when listening to music. The SS-AR1 rewards careful listening, recreating sound just as it was recorded. The performance stems from a carefully cultivated philosophy, honed through decades of work in the high end. The performance comes from Hokkaido maple, harvested from Japan's northern island in November, when the grain is tightest. It comes from a baffle board laminated to a thickness of 50 mm, from side panels of Nordic birch, from refinements in drive unit loading, port design, drive unit configuration and crossover parts selection.

In short, the Sony SS-AR1 is a loudspeaker for people who truly care about music.

A heritage in audio

Sony is no stranger to music reproduction. We began by creating both an audio tape recorder and audio tape, the first ever in Japan. We helped spark the early days of transistorized high fidelity and led the way with amplifiers using Field-Effect Transistors (FETs) and Vertical FETs (VFETs). We helped drive the PCM revolution, co-inventing the Compact Disc and we launched the Direct Stream Digital® audio revolution, which led to co-inventing the Super Audio CD. We've also delighted high-end listeners with our Esprit, ES Series and R Series components.

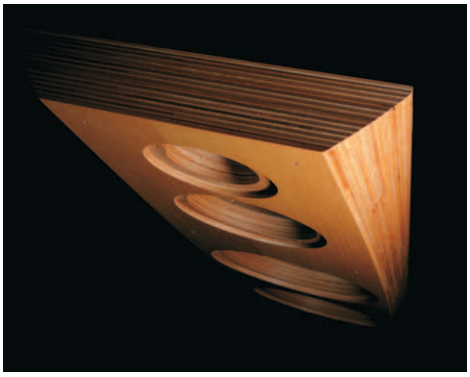
Along the way Sony has created significant speakers. Often restricted to Japan, occasionally sold worldwide, Sony high-end speakers have earned a select, passionate following. American aficionados remember our Esprit series Accurate Pistonic Motion speaker, the APM-6 (1981), while audiophiles and reviewers overseas have also acclaimed the SS-AL5 Mk II (1998) and SS-X90ED (2001).

In recent years, Sony's love of sound reproduction led to the creation of an independent development arm dedicated to high end loudspeakers. The typical Sony product is the result of extensive teams assigned to product planning, design and manufacturing. In dramatic contrast, the high end loudspeaker effort is led by just one man: Yoshiyuki Kaku.

As a boy, Kaku fell in love with live classical music and made numerous recordings. After earning a degree in Physics, Kaku came to Sony and was assigned to our semiconductor department. But he never lost his passion for music and eventually persuaded Sony management to move him into speaker design. His drive and uncompromising approach to engineering are indelibly stamped on the SS-AR1 loudspeaker.

Hokkaido maple after harvest.

Peeling the logs to create a continuous sheet of maple laminate.



The final baffle board is built of multiple layers of laminate and compressed to a thickness of 50 mm.

Hokkaido maple and Nordic birch

A major component of Kaku's research was a quest for the ideal cabinet materials. He conducted extensive listening tests of woods, including walnut, spruce, birch, and maple, in addition to laminations of various woods in combination and even laminations of wood and metal. After exhaustive auditions, Kaku settled on maple, a wood also favored by musical instrument makers.

Not content, Kaku proceeded to test maple from different countries and different regions, refining his search to wood from Japan's northern island of Hokkaido. Closer to Siberia than it is to Tokyo, Hokkaido features a magnificent natural environment and a cold climate. The cold gives Hokkaido maple a tight grain, which makes a marked contribution to the beauty of the sound.

Kaku designed the SS-AR1 with a front baffle of Hokkaido maple, laminated to a thickness of 50 mm (2"). This offers the strength to suppress unwanted vibrations while producing generous reverberation. With the assistance of local wood specialists, Sony hand-selected raw maple logs from Hokkaido's forests. The trees are felled in November, when their growth slows and the grain is at its tightest. This insistence on the specific time and location of harvest enables us to achieve close to optimum sound.

Kaku realized that building the entire cabinet of laminated Hokkaido maple would result in excessive hardness in the sound. So he selected another cold climate wood, Nordic birch, for the rest of the cabinet. Birch is not typically hard. However birch from the cold climate of Nordic countries has an extremely tight grain, resulting in ideal reverberation properties. The birch is laminated, curved and compressed to a thickness 32 mm (1¼")

Kaku built and tested this laboratory prototype, which features extensive metal cross-bracing.

Controlling enclosure harmonics

In theory, sound should come from the drive units only. Any harmonic vibration from the enclosure should be considered a distortion. Kaku has put this theory to extensive listening tests, and over the years has come up with his own, distinctive approach to address this.

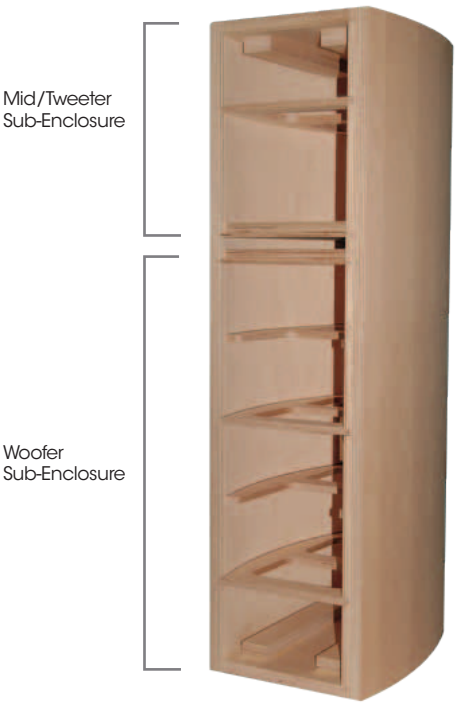
It was to minimize enclosure harmonics that Kaku first used Hokkaido maple. In 1998, the SS-AL5 Mk II incorporated a Hokkaido maple baffle board laminated to a thickness of 32 mm. Warmly regarded, the speaker won a coveted "Best Buy" rating from Japan's *Stereo* magazine.

For the SS-X90ED, Kaku used a different strategy to minimize enclosure harmonics: "mechanical grounding." He isolated the woofers from the enclosure and mounted them instead to a massive wooden assembly called the "G-Brace," which he fitted inside the enclosure. The SS-X90ED went on to generate an enthusiastic following among audiophiles.

But Kaku was still not completely satisfied. So he embarked upon a series of increasingly exotic prototypes with massive internal bracing and unusual brace materials, even metal. In the process, he discovered that optimizing loudspeaker sound would require a profound re-thinking. He realized that the design goal should no longer be to "eliminate enclosure harmonics." It should be to "control every detail" of the harmonics.

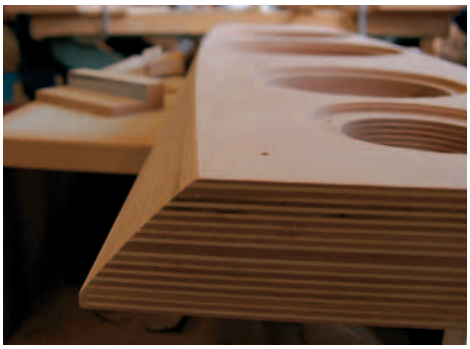
This new goal became the springboard for the development of the SS-AR1. It drove the selection of Hokkaido maple, Nordic birch, and the careful lamination of both woods.

In this way, the SS-AR1 cabinet is the product of exhaustive testing, involving countless wood samples, countless prototypes and countless hours in the listening room. Reviewers have repeatedly expressed their "surprise" at the relaxed, detailed, open sound of the SS-AR1. But to everyone who knows Kaku's uncompromising approach, it's no surprise at all.



In this cabinet assembly, you can see the two thick birch partitions and the air pocket between them. These isolate the midrange/tweeter sub-enclosure from the woofer sub-enclosure.

This top view demonstrates the curvature of the side panels.



The gentle curve of the baffle is more than cosmetic. It tends to spread out diffraction frequencies, for a soundstage with pinpoint accuracy.

Cabinet design

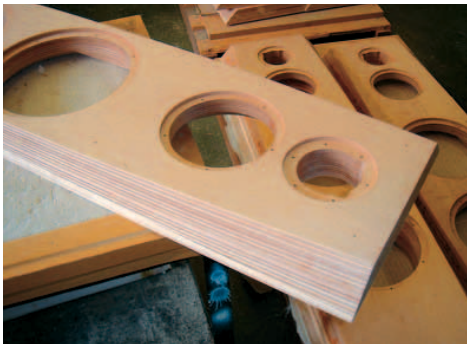
The physical design of the cabinet was considered as carefully as the materials. The cabinet is designed to achieve four major objectives:

Controlling woofer back radiation. A speaker's sound is primarily determined by the front radiation, the sound waves coming straight from the drivers into the room. However, the back radiation is also crucial. With twin 8-inch (200-mm) woofers, slight differences in back pressure can result in distortion. In theory, the back pressure on both woofers will be the same regardless of the bass reflex port location. But this is not the case in practice. The bass reflex port is meticulously designed for optimum back pressure. In addition, a rounded aluminum fitting on the port minimizes noise.

Isolating the woofer back-radiation from the midrange and tweeter. We were equally concerned about the potential interference between the twin woofers' back pressure and the clean operation of the midrange and tweeter. What appears from the outside to be a single enclosure is actually divided inside by two thick birch partitions with an air cavity in between. Just as a double-pane window with air in between helps provide thermal insulation in winter, the partitions and air cavity create two well-insulated enclosures: one for the woofers and one for the midrange/tweeter. The mid/tweeter sub-enclosure is also vented with a bass reflex port that's been carefully tuned and positioned.

Control of standing waves inside the cabinet. Box shapes with flat, parallel surfaces tend to resonate strongly at specific musical frequencies, causing standing waves. To fight this, the birch side panels are curved. It's another subtle way the cabinet enables clean, pinpoint imaging.

Control of edge diffraction. When a cabinet vibrates, it also triggers diffraction at the edges. Strong diffraction at any specific frequency can be a particular problem, degrading the speaker's ability to locate musical voices in space. For this reason, the edges of the baffle board are gracefully curved. This diffuses the frequencies of diffraction, for an exceptionally vivid soundstage.



Cabinet construction in Hamamatsu, Japan, a city world famous for musical instruments.

Creating the piano finish.

Cabinet assembly

In a perfect world, an 8-ohm resistor always measures 8 ohms. In the real world, things are never perfect. That's why engineering specifications always include some plus-or-minus tolerance for error. Of course, you expect to pay more for a quantity of resistors that's 8 ohms ±1% than for the same quantity that's 8 ohms ±5%.

The same applies to the dimensions of a speaker cabinet, which are rarely perfect. For easier assembly, designers typically make a slight allowance for error. This can leave loose joints that are usually filled with glue. The result is an acceptable, if ever-so slightly imperfect cabinet.

For certain mission-critical joints in the SS-AR1, Sony demanded nothing less than the highest possible accuracy in woodworking. So we reached out to a cabinet-making company in Hamamatsu, a city well known for musical instruments. In fact, the same company supplies wood components for grand pianos. As an exploratory exercise, we asked them to build a prototype but to leave the pieces unglued for our inspection.

When Kaku visited their workshop, he found a completely assembled cabinet and demanded an explanation. His host simply smiled as a workman with a rubber mallet disassembled the cabinet in a few seconds. The prototype was so precise, all of the pieces held tightly together without any glue at all.

Of course the final speakers are meticulously glued. And of course, the glue itself has been carefully chosen from several candidates, to have the least influence on the sound.

This cabinet company is responsible for the speaker's piano finish. This both enhances the sound quality and helps protect the wood from heat and humidity. The look of the finish is elusive, sometimes appearing to be solid black, sometimes deep brown or wood grain, depending on the subtleties of room light. The effect is exquisite.

As a final design flourish, the Sony logo appears on the front baffle in stainless steel. When you look carefully, you can see that the logo is slightly recessed underneath the wood finish, but the resulting surface is completely smooth. Executing this effect was a major accomplishment. It's a minor miracle hiding in plain sight.

Twin woofers feature aluminum cones and oversized ferrite magnets.

Sliced paper cone midrange.

The tweeter uses six neodymium magnets.

Drive units

The SS-AR1 is a four-driver three-way system of superlative performance. We started with an evaluation of the low frequencies. We asked which gives the better bass reproduction: one large-diameter woofer or multiple small-diameter woofers? Large woofers are extremely good at moving air, developing a unique sensation of acoustic pressure. However, high moving mass leads to an impression of slow response. Sony chose a two-driver system. This duplicates the surface area of a single larger driver, but reduces moving mass for faster response.

Next we considered drive unit diaphragms, each of which uses a material optimized for the specific frequency range. This dictated three separate materials for woofers, midrange and tweeter diaphragms. For the woofers, we chose the hardest of the three materials. Aluminum has the durability for high diaphragm excursion and intense pressure. For the midrange, our carefully chosen paper diaphragm is light but stiff. The tweeter incorporates lightweight fabric capable of high bandwidth in the tradition of Sony's Extended Definition (ED) tweeters.

Fabricating these precision drivers for the SS-AR1 required particular expertise. So the Sony team reached out to a world-renowned transducer specialist, Scan-Speak in Videbæk, Denmark. Working in close collaboration, they produced drivers that exceeded our high expectations.

Twin 200 mm aluminum woofers. These are remarkably strong, with a robust magnetic circuit. A copper ring optimizes the symmetry of the magnetic field, reducing distortion. Aluminum diaphragms, oversized ferrite magnets, a rigid enclosure and the common bass reflex port on the rear panel help generate bass response with power, authority and clarity.

130 mm midrange. This driver incorporates an exclusive sliced paper cone. The material is deliberately cut and re-adhered to suppress resonance and realize flat response. A ferrite magnet improves efficiency while a copper ring in the magnetic circuit reduces distortion.

25 mm soft dome tweeter. A special vent behind the tweeter smoothes out the air pressure around the magnetic circuit. Six neodymium magnets arranged in a circle produce high flux density in minimal space. A distinctive diaphragm adhesion and edge integration method help extend frequency response to 60 kHz.

Crossover

We are now near the end of loudspeaker development: crossover design and tuning. As in a marathon, it is the last mile that is the most difficult—and the most important. Here the sensitivity and taste of the designer come to the fore.

The SS-AR1 crossover incorporates carefully selected parts, including polypropylene film capacitors, air core capacitors, and Ferrite core capacitors. But this simple list hardly does the crossover justice. After undergoing anechoic chamber tests for linear frequency response, the completed speaker is subjected to round after round of listening tests.

Kaku auditioned with music that featured acoustic instruments and female vocals, sources that audiophiles recognize to be ruthless tests of loudspeaker quality. The repertoire runs to classical CDs and Super Audio CDs, chosen for their wide dynamics. These listening sessions are cross-checked against selections from the Jazz and Pop catalogues.

The system is tuned with multiple rounds of auditions both in our acoustically treated listening rooms and in our homes. Occasionally, golden-eared guests are invited in to listen and comment. But the ultimate authority at the end of the design process is the man who guided the development from the beginning: Kaku.

A final word

It has been said that talking about music is like dancing about architecture. This applies equally well to high fidelity loudspeakers. Writing about them (and reading about them) is a poor substitute for actually listening. The Sony SS-AR1 loudspeakers are not on display everywhere. They're offered by just a few retailers, carefully selected by Sony. We encourage you to make the effort to seek out these retailers. Take a handful of your best recordings, especially ones with acoustic instruments and vocals. Plan to spend an hour or more. The SS-AR1 loudspeakers will repay your effort handsomely.

Notes

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SS-AR1 Loudspeaker Specifications

Speaker System:
3-way, 4-driver, Bass reflex

Speaker Units:
Woofer: 200 mm (8-inch) cone type (2)
Midrange: 130 mm (5 ¼-inch) cone type (1)
Tweeter: 25 mm (1-inch) dome type (1)

Rated Impedance:
4 ohms

Maximum Input Power:
200 watts

Sensitivity:
88 dB (2.83 V/m)

Frequency Response:
28 to 60,000 Hz

Crossover Frequency:
400 Hz, 4,000 Hz (multi-slope network)

Dimensions (WxHxD):
Excluding projecting parts
12 5/8 x 41 ½ x 17 ¾ inches (320 x 1055 x 450 mm)

Including projecting parts
12 5/8 x 42 5/8 x 19 3/8 inches (320 x 1080 x 490 mm)

Mass:
126 lbs. (57 kg)

Supplied Accessories:
Operating instructions (1)
Warranty card (1)
Cleaning cloth (1)