

Yamaha

YST-SW515

Subwoofer



Most model names don't mean much at all, but in the case of Yamaha's subwoofers, that 'YST' prefix is actually extremely important, because the letters stand for Yamaha (Active) Servo Technology, and in this case, 'YST' is not just another bit of advertising 'puffery' but signifies a significant development in subwoofer design. In a nutshell, 'YST' allows you to very efficiently extract deep bass from a much smaller enclosure than usual.

The Equipment

Although Yamaha's YST circuitry is certainly different from what almost all other subwoofer manufacturers are offering—and also offers significant performance benefits—it is not new. Indeed, in a somewhat convoluted way, YST's evolution can be traced all the way back here to Australia and the work done in the '70s by well-known Australian engineer Neville A. Thiele. (Thiele later famously teamed up with US engineer Dr Richard Small to develop the ubiquitous Thiele/Small method of speaker alignment that is now used by every loudspeaker manufacturer in the world.)

Thiele had written a paper titled 'Loudspeaker Circuit Stabilising Networks for Audio Amplifiers' that contained some new and interesting theories about such amplifiers and their interactions with loudspeakers. Up until then, both amplifier designers and speaker designers had operated under the premise that they were 'stuck' with having to deal with fixed sets of constants for each device. Amplifier designers, for example, had to design based on the fact that their amplifiers even-

tually would be connected to a speaker with an impedance of 4–8 ohms, for example. In his paper, Thiele proposed building circuits that could 'trick' an amplifier into thinking it was connected to a loudspeaker with different electrical parameters than it actually had. This would then enable amplifier designers to do things they'd previously thought impossible.

Needless to say, Thiele's paper inspired many designers around the world to realise the impossible and develop such circuits, and one of those innovative designers was Katsuo Nagi in Japan, who named his circuit 'AST' (Active Servo Technology) and assigned his patent on the circuitry to Yamaha, which marketed it as 'AST' when it was used in its full-range speaker designs and 'YST' when it was used in its subwoofers. (A young Swedish electronics design called Erik Stahl developed another version of the circuit based on Thiele's paper. He dubbed his version 'ACE-Bass', patented it and then used it to found an entire company for himself, which is now known as AudioPro!)

To understand how AST/YST works, you need to understand that the difficulty of extracting deep bass from conventional dynamic speakers is that they all have a fundamental resonance frequency below which their output falls off very quickly (at 12dB per octave for a closed box and 18dB per octave for a vented enclosure). This means that they will deliver bass fairly readily down to this frequency (usually around 30–40Hz) after which the bass essentially 'disappears.' Katsuo Nagi realised that if he were to use an amplifier with a 'negative' output impedance he would be able to cancel

the various 'flow-on' effects that usually result from an amplifier being connected to the resistance of the loudspeaker's voice-coil.

There being no such thing as a 'negative' output impedance, Nagi developed his AST circuit, which instead made it appear to the driver as if the amplifier's output impedance was negative. The practical result of this was that it enabled him to build a subwoofer with 90 per cent less cabinet volume than a conventional bass reflex subwoofer while still maintaining similar bass output characteristics. In other words: 'bigger bass from a smaller box.' And the YST-SW515 is certainly small, measuring 350mm wide, 430mm high and 382mm deep. It weighs around 19kg.

Subwoofer fanciers will probably be aware that this new YST-SW515 replaces the old—and similarly-sized—YST-SW315. Visually, there's so little difference between them that the only real clue is the larger-diameter side-firing bass reflex port. (The one on the SW515 has a diameter of 100mm at its exit, but is mostly somewhat narrower—70mm—for the rest of its length). Inside, however, there has been a change, which is to the YST circuitry, which has been upgraded to 'II' status. Yamaha is tight-lipped about the details of this upgrade, giving me only the information that's generally available, which is that the new circuit 'combines negative impedance and constant-current principles to drive the speaker cone with even tighter control than previously.' This, says the company, produces a 'more stable and accurate low range response, not to mention higher sound pressure levels, for more natural and ener-

getic bass reproduction.' Also inside, of course, is Yamaha's own 250-watt (continuous into 5Ω) Class-D (PWM) amplifier.

The YST-SW515 has a down-firing bass driver that Yamaha rates at 250mm. Our tape measure showed that Yamaha is being more realistic with this measurement than quite a few other subwoofer manufacturers we could name, because the driver actually has an overall diameter of 270mm. However, the important diameter is the Thiele/Small diameter of 211mm, which puts the piston area (S_d) at 349cm². As you can probably see from the photograph, underneath the cone is a diffuser that Yamaha calls a 'QD Bass' (Quatre Dispersion Bass) assembly. This diffuser serves three purposes. First and most importantly, it isolates the output of the bass driver from the floor surface. One problem with many down-firing subwoofers that 'fire' directly at the floor is that their performance varies depending on the type of flooring you have. It's obvious when you think about it. No driver is going to be as efficient firing into thick carpet over an underlay as it will be on a solid concrete or wooden floor! Yamaha's QD bass assembly means the performance (and thus the sound) will be exactly the same irrespective of the nature of the floor surface in your listening room.

The second advantage of the QD bass assembly is that it ensures the 'slot' around the base of the subwoofer remains a constant, and thus presents exactly the radiating area the subwoofer designer intended—neither more nor less. With down-firing subwoofers that have feet, the 'slot' around the base becomes smaller when the subwoofer is placed on thick carpet, and larger when the subwoofer is placed on spikes, which is exactly what you don't want to happen! Finally, the QD bass assembly ensures highly efficient distribution of sound from the bass driver. (This, I believe, is actually the least important attribute of the QD bass assembly, but was obviously the 'sexiest' for Yamaha's PR people, who liked it so much they even gave it a fancy French title!)

Whereas most subwoofer manufacturers put their control panels on the back of their subwoofers, where they're difficult to reach and, even if you manage to reach them, you have to read all the words upside down, Yama-

ha's YST-SW515 has all the controls in a neat little sub-panel inset into the front of the subwoofer. From left to right, these are for: Power (Standby/On), B.A.S.S., High-Cut (40–140Hz) and Volume. B.A.S.S. is an acronym for 'Bass Action Selector System' and essentially allows you to select between two different equalisation settings, depending on whether you're watching a movie or listening to music. The default (out) position is 'Movie': you have to press the button in for 'Music'. (I should point out that it's not mandatory to follow the rules regarding switch setting. If you prefer the sound of the subwoofer when in 'Movie' mode, irrespective of whether you're listening to movies or music, just go for it.)

Having said that Yamaha puts the controls on the front where you can reach them, I have to say that it doesn't actually put *all* the controls there. You will have to reach around the back for the main power switch, the phase (Normal/Reverse) switch, and the auto-standby switching (Off/Low/High). Obviously all three are 'set-and-forget' settings, so it's not an

issue. Also on the back panel is a pair of gold-plated RCA phono inputs for line-level input, with the left-channel input being the one to use if you have only a single LFE output on your AV receiver. There's also a set of speaker-level inputs and speaker outputs.

Listening Sessions

You will certainly defeat the 'Quatre Dispersion' device if you push the YST-SW515 up against a rear wall, or into a corner, so remember to leave at least a little room for each of the four sides to 'breathe.' Even as little as 10cm should suffice, though as always, such distances are always 'up for grabs' and you should use what works in your room, with your system. Maintaining distance is even more important for that side-firing vent, which should be kept well away from any nearby adjacent hard surfaces. However, I also would not recommend you have the vent pointing towards the listen- ▶

Yamaha YST-SW515 Subwoofer

Brand: Yamaha
Model: SW-515
Category: Powered Subwoofer
RRP: \$999
Warranty: Five Years
Distributor: Yamaha Music Australia Pty Ltd
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- Small!
- Deep bass
- Front controls



- Volume
- Port noise

ing position because in my sessions I found that if I pushed the subwoofer too hard (i.e., played it 'way too loud') I could sometimes hear 'chuffing' from the port. That said, if you play at usual listening levels, you can have the vent pointing any way you like.

I usually find that setting up any new subwoofer in my room involves quite a bit of trial and error as I experiment with various combinations of speaker positions and control settings. Set-up was much, much faster with the YST-SW515 because I established almost straight away that I much preferred the sound of the subwoofer with its High Cut control set just a few notches up from its minimum (40Hz) setting. (And I say 'notches' figuratively, because the control actually has a totally smooth action over its operating range!) In my room and with my set-up this resulted in smooth, tight, and extended bass response that melded in beautifully with my large main front speakers. I also preferred the 'Movie' setting across the board, no matter what I was playing, so the B.A.S.S. button didn't get much action while I was listening.

Kick drum is always a good test for a subwoofer, and the YST-SW515 came up trumps whenever I tried it with kick drum, either with Sheffield's unique 'Drum CD' or with jazz or rock drum kits, producing a fast, clean head impact with just the right amount of over-


hang. It also proved excellent when reproducing bass guitar, where it proved very 'tuneful', allowing me to easily pitch the various notes in bass riffs. But it wasn't just the clarity and bass extension that impressed me about the YST-SW515, it was also that it didn't produce any unwanted sound in the upper bass region. This is rare to find in any subwoofer, and unheard-of at this price-point. It isn't only that you don't get tortured harmonics, but also that there is no background 'clutter' to obscure the mid-bass. (This freedom from background clutter is also one of the attributes of subwoofers using Parametric Acoustic Modeling technology, but these subs start at nearly three times the price of Yamaha's YST-SW515 and are all considerably larger!)

Despite my preference for operating the YST-SW515 with the High Cut set close to 40Hz, I did find this had the disadvantage that it put a lower-than usual limit on the maximum volume I was able to extract before the sub started to audibly protest (by chuffing), so if you find you need more volume, first try edging the High Cut control clockwise before you start increasing the volume. Another reason you might consider edging the High Cut clockwise is that it will make watching action movies much more exciting... because all those explosions and deep bass sounds will really sound spectacular!

LAB REPORT

Readers interested in a full technical appraisal of the performance of the Yamaha YST-SW515 Powered Subwoofer should continue on and read the LABORATORY REPORT published on the following pages. Readers should note that the results mentioned in the report, tabulated in performance charts and/or displayed using graphs and/or photographs should be construed as applying only to the specific example tested.

Conclusion

Yamaha's design team has ticked all the boxes with the YST-SW515 subwoofer. It's neat, small, looks good, is easy to position, delivers excellent low bass and has a sticker price of under a grand. It would be a great choice for medium-sized rooms and will sound even more awesome in smaller ones! 

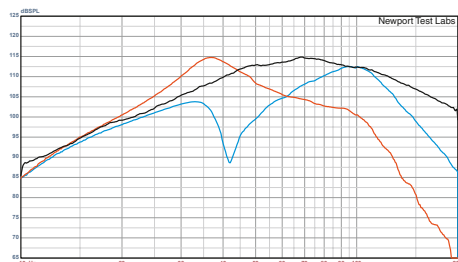


Décor

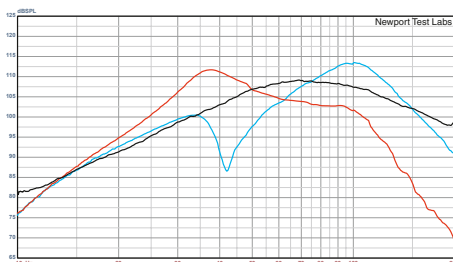
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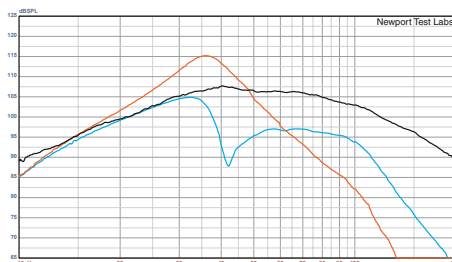
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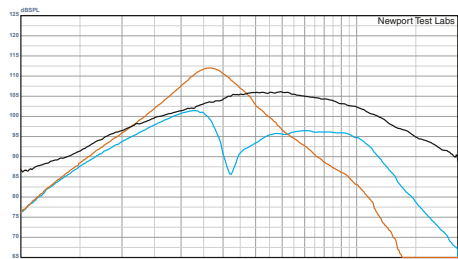
Graph 1. Frequency response (Movie Mode) showing the nearfield frequency response of the bass reflex port (red), the nearfield frequency response of the down-firing woofer (blue) and the far-field pink noise response (black) of the Yamaha YST-SW515 when the High Cut control is set to maximum (140Hz).



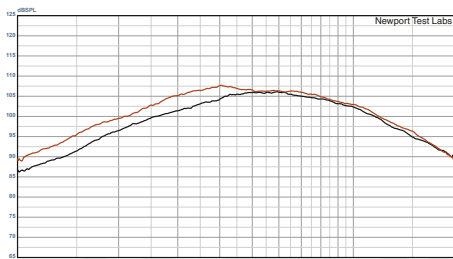
Graph 2. Frequency response (Music Mode) showing the nearfield frequency response of the bass reflex port (red), the nearfield frequency response of the down-firing woofer (blue) and the far-field pink noise response (black) of the Yamaha YST-SW515 when the High Cut control is set to maximum (140Hz).



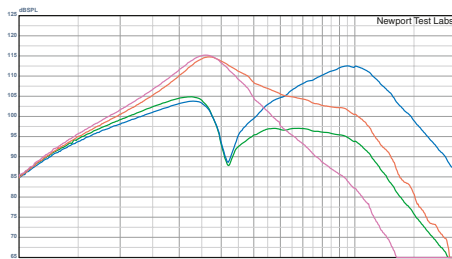
Graph 3. Frequency response (Movie Mode) showing the nearfield frequency response of the bass reflex port (red), the nearfield frequency response of the down-firing woofer (blue) and the far-field pink noise response (black) of the Yamaha YST-SW515 when the High Cut control is set to minimum (40Hz).



Graph 4. Frequency response (Music Mode) showing the nearfield frequency response of the bass reflex port (red), the nearfield frequency response of the down-firing woofer (blue) and the far-field pink noise response (black) of the Yamaha YST-SW515 when the High Cut control is set to minimum (40Hz).



Graph 5. Frequency response comparing the far-field Movie Mode frequency response (red trace) with the far-field Music Mode (black trace) frequency response when the High Cut control is set to minimum (40Hz). [Yamaha YST-SW515 Subwoofer]



Graph 6. Nearfield frequency responses showing maximum (140Hz) and minimum (40Hz) settings of the High Cut control when Yamaha YST-SW515 subwoofer is operated in Movie Mode. Port max (red); Port min (purple); Woofer max (blue); Woofer Min (green).

Test Results

The Yamaha YST-SW515 performed very well throughout the complete range of the tests conducted by *Newport Test Labs*. As with all powered subwoofers, the actual frequency response you will get from the YST-SW515 depends on the setting of the crossover (High Cut) control, and whether you choose 'Movie' or 'Music' mode (and, of course, the location of the subwoofer in your room). Overall, the Yamaha YST-SW515 proved to have the flattest, most linear in-room response when the High Cut control was set to 40Hz. *Graph 5* shows the response with this setting, for both Movie and Music modes. You can see that in Music mode, the response is curved, rather than flat, with the peak of the curve at 60Hz, but the overall frequency response is an excellent 26Hz to 110Hz ± 3 dB. In Movie mode, the response is quite a bit flatter than Music Mode, particularly between 30Hz and 80Hz over which frequency band it's an amazing ± 1.25 dB. The 'standard' ± 3 dB response in this mode is 23Hz to 115Hz. Yamaha's specification has the frequency response as extending from 20Hz to 160Hz, but because no dB limits are stated, this is actually a frequency 'range' rather than a frequency 'response'. As you can see from the graph, the Yamaha YST-SW515's frequency range easily extends down to 20Hz and up to 160Hz, as Yamaha states, but the actual response is 8dB down at 20Hz and 12dB down at 160Hz.

Some readers may find the graphs supplied by *Newport Test Labs* a little confusing, first because they're a little differently formatted than usual, and secondly because Yamaha appears to be working the YST-SW515's bass reflex port quite hard, so it's doing more work than I usually see in a bass reflex design. I presume this is at least partly because of the Yamaha Servo Technology. Basically, the first four graphs (Graphs 1 through 4) each have three traces on them. In each graph the black trace is the frequency response of the complete system, measured far-field (at 3 metres) using a pink noise test stimulus. The other two traces are the individual frequency responses of the bass reflex port (the red trace in each case), and the down-firing woofer (the blue trace in each case.) These two latter traces were measured using a near-field technique that essentially replicates the response that would be measured in an anechoic chamber.

However, because the wavelengths involved are so long, and it was impractical to acoustically isolate the port from the driver, there is some unavoidable interaction between the two traces, particularly on

that of the port's output above 50Hz.

What you can see on all four graphs is that the port's output peaks at 37Hz, a little lower than the cabinet's resonant frequency at 42Hz. The graphs show the effect on the YST-SW515's frequency response of the Movie and Music modes, and the setting of the High Cut control. The first and second graphs show performance in Movie Mode with the High Cut control set to 140Hz (*Graph 1*) and 40Hz (*Graph 2*.) The third and fourth graphs show performance in the Music mode, with the High Cut control set to 140Hz (*Graph 3*) and 40Hz (*Graph 4*.) You can see that across all four graphs, the output level of the port remains essentially the same below 45Hz, while the output level of the woofer varies across a range of 18dB (at 90Hz). This means that as you turn the High Cut anticlockwise you're essentially not only reducing the operating bandwidth of the woofer, but also altering the balance of forces between the port and the woofer and, as you can see, this makes for quite complex relationships between them. However, in all four cases, the black trace on the graph shows the end result of this relationship, in that it shows the overall frequency response that results when the port and woofer outputs sum at the listening position. The results are that the overall frequency responses returned by the Yamaha YST-SW515 at the various control settings used for the graphs are 38Hz to 130Hz ± 3 dB (*Graph 1*), 39Hz to 140Hz ± 3 dB (*Graph 2*); 26Hz to 110Hz ± 3 dB (*Graph 3*) and 23Hz to 115Hz ± 3 dB (*Graph 4*.) It's important to note that there's no 'best' of these, because you actually have to factor whichever of the settings is going to best match the low-frequency performance of your left and right front (main) speakers. So if you have quite small speakers, you'd probably get a 'best match-up' by setting the High Cut control more 'clockwise', whereas if you have fairly large main speakers, you'll get 'best match-up' by having the control more 'anticlockwise'. However, *Graph 5* compares the two 'most linear' responses, just so you can see how Movie mode compares with Music mode. You can see the Movie mode gives more of a 'kick' in the very low bass, while the upper bass is virtually the same as in the Music mode.

Overall, I was very impressed by the level of bass performance that Yamaha's engineers have been able to extract from such a physically small subwoofer, particularly one with a not overly-large bass driver.

Steve Holding