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THIEL CS5 SPEAKER

Manufacturer's Specifications

System Type: Tower-style, five way, acoustic suspension.

Drivers: Three 8-in. (203-mm) cone woofers, 5-in. (127-mm) cone midrange, 2-in. (50.8-mm) metal-dome upper midrange, and 1-in. (25.4-mm) metal-dome tweeter.

Frequency Response: 25 Hz to 20 kHz, ±1 dB.

Phase Response: Minimum, ±7°.

Sensitivity: 87 dB SPL at 1 meter for 2.83 V rms.

Crossover Frequencies: 50 Hz, 400 Hz, 1 kHz, and 3 kHz.

Impedance: 3 ohms nominal, 2 ohms minimum.

Recommended Amplifier Power: 100 to 400 watts per channel.

Dimensions: 64 in. H × 13 in. W × 17 in. D (162.6 cm × 33 cm × 43.2 cm).

Weight: 180 lbs. (82 kg).

Price: $9,200 per pair in standard finishes, $800 extra for rosewood; custom finishes are available on special order.

Company Address: 1042 Nandino Blvd., Lexington, Ky. 40511.

I first realized the Thiel CS5 loudspeakers had arrived when a truck and semi-trailer pulled up in front of my house and the driver unloaded two large, coffin-shaped, 250-pound wooden boxes in my driveway! It was a major chore just moving them temporarily into the garage with the help of my teenage son. I first saw and heard the CS5s at the last Summer Consumer Electronics Show in Thiel's hospitality suite. I was quite taken with their sound, and listened to Jim Thiel, the company's president and chief designer (also founder, owner, and chief honcho), enthusiastically explain some of the design and technical aspects of his system. This included showing me a very impressive, large CS5 crossover network containing 114 separate components!

Each system is large, tall, and heavy and contains six direct-radiator drivers. The massive, sloping front panel is made of a cast marble/polymer composite that provides a very rigid mounting surface for the drivers and is shaped to minimize unwanted cabinet edge diffraction. In addition to a very attractive gloss-black laminate finish, rosewood, walnut, white oak, and teak are available. Thiel's exacting manufacturing methods for the CS5 cabinets were written up in an article that appeared in *Furniture Design & Manu-*

The system's coherent phase response is due to careful driver placement and use of an elaborate, low-order crossover design.

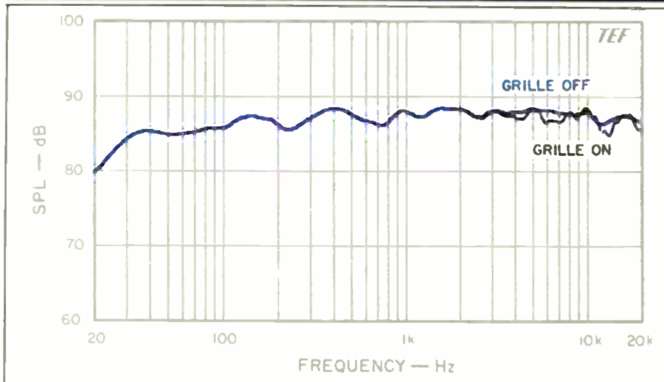

Fig. 1—Frequency response on axis. Note the minimal difference with the grille on.

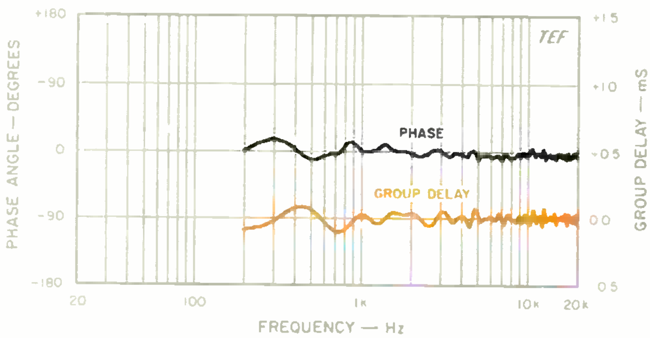

Fig. 2—On-axis phase response and group delay, corrected for tweeter arrival time. The phase curve is notably flat, within an envelope of approximately ±10°.

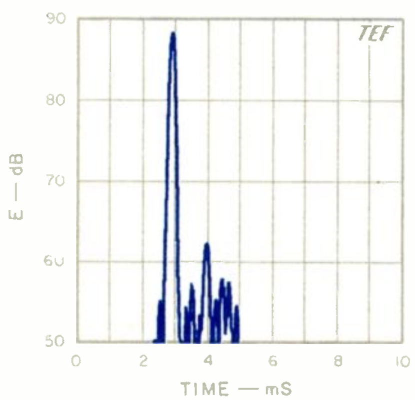

Fig. 3—Equivalent 1-meter, on-axis energy/time curve, measured at 3 meters with grille on.

facturing magazine in July 1988. (Ask Thiel for a reprint; it makes fascinating reading.)

Jim Thiel has been in the speaker business since 1977, when he entered the home hi-fi market with his Model 01 bookshelf system that used active electronic equalization. His company now manufactures four models of loudspeakers—the CS1.2, CS2, and CS3.5 as well as the CS5—and has grown to 27 employees and 27,000 square feet of production space.

Jim Thiel's design goals for the CS5 include very uniform and extended frequency response, time response accuracy, phase response accuracy, very low energy storage, and very low distortion. These are world-class goals that are very seldom met all at once, in any system, at any price. Read on in this review to see how well they have been met.

Thiel produced a very well done technical white paper on the CS5 that describes its technical and design features in great detail. I drew extensively on the information in this paper to generate some of the descriptive passages in this review. The white paper even has a section on measuring the CS5, which was very helpful to me.

The systems are designed to be both phase- and time-coherent using Thiel's Coherent Source design method, which carefully matches the effective acoustic distances from each driver to the listener's ears. This matching is done through physical driver placement and orientation, and through the use of special electrical all-pass delay circuits in the crossover. Phase coherence is achieved by the use of first-order (6-dB/octave) acoustic roll-off slopes for each driver. The 6-dB/octave crossover type is the only one that can simultaneously maintain correct amplitude, phase, and time information for the acoustic arrivals at a specific listening point. The crossover contains components that accurately tailor each driver's response to match its specific required acoustic target response. This type of crossover places high demands on the drivers, because their response must extend at least two octaves above and below the chosen crossover frequencies.

All of the CS5's drivers incorporate several special features that decrease distortion and increase dynamic range. All of the system's cone drivers (the three woofers and lower midrange) have very long, overhung coils with very large magnets to yield high excursion capability. Even the tweeter has been designed to have a large linear excursion capability, in excess of ±1.5 mm, due to the use of a short-coil, long-gap magnetic system and an unusually wide roll surround. The cone drivers all incorporate heavy copper "flux-stabilizer" rings that decrease distortion; in addition, their symmetrical-geometry pole configurations further reduce even harmonic distortion.

Thiel employs special means in the bass system to achieve 20-Hz bass extension and high output capability from a relatively small enclosure. This capability is achieved by using three long-excursion 8-inch woofers in a configuration that places two of them in a common main enclosure and the third in a separate sub-enclosure. All three woofers are used in parallel below 50 Hz, while the center, separately enclosed, woofer is used alone at higher bass frequencies. Operating only one woofer at higher frequencies can minimize line-source directivity effects. The impedance is

Frequency response is quite flat and extended, fitting within an envelope of ±2 dB

The CS5's energy/time curve, the best I've measured yet, shows how closely Thiel aligned the outputs of this system's drivers.

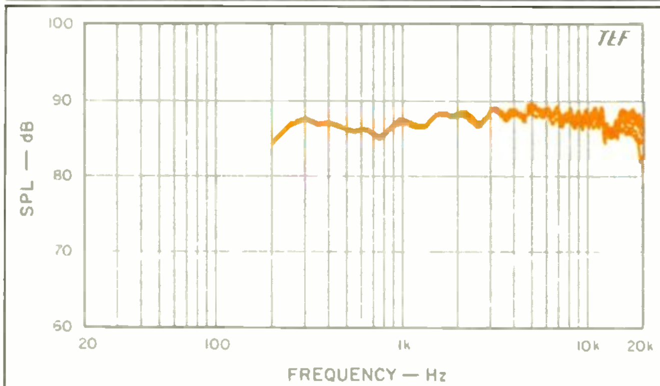

Fig. 7—Composite of horizontal frequency responses, taken every 5°, over a range of ±15° off axis. The average of these curves is the mean horizontal −15° to +15° on-axis curve of Fig. 6.

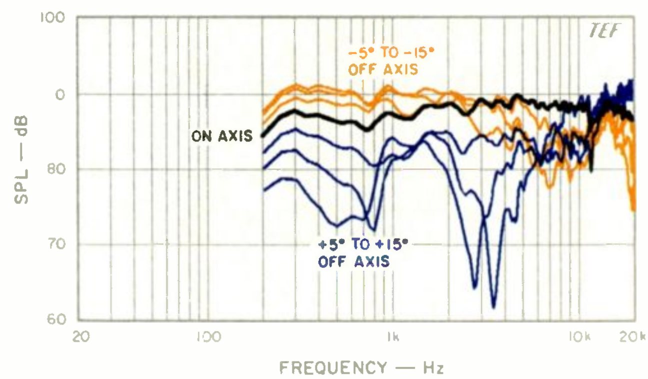

Fig. 9—Composite of vertical frequency responses, taken every 5°, over a range of ±15° off axis. The average of these curves is the mean vertical −15° to +15° on-axis curve of Fig. 8.

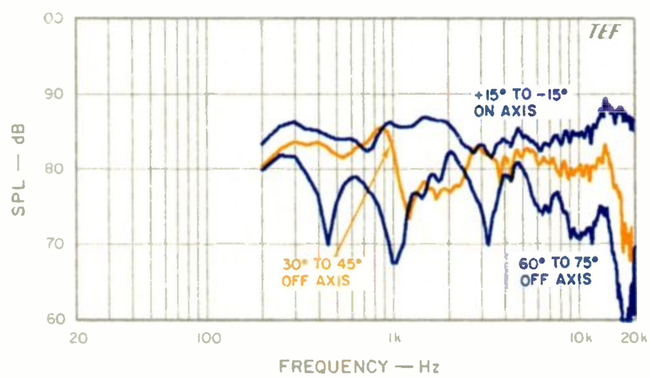

Fig. 8—Mean vertical responses derived from data of Fig. 5.

sponse is quite flat and extended and fits within a ±2 dB envelope from 31 Hz to 20 kHz. Above 100 Hz, it fits within a notably tighter window of ±1.5 dB. Below 100 Hz, the response is quite extended, being down only 3 dB at 26 Hz and 6 dB at 19 Hz. Averaging the response from 250 Hz to 4 kHz yields a sensitivity of 87.5 dB SPL, essentially equal to the manufacturer's rating. The grille has minimal effect on the response, and those effects primarily occur in the top two octaves, where the response is reduced only by about 1.5 dB between 6 to 7 kHz and 12 to 15 kHz.

A test comparing the axial response of both right and left speakers in the range from 200 Hz to 20 kHz (not shown) yielded an excellent match of ±0.5 dB. The differences in level were distributed approximately randomly over the measured range.

Figure 2 shows the on-axis phase and group-delay responses of the system, corrected for the time arrival of its tweeter. As can be seen, these curves are exceptionally flat and are not typical of most speakers whose phase response undergoes large changes as frequency increases. Above 400 Hz, the phase curve fits within an envelope of ±10°! The careful design attention given by Jim Thiel to achieving linear phase response is clearly evident. The minor fluctuations in the phase and group-delay responses are primarily coupled to the corresponding undulations in the magnitude curve through minimum-phase relationships. These fluctuations would be absent if the magnitude curve were equalized flat with a minimum-phase equalizer (99% of all equalizers are minimum phase). Because these curves are based on 2-meter data, I presume the phase response would be even flatter if I had been able to get better curves at a distance of 3 meters or more.

The on-axis, 1 meter, 2.83-V rms energy/time curve (ETC) is shown in Fig. 3. The data was measured at 2 meters and then referenced back to 1 meter. The test signal was linearly swept over the range from 200 Hz to 10 kHz, and it primarily emphasizes the response of the tweeter and upper midrange. The first-arrival response is exceptionally compact, which indicates the drivers' acoustic outputs are very closely aligned. All subsequent system output is greater than 25 dB down from the first arrival. This response represents the best ETC I have measured to date.

A high-level, low-frequency sine-wave sweep revealed that the woofers' maximum linear excursion capability was about ±0.2 inch (0.4 inch, peak to peak). The woofers had an effective radiating diameter of about 6¾ inches, which means that the three together can move nearly the same amount of air as a single 15-inch woofer. The drivers were

The woofers' maximum linear excursion capability proved to be about ±0.2 inch—or 0.4 inch, peak to peak!

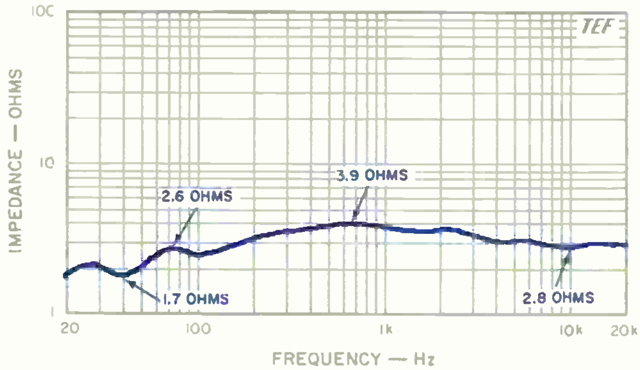

Fig. 10—Magnitude of impedance; note the logarithmic impedance scale. See text.

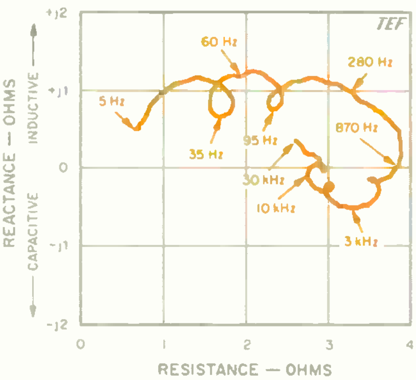

Fig. 11—Complex impedance, showing reactance and resistance vs. frequency. Note that the horizontal and vertical scales cover only a 4-ohm range.

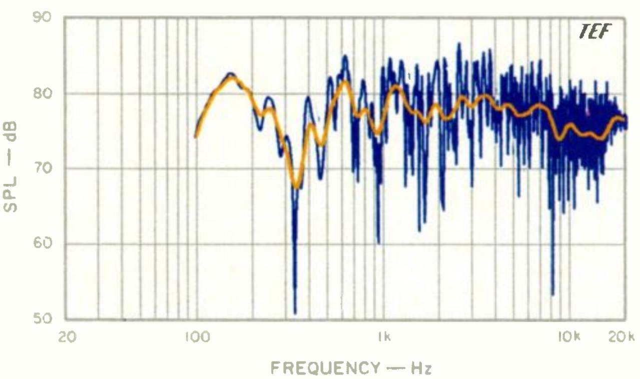

Fig. 12—Three-meter room response, showing both raw and smoothed data.

quite capable of being driven to much higher excursion amplitudes, up to about 0.7 inch, peak to peak, but with correspondingly higher distortion. Some dynamic offset was noted between 30 and 40 Hz at levels of 8 V rms and higher for the upper and lower woofers; the center woofer had no offset displacement in this frequency range. Curiously, the upper woofer displaced outward, and the lower woofer displaced inward! The whole enclosure was well sealed, and the side walls were very rigid and exhibited absolutely no wall vibration.

Figures 4 and 5 show, respectively, the CS5's horizontal and vertical off-axis frequency response in a "3-D" format. The curves were derived from measurements made approximately at 5° increments along the major horizontal and vertical planes of the system. The vertical off-axis curves were measured using the ground-plane technique at a distance of 3 meters. No additional smoothing was done except for the constant-bandwidth smoothing that results from the TDS measurement process. These graphs are normalized and have a logarithmic frequency scale. The normalization clearly reveals the differences between the on- and off-axis curves, because the on-axis curve is a straight line and the off-axis curves only show the deviation between them and the on-axis curve.

The normalized, horizontal off-axis responses, shown in Fig. 4, disclose a very well-behaved system. Each individual response curve is quite flat and approximately parallel to the on-axis curve for angles out to about 40°. This indicates that the CS5's curved front surface is indeed minimizing cabinet edge diffraction.

In contrast, the vertical off-axis responses, presented in Fig. 5, disclose a considerable amount of off-axis aberration, primarily due to the use of 6-dB/octave, first-order transitions in the crossover. In addition, the curves reveal a substantial amount of lobing, which means that the unavoidable directional lobes in the crossover regions are not aimed in the on-axis direction. Observe the left end of the graph at 200 Hz, where the lobe is aimed 30° downward and where a null in the response exists at 30° upward. This amount of lobing means that the response changes quite dramatically with small changes in vertical angle. The responses also show that the system's downward responses are substantially better than its upward ones. The responses just above the axis are extremely rough and depressed in level, in some cases by as much as 10 to 15 dB.

The mean horizontal and vertical on- and off-axis responses are shown in Figs. 6 and 8, respectively. These responses were derived from the previous "3-D" data by calculating response averages of several adjacent curves in specific angular regions; this approach is similar to that taken at the Canadian NRC's test facilities. Figures 7 and 9 are composites showing the individual response curves which made up the ±15° mean on-axis curves.

In the mean horizontal response curves, Fig. 6, the ±15° and 30° to 45° curves are quite flat and fairly smooth except for progressively more high-frequency roll-off as the angle increases. The 60° to 75° curve is somewhat rougher but still shows significant extension up to 15 kHz. The smooth, extended horizontal responses indicate that the systems should reproduce excellent stereo images over a wide hori-

Even when reproducing E_1 (41.2 Hz) at the highest levels, the Thiel CS5s overloaded gracefully.

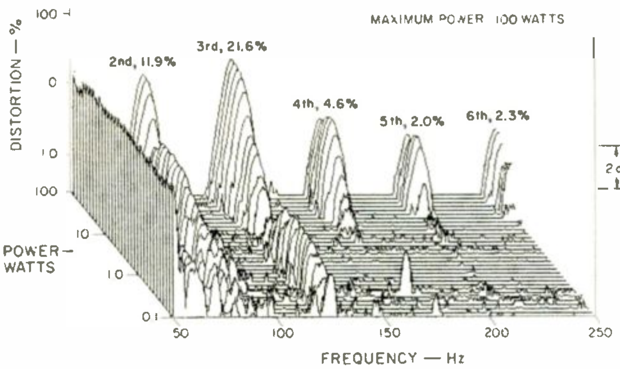

Fig. 13—Harmonic distortion products for the musical tone E_1 (41.2 Hz). The maximum-power figure of 100 watts is based on the CS5's rated impedance of 3 ohms; the actual maximum power is 176 watts, because the impedance drops to a minimum of 1.7 ohms at 41 Hz.

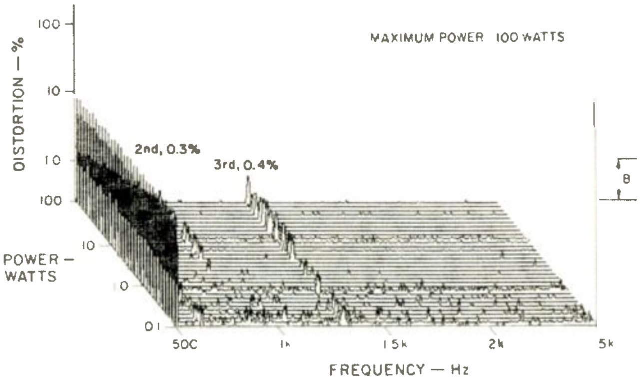

Fig. 15—Harmonic distortion products for the musical tone A_4 (440 Hz).

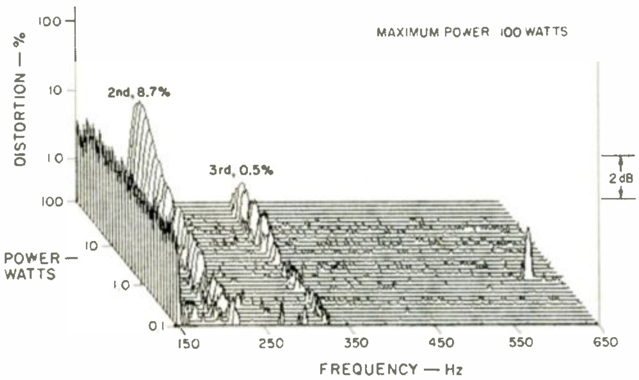

Fig. 14—Harmonic distortion products for the musical tone A_2 (110 Hz).

zontal listening area. Figure 7 shows a composite of all seven response curves that contributed to the ±15° mean on-axis curve of Fig. 6. The curves are all extremely close together, fitting in an envelope of ±1 dB up to 10 kHz and ±1.5 dB to 15 kHz.

The mean vertical responses are shown in Fig. 8. These curves are considerably rougher than the mean horizontal curves in Fig. 6 due to the strong effects of driver interference at off-axis angles. In this situation, the mean vertical responses are not as significant in predicting general trends in the response, as they normally would do, because the individual curves that made up the mean curves are very dissimilar. As an example, Fig. 9 shows all seven individual response curves that contributed to the ±15° mean on-axis curve of Fig. 8. Considerable variations of greater than ±10 dB are evident here. The extreme roughness of the upward curves (+5° to +15°) is very evident as compared to the downward (−5° to −15°) curves.

Figure 10 shows the CS5's magnitude of impedance plotted over the range from 20 Hz to 20 kHz. A very low minimum impedance of 1.7 ohms occurs at the power-hungry bass frequency of 40 Hz, and a maximum of only 3.9 ohms is reached at 700 Hz. This minimum/maximum range represents a ratio of 2.3 to 1. The very low impedance of the CS5 makes the system very sensitive to cable resistance. To keep cable-drop effects from causing peaks and dips in response greater than 0.1 dB, cable series resistance must be limited to a (very low) maximum of 35 milliohms!

Figure 11, a complex magnitude-phase (Nyquist) polar plot of impedance, covers the range from 5 Hz to 30 kHz—but note that the horizontal and vertical scales only cover a range of 4 ohms. The low impedance of the CS5 is clearly evident from this graph. At the lowest measured frequency of 5 Hz, the impedance is only 0.75 ohm! The positive reactance values between 5 and 870 Hz indicate that the system is inductive over this range. The phase angle of the impedance (not shown) reached a maximum of +43° at 17 Hz; above 20 Hz, the largest angle was +32°, at 55 Hz.

The extremely low impedance of the CS5 will make it a very demanding load on any amplifier. Only amps that can supply high current into low impedances should be used with the CS5. Additionally, only use short lengths of low-resistance cable to connect these systems to power amps.

Figure 12 shows the 3-meter room curve with both raw and sixth-octave smoothed data. The CS5 was in the right stereo position, and the test microphone was placed at ear height, at the listener's position on the sofa. The system was swept from 100 Hz to 20 kHz with a 2.83-V rms sine-wave signal (corresponding to 2.7 watts into the rated 3-ohm

No subwoofers required: At 20 Hz, a single CS5 can put a healthy 100 dB SPL into a listening room.

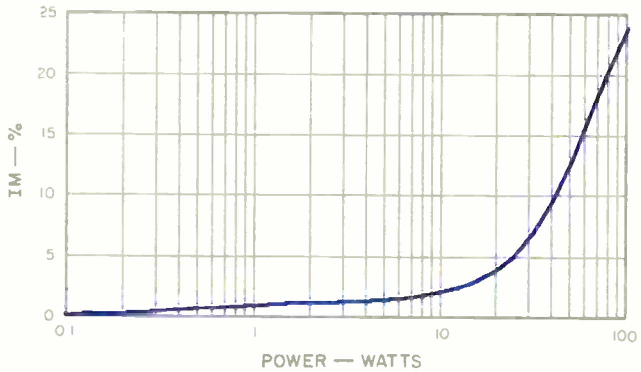

Fig. 16—IM distortion on 440 Hz (A_4) produced by 41.2 Hz (E_1) when mixed in one-to-one proportion.

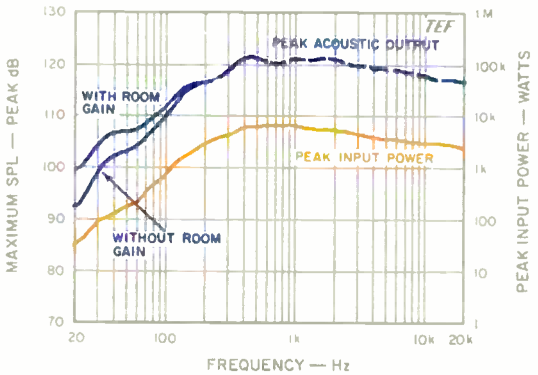

Fig. 17—Maximum peak sound output, measured at 1 meter on axis, and corresponding maximum peak input power levels. The effect of gain for a typical room is shown below 200 Hz on the output curve. Acoustic output above 600 Hz (dashed curve section) was limited by amplifier clipping.

load); the resultant sound levels can be read directly off the graph. The parameters of the TDS sweep were chosen so that the direct sound plus 13 mS of the room's reverberation were included. Except for a dip in the floor bounce region at 350 Hz, and some midrange roughness between 500 and 1,300 Hz, the curve is quite flat and extended.

Figures 13, 14, and 15, respectively, show the spectra of single-frequency harmonic distortion versus power level at the musical notes of E_1 (41.2 Hz), A_2 (110 Hz), and A_4 (440 Hz). These measurements indicate the level of harmonic distortion that is generated by the system with the application of a single-frequency sine wave at power levels from 0.1 to 100 watts (−10 to +20 dBW, a 30-dB dynamic range). The power levels were computed using the rated impedance of 3 ohms. The curves were run by successively increasing the sine-wave input level in 1-dB increments. At each power level, a swept spectrum analysis was done over a frequency range covering up to the fifth or sixth harmonic.

Figure 13 shows the E_1 (41.2-Hz) harmonic distortion data. The 100-watt maximum power is based on the rated impedance of 3 ohms; actual power is a much higher 176 watts, because the system's impedance reaches a minimum of 1.7 ohms at this test frequency. The nonharmonically related spikes, at lower power levels, are due to background noise in the measurement setup and were not generated by the speaker. At lower power levels, the second and third harmonics prevail at about the same level, while at higher power levels, the fourth, fifth, and sixth harmonics join the lower ones. At higher levels, the second and third harmonics predominate and reach 11.9% and 21.6%, respectively, at 100 watts. Even though this distortion is somewhat high, realize that 100 watts at 41 Hz generates a loud 100 dB SPL at 1 meter. At the highest levels, the system did not generate any extraneous noises; it overloaded quite gracefully.

The A_2 (110-Hz) harmonic data is shown in Fig. 14. The plot reveals that the second was the only significant harmonic over most of the power range. The second harmonic increases gradually with power, reaching a modest 8.7% at 100 watts. The third harmonic actually reached an intermediate high of about 0.5% at 40 Hz and then decreased to the measurement floor of the test at 100 watts. As in the previous graph, the random, nonharmonic information is due to background noise and other uncontrolled effects in the test setup.

The A_4 (440-Hz) harmonic measurements are shown in Fig. 15. Only the second and third harmonics were significant at 440 Hz, reaching levels of only 0.3% and 0.4%, respectively, at 100 watts. Even though the second harmonic distortion is mostly obscured by the fundamental bleed-through on the left in the graph, the second did not exceed 0.3% at any power level. These distortion levels are very low considering that at 440 Hz, the system generates in excess of 103 dB SPL at 1 meter with 100 watts input.

The IM distortion on a 440-Hz (A_4) tone created by a 41.2-Hz (E_1) tone of equal level is shown in Fig. 16. ("Equal level" refers here to input power, not output acoustic level.) The IM distortion gradually rises with power, reaching a high of about 24% at 100 watts. The first-order ($f_2 \pm f_1$) and second-order ($f_2 \pm 2f_1$) side frequencies predominated in this power range. The distortion is fairly high because the lower midrange, which handles the 440-Hz tone, also receives a significant amount of the 41-Hz tone due to the system's use of 6-dB/octave crossover slopes. Steeper crossover slopes would have reduced the IM distortion but at the expense of degrading the system's time-phase behavior.

Figure 17 shows the CS5's short-term peak-power input and output capabilities as a function of frequency. The tests were run by exercising the system with a high-level, shaped, 6½-cycle sine-wave tone burst from a Crown MA-2400 power amplifier configured in the bridged mode. The signal used for this test covers a third-octave bandwidth with a

The CS5s have delightfully clear and dynamic midrange coupled with a detailed, smooth treble few systems can compete with.

time duration that increases as the frequency decreases. The duty cycle of the test signal is low enough so that the long-term thermal characteristics of the speaker under test are not exercised.

The test consists of determining the maximum peak input power-handling capacity and maximum output peak sound pressure levels, in the range from 10 Hz to 20 kHz, at all the third-octave center frequencies, using waveform and audible judgments. For the CS5, the peak input power was calculated by assuming that the measured voltage was applied across the rated 3-ohm impedance.

The maximum peak electrical input power-handling capacity of the CS5 is shown in the lower curve of Fig. 17. Below 20 Hz (not shown), the peak input power was about 15 watts. In this subsonic region, the input power was limited primarily by the excursion capability and linearity of the woofer's suspension. Above 20 Hz, the input power rises smoothly up to about 600 Hz, where the test power amplifier ran out of gas at about 6 kW (135 V, peak). At all higher frequencies, the power amplifier's clip limit was reached before the speaker reached its limit! The high-frequency droop, noted in the curves of peak input power and peak acoustic output SPL, is also due to limitations of amplifier power bandwidth. These limitations occurred because the impedance of the CS5 drops below 3 ohms above 8 kHz. The CS5s handled these tests in a very straightforward manner without any anomalies or unexpected behavior.

The upper curve in Fig. 17 shows the maximum peak sound pressure levels the system can generate at a distance of 1 meter on axis for the input power levels shown in the lower curve. Also shown is the "room gain" of a typical listening room at low frequencies. This adds about 3 dB to the response at 80 Hz and 9 dB at 20 Hz. The peak acoustic output rises smoothly with frequency up to the midband region, where the power amplifier limits the output. As noted, the high-frequency decrease in output is also due to power amplifier limitations. With room gain, a single CS5 can generate peaks in excess of 110 dB SPL above 80 Hz and greater than 120 dB SPL above 350 Hz. Note that with room gain, the low-frequency output of a single system rolls off quite gradually with frequency, still providing a healthy 100 dB SPL at 20 Hz! Of course, a pair of these systems operating with mono bass will be able to generate even higher levels by some 3 to 6 dB. With this amount of bass output, subwoofers will definitely not be required with these speakers!

Use and Listening Tests

The listening portion of this review was performed in my auditioning room, which has dimensions of approximately 15½ × 27 × 8 feet. The room has normal living-room furnishings and a carpeted floor. Evaluation equipment included Onkyo Grand Integra DX-G10 and Meridian 206 CD players, a Krell KSP-7B preamp, a Krell KSA-200B solid-state power amplifier, and Straight Wire Maestro interconnects and speaker cables. As usual, I did the majority of my listening before I made the measurements.

All of the listening was done with the CS5s placed in my normal evaluation position, about 6 feet away from the short rear wall and separated by 8 feet. The side-wall spacing was about 4 feet. The speakers were toed in so that I was on the system axis laterally. Listening took place on the sofa, about 10 feet away, with my ears approximately 36 inches from the floor.

The systems were hooked up in a normal single-cable configuration (not bi-wired). Not only does Thiel not provide bi-wiring capability on the CS5s, they also philosophically discourage its use, believing that the speaker will sound better with one very good amplifier than with two lesser amplifiers. The company states that the speaker should always be used with the best amplifier that can be afforded rather than splitting the available money between two amps. It is Thiel's opinion that the amount of sonic improvement that can be attained by using two of the best power amplifiers represents a very poor cost/performance value. They believe that the extra money would be *much* better spent on purchasing a second pair of CS5s (good for Thiel, bad for amplifier manufacturers!). The second pair would be placed directly behind the first, pointing backwards, which would provide greater bass output, reduced distortion, and a greater sense of ease. Due to the CS5s' low impedance, the extra speakers would have to be wired in series with the original pair. Because the system's impedance doesn't vary much with frequency, this should be no problem.

The CS5s have been a delight to listen to. They have a high degree of midrange dynamics and clarity, coupled with a very smooth, detailed treble, that few systems can compete with. However, you had better be sitting down when I tell you this: You *have to be* sitting down when you listen to these systems! They have been optimized for a listening height of 36 inches at a distance of 10 feet, and you had better not raise your head! These speakers definitely have a sweet spot (or line) that extends laterally about 36 inches above the floor.

When I listened in a partially standing or standing position, I noticed that the excellent qualities of the system were greatly diminished. With higher positions, the upper midrange was depressed, rough, and sounded quite constricted. At heights above about 40 inches, the lateral image position of instruments would shift greatly, depending on height. Furthermore, I also noticed a "phasiness" or "swishiness" when I was in the process of standing up or sitting down. When sitting, however, the systems sounded excellent, with rock-stable imaging and a very open sound coupled with impressive depth and focus.

Unless otherwise stated, the following comments apply to listening done while I was sitting down. On Ana Caram's new Chesky CD, *Amazonia* (JD45), the CS5s did a very credible job of reproducing the ambience and soundstaging of the Brazilian jungle on the title track. The CS5s' height and driver placement contributed to an awareness of increased source height, and of an elevated sound source, that was not at all unpleasant. (When sitting, the tweeter is at an up angle of about 6°, whereas a typical system is usually at about 0°.)

On *Tommy Newsom and His TV Jazz Stars* (LaserLight 15 331), the sound was very clean and open, and the horns seemed to float in space in front of me. The bass lines were very even, and the room reverb on track 4 was reproduced very well. *Spies: By Way of the World* (Telarc CD-83305),

The Thiels are transparent and accurate, with linear response, near-subwoofer bass, excellent imaging, and extended dynamics.

encoded in Shure HTS surround, has turned out to be great demo material, even played in normal stereo. The CS5s did a super job on the kick drum and sound effects on track 6. Track 7's spatial effects were reproduced with lots of beyond-the-speaker images (the HTS processing, I presume), and the moving sounds on track 12 were very believable. Even though this is a highly processed multi-track CD, it's clean, well recorded, and fun!

The complex orchestration—with soloists, choir, and lots of percussion—on Gilbert Amy's *Missa Cum Jubilo* (Musi-France Erato 2292-45020-2) was rendered effortlessly, without any hint of harshness. (If you like Orff's *Carmina Burãna*, you'll like this disc.) The Sony Classical CD which includes Mozart's Sonata in B-Flat Major for Bassoon and Cello (from the Marlboro Music Festival—40th Anniversary series, SMK 46248), exhibited the CS5's very smooth midrange and upper midrange along with the balanced upper bass of the cello. On the very demanding organ version of *Pictures at an Exhibition* (Dorian DOR-90117), I did notice some IM distortion and muddiness on track 5 when the pedal notes were played at high volume; my reference systems were a bit cleaner on this track. The difficult passages on track 15 that made my reference systems stumble at 3:41 and 3:44, as noted in the B & W 801 Matrix Series 2 review in the November 1990 issue, were passed by the CS5s without any noticeable problems in dynamic offset.

Amanda McBroom's voice on the Sheffield Lab *West of Oz* (CD-15) was reproduced with more openness than my reference systems. The harmonica on tracks 1 and 2 seemed to float in space right above her head. (Who knows where the harmonica was supposed to be?) McBroom's solo on track 6 was effortless and clean. The CS5s also did a very convincing job on live rock music with the title track of my daughter's *Lick It Up* by Kiss (Mercury 814 297-2). I turned up the volume until the Krell was clipping at ±80 V (2.1 kW into 3 ohms!), where the sound level meter was indicating 98 dBA and 105 dBC at the listening position. The result was loud and fairly clean, a lot cleaner than a typical heavy-metal concert!

The Thiel CS5s have some exceptionally strong attributes in their favor: Accuracy, transparency, linear magnitude/phase response, low distortion, midrange dynamics and clarity, excellent soundstaging and imaging, extended dynamic range, a smooth and extended low end with near-subwoofer performance, and a smooth and detailed treble. Their downside includes a high price, heavy weight, large size, very low impedance, rough upper midrange response at elevated angles, and a potential for sensitivity to room acoustics because of an uneven off-axis vertical response. The CS5s, however, are a serious high-end contender and demand auditioning by anyone who's in the market for this caliber of loudspeaker.

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