Bose Model 1801 Stereo Amplifier

MANUFACTURER'S SPECIFICATIONS

(See text.) **Dimensions**: 7 3/16 in. H x 18 in. W x 18½ in. D. **Weight**: 82 lbs. **Prices**: $986.00, as tested; less LED and VU monitor display option, $799.00.

Discussions of amplifier design have heated up a bit since the introduction of the Bose 1801. In addition to employing a number of new design techniques and some devices not previously seen in this area, the 1801 is an example of the Bose Corporation's highly individualistic approach to design. As with the 901 and 501 speaker systems, it's just not possible to say that the Bose folks let anyone else do their design thinking for them. Again, as with the 901 and 501 speakers, they have rethought the basic problems and requestioned the basic assumptions that lay behind previous designs and approaches. Whether or not you agree with their concepts and conclusions, either on individual questions or overall approach, you must agree that they are radicals—in the old sense of the word, that they go to the root of things.

Rather than try to be a spokesman for the firm, through analysis of the amp, let us turn to a copyrighted booklet on the 1801 put out by Bose. This booklet is not a spec sheet in the usual sense but rather deals with the background and philosophy of design and specification mentioned above. Because Bose takes a rather unusual approach to these items, we have dispensed with our usual "Manufacturer's Specifications" block and will simply quote from the booklet. These are not verbatim quotes, but are, we feel, in context, accurate, and pretty well speak for themselves.

"Specification Philosophy

"We have reached a stage where consumers pay more for 'better' numbers in specifications without any knowledge of whether these 'better' numbers give better performance—in many cases they don't.

"In each case when we quote a specification for the 1801, we will quote not the actual specification but only the minimum necessary to achieve audible perfection with respect to the specified parameter.

"Setting aside the measurements for a moment, there is really only one specification that is meaningful. . . . When the 1801 is used within its ratings . . . ,[it] contributes no audible distortion or coloration of any kind on any music signals. It serves purely to amplify the power level of the musical signals."

"Power Rating

" . . . the characteristics of the human auditory process are such that a large increase in amplifier power produces only a small increase in perceived listening level. For example, it is necessary to *double* the amplifier power to produce a 3 dB increase in sound level which is the first significantly discernible increase in listening level. And the amplifier power must be increased by ten times to only double the subjective listening level . . . !

"There is no point in designing an amplifier to deliver more power than the loudspeaker can handle. . . . Even the best designed speakers should not be used with amplifiers delivering significantly greater than 250 watts rms per channel.

"Therefore, we elected to design the 1801 to deliver 250 watts rms per channel into an 8 ohm load. For four ohm loads, however, there are significant applications that can benefit from more than 250 watts. In particular, many 4 ohm loads will consist of two pairs of 8 ohm speakers connected in parallel. Hence, we have designed the 1801 to deliver 400 watts rms per channel into 4 ohm loads."

"Frequency Response

"Of all the specifications that have been traditionally used to measure amplifier performance, frequency response is perhaps the most important . . . our research indicates that in order to assure no audible coloration on any music signals, the frequency response in the range from 30 Hz to 10 kHz should be flat within ± 0.25 dB and the frequency response from 10 kHz to 15 kHz should be flat within ± 0.7 dB. In the extremes of the spectrum, from 20 to 30 Hz and from 15 kHz to 20 kHz, a tolerance of ± 1.0 dB is easily sufficient to guarantee no audible coloration."

"Transient Response

"This may come as a shock, but transient response is the most overrated specification parameter in the industry today. The facts are that if the frequency response is tightly controlled as discussed above, then, except for purely pathological cases involving specially designed phase shift networks, the transient response is irrelevant to the audible performance of the amplifier. If a design decision is made to specifically optimize, for example, the 10 kHz square wave transient response, then wide-bandwidth power transistors are required leading to increased cost, marginal stability circuits, and reduced reliability because of voltage breakdown problems associated with high-bandwidth transistors. This is a prime example of how the consumer pays for 'specsmanship.' "

"Overload Recovery

"This parameter is often confused with transient response because pulses are sometimes used to observe the overload characteristics. This difference is that transient response relates to normal operation of an amplifier while the pulses that are used to investigate the overload characteristics are such that they cause the amplifier to be driven beyond its design limits. . . .

"A well designed amplifier should recover from an overload in less than 25 microseconds."

"Input Impedance

"This is actually a very important parameter of an amplifier and one which has interesting design tradeoffs. The lower the input impedance, the more impressive the noise specifications become. However, low input impedances can interact with preamplifiers and other equipment to cause audible changes in the frequency response of the combined units—a factor that does not show up in any amplifier specification. To avoid this deterioration, the input impedance of an amplifier should be greater than 50,000 ohms."

"Noise and Hum

"The amplifier/speaker combination of the best music system should be capable of producing 115 dB instantaneous sound levels on musical passages when the amplifier is fully driven. If the amplifier has a signal-to-noise ratio of 100 dB, then the noise level in the room caused by the amplifier will be only 15 dB—well below the ambient noise of *any* room and therefore inaudible."

Distortion

"Distortion is a performance parameter frequently subject to specsmanship, to the detriment of amplifier reliability . . . one can achieve impressively low values of distortion at the high end of the audio spectrum (above 10 kHz). Unfortunately, this is accomplished at the expense of increased vulnerability to transistor second breakdown (a form of voltage breakdown) and greater susceptibility to internal oscillations that can destroy the amplifier—quite a price to pay for inaudible improvements in distortion.

"Harmonic distortion actually is significant in a practical sense only in the frequency range up to 10 kHz because above this range the harmonic distortion components all fall above 20 kHz and are inaudible. Basic psychoacoustic tests will show that total harmonic distortion less than 0.5 percent below 5 kHz and less than 1.0 percent between 5 and 10 kHz is inaudible on music or speech signals.

"Intermodulation distortion is a measure of unwanted signals generated by the interaction of two input signals of different frequencies that are applied simultaneously. IM distortion less than 0.5 percent (as measured according to IHF standards) is inaudible on music or speech signals."

Whether or not you agree with this design philosophy and approach to specifications, you probably agree that Bose has made a rather broad reappraisal of what's needed currently in amplifiers. And having said that, let's turn to the unit itself.

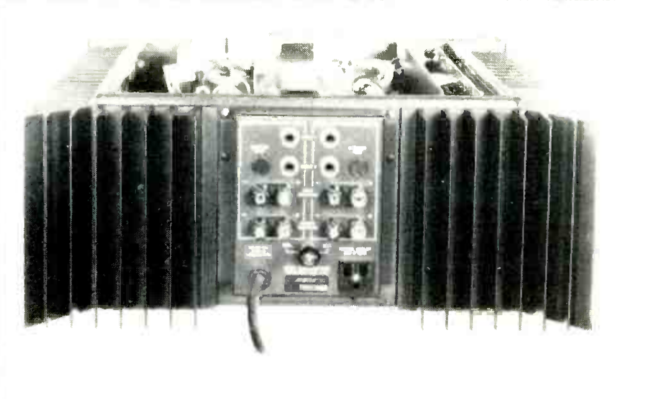


Fig. 1—Back panel of the Bose 1801

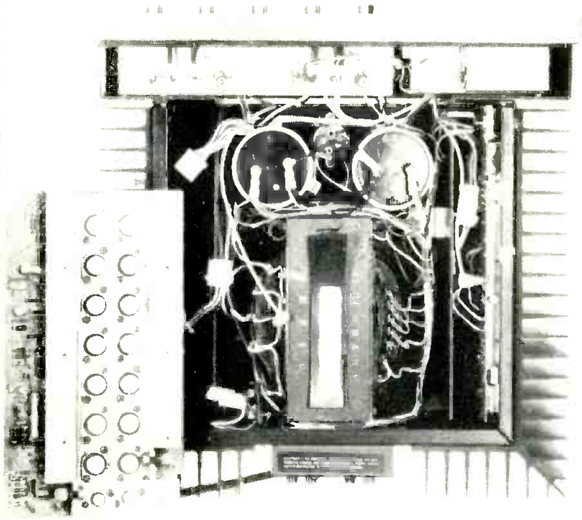


Fig. 2—Top view of the 1801, with one board removed.

Physical Description

After unpacking the amplifier, our first impression was to note the unusually large array of heat sinks extending around three sides. (Some 1300 square inches of radiating surface, according to the booklet.) To be strictly accurate, our first impression was conditioned by the *actual weight* of the amplifier—82 lbs.—and lifting it from the floor to a bench was no easy task. The power transformer alone turns the scales at 41 lbs.—a two kilowatt monster! On the left of the nicely finished front panel is an array of LEDs (Light Emitting Diodes) used as power indicators and to their right are two large VU meters. Underneath are five control knobs, the first being a combined a.c. power switch and meter/LED selector. Next comes the gain control for the left channel and then a two-position input switch. Next to that is the gain control for the right channel, and a speaker switch ends the line. The VU meters have a longer time constant than usual and are calibrated to read in *integrated power*. Fast transient peaks are handled by the LEDs which respond almost instantaneously. Each channel has a row of seven LED indicators calibrated from -12 dB to +24 dB referred to 1 watt (at 4 ohms). Thus, the +24 dB corresponds to a power of 256 watts and the next vertical line of four LEDs to the right indicates clipping. The selector switch gives a choice of LED display, VU meters or both together. The input and output connections are at the rear, phone jacks being used for the inputs and heavy-duty binding posts for the loudspeakers. A single a.c. outlet socket is provided, and a 10-amp fuse is also on the rear panel.

Mechanically, the 1801 is very solidly constructed—built like the proverbial battleship, in fact. All the components are of excellent quality—top-grade fiberglass circuitboards, heavy-duty connectors, 85° C. capacitors, and so on. There are two main boards, each of which contains a complete channel of amplification, including the power transistors and temperature protection circuits. The power transistors are placed on an aluminum alloy "heat coupler," as Bose calls it, which is in turn connected to the heat sinks via six screws. Circuitry on the board is connected up with three connectors. All this allows easy removal of the boards, if necessary, as we did for our top-side photo.

Circuit Description

The circuit arrangement is fairly conventional with the exception of the first stage which uses an op amp instead of the usual differential pair. Input impedance is higher than usual at 50 Kohms. A differential pair is actually used in the second stage. This is followed by the predriver stages and NPN silicon power drivers connected to two parallel sets of six power transistors—a total of 24 output transistors (32 counting the drivers) for both channels. A current-sensing protection circuit is employed—plus a thermal cutout. A relay in the power circuit switches on full power after a one-second delay, thus eliminating surges.

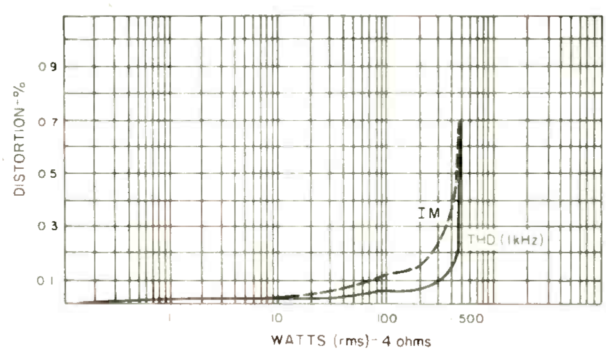


Fig. 3—Power output versus harmonic and IM distortion, 4 ohm loads, both channels driven.

Measurements

Figure 3 shows the power output versus harmonic and IM distortion for 4 ohm loads, both channels driven. It will be seen that the output for 0.5 percent THD is some 470 watts. This fell to 280 watts for 8 ohm loads—both figures exceeding the design goals by a comfortable margin. Distortion versus frequency is seen in Fig. 4, and frequency response is shown in Fig. 5. The response is 3 dB down at 53 kHz and 10 dB down at 100 kHz. Square wave response at 40 Hz, 1 kHz, and 10 kHz is shown in Figs. 6A, B, and C; note that there is no sign of overshoot.

Figure 7 shows symmetrical clipping at the overload point, which is no less than 625 watts! Power bandwidth extended from below 10 Hz to about 30 kHz (it was difficult to measure exactly owing to the action of the thermal cutout). Distortion does not increase at lower levels, and no trace of crossover distortion can be seen in the 10 milliwatt signal shown in Fig. 8. Hum and noise came out at 96 dB for one channel and 98 dB for the other. Sensitivity for full output was 1.7 volts.

The LEDs gave a very positive indication and were remarkably accurate. It was noted that a 100 watt (rms) signal produced a VU deflection of 0 VU—corresponding to about 250 watts of music power. Finally, stability was checked with various capacitive and reactive loads with no untoward effects.

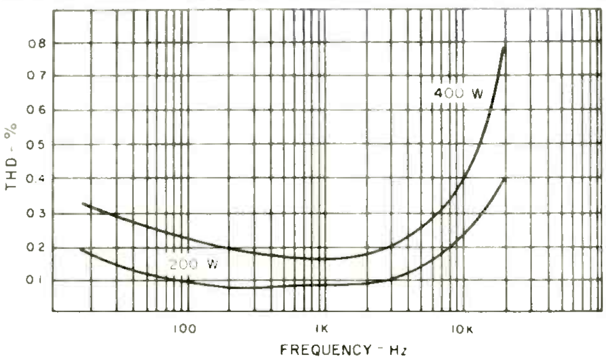


Fig. 4—Frequency versus harmonic distortion at two power levels.

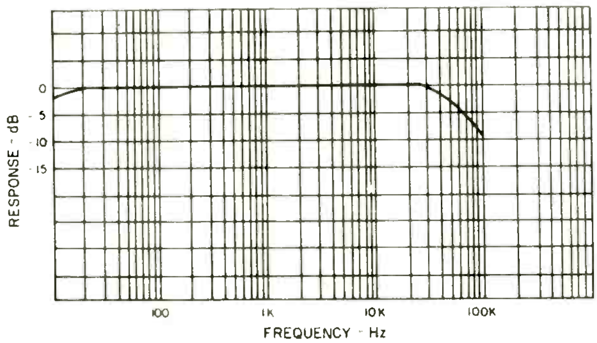
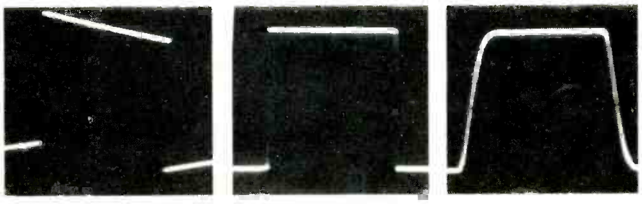


Fig. 5—Frequency response, 1 watt level.



A B C

Fig. 6—Square wave response at A, 40 Hz; B, 1 kHz, and C, 10 kHz.

Listening Tests

Listening tests were carried out over a period of several weeks using a wide variety of equipment including AR LST speakers, EPI 400s, a Crown IC-150 preamp, and three phono cartridges—a Shure V-15 Mk III, Decca Professional, and an Audio-technica 20. The turntable was a Thorens 125 Mk II. The sound was as clean and transparent as that produced by any of the other top-quality, high-power amplifiers.

This is certainly not surprising as the only noticeable difference is the slightly inferior (if that is the right word) square wave response at frequencies above 6 kHz. This is, however, a rather academic point, and no difference could be heard in listening tests between it and other amplifiers having a wider bandwidth. To amplify on this point a bit, there are two schools of thought on amplifier design, the narrowband and wideband groups[1,2,3,4]. The former argue that a 10 kHz square wave needs a bandwidth of ten times the 10 kHz (or 100 kHz) to reproduce it properly; ergo, since music has a much more complex waveform, a response of up to 200 kHz is needed. The narrowband school says that the argument is fallacious and that a response up to 20 kHz is quite adequate. However, the evidence is not conclusive, and more work certainly needs to be done to determine just what bandwidth really is necessary for the accurate reproduction of music waveforms—regardless of the present limitations of tapes, records, and broadcast transmissions.

Irrespective of where the 1801 stands regarding these bandwidth discussions, the sound is completely neutral—like the proverbial piece of wire with gain. Or as the booklet has it: ". . . the amplifier contributes no audible distortion or coloration of any kind on any musical signals. It serves purely to amplify the power level of the musical signals."

Summing up: The Bose 1801 is a well-engineered, beautifully made piece of equipment using high grade components, which should ensure a higher than average reliability. Power output is high enough for the most insensitive loudspeaker systems—even for rock *aficionados*. It is not particularly cheap, but then this high level of product quality rarely is. But don't forget, there is a version without the LED and VU meter displays which sells for less than $800.00.

Check No. 54 on Reader Service Card *George W. Tillett*

[1] **Amplifiers**, George W. Tillett, *British Audio Annual, Hi-Fi News*, 1965; reprinted AUDIO, April, 1971, p. 32.

[2] "Why Solid-State Amplifiers Can Sound Better," Morley Kahn, *Acoustec* publication.

[3] "Transistors for Hi-Fi," Myers and Kahn, **Electronics World**, April, 1964, p. 42.

[4] **Audio Quality**, G. Slot, Philips, Eindhoven, The Netherlands.

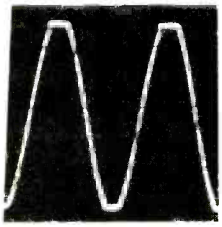


Fig. 7—Symmetrical clipping at 625 watts, 1 kHz.

Fig. 9—Hum and noise.

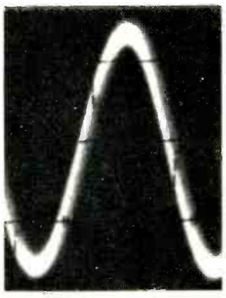


Fig. 8—10 milliwatt sine wave signal.

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output as read in playback on the VU meter. However, instead of my recordings sounding overly-bright, as expected, there is a very definite loss of high frequencies. I have tried under-biasing, but without success. My questions are: (1) How could I adjust playback equalization for optimum performance with Scotch 203, and do you think it would make a significant difference? (2) On occasion I have pinned my VU meters by some sort of feedback when, while listening to my tape through Koss ESP-7 electrostatic headphones, I pass my hand near the playback head of my deck. Is a feedback loop of this nature possible? Could such levels have magnetized my heads beyond the ability of my demagnetizer to remove it? (3) Is it possible, by feeding different frequencies into the recorder and monitoring their respective playback levels on my VU meters, to get some idea of my recorder's frequency response?— Bruce Schwartz, Philadelphia, Pa.

A. (1) At 3¾ ips, your machine should probably be somewhat underbiased in order to maintain frequency response out to 15,000 Hz. If underbiasing results in dull sound, this suggests something else is wrong, such as a playback head with a worn gap, a magnetized playback head, faulty record equalization, or faulty playback equalization. If tapes recorded on other machines sound satisfactory when played back on yours, then neither the playback head nor playback equalization is at fault. When going from conventional to low-noise tape, the adjustments required are in recording (bias, record equalization, and record drive), *not in playback.*

(2) Your hand is a source of hum, and apparently the playback head picked up enough to pin the meter. Whether this may have magnetized your head beyond redemption is something that I doubt. Have you tried using a bulk eraser to demagnetize the head?

(3) Yes, you can get a substantial idea of your recorder's overall response by feeding in various frequencies at a constant level and measuring their playback level on your meter. This assumes you have a true VU meter with substantially flat frequency response. Not all meters found in tape recorders are true VU meters with flat audio response.

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 134 North Thirteenth Street, Philadelphia, Pa. 19107. All letters are answered. Please enclose a stamped, self-addressed envelope.