audioXPRESS
The Audio Technology Authority

Article prepared for www.audioXpress.com

Outlaw Model 200

By Charles Hansen

Outlaw Audio
PO Box 975
Easton, MA 02334
866-688-5297
www.outlawaudio.com

Web-direct price $299 US
Weight: 18 pounds
Dimensions 1.75″ H × 17″ W × 11.5″ D
Warranty: 5 years

This review is a revision of a first one done by our Equipment Review specialist Charles Hansen. After our first measurements discovered some less than ideal results, the Outlaw management asked whether they could make suggested changes in the device and resubmit a second sample. This new review is the result.

We asked the manufacturer whether the changes made would be part of a new version of the amplifier. They indicated that it was not since they had a quantity of the boards which are the basis of the amp topology. These have been modified to achieve the improvements and will be part of regular offerings to buyers until a new batch is required. Charles Hansen assures me that this is often standard practice in the industry. We are satisfied that the revised version of the amplifier performs as we report it in this review.

I cannot resist pointing out that the above incident is not unique. Our reviewers often find problems, discuss them with manufacturers, and this leads to product improvements that might otherwise not be made. Please note that this is a service of audioXpress *to its readers and those in the industry whose products we review. —E.T.D.*

The Outlaw Audio Model 200 M-Block, which is sold only through the Internet, is a monoblock Class-G power amplifier. According to the Outlaw website, it uses a proprietary hybrid Class-A/B/Class-G design and is conservatively rated at 200W into an 8Ω load, 20Hz–20kHz, at less than 0.05% THD; or 300W into 4Ω. It also has a short-term dynamic power rating of 300W into 8Ω. The amplifier is compact at just 1¾″ (one rack-unit) high with a footprint that matches conventional 17″ wide components. There are two screws on each forward side that look as though they might accept rack mounts for pro audio applications.

The Model 200 is designed to be either operating or in standby mode, so there is no front-panel power switch. In the standby mode the Model 200 is turned on or off by a standard 12V DC (6–35V) trigger signal applied to a rear-panel jack, or when the "music sense" circuit detects the presence of an audio signal at the input jack. When the audio signal stops for 10 minutes, the amplifier automatically turns off.

INSIDE THE AMPLIFIER

Photo 1 shows the front panel, which has a three-color LED status indicator just below the Outlaw logo. It shows green when the unit is on, yellow when the unit is in standby, and red when the unit goes into self-protect mode.

PHOTO 1: Model 200 front view.

The heavy gauge steel chassis is quite rugged, and there are a large number of cooling slots in the top cover and bottom plate to enhance cooling. The cover is secured to the chassis with a total of nine screws. The amplifier sits on four plastic disks with rubber inserts. There is only 5/16″ of finger space under the unit, making it a bit awkward to pick up from a flat surface. Weight is heavily biased toward the power transformer side of the unit.

The rear panel (left-to-right in **Photo 2**) has a gold-plated RCA input jack, the pair of 12V trigger in-out jacks, and a trigger mode switch with On, Music, and 12V positions. The gold-plated 5-way speaker binding posts are on ¾″ centers, so you can use dual banana plugs. Next comes the line voltage selector switch, the on-off rocker switch, a fuse post with T5AL fuse, and the IEC power receptacle. The unit is furnished with

PHOTO 2: Model 200 rear view.

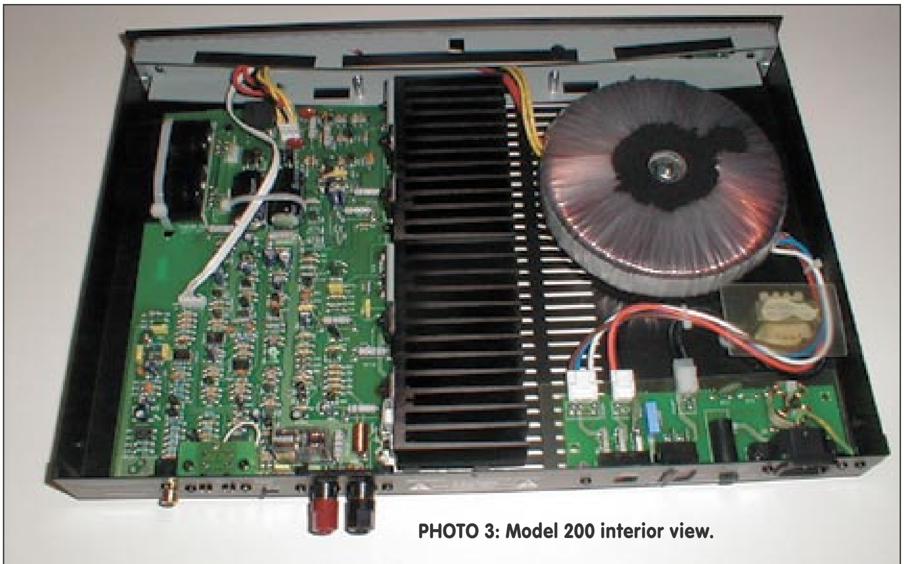


PHOTO 3: Model 200 interior view.

a heavy power cord.

Photo 3 shows the amplifier with the cover removed. All the jacks and switches are PC board mounted types. The input jack center contact is tin plated, and there are two ferrite beads on the PC board near the input. The AC input board has a common-mode toroidal choke and capacitor RFI filter followed by a chassis mounted choke. Keen Ocean Ltd., a Hong Kong supplier, makes the large 400VA toroidal power transformer.

A pair of hefty heatsinks occupies the center of the chassis. The rear heatsink has a thermal sensor switch to disconnect the speaker in case of excess power dissipation. The amplifier PC board is on the right, and it has a *lot* of components. The power supply is at the front of this board.

TOPOLOGY

A Class-G amplifier design was unveiled in an article by Len Feldman in the August 1976 issue of *Radio-Electronics* titled "Class-G High-Efficiency Hi-Fi Amplifier." In 1977, the Hitachi Dynaharmony HMA 8300 was generally recognized as the first Class-G power amplifier that made it into production.

The design uses two levels of power supply rails to power the output stage. The low voltage handles most of the audio up to some fraction of the rated output, and looks like a conventional amplifier. At some higher level of peak output voltage, the output devices are switched to the higher voltage rails. The advantage of Class-G is efficiency. The only power dissipated for most of the amplifier's operating range is that needed to bias and drive the output stage from the low voltage rails.

There are actually three different types of Class-G output stage[1]. In the series design, the higher voltage output stage is in series with the lower voltage stage. In the shunt design, both the high and low voltage stages drive the speaker load directly. The higher voltage stages remain off until the peak voltage demand reaches the point where they are biased into amplification.

The third type uses a single set of output devices and the power supply rails are shifted between two levels. The two rails are isolated by power diodes. The Outlaw 200 uses this third topology.

Switching spikes from the commutation diodes that deliver the low voltage rails, and then become back-biased when the high voltage rails take over, used to be a major problem. Modern Schottky diodes have pretty much obviated this as a noise source. The two commutation diodes in the Outlaw 200 have RC snubbers soldered across them.

A schematic was not furnished with the Outlaw 200. The power transformer has tapped secondaries (five leads) with two rectifier bridges to provide the two levels of power supply rails. The higher rail supply is filtered by two Su'scon 10,000µF 100V DC aluminum capacitors, and the lower by two Su'scon 3,300µF 50V capacitors.

The Model 200 operates in Class A/B up to 80W. Outlaw Audio says it transitions to Class G within 2µsec above 80W (one AC half-cycle at 20kHz has a duration of 25µsec). Power MOSFETs are used to switch the high voltage rails to the collectors of the output devices and their drivers. The output stage uses two parallel pairs of 15A Sanken bipolar transistors (types 2SC3519 and 2SA1386). High-power 40A MOSFETs switch the collectors of the output devices and their drivers to the high voltage rails.

An air core inductor is connected between the output stages and the positive speaker connector. The lower level audio circuits use carbon film, metal film, and flameproof power resistors. The capacitors are generic mylar film types, X7R ceramic disks, and Capxon aluminum capacitors. A few NP0 ceramic caps are used where critical values are needed. There are also four DIP op amp packages: two TL072s and one each TL071 and LM833.

The board component designations are numbered in five distinct groups. The parts beginning with 100 seem to be associated with the primary audio signal path, since the bipolar driver and output transistors (Q113 through Q118) are in this group. The LM833 and TL071 are also in this group, so these two op amps may handle the input amplification. The 200-series component designations are associated with the raw DC power supplies and the rail-switching Class-G MOSFETs (Q202 and Q203).

The function of the 300 series parts is a bit harder to determine. The resistors in this group are mostly carbon film types. They and the other 300-series parts, including one TL074, are grouped around the protection relay, so I assume they form the amplifier protection circuitry. The opto-isolator for the 12V-trigger (and perhaps the "music sense") circuit also falls in this group.

I have no idea of the function of the 400-series parts, which includes the other TL074 op amp. Based on the parts placement, they seem to be associated with the LM833 and TL071 op amps, and include many 1% precision resistors. The 500-series parts are located around two bipolar power transistors that appear to provide the two supply rails for the op amps, derived from the lower set of power amplifier DC rails.

MEASUREMENTS

I operated the single Model 200 amplifier I received at 10W into 8Ω for one hour. The chassis temperature increased to a comfortable 36° C right above the heatsinks. The THD reading at the end of this run-in period was the same as when I began: 0.012%.

There is a brief click in the speaker when starting up, and no noise at all shutting down the amplifier. The output noise consisted of a low-level hiss, measuring 2.8mV RMS (input terminated with 600Ω). I also measured +5mV of DC offset.

The Model 200 does not invert polarity. The input impedance measured 114k with my ohmmeter, but the AC input impedance was a much lower 14k, indicating a capacitively-coupled input stage. The gain at 2.83V RMS output into 4Ω and 8Ω loads was 28.2dB and 28.3dB, respectively. The output impedance at 20Hz and 1kHz (10W) was 0.06Ω, rising to 0.16Ω at 20kHz. The speaker negative terminal and the shell of the input phono jack are connected together, but there is a DC resistance of 220Ω between these audio connections and the enclosure, so the amplifier circuitry is not solidly grounded to the chassis.

The frequency response (**Fig. 1**) was within −1dB from 10Hz to 29kHz, with an output of 2.83V RMS at 1kHz into 8Ω. It was down −3dB at 54kHz. There was just a bit more HF rolloff with a 4Ω load, the −3dB point being 48kHz. The IHF speaker load, which has an impedance peak at 50Hz, produced only 0.1dB rise in the frequency response.

The Model 200 amplifier will be insensitive to variations in speaker impedance with frequency. When I connected a complex load consisting of 8Ω paralleled with a 2μF cap (a test of compatibility with electrostatic speakers), the output voltage began to increase just below 10kHz (dashed line in **Fig. 1**). The output peaked at a benign +1.65dB at 45kHz before dropping off rapidly.

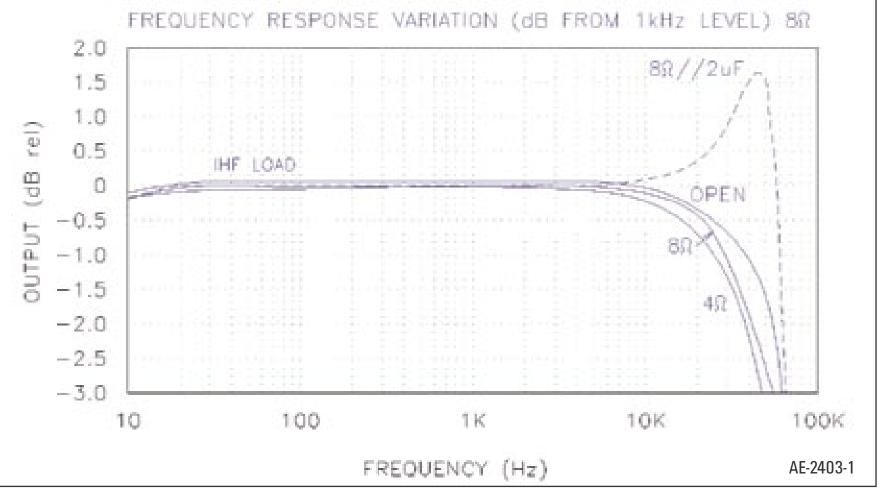
THD+N versus frequency is shown in **Fig. 2** for the loads indicated in the graph. During distortion testing, I engaged the test set 80kHz low-pass filter to limit the out-of-band noise. The peak distortion frequency point varies with the output power. The THD+N increases the most with the complex load. The 4Ω load data is shown with dashed lines.

Figure 3 shows THD+N versus output power for the loads and frequencies shown in the graph (4Ω 1kHz data shown with a dashed line). You can see the slight discontinuity from a smooth curve in the THD just below 100W. This is where the Class-G operation begins as the amplifier switches from its low voltage rails to the higher voltage rails. The 20kHz curve has an additional bump around 6W.

There was absolutely no strain right up to and beyond the point of maximum power, but note the slight increase in THD from 60Hz to 120Hz at two-thirds power in **Fig. 2**. This indicates that the mains power supply is beginning to show up in the output waveform at higher output power levels, albeit at very low levels.

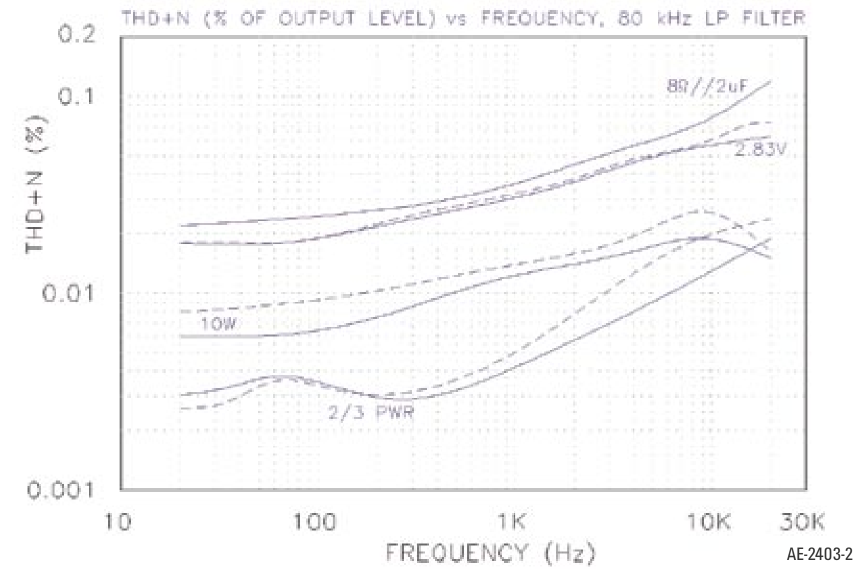
The amplifier reached its 1% 1kHz clipping point at 214W with the 8Ω load (0.47dBW of headroom) and 313W with the 4Ω load (0.18dBW of headroom). Both output AC half-cycles clipped at essentially the same level. While I was determining the 1% and 3% THD levels with the 8Ω load at 20kHz (205W and 207W, respectively), the heatsink temperature sensor switch tripped the amplifier and the front panel LED turned red. I had to wait five

FIGURE 1: Frequency response.



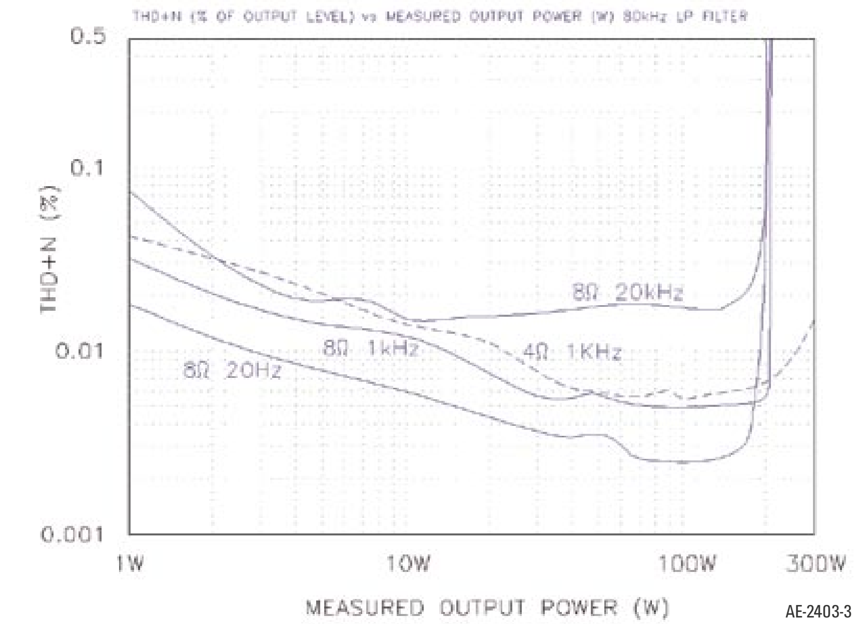
AE-2403-1

FIGURE 2: THD+N vs. frequency.



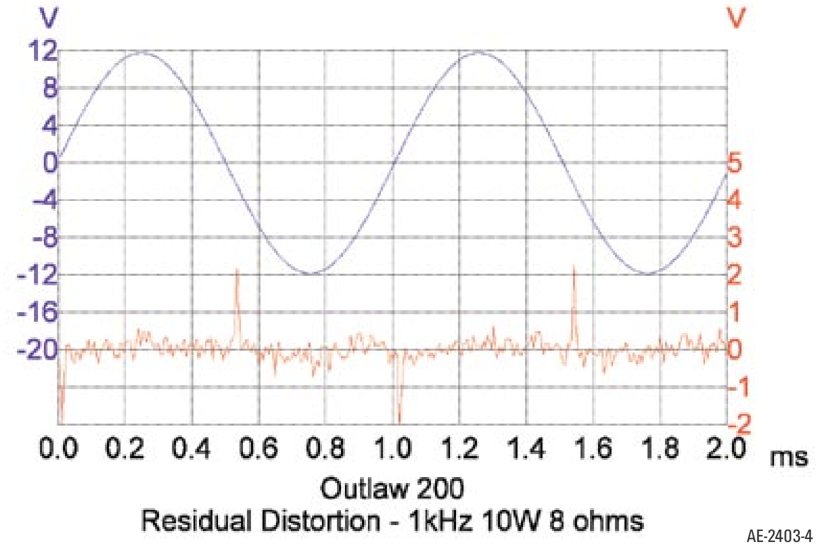
AE-2403-2

FIGURE 3: THD+N vs. output power.



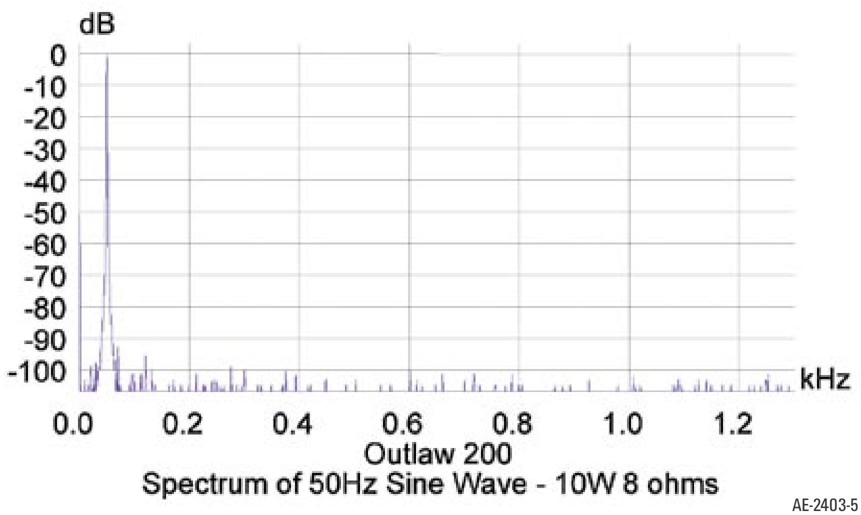
AE-2403-3

FIGURE 4: Residual distortion.



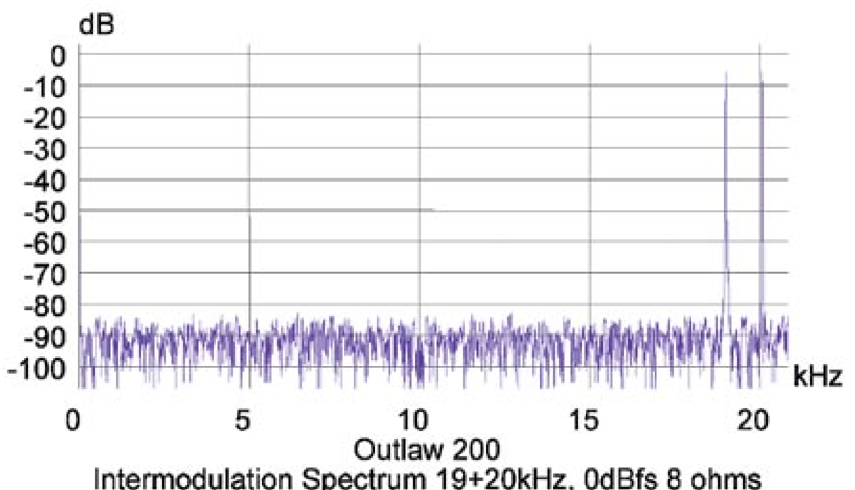
AE-2403-4

FIGURE 5: Spectrum of 50Hz sine wave.



AE-2403-5

FIGURE 6: Spectrum of 19kHz + 20kHz intermodulation signal.



AE-2403-6

minutes for the amplifier to cool down and reset before I could resume testing.

The top of the amplifier reached a maximum temperature of 46° C with 133W into 8Ω. The heatsink would be at a much higher temperature because there is about 1/8″ of air space between the heatsink and the cover.

The distortion residual waveform for 10W into 8Ω at 1kHz is shown in **Fig. 4**. The upper waveform is the amplifier output signal, and the lower waveform is the monitor output (after the THD test set notch filter), not to scale. This distortion residual signal shows noticeable crossover distortion spikes at each zero crossing. The THD+N at this test point is 0.012%.

The spectrum of a 50Hz sine wave at 10W into 8Ω is shown in **Fig. 5**, from zero to 1.3kHz. The THD+N here measures 0.0069%. The 2nd harmonic measures –98dB, while the 3rd, 4th, and 5th harmonics are all below –103dB. Low-level power line and power supply rectification artifacts are also present at 60Hz and 120Hz. The spectrum of a 1kHz sine wave (not shown) had a nearly identical distribution of harmonics.

Figure 6 shows the amplifier output spectrum reproducing a combined 19kHz + 20kHz CCIF intermodulation distortion (IMD) signal at 45Vpp into 8Ω. The 1kHz IMD product is –93dB (0.0022%), and the 18kHz product is –94dB (0.002%) and just barely shows above the noise floor of my IMD generator signal. Repeating the test with a multi-tone IMD signal (9kHz + 10.05kHz + 20kHz, not shown) resulted in a 950Hz product of –88dB and a 1050Hz product of –89dB. This gives a better indication of the amplifier's nonlinear response, because it is a closer approximation to music than a sine wave. The Model 200 produced excellent IMD results.

2.5Vp-p square waves of 40Hz and 1kHz into 8Ω were almost perfect, with just a hint of peaking on the leading edges of the 1kHz wave. The leading edge of the 10kHz square wave contained a noticeable peak about 18µsec wide (**Fig. 7**). When I connected 2µF in parallel with the 8Ω load, the Outlaw 200 displayed an underdamped 45kHz ringing (**Fig. 8**) on top of the square wave. This corresponds to the frequency response peak plotted in **Fig. 1**, and the amplifier remained stable during this test.

CONCLUSION

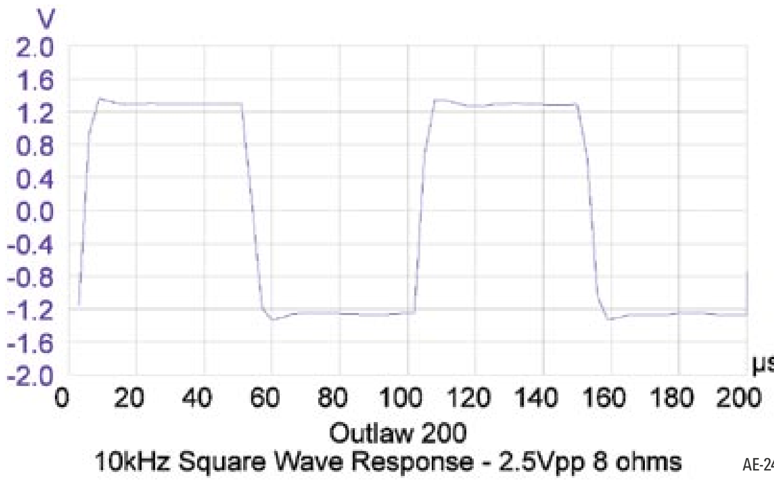
The Outlaw 200 is a good performer and pretty much bulletproof. While I was performing tests beyond 200W, I accidentally shorted the output while adding a second speaker load. The amplifier protested loudly for a second before its protection circuit tripped. It reset immediately after I corrected my connection error and reset the power switch. It continued to produce lower distortion and higher levels of power than the manufacturer's ratings, so there were no apparent ill effects.

A comparison of the measured results and the manufacturer's ratings is shown in **Table 1**. *aX*

References

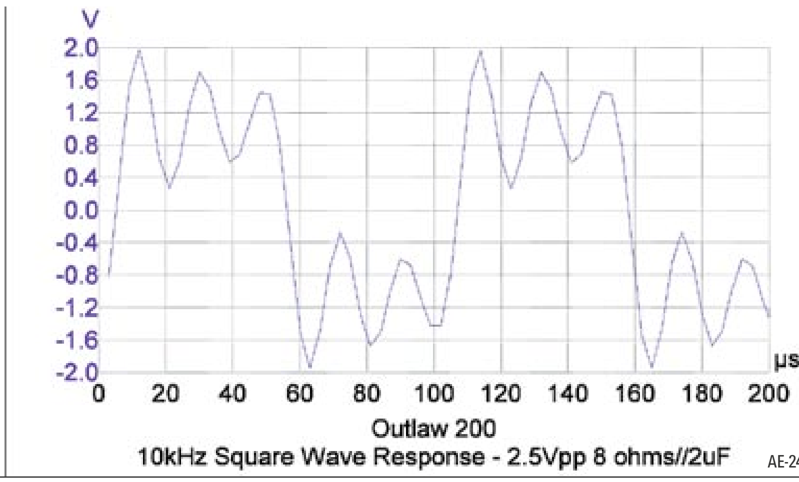
1. *Audio Power Amplifier Design Handbook*, by Douglas Self, p. 36–38, Second Edition, 2000, Newnes.

FIGURE 7: 10kHz square wave response into 8Ω load.



AE-2403-7

FIGURE 8: 10kHz square wave response into complex load.



AE-2403-8

TABLE 1 Measured Performance

Parameter	Manufacturer's Rating	Measured Results
Power Output (RMS)	200W, 8Ω 300W, 4Ω	205W 8Ω 20-20kHz 313W 4Ω 1kHz
Frequency Response	20Hz – 20kHz power bandwidth	10Hz – 25kHz ±1dB, 4Ω and 8Ω
Total Harmonic Distortion	<0.05%, 20Hz - 20kHz Rated Power	0.015%, 300W 4Ω 0.05%, 200W 8Ω
IMD - CCIF (19+20kHz) MIM (9+10.05+20kHz)	N/S	0.0022% CCIF 0.004% MIM
Input Impedance	>10k	14k at 1kHz
Signal to Noise Ratio	100dB unweighted	
Gain	+27dB, 1.7V sensitivity for full output	28.2dB 4Ω, 28.3dB 8Ω
Power Requirements	600W maximum, <3W Stand-by	
Output Impedance	N/S	0.06Ω 20Hz, 1kHz 0.16Ω 20kHz