Test of Sure Electronics amp

This is a bench review of the Sure Electronics IRS2092, purchased from Parts Express (P/N 320-313).

Note on the amplifier clock: The board as received from the factory was way off frequency. The left channel was measured at 329kHz, 3.3V p-p across the speaker. The right channel was 256kHz, 5.2Vpp across the speaker. I noted the output network was running very hot; the inductor was too hot to touch. The IR reference document says the amp was designed to operate at 400kHz for best performance. I adjusted the two pots on the board, which were flimsy and touchy. I set the L channel to 423kHz, and the R to 395kHz. The R channel clock then measured 2.0Vpp across the speaker, and the output inductor ran cooler.

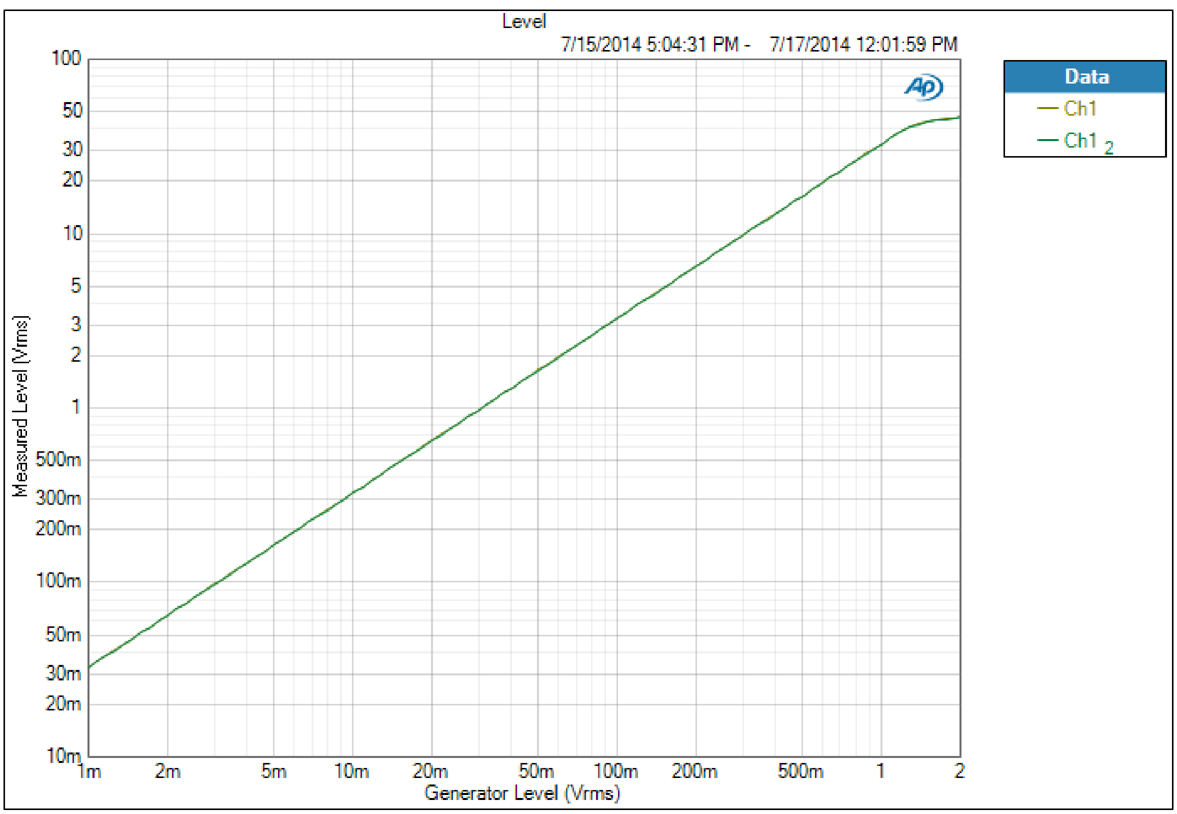
All of the following tests were made using an Audio Precision APX525 analyzer and a 100W resistor dummy load. The AP output was configured for analog unbalanced (RCA), 600Ω impedance. The AP input was set for analog balanced, 200kΩ impedance, AC-coupled, 90kHz bandwidth.

Measured gain (8Ω load)

L: 1kHz sine at 100mVrms input produced 3.423Vrms output (Gain = 30.2dB)

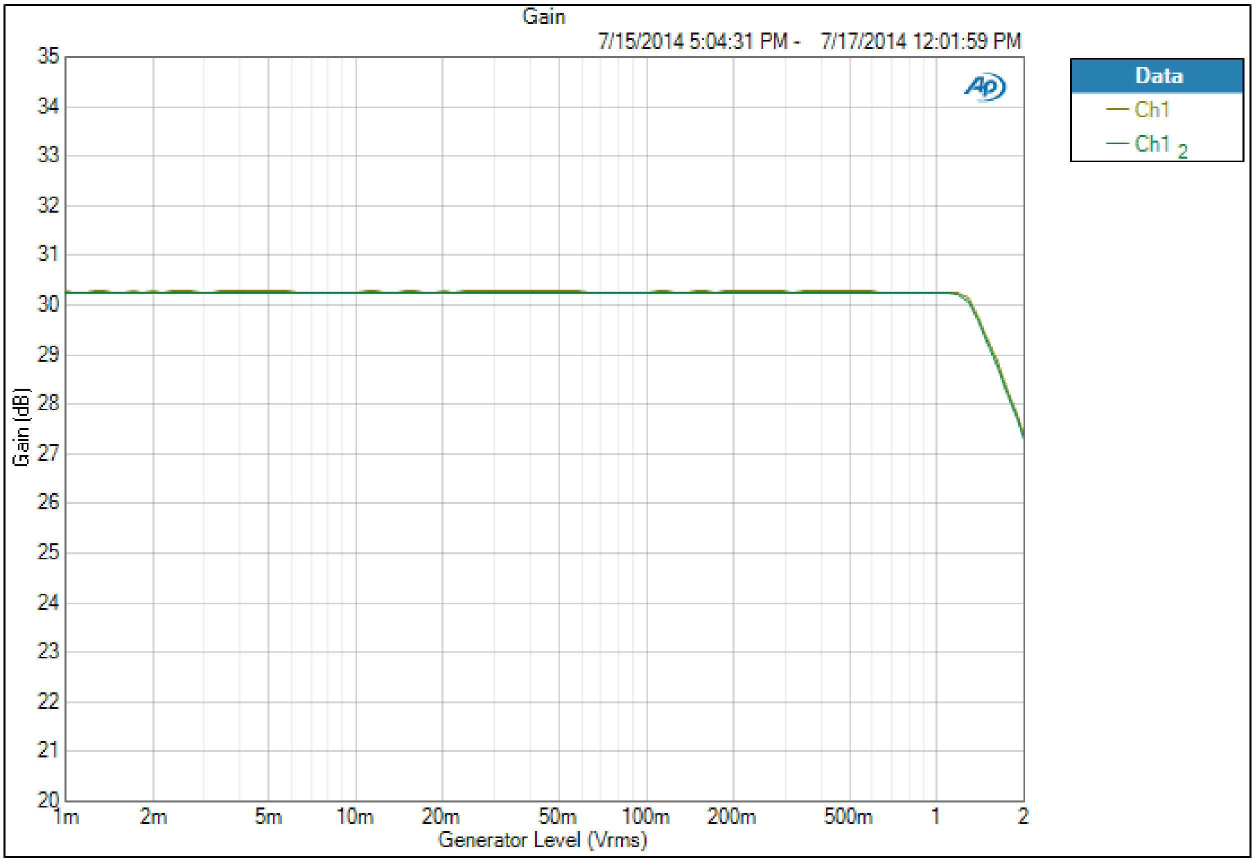
R: 1kHz sine at 100mVrms input produced 3.252Vrms output (Gain = 30.2dB)

Measure operating range by varying a 1kHz sine from 1mV to 2V rms into the amp, 8Ω load. This plot shows the L (Ch1) and R ($Ch1_2$) are practically identical:

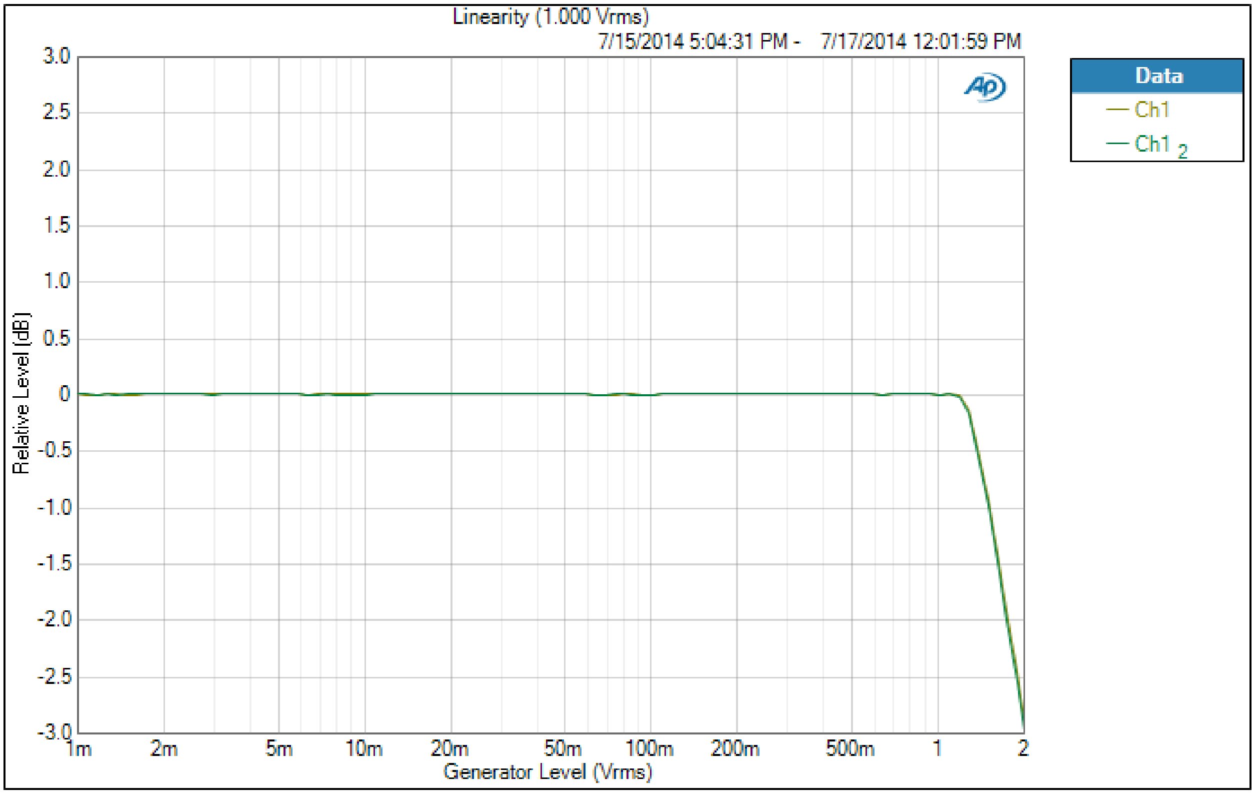


The amp gracefully goes into clipping as the input voltage goes too high. Note that 250W corresponds to $44.7V_{rms}$, and the amp achieves this into an 8Ω load.

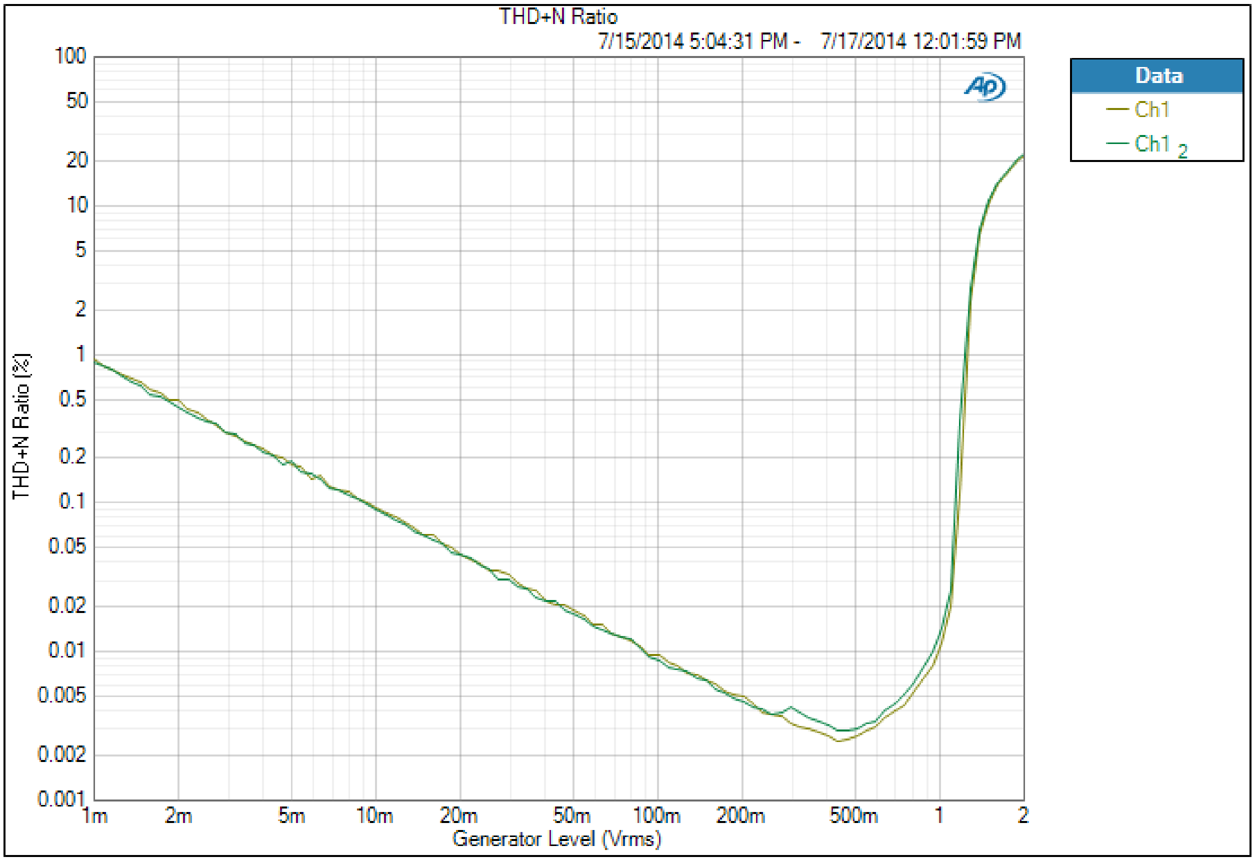
This figure is the gain versus input level. The amp is specified for 40dB gain in both the Sure Electronics and IR documentation. Unsure why my unit is about 10dB short, but I don't see this is a problem. The range of input levels is about right to match with the usual "line out" on most equipment.



This plot shows the same data as the previous one, but as deviation from the gain at 1.000Vrms input. It makes it easy to see the amp has a very linear gain function, and the two channels are practically identical.

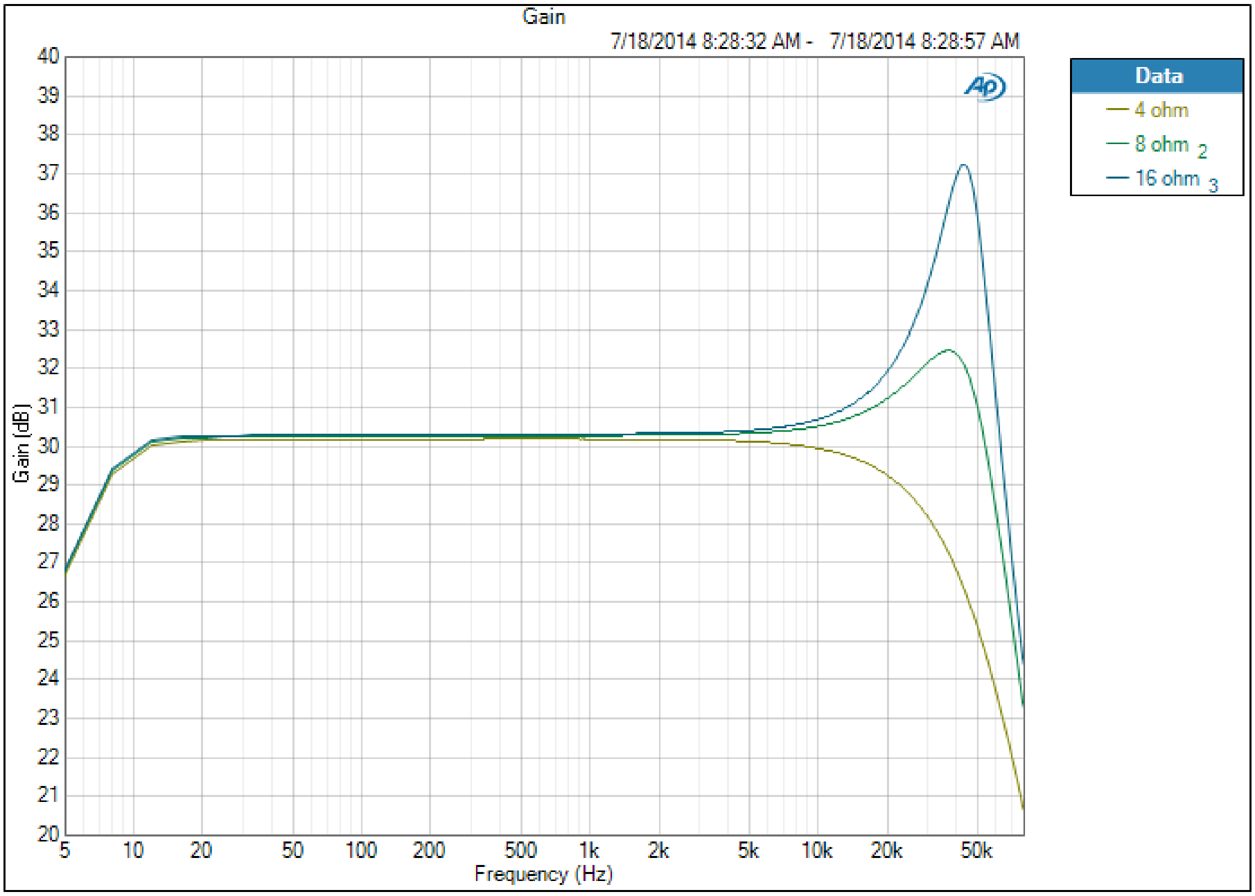


Next the THD+N ratio was measured using a 1kHz sine, increased in amplitude from 1mV to 2V rms. THD+N is A-weighted. The point of lowest distortion was for a 450mVrms input level.

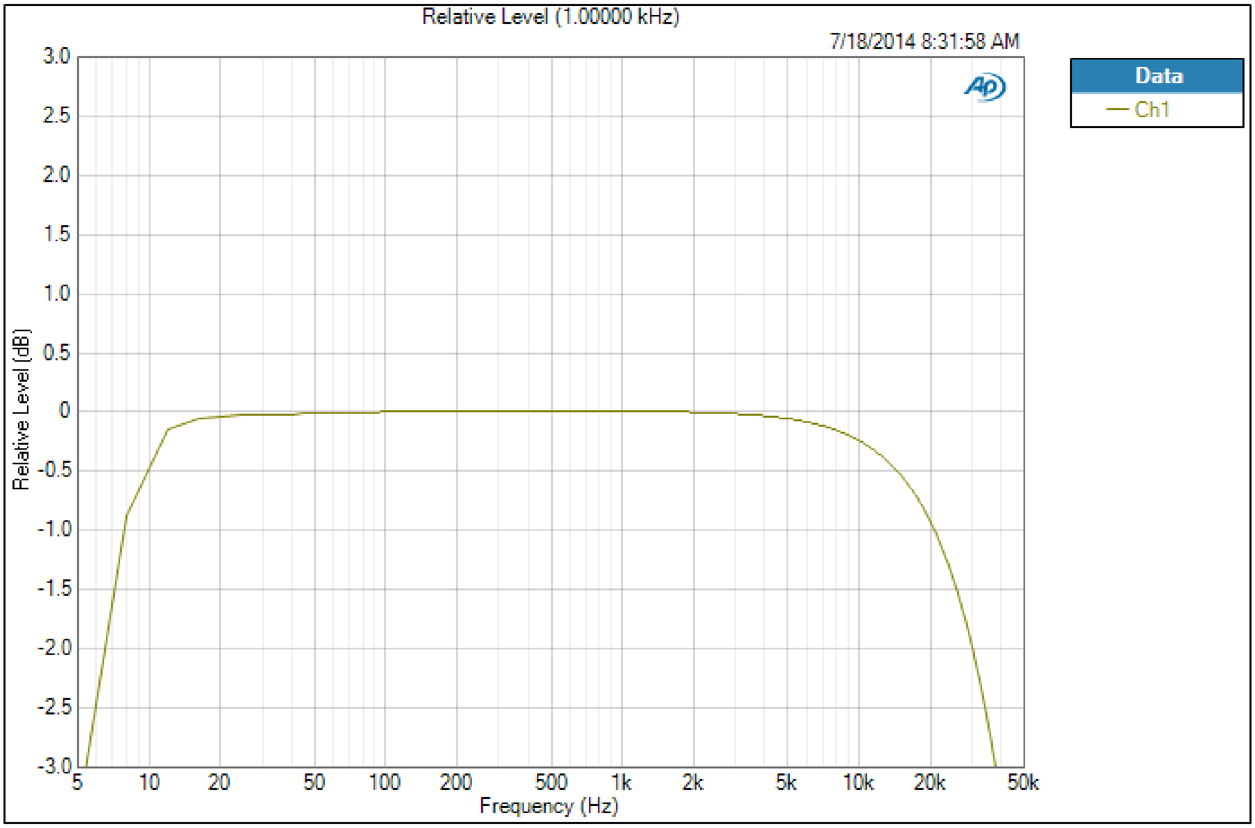


Most of the following tests were performed at $450mV_{rms}$ input. This produces $14.85V_{rms}$ into 8W, or about 27.5W.

This is a plot of frequency response to a sine at 450mVrms. The measurement was done for 4Ω, 8Ω, and 16Ω load resistors. Only L channel shown for clarity; the R channel was almost identical.

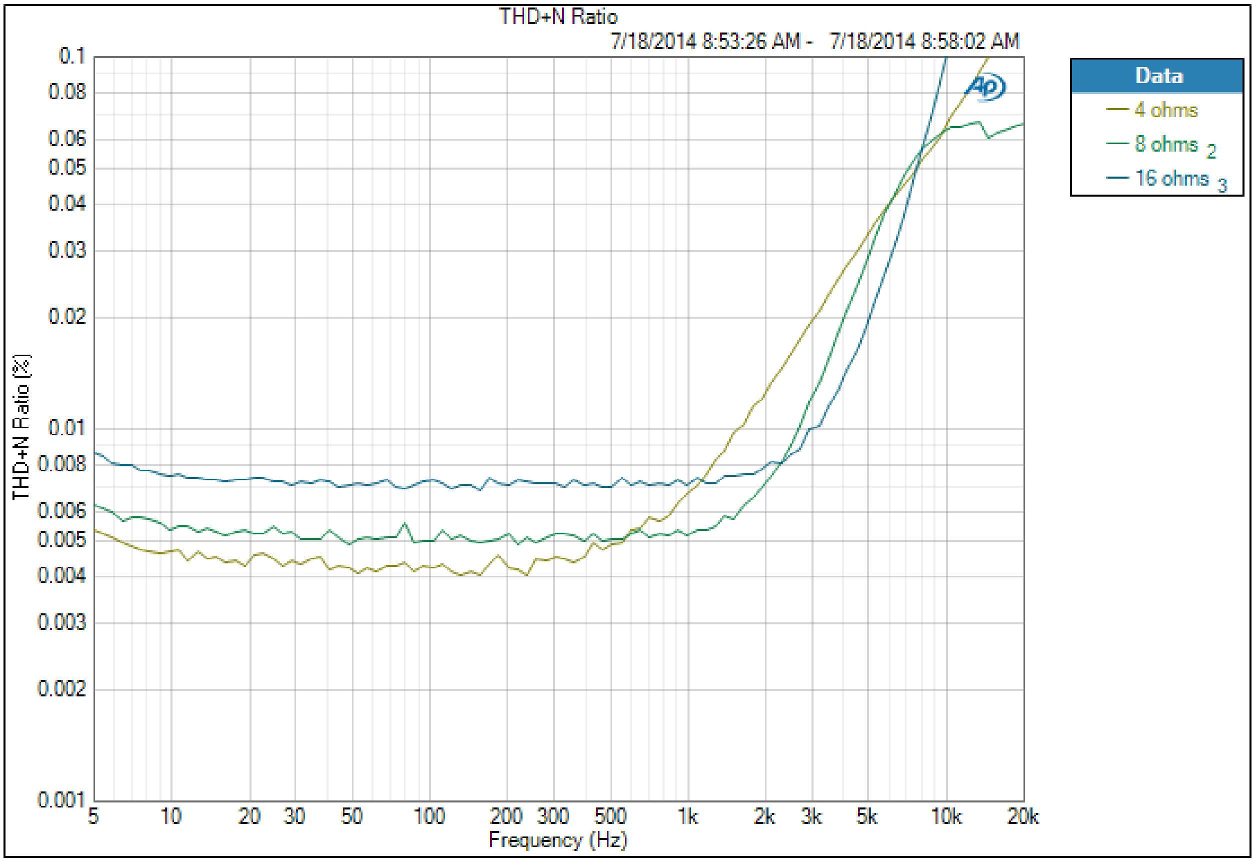


This is the same data, but close-up to make the -3dB points easier to read. This is the left channel into 4Ω; right channel identical.

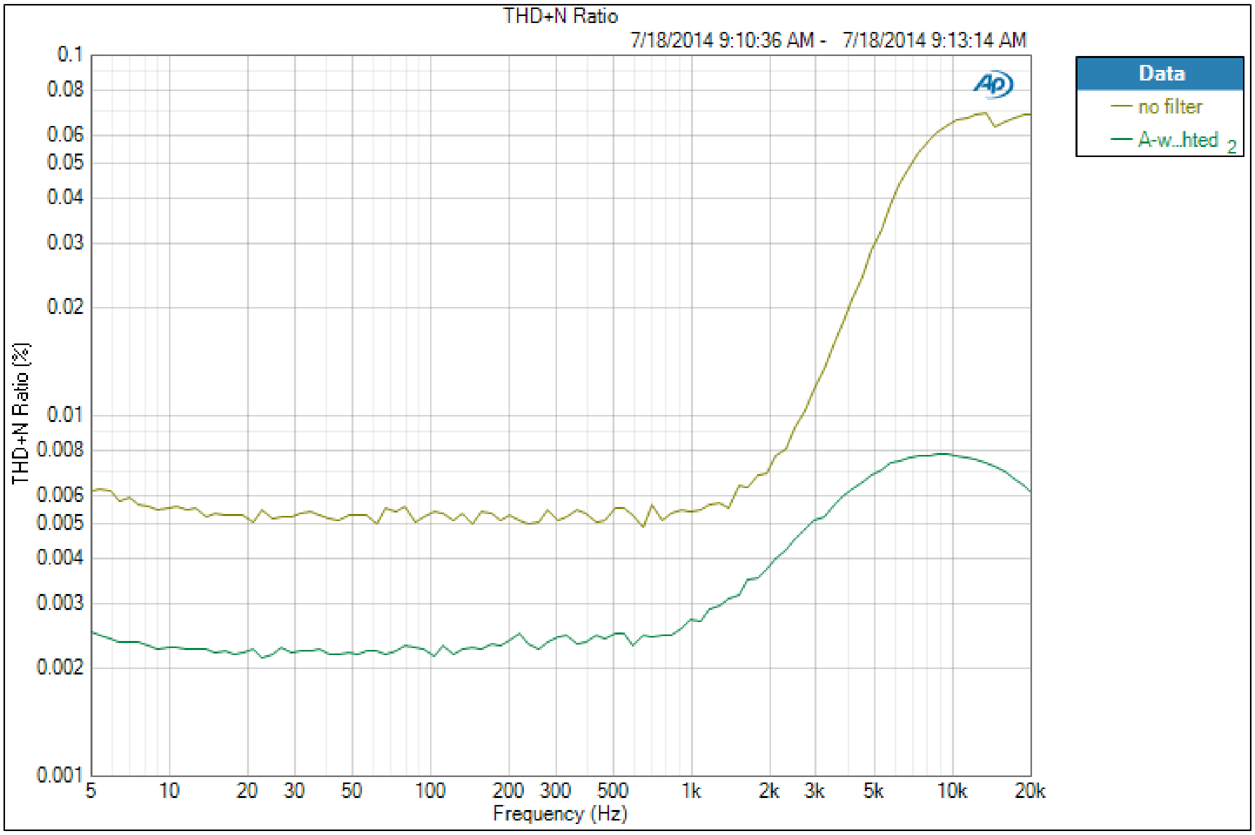


The IR document specified frequency response as 20Hz – 20kHz, +/-3dB, tested at 1W into 4Ω – 8Ω load. The Sure Electronics easily meets this spec. The low frequency roll-off is only 3dB down at 5.5Hz, making this well-suited for driving subwoofers.

This plot is a measurement of unfiltered/unweighted THD+N Ratio for 450mV$_{rms}$ input level at each of three loads (Left channel shown; right channel identical):



Out of curiosity, I made a plot of THD+N into 8Ω, 450mVrms input, with and without the A-weighted filter to compare the different results.



The IR reference design document specifies 0.05% THD+N @ 60W, 4Ω load. Under these conditions (15.49Vrms measured across 4 ohm load), I got 0.0065% A-weighted. Nice!

Here's a series of measurements made using 1kHz sine

power	load	gain	THD+N (A-wtd.)
1W (2.00V rms)	4Ω	30.155 dB	0.014 %
	8Ω	30.245 dB	0.015 %
10W (6.324Vrms)	4Ω	30.16 dB	0.0047 %
	8Ω	30.25 dB	0.0047 %
60W (15.492Vrms)	4Ω	30.16 dB	0.0063 %
100W (20.0V rms)	4Ω	30.15 dB	0.0089 %
200W (28.28V rms)	4Ω	Did not measure*	

*APX out of range

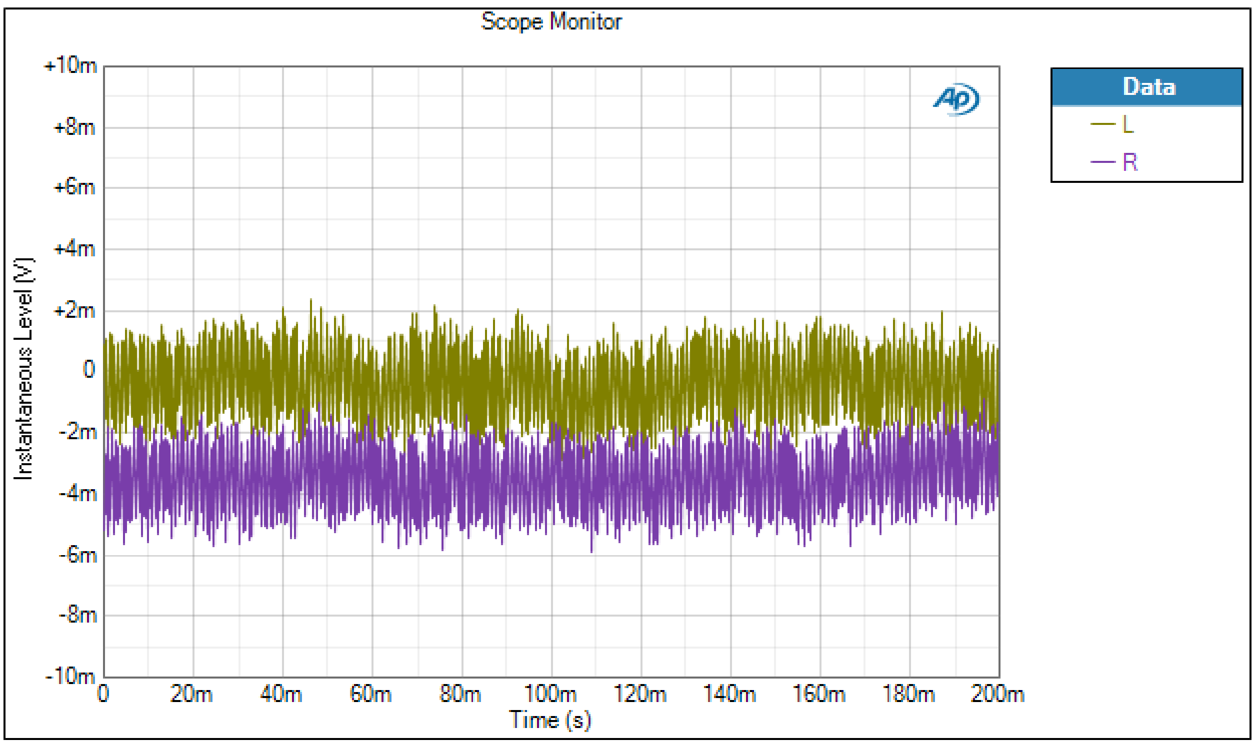
Following are efforts to measure noise.

The AP Signal to Noise Ratio measurement was made, using a 1kHz sine at 450mV$_{rms}$ to the input, and the amp connected to an 8Ω load, left channel only. (The test was repeated on the right channel only and was within 0.5dB.)

conditions	SNR
No filtering or weighting	86.1 dB
20Hz highpass filter	86.5 dB
20Hz highpass filter and 20kHz lowpass filter	90.7 dB
A-weighted filter only	93.3 dB
A-weighted filter and 1000Hz lowpass filter	100.2 dB

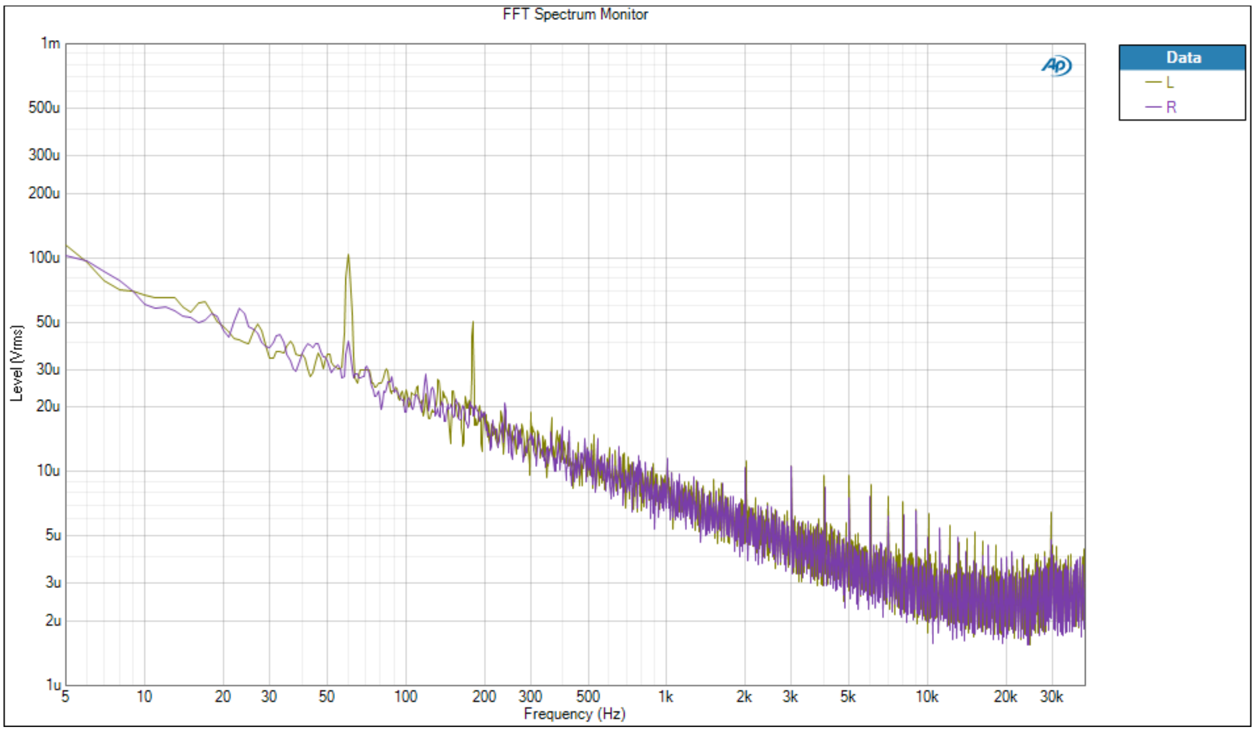
The last measurement was made with the intention of using this amp to drive subwoofers.

This is a plot of A-weighted residual noise and DC with the input terminated in 600Ω and the output connected to the 8Ω load. The right channel carries a slight DC component of roughly 3.5mV, which is negligible.

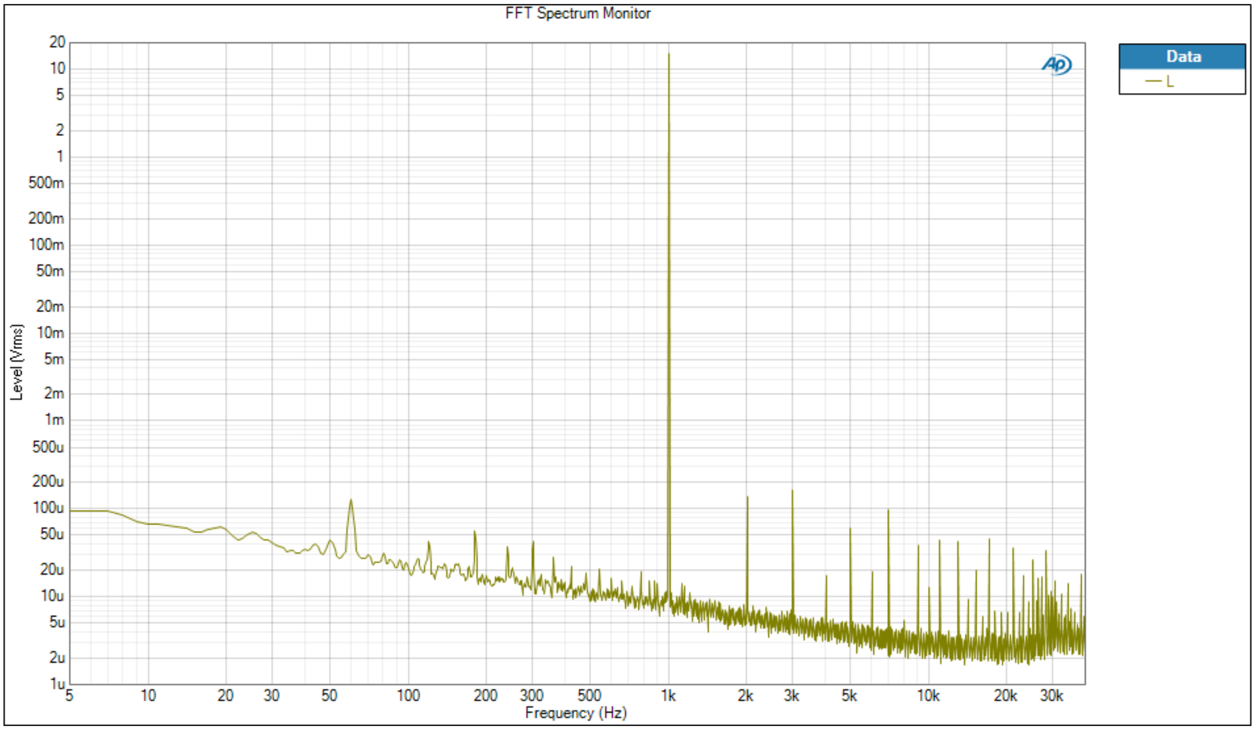


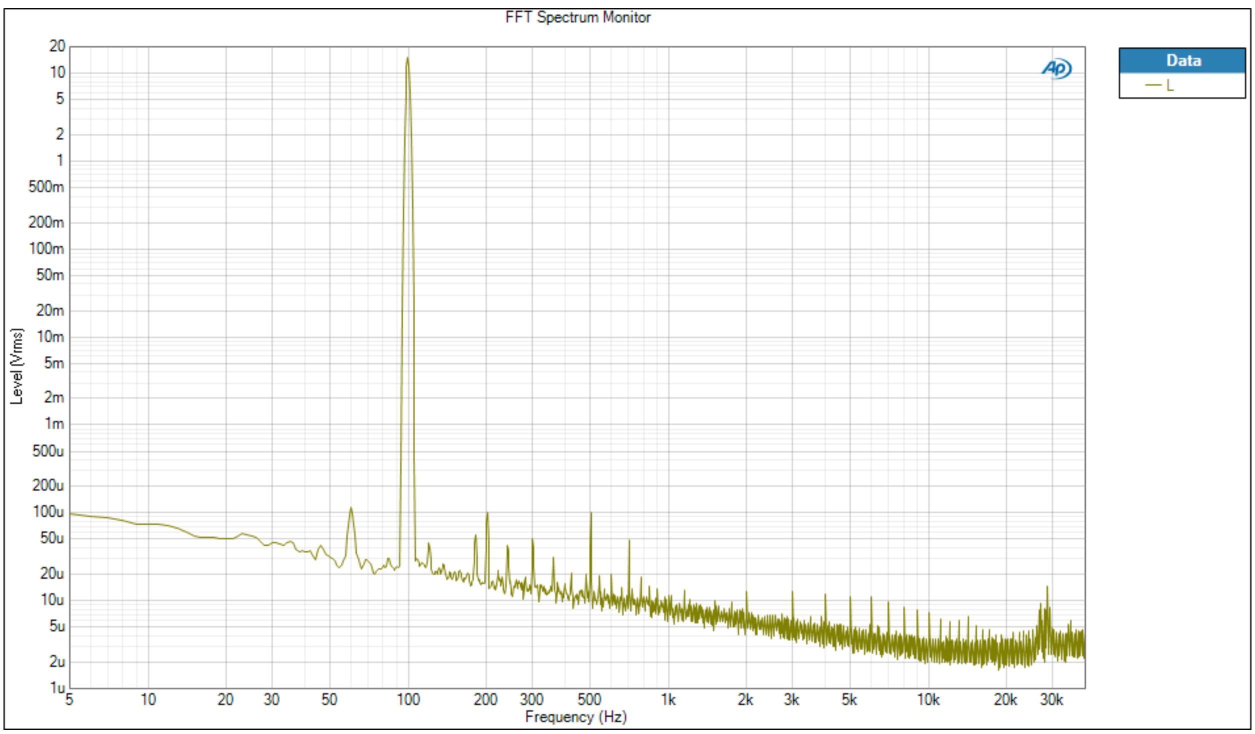
Under the same conditions, I ran an FFT and produced the following plot. The FFT was made with a sample rate of 2MHz, it has 192k points, an Equiripple window, and 10 averages. The periodic 1kHz family of tones is believed to be from the test signal generator itself.

The 60Hz (and 180Hz harmonic) AC line spike is about what was expected and is inaudible. The IR documentation says the PSRR is better than 50dB from 20Hz to 5kHz. The measured ripple on the power bus (with amp input disconnected, but output connected to loudspeaker) was 5.5mVrms on the +rail, and 7.5mVrms on the – rail. From the plot, the measured attenuation is at least 37dB. It's possible due to the relatively close proximity of the power supply components to the amp board that some of the 60Hz is simply coupled magnetically to the input circuit.

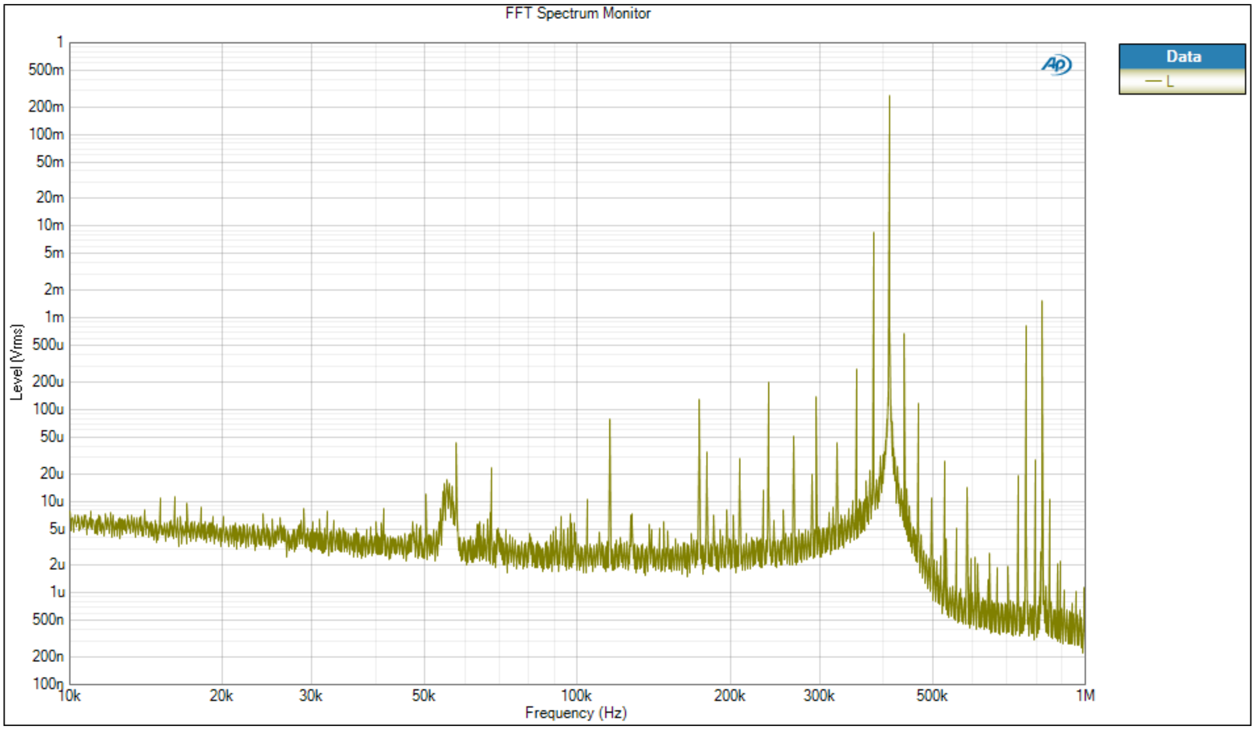


The next two plots are the same conditions but with a 1kHz sine, 450mV_{rms}, in the first plot, and a 100Hz sine in the second plot (R channel hidden for clarity; it's almost identical). These show roughly 100dB of dynamic range, which is excellent performance.

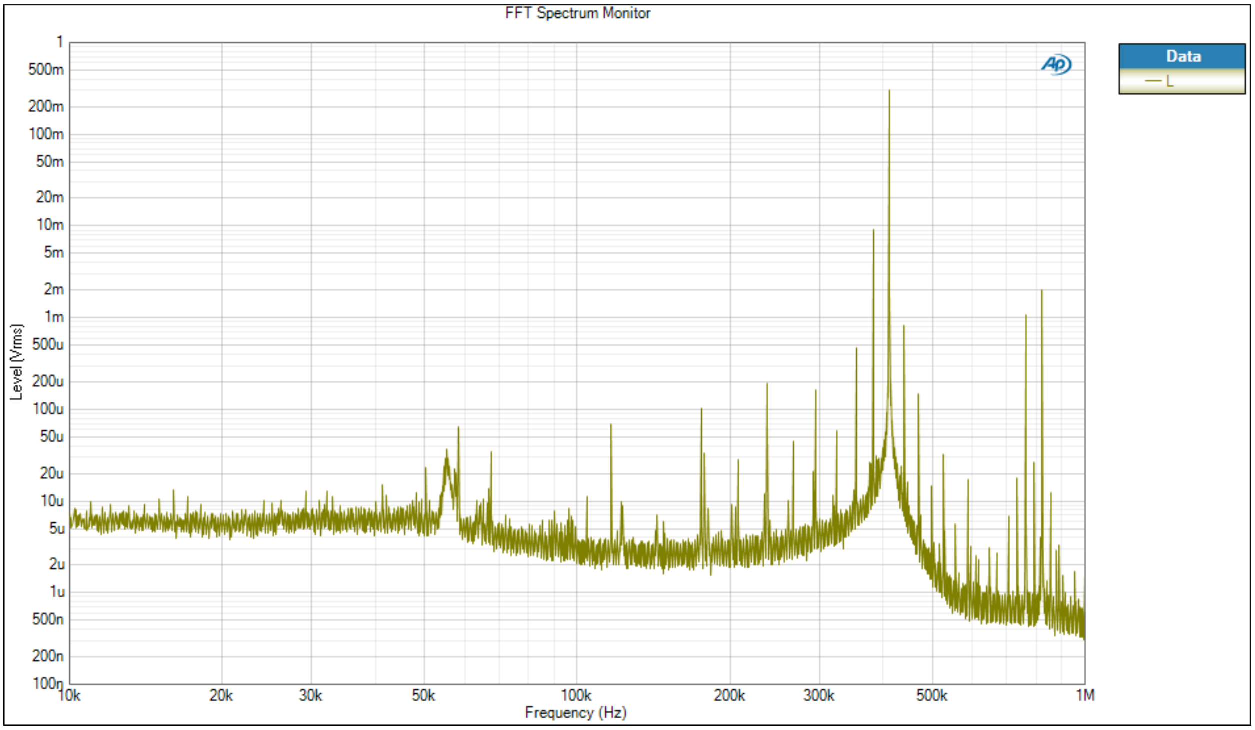




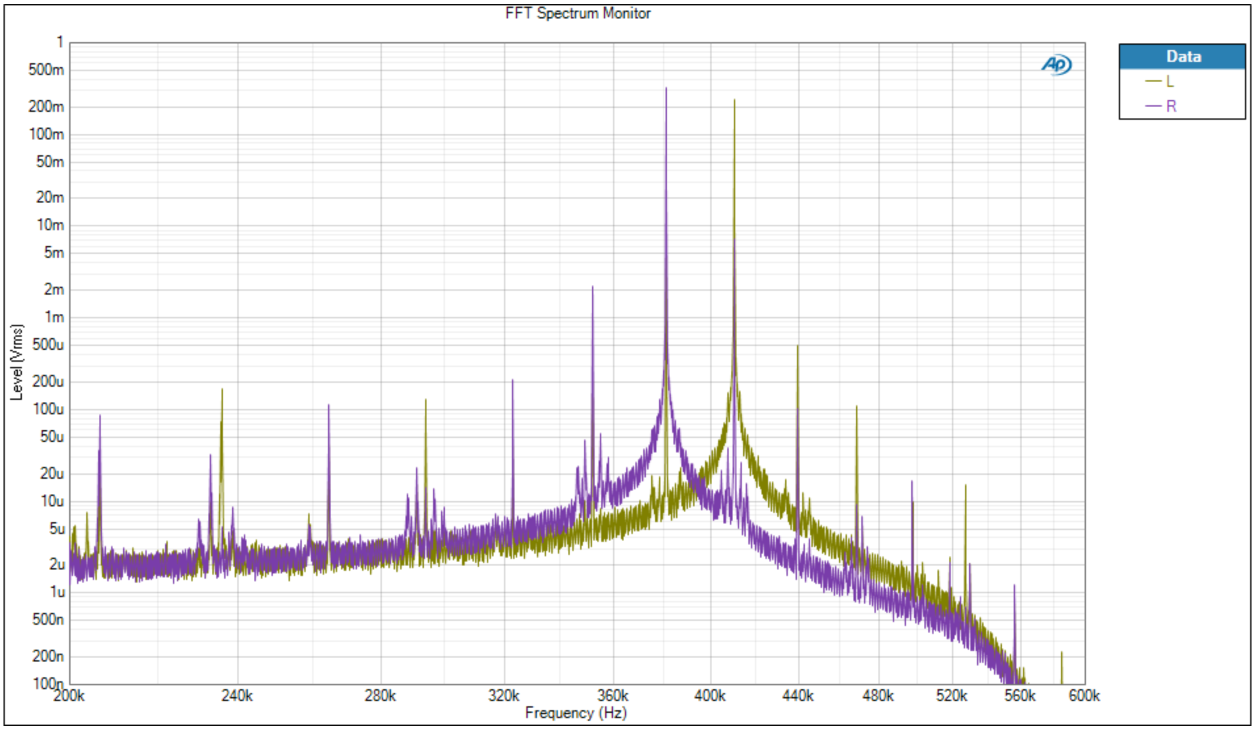
In the interest of seeing what the PWM oscillator was doing, an FFT was made up to 1MHz. Here, the sample rate was 2MHz, the FFT was 512k points using an Equiripple window. The amp was connected with the input terminated in 600Ω and the output into 4Ω. Left channel:



Repeating the test into an 8Ω load only made subtle differences:



Here is a plot of both channels into 8Ω loads (381 and 410kHz). Curiously, the amp design uses two separate PWM clock oscillators instead of a single one feeding both channels. The IR design document states the clocks should be adjusted to 400kHz (+/- 25kHz) for best performance. It says they should be matched accurately, or separated by at least 25kHz (to avoid beats falling within the audible range).



Crosstalk (450mV rms input signal):

Test frequency	L channel	R channel
10Hz	-87.3 dB	-87.4 dB
100Hz	-88.4 dB	-87.9 dB
1000Hz	-85.6 dB	-82.9 dB
10kHz	-72.5 dB	-65.6 dB

Damping factor was measured using the resistive load, 1W output:

Test frequency	Damping Factor, 4Ω	Damping Factor, 8Ω
10 Hz	142	213
100 Hz	152	228
1000 Hz	181	303

The IR documentation said the damping factor at 1kHz, 4W load, is 170, so the amp measures slightly better than claimed. This ought to be very good performance for a subwoofer. For audiophile work one might want higher numbers >500 but it takes short, heavy speaker cables and direct connection to a speaker for this to matter.

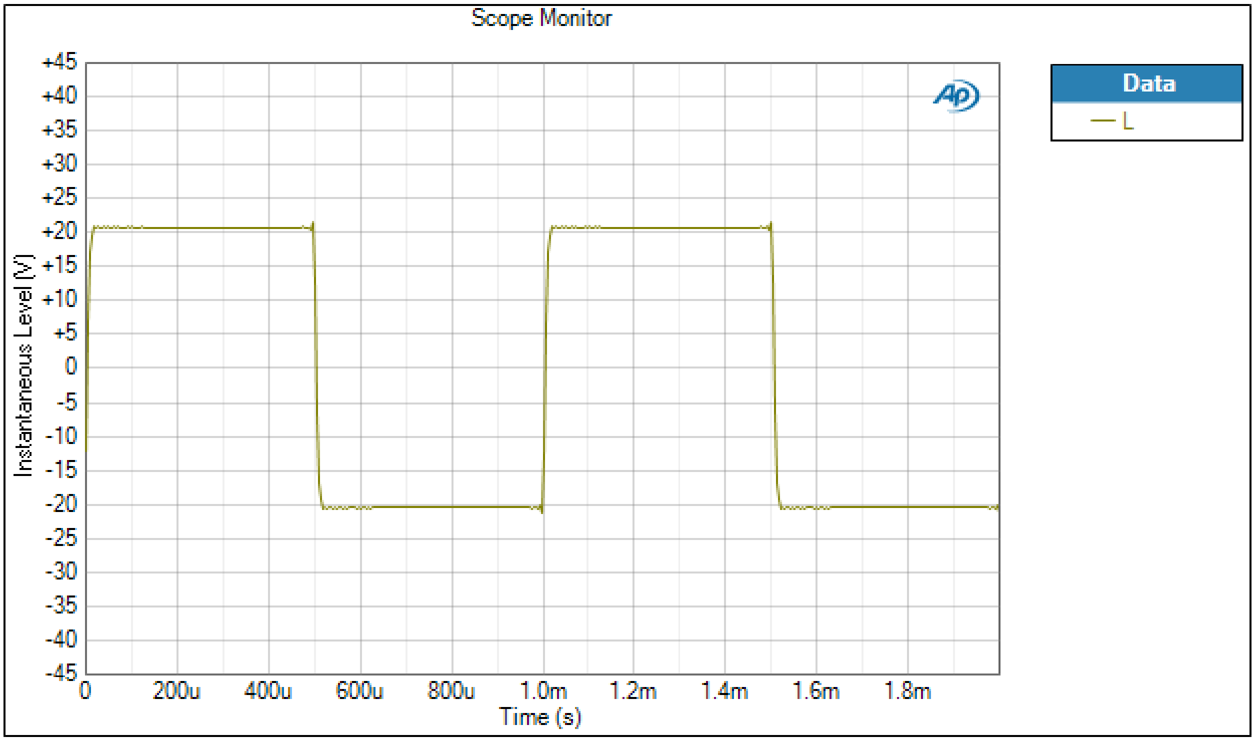
Interchannel phase was measured. For this test, Channel 2 (R) was used as the reference; the table shows the phase on Channel 1 (L).

frequency	Load	phase
10000	4 ohm	-10.21 deg
	8 ohm	+0.163 deg
	16 ohm	+5.616 deg
1000	4 ohm	-1.077 deg
	8 ohm	+0.023 deg
	16 ohm	+0.562 deg
100	4 ohm	-0.085 deg
	8 ohm	+0.026 deg
	16 ohm	+0.081 deg.

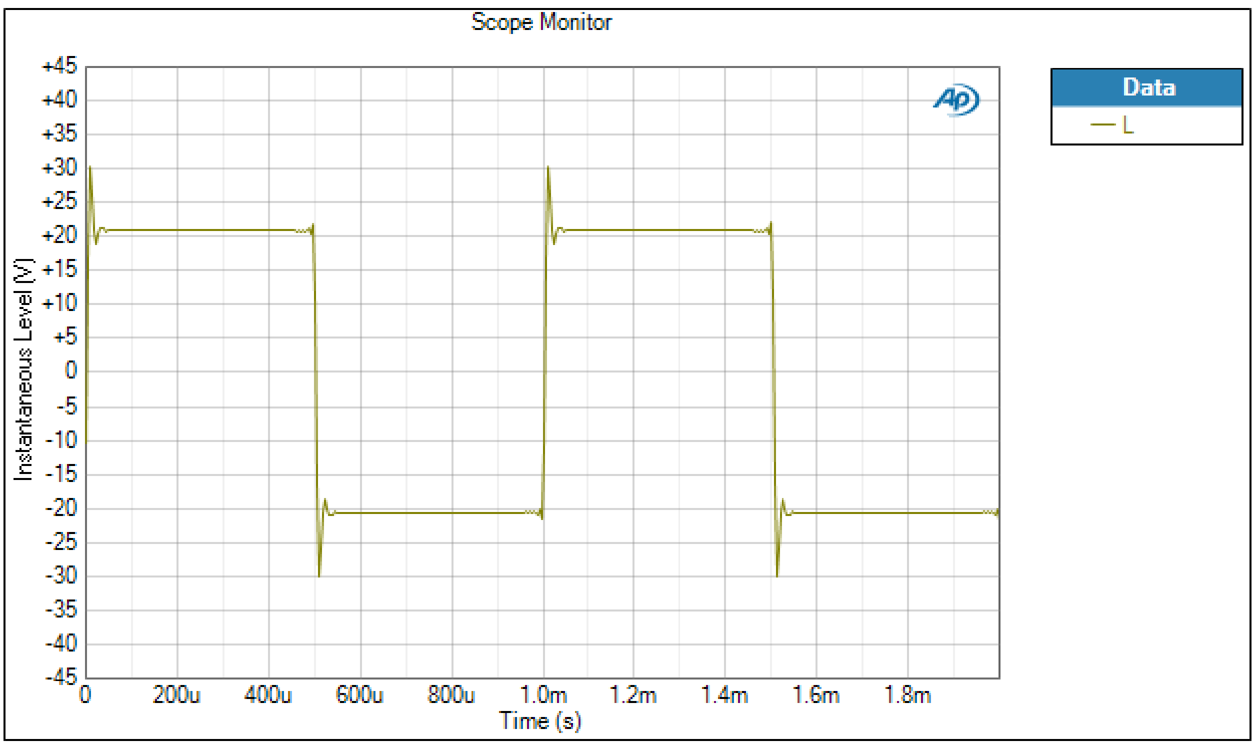
10Hz was within 0.1 deg. For all loads

Following are several plots of the amp's response to a square wave at 450mV_{rms}.

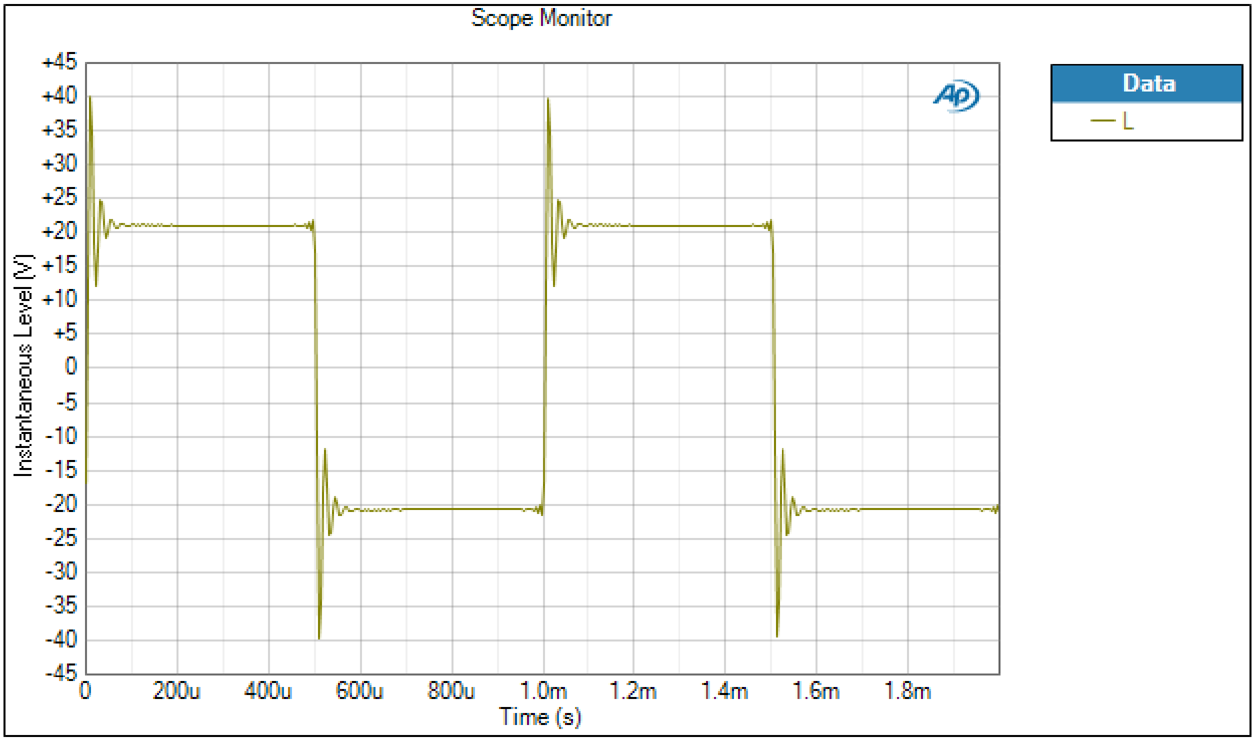
1kHz, 4Ω load:



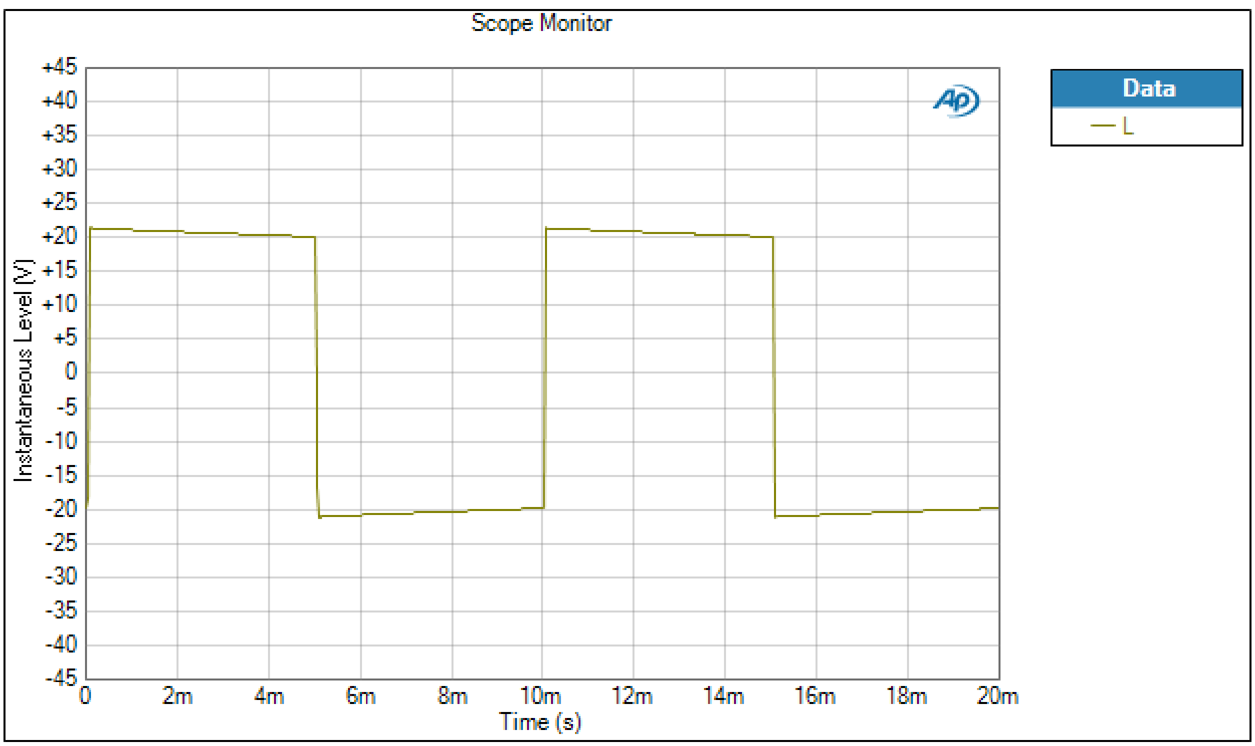
1kHz, 8Ω load:



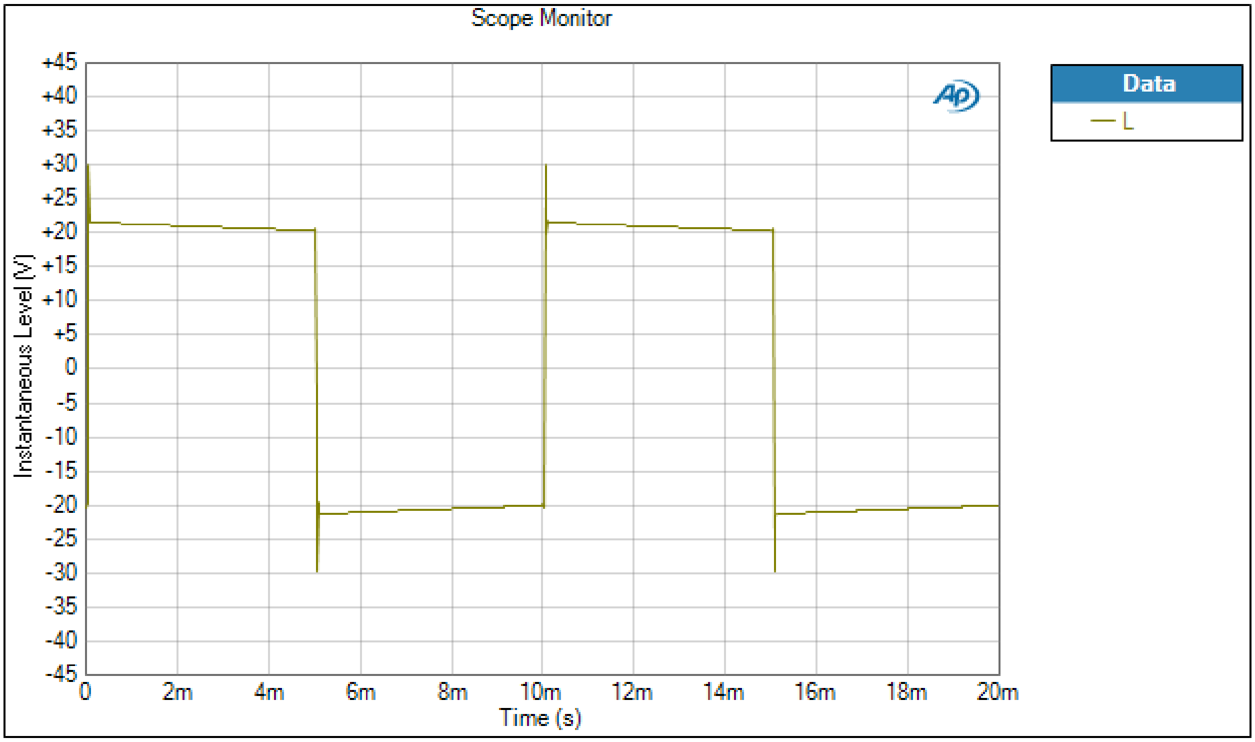
1kHz, 16Ω load:



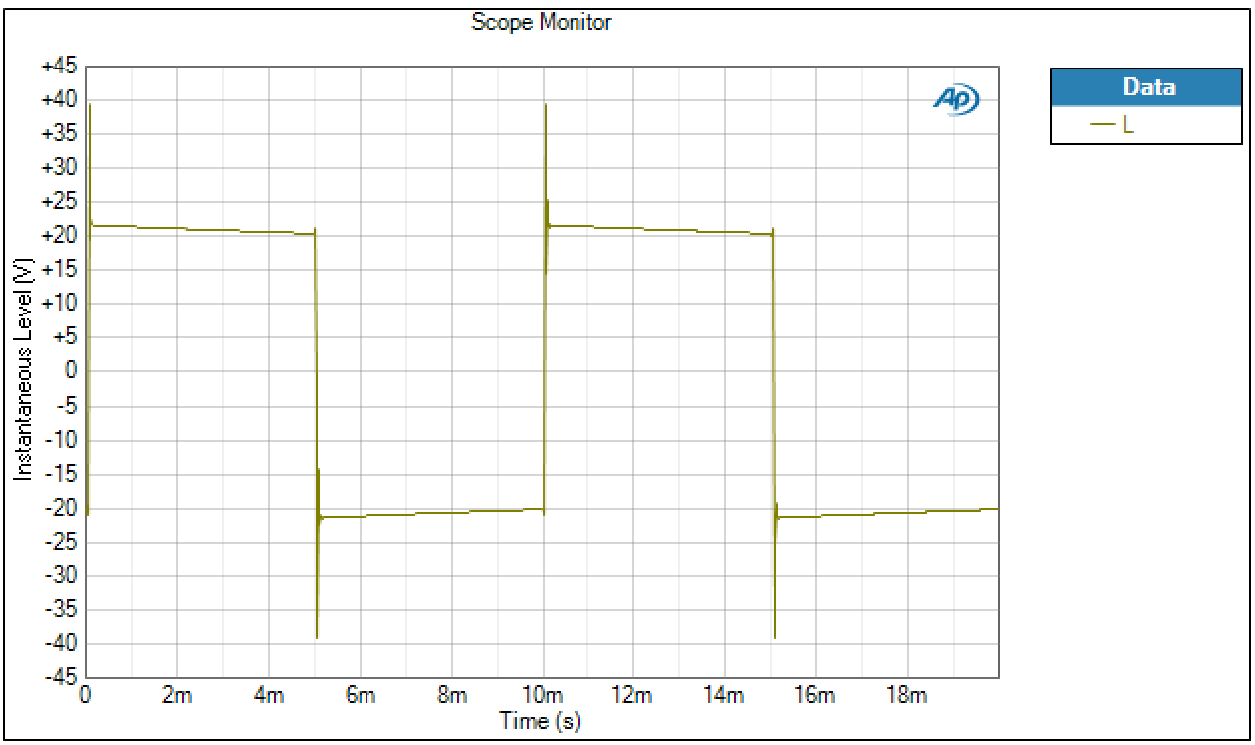
100Hz, 4Ω load:



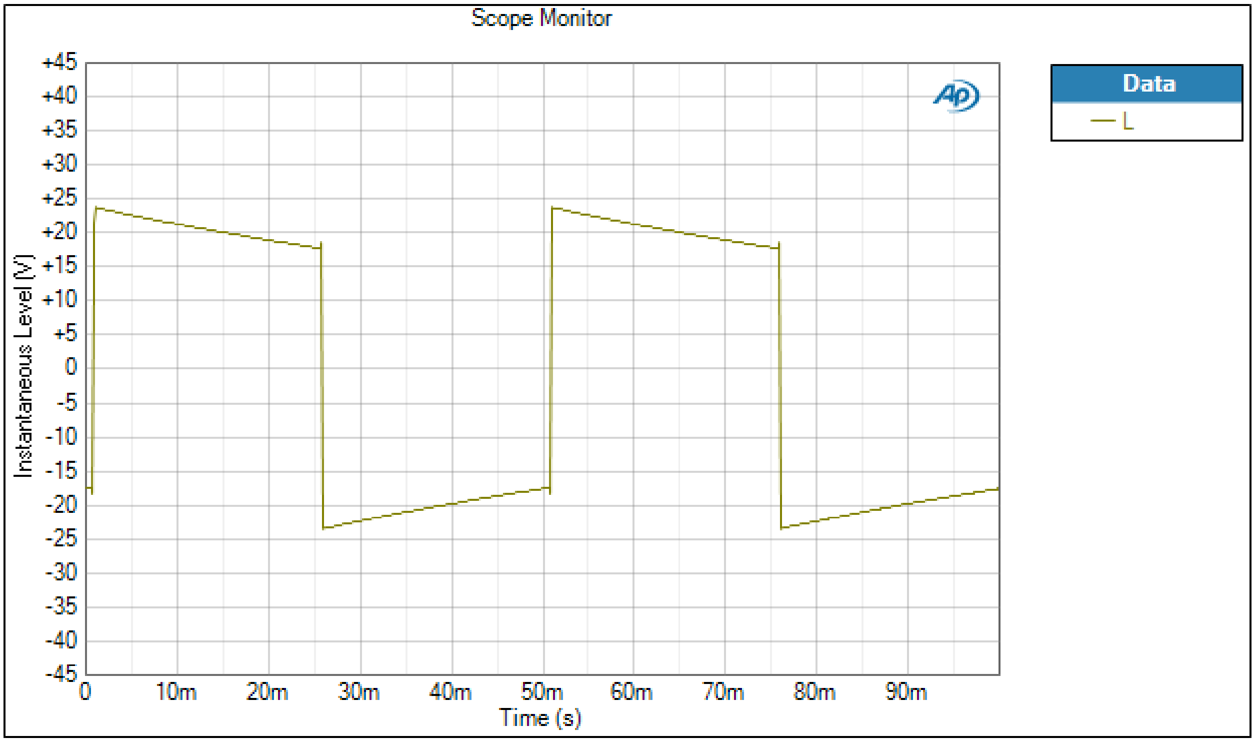
100Hz, 8Ω load:



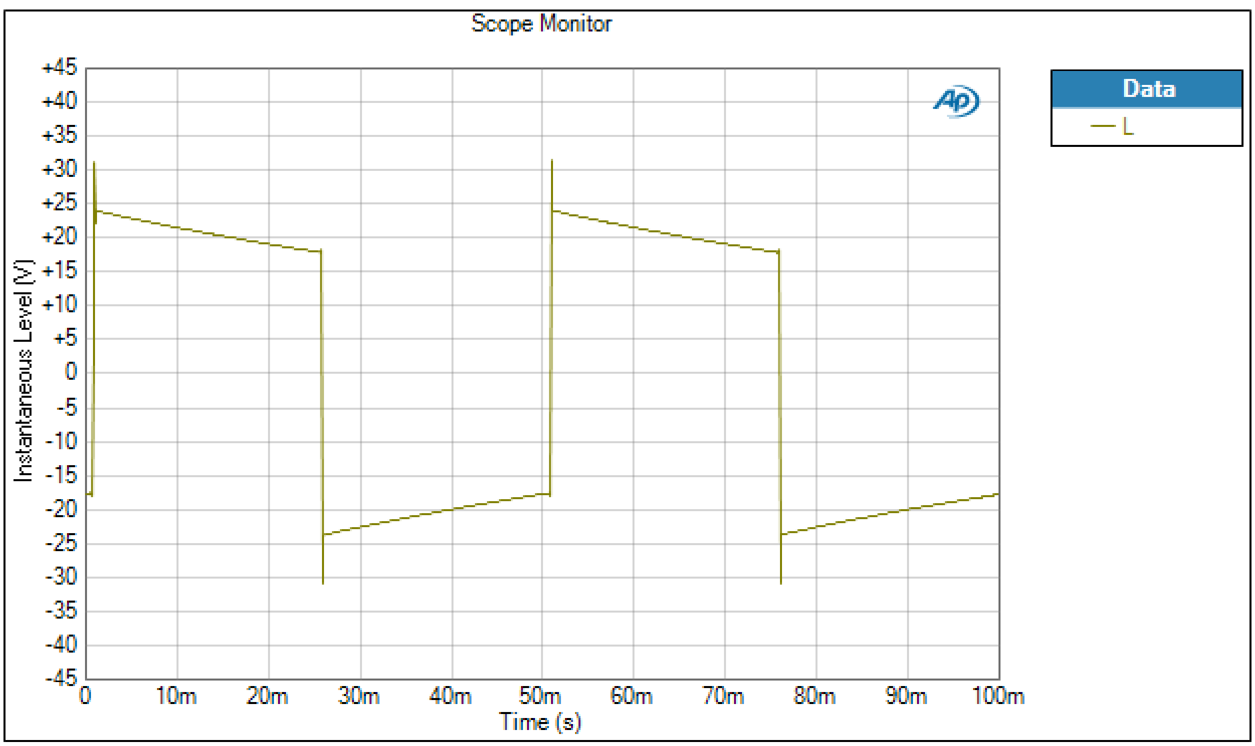
100Hz, 16Ω load:



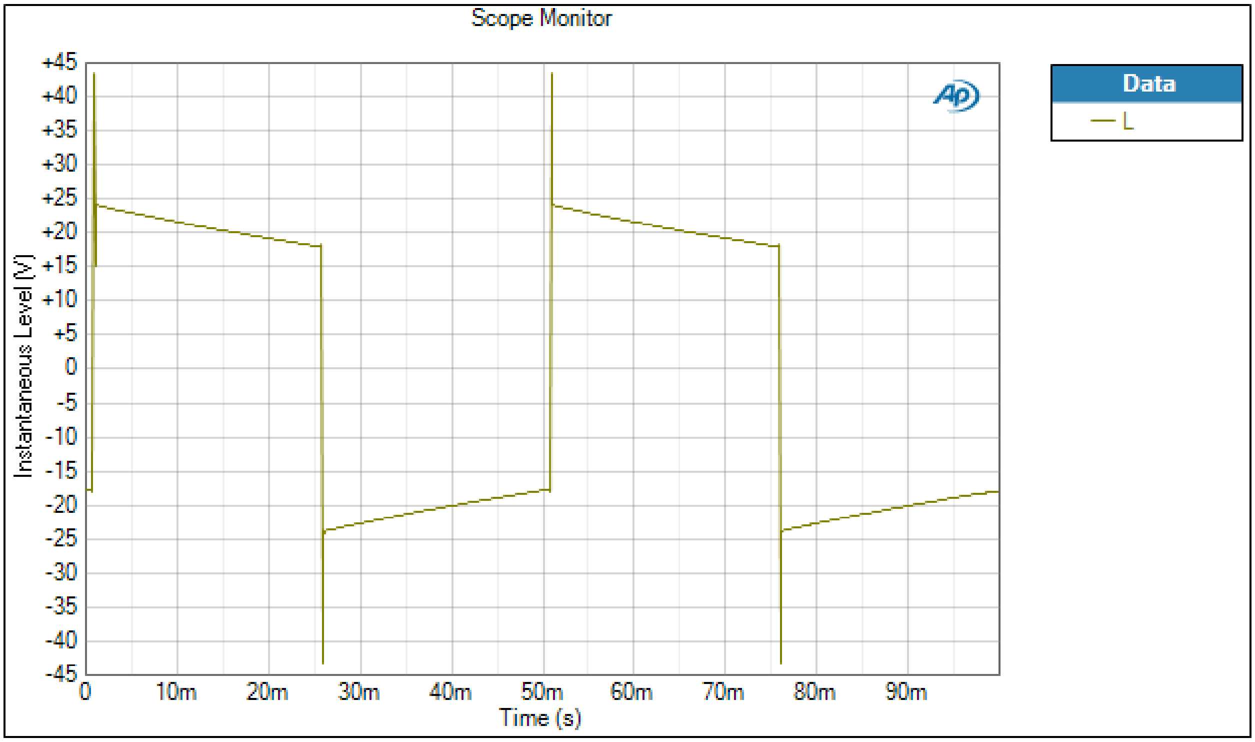
20Hz, 4Ω load:



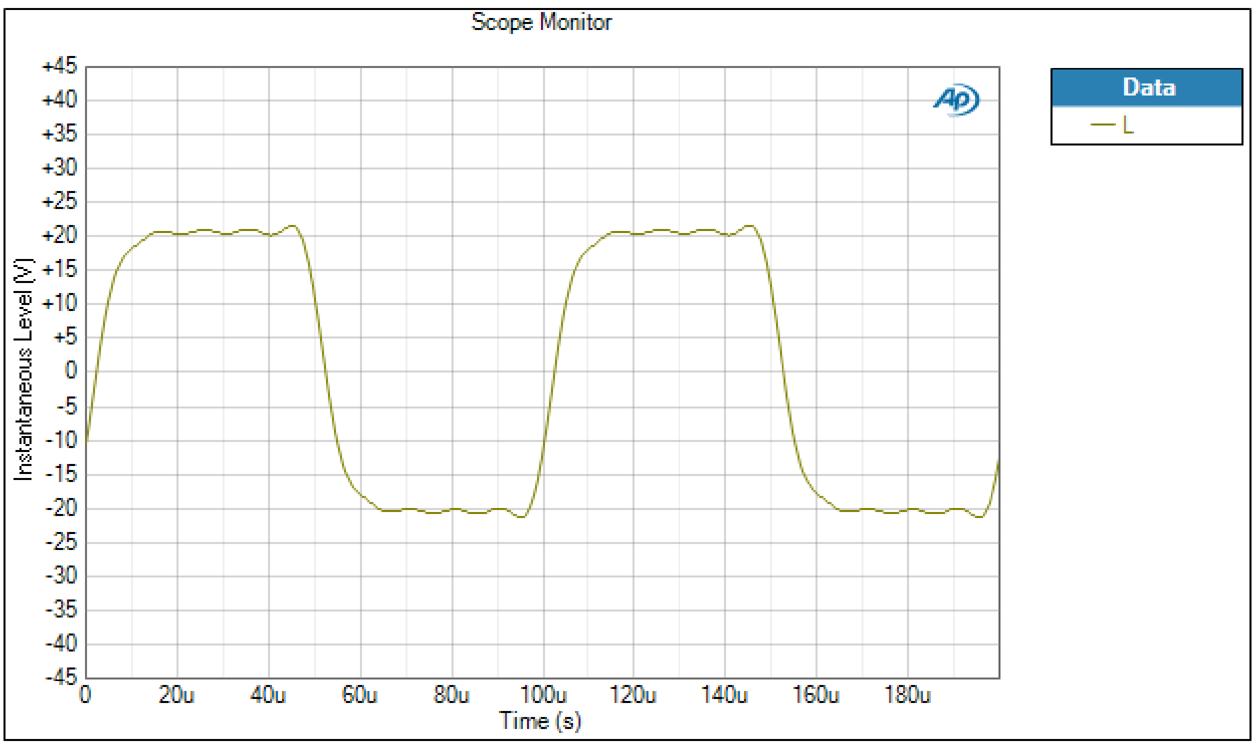
20Hz, 8Ω load:



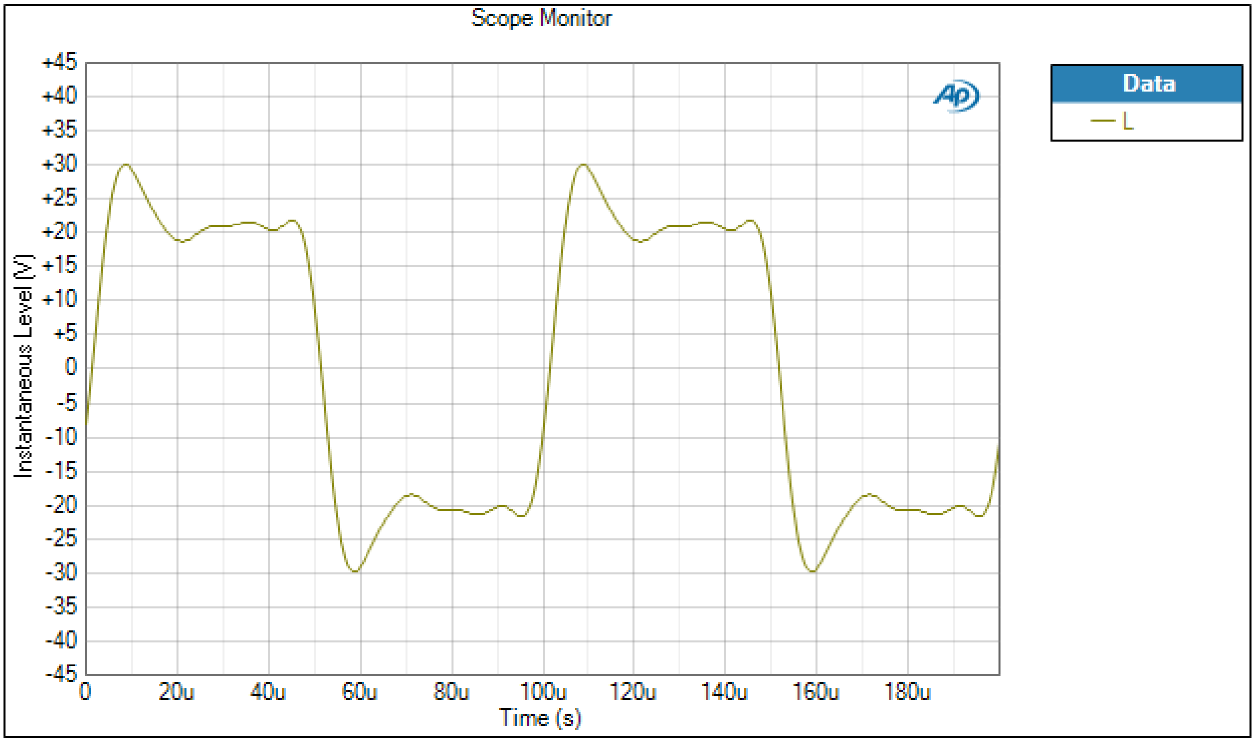
20Hz, 16Ω load:



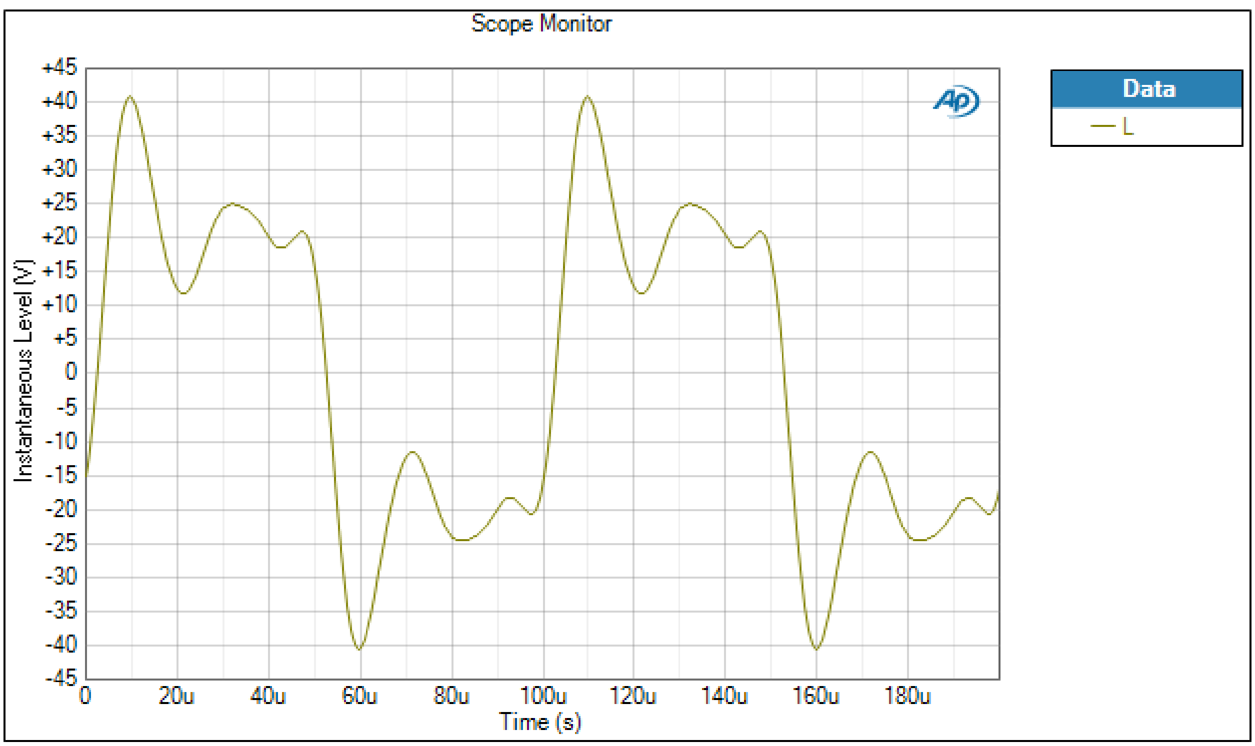
10kHz, 4Ω load:



10kHz, 8Ω load:



10kHz, 16Ω load:

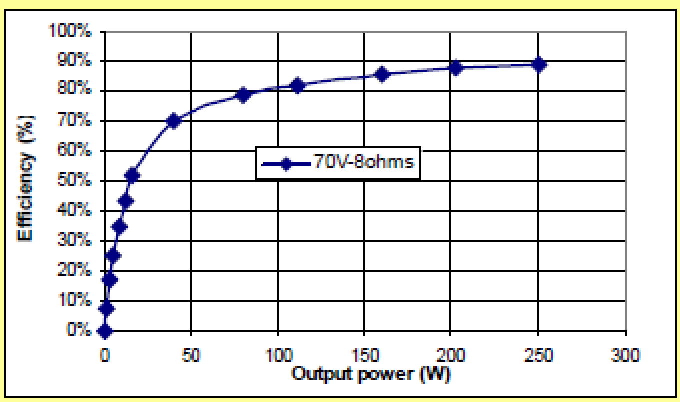


<u>Conclusion</u>

This amp met all published specs, except for overall gain, which was unimportant.

The main concern for long term use is the output inductor, which runs very hot to the touch, especially when the amp sits idle (i.e. nothing on the input). I think this will probably cause failure of the adjacent filter cap, since they are almost physically touching and will keep the cap at a constant, elevated temperature. The entire output load passes through this little inductor. The datasheet for this part rates it at 13.5A, which is fine but either it should be heatsinked or have a small blower fan for long life.

Everything about this amp suggests it would be excellent for driving a subwoofer. I might hesitate to use this amp for critical, audiophile listening in the rest of the audio band. Reasons include the potential of the switching frequency intermod'ing with program content, concerns about the "zobel" network on the output, and the under-damped performance above 1kHz. The reference design includes extensive, integrated protection against shorts, over-driving, and power supply over and under voltage. (These features were not tested.) And of course the high efficiency is very helpful when driving a large sub at 100W or higher levels. (The following plot of efficiency is from the reference design document.)



±B supply = ±70V

Fig 19 Efficiency versus Output Power, IRAUDAMP7D-200, 8 Ω, Stereo

July 20, 2014

Tim McVey