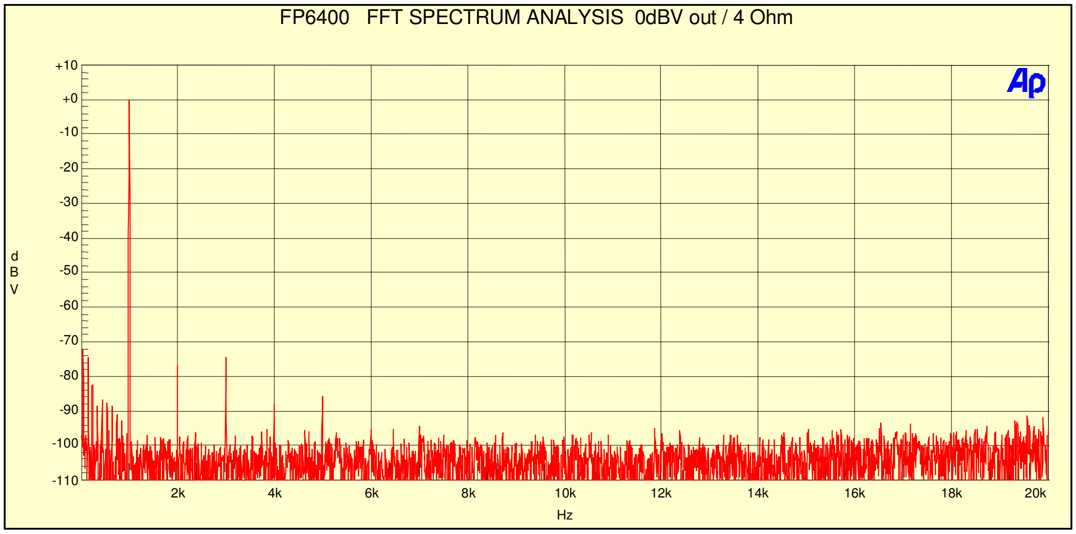
Bench Test Comparison

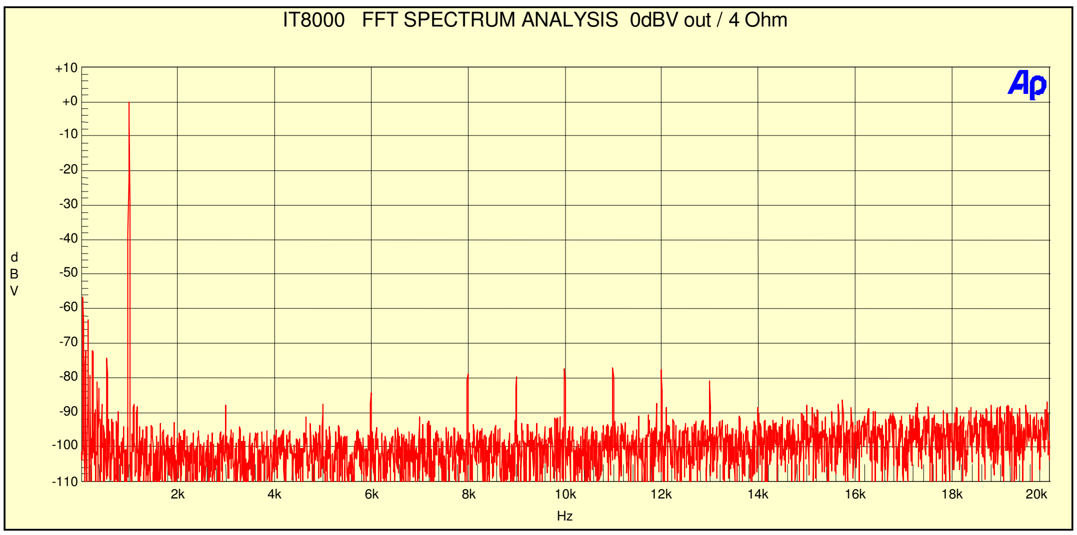
Lab Gruppen fP6400

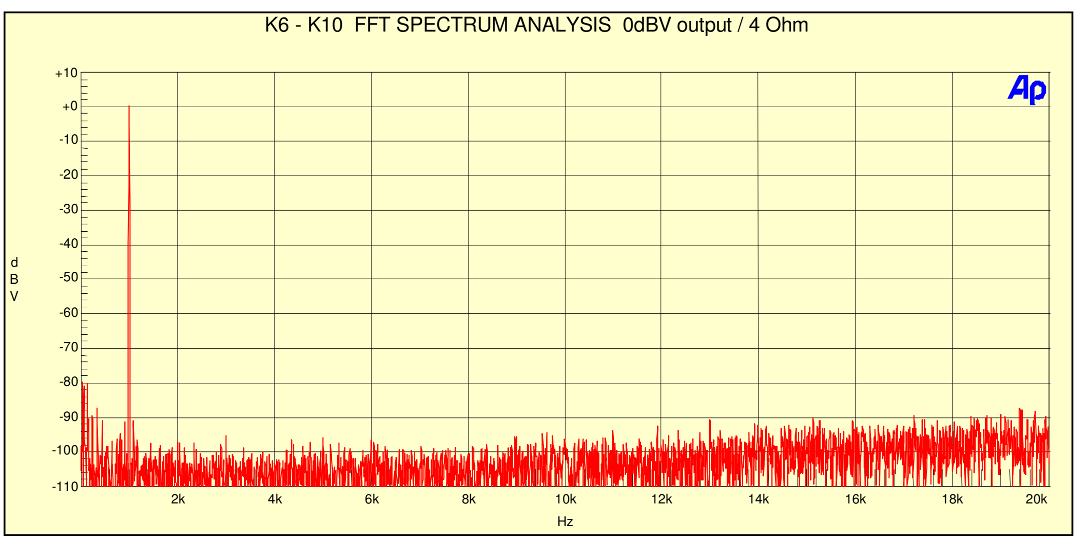
Crown I-T8000

Powersoft DIGAM K6 - K10

FFT Analysis







FFT Analysis

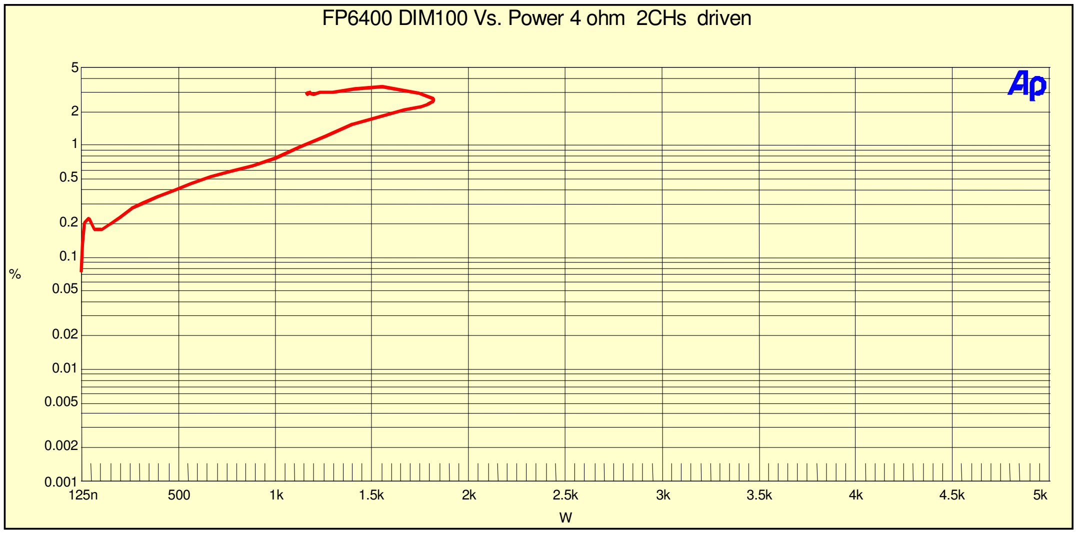
Definition: **The Fast Fourier Transform** converts a time domain representation of a signal into a frequency domain representation. However, a digitizer samples the waveform and transforms it into discrete values. The **Fast Fourier Transform (FFT)** is an optimized implementation of this principle.

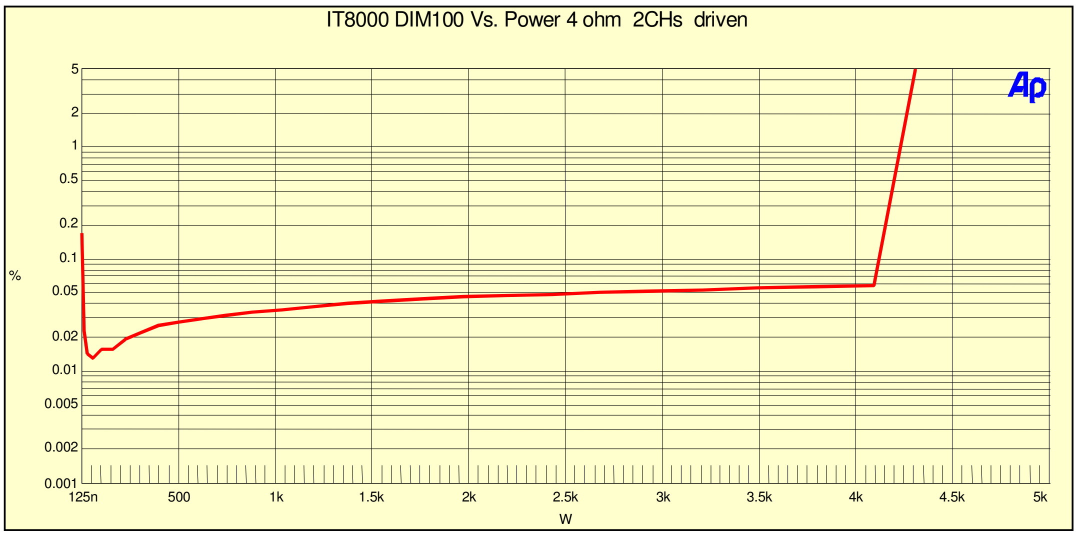
Shown here are the noise floor measurements across the audio frequency range measured in dBV (using a 4-ohm load on the amplifiers).

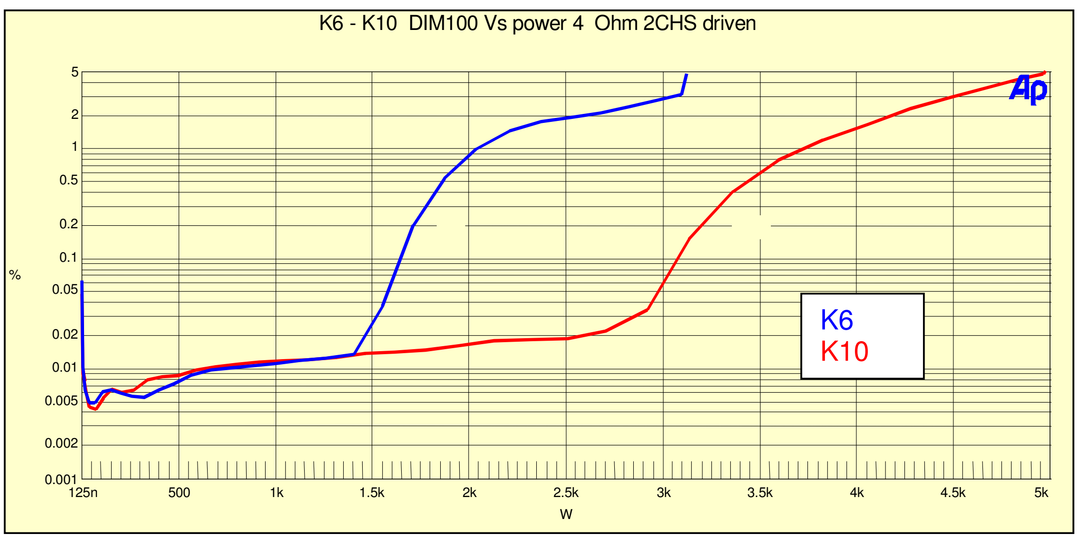
The peak level is obvious to see at around 1kHz for all models shown, while the residual levels are much lower across the remaining frequency range. Digital amplifiers typically have higher residual noise compared to linear designed amplifiers. This is visible in the Crown IT8000. The Lab Gruppen fP6400 has low residual noise at high frequencies but elevated harmonic noise at low frequencies. This is not the harmonic behavior of the K Series. The noise floor is much lower in the K compared to the Crown IT and slightly lower than the Lab Gruppen fP.

Amplifiers using switching technology for the output stage have an increased noise floor as the frequency rises.

DIM100 Vs. Power







DIM100 Vs Power

DIM (dynamic intermodulation distortion) A procedure designed to test the dynamic behavior of audio amplifiers.

Using an input signal combining 2 different frequencies to better simulate a “real world” test of the output stage of the amplifiers, the DIM100 test shows the distortion levels (%) with reference to the amplifier’s output power (W). Obviously, lower distortion is best. This test was conducted with both channels driven at 4-ohms.

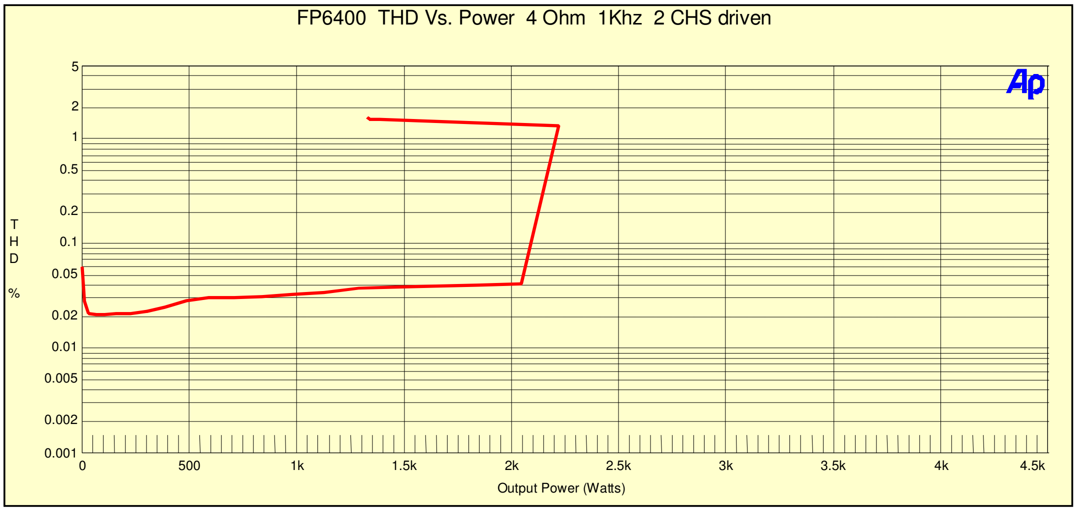
As shown, the fP6400 suffers when trying to follow the envelope of the input signal. The distortion value grows with the output power. During long-duration use, the limitations of the power supply in this amplifier will be evident. Their fold-back limiter will turn on and drastically reduce the signal.

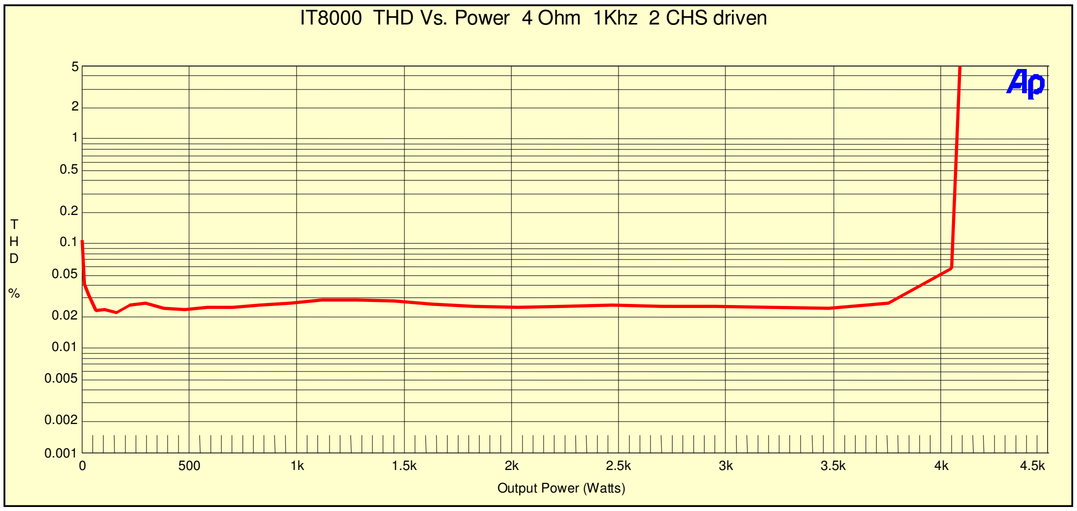
The IT performs well with this test. As shown, the distortion remains fairly low (close to 0.04%) until the output power reaches around 4kW.

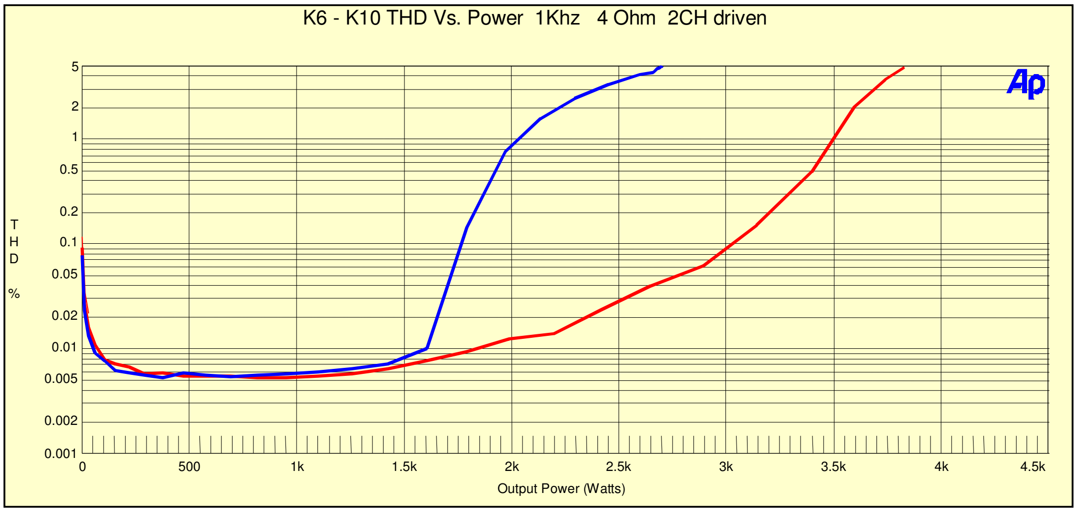
K series amplifiers have much lower distortion values up to 3kW of output power where the value starts to rise. A key point to understand is that in a real-world operating environment, at the 3kW output power level where the K Series distortion starts to rise, the level is quite loud and will “hide” the elevating distortion residual. Furthermore, any loudspeaker driven at those levels will produce a much higher intrinsic (inherent) distortion. Having said this, the rising distortion of the amplifier at these levels is negligible.

So, for this reason it is extremely important to have very low distortion levels at low/medium output power. At these power levels, the loudspeaker is not producing distortion and the final result will be clearer sound production overall.

THD (1 kHz) Vs. Power







THD (Total Harmonic Distortion) Vs Power at 1kHz

This test shows the distortion levels (%) with reference to the amplifier's output power (W). Obviously, lower distortion is best. This test was conducted with both channels driven at 4-ohms.

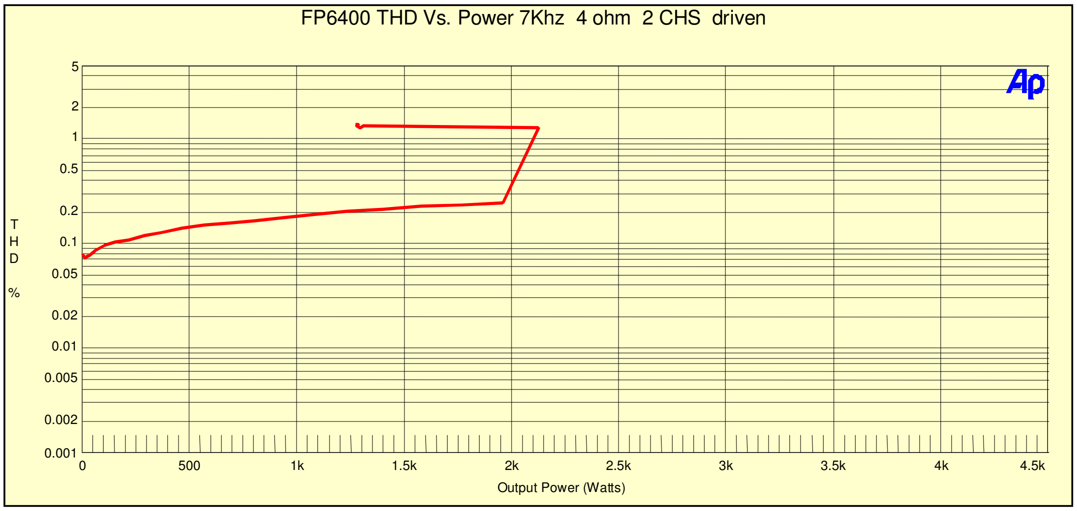
Having a pure 1kHz tone as the input signal, the Lab Gruppen fP6400
performance is much better compared to the previous test of DIM100 measurements. The low speed of the pre-regulator (that suffered from complex signals in the DIM test) in this case is not compromising the amplifier's performance. We must remember that in a "real-world" environment, complex signals (music program) will be used and not pure tones.

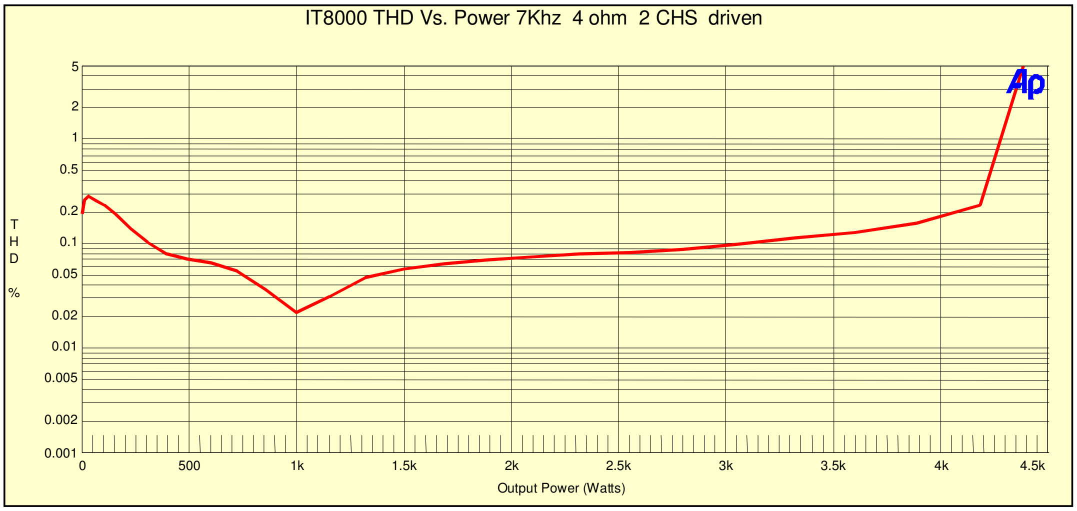
Before clipping, the fP behavior is relatively linear. Again, it is very clear to see the limitation of the power supply in long duration performances, with a typical fall-back limiter drastically reducing the output power.

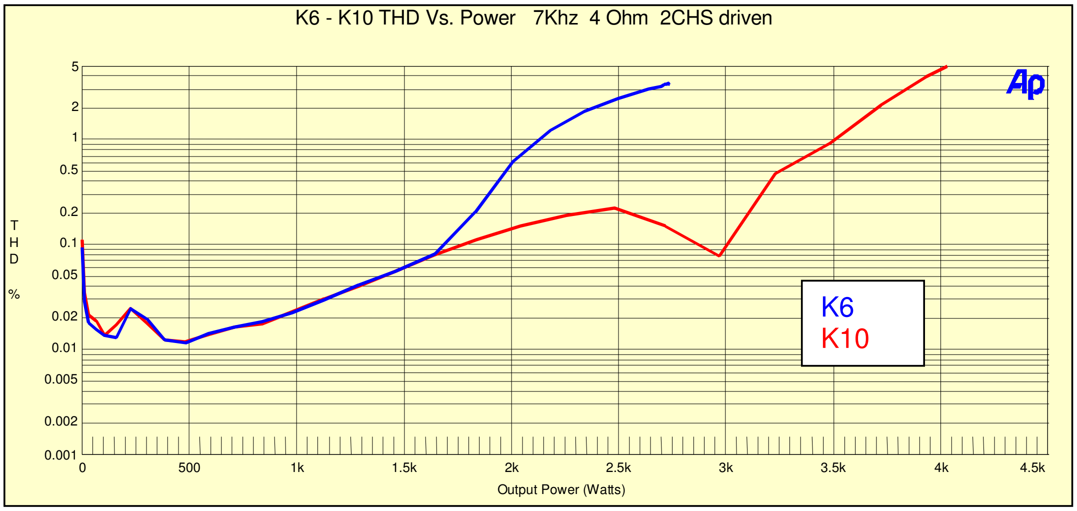
The IT and K Series perform well in this test, very similar to the DIM100. You will note that at low output power where the loudspeaker is not producing distortion, the K Series absolutely has the best results.

A smooth increase of distortion allows the amplifier to be used at very high power output levels thus, avoiding the introduction of hard saturation of the final output stage.

THD (7 kHz) Vs. Power





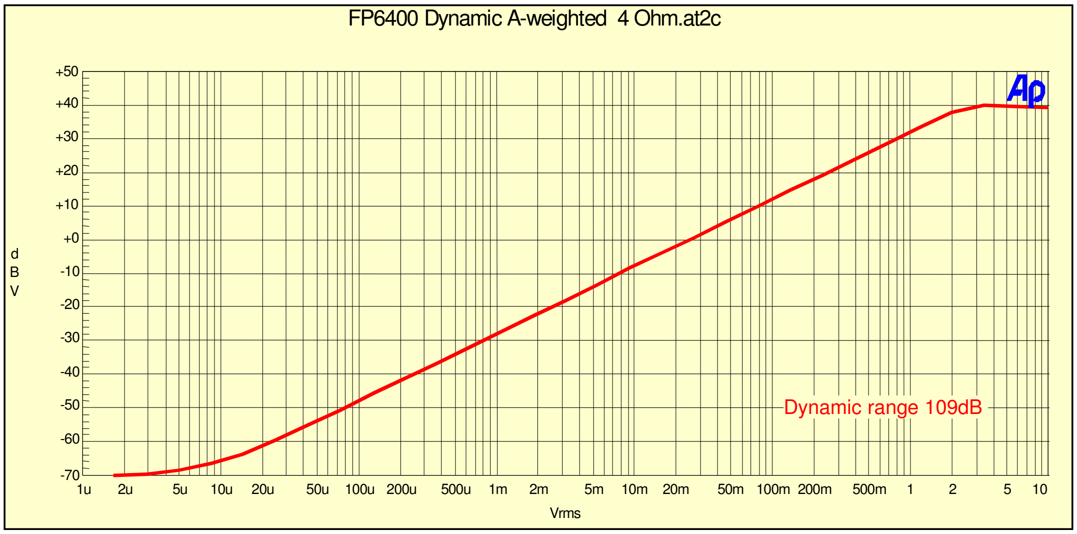


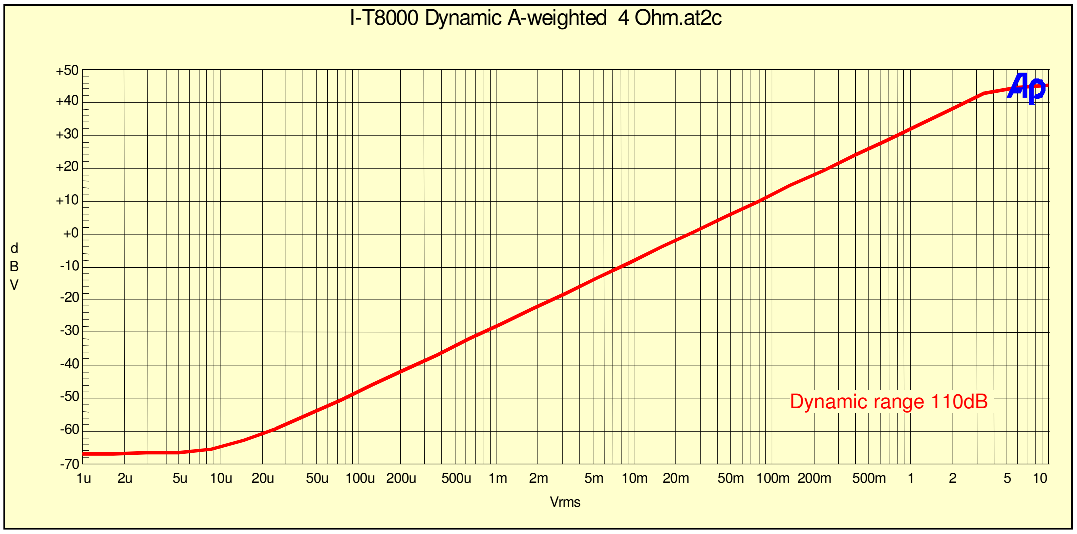
THD (Total Harmonic Distortion) Vs Power at 7kHz

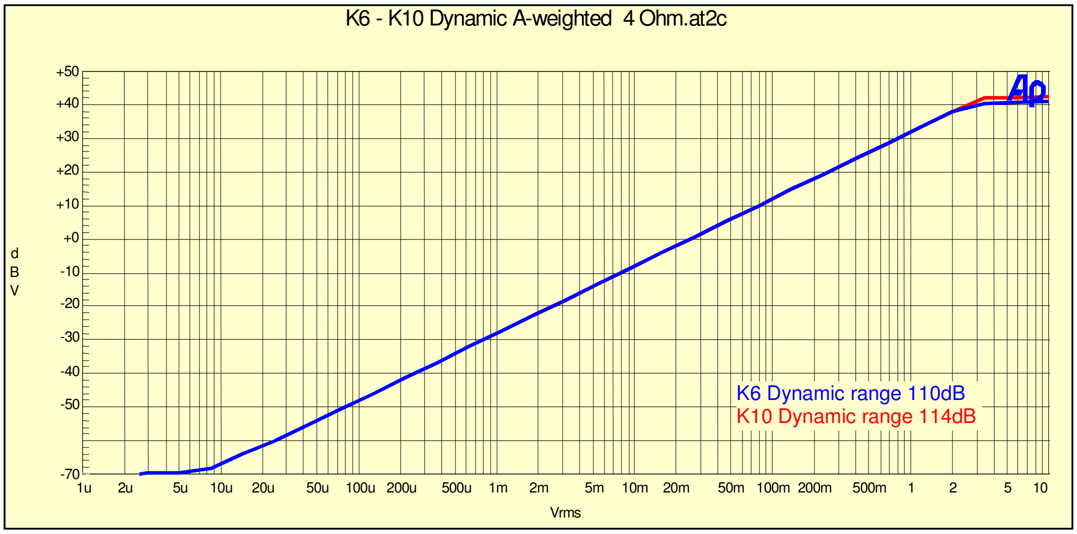
This test shows the distortion levels (%) with reference to the amplifier's output power (W). Obviously, lower distortion is best. This test was conducted with both channels driven at 4-ohms.

Same test conducted with a 7kHz pure tone input signal. This shows that the fP and IT's performance gets worse at this frequency level. The result of the K Series still remains very good.

Dynamic Range







Dynamic Range

Dynamic Range is the ratio of the loudest (undistorted) signal to that of the quietest (audible) signal in a unit or system as expressed in decibles (dB).

This test was conducted using an A-Weighted filter at 4-ohms.

The fP does not have very high peak output power however, due to its low noise floor, the dynamic range reaches 109dB.

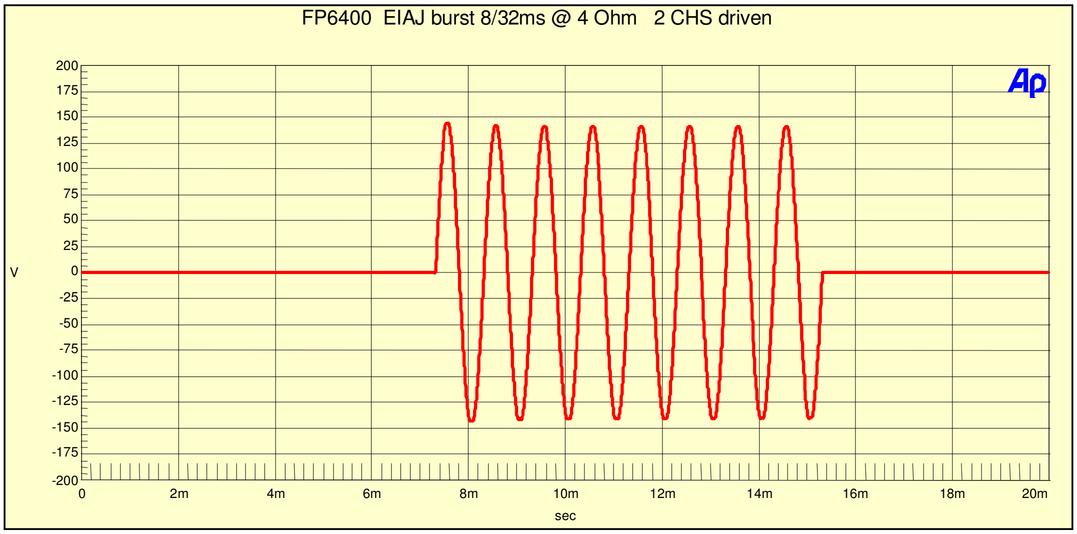
The IT has very high peak output power but the noise floor is high as well. This could be because the DSP cannot be by-passed unfortunately. In any case the dynamic range is 110 dB.

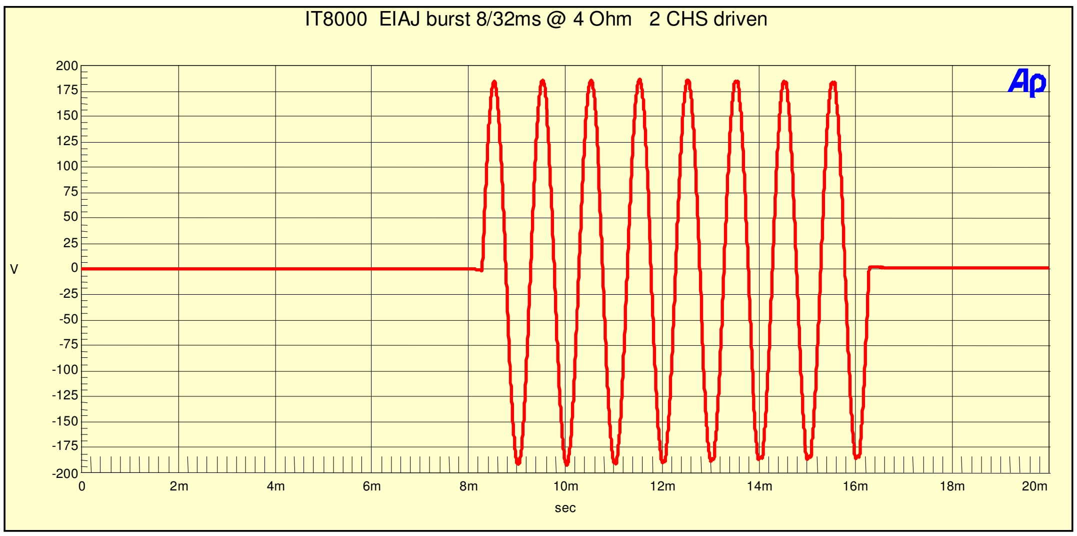
Obviously the K6 has a smaller value than K10, having the same noise floor but lower output peak power. The K10 has the best results with a dynamic range of 114 dB.

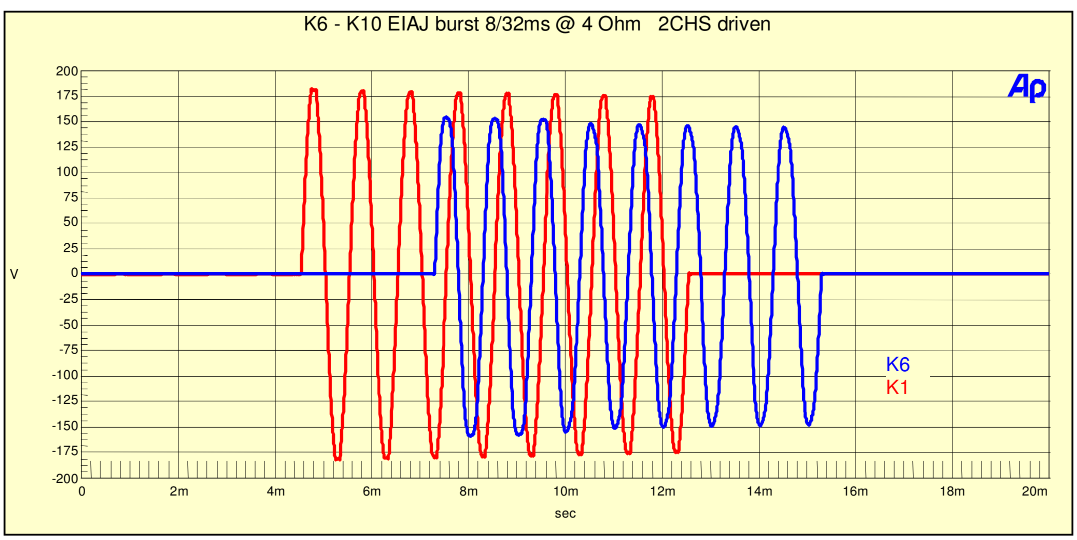
It is important to stress that in the case of amplifiers with equal dynamic range, the one with the lower noise floor should be considered to have the best performance. This translates to less noise from the loudspeaker.

In this test's conclusion, we see that the K10's performance is best with fP running second and IT last.

EIAJ Burst


FP6400 EIAJ burst 8/32ms @ 4 Ohm 2 CHS driven
V
sec
0
2m
4m
6m
8m
10m
12m
14m
16m
18m
20m


IT8000 EIAJ burst 8/32ms @ 4 Ohm 2 CHS driven
V
sec


K6 - K10 EIAJ burst 8/32ms @ 4 Ohm 2CHS driven
V
sec
K6
K1

EIAJ Burst

The EIAJ reference is a tone burst sequence of determined signals. Basically, 8 cycles of signals at maximum power and 32 cycles of other random levels.

The graphs show the “picture” of the output signal using an EIAJ burst at the input of the amplifier. This shows the maximum output voltage and how long of a duration (holding time) the amplifier can hold it at these levels.

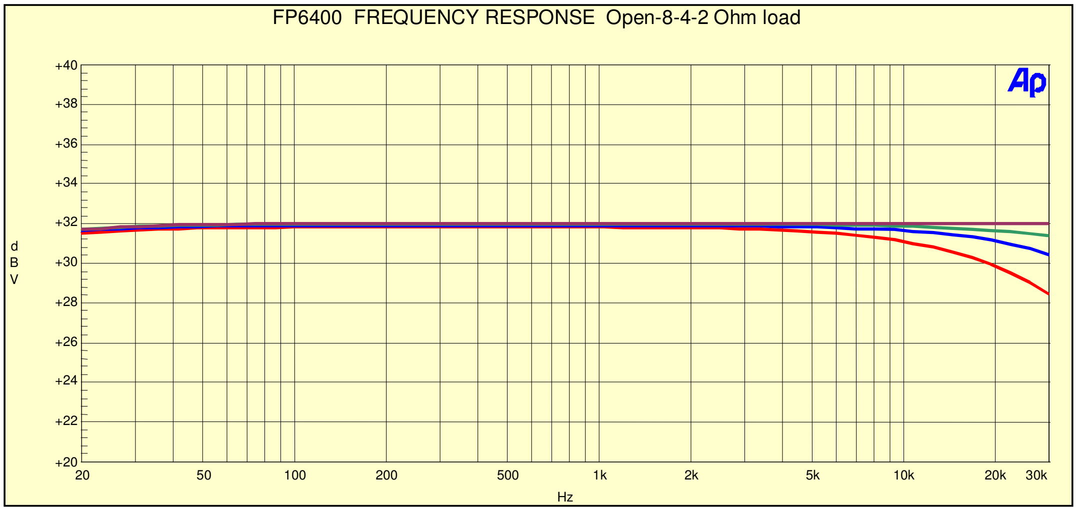
Looking at the fP chart you can see that, starting from the second cycle, the energy is slightly cut. After that it remains more or less at the same level.

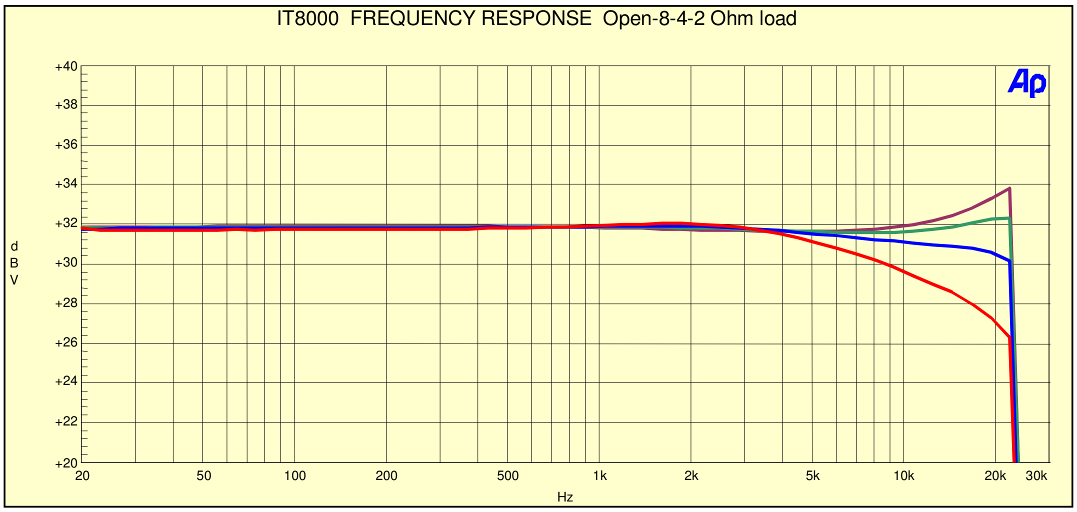
The performance of the IT is good, both for the peak level and for the holding time.

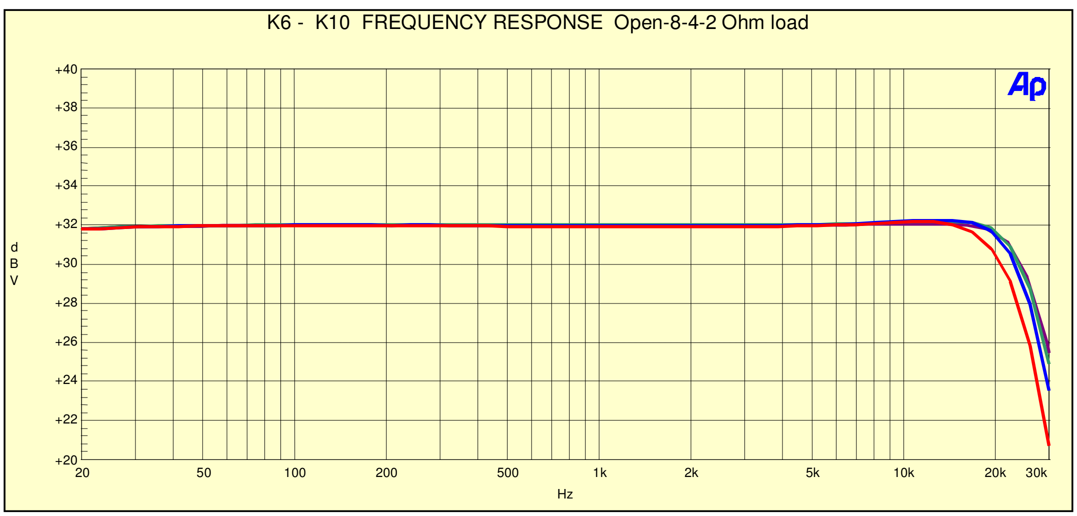
For this specific test and, thanks to its very high rail bus voltage, the IT
performs the best. The K10’s measurements are very close in comparison to the IT.

Take note that the K6 shows a perfect waveform (ie: not at all limited) thanks to it’s over sized power supply.

Frequency Response







Frequency Response

Frequency Response. In audio, this refers to amplitude-frequency response and quantifies a device's maximum and minimum frequency for full-output response.

Color codes: Red=2 Ohm, Blue = 4-Ohm, Green = 8-Ohm, Violet = no load present.

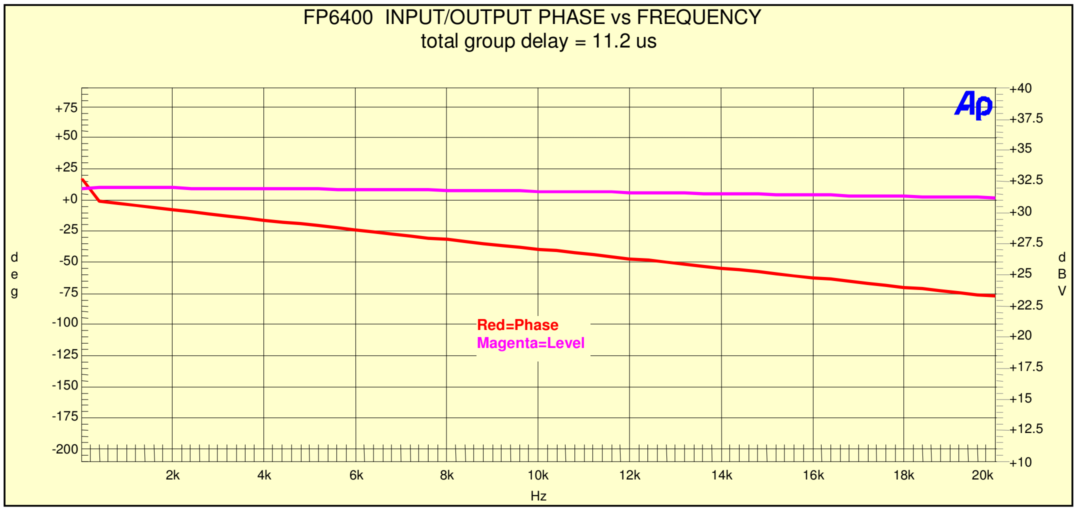
With no-load, the frequency response report has very little practical meaning. It gives us an idea about the amplifier's behavior in theory and how well the feedback loop compensation is. This can be useful to evaluate the amplifier's behavior when a sophisticated high-frequency driver is connected at the output. These drivers sometimes have very high impedance at the upper frequencies of audio band.

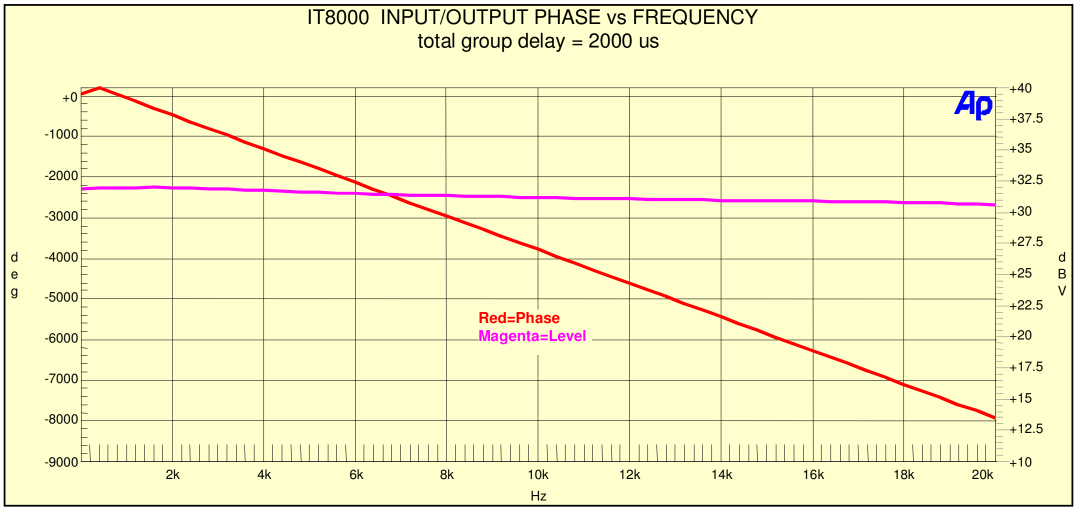
The fP with no load basically has a linear behavior across the frequency range, which would also be typical for a linear amplifier design. But in a "real-world" environment the fP's performance decreases at high frequencies, especially when the load impedance is low. This is because the high frequency output filter's effect on the signal is bigger when the output load impedance decreases. The loss is up to 2dB at 20 kHz. This also tells us that the fP should not be used at 2-Ohms, especially for high frequency use.

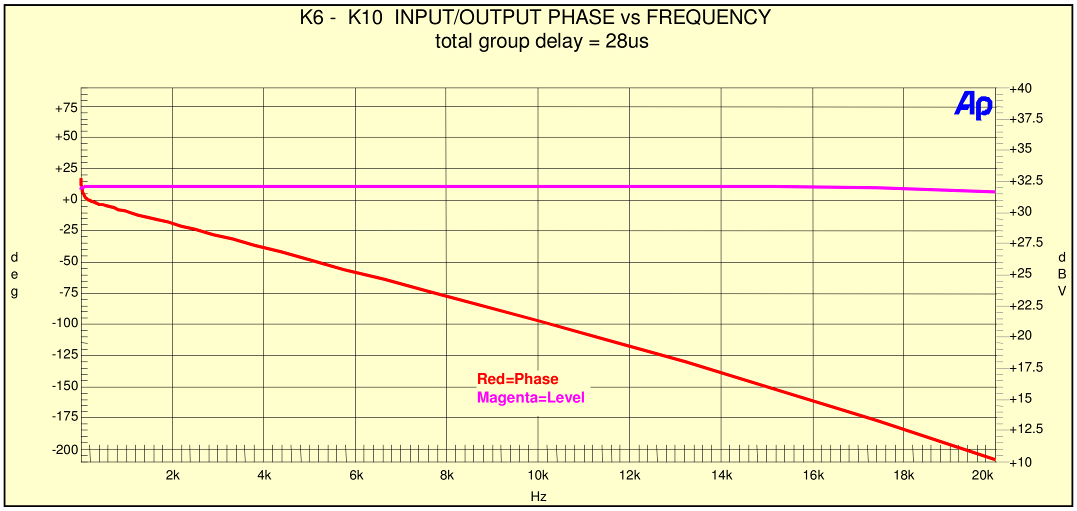
The IT shows a net cut at 22 kHz, which is performed by the internal DSP. The performances are heavily dependent on the load value. With a load of 4-Ohms, at around 20kHz, the loss is more than 2dB. At 2-Ohms it almost completely shuts down. This is the result of a compensation circuit that is not operating to it's proper capacity. We should also take note of the clear "peaking" on high impedance load values.

In this test, the K Series offers the best performance. First of all it has an extremely linear behavior across the complete range of frequencies and the results are very similar for each of the load impedances used. As you can see, these results are much better than the competitors. This is the result of intense research and development of Powersoft's compensation circuitry. Having said that, the K series can be used with no limitations into a 2-Ohm load. This K feature eases the programming job of external signal processors since it purely reproduces the input signals.

I/O Phase Vs. Frequency







I/O Phase Vs. Frequency

Input / Output Phase Vs. Frequency. The ideal behavior of this measurement is linear, because it shows the delay and the phase shifting introduced by the amplifier as a function of the input signal frequency.

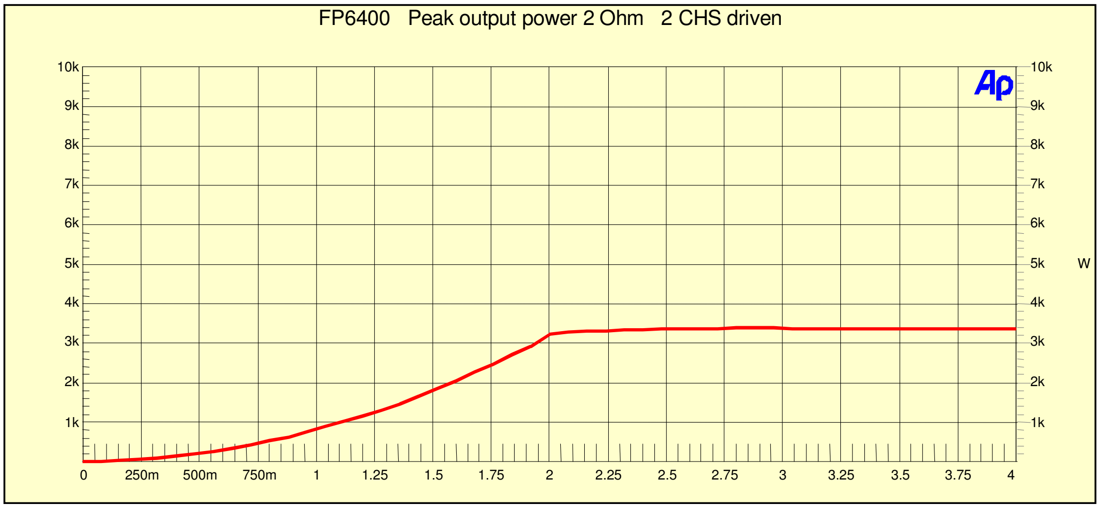
The fP6400's performance is very good, with just 11.2 uS of group delay. The equivalent phase shifting has very linear behavior, reaching a maximum amount of approximately 50 degrees.

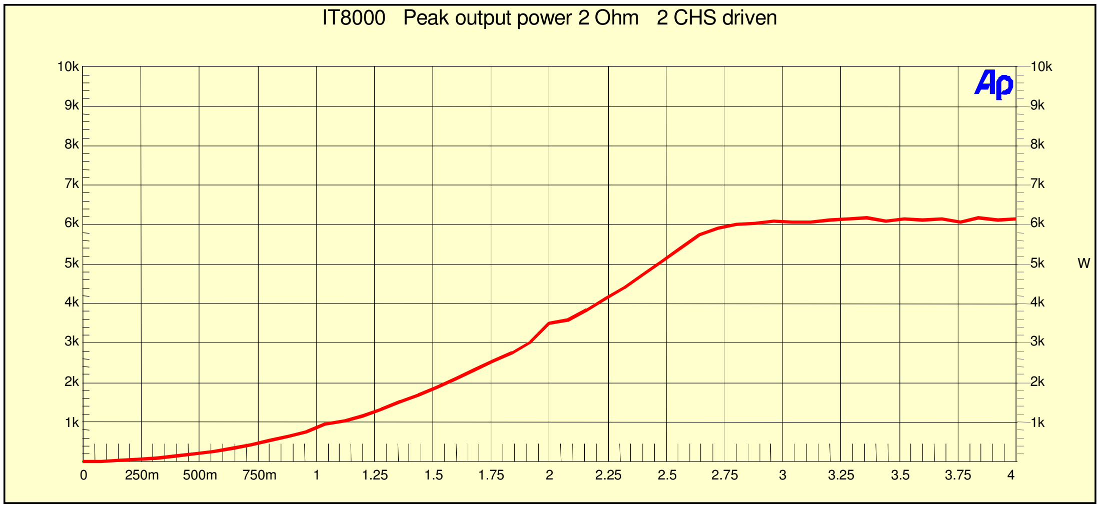
The K Series performs very good as well, with 28 uS of group delay and a maximum phase shift of 200 degrees. Take note that the phase behaviors constant slope produces a constant group delay thus, preserving the integrity of the input signal.

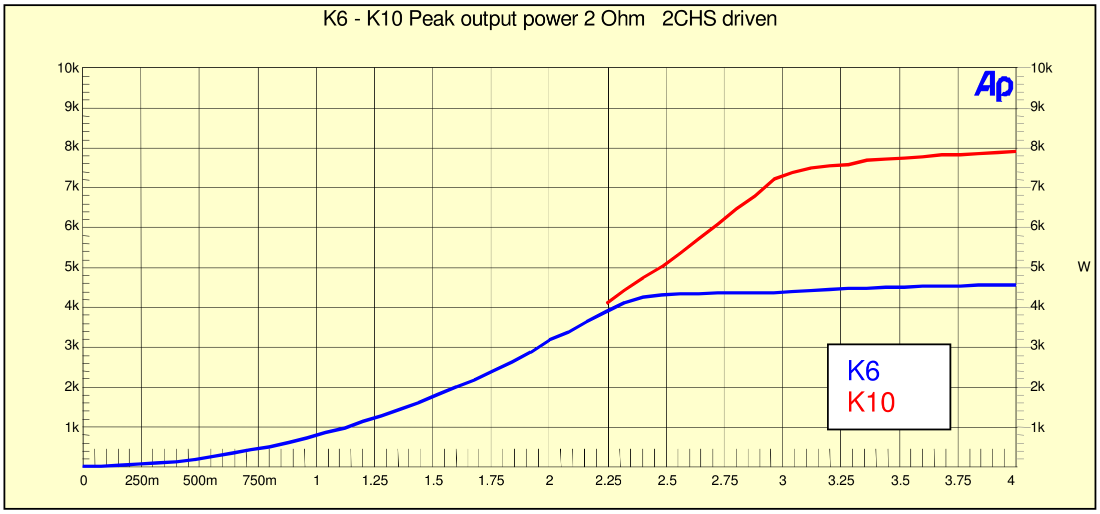
The performance of the Crown IT is very poor, with a latency of 2.000us (or 2 mS). This is mainly because of the internal DSP time, and also an enormous phase shift reaching 8000 degrees at 20 kHz. (please note: do not be confused by the chart for the IT as the scale used is different than the others in order to see this result).

Due to the IT's poor performance, the setup to run this test became very complicated. In some cases, not possible at all to measure the limits. This is the reason several loudspeaker manufacturers who are adopting "feedback" control technology discourage the use of IT amplifiers. It is also very difficult to use ITs in systems with other amplifier models due to incompatibility of the phase and time alignment.

Peak Output Power







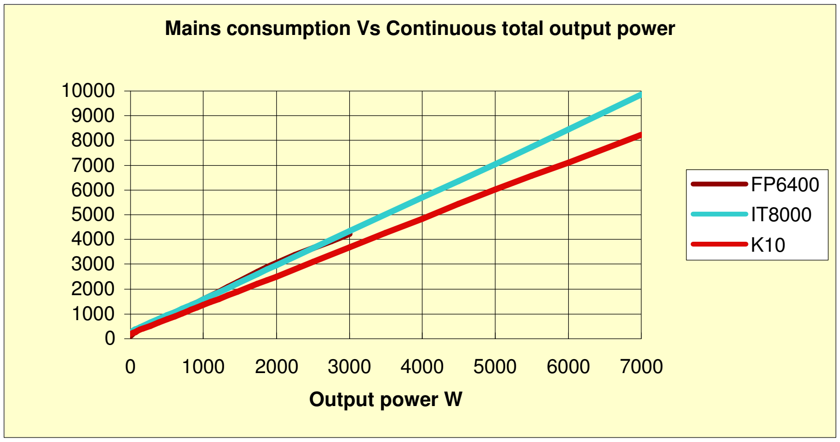
Peak Output Power

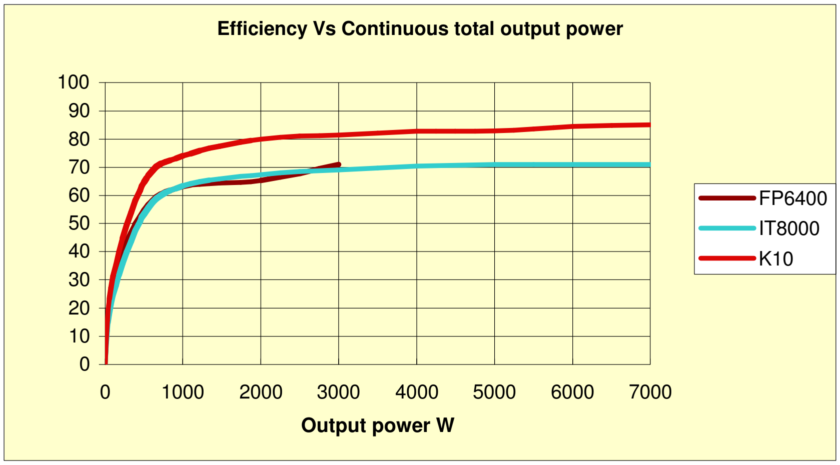
These charts show the output power (W) with reference to input signals from 0 to 4V at a 2-Ohm load.

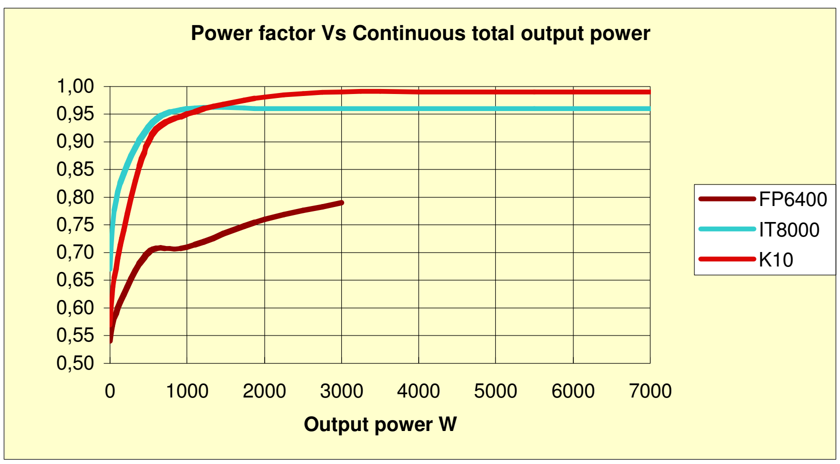
The fP has a maximum limit of 3200W per channel (as shown) with the clip limiter clamping the signal quite hard once it reaches this power level.

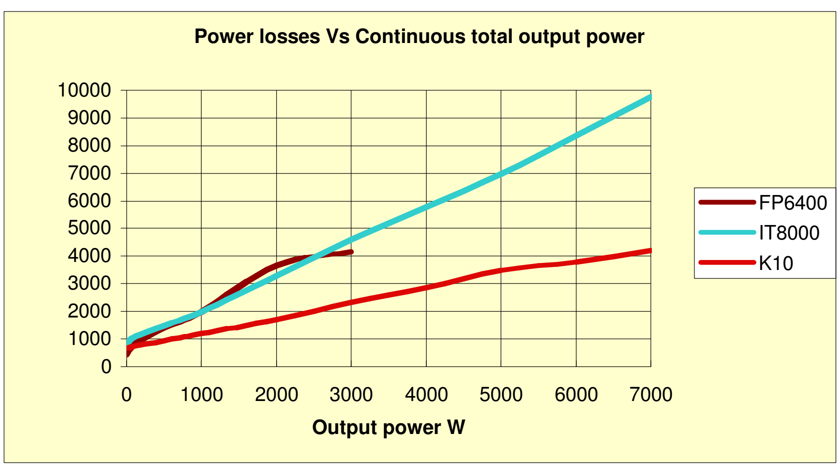
The IT's slope up to max power is quite strange however, it does reach 6000W per channel. You can also see the clip limiter clamping quite hard on this amp as well.

K6 and K10 have a nice slope up to max power and a smoother clip limiter. The K6
reaches 4500W per channel (45% more then the fP) and the K10 has the best performance with 7700W per channel.


Mains consumption Vs Continuous total output power
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
7000
Output power W
FP6400
IT8000
K10


Efficiency Vs Continuous total output power
100
90
80
70
60
50
40
30
20
10
0
0
1000
2000
3000
4000
5000
6000
7000
Output power W
FP6400
IT8000
K10


Power factor Vs Continuous total output power
1,00
0,95
0,90
0,85
0,80
0,75
0,70
0,65
0,60
0,55
0,50
0
1000
2000
3000
4000
5000
6000
7000
Output power W
FP6400
IT8000
K10


Power losses Vs Continuous total output power
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
7000
Output power W
FP6400
IT8000
K10

Mains Consumption Vs. Continuous Total Output Power

For these measurements, the performances of the 3 amps under test are shown on the same chart. Each amplifier's sweep is shown using a different color as noted.

In the first chart, we are comparing mains consumption (in Watts on the left of the chart) with reference to Output power (in Watts, levels shown horizontally across the bottom).

The fP and IT have similar results. Obviously, as you can see, the fP maxes out at 3200W of output power.

The IT requires 10000W from the mains to provide 7000W of Total Output Power while the K Series consumes 8000W to provide 7000W of Total Output Power.

Efficiency Vs. Continuous Total Output Power

In the second chart, the amplifier's efficiency is reported. This sweep is just another method to show the previous results (with Efficiency % on the left of the chart and Output Power Levels shown across the bottom).

You can see that the fP and IT have more or less an efficiency of 70% while the K Series is more than 80% efficient.

Power Factor Vs. Continuous Total Output Power

In the third chart, the Power Factor performance is shown. A number of 1 is the best performance measurement in this test.

The fP doesn't have the PFC (Power Factor Correction) circuit, and this is clearly confirmed in the sweep.

The PFC performance of the IT is slightly better than the K Series at low output power and reaches 0.95. The K Series is better than the IT at high output power reaching a very impressive 0.98.

Power Loss Vs. Continuous Total Output Power

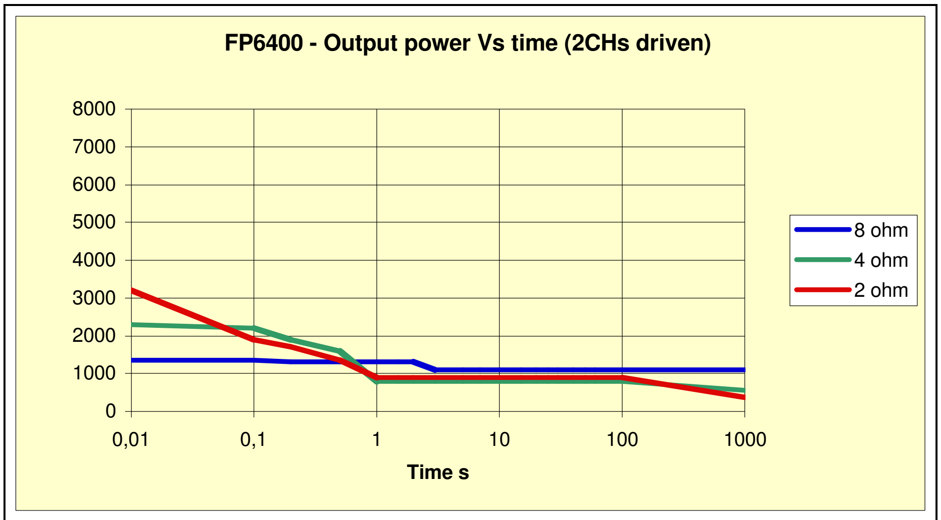
In the fourth chart, power dissipation is shown using BTU/h (British Thermal Unit per hour) as units of heat.

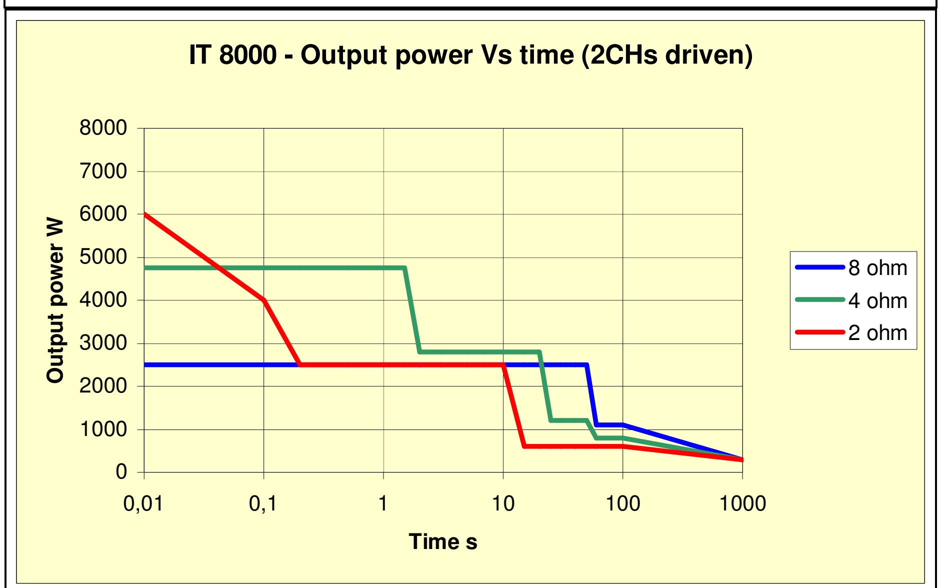
Looking at the chart, you can see that in order to produce 7000W of audio
power, the IT dissipates 10000 BTU, while the K Series uses only 4000 BTU (less than half). In other words, with the same amount of heat dissipation, you can use more than double the amount of K Series amplifiers verses ITs and you get more than double the amount of audio power.

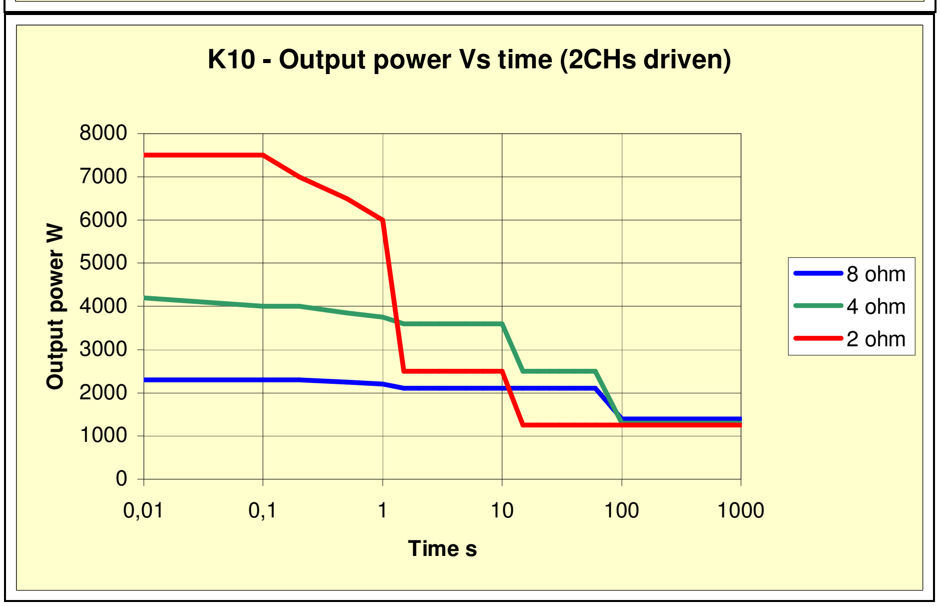
You will notice that, with the same heat dissipation, the fP is providing 3200W of power verses 7000W from the K Series.

In conclusion, we can certainly say that fP and IT amplifiers are much more expensive to run verses the K Series in terms of power consumption and air conditioning requirements.

These measurements have been performed at 230V. The K Series amplifiers' performance will remain more or less the same (less than 1% lower) at 120V mains.


FP6400 - Output power Vs time (2CHs driven)
8000
7000
6000
5000
4000
3000
2000
1000
0
0,01
0,1
1
10
100
1000
Time s
8 ohm
4 ohm
2 ohm


IT 8000 - Output power Vs time (2CHs driven)
Output power W
8000
7000
6000
5000
4000
3000
2000
1000
0
0,01
0,1
1
10
100
1000
Time s
8 ohm
4 ohm
2 ohm


K10 - Output power Vs time (2CHs driven)
Output power W
8000
7000
6000
5000
4000
3000
2000
1000
0
0,01
0,1
1
10
100
1000
Time s
8 ohm
4 ohm
2 ohm

Output Power Vs Time With Both Channels Driven

These charts show the output power of the amps Vs. time at 8-Ohms, 4-Ohms, and 2-Ohms.

At 8-Ohms, the fP produces a maximum output power that holds for a few seconds before the power drops. At 4-Ohms after 0.1s, it is visible that the output power drops due to the power supply's performance. The power continues to drop until around 1 second where it holds steady for about 100 seconds before dropping off again. At that point, thermal factors begin to reduce the output power.

At 2-Ohms the fP has a much higher peak power however, the power supply suffers much sooner. After about a second, the behavior is more or less the same as it was with a 4-Ohm load.

At 8-Ohms, the IT holds the maximum output power for about 90 seconds. After that, a protection circuit reduces the output level to roughly 1000W. Soon after, thermal factors reduce the output power to 250-300W only!

At 4-Ohms the IT performs well for over 1 second. While at 2-Ohms the behavior shows a starting peak power of 6000W which is then reduced to 4000 just after 0.1s.

As you can see, the K Series' performance has been tuned to produce a very high peak power and hold it for a long time, regardless of the load.

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