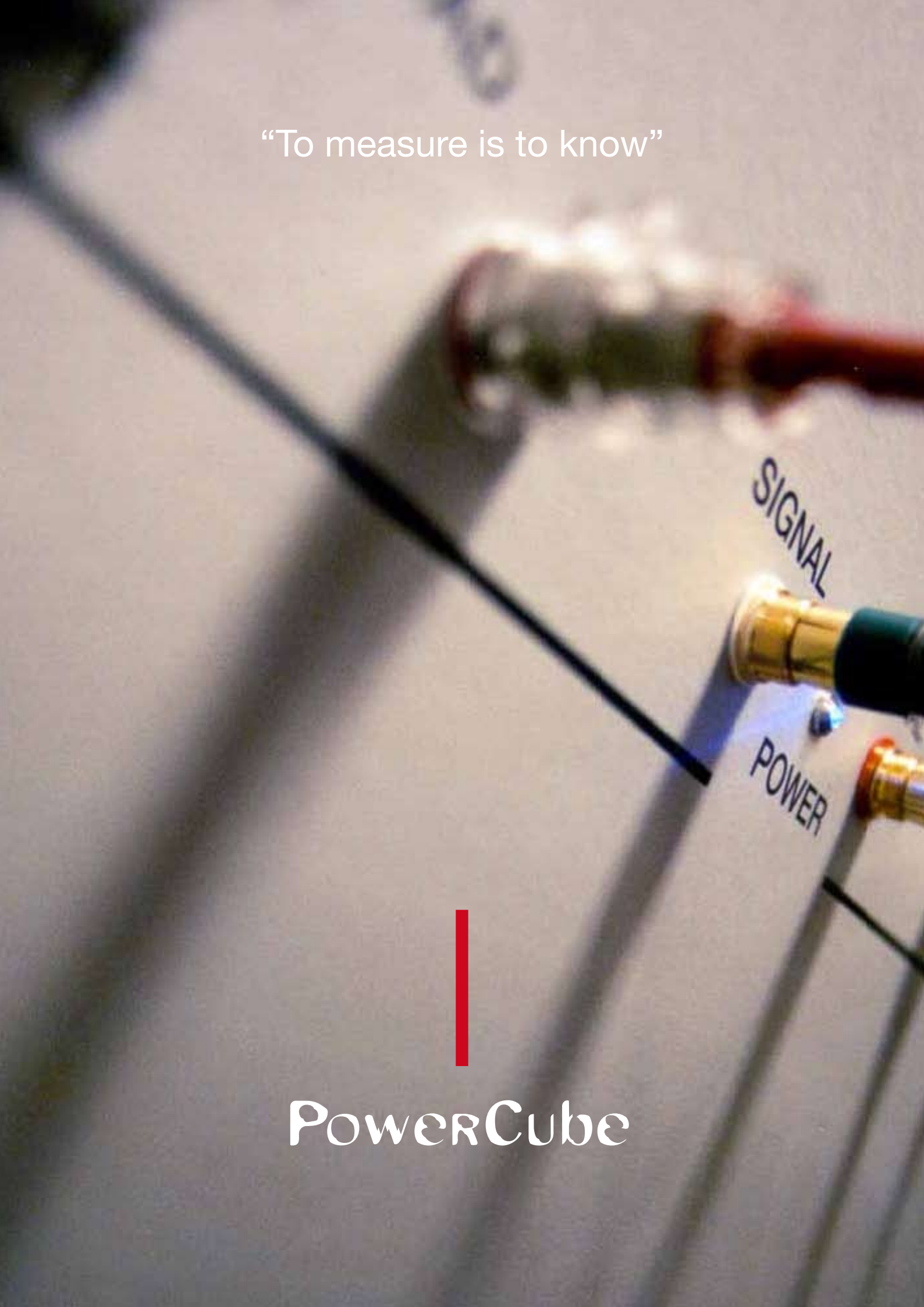

"To measure is to know"

PowerCube

Number One in amplifier stability test systems

Our latest system lets you test all your new audio amplifier constructions, conventional or Class D. Do you think Class D is the solution for stability? You'd better check it before you go into production!

For several decades it has been common knowledge that a loudspeaker is all but an 8 ohm resistor. Playing an 8 ohm speaker may hit the amplifier with impedances as low as 2 ohms, and with severe phase shifts as well - both capacitive and inductive.

AudioGraph's latest system lets you test your audio amplifier constructions, conventional or Class D. Magazines in Europe are using the AudioGraph measurements when reviewing amplifiers. It is used by developers to verify designs during construction – reducing costs and saving time.

The AudioGraph PowerCube is not only producing high quality, unique 3D-measurements of amplifiers, it is also an integrated part of the development and production cycle at the world leading audio manufacturers.

For more information and sales:
www.audiograph.se
or contact us directly on +46-13-23 94 94

Some of our customers

ALPINE

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Is CEA-2006 your new challenge?
Making IHF A-202 measurements?
Developing Class-D designs?
The answer is the PowerCube from AudioGraph!

Lars Ohlen, CEO and Lead Techinical Engineer, AudioGraph AB.

Introduction to the PowerCube graphs

Our new PowerCube system provides you with all the filtering and triggering you need to measure your latest amplifier, analog or Class D.

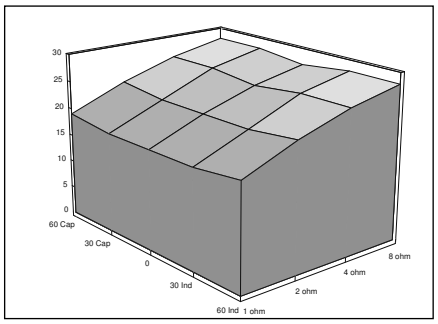


Fig 1
Good Example

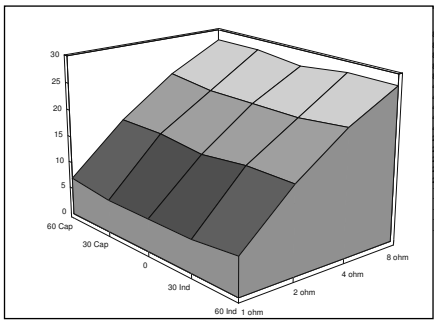


Fig 2
Poor Power Supply

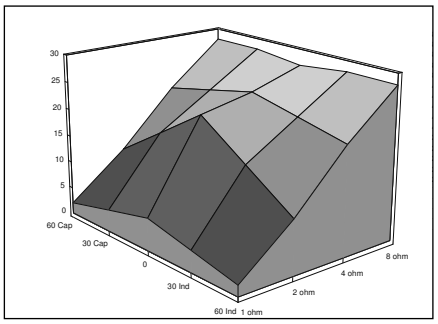
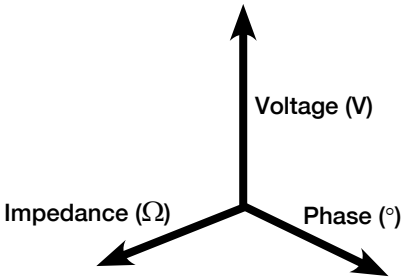


Fig 3
Current limiting

In *Fig.1*, you can find a good example. Regardless of the load, this amplifier can produce an almost equal voltage without clipping. Although you'll see some small losses when the load decreases, this amp will handle any loudspeaker.

In *Fig.2*, the output voltage is dramatically reduced into lower impedances. This amp will definitely not handle a real-world loudspeaker very well.

In *Fig.3*, the amplifier works into 8, 4 and 2 ohm resistive loads, but any reactive load will trigger the protection circuits and shut down the amplifier! This amp is essentially incapable of driving a real-world loudspeaker.



The two axes at the bottom of the cube represent the load conditions, and the height of the cube shows the amplifier's output voltage capability for the different conditions.

So you claim your amp is one ohm stable? Nothing can prove it like a print-out from Audiograph's dynamic test.

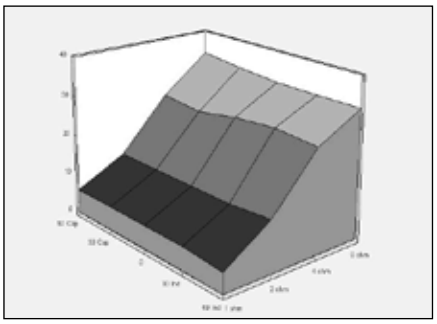


Fig 4
Class D, Well known brand
Home theatre receiver

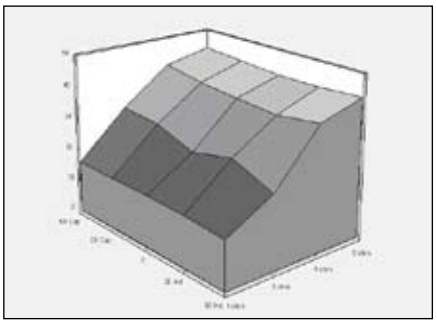


Fig 5
Class D, Well known brand
Home theatre receiver

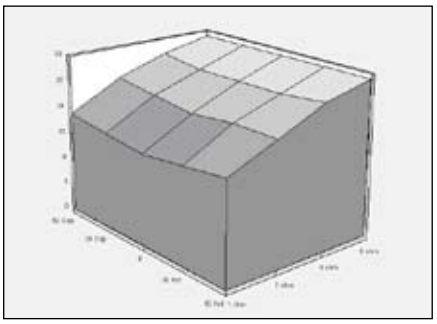


Fig 6
Rotel RB971 Stereo amp

If you claim your amp can deliver 100 watts into 8 ohms, you'd better check that it doesn't shut down into 2 ohms - because in a second the impedance of your 8 ohm loudspeaker may be there…

In *Fig.4* you can see an off-the-shelf Home Theater receiver with class D output stages - this one doesn't work at all below 4 ohms.

In *Fig.5* you can see another poor example, but this amp doesn't shut down quite as early into 1 or 2 ohms - so it has a better chance of handling the dynamic impedance dips of a real-world loudspeaker.

The perfect amp doesn't care about the load - it's a pure voltage generator - so the measurement of a theoretically ideal amp would produce a cube, hence the name "PowerCube".

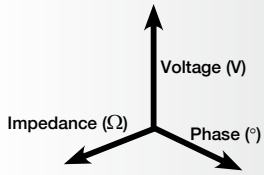
While you can't really expect to find an amplifier that will produce a perfect cube, you can see a good example in *Fig.6*:

This is a very well designed two channel amp from Rotel. Of course, good Class D amps do exist, just as with any other topology, but you need a PowerCube system to find them!

PowerCube basics and example graphs

To understand the need of the PowerCube test, you must be aware of how a loudspeaker appears to the amplifier during dynamic conditions.

Why the PowerCube test?
It's well known that an 8 ohms speaker for example, is nothing but 8 ohm at most frequencies. How far down against 1 ohm it goes depends on the specific loudspeaker. And we are not talking about the static impedance curve, but how the loudspeaker appears in a dynamic point of view. These examples does not concern the loudspeaker, but the amplifier. It's assumed that you know that loudspeakers can produce severe load cases to an amplifier, which can be difficult to handle for the amplifier.



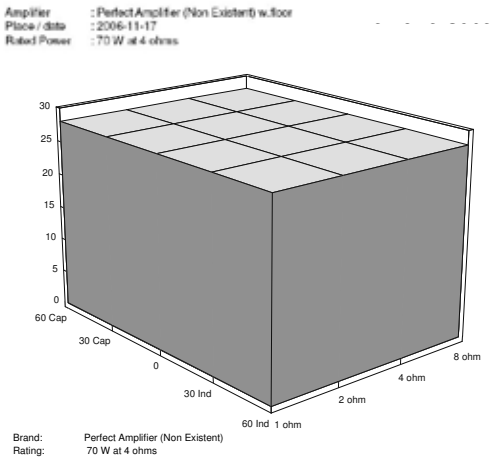
The two axes at the bottom of the cube represents the load conditions, and the height of the cube shows the amplifier's output voltage capability for the different conditions.

- Test is done at 1kHz
- Test signal* is 20 periods of 1kHz full power, 480 periods attenuated 20dB.
- Output power is measured at 1% THD for 20 different load conditions
- Loads used are 8,4,2,1 ohm, Resistive, +/-30 degrees, +/-60 degrees

* According to standard EIA RS-490 (formerly known as IHF A-202)

Example graphs and how to interpret them

This will bring you up to speed in how to interpret all the information that the graphs contains. The PowerCube test is a dynamic test – it tests the amplifier's dynamic output power capabilities



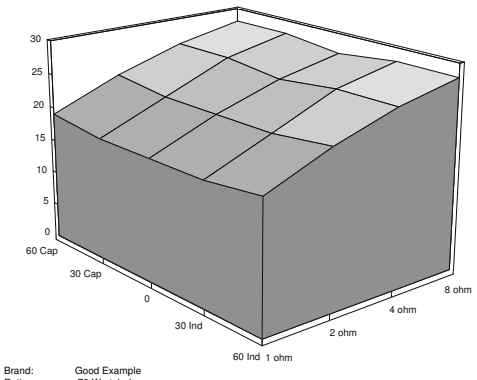
Measured output power [Equivalent Watts]

8 Ohm 60° Cap	98	W
8 Ohm 30° Cap	98	W
8 Ohm 0° Res	98	W
8 Ohm 30° Ind	98	W
8 Ohm 60° Ind	98	W
4 Ohm 60° Cap	196	W
4 Ohm 30° Cap	196	W
4 Ohm 0° Res	196	W
4 Ohm 30° Ind	196	W
4 Ohm 60° Ind	196	W
2 Ohm 60° Cap	392	W
2 Ohm 30° Cap	392	W
2 Ohm 0° Res	392	W
2 Ohm 30° Ind	392	W
2 Ohm 60° Ind	392	W
1 Ohm 60° Cap	784	W
1 Ohm 30° Cap	784	W
1 Ohm 0° Res	784	W
1 Ohm 30° Ind	784	W
1 Ohm 60° Ind	784	W

Example 1: The Perfect amplifier.

- The perfect amplifier would be a pure voltage generator that does not care at all about the load, hence the cube would be perfectly flat.
- This amp for example, is rated to 70 watts @ 4 ohm (RMS). That equals 16.7 Volts.

Amplifier : Good Example With floor
Place / date : 2006-11-17
Rated Power : 70 W at 4 ohms



Brand: Good Example
Rating: 70 W at 4 ohms

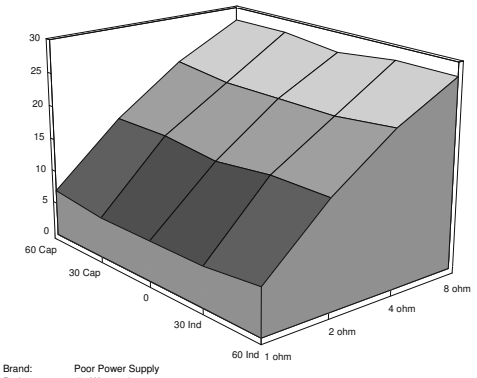
Measured output power [Equivalent Watts]

8 Ohm	60°	Cap	98	W
8 Ohm	30°	Cap	98	W
8 Ohm	0°	Res	91	W
8 Ohm	30°	Ind	98	W
8 Ohm	60°	Ind	98	W
4 Ohm	60°	Cap	169	W
4 Ohm	30°	Cap	169	W
4 Ohm	0°	Res	156	W
4 Ohm	30°	Ind	169	W
4 Ohm	60°	Ind	169	W
2 Ohm	60°	Cap	264	W
2 Ohm	30°	Cap	242	W
2 Ohm	0°	Res	242	W
2 Ohm	30°	Ind	242	W
2 Ohm	60°	Ind	264	W
1 Ohm	60°	Cap	361	W
1 Ohm	30°	Cap	324	W
1 Ohm	0°	Res	324	W
1 Ohm	30°	Ind	324	W
1 Ohm	60°	Ind	361	W

Example 2: A good example, a well designed amplifier.

- You will find some losses at lower impedances, but those are acceptable.
- The dynamic headroom is positive for all loads.
- The cube has a slight V-form, but that is quite normal – it's tough for the amp to produce high output levels when the current and voltage are in phase – output devices will get heated fast.

Amplifier : Poor Power Supply
Place / date : 2006-11-17
Rated Power : 70 W at 4 ohms



Brand: Poor Power Supply
Rating: 70 W at 4 ohms

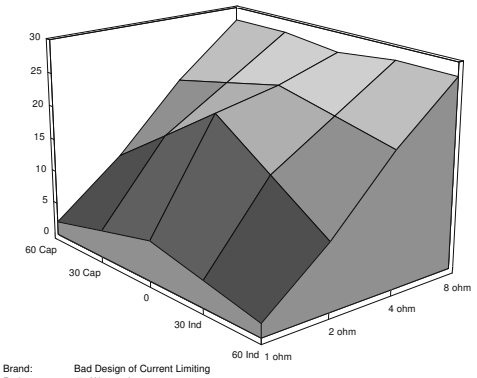
Measured output power [Equivalent Watts]

8 Ohm	60°	Cap	98	W
8 Ohm	30°	Cap	98	W
8 Ohm	0°	Res	91	W
8 Ohm	30°	Ind	98	W
8 Ohm	60°	Ind	98	W
4 Ohm	60°	Cap	132	W
4 Ohm	30°	Cap	121	W
4 Ohm	0°	Res	121	W
4 Ohm	30°	Ind	121	W
4 Ohm	60°	Ind	132	W
2 Ohm	60°	Cap	128	W
2 Ohm	30°	Cap	128	W
2 Ohm	0°	Res	112	W
2 Ohm	30°	Ind	128	W
2 Ohm	60°	Ind	128	W
1 Ohm	60°	Cap	49	W
1 Ohm	30°	Cap	36	W
1 Ohm	0°	Res	36	W
1 Ohm	30°	Ind	36	W
1 Ohm	60°	Ind	49	W

Example 3: Poor power supply.

- This amplifier works well at 8 ohm, but at lower impedances the output power decreases rapidly.
- If you test this amplifier with a classic 8 ohm resistor, it will appear quite normal. But if you connect it to a loudspeaker, it will quite soon reach voltage clipping.

Amplifier : Bad Design of Current Limiting w.floor
Place / date : 2006-11-17
Rated Power : 70 W at 4 ohms



Brand: Bad Design of Current Limiting
Rating: 70 W at 4 ohms

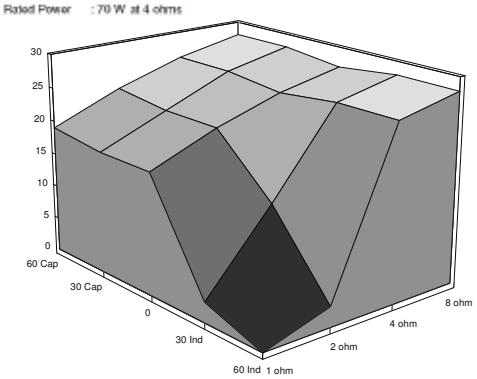
Measured output power [Equivalent Watts]

8 Ohm	60°	Cap	98	W
8 Ohm	30°	Cap	98	W
8 Ohm	0°	Res	91	W
8 Ohm	30°	Ind	98	W
8 Ohm	60°	Ind	98	W
4 Ohm	60°	Cap	100	W
4 Ohm	30°	Cap	121	W
4 Ohm	0°	Res	144	W
4 Ohm	30°	Ind	121	W
4 Ohm	60°	Ind	100	W
2 Ohm	60°	Cap	50	W
2 Ohm	30°	Cap	128	W
2 Ohm	0°	Res	242	W
2 Ohm	30°	Ind	128	W
2 Ohm	60°	Ind	50	W
1 Ohm	60°	Cap	4	W
1 Ohm	30°	Cap	16	W
1 Ohm	0°	Res	36	W
1 Ohm	30°	Ind	16	W
1 Ohm	60°	Ind	4	W

Example 4: Bad design of current limiting.

- This amplifier will act normal at all loads in 8 ohm, and also in 4 ohm resistive load.
- In all other load cases, the amplifier's current protection scheme shuts it down way to early. The result is voltage clipping when trying to drive a nonresistive loudspeaker. That would be all reallife loudspeakers.

Amplifier : Oscillating at Inductive Loads w.floor
Place / date : 2006-11-17
Rated Power : 70 W at 4 ohms



Brand: Oscillating at Inductive Loads
Rating: 70 W at 4 ohms

8 Ohm	60°	Cap	98	W
8 Ohm	30°	Cap	98	W
8 Ohm	0°	Res	91	W
8 Ohm	30°	Ind	98	W
8 Ohm	60°	Ind	98	W
4 Ohm	60°	Cap	169	W
4 Ohm	30°	Cap	169	W
4 Ohm	0°	Res	156	W
4 Ohm	30°	Ind	169	W
4 Ohm	60°	Ind	169	W
2 Ohm	60°	Cap	264	W
2 Ohm	30°	Cap	242	W
2 Ohm	0°	Res	242	W
2 Ohm	30°	Ind	98	W
2 Ohm	60°	Ind	4	W
1 Ohm	60°	Cap	361	W
1 Ohm	30°	Cap	324	W
1 Ohm	0°	Res	324	W
1 Ohm	30°	Ind	9	W
1 Ohm	60°	Ind	0	W

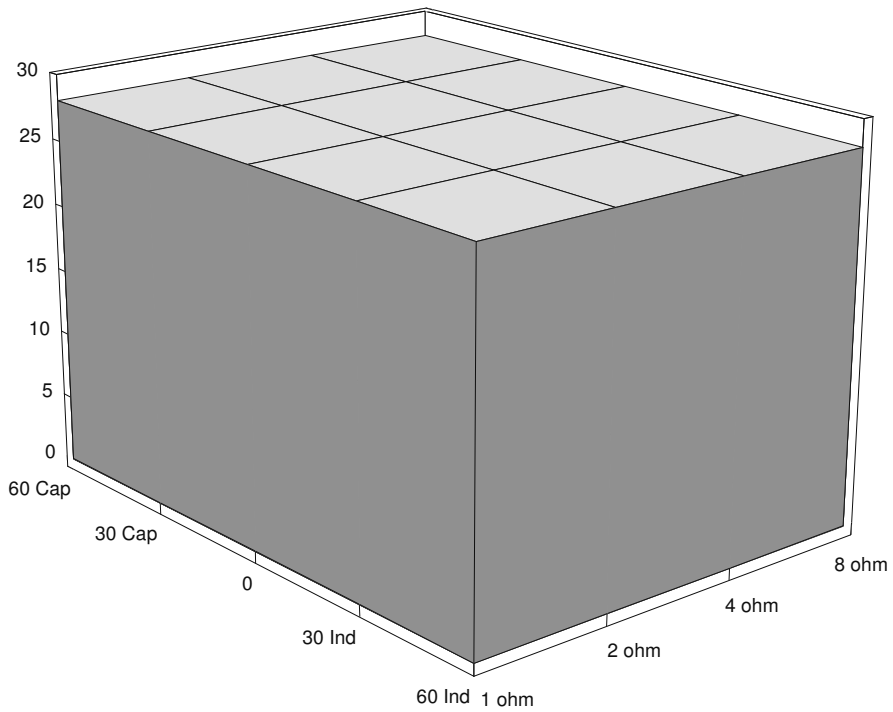
Example 5: Oscillating at inductive loads..

- This amplifier oscillates at a certain inductive load, causing the THD to hit levels over 40% and hence makes it impossible to measure any output power at all.
- This result is a dip to zero watts at that load, and probably burned tweeters if this would have been a real life test…

PowerCube graphs enlarged

These are the sames graphs as on the previous pages, but enlarged so you can study all the details.

Example 1: The Perfect amplifier

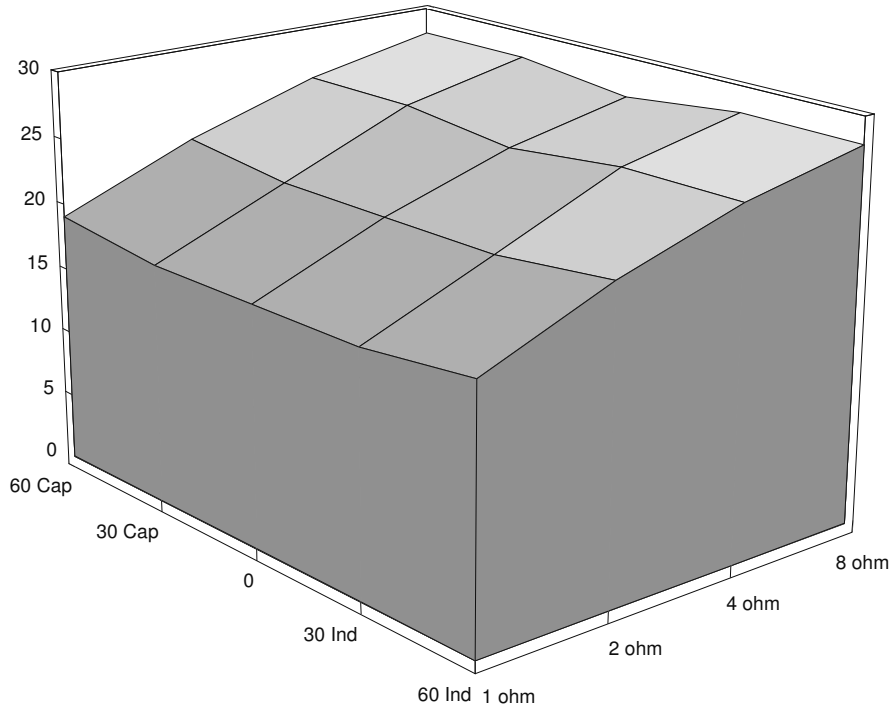


Brand: Perfect Amplifier (Non Existent)
Rating: 70 W at 4 ohms

Measured output power
[Equivalent Watts]

8 Ohm	60°	Cap	98	W
8 Ohm	30°	Cap	98	W
8 Ohm	0°	Res	98	W
8 Ohm	30°	Ind	98	W
8 Ohm	60°	Ind	98	W
4 Ohm	60°	Cap	196	W
4 Ohm	30°	Cap	196	W
4 Ohm	0°	Res	196	W
4 Ohm	30°	Ind	196	W
4 Ohm	60°	Ind	196	W
2 Ohm	60°	Cap	392	W
2 Ohm	30°	Cap	392	W
2 Ohm	0°	Res	392	W
2 Ohm	30°	Ind	392	W
2 Ohm	60°	Ind	392	W
1 Ohm	60°	Cap	784	W
1 Ohm	30°	Cap	784	W
1 Ohm	0°	Res	784	W
1 Ohm	30°	Ind	784	W
1 Ohm	60°	Ind	784	W

Example 2: A good example, a well designed amplifier

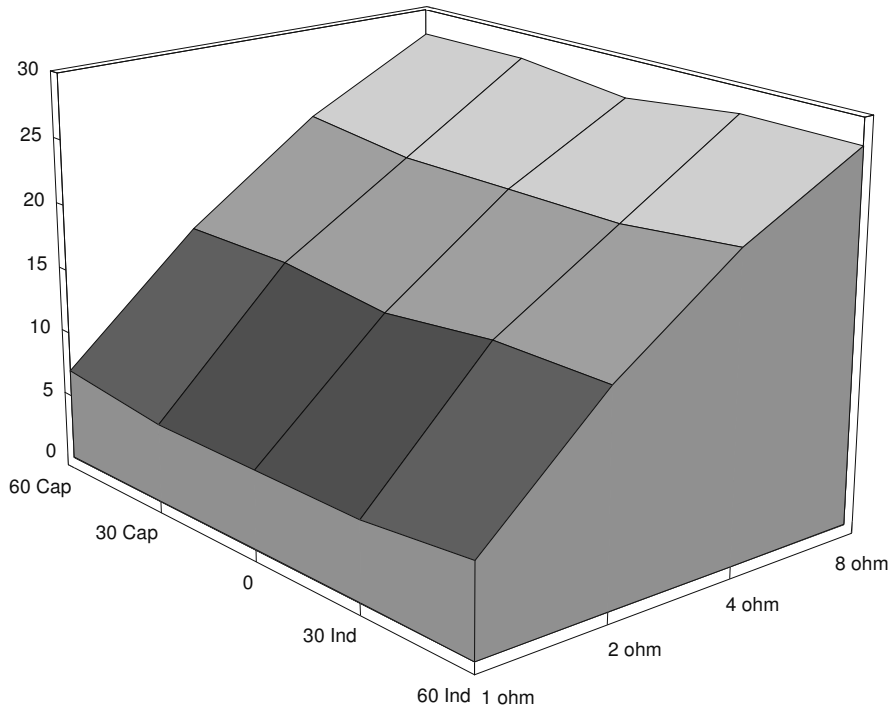


Measured output power
[Equivalent Watts]

8 Ohm	60° Cap	98	W
8 Ohm	30° Cap	98	W
8 Ohm	0° Res	91	W
8 Ohm	30° Ind	98	W
8 Ohm	60° Ind	98	W
4 Ohm	60° Cap	169	W
4 Ohm	30° Cap	169	W
4 Ohm	0° Res	156	W
4 Ohm	30° Ind	169	W
4 Ohm	60° Ind	169	W
2 Ohm	60° Cap	264	W
2 Ohm	30° Cap	242	W
2 Ohm	0° Res	242	W
2 Ohm	30° Ind	242	W
2 Ohm	60° Ind	264	W
1 Ohm	60° Cap	361	W
1 Ohm	30° Cap	324	W
1 Ohm	0° Res	324	W
1 Ohm	30° Ind	324	W
1 Ohm	60° Ind	361	W

Brand: Good Example
Rating: 70 W at 4 ohms

Example 3: Poor power supply

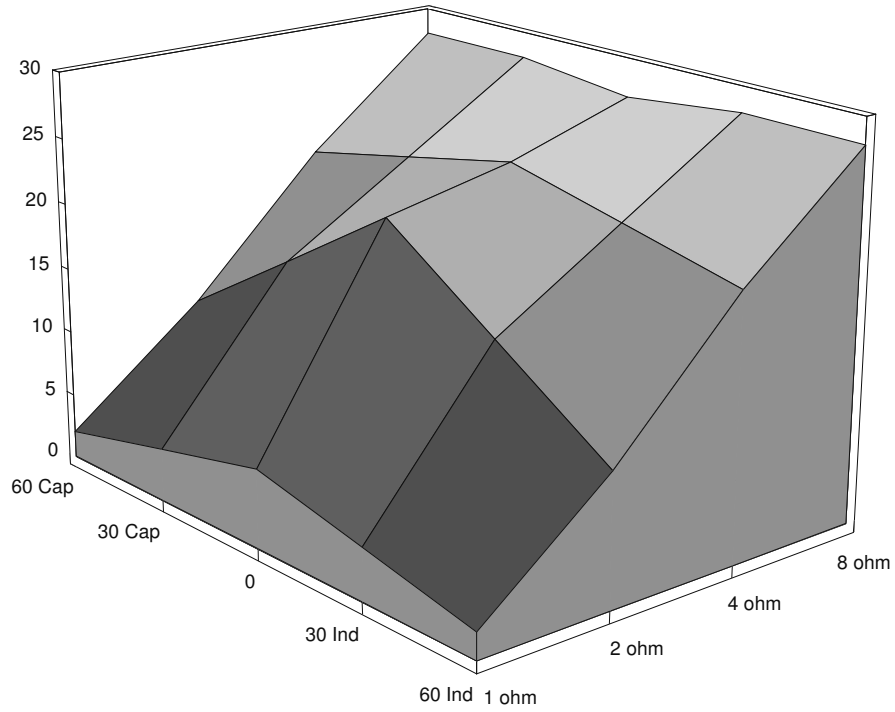


Measured output power
[Equivalent Watts]

8 Ohm	60° Cap	98	W
8 Ohm	30° Cap	98	W
8 Ohm	0° Res	91	W
8 Ohm	30° Ind	98	W
8 Ohm	60° Ind	98	W
4 Ohm	60° Cap	132	W
4 Ohm	30° Cap	121	W
4 Ohm	0° Res	121	W
4 Ohm	30° Ind	121	W
4 Ohm	60° Ind	132	W
2 Ohm	60° Cap	128	W
2 Ohm	30° Cap	128	W
2 Ohm	0° Res	112	W
2 Ohm	30° Ind	128	W
2 Ohm	60° Ind	128	W
1 Ohm	60° Cap	49	W
1 Ohm	30° Cap	36	W
1 Ohm	0° Res	36	W
1 Ohm	30° Ind	36	W
1 Ohm	60° Ind	49	W

Brand: Poor Power Supply
Rating: 70 W at 4 ohms

Example 4: Bad design of current limiting.

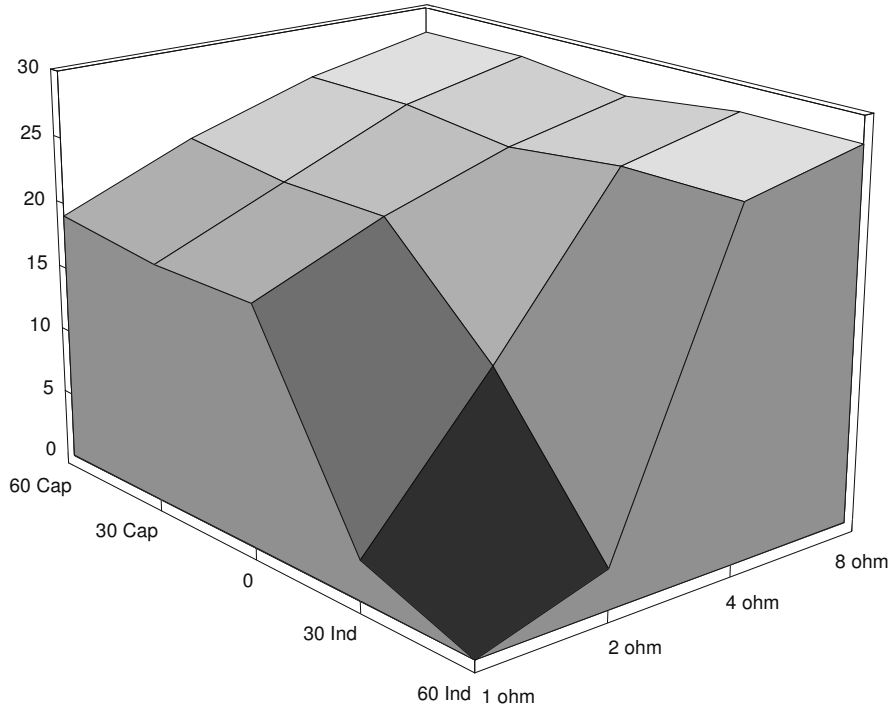


Brand: Bad Design of Current Limiting
Rating: 70 W at 4 ohms

Measured output power [Equivalent Watts]

8 Ohm	60°	Cap	98	W
8 Ohm	30°	Cap	98	W
8 Ohm	0°	Res	91	W
8 Ohm	30°	Ind	98	W
8 Ohm	60°	Ind	98	W
4 Ohm	60°	Cap	100	W
4 Ohm	30°	Cap	121	W
4 Ohm	0°	Res	144	W
4 Ohm	30°	Ind	121	W
4 Ohm	60°	Ind	100	W
2 Ohm	60°	Cap	50	W
2 Ohm	30°	Cap	128	W
2 Ohm	0°	Res	242	W
2 Ohm	30°	Ind	128	W
2 Ohm	60°	Ind	50	W
1 Ohm	60°	Cap	4	W
1 Ohm	30°	Cap	16	W
1 Ohm	0°	Res	36	W
1 Ohm	30°	Ind	16	W
1 Ohm	60°	Ind	4	W

Example 5: Oscillating at inductive loads



Brand: Oscillating at Inductive Loads
Rating: 70 W at 4 ohms

Measured output power [Equivalent Watts

8 Ohm	60°	Cap	98	W
8 Ohm	30°	Cap	98	W
8 Ohm	0°	Res	91	W
8 Ohm	30°	Ind	98	W
8 Ohm	60°	Ind	98	W
4 Ohm	60°	Cap	169	W
4 Ohm	30°	Cap	169	W
4 Ohm	0°	Res	156	W
4 Ohm	30°	Ind	169	W
4 Ohm	60°	Ind	169	W
2 Ohm	60°	Cap	264	W
2 Ohm	30°	Cap	242	W
2 Ohm	0°	Res	242	W
2 Ohm	30°	Ind	98	W
2 Ohm	60°	Ind	4	W
1 Ohm	60°	Cap	361	W
1 Ohm	30°	Cap	324	W
1 Ohm	0°	Res	324	W
1 Ohm	30°	Ind	9	W
1 Ohm	60°	Ind	0	W

PowerCube

Specifications for a standard test system

Generator
- 20 Hz to 20 kHz sine wave
- Residual distortion: 0,05% at 1 kHz typical
- Bursted test signal in accordance with EIA RS-490
- Two outputs with separate attenuators
- Output level from 0 V to 5 V in 4000 steps.

Analyzer
- 20 Hz to 20 kHz
- Anti aliasing filter: 40 kHz 6:th order G.I.C.
- Input range: 1volt to 130 volt peak
- Two parallel input channels
- Residual distortion: 0,05% at 1 kHz typical

1 kHz physical Loads (two sets)
- 8 ohm +60, +30, 0, -30, -60 degrees +/- 5%
- 4 ohm +60, +30, 0, -30, -60 degrees +/- 5%
- 2 ohm +60, +30, 0, -30, -60 degrees +/- 5%
- 1 ohm +60, +30, 0, -30, -60 degrees +/- 5%

Available options
- 200 Volts peak input range
- Bursted test signal in accordance with CEA-2006
- AES 17 filters
- Slew rate damper (for Class-D amplifier measurement)

Computer requirements

Minimum requirements:
- 1GHz CPU with Windows 2000 or Windows XP
- 128 Mb of memory
- Screen resolution of 1280 x1024
- One half length PCI slot place, 5 volt keyed
- One full length PCI slot place, 3 or 5 volt keyed

Power Rating

The loadbox is an integrated part of the PowerCube measurement system and it comes with three different power ratings. Power rating is increased by installing options 001 and 002 on a standard test system.

Number of channels:	2
Power rating:	400 W to 5000 W, depending on selected impedance and options installed. See separate table.
Impedances:	8,4,2,1 ohm
Phases:	0 degrees, +/-30 degrees, +/-60 degrees
Tolerances:	All loads are within +/-5%

All power specifications are subject to getting the heat out off the load box, airstreams must not be blocked.

Standard PowerCube system, normal power rating

Impedance	*Power Rating / channel EIA RS-490 1 kHz Burst. (formerly known as IHF A-202)*	*Power Rating / channel CEA 2006 50 Hz Burst (opt.005) (Resistive loads only)*
8 ohm	400 W	250 W
4 ohm	800 W	500 W
2 ohm	2400 W	1000 W
1 ohm	4800 W	1000 W

PowerCube system with option 001 installed, medium power rating

Impedance	*Power Rating / channel EIA RS-490 1 kHz Burst. (formerly known as IHF A-202)*	*Power Rating / channel CEA 2006 50 Hz Burst (opt.005). (Resistive loads only)*
8 ohm	1000 W	250 W
4 ohm	2000 W	500 W
2 ohm	4000 W	1000 W
1 ohm	4000 W	1000 W

PowerCube system with option 001 and 002 installed, high power rating

Impedance	*Power Rating / channel EIA RS-490 1 kHz Burst. (formerly known as IHF A-202)*	*Power Rating / channel CEA 2006 50 Hz Burst (opt.005). (Resistive loads only)*
8 ohm	2500 W	250 W
4 ohm	5000 W	500 W
2 ohm	5000 W	1000 W
1 ohm	5000 W	1000 W



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