audio | GRAph

PowerCube Option:
Water Cooled Load Box

Operation Manual
Version 1.4 - August 21, 2009

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System Description

Power supply

The Water cooled load box has a switching power supply. It will function properly from 100VAC to 240VAC.

Fuses

Fuses are mounted in the power inlet. You must remove the power cord to access them.
Use two ceramic slow blow fuses 5x20mm, 250V/4A for example Littlefuse #215004

> ⚠️ IMPORTANT:
> ALWAYS CONNECT THE WATER COOLED LOADBOX TO AN OUTLET WITH A GFI - GROUND FAULT INTERRUPTER.

DSP unit

For communication with the computer, please use a standard USB cable. The DSP unit will control the switching of the load resistors and measure the temperature on all of them.

Water Cooled Loads

The water cooled load box is, of course, cooled by water. It also has a wall of fans to help cooling the power resistors. For most applications, the fans will provide sufficient cooling. For the most demanding applications though, water cooling will be needed. We suggest that you test your specific application and investigate what cooling needs you have.

Load plates

The loads are mounted on six load plates. Five of them are water cooled, the last one is only air cooled. Each water cooled plate has two pipes for water connection.
- One pipe has a valve – this is the water *input* pipe – for water IN to the system.
- The other pipe has no valve – this is the water *output* pipe

Temperature measurement

The temperature of the load resistors is monitored by the software to prevent insufficient cooling.

Water connections

Water flow

At full power, 12 kW, each plate needs 16 liter/minute. At 10 kW, 6 liter/minute is sufficient. Temperature rise at each plate is quite modest, from 5 to 15 degrees centigrade. All tests at AudioGraph have been done with water connections in parallell. Probably you will get quite good cooling with the plates in serial as well if you a good water flow.

Total power dissipation

When the system is water cooled, maximum 12 kW can be dissipated in total. This includes air- and water cooling, and is the maximum power that can be dissipated from the Test Amplifier and the Load Amplifier together.

Example 1

When measuring half bridge amplifiers in 8 ohms (i.e. checking power capability for an eight ohm resistive load), the two connected amplifiers are connected with a 16 ohm resistor.   This resistor can handle 600 Watts continuously.

Using the CEA2006 50 Hz test signal, we will have a 40% duty factor, which allows us to load the resistor with 600/0.4 = 1500 watts during the 10 period tone burst.
(The test signal consists of 10 periods ON and 20 periods attenuated 20 dB)

These 1500 watts is shared of the two amplifiers, since they both "see" a virtual ground in the middle of the 16 ohm resistor. Hence, we may "in 8 ohms" use the Water cooled load box with a 750 watts test amplifier, and a 750 watts load amplifier.

The value doubles up when going to 4 ohms , so we can handle a 6,000 Watts amplifier in 1 ohm.

Example 2

When measuring a full bridge amplifier, the two respective amplifiers are connected with two 8 ohm resistors. But actually each resistor consists of two 16ohm/600 watts resistors in parallel, which gives the two amplifiers 2400/0.4 (duty factor) = 6000 watts to share.

Hence, we may in 8 ohm bridged mode measure amplifiers up to 3000 watts in 8 ohm. This value doubles up when going to 4 ohm (6000 Watt/4 ohm). But even if we in theory can handle 12000 watts in 2 ohm, and 24000 watts in 1 ohm, the system can't dissipate more power then 6000+6000 watts for test amplifier and load amplifier.

Max input voltage

There is another limitation as well, we cant measure more then +/-200 Volts peak. That equals 2500 Watts /8 ohm, which is the "voltage" limit for this system.

Understanding Electronic loads

Classic PowerCube measurements is done using reactive components as a load to the amplifier. Resistors, capacitors and inductors of proper values are connected to the amplifier to act as a model of a loudspeaker. The measurement is done with a 1kHz test signal which have become a de facto standard for dynamic power measurements.

To do a test at 50 Hz is a bit more complicated – if you want to decrease the frequency 20 times, the size of the capacitors and inductors will increase 20 times, which would make the system hard to implement.

The solution is an electronic load – we use *one* amplifier as a test object, and *another* amplifier as a load. We connect the two amplifiers with a resistor, and we feed the two amplifiers with phase shifted signals – this will end up in one amplifier seeing a capacitive load, and the other amplifier an inductive load.

Pros

The electronic load approach will let us measure PowerCubes at 50 Hz.

Cons

This electronic load approach using two identical amplifiers, will not let us tell inductive and capacitive loads apart. Since we feed the two amplifiers with two phase shifted signals, one of them will "see" a capacitive load, and the other will "see" an inductive load. If we for example will see a flaw in the PowerCube at 4 ohm/60 degrees, we can not really tell which one of the amplifiers that causes this – hence we can not tell capacitive and inductive loads apart.

PowerCube graphs

For clarity, we still plot the full PowerCube graph. In theory, the 30 degree values and 60 degree values should be identical. Sometimes, this is not the case, probably because of slight differences between the amplifiers.

Test setup

The test setup will look different depending of the topology of the amplifier – let's look at tests for half bridge and full bridge amplifiers one by one:
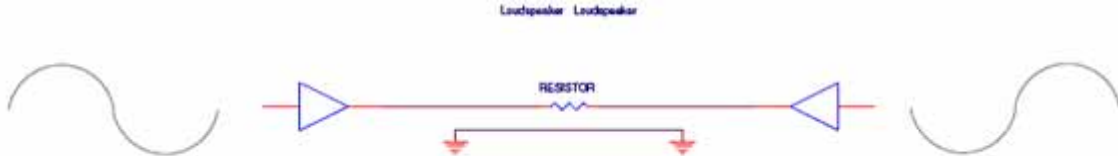
Measuring half-bridge amplifiers in theory

- We need two identical amplifiers, one as load and one as test object (actually both of them will act as load for each other):

- We connect the two amplifiers with a resistor:

- And finally, we feed them with phase shifted signals

When signals are 180 degrees out of phase, voltage and current will be aligned for each amplifier – making both of them 'see' an resistive load. A zero degrees, totally in phase, no current will flow and each amp will not 'see' any load at all. At all other phases, since voltage and current will not be in phase, the respective amplifier will 'see' an inductive or capacitive load.
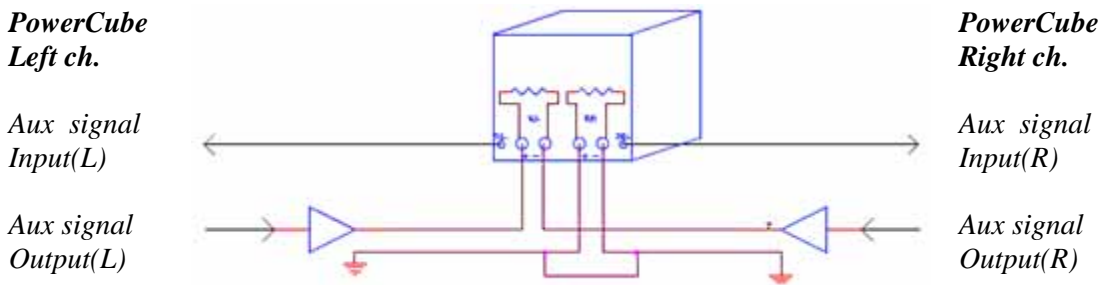
Measuring half-bridge amplifiers in real life

Connect the two amplifiers to the water cooled load box as follows:

Water cooled load box

Left amplifier
(Or left channel)

Right amplifier
(Or right channel)
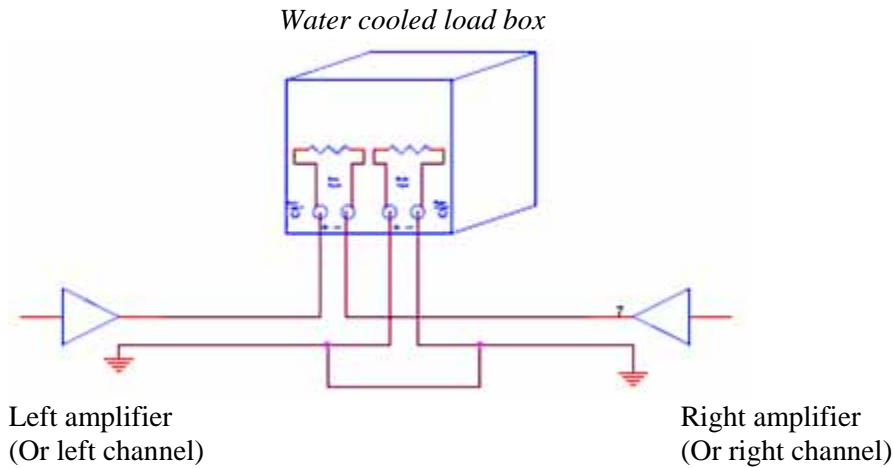
Of course the right resistor above is not really needed in this test setup, since it is shorted, but the system needs the ground reference from the amps.

Finally, connect the signals to and from the PowerCube unit:

PowerCube
Left ch.

PowerCube
Right ch.

Aux signal
Input(L)

Aux signal
Input(R)

Aux signal
Output(L)

Aux signal
Output(R)

## Measuring a half-bridge stereo amplifier

You may use a stereo half-bridge amplifier in the same way as above. Connect the respective channels together just as they were different amplifiers. The cable connecting the grounds is of course not needed.

WARNING: Some stereo amplifiers have swapped connectors on one channel, which means that "the hot" connector is black and the "ground" connector is red (this is to make bridging easy). When measuring amplifiers like this, use the GROUNDED connector as ground, not the black one – and don't forget to check the corresponding checkbox in the software!
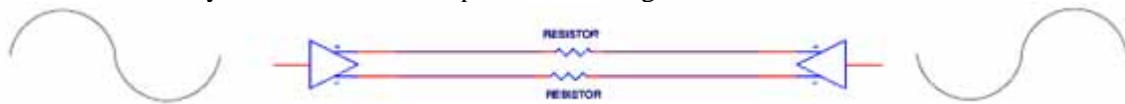
Measuring full-bridge amplifiers in theory

- We need two identical amplifiers, one as load and one as test object (actually both of them will act as load for each other):
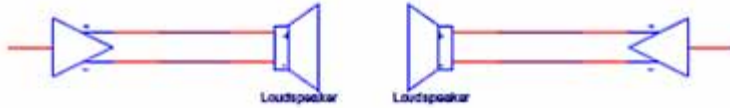
- We connect the two amplifiers with two resistors:
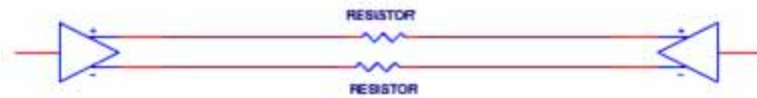
- And finally, we feed them with phase shifted signals

When signals are 180 degrees out of phase, voltage and current will be aligned for each amplifier – making both of them 'see' an resistive load. A 0 degrees, totally in phase, no current will flow and each amp will not 'see' any load at all. At all other phases, since voltage and current will not be in phase, the respective amplifier will 'see' an inductive or capacitive load.
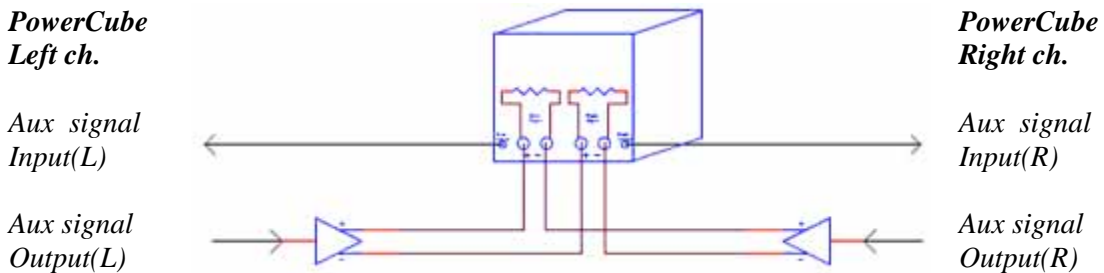
Measuring full-bridge amplifiers in real life

Connect the two amplifiers to the water cooled load box as follows:

Water cooled load box

Left amplifier
(Or left channel)

Right amplifier
(Or right channel)
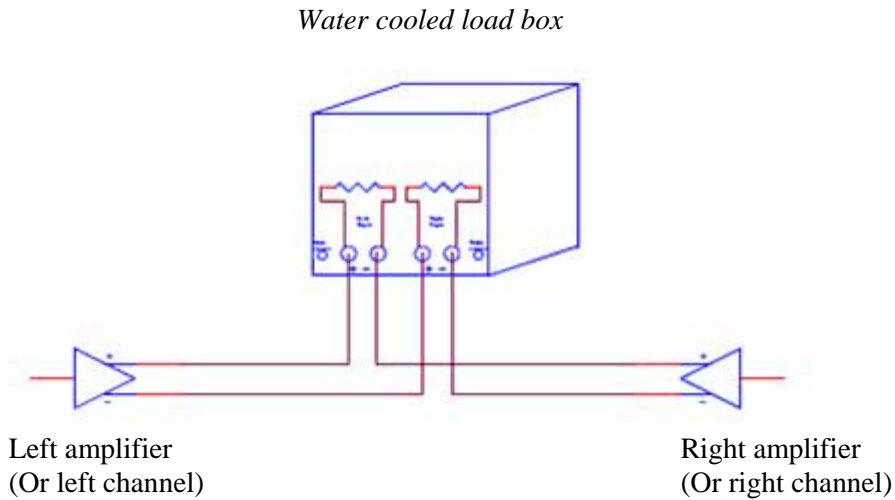
NOTE:
Do NOT connect negative outputs with each other when measuring full bridge amplifier.!

Finally, connect the signals to and from the PowerCube unit:

PowerCube
Left ch.

Aux signal
Input(L)

Aux signal
Output(L)

PowerCube
Right ch.

Aux signal
Input(R)

Aux signal
Output(R)

Measuring a full-bridge stereo amplifier

You may use a stereo full-bridge amplifier in the same way as above. Connect the respective channels together just as they were different amplifiers.

Tips to make it go easy

The electronic load test setup is far more complicated than the ordinary PowerCube test setup. You must be careful so you don't connect anything the wrong way. Here are some tips to make it easy for you:

- When using to separate amplifiers – always connect them with a common ground if possible.

- When testing amplifiers with DC power supply – try to make a common ground on the DC side. Make this ground wire as short as possible.

- Connect the computer, monitor, PowerCube and load box to the same power outlet to prevent ground loops.

- It's good to connect the amplifier (or the power supply) to power outlet using another phase (or circuit breaker). This will prevent EMI interference from the amplifier/power supply to reach the test setup.

- Don't use longer cables than necessary for signal connections

- Don't use other software on the computer when measuring an amplifier – if another software takes full control of the CPU, the PowerCube software could get stuck waiting for processing time, and that can cause permanent damage to the amplifier and the PowerCube system

- Always power up the PowerCube system before connecting an amplifier! When powering up the loadbox, all loads will connect and disconnect in about one second - causing very low impedance at the load connectors!

- Always connect your amplifier to the PowerCube system, before powering the amplifier!

- Keep your test environment 'clean' so you easily can identify your cables

- Make your first measurements with a stereo half bridge amplifier – using each channel as a load for the other channel. This is the easiest test setup!

Overloading

Values below are maximum values at continuous use. Both water- and fan cooling must be activated. For shorter durations though, such as a single measurement, overloading is possible even without water cooling activated. Since the temperature of the load resistors is monitored, the system will shut down before it gets damaged.

Max power handling with 50 Hz CEA 2006 signal, for each amplifier

Impedance	Half bridge	Full bridge
8 Ohm	750 W	3000
4 Ohm	1500 W	6000
2 Ohm	3000 W	6000
1 Ohm	6000 W	6000

Software

The PowerCube software comes with extensions for the Water Cooled load box.
We will walk you trough what is new to help you get started as fast as possible. But first you need to install the new software. You have two ways to go, but either way – Backup your data files first!

The easy install

If you want to make this the easy way, you can try to just replace Powercube.exe and Powercube.exe and Powercubesetup.mdb:

- Make backups of your system, or at least of your data file "PowerCube Measurements.mdb"
- Shut down your Powercube software
- Locate your Powercube.exe and rename it Powercube.old
- Locate your Powercubesetup.mdb and rename Powercubesetup.old
- Copy the new Powercube.exe to the same directory as where you found the old one.
- Copy the new Powercubesetup.mdb to the same directory as where you found the old one.
- Restart.
- If the software does not start properly, you need to do the full install – sorry!

The full install

- Make backups of your system, or at least of your data file "PowerCube Measurements.mdb"
- Open MS Windows control panel, and select "Add or Remove programs"
- Locate Powercube in the list and remove it
- Close control panel and its relating windows
- Run the setup.exe from the setup package – the software will guide you.

Select comport

First you must set up the connections between the PC and the Load box -this is done by selecting the right communications port, comport. To do this, you must power up your system – please do it this way:

- Connect your Load box to your PC with the enclosed USB cable.
- Connect your Load box to the mains with a power cord suitable for your country.
- Power up your Load box
- When powering up, relays will click and fans will start – this is normal.

Now MS Windows will detect your new USB device. Let windows install the necessary drivers (you don't have to locate it – they are known by Windows).
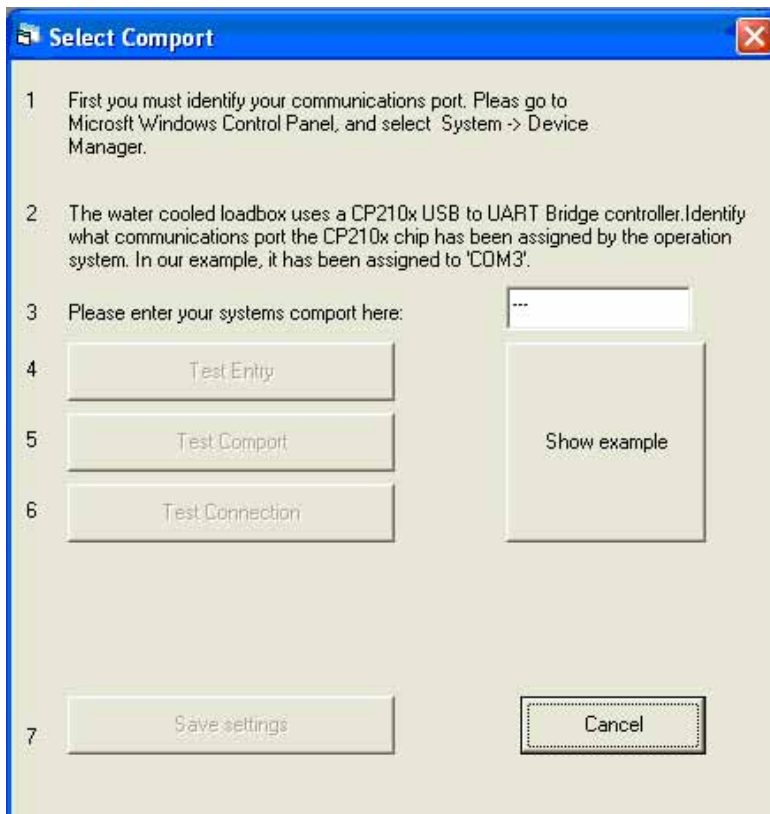
When Windows is done installing drivers – please start your PowerCube software.

When the software is up and running – please select "File -> select comport" from the menus:

Open the "Select comport window"
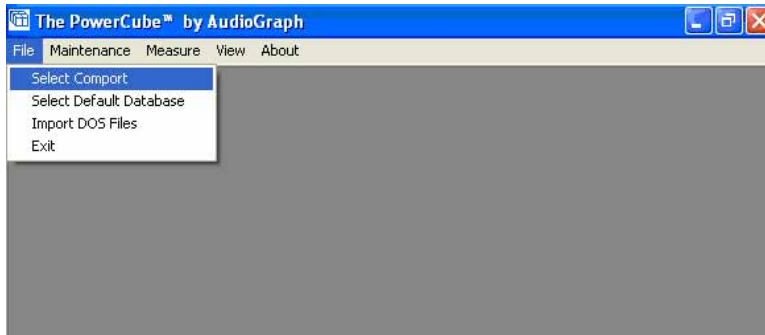
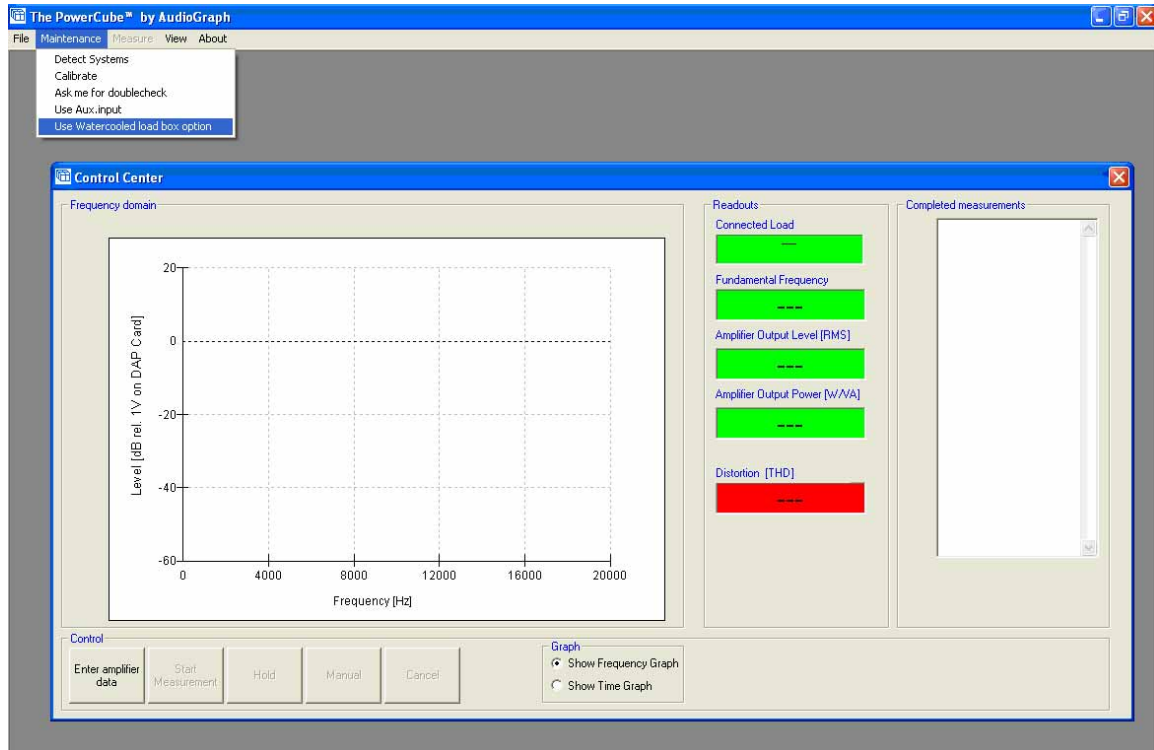## Let the software walk you through the comport selection

When you have selected the comport properly – save your selection!
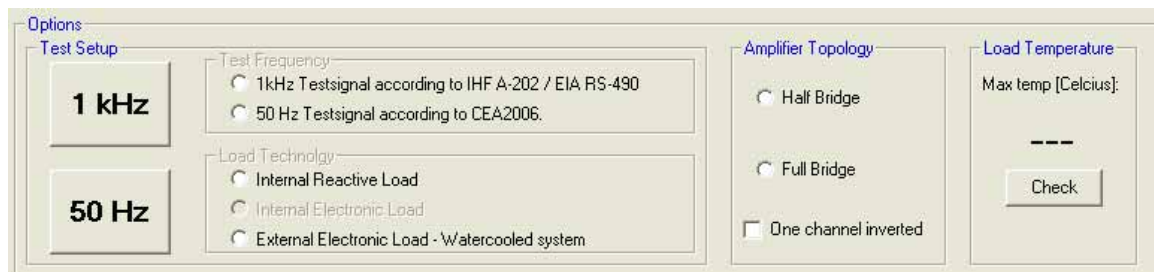
The Control Center

Please open the control center just as you are used to.
When its opened, activate the options to control your new Loadbox:

New Controls

The controls for the new options will be docked to the bottom of the control center window.

Test Setup

Select if you want to do an ordinary PowerCube measurement at 1 kHz, or a 50 Hz measurement using electronic load technology, with the water cooled load box. You have two buttons to make it easy – the rest is set up by the software.

Amplifier Topology

When using electronic loads it's extremely important to know what kind of amplifier you are measuring. Is it a half bridge design, or a full bridge?

> NOTE:
> Making the wrong selection, half- or full bridge, will make your measurement incorrect!

Some half bridge stereo amplifiers have swapped connectors on one channel, which means that "the hot" connector is black and the "ground" connector is red (this is to make a bridged output easy). Check or uncheck the checkbox according to your amplifiers design!

> NOTE:
> Making the wrong selection, inverted or not, will make your measurement incorrect!

> NOTE:
> Your respective amplifiers must be connected as described in "Understanding electronic loads" above.

Load Temperature

In this frame you will see the temperature of the hottest load resistor. It will be updated in the measurement loop. If it's not updated properly, a watchdog resets it after 15 seconds. Since a lot of concurrent processes are running, its normal that it is being reset and re-measured. When the loads get to hot, the system will shut down.

When not in a measurement loop, you can hit the "Check" button to get the load temperature.