NORECS

ProboStat™ Base Unit Heating Systems Manual

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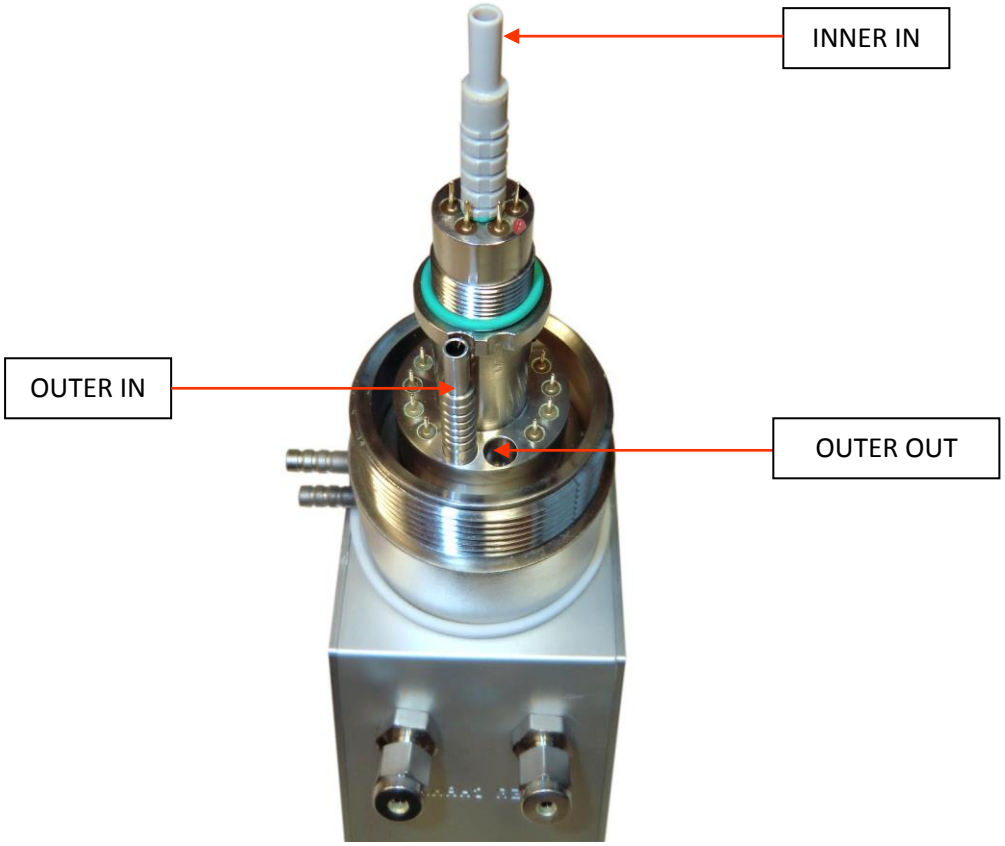
Base unit heating introduction

Base unit heating is an optional feature for ProboStat™ sample holders. The aim of this option is help the user in the task of heating the gas lines prior (and after) the cell chamber to avoid unwanted reactions such as condensation. With this option the base unit is divided into two compartments separating the gas lines and connectors to one compartment and keeping the electrical connectors and switches in another compartment. Heater and heat sensors are added into the compartment with the gas lines to heat and to monitor the heat. The system also includes simple voltage source with 1 V steps allowing the user to get started.

The base unit heating option helps users with temperature control, but additional steps are required to achieve optimal heating system.

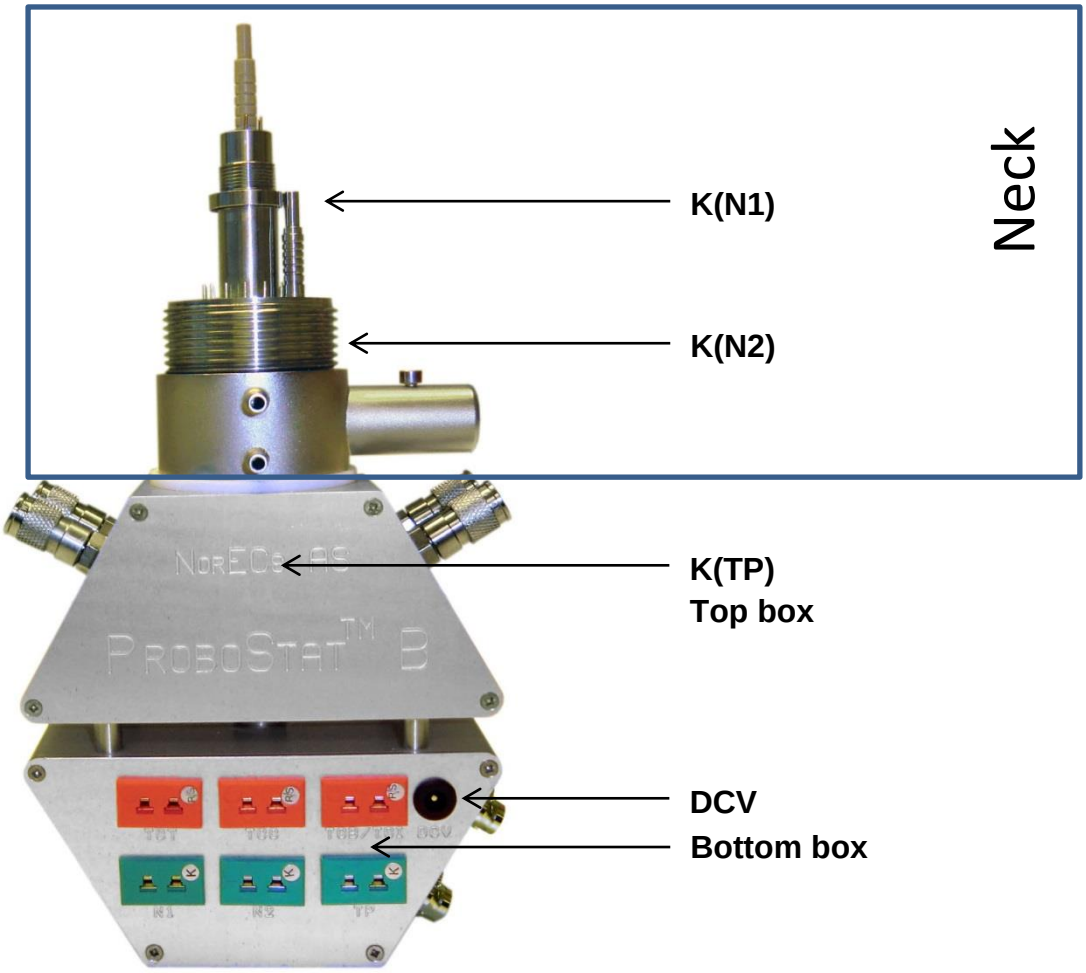
Important

On some of the heated base units, the neck gas connections for the outer chamber are: OUTER OUT on the left, OUTER IN on the right, while most ProboStat™ models have the opposite configuration: OUTER IN on the left, OUTER OUT on the right (see picture). Always test with flow of air or isopropanol when in doubt.



Terminology

Term	Explanation
Base unit	All parts of the sample holder that are outside the furnace.
Neck	Top part of the base unit where the electrical feedthroughs are located. The area where to connect the electrodes, support tubes and the outer enclosing tube with the flange.
Hexagon	The hexagon shaped box (combining top and bottom box).
Top box	Top box is the upper half of the base unit where the gas connections are located.
Bottom box	Bottom box is the lower half of the base unit where the electrical connection are located
K(TP)	Connection for the K-type thermocouple located inside the top box. Approximate sensor locations can be seen in the picture below. Also marked TP in some cases.
K(N1)	Connection for the K-type thermocouple located inside the neck as far up as possible in all versions.
K(N2)	Connection for the K-type thermocouple located inside the neck halfway up.
DCV (max 24 V DC)	Connection to power the heater inside. Only connect to DC power source, never exceed the maximum 24 V DC. Typical voltages used are less than 24 V DC.



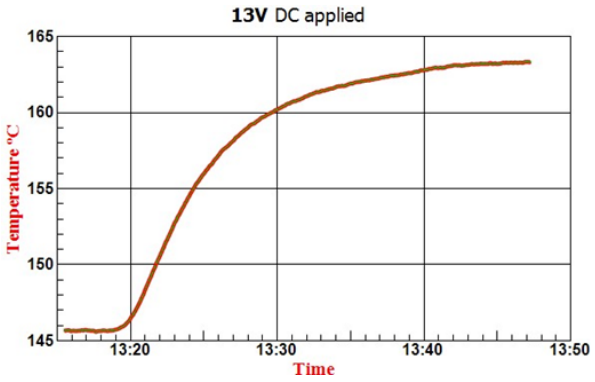
Base unit heating details

Resistance heater inside the top box can heat the gas lines that are inside the base unit. The heater is supplied with direct current from the included power supply. An adjustable DC power source is provided with the cell allowing 1 Volt steps. Do not connect the power supply before reading this entire manual. It is possible to ruin the base unit by overheating it.

To achieve precise control over the heating, connect to a laboratory power supply with fine voltage control. If used with the provided power supply, control output voltage by inserting different chips to set the voltage, see table at end of this document.

It is essential to get feedback of the temperatures, and not to exceed the set limits. Connect the K(TP), K(N1) and K(N2) to a thermocouple reader or multimeter capable reading K-thermocouples. NorECs Omega software with a multichannel multimeter can read large numbers of thermocouple voltages and convert them to temperatures.

To heat the base unit, select a low voltage such as 12 V DC, plug the power supply to the power inlet and then turn on the power supply. It will take significant time to reach temperature equilibrium as seen in the picture. **To avoid overheating, do not increase the applied voltage before the equilibrium is reached.**



N1 thermocouple is located close below the top level pins, and N2 likewise below the lower level pins. The temperatures they indicate are not the exact temperatures of the feedthroughs, but may be even 20ºC lower or higher depending on what kind of temperatures gradients the cell is exposed to.

The base unit heating option helps the user to heat the gas lines inside the top box, but additional steps may be necessary. The gas lines before the ProboStat™ base unit may need heating also. Also the neck area of ProboStat™ may require, if not active heating, at least some insulation. The required amount of heating power depends on the operating conditions, and to reach a good balance and procedure will require some experimentation.

To obtain feeling of the heating behavior, run tests with conditions as close to the real conditions of intended use, considering all the factors below:

1) Large items inside the sample holder such as the sample support tube and, specifically, the outer tube and the flange
2) Distance between furnace bottom and cell neck
3) Possible insulation on the neck area
4) Furnace temperature
5) Ambient temperature
6) Sunlight

7) Draft from a hood
8) Amount and temperature of ingoing gas
9) Heat brought to neck with outgoing gas

Reference values

These values are **not to be used as facts**, but instead show just a rough idea of the correlation between voltage, current and equilibrium temperatures. For each individual setup conditions are different, and as each batch of cartridge heaters differ, user should make table of their own similar to this for later reference.

Example table: Base unit heating system tested with moderate draft on base unit without a furnace.

Applied voltage, V DC	Resulting current, A	Equilibrium temperature, °C of K(TB)
13	2,32	165
14	2,48	182
15	2,64	204
16	2,8	230
17	2,95	264 (Above specifications – potential damage to the cell)

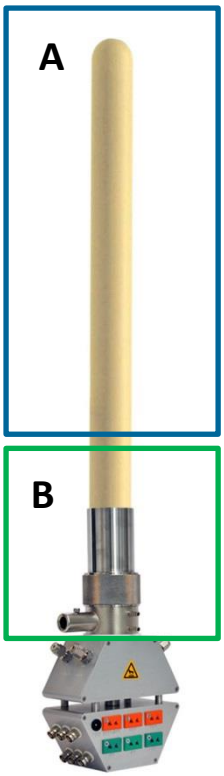
Note that 165 ºC is the maximum temperature the system is rated for. Long term test at 165 ºC is not recommended. Most parts tolerate more, but contact NORECS before attempting higher temperatures than 165 ºC.

Overheating protection

The top box is equipped with automatic overheating protection that will disconnect the circuit if and when temperature rises above 165°C. This is a safety feature only, and not intended to be used as a thermostat to limit the temperature on regular basis. Cutting off (and automatically recovering, after temperature have decreased) the power with relay will result in unsteady temperature and electrical interference. Limiting the temperature must be done by adjusting the applied voltage.

It is important to understand that the safety feature applies only to the hexagon or top box, and not to any possible additional heating on the neck. If additional heating solutions are applied to the neck, guarding against overheating is the responsibility of the user.

Neck heating details



Area A is inside a furnace, and will radiate heat down to area B. The amount is different for each setup. Care must be taken not to overheat the region B. If the temperature is too low in the neck region B, consider using external means such as insulation or external heaters to increase the temperature in the neck.

Adjustable power supply

A power supply is included in the system. It is capable of regulating the voltage from 12 to 24 VDC and 1.5 to 2.5A current. The power supply is borderline underpowered on purpose to avoid overheating accidents. Once the user is comfortable with the system, it is possible to proceed to use more advanced laboratory power supplies. In such case, disconnect and keep the plug:

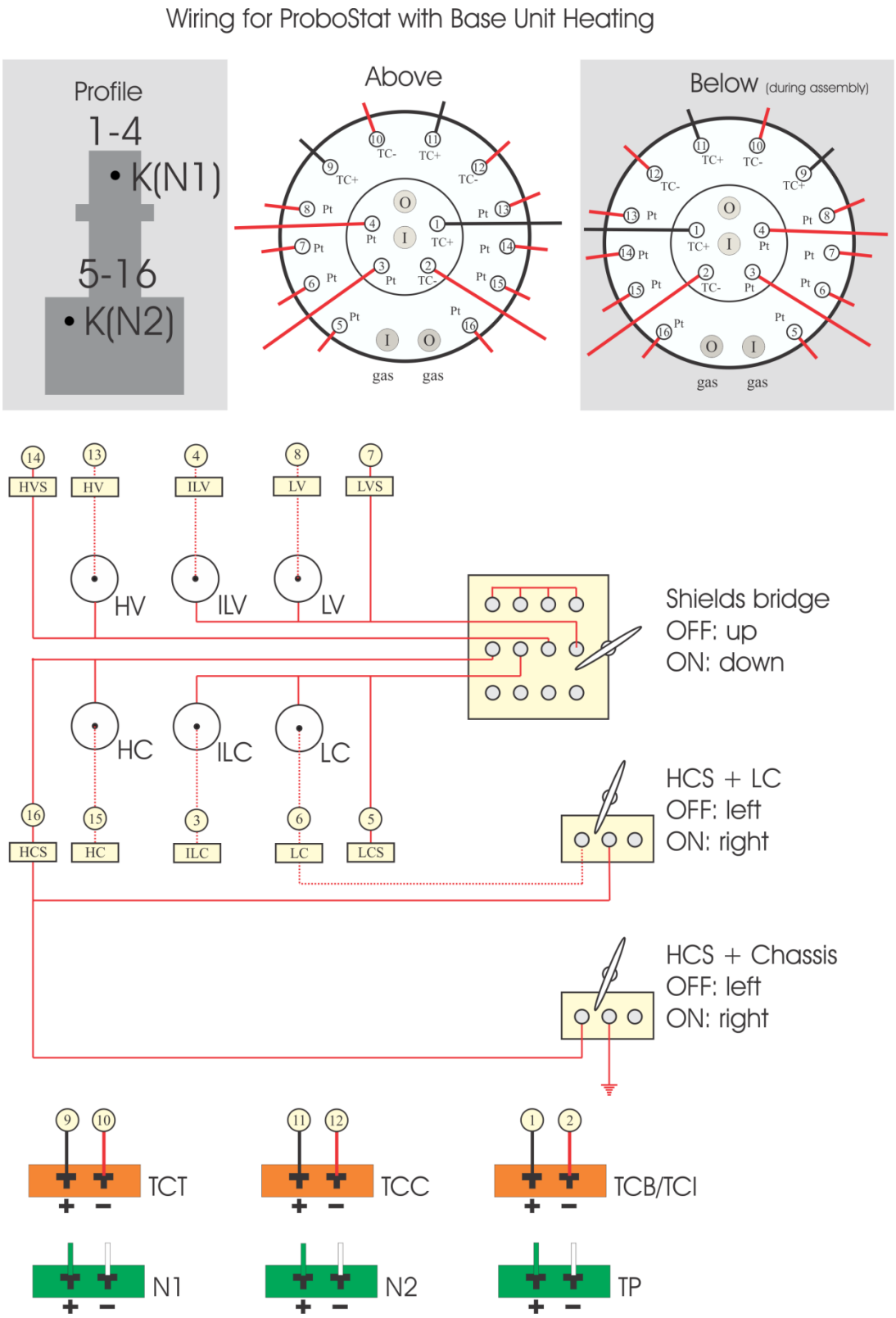
Mains plug is Europlug or Cenelec standard EN 50075, or as seen on this image:

Switches

Due to limited space the switches have different alignment than on the normal ProboStat™. On the heated base unit the switches are connected when in following position:

Shields bridge	connected when down
HCS + LC (High current shield to Low current)	connected when right
HCS + Chassis (High current shield to Chassis)	connected when right

Wiring overview



Troubleshooting

In case of problems print out and fill in this page, and send to POST@NORECS.COM

Issue	Task	Write results here
Base unit does not heat up	Measure resistance of the heating circuit. Disconnect the adapter at the end of the power supply and plug it into the cell. It has two pins so measuring circuit resistance is easy.	
	If possible, measure current through the heating circuit.	
If resistance of circuit was < 10 Ohm and current goes through	Supply 14 VDC to heating circuit. Measure voltage of K(TP) at 0, 1 and 5 minutes	
Identify base unit	Write down base unit serial number	
	Address of base unit	