# ProboStat™ Starting Guide

As we are always learning from feedback from our customers and users, and for giving better understanding of the ProboStat™ sample holder, we present this note as a complementary material to the ProboStat™ Manual. The main goal of this document is explanation of the ProboStat™ system design which is not covered in the Manual.

## 1. ProboStat™ Gas Supply System

### 1.1. Recommended reading

First, we recommend familiarizing youself with:

a) ProboStat™ Manual:

- Part 2 "Safety first", pp. 2-1 – 2-2,
- Part 4.2.4 "Gas connects", pp. 4-5 – 4-7,
- Part 4.4 "Support tubes", pp. 4-12 – 4.13,
- Part 4.5 "Gas supply tubes", pp. 4-13 – 4-14,
- Part 6.3 "Pressures, vacuum, leakage rates, atmosphere purity", pp. 6-1 – 6-2,
- Part 7.3 "Gas tightness", pp. 7-4 – 7-5,
- Part 9.3 "Over-atmospheric pressure", pp. 9-3 – 9-4,
- Part 9.4 "Wet gases with dew-point above room temperature", p. 9-4,
- Part 12.1.4 "Inner gas tubes", pp. 12-4 – 12-6.

b) NorECs web page www.norecs.com :

- FAQ – atmosphere control
- FAQ – sealing

### 1.2. Single and dual atmosphere modes

The ProboStat™ is a sample holder designed to perform experiments in single or dual atmosphere modes at near-atmospheric total pressure, and can be fed with virtually any gas.

#### 1.2.1. *Single atmosphere mode*

The term "single atmosphere mode" means that one gas is fed in both inner and outer ProboStat™ gas compartments. The single atmosphere mode is used for:

- 2-point impedance spectroscopy and conductivity measurements on disk sample
- 2-point conductivity measurements on disk sample with surface guard
- 4-point conductivity measurement on disk sample (van der Pauw geometry)
- 4-point conductivity measurement on bar sample
- Seebeck coefficient measurements
- Annealing and sintering under controlled atmospheres

#### *1.2.2. Dual atmosphere mode*

The term "dual atmosphere mode" means that the inner gas compartment is gas-tight separated from the outer gas compartment. Achieving this separation is a process we call sealing. Then sealed the inner and outer compartments can be fed with different gases or gas mixtures.

The dual atmosphere mode is used for:

- Transport number measurements
- SOFC and SOEC test and characterization
- Running electrochemical reactors / electrochemical pumping
- Permeability measurements

## 1.3. Gas connects, stems and stubs

#### *1.3.1. Gas connects*

The gas connects mounted on the base unit hexagon are by default Swagelok quick-connects. In the high-temperature base units the quick-connects are replaced by Swagelok bulkheads and mounted on the top part of the splitted hexagon.

The stainless steel (SS) base unit has SS gas lines and SS quick-connects (steel colour). The Ni-coated brass base unit has copper gas lines, and brass quick-connects (yellow colour).

The inner and outer ProboStat gas compartments are marked "INNER" and "OUTER". Each compartment has gas inlet and outlet quick-connects appropriately marked "IN" and "OUT", resulting in "INNER IN", "INNER OUT", "OUTER IN", and "OUTER OUT". The "IN"s are quick-connects with valves that are closed when matching stems are disconnected. The "OUTER" connectors are always open.

Table 1. Swagelok gas connects.

| Part no. | Type | Material | Valve | Function |
|---|---|---|---|---|
| B-QM2-B1-200 | Quick-connect | brass | yes | Gas IN |
| B-QM2-B1-200MB | Quick-connect | brass | no | Gas OUT |
| SS-QM2-B1-200 | Quick-connect | SS316 | yes | Gas IN |
| SS-QM2-B1-200MB | Quick-connect | SS316 | no | Gas OUT |
| SS-200-61 | Bulkhead | SS316 | no | Gas IN, Gas OUT |

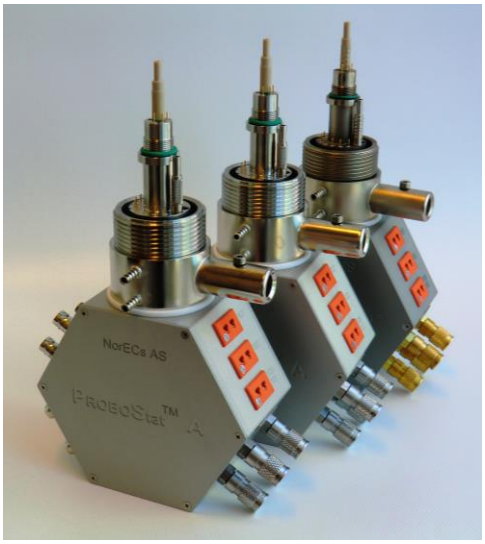



Fig. 1: SS and brass base units.


Fig. 2: IN and OUT quick-connects for INNER and OUTER gas compartments.


Fig. 3: SS bulkheads mounted on top part of splitted hexagon.

### *1.3.2. Gas stems*

As standard, the quick-connects are matched by four quick-connect stems for connecting to 1/8" tubing. The tubing material must be suitable for the gas used, and softer material than the ferrules of the stem.

Fig. 4: Brass quick-connect stem with valve, for "IN"s.

Fig. 5: Brass quick-connect stem without valve, for "OUT"s.

The valve on the stems opens only when plugged to a quick-connect with valve. To plug or unplug a stem pull/push it into the quick-connect while holding back the rasterized collar.

We recommend having some spare parts for gas connectors and stems, namely Swagelok brass and/or SS ferrule sets, parts no. B-200-SET and SS-200-SET accordingly.

Table 2: Swagelok gas stems.

| Part no. | Material | Valve | Function | Match to |
|---|---|---|---|---|
| B-QM2-D-200 | Brass | yes | Gas IN | B-QM2-B1-200 |
| B-QM2-S-200 | Brass | no | Gas OUT | B-QM2-B1-200MB |
| SS-QM2-D-200 | SS316 | yes | Gas IN | SS-QM2-B1-200 |
| SS-QM2-S-200 | SS316 | no | Gas OUT | SS-QM2-B1-200MB |

### *1.3.3. Gas stubs*

The inner IN and outer IN base unit gas lines are extended to the high temperature zone by various gas supply tubes mounted on the base unit using gas stubs and piece of silicone hose.

The gas stub for the inner gas compartment is made of PEEK and assembled by a Viton sealing O-ring. The PEEK gas stub is screwed onto the upper part of base unit body.

The gas stub for the outer gas compartment is made of SS and assembled by two Viton sealing O-ring. The SS gas stub is set into the lower part of base unit body.

Fig. 6: ProboStat™ PEEK and SS gas stubs

Fig. 7: ProboStat™ base unit with gas stubs mounted.

## 1.4. Base unit sealing O-rings

The ProboStat base units can be supplied with Viton or Isolast sealing O-rings depending on the base unit operating temperature. The standard base units are equipped with Viton O-rings, the high-temperature one – with Isolast version.

Fig. 8: Viton (green) and Isolast (black) O-rings.

Depending on use, the O-rings have four different sizes presented in the table below.

Table 3: Standard ProboStat™ O-rings.

| Size, mm | | Amount, pcs | Material | Mounting place | Use |
|---|---|---|---|---|---|
| Outer diameter | thickness | | | | |
| 40 | 3 | 1 | Viton/Isolast | Alumina, quartz or transport outer tubes | Outer tube mounting.<br>Sealing the base unit outer gas compartment against environment.<br>Base unit protection during transportation. |
| 15.6* | 1.78* | 1 | Viton/Isolast | Upper part of base unit body | Sealing between inner and outer gas compartments.<br>Sample support tube mounting. |
| 4 | 1 | 3 | Viton | SS and PEEK gas stubs | Gas stubs mounting |
| 43 | 2 | 2 | Viton/Isolast | Base unit core | Seal for water cooling system |

* Can be replaced by 16.0×1.5 mm O-ring depending on sample support tube socket shape.

## 1.5. Gas supply tubes

The ProboStat™ is supplied with various gas supply tubes. These are to be used inside the cell to supply gases directly to the sample area.

Table 4: Standard gas supply tubes delivered with the ProboStat™. *

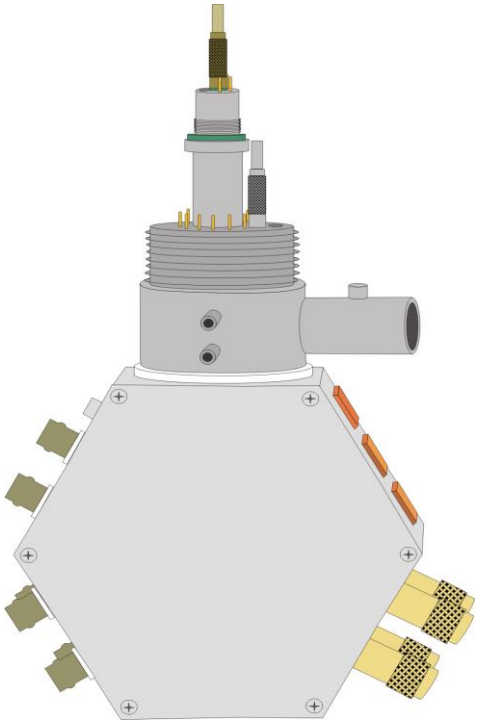
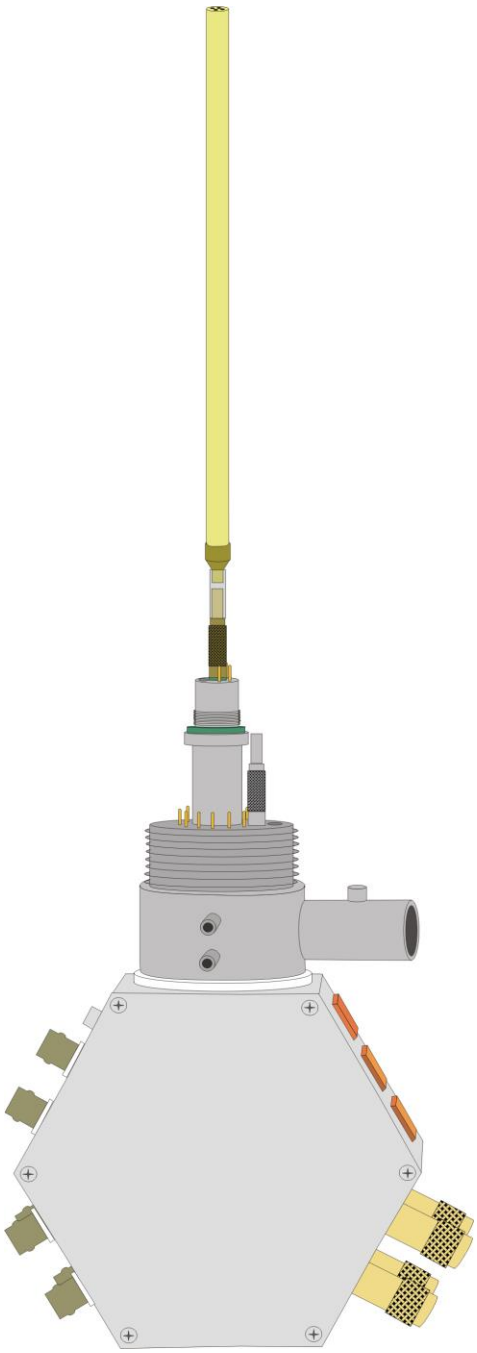
| Material | Shape | Diameter, mm | Length w/o silicone hose, mm | Sample support tube diameter, mm | Gas compartment | Working temperature, °C |
|---|---|---|---|---|---|---|
| Alumina | Straight | 4 | 480 | 10 - 20 | outer | < 1600 |
| Alumina | Straight | 3 | 480 | 24 | outer | < 1600 |
| Quartz | Bent | 4 | 525 | 10-20 | outer | < 950 |
| Quartz | Bent | 3 | 525 | 24 | outer | < 950 |
| Alumina | Multi-bore | 8.5 | 446 | 20-24 | inner | < 1600 |
| Alumina | Straight | 4 | 470 | 15-16 | inner | < 1600 |
| Alumina | Straight | 3 | 470 | 10-12 | inner | < 1600 |

*All numbers are for the system with 60 cm outer tube.

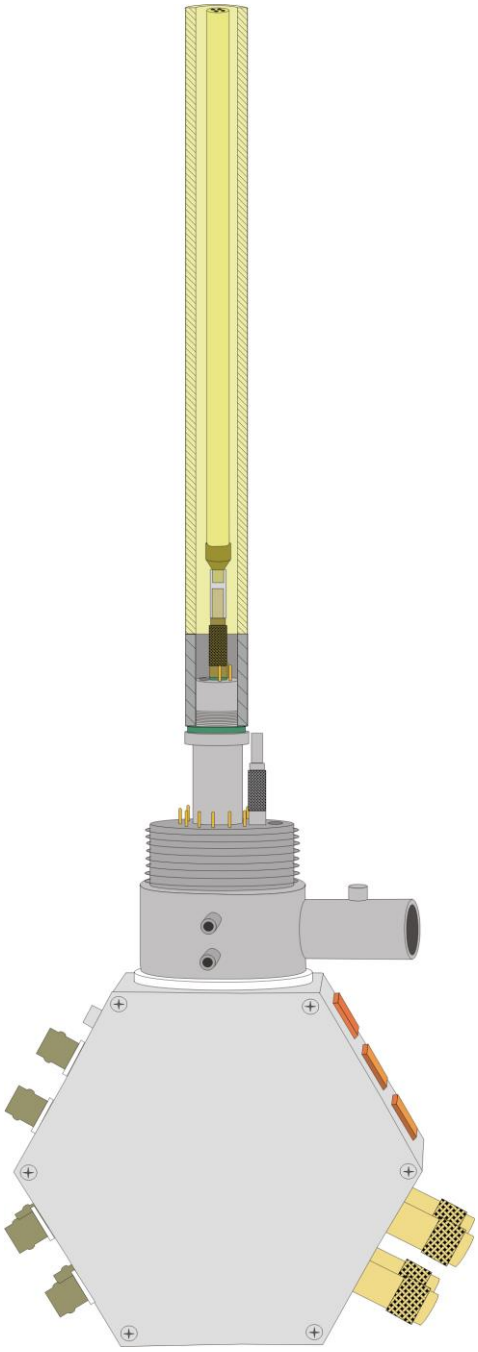
## 1.6. Setting up gas compartments

This part presents a step-by-step description how to create two ProboStat™ gas compartments. For simplicity only the gas supply system is shown. The electrical system, temperature control, spring-load system, and water cooling system will be described elsewhere.

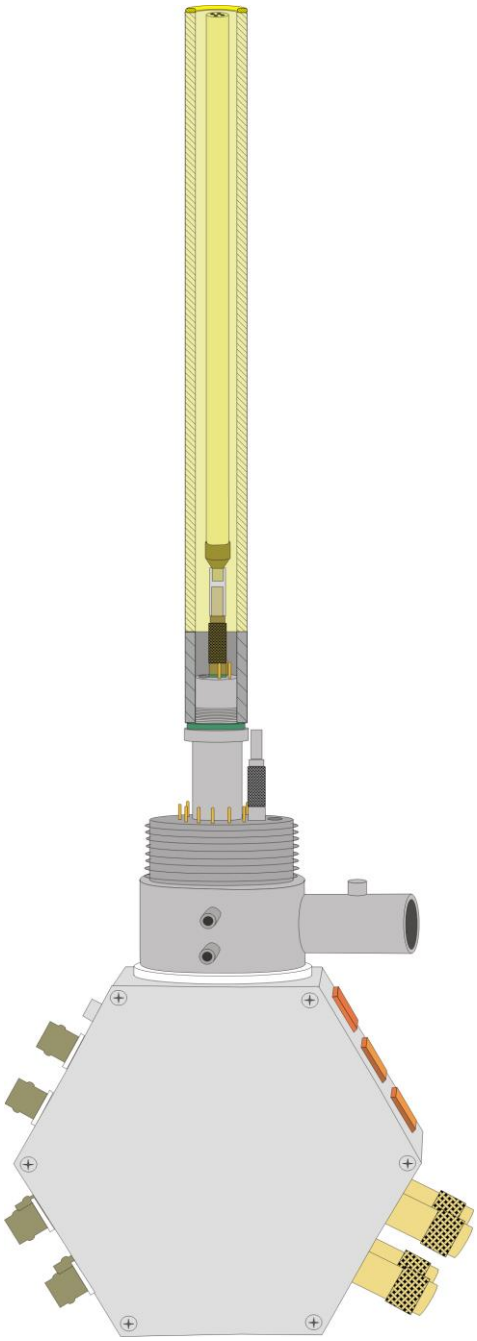
Table 5. Assembling ProboStat™ gas compartments.

| | |
|---|---|
| **Step 1:**<br><br>Place the ProboStat base unit on the bench, preferably fix it in a lab stand using a bar for base unit fixture.<br><br>  | **Step 2**:<br><br>Mount the inner gas supply tube onto the PEEK gas stub.<br><br>  |

**Step 3:** Mount the sample support tube tight.

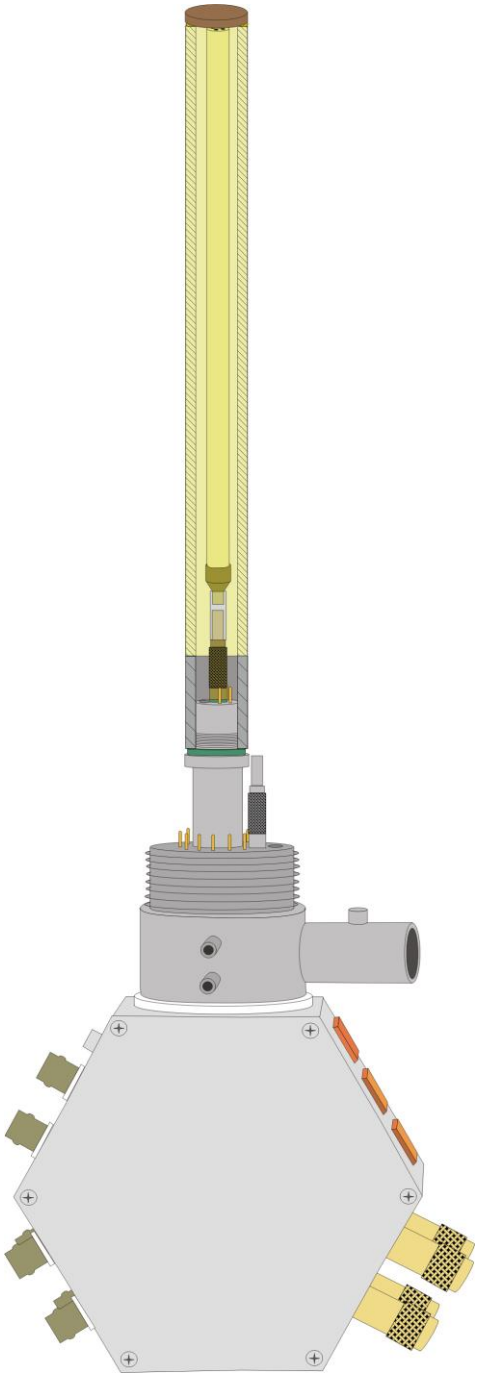


**Step 4:** Place an Au sealing ring on top of the sample support tube. *



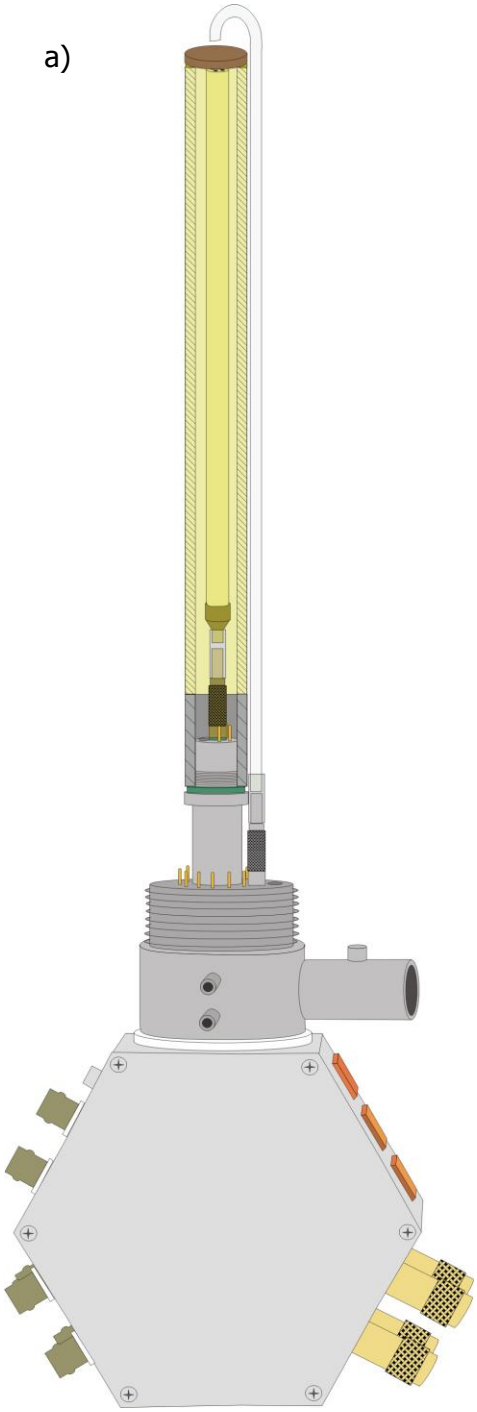
*This step is relevant for the gas compartments separation. If you plan to measure using the single atmosphere mode, skip this step.

**Step 5:** Place a sample on top of the gold ring (or directly on the sample support tube for the single atmosphere mode). Check that the gold ring and sample are centered.



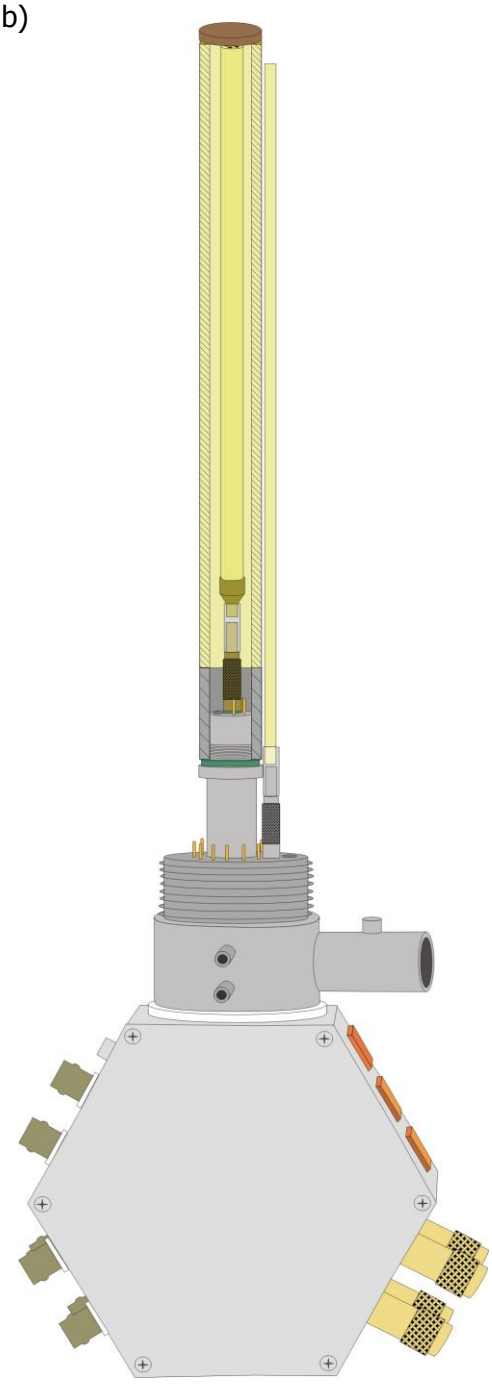
**Step 6:** Mount outer bent silica (a) or straight alumina (b) gas tube onto the SS gas stub.

a)

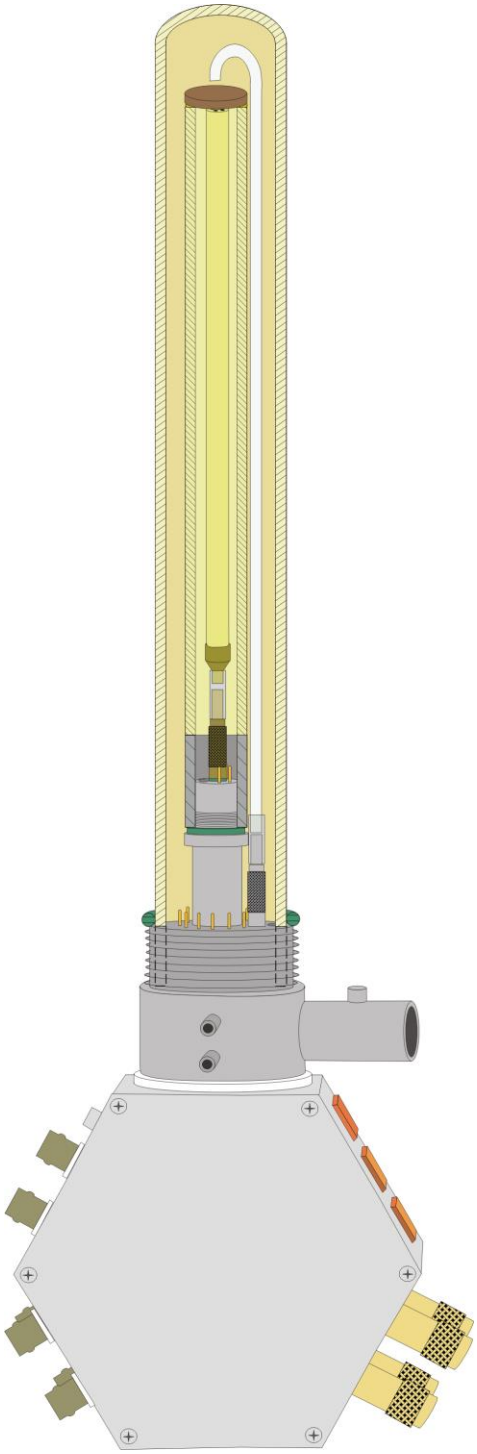


**Step 6:** Mount outer bent silica (a) or straight alumina (b) gas tube onto the SS gas stub.

b)

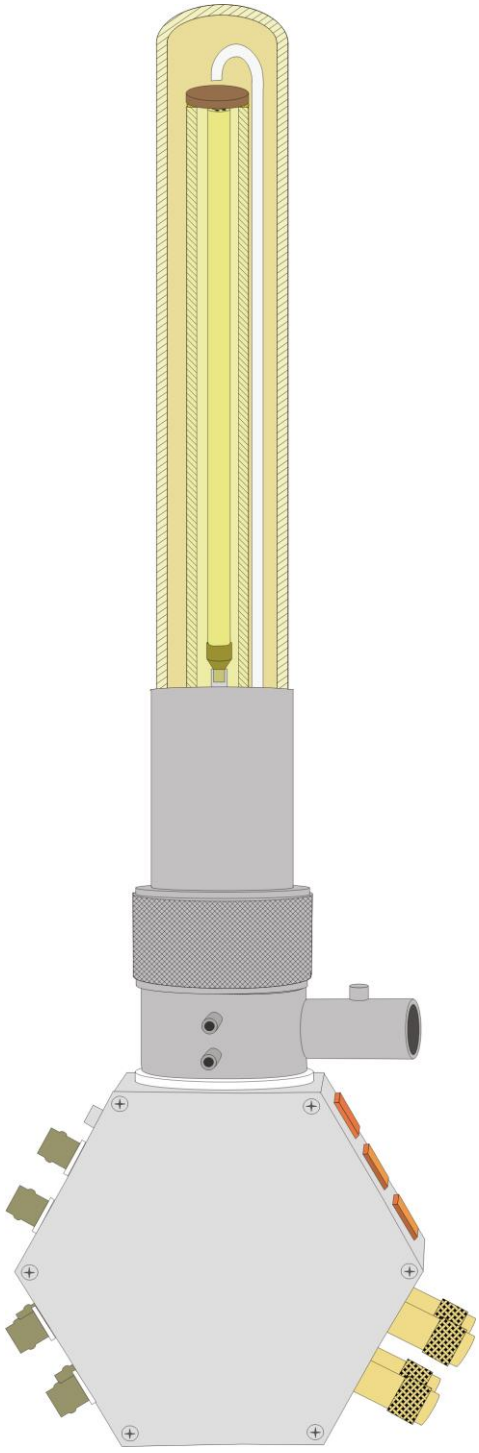


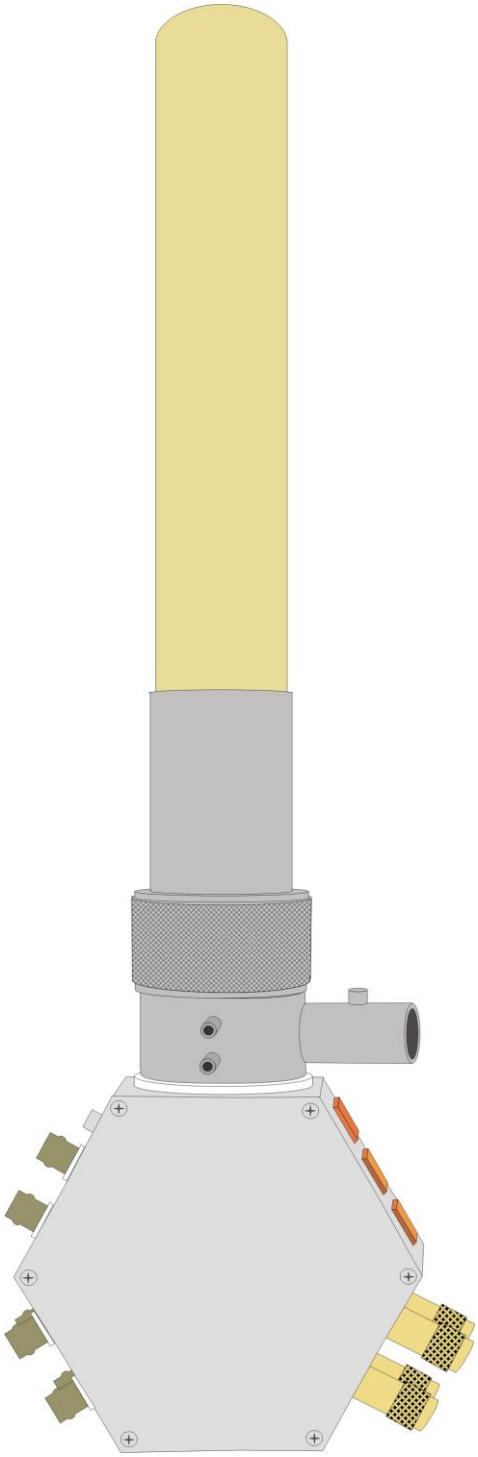
**Step 7:** Mount enclosing quartz or alumina tube and O-ring.*



*For simplicity the spring load assembly is not explained or drawn here. In real setup it is always present and push the sample down on the AU ring.

**Step 8:** Fasten the base unit flange.





# 2. ProboStat™ electrical system

In this part we describe ProboStat™ electrode contact assemblies, base unit electrical wiring, and coaxial cables.

## 2.1. Recommended reading

We recommend familiarizing youself with:

a) ProboStat™ Manual:

- Part 4.2.6 "Electrical feedthroughs", pp. 4-7 – 4-8,
- Part 4.2.7 "Sockets and switches on the connector box", pp. 4-8 – 4-10,
- Part 4.2.8 "Wiring Schemes", pp. 4-10 – 4-12,
- Part 4.7 "Thermocouple and electrode contacts", pp. 4-15 – 4-19,
- Part 6.4 "Electrical specification", pp. 6-2 – 6-3,
- Part 7.1 "Electrical wires", pp. 7-1,
- Part 12.4 "Instruction for fabrication of electrode contact assemblies", pp. 12-13 – 12-20.

b) NorECs web page www.norecs.com :

- FAQ – How can I repair a Pt electrode contact?

## 2.2. Electrode contact assemblies

Electrode contact assemblies (hereafter called electrode contacts) are assigned to contact the ProboStat™ base unit with a test sample located in the high-temperature zone.

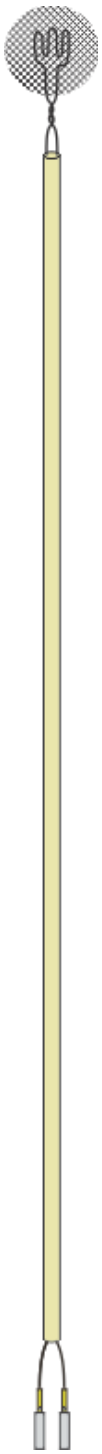
### *2.2.1. Description and denotation*

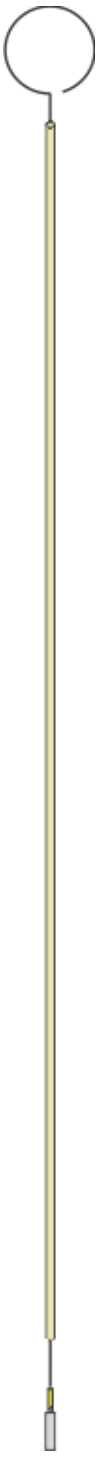
The electrode contacts for electrical measurements come in variety of types. Many of them are issued in 2-wire pairs; one for current and one for voltage.

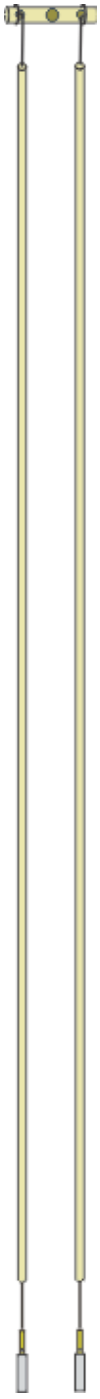
Table 6. Electrode contacts denotation

| Code | Description |
|---|---|
| H2N# | Electrode "hand" contact assembly, outer, 2-wire. # - diameter of Pt net disk |
| H1TN10 | Electrode "hand" contact assembly, outer, 1-wire, top |
| H1BN10 | Electrode "hand" contact assembly, outer, 1-wire, bottom |
| INH2N12 | Electrode "hand" contact assembly, inner, 2-wire |
| IN2 | Electrode contact assembly, inner, 2-wire |
| GP2 | Electrode contact assembly, general purpose, 2-wire |
| GP1 | Electrode contact assembly, general purpose, 1-wire |
| GR# | Guard ring. # - diameter of ring |
| vdP | Van der Pauw contact assembly |

Tabel 7. ProboStat™ electrode contacts.

| | | | |
|---|---|---|---|
| Electrode contact drawing |  |  |  |
| Code | H2N# | INH2N12 | IN2 |

| | | | |
|---|---|---|---|
| Electrode contact drawing |  |  |  |
| Code | GR# | GP2 | GP1 |

| | | | |
|---|---|---|---|
| Electrode contact drawing |  |  |  |
| Code | H1TN10 | H1BN10 | vdP2 |

### *2.2.2. High-voltage electrode contacts*

High-voltage (HV) electrode contacts are suitable for connection to special feedthroughs on the HV base unit. The HV base units are made upon request and usually not a matter for the detailed description.

There are two types of HV electrode contacts:

- Electrode "hand" contact assembly, outer, 1-wire, HV-version *(H1N10HV)*
- Guard ring, HV-version *(GR#HV)*

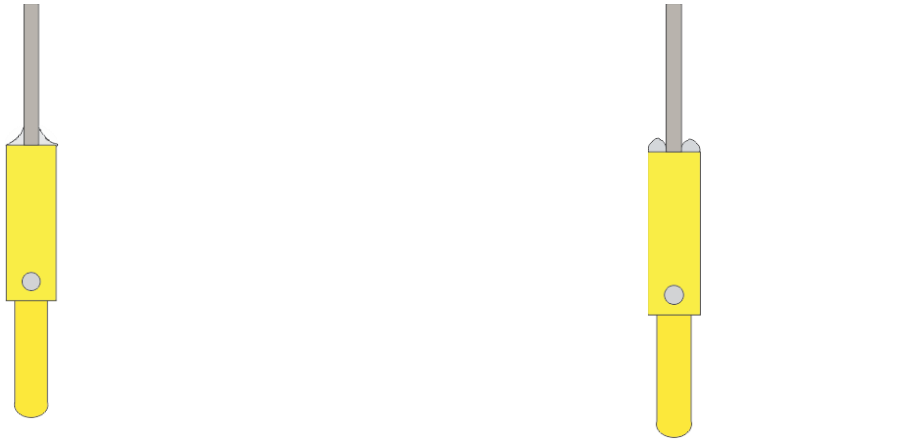
HV electrode contacts are shorter than normal and soldered to bigger mini-contacts.

### *2.2.3. Mini-contacts*

Supplied electrode contacts and thermocouples (see below) are soldered to female mini-contacts matching to the base unit feedthroughs. The mini-contacts are made of Au- and Ni-plated brass, and have size 22AWG, HV version – 20AWG.

### *2.2.4. Soldering of mini-contacts*

When soldering insert an appropriate metal wire into the mini-contact, and add solder by tiny portions until the mini-contact cup is filled. A solder drop should be visible through a small hole into the mini-contact. Make "shoulders" by pulling out the solder. It is important that solder wets metals.



Correct. The surfaces are wetted. Wrong. The surfaces are non-wetted.

Fig. 9. Soldering of mini-contacts.

#### *2.2.5. Mounting electrode contacts on the base unit.*

In order to connect the electrode contact to the base unit, mount the mini-contacts carefully onto appropriate feedthroughs. You may use a tweezers.

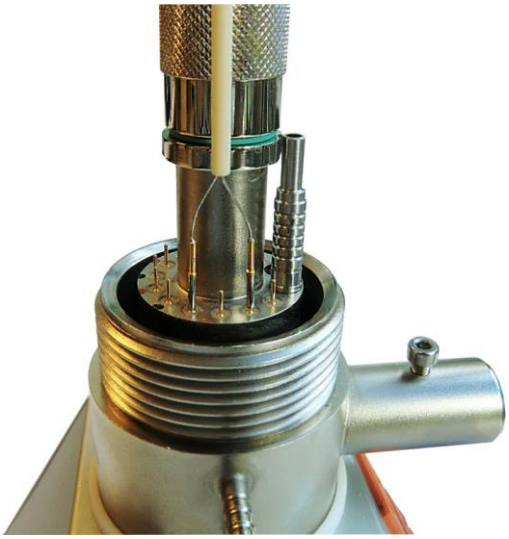


Fig. 10. The electrode contact connected to the base unit.

## 2.3. Base unit wiring

#### *2.3.1. Wiring overview*

The Wiring Overview (see next page, example for K-wired base unit) shows the coordinates, numbering and standard material of the electrical wiring for the base unit feedthroughs (top view, in relation to the gas inlets (I) and outlets (O)). Also the Phoenix-type chassis multi-connector that was fitted to early version is shown. The coding and functions are listed in detail in the table below.

We strongly recommend users to print the Wiring Overview (page 14-2 or 14-3 in the ProboStat™ manual) and hang it on a wall next to the ProboStat™ assembling point.

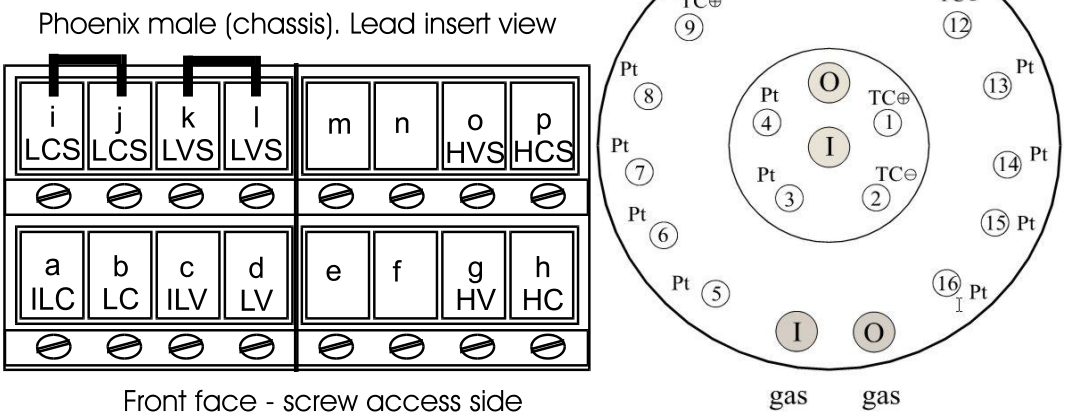
#### *2.3.2. Phoenix-type multi-connector*

The Phoenix type of multi-connector (Fig. 10) is no longer in use, and will not be described here. In case you need more information, please contact us.

# Wiring overview (all figures are top views)/K-Type

NorECs
Norwegian Electro Ceramics AS

The base unit shown here is for A-3 and higher. For A-2/A-1/B the outer **I**n and **O**ut gas paths (on the outer circle) are swapped.




Standard electrical wiring of ProboStat versions A-2 and later, using **S-type thermocouples**.

| Base unit feed-through code | Base unit feedthrough colour code | Standard material in hot zone | Function | Function code | Phoenix rectangular multi-connector (optional) code | BNC code (S = shield) | Thermocouple contact codes |
|---|---|---|---|---|---|---|---|
| 1 P | Green | NiCr | Bottom/inner TC+ | TCB+ | - | - | TCB+ |
| 2 N | White | NiAl | Bottom/inner TC- | TCB- | - | - | TCB- |
| 3 G | - | Pt | Inner low current | ILC | a | ILC | - |
| 4 G | - | Pt | Inner low voltage | ILV | c | ILV | - |
| 5 G | - | Pt | Low current shield | LCS | i,j | LCS | - |
| 6 G | - | Pt | Low current/Guard | LC | b | LC | - |
| 7 G | - | Pt | Low voltage shield | LVS | k,l | LVS | - |
| 8 G | - | Pt | Low voltage | LV | d | LV | - |
| 9 P | Green | NiCr | Top TC+ | TCT+ | - | - | TCT+ |
| 10 N | White | NiAl | Top TC- | TCT- | - | - | TCT- |
| 11 P | Green | NiCr | Centre/control TC+ | TCC+ | - | - | TCC+ |
| 12 N | White | NiAl | Centre/control TC- | TCC- | - | - | TCC- |
| 13 G | - | Pt | High voltage | HV | g | HV | - |
| 14 G | - | Pt | High voltage shield | HVS | o | HVS | - |
| 15 G | - | Pt | High current | HC | h | HC | - |
| 16 G | - | Pt | High current shield | HCS | p | HCS | - |

**Switches: Ch+HCS**: Chassis to shield (HCS), **LC+HCS**: Guard (LC) to shield (HCS), **when DOWN**.
**Shields Br.**: Connects all four shields together **when DOWN**.

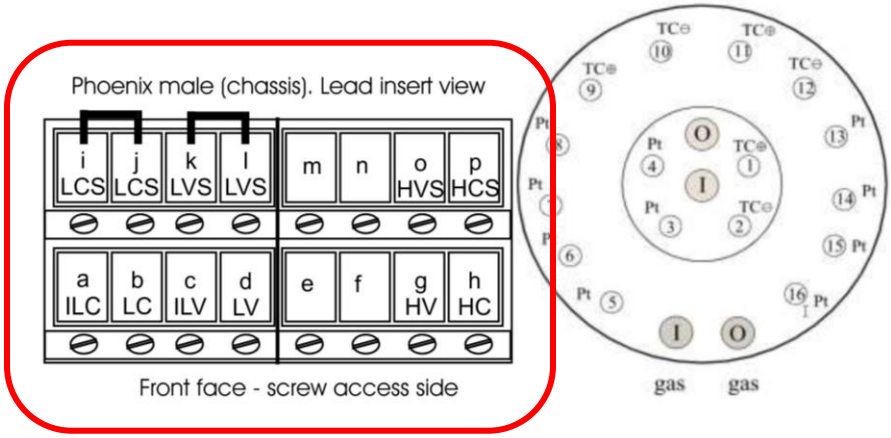



Fig. 10. Phoenix-type multi-connector wiring overview.

### *2.3.3. Overview of base unit electrical feedthroughs*

By electrical feedthrough we mean an assembly where the electrical lead goes through the base unit chassis from the electrode contacts to BNC contacts mounted on the base unit hexagon. The electrical feedthrough consists of male mini-contact, sitting in PEEK insulator, and soldered to compensation wire.

The feedthroughs are numbered starting with very top of the base unit and run clockwise from 1 to 4. The numbering continues on the outer ring from 5 to 16 again clockwise. The feedthroughs no. 1-4 are located in the inner gas compartment, no. 5-16 – in the outer.

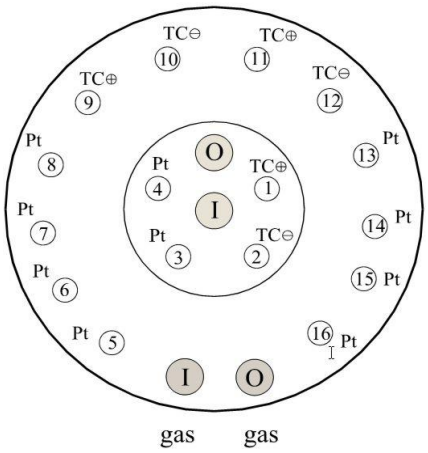



Fig. 11. Feedthrough numbering: drawing.

Fig. 12. Feedthrough numbering on base unit.


Fig. 13. Electrical feedthroughs codes

The feedthrough codes, standard materials and functionality are presented in the bottom table of the Wiring Overview.

### *2.3.4. Feedthroughs colour code*

The base unit has 16 feedthroughs: 10 electrical and 6 for thermocouples. All feedthroughs are colour coded.

Table 8. Feedthrough colour code

| Colour | Compensation wire to | Function |
|---|---|---|
| Red | Pt | Electrical, general<br>S-type thermocouple, negative |
| Black | Pt10%Rh | S-type thermocouple, positive |
| White | NiAl | K-type thermocouple, negative |
| Green | NiCr | K-type thermocouple, positive |

### *2.3.5. Signal and shield feedthroughs*

The ProboStat™ base unit has 10 electrical feedthroughs, 6 of them lead current or voltage signal, 4 - shield. The signal feedthroughs are soldered to the center of the BNC contacts, shields – to the plates.

ILC and ILV feedthroughs do not have own shield feedthroughs. However shield is important for some measurement instruments. For this reason, shield plates of LC and ILC, LV and ILV BNC contacts are connected pairwise. LCS and LVS act as shields for both, inner and outer, current and voltage probes.

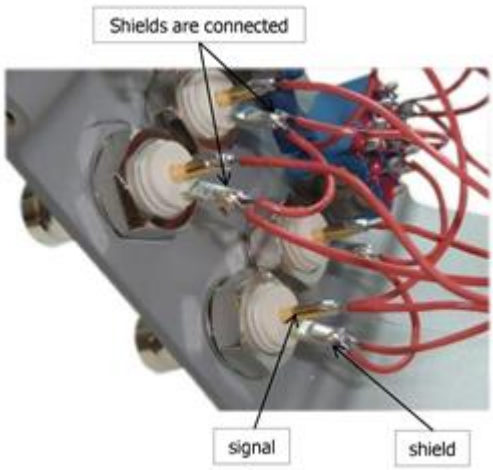



Fig. 14. Signal and shield connection from inside of the base unit.


Fig. 15. Signal and shield connection from outside of the base unit.

#### *2.3.6. Feedthrough function codes*

All feedthrough have own function codes listed in the bottom table of the Wring overview, see page 19. The codes HC, HV, ILC, ILV, LCS, LVS, and thermocouple codes are used only for feedthroughs denotation and have nothing to do with any codes or denotation on any measurement instrument.

### 2.4. Coaxial cables

The ProboStat™ is supplied with four identical shielded coaxial cables. The cables have color marks at the both ends for convenient use. These color marks have nothing to do with any codes or denotation on the ProboStat™ or measurement instruments.

Fig. 16. A coaxial cable with color mark.

## 3. ProboStat™ temperature control system

In this part we describe ProboStat™ thermocouple assemblies and base unit thermocouple wiring.

### 3.1. Recommended reading

We recommend familiarizing youself with:

a) ProboStat™ Manual:

- Part 4.7.1 "Thermocouples", pp. 4-17 – 4-18,
- Part 7.2 "Thermocouple operation, calibration, and temperature profiles", pp. 7-1 – 7-4,
- Part 8.1 "Temperature measurements", p. 8-1,
- Part 4.7 "Thermocouple and electrode contacts", pp. 4-15 – 4-19,
- Part 12.4 "Instruction for fabrication of thermocouple assemblies", pp. 12-11 – 12-13.

b) NorECs web page www.norecs.com :

- FAQ – Thermocouples and temperature control
- FAQ - Furnaces

## 3.2. Thermocouple assemblies

Thermocouple assemblies (hereafter called thermocouples) are assigned to control/read temperature in the high-temperature zone of the ProboStat™ cell.

### *3.2.1. Description and denotation*

The thermocouples come in variety of types listed in the Tables 9 - 10.

Table 9. Thermocouples denotation

| Code | Type (X) | Description |
|---|---|---|
| TCT/D-X | S, K | Disk sample top thermocouple assembly |
| TCI/D-X | S, K | Disk sample inner thermocouple assembly |
| TCC/D-X | S, K | Disk sample control thermocouple assembly |
| TCC/B-X | S, K | Bar sample control thermocouple assembly |
| TCB/B-X | S, K | Bottom thermocouple assembly for Seebeck coefficient measurements |
| TCT/B-X | S, K | Top thermocouple assembly for Seebeck coefficient measurements |

TCT/D and TCI/D are not listed in the Table 10 as these thermocouples are not included in the standard systems.

Table 10. ProboStat™ S-type thermocouple assemblies.

| | | | | |
|---|---|---|---|---|
| Thermocouple drawing |  |  |  |  |
| Code | TCC/D | TCC/B | TCT/B | TCB/B |

## 3.3. Thermocouples color codes

The ProboStat™ can be supplied with two types of thermocouples: S-type and K-type. The thermocouples lower ends are color marked according to standard for thermocouples.

The S-type thermocouple marked with red and black: the red wire – negative pole, the black wire – positive. The K-type thermocouple marked with white and green: the white wire – negative pole, the green wire – positive.

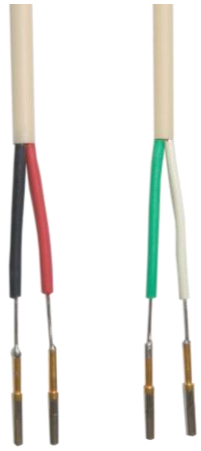


Fig. 17. Thermocouples color codes: S-type – black and red, K-type – green and white.

## 3.4. ProboStat™ thermocouple wiring

Three thermocouples can be connected to the ProboStat™ base unit, one - in the inner gas compartments, and two – from the outer one, see the Wiring overview (p. 19). The thermocouples have denotations starting with TC.

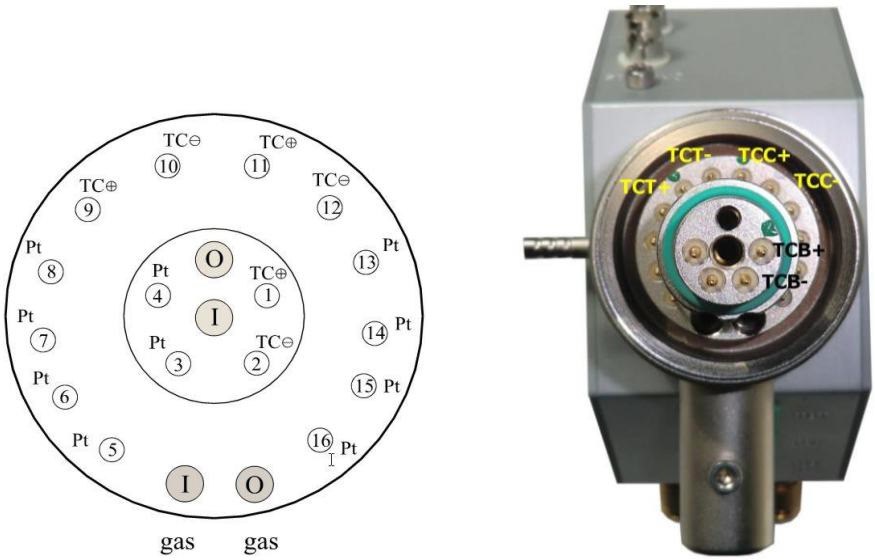



Fig. 18. The thermocouple feedthrough codes.

The thermocouple feedthroughs are marked with color code dots on the base unit: black and red or green and white.

The thermocouple feedthroughs lead voltage from the thermocouple tip in the high-temperature zone via base unit chassis to thermocouple socket mounted on the base unit hexagon. The thermocouple sockets mounted on the S-type base unit have orange color, mounted on the K-type base unit – green.

Fig. 19. Thermocouple sockets for S-type base unit.

Fig. 20. Thermocouple sockets for K-type base unit.

## 3.5. Mounting thermocouples on the base unit

Depending on measurement method one of three thermocouples should be mounted onto the base unit. Three thermocouples are needed for the Seebeck coefficient measurements only.

When mounting, comply with the base unit and thermocouple polarity. Always connect black to black, red to red, and white to white, green to green. If opposite, the furnace will overheat and melt.

Fig. 21. The S-type thermocouple mounted in the S-wired base unit.

### 3.6. Control and read thermocouples

The ProboStat™ thermocouple can function as a control thermocouple for the furnace. In this mode the temperature in the system is controlled by the ProboStat™ thermocouple.

In the reading mode the temperature in the system is controlled by the furnace thermocouple. The furnace and the ProboStat™ thermocouples are located at different positions resulting in a temperature gradient. This gradient can be as high as 20-30 degrees.

## 4. ProboStat™ spring load assemblies

The ProboStat™ can be equipped with two different spring load assemblies for different purposes: triangular top plate spring load assembly and two-rod van der Pauw spring load assembly.

### 4.1. Recommended reading

We recommend familiarize oneself with:

a) ProboStat™ Manual:

- Part 4.6. "Spring load assemblies", pp. 4-14 – 4-15,
- Part 12.2 "Instruction for fabrication of spring force assemblies", pp. 12-6 – 12-11.

## 4.2. Triangular top plate spring load assembly

The standard triangular top plate spring load assembly is used to press samples against the sample support tube and thereby also to hold electrode contacts in contact with the electrodes. This spring load assembly is used in all measurement setups except van der Pauw.

The triangular top plate spring load assembly consists of a top plate, three long alumina bars with Pt locks, and three springs.

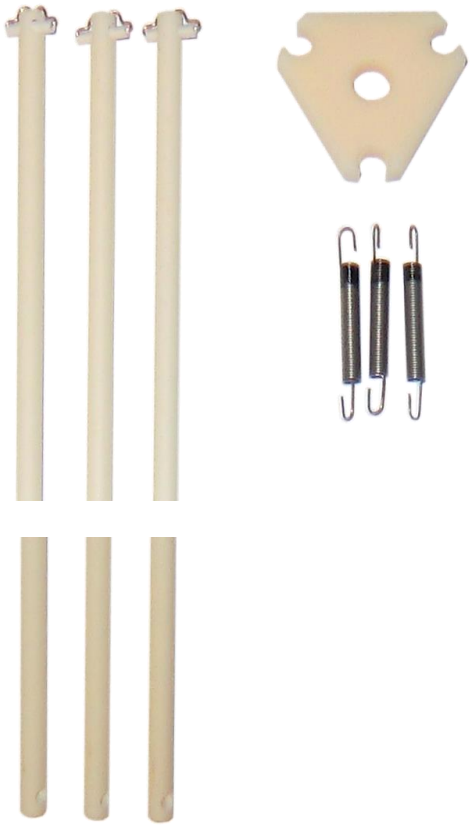


Fig. 22. The triangular top plate spring load assembly parts.

## 4.3. Two bars van der Pauw spring load assembly

A two bars van der Pauw spring load assembly is used to press the four electrodes of van der Pauw setup against the sample surface. It consists of two long bars, two springs, and bridging bar.

## 4.4. Spring load system mounting

### 4.4.1. *Triangular top plate spring load assembly*

Hook the springs onto the lower part of the spring force tubes. Thread the tubes through the holes in the triangle top plate. Hook springs over the base unit pedestal.

Fig. 23. Mounted spring load assembly. High temperature part of ACIS setup.

Fig. 24. Connections to the ProboStat™ base unit.

### 4.4.2. *Two bars van der Pauw spring load assembly*

In order to use this assembly, you need four electrode contacts. Please see the ProboStat™ manual.

Fig. 25. Top part of van der Pauw setup. The spring load assembly is marked by light-blue color.

### 4.5. Springs

The spring load assembly can be mounted using two types of springs, soft or stiff. The stiff springs are marked by black color, the soft – red one.

The total spring force for the soft version (a total of three springs) is approx. 14 N and for the stiff version 25 N. This correspond to approx. 1,4 and 2,5 Kg respectively.

For sealing, the stiff springs are recommended.

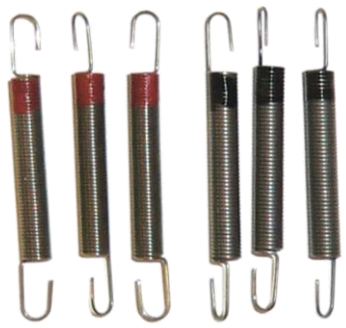


Fig. 26. Soft and stiff springs.

## 5. ProboStat™ water cooling system

We recommend familiarizing youself with the ProboStat™ Manual:

- Part 4.2.2. "Water cooling", pp. 4-3 – 4-4,
- Part 4.2.3. "Connector box and cooling water ring; change angle of the fixation bar", pp. 4-4 – 4-5.

Cooling water hose can be connected to the ProboStat™ base unit via two stubs on a water cooling cylinder. The water flows between the water cooling cylinder and the central base unit block and is sealed with two permanently compressed water cooling O-rings inside.

Water cooling is needed for overheating protection of the ProboStat™ base unit. In general if the base unit is too hot to touch it is good to use the water cooling system.

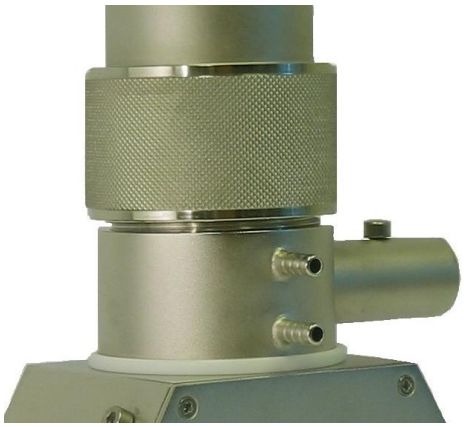


Fig.27. Cooling water hose stubs on water cooling cylinder.

Fig. 28. Water cooling O-rings.

Fig.29. Cooling water connected.

## 6. ProboStat™ Earth

On the base unit hexagon you can you can also find Earth point screw that is used for external Earth connection.


Fig. 30. Earth point screw.

# 7. Assembling ProboStat™ setups

The ProboStat™ is a versatile system. Having one base unit you can assemble it for many types of measurement by changing accessories. The ProboStat™ manual describes all methods in detail. Here we will consider only one example to cover the most common questions.

Let us consider 2-point impedance spectroscopy and conductivity measurements on disk sample as an example. See the ProboStat™ manual, part 8.2.2, pp. 8-2 – 8-7.

## 7.1. Assembling 2-point impedance spectroscopy and conductivity measurements on disk sample

### *7.1.1. List of accessories*

In order to find out all parts you need for this method, you should refer to Figure 8-1 in the ProboStat™ manual.

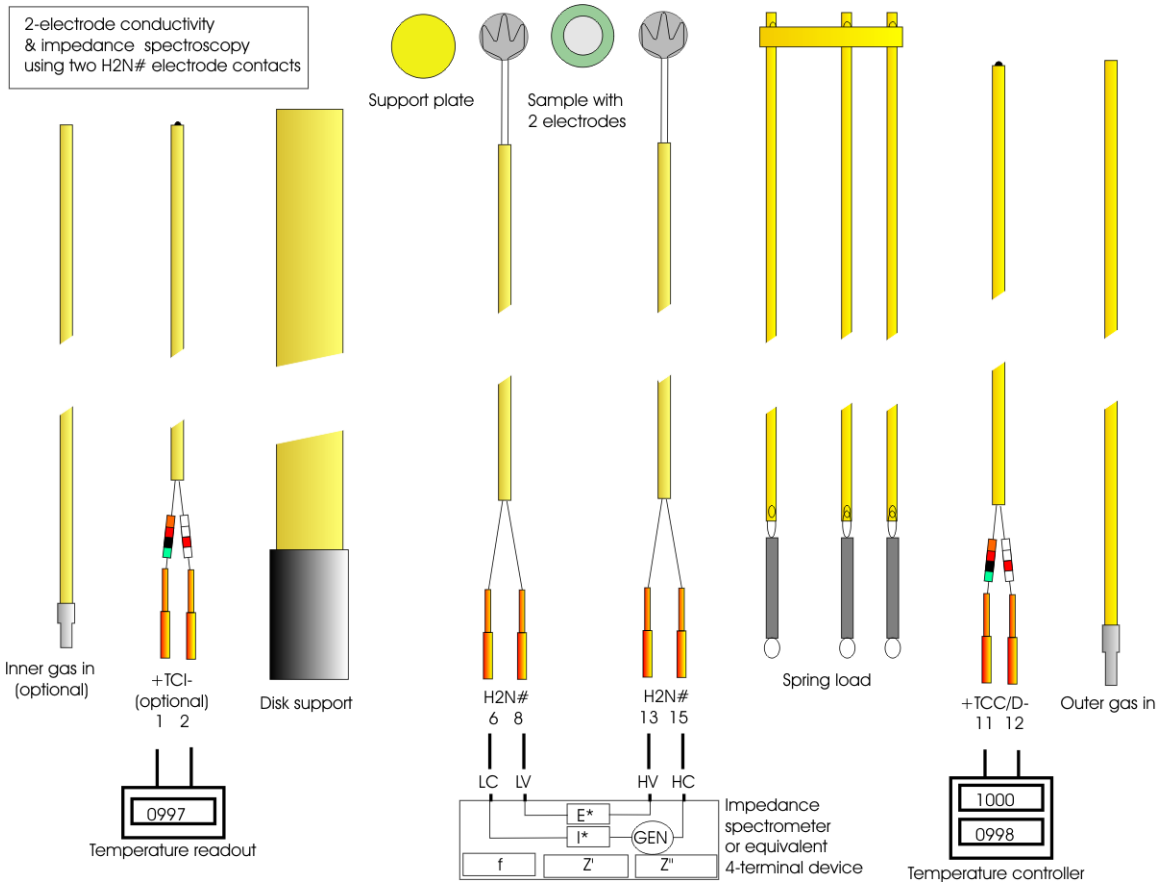



Fig. 31. Figure 8-1 in the ProboStat™ manual.

Accordingly, the next accessories should be used:

1. Inner gas supply tube (optional).
2. Inner thermocouple TCI/D (optional).
3. Sample support tube assembly for disk sample.
4. Sample support plate.
5. Two electrode "hand" contact assembly, outer, 2-wire (H2N#).
6. Spring load assembly.
7. Disk sample control thermocouple assembly (TCC/D).
8. Outer gas supply tube.
9. Enclosing tube (not in the picture).
10. Test sample.

#### *7.1.2. Electrode contacts and thermocouple connection*

The feedthroughs numbers in the drawing are given below the electrode contacts and thermocouples drawing.

The fist electrode contact is connected to the feedthroughs no. 6 and 8 (LC and LV). The second electrode contact is connected to the feedthroughs no. 13 and 15 (HV and HC).

The optional inner thermocouple should be connected to the feedthroughs no. 1 and 2 (TCB).

There are two equivalent ways for the thermocouple connection. The thermocouple can be connected to the feedthroughs no. 9 and 10 (TCT) or 11 and 12 (TCC).

#### *7.1.3. Cable connections*

The cable connections depends on the electrode contacts and thermocouple connections. In our example both electrode contacts are connected from the outer gas compartment. So, the BNC cables should be connected to the HC, HV, LC, and LV BNC sockets. The thermocouple cable can be connected to the TCT or TCC thermocouple socket.

In this complementary material we have tried to answer the most common questions we are asked by our customers. If you still have questions, please contact us at post@norecs.com or tel: +47 45916188.