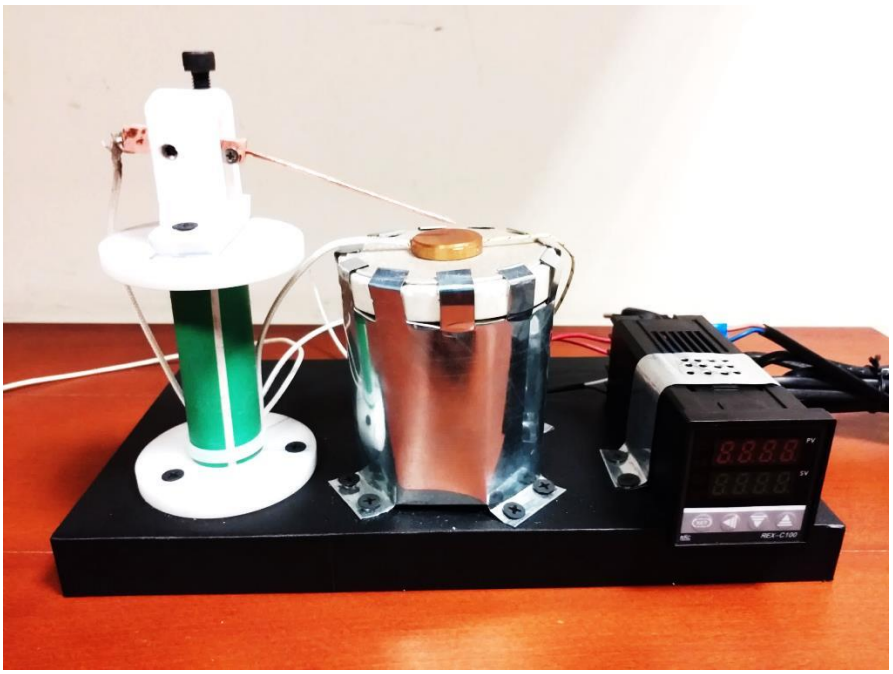
# HIGH TEMPERATURE PROBE STATION FOR DIELECTRIC, IMPEDANCE AND FERROELECTRICS MEASUREMENTS

(User Manual)



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## High Temperature Probe Station for Dielectric and Ferroelectrics Measurements

A probe station is an essential piece of equipment used in condensed matter physics for studying the electrical properties of the materials. It provides a platform for the sample to interface with the electrical test equipment. During sample testing (for dielectric and ferroelectric measurements), electrical probes are in parallel plate configuration connected to the sample disc and make electrical connections to the sample. Here we present the design and implementation of a probe station project that was carried out for the high temperature probe station under ambient pressure conditions.

The probe station was designed to have a durable, stable base and a 1" bottom electrode (Cu base plate). The top electrode is a Cu pointer wire which lowered on the sample surface to the make the electrical connection. The bottom electrode in seated on a flat heater as placed underneath. This electrode serves as sample stage. Figure 1 shows the schematic diagram of the probe station. The main parts of the probe station are labeled in the figure.

1. Heating stage (385 Ω Nichrome heater)
2. Temperature Controller (REX C100)
3. Spring loaded top electrode stage

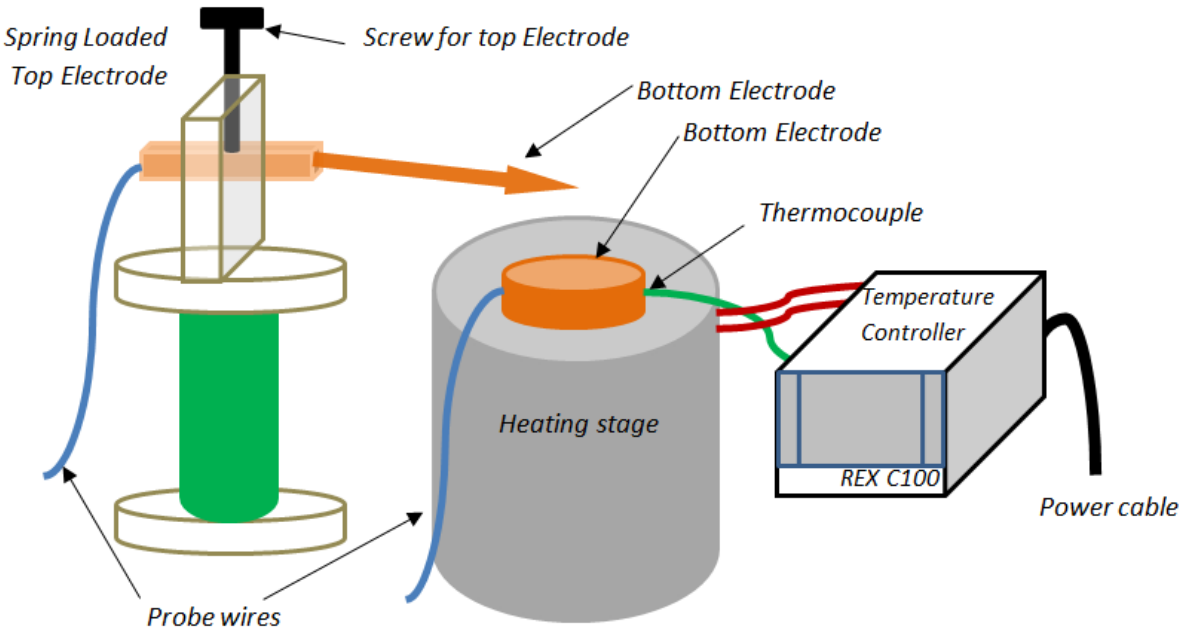



**Figure 1: Schematic diagram of the high temperature probe station.**

Figure 2 shows the photograph of the probe station.

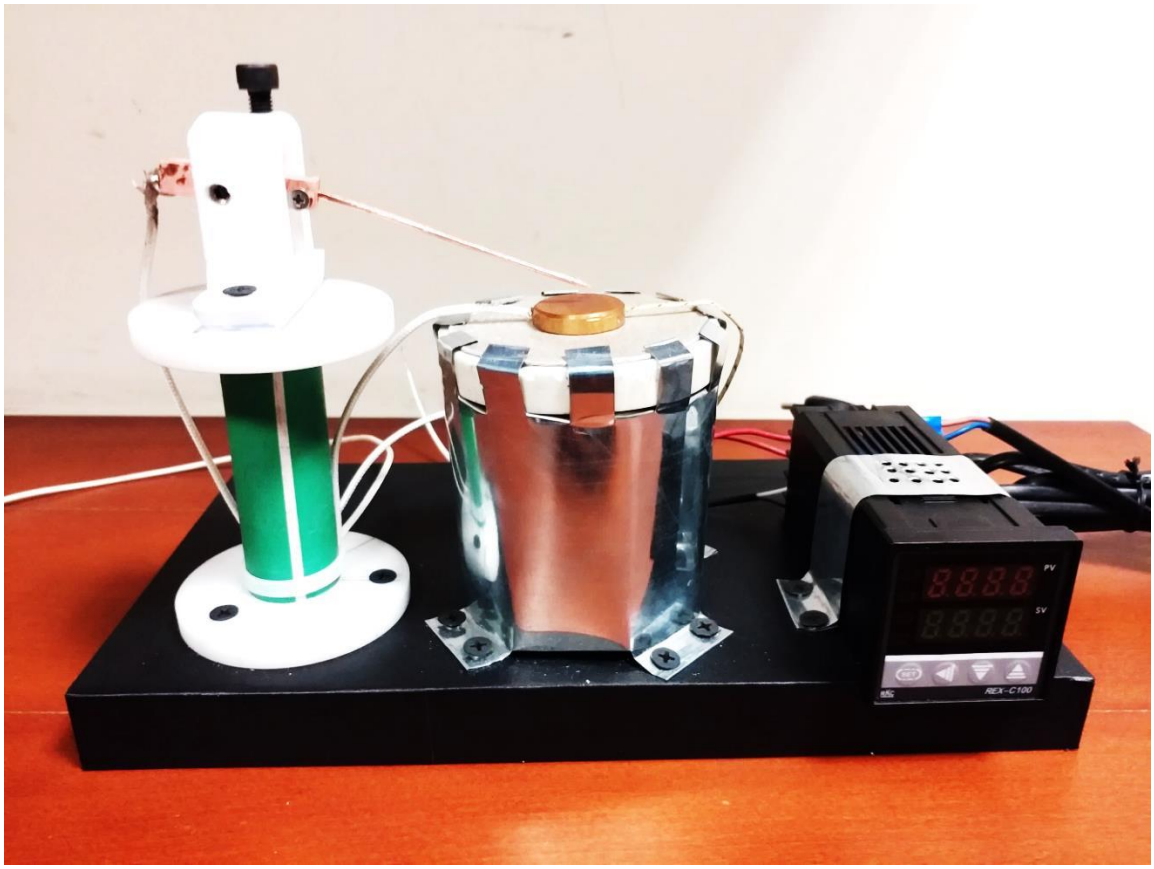



**Figure 2: Picture of the high temperature probe station.**

## Heater

The power of the heating element is 125 W and is operated on 220 Volts. The total resistance of the heating element is 385 Ω. The wire used for the elements is 36 standard wire gauge (SWG) Nichrome wire. The heater is flat disc type heater wound on mica sheet and sandwiched between the tin sheets. K-wool was used for the thermal insulation of the heating stage from the base wood.

## Top Electrode Spring loaded stage

Top electrode for the samples is made of Cu wire, attached to the Cu rectangular block for the spring loaded arrangement which is made of Teflon. The stage is prepared by two plastic discs and a pipe.

## Thermocouple

A miniature J-type thermocouple is used to measure the stage temperature. The thermocouple bulb is fixed in the glass capillary and fixed in the Cu disc on the heating stage. The temperature of the Cu disc and sample is assumed to be the same.

The thermocouple wires terminal are

***White ---------- Negative terminal***

***Black ---------- Positive terminal***

## Temperature Controller REX-C100

REX-C100 is a PID temperature controller, the front panel name are labeled in the figure 3 and details description in provided in Table 1.


**Figure 3: Front panel name and functions**

**Table 1: Detailed description of the REX-C100 front panel.**

| # | Panel Description | Content Description |
|---|---|---|
| 1 | PV | Measured Value of temperature |
| 2 | SV | Set Value of temperature |
| 3 | OUT1 | Output 1 point pilot lamp |
| 4 | AT | PID auto tuning pilot lamp |
| 5 | ALM1 | Alarm 1 pilot lamp |
| 6 | ALM2 | Alarm 2 pilot lamp |
| 7 | ▲ | Increasing Key |
| 8 | ▼ | Decreasing Key |
| 9 | ◀ | Shift Key |
| 10 | SET | Set mode key |

## Temperature Controller Wiring

The wiring connection for the REX-C100 to the heater and thermocouple are shown in Figure 4.

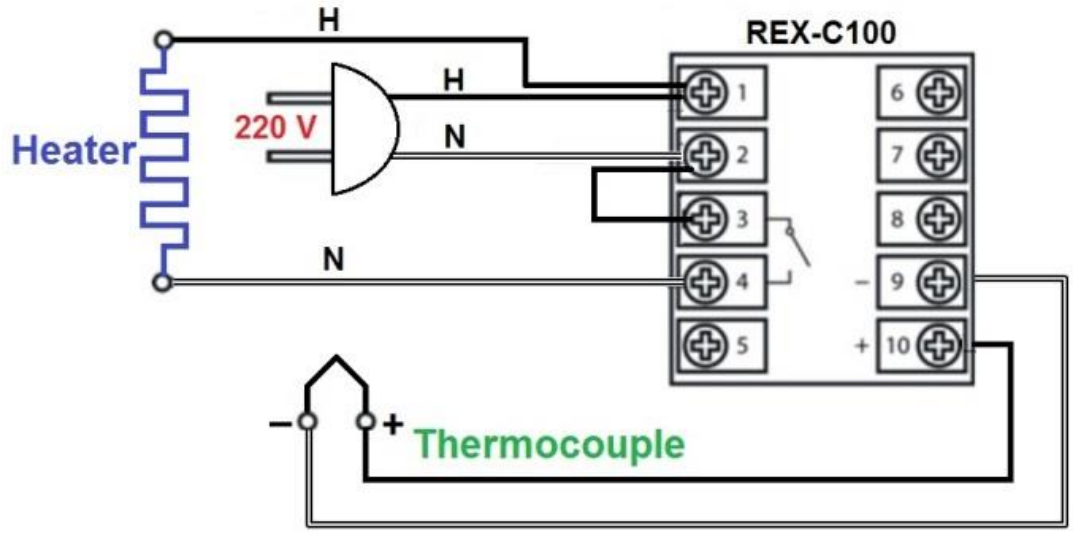
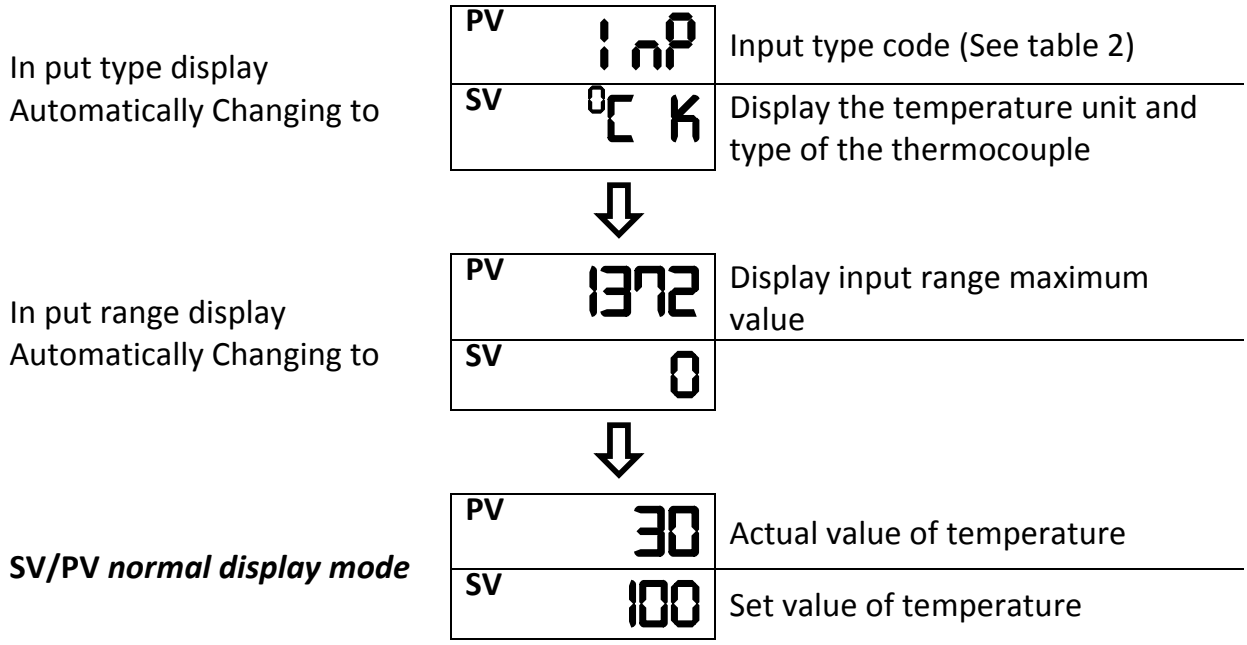



**Figure 4: PID temperature controller wiring diagram.**

## Operation

### Startup Process

Power on the temperature controller, the front panel indicates the following parameters during the boot process and automatically changing to reach to the SV/PV normal display state.




## Inputs Types (Thermocouples)

Table 2 shows the input types and corresponding display for different types of thermocouples and temperature sensors.

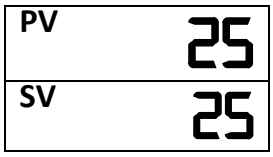
**Table 2: Inputs types of the REX-C100 temperature controller.**

| **Display** | K | J | r | S | b | E | n | T | AT | CU | mV | mA | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Input Mode** | Thermocouple (TC) | | | | | | | | RTD | | Voltage and Current | | |
| | K | J | R | S | B | E | N | T | Pt100 | Cu50 | mV | mA | V |

## Setting Mode:

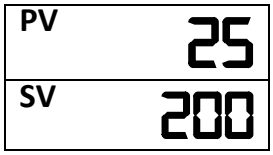
From PV/SV normal display state (The final display after booting process as shown on the)

**SV/PV *normal display mode***




- Press the “SET” button, the SV display start flashing.
- Press the shift (◀) button, and select the digit you want to modify
- Write the set point (e.g. 200 °C) value of temperature using (◀ , ▲ and▼) keys.
- Press the “SET” button to confirm the set point.
- The temperature controller turn to ***SV/PV Normal display state*** with new SV value.

**SV/PV *normal display mode***




## Parameter Setting Mode:

This mode is used to set the alarm, PID constants and other parameters.

Press and hold the SET button for more than 3 seconds, the PV display shows the “Parameter Settings mode” and SV display shows the corresponding values. Table 3 shows the list of parameters and their corresponding values in the parameter settings mode.

**Table 3: List of the parameters in the "Parameter Settings mode"**

| Symbol | Name | Specification | Setting | Factory Default |
|---|---|---|---|---|
| | PV<br>SV | Measured value<br>Set Value | Full scale (9999) | |
| AL 1 | AL1 | The first set of alarm settings | Full scale | |
| AL2 | AL2 | The second set of alarm settings | Full scale | |
| AtU | ATU | Self-tuning when temperature effect is not ideal to use this!!! | 0: OFF auto-tuning<br>1: Self tuning | 0 |
| P | P | Proportional band | 0-full scale, When P=0, ON/OFF<br>When P≠0, Instrument controlled by PID | 30 |
| I | I | Integration time | 0-3600 seconds<br>When set to zero, no integral control | 240 |
| D | D | Derivative time ( | 0-3600 seconds<br>When set to zero, no derivative control | 60 |
| Ar | Ar | Reference value | AT automatically set | 25 |
| T | T | Working period (seconds) | Time scale Period 1-100 s | 20 |
| oH | OH | The main control does work bandwidth | 0-100, same unit as PV | 2 |
| SC | SC | Measurement error correction | same unit as PV | 0 |
| LCK | LCK | Data Lock | 0000-0004 | 0000 |

## How to perform PID auto-tuning

- Set the default values of the "P", "I " and "D ".
- Go to the " AtU ", and enter the 1 then press the "SET" button.
- The AT lamp turns on, and self -tuning for the PID parameters starts.
- This process may take a few minutes.

## How to change the input type (Thermocouple Type)

- Press and hold the SET button for more than 3 seconds until the PV display shows the "Parameter Settings mode".
- Go to the data lock "LCK" parameters.
- Enter the code 0090 using shift (◀) up (▼) down (▲) keys and press SET to confirm the value.
- Press "SET" to return to the PV/SV normal display.

The following parameters will be appears, select the values for the specific type of thermocouple.

| Symbol | Set Value | Specification | Setting |
|---|---|---|---|
| SL 1 | 0000 | K | 0 – 1372 °C / 0 ~ 400.0 °C |
| | 0001 | J | 0 – 1200 °C / 0 ~ 400.0 °C |
| | 0002 | R | 0 – 1769 °C |
| | 0003 | S | 0 – 1769 °C |
| | 0004 | B | 0 – 1820 °C |
| | 0005 | E | 0 – 1820 °C |
| | 0006 | N | 0 – 1300 °C |
| | 0007 | T | -200 ~ 400 °C / -199.9 ~ 400.0 °C |
| | 0008 | Pt100 | -200 ~ 650 °C |
| | 0009 | Pt100 | -199.9 ~ 200 °C |
| | 0010 | Pt100 | -80 ~ 430 °C |
| | 0011 | Cu50 | -50 ~ 150 °C / -19.9 ~ 99.9 °C |
| | 0012 | 0-10 mA, 4-20 mA, 0-5 V, 1-5 V | -1999 ~ 9999 |
| | | | |
| SL4 | 0000 | Function of Alarm1 not set | ALM1 |
| | 0001 | Maximum deviation alarm | |
| | 0002 | Maximum/Minimum deviation alarm (outside the local area) | |
| | 0003 | Maximum/Minimum deviation alarm (inside the local area) | |
| | 0004 | Maximum value of process alarm | |
| | 0005 | Minimum deviation alarm | |
| | 0006 | Minimum value of process alarm | |
| | | | |
| SL5 | 0000 | Function of Alarm1 not settings | |
| | | | |
| SL8 | 0000 | Centigrade (unit °C) | |
| | 0001 | Fahrenheit (unit °F) | |

## Troubleshooting

Instrument will show the following messages which are useful for diagnosis the instrument does not work normally.

| Massage | Specification | Remedy |
|---|---|---|
| Err | Equipment error | Overhaul |
| 0000 | Input disconnection, polarity reversed or exceeds input range | Check the fault |
| nnnn | Input disconnection, polarity reversed or below input range | Check the fault |

## Conclusions

The fully functional probe station was designed and built successfully for the high temperature dielectric, impedance and ferroelectrics measurements.