ERS® User Manual

AC3 Controller SP110

User Manual • ERS AC3 Controller SP110, Version 3.2

ERS® electronic GmbH
Stettiner Str. 3
82110 Germering
Germany

Phone	+49 - 89 - 894 132 - 0
Service Hotline	+49 - 89 - 894 132 - 500
Telefax	+49 - 89 - 841 8766
E-Mail	info@ers-gmbh.de
Internet	www.ers-gmbh.de

Registered Trademark: AirCool®

1 Usage and Data

1.1 Copyright

Layout and production: ERS® electronic GmbH, D-82110 Germering
Original language: English

1.2 Use of this User Manual

1.2.1 Purpose

This User Manual contains the information required for the proper use of the Thermal System. The User Manual is delivered with the Thermal System and is an essential part of the product. It must be kept in an accessible, visible place next to the Thermal System.

Product Life Phases

The User Manual describes all the product life phases of the Thermal System. It consists of the following system conditions and applications that come after manufacturing: transport, installation, commissioning, operation, maintenance, service, storage and final disposal.

Each related chapter can be found easily with the table of contents in this User Manual.

1.2.2 User Qualifications

This User Manual applies exclusively to technically qualified personnel, who have been trained by ERS® or have completed an instruction course for the Thermal System. This instruction course must have been carried out with the authorization of ERS®. Only technically qualified personnel are capable of interpreting correctly the safety regulations contained in this User Manual correctly.

Personnel who have not been trained by ERS® or who have not received ERS® authorized training on the Thermal System are not considered as authorized working personnel. Unauthorized personnel are not permitted to carry out any kind of work on the Thermal System. ERS® declines all liability for any claims for damages which occur when stipulations are disregarded.

1.2.3 Important Safety Information

Be sure to read Chapter 2 Safety, page 13 prior to performing any work with or on the Thermal System! It contains important information that is significant for your own personal safety. This chapter must have been read and understood by all persons who perform any kind of work on or with the Thermal System during any stage of its serviceable life.

1.3 Intended Use

The Controller SP110 is designed for controlling the components of:

- AC3 Systems

The Controller SP110 is available as standalone version.

For all processes carried out with the Controller SP110, the safety instructions in Chapter 2 Safety, page 13 must be adhered to.

Any application exceeding the bounds of these specifications is considered improper use and can lead to serious personal injury or material damage. ERS® will not be held responsible for any damages resulting in such a case.

Further requirements of proper use are that you:

- Read and adhere to this User Manual.
- Adhere to the technical data. See Chapter1.7 Technical Data, page 11.
- Complete the maintenance work on schedule. See Chapter 5 Maintenance and Service, page 57.

Improper Use and Non-Adherence to Regulations

Other uses of the AC3 Controller SP110 are permissible only with written permission from ERS® electronic GmbH (ERS®). Any application not adhering to the above specifications is considered improper use. ERS® will not be held responsible for any personal injury or material damage resulting from improper use.

1.4 Residual Dangers

The Thermal System employs state of the art technology and was built in accordance with the recognized safety regulations. It has been subjected to comprehensive safety test and approval processes. However, it is not possible to completely rule out any danger involved in the use of the system. There are dangers involved

- for the life and well-being of the user
- for the Thermal System and other materials of the end user

as well as detrimental effects on the efficient working on and with the Thermal System.

For this reason, it is necessary that all activities involving the Thermal System are carried out by trained personnel in accordance with the guidelines in this User Manual. The technical data must be adhered to.

1.5 Scope of Delivery

The delivery consists of the following components:

Qty	Component		Part No.
1	AC3 Controller SP110		ERS 2001657
1	Power cable for AC3 Controller SP110		ERS 2001260
1	User Manual AC3 Controller SP110		ERS-D 100 110

Tab. 1.1 Scope of delivery

1.6 Description SP110

Fig. 1.1 Controller Sp110

The Controller SP110 continuously monitors the Chuck surface temperature using a precise platinum RTD sensor which is connected to a microprocessor controlled close loop temperature management system. It is operated via an ergonomically arranged touch screen display. The Controller SP110 is designed with a small footprint for easy integration at the customer's site.

Depending on the desired cooling the SP110 controller can connect to an Air Control Box PV110. The airflow will be controlled according to the selected temperature range.

For a remote operation via PC or prober software, a RS232C interface (Connector XC1) is available. The RJ45 interface (Connector XC3) is used for service and software update.

1.7 Technical Data

1.7.1 Type Label

A type label (Fig. 1-2) is attached to the System. It identifies the component and provides information about customer-specific adaptations, if such exists. When communicating with ERS®, you should always supply all the details on the type label. With this information, the ERS® customer service can provide you with the support you need in the shortest possible time.

The type label is usually located at the rear side of the System.

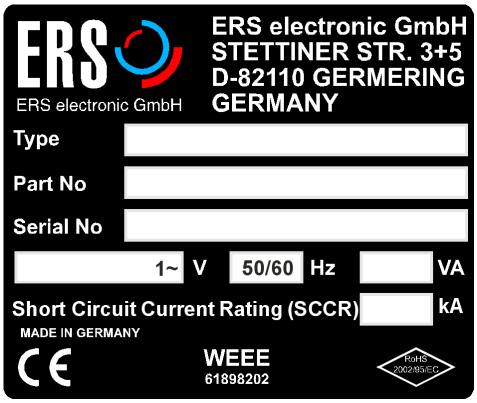


Fig. 1.6 Type Label

1.7.2 Dimensions and Weights

Fig. 1.7 Dimensions of the Controller SP110 (in mm)

Width	Height	Depth	Weight
300 mm 11.8"	140 mm 5.5"	360 mm 14.2"	12 kg 26.5 lb

Tab. 1.3 Dimensions of the Controller SP110

1.7.3 Performance Data

Smallest temperature preselection step	± 0.1°C
Chuck temperature display resolution	0.01°C
Control method	Low Noise DC / PID with Dynamic Temperature Control DTC
Temperature Display Accuracy	± 0.01°C
Temperature Range	+25°C to +300°C
Sound level	54 dB(A)

Tab. 1.4 Performance data: AC3 Controller SP110

1.7.4 Ambient Conditions

The Controller SP110 requires the following environmental conditions during operation:

Temperature	+18°C through +28°C
Relative air humidity	20% through 60%
Location	Dry room (indoor)

Tab. 1.5 Ambient conditions

1.7.5 Electrical Data

Power supply	100 through 230 VAC
Frequency	50 Hz / 60 Hz
Power consumption	1000 VA
Protection Class	IP 20
Short Circuit Current Rating (SCCR)	10 kA

Tab. 1.6 Electrical data: Controller SP110

2 Safety

2.1 Compulsory Reading Material!

Read this chapter prior to performing any work with or on the Thermal System It contains important information that is significant for your own personal safety.

This chapter must have been read and understood by all persons who perform any kind of work with or on the Thermal System during any stage of its serviceable life.

2.2 Safety and Technical Information

2.2.1 Structure of the Safety Notices

The following safety notices are indicating different danger levels.

DANGER

In high-risk situations, especially where there is danger of serious injury or death.

WARNING

In medium-risk situations, where a lack of attention to the notice can lead to physical injury or substantial material damage.

CAUTION

For low-level risks. Ignoring this notice can lead to mild physical injury, material damage or faulty products.

NOTE!

For technical requirements which must be strictly adhered to.

2.3 Safety-Related Responsibilities

The responsibilities for the safety of the Thermal System are assigned as follows:

- ERS® is responsible for the safety of the System.
- The end user is responsible for safety in the vicinity of the System.
- The end user is responsible for the adherence to the general safety guidelines in all work carried out on and with the System.

Areas of Responsibility for ERS®

System	Areas of responsibility
Electrical supply	From the interface between the electrical supply and the System
Grounding	From the interface between the ground connection cable and the System

Tab. 2.1 ERS® Responsibility

End User's Areas of Responsibility

Surrounding area of the System	Areas of responsibility
Electrical supply	Connecting cables to the connections of the System in accordance with Chapter 1.7.5 Electrical Data, page 12.
Grounding	To the connector of the System
Personnel	Ensuring that information is passed on when operating, maintenance or service personnel are substituted or changed. Providing training courses.

Tab. 2.2 Users Responsibility

2.4 General Safety Guidelines for the End User

2.4.1 Personnel

All personnel who work with the System must have the required technical qualifications and have received appropriate instruction and training. They must be informed about all conceivable dangers and risks which exist in conjunction with this system.

Unauthorized persons are not allowed access to System.

2.4.2 Operation

The System has to be only used for its stipulated purposes. See Chapter 1.3 Intended Use, page 8. All work instructions and operational procedures which could impair personnel safety or cause damage to the System are strictly prohibited. In addition, branch-specific and local regulations concerning prevention of accidents must always be followed.

2.4.3 Workplace

Condition

With appropriate instructions and checks, the end user guarantees a work place and working environment around the System that is in meticulous order and clean.

Safety Devices

The end user must draw up a safety concept and provide the required safety devices if adaptations are made to the System or if the system is incorporated in an overriding production line.

Warning Notice Plates

Clearly visible warning signs on the operational premises must notify personnel of residual dangers caused by the system.

Waste Materials

The end user is responsible for the eco-friendly disposal of ecologically harmful waste materials produced by processes.

2.4.4 User Manual

Reading and Understanding

The end user is responsible for making sure that each person who performs work on or with the System during any stage of its serviceable life has read and understood the relevant parts of this User Manual.

Safekeeping

The User Manual is delivered with the System and is considered to be an integral part of the product. This manual must always be at hand near the System at a defined location that is clearly visible. End users can order further copies of this User Manual from ERS®. You will find our contact address on the title page of this User Manual.

Completeness

Always use a complete and original copy of this User Manual! Text passages in this User Manual contain cross-references to other sections of the manual which, in turn, include important information. Incomplete copies of the manual or copies of single, separate pages cannot convey all the necessary information about the User Manual.

WARNING

Incomplete User Manual.

Missing safety instructions resulting from an incomplete copy of the User Manual can lead to serious or fatal injuries and material damage.

You must always work with a complete original copy of this User Manual! Do not copy individual pages.

2.4.5 Installation

Power Supply

The end user provides the connections for the supply of electricity to the System with the required performance and quality levels. See Chapter 3 Installation, page 20 and any supplementary information in the technical specifications.

Supply Lines

Electrical supply cables must be kept separate from one another and must be routed to the System under protection from mechanical stress. They must be routed in such a way that the safety and reliability of the System is not affected negatively. The mains connection of the System must be accessible at any time. All supply lines of the System must be installed without tripping points.

2.4.6 Maintenance and Service

The end user is obliged to only operate the System in technically faultless conditions. All maintenance and service work must be carried out in accordance with Chapter 5 Maintenance and Service, page 57.

Logout/Tagout

Make sure that the relevant system parts are de-energized and that they cannot be switched on again for the duration of the maintenance or service work. This must be done according to the lockout/tagout procedure described in Chapter 5.2 Tag out Procedure, page 58.

Safety Equipment

Only remove safety equipment after the System has been brought to a complete stop and lockout/tagout. Before powering the system on again, make sure that all the removed safety equipment has been reinstalled.

Spare Parts

WARNING

Non-original spare parts.

The use of non-approved parts can lead to malfunctions. This can lead to serious or even fatal injuries and considerable material damage.

When carrying out maintenance and service work, use original OEM or PMA spare parts only.

Adaptations

Consult ERS® before modifying the system. Unauthorized adaptations and alterations which affect the safety of the System are not permitted and void warranty.

Checks

Final Checks

After maintenance or service work, check that all the safety equipment is installed and functioning properly. Check the safety equipment especially after working on the electrical system. This applies in particular to the ground, ground wire, current path, and the safety circuits.

Revision Check

The end user is responsible for having performed revision checks according to the local regulations concerning prevention of accidents. This applies in particular to the electrical equipment of the system and if existing also to pressure containers and cryo-technical components.

Notification Rule

The end user is obliged to notify ERS® immediately as to any changes or irregularities that have been observed on the System.

2.4.7 Disposal

The end user must adhere to the pertinent regulations when disposing of the System. End users must hand over the system to either a licensed private or public disposal company or he must recycle the unit himself or dispose of it in accordance with the pertinent regulations. See Chapter 7.3 Disposal, page 68.

2.5 Safety Circuit

2.5.1 Overtemperature Alarm

The SP110 Controllers are equipped with an over temperature detection circuit, that operates independently of the temperature control PCB. Therefor the Chucks contain an extra sensor (PT1000) for over temperature detection. As the control board does not allow to set temperatures higher than the maximum allowed range of the chuck, the over temperature alarm circuit provides double security in case of a malfunction of the electronics or the power supplies. The over temperature circuit will switch off the power supply of the chuck heaters and trigger an alarm message at the display. As standard setting the alarm temperature is set 30°C higher than the maximum set temperature of the chuck.

Setting the Overtemperature Alarm Temperature

WARNING

Safety Circuit

Setting a higher temperature than the maximum allowed temperature of the connected chuck will not protect the chuck from overheating and can cause damage to the chuck.

1 Remove the cover of the Controller SP110.

2 Locate the over temperature circuit

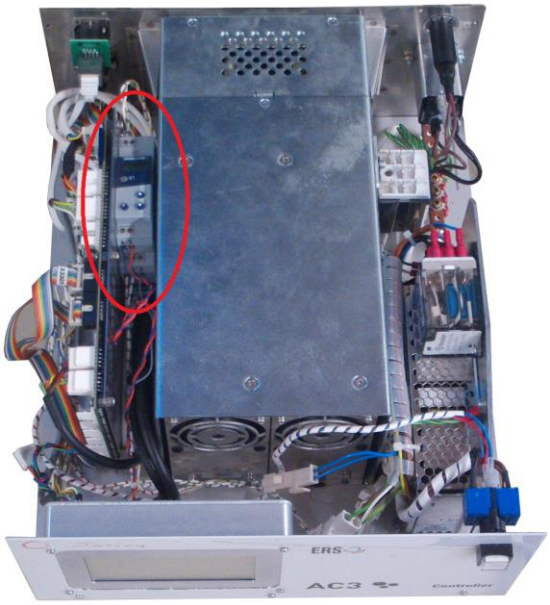


Fig. 2.1 location of the Overtemperature Controller

3 Press P at the device, the display will show SP and the set value.

Fig. 2.2 Overtemperature Controller

4 Use the arrow keys up / down to change the value
The device will store the changed value and return to normal operation one minute after the last key stroke.

	WARNING
	No warranty for unauthorized change of settings ERS will take no warranty for damages that result from wrong setting of the overheat protection.

2.6 Residual Dangers

Fig. 2.3 Residual dangers at the Controller SP110

- *Danger of lethal electrical shock at live parts connected to the mains*
- *Danger of injuries from moving fan*

Personnel working with the Controller, must take note of the following safety guidelines.

	WARNING
	Mains voltage. The Controller SP110 contains live voltage which is connected to the mains. Touching these parts causes a lethal electrical shock. The Controller SP110 must be turned off and in a voltage-free state before you carry out any work in the danger areas. Ground the equipment and secure the system against an inadvertently switch on. Ensure that nobody is remaining in the danger areas before you switch the system on again.

NOTE!

Only personnel with electrotechnical training are permitted to carry out work on the electrical equipment.

3 Installation

3.1 Personnel Qualifications

The standard of professional knowledge and experience which is usual for transport company personnel is an adequate qualification if the system is packaged and transported in accordance with the instructions given by a specially trained and authorized person. Only personnel with electrotechnical training are permitted to install the system.

3.2 Transport

The System may only be transported in its original packaging units. The commissioned transport company must be specialized in the transport of delicate commodities.

CAUTION

Damage to the system.

Improper handling during transportation can damage the system.
Measures:

- Pay attention to the packing symbols during transport.
- Always transport the system in its upright position and avoid shocks.

3.3 System Location Requirements

Environmental Conditions

The Thermal System should only be operated under the environmental conditions stipulated in Chapter 1.7.4 Ambient Conditions, page 12.

Operating Media

The Thermal System must be supplied with the required operating media during operation. See Chapter 1.7.5 Electrical Data, page 12. The supply lines must be routed in keeping with the local safety regulations.

Space Requirements

Refer to Chapter 1.7.2 Dimensions and Weights, page 11 for the dimensions of the Thermal System.

The safety clearance for the evacuation plan must be in accordance with the local safety regulations. Safety covers, etc., must be installed in such a way that the Thermal System remains accessible for maintenance and service work.

Placement of the Thermal System

The Controller SP110 must be placed on a flat, stable surface. For proper operation, the Controller SP110 must have sufficient air flow. Allow 4 inches of space on both sides and top of Controller SP110. DO NOT block air vents. DO NOT place the Controller SP110 near a hot surface. The mains switch on the front side of Controller SP110 must be operable at any time.

3.4 Unpacking

3.4.1 General

NOTE!

Transport malpractices can damage the system. ERS® delivers the System in a crate. Pay attention to the transport symbols and keep the crate upright!

1. Check the delivery papers to make sure the goods delivered match the specified equipment
2. Observe the transport symbols and the shock / tilt indicator on the packing units
3. Move the crate to the installation site
4. Remove the packing material and unpack the system carefully.

NOTE!

Keep the special packaging materials for later use. You will need them to transport and store the system. See Chapter 7.2 Storage, page 67.

5. Examine the system for signs of transport damage
6. Make sure the system is complete. See Chapter 1.5 Scope of Delivery, page 9.
7. Lodge any complaints immediately

3.5 Connections of the Controller SP110

This chapter describes the connections of the Controller SP110.

Fig. 3.1 Backside of the Controller SP110

1 *F5 Fuse Heater 1 T8A250V L*
2 *F6 Fuse Heater 2 T8A250V L*
3 *Ground connection*
4 *RJ 45 interface*
5 *XC1 - RS232 interface*
6 XR4 – N/A
7 *XR6 - PV 110 connector*
8 XR7 – external Display connector
9 *Chuck heater connector CN4*
10 *Chuck control connection CN5*
11 *F1 & F2 Fuse T15AI250V P*
12 *Mains connection XR1*
13 *F2 Automatic fuse 3A*

3.5.1 Connecting the Controller SP110 to the Mains

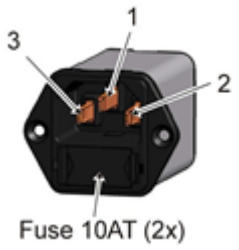
The Controller SP110 is equipped with a self-adjusting power supply. A voltage of 100VAC to 230VAC and a frequency of 50Hz or 60Hz can be applied without further adjustment.

Connect the Controller SP110 to the mains supply with the power cable to the connection socket XR1

NOTE!

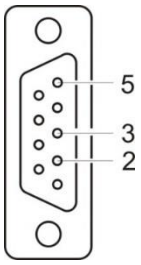
For electrical connections, take note of the relevant local/state and national codes and connect only in a safe and authorized manner.

3.5.2 Mains Connector XR1

Name	XR1	
Location	Rear of the Controller SP110	
Connection	Inlet connector with two fuses	
Pin assignment	Pin 1: ground Pin 2: neutral Pin 3: phase	

Tab. 3.1 Mains Connector XR1

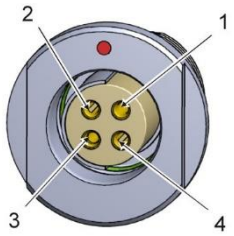
3.5.3 RS232 Interface XR2

Name		XR2	
Location		Rear of the Controller SP110	
Connection		D-Sub, 9 pin for external controller linkage	
Pin assignment		Pin 2: sent data Pin 3: received data Pin 5: ground	
Standard setup:			
	Bits/sec	9600	
	Parity	N	
	Bits per symbol	8	
	Stop bit	1	

Tab. 3.2 RS232-XR2

3.5.4 Connector CN4

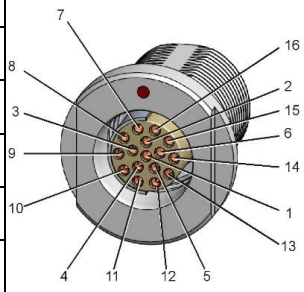
Name	CN4
Location	Rear of the Controller SP110
Connection	4 pin connector for Chuck Heater
Pin assignment	Pin 1: 6 or 8 inch positive Pin 2: 6 or 8 inch negative Pin 3: 12 inch positive Pin 4: 12 inch negative



Tab. 3.3 Connector CN4

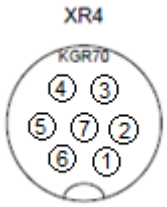
3.5.5 Connector CN5

Name		CN5
Location		Rear of the Controller SP110
Connection		16 pin connector for Chuck control
Pin assignment	1	not connected
	2	not connected
	3	not connected
	4	not connected
	5	not connected
	6	not connected
	7	not connected
	8	Ground
	9	Pt 100
	10	Pt 100
	11	Pt 100
	12	Pt 100
	13	Pt 1000
	14	Pt 1000
	15	KTY
	16	KTY



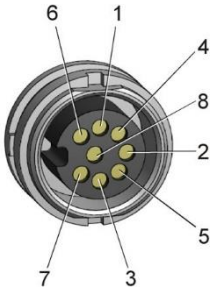
Tab. 3.4 Connector CN5

3.5.6 Connector XR4

Name		XR4	
Location		Rear of the Controller SP110	
Connection		7 pin for N/A	
Pin assignment	1	GND	
	2	TX	
	3	RX	
	4	DP in	
	5	ON /Off +24V	
	6	DP	
	7	GND	

Tab. 3.5 Connector XR4

3.5.7 Connector XR6

Name		XR6	
Location		Rear of the Controller SP110	
Connection		8 pin for PV 110 connection	
Pin assignment	1	+24V	
	2	0V	
	3	Control voltage	
	4	Ground Control voltage	
	5	0V Bypass Valve (optional: Prober Lock)	
	6	+24V Bypass Valve (optional: Air Mixer 300C)	
	7	not connected (optional: Aux Air)	
	8	not connected (optional: Pressure Signal)	

Tab. 3.6 Connector XR6

3.5.8 Connector XC3

Name		XC3	
Location		Rear of the Controller SP110	
Connection		Connector for Controller programming (RJ45)	
Pin assignment	1	D1+	
	2	D1-	
	3	D2+	
	4	D3+	
	5	D3-	
	6	D2-	
	7	D4+	
	8	D4-	

Tab. 3.7 Connector XC3

4 Operation

4.1 Operating Elements of the Controller SP110

The power switch of the Controller SP110 is located on the front panel in the upper right corner.

The Controller SP110 will be operated by the Touch Screen or being remote controlled via its RS232 instruction set.

Fig. 4.1 SP110

4.2 Navigation map

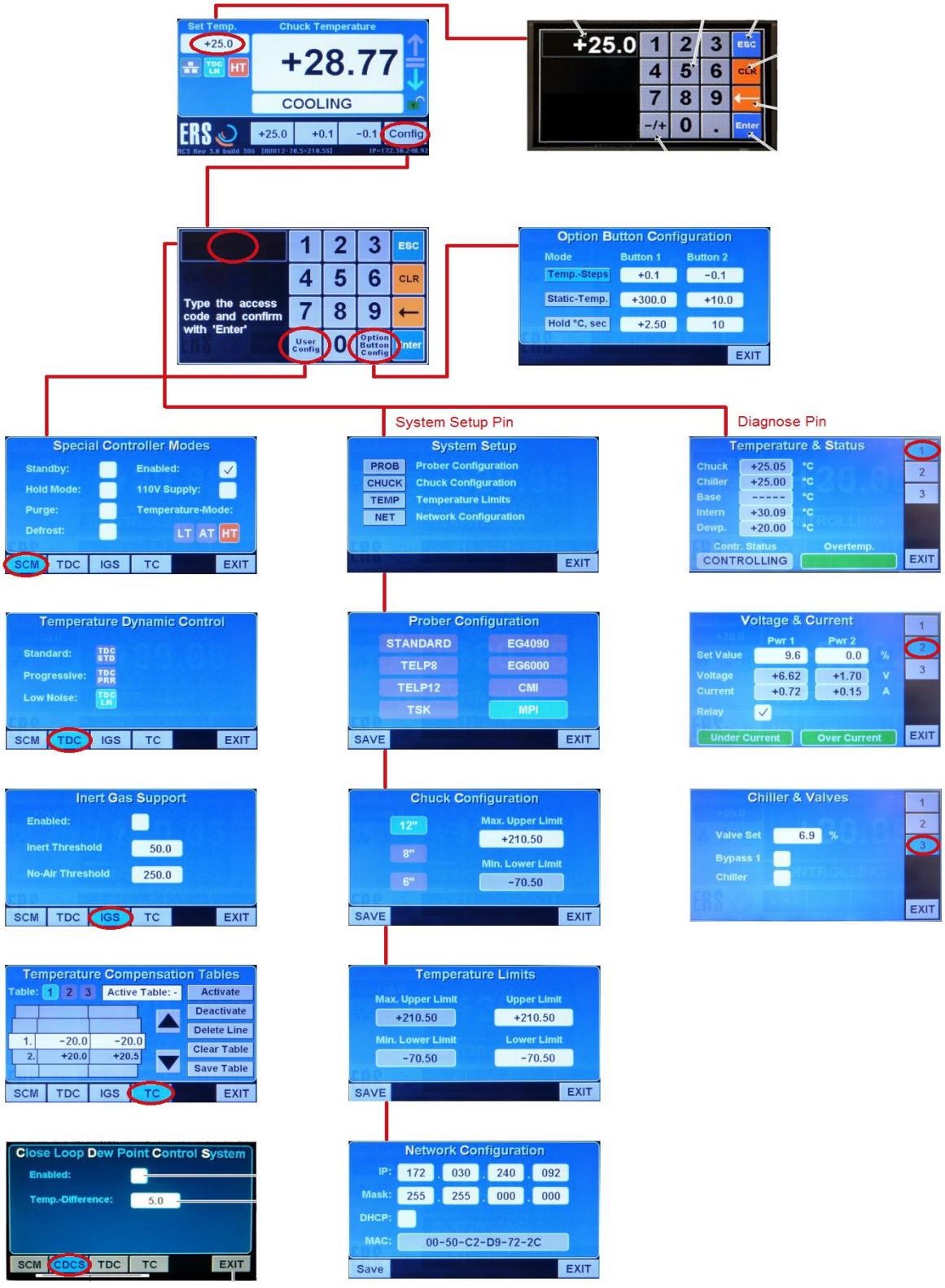


Fig. 4.2 Navigation map

4.3 Menu Screens

4.3.1 Operation Main screen

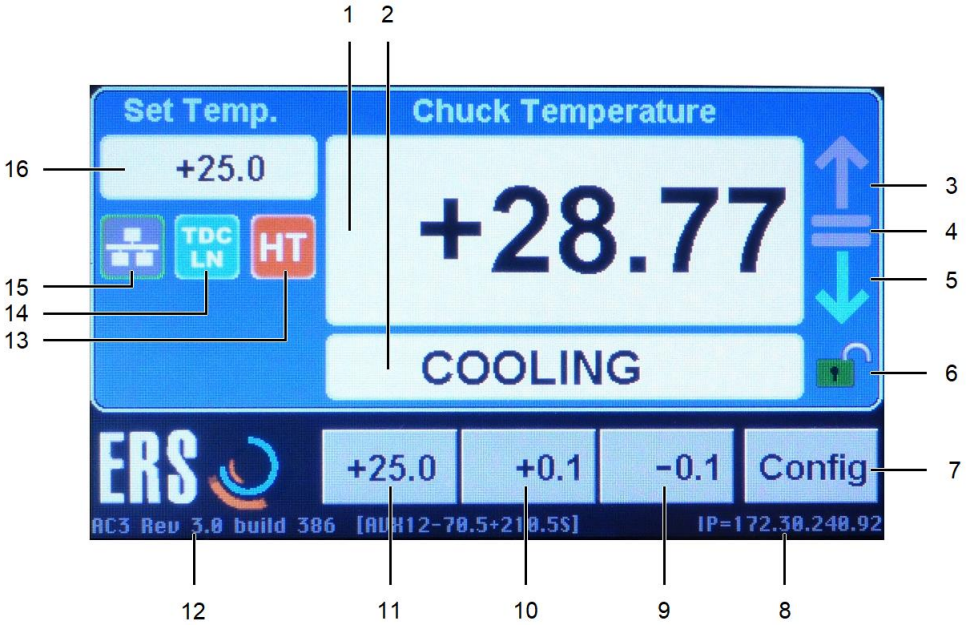


Fig. 4.3 Operation Main screen

Elements of the Operation Main screen:

1 Present Value (PV) or "Chuck Temperature":

This field shows the chucks present temperature. In case the chuck temperature is compensated using a compensation table or command, two temperature values are displayed. The first line (bigger font) shows the compensated temperature whereas the second line (smaller font) shows the uncompensated temperature.

2 Operation mode / Control status /Error Message area:

This field shows the Operation Modes, Control Status and Error messages. Operation Modes include BOOT, INIT, AUTO, Go to Standby, Standby Mode, Hold Mode, Defrost Mode and Purge Mode. Control States are HEATING, COOLING and CONTROLLING.

3 Red arrow upwards: indicates that the device is heating up.

4 This symbol turns green when the chuck temperature has reached the set temperature and it is stable within ± 0.25°C range. It flashes when the chuck temperature is within control range but yet steady or when the user has activated the Hold Mode.

5 Blue arrow downwards: indicates that the device is cooling down.

6 Lock/unlock sign:

The screen can be locked by sending a special command to the controller. The symbol shows an open lock in green if the user can operate the controller manually. If the prober sends a command to lock the touch screen the symbol changes to a red closed lock.

7 Config: Press this button to access the configuration windows.

8 TCP/IP Address.

The controllers are preconfigured to 172.30.240.x with 255.255.0.0 subnet mask. The IP-Address can be changed in the user configuration menu. Access to the configuration Menu is password protected. It must be entered before making changes.

9 Button 2:

Button 1 and Button 2 can be configured to set temperatures, step values or Hold Mode. Refer to the section "Option Button Configuration Screen"

10 Button 1:

Button 1 and Button 2 can be configured to set temperatures, step values or Hold Mode. Refer to the section "Option Button Configuration Screen".

11 “25°C" quick set button:
Press this button to set the Temperature to 25°C.

12 Software Release Version

13 Shows the active "Thermal system Usage Mode", see Special Controller Modes Screen.

14 This field displays the configured Temperature Dynamic Control Mode. There are three control modes; Low Noise (TDC LN), Standard (TDC STD) and Progressive Mode (TDC PRR).

15 This symbol shows the prober-controller communication activity. It turns blue when communicating otherwise remains gray.

16 "Set Temperature":
This field displays the Set Value (SV). Touch this field to open the temperature input window.

4.3.2 Temperature Input screen

After touching the area „Set Temperature“ the display shows the Temperature input screen.

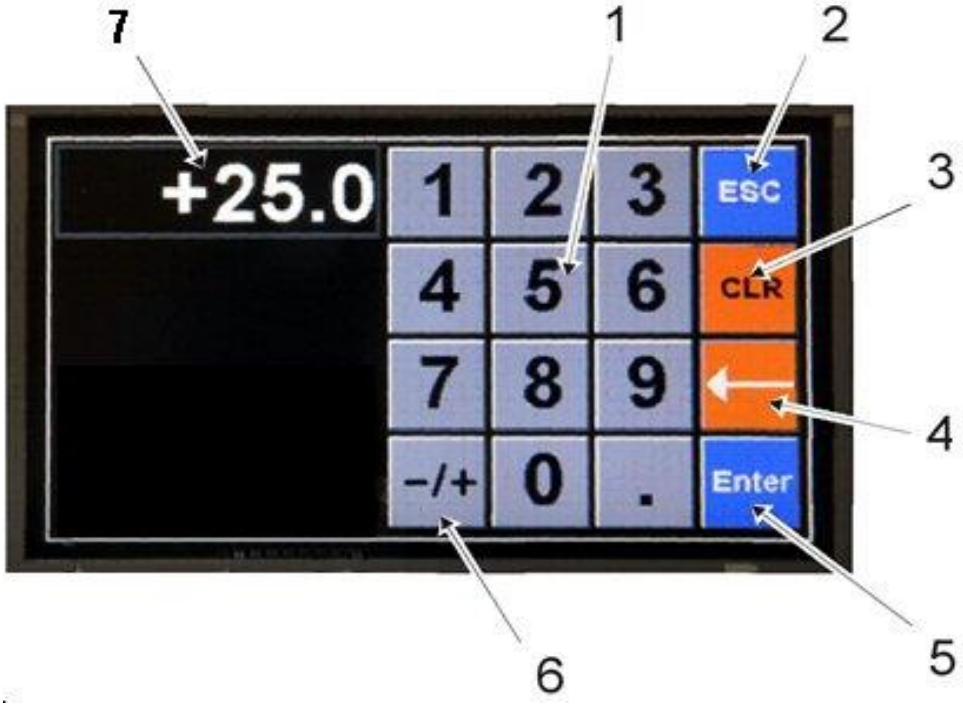


Fig. 4.4 Temperature input screen

Elements of the Temperature Input Screen:

1 Numeric Touch Pad for entering a new Set Value.

2 ESC: discard input and return to main screen.

3 CLR: Delete entered value.

4 Back key. Delete the last entered value.

5 Enter: Confirm input and return to main screen

6 ± Key: Toggle between negative and positive input.

7 Input field

4.3.3 Configuration screen

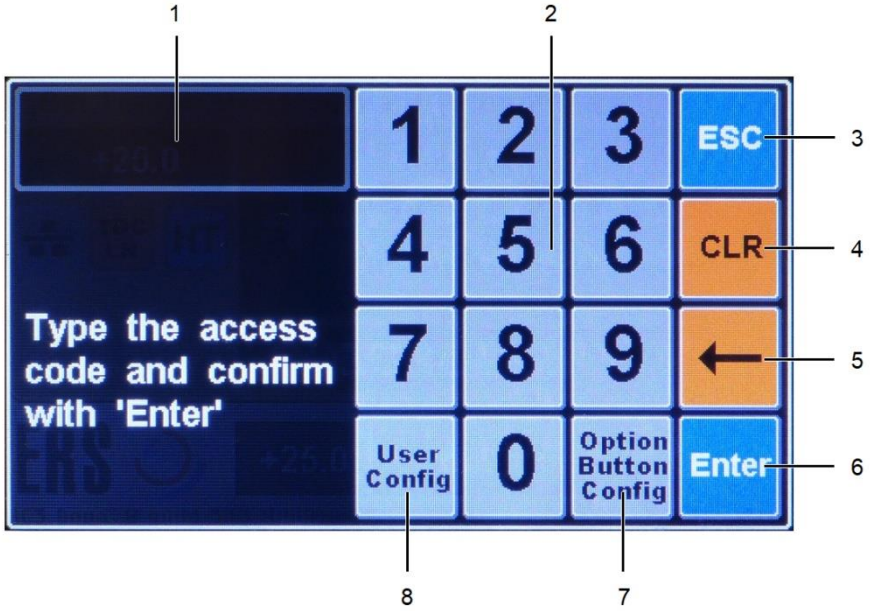


Fig. 4.5 Configuration screen

Elements of the Configuration screen:

1 Input field.

2 Numeric touch pad for the input of pin codes (for service personnel only).

3 ESC: Return to Main Screen

4 CLR: Delete entered pin code

5 Back key: Delete the last entered digit

6 “Enter”: confirm the input

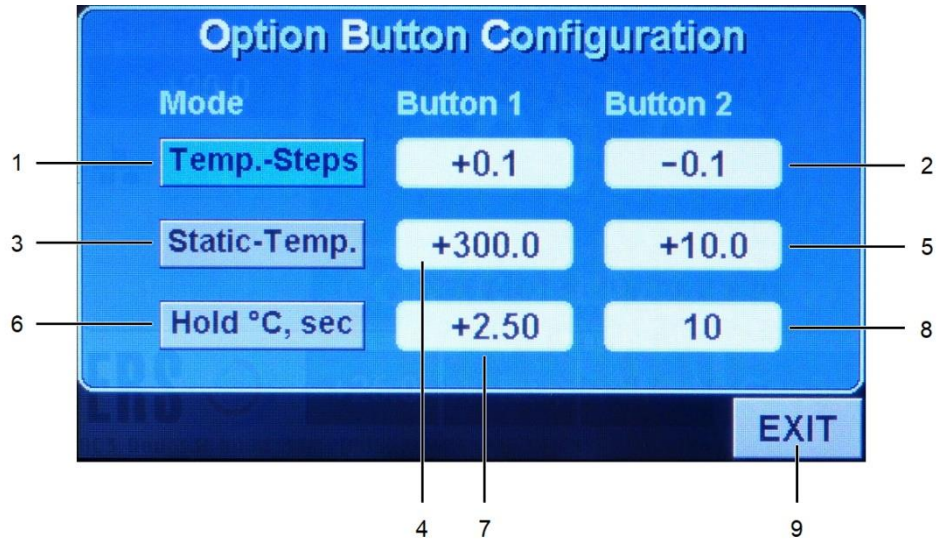
7 “Option Button Config” Opens the Option Button Configuration screen, see Fig 4-6

8 “User Config” opens the Special Controller Modes screen, see Fig 4-7

4.3.4 Option Button Configuration Screen

In the Main Screen press "Config" to open the "Configuration" screen.
Press "Option Button Config" to access the "Option Button Configuration" menu.
The changes made here affect the buttons described in Chapter 4.3.1 (9, 10, 11),. These buttons can be configured to either represent offsets to a set temperature, predefined set temperature values or to offer buttons to select / activate the hold modes.

Fig. 4.6 Option Button Configuration screen



Elements of the Option Button Configuration screen:

1 “Temp Steps” Touch to select the Temperature step mode
Select this mode to configure "Button 1" and "Button 2" with the same offset value. Button 1 will be preset with the positive offset and Button 2 will be preset with the negative value. Useful when the temperature has to be increased or decreased by small steps.

2 Touch this field to open an Input Window. The minimum and maximum values are -9.9°C and +9.9°C respectively n. The Buttons 1 and 2 will reflect your changes.

3 "Static Temp.": Touch to select the static temperature mode.

4 Field to enter preset temperature for "Button 1”

5 Field to enter preset temperature for "Button 2".

6 “Hold” Touch to select the hold selection mode

7 Touch this field to enter the deviation range in which the hold mode will stay active. If the temperature drifts away more than this value the system will go into controlling mode. the allowed values are within 0.25 and 9.99. See also the **RHR** interface command

8 Touch this field to enter the delay (waiting) time before the hold mode gets active. Allowed values between 10 seconds and 999 seconds (16.67 minutes) the default value is 60 seconds. See also the **RDT** interface command

9 Press the "Exit" Button to save the entered values and return to the main screen.

The Buttons 1 and 2 will reflect your changes.

4.3.5 Special Controller Modes Screen

Touching the button „User Config“ opens the “Special Controller Modes” Screen.

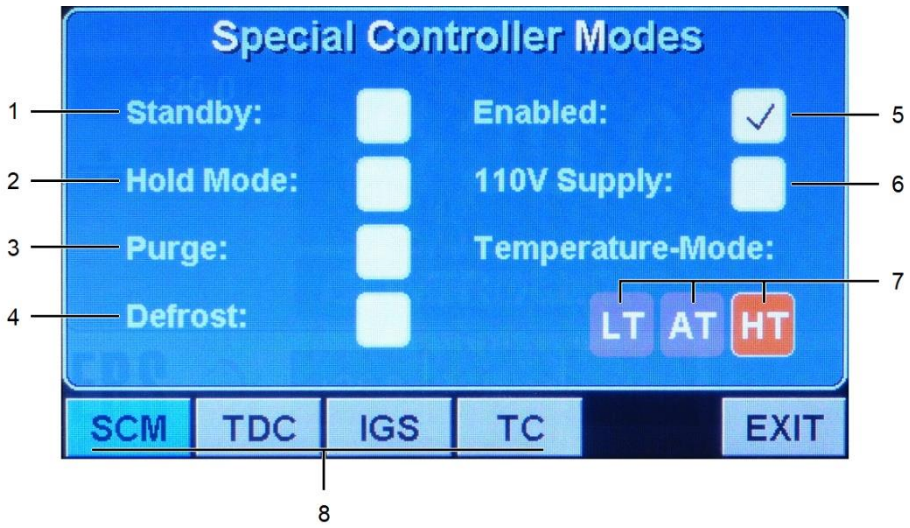


Fig. 4.7 Special Controller Modes screen

Elements of the "Special Controller Modes" screen:

Each mode will be activated and deactivated by touching the required white field. The activated mode is marked in a check box. When exiting the "Special Controller Modes" screen the operation main screen displays the activated mode in the Status / Message area.

1 Stand by. Activates or deactivates “Stand by” Mode, see Standby Mode,

2 Hold Mode, see Hold Mode

3 Purge Mode (optionally), see Purge Mode,

4 Defrost Mode (optionally), see Defrost Mode,

5 Enable / disable temperature control (must be on to operate)

6 No use with TS010 systems

7 Three different operating modes may be selected:

LT Low Temperature Mode

- Refrigeration is permanently on immediate cooling power available
- waste of energy when no cooling is needed
- recommended for frequent temperature cycling.

AT Automatic Mode

- At set temperatures above 50° C the refrigeration is turned off
- For lower set temperatures the refrigeration is turned on
- Energy saving, recommended as standard mode

HT High Temp Mode

- The refrigeration is permanently off
- Hot only mode, for lower temperatures AT or LT must be selected
- Recommended for longtime high temp testing

8 Tabs to switch between user configuration modes:
"SCM" Special Controller Modes Screen, the active screen
"TDC": switches to Temperature Dynamic Control Screen,
"SCC" "SCC": switches to System Check Control Screen,
(This button and screen is optional)
"TC": switches to "Temperature Compensation Tables",
"CDCS": switches to Loop Dew Point Control Screen,
(This button and screen is optional)

4.3.6 Close Loop Dew point control screen (Optional)

This screen will be present if an optional dew point sensor installed.

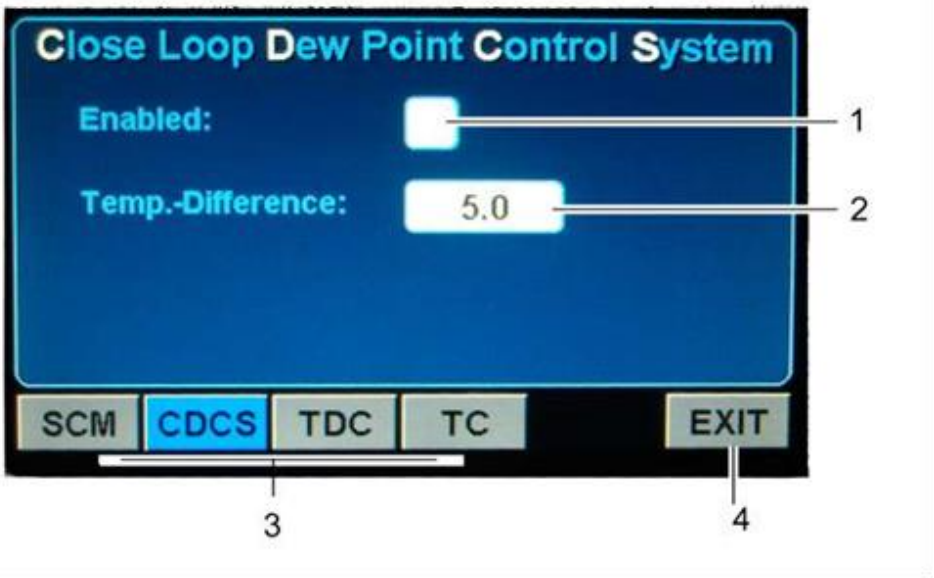


Fig. 4.8 Close Loop point Control screen

Elements of the Close Loop Dew Point Control screen:

1 Enable / disable “Close loop Dew Point Control System”.

2 Opens the Temperature Input Screen. This value determines how close the chuck temperature is allowed to approach the dew point temperature.

3 Tabs to switch between user configuration modes.

4 "EXIT": Returns to operation main screen.

Close Loop Dew Point Control

The Thermal System provides a dew point closed loop system to avoid any ice-formation on the wafer.

Condensation of moisture or ice-formation will occur if the chuck temperature is below the dew point of the ambient air. To prevent this situation, the chuck temperature may be controlled by the dew point monitoring system to ensure that the chuck temperature will not drop below the dew point of the ambient air.

The dewpoint must always be lower than the chuck temperature. To ensure that, a configurable dewpoint offset is saved on the system A value of 0.5 to 9.9°C can be set as distance of the chuck temperature to the dew point. Thus, the chuck system will not reach a temperature set point (target temperature) that is lower than the dew point of the ambient air. The default value is 5.0°C.

To avoid condensation on the wafer and air tubes, the dewpoint in the Prober has to be constantly monitored. The monitoring evaluates dewpoint sensor results, and if required, adapts the chuck set temperature and submits warnings.

- Remote control via RS232: send the interface command «SD1» to enable, or «SD0» to disable

4.3.7 Temperature Dynamic Control screen

The Button "TDC" navigates to the Temperature Dynamic Control screen.

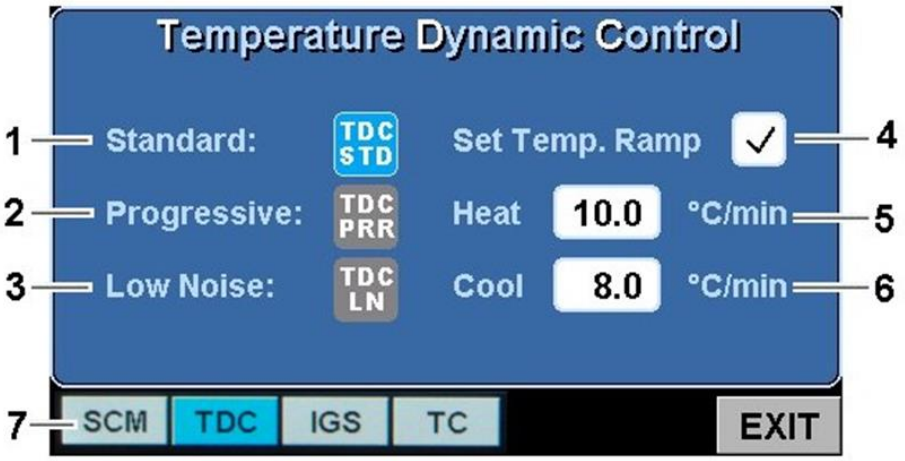


Fig. 4.9 Temperature Dynamic Control screen

Elements of the Temperature Dynamic Control screen:

The current mode is highlighted. The selected mode symbol is shown in the operation main screen. All settings of this screen are stored and will remain after power down.

1 **Standard mode:**
Compromise between very stable temperature controlling and minimizing the low noise distortions produced by the controller.

2 **Progressive mode:**
The controller tries to maintain the set temperature. No limits on current change. This controlling method is the best suited for applications that have varying power sources on the chuck.

3 **Low Noise mode:**
The controller limits the maximum control current allowed to stabilize the chuck temperature. This controlling method is best suited for low noise measurements. The controller will react slowly to external influences to the chuck.
Please refer to "Hold Mode" for further low noise stability.

4 This button (optional) enables the temperature ramp function. When enabled the heating and cooling speed is limited to the set values. When a new set temperature is entered the main display will show **RAMPING UP** or **RAMPING DOWN** instead of HEATING or COOLING.
A linear temperature rise or drop can be achieved within the limitations of the chuck system.

5 Maximum Heating rate (optional)

6 Maximum Cooling rate (optional)

7 Tabs to switch between user configuration modes. See Chapter 4.3.5 Special Controller Modes Screen, page 35.

8 "EXIT": Returns to operation main screen

4.3.8 Inert Gas Support screen

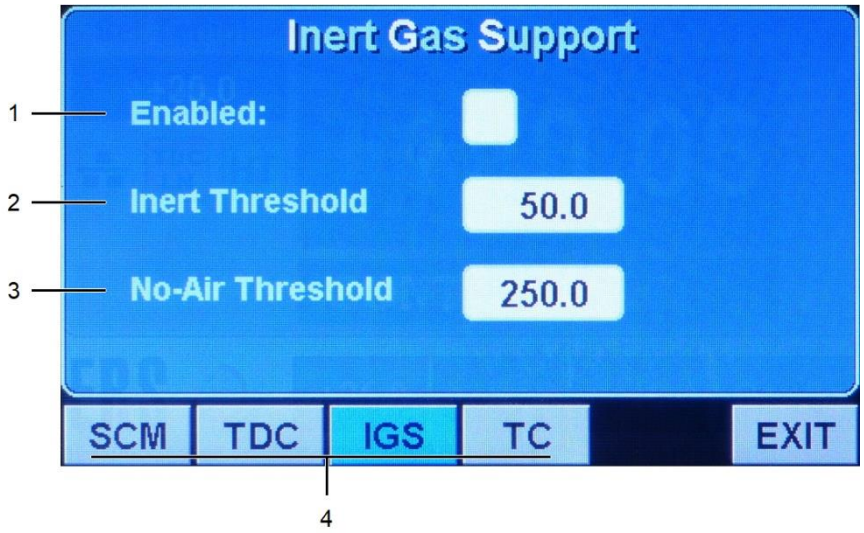


Fig. 4.10 Inert Gas Support screen

1 Enable/Disable Inert Gas Support by Checking/Unchecking the Box

2 Temperature 1 (“T1”) can be set by touching the field. Above this Temperature the purge air is turned off.

3 Temperature 2 (“T2”) can be set by touching the field. Above this Temperature Cooling is performed without the use of any air.

4.3.9 Temperature Compensation Tables screen

The Button "TC" navigates to the Temperature Compensation Tables screen, for further information see Chapter 4.5 Temperature Compensation.

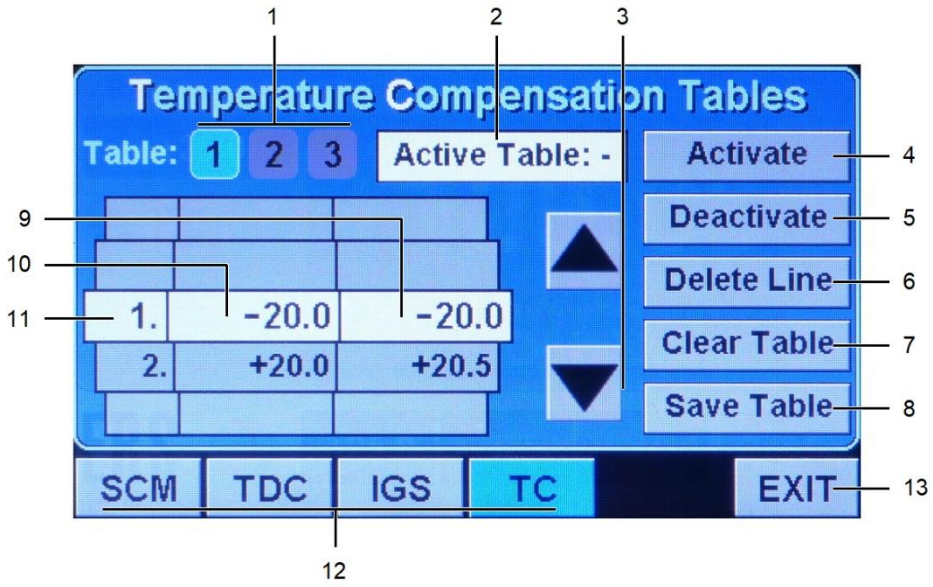


Fig. 4.11 Temperature Compensation Tables screen

Elements of the Temperature Compensation Tables screen:

1 Table numbers: Selects the required temperature compensation table.

2 Indicates the Active Table.

3 Scroll keys: Scrolls the lines in selected temperature compensation table up or down.

4 "Activate": Activates the selected temperature compensation table.

5 "Deactivate": Deactivates the selected temperature compensation table.

6 "Delete Line": Deletes the highlighted line in selected temperature compensation table

7 Clear Table": Deletes all lines in selected temperature compensation table.

8 "Save Table": Saves table values.

9 Compensation value. Touch this area to input or change the value. The maximum offset to the set value is ±9,99°C.

10 Value to be compensated. Touch this area to input or change value.

11 The high-lighted line that is being edited.

12 Tabs to switch between user configuration modes. See

13 "EXIT": Returns to operation main screen

4.3.10 System Setup screen

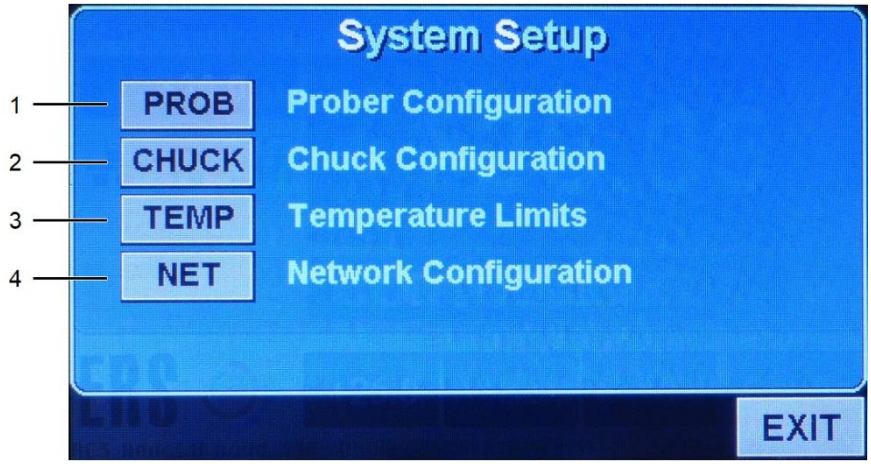


Fig. 4.12 System Setup screen

1 Button to enter Prober Configuration

2 Button to enter Chuck Configuration

3 Button to enter Temperature Limits Setup

4 Button to enter Network Configuration

4.3.11 Chuck Configuration screen

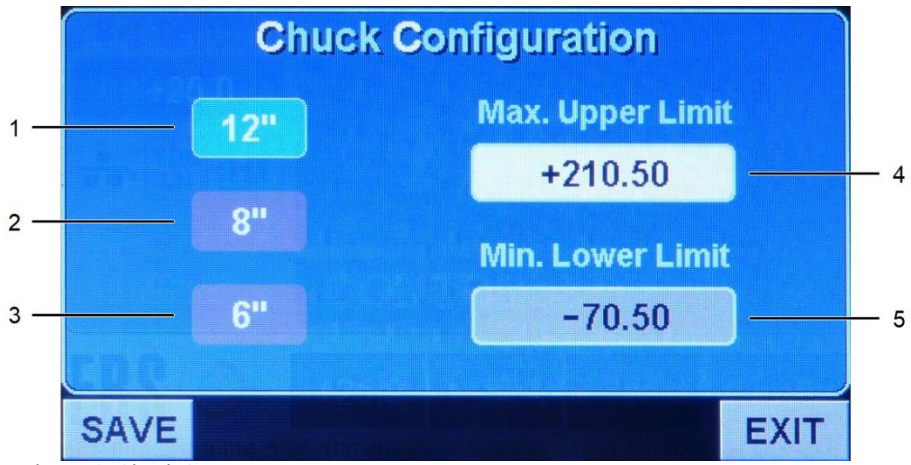


Fig. 4.13 Chuck Setup screen

1 Chuck diameter of 12 inch

Touch the Button according to your present Chuck size.

The turquoise Colure indicates the activated Mode.

2 Chuck diameter of 8 inch

3 Chuck diameter of 6 inch

4 Set the maximum Upper Temperature Limit according to your Chuck model and equipment

5 The minimum Lower Temperature Limit depends on your Chiller and Chuck model

4.3.12 Temperature Limits screen

Fig. 4.14 Temperature Limits screen

2 Set the Upper Limit according to your work process

4 Set the Lower Limit according to your work process and ambience conditions,

if the automated dewpoint Control isn´t activated.

4.3.13 Network Configuration screen

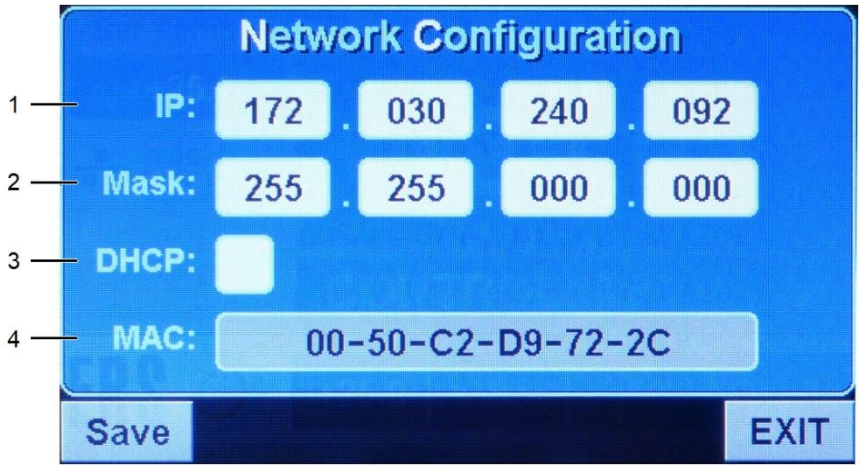


Fig. 4.15 Network Configuration screen

1 Set the Controllers IP address

2 Set the Subnet Mask

3 Enable/Disable Dynamic Host Configuration Protocol by checking/unchecking the Box

4 Mac address of your device

4.3.14 Diagnose Screen 1

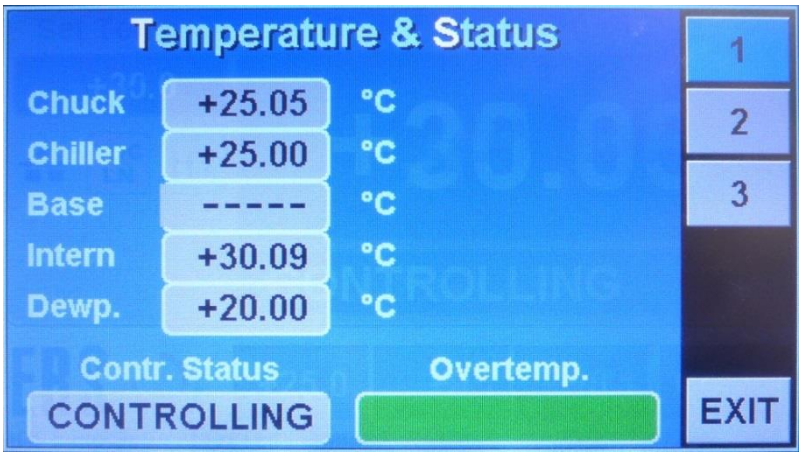


Fig. 4.16 Diagnose screen 1

- Actual chuck temperature
- Chiller air out temperature
- Chuck base temperature (if available)
- Internal temperature of controller electronics
- Measured dew point (set to 20 if no sensor present)

4.3.15 Diagnose Screen 2

Fig. 4.17 Diagnose screen 2

- Monitors setting, voltage, and current of chuck heating circuits.
  Set range is 0 to 100%
- Voltage and current are depending on the chuck type connected.

	WARNING
	setting of high current may heat up the chuck until the safety limit. Set heating current for short test purpose only. Unattended use may cause damage.

- The power relay may be turned off for checking the function.
- Pressing EXIT lets the controller return to normal operating mode

4.3.16 Diagnose Screen 3

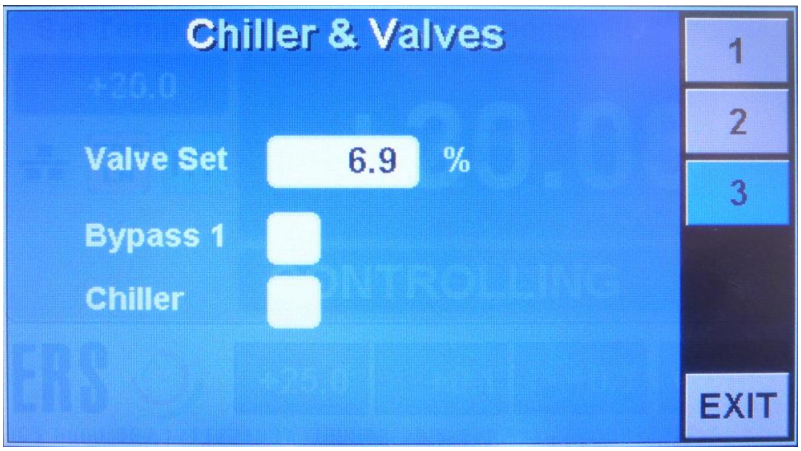


Fig. 4.18 Diagnose screen 3

- current setting of the Air Valve
- enable/disable the purge air Bypass to the Prober chamber
- enable/disable an attached Chiller

4.4 Special Operating Modes

4.4.1 Hold Mode

To eliminate the influence of changing current through the chuck's heating system, on sensitive measurements, the Thermal System is equipped with a feature called «Hold Mode». In this mode the current and air flow are locked at the present values while Hold Mode becomes active.
When the controlling current and air flow are locked, the Chuck temperature may drift off the set Temperature.
ERS recommends to deactivate the «Hold Mode» after testing has finished.
Choose the Hold selection in the Option Button screen for an easy accessibility.

4.4.2 Auto Hold Mode (A-Hold)

Auto Hold Mode can be set by pressing A-Hold or selecting Hold mode in the Special Controller Mode Screen or by issuing the SH1 command to the System.

A-Hold (**Auto Hold Mode**), becomes effective when the Chuck temperature has reached the set value and stabilized within a fixed Hold Mode Chuck Temperature deviation range of $\pm 1.20°C$. The time needed to go to Hold Mode is automatically determined by the System. This time depends on the Set temperature, Prober environment, Purge air, open cover and time the System has already been at the Set Temperature. Depending on these conditions it may take several minutes (6 minutes or more), until the system goes to Hold Mode.

Fig. 4.19 Main screen Auto-Hold

The Display will show “going to Hold”

When the conditions are stable the button will turn to green and the status display will show Hold Mode.

With the interface request command RH the answer is
“H10” for Hold Mode set but not yet reached (Going to Hold)
“H11” for Hold Mode set and reached (Hold Mode)

As the conditions are stable the temperature is expected to drift away slowly. Once the temperature differs by more than $\pm 1.20°C$, the controller will return in its “GOTO HOLD” state and is going to repeat this cycle until Hold Mode is unset.

4.4.3 Instant Hold Mode. (I-Hold)

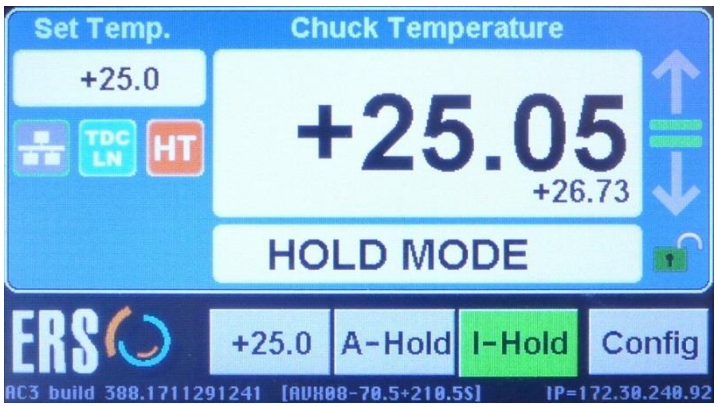


Fig. 4.20 Main screen Instant-Hold

This mode allows the Operator to set Hold Mode instantly while the following conditions are met:

The System will immediately go into Hold Mode when the Chuck temperature has been within $\pm 0.25°C$ for a period time which is determined by the Operator in the option button setup. This can be set to 10 till 999 seconds (16.67 minutes). This mode can be activated through the Probers serial Interface or the Display Menu. Depending on the conditions the temperature may drift out of range.

Display:

While the Thermal System is in «Hold Mode» the Operation Main screen will display «Hold Mode» in the Status / Message area. The control current will not change as long as the chuck temperature is within a range from the set temperature.

NOTE!

While in «Hold Mode» the chuck temperature may very slowly drift away from the set temperature. This is normal because of the locked temperature control (no current change).

After deactivating the «Hold» operation the Thermal system will instantly start to correct to the proper temperature.

Activating the «Hold Mode»

- Touch screen input:
  Press “Config” to enter "Special Controller Modes" screen and touch the check-box next to Hold Mode
- Remote control via RS232: send the command «SH1»

Deactivating the «Hold Mode»

- Touch screen input:
  Press “Config” to enter "Special Controller Modes" screen and touch the check-box next to Hold Mode
- Remote control via RS232: send the command «SH0»

4.4.4 Purge Mode

The purge mode is used as initial operation of the system and in case humidity has accidentally entered the systems tubing.

In the purge mode the refrigeration unit is switched off, the chuck temperature is set to +25°C and a specific amount of dry air is purged through all pneumatic parts of the chuck and the prober.

Activating the «Purge Mode»

- Touch screen input: Press “Config” to enter "Special Controller Modes" screen and touch the checkbox next to Purge Mode

The «Purge Mode» will be displayed in the Operation Main screen at the Status / Message area

Deactivating the «Purge Mode»

- Touch screen input: Press “Config” to enter "Special Controller Modes" screen and uncheck the check-box next to Purge Mode

4.4.5 Defrost Mode

The «Defrost Mode» is provided to warm up all system parts to safe, ice and moisture free conditions.

This means:

- the chuck temperature is set +60°C
- the refrigeration system is switched off and the air purging is set to the maximum value.

Activating the «Defrost Mode»

- Touch screen input: Press “Config” to enter "Special Controller Modes" screen and touch the checkbox next to Defrost
- Remote control via RS232: send the interface command «SO3»

The «Defrost Mode» will be displayed in the Operation Main screen at the Status / Message area

Deactivating «Defrost Mode»

- Touch screen input: Press “Config” to enter "Special Controller Modes" screen and touch the checkbox next to Defrost
- Remote control via RS232: send the interface command «S01»
- Set new temperature value

4.4.6 Standby Mode

When the system is set into «Standby Mode» the heater and the cooling air are switched off. Only a purge air is supplied to the prober.

If the actual chuck temperature is below +15°C or above +40°C the system will set +25°C for safety reasons first before going to «Standby Mode».

Display

When the user or prober sets the Thermal System to «Standby Mode» the display will show „**Go to Standby**“ if the Chuck temperature is below +15°C or above +40°C. The display will change to „**Standby Mode**“ when the Chuck temperature is with +15°C - +40°C range.

NOTE!

If the Chuck temperature is in the range of +15°C to +40°C the Thermal system goes immediately to «Standby Mode»

Activating the «Standby Mode»

- Touch screen input: Press “Config” to enter "Special Controller Modes" screen and touch the check-box next to Standby
- Remote control via RS232: send the interface command «SO2»

Returning from «Standby Mode» into Regular Operation

- Touch screen input: Press “Config” to enter "Special Controller Modes" screen and touch the check-box next to Defrost
- Remote control via RS232: send the interface command «SO1»
- Set new set temperature.

4.4.7 Prober Lock

The Thermal System has an optional compressed air outlet called Prober Lock. If a prober is equipped with a pneumatic lock mechanism, it may be connected to this outlet. Otherwise the outlet must be closed.

In automatic mode, the lock is “unlocked” between +14.5°C and < +60°C, and “locked” outside this range.

It can be forced to “unlocked” with prober command SPL0, to “locked” with SPL1 and reset to automatic mode with prober command SPLA.

It is also possible to control the lock via display using passwords “1590” to unlock, “1591” to lock and “1592” to reset to automatic mode.

After reset, the prober lock runs in auto-mode:
“Safe” temperature range: > +14.5°C and < +60°C: Prober Lock is “OFF”
Outside this temperature range, prober lock is “ON”

Prober lock set command: SPLx, where x can be: '0' - unlock, '1' - lock. 'A' – auto.
Prober lock request command: RPL, Controller response: PLx, where x can be: '0' - unlocked, '1' - locked, 'E' - switch failure.
Prober commands '0' and '1' override auto-mode

Display control via password:

- 1590 - unlock
- 1591 - lock
- 1592 - auto
- Passwords '1590' and '1591' override auto-mode

4.4.8 High Purge

High Purge is a situation where the prober requests the controller to switch-on purge air using the extra bypass valve for dry air. The prober setting overrides the automatic chiller purge air mechanism.

Behavior:

High Purge **ON**:

- an extra valve purges dry air into the chamber in any condition of the chuck

High Purge **OFF**:

- the extra valve is automatically controlled
- High purge is OFF, if INERT mode is enabled and active

Remote control via prober commands:

- Prober command: SHPx (SHP1 or SHP0)
- Prober Request: RHP (Response: HP0 or HP1)

4.4.9 Extra Cooling

The Thermal System may provide an extra air outlet AUX AIR to cool components close to the chuck, as e.g. prober head plate.

For Chuck temperatures above +150°C (with +/-5°C hysteresis), a valve will be automatically switched on. The valve will be switched off when the chuck temperature drops below +150°C.

- The output AUX AIR must be closed if not used
- Remote prober commands and requests are not needed.

4.4.10 Inert Gas Support

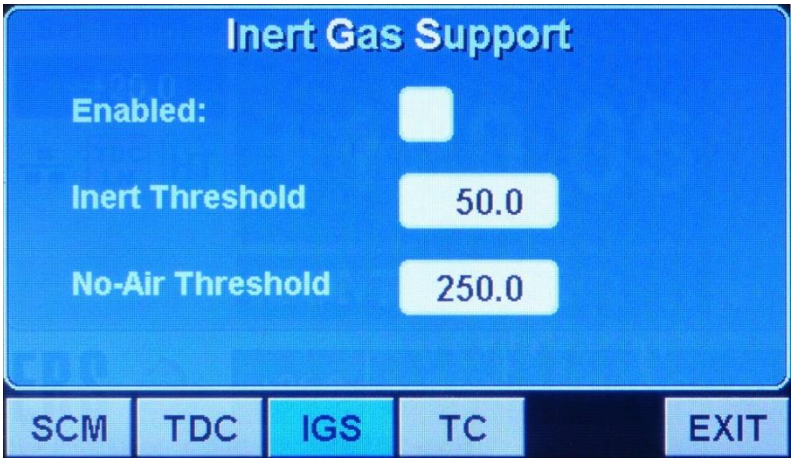


Fig. 4.21 Inert Gas Support

IGS (Inert Gas Support) in the User-Configuration menu is used to control inert gas support. It allows to set the temperatures T1, T2, and to enable/disable inert gas support by a checkbox.

Inert mode should be used if the prober is purged with nitrogen. Therefore, the purge air has to be switched off at temperatures above a temperature “T1”. The temperature T1 can be set by the user.

For temperatures above T2, which also can be set by the user, cooling of the chuck has to be performed without any air, as the return air would disturb the inert atmosphere.

Behavior:

- Inert mode enabled/disabled is a non-volatile setting, stored in the controller and its default setting is disabled.
- T1 is a non-volatile setting, stored in the controller; default value is 50°C
- T2 is a non-volatile setting, stored in the controller; default value is 150°C
- To avoid oscillation of purge or cooling air, a hysteresis of +/-3°C is implemented.

Remote control via prober commands:

- Set: SIMx (x=1 or 0)
- Request: RIM (Response is IM1 or IM0) Control via Display:

4.5 Temperature Compensation

Temperature compensation is intended to eliminate a known difference between the Device Under Test (DUT) and the value shown at the Thermal System´s display.

Several influences, such as wafer thickness, wafer surface, thermal conductivity, additional layers, airflow, etc. may DUT temperatures to be different from the temperature generated at the chuck surface. The Thermal System can store three different compensation tables in order to compensate for different working conditions. The user may select the compensation table 1, 2, 3, or deactivate, if no compensation is needed.

Each table may consist of up to 10 manually set temperature values with its corresponding compensation values. The Thermal System will interpolate between given compensation points. The maximum allowed compensation range is ± 9.9°C. A value pair of the compensation table consists of the set temperature and the compensated set point value. One table can contain up to 10 value pairs and it is recommended to store at least 2 value pairs, that the system can interpolate compensation offsets between these 2 values.

All temperatures between the minimum and maximum of the table values have either a stored offset or the offsets are interpolated. For set temperatures less than the table´s minimum, the minimum offset is used. Likewise, for set temperatures greater than the table´s maximum, the maximum offset is used accordingly.

4.5.1 Creating Compensation Tables

Entering compensation temperature values

The compensated temperature value is the temperature necessary to obtain the desired set point temperature at the measured point.

An example of a Compensation List will be shown in Chapter 8.1 Temperature Compensation List, page 71.

> **NOTE!**
>
> **If the measured chuck temperature is colder than set temperature, add the difference to obtain the compensated temperature. If warmer, subtract.**

Example of interactively creating a compensation Table:

Aim: Compensate Temperature at +85°C.

7 Attach a temperature sensor on the DUT (e. g. wafer to test, additional layer) at the top of the chuck. Connect the sensor to a calibrated temperature measuring device.

8 Set the Temperature on the main screen to +85°C.

9 The controller will start heating, cooling or controlling depending on the present chuck temperature. Wait until the chuck temperature has reached the set value and the temperature has stabilized (Controlling).

10 Note the actual value of your temperature measuring device (e.g. 84.5°C) and its corresponding set value (e.g. +85°C). While +85°C is the value to be compensated (left column on the TC screen), -0.5°C is the measured offset and +0.5°C is the required action, so +85.5°C is your compensation input value (right column on the TC screen)

11 Set a new value and repeat the steps (1) till (4) to create a list of pair values, that can be entered into a Temperature Compensation Table.

4.5.2 Define a new compensation table

Proceed as follows to define a new compensation table.

1 Select the compensation table n by selecting the Config ➔ User Config ➔ TC screen

2 Select the table (1, 2, or 3) you want to edit (see Fig 4-9)

3 Touch the “set field” (active row) to open the input windows, insert the compensation value and confirm with "Enter", to return to the compensation table. If you don't want to compensate the value, just enter the same value in both fields.

4 Select the next row by using the up and down buttons. Repeat step 3 for all rows you want to edit.

5 To delete a line, press "Delete Line"

6 To delete a complete table press "Clear Table".

- Select the compensation table by selecting the Config ➔ User Config ➔ TC screen (See Chapter 4.3.9 Temperature Compensation Tables screen, page 39.)

7 Press "Save Table" to store the table

4.5.3 Using Compensation Table

Selecting a Compensation Table

- Select the table number and press “Activate”.
- The operation main screen (See Chapter 4.3.1 Operation Main screen, page 29) shows now in the first line the compensated DUT temperature and in a small second line the actual chuck temperature value.

Disabling Temperature Compensation

- Select the compensation table n by selecting the Config ➔ User Config ➔ TC screen (See Chapter 4.3.9 Temperature Compensation Tables screen, page 39.)
- Press “Deactivate”

4.6 Remote Control via RS232

On delivery the RS232 interface is preconfigured according to the customer's prober maker and model. Only an ERS® Service can change this configuration. Therefore, customers cannot change this configuration.

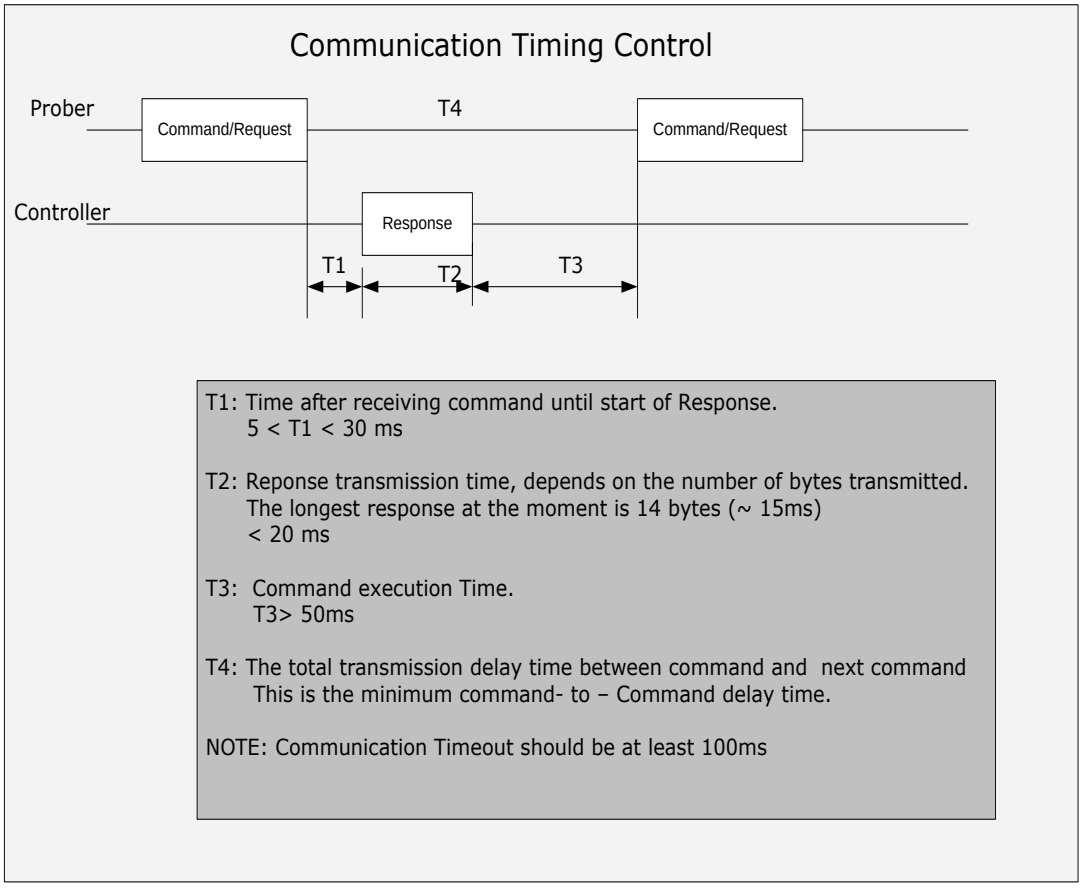
4.6.1 Command Interface

The Thermal system is able to support several transmission protocols among which are ASCII <CR><LF>; <ENQ><ACK> and other binary protocols.

Default is ASCII <CR><LF>.

4.6.2 Command Timing

The Prober commands have to be synchronized with the Responses from the Controller. This means that the Prober has to wait for a Response from the ERS Controller before issuing the next command or Request. ERS recommends that the Prober has to observe a Timeout delay between a command or request and a Response from an ERS System.



Tab. 4.1 Communication Timings

communication Timing defined by ERS

The controller will not respond to new commands or request while a command is executed. Wait for the response of a command and at least 100ms after a set command before addressing the controller again. See Appendix (8.4) for more details

4.6.3 Sending Commands via RS232

All ASCII Protocols have the same command format embedded between control codes.
The commands listed below are supported by all ERS® Systems.
The response messages are examples of ERS® Standard <CR><LF> protocol.

NOTE!

All commands must be written in capital letters.

Response from Controller to valid Request Commands:
"Response"<CR><LF> otherwise: "?"<CR><LF>

(s = + or -, x or y= digit 0 – 9)

Command	Description	Answer
STsxxxx	Set new set temperature [1/10 °C resolution] i.e. ST+0305 sets +30.5°C as new set temperature	OK: New temperature accepted ?: Error during transmission or invalid temperature
SOy	Set Operating Mode y = 1: set normal mode operation y = 2: set standby mode y = 3: set defrost mode y = 4: set purge mode	OK: New mode is accepted ?: Mode Invalid or not possible
SLy	Keyboard lock y = 0: release keyboard lock y = 1: set keyboard lock	OK: command is accepted ?: command not accepted
SR+xx-yy	Set deviation range for status display «=» and RI-Request answer «0» • +xx: max. positive deviation in 1/10°C • -yy: max. negative deviation in 1/10°C Example: SR+12-08 sets the range from set temperature +1.2°C to set temperature -0.8°C	OK: command is accepted ?: command not accepted
SHy	Set «Hold Mode» ON or OFF • y = 0: deactivate Hold Mode • y = 1: Activate Hold Mode	OK: command is accepted ?: command not accepted
SIHy	Activate Instant Hold Mode • y = 0: deactivate instant Hold Mode • y = 1: Activate instant Hold Mode	OK: command is accepted ?: command not accepted
SDTnnn	Set Hold Mode Delay Time nnn = 010..999 Seconds Default: 60 seconds for Instant Hold Mode, 360s (6 Min) for Auto Hold Mode	OK: command is accepted ?: command not accepted
SHRnnn	Set Hold Mode Temperature Range nnn=025 .. 999 (0.25°C .. 9.99°C) default: 1.2°C Valid for both modes	OK: command is accepted ?: command not accepted
SPLy	Set Prober lock automatic, ON or OFF: • y = 0 : Prober lock OFF • y = 1 : Prober lock ON • y = A : Prober lock is automatic	OK: command is accepted ?: command not accepted
SHPy	Set Prober High Purge: • y = 0 : High Purge OFF • y = 1 : High Purge ON	OK: command is accepted ?: command not accepted

SIMy	Set Inert Modus: • y = 0 : Inert Modus OFF • y = 1 : Inert Modus ON	OK: command is accepted ?: command not accepted
SCIn	Initialize the compensation process with table n (n = 1, 2, 3) See Chapter 4.5.2 Define a new compensation table, page 51.	OK: command is accepted ?: command not accepted
SCPn; vxxxx; vyyyy	Define the compensation table position n (n = 0 through 9) • xxxx: set temperature • yyyy: compensated temperature See Chapter 4.5.2 Define a new compensation table, page 51.	OK: command is accepted ?: command not accepted
SCS	Save the selected compensation table in EEPROM	OK: command is accepted ?: command not accepted
SCC	Close the compensation process	OK: command is accepted ?: command not accepted
SCT0	Disable temperature compensation	OK: command is accepted ?: command not accepted
SCTn	Select and activate the temperature compensation table n (n = 1, 2, 3)	OK: command is accepted ?: command not accepted
SDX	command «SD1» to enable, or «SD0» to disable close loop dewpoint control	OK: command is accepted ?: command not accepted
SREx	Set Ramp Enable 0 = Off 1= On	OK: command is accepted ?: command not accepted
SRHxxx	Set Ramp Heating rate in 0.1 C/ minute (SRH100 = 10.0C/min)	OK: command is accepted ?: command not accepted
SRCxxx	Set Ramp Cooling rate in 0.1 C/ minute (SRC100 = 10.0C/min)	OK: command is accepted ?: command not accepted

Tab. 4.2 RS232 Sending Commands

4.6.4 Request Commands via RS232

NOTE!

All commands must be written in capital letters otherwise the Thermal system will not accept the command and will therefore answer with «?».

(s = + or -, n or x or y = digit 0 – 9)

Command	Description	Answer
RC	Request actual temperature of Chuck [1/10°C resolution]	Csxxx example: response: C-600 (means: Thermal system temperature is -60.0°C)
RE	Request error status	Eyyy Example: E003 means that Error 03 has occurred. See Chapter 6.1 Error Messages and Recovery, page 62.
RF	Request measured dewpoint value	Fsxxxx Example: F-0585 (means actual dewpoint is -58.5°C)
RH	Request «Hold Mode» set / status	Hy y = 0: «Hold Mode» not active y = 1: «Hold Mode» active See Chapter 4.4.1 Hold Mode, page 44.
RH Changed from firmware 330. up	Request status of automatic Hold Mode	Hyy y = 00: «Hold Mode» not active y = 10: «Hold Mode» set but not yet reached yy = 11: «Hold Mode» set and reached
RIH	Request status of instant Hold Mode	IHy y = 0: instant Hold Mode not active y = 1: instant Hold Mode not active
RI	Request controlling status information	In n = 0: set temperature reached and controlling n = 1: heating up Chuck n = 2: cooling down Chuck n = 8: error
RL	Request keyboard lock status (see SL command)	Lx x = 0: keyboard is not locked x = 1: keyboard is locked
RM	Request allowed Minimum and Maximum Temperature limits	M sxxxx syyyy" xxxx = minimum set value yyyy = maximum set value that the controller can accept.
RO	Request operation mode	Oy y = 0: unit is off (not supported) y = 1: normal operation y = 2: «Standby Mode» active y = 3: «Defrost Mode»

RR	Request deviation range	R+xx-yy +xx: max. positive deviation in units of 1/10°C -yy: max. negative deviation in units of 1/10°C Example: R+05-08 means that the deviation range is set +0.5°C to 0.8°C from set temperature
RT	Request set temperature with 1/10 °C resolution	Tvxxxx Example: T-0105 means that the set temperature is -10.5°C
RD	Request dew point control status	Dy y = 0: dew point control is off y = 1: dew point control is on
RPL	Requests Prober Lock Status	Ply y = 0: unlocked y = 1: locked y = E: failure
RHP	Requests High Purge Status	HPy y = 0: no high purge y = 1: high purge active
RIM	Requests Inert Mode Status	IMy: y = 0: Inert mode OFF y = 1: Inert mode active
RCT	Request temperature values of compensation table position number (n = 0 through 3)	CTn n = 0: temperature compensation disabled n = 1 or 2 or 3: active table
RCPn	Request compensation temperature pair at position n of the active table	CPn; set; setc n = 0 through 9: table position number set: set temperature setc: compensated temperature
RRE	Request Ramp Enable status	REx 1 = enabled 0 = disabled
RRH	Request Ramp Heating rate	RHxxx xxx = heating rate in 1/10 deg C
RRC	Request Ramp Cooling rate	RHxxx xxx = cooling rate in 1/10 deg C

Tab. 4.3 RS232 Request Commands

5 Maintenance and Service

5.1 Introduction

This chapter provides an overview of all the necessary measures for a proper maintenance and service of the Thermal System.

The system can be operated with a minimum of difficulty if the preventive measures of maintenance and the specified working conditions and regulations are adhered to.

5.1.1 Safety Information

> **NOTE!**
>
> **Before carrying out maintenance and service work on the Thermal System, the appointed personnel must have read and fully understood Chapter 2 Safety, page 13.**
>
> **In particular, the safety instructions contained in Chapter 2.6 Residual Dangers, page 19 must be strictly adhered to.**

5.1.2 Personnel Qualifications

Personnel who carries out maintenance and service work must have the required technical qualifications and have received appropriate instruction and training.

5.1.3 Use of Spare Parts and Aid Materials

Spare Parts

System parts affected by abrasion or defects may only be replaced by original ERS® spare parts.

Aid Materials

The term aid materials covers all operating and cleaning materials required for the maintenance and service of the Thermal System.

Cleaning materials used:

- Dust-free, lint-free cloth
- Methanol, Ethanol, Isopropanol

5.2 Tag out Procedure

Maintenance and service work can be extremely dangerous if the serviced components are not shut down, de-energized and tagged out properly. Contact with live parts, the release of stored energy, or the unexpected start-up of the serviced component can cause serious injuries to personnel and also damage the equipment.

These hazards can be avoided through the strict use of the tag out procedure. In short, this means that you have to shut down, de-energize and tag out the component before servicing it. In Chapter 5.2.1 Applying Tag Out Devices, page 58, this procedure will be described in detail.

5.2.1 Applying Tag Out Devices

Before you begin with any maintenance or service work, the following steps must be performed in the given order:

Shut down

1. Prepare the Thermal System for shutdown (if necessary). Also make sure that the shutdown of the Thermal System will not affect the running processes.
2. Shut off the Thermal System. See Chapter 4.1 Operating Elements of the Controller SP11, page 27.

Tag out

3. Disconnect the Thermal System from the mains.
4. Disconnect the power cord at the Controller´s back side.
5. Place the power cord on top of the controller so that it is clearly visible.
6. Attach a prominent warning tag onto the power cord, next to the plug (See Fig. 5-1). This tag is a warning to others that the Thermal System must not be put back into operation until the tag has been removed by the authorized person. Tags must be written in a language that can be understood by all personnel. They must contain the following information:
   - A warning text or prohibitive sign
   - Name and phone number of the person in charge
   - Date and time when the component has been locked out

Fig. 5.1 Front and Back of a lockout tag (example)

7. Verify the isolated and de-energized state of the Thermal System

5.2.2 Removing Tag Out Device

WARNING

Tag outs.

Personnel who work on de-energized components may be seriously injured or killed if someone removes tag out devices and re-energizes the component without their knowledge.

Respect tag out devices! Tags must not be removed by anyone except the person who attached them.

Before removing tag out devices, the following steps must be performed:

1. Inspect the Thermal System to ensure that it is operationally intact and that nonessential items are removed from the area
2. Make sure that everyone is positioned safely and away from the component
3. Connect the power cord to the backside of controller and remove the tag
4. Make sure that all employees who work with the Thermal System know that the safety box (when used) has been unlocked and that the system will be energized
5. Connect the power cord to the mains and energize the Thermal System

5.3 Maintenance

5.3.1 Maintenance Schedule

The required maintenance work at the Controller SP110 must be carried out at regular intervals. In addition, you should always listen for unusual noises and pay immediate attention to any malfunction that occurs in the system during the interim period between official system inspection procedures.

Maintenance Verification

ERS® recommends that a record of all maintenance work performed on the Thermal System be kept in a logbook. This is particularly important if various different personnel are responsible for maintenance work on one system. A logbook allows the end-user to keep a reliable check on the type and date of performed maintenance work.

Component	Action	Interval	Instructions
Controller SP110	Basic Cleaning	Weekly	Chapter 5.3.2 page 60
	Check fuses	Process-specific	Chapter 5.3.3 page 61

Tab. 5.1 Maintenance

5.3.2 Basic Cleaning

NOTE!

Before cleaning the Thermal System shut off the power supply.

Wipe dirt off the Thermal System surface with a dust-free, lint-free cloth.

Use only a damp cloth to clean the touch screen and use only purified water on the cloth wiring out all excess water prior to wiping the screen. Do not use any cleaners or chemicals to clean the screen. In most cases a dry dust-free, lint-free cloth will do!

Consult ERS® electronic GmbH before using a different cleaning agent.

5.3.3 Changing Fuses

	WARNING
	Mains voltage. The controller contains live parts which are connected to the mains. Touching these parts can cause a lethal electrical shock. The controller must be disconnected from the mains. Secure the Controller to make sure that it cannot be switched on again inadvertently before you change the fuses.

The Controller SP110 is equipped with four safety fuses and one automatic fuse. These fuses are easy to access at the rear side of the Controller SP110. See Fig. 5-2.

Fig. 5.2 Location of the fuses at the backside of the Controller SP110

The fuses F5 and F6 can be changed by means of a screwdriver. The fuses F1 and F1A are mounted below the mains connector XR1.
Only use the fuses listed in Tab. 5-1.

F1	T15AL250V P	Safety fuse. TYPE time - lag	ERS 1001045
F2	T15AL250V P	Safety fuse. TYPE time - lag	ERS 1001045
Si3	3.0 AT	Reset table Push Button Circuit Protector	ERS 2001630
F5	T8A250V L	Safety fuse 8.0 Amp. TYPE time - lag	ERS 2001628
F6	T8A250V L	Safety fuse 8.0 Amp. TYPE time - lag	ERS 2001628

Tab. 5-1 Fuses to be used for all operating voltages

6 Troubleshooting

6.1 Error Messages and Recovery

If an error message is displayed a dead-end error has occurred. To reset the error condition cycle, turn the power switch of the AC3 Thermal System off.

If you cannot solve the problem by means of the descriptions in the following table, contact ERS® electronic GmbH to get further assistance.

Error message	Problem	Possible causes and recovery
ERR01 OVERTEMP	The Chuck temperature has passed the maximum temperature limit by more than 2°C.	Power source is out of control Reset the error when the temperature has dropped below the maximum value. If the error returns power supply or wiring is defective
ERR03 CHUCKCABLE	Analog-digital-converter error	Restart the System. Call ERS® electronic GmbH for support if the problem persists.
ERR04 CHUCKCABLE	The Chuck´s sensor cable or the Chuck sensor is defective.	Check the Chuck sensor cable for damages. Check the contacts at the connections. Call ERS® electronic GmbH for support if the problem persists.
ERR05 CHUCKVOLTx or CHUCKCURRx	Either one of the Chuck´s voltage sensors or the Chuck´s current sensors is defective.	Check the Chuck sensor cable for damages. Check the contacts at the connections. Call ERS® electronic GmbH for support if the problem persists.
ERR07 BASE SENSOR	The base sensor cable is broken or the base sensor is defective.	Check the base sensor cable for damages. Check the contact at the connections. Call ERS® electronic GmbH for support if the problem persists.

Error message	Problem	Possible causes and recovery
ERR08 EXTCHILL	External Chiller communication error.	Check the External Chiller cable for damages. Check the contacts at the connections. Call ERS® electronic GmbH for support if the problem persists.
ERR16 DEWPWARN	The dew point is too close to the Chuck temperature. Chuck temperature waits for better dewpoint.	Not enough purge air or bad sealing. Check purge air supply and check prober sealing.
ERR17 DEWPALARM	Severe dew point deterioration. Auto Chuck Defrost in progress.	Prober cover opened. Close prober cover.
ERR18 DEWPSENS	Dew point sensor not connected or defective.	Check dew point cable and sensor.
ERR40 ADC FROZEN	Analog-digital-converter error. Power has been switched off.	Please retrieve the log files from the controller SD-card and send them to ERS®. Press Reset to restart.
ERR61 OVERCURR HC1	The protective circuit has detected too much current to the Chuck heater No. 1. The Controller SP115P will shut off the Chuck power supply. (Dead end error)	Switch the Controller SP115P Off, then ON again after two minutes. Check cable for shortage If the error appears again replace power supply.
ERR62 PWR DEFECT HC1	Power Supply defect. The protective circuit measures no voltage and current.	Switch the Controller SP115P Off. Check and replace fuse. If the error appears again replace power supply.
ERR63 UNDERCURR HC1	The protective circuit has detected too low current in Channel 1. The Circuit can measure voltage, but no current.	Check Cable to Chuck. Check Chuck resistance Check fuses F5 and F6
ERR70 INTTEMP	The internal temperature is outside its limits!	Check if the air vents of the Controller are blocked.

Error message	Problem	Possible causes and recovery
ERR72 THERMO CUT	Thermal Cut-Out. Chuck temperature has passed the maximum temperature limit and the safeguard has switched off the chuck power. (Dead end error)	Power source is out of control Switch the Controller SP115P Off, then ON again after cool down.
ERR81 OVERCURR CH2	The protective circuit has detected too much current to the Chuck heater No 2 (Only for 300mm Chuck). The Controller SP115P will shut off the Chuck power supply. (Dead end error)	Switch the Controller Off, then ON again. Check CN4 for short circuit. If the error appears again replace power supply
ERR82 PWR DEFECT CH2	Power Supply defect. The protective circuit measures no voltage and current.	Switch the Controller Off. Check and replace fuse. If the error appears again replace power supply.
ERR83 UNDERCURR CH2	The protective circuit has detected too low current to the Chuck heater No 2 (Only for 300mm Chuck).	Check Cable to Chuck. Check Chuck resistance Check fuses F5 and F6
ERR89 NOCHILLER	The air temperature coming from the Chiller does not go cold	Check the chiller supply Cable connections
ERR97 AIRPRESS LOW	Air pressure at air input is too low.	Check air supply
ERR200 PROB LOCK	Prober lock switch signaled an error.	Check the Prober cable for damages. Check the contact at the connections. Call ERS® electronic GmbH for support if the problem persists.
ERR201 CHUCKTEMP	Chuck temperature differs. Power has been switched off.	Please retrieve the log files from the controller SD-card and send them to ERS®. Press Reset to restart.

Error message	Problem	Possible causes and recovery
ERR202 PT1000J	The PT1000J cable is defective.	Check the Chuck sensor cable for damages, Check the contacts at the connections and reset the error. Change the Cable if the error persists.
ERR203 PT100M	The PT1000 cable is defective.	Check the Chuck sensor cable for damages, Check the contacts at the connections and reset the error. Change the Cable if the error persists.

Tab. 6.1 Error messages and recovery

6.2 Wiring of the SP110

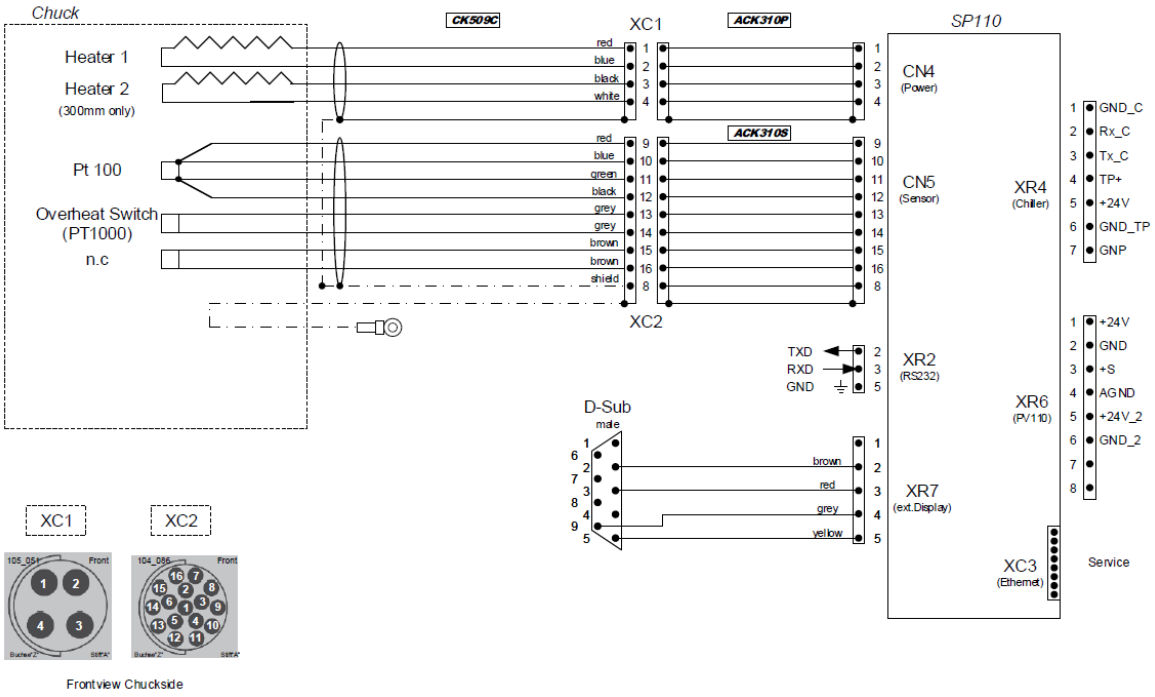


Fig. 6.1 Wiring of the Sp110

Resistance Table CN4

From Pin	To Pin	Approximate resistance	Remarks
1	2	7 - 10Ω	Resistance of heater 1
3	4	7 - 10Ω	Resistance of heater 2 (optional)

Tab. 6.1 Resistance Table of XC1 Connector

Resistance Table CN5

From Pin	To Pin	Approximate resistance	Remarks
9	10	1.5 Ω	Resistance of connecting lines
11	12	1.5 Ω	
10	11	110 Ω	Resistance of the Pt100 temperature sensor at room temperature
9	12	110 Ω	
15	16	2 kΩ	Resistance of base sensor
13	14	1 kΩ	Resistance of Pt1000 temperature sensor at room temperature

Tab. 6.2 Resistance Table of XC2 Connector

7 Storage, Disposal

7.1 Safety Regulations

Read Chapter 2 Safety, page 13, before you dispose of the system or put it into storage. Adhere to the Safety Signs which appear in this chapter.

7.2 Storage

The Thermal System may only be stored in its original packaging. You must note the packaging symbols and adhere to the following storage conditions:

Storage Conditions

Temperature	0 through 60 °C
Relative humidity	20 - 60% (non-condensing)

Tab. 7.1 Storage conditions

Required Space

Controller SP110	Approx. 600 mm × 600 mm × 200 mm (23.62" × 23.62" × 7.87")

Tab. 7.2 Required storage space

7.2.1 Deactivating the System

1. Switch off the Controller SP110. See Chapter Operating Elements of the Controller SP110, page 27.
2. Disconnect the Controller SP110 from the mains supply.
3. Disconnect all connectors from Controller SP110
4. Cover the system with plastic foil to protect it from dust.

7.3 Disposal

7.3.1 Personnel Qualifications

The end user can recycle or dispose of the system in accordance with the legal regulations. For the proper dismantling of the system and the sensible separation of materials, you require wide knowledge of mechanical work and in differentiating between waste materials.

NOTE!

ERS® electronic GmbH offers cost free recycling of the AC3Thermal System. For using this option send the Thermal System carriage paid to:

ERS electronic GmbH
Stettiner Straße 3
82110 Germering,
Germany

All components must be stored in its original packaging and declared with a recycling order.

Additional Qualifications

If dangerous materials as defined by guideline 91/689/EWG are being disposed of, the persons carrying out the work require additional knowledge in the following areas:

- Risks and dangers
- Disposal regulations
- Accident prevention regulations
- First aid measures

7.3.2 Statutory Basis

Responsibilities

The end user is responsible for correct disposal of the System. End users can either hand over the system to a licensed private or public disposal company or they can recycle the unit themselves or dispose of it in accordance with the pertinent regulations.

NOTE!

If the end user hands over the Thermal System to a disposal company then he/she must also forward a copy of this User Manual to the company in question. This User Manual contains important information which is required for system disposal.

Obligation to Register

Companies that dispose of and recycle their own waste material must be officially licensed to do so and are subject to official supervision. They can, under certain circumstances, be exempted from the obligatory license, provided that they are in a position to meet the demands for protection of the environment. These companies are obliged to register. For further information, contact the departmental office for environmental protection.

Environmental Statutes

Waste material must be recycled or disposed of in a manner which does not present a health hazard. Use only procedures and methods which do not cause damage to the environment. In particular, make sure that

- Air, water and ground are not contaminated
- Flora and fauna are not endangered
- Irritation from noise and odors does not occur
- Environment and landscape are not adversely affected

Classification

Subsequent to dismantling the system, you must sort the individual system parts into their respective waste categories. Do this in accordance with the classifications contained in the current European Waste Catalog (EWC) or other similar statutes. The EWC catalog is valid for all waste material irrespective of intention; i.e. if the material is destined for disposal or recycling.

Administration of Waste Material

Adhere to the official handling and administration plans which outline the procedure for dealing with waste material. These plans comprise the following:

- Type, amount and origin of waste material
- General technical regulations
- Special arrangements for specific waste products
- Suitable regions for dumping grounds and other disposal installations

The plans also include the following information:

- Natural persons and legal entities who have authorization to deal with waste material
- The estimated costs for recycling and disposal
- Measures which can be implemented to rationalize collection, sorting and handling of waste material
- Identification labels for hazardous waste

7.3.3 Disposal of Assemblies and Components

Metals and Alloys

- Aluminum (casing, cover plates, etc.)
- Copper (electric lines)
- Steel (profiles, mounting materials such as screws, etc.)
- Stainless steel

Glass

- Glass plates in display instrument

Synthetic Material and Rubber

- Synthetic material (command elements, tubing, casing, etc.)
- Rubber (seals, silicon tubing)

Composite Material

- Electrical material (cables, motors, components)
- Electronic material (printed circuit boards)

Packaging

- Wood (packing cases)
- Styrofoam (packing material)
- Plastic (foil)

8 Appendix

8.1 Temperature Compensation List

Compen-sation Table No.	Set temp. °C	Measured temp. °C	Temp. diff. °C	Action required °C	Comp. temp. input value °C
example	85	84.5	-0.5	+0.5	85.5
example	85	85.5	+0.5	-0.5	84.5
1 - 01					
1 – 02					
1 – 03					
1 – 04					
1 – 05					
1 – 06					
1 – 07					
1 – 08					
1 – 09					
1 – 10					
2 - 01					
2 – 02					
2 – 03					
2 – 04					
2 – 05					
2 – 06					
2 – 07					
2 – 08					
2 – 09					
2 - 10					

Tab. 9.1 Temperature Compensation List

8.2 Resistance Values of Pt100 Sensors

Resistance values from -60 °C up to +299 °C in Ohm:

°C	0	1	2	3	4	5	6	7	8	9
-60	76,33	76,73	77,12	77,52	77,92	78,32	78,72	79,12	79,51	79,91
-50	80,31	80,70	81,10	81,50	81,89	82,29	82,69	83,08	83,48	83,88
-40	84,27	84,67	85,06	85,46	85,85	86,25	86,64	87,04	87,43	87,83
-30	88,22	88,62	89,01	89,41	89,80	90,19	90,59	90,98	91,37	91,77
-20	92,16	92,55	92,95	93,34	93,73	94,13	94,52	94,91	95,30	95,69
-10	96,09	96,48	96,87	97,26	97,65	98,05	98,44	98,83	99,22	99,61
0	100,00	100,39	100,78	101,17	101,56	101,95	102,34	102,73	103,12	103,51
10	103,90	104,68	104,68	105,07	105,46	105,85	106,24	106,63	107,02	107,40
20	107,79	108,18	108,57	108,96	109,35	109,73	110,12	110,51	110,90	111,28
30	111,67	112,06	112,45	112,83	113,22	113,61	113,99	114,38	114,77	115,15
40	115,54	115,93	116,31	116,70	117,08	117,47	117,85	118,24	118,63	119,01
50	119,40	119,78	120,17	120,55	120,93	121,32	121,70	122,09	122,47	122,86
60	123,24	123,62	124,01	124,39	124,77	125,16	125,54	125,92	126,31	126,69
70	127,07	127,45	127,84	128,22	128,60	128,98	129,37	129,75	130,13	130,51
80	130,89	131,27	131,66	132,04	132,42	132,80	133,18	133,56	133,94	134,32
90	134,70	135,08	135,46	135,84	136,22	136,60	136,98	137,36	137,74	138,12
100	138,50	138,88	139,26	139,64	140,02	140,40	140,77	141,15	141,53	141,91
110	142,29	142,66	143,04	143,42	143,80	144,18	144,55	144,93	145,31	145,68
120	146,06	146,44	146,81	147,19	147,57	147,94	148,32	148,70	149,07	149,45
130	149,82	150,20	150,58	150,95	151,33	151,70	152,08	152,45	152,83	153,20
140	153,58	153,95	154,32	154,70	155,07	155,45	155,82	156,19	156,57	156,94
150	157,32	157,69	158,06	158,44	158,81	159,18	159,55	159,93	160,30	160,67
160	161,04	161,42	161,79	162,16	162,53	162,90	163,27	163,65	164,02	164,39
170	164,76	165,13	165,50	165,87	166,24	166,61	166,98	167,35	167,72	168,10
180	168,47	168,83	169,20	169,57	169,94	170,31	170,68	171,05	171,42	171,79
190	172,16	172,53	172,90	173,26	173,63	174,00	174,37	174,74	175,10	175,47
200	175,86	176,22	176,59	176,96	177,33	177,69	178,06	178,43	178,79	179,16
210	179,53	179,89	180,26	180,63	180,99	181,36	181,72	182,09	182,46	182,82
220	183,19	183,55	183,92	184,63	184,65	185,01	185,38	185,74	186,11	186,47
230	186,84	187,20	187,56	187,93	188,29	188,66	189,02	189,38	189,75	190,11
240	190,47	190,84	191,20	191,56	191,92	192,29	192,65	193,01	193,37	193,74
250	194,10	194,46	194,82	195,18	195,55	195,91	196,27	196,63	196,99	197,35
260	197,71	198,07	198,43	198,79	199,15	199,51	199,87	200,23	200,59	200,95
270	201,31	201,67	202,03	202,39	202,75	203,11	203,47	203,83	204,19	204,55
280	204,90	205,26	205,62	205,98	206,34	206,70	207,05	207,41	207,77	208,13
290	208,48	208,84	209,20	209,56	209,91	210,27	210,63	210,98	211,34	211,70

Tab. 9.2 Sensor Resistance Values

8.3 Temperature Conversion Table °C <-> °F

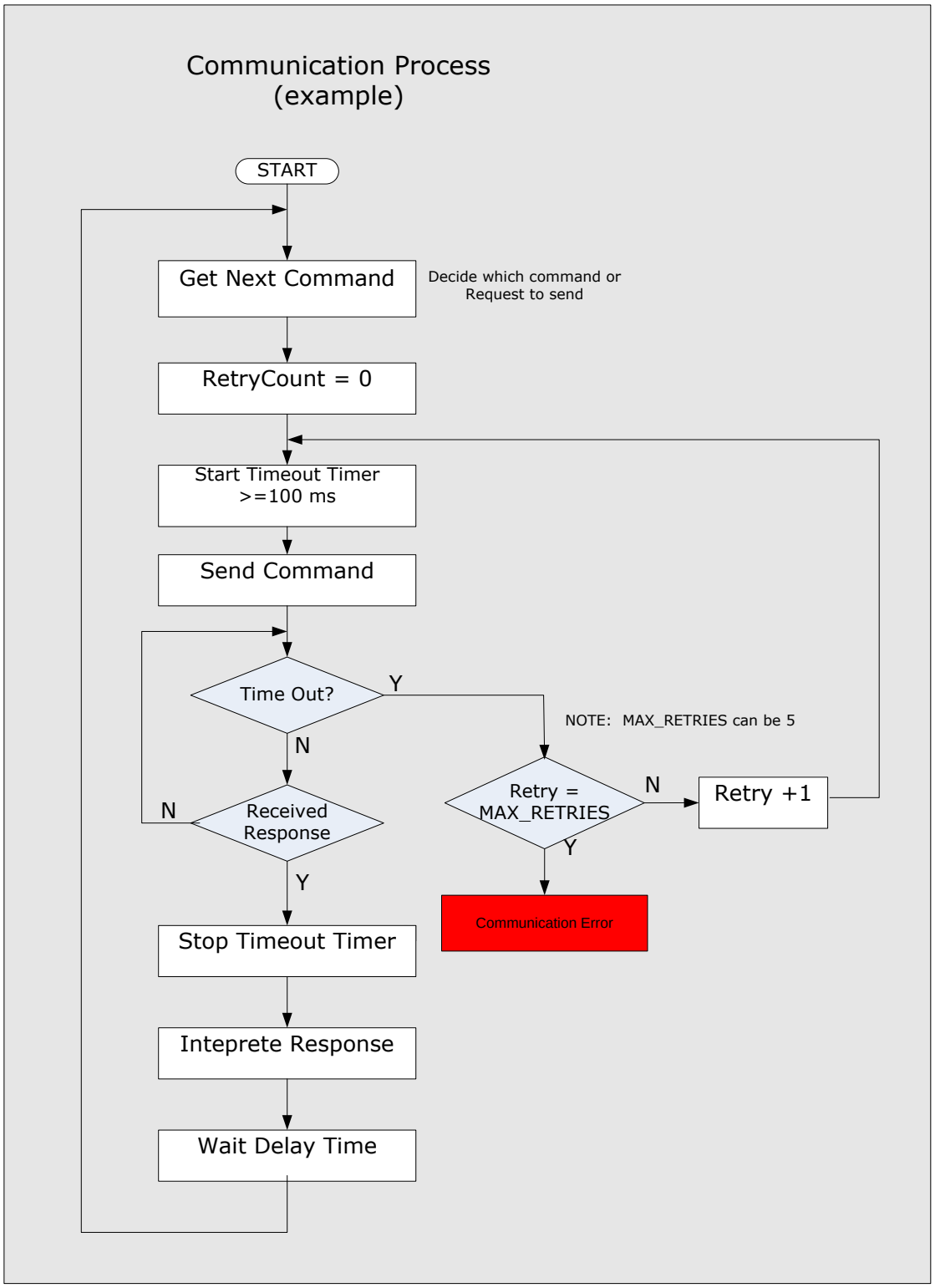
°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
25	77	71	159.8	117	242.6	163	325.4	209	408.2	255	491
26	78.8	72	161.6	118	244.4	164	327.2	210	410	256	492.8
27	80.6	73	163.4	119	246.2	165	329	211	411.8	257	494.6
28	82.4	74	165.2	120	248	166	330.8	212	413.6	258	496.4
29	84.2	75	167	121	249.8	167	332.6	213	415.4	259	498.2
30	86	76	168.8	122	251.6	168	334.4	214	417.2	260	500
31	87.8	77	170.6	123	253.4	169	336.2	215	419	261	501.8
32	89.6	78	172.4	124	255.2	170	338	216	420.8	262	503.6
33	91.4	79	174.2	125	257	171	339.8	217	422.6	263	505.4
34	93.2	80	176	126	258.8	172	341.6	218	424.4	264	507.2
35	95	81	177.8	127	260.6	173	343.4	219	426.2	265	509
36	96.8	82	179.6	128	262.4	174	345.2	220	428	266	510.8
37	98.6	83	181.4	129	264.2	175	347	221	429.8	267	512.6
38	100.4	84	183.2	130	266	176	348.8	222	431.6	268	514.4
39	102.2	85	185	131	267.8	177	350.6	223	433.4	269	516.2
40	104	86	186.8	132	269.6	178	352.4	224	435.2	270	518
41	105.8	87	188.6	133	271.4	179	354.2	225	437	271	519.8
42	107.6	88	190.4	134	273.2	180	356	226	438.8	272	521.6
43	109.4	89	192.2	135	275	181	357.8	227	440.6	273	523.4
44	111.2	90	194	136	276.8	182	359.6	228	442.4	274	525.2
45	113	91	195.8	137	278.6	183	361.4	229	444.2	275	527
46	114.8	92	197.6	138	280.4	184	363.2	230	446	276	528.8
47	116.6	93	199.4	139	282.2	185	365	231	447.8	277	530.6
48	118.4	94	201.2	140	284	186	366.8	232	449.6	278	532.4
49	120.2	95	203	141	285.8	187	368.6	233	451.4	279	534.2
50	122	96	204.8	142	287.6	188	370.4	234	453.2	280	536
51	123.8	97	206.6	143	289.4	189	372.2	235	455	281	537.8
52	125.6	98	208.4	144	291.2	190	374	236	456.8	282	539.6
53	127.4	99	210.2	145	293	191	375.8	237	458.6	281	541.4
54	129.2	100	212	146	294.8	192	377.6	238	460.4	284	543.2
55	131	101	213.8	147	296.6	193	379.4	239	462.2	285	545

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
56	132.8	102	215.6	148	298.4	194	381.2	240	464	286	546.8
57	134.6	103	217.4	149	300.2	195	383	241	465.8	287	548.6
58	136.4	104	219.2	150	302	196	384.8	242	467.6	288	550.4
59	138.2	105	221	151	303.8	197	386.6	243	469.4	289	552.2
60	140	106	222.8	152	305.6	198	388.4	244	471.2	290	554
61	141.8	107	224.6	153	307.4	199	390.2	245	473	291	555.8
62	143.6	108	226.4	154	309.2	200	392	246	474.8	292	557.6
63	145.4	109	228.2	155	311	201	393.8	247	476.6	293	559.4
64	147.2	110	230	156	312.8	202	395.6	248	478.4	294	561.2
65	149	111	231.8	157	314.6	203	397.4	249	480.2	295	563
66	150.8	112	233.6	158	316.4	204	399.2	250	482	296	564.8
67	152.6	113	235.4	159	318.2	205	401	251	483.8	297	566.6
68	154.4	114	237.2	160	320	206	402.8	252	485.6	298	568.4
69	156.2	115	239	161	321.8	207	404.6	253	487.4	299	570.2
70	158	116	240.8	162	323.6	208	406.4	254	489.2	300	572

Tab. 9.3 Temperature Conversion Table

8.4 Example of a synchronized Communication

synchronized communication with Timeout, and Error handling



Recommendation:

Since the Chuck Temperature doesn't change very fast, it´s not necessary to request the Chuck Temperature every few milliseconds. It is enough if every 100 ms or better every second a request is sent to the Controller.