USER MANUAL

HEAT3

DUAL MODE HEATING POWER SUPPLY

PREVAC

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DUAL MODE HEATING POWER SUPPLY

Rev. 1

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Precision and Vacuum Technology

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1 INTRODUCTION

Please read this manual carefully to ensure optimum operating conditions right from the start. This user manual handbook contains important information about functionality, installation, start-up and operation of the HEAT3 device.

1.1 RELEASE NOTE

Information about HEAT3 device version can be found at *www.prevac.pl*, in the tab: *DOWNLOAD*. On this page you can find information about possible changes between successive versions of the device, or changes between successive versions of the software.

1.2 INTENDED TO USE

HEAT3 is designed for heating a sample on a sample holder under clean UHV-conditions. The HEAT3 delivers two methods of sample heating:

1. Resistance heating method. The heating element is located close to the sample which becomes hot. This method is best suited for low temperature heating, up to a few hundred degrees.

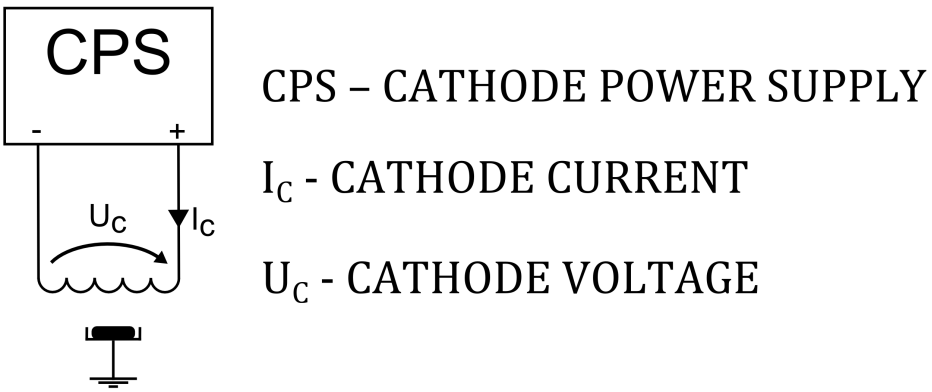
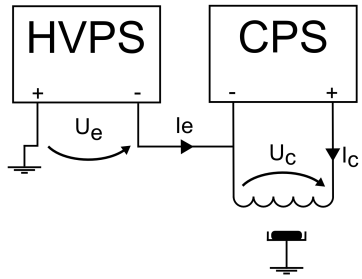


Figure 1.1: Overview of the resistance heating method

2. Electron bombardment heating method. The heater is located close to the sample again. The sample is at ground potential and the heater is raised to a high voltage (negative potential). In this method, the heater is used to generate electrons which are accelerated to the more positive (ground) potential where the sample is located. Electron bombardment heats the sample. This method is best suited for high temperature heating, up to 1600°C.

Temperature ramp control and cathode current ramp control protect the filament against deformation and overheating of the sample. The HEAT3 has a built-in PID controller which stabilizes the temperature at the desired level. The device can work in Auto mode (with temperature control) or Manual mode (without temperature control). Temperature can be controlled by 2 methods using AUTO mode:



CPS – CATHODE POWER SUPPLY
HVPS - HIGH VOLTAGE POWER SUPPLY
I_C- CATHODE CURRENT
U_C - CATHODE VOLTAGE
I_E - EMISSION CURRENT
U_e - EMISSION VOLTAGE

Figure 1.2: Overview of the electron bombardment heating method

1. Resistance heating method (RES MODE). Whereby temperature is stabilized by controlling the cathode current.
2. Electron bombardment heating method (EB MODE). Whereby temperature is stabilized by controlling the high voltage that sets the electron energy.
3. The HEAT3 can be delivered with three types of thermocouples suited to specific sample holder type. Thermocouple ranges table is shown below.

Thermocouple type	Minimum [K]	Maximum [K]
K	73.15	1645.15
C	273.15	2473.15
E	73.15	1273.15

Table 1.1: Thermocouple ranges

Optionally, the HEAT3 can operate with DT670/DT470 silicon diodes which are capable of measuring temperature in cryogenic systems. Diodes ranges are listed below:

Diode type	Minimum [K]	Maximum [K]
DT670	1.4	475
DT470	1.4	500

Table 1.2: Diodes ranges

There is also possibility to use PT100 resistance thermometer which can measure from 73.15 to 1123.15 Kelvin?s.
The HEAT3 can delivery 480W watts of power (40V for 12Amps) to the heater for Resistive heating and 300W watts of power for Electron Bombardment Heating (1000V for 300mA).

1.3 SAFETY

The owner of the equipment must ensure that all users are aware of the Health and Safety information contained in this manual. If the equipment is sold or passed to another owner, this manual must be included with the equipment.

1.3.1 PERSONNEL QUALIFICATIONS

All the work described in this document should only be carried out by persons who have suitable technical training and the necessary experience or who have been instructed by the end user of the product.

1.3.2 ILLUSTRATION OF RESIDUAL DANGERS

This Operating Manual illustrates safety notes concerning residual dangers as follows:

1. Information on preventing any kind of physical injury

2. Information on preventing extensive equipment and environmental damage

3. Information on correct handling or use. Disregarding safety notes can lead to malfunctions.

4. **Note: Indicates particularly important, but not safety-relevant information.**

1.3.3 GENERAL SAFETY INSTRUCTIONS

The HEAT3 protects the operator and surrounding area from electric shock or burn, mechanical hazards, excessive temperature, and spread of fire from the instrument. Environmental conditions outside of the conditions below may pose a hazard to the operator and surrounding area.

- Indoor use.
- Altitude to 2000 meters.
- Temperature for safe operation: 5 °C to 40 °C.
- Maximum relative humidity: 80% for temperature up to 31 °C decreasing linearly to 50% at 40 °C.
- Power supply voltage fluctuations not to exceed ±10% of the nominal voltage.
- Safety Class 1.

Figure 1.3: Do not insert objects through louvers and keep device dry

For all work you are going to do, adhere to the applicable safety regulations. Also observe all safety notes given in this document and forward the information to all other users of the product. In particular, pay attention to the following safety notes:

DANGER

Mains voltage.
Contact with live parts is extremely hazardous when any objects are introduced or any liquids penetrate into the device. Make sure that no objects enter through the louvers of the device. Keep the device dry.

WARNING

Improper use.
Improper use can damage the HEAT3 . Use the HEAT3 only as intended by the manufacturer.

WARNING

Improper installation and operation data.
Improper installation and operation data may damage the HEAT3 . Strictly adhere to the stipulated installation and operation data.

WARNING

Individual configuration of the device.
Individual configuration of the device by the client via the service application will void the liability of PREVAC.

1.3.4 GROUNDING

This product is a Safety Class 1 instrument. To minimize shock hazard, the instrument chassis must be connected to an electrical ground. Plug the power cable into an approved three-contact electrical outlet or use a three-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. For instruments designed to be hard-wired to the supply mains, the protective earth terminal must be connected to the safety electrical ground before another connection is made. Any interruption of the protective ground conductor, or disconnection of the protective earth terminal will cause a potential shock hazard that might cause personal injury.

1.3.5 LIVE CIRCUIT

Operating personnel must not remove the instrument cover. No internal adjustment or component replacement is allowed by non-PREVAC qualified personnel. Never replace components with power cable connected. To avoid injuries, always disconnect power , discharge circuits and remove external voltage source before touching components.

1.3.6 PARTS SUBSTITUTION AND MODIFICATIONS

Parts substitutions and modifications are allowed by authorized PREVAC service personnel only. For repairs or modifications, the instrument must be returned to PREVAC service facility.

1.3.7 VENTILATION

The instrument has ventilation holes in its side covers. Do not block these holes when the instrument is operating.

1.3.8 EXPLOSIVE ATMOSPHERE

DANGER

Explosive atmosphere
Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

1.3.9 CLEANING

Do not submerge instrument. Clean only with a damp cloth and mild detergent. Exterior only.

1.4 TECHNICAL DATA

1.4.1 MECHANICAL DATA

This section describes mechanical parameters, Figure 1.4 shows the HEAT3 rack mounted and stand alone dimensions.

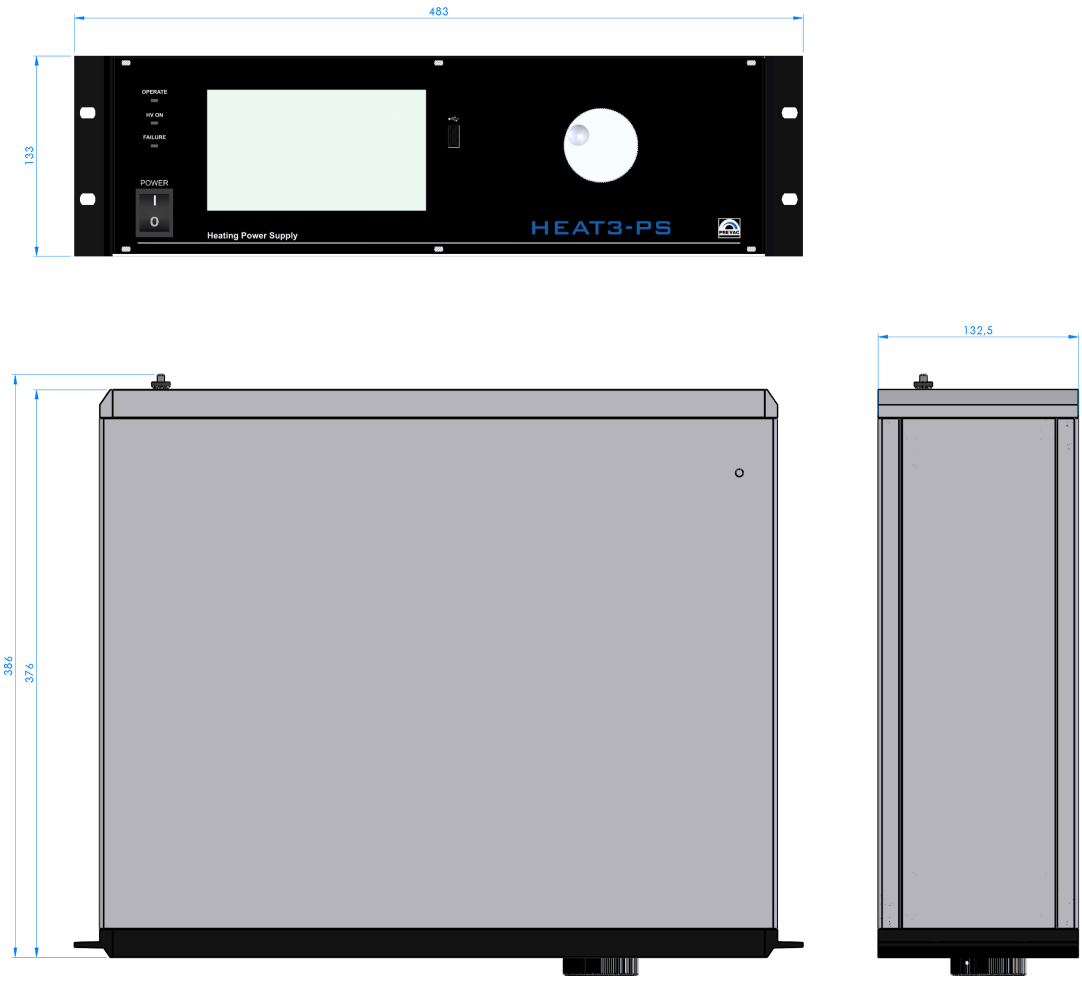


Figure 1.4: Dimensions

1.4.2 SPECIFICATION

PARAMETER	DESCRIPTION
Temperature control	Process temperature control with build-in PID controller
Process parameters.	PID controller finds optimized process PID parameters with auto-tuning function.
Temperature set point ramp rate	Adjustable from 0.1°/h to 1000°/s.
Cathode current ramp rate	Adjustable from 0.1 to 10 A/min
Emission voltage ramp rate	Adjustable from 10 to 1000 V/min
Temperature measurement	Two independent thermocouple inputs supports thermocouples: type K,C,E Two independent inputs for silicon diodes DT670/DT470 (option).
Temperature range	1,4K - 2473K, dependent on sample holder and temperature sensor type
Vacuum measurement	Compatible transmitters: CTR90/91, TTR90, TTR211/216, PTR225/237, PTR90, ITR90, ITR100, MKS870b, MKS937, PG105 (with PGA13 amplifier only)
Cathode power supply output voltage ripple	Less than 0.06 %
High voltage power supply output voltage ripple	Less than 0.05 %
Cathode voltage ramp rate	0.01 V/h - 200 V/s
Emission voltage ramp rate	1 V/h - 1000 V/s
Cathode power supply output current limit	0 - 10A (0 - 15A)*
Cathode power supply output voltage	0 - 40V DC (0 - 30V DC)*
High voltage power supply output current limit	0 - 300 mA DC (only for EB mode)
High voltage power supply output voltage (Ueset):	0 - 1000 V DC (only for EB mode)
Digital Input	4 inputs active high with isolated common input (max 50V to GND) using external logic voltage source max 24V. Possibility to use internal 24V source to drive Inputs.

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PARAMETER	DESCRIPTION
Digital Output	6 relay outputs with contacts capability: 4 relay NO; 2A/120VAC or 2A/24VDC 2 relay NO,NC; 8A/250VAC or 8A/24VDC
Analog Inputs	1 Vacuum gauge input 2 Universal inputs 0 - 10V, non isolated to GND
Analog Outputs	2 outputs 0 - 10V, non isolated to GND
Communication	RS232, RS485, Ethernet
Mains voltage	100 - 130 VAC 200 - 260 VAC
Frequency	50 - 60 Hz
Power consumption	1100W
Current consumption	8 A (for 230V) 11 A (for 110V)
Fuse	16A
Operating ambient temperature range	+15 °C - +40 °C

Table 1.3: Device specification

* - dependent on the installed DC module

1.4.3 OPERATION

The device can be controlled in two ways:

- Manually via control panel with integrated touch screen.
- Remote control via RS232, RS485 or Ethernet see chapter 6.

1.4.4 VACUUM GAUGE CHANNEL

Independent vacuum gauge may be connected to the HEAT3 .

PARAMETER	VALUE
PRESSURE CHANNEL:	
Sensor connector	RJ45
Compatible sensors	CTR90/91, TTR90, TTR211/216, PTR225/237, PTR90, ITR90, ITR100, BARATRON, ANALOG-IN, MKS870b, MKS937, MKS937A, PKR251, PCR280, PG105, ATMION
Voltage	Relative to voltage reading: ±0,3%
Absolute	±2 mV
Measuring rate	10 s^{-1}
Display rate	4 s^{-1}
Temperature drift	Temperature drift < 0.1 % per °C
Unit of measurement	mbar, Pa, Torr
Resolution of the A/D converter	24 bit

Table 1.4: Pressure channels specyfications

GAUGE TYPE EXAMPLES	PRESSURE LOW	PRESSURE HIGH	UNIT
Total measuring range	$2 \cdot 10^{-12}$	$2.1 \cdot 10^{5}$	mbar
CERAVAC transmitters	(CTR 90 and CTR 91):		
0.1 Torr (CTR 91 only)	$1 \cdot 10^{-5}$	$1 \cdot 10^{-1}$	Torr
1 Torr	$1 \cdot 10^{-4}$	$1 \cdot 10^{0}$	Torr
10 Torr	$1 \cdot 10^{-3}$	$1 \cdot 10^{1}$	Torr
100 Torr	$1 \cdot 10^{-2}$	$1 \cdot 10^{2}$	Torr
1000 Torr	$1 \cdot 10^{-1}$	$1 \cdot 10^{3}$	Torr
THERMOVAC transmitters	$5 \cdot 10^{-4}$	$1 \cdot 10^{3}$	mbar
IONIVAC transmitters ITR90	$5 \cdot 10^{-10}$	$5 \cdot 10^{-4}$	mbar
IONIVAC transmitters ITR100	$2 \cdot 10^{-10}$	$1 \cdot 10^{-1}$	mbar
Baratron transmiters (model dependent)	$1.3 \cdot 10^{-1}$	$2.1 \cdot 10^{5}$	mbar
10 Torr	$1 \cdot 10^{-3}$	$1 \cdot 10^{1}$	Torr
50 Torr	$5 \cdot 10^{-3}$	$5 \cdot 10^{1}$	Torr
100 Torr	$1 \cdot 10^{-2}$	$1 \cdot 10^{2}$	Torr
500 Torr	$5 \cdot 10^{-2}$	$5 \cdot 10^{2}$	Torr
1000 Torr	$1 \cdot 10^{-1}$	$1 \cdot 10^{3}$	Torr
20 psia	$2 \cdot 10^{-2}$	$2 \cdot 10^{1}$	psia
30 psia	$3 \cdot 10^{-2}$	$3 \cdot 10^{1}$	psia
50 psia	$5 \cdot 10^{-2}$	$5 \cdot 10^{1}$	psia
60 psia	$6 \cdot 10^{-2}$	$6 \cdot 10^{1}$	psia
100 psia	$1 \cdot 10^{-1}$	$1 \cdot 10^{2}$	psia
250 psia	$2.5 \cdot 10^{-1}$	$2.5 \cdot 10^{2}$	psia
500 psia	$5 \cdot 10^{-1}$	$5 \cdot 10^{2}$	psia
750 psia	$7.5 \cdot 10^{-1}$	$7.5 \cdot 10^{2}$	psia
1000 psia	$1 \cdot 10^{0}$	$1 \cdot 10^{3}$	psia
2000 psia	$2 \cdot 10^{0}$	$2 \cdot 10^{3}$	psia
3000 psia	$3 \cdot 10^{0}$	$3 \cdot 10^{3}$	psia
PTR transmitters (model dependent)	$5 \cdot 10^{-9}$	$1 \cdot 10^{3}$	mbar
PG105	$1.3 \cdot 10^{-3}$	$1 \cdot 10^{3}$	mbar

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GAUGE TYPE EXAMPLES	PRESSURE LOW	PRESSURE HIGH	UNIT
PKR 251	$5 \cdot 10^{-9}$	$1 \cdot 10^{3}$	mbar
PCR 280	$5 \cdot 10^{-5}$	$1.5 \cdot 10^{3}$	mbar
ATMION	$1 \cdot 10^{-10}$	$1 \cdot 10^{3}$	mbar
Analog In	0.000	10.000	V

Table 1.5: Vacuum Channels - Measuring Ranges

1.4.5 STANDARDS

SAFETY:

- LVD 2006/95/EC Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.
- PN-EN 61010-1 - Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

EMC:

- EMC 2004/108/EC Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
- EN 61326-1:2006 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

2 INSTALLATION

This chapter describes the procedures for unpacking, mechanical installation and electrical installation. Take care when lifting the unit that the weight and position do not exceed comfortable limits.

2.1 UNPACKING

1. Visually inspect the transport packaging for signs of external damage.
2. Unpack the HEAT3 and retain the packaging materials.

   Note: Retain the packaging materials for later use. The HEAT3 must be stored and transported in the original packaging material only.
3. Examine the HEAT3 for completeness.
4. Visually inspect the HEAT3 for signs of damage.

DANGER

Damaged product.
Putting a damaged product into operation can be extremely dangerous. Never attempt to put a damaged product into operation. Secure the damaged product from unintended operation. Send a damage report to the haulage company or the insurer.

2.2 MECHANICAL INSTALLATION

The HEAT3 is designed for installation into a rack according to DIN 41 494 (19", 3 HU) and occupying the whole width of the cassette. Before taking any actions read the safety notes below.

WARNING

Ambient temperature.
Exceeding the maximum permitted ambient temperature may damage the device. Make sure that the maximum permitted ambient temperature is not exceeded and that the air can flow freely through the louvers. Do not expose the device to direct sunlight.

DANGER

Protection class of the rack.
If the product is installed in a rack, it is likely to lower the protection class of the rack (protection from foreign bodies and water) e.g. according to the EN 60204-1 regulations for switching cabinets. Take appropriate measures to restore the required protection class of the rack.

2.3 COOLING

The HEAT3 is equipped with a cooling system . A set of fans is installed inside the power supply. The air is supplied from the power supply housing side panels. Hot air outlet is located on the right panel. A minimum 15mm space for air intake (side panels) and 15 cm for expelling warm air from the back of the power supply should be observed. HEAT3 should not be used at temperatures exceeding 40°C.

2.4 ELECTRICAL INSTALLATION

2.4.1 MAINS CONNECTION

The mains connection is designed for a mains cable which contains a European appliance connector IEC 320 C14 on the device side. A mains cable is supplied with the device. To improve grounding , connect vacuum system to the ground screw of HEAT3 power supply using additional ground cable as short as possible with cross-section $4mm^2$. Device output circuits are protected by 16 A fuse.

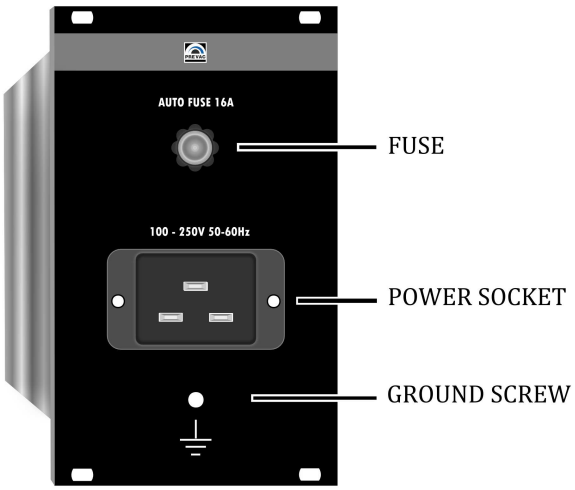


Figure 2.1: Rectifier Module

DANGER

Mains power.
Improperly grounded devices can be extremely dangerous in the event of a fault. Use three-wire mains or extension cables with protective ground only provided with HEAT3 . Plug the mains cable into wall sockets with protective ground only.

- Connect the European appliance connector of the mains cord with the mains connection of the device
- Connect the plug of the mains cable with the wall socket

NOTE: If the device is installed in a switching cabinet, the mains power can be supplied via a switchable central power distributor.

Figure 2.2: Power connector

DANGER

Risk Of Electric Shock - Fuse Replacement
To avoid electrical shock or personal injury, disconnect the power cord before opening the cover on the power entry module.

2.4.2 AC INPUT POWER CONNECTION

The AC (alternating current) power entry module, located in the rear panel of the HEAT3 , provides connection to the power source and a protective ground. It also holds the fuse.

2.4.3 POWER CORD

The HEAT3 comes with a detachable, three-wire power cord for connection to a power source with protective ground. The HEAT3 chassis is connected to the power ground to protect against electrical shock. Always connect to an AC outlet which has a properly connected protective ground. If necessary, or when in doubt, consult a certified electrician.

2.4.4 POWER SWITCH

The power switch is located on the front of the HEAT3 . The switch is a toggle type, marked with **I** and **O**. The **I** (on) position applies the power to the instrument. The **O** (off) position cuts off the

power to the instrument. However, turning the power switch off does not fully remove the AC power from inside the instrument.
Always disconnect the power cord from the power entry module to fully remove AC power from inside the instrument.

DANGER

Risk Of Electric Shock
Do NOT use the power switch as a disconnecting device; disconnect the power cord from the power entry module to fully remove hazardous voltage from inside the HEAT3 .

2.4.5 GROUNDING BOLD

A grounding lug is located on the rear panel, near the power entry module. Use heavy ground wire, wire braid, or copper strap of 4mm2 or larger to connect this grounding lug directly to a facility protective earth ground to provide additional protection against electrical shock. The ground screw can be used to connect the HEAT3 with the protective ground of e.g. a pumping station.

DANGER

Screw for internal protective conductor.
The internal protective conductor is connected to the casing with a screw. Do not turn or loosen this screw.

2.5 DEVICE REAR PANEL

This section contains a description of available sockets and connectors on the rear panel.

Construction of the HEAT3 is based on removable modules . All modules are removable by the user. There are seven different types of modules:

- Rectifier Module
- DC Module
- HV Module
- Measurement Module
- Analog I/O Card
- Digital I/O Card
- Communication Card

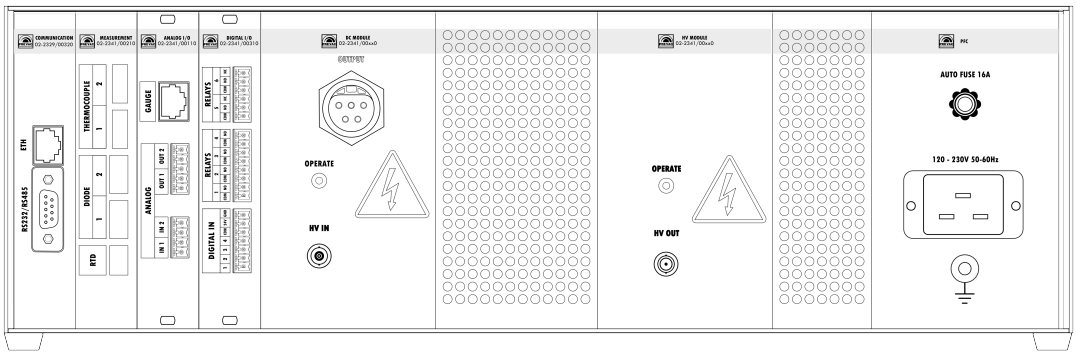


Figure 2.3: Rear view of HEAT3

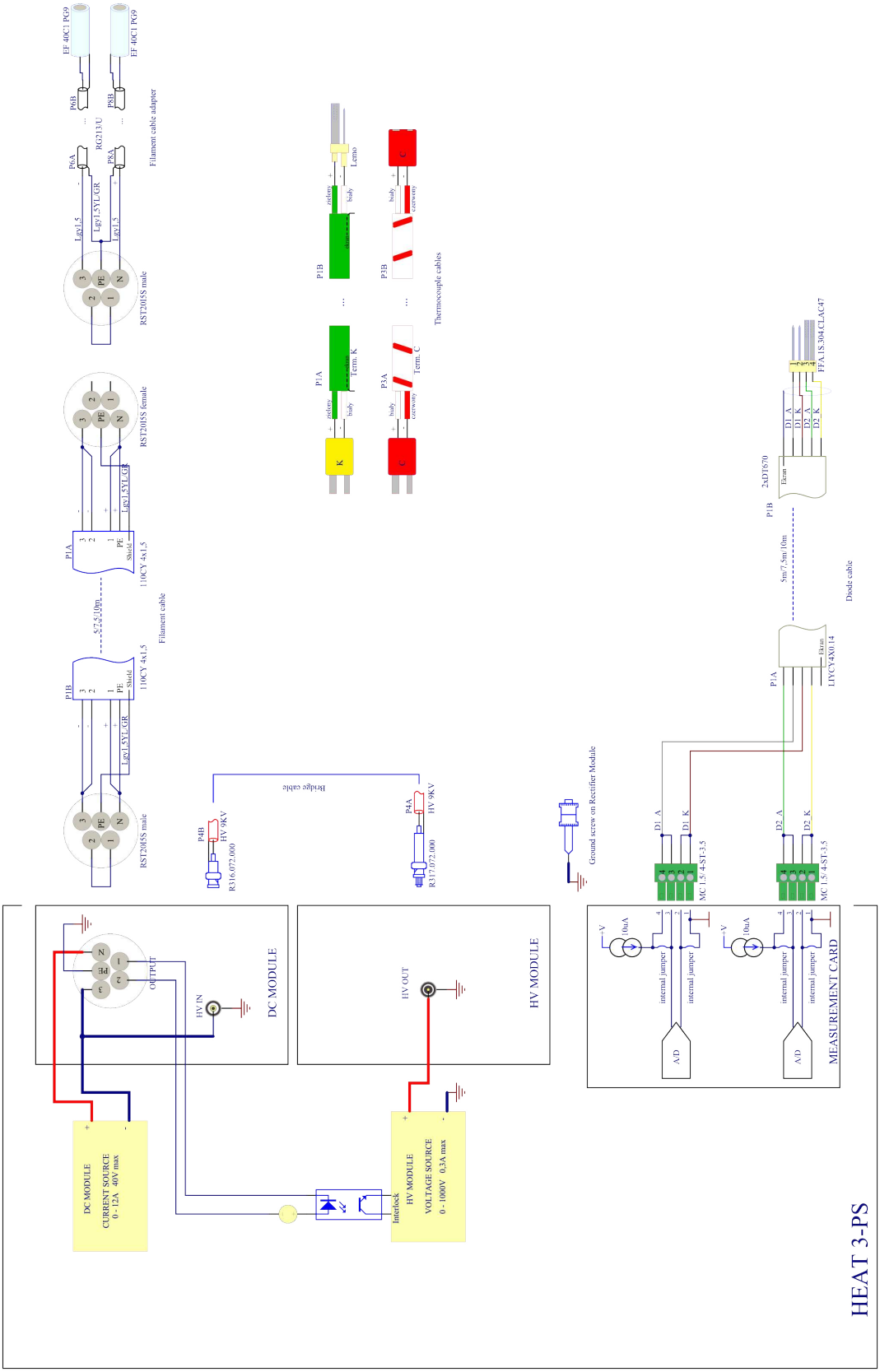


Figure 2.4: Wiring diagram description

2.5.1 RESISTIVE HEATING

Resistive heating, as mentioned, is used to heat the sample to a temperature of several hundred degrees. This method of heating the sample requires the DC Module, which is described below. This section provides information about the connections for the resistive heating.

2.5.1.1 DC MODULE

The HV IN socket in the DC Module is designed for Electron Bombardment Heating and therefore does not apply to resistive heating. This module has an LED indicator which informs if the DC Module is operating or not. During normal operation, the LED glows orange.

DANGER

DC Module
Under no circumstances should the DC Module be handled or moved while it is operating (when Operate LED glows orange).).

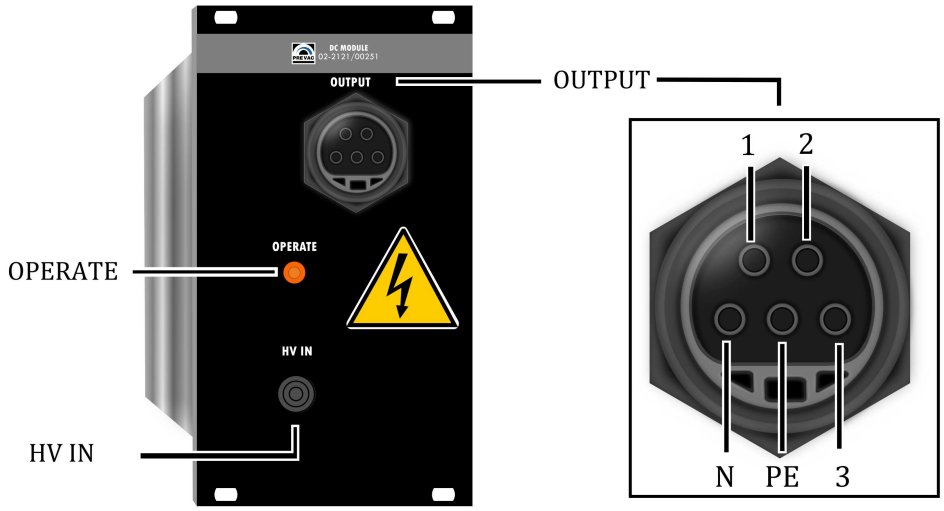


Figure 2.5: DC Module overview

PIN NAME	DESCRIPTION
1	Interlock
2	Interlock
3	Negative Output
PE	PE - Ground
N	Positive Output

Table 2.1: Module DC - pin description

Pins 1 and 2 in Module DC Output (fig.2.5) are used as safety INTERLOCK pins. At Electron bombardment heating mode they have to be short-circuited, because only then the HV module can turn

on. At resistance heating mode pins 1 and 2 does not have to be short-circuited.

2.5.1.2 WIRING FOR RESISTANCE HEATING

In order to meet the required connections for resistance, the DC Module output should be connected to the sample. The following images show the cathode (filament) cable. This cable is fastened together with the thermocouple cables.

Figure 2.6: Plug of the filament cable connected to the power supply

Figure 2.7: Plug of the filament cable connected to the vacuum system

Figure 2.8: Filament cable adapter

2.5.2 ELECTRON BOMBARDMENT HEATING

High temperature heating by electron bombardment of a sample uses both DC and HV modules.

2.5.2.1 HV MODULE

This module has an LED indicator which informs if the HV Module is operating or not. During normal operation the LED glows orange.

HV Module
Under no circumstances should the HV Module be handled or moved while it is operating (when Operate LED glows orange).

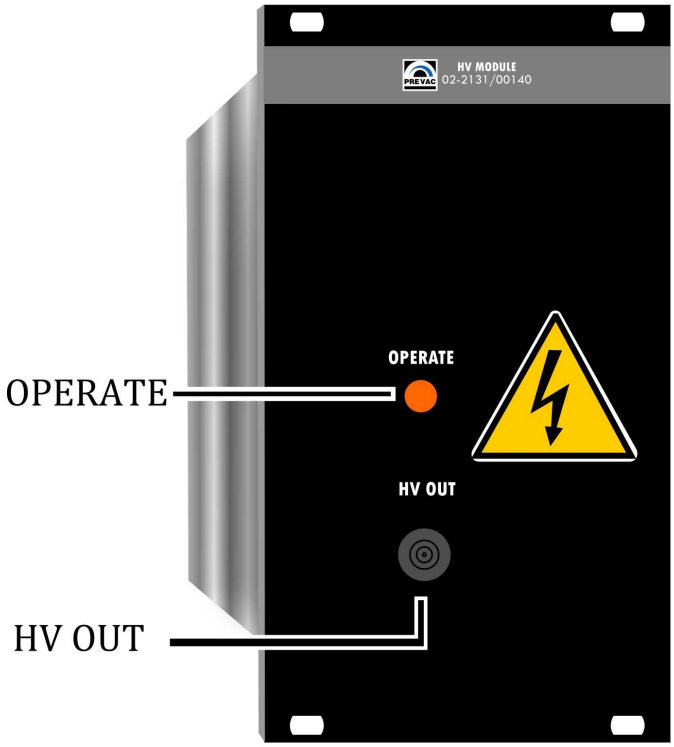


Figure 2.9: HV Module overview

2.5.2.2 WIRING FOR ELECTRON BOMBARDMENT HEATING

Electron bombardment heating requires a specific connection between the HV and DC modules. The connection is made by a bridge cable (red cable) supplied with the HEAT3. Link the HV OUT of HV Module with HV IN of DC Module as shown in the following figure.

Figure 2.10: Connection necessary for proper operation in Electron Bombardment mode

2.5.3 TEMPERATURE MEASUREMENT

Temperature measurement module contains:

- two thermocouples sockets
- two diode sockets
- one resistance thermometer socket

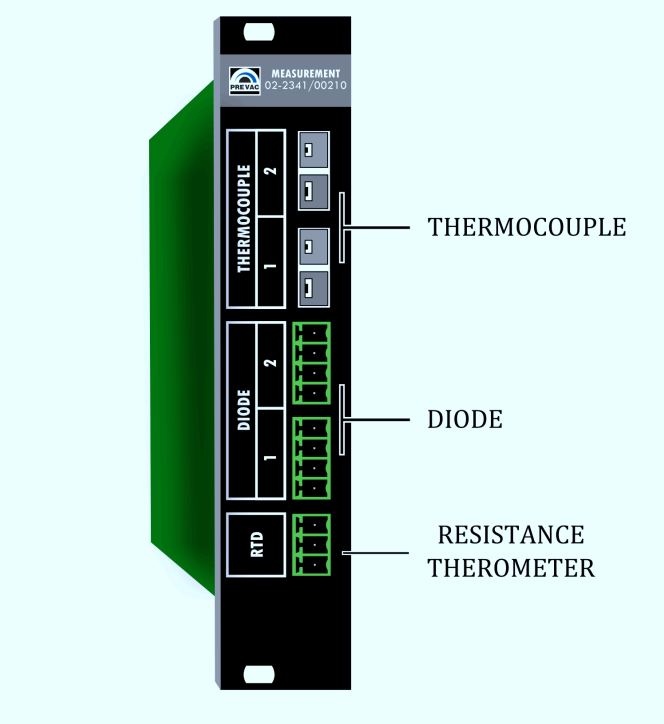


Figure 2.11: Measurement Module overview

2.5.3.1 RTD (RESISTANCE TEMPERATURE DETECTOR)

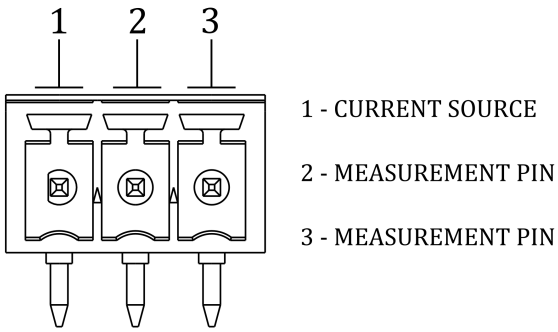


Figure 2.12: RTD (resistance temperature detector) socket

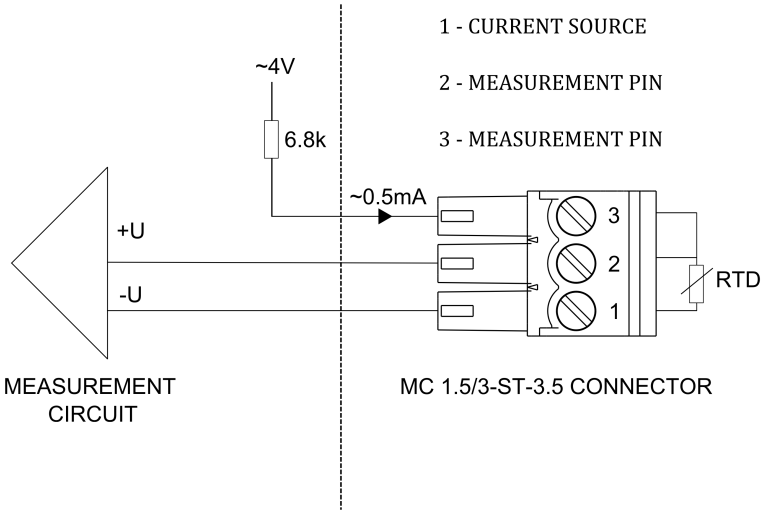


Figure 2.13: RTC Connection schematic

2.5.3.2 DIODE

Diode socket is used to connect DT670 and DT470 silicon diodes.

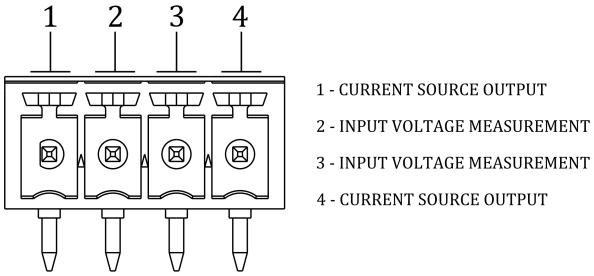


Figure 2.14: Diode socket

2.5.3.3 THERMOCOUPLE

The power supply has two independent thermocouple inputs. Both of them can be used to connect three types of thermocouples: C, K and E.

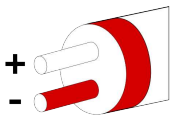
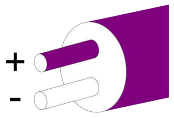
Thermocouple type	Minimum [K]	Maximum [K]
C		ANSI MC 96.1 Color Coding
E		IEC 584-3 Color Coding
K		IEC 584-3 Color Coding

Table 2.2: Supported thermocouple types

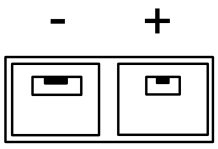


Figure 2.15: Thermocouple socket

2.5.4 DIGITAL IO CARD

The Digital Input/Output card provides four digital inputs and six relay outputs.

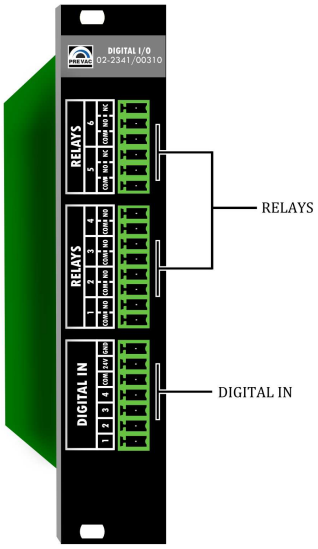


Figure 2.16: DIGITAL IO CARD view

2.5.5 DIGITAL IN CONNECTOR

The all digital inputs is active high logic level 24V, to activate single input should be connected as shown in Figure 2.17 below.
Digital IN 1 is reserved for e.g. a vacuum interlock signal from a suitable pressure gauge. The input is active low and should be connected as shown in Figure 2.17 below.
Digital IN 2 is reserved for a remote control signal from a host.

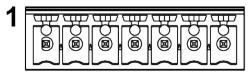


Figure 2.17: Digital In male connector

Interlock protection signal is provided to prevent accidental operation of the device when not under vacuum. If the protection signal is missing (open circuit), the HEAT3 returns to STANDBY mode and displays 'No interlock' message accompanied by a flashing control failure LED.

PIN NUMBER	FUNCTION	DESCRIPTION
1	Master Interlock	The global enable signal to switch the device to *OPERATE* state
2	Remote Control	The signal switching device for operation device to *REMOTE CONTROL* mode
3	Digital In 3	Configurable input from the device menu
4	Digital In 3	Configurable input from the device menu
5	Digital COM	Reference pin for digital inputs
6	24V	24V power output, the maximum total current can not be greater than 0.5A
7	GND	Ground

Table 2.3: Pin out Digital In description

WARNING

Permission signal

Switching device to *OPERATE* state requires the presence of a signal *MASTER INTERLOCK*. No *MASTER INTERLOCK* signal is indicate by warning message on screen.

Internal diagram of a single digital input shown in Figure 2.18.

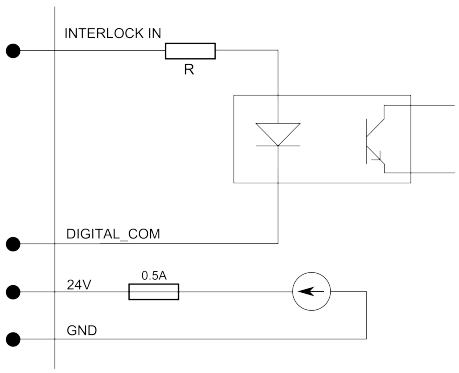


Figure 2.18: Digital in - internal diagram

Examples of control schematics digital inputs.

- Input activated permanently(Fig. 2.19). This connection can be used an initial testing *Digital IN* but is not recommended during normal device operation .
- Activation of the inputs using an external power source (DC supply, PLC, etc.). Allows activate any input by apply 24V relative to *Digital COM* pin .
- Activation input using external relays. Allow control device working state depending on external factors(pressure value, temperature etc.). Shown in figure keys may indicate: vacuum meter relay, bimetallic placed on a vacuum system etc.

WARNING

Digital input maximum voltage
Logic inputs accept signals from a range of 0 to 24 V. Exceeding these values may damage the input and measures should be in place to ensure these limits are not exceeded.

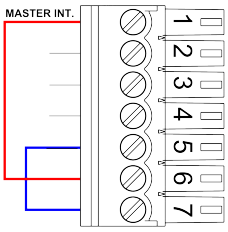


Figure 2.19: Permanently *Interlock*(not recommended)

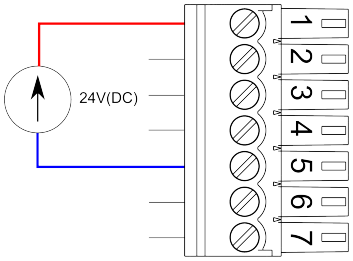


Figure 2.20: Inputs activated by external power supply

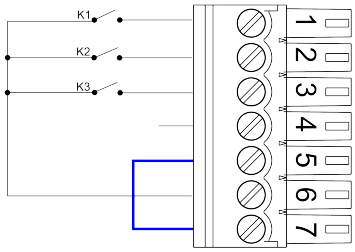


Figure 2.21: *Digital IN* activated by external relays.

2.5.6 RELAY OUTPUTS

DIGIAL IO CARD includes six relays outputs:

- four outputs with terminals COM and NO - connector RELAY 1-4,
- two relay outputs with terminals COM, NO and NC - connector RELAY 5 i 6.

The relay outputs pins are physically isolated from the device. The maximum current is limited by the model used relays and is 2 A.

Detailed relay outputs configuration, see 3.13.1.

Figure 2.22: Connector "RELAYS 1-4"

PIN NUMBER	FUNCTION	DESCRIPTION
1	Relay 1 output	contact COM (common)
2	Relay 1 output	contact NO (normal open), User-defined functions
3	Relay 2 output	contact COM (common)
4	Relay 2 output	contact NO (normal open), User-defined functions
5	Relay 3 output	contact COM (common)
6	Relay 3 output	contact NO (normal open), User-defined functions
7	Relay 4 output	contact COM (common)
8	Relay 4 output	contact NO (normal open),User-defined functions

Table 2.4: Pin out description of connector "RELAYS 1-4"

WARNING

The maximum current relays.
Output relays are rated for 24 VDC or 120 VAC and 2 A. Proper fusing and adequate wiring isolation and separation should be provided to assure these limits are not exceeded

Figure 2.23: Connector "RELAYS 2"

NUMER PINU	FUNKCJA	OPIS
1	Relay 5 output	contact COM (common)
2	Relay 5 output	contact NO (normal open), fUser-defined functions
3	Relay 5 output	contact NC (normal close) contact, User-defined functions
4	Relay 6 output	contact COM (common)
5	Relay 6 output	contact NO (normal open), User-defined functions
6	Relay 6 output	contact NC (normal close) contact, User-defined functions

Table 2.5: Pin out description of connector "RELAYS 5-6"

2.5.7 ANALOG IO CARD(OPTION)

Analog Input(*) / Output card contains analogue inputs, outputs and connection for a suitable vacuum gauge .

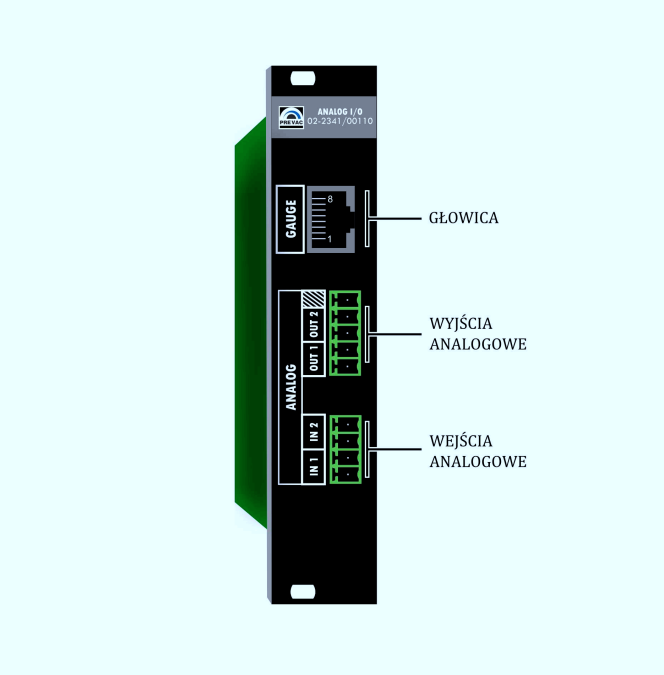


Figure 2.24: Analog I/O overview

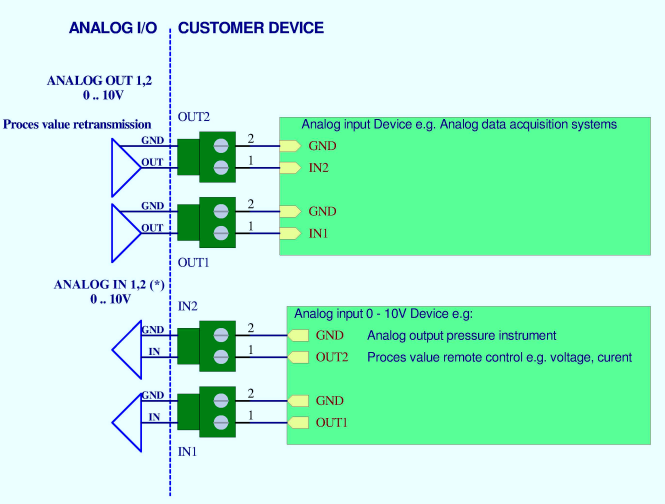


Figure 2.25: Analog Connection

* - FOR FUTURE USE

In order to connect a vacuum gauge to the HEAT3 , an appropriate transmitter must be used as described below.

Pin assignment of this connector is shown in Table 2.6:

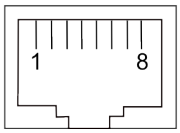


Figure 2.26: RJ45 Gauge connector

PIN NUMBER	FUNCTION	DESCRIPTION
1	24 V DC	Power supply
2	0 V DC	Ground
3	0 - 10 V DC	Analog measurement signal
4	Identification	Gauge type identification signal
5	GND	Signal GND
6	Input signal	CHANNEL STATUS
7	No connect	Not connected
8	24 V	HV ON (emission) steering signal

Table 2.6: Pin assignment of the channel sensors connector

WARNING

Improper transmitter.
Transmitters which are not designed for use with the HEAT3 may damage the device. Operate the HEAT3 with proper transmitters only. See compatible sensors list in Measuring Channel section in Operation chapter.

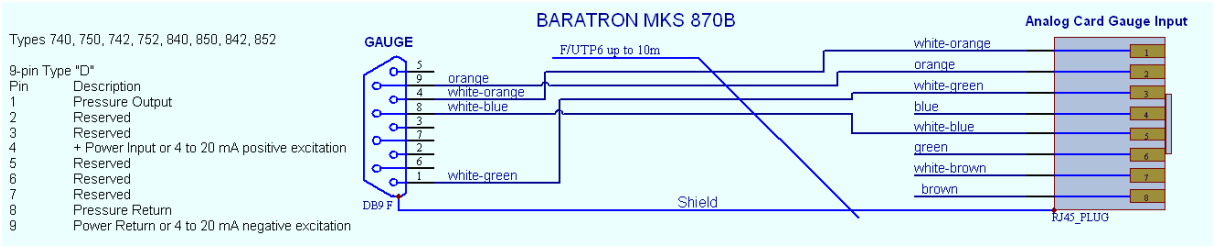


Figure 2.27: Baratron MKS gauge connection

Figure 2.28: Pirani gauge connection

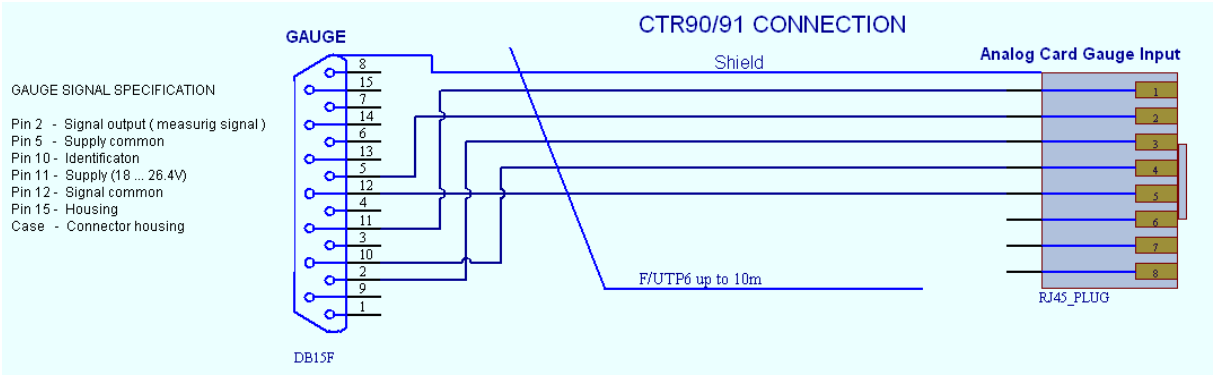


Figure 2.29: CTR90/91 gauge connection

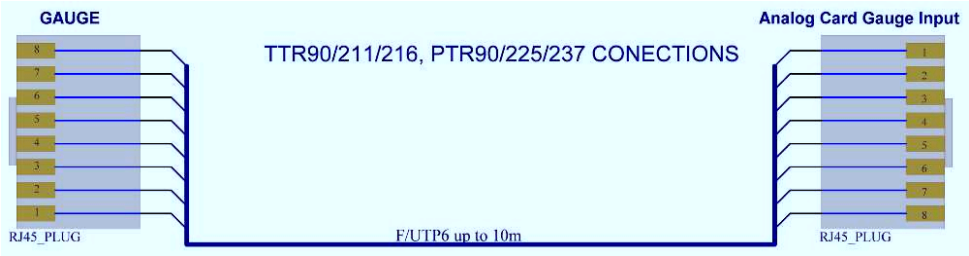


Figure 2.30: TTR/PTR gauge connection

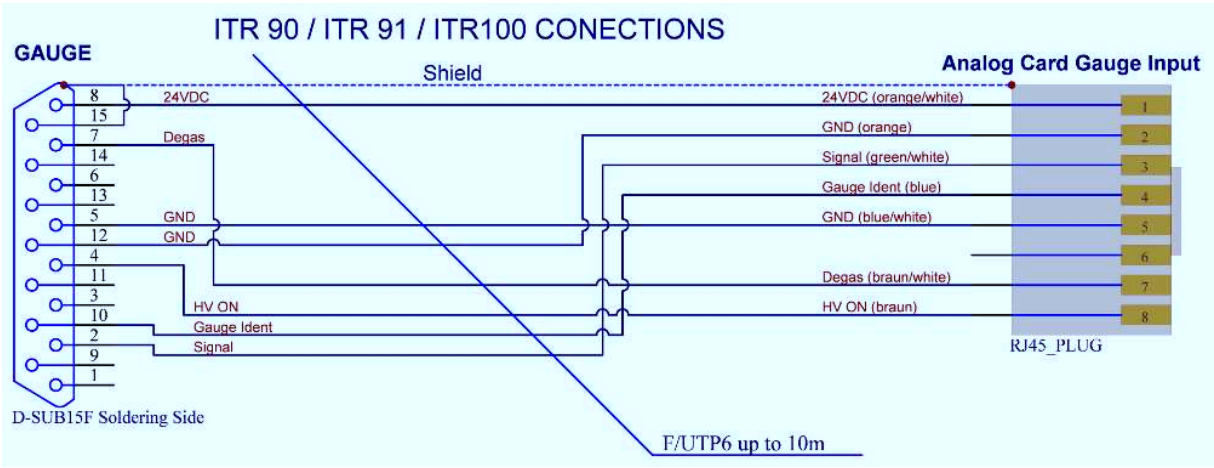


Figure 2.31: ITR gauge connection

Analog inputs can be used to control parameters such as:

- I_C
- I_{CLimit}
- U_C
- U_{CLimit}
- I_{ELimit}
- U_E

Analog output 0-10V allowing the retransmission of values such as:

- Cathode and emission current and voltage
- Process Value
- Thermocouples temperature
- Diodes temperatures
- Pressure

2.5.8 REMOTE CONTROL

The device comes supplied with the following communication interfaces:

- Serial interface RS232/RS485 (selected from menu),
- Ethernet interface (IEEE 802 standard),

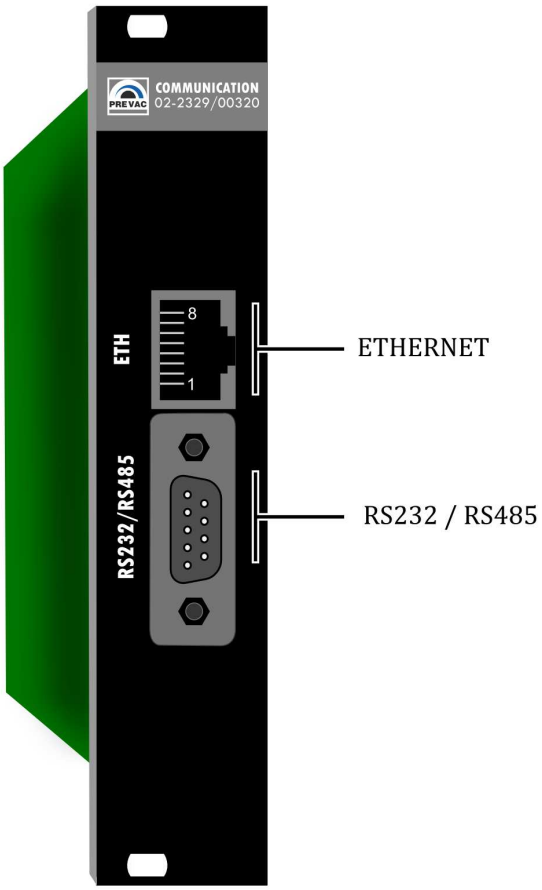


Figure 2.32: Remote control module

The remote interface allows read-back of the device parameters. In order to control and set the device parameters, the device must be switched to the remote control mode.
For a detailed description of the remote interface configuration, please see section **??**

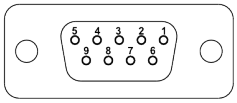


Figure 2.33: Serial interface connector(female 9 pin)

PIN NUMBER	FUNCTION	DESCRIPTION
2	RX	RS232 - Data signal RX
3	TX	RS232 - Data Signal TX
5	GND	Ground
8	D+	RS485 - Data signal positive
9	D-	RS485 - Data signal negative
1,4,6,7	none	not used

Table 2.7: Serial interface connector - pin description

3 OPERATING

Interaction with the HEAT3 takes place mainly via the touch panel and encoder. The front panel also contains LED status indicators describing the current state of the power supply.

3.1 TURN ON DEVICE

In order to turn on the device make sure that all of the connections on the rear panel are made correctly and that the AC connection meets the criteria provided in the AC source requirements section. If these conditions are met, set ***Power Switch*** into ***ON*** position on the front panel.

3.2 FRONT PANEL

There are several principal parts of the HEAT3 user interface:

- LED diode indicators
- Touch panel display
- USB port
- Digital encoder knob for setting parameters
- Power switch
- Backlight logo

Front panel of the HEAT3 device is shown in Figure

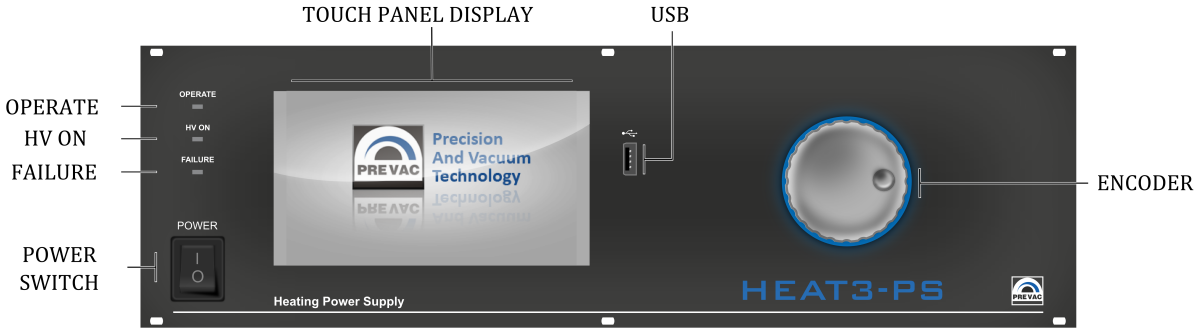


Figure 3.1: Front panel

3.2.1 LED INDICATORS

LED indicators inform about the operating state of the power supply:

- OPERATE – Green diode indicates operate status. Blinking indicates that some of the parameters are still stabilize.
- HV ON – Yellow diode indicates high voltage (> 48V) applied to any output pin,
- FAILURE – Blinking red diode indicates failure of the power supply. Additionally a corresponding failure message is displayed on the touch screen display.

3.2.2 TOUCH PANEL DISPLAY

The device has a TFT color display with a resolution of 800x480 pixels and a diagonal of 7" with 16:10 aspect ratio. The display has an integrated touch panel, which provides the user interface.

CAUTION

The touch panel is capable of processing only one input signal at a time. It is not permissible to simultaneously touch the touch panel at several points.

CAUTION

To operate the touch panel, do not use any pointed or sharp items. Such items can damage the foil resulting in input errors.

3.2.3 USB CONNECTOR

Allows removable media to be used for e.g. firmware or software upgrade . It is also possible to play videos on the screen.

3.3 USER INTERFACE

The HEAT3 is equipped with a colour display touch screen. All data and functions are accessible via the menus from this touch screen interface. Every operation must be performed by a tap on screen.

Main view contains 3 elements:

1. Main window - contains the most important parameters controlled by the device,
2. Menu - contains the device menu from where the user may enter the setup menu, upgrade firmware, show contents of the usb stick, playing videos,
3. Setup shortcut - contains list of favourites setup positions (see section ***Setup shortcuts***).

3.3.1 SWITCHING BETWEEN SCREENS

To toggle between screens, press the left or right hand side of the display. The navigation buttons are not initially shown on the screen but will be activated and displayed after pressing either side for longer than 1s. Movement between windows is looped- after window number 3, window number 1 is displayed again and vice versa.

3.3.2 PANELS OVERVIEW

The device contains three separate and distinct panels

- Heating panel

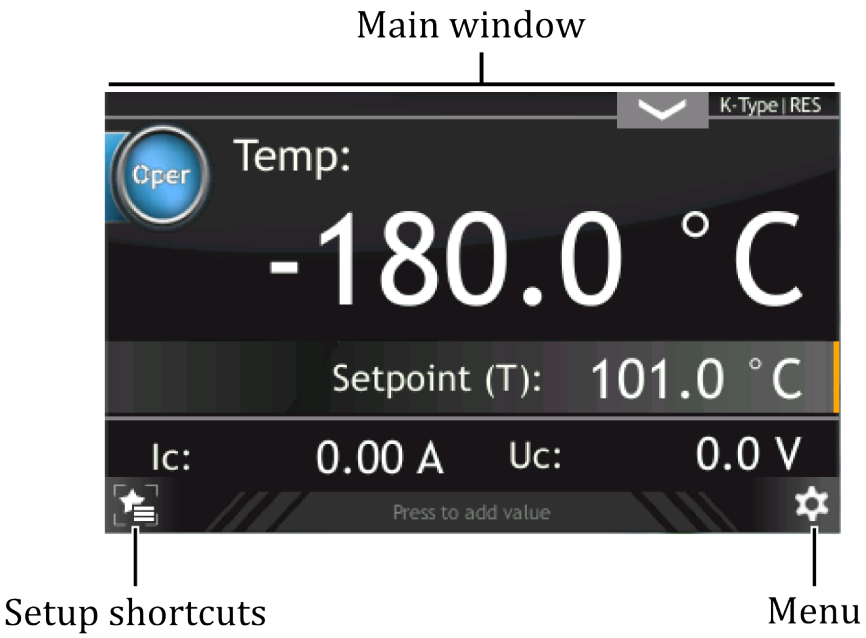


Figure 3.2: Screen main view

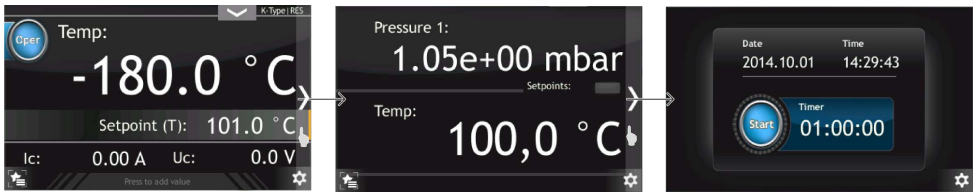


Figure 3.3: Moving between screens

- Vacuum panel
- Timer panel

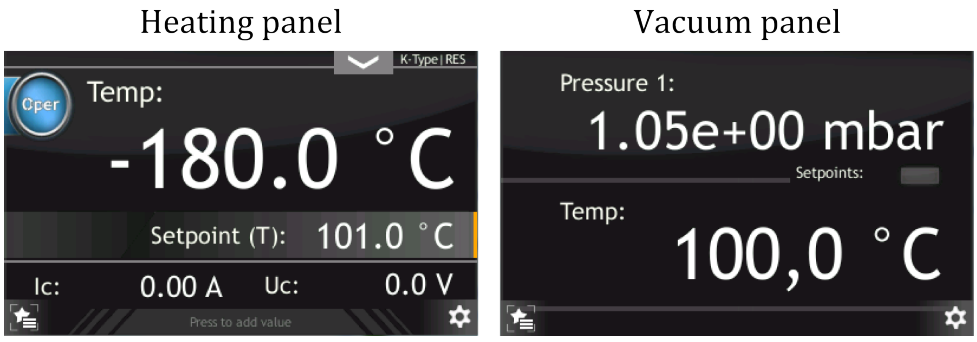


Figure 3.4: Moving between screens

The figures below describe panel configuration and interactive area for Heating and Vacuum panels which can be changed by tapping. The Timer panel will be described at the end of chapter.

The Heating panel contains information which is dependent on the current device configuration and which may be displayed in several configurations.

- Mode: RES, Regulation method: PID

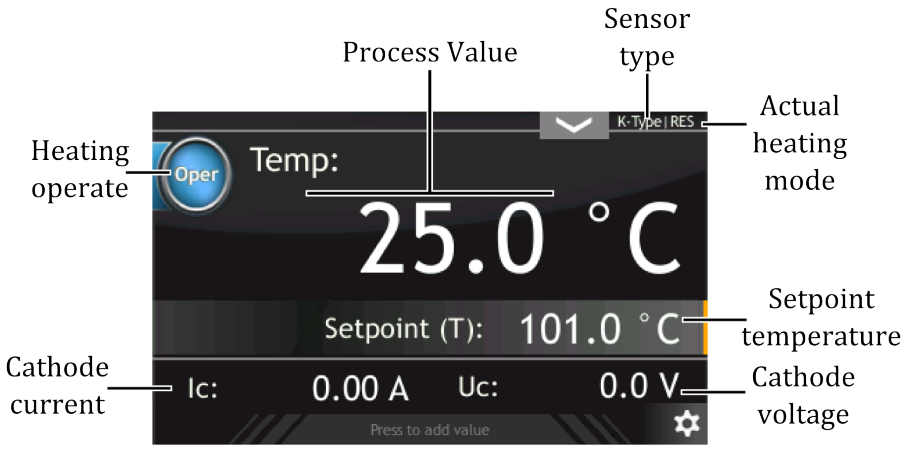


Figure 3.5: Heating panel description, Mode: RES, Regulation method: PID

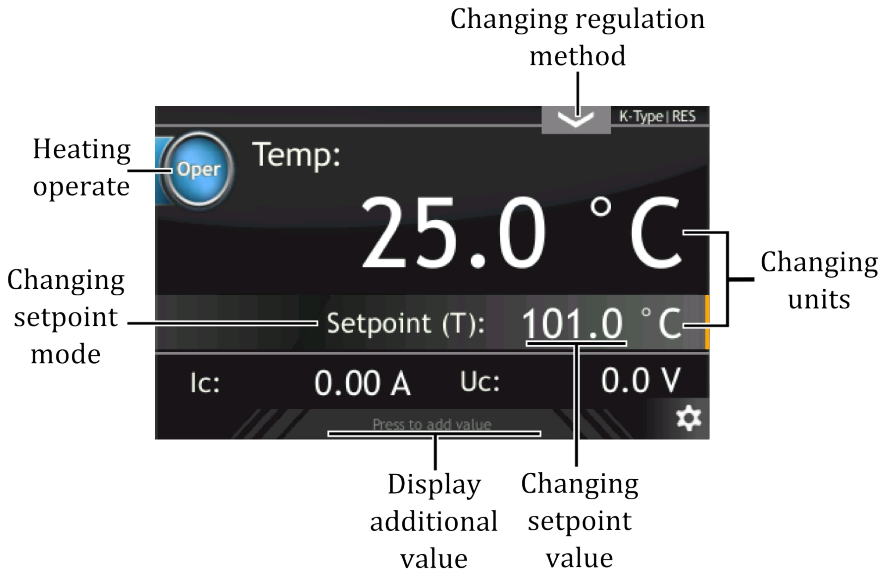


Figure 3.6: Heating panel active areas, Mode: RES, Regulation method: PID

- Mode: RES, Regulation method: Manual

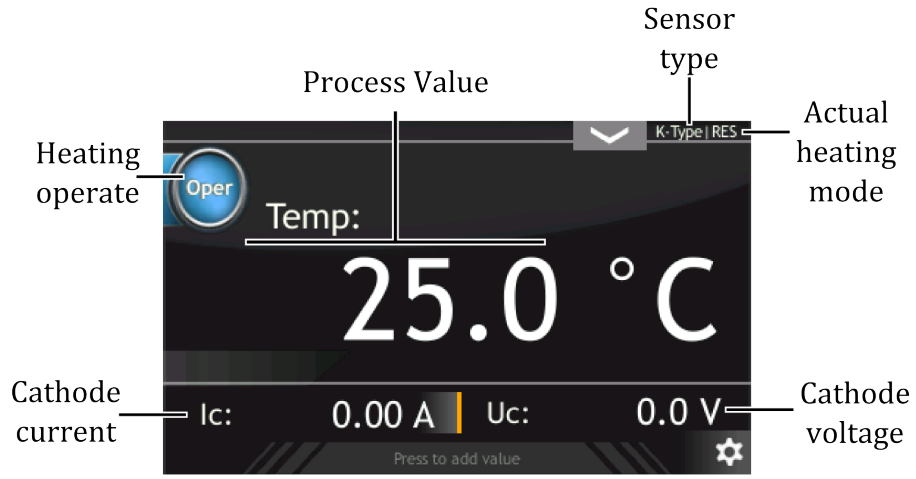


Figure 3.7: Heating panel description, Mode: RES, Regulation method: Manual

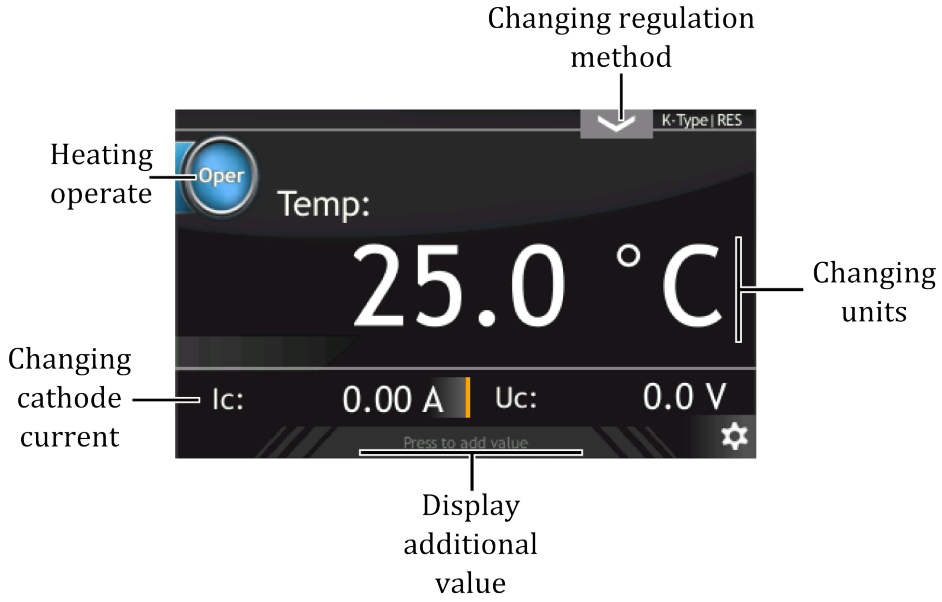


Figure 3.8: Heating panel active areas, Mode: RES, Regulation method: Manual

- Mode: EB, Regulation method: PID

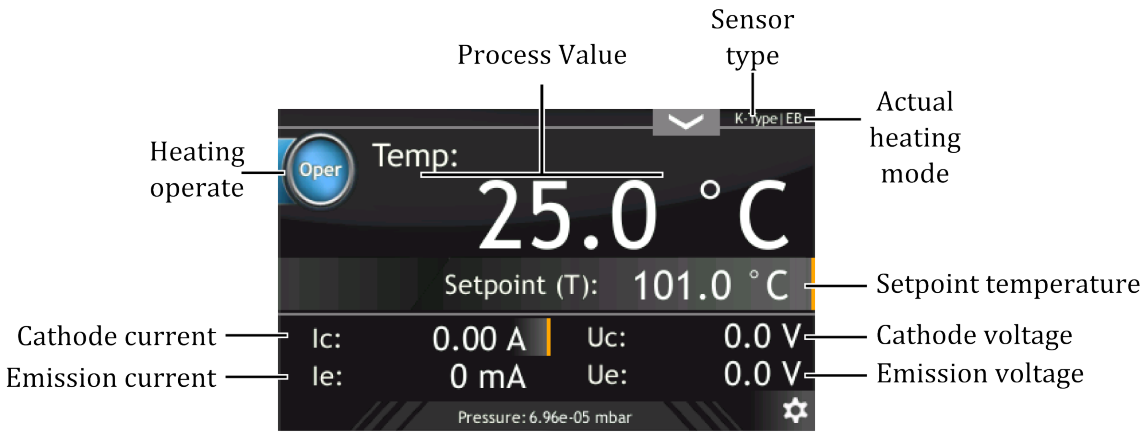


Figure 3.9: Heating panel description, Mode: EB, Regulation method: PID

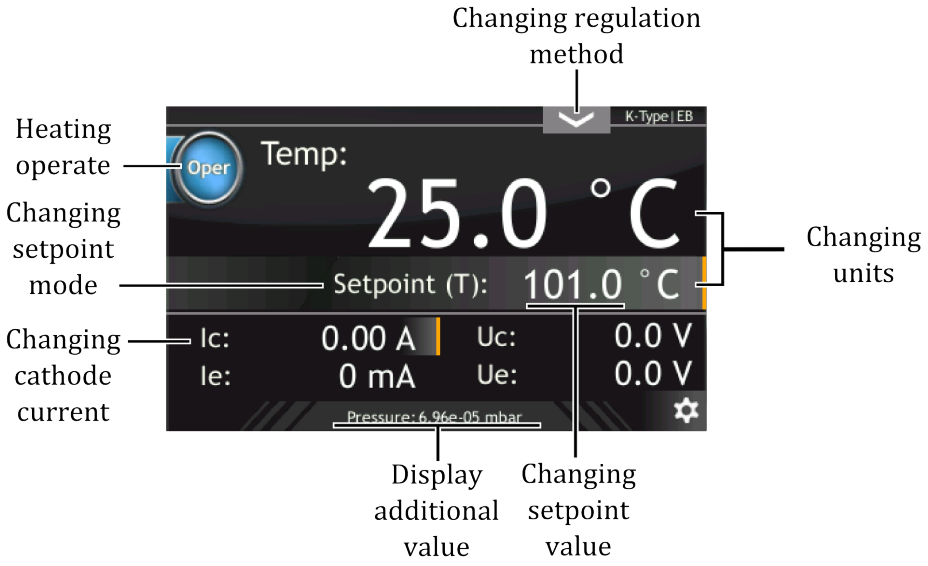


Figure 3.10: Heating panel active areas, Mode: EB, Regulation method: PID

- Mode: EB, Regulation method: Manual

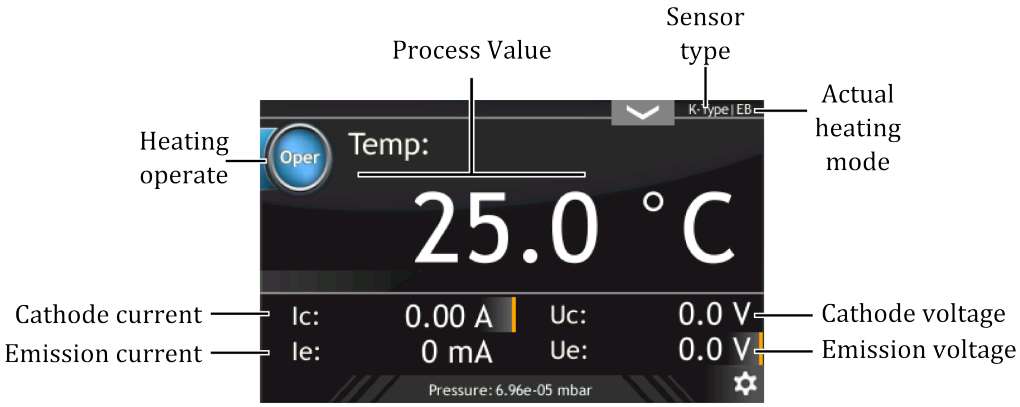


Figure 3.11: Heating panel description, Mode: EB, Regulation method: Manual

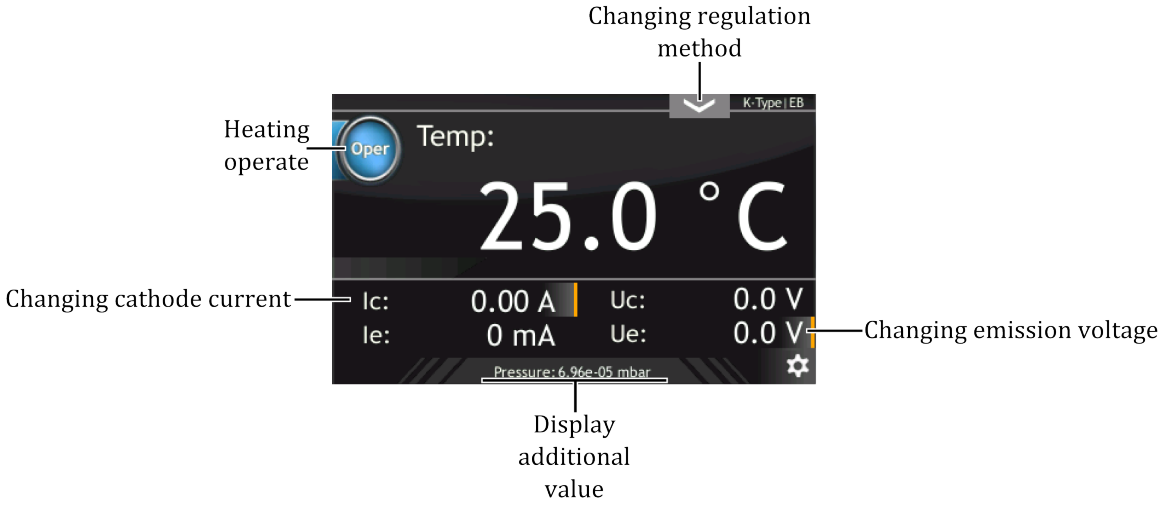


Figure 3.12: Heating panel active areas, Mode: EB, Regulation method: Manual

- Vacuum panel

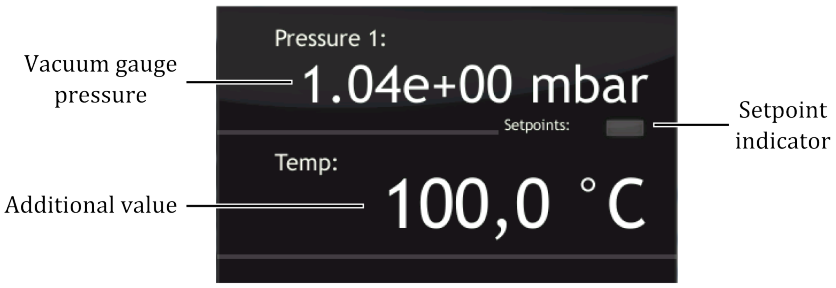


Figure 3.13: Vacuum panel description

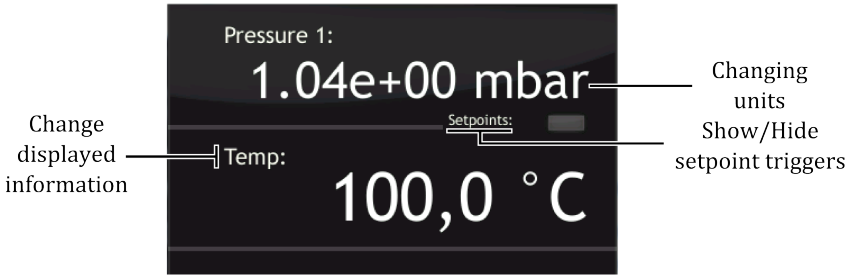


Figure 3.14: Vacuum panel active areas

3.3.3 DEVICE INTERACTION

To change the displayed measurement units:

1. Tap on units to change (e.g. Temp)
2. Select target units
3. Value in new units is displayed

Figure 3.15: Changing units

To add or change the display information on the Heating panel

1. Tap the bottom of the display
2. Select information to be displayed
3. New value is displayed

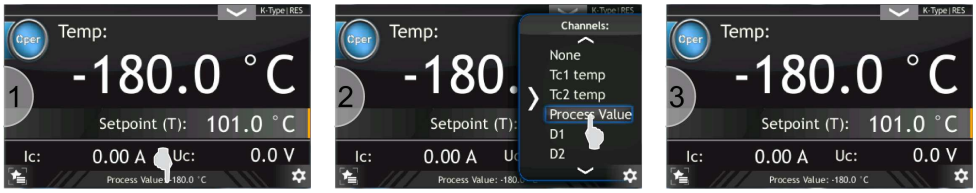


Figure 3.16: Changing additional information – Heating panel

To add or change the display information on the Vacuum panel

1. Tap on additional value label
2. Select value to be displayed
3. New value is displayed

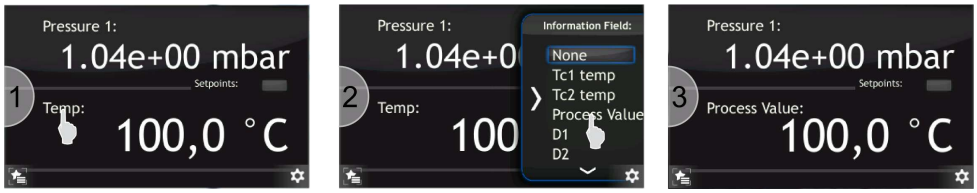


Figure 3.17: Changing additional information – Vacuum panel

3.3.4 OPERATING KNOB

Every input value can be modified using the knob located on the front panel. The Knob can be used to change values in both the main windows and setup menu.

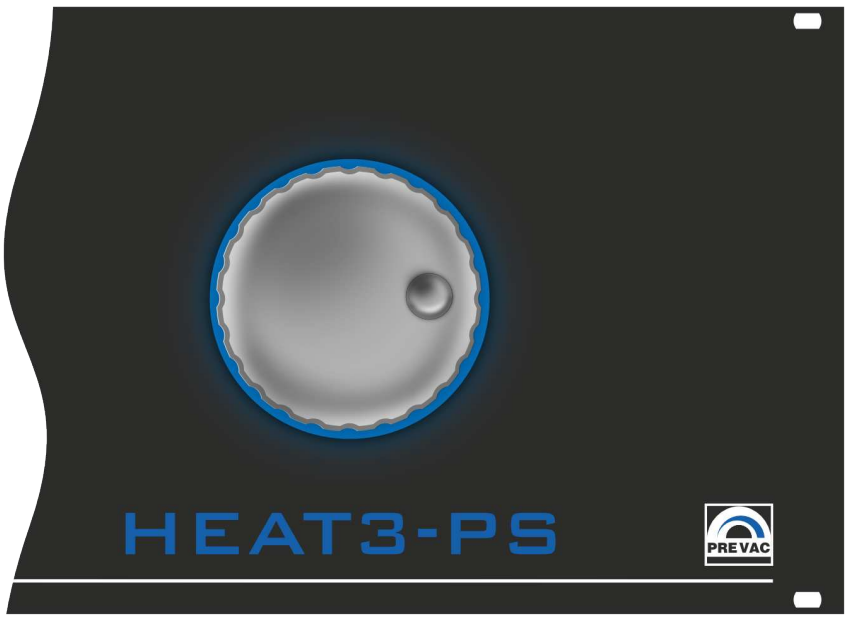


Figure 3.18: Knob placement

Every value in the main window with an orange line can be modified (e.g. Setpoint value). Changing the setpoint value by this method is described by the figure below; Changing setpoint value using knob.

1. Tap setpoint value. After tapping, the setpoint value will blink
2. Turn knob to change value
3. Tap again on setpoint value to disable value editing

Figure 3.19: Changing setpoint value using knob

Each value can also be modified by using the numeric keyboard. In order to display the numeric keyboard:

1. Tap value to edit (e.g. Setpoint),
2. Tap numeric keyboard button (see figure below),
3. For more information about numeric keyboard see *Numeric keyboard* section,

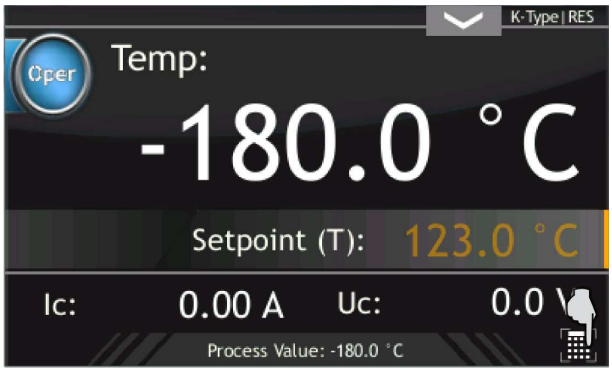


Figure 3.20: Editing value by numeric keyboard

3.3.5 NUMERIC KEYBOARD

Numeric values can be entered via the numeric keyboard. It consists of the numbers 0 to 9 and additional function keys to facilitate data entry and editing of the current data. The numeric keyboard is shown in Figure 3.21.

It is possible to enter data:

- directly from the numeric keypad by typing a value and confirming the entered value,
- by entering data in the form of the mantissa and exponent,

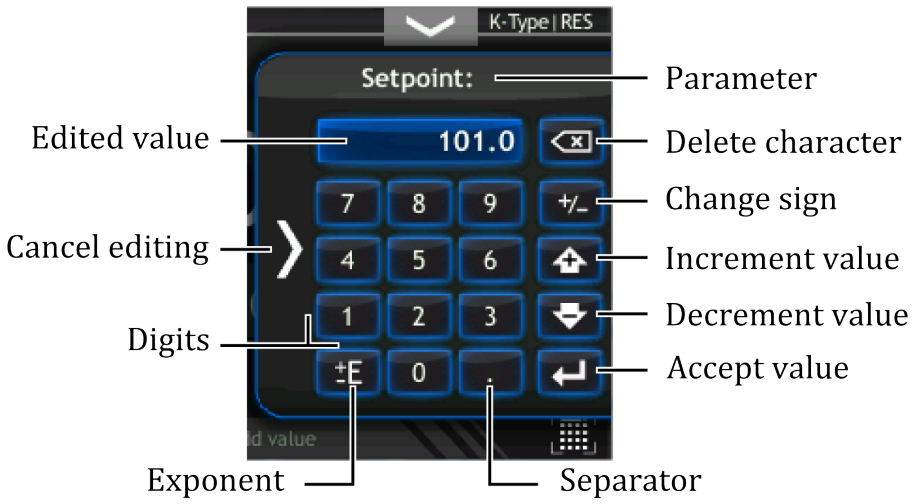


Figure 3.21: Numeric keyboard

- by increasing or decreasing the current value step by step.

Increment or decrement current value:

1. Select value to edit (e.g. Setpoint).
2. Tap on ***1*** and ***2*** to increment value by 12.
3. Tap on the ***Increment value*** button (every tap on the button increments the value by 12).
4. Value is increased.
5. To decrement value just tap on the ***Decrement value*** button (every tap on the button decrements the value by 12).
6. Confirm value by tapping the ***Accept value*** button.

Figure 3.22: Increment/decrement value by numeric keyboard

To enter a number in exponential form:

1. Enter the numeric value of the mantissa number along with a sign (e.g. -12.5)
2. Press the exponent button. To enter a negative exponent symbol, press the exponent button twice
3. Enter exponent value
4. After entering the value, it is possible to modify the sign of mantissa and the sign of exponent by using the exponent button or change sign button (see figure ***Numeric keyboard***)
5. Confirm value by Accept value button

Figure 3.23: Number in exponential form

3.3.6 ALPHANUMERIC KEYBOARD

The on-screen keyboard is used for entering alphanumeric data and also facilitates text entry. Figure 3.24 shows the alphanumeric keyboard with description of main keys.

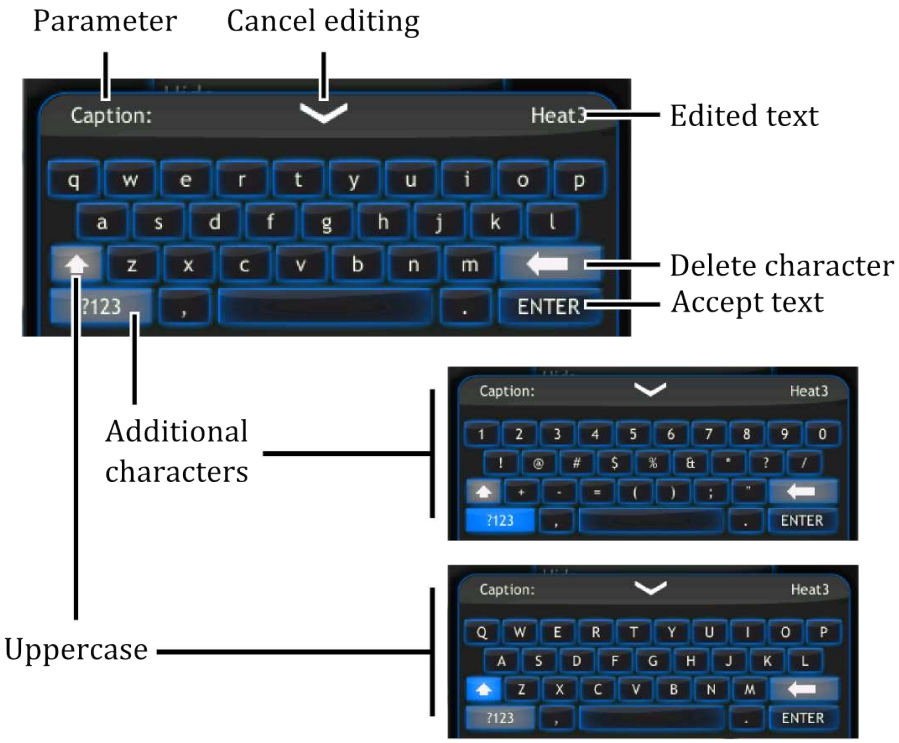


Figure 3.24: Alphanumeric keyboard

3.3.7 SETUP

Advanced configuration of the device parameters is possible via the setup menu. Tap the menu icon to expand the menu and then tap device setup icon (see Figures 3.25 - 3.26).

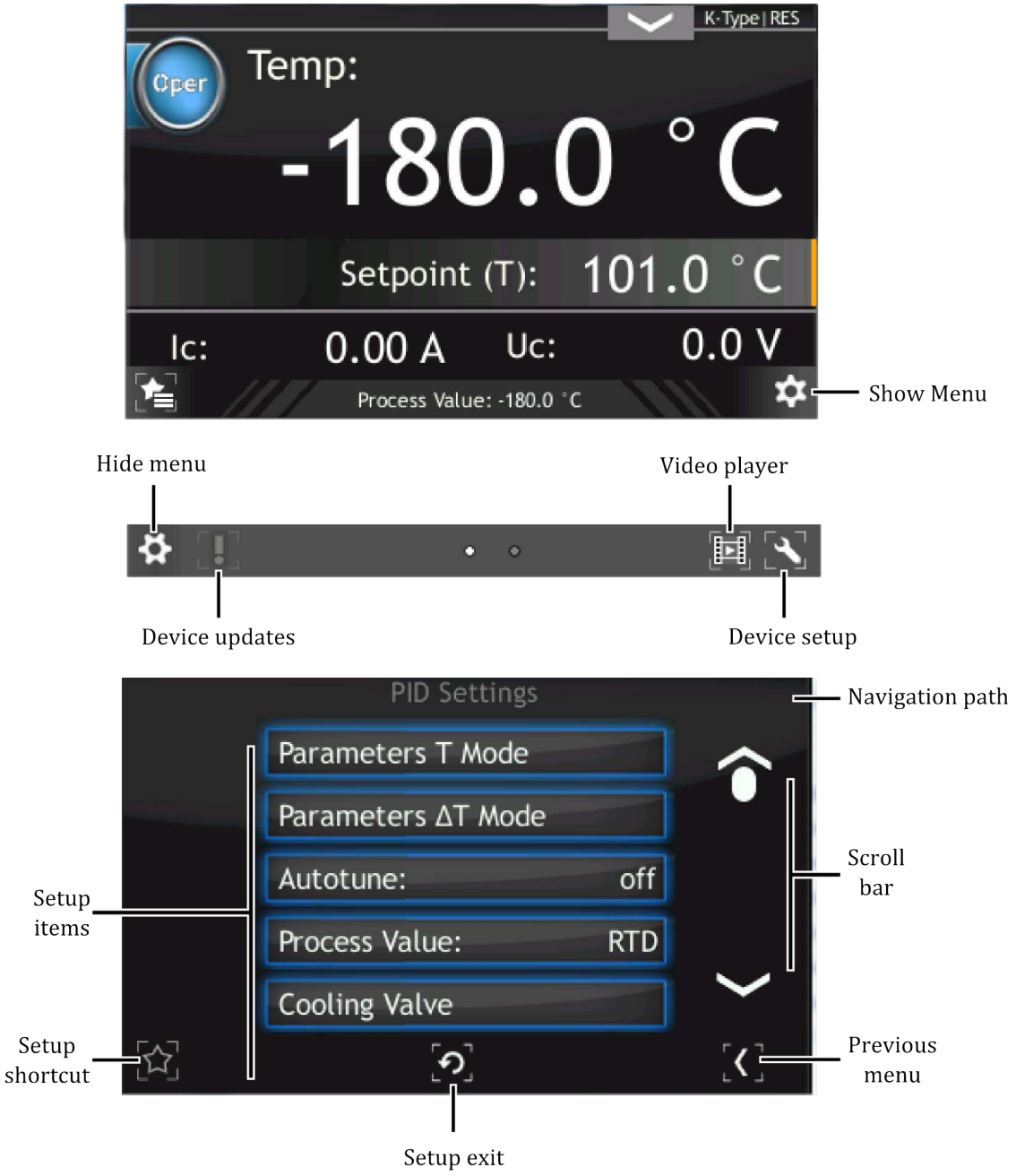


Figure 3.25: Device setup

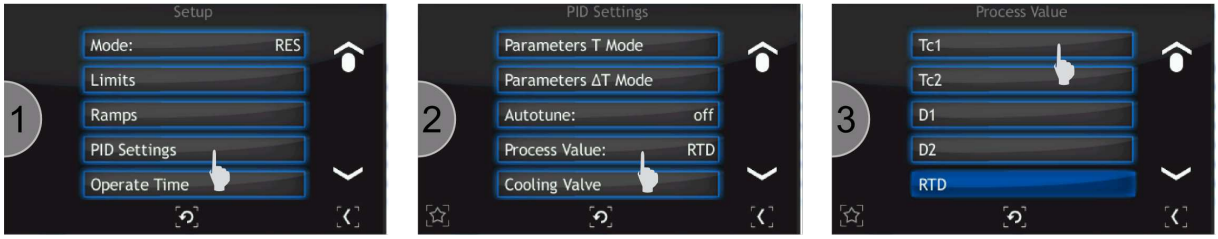


Figure 3.26: Navigating the setup (example)

3.3.8 SETUP SHORTCUTS

Frequently used commands/settings can be conveniently accessed by creating shortcuts.
To create a shortcut:

1. Navigate to the setup position where a shortcut should be created.
2. Tap on ***Setup shortcut*** to add the position to shortcuts (To remove position from shortcut list tap again on the ***Setup shortcut*** button).

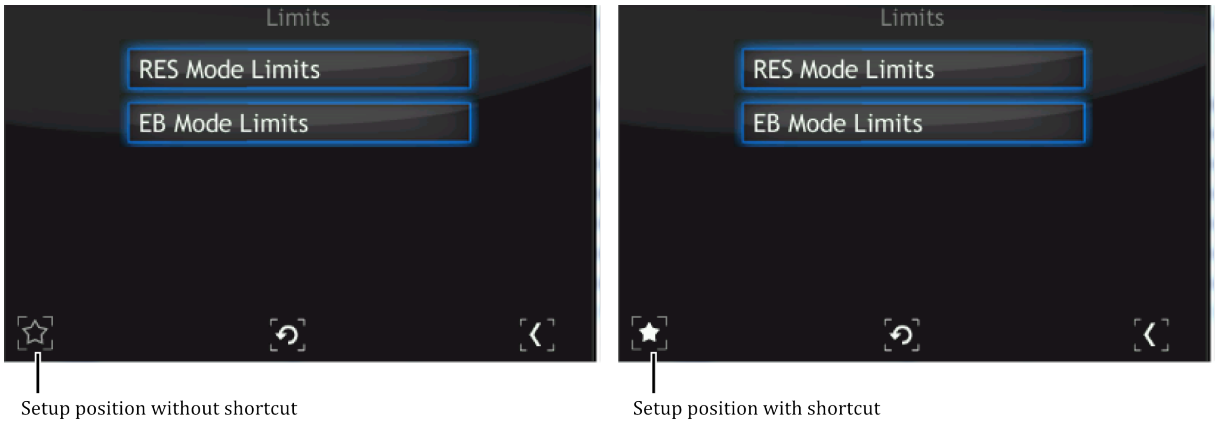


Figure 3.27: Setup shortcut on setup menu

To use shortcut:

1. On main panel tap on ***Setup shortcut*** button.
2. Select setup shortcut to enter (e.g. Operate Time).
3. Current setup position should be displayed.

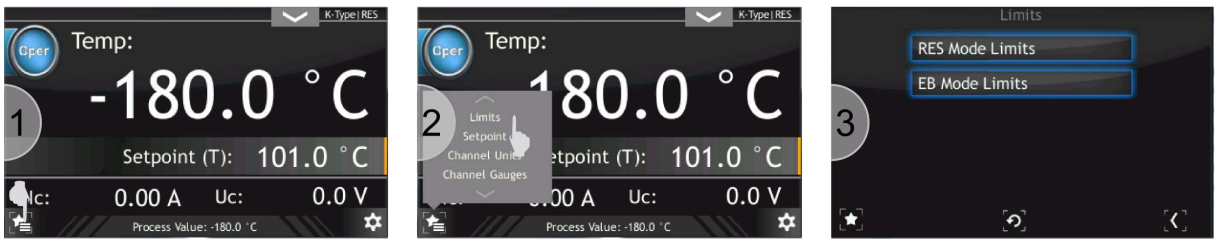


Figure 3.28: Using setup shortcut

3.3.9 TIMER PANEL

Additional screen contains countdown timer and information about the current time and date. Elapsed time is paired with a progress bar indicator located around the Start/Stop button. Timer value can be set from 23h:59m:59s to 00h:00m:01s. After pressing the ***Start*** button the time is counted from set value to zero. An audible beep sounds when the timer has completed and the set value is displayed once again.

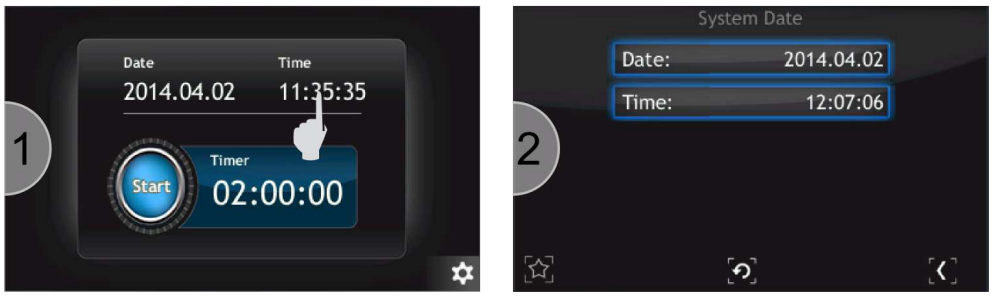


Figure 3.29: Go to system date

3.3.9.1 SETTING TIMER VALUE

In order to set the timer start value:

1. Tap ***timer field***.
2. Type a timer initial value using numeric button ***from 0 to 9*** and ***":" symbol as separator***. Confirm value by tapping ***Enter*** button.
3. New value is set and display in ***timer field***. Tap ***Start*** in order to run the timer
4. Timer is counting down,

The time may also be entered in seconds. The entered value is automatically converted to ***hh:mm:ss*** format

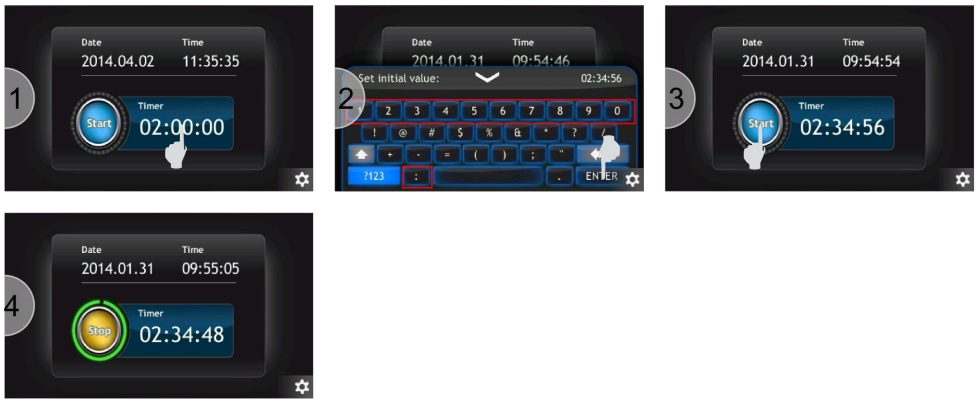


Figure 3.30: Set timer value

3.3.10 MESSAGES

The HEAT3 will automatically display both warning and error messages as appropriate.

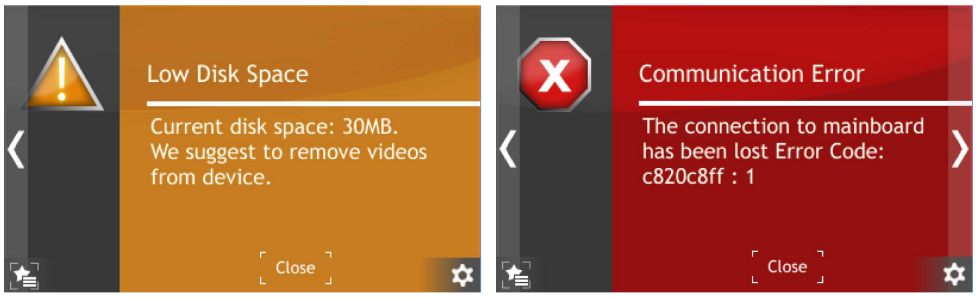


Figure 3.31: Messages

3.3.10.1 WARNING MESSAGE

Warning messages are displayed on the right of the screen. When present, they can be clicked to display the full warning information (see Figure 3.32). Warning messages consist of information together with a description field. When the problem causing the error no longer exists, the message is automatically removed whether or not it has been acknowledged.

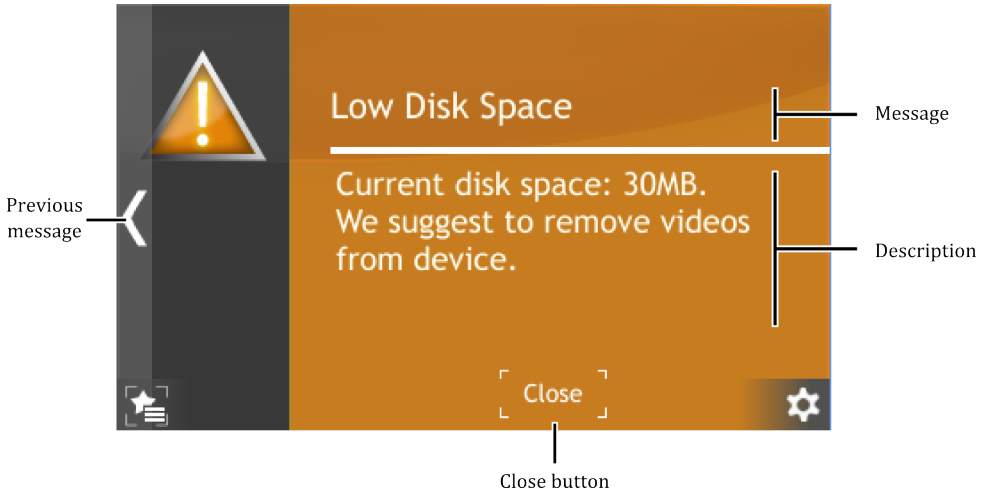


Figure 3.32: Warning message

3.3.10.2 ERROR MESSAGE

Error messages inform about critical issues. The message is displayed in full screen (see Figure 3.33). Error messages consist of an information field together with a description of the error. If the cause of error no longer exists, the error message will disappear after the user clicks OK. When the user clicks OK but the error still exists, then information about the event will continue to be displayed on the right hand side of the screen. If the cause of error still exists, please contact the manufacturer.

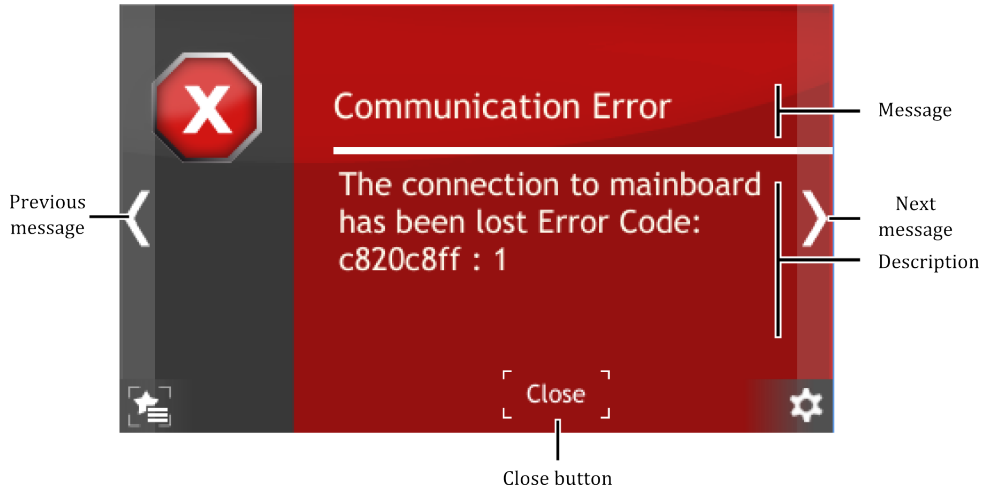


Figure 3.33: Error message

3.3.10.3 MULTIPLE MESSAGES

If several errors or warnings occur simultaneously they are indicated with a counter on the bottom right hand corner of a screen. The first digit (red) indicates the number of errors, the second digit (yellow) indicates the number of warnings. Clicking on this counter will bring up the message list. The list is displayed in date/time order from most recent to oldest. Error messages appear in the list before Warning messages.

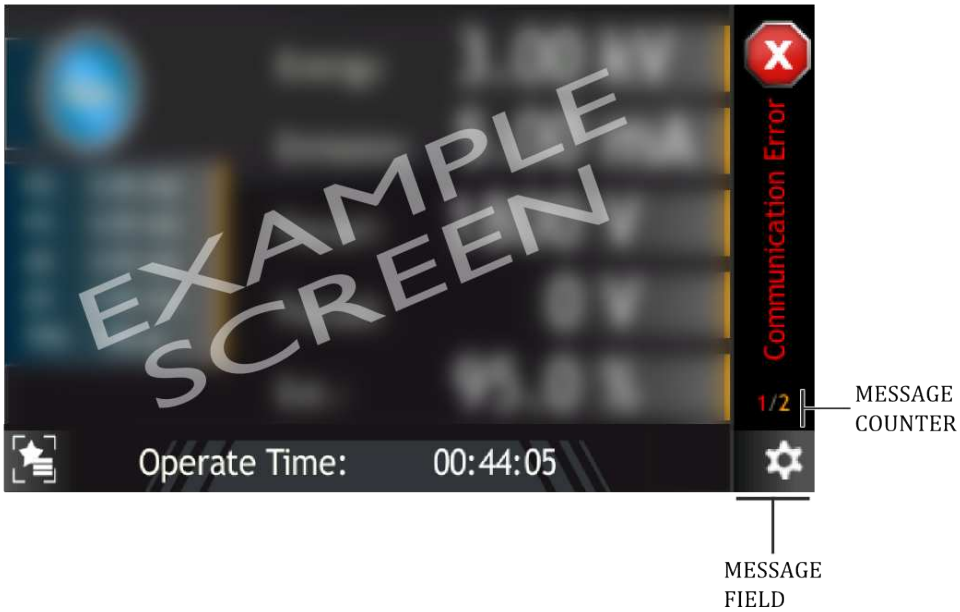


Figure 3.34: Multiple messages

3.3.11 VIDEO PLAYER

The HEAT3 device can play video files. Files can be played only from the device. Full instructions on how to copy a video file onto the device is in the subsection ***Copy video file to the device***. A short guide on how to play the video is included in subsection ***Playing Video***.

3.3.11.1 PLAYING VIDEO

In order to play a video go to the main screen and tap the ***Menu icon*** on the bottom right corner of the screen to display the menu bar. Then tap the ***Video player*** icon on the bottom right (see Figure 3.35).

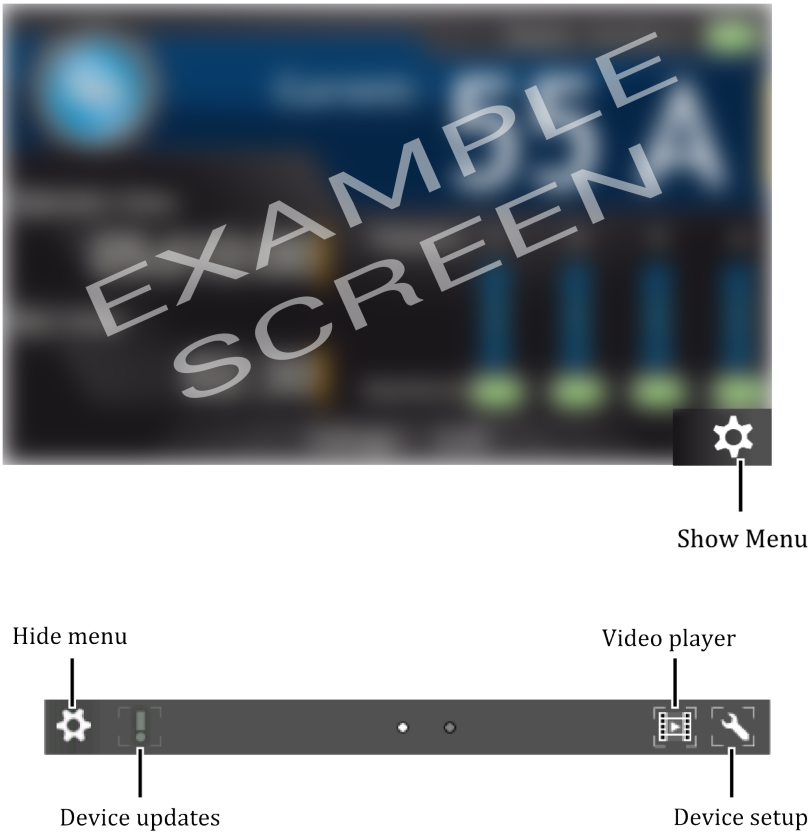


Figure 3.35: Menu bar - video player

1. Tap on the desired file to open video menu.

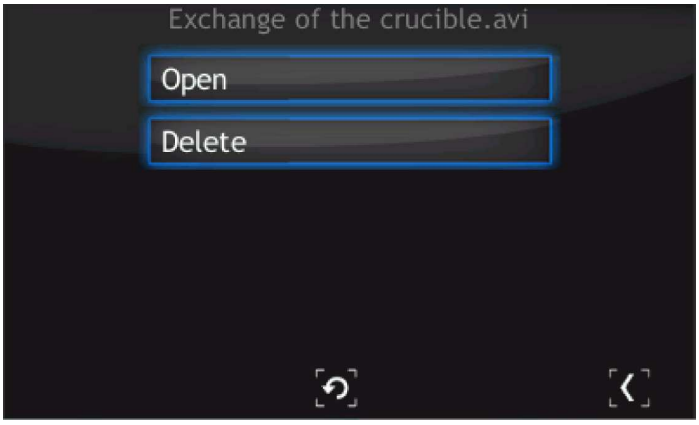


Figure 3.36: Video player - menu

2. From this menu, a video file can be played or deleted. In order to delete the file tap ***Delete*** and confirm the action by tapping ***Yes***.

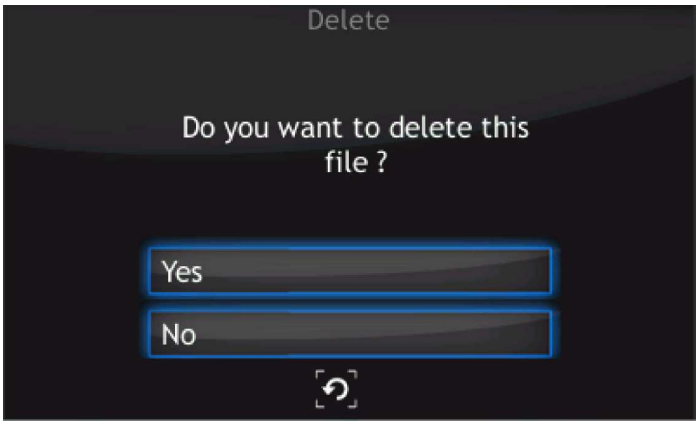


Figure 3.37: Video delete question

3. To open a video, tap ***Open***. The video player is displayed.
4. Tap on the screen to see the video player menu.

From this menu, the following controls are visible:

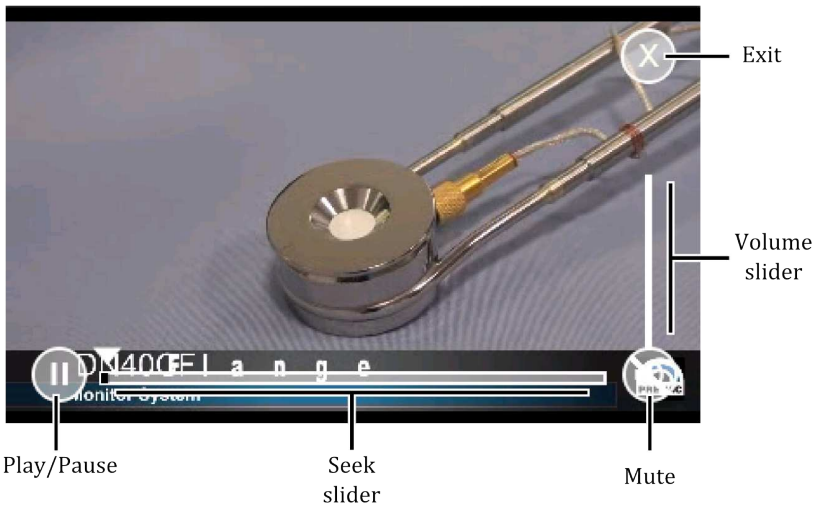


Figure 3.38: Video player

3.3.11.2 COPY VIDEO FILE TO THE DEVICE

In order to copy a video file to the device, connect a USB flash drive which contains the video files. The following hint appears ***New USB device detected***. Tap on the USB menu to show the menu.
Tap on the ***List of videos on USB*** button to see all the videos stored on the USB drive with *.avi extension (see Figure 3.40).

1. Choose a desired file from the list.
2. To copy file, tap ***Copy file to the device***.
3. Depending on the file size, the copy operation can take from a few seconds to several minutes. At the end of the copy operation, tap the ***Return*** button.

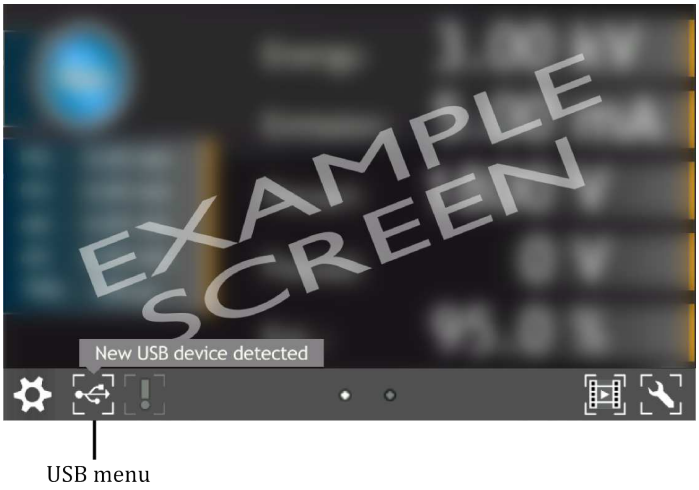


Figure 3.39: USB detected hint

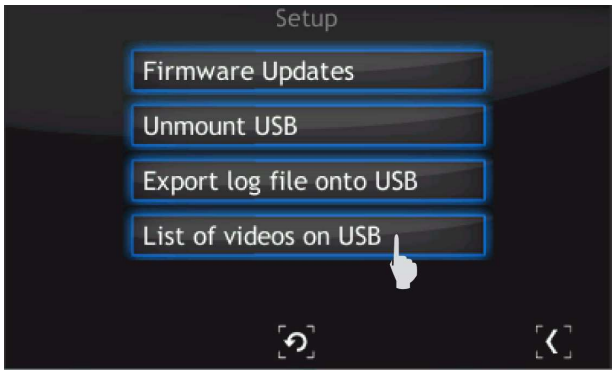


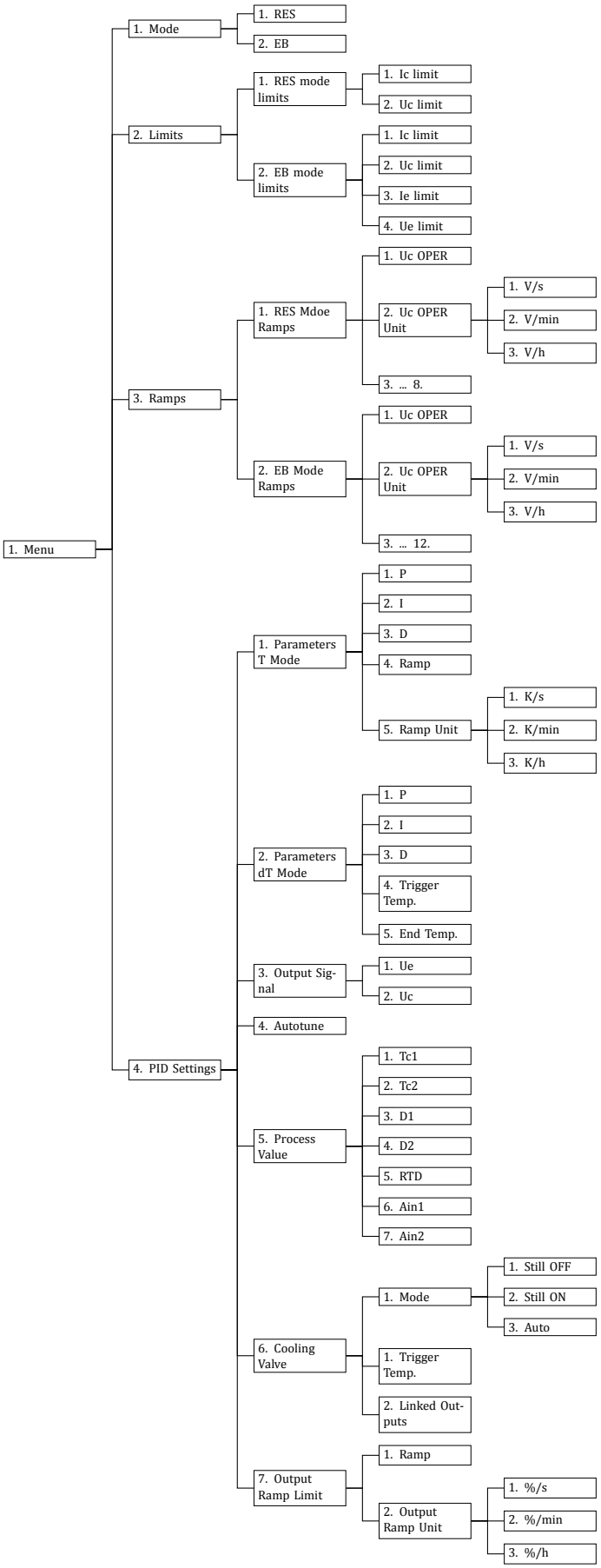
Figure 3.40: USB menu - list of videos on USB

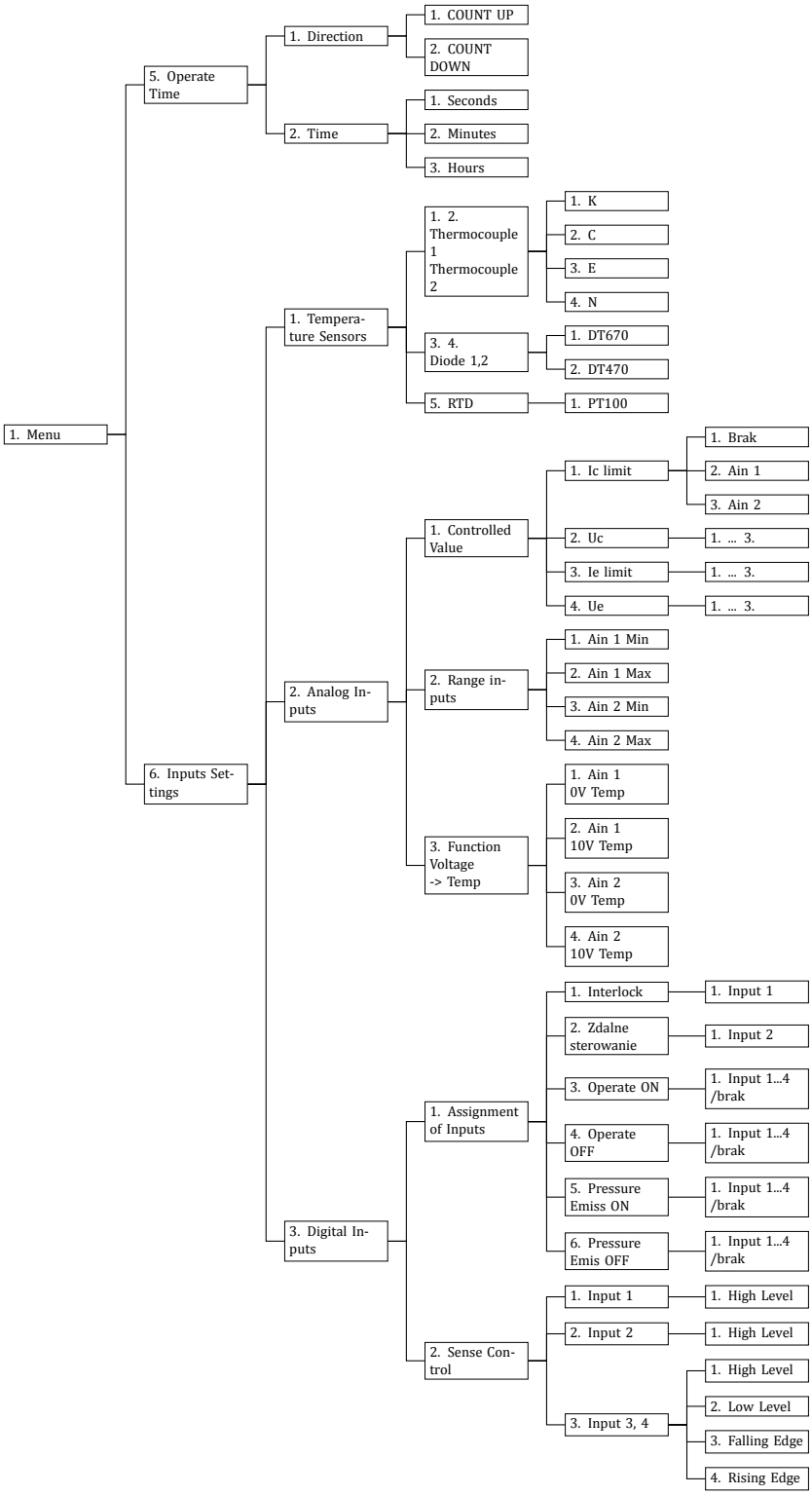
Figure 3.41: Copy *.avi to device

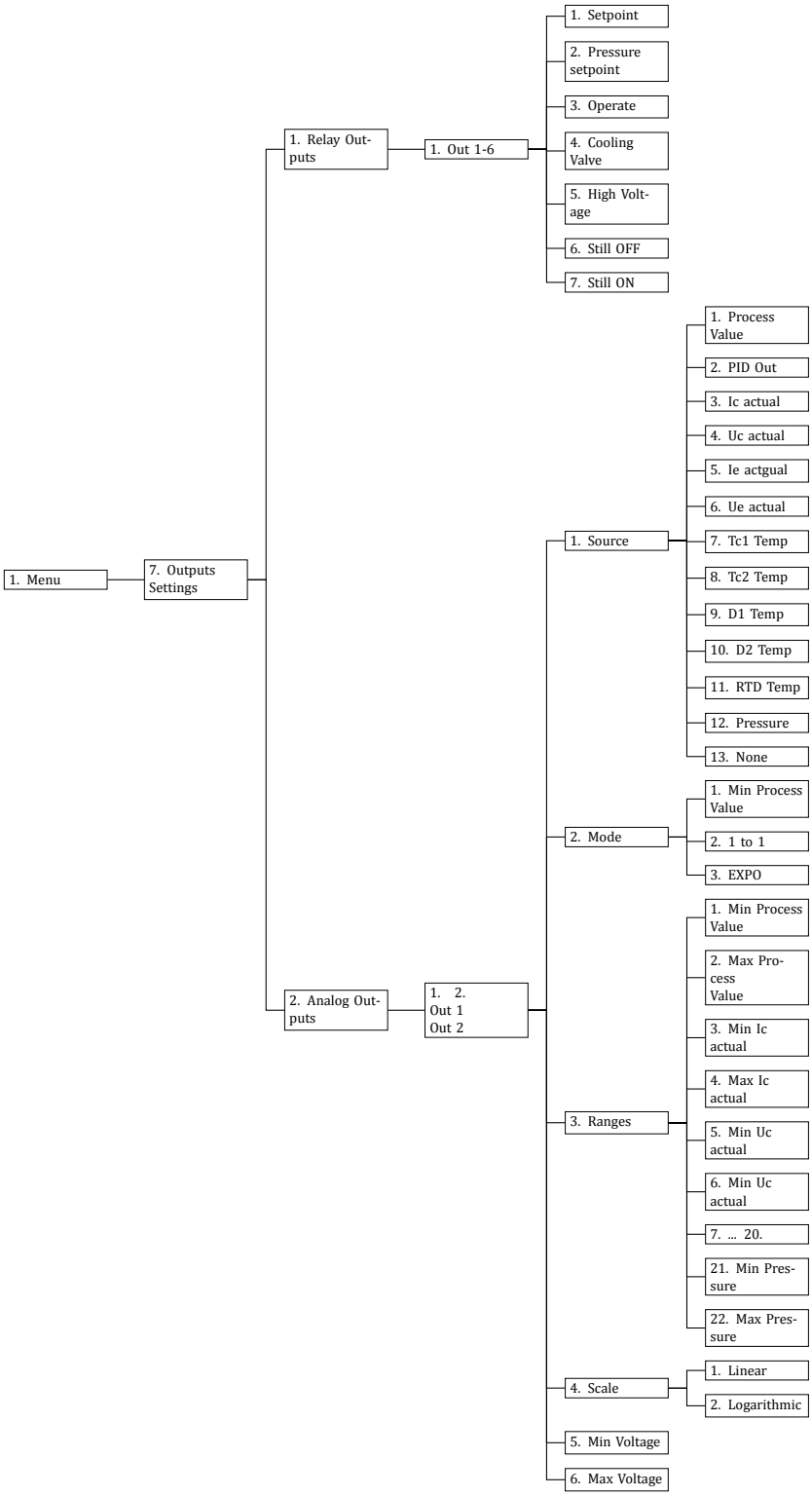
3.4 SETUP MENU

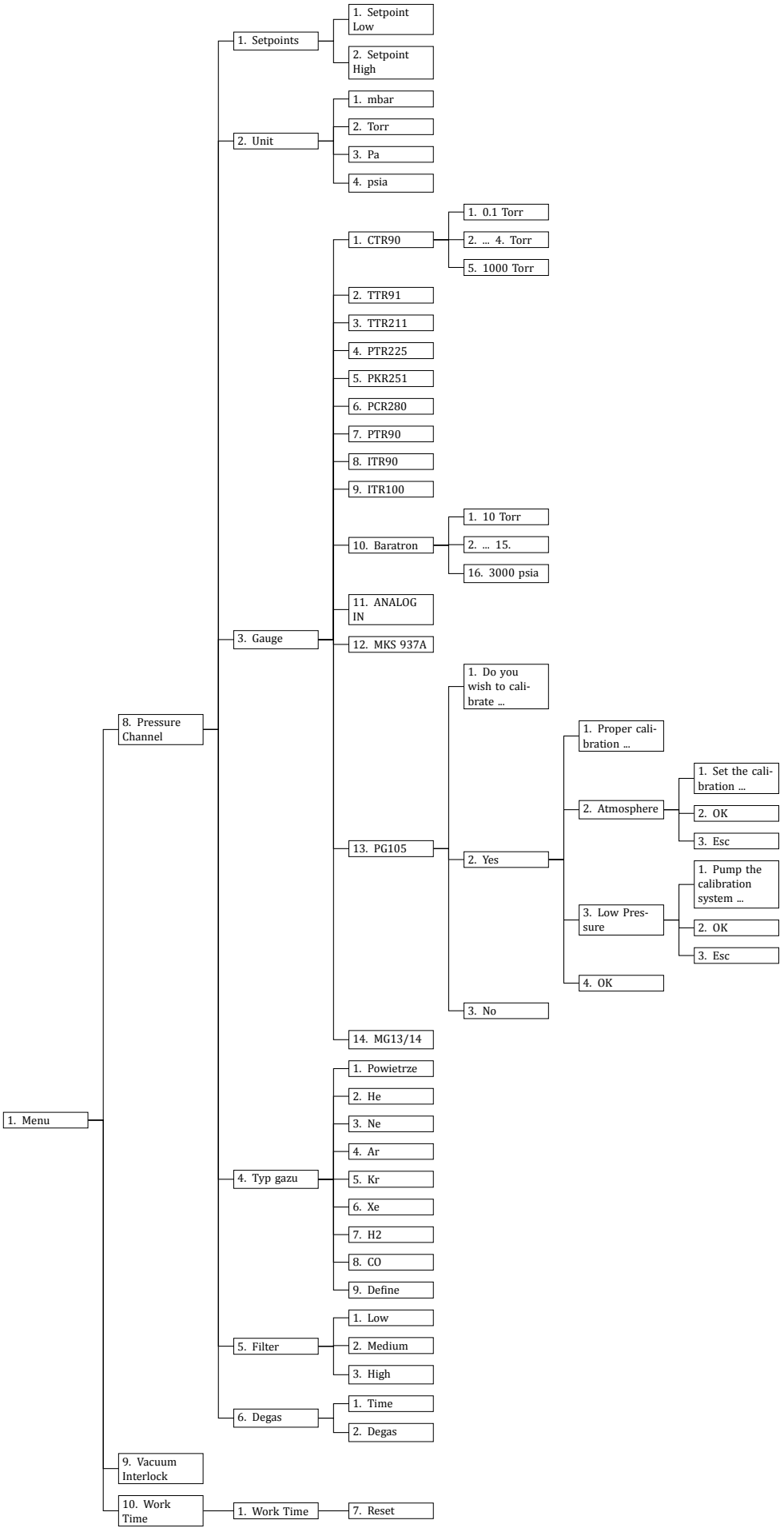
Allows access to the device configuration options such as PID settings, communication, etc., to store the changes, save them in accordance with instructions from the section 3.13.6.

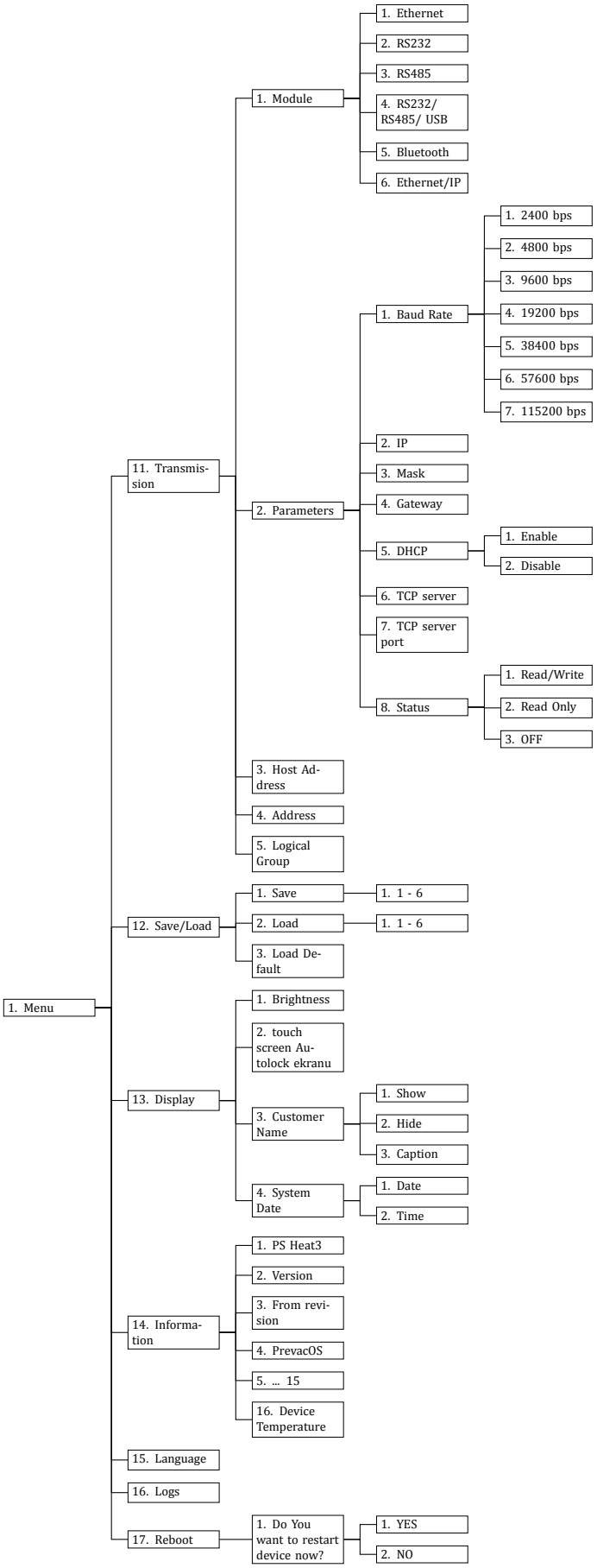
3.5 SETUP MENU TREE




1. Menu
5. Operate Time
1. Direction
1. COUNT UP
2. COUNT DOWN
2. Time
1. Seconds
2. Minutes
3. Hours
6. Inputs Settings
1. Temperature Sensors
1. 2. Thermocouple 1 Thermocouple 2
1. K
2. C
3. E
4. N
3. 4. Diode 1,2
1. DT670
2. DT470
5. RTD
1. PT100
2. Analog Inputs
1. Controlled Value
1. Ic limit
1. Brak
2. Ain 1
3. Ain 2
2. Uc
1. ... 3.
3. Ie limit
1. ... 3.
4. Ue
1. ... 3.
2. Range inputs
1. Ain 1 Min
2. Ain 1 Max
3. Ain 2 Min
4. Ain 2 Max
3. Function Voltage -> Temp
1. Ain 1 0V Temp
2. Ain 1 10V Temp
3. Ain 2 0V Temp
4. Ain 2 10V Temp
3. Digital Inputs
1. Assignment of Inputs
1. Interlock
1. Input 1
2. Zdalne sterowanie
1. Input 2
3. Operate ON
1. Input 1...4 /brak
4. Operate OFF
1. Input 1...4 /brak
5. Pressure Emiss ON
1. Input 1...4 /brak
6. Pressure Emis OFF
1. Input 1...4 /brak
2. Sense Control
1. Input 1
1. High Level
2. Input 2
1. High Level
3. Input 3, 4
1. High Level
2. Low Level
3. Falling Edge
4. Rising Edge


1. Menu
7. Outputs Settings
1. Relay Outputs
1. Out 1-6
1. Setpoint
2. Pressure setpoint
3. Operate
4. Cooling Valve
5. High Voltage
6. Still OFF
7. Still ON
2. Analog Outputs
1. 2. Out 1 Out 2
1. Source
1. Process Value
2. PID Out
3. Ic actual
4. Uc actual
5. Ie actgual
6. Ue actual
7. Tc1 Temp
8. Tc2 Temp
9. D1 Temp
10. D2 Temp
11. RTD Temp
12. Pressure
13. None
2. Mode
1. Min Process Value
2. 1 to 1
3. EXPO
3. Ranges
1. Min Process Value
2. Max Process Value
3. Min Ic actual
4. Max Ic actual
5. Min Uc actual
6. Min Uc actual
7. ... 20.
21. Min Pressure
22. Max Pressure
4. Scale
1. Linear
2. Logarithmic
5. Min Voltage
6. Max Voltage


1. Menu
8. Pressure Channel
1. Setpoints
1. Setpoint Low
2. Setpoint High
2. Unit
1. mbar
2. Torr
3. Pa
4. psia
3. Gauge
1. CTR90
1. 0.1 Torr
2. ... 4. Torr
5. 1000 Torr
2. TTR91
3. TTR211
4. PTR225
5. PKR251
6. PCR280
7. PTR90
8. ITR90
9. ITR100
10. Baratron
1. 10 Torr
2. ... 15.
16. 3000 psia
11. ANALOG IN
12. MKS 937A
13. PG105
1. Do you wish to calibrate ...
2. Yes
1. Proper calibration ...
2. Atmosphere
1. Set the calibration ...
2. OK
3. Esc
3. Low Pressure
1. Pump the calibration system ...
2. OK
3. Esc
4. OK
3. No
14. MG13/14
4. Typ gazu
1. Powietrze
2. He
3. Ne
4. Ar
5. Kr
6. Xe
7. H2
8. CO
9. Define
5. Filter
1. Low
2. Medium
3. High
6. Degas
1. Time
2. Degas
9. Vacuum Interlock
10. Work Time
1. Work Time
7. Reset


1. Menu
11. Transmis-sion
1. Module
1. Ethernet
2. RS232
3. RS485
4. RS232/ RS485/ USB
5. Bluetooth
6. Ethernet/IP
2. Parameters
1. Baud Rate
1. 2400 bps
2. 4800 bps
3. 9600 bps
4. 19200 bps
5. 38400 bps
6. 57600 bps
7. 115200 bps
2. IP
3. Mask
4. Gateway
5. DHCP
1. Enable
2. Disable
6. TCP server
7. TCP server port
8. Status
1. Read/Write
2. Read Only
3. OFF
3. Host Ad-dress
4. Address
5. Logical Group
12. Save/Load
1. Save
1. 1 - 6
2. Load
1. 1 - 6
3. Load De-fault
13. Display
1. Brightness
2. touch screen Au-tolock ekranu
3. Customer Name
1. Show
2. Hide
3. Caption
4. System Date
1. Date
2. Time
14. Informa-tion
1. PS Heat3
2. Version
3. From revi-sion
4. PrevacOS
5. ... 15
16. Device Temperature
15. Language
16. Logs
17. Reboot
1. Do You want to restart device now?
1. YES
2. NO

3.6 SELECTING THE TYPE OF LOAD

The current chosen method of heating can be observed in the upper right corner of the main window. Selection of the heating method is performed in the setup menu. Below is an example of switching from resistive heating mode to electron bombardment heating mode:

1. Go to: ***[1] Setup Menu*** -> ***[1] Mode***
2. Tap **EB**
3. Heating mode will change into **EB**
4. Leave setup
5. Heating mode change is visible on the main screen in the upper right corner

3.7 SELECTING THE TYPE OF TEMPERATURE MEASUREMENT

The temperature measurement module is capable of measuring temperature using various types of thermocouples, diodes and resistance thermometers. This section describes the steps that should be followed in order to change the type of temperature sensor and corresponding PID process value.

3.7.1 SELECTING THERMOCOUPLE

The HEAT3 is able to measure temperature via two thermocouple inputs simultaneously. The user can choose between three thermocouple types. The thermocouple type can be selected/changed for each channel as follows:

1. Go to: ***[1] Setup Menu*** -> ***[6] Input Settings*** -> ***[1] Temperature Sensors***
2. Tap desired thermocouple channel
3. Tap desired type of thermocouple
4. Thermocouple type on the selected channel will change
5. Selected thermocouple type will appear in the **Temperature Sensors** menu

3.7.2 SELECTING DIODE

Two channels are available for temperature measurement using diode sensors. The type of diode for each channel can be selected/changed as follows:

1. Go to: ***[1] Setup Menu*** -> ***[6] Input Settings*** -> ***[1] Temperature Sensors***
2. Tap desired diode channel
3. Tap desired type of diode
4. Diode type on the selected channel will change
5. Selected diode type will appear in the **Temperature Sensors** menu

3.7.3 SELECTING RTD

Two channels are available for temperature measurement using resistance thermometers. The type of resistance thermometer for each channel can be selected/changed as follows:

1. Go to: ***[1] Setup Menu*** -> ***[6] Input Settings*** -> ***[1] Temperature Sensors***
2. Tap **RTD**

3.7.4 CONTROLLED CHANNEL SELECTION

Each of the sensors connected to Temperature Measurement Module can be used as PID Regulator process value. The process value is simply an input signal for the PID Regulator. To assign a sensor as a process variable, the following steps should be taken:

1. Go to: ***[1] Setup Menu*** -> ***[4] PID Settings*** -> ***[5] Process Value***
2. Choose desired Process Value from available sensors
3. Selected sensor will be assigned as **Process Value**
4. Selected sensor type will appear in the **PID Settings** menu, tap **Setup Exit** button
5. In the right upper corner of screen, information concerning the selected sensors for process value is displayed

3.8 RESISTIVE HEATING

The following subsection describes how to select and configure the resistive type of heating, and describes the set limits and ramp values for each parameter.

Depending on the installed type of DC module (voltage type or current type), Heat3 device allows the User to control the value of the cathode current I_c (DC current module) or cathode voltage U_c (DC Voltage Module).

3.8.1 SELECTING RESISTANCE HEATING MODE

1. Go to: ***[1] Setup Menu*** -> ***[1] Mode***
2. Tap **RES**
3. RES heating mode will be assigned
4. RES heating mode will appear in the **Setup menu**
5. RES heating mode will appear in the **Main window** in the upper right corner of the screen

3.8.2 PID REGULATION

There are two methods of regulating in RES mode; manual and AUTO. In AUTO Regulation mode, the cathode voltage is controlled by the PID Controller. The AUTO Regulation method is selected as follows:

1. Tap **Regulation Method** button to display the **Regulation menu**
2. Tap **AUTO** button
3. Resistive heating will now be regulated by the PID Controller

Figure 3.42: Setting PID Regulation for resistive heating

3.8.3 MANUAL REGULATION

In Manual Regulation mode, the cathode current is under user control. The manual regulation method is chosen as follows:

1. Tap **Regulation Method** button to display the Regulation menu
2. Tap **Manual** button
3. Resistive heating will now be regulated by the user

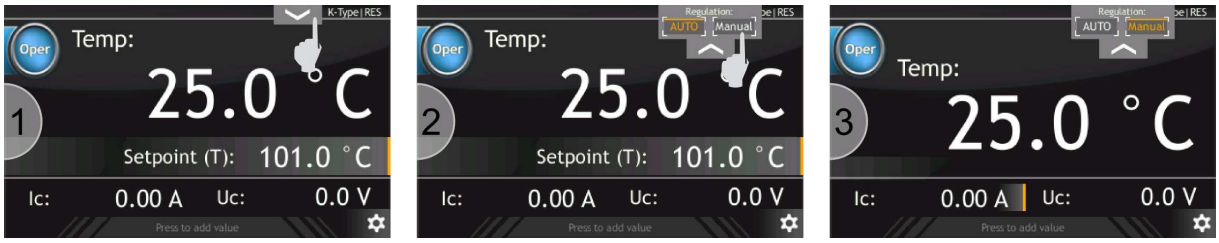


Figure 3.43: Setting manual regulation for resistive heating

3.8.4 SETTING RAMPS

Ramp levels can be set in a number of ways:

1. I_C Operate – ramp for cathode current during operation. This parameter accepts the following units:
   - A/s
   - A/min
   - A/h
2. I_C Operate->Standby – ramp for cathode current while changing operating state to standby. This parameter accepts the following units:
   - A/s
   - A/min
   - A/h
3. U_C Operate – ramp for cathode Voltage during operation. This parameter accepts the following units:
   - V/s

- V/min
- V/h

4. U_C Operate->Standby – ramp for cathode Voltage while changing operating state to standby. This parameter accepts the following units:
    - V/s
    - V/min
    - V/h

In order to determine the slope of the ramp for the selected parameters for resistive heating:

1. Go to: ***[1] Setup Menu*** -> ***[3] Ramps*** -> ***[3] RES Mode Ramps***
2. Select desired ramp to change and tap it
3. Tap **Numeric keyboard button**
4. Enter value
5. Tap **Enter** button in order to confirm new ramp value
6. Select desired ramp unit to change and tap it
7. Select one of the available units and tap it
8. New ramp unit will be applied
9. Newly selected ramp unit will appear on the **RES Mode Ramps** menu

3.8.5 SETTING LIMITS

Additional control of resistive heating can be accomplished by changing the limits of the cathode current and voltage supplies. These limits are valid for both manual and PID Controller regulation in Resistive Heating mode. Limits also affect the scaling values read via analog inputs, for example:

- U_C Limit is set to 10V
- Analog input is set as UC
- Analog input range is between 0V and 10V
- 0V on analog input will be equivalent to 0V of cathode voltage
- 10V on analog input will be equivalent to 10V of cathode voltage
- voltage scaling is described by the following formula:

$$U_C = \frac{A_{IN}}{A_{INMax}} U_{CLimit}$$

U_C - cathode voltage
A_{IN} – analog input voltage
A_{INMax} – maximum voltage level for analog input which is 10V
U_{CLimit} – limit for cathode voltage
The following example shows how to set limit for the cathode voltage of 20.60 V, this value will then never be exceeded for manual and PID regulation.

1. Go to: ***[1] Setup Menu*** -> ***[2] Limits*** -> ***[1] RES Mode Limits***
2. Tap U_C **Limit**
3. Tap **Numeric Keyboard**
4. Enter desired limit
5. New value is set

3.9 ELECTRON BOMBARDMENT HEATING

The following subsection describes how to select and configure the Electron Bombardment type of heating, and describes the set limits and ramp values for each parameter.

Depending on the installed type of DC module (voltage type or current type), Heat3 device allows the User to control the value of the cathode current I_c (DC current module) or cathode voltage U_c (DC Voltage Module).

3.9.1 SELECTING ELECTRON BOMBARDMENT MODE

1. Go to: ***[1] Setup Menu*** -> ***[1] Mode***
2. Tap **EB**
3. EB heating mode will be assigned
4. EB heating mode will appear in the **Setup menu**
5. EB heating mode will appear in the **Main window** in the upper right corner of the screen

3.9.2 PID REGULATION

There are two methods of regulating in EB mode; manual and AUTO. In AUTO Regulation mode, the cathode emission voltage is controlled by the PID Controller whilst cathode current is under user control. The AUTO Regulation method is selected as follows:

1. Tap **Regulation Method** button to draw forth Regulation menu
2. Tap **AUTO** button
3. Electron bombardment heating is now regulated by the PID Controller

Figure 3.44: Setting AUTO Regulation for electron bombardment

3.9.3 MANUAL REGULATION

In Manual Regulation mode, the cathode current and emission voltages are under user control. The manual regulation method is chosen as follows:

1. Tap Regulation Method button to draw forth Regulation menu
2. Tap Manual button
3. Electron bombardment heating will now be regulated by the user

Figure 3.45: Setting manual regulation for electron bombardment

3.9.4 SETTING RAMPS

Ramp levels can be set for:

1. I_C Operate – ramp for cathode current during operation. This parameter accepts the following units:
   - A/s
   - A/min
   - A/h
2. I_C Operate->Standby – ramp for cathode current while changing operating state to standby. This parameter accepts the following types of units:
   - A/s
   - A/min
   - A/h
3. U_E Operate – ramp for emission voltage while operating. This parameter accepts the following types of units:
   - V/s
   - V/min
   - V/h
4. U_E Operate->Standby – ramp for emission voltage while changing operating state to standby. This parameter accepts the following units:
   - V/s
   - V/min
   - V/h

5. U_C Operate – ramp for cathode Voltage during operation. This parameter accepts the following units:
    - V/s
    - V/min
    - V/h
6. U_C Operate->Standby – ramp for cathode Voltage while changing operating state to standby. This parameter accepts the following units:
    - V/s
    - V/min
    - V/h

In order to determine the slope of the ramp for the selected parameters for Electron Bombardment heating:

1. Go to: ***[1] Setup Menu*** -> ***[3] Ramps*** -> ***[2] EB Mode Ramps***
2. Select desired ramp to change and tap it
3. Tap **Numeric keyboard** button
4. Enter value
5. Tap **Enter** button in order to confirm new ramp value
6. Select desired ramp unit to change and tap it
7. Select one of the available units and tap it
8. New ramp unit will be selected
9. Newly selected ramp unit will appear on the **EB Mode Ramps** menu

3.9.5 SETTING LIMITS

Additional control of Electron Bombardment heating can be accomplished by changing the limits of:

- Cathode current and voltage
- Emission current and voltage

These limits are valid for both manual and PID Controller regulation in Electron Bombardment Heating mode. Limits also affect the scaling values read via analog inputs, for example:

- Cathode voltage limit U_C Limit is set to 10V
- Analog input is set as U_C
- Analog input range is between 0V and 10V
- 0V on analog input will be equivalent to 0V of cathode voltage
- 10V on analog input will be equivalent to 10V of cathode voltage
- voltage scaling can be described by the following formula:

$$U_C = \frac{A_{IN}}{A_{INMax}} U_{CLimit}$$

U_C - cathode voltage A_{IN} – analog input voltage A_{INMax} – maximum voltage level for analog input which is 10V U_{CLimit} – limit for cathode voltage
The following example shows how to set limit for the emission voltage of 500V, this value will then never be exceeded for manual and PID regulation.

1. Go to: ***[1] Setup Menu*** -> ***[2] Limits*** -> ***[2] EB Mode limits***
2. Tap U_E Limit
3. Tap **Numeric Keyboard**
4. **Numeric Keyboard** will pop up
5. Enter 500V and tap **Enter** button in order to confirm new value
6. New value of U_E **Limit** will appear

3.10 PID CONTROLLER

Closed loop PID control, often called feedback control, is the control mode most often associated with temperature controllers. In this mode, the controller attempts to keep the load at exactly the user entered setpoint, which can be either temperature or voltage. To do this, it uses feedback from the control sensor to calculate and actively adjust the control (heater) output. The control algorithm used is termed PID.

3.10.1 THEORY OF OPERATIONS

The PID control equation has three variable terms: proportional (P), integral (I), and derivative (D) The PID equation is:

$$PIDOutput = K \cdot e + I \int (e) dt + D \frac{dPV}{dt}$$

where the error (e) is defined as:
e = Setpoint – Process Value (PV)
PIDOutput varies over the range [0-100%]. This value is converted to: cathode voltage (U_C), emission voltage(U_E) or analog signal, depending on the working mode and the power supply configuration.
In MODE RES the PIDOutput controls cathode voltage (U_C). The Uc value is calculate by the following equation:

$$U_c = PIDOutput \frac{UClimit}{100}$$

In MODE EB the PIDOutput controls emission voltage (U_e). The Ue value is calculate by the following equation:

$$U_c = PIDOutput \frac{UElimit}{100}$$

If the PIDOutput is converted to an analog signal, then the output voltage is calculated by following equation:

$$AnalogOut(x) = PIDOutput[\%]\frac{100\%Voltage - 0\%Voltage}{100\%} + 0\%Voltage$$

The PIDOutput value is available in the additional information bar on the heating panel.
To configure the additional information bar to display the PID Output value:

1. From heating panel, tap additional information bar
2. Select PID Output from the subsequent available display information
3. Switch power supply to Operate mode
4. The actual PID Output value is displayed.

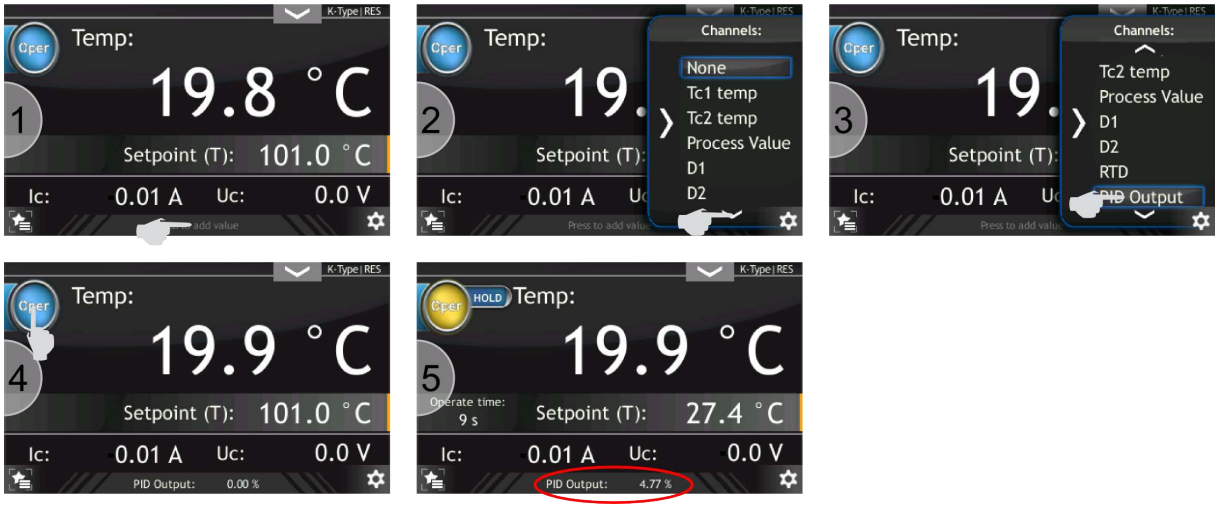


Figure 3.46: PIDOut configuration

3.10.1.1 Proportional band (PB)

The bandwidth over which the output power is proportioned between 0 – 100%. The relationship between proportional band and gain is described as:

$$K = \frac{100}{PB}$$

This means that a large proportional band corresponds to a small gain. A relatively small proportional band therefore corresponds to a large gain (K).
The gain(K), must have a value greater than zero. The value of the gain is multiplied by the error (e) which is defined as the difference between the setpoint and feedback temperatures, to define the proportional contribution to the output: Output (P) = Ke. If the proportional term is acting alone, with no integral, then there must always be an error value or the output will go to zero. Detailed information about the load, sensor, and controller is used to compute a gain setting (K). Most often, the gain setting is simply determined by trial and error. The gain setting is part of the overall control loop gain, as well as the heater range and object environment (e.g. cooling power). The gain setting will need to be changed if either of these conditions change.

3.10.1.2 Integral (I)

In the control loop, the integral term, also called reset, monitors the error over time in order to generate the integral contribution to the output:

$$Output(I) = I \int (e) dt$$

By adding the integral to the proportional contribution, the error that is necessary in a proportional-only system can be eliminated. When the error is at zero, controlling at the setpoint, the output is held constant by the integral contribution. The integral setting (I) is more predictable than the proportional setting. It is related to the dominant time constant of the load. Measuring this time constant allows a reasonable calculation of the integral setting.

3.10.1.3 Derivative (D)

The derivative term, also called rate, acts on the change in error with time:

$$Output(D) = D \frac{dPV}{dt}$$

By reacting to a fast changing error signal, the derivative can work to boost the output when the setpoint changes quickly, reducing the time it takes for temperature to reach the setpoint.

It can also see the error decreasing rapidly when the temperature nears the setpoint and reduce the output for less overshoot.

The derivative term can be useful in fast changing systems, but it is often turned off during steady state control because it reacts too strongly to small disturbances or noise. The derivative setting (D) is related to the dominant time constant of the load.

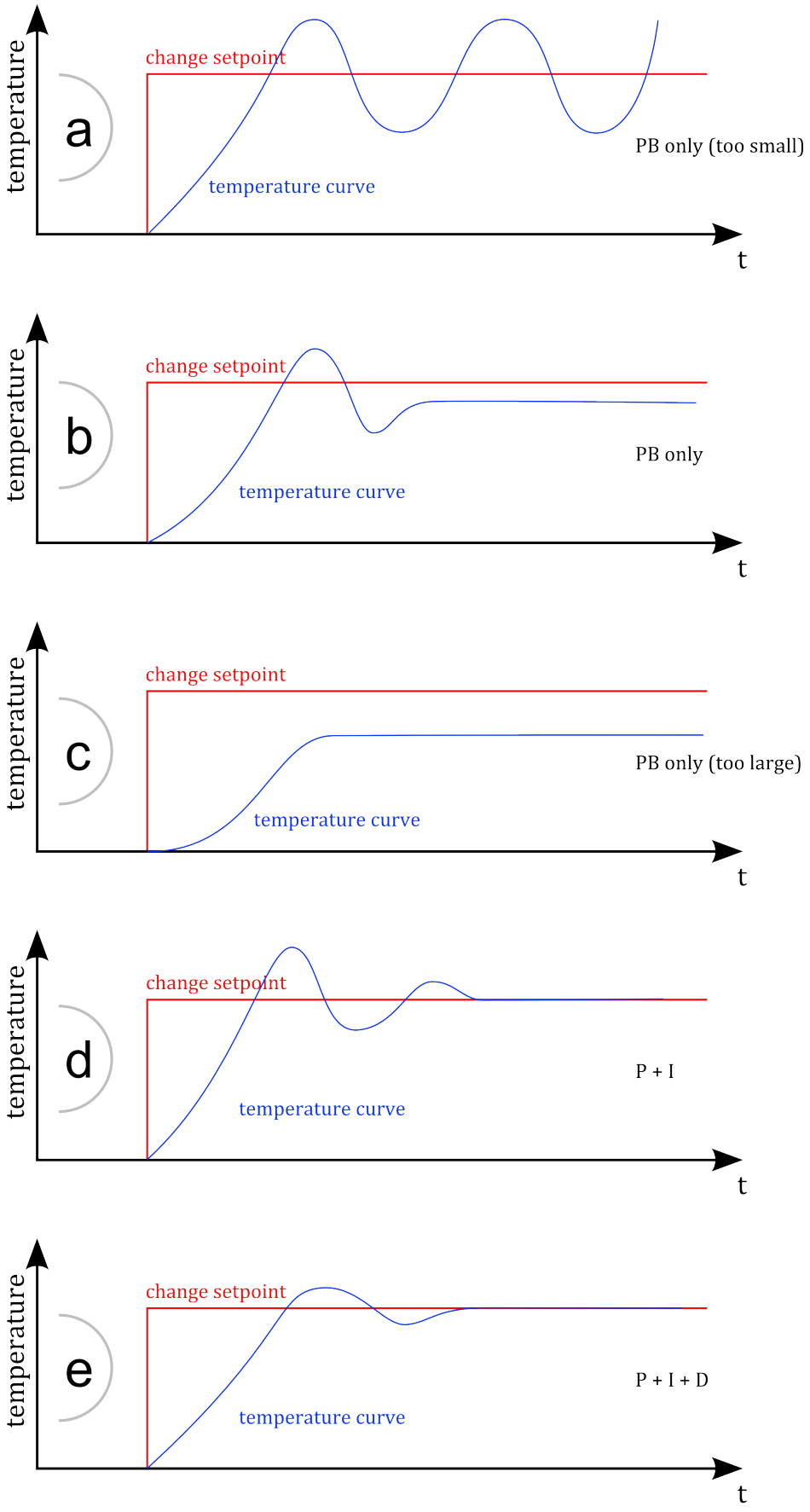


Figure 3.47: Examples of PID control.

3.10.2 TEMPERATURE CONTROL

The HEAT3-PS has a control setting that is not a normal part of a PID control loop. Manual Output can be used for open loop control, meaning feedback is ignored and the heater output stays at the user's manual setting. This is a useful way to apply constant heating power to a load when needed. The Manual Output term can also be added to the PID output. Some users prefer to set a power near that necessary to control.
The Built-in PID controller device has a flexible configuration (see PID block Diagram). The user can define one of the 7 input signals (TC1, TC2, D1, D2, RTD, Analog Input 1, Analog Input 2) and redirection output to one of the 4 outputs (HV module, DC module, Analog Out 1, Analog Out 2).

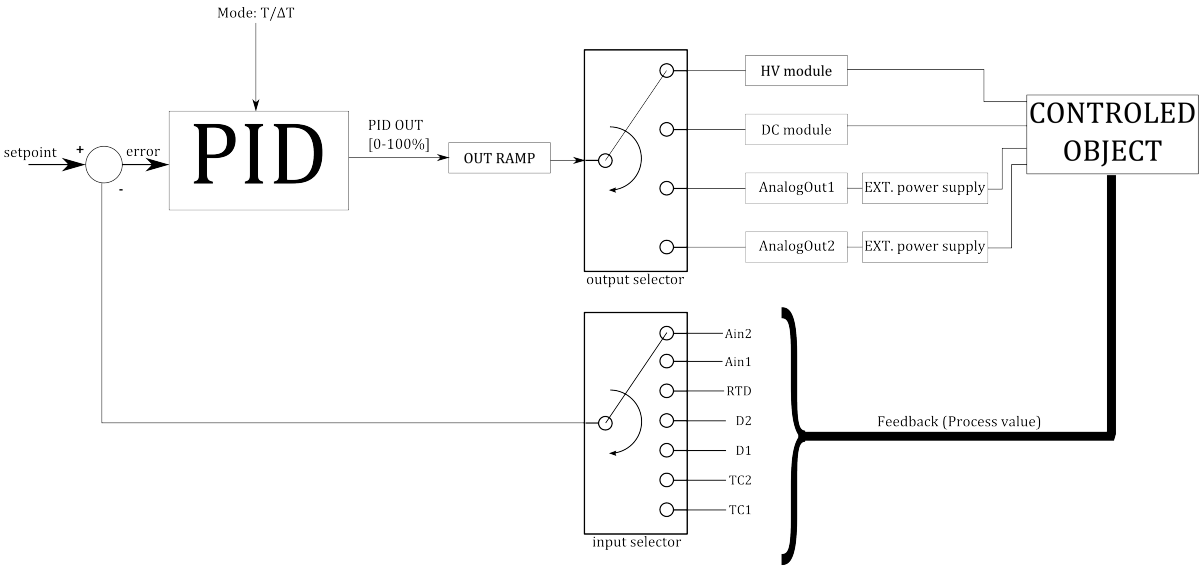


Figure 3.48: PID Block diagram.

The HEAT3 has the ability to work under two modes of process variable control:

- T mode - Classical PID temperature regulator
- ΔT mode - stabilizing derivative of object temperature $SP = \frac{dT}{dt}$

3.10.3 T MODE PARAMETERS

- **P** - Proportional Band adjustable from 0.1 to 1000.0.
- **I** - Integral Time adjustable from 1 to 1000 s, or turned off,
- **D** - Derivative Time adjustable from 1 to 1000 s, or turned off,
- **Ramp** - speed of set point ramp rate, or rise speed. Parameter can be changed within the range of 0.1 to 1000.0
- **Ramp Unit** – The temperature increment in a given time. Temperature increment can be set in second[s], minutes[min] or hour[h].

3.10.4 ΔT MODE PARAMETERS

- **P** - Proportional Band adjustable from 0.1 to 1000.0.
- **I** - Integral Time adjustable from 1 to 1000 s, or turned off,

- **D** - Derivative Time adjustable from 1 to 1000 s, or turned off,
- **Trigger Temp** – defines switching temperature at which switch from ΔT mode to T mode occurs.
- **End Temp** – defines final temperature (setpoint), after crossing the threshold temperature (Trigger Temperature) and switching to T mode.

Output signal
For EB MODE allows specify witch a physical quantity: the voltage current or the emission voltage will be controlled by a PID controller.
$\mathbf{U}_E$ - emission voltage is controlled by a PID regulator, cathode voltage is adjusted manually.
$\mathbf{U}_C$ - cathode voltage is controlled by a PID regulator, the emission voltage is controlled manually.
OUTPUT SIGNAL can be changed when the PID controller is in HOLD state.
For the operating in EB MODE when the cathode voltage is controlled by PID, should be chosen appropriate emission voltage Ue. The best results in dT MODE is obtained for the lowest Ue voltage, which allows achieve the target temperature.
For example, for the stabilization of the ramp temperature at 1K/s from the 300 °C to 1000°C, known that the temperature of 1000°C can be achieved with a voltage U_E = 530 V. Should therefore set the voltage U_E = 550 V. Setting the voltage much higher than required for a particular process, can cause oscillations in dT MODE.

Figure 3.49: Select output signal.

Autotune
The HEAT3-PS can automate the tuning process of typical vacuum system with the Autotune feature. To initiate autotune process tap the ***Autotune*** bar. When the Autotune process is run, the "Autotuning" message appears during changes to the actual temperature.
Autotune functions must run in PID mode and OPERATE state, after reaching a sample temperature that does not vary by more than ± 10% of the set point. Autotune is available only in PID T mode. After completion of the autotune process , the PID parameters are modified accordingly, and the power supply returns to normal operation in operate state. To abort the process before the end of the autotune process, the user should select ***Autotune off*** option from the ***PID Settings*** submenu.
Process Value – Input signal for the PID controller. It is an actual value in the control loop. The selected value is displayed on the heating panel.
Available input signals:

- Thermocouples (TC1, TC2),
- Diode (D1, D2),
- Resistance thermometer detectors (RTD),
  For detailed information refer to: Temperature module

- External analog signals (AIN1, AIN2),
  For detailed information refer to: Analog input configuration

3.10.5 COOLING VALVE

The Cooling valve option can control the cooling medium inflow if the vacuum system is properly configured for this. This option allows control of an external cooling valve, depending on the set-point temperature. For correct operation, this function requires correct configuration of the relay output for the attached valve.
MODE – working mode of cooling valve

- Still OFF – the assigned relay output is always OFF independent of setpoint temperature
- Still ON – the assigned relay output is always ON independent of setpoint temperature
- Auto – control of the assigned relay output depends on the setpoint temperature and preset threshold temperature.
- Trigger temp. – threshold temperature for on/off cooling valve.
- Linked Outputs - if any output relay is assigned to drive the cooling valve then the number value will be displayed. If no relays output is assigned to drive a cooling valve the message “none” is displayed.

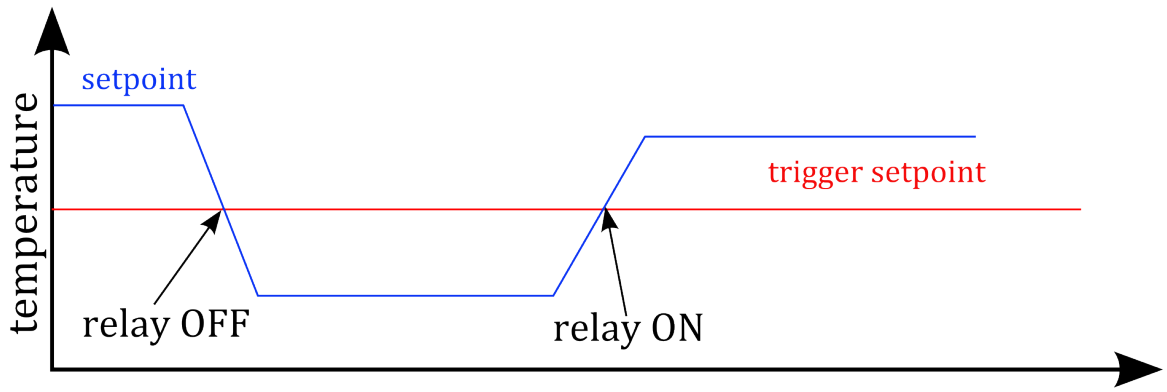


Figure 3.50: Relay driving relating set point value.

Output Ramp Limit Parameters supplied to the object to prevent too much power in a short time, and so prevent damage to the controlled object.

This option is available when the PID Output is assigned to Analog Out1 or Analog Out2.

For detailed information refer to: *Analog output configuration.*

Ramp - defines the rate of change of the output voltage. Is expressed in PIDOut[%]/[time unit].

Ramp Unit – defines time unit for Output Ramp Limit – seconds[s], minutes[min], hours[h].

Example: The output cannot change more than 10 % per minute.
Adjust: RAMP = 10
Set: RAMP UNIT = %/min

Example: The process temperature cannot change more than 5% per second.
Adjust: RAMP = 5
Set: RAMP UNIT = %/s

3.10.6 RAMP CONTROL

The HEAT3 generates a smooth setpoint ramp. The purpose of the Ramp rate function is to control the rate at which the process temperature can change. This feature would be used when rapid temperature changes could otherwise damage the product being controlled. The user can set a ramp rate in degrees per second[s]/minutes[min]/hours[h] with a range of 0 to 1000 and a resolution of 0.1. Once the ramp feature is turned on, its action is initiated by a setpoint change and switching from standby to operate. When a new setpoint is entered, the power supply changes the setpoint temperature from the old value to the new value at the ramp rate. When the Operate button is tapped, the actual process value is assigned to setpoint and changes to destination setpoint. A positive ramp rate is always entered and it is used by the instrument for ramping up and down.

Example: The process temperature cannot change more than 5 degrees per minute.
Adjust: RAMP = 5
Set: RAMP UNIT = K/min

Example: The process temperature cannot change more than 60 degrees per hour.
Adjust: RAMP = 60
Set: RAMP UNIT = K/h

NOTE: The ramp rate is not functional if RAMP is set to zero.

If RAMP function is enabled the actual setpoint value is displayed on the heating panel. After switching to OPERATE mode, the actual measurement temperature is assigned to the actual setpoint value. The setpoint actual value then changes according to the RAMP settings until the setpoint is reached.

Depending on the case, the actual setpoint value is increased or decreased.

If the capture temperature is greater than setpoint then the actual setpoint is decreased.

If the capture temperature is less than setpoint then the actual setpoint is increased.

The RAMP function can be paused at any time by tapping the *Hold* button. The actual setpoint change is stopped and the controller will stabilize at the last setpoint. When the *Hold* button is tapped again, the setpoint changes and RAMP function are resumed.

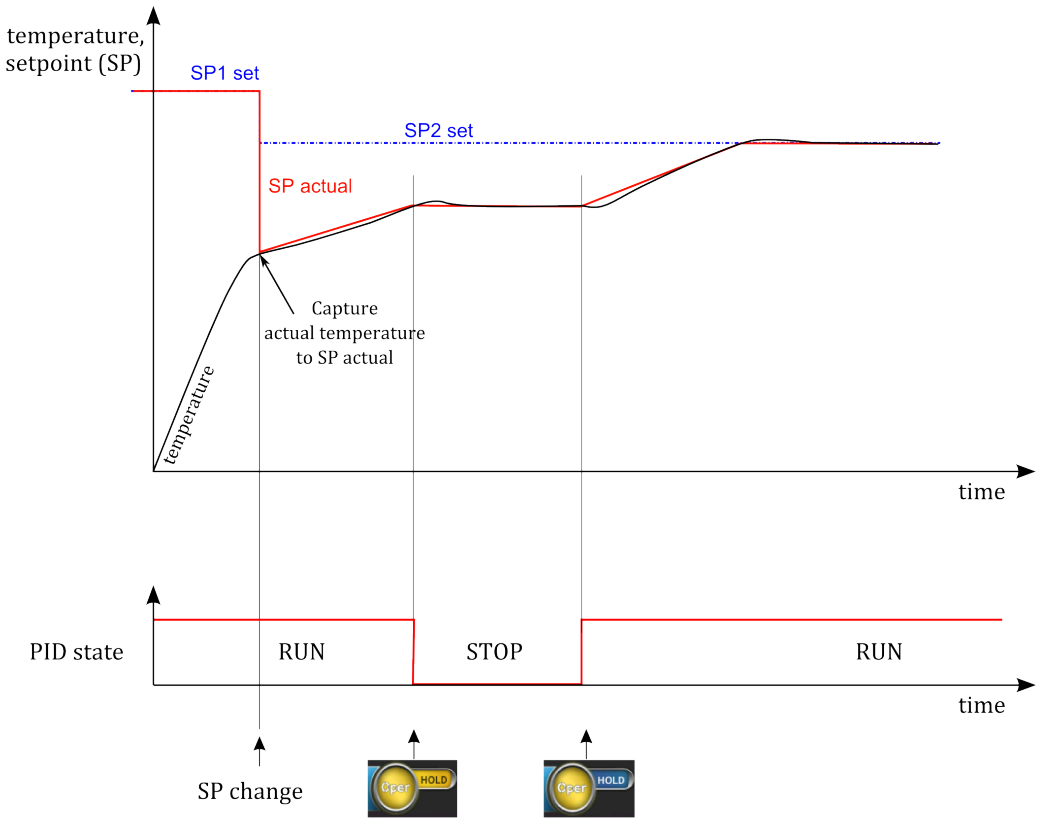


Figure 3.51: Timing in T mode with RAMP.

3.10.7 dT MODE PID CONTROL

dT mode allows for very precise control of temperature ramp . The user can set a ramp rate in degrees per second over the range -5 to 5 and with a resolution of 0.1.

To enable dT mode PID control, tap the ***Setpoint (T)*** on the main screen and select Working mode ***Setpoint(ΔT)*** from the list. Enabling dT mode switches the PID controller to the HOLD state with stabilization of temperature at the last set point. Ramp stabilization begins when the HOLD button is tapped and then the regulator proceeds to the RUN state. Tapping the HOLD button whilst operating in ΔT mode results in the PID controller switching to the HOLD state with stabilization of temperature at the last measurement temperature. Tapping HOLD again resumes working in ΔT mode.

Operation in ΔT mode continues until the *Trigger Temperature* is reached, at which point the regulator switches to T mode and stabilizes at the *End Temperature*.

There is complete flexibility in determining the value of Trigger Temperature and End Temperature. Trigger Temperature may by greater than End Temperature and vice versa.

The PID parameters for ΔT mode are fundamentally different from the parameters for the T mode. Therefore, the parameters for the ΔT mode and T mode are separated.

For ΔT mode, a typical parameter value set is:

- Proportional band (P) – Range 1 to 20,
- Integral time (I) – Range 1 to 10,
- Derivative time (D) – Range 1 to 20.

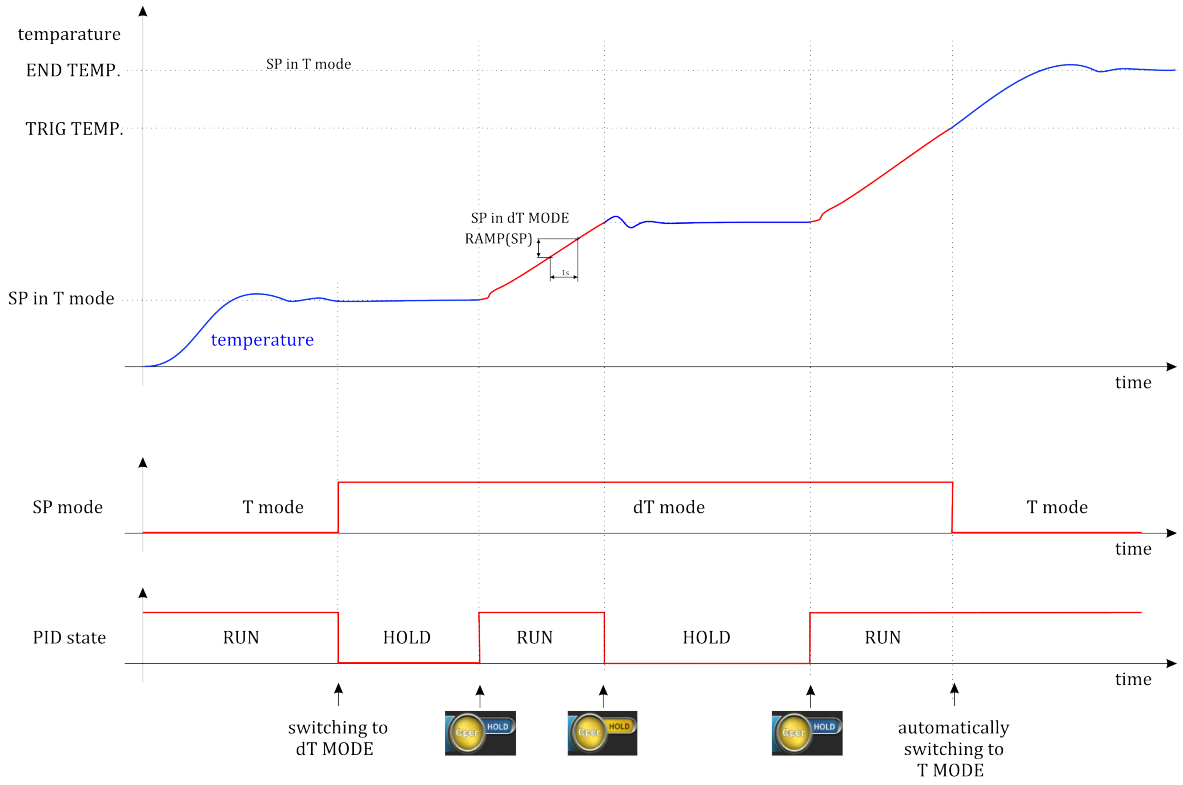


Figure 3.52: T mode/ dT mode switching characteristic.

3.10.8 TUNING

The HEAT3 offers various ways to set the necessary P, I and D parameters for closed loop control.

This section describes a few basics to help users get started. This technique will not be applicable in every case, but it has worked for many others in the field. It is also a good idea to begin at the middle of the temperature range of the heating system.

During tuning, we are essentially trying to match the characteristics of the controller to those of the process being controlled in order to obtain good control.

3.10.8.1 Manual PID Tuning:

Manual tuning is the most basic tuning method. The user manually enters values for P, I and D as well as the temperature range using their knowledge of the heating cooling system and some trial and error. Manual tuning can be used in any situation within the control capabilities of the instrument. Specify the controller parameters manually using the method describe below:

1. Set power supply to operate mode,
2. Switch the power supply to PID mode(closed loop PID control mode),
3. Turn integral and derivative off,
4. Enter a setpoint below the heating system's highest temperature,
5. Enter a proportional band of approximately 100,
6. The PIDOut value in additional information bar (onto heating panel) should display a value greater than zero and less than 100% when temperature stabilizes.

The load temperature should stabilize at a temperature below the setpoint. If the load temperature swings rapidly, the proportional value may be set too low and should be increased. Very slow changes in load temperature that could be described as drifting are an indication of a proportional setting that is too high.

7. Gradually decrease the proportional setting to halve it each time. At each new setting, allow time for the temperature of the load to stabilize,
8. As the proportional setting is decreased, there should be a setting in which the load temperature begins a sustained and predictable oscillation rising and falling in a consistent period of time (see fig. Examples of PID control (a))
9. The goal is to find the proportional value in which the oscillation begins. Do not turn the setting so high that temperature changes become rapid and unpredictable.
10. Record the proportional setting and the amount of time it takes for the load change from one temperature peak to the next. This time is called the oscillation period of the load. It helps describe the dominant time constant of the load, which is used in setting the integral.
11. Set the values of P, I and D according to Table 1 below.

Controller	P	I	D
P	$2 \cdot PB_{osc}$	OFF	OFF
P+I	$2.2 \cdot PB_{osc}$	0.8T	OFF
P+I+D	$1.7 \cdot PB_{osc}$	0.5T	0.12T

Table 3.1: PID parameters calculate

3.10.8.2 Automatic PID Tuning

The HEAT3 automates the tuning process with an AutoTune algorithm. This algorithm measures the system characteristics and calculates P, I and D. AutoTune will not work in every situation. In order to correct the parameters chosen in the autotune process use the guidance provided in the table below.

Controller	P	I	D
Slow Response	reduce	reduce	reduce
Large oscillations	increase	increase	increase

Table 3.2: Adjust PID parameters

3.11 VACUUM MEASUREMENT

The HEAT3 accommodates one pressure gauge head connection. The socket for connecting an appropriate gauge head is located on the rear panel on the Analog I/O Card. In order to ensure proper operation of the connected gauge, the device must first be configured appropriately. The vacuum measurement panel displays the values of the vacuum device attached to the vacuum head.

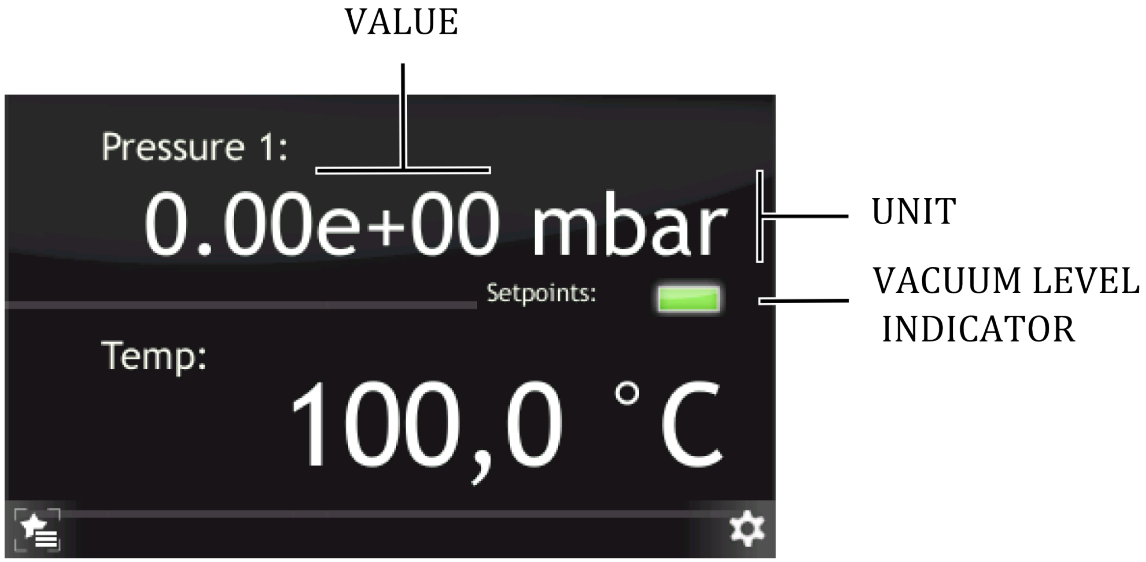


Figure 3.53: Vacuum measurement panel.

The Vacuum measurement panel contains of information about:

- **Unit** – changes pressure units
- **Value** – displays current value of pressure
- **Vacuum Level Indicator** - pressure setpoint

To check the current setpoint value for measurement channel, tap the *Vacuum Level Indicator* icon. The subsequent display contains information about the preset vacuum level. The displayed value is compared with the vacuum levels (Setpoint Low and High) and then the value is indicated by the vacuum gauge.
Set Levels are determining by the width of the hysteresis loop:

- The vacuum is below a preset level (LED off)
- The vacuum is above a preset level (LED on)

During operation, and if supported by the particular model, the device may relay additional information about the vacuum state. The displayed messages and their descriptions are detailed in the table 3.3.

3.11.1 SELECTING GAUGE TYPE

Gauge type specifies the type of transmitter. Supported gauge types with pressure parameters are included in the ***Introduction*** chapter in the ***Measuring Channel*** section. CTR90/91 and MKS870B models require the additional parameter FS (Full Scale) according to the model of head which is attached. This parameter defines the measuring range associated with the specific gauge type. For CTR90/91 heads, the FS value is expressed in units of Torr. For MKS970B heads, the FS value is expressed in units of Torr and PSI.
In order to select the desired gauge type:

1. Go to: ***[1] Setup Menu*** -> ***[8] Pressure Chanel*** -> ***[3] Gauge***
2. Tap desired gauge type.
3. Selected gauge type will appear in the ***Pressure Channel***.

INFORMATION	DESCRIPTION
Sensor Break!	Sensor is not connected or is damaged
Not calibrated	The head is not calibrated. This message appears when the head is connected to a PG105 gauge without prior calibration
High pressure	The vacuum level is outside the upper measuring range
Low pressure	The vacuum level is outside the lower measuring range
Degasing [time left]	The process of Degas is pending, information available from Degas heads
Wait for emission	The emission is enable and device wait for feedback from the vacuum gauge.

Table 3.3: Vacuum gauge messages

3.11.2 SELECTING UNITS

Changing the displayed measurement units:
- from the vacuum panel, by tapping ***Unit*** field (see ***Device interaction***)
- through ***Setup Menu***.

Example of how to change the displayed unit:

1. Go to: ***[1] Setup Menu*** -> ***[8] Pressure Chanel*** -> ***[2] Unit***
2. Select desired unit.
3. Desired unit will be assigned
4. Desired unit will appear in the ***Pressure channel*** menu.

3.11.3 SELECTING GAS TYPE

Sensors are normally calibrated for measurement in nitrogen or in air. If pressure measurements are being performed with other gases, it will be necessary to correct the reading accordingly. The Gas Type parameter is used to adjust the correction factor for the respective gas type. The actual pressure is obtained by multiplying the measured pressure with the correction factor:

$$P = \frac{I_c}{S_g \cdot I_e},$$

where:
P – pressure,
I_c – ion current,
S_g – sensitivity factor for gas g, $S_g = S_{N_2} \cdot R_g$
I_e – emission current,
S_{N_2} – gauge sensitivity for N_2,
R_g – gas correction factor.

The gas type correction becomes a function of the pressure if the pressure exceeds 0.5 mbar. This fact is taken into consideration for all gas types that can be selected:

GAS	R_g
He	0.18
Ne	0.30
D_2	0.35
H_2	0.46
N_2	1.00
Air	1.00
O_2	1.01
CO	1.05
H_2O	1.12
NO	1.15
NH_3	1.23
Ar	1.29
CO_2	1.42
CH_4 (methane)	1.4
Kr	1.94
SF_6	2.2
C_2H_6 (ethane)	2.6
Xe	2.87
Hg	3.64
C_3H_8 (Propane)	4.2
DEFINE	0.1 - 10

Table 3.4: Gas correction table

In order to select the correct gas type, use the Gas type in the setup menu. An example of the correct procedure is shown below:

1. Go to: ***[1] Setup Menu*** -> ***[8] Pressure Chanel*** -> ***[4] Gas Type***
2. Tap desired gas.
3. Desired gas will be assigned.
4. Desired gas will appear in the ***Pressure Channel*** / ***Pressure Channel menu***.

3.11.4 DEGAS SETTINGS

For the ionization gauge heads the degas procedure is available. The HEAT3 main panel displays information about the degas state. From the setup menu it is possible to:

- configure the length of degas,

- turn degas on and off.

The following example shows how to change the duration of the degas procedure and how to enable degassing:

1. Go to: ***[1] Setup Menu*** -> ***[8] Pressure Chanel*** -> ***[6] Degas***
2. Tap ***Time***.
3. Enter desired value on the numeric keyboard or using the knob .
4. Confirm by tapping ***Enter*** button.
5. Tap ***Degas*** in order to start the degas process.
6. Tap on ***Setup Exit*** button.
7. The vacuum level and state of vacuum degassing are now displayed alternately (for the time remaining until the end of the process.

3.11.5 SETTING SETPOINTS

In order to configure setpoints for the vacuum channel, the following parameters must be set:

1. Setpoint High – when reached, the Setpoint High value is indicated by the Setpoint LED associated with that measuring channel. Additionally, if one of the outputs has been linked to the setpoint high value, then the associated output relay is switched to open when the value is reached
2. Setpoint Low – when reached, the Setpoint Low value is indicated by the Setpoint LED switching off. Additionally, if one of the outputs has been linked to the setpoint low value, then the associated output relay is switched to closed when the value is reached

Configuration of the high and low setpoint must be made from the setup menu:

1. Go to: ***[1] Setup Menu*** -> ***[8] Pressure Chanel*** -> ***[1] Setpoints***
2. Tap on desired setpoint in order to change it
3. Tap **Numeric keyboard** button
4. **Enter** desired setpoint value
5. Confirm by tapping **Enter** button
6. Tap on **Setup Exit** button
7. Tap on the Setpoint LED icon in order to see currently set setpoint levels

3.11.6 PG105 HEAD CALIBRATION

The PG105 head requires an initial calibration procedure, which is necessary for the correct vacuum display. This is a two-point calibration: at atmospheric pressure and under vacuum:

1. Go to: ***[1] Setup Menu*** -> ***[8] Pressure Chanel*** -> ***[3] Gauge***
2. Tap arrow to scroll window down.

3. Tap on ***PG105*** gauge head.
4. You will be asked about calibration, tap ***Yes*** in order to enter into calibration menu.
5. Tap ***Atmosphere*** to start PG105 head calibration procedure.
6. Tap ***Ok***, then set the air pressure and wait ten minutes.
7. Tap ***Low pressure*** calibration.
8. Follow calibration information and wait 10 minutes.
9. Tap ***Done*** after calibration procedure.

3.11.7 GAUGE DAMAGE - MESSAGE "SENSOR BREAK"

When the message 'Sensor Break' appears either the vacuum gauge head is not connected to the Heat3 power supply or is damaged. This applies to all models supported by the Heat3 device with the exception of CTR90 and Baratron gauge heads. Neither of these gauge heads supports the re-transmission of an appropriate break signal to the Heat3 power supply which cannot therefore detect a disconnection of, or damage to, these gauge heads.

3.11.8 PRESSURE CHANNEL (OPTIONAL)

To change pressure channel settings go to: ***Setup Menu -> Pressure Channel***
The HEAT3 accommodates a pressure gauge head connection if the *analog card* option is installed. The sockets for connecting the gauge heads are located on the rear panel of the device. The device must be properly configured to ensure the correct operation of the connected gauge types. To do this, go to the configuration menu and then select *Pressure Channel*. Configuration options are described below:
Setup Menu -> Pressure Channel -> Setpoints:
Setpoint Low – when one of the outputs has been linked to the pressure channel, then the associated output relay is switched to close when the *Setpoint Low* is reached.
Setpoint High – when one of the outputs has been linked to the pressure channel, then the associated output relay is switched to open when the *Setpoint High* is reached.
Relay output configuration - look in subsection 3.13.1.

The *Setpoint* value is limited by the device to the range 1.00E-15 – 1.00E-2 mbar. The software does not allow setpoint values outside of this range. It is also not possible to set the *Setpoint Low* with a value greater than the *Setpoint High* and vice versa.
Settings of the *Pressure Setpoint* are related to *Vacuum Interlock* signal - look in subsection 3.11.9.

Setup Menu -> Pressure Channel -> Unit:
Unit - selection of the pressure display unit.

- **mbar** – the pressure is displayed in millibars.
- **Torr** – the pressure is displayed in Torr.
- **Pa** – the pressure is displayed in Pascals.
- **psia** – the pressure is displayed pound per square inch (psi).

Changing the displayed measurement units is also possible from the main panel, by tapping Unit field.
Setup Menu -> Pressure Channel -> Gauge:

Gauge - type of head selection. Please choose the specific type of head connected to the device. The following types of heads are currently supported: **CTR90/91, TTR90/91, TTR211, PTR225, PKR251, PCR280, PTR90, ITR90, ITR100, Baratron, MKS 937A, PG105, MG13/14** and **ANALOG IN**.
CTR90/91 and *Baratron* models require the additional parameter FS (Full Scale) according to the type of the head attached. This parameter defines the measuring range associated with the specific gauge type. For *CTR90/91* heads, the FS value is expressed in units of *Torr*. For *MKS970B* heads, the FS value is expressed in units of *Torr* and *psi*.
The *PG105* head requires an initial calibration procedure, which is necessary for the correct vacuum display. This is a two-point calibration: at atmospheric pressure and under vacuum. Continuation of the *PG105* head requires an additional amplifier (PGA13), shown in Fig. 3.54. The *PG105* is not part of a set HEAT3 and has to be ordered separately.

Figure 3.54: Pirani PG105 amplifier

Setup Menu -> Pressure Channel -> Gas Type:
Gas Type – defines the process gas correction factor. Sensors are normally calibrated for measurement in nitrogen or in air. If pressure measurements are being performed with other gases, it will be necessary to correct the reading accordingly. The Gas Type parameter is used to adjust the correction factor for the respective gas type. The actual pressure is obtained by multiplying the measured pressure with the correction factor:

$$P = P_{AIR} \cdot R_g$$

Where:
P - pressure
P_{AIR} – pressure in air
R_g – gas correction factor

If the gas is not available on the included list it can be defined by the user by selecting *Define* and then manually entering the gas correction value.
Setup Menu -> Pressure Channel -> Filter:
Filter – filtering pressure value. Filtering is done by averaging the measured voltage. Depending on the selected parameter(**Low, Medium, High**) changes as the number of samples taken to averaging.
Setup Menu -> Pressure Channel -> Degas:
A degas procedure is available for ionization gauge heads *(ITR90, ITR100 ...)* . The HEAT3 main panel displays information about the degas state. From the setup menu it is possible to configure the duration of degas and turn degas on/off:
Time - duration of degas (1 - 30 min)
Degas - turn degas *on* and *off*

3.11.9 VACUUM INTERLOCK (OPTIONAL)

To turn vacuum interlock on/off go to: ***Setup Menu -> Vacuum Interlock***
Vacuum Interlock signal depends on the setting of *Pressure Setpoint* - look in subsection 3.11.8. This protection signal is provided to prevent accidental operation of the device when not under

vacuum. When the *Vacuum Interlock* is activated, you can turn on the device in **OPERATE** state only if there is *Pressure Setpoint* reached. If the protection signal is missing (deterioration of the vacuum conditions), the HEAT3 rapidly returns to **STANDBY** mode and displays *'Vacuum Interlock Failure'* message accompanied by a flashing control failure LED. Loss of *Vacuum Interlock* signal can also be caused by removing the plug or damage the cable.

3.12 CONFIGURING ANALOG I/O

3.12.1 ANALOG OUTPUT CONFIGURATION

The rear panel connectors Analog Out 1 and Analog Out 2 each have a 0-10V analog signal available at their respective outputs. They can be used for example to control external devices or for data acquisition tasks. The behavior of the analog outputs, and the type of signal that will be converted to an analog value and available at the output, are easily configured.
To configure the analog outputs use the setup menu and follow **Output Settings/Analog Outputs** path and select the appropriate output to be configured. Available configuration options:
SOURCE – source to be converted to an analog value:

- **Process Value** – PID controller input signal
- **PID Out** – PID controller output signal.
- **Ic actual** – actual value of cathode current
- **Uc actual** - actual value of cathode voltage
- **Ie actual** – actual value of emission current
- **Ue actual** – actual value of emission voltage
- **Tc1 Temp** – thermocouple temperature on channel 1
- **Tc2 Temp** – thermocouple temperature on channel 2
- **D1 Temp** – diode temperature on channel 1
- **D2 Temp** – diode temperature on channel 2
- **RTD Temp** – resistance temperature detector
- **PRESSURE** - the measured pressure value from the head attached to Gauge input.
- **None** – set 0V to output

MODE – arithmetic conversion types of the measured signal:

- 1 to 1 - the signal is retransmitted directly from the input to the output,
- EXPO - The output voltage is calculated using the exponent without taking mantissa into account. From 1E-14, the output increases by 0.5 V per decade. It is defined by the relation (available for pressure source only).

$$U_{out} = \frac{Exponent+14}{2}[V]$$

- User Range - defines the measuring range over which the arithmetic conversion will apply.

RANGES – defining the conversion range:

- **Min Value** - the pressure value that will be corresponded to 0 V in the output,
- **Max Value** - the pressure value that will be corresponded to 10 V in the output.

SCALE – measured signal conversion type choice:

- **Linear** -linear output. It is sometimes useful to retransmit the pressure over a narrow range, covering several decades. In this case, the output voltage is directly proportional to the pressure. 10 V corresponds to the upper limit, 0 V corresponds to the lower limit of User Range:

$$U_{out} = 10 \cdot \frac{ReadingValue - MinValue}{MaxValue - MinValue}[V]$$

- **Logarithmic** - logarithmic output. It is often useful to retransmit the pressure over a wide range, covering over a dozen decades. In this case it is most convenient to operate with a logarithm scale. The logarithmic range is defined according to the relation:

$$U_{out} = Log\left(\frac{ReadingValue}{MinValue}\right) \cdot \frac{10}{Log\left(\frac{MaxValue}{MinValue}\right)}[V]$$

% Voltage – Voltage outputs depends on PID Out value. Only available for PID Out source:

- **0% Voltage** – voltage output corresponds to 0
- **100% Voltage** – voltage output corresponds to 100

3.12.1.1 SELECTING ANALOG OUTPUT

This section describes how to assign a parameter from some device to the analog output channel. The specific example below shows how to assign a Thermocouple on channel 1 to Analog Output 1:

1. Go to: ***[1] Setup Menu*** -> ***[2] Outputs Settings*** -> ***[2] Analog Outputs***
2. Select channel 1 by tapping **Out 1**
3. Tap on **Source**
4. Tap **Arrow**
5. Select **Tc1 Temp**
6. Define ranges by tapping **Ranges**
7. Enter ranges for Thermocouple on channel 1

The next example describe how to assign pressure to analog output on channel 2:

1. Go to: ***[1] Setup Menu*** -> ***[2] Outputs Settings*** -> ***[2] Analog Outputs***
2. Select channel 2 by tapping Out 2
3. Tap on Source
4. Tap Arrow
5. Select Pressure

6. Define ranges by tapping Ranges
7. Define mode to 1 to 1
8. Tap on Scale to edit value scaling mode
9. Tap Logarithmic

The final example describes how to transfer the PIDOut value to the analog output on channel 1:

1. Go to: ***[1] Setup Menu*** -> ***[2] Outputs Settings*** -> ***[2] Analog Outputs***
2. Select channel 1 by tapping Out 1
3. Tap on Source
4. Select PID Out.
5. Define 0% Voltage
6. Define 100% Voltage

3.12.2 ANALOG INPUT CONFIGURATION

The rear panel connectors Analog Input 1 and Analog Input 2 each have a 0-10V analog signal available at their respective inputs. Analog input signals can be used to control internal parameters of the device.
To configure analog inputs use the setup menu and follow **Input Settings/Analog Inputs**. Available configuration options:
EXTERNAL CONTROL

- **Ain1 Purpose/ Ain2 Purpose** – controlled internal parameter:
  - **None** – disable input,
  - **Ic limit** – control Ic limit parameter by analog input. Ic limit will be scaled between 0A and ***Ic Limit*** value (defined in path ***Setup/Limit*** in setup menu) depending on analog input value(0-10V),

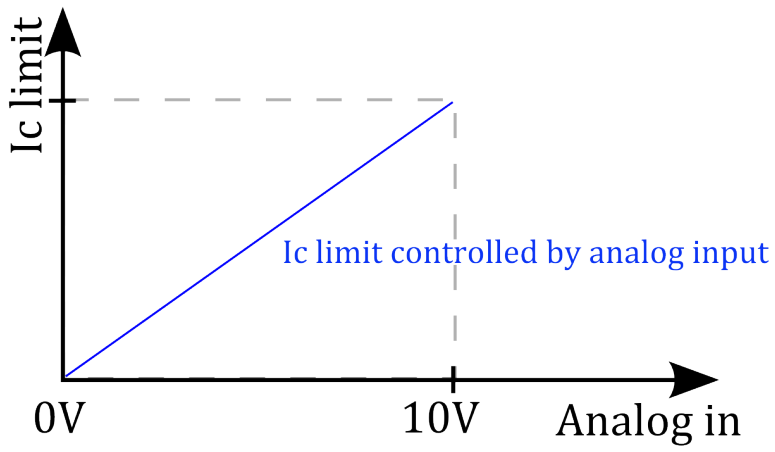


Figure 3.55: Ic limit controlled by analog input

  - **Uc** – control Uc value by analog input. Uc will be scaled between 0V and Uc value depending on analog input value(0-10V).

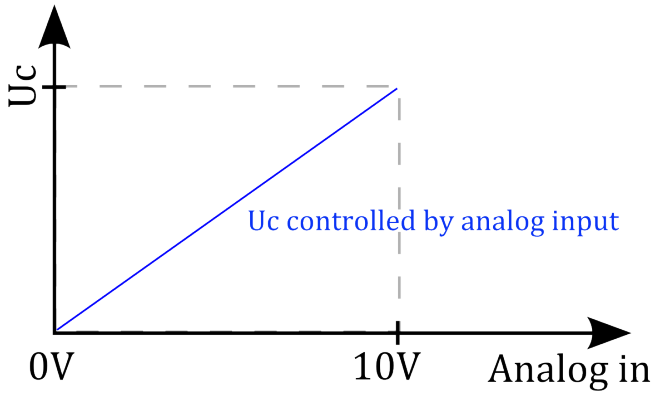


Figure 3.56: Uc controlled by analog input

– **Ie limit** – control Ie limit parameter by analog input. Ie limit will be scaled between 0A and Ie Limit value (defined in path Setup/Limit in setup menu) depending on analog input value(0-10V).

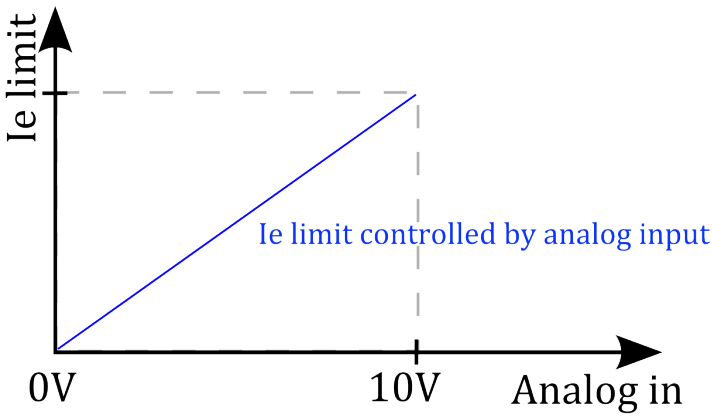


Figure 3.57: Ie limit controlled by analog input

– **Ue** – control Ue value by analog input. Ue will be scaled between 0V and Ue value depending on analog input value(0-10V).

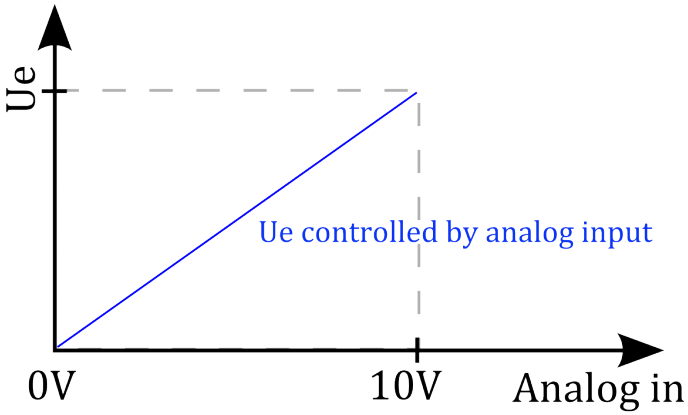


Figure 3.58: Ue controlled by analog input

FUNCTION VOLTAGE->TEMP – conversion voltage to temperature make effects only if input is combined with Process Value parameter selected in ***PID Settings*** setup option.

3.12.2.1 SELECTING ANALOG INPUT

This section describe how to assign some device parameters to the analog input channel. The example below describes how to assign the cathode current limit to Analog Input 1:

1. Go to: ***[1] Setup Menu*** -> ***[6] Inputs Settings*** -> ***[2] Analog Inputs***
2. Tap **External Control**
3. Select channel 1 by tapping **Ain1 Purpose**
4. Select ***Ic limit***
5. Ic limit is now connected with Ain1 Purpose

The following example describes how to combine the analog input with Process Value of PID Controller:

1. Go to: ***[1] Setup Menu*** -> ***[4] PID Settings*** -> ***[4] Process Value***
2. Tap **Arrow**
3. Select **Ain1**
4. To change temperature ranges for boundary voltage values (0V, 10V), go to previous menu
5. Tap **Arrow**
6. Tap **Inputs Settings**
7. Enter **Analog Inputs**
8. Tap on **Function Voltage->Temp**
9. Change temperature ranges for boundary voltage values for channel **Ain1**

The final example describes how to use analog input to perform voltage stabilization:

1. Follow steps 1-6 from previous example
2. Change ***Ain1 0V Temp*** and ***Ain1 10V*** Temp to 0°C
3. The analog input is now used to perform voltage stabilization

Figure 3.59: Analog input voltage stabilization

3.13 CONFIGURING DIGITAL I / O

The Digital Input / Output card has four digital inputs and six digital outputs.

3.13.1 RELAY OUTPUT CONFIGURATION

The HEAT3 has six relay outputs whose activity can be linked to the desired parameters. These outputs are physically isolated from the device (floating). The outputs are available on the **Digital I/O Card** which is located on the rear panel.

Relays can be configured in the Relay Outputs menu via the Setup Menu by selecting output from OUT1 to OUT6, and then assigning the desired output signal.

The following signal sources are available:

- **Setpoint** - the output is controlled by the temperature setpoint level
- **Pressure Setpoint** - the output is controlled by the temperature pressure setpoint level
- **Operate** - the output is controlled by the operate state
- **Cooling Valve** - the output is controlled by the cooling valve state
- **High Voltage** - the output is controlled by the high voltage state
- **Still OFF** - relay contacts are open
- **Still ON** - relay contacts are closed

Below is an example of the output assignment:

1. Go to: ***[1] Setup Menu*** -> ***[2] Outputs Settings*** -> ***[1] Relay Outputs***
2. Tap one of the available outputs from the list
3. Tap one of the parameters to assign it with selected output
4. Parameter will be assigned to output
5. Parameter will appear in the **Relay Outputs** menu on chosen channel

3.13.2 LOGIC INPUT CONFIGURATION

The device has four digital inputs (0-24V). The inputs are available on the Digital Input/Output Card located on the rear panel. Digital inputs are normally active in the LOW state.

Digital input maximum voltage
Logic inputs accept signals from a range of 0 to 24V. Exceeding these values may damage the input. Observe that these limits are not exceeded.

Input assignment The Assignment menu contains the following options:

- **Interlock** set interlock
- **Operate ON** turn Operate on
- **Operate OFF** turn Operate off
- **Pressure Emission ON** turn emission on
- **Pressure Emission OFF** turn emission off

In order to assign a Digital Input:

1. Go to: ***[1] Setup Menu*** -> ***[6] Inputs Settings*** -> ***[3] Digital inputs*** -> ***[1] Assignment of Inputs***
2. Tap desired position from the list
3. Tap one of the inputs
4. Selected **Input** will be assigned to chosen action
5. New input configuration will appear in **Assignment of Inputs** menu

Input configuration After assigning an appropriate action to the specified input, the activation type can be set. There are four activation types available:

- **Low Level** - the input is active by low state (0V or unplugged) (default)
- **High Level** - the input is active by high state (24V)
- **Falling Edge**- input is activated by the falling edge of the signal (change from 24V to 0V)
- **Rising Edge** - input is activated by the rising edge of the signal (change from 0V to 24V)

In order to set the inputs:

1. Go to: ***[1] Setup Menu*** -> ***[6] Inputs Settings*** -> ***[3] Digital inputs*** -> ***[2] Sence Control***
2. Tap desired input
3. Tap activation type
4. Activation type will be set
5. New input activation type will appear in **Sense Control Menu** menu

3.13.3 INTERLOCK AND REMOTE CONTROL INPUT DEFAULT ASSIGNMENT

Interlock by default is assigned to input1 with active high level. Remote Control by default is assigned to input2 with active high level. To see the connection diagram please refer to the installation chapter section on digital inputs.

3.13.4 COOLING VALVE

Assignment of a cooling valve to the digital output can be performed from the Setup Menu. Detailed information about the cooling valve can be found in Temperature control of PID Regulator subsection. In order to assign a digital output to a cooling valve:

1. Go to: ***[1] Setup Menu*** -> ***[7] Outputs Settings*** -> ***[1] Relay Outputs***
2. Choose desired relay output channel and tap it
3. Navigate menu to Cooling Valve
4. Tap Cooling Valve
5. Cooling Valve will be assigned
6. Cooling Valve will appear in the Relay Outputs menu on chosen channel

3.13.5 COMMUNICATION SETTINGS

To change communication settings go to: ***Setup Menu -> Communication***
The communication setup allow to configure remote control interface. Allow options:

- **Interface** - determines which interface will be used for communication,
- **Parameters** - advanced parameters for selected module,
- **Host Address** - the device ID that have permission to control (save and set parameters),
- **Address** - the current address,

There are three types of communication interfaces available in the HEAT3 :

- **Ethernet**
- **RS232**
- **RS485**

For details about pin assignment of RS232/485 see subsection 6
To change communication interface go to: ***Setup Menu -> Communication -> Interface***
Each communication interface is configured in ***Parameters*** submenu (***Setup Menu -> Communication -> Parameters***):

- ***Baud Rate*** (for interface RS232/RS485 only):
  - available speeds 2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps,
  - 8 bits of data, 1 bit stop and no parity parameters are fixed and cannot be changed,

- ***IP*** - adjusted manually if DHCP is disabled. Automatically set in the opposite case, when the device is powered on,
- ***Mask*** - subnetwork mask (logically subdivision of an IP network),
- ***Gateway*** - default gateway on a TCP/IP network,
- ***DHCP*** - Dynamic Host Configuration:
  - ***enable*** - automatic configuration on connection (IP address, gateway, subnet mask),
  - ***disable*** - IP protocol parameters must be set manually,
- ***TCP server port*** - specifies the port number used in network socket created by TCP server,

3.13.6 SAVING AND LOADING SETTINGS

To save or load parameters go to: ***Setup Menu -> Save/Load***

When the HEAT3 is powered off, the current device settings are lost. However, there are up to six different parameters slots which can be used to store current device parameters. Each can have an individual name and parameter set. The current status of the device (parameter values) can also be stored in memory.

In order to save the device configuration:

1. Go to menu ***Setup Menu -> Save/Load -> Save***.
2. Choose one of the sockets where settings will be stored (previous parameters will be erased) and tap it.
3. Enter desired name using keyboard.
4. Tap ***Enter*** button in order to accept given name.
5. Current parameters will be saved in the selected slot with a given name.

Restoring the saved settings is also achieved via the configuration menu. In order to load previously saved settings:

1. Go to menu ***Setup Menu -> Save/Load -> Load***.
2. Choose one of the slots from which device settings will be loaded and tap it.
3. Selected device settings will be loaded.

Default factory settings may also be loaded as follows:

1. Go to menu ***Setup Menu -> Save/Load***.
2. Tap ***Load Default*** in order to load factory settings.

3.13.7 DISPLAY SETTINGS

To change display settings go to: ***Setup Menu -> Display***
In *Display* submenu it is possible to change the following settings:
Brightness - display brightness value. Value can be in range 10-100

Touch Screen Autolock - When the value is set to ON the autolock function is active. If the touch panel is not used for longer than 3 min then the screen is locked. Unlock the device by pressing the "Yes" in the displayed message.

Customer Name - The device can be assigned individual name that appears on the top of main screen. This allows to distinguish between several devices of the same type.

System Date - The device has a built-in ***real time clock*** (RTC). The menu allows you to set the current date and time.
Setting a date should be the individual parts separated using the sign "-". For example: ***21-03-2014***
Setting a time should be the individual parts separated using the sign ":". For example: ***13:20:22***.
Alternate form of save time that are accepted: ***3:4:5 -> 03:04:05***, ***12:8:1 -> 12:08:01***

3.13.8 INFORMATION MENU

To display menu information go to:
Setup Menu -> Information.
This menu contains information about the device name and version, the current software version, serial and product number as well as the network parameters such as IP address, netmask and gateway.

3.13.9 LANGUAGE MENU

This submenu allows to change the device language.
In order to select the language go to ***Setup menu -> Language***.
To finish change the language the device must be reset.

3.13.10 LOGS MENU

To display logs menu go to ***Setup Menu -> Logs***.
This submenu displays the error history log. Displayed list of errors includes a description and the date of its occurrence

3.13.11 REBOOT

Restart the application running on the device. To restart device go to ***Setup Menu -> Reboot***.

4 STEP BY STEP

The following sections provide example scenarios for the resistance and electron bombardment heating modes. They contain a description of the steps that you must follow in order to heat sample in these modes.

4.1 RESISTANCE HEATING

Follow below steps in order to prepare device for resistance heating:

1. Install the device to the system (Chapter 2. Installation)
2. Turn on the device (Chapter 3 . Operating, ***Turn on device*** section)
3. Select RES heating mode (Chapter 3 . Operating, ***Selecting resistance heating mode section***)
4. Set up limits (see technical parameters of the sample holder) (Chapter 3 . Operating, **RES** => ***Setting limits section***)
5. Set up ramps (especially STBY ramps) (Chapter 3 . Operating, **RES** => ***Setting ramps section***)
6. Select the type of temperature measurement sensor (Chapter 3 . Operating - ***Selecting the type of temperature measurement*** section)
7. Set up all the outputs (analog and digital) (Chapter 3 . Operating - ***Analog output configuration*** section and ***Relay output configuration*** section)
8. Set up all the inputs (especially the interlock). (Chapter 3 . Operating - ***Analog input configuration*** section and ***Logic input configuration*** section)
9. Initiate the interlock signal

4.1.1 MANUAL REGULATION

In order to manually control heating, follow the steps below:

1. Pick up the MANUAL type of regulation (Chapter 3 . Operating, ***RES => Manual regulation*** section)
2. Reset cathode voltage (Uc = 0) (Chapter 3 . Operating, ***Device interaction*** section)
3. Turn on OPERATE (Tap ***Operate*** button in the left top corner of main panel)
4. Increase the cathode voltage (the cathode current limit may determinate the value of Ic) to heat the sample holder (Chapter 3 . Operating, ***Device interaction*** section)

4.1.2 PID REGULATION

In order to regulate heating using PID controller:

1. Pick up the PID type of regulation (Chapter 3 . Operating, ***RES => PID regulation*** section)

2. Set up PID, trigger temp and end temp parameters (Chapter 3 . Operating, ***PID Controller => T mode parameters*** and ***dT mode parameters*** section)
3. Set up the process value (Chapter 3 . Operating – ***Controlled channel selection*** section)
4. Reset cathode voltage (Uc = 0) (Chapter 3 . Operating, ***Device interaction*** section)
5. Turn on OPERATE (Tap ***Operate*** button in the left top corner of main panel)
6. Manipulate the type (T or dT) and value of setpoint (Interact with main panel)

4.2 ELECTRON BOMBARDMENT HEATING

Follow below steps in order to prepare device for electron bombardment heating:

1. Install the device to the system (Chapter 2. Installation)
2. Turn on the device (Chapter 3 . Operating, ***Turn on device*** section)
3. Select EB heating mode (Chapter 3 . Operating, ***Selecting electron bombardment heating mode*** section)
4. Set up limits (see technical parameters of the sample holder)) (Chapter 3 . Operating, **EB => *Setting limits*** section)
5. Set up ramps (especially STBY ramps) (Chapter 3 . Operating, **EB => *Setting ramps*** section)
6. Select the type of temperature measurement sensor (Chapter 3 . Operating - ***Selecting the type of temperature measurement*** section)
7. Set up all the outputs (analog and digital)) (Chapter 3 . Operating - ***Analog output configuration*** section and ***Relay output configuration*** section)
8. Set up all the inputs (especially the interlock)) (Chapter 3 . Operating - ***Analog output configuration*** section and ***Relay output configuration*** section)
9. Initiate the interlock signal

4.2.1 MANUAL REGULATION

In order to manually control heating, follow the steps below:

1. Pick up the MANUAL type of regulation (Chapter 3 . Operating, **RES => *Manual regulation section***)
2. Reset cathode voltage (Uc = 0) (Chapter 3 . Operating, ***Device interaction*** section)
3. Turn on OPERATE (Tap ***Operate*** button in the left top corner of main panel)
4. Increase the cathode voltage (the cathode current limit may determinate the value of Ic) to heat the sample holder
5. Increase the emission voltage (Ue) to initiate the flow of emission current (Chapter 3 . Operating, ***Device interaction*** section)

4.2.2 PID REGULATION

In order to regulate heating using PID controller:

1. Pick up the PID type of regulation (Chapter 3 . Operating, ***EB => PID regulation*** section)
2. Set up PID, trigger temp and end temp parameters (Chapter 3 . Operating, ***PID Controller => T mode parameters*** and ***dT mode parameters*** section)
3. Set up the process value (Chapter 3 . Operating – ***Controlled channel selection*** section)
4. Reset cathode voltage (Uc = 0) (Chapter 3 . Operating, ***Device interaction*** section)
5. Turn on OPERATE (Tap **Operate** button in the left top corner of main panel)
6. Increase the cathode voltage (the cathode current limit may determinate the value of Ic) to heat the sample holder
7. Manipulate the type (T od dT) and value of setpoint (Interact with main panel)

5 TROUBLESHOOTING

This section describes the errors, warnings and notifications appearing in HEAT3 . All informations displayed on the screen are divided into two groups:

- Errors and warnings which relate primarily to the device hardware are displayed in the message bar on the right side of the screen. They are identified by the colors red and yellow (for more information about them can be found in the chapter on user interface). Error disappears from the bar when it will be physically eliminated. This informations are stored in 5.1 section.
- All information that is not directly related to operation of the device is displayed as a message box. This informations presents notifications after user interaction. More informations can be found in **??** section.

5.1 MESSAGE BAR NOTIFICATIONS

5.2 NO INTERLOCK SIGNAL

- There is no connection to external interlock or interlock is not properly configured. Refer to the Digital input section of the “Installation“ chapter

5.3 NO EMISSION CURRENT Ie 0mA

- No high voltage bridge cable between DC module (socket HV IN) and HV module (socket HV OUT). Check that the link cable is connected as show below.

Figure 5.1: Bridge connection

- During manual operating of emission voltage **UE** for EB heating mode the **UE** can be set too low.
- Operate of power supply is OFF. Please refer to the Operating chapter
- Limit of IE is set to 0,1mA

- IE limit is set to external analog control and external control voltage is 0V.
- No power going to the DC Module. Switch off the HEAT3-PS wait half minute and switch on again if the problem still exist contact Prevac

5.4 HV SHORT CIRCUIT

Emission current reaches limit and high voltage output is close to 0V then:

- Short circuit to ground on heater of EB type sample. To check, disconnect the high voltage bridge cable shown on photo (see above section) and observe if the problem still exists. If yes then it's likely that the problem concerns the high voltage module.

5.5 HV FAIL – "HV POWER SUPPLY IS DAMAGED"

- High voltage UE read from device is close to 0V, for **UE** set > 0V and emission current **IE** close to 0mA
- No power going to the HV Module. Switch off the HEAT3-PS wait half minute and switch on again if the problem still exist contact Prevac

5.6 DC NO LOAD OR THE CONNECTION IS BROKEN

Messages can appear when operating is turning on

- DC load is disconnected from the device
- DC load is broken (electrical break)

5.7 DC CURRENT LIMIT

Messages can appear during normal operation, there could be several possibilities:

- DC load current has reached limit, check the limits set for appropriate sample heater type
- Short circuit in DC load or connections

5.8 DC SUPPLY FAILURE

- DC module load is short circuit => check load connections
- DC module is damaged => Contact Prevac

5.9 DC MODULE IS NOT AVAILABLE

- No DC module available or wrong module inserted to main board bus of Heat3
- Wrong contact between module and main board bus.
- Main board is damaged => contact Prevac

5.10 BUS CONNECTION FAIL

- Internal connection between the bus and the motherboard has been lost. Switch off, wait 30 seconds, then switch on again.
- If the problem appears again, it may indicate internal main board damage => contact Prevac

5.11 DEVICE COMMUNICATION ERROR

Internal connection on main board device has been lost

- Switch off, wait a 30 seconds and switch on again.
- If the problem appears again, it may indicate internal main board damage => contact Prevac

5.12 LOW DISC SPACE

- Disc space on USB flash drive is lower than 50 megabytes. This is suggestion to delete videos from the device

5.13 CRITICAL DISC SPACE

- Disc space on USB flash drive is lower than 2 megabytes. Please remove videos from device

6 REMOTE CONTROL

This chapter describes how to communicate with the device HEAT3 with the selected interface. Control HEAT3 is possible via one of three interfaces installed on your device RS232, RS485, Ethernet. Only one of these interfaces can be used at the same time. Selection and configuration of the communication interface is done as described in subsection 3.13.5.

6.1 CONNECTION PARAMETERS

PARAMETER	VALUE
Data bits	8
Parity	None
Stop bits	1
Flow control	None
Baud rate	57600 (default value)

Table 6.1: Connection parameters

6.2 DATA FRAME

DATA FRAME	
Byte	**Description**
1 - HEADER	First byte is responsible for identifying the serial protocol. Header in hexadecimal is 0xBB
2 - DATA LENGTH	Length of the data field. Maximum data file length is 0xFF (256 bytes). Prevac Serial Protocol
3 - DEVICE ADDRESS	Identification of hardware device address. Default value is 0xC8
4 - HOST ADDRESS	Host identification address. Assigned to host during the registration process (using a unique ID).
5 - FUNCTION CODE - MSB	First procedure function code byte 8th (MSB) bit is the read(0)/write(1) select bit
6 - FUNCTION CODE - LSB	Second procedure function code byte

continued on next page

continued from previous page	
Byte	**Description**
7 .. [7 + DATA LENGTH] - DATA FIELD	Data capture needed to realize defined functions.
[7 + DATA LENGTH] + 1(last frame position) - CRC	CRC is simple module 256 calculated without protocol header byte(see section 6.2.4)

Table 6.2: Data frame

6.2.1 ORDER TYPES

There are two types of commands:

- write orders,
- read orders.

Type the command defines the most significant bit of command code (see 6.2). If the bit is a logical "1", then the function code is interpreted as a command Save/Set. Otherwise, the order read. For example: order 0x7F06(set customer Name) allow read customer Name, and order 0xFF06(MSB set to "1") allow set customer Name.

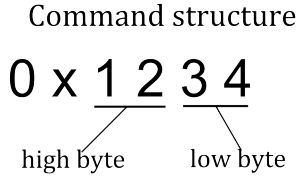


Figure 6.1: Command structure

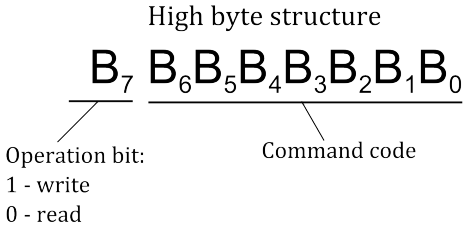


Figure 6.2: High byte command structure

For a read command, the device returns the value in a specific data type assigned to the command (see tables of orders).
For orders write the answers may be as follows:

- write command is correct (proper type, has the appropriate length and value), the device responds 0x00 value in the last byte in the data field.
- write order is incorrect, the device return error code in the last data field byte as shown in Table ref Global communication status codes.

WARNING

Read/Write Parameters.
Reading the parameters of the device is always allowed (even if the device is not in REMOTE CONTROL mode).
Writing parameters to the device requires:

- switching device in REMOTE CONTROL mode,
- registration using a unique ID
- receive permission to control as *Master*.

The registration procedure host is described in subsection 6.3

6.2.2 APPLIED DATA TYPES

DATA TYPE	DESCRIPTION	EXAMPLE
ASCII	The text value of the length specified in the *DATA LENGTH*	"CUSTOMER"
Long	4 bytes integer value in *Big endian* format(The most significant byte is placed first in data field)	0x000082AC
Byte	1 byte integer value, used for enumerate type and control command(ON/OFF)	0x05
Bool	true/false value (0 = false, 1 = true)	0x01, 0x00
Double	8 bytes value in IEEE 754 double-precision binary floating-point in *Big endian* format(The most significant byte is placed first in data field)	0x4028 A4DD 2F1A 9FBE

Table 6.3: Data types

6.2.3 INDEXING

There are 3 types of orders because of the type of indexing:

- indexed - require an index on firs byte of data fields in order to appeal to a particular object (module) on the device. On the following bytes to put the data in a format compatible with the type of order.
- indexed (no matter) - the index does not matter, but it is necessary to provide an index (eg. 1) on first byte data field. On the following bytes to put the data in a format compatible with the type of order
- without an index - only orders from the global group (see global commands table). The value we put from the first byte of the data field.

For example, reading the vacuum level from device that has 2 vacuum channels, needs to be sent command 0x0101 with the index 0x01 to read the value of the first channel:
TX: BB 01 C8 01 01 01 01 CD
Index and 0x02 to read the value of the second channel:
TX: BB 01 C8 01 01 01 02 CE.

WARNING

Index out of range.
If the index value is outside the range defined for a given command, the device returns the error code 0x93 in the last position of the data field.

If the order requires indexing, the table specified item *index* with with the scope of change. If the order does not apply to index this field *Index* is not specified in the table.

6.2.4 CRC

CRC is simple modulo 256 calculate without protocol header byte. Below is a sample code for the enumerator checksum value.

```
1 quint8 mod256_CRC = 0;
2 for(i= 1; i <= InputFrame->size; i++) mod256_CRC += InputFrame(i);
```

6.3 EXAMPLES

6.3.1 READ PARAMETERS FROM DEVICES

Read FG pressure value (Function code 0x0101, data field: 0x01 (index): **Request:**
TX: BB 01 C8 01 01 01 01 CD
Answer (CH1=6.25 E-2):
RX: BB 09 C8 01 01 01 01 3F B0 00 00 00 00 00 00 C4

6.3.2 SETUP PARAMETERS

Shutter control(Function code 0x8207, data field: 0x01 (index), 0x01 (1-ON / 0-OFF)
Request:

TX: BB 02 C8 01 82 07 01 01 56
Answer:
RX: BB 02 C8 01 82 07 01 00 55
Command executed correctly: last byte in data field equal 0.

Setting the target temperature out of range(Function code 0x8706, data field: 0x01[index], 1500.0 [target temperature])
Request:
TX: BB 09 C8 01 87 06 01 40 97 70 00 00 00 00 00 A7
Answer:
RX: BB 02 C8 01 87 06 01 91 EA
The order not executed: returned error code 0x91 in last byte data field (value too high - see **??**).

6.3.3 TAKING OVER CONTROL AS MASTER

Request:
TX: BB 01 C8 01 FF F1 01 BB
Answer:
RX: BB 01 C8 01 FF F1 00 BA
The data field equal to 0 - to take control goes correctly.

6.4 UNIQUE ID

For proper operation of mechanism for the allocation numbers of hosts is necessary to ensure that each computer using the unique ID during the registration process host(command 0x7FF0). A unique string of characters can be extracted from the operating system using the codes explained the program.

6.4.1 WINDOWS OPERATING SYSTEM

```
1  #define _WIN32_DCOM
2  #include <comdef.h>
3  #include <comutil.h>
4  #include <Wbemidl.h>
5  #pragma comment(lib, "wbemuuid.lib")
6
7  long get_uuid(char** uuid, int* size)
8  {
9          HRESULT hr = CoInitializeEx(0, COINIT_MULTITHREADED);
10         if (FAILED(hr))
11                 return 1;
12
13         hr = CoInitializeSecurity(
14                 NULL,
15                 -1,                          // COM authentication
16                 NULL,                        // Authentication services
17                 NULL,                        // Reserved
18                 RPC_C_AUTHN_LEVEL_DEFAULT,   // Default authentication
19                 RPC_C_IMP_LEVEL_IMPERSONATE, // Default Impersonation
20                 NULL,                        // Authentication info
21                 EOAC_NONE,                   // Additional capabilities
22                 NULL                         // Reserved
23                 );
24
```

```
25          if (FAILED(hr)) {
26                  CoUninitialize();
27                  return 1;
28          }
29
30          IWbemLocator *pLoc = NULL;
31
32          hr = CoCreateInstance(
33                  CLSID_WbemLocator,
34                  0,
35                  CLSCTX_INPROC_SERVER,
36                  IID_IWbemLocator, (LPVOID *)&pLoc);
37
38          if (FAILED(hr)) {
39                  CoUninitialize();
40                  return 1;
41          }
42
43          IWbemServices *pSvc = NULL;
44
45          hr = pLoc->ConnectServer(
46                  _bstr_t(L"ROOT\\CIMV2"), // Object path of WMI namespace
47                  NULL,                    // User name. NULL = current user
48                  NULL,                    // User password. NULL = current
49                  0,                       // Locale. NULL indicates current
50                  NULL,                    // Security flags.
51                  0,                       // Authority (for example, Kerberos)
52                  0,                       // Context object
53                  &pSvc                    // pointer to IWbemServices proxy
54                  );
55
56          if (FAILED(hr)) {
57                  pLoc->Release();
58                  CoUninitialize();
59                  return 1;
60          }
61
62          hr = CoSetProxyBlanket(
63                  pSvc,                         // Indicates the proxy to set
64                  RPC_C_AUTHN_WINNT,            // RPC_C_AUTHN_xxx
65                  RPC_C_AUTHZ_NONE,             // RPC_C_AUTHZ_xxx
66                  NULL,                         // Server principal name
67                  RPC_C_AUTHN_LEVEL_CALL,       // RPC_C_AUTHN_LEVEL_xxx
68                  RPC_C_IMP_LEVEL_IMPERSONATE, // RPC_C_IMP_LEVEL_xxx
69                  NULL,                         // client identity
70                  EOAC_NONE                     // proxy capabilities
71                  );
72
73          if (FAILED(hr)) {
74                  pSvc->Release();
75                  pLoc->Release();
76                  CoUninitialize();
77                  return 1;
78          }
79
80          IEnumWbemClassObject* pEnumerator = NULL;
81          hr = pSvc->ExecQuery(
82                  bstr_t("WQL"),
83                  bstr_t("SELECT * FROM Win32_ComputerSystemProduct"),
84                  WBEM_FLAG_FORWARD_ONLY | WBEM_FLAG_RETURN_IMMEDIATELY,
85                  NULL,
86                  &pEnumerator);
87
```

```
88          if (FAILED(hr)) {
89                  pSvc->Release();
90                  pLoc->Release();
91                  CoUninitialize();
92                  return 1;
93          }
94
95          IWbemClassObject *pclsObj = NULL;
96          ULONG uReturn = 0;
97
98          while (pEnumerator)
99          {
100                 HRESULT hr =pEnumerator->Next(WBEM_INFINITE, 1, &pclsObj, &
                        uReturn);
101
102                 if (uReturn == 0)
103                         break;
104
105                 VARIANT vtProp;
106
107                 hr = pclsObj->Get(L"UUID", 0, &vtProp, 0, 0);
108                 *size = SysStringLen(vtProp.bstrVal);
109                 *uuid = _com_util::ConvertBSTRToString(vtProp.bstrVal);
110                 // ConvertBSTRToString allocates a string you must delete!
111                 VariantClear(&vtProp);
112
113                 pclsObj->Release();
114         }
115
116         pSvc->Release();
117         pLoc->Release();
118         pEnumerator->Release();
119         CoUninitialize();
120
121         return 0;
122 }
123
124 // Usage example:
125 //      char* uuid;
126 //      int size;
127 //      get_uuid(&uuid, &size);
128 //      // do sth with uuid
129 //      delete[] uuid;
```

6.4.2 LINUX - OPEARATING SYSTEM

```
#include <stdio.h>
#include <stdlib.h>

// First make a copy of /sys/class/dmi/id/product_uuid to your source directory.
// Type: sudo cp /sys/class/dmi/id/product_uuid ./product_uuid
// Then change file attributes of the file you've copied.
// Type: sudo chmod 777 ./product_uuid

long get_uuid(char** uuid, int* size)
{
 long error = -1;
 FILE *file = popen("cat ./product_uuid | egrep
 '[A-Fa-f0-9]{8}\-[A-Fa-f0-9]{4}\-[A-Fa-f0-9]{4}\
 -[A-Fa-f0-9]{4}\-[A-Fa-f0-9]{12}'", "r");
 if (file != NULL) {
     *size = 36;
     *uuid = (char*)malloc(*size+1);
        // Allocated buffer you must free!
     if (*uuid != NULL) {
         fread(*uuid, 1, *size, file);
         (*uuid)[*size] = 0;
         error = 0;
     }
     pclose(file);
 }
 return error;
}

// Usage example:
//      char* uuid;
//      int size;
//      get_uuid(&uuid, &size);
//      // do sth with uuid
//      free(uuid);
```

6.4.3 ORDERS TYPES

There are two types of commands:

- Read/Write orders,
- Read only orders,

For read commands, the device returns the requested value in the specified data format.
For write commands, the depends on the send value:

- When send value is correct(correct type, has the correct length and value), then device sends 0x00 value into data field. The answer is located in last byte of the data field,
- When send value is incorrect, an appropriate error code is sent in the last byte of the data field.

6.4.4 REGISTER NEW HOST

If the remote controller connects to the device first time, follow the procedure for obtaining a host address according to the diagram below.

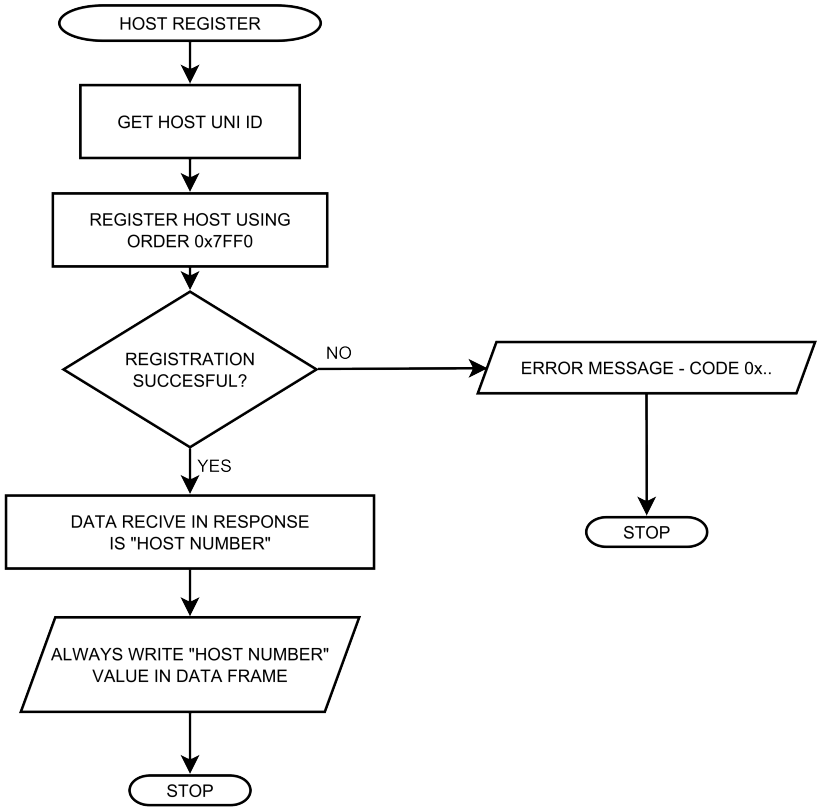


Figure 6.3: Host assign - diagram

Description of the allocation host number order is contained in the table 6.30.

Below is an example procedure for the preparation of a new host address. And then send a command set to Setpoint Low value.

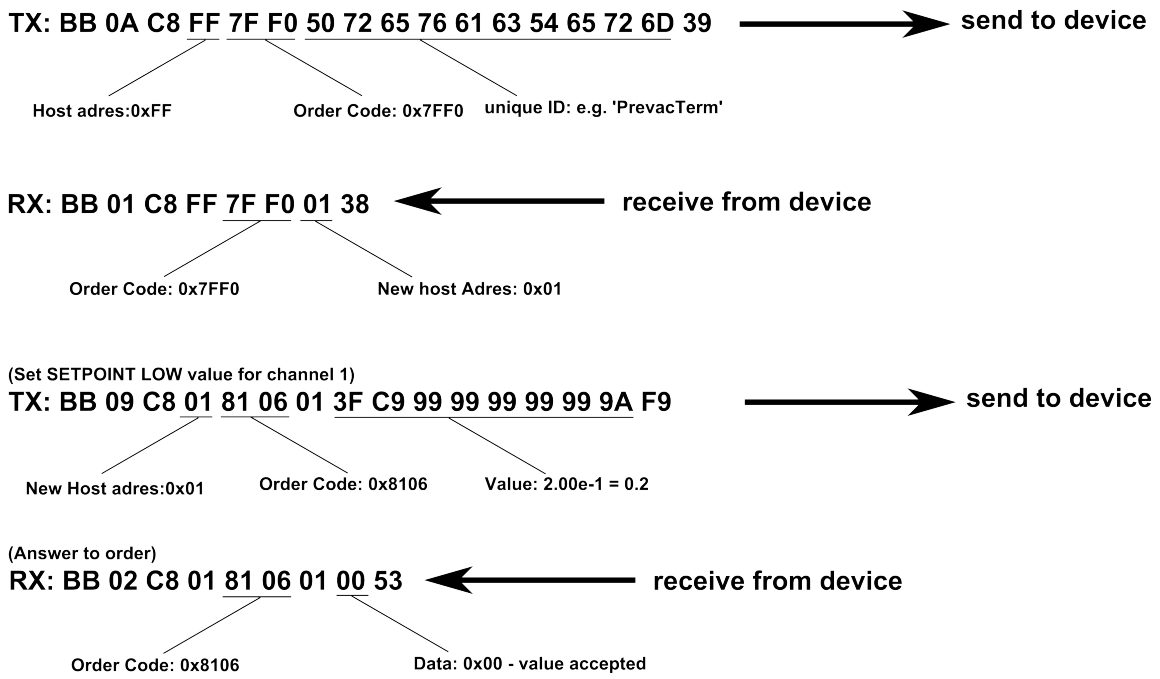


Figure 6.4: Host assign example

6.5 REMOTE CONTROL MODE

REMOTE CONTROL mode operations change the parameters from the touch panel are locked. You can monitor only the parameters on the screen and the settings in the configuration menu of the device. Device in *REMOTE CONTROL* mode display at the top of the main screen information banner with the inscription *"HEAT3 - REMOTE CONTROL"*

The device can be entered in remote control mode in two ways: hardware and software.

6.5.1 HARDWARE

Switching to *Remote Control* mode is done by activating the remote interlock input. Located on the rear panel (see section ref logicInputs). The input can be activated permanently by making a short connection between the activating input and pin 24V or activated from the outside (eg .: switch, PLC). Example plug configuration is shown in Figure 6.5. Exit *Remote Control* mode is possible only by deactivating the input *REMOTE INTERLOCK*.

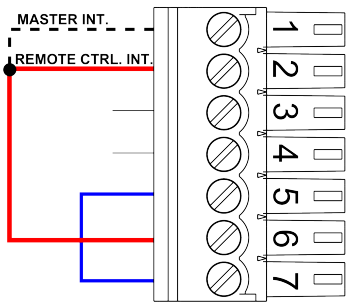


Figure 6.5: Activation *Remote Control Interlock*

6.5.2 SOFTWARE

Software switch to Remote Control mode is provided selecting ***C*OMMUNICATION -> REMOTE CONTROL -> ON**. Then device switches to Remote Control mode and remains in it until switched again to local mode by selecting ***C*OMMUNICATION -> REMOTE CONTROL -> OFF**.

Communication in software Remote Control mode is done according following principles:

- At a time control device it is only possible from one place (panel of the unit or remote computer with *MASTER* permissions). item Permissions to control in RC mode has a host that is in the *MASTER*. On the *Communications* submenu can check which host (of which number) currently has *Master* permissions.
- After the takeover of control by the remote *MASTER* device is locked to return to local control mode from the device menu (item ***C*OMMUNICATION -> REMOTE CONTROL** is grayed out).
- Host have *MASTER* permissions until kept communication with the device (the interval between frames will not be longer than 10 seconds) or relase rights master (using order 0xFFF1; data field = 0).
- In case of loss of communication between the host and the device for longer than 10 seconds the item ***C*OMMUNICATION -> REMOTE CONTROL** is active and is possible return to local control by setting item ***C*OMMUNICATION -> REMOTE CONTROL -> OFF**
- In case of loss of communication between the host and the device for longer than 60 seconds, it becomes possible take over control by another remote host.

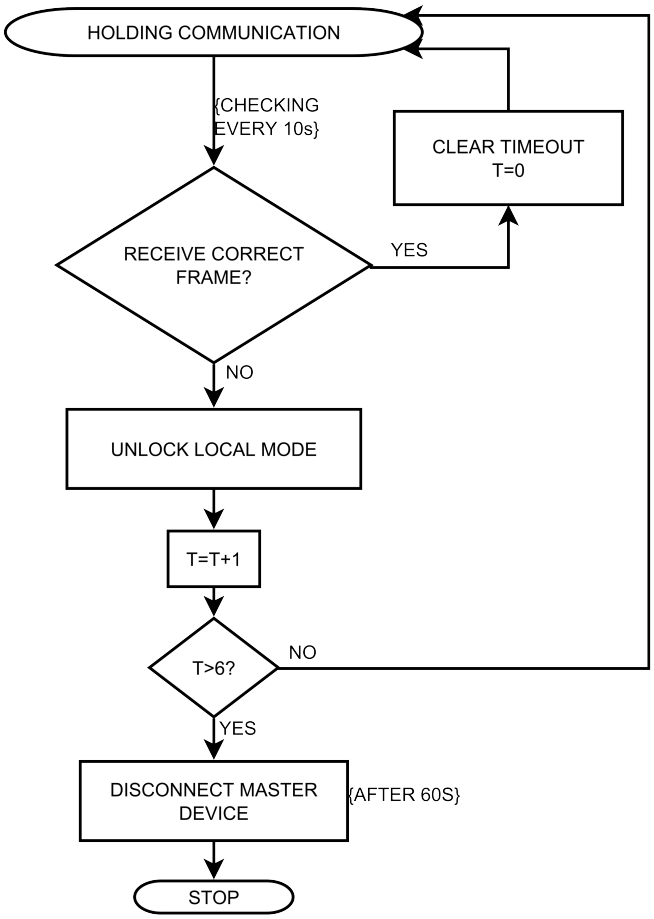


Figure 6.6: Keeping communication- diagram

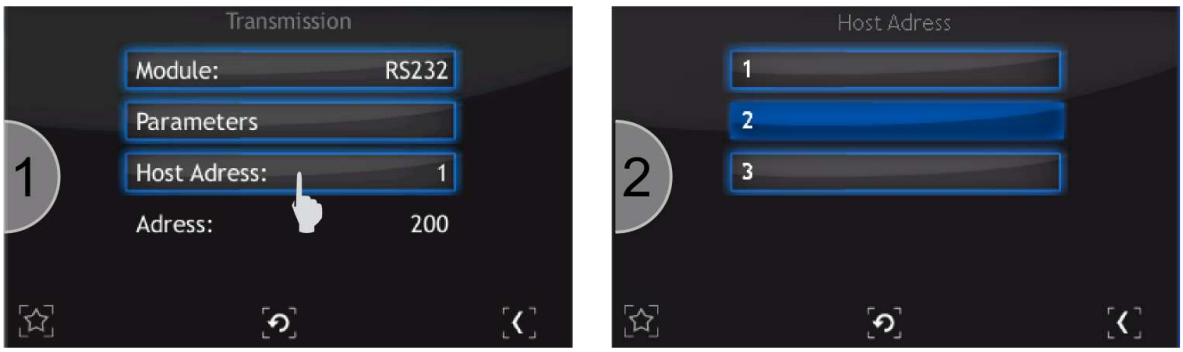


Figure 6.7: Preview of registered host addresses

Properly registered device will appear in the menu ***Communication -> Host address*** and will be able to control the device. If the list contains more than one device, you must choose which is to have permissions to write (control). Other devices in the list will be able to read only parameters.

6.6 GLOBAL DEVICE STATUSES

There are two types of device status: errors and warnings. Status appear in the bar at the right of the main screen of the device. To read the error status, use the command 0x7F51, for warning status use command 0x7F52. In response we receive a code whose meaning is contained in the tables below.

Error code	Description
7F01	Internal communication error
7F02	Communication with Anybus module error
7F03	Communication with Bluetooth Anybus module error
7F04	Critically low disk space

Table 6.4: Global error status

Warning code	Description
7F80	Low disk space.
7F06	Invalid read the internal temperature of the device.
7F07	The internal temperature of the device is above safe level.
7F08	The internal temperature of the unit is too high. Switching to standby mode.

Table 6.5: Global warning status

6.7 GLOBAL ERROR CODES

In response to the write command, it is possible to obtain the specifying error status code, which makes impossible execution of the order. The table below lists the global error codes (apply to all orders). Additionally, the device can return specific error codes, depending on the module in which it is equipped.

Status code	Description
0x00	No errors, order executed correctly
0x91	Value is too large
0x92	Value is too small
0x93	Wrong parameter (probably wrong data format or index out of range)
0x95	Read only parameter, write prohibited
0x96	Host not know and not registered
0x97	Host know but not selected to remote control
0x98	Device configured to work in local mode
0x99	Operation or parameter is not available

Table 6.6: Global status codes

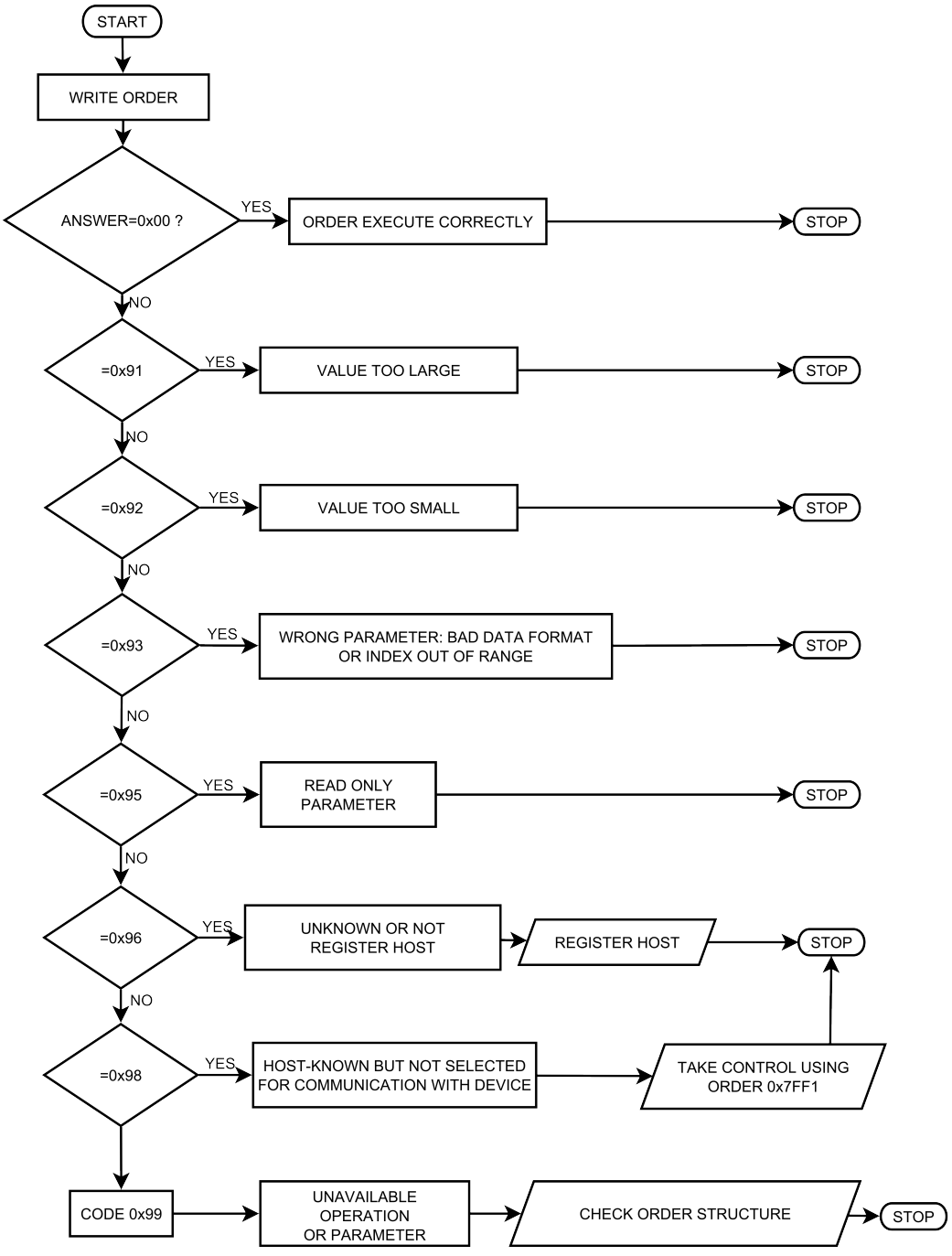


Figure 6.8: Write order example- diagram

6.8 HEAT3 STATUS CODES

Error code	Description
4101	DC module is not available.
4102	The connection to Bus has been lost.
4103	DC power supply is damaged or short circuit
4104	HV power supply is damaged.
4105	HV power supply has short circuit.
4106	Main power failure.
4107	Safety relay failure

Table 6.7: HEAT3 error status

Warning code	Description
4180	DC no load or the connection is broken.
4181	DC current has reached the limit.
4182	Emission current has reached the limit.
4183	No external interlock.
4184	No vacuum interlock.

Table 6.8: HEAT3 warning status

6.8.1 HEAT3 COMMUNICATION ERROR CODES

Error code	Description
0x51	Operate is ON
0x52	Internal communication error
0x53	Internal communication error with Bus
0x54	DC module is not available
0x55	No external interlock
0x56	Operate ON is currently controlled by a digital input
0x57	Temperature sensor failure
0x58	Main power failure
0x59	Operate is OFF
0x5A	Actual work mode is Manual or External Control
0x5B	HV module is controlled by Analog Input
0x5C	HV module is not available
0x5D	Actual work mode is External Control
0x5E	Actual work mode is PID OUT
0x5F	Actual work mode is Manual
0x60	Actual regulation mode is dT mode
0x61	Autotune is ON
0x62	Temperature Cart is not available
0x63	Analog Cart is not available
0x64	Device is not in EB mode
0x65	Actual work mode is PID OUT and RES mode
0x66	Actual work mode is PID OUT and EB mode with Output Signal set on Uc(Ic)
0x67	Actual work mode is PID OUT and EB mode with Output Signal set on Ue
0x68	There is no DC module with voltage control
0x69	There is no DC module with current control
0x6A	No vacuum interlock

Table 6.9: HEAT3 communication error codes

Error code	Description
VACUUM GAUGES COMMUNICATION ERROR CODES:	
0x80	CTR90 head not selected to set FS.
0x81	MKS870 head not selected to set FS.
0x82	Not selected "define" gas type.
0x83	Meter damaged.
0x84	Selected head does not support degas function.
0x85	Vacuum is too low to start system degassing.
0x86	Selected head does not support emission function.

Table 6.10: Vacuum gauges communication error codes

6.9 ORDERS LIST

6.9.1 GLOBAL ORDERS - FUNCTION CODE 0x7F..

ORDER NUMBER 0x7F01 READ PRODUCT NUMBER					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-15	Product number	ASCII			

Table 6.11: Read product number

ORDER NUMBER 0x7F02 READ SERIAL NUMBER					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-13	Serial number	ASCII			

Table 6.12: Read serial number

ORDER NUMBER 0x7F03 READ DEVICE VERSION					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1 - [DATA LENGTH]	Device version	ASCII			

Table 6.13: Read device version

ORDER NUMBER 0x7F04 READ HASH CODE VERSION					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1 - [DATA LENGTH]	Hash code	ASCII			

Table 6.14: Read hash code version

ORDER NUMBER 0x7F05 READ DEVICE NAME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1 - [DATA LENGTH]	Device name	ASCII			

Table 6.15: Read device name

ORDER NUMBER 0x7F06 CUSTOMER NAME					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1 - [DATA LENGTH]	Customer name (max 17 characters)	ASCII			

Table 6.16: Customer name

ORDER NUMBER 0x7F50 DEVICE STATUS					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Number of device errors 0 - no errors			0	255
2	Number of device warnings 0 - no warnings			0	255

Table 6.17: Read device status

ORDER NUMBER 0x7F51 ERROR CODES					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index of device error	BYTE		0	255
2 - 5	Device error code				

Table 6.18: Read error status code

ORDER NUMBER 0x7F52 WARNING CODES					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index of device warning			0	255
2 - 5	Device warning code				

Table 6.19: Read warning status code

ORDER NUMBER 0x7F60 VOLTAGE VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: 1 - U_c 2 - U_e 3 - U_{f1} 4 - U_{f2} 6 - U_{ext} 7 - U_{erg} 8 - U_{wehn} 9 - U_x 10 - U_y	BYTE			
2-9	Value	DOUBLE	V		

Table 6.20: Voltage value

ORDER NUMBER 0x7F61 ACTUAL VOLTAGE VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: 1 - U_c 2 - U_e 3 - U_{f1} 4 - U_{f2} 6 - U_{ext} 7 - U_{erg} 8 - U_{wehn} 9 - U_x 10 - U_y	BYTE			
2-9	Value	DOUBLE	V		

Table 6.21: Actual voltage value

ORDER NUMBER 0x7F62 CURRENT VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: 1 - I_c 2 - I_e 3 - I_{flux} 4 - I_{fil1} 5 - I_{fil2} 6 - I_{fil3} 7 - I_{fil4}	BYTE			
2-9	Value	DOUBLE	V		

Table 6.22: Current value

ORDER NUMBER 0x7F63 ACTUAL CURRENT VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: 1 - I_c 2 - I_e 3 - I_{flux} 4 - I_{fil1} 5 - I_{fil2} 6 - I_{fil3} 7 - I_{fil4}	BYTE			
2-9	Value	DOUBLE	V		

Table 6.23: Actual current value

ORDER NUMBER 0x7F70 RTC DATA SETTINGS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-10	Data value in format *yyyy.mm.dd*	ASCII			

Table 6.24: RTC data settings

ORDER NUMBER 0x7F71 RTC TIME SETTINGS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-8	Time value in format *hh:mm:ss*	ASCII			

Table 6.25: RTC time settings

ORDER NUMBER 0x7F72 PANEL TIMER TIME SETTINGS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-8	Set panel timer value in format *hh:mm:ss*	ASCII			

Table 6.26: Panel Timer time settings

ORDER NUMBER 0x7F73 PANEL TIMER ACTUAL TIME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-8	Actual panel timer value in format *hh:mm:ss*	ASCII			

Table 6.27: Actual panel timer value

ORDER NUMBER 0x7F74 PANEL TIMER START/STOP					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Panel Timer Start/Stop (Start=1, Stop=0)	BYTE			

Table 6.28: Panel timer start/stop

ORDER NUMBER 0x7F0C TOUCH SCREEN AUTOLOCK					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	0 - Touch screen autolock OFF 1 - Touch screen autolock ON				

Table 6.29: Touch screen autolock

ORDER NUMBER 0x7FF0 HOST NUMBER ASSIGN					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
QUERY:					
1 - [DATA LENGTH]	Unique ID	ASCII			
RESPONSE:					
1	Assigned host address	BYTE		1	255

Table 6.30: Host address assign

ORDER NUMBER 0x7FF1 MASTER MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
FOR WRITE ORDER:					
1	Assignment/release *MASTER* mode control 1 - Assignment control, 0 - Relase control,	Byte		0	1
FOR READ ORDER:					
1	*MASTER* control status (bit field) - status zwracany na poszczególnych bitach od B0(LSB) do B7(MSB). **B0:** Working as *MASTER* (0 - no, 1 - yes) **B1:** Take control as *MASTER*(0 - forbidden, 1 - permitted). Bit B1=1 if and only if B2=1, B3=1 i B4=0. **B2:** Device *REMOTE CONTROL* mode(0 - inactive, 1 - activate) **B3:** Host registration status(0 - not registered, 1 - registred) **B4:** Other *MASTER* host device in system (0 - no, 1- yes)	Byte			

Table 6.31: Assignment/release of Master mode

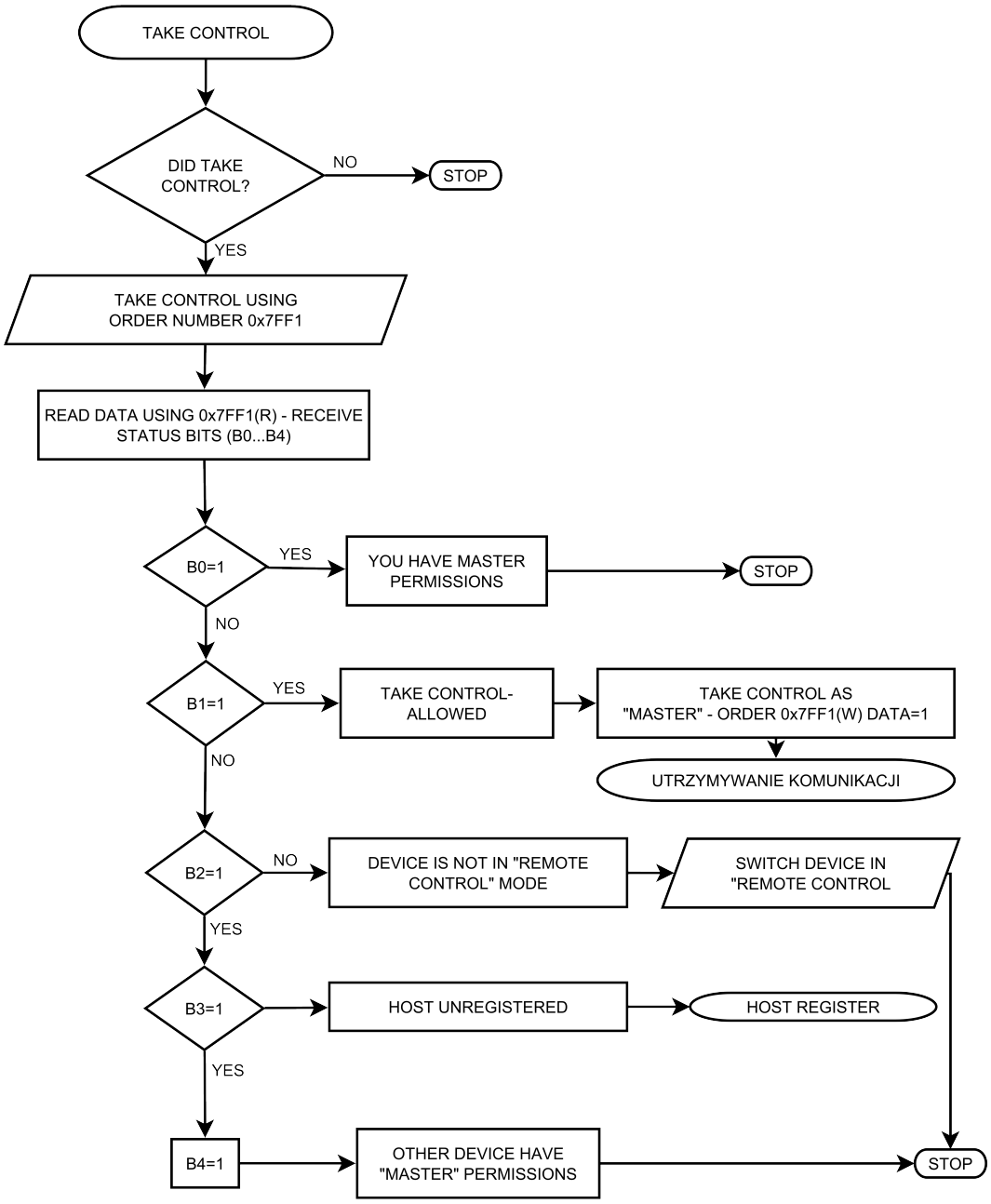


Figure 6.9: Assignment/release of Master mode - sequence diagram

ORDER NUMBER 0x7FAA SEND COMMAND TO DEVICE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-5	Command (5 characters)	ASCII			
6 - [DATA LENGTH]	Command data (max 32 characters)	ASCII			

Table 6.32: Send command

6.9.2 ORDERS HEAT3 - FUNCTION CODE 0x41..

Index value is without function.

ORDER NUMBER 0x4101 OPERATE CONTROL					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	OPERATE controll 0 - Operate OFF 1 - Operate ON	INT		0	1

Table 6.33: OPERATE controll

ORDER NUMBER 0x4102 RUN/HOLD CONTROLL					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	RUN/HOLD controll 0 - HOLD 1 - RUN	INT		0	1

Table 6.34: RUN/HOLD controll

ORDER NUMBER 0x4103 PROCESS VALUE UNIT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Process Value unit 0-Kelvin 1-Celsjusz 2-Farenheight 3-Volt (read only)	INT		0	3

Table 6.35: Process Value Unit

NUMER ROZKAZU 0x4104 TEMPERATURE READINGS FROM THERMOCOUPLE CHANEL					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index 1- Tc 1 2- Tc 2	INT		1	2
2-9	Temperature readings from thermocouple channel	Double	Kelvin		

Table 6.36: Temperature readings from thermocouple channel

ORDER NUMBER 0x4105 TEMPERATURE READINGS FROM DIODE CHANNEL					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index 1- D 1 2- D 2	INT		1	2
2-9	Temperature readings from diode channel	Double	Kelvin		

Table 6.37: Temperature readings from diode channel

ORDER NUMBER 0x4106 TEMPERATURE READINGS FROM RESISTANCE CHANNEL					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Temperature readings from resistance channel	Double	Kelvin		

Table 6.38: Temperature readings from resistance channel

ORDER NUMBER 0x4107 THERMOCOUPLE TYPE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index 1 - Tc1 2 - Tc2	INT		1	2
2	Type of thermocouple attached to the channel 0 - K-type thermocouple 1 - C-type thermocouple 2 - E-type thermocouple 3 - N-type thermocouple	INT		0	3

Table 6.39: Thermocouple type

ORDER NUMBER 0x4108 DIODE TYPE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index 1 - D1 2 - D2	INT		1	2
2	Type of diode attached to the channel 0 - diode DT670 1 - diode DT470	INT		0	1

Table 6.40: Type of diode attached to the channel

ORDER NUMBER 0x4109 RESISTANCE SENSOR TYPE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Type of resistance sensor attached to the channel 0 - PT100	INT		0	0

Table 6.41: Type of resistance sensor attached to the channel

ORDER NUMBER 0x410A REGULATION TYPE (T/dT)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Regulation type (T/dT) 0 - T mode 1 - dT mode	INT		0	1

Table 6.42: Regulation type (T/dT)

ORDER NUMBER 0x410B HEATING MODE EB/RES					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Heating mode EB/RES 0 - RES heating (resistive) 1 - EB heating (electron bombarded)	INT		0	1

Table 6.43: Heating mode EB/RES

ORDER NUMBER 0x410C WORK MODE (AUTO/MANUAL)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Work mode (AUTO/MANUAL) 0- Manual 1- PID Auto 2- External Controll (read only) 3- PID Out (read only)	INT		0	3

Table 6.44: Work mode (AUTO/MANUAL)

ORDER NUMBER 0x410D AUTOTUNE ON/OFF					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	AUTOTUNE ON/OFF 0- Autotune OFF 1- Autotune ON	INT		0	1

Table 6.45: AUTOTUNE ON/OFF

ORDER NUMBER 0x410E INPUT SELECTION FOR PROCES VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT		0	6
2	Input selection for Process Value 0- Thermocoulpe Channel 1 (Tc1) 1- Thermocoulpe Channel 2 (Tc2) 2- Diode Channel 1 (D1) 3- Diode Channel 2 (D2) 4- Resistance Channel (RTD) 5- Analog Input Channel 1 (Ain1) 6- Analog Input Channel 2 (Ain2)				

Table 6.46: Input selection for Process Value

ORDER NUMBER 0x410F CATHODE RAMP AT RES MODE AT OPERATE MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Cathode ramp at RES mode at OPERATE mode	Double	V(A)/ time unit	0,01	200

Table 6.47: Cathode ramp at RES mode at OPERATE mode

ORDER NUMBER 0x4110 CATHODE RAMP UNIT AT RES MODE AT OPERATE MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Cathode ramp unit at RES mode at OPERATE mode 0 - V(A)/s 1 - V(A)/min 2 - V(A)/h	INT		0	2

Table 6.48: Cathode ramp unit at RES mode at OPERATE mode

ORDER NUMBER 0x4111 CATHODE RAMP AT RES MODE (DURING TRANSMITION: STANDBY -> MANUAL)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Cathode ramp at RES mode (during transmition: STANDBY->MANUAL)	Double	V(A)/ Time Unit	0,01	200

Table 6.49: Cathode ramp at RES mode (during transmition: STANDBY->MANUAL)

ORDER NUMBER 0x4112 CATHODE RAMP UNIT AT RES MODE (DURING TRANSMISTION STANDBY->MANUAL)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Cathode ramp unit at RES mode (during transmition: STANDBY->MANUAL) 0 - V(A)/s 1 - V(A)/min 2 - V(A)/h	INT		0	2

Table 6.50: Cathode ramp unit at RES mode (during transmition: STANDBY->MANUAL)

ORDER NUMBER 0x4113 CATHODE RAMP AT EB MODE AT OPERATE MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Cathode ramp at EB mode at OPERATE mode	Double	V(A)/ time unit	0,01	200

Table 6.51: Cathode ramp at EB mode at OPERATE mode

ORDER NUMBER 0x4114 CATHODE RAMP UNIT AT EB MODE AT OPERATE MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Cathode ramp unit at EB mode at OPERATE mode 0 - V(A)/s 1 - V(A)/min 2 - V(A)/h	INT		0	2

Table 6.52: Cathode ramp unit at EB mode at OPERATE mode

ORDER NUMBER 0x4115 CATHODE RAMP AT EB MODE (DURING TRANSMITION: STANDBY -> MANUAL)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Cathode ramp at EB mode (during transmition: STANDBY->MANUAL)	Double	V(A)/ Time Unit	0,01	200

Table 6.53: Cathode ramp at EB mode (during transmition: STANDBY->MANUAL)

ORDER NUMBER 0x4116 CATHODE RAMP UNIT AT EB MODE (DURING TRANSMITION: STANDBY -> MANUAL)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Cathode ramp at EB mode (during transmition: STANDBY->MANUAL) 0 - V(A)/s 1 - V(A)/min 2 - V(A)/h	INT		0	2

Table 6.54: Cathode ramp at EB mode (during transmition: STANDBY->MANUAL)

ORDER NUMBER 0x4117 EMISSION VOLTAGE RAMP AT OPERATE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Emision voltage ramp at OPERATE mode	Double	V/time unit	0,01	200

Table 6.55: Emision voltage ramp at OPERATE mode

ORDER NUMBER 0x4118 UNIT OF EMISSION VOLTAGE RAMP AT OPERATE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Unit of emision voltage ramp at OPERATE mode 0 - V/s 1 - V/min 2 - V/h	INT		0	2

Table 6.56: Unit of emision voltage ramp at OPERATE mode

ORDER NUMBER 0x4119 EMISSION VOLTAGE RAMP (DURING TRANSMITION: STANDBY -> MANUAL)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Emision voltage ramp (during transmition: STANDBY->MANUAL)	Double	V/ time unit	0,01	200

Table 6.57: Emision voltage ramp (during transmition: STANDBY->MANUAL)

ORDER NUMBER 0x411A UNIT OF EMISSION VOLTAGE RAMP (DURING TRANSMITION: STANDBY -> MANUAL)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Unit of emision voltage ramp (during transmition: STANDBY->MANUAL) 0 - V/s 1 - V/min 2 - V/h	INT		0	2

Table 6.58: Unit of emision voltage ramp (during transmition: STANDBY->MANUAL)

ORDER NUMBER 0x411B SETPOINT FOR T MODE					R/W
Bajt	**Opis**	**Typ**	**Jednostka**	**Min**	**Max**
1	Index (irrelevant)	INT			
2-9	Setpoint for T mode	Double	Kelvin	0,0	9999,9

Table 6.59: Setpoint for T mode

ORDER NUMBER 0x411C RAMP RATE FOR T MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Ramp Rate for T mode	Double	Actual unit	0,0	1000,0

Table 6.60: Ramp Rate for T mode

ORDER NUMBER 0x411D RAMP RATE UNIT FOR T MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Ramp Rate unit for T mode 0 - Actual proces unit/s 1 - Actual proces unit/min 2 - Actual proces unit/h	INT		0	2

Table 6.61: Ramp Rate unit for T mode

ORDER NUMBER 0x411E SETOPINT FOR dT MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Setpoint for dT mode	Double	Kelvin/s	-5,0 K	+5,0 K

Table 6.62: Setpoint for dT mode

ORDER NUMBER 0x411F TRIGGER TEMPERATURE FOR dT MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Trigger temperature fot dT mode	Double	Kelvin	0,0K	9999,9K

Table 6.63: Trigger temperature fot dT mode

ORDER NUMBER 0x4120 END TEMPERATURE FOR T MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	End Temperature for T mode	Double	Kelvin	0,0K	9999,9K

Table 6.64: End Temperature for T mode

ORDER NUMBER 0x4121 THE P PARAMETER OF PID REGULATOR AT T MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	P Parameter of PID regulator at T mode	Double	Actual Unit	0,1	1000

Table 6.65: P Parameter of PID regulator at T mode

ORDER NUMBER 0x4122 THE I PARAMETER OF PID REGULATOR AT T MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	The I parameter of PID regulator at T mode	Double	second	0	1000

Table 6.66: The I parameter of PID regulator at T mode

ORDER NUMBER 0x4123 THE D PARAMETER OF PID REGULATOR AT T MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	The D parameter of PID regulator at T mode	Double	second	0	1000

Table 6.67: The D parameter of PID regulator at T mode

ORDER NUMBER 0x4124 THE P PARAMETER OF PID REGULATOR AT dT MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	The P parameter of PID regulator at dT mode	Double	Actual unit	0,1	1000

Table 6.68: The P parameter of PID regulator at dT mode

ORDER NUMBER 0x4125 THE I PARAMETER OF PID REGULATOR AT dT MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	The I parameter of PID regulator at dT mode	Double	sekundy	0	1000

Table 6.69: The I parameter of PID regulator at dT mode

ORDER NUMBER 0x4126 THE D PARAMETER OF PID REGULATOR AT dT MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	The D parameter of PID regulator at dT mode	Double	second	0	1000

Table 6.70: The D parameter of PID regulator at dT mode

ORDER NUMBER 0x4127 Ic LIMIT FOR RES MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Ic limit for RES mode	Double	Amper	0	12

Table 6.71: Ic limit for RES mode

ORDER NUMBER 0x4128 Uc LIMIT FOR RES MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Uc limit for RES mode	Double	Volt	0	40

Table 6.72: Uc limit for RES mode

ORDER NUMBER 0x4129 Ic LIMIT FOR EB MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Ic limit for EB mode	Double	Amper	0	12

Table 6.73: Ic limit for EB mode

ORDER NUMBER 0x412A Uc LIMIT FOR EB MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Uc limit for EB mode	Double	Volt	0	40

Table 6.74: Uc limit for EB mode

ORDER NUMBER 0x412B Ie LIMIT FOR EB MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Ie limit for EB mode	Double	mA	0	300

Table 6.75: Ie limit for EB mode

ORDER NUMBER 0x412C Ue LIMIT FOR EB MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Ue limit for EB mode	Double	Volt	1	1000

Table 6.76: Ue limit for EB mode

ORDER NUMBER 0x412D OUTPUT SIGNAL Ue/Uc(Ic)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Output signal Ue/Uc(Ic) 0- output Ue 1- output Uc/Ic (module dependent)	INT		0	1

Table 6.77: Output signal Ue/Uc(Ic)

ORDER NUMBER 0x412E READ/WRITE OF Uc TARGET VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Read/Write of Uc target value	Double	V	0	40

Table 6.78: Read/Write of Uc target value

ORDER NUMBER 0x412F READ ACTUAL VALUE OF Uc					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Read actual value of Uc	Double	V	0	40

Table 6.79: Read actual value of Uc

ORDER NUMBER 0x4130 READ/WRITE OF Ue TARGET VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Read/Write of Ue target value	Double	V	0	1000

Table 6.80: Read/Write of Ue target value

ORDER NUMBER 0x4131 READ ACTUAL VALUE OF Ue					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Read actual value of Ue	Double	V	0	1000

Table 6.81: Read actual value of Ue

ORDER NUMBER 0x4132 READ/WRITE OF Ic TARGET VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Read/Write of Ic target value	Double	A	0	12

Table 6.82: Read/Write of Ic target value

ORDER NUMBER 0x4133 READ ACTUAL VALUE OF Ic					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Read actual value of Ic	Double	A	0	12

Table 6.83: Read actual value of Ic

ORDER NUMBER 0x4134 READ ACTUAL VALUE OF Ie					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Read actual value of Ie	Double	A	0	0,3

Table 6.84: Read actual value of Ie

ORDER NUMBER 0x4135 COOLING VALVE MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Cooling Valve mode 0-Still OFF 1-Still ON 2-Auto	INT		0	2

Table 6.85: Cooling Valve mode

ORDER NUMBER 0x4136 COOLOING VALVE TRIGER TEMPERATURE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Cooling Valve trigger temperature	Double	Kelvin	0,0K	9999,9K

Table 6.86: Cooling Valve trigger temperature

ORDER NUMBER 0x4137 RAMP OF OUTPUT CONTROLLED BY PID					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Ramp of outlet controlled by PID	Double	%/Unit	0,0%	100,0%

Table 6.87: Ramp of outlet controlled by PID

ORDER NUMBER 0x4138 RAMP UNIT OF OUTLET CONTROLLED BY PID					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Ramp unit of outlet controlled by PID 0-%/s 1-%/min 2-%/h	INT		1	2

Table 6.88: Ramp unit of outlet controlled by PID

ORDER NUMBER 0x4139 VACUUM INTRELOCK ON/OFF					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2	Vaccum Interlock ON/OFF 0-Vacuum Interlock WYŁ. 1-Vacuum Interlock WŁ.	INT		0	1

Table 6.89: Vaccum Interlock ON/OFF

ORDER NUMBER 0x413A ACTUAL PROCESS VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index (irrelevant)	INT			
2-9	Actual Process Value	Double	Kelvin or Voltage		

Table 6.90: Actual Process Value

6.9.3 VACUUM GAUGE ORDERS - FUNCTION CODE 0x01..

ORDER NUMBER 0x0101 ACTUAL VACUUM GAUGE VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Value	DOUBLE	mbar		

Table 6.91: Read actual vacuum gauge value

ORDER NUMBER 0x0102 ACTUAL VACUUM GAUGE ANALOG VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Value	DOUBLE	V		

Table 6.92: Read actual vacuum gauge analog value

ORDER NUMBER 0x0103 VACUUM GAUGE UNIT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Unit: 0 - mbar 1 - Torr 2 - Pa 3 - psia				

Table 6.93: Vacuum gauge unit

ORDER NUMBER 0x0104 NO SENSOR IN THE VACUUM GAUGE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	State: 0 - False, 1 - True	Bool		0	1

Table 6.94: Read no sensor state

ORDER NUMBER 0x0105 VACUUM GAUGE STATUS					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Status: -1 - "Sensor Break!" 0 - Vacuum 1 - "Wait for emission" 2 - "No Emission" 3 - "Wait for ignition" 4 - "Not Calibrated" 5 - Voltage 6 - "Degasing " + time 7 - "Exter. Setpoint" 8 - "Low Pressure" 9 - "High Pressure" 10 - "0.00e+00"	BYTE			

Table 6.95: Read vacuum gauge status

ORDER NUMBER 0x0106 LOW SETPOINT IN MBAR					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Setpoint value	DOUBLE	mbar		

Table 6.96: Set/Read LOW Setpoint in mbar

ORDER NUMBER 0x0107 HIGH SETPOINT IN MBAR					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Setpoint value	DOUBLE	mbar		

Table 6.97: Set/Read HIGH Setpoint in mbar

ORDER NUMBER 0x0108 LOW SETPOINT IN VOLTS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Setpoint value	DOUBLE	V		

Table 6.98: Set/Read LOW Setpoint in volts

ORDER NUMBER 0x0109 HIGH SETPOINT IN VOLTS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Setpoint value	DOUBLE	V		

Table 6.99: Set/Read HIGH Setpoint in volts

ORDER NUMBER 0x010A TRIGGER STATE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	State: 0 - Off, 1 -	Bool		0	1

Table 6.100: Read trigger state

ORDER NUMBER 0x010B GAUGE TYPE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Type: 0 - CTR90 1 - TTR90 2 - TTR211 3 - PTR225 4 - PTR90 5 - ITR90 6 - ITR100 7 - Baratron 8 - ANALOG IN 9 - MKS 937A 10 - PG105 11 - MG13/14 12 - PKR 251 13 - PCR 280 14 - ATMION	BYTE			

Table 6.101: Set/Read gauge type

ORDER NUMBER 0x010C CTR90/91 FULL SCALE PARAMETER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	FS: 0 - 0.1 Torr 1 - 1 Torr 2 - 10 Torr 3 - 100 Torr 4 - 1000 Torr	BYTE			

Table 6.102: Set/Read full scale parameter for CTR90/91 gauge unit

ORDER NUMBER 0x010D Baratron FULL SCALE PARAMETER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	FS: 0 - 10 Torr 1 - 50 Torr 2 - 100 Torr 3 - 500 Torr 4 - 1000 Torr 5 - 20 psia 6 - 30 psia 7 - 50 psia 8 - 60 psia 9 - 100 psia 10 - 250 psia 11 - 500 psia 12 - 725 psia 13 - 1000 psia 14 - 2000 psia 15 - 3000 psia	BYTE			

Table 6.103: Set/Read full scale parameter for Baratron gauge unit

ORDER NUMBER 0x010E TYPE OF GAS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Typ of gas: 0 - Air 1 - He 2 - Ne 3 - Ar 4 - Kr 5 - Xe 6 - H2 7 - CO 8 - define	BYTE			

Table 6.104: Set/Read type of gas

ORDER NUMBER 0x010F DEFINED GAS FACTOR					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Gas factor value	DOUBLE			

Table 6.105: Set/Read defined gas factor

ORDER NUMBER 0x0110 DEGASS POSSIBILITY					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Possibility: 0 - degas possible 1 - vacuum gauge damaged 2 - meter does not support degas 3 - too low vacuum in chamber, to start the degassing	BYTE		0	3

Table 6.106: Read degas possibility

ORDER NUMBER 0x0111 DEGAS STATE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	0 - OFF, 1 - ON	BYTE		0	3

Table 6.107: Set/Read degas state

ORDER NUMBER 0x0112 DEGAS TIME					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-5	Time	LONG	Seconds		

Table 6.108: Set/Read degas time

ORDER NUMBER 0x0113 READ REMAINING DEGAS TIME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-5	Time	LONG	Seconds		

Table 6.109: Read remaining degas time

ORDER NUMBER 0x0114 EMISSION STATE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Emission: 0 - OFF, 1 - ON	BYTE			

Table 6.110: Set/Read emission state

ORDER NUMBER 0x0115 READ EMISSION STATE FROM VACUUM GAUGE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Emission: 0 - OFF, 1 - ON	BYTE			

Table 6.111: Read emission state from vacuum gauge

ORDER NUMBER 0x0116 FILTRATION LEVEL OF VACUUM MEASUREMENT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Filtration level: 0 - low 1 - medium 2 - high	BYTE			

Table 6.112: Set/Read filtration level of vacuum measurement

6.9.4 DIGITAL OUTPUTS ORDERS - FUNCTION CODE 0x03..

ORDER NUMBER 0x0301 ASSIGNMENT OF RELAYS FUNCTION					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Relay (Out) number. From 1 to number of all relays	BYTE			
2	Assigned function code: Code corresponds to the position of function in the menu "Relay Outputs/Out x". For example, if the menu looks as below: *Relay Outputs* *Out 1* *Setpoint 1* *Setpoint 2* *Still OFF* *Still ON* *None* Code of function *Still OFF* is 3	BYTE			

Table 6.113: Assigning of relays function

6.9.5 DIGITAL INPUTS ORDERS - FUNCTION CODE 0x04..

ORDER NUMBER 0x0401 ASSIGNMENT OF FUNCTION TO THE INPUT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index 1: Channel number	BYTE	1		
2	Index 2: Function code. 1 - Interlock 2 - Operate On 3 - Operate Off 4 - Pressure Emiss ON 5 - Pressure Emiss OFF 6 - Open Shutter 7 - Close Shutter 8 - Zero Thickness 9 - Zero Time 10 - Remote Control Availability of functions is device dependent.	BYTE			
3	Digital Input number. From 1 to number of all inputs	BYTE		1	

Table 6.114: Assignment of functions to the input

ORDER NUMBER 0x0402 DIGITAL INPUTS SENSE CONTROL					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Digital Input number. From 1 to number of all inputs	BYTE		1	
2	Sense: 1 - Low level 2 - High level 3 - Falling edge 4 - Rising edge			1	4

Table 6.115: Digital inputs sense control

6.9.6 ANALOG OUTPUTS ORDERS - FUNCTION CODE 0x05..

ORDER NUMBER 0x0501 SIGNAL SOURCE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2	Assigned signal source: Corresponds to the position of signal source in the menu "Source" of Analog out channel. For example, if the menu looks as below: *Source* *Pressure 1* *Pressure 2* *Usource* *Iemis* *None* Code of signal source *Iemi* is 4	BYTE		1	

Table 6.116: Set/Read signal source

ORDER NUMBER 0x0502 RETRANSMISSION MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2	Retransmission mode: 1 - range 2 - 1 to 1 3 - exponent	BYTE		1	3

Table 6.117: Set/Read work mode

ORDER NUMBER 0x0503 RETRANSMISSION SCALE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2	Retransmission scale: 1 - linear 2 - logarithmic	BYTE		1	2

Table 6.118: Set/Read retransmission scale

ORDER NUMBER 0x0504 MINIMUM VALUE OF RETRANSMITTED PARAMETER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2-9	Minimum value Unit and min/max is signal source dependent	DOUBLE			

Table 6.119: Set/Read minimum value of the retransmitted parameter.

ORDER NUMBER 0x0505 MAXIMUM VALUE OF RETRANSMITTED PARAMETER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2-9	Maximum value Unit and min/max is signal source dependent	DOUBLE			

Table 6.120: Set/Read maximum value of the retransmitted parameter.

ORDER NUMBER 0x0506 MINIMUM VALUE OF THE OUTPUT VOLTAGE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2-9	Output voltage	DOUBLE	V	0	10

Table 6.121: Set/Read minimum value of the output voltage.

ORDER NUMBER 0x0507 MAXIMUM VALUE OF THE OUTPUT VOLTAGE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2-9	Output voltage	DOUBLE	V	0	10

Table 6.122: Set/Read maximum value of the output voltage.

6.9.7 ANALOG INPUTS ORDERS - FUNCTION CODE 0x06..

ORDER NUMBER 0x0601 ASSIGNMENT OF INPUT TO THE FUNCTION					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Code controlled function Code corresponds to the position of function in the menu "Analog Inputs -> Controlled Value". For example, if the menu looks as below: *Analog Inputs* *Controlled Value* *U source* *I emis* Code of function *I emis* is 2	BYTE	1	1	
2	The number of analog input assigned to the function *0 - no input assigned*	BYTE		0	

Table 6.123: Assignment of input to the function

ORDER NUMBER 0x0602 INPUT RANGE MINIMAL VALUE (0V)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Analog Input number	BYTE		1	
2-9	Value	DOUBLE	V	0	10

Table 6.124: Analog inputs minimal input range

ORDER NUMBER 0x0603 INPUT RANGE MAXIMAL VALUE (10V)					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Analog Input number	BYTE		1	
2-9	Value	DOUBLE	V	0	10

Table 6.125: Analog inputs maximal input range

6.9.8 PID REGULATOR ORDERS - FUNCTION CODE 0x09..

ORDER NUMBER 0x0901 SETPOINT VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	Setpoint value	DOUBLE	K		

Table 6.126: Setpoint value

ORDER NUMBER 0x0902 ACTUAL SETPOINT VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	Actual setpoint value	DOUBLE	K		

Table 6.127: Actual setpoint value

ORDER NUMBER 0x0903 PID REGULATOR TYPE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2	Regulator type 0 - T 1 - delta T	BYTE			

Table 6.128: Regulator type

ORDER NUMBER 0x0904 P parameter - T mode					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	P parameter	DOUBLE	K		

Table 6.129: Regulator T mode - P parameter

ORDER NUMBER 0x0905 I parameter - T mode					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	I parameter	DOUBLE	sec		

Table 6.130: Regulator T mode - I parameter

ORDER NUMBER 0x0906 D parameter - T mode					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	D parameter	DOUBLE	sec		

Table 6.131: Regulator T mode - D parameter

ORDER NUMBER 0x0907 P parameter - dT mode					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	P parameter	DOUBLE	K		

Table 6.132: Regulator dT mode - P parameter

ORDER NUMBER 0x0908 I parameter - dT mode					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	I parameter	DOUBLE	sec		

Table 6.133: Regulator dT mode - I parameter

ORDER NUMBER 0x0909 D parameter - dT mode					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	D parameter	DOUBLE	sec		

Table 6.134: Regulator dT mode - D parameter

ORDER NUMBER 0x090A ASSIGNMENT OF THE INPUT PARAMETER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2	Input parameter	BYTE			

Table 6.135: Input parameter

ORDER NUMBER 0x090B SETPIONT MAX VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	Setpiont max value	DOUBLE	K		

Table 6.136: Setpoint max value

ORDER NUMBER 0x090C SETPIONT MIN VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	Setpiont min value	DOUBLE	K		

Table 6.137: Setpoint min value

ORDER NUMBER 0x090D RAMP RATE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	Ramp rate value	DOUBLE	K		

Table 6.138: Ramp rate value

ORDER NUMBER 0x090E RAMP RATE UNIT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2	Ramp rate unit	BYTE			

Table 6.139: Setpoint max value

ORDER NUMBER 0x090F TRIGGER TEMPERATURE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	Trigger temperature	DOUBLE	K		

Table 6.140: Trigger temperature

ORDER NUMBER 0x0910 END TEMPERATURE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	End temperature	DOUBLE	K		

Table 6.141: End temperature

ORDER NUMBER 0x0911 PID OUTPUT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-9	PID Output	DOUBLE	%		

Table 6.142: PID Output

ORDER NUMBER 0x0912 SET AUTOTUNE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2	Autotune	BYTE			

Table 6.143: Set autotune

ORDER NUMBER 0x0913 AUTOTUNE STATE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2	Autotune state	BYTE			

Table 6.144: Autotune state

6.9.9 OPERATE TIMER ORDERS - FUNCTION CODE 0x11..

ORDER NUMBER 0x1101 TIMER COUNTING DIRECTION					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2	Counting direction 0 - down 1 - up	BYTE		0	1

Table 6.145: Timer counting direction

ORDER NUMBER 0x1102 OPERATE TIME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-5	Operate time	LONG	sec		

Table 6.146: Operate time

ORDER NUMBER 0x1103 OPERATE TIME SETPOINT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-5	Operate time setpoint	LONG	sec		

Table 6.147: Operate time setpoint

7 MAINTANCE AND SERVICE

7.1 MAINTANCE

The HEAT3 does not require any special maintenance work.

7.2 CLEANING

For cleaning of the outside of the device, a slightly moistened cloth will usually do. Do not use any aggressive or abrasive cleaning agents.

DANGER

Mains voltage.
Components inside of the HEAT3 are components at mains voltage. Do not insert any objects through the louvers of the device. Protect the device from liquids. Do not open the device.

7.3 FIRMWARE UPGRADE

On the pictures below we will use the names of {device_name} and {version}:

- {device_name} in this case means HEAT3 .
- {version} is in numerical form and contains 3 digits separated by a dots. E.g: 1.0.0 or 3.1.5

WARNING

Firmware upgrade

During the upgrade, do not turn off the HEAT3 or disconnect it from the wall outlet. Failure to do so may cause damage to the HEAT3 , with the result that the unit is not unfit for use and will require repair.

In order to update the software/firmware via USB the USB memory stick must be formatted as FAT / FAT32. Then simply copy the update file received from us to the memory stick and insert into the USB slot on the front of the HEAT3 . The “New USB Device Detected” hint will appear on the bottom of the screen.

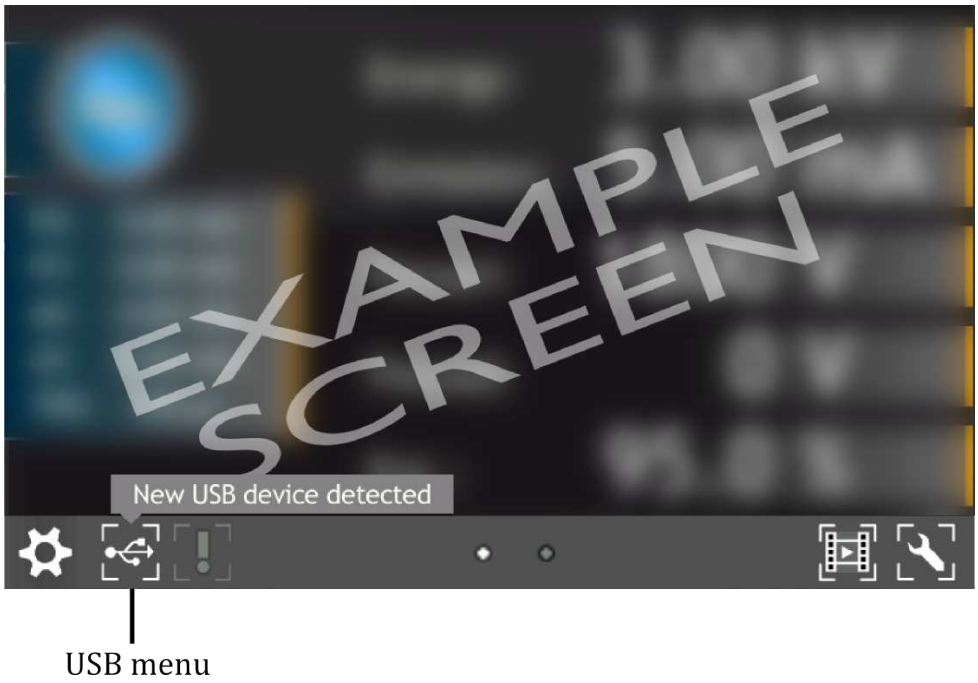


Figure 7.1: USB detected hint

The USB menu is accessed by clicking the USB icon on the bottom of the screen. This displays several options:

- see list of found firmware,
- copy user manual to USB,
- un-mount USB drive,
- export log file onto USB,
- see list of videos on USB,
- copy new language to device,

Figure 7.2: USB menu

To update the current version to a newer version, select the Firmware Updates option. To accelerate the search for updates on the USB drive, delete all files except the updates.

Figure 7.3: Firmware list

In order to choose one of the updates simply click on the name. The “Do you want to update firmware to selected version? After whole procedure device will be rebooted” phrase will appear. Selecting No returns the user to the main menu of Firmware Updates. It is highly recommended to finish all the work on the device and save your data before pressing the “Yes” button.

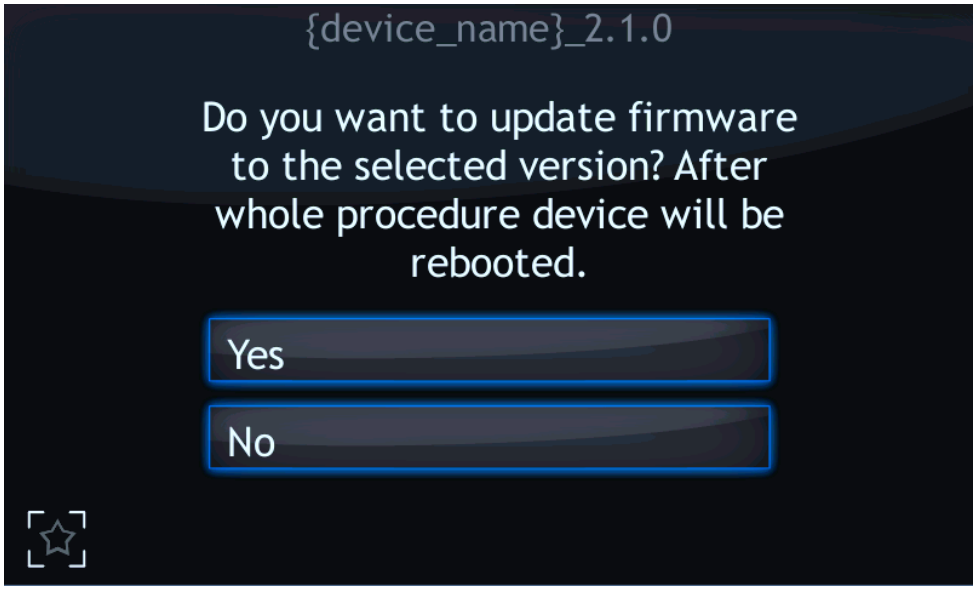


Figure 7.4: Restart message

After selecting to proceed with the update, the device will stop and the updating procedure will be initiated. The update process takes a few minutes during which time the screen below is displayed.

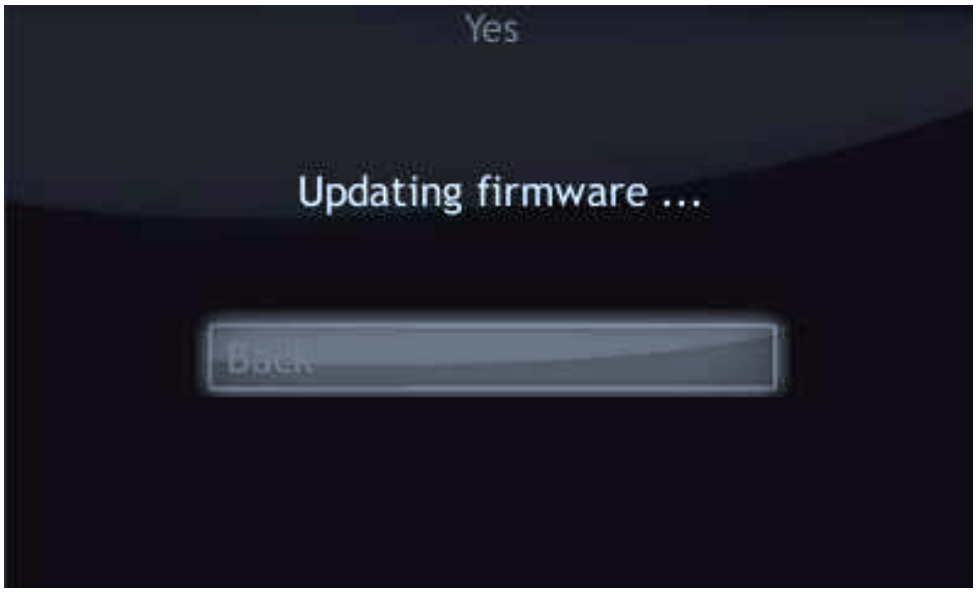


Figure 7.5: Updating firmware

Upon successful installation, the message with "updated" statuses should be displayed.

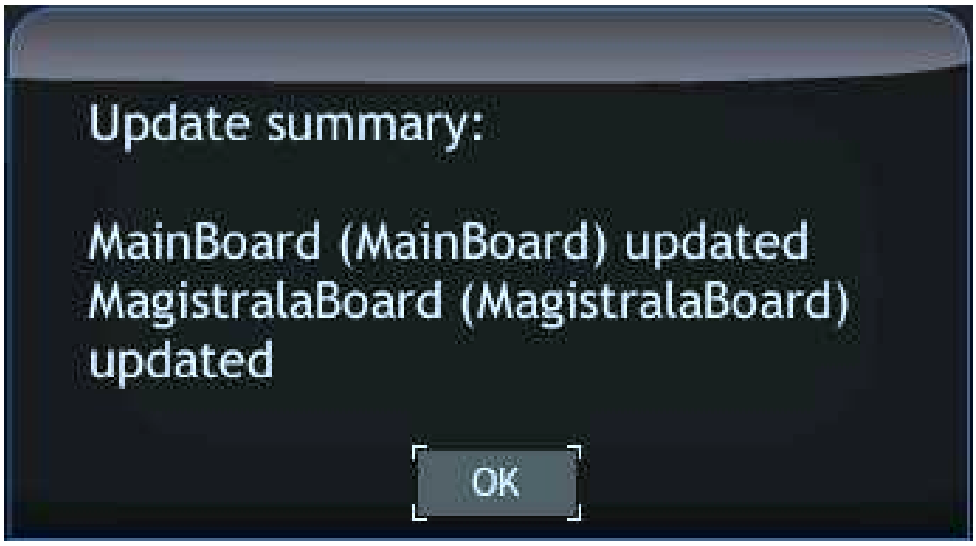


Figure 7.6: Update summary example

Select “OK” to reboot the device and finish the upgrade.

7.3.1 AUTO UPDATE

The auto-update feature compares the current version of main-board and bus firmware with software. In case of any mismatch (for example if the micro SDHC card was swapped) the user will be informed with a blinking exclamation icon.

- To synchronize the firmware, select the exclamation icon.
- The screen below is displayed. If the “Recommended Updates” message is visible, tap the “Auto Update” button in order to synchronize firmware and software. Then follow the procedure from the previous section Upgrading firmware via USB.

Figure 7.7: Auto update 1

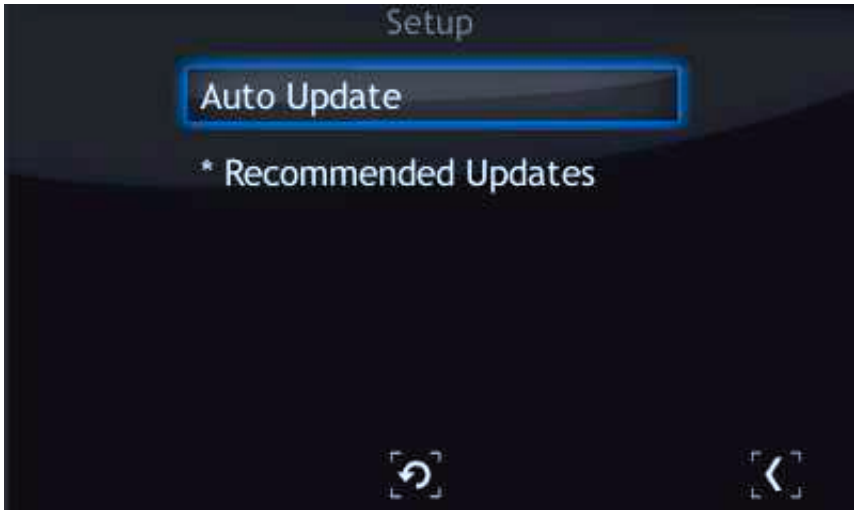


Figure 7.8: Auto update 2

7.4 PREBOOT ENVIRONMENT

To run the Preboot application press on the logo at HEAT3 startup (7.9).

Figure 7.9: Enter into preboot environment

The Preboot Environment is an application to boot the HEAT3 . Its main task is to launch the device in the version selected by the user. It can also be used to run other tools, such as the gauge calibration application.
The main menu consist three options:

- Reboot – rebooting HEAT3 .
- Continue booting – close Preboot Environment and continue starting HEAT3 .
- Continue booting (photo mode) – allow to run device with screenshot function.

7.4.1 BOOT MENU

Boot menu allows the user set which version of the HEAT3 and Preboot Environment will be run after the start of device. In order to switch software version, click on “Software boot version” combo box.

Figure 7.10: Boot menu

Then select one of the available versions, for example default.

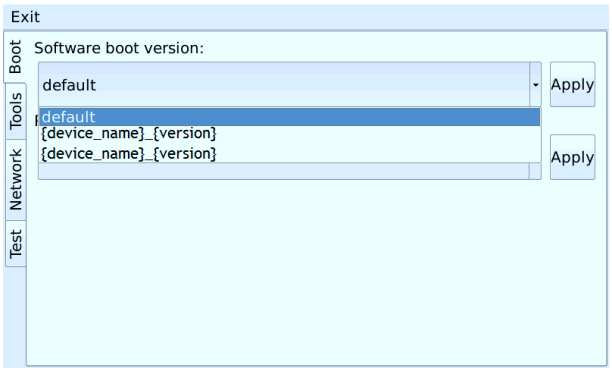


Figure 7.11: Switch software version

To apply changes press Apply button. From now the default version will be automatically run after restarting HEAT3 .

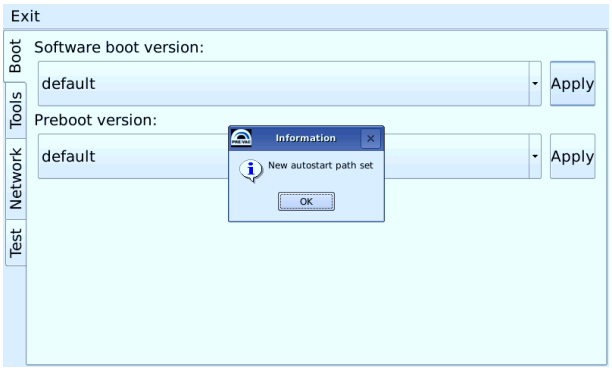


Figure 7.12: Message box confirming the changed settings

7.4.2 TOOLS MENU

The Tools menu allows the user to run applications such as touch screen or power supply calibration.

Figure 7.13: Tools menu

In order to select one of the applications, tap the desired application from the tools combo box and tap the Run button.

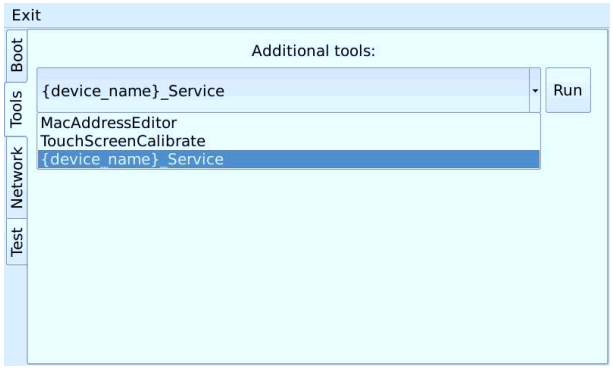


Figure 7.14: Selecting additional tool

7.4.3 NETWORK TAB

From this tab the user can configure the IP address, netmask and enable / disable DHCP.

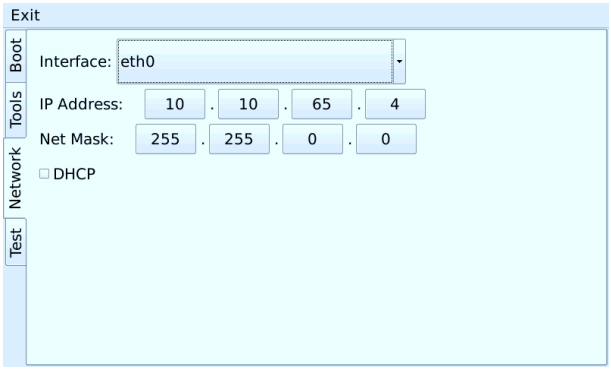


Figure 7.15: Network tab

After tapping on one of the editable fields, the numeric panel for editing values will appear . Input values can be completed by tapping X button in the upper-left corner of the screen.

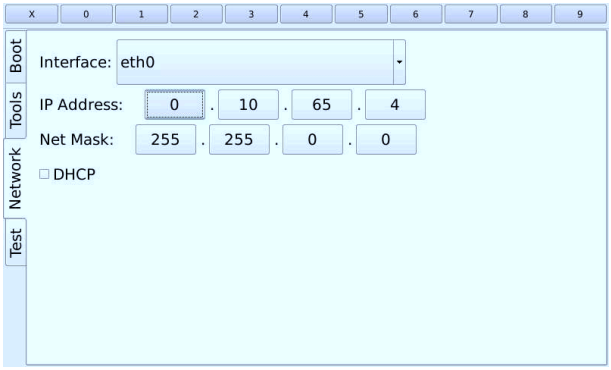


Figure 7.16: Numeric panel

7.4.4 TEST TAB

From this tab the user can test the speaker.

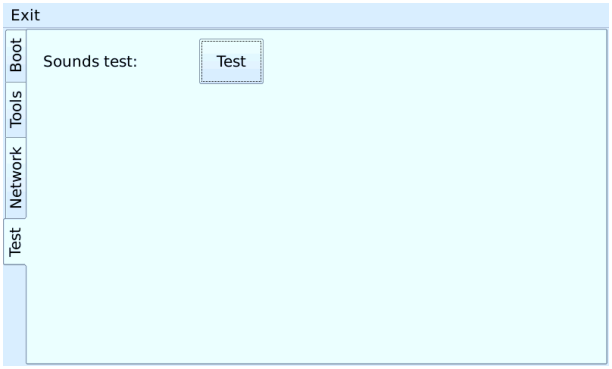


Figure 7.17: Test tab

8 STORAGE AND DISPOSAL

8.1 PACKING

Please retain the original packaging. The packaging is required for storing the HEAT3 and for shipping it to an authorized PREVAC service center.

8.2 STORAGE

The HEAT3 should only be stored in a dry room. The following requirements must be met:

PARAMETER	VALUE
Ambient temperature	-20...50°C
Humidity	as low as possible; preferably in an air-tight plastic bag with a desiccant

Table 8.1: Storage parameters

8.3 DISPOSAL

The product must be disposed of in accordance with the relevant local regulations for the environmentally safe disposal of systems and electronic components.