PCN 4 / PCN 7

User's manual

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Revision

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History of the revisions

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a	Document creation	24/10/2023
b	Rectangle removed on figure 16	12/01/2024
c		
d		
e		

1. GENERAL PRESENTATION

1.1. INTRODUCTION

Thanks to different optical systems (cameras, scanners, radiometers, thermal imaging systems...), infrared thermography allows the measurement of the emitted power of an object and possibly its temperature.

The reference IR sources PCN allow the characterization or the calibration of these optical systems.

The PCN is a reference blackbody with a square emitting surface which temperature is accurately regulated over a wide temperature range. This blackbody family is particularly suitable for production line applications.

As every HGH's blackbody, it provides an emissive surface with superior uniformity. Its highly stable radiometric structure makes it a reliable IR reference source delivered with a certificate of calibration valid for 2 years.

Figure 1 : Left : PCN-4 head / Right : PCN-7 head

Table 1 shows the list of available PCN models.

	Emissive surface size	Temperature range
PCN-4	100 mm x 100 mm	[0°C ; 100°C]
PCN-7	180 mm x 180 mm	[5°C ; 100°C]

Table 1 List of available PCN models

Associated to higher level INFRATEST software, the PCN allows performing all the following IR tests and calibration of thermal imagers, detectors and IR cores:

- Thermal calibration
- Temporal noise
- Fixed pattern noise
- NETD (Noise Equivalent Temperature Difference)
- SiTF (Signal Transfer Function)

- Temporal noise power spectral density
- Spatial noise power spectral density
- Non Uniformity correction
- Bad pixel location

1.2. FEATURES

- ✓ High emissivity,
- ✓ High display resolution to 0.001°C for temperature measurements and set point,
- ✓ High regulation stability better than 20mK,
- ✓ High uniformity,
- ✓ High speed heating and **cooling** down,
- ✓ Easy integration into the production line whatever the orientation,
- ✓ Supplied with International Primary Standards traceable radiometric calibration certificates over LWIR range certificate valid for 2 years,
- ✓ User selectable display of physical temperature or radiometric temperature,
- ✓ Remote control through Ethernet communication link,
- ✓ Delivered with ready-to-use remote control software Infratest-Platform.

2. DESCRIPTION

The system consists in two main sub-assemblies:

- The Electronic Controller
- The Blackbody Head

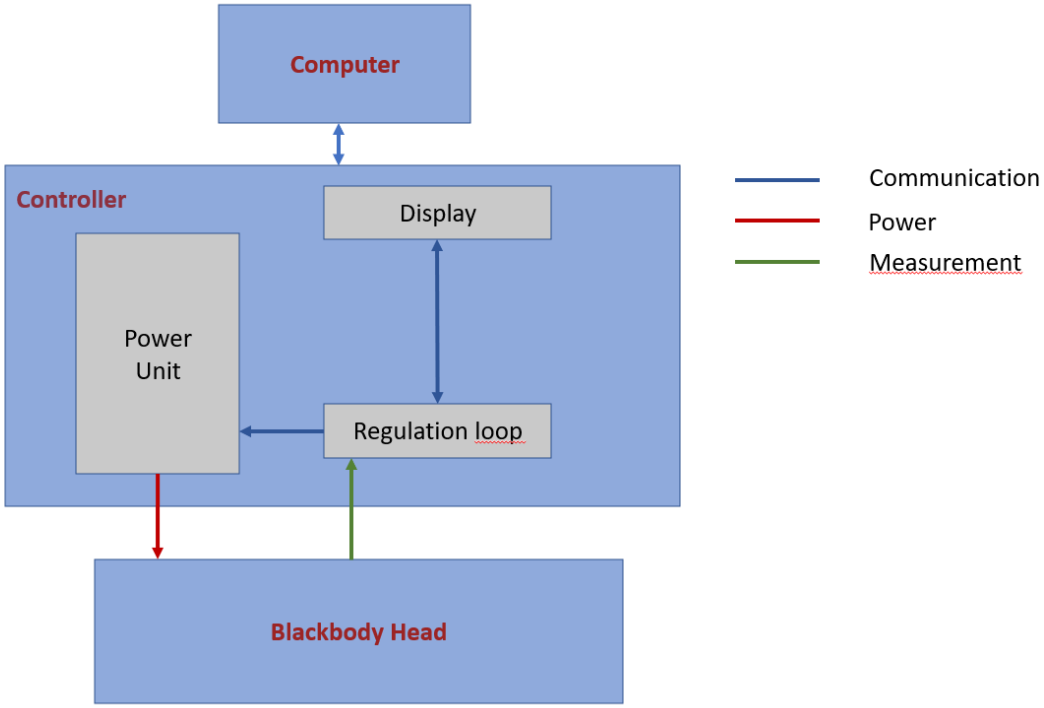
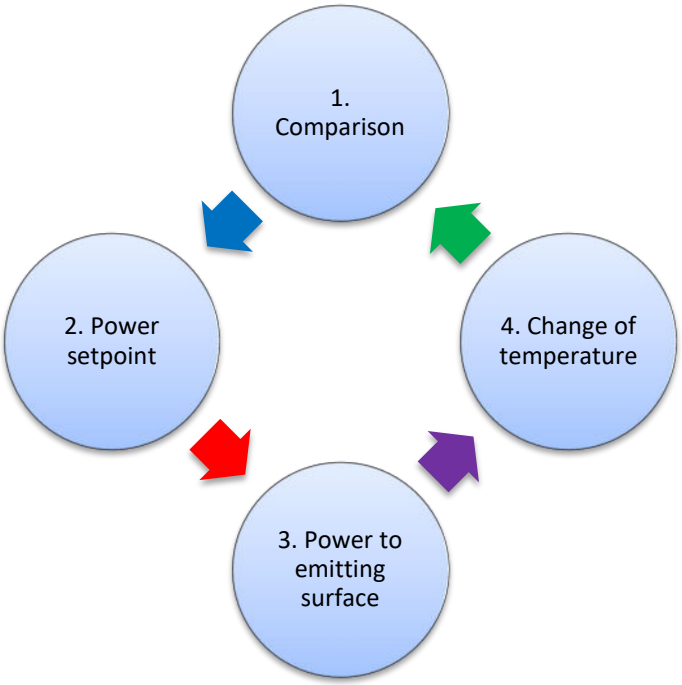


Figure 2 : Synoptic scheme

The principle of operation of the PCN is based on the temperature regulation loop:

1. Comparison of the actual temperature of the surface with the temperature setpoint. The temperature of the surface is measured by the sensor inserted into the emitting surface.
2. Conversion of the comparison result into power setpoint
3. Application of the power to the emitting surface (heating or cooling)
4. Modification of the emitting surface temperature



2.1. ELECTRONIC CONTROLLER

The electronic controller processes the output data of the temperature sensors and controls the Power Unit through a dedicated communication link. Then the Electronic Controller sends the power to the Blackbody Head in order to regulate its temperature at the desired set-point.

By default, the controller is configured to control one blackbody head. In option, the controller can be configured to control two heads of the same size.

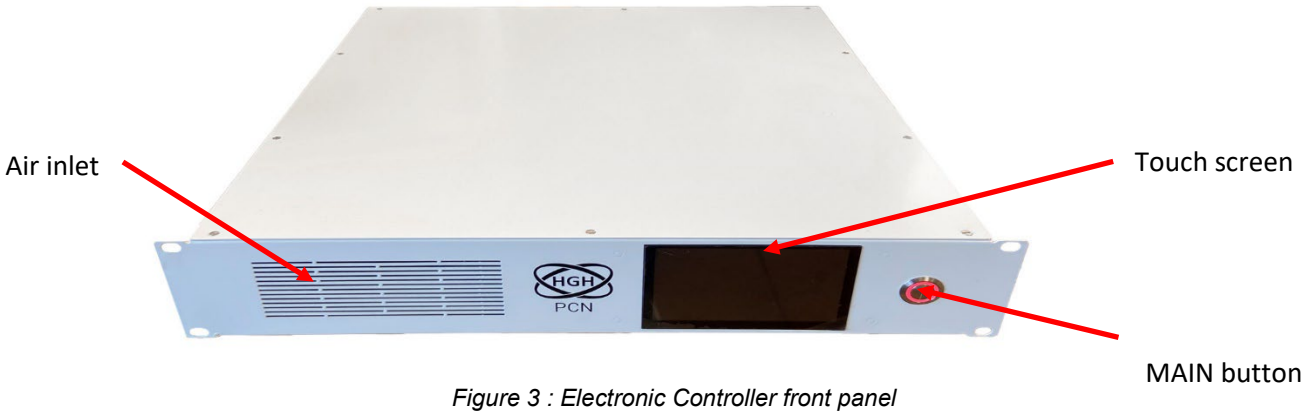


Figure 3 : Electronic Controller front panel

The front panel entails:

- a main button,
- a touchscreen.

The main button allows switching ON or OFF the controller. In user mode, the blackbody temperature is displayed on the screen in real time.

The mains button is lighted when the power switch at the rear panel is ON.

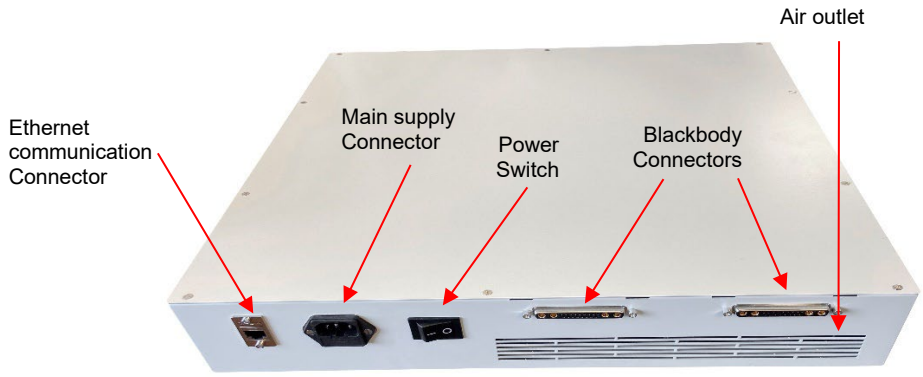


Figure 4 : Electronic Controller rear panel

The Mains Supply connector, the power switch, Blackbody Connectors and the communication connector are located on the rear panel.

The Power Switch allows the voltage supply of the controller.

The electronic controller is also rackable in an electrical cabinet.

Four M6×16 screws are needed to assemble a controller in the cabinet.

2.2. BLACKBODY HEAD

The blackbody head of the PCN entails a temperature-controlled emitting dark surface.

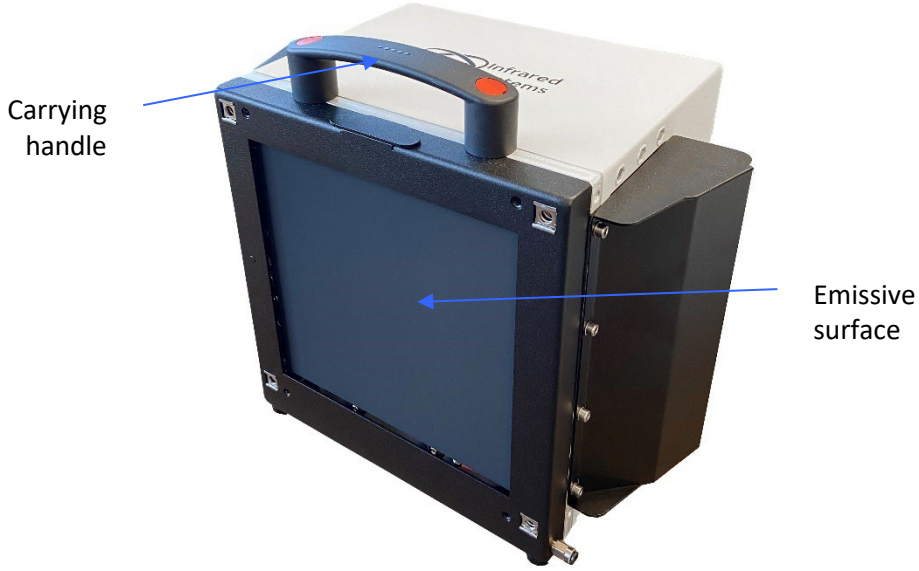


Figure 5 : PCN head (front view)

Figure 6 : PCN head (rear view)

The temperature of the emissive surface is measured with a high precision thermometric platinum sensor.

A set of thermoelectric elements using Peltier effect allows controlling the temperature of the blackbody.

Fans cool down the hot face of the thermoelectric elements at ambient temperature to increase the efficiency and the working temperature range.

The blackbody head is connected to the electronic controller using the “BLACKBODY” connector.

When the blackbody head is not in use, it is preferable to set its cover using the four latches:

Figure 7 : Blackbody Head cover

2.3. SUPPLY

2.3.1. Single head configuration

The reference blackbody PCN is delivered in one case including:

- Blackbody head with protective cover,
- Electronic controller,
- Electronic controller Main power cable,
- Head to electronic controller cable,
- A USB key including remote control software Infratest-Platform, the operating manual of the communication protocols and this operating manual,
- A Quick Start sheet,
- Ethernet to PC cable,
- Calibration Certificate,
- Control sheet,
- HGH Declaration of Conformity.

2.3.2. Double head configuration

In addition to the above items, the supply includes:

- Second blackbody head with protective cover,
- Second head to electronic controller cable,
- Second head calibration certificate
- Second head control sheet.

3. OPERATION

3.1. PREPARATION OF THE BLACKBODY

First, keep the packaging used for sending the blackbody. It must be used if the blackbody is sent back to HGH for maintenance or calibration. If HGH Customer Support receives a blackbody not properly packed, cost of a new packaging may be charged at that time.

Before connection, check on the electronic controller that both switches (power and mains) are *OFF*.

Use the handles to lift the Blackbody head (PCN-7 only). If necessary, handles can be removed using an M4 hexagonal male key.

Set the blackbody head on a stable surface or support. HGH recommends to fix it using the dedicated holes in its base plate or lateral holes.

Check that fans air inlets and outlets are not obstructed.

Check on the identification labels that both head and electronic controller have the same type (example : PCN-4). Never try to connect a head that has not the same type as the Electronic controller.

Correctly connect the cables in the following order:

High voltage, do not put your fingers into the connectors.

1. If necessary, connect the Ethernet communication cable,
2. Connect the blackbody head to controller cable,
3. Check that mains terminals are equipped with **ground connectors**. Then check that the main supply is correct and connect the Electronic controller Main power cable.

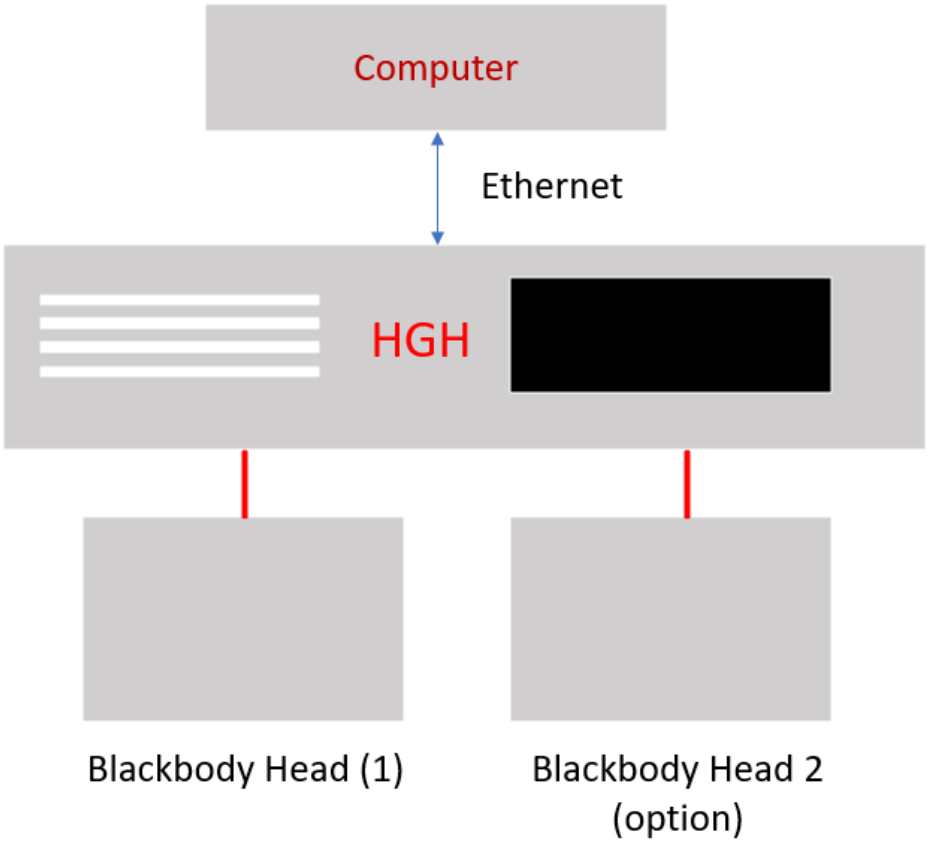


Figure 8 : Interconnection diagram

Remove the protective cover and switch the POWER and MAINS buttons *ON*.

The main screen is then displayed. This is the screen on which the temperatures are displayed.

Check on the identification label on the head that its serial number is the same as written in the controller. To check the serial number written in the controller please refer to Figure 13.The number is written in front of the Blackbody type.

3.2. USER INTERFACE

3.2.1. Starting procedure

Switch on the power switch at the rear panel of the controller. The main button at the front panel of the controller becomes red. Then turn on this main button. During the starting procedure this button is blinking blue. This procedure may last a few seconds before the HGH logo appears.

Some tests are set up in the controller. The result of these tests is displayed. Please refer to the Quick Start Sheet supplied with the blackbody or to the paragraph 5.3.2.

By validating the result screen, the main screen is displayed.

3.2.2. Main screen

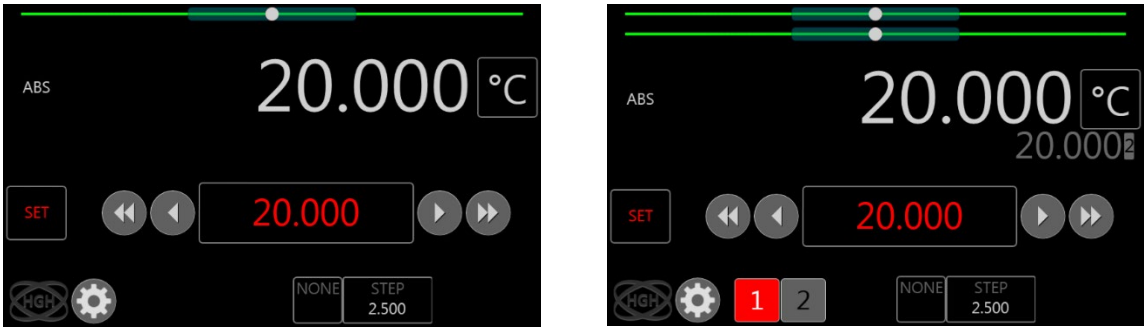


Figure 9 : Main screen, left: Single Blackbody configuration/ right: Double Blackbody configuration

3.2.2.1. General operation

The screen is a touch screen: areas with possible action are surrounded by a rectangle or a circle. This rule is applicable whatever the displayed page.

Examples:

- Actions possible: 

- No action possible: 

Temperature set point (***20.000*** in red in the above example, left): indicates the current temperature set point. Press this button to get to set point modification keypad (refer to paragraph 3.2.3).

: indicates if the temperature is displayed in °C, °F or K. Press the button to change the temperature unit.

: This button gives access to predefined set-points.


: This button gives access to protected parameters (administrator only) and user parameters.

: Press this button to choose the value of the step between two set points.


: Press these buttons to move on the previous or the next set point. The gap is the STEP value or ten times the STEP value 
.

The top line provides a graphical display of all temperature's status.

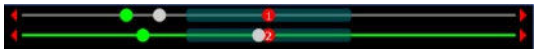
● : The temperature set point is characterized by the red dot. The white dot describes the status of the blackbody temperature. It appears in green when the temperature of the blackbody has reached the set point and is stabilized at ±0.1°C (blue area around the setpoint - this default value can be modified in the administrator menu, refer to paragraph 3.2.5.2). If the blackbody hasn't reached the set point yet the dot is white.

3.2.2.2. Double blackbody configuration

In the case where two heads are connected, some buttons are added and additional information are required to control them simultaneously.

: This selector allows the selection of the blackbody to be controlled. The red button is the actual selected blackbody (eg : here is the Blackbody #1 selected).

: This is a display information only; it shows the temperature of the non-selected emissive head following by its number (eg : here the Blackbody #2's surface is stabilized at 29.999 °C).


: There are two stability rod, each one is differentiated by the blackbody number (eg : the Blackbody #2 is stabilized while #1 is heating).

3.2.3. Numeric keypads

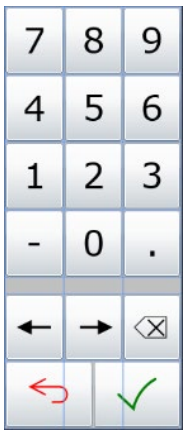


Figure 10: Numeric keypad

This screen is the numeric keypad that appears anytime the user presses a numerical value he wants to modify or the temperature set point button in the main screen. It allows entering a new value for

the corresponding variable. When a new value is entered, the user must press  to take it into account and then press Return () to get back to the screen from which the keypad was called. If different values can be changed in the same screen, press  to get from one value to the next.

 Press this button to suppress the previous variable.

 Press these buttons to select any variable in the number.

Press the variable anywhere you want to set the cursor at this position.

Figure 11 : Letter keypad

This screen is the keypad that appears anytime the user presses a not-only numerical value like a password. When a new value is entered, the user must press  to take it into account.

 Press this button to suppress the previous variable.

Press the selected variable to set the cursor at this position.

3.2.4. Predefined set-points

In this screen, there are predefined temperature set points that can be chosen by the user instead of entering them manually from the main screen. Its purpose is to make it faster and more convenient for the user to select the temperature set points that he often uses.

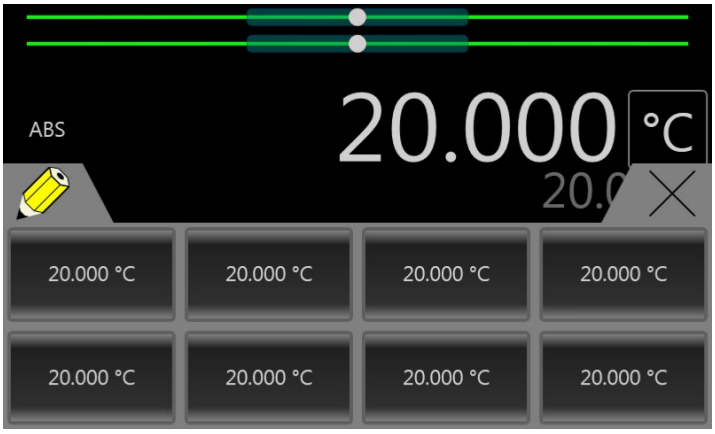


Figure 12 : Predefined temperature table

The different predefined temperature set points can be changed by the user:

Press  to select the temperature set-points. Press one of these temperatures to change the temperature set point to the corresponding value. In this example, the current mode is ABS, so for instance, pressing a temperature changes the temperature set point from 30.000°C to the value on the button.

Warning: it is not possible to change from one mode to the other from this screen; it must be done from the main screen.

Press ✖ to get back to the main screen.

3.2.5. Advanced menu

This menu gives access to protected parameters such as calibration parameters. Some can't be modified (user menu), some can be modified by an advanced customer administrator, others are factory parameters and only HGH has an access to them.

Click on the  button of the main screen to get to the administrator selection screen:

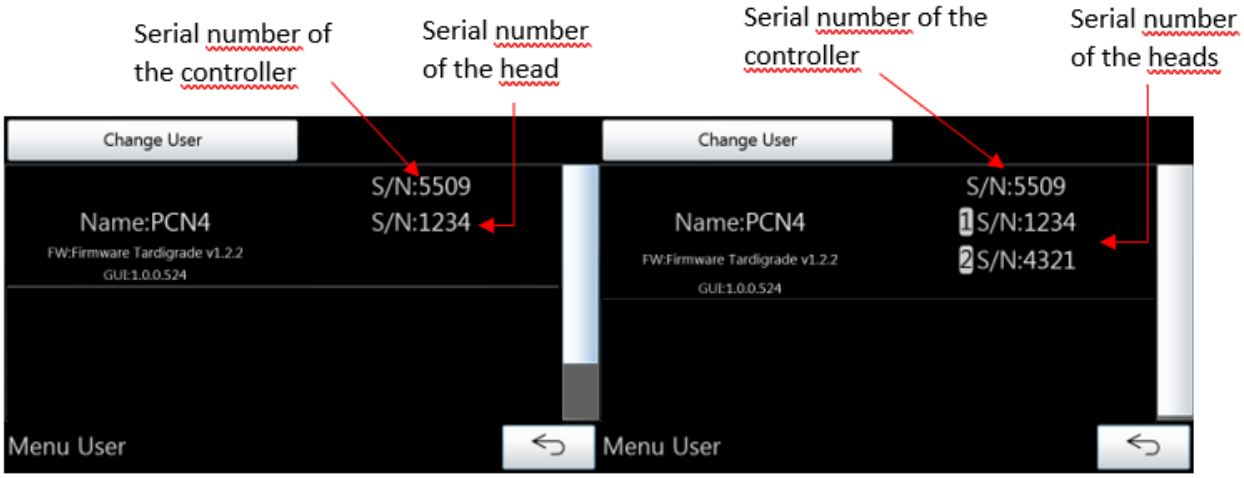


Figure 13 : Selection screen (1/2), left : 1 head connected / right : 2 heads connected

The menu by default is the user menu. To switch on Advanced menu, click on *Change User* to display the following screen.

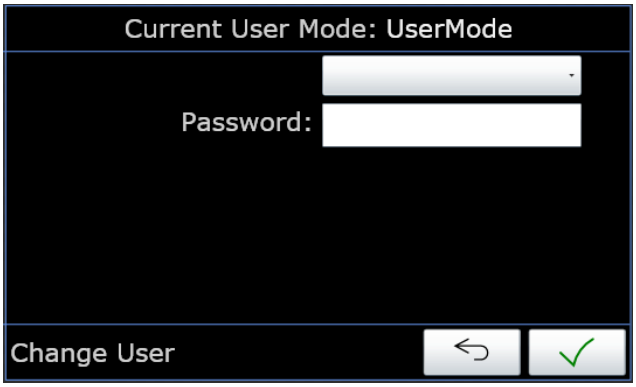


Figure 14 : Selection screen (2/2)

Choose Advanced in the drop menu. Then enter the customer password using the numeric keypad. The Advanced password is provided in the control sheet of the blackbody.

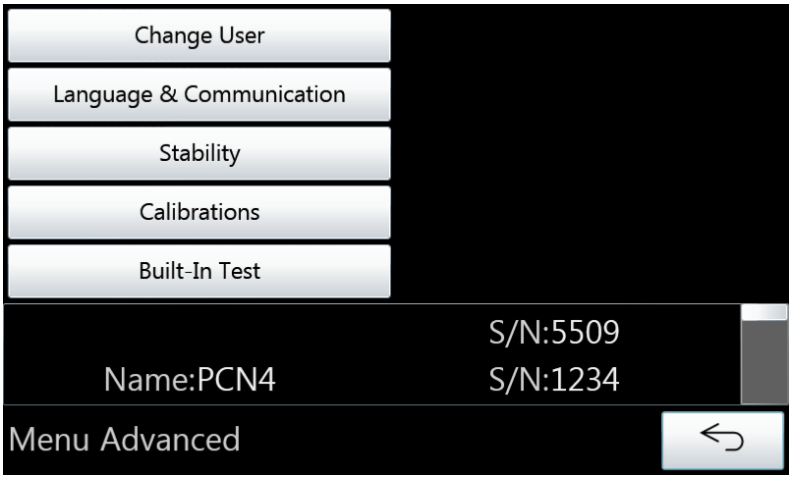


Figure 15 : Customer advanced menu screen

3.2.5.1. Language & communication menu

Click on *Language & communication* on the advanced menu to display the following screen.

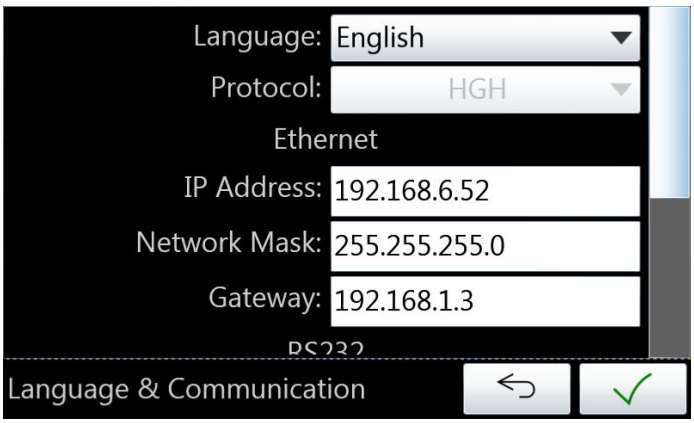


Figure 16 : Language & communication menu

Language: Choose the operation language of the controller (English or French).

Ethernet is the configuration of Ethernet control interface.

Default values are described in paragraph 4.

3.2.5.2. Stabilization menu

Click on *Stabilization* on the advanced menu to display the following screen:

Figure 17 : Stabilization menu screen, left: 1 head connected / right : 2 heads connected

This menu allows modifying the stabilization criteria.

Tolerance is the temperature tolerance (in °C) into which the blackbody is considered as stabilized.

Duration is the time in seconds during which the temperature error needs to be into the tolerance range so that the blackbody is considered as stabilized.

In the case both criteria are satisfied the circle at the top of the main screen becomes green and remains in the blue area stabilization.

Default values are:

Stabilization tolerance: 0.10°C

Stabilization counter: 20s

 : Press this button to validate the new parameters and get back to the advanced menu.

 : Press this button to get back to the advanced menu.

 : Press this button to get back to the default values.

3.2.5.3. Calibration parameters menu

Click on *Calibration* on the advanced menu to display the following screen.

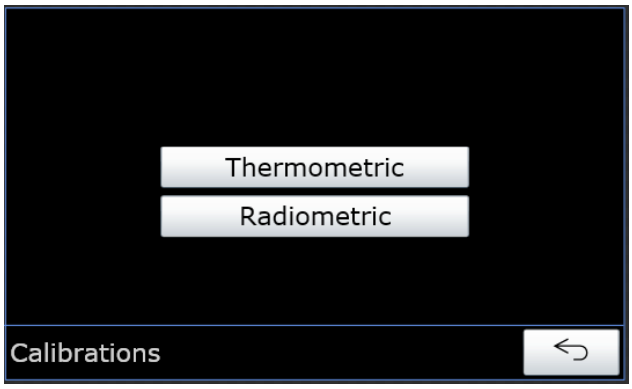


Figure 18 : Main calibration menu

3.2.5.3.1. Thermometric calibration menu

Do not modify the TSES (Emissive Surface Temperature Sensor) sensor parameters without HGH recommendation.

3.2.5.3.2. Radiometric calibration menu

Click on Radiometric on the calibration menu to display the following screen.

Figure 19 : radiometric calibration menu

This menu gives access to compensation parameters so that the actual radiance temperature equals the displayed temperature.

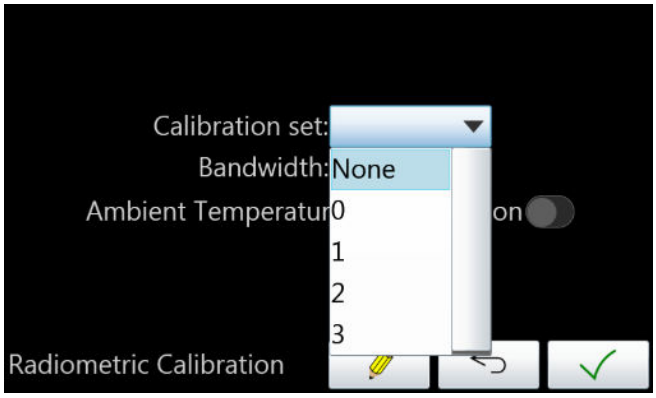


Figure 20 : Compensation set selection

On the drop menu choose the compensation set. The following choices are possible:

None: no compensation set

1: LWIR spectral bandwidth radiance temperature compensation set

0, 2 and **3** are remained free for complementary tables.

When **None** is selected, the displayed temperature is the physical temperature of the emissive surface. Actual emissivity of the emissive surface must be taken into account in order to calculate the radiance of the source. Alternatively, the radiance can be calculated using the actual radiated temperature and emissivity value 1. The actual radiated temperature vs. displayed temperature table is shown on the delivered calibration certificate before compensation.

Displayed temperature / *Température affichée* (°C)	Real temperature of the source under test / *Température réelle de la source à étalonner* (°C)
20	20,07
50	49,64
70	69,47

Figure 21 : Example: displayed temperature vs. actual radiated temperature with no compensation

In order to avoid this complex calculation, the selection of one of the available compensation sets allows to have:

Displayed temperature = Radiated temperature

Thus, the source behaves like a perfect blackbody over the selected spectral bandwidth. The selected bandwidth is written below the calibration set.

The PCN blackbodies are delivered with a compensation table in LWIR. By default, the LWIR table is selected upon delivery. The selected table is shown on the main menu screen (see Figure 9).

Displayed temperature / *Température affichée* (°C)	Real temperature of the source under test / *Température réelle de la source à étalonner* (°C)
20	20,0
50	50,0
70	70,0

Figure 22 : Example: displayed temperature vs. actual radiated temperature with compensation

Important remarks:

- HGH radiometric calibration results are traceable to International Primary Standard.
- The validity of this calibration cannot exceed 2 years.
- The calibration results are valid only at room temperature noted into the certificate ±2°C.

3.3. OPERATION IN EXTENDED ENVIRONMENT RANGE

3.3.1. Special recommendations for operation

PCN are blackbodies compatible with wide environment range such as climatic chamber operation. The range of use is [-20°C; 70°C].

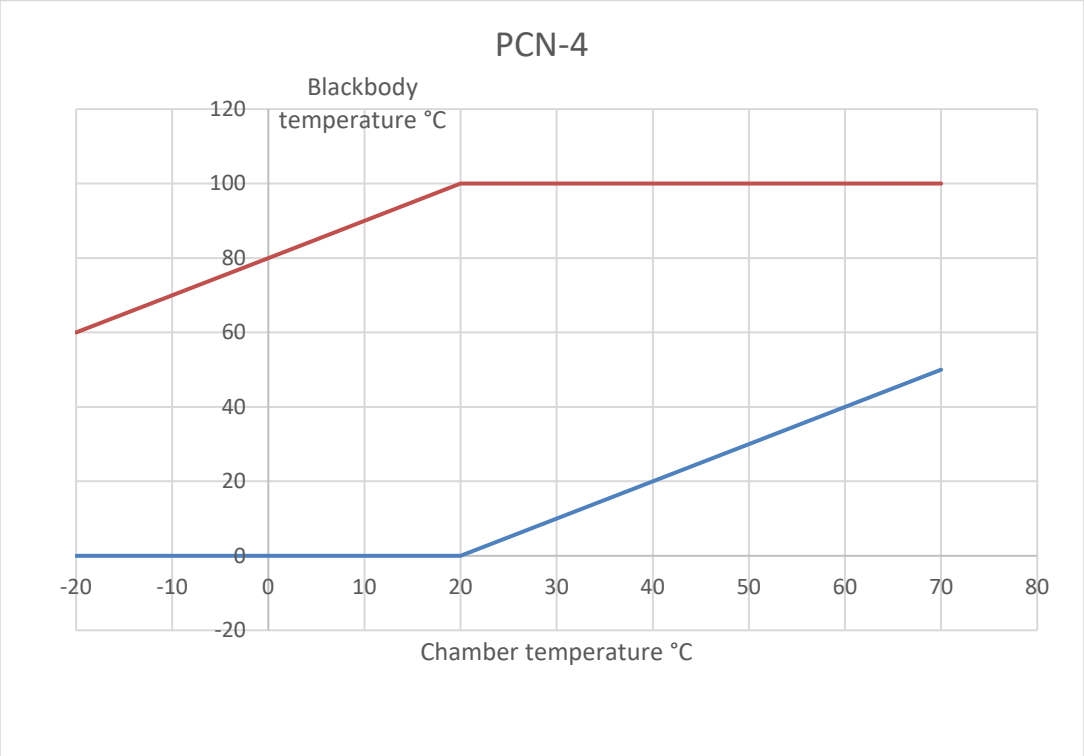
HGH recommends to start tests at high ambient temperature and then set the climatic chamber temperature at lower temperatures (down to -20°C), rather than directly turning the blackbody on when the climatic chamber is under 0°C.

When the climatic chamber is heating, make sure the blackbody setpoint remains higher than the climatic chamber temperature to avoid condensation on the blackbody head. If not possible, set the blackbody temperature 30°C above the dew point during 30 minutes after climatic chamber temperature stabilization in order to remove residual humidity from the head.

Please make sure the blackbody head does not remain under dew point over long periods.

3.3.2. Blackbody temperature achievable range

The minimum and maximum achievable temperatures on the emissive surface depends on the environment temperature and are shown on the below Figure 23.



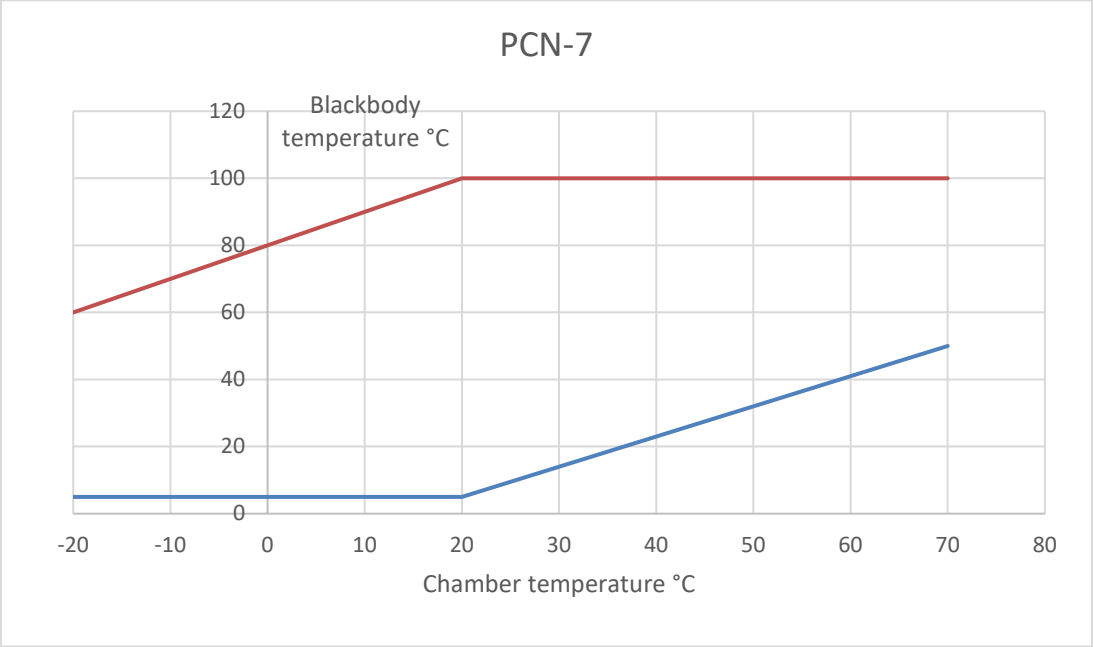


Figure 23: Achievable temperature range vs. chamber temperature

4. REMOTE CONTROL THROUGH ETHERNET INTERFACE

Ethernet interface enables to connect several blackbodies on a network and to control them from a distant PC.

The communication protocol is defined in the user's manual of the DCN, ECN and RCN Ethernet protocol.

The blackbody is delivered with IP address **192.168.1.201**. You can change this IP address using INFRATEST – Platform.

5. PRECAUTIONS OF USE AND MAINTENANCE

5.1. ELECTRONIC CONTROLLER

High voltage, do not put your fingers into the connectors.

Connect the Electronic controller on mains plug equipped with a **ground** terminal.

Control the correct connection of the connectors on back panels.

Do not cover the aeration holes.

Clean the controller with a humid soft cloth. Do not use solvent or alcohol.

Do not press the touch switches of the screen with a force greater than 30N.

Do not use benzene, paint thinner or other volatile solvents and do not use chemically treated cloths to clean the screen.

Never try to open the Electronic controller without HGH advice.

5.2. BLACKBODY HEAD

Danger OF COLD OR HEAT BURN

Avoid shocks to protect the thermoelectric elements.

Do not touch the emissive surface of the blackbody otherwise its emissivity could be seriously damaged.

Do not spray any paint or any other product on the emissive surface as it would damage its optical properties.

Remove dust with dry compressed air only.

Do not cover aeration holes.

Condensation or ice on the emissive surface causes little damages on the emissivity. It is however highly recommended to avoid maintaining the blackbody at low temperature to minimize the risk of damage.

Clean the blackbody's head with a humid soft cloth. Do not use solvent.

Install the protective cover, check that no condensation water remains, in case of storage or if the blackbody is unused for a long time.

5.3. TROUBLE SHOOTING

5.3.1. The main button remains off

When the user switches ON the power switch a red light appears around the main button. If not, the controller may be misconnecting from the main supply. Press the main button. If nothing happens, the system remains silent and the screen off, check that the mains line is correctly 230V powered. Try again.

If the light indicator still remains off, please contact HGH.

5.3.2. Autotest

Startup and continuous tests are set up in the controller. Press the *Built-in-test* button in the Advanced menu to display the following screen.

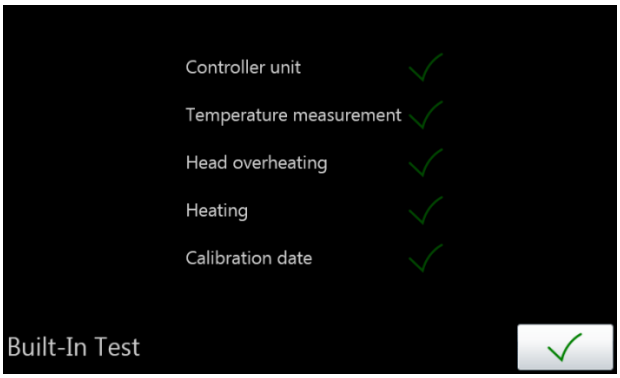


Figure 24 : Built-in-test result

If one of the 4 criteria is false (✗ instead of ✓), press ✚ to show the following screen

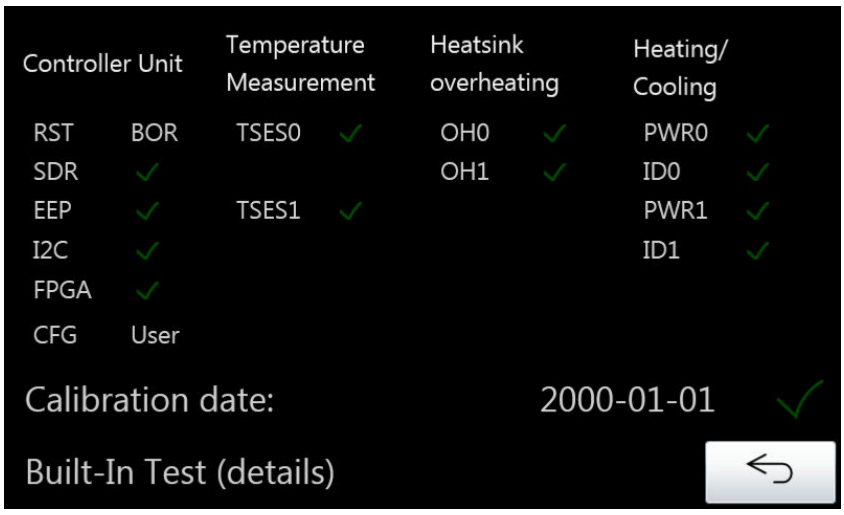


Figure 25 : Built-in-test advanced menu

Controller unit :

- If an error appears on this part, turn the blackbody off and on. If the error remains, please contact HGH.

Temperature measurement : Sensor failure (Emissive Surface Temperature Sensor (TSES).

- Check that the blackbody cable (between the Electronic controller and the head) W01 is correctly connected. Try again. If the error remains, please contact HGH.

Heatsink overheating :

- Check that the fans are working, and that the fans inlets and outlets are not obstructed. Try again. If the error remains please contact HGH.

Heating/cooling :

PWR0 : Power failure

- Check that the blackbody cable (between the Electronic controller and the head) W01 is correctly connected. Try again. If the error remains, please contact HGH.

ID0 : Wrong head connected. If so, please connect the good head.

5.3.3. The fans don't work

You switched ON the electronic controller the RUN indicator lights normally on it, but the fans remain static.

- Check that the blackbody cable (between the Electronic controller and the head) W01 is correctly connected. Try again.
- Switch OFF the Electronic controller. Unplug the blackbody cable W01.
- Use an ohmmeter to measure the resistance between pin n°1 and pin n°10 on the blackbody connector of the head (Refer to Figure 6). If the resistance is more than 1kΩ, the fans might be damaged.

Otherwise, the controller might be faulty. Please contact HGH.

5.3.4. Inactive touchscreen

You switched on the controller and its touch screen remains inactive, it remains empty or the display is fixed, the measured temperatures don't change.

- The touchscreen communication may be interrupted. Switch OFF and ON the controller, then the operation may be normal.

The measured temperatures display seems to be normal but when you touch the screen it doesn't react.

- The touch screen may be locked. Actually, the touch screen can be locked by INFRATEST - Platform through the computer interface. You can unlock the touch screen through the same interface (refer to INFRATEST - Platform manual). Anyway, if you switch OFF then ON the controller, the touch screen will be unlocked.

5.3.5. Limited temperature range

You tried to set an extreme value in the specified working range but the blackbody temperature changes but can't reach this value.

- Check that the blackbody head is in a quiet environment protected from wind.
- The temperature ranges are given for a 20°C ambient temperature (refer to paragraph 6.2). For instance:
- If the ambient temperature is 10°C the blackbody possibly can't reach T_{abs_max} value.
- If the ambient temperature is 30°C the blackbody possibly can't reach T_{abs_min} value.

After having checked that the working conditions are consistent with the specified ones, if the temperature range is still limited, the power system needs re-adjustment or the thermoelectric elements might be deteriorated, please contact HGH.

5.3.6. The blackbody is unstable

You switched on the blackbody and set a temperature; the blackbody reaches the temperature but the stability is not good.

- Check that the blackbody head is in a quiet environment protected from wind.
- Check that the cables are correctly plugged and locked.
- Check that cables path is not near from a powerful electromagnetic emitter (unprotected electronic device).
- Check that ground is effectively connected to the controller.
- For perturbed atmospheric conditions (climatic chambers with circulating air), HGH offers different solutions like shelters or lens to blackbody head sleeve interface. Please contact HGH.

5.3.7. Blackbody shut down recommendations

In order to maintain at best the paint on the blackbody plate, it is recommended to input a blackbody temperature superior to the ambient temperature in which the blackbody is placed before switching off the blackbody.

For example, if the blackbody is in a room where it is 25°C ambient temperature, it's recommended to put the blackbody temperature at 50°C.

This avoids to have ice or condensation on the plate when switching off the blackbody.

6. MAIN CHARACTERISTICS

6.1. CONDITIONS OF USE

6.1.1. Electronic controller

PARAMETER		RANGE OF REFERENCE	RANGE OF USE	RANGE OF STOCKING
Climatic conditions	Ambient temperature	20°C ± 5°C	+5°C to +45°C	-20°C/+70°C
	Relative humidity without condensation	45% to 75%	20% to 80% (70% at 45°C)	10% to 80%

	RANGE OF REFERENCE	RANGE OF USE
PCN-4	100 to 250 VAC – 50 Hz or 60 Hz	90 VAC to 260 VAC – 45 Hz to 65 Hz
PCN-7		

6.1.2. Blackbody head

PARAMETER		RANGE OF REFERENCE	RANGE OF USE	RANGE OF STOCKING
Climatic conditions	Ambient temperature	20°C ± 5°C	-20°C to +70°C	-20°C to +70°C
	Relative humidity without condensation	45% to 75%	20% to 80% (70% at 45°C)	10% to 80%

6.2. MAIN SPECIFICATIONS

6.2.1. Mechanical characteristics

6.2.1.1. Electronic controller

- Description: 2U rack case, 19 inches (84 F) according CEI 297.3
- Dimensions: H 95 with feet x W 483 x D 466.5
- Weight: 6.5 kg (single head) / 8.5 kg (double head)
- Waterproofness: IP 20 according CEI 529

6.2.1.2. Blackbody head

Dimensions: Please contact HGH to receive drawings and STEP documents.

Minimum radius of curvature of cables: R = 110 mm

6.2.1.3. Functional characteristics

Temperature measurement:

- 2 inputs for Pt sensor, 4 wires (compensation of the resistance of the wires). Linearization according to EIT 90 ().
- measurement current: 1 mA
- resolution: 0.001°C
- display range: -10.000°C to 105.000°C

Temperature measurement incertitude: ± 0.03°C at 0°C and ± 0.05°C at 100°C

Resolution of the temperature set points: ± 0.001°C

Regulation: PID type

Temperature measurement: Pt sensor 100 at 0°C qualified class A according CEI 751 (NFC 42330), calibrated sensor

Protection of the Electronic controller:

- Protected with 2 delayed fuses: 6.3 A, 5 x 20mm glass cartridge
- Suppressor: according to VDE 0871-A

PCN Type	Unit	PCN-4	PCN-7
Thermal uniformity at 50°C	°C RMS	0.1	0.2
Thermal uniformity for -5°C < ΔT < +5°C	°C RMS	< 0.01	
Long term thermal stability at 20°C:	mK RMS	20	
Emissivity	-	0.98 ± 0.02	
Power supply (single head)	W	800	
Power supply (double head)	W	1600	
Minimum temperature	°C	0	5
Maximum temperature	°C	100	
Area size (square)	mm	100	180

7. Appendix 1

Platinum resistance thermosensors 100 Ω at 0°C

Table of relation between resistance and temperature, based on the following interpolation functions given by EIT 90:

- t in °C $\in [0°C, 850°C]$ $R(t) = R(0°C) \times (1 + A \times t + B \times t^2)$ in Ω
- t in °C $\in [-200°C, 0°C]$ $R(t) = R(0°C) \times (1 + A \times t + B \times t^2 + C \times t^3 \times (t - 100°C))$ in Ω

With:

$R(0°C) = 100\Omega$

$A = 3.9083 \times 10^{-3} °C^{-1}$

$B = -5.775 \times 10^{-7} °C^{-2}$

$C = -4.183 \times 10^{-12} °C^{-4}$

Real resistance values are taken into account as calibration parameters to compensate the error due to the sensor accuracy.