

Temperature Control Unit

● User Manual

Version 004



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1 About

1.1 This Manual

This manual is intended to be a reference guide for operators. It provides detailed information about the user level maintenance, service and overall use of the Bruker device.

The figures shown in this manual are designed to be general and informative and may not represent the specific Bruker model, component or software/firmware version you are working with. Options and accessories may or may not be illustrated in each figure.

Carefully read all relevant chapters before working on the device!

This manual describes parts and procedures relevant to the device version it is delivered with. For older hardware, please refer to the manual supplied at the time.

1.2 Policy Statement

It is the policy of Bruker to improve products as new techniques and components become available. Bruker reserves the right to change specifications at any time.

Every effort has been made to avoid errors in text and figure presentation in this publication. In order to produce useful and appropriate documentation, we welcome your comments on this publication. Support engineers are advised to regularly check with Bruker for updated information.

Bruker is committed to providing customers with inventive, high quality products and services that are environmentally sound.

1.3 Symbols and Conventions

Safety instructions in this manual are marked with symbols. The safety instructions are introduced using indicative words which express the extent of the hazard.

In order to avoid accidents, personal injury or damage to property, always observe safety instructions and proceed with care.



! DANGER

This combination of symbol and signal word indicates an immediately hazardous situation which could result in death or serious injury unless avoided.



WARNING

This combination of symbol and signal word indicates a potentially hazardous situation which could result in death or serious injury unless avoided.



CAUTION

This combination of symbol and signal word indicates a possibly hazardous situation which could result in minor or slight injury unless avoided.

SAFETY INSTRUCTIONS

This combination of color and signal words are used for control flow and shutdowns in the event of an error or emergency.

NOTICE

This combination of symbol and signal word indicates a possibly hazardous situation which could result in damage to property or the environment unless avoided.



This symbol highlights useful tips and recommendations as well as information designed to ensure efficient and smooth operation.

2 Introduction

The main application of the MRI Temperature Control Unit is to monitor the temperature of the interface between the animal and the MRI CryoProbe and to keep it at any chosen temperature value (within limits). It provides the temperature control for an MRI CryoProbe by means of a resistive heater and two temperature sensors (of type PT100). One sensor is used to control the temperature and the other one is for safety reasons.

The unit provides a variety of options for temperature limits and alarm settings which the user can adjust for the individual use within the range described in this User Manual. Furthermore, the unit provides an internal acoustic alarm, a switch for an external alarm and two RS232 connections to configure and monitor the MRI Temperature Control Unit by a computer.

This manual is intended to be used by trained device users. It contains information about the device: operation, safety, maintenance, etc. .

2.1 Disclaimer

The unit should only be used for its intended purpose as described in this manual. Use of the unit for any purpose other than that for which it is intended is taken only at the users own risk and invalidates any and all manufacturer warranties.

Service or maintenance work on the unit must be carried out by qualified personnel. Only trained persons should operate the unit.

Read this manual before operating the unit. Pay particular attention to any safety related information.

2.2 Version

The manual is written for Temperature Control Unit Z106553, ECL 01.01.

2.3 Limitation of Liability

All specifications and instructions in this manual have been compiled taking account of applicable standards and regulations, the current state of technology and the experience and insights we have gained over the years.

The manufacturer accepts no liability for damage due to:

- Failure to observe this manual
- Improper use
- Deployment of untrained personnel
- Unauthorized modifications
- Technical modifications

- Use of unauthorized spare parts

The actual scope of supply may differ from the explanations and depictions in this manual in the case of special designs, take-up of additional ordering options, or as a result of the latest technical modifications.

The undertakings agreed in the supply contract as well as the manufacturer's Terms and Conditions and Terms of Delivery and the legal regulations applicable at the time of conclusion of the contract shall apply.

2.4 Before You Begin

This user manual contains information that are necessary for the safe operation of the device.

Consider all safety references!

3 General use

In the measurement volume under the RF CoilHead, the maintenance of a steady interface temperature between the animal and the surface of the Coil housing is critical. The temperature at the interface of Coil housing / Animal has to be kept precisely at a selected value (e.g. 38°C) to avoid any discomfort to the animal. The MRI CryoProbe relies on active heating of the CoilHead in order to maintain the required temperature and to protect itself against moisture.

NOTICE

The Temperature Control Unit has to be switched on whenever the CryoProbe is in the Cold state and during Cooldown and Warmup to protect the Coil housing against moisture.

With the MRI Temperature Control Unit the temperature of the Animal/MRI CryoProbe interface can be monitored and kept at any chosen temperature value (within limits). The unit is connected by a dedicated cable set (default length = 10m + 5m) to the MRI CryoProbe. The connection is designed to pass through the anesthesia filter plate between the magnet room and the operator room.

The MRI Temperature Control Unit has to be placed within the operator room so that the operator has visual and acoustic contact to it at all times. The unit provides a visual and acoustical alarm when certain temperature parameters at the Animal/MRI CryoProbe interface exceed the specified limits.

In this chapter, an introduction to the basic functions and principal use of the Temperature Control Unit as well as its application is given. This is followed by an operation description "[How to use the Temperature Control Unit?](#)" on page 15 and instruction on how to adjust the unit settings for the alarm and the limiter in "[Parameters](#)" on page 18. Additionally, advices on how the user can troubleshoot any problems that may arise in the Temperature Control Unit are given in "[Trouble shooting](#)" on page 25. The interfaces and possible configurations for alarm settings are discussed in "[Interfaces](#)" on page 27.

3.1 Basic functions

- The unit provides a temperature control system of the Coil housing surface of an MRI CryoProbe by means of a resistance heater and two temperature sensors PT100. One sensor is for controlling the temperature, and the second sensor is used for safety purposes.
- The unit provides connections for two suitable PT100 temperature sensors and a heater load resistance all in one connector. Constantly, it monitors the MRI CryoProbe Coilhead temperature and makes appropriate adjustments to the regulation heater power.

- The Temperature Control Unit provides a variety of possibilities for alarm and limit settings which can be adjusted for the individual needs of the user within the described ranges.
- The unit provides an internal sound alarm and supports a connection which can be used for an external alarm system.
- Furthermore, it provides two RS232 connections for configuration and monitoring via a computer.

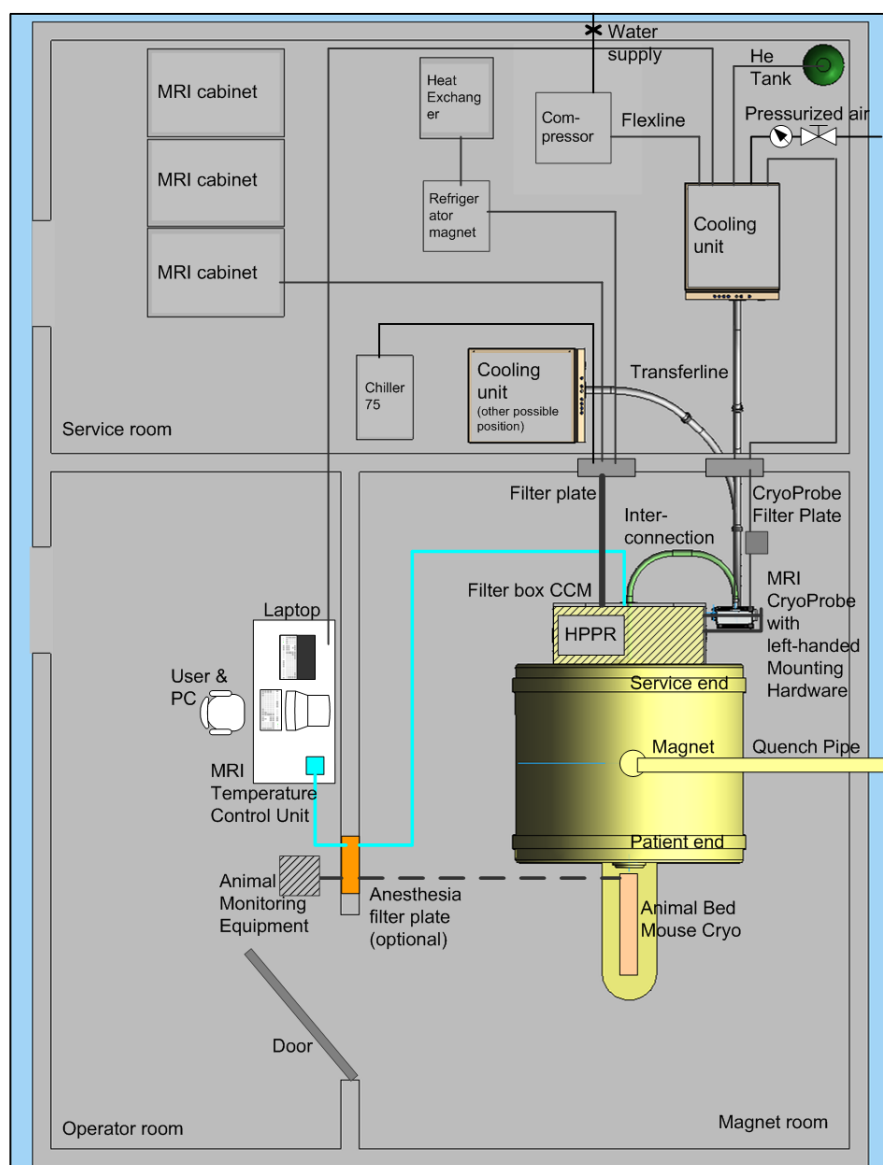


Figure 3.1 MRI Temperature Control Unit in an MRI setting.

The principal arrangement of the MRI Temperature Control Unit within the measurement setup is shown in [Figure 3.1](#). The basic function is to maintain the temperature at the interface of Coil housing / Animal precisely at a selected value (e.g. 38°C) to avoid any discomfort to the animal and to protect the Coil housing against moisture.

3.2 Set-up Procedure

NOTICE

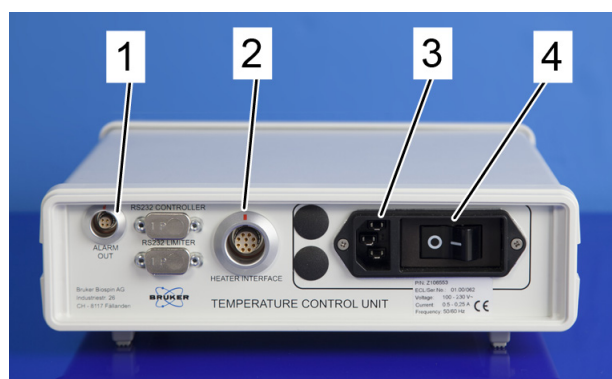
The Set-up Procedure has to be done before the CryoProbe can be cooled down.

- [1] Unpack the Temperature Control Unit.
- [2] Place the Temperature Control Unit within the Operator room so that the operator can always observe the display of the unit.

NOTICE

- ▶ In case of an emergency the main connector has to be disconnected from the socket. Therefore, the main connector of the Temperature Control Unit has to be accessible at all times. Choose the position of the Temperature Control Unit to fulfill this requirement.
- ▶ Lay the power supply and connection cables in a way to prevent accidents (such as tripping over the cables).

- [3] Plug the Temperature Control Unit interface output, coming from the Temperature Control Unit (Figure 3.2: (2)) in the P1 socket (Figure 3.3: (3)) at the RF sealing ring.

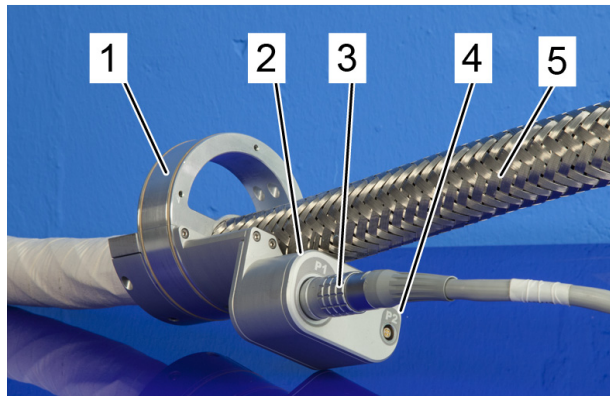


1. Alarm output connector
2. Heater interface connector
3. Power supply connector
100 - 230 V
4. Main power switch 0 / I

Figure 3.2: Power supply connection of the MRI Temperature Control Unit.



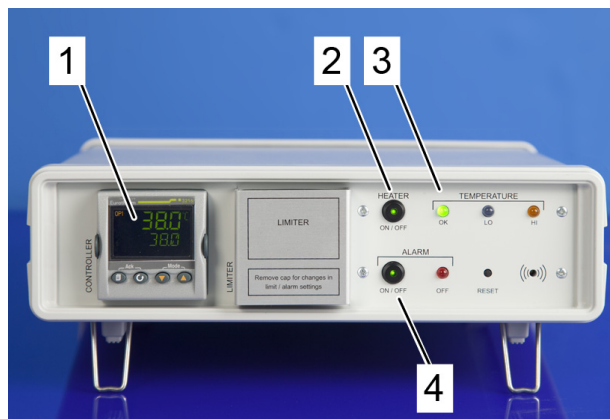
This connection has to run via the optional Anesthesia filter plate between the Operator room and the Magnet room.



1. RF sealing ring
2. P1 socket
3. Connector of Temperature Control Unit interface output
4. P2 socket
5. Interconnection

Figure 3.3: Interconnection with RF sealing ring and connector Temperature Control Unit cable.

- [4] Connect the power supply cable (Figure 3.2: (3)) to the Temperature Control Unit.
- [5] Connect the alarm cable (if an external alarm system is available)
- [6] Connect the RS232 interface to a monitor system (if available).
- [7] Afterwards switch the Temperature Control Unit on (see ["Switch on Procedure" on page 16](#)).



1. Controller showing Temperature of the CoilHead surface.
2. Toggle button 'HEATER'
3. GREEN LED
4. Alarm toggle button

Figure 3.4: Temperature Control unit is in 'normal operation' modus, when the controller (1) shows a temperature of 35°- 38°C and the toggle button (2) is lit up green, while the GREEN LED (3) shows that the Temperature is ok.

4 Functions

4.1 Introduction to front panel

On the front panel, you will find:

1. Eurotherm controller (Type 3216), called **controller**
2. Eurotherm limiter with cap (Type 3216i), called **limiter**
3. Heater toggle button ON / OFF
4. Temperature indicator: *GREEN LED = temperature ok*
5. Temperature indicator: *BLUE LED = temperature low*
6. Temperature indicator: *ORANGE LED = temperature high*
7. Beeper
8. Reset push button
9. Alarm indicator ON / OFF: *RED LED flashing = alarm is OFF*
10. Alarm toggle button ON / OFF

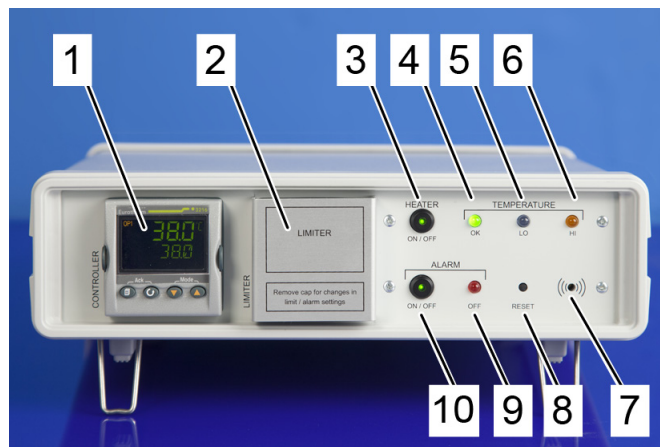


Figure 4.1: Front panel of the MRI Temperature Control Unit with Limiter unit covered

4.2 Introduction to rear panel

On the rear panel, you will find:

1. Alarm output connector (can be used to trigger external alarm systems)
2. RS232 connector for the controller
3. RS232 connector for the limiter

- 4. Heater interface connector
- 5. 100 - 230 VAC connector
- 6. Main power switch 0 / I

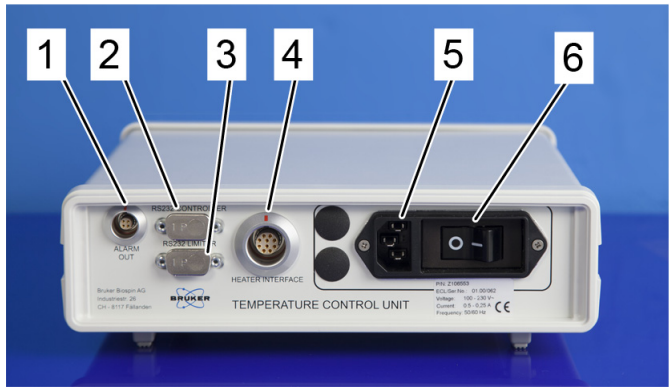


Figure 4.2: The rear panel of the MRI Temperature Control Unit.

4.3 Technical Information

Table 4.1: Technical specifications of the Temperature Control Unit

Technical specifications of the Temperature Control Unit	
Weight	2.6 kg
Dimensions (l x w x h)	265 mm x 260 mm x 80 mm
Power supply (Standard)	100 - 230 VAC ± 10% : 50/60 Hz single phase
Current	0.5 - 0.25 A

4.4 Storing Conditions

It is necessary to store the Temperature Control Unit before installation obey the following instructions:

- Store the box in a closed, dry and dust-free room.
- Store the box upright.
- Prevent the box from the risk arising from exposure to mechanical vibrations.
- Storage temperature: 5 - 40°C.
- Storage humidity: less than 50 % @ 23 °C.

4.5 Environmental Conditions

- Use the device only in a dry location.
- Use the device only below < 2000 m altitude.
- The device shall be operated only between +7 °C and +38 °C.
- Maximum relative humidity up to 31 °C should be < 80 %.
- Maximum relative humidity between 31 °C and 40 °C linear decreasing 80 - 50%.

4.6 Cleaning Procedure

- Disconnect the device from the power supply grid before cleaning.
- For cleaning use a soft, clean and dry cloth.

4.7 How to use the Temperature Control Unit?

The following three sections describe the *switch on*, *autotune* and *reset* procedures of the Temperature Control Unit.

Use the following *switch on* procedure to start the Temperature Control Unit and to set and control the temperature at the Coil housing surface/ Animal interface.

The *autotune* procedure allows the user to define the parameter for the PID controller (proportional-integral-derivate controller) to regulate the defined target temperature within limits.

With the *reset* procedure the user can reset the parameters to default values (see ["Default parameters" on page 19](#))

4.7.1 Switch on Procedure

NOTICE

- The heater cable is connected to the P1 socket at the RF sealing ring and the Temperature Control Unit, according to "Set-up Procedure" on page 11.
- The Temperature control unit should be used with the alarm function engaged!

Table 4.2: Switch on Procedure

a1	Switch ON the main power at the rear panel. The heater and the alarm are automatically active (and if the temperature is too low an acoustic alarm is given). Indicators on the front panel have the following status: steady <i>BLUE LED</i> (Figure 4.1: (5)) & acoustic alarm signal: <i>temperature low</i> This is given by the fact that the Coil housing is at room temperature (< default parameter 38°C). Remark: A brief self test of the Eurotherm controller (and covered limiter) will follow in which all elements of the display light up and the firm-ware version number is shown. The Eurotherm controller and limiter are configured with the default parameters shown in Table 4.5 on page 19 & Table 4.6 on page 20 respectively.
a2	Set the target temperature (SP1) on the controller to the desired temperature (within the limits shown in Table 4.8 on page 22) Press  to raise the set point of the temperature Press  to lower the setpoint of the temperature Remark: Default parameter is 38°C  Current Temperature SP1
a3	When the actual temperature is above A1.LO the alarm goes OFF and the GREEN LED indicates that the temperature is ok.

4.7.2 Autotune procedure

NOTICE

The *Autotune procedure* may be only performed when there is no animal in contact with the Coil housing. Therefore remove any animal from the MRI Cryo Probe before performing this procedure, as the Autotune procedure will cause wide temperature excursions (necessary for the calibration process) which in general may be far outside of the permissible temperature range for the animal and may result in injury or death of the animal.

The PID parameters for the temperature controller are configured according to the default settings in [Table 4.5 on page 19](#) and [Table 4.6 on page 20](#).

To optimize the PID parameters it is possible to perform an autotune procedure on the controller. For subsequent adjustment of the Temperature Control Unit parameters, the Eurotherm controller/limiter will give no message that implies that the user has already access and no password is required. Proceed to step b5 of [Table 4.2 on page 16](#) for repeated adjustment of the Temperature Control Unit parameters.

Table 4.3: Autotune procedure for adjusting the PID control parameter

Autotune procedure for adjusting the PID control parameter.	
b1	Press and hold  for 5 sec on the controller. Remark: After a few seconds the display will show: 
b2	Release 
b3	Press  or  to choose LEV 2 (Level 2) Remark: After 2 seconds the display will show: 
b4	Press  or  to enter the pass code. Default pass code = 2 Remark: After Level 2 has been entered, the home display will be shown. 

b5	Press  to step through the list of parameters until the parameter A.TUNE is reached Remark: The acronyms of the parameters is shown in the lower display
b6	Press  to enable the Autotune Remark: A.TUNE = on
b7	Press  to return to home display Remark: The temperature and the mnemonic "tune" will flash during the autotuning process.

4.7.3 Reset procedure

The controller can be reset by pressing the reset push button on the front panel (Figure 4.1: (8)) with a ball pen.

Table 4.4: Resetting the Temperature Control Unit

Resetting the Temperature Control Unit	
c1	Press Reset push button on the front panel (Figure 4.1: (8)) with a ball pen to reset the controller. One of the following indicators on the front panel for temperature will light up: GREEN LED (Figure 4.1: (4)) for <i>temperature ok</i> BLUE LED (Figure 4.1: (5)) for <i>temperature low</i> ORANGE LED (Figure 4.1: (6)) for <i>temperature high</i> Heater ON Alarm ON

4.8 Parameters

In the following chapters the parameter subset used to control the heater function of the Temperature Control Unit for MRI CryoProbe applications is given.

These parameters are set by default for the controller and limiter unit. The EURO-THERM units for controller and limiter offer further parameter options which are described in the *User Guide 3200 PID Temperature controllers* (which can be found under <http://www.eurotherm.co.uk/document-library/> where it is listed as *3200 User guide Issue 6 English, French, German HA028582*) by Eurotherm itself.

4.8.1 Default parameters

The required parameters (alarm / limits) of the EUROTHERM controller and limiter for usual MRI application are set by the manufacturer as listed in [Table 4.5 on page 19](#) and [Table 4.6 on page 20](#), respectively. The parameters are given in the order as they appear on the display when you follow the procedure described in [Table 4.6 on page 20](#). Some parameters can be seen in LEVEL1 and 2 but only be modified within LEVEL 2, as marked in the first column of [Table 4.5 on page 19](#). The highlighted parameters in [Table 4.5 on page 19](#) and [Table 4.6 on page 20](#) are the temperature settings and the controller parameters with which the temperature control can be modified when changing them.

Other possible settings will be also discussed in [Table 4.8 on page 22](#).

Table 4.5: Controller settings

CONTROLLER SETTINGS			
Level	Parameter	Description	Default parameter
1, 2	WRK.OP	Working output	read only value 0 -100%
2	UNITS	Temperature display units	C°
2	SP.HI	Highest adjustable temperature	39°C
2	SP.LO	Lowest adjustable temperature	20°C
1, 2	SP1	Target temperature (=set point in Eurotherm Manual)	38°C
1, 2	SP2	Second adjustable temperature	35°C
2	SP.RAT	Rate of change of setpoint value	OFF
2	TM.CFG	Timer configuration	nonE
2	A4.HI	Alarm maximal temperature -> power off	50°C
2	A.TUNE	Autotune	OFF
2	PB	Proportional band.	4 units
2	TI	Integral time	30 sec

2	TD	Derivative time. Determines how strongly the controller will react to the rate of change temperature.	5 sec
2	MR	Manual reset	0
2	OP.HI	Output high. Sets the maximum heating power applied to the process.	100%
2	LD.AMP	Load current	0.0
2	LK.AMP	Leak current	0.0
2	LD.ALM	Load current threshold	OFF
2	CK.ALM	Leak current threshold	OFF
2	HC.ALM	Overcurrent threshold	OFF
2	ADDR	Communication address of the controller	1
2	HOME	Home display	Std
2	ID	Customer ID	0
2	REC.NO	Current recipe number	1
2	STORE	Recipe to store	nonE

Table 4.6: Limiter settings

LIMITER SETTINGS			
Level	Parameter	Description	Default parameter
2	P.RST	Peak reset	OFF
1, 2	High	Peak high	read only value
1, 2	Low	Peak low	read only value
1, 2	A1.LO	Alarm for insufficient temperature	30°C
1, 2	A2.HI	Alarm for excess temperature	41°C
1, 2	A4.HI	Alarm maximal temperature -> power off	50°C
2	ADDR	Communication address of the controller	1
2	HOME	Home display	P.A.ro
2	ID	Customer ID	0
2	REC.NO	Current recipe number	1
2	STORE	Recipe to store	nonE
2	UNITS	Temperature display units	C°

4.8.2 Adjustment of parameters

The following procedure describes the change of parameters for the first time after the Temperature Control Unit has been switched on. For subsequent adjustment of the Temperature Control Unit parameters, the Eurotherm controller/limiter will give no message which implies that the user has already access and no password is required. Proceed to step d6 of [Table 4.7](#) for repeated adjustment of the Temperature Control Unit parameters.

Table 4.7: Adjustments of the parameters on the controller and/or the limiter.

Adjustments of the parameters on the controller and/or the limiter.	
d1	Controller: nothing Limiter: Remove the cap of the limiter unit to change the limit and alarm settings
d2	Press and hold  for 5sec Remark: After a few seconds the display will show: LEV 1 GOTO
d3	Release 
d4	Press  or  to choose LEV 2 (Level 2) Remark: After 2 seconds the display will show: 0 CODE
d5	Press  or  to enter the pass code. Default pass code = 2 Remark: After you entered in Level 2
d6	Press  to step through the list of parameters given in Table 4.5 on page 19 and Table 4.6 on page 20 respectively. Remark: These Tables contain the default settings, other possibilities are given in Table 4.8 on page 22 and Table 4.9 on page 22
d7	Press  to return to home display

4.8.3 Pre-programmed recipes

Two parameter settings are stored as so called *recipes* to support the user. The following two Tables contain the predefined parameter settings stored in recipes 1 and 2. The first is the default setting, while the second should be only used for phantom measurements, allowing low temperatures.

NOTICE

Be aware of the fact that you have to have the same recipe number for the controller and the limiter to have the Temperature Control Unit in proper function.

The procedure to switch between the two recipes will be explained in [4.8.4](#).

Table 4.8: Possible Controller settings

CONTROLLER SETTINGS				
Parameter	Description	Constrictions/ assumptions	Possible configurations	
			REC.NO1 (default)	REC.NO2
SP1	Target temperature	< A2.HI > A1.LO < A4.HI < SP.HI > SP.LO	38°C	25°C
SP.HI	Highest adjustable temperature	< A4.HI	39°C	39°C
SP.LO	Lowest adjustable temperature	minimum 5°C	20°C	15°C
A4.HI	Alarm maximal temperature -> power off	Do not change: safety !	50°C	50°C

Table 4.9: Possible Limiter settings

LIMITER SETTINGS				
Parameter	Description	Constrictions/ assumptions	Possible configurations	
			REC.NO1 (default)	REC.NO2
A1.LO	alarm for insufficient temperature	minimum 3°C lower as SP1 of controller	30°C	22°C
A2.HI	alarm for excess temperature	minimum 3°C higher as SP1 of controller	41°C	30°C
A4.HI	alarm maximal temperature -> power off	Do not change: safety !	50°C	50°C

4.8.4 Switch between the recipes

For subsequent adjustment of the Temperature Control Unit parameters, the Eurotherm controller/limiter will give no message which implies that the user has already access and no password is required. Proceed to step e6 of [Table 4.10](#) for repeated adjustment of the Temperature Control Unit parameters.

Table 4.10: Switch between recipes for controller and limiter.

Switch between recipes for controller and limiter	
e1	Controller: nothing Limiter: Remove the cap of the limiter unit to change the limit and alarm settings
e2	Press and hold  for 5sec Remark: After a few seconds the display will show: 
e3	Release 
e4	Press  or  to choose LEV 2 (Level 2) Remark: After 2 seconds the display will show: 
e5	Press  or  to enter the pass code. Default pass code = 2 Remark: After Level 2 has been entered, the home display will be shown. 
e6	Press  to step through the list of parameters until the parameter REC.NO is reached Remark: The default value is REC.NO =1
e7	Press  to change to REC.NO = 2. Remark: REC.NO=1 is set as default.
e8	Press  to return to home display Remark: The parameter settings will have changed to the once listed in the Tables Table 4.8 and Table 4.9 which can be used for measurements on the dummy.

When you like to switch back to the default parameter setting, you have to follow the above given procedure and change this time to REC.NO=1.

4.8.5 Timer and further settings

For the timer setup and further detailed description of all parameters and their adjustment please see the *User Guide 3200 PID Temperature controllers* (which can be found under <http://www.eurotherm.co.uk/document-library/> where it is listed as *3200 User guide Issue 6 English, French, German HA028582*) by Eurotherm itself.

4.9 Operating states

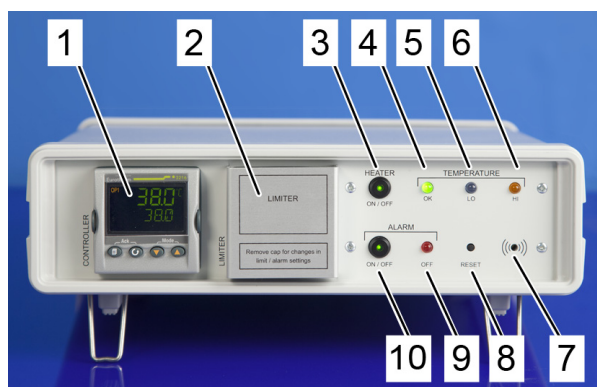


Figure 4.3: Front panel LED status.

The operating status of the LEDs on the front panel directly provides the user with information about the status of the unit. When the current status on the front panel and display is not described in the following [Table 4.11](#) please refer to [Table 4.12](#) and check if a failure appeared and what would be the next step to do.

Table 4.11: Coding of the operating status

LED Display	mode	status
Figure 4.3: (3): Heater ON / OFF	GREEN LED lights up	Heater is ON
Figure 4.3: (3): Heater ON / OFF	GREEN LED off	Heater is OFF
Figure 4.3: (3): Heater ON / OFF	GREEN LED flashes	Heater is OFF. Please check 4.8.5 for further details.
Figure 4.3: (4): Temperature = ok	GREEN LED lights up	Temperature is ok and within the limits of A1.LO and A2.HI (limiter)
Figure 4.3: (5): Temperature = low	BLUE LED lights up	Temperature is below limit A1.LO
Figure 4.3: (6): Temperature = high	ORANGE LED lights up	Temperature is over the limit A2.HI (limiter) → Heater switches off and Alarm goes active when switched on
Figure 4.3: (10): Alarm ON/OFF	LED green on push button active	Alarm system is operating
Figure 4.3: (10): Alarm ON/OFF	LED green off on push button & LED red (9) flashes	Alarm system is not operating

4.10 Trouble shooting

Table 4.12: Cases of trouble shooting

failure	Trouble shooting
Sensor broken (S.br) on Eurotherm display	One of the connections to the temperature sensors is defective: 1. Please check that the connector to the heater interface is plugged in. 2. Please contact Bruker Service Hotline if the connector is plugged in and the error message is still active.
Temperature is too low	1. Please check that the Heater ON / OFF is on: <i>GREEN LED</i> active 2. Check the status of SP1 (default value = 38°C) and A1.LO on the Eurotherm controller. 3. Check the level of WRK.OP () on the Eurotherm controller, it should be between 1 and 100% heating power.
Temperature is too high	1. Please check the status of SP1 (default value = 38°C) and on the Eurotherm controller and A2.HI on the limiter.
Alarm sound and <i>RED LED</i>	1. Please check if you have a problem as described in 4.8.5 and if so modify the temperature and/or controller settings to those of the default parameter settings (Table 4.5 on page 19 & Table 4.6 on page 20).
Heater ON / OFF toggle button with <i>GREEN LED</i> is flashing	Heater is not working. Please check 4.8.5 for further details.
No power	1. Please check the main switch. 2. Check if all cables are connected.

4.10.1 Overshooting of the controller

When the temperature A2.HI reaches the upper level the following situation can appear:

- The heater alarm starts and the *ORANGE LED* for *temperature high* lights up. Furthermore, the LED green on the Heater toggle button flashes.
- The temperature on the home display of the controller display is decreasing (Heater is off).
- Suddenly the alarm stops, the *GREEN LED* for *temperature ok* lights up, while the *ORANGE LED* switches off. The *GREEN LED* on the Heater toggle button comes.
- The temperature on the home display of the controller display is increasing again (Heater is on).
- The heater alarm restarts and the *RED LED* for *temperature high* lights up. Furthermore, the *GREEN LED* on the Heater toggle button flashes.
- If you have not already removed the Animal Bed Mouse Cryo after the first alarm then intervene now and remove it from the magnet bore. Then check the tem-

perature settings for SP1 and A2.HI. The difference between the temperature settings for SP1 and A2.HI should be set to 3°C.

Troubleshooting

In this chosen settings the limit borders are set too close to each other which implies that when the temperature overshoots the limit, the alarm, defined by A2.HI, will kick in and the heater will switch off. After a while the temperature is below A2.HI, then the heater starts to heat again. The level of A2.HI is quickly reached again and the alarm starts once more.

You can avoid this problem only by choosing a higher temperature setting for A2.HI. A 3°C temperature difference between SP1 and A2.HI is recommended.

In this context, please also check the parameters PB, TI and TD which directly define the controller.

5 Interfaces

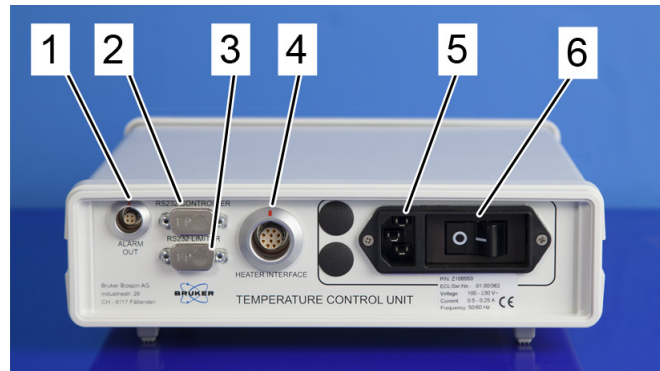


Figure 5.1: The rear panel of the MRI Temperature Control Unit.

The following [Figure 5.2:](#) shows the Heater interface output connector which is in position 4 of [Figure 5.1:](#)

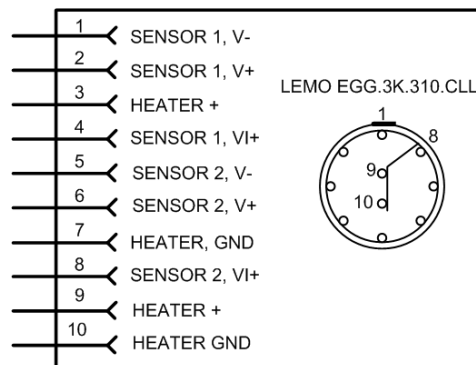


Figure 5.2: Interface of the Heater interface output.

Sensor 1 is a thermosensor of the PT100 type for controlling the temperature. Sensor 2 is also a thermosensor PT100 used to monitor the temperature for safety. Its signals go to the limiter. Both sensors use the 3 point measurement method

Heater output values	
Heater output voltage	0 - 20 VDC
Heater output current limit	max. 1 A
Heater output power	20 W
Heater resistive load	nominal 30 Ω / min. 20 Ω

5.1 Cable

The Temperature control unit is connected to the Heater interface with a shielded cable (10 pin). The maximum length of the cable is 25m.

5.2 RS232

It is possible to control and program the EUROTHERM controller and limiter with the software iTools provided by EUROTHERM (which can be found under <http://www.eurotherm.co.uk/document-library/> and is named *iTools Configuration and Monitoring Software Help Manual Issue 2 English*). The control and programming interface can be accessed by two RS232 interfaces on the rear panel of the Temperature Control Unit, both can be used for controlling and for programming the controller or the limiter. The interfaces are shown in [<\\$elemparanum](#)

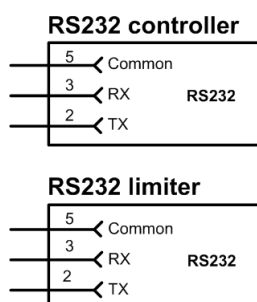


Figure 5.3: RS232 Controller and Limiter

5.2.1 Alarm output connector

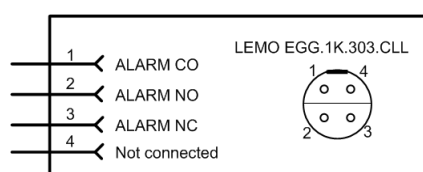


Figure 5.4: Connector for an external alarm unit (socket outside)

The self-contained MRI Temperature Control Unit can be output to an external alarm system via a relay contact (potential free). The specifications for the alarm plug output are given with max. 42VDC and a current of max. 2A for 30VDC.

In the event of a mains power failure (230V), the MRI Temperature Control Unit will disengage itself. This will typically result in a temperature decrease at the Coilhead surface to a value between 0..10°C.

Optional external alarm systems

When the MRI Temperature Control Unit is connected to an external alarm system, it can be used in two operation modes:

- Active external alarm mode:** In the case of a mains power failure all lights on the MRI Temperature Control Unit, including the LED that shows the actual temperature, will go out. Moreover, the acoustic alarm of the unit will stop functioning and the relays for the external alarm will also have no power in such an event. It must therefore be noted that there will be no power available to trigger an active alarm in the event of a mains power failure. Depending on which other systems are hooked up on the same phase, the power failure may or may not be detected. In the case of an undetected power failure during an animal measurement, a life-threatening situation for the animal may result. After the main power failure the MRI Temperature Control Unit is automatically on and finds and controls the defined settings again.

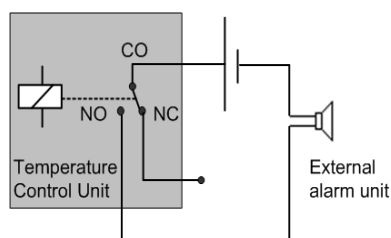


Figure 5.5: Circuit diagram for active external alarm.

- Passive external alarm mode:** For installations which require an enhanced safety level, the MRI Temperature Control Unit can be configured for a passive alarm mode. In this configuration, the alarm is always active (even when the unit is turned off) except when the MRI Temperature Control Unit is operating and the temperature is within limits. In the passive alarm generation mode, the alarm output will be active when the unit is switched off or the heater is disabled. In this configuration, the connected external alarm system must be powered such that it will still function during a mains power failure, otherwise the advantage of using the passive mode will be lost.

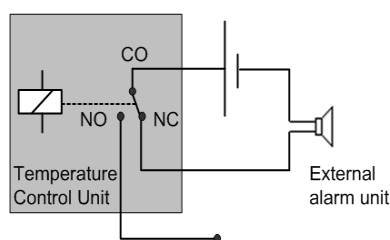


Figure 5.6: Circuit diagram for passive external alarm.

In the standard configuration the Temperature Control Unit is in the active external alarm mode. In case you would like to change the alarm mode of the Temperature control unit, please contact BRUKER service.

5.2.2 Uninterruptable Power Supply (optional but highly recommended)

In general, Bruker recommends the use of an uninterruptable power supply system (UPS) to protect the MRI CryoProbe systems from mains power failure. Within an MRI CryoProbe system the Cooling Unit and the MRI Temperature Control Unit should be connected to the UPS.

6 Contact

Bruker corporation provides dedicated hotlines and service centers, so that our specialists can respond as quickly as possible to all your service requests, applications questions, software or technical needs.

Please select the MRI service center or hotline you wish to contact from our list

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