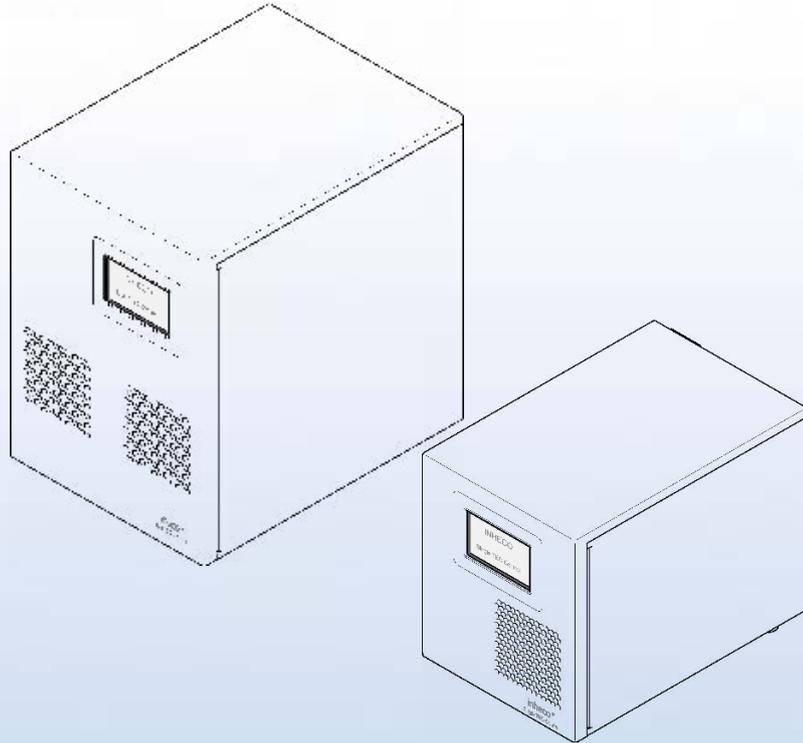# Firmware Command Set
of
Multi / Single TEC Control
(MTC / STC)

for firmware version 2.53, 2.65 , 2.81, 2.83, 2.86 and 2.87

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1 DOCUMENT HISTORY

Verrsion	Date	Author	Description of document changes	Corresponding Firmware
0.0	07/07/07	TTH/RPU	First draft	V0.10
0.1	11/11/07	TTH	First executable firmware exists	V0.11
0.2	03/10/08	TTH	Alpha test version	V1.07
0.3	04/16/08	TTH/RPU	Beta test version	V1.20
0.4	08/31/08	TTH/RPU	Pre series version	V1.39
0.5	10/13/08	TTH/RPU	Pre series version	V1.50
0.6	12/12/08	TTH	Commands corrected and added (ADE). Error code table separated.	V1.66
0.7	01/19/09	TTH/CGE/RPU	Improved description of offsets and calibration. Adapted to FW	V1.70
0.8	07/07/09	TTH/MST	Change requests included New: Errors 13/16/26-32; Commands: SLT/RLT/RCF/SCF	V1.78 V1.80
0.9	01/27/10	TTH	REC + details; syntax errors eliminated S/RST, S/RSS & S/RSR extended	V1.87
0.10	08/26/10	TTH	RRD Runtime extended	V2.06
0.11	10/20/10	TTH	FW and Dll History improved/added Commands 0RMT/SMT corrected Error 22 slot modules added Section 8.2 Demo Application added	V2.11
0.12	11/2010	TTH	SCF after FW upload to avoid error 26	V2.14
1.00	3/2012	eDok	Facelift	V 2.17
1.01	11/2012	eDok	New error tables and commands R/SVT added	V 2.21
1.02	06/2013	AWA	revision history of dll updated	V2.21
1.03	08/2016	AWA/VCE	New FW Version (bug fixing)	V2.53
1.04	12/2017	AWA/VCE	Thermoshake AC implementation	V2.65 (only slot)
1.05	01/2021	AWA/VCE	CPLC2, Teleshake AC and Teleshake 95 AC implementation	V2.81 and 2.86
1.06	06/2021	AWA/VCE	Thermoshake AC clamp control modification	V2.87 (only slot)

2 FIRMWARE UPDATE HISTORY

FW-Version	Description of functional changes	Date
V0.10	First version	07/2007
V0.11	First version with full functionality (Heating, Shaking, Cooling)	08/2007
V1.07	03/08 alpha test version	12/2007
V1.20	04/08 beta test version	02/2008
V1.50	Pre series version. New: Comma separated parameters and external EEPROM handling, error codes extended.	04/2008
V1.66	Improved error and device EEPROM handling, Startup implemented, two temperature sensors implemented per slot module	08/2008
V1.70	Series freeze candidate: Display errors no longer exist, endurance- tested version. SCO added	10/2008
V1.75	Boost Offset and Boost Time re enabled, ext EEPROM handling improved	12/2008
V1.78	Hologic FDA Freeze. Version stable for 5 months with only minor bugs	01/2009
V1.80	Display layout improved	08/2009
V1.85	REC details; More ext EEPROM values (RLT, RLO5/7)	10/2009
V1.87	Shaking arrangements added	01/2010
V2.00	Series start firmware	02/2010
V2.01	Offset setting via display enabled; humidity depicted on display	02/2010
V2.02	Display layout improved	02/2010
V2.03	Timing ext. EEPROM Hdl configurable	03/2010
V2.04	12 V slot modules became damaged when a 24 V device was connected. This error has been removed.	03/2010
V2.05	MTC enabled to handle new INHECO devices like Heated LID or Heat PAC	06/2010
V2.06	Maximum Runtime devices extended from 445 days to > 10 years.	08/2010
V2.07	Bugfix error RAT2 every ten minutes wrong temperature AttentionNoBoot as reply to 0RFV0 if no boot code MB is present. Incorrect error entry 16 at STC without slot module disabled. Error 12 debounced. Speed of communication with external EEPROM has been slowed down to improve communication with external EEPROM of Thermo-shakes.	09/2010
V2.08	RRD works now with old and new devices. No incorrect entry MB error 27–32.	09/2010
V2.09	New error 22 slot module added: Cable break in ground line PT100_1 & PT100_2. This error entry is connected with TEC power off!	09/2010
V2.10	SAP100 % at startup disabled for all cases. Timing changed: longer delay but no USB HID communication errors.	10/2010
V2.11	Command SEC corrected	10/2010
V2.12	Timeout behavior further improved by adopting internal cycle times	11/2010
V2.13	Slot module: temperature offset handling for SDO0 & SHO changed	11/2010
V2.14	MB: Timing startup changed to eliminate STC error with 31st Init message (Error 2 Slot). Slot module: Negative values of 31st Init message can also be received twice without leading to error 2.	12/2010

FW-Version	Description of functional changes	Date
V2.17	MB: Error 10 corrected;	03/2012
	MB: Bug eliminated: error with humidity calculation.	
	Slot: Bug eliminated: error with strait line shaking at low frequencies.	
	Slot: Bug eliminated: sporadically occuring stop and go when changing rpm during shaking.	
V2.21	MB: Command SRE disabled	11/2012
	Slot: Commands S/RVT enabled and function virtual 12 V implemented.	
V2.53	Runtime EEPROM update bug fixed; external communication during writing time to external EEPORM is inhibited.	08/2016
	The bug leading somtimes to incorrect error entries has been fixed	
	Task desynchonization due to timer overflow fiex	
	Several display bugs have been fixed.	
	Time between commands adjusted from 200 ms to 400-600ms	
V2.65	Firmware for yellow slot module for Thermoshake AC	12/2017
V2.78	Firmware for MB and yellow slot module for Thermoshake AC	10/2018
V2.81	Firmware for yellow Slot for Thermoshake AC
Bugfixes: Error 31 now stops the Shaker
Warning 3 is now triggered only when the RPM control algorithm is active
New Features:
Warning 34 RPM Monitoring has been reworked	07/2019
V2.83	Firmware for MB and black slot module.	01/2021
	MB: firmware to control the new yellow slot Teleshake 95 AC and Teleshake AC and the new black slot CPLC2 devices.	
	Black slot: firmware to control the new black slot CPLC2 device.	
V2.86	Firmware for yellow Slot to control the Thermoshake AC, Teleshake 95 AC and Teleshake AC.	01/2021
V2.87	Firmware for yellow Slot, Clamping Mechanism on the Thermoshake AC has now an increased delay of 700ms	06/2021

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3 ABBREVIATIONS

The document uses the following abbreviations and terms:

Abbreviation / Term	Description
Controller	Microprocessor with on chip peripheral.
crc	Cyclic redundancy check
Device	INHECO Heating / Cooling / Shaking Unit
FCS	Firmware Command Set
FW	Firmware
HID	Human Interface Device
MB	Mainboard of the MTC/STC
ms	Millisecond
MTC	Multi TEC Control
PWM	Pulse-Width Modulation
Slot	Slot module of the MTC/STC
SSB	Serial Slot Bus
STC	Single TEC Control
TEC	Thermo Electric Cooler
USB	Universal Serial Bus
µC	Micro controller
AC	Automated Clamp Mechanism

4   INTRODUCTION

4.1.   Purpose

This document contains detailed information about all firmware commands implemented in the firmware of INHECO's Multi/Single TEC Control Units (MTC/STC).

4.2.   Scope

This document is intended for software engineers in order to help them write service and setup tools or application software. It is not part of the end-user documentation.

4.3.   Device Overview

The Multi/Single TEC Control unit can be connected to the PC via USB or be used as a stand-alone device via touch screen. The touch screen enables access to MTC/STC basic features only. The USB transfers transparent information to the device and vice versa. The Multi/Single TEC Control Mainboard appears to the USB as a HID slave device. A maximum of six slot modules can be plugged into the MTC. The STC features one slot module plug.

The MTC/STC identifies itself as an HID to the USB host. The USB host is usually a PC or a notebook. The drivers for communication with a HID include the PC operating system e.g. Windows XP. In addition to these HID drivers, a driver is needed which is compatible with the protocol of the INHECO MTC/STC Commands, for example the InhecoMTCdll.dll (Description see → chapter 9). It is recommended to use this dll.

> **INFO**
>
> The USB is not optimized for secure real time data transfer. Therefore all communication is secured by a cyclic redundancy checksum (crc). If communication between the PC and the MTC/STC frequently fails or results in timeouts, the PC is responsible in most cases. Therefore we recommend the following for stable MTC/STC usage:
>
> - No (or not too many) other devices should be connected to the USB because they might have an influence on the communication stability of the MTC/STC.
> - Use a simple, stable workstation PC. Front USB Ports are usually more problematic than back USB Ports.
> - The stability of the communication has to be verified with every PC.
> - Windows Vista and Windows 7 seems to be more stable than Windows XP.
> - Do not activate the automatic updates from Windows.
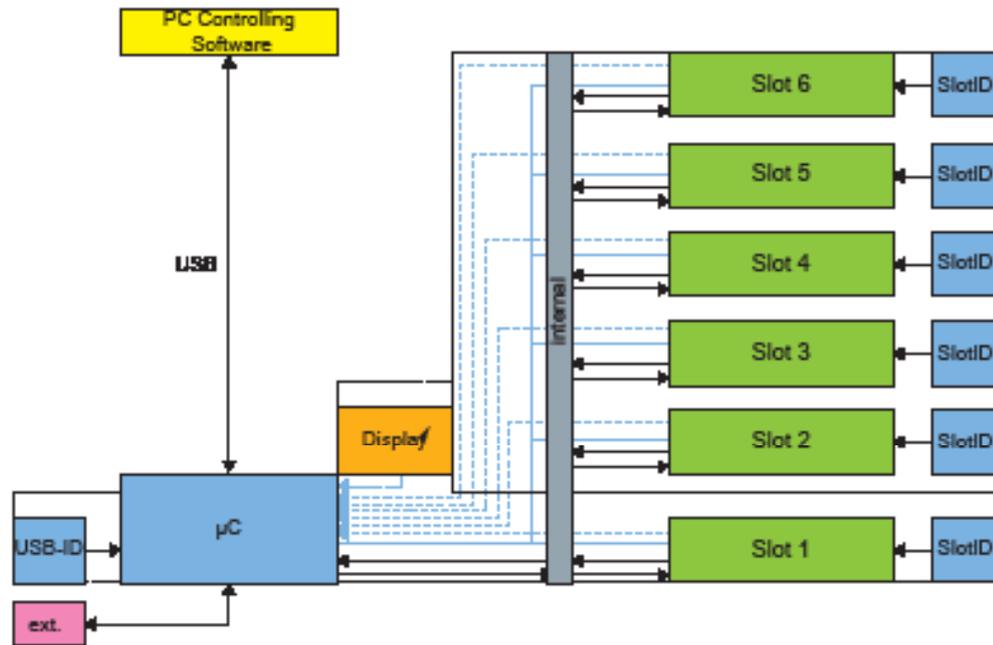
Fig.1: *Communication lines at the MTC/STC (STC one slot only)*

4.4. Operation & Setup

The following preliminary actions have to be performed in order to operate the MTC/STC.

- Set address with DIP switches 1–3.

- Connect power, USB and external sensor, if needed.

- Hardware configuration – if necessary. Set offsets (Disposable and/or Boost).

- Set origin of control parameters, internal or external EEPROM: Command SPO (default is external EEPROM usage) .

- Deactivate the touch screen (command ADE), if you have sensitive processes.

- Set control parameters: Commands SRT, SPP, SPI, SPD, …

4.5. USB-ID via DIP switches

The DIP switches 1–3 configure the address of the device. The significance of the DIP switch position is shown below. Up to 8 MTC/STCs can be controlled by one PC.
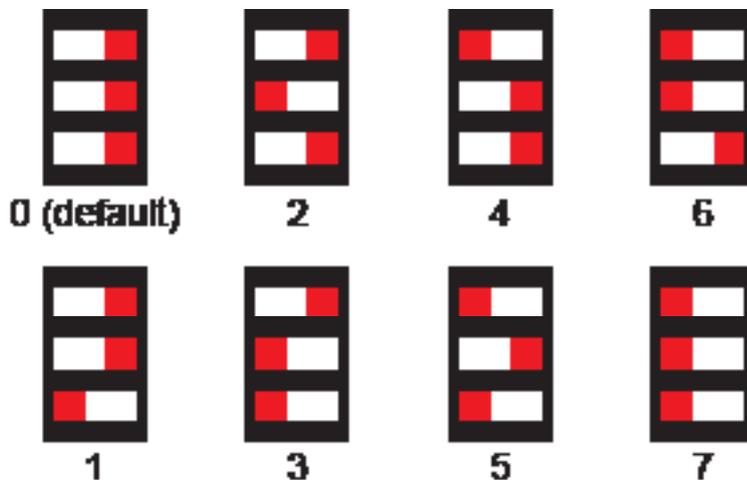
Fig.2: *Possible DIP switch positions*

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4.6. Device Temperature Sensors

The temperature offset (command SHO and SCO) for the different plate types will be handled by the device EEPROM. The controlling PC measures the room temperature and relative humidity via an internal sensor on the mainboard or external sensor (optional). Depending on the temperature difference between target and ambient temperature, the offset for the device can be calculated and set (command SRT).

4.7. Reset/Startup Behavior

The MTC/STC replies to the first command after this synchronisation-registration procedure with the error code 6 (Reset detected, see → chapter 6.1) i.e. always after power on. This error must not occur without a hardware reset. Please contact INHECO if a reset is detected frequently. Exception: After the software reset command SRS this error code 6 is mandatory.

At power on, the MTC/STC performs a self test and reads out the memory of the devices that are plugged into the slot modules. During this procedure the fans of the devices are running and the MTC/STC displays a boot screen. It is very important that the values read from the devices memories are correct. Therefore they are secured by a cyclic redundancy check. The MTC/STC tries up to three times to read out the memories. In this case the startup lasts around 20 seconds. Some error entries are associated with problems during this procedure. i.e. if the LEDs light up red after startup, it is very likely that there are problems with the device memory. Heating and cooling activities are disabled if such an error occurs.

> **NOTE**
> Do not unplug devices after startup. Always switch off the MTC/STC before you connect/disconnect a device.

5 COMMANDS

The MTC/STC consists of multiple components, mainboard and slots. As a consequence the commands need to be addressed to the relevant component in each case. A message starting with "0" addresses the mainboard. A message starting with "1 … 6" addresses the slot modules 1 … 6. For example the command Report Firmware Version is 0RFV for the mainboard and 3RFV for slot module 3.

There are three types of commands:

- Action commands: These get the devices to perform an action like cooling or shaking.

- Set commands: Configure the controller, e.g. set the target temperature.

- Report commands: The MTC/STC replies with information such as the current surface temperature (command RAT).

Lots of commands like the maximum allowed MTC/STC housing temperature are protected by a keyword (factory setting). This keyword always has six alphanumeric characters and depends on the serial number of the MTC/STC-mainboard and is needed to protect the factory settings and the funcitionality within the INHECO specified parameter.

The MTC/STC replies to the first four characters of every command with a modified echo. The modification changes the capitals of the commands to small letters. i.e. the reply to 5ASE1 is 5ase0. Therefore it is easy to identify correct answers to the commands. This feature may increase integrity of the communication.

Report and Action commands have either one parameter or none. Set Commands may have up to four parameters. The first parameter follows immediately after the command, whereas the next parameters are separated with commas (e.g. 0SHOkey,5,20).

> **INFO**
> The number of parameters may depend on the device to which the command is addressed, e.g. Command SHO addressed to:
> Mainboard: 0SHOkey,SlotID,Value
> Slot (eg. Slot 1):   1SHOkey,Value

5.1. Common Commands

RFV   Report Firmware Version

Returns various system-dependent information about the firmware or hardware that is currently loaded.

> **INFO**
> This information can be used to identify the characteristics of the selected device.

RFV*Selector*			
Parameter, Response	Parameter		Response
	Name	Validity	
	Selector	0	Bootstrap Version
		1	Application Version
		2	Serial number
		3	Current hardware version
		4	INHECO copyright
Error	(5) Invalid operand		

SFV   Set Serial Number

This command sets the device and mainboard serial number.

SFV*Key,SN*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SN	4 numbers	Serial number
Error	(5) Invalid operand; (8) wrong keyword		

RDC   Report Diagnostic Counters

Reports the current (since last power-on) and total operating time.

RDC*Selector*			
Parameter, Response	Parameter		Response
	Name	Validity	
	Selector	1	Current operating time [s]
		2	Total operating time [s]
Error	(5) Invalid operand		

SDC   Set Delete Counter

Deletes the counter of the operating times.

SDC*Key*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
Error	(5) Invalid operand		

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RCF — Report CRC16 Flash Memory

Reports checksum or number of lines into the µCs flash memory.

RCF *Selector*			
Parameter, Response	Parameter		Response
	Name	Validity	
	Selector	0	CRC16 the µC has calculated in the first 30 seconds after startup
		1	Number of full lines of the flash memory
Error	(5) Invalid operand		

SCF — Set CRC16 Flash Memory

Sets CRC16 for Flash Memory.

> **INFO**
> During the first minute the µCs calculate a cyclic redundant checksum of their flash memory. When they have finished they compare it with the values that are set here. If they are identical the flash is ok and if not error code 26 is set.

SCF *Key, Selector, Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Selector	0	Sets the crc16 for the flash memory
		1	Sets number of lines in the flash code
	Value	000000 … 065535	Either crc16 or number of lines
Error	(5) Invalid operand		

REC — Report Error Code

Reports the Error Code of the devices.

> **INFO**
> Up to 7 errors can be stored in the error memory.
> Error Codes have different meanings in slot module (Codes 01… 49) and mainboard (Codes 1 … 32). Please refer to table 2 of Appendix A which describes the Mainboard Error Codes. An example of the use of this command is given in → chapter 6.2.

REC *Selector*			
Parameter, Response	Parameter		Response
	Name	Validity	
	Selector	1 … 32 (mainboard) or 1 … 46 (slot modules)	When the corresponding error has occurred the reply gives detailed information about the specific code: Number of occurrences and time of the last occurrence (reply to RDC2 at that moment).
		any other value or no selector	Listing of codes of errors that have occured (if any). The error codes are separated by "_"
Error	(5) Invalid operand		

SEC   Set Error Code

Resets the Error Codes of the device and eliminates the red LED on the slot module.

SEC*Key*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
Error	(5) Invalid operand		

SRS   Set Reset System

Resets the mainboard and the slot-device without losing USB connectivity.

INFO
After such a command, the device FW starts the same way as after a normal power-up, see → chapter 4.7.

SRS*Selector*			
Parameter	Name	Validity	Description
	Selector	0	generates Watchdog Reset
		1	jumps to Bootloader
Error	(5) Invalid operand		

5.2. Mainboard-Specific Commands

RAV   Report Analog Values

Reports Analog Values from the AD Converter.

RAV *Selector*			
Parameter, Response	Parameter		Response
	Name	Validity	
	Selector	0 … 31	AD Port 0 … 31
Error	(4) Invalid command; (5) Invalid operand.		

RCI   Report Calibration Inclination

Reports the inclination of the PT100 calibration curve of the mainboard.

> **INFO**
> The value is stored on the EEPROM of the mainboard; see → chapter 8.1.

RCI		
Response	Range	Description
	0 … 9999	Inclination of the calibration curve
Error	(4) Invalid command; (5) Invalid operand.	

SCI   Set Calibration Inclination

Sets the inclination of the PT100 calibration curve of the slot module.

> **INFO**
> The value is stored on the EEPROM of the mainboard; see → chapter 8.1.

SCI *Key,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Value	0 … 9999	Inclination of the PT100 calibration curve of the slot module
Error	(4) Invalid command; (5) Invalid operand; (8) wrong keyword.		

RCT   Report Calibration Offset Temperature

Reports the offset of the PT100 calibration curve of the mainboard.

> Info
> The value is stored on the EEPROM of the mainboard; see → chapter 8.1.

RCT		
Response	Range	Description
	0 … 9999	Offset value of the calibration curve
Error	(4) Invalid command; (5) Invalid operand.	

SCT   Set Calibration Offset Temperature

Sets the offset of the PT100 calibration curve of the mainboard.

> **INFO**
> The value is stored on the EEPROM of the mainboard; see → chapter 8.1.

SCT*Key,Date,User,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Date	YYYY-MM-DD	YYYY: year; MM: month; DD: day
	User	xxx	AAA … ZZZ
	Value	0 … 9999	Offset value of the PT100 calibration curve of the mainboard
Error	(4) Invalid command; (5) Invalid operand; (8) wrong keyword.		

RHV   Report Housing Values

Reports the current status values (listed below) of the MTC/STC.

RHV*Selector*			
Parameter, Response	Parameter		Response
	Name	Validity	
	Selector	0	Power supply value [1/10 V]
		1	Housing fan [on / off]
		2	Temperature mainboard sensor 1 (housing) [1/10 °C]
		3	relative humidity sensor 1 (housing) [1/10%]
		4	Temperature mainboard sensor 2 (housing) [1/10 °C]
		5	Ambient temperature sensor 1 (external) [1/10 °C]
		6	Ambient relative humidity sensor (external) [%]
	(Without the external sensor accessory the reply to 0RHV5/6 is invalid.)	7	Analog sensor 1 (external) [1/10 °C]
		8	Analog sensor 2 (external) [1/10 °C]
		9	Maximum measured temperature [1/10 °C] to be erased with the command SMTkey,0
Error	(4) Invalid command; (5) Invalid operand.		

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RLO   Report Limits On Board Diag

Reports the limits for specific values that are controlled every second from the mainboard.

RLO*Selector*			
Parameter, Response	Parameter		Response
	Name	Validity	
	Selector	1	Max allowed voltage power supply [1/10 V]
		2	Min allowed voltage power supply [1/10 V]
		3	Min allowed housing temperature [1/10 °C]
		4	Max allowed housing temperature [1/10 °C]
		5	Maximum allowed temperature difference front and rear mainboard sensor [1/10 °C]
		6	Maximum allowed humidity [1/10% rel. humid.]
Error	(4) Invalid command; (5) Invalid operand.		

SLO   Set Limits On Board Diag

Sets the limits for specific values that are controlled every second from the mainboard.

SLO*Key,Selector,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Selector	1	Max allowed voltage power supply [1/10 V]
		2	Min allowed voltage power supply [1/10 V]
		3	Min allowed housing temperature [1/10 °C]
		4	Max allowed housing temperature [1/10 °C]
		5	Maximum allowed temperature difference front and rear mainboard sensor [1/10 °C]
		6	Maximum allowed humidity [1/10% rel. humid.]
	Value	0 … 9999	Value
Error	(4) Invalid command; (5) Invalid operand; (8) wrong keyword.		

RMA   Report AD Channels

Reports the AD channels that need to be measured (bit-coded).

> **INFO**
> A multiplexer on the mainboard will act accordingly and only guide its coded channels to the 16-bit AD Converter of the mainboard. For details, → see SMA.

RMA		
Response	Range	Description
	0 … 0xFFFFFFFF	CNTR of MTC (default: 3766624803)
	0 … 0xFFFF	CNTR of STC (default: 65535)
Error	–	

SMA   Set AD Channels

Sets bit coded the AD Channels that need to be measured.

INFO

A multiplexer on the mainboard will act accordingly and guide only its coded channels only to the 16-bit AD Converter of the mainboard.

If one channel per slot is to be measured (Channels 5, 9, 13, 17, 23 and 29 of the MUX), the voltage of the power supply and the PT100 sensor on the mainboard should be converted (Channels 0 and 1). Values of the external sensor that may be plugged into the mainboard should also be converted (Channels 30 and 31). In the 32-bit (long) variable CNTR the respective bits must be set. Consequently its value must be in hex: 0xE0822223. The communication allows us to send decimal values only. Therefore for the default, described above, 0SMAKey,3766624803 must be sent to the mainboard.

Remark: To enable all 32 Channels 0xFFFFFFFF i.e. 4294967295 must be sent to the MTC mainboard. The STC has 16 channels only. Therefore the maximum and the default setting is 0xFFFF i.e. 65535.

SMA*Key,CNTR*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	CNTR	0 … 0xFFFFFFFF	Bit coded activated channels for AD conversion, MTC
		0 … 0xFFFF	Bit coded activated channels for AD conversion, STC
Error	(5) Invalid operand; (8) wrong keyword.		

RSN   Report Serial Number external device

Reports the serial number of a device that is connected to the selected slot module.

RSN*SlotID*				
Parameter, Response	Parameter		Response	
	Name	Validity	Range	Description
	SlotID	1 … 6	0	No slot module is mounted
			65535	No device was connected to the selected slot module at startup or the device has no external EEPROM.
			0 … 9999	Serial number of the device connected to the selected slot module
Error	(5) Invalid operand.			

SSN   Set Serial Number external device

Sets serial number of the device that is connected to the relevant slot module, provided that it has a device EEPROM.

SSN*Key,SlotID,SN*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SlotID	1 … 6	ID of the slot to which the relevant device is connected
	SN	1 … 9999	Serial number to be set for the device
Error	(5) Invalid operand; (8) wrong keyword.		

RTD   Report Type (external) Device

Reports the type of the mainboard (STC or MTC), or
Reports the type of the external device that is connected to the selected slot module.

RTD*Selector*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Selector	0	Reports the type of the mainboard
		1 … 6	Reports the type of external device connected to the slot module with this ID
Response	if Selector	Range	Description
	0	0	STC
		1	MTC
		255	Not set: acts as MTC
	1 … 6	0	Thermoshake
		1	CPAC
		2	Teleshake
		3	CPLC
		4	CPAC 2TEC
		5	Heat PAC
		6	Cycler
		7	Heated Lid
		8	ACAC
		9	LCAC
		10	CPHF
		12	Thermoshake AC
		13	Teleshake AC
		14	Teleshake 95 AC
		15	CPLC2
Error	(5) Invalid operand		

STD   Set Type (external) Device

Sets the type of the mainboard (STC, MTC), or
Sets the type of the external device that is connected to the selected slot module.

STD*Key,Selector,Type*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Selector	0	Set the type of the mainboard
	Type	0	STC
		1	MTC
	Selector	1 … 6	Set the type of the external device connected to the slot module with this ID
	Type	0	Thermoshake
		1	CPAC
		2	Teleshake
		3	CPLC
		4	CPAC 2TEC
		5	Heat PAC
		6	Cycler
		7	Heated Lid
		8	ACAC
		9	LCAC
		10	CPHF
		12	Thermoshake AC
		13	Teleshake AC
		14	Teleshake 95 AC
		15	CPLC2
Error	(5) Invalid operand; (8) wrong keyword.		

NOTE
Device Type 12 for Thermoshake AC is only accepted for STC/MTC with firmware ≥ 2.65
Device Type 13 and 14 > 2.78.
Device Type 15 for CPLC2 works only with MB >= 2.83 and Black Slot >= 2.83.

RRD   Report Runtime Device

Reports the runtime of the external device that is connected to the selected slot.

RRD*SlotID*			
Parameter, Response	Parameter		Response
	Name	Validity	
	SlotID	1 … 6	Runtime of the external device that is connected to the selected slot (0 … 65335 [min]).
Error	(5) Invalid operand		

SRD   Set Runtime Device

Runtime is set to zero.

SRD*Key,SlotID*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SlotID	1 … 6	ID of the slot to which the relevant device is connected
Error	(5) Invalid operand; (8) wrong keyword.		

SPP   Set PID Controller Coefficients (Proportional Gain)

Sets PID Controller Coefficients: proportional gain.

> **INFO**
> The mainboard must be addressed in order to change the PID parameters, if the MTC/STC is to use the external EEPROM values (default). Alternatively, internal EEPROM values of each slot module can be used. The command SPO (Set PID Origin) switches between the internal slot EEPROM and the external device EEPROM as the origin of the PID parameters (not recommended). The PID values can only be read from the slot device after startup of the MTC/STC.

SPP*SlotID,Heat/Cool,Value*			
Parameter	Name	Validity	Description
	SlotID	1 … 6	ID of the slot
	Heat/Cool	0	PID values for Heating
		1	PID values for Cooling
	Value	0 … 255	proportional gain 0 … 255
Error	(5) Invalid operand		

SPI   Set PID Controller Coefficients (Integration Value)

Sets PID Controller Coefficients: integration part.

SPI*SlotID,Heat/Cool,Value*			
Parameter	Name	Validity	Description
	SlotID	1 … 6	ID of the slot
	Heat/Cool	0	PID values for Heating
		1	PID values for Cooling
	Value	0 … 255	Integration value gain 0 … 255
Error	(5) Invalid operand		

SPD   Set PID Controller Coefficients (Differential Part)

Sets PID Controller Coefficients: differential part.

SPD*SlotID,Heat/Cool,Value*			
Parameter	Name	Validity	Description
	SlotID	1 … 6	ID of the slot
	Heat/Cool	0	PID values for Heating
		1	PID values for Cooling
	Value	0 … 255	Differential part 0 … 255
Error	(5) Invalid operand		

SRT   Set Room Temperature

Sets the ambient temperature for the offset compensation curves in 1/10 °C.

> **INFO**
> Temperature ist set in 1/10 °C (for example: 121 = 12.1 °C.
> For details see → chapter 7.1.

SRT*SlotID,Value*			
Parameter	Name	Validity	Description
	SlotID	1 … 6	ID of the slot to which the relevant device is connected
	Value	0 … 510	Set room temperature close to device in 1/10 °C
Error	(5) Invalid operand		

SHO   Set Heat-Up/Cool Down Offset

Set Heat-Up temperature offset for the device.

> **INFO**
> Defines the offset temperature line for the different devices in 1/10 °C (for example: 121 = 12.1 °C. For details see → chapter 7.1 ,Set by INHECO.

SHO*Key,SlotID,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SlotID	1 … 6	ID of the slot to which the relevant device is connected
	Value	0 … 255	Set heat-up temperature offset for devices in 1/10 °C
Error	(5) Invalid operand		

SCO   Set Constant Offset

Sets constand offset.

> **INFO**
> This constant offset is set during the calibration procedure. Due to varying cable length a constant offset must be added or subtracted. Value is set in 1/100 °C. Set by INHECO.

SCO*Key,SlotID,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SlotID	1 … 6	ID of the slot to which the relevant device is connected
	Value	–999 … 999	Offset in 1/100 °C
			e.g at std CPAC it is approx. –60, i.e. 0.6 °C
Error	(5) Invalid operand		

RCM   Report Calibration Mark

Reports the date and an alphanumeric string (e.g. operator) of the last calibration for the mainboard or the devices connected to the specified slot module.

> **INFO**
> The last written Calibration Mark is usually read by this command.
> Up to ten Calibration Marks can be written into the mainboard EEPROM or the device EEPROM. Previous Calibration Marks can be read with the following procedure:
> - 0RCPi reports the Calibration Counter
> - 0SCP_key,I,cnt sets the Calibration Counter to the desired value, e.g. cnt = 0.
> - Reset mainboard either via power off/on or via 0SRS
> - 0RCMi reports the desired "old" Calibration Mark
> - Reset the counter to the value of step 1

RCM*ID*			
Parameter	Parameter		Description
	Name	Validity	
	ID	0	Reports data from the mainboard
		1 … 6	Reports data from the device connected to the specified slot module
Response	Format		Description
	YYYY-MM-DD,xxx		YYYY: year; MM: month; DD: day
			xxx: three alphanumeric characters
Error	(5) Invalid operand		

SCM   Set Calibration Mark

Sets the date and e.g. operator of the last calibration for the mainboard and the devices.

> **INFO**
> Up to ten Calibration Marks can be written into the mainboard EEPROM or the device EEPROM. Set by INHECO.

SCM*Key,SlotID,Date,USR*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SlotID	0	Mainboard
		1 … 6	ID of the slot
	Date	YYYY-MM-DD	YYYY: year; MM: month; DD: day
	USR	xxx	Operator (three alphanumeric characters)
Error	(5) Invalid operand		

SDO   Set Disposable Offset

Sets specific temperature offset.

> **INFO**
> For details see → chapter 7.3.1.2.
> Only affects the external device EEPROM. Internal slot EEPROM is changed with the relevant slot command.

SDO*SlotID,Selector,Value*			
Parameter	Name	Validity	Description
	SlotID	1 … 6	ID of the slot to which the relevant device is connected
	Selector	0 … 8	Offset place
	Value	0 … 255	Temperature in 1/10 °C
Error	(5) Invalid operand		

SDX   Set Disposable X-Axis temperature

Sets specific disposable offset.

> **INFO**
> For details see → chapter 7.1.3.2.
> Only affects the external device EEPROM. Internal slot EEPROM is changed with the relevant slot command.

SDX*SlotID,Selector,Value*			
Parameter	Name	Validity	Description
	SlotID	1 … 6	ID of the slot to which the relevant device is connected
	Selector	0 … 8	Place
	Value	0 … 2550	Temperature in 1/10 °C
Error	(5) Invalid operand		

SRE   Set Reset External EEPROM

Writes the default parameter (see command SDP) back to the external EEPROM.

SRE*SlotID*			
Parameter	Name	Validity	Description
	SlotID	1 … 6	ID of the slot
Error	(5) Invalid operand;(3) Command not possible (if ext EEPROM is unreachable).		

SDP   Set Default Parameter

Sets Default Parameter ext EEPROM.

SDP *Key,SlotID,Selector,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SlotID	1 … 6	ID of the slot
	Selector	1	P-Part 0 (heating)
		2	P-Part 1 (cooling)
		3	I-Part 0 (heating)
		4	I-Part 1 (cooling)
		5	D-Part 0 (heating)
		6	D-Part 1 (cooling)
		7	Room temperature
		8	Heat offset device
		9	Max allowed temperature
		10	Value for SDO0 (typical 0)
		11	Value for SDO1 (typical 0)
		12	Value for SDX0 (typical 700)
		13	Value for SDX1 (typical 2550)
	Value	0 … 255	Value to be set
Error	(5) Invalid operand; (8) wrong keyword.		

RMT   Report maximum allowed device Temperature

Maximum allowed temperature of the device connected to slot with specified ID.

> **INFO**
> The temperature is reported in 1/10 °C, e.g: 345 = 34.5 °C.

RMT *SlotID*			
Parameter, Response	Parameter		Response
	Name	Validity	
	SlotID	1 … 6	0 … 1999 Maximum allowed temperature in 1/10 °C of the device connected to slot with specified ID
Error	(5) Invalid operand		

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SMT   Set maximum allowed device Temperature

Writes the maximum allowed device temperature to the device EEPROM.

> **INFO**
> To be read with the slot command RMT1 (see → page 36) and not with the mainboard command described RMT above.

SMT*Key,ID,Selector,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	ID	0	Mainboard
		1 … 6	Slots
	Selector	0	erase max logged temp
		1	Set max allowed temperature to Value (only possible at slots, i.e. ID > 0)
	Value	0 … 2000	Max allowed temperature in 1/10 °C (only possible at slots, i.e. Selector = 1 and ID > 0)
Error	(4) Invalid command; (5) Invalid operand; (8) wrong keyword.		

SLT   Set lowest allowed device Temperature

Writes the minimum allowed device temperature to the device EEPROM.

> **INFO**
> To be read with the Slot Command RLT.

SLT*Key,SlotID,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SlotID	1 … 6	ID of the slot to which the relevant device is connected
	Value	–127 … 127	Minimum allowed temperature in 1/10 °C
Error	(4) Invalid command; (5) Invalid operand; (8) wrong keyword.		

SDB   Set Dummy Byte ext EEPROM

Writes a Dummy Byte to the external EEPROM of the device connected to slot module SlotID. This forces the MB to recalculate and write the ext EEPROM crc of the device. Error 19 + SlotID is no longer present after this.

SDB*SlotID,Value*			
Parameter	Name	Validity	Description
	SlotID	1 … 6	ID of the slot to which the relevant device is connected
	Value	–127 … 127	Arbitrary value
Error	(4) Invalid command; (5) Invalid operand.		

SDT   Set Delta Temp max allowed for device

Sets max allowed temperature difference between the two PT100 sensors.

INFO
For compatibility reasons this value is read out with the slot module command RLO7 (see → page 33).

SDT*Key,SlotID,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SlotID	1 … 6	ID of the slot
	Value	0 … 255	Max allowed temperature difference [1/10 °C]
Error	(4) Invalid command; (5) Invalid operand.		

SAN   Set Article Number

Sets the article number of the device connected to slot „SlotID" to the value „Value".

SAN*Key,SlotID,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	SlotID	1 … 6	ID of the slot
	Value	yyyyyyy	INHECO article number (always seven digits) e.g. 8900033 (Heated Lid) or 7100136 (Teleshake)
Error	(4) Invalid command; (5) Invalid operand.		

RAN   Report Article Number

Reports the article number of the device connected to slot „SlotID".

RSN*SlotID*				
Parameter, Response	Parameter		Response	
	Name	Validity	Range	Description
	SlotID	1 … 6	yyyyyyy	INHECO article number (always seven digits) of the device connected to slot „SlotID"
			7000255	No device connected to slot „SlotID"
Error	(5) Invalid operand.			

AEO   Action Emergency OFF

Instantly switches off all power outputs of the slots.

INFO
The command is intended as an emergency off.

AEO			
Parameter	Name	Validity	Description
	–	–	–
Error	–		

AVE   Action Voltage Enable

Enables/disables the 24 V supply for the slot power-periphery (the slot µC has additional 5V power).

AVE*Selector*			
Parameter	Name	Validity	Description
	Selector	0	Off
		1	On
Error	(5) Invalid operand		

ADD   Action Disable Display-Touchscreen

Disables the touch panel of the display.

> **INFO**
> Please use 0ADD1 and 0ASD to reactivate it. ASD to reactivate it.

ADD			
Parameter	Name	Validity	Description
	Selector	0	Disabled
		1	Enabled
Error	(5) Invalid operand		

ASD   Action Setup Display

Resets the display and reactivates touch panel.

> **INFO**
> Display needs about 8 seconds to get refreshed.

ASD			
Parameter	Name	Validity	Description
	–	–	–
Error	–		

AUM   Action Upload Mode

Activates upload mode.

> Info
> No internal messages are exchanged during the firmware upload of one slot.
> Temperatures are not updated in upload mode.

AUM*Selector*			
Parameter	Name	Validity	Description
	Selector	0	disabled
		1	enabled
Error	(5) Invalid operand		

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5.3. Slot specific commands

RTD   Report Type Device

Reads the type of the device functionality.

> **INFO**
> A device can be identified with the read command. If no device is connected it reports the type of the last device connected.

RTD		
Response	Range	Description
	0	Thermoshake
	1	CPAC
	2	Teleshake
	3	CPLC
	4	CPAC 2 TEC
	5	HeatPac
	6	Cycler
	7	Heated Lid
	8	ACAC
	9	LCAC
	10	CPHF
	12	Thermoshake AC
	13	Teleshake AC
	14	Teleshake 95 AC
	15	CPLC2
Error	(5) Invalid operand	

STD   Set Type Device

Sets the functionality for the device.

STD*Key,Type*			
Response	Name	Validity	Description
	Type	0	Thermoshake
		1	CPAC
		2	Teleshake
		3	CPLC
		4	CPAC 2 TEC
		5	HeatPac
		6	Cycler
		7	Heated Lid
		8	ACAC
		9	LCAC
		10	CPHF
		12	Thermoshake AC
		13	Teleshake AC
		14	Teleshake 95 AC
		15	CPLC2
Error	(5) Invalid operand		

RRS   Report Reservoir Status (Thermoshake)

Reads the status of the Thermoshake reservoir.

RRS		
Response	Range	Description
	0	Reservoir is below 1/3 (please refill reservoir)
	1	Reservoir is at least 1/3 full
Error	(5) Invalid operand	

RLO   Report Limits On Board Diagnosis

Reports the limits for specific values (temperatures, voltages) that are controlled every second from the slot module.

> **INFO**
> Temperatures and voltages are reported in 1/10 °C and 1/10 V
> (e.g: 345 = 34.5 °C and 114 = 11.4 V).

RLO*Selector*				
Parameter, Response	Name	Validity		Response
	Selector	1	12 V Slot Module only	Min allowed voltage 14 [1/10 V]
		2		Max allowed voltage 14 [1/10 V]
		3		Min allowed voltage 12 [1/10 V]
		4		Max allowed voltage 12 [1/10 V]
		5	24 V Slot Module only	Max RPM Shaker [rpm]
		6		Max device temperature [1/10 °C]
		7		Max allowed delta temperature Sensor 1 and Sensor 2 [1/10 °C]
Error	(4) Invalid command; (5) Invalid operand.			

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SLO   Set Limits On Board Diagnosis

Sets the limits for specific values (temperatures, voltages, RPM) that are controlled every second from the slot module.

> **INFO**
> Temperatures and voltages are set in 1/10 °C and 1/10 V
> (e.g: 345 = 34.5 °C and 114 = 11.4 V).

SLO*Key,Selector,Value*				
Parameter	Name	Validity		Description
	Key	xxxxxx		Secret key
	Selector	1	12 V Slot Module only	Min allowed voltage 14 [1/10 V]
		2		Max allowed voltage 14 [1/10 V]
		3		Min allowed voltage 12 [1/10 V]
		4		Max allowed voltage 12 [1/10 V]
		5	24 V Slot Module only	Max RPM Shaker [rpm]
		6		Max device temperature Tm [1/10 °C]
		7		Max allowed delta temperature dT Sensor 1 and Sensor 2 [1/10 °C]
	Value	$0 < U < 255$		for Selector = 1…4
		$60 < rpm < 10000$		for Selector = 5
		$200 < Tm < 1440$		for Selector = 6
		$1 < dT < 255$		for Selector = 7
Error	(4) Invalid command; (5) Invalid operand; (8) wrong keyword.			

SBM   Set Boot Mode

Changes the startup behavior of the slot module.

> **INFO**
> To start with the boot application after the next reset choose SBMB (for firmware upload for example).
> To start the main application choose SBMM (default).
> If the slot module starts in the bootcode it can be changed back to the application with the command **M**.

SBM*Mode*			
Parameter	Name	Validity	Description
	Mode	B	Start boot application after next reset
		M	Start main application after next reset
Error	–		

ADE   Action Display Enable

Configures the slot module to react to display commands.

ADE*Selector*			
Parameter	Name	Validity	Description
	Selector	0	With the touch screen activated it is possible to scroll to menus, but changing settings, e.g. target temperature is impossible.
		1	Reacts to USB commands and display input.
Error	(5) Invalid operand		

5.4. Heating and Cooling (Cooling restricted to CPAC and Thermoshake)

RAT   Report Actual Device-Temperature

Reports the current average temperature of the devices.

> **INFO**
> The temperature is reported in 1/10 °C, e.g: 345 = 34.5 °C.

RAT *Selector*			
Parameter	Name	Validity	Description
	Selector	1	Report temperature measured at the main PT100 sensor directly, without any offset compensation
		2	Report temperature measured at the redundant PT100 sensor directly, without any offset compensation
		other value or blank	Report full compensated temperature, i.e. the liquid temperature in the disposable. This temperature is shown on the display either.
Response	Range		Description
	0 … 1999		Temperature in 1/10 °C
Error	(5) Invalid operand		

RTT   Report Target Temperature

Reports the target temperature of the device, which is set with STT in integer format.

> **INFO**
> The temperature is reported in 1/10 °C, e.g: 345 = 34.5 °C.

RTT		
Response	Range	Description
	0 … 1999	Temperature in 1/10 °C
Error	(5) Invalid operand	

STT   Set Target Temperature

Sets the temperature for each device.

> **INFO**
> The temperature is set in 1/10 °C, e.g: 345 = 34.5 °C.
> The minimum and maximum allowed values are set with the commands SMT (see → page 37) and SLT (see → page 37).

STT *Temperature*			
Parameter	Name	Validity	Description
	Temperature	min … max. temperature	Set target temperature. [1/10 °C]
Error	(5) Invalid operand		

RHE   Report Heater Enable Status (heating/cooling)

Reports the status of the heating / cooling mode.

INFO
If the selector is 1, the status of the output is reported directly i.e. it is 0 or 1 during full power heating or cooling, 2 if off and it fluctuates between 0 and 1 during controlled operation).

RHE*Selector*			
Parameter	Parameter		Description
	Name	Validity	
	Selector	1	Reports what the controller is currently doing i.e. it toggles when the MTC/STC PID controller toggles power
		Other values	It does not toggle, i.e. it indicates the previous customer request
Response	Range		Description
	0		Device is heating
	1		Device is cooling
	2		Device is off
Error	(5) Invalid operand		

RMT   Report maximum allowed Device Temperature

Report maximum allowed temperature of the device.

INFO
The temperature is reported in 1/10 °C, e.g: 345 = 34.5 °C.

RMT*Selector*			
Parameter	Name	Validity	Description
	Selector	0	Maximum temperature that has been measured since last restart
		1	Maximum allowed temperature (depending from SMT setting stored on slot module or device)
Response	Range		Description
	0 … 2000		Temperature in 1/10 °C
Error	(5) Invalid operand		

SMT   Set maximum allowed Device Temperature

Sets maximum allowed device temperature for the device that is being controlled by the slot module.

> **INFO**
> The maximum temperature is set in 1/10 °C, e.g: 345 = 34.5 °C.

SMT*Key,Selector,Temperature*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Selector	0	Erases max measured temperature
		1	Sets maximum allowed temperature defined with parameter Temperature
	Temperature	0 … 1999	Set maximum allowed slot temperature in 1/10 °C (only if Selector = 1)
Error	(5) Invalid operand; (8) wrong keyword.		

RLT   Report lowest allowed Device Temperature

Reports minimum allowed temperature of the device.

> **INFO**
> The temperature is reported in 1/10 °C, e.g: 115 = 11.5 °C.

RLT		
Response	Range	Description
	−127 … 127	Termperature in 1/10 °C
Error	(5) Invalid operand	

SLT   Set lowest allowed Device Temperature

Sets minimum allowed device temperature for the device which the slot is controlling.

> **INFO**
> The minimum temperature is set in 1/10 °C, e.g: 40 = 4.0 °C.

SLT*Key,Temperature*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Temperature	−127 … 127	Minimum allowed slot temperature in 1/10 °C
Error	(5) Invalid operand; (8) wrong keyword.		

RVC   Report Voltage CPAC

The 12 V slot module (blue) is able to indicate the voltage of its TEC and fan supply. This is reported as a reply to this command.

> **INFO**
> Only available for 12 V/14 V devices.
> The voltage is reported in 1/10 V, e.g: 235 = 23.5 V.

RVC		
Response	Range	Description
	0 … 999	Voltage in 1/10 V
Error	–	

RTC   Report TEC Current

The slot module is able to measure the current of the TEC. This is reported as a reply to this command.

> **INFO**
> The current is reported in 1/10 A, e.g: 47 = 4.7 A.

RTC		
Response	Range	Description
	0 … 99	Current in 1/10 A
Error	–	

RAP   Report Actual PWM Value

Reports the actual PWM value of the selected device.

RAP		
Response	Range	Description
	0	Device is neither heating nor cooling
	Other values	PWM 0 … 1000 in 1/10%
		Value gives percentage of the high interval time.
Error	(5) Invalid operand	

SAP   Set PWM Value Directly

Sets directly the PWM value in % of maximum power.

> **NOTE**
> This command is for development and testing purposes only.

> **INFO**
> The command does not influence if the device is cooling or heating.
> If it is cooling before SAP is used, it will continue to cool after SAP has been used. SAP only changes the cooling power. To switch to heating first use STT and ATE and then SAP.

SAP *Value*			
Parameter	Name	Validity	Description
	Value	0 … 100	PWM relation high interval time in %
		100	Full Power mode
		0	SAP is off à ordinary temperature (PID) is able to work
		> 0	PID is off and PWM relation is set.
Error	(5) Invalid operand; (8) wrong keyword.		

RDT   Report Delta Temperature

Reports the absolute temperature difference between the target and actual plate temperature.

> **INFO**
> The temperature is reported in 1/10 °C, e.g: +0345 = 34.5 °C.
> If the actual plate temperature is above the target temperature, a minus is displayed.

RDT		
Response	Range	Description
		Delta temperature in 1/10 °C
Error	(5) Invalid operand	

RHO   Report Heat-Up/Cool down Offset

Reports Heat Up offset of the plate at 70 °C.

> **INFO**
> For details see → chapter 7.1.
> The temperature is reported in 1/10 °C, e.g: 121 = 12.1 °C.

RHO		
Response	Range	Description
	−255 … 255	Offset temperature in 1/10 °C
Error	(5) Invalid operand	

SHO Set Heat-Up/Cool-Down Offset

Sets Heat-Up temperature offset for the plate type used (disposable).

> **INFO**
> Defines the offset temperature line for the various disposables.
> Offset is set in 1/10 °C, e.g.: 121 = 12.1 °C. Origin of the straight line is set in 1/10 °C.
> This value is set by INHECO.

SHO*Key,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Value	−255 … 255	Set heat-up temperature offset for plate type at 70 °C. In 1/10 °C.
Error	(5) Invalid operand		

RCO Report Constant Offset

Reports constant offset.

> Info
> The offset temperature is reported in 1/100 °C, e.g: 460 = 4.60 °C.

RCO		
Response	Range	Description
	−999 … 1000	Offset temperature in 1/100 °C
Error	(5) Invalid operand	

SCO Set Constant Offset

Sets constant offset at calibration of the devices.

> Info
> A constant offset e.g. due to varying cable length must be added or subtracted.
> As this is a very sensitive setting the value is set in 1/100 °C.
> This value is set by INHECO.

SCO*Key,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Value	−999 … 999	Set Constant Offset in 1/100 °C
Error	(5) Invalid operand		

RRT   Report (set) Room Temperature

Reports the temperature that has been set with SRT.

> **INFO**
> For details see → chapter 7.1.
> The temperature is reported in 1/10 °C, e.g: 121 = 12.1 °C.

RRT		
Response	Range	Description
	0 … 510	Offset temperature in 1/10 °C
Error	(5) Invalid operand	

SRT   Set Room Temperature

Sets the temperature for the offset compensation curves.

> **INFO**
> It is intended to be set close to room temperature in the vicinity of the devices.
> The temperature is set in 1/10 °C, e.g: 121 = 12.1 °C in 1/10 °C.
> For details see → chapter 7.1.

SRT*Value*			
Parameter	Name	Validity	Description
	Value	0 … 510	Set room temperature close to device in 1/10 °C
Error	(5) Invalid operand		

RBO   Report Boost Offset

Reports Boost temperature offset.

> **INFO**
> For details see → figure 6.
> The temperature is reported in 1/10 °C, e.g: 121 = 12.1 °C.

RBO		
Response	Range	Description
	0 … 300	Boost temperature offset
Error	(5) Invalid operand	

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SBO   Set Boost Offset

Sets Boost temperature offset.

> **NOTE**
> The Boost temperature offset is set in 1/10 °C, e.g: 121 = 12.1 °C.
> For details see → figure 6.

SBOOffset			
Parameter	Name	Validity	Description
	Offset	0 … 300	Set heat-up temperature offset for boost. Range also depends from the maximum allowed temperature (see SMT) and the target temperature (see STT).
Error	(5) Invalid operand		

RBT   Report Boost Time

Reports Boost time.

> Info
> For details see → figure 6.

RBT		
Response	Range	Description
	0 … 30000	Boost time [sec]
Error	(5) Invalid operand	

SBT   Set Boost Time

Sets Boost time in seconds.

> **INFO**
> For details see → figure 6.

SBTTime			
Parameter	Name	Validity	Description
	Time	0 … 30000	Boost time [sec]
Error	(5) Invalid operand		

RCD   Report Calibration Date

Reports the date of thermal adjustment and calibration.

RCD		
Response	Format	Description
	YYYY-MM-DD,xxx	Date and operator YYYY: year; MM: month; DD: day xxx: three alphanumeric characters
Error	–	

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RCI   Report Calibration Inclination

Reports the value of the inclination of the PT100 calibration line.

> **INFO**
> The calibration line can be mapped in connection with RCT. Offset temperature T and inclination I are set automatically after the commands SCL and SCH have been used to calibrate the device.

RCI*Sensor*			
Parameter, Response	Parameter		Response
	Name	Validity	
	Sensor	0	Inclination of calibration line Sensor 1 (main)
		1	Inclination of calibration line Sensor 2 (redundant)
Error	(5) Invalid operand		

RCT   Report Calibration Offset Temperature

Reports the value of the temperature offset of the PT100 calibration line.

> **INFO**
> The calibration line can be mapped in connection with RCI. Offset temperature T and inclination I are set automatically after the commands SCL and SCH have been used to calibrate the device.

RCT*Sensor*			
Parameter, Response	Parameter		Response
	Name	Validity	
	Sensor	0	Offset of calibration line Sensor 1 (main)
		1	Offset of calibration line Sensor 2 (redundant)
Error	(5) Invalid operand		

SCL   Set Calibration Low

Set lower temperature adjustment points for the sensors.

SCL			
Parameter	Name	Validity	Description
	–	–	–

SCH   Set Calibration High and Date

Sets higher temperature adjustment points and date with operator of adjustment for the sensors.

> **INFO**
> Set by INHECO.

SCH*Key,Date,Operator*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Date	YYYY-MM-DD	YYYY: year; MM: month; DD: day
	Operator	xxx	Operator (three alphanumeric characters)
Error	(5) Invalid operand; (8) wrong keyword.		

RCM   Report Calibration Mark

Reports the date and an alphanumeric string (e.g. operator) of the last calibration for the slots.

RCM		
Response	Format	Description
	YYYY-MM-DD,xxx	Date and alphanumeric string YYYY: year; MM: month; DD: day xxx: three alphanumeric characters
Error	(5) Invalid operand	

SCM   Set Calibration Mark

Sets the date and e.g. operator of the last calibration for the mainboard and the devices.

SCM*Key,Date,Value*			
Parameter	Name	Validity	Description
	Key	xxxxxx	Secret key
	Date	YYYY-MM-DD	YYYY: year; MM: month; DD: day
	Value	xxx	Operator (three alphanumeric characters)
Error	(5) Invalid operand; (8) wrong keyword.		

RPO   Report Parameter Origin

Reports origin of the PID parameters, max allowed temperature and type device.

RPO		
Response	Range	Description
	0	Origin is internal slot EEPROM
	1	Origin is external device EEPROM (default)
	255	Not yet set, device tries to use external EEPROM
Error	(5) Invalid operand	

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SPO   Set Parameter Origin

Sets origin of the calibration and PID values, max allowed temperature, type device, etc.

SPO*Selector*			
Parameter	Name	Validity	Description
	Selector	0	Internal slot EEPROM is used
		1	External device EEPROM is used (default).
		255	Not specified
Error	(5) Invalid operand		

RPP   Report PID Controller Coefficients (Proportional Gain)

Reports the PID controller coefficients proportional gain.

RPP*Selector*			
Parameter	Name	Validity	Description
	Selector	0	Heating
		1	Cooling
Response	Range		Description
	0 … 255		PID controller coefficients proportional gain
Error	(5) Invalid operand		

SPP   Set PID Controller Coefficients (Proportional Gain)

Sets PID controller coefficients: proportional gain.

> **INFO**
> Only affects the internal slot EEPROM.
> Device-specific external EEPROM is changed with the relevant mainboard command (default).

SPP*Selector,Value*			
Parameter	Name	Validity	Description
	Selector	0	Heating
		1	Cooling
	Value	0 … 255	PID controller coefficients proportional gain
Error	(5) Invalid operand		

RPI   Report PID Controller Coefficients (Integration Value)

Reports the PID controller coefficients integration value.

RPI*Selector*			
Parameter	Name	Validity	Description
	Selector	0	Heating
		1	Cooling
Response	Range		Description
	0 … 255		PID controller coefficients integration value
Error	(5) Invalid operand		

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SPI   Set PID Controller Coefficients (Integration Value)

Sets PID Controller Coefficients: integration value.

> **INFO**
> Only affects the internal slot EEPROM.
> Device-specific external EEPROM is changed with the relevant mainboard command (default).

SPI*Selector,Value*			
Parameter	Name	Validity	Description
	Selector	0	Heating
		1	Cooling
	Value	0 … 255	PID controller coefficients integration value
Error	(5) Invalid operand		

RPD   Report PID Controller Coefficients (Differential Part)

Reports the PID controller coefficients differential part.

RPD*Selector*			
Parameter	Name	Validity	Description
	Selector	0	Heating
		1	Cooling
Response	Range		Description
	0 … 255		PID controller coefficients differential part
Error	(5) Invalid operand		

SPD   Set PID Controller Coefficients (Differential Part)

Sets PID controller coefficients: differential part.

> Info
> Only affects the internal slot EEPROM.
> Device-specific external EEPROM is changed with the relevant mainboard command (default).

SPD*Selector,Value*			
Parameter	Name	Validity	Description
	Selector	0	Heating
		1	Cooling
	Value	0 … 255	PID controller coefficients differential part
Error	(5) Invalid operand		

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RDO   Report Disposable Offset

Reports the disposable-specific offset.

> **INFO**
> For details see → chapter 7.1.3.2.

RDO*Selector*			
Parameter	Name	Validity	Description
	Selector	0 … 8	Offset place
Response	Range		Description
	0 … 255		disposable-specific offset
Error	(5) Invalid operand		

SDO   Set Disposable Offset

Sets disposable-specific offset.

> **INFO**
> Only affects the internal slot EEPROM.
> Device-specific external EEPROM is changed with the relevant mainboard command (default).
> For details see → chapter 7.1.3.2.

SDO*Selector,Value*			
Parameter	Name	Validity	Description
	Selector	0 … 8	Offset place
	Value	0 … 255	Differential part
Error	(5) Invalid operand		

RDX   Report Disposable X-Axis Temperature

Reports the disposable-specific offset.

> **INFO**
> For details see → chapter 7.1.3.2.
> The temperature is reported in 1/10 °C, e.g: 345 = 34.5 °C.

RDX*Selector*			
Parameter	Name	Validity	Description
	Selector	0 … 8	Offset place
Response	Range		Description
	0, 10, 20, 30, … 2550		disposable-specific offset temperature in 1/10 °C
Error	(5) Invalid operand		

SDX   Set Disposable X-Axis Temperature

Sets disposable-specific offset.

> **INFO**
> Influences only the internal slot EEPROM.
> Device-specific external EEPROM is changed with the relevant mainboard command (default).
> For details see → chapter 7.1.3.2.

SDX*Selector,Value*			
Parameter	Name	Validity	Description
	Selector	0 … 8	Offset place
	Value	0 … 2550	disposable-specific offset temperature in 1/10 °C 0, 10, 20, 30, … 2550
Error	(5) Invalid operand		

SHV   Set High Voltage

Sets the Supply Voltage for the TEC of the device.

> **INFO**
> 12 V module-specific command that has no effect on 24 V slot modules.

SHV*Selector*			
Parameter	Name	Validity	Description
	Selector	0	Lower voltage à 12 V supply for the TEC (optimum for cooling performance)
		1	Higher voltage à 14 V supply for the TEC (optimum for heating performance)
Error	(4) Invalid command; (5) Invalid operand.		

ATE   Action Temperature Enable

Starts heating or cooling until the temperature previously set by STT has been reached.

> **INFO**
> After the STT temperature has been reached it will be stabilised.

ATE*Selector*			
Parameter	Name	Validity	Description
	Selector	0	Off
		1	On
Error	(5) Invalid operand		

5.5. Shaking (Thermoshake and Teleshake only)

5.5.1. Shaking Commands related to all INHECO Shake devices

RVT   Report Virtual Twelve Volt

Reports if the „virtual 12 V feature" is enabled.

RVT		
Response	Range	Description
	0	virtual 12 V disabled
	1	virtual 12 V enabled
Error	(4) Invalid command; (5) Invalid operand	

SVT   Status Set Virtual Twelve Volt

Sets the „virtual 12 V feature" on/off.

SVT*Status*			
Parameter	Name	Validity	Description
	Status	0	disables virtual 12 V
		1	enables virtual 12 V
Error	(4) Invalid command; (5) Invalid operand.		

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5.5.2. Shaking Commands partly related to INHECO Shake devices

RSR   Read Shaker Revolutions for Thermoshake and Teleshake

Reads the set shaker frequency (revolution).

> **INFO**
> As the MTC/STC devices have no shaker monitoring as yet this command only returns the value that has been set previously with the SSR command.

RSR*Nr*			
Parameter	Parameter		Description
	Name	Validity	
	Nr	1	Report frequency for number of shake period when shaking arrangement is planned, which can be started with ASE4
		2	
		Other values	Report frequency for ASE1
Response	Range		Description
	0 … 9999		Shaker frequency [rpm]
Error	(5) Invalid operand		

RSR   Read Shaker Revolutions for Thermoshake AC, Teleshake95 AC and Teleshake AC

Reads the set shaker frequency (revolution).

RSR			
Response	Range		Description
	0 … 3000		Shaker frequency [rpm]
Error	(5) Invalid operand		

SSR   Set Shaker Revolutions for Thermoshake and Teleshake

Sets the shaker frequency (revolution).

> **INFO**
> For smooth figures frequencies above 120 rpm are recommended.

SSR*Revolutions* or SSR*Nr,Revolutions*			
Parameter	Name	Validity	Description
	Revolutions	60 … 2000	Shaker frequency [rpm] / no leading zero
	Nr	1	Number of shake period when shaking arrangement is planned, which can be started with ASE4.
		2	(For a more detailed description see command ASE, → page 52.)
		Other values	For ASE1
Error	(4) Invalid command; (5) Invalid operand.		

SSR   Set Shaker Revolutions for Thermoshake AC, Teleshake95 AC and Teleshake AC

Sets the shaker frequency (revolution).

> **INFO**
> For smooth figures frequencies above 150 rpm are recommended.

SSR*Revolutions*			
Parameter	Name	Validity	Description
	Revolutions	150 … 3000	Shaker frequency [rpm] / no leading zero
Error	(4) Invalid command; (5) Invalid operand.		

ASE   Action Shaker Enable

Starts/stops shaking with the number of revolutions set by SSR, the shape set by SSS and the duration set by SST. For Thermoshake AC only the shaking with the number of revolutions set by SSR is started. As the commands SSS and SST does not exist for the Thermoshake AC.

ASE*Selector*			
Parameter	Name	Validity	Description
	Selector	0	Off (for Thermoshake AC, Teleshake AC, Teleshake AC 95 this might take 6-31 sec)
		1	On (for Thermoshake AC, Teleshake AC, Teleshake AC 95 this might take 6-31sec)
		4	Starts special shaking arrangement, see Info above (this selector does not exist for Thermoshake AC, Teleshake AC and Teleshake AC 95)
Error	(5) Invalid operand		

> Info
> As of Firmware Version 1.87, **ASE4 starts a shaking arrangement for Thermoshake and Teleshake, this feature does not exist for Thermoshake AC, Teleshake AC and Teleshake 95 AC.**
> Its duration, frequencies and shape is determined by the parameters set with the commands SST, SSR and SSS, respectively.
> One example is: Let the shaker shake 5 seconds clockwise at 400 rpm followed by 10 seconds anticlockwise movement at 800 rpm. After 60 seconds shaking should stop.
> Commands for this example are:
> - SST1,50
> - SSR1,400
> - SSS1,1
> - SST2,100
> - SSR2,800
> - SSS2,0
> - SST3,600
> - ASE4

5.5.3. Shaking Commands related to Shake devices except Thermoshake AC, Teleshake AC and Teleshake 95 AC

RSS   Read Shaker Shape

Reads the shape of the movement, in other words the motion, in which the item is to be shaken.

RSS*Nr*			
Parameter	Parameter		Description
	Name	Validity	
	Nr	1	Read figure for number of shake period when shaking arrangement is planned, which can be started with ASE4
		2	
		Other values	Read shaking motion with ASE1
Response	Range		Description
	0		Circle anticlockwise
	1		Circle clockwise
	2		Up left down right
	3		Up right down left
	4		Up-down
	5		Left-right
Error	(5) Invalid operand		

SSS   Set Shaker Shape

Sets the shape of the figure that should be shaked.

SSS*Figure* or SSS*Nr,Figure*			
Parameter	Name	Validity	Description
	Figure	0	Circle anticlockwise
		1	Circle clockwise
		2	Up left down right
		3	Up right down left
		4	Up-down
		5	Left-right
	Nr	1	Number of shake period when shaking arrangement is planned, which can be started with ASE4.
		2	
Error	(4) Invalid command; (5) Invalid operand.		

RST   Read Shaker Times

Reads the shaker's periodic shaking times, which are set with the command SST.

RST*Nr*			
Parameter	Name	Validity	Description
	Nr	1	Number of shake period when shaking
		2	arrangement is planned, which can be started with ASE4.
		3	End of shake arrangement
Response	Range		Description
	0 … 10.000.000		Duration of period specified by Nr (Nr = 1 or 2) resp. Duration of whole shaking arrangement (Nr = 3) in [1/10 s] 0 means endless
Error	(5) Invalid operand.		

SST   Set Shaker Times

Sets periodic shaking times.

> **INFO**
> For a detailed description see command ASE (see → page 52).

SST*Nr,Time*			
Parameter	Name	Validity	Description
	Nr	1	Number of shake period when shaking
		2	arrangement is planned, which can be started with ASE4.
		3	End of shake arrangement
	Time	0 … 10.000.000	Time of of period specified by Nr [1/10 s]; 0 means endless
Error	(4) Invalid command; (5) Invalid operand.		

RSE   Report Shaker Enable Status

Reads shaker enable status.

RSE		
Response	Range	Description
	0	Shaker off
	1	Shaker on
Error	(4) Invalid command; (5) Invalid operand	

5.5.4. Shaking Commands only related to Thermoshake AC
RIS   Report Information of Shaker (for Thermoshake AC only

Reports diagnostic information on the Thermoshake AC

RIS*Selector*			
Parameter	Parameter		Description
	Name	Selector	
		1	Reserved
		2	Reserved
		3	Communication Bus Busy Status; 255 Represents a communication error
		4	1 is shaking 0 is not shaking 1 will also be reported if SSR0 has been used to only close the clamps.
		5	Reserved
		6	Shaker Status 0-Idle/Done 1-Action in Progress 2-Reinitialisation in Progress 3-Error State This command should be used after ASE1/0 to check the status of the shaker. If everything goes as expected a transition from 1 to 0 can be observed. If the clamps are experiencing an issue the state will change from 1 to 2 and the system will test the clamps. If all goes well the state will change from 2 to 1 and then to 0. If the clamp issue appears to be permanent the state will change to 3, and the Thermoshake AC will be inoperable.
Error (5th byte)	(4) invalid command (wrong command) (5) Invalid operand (wrong selector)		

RSP 35   Report Teleshake Staus

Reports diagnostic information on the Teleshake AC

RSP35			
Response	Parameter		Description
	Name	Response	
		0	idel/doing nothing
		1	Shaking
		2	Not Shaking, but is should be shaking
		3	Task currently in progress. Only shown during internal debugging session.
		4	In Error, a serious error occured in the Telesake, use the REC command to see set error codes.
Error (5th byte)	(4) invalid command (wrong command) (5) Invalid operand (wrong selector)		

RCS   Report Clamp Status

Reports the status of the clamps on the Thermoshake AC, Teleshake AC and Teleshake 95 AC

> **INFO**
> For a detailed description see command ASE (see → page 52).

RCS			
Parameter	Name	Validity	Description
	Nr	1	Clamps are open
		2	Clamps are closed
		0	Unknown. An error must have occured
Error	(4) Invalid command; (5) Invalid operand.		

6 ERROR HANDLING AT THE MTC/STC

Two types of error may occur on the MTC/STC. The first type is immediately communicated to the PC via USB. The 5th byte of each reply message includes this error information, and the PC application can then decide how to respond to the error. The second type of error consists of codes stored in a non-versatile form, which can be read with the command REC (see → page 16) and erased with the command SEC (see → page 17).

6.1. Error byte in the reply to every command

Please refer to table one in Appendix A which describes all error codes represented by the 5th byte of the reply to each message

6.2. Description Commands REC/SEC

Many different errors can be stored in the EEPROM of the µCs, for example, Error 11 when the TEC current is too low. At the same time the error code is stored, the LED of the relevant slot (back of M/STC) or mainboard (not visible in the case of closed housing) lights up red and blinks orange when communication is active. Whereas the red LED vanishes after a reset, the error code remains stored in a non-versatile form in the EEPROM and can be read with the command REC. When the command REC is used without argument, two error codes separated by an underscore are included in the reply string. The entry of the error codes is debounced. The limits for the values, if some error codes are to be stored, can be set with the command SLO (Set Limits Onboard diagnosis). One example is the maximum allowed voltage of the power supply.

Since Firmware Version 1.85 it is possible to get additional information about a specific error. If you use the REC command with the error code as an argument the reply string contains information about the number of occurrences of the error and the time and date of the last occurrence. The time is given in the runtime of the slot module or mainboard, i.e. the reply to RDC2 at the moment of error occurrence. To get all information about the error codes of e.g. slot module 3 refer to the procedure implemented in the demo tool (see → chapter 9.2) or demo tool manual on USB-Stick.

Command	to report …	Reply (example)	Result
3REC	all error codes	3rec0_05_26_02_06_01	The five errors 1, 6, 2, 26 and 5 occurred.
3RDC2	the actual run time	3rdc000123682	The slot module run time is 123682 seconds (i.e. this slot module worked for ~34 hours)
3REC1	details of all errors	3rec0001:_001_00102031	Error 1 occurred 1 time, 123682 – 102031 = 21651 seconds (~6 hours) ago.
3REC6		3rec0006:_003_00123646	Error 6 occurred 3 times, 123682 – 123646 = 36 sec ago.
3REC2		3rec0002:_007_00123628	Error 2 occurred 7 times, 123682 – 123628 = 54 sec ago.
3REC26		3rec0026:_031_00123671	Error 26 occurred 31 times, 123682 – 123671 = 11 sec ago.
3REC5		3rec0005:_107_00102235	Error 5 occurred 107 times, 23682 – 102235 = 21447 sec (~6 hours) ago

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Conclusion: In this example it seems that slot module 3 (or the device connected to it) had problems with the TEC voltage (errors 1 and 5, ~6 hours run time ago). And it still has problems with the checksums of either the device EEPROM (code 2 and 6) or the flash memory (code 26).

Please refer to table 2 of Appendix A which describes the Mainboard Error Codes.

> Info
> All error entries remain until they are erased with the SEC command (this command erases the entire error memory).

6.3.   Status LEDs

The slot modules and the mainboard have LEDs that can light up red, green or yellow. The mainboard LED cannot be seen when the housing is closed, whereas the slot module LEDs are located on the back of the MTC/STC.

- The green light is toggled when a SSB message has been received.

- The red light is switched on when an error has been detected.

- The red light blinks slowly during the firmware upload.

- Yellow light: see comment in table 4, "Normal mode with error".

As a result, the scenarios described in → table 2 are possible.

Tab.1: Description of the slot modules status LEDs

Mode	LED behavior	Comment
Normal Mode without errors	LEDs are blinking green with same frequency of about 5 Hz.	Every 30 ms a cyclical message is sent by the MAINBOARD. Therefore each slot receives every 180 ms a new internal message. This determines the blinking frequency of the LEDs of all connected slot modules.
Normal mode with high communication rate and without errors	LEDs are blinking green with different frequency.	The blinking frequency of the LED of the slot module that is being addressed by the USB command blinks faster. All other LEDs blink more slowly than they do when there is no external communication.
Normal Mode with error	The LED of the slot module that has an error blinks red/yellow. All other LEDs blink green.	If the green and the red LED are simultaneously on, the color appears yellow. This is not an extra signal, but it indicates that an error occured and communication is active.
Firmware upload mode	The LED of the slot module that is being updated blinks red slowly. All other LEDs stop blinking.	During upload the internal communication is stopped with the command 0AUM1. The passive LEDs continue to have the same status they had when the mainboard received that command.

6.4. Display

Since FW 1.85 the codes of actual errors get displayed on the S/MTC screen until the customer presses "ok" on the touch screen. This happens once for every different error code after each power on. Slot module error codes are displayed only when the relevant slot is selected on the touch screen (MTC only).

The display is reset every 15 minutes. After the reset the error code disappears from the display. For a problem-free readout of error codes, confidently please use the USB, e.g. with the demo tool presented in → chapter 9.2.

7 ADJUSTMENT

7.1. Thermal Adjustment

> **INFO**
> This manual thermal adjustment procedure should only be used if it is impossible to use the automated INHECO Thermal Adjustment Measuring System!

7.1.1. Slot Module

To adjust the temperature sensors on the heating plate for the device e.g. on slot module 1, follow the step-by-step instructions below:

- Plug the INHECO Calibrator into the slot-device 1 (please contact INHECO if recalibration of the devices is needed).

- Choose the low position of the switch (0 °C).

- Send 1SCL.

- Choose the high position of the switch (50 °C).

- Send 1SCH**Keyword,Date**,USR (Date is 20YY-MM-DD, USR are three alphanumeric characters such as MST)

→ The thermal calibration of slot module 1 is completed.

All other slot modules are adjusted the same way.

7.1.2. Mainboard

On the mainboard, calibration parameters are set directly, rather than values at two temperatures being used for calibration. In particular the value of the slope is taken from the PT100 of the slot-devices. It is usually 290 or 289 (Command xSCIKey,290). Therefore only one value at one temperature must be used to set the offset. The digital sensor value that has already been calibrated can be used for this value (use 0RHV2 to get the digital sensor temperature). The value "123", set by xSCTkey123 is subtracted from the temperature. For example if you have the following situation:

- Calibration Inclination: 0RCI à 290

- Calibration Offset: 0RCT à 3300

- Digital Sensor Temperature: 0RHV2 à 233 (23.3 °C)

- Analog Sensor reply: 0RHV4 à 133 (not correctly calibrated)

Use the following command to calibrate the mainboard PT100:
SCTkey,3200

Now the reply is:
Analog sensor reply: 0RHV4 à 233 (correctly calibrated)

7.1.3. Devices

At least two different origins for temperature offsets exist for the devices. The MTC/STC can handle two offsets. The first is based on the position of the PT100 sensor inside the device. The second is due to the labware (disposable) and the heat load. The first is set by INHECO and is key word protected whereas the second can be set by the customer.

7.1.3.1. Heater Offset (Command SHO)

In all INHECO devices that can be handled by the MTC/STC, two PT100 sensors are present. Different positions of the sensors in different devices and different cable lengths may lead to errors in the temperature calculation. These errors can be compensated for with the help of the heater offset curve. The heater offset curve is a straight line which should intercept zero at room temperature. The two commands:

iSRT250

iSHOkey,90

generate the offset line shown in → see below in figure 3.

The value behind SRT is the 0 °C interception temperature.

The value behind SHOkey is the offset temperature (in 1/10 °C) at a specific target temperature. Setting this offset to 9 °C, as in this example, automatically determines an offset of 5 °C at 50 °C or –3 °C at 10 °C.
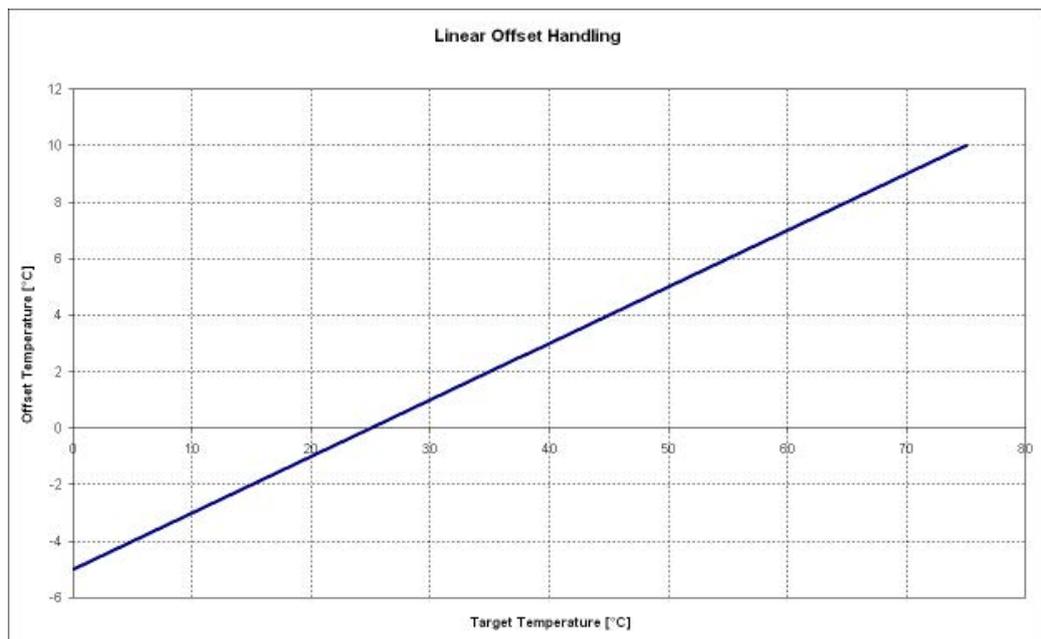
Fig.3: Linear Offset handling, device-specific and disposable-specific

INHECO CPAC devices are adjusted with flat bottom adapters.

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7.1.3.2.   Linear disposable offset (Commands SDO and SDX)

The commands of → table 3 (below) generate the offset curve given in → figure 3 for the disposable offset at the device connected to the slot module 1. Using the command SRT adapts the line to the ambient temperature.

Tab.2: Commands for a linear offset

Command to store in internal EEPROM of slot module 1	Command to store in device EEPROM of device connected to slot module 1
1SRT250	0SRT1,250
1SDO0,90	0SDO1,0,90
1SDX0,700	0SDX1,0,700
1SDX1,2550	0SDX1,1,2550

During heating activities, the temperature in the liquid to be heated is typically lower than the temperature on the surface of the heating device. Therefore the MTC/STC can add an offset to the target temperature.

The higher the difference between ambient and target temperature the bigger this offset should be. The MTC/STC calculates this automatically if the target temperature is changed.

But what can we do, if the ambient temperature changes? – For this task an external temperature sensor (see → figure 4 below) can be connected to the MTC/STC. It can be plugged into the back of the MTC/STC and can easily be read out with 0RHV5 (temperature) and 0RHV6 (Humidity). To adjust the offset to the ambient temperature the following steps are recommended:

• Place the sensor in the vicinity of the heating/cooling devices.

• Read out the temperature at frequent intervals
  (e.g. every hour 0RHV5 … Reply is e.g. 0rhv00280).

• Send this temperature to all devices
  (e.g. to device connected with slot module 3: 0SRT3,280)

• Repeat the 2nd and 3rd step till the end of the session.
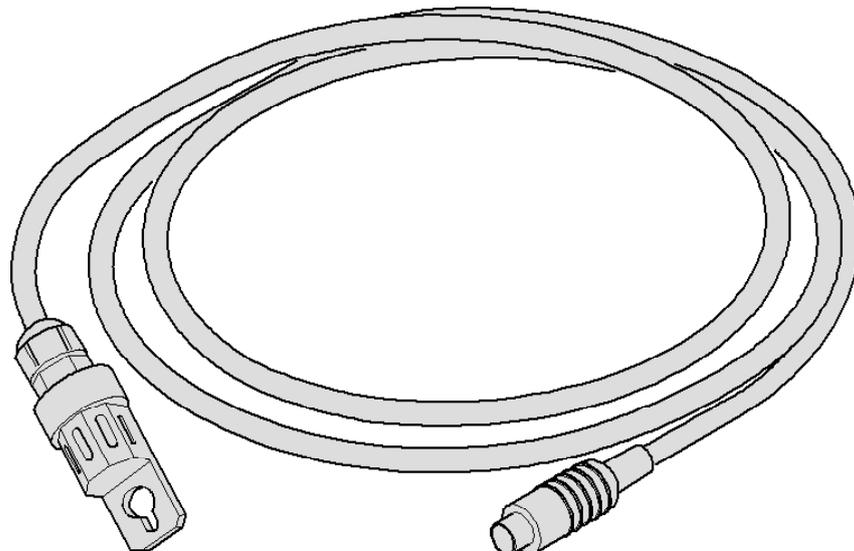
Fig.4: External temperature and relative humidity sensor

7.1.3.3.   Non-linear disposable offset (Commands SDO and SDX)

If the DX1 is not 2550 (use 1RDX1 to check this) a stairway offset is used.
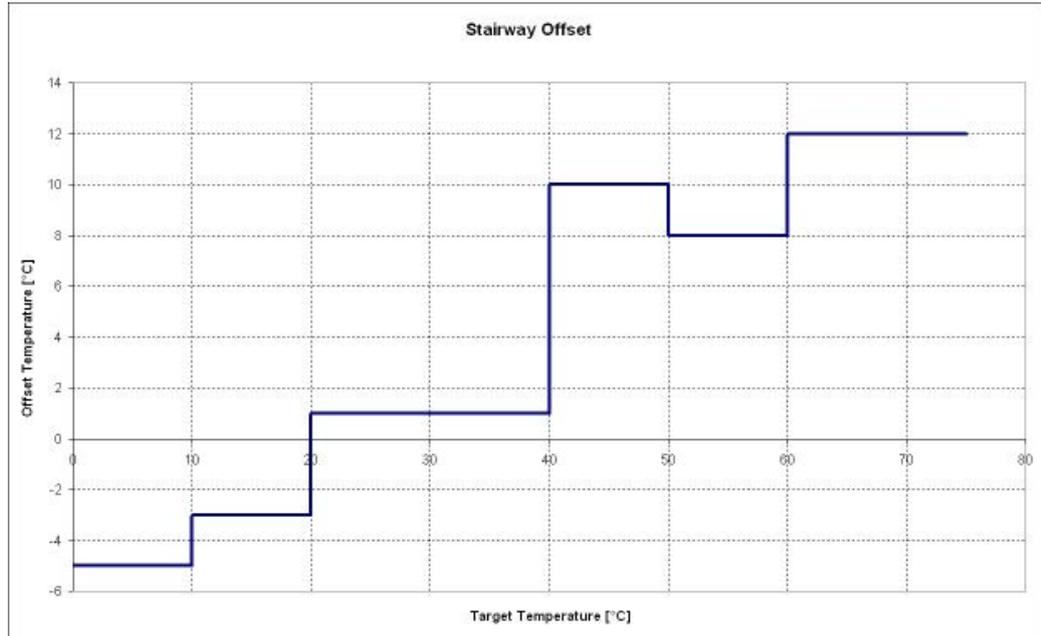
Fig.5: Advanced stairway offset handling for disposable offset (see → table 4 below)

The commands shown in → table 4 below will lead to the offset stairway for the device connected to slot module 1 presented in → figure 5 above:

Tab.3: Commands for a stairway offset (example)

Command to store in internal EEPROM of slot module 1	Command to store in device EEPROM of device connected to slot module 1
1SRT250	0SRT1,250
1SDX0,0	0SDX1,0,0
1SDX1,100	0SDX1,1,100
1SDX2,200	0SDX1,2,200
1SDX3,400	0SDX1,3,400
1SDX4,500	0SDX1,4,500
1SDX5,600	0SDX1,5,600
1SDX6,750	0SDX1,6,750
1SDO0,−50	0SDO1,0,−50
1SDO1,−30	0SDO1,1,−30
1SDO2,10	0SDO1,2,10
1SDO3,100	0SDO1,3,100
1SDO4,80	0SDO1,4,80
1SDO5,120	0SDO1,5,120

The customer has the option of setting up to 9 different offset values for the different temperatures that are to be controlled. 0SDO1,2,10 sets the offsets at temperatures between 0SDX1,2,value1 and SDX1,3,value2 to 1 °C.

> **INFO**
> 1SDX0,100; 1SDX1,1000; SDO0,10; SDO1,10 leads to a constant offset of 1 °C for all temperatures between 10 °C and 100 °C.

7.2. Boost Time and Boost Offset

The PID controller of the slot modules can be used in different ways. For example the PID parameters can be chosen in such a way, that the target temperature will be reached fast but without beeing exceeded (the aperiodic case). In this case the adequate parameters differ for every different customer application. Therefore we recommend using boost time and boost offset. Firstly, setting the PID parameters is less critical when these are used. Secondly, the offset is needed in any case to bring the liquid in the disposables to the target temperature at a faster pace and with greater precision. Boost Time and Boost Offset can be set with the commands SBT and SBO respectively.
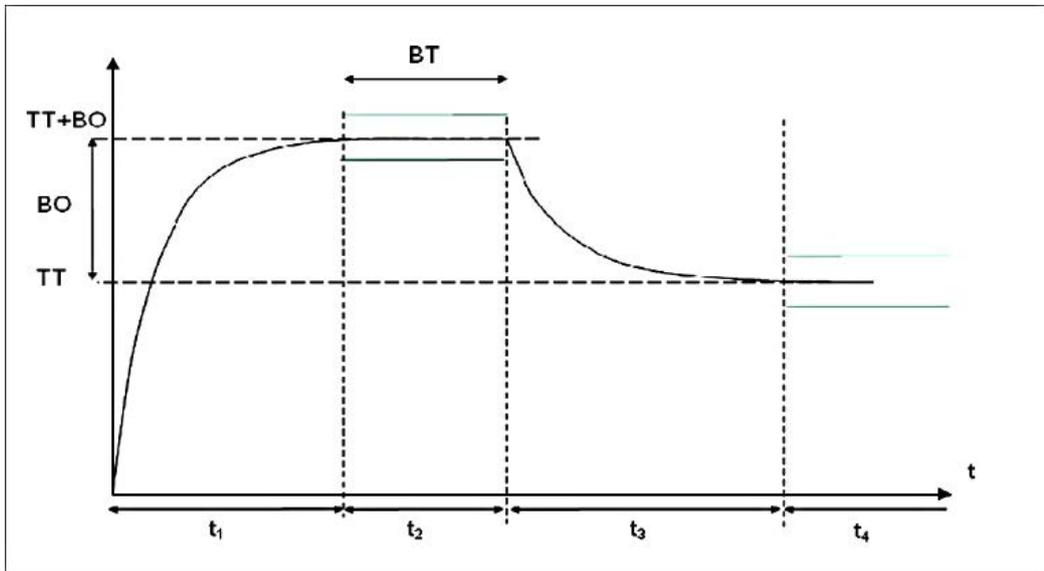
Fig.6: Definition of Boost Offset and Boost Time
TT = Target temperature; BO = Booster offset; BT = Boost time (t2)

The times t_1 and t_3 may be controlled and an error code can be stored if the time increases a specified value.

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8 HANDLING CONFIGURATION PARAMETERS

All configuration parameters are stored in the non-versatile EEPROM. Some very important parameters can either be stored in the slot module EEPROM or in the external EEPROM. To change internal values the slot commands must be used (e.g. 3SPP0xy). Mainboard commands must be used to change external parameters (e.g. 0SPP3,0,xy).

The following tables → 5 (below), → 6 and → 7 give an overview over the EEPROMs contents.

8.1. Mainboard

Tab.4: EEPROM Content of the Mainboard

Name	Commands connected to the value	Position in the EEPROM	Description
Serial number	SFV	6	
Awake time	RDC/SDC	8	
Calibration Year	SCH	12	
Calibration Month	SCH	14	
Calibration Day	SCH	16	
Max Power Supply voltage	SLO1	32	
Min Power Supply voltage	SLO2	18	
Max Housing temperature	SLO3	20	
Max Humidity	SLO6	26	
Max Fan RPM	SLO7	28	
Min Fan RPM	SLO8	30	
Difference temperature Sensor 1/2	SLO5	24	
Calibration Inclination M	SCI	36	Calibration data for the analog sensor located at the front of the mainboard
Calibration Offset T	SCT	38	Calibration data for the analog sensor located at the front of the mainboard
Error Codes	REC/SEC	50ff	
Shadow Error Codes	REC_KEY_	62ff	
Calibration Data	SCM/SCP	131–179	One set has 9 bytes
CRC Cecksum for Flash	SCF/RCF	180	4-byte length and CRC16
Type Device	STD	252	STC or MTC
Error occurrence time	REC	256	
Error occurrence counter	REC	296	

8.2. Slot Module

Tab.5: EEPROM Content of the Slot

> **INFO**
> Device-dependent values for the temperature control algorithm (which is implemented in the slot module) are stored in external EEPROM and in the slot module EEPROM. They are marked with an asterisk "*".

Name	Commands connected to the value	Position in the EEPROM	Description
Calibration Value M	SCH/SCL/RCI0	2	1st sensor
Calibration Value T	SCH/SCL/RCT0	4	1st sensor
Serial number	SFV	6	
Awake time	RDC/SDC	10	
Calibration Date	SCH	12	6 bytes
Max allowed temperature*	SMT/RMT	18	
Min allowed temperature*	SLT/RLT	184	
Offset temperature*	SHO/RHO	20	
Room temperature*	SRT/RRT	22	
Device Type*	STD/RTD	24	0 à Thermoshake; 1 à CPAC; 2 à Teleshake; 4 CPAC 2 TEC
P-Part of PID ctrl*	SPP/RPP	26–32 and 76–82	SPI/RPI SPD/RPD 2*6 bytes
Disposable Offset*	SDO/RDO	106	Up to 9 offset values, For details see → chapter 7.1.3.2.
Disposable X-Axis*	SDX/RDX	116	The temperature at which the offset is valid
Target temperature	STT	34	
Min voltage 14	SLO1	36	
Max voltage 14	SLO2	38	
Min voltage 12	SLO3	40	
Max voltage 12	SLO4	42	
RPM Shaker	SSR/RSR	44	
Max temperature device Measured	SMT/RMT1	46	SMT0 sets measured temperature to 0 °C
Max temperature device Allowed	SLO6	48	
Max RPM device allowed*	SLO5	50	
Max Delta Temp Sensor 1 and 2*	SLO7	90	Maximum allowed temperature difference between the two PT100 sensors in a „steady state"
Calibration Value M	SCH/SCL/RCI1	102	2nd sensor
Calibration Value T	SCH/SCL/RCT1	104	2nd sensor
Error Codes	REC/SEC	52ff	

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Name	Commands connected to the value	Position in the EEPROM	Description
Shadow Error Codes	REC_KEY_	62ff	INHECO internal error codes
Calibration Data	SCM/SCP	131-179	Up to 5 sets, each set with 9 bytes
CRC Cecksum for Flash	SCF/RCF	180	4-byte length and CRC16
Error occurrence time	REC	256	
Error occurrence counter	REC	296	

8.3. External EEPROM

One big advantage of the MTC/STC is that it allows you to store the settings not only in the MTC/STC itself but also in the device connected to it, namely CPAC, Thermoshake, Teleshake, etc. In the device EEPROM, the MTC/STC can store device-specific parameters like the PID parameters and temperature offsets. With the command xSPOi (Set PID Origin) all slots can be configured to either use the internal slot EEPROM or the external device EEPROM as the origin for the parameters. The Default setting is that the MTC/STC uses the device EEPROM. The following table shows which parameters are stored in the external EEPROM:

Tab.6: Content of the external device EEPROM
  Slot = Slot ID

Name	Commands connected to the value	Position in ext EEPROM	Description
PID Parameter	0SPPSlot,0/1,DATA; 0SPISlot,0/1,DATA, 0SPDSlot,0/1,DATA	1 2/3 4/5	2 times 3 bytes, one for P, one for I and one for D (Heating and Cooling); Values can be read at relevant slot 4 seconds after Set e.g. via 3RPP0
Heater offset	0SHOkey,Slot,DATA	6	Offset at 70 °C 2 bytes
Room temperature	0SRT,Slot,DATA	8	Room temperature 1 byte
SPP0	0SPPSlot,0/1,DATA	9	P Value 0
Type device	0STDkey,Slot	10	CPAC, Thermoshake, Teleshake, CPAC2TEC
Disposable Offset	0SDO/0SDX	11–28	18 bytes
Constant Offset	0SCOkey,Slot,DATA	29	2 bytes
Maximum Allowed temperature	0SMTkey, Slot,1,DATA	31	1 byte, to be set from INHECO [1/10 °C] Read at slot only
CRC	–	32	Checked by slot module
–	–	33–39	empty
Run Time	0RRDSlot	40	3 bytes read via 0RRD
Minimum temperature	0RLTSlot	44	2 bytes; can only be read
Maximum temperature	0RMTSlot	46	2 bytes; can only be read
Serial number	0SSNKey,Slot,DATA	51	Devices serial number (two byte)
Calibration Mark	0SCMSlot	53–112	10 times 6 bytes (3 Date + 3 Name)
–	–	113–120	empty

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Name	Commands connected to the value	Position in ext EEPROM	Description
Default Parameter	0SRESlot, 0SDPkey,Slot,,j,	121–134	14 bytes
Article Number	0SANSlot,Number	137	last three digits of article number are stored
–	–	140-194	empty
Calibration Mark count	0SCP	195	Set Calibration Date Position Counter
		196-209	Internal Data (Calibrator Settings)
Minimum Allowed temperature	0SLTkey,Slot,DATA	210	1 byte
Max Delta T PT100 1–2	0SDT	211	
Max RPM	0SMR	212	
–	–	213–229	empty
CRCII		230	Second crc checked by MB

As the mainboard handles the external EEPROM and the slots need most of its content (e.g. for temperature control), lots of communication must take place between the mainboard and the slots when the commands listed in the second column are used. If something goes wrong when you use of the external EEPROM configuration commands, please restart the MTC/STC. Then check if the values are correct.

If e.g. device 3 behaves in an unexpected way use 0SRE3 to set its external EEPROM back to the default settings.

9 DESCRIPTION OF THE MTC/STC DLL

The name of the dll is InhecoMTCdll.dll. In addition the HID.dll is needed, whereby the latter is part of the Microsoft Windows software. As mentioned above the MTC/STC are recognized on the USB as Human Interface Device (HID). A simple dll for communication with the MTC/STC is comprised of only three functions. `GlobCom Go = new GlobCom();` needs to be first instantiated. The GlobCom object is then used to call up the following functions:

`public int FindTheUniversalControl(int ID);`

`public void` WriteOnly(`string msg`);

`public string` ReadSync();

`FindTheUniversalControl(int ID)` must be called with the DIP switch settings of the MTC/STC as ID to find the relevant MTC/STC. It returns 1 if the MTC/STC could be found and 0 if not. The three DIP switches allow 8 unique MTC/STC IDs. Therefore eight MTC/STCs can be controlled by one PC at once.

`WriteOnly(string msg)` sends the commands that are described in this Firmware Command Set document as msg to the MTC/STC.

`string ReadSync()` reads the reply of the MTC/STC again, as described in this Firmware Command Set document.

It is strongly recommended that you use `ReadSync()` immediately after `WriteOnly(msg)`.

The delay between command (write) and reply (read) is usually less than 100 miliseconds (ms). In any case, we recommend that you do not send commands more frequently than every 100 ms.

Timeouts and CRC errors are handled by the Dll automatically (since revision 1.2.2.0).

Some of the error codes described in → table 1 are generated by the Dll.

When more than one MTC/STC is connected to the PC the MTC/STC accessed is always the one with the ID that was operand of the last call of `FindTheUniversalControl(ID)`.

9.1. Dll Revision History

Dll Revision	Description of changes	Date (MM/DD/YYYY)	Compatibility to FW
1.0.0.0	Initial version	07/07/2007	0.00–1.00
1.1.0.0	Marshalling tested to get better timeout behavior (Errors 7mtcDllErrorTO and ErrD1llNoreply introduced)	12/12/2007	1.00–1.50
1.2.0.0	First version with full functionality (marshalling partly removed)	04/17/2008	1.50–1.78
1.2.1.0	CRC calculation corrected (take care of special case if(crc == #))	05/13/2008	1.78 or higher
1.2.2.0	CRC check added to the reply message. Error ErrD1llCalc is reported in this case. Function Read Sync has been debounced.	05/14/2008	1.78 or higher
1.2.3.0	Dll has been compiled with strong names.	09/15/2009	1.78 or higher
1.2.4.0	Compiler option target x86 has been chosen. Windows 64 bit systems are able to use this dll.	04/08/2010	1.78 or higher
1.2.5.0	Compiled with Visual Studio 2010	04/30/2011	1.78 or higher
1.2.6.0	Communication Issues are handled automatically by the dll. Therefore the HID buffer erase subroutine must take the Device ID.	04/26/2012	1.78 or higher
1.2.7.0	Automated resending of commands after timeout disabled	06/13/2013	1.78 or higher
1.2.7.2	Fixed memory allocation issue	08/03/2018	1.78 or higher
1.3.0.0	.Net Framework 4.5.2, 64 bit compatible	23/06/2020	1.78 or higher

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9.2. Demo Application

The following application uses the dll:
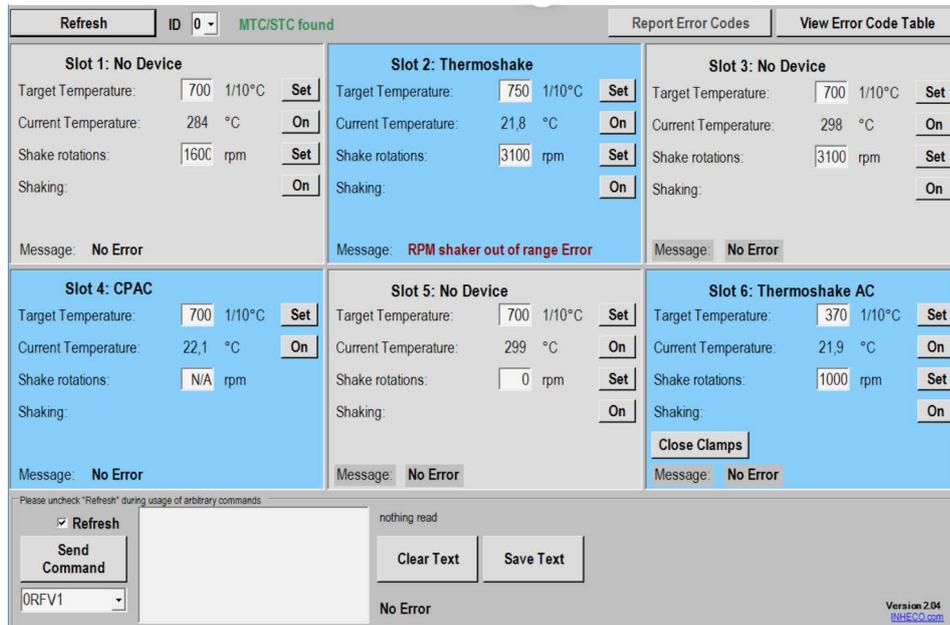
Fig.7: Screenshot of an example application.

The „Report Error Codes" button is a new feature. When you click on it the application collects details of all error codes of the connected M/STC and reports them in the following window:
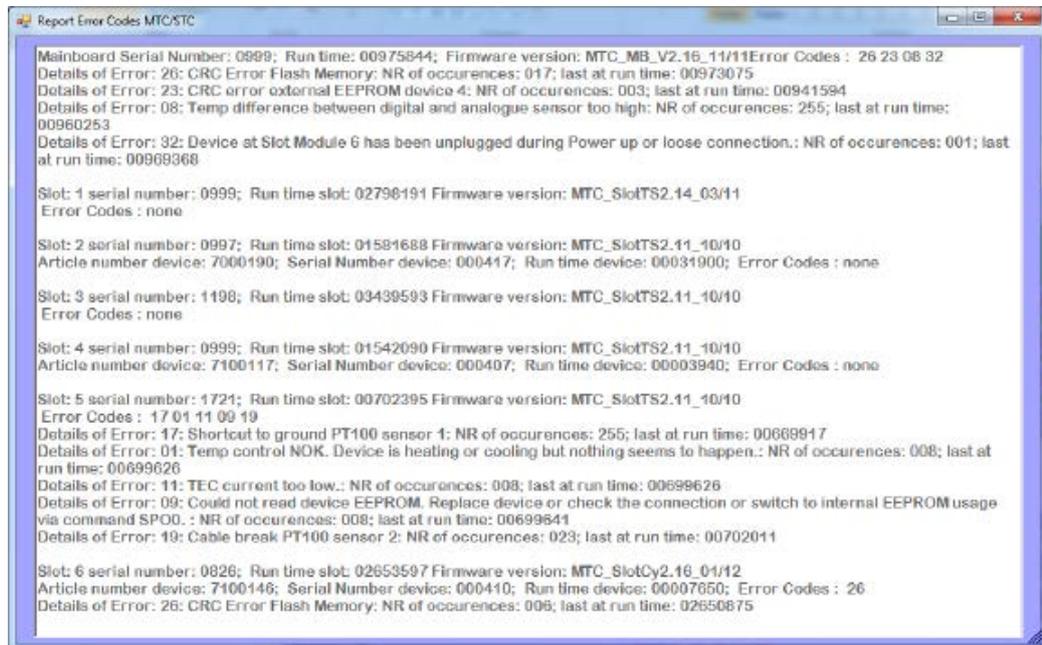
Fig.8: Error Report

For detailed information please refer to our demotool manual which can be downloaded from our login area on **www.inheco.com**

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10 FIRMWARE UPLOAD

The Flash memory of both devices, the mainboard and the slot modules, can be updated via USB. To update the firmware of the mainboard you can generally use a tool from Atmel, the µC supplier. To update the firmware of the slot modules an INHECO tool is needed.

> Info
> The newest version of the tools and the present document can be downloaded from our homepage **www.inheco.com.** Please contact us for access to the customer login area.

10.1. Mainboard

- Install the FLexible In system Programmer (FLIP) Tool from Atmel.

- Send 0SRS1 (Software Reset mainboard) to the MTC/STC.

→ The HID device MTC/STC disappears from the USB.

→ A device called AT90USB128 appears on the USB. The first time Windows will ask for a driver for this device. The driver is located in a FLIP subdirectory, usually at: /Programs/Atmel/Flip420/usb/.
(Path name may differ according to Flip Revision).

- Install the driver.

- Start FLIP (FLIP needs the Java Virtual Machine. Please install this if it is not already installed on your PC and start FLIP again).

→ The following screen will appear:
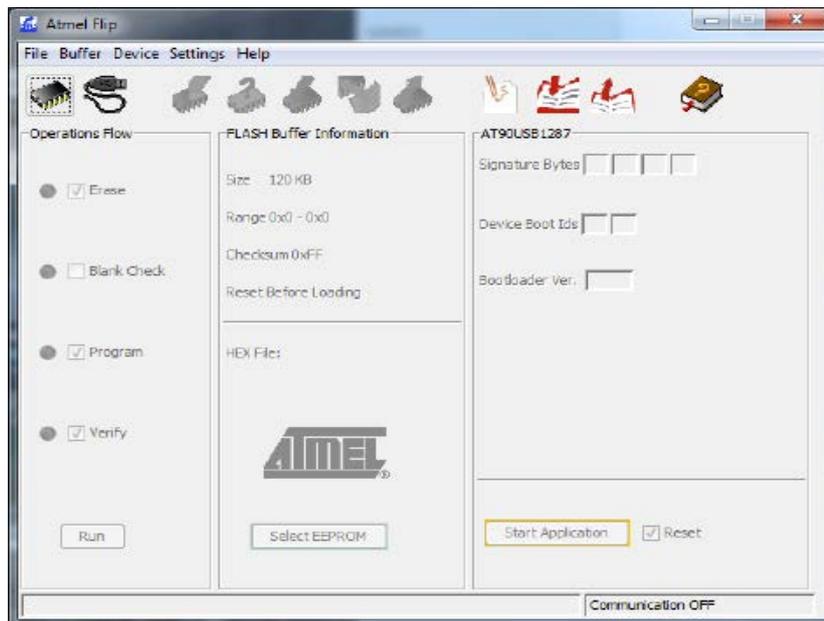
- Click the button in the top left corner and choose the relevant µC (AT90USB1287)

- Click the button next to this and connect to the Mainboard Boot Program

→ The FLIP display changes, see next screenshot.

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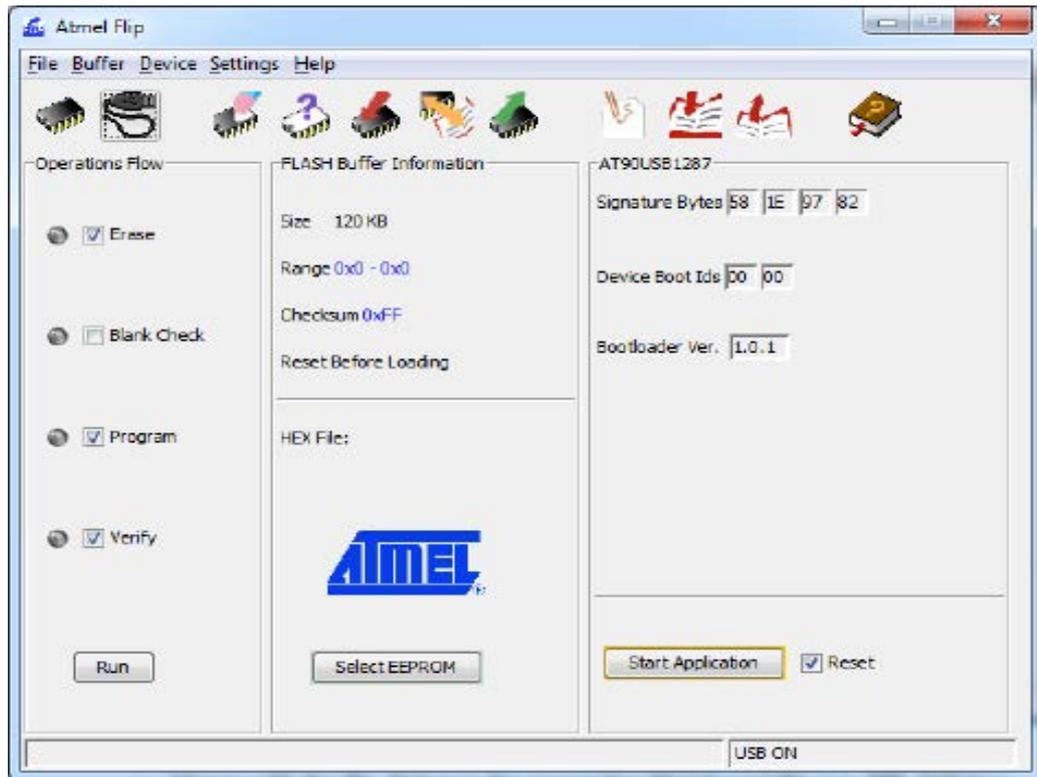
- In the File menu, select the relevant mainboard file e.g. MB_210.hex.
- Click the "Run" button and wait about three seconds.
- Click the "Start Application" button.
- Exit FLIP.
- You will probably need to restart the MTC/STC.
- Please check the firmware version after the upload.

Each firmware is signed with a checksum. If this checksum is not written, error 26 occurs. Unfortunately the Flip Tool is unable to write this checksum automatically (this happens when the upload is done by INHECO).

It is possible to write this checksum "manually", but the keyword of the mainboard is needed. To write the checksum use the following commands (assuming the keyword is: _EY5<3):

- Send 0RCF0
- Reply is something like 0rcf0048929
- Send 1SCF_EY5<3,0,48929
  (You see I took the keyword from above after 1SCF and the reply to 0RCF0 after ,0,!!)
- Send 0RCF1
- Reply is something like 0rcf0046336
- Send 0SCF_EY5<3,1,46336
  (You see I took the keyword from above after 1SCF and the reply to 0RCF0 after ,1,!!)
- Finally, send 0SEC_EY5<3 to erase all error entries
- Restart M/STC

→ now no error 26 should occur.

10.2. Slot Modules

The Firmware of the slot modules always starts with the Boot Program. The user does not realise this because it immediately branches to the main program, if the main program is valid. This ensures that a firmware update is always possible, even if no main program was installed or if the upload failed.

To switch e.g. slot module 3 between the Main Program and the Boot Program, the following commands can be used:

- Main → Boot:
  3SBMB (Set Boot Mode Boot) followed by 3SRS1 (Software Reset).

- Boot → Main:
  3M (Main) followed by 3S (Software Reset).

In both cases the software reset can be replaced by a hardware reset.

Of course the upload tool (▶) does this automatically. The user has to choose the relevant slot module address and has to click „Upload Slot". The Upload needs about twelfe minutes. It is slow because all data must be gated via: PC--USB-HID--Mainboard--SSB--Slot and the reply: Slot-- SSB-Mainboard--HID--USB--PC.

INHECO MTC/STC Firmware Update Tool 2.14

Found MTC/STC | Please enter the keys into the fields before starting the upload.
The keys can be retrieved from our homepage. www.inheco.com

Modules

Module	Serial Number	Key	Revision	Status
Mainboard	0999		FW: 2.16	
Slot 6	0826		FW: 2.16	
Slot 5	1721		FW: 2.11	
Slot 4	0999		FW: 2.11	
Slot 3	1198		FW: 2.11	
Slot 2	0997		FW: 2.11	
Slot 1	0999		FW: 2.14	

Start upload firmware of all devices (first insert keys)

Dear Customer,
this text box will contain success details (and/or failure details) after your upload and subsequent re-start of your MTC/STC. The details will only appear after the re-start. In case of upload failures, please copy the complete text field content and send it to techhotline@inheco.com for technical assistance.

- Check the Firmware versions after the upload and restart MTC.

Commands alphabetical

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APPENDIX A

ERROR CODES

Lots of different errors can be stored into the EEPROM of the µCs, one example is Error 11 when the TEC current is too low. Simultaneously to the storage of the error code, the LED of the respective slot (back of M/STC) or mainboard (not visible at closed housing) becomes red and blinks orange when communication is active. Whereas the red LED vanishes after a reset, the error code remains non versatile into the EEPROM and can be read with the command „Report error codes". When the command „Report error codes" is used a second window opens with more information for the error codes.

Reply Message Bytes

The following Codes are shown in the text field of each corresponding slot

Code	Flag set by	Error Message	Description	Impact	Additional Actions	Recommendations
0		Message O.K.	Normal return message.			
1[1]	Dll or Slot	External message protocol violation	For example the crc of an external message was not correct. This error can be generated either by the dll or by the slot modules.	MTC/STC can not ensure that the command has been read correctly	if error message is consistent please use another PC or contact your workstation software provider	Resend message
2[1]	MB or Slot	Internal message protocol violation	For example the crc of an internal message was not correct. This error can be generated by the MB or the slot modules.	MTC/STC can not ensure that the command has been read correctly	if error message is consistent please contact INHECO	Resend message
3	MB or Slot	Command not executable	Condition for the command is not fulfilled e.g. CPAC should shake.	MTC/STC does not execute the command		Check if there is e.g. a typo in your command and resend message
4	MB or Slot	Command unknown	Command does not exist.	MTC/STC does not execute the command		Check if there is e.g. a typo in your command and resend message
5	MB or Slot	Wrong parameter	e.g. RFV1 exists but RFV9 not	MTC/STC does not execute the command		Check the Parameter, e.g. value selected that is above maximum value or typo in the value and resend message
6	MB or Slot	Reset detected	After software, power on or watch-dog reset. Please inform INHECO if this error occurs during normal operation.	No Impact after the first command, command will be executed		IF error message is consistent please contact INHECO

Code	Flag set by	Error Message	Description	Impact	Additional Actions	Recommendations
7[1)	MB	Slot Id unknown	Slot Id > 6 (MTC) or respective slot module plug is empty. Slot Id > 2 (STC) or respective slot module plug is empty.	MTC/STC does not execute the command		Check the SlotID, the first character of the command. Is it reasonable? Check if the slot module is mounted correctly.
8	MB or Slot	Wrong keyword	The serial number specific keyword was wrong.	MTC/STC does not execute the command		Change password
9	Slot	Timeout from slot-module	Slot-module is/was connected but does not reply. Maybe configuration changed after reset. Reset MTC/STC.	MTC/STC can not ensure that the command has been read correctly	if error message is consistent please contact INHECO	Resend message
A[1)	MB or Slot	I am busy with an action command or startup	Up to 20 seconds after power on and in some other cases the MTC/STC cannot handle additional commands. If the error code 'A' does not disappear after the startup it is a strong indication that the EEPROM memory of the connected device connected to the affected Slot Module is either out of order or something has destroyed its CRC. Please contact INHECO. In this situation the error code 2 becomes stored to the slot modules error memory (See Table 3)	MTC/STC does not execute the command		Wait 400-600 ms and resend message
B		Reserved				
C	MB	Housing temperature not OK	Housing temperature or humidity out of range	Command will be executed, If possible	Error Entry 4 Mainboard happens	Use REC command or the demo tool to check the error memory
D[1)	DLL	Response time too long	Dll Error timeout from USB	MTC/STC can not ensure that the command has been read correctly	If error message is consistent please use another PC or contact your workstation software provider	Resend message

Code	Flag set by	Error Message	Description	Impact	Additional Actions	Recommendations
E	MB	Voltage power supply not OK	Voltage power supply out of range.	Command will be executed, if possible	Error Entry 1 Mainboard happens	
F	MB	Housing fan not OK	Housing fan is blocked or disconnected	Command will be executed, if possible	Error Entry 7 Mainboard happens	
G	Slot	Device temp not OK	Device temperature too high (e.g. Thermoshake > 80 °C).	Command will be executed, if possible	Error Entry 8 or 13 Slot Module happens	
H	Slot	RPM too high	Setting increases limit set by SLO5	Command will be executed, if possible	Error Entry 3 Slot Module happens	
I	Slot	CPAC voltage not OK	CPAC voltage out of range.		Error Entry 4 or 5 Slot Module happens	
J	Slot	Shaker is currently busy	A shaker related task is already in prograss	Shaker will not respond to any new ASE commands	If this state persists for 2 minutes please restart the device. If this problem is still present after the restart lease contact INHECO.	
K	Slot	TEC current too low	TEC current is below 1 A. TEC current is checked always when the Slot Module is heating or cooling.	Command will be executed, if possible	Error Entry 11 Slot Module happens	Use REC command or the demo tool to check the error memory
L	Slot	Internal shaker Communication is down	The internal Shaker communication bus seems to be unresponisve. Please contact INHECO	Shaker commands will not be accepted.	Error Entry 27 Slot Module happens	
M	Slot	Shaker does not work properly	An issue with the clamping system or the shaker motor occurred.	Shaker becomes unresponsive	Error Entry 28, 29 Slot Module happens	
N	Slot	Shaker bus is currently busy	A shaker related task is already in prograss	Shaker will not respond to any new ASE commands	If this state persists for 2 minutes please restart the device. If this problem is still present after the restart lease contact INHECO.	
O	Slot	Shaker bus has been blocked due to a serious error		Shaker will not respond to any comannds	Error Entry 27 Slot Module happens	

Code	Flag set by	Error Message	Description	Impact	Additional Actions	Recommendations
R	Slot	Cable break or shortcut PT100	µC reads extreme values at one of the two PT100 sensors. At Thermoshake shortcut to ground of the second PT100 sensor indicates that the reservoir is empty.	Command will be executed, if possible	Error Entry 7, 17, 18 or 19 Slot Module happens	Use REC command or the demo tool to check the error memory
T	Slot	Delta T too high	Temperature difference between main sensor and supervisor sensor too high.	Command will be executed, if possible	Error Entry 12 Slot Module happens	Use REC command or the demo tool to check the error memory
W	Slot	Wrong device connected	An 12 V device (blue) is connected to a 24 V Slot Module (black) or vice versa. Please unplug it and restart M/STC.	Command will be executed, if possible	Error Entry 15 Slot Module happens	Use REC command or the demo tool to check the error memory

1) Command may not be received by the MTC/STC. Please resend it after a short delay (recommended 400-600 ms).
    With a dll Revision smaller than 1.2.6.0 please also erase HID buffer with the command find MTC (ID).

Reply Error Codes Mainboard

The following Codes are shown in the MTC/STC Display and in the Error Code log files. These error codes can be read out with the Demotool using the button „report error codes" or with the command 0REC which reports the Error Code of the Mainboard (please refer to Firmware Command Set to learn more about using the commands). Up to 7 errors can be stored into the error memory.

When you use the button „report error codes" following window will open.
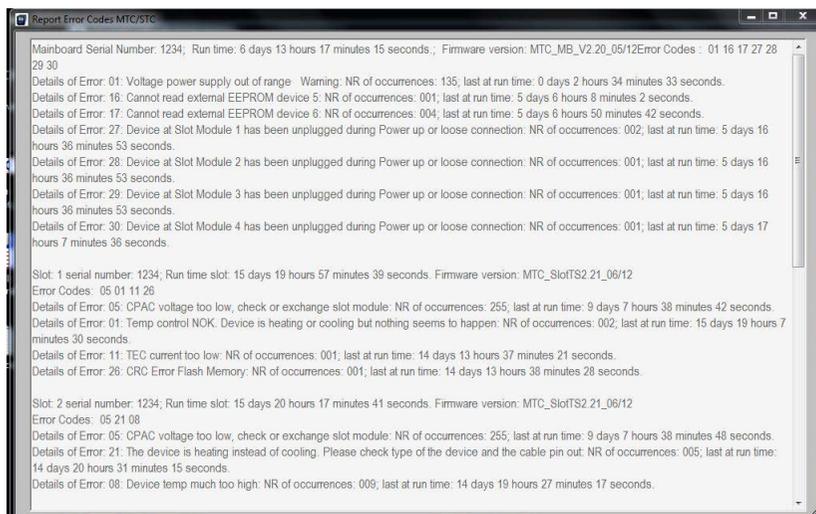
In the first line the information about the overall run time of mainboard, the firmware version of mainboard and the error codes are displayed.

In the following the error codes are explained in detail with:
- short description
- Warning or Error (tells something about the severness of an error code)
- NR (Number) of occurences
- Time when the error occured Last at run time

After the information about the Mainboard the infomation for each slot follows correspondingly to the mainboard.

If an error occured just a fiew times e.g. once and compared to the overall runtime long ago (e.g. error 01 of mainboard in this screenshot) it can be neglected. For all other error codes please refer to the following tables to get more recommendations.

Error	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
1	W	Voltage power supply out of range	non, if the error code does not appear frequently	Send frequently 0RLO1to the Mainboard. If the reply is always 0rlo00250 the error entry happens accidently. If the reply is 0rloE0250 there seems to be a voltage problem and the Mainboard must be replaced	In addition you can send 0RHV0 to the Mainboard and check if the reply value is reasonable. E.g. if the Voltage is 0rhv00241

Error	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
2	E	Digital housing temperature out of range	24 V Power supply is switched off, connected devices are no longer usable		Use the command 0RHV2 to watch the housing temperature. Check if ventilation slot is not covered and ensure that the air flow is granted and check temperature again.
3	W	Analogue housing temperature out of range	non, if the error code does not appear frequently	Send frequently 0RLO5 to the Mainboard. If the reply is always 0rlo00050 the error entry happens accidently. If the reply is 0rloC0050 there seems to be a voltage problem and the Mainboard must be replaced	Use the command 0RHV4 to watch the value of the analogue housing temperature sensor. Check if ventilation slot is not covered and ensure that the air flow is granted and check temperature again.
4	W	Humidity out of range	non, if the error code does not appear frequently	Send frequently 0RLO6 to the Mainboard. If the reply is always 0rlo00850 the error entry happens accidently. If the reply is 0rloC0850 there seems to be a voltage problem and the Mainboard must be replaced	Use the command 0RHV3 to watch the value of the humidity sensor. Check if ventilation slot is not covered and ensure that the air flow is granted and check humidity again. Remark: The humidity inside the housing is usually lower then outside.
5	E	MUX or AD converter not OK	Controller disables all heating/cooling and shaking activities	Send 0RMA to the mainboard and report result to INHECO	Controller MTC / STC has to be returned to INHECO
6	W	Power switch not OK	non, if the error code does not appear frequently	Use the demo tool and report error codes to INHECO	If the number of occurences of error 6 increases after every power cycle, replace the M/STC.
7	W	Housing fan is not running when connected devices are in operation	Controller might overheat	check whether fan is running when connected devices are in operation.	If fan is not running when connected devices in operation, please check the cabling to the fan. If the plug is connected correctly return controller back to INHECO

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Error	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
8	W	Temperature difference betweeen analogue and digital sensor is too high	non, if the error code does not appear frequently	Send frequently 0RLO5 to the Mainboard. If the reply is always 0rlo00050 the error entry happens accidently. If the reply is 0rloC0050 there seems to be a voltage problem and the Mainboard must be replaced	Use the command 0RHV4 and 0RHV2 to watch the value of the analogue and the digital housing temperature sensor, respectively. Change the air flow and check temperatures again.
9		Reserved			
10	W	RAM test of main board failed	Non	please contact INHECO	Check with 0REC10 the number of occurrences. If the number is higher then 20. Please contact INHECO
11	W	STC only, Power switch not working (no 24V power supply)	Controller disables alle heating/cooling and shaking activities		Controller STC has to be returned to INHECO
12	W	Cannot read external EEPROM of device 1	Controller cannot use data from external EEPROM	Check connection, if devices is correctly connected there are 2 options 1. Switch from external EEPROM (device) to internal EEPROM by using the command SPO0 2. Return device back to INHECO	if device is correctly connected, return device back to INHECO
13	W	Cannot read external EEPROM of device 2			
14	W	Cannot read external EEPROM of device 3			
15	W	Cannot read external EEPROM of device 4			
16	W	Cannot read external EEPROM of device 5			
17	W	Cannot read external EEPROM of device 6			
18		Reserved			
19		Reserved			
20	W	CRC error external EEPROM of device 1			Please contact INHECO
21	W	CRC error external EEPROM of device 2			
22	W	CRC error external EEPROM of device 3			
23	W	CRC error external EEPROM of device 4			
24	W	CRC error external EEPROM of device 5			
25	W	CRC error external EEPROM of device 6			

Error	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
26	E	CRC error flash memory	Maybe something went wrong after an Firmware update. Contact INHECO to set the Checksum manually.		Switch M/STC on Wait 2 minutes Send 0RCF0 and 0RCF1 to the effected Mainboard and send xRCF0 and xRCF1 (x = SlotID 1-6) to effected Slot Module Send the reply to INHECO together with the Serialnumber of MTC/STC and the Serialnumber of the slot.
27	W	Unplugged Device at **slot module 1** during power up or device lost connection	Non		Make sure that devices are not disconnected from controller when controller is in operation.
28	W	Unplugged Device at **slot module 2** during power up or device lost connection			
29	W	Unplugged Device at **slot module 3** during power up or device lost connection			
30	W	Unplugged Device at **slot module 4** during power up or device lost connection			
31	W	Unplugged Device at **slot module 5** during power up or device lost connection			
32	W	Unplugged Device at **slot module 6** during power up or device lost connection			

Error Codes Slot

The following Codes are shown in the MTC/STC Display and in the Error Code log files. These error codes can be read out with the Demotool using the button „report error codes" or with the command XREC which reports the Error Code of the Devices. Up to 7 errors can be stored into the error memory.

Code	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
1	W	Temperature control not OK	non, if only shown at start up		
2	E	CRC error of external EEPROM of connected device(s). External EEPROM of device is no longer in use	heating and cooling of connected device is disabled	Send write Command 0SDOx,5,0, (x=SlotID) to EEPROM. Restart STC/MTC/ STC. If error is still shown 2 options are possible: 1. Switch from external EEPROM (device) to internal EEPROM by using the command xSPO0 (x=SlotID) 2. Return device back to INHECO	If the device is necessarily needed and you are sure you won´t exchange devices at this slot, switch to internal EEPROM,otherwise return the device (only the device) back to INHECO
3	W	RPM Shaker too high, speed of more than 2000 rpm was set	non	check set rpm (on display)	check set rpm (on display or with RSR command)
4	E	Voltage too high of connected device(s)	heating / cooling and shaking of connected device is disabled	non	Exchange Slot module
5	W	Voltage too low of connected device(s)	non, if message reply byte „I" is not set	Send frequently 1RPO to the affected Slot (here Slot 1). If the reply is always 1rpo00001 the error entry happens accidently. If the reply is 1rpoI0001 there seems to be a voltage problem a decision must be made if low voltage is acceptable from customer.	If not acceptable Slot Module has to be exchanges

Code	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
6	W	Fan of device is not running	cooling is no longer working correctly if fan is not running during cooling	check whether fan of CPAC or Thermoshake device is running during cooling	If fan is running device is ok, ignore error message. If fan is not running, return CPAC or Thermoshake device back to INHECO. Attention: The fan runs at cooling processes only. The pump of the Thermoshake which is connected to the same circuit must run during all activities, of course.
7	W	Reservoir of Thermoshake is almost empty or shortcut to ground sensor 2	If message reply byte „R" is set frequently, refill reservoir of Thermoshake	Start a cooling process and send the command RRS to the affected Slot ID. If reply is (at Slot Id =1) always 1 rrs00 then the reservoir is indeed empty. Refill the reservoir.	Refill reservoir of Thermoshake. If the device is no Thermoshake most probably sensor 2 is defect and the device must be repaired
8	E	Temperature of device is too high	Heating of device is disabled	check what maximum termperature is set xRMT1. Adjust temperature to maximum allowed limit or contact INHECO to clarify whether a change of the upper temperature limit is possible.	Adjust temperature to maximum allowed limit please contact INHECO to get full command and to clarify whether a change of the upper temperature limit is possible.
9	E	Could not read EEPROM of device	heating and cooling of connected device is disabled	Send write Command 0SDOx,5,0, (x=SlotID) to EEPROM. Restart MTC/STC. If error is still shown 2 options are possible: 1. Switch from external EEPROM (device) to internal EEPROM by using the command xSPO0 (x = Slot ID 1-6) 2. Return device back to INHECO	If the device is necessarily needed and you are sure you won´t exchange devices at this slot, switch to internal EEPROM,otherwise return the device (only the device) back to INHECO.
10	W	RAM test failed	non	please contact INHECO	Check with 1REC10 the number of occurrences. If the number is higher then 20 Please contact INHECO

Code	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
11	W	TEC current to low	non	TEC current is checked during the start-up only. Therefor restart MTC/STC and check if error occurs again.	Use the demo tool and report error codes If the number of occurences of error 11 increases after every power cycle, replace the device. Check cable connections.
12	W	Temperature difference between control sensor and monitoring sensor is too high	non, device is still heating, cooling or shaking	check whether a asymetrical load is place on the contact surface of the device (e.g. only one half of the plate is filled with fluid).	Please contact INHECO
13	E	Temperature too low	non	check whether the temperature is set below the minimum allowed temperature. Adjust temperature to minimum allowed limit or contact INHECO to clarify whether a change of the lower temperature limit is possible.	Adjust temperature to minimum allowed limit or contact INHECO to clarify whether a change of the lower temperature limit is possible
14	E	Unknown device connected	heating and cooling of connected device is disabled	check whether appropiate device is connected (boot of connector has to have the same color as the slot module). Restart Controller, if Error is still shown return connected device to INHECO	check whether appropiate device is connected (boot of connector has to have the same color as the slot module). Restart Controller, if Error is still shown return connected device to INHECO
15	E	Type of device stored in EEEPROM does not fit to connected device. Wrong device connected (12V device to 24V slot or vice versa)	heating and cooling of connected device is disabled	check whether appropiate device is connected (boot of connector has to have the same color (black or blue) as the slot module)	Connect a correct device to Slot. After restart the error should be gone. If error is still shown, return Slot back to INHECO.
16		reserved			
17	E	short cut to ground controlling sensor (sensor 1)	heating and cooling of connected device is disabled		Return the device back to INHECO
18	E	cable break controlling sensor (sensor 1)	heating and cooling of connected device is disabled		Return the device back to INHECO

Code	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
19	W	cable break monitoring sensor (sensor 2)	non, if message reply byte „R" is not set frequently	Send frequently 1RPO to the affected Slot (here Slot 1). If the reply is always 1rpo00001 the error entry happens accidently. If the reply is 1rpoR0001 there seems to be a cable break and the device must be repaired or replaced.	
20	E	Communication error between Slot module and controller main board. Error code will be only used for internal INHECO evaluation	if error 2 is also shown, heating, cooling and shaking of devices is disabled.	Please contact INHECO for further evaluation. Error 20 in conjunction with error 2 shows more detailed information for the failure evaluation.	Please contact INHECO for further evaluation
21	E	Connected device is heating instead of cooling	Heating of device is disabled	Report type device and send the information to INHECO. Best: Use the demo tool and report error codes.	This may happen accidently if the load is very heavy and very hot. Please ignore the error in such a case and restart cooling.
22	E	Cable break (ground) of controlling sensor (sensor 1) and / or monitoring sensor (sensor 2)	heating and cooling of connected device is disabled		connected device has to be returned to INHECO
26	E	CRC error Flash memory of Slot modul, Initialization or Firmware update of Slot might be not OK		Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
27	E	Shaker bus Communication Error	Serious communication error. Shaker type AC becomes inoperable	Shaker type AC becomes inoperable Stop using the device and please contact INHECO for further evaluation	Please contact INHECO for further evaluation
28	E	Error regarding the Clamp Mechanism. The current position of the Clamp does not reflect the expected position	Shaker type AC becomes inoperable	Stop using the device and please contact INHECO for further evaluation	Please contact INHECO for further evaluation
29	E	Shaker with clamp mecahnism does not respond to commands	Shaker type AC cannot be controlled	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation

Code	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
30	E	The Thermoshake AC has detected a motor fault	Thermoshake AC stops shaking (specific error for this device type)	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
31	E	For Shaker with clamp mechanims current RPM value differecne to set point >4000rpm	Shaker type AC stops shaking	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
32	E	Error regarding the Clamp Mechanism for all shaker with clamp mechanism. The end position cannot be reached	Shaker type AC becomes inoperable	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
33	E	Shaker Bus Communication Time Out	Shaker type AC becomes inoperable	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
34	W	The Shaker does not seem to reach its set point. A difference greater than 20 rpm has been detected	The device continues its operations but will probably not shake with the desired RPM	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
35	W	The shaker has detected a RPM outlier of ≥ 10%.	The control algorithm adapts to the outlier and should proceed shaking	If no other errors of warnings are being reported then you can ignore this warning. If other warnings and errors appear then please contact INHECO for further evaluation.	Please contact INHECO for further evaluation
36	W	reserved for later use			
37	W	For Teleshake AC and Teleshake95 AC: EEPROM parameters have not been correctly transmitted to the device.	Can only come during initialization. Device should no longer be used for shaking.	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation

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Code	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
38	W	For Teleshake AC and Teleshake95 AC: Communication with the Motor is erroneous (hardware defect on PCB, which should happen very rarely).	The MTC cannot run its normal shaking control during runs. The shaking performace won´t be as stabil as usual. Which might cause a different shaking rpm as set. This might cause bad biological results. If the error results in a full stop the error 29 is set.	User needs to check its results whether decreased shaking had an influence. Please check whether this error is reproducible or if it was a one time error. If it is reproducible please contact INHECO for further evaluation	Please contact INHECO for further evaluation
39	E	for internal use in INHECO software department only			
40	E	For Teleshake AC and Teleshake95 AC: Motor OCP Error	Shaking will stop and clamps will open	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
41	E	For Teleshake AC and Teleshake95 AC: Motor CPOC Error	Shaking will stop and clamps will open	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
42	E	For Teleshake AC and Teleshake95 AC: Motor OTS Error	Shaking will stop and clamps will open	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
43	E	For Teleshake AC and Teleshake95 AC: Motor UVLO Error	Shaking will stop and clamps will open	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
44	W	reserved for internal use			

Code	Error (E) / Warning (W)	Description of Error Codes	Impact	Additional Actions	Recommendation
45	E	For Teleshake AC and Teleshake95 AC: Motor VMOV Eror	Shaking will stop and clamps will open	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
46	W	For Teleshake AC and Teleshake95 AC: max servo current has been reached. There might be a problem with the clamping system	Is mostly set at same time as error 28 or 32. If error 28 or 32 are not set it might be an indication that the clamp mechanism needs a service soon.	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
47	W	For Teleshake AC and Teleshake95 AC: The motor maximal current has been reached. There might be a problem with the shaker	Is mostly set at same time as error 29 or error 40-45. If only error 47 is shown it might be an indication that the shaking motor needs a service. It is not a warranty case as long as shaker performance is ok.	To test shaking performance use the IMP (INHECO Measurement plate). Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
48	W	For Teleshake AC and Teleshake95 AC: Min servo current has not been reached, There might be an issue with the shaker	Is mostly set at same time as error 28 or 32. If error 28 or 32 are not set it might be an indication that the clamp mechanism needs a service soon.	Please contact INHECO for further evaluation	Please contact INHECO for further evaluation
49	W	For Teleshake AC and Teleshake95 AC: Min motor current has not been reached. There might be an issue with the shaker.	Is mostly set at same time as error 29 or error 40-45. If only error 49 is shown it might be an indication that the shaking motor needs a service. It is not a warranty case as long as shaker preformance is ok.	To test shaking performance use the IMP (INHECO Measurement plate). Please contact INHECO for further evaluation	Please contact INHECO for further evaluation

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