

# Communication Protocol

## TEC Controller

### TEC-Family

(TEC-1089, TEC-1090, TEC-1122, TEC-1123)

|          |                                                                         |           |
|----------|-------------------------------------------------------------------------|-----------|
| <b>1</b> | <b>General Description.....</b>                                         | <b>2</b>  |
| 1.1      | Protocol Specifications .....                                           | 2         |
| 1.2      | Interfaces, Baud Rate and Address .....                                 | 2         |
| <b>2</b> | <b>TEC-Family Commands.....</b>                                         | <b>3</b>  |
| 2.1      | Set Commands.....                                                       | 3         |
| 2.2      | Query Commands .....                                                    | 4         |
| <b>3</b> | <b>Service Software Parameters .....</b>                                | <b>5</b>  |
| 3.1      | Payload Format description.....                                         | 5         |
| 3.1.1    | Parameter Value Read .....                                              | 5         |
| 3.1.2    | Parameter Value Set .....                                               | 5         |
| 3.2      | Parameter list .....                                                    | 6         |
| 3.2.1    | Common Product Parameters (Read only) .....                             | 6         |
| 3.2.2    | Tab: Monitor (Read only).....                                           | 6         |
| 3.2.3    | Tab: Operation.....                                                     | 8         |
| 3.2.4    | Tab: Temperature Regulation .....                                       | 9         |
| 3.2.5    | Tab: Object Temperature .....                                           | 10        |
| 3.2.6    | Tab: Sink Temperature.....                                              | 11        |
| 3.2.7    | Tab: Expert .....                                                       | 13        |
| 3.2.8    | Other Parameters (Not directly displayed in the Service Software) ..... | 14        |
| <b>4</b> | <b>Bootloader.....</b>                                                  | <b>17</b> |
| 4.1      | Bootloader Control (BC?) .....                                          | 17        |
| 4.1.1    | Bootloader Command.....                                                 | 17        |
| 4.1.2    | Bootloader Status.....                                                  | 17        |
| 4.2      | Bootloader Stream (BS?) .....                                           | 18        |
| 4.2.1    | Data Stream .....                                                       | 18        |
| 4.2.2    | Bootloader Status.....                                                  | 18        |
| <b>5</b> | <b>Old Commands (Not recommended for new Designs).....</b>              | <b>19</b> |
| 5.1      | Set Commands (Will be removed in next Version) .....                    | 19        |
| 5.2      | Query Commands (Will be removed in next Version) .....                  | 19        |
| <b>6</b> | <b>Change Log.....</b>                                                  | <b>20</b> |

# 1 General Description

## 1.1 Protocol Specifications

- The used communication protocol is based on the “MeCom Protocol Specification” Document me5117B.
- The Control Interface has to use the ‘#’ as source identifier.

## 1.2 Interfaces, Baud Rate and Address

- Interface RS485 Channel 1:
  - Default baud rate is 57600. This can be changed to an other value by using the corresponding command. The new baud rate will be saved to the non volatile memory
  - The Default Address is 2. It is possible to use 255 as broadcast
- Interface USB:
  - All commands are also accessible through the USB Interface
  - The baud rate is fixed to 57600
  - Address is like RS485. Additional the address 0 is also used as broadcast

## 2 TEC-Family Commands

### 2.1 Set Commands

| Command             | Mnemonic | Arguments / Description                                                                                                                                                                                                            |     |        |                                                                                                                                            |
|---------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------|--------------------------------------------------------------------------------------------------------------------------------------------|
|                     |          | Type                                                                                                                                                                                                                               | Min | Max    | Description                                                                                                                                |
| Parameter Value Set | VS       |                                                                                                                                                                                                                                    |     |        | Sets the corresponding Parameter<br>See 3 Service Software Parameters for details                                                          |
| Reset Device        | RS       | -                                                                                                                                                                                                                                  | -   | -      | Resets the Processor 200ms after this command.                                                                                             |
| Emergency Stop      | ES       | -                                                                                                                                                                                                                                  | -   | -      | Disables all Power Outputs immediately and the Error 11 is generated.                                                                      |
| Set Address         | SA       | This Command is used to set the address of a device to a specific address. It can be sent to the device as broadcast command. The device will only recognize this command if the "Device Type" and the "Serial Number" is correct. |     |        |                                                                                                                                            |
|                     |          | INT32                                                                                                                                                                                                                              | 0   | +INT32 | Device Type of the device to be addressed.<br>(ex. 1089, 1090, 1122, 1123)<br>If the Device Type is sent as 0, the Device Type is ignored. |
|                     |          | INT32                                                                                                                                                                                                                              | 0   | +INT32 | Serial Number of the device to be addressed.<br>If the Serial Number is sent as 0, the Serial Number is ignored.                           |
|                     |          | UINT8                                                                                                                                                                                                                              | -   | -      | 0: Set to the address given by the "Address Field".<br>1: Set to the CH1 Rack Terminal Output (do not use!)                                |
|                     |          | UINT8                                                                                                                                                                                                                              | 0   | 254    | Address Field.                                                                                                                             |

## 2.2 Query Commands

| Request                             | Mnemonic       | Description                                                                           | Server Response |                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------|----------------|---------------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     |                |                                                                                       | Type            | Description                                                                                                                                                                                                                                                                                                           |
| Firmware Identification String      | ?IF            | Returns the Firmware Identification String                                            | 20x 8bit        | For TEC-1122:<br>"8065-TEC SW G01       "<br>(Filled up with spaces)                                                                                                                                                                                                                                                  |
| Parameter Value Read                | ?VR            | Returns the corresponding Parameter value                                             |                 | See <a href="#">3 Service Software Parameters</a> for details                                                                                                                                                                                                                                                         |
| Bootloader Control                  | ?BC            | For Controlling the Bootloader                                                        | UINT32          | See 4 Bootloader for Details                                                                                                                                                                                                                                                                                          |
| Bootloader Stream                   | ?BS            | Bootloader Data Stream                                                                |                 | See 4 Bootloader for Details                                                                                                                                                                                                                                                                                          |
| Download Lookup Table Page 256 Byte | ?LT<br>UINT4   | Command<br>0: Status Query<br>1: Program<br>2: Do Analyze Data                        | UINT4           | 0: Idle<br>1: Erasing or Writing (Sent Data is ignored)<br>2: New Data accepted<br>3: Error                                                                                                                                                                                                                           |
|                                     | 1 x UINT32     | Lookup Table Page Offset                                                              |                 |                                                                                                                                                                                                                                                                                                                       |
|                                     | 256 x<br>UINT8 | 32 x 8 Byte Commands                                                                  |                 |                                                                                                                                                                                                                                                                                                                       |
| Settings Download                   | ?SD            | Can be used to download the exported Settings Dump (*.mepar) of the Service Software. |                 |                                                                                                                                                                                                                                                                                                                       |
|                                     |                | One Line of the Settings Dump File (*.mepar)                                          | UINT4           | 0: Parameter Accepted<br>1: CRC wrong: Possible causes: <ul style="list-style-type: none"> <li>• The *.mepar File has been modified</li> <li>• The firmware version is not exactly the same as it was while the *.mepar file has been created</li> <li>• The *.mepar File was created for an other device.</li> </ul> |

## 3 Service Software Parameters

### 3.1 Payload Format description

The Parameter Instance is used to control the TEC Output Channel 1 or 2.

If there is only one instance available, Parameter Instance must be set to 1 (e.g. Firmware Version)

#### 3.1.1 Parameter Value Read

| Type  | Mnemonic | Field 1                | Field 2                     |
|-------|----------|------------------------|-----------------------------|
| Query | ?VR      | UINT16<br>Parameter ID | UINT8<br>Parameter Instance |

| Type     | Field 1                                                     |
|----------|-------------------------------------------------------------|
| Response | <defined Format><br>Parameter Value<br>Or Server Error Code |

#### 3.1.2 Parameter Value Set

| Type  | Mnemonic | Field 1                | Field 2                     | Field 3                             |
|-------|----------|------------------------|-----------------------------|-------------------------------------|
| Query | VS       | UINT16<br>Parameter ID | UINT8<br>Parameter Instance | <defined Format><br>Parameter Value |

| Type     |                                    |
|----------|------------------------------------|
| Response | Normal ACK or<br>Server Error Code |

## 3.2 Parameter list

This capture contains all parameters which can also be accessed by the service software. The order is the same as in the service software. Please refer to TEC-Family user manual for detailed parameter description.

### 3.2.1 Common Product Parameters (Read only)

#### 3.2.1.1 Device Identification

| ID  | Name             | Format | Value Range | Description                                                                                          |
|-----|------------------|--------|-------------|------------------------------------------------------------------------------------------------------|
| 100 | Device Type      | INT32  | ..          | 1122 → TEC-1122                                                                                      |
| 101 | Hardware Version | INT32  | ..          | 123 → 1.23                                                                                           |
| 102 | Serial Number    | INT32  | ..          |                                                                                                      |
| 103 | Firmware Version | INT32  | ..          | 123 → 1.23                                                                                           |
| 104 | Device Status    | INT32  | 0 ... 5     | 0: Init<br>1: Ready<br>2: Run<br>3: Error<br>4: Bootloader<br>5: Device will Reset within next 200ms |
| 105 | Error Number     | INT32  | ..          |                                                                                                      |

### 3.2.2 Tab: Monitor (Read only)

#### 3.2.2.1 CHx Temperature Measurement

| ID   | Name               | Format  | Value Range | Description |
|------|--------------------|---------|-------------|-------------|
| 1000 | Object Temperature | FLOAT32 | °C          |             |
| 1001 | Sink Temperature   | FLOAT32 | °C          |             |

#### 3.2.2.2 CHx Temperature Control

| ID   | Name                              | Format  | Value Range | Description |
|------|-----------------------------------|---------|-------------|-------------|
| 1010 | Target Object Temperature         | FLOAT32 | °C          |             |
| 1011 | (Ramp) Nominal Object Temperature | FLOAT32 | °C          |             |
| 1012 | Thermal Power Model Current       | FLOAT32 | A           |             |

#### 3.2.2.3 CHx Output Stage Monitoring

| ID   | Name                  | Format  | Value Range | Description |
|------|-----------------------|---------|-------------|-------------|
| 1020 | Actual Output Current | FLOAT32 | A           |             |
| 1021 | Actual Output Voltage | FLOAT32 | V           |             |

#### 3.2.2.4 CHx Temperature Controller PID Status

| ID   | Name                 | Format  | Value Range | Description |
|------|----------------------|---------|-------------|-------------|
| 1030 | PID Lower Limitation | FLOAT32 | %           |             |
| 1031 | PID Upper Limitation | FLOAT32 | %           |             |
| 1032 | PID Control Variable | FLOAT32 | %           |             |

#### 3.2.2.5 CHx Temperature Measurement

| ID   | Name                        | Format  | Value Range | Description |
|------|-----------------------------|---------|-------------|-------------|
| 1040 | Object Sensor Raw ADC Value | INT32   | ..          |             |
| 1041 | Sink Sensor Raw ADC Value   | INT32   | ..          |             |
| 1042 | Object Sensor Resistance    | FLOAT32 | Ohm         |             |
| 1043 | Sink Sensor Resistance      | FLOAT32 | Ohm         |             |

#### 3.2.2.6 Firmware and Hardware Versions

| ID   | Name                  | Format | Value Range | Description |
|------|-----------------------|--------|-------------|-------------|
| 1050 | Firmware Version      | INT32  | ..          | 123 → 1.23  |
| 1051 | Firmware Build Number | INT32  | ..          |             |
| 1052 | Hardware Version      | INT32  | ..          | 123 → 1.23  |
| 1053 | Serial Number         | INT32  | ..          |             |

#### 3.2.2.7 Power Supplies and Temperature

| ID   | Name                   | Format  | Value Range | Description |
|------|------------------------|---------|-------------|-------------|
| 1060 | Driver Input Voltage   | FLOAT32 | V           |             |
| 1061 | 10V Internal Supply    | FLOAT32 | V           |             |
| 1062 | 3.3V Internal Supply   | FLOAT32 | V           |             |
| 1063 | Base Plate Temperature | FLOAT32 | °C          |             |

#### 3.2.2.8 Error Status

| ID   | Name            | Format | Value Range | Description |
|------|-----------------|--------|-------------|-------------|
| 1070 | Error Number    | INT32  | ..          |             |
| 1071 | Error Instance  | INT32  | ..          |             |
| 1072 | Error Parameter | INT32  | ..          |             |

#### 3.2.2.9 Parallel Output Stage Monitoring (Common Load)

| ID   | Name                  | Format  | Value Range | Description |
|------|-----------------------|---------|-------------|-------------|
| 1090 | Actual Output Current | FLOAT32 | A           | (CH1 + CH2) |

### 3.2.2.10 Driver Status

| ID   | Name                              | Format | Value Range | Description                                                                                                                  |
|------|-----------------------------------|--------|-------------|------------------------------------------------------------------------------------------------------------------------------|
| 1080 | Driver Status                     | INT32  | 0 ... 5     | 0: Init<br>1: Ready<br>2: Run<br>3: Error<br>4: Bootloader<br>5: Device will Reset within next 200ms                         |
| 1081 | Parameter System:<br>Flash Status | INT32  | 0 ... 1     | 0: All Parameters are saved to Flash<br>1: Save to flash pending or in progress.<br>(Please do not power off the device now) |

### 3.2.2.11 Object Temperature Stability Detection

| ID   | Name                  | Format | Value Range | Description                                                                 |
|------|-----------------------|--------|-------------|-----------------------------------------------------------------------------|
| 1200 | Temperature is Stable | INT32  | 0 .. 2      | 0: Temperature regulation is not active<br>1: Is not stable<br>2: Is stable |

## 3.2.3 Tab: Operation

### 3.2.3.1 CHx Output Stage Control Input Selection

| ID   | Name            | Format | Value Range | Description                                                                                                            |
|------|-----------------|--------|-------------|------------------------------------------------------------------------------------------------------------------------|
| 2000 | Input Selection | INT32  | 0 ... 2     | 0: Static Current/Voltage (Uses ID 2020...)<br>1: Live Current/Voltage (Uses ID 50001...)<br>2: Temperature Controller |

### 3.2.3.2 CHx Output Stage Enable

| ID   | Name   | Format | Value Range | Description                                                    |
|------|--------|--------|-------------|----------------------------------------------------------------|
| 2010 | Status | INT32  | 0 ... 2     | 0: Static OFF<br>1: Static ON<br>2: Live OFF/ON (See ID 50000) |

### 3.2.3.3 CHx Output Stage 'Static Current/Voltage' Control Values

| ID   | Name        | Format  | Value Range                                                | Description |
|------|-------------|---------|------------------------------------------------------------|-------------|
| 2020 | Set Current | FLOAT32 | 1089 / 1122:<br>-10A ... 10A<br>1090 / 1123:<br>-16A / 16A |             |
| 2021 | Set Voltage | FLOAT32 | 0V ... 19V                                                 |             |

### 3.2.3.4 CHx Output Stage Limits

| ID   | Name                    | Format  | Value Range                                              | Description |
|------|-------------------------|---------|----------------------------------------------------------|-------------|
| 2030 | Current Limitation      | FLOAT32 | 1089 / 1122:<br>0A ... 10A<br>1090 / 1123:<br>0A / 16A   |             |
| 2031 | Voltage Limitation      | FLOAT32 | 0V ... 19V                                               |             |
| 2032 | Current Error Threshold | FLOAT32 | 1089 / 1122:<br>0A ... 14A<br>1090 / 1123:<br>0A ... 20A |             |
| 2033 | Voltage Error Threshold | FLOAT32 | 0V ... 24V                                               |             |

### 3.2.3.5 General Operating Mode

| ID   | Name                   | Format | Value Range | Description                                                                                                   |
|------|------------------------|--------|-------------|---------------------------------------------------------------------------------------------------------------|
| 2040 | General Operating Mode | INT32  | 0 ... 2     | 0: Single (Independent)<br>1: Parallel (CH1 → CH2); Individual Loads<br>2: Parallel: (CH1 → CH2); Common Load |

### 3.2.3.6 Device Address

| ID   | Name           | Format | Value Range | Description |
|------|----------------|--------|-------------|-------------|
| 2051 | Device Address | INT32  | 0 ... 254   |             |

### 3.2.3.7 RS485 Channel 1 Settings

| ID   | Name              | Format | Value Range   | Description |
|------|-------------------|--------|---------------|-------------|
| 2050 | Channel Baud Rate | INT32  | 4800 ... 1M   | Bits/s      |
| 2052 | Response Delay    | INT32  | 0us ... 1E6us |             |

## 3.2.4 Tab: Temperature Control

### 3.2.4.1 CHx Nominal Temperature

| ID   | Name               | Format  | Value Range              | Description |
|------|--------------------|---------|--------------------------|-------------|
| 3000 | Target Object Temp | FLOAT32 | -50 °C ... 200 °C        |             |
| 3003 | Coarse Temp Ramp   | FLOAT32 | 1E-6 °C/s ...<br>50 °C/s |             |
| 3002 | Proximity Width    | FLOAT32 | 0.1 °C ... 200 °C        |             |

### 3.2.4.2 CHx Temperature Controller PID Values

| ID   | Name | Format  | Value Range         | Description |
|------|------|---------|---------------------|-------------|
| 3010 | Kp   | FLOAT32 | 0%/°C ... 10000%/°C |             |
| 3011 | Ti   | FLOAT32 | 0.0001s ... 10000s  |             |
| 3012 | Td   | FLOAT32 | 0s ... 10000s       |             |

### 3.2.4.3 CHx Modelization for Thermal Power Regulation

| ID   | Name | Format | Value Range | Description                                                                                          |
|------|------|--------|-------------|------------------------------------------------------------------------------------------------------|
| 3020 | Mode | INT32  | 0 ... 3     | 0: Peltier, Full Control<br>1: Peltier, Cool Only<br>2: Peltier, Heat Only<br>3: Resistor, Heat Only |

### 3.2.4.4 CHx Peltier Characteristics

| ID   | Name                       | Format  | Value Range    | Description              |
|------|----------------------------|---------|----------------|--------------------------|
| 3030 | Maximal Current            | FLOAT32 | 0.1A ... 1000A |                          |
| 3031 | Maximal Voltage            | FLOAT32 | 0.1V ... 1000V |                          |
| 3032 | Cooling Capacity<br>Qmax   | FLOAT32 | 1W ... 1000W   |                          |
| 3033 | Delta Temperature<br>dTmax | FLOAT32 | 1°C ... 200°C  |                          |
| 3034 | Positive Current is        | INT32   | 0 ... 1        | 0: Cooling<br>1: Heating |

### 3.2.4.5 CHx Resistor Characteristics

| ID   | Name            | Format  | Value Range          | Description |
|------|-----------------|---------|----------------------|-------------|
| 3040 | Resistance      | FLOAT32 | 0.001Ohm ... 10k Ohm |             |
| 3041 | Maximal Current | FLOAT32 | 0.01A ... 1000A      |             |

## 3.2.5 Tab: Object Temperature

### 3.2.5.1 CHx Object Measurement Settings

| ID   | Name               | Format  | Value Range           | Description |
|------|--------------------|---------|-----------------------|-------------|
| 4001 | Temperature Offset | FLOAT32 | -1E4°C ... 1E4°C      |             |
| 4002 | Temperature Gain   | FLOAT32 | 0.5°C/°C ... 2.0°C/°C |             |

### 3.2.5.2 CHx Actual Object Temperature Error Limits

| ID   | Name                  | Format  | Value Range            | Description |
|------|-----------------------|---------|------------------------|-------------|
| 4010 | Lower Error Threshold | FLOAT32 | -50 °C ... 200 °C      |             |
| 4011 | Upper Error Threshold | FLOAT32 | -50 °C ... 200 °C      |             |
| 4012 | Max Temp Change       | FLOAT32 | 1 °C/s ...<br>200 °C/s |             |

### 3.2.5.3 CHx Object NTC Sensor Characteristics

| ID   | Name                         | Format  | Value Range        | Description |
|------|------------------------------|---------|--------------------|-------------|
| 4020 | Lower Point:<br>Temperature  | FLOAT32 | -250 °C ... 250 °C |             |
| 4021 | Lower Point:<br>Resistance   | FLOAT32 | 1Ohm ...<br>1MOhm  |             |
| 4022 | Middle Point:<br>Temperature | FLOAT32 | -250 °C ... 250 °C |             |
| 4023 | Middle Point:<br>Resistance  | FLOAT32 | 1Ohm ...<br>1MOhm  |             |
| 4024 | Upper Point:<br>Temperature  | FLOAT32 | -250 °C ... 250 °C |             |
| 4025 | Upper Point:<br>Resistance   | FLOAT32 | 1Ohm ...<br>1MOhm  |             |

### 3.2.5.4 CH1 Object Temperature Stability Indicator Settings

| ID   | Name               | Format  | Value Range    | Description |
|------|--------------------|---------|----------------|-------------|
| 4040 | Temperature Window | FLOAT32 | 0 °C ... 50 °C |             |
| 4041 | Min Time in Window | FLOAT32 | 0s ... 86400s  |             |

### 3.2.5.5 CHx Object Temperature Measurement Limits (Read Only)

| ID   | Name                                 | Format  | Value Range | Description |
|------|--------------------------------------|---------|-------------|-------------|
| 4030 | Lowest Resistance                    | FLOAT32 | Ohm         |             |
| 4031 | Highest Resistance                   | FLOAT32 | Ohm         |             |
| 4032 | Temperature at Lowest<br>Resistance  | FLOAT32 | °C          |             |
| 4033 | Temperature at<br>Highest Resistance | FLOAT32 | °C          |             |

## 3.2.6 Tab: Sink Temperature

### 3.2.6.1 CHx Sink Measurement Settings

| ID   | Name               | Format  | Value Range                | Description |
|------|--------------------|---------|----------------------------|-------------|
| 5001 | Temperature Offset | FLOAT32 | -1E4 °C ...<br>1E4 °C      |             |
| 5002 | Temperature Gain   | FLOAT32 | 0.5 °C/°C ...<br>2.0 °C/°C |             |

### 3.2.6.2 CHx Actual Sink Temperature Error Limits

| ID   | Name                  | Format  | Value Range            | Description |
|------|-----------------------|---------|------------------------|-------------|
| 5010 | Lower Error Threshold | FLOAT32 | -50 °C ... 200 °C      |             |
| 5011 | Upper Error Threshold | FLOAT32 | -50 °C ... 200 °C      |             |
| 5012 | Max Temp Change       | FLOAT32 | 1 °C/s ...<br>200 °C/s |             |

### 3.2.6.3 CHx Sink NTC Sensor Characteristics

| ID   | Name                         | Format  | Value Range        | Description |
|------|------------------------------|---------|--------------------|-------------|
| 5020 | Lower Point:<br>Temperature  | FLOAT32 | -250 °C ... 250 °C |             |
| 5021 | Lower Point:<br>Resistance   | FLOAT32 | 1Ohm ...<br>1MOhm  |             |
| 5022 | Middle Point:<br>Temperature | FLOAT32 | -250 °C ... 250 °C |             |
| 5023 | Middle Point:<br>Resistance  | FLOAT32 | 1Ohm ...<br>1MOhm  |             |
| 5024 | Upper Point:<br>Temperature  | FLOAT32 | -250 °C ... 250 °C |             |
| 5025 | Upper Point:<br>Resistance   | FLOAT32 | 1Ohm ...<br>1MOhm  |             |

### 3.2.6.4 CHx Sink Temperature Source Selection

| ID   | Name                          | Format  | Value Range       | Description                   |
|------|-------------------------------|---------|-------------------|-------------------------------|
| 5030 | Sink Temperature<br>Selection | INT32   | 0 ... 1           | 0: External<br>1: Fixed Value |
| 5031 | Fixed Temperature             | FLOAT32 | -50 °C ... 200 °C |                               |

### 3.2.6.5 CHx Sink Temperature Measurement Limits (Read Only)

| ID   | Name                                 | Format  | Value Range | Description |
|------|--------------------------------------|---------|-------------|-------------|
| 5040 | Lowest Resistance                    | FLOAT32 | Ohm         |             |
| 5041 | Highest Resistance                   | FLOAT32 | Ohm         |             |
| 5042 | Temperature at Lowest<br>Resistance  | FLOAT32 | °C          |             |
| 5043 | Temperature at<br>Highest Resistance | FLOAT32 | °C          |             |

### 3.2.7 Tab: Expert

This settings are hardware depending. Before change, please call the Manufacturer.

#### 3.2.7.1 CHx Object Measurement Settings

| ID   | Name                   | Format  | Value Range              | Description                                                                                                                                                               |
|------|------------------------|---------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6000 | PGA Gain               | INT32   | 0 ... 8                  | 0: Gain = 1<br>1: Gain = 2<br>2: Gain = 4<br>3: Gain = 8<br>4: Gain = 16<br>5: Gain = 32<br>6: Gain = 64<br>7: Gain = 128<br>8: Auto Gain 1 or 8                          |
| 6001 | Current Source         | INT32   | 0 ... 7                  | 0: Current OFF<br>1: Current = 50uA<br>2: Current = 100uA<br>3: Current = 250uA<br>4: Current = 500uA<br>5: Current = 750uA<br>6: Current = 1000uA<br>7: Current = 1500uA |
| 6002 | ADC Rs                 | FLOAT32 | 10 Ohm ...<br>1MOhm      |                                                                                                                                                                           |
| 6003 | ADC Calibration Offset | FLOAT32 | -1E5°C ...<br>1E5°C      |                                                                                                                                                                           |
| 6004 | ADC Calibration Gain   | FLOAT32 | 0.5°C/°C ...<br>2.0°C/°C |                                                                                                                                                                           |
| 6005 | Sensor Type Selecton   | INT32   | 0 ... 2                  | 0: NTC<br>1: Pt100<br>2: Pt1000                                                                                                                                           |

#### 3.2.7.2 CHx Sink Measurement Settings

| ID   | Name                   | Format  | Value Range              | Description |
|------|------------------------|---------|--------------------------|-------------|
| 6010 | ADC Rv                 | FLOAT32 | 10 Ohm ...<br>1MOhm      |             |
| 6013 | ADC vps                | FLOAT32 | 0V ... 100V              |             |
| 6011 | ADC Calibration Offset | FLOAT32 | -1E5°C ...<br>1E5°C      |             |
| 6012 | ADC Calibration Gain   | FLOAT32 | 0.5°C/°C ...<br>2.0°C/°C |             |

### 3.2.8 Other Parameters (Not directly displayed in the Service Software)

#### 3.2.8.1 Power Supply Parameters (Bus-Controlled) Mode Parameters

The following parameters are volatile parameters. They have a defined reset state.

| ID    | Name             | Format  | Value Range                                                | Description                                                                                                                               |
|-------|------------------|---------|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 50000 | Live Enable      | INT32   | 0 ... 1                                                    | 0: Disabled (Reset State)<br>1: Enabled<br><br>If the Parameter ID 2010 is set to 'Live OFF/ON' this Parameter defines the Enable status. |
| 50001 | Live Set Current | FLOAT32 | 1089 / 1122:<br>-10A ... 10A<br>1090 / 1123:<br>-16A / 16A | 0A at Reset<br><br>If the Parameter ID 2000 is set to 'Live Current/Voltage' this Parameter defines the Set Current.                      |
| 50002 | Live Set Voltage | FLOAT32 | 0V ... 19V                                                 | 0V at Reset<br><br>If the Parameter ID 2000 is set to 'Live Current/Voltage' this Parameter defines the Set Voltage.                      |

#### 3.2.8.2 Temperature Regulator additional Parameters

The following parameters are volatile parameters. They have a defined reset state.

| ID    | Name                                       | Format  | Value Range       | Description                                                                                                                                                                                        |
|-------|--------------------------------------------|---------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 50010 | Sine Ramp Start Point                      | INT32   | 0 ... 1           | 0: On a new Target Value, the actually measured Temperature is taken as Start Temperature. (Reset State)<br>1: On a new Target Value, the current Target Temperature is taken as Start Temperature |
| 50011 | Object Target Temperature Source Selection | INT32   | 0 ... 1           | 0: Taken form Parameter ID 3000 (Reset State)<br>1: Taken form Parameter ID 50012                                                                                                                  |
| 50012 | Object Target Temperature                  | FLOAT32 | -50 °C ... 200 °C | 0 °C at Reset                                                                                                                                                                                      |

### 3.2.8.3 Auto Tuning Module

| ID    | Name                                                      | Format               | Value Range | Description                                                                                                                                                                 |
|-------|-----------------------------------------------------------|----------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 51000 | Auto Tuning Start                                         | INT32                | 1           | Writing 1 to this parameter initiates the Auto Tuning process.                                                                                                              |
| 51001 | Auto Tuning Cancel                                        | INT32                | 1           | Writing 1 to this parameter cancels the Auto Tuning process.                                                                                                                |
| 51010 | Tuning Parameter 2A<br>(Temperature peak-peak value)      | FLOAT32<br>Read Only | °C          | Returns the Temperature peak-peak value recorded while the Tuning Process was running.                                                                                      |
| 51011 | Tuning Parameter 2D<br>(Control Variable peak-peak value) | FLOAT32<br>Read Only | %           | Returns the Control Variable peak-peak value recorded while the Tuning Process was running.                                                                                 |
| 51012 | Tuning Parameter Ku<br>(Ultimate gain)                    | FLOAT32<br>Read Only | %/°C        | Returns the Ultimate Gain calculated based upon the 2A and 2D values.                                                                                                       |
| 51013 | Tuning Parameter Tu<br>(Ultimate period)                  | FLOAT32<br>Read Only | s           | Returns the recorded Ultimate Period.                                                                                                                                       |
| 51014 | PID Parameter Kp                                          | FLOAT32<br>Read Only | %/°C        | Returns the optimized Proportional Gain for the PID Controller.                                                                                                             |
| 51015 | PID Parameter Ti                                          | FLOAT32<br>Read Only | s           | Returns the optimized Integral Time for the PID Controller.                                                                                                                 |
| 51016 | PID Parameter Td                                          | FLOAT32<br>Read Only | s           | Returns the optimized Derivative Time for the PID Controller.                                                                                                               |
| 51017 | Coarse Temp Ramp                                          | FLOAT32<br>Read Only | °C/s        | Returns a recommendation value for the Target Temperature Ramp function.                                                                                                    |
| 51018 | Proximity Width                                           | FLOAT32<br>Read Only | °C          | Returns a recommendation value for the Target Temperature Ramp function.                                                                                                    |
| 51020 | Tuning Status                                             | INT32                | -           | 0: Idle<br>1: Ramping to Target Temperature...<br>2: Preparing for Acquisition...<br>3: Acquiring Data...<br>4: Success. Tuning Complete!<br>10: Error. Check Error Number! |
| 51021 | Tuning Progress                                           | FLOAT32<br>Read Only | 0 ... 100%  |                                                                                                                                                                             |

### 3.2.8.4 Lookup Table Control

| ID    | Name                                      | Format | Value Range   | Description                                                                                                                                                                       |
|-------|-------------------------------------------|--------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 52000 | Lookup Table Start                        | INT32  | 1             | Writing 1 to this parameter initiates the Lookup process.                                                                                                                         |
| 52001 | Lookup Table Stop                         | INT32  | 1             | Writing 1 to this parameter cancels the Lookup progress process.                                                                                                                  |
| 52002 | Lookup Table Status                       | INT32  | 0 ...4        | 0: Not initialized<br>1: Table Data not valid<br>2: Analyzing Data Table<br>3: Ready (Data Table OK)<br>4: Executing...<br>5: Max nr of Tables exceeded<br>6: Sub Table not found |
| 52003 | Lookup Table Status<br>Current Table Line | INT    | INT32         | Only valid if "Lookup Table Status" is "Executing...".<br>Information about the currently executed Data Table Line.                                                               |
| 52010 | Lookup Table ID<br>Selection              | INT32  | INT32         | Selection of the Lookup Table part to be executed                                                                                                                                 |
| 52012 | Nr Of Repetitions                         | INT32  | 0 ... 100'000 | Nr Of Executions of the REPEAT_MARK Elements                                                                                                                                      |

## 4 Bootloader

The Bootloader can be controlled over a Control and Stream Command.

It is important to have the correct Command Sequence

1. Activate Bootloader
2. Clear Memory
3. Send Stream
4. ReBoot

If there is an Error restart the Update Process

### 4.1 Bootloader Control (BC?)

| Type  | Mnemonic | Field 1                      |
|-------|----------|------------------------------|
| Query | ?BC      | UINT32<br>Bootloader Command |

| Type     | Field 1                                             |
|----------|-----------------------------------------------------|
| Response | UINT32<br>Bootloader Status<br>Or Server Error Code |

#### 4.1.1 Bootloader Command

| Bit   | Description                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------|
| NoBit | (No bit set) No Operation. Can be used to read only the Bootloader Status                                                     |
| 0     | Bootloader Activate. Enable the Erase and Write Flash functions                                                               |
| 1     | Clear Memory. Clears the Update Memory. A response can take up to 8.5s                                                        |
| 2     | ReBoot. Reboots the Application and start the Update process. Only valid if there is a valid Application in the Update Memory |

#### 4.1.2 Bootloader Status

| Bit | Description                                                                |
|-----|----------------------------------------------------------------------------|
| 0   | Bootloader is activated and running                                        |
| 1   | Memory is cleared                                                          |
| 2   | Valid Application. There is a Valid Application in the Update Memory       |
| 3   | Bootloader Error. There is an Error. Wrong Command Sequence, CRC Wrong.... |

## 4.2 Bootloader Stream (BS?)

| Type  | Mnemonic | Field 1                             |
|-------|----------|-------------------------------------|
| Query | ?BS      | Data Stream<br>Part of the Hex File |

| Type     | Field 1                                             |
|----------|-----------------------------------------------------|
| Response | UINT32<br>Bootloader Status<br>Or Server Error Code |

### 4.2.1 Data Stream

The Data Stream command is used to send the Hex File content to the microcontroller.

Add a few Hex File lines to the Payload Field of the communication protocol frame and remove all '\n' and '\r' from the stream. (The Hex File lines are then only separated by the double dot).

The maximum size of the Payload Field is 512Bytes.

It is recommended to send 10 Hex File Lines in one package. This will not exceed the 512Byte limit.

### 4.2.2 Bootloader Status

See 4.1.2 Bootloader

## 5 Legacy Commands (Not Recommended for New Designs)

### 5.1 Set Commands

| Command            | Mnemonic | Arguments / Description |     |        |                                                                         |
|--------------------|----------|-------------------------|-----|--------|-------------------------------------------------------------------------|
|                    |          | Type                    | Min | Max    | Description                                                             |
| Enable TEC 1       | E1       | UINT4                   | 0   | 1      | 0 → Disable Temperature regulation<br>1 → Enable Temperature regulation |
| Enable TEC 2       | E2       | UINT4                   | 0   | 1      | 0 → Disable Temperature regulation<br>1 → Enable Temperature regulation |
| Nominal Temp TEC 1 | N1       | UINT16                  | 0   | 65'000 | Sets the nominal temperature for TEC 1. 123 = 1.23 °C (Saved to Flash)  |
| Nominal Temp TEC 2 | N2       | UINT16                  | 0   | 65'000 | Sets the nominal temperature for TEC 2. 123 = 1.23 °C (Saved to Flash)  |

### 5.2 Query Commands

| Request                     | Mnemonic | Description                                   | Server Response |                                                                                 |
|-----------------------------|----------|-----------------------------------------------|-----------------|---------------------------------------------------------------------------------|
|                             |          |                                               | Type            | Description                                                                     |
| Version Information         | ?VI      | Returns the software version                  | UINT16          | SW Version: 100 equals 1.00                                                     |
|                             |          |                                               | UINT16          | Build Number.                                                                   |
| Error                       | ?ER      | Returns the current error number.             | UINT8           | 0 → No Error. For all other numbers check the error list (TBD) in the appendix. |
| Device Status               | ?DS      | Returns the device status                     | 8 bit<br>UINT8  | Status numbers TBD                                                              |
| Temperatures TEC 1          | ?T1      | Returns the actual Temperatures for TEC1      | UINT16          | TEC 1 Object Temperature (123 = 1.23 °C)                                        |
|                             |          |                                               | UINT16          | TEC 1 Sink Temperature (123 = 1.23 °C)                                          |
| Temperatures TEC 2          | ?T2      | Returns the actual Temperatures for TEC2      | UINT16          | TEC 2 Object Temperature (123 = 1.23 °C)                                        |
|                             |          |                                               | UINT16          | TEC 2 Sink Temperature (123 = 1.23 °C)                                          |
| Base plate Temperature      | ?BT      | Returns the base plate temperature            | UINT16          | Temperature (4312 = 43.12 °C)                                                   |
| Actual output current TEC 1 | ?C1      | Returns the actual output current of the TEC1 | INT16           | 16 Bit signed Value in mA.<br>Positive value means heating.                     |
| Actual output current TEC 2 | ?C2      | Returns the actual output current of the TEC2 | INT16           | 16 Bit signed Value in mA.<br>Positive value means heating.                     |

## 6 Change Log

| Changed by       | Dok | STM32 SW Version | Change Log                                                                                                                                                                                                                                                                                                                     |
|------------------|-----|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 03.04.12 ML      | A   |                  | <ul style="list-style-type: none"> <li>2.2 Query Commands: Query ?BT, ?C1, ?C2 added.</li> </ul>                                                                                                                                                                                                                               |
| 08.05.12 ML      | B   | 0.41             | <ul style="list-style-type: none"> <li>2.1 Set Commands: Set ET added.</li> </ul>                                                                                                                                                                                                                                              |
| 21.05.12 ML      | C   | 0.50             | <ul style="list-style-type: none"> <li>Add: 3 Service Software Parameters</li> <li>Add: 0</li> <li>Bootloader</li> </ul>                                                                                                                                                                                                       |
| 03.07.12 ML      | D   | 0.60             | <ul style="list-style-type: none"> <li>Add: 3.2.4.4 ID 5034 (Positive current is: Cooling / Heating)</li> </ul>                                                                                                                                                                                                                |
| 10.07.12 ML      | D   | 0.61             | <ul style="list-style-type: none"> <li>Add: 2.1 Set Command "RS".</li> <li>Del: 2.1 Set Command "ET"</li> </ul>                                                                                                                                                                                                                |
| 12.07.12 ML      | F   |                  | <ul style="list-style-type: none"> <li>Measurement System simplified</li> <li>Expert Settings added</li> <li>Mod: 2.2 Query Commands: ?IF (String changed)</li> <li>Mod: All Temperature Ranges -50 ... 200 °C</li> </ul>                                                                                                      |
| 16.08.12 ML      | G   | 0.70             |                                                                                                                                                                                                                                                                                                                                |
| 22.08.12 US      | H   | 0.70             | <ul style="list-style-type: none"> <li>Mod: RS485 Interface: 'Channel 1' / Default Baud rate: '57600'</li> </ul>                                                                                                                                                                                                               |
| 01 Oct 2012 ML   | I   | 1.00             | <ul style="list-style-type: none"> <li>Add: Auto Tuning</li> <li>Mod: 3.2.4.1 CHx Nominal Temperature: Ramp function changed</li> <li>Add: Device Type dependent Limits</li> <li>Add: 3.2.2.11 Object Temperature Stability Detection</li> <li>Add: 3.2.5.4 CH1 Object Temperature Stability Indicator Settings</li> </ul>     |
| 28 Nov 2012 ML   | J   | 1.10             | <ul style="list-style-type: none"> <li>Add: 2.2 Query Commands: ?LT (Lookup Table Download added)</li> <li>Add: 3.2.8.2 Temperature Regulator additional Parameters</li> <li>3.2.8.4 Lookup Table Control</li> </ul>                                                                                                           |
| 22 Jan 2013 ML   | K   | 1.30             | <ul style="list-style-type: none"> <li>Add: Parameter ID 1081 (Parameter System Flash Status)</li> <li>Add: Parameter ID 6013 (Sink Temperature VPS)</li> <li>Add: ES Command (Emergency Stop)</li> <li>Mod: Parameter ID 2010 (Power Supply Enable)</li> <li>Mod: Parameter ID 2000 (Power Supply Input Selection)</li> </ul> |
| 18 Feb 2013 ML   | L   | 1.31             | <ul style="list-style-type: none"> <li>Add: Parameter ID 104 (Device Status)</li> <li>Add: Parameter ID 105 (Error Number)</li> </ul>                                                                                                                                                                                          |
| 11 March 2013 ML | M   | 1.40             | <ul style="list-style-type: none"> <li>Mod: Parameter names changed (as it is called in Service Software)</li> <li>Mod: Parameter ID 2040 (General Operating Mode)</li> <li>Add: Parameter ID 1090 (Parallel Output Stage Monitoring)</li> <li>Add: SA and ?SD Command</li> </ul>                                              |