Communication Protocol TEC Controller

TEC-Family

(TEC-1089, TEC-1090, TEC-1091, TEC-1092, TEC-1122, TEC-1123)

1 General Description

If you have any questions, please do not hesitate to contact us under:
contact@meerstetter.ch or www.meerstetter.ch

1.1 Protocol Specifications

- General Serial Interface Specs: 8 Data bits; no Parity; 1 Stop bit; no Handshaking
- The used communication protocol is based on the “MeCom Protocol Specification” Document me5117B.
- The Control Interface has to use the ‘#’ as source identifier.
- Some Domo Applications could help to implement this specification. Please check also the Example Communication Strings at the end of this document.
    - The **MeComAPI** with demo Application shows the fully implementation of this protocol for C and C++ applications. Tested on Windows, Linux and Microcontrollers.
    - The **MeComAPI for .Net** is a C# based library that enables communication over RS232/RS485, direct FTDI driver access or Ethernet.
    - The **LDD-TEC-Sample Application** shows only the Query Strings for getting the Service Software Parameters.

1.2 Addressing

The package format contains an address field, to address up to 253 devices on the same bus. The device reacts in the following cases:

- The device receives a package that matches to the user configurable device address.
    - The device address can be configured and is nonvolatile.
    - An offset to the configured address can be added by using the PBC pins. This allows the user to have the same configuration on more than one device on a bus. The individual address is then set by hardware bridged pins on the PBC connector.
- The device receives a package with the address 0. (broadcast)
- The device receives a package with the address 255. Similar like 0, but it does not send an answer back to the host. This can for example be used to change the serial speed on each device connected to the bus.

1.3 Connecting Service Software

- By default, the Service Software always sends to each FTDI USB interface the “?IF” command with 57600 Baud and checks if it gets the correct answer.
- If an answer has been received, then it checks the firmware version.
- If the firmware version matches, then it uses the CS (Change Speed) command to temporarily change the speed from 57600 to 1M Baud. Please have a look at the 2 tables on the next page.
- Using the factory default settings, it is possible to connect the Service Software on each interface (USB, RS232 TTL, RS485).
- If the Base Baud Rate has been changed to n different value, it is possible to change the Service Software behavior by passing some additional startup parameters. It is recommended to create a shortcut to the .exe file and then modify the shortcut parameters. Startup parameters:
    - `Service_TEC.exe /LoSpeed 115200`
      Sets the initial speed to a certain Baud Rate. At default, this value is 57600
    - `Service_TEC.exe /HiSpeed 921600`
      Sets the high speed value to a certain Baud Rate. At default, this value is 1000000
    - `Service_TEC.exe /Speed 115200:`
      Changes both the `LoSpeed` and the `HiSpeed` to a certain Baud Rate.
    - `Service_TEC.exe /IP 192.168.1.191 /DevAddr 3`
      Sets the Mode to Ethernet and uses the given IP Address and Device Address to connect.
- To use RS485 we recommend the following interface cable:
  http://www.ftdichip.com/Products/Cables/USBRS485.htm
- To use RS232 TTL we recommend the 3.3V versions of the following interface cable:
  http://www.ftdichip.com/Products/Cables/USBTTLSerial.htm

1.4 Interfaces, Baud Rate

The following table shows the available interfaces for the different product categories. All interfaces support the same commands. It is also possible to use several interfaces simultaneously, for example one interface to connect the Service Software and a second one to connect a custom application.

	TEC-1089; TEC-1090; TEC-1122; TEC-1123	**TEC-1091**	**TEC-1092**
Interface 1	USB UART MODE 1	USB UART MODE 1	RS232 TTL Together with EVL-1093: USB UART MODE 3
Interface 2	RS485 Channel 1 UART MODE 2	RS232 TTL UART MODE 2	RS485 UART MODE 3
Interface 3	RS485 Channel 2 UART MODE 2	RS485 UART MODE 2	Not available

UART MODEs

	Primary Base Baud Rate	Secondary Baud Rate	Description
UART MODE 1	Fixed to 57600	None	Fixed to 57600, but can temporarily be changed with the CS command to a different value. Falls back to 57600 if no data has been received for more than 5s. Is always compatible with the Service Software.
UART MODE 2	Configurable	None	Configurable Primary Base Baud Rate, but can temporarily be changed with the CS command to a different value. Falls back to Primary Base Baud Rate if no data has been received for more than 5s. Is only compatible with the Service Software when the Primary Base Baud Rate is set to 57600 or Startup Parameters are used.
UART MODE 3	Configurable	57600	Configurable Primary Base Baud Rate, but can temporarily be changed with the CS command to a different value. Falls back to Primary Base Baud Rate if no data has been received for more than 5s. A secondary UART is always listening on this interface with 57600 and therefore it is always compatible with the Service Software. Is always compatible with the Service Software.

1.5 Flash Parameters (nonvolatile) / RAM Parameters (volatile)

Most of the Parameters are being saved to the flash after a delay of 0.5 seconds, after the last parameter has been modified. The flash can only be re written about 100'000 times. This means it is not recommended to write regularly to a parameter that is being saved to the flash. There are 2 possibilities to solve this problem:

- Disabling the automatic save mechanism to the flash: We recommend to setup the TEC like it is being desired and then switch of the saving to the flash. This way, the TEC has always the desired default configuration after startup. Please consult the User Manual for more information about this option.
- The use of special parameters that are only saved in the RAM. Search for "volatile parameter" in this document.

2 TEC-Family Commands

2.1 Set Commands

Command	Mnemonic	Arguments / Description			
		Type	**Min**	**Max**	**Description**
Parameter Value Set	VS				Sets the corresponding Parameter See 3 Service Software Parameters for details
Reset Device	RS	-	-	-	Resets the Processor 200ms after this command. The effective reset may be later if the system needs to save any settings to the flash.
Emergency Stop	ES	-	-	-	Disables all Power Outputs immediately and the Error 11 is generated.
Change Speed	CS	INT32	4800	1M	Changes the speed of the communication interface where this command was received. If no communication is recognized on the changed interface for more than 5s, the speed is changed back to the Base Baud Rate. The address is ignored to detect communication on the interface, just a valid package frame is necessary.
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. (ex. 1089, 1090, 1091, 1122, 1123) If the Device Type is sent as 0, the Device Type is ignored.
		INT32	0	+INT32	Serial Number of the device to be addressed. If the Serial Number is sent as 0, the Serial Number is ignored.
		UINT8	-	-	0: Set to the address given by the “Address Field”. 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: "8065-TEC SW G01 " (Filled up with spaces)
Parameter Value Read	?VR	Returns the corresponding Parameter value		See 3 Service Software Parameters for details
Parameter Limit Read	?VL	Returns the corresponding Limits		See 3 Service Software Parameters 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 UINT4 1 x UINT32 256 x UINT8	Command 0: Status Query 1: Program 2: Do Analyze Data Lookup Table Page Offset 32 x 8 Byte Commands	UINT4	0: Idle 1: Erasing or Writing (Sent Data is ignored) 2: New Data accepted 3: Error
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 1: CRC wrong: Possible causes: • The *.mepar File has been modified • The firmware version is not exactly the same as it was while the *.mepar file has been created • The *.mepar File was created for an other device.
Set Enable, Target Temperature and get Actual Temperature	?TT UNIT4 UNIT4 FLOAT32 FLOAT32	Command Live Enable CH1 Live Enable CH2 Target Temp CH1 Target Temp CH2	UNIT4 FLOAT 32 FLOAT 32	Device Status (Live Parameter ID 104) Actual Object Temperature CH1 (Writes to Parameter ID 50012) Actual Object Temperature CH2 (Writes to Parameter ID 50012)
		This is a customized command: A write to this command sets the Parameter ID 50011 automatically to 1. Set the TEC Output Stage Enable to “Live OFF/ON” to use this command.		

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 Parameter ID	UINT8 Parameter Instance

Type	**Field 1**
Response	<defined Format> Parameter Value Or Server Error Code

3.1.2 Parameter Value Set

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

Type	
Response	Normal ACK or Server Error Code

3.1.3 Parameter Limit Read

Type	**Mnemonic**	**Field 1**	**Field 2**
Query	?VL	UINT16 Parameter ID	UINT8 Parameter Instance

Type	**Field 1**	**Field 2**	**Field 3**
Response	UINT8 0: FLOAT32 1: INT32 Or Server Error Code	<defined Format> Parameter Min Value	<defined Format> Parameter Max Value

3.2 General Value Range Description

Name	**Min**	**Max**	**Description**
RNG_TEMP	-273°C	1000°C	General Temperature Range

3.3 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.

3.3.1 Common Product Parameters

3.3.1.1 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: Init 1: Ready 2: Run 3: Error 4: Bootloader 5: Device will Reset within next 200ms
105	Error Number	INT32	..	
106	Error Instance	INT32		
107	Error Parameter	INT32		
108	Save Data to Flash	INT32	..	0: Enabled 1: Disabled (All Parameters can then be used as RAM Parameters)
109	Parameter System: Flash Status	INT32	..	0: All Parameters are saved to Flash 1: Save to flash pending or in progress. (Please do not power off the device now) 2: Saving to Flash is disabled

Hint: Parameter 100 -999 are ready only, expect Parameter 108.

3.3.2 Tab: Monitor (Read only)

3.3.2.1 CHx Temperature Measurement

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

3.3.2.2 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	

3.3.2.3 CHx Output Stage Monitoring

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

3.3.2.4 CHx FAN Controller

ID	Name	Format	Value Range	Description
1100	Relative Cooling Power	FLOAT32	%	
1101	Nominal FAN Speed	FLOAT32	rpm	
1102	Actual FAN Speed	FLOAT32	rpm	
1103	FAN PWM Level	FLOAT32	%	

3.3.2.5 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	%	

3.3.2.6 CHx Temperature Measurement

ID	Name	Format	Value Range	Description
1040	Object Sensor ADC Value	FLOAT32	..	
1041	Sink Sensor Raw ADC Value	FLOAT32	..	
1042	Object Sensor Resistance	FLOAT32	Ohm	
1043	Sink Sensor Resistance	FLOAT32	Ohm	
1044	Sink Sensor Temperature	FLOAT32	°C	Shows the Sink Temperature even if the Sink Temperature Source Selection is set to “Fixed Value”
1045	Object Sensor Temperature	FLOAT32	°C	Shows always the calculated Object Temperature of the Measurement CH. Even if the Object Temperature Source Selection is modified or the device is operating in parallel mode.
1046	Object Sensor Type	INT32	..	0: Unknown Type 1: PT100 2: PT1000 3: NTC18K 4: NTC39K 5: NTC56K 6: NTC1M

3.3.2.7 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	..	

3.3.2.8 Power Supplies and Temperature

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

3.3.2.9 Device Temperature Mode (Standard or Extended)

ID	Name	Format	Value Range	Description
1110	Maximum Device Temperature	FLOAT32	°C	
1111	Maximum Output Current	FLOAT32	A	

3.3.2.10 Parallel Output Stage Monitoring (Common Load)

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

3.3.2.11 Error Status

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

3.3.2.12 Driver Status

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

3.3.2.13 Object Temperature Stability Detection

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

3.3.3 Tab: Operation

3.3.3.1 CHx Output Stage Control Input Selection

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

3.3.3.2 CHx Output Stage Enable

ID	Name	Format	Value Range	Description
2010	Status	INT32	..	0: Static OFF 1: Static ON 2: Live OFF/ON (See ID 50000) 3: HW Enable (Check PBC Config)

3.3.3.3 CHx Output Stage 'Static Current/Voltage' Control Values

ID	Name	Format	Value Range	Description
2020	Set Current	FLOAT32	1092: -1.2A … 1.2A 1091: -4A … 4A 1089 / 1122: -10A … 10A 1090 / 1123: -16A / 16A	
2021	Set Voltage	FLOAT32	TEC-1092: 0V … 9.6V -SV Version und TEC-1091: 0V … 21V -HV Version: 0V … 30V	

3.3.3.4 CHx Output Stage Limits

ID	Name	Format	Value Range	Description
2030	Current Limitation	FLOAT32	1092: -1.2A … 1.2A 1091: -4A … 4A 1089 / 1122: -10A … 10A 1090 / 1123: -16A / 16A	
2031	Voltage Limitation	FLOAT32	TEC-1092: 0V … 9.6V -SV Version und TEC-1091: 0V … 21V -HV Version: 0V … 30V	
2032	Current Error Threshold	FLOAT32	1092: 0A … 1.4A 1091: 0A … 5.6A 1089 / 1122: 0A … 14A 1090 / 1123: 0A … 20A	
2033	Voltage Error Threshold	FLOAT32	1092: 0A … 13V -SV Version: 0V … 25V -HV Version: 0V … 34V	

3.3.3.5 General Operating Mode

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

3.3.3.6 Device Address

ID	Name	Format	Value Range	Description
2051	Device Address	INT32	0 … 254	

3.3.3.7 UART Interface Settings

ID	Name	Format	Value Range	Description
2050	Base Baud Rate	INT32	4800 … 1M	Instance 1 = Interface 1…
2052	Response Delay	INT32	0us … 1E6us	Instance 1 = Interface 1…

3.3.3.8 Communication Watchdog

ID	Name	Format	Value Range	Description
2060	Timeout	FLOAT32	0.1 … 600s	0 disables the Watchdog

3.3.4 Tab: Temperature Control

3.3.4.1 CHx Nominal Temperature

ID	Name	Format	Value Range	Description
3000	Target Object Temp	FLOAT32	*RNG_TEMP*	
3003	Coarse Temp Ramp	FLOAT32	1E-6°C/s … 50°C/s	
3002	Proximity Width	FLOAT32	0.1°C … 200°C	

3.3.4.2 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	
3013	D Part Damping PT1	FLOAT32	0 … 1	

3.3.4.3 CHx Modelization for Thermal Power Regulation

ID	Name	Format	Value Range	Description
3020	Mode	INT32	0 … 3	0: Peltier, Full Control 1: Peltier, Heat Only - Cool Only 2: Resistor, Heat Only

3.3.4.4 CHx Peltier Characteristics

ID	Name	Format	Value Range	Description
3030	Maximal Current Imax	FLOAT32	0.1A … 1000A	
3033	Delta Temperature dTmax	FLOAT32	1°C … 200°C	
3034	Positive Current is	INT32	..	0: Cooling 1: Heating

3.3.4.5 CHx Resistor Characteristics

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

3.3.4.6 CHx Peltier, Heat Only – Cool Only Boundaries

ID	Name	Format	Value Range	Description
3051	Upper Boundary	FLOAT32	*RNG_TEMP*	
3050	Lower Boundary	FLOAT32	*RNG_TEMP*	

3.3.5 Tab: Object Temperature

3.3.5.1 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	

3.3.5.2 CHx Actual Object Temperature Error Limits

ID	Name	Format	Value Range	Description
4011	Upper Error Threshold	FLOAT32	*RNG_TEMP*	
4010	Lower Error Threshold	FLOAT32	*RNG_TEMP*	
4012	Max Temp Change	FLOAT32	1°C/s … 200°C/s	

3.3.5.3 CHx Object NTC Sensor Characteristics

ID	Name	Format	Value Range	Description
4024	Upper Point: Temperature	FLOAT32	*RNG_TEMP*	
4025	Upper Point: Resistance	FLOAT32	1Ohm … 1MOhm	
4022	Middle Point: Temperature	FLOAT32	*RNG_TEMP*	
4023	Middle Point: Resistance	FLOAT32	1Ohm … 1MOhm	
4020	Lower Point: Temperature	FLOAT32	*RNG_TEMP*	
4021	Lower Point: Resistance	FLOAT32	1Ohm … 1MOhm	

3.3.5.4 CH1 Object Temperature Stability Indicator Settings

ID	Name	Format	Value Range	Description
4040	Temperature Deviation	FLOAT32	0°C … 50°C	
4041	Min Time in Window	FLOAT32	0s … 86400s	
4042	Max Stabilization Time	FLOAT32	0s … 86400s	

3.3.5.5 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 Resistance	FLOAT32	°C	
4033	Temperature at Highest Resistance	FLOAT32	°C	
4034	Object Sensor Type	INT32	..	0: Unknown Type 1: PT100 2: PT1000 3: NTC18K 4: NTC39K 5: NTC56K 6: NTC1M

3.3.6 Tab: Sink Temperature

3.3.6.1 CHx Sink Measurement Settings

ID	Name	Format	Value Range	Description
5001	Temperature Offset	FLOAT32	-1E4°C … 1E4°C	
5002	Temperature Gain	FLOAT32	0.5°C/°C … 2.0°C/°C	

3.3.6.2 CHx Actual Sink Temperature Error Limits

ID	Name	Format	Value Range	Description
5011	Upper Error Threshold	FLOAT32	*RNG_TEMP*	
5010	Lower Error Threshold	FLOAT32	*RNG_TEMP*	
5012	Max Temp Change	FLOAT32	1°C/s … 200°C/s	

3.3.6.3 CHx Sink NTC Sensor Characteristics

ID	Name	Format	Value Range	Description
5024	Upper Point: Temperature	FLOAT32	*RNG_TEMP*	
5025	Upper Point: Resistance	FLOAT32	1Ohm … 1MOhm	
5022	Middle Point: Temperature	FLOAT32	*RNG_TEMP*	
5023	Middle Point: Resistance	FLOAT32	1Ohm … 1MOhm	
5020	Lower Point: Temperature	FLOAT32	*RNG_TEMP*	
5021	Lower Point: Resistance	FLOAT32	1Ohm … 1MOhm	

3.3.6.4 CHx Sink Temperature General

ID	Name	Format	Value Range	Description
5030	Sink Temperature Selection	INT32	..	0: External 1: Fixed Value
5031	Fixed Temperature	FLOAT32	*RNG_TEMP*	
5032	Upper ADC Limit Error	INT32	..	0: Enabled 1: Disabled

3.3.6.5 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 Resistance	FLOAT32	°C	
5043	Temperature at Highest Resistance	FLOAT32	°C	

3.3.7 Tab: Expert

3.3.7.1 Sub Tab: Temperature Measurement

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

3.3.7.1.1 CHx Object Measurement Settings

ID	Name	Format	Value Range	Description
6000	PGA Gain	INT32	..	0: Gain = 1 1: Gain = 2 2: Gain = 4 3: Gain = 8 4: Gain = 16 5: Gain = 32 6: Gain = 64 7: Gain = 128 8: Auto Gain 1 or 8 9: Auto Gain 1 or 8 or 32
6001	Current Source	INT32	..	TEC-1092: 0: OFF 1: 10uA 2: 50uA 3: 100uA 4: 250uA 5: 500uA 6: 1000uA 7: 1500uA Others: 0: OFF 1: 50uA 2: 100uA 3: 250uA 4: 500uA 5: 750uA 6: 1000uA 7: 1500uA
6002	ADC Rs	FLOAT32	10 Ohm … 1MOhm	
6003	ADC Calibration Offset	FLOAT32	-1E5°C … 1E5°C	
6004	ADC Calibration Gain	FLOAT32	0.5°C/°C … 2.0°C/°C	
6005	Sensor Type Selection	INT32	..	0: NTC 1: Pt100 2: Pt1000
6006	ADC Rp	FLOAT32	0Ohm … 1MOhm	

3.3.7.1.2 CHx Sink Measurement Settings

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

3.3.7.2 Sub Tab: Display

3.3.7.2.1 Display Configuration

Instance 1 is display Line 1 and Instance 2 is Display Line 2.

ID	Name	Format	Value Range	Description
6020	Display Type	INT32	..	0: OFF 1: OLED 2x16
6021	Display Line 1 / 2 Default Text	INT32	..	See TEC Family User Manual
6022	Display Line 1 / 2 Alternative Text	INT32	..	See TEC Family User Manual
6023	Display Line 1 / 2 Alternative Mode	INT32	..	0: None 1: On Error 2: Toggle on Error 3: Toggle

3.3.7.3 Sub Tab: PBC

3.3.7.3.1 PBC Configuration (RES1 … RES8)

Instance 1 is RES1. Instance 2 is RES2…

ID	Name	Format	Value Range	Description
6100	PBC RESx	INT32	..	0: No Function (Output is Z) 1: Data Interface (See 3.3.8.5) 2: TEC OK (1 when Ready or Running) 3: CH1 Stable 4: CH2 Stable 5: CH1 HW Enable 6: CH2 HW Enable 7: CH1 FAN PWM 8: CH2 FAN PWM 9: CH1 FAN Tacho 10: CH1 FAN Tacho 11: TEC Error 12: CH1 Rmp/Stable 13: CH2 Rmp/Stable 14: TEC Run 15: CH1 Not Stable 16: CH2 Not Stable 17: CH1 TempUp 18: CH2 TempUp 19: CH1 TempDown 20: CH2 TempDown 21: CH1 Pump 22: CH2 Pump 23: CH1 Lookup Start 24: CH2 Lookup Start 25: Dev Adr +1 (Device Address) 26: Dev Adr +2 (Device Address) 27: Dev Adr +4 (Device Address) 28: CH1 FAN Stop 29: CH2 FAN Stop 30: CH1 Alt Target T1 31: CH1 Alt Target T2 32: CH2 Alt Target T1 33: CH2 Alt Target T2

3.3.7.3.2 CHx Change Target Temperature Buttons

ID	Name	Format	Value Range	Description
6111	Upper Temp Limit	FLOAT32	*RNG_TEMP*	
6110	Lower Temp Limit	FLOAT32	*RNG_TEMP*	
6112	Step Size	FLOAT32	0°C … 1000°C	

3.3.7.3.3 CHx Pump Control

ID	Name	Format	Value Range	Description
6120	Actual Temperature Source	INT32	..	0: Sink 1: Object
6121	ON Threshold	FLOAT32	*RNG_TEMP*	
6122	OFF Threshold	FLOAT32	*RNG_TEMP*	

3.3.7.3.4 CHx Alternative Target Temperature over PCB RESx Pin

ID	Name	Format	Value Range	Description
6130	Temperature 1	FLOAT32	*RNG_TEMP*	
6131	Temperature 2	FLOAT32	*RNG_TEMP*	
6132	Temperature 3	FLOAT32	*RNG_TEMP*	

3.3.7.4 Sub Tab: FAN

3.3.7.4.1 CHx FAN Control Enable

ID	Name	Format	Value Range	Description
6200	FAN Control Enable	INT32	..	0: Disabled 1: Enabled

3.3.7.4.2 CHx FAN Temperature Controller

ID	Name	Format	Value Range	Description
6210	Actual Temperature Source	INT32	..	0: Sink 1: Object
6211	Target Temperature	FLOAT32	*RNG_TEMP*	
6212	Kp	FLOAT32	0%/°C … 10000%/°C	Temperature Controller
6213	Ti	FLOAT32	0.0001s … 10000s	Temperature Controller
6214	Td	FLOAT32	0s … 10000s	Temperature Controller

3.3.7.4.3 CHx FAN Speed Controller

ID	Name	Format	Value Range	Description
6220	0% Speed	FLOAT32	0 … 100000	FAN Speed when no cooling is required
6221	100%	FLOAT32	0 … 100000	FAN Speed when maximum cooling is required
6222	Kp	FLOAT32	0%/°C … 10000%/°C	Speed Controller
6223	Ti	FLOAT32	0.0001s … 10000s	Speed Controller
6224	Td	FLOAT32	0s … 10000s	Speed Controller
6225	Bypassing Speed Controller	INT32	..	0: No 1: Yes
6226	FAN Surveillance	INT32	..	0: Enabled 1: Disabled

3.3.7.4.4 FAN General Settings

ID	Name	Format	Value Range	Description
6230	FAN PWM Frequency	INT32	..	0: 25kHz 1: 1kHz

3.3.7.5 Sub Tab: Misc

3.3.7.5.1 CHx Actual Object Temperature

ID	Name	Format	Value Range	Description
6302	Observe Mode	INT32	..	0: Automatic 1: Disabled 2: Enabled
6301	Control Speed	INT32	..	0: 10Hz 1: 80Hz/90Hz 2: 1Hz
6300	Source Selection	INT32	..	0: Internal from its own Channel 1: External (Over Parameter 52200) 2: Internal from Channel 2 (only valid on Inst 1)

3.3.7.5.2 Parameter System Save to Flash Configuration

ID	Name	Format	Value Range	Description
108	Save Data to Flash	INT32	..	0: Enabled 1: Disabled

3.3.7.5.3 Error State Auto Restart Delay

ID	Name	Format	Value Range	Description
6310	Delay till Restart	FLOAT32	0s … 86400s	

3.3.7.5.4 Device Temperature Mode (Output Stage)

ID	Name	Format	Value Range	Description
6330	Mode	INT32	..	0: Standard 1: Extended

3.3.7.5.5 Output Stage Controller Limit (Error 108)

ID	Name	Format	Value Range	Description
6320	Error Delay	INT32	-1 … 20000000ms	-1: does fully disable the Error 108 (Not recommended) 0: Will be set automatically to 1ms.

3.3.8 Other Parameters (Not directly displayed in the Service Software)

3.3.8.1 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: Disabled (Reset State) 1: Enabled If the Parameter ID 2010 is set to 'Live OFF/ON' this Parameter defines the Enable status.
50001	Live Set Current	FLOAT32	1092: -1.2A … 1.2A 1091: -4A … 4A 1089 / 1122: -10A … 10A 1090 / 1123: -16A / 16A	0A at Reset If the Parameter ID 2000 is set to 'Live Current/Voltage' this Parameter defines the Set Current.
50002	Live Set Voltage	FLOAT32	1092: 0V … 9.6V -SV Version und TEC-1091: 0V … 21V -HV Version: 0V … 30V	0V at Reset If the Parameter ID 2000 is set to 'Live Current/Voltage' this Parameter defines the Set Voltage.

3.3.8.2 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: On a new Target Value, the actually measured Temperature is taken as Start Temperature. (Reset State) 1: On a new Target Value, the current Target Temperature is taken as Start Temperature
50011	Object Target Temperature Source Selection	INT32	..	0: Taken form Parameter ID 3000 (Reset State) 1: Taken form Parameter ID 50012
50012	Object Target Temperature	FLOAT32	*RNG_TEMP*	0°C at Reset

3.3.8.3 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.
51002	Thermal Model Speed	INT32	0-1	0: Fast Model 1: Slow Model
51010	Tuning Parameter 2A (Temperature peak-peak value)	FLOAT32 Read Only	°C	Returns the Temperature peak-peak value recorded while the Tuning Process was running.
51011	Tuning Parameter 2D (Control Variable peak-peak value)	FLOAT32 Read Only	%	Returns the Control Variable peak-peak value recorded while the Tuning Process was running.
51012	Tuning Parameter Ku (Ultimate gain)	FLOAT32 Read Only	%/°C	Returns the Ultimate Gain calculated based upon the 2A and 2D values.
51013	Tuning Parameter Tu (Ultimate period)	FLOAT32 Read Only	s	Returns the recorded Ultimate Period.
51014	PID Parameter Kp	FLOAT32 Read Only	%/°C	Returns the optimized Proportional Gain for the PID Controller.
51015	PID Parameter Ti	FLOAT32 Read Only	s	Returns the optimized Integral Time for the PID Controller.
51016	PID Parameter Td	FLOAT32 Read Only	s	Returns the optimized Derivative Time for the PID Controller.
51022	Slow PI Parameter Kp	FLOAT32 Read Only	%/°C	Returns the optimized Proportional Gain for the PID Controller.
51023	Slow PI Parameter Ti	FLOAT32 Read Only	s	Returns the optimized Integral Time for the PID Controller.
51024	PID D Part Damping PT1 Recommendation	FLOAT32 Read Only	..	Returns a recommendation value for the PID D Part Damping.
51017	Coarse Temp Ramp	FLOAT32 Read Only	°C/s	Returns a recommendation value for the Target Temperature Ramp function.
51018	Proximity Width	FLOAT32 Read Only	°C	Returns a recommendation value for the Target Temperature Ramp function.
51020	Tuning Status	INT32 Read Only	..	0: Idle 1: Ramping to Target Temperature... 2: Preparing for Acquisition... 3: Acquiring Data... 4: Success. Tuning Complete! 10: Error. Check Error Number!
51021	Tuning Progress	FLOAT32 Read Only	0 … 100%	

3.3.8.4 Lookup Table Control

The following parameters are volatile parameters.

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: Not initialized 1: Table Data not valid 2: Analyzing Data Table 3: Ready (Data Table OK) 4: Executing… 5: Max nr of Tables exceeded 6: Sub Table not found
52003	Lookup Table Status Current Table Line	INT32	INT32	Only valid if “Lookup Table Status” is “Executing…”. Information about the currently executed Data Table Line.
52010	Lookup Table ID 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

3.3.8.5 PBC (Platform Bus Connector) RES1 … RES8 Signal Control

The following parameters are volatile parameters.

This feature can be used to control the PBC reserve signals RES1 through RES8.

The particular pins are addressed by a bit field.

Example:

To configure RES3 and RES4 as Output Pins, and to set RES3 to High Level and RES4 to Low Level, use the following commands:

Set ID 52102 to 4 (Set Bit Number 2 to '1')

Set ID 52101 to 12 (Set Bit Numbers 2 and 3 to '1')

Set ID 52100 to 1 (Enable the Function)

This command order has been chosen to avoid spikes. After Reset, all values are set to 0.

Bit Field Description:

Bit Number	Output Signal
0	RES1
1	RES2
2	RES3
3	RES4
4	RES5
5	RES6
6	RES7
7	RES8

ID	Name	Format	Value Range	Description
52100	Enable Function	INT32	0 … 1	Enables the Output Signal control function.
52101	Set Output to Push-Pull	INT32	0 … 255	If a Bit is set to '0', the Output Signal is at High Impedance (used as input). If a Bit is set to '1', the Output Signal is driven.
52102	Set Output States	INT32	0 … 255	Sets the output states of driven signals.
52103	Read Input States	INT32	0 … 255	Reads the (input) states of all signals back.

3.3.8.6 Set Actual Object Temperature from external

The following parameters are volatile parameters.

ID	Name	Format	Value Range	Description
52200	External Object Temperature	FLOAT32	*RNG_TEMP*	Initial Value will be NAN. NAN causes the temperature controller to Stop. This Value should be set every 100ms or faster. To enable this feature use Parameter 6300. If this Parameter is not being set for more than 5s, the value will automatically set to NAN. (This stops the temperature controller)

4 Bootloader

The Bootloader an 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 Bootloader Command

Type	Field 1
Response	UINT32 Bootloader Status 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 Part of the Hex File

Type	Field 1
Response	UINT32 Bootloader Status 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 Filed 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 Example Communication Strings

- If you have any questions, please do not hesitate to contact us under: contact@meerstetter.ch or www.meerstetter.ch
- The following Example Communication Strings have been captured with the MeComAPI ComLog.txt file.
- It shows the Serial Communication Data as it would appear on a normal Serial Terminal Program. Only the “OUT:” and “IN:” tags have been added by the MeComAPI. The End-of-Frame Byte is not shown, because it is a ASCII <CR> (Carriage Return, 0x0D).
- All the Frame data is colored to better understand what is going on:
  - Control
  - Address (Using address 0, the device will always answer independent from its address.)
  - Sequence Number
  - Payload / Other Payload part
  - Cecksum

Get Firmware Identification String

OUT: #0015AA?IF62AE

IN: !0015AA8065-TEC SW G01 7199

→ Result is “8065-TEC SW G01 “

Get Device Type (Using Parameter Value Read)

Parameter ID: 100 (0x0064); Instance 1

OUT: #0015AB?VR00640180000

IN: !0015AB00000441 1DBD

→ Result is 0x00000441 → 1089

Get Serial Number (Using Parameter Value Read)

Parameter ID: 102 (0x0066); Instance 1

OUT: #0015AC?VR00660180125

IN: !0015AC000000706F2C

→ Result is 0x00000070 → Interpreted as an INT32: Decimal Value 112

Set TEC Output Stage Enable Status (Using Parameter Value Set Command)

Parameter ID: 2010 (0x07DA); Instance 1; New value is 2 (Live OFF/ON) as INT32

OUT: #0015AEVS07DA0100000002 8F97

IN: !0015AE8F97

→ As Result we get a ACK. The ACK sends the Checksum of the Set Command back.

Get TEC Object Temperature (Using Parameter Value Read)

Parameter ID: 1000 (0x03E8); Instance 1

OUT: #0015AB?VR03E801C21A

IN: !0015AB41CD2F28D5C2

→ The Result is 0x41CD2F28 → Interpreted as an FLOAT32: 25.648026°C

You may use the tool: http://www.h-schmidt.net/FloatConverter/ for tests.

Usually Microcontrollers do support float according to IEEE754 by an Hardware or Software FPU.

Set TEC Target Object Temperature (Using Parameter Value Set)

Parameter ID: 3000 (0x0BB8); Instance 1; New Value 21.750°C AS FLOAT32 according to IEEE754

The new Value 21.75 is being transmitted as Hexadecimal Representation 0x41AE0000.

You may use the tool: http://www.h-schmidt.net/FloatConverter/ for tests.

Usually Microcontrollers do support float according to IEEE754 by an Hardware or Software FPU.

OUT: #0015B0VS0BB80141AE0000C482

IN: !0015B0DC00

→ As Result we get a ACK. The ACK sends the Checksum of the Set Command back.

Querying a not available Parameter ID (Using Parameter Value Read)

Parameter ID: 1234 (0x04D2); Instance 1

OUT: #0015AC?VR04D2017BFE

IN: !0015AC+0532DA

→ As Result we get the Server Error Code 0x05 which means that this Parameter is not available.

6 Change Log

Changed by	Dok	STM32 SW Version	Change Log
03.04.12 ML	A		• 2.2 Query Commands: Query ?BT, ?C1, ?C2 added.
08.05.12 ML	B	0.41	• 2.1 Set Commands: Set ET added.
21.05.12 ML	C	0.50	• Add: Bootloader • Add: Chapter Service Software Parameters
03.07.12 ML	D	0.60	• Add: 3.3.4.4 ID 5034 (Positive current is: Cooling / Heating)
10.07.12 ML	D	0.61	• Add: 2.1 Set Command “RS”. • Del: 2.1 Set Command “ET”
12.07.12 ML	F		• Measurement System simplified • Expert Settings added • Mod: 2.2 Query Commands: ?IF (String changed) • Mod: All Temperature Ranges -50 … 200 °C
16.08.12 ML	G	0.70	
22.08.12 US	H	0.70	• Mod: RS485 Interface: 'Channel 1' / Default Baud rate: '57600'
01 Oct 2012 ML	I	1.00	• Add: Auto Tuning • Mod: 3.3.4.1 CHx Nominal Temperature: Ramp function changed • Add: Device Type dependent Limits • Add: 3.3.2.13 Object Temperature Stability Detection • Add: 3.3.5.4 CH1 Object Temperature Stability Indicator Settings
28 Nov 2012 ML	J	1.10	• Add: 2.2 Query Commands: ?LT (Lookup Table Download added • Add: 3.3.8.2 Temperature Regulator additional Parameters • 3.3.8.4 Lookup Table Control
22 Jan 2013 ML	K	1.30	• Add: Parameter ID 1081 (Parameter System Flash Status) • Add: Parameter ID 6013 (Sink Temperature VPS) • Add: ES Command (Emergency Stop) • Mod: Parameter ID 2010 (Power Supply Enable) • Mod: Parameter ID 2000 (Power Supply Input Selection)
18 Feb 2013 ML	L	1.31	• Add: Parameter ID 104 (Device Status) • Add: Parameter ID 105 (Error Number)
11 March 2013 ML	M	1.40	• Mod: Parameter names changed (as it is called in Service Software) • Mod: Parameter ID 2040 (General Operating Mode) • Add: Parameter ID 1090 (Parallel Output Stage Monitoring) • Add: SA and ?SD Command

Changed by	Dok	STM32 SW Version	Change Log
10 April 2013 ML	N	1.41	• Add: 3.3.8.5 PBC (Platform Bus Connector) RES1 … RES8 Signal Control • Add: Parameter ID 106 (Error Instance) • Add: Parameter ID 107 (Error Parameter)
17 June 2013 ML	O	1.50	• Add: Command ?VL (Parameter Limit Read)
27 June 2013 ML	P		• Add: 5 Example Communication Strings
14 August 2013 ML	Q	1.60	• Add: Monitor: 3.3.2.4 CHx FAN Controller • Add: 3.3.7.2 Sub Tab: Display • Add: 3.3.7.3 Sub Tab: PBC • Add: 3.3.7.3.2 CHx Change Target Temperature Buttons • Add: CHx Pump Control • pSub Tab: FAN • Mod: General Temperature Range set to -273 … +1000°C • Add: Parameter: 108 (Save Data to Flash) • Add: Parameter: 109 (Parameter System: Flash Status) • Add: Parameter: 6300 (Actual Object Temperature Source Selection) • Add: Parameter: 52200 (External Actual Object Temperature) • Add: Parameter: 2010 (Enable) Option 3 (HW Enable)
15 Oct 2013 ML	R	1.70	• Add: Value Ranges for TEC-1091 • Add: Parameter 6100: New “TEC Error”, and “CHx Rmp/Stable” • Add: Parameter 4042 Max stabilization Time • Add: Parameter 6310 Delay till Restart

12 Dec 2013	S	1.80	• Mod: Parameter 6100:
			  ○ Add: Option TEC Run and CHx Not Stable
			  ○ Add: Option CHx Temp Up/Down
			• Mod: Parameter 6021, 6022 Value Range extended to 0 ... 27

21 Feb 2014	T	1.91	• Mod: Parameter 2021, 2031, 2033, 50002 ○ Voltage Range for –SV and –HV Version changed • Add: Parameter 6110 – 6112 (CHx Change Target Temperature Buttons) • Add: Parameter 6225 (Bypassing FAN Speed Controller)
7 Aug 2014	U	2.00	• Bug: Value Ranges removed for selective parameters • Mod: Auto Tuning: Add Par: 51002, 51022, 51023, 51024 • Add: PID Parameters: New Parameter: 3013
24 Nov 2014	V	2.10	• Add: 3.3.3.8 Communication Watchdog • Add: General Serial Interface Specs
2 Feb 2015	W	2.20	• Add: Command ?TT • Add: Description about Flash and RAM parameters • Add: Parameter 6320 (CHx Output Stage Controller Limit Error Delay)

Changed by	Dok	STM32 SW Version	Change Log
16 March 2015	X	2.30	• Mod: Parameter ID 1061: New Name: Medium Internal Supply • Add: Parameter ID 1044: Sink Sensor Temperature
15 July 2015	Y	2.40	• Add: Parameter ID 6120 – 6122 (Pump Control) • Mod: Parameter ID 6100 (Add Pump selection)
16 Sept 2015	Z	2.41	• Bug: Parameter ID 52101 Example: Bug fixed
29 Dez 2015	AA	2.50	• Add: Parameter ID 1045 (Object Temperature Measurement) • Mod Parameter ID 6300 (Take Temp of CH2 for CH1) • Mod: TEC maximum output voltages modified • Add: Parameter ID 1110 (Maximum Device Temperature) • Add: Parameter ID 1111 (Maximum Output Current) • Add: Parameter ID 6330 (Device Temperature Mode)
21 April 2016	AB	2.60	• Add: Parameter ID 6226 (FAN Surveillance Disable option) • Mod: ?VL command documentation optimized
3 June 2016	AC	2.70	• Add. Parameter ID 5032 (Sink Upper ADC Limit Erro) • Add: Parameter ID 6006 (Object Measurement Rp)
5 Sept 2016	AD	2.72	• Add: Parameter ID 4034 (Object Sensor Type) • Mod: Examples address changed to 0.
2 February 2017	AE	3.00	• Add: CS command (change speed) • Mod: Parameter ID 1040, 1041 Object and Sink ADC values Format changed from INT32 to FLOAT32 • Mod: Parameter ID 2050, 2052 UART Baud Rate and RS485 Replay delay settings are now available for all 3 interfaces. • Del: Legacy Commands removed (also from firmware) • Mod: Parameter ID 6100 options extended. • Del: Peltier Umax and Qmax removed • Add: Parameter ID 6130 Alternative Target Temperature over PBC RESx Pin • Add: Parameter 6302 Object Temperature Observe Mode • Add: Parameter 6301 Control Speed (Temperature Controller) • Mod: Parameter 3020 Mode Generalized • Add: Parameter 3050, 3051 Heat Only – Cool Only Boundaries.