Communication Protocol
TEC Controller

TEC-Family
(TEC- 1089, 1090, 1091, 1092, 1122, 1123, 1161, 1162, 1163, 1166, 1167)

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1 General Description

If you have any questions, please do not hesitate to contact us.

This document mainly describes the proprietary MeCom Protocol. Details about each parameter can be found in this document and in the User Manual.

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 me5117C.
- Some Demo Applications could help to implement this specification. Please also check 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.
    - **LabVIEW VI** Sample Application.
    - **Python** Sample Application.

1.2 Addressing

The package format contains an address field, to address up to 254 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 GPIO 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 GPIO pins.
- 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. By default, this value is 57600.
  - `Service_TEC.exe /HiSpeed 921600`
    Sets the high-speed value to a certain Baud Rate. By 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:
  www.ftdichip.com/Products/Cables/USBRS485.htm

- To use RS232 TTL, we recommend the 3.3V versions of the following interface cable:
  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.

Inter-face	TEC- 1089, 1090, 1122, 1123	TEC-1091 HW < 3.00	TEC-1092	TEC-1161	TEC- 1162, 1163, 1166, 1167
1	USB UART MODE 1	USB HW < v3.00: UART MODE 1 HW >= v3.00 UART MODE 3	RS232 TTL Together with EVL-1093: USB UART MODE 3	USB UART MODE 3	USB UART MODE 3
2	RS485 Channel 1 UART MODE 2	RS232 TTL HW < v3.00: UART MODE 2 HW >= v3.00 UART MODE 3	RS485 UART MODE 3	RS485 UART MODE 3	RS485 1 UART MODE 2
3	RS485 Channel 2 UART MODE 2	RS485 HW < v3.00: UART MODE 2 HW >= v3.00 UART MODE 3	Not available	RS485 UART MODE 3	RS232 TTL UART MODE 2

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.

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 off 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

Here only the specialized commands are specified. The standards are specified in the document 5117.

Command	Mnemonic	Arguments / Description			
		Type	Min	Max	Description
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.

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2.2 Query Commands

Here only the specialized commands are specified. The standards are specified in the document 5117.
The Firmware identification (?IF) is: "8065-TEC SW G01   " (20 chars)

Request	Mnemonic	Description	Server Response	
			Type	**Description**
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	Command 0: Status Query 1: Program 2: Do Analyze Data	UINT4	0: Idle 1: Erasing or Writing (Sent Data is ignored) 2: New Data accepted 3: Error
	1 x UINT32	Lookup Table Page Offset		
	256 x 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 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 another 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 usually used to control the TEC Output Channel 1 or 2. In case the Instance does not refer to the Channel (e.g., GPIO or Display Parameters) it is noted in this document.

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

➔ All standard commands have been transferred to document 5117.

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 the TEC-Family User Manual (5216) for detailed parameter descriptions.

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

Note: Parameters 100 -999 are read-only, except 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	..	
1046	Object Differential Voltage	FLOAT32	V	
1042	Object Sensor Resistance	FLOAT32	Ohm	
1045	Object Sensor Temperature	FLOAT32	°C	Always shows 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.
1041	Sink Sensor Raw ADC Value	FLOAT32	..	
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"

3.3.2.7 Firmware and Hardware Versions

ID	Name	Format	Value Range	Description
1051	Firmware Build Number	INT32	..	
1054	Min Version for Firmware Downgrade	INT32	..	123 → 1.23

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	Device Temperature	FLOAT32	°C	Temperature of the TEC Controller itself

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 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

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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 GPIO 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 / 1161-4A: -4A … 4A 1089 / 1122 / 1161-10A: -10A … 10A 1090 / 1123: -16A … 16A 1162 / 1166: -5A … 5A 1163 / 1167: -25A … 25A	
2021	Set Voltage	FLOAT32	1092: 0V … 9.6V -SV Version and 1091 / 1161: 0V … 21V -HV Version: 0V … 30V 1162 / 1163 / 1166 / 1167: 0V … 57V	

3.3.3.4 CHx Output Stage Limits

ID	Name	Format	Value Range	Description
2030	Current Limitation	FLOAT32	See parameter ID: 2020	
2031	Voltage Limitation	FLOAT32	See parameter ID: 2021	
2032	Current Error Threshold	FLOAT32	1092: 0A … 1.4A 1091 / 1161-4A: 0A … 5.6A 1089 / 1122 / 1161-10A: 0A … 14A 1090 / 1123: 0A … 20A 1162 / 1166: -7A … 7A 1163 / 1167: -35A … 35A	
2033	Voltage Error Threshold	FLOAT32	1092: 0A … 13V -SV Version and 1091 / 1161: 0V … 25V -HV Version: 0V … 34V 1162 / 1163 / 1166 / 1167: 0V … 60V	

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

3.3.3.9 CANopen Interface

ID	Name	Format	Value Range	Description
2070	Node ID	INT32	1 … 127	
2071	Bit Rate	INT32	10 … 1000 kbit/s	
2072	CAN1	INT32	0 … 1	0: CAN 1 Disabled 1: CAN 1 Enabled

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°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	0s … 10000s	0s disables the integral term
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 … 2	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	Maximum 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	Maximum 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 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	

3.3.5.4 CHx Object Temperature Measurement Limits (Read Only)

ID	Name	Format	Value Range	Description
4035	Highest Voltage	FLOAT32	V	
4036	Lowest Voltage	FLOAT32	V	
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/NTC 7: VIN1 8: VIN2

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 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

3.3.6.4 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: Auto Tuning

The following parameters are volatile parameters.

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 Tab: Advanced

3.3.8.1 Tab: Advanced / Temperature Measurement

These settings are hardware dependent. Before change, please contact the Manufacturer.

3.3.8.1.1 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	
6007	PGA Bypass	INT32	..	0: Disabled 1: Enabled	
6001	Current Source	INT32	..	TEC- 1091, 1092, 116x: 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
6008	Current Source 2 Out	INT32	..	TEC- 1091, 1092, 116x: 0: OFF 1: AIN0 (UB) 2: AIN1 (UA) 3: AIN2 4: AIN3 (IA) 5: REFP0 (IB) 6: REFN0	Others: 0: OFF 1: AIN0 (UB) 2: AIN1 (UA) 3: AIN2 (IA) 4: AIN3
6009	Measurement Type	INT32	..	0: Resistance 1: Voltage	
6002	ADC Rs	FLOAT32	10 Ohm … 1MOhm		
6006	ADC Rp	FLOAT32	0Ohm … 1MOhm	0 Ohm means not assembled.	
6003	ADC Calibration Offset	FLOAT32	-1E5°C … 1E5°C		
6004	ADC Calibration Gain	FLOAT32	0.5°C/°C … 2.0°C/°C		

3.3.8.1.2 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	

3.3.8.2 Tab: Advanced / Temperature Conversion

3.3.8.2.1 CHx Object Conversion Mode

ID	Name	Format	Value Range	Description
6005	Sensor Type Selection	INT32	..	0: NTC
				1: Pt100
				2: Pt1000
				3: Voltage

3.3.8.2.2 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	

3.3.8.2.3 CHx Object Voltage to Temperature Conversion

ID	Name	Format	Value Range	Description
6400	Reference Temp	FLOAT32	*RNG_TEMP*	Reference Temperature in °C
6401	Reference Voltage	FLOAT32	-5V … 5V	Voltage output at the Reference Temperature
6402	Temperature Slope	FLOAT32	-100V/°C … 100//°C	Voltage change per temperature change

3.3.8.2.4 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	

3.3.8.3 Tab: Advanced / ADS Self Check

3.3.8.3.1 CHx Object Measurement ADS Self Check Settings. The Parameter 6051 is volatile.

ID	Name	Format	Value Range	Description
6050	Self-Check Period	INT32	*0 … 2000000000s*	Self-check Period in s. 0 disables the periodic self-check.
6051	Self-Check Trigger	INT32	0 … 1	Writing a 1 to this parameter triggers the automatic self-check. The parameter is automatically set to 0 after the check is finished.
6052	IRs Error Enable	INT32	0 … 1	If this parameter is set to 1 an error is thrown when the measured IRs is out of boundaries.

3.3.8.3.2 CHx Object Measurement ADS Self Check Results. The following Parameters are volatile.

ID	Name	Format	Value Range	Description
6053	AVDD	FLOAT32	V	Analog Supply Voltage measured by the ADC TEC 1091, 1092, 116x: 5V Other TEC-Controllers: 3.3V
6054	IRs	FLOAT32	I	Current through the reference Resistor See parameter 6001 for nominal value.
6055	VRef	FLOAT32	V	Voltage at the reference voltage input of the AD-Converter

3.3.8.4 Tab: Advanced / Lookup Table

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

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3.3.8.5 Tab: Advanced / Display

3.3.8.5.1 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
6023	Display Line 1 - 4 Alternative Mode	INT32	..	0: None 1: On Error 2: Toggle on Error 3: Toggle
6024	Display Line 1 - 4 Default Text	LATIN1	..	See TEC Family User Manual
6025	Display Line 1 - 4 Alternative Text	LATIN1	..	See TEC Family User Manual
6026	Display Line 1 - 4 Startup Text	LATIN1	..	See TEC Family User Manual

3.3.8.6 Tab: Advanced / GPIO

3.3.8.6.1 GPIO Configuration (GPIO1 …GPIO8)

Instance 1 is GPIO1. Instance 2 is GPIO2…

ID	Name	Format	Value Range	Description
6100	GPIO Function	INT32	..	0: No Function 1: Data Interface (See 3.3.9.3) 2: TEC OK (1 when Ready or Running) 3: Stable 4: HW Enable 5: Fan PWM 6: Fan Tacho 7: Rmp/Stable 8: Run 9: TempUp 10: TempDown 11: Pump 12: Lookup Start 13: Adr +1 (Device Address) 14: Adr +2 (Device Address) 15: Adr +4 (Device Address) 16: Fan Stop 17: Alt Target T1 18: Alt Target T2 19: PowerSt 0A 20: Encoder A 21: Encoder B 22: Ramp 23: Fix 0
6101	GPIO Level Assignment	INT32	..	0: Positive 1: Negative
6102	GPIO Hardware Configuration	INT32	..	0: IN WeakNo 1: IN WeakUp 2: IN WeakDown 3: OUT PushPull 4: OUT OD NoPull 5: OUT OD WeakUp
6103	GPIO Channel	INT32	..	1: Channel 1 2: Channel 2

3.3.8.6.2 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	

3.3.8.6.3 CHx Pump Control

ID	Name	Format	Value Range	Description
6120	Actual Temperature Source	INT32	..	0: CH1 Sink 1: CH1 Object 2: CH2 Sink 3: CH2 Object 4: Device Temperature
6121	ON Threshold	FLOAT32	*RNG_TEMP*	
6122	OFF Threshold	FLOAT32	*RNG_TEMP*	

3.3.8.6.4 CHx Alternative Target Temperature over GPIO 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*	

3.3.8.7 Tab: Advanced / Fan

3.3.8.7.1 CHx Fan Control Enable

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

3.3.8.7.2 CHx Fan Temperature Controller

ID	Name	Format	Value Range	Description
6210	Actual Temperature Source	INT32	..	0: CH1 Sink 1: CH1 Object 2: CH2 Sink 3: CH2 Object 4: Device Temperature
6211	Target Temperature	FLOAT32	*RNG_TEMP*	
6212	Kp	FLOAT32	0%/°C … 10000%/°C	Temperature Controller
6213	Ti	FLOAT32	0s … 10000s	Temperature Controller, 0s disables the integral term
6214	Td	FLOAT32	0s … 10000s	Temperature Controller

3.3.8.7.3 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% Speed	FLOAT32	0 … 100000	Fan Speed when maximum cooling is required
6227	Fan Min Speed Start	FLOAT32	0 … 100000	Speed above which the Fan starts
6228	Fan Min Speed Stop	FLOAT32	0 … 100000	Speed below which the Fan stops
6222	Kp	FLOAT32	0%/°C … 10000%/°C	Speed Controller
6223	Ti	FLOAT32	0s … 10000s	Speed Controller 0s disables the integral term
6224	Td	FLOAT32	0s … 10000s	Speed Controller
6225	Bypassing Speed Controller	INT32	..	0: No 1: Yes
6226	Fan Surveillance	INT32	..	0: Enabled 1: Disabled

3.3.8.7.4 Fan General Settings

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

3.3.8.8 Tab: Advanced / Misc

3.3.8.8.1 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: CH1 Object 1: CH1 Sink 2: CH2 Object 3: CH2 Sink 4: Device 5: External

3.3.8.8.2 Parameter System Save to Flash Configuration

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

3.3.8.8.3 Error State Auto Restart Delay

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

3.3.8.8.4 Device Temperature Mode (Output Stage)

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

3.3.8.8.5 Output Stage Controller Limit (Error 108)

ID	Name	Format	Value Range	Description
6320	Error Delay	INT32	-1 … 20000000ms	-1: fully disable the Error 108 (not recommended) 0: set the delay to 1ms automatically

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

3.3.9.1 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	See Parameter ID 2020	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	See Parameter ID 2021	0V at Reset If the Parameter ID 2000 is set to 'Live Current/Voltage' this Parameter defines the Set Voltage.

3.3.9.2 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

3.3.9.3 GPIO (General Purpose Input Output) GPIO1 … GPIO8 Signal Control

The following parameters are volatile parameters.

This feature can be used to manually control the GPIO1 through GPIO8 signals.

The respective GPIOs must be set to the "Data Interface" function to allow these parameters to control them.

The pins are addressed by a bit field.

Example:

To configure GPIO3 / GPIO4 as output pins, and to set GPIO3 to high level and GPIO4 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	GPIO 1
1	GPIO 2
2	GPIO 3
3	GPIO 4
4	GPIO 5
5	GPIO 6
6	GPIO 7
7	GPIO 8

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. Note: By default, the GPIOs use the Hardware Configuration defined by Parameter 6102. This setting will override the Hardware Configuration and set it to "OUT PushPull".
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.

3.3.9.4 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 doesn't get refreshed for longer than 5s, the value will automatically be set to NAN. This stops the temperature controller.

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4 Bootloader

- The new application can be downloaded using all communication interfaces.
- The Bootloader can be controlled over a Control and Stream command.
- The whole new application will be cached and verified onboard, before the old application gets erased.
- Do not interrupt the power after the ReBoot command, till the device is answering to your queries again. Interrupting the power after the ReBoot command can cause irreversible memory errors.
- Do not worry about communication failures, wrong command sequences or downloading the wrong firmware using this bootloader. Everything is verified, before the bootloader enters the critical process. If the power is not being interrupted after the ReBoot command, no irreversible errors are possible.

It is important to have the correct command sequence:

1. Activate Bootloader using Command **BootloaderActivate**.
2. Query the status using **NoOperation** and wait till it reports the status activated.
3. Clear the update memory using the command **ClearMemory.**
4. Query the status using **NoOperation** and wait till it reports the status memory is cleared.
5. Send the whole .hex file using the Bootloader Stream command.
6. Query the status using **NoOperation** and wait till it reports the status Valid Application.
7. Start replacing the running application. Send the command **ReBoot**. Attention:
    a. The device will not answer your queries for typically 10s. (May take longer)
    b. Do not interrupt the power during this process!
    c. Constantly send queries (e.g. ?IF) to the device, to see if the new application is already running. If the device is answering your queries again, the critical process is finished.
8. Verify the expected firmware version.

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	Value	Description
NoBit	0x00	(No bit set) **NoOperation**. Can be used to read only the Bootloader Status.
0	0x01	**BootloaderActivate**. Starts enabling the update memory.
1	0x02	**ClearMemory**. Starts clearing the update memory.
2	0x04	**ReBoot**. Starts replacing the running application. Will only be accepted if the Bootloader Status reports "Valid Application".

4.1.2 Bootloader Status

Bit	Value	Description
0	0x0001	Bootloader is activated.
1	0x0002	Memory is cleared.
2	0x0004	Valid Application. There is a Valid Application in the Update Memory.
3	0x0008	Bootloader Error. This flag will always be set if an error occurs. See additional flags below (FW >= v5.00).
4	0x0010	Error: CRC error detected in the downloaded file.
5	0x0020	Error: The Firmware Identification String does not match. The downloaded firmware is not intended for this device.
6	0x0040	Error: This firmware is not made for this firmware branch.
7	0x0080	Error: The firmware is too old for this device.
8	0x0100	Error: AES decryption failure. The code was encrypted with a different key.
9	0x0200	Error: This firmware is too new for the currently installed firmware version. Please check the Software Release Notes. An intermediate firmware might be needed.
10	0x0400	Error: Unencrypted firmware file detected. It is not possible to install this firmware anymore. Please contact the manufacturer.
11	0x0800	Error: Feature Firmware Update Limit reached. The downloaded file contains a firmware that is too old for the device.
12	0x1000	Error: Feature Firmware Update Limit reached. The downloaded file contains a firmware that is too new for the device.

4.2 Bootloader Stream (BS?)

Type	Mnemonic	Field 1	Field 2
Query	?BS	UINT32 Length in bytes of field 2	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

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5 Example Communication Strings

- If you have any questions, please do not hesitate to contact us via email: contact@meerstetter.ch or via our website: www.meerstetter.ch.
- The following Example Communication Strings have been captured with the MeComAPI log 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 an ASCII <CR> (Carriage Return, 0x0D).
- The Checksum is calculated using the CRC16-CCITT (XMODEM) algorithm over the previous frame data as ASCII String.
- To easily assemble command strings for our protocol we have a small tool on our website that you can make use of: www.meerstetter.ch/MeCom.
- 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
    - Checksum

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?VR0064018000

IN: !0015AB000004411DBD

→ Result is 0x00000441 → 1089

Get Serial Number (Using Parameter Value Read)

Parameter ID: 102 (0x0066); Instance 1

OUT: #0015AC?VR0066018125

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: #0015AEVS07DA01000000028F97

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: www.h-schmidt.net/FloatConverter for tests.

Usually, Microcontrollers do support float according to IEEE754 by a 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.

OUT: #0015B0VS0BB80141AE0000C482

IN: !0015B0C482

→ 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 CANopen

Please consider that this is the first implementation of CANopen. We gladly accept suggestions for improvement (support@meerstetter.ch).

Supported Features:

- All mandatory functions of CiA 301
- 1 SDO Server
- EMCY
- Producer Heartbeat
- 16 RPDO and 16 TPDO with dynamic object mapping

General Information:

- The CAN ID and Bitrate can be set using the Service Software and will be saved in the non-volatile memory.
- All the CAN Objects in the Communication Segment are only saved in the volatile memory, so they need to be re-configured after every reset.
- Expect for the "Monitor" Objects, most of the Objects in the "Manufacturer Segment" are saved in the non-volatile memory.
- The device has its own parameter system, which is used to handle all the parameters for the device operation. This parameter system only supports INT32 and FLOAT32 (REAL32) values. Therefore, every parameter in the Manufacturer Segment have always a size of 4 bytes.
- Most of the parameters have only 1 instance, but some have several instances. For example, the External Temperature Measurement. For simplification, all objects in the Manufacturer Segment are always arrays. The subindex 0 is always the "Highest sub-index supported" or in other words, maximal number of instances. Subindex 1 … n represent the parameter instances 1 … n.
- The name of the objects in the EDS file are closely linked to the Service Software.

6.1 Feature Details

6.1.1 EMCY

The error reporting only reports a few CANopen stack specific error messages. All other error messages are manufacturer specific.

For manufacturer specific errors the EEC Field shows 0xFF00 + <Meerstetter Specific Error Number>. This number can be found in the User Manual.

Usage of the MEF bytes:

- Byte 0: Instance (Channel): For example, if the External Temperature Sensor on channel 2 has a problem, then this byte is set to 2. Usually, it is 1 for this device.
- Byte 1 … 4: Additional information for support purposes. Please provide this number if you contact our support.

6.1.2 PDO

- The mapping tables have always 2 Mapping Entries, because the "Manufacturer Segment" Objects always have a size of 4 bytes.
- Some parameters have a very high update rate internally, so be careful, when using TPDOs with should automatically transmit if the value has changed.

7 Change Log

Date of change	Doc Version	Changed/ Approved	STM32 SW Version	Changes
2 Feb 2015	W	ML	2.20	• Add: Command ?TT • Add: Description about Flash and RAM parameters • Add: Parameter 6320 (CHx Output Stage Controller Limit Error Delay)
16 March 2015	X	ML	2.30	• Mod: Parameter ID 1061: New Name: Medium Internal Supply • Add: Parameter ID 1044: Sink Sensor Temperature
15 July 2015	Y	ML	2.40	• Add: Parameter ID 6120 – 6122 (Pump Control) • Mod: Parameter ID 6100 (Add Pump selection)
16 Sep 2015	Z	ML	2.41	• Bug: Parameter ID 52101 Example: Bug fixed
29 Dec 2015	AA	ML	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	ML	2.60	• Add: Parameter ID 6226 (Fan Surveillance Disable option) • Mod: ?VL command documentation optimized
3 June 2016	AC	ML	2.70	• Add. Parameter ID 5032 (Sink Upper ADC Limit Error) • Add: Parameter ID 6006 (Object Measurement Rp)
5 Sept 2016	AD	ML	2.72	• Add: Parameter ID 4034 (Object Sensor Type) • Mod: Examples address changed to 0

Date of change	Doc Version	Changed/ Approved	STM32 SW Version	Changes
2 Feb 2017	AE	ML	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 GPIO 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
28 June 2018	AF	HS	3.11	• Del: All standard commands moved to document 5117C • Del: Parameter 1046 because it was doubled. See ID 4034 • Add: Temperature Measurement Parameters: 6007, 6008, 6009 • Add: Temperature Conversion Parameters: 6400, 6401, 6402 • Add: Voltage option to the Sensor Type Selection parameter 6005 • Add: Monitor Value 1046 Object Differential Voltage • Add: Object Temperature Parameter 4035 Highest Voltage and 4036 Lowest Voltage • Add: Fan Control Parameters 6227 and 6228 • Add: Fan Control Parameter 6210 more options • Mod: GPIO Parameter 6100 changed options • Add: Display Parameters 6024, 6025 and 6026 • Del: Display Parameters 6021 and 6022 • Add: GPIO Parameters 6101, 6102 and 6103
15 Oct 2018	AH	HS	3.11	• Bug: Communication Example ACK example was wrong • Add: Hint for Python example
15 Jan 2019	AI	HS	3.20	• Add: ADS Self Check Parameter 6050 – 6055 • Mod: Parameter 3002 range modified

Date of change	Doc Version	Changed/ Approved	STM32 SW Version	Changes
30 August 2019	AJ	ML	4.10	• Add: Parameter 1054: Min firmware version • Bug: Parameter 6227 - 6228 was documented as INT32 instead of FLOAT32 • Bug: 4.1 Interfaces, Baud Rate documentation relating TEC-1091 HW version was wrong
11 March 2020	AK	HS	4.20	• Add: Pump Control Parameter 6120 more options • Add: TEC-1161 to Interfaces/Baudrate
30 July 2020	AL	ML/HS	5.00	• Add: Bootloader Flags (?BC) • Bug: Bootloader Stream (?BS): Length field was missing
30 July 2021	AM	XF/HS	5.00	• Add: TEC-1161 Current and Voltage range information for Parameters 2020, 2021, 2030 – 2033, 50001 and 50002 • Add: Information about Checksum algorithm
23 March 2023	AN	ML/XF	5.10	• Add: Parameter 6100 GPIO Function: Ramp • Del: Doubled Parameter Numbers: - 1081: Parameter System Flash Status - 1080: System Status - 1070, 1071, 1072: Error Registers - 1052: Hardware Version - 1053: Serial Number - 1050: Firmware Version • Add: GPIO Function Parameter: 6100: Fix 0 • Add: CANopen Interface Parameters • Add: Hint that PID Ti = 0s disables the integral term • Add: CANopen section • Add: Parameter 4034: Object Sensor Type: VIN2 • Add: Parameter limits for TEC-1162/1163/1166/1167 • Mod: Parameter 6300: Object Temperature Source Selection • Add: UART Modes for TEC-1162 based devices