Communication Protocol – LDD-1321

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Index

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1 General Description

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 specifications: 8 data bits; no parity; 1 stop bit; no handshaking.
- The communication protocol used is based on the “MeCom Protocol Specification 5117x” document.
- Our demo applications and APIs can help you implement this specification. Please also check the example communication strings at the end of this document.
    - The **MeComAPI** (with demo application) shows the full implementation of this protocol for C and C++ applications. Tested on Windows, Linux, and microcontrollers.
    - The **MeComAPI for .NET** (with demo application) is a C# based library that enables communication over RS232/RS485, direct FTDI driver access or Ethernet.
    - The **MeCom Command Tool** is a web app to easily generate MeCom command strings.
    - We also provide **Python** and **LabVIEW** examples. These are not directly compatible with the LDD-1321 as they feature parameters of other devices, but they feature the same communication protocol.

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 can be added to the configured address 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 to 0, but the device does not send an answer back to the host. This can for example be used to change the serial speed on all devices connected to the bus.

1.3 Connecting the Configuration Software

- By default, the Configuration 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 Configuration Software on each interface (USB, RS232 TTL, RS485).
- If the Base Baud Rate has been changed to a different value, it is possible to change the Configuration 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:
    - … .exe /Ftdi -LowSpeed=115200
      Sets the initial speed to a certain Baud Rate. By default, this value is 57600.
    - … .exe /Ftdi -HighSpeed=921600
      Sets the high-speed value to a certain Baud Rate. By default, this value is 1000000.
    - … .exe /Ftdi -Speed=115200
      Changes both the Connecting Speed and the High Speed Rate to a certain Baud Rate.
    - … .exe /Ethernet -IP=192.168.1.191 /Connection -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

1.3.1 All Startup Arguments

Please review the settings of the "Connection Criteria" window of the Configuration Software first.
Use it like this: `.exe /Connection -DevAddr=7 -DevSerialNr=10568 /Ftdi -Speed=115200`

Main Command	Argument	Description
/Connection	-DevAddr=X	Sets the Device Address criteria to X. X can be a value from 0 to 255
	-DevSerialNr=X	Sets the Device Serial Number criteria to X.
/Ftdi	-SerialNr=X	Only connects to a device with the given FTDI Chip Serial Number like DK0FPV09. This value is shown in the "Connection Criteria" window.
	-LowSpeed=X	Sets the Connection Speed to X. X can be 4800 … 1000000
	-HighSpeed=X	Sets the High Speed Rate to X. X can be 4800 … 1000000
	-Speed=X	Same as LowSpeed and HighSpeed. Sets both values to the same value.
/Ethernet	-IP=X	Switches to "Use Ethernet (TCP) Connection". Pass the IP like 192.168.234.88
	-Port=X	If not specified, it uses the TCP/IP port 50000.
/Serial	-Name=X	Like COM1
	-LowSpeed=X	Sets the Connection Speed to X. X can be 4800 … 1000000. Default is 57600
	-HighSpeed=X	Sets the High Speed Rate to X. X can be 4800 … 1000000. Default is 921600
	-Speed=X	Same as LowSpeed and HighSpeed. Sets both values to the same value.

1.4 Interfaces, Baud Rate

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

	LDD-1321
Interface 1	USB UART MODE 3
Interface 2	RS485 UART MODE 2
Interface 3	RS232 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 7s. Always compatible with the Configuration 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 7s. Compatible with the Configuration Software only 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 7s. A secondary UART is always listening on this interface with 57600 and therefore it is always compatible with the Configuration Software.

1.5 Flash Parameters (non-volatile) / RAM Parameters (volatile)

This device does not save any parameters automatically to the flash (nonvolatile memory). If the parameters should be saved to the nonvolatile memory, send the “Save Parameter to Flash” command. This command is described in the Document “MeCom Protocol Specification 5117”.

The Configuration Software automatically sends the save command after performing a “Write Config” action.

The flash can only be rewritten about 100'000 times. Therefore, we recommend avoiding periodic “Save Parameter to Flash” commands. Only send this command when needed.

2 LDD-1321 Commands

2.1 Set Commands

Only the device-specific commands are listed here. The standard device-agnostic commands (like reset and value set) are specified in the document 5117.

Command	Mnemonic	Arguments			
		Type	Min	Max	Description
Change Speed	CS	INT32	4800	1M	Changes the speed of the communication interface where this command was received. If no communication is detected on the interface for more than 7s, the speed is changed back to the Base Baud Rate. The address is ignored when detecting communication on the interface, just a valid package frame is necessary.

2.2 Query Commands

Only the device-specific commands are listed here. The standard commands are specified in document 5117.

The firmware identification string of LDD-1321 devices is: "`8157-LDD-AN-LIN  G01`" (20 chars).

Request	Mnemonic	Description	Server Response	
			Type	**Description**
Bootloader Control	?BC	Control the bootloader	UINT32	See 4 Bootloader for details
Bootloader Stream	?BS	Bootloader data stream		See 4 Bootloader for details
Settings Download	?SD	Can be used to load the exported Settings Dump (*.mepar) of the Service Software. (The Configuration Software does currently not support this feature)		
		One line of the settings dump File (*.mepar)	UINT4	0: Parameter accepted 1: CRC incorrect. 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.

3 Configuration Software Parameters

3.1 Payload Format Description

See document 5117 for more information about the MeCom protocol.

The parameter instance is used to control multiple instances of the same feature, if available on a device. If a feature is present only once, it will be controlled through instance 1. For example, the LDD-1321 has a single current drive channel, so the target current only has one instance.

3.2 Parameter List

3.2.1 Common Product Parameters

3.2.1.1 Device Identification

ID	Name	Format	Unit/Range	Description
100	Device Type	INT32		E.g. 1321 → LDD-1321
101	Hardware Version	INT32		E.g. 123 → 1.23
102	Serial Number	INT32		
103	Firmware Version	INT32		E.g. 123 → 1.23
104	Device Status	INT32		0: Init 1: Ready 2: Run 3: Error 4: Bootloader 5: Device will reset within next 200 ms
105	Error Number	INT32		
106	Error Instance	INT32		
107	Error Parameter	INT32		
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 during this process).
110	Error Text	LATIN1		Use the ?VB command to query the error text.
111	Device Reset	INT32	0 … 1	Write 1 to this parameter to trigger a reset.
112	Firmware Version	FLOAT32		Same as parameter 103, but as float. Round it to two decimal places.
115	Random Startup Value	INT32	..	Random value, which gets updated at each system start. Might be used to detect an unexpected reboot.

Hint: parameters 100-999 are read-only.

3.2.2 General

3.2.2.1 LDD Channel Source Selection

ID	Name	Format	Unit/Range	Description
2101	Nominal Output Current	INT32	..	0: Set Current 1: Analog Voltage Input 2: Light Power Control 3: Lookup Table 4: Signal Generator

3.2.2.2 TEC Channel Source Selection

ID	Name	Format	Unit/Range	Description
6300	Object Source Selection	INT32	..	0: External 1 1: External 2 2: Device (LDD) 3: Device (TEC)
6320	Sink Source Selection	INT32	..	0: External 1 1: External 2 2: Device (LDD) 3: Device (TEC) 4: Fixed
6321	Fixed Temperature	FLOAT32	-273 °C … 1000 °C	

3.2.2.3 Fan Channel Source Selection

ID	Name	Format	Unit/Range	Description
6210	Actual Temperature Source	INT32	..	0: External 1 1: External 2 2: Device (LDD) 3: Device (TEC)

3.2.3 System

3.2.3.1 System Parameters

ID	Name	Format	Unit/Range	Description
1051	Firmware Build Number	INT32		
1054	Min Version for Firmware Downgrade	INT32		123 → 1.23
1067	Unique ID	LATIN1		This is the UniqueID of the processor on the device.

3.2.3.2 TEC Driver Hardware Info

These parameters read 0 or empty if no or no compatible TEC-Controller is detected.

ID	Name	Format	Unit/Range	Description
120	Device Type	INT32		E.g. 1191 → PWR-1191
121	Hardware Version	INT32		E.g. 123 → 1.23
122	Serial Number	INT32		
263	Unique ID	LATIN1		This is the UniqueID of the TEC Controller
123	Maximum Current	FLOAT32	A	Maximum Output Current of TEC Controller

3.2.3.3 Supplies

ID	Name	Format	Unit/Range	Description
1060	Driver Input Voltage	FLOAT32	V	
1061	8V Internal Supply	FLOAT32	V	
1062	5V Internal Supply	FLOAT32	V	
1063	3.3V Internal Supply	FLOAT32	V	
1064	−3.3V Internal Supply	FLOAT32	V	

3.2.3.4 Device Temperature Management

ID	Name	Format	Unit/Range	Description
1065	Device Temperature	FLOAT32	°C	
1066	Powerstage Temperature	FLOAT32	°C	Instance 1: LDD Device Temperature Instance 2: TEC Device Temperature

3.2.3.5 System Counters

ID	Name	Format	Unit/Range	Description
1080	Operating time		s	
1081	Operating time running		s	

3.2.3.6 LDD Internal Parameters

ID	Name	Format	Unit/Range	Description
1404	Gate Voltage	FLOAT32	V	
1102	Actual Output Current Raw ADC Value	INT32		
1103	Raw DAC Value	INT32		
1502	Analog Voltage Input Raw ADC Value	INT32		
1601	Light Power Controller Output Level	FLOAT32	%	

3.2.4 Laser Current Control

3.2.4.1 Nominal Output Current

ID	Name	Format	Unit/Range	Description
2102	Target Current	FLOAT32	A	

3.2.4.2 Nominal Current Limits

ID	Name	Format	Unit/Range	Description
2122	Max Nominal Current	FLOAT32	A	
2123	Min Nominal Current	FLOAT32	A	

3.2.4.3 LDD Nominal Current Ramp

ID	Name	Format	Unit/Range	Description
2113	Slope Limit	FLOAT32	A/s	

3.2.4.4 Nominal Current Output

ID	Name	Format	Unit/Range	Description
1402	Nominal Output Current (Ramp)	FLOAT32	A	

3.2.4.5 Laser Output

ID	Name	Format	Unit/Range	Description
2100	Output Enable	INT32		0: OFF 1: ON

3.2.4.6 Output Stage Limits

ID	Name	Format	Unit/Range	Description
2120	Current Error Threshold	FLOAT32	A	
2121	Voltage Error Threshold	FLOAT32	V	

3.2.4.7 Anode Voltage Settings

ID	Name	Format	Unit/Range	Description
2131	Laser Forward Voltage	FLOAT32	V	
2132	Laser Diff. Resistance	FLOAT32	Ω	

3.2.4.8 Anode Voltage Supply

ID	Name	Format	Unit/Range	Description
2130	Supply Enable	INT32		0: OFF 1: ON

3.2.4.9 Output Monitoring

ID	Name	Format	Unit/Range	Description
1106	Nominal Anode Voltage	FLOAT32	V	
1104	Actual Anode Voltage	FLOAT32	V	
1105	Actual Cathode Voltage	FLOAT32	V	
1100	Actual Output Current	FLOAT32	A	
1101	Actual Output Voltage	FLOAT32	V	

3.2.5 Light Power Control

3.2.5.1 Nominal Power Limits

ID	Name	Format	Unit/Range	Description
3121	Max Nominal Power	FLOAT32	W	
3122	Min Nominal Power	FLOAT32	W	

3.2.5.2 Nominal Output Power

ID	Name	Format	Unit/Range	Description
3101	Set Power	FLOAT32	W	

3.2.5.3 Power Controller PID Values

ID	Name	Format	Unit/Range	Description
3110	Kp	FLOAT32	A/W	
3111	Ti	FLOAT32	s	
3112	Td	FLOAT32	s	
3113	Slope Limit	FLOAT32	W/s	

3.2.5.4 Monitor

ID	Name	Format	Unit/Range	Description
1602	Nominal Current	FLOAT32	A	

3.2.6 Lookup Table

3.2.6.1 Lookup Table Download

ID	Name	Format	Unit/Range	Description
3200	Lookup Table	Big Data FLOAT32		Limited to 1000 samples (parameter updated by download widget)

3.2.6.2 Lookup Table Settings

ID	Name	Format	Unit/Range	Description
3201	Loop Enable	INT32	0 … 1	0: loop disabled 1: loop enabled
3202	Interval	INT32	≥ 1 cycle*	

*1 cycle = 0.64 ms

3.2.6.3 Monitor

ID	Name	Format	Unit/Range	Description
3210	Nominal Current	FLOAT32	A	

3.2.7 Signal Generator

3.2.7.1 Common Waveform Settings

ID	Name	Format	Unit/Range	Description
3300	Wave Function	INT32	0 … 3	0: Custom 1: Sine 2: Square 3: Triangle
3301	Current High	FLOAT32	A	
3302	Current Low	FLOAT32	A	

3.2.7.2 Custom Waveform Settings

ID	Name	Format	Unit/Range	Description
3303	Rise Time	INT32	≥ 0 cycles*	
3304	Fall Time	INT32	≥ 0 cycles*	
3305	High Time	INT32	≥ 5 cycles*	
3306	Low Time	INT32	≥ 5 cycles*	

*1 custom waveform cycle = 0.64 ms

3.2.7.3 Preset Waveform Settings

ID	Name	Format	Unit/Range	Description
3307	Signal Period Time	INT32	≥ 5 cycle*	

*1 preset waveform cycle = 2.56 ms

3.2.7.4 Monitor

ID	Name	Format	Unit/Range	Description
3310	Nominal Current	FLOAT32	A	

3.2.8 Analog Voltage Input

3.2.8.1 Monitor

ID	Name	Format	Unit/Range	Description
1500	Analog Voltage Input	FLOAT32	V	
1510	Nominal Current	FLOAT32	A	

3.2.8.2 User Settings

ID	Name	Format	Unit/Range	Description
7013	Current Factor	FLOAT32	A/V	This factor sets the scale when the analog input is used as source for the laser current setpoint.

3.2.8.3 User Calibration

ID	Name	Format	Unit/Range	Description
7011	Offset	FLOAT32	V	
7012	Gain	FLOAT32	V/V	

3.2.8.4 Hardware Calibration

ID	Name	Format	Unit/Range	Description
9001	Offset	FLOAT32	V	
9002	Gain	FLOAT32	V/V	

3.2.9 Photodiode Input

3.2.9.1 Monitor

ID	Name	Format	Unit/Range	Description
1501	Photodiode Input	FLOAT32	A	
1600	Light Power	FLOAT32	W	

3.2.9.2 User Settings

ID	Name	Format	Unit/Range	Description
7010	Laser Power System Scale	FLOAT32	V/A	

3.2.9.3 Hardware Settings

ID	Name	Format	Unit/Range	Description
9000	Photodiode Rs	FLOAT32	Ω	

3.2.10 LDD Measurement Calibration

3.2.10.1 Current Measurement User Calibration

ID	Name	Format	Unit/Range	Description
8000	Offset	FLOAT32	A	
8001	Gain	FLOAT32	A/A	

3.2.10.2 Current Set User Calibration

ID	Name	Format	Unit/Range	Description
8002	Offset	FLOAT32	A	
8003	Gain	FLOAT32	A/A	

3.2.10.3 Current Measurement Hardware Calibration

ID	Name	Format	Unit/Range	Description
8004	Offset	FLOAT32	A	
8005	Gain	FLOAT32	A/A	

3.2.10.4 Current Set Hardware Calibration

ID	Name	Format	Unit/Range	Description
8006	Offset	FLOAT32	A	
8007	Gain	FLOAT32	A/A	

3.2.10.5 VLDA Set Hardware Calibration

ID	Name	Format	Unit/Range	Description
8008	Offset	FLOAT32	V	
8009	Gain	FLOAT32	V/V	

3.2.11 Temperature Controller

3.2.11.1 Main Input Temperatures

ID	Name	Format	Unit/Range	Description
4000	Target Object Temp	FLOAT32	−273 °C … 1000 °C	
1000	Object Temperature	FLOAT32	°C	
1001	Sink Temperature	FLOAT32	°C	

3.2.11.2 Nominal Temperature Ramp

ID	Name	Format	Unit/Range	Description
4003	Coarse Temp Ramp	FLOAT32	1E−6 °C/s … 50 °C/s	
4002	Proximity Width	FLOAT32	0°C … 200°C	
4004	Ramp Start Point	INT32	0 … 1	0: On a new Target Value, the actually measured Temperature is taken as Start Temperature. This is the default behaviour. 1: On a new Target Value, the current Target Temperature is taken as Start Temperature
1011	(Ramp) Nominal Object Temperature	FLOAT32	°C	

3.2.11.3 Peltier, Heat/Cool Only Boundaries

ID	Name	Format	Unit/Range	Description
4051	Upper Boundary	FLOAT32	-273 °C … 1000 °C	
4050	Lower Boundary	FLOAT32	-273 °C … 1000 °C	

3.2.11.4 Temperature Control

ID	Name	Format	Unit/Range	Description
4010	Kp	FLOAT32	0 %/°C … 10000 %/°C	
4011	Ti	FLOAT32	0 … 10000 s	0s disables the integral term
4012	Td	FLOAT32	0 … 10000 s	
4013	D Part Damping PT1	FLOAT32	0 … 1	
1032	PID Control Variable	FLOAT32	%	

3.2.11.5 Thermal Model

ID	Name	Format	Unit/Range	Description
4020	Mode	INT32	0 … 2	0: Peltier, Full Control 1: Peltier, Heat/Cool Only 2: Resistor, Heat Only

3.2.11.6 Thermal Model Mode: Peltier, Full Control or Peltier, Heat/Cool Only

ID	Name	Format	Unit/Range	Description
4032	Positive Current is	INT32	0 … 1	0: Cooling 1: Heating
4030	Maximum Current Imax	FLOAT32	0.1A … 1000A	From the Peltier Datasheet
4031	Delta Temperature dTmax	FLOAT32	1°C … 200°C	From the Peltier Datasheet

3.2.11.7 Thermal Model Mode: Resistor, Heat Only

ID	Name	Format	Unit/Range	Description
4040	Resistance	FLOAT32	0.001 Ω … 10 kΩ	
4041	Maximum Current	FLOAT32	0.01 A … 1000 A	

3.2.11.8 Thermal Model Outputs

ID	Name	Format	Unit/Range	Description
1012	Thermal Power Model Current	FLOAT32	A	
1030	PID Lower Limitation	FLOAT32	%	
1031	PID Upper Limitation	FLOAT32	%	

3.2.11.9 Stability Indicator

ID	Name	Format	Unit/Range	Description
4060	Temperature Deviation	INT32	0°C … 50°C	
4061	Min Time in Window	INT32	0 s … 86400 s	
4062	Max Stabilization Time	INT32	0 s … 86400 s	
1050	Temperature is Stable	INT32	0 … 2	Temperature control is 0: not active 1: not stable 2: stable

3.2.11.10 TEC Output Stage

ID	Name	Format	Unit/Range	Description
2000	Output Enable	INT32	0 … 1	0: OFF 1: ON

3.2.11.11 TEC Driver Output Stage Monitoring

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

3.2.11.12 TEC Output Stage Input Selection

ID	Name	Format	Unit/Range	Description
2010	Input Selection	INT32	..	0: Current/Voltage (uses the 'Fixed Current/Voltage' parameters) 1: Temperature Controller

3.2.11.13 TEC Output Stage 'Fixed Current/Voltage' Control Values

ID	Name	Format	Unit/Range	Description
2020	Set Current	FLOAT32	−4 … 4 A	
2021	Set Voltage	FLOAT32	0 … 21 V	

3.2.11.14 TEC Output Stage Limits

ID	Name	Format	Unit/Range	Description
2030	Current Limitation	FLOAT32	See parameter ID 2020	
2031	Voltage Limitation	FLOAT32	See parameter ID 2021	
2032	Current Error Threshold	FLOAT32	0 … 5.6 A	
2033	Voltage Error Threshold	FLOAT32	0 … 24 V	

3.2.12 TEC Auto Tuning

The following parameters are volatile parameters.

3.2.12.1 Status

ID	Name	Format	Unit/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.
51020	Tuning Status	FLOAT32 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%	

3.2.12.2 Tuning Results

3.2.12.2.1 Results for PID Controller

ID	Name	Format	Unit/Range	Description
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.

3.2.12.2.2 Results for PI Controller

ID	Name	Format	Unit/Range	Description
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.

3.2.12.2.3 Nominal Temperature Ramping Recommendation

ID	Name	Format	Unit/Range	Description
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.

3.2.12.2.4 PID D Part Damping PT1 Recommendation

ID	Name	Format	Unit/Range	Description
51024	PID D Part Damping PT1 Recommendation	FLOAT32 Read Only	..	Returns a recommendation value for the PID D Part Damping.

3.2.12.2.5 Raw Auto Tuning Results

ID	Name	Format	Unit/Range	Description
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.

3.2.13 External Temperature

3.2.13.1 Analog Digital Converter

3.2.13.1.1 Calibration

ID	Name	Format	Unit/Range	Description
5100	ADC Calibration Offset	FLOAT32		
5101	ADC Calibration Gain	FLOAT32		

3.2.13.1.2 ADC Output

ID	Name	Format	Unit/Range	Description
1202	Raw ADC Value	FLOAT32		
1201	Resistance	FLOAT32	Ω	

3.2.13.2 Temperature Conversion

3.2.13.2.1 NTC Sensor Characteristics

ID	Name	Format	Unit/Range	Description
5020	Lower Point: Temperature	FLOAT32		
5021	Lower Point: Resistance	FLOAT32		
5022	Middle Point: Temperature	FLOAT32		
5023	Middle Point: Resistance	FLOAT32		
5024	Upper Point: Temperature	FLOAT32		
5025	Upper Point: Resistance	FLOAT32		

3.2.13.2.2 Temperature Calibration

ID	Name	Format	Unit/Range	Description
5001	Temperature Offset	FLOAT32	°C	
5002	Temperature Gain	FLOAT32	°C/°C	

3.2.13.2.3 Conversion Output

ID	Name	Format	Unit/Range	Description
1200	Temperature	FLOAT32	°C	

3.2.13.3 Measurement Limits

ID	Name	Format	Unit/Range	Description
5040	Lowest Resistance	FLOAT32	Ω	
5041	Highest Resistance	FLOAT32	Ω	
5042	Temperature at Lower Resistance	FLOAT32	°C	
5043	Temperature at Highest Resistance	FLOAT32	°C	

3.2.13.4 Surveillance

ID	Name	Format	Unit/Range	Description
5030	ADC Limit Errors	INT32		0: None 1: Upper Only 2: Lower Only 3: Both
5031	Temperature Limit Errors	INT32		0: None 1: Upper Only 2: Lower Only 3: Both
5011	Upper Error Threshold	FLOAT32	°C	
5010	Lower Error Threshold	FLOAT32	°C	

3.2.14 Fan

ID	Name	Format	Unit/Range	Description
6200	Fan Control Enable	INT32		0: Disabled 1: Enabled

3.2.14.1 Fan General Settings

ID	Name	Format	Unit/Range	Description
6230	Fan PWM Frequency	INT32		0: 25 kHz 1: 1 kHz

3.2.14.2 Fan Temperature Cooler

ID	Name	Format	Unit/Range	Description
6211	Target Temperature	FLOAT32	−273 °C … 1000 °C	
6212	Kp	FLOAT32	0 %/°C … 10000 %/°C	Temperature Controller
6213	Ti	FLOAT32	100 us … 10000 s	Temperature Controller, 0 s disables the integral term
6214	Td	FLOAT32	0 s … 10000 s	Temperature Controller

3.2.14.3 Fan Speed Controller

ID	Name	Format	Unit/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	100 us … 10000 s	Speed Controller 0 s disables the integral term
6224	Td	FLOAT32	0 s … 10000 s	Speed Controller
6225	Bypassing Speed Controller	INT32		0: No 1: Yes
6226	Fan Surveillance	INT32		0: Enabled 1: Disabled

3.2.14.4 Fan Controller Monitoring

ID	Name	Format	Unit/Range	Description
1210	Relative Cooling Power	FLOAT32	%	
1211	Nominal Fan Speed	FLOAT32	rpm	
1212	Actual Fan Speed	FLOAT32	rpm	
1213	Fan PWM Level	FLOAT32	%	

3.2.15 Communication

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

3.2.15.1 UART Interface Settings

ID	Name	Format	Unit/Range	Description
2050	Base Baud Rate	INT32	4800 … 1M	Instance 1 = Interface 1 etc.
2052	Response Delay	INT32	0 … 1E6 µs	Instance 1 = Interface 1 etc.

3.2.15.2 Communication Watchdog

ID	Name	Format	Unit/Range	Description
2060	Timeout	FLOAT32	0; 0.1 … 60s	0: Disable the watchdog

3.2.15.3 CANopen Interface

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

3.2.16 I/O

3.2.16.1 GPIO Configuration

The instance number corresponds to the GPIO number.

ID	Name	Format	Unit/Range	Description
6100	GPIO Function	INT32		0: No Function 1: Signal Control (see 3.2.19) 2: LDD OK (1 when Ready or Running) 3: LDD HW Enable 4: TEC HW Enable 5: LDD Toggle HW Enable 6: TEC Toggle HW Enable 7: Pulse Input 8: LDD Run 9: TEC Stable 10: TEC Ramp / Stable 11: TEC Ramp 12: Fan PWM 13: Fan Tacho 14: Fan Stop 15: Pump 16: Dev Addr +1 (Device Address) 17: Dev Addr +2 (Device Address) 18: Dev Addr +4 (Device Address) 19: TEC Alt Target T1 20: TEC Alt Target T2 21: TEC Power Stage 0 A 22: Fix 0 23: LDD HW Enable (edge) 24: TEC HW Enable (edge)
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

3.2.16.2 Pump Control

ID	Name	Format	Unit/Range	Description
6120	Actual Temperature Source	INT32		0: External 1 1: External 2 2: Device (LDD) 3: Device (TEC)
6121	ON Threshold	FLOAT32	−273 °C … 1000 °C	
6122	OFF Threshold	FLOAT32	−273 °C … 1000 °C	

3.2.16.3 Alternative TEC Target Temperature over GPIO Pin

ID	Name	Format	Unit/Range	Description
6133	Temperature 0	FLOAT32	−273 °C … 1000 °C	
6130	Temperature 1	FLOAT32	−273 °C … 1000 °C	
6131	Temperature 2	FLOAT32	−273 °C … 1000 °C	
6132	Temperature 3	FLOAT32	−273 °C … 1000 °C	

3.2.17 Advanced Misc Settings

3.2.17.1 LDD Reset Behavior

ID	Name	Format	Unit/Range	Description
2140	Always off after Reset	INT32		0: Disabled, LDD Output Enable remains unchanged 1: Enabled, LDD Output Enable is turned off after every reset

3.2.17.2 TEC Output Stage Controller Limit (Error 208)

ID	Name	Format	Unit/Range	Description
6330	Error Delay	INT32	-1 … 20000000 ms	-1: fully disable the Error 208 (not recommended) 0: set the delay to 1ms automatically

3.2.17.3 Error State Auto Reset Delay

ID	Name	Format	Unit/Range	Description
6310	Delay until Reset	FLOAT32	0 s … 86400 s	0: No Auto Reset Cannot trigger 20 seconds after a reset to avoid boot loops In case of an interlock error the delay time only starts to elapse once the interlock has been released again

3.2.18 License

3.2.18.1 License Key

ID	Name	Format	Unit/Range	Description
54000	Feature Key Store	LATIN1	0 … 256 Elements	
54001	Feature Key Status	INT32		0: Empty 1: Valid 2: Wrong structure 3: HMAC fail 4: Header fail 5: Device type wrong 6: Unique ID wrong

3.2.18.2 Light Power Control – Feature Status

ID	Name	Format	Unit/Range	Description
54010	LPC Feature Status	INT32		0: Locked 1: Trial 2: Extended Trial 3: Fully Enabled
54011	LPC Feature Trial From Time	INT32	s	
54012	LPC Feature Trial To Time	INT32	s	

3.2.19 GPIO Signal Control

The following parameters are volatile parameters.

This feature can be used to control the GPIO signals.
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 (sets bit #2 to '1')
Set ID 52101 to 12 (sets bits #2 and #3 to '1')
Set ID 52100 to 1 (enables the function)

Bit Field Description

Bit Number	Output Signal
0	GPIO1
⋮	⋮
10	GPIO2

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

ID	Name	Format	Unit/Range	Description
52100	Enable Function	INT32	0 … 1	Enable the output signal control function.
52101	Set Output to Push-Pull	INT32	0 … 1023	If a bit is set to 0, the output signal is at high impedance (set as input). If a bit is set to 1, the output signal is driven.
52102	Set Output States	INT32	0 … 1023	Set the output states of driven signals.
52103	Read Input States	INT32	0 … 1023	Read back the (input) states of all signals.

4 Bootloader

- The firmware can be downloaded using all (not CANopen) communication interfaces.
- The Bootloader can be controlled with the Control and Stream commands.
- The whole new firmware will be cached and verified onboard, before the old firmware gets erased.
- Do not interrupt the power after the ReBoot command, until the device answers 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 interrupted after the ReBoot command, no irreversible errors are possible.

It's necessary to use the correct command sequence:

1. Activate the bootloader using the **BootloaderActivate** command.
2. Query the status using **NoOperation** and wait until it reports the "activated" status.
3. Clear the update memory using the **ClearMemory** command**.**
4. Query the status using **NoOperation** and wait until it reports the "memory is cleared" status.
5. Send the whole *.hex* file using the Bootloader Stream command.
6. Query the status using **NoOperation** and wait until it reports the "valid application" status.
7. Start replacing the running application by sending the **ReBoot** command. Attention:
    a. The device will typically not answer your queries for 10s (it 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 firmware is already running. If the device is answering your queries again, the critical process has ended.
8. Verify if the firmware version is as expected.

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 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: firmware update limit reached. The downloaded file contains a firmware that is too old for the device.
12	0x1000	Error: 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 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 512 Bytes.

It is recommended to send 10 hex file lines in one package. This will not exceed the 512 Byte limit.

4.2.2 Bootloader Status

See 4.1.2 Bootloader Status.

5 Example Communication Strings

- 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 an ASCII <CR> (Carriage Return, 0x0D).
- The Checksum is calculated using the CRC16/XMODEM algorithm over the previous frame data as ASCII String.
- All the Frame data is colored to better understand what is going on:
  - Control
  - Address (using address 0, the device will always answer independently from its address.)
  - Sequence Number
  - Payload / Other Payload
  - Checksum

Get firmware identification string (note: example from another device, see Chapter 2.2 for the relevant firmware identification string)

```
OUT: #001EF8?IFF1E4
IN:  !001EF88144-LDD-130X G1     CED8
```

→ Result: “8144-LDD-130X G1 “

Get device type (using parameter Value Read)

Parameter ID: 100 (0x0064); Instance 1

```
OUT: #000F24?VR0064012B1A
IN:  !000F2400000517EABE
```

→ Result: 0x00000517 → 1303

Get serial number (using parameter Value Read)

Parameter ID: 102 (0x0066); Instance 1

```
OUT: #0015AC?VR0066018125
IN:  !0015AC00000706F2C
```

→ Result: 0x00000070 → Interpreted as an INT32: decimal value 112

Querying a non-available parameter ID (using parameter Value Read)

Parameter ID: 1234 (0x04D2); Instance 1

```
OUT: #0015AC?VR04D2017BFE
IN:  !0015AC+0532DA
```

→ As a result, we get the Server Error Code 0x05 which means that this parameter is not available.

You can use the tool: http://www.h-schmidt.net/FloatConverter/ for tests involving FLOAT32 parameters. Usually, microcontrollers support float according to IEEE754 by Hardware or Software FPU.

6 CANopen

Supported Features:

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

General Information:

- The CAN ID and Bitrate can be set using the Configuration 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.
- Except 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 Configuration 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.

6.1.3 Store Parameter

- Only “Save all Parameters” is available.
- Saves the following CANopen parameters from the Communication Segment:
    - 0x1005 – COB-ID SYNC
    - 0x1015 – Inhibit Time Emergency
    - 0x1017 – Producer Heartbeat Time
    - 0x1400 – Receive PDO Communication Parameters
    - 0x1600 – Receive PDO Mapping Parameters
    - 0x1800 – Transmit PDO Communication Parameters
    - 0x1A00 – Transmit PDO Mapping Parameters
- Saves all Manufacturer Segment parameters, except for the Monitor parameters.

6.1.4 Restore Default Parameters

- Only “Restore all Default Parameters” is available.
- Restores only the CANopen Communication Segment parameters to its default value, not the Manufacturer Parameters.

A Change History

Date of change	Version	Changed/ Approved	Change / Reason
2023-06-14	A	RS / HS	• First edition
2023-09-15	B	RS, HS / RS	• Add parameters related to PWR-1191, analog input
2023-09-26		SC / RS	• Add parameters related to LPC
2023-11-01		SC / RS	• Add parameters related to LUT
2023-12-13		SC / HS	• Add signal generator parameters
2024-01-24		RS / HS	• Mod: 1.5 Flash Parameters (nonvolatile) / RAM Parameters (volatile) • Add: CANopen NonVolatile Parameters • Del: Par 108: Disable save to flash • Mod: Par 109: Delete status “Save to flash disabled” • Add: Par 110: Error Text • Add: Par 111: Device Reset • Add: Par 112: Firmware Version as FLOAT32 • Add: CANopen Chapter
2024-06-25	C	SC / RS	• Mod: extended auto reset description • Mod: GPIO function list updated • Del: volatile source parameters (3100, 50000, 50001, 50022) • Mod: source selection parameters (2100, 2101) • Add: LPC output level parameter (1601)
2025-03-18	D	SC / MLO	• Del: “static” terminology • Del: GPIO Output Enable option • Fix: communication watchdog range • Fix: GPIO signal control range • Mod: reduced number of GPIO channels to 2 • Add: description about auto reset on interlock error • Add: Reset behavior

Date of change	Version	Changed/ Approved	Change / Reason
2026-02-23	E	SC / SR	• Add: Par 115: Random Startup Value • Add: Par 1067 & 263: LDD & TEC Unique ID • Add: System Counters • Add: Feature Licenses • Mod: Ramp Start Point parameter is now non-volatile. Changed ID from 50010 to 4004. • Bug: UART Mode: Fall back time changed from 5s to 7s (documentation was wrong) • Del: Par 6340: Disable on LDD Error • Mod: Par 2102: Set Current renamed to Target Current and now linked to the selected source • Mod: Separate LDD and TEC device temperature source for parameter 6300 and 6320 (object/sink input source) • Add: nominal current monitor parameter for every input source: Par 1510, 1602, 3210 and 3310 • Del: Par 1010: Target Object Temperature (Monitor) • Add: Par 6133: Alternative Target Temperature over GPIO Pin: Temperature 0