Communication Protocol Laser Diode Driver

LDD-Family
(LDD-1121, LDD-1124, LDD-1125)

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

- The used communication protocol is based on the “MeCom Protocol Specification” Document me5117B.
- The Control Interface has to use the ‘#’ as source identifier.
- There are some Domo Applications which 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
    - The LDD-TEC-Sample Application shows only the Query Strings for getting the Service Software Parameters.

1.2 Interfaces, Baud Rate and Address

- Interface RS485 Channel 1:
    - Default baud rate is 57600. This can be changed to an other value by using the corresponding command. The new baud rate will be saved to the non volatile memory.
    - The Default Address is 1. It is possible to use 255 as broadcast.
- Interface USB:
    - All commands are also accessible through the USB Interface.
    - The baud rate is fixed to 57600. (Could be changed by an not published command)
    - Address is like RS485. Additional the address 0 is also used as broadcast.

2 LDD-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.
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. 1121, 1124, 1125) 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**
Device Identification	?IF	Returns the device Info string	20x 8bit	For LDD: `8063-LDD SW G01`
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	UINT 32	See 4 Bootloader for Details
Bootloader Stream	?BS	Bootloader Data Stream		See 4 Bootloader for Details
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.

3 Service Software Parameters

3.1 Payload Format description

The Parameter Instance is used to control multiple instances (not available on LDD. Instance = 1)
If there is only one Instance available, 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	0: Float 1: Integer Or Server Error Code	<defined Format> Parameter Min Value	<defined Format> Parameter Max Value

3.2 Parameter list

This capture contains all parameters which can also be accessed by the service software. The order is the same as in the service software.

3.2.1 Common Product Parameters

3.2.1.1 Device Identification

ID	Name	Format	Value Range	Description
100	Device Type	INT32	..	1121 → LDD-1121
101	Hardware Version	INT32	..	123 → 1.23
102	Serial Number	INT32	..	
103	Firmware Version	INT32	..	123 → 1.23
104	Device Status	INT32	0 … 5	0: Init 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 … 1	0: Enabled 1: Disabled (All Parameters can then be used as RAM Parameters)
109	Parameter System: Flash Status	INT32	0 … 1	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.

3.2.2 Tab: Monitor (Read only)

3.2.2.1 Firmware and Hardware Versions

ID	Name	Format	Value Range	Description
1000	Device Type	INT32	..	1121 → LDD-1121
1001	Serial Number	INT32	..	
1002	Hardware Version	INT32	..	123 → 1.23
1003	Firmware Version [STM32]	INT32	..	123 → 1.23
1004	Firmware Build Number	INT32	..	
1005	FPGA Version	INT32	..	123 → 1.23

3.2.2.2 Laser Diode Values

ID	Name	Format	Value Range	Description
1016	Laser Diode Current	FLOAT32	A	
1017	Laser Diode Voltage	FLOAT32	V	
1015	Laser Diode Temperature	FLOAT32	℃	

3.2.2.3 Laser Light Values

ID	Name	Format	Value Range	Description
1060	Photo Diode Current	FLOAT32	A	
1061	Laser Power	FLOAT32	W	

3.2.2.4 Laser Diode Values (Details)

ID	Name	Format	Value Range	Description
1011	Laser Diode Current CW	FLOAT32	A	Averaged over 100ms
1010	Laser Diode Current Actual	FLOAT32	A	
1013	Laser Diode Voltage Actual	FLOAT32	V	
1012	Laser Diode Current Pulse	FLOAT32	A	Last Pulse Current
1014	Laser Diode Voltage Pulse	FLOAT32	V	

3.2.2.5 Power Supplies

ID	Name	Format	Value Range	Description
1020	Driver Input Voltage	FLOAT32	V	
1021	10V Internal Supply	FLOAT32	V	
1022	3.3V Internal Supply	FLOAT32	V	
1023	1.2V Internal Supply	FLOAT32	V	

3.2.2.6 Error Status

ID	Name	Format	Value Range	Description
1030	Error Number	INT32	..	
1031	Error Instance	INT32	..	
1032	Error Parameter	INT32	..	

3.2.2.7 Driver Values

ID	Name	Format	Value Range	Description
1040	Buck Converter 1 Current	FLOAT32	A	
1041	Buck Converter 2 Current	FLOAT32	A	
1042	Buck Converter 3 Current	FLOAT32	A	
1043	Base Plate Temperature	FLOAT32	℃	

3.2.2.8 Driver Status

ID	Name	Format	Value Range	Description
1050	Driver Status	INT32	..	0: Init 1: Ready 2: Run 3: Error 4: Bootloader 5: Device will Reset
1051	Parameter System: Flash Status	INT32	0 … 1	0: All Parameters are saved to Flash 1: Save to flash pending or in progress. (Please do not power off the device now)

3.2.3 Tab: Operation Control

3.2.3.1 Current Settings

ID	Name	Format	Value Range	Description
2000	Input Source	INT32	0 … 4	0: Internal Generator 1: CW 2: Data Interfaces 3: HW Pin4 4: LPC (Light Control)
2001	Current CW	FLOAT32	LDD1121: 0 … 15A LDD1124: 0 … 1.5A LDD1125: 0 … 30A	
2002	Current High	FLOAT32	LDD1121: 0 … 15A LDD1124: 0 … 1.5A LDD1125: 0 … 30A	
2003	Current Low	FLOAT32	LDD1121: 0 … 15A LDD1124: 0 … 1.5A LDD1125: 0 … 30A	
2004	High Time	FLOAT32	1E-6 … 10s	Resolution: 10us
2005	Low Time	FLOAT32	1E-6 … 10s	Resolution: 10us
2006	Rise Time	FLOAT32	1E-6 … 10s	Resolution: 10us
2007	Fall Time	FLOAT32	1E-6 … 10s	Resolution: 10us
2008	Generator Trigger	INT32	0 … 1	0: OFF 1: HW Pin7

3.2.3.2 Pulse Settings

ID	Name	Format	Value Range	Description
2010	Input Source	INT32	0 … 3	0: OFF 1: Internal Generator 2: Data Interfaces 3: HW Pin8
2011	High Time	FLOAT32	10E-9 … 10s	Resolution: 10ns
2012	Low Time	FLOAT32	10E-9 … 10s	Resolution: 10ns

3.2.3.3 Enable Settings

ID	Name	Format	Value Range	Description
2020	Input Source	INT32	0 … 3	0: OFF 1: ON 2: Data Interfaces 3: HW Pin9

3.2.4 Tab: Laser Power Control

3.2.4.1 Laser Power (LP) Settings

ID	Name	Format	Value Range	Description
5000	Input Source	INT32	0 … 2	0: Internal Generator 1: CW 2: Data Interfaces
5001	LP CW	FLOAT32	0 … 1000W	
5002	LP High	FLOAT32	0 … 1000W	
5003	LP Low	FLOAT32	0 … 1000W	
5004	High Time	FLOAT32	1E-6 … 10s	Resolution: 10us
5005	Low Time	FLOAT32	1E-6 … 10s	Resolution: 10us
5006	Rise Time	FLOAT32	1E-6 … 10s	Resolution: 10us
5007	Fall Time	FLOAT32	1E-6 … 10s	Resolution: 10us

3.2.4.2 PID Laser Power Control Parameters

ID	Name	Format	Value Range	Description
5010	Kp	FLOAT32	1E-3 … 1000A/W	
5011	Ti	FLOAT32	1E-6 … 10s	
5012	Td	FLOAT32	0 … 10s	
5013	Slope Limit	FLOAT32	1E-6 … 1W/us	

3.2.4.3 Laser Power Control Soft-Start Configuration

ID	Name	Format	Value Range	Description
5020	Current Limiter Start Value	FLOAT32	LDD1121: 0 … 15A LDD1124: 0 … 1.5A LDD1125: 0 … 30A	
5021	Current Limiter Ramp	FLOAT32	1E-6 … 1A/us	

3.2.4.4 Laser Power (LP) Measurement Settings

ID	Name	Format	Value Range	Description
5030	LP System Scale	FLOAT32	0 … 1000A/W	

3.2.5 Tab: Settings

3.2.5.1 PID Current Control Parameter

ID	Name	Format	Value Range	Description
3000	Kp	FLOAT32	1E-3 … 1000%/A	
3001	Ti	FLOAT32	1E-6 … 10s	
3002	Td	FLOAT32	0 … 10s	

3.2.5.2 Analog Control

ID	Name	Format	Value Range	Description
3010	Current Factor	FLOAT32	0 … 100A/V	

3.2.5.3 Maximum Values

ID	Name	Format	Value Range	Description
3020	Current Limit Max [A]	FLOAT32	LDD1121: 0 … 15A LDD1124: 0 … 1.5A LDD1125: 0 … 30A	
3021	Current Limit Min [A]	FLOAT32	LDD1121: 0 … 15A LDD1124: 0 … 1.5A LDD1125: 0 … 30A	
3022	Max Current Error [A]	FLOAT32	LDD1121: 0 … 18.5A LDD1124: 0 … 1.85A LDD1125: 0 … 35A	
3023	Slope Limit [A/us]	FLOAT32	1E-6 … 1A/us	

3.2.5.4 Trigger Output Settings

ID	Name	Format	Value Range	Description
3080	Pulse Trigger Output	INT32	0 … 1	0: Disabled 1: HW Pin6

3.2.5.5 Communication

ID	Name	Format	Value Range	Description
3030	Communication Watchdog	FLOAT32	0 … 60s	0: Disabled Resolution: 0.1s

3.2.5.6 Device Address

ID	Name	Format	Value Range	Description
3040	Device Address	INT32	0 … 254	

3.2.5.7 RS485 Channel 1 Settings

ID	Name	Format	Value Range	Description
3050	Baud Rate	INT32	4800 … 1M Bits/s	
3051	Response Delay	INT32	0 … 1E6us	

3.2.5.8 Laser Diode Temperature Settings

ID	Name	Format	Value Range	Description
3060	Lower Error Threshold	FLOAT32	-20 … 120℃	
3061	Upper Error Threshold	FLOAT32	-20 … 120℃	

3.2.5.9 NTC Sensor Characteristic

ID	Name	Format	Value Range	Description
3070	Lower Point Temp.	FLOAT32	-273 … 250℃	
3071	Lower Point Res.	FLOAT32	1 … 1E6Ω	
3072	Middle Point Temp.	FLOAT32	-273 … 250℃	
3073	Middle Point Res.	FLOAT32	1 … 1E6Ω	
3074	Upper Point Temp.	FLOAT32	-273 … 250℃	
3075	Upper Point Res.	FLOAT32	1 … 1E6Ω	

3.2.6 Tab: Expert

3.2.6.1 Laser Diode Temperature Measurement Settings

ID	Name	Format	Value Range	Description
4000	ADC Calibration Offset	FLOAT32	-1E4 … 1E4	
4001	ADC Calibration Gain	FLOAT32	0.5 … 2	
4002	ADC Rv	FLOAT32	1 … 1E6Ω	
4003	Temperature Offset	FLOAT32	-5 … 5℃	
4004	Temperature Gain	FLOAT32	0.5 … 2℃/℃	

3.2.6.2 Laser Power Measurement Settings

ID	Name	Format	Value Range	Description
4010	Measurement Rs	FLOAT32	1 … 1E6Ω	

3.2.6.3 Current Measurement Settings

ID	Name	Format	Value Range	Description
4020	Current Offset	FLOAT32	-0.1 … 0.1A	
4021	Current Gain	FLOAT32	0.95 … 1.05A/A	

3.2.6.4 Laser Power Measurement Settings

ID	Name	Format	Value Range	Description
4030	Laser Power Offset	FLOAT32	-100 … 100W	
4031	Laser Power Gain	FLOAT32	0.2 … 5W/W	

3.2.6.5 LDD Parallel Master / Slave Configuration

ID	Name	Format	Value Range	Description
4100	Parallel Function / Type	INT32	0 … 2	0: Disabled 1: Master 2: Slave
4101	RS485 Sync. Channel	INT32	0 … 1	0: RS485 CH 1 1: RS485 CH 2
4102	Master: Number Of Slaves	INT32	0 … 256	
4103	Slave: Slave ID	INT32	0 … 256	

3.2.7 Not in Service Software displayed Parameters

3.2.7.1 Current Wave Parameters (Bus-Controlled)

Obsolete: Use Parameter 108 to disable the Flash writing. All parameter are the volatile and the flash does not wear unnecessary.

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

ID	Name	Format	Value Range	Description
50000	Current	FLOAT32	LDD1121: 0 … 15A LDD1124: 0 … 1.5A LDD1125: 0 … 30A	0A (Reset State)
50001	Pulse	INT32	0 … 1	0: OFF (Reset State) 1: ON
50002	Enable	INT32	0 … 1	0: OFF (Reset State) 1: ON
50003	Light	FLOAT32	0 … 1000W	

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 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 Sequenze, CRC Wrong….

4.2 Bootloader Stream (BS?)

Type	Mnemonic	Field 1
Query	?BS	Data Stream 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 (Address 2 has been used)
  - Sequence Number
  - Payload / Other Payload part
  - Cecksum

Get Firmware Identification String

OUT: #0215AA?IFED08

IN: !0215AA8063-LDD SW G01 401B

→ Result is “8063-LDD SW G01 “

Get Device Type (Using Parameter Value Read)

Parameter ID: 100 (0x0064); Instance 1

OUT: #0215AB?VR006401 76C2

IN: !0215AB00000461F119

→ Result is 0x00000461 → 1121

Get Serial Number (Using Parameter Value Read)

Parameter ID: 102 (0x0066); Instance 1

OUT: #0215AC?VR006601 77E7

IN: !0215AC00000036 49E8

→ Result is 0x00000036 → Interpreted as an INT32: Decimal Value 54

Set LDD Enable Input Source (Using Parameter Value Set Command)

Parameter ID: 2020 (0x07E4); Instance 1; New value is 3 (HW Pin9) as INT32

OUT: #0215AEVS07E401000000031592

IN: !0215AE1592

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

Get LDD Laser Diode Current (Using Parameter Value Read)

Parameter ID: 1016 (0x03F8); Instance 1

OUT: #0215B2?VR03F801087F

IN: !0215B23F4CB0003A93

→ The Result is 0x3F4CB000 → Interpreted as an FLOAT32: 0.799561A

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 LDD Current CW (Using Parameter Value Set)

Parameter ID: 2001 (0x07D1); Instance 1; New Value 0.56A AS FLOAT32 according to IEEE754

The new Value 0.56 is being transmitted as Hexadecimal Representation 0x3F0F5C29.

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: #0215B4VS07D1013F0F5C291279

IN: !0215B41279

→ 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: #0215B5?VR04D20159F8

IN: !0215B5+053642

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

6 Old Commands (Not recommended for new Designs)

6.1 Set Commands (Will be removed in feature Version)

Command	Mnemonic	Arguments / Description			
		Type	Min	Max	Description
Current Pulse	CP	16 bit	0	15'000	Pulse current in mA → (15 A => 15'000)
Current Maximum	CM	16 bit	0	15'000	Set a software limit for max current in mA → (5 A => 5'000)
Enable	EN	Digit	0	1	0 → Disable LDD-112x 1 → Enable LDD-112x
Analog Current Factor	AF	16 bit	0	30'000	Sets the Current Factor for the Analog interface [mA/V] (2V at analog interface and this value is 5000 → 10A)
Temperature Error Threshold	ET	16bit	0	20'000	Laser Diode Temperature (4312 = 43.12°C) Under Error Threshold
		16bit		20'000	Laser Diode Temperature (4312 = 43.12°C) Upper Error Threshold

6.2 Query Commands (Will be removed in feature Version)

Request	Mnemonic	Description	Server Response	
			Type	Description
Version Information	?VI	Returns the software version	16bit	SW Version: 100 equals 1.00
			16bit	Build Number.
Error	?ER	Returns the current error number.	8bit	0 → No Error. For all other numbers check the error list (TBD) in the appendix.
Device Status	?DS	Returns the device status	8bit	Status numbers TBD
Current Actual	?CA	Returns the actual current	16bit	Actual current in mA
Base plate Temperature	?BT	Returns the base plate temperature	16bit	Temperature (4312 = 43.12°C)

7 Change Log

Changed by	Dok	STM32 SW Version	Change Log
03.04.12 ML	E	0.60	Query ?BT added.
14.05.12	F	0.60	Set ET added. Bootloader Querys added
11.06.12	G	0.70	Add: 3 Service Software Parameters
23.08.12 US	H	0.70	Add: Paragraph 'Interfaces, Baud Rate and Address'
27.08.12	I	1.00	Add: 3.1.3 Parameter Limit Read Add: LDD-1125
28.09.12	J	1.00	Add: ID for CW Current Mod: 3.2 Parameter list
21.11.12	K	1.10	Add: Light Control Parameters Add: Calibration Parameters (Current Light)
21.03.13	L	1.20	Add: Flash Status Parameters
11.03.13	M	1.30	Add: SA and ?SD command
10.04.13	N	1.40	Add: Parameter ID 106 (Error Instance), Parameter ID 107 (Error Parameter)
18.06.13	O	1.50	Add: Parameter ID 3016 (Laser Diode Current, Smart Value) Add: Parameter ID 3017 (Laser Diode Voltage, Smart Value) Add: Parameter ID 3080 (Pulse Trigger Output) Add: Value Ranges for LDD-1124
27.06.13	P	1.50	Bug: Parameter “Parameter System: Flash Status” is 1051 Add: 5 Example Communication Strings
08.08.13	Q	1.60	Add: Flash Parameters 108, 109 Mod: Marked Obsolete 3.2.7.1 Current Wave Parameters (Bus-Controlled)
25.09.13	R	1.80	Add: 3.2.6.5 LDD Parallel Master / Slave Configuration
23.12.13	S	1.90	Add: Parameter ID 2008 (Generator Trigger)