

Communication Protocol – LDD-130x



LDD-130x:

LDD-1301

LDD-1303

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 Member of Berndorf Group



Developed, assembled, and tested in Switzerland

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1 General Description

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

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 5117D” 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.

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 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 a 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_LDD-130x.exe /LoSpeed 115200
Sets the initial speed to a certain Baud Rate. The default value is 57600
 - Service_LDD-130x.exe /HiSpeed 921600
Sets the high speed value to a certain Baud Rate. The default value is 1000000
 - Service_LDD-130x.exe /Speed 115200:
Changes both the LoSpeed and the HiSpeed to a certain Baud Rate.
 - Service_LDD-130x.exe /IP 192.168.1.191 /DevAddr 3
Sets the Mode to Ethernet and uses the given IP Address and Device Address to connect.
- To use RS485 we recommend the following interface cable:
<http://www.ftdichip.com/Products/Cables/USBRS485.htm>
- To use RS232 TTL we recommend the 3.3V versions of the following interface cable:
<http://www.ftdichip.com/Products/Cables/USBTTLSerial.htm>

1.4 Interfaces, Baud Rate

The following table shows the available interfaces for the different products. 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.

| | |
|--------------------|--------------------------------|
| | LDD-1301, LDD-1303 |
| Interface 1 | USB UART MODE 3 |
| Interface 2 | RS485 Channel 1 UART MODE 2 |
| Interface 3 | RS232 Channel 2 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 (non-volatile) / RAM Parameters (volatile)

Most of the Parameters are 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 gets saved to the flash. There are 2 possibilities to solve this problem:

- Disabling the automatic save-to-flash mechanism: We recommend to setup the device how you desire, then switch off the saving to the flash. This way, the device 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 LDD-130x Commands

2.1 Set Commands

Here only the device-specific commands are listed. The standard commands are specified in the document 5117.

| Command | Mnemonic | Arguments | | | Description |
|----------------|----------|-----------|------|-----|--|
| | | Type | Min | Max | |
| Emergency Stop | ES | - | - | - | Disables all Power Outputs immediately and generates Error 11. |
| 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 5s, 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

Here only the device-specific commands are listed. The standard commands are specified in the document 5117.

The firmware identification string of LDD-130x devices is: "8144-LDD-130X G1 " (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 download the exported Settings Dump (*.mepar) of the Service Software. | | |
| | | 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 Service Software Parameters

3.1 Payload Format Description

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-130x devices have a single current driver channel, so e.g. the target current only has one instance.

See document 5117 for more information about the MeCom protocol.

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. 1303 → LDD-1303 |
| 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 200ms |
| 105 | Error Number | INT32 | | |
| 106 | Error Instance | INT32 | | |
| 107 | Error Parameter | INT32 | | |

3.2.1.2 Flash

| ID | Name | Format | Unit/Range | Description |
|-----|-----------------------------------|--------|------------|---|
| 108 | Save Data to Flash | INT32 | | 0: Enabled 1: Disabled (all Parameters can then be used as volatile 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 during this process). 2: Saving to Flash is disabled |

Hint: Parameter 100-999 are read-only, except Parameter 108.

3.2.2 Tab: Monitor (read-only)

3.2.2.1 Output Stage Monitoring

| ID | Name | Format | Unit/Range | Description |
|------|-----------------------|---------|------------|-------------|
| 1100 | Actual Output Current | FLOAT32 | A | |
| 1101 | Actual Output Voltage | FLOAT32 | V | |

3.2.2.2 External Temperature Measurement x

| ID | Name | Format | Unit/Range | Description |
|------|---------------|---------|------------|-------------|
| 1200 | Temperature | FLOAT32 | °C | |
| 1201 | Resistance | FLOAT32 | Ω | |
| 1202 | Raw ADC Value | FLOAT32 | | |

3.2.2.3 Power Stage Phase Monitoring

| ID | Name | Format | Unit/Range | Description |
|------|-------------------------------|---------|------------|---|
| 1300 | Phase Current x | FLOAT32 | A | Only used in LDD-1303, always NA or 0 in LDD-1301 |
| 1301 | Phase Symmetrization Factor x | FLOAT32 | | Only used in LDD-1303, always NA or 0 in LDD-1301 |

3.2.2.4 Internal Parameters

| ID | Name | Format | Unit/Range | Description |
|-------|---------------------------------|---------|------------|-------------|
| 50000 | Volatile Output Enable | FLOAT32 | | |
| 50001 | Volatile Nominal Output Current | FLOAT32 | A | |
| 1402 | Nominal Output Current (Ramp) | FLOAT32 | A | |
| 1403 | Output Level | FLOAT32 | % | |
| 1404 | Calculated Input Current | FLOAT32 | A | |
| 1405 | Calculated Output Current | FLOAT32 | A | |

3.2.2.5 Power Stage Temperature Monitoring

| ID | Name | Format | Unit/Range | Description |
|------|--------------------------------|---------|------------|---|
| 1302 | Temperature Phase x Buck/Boost | FLOAT32 | °C | Only one value used in LDD-1301, other values are NA. All values used in LDD-1303 |

3.2.2.6 Analog Input

| ID | Name | Format | Unit/Range | Description |
|------|----------------------|---------|------------|-------------|
| 1500 | Analog Voltage Input | FLOAT32 | V | |
| 1501 | Photodiode Input | FLOAT32 | mA | |

3.2.2.7 Firmware and Hardware Versions

| ID | Name | Format | Value Range | Description |
|------|------------------------------------|--------|-------------|-------------|
| 1050 | Firmware Version | INT32 | | 123 → 1.23 |
| 1051 | Firmware Build Number | INT32 | | |
| 1054 | Min Version for Firmware Downgrade | INT32 | | 123 → 1.23 |
| 1052 | Hardware Version | INT32 | | 123 → 1.23 |
| 1053 | Serial Number | INT32 | | |

3.2.2.8 Power Supplies and Temperature

| ID | Name | Format | Unit/Range | Description |
|------|----------------------|---------|------------|-------------|
| 1060 | Device Input Voltage | FLOAT32 | V | |
| 1061 | 12V Internal Supply | FLOAT32 | V | |
| 1062 | 5V Internal Supply | FLOAT32 | V | |
| 1063 | 3.3V Internal Supply | FLOAT32 | V | |
| 1064 | -5V Internal Supply | FLOAT32 | V | |
| 1065 | Device Temperature | FLOAT32 | °C | |

3.2.2.9 Error Status

| ID | Name | Format | Unit/Range | Description |
|------|-----------------|--------|------------|-------------|
| 1070 | Error Number | INT32 | | |
| 1071 | Error Instance | INT32 | | |
| 1072 | Error Parameter | INT32 | | |

3.2.2.10 Driver Status

| ID | Name | Format | Unit/Range | Description |
|------|-------------------------------|--------|------------|---|
| 1080 | Driver Status | INT32 | | 0: Init 1: Ready 2: Run 3: Error 4: Bootloader 5: Device will Reset within the next 200ms |
| 1081 | Parameter System Flash Status | INT32 | | 0: All Parameters are saved to flash 1: Save to flash pending or in progress (please do not power off the device during this process). 2: Saving to flash is disabled |

3.2.3 Tab: Operation

3.2.3.1 Input Source Selection

| ID | Name | Format | Unit/Range | Description |
|------|------------------------|--------|------------|---|
| 2100 | Output Enable | INT32 | | 0: Static OFF 1: Static ON 2: Volatile 3: GPIO |
| 2101 | Nominal Output Current | INT32 | | 0: Set Current 1: Volatile |

3.2.3.2 Nominal Output Current Values

| ID | Name | Format | Unit/Range | Description |
|------|-------------|---------|------------|-------------|
| 2102 | Set Current | FLOAT32 | A | |

3.2.3.3 Current Controller Settings

| ID | Name | Format | Unit/Range | Description |
|------|-------------|---------|------------|-------------|
| 2110 | PID Kp | FLOAT32 | %/A | |
| 2111 | PID Ti | FLOAT32 | s | |
| 2112 | PID Td | FLOAT32 | s | |
| 2113 | Slope Limit | FLOAT32 | A/s | |

3.2.3.4 Output Stage Limits

| ID | Name | Format | Unit/Range | Description |
|------|-------------------------|---------|--------------------|-------------|
| 2122 | Max Nominal Current | FLOAT32 | 1303: 0 ... 20A | |
| 2123 | Min Nominal Current | FLOAT32 | 1303: 0 ... 20A | |
| 2120 | Current Error Threshold | FLOAT32 | A | |
| 2121 | Voltage Error Threshold | FLOAT32 | V | |

3.2.3.5 Laser Diode Characteristics

| ID | Name | Format | Unit/Range | Description |
|------|---------------------------|---------|------------|----------------------------------|
| 2130 | Slope Compensation Factor | FLOAT32 | 0 ... 1 | |
| 2131 | Max Diode Current | FLOAT32 | 0 ... 100A | Max Current from Diode Datasheet |

3.2.3.6 Device Address

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

3.2.3.7 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 μ s ... 1E6 μ s | Instance 1 = Interface 1 etc. |

3.2.3.8 Communication Watchdog

| ID | Name | Format | Unit/Range | Description |
|------|---------|---------|--------------|-------------------------|
| 2060 | Timeout | FLOAT32 | 0.1 ... 600s | 0: Disable the watchdog |

3.2.4 Tab: External Temperature

3.2.4.1 External Temperature Measurement Settings x

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

3.2.4.2 External Temperature Error Limits x

| ID | Name | Format | Unit/Range | Description |
|------|-----------------------|---------|------------|-------------|
| 5011 | Upper Error Threshold | FLOAT32 | °C | |
| 5010 | Lower Error Threshold | FLOAT32 | °C | |

3.2.4.3 External Temperature Errors Enable x

| 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 |

3.2.4.4 External Temperature Measurement Limits x

| 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 | |

3.2.5 Tab: Analog Interfaces

| ID | Name | Format | Unit/Range | Description |
|------|---------------|---------|-----------------|-------------------------|
| 7000 | Signal Source | INT32 | | 0: Set Value 1: Sync |
| 7001 | Set Value | FLOAT32 | -0.5V ... 10.5V | |
| 7002 | Sync Scaling | FLOAT32 | V/A | |

3.2.6 Tab: Advanced / External Temperature Measurement

3.2.6.1 External Temperature ADC Calibration x

| ID | Name | Format | Unit/Range | Description |
|------|--------|---------|------------|-------------|
| 5100 | Offset | FLOAT32 | | |
| 5101 | Gain | FLOAT32 | | |

3.2.6.2 External NTC Sensor Characteristics x

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

3.2.7 Tab: Advanced / LDD Measurement

3.2.7.1 Current Calibration

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

3.2.7.2 Voltage Calibration

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

3.2.8 Tab: Advanced / Analog Interfaces

3.2.8.1 Analog Output DAC Calibration

| ID | Name | Format | Unit/Range | Description |
|------|--------|---------|------------|-------------|
| 9000 | Offset | FLOAT32 | | |
| 9001 | Gain | FLOAT32 | | |

3.2.9 Tab: Advanced / GPIO

3.2.9.1 GPIO General / GPIO Configuration (GPIO1 ... GPIO10)

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 3.2.12.2) 2: LDD OK (1 when Ready or Running) 3: No Function 4: HW Enable 5: No Function 6: No Function 7: No Function 8: LDD Run 9: No Function 10: No Function 11: No Function 12: No Function 13: Adr +1 (Device Address) 14: Adr +2 (Device Address) 15: Adr +4 (Device Address) 16: No Function 17: No Function 18: No Function 19: No Function 20: No Function 21: No Function 22: Pulse Input |
| 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 ... 10: Channel 10 |

3.2.9.2 GPIO Detail

3.2.10 Tab: Advanced / Temperature Correction

3.2.10.1 Temperature Correction Settings

| ID | Name | Format | Unit/Range | Description |
|------|-------------|---------|------------|--|
| 6110 | Source | INT32 | | 0: OFF 1: Ext Temp 1 2: Ext Temp 2 |
| 6111 | Offset [°C] | FLOAT32 | °C | |
| 6112 | Gain [A/°C] | FLOAT32 | A/°C | |

3.2.11 Tab: Advanced / Misc

3.2.11.1 Parameter System Save to Flash Configuration

| ID | Name | Format | Unit/Range | Description |
|-----|--------------------|--------|------------|---------------------------|
| 108 | Save Data to Flash | INT32 | | 0: Enabled 1: Disabled |

3.2.11.2 Error State Auto Reset Delay

| ID | Name | Format | Unit/Range | Description |
|------|-------------------|---------|---------------|------------------|
| 6310 | Delay until Reset | FLOAT32 | 0s ... 86400s | 0: No Auto Reset |

3.2.12 Other Parameters (not displayed in the Service Software)

3.2.12.1 Driver Parameters

| ID | Name | Format | Unit/Range | Description |
|-------|------------------------|---------|------------|-------------------------------|
| 50000 | Volatile Output Enable | INT32 | | 0: Static OFF 1: Static ON |
| 50001 | Volatile Set Current | FLOAT32 | | |

3.2.12.2 GPIO Signal Control

The following parameters are volatile parameters.

| <p>This feature can be used to control the GPIO signals. The pins are addressed by a bit field.</p> <p>Example: To configure GPIO3 / GPIO4 as output pins, and to set GPIO3 to high level and GPIO4 to low level, use the following commands:</p> <p>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)</p> | <table border="1"> <thead> <tr> <th colspan="2">Bit Field Description</th> </tr> <tr> <th>Bit Number</th> <th>Output Signal</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>GPIO1</td> </tr> <tr> <td>⋮</td> <td>⋮</td> </tr> <tr> <td>10</td> <td>GPIO2</td> </tr> </tbody> </table> | Bit Field Description | | Bit Number | Output Signal | 0 | GPIO1 | ⋮ | ⋮ | 10 | GPIO2 |
|--|---|-----------------------|--|------------|---------------|---|-------|---|---|----|-------|
| 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 ... 255 | If a bit is set to 0, the output signal is at high impedance s(set as input). If a bit is set to 1, the output signal is driven. |
| 52102 | Set Output States | INT32 | 0 ... 255 | Set the output states of driven signals. |
| 52103 | Read Input States | INT32 | 0 ... 255 | Read back the (input) states of all signals. |

4 Bootloader

- The firmware can be downloaded using all 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

```
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: !0015AC000000706F2C
→ Result: 0x00000070 → Interpreted as an INT32: decimal value 112
```

Querying a not 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.

A Change History

| Date of change | Version | Changed/ Approved | Change / Reason |
|------------------|---------|----------------------|---|
| 20 December 2021 | 5260A | RS/HS | <ul style="list-style-type: none">• First edition |
| 24 February 2022 | 5260B | HS/PV | <ul style="list-style-type: none">• Comments added to phase current, balancing factors, and power stage temperatures because some values are not used in the LDD-1301 |