ETHERNET PROTOCOL

LD-MRS
Laser Scanner

SICK
Sensor Intelligence.

Table of Content

1. Introduction

This document describes how data is received and transmitted from respectively to the LD - MRS via the Ethernet connection. Addressed systems are LD - MRS 400001 and LD - MRS 400102 sensors and applications using the current API / software versions.

2. Ethernet configuration

The LD - MRS uses default Ethernet configurations until changed by the user.

Default Ethernet settings	
IP address	192.168.0.1
Subnet mask	255.255.255.0
Port	12002

3. Data encoding

⚠ See the data type description if little or big endian byte order is used!

Timestamps represent the time encoded in 8 bytes. The higher 4 bytes are the number of seconds. The lover 4 bytes represent the fractional seconds with a resolution of 2^{-32} s. These 2 values must be interpreted as two unsigned 32 bit values.

4. Data header

Each message always starts with a data header. To resync just search for the magic word.

Data header					
Bytes	Offset	Field	Type	Byte order	Description
4	0	Magic word (0xAFFEC0C2)	uint32	Big endian	The magic word is used for searching messages and to distinguish between different versions
4	4	Size of previous message	uint32	Big endian	Helps to navigate backwards through a file. Unused in live data. Not mandatory
4	8	Size of this message	uint32	Big endian	Helps to read the message data. Size of message content without this header
1	12	Reserved	uint8	Big endian	–
1	13	Device ID	uint8	Big endian	ID of the connected device. Unused in data received directly from scanner. Not mandatory
2	14	Data type	uint16	Big endian	Specifies the data type within message
8	16	Timestamp	uint64	Big endian	Time when this message was created. Not mandatory
Total: 24 bytes					

5. Scan data

Each scan data block starts with a header followed by the scan point list. For angle information the unit angle ticks is used. A LD - MRS uses 11520 ticks per rotation. Thus the angular resolution $\frac{1}{32}^{\circ}$. This value is needed to convert angle ticks: $\text{angle} = 2\pi \cdot \frac{\text{angle ticks}}{\text{angle ticks per rotation}}$. Angles are given in the ISO 8855 / DIN 70000 scanner coordinate system.

Scan header (data type: 0x2202)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Scan number	uint16	Little endian	The number of this scan. The number will be increased from scan to scan
2	2	Scanner status	uint16	Little endian	**0x0007**: reserved **0x0008**: set frequency reached **0x0010**: external sync signal **0x0020**: sync ok **0x0040**: sync master **0xFF80**: reserved
2	4	Sync phase offset	uint16	Little endian	Phase difference (conversion factor 409.6 ns) between sync signal and scanner mirror crossing the synchronization angle
8	6	Scan start time	uint64	Little endian	Time when first measurement was done
8	14	Scan end time	uint64	Little endian	Time when last measurement was done
2	22	Angle ticks per rotation	uint16	Little endian	Number of angle ticks per rotation
2	24	Start angle	int16	Little endian	Start angle in angle ticks of this scan

2	26	End angle	int16	Little endian	End angle in angle ticks of this scan
2	28	Scan points	uint16	Little endian	Number of scan point transmitted in this scan
2	30	Reserved	int16	Little endian	–
2	32	Reserved	int16	Little endian	–
2	34	Reserved	int16	Little endian	–
2	36	Reserved	int16	Little endian	–
2	38	Reserved	int16	Little endian	–
2	40	Reserved	int16	Little endian	–
2	42	Reserved	uint16	Little endian	–
Total: 44 bytes					

6. Scan point

An array of points follows the scan header. See number of scan points in the scan header description above.

Scan point					
Bytes	Offset	Field	Type	Byte order	Description
1	0	Echo and layer	uint8	Little endian	**Bits 0 – 3**: scan layer of point **Bits 4 – 7**: echo number of point (both zero – based)
1	1	Flags	uint8	Little endian	**0x01**: transparent point **0x02**: clutter (atmospheric) **0x08**: dirt **0x0F**: reserved
2	2	Horizontal angle	int16	Little endian	Angle of point in angle ticks in the scanner coordinate system
2	4	Radial distance	uint16	Little endian	Distance of point in angle ticks in the scanner coordinate system
2	6	Echo pulse width	uint16	Little endian	Detected width of this echo pulse in cm
2	8	Reserved	uint16	Little endian	–
Total: 10 bytes					

7. Errors and warnings

As soon LD - MRS detects an error or wants to emit a warning, this message is sent. Errors and warnings bits are reset after sending this message. This message will be sent periodically as long as errors or warnings persist.

Errors and warnings (data type: 0x2030)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Error register 1	uint16	Little endian	**Bits 0 – 1**: contact support **Bit 2**: scan buffer transmitted incompletely, decrease scan resolution, frequency or range; contact support **Bit 3**: scan buffer overflow, decrease scan resolution, frequency, range, contact support **Bits 4**: contact support **Bits 5 – 7**: reserved **Bit 8**: APD under temperature, provide heating **Bit 9**: APD over temperature, provide cooling **Bits 8 – 9**: APD temperature sensor defect, contact support **Bits 10 – 13**: contact support **Bits 14 – 15**: reserved

2	2	Error register 2	uint16	Little endian	**Bits 0 – 3**: contact support **Bit 4**: incorrect configuration data, load correct values **Bit 5**: configuration contains incorrect parameters, load correct values **Bit 6**: data processing timeout, decrease scan resolution or frequency **Bit 7**: contact support **Bit 8 – 15**: reserved
2	4	Warning register 1	uint16	Little endian	**Bit 0**: internal communication error **Bits 1 – 2**: internal warning **Bit 3**: temperature very low **Bit 4**: temperature very high **Bits 5 - 6**: internal warning **Bit 7**: synchronization error, check synchronization and scan frequency **Bits 8 – 15**: reserved

2	6	Warning register 2	uint16	Little endian	**Bit 0**: reserved **Bit 1**: Ethernet interface blocked, check Ethernet connection **Bit 2**: reserved **Bit 3**: contact support **Bit 4**: error receiving Ethernet data, check Ethernet connection or data **Bit 5**: incorrect or forbidden command received, check command **Bit 6**: memory access failure, restart scanner, contact support **Bits 7 – 15**: reserved
2	8	Reserved	uint16	Little endian	–
2	10	Reserved	uint16	Little endian	–
2	12	Reserved	uint16	Little endian	–
2	14	Reserved	uint16	Little endian	–
Total: 16 bytes					

8. Command interface

Commands are used for configuring scanner parameters. Data structures below shows how messages are formed and transmitted.

«Reset» command (data type: 0x2010)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x0000)	uint16	Little endian	Reset digital signal processor (DSP)
2	2	Reserved	uint16	Little endian	–
Total: 4 bytes					

«Get status» command (data type: 0x2010)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x0001)	uint16	Little endian	Request information about the status of the sensor
2	2	Reserved	uint16	Little endian	–
Total: 4 bytes					

«Save configuration» command (data type: 0x2010)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x0004)	uint16	Little endian	Save the current configuration of the sensor permanently. Multiple parameters may be changed before saving the changes permanently
2	2	Reserved	uint16	Little endian	–
Total: 4 bytes					

«Set parameter» command (data type: 0x2010)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x0010)	uint16	Little endian	Set a single parameter by its index to the sensor memory. Parameter is set only temporarily until it will saved
2	2	Reserved	uint16	Little endian	–
2	4	Parameter index	uint16	Little endian	Refer to the sensor parameter list (see below)
4	6	Parameter	uint32	Little endian	Set parameter accordingly to parameter list. If e.g. a 2 byte value is set, use the first 2 bytes. Fill the remaining 2 bytes with zero
Total: 10 bytes					

«Get parameter» command (data type: 0x2010)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x0011)	uint16	Little endian	Read a single parameter with its index from the sensor
2	2	Reserved	uint16	Little endian	–
2	4	Parameter index	uint16	Little endian	Refer to the sensor parameter list (see below)
Total: 6 bytes					

«Reset default parameters» command (data type: 0x2010)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x0001A)	uint16	Little endian	Reset all parameters to the factory defaults
2	2	Reserved	uint16	Little endian	–
Total: 4 bytes					

«Start measure» command (data type: 0x2010)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x00020)	uint16	Little endian	Starts the measurement with the current settings
2	2	Reserved	uint16	Little endian	–
Total: 4 bytes					

«Stop measure» command (data type: 0x2010)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x00021)	uint16	Little endian	Stops the measurement until it is restarted
2	2	Reserved	uint16	Little endian	–
Total: 4 bytes					

«Set NTP timestamp seconds» command (data type: 0x2010)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x00030)	uint16	Little endian	Sets the seconds of NTP timestamp
4	2	Reserved	uint32	Little endian	–
4	6	Timestamp	uint32	Little endian	Seconds (NTP format). The time will be set in the sensor when the fractional seconds command is received (see below)
Total: 10 bytes					

«Set NTP timestamp fractional seconds» command (data type: 0x2010)					
⚠ Before this command can be executed, first «Set NTP timestamp seconds» must be send!					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID (0x00031)	uint16	Little endian	Sets the fractional seconds of NTP timestamp
4	2	Reserved	uint32	Little endian	–
4	6	Timestamp	uint32	Little endian	Fractional seconds (NTP format)
Total: 10 bytes					

«Get status» reply (data type: 0x2020)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID	uint16	Little endian	**0x0001**: command succeeded **0x8001**: command failed If failed, the rest of the reply is not sent
2	2	Firmware version	uint16	Little endian	E.g. 0x1230 = version 1.2.3, 0x123B = version 1.2.3b
2	4	FPGA version	uint16	Little endian	E.g. 0x1230 = version 1.2.3, 0x123B = version 1.2.3b
2	6	Scanner status	uint16	Little endian	**Bit 0**: motor on **Bit 1**: laser on **Bit 2**: reserved **Bit 3**: frequency locked **Bit 4**: external sync signal **Bit 5**: phase locked **Bits 6 – 10**: reserved
4	8	Reserved	uint32	Little endian	–
2	12	Temperature	uint16	Little endian	$T(°C) = -\frac{\text{Temperature} - 579.2364}{3.63}$
2	14	Serial number 0	uint16	Little endian	'YYCW' (e.g. 'YYCW' = 0x0740 = year '07, calendar week 40)
2	16	Serial number 1	uint16	Little endian	Counter of serial number
2	18	Reserved	uint16	Little endian	–
6	20	FPGA timestamp	3 * uint16	Little endian	'YYYY' 'MMDD' 'hhmm' (FPGA version state)
6	26	DSP timestamp	3 * uint16	Little endian	'YYYY' 'MMDD' 'hhmm' (Firmware version state)
Total: 32 bytes					

«Save configuration» reply (data type: 0x2020)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID	uint16	Little endian	**0x0004**: command succeeded **0x8004**: command failed
Total: 2 bytes					

«Set parameter» reply (data type: 0x2020)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID	uint16	Little endian	**0x0010**: command succeeded **0x8010**: command failed
Total: 2 bytes					

«Get parameter» reply (data type: 0x2020)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID	uint16	Little endian	**0x0011**: command succeeded **0x8011**: command failed If failed, the rest of the reply is not sent
2	2	Parameter index	uint16	Little endian	Refer to the sensor parameter list (see below).
4	4	Parameter	uint32	Little endian	A parameter value according to the index
Total: 8 bytes					

«Reset default parameters» reply (data type: 0x2020)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID	uint16	Little endian	**0x001A**: command succeeded **0x801A**: command failed
Total: 2 bytes					

«Start measure» reply (data type: 0x2020)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID	uint16	Little endian	**0x0020**: command succeeded **0x8020**: command failed
Total: 2 bytes					

«Stop measure» reply (data type: 0x2020)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID	uint16	Little endian	**0x0021**: command succeeded **0x8021**: command failed
Total: 2 bytes					

«Set NTP timestamp seconds» reply (data type: 0x2020)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID	uint16	Little endian	**0x0030**: command succeeded **0x8030**: command failed
Total: 2 bytes					

«Set NTP timestamp fractional seconds» reply (data type: 0x2020)					
Bytes	Offset	Field	Type	Byte order	Description
2	0	Command ID	uint16	Little endian	**0x0031**: command succeeded **0x8031**: command failed
Total: 2 bytes					

Parameter list				
Bytes	Parameter index	Parameter name	Type	Description
4	0x1000	IP address	uint32	IP address of the sensor
2	0x1001	TCP port	uint16	TCP port of the sensor
4	0x1002	Subnet mask	uint32	Subnet mask of the sensor
4	0x1003	Standard gateway	uint32	Gateway of the sensor
2	0x1012	Data output flags	uint16	**True**: disable output **False**: enable output **Bit 0**: ETH scan data **Bit 1 – 3**: reserved **Bit 4**: ETH errors / warnings **Bit 5 – 15**: reserved
2	0x1100	Start angle	int16	In $1/32^{\circ}$, in the sensor coordinate system. Valid range: [**-1920; 1599**]. Start angle must be greater than the end angle!
2	0x1101	End angle	int16	In $1/32^{\circ}$, in the sensor coordinate system. Valid range: [**-1919; 1600**]. Start angle must be greater than the end angle!

2	0x1102	Scan frequency	uint16	In $1/256$ Hz. Valid values: **3200** (12.5 Hz) **6400** (25.0 Hz) **12800** (50.0 Hz)
2	0x1103	Sync angle offset	int16	In $1/32^{\circ}$, in the sensor coordinate system. Valid range: **[-5760; 5759]** $(-180^{\circ} \dots 180^{\circ})$
2	0x1104	Angular resolution type	uint16	**0**: focused **1**: constant **2**: reserved
2	0x1105	Angle ticks per rotation	uint16	**11520** (read only)

Example (set IP address: 10.152.32.200)					
Bytes	Offset	Data header	Type	Byte order	Content
4	0	Magic word	uint32	Big endian	**0xAFFEC0C2**
4	4	Size of previous message	uint32	Big endian	**0x0000**
4	8	Size of this message	uint32	Big endian	**0x000A**
1	12	Reserved	uint8	Big endian	**0x0000**
1	13	Device ID	uint8	Big endian	**0x0007**
2	14	Data type	uint16	Big endian	**0x2010**
8	16	Timestamp	uint64	Big endian	**0x0000**
Bytes	Offset	Message data	Type	Byte order	Content
2	24	Command ID	uint16	Little endian	**0x0010**
2	26	Reserved	uint16	Little endian	**0x0000**
2	28	Parameter index	uint16	Little endian	**0x1000**
4	30	Parameter	uint32	Little endian	**0x0A824C8**
Total: 34 bytes					

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