
INTERFACE CONTROL DOCUMENT

This document describes mechanical, optical, electrical and software interface of the following Noptel LRX family modules:

- LRX-20A
- LRX-25A
- LRX-42A



Figure 1. LRX-20A and LRX-25A



Figure 2. LRX-42A

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Document versions:

Version	Date	Author	Firmware	Notes
2.3	29.4.2020	Juha Leskinen	1.5.2. →	All measurement commands replaced by new general measurement command (CCh). Previous measurement commands are still supported (doc. OS43418HE)
2.3	28.5.2020	Matti Hiekkaranta		Chapters reorganization. Tables etc. added.
2.31	29.6.2020			Frame bits corrected.
2.32	21.8.2020	Juha Leskinen		Missing cross-reference fixed.

1 General

This chapter includes references for mechanical interfaces of each module and information about eye-safety and optical crosstalk.

1.1 Mechanical interface

Dimensions, fixing points and mechanical alignment of the LRX's are shown in separate documents as follows:

Table 1: Mechanical interface document and dimensions of each module

Module	Document number	Dimensions [mm]	Weight [g]
LRX-20A	D43504	67 x 48 x 34	120
LRX-25A	D43294	88 x 53 x 37	136
LRX-42A	D43860	102 x 70 x 51	250

1.2 Eye-safety

The LRX range finder modules are classified to Class 1 or Class 1M as follows:

Table 2: Laser classification of each module

Module	Laser classification
LRX-20A	1
LRX-25A	1
LRX-42A	1M (default) / 1 (optional)

1.2.1 Class 1 modules

The LRX is eye-safe in every measurement mode.

The system which uses Class 1 LRX module shall have labelling according IEC 60825-1:2014 as follows:

Text borders and symbols are recommended to be black on a yellow background, but for Class 1 this color combination need not be used.

The labels shall be durable, permanently affixed, legible, and clearly visible during operation, maintenance or service, according to their purpose.

If the size or design of the product makes labelling impractical, the label shall be included with the user information or on the package.

Direct printing or engraving of equivalent labels on the laser product or panels is acceptable.

Class 1 laser product shall have affixed an explanatory label bearing the words:

CLASS 1 LASER PRODUCT

Alternatively, the label illustrated in Figure below may be affixed to the product:

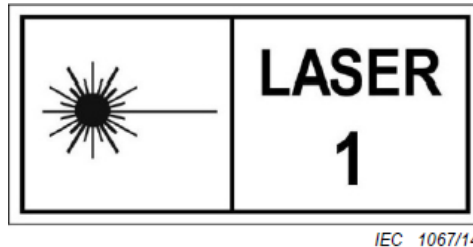


Figure 3. Alternative label for Class 1

1.2.2 Class 1M modules

The system which uses Class 1M LRX module shall have labelling according IEC 60825-1:2014 as follows:

Text borders and symbols are recommended to be black on a yellow background, but for Class 1M this color combination need not be used.

The labels shall be durable, permanently affixed, legible, and clearly visible during operation, maintenance or service, according to their purpose.

If the size or design of the product makes labelling impractical, the label shall be included with the user information or on the package.

Direct printing or engraving of equivalent labels on the laser product or panels is acceptable.

Class 1M laser product shall have affixed an explanatory label bearing the words:

**LASER RADIATION
DO NOT EXPOSE USERS OF TELESCOPIC OPTICS
CLASS 1M LASER PRODUCT**

Alternatively, the label illustrated in Figure below may be affixed to the product:



Figure 4. Alternative label for Class 1M

Instead of the above labels on the product, at the discretion of the manufacturer, the same statements may be included in the information for the user.

1.3 Transmitter divergence

The following table represents transmitter divergence of each LRX module.

Table 3: Typical transmitter beam divergence

LRX Module	LRX-20A	LRX-25A	LRX42A
Beam Divergence [mrad]	0.6	0.35	0.25

1.4 Optical crosstalk

When installing the LRX module in the user's housing it is important to minimize the level of optical crosstalk between transmitter and receiver.

Level of optical crosstalk can be checked as described in the chapter "3.3 Check optical crosstalk".

Front glass requirements:

- Normal BK7 clear glass operates well with anti-reflection coating at 1.55 μm . Thickness is not critical, but optical crosstalk can get worse with very thick glass; ≤ 3 mm is fine.
- The glass should be installed parallel to front surface and **as close to LRX as possible**. Possible gap should be filled with O-ring type solution or another method to prevent optical crosstalk between the receiver and transmitter optics.

Take also care that mechanical structures in front of LRX are not reflecting laser radiation back to the LRX. Matte black paint can be used to reduce reflections.

1.5 Disposal



Do not dispose this product as unsorted municipal waste.

In the European Union all electrical and electronic products, batteries, and accumulators must be taken to separate collection at the end of their working life.

2 Electrical interface

This chapter describes electrical interface including connector pinout and typical supply power consumption details.

Connector type: Molex 53261-1071 (Connector for the cable: Molex 51021-1000)

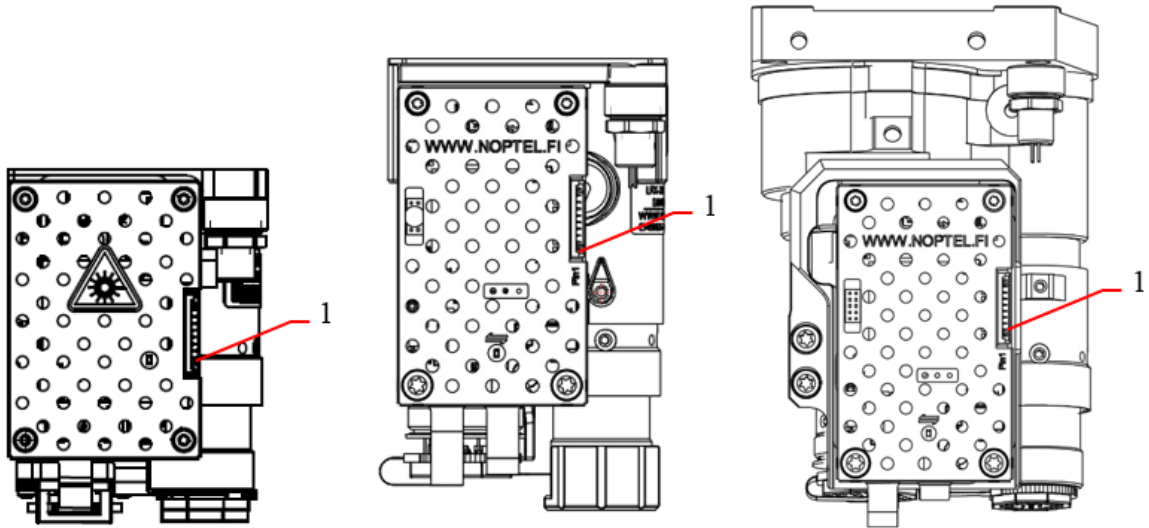


Figure 5. LRX-20A, LRX-25A and LRX-42A Pin1 location

Table 4: Molex connector pinout

pin #	IN/OUT	Description
1	IN	RS-422 RX+ (or UART TXD) *1
2	IN	RS-422 RX- (or RS-232 RX or UART RXD) *1
3	GND	RS-422 GND
4	OUT	RS-422 TX+ *1
5	OUT	RS-422 TX- (or RS-232 TX) *1
6	GND	Case/Supply ground *2
7 & 8	IN	Supply voltage input (6.5 - 30V). Reverse voltage protected. See Table 5 for power consumption.
9	GND	Case/Supply ground *2
10	IN	Shutdown when pulled down <0.5V, Power On when > 1.1V(internal 100 kΩ pull up)

*1 The default interface is RS-422. Serial interface option must be defined during ordering.

*2 Isolation of the case from the electrical ground is possible. Isolation option must be defined in the order!

Table 5: Typical power consumption of the LRX-20A, LRX-25A & LRX-42A.

Operation	Total [W]
Measure	3.7
Optional Pointer	0.9
Standby	0.2

3 Serial communication protocol

This chapter describes the main command frames of laser range finder. Notice that all commands described in earlier ICD document versions are still supported.

Default baud rate is 115200 bps (no parity, 8 data bits, 1 stop bit). Default electrical interface is RS-422. RS-232 and UART are options. Serial transfer speed can be changed by the user.

After about 50 ms from the power on the device sends a string “LRX x.x.x” where “x.x.x” is the firmware version (e.g. 1.5.3). After the string the device is ready to take commands.

3.1 Standard acknowledgement frame

Standard answer does not contain any data. Notice, that Check byte is an “exclusive OR” of **50h** and **arithmetic sum** of all data including synchronization bytes.

Standard acknowledgement frame:

Byte	MSB							LSB	HEX	Note
	7	6	5	4	3	2	1	0		
-2	0	1	0	1	1	0	0	1	59h	1. synchronization byte
-1	y	y	y	y	y	y	y	y	YYh	2. synchronization byte Echo of command byte
0	0	0	1	1	1	1	0	0	3Ch	Acknowledgement byte
1	x	x	x	x	x	x	x	x	XXh	Check byte, checksum XOR 50h XX = (59h + YYh + 3Ch) XOR 50h

3.2 Execute range measurement

This command executes range measurements. The measurement mode is selected by setting measurement mode byte 1.

Table 6. Measurement mode list.

Mode	Description	Rate [Hz]
SMM	Single Measurement Mode	0.2 ^{*1}
Quick SMM 1 / 2	Quick Single Measurement Mode(s) Reduced measuring time, lower range performance.	0.5 / 1 ^{*1}
CMM	Continuous Measurement Mode Used when fixed repetition rates are needed.	1, 4, 10, 20, 100, 200

^{*1} No limits for the Class 1M module.

Command frame

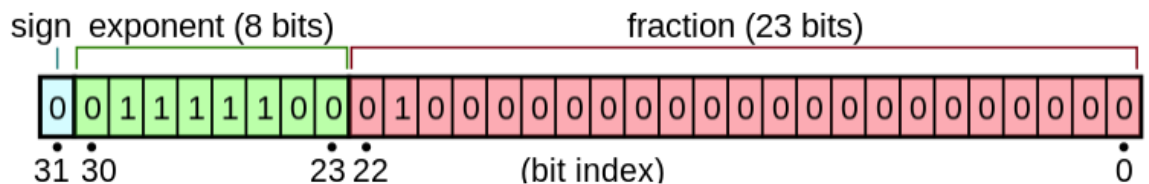
Byte	MSB								HEX	Note
	7	6	5	4	3	2	1	0		
0	1	1	0	0	1	1	0	0	CCh	Execute range measurement Measurement mode: 00h = SMM 10h = Quick SMM 1 20h = Quick SMM 2 01h = CMM 1 Hz *1 02h = CMM 4 Hz *1 03h = CMM 10 Hz *1 04h = CMM 20 Hz *1 05h = CMM 100 Hz *1 06h = CMM 200 Hz *1 Reserved Reserved Check byte
1	0	0	X	X	X	X	X	X	XXh	
2	0	0	0	0	0	0	0	0	00h	
3	0	0	0	0	0	0	0	0	00h	
4	X	X	X	X	X	X	X	X	XXh	

*1 Module returns measurements until stopped. Continuous modes can be stopped with any command e.g. A Break command C6h 96h (see chapter 3.13).

Response frame

Byte	MSB								HEX	Note
	7	6	5	4	3	2	1	0		
-2	0	1	0	1	1	0	0	1	59h	Synchronization byte
-1	1	1	0	0	1	1	0	0	CCh	Echo of command byte
0-3	X	X	X	X	X	X	X	X	XXh	Range 1 [m] *1
4	X	X	X	X	X	X	X	X	XXh	Signal level 1 (LSB)
5	X	X	X	X	X	X	X	X	XXh	Signal level 1 (MSB)
6-9	X	X	X	X	X	X	X	X	XXh	Range 2 [m] *1
10	X	X	X	X	X	X	X	X	XXh	Signal level 2 (LSB)
11	X	X	X	X	X	X	X	X	XXh	Signal level 2 (MSB)
12-15	X	X	X	X	X	X	X	X	XXh	Range 3 [m] *1
16	X	X	X	X	X	X	X	X	XXh	Signal level 3 (LSB)
17	X	X	X	X	X	X	X	X	XXh	Signal level 3 (MSB)
18	X	MT	NT	ERR	NR	TTE	LA	LPW	XXh	Status byte #3 *2
19	X	X	X	X	X	X	X	X	XXh	Check byte (checksum XOR 50h)

*1 IEEE 754: single-precision binary floating-point format.



*2 Byte 6 is Status byte #3. Read chapter 3.4 for more information.

An example - To start 10 Hz continuous mode send the following command bytes:

CCh 03h 00h 00h 9F

3.2.1 Single Measurement Mode

In the Single Measurement Mode, the LRF makes a single distance measurement with best possible performance. Default maximum range setting is 32 km.

The LRF returns the first, second and last targets in the merit order, the most probable target first. The user may sort the ranges to the distance order if preferred. If less than three (3) targets are found the remaining distances are zero (0.0).

If user requests too many measurements within ten (10) seconds, the sensor will respond “0.5” m to all distances and does not activate the transmitter due to eye-safety limits. The next measurement is possible after the status bit NR (Not Ready to perform) clears (see chapter 3.4 for further information).

3.2.2 Quick Single Measurement Mode

A Quick Single Measurement Mode executes a single measurement with limited maximum duration.

Quick SMM 1: Duration max. 0.35 seconds.

Quick SMM 2: Duration max. 0.65 seconds.

3.2.3 Continuous Measurement Mode

When the mode is enabled the module will start to measure at selected rate. The range data up to three different distances are returned. If no target is detected zero (0.0) value is returned as distance. Mode will be stopped if any command is sent during continuous measurement.

Continuous mode can be running non-stop.

Note: High temperature operation may reduce performance and Mean Time To Failure (MTTF).

Table 7. Approximate range performance in the continuous modes compared to single measurement mode, SMM (Target size 2.3 x 2.3 m).

Mode [Hz]	LRX-20A Range[%]	LRX-25A Range [%]	LRX-42A Range [%]
1	83	83	95
4	65	69	86
10	45	50	74
20	40	48	66
100	TBD	18	18
200	TBD	18	18

3.3 Check optical crosstalk

This diagnostic command can be used to check the optical crosstalk from the front glass or mechanical structures after integrating the LRF to the user system.

Most reliable result is achieved by aiming the LRF towards clear sky. The output indicates the maximum distance the crosstalk may have an effect to the performance. Optimal values are less than 100 m.

Note: If value is not zero (0), it is important to test the measurement is operating normally in the range up to given value. Requires firmware 1.5.3 or later.

Command frame

Byte	MSB								LSB	HEX	Note
	7	6	5	4	3	2	1	0			
0	1	1	0	1	1	1	1	0		DEh	Check optical crosstalk
1	1	0	0	0	1	1	1	0		8Eh	Check byte

Response frame

Byte	MSB								LSB	HEX	Note
	7	6	5	4	3	2	1	0			
-2	0	1	0	1	1	0	0	1		59h	Synchronization byte
-1	1	1	0	1	1	1	1	0		DEh	Echo of command byte
0	x	x	x	x	x	x	x	x		XXh	Effect range (LSB) [m]
1	x	x	x	x	x	x	x	x		XXh	Effect range (MSB)
2	x	x	x	x	x	x	x	x		XXh	Check byte

3.4 Status query

This will return the status bytes of the device.

Command frame

Byte	MSB								LSB	HEX	Note
	7	6	5	4	3	2	1	0			
0	1	1	0	0	0	1	1	1		C7h	Ask Status
1	1	0	0	1	0	1	1	1		97h	Check byte

Response frame

Status byte 3 is the same in command 12h (see chapter 1.3).

Byte	MSB								LSB	HEX	Note
	7	6	5	4	3	2	1	0			
-2	0	1	0	1	1	0	0	1		59h	Synchronization byte
-1	1	1	0	0	0	1	1	1		C7h	Echo of command byte
0	GP	TP	REB	NR	TEMP	POINT	RB	LP		XXh	Status byte #1 *1
1	PNTR	HV	UTX	DC	MEM	FPGA	LB	CP		XXh	Status byte #2 *1
2	x	MT	NT	ERR	NR	TTE	LA	LPW		XXh	Status byte #3 *1
3	x	x	x	x	x	x	x	x		XXh	Check byte

*1 Status bytes #1, #2 and #3 of status query response frame:

Name	Byte.bit	Meaning, status byte 1	Action
GP	0.7	General problems.	Contact service
TP	0.6	Transmitter problems	Contact service

REB	0.5	Rebooted since last status answer.	
NR	0.4	RF not ready to perform.	Measurement is not possible before the bit clears
TEMP	0.3	Temperature exceeding operational limits.	Warning only, but if the temperature reading is not correct the unit should be shipped to the service
POINT	0.2	Pointer active.	
RP	0.1	Receiver problems.	Contact service *2
LP	0.0	Laser power problems.	Contact service *2
Name	Byte.bit	Meaning, status byte 2	Action
VPOINT	1.7	Pointer active.	
HV	1.6	High voltage out of limits.	
TBD	1.5		
DC	1.4	DCDC output out of limits	Contact service *2
MEM	1.3	Memory problem	Contact service *2
TDB	1.2	Not in use	
LB	1.1	Low battery	Check power supply
CP	1.0	Communication problem, last received	Check communication link
Name	Byte.bit	Meaning, status byte 3	Action
PWR	2.7/6.7	Electrical power out of limits	Contact service *2
MT	2.6/6.6	Multiple Targets	
NT	2.5/6.5	No Targets	
ERR	2.4/6.4	ERRor reported by LRX. More information in status bytes 1 & 2.	Contact service or use command C7h to check status bytes 1 & 2
NR	2.3/6.3	Not Ready to perform. Too high requested measurement frequency.	Wait until the bit is cleared
TTE	2.2/6.2	Transmitter timing error.	Contact service
LA	2.1/6.1	Laser Active (if continuous pulsing mode set)	
LPW	2.0/6.0	Laser PoWer on (laser driving voltage on)	

*2 If device operates normally it is safe to use until it can be shipped to be serviced.

3.5 Set alignment pointer

This command controls the alignment pointer. The pointer is switched off automatically after range finding.

Command frame

Byte	MSB							LSB		HEX	Note
	7	6	5	4	3	2	1	0			
0	1	1	0	0	0	1	0	1	C5h	Set pointer mode 0 – pointer OFF 1 – reserved 2 – visible pointer ON 3 – reserved	
1	0	0	0	0	0	0	x	x	0Xh		
2	x	x	x	x	x	x	x	x	XXh		

Answer: Standard acknowledgement frame.

3.6 Ask range window

This command returns the range window setting in use. Range window is used to select the operational distance range.

Command frame

Byte	MSB				LSB				HEX	Note
	7	6	5	4	3	2	1	0		
0	0	0	1	1	0	0	0	0	30h	Ask Range Window
1	0	1	1	0	0	0	0	0	60h	Check byte

Response frame

Byte	MSB				LSB				HEX	Note
	7	6	5	4	3	2	1	0		
-2	0	1	0	1	1	0	0	1	59h	Synchronization byte
-1	0	0	1	1	0	0	0	0	30h	Echo of command byte
0	0	0	0	x	x	x	x	x	XXh	Minimum Distance (LSB) [m]
1	x	x	x	x	x	x	x	x	XXh	Minimum Distance (MSB)
2	0	0	0	x	x	x	x	x	XXh	Maximum Distance (LSB) [m]
3	x	x	x	x	x	x	x	x	XXh	Maximum Distance (MSB)
4	x	x	x	x	x	x	x	x	XXh	Check byte (checksum XOR 50h)

3.7 Set minimum range

Ignore targets closer than minimum range setting. Maximum accepted value is five (5) meters less than Max Range setting. Minimum value is zero (0) meters.

To save range window setting into the permanent memory see chapter 3.9.

Command frame

Byte	MSB				LSB				HEX	Note
	7	6	5	4	3	2	1	0		
0	0	0	1	1	0	0	0	1	31h	Set minimum range
1	0	0	0	x	x	x	x	x	XXh	Min Range (LSB) [m]
2	x	x	x	x	x	x	x	x	XXh	Min Range (MSB)
3	x	x	x	x	x	x	x	x	XXh	Check byte (checksum XOR 50h)

Answer: Standard acknowledgement frame.

3.8 Set maximum range

Ignore targets further than the maximum range setting. Minimum accepted value is 5 meters more than Minimum Range setting.

Shorter range will shorten the measurement time in Single Measurement Mode somewhat.

To save range window setting into the permanent memory see chapter 3.9.

Command frame

Byte	MSB				LSB				HEX	Note
	7	6	5	4	3	2	1	0		
0	0	0	1	1	0	0	1	0	32h	Set maximum range
1	0	0	0	x	x	x	x	x	XXh	Max Range (LSB) [m]
2	x	x	x	x	x	x	x	x	XXh	Max Range (MSB)
3	x	x	x	x	x	x	x	x	XXh	Check byte (checksum XOR 50h)

Answer: Standard acknowledgement frame.

3.9 Set baud rate and save settings

This command sets baud rate of the module. Default baud rate is 115200 bps. The command changes baud rate immediately after acknowledgement frame. The setting can be saved to permanent memory by using baud rate selection zero (0). The current range window setting is also saved to permanent memory.

For example: 38400 bps is set by sending bytes: C8h, 03h, 9Bh.

Command frame

Byte	MSB				LSB				HEX	Note
	7	6	5	4	3	2	1	0		
0	1	1	0	0	1	0	0	0	C8h	Set baud rate
1	0	0	0	0	0	x	x	x	0Xh	Baud rate selection: 0 = Save setting 1 = 9600 bps 2 = 19200 bps 3 = 38400 bps 4 = 57600 bps 5 = 115200 bps (default) 6 = 230400 bps
2	1	0	0	1	1	x	x	x	9Xh	Check byte (checksum XOR 50h)

Answer: Standard acknowledgement frame.

3.10 Request identification

Requests identification information from the LRX.

Command frame

Byte	MSB				LSB				HEX	Note
	7	6	5	4	3	2	1	0		
0	1	1	0	0	0	0	0	0	C0h	Send Identification Frame
1	1	0	0	1	0	0	0	0	90h	Check byte

Response frame

Byte	MSB				LSB				HEX	Note
	7	6	5	4	3	2	1	0		
-2	0	1	0	1	1	0	0	1	59h	Synchronization byte
-1	1	1	0	0	0	0	0	0	C0h	Echo of command byte

0-14	x	x	x	x	x	x	x	x	XXh	15 bytes: Device ID string (“LRX-???”)
15	0	0	0	0	1	1	0	1	0Dh	CR (Carriage Return)
16	0	0	0	0	1	0	1	0	0Ah	LF (Line Feed)
17-31	x	x	x	x	x	x	x	x	XXh	15 bytes: Reserved for Additional information
32	0	0	0	0	1	1	0	1	0Dh	CR
33	0	0	0	0	1	0	1	0	0Ah	LF
34-43	x	x	x	x	x	x	x	x	XXh	10 bytes: Serial number string
44	0	0	0	0	1	1	0	1	0Dh	CR
45	0	0	0	0	1	0	1	0	0Ah	LF
46	x	x	x	x	x	x	x	x	XXh	Firmware version (LSB)
47	0	0	0	0	0	0	0	0	XXh	Firmware version (MSB)
48	1	0	1	1	0	0	0	1	B1h	Electronics type
49	1	0	1	1	0	0	0	0	B0h	Optics type
50-57	x	x	x	x	x	x	x	x	XXh	8 bytes: Date YY-MM-DD *1
58	0	0	0	0	1	1	0	1	0Dh	CR
59	0	0	0	0	1	0	1	0	0Ah	LF
60-67	x	x	x	x	x	x	x	x	XXh	8 bytes: Time HH:MM:SS *1
68	0	0	0	0	1	1	0	1	0Dh	CR
69	0	0	0	0	1	0	1	0	0Ah	LF
70	x	x	x	x	x	x	x	x	XXh	Check byte (checksum XOR 50h)

*1 Date and time of the firmware

3.11 Request diagnostic data

Information frame includes data which can be used in diagnostic purposes.

Command frame

Byte	MSB							LSB	HEX	Note
	7	6	5	4	3	2	1	0		
0	1	1	0	0	0	0	1	0	C2h	Request diagnostic data
1	1	0	0	1	0	0	1	0	92h	Check byte

Response frame

Byte	MSB							LSB	HEX	Note
	7	6	5	4	3	2	1	0		
-2	0	1	0	1	1	0	0	1	59h	Synchronization byte
-1	1	1	0	0	0	0	1	0	C2h	Echo of command byte
0	x	x	x	x	x	x	x	x	XXh	Diagnostic data
1									XXh	Diagnostic data
2									XXh	Diagnostic data
3									XXh	Diagnostic data
4									XXh	Diagnostic data
5									XXh	Diagnostic data
6									XXh	Diagnostic data
7									XXh	Diagnostic data

8									XXh	Target 1 distance [1 m], LSB
9									XXh	Target 1 distance, MSB
10									XXh	Target 2 distance [1 m], LSB
11									XXh	Target 2 distance, MSB
12									XXh	Target 3 distance [1 m], LSB
13									XXh	Target 3 distance, MSB
14									XXh	Target 1 magnitude
15									XXh	Target 2 magnitude
16									XXh	Target 3 magnitude
17									XXh	Not in use
18									XXh	Battery voltage (+U [mV]), LSB
19									XXh	Battery voltage, MSB
20									XXh	Power consumption [mW], LSB
21									XXh	Power consumption [mW], MSB
22									XXh	IO voltage (+3300 mV), LSB
23									XXh	IO voltage, MSB
24									XXh	Detector bias ([0.01V]), LSB
25									XXh	Detector bias, MSB
26									XXh	+5V voltage [mV], LSB
27									XXh	+5V voltage [mV], MSB
28									XXh	RX temperature [0.01°C], LSB
29									XXh	RX temperature [0.01°C], MSB
30									XXh	Status byte 1 *1
31									XXh	Status byte 2 *1
32									XXh	Status byte 3 *1
33									XXh	Pulse Counter [millions of pulses] (LSB)*2
34									XXh	Pulse Counter *2
35									XXh	Pulse Counter (MSB) *2
36									XXh	RS error counter
37	X	X	X	X	X	X	X	X	XXh	Check byte (checksum XOR 50h)

*1 For more information about status bytes check chapter 3.4.

*2 When the count has increased to 1 000 the laser is entering to end of lifetime period. However, the laser has been tested for even 10 times higher pulse count in room temperature, so lifetime up to value of 10 000 may be possible without noticeable deterioration.

3.12 Reset serial error counter

Error counter is returned in the diagnostic data (see chapter 3.11).

Command frame

Byte	MSB							LSB	HEX	Note
	7	6	5	4	3	2	1	0		
0	1	1	0	0	1	0	1	1	CBh	Reset error counter of serial communication
1	1	0	0	1	1	0	1	1	9Bh	Check byte (checksum XOR 50h)

Answer: Standard acknowledgement frame.

3.13 Break range measurement

The command can be used to stop continuous measurement.

Command frame

Byte	MSB				LSB				HEX
	7	6	5	4	3	2	1	0	
0	1	1	0	0	0	1	1	0	C6h
1	1	0	0	1	0	1	1	0	96h

Note
Break range measurement
Check byte (checksum XOR 50h)

Answer: Standard acknowledgement frame.