TELEGRAM LISTING

User Protocol Services for Configuring/Operating the LD-OEM/LD-LRS Laser Measurement System

Firmware Version 1.00

SICK
Sensor Intelligence.

Software Versions

Device	Function	Version
NAV310, LD-OEM1501, LD-LRS36x1	Firmware	from V1.00

Latest Manual Version

For the latest version of this manual (PDF), see **www.sick.com**.

Contents

Abbreviation

CAN	**C**ontroller **A**rea **N**etwork
CRC	**C**yclic **r**edundancy **c**heck
DID	Transmitter **ID**
DSP	**D**igital **S**ignal **P**rocessor
EDM	**E**lectronic **D**istance **M**eter
LD	**L**adar **D**igital (Ladar = Laser Radar)
LD-LRS	**L**adar **D**igital - **L**onge **R**ange **S**canner
SID	**S**ender **ID**
UPF	**U**ser **P**rotocol **F**rame
USP	**U**ser **S**ervice **P**rotocol

Tables

Figures

1 Notes on this document

1.1 Purpose

This document shows you how to use and configure (parameterise) the NAV310 / LD-OEM1501/ LD-LRS36x1 by means of a compact command language (User Protocol Ser-vices), based on telegrams.

The document contains information on:

- Data communication between the host/driver and laser measurement system
- Configuration by means of telegrams
- Commands/responses in the telegrams
- Troubleshooting

Note From now on, the NAV310 / LD-OEM1501/ LD-LRS36x1 (NAV310, LD-OEM1501, LD-LRS3601/3611) will simply be referred to as the “NAV310/LD-OEM/LD-LRS“.

1.2 Target audience

This document is aimed at technicians and engineers.

1.3 Information content

This document contains all the information required for communicating with the NAV310/LD-OEM/LD-LRS by means of telegrams.

The NAV310 must be **mounted, installed electrically and programmed with the basic communication parameters** in accordance with the specifications in the *NAV310 Operating Instructions* (German edition: part no. 8016534, English edition: part no. 8016535).

The LD-OEM1501 must be **mounted, installed electrically and programmed with the basic communication parameters** in accordance with the specifications in the *LD-OEM15xx Operating Instructions* (German edition: part no. 8013893, English edition: part no. 8016263).

The LD-LRS36x1 must be **mounted, installed electrically and programmed with the basic communication parameters** in accordance with the specifications in the LD-LRS36xx Operating Instructions (German edition: part no. 8016505, English edition: part no. 8016506).

For the basic description of the data communication via the three interface types of the NAV310/LD-OEM/LD-LRS see the appendix in the operating instructions.

For further information on laser measurement technology, please contact the SICK AG or visit the SICK Web site at **www.sick.com**.

1.4 Symbols

Certain information in this documentation is specially highlighted to draw your attention:

Reference Italics are used to refer to more detailed information elsewhere.

Explanation Explanations provide background information on technical correlations.

Note Provide information on special features.

Default settings Lists the default factory settings for the NAV310/LD-OEM/LD-LRS.

This symbol indicates that further technical documentation is available for the subject in question.

This symbol indicates important information.

This symbol warns against improper use of the NAV310/LD-OEM/LD-LRS.

2 Safety information

2.1 Authorized users

To ensure that the NAV310/LD-OEM/LD-LRS works properly and safely, it must be installed, parameterised, and operated by sufficiently qualified personnel.

The following qualifications are required for commissioning and operation:

- Basic, practical training in electrical engineering
- Knowledge of the relevant safety guidelines
- Knowledge of the hardware and software environment for the relevant application
- Basic data transfer knowledge
- Basic programming knowledge

2.2 Indended use

The NAV310/LD-OEM/LD-LRS is a non-contact, stand-alone remote or networking (Ethernet) distance measuring system designed for use in industrial environments.
The NAV310/LD-OEM/LD-LRS outputs measured conture values as raw data via a data interface. These data can be queried and evaluated in real time by a host computer with fast data communication by means of application software (driver) provided by the customer.
The four switching outputs “OUT 1“ to “OUT 4“ as well as the two yellow LEDs can be freely assigned to a function by means of the application software.

Implementing the device in any other applications, modifying it in any way, whether during mounting and electrical installation, or making changes to the SICK software will result in an annulment of any warranty claims vis-à-vis SICK AG.

2.3 General safety instructions and protection measures

1. The NAV310/LD-OEM/LD-LRS uses a class 1 laser (eye-safe).
   Observe the laser safety standards to EN/IEC 60825-1 (latest version).
2. When using electrical systems, observe the standard safety precautions.
   (The NAV310/LD-OEM/LD-LRS requires 24 V DC).


ATTENTION

The NAV310 / LD-OEM1501/ LD-LRS36x1 are not devices for personnel protection in the sense of valid safety standards for machines.

3 Introduction

3.1 General

This document describes the services, which control the action of the NAV310/LD-OEM/LD-LRS.

3.1.1 Purpose of the NAV310/LD-OEM/LD-LRS

The NAV310/LD-OEM/LD-LRS scans the surroundings by a laser beam and supplies the measured distances. The resulting data are polar coordinates.
The NAV310/LD-OEM/LD-LRS head rotates clockwise (mathematical negative). The origin of the coordinate system is shown in *Fig. 3-1*.

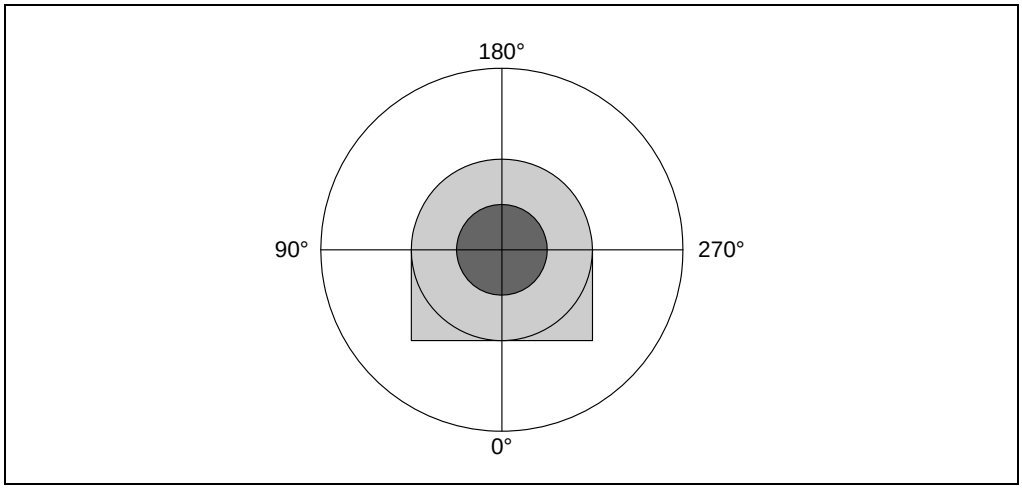

Fig. 3-1: Position of the NAV310/LD-OEM/LD-LRS in the polar coordinates (top view)

Communication with the sensor is possible via Ethernet.

3.2 Host protocol

The host protocol provides a set of commands to control the NAV310/LD-OEM/LD-LRS. This set of commands is divided into different service groups.

When the NAV310/LD-OEM/LD-LRS has received a host protocol command, it answers with a certain response. The NAV310/LD-OEM/LD-LRS responds when the service has been processed. Generally, this takes less than one second. An exception is the service TRANS_ROTATE, which can take several seconds.

3.2.1 Data type definition

Type	Format	Valid values
signed		
INT16	2 Byte	–32,768 to +32,767
unsigned		
BYTE	1 Byte	0 to 255
WORD	2 Byte	0 to 65535
DWORD	4 Byte	0 to 4,294,967,295

Table 3-1: Data type definition

3.2.2 Service code

The service code is used to determine the kind of service of a host request. It can be seen as the command. Its data format is WORD.

The most significant bit defines whether the code is a request or a response. For a request the most significant bit is set to zero and for a response it is set to one. Usually the NAV310/LD-OEM/LD-LRS does not request any data. Consequently, requests are sent by the host whereas responses are sent by the NAV310/LD-OEM/LD-LRS. The remaining of the high byte determines the service group and the low byte defines the service number (*Table 3-2*).

Bit 15	Bit 14 to 8	Bit 7 to 0
Response bit	Service group 0 to 127	Service number 0 to 255

Table 3-2: Service code

4 Available services

The following list gives an overview of the provided services.

Service group 01h: Status Services		
Service No.	Service	See
01h	GET_IDENTIFICATION	*Section 5.1.1, Page 15*
02h	GET_STATUS	*Section 5.1.2, Page 15*
03h	Reserved	-
04h	GET_SIGNAL	*Section 5.1.3, Page 16*
05h	SET_SIGNAL	*Section 5.1.4, Page 17*

Table 4-1: Overview: Status Services

Service group 02h: Configuration Services		
Service No.	Service	See
01h	SET_CONFIG	*Section 5.2.1, Page 18*
02h	GET_CONFIG	*Section 5.2.2, Page 22*
03h	SET_TIME_ABS	*Section 5.2.5, Page 24*
05h	GET_SYNC_CLOCK	*Section 5.2.5, Page 24*
06h	Reserved	-
07h	Reserved	-
08h	Reserved	-
09h	SET_FILTER	*Section 5.2.6, Page 25*
0Ah	SET_FUNCTION	*Section 5.2.7, Page 26*
0Bh	GET_FUNCTION	*Section 5.2.8, Page 31*

Table 4-2: Overview: Configuration Services

Service group 03h: Measurement Services		
Service No.	Service	See
01h	GET_PROFILE	*Section 5.3.2, Page 35*
02h	CANCEL_PROFILE	*Section 5.3.3, Page 36*

Table 4-3: Overview: Measurement Services

Service group 04h: Working Services		
Service No.	Service	See
01h	DO_RESET	*Section 5.4.1, Page 37*
02h	TRANS_IDLE	*Section 5.4.2, Page 37*
03h	TRANS_ROTATE	*Section 5.4.3, Page 38*
04h	TRANS_MEASURE	*Section 5.4.3, Page 38*

Table 4-4: Overview: Working Services

Service group 07h: File Services		
Service No.	Service	See
03h	LOAD	*Section 5.5.2, Page 40*

Table 4-5: Overview: File Services

Service group 10 to 3Fh: Application Services	
Service No.	Service
Services are depending on application software in application DSP	

Table 4-6: Overview: Application Services

5 Service definitions

5.1 Status Services

5.1.1 GET_IDENTIFICATION

Request command **0101h**:

Description	Information about the NAV310/LD-OEM/LD-LRS type, firmware and application version	
Parameter	*Type*	*Meaning*
IDENTITEM	WORD	0000h Part number of the sensor (NAV310/LD-OEM/LD-LRS) 0001h Name of sensor (NAV310/LD-OEM/LD-LRS) 0002h Version of the sensor (NAV310/LD-OEM/LD-LRS) 0003h Serial number of the NAV310/LD-OEM/LD-LRS unit 0004h Serial number of EDM unit 0010h Part number of the sensor 0011h Name of the sensor 0012h Version of the firmware 0020h Part number of the application software 0021h Name of the application software 0022h Version of the application software

Table 5-1: Status Services: GET_IDENTIFICATION (request command)

NAV310/LD-OEM/LD-LRS response **8101h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
IDENTITEM	WORD[6]	*See request command*
SENSSTAT	DWORD	Status of NAV310/LD-OEM/LD-LRS

Table 5-2: Response to GET_IDENTIFICATION

The return value of GET_IDENTIFICATION is a string of ASCII characters. Two characters are transmitted within a single WORD.

If the requested IDENTITEM is invalid, the NAV310/LD-OEM/LD-LRS responses to the IDENTITEM 0000h (part number).

5.1.2 GET_STATUS

Request command **0102h**:

Description	Status query	
Parameter	*Type*	*Meaning*
-	-	-

Table 5-3: Status Services: GET_STATUS (request command)

NAV310/LD-OEM/LD-LRS response **8102h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
SENSSTAT	DWORD	Status of the sensor (NAV310/LD-OEM/LD-LRS)

Table 5-4: Response to GET_STATUS

The definition of the SENSTAT value is shown in *Chapter 6.3 Sensor mode values, Page 43*.

5.1.3 GET_SIGNAL

Request command **0104h**:

Description	Reads the value of the switch and LED port	
Parameter	*Type*	*Meaning*
-	-	-

Table 5-5: Status Services: GET_SIGNAL (request command)

NAV310/LD-OEM/LD-LRS response **8104h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
PORTVAL	WORD	Lower Byte: Port bits Upper Byte: 00h

Table 5-6: Response to GET_SIGNAL

The definition of the 8 port bits of PORTVAL:

Bit	**Meaning**
0	LED 0 (yellow)
1	LED 1 (yellow)
2	LED 2 (green)
3	LED 3 (red)
4	Switch 0
5	Switch 1
6	Switch 2
7	Switch 3

Table 5-7: Definition of the 8 port bits of PORTVAL

Note A LED or switch is on when the corresponding bit is set to 1.

5.1.4 SET_SIGNAL

Request command **0105h**:

Description	Sets the switches and LEDs	
Parameter	*Type*	*Meaning*
PORTVAL	WORD	Lower byte: Port bits Upper byte: Do not care

Table 5-8: Status Services: SET_SIGNAL (request command)

NAV310/LD-OEM/LD-LRS response **8105h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
PORTVAL	WORD	Request successful: Lower byte: Port bits Upper byte : 00h Request failed: Lower byte: FFh Upper byte: FFh

Table 5-9: Response to SET_SIGNAL

Note The definition of PORTVAL is given in GET_SIGNAL.

Bit 2 (LED 2, green) and Bit 3 (LED 3, red) are not accessible via the service SET_SIGNAL.

5.2 Configuration Services

The configuration services handle the parameter setting and the internal clock of the NAV310/LD-OEM/LD-LRS. The internal clock is a 16-bit counter that supplies the internal time in milliseconds.

5.2.1 SET_CONFIG

Request command **0201h**:

One time set-up for the application (all parameters are stored permanently in a non-volatible memory).

Description	Sets the configuration	
Parameter	*Type*	*Meaning*
CONFIGITEM	WORD	0000h RS232 / RS422 configuration key 0001h Reserved 0002h Reserved 0003h Reserved 0005h Ethernet configuration key 0010h Global configuration 0011h Interlace configuration key
CONFIGDATA	WORD[k]	Configuration parameters; depend on configuration key

Table 5-10: Configuration Services: SET_CONFIG (request command)

Configuration parameters for RS 232/422 configuration, CONFIGITEM = 0001h

Parameter	*Meaning*
CONFIGDATA[0]	Baud rate: 0001h 4,800 bd 0002h 9,600 bd 0003h 19,200 bd 0004h 38,400 bd 0005h 57,600 bd 0006h 115,200 bd
CONFIGDATA[1]	**Not supported, always written as 0** 0: No parity 1: Even parity 2: Odd parity
CONFIGDATA[2]	**Not supported, always written as 1** 1: One stop bit 2: Two stop bits
CONFIGDATA[3]	**Not supported, always written as 8** Number of bits per character (1 to 8 bit)

Table 5-11: Configuration Services: Configuration parameters for RS 232/422

Configuration parameters for Ethernet configuration, CONFIGITEM = 0005h

Parameter	*Meaning*	*Example*
CONFIGDATA[0]	IP address: leftmost part	192 = 00C0h
CONFIGDATA[1]	IP address	168 = 00A8h
CONFIGDATA[2]	IP address	1 = 0001h
CONFIGDATA[3]	IP address: rightmost part	11 = 000Bh

Table 5-12: Configuration Services: Configuration parameters for Ethernet

CONFIGDATA[4]	Subnet mask: leftmost part	255	=	00FFh
CONFIGDATA[5]	Subnet mask	255	=	00FFh
CONFIGDATA[6]	Subnet mask	255	=	00FFh
CONFIGDATA[7]	Subnet mask: rightmost part	0	=	0000h
CONFIGDATA[8]	Standard gateway: leftmost part	192	=	00C0h
CONFIGDATA[9]	Standard gateway	168	=	00A8h
CONFIGDATA[A]	Standard gateway	1	=	0001h
CONFIGDATA[B]	Standard gateway: rightmost part	1	=	0001h
CONFIGDATA[C]	Node ID	16	=	10h = Sensor ID
CONFIGDATA[D]	Reserved			

Table 5-12: Configuration Services: Configuration parameters for Ethernet

Configuration parameters for global configuration, CONFIGITEM = 0x10h

Parameter	*Meaning*
CONFIGDATA[0]	NAV310/LD-OEM/LD-LRS sensor ID: 0000h to 00FEh (1 to 254)
CONFIGDATA[1]	Nominal value motor speed 0005h to 0014h (5 to 20)
CONFIGDATA[2]	Angle step; difference between two laser pulses in 1/16 degrees. The value must be a divisor of 5.760 and greater than 1.

Table 5-13: Configuration Services: Configuration parameters for global configuration

Note All three values must be set at the same time.

NAV310/LD-OEM/LD-LRS response **8201h**:

Description	Response of NAV310/LD-OEM/LD-LRS		
Parameter	*Type*	*Meaning*	
CONFIGRESULT	WORD	0000h FFFFh	Configuration setting was successful Configuration setting was not successful

Table 5-14: Response to SET_CONFIG

Note The following is not available for NAV310.

Configuration parameters for Interlace configuration, CONFIGITEM = 0011h

Parameter	*Meaning*
CONFIGDATA[0]	Interlace mode: 0000h interlace off 0001h 2x interlace 0002h 3x interlace 0003h 4x interlace

Table 5-15: Configuration Services: Interlace configuration

NAV310/LD-OEM/LD-LRS response **8201h**:

Description	Response of NAV310/LD-OEM/LD-LRS		
Parameter	*Type*	*Meaning*	
CONFIGRESULT	WORD	0000h FFFFh	Configuration setting was successful Configuration setting was not successful

Table 5-16: Response to SET_CONFIG

The selected interlace-configuration can be retrieved by GET_CONFIG, CONFIGITEM = 0011h.

The interlace-function allows a higher angular resolution using the same rotation frequency.

Within SOPAS or by a telegram command the intended resolution, the number of scans to build one combined high resolution scan and the sector to be scanned has to be defined.

The scanner firmware calculates the corresponding angular resolution for the individual scans.

The sequence number of an interlace scan is indicated by the parameter LAYERNUM in the GET_PROFILE response. To use this parameter it is necessary to select “LAYERNUM” in the parameter PROFILEFORMAT of the GET_PROFILE request command.

Example 1:

- 4x Interlace
- Sector 90°-269°
- Target angular resolution 0.0625°
- Rotation frequency 10 Hz

There will be 4 alternating scans at 10 Hz:

1st Scan:	LAYERNUM 0000	Start angle 90°,	Resolution 0.25°
2nd Scan:	LAYERNUM 0001	Start angle 90.125°	Resolution 0.25°
3rd Scan:	LAYERNUM 0002	Start angle 90.0625°	Resolution 0.25°
4th Scan:	LAYERNUM 0003	Start angle 90.1875°	Resolution 0.25°

Table 5-17: Alternating scans - Example 1

Set-up sequence in SOPAS:

To avoid that a forbidden combination of parameters will be selected (invalid conditions), it is recommended to select first an allowed setting and then beginning with the interlace-setting, to set-up the wanted settings:

1. Rotation frequency to 10Hz
2. Interlace to 4x
3. If necessary the sector configuration
4. Angular resolution to 0.0625°
5. Rotation frequency to 10 Hz

Example 2:

- 2x Interlace
- Sector 90°-269°
- Target angular resolution 0.125°
- Rotation frequency 10 Hz

There will be 2 alternating scans at 10 Hz:

1st Scan:	LAYERNUM 0000	Start angle 90°,	Resolution 0.25°
2nd Scan:	LAYERNUM 0001	Start angle 90.125°	Resolution 0.25°

Table 5-18: Alternating scans - Example 2

Set-up sequence in SOPAS:

To avoid that a forbidden combination of parameters will be selected (invalid conditions), it is recommended to select first an allowed setting and then beginning with the interlace-setting, to set-up the wanted settings:

1. Rotation frequency to 5 Hz
2. Interlace to 2x
3. If necessary the sector configuration
4. Angular resolution to 0.125°
5. Rotation frequency to 10 Hz

5.2.2 GET_CONFIG

Request command **0202h**:

Description	Reads the configuration settings	
Parameter	*Type*	*Meaning*
CONFIGITEM	WORD	Configuration key

Table 5-19: Configuration Services: GET_CONFIG (request command)

NAV310/LD-OEM/LD-LRS response **8202h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
CONFIGRESULT	WORD	Configuration key. If this value is FFFFh, the requested configuration key was invalid and the CONFIGDATA field is empty
CONFIGDATA	WORD [k]	Configuration parameters; depend on configuration key

Table 5-20: Response to GET_CONFIG

See *Chapter 5.2.1 SET_CONFIG, Page 18* (SET_CONFIG service) for details of configuration key values and parameters.

5.2.3 SET_TIME_ABS

Request command **0203h**:

Description	Sets the internal clock to the time stamp value	
Parameter	*Type*	*Meaning*
SYNCABS	WORD	New value of the internal clock (ms)

Table 5-21: Configuration Services: SET_TIME_ABS (request command)

NAV310/LD-OEM/LD-LRS response **8203h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
SYNCTIME	WORD	New value of the internal clock (ms)

Table 5-22: Response to SET_TIME_ABS

5.2.4 SET_TIME_REL

Request command **0204h**:

Description	Corrects the internal clock by a defined value	
Parameter	*Type*	*Meaning*
SYNCREL	INT16	Offset value (ms), which corrects the internal clock

Table 5-23: Configuration Services: SET_TIME_REL (request command)

NAV310/LD-OEM/LD-LRS response **8204h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
SYNCTIME	WORD	New value of the internal clock (ms)

Table 5-24: Response to SET_TIME_REL

5.2.5 GET_SYNC_CLOCK

Request command **0205h**:

Description	Reads the internal time of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
-	-	-

Table 5-25: Configuration Services: GET_SYNC_CLOCK (request command)

NAV310/LD-OEM/LD-LRS response **8205h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
SYNCTIME	WORD	Actual time of the internal clock (ms)

Table 5-26: Response to GET_SYNC_CLOCK

5.2.6 SET_FILTER

Note The following is not available for NAV310.

Request command **0209h**:

Description	Sets the filter configuration	
Parameter	*Type*	*Meaning*
FILTERITEM	WORD	0001h Nearfield suppression
FILTERDATA	WORD[k]	Filter parameters, depend on Filteritem

Table 5-27: Configuration Services: SET_FILTER (request command)

Configurations parameters for nearfield suppression, FILTERITEM = 0001h:

Parameter	*Meaning*
FILTERDATA[0]	0000h Nearfield suppression OFF 0001h Nearfield suppression ON

Table 5-28: Configuration Services: configuration parameters for nearfield suppression

NAV310/LD-OEM/LD-LRS response **8209h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
FILTERITEM	WORD	Filter item: If this values FFFFh, the requested item was invalid and the FILTERDATA field is empty
FILTERDATA	WORD[k]	Filter parameters, depend on Filteritem

Table 5-29: Response to SET_FILTER

5.2.7 SET_FUNCTION

Request command **020Ah**:

Description	Assigns a measurement function to an angle range	
Parameter	*Type*	*Meaning*
SECTORNUM	WORD	Number of the measurement sector. Valid values: 0 to 7 (first sector is always 0)
SECTORFUNC	WORD	Measurement function for the sector. 0: Not initialised (always needed for last sector) 1: No measurement 2: Reserved 3: Normal measurement 4: Reference measurement
SECTORSTOP	WORD	Last angle of the current sector. NOTE: This Angle is given in 1/16 degrees. It must be an integer multiple of the angle step, i.e. of the angle between two laser pulses otherwise this sector is unreachable for the measurement kernel. Example: SECTORSTOP for sector 0 to 180°: (180° minus 1 angle step) x 16. Next sector starts at 180° (SECTORSTOP + 1 angle step)
FLASHFLAG	WORD	1: The sector configuration is written to flash memory Else: The sector configuration stays temporary and is lost after a reset.

Table 5-30: Configuration Services: SET_FUNCTION (request command)

Note

- If SECTORNUM > 7, SECTORNUM will be set to 7.
- If SECTORFUNC has an invalid number, SECTORFUNC will be set to 0 (Not Initialized).
- If SECTORSTOP is greater than a full circle (≥ 5,760 steps), SECTORSTOP will be reduced to an angle less than 5,760 steps.
  The value SECTORSTOP is not checked relating to the fact, if it is an integer multiple of the angle step. The service TRANS_MEASURE will do this.

A Sector (SECTORNUM) is defined by its function (SECTORFUNC) and its end angle (SECTORSTOP). The chosen function is performed until the end angle has been reached. Once the end angle has been reached, the defined function is performed for the last time. After this the measurement kernel switches to the next defined function. Consequently the start angle of a sector is defined by the end angle of the previous sector. The start angle of a sector equals the end angle of the previous sector plus the angle step width.

Sectors must be defined in increasing order starting at zero. If N sectors are configured, the function of sector N+1 must be 0 (*Not initialized*). This is not necessary, if all 8 sectors are configured. The following pages show 3 different examples.

Example 1:
Supposed the NAV310, LD-OEM1501, LD-LRS3601/3611 is to be set up for 360° measurement (*Fig. 5-1*).

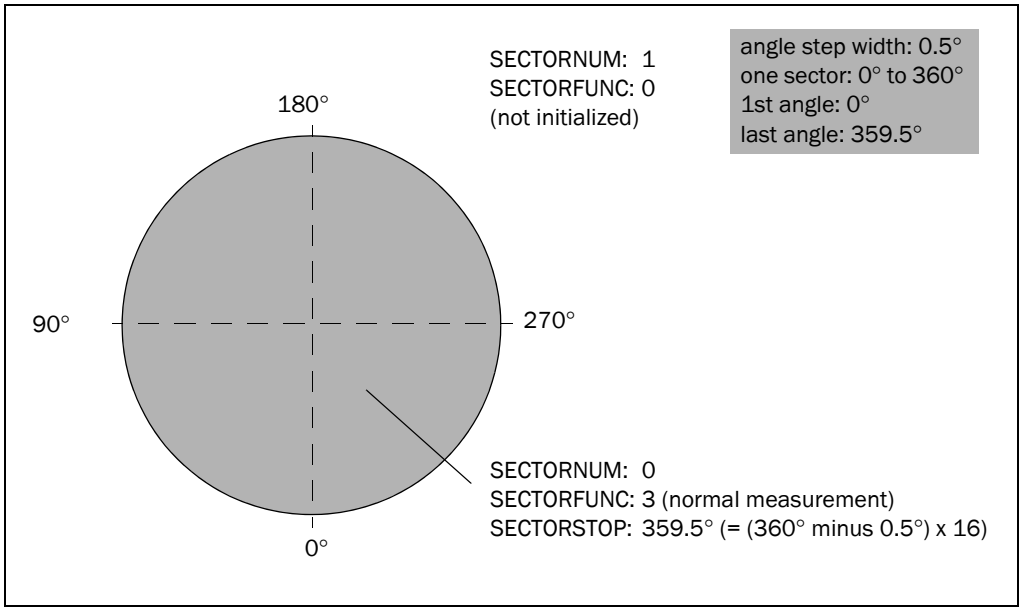

Fig. 5-1: Example 1: Using the whole range as one sector for measurement (top view)

In this case two sectors need to be defined: The first sector is sector 0, which is defined as *Normal measurement*. Assumed the defined stop angle is 0° and the angle step width is 0.5°, the first measurement of the sector is taken at 0.5° and the last measurement is taken at 0°. To get scans starting at 0°, the end angle must be defined as 359.5°(= 5,752/16)°.
The second sector is sector 1 which must be defined as *Not initialized*.

Example 2:

Scans starting at 90° and ending at 180° shall be taken (*Fig. 5-2, Page 29*). The angle step width is 0.5°.

Three sectors need to be defined: one for the measurement area, one for the none measurement area and one as *Not initialized*. To set this configuration, sector 0 is defined as *No measurement* with end angle 89.5° and sector 1 is defined as *Normal measurement* with end angle 179.5°. Sector 2 must be defined as *Not initialized*.

Explanation The first sector should be defined as *No measurement*, because the transmission of the profile data starts with sector 0. The transmission of profile data is much more efficient, when the sensor is not scanning.

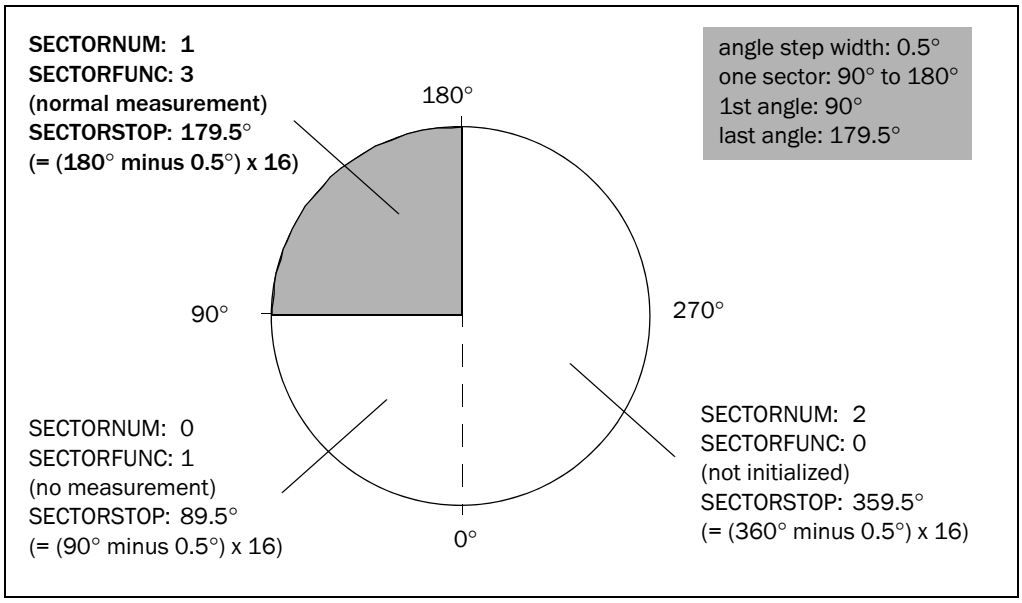

Fig. 5-2: Example 2: Using the sector 90° to 180° for measurement (top view)

Example 3:

The scan should be done in 2 sectors. Scans starting from 125° to 147° and 270° to 360° shall be taken (*Fig. 5-3*). The angle step width is 0.5°. The area from 125° to 147° shall be used for a reference measurement. The nearfield suppression is on.

Five sectors need to be defined, two for the measurement areas, two for the none measurement areas and one as *Not initialized*. To set this configuration, sector 0 is defined as *No measurement* with end angle 124.5° and sector 1 is defined as *Normal measurement* with end angle 146.5°. Sector 2 must be defined as *No measurement* with end angle 269.5°. Sector 3 must be defined as *Normal measurement* with end angle 359.5°. Sector 4 must be defined as *Not initialized*.

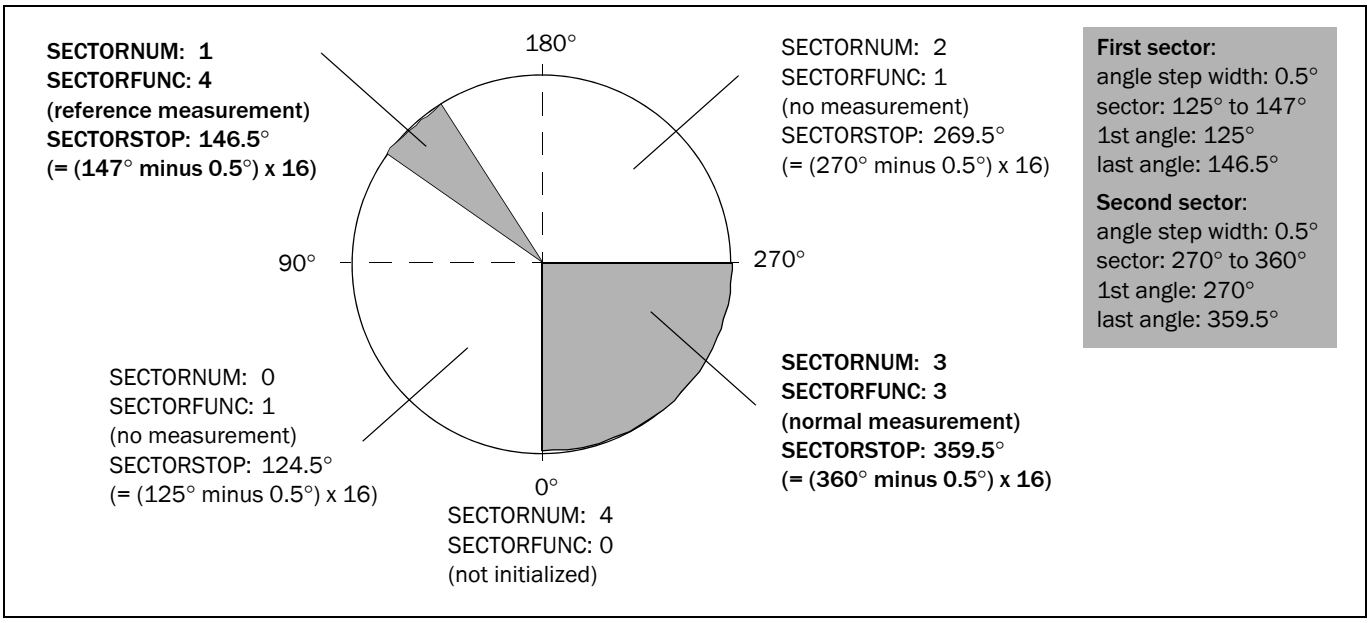

Fig. 5-3: Example 3: Using two sectors (125° to 147°) and (270° to 360°) for measurement (top view)

Explanation The first sector should be defined as *No measurement*, because the transmission of the profile data starts with sector 0. The transmission of profile data is much more efficient, when the sensor is not scanning.

NAV310/LD-OEM/LD-LRS response **820Ah**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
SECTORNUM	WORD	Number of the measurement sector. Valid values: 0 to 7
SECTORFUNC	WORD	Measurement function for the sector
SECTORSTOP	WORD	End angle of the sector

Table 5-31: Response to SET_FUNCTION

The values can differ from the ones which should be set.

The response parameters SECTORNUM, SECTORFUNC and SECTORSTOP are set to 0xFFFFh if SECTORNUM or the request itself were invalid.

5.2.8 GET_FUNCTION

Request command **020Bh**:

Description	Returns the configuration of the declared sector	
Parameter	*Type*	*Meaning*
SECTORNUM	WORD	Number of the measurement sector. Valid values: 0 to 7

Table 5-32: Configuration Services: GET_FUNCTION (request command)

NAV310/LD-OEM/LD-LRS response **820Bh**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
SECTORNUM	WORD	Number of the measurement sector.
SECTORFUNC	WORD	Measurement function for the sector 0: Not initialised 1: No measurement 2: Reserved 3: Normal measurement 4: Reference measurement If activated, the nearfield suppression (see also *Chapter 5.2.6 SET_FILTER, Page 25*) will be not active in this sector. May be used for a reference measurement or other measurements in the close area.
SECTORSTOP	WORD	End angle of the sector

Table 5-33: Response to GET_FUNCTION

The response parameters SECTORNUM, SECTORFUNC and SECTORSTOP are set to 0xFFFFh if SECTORNUM or the request itself were invalid.

In the scan configuration all active sectors will be finished by a sector with SECTORFUNC = „Not Initialized“

Note: For sectors, where the value of SECTORNUM is higher than the last active sector, the response command to

the GET_FUNCTION command consist of:

SECTORNUM: Number of sector

SECTORFUNC: 0

SECTORSTOP 0

5.3 Measurement Services

5.3.1 Data format

The distance value is represented by a 16-bit binary value with a resolution (step width) of 3.9 mm (1/256 m). The angle is also represented by a 16-bit binary value with a resolution of 1/16°.

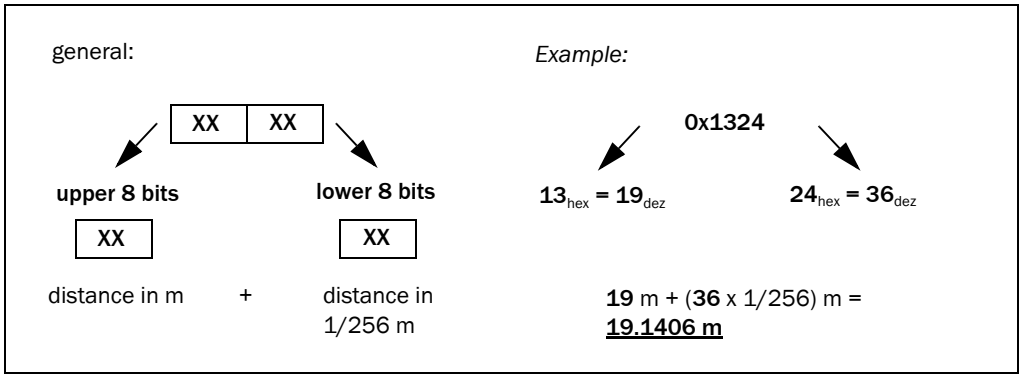

Fig. 5-4: Structure of the 16-bit binary distance values, represented in a WORD

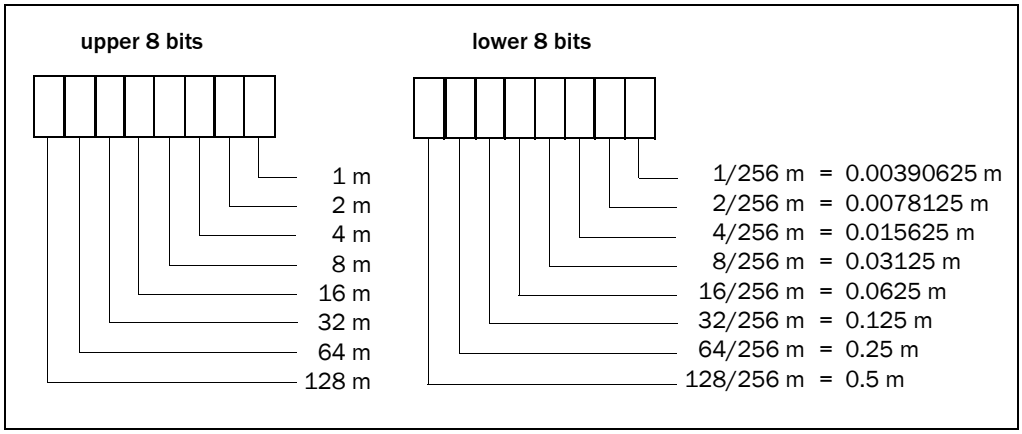

Fig. 5-5: Distance resolution of the upper and lower bit blocks

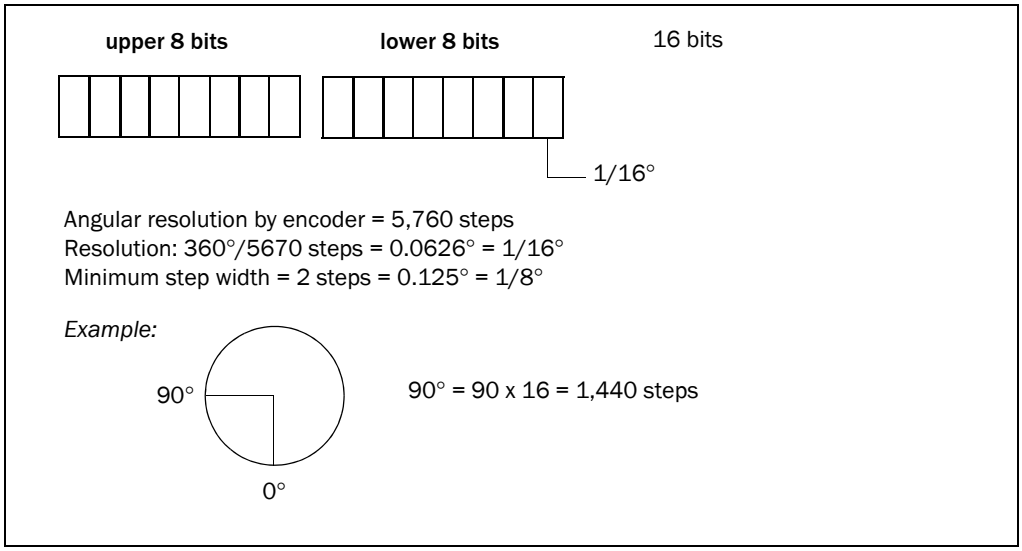

Fig. 5-6: Angular resolution by the encoder, represented in a WORD

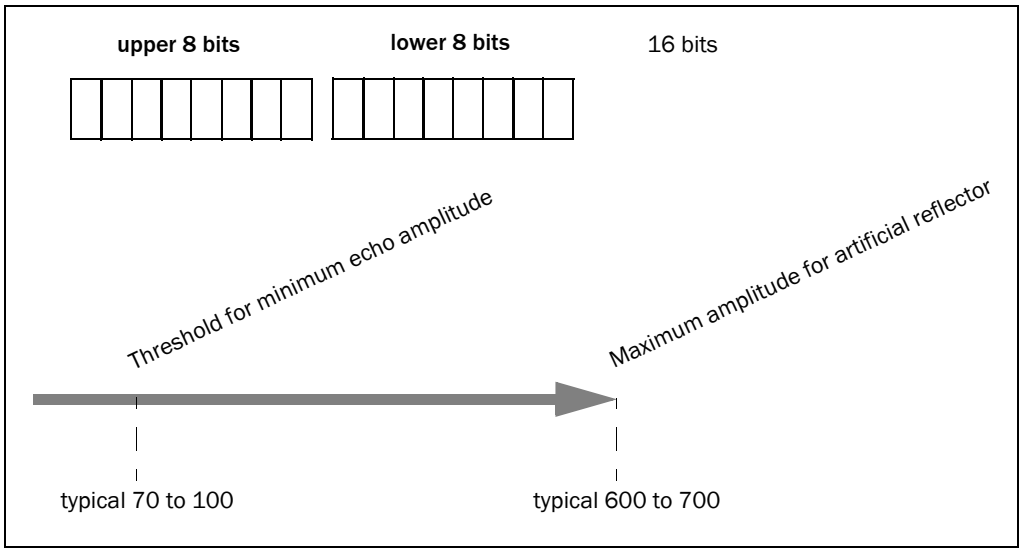

Fig. 5-7: Echo amplitude, represented in a WORD

5.3.2 GET_PROFILE

Request command **0301h**:

Description	Requests n profiles of a defined format	
Parameter	*Type*	*Meaning*
PROFILENUM	WORD	Number of profiles, if it is equals 0 the NAV310/LD-OEM/ LD-LRS sends profiles continuously, until the user sends the CANCEL_PROFILE command
PROFILEFORMAT	WORD	16-bit array

Table 5-34: Measurement Services: GET_PROFILE (request command)

The definition of the 16-bit array PROFILEFORMAT:

Bit	**Meaning**
0	Number of the transmitted profile
1	Profile counter
2	Number of Layer
3	Number of Sector
4	Angle step
5	Number of points of the sector
6	Time stamp when the sector starts
7	Start direction of the sector
8	Measured distances
9	Direction of measured distances
10	Echo amplitudes
11	Time stamp when the sector ends
12	End direction of the sector
13	NAV310/LD-OEM/LD-LRS mode
14	reserved (always 0)
15	reserved (always 0)

Table 5-35: Definition of the 16-bit array of PROFILEFORMAT

NAV310/LD-OEM/LD-LRS response **8301h**:

Description		Response of NAV310/LD-OEM/LD-LRS					
CB*)	*Parameter*	*Type*	*Meaning*				
**)	PROFILEFORMAT	WORD	Format of the following profile				This data is sent with each Scan
**)	PROFILEINFO	WORD	Most significant byte: number of layers (always 1) Least significant byte: number of sectors				
0	PROFILESENT	WORD	Number of the profiles sent to the host. Counts from 0 to PROFILENUM. If PROFILENUM = 0, a 16-bit counter counts continuously.				
1	PROFILECOUNT	WORD	Number of the profiles gathered by the NAV310/LD-OEM/LD-LRS. 16-bit counter that counts continuously.				
2	LAYERNUM	WORD	Number of the layer (always 0)			This data is sent with each layer	
3	SECTORNUM	WORD	Number of the sector		This data is sent with each sector		
4	DIRSTEP	WORD	Angle step in (degree x 16)				
5	POINTNUM	WORD	Number of points of the sector				
8	TSTART	WORD	Time stamp when the sector starts at the first point in (ms)				
7	STARTDIR	WORD	Start direction of the sector in (degree x 16)				
8	DISTANCE-n	WORD	Measured distance (m x 256)	This data is sent with each distance point			
9	DIRECTION-n	WORD	Direction in (degree x 16)				
10	ECHO-n	WORD	Echo amplitude				
11	TEND	WORD	Time stamp of the last point in (ms)				
12	ENDDIR	WORD	End direction in (degree x 16)				
13	SENSTAT	DWORD	Status of NAV310/LD-OEM/LD-LRS				

*) CB = Corresponding Bit in PROFILEFORMAT

**) always sent

Table 5-36: Response to GET_PROFILE

The response contains – beside PROFILEFORMAT and PROFILEINFO, which are always sent – only the parameters requested in PROFILEFORMAT.

If the request command is invalid (no request parameters or PROFILEFORMAT = 0x0000h), the command is ignored and exactly one response, containing no parameters, is sent. No profiles are sent. If a measured point is invalid, DISTANCE is set to 0000h.

5.3.3 CANCEL_PROFILE

Request command **0302h**:

Description	Stops the profile output	
Parameter	*Type*	*Meaning*
-	-	-

Table 5-37: Measurement Services: CANCEL_PROFILE (request command)

NAV310/LD-OEM/LD-LRS response **8302h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*

Table 5-38: Response to CANCEL_PROFILE

Description	Response of NAV310/LD-OEM/LD-LRS	
SENSTAT	DWORD	Status of LD

Table 5-38: Response to CANCEL_PROFILE

The CANCEL_PROFILE command does not abort the transmission of the currently transmitted profile. Thus, the transmission of the current profile is completed before the CANCEL_PROFILE command terminates transmission of profiles.

5.4 Working Services

5.4.1 DO_RESET

Request command **0401h**:

Description	The NAV310/LD-OEM/LD-LRS enters a reset sequence	
Parameter	*Type*	*Meaning*
RESETLEVEL	WORD	0000h Reset 0001h Reset 0002h Stop measure

Table 5-39: Working Services: DO_RESET (request command)

NAV310/LD-OEM/LD-LRS response **8401h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
RESETLEVEL	WORD	The same value as in the Request command

Table 5-40: Response to DO_RESET

If RESETLEVEL is requested, the NAV310/LD-OEM/LD-LRS transmits the response after executing the command. The NAV310/LD-OEM/LD-LRS does not respond to any request during reset and system initialization.

5.4.2 TRANS_IDLE

Request command **0402h**:

Description	Sets the NAV310/LD-OEM/LD-LRS into the IDLE mode: the motor of the rotating prism stops and the laser is switched off	
Parameter	*Type*	*Meaning*
-	-	-

Table 5-41: Working Services: TRANS_IDLE (request command)

NAV310/LD-OEM/LD-LRS response **8402h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
SENSTAT	DWORD	Status of NAV310/LD-OEM/LD-LRS

Table 5-42: Response to TRANS_IDLE

5.4.3 TRANS_ROTATE

Request command **0403h**:

Description	Sets the NAV310/LD-OEM/LD-LRS into the ROTATE mode: the motor starts, when it is off, and rotates with a speed, defined by REV. The laser is switched off.	
Parameter	*Type*	*Meaning*
REV	WORD	0 Scanning frequency corresponds to the configuration parameter 1 to 4 Reserved 5 to 20 Scanning frequency in Hz

Table 5-43: Working Services: TRANS_ROTATE (request command)

NAV310/LD-OEM/LD-LRS response **8403h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
SENSTAT	DWORD	Status of NAV310/LD-OEM/LD-LRS

Table 5-44: Response to TRANS_ROTATE

If the request parameter REV is invalid, the NAV310/LD-OEM/LD-LRS is set to the IDLE mode.

The response to the TRANS_ROTATE command is sent when the rotation frequency is stable or after a constant time of several seconds.

5.4.4 TRANS_MEASURE

Request command **0404h**:

Description	Sets the NAV310/LD-OEM/LD-LRS into the MEASURE mode: the laser starts with the next revolution; a request for a profile can be started	
Parameter	*Type*	*Meaning*
-	-	-

Table 5-45: Working Services: TRANS_MEASURE (request command)

NAV310/LD-OEM/LD-LRS response **8404h**:

Description	Response of NAV310/LD-OEM/LD-LRS	
Parameter	*Type*	*Meaning*
SENSTAT	DWORD	Status of NAV310/LD-OEM/LD-LRS
ERRORCODE	WORD	0: OK, NAV310/LD-OEM/LD-LRS measures 1: Maximum laser pulse frequency too high 2: Mean laser pulse frequency too high 3: The sector borders are not configured correctly 4: A sector border is not a whole multiple of the angle step

Table 5-46: Response to TRANS_MEASURE

5.5 File Services

Note Only available for NAV310.

There is a total amount of 32k x16-bit flash memory used in the NAV310 to store angular compensation data. The values for the compensation are stored as INT32 with a resolution of 1/1000°.

5.5.1 Angular compensation by NAV310 Application

The applied formula is:

```
AngleComp =
AngleRaw + (AngleCompAmp * sin(AngleRaw - AngleCompPhase) + AngleCompOffset
```

Example in the program language C:

The following example of a C code algorithm may be implemented:

```
angleRaw:Raw angle as float in degrees (0.000..359.999)
angleComp:Compensated angle as float in degrees (0.000..359.999)

AngleCompAmp
AngleCompPhase
AngleCompOffset: Compensation parameters as int in 1/1000 degrees



float compensateAngle(float angleRaw)
{
float angleComp;

angleRaw += ((float) AngleCompOffset)/1000.0;
angleRaw += (((float) AngleCompAmp)/1000.0)
* sin((DEGTORAD * (angle - ((float) AngleCompPhase)/1000.0)));
return angleComp;
}
```

Example:

AngleCompAmp = Data from LOAD(0x2018) <<16 OR Data from LOAD(0x1018)

Note The compensation data are only valid if the scanner is mounted by the threads at the bottom and *not* by the threats on the backside of the housing

You cannot compensate for the remaining angular deviation of a few milligrads after the compensation.

5.5.2 LOAD

Request command **0703h** (only read angular compensation table):

Description	Recalls a file	
Parameter	*Type*	*Meaning*
FILE_ID	WORD	File ID. Valid values: 1018h, 101Ah, 2018h, 201Ah

Table 5-47: File Services: LOAD (request command)

Parameter	**Type**	**File-ID upper 16 bit**	**File-ID lower 16 bit**
AngleCompAmp	**WORD**	**0x2018**	**0x1018**
AngleCompPhase	**WORD**	**0x2019**	**0x1019**
AngleCompOffset	**WORD**	**0x201A**	**0x101A**

Table 5-48: Parameters LOAD

NAV310 response **8703h**:

Description	Response of NAV310	
Parameter	*Type*	*Meaning*
FILE_ID	WORD	File ID
LOAD_STAT	WORD	0: File Ok 1: File does not exist 2: Request incorrect (In this case, the response parameter File_ID has no meaning)
DATA_FILE	WORD[n]	Data stored
n equals the number of words stored		

Table 5-49: Response to LOAD

Note The compensation data are only valid if the scanner is mounted by the threads at the bottom and *not* by the threats on the backside of the housing

You cannot compensate for the remaining angular deviation of a few milligrads after the compensation.

6 Sensor modes

6.1 Description of the sensor modes

6.1.1 IDLE mode

In the IDLE mode the motor and the laser module are off. A TRANS_ROTATE command sets the sensor into ROTATE mode.

The IDLE MODE is also entered when a TRANS_IDLE command has been received. If the NAV310/LD-OEM/LD-LRS is in the ROTATE mode when the TRANS_IDLE command is received, the device is forced into IDLE mode.

6.1.2 ROTATE mode

The motor of the spinning prism rotates. The rotating frequency is monitored by the NAV310/LD-OEM/LD-LRS. The laser is off.

A TRANS_IDLE command sets the NAV310/LD-OEM/LD-LRS into the IDLE mode, a TRANS_MEAS command into the MEASURE mode.

6.1.3 MEASURE mode

The motor of the rotating prism rotates and is monitored by the NAV310/LD-OEM/LD-LRS. The laser pulses in the defined zones. The GET_PROFILE command is available.

A TRANS_ROTATE command sets the NAV310/LD-OEM/LD-LRS into the ROTATE mode.

6.2 Availability of the service commands

The following tables show the availability of the service commands. If a service is requested, which is not available in this mode, the NAV310, LD-OEM1501, LD-LRS3601, LD-LRS3611 sends the SERVICE_FAILURE response.

Service Group	Service	IDLE mode	ROTATE mode	MEASURE mode
Status Services	GET_IDENTIFICATION	X	X	X
	GET_STATUS	X	X	X
	GET_SIGNAL	X	X	X
	SET_SIGNAL	X	X	X

Table 6-1: Availability of the service commands: Status Services

Service Group	Service	IDLE mode	ROTATE mode	MEASURE mode
Configuration Services	SET_CONFIG	X		
	GET_CONFIG	X	X	
	GET_SYNC_CLOCK	X	X	X
	SET_FILTER	X	X	
	SET_FUNCTION	X	X	
	GET_FUNCTION	X	X	

Table 6-2: Availability of the service commands: Configuration Services

Service Group	Service	IDLE mode	ROTATE mode	MEASURE mode
Measurement Services	GET_PROFILE			X
	CANCEL_PROFILE			X

Table 6-3: Availability of the service commands: Measurement Services

Service Group	Service	IDLE mode	ROTATE mode	MEASURE mode
Working Services	DO_RESET	X	X	X
	TRANS_IDLE	X	X	
	TRANS_ROTATE	X	X	X
	TRANS_MEASURE		X	X

Table 6-4: Availability of the service commands: Working Services

Note: The following is only available for NAV310.

Service Group	Service	IDLE mode	ROTATE mode	MEASURE mode
File Services	LOAD (only read angular compensation table WK	X	X	

Table 6-5: Availability of the service commands: File Services

6.3 Sensor mode values

The sensor mode value SENSTAT is a DWORD type. The following table defines the coding of SENSTAT.

Only bits 0 to 7 are valid. Bits 8 to 32 are for future use.

Bit	Number of bits	Function
0 to 3	4	Working mode 1h: IDLE Mode 2h: ROTATE mode 3h: MEASURE mode 4h: ERROR mode 5 to Fh: Reserved
4 to 7	4	Motor mode 0h: Motor ok 1 to 8h: Reserved 9h: Motor spin to high 4h: Motor spin to low Bh: Motor stops or coder error C to Fh: Reserved
8 to 31	24	Reserved

Table 6-6: Sensor mode values

7 Examples for user protocol services

This chapter shows some simple examples how service commands are build on the Ethernet interface.

7.1 Ethernet interface

7.1.1 Data structure via Ethernet Interface for realtime measurement

The communication protocol follows the TCP/IP standard. The transferred data are automatically split up into multiple packets by the ethernet controller if necessary. For the programmer this is not relevant. On the receiving end the individual packets are automatically collected and put into the correct sequential order.

The connection will be established via the Port 49152.

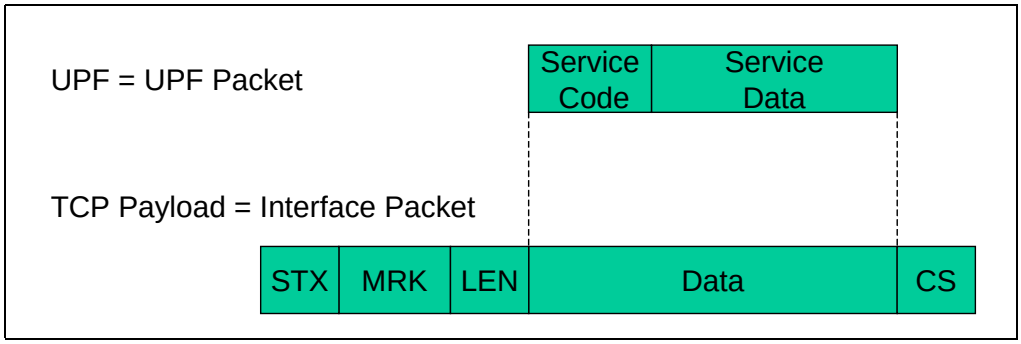

Fig. 7-1: Ethernet: Structure of the UPF packet in the User Service Protocol

STX "Start of Text", will be transferred as a single byte 0x02.

MRK Definition of the transmission format "USP"= 0x55, 0x53,0x50 (3 Bytes).

LEN UPF-Length = the number of the following bytes in <data>, coded as 32 Bit integer (four bytes) without leading sign, the MSB (most significant byte) must be transmitted first of all.

CS Checksum (single byte), calculated as exclusive-or-relation of all bytes contained in "Data".

7.1.2 Test sequence to check a Ethernet connection

Example: Request for status

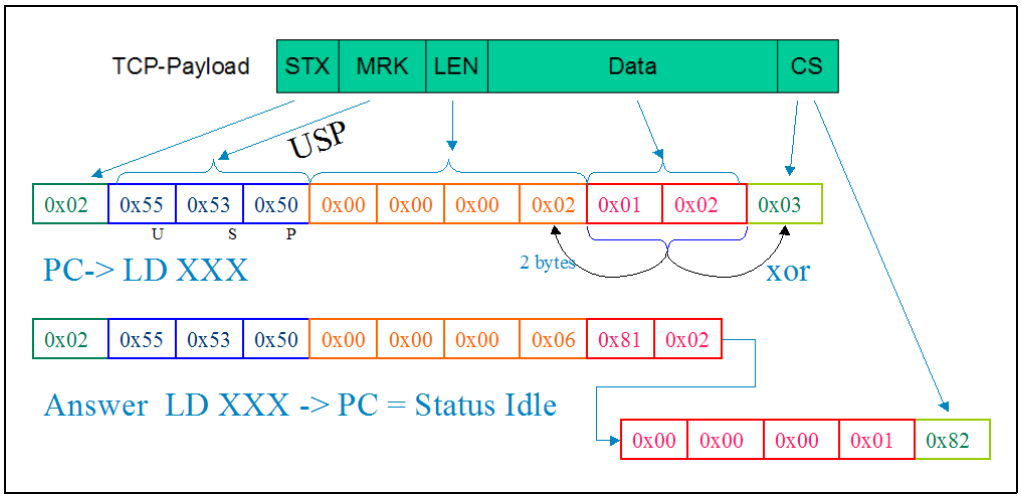

Fig. 7-2: Ethernet: Request by the PC/answer of the NAV310/LD-OEM/LD-LRS to status request

8 Maximum data throughput

The following tables show the limits and maximum possible data throughputs of the three on-board interfaces of the NAV310/LD-OEM/LD-LRS.

The used unit is 1 Word = 2 bytes = 16 bits.

Assumed is a host computer which is directly connected to the NAV310/LD-OEM/LD-LRS (peer-to-peer). The host computer must be fast enough to fetch all data from the receiving interface.

8.1 Data throughput at usage of the User Service Protocols

Interface	Format	Net rate of Payload	Overhead Framing USP	Net rate USP Data	Net rate USP Data (Words per Scan rate)
Ethernet (10 Mbit/s)	Binary	approx. 200 kbyte/s	9 Byte per packet	> 110 Kbyte/s	20,000 words at 5 Hz 10,000 words at 10 Hz 5,000 words at 20 Hz

Table 8-1: Data throughput of NAV310/LD-OEM/LD-LRS data interfaces if User Service Protocols are used

8.2 Examples of NAV310/LD-OEM/LD-LRS configurations for real time transmission

The scan area is the sum of all active sectors.

General limits:

- Maximum average pulse rate: 10,800 Hz
- Pulse-to-pulse: 14,400 Hz
- Max. data words per scan: 2,880 (plus header)

8.2.1 Ethernet interface

Scanning area	Angular resolution	Scanning frequency	PROFILEFORMAT (example)	Words per scan	Pulses per second (average)	Pulses per second (pulse to pulse)
180°	0.125°	5 Hz	0x3DFF = Dist + Echo	2,880	7,200	14,400
270°	0.125°	5 Hz	0x39FF = Distance	2,160	10,800	14,400
360°	0.1875°	5 Hz	0x39FF = Distance	1,920	9,600	9,600
360°	0.25°	7 Hz	0x3DFF = Dist **+ Echo**	2,880	10,080	10,080
360°	0.375°	**10 Hz**	0x3DFF = Dist + Echo	1,920	9,600	9,600
180°	0.25°	10 Hz	0x3DFF = Dist + Echo	1,440	7,200	14,400
270°	0.25°	10 Hz	0x3DFF = Dist **+ Echo**	**2,160**	10,800	14,400
360°	0.375°	11 Hz	0x3DFF = Dist **+ Echo**	**1,920**	10,560	10,560
180°	0.5°	20 Hz	0x3DFF = Dist + Echo	720	7,200	14,400
270°	0.5°	20 Hz	0x3DFF = Dist **+ Echo**	**1,080**	10,800	14,400
360°	0.75°	20 Hz	0x3DFF = Dist + Echo	960	9,600	9,600

Table 8-2: Data throughput of the Ethernet interface depending of the NAV310/LD-OEM/LD-LRS configuration

9 Error handling

9.1 Fatal errors

Red LED lights, communication possible:

The prism head doesn't rotate, although it should. The NAV310/LD-OEM/LD-LRS switches the laser automatically off.

Red LED lights, communication not possible:

The internal service management of the NAV310/LD-OEM/LD-LRS is out of order.

9.2 Service errors

A service request sent with missing or invalid parameters leads to a response, that indicates in the return value, that the request was invalid. For details see the descriptions of the services.

An invalid command request is answered by a SERVICE_FAILURE (FF00h).

Notes:

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