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

Firmware Version from V1.01

SICK

LD Software Versions

Software/Tool	Function	Version
LD OEM	Firmware	from V 1.04

 8 010 348/0000/13-08-2003

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Abbreviation

APD	**A**valanche **P**hoto **D**iode
ARCnet	**A**ttached **R**esource **C**omputing **Net**work
CAN	**C**ontroller **A**rea **N**etwork
DSP	**D**igital **S**ignal **P**rocessor
EDM	**E**lectronic **D**istance **M**eter
LD	**L**adar **D**igital (Ladar = Laser Radar)

Tables

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1 Notes on this document

1.1 Purpose

This document shows you how to use and configure (parameterise) the LD OEM laser measurement system by means of a compact command language (User Protocol Services), 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 LD OEM laser measurement system will simply be referred to as the "LD".

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 LD by means of telegrams.

The LD is **mounted, installed electrically and for the communication parameters basic setted** in accordance with the specifications in the *LD OEM Operating Instructions* (German edition: order no. 8 010 327, English edition: order no. 8 010 328).

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 to it:

Note Provide information on special features.

Default Lists the default factory settings for the LD.

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

This symbol indicates important information.

CAUTION

This symbol warns against improper use of the LD.

ATTENTION

2   Safety information

2.1   Authorized users

To ensure that the LD 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 LD is a non-contact, stand-alone remote or networking (CAN, ARCnet) distance measuring system designed for use in industrial environments. The LD outputs measured conture values as raw data via a serial 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 "Safe 1 + 2" and "Alarm 1 + 2" 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 LD uses a class 1 laser (eye-safe).
   Observe the laser safety standards to DIN EN 60825-1 (latest version).
2. When using electrical systems, observe the standard safety precautions.
   (The LD requires 24 V DC).

ATTENTION

The LD laser measurement system is not a device for personnel protection in the sense of valid safety standards for machines.

3   Introduction

3.1   General

This document desribes the services, which control the action of the LD.

3.1.1   Purpose of the LD

The LD scans the surroundings by a laser beam and supplies the measured distances. The resulting datas are polar coordinates. The LD head rotates clockwise (mathematical nega-tive). The origin of the coordinate system is shown in *Fig. 3-1*.
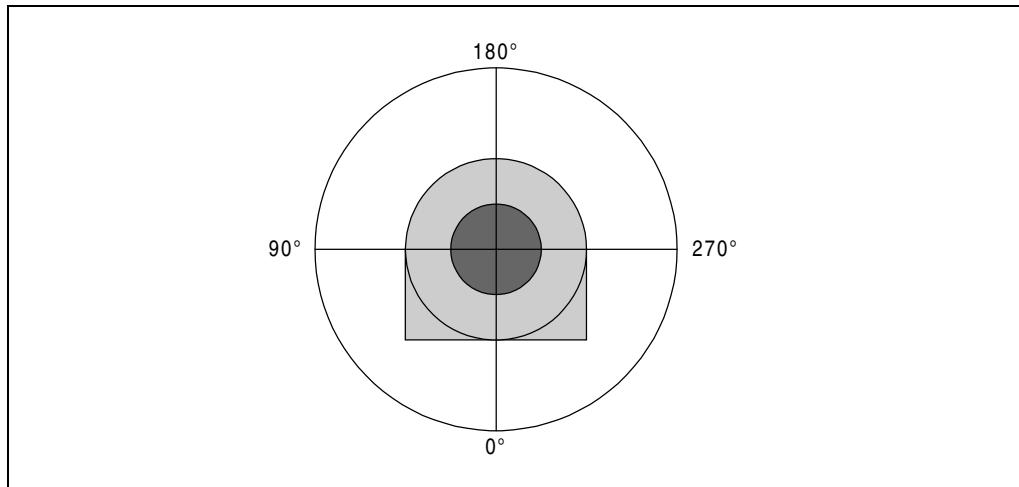
Fig. 3-1:   Position of the LD in the polar coordinates (top view)

Communication with the sensor is possible via several interfaces:

- RS 232/RS 422
- CAN
- optional: ARCnet
- optional: internal with application board

The LD owns 4 LEDs. The red LED indicates a fatal error. The green LED blinks permanently, indicating, that the device "lives". When the LD emitts laser pulses, the green LED blinks with a higher frequency. The programmable function of the two yellow LEDs are accessible by the user.

3.2   Host protocol

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

When the LD has received a host protocol command, it answers with a certain response. The LD 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.

Host protocol commands can be received via all interfaces. The interface dependent de-scription of the protocol can be found in the *LD OEM Operating Instructions* (German edition: order no. 8 010 327, English edition: order no. 8 010 328).

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3.2.1　Data type definition

Type	Format	Valid values
signed		
INT16	2 Byte	−32768 ... +32767
unsigned		
BYTE	1 Byte	0 ... 255
WORD	2 Byte	0 ... 65535
DWORD	4 Byte	0 ... 4 294 967 295

Tab. 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 LD does not request any data. Consequently, requests are sent by the host whereas responses are sent by the LD. The remaining of the high byte determines the service group and the low byte defines the service number (*Tab. 3-2*).

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

Tab. 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 13*
02h	GET_STATUS	*Section 5.1.2, Page 13*
03h	Reserved	-
04h	GET_SIGNAL	*Section 5.1.3, Page 14*
05h	SET_SIGNAL	*Section 5.1.4, Page 14*
06h	REGISTER_APPLICATION	*Section 5.1.5, Page 15*

Tab. 4-1:   Overview: Status Services

Service group 02h: Configuration Services		
Service No.	Service	*See*
01h	SET_CONFIG	*Section 5.2.1, Page 16*
02h	GET_CONFIG	*Section 5.2.2, Page 18*
03h	SET_SYNC_ABS	*Section 5.2.3, Page 18*
04h	SET_SYNC_REL	*Section 5.2.4, Page 19*
05h	GET_SYNC_CLOCK	*Section 5.2.5, Page 19*
06h	Reserved	-
07h	Reserved	-
08h	Reserved	-
09h	Reserved	-
0Ah	SET_FUNCTION	*Section 5.2.6, Page 19*
0Bh	GET_FUNCTION	*Section 5.2.7, Page 21*

Tab. 4-2:   Overview: Configuration Services

Service group 03h: Measurement Services		
Service No.	Service	*See*
01h	GET_PROFILE	*Section 5.3.1, Page 22*
02h	CANCEL_PROFILE	*Section 5.3.2, Page 23*

Tab. 4-3:   Overview: Measurement Services

Service group 04h: Working Services		
Service No.	Service	*See*
01h	DO_RESET	*Section 5.4.1, Page 24*
02h	TRANS_IDLE	*Section 5.4.2, Page 24*
03h	TRANS_ROTATE	*Section 5.4.3, Page 25*
04h	TRANS_MEASURE	*Section 5.4.3, Page 25*

Tab. 4-4:   Overview: Working Services

Service group 05h: Maintenance Services	
Service No.	Service
The user has no access to these services	

Tab. 4-5:   Overview: Maintenance Services

Service group 06h: Interface Routing Services		
Service No.	Service	*See*
01h	COM_ATTACH	*Section 5.5.1, Page 26*
02h	COM_DETACH	*Section 5.5.2, Page 26*
03h	COM_INIT	*Section 5.5.3, Page 27*
04h	COM_OUTPUT	*Section 5.5.5, Page 29*
05h	COM_DATA	*Section 5.5.7, Page 31*

Tab. 4-6:   Overview: Interface Routing Services

Service group 07h: File Services		
Service No.	Service	*See*
01h	DIR	*Section 5.6.1, Page 32*
02h	SAVE	*Section 5.6.2, Page 32*
03h	LOAD	*Section 5.6.3, Page 33*
04h	DELETE	*Section 5.6.4, Page 33*

Tab. 4-7:   Overview: File Services

Service group 08h: Monitor Services		
Service No.	Service	*See*
01h	MONITOR_ENABLE_LOG	*Section 5.7.1, Page 34*
02h	MONITOR_PROFILE_LOG	*Section 5.7.2, Page 34*

Tab. 4-8:   Overview: Monitor Services

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

Tab. 4-9:   Overview: Application Services

Service group 7Eh: Adjust Services	
Service No.	Service
The user has no access to these services	

Tab. 4-10: Overview: Adjust Services

Service group 7Fh: Special Services		
Service No.	Service	*See*
00h	SERVICE_FAILURE	*Section 5.8.1, Page 35*

Tab. 4-11: Overview: Special Services

LD Laser Measurement System

5   Service definitions

5.1   Status Services

5.1.1   GET_IDENTIFICATION

Request command **0101h**:

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

Tab. 5-1:   Status Services: GET_IDENTIFICATION (request command)

LD response **8101h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
IDENTITEM	WORD [6]	*See request command*
SENSSTAT	DWORD	Status of LD

Tab. 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 LD responses to the IDENTITEM 0000h (part number).

5.1.2   GET_STATUS

Request command **0102h**:

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

Tab. 5-3:   Status Services: GET_STATUS (request command)

LD response **8102h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
SENSSTAT	DWORD	Status of the sensor (LD)

Tab. 5-4:   Response to GET_STATUS

The definition of the SENSTAT value is shown in *Section 6.3, Page 38*.

5.1.3   GET_SIGNAL

Request command **0104h**:

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

Tab. 5-5:   Status Services: GET_SIGNAL (request command)

LD response **8104h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
PORTVAL	WORD	Lower Byte: Port bits Upper Byte: 00h

Tab. 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

Tab. 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

Tab. 5-8:   Status Services: SET_SIGNAL (request command)

LD Laser Measurement System

LD response **8105h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*

PORTVAL	WORD	Request successful:
		    Lower byte: Port bits
		    Upper byte : 00h
		Request failed:
		    Lower byte: FFh
		    Upper byte: FFh

Tab. 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.

5.1.5   REGISTER_APPLICATION

Request command **0106h**:

Description	Registers the identification datas of the application firmware	
Parameter	*Type*	*Meaning*
APPL_ARTICLE	WORD [6]	Part number of the application software
APPL_NAME	WORD [6]	Name of the application software
APPL_VERSION	WORD [6]	Version of the application software

Tab. 5-10: Status Services: REGISTER_APPLICATION (request command)

LD response **8106h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
RESULT	WORD	0, if successful

Tab. 5-11: Response to REGISTER_APPLICATION

Note   Each parameter in the request command is a byte sequence of 12 ASCII characters.

This command is only accepted, if it was sent by the application board.

5.2 Configuration Services

The configuration services handle the parameter setting and the internal clock of the LD. 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-volatile memory).

Description	Sets the configuration	
Parameter	*Type*	*Meaning*
CONFIGITEM	WORD	0000h (historical: ARCnet configuration key) 0001h RS 232/RS 422 configuration key 0002h CAN configuration key 0003h Reserved 0004h ARCnet configuration key 0010h Global configuration
CONFIGDATA	WORD [k]	Configuration parameters; depend on configuration key

Tab. 5-12: 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 ... 8 bit)

Tab. 5-13: Configuration Services: Configuration parameters for RS 232/422

Configuration parameters for CAN configuration, CONFIGITEM = 0002h

Parameter	*Meaning*
CONFIGDATA [0]	CAN data transmission rate: 0000h 10 kbps 0001h 20 kbps 0002h 50 kbps 0003h 125 kbps 0004h 250 kbps 0005h 500 kbps 0006h 1 Mbps

Tab. 5-14: Configuration Services: Configuration parameters for CAN

Parameter	Meaning
CONFIGDATA[1]	Basic value of the host CAN identifier
CONFIGDATA[2]	Mask value of the host CAN identifier
CONFIGDATA[3]	Basic value of the LD CAN identifier
CONFIGDATA[4]	Broadcast-ID (0000 ... 07FFh) FFFFh: Broadcast ID disabled

Tab. 5-14: Configuration Services: Configuration parameters for CAN (contd.)

Note The basic value and the mask value of the host CAN identifier determines, which CAN messages the LD accepts.

Example:

HostBase = 0x180, HostMask = 0x007, the LD accepts all CAN identifiers in the range of 0x180 ... 0x187.

In addition, the LD accepts the CAN-identifier specified by the parameter Broadcast ID. The CAN identifier of the host sensor results from a logical OR operation between the LD ID and the base value of the LD CAN identifier.

Configuration parameters for ARCnet, CONFIGITEM = 0004h

Parameter	Meaning
CONFIGDATA[0]	Reserved
CONFIGDATA[1]	ARCnet baud rate: 0000h 156.25kbps 0001h 312.5 kbps 0002h 625 kbps 0003h 1.25 Mbps 0004h 2.5 Mbps 0005h 5 Mbps

Tab. 5-15: Configuration Services: Configuration parameters for ARCnet

Note The ARCnet node ID has the same value as the LD ID.

Configuration parameters for global configuration, CONFIGITEM = 0x10

Parameter	Meaning
CONFIGDATA[0]	LD ID: 0000h ... 00FEh (1 ... 254)
CONFIGDATA[1]	Nominal value motor speed 0005h ... 0014h (5 ... 20)
CONFIGDATA[2]	Angle step; difference between two laser pulses in 1/16 degrees. The value must be a divisor of 5760 and greater than 1.

Tab. 5-16: Configuration Services: Configuration parameters for global configuration

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

LD response **8201h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
CONFIGRESULT	WORD	0000h Configuration setting was successful FFFFh Configuration setting was not successful

Tab. 5-17: Response to REGISTER_APPLICATION

5.2.2 GET_CONFIG

Request command **0202h**:

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

Tab. 5-18: Configuration Services: GET_CONFIG (request command)

LD response **8202h**:

Description	Response of LD	
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

Tab. 5-19: Response to GET_CONFIG

See *Section 5.2.1, Page 16* (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]

Tab. 5-20: Configuration Services: SET_TIME_ABS (request command)

LD response **8203h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
SYNCTIME	WORD	New value of the internal clock [ms]

Tab. 5-21: 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

Tab. 5-22: Configuration Services: SET_TIME_REL (request command)

LD response **8204h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
SYNCTIME	WORD	New value of the internal clock [ms]

Tab. 5-23: Response to SET_TIME_REL

5.2.5 GET_SYNC_CLOCK

Request command **0205h**:

Description	Reads the internal time of LD	
Parameter	*Type*	*Meaning*
-	-	-

Tab. 5-24: Configuration Services: GET_SYNC_CLOCK (request command)

LD response **8205h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
SYNCTIME	WORD	Actual time of the internal clock [ms]

Tab. 5-25: Response to GET_SYNC_CLOCK

5.2.6 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 ... 7
SECTORFUNC	WORD	Measurement function for the sector. 0: Not initialised 1: No measurement 2: Reserved 3: Normal measurement
SECTORSTOP	WORD	End angle of the 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.

Tab. 5-26: Configuration Services: SET_FUNCTION (request command)

Description	Assigns a measurement function to an angle range	
FLASHFLAG	WORD	1: The sector configuration is written to flash memory Else: The sector configuration stays temporary and is lost after a reset.

Tab. 5-26: Configuration Services: SET_FUNCTION (request command) (contd.)

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 ($\geq$ 5760), SECTORSTOP will be reduced to an angle less than 5760. 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 is defined by its function and its end angle. 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 endangle 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 neccessary, if all 8 sectors are configured.

Example 1:
Supposed the LD is to be set up for 360° measurement. In this case only one sector needs to be defined. This is sector 0, which is defined as *Normal measurement*.
Assumed the defined stop angle is 0 and the angle step width is 0,5° (8) 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°(5752/16)°.
Sector 1 must be defined as *Not initialized*.

Example 2:
Scans starting at 90° and ending at 210° shall be taken. The angle step width is 0,25°. Two sectors need to be defined one for the measurement area and one for the none measurement area. To maintain this configuration sector 0 is defined as *No measurement* with end angle 89,75° and sector 1 is defined as *Normal measurement* with end angle 210°.
Sector 2 must be defined as *Not initialized*.

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

LD response **820Ah**:

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

Tab. 5-27: 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 ifself were invalid.

5.2.7   GET_FUNCTION

Request command **020Bh**:

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

Tab. 5-28: Configuration Services: GET_FUNCTION (request command)

LD response **820Bh**:

Description	Response of LD	
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
SECTORSTOP	WORD	End angle of the sector

Tab. 5-29: Response to GET_FUNCTION

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

5.3   Measurement Services

5.3.1   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 LD sends profiles continuously, until the user sends the CANCEL_PROFILE command
PROFILEFORMAT	WORD	16-bit array

Tab. 5-30: 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	LD mode
14	reserved (always 0)
15	reserved (always 0)

Tab. 5-31: Definition of the 16-bit array of PROFILEFORMAT

LD Laser Measurement System

LD response **8301h**:

Description	Response of LD					
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				
PROFILESENT	WORD	Number of the profiles sent to the host. Counts from 0 to PROFILENUM. If PROFILENUM = 0, a 16-bit counter counts continuously.				
PROFILECOUNT	WORD	Number of the profiles gathered by the LD. 16-bit counter that counts continuously.				
LAYERNUM	WORD	Number of the layer (always 0)			This data is sent with each layer	
SECTORNUM	WORD	Number of the sector		This data is sent with each sector		
DIRSTEP	WORD	Angle step in [degree x 16]				
POINTNUM	WORD	Number of points of the sector				
TSTART	WORD	Time stamp when the sector starts at the first point in [ms]				
STARTDIR	WORD	Start direction of the sector in [degree x 16]				
DISTANCE-n	WORD	Measured distance [m x 256]	This data is sent with each distance point			
DIRECTION-n	WORD	Direction in [degree x 16]				
ECHO-n	WORD	Echo amplitude				
TEND	WORD	Time stamp of the last point in [ms]				
ENDDIR	WORD	End direction in [degre x 16]				
SENSTAT	DWORD	Status of LD				

Tab. 5-32: 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.

5.3.2   CANCEL_PROFILE

Request command **0302h**:

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

Tab. 5-33: Measurement Services: CANCEL_PROFILE (request command)

LD response **8302h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
SENSTAT	DWORD	Status of LD

Tab. 5-34: 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 LD enters a reset sequence	
Parameter	*Type*	*Meaning*
RESETLEVEL	WORD	0000h Reset (CPU reinitialized) 0001h Restart (CPU not reinitialized) 0002h Halt application and enter IDLE state 0010h Reload APD voltage setting others reserved

Tab. 5-35: Working Services: DO_RESET (request command)

LD response **8401h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
RESETLEVEL	WORD	The same value as in the Request command

Tab. 5-36: Response to DO_RESET

If RESETLEVEL 0000h or 0001h is requested, the LD transmits the response to this command, before it enters the reset sequence.

If RESETLEVEL 0002h or 0010h is requested, the LD transmits the response after executing the command. The LD does not respond to any request during reset and system initialisation.

5.4.2 TRANS_IDLE

Request command **0402h**:

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

Tab. 5-37: Working Services: TRANS_IDLE (request command)

LD response **8402h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
SENSTAT	DWORD	Status of LD

Tab. 5-38: Response to TRANS_IDLE

5.4.3 TRANS_ROTATE

Request command **0403h**:

Description	Sets the LD 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 ... 4 Reserved 5 ... 20 Scanning frequency in Hz

Tab. 5-39: Working Services: TRANS_ROTATE (request command)

LD response **8403h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
SENSTAT	DWORD	Status of LD

Tab. 5-40: Response to TRANS_ROTATE

If the request parameter REV is invalid, the LD 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 LD into the MEASURE mode: the laser starts with the next revolution; a request for a profile can be started	
Parameter	*Type*	*Meaning*
-	-	-

Tab. 5-41: Working Services: TRANS_MEASURE (request command)

LD response **8404h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
SENSTAT	DWORD	Status of LD
ERRORCODE	WORD	0: OK, LD 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

Tab. 5-42: Response to TRANS_MEASURE

5.5   Interface routing Services

Interface routing means: a host or application program may attach to one of the available interfaces in order to have total control over communication via the attached interface. Any data received by the attached interface is forwarded to the interface that issued the attach command (the master interface). Data will not be interpreted by the measurement CPU. The master interface may output data via the interfaces it is attached to.

The interface routing comprises the services COM_ATTACH, COM_DETACH, COM_INIT, COM_OUTPUT and COM_DATA. Depending on the attached interface, the services COM_INIT, COM_OUTPUT and COM_DATA differ. So, these three services are defined for each interface.

Interface routing is only possible for RS 232/RS 422 and CAN.

Normally, the sensor transmits only command responses (after receiving the corresponding requests). The COM_DATA service is transmitted by the LD without request.

CAUTION

5.5.1   COM_ATTACH

Request command **0601h**:

Description	Attach an interface; any data which will be received by the attached inter-face is forwarded to the interface that issued this command. The attached interface will be deinitialized.		
Parameter	*Type*	*Meaning*	
INTERFACE_ID	WORD	1: RS 232/RS 422 2: CAN	

Tab. 5-43: Interface routing Services: COM_ATTACH (request command)

LD response **8601h**:

Description	Response of LD		
Parameter	*Type*	*Meaning*	
INTERFACE_ID	WORD	*See command request*	
RESULT	WORD	0x0000h: COM_ATTACH successful 0xFFFFh: COM_ATTACH not successful	

Tab. 5-44: Response to COM_ATTACH

5.5.2   COM_DETACH

Request command **0602h**:

Description	Detaches an attached interface; the measurement module becomes again the source and destination for data transferred via the detached interface		
Parameter	*Type*	*Meaning*	
INTERFACE_ID	WORD	as defined in COM_ATTACH service	

Tab. 5-45: Interface routing Services: COM_DETACH (request command)

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LD response **8602h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	as defined in COM_ATTACH service
RESULT	WORD	0x0000h: COM_DETACH successful 0xFFFFh: COM_DETACH not successful

Tab. 5-46: Response to COM_DETACH

5.5.3   COM_INIT (RS 232/RS 422)

Request command **0603h**:

Description	Initializes the RS 232/RS 422 interface	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	1 (RS 232/RS 422)
BAUDRATE	WORD	1: 4 800 bd 2: 9 600 bd 3: 19 200 bd 4: 38 400 bd 5: 57 600 bd 6: 115 200 bd
PARITY	WORD	0: No parity 1: Even parity 2: Odd parity
STOPBIT	WORD	1: One stop bit 2: Two stop bits
CHARLENGTH	WORD	Number of bits per character (1 ... 8 bit)

Tab. 5-47: Interface routing Services: COM_INIT (RS 232/RS 422) (request command)

LD response **8603h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	1 (as defined in COM_ATTACH service)
RESULT	WORD	0x0000h: COM_INIT successful 0xFFFFh: COM_INIT not successful

Tab. 5-48: Response to COM_INIT (RS 232/RS 422)

5.5.4   COM_INIT (CAN)

Request command **0603h**:

Description	Initializes the attached interface with the baud rate and the filter for the messages to receive	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	2 (CAN)
BAUDRATE	WORD	1: 10 kbps 2: 20 kbps 3: 50 kbps 4: 125 kbps 5: 250 kbps 6: 500 kbps 7: 1 Mbps
IDRX_HIGH	WORD	Receive message identifier, upper part. Bit 15: 0: standard identifier 1: extended identifier Bit 14: Reserved Bit 13: Reserved In case of extended identifier, Bit 12 ... 0 represent Bit 28 ... 16 of the extended identifier
IDRX_LOW	WORD	Receive message identifier, lower part. In case of standard identifier, Bit 10 ... 0 represent the standard identifier. In case of extended identifier, Bit 15 ... 0 represent Bit 15 ... 0 of the extended identifier.
LAM_HIGH	WORD	Local Acceptance Mask, upper part. In case of extended identifier, Bit 12 ... 0 represent the mask of Bit 28 ... 16 of the extended identifier.
LAM_LOW	WORD	Local Acceptance Mask, lower part. In case of standard identifier, Bit 10 ... 0 represent the mask of the standard identifier. In case of extended identifier, Bit 15 ... 0 represent the mask of Bit 15 ... 0 of the extended identifier.

Tab. 5-49: Interface routing Services: COM_INIT (CAN) (request command)

Incoming messages are compared with the identifier specified in MSGID_HIGH and MSGID_LOW, omitting the bits specified in LAM_HIGH and LAM_LOW. If the identifier matches, the message is sent to the master interface by the COM_DATA service.

If the acceptance mask is set to $0x00000000h$, only messages with exactly the same identifier like IDRX_HIGH/LOW are accepted. An acceptance mask of $0x1FFFFFFFh$ respective $0x000007FFh$ allows all messages to be received.

LD response **8603h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	2 (CAN)
RESULT	WORD	0x0000h: COM_INIT successful 0xFFFFh: COM_INIT not successful

Tab. 5-50: Response to COM_INIT (CAN)

5.5.5   COM_OUTPUT (RS 232/RS 422)

Request command **0604h**:

Description	Output data to the RS 232/RS 422 interface	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	1 (RS 232/RS 422)
CHARS	WORD[0]	Bits 7... 0 contain the char. If the defined CHARLENGTH is less than 8 bit, the leading bits will be ignored.
CHARS	...	...

Tab. 5-51: Interface routing Services: COM_OUTPUT (RS 232/RS 422) (request command)

LD response **8604h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	1 (as defined in COM_ATTACH service)
RESULT	WORD	0x0000h: COM_OUTPUT successful 0xFFFFh: COM_OUTPUT not successful

Tab. 5-52: Response to COM_OUTPUT (RS 232/RS 422)

The command response is send immediatly and indicates, that the first character has been written to the output buffer.

5.5.6   COM_OUTPUT (CAN)

Request command **0604h**:

Description	Output data to an attached interface		
Parameter	*Type*	*Meaning*	
INTERFACE_ID	WORD	2 (CAN)	
NO_OF_MSGS	WORD	Number of the following CAN messages (1 ... 128). A CAN message is composed of the datas MSGID_HIGH, MSGID_LOW, MSG_LENGTH and DATA[i]. The Number of DATA[ ] words may be less than 4, depending on MSG_LENGTH.	
MSGID_HIGH	WORD	Bit 15: 0: standard identifier 1: extended identifier Bit 14: Reserved Bit 13: Reserved In case of extended identifier, Bit 12 ... 0 represent Bit 28 ... 16 of the extended identifier	One CAN message
MSGID_LOW	WORD	In case of standard identifier, Bit 10 ... 0 represent the standard identifier. In case of extended identifier, Bit 15 ... 0 represent Bit 15 ... 0 of the extended identifier.	
MSG_LENGTH	WORD	Number of bytes to transmit (0 ... 8)	
DATA[0]	WORD	Bit 15 ... 8: data byte #1 Bit 7 ... 0: data byte #2	
DATA[1]	WORD	Bit 15 ... 8: data byte #3 Bit 7 ... 0: data byte #4	
DATA[2]	WORD	Bit 15 ... 8: data byte #5 Bit 7... 0: data byte #6	
DATA[3]	WORD	Bit 15 ... 8: data byte #7 Bit 7 ... 0: data byte #8	
The following messages			

Tab. 5-53: Interface routing Services: COM_OUTPUT (CAN) (request command)

LD response **8604h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	2 (CAN)
RESULT	WORD	0x0000h: COM_OUTPUT successful 0xFFFFh: COM_OUTPUT not successful

Tab. 5-54: Response to COM_OUTPUT (CAN)

The command response is send immediatly and indicates, that the transmission is initiated successfully.

5.5.7 COM_DATA (RS 232/RS 422)

Request command **0605h**:

Description	Forward data that was received on the RS 232/RS 422 interface to the master interface	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	1 (RS 232/RS 422)
TIMESTAMP	WORD	Timestamp of the last character of the following data
CHAR	WORD[0]	One received character, right justified
CHAR	...	...

Tab. 5-55: Interface routing Services: COM_DATA (RS 232/RS 422) (request command)

Note A buffer (size: 64 characters) is filled with the incoming datas. If the buffer is full or if a baud rate dependent timeout is expired, the COM_DATA service is send.

A BREAK signal forces the LD to the IDLE mode. (A DO_RESET with RESETLEVEL = 2 is executed.)

This service is sent by the LD. No response.

5.5.8 COM_DATA (CAN)

Request command **0605h**:

Description	Forward data that was received on an attached interface to the master interface	
Parameter	*Type*	*Meaning*
INTERFACE_ID	WORD	2 (CAN)
TIMESTAMP	WORD	Internal time of the LD at reception of the CAN message
MSGID_H	WORD	Bit 15: 0: standard identifier 1: extended identifier Bit 14: Reserved Bit 13: Reserved In case of extended identifier, Bit 12 ... 0 represent Bit 28 ... 16 of the extended identifier.
MSGID_L	WORD	In case of standard identifier, Bit 10 ... 0 represent the standard identifier. In case of extended identifier, Bit 15 ... 0 represent Bit 15 ... 0 of the extended identifier.
MSG_LENGTH	WORD	Number of bytes to transmit (0 ... 8)
DATA[0]	WORD	Bit 15 ... 8: data byte #1 Bit 7... 0: data byte #2
DATA[1]	WORD	Bit 15 ... 8: data byte #3 Bit 7 ... 0: data byte #4
DATA[2]	WORD	Bit 15 ... 8: data byte #5 Bit 7... 0: data byte #6
DATA[3]	WORD	Bit 15 ... 8: data byte #7 Bit 7 ... 0: data byte #8

Tab. 5-56: Interface routing Services: COM_OUTPUT (CAN) (request command)

Depending on the length of the received message (MSG_LENGTH), the number of DATA[i] words may be less than 4.

This service is sent by the LD. No response.

5.6   File Services

There is a total amount of 32k x 16-bit flash memory available in the LD to store application specific configuration data. Data can be stored in a file, which is identificated by a unique ID. Valid File IDs are 0100h ... FFFFh.

The following services provide access to this memory resource.

5.6.1   DIR

Request command **0701h**:

Description	Lists the stored files in the flash memory	
Parameter	*Type*	*Meaning*
-	-	-

Tab. 5-57: File Services: DIR (request command)

LD response **8701h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
FREE_MEM	WORD	Available memory space in terms of WORDs
DIR	WORD[n]	File ID

Tab. 5-58: Response to DIR

The Length n of the DIR parameter depends on the number of stored files, i.e. the number of returned DIR words equals the number of stored files.

5.6.2   SAVE

Request command **0702h**:

Description	Stores data into the flash memory	
Parameter	*Type*	*Meaning*
FILE_ID	WORD	File ID. Valid values: 0100 ... FFFFh
DATA_FILE	WORD[n]	Data to be stored
n equals the number of words to be stored		

Tab. 5-59: File Services: SAVE (request command)

Note   To replace an already existent file, this file must be removed by a DELETE command first.

LD response **8702h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
FILE_ID	WORD	File ID
SAVE_STAT	WORD	0: File saved successfully 1: Not enough memory 2: File already exists 3: Flash failed 4: Invalid file ID or request incorrect

Tab. 5-60: Response to SAVE

If a storage failed (DEL_STAT = 3), the file system may be corrupt or the flash memory may be defect.

5.6.3 LOAD

Request command **0703h**:

Description	Recalls a file	
Parameter	*Type*	*Meaning*
FILE_ID	WORD	File ID. Valid values: 0100 ... FFFFh

Tab. 5-61: File Services: LOAD (request command)

LD response **8703h**:

Description	Response of LD	
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		

Tab. 5-62: Response to LOAD

5.6.4 DELETE

Request command **0704h**:

Description	Deletes a file	
Parameter	*Type*	*Meaning*
FILE_ID	WORD	File ID. Valid values: 0100 ... FFFFh. It is the users responsibility to make sure that there are no duplicate IDs in the system.

Tab. 5-63: File Services: DELETE (request command)

LD response **8704h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
DEL_STAT	WORD	0: File deleted successfully 1: File does not exist 2: Delete failed 3: Invalid File_ID or request incorrect

Tab. 5-64: Response to DELETE

If a deletion failed (DEL_STAT = 2), the file system may be corrupt or the flash memory is defect.

5.7   Monitor Services

Monitor services are used to get LD data (scan profiles) separately from the running application.

Depending on the monitor service; the data to be monitored may be sent without prior request.

5.7.1   MONITOR_RUN

Request command **0801h**:

Description	Enables/disables monitor services. Monitor services are assigned to the interface that issued the enable command and can't be requested via other interfaces until the monitor services are disabled again	
Parameter	*Type*	*Meaning*
MON_RUN	WORD	0: Monitor functions disabled else: Monitor functions enabled

Tab. 5-65: Monitor Services: MONITOR_RUN (request command)

LD response **8801h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
RESULT	WORD	0x0000h: Request successful 0xFFFFh: Request not successful

Tab. 5-66: Response to MONITOR_RUN

5.7.2   MONITOR_PROFILE_LOG

Request command **0802h**:

Description	Enables/disables profile logging. If profile logging is enabled, profiles are transferred to the monitor application whenever they are sent to the application module respective host application.	
Parameter	*Type*	*Meaning*
MON_PROFILE_LOG	WORD	0: disable profile logging else: enable profile logging

Tab. 5-67: Monitor Services: MONITOR_PROFILE_LOG (request command)

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Profiles are sent using the response service code of the GET_PROFILE service; the profile format is the same as commanded in the GET_PROFILE service request that was issued by the application.

LD response **8802h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
RESULT	WORD	0x0000h: Request successful 0xFFFFh: Request not successful

Tab. 5-68: Response to MONITOR_PROFILE_LOG

5.8   Special Services

5.8.1   SERVICE_FAILURE

If an illegal service request is sent to the LD, the device responses with a SERVICE_FAILURE instead of the usual response.

LD response **FF00h**:

Description	Response of LD	
Parameter	*Type*	*Meaning*
Reserved	DWORD	Reserved (always 0)
SENSTAT	DWORD	LD mode value. See *Section 6.3, Page 38*

Tab. 5-69: Response to an illegal service request

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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 LD 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 rotating prism rotates. The rotating frequency is monitored by the LD. The laser is off.

A TRANS_IDLE command sets the LD 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 LD. The laser pulses in the defined zones. The GET_PROFILE command is available.

A TRANS_ROTATE command sets the LD into the ROTATE mode.

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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 LD 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
	REGISTER_APPLICATION	X		

Tab. 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		
	SET_SYNC_ABS	X	X	
	SET_SYNC_REL	X	X	
	GET_SYNC_CLOCK	X	X	X
	SET_FUNCTION	X	X	
	GET_FUNCTION	X	X	

Tab. 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

Tab. 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

Tab. 6-4:   Availability of the service commands: Working Services

Service Group	Service	IDLE mode	ROTATE mode	MEASURE mode
Interface Routing Services	COM_ATTACH	X		
	COM_DETACH	X		
	COM_INIT	X		
	COM_OUTPUT	X	X	X
	COM_DATA	X	X	X

Tab. 6-5:   Availability of the service commands: Interface Routing Services

Service Group	Service	IDLE mode	ROTATE mode	MEASURE mode
File Services	DIR	X		
	SAVE	X		
	LOAD	X		
	DELETE	X		

Tab. 6-6:   Availability of the service commands: File Services

Service Group	Service	IDLE mode	ROTATE mode	MEASURE mode
Monitor Services	MONITOR_RUN	X	X	X
	MONITOR_PROFLIE_LOG	X	X	X

Tab. 6-7:   Availability of the service commands: Monitor 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 ...7 are valid. Bits 8 ... 32 are for future use.

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

Tab. 6-8:   Sensor mode values

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7   Error handling

7.1   Fatal errors

Red LED lights, communication possible:

The scan head doesn't rotate, although it should. The LD switches the laser automatically off.

Red LED lights, communication not possible:

The internal service management of the LD is out of order.

7.2   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).

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