LASER MIRROR SCANNER
LMS-Q280i
TECHNICAL DOCUMENTATION AND USER'S INSTRUCTIONS

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This manual has been compiled with care. However, should you discover any error, we would be grateful if you would let us know.

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Important Note:

The LMS-Q280i makes use of a high power laser source and an extremely high sensitive optical receiver. As a result of this powerful signal detection electronics, the LMS-Q280i works with non-cooperative targets (natural reflecting targets like trees, stones etc.) as well as with cooperative targets (reflecting targets). The following reflecting target materials can be used:

- o Reflecting paint
- o Reflecting foil

Due to the high power level of the laser transmitter, high quality glass retro-reflectors must not be used as a target !!! Using such retro-reflectors can permanently damage the instrument.

C O N T E N S

1 General

The **Laser Mirror Scanner LMS-Q280i** is a 2D laser scanner based upon accurately measuring the distance by means of electro-optical pulsed time-of-flight range measurement and upon fast scanning the laser beam by means of an opto-mechanical scan mechanism. The high range performance, the fast line scanning, and the overall system design makes the LMS-Q280i well suited for airborne laser scanning applications.

1.1 System Configuration

The laser scanner LMS-Q280i consists mainly of two subsystems, an accurate laser rangefinder electronics and a line scanning mechanism, installed in a rugged housing.

1.1.1 Rangefinder System

The rangefinder system is based upon the principle of time-of-flight measurement of short infrared laser pulses.

A laser source emits infrared light pulses, which are collimated by a transmitter lens system. Via the receiver lens, part of the echo signal reflected by the target hits a photodiode which generates an electrical receiver signal. The time interval between transmitted and received pulses is counted by means of a quartz-stabilized clock frequency. The measured time value is passed to the internal microcomputer which processes the measured data and prepares it for data output.

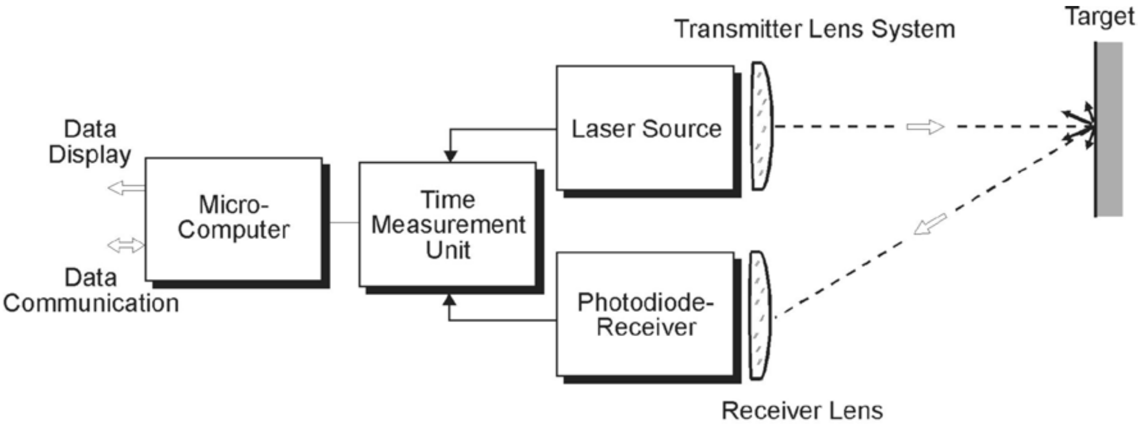


Fig. 1 Measurement principle of the pulsed range finder

1.1.2 Scanner Mechanism

The scanner mechanism deflects the laser beam for range measurement into a precisely defined direction. Each scan line is composed of a number of pixels (single laser measurements).

The angular deflection of the laser beam is realized by a rotating polygon mirror wheel. The polygon-mirror is composed of flat reflective surfaces arranged around the wheel perimeter. The wheel rotates continuously at a fixed speed to provide repetitive unidirectional scans.

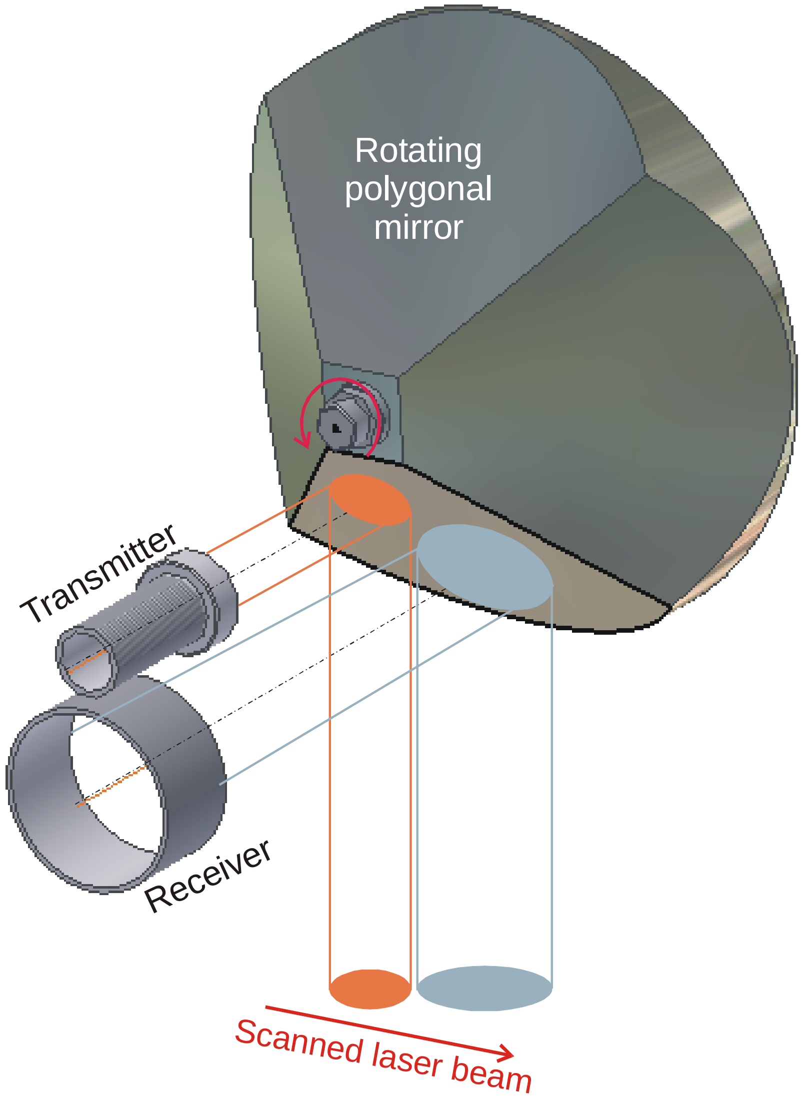


Fig. 2 Principle of beam deflection by a rotating mirror

Due to the finite aperture dimensions, only a fractional part of the polygon mirror surfaces (excluding the edge areas) can be used for scanning (please refer to chapter 5.3, LMS-Q280i Timing characteristic).

1.1.3 True Color Channel (optional)

Beside the laser transmitter and the laser receiver, the LMS-Q280i has optionally an integrated true color channel which provides the color of the target´s surface as an additional information to each laser measurement. Color data are included in the binary data stream of the LMS-Q280i allowing straightforward texturing of scanned surface model.

1.1.4 Interfaces

1.1.4.1 Electrical Interfaces

The laser scanner LMS-Q280i requires a single power supply with nominally 24V DC.

Supply voltage	24V DC
Permitted supply voltage range	18V DC to 32V DC
Current consumption (scanning operation)	typically 3A at 24V DC

1.1.4.2 Data Interfaces

LAN Interface	Ethernet Network interface, using the TCP/IP protocol
RS232 serial interface	Bi-directional interface for scanner configuration
Parallel interface	ECP compatible, Uni-directional interface, provides the scan data

The pin assignment of the interface connectors can be found in chapter 4.2, Connectors and Pin Assignments.

2 Design of Laser Scanner LMS-Q280i

2.1 Mechanical Design

The housing of the LMS-Q280i laser scanner is designed to meet the requirements for an installation on board of an airplane or helicopter. The slim design and the scan direction perpendicular to the longitudinal axis of the laser scanner allows straightforward integration also under narrow space conditions.

The housing consists of a very stable base plate, which carries 6 pcs. M6 mounting threads and the beam output aperture window.

The top plate provides 6 pcs. M6 mounting threads for the installation of an inertial measurement unit or other additional equipment. This mounting threads are firmly connected to the internal frame structure. Additionally, the top plate is equipped with a heat-sink profile.

For adequate heat dissipation, the rear plate is equipped with a heat-sink profile. On this side of the laser scanner, there are the connectors for power supply and data interface as well as the fuse holders located.

For additional information about heat dissipation, please refer to chapter 4.5, Instrument Cooling

The front plate carries a desiccant cartridge and valve for nitrogen purging of the instrument.

The side plates are made of aluminum profile shells.

All outer parts are colorless or black anodized.

The figures on the next pages show the mechanical dimensions of the LMS-Q280i laser scanner.

2.2 Mechanical Drawings

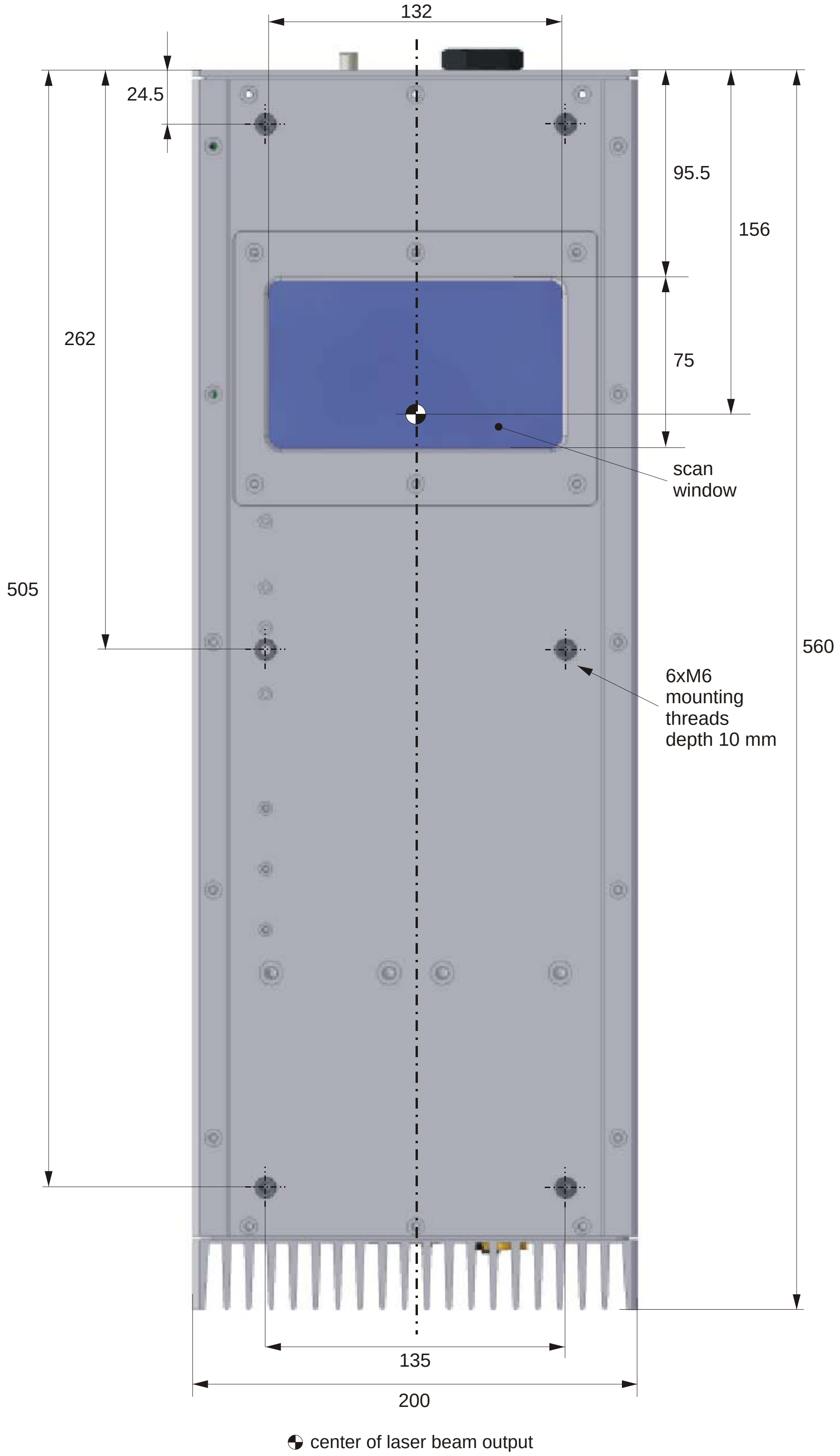


Fig. 3 Bottom view of LMS-Q280i (base plate side)

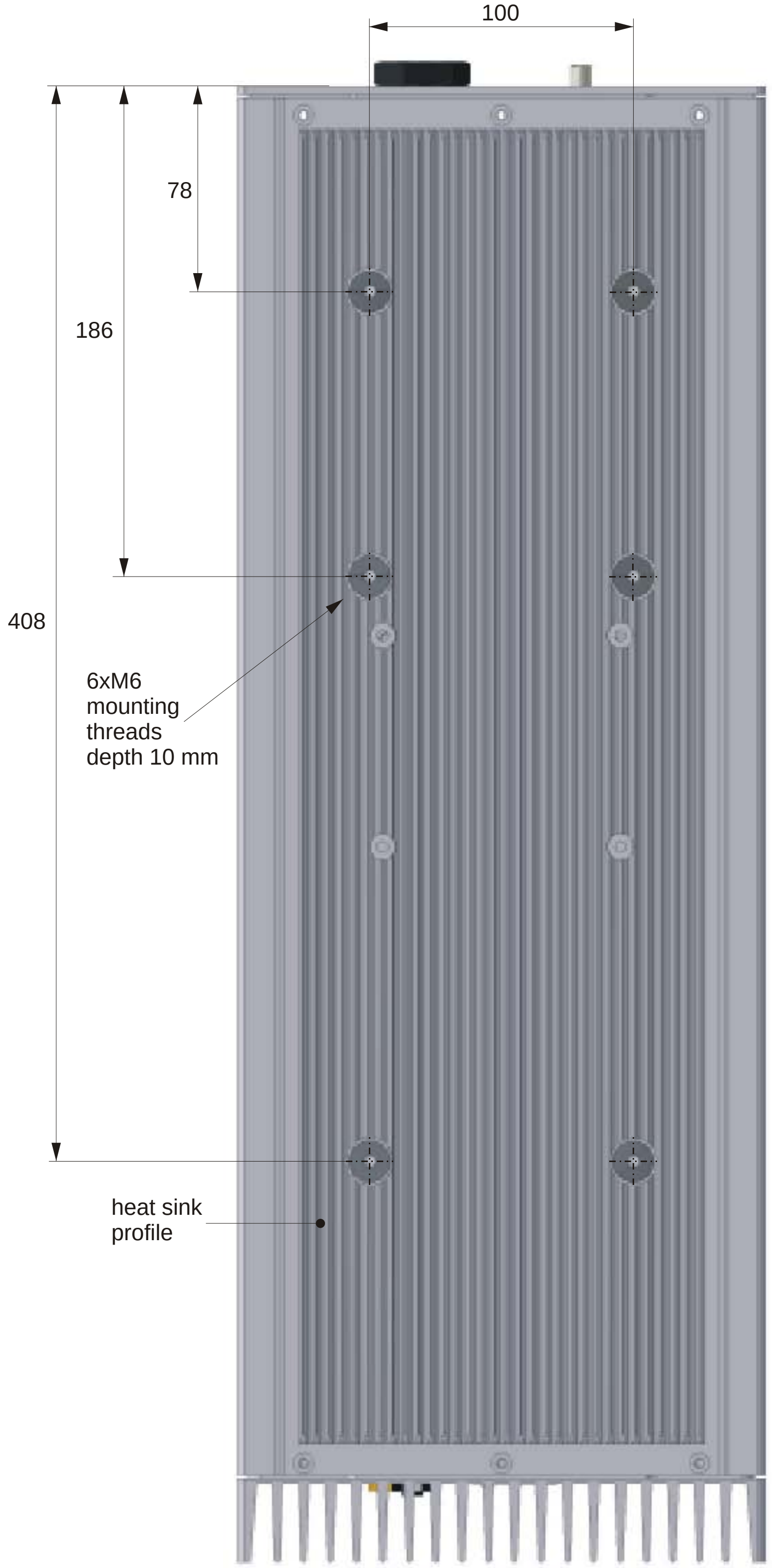


Fig. 4 Top view of LMS-Q280i (top plate side)

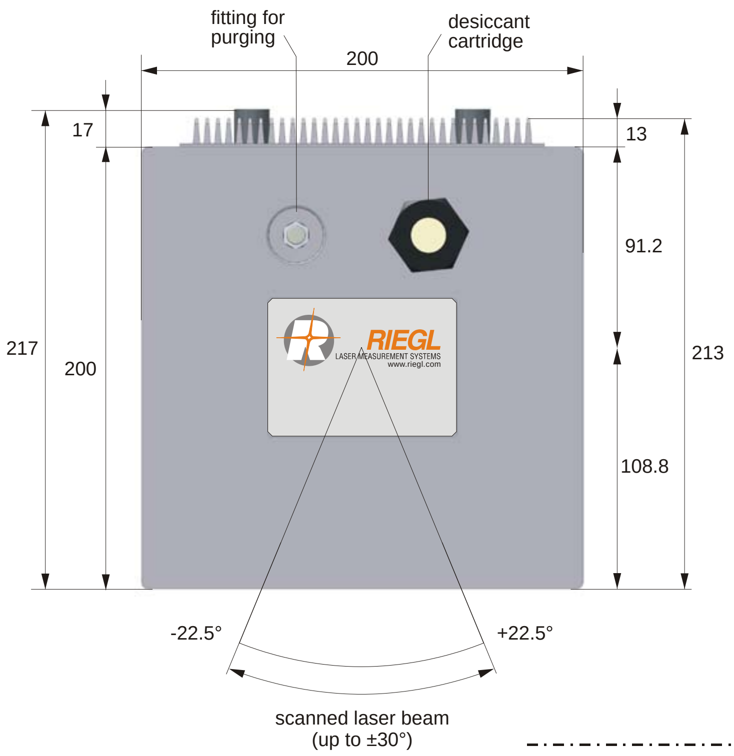


Fig. 5 Front view of LMS-Q280i (front plate side)

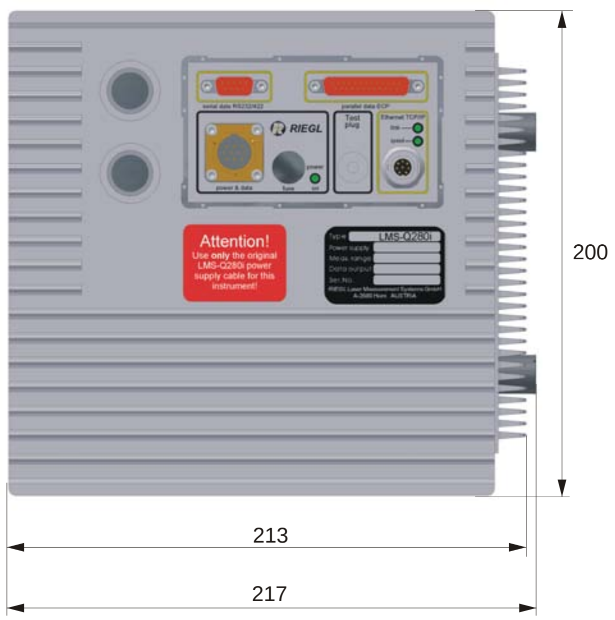


Fig. 6 Rear view of LMS-Q280i (rear plate side)

3 Safety Instructions

3.1 General Safety

GENERAL SAFETY	EN 61010-1

LMS-Q280i meets or exceeds the requirements of the following European Standard: **EN 61010-1** (April 1993) *Safety requirements for electrical equipment for measurement, control, and laboratory use* Part 1: *General Requirements*

Note the following explanations and important instructions:

Temperature: See chapter 5 Specifications for temperature limits for storage and operation.

> Storage and operation at temperatures outside the specified temperature ranges may cause wrong measurement results or even damage of the instrument.

Sunlight: The ***LMS-Q280i*** makes use of the optical time-of-flight technique to determine the distance to the object. For this purpose it comprises sensitive optical, electrical and mechanical components. Thus the ***LMS-Q280i*** requires appropriate handling:

> Unnecessary exposure of the internal optical and electronic parts to direct sunlight via the front window should be avoided.

Altitude: The unit is specified for an altitude up to 2000m (operation or storage).

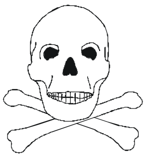
Relative Humidity: The unit is specified for a relative humidity of 80% at or below +31°C; linearly decreasing to 50% at +40°C.

Enclosure: The instrument ***LMS-Q280i*** is water resistant on the outside but must not however be subjected to rain or dripping water or submerged under water.

The optical glass panes should be treated with the care customarily due to optical instruments and, only when absolutely necessary, should they be gently cleaned using a suitable lens cleaning fluid (e.g. pure ethylene alcohol).

> **Never apply mechanical force or shock to the glass panes or to the housing itself!**
> As with other optical instruments, the ***LMS-Q280i*** should be protected from being shaken or knocked.

Power supply: Before operating the ***LMS-Q280i*** make sure that its case is properly grounded.
The power supply cable is to be connected with a suitable DC-power supply with a maximum voltage of 32 V DC (nominal 24 V DC).



The instrument **must never** be connected to 110 or 230 VAC!

Opening the instrument is unacceptable due to the danger presented by the high voltages, and must therefore be avoided at all costs.

The negative pole of the external line voltage is directly connected to the instrument's housing. This should be remembered when connecting it to other instruments.

ANY USE OF THE ***LMS-Q280i*** IN CONTRADICTION TO THE INSTRUCTIONS AS GIVEN IN THE MANUAL CAN BE DANGEROUS AND IS, THEREFORE, STRICTLY FORBIDDEN!

3.2 Electromagnetic Compatibility

ELECTROMAGNETIC COMPATIBILITY[1]	EN 61326

Laser scanner ***LMS-Q280i*** meets or exceeds the requirements of the following European Standards:

EN 61326-1 (1997) *Electrical equipment for measurement, control and laboratory use; EMC requirements;* Part 1: *General requirements* (IEC 61326-1:1997)

EN 61326/A1 (1998) *Electrical equipment for measurement, control and laboratory use; EMC requirements* (IEC 61326:1997/A1:1998)

> **WARNING:**
>
> The ***LMS-Q280i*** is a class A equipment intended for industrial environment. Therefore, it **must not** be used in residential, commercial and light industry environment.

The labeling of the ***LMS-Q280i***, which is affixed on the front side of the housing of the instrument, meets the requirements of the commission's guideline 89/336/EEC:

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1) The tests have been run using default scanner parameter settings. The tests have been performed using original ***RIEGL*** data and power supply cables, powered with 24 V DC provided by an PbGel-Powerpack.

To maintain emission requirements when connecting to the I/O interface of the LMS-Q280i use only a high-quality shielded data interface cable. The cable shield must have low impedance connections to both connector housings.

Any changes or modifications to the standard equipment not expressly approved by ***RIEGL*** as well as any non-observance if the directions for installation may cause harmful interference and void the authorization to operate this equipment.

The following table lists the applied standards and the performance criteria (see also definition below) for the evaluation of the immunity test results:

CISPR 16-1 Edition 2.1: 2002

Specification for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus

CISPR 16-2 Edition 1.2: 2002

Specification for radio disturbance and immunity measuring apparatus and methods; Part 2: Methods of measurement of disturbances and immunity

EN 61000-4-2 + A1 + A2 : 2002

Electromagnetic compatibility (EMC); Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test (IEC 61000-4-2:1995 + A1:1998 + A2:2001)

Performance Criterion B

EN 61000-4-3 + A1 + A2: 2002

Electromagnetic compatibility (EMC); Part 4-3: Testing and measurement techniques - Radiated, radio frequency, electromagnetic field immunity test (IEC 61000-4-3:1995 + A1:1998 + A2:2000)

Performance Criterion A

EN 61000-4-4 + A1 + A2: 2002

Electromagnetic compatibility (EMC); Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test (IEC 61000-4-4:1995 + A1:2000 + A2:2001)

Performance Criterion B

EN 61000-4-5 + A1: 2002

Electromagnetic compatibility (EMC); Part 4-5: Testing and measurement techniques - Surge immunity test (IEC 61000-4-5:1995 + A1:2001)

Performance Criterion C

EN 61000-4-6 + A1: 2002

Electromagnetic compatibility (EMC); Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio frequency fields (IEC 61000-4-6:1996 + A1:2000)

Performance Criterion A

EN 61000-4-8 + A1: 2002

Electromagnetic Compatibility (EMC); Part 4-8: Testing and Measurement Techniques - Power Frequency Magnetic Field Immunity Test (IEC 61000-4-8:1993 + A1: 2000)

Performance Criterion A

Definition of the performance criteria and acceptable degradations:

Performance Criterion A: during testing, normal performance within defined limits

- additional distance depending range error up to ±10 cm;
- additional statistical range error up to ±25 cm;
- loss of range
- additional angle error up to ±1 °;

Performance Criterion B: during testing, temporary degradation or loss of function or performance which is self-recovering

- loss or heavy degradation of functionalities during testing with self-recovering after finishing the test;

Performance Criterion C: during testing, temporary degradation or loss of function or performance which requires operator intervention or system reset occurs

- loss or heavy degradation of functionalities during testing with self-recovering after finishing the test; a system reset may occur;
- loss or heavy degradation of functionalities which require simple user intervention, e.g. replacement of a fuse, switching the device Off and On, restoration of settings;

3.3 Laser Safety

The laser scanner instrument **LMS-Q280i** is classified as **Class 1** laser product in compliance with the International Eye safety regulation **IEC60825-1:1993+A1:1997+A2:2001** and the European Eye safety regulation **EN60825-1:1994+A1:2002+A2:2001** *Safety of Laser Products*, *Equipment Classification, Requirements and User´s Guide*.

Class 1*: Lasers which are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing (IEC60825-1:2001, Sub-clause 8.2).*

The labeling of the **LMS-Q280i** meets the requirements of the above standard (IEC60825-1:2001, sub-clause 5.1 and 5.2). It is affixed two times near the front pane on the LMS-Q280i.

CAUTION! The invisible laser radiation <u>inside</u> the instrument may exceed the accessible emission limits of laser class 1, thus **never open the instrument's housing**! Do not operate evidently damaged instruments! If the instrument is handled incompetently, the manufacturers absolve themselves from granting any guarantee or insurance whatsoever.

Aligning the infrared laser instrument with the lenses of CCD-cameras or infrared night vision devices can result in damage to them and is therefore not permitted.

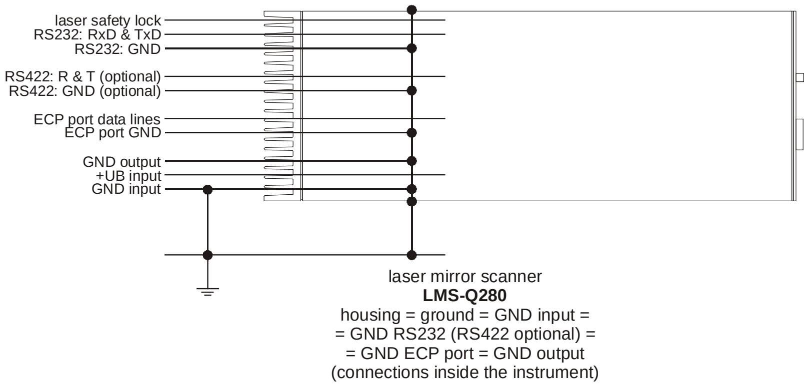
Note: The laser beam exits the instrument via the front window as indicated in the mechanical drawings.

IMPORTANT NOTE : This classification is based on the condition that the laser beam is continuously scanned. The LMS-Q280i emits laser radiation only, when in scanning operation. In case of any fault of the driving mechanism, the laser is switched off immediately.

4 Operating Instructions

4.1 Preparing the Power Supply

- All ground terminals of data interfaces, control lines and power supply and the housing are internally connected (common ground). Details are shown by the following scheme:



- The connections between the ground terminals and the housing, which are within the instrument, are **not suitable to drain off potential differences**. Therefore, further ground connections have to be provided during installation.
- The DC-power supply has to fulfill the requirements for 'Limited Circuit' according to EN 61010-1 and the requirements for 'SELV' circuits according to EN 60950.
- The power supply cable is to be connected to a suitable DC power supply with a voltage specified in chapter 5 Specifications. The negative pole of the supply voltage has to be grounded.
- The LMS-Q280i is protected by 3 fuses (located on the rear plate of the instrument), one for the range finder part electronics, one for the scanning mechanism and one for the laser transmitter (for fuse types and ratings see chapter 4.1.1). The current drain capacity of the power supply must be at least three times the sum of the rated currents of the three fuses, so the fuses can be activated reliably if necessary (for example, in the case of false polarity).
- When using a long power supply cable, the drop of voltage should be considered when adjusting the supply voltage. The negative pole of the supply voltage should be connected to ground near the instrument.
- The internal resistance of the power supply must be low enough for the supply voltage not to fall short below the minimum voltage of the instrument.
- The control inputs, analog and digital outputs, and the serial interface of the laser mirror scanner may be connected only to equipment fulfilling the requirements for 'SELV' circuits according to EN 60950.
-

For electromagnetic compatibility, use only original *RIEGL* power supply cables and low-noise power supply units, which meet the relevant CE requirements.

4.1.1 Fuses

The laser scanner LMS-Q280i is equipped with 3 glass tube fuses. The fuse holders are located at the rear side of the instrument.

fuse holder for scanning mechanism
2.0 A quick-acting
(according to IEC60127 and EN60127)

fuse holder for laser module
1.25 A quick-acting
(according to IEC60127 and EN60127)

fuse holder for rangefinder electronics
1.0 A quick-acting
(according to IEC60127 and EN60127)

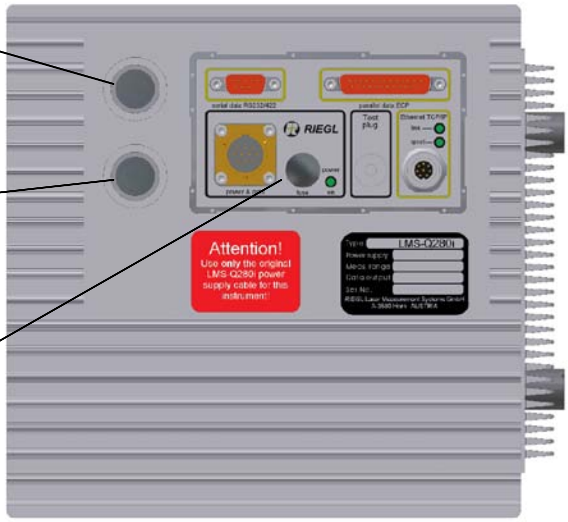


Fig. 7 Fuse Holders LMS-Q280i

The fuse holders can be opened and closed by means of a coin used like a screw driver.

Note: Replace a blown fuse only with specified type and rated fuse!

4.2 Connectors and Pin Assignments

The connectors for power supply and data interface are located at the rear side of the LMS-Q280i.

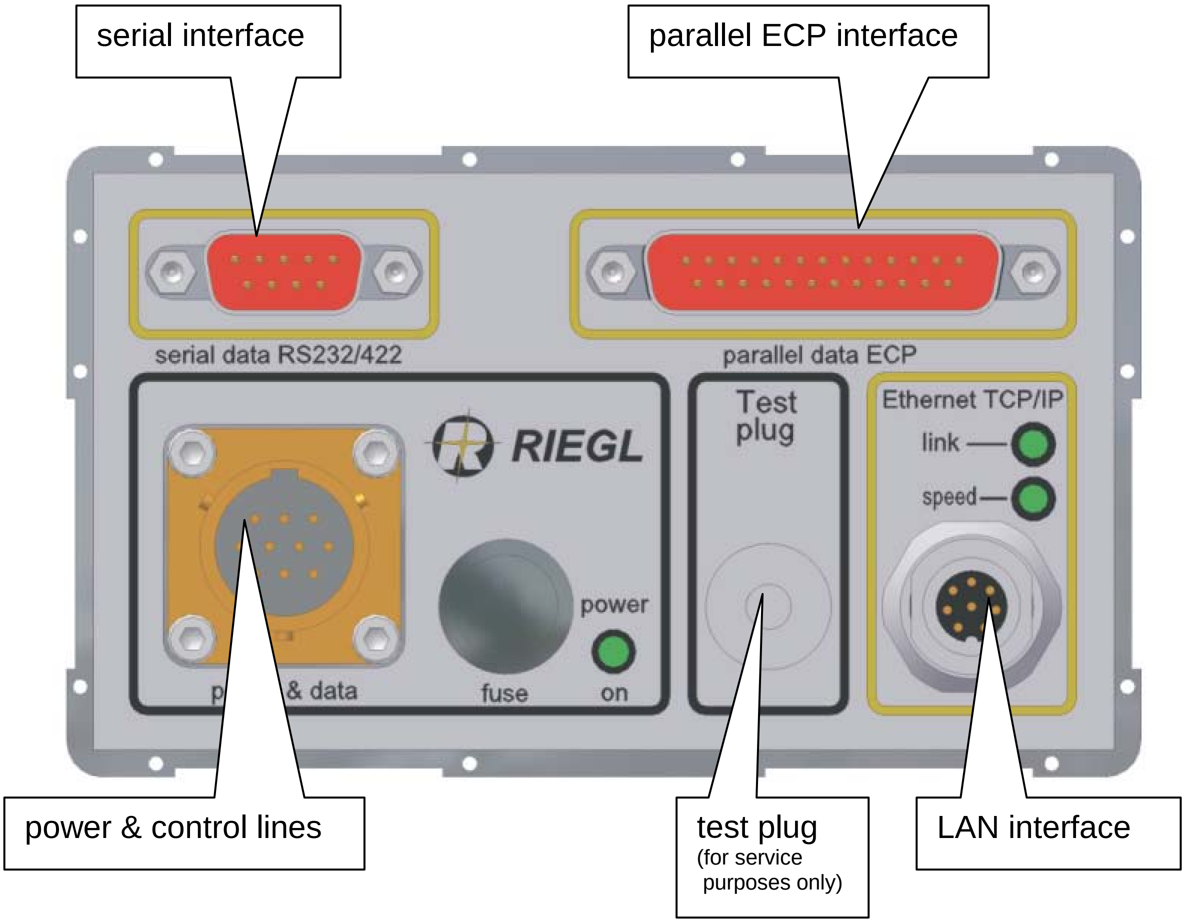
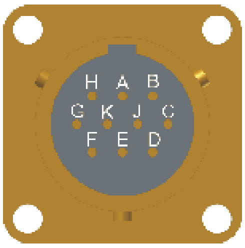


Fig. 8 Connectors for power supply and data interfaces

4.2.1 Plug for Power Supply

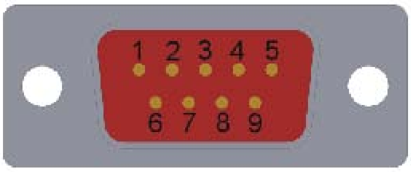


Type of connector : Souriau 851 02E 12-10 P50, male

Pin	Assignment	Color	Note
A	Laser safety lock	brown	
B			*) not used for LMS-Q280i
C	GNDin	yellow green	Power Supply Ground
D			*) not used for LMS-Q280i
E	Trigger	yellow	Input for external SYNC signal
F	Marker	green	TTL output factory internal usage
G	+UB 18-32 VDC	black 2	Power Supply
H	GNDout	white	
J	GNDin	black 3	Power Supply Ground
K	+UB 18-32 VDC	black 1	Power Supply

*) Any use of these pins for whatever connections can damage the data output and is, therefore, strictly prohibited!

4.2.2 Plug for Serial Interface (RS232)



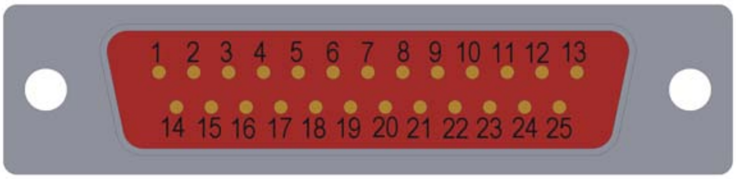
Type of connector : Sub-D, 9-pin, male

Pin	Assignment	Color	Note
1	must not be connected		*)
2	RxD		RS232 data input
3	TxD		RS232 data output
4	must not be connected		*)
5	GND		Signal GND
6	must not be connected		*)
7	must not be connected		*)
8	must not be connected		*)
9	must not be connected		*)

*) Any use of these pins for whatever connections can damage the data output and is, therefore, strictly prohibited!

The serial data interface is used for configuration of the scanner.

4.2.3 Plug for Parallel Interface



Type of plug: Sub-D, 25-pin, male

Pin	Source	Name	Centronics Name
1			
2	RD	Data 1 (LSB)	Data 1
3	RD	Data 2	Data 2
4	RD	Data 3	Data 3
5	RD	Data 4	Data 4
6	RD	Data 5	Data 5
7	RD	Data 6	Data 6
8	RD	Data 7	Data 7
9	RD	Data 8 (MSB)	Data 8
10	RD	PeriphClk	nAck
11			
12			
13			
14	PC	HostAck	nAutoFd
15			
16	PC	Direction	nInit
17			
18		Signal GND	
19		Signal GND	
20		Signal GND	
21		Signal GND	
22		Signal GND	
23		Signal GND	
24		Signal GND	
25		Signal GND	

PC...Personal Computer
RD...*Riegl* Device
Levels are TTL-levels

For detailed information about the parallel data interface, please refer to chapter 6.4, ECP Data output.

4.2.4 Plug for Ethernet Interface

Manufacturer: Lumberg Inc.
Type: Micro (M12) Female/S3426 Receptable
Number of Pins: 8

For detailed information about the Ethernet data interface, please refer to chapter 6.5 LAN interface .

4.3 Cables

The laser scanner LMS-Q280i is shipped with three cables.

4.3.1 Power Supply Cable

The length of the cable is approx. 6m.

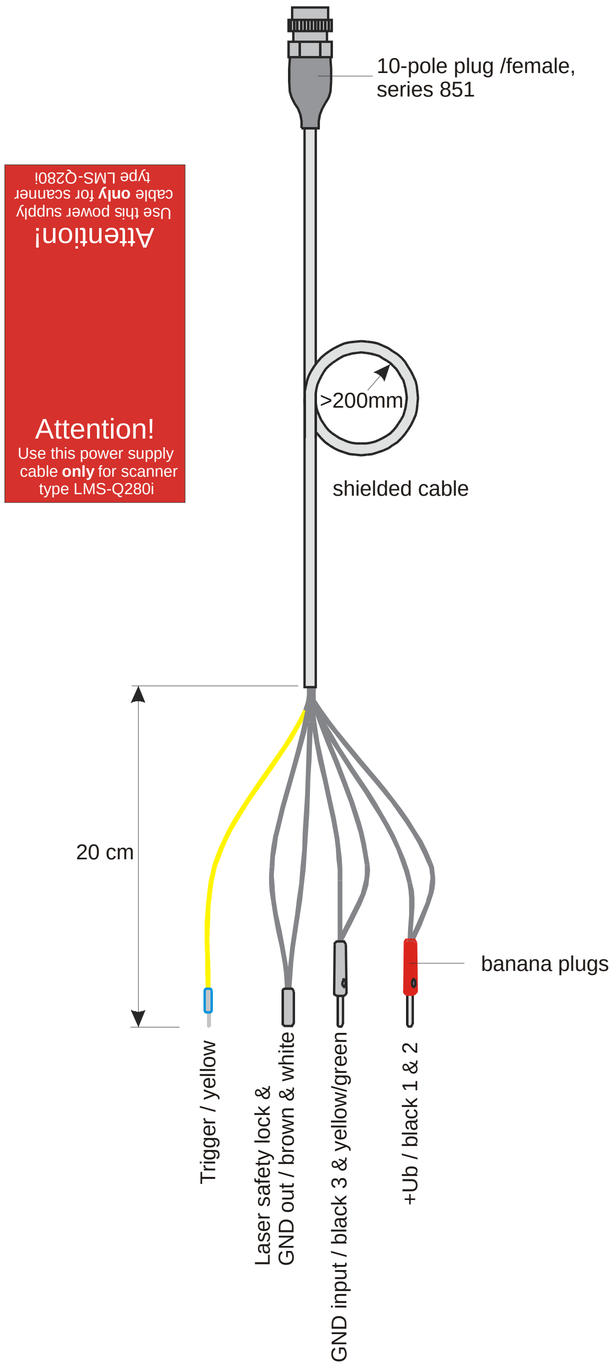


Fig. 9 Power supply cable

4.3.2 Parallel Data Cable

The parallel data cable uses a standard PC-Printer cable pinning, but needs improved noise immunity to ensure highest possible data transfer rates. The cable has to meet the requirements of IEEE Std. 1284-1994. The end of the parallel cable is equipped with 25-pole Sub-D connectors enabling to connect the LMS-Q280i directly to the LPT printer port of a personal computer. The length of the parallel cable is approx. 6 m .

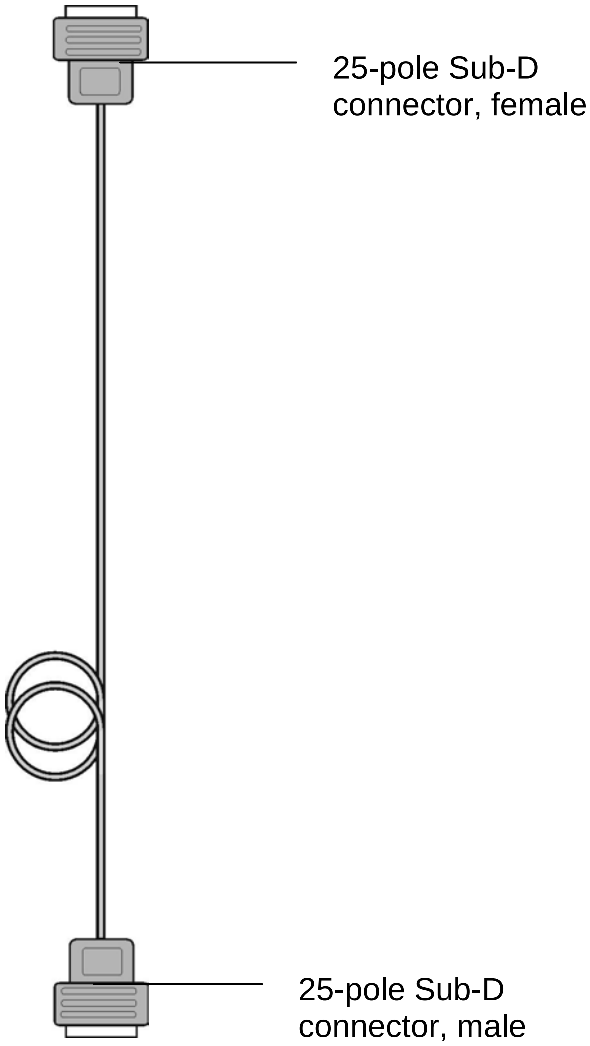
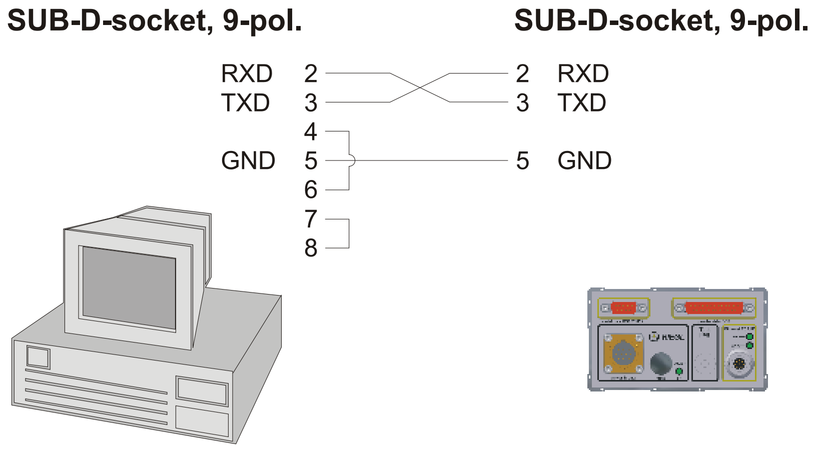


Fig. 10 Parallel data cable

4.3.3 Serial Data Cable

Cable configuration:



The cable length is approx. 3m.

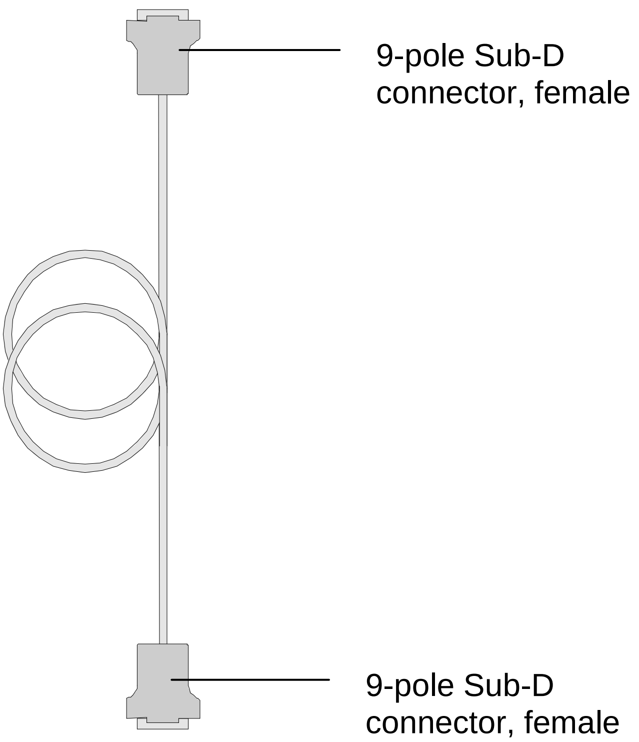


Fig. 11 Serial data cable

4.3.4 LAN-TCP/IP Data Cable

Using the included Ethernet Interface cables the LMS-Q280i can be connected to an Ethernet hub or to a PC/Laptop Ethernet connector.

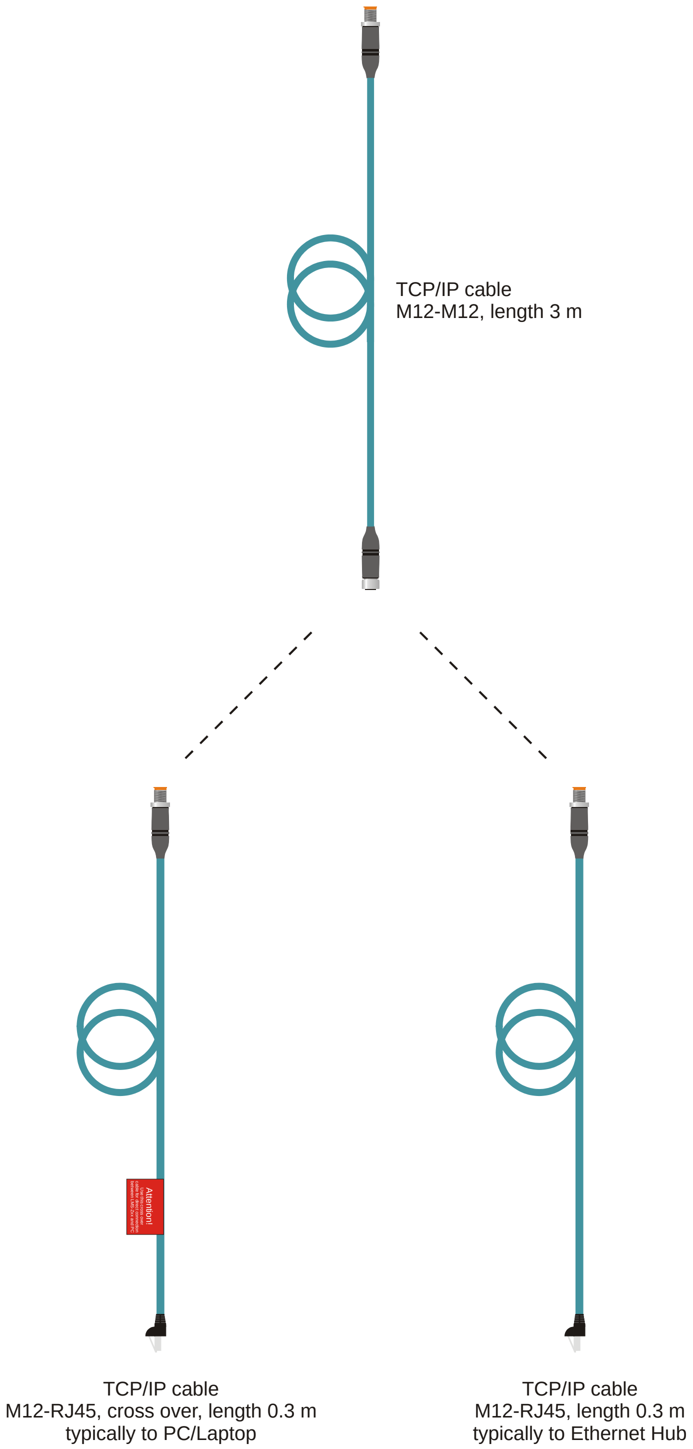


Fig. 12 Ethernet interface cable

4.4 Mounting the LMS-Q280i

The base plate of the LMS-Q280i provides 6 pcs. steel inserts with M6 threads, depth 10mm. This threads are intended to be used for mounting the laser scanner to a shock proof support plate. For installation of an inertial measurement unit, the LMS-Q280i provides additionally 6 pcs. steel inserts with M6 threads in the heat sink profile of the top plate, which are firmly connected to the internal frame structure. The position of these mounting threads can be found in the drawing below.

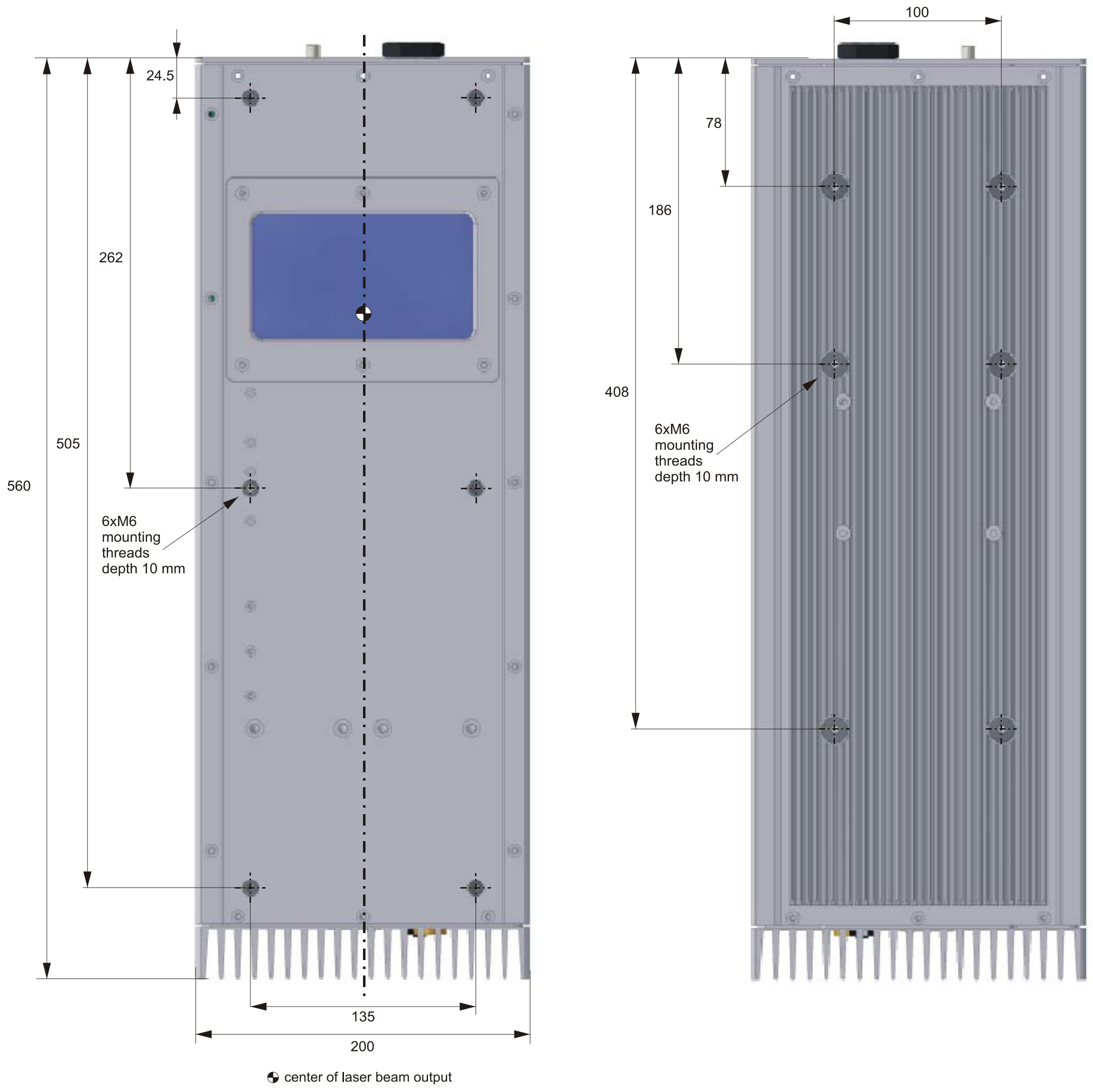


Fig. 13 Position of mounting threads

4.5 Instrument Cooling

To enable appropriate heat dissipation by means of natural air convection, the heat sink profiles must not be covered by objects which are located very closed to the laser scanner. Operation at higher ambient temperature and/or reduced air convection (low atmospheric pressure) could require additional forced cooling (external fan). The housing surface temperature should not exceed +40°C.

4.6 General System Set Up and Cabling

- Provide a suitable power supply for the laser scanner (please refer to chapter 4.1, Preparing the Power Supply).
    - Mount the laser scanner LMS-Q280i by means of the mounting threads.
    - Connect the LAN-TCP/IP interface or alternatively the parallel and the serial interface of the instrument to a personal computer or equivalent data acquisition unit using the LAN cable or the parallel and serial connection cables.
    - Connect the instrument to the power supply using the power supply cable.

After switching-on the power supply the scanner starts with

- the "Laser setup and test procedure" (see chapter 4.7 for details), and then

starts scanning automatically.

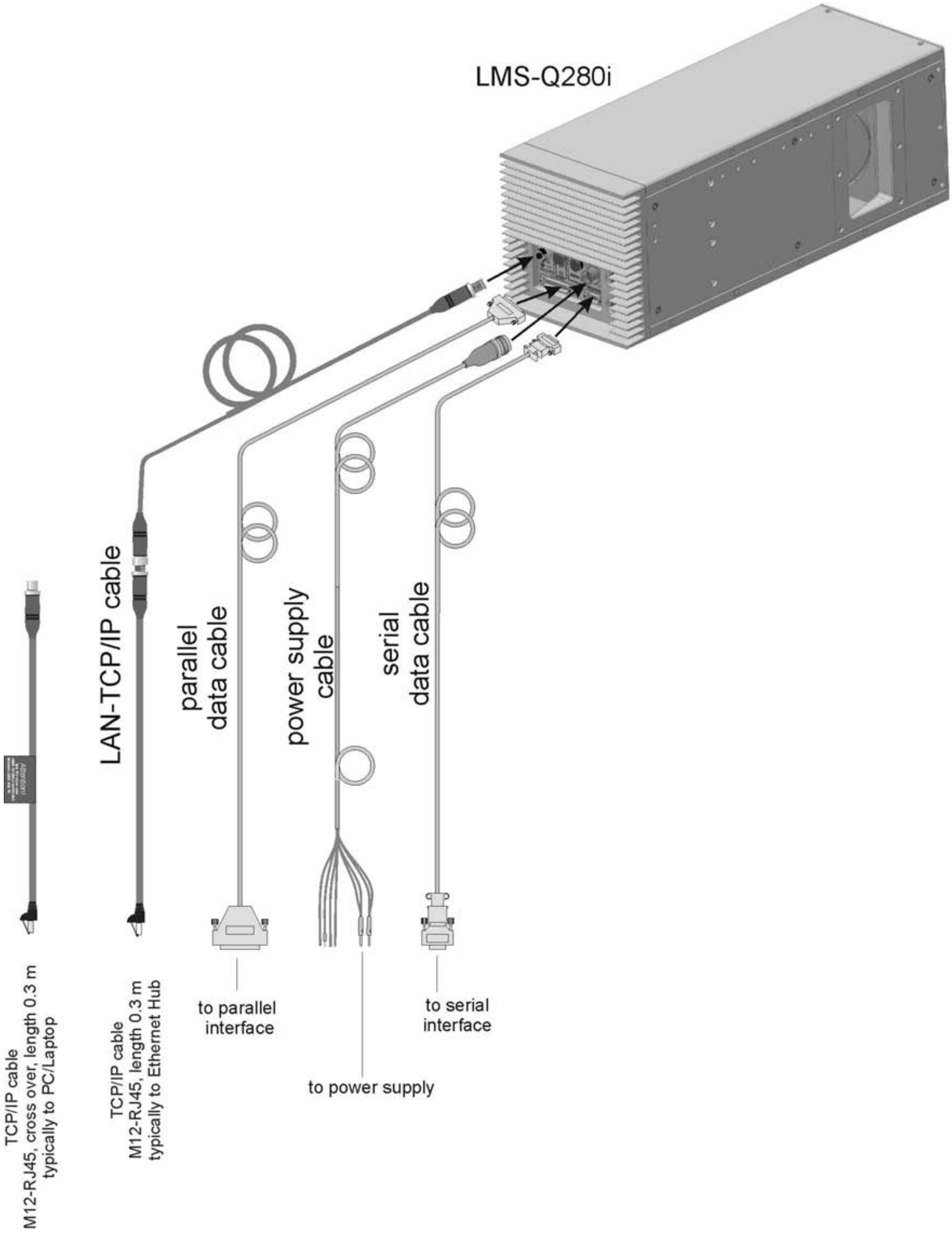


Fig. 14 Cabling of laser scanner LMS-Q280i

4.7 Laser Setup and Test Procedure

At power up a **laser setup and test procedure**, typically lasting 20 seconds (the effective time depends on instrument’s and ambient temperature) is executed. A beep sequence indicates that the setup procedure is in progress.

If the laser setup and test procedure is passed, the laser is ready for measurement, otherwise an error message is sent.

5 Specifications

5.1 Technical data

Technical Data of the Scanning Mechanism	
Scanning mechanism:	rotating polygon mirror
Number of mirror facets:	4
Scan angle range:	45° (60° at 90% meas. range)
Angular movement:	linear
Scan speed :[1]	5 lines/s up to max.80 lines/s
Minimum angle step width :	0.02°
Angle readout resolution:	0.0025°

1) Scanning rates selectable via LAN-TCP/IP or serial interface, max. 30 scans/sec. for 60° scanning range

Technical Data of the Laser Range Measurement	
Measurement principle:	Single-shot time-of-flight measurement
Measurement range [1] for natural targets, ρ ≥ 20% for natural targets, ρ ≥ 80%	 850 m 1500 m
Maximum range :	2000 m
Minimum range:	30 m
Measurement accuracy [2] (1σ standard deviation)	typ.± 20 mm
Measurement resolution:	5 mm
Target detection modes:	First target, last target (up to 4 echoes) or alternating
Laser pulse repetition rate PRR [3]:	24.000 Hz
Laser wavelength:	near infrared
Laser beam divergence [4] :	0.5 mrad
Eye safety class according to IEC60825-1:2001 [5]	

1) The following conditions are assumed:
   - target is larger than the foot print of laser beam
   - normal incident angle of laser beam
   - visibility 10 km
   - average ambient brightness
2) Standard deviation, plus distance depending error≤ ± 20ppm
3) Average measurement rate is 1/2 of PRR rate @ scan angle range 45°
4) 0.5 mrad corresponds to 5 cm beam width per 100m distance
5) The classification is based upon the assumption that the laser beam is continuously scanned.

Physical and Electrical Data

Main dimensions :	560 x 200 x 208,5 (L x W x H)
Weight :	20 kg
Protection class:	IP54
Temperature range: Operation: Storage:	 0°C up to +40°C -10°C up to +50°C
Power consumption:	approx. 70 W
Voltage supply range:	18 – 32 V DC
Interfaces	
Mechanical interface	Steel thread inserts
Data interface	Ethernet, twisted pair LAN,10 / 100 MBit, industrial connector Serial Interface for configuration, industrial Sub connector Parallel ECP interface for data output , industrial Sub-D connector
Power supply	10 pin MIL connector
Additional control lines	- Laser safety lock line - TTL input for synchronization - TTL output (optionally)
Optional True Color Channel	
Provides the color of target surface as an additional information to each laser measurement.	
Orientation	co-aligned with transmitter and receiver channel
Resolution	16 bit each color
Spectral range	blue: 380-470 nm green: 510-590 nm red: 590–710 nm
Field of view	1.4 mrad

5.2 Definition of axes

The following drawing shows the definition of the coordinate system of the LMS-Q280i.

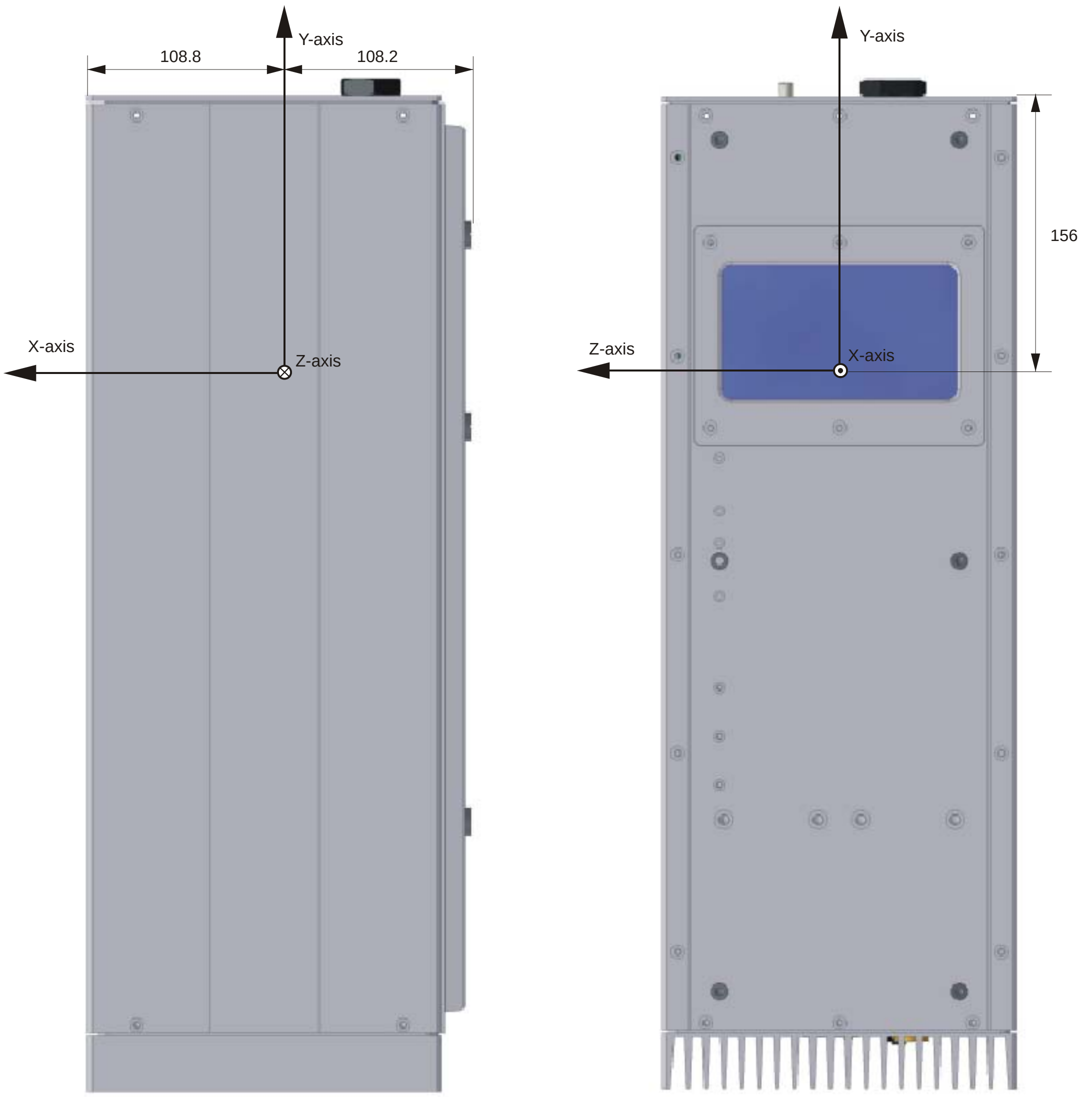
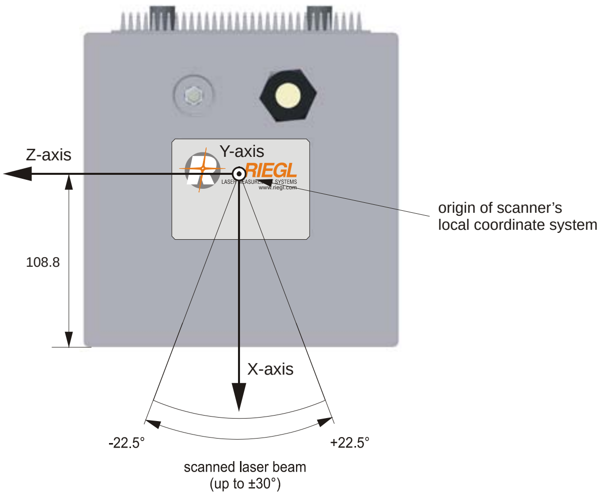
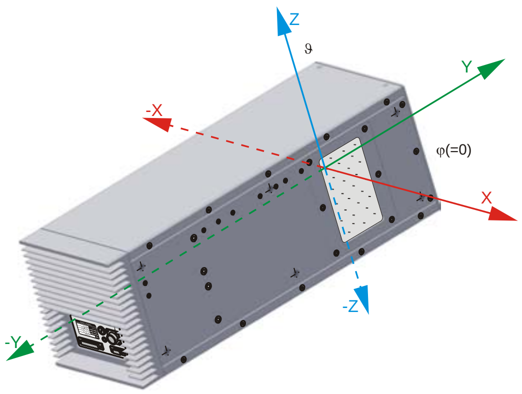
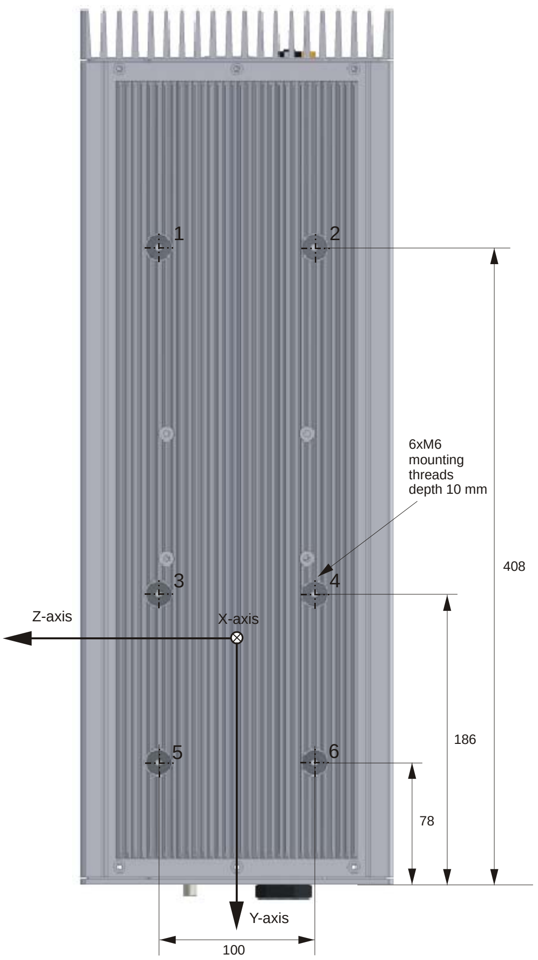


Fig. 15 Definition of axes 1







Coordinates of mounting points for IMU			
point no.	X	Y	Z
1	-108.2	-252	50
2	-108.2	-252	-50
3	-108.2	-30	50
4	-108.2	-30	-50
5	-108.2	78	50
6	-108.2	78	-50

Fig. 16 Definition of axes 2

5.3 LMS-Q280i Timing Characteristic

As mentioned in chapter 1.1.2, only a part of the mirror facets can be used for data acquisition. At the edges of the facets the laser beam is split into two beams and no measurement is possible. The utilization of 45° out of 90° results in a duty factor of 50 percent. That is the reason for gap times between two consecutive scan lines. Fig. 16 shows the timing situation for the LMS-Q280i.

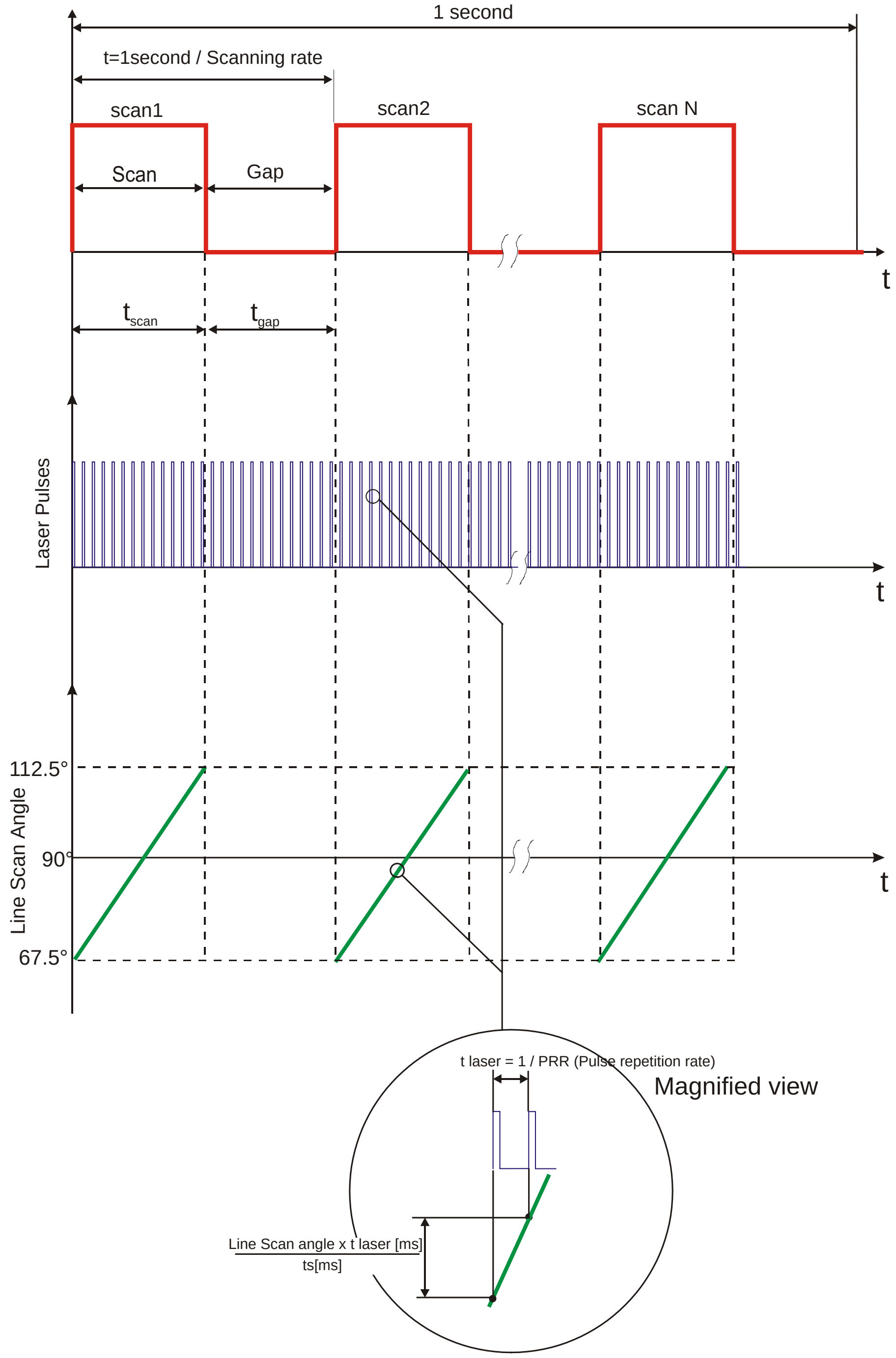


Fig. 17 Timing diagram for the scan mechanism

5.4 External Synchronization and Internal Reference Timer

The LMS-Q280i provides an internal timer with a timing resolution of 10 µs. It is a 3 byte wide timer and automatically started at power up. With 3 bytes it overruns every 167.77216 seconds.

The **timer value at the start of the scan data line** (LineTimeStamp) is provided for further data processing within the trailer data contained within each scan line data (see chapter, 6.4.1.4 Structure of trailer). Additionally, a LaserShotTimeStamp can be added to each measurement, if more detailed timing information is needed (see chapters 6.4.2 (Fn command) , 6.4.1.3 and 6.4.1.4)

Additionally, the instrument provides an input for an external SYNC pulse. The external SYNC pulse synchronizes the internal timer to an external event (e.g. 1pps GPS pulse). The rising edge of the external pulse resets the internal timer and the number of external SYNC pulses are counted. The counter value is supplied optionally in the trailer data (SyncCounter, see chapter 6.4.1.4)

Specifications of the external SYNC pulse:

Signal level :	TTL, positive, with respect to GNDout
Pulse duration :	min. 15µs
Trigger edge :	rising edge

The input is protected against over voltage and negative voltage.

6 Data Communication and Interfaces

When using the LMS-Q280i without Ethernet / TCPIP interface, 2 interfaces are used:

- a **serial RS232** (PC COM-Port) interface for configuration and control
- a **parallel ECP** (PC LPT-Port) interface for fast scan data output

With the Ethernet / TCPIP interface, these 2 interfaces (2 cable connections) can be replaced by one interface (one cable), using 2 ports: a **data port** (port number 20001) and a **configuration port** (port number 20002).
All syntax rules and data format / structure descriptions of the following chapters are identically used for communication via the TCPIP interface ports, where the rules relevant for the serial interface are used for the configuration port and the data structures for ECP parallel interface are used for the data port.

With Ethernet / TCPIP interface some specific commands for TCPIP configuration (e.g. IP-address) have to be previously set using the serial RS232 interface.

6.1 Programming Mode / Measurement Mode for Serial Interface

The instrument provides a programming mode to set and display measurement and control parameters. To enter the programming mode (leaving the measuring mode) send a ^P (Ctrl P, ASCII 10hex) to the instrument, to leave the programming mode (re-entering the measuring mode) send a Q<Cr> (like quit). <Cr> means Carriage return (ASCII 0Dhex).
Measurements and scans are carried out in the measurement mode. After power up the instrument starts with measurement mode.

The communication parameters are pre-adjusted in factory to

19200 baud
1 start bit
8 data bits
no parity
1 stop bit

For achieving electromagnetic compatibility, use original *RIEGL* data cable for communications only!

6.2 Data Format for Serial Interface

6.2.1 Data Format for Serial Interface in Programming Mode

The programming mode uses ASCII character strings to set parameters or ask for current parameter settings. After starting programming mode with command ^P, the instrument replies with the message

*<Cr>[<Lf>]

where <Cr> means a Carriage return (0Dhex) and [<Lf>] means an optional Line Feed (0Ahex) (<Cr> or <Cr><Lf> sequence can be selected by the user via parameter CS) .

Basically the programming mode works with a **command / reply concept**: A command is sent to the instrument, which answers with a reply message.

The first character(s) of the reply message always is(are)

***** - when the last command could be interpreted correctly.
- if a ^P has been sent. ^P starts or restarts the programming mode and additionally clears the receive buffer (so when e.g. sending a ^P after an incorrect command string part, the incorrect characters already sent are cleared)

? when the last command could not be interpreted because
- the parameter value is out of range and/or
- an array index specified is out of range

?? when the last command could not be interpreted because:
- an unknown command was sent or
- the parameter cannot be accessed in the current access level

= when the value of a parameter was requested.

**** when the line is continued (the reply message consists of more than 1 lines)

Example:

Command	*Reply*	*Meaning*
T1<Cr>	*T1<Cr><Lf>	Measurement time T1
.T<Cr>	=T1<Cr><Lf>	Meas. time = T1
ABcd<Cr>	??ABCD<Cr><Lf>	ABCD is not a valid command

This example assumes that the separator <Cr><Lf> is selected.

Lower case letters of a command are converted to upper case letters internally. Line feeds <Lf>, following the <Cr> in the command string, are ignored. Spaces are ignored and therefore may occur everywhere in the command string.

6.2.2 Data Format for Serial Interface in Measurement Mode

Coding mode ASCII or BINARY can be selected by user, see chapter 6.3.4.5, Coding mode of the serial result data output

Important note: In scanning mode the serial result output must be switched off by command RO. Set RO8 to output data to ECP port only !
The serial result output is used for scanners for debug and test purposes only.

Data Format in Result Coding Mode ASCII

The ASCII data string has variable length and is delimited by <Cr> or <Cr><Lf> respectively. The data string is parted into separate blocks. The user can specify which **data blocks** are included into the data string.

The first character(s) within the block is(are) named the **block identifier**. **Block identifiers are always lower case letters**, where data (messages and status information) are always upper case letters The following block identifiers are used:

r	Range
a	Signal intensity (Amplitude)
b	Line scan angle
q	Measurement quality
t	SensorTimeStamp (SYNC Timer)
cr	True color data, red part
cg	True color data, green part
cb	True color data, blue part
m	Message, status information

The length of the block depends on the data and is not constant. If the character following the identifier is a "+" , a "-" or a ASCII-digit, the data block represents a number (e.g. the range in meters). If it is a letter, it represents status information.

Example: It is assumed that the output of range and amplitude is activated:

r123.4;a138<Cr><Lf>

Error and status information are messages and given in the following format: (e.g. error: supply voltage too low)

mERROR:LOW_BATT<Cr><Lf>

Note that under environmental conditions providing high electromagnetic irradiance, the amplitude measurement can be disturbed or disorted.

Data Format in Result Coding Mode BINARY

The binary data string uses the most significant bit 7 (MSB) of data for synchronization purposes. The MSB is set to 1 for the first byte of the data string, and is set to 0 for the following bytes.
Data is included in the data string, when the corresponding bit in the Data format descriptor (see chapter 6.3.4.4, Selecting data blocks for the serial interface data string) is set. Data is transmitted in order high to low byte.

Data bytes are issued in the following order:

Distance 3 bytes (if corresponding bit is set in F parameter)
Amplitude 1 byte (if corresponding bit is set in F parameter)
Line angle 4 byte (if corresponding bit is set in F parameter)
Quality 1 byte (if corresponding bit is set in F parameter)
SensorTimeStamp 4 byte (if corresponding bit is set in F parameter)
True color data 6 byte (if corresponding bit is set in F parameter)

3 bytes Distance, order D1 – D2 – D3:
Distance [mm] = (D1 and 7Fhex) * 128 * 128 +
(D2 and 7Fhex) * 128 +
(D3 and 7Fhex)

1 byte Amplitude A1:
Amplitude [0..255] = (A1 and 7Fhex) * 2

4 bytes Line angle, order L1 – L2 – L3 – L4:
Line angle[degree/10000] = (L1 and 7Fhex) * 128 * 128 * 128 +
(L2 and 7Fhex) * 128 * 128 +
(L3 and 7Fhex) * 128 +
(L4 and 7Fhex)

1 byte Quality Q1:
Quality [0..100] = (Q1 and 7Fhex)

4 bytes SensorTimeStamp (SYNC Timer), order T1 – T2 – T3 – T4:
Timer[10^{-5} s] = (T1 and 7Fhex) * 128 * 128 * 128 +
(T2 and 7Fhex) * 128 * 128 +
(T3 and 7Fhex) * 128 +
(T4 and 7Fhex)

6 byte True color data, order R1-R2-G1-G2-B1-B2:
Red Part= (R2 and 7Fhex) + 128 * (R1 and 7Fhex)
Green Part = (G2 and 7Fhex) + 128 * (G1 and 7Fhex)
Blue Part = (B2 and 7Fhex) + 128 * (B1 and 7Fhex)

Example:
Assume that F5 is set; then a data string
82 – 73 – 2F – 1C
means:
Distance = 2*128*128 + 115*128 + 47 = 47.663 mm
Amplitude = 56

Note: The ASCII communication in programming mode is not effected. Status and error messages are always given in ASCII mode, regardless of the setting of RM

A correct data reception procedure therefore should read data and wait for a byte with the MSB set to 1, then read a number of bytes according to the setting of the F command to read all data of 1 measurement. This method would automatically ignore all possible ASCII codes (status and error messages and programming mode).

6.3 Parameters and Controlling Commands

6.3.1 Parameter Data Types in Programming Mode

The instrument supports the following data types:

Byte:	8-bit value, signed or unsigned
Integer:	16 bit value, signed or unsigned
Long:	32 bit value, signed or unsigned
String:	a sequence of characters
Command:	no value specified

These base types can be grouped to
Arrays: of byte, integer, long, string or command

Setting a parameter is done by specifying the **parameter name**. For arrays the name is followed by the **array range specification** given within brackets [ ]. For Bytes, Integers and Longs an **optional "="** may follow. For strings a "=" must follow. For data types byte, integer, long and string then the **value to be set** must follow.

Command	*Reply*	*Type*	*Meaning*
T=3	*T3	Byte	Setting measurement time
O-1000	*O-1000	Integer	Setting range offset – 1 m
W	*W	Command	Saving parameters

To **get (inquire) the value of a parameter**, a point "." is set before the parameter name.

Command	*Reply*	*Meaning*
.T	=T3	Ask for current measurement time
.O	=O0	Ask for current offset
.ABC	??ABC	Don't know command ABC
.#SN	=#SN9991100	Ask for string serial number

If an **error is detected** (e.g. during execution of a command in programming mode or previously in measurement mode), all replies in programming mode get an exclamation mark added. An error is pending until it is acknowledged by command "ERRACK" (so the exclamation mark is added to all command replies until the error is acknowledged). See chapter 6.6 for details.

Command	*Reply*	*Meaning*
W	*W!	Save, an error has occurred
.T	=T3!	Ask for current measurement time, error pending

Command	*Reply*	*Meaning*
^P	*!	Start of programming mode, an error is already pending

6.3.2 Several Basic Commands

6.3.2.1 Starting and Finishing Programming Mode

Command	*Reply*	*Meaning*
^P	*****	Start the programming mode
Q<Cr>	***Q**	Quit the programming mode and return to measurement mode

Example:

Command	Reply	Remark
^P	*	Programming mode started
T0	*T0	Set measurement time T0
Q	*Q	Quit programming mode

6.3.2.2 Reset

Command	*Reply*	*Meaning*
RESET<Cr>		Reset does an internal processor reset and a new start. Please note that the internal laser hardware is not reset (it still is power supplied), therefore this is not complete identical to switching off and on.

6.3.2.3 Setting Parameters to Default Values

Command	*Reply*	*Meaning*
DEFAULT<Cr>	***DEFAULT**	This command sets several parameters to an initial default value.

The following parameters are set to the listed default status:

Default setting	**Meaning**
T0	Measurement time T0
U0	Range unit meter
A2	Trigger mode free running
F13	Serial interface: data string includes range + amplitude+ angle
MQ50	Minimum measurement quality 50 percent
O0	Range Offset 0
CS1	Serial interface: Line Separator <Cr> + <Lf>
RM0	Serial interface: Result mode ASCII
RO8	Result output at ECP only
AL0	Amplitude window low value 0
AH255	Amplitude window high value 255
TS1	Last target measurement

XB1	ECP output: 1 measurement per block
XM1	ECP output: Hold 1 block in memory
XOS0	ECP output: Range in units of [1 mm]

The tests for electromagnetic compatibility according to the requirements of the European Union have been performed using default parameter settings. In case of any disturbances of the instrument's functionalities due to electromagnetic influences, use default settings.

6.3.2.4 Getting Help

Command	*Reply*	*Meaning*
.HELP	**see example**	Getting help to the available commands.
HELPFOR=[str]<Cr>	***HELPFOR[STR]**	Restrict the list of commands to commands including the string [str]. If [str] is an empty string [], all commands are listed.
.HELPGROUPS	**see example**	Display all available help groups. Each available command belongs at least to one group.
.HELP[n]		Getting help for specific helpgroup n. A restriction of the command list by HELPFOR=[str] operates additionally.

Example for Help:

Command	**Reply**
HELPFOR=O	*HELPFOR=O
.HELP	\ O : User offset, Acc=RW, Integer[-32767,32767], Save=W =HELP
HELPFOR=C	*HELPFOR=C
.HELP	\ CB : Communication Baudrate, Acc=RW, Byte[0,9], Save=W \ CP : Communication Parity, Acc=RW, Byte[0,4], Save=W \ CS : Communication Separator, Acc=RW, Byte[0,1], Save=W =HELP
HELPFOR	*HELPFOR

Each help line to a parameter has the following structure:

\ParName : Short description , Access , Type and Range , Saving

Each lines start with “****” to indicate that another line follows.
ParName shows the parameter name to be entered; e.g. “O” is used to set the range offset.
ParName[len] indicates an array type with len elements.

Short description describes the meaning of the parameter.

Access describes how the parameter can be used:

R = Read, W = Write, RW = Read and Write.
E.g. "HELP" can be used as Read command only (.HELP), "RESET" can be used as Write command only and "O" can be used as Read and Write command (writing and reading the offset).

Type and Range describes the parameter type and valid settings..
Byte is a 8 bit value, **Integer** a 16 bit value, **Long** a 32 bit value and **String** a character string. **Command** has no additional value to be set.
For Byte, Integer and Long the range of valid settings is indicated in the form **[min,max],** where min is the minimum possible setting and max is maximum possible setting. For strings the value within the brackets describes the maximum length.

"Save=W" means that the parameter setting can be saved with command "W", **"Save=#W"** means that the parameter setting can be saved with command "#W" (service level only) and "**Save=No**" means that nothing is saved.

Example for Help groups:

Command	**Reply**
.helpgroups	\ 0: Basic \ 1: Info \ 2: Communication \ 3: Measurement \ 4: Laser \ 5: Scanner Basic \ 6: Scanner Extended \ 7: Optic \ 8: Angular Basic \ 9: Adjustment \ 10: Streams =HELPGROUPS
.help[1]	\ TIME : Current time, Acc=RW, String[9], Save=No \ DATE : Current date, Acc=RW, String[9], Save=No \ OPTIME[3] : Total operating-/Laser on-/ Motor on time, Acc=R, String[13], Save=No \ TEMP : Temperature, Acc=R, Byte[-127,127], Save=No =HELP[1]

6.3.2.5 Saving Parameters Permanently

Command	*Reply*	*Meaning*
W<Cr>	***W**	Saves parameters permanently. That means that current settings are kept when the instrument is switched off and on again. Note that some time (typically tenth of seconds, but under certain circumstances up to 1-2 seconds) is needed to save data and to reply.

6.3.2.6 Total Instrument Operating Time

Command	Reply	Meaning
.OPTIME[0]<Cr>	**=OPTIME[0]hhhh:mm:ss**	Total operating time of scanner, that is the total time the instrument has been power supplied. hhhh hours mm minutes ss seconds
.OPTIME[1]<Cr>	**=OPTIME[1]hhhh:mm:ss**	Total laser operating time (laser on), format like OPTIME[0]
.OPTIME[2]<Cr>	**=OPTIME[2]hhhh:mm:ss**	Total scan operating time (scanner in motion), format like OPTIME[0]
.OPSECS[0]<Cr>	**=OPSECS[0]n**	Total operating time of scanner in seconds, $0 \leq n \leq 2147483647$
.OPSECS[1]<Cr>	**=OPSECS[1]n**	Total laser operating time in seconds, $0 \leq n \leq 2147483647$
.OPSECS[2]<Cr>	**=OPSECS[2]n**	Total scan operating time (scanner in motion) in seconds, $0 \leq n \leq 2147483647$

6.3.3 Basic Measurement Parameters

6.3.3.1 Enabling the Desired Data Outputs for Results

Command	*Reply*	*Range*	*Meaning*
ROn<Cr>	***ROn**	$0 \le n \le 255$	Enabling the **output of measurement results** for different outputs: The bits of the value have the following meaning: bit 0: Serial interface output bit 3: ECP data output Example: RO8 sets ECP output only, RO9 sets ECP + serial output

In scanning mode enable the ECP data output only, therefore set to RO8 !

Note that the command effects the **output of measurement results only**. Therefore e.g. errors are still reported on the serial output, even when the corresponding data output bit 0 in RO is cleared. Similarly the serial programming mode is not effected by the setting for the serial data output in RO.

6.3.3.2 Selective Measurement of Strong Reflector Targets (Setting an Amplitude Window)

Command	*Reply*	*Range*	*Meaning*
ALn<Cr>	***ALn**	$0 \le n \le 255$	Setting the minimum value of signal amplitude values accepted
AHn<Cr>	***AHn**	$0 \le n \le 255$	Setting the maximum value of signal amplitude values accepted

These feature allows to set an signal amplitude window to measure targets with a reflectivity in a certain range. E.g. to measure only targets equipped with reflectors and to make it insensitive for diffusely reflecting targets, set AL to a value of approx. 80 and AH to 255.

6.3.3.3 Switching the Laser Off and On, Laser Lock

Command	Reply	Range	Meaning
LASERn<Cr>	*** LASERn**	$0 \leq n \leq 1$	Software laser switch n=0: laser off (like command ^F in measurement mode) n=1: laser on (like command ^N in measurement mode)

6.3.3.4 Target Selection

Command	*Reply*	*Range*	*Meaning*
TSn<Cr>	***TSn**	$0 \leq n \leq 2$	0: measurement of FIRST TARGET 1: measurement of LAST TARGET 2: ALTERNATIG first / last target

The **LAST TARGET** detection is useful for measurement situations where targets in front (trees, bushes ...) partly block the sight to the desired measurement target.
For last target detection up to 4 targets with an intermediate distance of at least 5 meters between consecutive targets can be handled.

An **ALTERNATING** measurement mode enables automatic switching between first and last target. When scanning, the mode first target / last target is alternated with every laser shot in a scan line. Each line starts with first target mode.

When using the LMS-Q280i under environmental conditions providing electrical, electrostatic and/or electromagnetic disturbances, only the program FIRST TARGET has to be used in the interest of achieving the highest possible reliability of measurement. The programs LAST TARGET or ALTERNATING must not be used!

6.3.3.5 Hardware Resolution Mode and Maximum Range

The **hardware resolution** is fixed **5 mm**. Earlier versions of the LMS-Q280i had user selectable hardware resolution modes (command HWRES) with different possible maximum range values.
The **nominal maximum range** is **2000 m**; note that the effective maximum range depends on the target quality (distance to target, reflectivity, visibility, size of target, angle of incidence of laser beam etc.) and usually is lower.

6.3.4 Adjusting Parameters for Serial Interface

6.3.4.1 Setting the Baud Rate and Parity

Command	Reply	Range	Meaning
CBn<Cr>	***CBn**	$0 \le n \le 9$	Setting the Baudrate for communication via serial interface. n = 0: 150 n = 1: 300 n = 2: 600 n = 3: 1200 n = 4: 2400 n = 5: 4800 n = 6: 9600 n = 7: 19200 n = 8: 38400 n = 9:115200
CPn<Cr>	***CPn**	$0 \le n \le 4$	Setting Parity for communication via serial interface. n = 0: 8 Data Bits, no Parity n = 1: 8 Data Bits, even Parity n = 2: 8 Data Bits, odd Parity n = 3: 8 Data Bits, Parity = Mark (= No Parity, 2 Stop Bits) n = 4: 8 Data Bits, Parity = Space

Note that it is necessary to save parameters permanently by command “W” and to reset the instrument to activate new values of CB or CP.

When using the LMS-Q280i under environmental conditions providing electrical, electrostatic and/or electromagnetic disturbances, data communication with high baud rates may result in communication errors. In this case set the baud rate to a lower value.

6.3.4.2 Setting the Line Separator

Command	Reply	Range	Meaning
CSn<Cr>	***CSn**	$0 \le n \le 1$	Setting the Line Separator for data string sent via serial interface. n = 0: Carriage Return <Cr> n = 1: Carriage Return + Line Feed <Cr> + <Lf>

6.3.4.3 Setting the Serial Mode

Command	*Reply*	*Range*	*Meaning*
CMn<Cr>	***CMn**	$0 \le n \le 1$	Setting the serial mode. n = 0: RS232 n = 1: RS422

Note that it is necessary to reset the instrument to activate new values of CM.

6.3.4.4 Selecting Data Blocks for the Serial Interface Data String

Command	Reply	Range	Meaning
Fn<Cr>	***Fn**	$0 \le n \le 65535$	Setting the data blocks forming the result output data string. The bits of the value have the following meaning: bit 0: Enable range data output bit 2: Enable amplitude data output bit 3: Enable angle data output bit 5: Enable quality data block bit 6: Enable SYNCTimer data block bit 7: Enable True color data block Example: F5 sets output of range and amplitude value.

The setting of the F – Parameter also effects the data structure of the ECP port data, see chapter 6.4.2 .

6.3.4.5 Coding Mode of the Serial Result Data Output

Command	Reply	Range	Meaning
RMn<Cr>	***RMn**	$0 \le n \le 1$	Result coding mode. Coding the measurement result data of the serial data output ASCII (standard) or binary **Note: The ASCII communication in programming mode is not effected. Status and error messages are always given in ASCII mode, regardless of the setting of RM**

6.3.5 Definition of Scan Pattern

6.3.5.1 Scan Pattern Basics

The scan pattern is mainly defined by the following parameters:

- Start angle
- Angular step width between measurements
- Number of measurements forming a scan

Command	*Range*	*Meaning*
RF_START_Ln <Cr>	0 ≤ n ≤ 3599999	Setting the start angle for the Scan in units of 0.0001 degree.
RF_NUMBER_L n <Cr>	1 ≤ n ≤ XBMAX [1)] [1)] see chapter 6.4.2	Setting the number of measurements per line. **Note : In scanning mode the setting of XB for the ECP data output (block buffer size) is automatically set equal to RF_NUMBER_L.**
RF_DELTA_L n <Cr>	200 ≤ n ≤ 4000	Setting the Scan angle increment between two consecutive laser shots in units of 0.0001 degree. **Note: Values are truncated according to the resolution of the internal angle encoders; e.g. for a resolution of 2.5 mdeg the value is truncated to a multiple of 2.5 mdeg (e.g. a setting of 187 results in an effective angle increment of 175 according to 7x2.5 mdeg)**
SC_WRITE <Cr>		Activate the scanner settings by internally writing the scanner relevant parameters to the scanner module (e.g. scanner speed depending on setting of RF_DELTA_L). This command is executed automatically at startup sequence and must be sent after changing scanner parameter RF_DELTA_L.
SC_SCAN <Cr> **SC_SCANCONT <Cr>**		Start the scanner motion (movement). Note: With parameter AUTOSCAN = 1 this is done automatically at startup.
SC_NOSCAN <Cr>		Stop the scanning movement

6.3.5.2 Scan Pattern Example

A typical command sequence in order to set a scan pattern with 0.1 degree angular step width and full (45 degree) scan area would be:

Command	meaning
^P	enter programming mode
SC_NOSCAN< Cr>	stop the scan motion
RF_DELTA_L1000<Cr>	angle step width 0.1 degree
RF_NUMBER_L451<Cr>	so scan range is 45 degree (number = (45 / 0.1) + 1)
RF_PRENUM_L2	factory setting for internal timing reasons, there are two laser shots prior to the begin of scan line
RF_START_L223000<Cr>	start of scan line at angle 22.5000 degree (22.3 + 2 x 0.1 pre-shots) note: for calculation of the beam angle, an offset of 45 degree (50 gon) is added, see chapter 6.4.1.1.3, PolarAngleID
SC_WRITE<Cr>	set the parameters (and derived scan speed …)
SC_SCAN<Cr>	now start the new scan
W<Cr>	save permanently, if desired, otherwise omit this command
Q>Cr>	quit programming mode

With the nominal laser pulse rate of PRR = 24.000 Hz, the resulting scan rate (lines per second) is

LPS = RF_DELTA_L * PRR * 4 / 3600000 = 26.7 lines (scans) per second

Automatic Adjustment of Scan Rate:

The line scan rate is adjusted automatically in case the pulse repetition rate changes in order to keep the angular spacing constant.

6.3.5.3 Scan Related Commands

Command	*Meaning*
.SC_STATUS <Cr>	Reading the status from the scanning module. Reading this value is necessary to get additional error information for the error "mERROR:SCAN_STATUS". For correct operation the value is 0. The bits of returned value (starting with bit index 0) have the following meaning: Bit 2: 1=Scanner supply voltage currently out of range Bit 3: 1= Scan movement not full speed Bit 4: 1= Scanner movement off Bit 6: 1= Encoder missing marker pulse Bit 11: 1= Scan No Motion Error Bit 12: 1= Line Scanner PLL locked Error Bit 13: 1= Scanner Supply Voltage out of range Error Bit 14: 1= Scanner FPGA Boot Error Bit 15: 1= Scanner FPGA Download Error
.SC_STATUS_LIST <Cr>	Reading and interpreting bits of SC_STATUS, displaying a list of message lines for each bit set in SC_STATUS, each message line starting with "\". SC_STATUS = 0 is displayed as line "\ MOTION_OK". Example: Command Reply: .SC_STATUS_LIST \ MOTION_OK =SC_SATUS_LIST
.SC_ERROR <Cr>	Reading this value is necessary to get additional error information for the error "mERROR:SCAN_COMMUNICATION". The bits of returned value (starting with bit index 0) have the following meaning: Bit 0: 1= No PDR Error Bit 1: 1= Bad Frame Ctrl Byte Error Bit 2: 1= Bad Checksum at last R/W Error Bit 3: 1= Bad Echo at last R/W Error Bit 4: 1= PDR at wrong position Error Bit 8: 1= Bad command or answer Error Bit 9: 1= Unknown command Error Bit 10: 1= PDR2 timeout Error Bit 12: 1= Error in Scanner, to be found in SC_STATUS **With Error acknowledge command "ERRACK" the value is set to 0.**
.SC_ERROR_LIST <Cr>	Interpreting bits of SC_ERROR, displaying a list of message lines for each bit set in SC_ERROR, each message line starting with "\"

Command	*Meaning*
.SC_VERSION <Cr>	Reading the current software version of the scanning module
. EALDESC[0]<Cr>	Getting the **total angle range of a full circle**
. EALDESC[1]<Cr>	Getting the **number of encoder lines of a full circle**
. EALDESC[2]<Cr>	**If 0**: angle is scaled in **gon;** angle resolution of scan angle = 400 / EALDESC[1] **If 1**: angle is scaled in **degree;** angle resolution of scan angle = 360 / EALDESC[1]
.EAL <Cr>	Get the current angle in units of 0.0001 degree

6.3.6 Several Additional Commands

6.3.6.1 Getting Version, Type and Serial Number Information

Command	*Meaning*
. #V<Cr>	Getting Software Version
. #VI<Cr>	Getting Instrument Ident
. #VN<Cr>	Getting Instrument Name
. #VM<Cr>	Getting Instrument Modification
. #SN<Cr>	Getting Instruments serial number

6.3.6.2 Getting Supply Voltage and Instrument Temperature

Command	*Meaning*
. V<Cr>	Getting supply voltage in units of 0.1 volt. This voltage is measured internally, therefore voltage loss from the supply cable can not be taken into account.
. TEMP<Cr>	Getting Temperature within instrument in units of degree Celsius. Note that the temperature within in the instrument usually is some degrees higher than ambient temperature.

6.3.6.3 Error Handling

Command	*Meaning*
. ERR<Cr>	Get a list of errors. Each error detected is listed in a line, where each line starts with “\” and is followed by an error message. The last line then is “=ERR” as response to the “.ERR” command. Note that while in measurement mode errors are automatically sent as messages.
ERRACK<Cr>	Error acknowledge. This command clears all errors listed with .ERR and no errors are pending any more. Note that FATAL errors can not be acknowledged.

For detailed description of error handling and error lists see chapter 6.6

6.3.7 Control Commands in Measurement Mode

Command	*Meaning*
^P (10hex)	From measurement mode, **start programming mode**. In programming mode, ^P restarts the program mode, therefore clears all characters already sent since the last carriage return (clears the input buffer).
^N (0Ehex)	**Switch on the laser (laser on only when additionally hardware laser lock is in status “on” and wheel in rotation,** see chapter 6.3.3.3**)**
^F (06hex)	**Switch off the laser**

6.3.8 Additional Low Level Commands

The following list of commands is usually not needed for standard usage.
It lists
- Commands needed for debugging and testing
- General range finder commands, not needed for the scanning application

6.3.8.1 Low Level Scanning Commands

ICAN <Cr>		Super User Password
AUTOSCAN n <Cr>	$0 \leq n \leq 1$	Setting the instrument mode at startup. **For scanning AUTOSCAN must be set to 1**. Value 0 is used only for factory adjustments. Needs Super User Password
SCAN <Cr>		Start the scanning mode in range finder module. Note that the scanner (scanning movement) must be started separately by command SC_SCAN. With parameter AUTOSCAN = 1, commands SCAN and SC_SCAN are executed automatically Needs Super User Password
NOSCAN <Cr>		Stop the scanning mode in range finder module. Note that the scanner (scanning movement) must be stopped separately with command SC_NOSCAN. For debug purposes only. Needs Super User Password
SC_RESET <Cr>		Resets the scanning unit Needs Super User Password
.#MID_MAIN <Cr>		Getting the ECP data output Measurement ID Main. Needs Super User Password
.#MID_SUB<Cr>		Getting the ECP data output Measurement ID Sub. Needs Super User Password

6.3.8.2 (Extended) Range Finder Commands

The LMS-Q280i includes *RIEGL* Rangefinder electronics module, which is set to a mode to fit to the application in the scanner. The following part lists this commands.

For correct scanning operation, some parameters must be set to certain values, which is done in the factory.

Do not change these parameters, otherwise correct scanning operation cannot be guaranteed.

Command	*Range*	*Setting*	*Meaning*
Tn<Cr>	0 ≤ n ≤ 7	don't care	Selection of **measurement time**. Setting / Meas. Time / Laser shots / measurement T0 1/13000 sec 1 T1 1/6500sec 2 T2 5/13000 5 T3 1/130 sec 100 T4 2/13 sec 2000 T5 5/13 sec 5000 T6 0.77 sec 10000 T7 1.53 sec 20000 **In scanning mode the measurement time setting is ignored. Each measurement is a single shot measurement (T0) at a certain angle. The command is used for debug purposes in mode NOSCAN only.**
Un<Cr>	0 ≤ n ≤ 2	don't care	Selection of **range measurement unit** n = 0 : unit meter n = 1 : unit feet n = 2 : unit yards The conversion factors are: 1 meter = 3.28084 feet 1 meter = 1.0936 yards **For scanning: Note that units of measurement for ECP output are not effected, the ECP output always uses meters**
An<Cr>	0 ≤ n ≤ 2	2	Selection of measurement trigger mode n = 0: Trigger external (TTL input) n = 1: Trigger via serial interface (^X) n = 2: Free running, automatic start **For scanning mode always select trigger mode A2**
On<Cr>	-32767 ≤ n ≤ 32767	0	Setting an range offset value in units of [mm]. This offset is used to adapt the zero plane according to different mounting positions. Positive values increase the displayed range value. **For scanning mode always set offset 0**

Command	*Range*	*Setting*	*Meaning*
MQn<Cr>	$0 \leq n \leq 100$	don't care	Setting the **minimum required measurement quality**. The quality of a measurement is relevant for results obtained by averaging of single shot measurements only (measurement times > T0). The quality is the percentage of emitted laser shots resulting in an detectable echo signal. Measurement results with quality values less than MQ indicate "no target" For single shot measurements the quality can only be 0 (no echo detected) or 100 (echo detected). According to the average rate of the selected measurement time, the minimum number of pulses necessary for a valid measurement result MQN is calculated internally. The resulting MQN value must be ≥ 1 (At least one single shot measurement is needed; it is internally set to 1, if the MQN value is less than 1).

6.4 ECP Data Output

The ECP data output is a **8 BIT PARALLEL DATA OUTPUT**. It has been designed to be directly connected to an **ECP compatible LPT printer port of an PC or compatible data acquisition unit** (this ports are also addressed *extended parallel ports* or *enhanced parallel ports*). ECP ports offer high data transfer rates. Although designed for personal computers, interfacing to other equipment is rather straight forward.
Specifications of the ECP mode can be found in IEEE standard 1284 -1994.

6.4.1 Reading Data via ECP

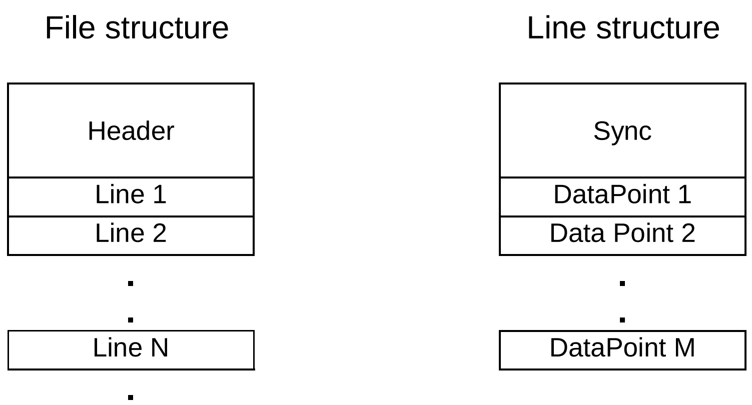
In order to read data from the ECP port we strongly recommend to install and use RiPORT on the acquisition system. RiPORT is a driver to be installed on the following platforms: WINDOWS NT, WINDOWS 2000, or WINDOWS XP. Please follow the installation instruction provided with the RiPORT driver.

Reading data from the ECP port via RiPORT can be seen like reading data from a file. Examples, written in C, show how to use functions

- RiPortOpen
- RiPortRead
- RiPortClose

For operating systems Windows 98 and WINDOWS ME the ECP port has to be accessed directly. Please consult the examples supplied with the driver (C++ source file **RiPort.CPP)**

The “ECP data file” or, in other words, the binary data stream, starts with a **header record**, followed by **line records** containing the line data (measurements). Every line record starts with a synchronization sequence, followed by (a user definable number of) data point data and ends with a trailer.



With **RiPortOpen** the ECP port is opened to receive data from the instrument. The first block read is the header block. Note that the header record is read only once after opening the ECP file.

The following structure definitions use a notation

Name1 : BitSize1 - Name2 : BitSize2

Where NameX is the name of element X and BitSizeX the bit size of the element X.

6.4.1.1 Structure of Header

The header consists of three consecutive blocks

Header Preamble Block
Header Main Block
Header Parameter Block

6.4.1.1.1 Header Preamble Block

HeaderSize:32 – DataSetLen:16 – ProtocolId:8 – HeaderID:8

Element name (size)	***Meaning***	***Value***
HeaderSize (unsigned 32 bit)	is the size of the header in bytes, including the bytes of HeaderSize. Therefore data starts HeaderSize bytes after the first byte (lowest byte of HeaderSize) of the header	specific
DataSetLen (unsigned 16 bit)	Length of Dataset in Bytes not including optional Sync field, CRC... (For each bit set in ProtocolID, 2 bytes have to be added to DataSetLen to jump to the next Data set.)	Scan specific
ProtocolID (unsigned 8 bit)	Each bit set describes a 16 bit field added to a dataset Bit 0 = 0: No Sync field present Bit 0 = 1: 16 Bit Sync field present Bit 1 = 0: No CRC field present Bit 1 = 1: 16 Bit CRC field present	1
HeaderID (unsigned 8 bit)	is the Header identity	10

6.4.1.1.2 Header Main Block for Header ID 10

MeasOffset:16 - MeasSize:16 - MeasCount:16- LeadInIDMain:8 - LeadInIDSub:16 - MeasIDMain:8 - MeasIDSub:16 - TrailerIDMain:8 - TrailerIDSub:16 - ParameterIDMain:8 - ParameterIDSub:16

Element name (size)	***Meaning***	***Value***
MeasOffset (unsigned 16 bit)	Offset of the first byte of the Meas record from the start of the data. Adding the offset effectively 'jumps' over the LeadIn record of the data	0
MeasSize (unsigned 16 bit)	Size of the one Meas record (data point) in bytes. Knowing the size allows ignoring unknown fields. The n'th measurement thus has an offset of MeasOffset + n * MeasSize	specific
MeasCount (unsigned 16 bit)	Number of measurement per Data set (line)	Scan specific
LeadInIDMain (unsigned 8 bit)	LeadIn Record ID Main; if Main and Sub are zero, this record is not present in the Data record	0
LeadInIDSub (unsigned 16 bit)	LeadIn Record ID Sub	0
MeasIDMain (unsigned 8 bit)	Meas Record ID Main	129
MeasIDSub (unsigned 16 bit)	Meas Record ID Sub, interpret the bits similar to description of Parameter F	specific
TrailerIDMain (unsigned 8 bit)	Trailer Record ID Main , if Main and Sub are zero, this record is not present in the Data record	6
TrailerIDSub (unsigned 16 bit)	Trailer Record ID Sub	1
ParameterIDMain (unsigned 8 bit)	Parameter Record ID Main	4
ParameterIDSub (unsigned 16 bit)	Parameter Record ID Sub	1

6.4.1.1.3 Header Parameter Block

Parameter ID 4.0

SerialNumber:64 – RangeUnit:32 – AngleUnit:32 – TimerUnit:32 – PoalrAngleID:8

Parameter IDs greater or equal to 4.1 further add

…. HWRes:8 – Target:8

Element name (size)	***Meaning***	***Value***
SerialNumber (64 bit)	null terminated string, 8 characters, instrument serial number	specific
RangeUnit (floating point 32 bit)	Range measurement unit in meters [m]	0.001
AngleUnit (floating point 32 bit)	Angle unit in gon. Full circle is 400 gon.	0.0001111111
Timer Unit (floating point 32 bit)	SensorTimeStamp (SYNC Timer, time of measurement) unit in seconds [s].	0.00001
PolarAngleID (unsigned 8 bit)	Defining the rule for calculation of the polar angle of the laser beam, based on the PolarAngle value supplied by the scanner. For PolarAngleID >= 64 (codes mirror type 1): NumberOfFacets = (PolarAngleID - 64 BeamPolarAngle[gon] = 50.0 + PolarAngle mod (400/AngleUnit/ NumberOfFacets)) * AngleUnit For AngleUnit = 0.000111111: **BeamPolarAngle[degree]=45.0 +(PolarAngle mod 900000)*0.0001** mod means modulo function	68 (number of facets = 4)
HWRes (unsigned 8 bit)	Setting of parameter HWRes, defining the hardware resolution of the range measurement (see chapter 6.3.3.5)	0..2
Target (unsigned 8 bit)	Setting of parameter TS, defining the target detection mode (see chapter 6.3.3.4)	0..2

Header example:

Hex sequence	Meaning
31 00 00 00	HeaderSize is 49 bytes
39 00	DataSetLen: 57 bytes per DataSet (line) (3 measurements x 16bytes + 9 bytes trailer)
01	ProtocolID = 1 (Sync Field on)
0A	HeaderID = 10
00 00	MeasOffset = 0
10 00	MeasSize = 16, each measurement has 16 bytes
03 00	MeasCount = 3, 3 measurements per line
00	LeadInMain = 0
00 00	LeadInSub = 0
81	MeasIDMain = 129
CD 00	MeasIDSub = binary 1101101 (range + amplitude +

	polar angle + sync timer + true color data output enabled)
06	TrailerIDMain = 6
01 00	TrailerIDSub = 1
04	ParameterIDMain = 4
01 00	ParameterIDSub = 1
39 39 39 33 33 37 31 00	Null terminated serial number string = “9993371”
6F 12 83 3A	RangeUnit = 0.001 m
51 04 E9 38	AngleUnit = 0.000111111 gon (corresponds to 0.0001 degree)
AC C5 27 37	Timer unit = 0.00001 seconds
44	PolarAngleID = 68, that is mirror type 1 with 4 mirror facets
02	HWRes = 2, hardware resolution
01	Target selection = 1, last target mode

6.4.1.2 Structure of Data in a Line

Consecutive data lines have the following structure:

Synchronization sequence (identical to DataSetLen in header)
Data point 1
Data point 2
.
Data point M
Trailer

Synchronization sequence (identical to DataSetLen in header)
Data point 1
.
.

The **Synchronization sequence** is formed by 2 bytes representing the number of bytes in one line. This value is identical to the value of DataSetLen in the header.

6.4.1.3 Structure of a Data Point

Each data point with Measurement ID 129.x has the following structure:

Range:24 (if bit 0 of MeasIDSub is 1) - Intensity: 8 (if bit 2 of MeasIDSub is 1) - AngleOfMirrorWheel:24 (if bit 3 of MeasIDSub is 1) – LaserShotTimeStamp:24 (if bit 7 of MeasIDSub is 1) – TrueColorRed:16 - TrueColorGreen:16 - TrueColorBlue:16 (if bit 8 of MeasIDSub is 1)

Element name (size) ***Byte Order***	***Meaning***
Range (unsigned 24 bit) R1-R2-R3	Distance to target [Parameter.RangeUnit] = R1 +256*R2 + 65536*R3
Amplitude (unsigned 8 bit) A1	Signal amplitude of received target echo signal[0..255] = A1
AngleOfMirrorWheel (unsigned 24 bit) L1-L2-L3	Angle of mirror wheel [Parameter.AngleUnit] = L1 +256*L2 + 65536*L3 **To calculate the laser beam angle, see Parameter. PolarAngleID**
LaserShotTimeStamp (unsigned 24 bit) T1-T2-T3	Time stamp [Parameter.TimerUnit] = T1 +256*T2 + 65536*T3 The timer starts with system power up and is a **24bit timer**, although 32bit are reserved. With Parameter.TimerUnit = 10 microseconds, it therefore overflows after 167.77215 seconds. The timer can be reset by the rising edge of an external pulse supplied via input TRIG (see chapter 5.4) for synchronization to external events (e.g. GPS).
TrueColorRed (unsigned int 16 bit) R1-R2	True color data red part [0..65535] = R1 + 256*R2
TrueColorGreen (unsigned int 16 bit) G1-G2	True color data green part [0..65535] = G1 + 256*G2
TrueColorBlue (unsigned int 16 bit) B1-B2	True color data blue part [0..65535] = B1 + 256*B2

Example:
It is assumed that the F parameter is set to 205 (enable output of range + amplitude + polar angle + sync timer + true color data):

Header:

39 00
87 D8 00 0E 2E DE 06 0D B1 54 21 00 23 00 0C 00
34 E1 00 0B 0F DF 06 14 B1 54 19 00 23 00 0E 00
BD DA 00 0F D7 DF 06 1C B1 54 1B 00 1F 00 08 00
00 45 00 03 00 00 0C B1 54

Sync Sequence: 2A 00

Range 1:	00D887hex => 34776 x RangeUnit = 34.776 m
Amplitude 1:	0Ehex => 14
MirrorAngle1:	06DE2Ehex = 450094 => BeamAngle = 50.0 + (450094 mod 900000)*0.000111111 = 100.0103 gon = 90.0094 degree

TimeStamp1:	54B10Dhex = 5550349 x TimerUnit = 55.50349 sec
TrueColorRed1:	0021hex = 33
TrueColorGreen1:	0023hex = 35
TrueColorBlue1:	000Chex = 12
Range 2:	00E134hex => 57652 x RangeUnit = 57.652 m
Amplitude 2:	0Bhex = 11
MirrorAngle2:	06DF0Fhex = 450319 => BeamAngle = 50.0 + (450319 mod 900000)*0.000111111 = 100.0353 gon = 90.0319 degree
TimeStamp2:	54B114hex = 5550356 x TimerUnit = 55.50356 sec shot 2 is 70 microseconds after shot 1
TrueColorRed2:	0019hex = 25
TrueColorGreen2:	0023hex = 35
TrueColorBlue2:	000Ehex = 14

.
.

Trailer: 00 45 00 03 00 00 0C B1 54 (see next chapter)

ScanStatus:	0
ECPLineCounter:	0045hex => 69
Sync Counter	000003hex = 3; 3 trigger pulses (resetting the Sync timer) have been detected on external pin TRIGGER
LineTimeStamp	54B10Chex 5550348 x TimerUnit = 55.50348 sec Line started at time 55.50348 sec

6.4.1.4 Structure of Trailer

The trailer with Trailer ID 6.0 as the following structure:

ScanStatus:8 – ECPLineCounter:16

Trailer IDs greater or equal to 6.1 further add

… SyncCounter:24– LineTimeStamp:24

Element name (size)	***Meaning***
ScanStatus (unsigned 8 bit)	For future expansion.
ECPLineCounter (unsigned 16bit) N1-N2	ECPLineCounter = N1 + 256*N2 This Counter is incremented with each complete line transmitted to the internal ECP port buffer. Consecutive ECPLineCounter values of data read by the user system indicate, that no data is lost, or in other words, the system reading ECP data is fast enough not to loose any scan line.
Sync Counter (unsigned 24 bit) S1–S2–S3	Sync Counter = S1 + 256*S2 + 65536*S3 The Sync counter counts external SYNC pulses (positive edge) detected on input TRIG. Each pulse on the input also resets the internal timer (LineTimeStamp and LaserShotTimeStamp). The input is typically used for GPS reference pulses (typically each second).
LineTimeStamp (unsigned 24 bit) T1-T2-T3	Line Time stamp [Parameter.TimerUnit] = T1 +256*T2 + 65536*T3 LineTime Stamp derived from the sensor's internal timer with resolution [Parameter.TimerUnit]. The timer starts with system power up and is a **24bit timer**, although 32bit are reserved. With Parameter.TimerUnit = 10 microseconds, it therefore overflows after 167.77215 seconds. The timer can be reset by the rising edge of an external pulse supplied via input TRIG (see chapter 5.4) for synchronization to external events. LineTimeStamp is the timer value latched with the first laser measurement of line.

6.4.1.5 Special Coded Status Data

There are several measurement situations where no distance measurement data is available:

Measurement situation	*Range*	*Amplitude*
No target available or badly reflecting target	0	0
Underflow, Distance value less than 0 (including offsets)	0	0

Note that errors and status message (like programming mode of serial interface) are not reported on the ECP data output.

6.4.1.6 ECP Port Data Buffer

The ECP port of the instrument has a data buffer integrated. If the data receiving unit (the PC) is temporally inactive and cannot read data - e.g. when it has to handle other tasks – this will not cause loss of data.

This data buffer can be configured by the user via 2 parameters:
- The **number of data points** (measurements) **in a data block**
- The number of **blocks to be hold** in memory

Configuring the ECP port buffer is automatically done with command SCN_APPLY, so there is no need for the user to configure the ECP port buffer

These commands **divide the internal data buffer in blocks** (data lines) according to data block size, so each block can store the desired number of measurements.
The second parameter, the number of blocks to be hold, defines the maximum value of blocks to be hold in memory. Setting this hold parameter to N blocks means that the buffer **holds a maximum of N** blocks.
If N is large and reading of data is fast enough, the buffer will never fill up and data read is always last data.
On the other hand, if reading is interrupted for a longer time (e.g. because the data receiving unit is not interested on new data), this buffer will fill up. When full, each new data line then **overwrites the oldest of the N blocks** already filled.

Examples:

Blocks to be hold = 1; that means that 2 blocks are reserved. Start reading of a block (and interrupting the reading for even a long time) locks this block while the other block is always updated with the new data in the background.

Blocks to be hold = 2; that means that 3 blocks are reserved. Start reading of a block (and interrupting the reading for even a long time) locks one block while the other 2 blocks are filled alternatively in the background.

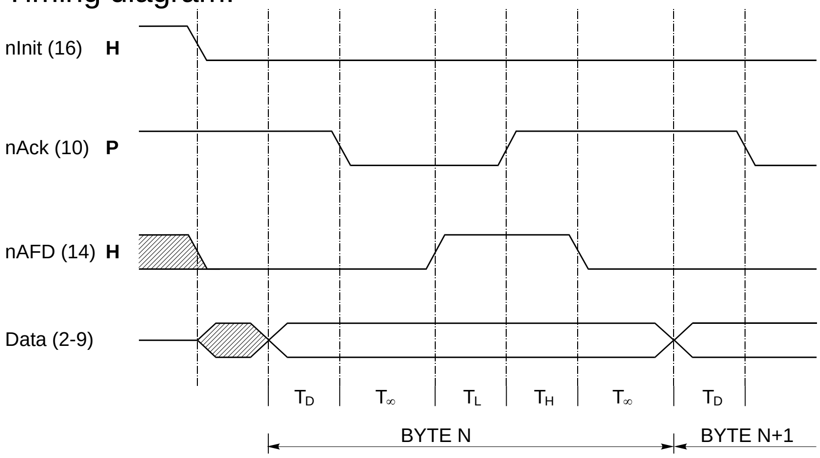
To guarantee, that **always new data is to be read** even when data reading is interrupted for longer times, set blocks to be hold to 1.

To guarantee, that **no data or as few as possible data is lost** even when data reading is interrupted for longer times, set blocks to be hold as large as possible (data is lost from that time on when the internal data buffer is full) .

Data is set ready to be read via ECP as soon as a data block is filled. That means, if a block (line) is defined to store 10 measurements, the block can be read after 10 measurements (and not after the first one).

6.4.1.7 ECP Port Timing

Timing diagram:



Time	Minimum	Maximum	Description
T_D	0		Minimum data set up time
T_∞	0	Infinite	Infinite response time
T_L	0	35 ms	Peripheral response time
T_H	0	1.0 s	Host response time

The timing diagram shows true voltage levels, which can be measured at the corresponding connector pins. The ‘nInit’ line controls direction of the data transfer. Since the only used direction is from the instrument to the computer, this line may be ignored on non personal computer based implementations. The data lines (2-9) must be input only on the computer in this case, and ‘nInit’ is held low permanently.

The instrument prepares for data transmission by placing data on the bus. After T_D the instrument then sets ‘PeriphClk’ (nAck) low to indicate to be ready to send the data. The computer then sets ‘HostAck’ (nAutoFd) high to acknowledge the handshake. The instrument then sets ‘PeriphClk’ (nAck) high. The computer is expected to accept the data and to set ‘HostAck’ (nAutoFd) low, completing the transfer.

6.4.2 Configuring the ECP Data Output

Command	*Reply*	*Range*	*Meaning*
XBn<Cr>	***XBn**	$1 \leq n \leq$ XBMAX[1)]	Setting the of number of measurements per block(line). Data is set ready on the ECP port after n measurements (after whole data of a line is ready) **Note: With setting of RF_NUMBER_L, XB and XM are automatically set. No user adjustment is necessary**.
XMn<Cr>	***XMn**	$1 \leq n \leq$ XMMAX[1)]	Setting the number of blocks (lines) hold in memory. See description of ECP output principles – Data Buffer **Note: With setting of RF_NUMBER_L, XB and XM are automatically set. No user adjustment is necessary**
XOSn<Cr>	***XOSn**	$0 \leq n \leq 6$	Setting the unit for range data; n = 0: 1 mm n = 1: 2 mm n = 2: 4 mm n = 3: 8 mm n = 4: 16 mm n = 5: 32 mm n = 6: 64 mm The unit and resolution of range data on the serial output is not effected. **For Q280i XOS is set to n=0 and there is no need to change it**
.XS<Cr>			Query the ECP buffer size in words, for Q280i typically XS = 262143.
XNn <Cr>	***XNn**	$0 \leq n \leq$ 65535	Set and query the ECPLineCounter, sent with each line via the ECP port (see trailer description). The counter e.g. can be reset to 0 before starting a scan sequence.

1) Due to the limitation of the internal buffer the values XB and XM have limits according to the following formula:

for Q280i **without** optional true color receiver channel:

[(11*XB + 3) div 2 + 1] * (XM+1) < XS

for Q280i **with** optional true color receiver channel:

[(17*XB + 3) div 2 + 1] * (XM+1) < XS

where div means an integer division

Command	Reply	Range	Meaning
Fn<Cr>	***Fn**	$0 \leq n \leq 65535$	Setting the data blocks forming the ECP result output data. The bits of the value have the following meaning: bit 0: Enable range data output bit 2: Enable amplitude data output bit 3: Enable angle data output bit 5: Enable quality data block bit 6: Enable SYNCTimer data block bit 7: Enable True color data block Example: F5 sets output of range and amplitude value. Note: The setting of the F – Parameter also effects the data structure of the serial port data output (used for debug purposes only)

6.5 LAN interface

6.5.1 Overview

The LMS-Q280i provides a LAN interface.
It implements 10Base-T/ 100Base-TX according IEEE802.3.

In your LAN, the LMS-Q280i behaves like a data server. A client computer can connect to this server using TCPIP protocol. The instrument implements two ports:

- port 20001 for data interfacing
- port 20002 for configuration

Both ports are to be seen as re-routing the respective local interface to be accessible via a LAN. Thus, when the LAN interface is active, the local interfaces, i.e. the ECP data output and the RS232-interface, are inactive. There may be connections to these interfaces, but they will be 'dead'.

Port 20001 transmits the 3D data in the same way the ECP data output does. Thus, the definition of the data structure, as given in section 6.4.1, is fully applicable to for this port. Port 20001 does not accept any incoming data.

Port 20002 re-routes the RS232-interface. Thus it provides the full functionality of the RS232-interface to the client.

6.5.2 Activation

At startup of the instrument, the local interfaces are active (messages sent via RS232). Depending on the setting of parameter IP_MODE,

- the LAN interface remains deactivated (IP_MODE0).
- The instrument checks if a LAN link can be found (IP_MODE1), i.e. if the instrument is connected to a HUB (or PC) via a LAN cable. Message "mWAIT_LANLINK" indicates this status. If this link is found within the time specified by parameter IP_LANLINK_TIMEOUT, the instruments activates the LAN interface and deactivates the local interfaces (message "mLAN_CONTROL"). If the link is not found within this time, the LAN interface remains deactivated and the local interfaces keep active (message "mLOCAL_CONTROL").

This method ensures, that – independent of the setting of IP_MODE - the local interfaces can be activated by simply unplugging the LAN-cable and rebooting the instrument.

6.5.3 Configuring the LAN Interface

Command	*Range*	*Meaning*
IP_ADDRn<CR>	000.000.000.000 ≤ n ≤ 255.255.255.255	Setting the IP address (default: 192.0.168.234)
IP_MODEn<CR>	0 ≤ n ≤ 1	Setting the activation mode of the LAN interface: n = 0: LAN interface is off, local interfaces (ECP, RS232) are active n = 1: LAN interface is preferred
IP_APPLY<CR>	-	Activates all IP-xxxx settings and resets the LAN interface!

To understand the following parameters, detailed knowledge about TCP/IP is required. Thus be careful on modifying these settings!

Command	*Range*	*Meaning*
IP_CHAR_TIMEOUTn<CR>	$0 \le n \le 65535$.	Timeout for character transmission, unit [ms] Needs Super User Password
IP_CON_TIMEOUTn<CR>	$0 \le n \le 3600$.	Timeout for TCP/IP connection, unit [s]: If client does not show any activity within this time, the instrument closes the connection. n = 0: no timeout, connection remains unlimited time $1 \le n \le 29$: behaves like n = 30 $30 \le n \le 3600$: timer activated Needs Super User Password
IP_TRANS_RETRIESn<CR>	$3 \le n \le 30000$	Maximum number of re-transmissions of a TCP/IP segment, if this number is exceeded, the instrument closes the connection. Needs Super User Password
IP_LANLINK_TIMEOUTn<CR>	$2000 \le n \le 65535$	Timeout for detection of a link on the LAN interface, unit [ms]. Needs Super User Password
IP_GATEWAYn<CR>	$000.000.000.000 \le n \le 255.255.255.255$	Setting the IP address of the gateway, this command is not used yet. Needs Super User Password
IP_SUBNETMASKn<CR>	$000.000.000.000 \le n \le 255.255.255.255$	Setting the subnet mask, this command is not used yet. Needs Super User Password

6.6 Errors and Error Handling

The Scanner knows 4 different types of errors:

- **Fatal Errors**
- **Standard Errors with Requested User Intervention**
- **Standard Errors**
- **Warnings**

After power up the system checks and prepares several internal hardware components. Errors are pushed onto an internal error stack. Therefore it can happen that more than 1 error is reported.

A **fatal error** causes a lock of measurement and in programming mode only few commands are available (e.g. .HELP, .ERR, Q). The laser is switched off. Fatal error messages always start with “FATAL:”

A **standard error** causes a lock of measurement, but programming mode is available. Standard error messages always start with “ERROR:”

A **standard error with requested user intervention** like a standard error locks the measurement; programming mode is available and error messages start with “ERROR:”. These types of error need a user intervention, e.g. with a “high temperature error” the instrument must be cooled down or with a “low voltage error” the power supply voltage must be increased (perhaps battery changed).

Warnings are reported, but measurement can be (or is) continued. Warning messages always start with “WRNG:”

Errors occurred are pending until they are acknowledged with command “**ERRACK**”. When errors are acknowledged, measurement can be continued. Fatal errors can not be acknowledged.

In measurement mode errors are reported automatically as messages (e.g. “mERROR:LOW_BAT”) . In programming mode an error is indicated by an exclamation mark added to the reply string before the carriage return. To get the error message, the command “.ERR” must be sent to receive a list of errors occurred:

Example:

Command	Reply	Meaning
W<Cr>	*W!	An error occurred
.ERR	\FATAL:FLASH_RW =ERR	

Command	*Meaning*
.ERR<Cr	Reading a list of all errors occured. Each error message of a pending error is coded in a line starting with "\".
ERRACK< Cr>	Error acknowledge. No further errors are pending after this command is executed. Fatal errors cannot be acknowledged.
.ERRCNT<Cr>	Reading the number of errors occurred.
.ERRTYPE[n]<Cr>	Reading the error type of occurred error number n, starting count of n with 0. Therefore .ERRTYPE[0] returns the error type of the first (or only one) error pending. **Type(severity)** **Error** 1 Standard error 2 Standard error with requested user intervention 3 Fatal error
.ERRNUM[n]<Cr>	Reading the error code number (see table of error messages following, column "Err No") of occurred error number n, starting count of n with 0.
.ERRSEV<Cr>	Reading the severity of the most severe error occured.
.ERRMSG[n]<cr>	Reading the error message (see table of error messages following) of occurred error number n. Note: E.g. n=0 means message of the first error occurred and not the error message of error with error code number 0.

A list of errors is given on the next pages. If fatal errors occur, please contact your sales representative.

6.7 Status and Error Messages

Error	Err No	Meaning
mERROR:TOO_MANY_ERRORS	1	Too many errors (>16), error stack overflow, not all errors can be reported
mWRNG:TOO_MANY_WARNINGS	2	Too many warnings (>16), not all warnings can be reported
mFATAL:FLASH_RW	11	Error in reading or writing flash memory
mFATAL:BAD_ECP	12	Error on ECP data port; only for instruments with ECP data output
mFATAL:LCA_DATA mFATAL:LCA_INIT mFATAL:LCA_DONE	13 14 15	Error in internal hardware
mFATAL:BAD_MEAS_HW	16	Error in internal measurement hardware
mERROR:FLASHR_BAD_CS	21	Error in reading permanently saved parameters, a check-sum error was found (but data was read!)
mFATAL:FLASHR_NOWRITE mFATAL:FLASHR_BAD_BACKUP	22 23	Error in reading permanently saved parameters.
mFATAL:FLASHR_BAD_FACT_ID	24	Factory parameter data is not fitting to the current software version. Factory data is not valid, but essential; cannot continue!
mERROR:FLASHR_BAD_USER_ID	25	User parameter data is not fitting to current software version. Some parameter settings may be wrong. Check all user parameters, reset them and save them again with command W
mFATAL:FLASHW_FILE_TOO_LONG mFATAL:FLASHR_BAD_TYPE	26 27	Could not save parameters permanently.
mWRNG:RS232_OVERFLOW mWRNG:RS232_OVERRUN	41 42	Serial interface error: some characters are lost in receiving. Possible reason: Commands are sent while data is saved with command W
mERROR:LOW_TEMP	45	The instrument internal temperature is too low
mERROR:HIGH_TEMP	46	The instrument internal temperature is too high
mERROR:LOW_BAT	47	The supply voltage is too low
mERROR:HIGH_BAT	48	The supply voltage is too high
mERROR:BAD_SLOPE	50	Internal error: Bad essential parameter for hardware configuration
mERROR:MEAS_BUFFER_OVERFLOW	51	Internal error: Buffer overflow, laser pulse rate (measurement rate) too high. For scanners: lower the laser pulse rate by increasing the angle step width of line scan.
mERROR:PARAMETERS_OUT_RANGE: n	52	n saved Parameters have been outside range, these parameters have been set to default.
mRGB_BAD_OFFSET_CAL	53	Error in RGB sensor (true color channel): could not calibrate correctly

Error	Err No	Meaning
mFATAL:BAD_STREAM_ID	54	Internal Error in downloading hardware specific data
mFATAL:SSL_TEMP_OUT_RANGE	57	Solid state laser types only: temperature out of range
mFATAL:SSL_SHUTTER FAILED	58	Solid state laser types only: shutter function failed
mERROR:SCAN_COMMUNICATION	29	Error in communication between range finder unit and scanner unit. See parameter SC_ERROR for detailed reason of error
mERROR:SCAN_STATUS	30	Error in scanner unit. See parameter SC_STATUS for detailed reason of error
mERROR:SCAN_NO_MOTION	28	Error, frame scanner does not move.
mFATAL:SID_RW_FAILED	70	Internal Error in Serial Interface Device
mERROR:PRR_OUT_OF_RANGE	71	Solid state laser types only: Laser Pulse rate out of range
mFATAL: PELTIER_TEMP_DEFECT	72	Solid state laser types only: Internal hardware fault (Peltier element)
mFATAL: PELTIER_ DEFECT	73	Solid state laser types only: Internal hardware fault (Peltier element)
mERROR: PRR_INIT_OUT_OF_RANGE	74	Solid state laser types only: Internal hardware fault: Laser Pulse rate out of range
mFATAL:ECP_OVERFLOW	79	Error on internal ECP data port; ECP port fifo overflows
mWRNG:ECP_PORT_OPEN	82	Several parameters (e.g. the number of measurements per line RF_NUMBER_L) are displayed in the ECP port Data Header. When changing such parameters, the parallel ECP port must be closed the parameters changed and programming mode left, and the data port newly reopened, so the new changed header can be read by the user application. Therefore, close the ECP parallel port before changing such parameters.
mFATAL:ECP_SELFCHECK_FAILED	97	Error on internal ECP and / or TCPIP hardware: internal self check failed
mERROR:TCPIP_BAD_MAC_ADDR	90	Ethernet MAC address invalid
mERROR:TCPIP_BAD_IP_ADDR	91	IP address invalid
mERROR:TCPIP_NOT_CONFIGURED	92	Internal LAN interface configuration error
mWRNG:TCPIP_DATA_PORT_OPEN	93	Several parameters (e.g. the number of measurements per line RF_NUMBER_L) are displayed in the Data Header. When changing such parameters, the connection to TCP/IP data port must be closed, the parameters changed and programming mode left, and the data port newly reopened, so the new changed header can be read by the user application. Therefore, close the TCP/IP data port before changing such parameters.

Error	Err No	Meaning
mFATAL:HTR_EM_LOTEMP	100	Internal heater module error
mFATAL:HTR_HW_FAILED	101	Internal heater module error
mFATAL:LASER_MODULE_DEFECT	102	Internal laser module failed
mFATAL:LASER_MODULE_NOT_READY	103	Internal laser module did not get ready
mFATAL:NO_LASER_REF	104	Internal laser module failed
mFATAL:PRR_OUT_OF_RANGE	105	Internal laser module, unexpected PRR

Message	Meaning
m##Q280i##	Startup message
mWAITSCAN	Scanner unit is started, wait until zero position of frame scanner unit is detected and until start position of frame scan is reached.
mSCANNING	Scanning has already started; this message indicates that a scan is in progress
mSCANNER_READY	Scanner is set “single triggered scan” mode and ready to be triggered.
mWAIT_LASER	Solid state laser setup and test procedure is started. This procedure is executed at instrument power up and after standby.
mLASER_READY	Solid state laser setup and test procedure is successfully finished.
mUNDERFLW	Range measurement result < 0 (including offsets), usually relevant in non scanning mode only
mLASER OFF	No measurement, laser is switched off by command ^F or LASER=0, usually relevant in non scanning mode only