User Manual

RF70A

Version 1.3

CE

Dear User,

You are advised to carefully read this User Manual before turning on the Laser Distance Sensor RF70A for the first time.

This is necessary to ensure that you will be able to use all the capabilities and features provided by your new purchase.

This product is subject to ongoing technological developments.

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Note:

Proper care has been used in compiling this document. No liability will be accepted in the event of damage resulting from the failure to comply with the information contained herein.

ASTECH GmbH, Schonenfahrerstr. 5, D-18057 Rostock

Internet www.astech.de E-Mail info@astech.de

Telephone +49 (0)381 / 44073-0 Telefax +49 (0)381 / 44073-20

Revision History

Manual Version	Date	Changes
1.0	2019-05-28	Established
1.1	2020-06-12	Pin assignment changed
1.2	2023-07-04	Digital signals added to pin assignment, Update of technical data
1.3	2023-10-11	Technical drawing changed, Command GN changed

I. Content

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Used Symbols

Sign warns against emitting visible and invisible laser radiation.

Sign warns against danger of electrical power and of electric shock.

Sign warns against danger.

Sign shows information for use in hazardous environments.

Sign warns against electrostatic discharge issues

Sign indicates important information regarding device use of the device.

The sign shows protection class 3 (protective extra-low voltage).

Sign indicates degree of protection (IP) of the device.

Sign informs that special guidelines had to be applied for device disposal.

1 General information

The RF70A is a laser distance sensing module for OEM customers. It is made to be integrated in existing sensor systems or application and customer specific housings.

The RF70A provides distance sensing capabilities up to a distance of 70 m with target surface reflectivity of just 10%. If it is possible to use special reflectors the maximum detection range can be extended to more than 250 m.

The basic measurement principle of the RF70A is the well-known time-of-flight principle with invisible infrared laser pulses. With a maximum measurement frequency of 40 kHz the RF70A is one of the fastest long-range distance sensors on the market which allows solving even hardest surveillance or general sensing applications.

The LDS/RF70 device series provides sophisticated functions and algorithms to adapt the sensing capabilities to many different application characteristics. It is able to control a connected heating based on internal temperature sensors. There are also functions to control connected interfaces like 4-20mA current output or digital interfaces.

Due to its 5V power supply and the CMOS-level interfaces it is quite easy to connect the device directly to a signal processor or microcontroller.

Intended applications for the RF70A are:

- Rapid process monitoring
- High speed object detection and intrusion detection
- Fast light barrier with background suppression
- Altimeter for drones and UAVs
- Collision avoidance sensor for automotive or AGV applications
- Height profile scanning in traffic applications

2 Safety advice

2.1 Laser class

Based on the standard EN 60825-1:2014 the RF70A is in correspondence with laser class 1. The laser radiation of class 1 lasers is not dangerous to the human eye, thus, any injury can be excluded.

2.2 Basic safety advice

Please read the safety and operating advice carefully, and observe the advice when operating the device.

The RF70A is equipped with a laser diode emitting in the infrared spectrum, which is not visible to the human eye.

The **operating and storage conditions** have to be observed (see chapter 3.1). The inobservance of this advice and the adverse use of the device can lead to injuries of the user or to damage of the device.

Do not touch the electronic parts of the device when it is connected to the power supply. There is a potential risk of an electric shock to the operator or of damage to the device.

Ensure there is no voltage applied when establishing a connection to the device and while integrating the device into the customer system. There is a potential risk of an electric shock to the operator or of damage to the device.

The device may only be **operated as intended** and in faultless condition.

Safety installations must not be rendered ineffective.

Safety and warning signs must not be removed.

The device may **not be used in explosive environments**; otherwise there is the danger of damage to the RF70A and the surrounding equipment, and of injuries of the user.

Observe the operating conditions for the RF70A. Adverse use can cause damage to the device and will void the warranty.

The device is **not shatter-proof**. Do not let the device fall onto the ground, and avoid any shock.

The device is delivered in a solid cardboard box, which is suited for the transport of the device.

Please consider the assembly advices when integrating the device in the system. By applying the wrong voltage level and/or polarity to the RF70A a permanent damage may be caused.

Keep the device away from water and other liquids. Avoid any soiling by dust or other contaminants. Always handle the device with the due care. When cleaning the device, follow the cleaning instructions.

Avoid touching the optics and do not use the device if the optics are soiled or clouded. Avoid touching the electronic parts.

Do not perform any modification to the device as this may cause potential harm to the opera-tor and the device. Any modification on the device will void the warranty.

2.3 Cleaning and maintenance

The RF70A does not require any maintenance. Keep the optical glass surfaces (laser and receiver lenses) free of deposits to ensure trouble-free measurements. Dust can be removed using an air brush. In case of dirt which is hard to remove, please contact the manufacturer.

Do not be clean the device by using solvents or mechanical tools. Electrical, mechanical or optical modifications of the device are not permitted!

2.4 Disposal

	For the disposal of the device, special environmental protection guidelines apply. Do not dispose the device with the usual domestic refuse. The manufacturer offers to take back the device after the end of the product life cycle, and to dispose of the product in accordance with the effective environmental protection guidelines. Please note that this service is subject to a charge.

3 Operational conditions / Intended use

3.1 Operating and storage conditions

Operating temperature:	-10 °C … +60 °C
Storage temperature:	-40 °C ... +70 °C
Air humidity:	10 % ... 90 % not condensing

3.2 Intended use

The laser distance meter RF70A is a custom-built functional model. It is destined for professionals to be used solely at research and development facilities. The customer and system integrator are responsible for compliance with the relevant guidelines, laws and standards, in particular compliance with the safety requirements.

3.3 Improper use and possible error sources

- The unit may be used only as described.
- Please do not remove any labels and type plates.
- Repair work must not be performed by the user. In case of questions or doubt, the manufacturer is to be consulted.
- In order to obtain correct measuring values the following advice is to be observed:

  1. Measurements against the sun or onto surfaces with low reflectivity in very bright environments can result in faulty measurements.

  2. Measurements through glass, optical filters, Plexiglas or other translucent materials can result in measurement errors.

4 Device description

4.1 General device description

The laser distance meter RF70A was designed as a compact range finder module dedicated for easy integration.

4.2 Technical data

Table 1: Technical Data

Measurement	
Measurement principle	Laser pulse - Time of flight measurement
Measuring range	
Total range	0.2 m … 270 m
On target board [1)]	0.5 m … 270 m
Onto natural surface, 80 % reflectivity [2)]	0.2 m … 125 m
Onto natural surface, 10 % reflectivity [2)]	0.2 m … 70 m
Measuring accuracy [3)]	±60 mm (single measurement, 1 σ)
Repeatability [1)]	±25 mm (1 σ)
Resolution	1 mm (decimal output ≤ 15 kHz)
Maximum measuring rate	40 kHz

1) e.g. Scotchlite Cube 3000x
2) Dependent on target reflectance, influence of extraneous light and atmospheric conditions
3) Accuracy can be ± 100 mm for close-up ranges up to 1 m.

Laser	
Laser wavelength	905 nm (invisible, near-infrared)
Laser divergence	2 mrad x 0.4 mrad
Laser class	Laser class 1, EN 60825-1:2014
Connector	DF12(3.0)-30DS-0.5V(86), provider: HIROSE
Power supply	+5 V ± 10% DC, < 0.3A
Power consumption (maximum)	≤ 2 W

Interfaces	
Serial interface	UART, LVCMOS 3.3 V
Digital interface	LVCMOS 3.3 VDV, unprotected 2x digital out (Q1, Q2) with programmable distance range 1x trigger in (TRG in) for external control of measurement 1x trigger out (TRG out) for master-slave operation

Operating conditions	
Operating temperature	-10° C … +60 °C
Storage temperature	-40 °C … +70 °C
Humidity	10 % … 90 %, non-condensing

Mechanical data	
Protection class	IP 00
Size (l × w × h)	51 mm × 46 mm × 25 mm
Weight	60 g

4.3 Laser beam image

Divergence of Transmitter: 2 mrad x 0.4 mrad

Divergence of Receiver: 5.8 mrad

The table below shows the size of the laser spot on the target in dependence on the distance. In this sight the lenses of the RF70A are installed vertical above each other.

Table 2: Laser spot size

Distance	Laser spot Width	Laser Spot height	Footprint (not true scale)
0.2 m	14 mm	9 mm	
1 m	14 mm	10 mm	
5 m	15 mm	19 mm	
10 m	17 mm	30 mm	
20 m	19 mm	51 mm	
70 m	32 mm	157 mm	
150 m	52 mm	327 mm	
290 m	87 mm	625 mm	

The above-mentioned laser spot holds approx. 50 % of the entire laser energy. An aura with less energy forms around that spot.

5 Integration of the RF70A

5.1 Preparatory work prior to integration

- Remove the packaging of the RF70A
- Check the delivery for completeness
- Examine the device for damage

The RF70A is an electrostatic sensitive device. Observe precautions for handling with electrostatic sensitive devices.

5.2 Mechanical integration

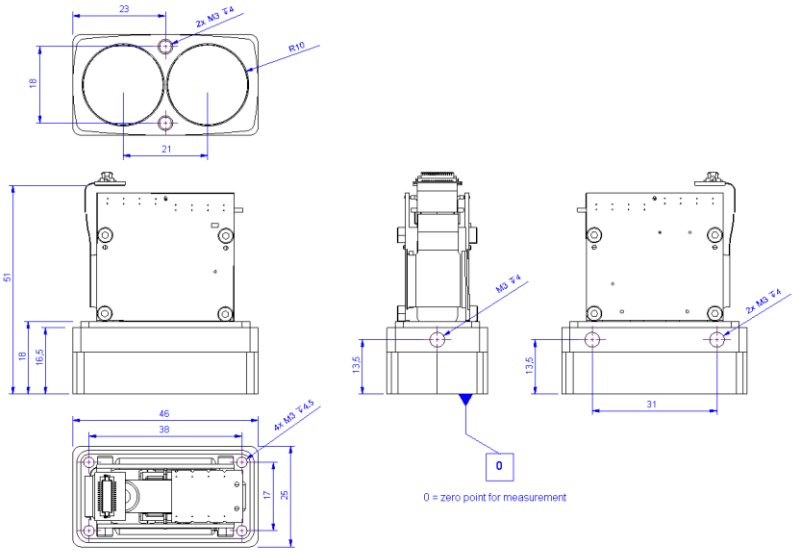


Figure 1: Dimensions and mounting of the RF70A

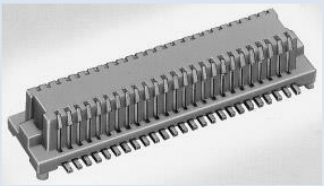
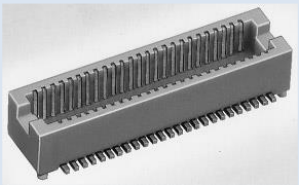
The RF70A can be mounted with two M3 screws either at the front or at the bottom side. All threads are 4 mm deep. Screws with washer and ring washer are recommended. Screws are not included in the scope of delivery.

The zero point for measurement is identical with the housing of the front face.

5.3 Electrical integration

The module connection is made via a 30 pin header –receptable combination of the DP12 series from HIROSE.

Table 3: Connector information

Connector on module	Connector on user cable / PCB
	
HIROSE DF12(3.0)-30DS-0.5V(86)	HIROSE DF12(3.0)-30DP-0.5V(86)
Male, receptable	Female, header

All pins/connections are directly connected to the microcontroller. Observe precautions for handling with electrostatic sensitive devices.

Table 4: Connector pin assignment

Description	Signal	Pin	Pin	Signal	Description
Do not connect	HEATER1	2	1	ONOFF	Connect to GND
+5 V ± 10% < 0.3 A Peak 1 A/500µs	VDC	4	3	GND	
	VDC	6	5	GND	
	VDC	8	7	GND	
Do not connect		10	9		Do not connect
Digital output, 3.3 V CMOS	Q2	12	11		Do not connect
Do not connect		14	13		Do not connect
Digital output, 3.3 V CMOS	Q1	16	15		Do not connect
Do not connect		18	17		Do not connect
Do not connect		20	19		Do not connect
Do not connect		22	21		Do not connect
Do not connect		24	23	UART Rx	3.3 V CMOS In
Do not connect		26	25	UART Tx	3.3 V CMOS Out < 5 mA
Do not connect		28	27	TRG OUT	Trigger output, 3.3 V CMOS
Do not connect	HEATER2	30	29	TRG IN	Trigger input, 3.3 V CMOS

6 Parameter setup

6.1 General Information

The RF70A is parameterized using the serial interface. Precondition for programming via UART is a connection provided by a terminal program (e.g. HyperTerminal). The set parameter values are stored in the EEPROM immediately. The last entered data will be available upon restarting.

6.2 UART Transmission protocol

- Interface settings: Asynchronous, 8 data bits, no parity, 1 stop bit
- Transmission protocol format / syntax: 7 bit ASCII
- Proprietary transmission protocol
- Commands are case-insensitive (NO differentiation between lower and upper case).
- Decimal separator in the output of figures is the dot "." (0x2E).
- The terminator of a command (sending command) is ENTER (0x0D, 0x0A) or Carriage Re-turn (0x0D) or Line Feed (0x0A)
- Where parameters have several values, they are separated by a space (0x20).
- The response to commands with parameters is the respective command including the parameters.
- The response to commands without parameters is the respective command including the current parameters.
- The response to commands with parameters outside of the valid value range is the respective command including the current parameters.
- The response to unknown commands and faulty parameter formats is a "?" (0x3F).
- Distances are always entered in meter (m) with 3 decimal places after the separator.

  631 cm Input: 6.310
  5.123 m Input: 5.123

- Retrieve parameter values
  Input: PARAMETER<CR (0x0D)>
- Set parameter values
  Input: PARAMETER VALUE1 VALUE2<CR (0x0D)>
- Starting a measurement (operating mode)
  Input: COMMAND<CR (0x0D)>
- Stopping a measurement (continuous operating mode)
  Input: <ESC (0x1B)>

The set parameters are stored in the non-volatile EEPROM immediately. The last entered data will be available upon restarting.

6.3 Identification

ID – Device identification information

When entering the command ID, the RF70A will respond by displaying the device identification information in the order ID, serial number, firmware version.

Query: ID<CR (0x0D)>

Response: ID SN 180004 V3.38R 630 (example)

ID? – Online help

By entering the command ID? the user will obtain an overview of all available operations and parameters described in the following sections.

Query: ID?

Response:

Operation Mode
- DM[Enter].....single distance
- DT[Enter].....continuous distance

Status
- TP[Enter].....internal temperature [°C]
- HW[Enter].....hardware status
- PA[Enter].....display parameter

Setup Parameter
- PR[Enter].....reset parameter
- DR[Enter].....reset device
- AS[Enter]/ASs[Enter].....display/set autostart command
- MF[Enter]/MFx[Enter].....display/set measure frequency
- GN[Enter]/GNx[Enter].....display/set receiver gain
- SA[Enter]/SAx[Enter].....display/set average value
- MW[Enter]/MW x y z[Enter]....display/set measure window
- OF[Enter]/OFx[Enter].....display/set distance offset
- SO[Enter].....set current distance to offset
- SE[Enter]/SEx[Enter].....display/set error mode
- Q1[Enter]/Q1w x y z[Enter]..display/set digital out Q1
- Q2[Enter]/Q2w x y z[Enter]..display/set digital out Q2
- QA[Enter]/QAx y[Enter].....display/set analog out QA
- BR[Enter]/BRx[Enter].....display/set serial baud rate
- SD[Enter]/SDx y[Enter].....display/set serial output format
- UB[Enter]/UBx[Enter].....display/set unit for binary output
- TE[Enter]/TEx[Enter].....display/set serial terminator
- ST[Enter]/STx[Enter].....display/set first or last target for outout
- TC[Enter]/TCx[Enter].....display/set DT recalibration timing x in sec (0 off)
- TI[Enter]/TIx y[Enter].....display/setup input trigger
- TO[Enter]/TOx[Enter].....display/setup output trigger

6.4 Operating modes

DM – Single distance measurement

The RF70A performs one measurement and then waits for new commands.
The duration of the measurement depends on the number of preset measuring values SA and the preset measuring frequency MF.

Input: DM

DT – Continuous distance measurement (distance tracking)

The RF70A performs a continuous measurement.
The measurement can be interrupted by sending ESC (Escape) = 0x1B.

The measurement output frequency is determined by the number of preset measuring values SA, the preset measuring frequency MF and the data format of serial output SD. Parameter baud rate is important for the data transfer.

Input: DT
Output: Example for setting SD 0 3

```
D 0002.935 21.1 57.2
```

Output format = decimal (D)
Distance = 2.935 m
Signal quality = 21.1
Temperature 57.2 °C

The output frequency of DT is connected to the baud rate BR. If the baud rate is to low not all measured values can be transmitted over the serial interface.

6.5 Status

TP – Internal temperature

Output of the internal temperature of the device in °C

Query: TP

Output: `TP 048.4`

The user of the RF70A must make sure that the stated ambient temperature (operating temperature) is adhered to. In case of deviations below or above the temperature range no measurement is possible. The RF70A will send an error message.

HW – Hardware status

A device-specific list of parameters and measurements is shown. All parameters are internal information regarding the hardware status, changes are not possible.

Query HW

Output
```
Temp (Board) 45.0°C
Laser voltage 25485mV
Measure Result 0
```

Table 5: Explanation of hardware status items

Status item	Description
Error code	Fault indication
Temp (Board)	Temperature of the controller (internal)
Laser voltage	Supply voltage for Laser diode driver
Status of measurement	Classification of measurement conditions, information about source of error message 0 – Measurement o.k. 1 – Out of measurement window 2 – Invalid pulse width 3 – Small pulse width 4 – Distance out of range 5 – Noise pulse detected 6 – No pulses

PA – Parameter overview

Output of a list of parameters with current settings

Query: PA

Response

```
measure frequency[MF].............500(max 40000)Hz
average value[SA].................2
measure window[MW]...............-290.000 290.000 0
trigger in[TI]....................internal trigger
trigger out[TO]...................rising edge
distance offset[OF]..............0.000
error mode[SE]....................1
digital out[Q1]...................0.000 1.000 0.050 1
digital out[Q2]...................0.000 1.000 0.050 1
analog out[QA]....................0.000 1.000
receiver gain[GN].................0
serial baud rate[BR].............115200
serial outputformat[SD].. .......dec(0),value+amplitude
(1)
unit for binary output[UB].......1000.000
serial output terminator[TE].....0Dh0Ah (0)
autostart command[AS]............DT
select target[ST].................0/first
recalibration timing[TC].........1 sec/enabled
```

PR – Parameter reset

All parameters are reset to the factory settings except baud rate (BR) and target selection (ST).

Query: PR

Response

```
reset parameter
measure frequency[MF].............10000(max 40000)Hz
average value[SA].................1000
measure window[MW]................-290.000 290.000 0
trigger in[TI]....................internal trigger
trigger out[TO]...................rising edge
distance offset[OF]...............0.000
error mode[SE]....................1
digital out[Q1]...................0.000 1.000 0.050 1
digital out[Q2]...................0.000 1.000 0.050 1
analog out[QA]....................0.000 1.000
receiver gain[GN].................0
serial baud rate[BR]..............115200
serial output format[SD].........dec (0), value (0)
unit for binary output[UB].......1000.000
serial output terminator[TE].....0Dh0Ah (0)
autostart command[AS].............DT
select target[ST].................0/first
recalibration timing[TC].........1 sec/enabled
```

DR – Device reset (restart module)

DR executes a cold start of the RF70A and practically simulates a voltage interruption. This command is useful when the autostart command has been changed.

Input: DR

Response: Reset device

6.6 Parameter

Transfer of the settings to the RF70A: Command + terminator 0x0D (ENTER)

In case of commands with one parameter, that parameter is entered directly or separated by a space (0x20). In case of commands with several parameters, those are separated from each other by a space (0x20).

AS – Autostart function

The autostart function determines what the RF70A does after a cold start. Upon connection to the supply voltage and after the internal switch-on routine, the RF70A carries out the command automatically and sends the data to the available outputs.

Query: AS

Set: ASx

Value range: BR, DM, DT, HW, ID, ID?, MF, MW, OF, PA, PR, Q1, Q2, QA, SA, SE, SD, TE, TP

Standard: DT

The time duration between switching on the supply voltage and the output of the first measured value is max. 750 ms (if SA=1).

BR – Baud rate

BR enables the adjustment of the serial baud rate. As soon as a new baud rate has been set, the device will immediately start to communicate based on that new baud rate. Adjust the baud rate of the connected receiver according to the new value of BR.

Query: BR

Set: BRx

Value range: 9600, 19200, 115200, 230400, 460800, 921600, 1843200, 2000000

Standard: 115200 baud / 8 data bits / 1 stop bit / no parity

Example:

Input: BR 115200

Output: BR 115200

Setting a very high baud rate implies a risk. Some computers are unable to support a baud rate of 460 800, for example. If the baud rate is set via the command BR460800, communication will no longer be possible without an interface converter, i.e. it will be impossible to reset the baud rate to a lower value without any auxiliary means!

GN – Gain

GN parameterizes the amplification of the receiver channel.

Query:	GN
Set:	GNx
Value range:	-1, 0, 1, 2, 3 10 … 10000 (see **Fehler! Verweisquelle konnte nicht gefunden werden.** and **Fehler! Verweisquelle konnte nicht gefunden werden.**)
Standard:	0
Input:	GN 2
Output:	`GN 2`

Meaning of GN >10 sets the gain value for amplification directly

Table 6: Description of gain steps

Value	Description
GN -1	Automatic control of amplification depending on the received light
GN 0	Fix gain step with optimal gain setting for most applications
GN 1 … GN 3	Fix gain steps with higher gain than GN 0
GN 10…10000	Individual adjustment of gain by direct entry of gain value

Table 7: Comparison of Gain steps and Gain values

Gain step	Gain value direct	Gain voltage
0	192	0.576 V
1	267	0.801 V
2	337	1.011 V

- The bigger the gain value is selected, the higher is the gain voltage and with that the amplification of the received signal.
- Higher amplification allows to detect bad reflecting surfaces in big distances, but reduces the accuracy.
- Low amplification reduces the number of interference pulses in near field measurements on good reflecting targets.
- Gain values above 1000 are only recommend for applications with big distance ranges and bad reflecting targets.

MF – Measurement frequency

MF parameterizes the number of single pulses to be transmitted per second. This is also the number of single distance measurements per second.

Query: MF

Set: MFx

Value range: 1 … 40000, resolution 1

Standard: 10000

Example:

Input: MF 1000
Output: MF 1000 Hz

The achievable output frequency depends on the following terms of the setup:

- Used interfaces (e.g. serial interface RS232 or RS422; analog output)
- length of the interface cable
- transfer speed (baud rate)
- average (parameter SA)
- data format of output value (binary, decimal --> parameter SD)
- number of output values (distance/ signal strength/ temperature - parameter SD)

The number of transmitted distance values is directly connected to the parameters MF and SA (average):

Output rate = MF x SA

Example:

With MF = 1 and SA = 1000 one measurement is done every second, but the output time is about 17 minutes (1000 s).

The baud rate setting (BR) is responsible for the limitation of the output rate. Please check the dependence of measuring frequency/ output frequency with baud rate and data format of serial interface output (SD) in the tables below. If measuring frequency will be higher as the values in the table, some of the measured distance values will be lost. Please double check with a new setting of measuring frequency MF the BR setting.

Table 8: Binary output - Maximum measurement frequency (MF_{max})

Output values	Distance	Distance + signal quality	Distance + temperature	Distance + signal quality + temperature
Output data format	SD 2 0	SD 2 1	SD 2 2	SD 2 3
Length of output data	2	3	3	4
Baud rate	**Maximum output frequency = MF_{max} with SA 1**			
9600	470	300	300	220
19200	900	600	600	450
115200	5750	3800	3800	2880
230400	11600	7700	7700	5800
460800	23200	15500	15500	11600
921600	40000	30300	30300	23000
2000000	40000	40000	40000	34000

Table 9: Decimal output - Maximum measurement frequency (MF_{max})

Output values	Distance	Distance + signal quality	Distance + temperature	Distance + signal quality + temperature
Output data format	**SD 0 0**	**SD 0 1**	**SD 0 2**	**SD 0 3**
Length of output data	**11**	**16**	**17**	**22**
Baud rate	**Maximum output frequency = MF_{max} with SA 1**			
9600	80	50	48	40
19200	160	100	90	75
115200	1000	700	660	480
230400	2000	1400	1300	980
460800	4100	2750	2500	1850
921600	7300	4750	4350	3300
2000000	12200	7850	6480	5000

MW – Measurement window

The measurement window defines the general distance boundaries for a successful measurement, starting at distance x and ending at distance y. The third parameter z sets the output value for the case that a successful distance measurement results outside the measurement window boundaries.

The measurement window function is useful for:

- Blanking out interfering objects before or behind a certain distance range

- Determining a defined measurement range

Query: MW

Set: MWx y z

Value range x: float32, resolution 0.001 = 1 mm

Value range y: float32, resolution 0.001 = 1 mm

Value range z: 0, 1

Standard: -71.000 71.000 0

Output: MW -71.000 71.000 0

RF70A does not perform a plausibility check of the preset measurement window. It is the responsibility of the user to set the correct parameters.

Table 10: Measurement window - output behavior

	Measurement window		
	distance < x	**x < distance < y**	**distance > y**
z = 0	DE02	Measured value	DE02
z = 1	No output / blanking pulse	Measured value	No output / blanking pulse

OF – Offset

OF parameterizes a user-specific offset x which is added to the measured value.

Query: OF

Set: OFx

Value range x: float32, resolution 0.001 m (-250.000 m … +250.000 m)

Standard: 0.000

Output: OF 0.000

RF70A does not perform a plausibility check of the preset offset. It is the responsibility of the user to set the correct parameters.

SO –Set offset

SO carries out a single distance measurement and sets it as - OF (offset, see above). SO can only be executed and is not really a parameter. The function SO can be used for zero adjustment of distances in systems or processes.

AS the use of SO directly influences the measured distance value it also interacts with the parameters MW, OF and the setup of the interfaces.

SA – Mean value / Scan average

SA parameterizes the number x of the single measured values to be averaged for one measurement. SA directly correlates with the measurement frequency MF. SA and MF determine the output frequency of the measured values.

Query SA

Set: Sax

Value range x: 32 bit integer, resolution 1

Standard: 1

The dispersion of the measured values can be reduced by calculating the mean value.

$$\sigma_{SA} \frac{\sigma_1}{\sqrt{SA}}$$

σ_{SA} = Dispersion after mean value determination from several distance measurements

σ_1 = Dispersion of single measured value (± 60 mm)

SA = Value of parameter SA

For table below applies:

Measuring frequency 15 kHz and output frequency 15 kHz will be achieved with Baudrate 921.600 in binary output encoding.

Table 11: Influence of parameter SA

Measurement frequency MF(Hz)	SA – Mean value	Outpur frequency (Hz)	Dispersion (mm)
15000	1	15000	± 60
15000	10	1500	± 19
15000	100	150	± 6
15000	1000	15	± 2

SD –Data format of serial interface output

SD parameterizes the output format n and the output values m.

Query: SD

Set: SDn m

Value range n: 0, 1, 2

Value range m: 0, 1, 2, 3

Standard: 0 0

Example:

Input: SD0 3
Output: SD 0 3

Table 12: SD n - Output formats

n	Output format
0	Decimal
1	Hexadecimal (not yet available)
2	Binary

Table 13: Output values - SD m

m	Output format
0	Distance
1	Distance + Signal Quality (not available for n = 2 (binary))
2	Distance + Temperature (not available for n = 2 (binary))
3	Distance + Signal Quality + Temperature (not available for n = 2 (binary))

In conjunction with the baud rate, the output format determines the maximum possible output speed of measured values. If a higher measurement frequency is set, the results of some measurements will not be transmitted.

The binary distance range will be determined by parameter UB. If the distance value is below or above the distance range, the binary output is 0.

Explanation binary output format

Distance value:

2 Byte, MSB = Bit 7
MSB of Byte 1 is always **1**
MSB of Byte 0 is always **0**
Measurement data = Bit 6 … Bit 0 of each Byte
Coding: Two's compliment
Scaling factor from binary to decimal values: ***1/100**

	Byte 1 Distance								Byte 0 Distance							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Data	**1**	x	x	x	x	x	x	x	**0**	x	x	x	x	x	x	x

Signal strength:

1 Byte
MSB = Bit 7
MSB of Byte 0 is always **0**
Measurement Data = Bit 6 … Bit 0
Scaling factor from binary to decimal values: ***2**

	Byte 0 Signal						
Bit	7	6	5	4	3	2	1
Data	**0**	x	x	x	x	x	x

Temperature:

1 Byte
MSB = Bit 7
MSB of Byte 0 is always **0**
Measurement Data = Bit 6 … Bit 0
Conversion from binary to decimal values: **-40**

	Byte 0 Temperature						
Bit	7	6	5	4	3	2	1
Data	**0**	x	x	x	x	x	x

Example:

Distance	**1**0000010 **0**1010010								**:100** = 3,38m
Signal	**0**	0	0	0	1	0	1	1	***2** = 22
Temperature	**0**	1	0	1	1	1	0	1	**-40** = 53*C

ST – Select Target

ST defines the target which will be detected. RF70A is able to detect 4 different targets in maximum. Selection will be done between first or last detected target. Output will be the distance to the defined target.

First target = target next to the RF70A

Last target = last detected target

Query: ST

Set: STx

Value range x: 0 (first target) or 1 (last target)

Standard: 0

Output: ST 0

Parameter MW (measurement window) and SA (mean value, average) will influence the output. If the selected target will be outside of the range of measurement window the output will show error DE02 or nothing. Please see setting of MW parameter z.

TC – Time Calibration

TC parameterizes the time duration between two customized calibrations. The calibration is necessary to stabilize the distance accuracy and to avoid a lower accuracy because of operating temperature changes.

Query: TC

Set: TCx

Value range x: 0 (no calibration), 1 … 3660 sec. (= 1 sec … 1 h interval)

Standard: 1

Up to a Measuring frequency of approx. 35 kHz the calibration will be done without any influences of the output frequency.
Between 35 k Hz and 40 kHz it could be possible that the data output will interrupt for one (1) distance output every x seconds (x= parameter of TC).

TE – Terminator

Sets the termination for the output of measured values in decimal format (SD = 0).

Query: TE

SET: TEn

Value range n: 0 … 9

Example

Input: TE 1
Output: TE 1

Table 14: TE - Termination characters

n	ASCII	
0	0x0D 0x0A	CR LF
1	0x0D	CR
2	0x0A	LF
3	0x02	STX
4	0x03	ETX
5	0x09	HTab
6	0x20	Space
7	0x2C	Single quote
8	0x3A	Colon
9	0x3B	Semicolon

Trigger setup – general information

The LDS70A Trigger may be used as input or output. There are three possible scenarios:

1. Trigger input – externally initiated measurement

   External trigger signal will be sent to LDS70A to start a single measurement like DM in accordance with parameter TI.

2. Trigger output - connection between two devices:

   The output trigger signal of the 1. LDS70A (parameterized with TO) starts a single measurement DM of the second LDS70A (parameterized with TO).

3. Continuous distance tracking controlled by trigger

Differences between trigger input and trigger output:

Important is the parameter y of TI and TO.

TI y > 0 / TO y = 0	Trigger input The measurement starts after an external trigger impulse.
TI y = 0 / TO y >0	Trigger output LDS70A sends a trigger impulse to the second device.

The parametrization of the trigger connection is carried out via the serial interface.

TI – Trigger setup input

The parameterization of trigger input will be set by the command TI.

x	edge	Sets the sensitive edge of the trigger signal and controls start and stop for Autotrigger function
		0 rising edge (low-high)
		1 falling edge (high-low)
		2 both rising and falling edge
		3 start/stop Autotrigger with rising edge
		4 start/stop Autotrigger with falling edge
y	delay	Sets the time delay between trigger event and start of measurement in milliseconds

Query:	TI
Set:	TI x y
Value range x:	0, 1, 2, 3, 4
Value range y	0 to max 60.000 ms (1 minute) active: from 1 ms upwards disabled: 0 ms
Standard:	0 0
Output:	`Trigger (input) [TI]: 0, 0`

Autotrigger function

The LDS70A provides a so called Autotrigger function. This function uses the trigger input signal to control the operating mode which is selected by the Autostart command (AS). The first trigger event starts the execution of the AS command. The next trigger input event will stop this process. The Autotrigger function is parameterized by the command TI (trigger input).

Example:

AS DT

TI 3 10

The continuous distance tracking (DT) starts with the first rising edge of the trigger input signal. The delay between the trigger event and start of measurement is 10 ms. The next rising edge of the trigger input signal will stop the continuous distance tracking. There is also a delay of 10 ms between trigger event and stop of measurement.

TO – Trigger setup output

The parameterization of trigger output will be set with command TO.

Query:	TO	
Set:	TO x	
Value range x:	0, 1, 2, 3	
	Sets the sensitive edge of the trigger signal	
	0	rising edge (low-high)
	1	falling edge (high-low)
	2	both rising and falling edge
Standard	0	
Output	`Trigger (output) [TO]: 0`	

Maximum frequency of Trigger OUT (TO) = MF (Measurement frequency)

UB – Unit for binary output

UB parameterized the scaling factor for the binary output format (in mm).

Query: UB

Set: UBx

Value range x: float 32, resolution 0.001

Standard: 1000.000

Example:

Input: UB 2.5
Output: UB 2.500

The parameter UB influences all measurement outputs in binary format independent of the measurement frequency. The binary output format is selected by the parameter SD.

Examples:

UB 0.001	→	resolution 1 µm
UB 1.000	→	resolution 1 m
UB 1000.000	→	resolution 1 mm (standard)

The measuring range will be depicted with 14 signed bits.

Binary output range: – 8192 ≤ Distance ≤ 8192

If the distance value is below or above the binary distance range, the binary output will be 0.

Distance value (binary) = Measured distance (mm) / UB

7 Error processing

The RF70 is equipped with powerful error detection and handling capabilities. It observes a certain number of important parameters and thresholds. In case of a violation or drop out the corresponding error code is set and displayed on the interfaces.

Non-critical errors will be reset automatically, a critical error requires a device reset (see Table 15) initiated by command DR or power off/ on.

Table 15: Error codes

Error code	Description	Reset
DE02	No distance identified	Automatically, with next measured distance value
DE04	Device error (hardware)	Non-automatic, device reset necessary
DE06	Temperature out of range	Automatically, when internal temperature is in specified range
DE10	Internal laser voltage below defined minimum voltage ($ULaser_{MIN}$)	Non-automatic, device reset necessary

In case of one or more detected errors, the error code with the highest index will be outputted (most serious defect/ error).

Example:

no distance value identified, no other error: DE02

no distance value identified, in addition temperature out of range: DE06

The communication with the RF70A (e.g. parameterizing, reset or start of new measurement) will be not influence by the error message.

The measuring mode DT can be stopped with <ESC> in case of error and error message output too.

If DT is started and the error did not reset automatically, the error message will be outputted again.

If critical errors (DE04 or DE10) do not disappear after a device reset, please contact your supplier for a technical check.

In binary format all errors will be sent as “0” (00).

The described error codes will be outputted, if an error is detected during:

- Continuous measurement (DT)
- Measuring mode (DM, DT) will be started.

Output of error message (like output of measuring values):

- once for measuring mode DM
- in the specified output frequency for measuring mode DT

The temperature (check with command TP) may be higher than the ambient temperature.

Approx. 30 min after power ON the measured temperature could be 25 Kelvin higher than ambient temperature.