Translation of original operating instructions

RSL 200 / RSL 400 safety laser scanner
UDP specification

SAFE IMPLEMENTATION AND OPERATION

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1 About this document

The safety sensors of series RSL 235, RSL 430, RSL 440, RSL 425, RSL 445, and RSL 455P can send data to any IP address via *User Datagram Protocol* (UDP). This document describes the format of the UDP data.

1.1 Document target group

The document is aimed at developers who receive UDP data and process it further in appropriate target systems.

1.2 Other applicable documents

In addition to this specification, an MS Visual Studio project is available for the RSL 400 series safety sensors:

- RSL400_UPD (VS2008)
  The software for the RSL400_UDP project can be found on the product page for the safety sensor under the *Downloads* tab.
- Project scope:
  C/C++ header for UDP data formats
  Demo program which receives UDP data and displays it in text form.

1.3 Used symbols and signal words

Table 1.1: Warning symbols and signal words

NOTE	Signal word for property damage Indicates dangers that may result in property damage if the measures for danger avoidance are not followed.

Table 1.2: Other symbols

	Symbol for tips Text passages with this symbol provide you with further information.
	Symbol for action steps Text passages with this symbol instruct you to perform actions.

Table 1.3: Terms and abbreviations

IP address	Network address, which is based on the Internet Protocol (IP)
UDP	User Datagram Protocol; user data segment protocol

1.4 Downloading configuration software *Sensor Studio* from the Internet

↳ Call up the Leuze home page: **www.leuze.com**.

↳ Enter the type designation or part number of the safety sensor as the search term.

↳ The configuration software *Sensor Studio* can be found on the product page for the safety sensor under the *Downloads* tab.

2 Configuring the safety sensor

In order to send UDP data, you must configure the safety sensor accordingly.

Prerequisites:

- Safety sensor mounted and connected correctly (see safety sensor's *original operating instructions*)
- Configuration and diagnostic software *Sensor Studio* (see safety sensor's *original operating instructions*)
- Device manager (DTM) *LeSafetyCollection* (see safety sensor's *original operating instructions*)
- Safety sensor connected to the PC correctly (see safety sensor's *original operating instructions*)

↳ Create a configuration project using *Sensor Studio* with a connection to the safety sensor (see safety sensor's *original operating instructions*).

↳ Select **SETTINGS > Data telegrams**.

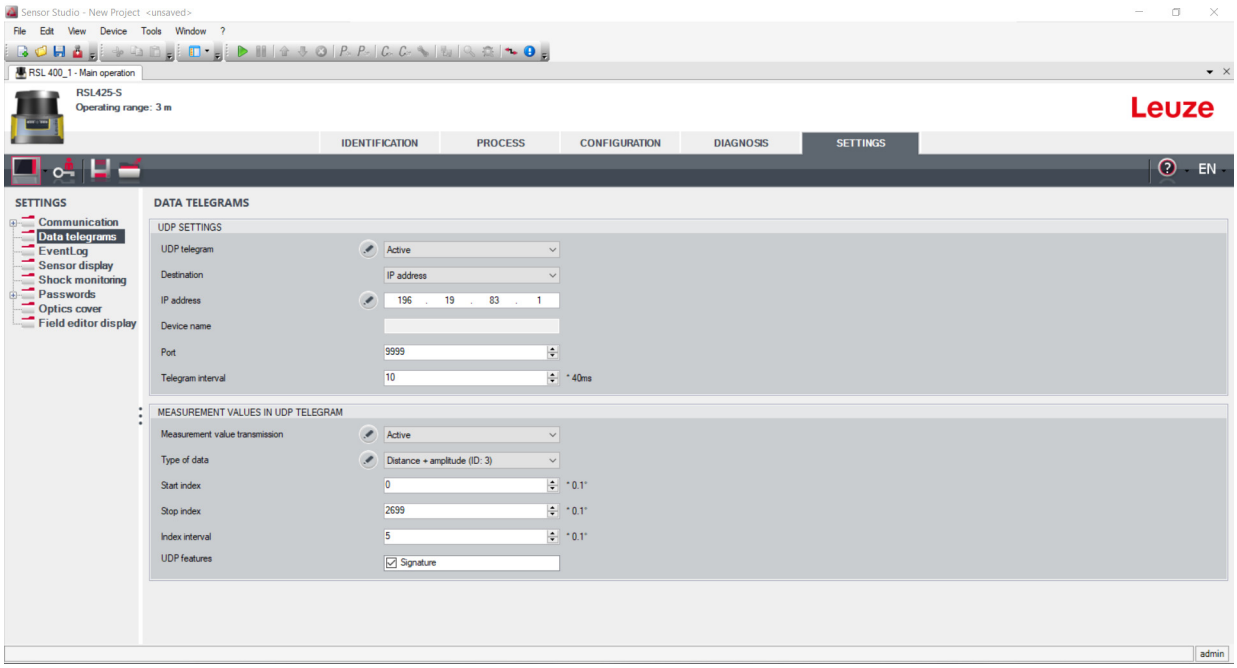

Figure 2.1: UDP settings

↳ Activate the *UDP telegram* in the **UDP SETTINGS** dialog.

Specify the device name and the IP address for the target device.

↳ Set the parameters for the data scope in the **MEASUREMENT VALUES IN UDP TELEGRAM** dialog.

- Measurement value transmission: Activation of measurement data transmission
- Start index/Stop index: Scanning angle of transmitted measurement data
- Index interval: Angular resolution of transmitted measurement data
- Data type: 2 types selectable, 'Distance (ID: 6)' or 'Distance + Signal strength (ID: 3)' for the device variants RSL 235, RSL 425, RSL 445 and RSL 455P. Only data type 'Distance (ID: 6)' can be selected for the RSL 430 and RSL 440 device models.
- Telegram interval: Setting the transmission interval:
  - RSL 200: min. 1 = 25 ms
  - RSL 400: min. 1 = 40 ms

↳ Transfer the configuration project to the safety sensor (see safety sensor's *original operating instructions*).

The first UDP data is sent to the configured target device after the transfer.

3 UDP specification

3.1 System profile

The safety sensor can send process data to any network target for each scan cycle. This process data, relative to the respective scan cycle, is called the *system profile*.

The system profile shows the following process data:

- Extended status profile: Status profile and measurement contour description
- Measurement data
  The transmission of the measured values is activated via *Sensor Studio*: **DATA TELEGRAMS > MEASURED VALUES IN UDP TELEGRAM > Measurement value transmission.** Two measurement data types can be selected: “Distance (ID:(ID: 6)” or “Distance + signal strength (ID: 3)”

A complete system profile consists of multiple UDP data packages. The system profile is based on defined data fragments which are configured as components of the telegram definition and status profile ((see chapter “Configuring the safety sensor” in the original operating instructions).
This specification describes the integration of data fragments into the system profile.

3.2 Basic design

For internal processing purposes, each UDP data package is preceded by Header 1 (H1) and Header 2 (H2).

Table 3.1: UDP data package design

8 bytes	**4 bytes**	**2 bytes**	**2 bytes**	**4 bytes**	
Header 1	Header 2	ID	Block	Scan	<data>

- The first four bytes of Header 1 specify the total length of the transferred UDP data package.

Table 3.2: Header 1 design

Total length				**Header size**	**Follow flag**	**Request ID**	
[Lo byte]	…	…	[Hi byte]	8		[Lo byte]	[Hi byte]

- The ID identifies the type of UDP data package.
- The safety sensor may only send UDP data packages up to a maximum size which is sufficient for most information. If the amount of data exceeds this size, each UDP data package is designated with an additional block number (0 … 65535).
  This ensures that the UDP data packages can be reconstructed in the correct chronological order.
- A complete system profile consists of multiple UDP data packages. Every UDP data package contains the scan number. This ensures that the UDP data packages of a system profile are coherent. The scan number increases after every scan cycle. After 4294967296 (2^{32}) cycles, the scan number starts again at 0.

3.3 UDP data packages for system profile

The system profile shows the following process data:

- Extended status profile: Status profile plus measurement contour description
- Measurement data

The safety sensor normally sends the UDP data packages as follows:

H1/H2	ID	Block	Scan	Extended status profile

Optional UDP data packages:

H1/H2	ID	Block	Scan	Measurement data, 1st fragment
H1/H2	ID	Block	Scan	Measurement data, 2nd fragment
…				
H1/H2	ID	Block	Scan	Measurement data, n. fragment

3.3.1 Extended status profile RSL 200

The measurement contour description is sent in addition to the status profile with the extended status profile.

H1/H2	ID	Block	Scan	Status profile	Measurement contour description

- ID: 1
- Block: consecutive block numbers (0 … 65535)
- Scan: consecutive scan numbers (0 … 4294967295)
- Data: see table 3.3 and see table 3.4
- Data length: fixed
  20 bytes (frame) + 28 bytes (status profile) + 8 bytes (measurement contour description)

	All measurement contour description fields are filled in with *Zero* if measurement value transmission is inactive (no measurement contour).

Status profile

Table 3.3: Status profile design

Byte	Bit	Signal	Value "0"	Value "1"	Default	Description
0	-	-	-	-	21	Type (model) of status profile
1	-	OP-MODE	-	-	1	Operating mode 0: Not configured 1: Safety mode 2: Simulation mode

Byte	Bit	Signal	Value "0"	Value "1"	Default	Description
Messages and OSSDs						
2	7	ERROR	off	on	0	Collective message: Error with switch-off of the OSSDs
	6	WARNING	off	on	0	Collective message: Warning without switch-off of the OSSDs
	5	SCREEN	off	on	0	Contamination display for optics cover: Warning or error (switch-off of the OSSDs)
	4	EDM	off	on	0	EDM collection error
	3	FIELD TRI-PLE	off	on	0	Collective message: Error detected by field triple selection monitoring
	2	SCREEN_ ERROR	off	on	0	Contamination display for optics cover: Error (switch-off of the OSSDs)
	1	SCREEN_ WARNING	off	on	0	Contamination display for optics cover: Warning
	0	Reserved	-	-	0	Reserved
3	7	OSSD	off	on	0	OSSD state
	6	PF_VIO	violated	free	0	Status of active protective field
	5	WF_VIO_1	violated	free	0	Status of active warning field 1
	4	WF_VIO_2	violated	free	0	Status of active warning field 2
	3	RES	off	Active	0	State of start/restart interlock
	2	CLEAR	off	on	0	Internal signal OSSD
	1	PARK	off	parked	0	Park request fulfilled
	0	Reserved	-	-	0	Reserved
Field triple selection						
4	-	TRIPLE_SEL	-	-	-	Selected field triple (Area: 1 - 32)
5	0	SSREC	off	Active	0	EventLog

Byte	Bit	Signal	Value "0"	Value "1"	Default	Description
Control inputs						
6	7	IN8	off	on	0	Control input
	6	IN7	off	on	0	Control input
	5	IN6	off	on	0	Control input
	4	IN5	off	on	0	Control input
	3	IN4	off	on	0	Control input
	2	IN3	off	on	0	Control input
	1	IN2	off	on	0	Control input
	0	IN1	off	on	0	Control input
Outputs						
7	7	OUT8	off	on	0	Output
	6	OUT7	off	on	0	Output
	5	OUT6	off	on	0	Output
	4	OUT5	off	on	0	Output
	3	OUT4	off	on	0	Output
	2	OUT3	off	on	0	Output
	1	OUT2	off	on	0	Output
	0	OUT1	off	on	0	Output
Voltage						
8 … 9	-	VOLT	-	-	0	Voltage supply in [0.1 mV]
Temperature						
10 … 11	-	TEMP	-	-	0	Temperature in [0.1°C]
Reserved[1)]						
12 … 15	-	Reserved	-	-	0	Reserved
Scan number						
16 … 19	-	SCAN_NUM	-	-	0	Consecutive numbering of scans. Range (32 bit): 0 … 4294967295
Signature						
20 … 23	-	SAFE_SIG	-	-	0	Signature Range (32 bit): 0 … 4294967295

Byte	Bit	Signal	Value "0"	Value "1"	Default	Description
Data error						
24	-	ERR_CLASS	-	-	0	Error classification
25 … 26	-	ERR_NUM	-	-	0	Number error Area: 1-65534
27	-	Reserved	-	-	0	Reserved

1) The reserved bytes always have the value 0

Measurement contour description

Table 3.4: Measurement contour description design

Byte	Bit	Value range	Description
0 … 1	15 … 0	0 … 1350 0 ≤ **Start index** < Stop index	Start index
0 … 3	15 … 0	0 … 1350 Start index < **Stop index** ≤ 1350	Stop index
4 … 5	15 … 0	1 … 8	Index interval
6 … 7	15 … 0	-	Reserved

The total number of scanning beams is calculated according to the following formula:

$$n = 1 + \text{ceil}\left(\frac{\text{Stop index} - \text{Start index}}{\text{Index interval}}\right)$$

n total number of scanning beams

The ceil(x) function determines the smallest integer that is greater than or equal to the value x. The resulting number must be less than or equal to 1351 (depending on the UDP settings; 1351 = maximum resolution of the laser scanner).

3.3.2 Extended status profile RSL 400

The measurement contour description and the signature are sent in addition to the status profile with the extended status profile.

H1/H2	ID	Block	Scan	Status profile	Measurement contour description	Signature

- ID: 1
- Block: consecutive block numbers (0 … 65535)
- Scan: consecutive scan numbers (0 … 4294967295)
- Data: see table 3.5 and see table 3.6
- Data length: fixed
  20 bytes (frame) + 20 bytes (status profile) + 8 bytes (measurement contour description) + 12 bytes (signature)

	All measurement contour description fields are filled in with *Zero* if measurement value transmission is inactive (no measurement contour).

	NOTE
	Optionally, the configuration signature can be transferred as an additional parameter with the extended status profile. The configuration signature is transferred with the extended status profile if transfer of the configuration signature is activated on the “Data telegram” page in Sensor Studio. If the transfer is not activated, the status profile retains its 20 byte data length. Transfer of the configuration signature is only available from firmware version 5.6.

Status profile

Table 3.5: Status profile design

Byte	Bit	Signal	Value "0"	Value "1"	Default	Description
0	-	-	-	-	1	Type (model) of status profile. Extensions require a new type of status profile.
1	-	OP-MODE	-	-	1	Operating mode • 1: Safety mode • 2: Simulation mode
Messages and OSSDs						
2	7	ERROR	off	message	0	Collective message: Error with switch-off
	6	ALARM	off	message	0	Collective message: Warning without switch-off (also window warning)
	5	SCREEN	off	message	0	Contamination display for optics cover: Warning or switch-off
	4	EDM	off	message	-	EDM collection error
	3	FIELD PAIR	off	message	-	Collective message: Fault detected by field pair selection monitoring
	2	E-STOP	off	message	-	Error with OSSD linkage / Emergency stop monitoring
	1	A-OSSD	off	on	0	OSSD state, protective function A
	0	B-OSSD	off	on	0	OSSD state, protective function B

Byte	Bit	Signal	Value "0"	Value "1"	Default	Description
Emergency stop, parking						
3	7	Status-Input-SE	off	on	0	Status of the inputs SE1 and SE2 E-STOP
	6	Mode-PARK	off	parked	0	Park request fulfilled
	5	Reserved	-	-	-	Reserved
	4	Reserved	-	-	-	Reserved
	3	Reserved	-	-	-	Reserved
	2	Reserved	-	-	-	Reserved
	1	A-OSSD-WF	off	on	0	State of the second OSSD bit of protective function A if warning field is defined as protective field. Only with RSL 455P
	0	B-OSSD-WF	off	on	0	State of the second OSSD bit of protective function B if warning field is defined as protective field. Only with RSL 455P
Electrical signals on the safety sensor connection						
4	7	F1	-	-	-	Control input, input group 0
	6	F2	-	-	-	Control input, input group 0
	5	F3	-	-	-	Control input, input group 0
	4	F4	-	-	-	Control input, input group 0
	3	F5	-	-	-	Control input, input group 0
	2	F6	-	-	-	Control input, input group 1
	1	F7	-	-	-	Control input, input group 1
	0	F8	-	-	-	Control input, input group 1
5	7	F9	-	-	-	Control input, input group 1
	6	F10	-	-	-	Control input, input group 1
	5	RES1	-	-	-	Restart input, protective function A
	4	RES2	-	-	-	Restart input, protective function B
	3	EA1	-	-	-	Status EA1. If EDM is configured: Status EDM input, protective function A
	2	EA2	-	-	-	Status EA2. If EDM is configured: Status EDM input, protective function B
	1	EA3	-	-	-	Status EA3
	0	EA4	-	-	-	Status EA4

Byte	Bit	Signal	Value "0"	Value "1"	Default	Description
6	7	SE1	-	-	0	Linkage input
	6	SE2	-	-	0	Linkage input
	5	PNP-NPN	NPN	PNP	0	PNP/NPN changeover
	4	A1	-	-	-	Output
	3	A2	-	-	-	Output
	2	A3	-	-	-	Output
	1	A4	-	-	-	Output
	0	MELD	-	-	-	Output
7	-	Reserved	-	-	-	Reserved
8 … 11	31 … 0	Scan	-	-	value	Consecutive numbering of scans. Resetting to 0 by switching off
Protective function A						
12	7	A-ACTIVE	off	Active	0	Protective function A is active or configured
	6	A-WF-VIO	violation	free	0	Status of active warning field; protective function A
	5	A-PF-VIO	violation	free	0	Status of active protective field; protective function A
	4	A-RES	off	Active	0	Start/restart interlock active, restart request A
	3	A-CLEAR-PF	off	on	0	Internal signal OSSD A
	2	A-RES-WF	off	Active	0	Start/restart interlock active, restart request A-WF; only with RSL 455P
	1	A-SAFE-WF-CLEAR	off	Active	0	Internal signal; only with RSL 455P
	0	A-WF-IS-PF	off	on	0	Warning field configured as protective field; only with RSL 455P
Field pair selection A						
13	7 … 4	A-BANK-SEL	-	-	0	Selected bank A Numbers 1 … 10
	3 … 0	A-PAIR-SEL 1	-	-	0	First selected field pair A Numbers 1 … 10
14	7 … 4	A-PAIR-SEL 2	-	-	0	With temporally overlapping protective fields: Second selected field pair A with numbers 1 … 10
	3 … 0	Reserved	-	-	-	Reserved

Byte	Bit	Signal	Value "0"	Value "1"	Default	Description
Indication signals of protective function A						
15	7	A-WF-VIO-SEG-1	violation	free	0	Status of warning field segment 1, protective function A
	6	A-WF-VIO-SEG-2	violation	free	0	Status of warning field segment 2, protective function A
	5	A-PF-VIO-SEG-1	violation	free	0	Status of protective field segment 1, protective function A
	4	A-PF-VIO-SEG-2	violation	free	0	Status of protective field segment 2, protective function A
	3	A-FP-SEL-1	violation	free	0	Defined field pair selected Protective function A
	2	A-FP-SEL-2	violation	free	0	Defined field pair selected Protective function A
	1	Reserved	-	-	-	Reserved
	0	Reserved	-	-	-	Reserved
Protective function B						
16	7	B-ACTIVE	off	Active	0	Protective function B is active or configured
	6	B-WF-VIO	violation	free	0	Status of active warning field; protective function B
	5	B-PF-VIO	violation	free	0	Status of active protective field; protective function B
	4	B-RES	off	Active	0	Start/restart interlock active Restart request B
	3	B-CLEAR-PF	off	on	0	Internal signal OSSD B
	2	B-RES-WF	off	Active	0	Start/restart interlock active, restart request B-WF; only with RSL 455P
	1	B-SAFE-WF-CLEAR	off	Active	0	Internal signal; only with RSL 455P
	0	B-WF-IS-PF	off	on	0	Warning field configured as protective field; only with RSL 455P
Field pair selection B						
17	7 … 4	B-BANK-SEL	-	-	0	Selected bank B Numbers 1 … 10
	3 … 0	B-PAIR-SEL 1	-	-	0	First selected field pair B Numbers 1 … 10
18	7 … 4	B-PAIR-SEL 2	-	-	0	With temporally overlapping protective fields: Second selected field pair B with numbers 1 … 10
	3 … 0	Reserved	-	-	-	Reserved

Byte	Bit	Signal	Value "0"	Value "1"	Default	Description
Indication signals of protective function B						
19	7	B-WF-VIO-SEG-1	violation	free	0	Status of warning field segment 1 Protective function B
	6	B-WF-VIO-SEG-2	violation	free	0	Status of warning field segment 2 Protective function B
	5	B-PF-VIO-SEG-1	violation	free	0	Status of protective field segment 1 Protective function B
	4	B-PF-VIO-SEG-2	violation	free	0	Status of protective field segment 2 Protective function B
	3	B-FP-SEL-1	violation	free	0	Defined field pair selected Protective function B
	2	B-FP-SEL-2	violation	free	0	Defined field pair selected Protective function B
	1	Reserved	-	-	-	Reserved
	0	Reserved	-	-	-	Reserved

Measurement contour description

Table 3.6: Measurement contour description design

Byte	Bit	Value range	Description
0 … 1	15 … 0	0 … 2699 0 ≤ **Start index** < Stop index	Start index
0 … 3	15 … 0	0 … 2699 Start index < **Stop index** ≤ 2699	Stop index
4 … 5	15 … 0	1 … 8	Index interval
6 … 7	15 … 0	-	Reserved

The total number of scanning beams is calculated according to the following formula:

$$n = 1 + \text{ceil}\left(\frac{\text{Stop index} - \text{Start index}}{\text{Index interval}}\right)$$

n total number of scanning beams

The ceil(x) function determines the smallest integer that is greater than or equal to the value x.

Signature

The structure for transfer of the additional parameter "signature" is as follows:
2 bytes Id 0x001, 2 bytes length 0x0008, 8 bytes signature

Table 3.7: Signature

ID		Length		Description
LowByte	HighByte	LowByte	HighByte	8 bytes
0x01	0x00	0x08	0x00	Signature

3.3.3 Measurement data

The measurement data is transferred via multiple UDP packages according to the configuration.
The expected number of values can be calculated using the measurement contour description. The measurement contour can be reconstructed in its entirety and in the correct chronological order with this result and the block number.

H1/2	ID	Block	Scan	Measurement data, (n. fragment)

- ID (16 bit): 6: Distance measurement data type 3: Distance + signal strength measurement data type
- Block no. (16 bit): consecutive (0 - 65535)
- Scan no. (32 bit): consecutive (0 - 4294967295)

3.3.3.1 Distance measurement data type (ID: 6)

This telegram type transmits 2 bytes for each measurement value

Table 3.8: Data

Measurement value 1		Measurement value 2		…	Measurement value n	
Distance [mm]		Distance [mm]		…	Distance [mm]	
[Lo byte]	[Hi byte]	[Lo byte]	[Hi byte]	…	[Lo byte]	[Hi byte]

The expected number of beams (measured values) n for this data package is calculated using the formula described in chapter 3.3.2 or 3.3.1.
The total number of bytes occupied by all measurement data results from the following equation:

NumberOfBytes = 2 x n

RSL 200: The distance can be in the range of 0 … 32767 mm. Real values typically reach a distance of up to 25000 mm.
RSL 400: The distance can be in the range of 0 … 65535 mm. Real values typically reach a distance of up to 50000 mm.

3.3.3.2 Distance + signal strength measurement data type (ID: 3)

This telegram type transmits 4 bytes for each measurement value

Table 3.9: Data

Measurement value 1				Measurement value 2				…	Measurement value n			
Distance [mm]		Signal strength [digits]		Distance [mm]		Signal strength [digits]		…	Distance [mm]		Signal strength [digits]	
[LB]	[HB]	[LB]	[HB]	[LB]	[HB]	[LB]	[HB]	…	[LB]	[HB]	[LB]	[HB]

The expected number of beams (measured values) n for this data package is calculated using the formula described in chapter 3.3.2 or 3.3.1.
The total number of bytes occupied by all measurement data results from the following equation:

NumberOfBytes = 4 x n

RSL 200: The distance can be in the range of 0 mm –32767 mm. Real values typically reach a distance of up to 25000 mm.
RSL 400: The distance can be in the range of 0 – 65535 mm. Real values typically reach a distance of up to 50000 mm.
The signal strength can be in the range of 0 … 65535 (RSL 200 & RSL 400).