KEYENCE

Safety Laser Scanner

SZ-16D

Communication Manual

Read this manual before using the system in order to achieve maximum performance.
Always keep this manual in a safe place for future reference.

Introduction

This manual explains the handling, operation and precautionary points of the RS422A communication function of the SZ-16D. In order to fully utilize the performance and functions of the SZ-16D, please use it after fully reading this book and understanding its contents.
Keep this manual in a safe place after reading it so that you can refer to it at any time.
Ensure this manual is provided to the end user of this device.

Also, to ensure safe use of the SZ-16D, without fail, fully read the SZ Series user's manual and ensure that its contents are fully understood.

In order to use the functions depicted in this manual, the SZ Configurator (SZ setting software) must be the Ver2.0 or newer.

Safety headings

Important points in this manual concerning safety will be shown as follows. Follow these points under all circumstances.

⚠ **Danger**   Failure to follow the instruction results in significant harm to the machine operators including serious injury or death.

⚠ **Caution**   Failure to follow the instruction may result in damage to the SZ or to the machine on which the SZ is installed.

Note   Provides additional information for proper operation.

Reference   Provides advanced and useful information for operation.

📖   Indicates reference pages in this manual.

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MEMO

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Before use

1-1 RS-422A Communication Overview

Using the RS-422A communication, information such as the measurement distance data of the internal measurement range of the SZ-16D, the ON/OFF status of the OSSD output, or the error condition can be acquired. Also, the warning zone can be switched.

The SZ-16D can support a maximum of 4 multi-drop connections.

⚠ **Danger**   All of the data received from the RS-422A communication, cannot be used by the safety control system. Use it is used in error, the operator of the device may be threatened with death or serious injury.

Note   If a USB is used, information such as the measurement distance data of the internal measurement range from the SZ-16D, the ON/OFF status of the OSSD output, or the error condition cannot be acquired. Also, the warning zone cannot be switched.

External devices such as a computer
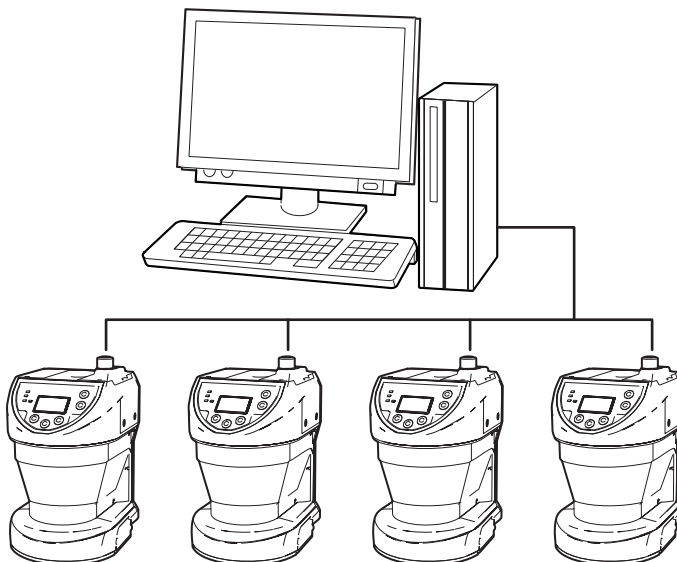
SZ-16D (up to 4 multi-drop connections can be supported)

Communication specifications

Item	Specification
Communication method	Full duplex
Synchronous method	Start-stop
Baud rate	9600/19200/38400/57600/125k/250k bps (Default Value: 38400)
Data bit length	8 bit
Parity check	None
Stop bit length	1 bit
Maximum connections	4 units (multi-drop link)
Transmission distance	30 m
Data transfer direction	LSB

Reference   For other than communication-related specifications, refer to 📖 "SZ Series User's Manual".

1-2 Part Names

Safety laser scanner SZ-16D

USB port

RS-422A communication port (M12 A-code female connector 5 pin)
* The connector cover is connected at the time of shipping

RS-422A Communication indicator
* When data is sent from the SZ-16D the indicator blinks, otherwise it is off.

Reference | Concerning details of parts and their names refer to □ "SZ Series User's Manual".
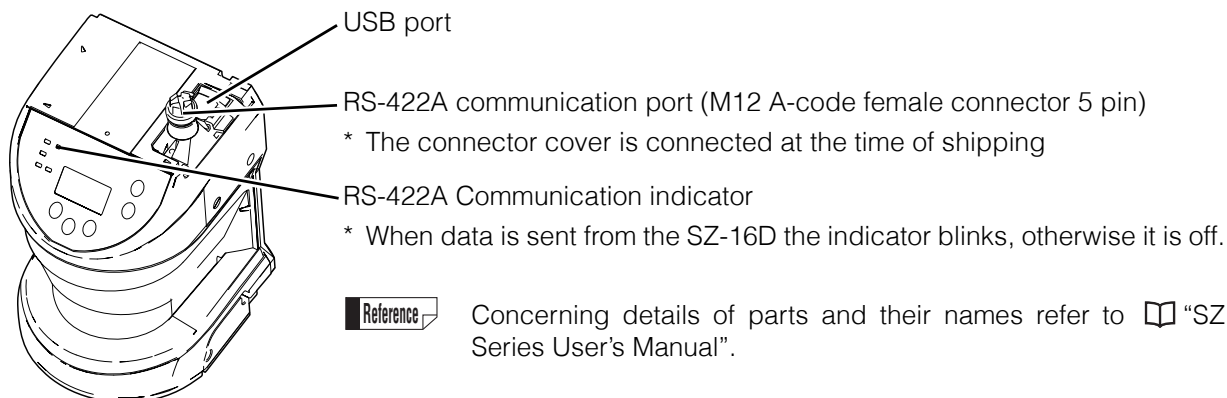
Input/output circuit diagram (RS-422A communication port)

Send data → TxD+ / TxD–

Receive data ← RxD+ / RxD– / SG
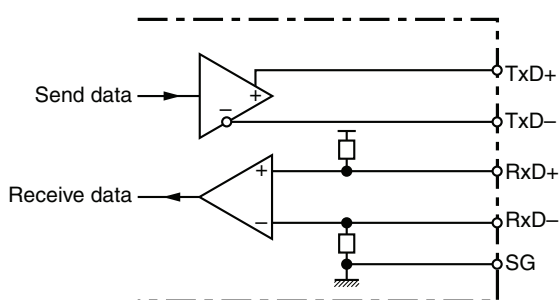
RS-422A communication connector cable SZ-C5D

External dimensions

R3
32
32
ø12
ø7.1
ø14

ø7.1, Length 5 m, 6 cores (3 pair twist) shielded cable
Nominal cross-sectional area 0.3 mm^2,
Wire core insulated diameter 1.3 mm

Pin position

M12 A-code
Male connector
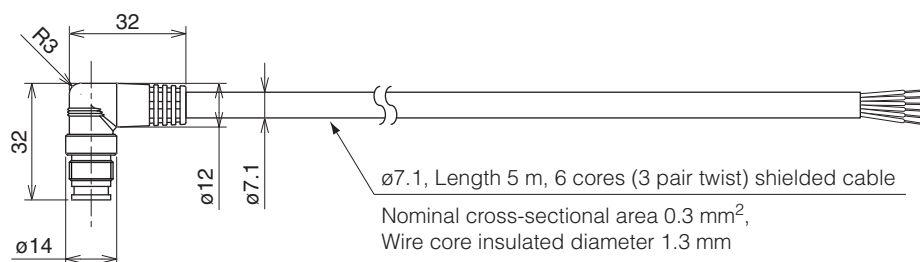
Pin number	Signal name	Type	Insulation	Remarks
1	RxD–	Input	Green/White	RxD+ and twist pair
2	RxD+	Input	Green	RxD– and twist pair
3	TxD–	Output	Red/White	TxD+ and twist pair
4	TxD+	Output	Red	TxD– and twist pair
5	SG	—	Black	Connection to the SG of the external device

* The shielded wire and the Black/white wires are not connected with any pin.

Connection method

1 Twist the connector cover counter-clockwise, and remove from the RS-422A communication port of the SZ-16D.
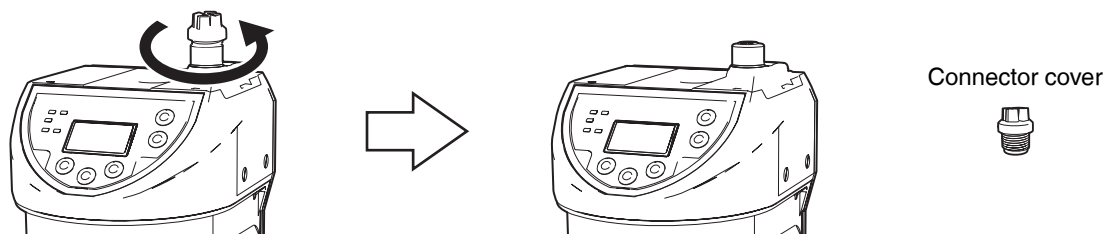
Connector cover

2 Ensuring that the arrow and the notch are in the same position, connect the RS-422A communication connector cable to the SZ-16D.

Arrow

Notch

45°
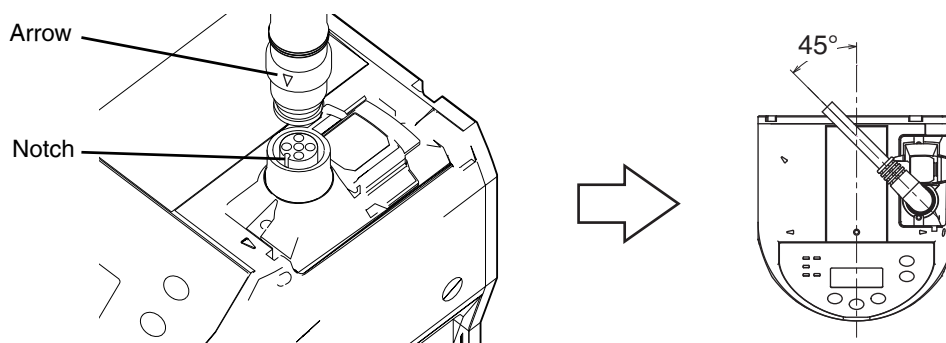
3 Using the screw of the RS-422A communication connector cable, tighten firmly to secure.
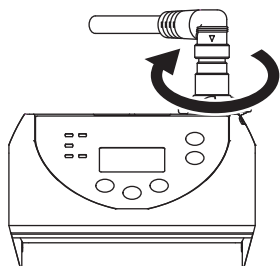
⚠ **Caution** | SZ-16D doesn't fulfill the requirements of IP65 degree of protection with the RS-422A communication connector cable unattached. Please connect the RS-422A communication connector cable.

2

RS-422A Communication

2-1 RS-422A Communication Function

Items that can be communicated with

Items that can be communicated with are explained in the table below.
Concerning details for items such as send/receive format or sendable data, please refer to 📖 "2-2 Send/Receive Format" (page 2-4).

Attribute	Number	Name
Read	1	Request measured value
	2	Start continuous sending
	3	Request all conditions
	4	Request OSSD state
	5	Request zone condition
	6	Request SZ state
	7	Request interlock condition
	8	Request error/alert number
	9	Request AUX condition
	10	Request input condition
	11	Request selected bank number
	12	Request zone data
	13	Request measurement range
	14	Request OSSD OFF history
	15	Request working time
Write	16	Set measurement range
	17	Select reading zone
	18	Start/Stop the communication monitor
	19	Set communication bank number
	20	Stop continuous sending
	21	Reset communication monitoring timer

Attributes have two types "Read" and "Write".

■ Read

Read is communication to send from the internal data of the SZ-16D to external devices. In response to a command from an external device (such as a computer), the SZ-16D will send the requested data.

■ Write

Write is communication to make changes to the settings of the SZ-16D from an external device. In response to a command from an external device (such as a computer), the SZ-16D will change the specified settings.

Request Mode and Continuous Sending Mode

For the reading method of data from the SZ-16D, there are two types: request mode and continuous sending mode.

■ Request mode

This is the mode for the SZ-16D to return data in response to a command from an external device (such as a computer). All of the data that can be read from the SZ-16D can be received.

■ Continuous sending mode

Based on the command from an external device (such as a computer), this mode is for the continuous sending of the measurement distance data from the SZ-16D. After the SZ-D has sent the measurement data once, it will continue to send the measurement distance data. To stop the continuous sending, it is necessary to send a stop command "Command Number 20 Stop continuous sending" from continuous sending mode of the external device.

For read of other than the measurement distance data, it is not supported in the continuous sending mode.

1. Request mode sequence
(communication procedure)

```
┌─→ Send command from an
│     external device
│          ↓
│   SZ-16D receive command
│          ↓
│   SZ-16D send data (response)
│          ↓
│   External device receive data
└──────────┘
```

2. Continuous sending mode sequence
(communication procedure)

```
    Send command from an
      external device
           ↓
    SZ-16D receive command
           ↓
┌─→ SZ-16D send data (response)
│          ↓
│   External device receive data
└──────────┘
```

2-2 Send/Receive Format
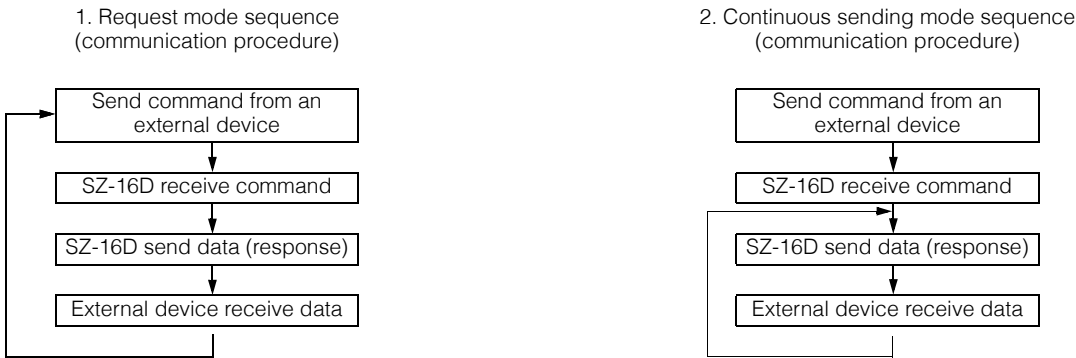
The send/receive format between the external device and the SZ-16D is as follows.

Note	Concerning multiple SZ16D devices connected via multi-drop connections, the command cannot be sent simultaneously. Please send/receive the command to each unit individually.

Read

■ Send command (from external device to SZ-16D)

Command	Communication ID	CRC1	CRC2
1 byte	1 byte	1 byte	1 byte

■ Response send (SZ-16D to external device): <u>when measurement distance data read</u>

0x00	0x00	0x00	0x00	Command	Communication ID	Data	CRC1	CRC2
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	5 to 1505 bytes	1 byte	1 byte

When read is via the "Command number 1 Request measured value" or "Command 2 Start continuous sending", "0x00" will be entered into the response data head number.
When the continuous sending occurs, this "0x00" data can be separated.

■ Response send (SZ-16D to external device): <u>Other than measurement distance data read</u>

Command	Communication ID	Data	CRC1	CRC2
1 byte	1 byte	1 to 10 bytes	1 byte	1 byte

■ Error response (SZ-16D to external device)

*	Communication ID	CRC1	CRC2
1 byte	1 byte	1 byte	1 byte

* The sent command from the external device will cause bit inversion, and will become the lead data of the error response.
When the command is incorrect, such as when the SZ-16D cannot read while it is turning on, an error response will be sent.

| Reference | Concerning the lead data of the error response.
Bit inverted data of the sent command from the external device will become the lead data of the error response. |
|---|---|

(Example) When the command (0x00) is sent, the error response lead data will be (0xFF).
When replacing (0x00) with a binary number it will be (00000000), and if it is bit inverted it will be (11111111).
If (11111111) is replaced with a hex number it will be (0xFF).

Write

■ Command send (external device to SZ-16D)

Command	Communication ID	Data	CRC1	CRC2
1 byte	1 byte	0 to 6 bytes	1 byte	1 byte

■ Response send (SZ-16D to external device)

Command	Communication ID	CRC1	CRC2
1 byte	1 byte	1 byte	1 byte

■ Error response (SZ-16D to external device)

*	Communication ID	CRC1	CRC2
1 byte	1 byte	1 byte	1 byte

* The sent command from the external device will cause bit inversion, and will become the lead data of the error response.
When the command is incorrect, Such as when the SZ-16 cannot read while it is turning on, an error response will be sent.

Send/Receive Format Details

Command

■ Read

Attribute	Number	Command name	Command format[1]	Response send data size
Read	1	Request measured value	0x90	5 to 1505 bytes
	2	Start continuous sending	0x91	5 to 1505 bytes
	3	Request all conditions	0x92	9 bytes
	4	Request OSSD state	0x93	1 byte
	5	Request zone condition	0x94	2 bytes
	6	Request SZ state	0x95	1 byte
	7	Request interlock condition	0x96	1 byte
	8	Request error/alert number	0x97	1 byte
	9	Request AUX condition	0x98	1 byte
	10	Request input condition	0x99	2 bytes
	11	Request selected bank number	0x9A	1 byte
	12	Request zone data	0x9B	1504 bytes
	13	Request measurement range	0x9C	6 bytes
	14	Request OSSD OFF history	0x9D	10 bytes
	15	Request working time	0x9E	4 bytes

[1] "0x90" represents "90" of the hex number

■ Write

Attribute	Number	Command name	Command format[1]	Response send data size
Write	16	Set measurement range	0x80	6 bytes
	17	Select reading zone	0x82	2 bytes
	18	Start/Stop the communication monitor	0x8B	1 byte
	19	Set communication bank number	0x8D	1 byte
	20	Stop continuous sending[2]	0xA0	0 byte
	21	Reset communication monitoring timer[2]	0xAA	0 byte

[1] "0x90" represents "90" of the hex number

[2] When the command number is 20, 21, there is no sent response.

Communication ID

When the data is sent or received, the communication ID must be specified.
Also, before the RS-422A communicates, the communication ID must be assigned from 0 to 3 to the
SZ-16D. For details concerning how to set the communication ID, refer to ◫ "2-3 SZ Configurator
Necessary Settings" (page 2-15).

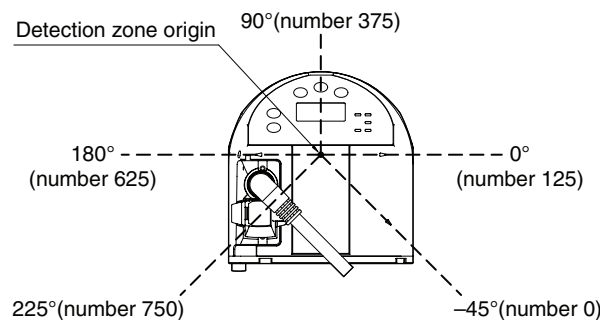| Communication ID	Format
0	0x00
1	0x01
2	0x02
3	0x03

Data

Based on the command sent from the external device, the data will be decided from the read data from
the SZ-16D.
Also, the contents written into the SZ-16D will be decided by the combination of the command and data.

■ Command Number 1 Request measured value

The SZ-16D will cause the internal mirror to scan. Over a range or 270° and for every 0.36° the
measurement distance data will be received.
The maximum data length is 1505 bytes, it will be sent to the external device from the SZ-16D in request
mode.
Concerning request mode, refer to ◫ "Request Mode and Continuous Sending Mode" (page 2-3).

As in the diagram below, the position of -45° is the first spot of the optical axis, and the position of 250° is
the 750th position. The optical axes are from 0 to 750 for a total of 751 optical axes.

Detection zone origin   90°(number 375)

180°
(number 625)   0°
(number 125)

225°(number 750)   –45°(number 0)

> **Note**
> • The time of the SZ-16D internal data renewal of the measurement distance data will occur
>   simultaneously with the scan cycle. (Scan cycle A: 30 ms, Scan cycle B: 33 ms ◫ SZ User's Manual
>   "Section 2-6, Response Time and Scan Cycle")
> • For the SZ-16D, from the time the power is turned on to normal operation, approximately 20 seconds
>   will be necessary. If the measurement distance data is read before normal operation is achieved, an
>   error response from the SZ-16D will be sent.
> • If the measurement distance data of the stopped condition of the laser projection of the SZ-16D is read
>   out, an error response from the SZ-16D will be returned.
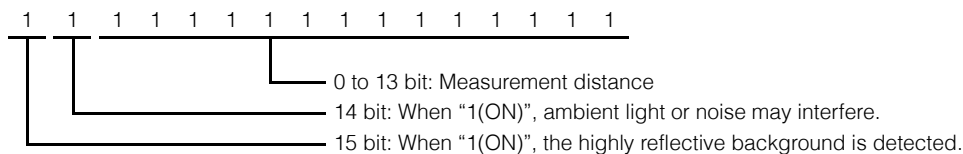
> **Reference** If the "Command Number 16 Set measurement range" is activated, settings such as the read angle
> range or optical axis number of the measurement distance data can be specified. From the initial
> settings, all of the measurement distance data from 0 to 750 will be read out.

Order	Contents	Data range	Remarks
1st byte	Data length (upper level)	0x00 to 0x05	The data length sent from the SZ-16D will be displayed as data
2nd byte	Data length (lower level)	0x00 to 0xFF	with a hex number and 4 columns.
3rd byte	Scan frequency	0x00 to 0xFF	The scanning frequency will be displayed as data with a hex number and 2 columns. If a 255 scan occurs, it will return to 0. For measurement distance data from the 4th byte, it will become the data received from the time of this scan frequency.

Order	Contents	Data range	Remarks
4th byte	Number 0 measurement distance data (upper level)	0x00 to 0xFF	The measurement distance, the interfering conditions such as ambient light and noise, and the detection conditions of a highly reflective background is displayed as a hex number 4 column data. Bits 0 to 13 displays the measurement distance (unit: mm). Bit 14 displays conditions such as ambient light and noise, and bit 15 displays the detection conditions of a highly reflective background. The maximum value of the measurement distance is 16383. Even when the measurement object is not there, it will be read as 16383. The number of read out bytes can be decreased by specifying "Command Number 16 Set measurement range". The optical axis number will be read out in order from the smallest.
5th byte	Number 0 measurement distance data (lower level)	0x00 to 0xFF	
6th byte	Number 1 measurement distance data (upper level)	0x00 to 0xFF	
7th byte	Number 1 measurement distance data (lower level)	0x00 to 0xFF	
• • •	• • •	• • •	
1504th byte	Number 750 measurement distance data (upper level)	0x00 to 0xFF	
1505th byte	Number 750 measurement distance data (lower level)	0x00 to 0xFF	

● **Measurement distance data details**

If the read hex decimal 4 column data is changed with a binary number, it will become 16 bit data. For example, if the read out data is 0xFFFF, it will be as follows.

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

0 to 13 bit: Measurement distance
14 bit: When "1(ON)", ambient light or noise may interfere.
15 bit: When "1(ON)", the highly reflective background is detected.

If the 0 to 13 bits are changed to a decimal number, the measurement distance will be displayed as 16383 mm. Since both the bit 14 or bit 15 are ON, there may be ambient light or noise interference, and it may be detected as a reflective background.

■ **Command Number 2 Start continuous sending**

The same data as the "Command Number 1 Request measured value" from the SZ-16D to the external device, is sent in continuous sending mode.
Concerning the continuous sending mode, refer to 📖 "Request Mode and Continuous Sending Mode" (page 2-3).

Note

If the laser projection of the SZ-16D is stopped during continuous sending, the continuous sending will be stopped.

■ **Command Number 3 Request all conditions**

The operation condition of the SZ-16D as well as the ON/OFF condition of the input and output can be read. Data length is 9 bytes.

Order	Contents	Data range	Remarks
1st byte	OSSD ON/OFF condition	0x00, 0x01	0x00: OFF, 0x01: ON
2nd byte	Detection condition of 1/2 of protection zone and warning zone	0x00 to 0x07	Change the data to binary number, then detection condition of each zone is displayed by the ON/OFF of each bit. Bit is ON: detection in progress Bit is OFF: detection not in progress Bit 0: Protection zone Bit 1: Warning zone 1 Bit 2: Warning zone 2
3rd byte	Condition of main body of SZ-16D	0x00 to 0x05	0x00: Activating 0x01: Normal operation 0x02: Waiting for bank input condition 0x03: Setting is ON 0x04: Error condition 0x05: Safety function not yet set

Order	Contents	Data range	Remarks
4th byte	Interlock condition	0x00 to 0x03	Change the data to binary number, then detection condition of each zone is displayed by the ON/OFF of each bit. Bit 0 ON: Interlock condition Bit 0 OFF: It is not interlock condition Bit 1 ON: Interlock-reset-ready output ON Bit 1 OFF: Interlock-reset-ready output OFF
5th byte	Error number[*1]	0x00 to 0x2E	The most recently occurring error number is displayed as a hex number and 2 column data. (Example) 0x00 means it is not error condition, 0x01 error number 1 (OSSD 1 error), 0x0A error number 10 (bank input error)
6th byte	Alarm number	0x00 to 0x04	0x00: It is not alarm condition 0x01: Window pollution 0x02: Light interference 0x03: AUX over current 0x04: High-reflective background
7th byte	AUX output ON/OFF condition	0x00 to 0x0F	If the data is changed with a binary number, the ON/OFF condition of AUX1 to AUX4 will be shown by each bit. Bit is ON: AUX output is ON Bit is OFF: AUX output is OFF Bit 0: AUX 1 Bit 1: AUX 2 Bit 2: AUX 3 Bit 3: AUX 4
8th byte	Input ON/OFF condition (upper level)	0x00 to 0x03	If the data is changed with a binary number, the ON/OFF condition will be shown by each bit. The ON/OFF input from bit 0 to bit 9 is displayed, and the input ON condition is displayed when the bit is ON. Bit 0: Reset input Bit 1: EDM input Bit 2: Bank input A Bit 3: Bank input B
9th byte	Input ON/OFF condition (lower level)	0x00 to 0xFF	Bit 4: Bank input C Bit 5: Bank input D Bit 6: Bank input a Bit 7: Bank input b Bit 8: Bank input c Bit 9: Bank input d Bit 10 to 15: Not used (fixed as OFF)

*1   The error number, will show the number displayed in * of "Error *" in the display. For details concerning errors, refer to 📖 SZ User's Manual "8-2 Trouble Shooting".

⬜ Reference ◹   If the 7 (0x07) of the hex number is changed to a binary number, it will become "00000111". From the right and in order they are counted as bit 0, bit 1. In this case, from bit 0 to bit 2 are displayed as ON.

■ Command Number 4 Request OSSD state

Only the 1st byte of "Command Number 3 Request all conditions" is read.

■ Command Number 5 Request zone condition

Only the 2nd byte of "Command number 3 Request all conditions" is read.

■ Command Number 6 Request SZ state

Only the 3rd byte of "Command Number 3 Request all conditions" is read.

■ Command Number 7 Request interlock condition

Only the 4th byte of "Command Number 3 Request all conditions" is read.

■ Command Number 8 Request error/alert number

Only the 5th and 6th byte of "Command Number 3 Request all conditions" is read.

■ Command Number 9 Request AUX condition

Only the 7th byte of "Command Number 3 Request all conditions" is read.

■ Command Number 10 Request input condition

Only the 8th and 9th byte of "Command Number 3 Request all conditions" is read.

■ Command Number 11 Request selected bank number

The input bank of the SZ-16D or the bank number selected by the "Command Number 19 Set communication bank number" will be read as data. The data length is 2 bytes.
When the warning bank switching via communication of the SZ Configurator is valid or not, the read data will change.
Concerning the setting method of the warning bank switching via communication, refer to 📖 "2-3 SZ Configurator Necessary Settings" (page 2-15).

● Warning bank switching via communication: <u>Invalid</u>

Order	Contents	Data range	Remarks
1st byte	Bank number while selected	0x00 to 0x0F	The data displayed via the hex number displays the selected bank number. (Example) 0x00 is bank 0, 0x0A is bank 10
2nd byte	Not yet used	0x00 fixed	—

● Warning bank switching via communication: <u>Valid</u>

Order	Contents	Data range	Remarks
1st byte	Protection zone bank number while selected	0x00, 0x01	0x00: Protection zone bank A 0x01: Protection zone bank B
2nd byte	Warning zone bank number while selected	0x00 to 0x0F	The data displayed via the hex number displays the selected bank number. (Example) 0x00 is bank 0, 0x0A is bank 10

| Reference	Regardless of whether the "Warning bank switching via communication" is valid or not, the Protection zone bank change cannot be done through the communication. The protection zone can only be changed through the bank input.

■ Command Number 12 Request zone data

Note	• When sending "Command Number 12 Request zone data", it is necessary to send "Command Number 17 Select reading zone" first. If the "Command Number 12 Request zone data" is sent without sending "Command Number 17 Select reading zone", the SZ-16D will send an error response. • If the bank assigned to the projection stop function is specified and the zone data is acquired, incorrect data will be sent in response.

This command specified to the bank via "Command Number 17 Select reading zone", is the read command to confirm the zone setting distance.
The zone is read every 0.36° and 10 mm. The data length is 1504 bytes.

As in the diagram below, the position of -45° is the first spot of the optical axis, and the position of 225° is the 750th position.
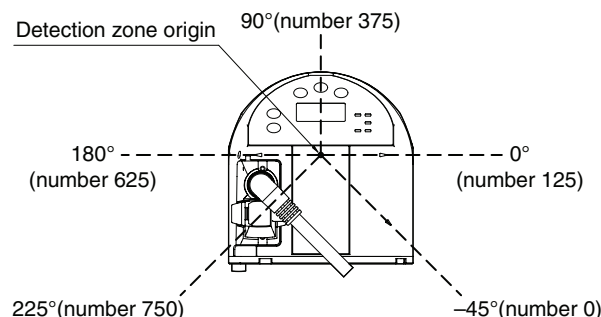
Order	Contents	Data range	Remarks
1st byte	Selection of protection zone/ warning zone 1/ warning zone 2	0x00 to 0x02	0x00: Protection zone 0x01: Warning zone 1 0x02: Warning zone 2

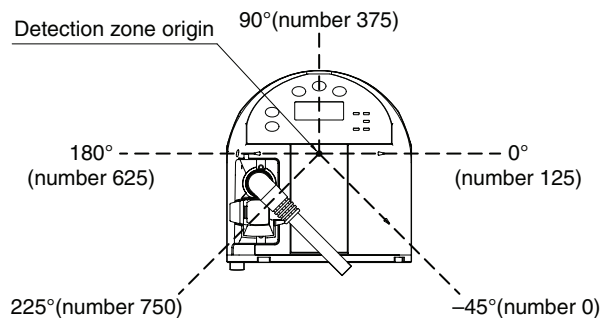| Order	Contents	Data range	Remarks
2nd byte	Bank number	0x00 to 0x0F	Data displayed by the hex number, is displayed by the bank number. (Example) 0x00 is bank 0, 0x0A is bank 10.
3rd byte	0th measurement distance data (upper level)	0x00 to 0x3F	If the hex number 4 column data is changed to a decimal number it will become measurement distance (unit: mm). In the case of the protection zone, a maximum of 4200 (unit: mm) of measurement data can be read. In the case of warning zone, a maximum of 10000 (unit: mm) of measurement data can be read out.
4th byte	0th measurement distance data (lower level)	0x00 to 0xFF	
5th byte	1st measurement distance data (upper level)	0x00 to 0x3F	
6th byte	1st measurement distance data (lower level)	0x00 to 0xFF	
• • •	• • •	• • •	
1503th byte	750th measurement distance data (upper level)	0x00 to 0x3F	
1504th byte	750th measurement distance data (lower level)	0x00 to 0xFF	

■ Command Number 13 Request measurement range

This command is the read command to confirm the conditions specified by the "Command number 16 Set measurement range". The read data is the same as that written by the "Command Number 16 Set measurement range".

■ Command Number 14 Request OSSD OFF history

From the maximum 20 items from the OSSD OFF history stored to the SZ-16D, the most recent history will be read as data. The data length is 9 bytes.
Concerning details of OSSD OFF history, refer to 📖 "SZ User's Manual".

As in the diagram below, the position of -45° is the first spot of the optical axis, and the position of 225° is the 750th position.

Order	Contents	Data range	Remarks
1st byte	When the OSSD is OFF (maximum upper level)	0x00 to 0xFF	The time from when the SZ-16D is turned on, as 0, to when the OSSD is turned OFF (unit: 0.1 seconds) is displayed as hex number 8 columns. Data range is from 0 to 4294967295, and the time range is from 0 to 429496729.5 seconds.
2nd byte	When the OSSD is OFF (2nd byte)	0x00 to 0xFF	
3rd byte	When the OSSD is OFF (3rd byte)	0x00 to 0xFF	
4th byte	When the OSSD is OFF (maximum lower level)	0x00 to 0xFF	
5th byte	Detected optical axis number (upper level)	0x00 to 0x02	The detected optical axis number is displayed by the hex number 4 column data. The data range is 0 to 750.
6th byte	Detected optical axis number (lower level)	0x00 to 0xFF	
7th byte	Detected distance (upper level)	0x00 to 0x10	The measurement distance (unit: mm) is displayed in hex number 4 column data. A maximum of 4200 mm measurement distance is read.
8th byte	Detected distance (lower level)	0x00 to 0xFF	
9th byte	Bank when detected	0x00 to 0x0F	The data displayed by the hex number is displayed in the bank number of the protection zone. (Example) 0x02 is bank 2, 0x0A is bank 10.

Reference
- When all of the 5th to 8th byte of the read data is "0xFF", if the OSSD is off due to an error condition of the SZ-16D, it will be displayed. The error number showing the error contents is read out as "Command Number 8 Request error/alert number".
- In conjunction with the operation time read by the "Command Number 15 Request working time", the time the OSSD is OFF will be calculated. ("Present time" – "Operation time" + "Time ODDS is duration" = "OSSD OFF time")

■ Command Number 15 Request working time

From the time the power SZ-16D is turned on, the passed time will be displayed. The data length is 4 bytes and the read time unit is 0.1 seconds.

Order	Contents	Data range	Remarks
1st byte	Operating time (maximum upper level)	0x00 to 0xFF	The time from when the SZ-16D is turned on, as 0, to when the OSSD is turned OFF (unit: seconds) is displayed as hex number 8 columns. Data range is from 0 to 4294967295, and the time range is from 0 to 429496729.5 seconds.
2nd byte	Operating time (2nd byte)	0x00 to 0xFF	
3rd byte	Operating time (3rd byte)	0x00 to 0xFF	
4th byte	Operating time (maximum lower level)	0x00 to 0xFF	

■ Command Number 16 Set measurement range

Note

When using both the Commands "Command Number 16 Set measurement range" and "Command Number 17 Select reading zone", ensure the command send is done in the determined order. If it is not done in the correct order, incorrect data will be sent as a response.

■ Correct order
- "Command Number 16 Set measurement range" then "Command Number 1 Request measured value"
- "Command Number 16 Set measurement range" the "Command Number 2 Start continuous sending"
- "Command Number 17 Select reading zone" to "Command Number 12 Request zone data"
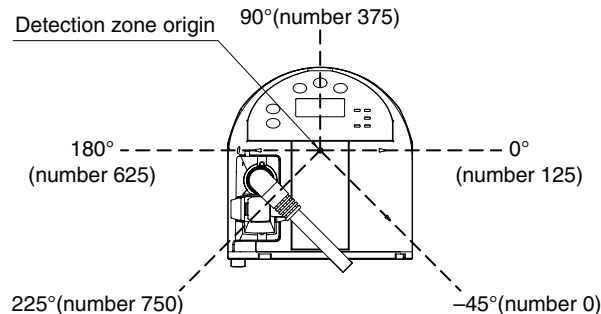
■ Incorrect order
- "Command Number 16 Set measurement range" then "Command Number 12 Request zone data"
- "Command Number 17 Select reading zone" then "Command Number 1 Request measured value"
- "Command Number 17 Select reading zone" then "Command Number 2 Start continuous sending"

"Command Number 1 Request measured value" and "Command Number 2 Start continuous sending" will specify the angle range and optical axis of the read measurement distance data. Data length is 6 bytes.

Order	Contents	Data range	Remarks
1st byte	The optical axis that begins to acquire the measurement distance data (upper level).	0x00 to 0x02	The detecting optical axis number is displayed by the hex number 4 column data. The data range is 0 to 750.
2nd byte	The optical axis that begins to acquire the measurement distance data (lower level).	0x00 to 0xFF	
3rd byte	The optical axis range that begins to acquire the measurement distance data (upper level).	0x00 to 0x02	From the optical axis number specified with the 1st and 2nd bytes, the range of measurement distance data to be received is specified as a number of optical axes. The received range is displayed as 4 digits of hexadecimal data. The data range is 1 to 751.
4th byte	The optical axis range that begins to acquire the measurement distance data (lower level).	0x00 to 0xFF	
5th byte	The skip count of the optical axis receiving the measurement distance data (upper level).[1]	0x00 to 0x02	For the optical axis acquiring the measurement distance data, how many data acquiring optical axes there are can be specified. The skip count is displayed in hex number 4 column data. The data range is from 0 to 750.
6th byte	The skip count of the optical axis receiving the measurement distance data (lower level).[1]	0x00 to 0xFF	

[1] If the skip count is 0, the entire range of the optical axis specified by bytes 1 to 4 will be specified.

(Example)   When the optical axis number is specified as 125, the number of optical axes as 251, and skip count as 9

From the 125th optical axis, the measurement distance data will be received every 10 optical axes over a range of 251 optical axes (from optical axis 125 to optical axis 375). The measurement distance data from the 125th, 135th, 145th… 355th, 365th, 375th optical axes will be received.

As for the angle range, in the diagram below the angle range from 0° to 90° is specified.

■ **Command Number 17 Select reading zone**

| Note | When using both the "Command Number 16 Set measurement range" and the "Command Number 17 Select reading zone", ensure the command is sent in the correct order. If the command is sent in the incorrect order, incorrect data may be sent back. |

■ Correct order
• "Command Number 16 Set measurement range" to "Command Number 1 Request measured value"
• "Command Number 16 Set measurement range" to "Command Number 2 Start continuous sending"
• "Command Number 17 Select reading zone" to "Command Number 12 Request zone data"

■ Incorrect order
• "Command Number 16 Set measurement range" to "Command Number 12 Request zone data"
• "Command Number 17 Select reading zone" to "Command Number 1 Request measured value"
• "Command Number 17 Select reading zone" to "Command Number 2 Start continuous sending"

The zone and bank of the read setting distance data will be specified by "Command Number 12 Request zone data". The data length is 2 bytes.

Order	Contents	Data range	Remarks
1st byte	Selection of protection zone, warning zone 1 and warning zone 2	0x00 to 0x02	0x00: Protection zone 0x01: Warning zone 1 0x02: Warning zone 2
2nd byte	Bank number	0x00 to 0x0F[*1]	Data displayed in hex number will display the bank number. (Example) 0x00 is bank 0, 0x0A is bank 10

*1   A bank number larger than the number of banks set to the SZ Configurator cannot be specified.

■ **Command Number 18 Start/Stop the communication monitor**

In order to use the communication monitor, it is necessary to set the monitor as enabled via the SZ Configurator.

In the default condition the communication monitor is stopped. If the communication monitor is started, the communication monitoring timer of the internal portion of the SZ-16D will count up. If the command of the RS-422A communication from the external device to the SZ-16D is sent correctly, this timer will be cleared. If within the specified watch interval of the SZ Configurator the communication monitoring timer is not cleared, there will be a communication monitoring error, and the OSSD will be maintained in an OFF condition.

If it cannot be confirmed that the commands are sent from an external device at regular intervals, the machine can be stopped.

Concerning the setting method of the monitoring interval, refer to 📖 "2-3 SZ Configurator Necessary Settings" (page 2-15).

Order	Contents	Data range	Remarks
1st byte	Start/stop of Communication monitor	0x00, 0x01	0x00: Communication monitor stop 0x01: Communication monitor start Default value: 0x00

⚠ **Danger**   The communication monitor function cannot be used in the safety control system. If it is used in error, the operator of the device may be threatened with death or serious injury.

Reference   When acquiring the measurement distance data in continuous sending mode, the communication monitoring timer can be cleared by the "Command Number 21 Reset communication monitoring timer".

● **How to return from a communication monitoring error**

If the reset is input, the error can be cleared. After clearing the error, the communication monitor will be in the stop condition.

■ **Command Number 19 Set communication bank number**

Only when the warning bank switching via communication is enabled via the SZ Configurator, is the command enabled. Based on this command the warning zone can be switched.
Concerning the warning bank switching via communication settings method, refer to 📖 "2-3 SZ Configurator Necessary Settings" (page 2-15).

Order	Contents	Data range	Remarks
1st byte	Switch bank number	0x00 to 0x0F	Data displayed in hex number will display the bank number. (Example) 0x00 is bank 0, 0x0A is bank 10 (Default value: 0x00)

Note

• When the warning bank switching via communication is enabled, after the power is turned on or the settings are transmitted from the SZ Configurator, the warning zone of the SZ-16D is operated via bank number 0.
• Regardless of the settings at the bank switch time of the SZ Configurator, the switch time duration of the warning zone will be within 35 ms. Concerning the switch time duration, refer to 📖 SZ User's Manual "Safety function 2" (Page 6-14).

■ **Command Number 20 Stop continuous sending**

If started with "Command Number 2 Start continuous sending", the continuous sending measurement distance data of the SZ-16D will be stopped.

■ **Command Number 21 Reset communication monitoring timer**

Used when the communication monitor is used by the continuations sending mode. If within the communication monitoring interval specified by the SZ Configurator, this command is used and the communication monitoring timer is cleared, the count will be restarted from 0.

CRC1/CRC2

To check whether the send command (from the external device to the SZ-16D) or the response (from the SZ to the external device) is being sent correctly, the CRC is attached to the end of the send/receive format. The CRC is 2 bytes if CRC1 and CRC2 are combined.

The CRC will be automatically decided based on the send/receive format. Concerning the confirmation method of the CRC, refer to 📖 "RS-422A Communication test" (page 2-17).

| Reference | The calculation method of the CRC is CCITT-CRC ($X^{16} + X^{12} + X^5 + X^0$)

Refer to below for a representative example of the CRC

Attribute	Name	Command	Communication ID	CRC1	CRC2
Read	Request measured value	0x90	0	0x18	0xEB
	Request measured value	0x90	1	0x08	0xCA
	Request measured value	0x90	2	0x38	0xA9
	Request measured value	0x90	3	0x28	0x88
	Start continuous sending	0x91	0	0x2B	0xDA
	Start continuous sending	0x91	1	0x3B	0xFB
	Start continuous sending	0x91	2	0x0B	0x98
	Start continuous sending	0x91	3	0x1B	0xB9
	Request all conditions	0x92	0	0x7E	0x89
	Request OSSD state	0x93	0	0x4D	0xB8
	Request zone condition	0x94	0	0xD4	0x2F
	Request SZ state	0x95	0	0xE7	0x1E
	Request interlock condition	0x96	0	0xB2	0x4D
	Request error/alert number	0x97	0	0x81	0x7C
	Request AUX condition	0x98	0	0x91	0x42
	Request input condition	0x99	0	0xA2	0x73
	Request selected bank number	0x9A	0	0xF7	0x20
	Request zone data	0x9B	0	0xC4	0x11
	Request measurement range	0x9C	0	0x5D	0x86
	Request OSSD OFF history	0x9D	0	0x6E	0xB7
	Request working time	0x9E	0	0x3B	0xE4
Write	Stop continuous sending	0xA0	0	0x1D	0x7E
	Stop continuous sending	0xA0	1	0x0D	0x5F
	Stop continuous sending	0xA0	2	0x3D	0x3C
	Stop continuous sending	0xA0	3	0x2D	0x1D
	Reset communication monitoring timer	0xAA	0	0xF2	0xB5

2-3   SZ Configurator Necessary Settings

In order to use the RS-422A communication function, it is necessary to set a SZ Configurator Ver2.0 or newer.
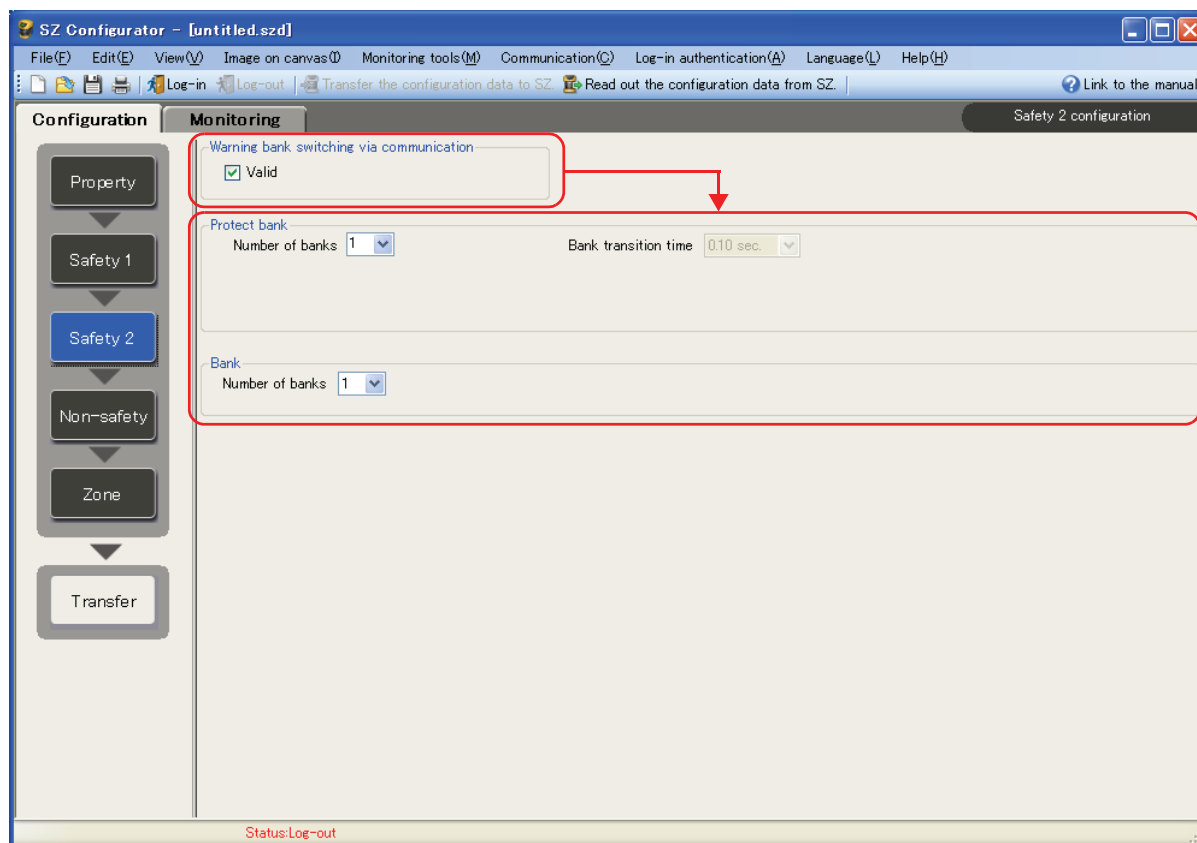The settings are accessed through the setting tab "Safety 2" "Non-safety" or "Communication" from the menu.
For and overview of the SZ Configurator, refer to 📖 SZ User's Manual "Section 6 Configuration through the configuration software".
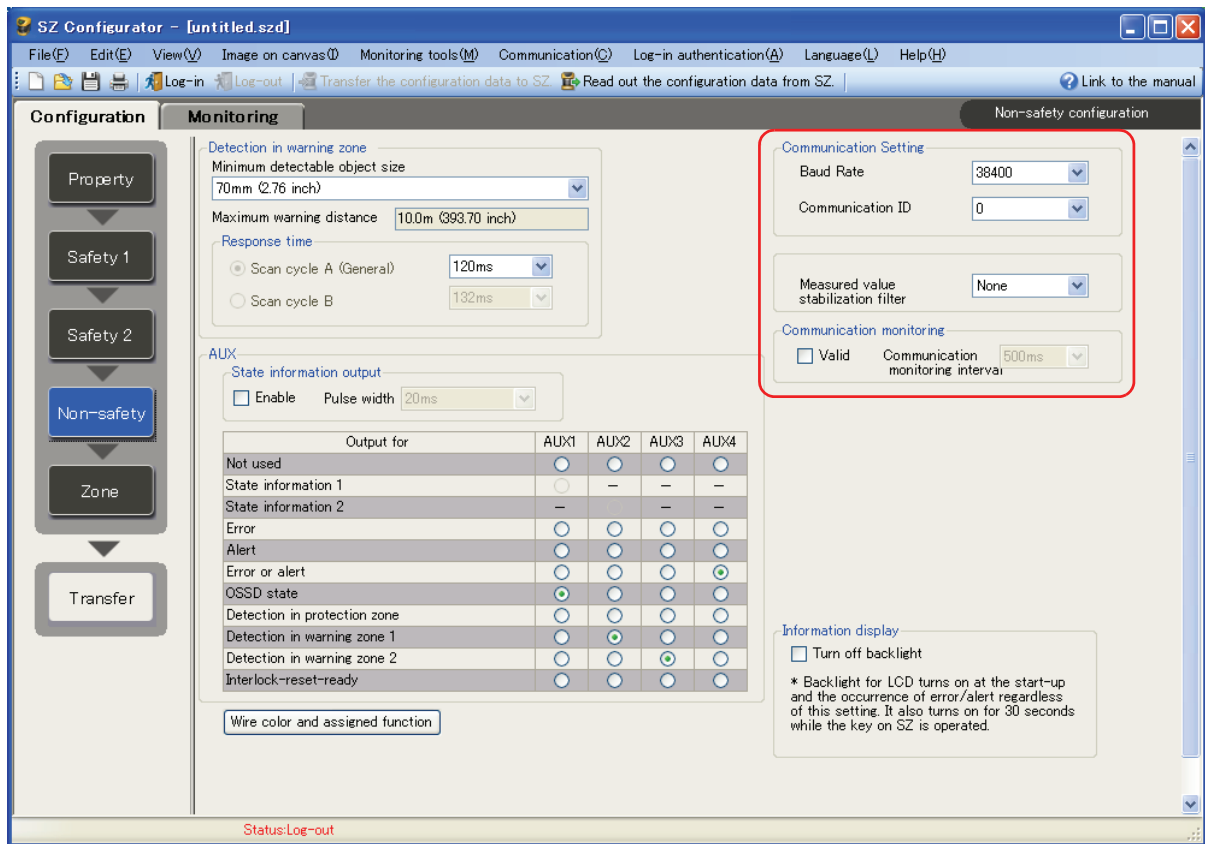
Safety 2

Item	Description
Warning bank switching via communication	If the valid check box ☑ is checked, the warning zone can be switched by the RS-422A communication function. Also, the maximum number for the protection bank is 2, and the maximum number for the warning bank is 16. Default value : ☐ (Check OFF)
Protect bank	Select the number of banks of the protection zone to be used. One protection zone can be set to one bank. The protection zone cannot be switched with the RS-422A communication function. Concerning the displayed "Bank transition time" and "Laser shutdown", refer to 📖 "SZ User's Manual". Setting range : 1 to 2 (Called Protection bank A to Protection bank B) Default value : 1
Bank	Specifies the number of banks used for the warning zone. Two warning zones can be set to 1 bank. Setting range : 1 to 16 (Called Warning bank 0 to Warning bank 15) Default value : 1

Non-safety

Item		Description
Communication settings[1]	Baud rate	Set the RS-422A communication baud rate. If the baud rate of the external device and the SZ-16D are not the same, there cannot be any communication. Setting range : 9600, 19200, 38400, 57600, 125k, 250k bps Default value : 38400 bps
	Communication ID	Specifies the communication ID of the SZ-16D. When there is a multi-drop connection, set so that it is not he same ID as above the RS-422A communication line. Setting range : 0 to 3 Default value : 0
Measured value stabilization filter		Specifies the filtering strength of the measurement distance data acquired by the RS-422A communication. As the filtering strength increases, the stability of the acquired data increases, however, the response will become slower.[2] Setting range : None, Low, High Default value : None
Communication monitoring		If the valid check box ☑ is checked, the communication monitor will be valid. If the command from the external device to the SZ-16D is not sent within the specified monitoring interval, there will be a communication monitor error and the OSSD will turn OFF. Default value : ☐ (Check OFF)
	Communication monitoring interval	Setting range : 100 ms, 500 ms, 1 s, 5 s Default value : 500 ms

*1 Concerning communication settings, after sending the settings even if the power of the SZ-16D is turned off, it will be stored.

*2 The response will be slowed by about 2 scan cycles when "Low", and when "High" by about 3 cycles.
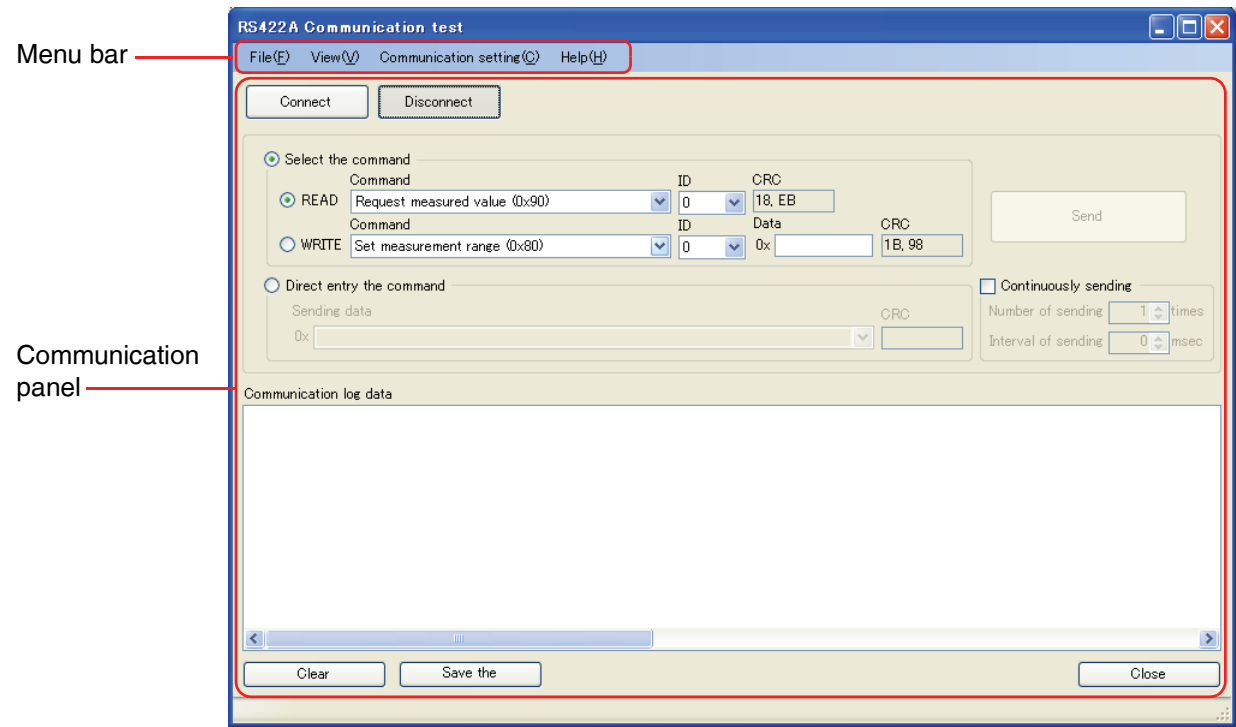
RS-422A Communication test

If the "RS-422A communication test" dialog box is used, the RS-422A communication test can be done via the SZ-16D and the computer to which the SZ Configurator is installed.
When conducting a communication test, it is necessary to connect the computer and the SZ-16D via the connector cable for RS-422A communication use.
📖 "1-3 Connection of the RS-422A Communication Connector Cable" (page 1-4)

For an overview of the SZ Configurator, refer to 📖 SZ User's Manual "Configuration through the configuration software".

Note	
	When there is not a RS-422A communication port on the computer, the communication test cannot occur. Use something such as an already established serial communication port to switch the device of the RS-422A communication.

Select [Communication (C)] then [RS-422A communication test (T)]. The "RS-422A communication test" dialog box will appear.

Menu bar

Communication panel

Menu bar

■ File (F)

● Save the comminucation log (S)
The send/receive result displayed in the communication log will be saved in a text document.

Other procedure: Click the [Save the] button on the communication panel.

● Exit (X)
[RS-422A communication test] dialog box will close.

■ Display (V)

Select whether the Data, CRC and communication log display will be as a decimal number or a hex number.

■ Communication setting (C)

● Serial port
Setting range: Within the COM port provided with the computer, the active ports will be displayed. On computers where there is no COM port it will be blank, and communication with the SZ-16D is not possible.

● Baud rate
Ensure the baud rate is matched with that of the SZ-16D.
Setting range: 9600, 19200, 38400, 57600, 125k, 250k bps

■ Help (H)

● Communication Manual
PDF data of the SZ-16D Communication Manual will be displayed.

Communication panel

Item		Description
Connect/Disconnect		If "Connect" is selected, the RS-422A communication command Send/Receive test will begin. When "Connect" is not enabled, check whether the communication port is being used by another application. Default value : Disconnect
Telegraph send	Select the command	If "Select the command" is selected, the pull-down command, the communication ID, and the data can be selected. The CRC will automatically make the calculation and operate from the selected command. "Read" attribute is the "Read" command, and "Write" is the "Write" command. It is necessary to input the data directly. Insert a [,] (comma) for each byte.
	Direct entry the command	If the "Direct entry the command" is selected, the command, the communication ID, and the data can be input directly. The CRC will automatically make the calculation and operate from the selected command.
	Continuously sending	If the Continuously sending check box ☑ is checked, the send command will be continuously sent. If the send button is pressed once, the selected "Number of sending" and "Interval of sending" will each send a command. • Number of sending: selection range 1 to 999 times, default value once • Interval of sending: selection range 0 to 1000 ms, default value 0 ms
	Send	If the "Send" button is clicked, a command is sent to the SZ-16D connected to the RS-422A communication port.
Communication log data		The command sent to the SZ-16D will display the response returned from the SZ-16D. The send data from the computer is displayed in blue, and the response from the SZ-16D is displayed in red. However, when the response contents from the SZ-16D does not match with the CRC and a send error occurs, it will display in green.
Clear		The communication result displayed in the communication log data will be cleared.
Save the		If the "Save the" button is clicked, the communication result displayed in the communication log is saved as text data.
Close		The [RS-422A communication] dialog box will close.

2-4 Communication time

Herein describes the communication time of the communication command.

| Note |

When the SZ Configurator is transferring the settings or reading out the settings of the SZ-16D, the communication times listed below cannot be met. The delay may cause the times to be as much a multiple of the times listed below.
Data read from the SZ-16D will be data from within a maximum of 35 ms from after the command being sent from the external device.

Request mode
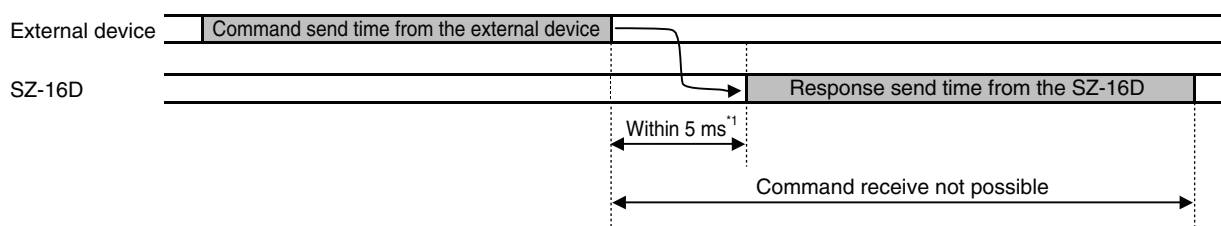
*1   When "Command Number 12 Request zone data" and "Command Number 17 Select reading zone" is read, they will be within 35 ms.

| Reference |

The command send time from the external device and the response send time from the SZ-16D can be calculated based on the calculation method below.
• Send time = Send byte count x 10 ÷ Baud rate

(Example)   When the baud rate is 38400bps, and "Command Number 1 Request measured value"
• Command send time from external device: 4 (byte) x 10 ÷ 38400 ≒ 1 ms
• Response send time from the SZ-16D (Maximum Command Number): 1513 (bytes) x 10 ÷ 38400 ≒ 394 ms

Continuous sending mode

Herein describes the communication time of "Command Number 2 Start continuous sending" and "Command Number 21 Reset communication monitoring timer".
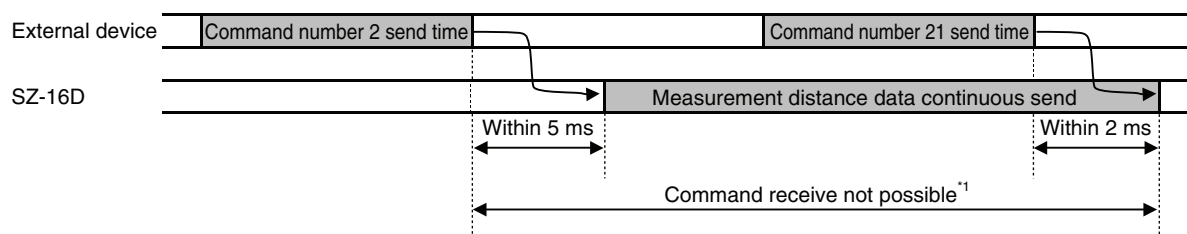
*1   Even during the receive command impossible period, the receipt of "Command Number 20 Stop continuous sending" and "Command Number 21 Reset communication monitoring timer" is possible.
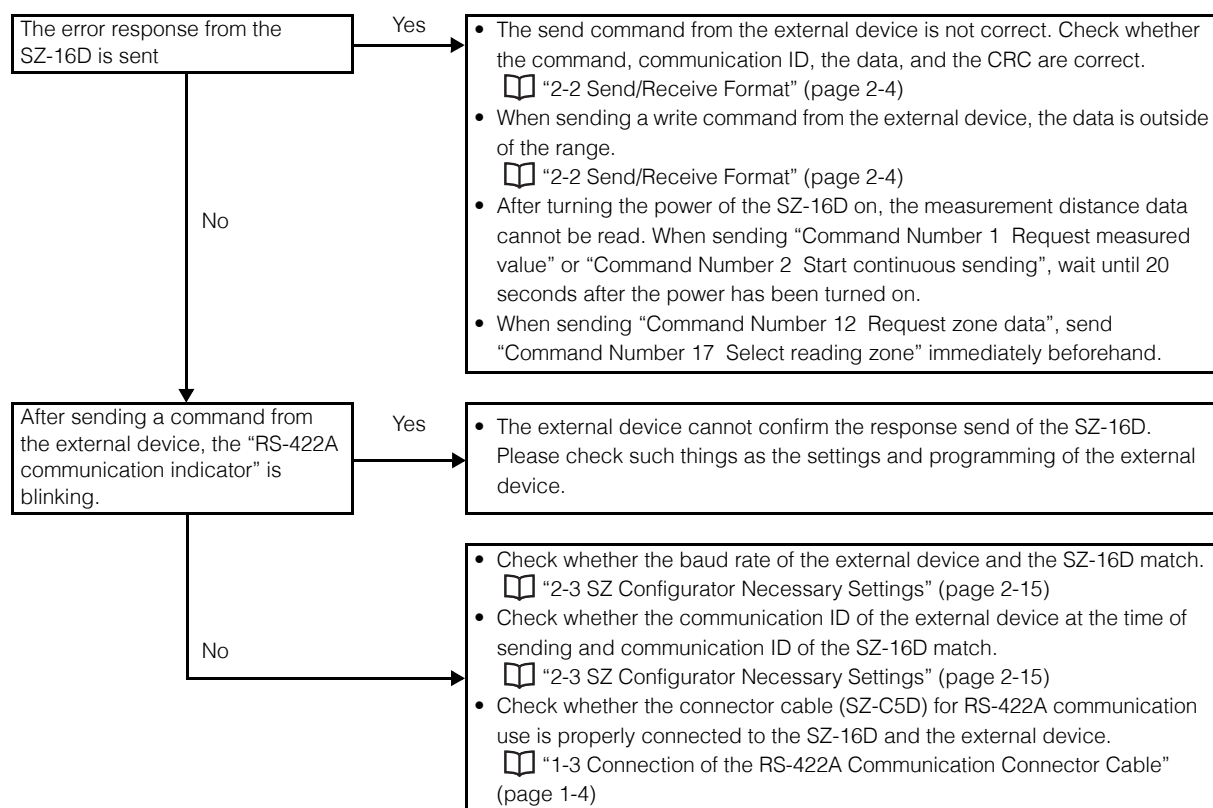
2

MEMO

3

Appendix

3-1 | Trouble Shooting

Herein describes troubleshooting when the RS-422A communication between the external device and the SZ-16D is abnormal. For troubleshooting concerning the main body of the SZ, refer to ☐ SZ User's Manual "8-2 Troubleshooting".

The error response from the SZ-16D is sent — **Yes** →
- The send command from the external device is not correct. Check whether the command, communication ID, the data, and the CRC are correct.
  ☐ "2-2 Send/Receive Format" (page 2-4)
- When sending a write command from the external device, the data is outside of the range.
  ☐ "2-2 Send/Receive Format" (page 2-4)
- After turning the power of the SZ-16D on, the measurement distance data cannot be read. When sending "Command Number 1 Request measured value" or "Command Number 2 Start continuous sending", wait until 20 seconds after the power has been turned on.
- When sending "Command Number 12 Request zone data", send "Command Number 17 Select reading zone" immediately beforehand.

No

After sending a command from the external device, the "RS-422A communication indicator" is blinking. — **Yes** →
- The external device cannot confirm the response send of the SZ-16D. Please check such things as the settings and programming of the external device.

No →
- Check whether the baud rate of the external device and the SZ-16D match.
  ☐ "2-3 SZ Configurator Necessary Settings" (page 2-15)
- Check whether the communication ID of the external device at the time of sending and communication ID of the SZ-16D match.
  ☐ "2-3 SZ Configurator Necessary Settings" (page 2-15)
- Check whether the connector cable (SZ-C5D) for RS-422A communication use is properly connected to the SZ-16D and the external device.
  ☐ "1-3 Connection of the RS-422A Communication Connector Cable" (page 1-4)

Revision History

Date of creation	Version	Revision contents
December 2010	Official release	
May 2015	2nd edition	

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