

# SX5 Safety Laser Scanner Advanced Measurement Communication Manual



Original Instructions

p/n: 242238 Rev. A

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# Chapter 1 About This Document

## Important ... Read This Before Proceeding!

It is the responsibility of the machine designer, controls engineer, machine builder, machine operator, and/or maintenance personnel or electrician to apply and maintain this device in full compliance with all applicable regulations and standards.

The device can provide the required safeguarding function only if it is properly installed, properly operated, and properly maintained. This Communication Manual attempts to supplement the Instruction Manual in providing complete installation, operation, and maintenance instructions. *Reading these manuals in their entirety is highly recommended to ensure proper understanding of the operation, installation, and maintenance.* Please direct any questions regarding the application or use of the device to Banner Engineering Corp..



**WARNING:**



- The user is responsible for following these instructions.
- **Failure to follow any of these responsibilities may potentially create a dangerous condition that could result in serious injury or death.**
- Carefully read, understand, and comply with all instructions for this device.
- Perform a risk assessment that includes the specific machine guarding application. Guidance on a compliant methodology can be found in ISO 12100 or ANSI B11.0.
- Determine what safeguarding devices and methods are appropriate per the results of the risk assessment and implement per all applicable local, state, and national codes and regulations. See ISO 13849-1, ANSI B11.19, and/or other appropriate standards.
- Verify that the entire safeguarding system (including input devices, control systems, and output devices) is properly configured and installed, operational, and working as intended for the application.
- Periodically re-verify, as needed, that the entire safeguarding system is working as intended for the application.

## Use of Warnings and Cautions

The precautions and statements used throughout this document are indicated by alert symbols and must be followed for the safe use of the SX Series Safety Laser Scanner. Failure to follow all precautions and alerts may result in unsafe use or operation. The following signal words and alert symbols are defined as follows:

| Signal Word and Symbol   | Definition   |
|--|--|
| <br><b>WARNING:</b> | <b>Warnings</b> refer to potentially hazardous situations which, if not avoided, could result in serious injury or death.  |
| <br><b>CAUTION:</b> | <b>Cautions</b> refer to potentially hazardous situations which, if not avoided, could result in minor or moderate injury. |

These statements are intended to inform the machine designer and manufacturer, the end user, and maintenance personnel, how to avoid misapplication and effectively apply the SX Series Safety Laser Scanner to meet the various safeguarding application requirements. These individuals are responsible to read and abide by these statements.

## UDP-Based Monitoring

This document applies to the following models of SX Safety Laser Scanners:

- SX5-B6
- SX5-M10
- SX5-M70
- SX5-ME70
- SX5-R

Master devices, SX5-Mxxx, can be connected to up to three Remote devices, SX5-R, in a cascade configuration. In this case, the system created by the master and one to three remote scanners are referred to as a cluster.

## About this Manual

This Communication Manual is a supplement to the SX5 Instruction Manual and describes the advanced measurement data obtainable from the scanner.

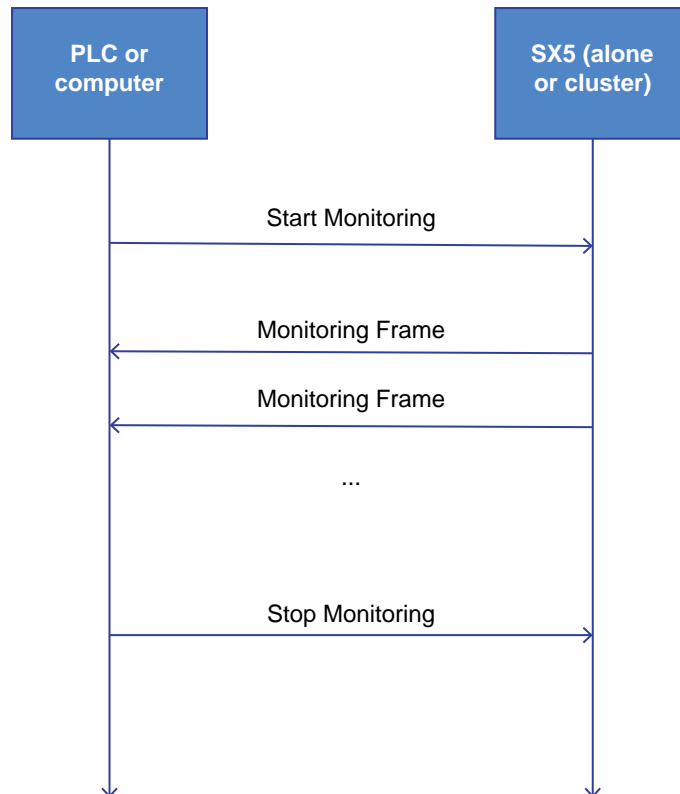
Download the SX5 Instruction Manual, p/n 208913, from [www.bannerengineering.com](http://www.bannerengineering.com).

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# Chapter 2 UDP Based Monitoring for the SX Series Safety Laser Scanner

The SX Series Safety Laser Scanner supports a UDP client-server communication over Ethernet (up to 100 Mbps) that allows a PLC or computer (client) to run the SX Series Safety Laser Scanner monitoring function on the SX Series Safety Laser Scanner (server).



Activating the monitoring function makes it possible to receive measurement distance data and information about the status of the scanner. Information is sent to the PLC or computer by a continuous flow of UDP packets.

If multiple scanners are connected to each other as a cluster, the main unit, Master unit, is responsible for collecting and sending all monitoring frames to the client (PLC or computer).

The data sent from the master device to the client for each complete scan are structured in 6 monitoring frames (see ["Monitoring Frame \(from Device to Client\)" on page 11](#)). If remote devices are connected to the Master device, an additional monitoring frame is sent for each remote device.

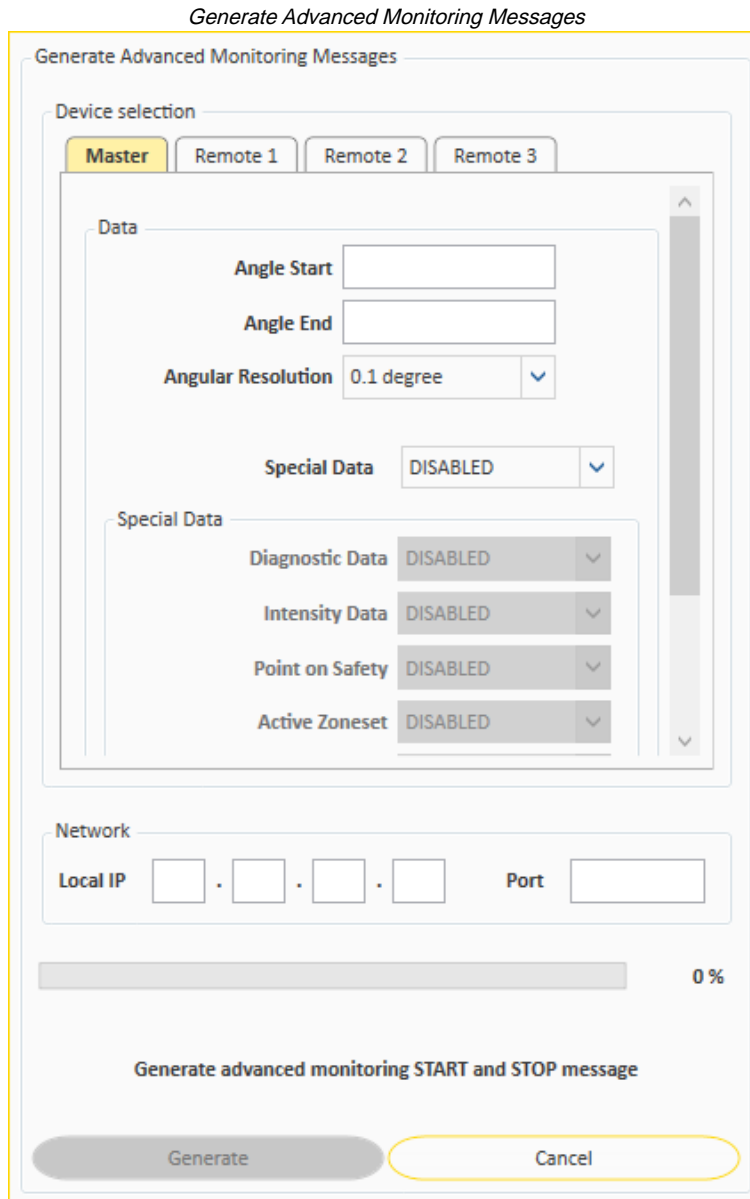
## Client Disconnection

Because UDP is a connectionless protocol, disconnecting the client (PLC or computer) from the network (that is, unplugging the Ethernet cable or power off the client) does not result in stopping the monitoring function: If the client's IP has not changed, reconnecting the client to the network allows the monitoring frames to reach the client again. If the client's IP has changed (or the client has been replaced with another one), frames do not reach the client since they are still sent to the previous IP address and port.

# How to Create the Start and Stop Messages

The start and stop messages, referenced in the next section, are created in the SX Series Safety Laser Scanner Configuration Software.

In the Configuration Software version 3.1.3 or higher the option to **Generate Advanced Monitoring Messages** exist. Open the desired configuration that contains the topography of the cluster (Master model and appropriate number of remotes) or create the structure. Under the small **Options** menu is **Advanced Monitoring**.



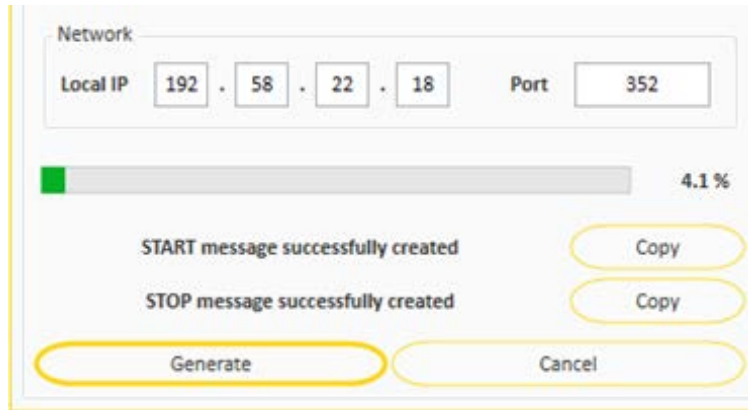
From this box the area from which the data is gathered can be limited by entering a start and stop angle. The angular resolution can be selected. The scanner's safety function has a resolution of 0.1 degree, but this results in a lot of data. The resolution can be selected from 0.1 degree up to 5 degrees. For the remote scanners, the resolution can be selected from 0.5 degree up to 5 degrees (only 1 packet per remote).

If any of the special data is desired, enable it in the **Special Data** box. First, enable the **Special Data** box from the **Special Data** menu in the **Data** box.

To receive data from a remote scanner, select the desired remote page in the **Generate Advanced Monitoring Messages** page. Then enable the **Monitoring**.

Enter the IP address and port of the client (PLC or computer) in the **Network** box.

After the desired settings have been selected, click **Generate** to create the START and STOP messages. Once generated the START and STOP messages can be copied.



Network

Local IP 192 . 58 . 22 . 18 Port 352

4.1 %

START message successfully created Copy

STOP message successfully created Copy

Generate Cancel



**WARNING:** Advanced Measurement data may only be used for general monitoring and control activities. Do not use this data for safety-related applications.

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# Chapter 3 Command List

The Advanced Measurement protocol includes the following messages:

- Start Request
- Start Reply
- Monitoring Frame(s)
- Stop Request
- Stop Reply

The "[Appendix](#)" on page 22 provides some examples of the available messages described in this chapter.

## Start Request (from Client (PLC or computer) to Device)

The start command must be sent to the SX Series Safety Laser Scanner IP address using UDP port 3000. This command provides the device with information to be sent back to the client.

**NOTE:** Banner recommends that the Start command be generated using the SX Series Safety Laser Scanner Configuration Software (**Options > Advanced Monitoring**). This ensures that the message is correct and that the information requested meets the communication band.

The UDP payload uses the following format. Unless otherwise indicated, the byte order is little endian.

| Offset | Length | Field             | Description  |
|--------|--------|-------------------|--|
| 0x00   | 4      | CRC               | A CRC32 of all the following fields. See " <a href="#">CRC Computation</a> " on page 17  |
| 0x04   | 4      | Seq Number        | Sequence number of the message   |
| 0x08   | 8      | <i>reserved</i>   | Use all zeros  |
| 0x10   | 4      | Op Code           | Operation Code (start 0x35)  |
| 0x14   | 4      | IP                | Client IP address. Byte order: big endian.   |
| 0x18   | 2      | Port              | Client communication port  |
| 0x1A   | 1      | Device Enabled    | Enables or disables the monitoring message on one or more devices. <sup>a</sup><br><br><b>NOTE:</b> The Master device is always active, therefore its default value is (1000). |
| 0x1B   | 1      | Intensity Enabled | Enables or disables the intensity field on a device. <sup>a</sup>  |

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| Offset | Length | Field                   | Description  |
|--------|--------|-------------------------|--|
| 0x1C   | 1      | Point in Safety Enabled | Enables or disables the Point in Safety field, which specifies whether the point of a device lies within the Safety Zone. <sup>a</sup>   |
| 0x1D   | 1      | Active Zone-Set Enabled | Enables or disables the field that indicates which Zone Set is active in the device. <sup>a</sup>  |
| 0x1E   | 1      | I/O Pin Enabled         | Enables or disables the field that shows the configured I/O pins. <sup>a</sup>   |
| 0x1F   | 1      | Scan Counter Enabled    | Enables or disables the scan counter field. <sup>a</sup>   |
| 0x20   | 1      | Speed Encoder Enabled   | Enables or disables the field that specifies whether the encoder is active. Because the encoder can only be enabled on the Master device (model SX5-ME70), this 1-byte mask will be (1111) if the encoder is active, or (0000) if the encoder is not active.                   |
| 0x21   | 1      | Diagnostics Enabled     | Enables diagnostics on the selected device. <sup>a</sup>   |
| 0x22   | 2      | Master Start Angle      | Indicates the start angle of the Master device expressed in tenths of a degree. <sup>b</sup>   |
| 0x24   | 2      | Master End Angle        | Indicates the end angle of the Master device expressed in tenths of a degree. <sup>c</sup>   |
| 0x26   | 2      | Master Resolution       | Indicates the angle resolution of the Master device expressed in tenths of a degree. Example: to sample an angle every 0.1°, this value must be $0.1 \times 10 = 1$  |
| 0x28   | 2      | Remote 1 Start Angle    | Indicates the start angle of Remote 1 expressed in tenths of a degree. <sup>b</sup><br><br><b>NOTE:</b> If the Device Enabled mask of Remote 1 is false (value = 0), this field will have a value = 0.   |
| 0x2A   | 2      | Remote 1 End Angle      | Indicates the end angle of Remote 1 expressed in tenths of a degree. <sup>b</sup><br><br><b>NOTE:</b> If the Device Enabled mask of Remote 1 is false (value = 0), this field will have a value = 0.   |
| 0x2C   | 2      | Remote 1 Resolution     | Indicates the angle resolution of Remote 1 expressed in tenths of a degree. Example: to sample an angle every 5.0°, this value must be $5.0 \times 10 = 50$<br><br><b>NOTE:</b> If the Device Enabled mask of Remote 1 is false (value = 0), this field will have a value = 0. |
| 0x2E   | 2      | Remote 2 Start Angle    | Indicates the start angle of Remote 2 expressed in tenths of a degree. <sup>b</sup><br><br><b>NOTE:</b> If the Device Enabled mask of Remote 2 is false (value = 0), this field will have a value = 0.   |

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| Offset | Length   | Field                | Description   |
|--------|----------|----------------------|---|
| 0x30   | 2        | Remote 2 End Angle   | Indicates the end angle of Remote 2 expressed in tenths of a degree. <sup>b</sup><br><br><b>NOTE:</b> If the Device Enabled mask of Remote 2 is false (value = 0), this field will have a value = 0.  |
| 0x32   | 2        | Remote 2 Resolution  | Indicates the angle resolution of Remote 2 expressed in tenths of a degree. Example: to sample an angle every 5.0°, resolution value is $5.0 \times 10 = 50$<br><br><b>NOTE:</b> If the Device Enabled mask of Remote 2 is false (value = 0), this field will have a value = 0. |
| 0x34   | 2        | Remote 3 Start Angle | Indicates the start angle of Remote 3 expressed in tenths of a degree. <sup>b</sup><br><br><b>NOTE:</b> Note: If the Device Enabled mask of Remote 3 is false (value = 0), this field will have a value = 0.  |
| 0x36   | 2        | Remote 3 End Angle   | Indicates the end angle of Remote 3 expressed in tenths of a degree. <sup>b</sup><br><br><b>NOTE:</b> If the Device Enabled mask of Remote 3 is false (value = 0), this field will have a value = 0.  |
| 0x38   | 2        | Remote 3 Resolution  | Indicates the angle resolution of Remote 3 expressed in tenths of a degree. Example: to sample an angle every 5.0°, resolution value is $5.0 \times 10 = 50$<br><br><b>NOTE:</b> If the Device Enabled mask of Remote 3 is false (value = 0), this field will have a value = 0. |
| TOTAL  | 58 BYTES |                      |   |

<sup>a</sup> 1-byte mask. Only the last 4 bits (little endian) are used, each of which represents a device. For example, (1000) only enables the Master device, while (1010) enables both the Master and the second Remote device.

<sup>b</sup> The start angle must have a minimum value of 0 degrees and must not exceed the end angle.

<sup>c</sup> The end angle must have a maximum value of 275 degrees and must not be less than the start angle.

## Start Reply (from Device to Client)

The UDP uses the following format. Unless otherwise indicated, the byte order is little endian.

| Offset | Length | Field           | Description   |
|--------|--------|-----------------|---|
| 0x00   | 4      | CRC             | A CRC32 of all the following fields. <a href="#">"CRC Computation" on page 17</a> |
| 0x04   | 4      | <i>reserved</i> | - (all zeros should be received)  |

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| Offset | Length   | Field    | Description   |
|--------|----------|----------|---|
| 0x08   | 4        | OP Code  | Operation Code (Start 0x35)   |
| 0x0C   | 4        | Res Code | Operation result. If the message is accepted, the returned value is 0x00. If the message is refused, the returned value is 0xEB. If the CRC is not correct, the device will not send any message. |
| TOTAL  | 16 BYTES |          |   |

## Stop Request (from Client to Device)

The Stop Command must be sent to the SX Safety Laser Scanner IP address using UDP port 3000. The UDP uses the following format. Unless otherwise indicated, the byte order is little endian.

| Offset | Length   | Field           | Description   |
|--------|----------|-----------------|---|
| 0x00   | 4        | CRC             | A CRC32 of all the following fields. See <a href="#">"CRC Computation" on page 17</a> . |
| 0x04   | 12       | <i>reserved</i> | Use all zeros   |
| 0x10   | 4        | Op Code         | Operation Code (Stop 0x36).   |
| TOTAL  | 20 BYTES |                 |   |

## Stop Reply (from Device to Client)

The UDP uses the following format. Unless otherwise indicated, the byte order is little endian.

| Offset | Length   | Field           | Description   |
|--------|----------|-----------------|---|
| 0x00   | 4        | CRC             | A CRC32 of all the following fields. See <a href="#">"CRC Computation" on page 17</a> .   |
| 0x04   | 4        | <i>reserved</i> | - (all zeros should be received)  |
| 0x08   | 4        | Op Code         | Operation Code (Stop 0x36).   |
| 0x0C   | 4        | Res Code        | Operation result. If the message is accepted, the returned value is 0x00. If the message is refused, the returned value is 0xF7. If the CRC is not correct, the device will not send any message. |
| TOTAL  | 16 BYTES |                 |   |

## Monitoring Frame (from Device to Client)

Monitoring frames are sent by the SX Safety Laser Scanner after a start command. Monitoring frames are sent to the IP address and UDP port specified by the Start Command message.

Each monitoring frame is always composed of:

- 6 messages for the Master device
- 1 message for each Remote device

Each message is composed of the following elements:

- The same information is always stored in the first 19 bytes.
- The remaining bytes are variable in number and depend on the configuration sent with the Start Command. Each configuration sent with the Start Command prompts the system to send data in the monitoring frame. For more information on decoding additional information, refer to ["Additional Information" on page 13](#)
- The end of the message is given by either the length or the end message header ID with LEN 0.

**NOTE:** Measurement data are always included in the frame; it is not optional.

The UDP uses the following format. Unless otherwise indicated, the byte order is little endian.

| Offset | Length   | Field                  | Description   |
|--------|----------|------------------------|---|
| 0x00   | 4        | Device Status          | Bit mask representing the device status " <a href="#">Device Status</a> " on page 12.                   |
| 0x04   | 4        | Op Code                | Constant 0xCA.  |
| 0x08   | 4        | Working Mode           | Online = 0x00<br>Offline = 0x01<br>Offline test = 0x02  |
| 0x0C   | 4        | Transaction Type       | Configuration Software monitoring transaction = 0x05.   |
| 0x10   | 1        | Scanner ID             | Scanner identification:<br>0 = master/standalone<br>1 to 3 = remote position                            |
| 0x11   | 2        | From Theta             | From Theta Angle.   |
| 0x13   | 2        | Resolution             | Angle resolution selected during the configuration phase. The value is expressed in tenths of a degree. |
| 0x15   | Variable | Additional Information | Additional information that depends on the start configuration.   |

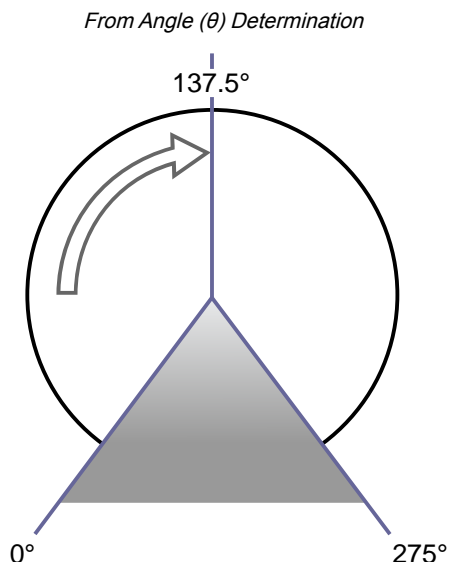
## Device Status

The device status bitmask can be decoded according to the following table:

| BIT7  | BIT6  | BIT5  | BIT4  | BIT3  | BIT2    | BIT1 | BIT0 |
|-------|-------|-------|-------|-------|---------|------|------|
| OSSD1 | OSSD2 | OSSD3 | Warn1 | Warn2 | Ref_Pts | -    | -    |

## From Theta

The following diagram shows the reference system for the **From Theta** field:

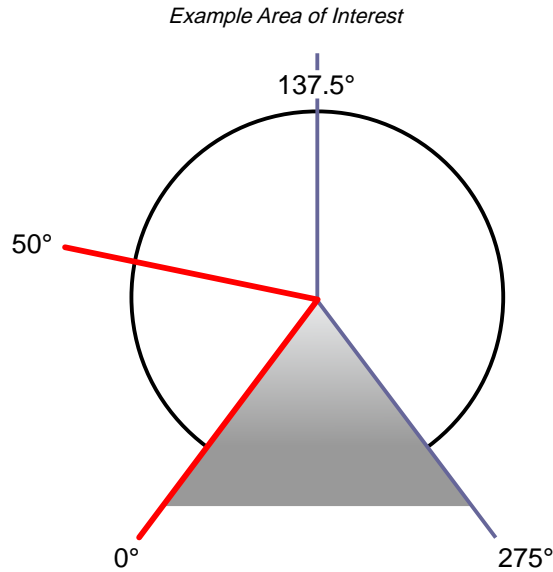


The formula to compute the angular region interested by the measures of a frame is:

$$\text{Start angle} = \text{"FromTheta"} / 10 \text{ {degrees}}$$

$$\text{End angle} = (\text{"FromTheta"} + (\text{"Resolution"} \times \text{"Number of Samples"})) / 10 \text{ {degrees}}$$

For example: A frame with "From Theta" equal to 0, "Resolution" equal to 1 and "Number of Samples" equal to 500 covers the angular region from 0 to 50°.



## Additional Information

The **Additional Information** field is variable in content and size.

It consists of a vector of the following structures

| Header ID | Header length in bytes | Payload           |
|-----------|------------------------|-------------------|
| (1 byte)  | (2 bytes)              | (variable length) |

The following tables show how the client can decode all possible structures:

| I/O Pin |        |   |
|---------|--------|---|
| ID      | Length | Payload   |
| 0x01    | 62     | Area representing the state of the cluster input and output pins (see <a href="#">"I/O Pin State" on page 15</a> ). |

| Scan Counter |        |  |
|--------------|--------|--|
| ID           | Length | Payload  |
| 0x02         | 4      | Counter indicating the number of rounds that the motor has performed since power-up. It can be used as a timestamp for the data of the same frame. |

| Zone Set |        |  |
|----------|--------|--|
| ID       | Length | Payload  |
| 0x03     | 1      | Zone set currently active on the cluster. The zone set number is 0-based (that is, "Zone Set 0" refers to the first zone set). |

| Diagnostics |        |   |
|-------------|--------|---|
| ID          | Length | Payload   |
| 0x04        | 40     | Area representing diagnostics fault errors (see <a href="#">"Diagnostics" on page 16</a> ). |

| Measures |          |   |
|----------|----------|---|
| ID       | Length   | Payload   |
| 0x05     | Variable | An array of little endian 16-bit unsigned integers representing distances in millimeters. The actual number of samples is given by Length divided by two. |

| Intensity |          |   |
|-----------|----------|---|
| ID        | Length   | Payload   |
| 0x06      | Variable | An array of 16-bit unsigned integers representing the received normalized signal intensities. The actual number of samples is given by Length divided by two. |

**NOTE:** Enabling the intensity doubles the minimum angular resolution.

**NOTE:** The two most significant bits (15 and 14) represent the channel, while the other (13 to 0) represent the intensity, as illustrated in the table below.

|                              | Byte 1  |    |             |    |    |    |   |   | Byte 2 |   |   |   |   |   |   |   |
|------------------------------|---------|----|-------------|----|----|----|---|---|--------|---|---|---|---|---|---|---|
|                              | 15      | 14 | 13          | 12 | 11 | 10 | 9 | 8 | 7      | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|                              | Channel |    | Energy Data |    |    |    |   |   |        |   |   |   |   |   |   |   |
| Diffusive                    | 0       | 0  |             |    |    |    |   |   |        |   |   |   |   |   |   |   |
| Auxiliary                    | 0       | 1  |             |    |    |    |   |   |        |   |   |   |   |   |   |   |
| Reflective                   | 1       | 0  |             |    |    |    |   |   |        |   |   |   |   |   |   |   |
| Intensity data not available | 1       | 1  |             |    |    |    |   |   |        |   |   |   |   |   |   |   |

| Encoder |        |   |
|---------|--------|---|
| ID      | Length | Payload   |
| 0x07    | 4      | Two 16-bit unsigned integers representing speeds in cm/s read from the encoders. By order is big endian. This value is expressed in cm/s. |

| Point Safety |          |   |
|--------------|----------|---|
| ID           | Length   | Payload   |
| 0x08         | Variable | A bitmask representing all points for which a measure has been requested. If the point is falling in the active safety area, then bit=1, otherwise bit=0. |

| Frame End Before Standard Length |        |  |
|----------------------------------|--------|--|
| ID                               | Length | Payload  |
| 0x09                             | 0      | Field that identifies the end of the frame (no more data available). |

**NOTE:** I/O Pin, Scan Counter, and Diagnostics messages are repeated on every frame, if active.

**NOTE:** Encapsulated messages are ordered according to their enumeration. For example, if I/O Pin and Measures are active, the message will first indicate the I/O Pin data.

## I/O Pin State

The input state area is split into two sections: physical inputs and logical inputs.

Because inputs may change at a frequency higher than the message transmission, the physical input section consists of three identical records that store the last three sets of input values. Each record is described in the following table:

| Length | Field                  | Description   |
|--------|------------------------|---|
| 4      | <i>reserved</i>        | -   |
| 10     | Physical Input Signals | Byte array representing the physical input values (see below) |

The physical input signals array can be decoded according to the following tables. Bytes from 0 to 5 are unused.

### Byte 6

| Bit7                       | Bit6                       | Bit5                       | Bit4                       | Bit3                       | Bit2                       | Bit1                       | Bit0                       |
|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Zone Set Switching Input 8 | Zone Set Switching Input 7 | Zone Set Switching Input 6 | Zone Set Switching Input 5 | Zone Set Switching Input 4 | Zone Set Switching Input 3 | Zone Set Switching Input 2 | Zone Set Switching Input 1 |

### Byte 7

| Bit7        | Bit6        | Bit5      | Bit4      | Bit3             | Bit2      | Bit1 | Bit0  |
|-------------|-------------|-----------|-----------|------------------|-----------|------|-------|
| Override 12 | Override 11 | Muting 12 | Muting 11 | Muting Enabled 1 | Restart 1 | -    | Reset |

### Byte 8

| Bit7  | Bit6        | Bit5        | Bit4      | Bit3      | Bit2            | Bit1      | Bit0  |
|-------|-------------|-------------|-----------|-----------|-----------------|-----------|-------|
| EDM 2 | Override 22 | Override 21 | Muting 22 | Muting 21 | Muting Enable 2 | Restart 2 | EDM 1 |

### Byte 9

| Bit7 | Bit6  | Bit5        | Bit4        | Bit3      | Bit2      | Bit1            | Bit0      |
|------|-------|-------------|-------------|-----------|-----------|-----------------|-----------|
| -    | EDM 3 | Override 32 | Override 31 | Muting 32 | Muting 31 | Muting Enable 3 | Restart 3 |

The logical input section is described by the following table:

| Length | Field                 | Description  |
|--------|-----------------------|--|
| 4      | <i>reserved</i>       | -  |
| 8      | Logical Input Signals | Byte array representing the physical input values. |

The output section is described by the following table:

| Length | Field           | Description                                    |
|--------|-----------------|--|
| 4      | <i>reserved</i> | -  |
| 4      | Outputs         | Bitmask representing output values (see below) |

The output bitmask can be decoded according to the following tables.

|             |             |             |                  |             |             |             |             |
|-------------|-------------|-------------|------------------|-------------|-------------|-------------|-------------|
| Bit31       | Bit30       | Bit29       | Bit28            | Bit27       | Bit26       | Bit25       | Bit24       |
| -           | -           | -           | OSSD1_REF<br>PTS | WARN2_SL 3  | WARN1_SL V3 | OSSD3_SLV 3 | OSSD2_SLV 3 |
| Bit23       | Bit22       | Bit21       | Bit20            | Bit19       | Bit18       | Bit17       | Bit16       |
| OSSD1_S LV3 | WARN2_S 2   | WARN1_S LV2 | OSSD3_S LV2      | OSSD2_S LV2 | OSSD1_S LV2 | WARN2_S LV1 | WARN1_S LV1 |
| Bit15       | Bit14       | Bit13       | Bit12            | Bit11       | Bit10       | Bit9        | Bit8        |
| OSSD3_S LV1 | OSSD2_S LV1 | OSSD1_S LV1 | WARN2_M          | WARN1_M     | OSSD3_M     | OSSD2_M     | OSSD1_M     |
| Bit7        | Bit6        | Bit5        | Bit4             | Bit3        | Bit2        | Bit1        | Bit0        |
| WARN2       | WARN1       | OSSD3_LOCK  | OSSD3            | OSSD2_LOCK  | OSSD2       | OSSD1_LOCK  | OSSD1       |

## Diagnostics

The following table shows the structure of the diagnostic payload:

| Length | Field                  | Description  |
|--------|------------------------|--|
| 4      | <i>reserved</i>        | -  |
| 36     | Diagnostic Information | Byte array representing diagnostic information (see below) |

In the diagnostic information field, each device (starting from the master) is assigned 9 bytes. Those bytes can be decoded according to the following tables, in which Bit = 1: Error; Bit = 0: No Error.

*Byte 0*

|   |  |   |                |                |                |                |                |
|---|--|---|----------------|----------------|----------------|----------------|----------------|
| Bit7                                    | Bit6   | Bit5                                      | Bit4           | Bit3           | Bit2           | Bit1           | Bit0           |
| OSSD1<br>Overcurrent /<br>Short circuit | Short circuit at<br>least between<br>two OSSDs | Integrity check<br>problem on any<br>OSSD | Internal error | Internal error | Internal error | Internal error | Internal error |

*Byte 1*

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------|------|------|------|------|------|------|------|

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|                       |                      |                 |                      |                |                |   |                                   |
|-----------------------|----------------------|-----------------|----------------------|----------------|----------------|---|-----------------------------------|
| Window cleaning alarm | Power supply problem | Network problem | Dust circuit failure | Internal error | Internal error | - | OSSD2 Overcurrent / Short circuit |
|-----------------------|----------------------|-----------------|----------------------|----------------|----------------|---|-----------------------------------|

Byte 2

| Bit7            | Bit6           | Bit5           | Bit4           | Bit3             | Bit2  | Bit1   | Bit0                    |
|-----------------|----------------|----------------|----------------|------------------|---|--|-------------------------|
| Measure problem | Internal error | Internal error | Internal error | Incoherence data | Zone: Invalid input transition or integrity | Zone: Invalid input configuration / connection | Window cleaning warning |

Byte 3

| Bit7                           | Bit6           | Bit5           | Bit4          | Bit3                          | Bit2           | Bit1           | Bit0                            |
|--------------------------------|----------------|----------------|---------------|-------------------------------|----------------|----------------|---------------------------------|
| Internal communication problem | Internal error | Internal error | Generic error | Display communication problem | Internal error | Internal error | Temperature measurement problem |

Byte 4

| Bit7                 | Bit6 | Bit5 | Bit4       | Bit3       | Bit2                | Bit1               | Bit0                    |
|----------------------|------|------|------------|------------|---------------------|--------------------|-------------------------|
| Encoder Out of Range | -    | -    | EDM2 Error | EDM1 Error | Configuration error | Out of range error | Temperature range error |

Byte 5

| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0                   |
|------|------|------|------|------|------|------|------------------------|
| -    | -    | -    | -    | -    | -    | -    | Encoder: Generic error |

Bytes 6 to 8 are not used.

**NOTE:** After the monitoring function is active, modify the configuration by sending a Stop command first, and then a new Start command with the new configuration.

## CRC Computation

The following CRC32 is used to detect accidental changes to raw data while exchanging frames between client and server.

| Parameter       | Value      |
|-----------------|------------|
|                 | 32         |
| Polynomial      | 0x04C11DB7 |
| Initial Value   | 0xFFFFFFFF |
| Final XOR Value | 0xFFFFFFFF |

### Source Code Example

```
public class CRC32
{
    private const UInt32 ORDER = 32;
    private const UInt32 TOP_BIT = 0x80000000;
    private const UInt32 TABLE_SIZE = 256;
```

```
private const UInt32 polynomial = 0x04c11db7;
public const UInt32 Initial = 0xffffffff;
private const UInt32 finalXor = 0xffffffff;
private static UInt32[] table = new UInt32[TABLE_SIZE];
private static bool isTableGenerated = false;

public CRC32()
{
    generatedTable();
}

public UInt32 compute(byte[] data)
{
    return finalize(computeIncremental(Initial, data));
}

public UInt32 computeIncremental(UInt32 crc, byte[] data)
{
    UInt32 i;
    byte b, pos;

    for (i = 0; i < data.Length; i++)
    {
        b = reflect8(data[i]);

        pos = (byte)((crc ^ (b << 24)) >> 24);
        crc = (UInt32)((crc << 8) ^ ((UInt32)table[pos]));
    }

    return crc ;
}

public UInt32 finalize(UInt32 crc)
{
    UInt32 result;

    result = reflect32(crc) ^ finalXor;
    if (result == 0xffffffff) result ^= 0x1;
    return result;
}

private static void generateTable()
{
    UInt32 bit, div, curr;

    if (isTableGenerated)
        return;

    for (div = 0; div < TABLE_SIZE; div++)
    {
        curr = div << 24;
        for (bit = 0; bit < 8; bit++)
        {
            if ((curr & TOP_BIT) != 0)
            {
                curr << 1;
                curr ^= polynomial;
            }
            else
            {
                curr <<= 1;
            }
        }

        table[div] = curr;
    }

    isTableGenerated = true;
}

private static byte reflect8(byte b)
```

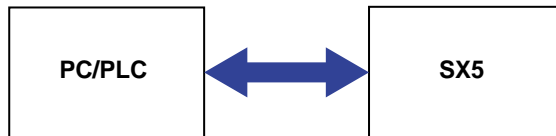
```
{
    byte r, i;
    r = 0;
    for (i = 0; i < 8; i++)
    {
        if ((b & (1 << i)) != 0) r |= ((byte)(1 << (7 - i)));
    }
    return r;
}

private static UInt32 reflect32(UInt32 b)
{
    int r, i;
    r = 0;
    for (i = 0; i < 32; i++)
    {
        if ((b & (1 << i)) != 0) r |= ((int)(1 << (31 - i)));
    }
    return (uint)r;
}
```

Chapter Contents

# Chapter 4 Data Processing Time

The time to process data from UDP command communications is as follows.



The communication time between the SX5 and other devices (that is, PLC or computer) differs depending on your communication environment.

The time elapsed from the acquisition by the SX5 of the first measure contained in a frame and the expedition of the corresponding UDP frame depends on the actual scanner and on the number of connected SX5 devices. Refer to the following table.

| Scanner ID Value | No Remote Connected | 1 Remote Connected | 2 Remote Connected | 3 Remote Connected |
|------------------|---------------------|--------------------|--------------------|--------------------|
| 0 (Master)       | 2 ms                | 2 ms               | 2 ms               | 2 ms               |
| 1 (Remote #1)    | NA                  | 30 + 2 ms          | 30 + 2 ms          | 30 + 2 ms          |
| 2 (Remote #2)    | NA                  | NA                 | 30 + 4 ms          | 30 + 4 ms          |
| 3 (Remote #3)    | NA                  | NA                 | NA                 | 30 + 6 ms          |

Chapter Contents

# Chapter 5 Distance Accuracy vs. Target Reflectivity

---

Considering a distance range from 0 mm to 5500 mm, the following table shows how distance measurement accuracy is affected by the target's reflectivity:

| Target Reflectivity | Typical Distance Error |
|---------------------|------------------------|
| 1.80%               | ± 30 mm                |
| 18%                 | ± 24 mm                |
| 90%                 | ± 21 mm                |
| 100%                | ± 12 mm                |

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# Chapter 6 Appendix

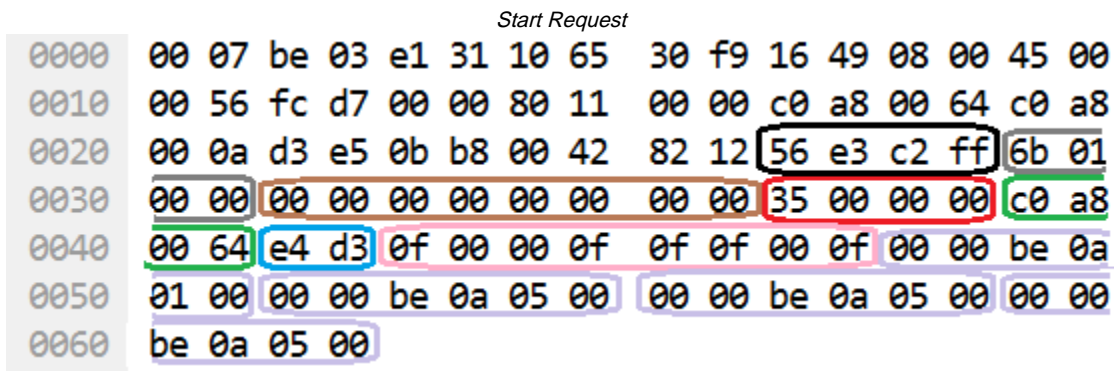
## Protocol Examples

The following examples are based on firmware version 3.1.0 and assume that the cluster is always composed of 1 Master and 3 Remote scanners.

### Monitoring Started Via the Configuration Software

#### Start Request

The following figure shows a start command request performed by the Configuration Software.



The colors used in the figure mean the following:

| Color | Description                       | Format          | Additional Information  |
|-------|-----------------------------------|-----------------|---|
| Black | CRC of the command                | Little endian   |   |
| Gray  | Sequence number                   | Little endian   |   |
| Brown | <i>reserved</i>                   | Empty/all zeros |   |
| Red   | Operation code                    | Little endian   | In this example, the operation code of 0 × 35 identifies the start command  |
| Green | IP address of the receiver client | Big endian      | In this example, the IP address is 192.168.0.100  |
| Blue  | Port number                       | Big endian      | In this example, the port number is 58579   |
| Pink  | Enabled bit                       |                 | In this example, zone set, I/O, scan counter, and diagnostics are enabled on four devices. Measures are enabled by default. |

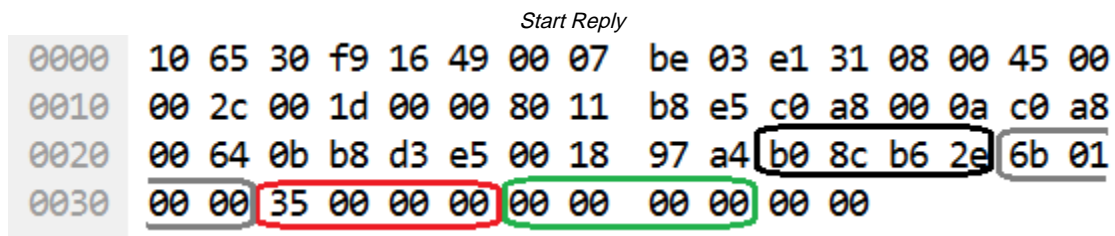
Continued on page 23

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| Color  | Description  | Format  | Additional Information |
|--------|--|---|------------------------|
| Purple | Each slot represents the start angle, stop angle, and resolution for each scanner. Each value is 2-bytes long and expressed in tenths of a degree. | Little endian: <ul style="list-style-type: none"> <li>Master (first slot): start angle is 0, stop angle is 2750 (0x0ABE), resolution is 1</li> <li>Remotes (second, third, and fourth slots): start angle is 0, stop angle is 2750, resolution is 5.</li> </ul> |                        |

### Start Reply

The following figure shows a start command response.



The colors used in the figure mean the following:

| Color | Description        | Format        | Additional Information                    |
|-------|--------------------|---------------|---|
| Black | CRC of the command | Little endian |   |
| Gray  | Sequence number    | Little endian |   |
| Red   | Operation code     | Little endian |   |
| Green | Operation result   |               | In this case, all zeros, meaning no error |

### Monitoring frame created by the Master Scanner

The Master scanner divides its 275° into six zones: five zones of 50° each and the last zone of 25°. Each zone corresponds to a different frame (the Master scanner needs a total of six frames to transfer a complete set of measures).

The following figure shows the Master frame for the first zone (0° – 50°).

Master Frame 1

|      |                         |                         |      |                         |                         |      |                         |                         |       |
|------|-------------------------|-------------------------|------|-------------------------|-------------------------|------|-------------------------|-------------------------|-------|
| 0000 | 10 65 30 f9 16 49 00 07 | be 03 e1 31 08 00 45 00 | 01d0 | 00 93 00 93 00 93 00 93 | 00 93 00 9d 00 9d 00 9d | 03a0 | 01 c3 01 c3 01 cc 01 ce | 01 ce 01 ce 01 ce 01 bf | 01 bf |
| 0010 | 04 97 00 20 00 00 00 11 | b4 77 c8 a8 00 0a c8 a8 | 01e0 | 00 92 00 9c 00 88 00 92 | 00 92 00 9e 00 88 00 92 | 03b0 | 01 bf 01 bf 01 c8 01 c9 | 01 c9 01 bf 01 c9 01 bf | 01 bf |
| 0020 | 00 64 07 d0 d3 e4 04 83 | 37 c2 00 00 00 00 ca 00 | 01f0 | 00 88 00 92 00 88 00 92 | 00 9c 00 92 00 92 00 92 | 03c0 | 01 c9 01 c9 01 c9 01 c9 | 01 d3 01 d3 01 be 01 be | 01 be |
| 0030 | 00 00 00 00 00 00 05 00 | 00 00 00 00 00 00 01 00 | 0200 | 00 92 00 9c 00 9c 00 92 | 00 92 00 9c 00 92 00 92 | 03d0 | 01 c8 01 b4 01 c8 01 be | 01 c1 01 d7 01 c4 01 b1 | 01 b1 |
| 0040 | 5f 00 32 37 39 00 00 00 | 00 00 00 00 00 00 00 00 | 0210 | 00 92 00 91 00 91 00 e1 | 00 ea 00 e0 00 e0 00 e0 | 03e0 | 01 b1 01 ea 01 e8 01 e4 | 01 e7 01 e9 01 e5 01 e7 | 01 e7 |
| 0050 | 32 38 30 00 00 00 00 00 | 00 00 00 00 00 00 32 37 | 0220 | 00 e0 00 e0 00 e9 00 e9 | 00 e0 00 e9 00 e9 00 df | 03f0 | 01 e5 01 e7 01 ed 01 f1 | 01 e4 01 ea 01 f0 01 ee | 01 ee |
| 0060 | 36 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | 0230 | 00 df 00 a5 00 e8 00 df | 00 e8 00 e8 00 e8 00 e8 | 0400 | 01 ee 01 ed 01 ef 01 f1 | 01 ee 01 ef 01 f3 01 ee | 01 ee |
| 0070 | 00 00 00 00 00 00 00 00 | 00 00 00 00 14 00 00 00 | 0240 | 00 de 00 f2 00 de 00 de | 00 de 00 de 00 e7 00 de | 0410 | 01 f9 01 ef 01 f1 01 ed | 01 f2 01 f4 01 e8 01 ea | 01 ea |
| 0080 | 02 05 00 3e 7d 00 00 03 | 02 00 00 04 29 00 00 00 | 0250 | 00 d4 00 d4 00 d3 00 fd | 00 f4 00 f4 00 ea 00 e1 | 0420 | 01 f6 01 f5 01 ef 01 f8 | 01 ed 01 f5 01 f4 01 f0 | 01 f0 |
| 0090 | 00 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | 0260 | 00 d7 00 d7 00 f7 00 fa | 00 f7 00 f8 00 f3 00 fb | 0430 | 01 f7 01 f4 01 f0 01 e6 | 01 e9 01 e6 01 ec 01 e5 | 01 e5 |
| 00a0 | 00 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | 0270 | 00 f6 00 f5 00 fe 00 f8 | 00 f3 00 f1 00 f4 00 f3 | 0440 | 01 e8 01 ed 01 eb 01 f0 | 01 f3 01 b9 01 b9 01 c3 | 01 c3 |
| 00b0 | 00 00 00 00 00 00 05 e9 | 03 be 00 be 00 c7 00 c7 | 0280 | 00 f4 00 f3 00 f4 00 f3 | 00 f5 00 f2 00 f0 00 fa | 0450 | 01 c3 01 cb 01 cb 01 b8 | 01 b8 01 c2 01 c2 01 b8 | 01 b8 |
| 00c0 | 00 c7 00 d1 00 d1 00 d1 | 00 d1 00 c7 00 d1 00 d1 | 0290 | 00 f3 00 f8 00 f4 00 f7 | 00 fb 00 f0 00 f9 00 fa | 0460 | 01 af 01 a5 01 9c 01 9c | 01 9c 01 88 01 7f 01 75 | 01 75 |
| 00d0 | 00 d1 00 c7 00 d1 00 d1 | 00 d1 00 d1 00 d1 00 da | 02a0 | 00 04 01 09 01 16 01 1d | 01 2b 01 36 01 4a 01 56 | 0470 | 01 6c 01 58 01 58 01 45 | 01 08 01 08 01 08 01 ff | 01 ff |
| 00e0 | 00 do 00 d1 00 do 00 d1 | 00 d1 00 d1 00 d1 00 do | 02b0 | 01 64 01 6d 01 77 01 81 | 01 8a 01 8f 01 96 01 99 | 0480 | 00 f3 00 f3 00 f3 00 f3 | 00 eb 00 eb 00 ea 00 ea | 00 ea |
| 00f0 | 00 d1 00 da 00 da 00 d1 | 00 da 00 d1 00 d1 00 d1 | 02c0 | 01 a5 01 9b 01 a1 01 a4 | 01 a6 01 a3 01 9e 01 a2 | 0490 | 00 f4 00 ea 00 f4 00 f4 | 00 f4 00 fe 00 fd 00 0b | 00 0b |
| 0100 | 00 da 00 da 00 e4 00 da | 00 da 00 da 00 da 00 00 | 02d0 | 01 a3 01 a4 01 a5 01 a0 | 01 a4 01 a6 01 9f 01 a3 | 04a0 | 01 09 00 00 00          |                         |       |
| 0110 | 00 da 00 89 00 89 00 88 | 00 88 00 88 00 89 00 88 | 02e0 | 01 a2 01 a0 01 9c 01 a2 | 01 9e 01 a6 01 9d 01 a7 |      |                         |                         |       |
| 0120 | 00 88 00 89 00 89 00 89 | 00 89 00 89 00 88 00 89 | 02f0 | 01 a6 01 a7 01 a7 01 ac | 01 ac 01 aa 01 a8 01 ad |      |                         |                         |       |
| 0130 | 00 93 00 89 00 89 00 88 | 00 89 00 88 00 89 00 89 | 0300 | 01 ab 01 b0 01 ad 01 a7 | 01 ac 01 ac 01 ad 01 af |      |                         |                         |       |
| 0140 | 00 93 00 88 00 89 00 89 | 00 89 00 89 00 89 00 89 | 0310 | 01 a9 01 b1 01 af 01 ab | 01 ad 01 ac 01 af 01 b0 |      |                         |                         |       |
| 0150 | 00 93 00 89 00 89 00 89 | 00 89 00 93 00 93 00 93 | 0320 | 01 ad 01 b1 01 ac 01 af | 01 ad 01 ad 01 a9 01 b7 |      |                         |                         |       |
| 0160 | 00 93 00 93 00 92 00 92 | 00 92 00 92 00 92 00 92 | 0330 | 01 b9 01 a5 01 af 01 a1 | 01 a6 01 a7 01 a8 01 ab |      |                         |                         |       |
| 0170 | 00 92 00 9c 00 9c 00 92 | 00 9c 00 92 00 92 00 9c | 0340 | 01 ae 01 d5 01 8a 01 b1 | 01 ba 01 b1 01 c4 01 ba |      |                         |                         |       |
| 0180 | 00 9c 00 92 00 92 00 92 | 00 92 00 92 00 92 00 9c | 0350 | 01 ba 01 ba 01 ba 01 ba | 01 ba 01 b1 01 a7 01 9e |      |                         |                         |       |
| 0190 | 00 9c 00 9c 00 9c 00 9b | 00 91 00 9b 00 a5 00 9b | 0360 | 01 94 01 94 01 94 01 9d | 01 94 01 94 01 9d 01 9d |      |                         |                         |       |
| 01a0 | 00 a5 00 9b 00 9b 00 9b | 00 91 00 9b 00 9b 00 a5 | 0370 | 01 9d 01 9d 01 9d 01 9d | 01 9d 01 9d 01 94 01 94 |      |                         |                         |       |
| 01b0 | 00 9b 00 93 00 9d 00 9d | 00 93 00 9d 00 9d 00 9d | 0380 | 01 94 01 c2 01 cb 01 c3 | 01 c5 01 c1 01 c1 01 89 |      |                         |                         |       |
| 01c0 | 00 9d 00 9d 00 9d 00 93 | 00 89 00 93 00 93 00 89 | 0390 | 01 9d 01 a6 01 a6 01 b9 | 01 b0 01 c3 01 c3 01 cc |      |                         |                         |       |

The colors used in the figure mean the following:

| Color  | Description  | Format        | Additional Information   |
|--------|--|---------------|--|
| Black  | Device status  | Little endian |  |
| Orange | Operation code                                       | Little endian | In this example, the operation code of 0xCA identifies a monitoring frame command  |
| Gray   | Working mode   |               |  |
| Red    | Transaction type                                     | Little endian | In this example, the transaction type is 5   |
| Yellow | Scanner ID   |               | Master is equal to zero  |
| Green  | From theta   | Little endian | Start angle of this frame  |
| Blue   | Resolution   | Little endian |  |
| Purple | Header ID  |               | See <a href="#">"Header and Payload on page 25"</a> for the list of IDs and data requested.  |
| Brown  | Payload length (+1) in bytes of the corresponding ID | Little endian | In this example, this field is 0x3F = 63. This means that 63 must be added to the current position to move to the start of the next header ID. |

The frame format does not change between zones, but the values can. In particular, 'From Theta' values change according to the start angle value of the relevant frame.

- Hex 0x0000 (decimal 0) for the first frame
- Hex 0x01F4 (decimal 500) for the second frame
- Hex 0x03E8 (decimal 1000) for the third frame
- Hex 0x05DC (decimal 1500) for the fourth frame
- Hex 0x07D0 (decimal 2000) for the fifth frame
- Hex 0x09C4 (decimal 2500) for the sixth frame



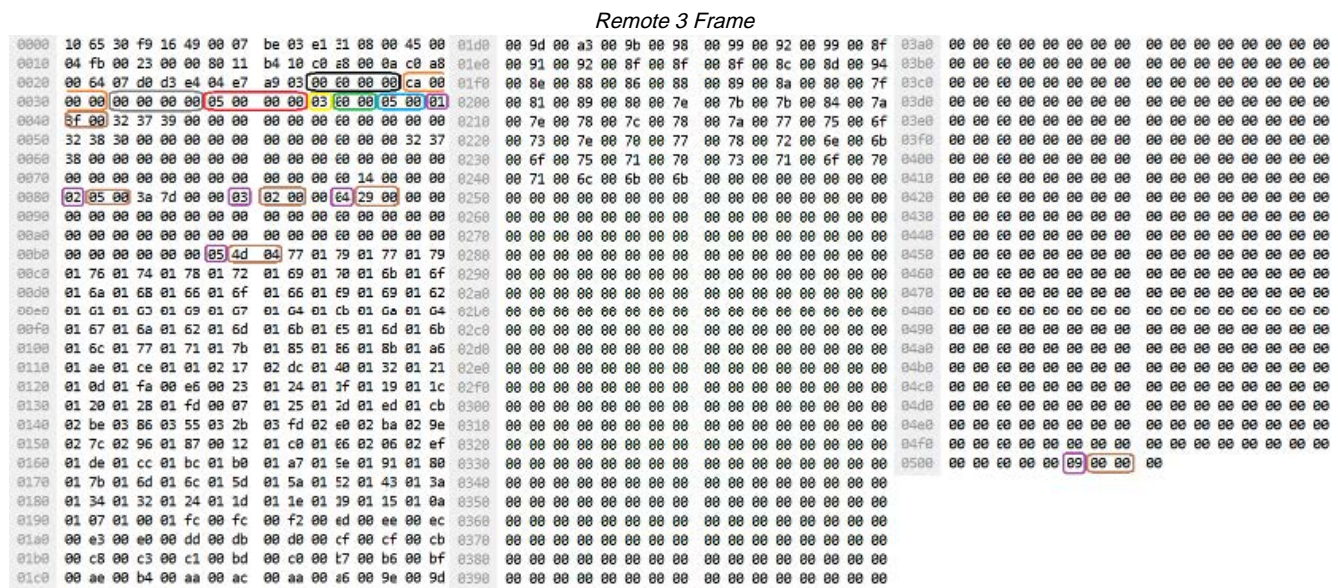
Header and Payload

| Header Value | Description  | Payload Length |
|--------------|--------------|----------------|
| 0x01         | I/O data     | 0x003F         |
| 0x02         | Scan counter | 0x0005         |
| 0x03         | Zone set     | 0x0002         |
| 0x04         | Diagnostics  | 0x0029         |
| 0x05         | Measures     | 0x039E         |
| 0x09         | End of frame | 0x0000         |

### Monitoring frame from Remote Scanner

Differing from the Master, a Remote scanner does not divide its 275° into six zones, but it can send all 275° of values through a single frame. The maximum resolution it can support is 0.5 degrees, which is why a single frame for each scan is enough to send all the data.

The following figure shows the frame of a Remote Scanner:



The colors used in the figure mean the following:

| Color  | Description      | Format        | Additional Information  |
|--------|------------------|---------------|---|
| Black  | Device status    | Little endian |   |
| Orange | Operation code   | Little endian | In this example, the operation code of 0xCA identifies a monitoring frame command |
| Gray   | Working mode     |               |   |
| Red    | Transaction type | Little endian |   |

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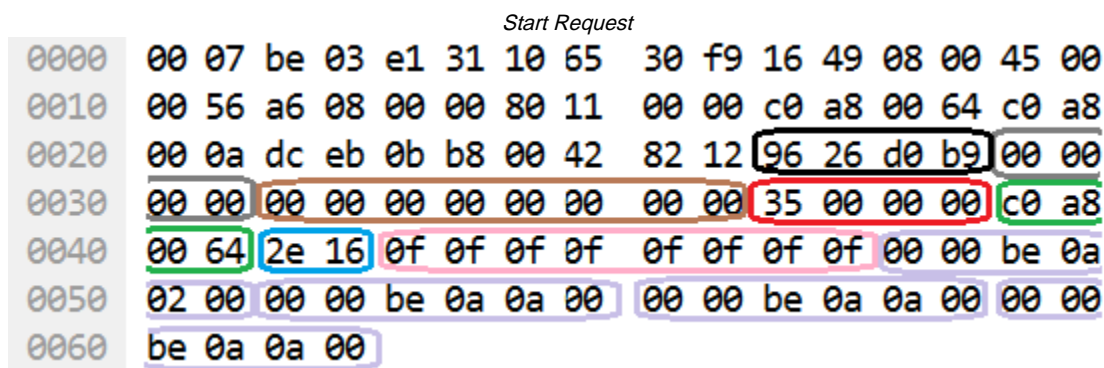
Continued from page 25

| Color  | Description                            | Format        | Additional Information   |
|--------|--|---------------|--|
| Yellow | Scanner ID                             |               | Master is equal to zero <ul style="list-style-type: none"> <li>• First Remote equal to one</li> <li>• Second Remote equal to two</li> <li>• Third remote equal to three</li> </ul> |
| Green  | From theta                             | Little endian | Start angle of this frame  |
| Blue   | Resolution                             | Little endian |  |
| Purple | Header ID                              |               | The data transferred is the same as the Master scanner, see <a href="#">"Header and Payload on page 25"</a> for the list of IDs and data requested                                 |
| Brown  | Payload length of the corresponding ID | Little endian |  |

## Full Angle Monitoring

### Start Request

The following figure shows a customer start command request.



The colors used in the figure mean the following:

| Color | Description                       | Format          | Additional Information                                  |
|-------|-----------------------------------|-----------------|---|
| Black | CRC of the command                | Little endian   |   |
| Gray  | Sequence number                   | Little endian   |   |
| Brown | <i>reserved</i>                   | Empty/all zeros |   |
| Red   | Operation code                    | Little endian   |   |
| Green | IP address of the receiver client | Big endian      |   |
| Blue  | Port number                       | Big endian      |   |
| Pink  | Enabled bit                       |                 | In this case all data types are enabled on four devices |

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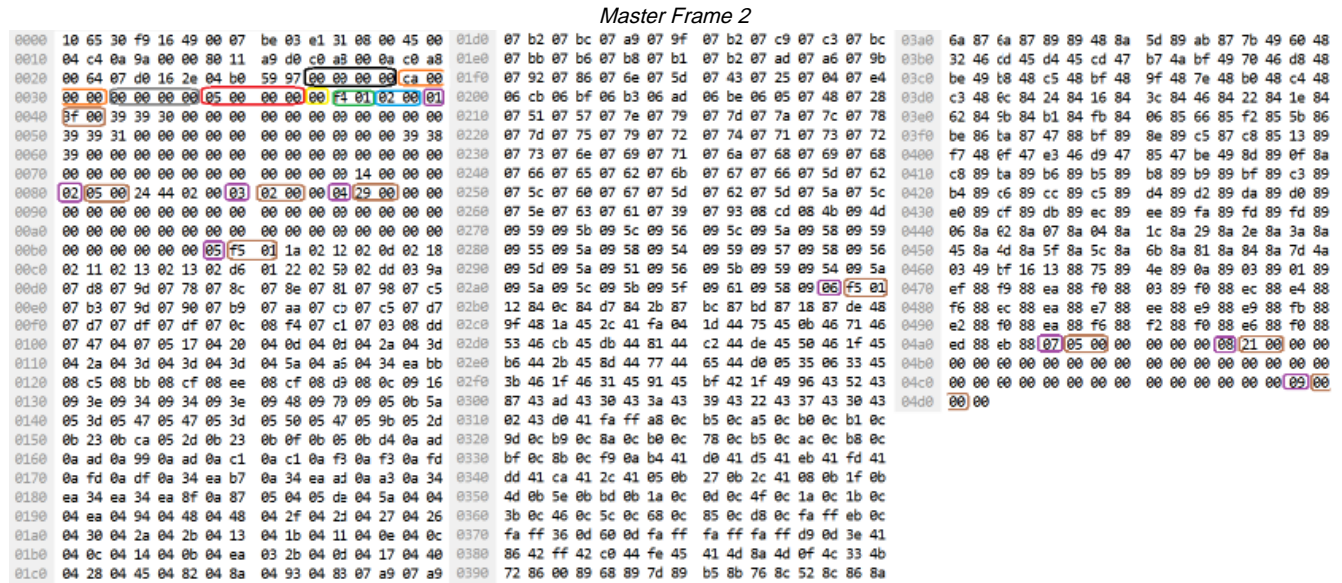
Continued from page 26

| Color  | Description  | Format  | Additional Information |
|--------|--|---|------------------------|
| Purple | Each slot represents the start angle, stop angle, and resolution for each scanner. | Each value is 2-bytes long and expressed in tenth of a degree: <ul style="list-style-type: none"> <li>Master (first slot): start angle is 0, stop angle is 2750 (0x0ABE), resolution is 2</li> <li>Remotes (second, third, and fourth slots): start angle is 0, stop angle is 2750, resolution is 10</li> </ul> |                        |

The start command response is the same as the one described in "Start Reply" on page 23.

### Monitoring Frame Created by the Master Scanner

The following figure shows the Master frame for the second zone (50° to 100°).



The colors used in the figure mean the following:

| Color  | Description       | Format        | Additional Information  |
|--------|-------------------|---------------|---|
| Black  | Device status     | Little endian |   |
| Orange | Operation code    | Little endian |   |
| Gray   | Working mode      |               |   |
| Red    | Transaction type  | Little endian |   |
| Yellow | Scanner ID        |               | Master is equal to zero   |
| Green  | From theta        | Little endian | Start angle of this frame, 0x01F4 equals 500                              |
| Blue   | Resolution (0x02) | Little endian |   |
| Purple | Header ID         |               | See "Header and Payload on page 28 for the list of IDs and data requested |

Continued on page 28



Continued from page 28

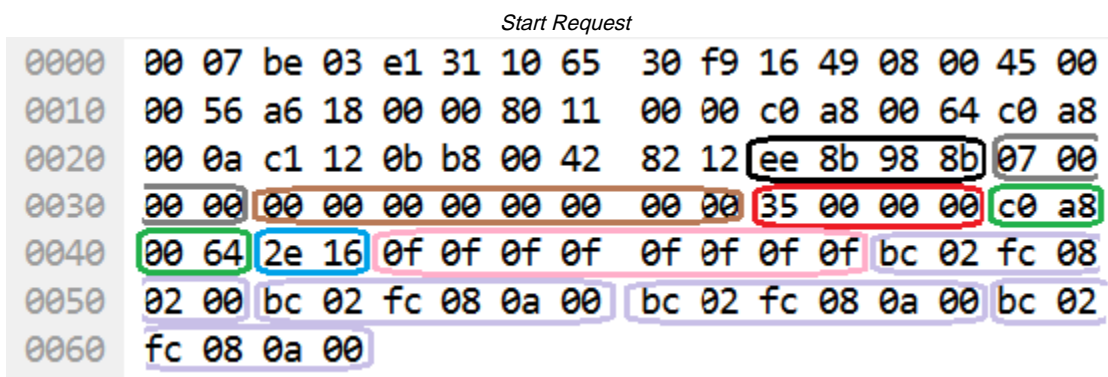
| Color  | Description                            | Format        | Additional Information   |
|--------|--|---------------|--|
| Yellow | Scanner ID                             |               | In this case the second Remote has a value equal to 0x02   |
| Green  | From theta                             | Little endian | Start angle is equal to 0x00   |
| Blue   | Resolution (0x0A)                      | Little endian |  |
| Purple | Header ID                              |               | The data transferred is the same as the Master scanner, see <a href="#">"Header and Payload on page 28"</a> for the list of IDs and data requested |
| Brown  | Payload length of the corresponding ID | Little endian |  |

## Partial Angle Monitoring

It is possible to request not only full angle data, but also partial angle data. In this example, the monitoring data request of the range 70° to 230° is analyzed.

### Start Request Customer Command

The following figure shows a customer start command request.



The colors used in the figure mean the following:

| Color | Description                       | Format          | Additional Information                                  |
|-------|-----------------------------------|-----------------|---|
| Black | CRC of the command                | Little endian   |   |
| Gray  | Sequence number                   | Little endian   |   |
| Brown | <i>reserved</i>                   | Empty/all zeros |   |
| Red   | Operation code                    | Little endian   |   |
| Green | IP address of the receiver client | Big endian      |   |
| Blue  | Port number                       | Big endian      |   |
| Pink  | Enabled bit                       |                 | In this case all data types are enabled on four devices |

Continued on page 30

Continued from page 29

| Color  | Description  | Format  | Additional Information |
|--------|--|---|------------------------|
| Purple | Each slot represents the start angle, stop angle, and resolution for each scanner. | Each value is 2-bytes long and expressed in tenth of a degree: <ul style="list-style-type: none"> <li>• Master (first slot): start angle is 700, stop angle is 2300, resolution is 2</li> <li>• Remotes (second, third, and fourth slots): start angle is 700, stop angle is 2300, resolution is 10.</li> </ul> |                        |

## Monitoring Frame created by the Master Scanner

In this case, the Master frame is received as in "[Master Frame Content on page 30](#)": the first and last frames are outside the angel range requested and all header IDs are present except for the payload of measure related data (measure, intensity and point in safety), for which the header ID length is equal to one.

The second and fifth frames contain measure related data of only a part of the sector.

The third and fourth frames contain measure data of the entire sector.

### Master Frame Content

| Frame Number | I/O Pin | Scan Counter | Zone Set | Diagnostics | Measure | Intensity | Encoder | Point in Safety |
|--------------|---------|--------------|----------|-------------|---------|-----------|---------|-----------------|
| 1            | x       | x            | x        | x           |         |           | x       |                 |
| 2            | x       | x            | x        | x           | x       | x         | x       | x               |
| 3            | x       | x            | x        | x           | x       | x         | x       | x               |
| 4            | x       | x            | x        | x           | x       | x         | x       | x               |
| 5            | x       | x            | x        | x           | x       | x         | x       | x               |
| 6            | x       | x            | x        | x           |         |           | x       |                 |

The following two figures show the Master frame for the first (0° – 50°) and sixth (250° – 275°) frames. The behavior described above is observed (only header ID highlighted in purple).

Master Frame 1

|      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 0000 | 10 | 65 | 30 | f9 | 16 | 49 | 00 | 07 | be | 03 | e1 | 31 | 08 | 00 | 45 | 00 |
| 0010 | 00 | bc | 0f | fc | 00 | 00 | 80 | 11 | a8 | 76 | c0 | a8 | 00 | 0a | c0 | a8 |
| 0020 | 00 | 64 | 07 | d0 | 16 | 2e | 00 | a8 | 5c | 69 | 00 | 00 | 00 | 00 | ca | 00 |
| 0030 | 00 | 00 | 00 | 00 | 00 | 00 | 05 | 00 | 00 | 00 | 00 | 00 | 00 | 02 | 00 | 01 |
| 0040 | 3f | 00 | 31 | 35 | 36 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 0050 | 31 | 35 | 37 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 31 | 35 |
| 0060 | 35 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 0070 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 14 | 00 | 00 | 00 |
| 0080 | 02 | 05 | 00 | af | 66 | 04 | 00 | 03 | 02 | 00 | 00 | 04 | 29 | 00 | 00 | 00 |
| 0090 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 00a0 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 00b0 | 00 | 00 | 00 | 00 | 00 | 00 | 05 | 01 | 00 | 06 | 01 | 00 | 07 | 05 | 00 | 00 |
| 00c0 | 00 | 00 | 00 | 08 | 01 | 00 | 09 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |

Master Frame 6

|      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 0000 | 10 | 65 | 30 | f9 | 16 | 49 | 00 | 07 | be | 03 | e1 | 31 | 08 | 00 | 45 | 00 |
| 0010 | 00 | bc | 10 | 02 | 00 | 00 | 80 | 11 | a8 | 70 | c0 | a8 | 00 | 0a | c0 | a8 |
| 0020 | 00 | 64 | 07 | d0 | 16 | 2e | 00 | a8 | 4f | a4 | 00 | 00 | 00 | 00 | ca | 00 |
| 0030 | 00 | 00 | 00 | 00 | 00 | 00 | 05 | 00 | 00 | 00 | 00 | c4 | 09 | 02 | 00 | 01 |
| 0040 | 3f | 00 | 31 | 35 | 36 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 0050 | 31 | 35 | 37 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 31 | 35 |
| 0060 | 38 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 0070 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 14 | 00 | 00 | 00 |
| 0080 | 02 | 05 | 00 | b0 | 66 | 04 | 00 | 03 | 02 | 00 | 00 | 04 | 29 | 00 | 00 | 00 |
| 0090 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 00a0 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 00b0 | 00 | 00 | 00 | 00 | 00 | 00 | 05 | 01 | 00 | 06 | 01 | 00 | 07 | 05 | 00 | 00 |
| 00c0 | 00 | 00 | 00 | 08 | 01 | 00 | 09 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |

The following figure shows the second frame (50°–100°), where the data requested corresponds to a part of the sector. The start angle is not 500, but 700.

Master Frame 2

|      |                         |                         |      |                         |                         |
|------|-------------------------|-------------------------|------|-------------------------|-------------------------|
| 0000 | 10 65 30 f9 16 49 00 07 | be 03 e1 31 08 00 45 00 | 01d0 | 09 59 09 56 09 59 09 55 | 09 51 09 5d 09 5f 09 62 |
| 0010 | 03 27 0f fd 00 00 80 11 | a6 0a c0 a8 00 0a c0 a8 | 01e0 | 09 5c 09 5d 09 06 2d 01 | fa ff fa ff d7 0d 87 0d |
| 0020 | 00 64 07 d0 16 2e 03 13 | 06 b4 00 00 00 00 ca 00 | 01f0 | 55 42 05 43 9c 44 42 4d | 14 46 7b 4d 45 4c 70 4b |
| 0030 | 00 00 00 00 00 05 00 00 | 00 00 00 bc 02 02 00 01 | 0200 | 37 86 df 88 9b 89 7a 89 | 68 8b 81 8c 6b 8c ca 8a |
| 0040 | 3f 00 31 35 36 00 00 00 | 00 00 00 00 00 00 00 00 | 0210 | 71 87 1c 87 57 89 5b 8a | 87 89 d3 87 9b 49 83 48 |
| 0050 | 31 35 37 00 00 00 00 00 | 00 00 00 00 00 00 31 35 | 0220 | 5c 46 dc 45 dc 45 20 47 | c6 4a 26 4a 7b 46 d3 48 |
| 0060 | 35 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | 0230 | a0 49 2c 49 c5 48 d0 48 | 9e 48 90 48 b8 48 d1 48 |
| 0070 | 00 00 00 00 00 00 00 00 | 00 00 00 00 14 00 00 00 | 0240 | ce 48 cd 48 11 84 27 84 | 09 84 29 84 2a 84 16 84 |
| 0080 | 02 05 00 af 66 04 00 03 | 02 00 00 04 29 00 00 00 | 0250 | 44 84 8e 84 8e 84 d9 84 | 03 85 62 85 dd 85 48 86 |
| 0090 | 00 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | 0260 | 88 86 c3 87 3a 88 b9 89 | 8e 89 15 88 19 85 27 89 |
| 00a0 | 00 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | 0270 | 63 49 52 47 e9 46 e3 47 | 63 47 3a 49 5d 89 09 8a |
| 00b0 | 00 00 00 00 00 05 2d    | 01 34 ea 34 ea 7b 0a c1 | 0280 | b6 89 b1 89 b8 89 ad 89 | b4 89 bf 89 b0 89 b4 89 |
| 00c0 | 0a 17 05 d4 04 63 04 ea | 04 0d 04 94 04 48 04 35 | 0290 | b7 89 cb 89 cf 89 c4 89 | ce 89 d0 89 ce 89 cd 89 |
| 00d0 | 04 2e 04 2a 04 23 04 23 | 04 31 04 2b 04 27 04 10 | 02a0 | d3 89 e7 89 e4 89 e0 89 | ec 89 fa 89 f1 89 f5 89 |
| 00e0 | 04 22 04 11 04 0e 04 06 | 04 0c 04 0c 04 f8 03 e1 | 02b0 | fc 89 ff 89 08 8a 04 8a | 1d 8a 21 8a 25 8a 3f 8a |
| 00f0 | 03 22 04 04 04 17 04 35 | 04 1e 04 28 04 78 04 8f | 02c0 | 48 8a 54 8a 4d 8a 59 8a | 65 8a 82 8a 8e 8a 4d 4b |
| 0100 | 04 93 04 fc 06 b2 07 9f | 07 b2 07 b2 07 a9 07 a9 | 02d0 | 0a 49 6e 16 af 14 54 89 | 5f 89 17 89 fc 88 f9 88 |
| 0110 | 07 a9 07 9f 07 c3 07 bf | 07 bc 07 b9 07 bd 07 ba | 02e0 | f9 88 e9 88 ea 88 ee 88 | ef 88 f1 88 ec 88 eb 88 |
| 0120 | 07 b4 07 aa 07 a3 07 99 | 07 91 07 80 07 76 07 62 | 02f0 | f2 88 e7 88 e2 88 f9 88 | ef 88 ed 88 f0 88 ec 88 |
| 0130 | 07 4b 07 1f 07 04 07 e5 | 06 d0 06 c2 06 bc 06 b4 | 0300 | ee 88 ed 88 dd 88 f1 88 | fe 88 e6 88 e8 88 e7 88 |
| 0140 | 06 ab 06 df 06 3e 07 28 | 07 51 07 6b 07 7f 07 7c | 0310 | e4 88 eb 88 07 05 00 00 | 00 00 00 08 14 00 00 00 |
| 0150 | 07 7e 07 79 07 7b 07 7a | 07 74 07 77 07 71 07 75 | 0320 | 00 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 |
| 0160 | 07 6f 07 6e 07 65 07 6e | 07 6f 07 6e 07 6f 07 6a | 0330 | 00 09 00 00 00          |                         |
| 0170 | 07 6b 07 63 07 68 07 67 | 07 66 07 61 07 67 07 62 |      |                         |                         |
| 0180 | 07 5e 07 65 07 5f 07 5a | 07 60 07 5f 07 60 07 5d |      |                         |                         |
| 0190 | 07 61 07 58 07 62 07 5c | 07 5d 07 58 07 5d 07 13 |      |                         |                         |
| 01a0 | 07 76 08 ae 08 2a 09 48 | 09 57 09 57 09 59 09 59 |      |                         |                         |
| 01b0 | 09 57 09 57 09 5a 09 5b | 09 55 09 58 09 53 09 58 |      |                         |                         |
| 01c0 | 09 59 09 5b 09 55 09 51 | 09 5a 09 50 09 59 09 59 |      |                         |                         |



## Monitoring frame from the Remote Scanner

The following figure shows the Remote 1 frame. The start angle is not zero but 700.

*Remote 1 Frame*

```

0000 10 65 30 f9 16 49 00 07 be 03 e1 31 08 00 45 00 01d0 00 d7 00 7f 01 36 ea 36 ea e1 01 ba 01 a6 01 b0
0010 03 50 10 04 00 00 80 11 a5 da c0 a8 00 0a c0 a8 01e0 01 09 02 34 ea 34 ea 34 ea ea ed 01 30
0020 00 64 07 d0 16 2e 03 3c 93 0f 00 00 00 00 ca 00 01f0 01 e2 00 d8 00 dc 00 86 00 06 41 01 fa ff fa ff
0030 0f 00 00 00 00 00 05 00 00 00 01 bc 02 0a 00 01 0200 fa ff 21 44 96 42 5a 44 a0 44 83 43 50 41 fa ff
0040 3f 00 31 35 39 00 00 00 00 00 00 00 00 00 00 00 0210 fa ff 19 04 c8 03 2c 41 ee 41 63 43 0e 43 9c 88
0050 31 35 37 00 00 00 00 00 00 00 00 00 00 00 00 31 35 0220 9b 47 dd 47 b6 88 e9 88 04 89 26 89 4a 89 5f 89
0060 38 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0230 8a 89 5a 48 81 88 9e 88 95 88 92 88 8f 88 97 88
0070 00 00 00 00 00 00 00 00 00 00 00 00 14 00 00 00 0240 88 88 94 88 96 88 89 88 8e 88 89 88 78 88 7d 88
0080 02 05 00 93 66 04 00 03 02 00 00 04 29 00 00 00 0250 66 88 63 88 68 88 5d 88 7c 88 1a 86 61 86 5a 88
0090 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0260 40 46 61 88 a8 87 f7 86 12 87 69 87 9f 87 d2 87
00a0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0270 fe 87 3b 88 72 88 94 88 a6 88 b7 88 06 89 57 89
00b0 00 00 00 00 00 00 05 41 01 34 ea 34 ea 34 ea cf 0280 6d 89 ea 85 2f 89 4f 89 93 89 98 89 57 89 ec 89
00c0 00 4b 01 59 00 61 00 14 01 bf 01 34 ea 34 ea 61 0290 47 89 4b 89 c3 89 e0 89 9c 89 02 8a 0a 8a 1e 8a
00d0 08 92 08 f9 01 8d 01 09 01 2a 01 34 07 08 07 23 02a0 5b 8a 4b 8a 0b 8a d6 89 51 89 4f 8a ef 89 29 8a
00e0 08 d6 07 d3 07 c5 07 c6 07 b8 07 b6 07 b1 07 f7 02b0 7d 8a 82 8a 42 8a f5 89 e6 89 45 8a 54 8a 55 8a
00f0 07 9a 09 a9 09 ac 09 aa 09 a4 09 b2 09 a6 09 a5 02c0 56 8a 47 8a 2c 8a 48 8a 49 8a 8f 89 e8 89 b6 89
0100 09 ab 09 ae 09 b2 09 b9 09 bd 09 c8 09 cc 09 d1 02d0 e6 89 e4 89 8b 89 8c 89 ba 89 c5 89 d5 89 d4 89
0110 09 dc 09 da 09 9c 06 62 06 1d 06 e9 05 0a 06 14 02e0 87 89 68 89 f0 89 02 8a f6 89 f1 89 f5 89 ea 89
0120 06 f2 06 b1 06 70 06 22 06 e9 05 aa 05 6f 05 42 02f0 ea 89 c7 89 77 89 a6 88 0e 87 74 48 7c 47 7e 48
0130 05 20 05 f4 04 d1 04 b0 04 8c 04 6b 04 50 04 45 0300 c9 85 7b 48 0a 46 f6 45 1e 46 69 46 fa 44 ac 44
0140 04 19 04 ff 03 ef 03 cd 03 b6 03 a6 03 9b 03 7f 0310 e6 44 f0 43 e6 43 b6 41 65 03 40 02 2c 41 2c 41
0150 03 6e 03 65 03 51 03 3e 03 33 03 25 03 26 03 1a 0320 49 41 2f 41 2c 41 fa ff fa ff fa ff fa ff fa ff
0160 03 0a 03 08 03 b5 02 a9 02 ad 02 b7 02 c9 02 ca 0330 2c 41 ef 42 81 44 06 46 e2 47 5e 48 07 05 00 00
0170 02 c1 02 bc 02 86 02 7f 02 7a 02 6f 02 70 02 6c 0340 00 00 00 08 15 00 00 00 00 00 00 04 70 ee 07 00
0180 02 67 02 68 02 60 02 80 02 78 02 79 02 6f 02 75 0350 00 00 00 00 00 00 00 00 00 00 00 09 00 00 00
0190 02 64 02 4b 02 4a 02 4a 02 45 02 4a 02 51 02 67
01a0 02 69 02 68 02 6e 02 6d 02 70 02 71 02 70 02 74
01b0 02 71 02 76 02 7c 02 fc 01 ef 01 f3 01 87 02 0f
01c0 02 c2 01 2e 01 cb 00 9a 00 cc 00 c2 00 c3 00 fe

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Chapter Contents

# Chapter 7 Contact Us

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Banner Engineering Corp. headquarters is located at: 9714 Tenth Avenue North | Plymouth, MN 55441, USA | Phone: + 1 888 373 6767

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