RS-485 Protocol frame

PosCon OXE7 – Edge measurement in a new dimension

Contents

1 Protocol frame

1.1 Basic Principle

- The host is sending a command to the sensor.
- The sensor answers either with the identical command (if it was e.g. a setup command) or with the requested data or the result of an action.
- The address, with which the sensor answers, is always the sensor address.
- The address 0 is reserved as broadcast address. Address 0 is also used to ask a sensor for its address.
- [1]) The maximum number of addresses may be different for different sensors. It depends on the power of the line driver and the loads.
- Invalid values are displayed as 9999.99
- Note: some commands will be used by all sensors, but they will not be identical. E.g. set range will be different for OXP7 and OM70D type. OM70D type will not have left and right limit.
- Sensor settings, which have been changed by a command, are volatile until they have been saved as the working configuration in the sensors nonvolatile memory by an additional command.

1.2 General

Name	Number of Bits
Start Bits	1
Stop Bits	1
Length of data String	8
Parity	none

1.3 Framing

The outer frame of a command always is SOF and EOF
All entries expect the first and the last are separated by a comma on both sides
All data are ACII data
But there are exceptions to the ASCII rule.

From Host to Sensor	
Start of Frame (SOF)	{
Address	1..n [1])
Separator	","
Command	0..999
Separator	","
Data	ASCII, separated by ","
Separator	","
Checksum	3 Char
End of Frame (EOF)	}

From Sensor to Host	
Start of Frame (SOF)	{
Address	1..n [1])
Separator	","
Command	000..999
Separator	","
Data	ASCII, separated by ","
Separator	","
Checksum	3 Char
End of Frame (EOF)	}

1.4 Checksum

The checksum (CS) is the XOR of the values of all characters including frame and commas up to and including the last comma before the checksum. It is a decimal number from 000 to 255. Leading zeroes are transferred. It will be transferred as a decimal number always with 3 digits.

Checksum Sample

	ASCII Char	Value (Hex)	Checksum calculation (HEX)	Remarks
Start of Frame (SOF)	{	7B	7B	
Address	1	31	(7B) XOR (31) = 4A	Address = 1
Separator	,	2C	(4A) XOR (2C) = 66	
Command	0 1 0	30 31 30	(66) XOR (30) = 56 (56) XOR (31) = 67 (67) XOR (30) = 57	Always 3 Char Set Baud Rate
Separator	,	2C	(57) XOR (2C) = 7B	
Data	2	32	(7B) XOR (32) = 49	2 = 115200 Baud
Separator	,	2C	(49) XOR (2C) = 65	65_H = **101_D**
Checksum	**1** **0**	31 30		Always 3 Char

	1	31		
End of Frame (EOF)	}	-		

1.5 Error Handling

Errors will only be returned, if the address and the core of framing was correct.

From Sensor to Host	
Start of Frame (SOF)	{
Address	1..n [1])
Separator	","
Command	000..999
Separator	","
Error Flag	"E"
Separator	","
Error Number	000..999
Separator	","
Checksum	3 Char
End of Frame (EOF)	}

If there are more than one error in one command, the sensor will return the error number of the first error.

Communication Error #	Description
001	False checksum
002	False command
003	False frame
004	False value or parameter
005	Missed command 000, “RS-485 CONTROLS THE SENSOR”
006	Out of range
007	Buffer overflow
100	Distance out of Range (see FSP)
101	Angle out of Range (see FSP)
102	Flatness out of Range (see FSP)
103	Length out of Range (see FSP)
200	Fatal Error (Reset sensor, Power Off / On)

1.6 There are 3 different kinds of sensor configurations

1. **Factory configuration**: It is stored in the sensor and cannot be changed by the user.

2. **Temporary configuration**: It is part of a configuration changed by command. The modification is of immediate effect. But it is not saved in the sensor's nonvolatile memory. Temporary configurations are lost after power-down.

3. **Working configuration**: It must be stored in Setting 0 of the sensor's nonvolatile memory by command and is automatically used when power is applied.

   The working configuration procedure:
   First select the required values by configuration commands. **All configurations are still temporary!** If you want the configuration for further use, it must be store as the working configuration by this command 001. Only with this command, the configuration is stored in a non-volatile memory. After power up no new configuration is required the sensor use automatic the Setting 0.

   Also all this command must be stored:
   - Set FLEX MOUNT Numeric
   - Activate FLEX MOUNT
   - Deactivate FLEX MOUNT
   - RESET to FACTORY SETTINGS
   - APPLY SETTINGS
   - …

   The only exception is. It must not be stored extra:
   - Set SETTING 0 for DUPLICATING

2 Commands

In each chapter, the structure of every command will be documented and explained with an example.

2.1 Command 000 “RS-485 CONTROLS THE SENSOR”

Host: {Address, Command, RS-485 Controls the sensor, Checksum}
Sensor: {Address, Command, RS-485 Controls the sensor, Checksum}

The configurations of the OXE7 can be made on two ways:

- Via Display
- Via RS-485

For an unambiguous control of the sensor, only one way is allowed! If the RS-485 is used, the first command **must** be the lock command “RS-485 Controls the sensor”. This command cannot be saved.
With this command “RS-485 Controls the sensor” = 1:

- NO changes are possible via display.
- Analogous voltage output = 0V, Analogous current output = 4mA
- Switch-out = low
- Alarm-out = high (Remark: Low suggests all is ok)

To change the configuration between RS485 and display, the host must send the unlock command. After this command, the customer can use the sensor by display and all outputs are unlocked.

Number	Function	Remark
1	lock	NO changes are possible via display. Analogous voltage output = 0V, Analogous current output = 4mA Switch-out = low Alarm-out = high (Remark: Low suggests all is ok)
0	unlock	

If the sensor is not in mode “RS-485 CONTROLS THE SENSOR” and the sensor receives another command it will return the error number (005). See chapter 1.5 Error handling.

Example: Address = 1

Host	Sensor	Comment
{1,000,1,xxx}	{1,000,1,xxx}	locked = RS-485 controls the sensor

2.2 Command 001 “STORE in SETTINGS”

ALL changes in the sensor configuration are temporary and are at first only stored in volatile memory. They will be lost after power OFF/ON!
If you want a configuration for further use, it **must** be stored as the working configuration by this command 001. With this command the configuration is being stored in non-volatile memory. After power on the sensor will automatically us the **Setting 0**.
Details see in the specification of display menu “20140218_DisplayOperation_3_xx”.

Host: {Address, Command, Setting Number, Checksum}
Sensor: {Address, Command, Setting Number, Checksum}

Number	Function	Remarks
0	Setting 0	Power on setting / working configuration
1	Setting 1	
2	Setting 2	
3	Setting 3	

Example: Address = 1, Setting 3

Host	Sensor	Comment
{1,001,3,xxx}	{1,001,3,xxx}	Actual configurations stored in "Setting 3"

2.3 Command 002 "APPLY SETTINGS"

Host: {Address, Command, Setting Number, Checksum}
Sensor: {Address, Command, Setting Number, Checksum}

With this command, the stored Setting 1, Setting 2 or Setting 3 will be applied as working configuration (Setting 0). Details see in the specification of display menu "20140218_DisplayOperation_3_xx".

Number	Function
1	Setting 1
2	Setting 2
3	Setting 3

Example: Address = 1, Setting 2

Host	Sensor	Comment
{1,002,2, xxx}	{1,002,2,xxx}	Apply the stored "Setting 2" as actual configuration

Just like with any other configuration,if this configuration shall be used as standard after the next power up, it must be stored with the command "Save Configuration in SETTING" in Setting 0.
Also this command must be stored!

2.4 Command 003 "RESET to FACTORY SETTINGS"

Host: {Address, Command, Checksum}
Sensor: {Address, Command, Checksum}

First, the sensor sends the response and then it reboot.
All parameters are reset to factory configurations. See FSP chapter 4.4.1.9.

Example: Address = 1

Host	Sensor	Comment
{1,003,xxx}	{1,003,xxx}	Reset to factory configuration

2.5 Command 010 “Set BAUD RATE”

Host: {Address, Command, Baud Rate, Checksum}
Sensor: {Address, Command, Baud Rate, Checksum}

Number	Function
0	38’400
1	57’600
2	115’200

Example: Address = 1, Baud Rate 2

Host	Sensor	Comment
{1,010,2,xxx}	{1,010,2,xxx}	Baud Rate at 115’200 Answer with old Baud Rate

2.6 Command 012 “Set ADDRESS”

Host: {Current Address, Command, New Address, Checksum}
Sensor: {Current Address, Command, New Address, Checksum}

Details see in FSP chapter 4.5.1.6

Example: Old Address = 1, New address = 2

Host	Sensor	Comment
{1,012,2,xxx}	{1,012,2,xxx}	

2.7 Command 013 “Get ADDRESS”

Host: {Broadcast Address, Command, Checksum}
Sensor: {Broadcast Address, Command, Address, Checksum}

Details see in FSP chapter 4.5.1.6

Example: Broadcast Address = 0

Host	Sensor	Comment
{0,013,xxx}	{0,013,1,xxx}	Address = 1

Remarks: The address 0 is reserved as broadcast address. Address 0 is used to ask a sensor for its address. In this mode only **one** sensor may be connected to the host. Otherwise this will result in a bus conflict.

2.8 Command 020 “Set MEASUREMENT TYPE”

This command selects the “Measurement Type”. The selected “Measurement Type” will be used for all outputs (Analog-Out, Digital-Out, LED’s).

Host: {Address, Command, Measurement Type, Checksum}

Sensor: {Address, Command, Measurement Type, Checksum}

Number	FUNCTION	MEASURE TYPE
0	Edge	Edge L rise
1	Edge	Edge L fall
2	Edge	Edge R rise
3	Edge	Edge R fall
4	Width	Width
5	Width	Center width
6	Gap	Gap
7	Gap	Center gap

Example: Address = 1, Measurement Type 6

Host	Sensor	Comment
{1,020,6,xxx}	{1,020,6,xxx}	Gap

2.9 Command 031 “Get MEASUREMENT”

Host: {Address, Command, Checksum}
Sensor: {Address, Command, Get Measurement, Quality, Checksum}

With this command the sensor will return the value of the measurement type that was previously selected by the command “Set Measurement Type” and his quality.

Number	Quality of the measurement value
0	“Valid”
1	„Low Signal“: See FSP DF10.070
2	„No Edge“: See FSP DF10.070
3	„Low Signal, No Edge“: See FSP DF10.070
4	“No Signal”: See FSP DF10.070

Example: Address = 1, Valid = 0

Host	Sensor	Comment
{1,031,xxx}	{1,031,100.64,0,xxx}	Value = 100.64 mm Quality of the measurement value is “Valid”

2.10 Command 040 “Set PRECISION”

Precision means: Filter behavior on all output signals. Details see in FSP chapter 4.4.1.11

Host: {Address, Command, Precision, Checksum}
Sensor: {Address, Command, Precision, Checksum}

Function Number	Function Name	Function Values
0	Standard	Median = off, Moving Average = off
1	High	Median = 7, Moving Average = 16
2	Very High	Median = 15, Moving Average = 128

Example: Address = 1, Precision High

Host	Sensor	Comment
{1,040,1,xxx}	{1,040,1,xxx}	Precision High (Median = 7, Moving Average = 16)

2.11 Command 042 “Set EDGE HEIGHT”

Host: {Address, Command, Height, Checksum}
Sensor: {Address, Command, Height, Checksum}

This command sets the minimum height of an edge that must be detected. Height is a global variable, if it is changed, then it changes for ALL three different measuring functions:

EDGE: EDGE HEIGHT
WIDTH: OBJ HEIGHT
GAP: GAP DEPTH

Details see in FSP chapter 4.2.2.3.

Example: Address = 1, Edge Height 4mm

Host	Sensor	Comment
{1,042,4,xxx}	{1,042,4,xxx}	Edge Height 4mm

2.12 Command 044 “Set OBJECT”

Host: {Address, Command, Bright/Dark Object, Checksum}
Sensor: {Address, Command, Bright/Dark Object, Checksum}

This command sets the duration of the laser pulse and shutter time. A longer laser pulse results in higher sensitivity to dark objects and the time for measurement is increased. Details see in FSP chapter 4.2.3

Number	Function
0	Bright Object
1	Dark Object

Example: Address = 1, Bright Object

Host	Sensor	Comment
{1,044,0,xxx}	{1,044,0,xxx}	Bright Object

2.13 Command 050 “Set FIELD OF VIEW”

Host: {Address, Command, Limit left, Limit right, Offset, Checksum}
Sensor: {Address, Command, Limit left, Limit right, Offset, Checksum}

With “Field of View” the sensor can change his measuring field. Details see in FSP chapter 4.2.1.1.

Example: Address = 1,

Host	Sensor	Comment
{1,050,-37,37,15,xxx}	{1,050,-37,37,15,xxx}	Limit left = -37 Limit right = 37 Offset = 15

2.14 Command 054 “Set FIELD OF VIEW, Auto”

Host: {Address, Command, Height, Checksum}
Sensor: {Address, Command, Height, Width, Checksum}

With this command we can preselect the height of the rectangle in field of view. The sensor calculates the maximum width of the rectangle in field of view and send it back.
Error handling, see chapter 1.5. Limits see FSP chapter 4.2.1.1.

Example: Address = 1, Height = 47mm

Host	Sensor	Comment
{1,054,47,xxx}	{1,054,47,95,xxx}	Height = 47mm Width = 95mm

2.15 Command 058 “Set FIELD OF VIEW, Set max Values”

Host: {Address, Command, Checksum}
Sensor: {Address, Command, LIMIT LEFT, LIMIT RIGHT, OFFSET, Checksum}

Set FIELD OF VIEW to max Values. Limits see FSP chapter 4.2.1.1.

Example: Address = 1, FIELD OF VIEW Set to max Values

Host	Sensor	Comment
{1,058,xxx}	{1,058,-63,63,0,xxx}	LIMIT LEFT = -63 mm LIMIT RIGHT = 63 mm OFFSET = 0 mm

2.16 Command 060 “Set FLEX MOUNT Numeric”

Host: {Address, Command, Angle, Distance, Checksum}
Sensor: {Address, Command, Angle, Distance, Checksum}

The wording “FLEX MOUNT” is a marketing name. It means that the sensor angle and distance can teached by a reference object. Limitations see FSP chapter 4.2.1.3

Example: Address = 1

Host	Sensor	Comment
{1,060,-15.2,202,xxx}	{1,060,-15.2,202,xxx}	Angle = -15.2° Distance = 202mm

2.17 Command 062 “Activate FLEX MOUNT”

Host: {Address, Command, Reference thickness, Checksum}
Sensor: {Address, Command, Reference thickness, Angle, Distance, Checksum}

The wording “FLEX MOUNT” is a marketing name. It means that the sensor angle and distance can teached by a reference object.

To activate the FLEX MOUNT, all four of these measured values must be inside their limits.

Value	Error Number
Distance out of Range	See chapter 1.5 Error handling.
Angle out of Range	See chapter 1.5 Error handling.
Flatness out of Range	See chapter 1.5 Error handling.
Length out of Range	See chapter 1.5 Error handling.

If one value is outside its limits, the sensor will return the error number and the FLEX MOUNT is NOT activated. See FSP chapter 4.2.1.3

Example: Address = 1

Host	Sensor	Comment
{1,062,11,xxx}	{1,062,11,-15.2, 202,xxx}	Reference thickness = 11mm Angle = -15.2° Distance = 202mm FLEX MOUNT is activated

2.18 Command 063 “Deactivate FLEX MOUNT”

Host: {Address, Command, Checksum}
Sensor: {Address, Command, Checksum}

The wording “FLEX MOUNT” is a marketing name. It means that the sensor angle and distance can teached by a reference object. Descriptions see in the FSP.
By deactivating the FLEX MOUNT, the sensor will return to the factory configuration. See FSP chapter 4.4.1.9.

Example: Address = 1

Host	Sensor	Comment
{1,063,xxx}	{1,063,xxx}	FLEX MOUNT is deactivated

The FLEX MOUNT settings will be reset to factory configuration. See FSP chapter 4.4.1.9.

2.19 Command 070 “Set DIGITAL OUT”

Host: {Address, Command, Type, Switch Point 1, Switch Point 2, Polarity, Checksum}
Sensor: {Address, Command, Type, Switch Point 1, Switch Point 2, Polarity, Checksum}

The senor has two types of digital outputs:

- Point (there is only one value to compare with the measured value.
- Window (therer are two values, which define a window to be compared with the measured value.)

This command defines the complete configuration.

Details see in FSP chapter 4.4.1.12
Type

Number	Type
0	Point
1	Window

Number	Polarity
0	Active high
1	Active low

Example: Address = 1, Point

Host	Sensor	Comment
{1,070,0,-35,-35,1,xxx}	{1,070,0,-35,xx,1,xxx}	Switch Point = -35mm, Active low

At the type “Point”, the “Switch Point 2” can be any value.

Example: Address = 1, Window

Host	Sensor	Comment
{1,070,1,-35,20,0,xxx}	{1,070,1,-35,20,0,xxx}	Switch Point 1= -35mm Switch Point 2= 20mm Active high

2.20 Command 080 “Set LANGUAGE”

Host: {Address, Command, Language, Checksum}
Sensor: {Address, Command, Language, Checksum}

Details see in the specification of display menu “20140218_DisplayOperation_3_xx”.

Number	Function
0	English
1	German
2	Italian
3	French

Example: Address = 1, Language English

Host	Sensor	Comment
{1,080,0,xxx}	{1,080,0,xxx}	Language English

2.21 Command 082 “Set DISPLAY BACKLIGHT”

Host: {Address, Command, Display Light, Checksum}
Sensor: {Address, Command, Display Light, Checksum}

This command sets the time when the backlight is on.
Details see in the specification of display menu “20140218_DisplayOperation_3_xx”.

Number	Function
0	OFF after 5 min
1	OFF after 10 min
2	OFF after 20 min
3	Always ON

Example: Address = 1, Display Light Always ON

Host	Sensor	Comment
{1,082,3,xxx}	{1,082,3,xxx}	Display Light Always ON

2.22 Command 084 “Lock/Unlock TOUCH BUTTONS”

Host: {Address, Command, Touch Button, Checksum}
Sensor: {Address, Command, Touch Button, Checksum}

On the display we had four touch buttons. With this command the buttons can be locked or unlocked.

Number	Function	Remark
1	lock	Display: The distance value appears on the display. If one of the four buttons is activated, then the message: “RS-485 locked the touch buttons” will appear on the display. NO changes are possible via display.
0	unlock	

Example: Address = 1

Host	Sensor	Comment
{1,084,1,xxx}	{1,084,1,xxx}	Touch Buttons unlocked

2.23 Command 091 “Get SENSOR INFO”

From Host: {Address, Command, Checksum}
From Sensor: {Address, Command, Sensor Type, Serial Number, Checksum}

Example: Address = 1

Host	Sensor	Comment
{1,091,xxx}	{1,091,OXE7.E25T-MB3E.SIMD.7AI, 123456789_001,xxx}	Sensor Type = OXE7.E25T-MB3E.SIMD.7AI Serial Number = 123456789_001

2.24 Command 093 “LIVE MONITOR”

Host: {Address, Command, Checksum}
Sensor: {Address, Command, Angle, Distance, Checksum}

With this command the sensor returns the angle and the distance along the measuring axis.
Details see in the specification of display menu “20140218_DisplayOperation_3_xx”.

Example: Address = 1

Host	Sensor	Comment
{1,093,xxx}	{1,093,-15.2,200,xxx}	Angle -15.2° Distance = 200mm

2.25 Command 401 “Get all SETTINGS”

To check the configuration of the sensor, we have a global command “Get all SETTING”.

Host: {Address, Command, Setting Number, Checksum}
Sensor: {Address, Command, Setting Number, RS485 Baud Rate, RS485 Address, Display light, Language, Touch buttons, Switch Type, Switch point 1, Switch point 2, Switch polarity, Meas Type, Precision, Object, Edge height, Flex mount status, Angle, Distance, Field of view status, Limit left, Limit right, Offset, Height, Checksum}

Number	Function	Remarks
0	Setting 0	Power on setting / working setting
1	Setting 1	
2	Setting 2	
3	Setting 3	

The detail specifications of the Setting see in the chapter before.

Number	Setting	Remarks
0	RS485 Baud Rate	
1	RS485 Address	
2	Display light	
3	Language	
4	Touch buttons	Lock/Unlock
5	Switch Type	Digital out, Point /Window
6	Switch point 1	Digital out
7	Switch point 2	Digital out
8	Switch polarity	Digital out
9	Meas type	
10	Precision	
11	Object	
12	Edge height	
13	Flex mount status	Active = 1 Deactive = 0
14	Angle	Flex mount

15	Distance	Flex mount
16	Limit left	
17	Limit right	
18	Offset	
19	Height	

Example: Address = 1, Setting 0

Host	Sensor	Comment
{1,401,0,xxx}	{1,401,0,2,4,3,1,...,xxx}	0 = Setting 0 2 = Baud Rate 115’200 4 = Address 004 3 = Display light Always ON 1 = Language German …

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