

## PST20 User Manual RS232 & RS485 HEX

### 4 DATA READING AND COMMUNICATION

#### 4.1 Preparation For Data Reading

- 1) After installing PST20, please correctly connect the power cable and the signal cable according to the connection definition;
- 2) Check and confirm the correct connection of power cable and signal cable before power on PST20. The sensor should be preheated for 1 minute after the first power on. Be careful not to restart PST20 continuously and instantaneously;
- 3) Reading the angle data of PST20 according to output type and communication protocol.

The output types and protocols of PST20 series inclinometers are diversified in order to meet different needs from customers. Users need to implement the specific outputs and protocols in the process of reading angle data. Users can also purchase the PSTsoftware which is applicable to communication with all PST series inclinometers to acquire and store angle datas of PST20 series inclinometers.

#### 4.2 HEX Protocol (RS232 and RS485 output)

SST20 inclinometer with RS232 or RS485 output interface supports HEX protocol. When communicating, the default serial port property is as below:

Items	Default value
Baud rate	9600bps
Data bits	8 bits
Start bits	1 bit
Stop bits	1 bit
Parity	None
Flow control	None

User can change the baud rate according to the application, and the available baud rates are: 1200bps, 2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps and 115200bps. User can send ASCII command "\$BAU =#" to set baud rate, specific operation is explained in "SST20 ASCII communication protocol", except for baud rate the other properties can not be modified.

When PST20 communicates with HEX protocol, the host computer sends a command to PST20, then PST20 responds and returns the data. In communication, the dwell time between data bytes of a frame is less than 5 ms, otherwise the sensor will start receiving data again.

### 4.2.1 Data Frame Format

#### Host computer request format:

0xCC	Data				Checksum
	Address	Request Command	Set data length	Setting parameters	
1Byte	1Byte	1Byte	1Byte	Multiple bytes	1Byte
Checksum = (Address + Request Command + Set data length + Setting parameters) & 0xFF					

0xCC is start character;

Address character is the addressable address of PST20, range from 0x00 to 0xFF, the factory default is 0xFF;

The request command is the function code that distinguishes each instruction;

The set data length is the byte length of the new write parameter;

The setting parameters is the content of the new write parameter, which can be default. When it is default, the data length should be set 0x00.

#### Sensor response format:

0xCC	Data				Checksum
	Address	Response Command	Response data length	Response parameters	
1Byte	1Byte	1Byte	1Byte	Multiple bytes	1Byte
Checksum = (Address + Response Command + Response data length + Response parameters) & 0xFF					

0xCC is start character;

Address character is the addressable address of PST20, range from 0x00 to 0xFF, the factory default is 0xFF;

The response command responses for the request command, the response command is smaller than the request command 0x10;

The response data length is the byte length of the response parameter after new write parameter.

### 4.2.2 HEX Command

User can use ASCII commands to read configuration parameters or set configuration parameters:

	Function	Request Command	Response command
1	Modify sensor address	0x81	0x71
2	Reading sensor angle	0x8C	0x7C
3	Sensor angle zeroing	0x8E	0x7E
4	Modify sensor bandwidth	0x89	0x79
5	Modify sensor filter coefficient	0x8A	0x7A
6	Modify sensor zero offset	0x8F	0x7F
7	Restore factory settings	0x87	0x77

The detail explanation of commands are:

1) Modify sensor address, request command 0x81

PC sending:

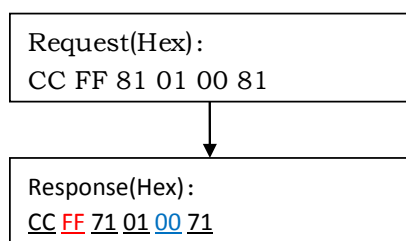
0xCC	Data				Checksum
	Current address	0x81	0x01	New address	
1Byte	1Byte	1Byte	1Byte	1Byte	1Byte
Checksum = (Current address + 0x81 + 0x01 + New address) & 0xFF					

Sensor response:

0xCC	Data				Checksum
	Current address	0x71	0x01	New address	
1Byte	1Byte	1Byte	1Byte	1Byte	1Byte
Checksum = (Current address + 0x71 + 0x01 + New address) & 0xFF					

Note: After the host computer sends the request to modify the sensor address instruction, the sensor first responds and returns the data frame: the current address is still the old address, the sensor new address is set to the new address. In the after communication, sensor uses the newly modified address. If the request instruction is sent unsuccessfully, the sensor does not respond.

For example, the current sensor address is 0xFF, host computer requests to change its address to 0x00, and the request instructions and responses are sent back as follows:



The sensor's current address is 0xFF, and the sensor's address is changed to 0x00 by requesting. After sending the request instruction, the sensor still uses 0xFF as the current address for the first correct response to the return information. Then the sensor's communication needs 0x00 as the address to communicate.

2) Reading sensor angle, request command 0x8C

PC sending:

0xCC	Data			Checksum
	Sensor address	0x8C	0x00	
1Byte	1Byte	1Byte	1Byte	1Byte
Checksum = (sensor address + 0x8C + 0x00) & 0xFF				

Sensor response:

0xCC	Data				Checksum
	Sensor address	0x7C	0x04 or 0x08	Sensor angle	
1Byte	1Byte	1Byte	1Byte	4Bytes or 8Bytes	1Byte
Checksum = (sensor address + 0x7C + 0x04 + single-axis angle) & 0xFF or Checksum = (sensor address + 0x7C + 0x08 + dual-axis angle) & 0xFF					

Note: Host computer sends out the angle request instruction: single-axis sensor responds to the return angle data is 4 bytes, the length of the angle data bytes is 0x04; dual-axis sensor responds to the return angle data is 8 bytes, the first 4 bytes are X-axis angle data, the last 4 bytes are Y-axis angle data, and the length of the angle data bytes is 0x08. The angle data type is floating point number, low byte before, high byte at the back. The unit of angle data is degree. If the request instruction is sent unsuccessfully, the sensor does not respond.

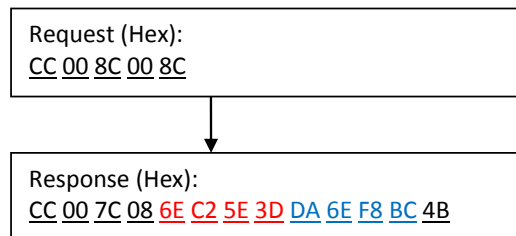
Angle representation of single-axis sensor:

Sensor angle data			
7 Byte0 0	15 Byte1 8	23 Byte2 16	31 Byte3 24

Angle representation of dual-axis sensor:

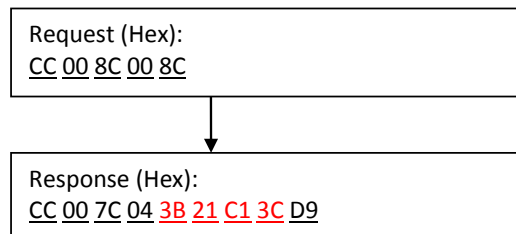
Sensor angle data							
X-axis				Y-axis			
7 Byte0 0	15 Byte1 8	23 Byte2 16	31 Byte3 24	7 Byte0 0	15 Byte1 8	23 Byte2 16	31 Byte3 24

For example, the address of the dual-axis tilt sensor is 0x00, and the host computer requests the sensor angle data as below:



The current address of the sensor is 0x00. By sending the request angle command, the sensor responds to the message that the X-axis angle data is 0.054 degrees (6E C2 5E 3D, 32-bit floating-point number, low byte before, high byte after); and the Y-axis angle data is - 0.030 degrees (DA 6E F8 BC, 32-bit floating-point number, low byte before, high byte after).

For example, the address of the single-axis tilt sensor is 0x00, and the host computer requests the sensor angle data as below:



The current address of the sensor is 0x00. By sending the request angle command, the sensor responds to the return message with an angle of 0.023 degrees (3B 21 C1 3C, 32-bit floating-point number, low byte before, high byte after).

## 3) Sensor angle zeroing, request command 0x8E

PC sending:

0xCC	Data			Checksum
	Sensor address	0x8E	0x00	
1Byte	1Byte	1Byte	1Byte	1Byte
Checksum = (sensor address + 0x8E + 0x00) & 0xFF				

Sensor response:

0xCC	Data					Checksum
	Sensor address	0x7E	0x05 or 0x09	0xBB	Offset data	
1Byte	1Byte	1Byte	1Byte	1Byte	4Bytes or 8Bytes	1Byte
Checksum = (sensor address + 0x7E + 0x05 + 0xBB + single-axis offset data) & 0xFF or Checksum = (sensor address + 0x7E + 0x09 + 0xBB + dual-axis offset data) & 0xFF						

Note: Host computer sends the instruction to set the sensor to zero. After the sensor responds, the current angle value is recorded as zero offset, and the current angle is cleared. The return message contains zero offset data at the same time. The zero offset data returned by the single-axis sensor is 4 bytes, the zero offset data returned by the dual-axis sensor is 8 bytes, the first 4 bytes are X-axis zero offset, and the last 4 bytes are Y-axis zero offset. Zero offset data is 32 bit floating point, low byte before, high byte after.

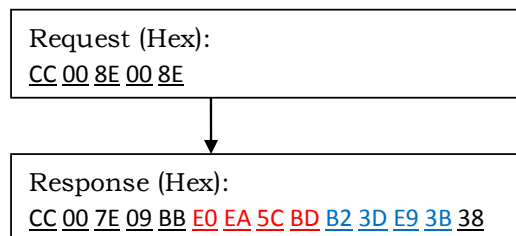
Zero offset data representation of single-axis sensor:

Zero offset data of single-axis			
7 Byte0 <sup>0</sup>	15 Byte1 <sup>8</sup>	23 Byte2 <sup>16</sup>	31 Byte3 <sup>24</sup>

Zero offset data representation of dual-axis sensor:

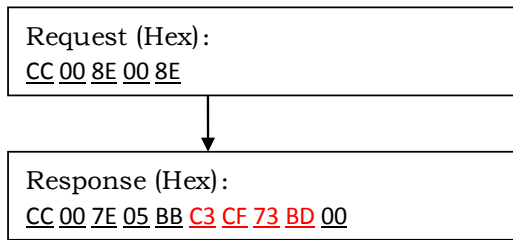
Zero offset data of dual-axis							
X-axis				Y-axis			
7 Byte0 <sup>0</sup>	15 Byte1 <sup>8</sup>	23 Byte2 <sup>16</sup>	31 Byte3 <sup>24</sup>	7 Byte0 <sup>0</sup>	15 Byte1 <sup>8</sup>	23 Byte2 <sup>16</sup>	31 Byte3 <sup>24</sup>

For example, the address of the dual-axis sensor is 0x00, and the host computer requests the sensor's current angle to be zero as follow:



Sensor current address is 0x00, by sending the request to set the current angle zero, the sensor response back to the message: X axis zero offset data is - 0.053 degrees (E0 EA 5C BD, 32-bit floating point, low byte before, high byte after); Y axis zero offset data is 0.007 degrees (B2 3D E9 3B, 32-bit floating point, low byte before, high). The byte is later.

For example, the address of the single-axis sensor is 0x00, and the host computer requests the sensor's current angle to be zero as follow:



The sensor's current address is 0x00. By sending the request to zero the current angle, the sensor responds by sending back a message with a zero offset of -0.059 degrees (C3 CF 73 BD, 32-bit floating-point number, low byte before, high byte after).

#### 4) Modify sensor bandwidth, request command 0x89

PC sending:

0xCC	Data				Checksum
	Sensor address	0x89	0x01	Sensor bandwidth	
1Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte
Checksum = (sensor address + 0x89 + 0x01 + sensor bandwidth) & 0xFF					

Sensor response:

0xCC	Data					Checksum
	Sensor address	0x79	0x02	Sensor bandwidth	State byte	
1Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte
Checksum = (sensor address + 0x79 + 0x02 + sensor bandwidth + State byte) & 0xFF						

Note: the SST20 tilt sensor can support the modification of bandwidth: 3Hz (default), 5Hz and 10Hz.

The HEX value corresponding to the set bandwidth is:

Bandwidth to Hex value.

3Hz to 0x00

5Hz to 0x01

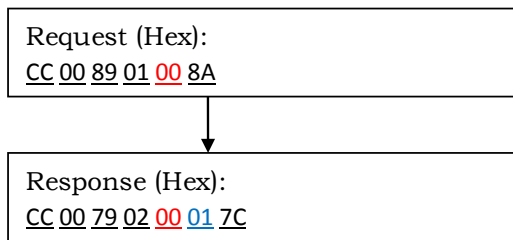
10Hz to 0x02

When the bandwidth is set, the sensor returns the settings status byte:

When the status byte is 0x00, the settings fail;

When the state byte is 0x01, the setting is successful.

For example, the address of the tilt sensor is 0x00, and the upper computer requests to modify the bandwidth of the sensor to 3Hz as follow:



The current address of the sensor is 0x00, and the bandwidth is modified to 3Hz by sending a request. 00 is the set bandwidth (0x00 corresponds to 3Hz bandwidth) and the status byte is 01 (indicating the setup is successful).

5) Modify sensor filter coefficient, request command 0x8A

PC sending:

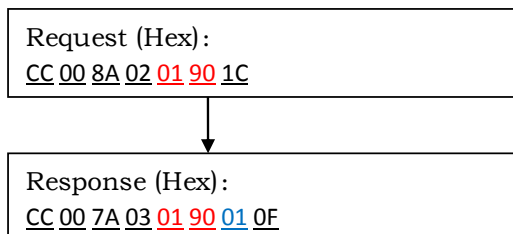
0xCC	Data				Checksum
	Sensor address	0x8A	0x02	Filter coefficient	
1 Byte	1 Byte	1 Byte	1 Byte	2 Bytes	1 Byte
Checksum = (sensor address + 0x8A + 0x02 + filter coefficient) & 0xFF					

Sensor response:

0xCC	Data					Checksum
	Sensor address	0x7A	0x03	Filter coefficient	Status byte	
1 Byte	1 Byte	1 Byte	1 Byte	2 Bytes	1 Byte	1 Byte
Checksum = (sensor address + 0x7A + 0x03 + filter coefficient + status byte) & 0xFF						

Note: SST20 tilt sensor can support modified filter coefficients: 0 ~ 65535 (hexadecimal range is 0x0000 ~ 0xFFFF). When the sensor filter coefficient is set, the sensor will return the settings status byte: the settings fail when the status byte is 0x00, and the settings are successful when the status byte is 0x01.

For example, the tilt sensor address is 0x00, and the host computer requests a modification of the sensor filter coefficient of 400 (0x0190), as follows:



The current address of the sensor is 0x00, and the filter coefficient is 400 by sending a request. In the feedback information of the sensor response, 0190 is the set filter coefficient (0x0190 corresponds to 400 filter coefficient), and the state byte is 01 (indicating that the setting is successful).

## 6) Modify sensor zero offset, request command 0x8F

PC sending:

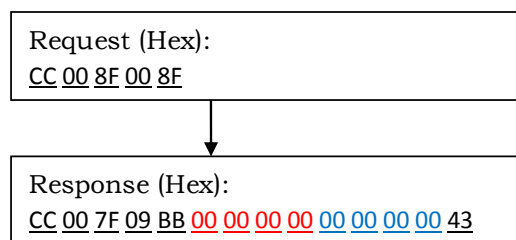
0xCC	Data			Checksum
	Sensor address	0x8F	0x00	
1Byte	1Byte	1Byte	1Byte	1Byte
Checksum = (sensor address + 0x8F + 0x00) & 0xFF				

Sensor response:

0xCC	Data					Checksum
	Sensor address	0x7F	0x05 or 0x09	0xBB	Zero offset data	
1Byte	1Byte	1Byte	1Byte	1Byte	4Bytes or 8Bytes	1Byte
Checksum = (sensor address + 0x7F + 0x05 + 0xBB + single-axis zero offset data) & 0xFF or Checksum = (sensor address + 0x7F + 0x09 + 0xBB + dual-axis zero offset data) & 0xFF						

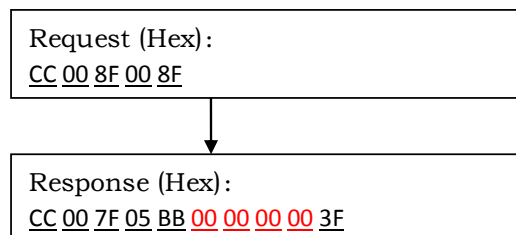
Note: Host computer sends zero-setting instructions to the sensor. After the sensor responds, the current X-axis and Y-axis zero offsets are cleared. The return message contains the new zero offset data (0.0). The zero offset data returned by the single-axis sensor is 4 bytes, the zero offset data returned by the dual-axis sensor is 8 bytes, the first 4 bytes are X-axis zero offset, and the last 4 bytes are Y-axis zero offset. The zero offset data is 32 bit floating point, low byte before and high byte at the back.

For example, the address of the dual-axis sensor is 0x00, and the host computer requests the sensor's current angle to be zero as follow:



The current address of the sensor is 0x00, and the current angle zero is cleared by sending a request. The sensor responds by sending back information: the X-axis new zero offset data is 0.0 degrees (00 00 00 00 00, 32-bit floating point number, low byte before, high byte after); the Y-axis new zero offset data is 0.0 degrees (00 00 00 00, 32-bit floating point number, low byte in front). The high byte is later.

For example, the address of the single-axis sensor is 0x00, and the host computer requests the sensor's current angle to be zero as follow:



The sensor's current address is 0x00. By sending the request to set the current angle to zero, the sensor responds by returning a message that the new zero offset data is 0.0 degrees (00 00 00 00, 32-bit floating-point number, low byte before, high byte after).



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## 7) Restore factory settings, request command 0x87

PC sending:

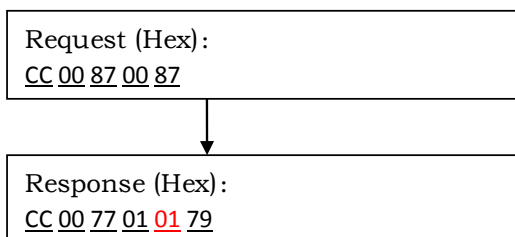
0xCC	Data			Checksum
	Sensor address	0x87	0x00	
1Byte	1Byte	1Byte	1Byte	1Byte
Checksum = (sensor address + 0x87 + 0x00) & 0xFF				

Sensor response:

0xCC	Data				Checksum
	Sensor address	0x77	0x01	Status byte	
1Byte	1Byte	1Byte	1Byte	1Byte	1Byte
Checksum = (sensor address + 0x77 + 0x01 + status byte) & 0xFF					

Note: Host computer sends some parameters to resume factory setting instructions. After the sensor responds, it will output refresh rate (default value 5Hz in continuous output mode), filter coefficient (default value 200D, C8H), X-axis zero offset (default value varies with sensor), Y-axis zero offset (default value varies with sensor). And the bandwidth (default value 3Hz) restores the factory settings. When some parameters are restored to factory settings, the sensor returns the status byte: when the status byte is 0x00, the recovery fails; when the status byte is 0x01, the recovery is successful.

For example, the dual-axis sensor address is 0x00, and the host computer requests that some of the sensor parameters be restored to the factory settings as follow:



The current address of the sensor is 0x00, and some parameters of the recovery request are set to the factory value. In the sensor response, the status byte is 01 (indicating the recovery is successful).

## We are here for you. Addresses and Contacts.

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