

# User Manual

## TargetPoint SX

High Performance Digital Magnetic Compass



## Table of Contents

<b>1. COPYRIGHT &amp; WARRANTY INFORMATION .....</b>	<b>1</b>
<b>2. INTRODUCTION .....</b>	<b>2</b>
<b>3. SPECIFICATIONS.....</b>	<b>3</b>
3.1 Performance Specifications .....	3
3.2 Operating Characteristics .....	3
3.3 Mechanical Drawings.....	5
<b>4. TARGETPOINT SX MODULE SET-UP.....</b>	<b>6</b>
4.1 Electrical Connections.....	6
4.2 Installation Location.....	7
4.2.1 Operate within the device’s dynamic range.....	7
4.2.2 Locate away from changing magnetic fields .....	7
4.2.3 Mount in a physically stable location .....	7
4.2.4 Location-verification testing.....	7
4.3 Mechanical Mounting.....	8
4.4 Elevation & Bank Convention .....	8
<b>5. OPERATION WITH ASCII PROTOCOL .....</b>	<b>9</b>
5.1 Command Set.....	9
5.2 General Operation .....	11
5.2.1 Wakeup from Sleep Mode.....	11
5.2.2 Shutdown .....	11
5.2.3 Request Status .....	11
5.3 Taking Measurements (Modes 1 & 3) .....	12
5.3.1 Setting the Operation Mode.....	12
5.3.2 Request Measurement .....	15
5.4 Taking Measurements (Modes B & D).....	15
5.5 User Calibration (Mode 6) .....	17
5.5.1 Resetting Calibration Coefficients .....	17
5.5.2 Initiating a User Calibration .....	18
5.5.3 Request Calibration Sample.....	19
5.6 Configuration .....	20
5.6.1 Set Mounting Orientation.....	20
5.6.2 Get Mounting Orientation .....	21
5.6.3 Baud Rate.....	21
5.6.4 Set Reporting Rate .....	22
5.6.5 Set Measurement Range .....	23
5.6.6 Set Declination .....	24
5.6.7 Set Damping Coefficient .....	25
5.6.8 Set Coding in Decimal or Hexdecimal .....	25
5.6.9 Set Gimbaling On or Off .....	26
5.6.10 Store Startup Configuration.....	26

5.6.11	Reset .....	26
5.7	TargetPoint SX Command/Response Examples.....	27
5.7.1	Initialization.....	27
5.7.2	Status .....	28
5.7.3	Measurement.....	28
5.7.4	12RT and 12PT Calibration.....	29
5.7.5	4PT Calibration.....	31
<b>6.</b>	<b>USER CALIBRATION.....</b>	<b>32</b>
<b>I.</b>	<b>APPENDIX DEMO PROGRAM.....</b>	<b>35</b>
1.1	Software Set-Up.....	35
1.2	Hardware Set-Up .....	35
1.3	Running the TargetPoint Calibration Program .....	35
1.3.1	Performing a Calibration.....	37
1.3.2	Logging Data.....	38
1.3.3	Restoring Configuration Settings to Factory Default.....	38

## List of Tables

Table 3-1: Performance Specifications <sup>1</sup> .....	3
Table 3-2: I/O Characteristics .....	3
Table 3-3: Power Requirements .....	4
Table 3-4: Mechanical Characteristics .....	4
Table 4-1: Pin Descriptions .....	6
Table 5-1: Serial Interface Configuration .....	9
Table 5-2: Command Set .....	10
Table 5-3: Request Status Response .....	12
Table 5-4: Measurement Response Data in Hex Coding .....	13
Table 5-5: Measurement Response Data in Decimal Coding .....	14
Table 5-6: Mode B&D Output Data in Hex Coding .....	16
Table 5-7: Mode B&D Output Data in Decimal Coding .....	16
Table 5-8: Soft/Hard Iron Calibration Score Results .....	19
Table 5-9: Soft/Hard Iron Calibration Sample Request Response .....	19
Table 5-10: Hard Iron Calibration Sample Request Response .....	20
Table 5-11: Set Data Integration Time in Hex .....	22
Table 5-12: Set Data Integration Time in Dec .....	22
Table 5-13: Set Measurement Range .....	23
Table 5-14: Set Declination .....	24
Table 5-15: Set Damping Coefficient .....	25
Table 5-16: Set Coding .....	25
Table 5-17: Set Gimballing .....	26
Table 6-1: 12RT and 12PT Calibration Pattern .....	34
Table 6-2: 4PT Calibration Pattern .....	34

## List of Figures

Figure 3-1: TargetPoint SX Mechanical Drawing .....	5
Figure 4-1: TargetPoint SX Mounting Orientations .....	8
Figure 6-1: 12RT and 12PT Calibration Pattern .....	33

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# 1. Copyright & Warranty Information

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## 2. Introduction

Thank you for purchasing TargetPoint SX module (pn 14487). The TargetPoint SX is a high-accuracy digital magnetic compass (DMC), housed in a robust aluminum enclosure. Combining PNI's patented magneto-inductive sensors and measurement circuitry with a 3-axis MEMS accelerometer, this high performance compass module was designed as a standalone DMC for easy integration into laser range finders and targeting systems. The accuracy and reliability of the TargetPoint SX makes it an ideal choice for threat detection, situational awareness, and neutralization.

We're sure the TargetPoint SX will help you to achieve the greatest performance from your system. Thank you for selecting PNI and the TargetPoint SX.

---

## 3. Specifications

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### 3.1 Performance Specifications

**Table 3-1: Performance Specifications<sup>1</sup>**

Parameter	Value
Azimuth (Heading) Accuracy	0.3° rms
Azimuth Specified Range	360°
Elevation (Pitch) & Bank (Roll) Accuracy	0.2° rms
Elevation & Bank Specified Range <sup>2</sup>	± 45°
Angular Resolution	0.01°
Magnetometer Calibrated Range	± 150 µT
Accelerometer Calibrated Range	± 1.0 g

**Footnote:**

1. Specifications subject to change. Assumes: a) a gimbal-mounted 12RT Calibration is performed, b) the magnetic field inclination (dip angle) is between -75° and +75°, c) the module is motionless, and d) the local magnetic field is clean relative to the calibration.
2. Full operational range of ± 180° for Bank, and -90° < Elevation < 90°.

---

### 3.2 Operating Characteristics

**Table 3-2: I/O Characteristics**

Parameter	Value	
Data Interface	CMOS/TTL <sup>1</sup> serial UART	
Communication Protocol	ASCII	
Communication Voltages	Transmit (Tx)	Low =0.35V(max), High =3.95 V(min)
	Receive (Rx)	Low = 0.8V(max), High = 2.03V(min)
Communication Rate	300 to 38400 Baud, 9600 default	
Reporting Rate	Continuous Measurement	1, 2, 5, 10, and 20 Hz
	Single Measurement	10 Hz maximum

**Footnote:**

1. CMOS 5V and TTL-compliant logic levels.

**Table 3-3: Power Requirements**

Parameter	Value
V <sub>IN</sub> – Supply Voltage	4.5 to 5.5 VDC
Average Current Draw @ max. sample rate	11 mA typical
Sleep Mode Current Draw	0.7 mA typical

**Table 3-4: Mechanical Characteristics**

Parameter	Value
Dimensions ( <i>l x w x h</i> )	33 x 31 x 13.5 mm (1.30" x 1.22" x 0.53")
Weight	17 gm max
Connector	4-pin MIL-MAX, pn 850-10-004-10-001000
Mounting Options	Z down, Z up and side-mount Left



### 3.3 Mechanical Drawings

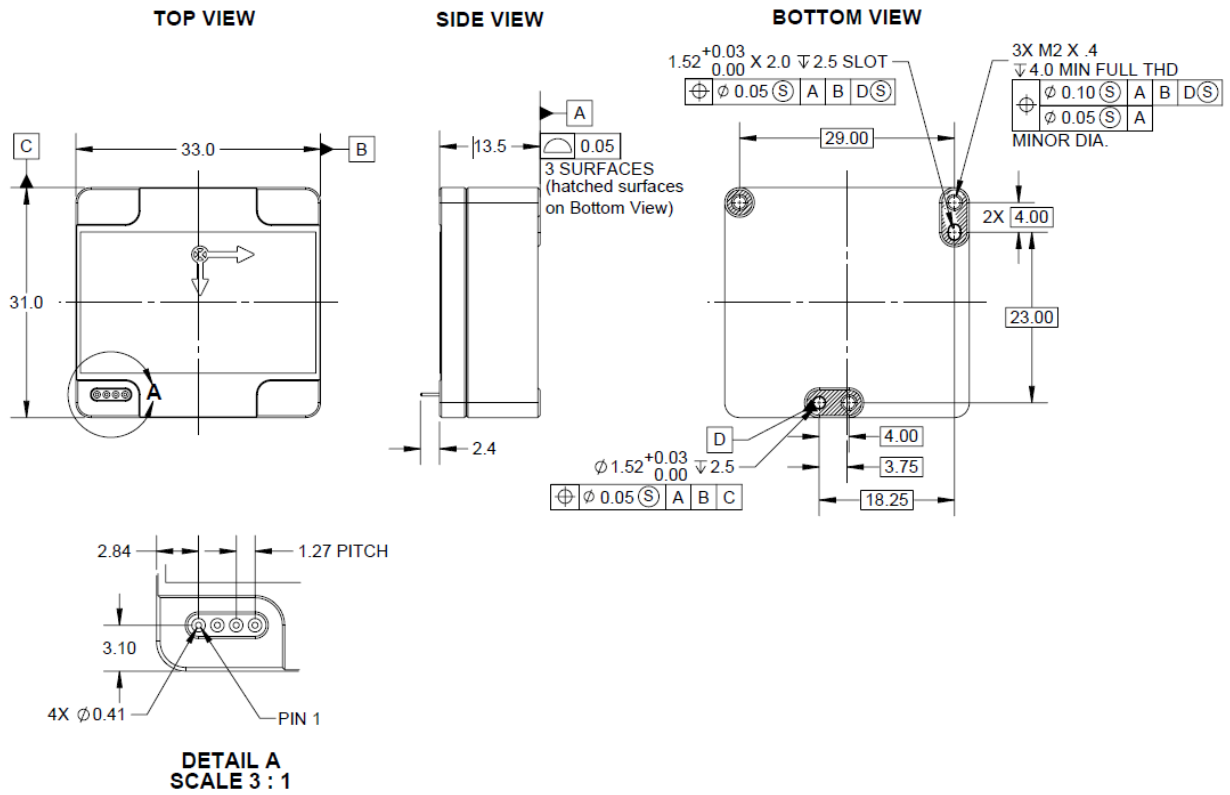


Figure 3-1: TargetPoint SX Mechanical Drawing

---

## 4. TargetPoint SX Module Set-Up

This section describes how to configure the TargetPoint SX module in your host system. To install the TargetPoint SX into your system, follow these steps:

- Make electrical connections to the TargetPoint SX module.
- Choose a mounting location.
- Mechanically mount the TargetPoint SX in the host system.
- Perform a user calibration.

---

### 4.1 Electrical Connections

The TargetPoint SX module incorporates a 4 pin Mil-Max connector, part number 850-10-004-10-001000, which mates with Mill-Max part 851-XX-004-10-001000 or equivalent. The pin-out is given in Table 5-1.

**Table 4-1: Pin Descriptions**

Pin #	Pin Function
1	GND
2	V <sub>IN</sub> <sup>1</sup>
3	TxD
4	RxD

**Footnote:**

1. See Table 3-3 for V<sub>IN</sub> specification

---

**Note:** The 4 pin connector of the TargetPoint SX module is not keyed, so it is possible to plug it in backwards. This won't damage the device but will stop it from functioning. Additionally, there is no locking mechanism to keep the connector in place, so the user should take care to ensure the connector is actually connected. Since the TargetPoint SX module normally is used as a board-mounted device, these issues generally are not a problem when using the SX in a system but can cause some confusion when performing off-line testing.

---

After making the electrical connections, PNI recommends performing some simple tests to ensure the TargetPoint SX is working as expected. Section 6 for how to operate the TargetPoint SX using PNI's ASCII-protocol command language.

---

## 4.2 Installation Location

The TargetPoint SX should be mounted with the following considerations in mind.

---

### 4.2.1 Operate within the device's dynamic range

The TargetPoint SX can be user calibrated by the user to correct for static magnetic fields created by the host system. Each axis of the TargetPoint SX has a calibrated dynamic range of  $\pm 150 \mu\text{T}$ , so the total field should be within this range to ensure accurate heading readings. For example, this range might be exceeded if the TargetPoint SX is placed too closely to large masses of ferrous metals, large electric currents, permanent magnets such as electric motors, and so on.

---

### 4.2.2 Locate away from changing magnetic fields

It is not possible to calibrate for changing magnetic anomalies. Thus, for greatest accuracy, keep the TargetPoint SX away from sources of local magnetic distortion that will change with time; such as electrical equipment that will be turned on and off, or ferrous bodies that will move relative to the TargetPoint SX. Ensure the module is not mounted close to cargo or payload areas that may be loaded with materials that distort the local magnetic field.

---

### 4.2.3 Mount in a physically stable location

The TargetPoint SX works best when stationary. Non-gravitational accelerations result in distorted readings of Earth's gravitational vector, thus distorting the heading reading. Choose a location isolated from excessive shock, oscillation, or vibration.

---

### 4.2.4 Location-verification testing

Location-verification testing should be performed at an early stage of development to understand and accommodate the magnetic distortion contributors in a host system.

#### **Determine the distance range of field distortion.**

Place the TargetPoint SX in a fixed position, then move or energize suspect components while observing the module's output to determine when the suspect components begin to distort the readings.

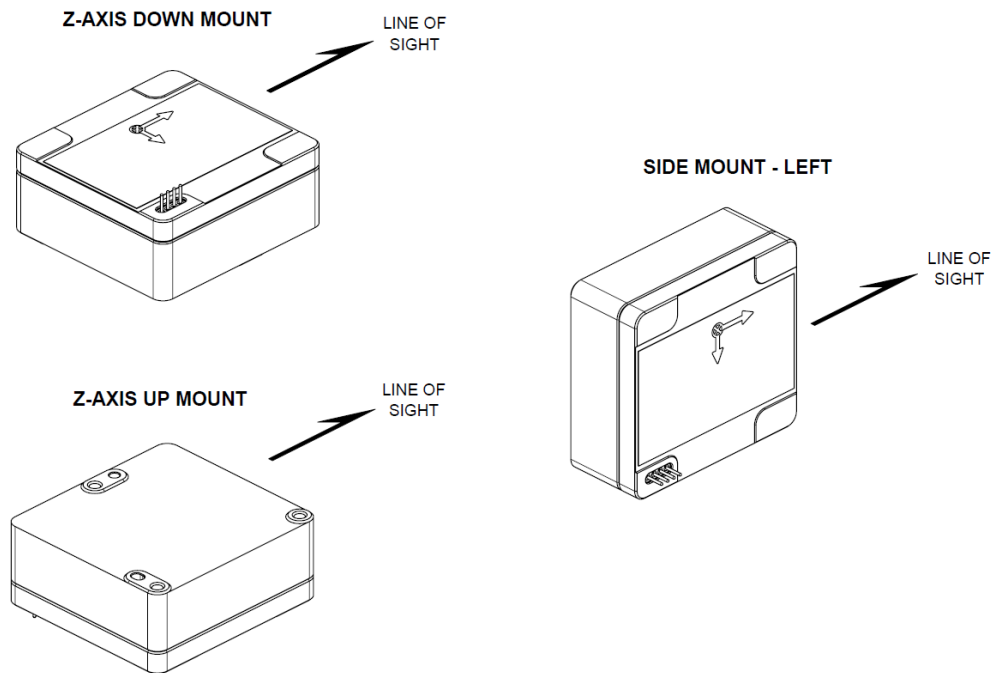
#### **Determine if the maximum field is within the compass' dynamic range.**

With the compass mounted, rotate and tilt the system in as many positions as possible. Monitor the magnetometer outputs while doing this, observing if the dynamic range is exceeded.

---

## 4.3 Mechanical Mounting

Refer to Section 3.3 for dimensions, hole locations, and the reference frame orientation. The TargetPoint SX is factory calibrated with respect to its mounting holes and it should be aligned within the host system with respect to these mounting holes. The arrow should be pointing in the same direction as the host system. The TargetPoint SX can be mounted either level or on its side. Ensure any stand-offs and screws used to mount the module are non-magnetic.



*Figure 4-1: TargetPoint SX Mounting Orientations*

---

## 4.4 Elevation & Bank Convention

The TargetPoint SX uses MEMS accelerometers to measure the tilt of the compass. This data is output as elevation (pitch) and bank (roll) data, and also is used in conjunction with the magnetometers to provide a tilt-compensated azimuth (heading) reading.

The module references both elevation and bank to the horizontal plane. A positive elevation is when the front edge of the module is rotated upward, and a positive bank is when the right edge of the module is rotated downward.

---

## 5. Operation with ASCII Protocol

The TargetPoint SX utilizes an ASCII protocol that is transmitted over a CMOS-level serial interface. Measurement and configuration values generally are reported in hexadecimal format.

The serial interface should be configured as follows. The default baud rate is 9600.

**Table 5-1: Serial Interface Configuration**

Parameter	Value
Number of Data Bits	8
Start Bits	1
Stop Bits	1
Parity	none

---

### 5.1 Command Set

Table 6-2 summarizes the command set for the TargetPoint SX, and the following sections provide additional detail on these commands. Note that examples of command code are provided in Section 6.7, and more detailed information regarding User calibration (Mode 6) is provided in Section 7.

## Table 5-2: Command Set

General Function	Command Description	ASCII Character Number								
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th
General Operation	Wake up	z								
	Shutdown	S	h	u	t	d	o	w	n	<CR>
	Status Request	I								
Making Measurements (modes 1, 3, B, D)	Begin Continuous Output of AEB Data (Mode 1)	S	9	1	<CR>					
	Place in Single Measurement AEB Mode (Mode 3)	S	9	3	<CR>					
	Begin Continuous Output of Mxyz & Axyz Data (Mode B)	S	9	B	<CR>					
	Place in Single Measurement Mxyz & Axyz Mode (Mode D)	S	9	D	<CR>					
	Request Single Measurement	M								
User Calibration (Mode 6)	Start 12 Point Hard & Soft Iron Calibration	S	9	6	<CR>	X				
	Start 4 PT Hard Iron Calibration	S	9	6	<CR>	W				
	Reset Hard/Soft Iron Coefficients	S	9	6	<CR>	X	S	0	<CR>	
	Reset Hard Iron Coefficients	S	9	6	<CR>	W	S	0	<CR>	
	Request Calibration Sample	Q								
Configuration	Reset	R								
	Coding Selection	Decimal Coding	S	8	1	<CR>				
		Hex Coding	S	8	2	<CR>				
	Save Settings	Store Current Configuration	S	7	<CR>					
	Gimballing Settings	Gimballing On	S	6	1	<CR>				
		Gimballing Off	S	6	2	<CR>				
	Mounting Orientation	Set Z-Down Level Mount	S	6	3	<CR>				
		Set Z-Up Level Mount	S	6	4	<CR>				
		Set Side Mount	S	6	5	<CR>				
		Get Mounting Orientation	S	6	?	<CR>				
	Baud Rate	Set 300 Baud	S	B	0	1	2	C	<CR>	
		Set 600 Baud	S	B	0	2	5	8	<CR>	
		Set 1200 Baud	S	B	0	4	B	0	<CR>	
		Set 2400 Baud	S	B	0	9	6	0	<CR>	
		Set 4800 Baud	S	B	1	2	C	0	<CR>	
		Set 9600 Baud	S	B	2	5	8	0	<CR>	
		Set 19200 Baud	S	B	4	B	0	0	<CR>	
		Set 38400 Baud	S	B	9	6	0	0	<CR>	
	Damping Factor	Set Damping Factor	S	5	#	#	<CR>			
	Reporting Rate	Set 1 Hz Rate	S	4	0	A	<CR>			
		Set 2 Hz Rate	S	4	0	5	<CR>			
		Set 10 Hz Rate	S	4	0	1	<CR>			
		Set 20 Hz Rate	S	4	0	0	<CR>			
	Measurement Range	Set Resolution	S	3	#	#	#	#	<CR>	
		ASCII Characters 3 to 6 ('#') define the range in HEX or DEC								
	Declination	Set Declination								
		Negative Declination	S	2	#	#	#	#	<CR>	
		Positive Declination	S	1	#	#	#	#	<CR>	
		ASCII Characters 3 to 6 ('#') define the value in HEX or DEC								

---

## 5.2 General Operation

---

### 5.2.1 Wakeup from Sleep Mode

The Wakeup command re-activates the TargetPoint SX from Sleep Mode. Upon issuing a Wakeup command, the host system should wait at least 100 ms before issuing subsequent TargetPoint SX commands.

**Command String:** `z`

**Response String:** none

---

### 5.2.2 Shutdown

The host system issues a Shutdown command to the TargetPoint SX to place it in Sleep Mode. In Sleep Mode the sensors and many of the functions of the microprocessor are turned off, such that power consumption is significantly reduced. The TargetPoint SX is re-activated by the host system by sending the Wakeup command.

**Command String:** `Shutdown<CR>`

**Response String:** none

---

### 5.2.3 Request Status

The Request Status command is issued by the host system to retrieve the TargetPoint SX's hardware and software revisions, operational configuration, temperature, CPU and temperature status.

**Command String:** `I`

**Response Strings:**

Table 6-3 provides the format of the Request Status response message from the TargetPoint SX. The ASCII numeric values are in hexadecimal.

---

**Note:** The Data Valid bit is 'Valid' when the CPU Status and Temperature Status bits are "Pass". The Data Valid bit is "Error" if either the CPU Status or Temperature Status bits are "Fail". The checksum calculation is to add characters 2 through 24 as an 8-bit sum, then 'OR' the 8-bit sum with the Data Valid bit.

---

**Table 5-3: Request Status Response**

Character Number	Value	Description
1	S	Message Frame Start.
2 and 3	00	Software version.
4 and 5	00	Hardware version.
6 to 9	0000	Unused. Always 0.
10 and 11	00	Reporting Rate. 1 Hz = 0A, 2 Hz = 05, 10 Hz = 01, 20 Hz = 00
12 and 13	00	Unused. Always 0.
14 to 17	0000	Measuring Range, MSD first, 2's complement.
18 and 19	00	Temperature (deg C), MSD first, 2's complement.
20	0	Operation Mode: 1 (continuous) or 3 (single measurement).
21 and 22	00	CPU Status. 0xFF = Pass, 0x7F = Fail
23 and 24	00	Temperature Status. 0xFF = Pass, 0xFB = Fail.
25 and 26	00	Checksum/Data Valid. MSD first. Bit 7 = data (1 = Valid, 0 = Error) Bit 6 = checksum MSB Bit 5 = checksum Bit 4 = checksum Bit 3 = checksum Bit 2 = checksum Bit 1 = checksum Bit 0 = checksum LSB
27	<CR>	End of message frame (carriage return).

---

## 5.3 Taking Measurements (Modes 1 & 3)

The TargetPoint SX can report data either continuously (Mode 1) or one data set at a time after receiving a request for data (Mode 3). The sections below discuss how to obtain data from the module in these two modes.

---

### 5.3.1 Setting the Operation Mode

The commands to put the TargetPoint SX into continuous measurement mode (Mode 1) or single measurement mode (Mode 3) are given below. The default on powering up is Mode 3. For Mode 1, data will start being reported right after issuing the command, while for



Mode 3 a Request Measurement command must be sent to obtain data. In both cases, azimuth, elevation, and bank are reported.

---

**Note:** If the TargetPoint SX is put into continuous measurement mode (Mode 1), the current configuration is saved, and then the DMC is turned off, when the DMC is powered up again it will revert to Mode 3. If continuous reporting is desired, it is necessary to issue the Mode 1 command string each time the DMC is powered on.

---

**Command Strings:**

Continuous measurement:       `S91<CR>`  
 Single measurement:           `S93<CR>`

**Response Strings:**

The following table illustrates the response format for azimuth, elevation and bank measurement data for Operation Modes 1 and 3. Note that the azimuth, elevation, and bank values are given in hexadecimal format.

**Table 5-4: Measurement Response Data in Hex Coding**

Character Number	Value	Description
1	S	Frame Start
2 to 5	AAAA	Azimuth
6 to 9	EEEE	Elevation
10 to 13	BBBB	Bank
14 and 15	FF	Checksum / data valid: MSB first. Bit 7 = data valid (always 1). Bit 6 = checksum MSB Bit 5 = checksum Bit 4 = checksum Bit 3 = checksum Bit 2 = checksum Bit 1 = checksum Bit 0 = checksum LSB
16	<CR>	Frame End (Carriage Return).

**Table 5-5: Measurement Response Data in Decimal Coding**

Character Number	Value	Description
1	<CR>	Frame Start (Carriage Return)
2	<SPACE>	1 space character
3 to 6	AAAA	Azimuth, no leading zero suppression
7	<SPACE>	1 space character
8	d	Unit in degree if range is 360
	m	Unit in mil if range is 6400
	‘ ‘	Other ranges
9-10	<SPACE> x 2	2 space characters
11	+/-	Sign, positive or negative
12-15	EEEE	Elevation, no leading zero suppression
16	<SPACE>	1 space character
17	d	Unit in degree if range is 360
	m	Unit in mil if range is 6400
	‘ ‘	Other ranges
18-19	<SPACE> x 2	2 space characters
20	+/-	Sign, positive or negative
21-24	BBBB	Bank, no leading zero suppression
25-28	<SPACE> x 4	4 space characters
29	+/-’ ‘	Sign displayed during a declination input
30-35	<SPACE> x 6	6 space characters
36	<CR>	Frame End (Carriage Return)

Reported measurement values are based on circle division units whereby the unit circle is divided by the value set by the Measurement Range command. The TargetPoint SX uses a default measurement range value of 0x7FFF or 32767. The reported azimuth, elevation and bank can thereby be converted to degrees or mils as follows.

- Units per deg:  $32767/360 = 91.019444$  units/deg
- Units per mil:  $32767/6400 = 5.119843$  units/mil.

The default TargetPoint SX measurement ranges are as follows:

- Azimuth: 0 to 32767 units for a range of 0 to 360 deg.

- Elevation: 0 to +/-8191 units for a range of +/- 90 deg.
- Bank: 0 to +/-16383 units for a range of +/- 180 deg.

---

### 5.3.2 Request Measurement

While in Operation Mode 3 (single measurement mode) or Operation Mode 6 (calibration mode), the host system issues a Request Measurement command to obtain azimuth, elevation, and bank measurements from the TargetPoint SX.

The TargetPoint SX produces a Request Measurement response within 100 ms. Therefore, the host system can reliably issue a Request Measurement command to the TargetPoint SX at a 10 Hz rate. The host system should not issue a Request Measurement command to the TargetPoint SX at a rate greater than 10 Hz.

If issuing a Request Measurement command while in Operation Mode 6 (calibration), the host system should issue the command at a 1 Hz rate. The rate should not exceed this.

**Command String:** 'M'

**Response String:**

See Table 6-4 and Table 6-5 for the Measurement Response Data message format.

---

## 5.4 Taking Measurements (Modes B & D)

The TargetPoint SX can report magnetic field and acceleration values either continuously (Mode B) or one data set at a time after receiving a request command **M** (Mode D). The sections below discuss how to obtain data from the module in these two modes.

**Command Strings:**

Continuous measurement: 'S9B<CR>'

Single measurement: 'S9D<CR>'

**Response Strings:**

The following table illustrates the response format for magnetic field measurement data and acceleration values in XYZ axes for Operation Modes B and D.

**Table 5-6: Mode B&D Output Data in Hex Coding**

Character Number	Value	Description
1	S	Frame Start
2 to 5	XXXX	Magnetic field X-axis
6 to 9	YYYY	Magnetic field Y-axis
10 to 13	ZZZZ	Magnetic field Z-axis
14 to 17	xxx	Acceleration X-axis
18 to 21	yyy	Acceleration Y-axis
22 to 25	zzz	Acceleration Z-axis
26 and 27	FF	Checksum / data valid: MSB first. Bit 7 = data valid (always 1). Bit 6 = checksum MSB Bit 5 = checksum Bit 4 = checksum Bit 3 = checksum Bit 2 = checksum Bit 1 = checksum Bit 0 = checksum LSB
28	<CR>	Frame End (Carriage Return).

**Table 5-7: Mode B&D Output Data in Decimal Coding**

Character Number	Value	Description
1	<CR>	Frame Start (Carriage Return)
2 to 3	<SPACE> x 2	2 space characters
4	+/-	Sign, positive or negative
5 to 9	XXXX	Magnetic field X-axis, leading zero suppression
10 to 11	<SPACE> x 2	2 space characters
12	+/-	Sign, positive or negative
13 to 17	YYYY	Magnetic field Y-axis, leading zero suppression
18 to 19	<SPACE> x 2	2 space characters

20	+/-	Sign, positive or negative
21 to 25	ZZZZ	Magnetic field Z-axis, leading zero suppression
26 to 27	<SPACE> x 2	2 space characters
28	+/-	Sign, positive or negative
29 to 33	xxxx	Acceleration X-axis, leading zero suppression
34 to 35	<SPACE> x 2	2 space characters
36	+/-	Sign, positive or negative
37 to 41	yyyy	Acceleration Y-axis, leading zero suppression
42 to 43	<SPACE> x 2	2 space characters
44	+/-	Sign, positive or negative
45 to 49	zzzz	Acceleration Z-axis, leading zero suppression
50 to 51	<SPACE> x 2	2 space characters
52	+/-/ ' ‘	Sign displayed during a declination input
53 to 58	<SPACE> x 6	6 space characters
59	<CR>	Frame End (Carriage Return)

---

## 5.5 User Calibration (Mode 6)

See Section 7 for general information on calibration and the 3 calibration methods (12RT, 12PT, and 4PT) available with the TargetPoint SX. Section 7 explains the differences between the methods, when each one is appropriate, and the specific calibration pattern for each one.

---

### 5.5.1 Resetting Calibration Coefficients

The TargetPoint SX comes with factory-generated calibration coefficients. These are very accurate coefficients for cases where no local magnetic distortions are present (i.e., the magnetic field surrounding the module is clean). In most cases, the host system of the module is not magnetically clean and a calibration must be performed to compensate for magnetic distortions present in the host system. After a new user calibration, with an acceptable score, the calibration coefficients will be saved in the module. These calibration coefficients can be subsequently refined (12PT and 4PT Calibrations). However, if the local field has changed substantially it is wise to reset the calibration coefficients back to their factory-generated values and recalibrate with these as the baseline (12RT Calibration). The commands below are for resetting the coefficients to their factory values.

### Command Strings:

Reset Soft/Hard Iron Coefficients:   `S96<CR>XS0<CR>`  
Reset Hard Iron Coefficients:       `S96<CR>WS0<CR>`

### Response Strings:

Reset Soft/Hard Iron Successful       `CS--<CR>`  
Reset Soft/Hard Iron Not Successful   `CSxx<CR>`  
Reset Hard Iron Successful            `CS--<CR>`  
Reset Hard Iron Not Successful        `CSxx<CR>`

---

## 5.5.2 Initiating a User Calibration

There are two basic commands for initiating a user calibration, as given below. The Soft/Hard Iron Calibration requires taking 12 calibration samples and corrects for both soft and hard iron distortions. The Hard Iron Calibration requires taking 4 calibration samples and corrects for only changes in hard iron distortions. Initially the coefficients should be reset, and a 12 point Soft/Hard Iron Calibration should be performed (e.g., 12RT Calibration). After this the calibration coefficients can be refined by either performing another 12 point Soft/Hard Iron Calibration without resetting the coefficients (e.g., 12PT Calibration) or by performing a 4-point Hard Iron Calibration (e.g., 4PT Calibration). When the TargetPoint SX is first calibrated in the host system, PNI recommends first performing a 12RT Calibration and immediately following this with a 12PT Calibration.

### Command Strings:

Initiate Soft/Hard Iron Calibration:   `S96<CR>X`  
Initiate Hard Iron Calibration:        `S96<CR>W`

### Response Strings:

After a soft/hard iron or hard iron user calibration is performed, the TargetPoint SX issues a Score Results message indicating the quality of the user calibration. See the tables below.

**Table 5-8: Soft/Hard Iron Calibration Score Results**

Character Number	Value	Description
1	C	Calibration message.
2	S	Frame Start.
3 and 4	01 to 99 (OK) or xx (Bad).	Calibration score. If the score is $\leq 99$ , the calibration coefficients are programmed to non-volatile memory. If the score is $>99$ , "xx" is sent and the coefficients are not programmed. The score should be $\leq 10$ to ensure acceptable accuracy.
5	<CR>	End of frame (Carriage Return).

### 5.5.3 Request Calibration Sample

The Request Calibration Sample command is sent by the host system to the TargetPoint SX to command the TargetPoint SX to take a calibration sample during a user calibration. The host must wait for a Calibration Sample Request Response from the TargetPoint SX before issuing the next sample request.

**Command String:** '\Q'

**Response String:**

See the tables below for the Calibration Sample Request Response message format.

**Table 5-9: Soft/Hard Iron Calibration Sample Request Response**

Character Number	Value	Description
1	S	Frame Start.
2	0 to 1	Current calibration measurement MSD.
3	0 to 9	Current calibration measurement LSD.
4	' '	Space
5	' ' or E	Space = OK, or E = Error
6	<CR>	End of frame (Carriage Return).

**Table 5-10: Hard Iron Calibration Sample Request Response**

Character Number	Value	Description
1	S	Frame Start.
2	0	Current calibration measurement MSD. Note: Always 0.
3	1 to 4	Current calibration measurement LSD.
4	' '	Space
5	' ' or E	Space = OK, or E = Error
6	<CR>	End of frame (Carriage Return).

---

## 5.6 Configuration

The following settings can be configured within the TargetPoint SX, where the default values are also given. Changes can be saved with the Store Startup Configuration command.

- Mounting Orientation (default = Z-axis Down Level Mount)
- Measurement Report Rate (default = 20 Hz)
- Baud Rate (default = 9600)
- Measurement Range (default = 0x7FFF [32767<sub>d</sub>])
- Declination (default = 0)
- Damping (default = 0)
- Coding (default = Hex)
- Gimballing (default = On)

---

### 5.6.1 Set Mounting Orientation

This command is issued by the host system in order to set the TargetPoint SX's mounting orientation to 3 selections. The Z-axis Down Level Mount is factory default setting. To save the new mounting option for the next power on startup, the S7 command should be issued.

---

**Note:** Whenever the TargetPoint SX's mounting orientation is changed, the user must immediately perform a successful 12RT calibration. Only a successful 12RT calibration will save the new mounting orientation to the TargetPoint SX's non-volatile memory.

---



**Command Strings:**

```
Set Z-axis Down Level Mount:    `S63<CR>`  
Set Z-axis Up Level Mount:      `S64<CR>`  
Set Side Mount Left:           `S65<CR>`
```

**Response Strings:** none

---

## 5.6.2 Get Mounting Orientation

This command is issued by the host system to query the module's mounting orientation.

**Command String:** `S6?<CR>`**Response Strings:**

```
Z-axis Down Level mount:        `S63<CR>`  
Z-axis Up Level mount:          `S64<CR>`  
Side mount Left:               `S65<CR>`
```

---

## 5.6.3 Baud Rate

The Baud Rate command is sent by the host system to configure the TargetPoint SX's data communication rate. This command must be followed by a Store Startup Configuration command to permanently store the desired baud rate. Note that one must sequentially step through all the baud rates between the current and the desired rate. It is not possible to jump from e.g., 9600 to 38400 (or reverse).

**Command Strings in Hex:**

```
Set Baud Rate 300:              `SB012C<CR>`  
Set Baud Rate 600:              `SB0258<CR>`  
Set Baud Rate 1200:             `SB04B0<CR>`  
Set Baud Rate 2400:             `SB0960<CR>`  
Set Baud Rate 4800:             `SB12C0<CR>`  
Set Baud Rate 9600:             `SB2580<CR>`  
Set Baud Rate 19200:            `SB4B00<CR>`  
Set Baud Rate 38400:            `SB9600<CR>`
```

**Command Strings in Dec:**

```
Set Baud Rate 300:              `SB0300<CR>`  
Set Baud Rate 600:              `SB0600<CR>`  
Set Baud Rate 1200:            `SB1200<CR>`
```

```

Set Baud Rate 2400:  `SB2400<CR>'
Set Baud Rate 4800:  `SB4800<CR>'
Set Baud Rate 9600:  `SB9600<CR>'
Set Baud Rate 19200: `SB1920<CR>'
Set Baud Rate 38400: `SB3840<CR>'

```

**Response String:** none

## 5.6.4 Set Reporting Rate

This command sets the measurement data reporting rate of the TargetPoint SX. The reporting rate is set as time interval which is the data integration time in seconds for the TPSX to sample data for one measurement. The integration time is calculated as (value/10)s.

**Table 5-11: Set Data Integration Time in Hex**

Character Number	Value	Description
1	S	Frame Start.
2	4	Set time interval value.
3 to 4	00 to F0 00 = 0.05s	Integration time value 0.1 to 24s.
5	<CR>	End of message frame (carriage return).

**Table 5-12: Set Data Integration Time in Dec**

Character Number	Value	Description
1	S	Frame Start.
2	4	Set time interval value.
3 to 5	000 to 240 000 = 0.05s	Integration time value 0.1 to 24s.
6	<CR>	End of message frame (carriage return).

Following examples show how to set the TargetPoint SX with 1, 2, 10, and 20 Hz reporting rates.

**Command Strings in Hex:**

```
1 Hz report rate:    `S40A<CR>'
2 Hz report rate:    `S405<CR>'
10 Hz report rate:   `S401<CR>'
20 Hz report rate:   `S400<CR>'
```

**Command Strings in Dec:**

```
1 Hz report rate:    `S4010<CR>'
2 Hz report rate:    `S4005<CR>'
10 Hz report rate:   `S4001<CR>'
20 Hz report rate:   `S4000<CR>'
```

**Response Strings:** none

---

**Note:** The reporting rate must not exceed 2 Hz when performing a user calibration. The measurement response time to a Request Measurement command is based on the programmed report rate (1 Hz rate = 1 second, 2 Hz rate = 500ms).

---

### 5.6.5 Set Measurement Range

The Set Measurement Range command is sent by the host system to set the circle division units (resolution) reported back for azimuth, elevation and bank. The default measurement range value used by the TargetPoint SX is 0x7FFF.

**Table 5-13: Set Measurement Range**

Character Number	Value	Description
1	S	Frame Start.
2	3	Set Measurement Range value.
3 to 6	0002 to 7FFF (Hex) 0002 to 9999 (Dec)	Measurement Range in hexadecimal or decimal value.
7	<CR>	End of message frame (carriage return).

---

## 5.6.6 Set Declination

The Set Declination command is sent by the host system to set declination value. The measurement range must be considered to decide the declination value. The default declination value used by the TargetPoint SX is 0.

The deviation of the compass from true north is an angle called "declination" (or "magnetic declination"). NOAA has an [online calculator](#) for estimating the declination at any longitude/latitude on a specific date.

**Table 5-14: Set Declination**

Character Number	Value	Description
1	S	Frame Start.
2	1 or 2	Sign, 1 positive value, 2 negative
3 to 6	0000 to 7FFF (Hex) 0000 to 9999 (Dec)	Declination value
7	<CR>	End of message frame (carriage return).

Declination is saved as a value, not an angle. Following example shows how to convert it to angle. Measurement range setting is a key factor for the calculation. If Measurement range is changed by host system, the declination value should be changed by host too. TargetPoint SX just adds or subtracts the value from azimuth based on its sign, no other conversion is involved.

For example:

S37FFF<CR> Measurement range 7FFF=32767 is 360°

S101FF<CR> Declination positive 1FF=511 value, is  $5.61^{\circ} = (511/32767)*360$

---

## 5.6.7 Set Damping Coefficient

The damping coefficient controls the moment of inertia of a compass needle. The bigger the value, the longer time and more oscillation it will take for the compass needle to settle down at its equilibrium position. The default damping value used by the TargetPoint SX is 0.

**Table 5-15: Set Damping Coefficient**

Character Number	Value	Description
1	S	Frame Start.
2	5	Set damping factor
3 to 4	00 to FF (Hex) 00 to 99 (Dec)	Damping coefficient value 0 and 1 no damping
5	<CR>	End of message frame (carriage return).

---

## 5.6.8 Set Coding in Decimal or Hexadecimal

The set coding command is issued by the host system to set TargetPoint SX in hexadecimal or decimal coding.

**Table 5-16: Set Coding**

Character Number	Value	Description
1	S	Frame Start.
2	8	Set coding
3	1 or 2	1 decimal, 2 hex coding
4	<CR>	End of message frame (carriage return).

---

## 5.6.9 Set Gimbaling On or Off

The set gimbaling command is issued by the host system to set TargetPoint SX gimbaling on or off.

**Table 5-17: Set Gimbaling**

Character Number	Value	Description
1	S	Frame Start.
2	6	Set coding
3	1 or 2	1 On, 2 Off
4	<CR>	End of message frame (carriage return).

---

## 5.6.10 Store Startup Configuration

The Store Startup Configuration command is issued by the host system to store the following current TargetPoint SX configuration parameters:

- Operation Mode
- Mounting Orientation
- Baud Rate
- Reporting Rate
- Measurement Range
- Declination
- Damping
- Coding
- Gimbaling

**Command String:** `\S7<CR>`

**Response String:** none

---

## 5.6.11 Reset

The Reset command is issued by the host system to reset the TargetPoint SX to its last saved configuration state. The stored configuration parameters include the following:

- Mounting Orientation
- Baud Rate

- Reporting Rate
- Measurement Range
- DeclinationR
- Damping
- Coding
- Gimballing

**Command String:** `R`

**Response String:** none

---

*Note: The host system should wait at least 100ms before issuing TargetPoint SX commands immediately following a TargetPoint SX Reset command and at least 800 ms immediately following a TargetPoint SX Power Up.*

---

## 5.7 TargetPoint SX Command/Response Examples

The following sections list the commands generated by the host system and responses generated by the TargetPoint SX for TargetPoint SX initialization, status, measurement and calibration.

### 5.7.1 Initialization

A typical TargetPoint SX initialization is as follows:

```

CMD      - RESET
CMD      - SET REPORTING RATE: 2.00 Hz
CMD      - SET MEASUREMENT RANGE: 7FFF
CMD      - SELECT OPERATION MODE: 3
CMD      - SET MOUNTING ORIENTATION: LEVEL

```

The following listing is an initialization that checks, changes and saves the TargetPoint SX attitude.

```

CMD      - RESET
CMD      - SET REPORTING RATE: 2.00 Hz
CMD      - SET MEASUREMENT RANGE: 7FFF
CMD      - SELECT OPERATION MODE: 3
CMD      - GET MOUNTING ORIENTATION
RESP     - Mounting Orientation: SIDE
CMD      - SET MOUNTING ORIENTATION: LEVEL
CMD      - STORE START-UP CONFIGURATION
CMD      - RESET

```

```
CMD      - GET MOUNTING ORIENTATION
RESP     - Mounting Orientation: LEVEL
```

Note that the 'Store Startup Configuration' command in the listing above results in the default TargetPoint SX mounting orientation of Level after issuing a 'Reset' command.

---

## 5.7.2 Status

The following shows a transaction between the host system and the TargetPoint SX during initialization, whereby the TargetPoint SX is queried for status.

```
CMD      - RESET
CMD      - SET REPORTING RATE: 2.00 Hz
CMD      - SET MEASUREMENT RANGE: 7FFF
CMD      - SELECT OPERATION MODE: 3
CMD      - GET MOUNTING ORIENTATION
RESP     - Mounting Orientation: LEVEL
CMD      - REQUEST STATUS
RESP     - Status Output:
           Software Version      : 01
           Hardware Version      : 01
           Unused                : 0000
           Measurement Time      : 05
           Unused                : 00
           Measurement Range      : 7FFF
           Temperature (C)       : 19
           Operation Mode        : 3
           CPU Status            : FF
           Temperature Status     : FF
```

---

## 5.7.3 Measurement

The following listing shows a transaction between the host system and the TargetPoint SX, whereby the TargetPoint SX is initialized and then queried for measurement output of azimuth, elevation, and bank data:

```
CMD      - RESET
CMD      - SET REPORTING RATE: 2.00 Hz
CMD      - SET MEASUREMENT RANGE: 7FFF
CMD      - SELECT OPERATION MODE: 3
CMD      - GET MOUNTING ORIENTATION
RESP     - Mounting Orientation: LEVEL
```



CMD - REQUEST MEASUREMENT  
RESP - Measurement Output.

Note: Selecting Operation Mode 1 in lieu of Operation Mode 3 produces a continuous stream of measurement output from the TargetPoint SX at the initialized reporting rate. For Operation Mode 1, the user does not issue a Measurement Data Request.

---

## 5.7.4 12RT and 12PT Calibration

The following commands and responses illustrate a 12RT Calibration with measurement reporting between calibration sample requests. The 12PT Calibration would be identical to the 12RT Calibration except the first two commands to reset the hard iron and soft/hard iron coefficients would be omitted. For best results, first run a 12RT Calibration and immediately after this run a 12PT Calibration.

---

**Note:** *The programmed reporting rate must not exceed 2 Hz during a user calibration. The measurement output response time to a Request Measurement command is based on the programmed report rate (1 Hz rate = 1 second, 2 Hz rate = 500ms).*

---

### Sequence of commands and responses:

CMD - RESET HARD IRON COEFFICIENTS  
RESP - Hard Iron Calibration Reset Successful.  
CMD - RESET SOFT/HARD IRON COEFFICIENTS  
RESP - Soft/Hard Iron Calibration Reset Successful.  
CMD - RESET  
CMD - INITIATE SOFT/HARD IRON CALIBRATION  
CMD - REQUEST MEASUREMENT  
RESP - Measurement Output.  
CMD - REQUEST CALIBRATION SAMPLE  
RESP - Soft/Hard Iron Cal. Current Measurement: 01  
CMD - REQUEST MEASUREMENT  
RESP - Measurement Output.  
CMD - REQUEST CALIBRATION SAMPLE  
RESP - Soft/Hard Iron Cal. Current Measurement: 02  
CMD - REQUEST MEASUREMENT  
RESP - Measurement Output.  
CMD - REQUEST CALIBRATION SAMPLE  
RESP - Soft/Hard Iron Cal. Current Measurement: 03  
CMD - REQUEST MEASUREMENT  
RESP - Measurement Output.  
CMD - REQUEST CALIBRATION SAMPLE

```

RESP - Soft/Hard Iron Cal. Current Measurement: 04
CMD - REQUEST MEASUREMENT
RESP - Measurement Output.
CMD - REQUEST CALIBRATION SAMPLE
RESP - Soft/Hard Iron Cal. Current Measurement: 05
CMD - REQUEST MEASUREMENT
RESP - Measurement Output.
CMD - REQUEST CALIBRATION SAMPLE
RESP - Soft/Hard Iron Cal. Current Measurement: 06
CMD - REQUEST MEASUREMENT
RESP - Measurement Output.
CMD - REQUEST CALIBRATION SAMPLE
RESP - Soft/Hard Iron Cal. Current Measurement: 07
CMD - REQUEST MEASUREMENT
RESP - Measurement Output.
CMD - REQUEST CALIBRATION SAMPLE
RESP - Soft/Hard Iron Cal. Current Measurement: 08
CMD - REQUEST MEASUREMENT
RESP - Measurement Output.
CMD - REQUEST CALIBRATION SAMPLE
RESP - Soft/Hard Iron Cal. Current Measurement: 09
CMD - REQUEST MEASUREMENT
RESP - Measurement Output.
CMD - REQUEST CALIBRATION SAMPLE
RESP - Soft/Hard Iron Cal. Current Measurement: 10
CMD - REQUEST MEASUREMENT
RESP - Measurement Output.
CMD - REQUEST CALIBRATION SAMPLE
RESP - Soft/Hard Iron Cal. Current Measurement: 11
CMD - REQUEST MEASUREMENT
RESP - Measurement Output.
CMD - REQUEST CALIBRATION SAMPLE
RESP - Soft/Hard Iron Cal. Current Measurement: 12
RESP - Soft/Hard Iron Cal Score = 5. Stored to non-
      volatile memory.

```

Following the TargetPoint SX's response to the final calibration sample request, the user should stop issuing Request Measurement commands to the TargetPoint SX and wait at least 20 seconds for the final score to be reported. It typically takes less than 10 seconds

to determine the score, but the amount of time varies depending on the surrounding environment and the quality of the user calibration.

---

## 5.7.5 4PT Calibration

The following commands and responses illustrate a 4PT Calibration with measurement reporting by the TargetPoint SX between calibration sample requests.

---

**Note:** *The programmed reporting rate must not exceed 2 Hz during a user calibration. The measurement output response time to a Request Measurement command is based on the programmed report rate (1 Hz rate = 1 second, 2 Hz rate = 500ms).*

---

### Sequence of commands and responses:

```
CMD      - RESET
CMD      - INITIATE HARD IRON CALIBRATION
CMD      - REQUEST MEASUREMENT
RESP     - Measurement Output.
CMD      - REQUEST CALIBRATION SAMPLE
RESP     - Hard Iron Cal. Current Measurement: 1
CMD      - REQUEST MEASUREMENT
RESP     - Measurement Output.
CMD      - REQUEST CALIBRATION SAMPLE
RESP     - Hard Iron Cal. Current Measurement: 2
CMD      - REQUEST MEASUREMENT
RESP     - Measurement Output.
CMD      - REQUEST CALIBRATION SAMPLE
RESP     - Hard Iron Cal. Current Measurement: 3
CMD      - REQUEST MEASUREMENT
RESP     - Measurement Output.
CMD      - REQUEST CALIBRATION SAMPLE
RESP     - Hard Iron Cal. Current Measurement: 4
RESP     - Hard Iron Cal Score = 1. Stored to non-volatile
          memory.
```

Following the TargetPoint SX's response to the final calibration sample request, the user should stop issuing Request Measurement commands to the TargetPoint SX and wait at least 20 seconds for the final score to be reported. It typically takes less than 10 seconds to determine the score, but the amount of time varies depending on the surrounding environment and the quality of the user calibration.

---

## 6. User Calibration

The magnetic sensors in the TargetPoint SX are factory calibrated in a magnetically controlled environment. Consequently, sources of magnetic distortion positioned near the TargetPoint SX in the user's system will distort Earth's magnetic field and should be compensated for. Examples of such sources include ferrous metals and alloys (ex. iron, nickel, non-stainless steel, etc.), batteries, audio speakers, current-carrying wires, and electric motors. Compensation is accomplished by user calibrating the module while mounted in the user's system. It is expected the sources of magnetic distortion will remain fixed relative to the module's position within the user's system. By performing a user calibration, the TargetPoint SX identifies the local sources of magnetic distortion within the host system and negates their effects from the overall reading to provide an accurate compass heading. Both hard iron and soft iron sources can be compensated for, wherein hard iron sources generate a magnetic field and soft iron sources distort an existing field. For additional information on this, see PNI's white paper "Local Magnetic Distortion Effects on 3-Axis Compassing", which can be found at [www.pnicorp.com](http://www.pnicorp.com).

The TargetPoint SX provides three methods of calibration, termed 12RT Calibration, 12PT Calibration and 4PT Calibration. 12RT Calibration and 12PT Calibration compensate for hard and soft iron distortions in the host system, and store both hard iron and soft iron calibration coefficients after completing the calibration routine. For 12RT Calibration, the existing soft iron and hard iron calibration coefficients are reset to factory-generated values prior to running the calibration routine, while 12PT Calibration refines the existing calibration coefficients. The only difference between 12RT Calibration and 12PT Calibration is that the calibration coefficients are reset for 12RT Calibration and they are not reset for 12PT Calibration. A 12RT Calibration should be run when the module is first calibrated in the host system and whenever significant changes in the local magnetic field occur. A 12PT Calibration can be run when the local field has not changed significantly. For best results, run a 12RT Calibration and immediately follow this with a 12PT Calibration. The 4PT Calibration is a relatively quick procedure to update the hard iron coefficients of a prior calibration. A 4PT Calibration is particularly useful to compensate for changes in the magnetic signature of a gun barrel after it has been fired.

The order of calibration points doesn't matter, and the best performance will have the sample points evenly distributed on a circle of 360° as azimuth and tilt angle equal or bigger than  $\pm 30^\circ$  on each point.

For 12RT and 12PT Calibrations, 12 calibration samples are taken with the first 6 samples collected at +30° elevation, 0° bank, and in 60° azimuth increments. The remaining 6 samples are collected at -30° elevation, 0° bank, and in the same 60° azimuth increments. See Figure 6-1 below. PNI recommends performing 12RT and 12PT Calibrations on a gimballed fixture. For 4PT

Calibration, 4 calibration samples are collected at 90° azimuth increments with the compass kept at 0° bank and alternating between +30° and -30° elevation.

---

**Note:** The programmed sample rate must not exceed 2 Hz during a user calibration. The measurement output response time to a Request Measurement command is based on the programmed report rate (1 Hz rate = 1 second, 2 Hz rate = 500ms).

---

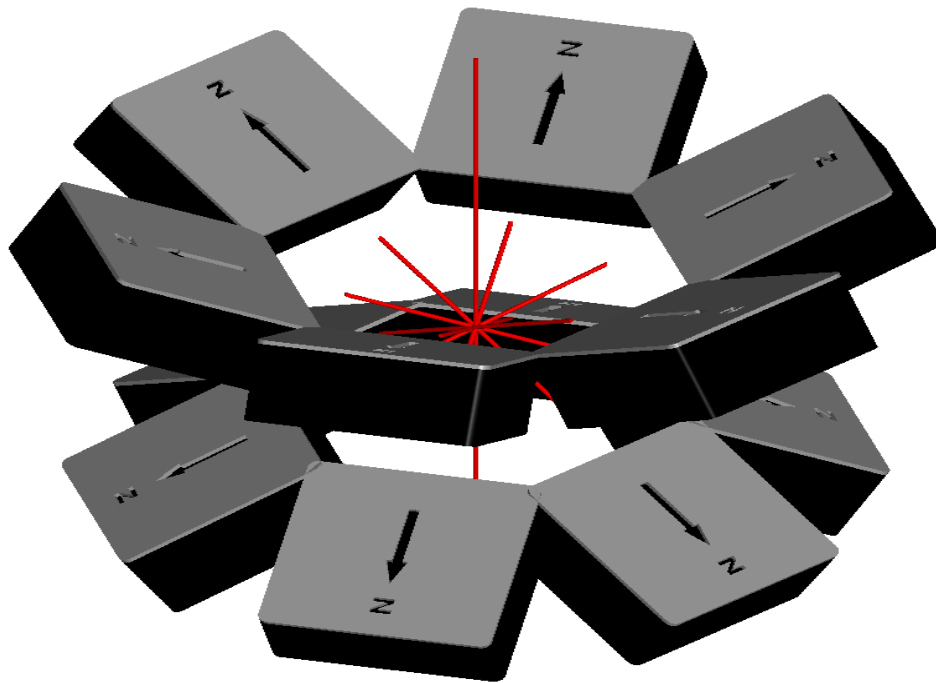


Figure 6-1: 12RT and 12PT Calibration Pattern

**Table 6-1: 12RT and 12PT Calibration Pattern**

Sample #	Azimuth	Elevation	Bank
First Circle			
1	0°	+30°	0°
2	60°	+30°	0°
3	120°	+30°	0°
4	180°	+30°	0°
5	240°	+30°	0°
6	300°	+30°	0°
Second Circle			
7	0°	-30°	0°
8	60°	-30°	0°
9	120°	-30°	0°
10	180°	-30°	0°
11	240°	-30°	0°
12	300°	-30°	0°

**Table 6-2: 4PT Calibration Pattern**

Sample #	Azimuth	Elevation	Bank
1	0°	+30°	0°
2	90°	-30°	0°
3	180°	+30°	0°
4	270°	-30°	0°

---

## 7. Appendix Demo Program

Two demo programs are available to use with the TargetPoint SX: the TargetPoint Calibration Program and the TargetPoint Studio. Both provide azimuth, elevation, and bank output, but the TargetPoint Calibration Program allows the user to perform a user calibration, while TargetPoint Studio provides the user with sensor data. PNI recommends first running the TargetPoint Calibration Program and performing a user calibration to properly compensate for magnetic distortions in the user's host system.

Both programs put an easy-to-use, graphical-user interface (GUI) onto the ASCII command language used by the TargetPoint SX. The TargetPoint demo programs also include the ability to log and save the outputs of the TargetPoint SX to a file. All of this allows you to quickly understand the capabilities of the TargetPoint SX. Check the PNI website for the latest TargetPoint demo program updates at [www.pnicorp.com](http://www.pnicorp.com).

---

### 7.1 Software Set-Up

The TargetPoint demo programs are provided as .msi files which can be downloaded from PNI's website. They work with Windows 7, and Windows 10 operating systems. Simply copy the files onto your computer, then double click on the files to install the executable programs.

---

### 7.2 Hardware Set-Up

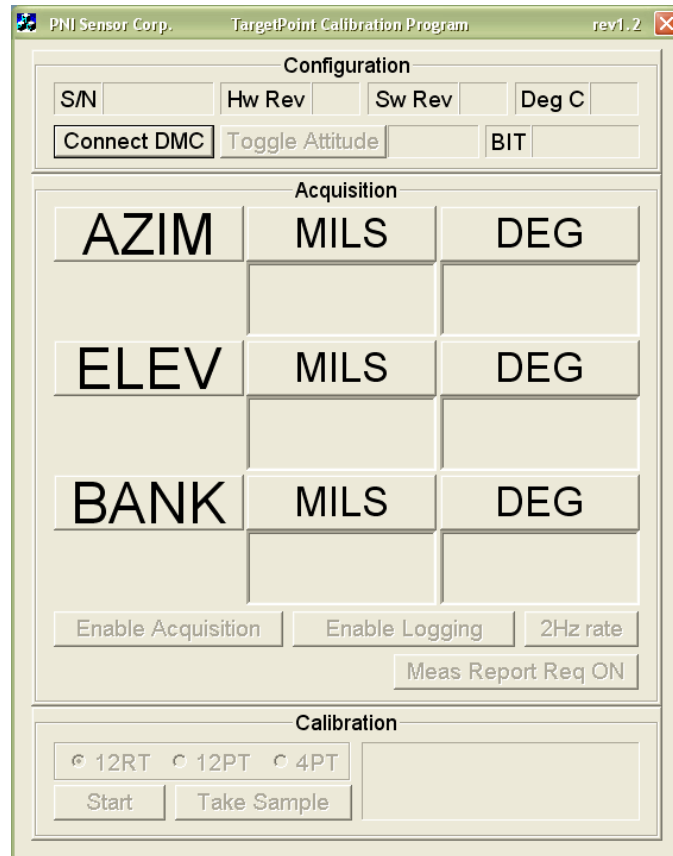
See Section 4.2 for specific issues to consider when mounting or using the TargetPoint SX. Connect a USB to TTL serial cable between a USB port on your computer and TargetPoint SX 4-pin connector. See Section 4.1 for electrical connections.

---

### 7.3 Running the TargetPoint Calibration Program

To help ensure accurate heading output, it is necessary to first calibrate the TargetPoint SX. If you have not already done so, please review Section 7 for general information on calibration and the calibration methods available with the TargetPoint SX. Section 7 explains the differences between calibration methods, when each one is appropriate, and the recommended calibration pattern for each method.

The TargetPoint Calibration Program supports baud rate 9600. If the TargetPoint SX is changed to other baud rates from factory default, please change it to 9600 before running this program. Double-click on the TargetPoint\_Cal\_Program icon. The window shown below will open.



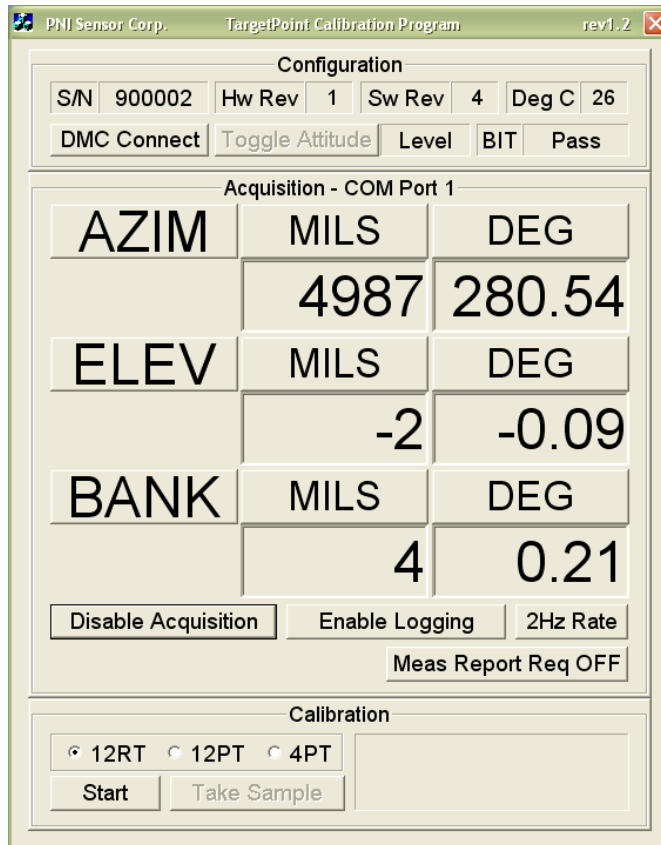
Click the “DMC Connect” button to initiate communication with the TargetPoint SX. The program will automatically scan COM ports 1 to 50, looking for the module. Once the correct port is found, communication with the module will be enabled and the GUI will populate the “S/N”, “Hw Rev”, “Sw Rev”, and “Deg C” fields, plus the “Acquisition” line will identify the appropriate COM port.

After making a connection, the “Toggle Attitude” button will become active and indicate “Level”. If the module is mounted on its side, click the “Toggle Attitude” button and it will now read “90 Deg”. The “90 Deg” means Z-up mount for TPSX.

The “2Hz Rate” button indicates the data rate is set to 2 Hz. Clicking this button changes the data rate to 10 Hz and the button will now read “10Hz Rate”.

To begin outputting data to the screen, first click “Meas Report Req ON”. The button will now say “Meas Report Req OFF”. Next click “Enable Acquisition”. The button will now say “Disable Acquisition”. The azimuth, elevation, and bank fields should now be populated, as shown in the example below.





### 7.3.1 Performing a Calibration

See Section 6 for general information on calibration and the calibration methods available with the TargetPoint SX. Section 6 explains the differences between the methods, when each one is appropriate, and the specific calibration pattern for each method.

To perform a calibration in the TargetPoint Calibration Program it is necessary that data acquisition and measurement reporting are enabled, such that orientation data is now streaming on the screen. To start the calibration, first select the desired type of calibration to be performed (“12RT”, “12PT”, or “4PT”), then click the “Start” button. The “Start” button will now change to “Stop”, and the calibration can be aborted anytime by clicking the “Stop” button. During the user calibration, the Azimuth, Elevation, and Bank values are updated. Note that the data rate will be 1 Hz during calibration, regardless of the “...Rate” button. To take a calibration sample, click the “Take Sample” button. After clicking this button, it becomes disabled and the orientation data is halted while the TargetPoint SX records the sample. Once the calibration sample is recorded the “Take Sample” button becomes active and the calibration status box is updated with the last acquired sample. Now another sample may be taken. Note that the TargetPoint SX needs to be completely still when clicking “Take Sample”. Also, it is best if the module’s location remains fixed while the orientation is changed. Once the final calibration sample has been

taken, the program will calculate the calibration score. An acceptable calibration score is  $\leq 10$ .

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### 7.3.2 Logging Data

To log data in the TargetPoint Calibration Program, first ensure both the “Enable Acquisition” and the “Meas Report Req ON” buttons have been selected, such that orientation data is now streaming on the screen. Next click the “Enable Logging” button. The button will now say “Disable Logging”. Once you have logged your data, click the “Disable Logging” button. A .txt file will be created in the same folder where the TargetPoint\_Cal\_Program.exe resides. The log file contains azimuth, elevation, and bank outputs in raw units, degrees, and mils. Data is logged every 500 ms (2 Hz).

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### 7.3.3 Restoring Configuration Settings to Factory Default

After the TargetPoint Calibration Program is executed, the following configuration settings of TargetPoint SX will be reset to factory default.

- Mounting Orientation (default = Z-axis Down Level Mount)
- Measurement Report Rate (default = 2 Hz)
- Measurement Range (default = 0x7FFF [32767<sub>d</sub>])

*Note the following settings are not reset to factory default by this program*

- *Declination*
- *Coding*
- *Damping*
- *Gimballing*