PaXini PX-6AX GEN 3 Series Multidimensional Tactile Sensor

User Manual

Model

DP -S1813-Elite PXSR-STDDP03F
DP -S2015-Elite PXSR-STDDP03G
IP -S1610-Elite PXSR-STDIP03B
MC -M2020-Elite PXSR-STDMC03A

DP -S1813-Core PXSR-STDDP03D
DP -S2716-Core PXSR-STDDP03C
DP -S3013-Core PXSR-STDDP03E
IP -M2324-Core PXSR-STDIP03A
CP -M3025-Core PXSR-STDCP03B

DP -M2826-Omega PXSR-STDDP03B
DP -L3530-Omega PXSR-STDDP03A
CP -L5325-Omega PXSR-STDCP03A

PaXini Technology

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Catalogue

1. Overview

1.1 Introduction

The Paxini PX-6AX GEN3 Multidimensional Tactile Sensors are highly integrated sensors feature three-dimensional tactile capabilities, integrating several key functions within a single compact unit. These functions include sensor signal sampling, signal processing, multidimensional tactile algorithms, and communication transmission.

Main Features: The integration of this sensor into a robotic hand facilitates the collection and interpretation of tactile data, enhancing the robot's sensory capabilities. This advancement allows robots to discern surface textures and object interactions, leading to improved environmental awareness and refined manipulation skills. The sensor's versatility supports a wide array of tasks and environments, while its sophisticated hardware and algorithms enable adaptive and intelligent robotic operations.

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How It Works: PX-6AX GEN3 Multidimensional Tactile Sensor Series operates on a semi-flexible design that leverages the Hall effect for precise force distribution measurements and multidimensional force data. It features a dual-layered architecture with a pliable layer for deformation-induced magnetic field alterations and a rigid sensing layer for high-fidelity force and tactile data acquisition, processed through an integrated algorithm. The tactile sensor's Anti-Stray Magnetic Field Function discerns and isolates force-induced magnetic signals from environmental interference. Utilizing advanced algorithms, the Hall sensors' data is refined to eliminate external magnetic influences, guaranteeing the integrity and precision of the signal outputs.

1.2 Specification

Model	DP-S1813-Elite PXSR-STDDP03F	DP-S2015-Elite PXSR-STDDP03G	IP -S1610-Elite PXSR-STDIP03B	MC-M2020-Elite PXSR-STDMC03A
Output Signals	Triaxial force array and Triaxial resultant force	Triaxial force array and Triaxial resultant force	Triaxial force array and Triaxial resultant force	Triaxial force array and Triaxial resultant force
Dimensions (mm)	18x13x10	20x15x10	16x10x8	20x20x8
Number of Force Signals in Array	31	52	25	9
Range of Force	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N
Measurement Accuracy	1% FS	1% FS	1% FS	1% FS
Minimum Detectable Force	0.1 N	0.1 N	0.1 N	0.1 N
Spatial Resolution	1 mm	1 mm	1 mm	1 mm
Anti-Magnetic	YES *	YES *	YES *	YES *
Output Frequency	83.3 Hz	83.3 Hz	83.3 Hz	83.3 Hz
Safe Load	200%	200%	200%	200%
Shock Overload	300%	300%	300%	300%
Service Life	Supports over 10 million cycles*	Supports over 10 million cycles*	Supports over 10 million cycles*	Supports over 10 million cycles*
Operating Voltage	3 ~ 5 V	3 ~ 5 V	3 ~ 5 V	3 ~ 5 V
Maximum Operating Current	150 mA	150 mA	150 mA	100 mA

*Please refer to the official experimental specifications provided by Paxini.

Model	DP-S1813-Core PXSR-STDDP03D	DP-S2716-Core PXSR-STDDP03C	DP-S3013-Core PXSR-STDDP03E	IP-M2324-Core PXSR-STDIP03A
Output Signals	Triaxial force array and Triaxial resultant force	Triaxial force array and Triaxial resultant force	Triaxial force array and Triaxial resultant force	Triaxial force array and Triaxial resultant force
Dimensions (mm)	18x13x10	27x16x13	30x13x10	23x24x8
Number of Force Signals in Array	51	116	96	68
Range of Force	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N
Measurement Accuracy	1% FS	1% FS	1% FS	1% FS
Minimum Detectable Force	0.1 N	0.1 N	0.1 N	0.1 N
Spatial Resolution	1 mm	1 mm	1 mm	1 mm
Anti-Magnetic	YES *	YES *	YES *	YES *
Output Frequency	83.3 Hz	83.3 Hz	83.3 Hz	83.3 Hz
Safe Load	200%	200%	200%	200%
Shock Overload	300%	300%	300%	300%
Service Life	Supports over 10 million cycles*	Supports over 10 million cycles*	Supports over 10 million cycles*	Supports over 10 million cycles*
Operating Voltage	3 ~ 5 V	3 ~ 5 V	3 ~ 5 V	3 ~ 5 V
Maximum Operating Current	200 mA	300 mA	300 mA	350 mA

Model	CP-M3025-Core PXSR-STDCP03B	DP-M2826-Omega PXSR-STDDP03B	DP-L3530-Omega PXSR-STDDP03A	CP-L5325-Omega PXSR-STDCP03A
Output Signals	Triaxial force array and Triaxial resultant force	Triaxial force array and Triaxial resultant force	Triaxial force array and Triaxial resultant force	Triaxial force array and Triaxial resultant force
Dimensions (mm)	30x25x8	28x26x14	35x30x15	53x25x8
Number of Force Signals in Array	77	127	135	239
Range of Force	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N	Normal Fz:0 ~ 25 N Tangential Fxy:± 10 N
Measurement Accuracy	1% FS	1% FS	1% FS	1% FS
Minimum Detectable Force	0.1 N	0.1 N	0.1 N	0.1 N
Spatial Resolution	1 mm	1 mm	1 mm	1 mm
Anti-Magnetic	YES *	YES *	YES *	YES *
Output Frequency	83.3 Hz	83.3 Hz	83.3 Hz	83.3 Hz
Safe Load	200%	200%	200%	200%
Shock Overload	300%	300%	300%	300%
Service Life	Supports over 10 million cycles*	Supports over 10 million cycles*	Supports over 10 million cycles*	Supports over 10 million cycles*
Operating Voltage	3 ~ 5 V	3 ~ 5 V	3 ~ 5 V	3 ~ 5 V
Maximum Operating Current	350 mA	400 mA	400 mA	700 mA

2 . Before You Start

2.1 Precautions

When using tactile sensors, here are some considerations to keep in mind:

1. **Cleaning and Maintenance:** Regularly clean the tactile sensors to remove dust, grease, or stains. Follow the cleaning guidelines provided by the manufacturer, using appropriate cleaning agents and tools. Avoid using overly abrasive cleaners to prevent damage to the sensor.
2. **Environmental Adaptation:** Tactile sensors may be sensitive to environmental conditions. Ensure that the sensors are used under suitable temperature, humidity, and other environmental conditions. Avoid exposure to excessively high or low temperatures, humidity levels, or other adverse environmental factors.
3. **Waterproof Protection:** If the tactile sensor is used in damp or liquid environments, ensure that the sensor has appropriate waterproof protection. Check that the seals and connections of the sensor are intact, and take necessary protective measures, such as using waterproof covers or sealing compounds. In addition to waterproof protection for the sensor itself, the connector should also be sealed and protected.
4. **Pay Attention to Power and Electrical Connections:** When connecting the power and electrical circuits of the tactile sensor, ensure proper connections and follow relevant safety standards and regulations. Avoid power overload, short circuits, or other electrical issues.
5. **Follow Manufacturer Guidelines:** Adhere to the operating manual, safety guidelines, and maintenance recommendations provided by the manufacturer. Different models of tactile sensors may have different requirements and characteristics, so always refer to the relevant manufacturer guidelines to ensure correct use and maintenance of the sensor.
6. **Storage and Transportation:** If storing or transporting tactile sensors, take care to avoid severe vibrations, compression, or other situations that could cause damage to the sensor.

Before using the tactile sensor, be sure to thoroughly read the relevant product documentation and guidelines, and follow the manufacturer's recommendations and instructions.

2.2 Security Warning

Caution: Avoid accidental ingestion by children.
Caution: Prevent the product from getting soaked in water.
Caution: Keep the product away from sources of fire.
Caution: Prevent product debris from splashing into the eyes.

2.3 Disclaimer

This product is a tactile sensor that can be used in normal environments, such as touching, gripping, squeezing, etc. It is not suitable for extreme scenarios, such as poking, burning, knocking, etc. Such actions may damage the functionality and performance of the product, and could even pose a danger. If customers encounter these extreme scenarios while using the product, they should immediately stop using it and contact our customer service personnel. We will do our best to provide you with solutions and services.

In addition, this product is also not suitable for the following extreme scenarios:

1. Immersing the tactile sensor in liquids such as water, oil, acids, or alkalis, which may cause short circuits, corrosion, or oxidation.
2. Exposing the tactile sensor to environments with high temperatures, low temperatures, high humidity, strong light, or strong magnetic fields, which may result in material deformation, aging, or failure.
3. Connecting the tactile sensor to incompatible power supplies, signal sources, or devices, which may cause excessive voltage, current, or interference.
4. Cutting, scratching, tearing, or folding the tactile sensor, which may lead to structural damage, electrode breakage, or signal loss.
5. Using the tactile sensor in unsuitable application scenarios, such as medical, military, or aviation fields, which may lead to safety risks or legal liabilities.

Our company is not responsible for any loss or injury caused by the customer's violation of this disclaimer. Customers are advised to carefully read and agree to this disclaimer before purchasing and using the product.

Our company reserves the final right to interpret the product specifications. If you have any questions or objections, please contact us in a timely manner. Thank you for your support and trust.

2.4 Unboxing Inspection

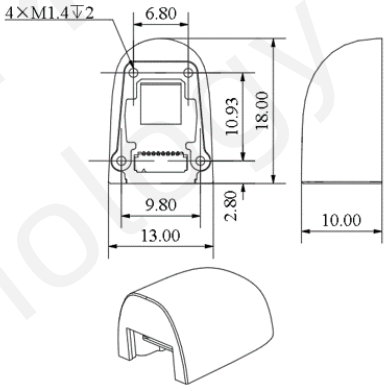
When you receive a new product and proceed with the unboxing inspection, here are some recommended steps:

1. **Check the Packaging:**Inspect the product's external packaging to ensure it is intact and undamaged. If the packaging shows obvious signs of damage or deformation, it may indicate that the product was damaged during transit. Before signing off, you can take photos of the packaging condition as evidence for future reference, should you need to present it to the supplier or logistics company.
2. **Verify Accessories:** Cross-reference the accessories listed on the product packaging or manual to ensure all components are included in the package, with no omissions or damages. If any accessories are missing or damaged, contact the supplier promptly to address the issue.
3. **Inspect the Product Appearance:** Carefully examine the product's appearance to ensure there are no visible scratches, dents, deformations, or other damages. Should any issues arise, immediately contact the supplier and document the damages with photos as evidence.
4. **Safety Precautions:** When conducting any tests or operations, always pay attention to safety precautions. Follow the warnings and safety guidelines outlined in the product manual to ensure a safe and reliable operation process.

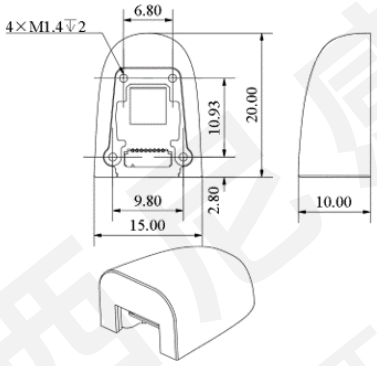
If you encounter any problems, damages, or anomalies during the unboxing inspection, it's advisable to immediately contact the supplier or seller, report the issue, and seek a resolution. Keep all related photos, documents, and communication records for future reference if needed.

3.Dimensions and Installation

3.1 Appearance and Dimensions



DP-S1813-Elite PXSR-STDDP03F



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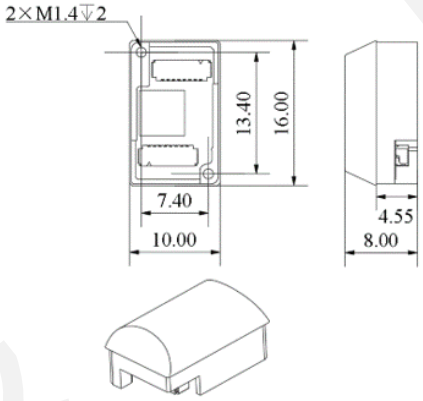
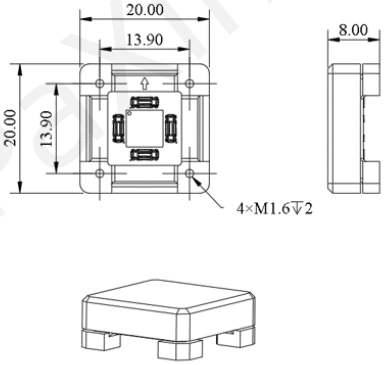
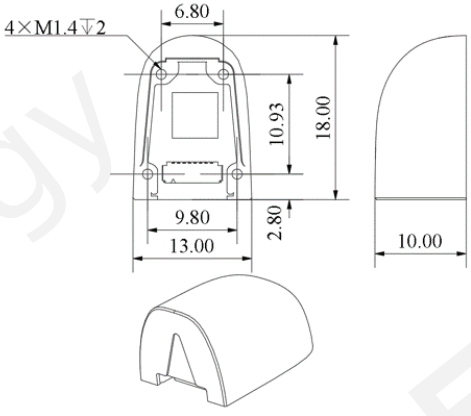


IP -S1610-Elite PXSR-STDIP03B



MC-M2020-Elite PXSR-STDMC03A



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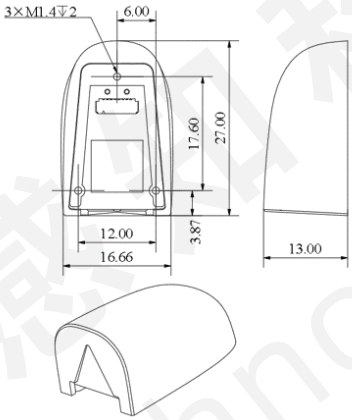
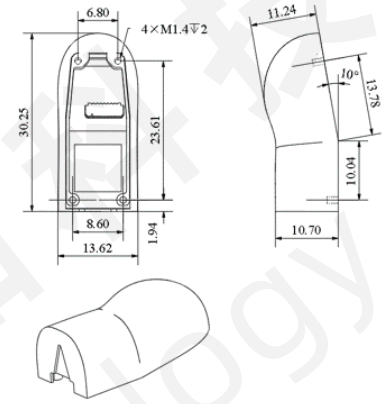


DP-S2716-Core PXSR-STDDP03C

*The linear dimensional tolerance of the positioning holes is ± 0.05mm, and the tolerance of other unmarked dimensions is ± 0.1mm



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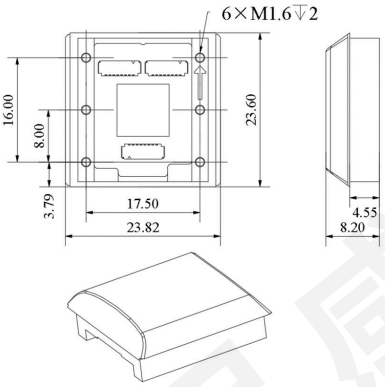

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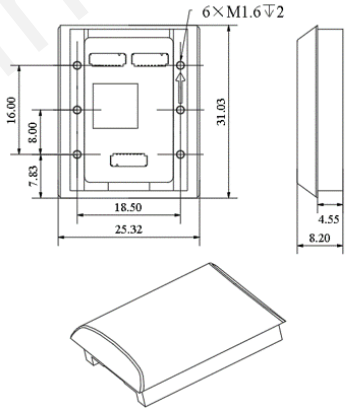

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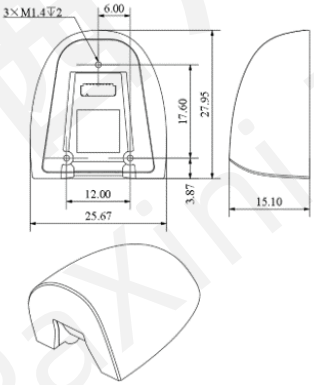

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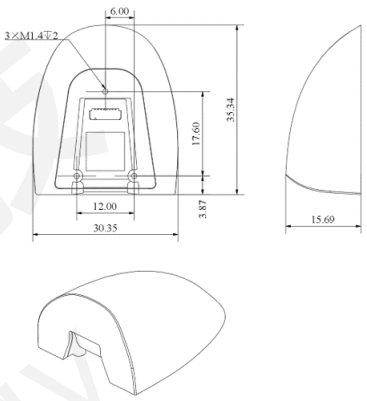

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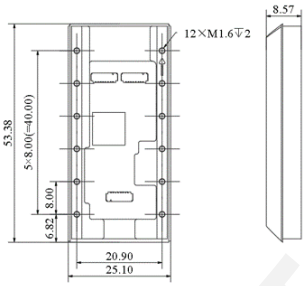


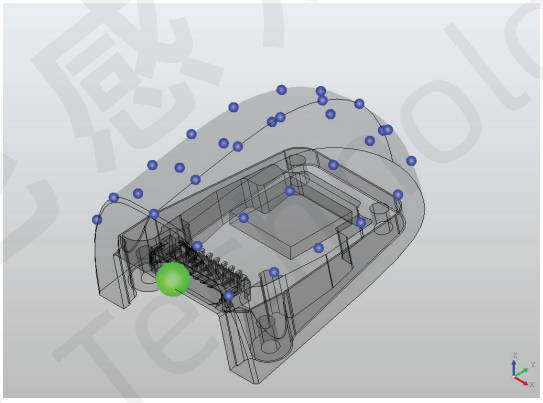
CP-L5325-Omega PXSR-STDCP03A

*The linear dimensional tolerance of the positioning holes is ± 0.05mm, and the tolerance of other unmarked dimensions is ± 0.1mm

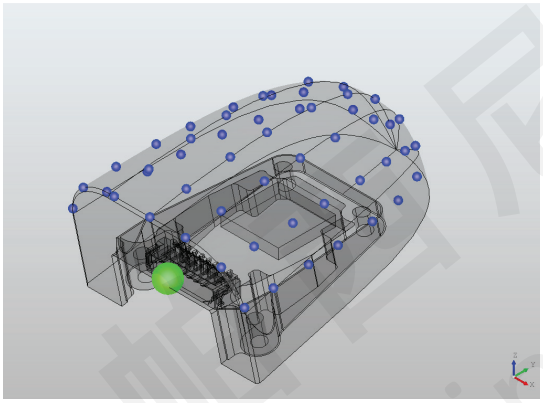
3.2 Coordinate System

Coordinates of Force Signals in Array

The green dot at the tail of the sensor bracket is the origin of the global coordinate system (0,0,0), which is for determining the spatial position of each force signal within the array. The global coordinate position and force signals in array are shown as follows.



DP-S1813-Elite PXSR-STDDP03F



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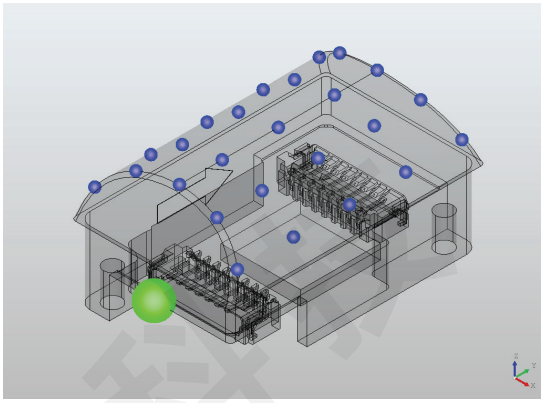

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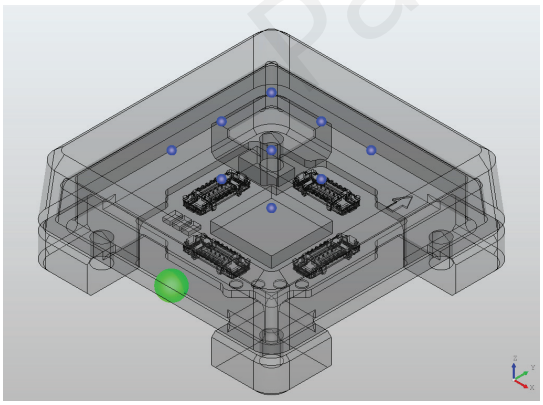
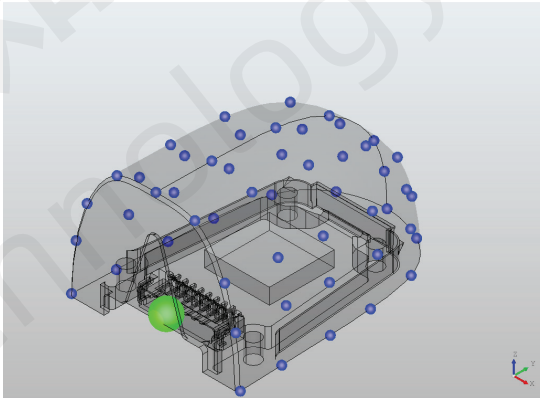
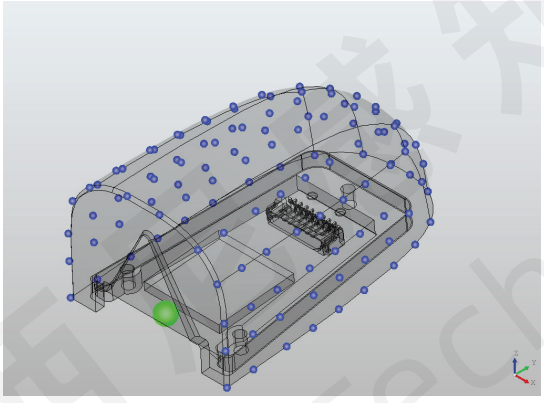


MC-M2020-Elite PXSR-STDMC03A



DP-S1813-Core PXSR-STDDP03D



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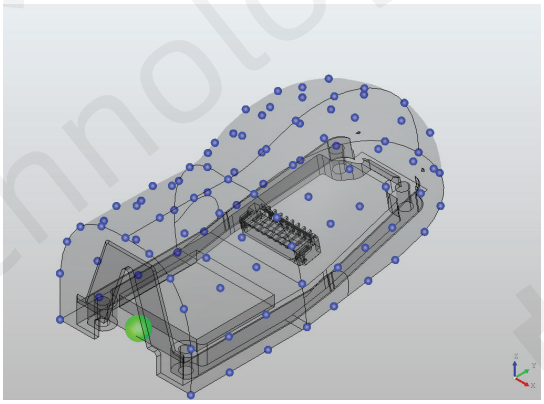

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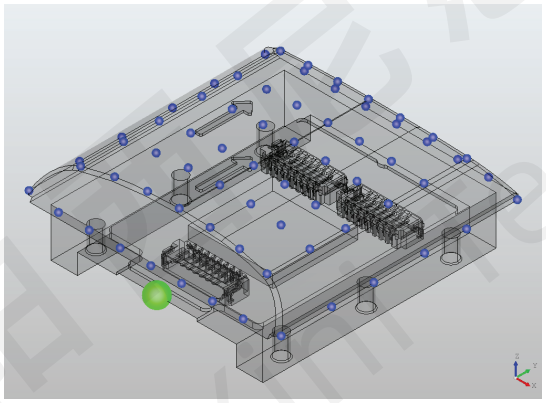

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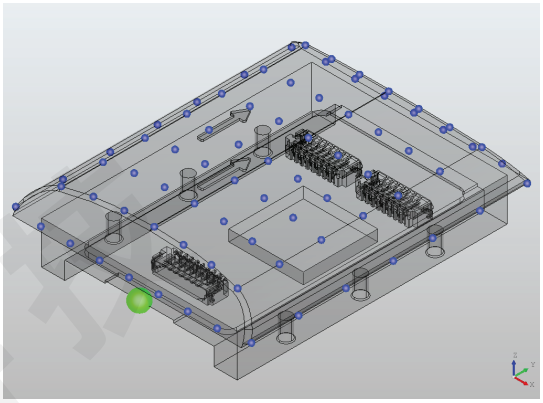
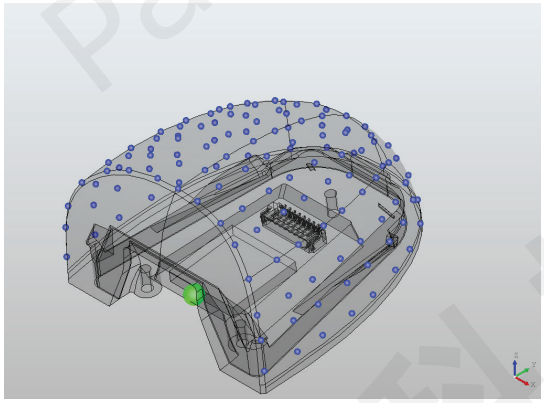
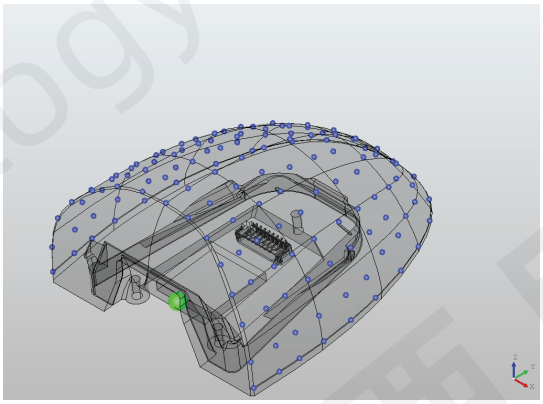


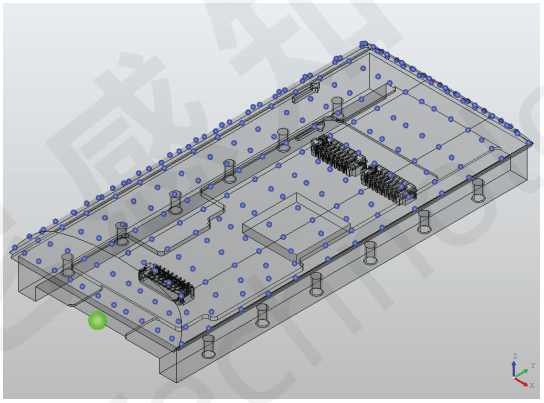
CP-M3025-Core PXSR-STDCP03B



DP-M2826-Omega PXSR-STDDP03B



DP-L3530-Omega PXSR-STDDP03A



CP-L5325-Omega PXSR-STDCP03A

3.3 Device Connection

When using the host computer software, make sure that the sensor is connected to the corresponding communication board. The communication board (optional) is connected to the PC via a USB cable. To update the sensor firmware, there are three methods:

1. Use the 10-channel SPI hub for flashing; note that the sensor needs to be connected to the CN1 port.

2. Use the serial converter board for flashing.

3. Use the high-speed communication board for flashing.

4.Host Computer Software

4.1 Data Visualization

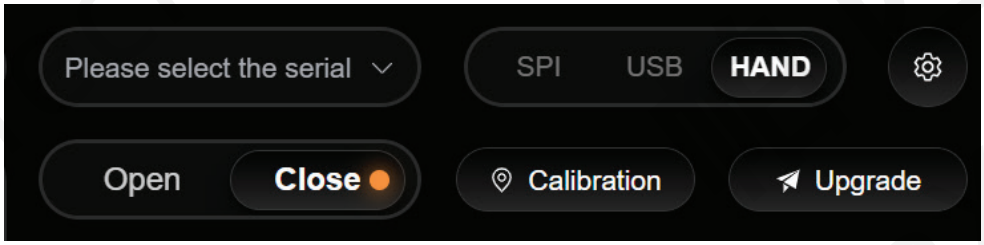
After ensuring that the steps in the 3.3 device connection have been completed, start the pxsr-gen3 software. **Single sensor connection:**

1. Select the communication board (SPI: 10-channel SPI hub; USB: serial converter board; HAND: high-speed communication board).

2. Select the COM port.

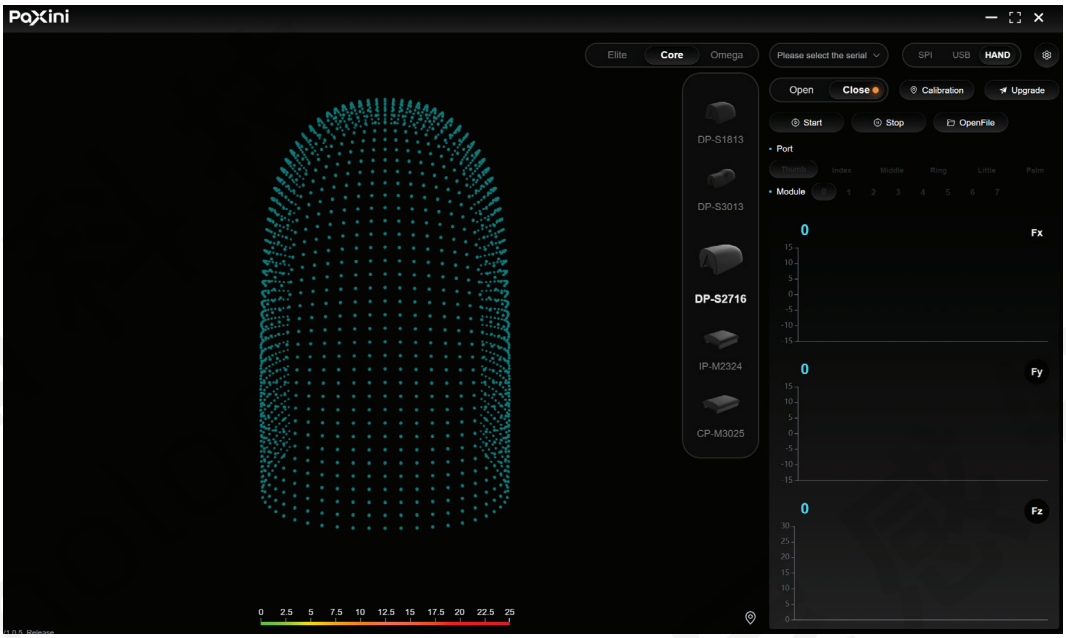
3. Click **[Open]**, and the host computer will automatically identify the sensor model and start the connection with the sensor.

Note: To connect an MC-M2020-Elite sensor via the 10-channel SPI hub, first select the sensor model in pxsr-gen3 software prior to clicking **[Open]**; if connecting to other models of sensors, just confirm that the currently selected model is not MC-M2020.



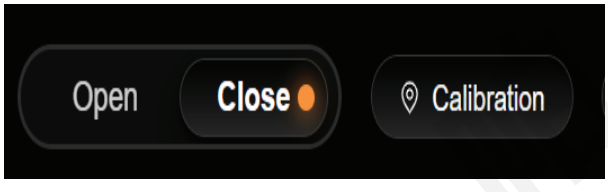
On the right side of the software is the plot of the resultant forces Fx, Fy, Fz over time.

Note: After the sensor is successfully connected, the version information of the sensor will be displayed in the upper right corner and the resultant force curve will also be shown on the right side.



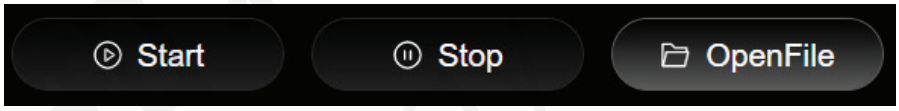
Make sure that when the sensor has no-load, click **[Calibration]** and set the sensor to zero for calibration.

When pressed, the magnitude and the direction of the resultant force will be displayed at the corresponding positions in the UI. The greater the force, the larger the points in the dot matrix.



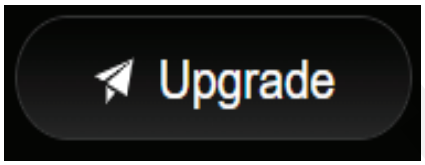
4.2 Data Recording

Click the **[Start]** to begin recording the force data from the sensor. Click **[Stop]** to cease recording. Clicking the **[OpenFile]** will open the folder containing the records.

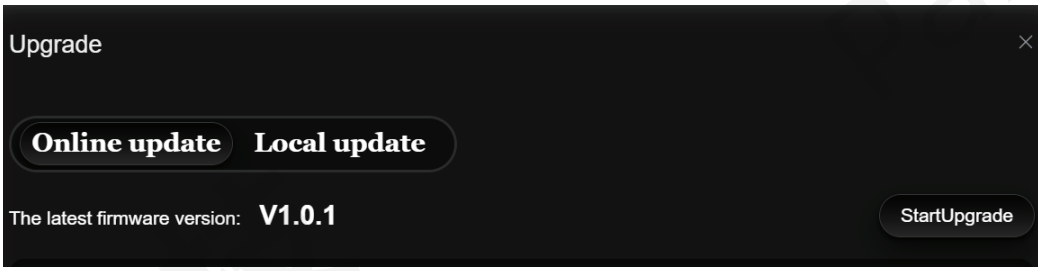


4.3 Firmware Update

Click on **[Upgrade]** to enter the firmware upgrade window. Please reconfirm that the sensor is connected to the CN1 port of the 10-channel SPI hub, or to the serial converter board/high-speed communication board.



Select **[Online update]** , and then click **[Start Upgrade]** to initiate the firmware flashing program.



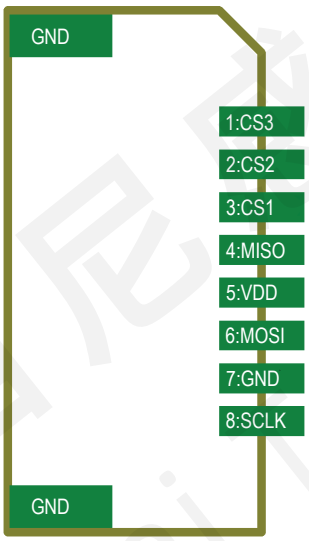
5. Communication Protocol

5.1 Pin Definition

DP-S1813-Elite	**PXSR-STDDP03F**
DP-S2015-Elite	**PXSR-STDDP03G**
DP-S1813-Core	**PXSR-STDDP03D**
DP-S2716-Core	**PXSR-STDDP03C**
DP-S3013-Core	**PXSR-STDDP03E**
DP-M2826-Omega	**PXSR-STDDP03B**
DP-L3530-Omega	**PXSR-STDDP03A**

Connector spec:
DF53-8S-0.6H
8pin Spacing 0.6mm
1P=CS3
2P=CS2
3P=CS1
4P=MISO
5P=VDD
6P=MOSI
7P=GND
8P=SCLK

Note: VDD is 3 to 5V, and the high level of the other pins is 3.3V



IP -S1610-Elite **PXSR-STDIP03B**
IP -M2324-Core **PXSR-STDIP03A**
CP-M3025-Core **PXSR-STDCP03B**
CP-L5325-Omega **PXSR-STDCP03A**

Note: VDD is 3 to 5V, and the high level of the other pins is 3.3V

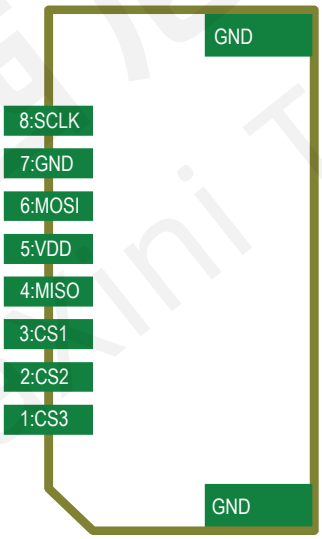
The direction of the arrow on the sensor bracket

OUT
Connector spec:
DF53-8S-0.6H
8pin Spacing 0.6mm

1P=SCLK
2P=GND
3P=MOSI
4P=VDD
5P=MISO
6P=CS1
7P=CS2
8P=CS3

IN
Connector spec:
DF53-8S-0.6H
8pin Spacing 0.6mm

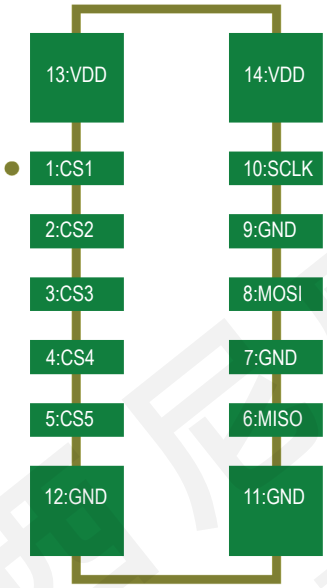
8P=SCLK
7P=GND
6P=MOSI
5P=VDD
4P=MISO
3P=CS1
2P=CS2
1P=CS3



MC-M2020-Elite PXSR-STDMC03A

Connector spec:
BM28B0.6-10DS

1P=CS1
2P=CS2
3P=CS3
4P=CS4
5P=CS5
6P=MISO
7P=GDN
8P=MOSI
9P=GND
10P=SCLK
11P=GND
12P=GND
13P=3V3
14P=3V3



Terminal TOP layer view

5.2 Selection Of Communication Protocols

5.2.1 Protocol Initialization

Protocol selection and initialization will only be carried out when the module is powered on. Once the power-on is successful and the initialization is completed, the protocol will not change.

5.2.2 Settings Protocols

Corresponding protocols	Pin definition			CS3	CS2	CS1
SPI	SPI_CLK	SPI_MISO	SPI_MOSI	1	1	1
UART	UART_TX(slave)	UART_RX(slave)		0	0	0
IIC			SCL	0	0	SDA (1)

The order of address encoding values is CS3\CS2\CS1. For example, in IIC connection mode, the levels of CS3\CS2\CS1 are 001 when powered on.

The sensor automatically selects the corresponding protocol according to the connection status.

Note:

SPI mode: CS3\CS2\CS1 need to be connected to the host GPIO, and CS3\CS2\CS1 need to be pulled up when powered on.

UART mode: No need to connect CS3\CS2\CS1 or directly pull them down.

IIC mode: Need to connect CS1 and pull it up, no need to connect CS3\CS2 or directly pull them dowm.

5.3 SPI Communication Protocol

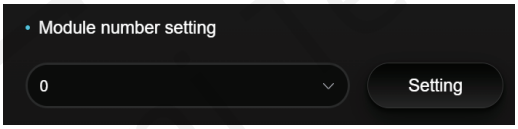
5.3.1 SPI Film Selection Definition

CS3\CS2\CS1 are the address decoding pins, the available chip selection number range is 001 to 110. The following are the factory default chip selection numbers.

	CS3	CS2	CS1
DP（fingertip）	0	1	1
IP（middle finger pad）	0	1	0
CP（closed finger pad）	0	0	1

Palm sensor MC-M2020, CS5\CS4\CS3\CS2\CS1 are address decoding pins, with the default being 00001. Currently, the available chip selection number range is 00001 to 01000.

*In the accompanying software, click on **[Settings] to change the module number of the sensor. The module number = chip selection number - 1.**



5.3.2 SPI Configuration Requirements

SPI_InitStructure.SPI_CPOL = SPI_CPOL_High; //Idle state for serial clock is high level
SPI_InitStructure.SPI_CPHA = SPI_CPHA_2Edge; //Data is sampled on the second rising edge of the serial synchronous clock

Data transmission order: Most Significant Bit First (i.e., bit7 of each byte is transmitted first)

It is recommended to connect a 51Ω resistor in series with the clock signal at the host end to enhance the stability of signal transmission

5.3.3 SPI Read/ Write Timing

Write:

Pull Down CS	Delay	Function Code + Data, Etc	Delay	Raise All CS	Delay
	>=8us		>=25us		>=8us

Read:

Pull Down CS	Delay	Function Code + Address+ Length	Delay	Data,Etc	Delay	Raise All CS	Delay
	>=8us		>=25us		>=25us		>=8us

5.3.4 Protocol Format

SPI Read:

0x80 + Function Code	Start Address	Read Data Byte Length	Staus	Data	CRC8 Check
0xFB	2 bytes，Little-Endian	2 bytes，Little-Endian	1 byte		1 byte

CRC8 Check：Perform CRC check on all preceding bytes
0xFB：The function code 0x7B is obtained after the highest position of 1

SPI Write:

0x00 +Function Code	Start Address	Write Data Byte Length	Data	CRC8 Check
0x79	2 bytes，Little-Endian	2 bytes，Little-Endian		1 byte

CRC8 Check：Perform CRC check on all preceding bytes

5.3.5 Instruction

Write the meanings of the module's function codes, data, and so on:

Position	Meaning	Instruction
bytes 1	Function Code	0x79（User Configuration Area）
bytes 2~3	Start Address	Little-Endian
bytes 4~5	Write Data Byte Length	Little-Endian
bytes 6	Data	Refer to Section 5.6
bytes 7	CRC8 Check	Perform CRC check on all preceding bytes

The meaning of reading the module's function code + address + length:

Position	Meaning	Instruction
bytes 1	Function Code	0x7B (Application Area)
bytes 2~3	Start Address	Little-Endian
bytes 4~5	Read Data Byte Length	Little-Endian, Refer to Section 5.6, For example, when reading the data of three measurement points (Fx, Fy, Fz), the data length = 3*3

The meaning of reading data from the module:

Position	Meaning	Instruction
bytes 6	Status	For debugging, return from the slave machine, no need to pay attention
bytes 7~...	Data	Return from the slave machine
The last 1 byte	CRC8 Check	Perform CRC check on all preceding bytes, Return from the slave machine

5.4 UART Communication Protocol

5.4.1 UART Setting Requirement

Baud rate: 921600
Data bits: 8 bit
Stop bit: 1 bit
Parity check: NONE
Flow Control: NONE
It is recommended that users set the host Tx to push-pull mode to enhance the driving capability; set the host Rx to open-drain mode and use 1k-1.5k resistors to pull up the bus.

This protocol can only be executed through the request -> return mode.

Device address = module number +1, refer to Section 5.3

5.4.2 UART Protocol Format

Read - Request frame

Frame Header		Frame Length	Device Address	Reserved	0x80 +Function Code	Start Address	Data Length	LRC Check
data[0-1]		data[2-3]	data[4]	data[5]	data[6]	data[7-10]	data[11-12]	data[13]
0x55	0xAA	2 bytes, Little	1 byte	0x00	0xFB	4 bytes, Little	2 bytes, Little	1 byte

Read - Response frame

Frame Header		Frame Length	Device Address	Reserved	0x80 +Function Code	Start Address	Returned Data Length	Status	Returned Data	LRC Check
data[0-1]		data[2-3]	data[4]	data[5]	data[6]	data[7-10]	data[11-12]	data[13]		data[N+14]
0xAA	0x55	2 bytes, Little	1 byte	0x00	0xFB	4 bytes, Little	2 bytes, Little	1 byte	N bytes	1 byte

LRC Check: Perform LRC check on all preceding bytes

Write - Request frame

Frame Header		Frame Length	Device Address	Reserved	0x00 +Function Code	Address	Data Length	Write Data	LRC Check
data[0-1]		data[2-3]	data[4]	data[5]	data[6]	data[7-10]	data[11-12]		data[N+14]
0x55	0xAA	2 bytes, Little	1 byte	0x00	0x79	4 bytes, Little	2 bytes, Little	N bytes	1 byte

Write - Response frame

Frame Header		Frame Length	Device Address	Reserved	0x00 +Function Code	The Address For Writing Instructions	Returned Data Length	Status	LRC Check
data[0-1]		data[2-3]	data[4]	data[5]	data[6]	data[7-10]	data[11-12]	data[13]	data[14]
0xAA	0x55	2 bytes, Little	1 byte	0x00	0x79	4 bytes, Little	2 bytes, Little	1 byte	1 byte

Status:

0x00: write success

LRC Check: **Perform LRC check on all preceding bytes**

Frame Length: From data[4] to data[N+13]

W = 0x00 ; R = 0x01

0xFB: Set the highest bit of function code 0x7B to 1

5.4.3 UART Command Example

Read the first 32 bytes at address 1038 (force signals in array) in the 0x7B area.

55 AA 09 00 01 00 FB 0E 04 00 00 20 00 CA The equipment address is 01
55 AA 09 00 02 00 FB 0E 04 00 00 20 00 C9 The equipment address is 02
55 AA 09 00 03 00 FB 0E 04 00 00 20 00 C8 The equipment address is 03

5.5 IIC Communication Protocol

5.5.1 IIC Setting Requirement

The IIC rate is tentatively set at 200K and below.

The device address = module number +1. The module number is referred to Section 5.3.

All data are presented in little-endian mode.

IIC SDA and SCL need to be set to open-drain mode. In terms of hardware, strong pull-up is required. It is recommended to use a resistor of 4.7K or less for pull-up.

5.5.2 IIC Protocol Format

Read - Request frame

(Device Address << 1) | W	0x80 + Function Code	Start Address	Data Length	LRC Check
data[0]	data[1]	data[2-5]	data[6-7]	data[8]
1 byte	0xFB	4 bytes, Little	2 bytes, Little	1 byte

Read - Response frame

(Device Address << 1) | R	0x80 + Function Code	Start Address	Returned Data Length	Status	Returned Data	LRC Check
data[master]	data[0]	data[1-4]	data[5-6]	data[7]		data[N+8]
1 byte	0xFB	4 bytes，Little	2 bytes，Little	1 byte	N bytes	1 byte

Data reading process: Request frame sent + waiting delay ≥ 25us + response frame reads data back

- Both the request frame and the response frame require the participation of the host, among which:

- The red part indicates that the host controls the SDA line to send data and the slave receives data

- The blue part is for the slave control SDA to send data and the host to receive data

LRC check: Perform LRC check on all the preceding bytes

Write - Request frame

(Device Address << 1) | W	0x00 + Function Code	Start Address	Return The Byte Length	write data	LRC Check
data[0]	data[1]	data[2-5]	data[6-7]		data[N+8]
1 byte	0x79	4 bytes，Little	2 bytes，Little	N bytes	1 byte

Write - Response frame

(Device Address << 1) | R	0x00 + Function Code	Start Address	Return the byte length	Status	LRC Check
data[master]	data[0]	data[1-4]	data[5-6]	data[7]	data[N+8]
1 byte	0x79	4 bytes，Little	2 bytes，Little	1 byte	1 byte

Data reading process: Request frame sent + waiting delay ≥ 25us + response frame reads data back

- Both the request frame and the response frame require the participation of the host, among which:

- The red part indicates that the host controls the SDA line to send data and the slave receives data

- The blue part is for the slave control SDA to send data and the host to receive data

Status：

0x00: write success

LRC check: Perform LRC check on all the preceding bytes

W = 0x00，R = 0x01

0xFB：Set the highest bit of function code 0x7B to 1

5.5.3 IIC Command Example

The fingertip module number is 02: Read the first 32 bytes at address 1038 (force signals in array) in the 0x7B area.

(Request frame) sent by the host: 06 FB 0E 04 00 00 20 00 CD ((Device Address 3) << 1) | 0
(Response frame) sent by the host: 07 ((Device Address 3) << 1) | 1

5.6 Address Description

5.6.1 User Configuration Area: (Function Code: 0x79) (not continuous write operations)

Address	Register Declaration	Streamability	Remarks
1	Reserve		
2	Reserve		
3	Calibration. Setting it to 1 is effective. Set it to 0 for normal operation	W	Only one byte can be written

5.6.2 Application Area: (Function Code: 0x7B) (Read-only area, supports continuous reading)

1008	Combined Force Value FX	Data Range for Fx (-128 to +127), Fy (-128 to 127), Fz (0 to 255) One LSB represents one unit of data resolution. When the resultant force value Fz is read as 10, the magnitude of the force measured by Fz is 10*0.1N=1.0N
1009	Combined Force Value FY	
1010	Combined Force Value FZ	
1038	Force on the 1st force in array FX	A single byte represents the data range Fx (-128 to +127), Fy (-128 to 127), and Fz (0 to 255).
1039	Force on the 1st force in array FY	
1040	Force on the 1st force in array FZ	
1041	Force on the 2nd force in array FX	
1042	Force on the 2nd force in array FY	
1 . . .	...	
1 . . .	...	
1383*	Force on the 116th force in array FX	
1384*	Force on the 116th force in array FY	
1385* ...	Force on the 116th force in array FZ ...	

6. Maintenance and Troubleshooting

6.1 Daily Maintenance and Surface Cleaning

When the sensor's elastomeric surface becomes dusty, it is recommended to gently remove the dust using clear tape. Alternatively, paper towels, lens cleaning cloths, water-based wet wipes, or cotton cloths with a low concentration of alcohol can be used for cleaning.

The sensor's casing can be cleaned using paper towels, lens cleaning cloths, or water-based wet wipes, but it should not come into contact with alcohol or other organic/non-polar solvents.

6.2 Troubleshooting

● **The Host Computer Software displays jumbled sensor values**

You can verify the actual sensors being accessed by gently pressing the elastomer on each tactile sensor connected to the computer, while observing if the images displayed in the software change with the pressure applied. Check for sources of interference around the tactile sensors, such as pressure points, magnetic fields, etc. If the readout values tend to stabilize without fluctuation and the sensors are not affected by other sources of interference, click the CALIBRATION button to zero the sensors.

● **After turning on the sensor, the Host Computer Software is unable to receive data**

Please check the following elements in sequence:

1. Ensure the sensor's Dupont wires are securely connected to the data processing box.
2. Verify the data processing box is properly connected to the computer, and the LED on the box is green.
3. Make sure the correct COM port is selected and there is no interference from other COM ports.
4. The port switch should be set to OPEN PORT. Try toggling the OPEN PORT switch to see if it becomes effective.

● **The resultant force calculated from the sum of distributed forces is inaccurate**

There are several potential causes for this issue. Please troubleshoot according to the following reasons:

1. The object applying force contacted areas outside the sensing surface range of the elastomer.
2. The tactile sensor's casing (except for the mounting connector locations) is subjected to force during operation.
3. The elastomer is contacted by external objects at a high speed or deeply pressed by sharp objects.
4. The measuring surface is subjected to a large area of uniformly distributed force in the direction along the surface.
5. The localized force exceeds the range.

7.Technical Support

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