

1. Product Overview

1.1 Product Features

The TS-F-C fingertip tactile sensor is an intelligent bionic tactile sensing solution independently developed by Tashan Technology for robotic thumb perception and dexterous manipulation.

Designed specifically for humanoid robotic hands, the TS-F-C provides enhanced contact area and increased force capacity compared with standard fingertip tactile sensors.

It supports:

- Three-dimensional force sensing (normal and tangential forces)
- Proximity detection
- Pressure sensing
- Material recognition

The sensor mimics the physical characteristics and tactile capabilities of the human thumb and enables stable, precise, and adaptive grasping performance.

1.2 Intended Use and Application Scope

The sensor is primarily used for:

- Non-contact object position detection
- Normal force and tangential force measurement
- Adaptive grasping in robotic hands

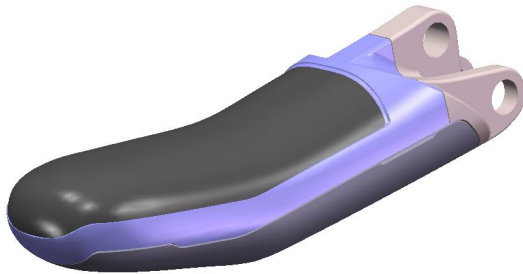
It has broad application prospects in:

- Scientific research and education
 - Biomedicine
 - Space exploration
 - Hazardous environment operations
 - Industrial manufacturing
 - Service robotics
-

1.3 Operating Environment

- Operating Temperature: -10°C to 50°C
 - Storage Temperature: -20°C to 85°C
 - Humidity: Non-condensing
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1.4 Product Appearance



2. Structural Characteristics and Working Principle

2.1 Overall Structure and Operating Environment

Structure

The tactile sensor consists of:

- Flexible silicone skin surface
- Rigid Printed Circuit Board (PCB)
- Insulated plastic base housing
- External silicone fingertip cover

Operating Environment

The sensor utilizes non-contact capacitive sensing technology.

Since capacitance measurements are sensitive to environmental conditions such as temperature and humidity, operation should be performed within the specified environmental limits.

Caution:

Long-term overload pressure may cause incomplete recovery of the silicone structure. Continuous operation beyond the specified force range should be avoided.

2.2 Functional Units and Interconnections

The sensor system consists of:

- Sensor Unit (TS-F-C)
- Main Controller

The controller supports simultaneous connection of up to five tactile sensors.

A host computer is required for monitoring and configuration.

Sensor Unit

The sensor transmits:

- Raw capacitance values
- Calibrated force values
- Proximity sensing data

to the host system via the I²C protocol.

Host System

Dedicated software allows users to:

- Monitor sensor data
 - Update firmware
 - Configure sensor parameters
 - Perform diagnostics and debugging
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3. Technical Specifications

3.1 Main Functions

Sensor Unit (TS-F-C)

- Non-contact proximity detection
- Algorithm-based perception (e.g., object interaction features)
- Contact-based adaptive grasping

Main Controller

- Processes and transmits sensor data to the host computer
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3.2 Key Parameters

Normal Force

- Range: 30 N
- Minimum Detectable Force: 0.1 N
- Resolution: 0.1 N
- Accuracy: 5% FS

Tangential Force

- Range: 30 N
- Minimum Detectable Force: 0.25 N
- Resolution: 0.25 N
- Directional Resolution: 45°
- Direction Range: 0°–359°

Sampling

- Capacitance Sampling: 24-bit
- Sampling Frequency: ≥ 50 Hz

Electrical Characteristics

- Rated Voltage: 3.3 V / 5 V
- Maximum Static Current: 15 mA

Installation

- Mounting Method:
Fixed to the thumb structure through the rear mounting holes and joint shaft assembly

Connection

- Connector: SMD 4-Pin, 0.8 mm pitch
- Cable: 4-core, 0.0316 mm²

Mechanical Dimensions

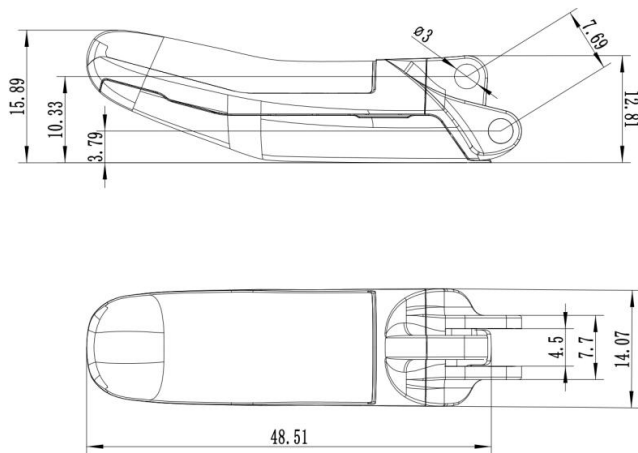
- 31.34 mm × 17.17 mm × 16.5 mm

Environmental Conditions

- Operating Temperature: -10°C to 50°C
- Storage Temperature: -20°C to 85°C
- Humidity: Non-condensing

3.3 Dimensions and Cable Length

Sensor Dimensions



- Cable Length: 200 mm
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4. Installation and Commissioning

4.1 Hardware Installation

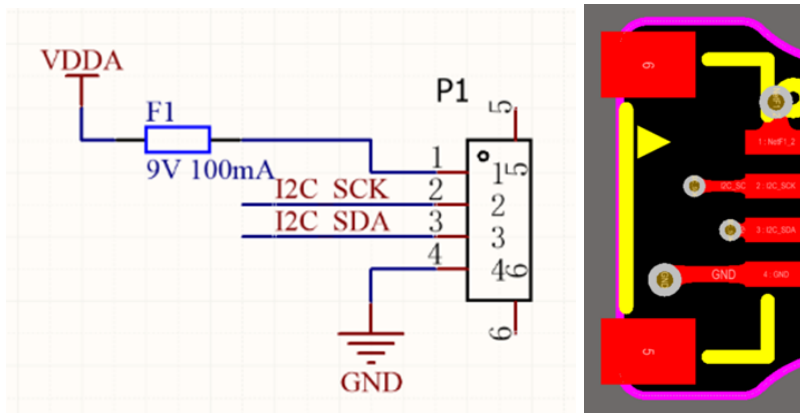
Sensor Installation

The customer designs the finger structure according to application requirements.

Tashan assembles and calibrates the tactile sensor before delivery.

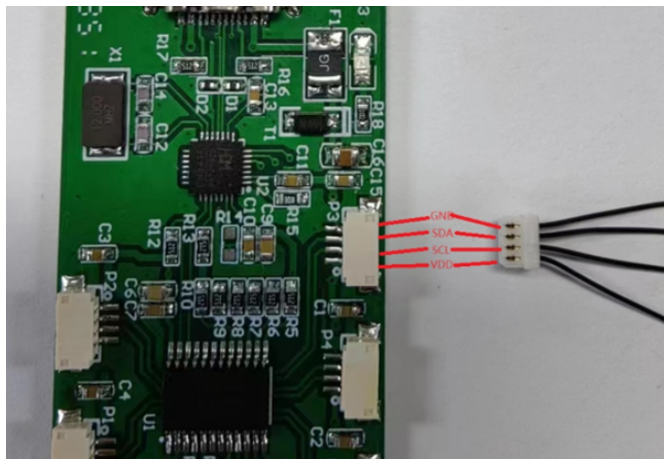
The calibrated sensor is then installed onto the customer's robotic hand.

Interface Definition



The module uses a 0.8 mm pitch IDC connector.

The I²C adapter board utilizes the **PCA9548APWR** for multi-channel switching to improve communication robustness.



USB-to-I²C conversion is implemented using the **CH341 chip**.

4.2 Software Installation

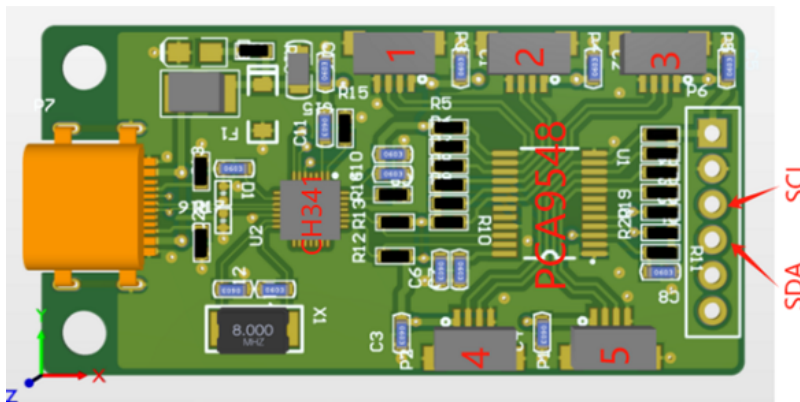
CH341 Driver Installation

1. Run CH341PAR.EXE
 2. Click Install
 3. Confirm successful installation
-

4.3 Debugging Procedure

4.3.1 Preparation

- Install CH341 USB-to-I²C driver
- Connect sensor to adapter board
- Connect adapter board to PC using USB-C



4.3.2 Adapter Board Description

The adapter board consists of:

- CH341 (USB-to-I²C)
- PCA9548 (I²C multi-channel switch)

The target sensor is selected via host software.

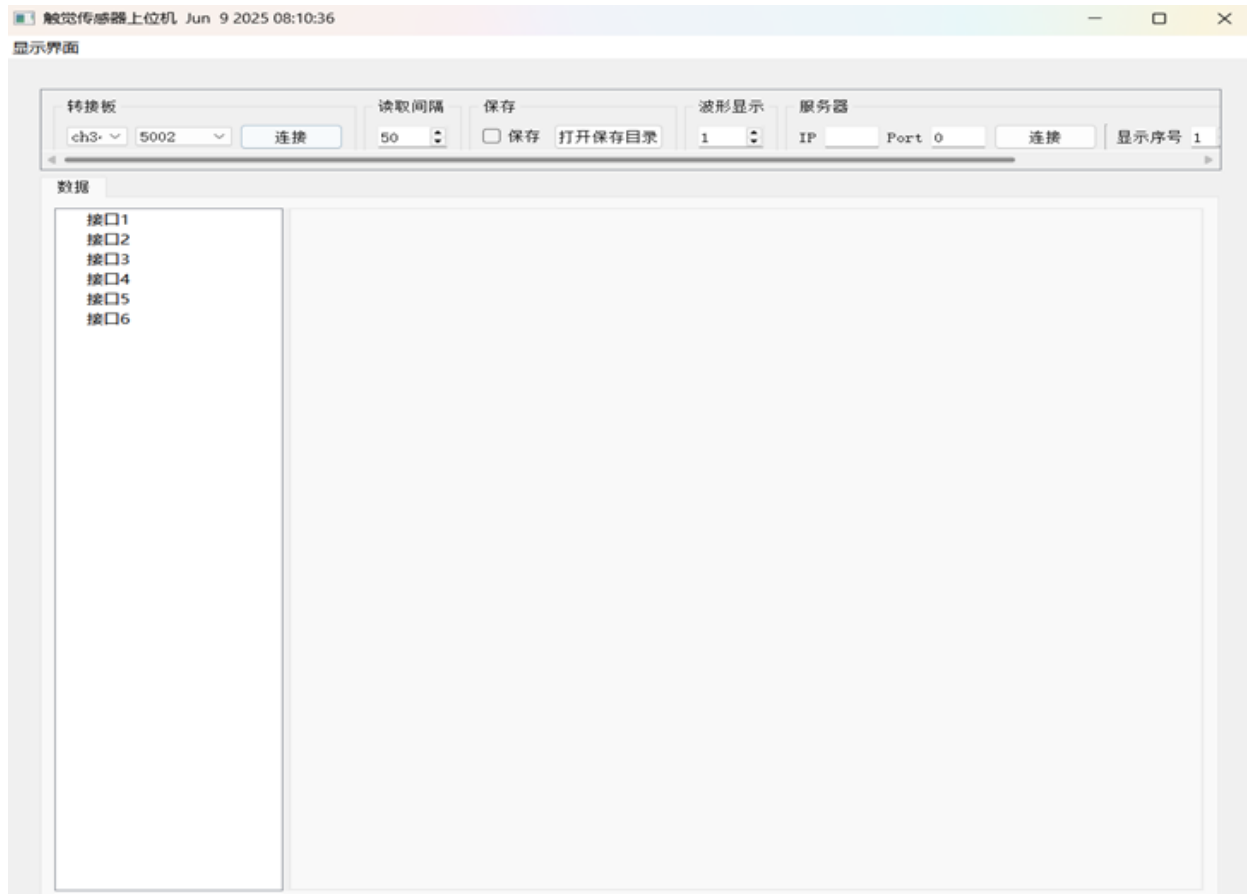
- PCA9548 I²C Address: **0x70**

PCB Interface (Device No.)	PCA9548 Channel	Description
Device 1	Channel 4	Standard Sensor Connection
Device 2	Channel 5	Standard Sensor Connection
Device 3	Channel 6	Standard Sensor Connection
Device 4	Channel 3	Standard Sensor Connection
Device 5	Channel 2	Standard Sensor Connection
Debug Port	Channel 0	External logic analyzer connection for I ² C protocol monitoring

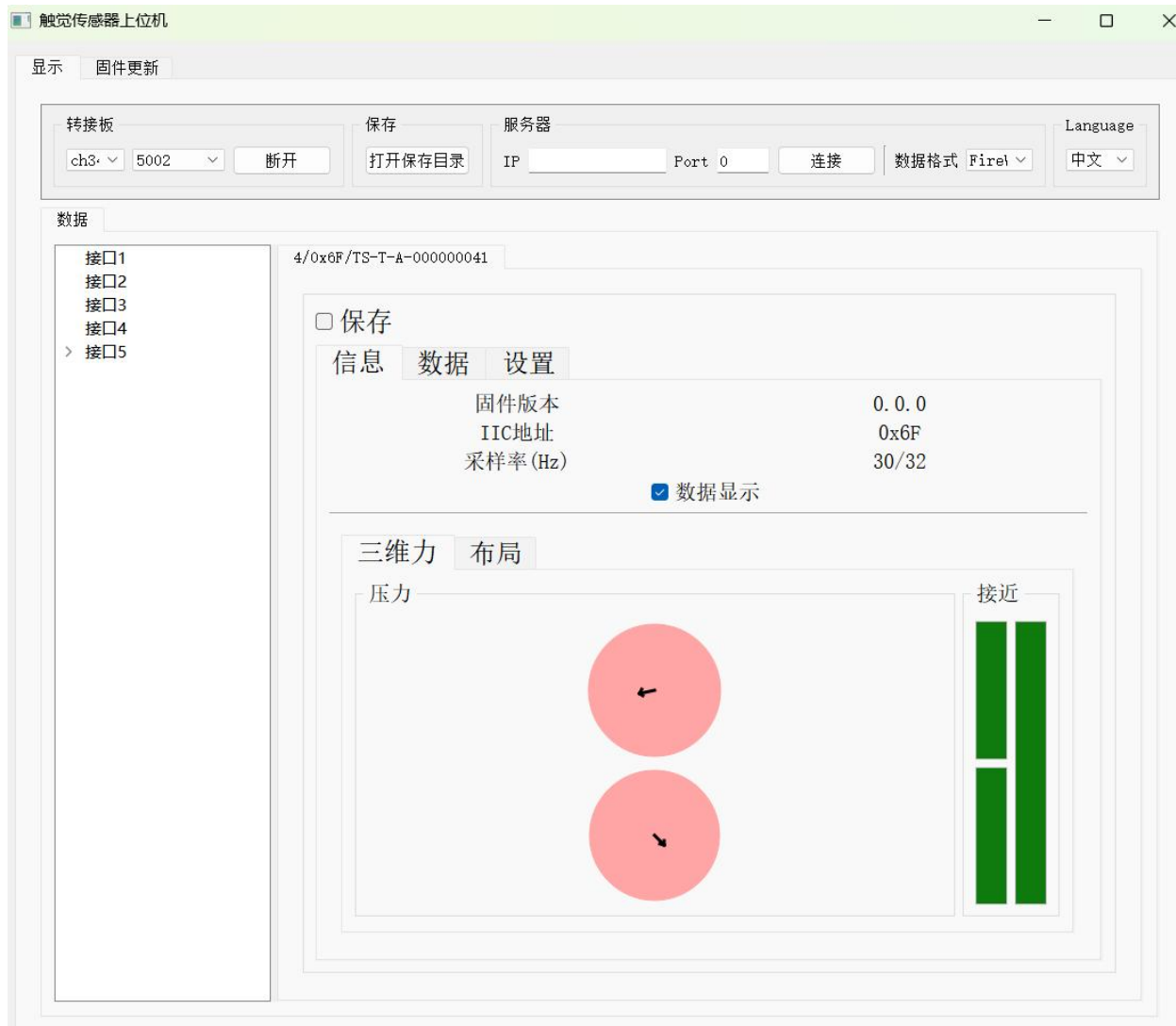
4.3.3 Host Software Operation

1. Device Connection

- Open **SensorShow.exe**
- Connect adapter board to PC
- Click *Connect*



- System automatically detects connected sensors



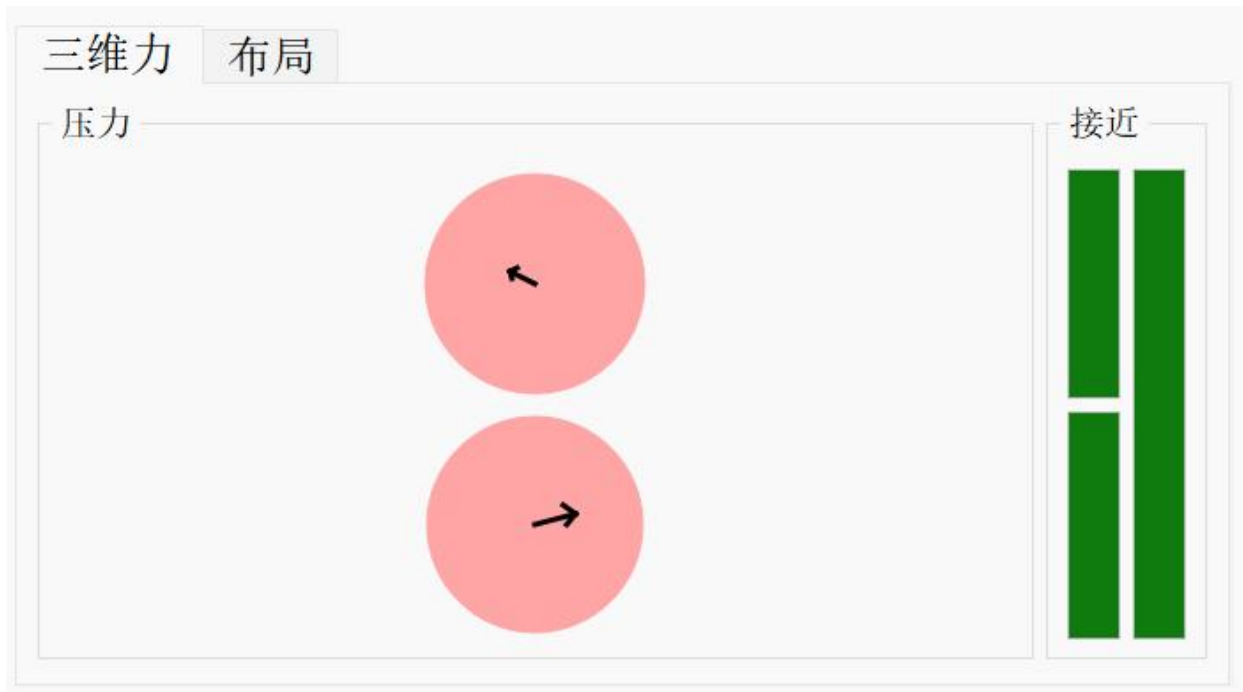
2. Finger Information Interface

Displays:

- Firmware version (compilation date)
- Device type (large/small finger)
- I²C address
- Sampling rate
- 3D force results

Visualization:

- Normal Force → color intensity
- Tangential Force → arrow length
- Tangential Force Angle → arrow direction (0°–359°)
- Proximity → bar chart variation



3. Data Interface

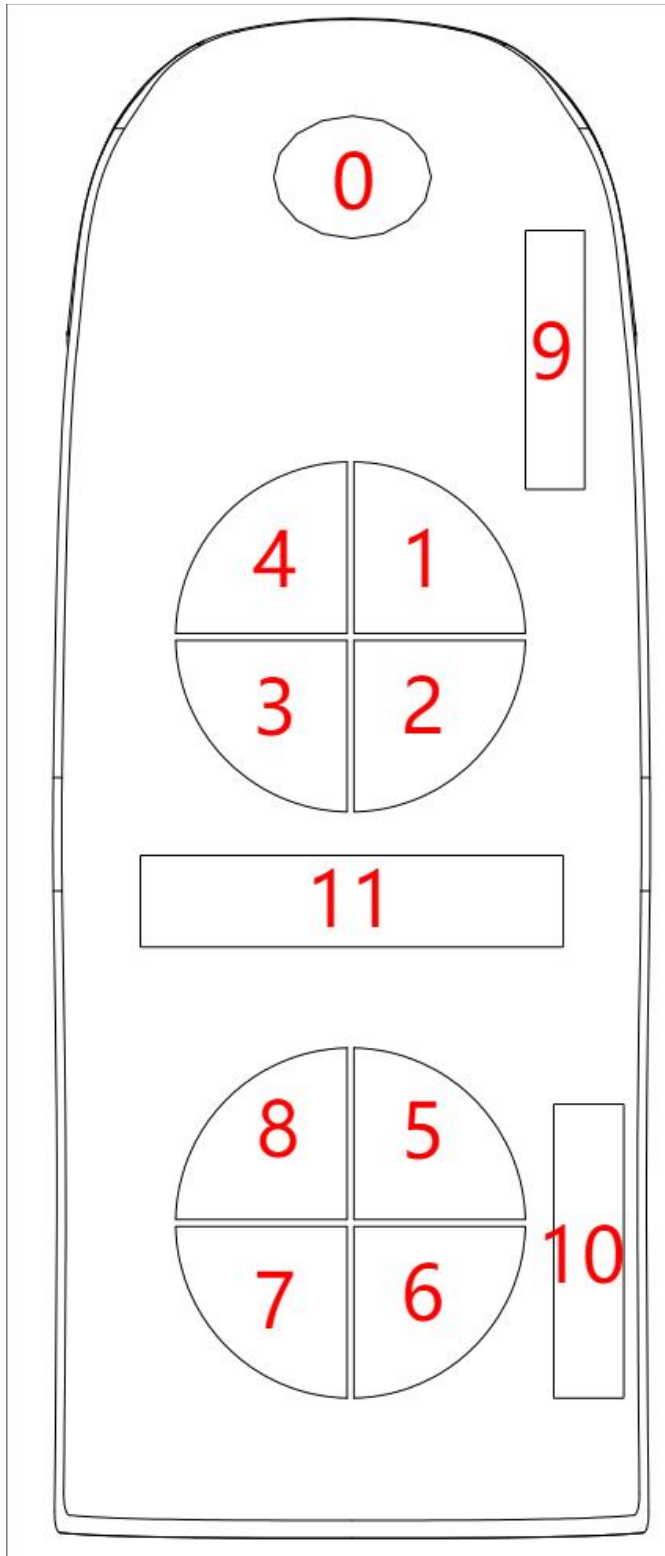
Displays real-time sampling channel values.

- Supports output modes:
 - Raw values
 - Filtered values
 - Baseline values
 - Difference values
- Channel reset allows recalibration of baseline

□ 保存

信息 数据 设置

通道0	3476174	复位	☒ 使能
通道1	3328223	复位	☒ 使能
通道2	3345052	复位	☒ 使能
通道3	3501988	复位	☒ 使能
通道4	3207974	复位	☒ 使能
通道5	3320198	复位	☒ 使能
通道6	3539044	复位	☒ 使能
通道7	3348294	复位	☒ 使能
通道8	3262852	复位	☒ 使能
通道9	3257448	复位	☒ 使能
通道10	3278616	复位	☒ 使能
通道11	3352326	复位	☒ 使能
通道12	3311862	复位	☒ 使能
通道13	3988606	复位	☒ 使能
通道14	3963180	复位	☒ 使能
通道15	8188370	复位	☒ 使能
法向力0	0.00		
切向力0	0.00		
方向0	65535		
法向力1	0.00		
切向力1	0.00		



4. Settings Interface

Provides:

- Device reset
- Factory reset
- Output type selection
- I²C address configuration (range: 0x01–0x6F)
- Channel reset
- Channel value adjustment (~3,000,000 baseline)

☐ 保存

信息 数据 设置

复位

输出类型 原始值

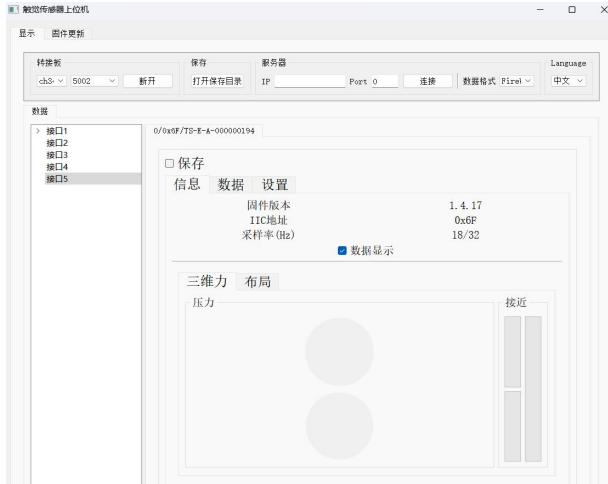
IIC地址 0x6f 111 确定

通道复位

通道值调整

5. Data Saving

- Format: CSV
- Path: /data folder in software directory
- Naming:
YYYY-MM-DD-HHMMSS__sensorID.csv



2024-04-24_144300_3.csv
2024-04-24_144017_3.csv
2024-04-24_132330_2.csv
2024-04-24_113100_1.csv
2024-04-23_130724_1.csv
2024-04-23_130634_1.csv
2024-04-23_110021_1.csv
2024-04-23_105946_1.csv
2024-04-23_105941_1.csv
2024-04-15_094907_2.csv
2024-03-15_130250_1.csv
2024-03-01_145840_3.csv
2024-02-27_111005_2.csv
2024-02-27_111005_3.csv
2024-02-27_111005_4.csv

T3	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
	通道0	通道1	通道2	通道3	通道4	通道5	通道6	通道7	通道8	通道9	通道10	通道11	法向力0	切向力0	切向力方	法向力1
2	4339090	3835998	3603764	3523182	3672168	3106920	3060740	3147774	3200248	3704502	3794910	4154192	0	0	65535	0
3	4336852	3835656	3604788	3522652	3671978	3108020	3059564	3147546	3199944	3705488	3793810	4152448	0	0	65535	0
4	4338142	3835656	3604674	3522652	3671410	3107224	3060360	3147546	3199908	3705488	3793810	4152448	0	0	65535	0
5	4337726	3837780	3604408	3522880	3672320	3107224	3060778	3148114	3200058	3706816	3795290	4153358	0	0	65535	0
6	4337876	3834860	3603916	3522766	3671524	3106200	3060588	3147622	3200248	3705716	3795556	4153926	0	0	65535	0
7	4338446	3835620	3603270	3522652	3672168	3107488	3060398	3147356	3200438	3705716	3795214	4154874	0	0	65535	0
8	4339318	3835960	3603574	3522994	3672092	3106806	3060626	3147546	3200476	3702454	3794606	4153244	0	0	65535	0
9	4336740	3834784	3603916	3523108	3671864	3106958	3060550	3147394	3200324	3705868	3794038	4153662	0	0	65535	0
0	4337422	3837516	3603802	3523144	3670310	3106730	3060740	3147622	3199870	3706474	3795592	4154002	0	0	65535	0

6. TCP Data Transmission

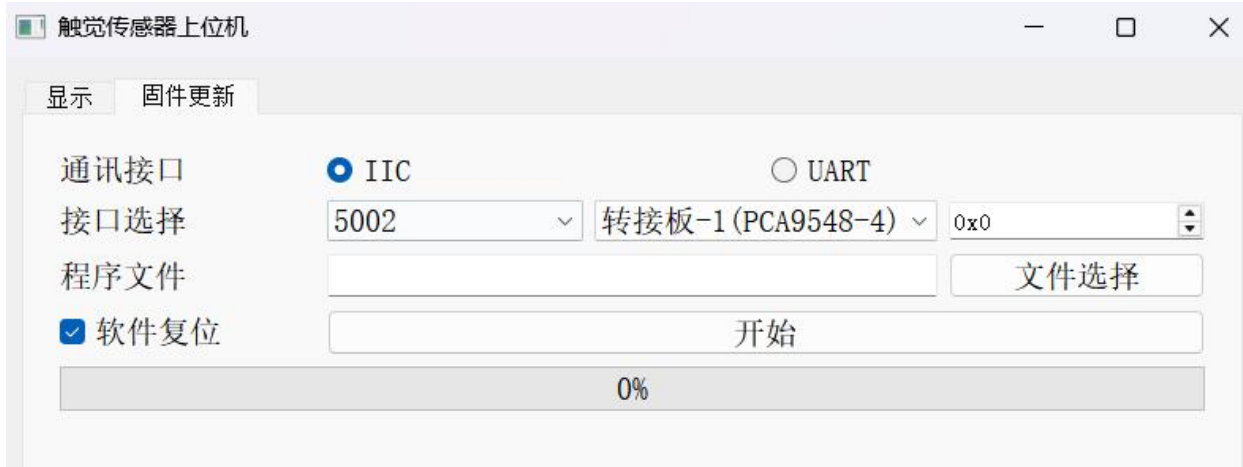
The software acts as a TCP client.

Format:

data1,data2,...,data14\r\n

7. Firmware Update

1. Connect device
2. Select device ID
3. Select **.bin** file
4. Enable *Software Reset*
5. Click *Start*



5. Operation and Use

5.1 Pre-Use Inspection

- Verify operating environment
- Ensure applied force remains within range
- Inspect silicone surface
- Check mounting integrity
- Verify software operation

5.2 Safety Precautions

- Avoid overload operation
- Prevent damage from sharp objects
- Do not disassemble the sensor
- Stop operation immediately if abnormal behavior occurs

5.3 Data Acquisition and Communication Protocol

I²C Communication

- Standard Mode: 100 kHz

- Fast Mode: 400 kHz
 - Default address: **0x6F**
 - Configurable range: **0x01–0x6F**
 - Broadcast address: **0x00**
-

Checksum Calculation

Example:

Command:

aa 55 03 71 00 00 00 00 00

Checksum:

73 01

6. Maintenance and Care

6.1 Storage Requirements

Store the sensor inside an anti-static bag when not in use.

Recommended storage conditions:

- Cool environment
 - Dry environment
 - Dust-free environment
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6.2 Routine Maintenance

- Operated by trained personnel
- Follow operating procedures
- Avoid underwater use
- Avoid single-point overload
- Regularly inspect fasteners
- Do not disassemble internal components
- Immediately stop operation if abnormalities occur

7. Additional Information

7.1 Warranty

- 1-year replacement
- 2-year repair (non-human damage)