

1. Product Overview

1.1 Product Features

The TS-F-A2 fingertip tactile sensor is an intelligent bionic tactile sensing solution independently developed by Tashan Technology for robotic perception applications.

Compared with conventional single-point tactile architectures, the TS-F-A2 features a higher-density multi-channel sensing structure, enabling richer contact perception and more detailed force distribution sensing.

It supports:

- Multi-channel contact distribution sensing
- Proximity detection
- Pressure sensing

The sensor mimics the physical characteristics and tactile capabilities of human fingertip skin and is highly compatible with humanoid robotic hands.

It features:

- High sensing accuracy
 - Stable and precise grasping capability
 - Enhanced contact perception resolution
 - Strong adaptability for dexterous manipulation tasks
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1.2 Intended Use and Application Scope

The sensor is primarily used for:

- Non-contact object position detection
- Multi-point contact sensing
- Normal force and tangential force measurement
- Adaptive robotic grasping
- Contact distribution perception

It has broad application prospects in:

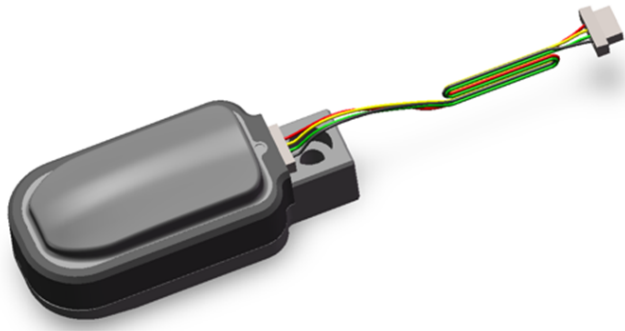
- Humanoid robotics

- Scientific research and education
 - Biomedicine
 - Space exploration
 - Hazardous environment operations
 - Industrial automation
 - 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 detection technology.

Since capacitance is sensitive to environmental conditions such as temperature and humidity, the sensor should be operated in a relatively stable environment within specified conditions.

Caution:

Long-term overload pressure on the silicone surface may result in incomplete rebound behavior. Continuous operation beyond rated force limits should be avoided.

2.2 Functional Units and Interconnections

The sensor system consists of:

- **Sensor Unit (Fingertip Module)**
- **Main Controller**

The main controller supports simultaneous connection of up to five sensor modules. A host computer must be provided by the user.

Sensor Unit

The sensor transmits:

- Raw multi-channel capacitance values
- Calibrated force values
- Contact distribution information

to the host system via the I²C protocol.

Host System

Dedicated host software enables users to:

- Monitor sensor data

- Visualize channel distributions
 - Update firmware
 - Configure sensor parameters
 - Perform debugging and calibration
-

3. Technical Specifications

3.1 Main Functions

Fingertip Sensor

- Non-contact proximity detection
 - Multi-channel tactile perception
 - Contact distribution sensing
 - Adaptive grasping
 - Algorithm-based object interaction perception
-

3.2 Key Parameters

Normal Force

- Range: 50 N
- Minimum Detectable Force: 0.1 N
- Resolution: 0.1 N
- Accuracy: 5% FS

Tangential Force

- Range: 20 N
- Minimum Detectable Force: 0.25 N
- Resolution: 0.25 N
- Directional Resolution: 45°
- Directional Range: 0°–359°

Sensing Channels

- 14 tactile sensing channels

Sampling

- Capacitance Sampling: 24-bit (dimensionless)
- Sampling Frequency: ≥ 50 Hz

Electrical Characteristics

- Rated Voltage: 3.3V / 5V
- Maximum Static Operating Current: 20 mA

Installation

- Mounting: Fixed via rear structural mounting hole
- Operating Position: Sensor surface

Connection

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

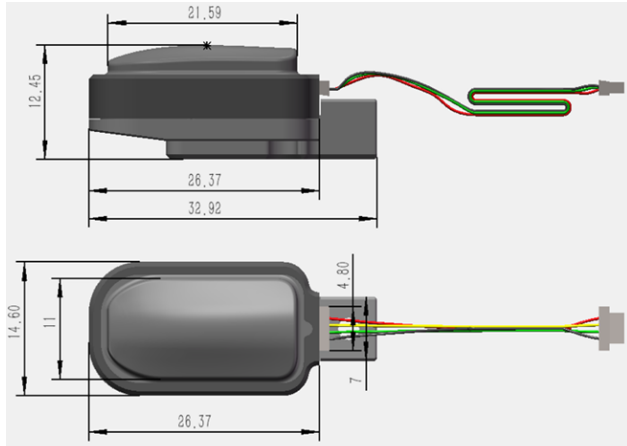
Mechanical Dimensions

- 32.92 × 14.6 × 12.45 mm
(excluding silicone fingertip cover)

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



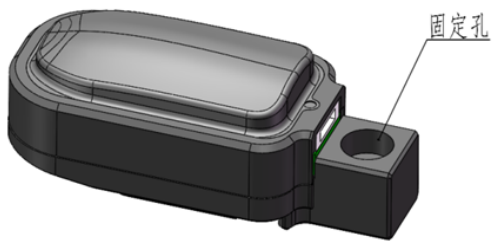
- Cable Length: 200 mm

4. Installation and Commissioning

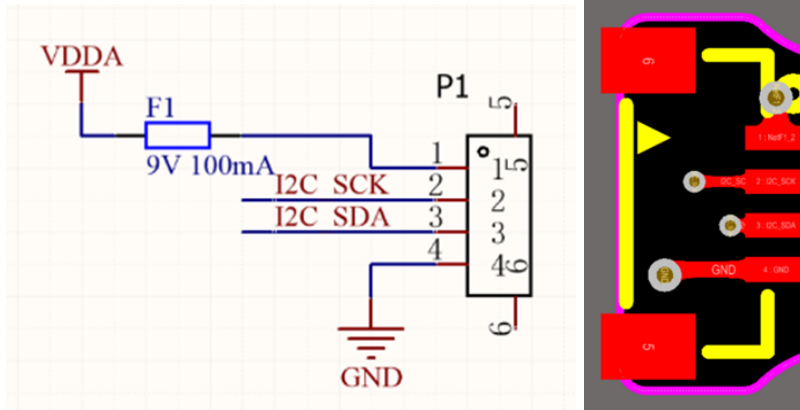
4.1 Hardware Installation

Fingertip Sensor Installation

The sensor is mounted onto the robotic finger structure via designated mounting holes.

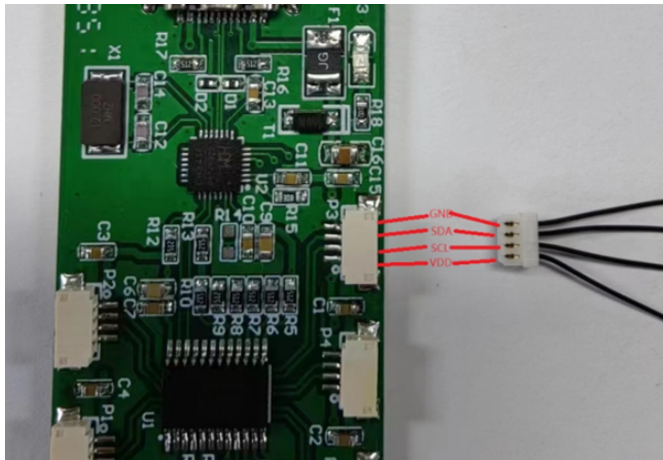


Interface Definition



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

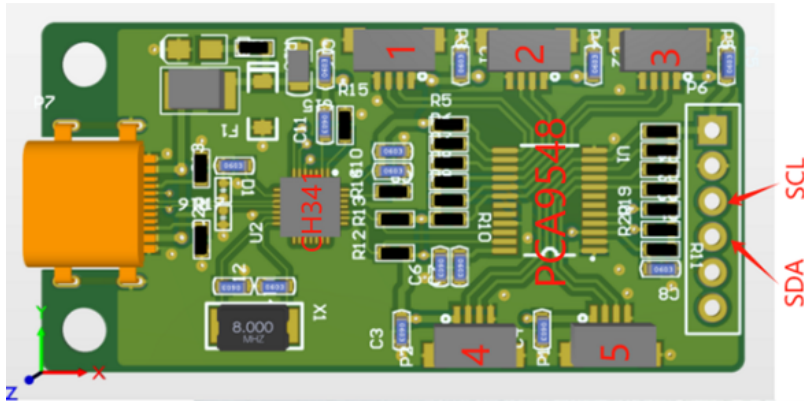
CH341 Driver Installation

1. Run **CH341PAR.EXE**
2. Click *Install*
3. Confirm installation completion

4.3 Debugging Procedure

4.3.1 Preparation

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



4.3.2 Adapter Board Description

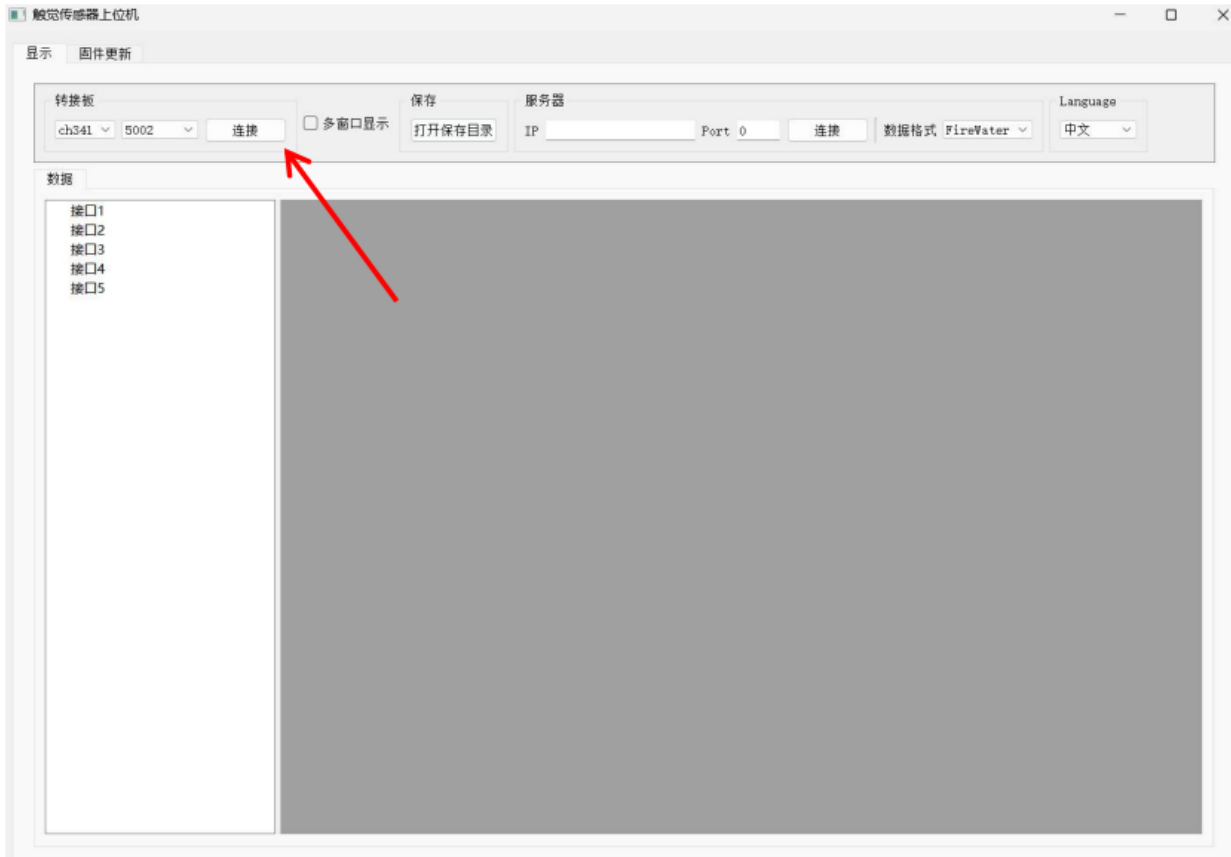
The adapter board consists of:

- CH341 USB-to-I²C interface
- PCA9548 I²C multi-channel switch
- PCA9548 fixed I²C address: **0x70**

4.3.3 Demo Software Operation

1. Device Connection

- Open **SensorShow.exe**
- Connect adapter board to PC
- Click *Connect*
- The software automatically scans and reads connected sensors



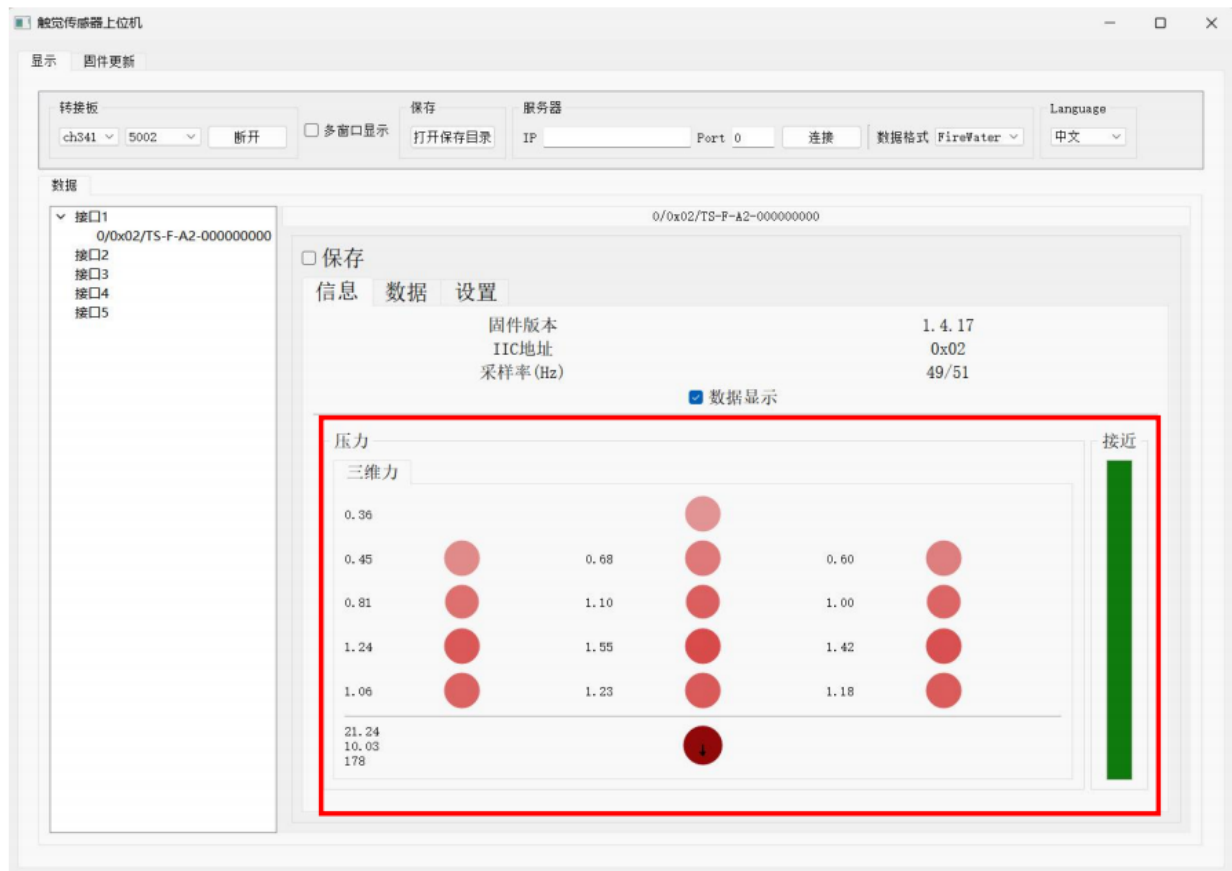
2. Finger Information Interface

Displays:

- Firmware version
- Device type
- I²C address
- Sampling rate
- 3D force calculation results

Visualization

- Normal Force → color intensity
- Tangential Force → arrow length
- Tangential Force Angle → arrow direction
- Proximity → dynamic bar visualization



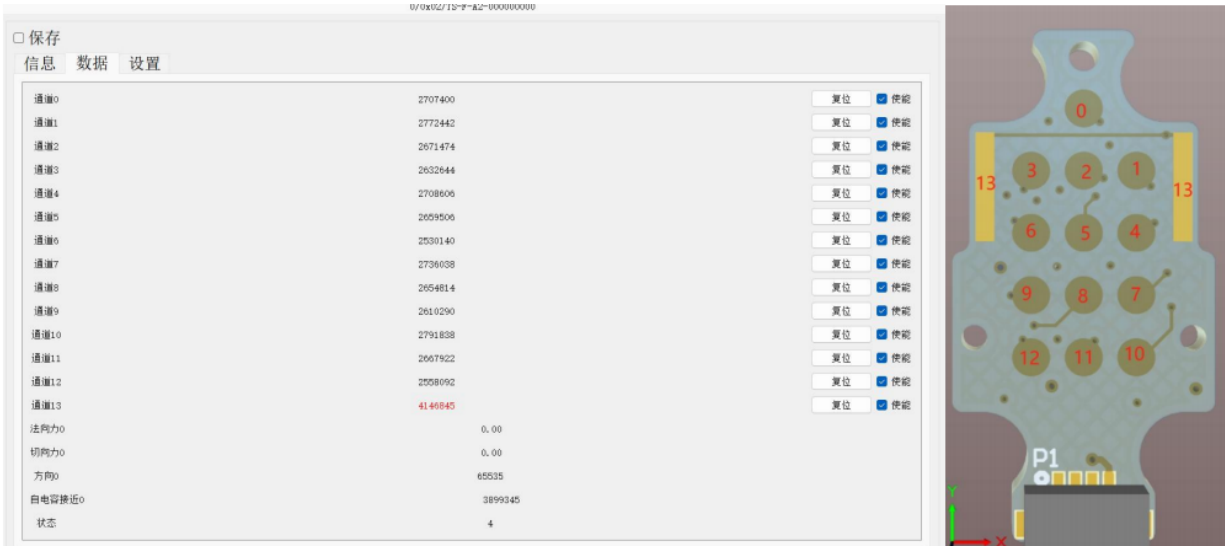
3. Multi-Channel Data Interface

Displays real-time values for all 14 sensing channels.

Supported output types:

- Raw values
- Filtered values
- Baseline values
- Difference values

Users can reset individual channels to recalibrate baseline values and compensate for environmental drift.



4. Settings Interface

Provides:

- Device reset
- Factory reset
- Output type selection
- I²C address configuration
- Channel reset
- Channel value adjustment

0/0x02/TS-F-A2-000000000

☐ 保存

信息

数据

设置

复位

输出类型

原始值

IIC地址

0x2

2

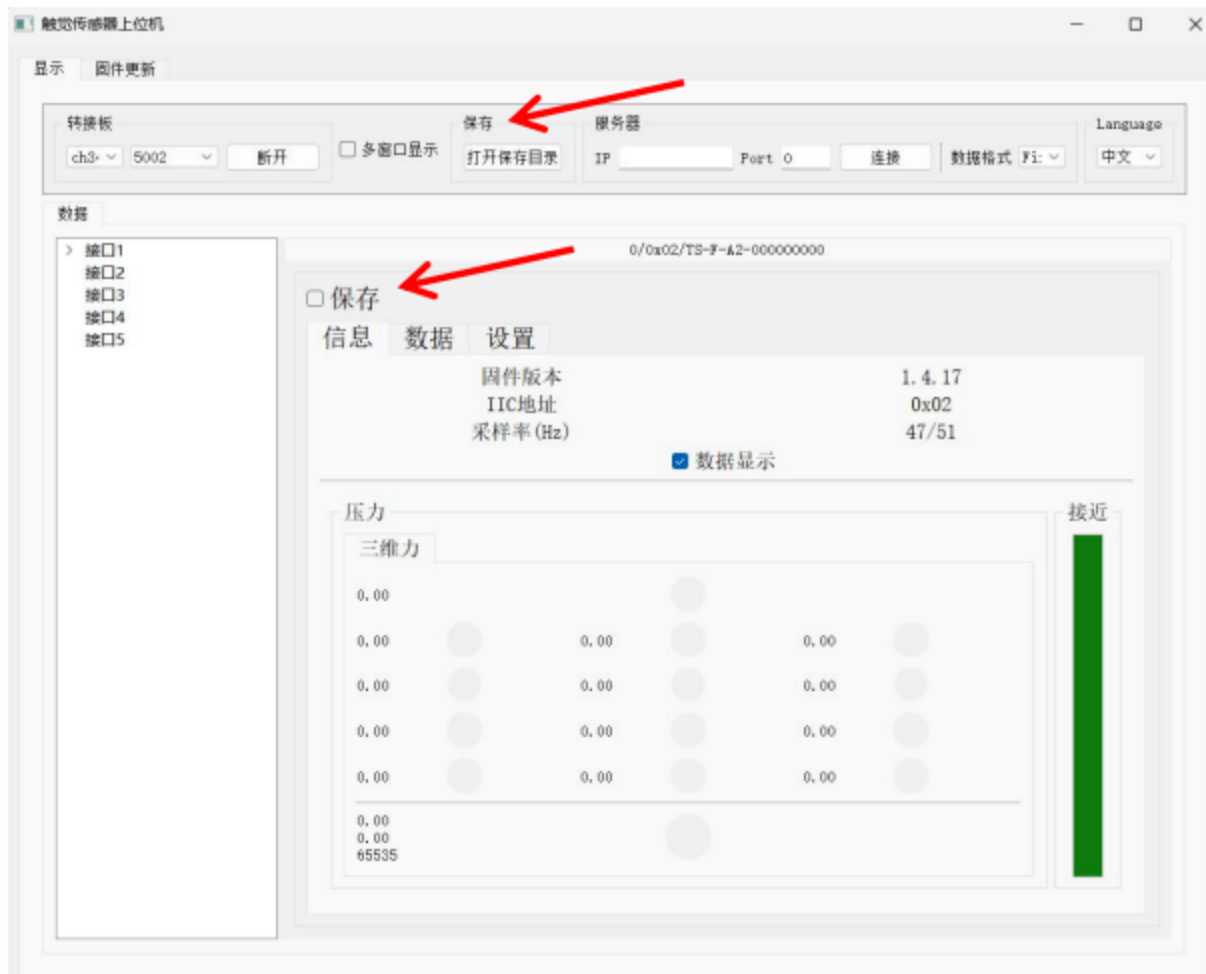
确定

通道复位

通道值调整

5. Data Saving

- Format: CSV
- Path: /data directory
- Naming format:
YYYY-MM-DD-HHMMSS__sensorID.csv



6. TCP Data Transmission

The host software functions as a TCP client.

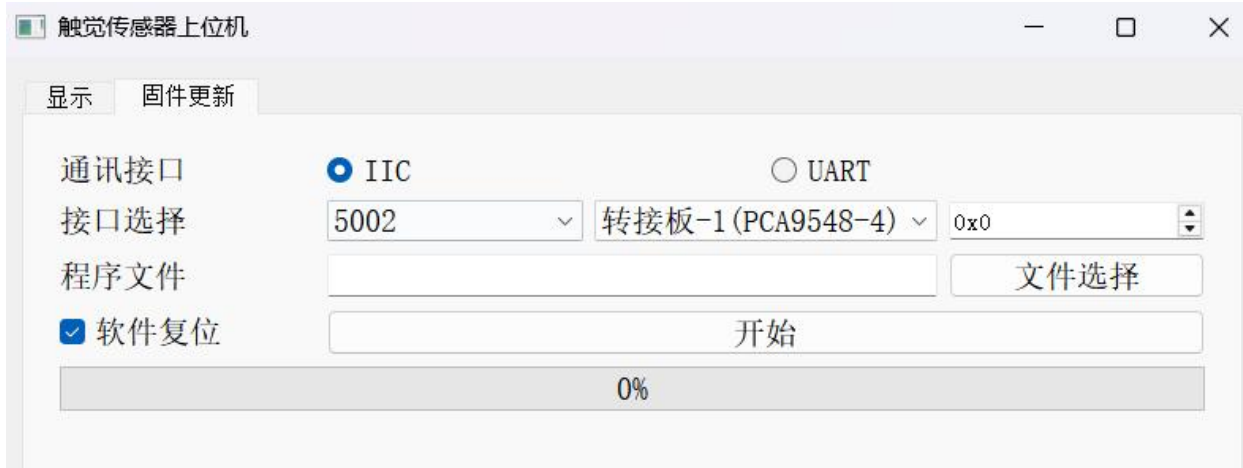
Data Format:

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

7. Firmware Update

1. Connect device
2. Select device ID
3. Select .bin firmware file

4. Enable *Software Reset*
5. Click *Start*



5. Operation and Use

5.1 Pre-Use Inspection

- Verify environmental conditions
- Ensure applied force remains within rated range
- Inspect silicone surface for damage or contamination
- Check structural fastening
- Confirm software functionality

5.2 Safety Precautions

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

5.3 Data Acquisition and Protocol

I²C Communication

Supported modes:

- Standard Mode: 100 kHz
- Fast Mode: 400 kHz

Address Configuration

- Default address: **0x6F**
 - Configurable range: **0x01–0x6F**
 - Broadcast address: **0x00**
-

Data Structure

The TS-F-A2 supports:

- 14-channel tactile data
 - 3D force outputs
 - Tangential force angle
 - Proximity data
-

Checksum Calculation

Example:

Command:

aa 55 03 71 00 00 00 00 00

Checksum:

73 01

(C implementation identical to other Tashan tactile products)

6. Maintenance and Care

6.1 Storage Requirements

Store the sensor in an anti-static bag in a cool and dry environment.

6.2 Routine Maintenance

- Operated by trained personnel
 - Follow standard operating procedures
 - Avoid underwater or point-load operation
 - Regularly inspect fastening components
 - Stop operation immediately if abnormalities occur
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7. Additional Information

7.1 Warranty

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