# Tashan Gripper Tactile Sensor TS-E-B Product Manual

## 1. Product Overview

### 1.1 Product Features

The TS-E-B series dual-finger tactile sensor for robotic grippers is an intelligent bionic skin product independently developed by Tashan Technology for robotic grasping perception. It enables:

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

The sensor mimics the physical characteristics and tactile capabilities of human finger skin and is highly compatible with a wide range of robotic grippers. It features high versatility, precise perception, and ensures stable, accurate grasping performance.

### 1.2 Intended Use and Application Scope

The sensor is primarily used for:

- Non-contact object position detection
- Object material identification
- Normal force and tangential force measurement

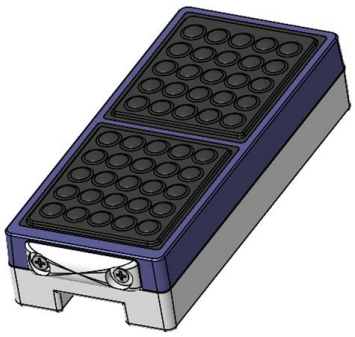
- Adaptive grasping in conjunction with robotic arms

It has broad application prospects in fields such as scientific research and education, biomedicine, space exploration, hazardous environment operations, industrial manufacturing, and service robotics.

### 1.3 Operating Environment

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

### 1.4 Product Appearance



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## 2. Structural Characteristics and Working Principle

### 2.1 Overall Structure and Operating Environment

- **Structure**: The tactile sensor consists of a flexible silicone skin surface, a rigid Printed Circuit Board (PCB), and an insulated plastic base housing.

- **Operating Environment**: The sensor utilizes non-contact capacitive detection. Since capacitance is highly sensitive to temperature and humidity, the sensor must be operated in a relatively stable environment within the specified conditions.
- **Caution**: Prolonged overload pressure on the flexible silicone may result in incomplete rebound. Long-term over-range operation must be strictly avoided.

### 2.2 Functional Units and Interconnections

The sensor kit consists of two main components:

1. **Sensor Units (Dual Fingers)**: Transmits raw capacitance values (caused by silicone deformation) and calibrated force values to the host system via the I²C protocol.
2. **Main Controller**: Supports simultaneous connection with up to five sensor units and processes data for the host computer.

*(Note: A host computer must be provided by the user.)*

Using the dedicated host software, users can view sensor data, update firmware, configure parameters, and assist in debugging.

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## 3. Technical Specifications

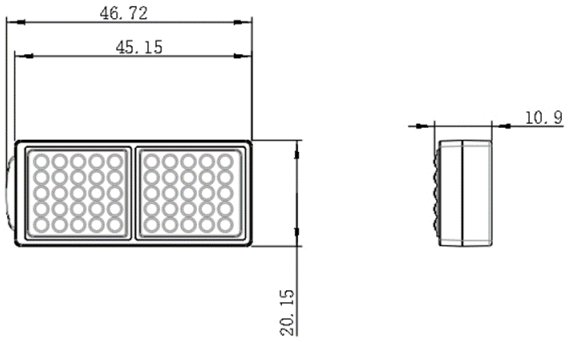
### 3.1 Main Functions

- **Sensor Unit (Dual Finger)**: Enables non-contact proximity detection, algorithm-based material recognition, and contact-based adaptive grasping.
- **Main Controller**: Processes and transmits finger data to the host computer.

### 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: 40 N | Minimum Detectable Force: 0.25 N | Resolution: 0.25 N | Directional Resolution: 45° | Directional Range: 0°–359°
- **Sampling**: Dimensionless capacitance sampling, 24-bit
- **Sampling Frequency**: $\geq 50$ Hz
- **Electrical Characteristics**: Rated Voltage: 3.3V / 5V | Maximum Static Operating Current: 20 mA
- **Installation**: Bolt-fixed to the robotic gripper connection plate. Connector: SMD 4-Pin, 0.8 mm pitch. Cable: 4-core, 0.0316 mm².
- **Mechanical Dimensions**: 46.72 mm × 20.15 mm × 10.9 mm

### 3.3 Dimensions and Cable Length




- **Cable Length**: Dual-finger tactile sensor cable length is 200 mm.

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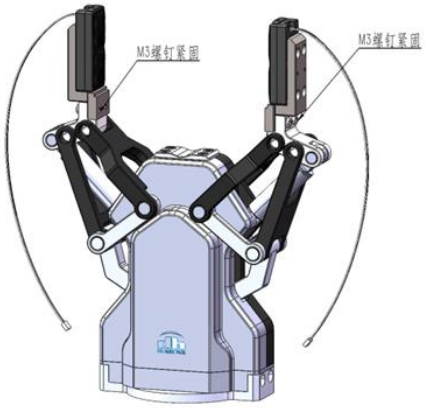
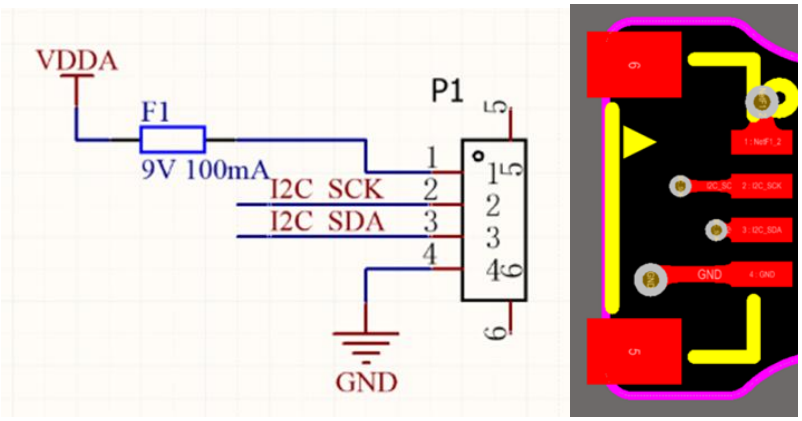
# 4. Installation and Commissioning

### 4.1 Hardware Installation

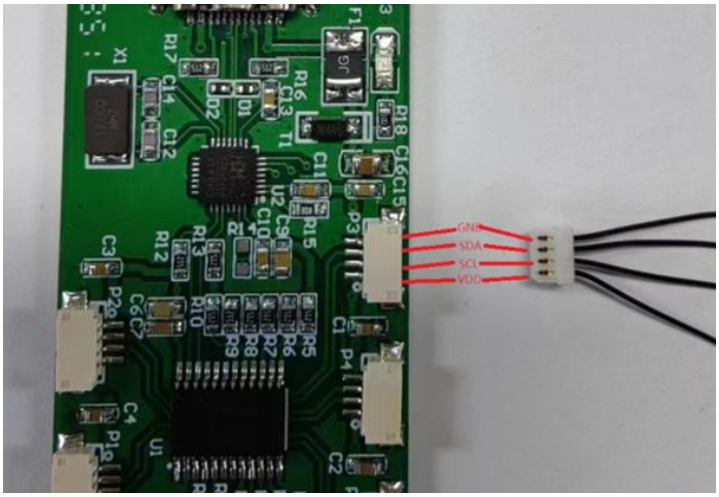
- **Finger Installation**: Securely mount the sensor fingers to the robotic gripper.




- **Interface Definition**:




  - The internal module uses a 0.8 mm pitch IDC socket.
  - The I²C adapter board utilizes the PCA9548APWR for multi-channel I²C switching to enhance communication reliability.




- USB-to-I²C conversion is handled by the CH341 chip.

## 4.2 Software Installation

**Software Package Includes:**

- Drivers (Adapter board and Demo software)
- Demonstration Host Software (For monitoring, parameter configuration, and firmware updates)

**CH341 USB-to-I²C Driver Installation:**

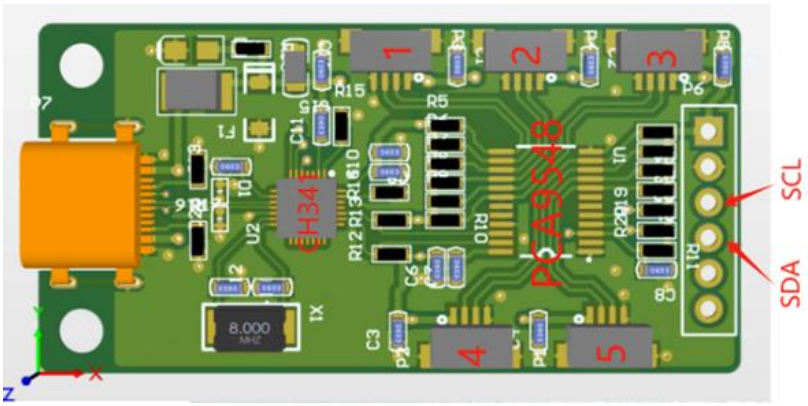
1. Run CH341PAR.EXE.
2. Click **Install**.
3. Confirm the pop-up prompt upon success and close the installer.

## 4.3 Debugging Procedure

### 4.3.1 Preparation

- Install the USB-to-I²C driver (CH341PAR.EXE).
- Connect the sensor to the adapter board.

- Connect the adapter board to the PC via a USB-C cable.




### 4.3.2 Adapter Board Instructions

The adapter board consists of a USB-to-I²C chip (CH341) and a multi-channel I²C switch (PCA9548). The target sensor is selected via the host software. The fixed I²C address of the PCA9548 is 0x70.

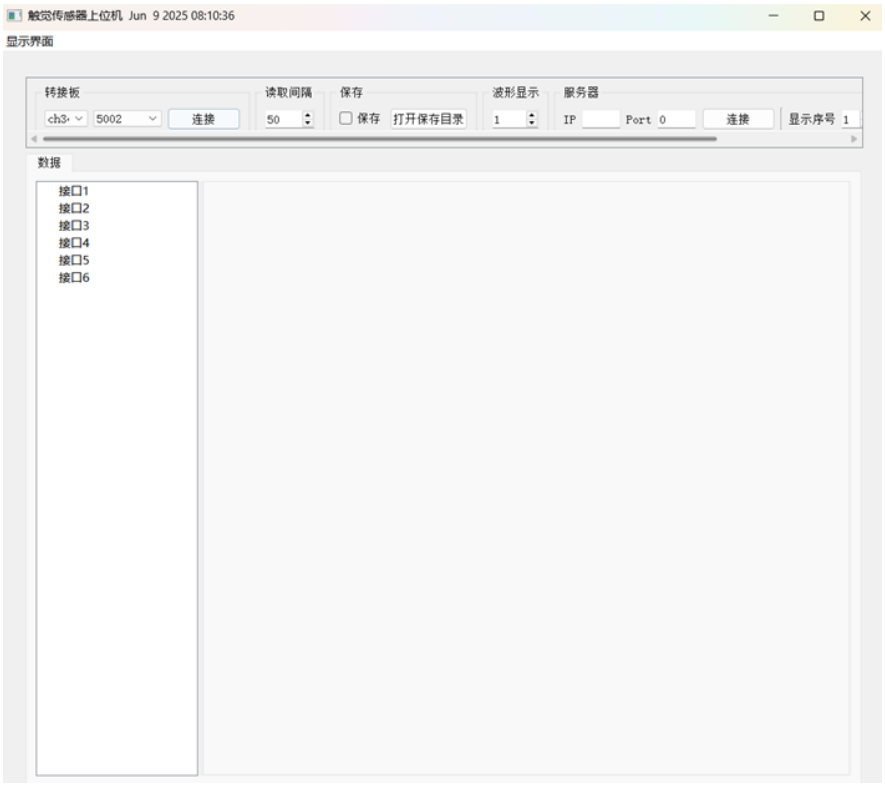
| **PCB Interface (Device No.)** | **PCA9548 Channel** | **Description** |
|---|---|---|
| Device 1 | Channel 4 | Standard Sensor Connection |
| Device 2 | Channel 5 | Standard Sensor Connection |
| Device 3 | Channel 6 | Standard Sensor Connection |
| Device 4 | Channel 3 | Standard Sensor Connection |

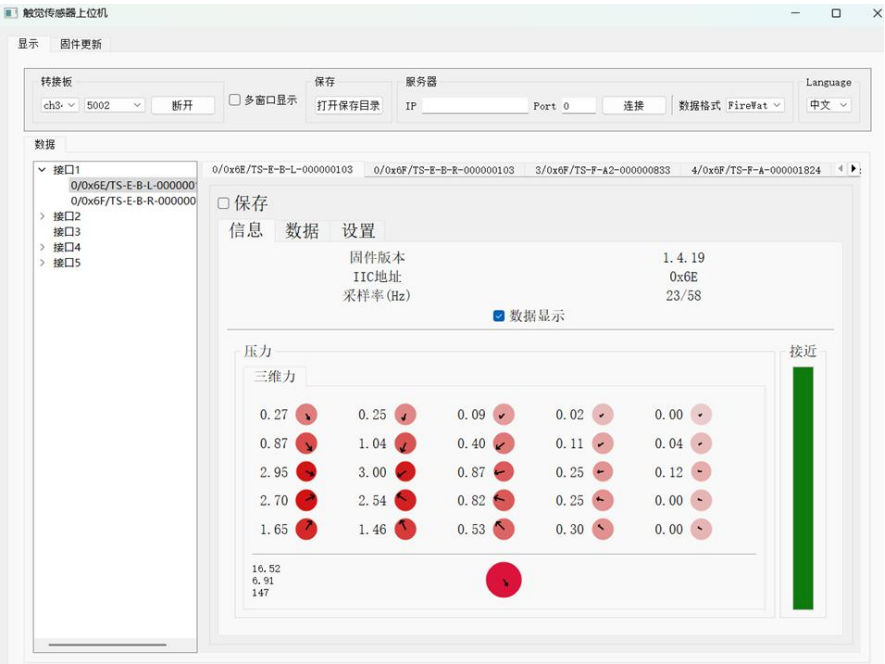
| | | |
|---|---|---|
| Device 5 | Channel 2 | Standard Sensor Connection |
| Debug Port | Channel 0 | External logic analyzer connection for I²C protocol monitoring |

### 4.3.3 Demo Host Software Operation Flow

#### 1. Device Connection

- Open SensorShow.exe.
- After connecting the adapter board to the PC, click **Connect**. The status will change to "Connected", and the software will automatically scan for attached fingers and read data.






## 2. Finger Information Interface

This interface displays the firmware compilation date, device type (Large/Small Finger), I²C address, sampling rate (samples per second), and 3D force calculation results.

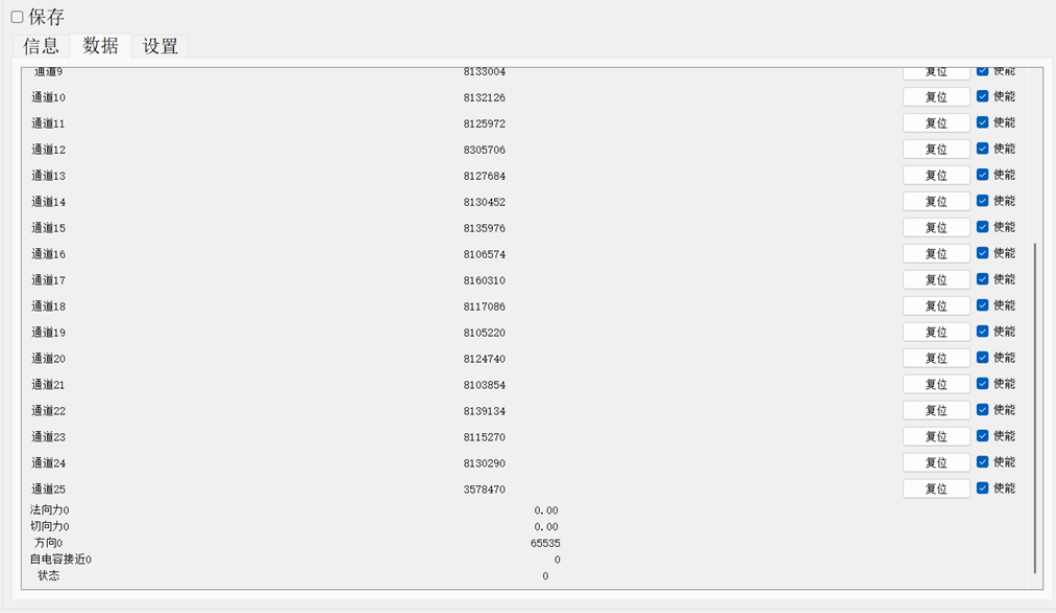

- **Normal Force**: Perpendicular to the finger surface. Indicated by color depth (darker color = higher normal force).

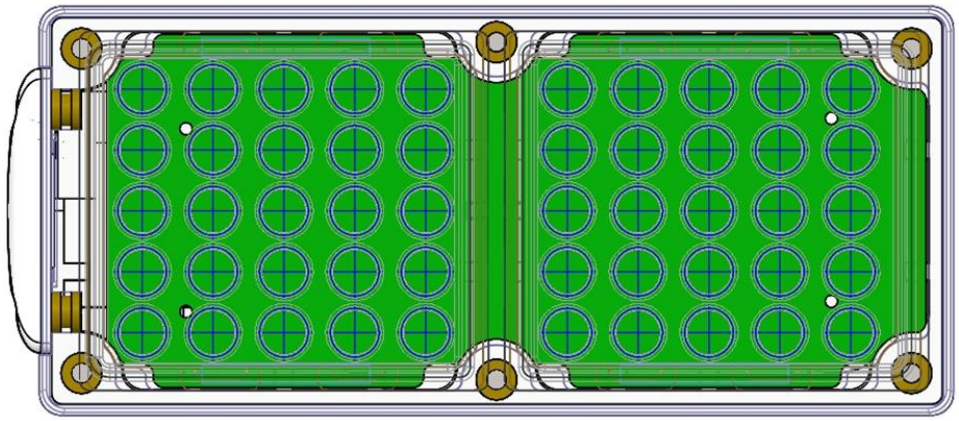
- **Tangential Force**: Parallel to the finger surface. Indicated by arrow length (longer arrow = higher tangential force).
- **Tangential Force Angle**: The fingertip direction (upwards) is defined as the 0° reference. The angle is measured clockwise (0°–359°), and the arrow dynamically points to the tangential force direction.
- **Proximity Capacitance**: Displays the variation in proximity sensing channels as a dynamic bar chart.

**3. Finger Data Interface**

Displays real-time data values for all sampling channels within the finger.

- **Acquisition Channel Reset**: Click on a specific channel to recalculate its baseline. This prevents data misjudgments caused by environmental factors or drift.



**4. Finger Settings Interface**

Provides sensor-specific control commands and configuration parameters:

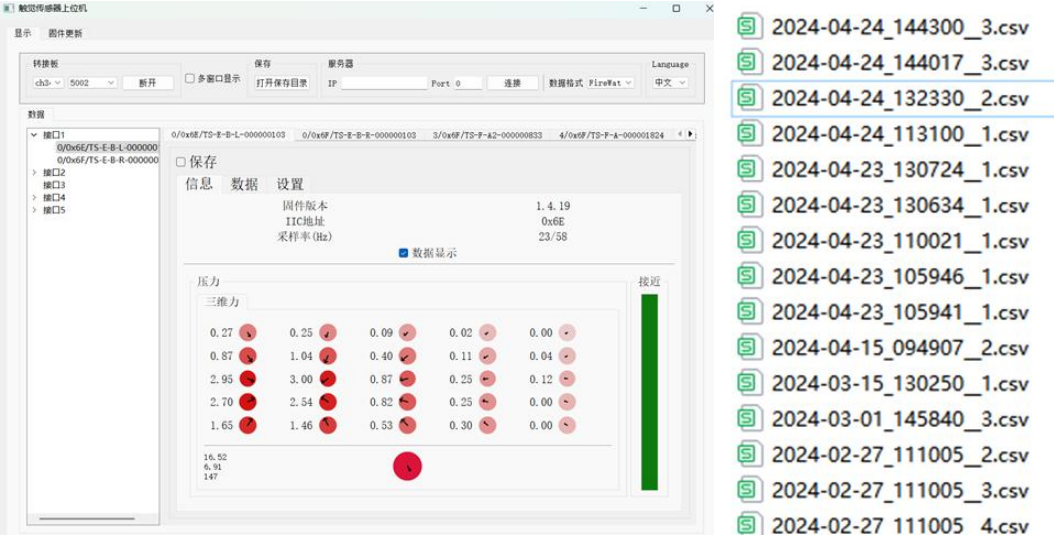
- **Reset**: Executes a device reboot command.
- **Output Type**: Toggles data output between **Raw Value** (original sampled capacitance) and **Difference Value** (relative change after force application).
- **I²C Address Setting**: *(Note: Address modification is not supported for this specific sensor).*
- **Channel Reset**: Resets the baselines for all channels simultaneously.

- **Channel Value Adjustment**: Calibrates all raw channel values to a baseline of approximately 3,000,000. This prevents numerical errors caused by long-term operation or environmental shifts.


### 5. Data Saving

Sensor data can be logged by checking specific devices or selecting "Save All".

- **Directory**: Data is exported to the data folder located within the software's root directory.
- **Format**: .csv file.
- **Naming Convention**: YYYY-MM-DD-HHMMSSms__sensor_number.csv.



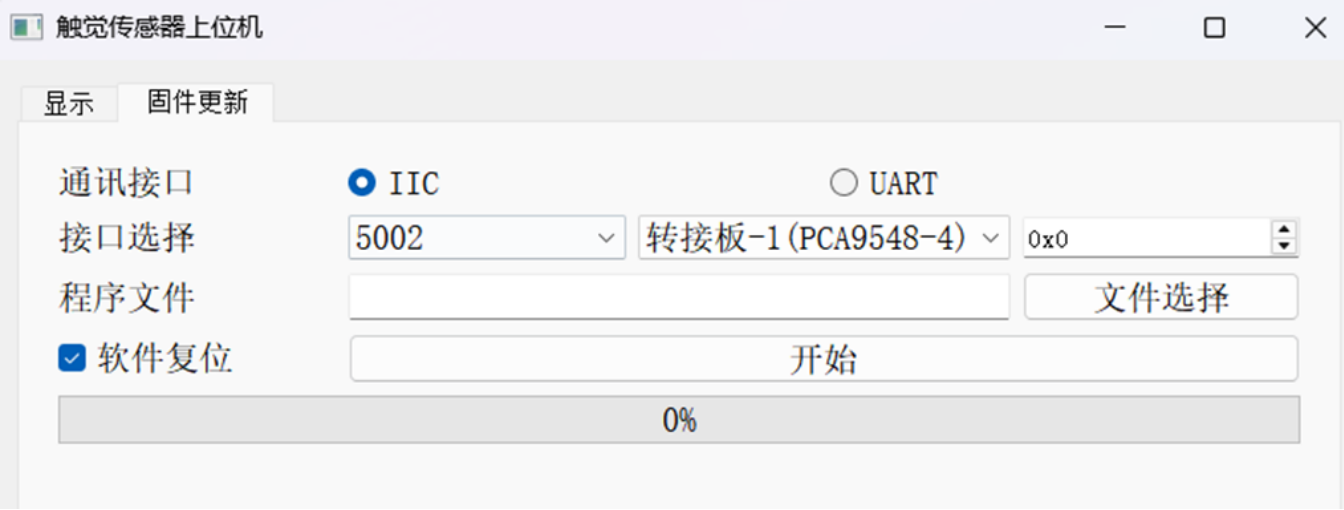
### 6. TCP Data Transmission

The demo software acts as a TCP Client to output real-time measurement values as a string, allowing users to route data to third-party waveform display software.

- **Data String Format**:
  data1,data2,data3,data4,data5,data6,data7,data8,data9,data10,data11,data12,data13,data14₩r₩n

### 7. Firmware Update

1. Ensure the adapter board and sensor are properly connected to the PC.
2. Select the target **Device Number**.
3. Select the firmware binary (.bin) file.
4. Check **Software Reset** and click **Start**.
5. Wait for the update to succeed. *(Troubleshooting: If the update fails, retry the process or swap the order of Step 1 and Step 4).*

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## 5. Operation and Use

## 5.1 Pre-Use Inspection

- Ensure environmental conditions meet the specified requirements.
- Estimate the applied force to confirm it falls within the sensor's measurement range.
- Remove the anti-static cover and inspect the silicone surface for damage or debris.
- Verify that all fastening bolts are securely tightened.
- Confirm that the software is functioning properly.

## 5.2 Safety Precautions During Operation

- Strictly avoid forces exceeding the sensor's rated limits.
- Prevent sharp or abrasive objects from damaging the silicone surface.
- Do not disassemble or modify the sensor components without authorization.
- Halt operations immediately if abnormal noise or malfunction occurs.

## 5.3 Data Acquisition and Protocols

## I²C Protocol Data Read/Write

The sensor utilizes the I²C protocol for data transmission, supporting both Standard Mode (100 kHz) and Fast Mode (400 kHz). The sensor operates as an I²C slave device and automatically initiates capacitance sampling by default; however, specific protocols must be followed to read the data.

The module contains two independent internal sensors with fixed I²C addresses: `0x6E` (cable side) and `0x6F`. These addresses are fixed and cannot be modified. Unlike other finger modules, this sensor **does not support Address 0x00 broadcasting**.

**Checksum Calculation**

- **Length**: Calculated from the first read/write byte up to (but not including) the checksum bytes.

- **Example**: For the command aa 55 03 71 00 00 00 00 00, the checksum is 73 01.
- **C Language Reference Function**:

```
static void CalcSum(uint8_t *pdata, uint16_t n)

{

    uint16_t sum = 0;

    for (int i = 0; i < n; i++)

    {

        sum += *(pdata + i);

    }

    *(pdata + n) = sum & 0xFF;          // Low Byte (LSB)

    *(pdata + n + 1) = sum >> 8;        // High Byte (MSB)

}
```

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# 6. Maintenance and Care

## 6.1 Storage Requirements

When not in use, store the sensor in an anti-static bag to provide dust, moisture, and static protection. Keep in a cool, dry environment.

## 6.2 Routine Maintenance

- The product must be operated by trained personnel familiar with the manual.
- Do not use underwater or subject to unilateral/single-point load operations.
- Regularly tighten bolts to prevent malfunctions caused by vibration or loosening.

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# 7. Additional Information

## 7.1 Warranty

Using Tashan sensors implies unconditional acceptance of the limited warranty terms. For damages not caused by human factors, the product is covered by a 1-year replacement and 2-year repair policy.