ROBOTOUS

# RFT(Robotous Force/Torque Sensor) Series

## Installation and Operation Manual

REVISION 1.0

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# 1. Caution

## 1.1. Notices

⚠ The operator must have read and understood all of the instructions in the following manual before handling the RFT series.

⚠ This manual includes the overall information of RFT series about installation, operation, specification, ordering information etc.

## 1.2. Warning

⚠ Do not install and operate a sensor that is damaged or lacking parts.

⚠ Do not disassemble or repair the sensor. This may cause irreparable damage to the sensor and void the warranty

⚠ Always consider the sensor payload

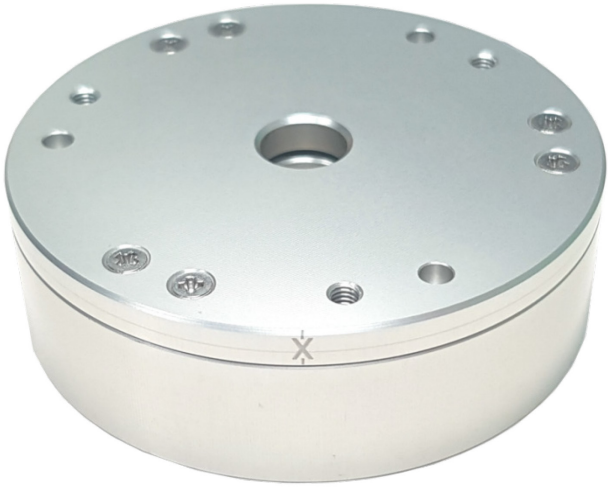
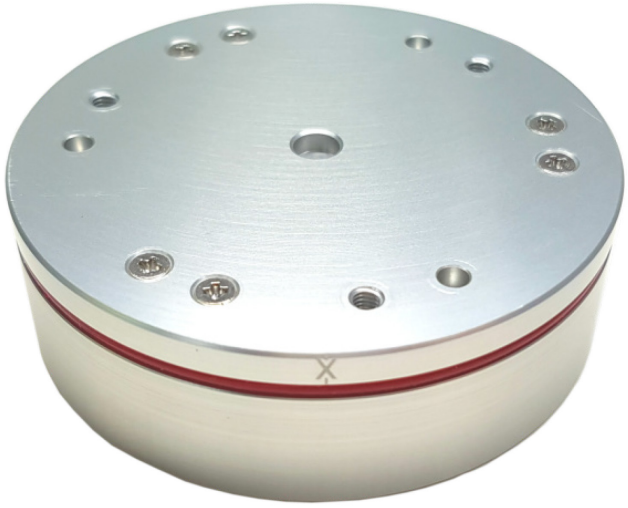
⚠ Do not exert excessive forces or torques on the sensor. This can create incorrect measurement of forces and cause possible damage to the sensor. When a force is applied to the sensor, torques are exerted on the sensor simultaneously. Be aware that all six axes should fall within the ranges and not exceeding the ratings. If the rating of even one of the six axes is exceeded, correct detection of forces will fail for all axes. Refer to Section 4.2 Specifications for the RFT series for specific sensor overload values.

⚠ If the sensor experiences a sudden change in temperature and humidity, the sensor's temperature correction feature may no longer function correctly, causing erratic sensor output. When handling the sensor, ensure the operating environment is not subject to sudden changes in temperature and humidity.

⚠ Do not remove or damage the label on sensor to maintain warranty.

## 2. Installation

### 2.1. Overview

| Normal type | Dust Seal type |
|---|---|
| RFT40-SA01 | RFT44-SB01 |
|  |  |
| RFT60-HA01 | RFT64-SB01 |
|  |  |

- Capacitive Type
  - Sensing capacitance of deformed gap
- High Durability
  - No strain gauge, No adhesive
- Easy Interface
  - Built-in signal circuit & MCU
  - CAN, USB, RS-232, RS-422
- Applications
  - Field/Industrial Robots, Service Robots and Etc,.

2.2. Power Supply Specifications

| Item | RFT40-SA | RFT44-SB | RFT60-HA | RFT64-SB |
|---|---|---|---|---|
| Input operating voltage | 4.5V to 5.5V DC | | | |
| Max power consumption | 0.5W | | | |
| Overvoltage protection | Warning<br>Maximum output voltage tolerance is ±10%,<br>exceeding this limit, it could damage the Sensor. | | | |

2.3. Wiring

- In accordance digital interface, the cable wiring of sensor can be change follow,


| Communication Interface | BLACK | RED | GREEN | YELLOW | ORANGE | BROWN |
|---|---|---|---|---|---|---|
| CAN | GND | VCC(5V) | CAN_H | CAN_L | (NC) | (NC) |
| RS-232 | GND | VCC(5V) | RX | TX | (NC) | (NC) |
| RS-422 | GND | VCC(5V) | TX+ | TX- | RX- | RX+ |

✓ NOTE 0. For CAN and RS-422 communication, there is no terminal resistor inside. The operator have to connect terminal resistor to use the sensor normally.
✓ NOTE 1. Shield line is connected with internal GND line. Thus, it is unnecessary to connecting between the shield line and any ground

# 3. Operation

## 3.1. Digital Interfaces

- CAN(Control Area Network)
- RS-232
- RS-422
- USB(Virtual COM Port) : expected to be released soon
- EtherCAT : expected to be released soon

## 3.2. Communication Packets

- Command Packet
  - Transmit packet to the Force/Torque sensor
  - Setting parameters of the Force/Torque sensor.
  - Packet Size : It differs according to the interfaces refer to Section 3.5 Communication Packet Structure
  - Data Field Size : 8 Bytes
- Response Packet
  - Received packet from the Force/Torque sensor
  - Receive the data processing result according to command packets
  - Packet Size : It differs according to the interfaces refer to Section 3.5 Communication Packet Structure
  - Data Field Size : 16 Bytes

## 3.3. Basic Operation

- Notices
  - The operator should transmit the F/T Output command in order to measure force and torque data because the Force/Torque sensor is idle state after applying proper voltage.
  - The Force/Torque sensor saves the setting parameters
    - After setting the parameters, resetting is unnecessary even if the Force/Torque sensor is powered off
    - But, The Force/Torque sensor does not save the F/T Output command, F/T Output Stop command, bias command.
  - Available commands while measuring force and torque data
    - F/T Output Stop Command
    - Bias Command
    - Except for the above commands, all commands are able to use after transmitting F/T Output Stop command
- Force Torque measurement by default setting
  - Step 1. Transmit F/T Output command [Command ID = 11(0x0B)]
  - Step 2. Receive force and torque data

- After changing setting, Measure the Force/Torque
  - Step 1. Transmit setting command
    - Setting commands and detailed description refer to Section 3.6 Functional Detailed Data Field
  - Step 2. Check the response packet
    - Receive the data processing result according to the commands
  - Step 3. Transmit F/T Output command
  - Step 4. Receive force and torque data

- Change the setting while measuring force and torque data
  - Step 1. F/T Output Stop command transmission [Command ID = 12(0x0C)]
  - Step 2. Transmit setting commands
  - Step 3. Check the response packet
    - Receive the data processing result according to the commands
  - Step 4. Transmit F/T Output command
  - Step 5. Receive force and torque data

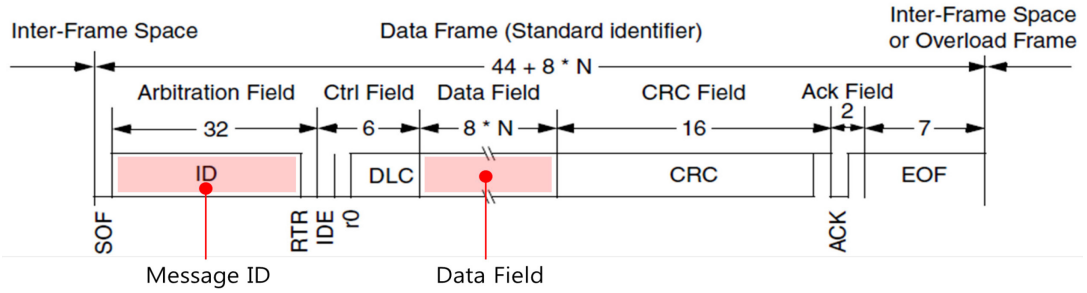
- Measurement the force and torque and set bias
  - Step 1. Transmit F/T Output command [Command ID = 11(0x0B)]
  - Step 2. Transmit Set Bias command [Command ID = 17(0x11)]
    - Set Bias command and detailed description refer to Section 3.6 Functional Detailed Data Field
  - Step 3. Receive the force and torque data

## 3.4. Default Setting

| Item | Default Values | | Remarks |
|---|---|---|---|
| | CAN | UART | |
| Filtering | Filter OFF | Filter OFF | |
| Data Transmit Rate | 200Hz | 200Hz | |
| Message ID | Receiving Message ID : 100(0x64)<br>Transmitting Message ID #1: 1(0x01)<br>Transmitting Message ID #2: 2(0x02) | N/A | Only CAN Version |
| Communication Setting | CAN 2.0 A, B Compatible<br>Identifier: Standard Identifier<br>Bit rate: 1Mbps<br>Number of Data: 8 Bytes | Baud Rate: 115,200bps<br>1 Stop Bit<br>No Parity<br>No Flow Control<br>Number of Data Bit: 8Bits | |

## 3.5. Communication Packet Structure

### 3.5.1. CAN Communication Packet Structure




- Above figure shows the message structure of a standard CAN communication
  - Maximum data field size is 8 Byte each CAN message
- The Force/Torque sensor uses the message ID and data filed of the CAN communication
- The command packet occupies 1 message ID of CAN communication
  - The receiving message ID of the Force/Torque sensor is message ID of the command packet
  - Default the receiving message ID = 100 (0x64)
  - Refer to Section 3.6 Functional Detailed Data Field for each response packet
- The response packet occupies 2 message ID of CAN communication
  - The Force/Torque sensor transmits the messages continuously about the command processing result through 2 sequential message IDs
  - The Transmitting message ID of the Force/Torque sensor is message ID of the response packet
  - Default transmitting message ID #1 = 1(0x01)
  - Default transmitting message ID #2 = 2(0x02)
  - Received 8bytes of data as ID#1 is consists of Data 1 to 8 from Response Packet data field.
  - Received 8bytes of data as ID#2 is consists of Data 9 to 16 from Response Packet data field.
  - Refer to Section 3.6 Functional Detailed Data Field for each response packet

### 3.5.2. UART Communication Packet Structure

- Command Packet Structure

| SOP | Data Field | | | Checksum | EOP |
|---|---|---|---|---|---|
| | Data 1 | .... | Data 8 | | |
| 85(0x55) | Command Data Field | | | | 170(0xAA) |

- Response Packet Structure

| SOP | Data Field | | | Checksum | EOP |
|---|---|---|---|---|---|
| | Data 1 | .... | Data 16 | | |
| 85(0x55) | Response Data Field | | | | 170(0xAA) |

- RS-232, RS-422 interfaces utilize UART communication
- UART packet structure consists of the SOP(Start Of Packet), Data Field, Checksum and EOP(End Of Packet)
  - SOP field size is 1Byte, fixed value 85(0x55)
  - EOP field size is 1Byte, fixed value 170(0xAA)
  - The data field size of the command packet is 8Byte

- The data field size of the response packet is 16Byte
- The data field size of the checksum is 1Byte, the checksum value is summation of each data of data field
- Refer to Section 3.6 Functional Detailed Data Field for each data field of the command packet and the response packet

## 3.6. Functional Detailed Data Field

### 3.6.1. Command Summary

| Command | Command ID | Number of Parameter | Response Packet status | Available Command while measuring data | Remarks |
|---|---|---|---|---|---|
| Read Model Name | 1(0x01) | 0 | Yes | - | |
| Read S/N | 2(0x02) | 0 | Yes | - | |
| Read Firmware Ver. | 3(0x03) | 0 | Yes | - | |
| Set Communication ID | 4(0x04) | 3 | Yes | - | Only CAN |
| Read Communication ID | 5(0x05) | 0 | Yes | - | Only CAN |
| Set Baud-rate | 6(0x06) | 1 | Yes | - | Only UART |
| Read Baud-rate | 7(0x07) | 0 | Yes | - | |
| Set Filter | 8(0x08) | 2 | Yes | - | |
| Read Filter Setting | 9(0x09) | 0 | Yes | - | |
| F/T 1 sample Output | 10(0x0A) | 0 | Yes | - | |
| F/T Output | 11(0x0B) | 0 | Yes | - | |
| F/T Output Stop | 12(0x0C) | 0 | No | Yes | |
| Reserved | 13(0x0D) | N/A | N/A | - | |
| Reserved | 14(0x0E) | N/A | N/A | - | |
| Set Output Rate | 15(0x0F) | 1 | Yes | - | |
| Read Output Rate | 16(0x10) | 0 | Yes | Yes | |
| Bias Setting | 17(0x11) | 1 | No | - | |
| Read Overload Log | 18(0x12) | 0 | Yes | - | |

### 3.6.2. Read Model Name

◘ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

- ID : Command ID = 1(0x01)

◘ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 |

- ID : Response ID = 1(0x01) <same with command ID>
- R1 ~ R15 : Model name in ASCII code

### 3.6.3. Read S/N

◘ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Command ID = 2(0x02)

◘ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 |

◆ ID : Response ID = 2(0x02) <same with command ID>

◆ R1 ~ R15 : S/N in ASCII code

### 3.6.4. Read Firmware Version

◘ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Command ID = 3(0x03)

◘ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 |

◆ ID : Response ID = 3(0x03) <same with command ID>

◆ R1 ~ R15 : Firmware Version in ASCII code

### 3.6.5. Set Communication ID (Only CAN)

◘ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | Receiving ID | Transmitting ID#1 | Transmitting ID#2 | XX | XX | XX | XX |

◆ ID : Command ID = 4(0x04)

◆ Receiving ID of Force/Torque sensor

◆ ID #1: first transmitting message ID

◆ ID #2: second transmitting message ID

◆ Setting range : 1(0x01) ~ 255(0xFF), the Receiving and transmitting ID should be different from each others

◘ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Response ID = 4(0x04) <same with command ID>

◆ R1 : Command processing result [1(0x01) : normal operation, 0(0x00) –error occurrence]

◆ R2 : refer to Section 3.6.19 Error Code for error code

3.6.6. Read Communication ID (Only CAN)

□ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Command ID = 5(0x05)

□ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | R3 | R4 | R5 | R6 | XX | XX | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Response ID = 5(0x05) <same with command ID>

◆ R1 : Present Receiving ID

◆ R2 : Present Transmitting ID #1

◆ R3 : Present Transmitting ID #2

◆ R4 : Set Receiving ID

◆ R5 : Set Transmitting ID #1

◆ R6 : Set Transmitting ID #2

◆ Changed setting is applied in the Force/Torque sensor after the sensor is powered on again

3.6.7. Set Baud-rate(Only UART)

□ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | Setting baud-rate | XX | XX | XX | XX | XX | XX |

◆ ID : Command ID = 6(0x06)

◆ Setting baud-rate

- CAN : 1Mbps is fixed value
- UART [Default 0(0x00): 115,200 bps]
  - 1(0x01): 921,600bps
  - 2(0x02): 460,800bps
  - 3(0x03): 230,400bps
  - 4(0x04): 115,200bps
  - 5(0x05): 57,600bps

□ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Response ID = 6(0x06) <same with command ID>

◆ R1 : Command processing result [1(0x01) : normal operation, 0(0x00) –error occurrence]

◆ R2 : refer to Section 3.6.19 Error Code for error code

✓ Notices
- Both baud-rate and output rate setting are set correlatively
- The setting is enabled when all values of baud rate and output rate has been established properly

- refer to Section 3.6.16 Detailed Set Output Rate

3.6.8. Read Baud-rate

◘ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Command ID = 7(0x07)

◘ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Response ID = 7(0x07) <same with command ID>

◆ R1 : present baud rate

◆ R2 : set baud rate

◆ Changed setting is applied in the Force/Torque sensor after the sensor is powered on again

3.6.9. Set Filter

◘ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | Filter Type | Detail Setting | XX | XX | XX | XX | XX |

◆ ID : Command ID = 8(0x08)

◆ Filter Type

■ 0: None filter, 1 – 1st order low-pass filter

◆ Detail setting

| Filter | Detailed setting value | Cutoff Frequency[Hz] |
|---|---|---|
| 0(0x00) | 0(0x00) | No filtering |
| 1(0x01) | 0(0x00) | No filtering |
| 1(0x01) | 1(0x01) | 500 |
| 1(0x01) | 2(0x02) | 300 |
| 1(0x01) | 3(0x03) | 200 |
| 1(0x01) | 4(0x04) | 150 |
| 1(0x01) | 5(0x05) | 100 |
| 1(0x01) | 6(0x06) | 50 |
| 1(0x01) | 7(0x07) | 40 |
| 1(0x01) | 8(0x08) | 30 |
| 1(0x01) | 9(0x09) | 20 |
| 1(0x01) | 10(0x0A) | 10 |
| 1(0x01) | 11(0x0B) | 5 |
| 1(0x01) | 12(0x0C) | 3 |

| | | |
|---|---|---|
| 1(0x01) | 13(0x0D) | 2 |
| 1(0x01) | 14(0x0E) | 1 |

◘ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Response ID = 8(0x08) <same with command ID>
◆ R1 : Command processing result [1(0x01) : normal operation, 0(0x00) –error occurrence]
◆ R2 : refer to Section 3.6.19 Error Code for error code

### 3.6.10. Read Filter Setting

◘ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Command ID = 9(0x09)

◘ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Response ID = 9(0x09) <same with command ID>
◆ R1 : Filter Type
◆ R2 : Filter detailed setting value

### 3.6.11. F/T 1 sample Output

◘ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

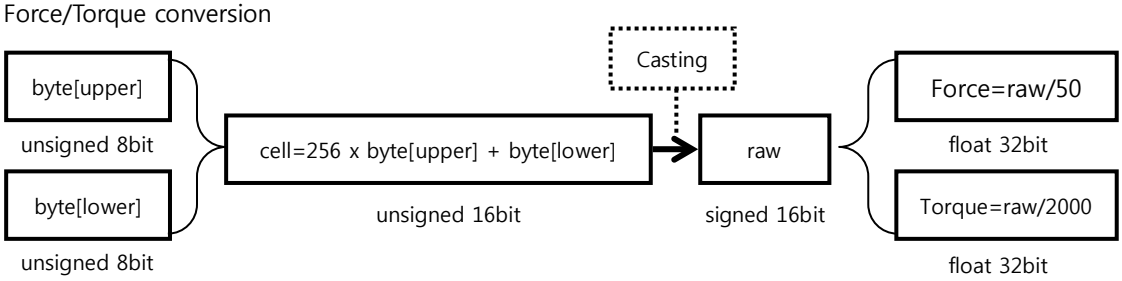
◆ ID : Command ID = 10(0x0A)

◘ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | XX | XX |

◆ ID : Response ID = 10(0x0A) <same with command ID>
◆ R1 ~ R12 : Each value of the force and torque is composed of 2byte(signed short)
◆ R1 : Fx's upper byte, R2 : Fx's lower byte
◆ R3 : Fy's upper byte, R4 : Fy's lower byte
◆ R5 : Fz's upper byte, R6 : Fz's lower byte
◆ R7 : Tx's upper byte, R8 : Tx's lower byte
◆ R9 : Ty's upper byte, R10 : Ty's lower byte

- R11 : Tz's upper byte, R12: Tz's upper byte
- Force/Torque conversion




- R13 : Overload Status
  - If each force and torque exceeds the specification of sensors by more than 120%, the Bit value of exceeded force or torque increases by 1.

| Overload Status | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| Reserved | Reserved | Fx | Fy | Fz | Tx | Ty | Tz |

### 3.6.12. F/T Output

- Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

- ID : Command ID = 11(0x0B)

- Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | XX | XX |

- ID : Response ID = 11(0x0B) <same with command ID>
- R1 ~ R12 : Each value of the force and torque is composed of 2byte(signed short)
  - R1 : Fx's upper byte, R2 : Fx's lower byte
  - R3 : Fy's upper byte, R4 : Fy's lower byte
  - R5 : Fz's upper byte, R6 : Fz's lower byte
  - R7 : Tx's upper byte, R8 : Tx's lower byte
  - R9 : Ty's upper byte, R10 : Ty's lower byte
  - R11 : Tz's upper byte, R12: Tz's upper byte
  - refer to Section 3.6.11. F/T 1 sample Output for Force Torque conversion
- R13 : Overload Status
  - If each force and torque exceeds the specification of sensors by more than 120%, the Bit value of exceeded force or torque increases by 1.

| Overload Status | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| Reserved | Reserved | Fx | Fy | Fz | Tx | Ty | Tz |

### 3.6.13. F/T Output Stop

- Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Command ID = 12(0x0B)

□ Data field of response packet

◆ This command has no response packet.

3.6.14. Set Output Rate

□ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | Output Rate | XX | XX | XX | XX | XX | XX |

◆ ID : Command ID = 15(0x0F)

◆ Output Rate
  ■ Default : 0 [200Hz]

◆ refer to Section 3.6.16 Detailed Set Output Rate for output rate

□ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Response ID = 15(0x0F) <same with command ID>

◆ R1 : Command processing result [1(0x01) : normal operation, 0(0x00) –error occurrence]

◆ R2 : refer to Section 3.6.19 Error Code for error code

✓ Notices
- Both baud-rate and output rate setting are set correlatively
- The setting is enabled when all values of baud rate and output rate has been established properly
- refer to Section 3.6.16 Detailed Set Output Rate

3.6.15. Read Output Rate

□ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Command ID = 16(0x10)

□ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX | XX |

◆ ID : Response ID = 16(0x10) <same with command ID>

◆ R1 : refer to Section 3.6.16 Detailed Set Output Rate for ouput Rate

3.6.16. Detail Set Output Rate

□ CAN Interface

| Communication Setting | Detailed setting value (Output frequency[Hz]) | note |
|---|---|---|

| Setting value | Baud-rate | 0x00 (200) | 0x01 (10) | 0x02 (20) | 0x03 (50) | 0x04 (100) | 0x05 (200) | 0x06 (333) | 0x07 (500) | 0x08 (1000) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| XX | 1Mbps | O | O | O | O | O | O | O | O | O | |

- Default Baud-rate: 1Mbps Fixed
- Default Output-rate: 0 [200Hz]

□ UART Interface Version

| Communication Setting | | Detailed setting value (Output frequency[Hz]) | | | | | | | | | note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Setting value | Baud-rate | 0 (200) | 1 (10) | 2 (20) | 3 (50) | 4 (100) | 5 (200) | 6 (333) | 7 (500) | 8 (1000) | |
| 0 | 115,200bps | O | O | O | O | O | O | O | X | X | |
| 1 | 921,600bps | O | O | O | O | O | O | O | O | O | |
| 2 | 460,800bps | O | O | O | O | O | O | O | O | X | |
| 3 | 230,400bps | O | O | O | O | O | O | O | O | X | |
| 4 | 115,200bps | O | O | O | O | O | O | O | X | X | |
| 5 | 57,600bps | O | O | O | O | O | O | X | X | X | |

- Default Baud-rate: 115,200bps
- Default Output-rate: 0 [200Hz]

3.6.17. Set Bias

□ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | Bias setting value | XX | XX | XX | XX | XX | XX |

- ID : Command ID = 17(0x11)
  - Bias setting value 0(0x00): un-bias,
  - Bias setting value 1(0x01): set-bias

□ Data field of response packet

- This command has no response packet.

3.6.18. Read Overload Count

□ Data field of command packet(8byte) (XX : Don't care)

| Data Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
| ID | XX | XX | XX | XX | XX | XX | XX |

- ID : Command ID = 18(0x12)

□ Data field of response packet(16byte) (XX : Don't care)

| Data Field | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 |
| ID | R1 | R2 | R3 | R4 | R5 | R6 | XX | XX | XX | XX | XX | XX | XX | XX | XX |

- ID : Response ID = 18(0x12) <same with command ID>

- R1 : Fx Overload count
- R2 : Fy Overload count
- R3 : Fz Overload count
- R4 : Tx Overload count
- R5 : Ty Overload count
- R6 : Tz Overload count
- Maximum Overload count value: 255 (0xFF)

### 3.6.19. Error Code

| Code | Description |
|---|---|
| 1(0x01) | Unsupported command |
| 2(0x02) | Setting range error<br>-If it exceed the range to ID, Baud-rate, filter setting etc. |
| 3(0x03) | Data storage error<br>- Internal data storage error occurred |

## 3.7. C Sample Code for F/T Conversion

### 3.7.1. CAN Interface

```
unsigned char data_field[16]; // storage buffer for data field
//..... Received CAN data Save .....
// 8 byte data of can message id is #1 save in data_field [0] ~ [7]
// 8 byte data of can message id is #2 save in data_field [8] ~ [15]
// data field processing
short raw_data[6] = { 0 };
unsigned short temp;
// response ID checking
if( (data_field[0] != 10) || (data_field[0] != 11) )
        return;

for (int idx = 0; idx < 6; idx++)
{
        temp = data_field [2 * idx + 1] * 256;
        temp += data_field [2 * idx + 2];
        raw_data[idx] = (signed short)temp; // variable casting
}

// Conversion from signed short data to float data and data scaling
// Set Force/Torque Original
float ft_array[6];
for (n = 0; n < 3; n++)
{
    ft_array[n] = (((float)raw_data[n] ) / 50.);
    ft_array[n + 3] = (((float)raw_data[n + 3] ) / 2000.);
}
// Overload status value
unsigned char overload_status = can_msg_data[13];
```

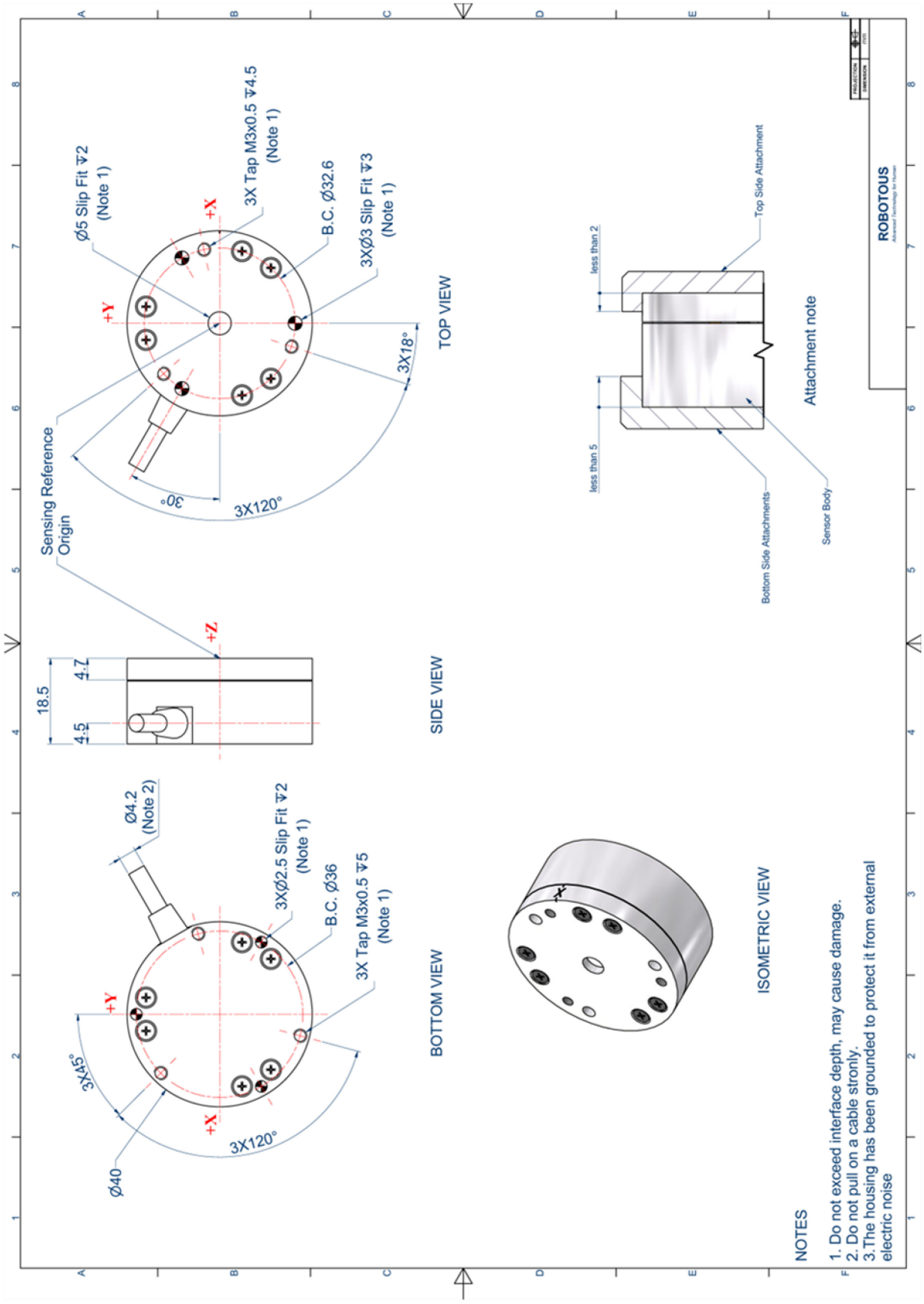
3.7.2. UART Interface

```
unsigned char uart_rx_buffer[100]; // receive buffer for uart communication
unsigned char data_field[16]; // storage buffer for data field
// check the SOP, EOP, Checksum of received UART data
// SOP == 0x55, EOP == 0xAA, Checksum == summation of each data in data_field

// Save the data field's data in data field buffer
for(int idx = 0; idx < 16; idx++)
        data_field[idx] = uart_rx_buffer[idx + 1]; //in case that rx_buffer[0] is SOP
// data field processing
short raw_data[6] = { 0 };
unsigned short temp;
// response ID checking
if( (data_field[0] != 10) || (data_field[0] != 11) )
        return;

for (int idx = 0; idx < 6; idx++)
{
        temp = data_field [2 * idx + 1] * 256;
        temp += data_field [2 * idx + 2];
        raw_data[idx] = (signed short)temp; // casting process
}

// Conversion from signed short data to float data and data scaling
// Set Force/Torque Original
float ft_array[6];
for (n = 0; n < 3; n++)
{
    ft_array[n] = (((float)raw_data[n] ) / 50.);
    ft_array[n + 3] = (((float)raw_data[n + 3] ) / 2000.);
}
// Overload status value
unsigned char overload_status = can_msg_data[13];
```

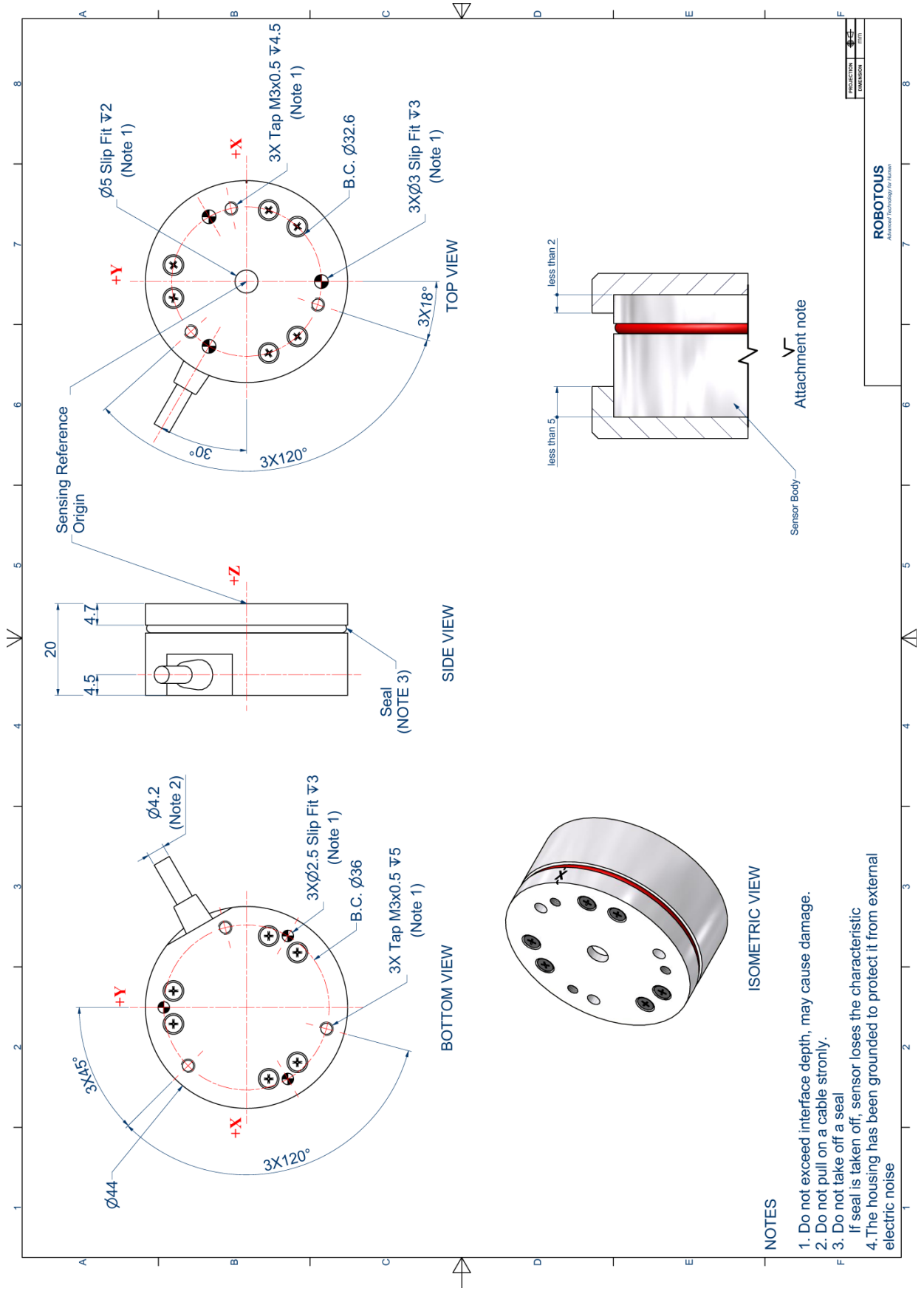
# 4. Product Specification

## 4.1. Customer Drawing

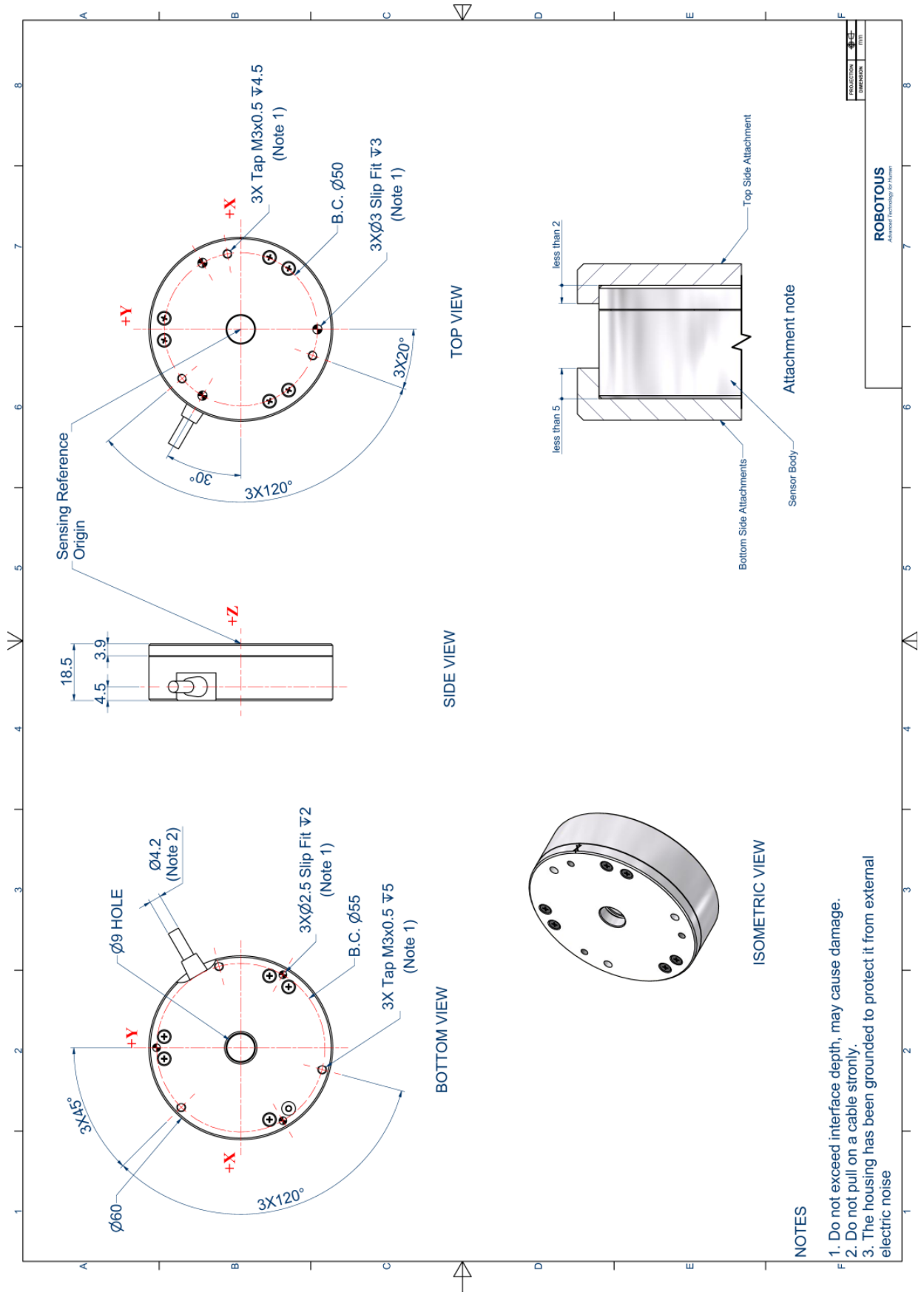
### 4.1.1. RFT40-SA01



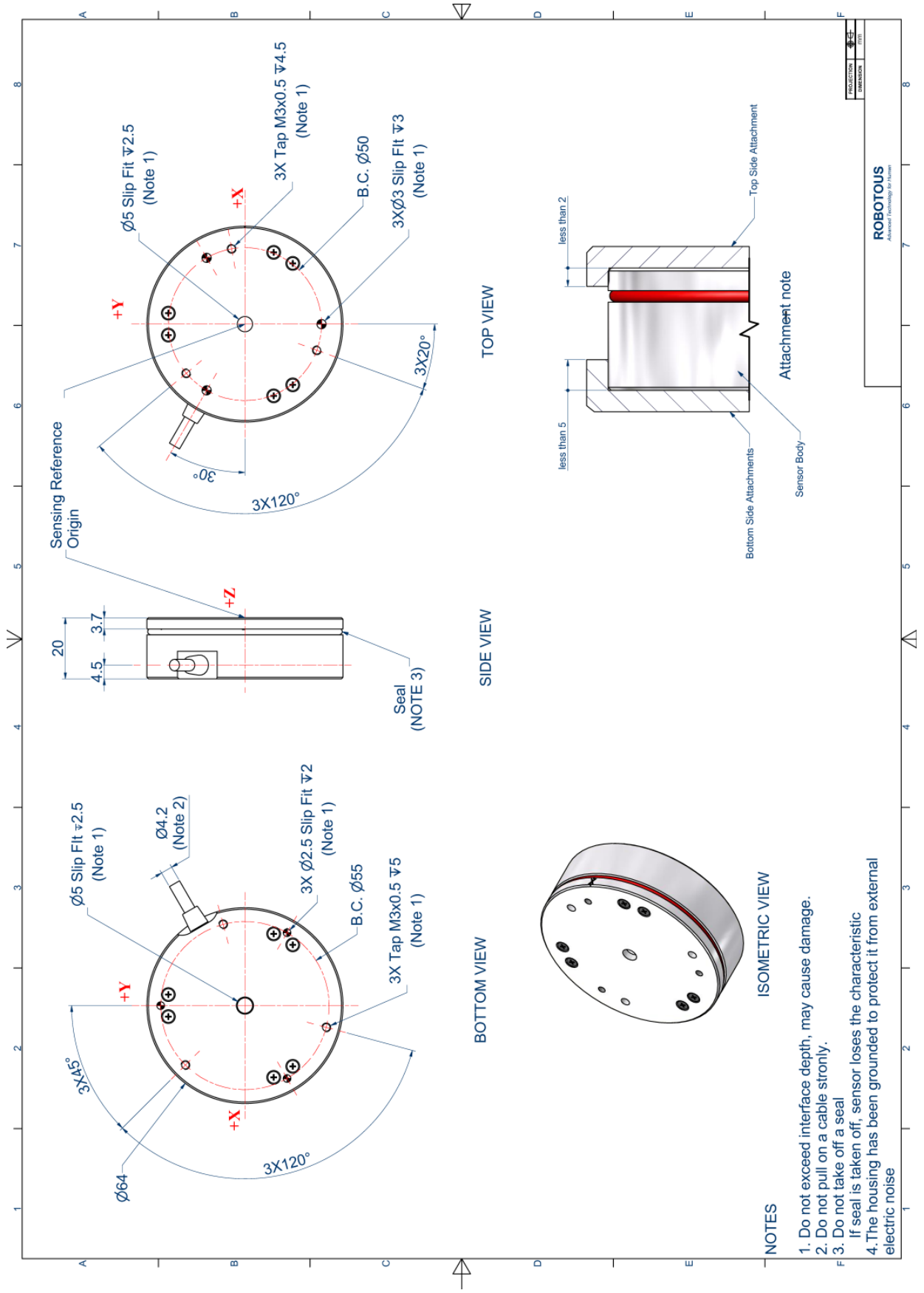
4.1.2. RFT44-SB01



4.1.3. RFT60-HA01



4.1.4. RFT64-SB01



4.2. Specifications

| Specifications | Dimension | | Weight | Data rate | Load Capacity | | | Resolution | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ø | H | Except cable | Maximum | Fx, Fy | Fz | Tx, Ty, Tz | Fx, Fy | Fz | Tx, Ty, Tz |
| | mm | mm | g | Hz | N | N | Nm | mN | mN | mNm |
| RFT40-SA01 | 40 | 18.5 | 60 | 200 | 100 | 150 | 2.5 | 200 | 200 | 8 |
| RFT44-SB01 | 44 | 20 | 70 | 200 | 100 | 150 | 2.5 | 200 | 200 | 8 |
| RFT60-HA01 | 60 | 18.5 | 120 | 1,000 | 150 | 200 | 4 | 150 | 200 | 5 |
| RFT64-SB01 | 64 | 20 | 140 | 1,000 | 150 | 200 | 4 | 150 | 200 | 5 |

- Resolution : The standard deviation of each six components of force and torque for 10second, the data through internal 1st-order low pass filter which has cutoff frequency 100Hz

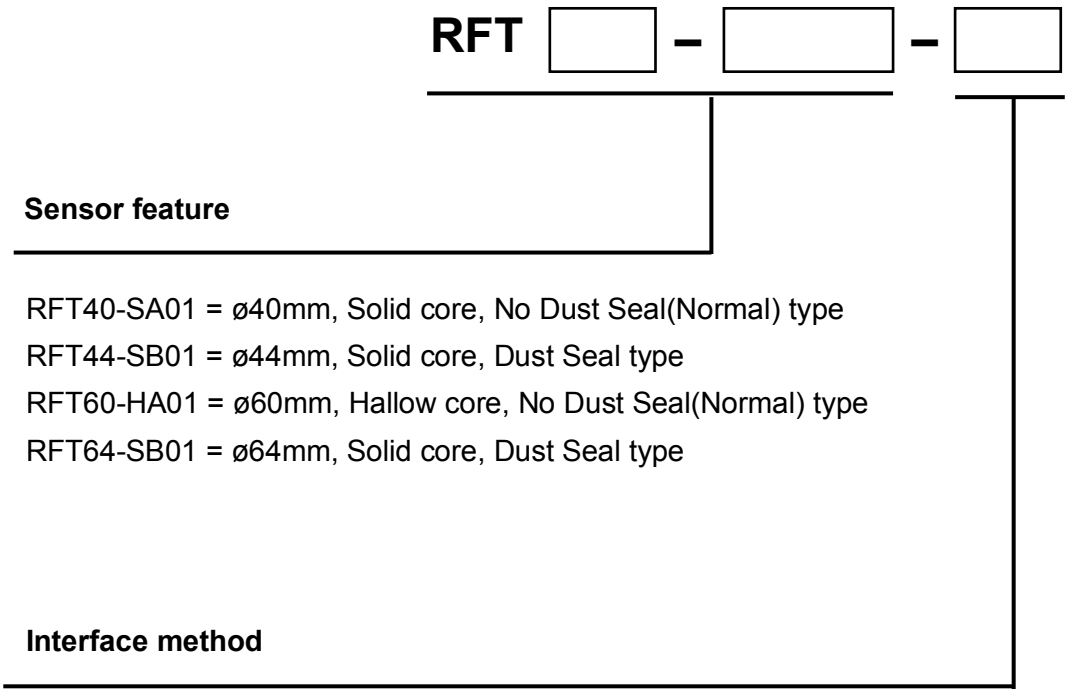
| Specifications | Dimension | | Hysteresis | | | Overload capacity | | | | Cross talk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ø | H | Fx, Fy | Fz | Tx, Ty, Tz | Fx, Fy | Fz+ | Fz- | Tx, Ty, Tz | Fx, Fy | Fz | Tx, Ty, Tz |
| | mm | mm | %FS | | | % | | | | %FS | | |
| RFT40-SA01 | 40 | 18.5 | 2 | 0.5 | 1 | 150 | 150 | 300 | 150 | 3 | 3 | 3 |
| RFT44-SB01 | 44 | 20 | 2.5 | 1 | 3 | 150 | 150 | 300 | 150 | 3 | 3 | 3 |
| RFT60-HA01 | 60 | 18.5 | 2.5 | 1 | 1 | 150 | 150 | 300 | 150 | 3 | 3 | 3 |
| RFT64-SB01 | 64 | 20 | 3 | 2 | 2 | 150 | 150 | 300 | 150 | 3 | 3 | 3 |

- Fz+ : Tensile force, Fz- : Compressive force . The capacity of compressive force is more capacity than the capacity of tensile force

4.3. Option of interface specifications

✧ All of the RFT series supports the CAN, UART(RS-232/422)
✧ USB, EtherCAT interface expected to be released. The CAN Interface can be extended the EtherCAT interface which will be released

## 5. Ordering Information




Example) **RFT64-SB01-A**

= ROBOTOUS Force/Torque Sensor Ø64mm Solid core with Dust seal CAN Interface

## 6. Contact(Technical Assistance)

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