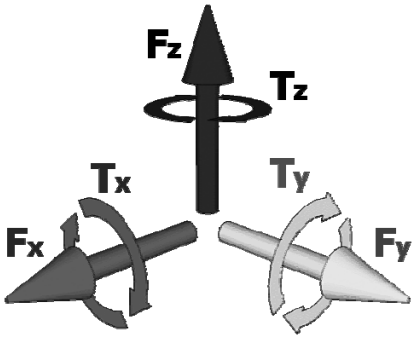
6 Axis Force Torque Sensor
RFT Series

Installation and Operation Manual

REVISION 1.8



ROBOTOUS Co., Ltd.

Contents

1. Caution

1.1. Notices

⚠ The user must read and understand all of the instructions in this manual before using the RFT series F/T sensors.

⚠ This manual covers installation, operation, specification, and ordering information of RFT series F/T sensors..

1.2. Warning

⚠ Do not install and operate a F/T sensor that is damaged or lacking some parts.

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

⚠ Always take payload applied to the F/T sensor into consideration for safe usage.

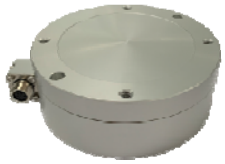
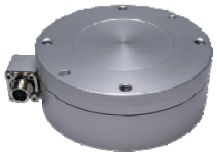
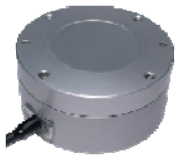
⚠ Do not exert excessive forces or torques on the sensor. This can create incorrect measurement and cause damage to the sensor. When force is applied to the sensor, torque is exerted on the sensor simultaneously. Make sure all components of force and torque stay within allowed ranges. Even if a component of them exceeds its limit, this may result in incorrect measurement of the other component. Refer to Section 4.1 Performance Specifications.

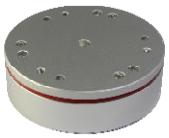
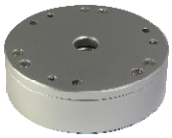
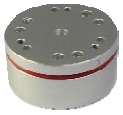
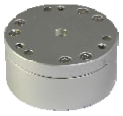
⚠ If the sensor experiences a sudden change in temperature and humidity, the sensor's temperature correction feature may no longer function correctly and cause erratic sensor output. Please ensure the sensor is not subject to sudden changes in temperature and humidity.

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

2. Installation

2.1. Overview

Item	RFT90-6A01	RFT80-6A02	RFT80-6A01	RFT64-6A01
Product Image				
Hollow Core			●	
Dust Seal				
Temp. Compensation	●	●		●

Item	RFT64-SB01	RFT60-HA01	RFT44-SB01	RFT40-SA01
Product Image				
Hollow Core		●		
Dust Seal	●		●	
Temp. Compensation				

Capacitive Type
Sensing capacitance variation by structural deformation

Reliable Performance
Immunity to electrical noise, robust calibration, no sensor drift

High Durability
Mechanical overload protection, no adhesive

Easy Installation All-in-one device with embedded signal processing, interface software support

Low Cost
Simple structure, simplified fabrication process

Various Output Options
RS422, RS232, CAN, USB, and EtherCAT

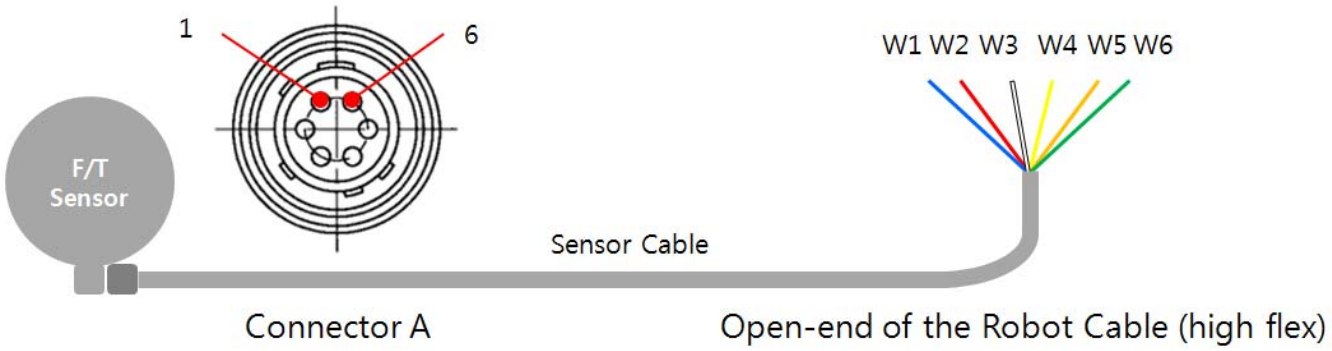
2.2. Power Supply Specifications

Item	RFT Series
Input voltage	5V DC
Max. power consumption	0.5W
Warning	Input voltage tolerance: ±10% **The F/T sensor may be damaged if input voltage exceeds the limits.**

2.3. Wiring

- General notices
  - Sensor output interface may have a different mapping between wire colors and functions. Please make sure each wire color matches a correct function while connecting to a corresponding interface.
  - For CAN and RS-422, the user has to connect a terminal resistor of 120Ω for normal operation, because the sensor doesn't have any terminal resistor inside.
  - The shield line is connected to the internal GND, so it doesn't have to be connected to any ground outside.
  - For RS-232, the RX from one device should go to the TX of the other, and vice-versa.

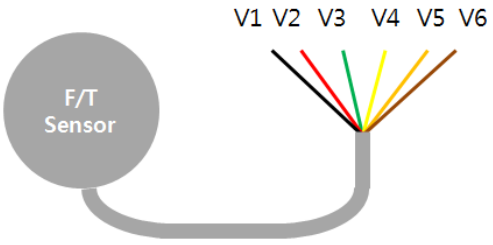
- RFT90-6A01 | RFT80-6A02 | RFT80-6A01



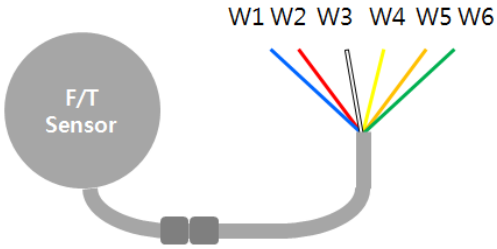
Connector A (Sensor Side)					
Pin No.	Signal				Color
	CAN	RS232	RS422	USB	
1	GND	GND	GND	GND	Blue
2	VCC	VCC	VCC	VCC	Red
3	C_H	TX	TX+	D-	White
4	C_L	RX	TX-	D+	Yellow
5	-	-	RX-	-	Orange
6	-	-	RX+	-	Green

Cable End (Host Side)					
Pin No.	Color	Signal			
		CAN	RS232	RS422	USB
W1	Blue	GND	GND	GND	GND
W2	Red	VCC	VCC	VCC	VCC
W3	White	C_H	TX	TX+	D-
W4	Yellow	C_L	RX	TX-	D+
W5	Orange	-	-	RX-	-
W6	Green	-	-	RX+	-

- RFT64-6A01 | RFT64-SB01 | RFT60-HA01 | RFT44-SB01 | RFT40-SA01



Open-end of the Standard Cable



Open-end of the Robot Cable (high flex)

Cable End (Host Side)					
Pin No.	Color	Signal			
		CAN	**RS232**	**RS422**	**USB**
V1	Black	GND	GND	GND	GND
V2	Red	VCC	VCC	VCC	VCC
V3	Green	C_H	TX	TX+	D-
V4	Yellow	C_L	RX	TX-	D+
V5	Orange	-	-	RX-	-
V6	Brown	-	-	RX+	-

Cable End (Host Side)					
Pin No.	Color	Signal			
		CAN	**RS232**	**RS422**	**USB**
W1	Blue	GND	GND	GND	GND
W2	Red	VCC	VCC	VCC	VCC
W3	White	C_H	TX	TX+	D-
W4	Yellow	C_L	RX	TX-	D+
W5	Orange	-	-	RX-	-
W6	Green	-	-	RX+	-

3. Operation

3.1. F/T Sensor Output Interfaces

- CAN (Control Area Network)
- RS-232
- RS-422
- USB (Virtual COM port)
- EtherCAT (with an external board (e.g., RFTEC-02), embedded for RFT80-6A02 and RFT64-6A01 only)

3.2. Communication Packets

- Command Packet
  - To transmit commands to the F/T sensor.
  - To set parameters of the F/T sensor.
  - The size of the packet depends on sensor output interfaces, refer to Section 3.5 Packet Structure.
  - The size of data field is 8 bytes.
- Response Packet
  - To receive responses from the F/T sensor.
  - To receive the result of data processing of the command packet
  - The size of the packet depends on data output interfaces, refer to Section 3.5 Packet Structure.
  - The size of data field is 16 bytes

3.3. Basic Operation

- Notices
  - A user has to send the command “Start F/T Data Output” in order to measure and receive force and torque data from the sensor. Otherwise, the F/T sensor stays idle even after applying power.
  - The F/T sensor can save current parameter settings which is valid even after rebooting it.
    - However, the sensor does not save the following commands: Start F/T Data Output, Stop F/T Data Output, and Set Bias.
  - The following commands only are executable during measuring force and torque data: F/T Data Output Stop and Set Bias.
    - The rest of commands are available in idle state or after executing the command of “Stop F/T Data Output Stop”.
- How to measure force & torque from the sensor with default setting
  - Step 1. Send the command “Start F/T Data Output” [Command ID = 11(0x0B)].
  - Step 2. Receive force and torque data from the sensor.
- How to measure force & torque after setting parameters
  - Step 1. Send a command for parameter setting of the sensor. (Refer to Section 3.6 Packet Definition.)

- Step 2. Receive a corresponding response packet and check whether there was an error in processing the command.
- Step 3. Send the command “Start F/T Data Output”.
- Step 4. Receive force and torque data from the sensor.

- How to set a parameter while measuring force and torque.
  - Step 1. Send the command “Stop F/T Data Output” [Command ID = 12(0x0C)]
  - Step 2. Send a command for setting a parameter.
  - Step 3. Receive a corresponding response packet and check whether there was an error in processing the command.
  - Step 4. Send the command “Start F/T Data Output”.
  - Step 5. Receive force and torque data from the sensor.

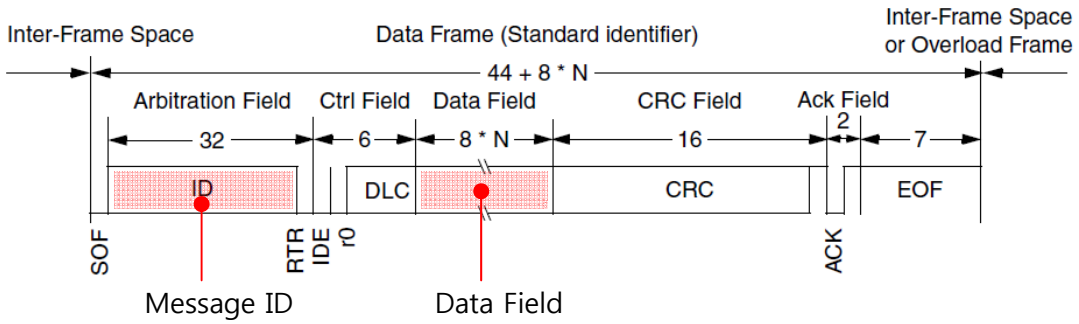
- How to set bias while measuring force and torque
  - Step 1. Send the command “Start F/T Data Output” [Command ID = 11(0x0B)].
  - Step 2. Send the command “Set Bias” [Command ID = 17(0x11)]
  - Step 3. Receive force and torque data from the sensor.

3.4. Default Setting of Communication

Item	Default Values		Remarks
	CAN	UART	
Filtering	Filter OFF	Filter OFF	
Data Output Rate	200Hz	200Hz	
Message ID	Receiver ID : 100(0x64) Transmitter ID #1: 1(0x01) Transmitter ID #2: 2(0x02)	N/A	CAN only
Communication Setting	CAN 2.0 A, B Compatible Identifier: Standard Identifier Bit Rate: 1Mbps Size of Data: 8 Bytes	Baud Rate: 115,200bps 1 Stop Bit No Parity No Flow Control Data Length: 8 Bits	

3.5. Packet Structure

3.5.1. Packet Structure of CAN Interface



- The message structure of a standard CAN communication is shown in the figure above.
  - Maximum data field size of a CAN packet is 8 bytes.
- The force/torque sensor uses the arbitration field (message ID) and data field of CAN packet.
- The command packet needs a message ID to send 1 byte command to the sensor.
  - Receiver ID of CAN communication is a message ID for receiving commands.
  - The default receiver ID is 100 (0x64).
  - Refer to Section 3.6 Packet Definition for more information.
- The response packet needs 2 message IDs to receive 16 bytes data from the sensor. In other words, it is made of two sequential CAN packets.
  - Transmitter ID #1 and transmitter ID #2 are message IDs for the two sequential CAN packets, respectively.
  - The default transmitter ID #1 is 1(0x01).
  - The default transmitter ID #2 is 2(0x02).
  - 8 bytes data in a CAN packet with transmitter ID #1 occupies Data 1- Data 8 of the response packet data field.
  - 8 bytes data in a CAN packet with transmitter ID #2 occupies Data 9 – Data 16 of the response packet data field.

3.5.2. Packet Structure of UART interface

- 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, and USB interfaces utilize UART communication.
- UART packet structure consists of SOP (Start Of Packet), Data Field, Checksum and EOP (End Of Packet)

- The size of SOP field is 1 byte, it is fixed to 85(0x55).
- The size of EOP field is 1 byte, it is fixed to 170(0xAA).
- The data field of the command packet has 8 bytes length.
- The data field of the response packet has 16 bytes length.
- The size of the checksum field is 1 byte, the checksum value is summation of each data in data field.

3.6. Packet Definition

3.6.1. Summary of command packets

Command	Command ID	No. of Parameters	w/ Response Packet	Remarks
Read Model Name	1(0x01)	0	Yes	
Read Serial Number	2(0x02)	0	Yes	
Read Firmware Version	3(0x03)	0	Yes	
Set Communication ID	4(0x04)	3	Yes	CAN only
Read Communication ID	5(0x05)	0	Yes	CAN only
Set Baud-rate	6(0x06)	1	Yes	UART only
Read Baud-rate	7(0x07)	0	Yes	
Set Filter	8(0x08)	2	Yes	
Read Filter Setting	9(0x09)	0	Yes	
Read F/T data (once)	10(0x0A)	0	Yes	
Start F/T Data Output	11(0x0B)	0	Yes	
Stop F/T Data Output	12(0x0C)	0	No	Available even during data output
Reserved	13(0x0D)	N.A.	N.A.	
Reserved	14(0x0E)	N.A.	N.A.	
Set Data Output Rate	15(0x0F)	1	Yes	
Read Data Output Rate	16(0x10)	0	Yes	Available even during data output
Set Bias	17(0x11)	1	No	
Read Count of Overload Occurrence	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 Serial Number**

◘ 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 (for CAN only)**

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

Data Field							
D1	D2	D3	D4	D5	D6	D7	D8
ID	Receiver ID	Transmitter ID#1	Transmitter ID#2	XX	XX	XX	XX

◆ ID : Command ID = 4(0x04)

◆ Receiver ID: ID of Force/Torque sensor

◆ Transmitter ID #1: the first message ID for transmitting two sequential messages

◆ Transmitter ID #2: the second message ID for transmitting two sequential messages

◆ Allowable range of ID: 1(0x01) ~ 255(0xFF)

◆ Note that Receiver/transmitter IDs must differ from each other.

◘ 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 : Result of command processing [1(0x01) : success, 0(0x00) : failure]
- R2 : Refer to Section 3.6.19 Error Codes

3.6.6. **Read Communication ID (for CAN only)**

- 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 : Current receiver ID
- R2 : Current transmitter ID #1
- R3 : Current transmitter ID #2
- R4 : Receiver ID to set
- R5 : Transmitter ID #1 to set
- R6 : Transmitting ID #2 to set
- Note that new receiver/transmitter IDs(R4~R6) are applied at next reboot of the sensor

3.6.7. **Set Baud-rate (for UART only)**

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

Data Field							
D1	D2	D3	D4	D5	D6	D7	D8
ID	Baud-rate parameter	XX	XX	XX	XX	XX	XX

- ID : Command ID = 6(0x06)
- Baud-rate parameter
  - CAN : 1Mbps, fixed
  - UART [Default 0(0x00): 115,200 bps]

Baud-rate parameter	**Baud-rate** (bps)
0(0x00)	115,200
1(0x01)	921,600
2(0x02)	460,800
3(0x03)	230,400
4(0x04)	115,200

5(0x05)	57,600

◘ 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 : Result of command processing [1(0x01) : success, 0(0x00) : failure]
- ◆ R2 : Refer to Section 3.6.19 Error Codes
- ◆ Notices
  - Note that baud-rate is related to available data output rates.
  - Refer to Section 3.6.16 Allowable Data 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 : Current baud-rate
- ◆ R2 : Baud-rate to set at next reboot of sensor

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	Filter Parameter	XX	XX	XX	XX	XX

- ◆ ID : Command ID = 8(0x08)
- ◆ Filter Type
  - ■ 0: No filter, 1: 1st order low-pass filter
- ◆ Filter Parameter

Filter Type	Filter Parameter	Cutoff Frequency [Hz]
0(0x00)	0(0x00)	No filter
1(0x01)	0(0x00)	No filter
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 : Result of command processing [1(0x01) : success, 0(0x00): failure]
◆ R2 : refer to Section 3.6.19 Error Codes

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 parameter

3.6.11. **Read F/T Data (once)**

◘ 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)

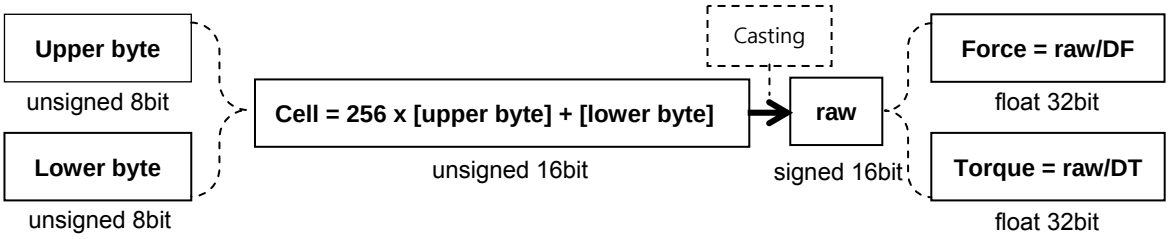
Data Field															
D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16
ID	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	XX	XX

◆ 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 lower byte

◆ How to convert to force and torque values



◆ R13 : Status of Overload

Status of Overload							
Bit7	Bit6	Bit5 (Fx)	Bit4 (Fy)	Bit3 (Fz)	Bit2 (Tx)	Bit1 (Ty)	Bit0 (Tz)
Reserved	Reserved	0/1	0/1	0/1	0/1	0/1	0/1

- If each components of force and torque exceed its rated load capacity by more than 20%, the corresponding bit is set to 1, and reset to 0 if not.

◆ Divider DF, DT

Divider		
Model	DF	DT
RFT80-6A02	50	1000
RFT80-6A01	50	1000
RFT64-6A01	50	1000
RFT64-SB01	50	2000
RFT60-HA01	50	2000
RFT44-SB01	50	2000
RFT40-SA01	50	2000

3.6.12. **Start F/T Data 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 components of force & torque are composed of 2 parameters as follows:

- 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 lower byte
- Refer to Section 3.6.11.Read F/T Data to get real force & torque values.

◆ R13 : Status of Overload, refer to Section 3.6.11.

3.6.13. **Stop F/T Data 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 = 12(0x0C)

◘ Data field of response packet

◆ This command is not followed by any response packet.

3.6.14. **Set Data 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 Parameter	XX	XX	XX	XX	XX	XX

◆ ID : Command ID = 15(0x0F)

◆ Output Rate Parameter

- Default : 0 [200Hz]
- Refer to Section 3.6.16 Allowable Data 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 : Result of command processing [1(0x01): success, 0(0x00): failure]
- R2 : Refer to Section 3.6.19 Error Code for error code
- Notice:
  - High data output rate may not work at a low baud-rate.
  - Please refer to Section 3.6.16 Allowable Data Output Rate

3.6.15. **Read Data 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 Allowable Data Output Rate

3.6.16. **Allowable Data Output Rate**

□ CAN Interface

Communication		Output Rate Parameter (Output rate, Hz)								
Baud-rate Parameter		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

Communication		Output Rate Parameter (Output rate, Hz)								
Baud-rate Parameter		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**

- Receiving the command with set-bias, the sensor saves current output values as a reference and begins to send offset of the following output values from the reference.
- Receiving the command with un-bias, the sensor begins to send offset of the following output values from the factory bias which is a reference saved in a factory setting.
- Data field of command packet(8byte) (XX : Don't care)

Data Field							
D1	D2	D3	D4	D5	D6	D7	D8
ID	Bias parameter	XX	XX	XX	XX	XX	XX

  - ID : Command ID = 17(0x11)
    - Bias parameter 0(0x00): un-bias,
    - Bias parameter 1(0x01): set-bias
- Data field of response packet
  - This command is not followed by any response packet.

3.6.18. **Read Count of Overload Occurrence**

- 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 : Number of overload occurrence of Fx
  - R2 : Number of overload occurrence of Fy
  - R3 : Number of overload occurrence of Fz
  - R4 : Number of overload occurrence of Tx
  - R5 : Number of overload occurrence of Ty
  - R6 : Number of overload occurrence of Tz
  - Maximum count of overload occurrence: 255 (0xFF)

3.6.19. **Error Codes**

Error Code	Description
1(0x01)	Unsupported command
2(0x02)	Out of range error, a parameter such as ID, baud-rate, filter setting, (etc.) is out of the allowable range.

3(0x03)	Failed to set parameters

3.7. C Sample Code for Force & Torque 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;
unsigned DF=50, DT=2000; // DF, DT depend on the model, refer to 3.6.11
// 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] ) / DF);    // refer to 3.6.11
      ft_array[n + 3] = (((float)raw_data[n + 3] ) / DT); // refer to 3.6.11
}
// 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;
unsigned DF=50, DT=2000; // DF, DT depend on the model, refer to 3.6.11
// 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] ) / DF);
    ft_array[n + 3] = (((float)raw_data[n + 3] ) / DT);
}
// Overload status value
unsigned char overload_status = can_msg_data[13];
```

4. Product Specification

4.1. Performance specifications

Model	Dimensions		Weight	Data rate	Load capacity			Resolution		
	Ø	H	w/o cable	Max.	Fx, Fy	Fz	Tx, Ty, Tz	Fx, Fy	Fz	Tx, Ty, Tz
	mm	mm	g	Hz	N	N	Nm	mN	mN	mNm
RFT90-6A01	80	33	418	1,000	600	600	40	150	150	5
RFT80-6A02	80	30	294	1,000	400	400	20	80	80	4
RFT80-6A01	80	22	226	1,000	400	400	20	100	100	5
RFT64-6A01	64	30	175	1,000	200	200	10	80	80	4
RFT64-SB01	64	20	140	1,000	150	200	4	150	200	5
RFT60-HA01	60	18.5	120	1,000	150	200	4	150	200	5
RFT44-SB12	44	20	70	200	100	150	2.5	200	200	8
RFT40-SA01	40	18.5	60	200	100	150	2.5	200	200	8

- Resolution is the standard deviation of each six components of force and torque measured for 10 seconds, the measurement data passed through an internal 1st-order low pass filter with cutoff frequency of 100Hz.

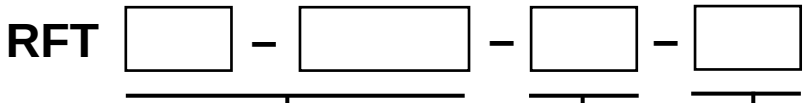
Model	Dimensions		Hysteresis			Overload capacity				Crosstalk		
	ø	H	Fx, Fy	Fz	Tx, Ty, Tz	Fx, Fy	Fz+	Fz-	Tx, Ty, Tz	Fx, Fy	Fz	Tx, Ty, Tz
	mm	mm	%FS			%				%FS		
RFT90-6A01	90	33	1	1	1	300	300	300	300	3	3	3
RFT80-6A02	80	30	1	1.5	2	300	300	300	300	3	3	3
RFT80-6A01	80	22	2.5	1	1	150	200	400	200	3	3	3
RFT64-6A01	64	30	1	1.5	2	300	300	300	300	3	3	3
RFT64-SB01	64	20	3	2	2	150	150	300	150	3	3	3
RFT60-HA01	60	18.5	2.5	1	1	150	150	300	150	3	3	3
RFT44-SB12	44	20	2.5	1	3	150	150	300	150	3	3	3
RFT40-SA01	40	18.5	2	0.5	1	150	150	300	150	3	3	3

- Fz+: tensile force, Fz-: compressive force.

4.2. Data output interface

- RFT series support CAN, UART(RS-232/422), EtherCAT, and USB interfaces.

5. Product Ordering Information



Sensor Feature

RFT90-6A01 = ø90mm, High resolution, Temp. compensation
RFT80-6A02 = ø80mm, High resolution, Temp. compensation
RFT80-6A01 = ø80mm, High resolution
RFT64-6A01 = ø64mm, High resolution, Temp. compensation
RFT64-SB01 = ø64mm, Dust seal
RFT60-HA01 = ø60mm, Hollow core
RFT44-SB01 = ø44mm, Dust seal

Interface Method

A = CAN
B = RS-232
C = RS-422
D = USB
E = EtherCAT (External board, e.g. RFTEC-02)
(Embedded for RFT80-6A02 and RFT64-6A01)

Cable Option

" " = Default, Shielded, General signal cable, 2 meters
R3 = Shielded, Robot cable, 3 meters
R5 = Shielded, Robot cable, 5 meters

[Example] **RFT64-SB01-A:**

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

6. Contact Information (Technical Support)

- **Homepage** www.robotous.com
- **Tel.** +82-31-606-9918
- **E-mail** support@robotous.com
- **Address** 2F NEX-CENTER, SKn TECHNOPARK, 124 SAGUMAKGOL-RO, JUNGWON-GU, SEONGNAM-SI, GYEONGGI-DO, KOREA 13207,

7. APPENDIX: Dimensions of RFT Series

- **RFT90-6A01**
- **RFT80-6A02**
- **RFT80-6A01**
- **RFT64-6A01**
- **RFT64-SB01**
- **RFT60-HA01**
- **RFT44-SB01**
- **RFT40-SA01**