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Aurora Digital Multivariate Sensor 213ML5-R0 User Manual

Taiwan Link Solution Co., Ltd.

A Professional Provider of Vibration Analysis, Monitoring, and Diagnostic Solutions
Dedicated to Maximizing the Value of Your Products and Equipment.



TABLE OF CONTENTS — SYSTEM INSTALLATION AND OPERATION MANUAL

- 1 Aurora System Introduction 6
 - 1.1 Objective 6
 - 1.2 Product Description.....7
 - 1.2.1 Introduction to 213ML5-R0 Smart Sensor and Accessories 7
 - 1.2.1.1 213ML5-R0 RS485 Wired Digital Triaxial Multivariate Sensor 7
 - 1.2.1.2 Smart Sensor Base 3838 and Magnetic Mount 3838M 8
- 2 213ML5-R0 Digital Multivariate Sensor Introduction 9
 - 2.1 213ML5-R0 Function Description 9
 - 2.2 213ML5-R0 Communication Architecture 10
 - 2.3 213ML5-R0 Wiring Definitions 11
 - 2.4 213ML5-R0 LED Definitions 11
 - 2.5 213ML5-R0 Digital Multivariable Sensor: Raw Vibration Signal Output Description and Workflow 13
 - 2.5.1 213ML5-R0 Digital Multivariable Sensor Raw Vibration Signal Output Description 13
 - 2.5.2 213ML5-R0 Digital Multivariable Sensor: Raw Vibration Signal Output Workflow 14
 - 2.6 Reading Other Information of the 213ML5-R0 Digital Multivariate Sensor 23
 - 2.6.1 Reading Other Information of the 213ML5-R0 Digital Multivariate Sensor 24
 - 2.7 Control the LED of the 213ML5-R0 Digital Multivariate Sensor.....30
- 3 213ML5-R0 Digital Multivariable Sensor Deployment Guide 32
 - 3.1 On-site Mounting of the Smart Sensor 32

3.2	Field Wiring	36
4	Customer Service	37
AppendixA.	Datasheet	38
AppendixB.	Dimensions	39
AppendixC.	Aurora Wire Specifications	40
AppendixD.	Appendix D Document Revision History.....	41

LIST OF FIGURES AND TABLES

Figure 1-1 213ML5-R0 RS485 Wired Digital Triaxial Multivariate Sensor 7

Figure 1-2 Smart Sensor Base 3838 8

Figure 1-3 Smart Sensor Magnetic Base 3838M 8

Figure 1-4 M3 Socket Head Cap Screw.....8

Figure 2-1 213ML5-R0 Status LED Indicators..... 11

Figure 2-2 213ML5-R0 Raw Vibration Signal Flowchart 15

Figure 2-3 CRC16 calculation rules.....24

Figure 2-4 CRC16 calculation rules.....26

Figure 2-5 CRC16 calculation rules.....28

Figure 2-6 CRC16 calculation rules.....30

Figure 3-1 magnetic base 32

Figure 3-2 Base Assembly 32

Figure 3-3 Recommended AB Epoxy Brand and Model.....33

Figure 3-4 Pre-screwing Screws.....33

Figure 3-5 Applying AB Epoxy to the Base 34

Figure 3-6 Securing the Base to the Equipment Surface.....34

Figure 3-7 Waiting for the AB Epoxy to Cure.....35

Figure 3-8 Hex Socket Cap Screw Locking.....35

Figure 3-9 Successful Installation of the 213ML5-R0 Digital Multivariable Sensor 36

Table 2-1	213ML5-R0 RS485 Communication Parameters	10
Table 2-2	213ML5-R0 Wiring Definitions.....	11
Table 2-3	213ML5-R0 Operating Status LED Definitions.....	12
Table 2-4	213ML5-R0 Data Exchange LED Definitions.....	12
Table 2-5	213ML5-R0 Capture buffer start mode Send.....	16
Table 2-6	213ML5-R0 Capture buffer start mode Response	17
Table 2-7	213ML5-R0 Capture buffer FIFO access mode Send.....	18
Table 2-8	213ML5-R0 Capture buffer FIFO access mode Response	19
Table 2-9	213ML5-R0 Capture buffer stop mode Send.....	21
Table 2-10	213ML5-R0 Capture buffer stop mode Response.....	22
Table 2-11	213ML5-R0 Read sensor ID Send	24
Table 2-12	213ML5-R0 Read sensor ID Response	25
Table 2-13	213ML5-R0 Read Firmware Version Number Send.....	26
Table 2-14	213ML5-R0 Read Firmware Version Number Response	27
Table 2-15	213ML5-R0 Read Temperature Send	28
Table 2-16	213ML5-R0 Read Temperature Response.....	29
Table 2-17	213ML5-R0 LED indicator identification Send	30
Table 2-18	213ML5-R0 LED indicator identification Response.....	31

1 Aurora System Introduction

1.1 Objective

The objective of this sensor user manual is to ensure that you are capable of installing the 213ML5-R0 digital multivariate sensor onto your equipment and obtaining digital signals using your terminal equipment.

How to select, configure, and deploy a third-party intermediate device hub between the sensor and your terminal equipment, as well as how to analyze, diagnose, and predict based on the collected digital signals, are excluded from the scope of this manual.

1.2 Product Description

The product items of the Aurora digital multivariate sensor include the 213ML5-R0 sensor along with its base and magnetic mount accessories.

1.2.1 Introduction to 213ML5-R0 Smart Sensor and Accessories

1.2.1.1 213ML5-R0 RS485 Wired Digital Triaxial Multivariate Sensor

The 213ML5-R0 is an RS485 wired digital multivariate sensor designed for measuring low-frequency bandwidth response. It features built-in triaxial vibration and temperature sensors, enabling real-time sensing and continuous output of raw vibration and temperature signals from mechanical equipment. It transmits raw data to connected third-party receivers or gateways using a command set over RS485 interface. The 213ML5-R0 supports configurable data update intervals of 10ms, 25ms, 50ms, 100ms, 200ms, 250ms, and 500ms. Additionally, it provides raw data outputs for both acceleration and velocity, which can be selected when issuing commands.



Figure 1-1 213ML5-R0 RS485 Wired Digital Triaxial Multivariate Sensor

1.2.1.2 Smart Sensor Base 3838 and Magnetic Mount 3838M

Aurora provides two types of fixtures—magnetic and non-magnetic—to secure the 213ML5-R0 onto the monitored equipment.

When you purchase the non-magnetic fixture 3838, the package includes one non-magnetic fixture (as shown in Figure 1-2) and a pair of M3 hex socket screws (as shown in Figure 1-4). It is used by applying adhesive to glue one side of the fixture onto the equipment surface, and then using the screws to lock the smart sensor onto the fixture.

When you purchase the magnetic fixture 3838M, the package includes one magnetic fixture (as shown in Figure 1-3) and a pair of M3 hex socket screws (as shown in Figure 1-4). It is used by attaching the magnetic side of the fixture onto the equipment surface, and then using the screws to lock the smart sensor onto the fixture.



Figure 1-2 Smart Sensor Base 3838



Figure 1-3 Smart Sensor Magnetic Base 3838M



Figure 1-4 M3 Socket Head Cap Screw

2 213ML5-R0 Digital Multivariate Sensor Introduction

2.1 213ML5-R0 Function Description

The 213ML5-R0 is a digital multivariable sensor designed to measure three-axis, low-bandwidth vibrations and continuously output raw signals. The white arrow on its exterior defines the measurement direction. Additionally, the 213ML5-R0 features a built-in temperature sensor, allowing it to simultaneously measure the surface temperature of the equipment.

The 213ML5-R0 offers configurable data update intervals, with available options of 10 ms, 25 ms, 50 ms, 100 ms, 200 ms, 250 ms, and 500 ms per update.

The 213ML5-R0 allows users to choose between raw acceleration and velocity data output via commands. Depending on the user's setting, the sensor will output the corresponding raw vibration data.

If you require the smart sensor to analyze OA (Overall Value) as defined by ISO-10816/ISO-20816, a higher-end smart sensor will be needed. Suitable options include our RS485 wired versions, such as the 213MM3-R0 and 313MM3-R0, or the Bluetooth version, the 213MM1-B1.

If you need the smart sensor to analyze vibration energy corresponding to various rotating equipment fault modes, or analyze energy for custom fault modes—or even leverage the sensor's feature data to build a Remaining Useful Life (RUL) model for equipment life estimation—we highly recommend upgrading to our higher-end smart sensors, such as the RS485 wired version 213MM2-R1, 313MM2-R1, 413MM2-R1 or the Bluetooth version 213MM1-B1.

For instructions on operating and applying other higher-end sensors, please consult the instruction manuals provided for the specific sensors or edge gateways.

2.2 213ML5-R0 Communication Architecture

The 213ML5-R0 utilizes Command over RS485 to transmit raw vibration signals to any intermediate device hub that supports Command over RS485 conversion. The signals are then forwarded to various edge gateways via wired or wireless networks.

We provides official commands and sample code, allowing users to develop their own software to monitor equipment.

The RS485 communication settings for the 213ML5-R0 are detailed in Table 2-1 to the right.

Baudrate	115,200 bit/sec
Data bit	8 bits
Parity	None
Stop bit	1 bit
Flow control	None

Table 2-1 213ML5-R0 RS485 Communication Parameters

2.3 213ML5-R0 Wiring Definitions

The 213ML5-R0 requires an external 12-24V DC power supply. The wiring definitions are listed in Table 2-2 to the right. The red wire represents the positive pole, and the black wire represents the negative pole. The green and yellow wires are RS485 DATA+ and DATA- respectively. The brown wire is used to restore the sensor to the factory settings; for details on its application, please refer to 3.2.

Red	VDC+ (12~24V)
Thin Black	GND
Green	RS485 DATA+
Yellow	RS485 DATA-
Brown	TTL Factory Reset
Thick Black	Shield

Table 2-2 213ML5-R0 Wiring Definitions

2.4 213ML5-R0 LED Definitions

As shown in Figure 2-1, the 213ML5-R0 features three LED indicators on its top surface . From top to bottom, they are the PWR, TX, and RX indicators .



Figure 2-1 213ML5-R0 Status LED Indicators

As shown in Table 2-3 on the right, if the PWR LED on the 213ML5-R0 smart sensor is flashing continuously, it indicates that the sensor is currently acquiring raw vibration signals, during which it will continuously and uninterruptedly output the raw data. If the PWR LED is blinking, it means the sensor is in Standby mode, waiting for a command from the user.

If the PWR LED remains solid OFF, it indicates an abnormal power supply or a damaged sensor; please check the power supply status or contact your local distributor for assistance. If the PWR, TX, and RX LEDs are all solid ON, it means the 213ML5-R0 firmware is corrupted and the sensor has entered recovery mode; please contact your distributor for further service.

PWR flashing continuously (60ms)	The 213ML5-R0 is actively acquiring raw vibration signals and will output them continuously without interruption.
PWR flashing once	The 213ML5-R0 is in Standby mode, waiting for user commands.
PWR, TX, RX all remaining solid on	The 213ML5-R0 firmware is corrupted, and the device has entered recovery mode. Please contact your distributor for support.

Table 2-3 213ML5-R0 Operating Status LED Definitions

As shown in Table 2-4 on the right, the TX and RX LEDs will flash when the 213ML5-R0 smart sensor is uploading raw vibration signals to or receiving commands from various edge devices. If the TX and RX LEDs remain solid OFF, it indicates a signal wiring abnormality between the 213ML5-R0 and the edge device, that the edge device has not issued a command, or that the sensor is damaged. Please check for these possibilities or contact your local distributor for further service.

TX flashing once	The 213ML5-R0 is uploading data via the RS-485 interface.
RX flashing once	The 213ML5-R0 is downloading parameters via the RS-485 interface.

Table 2-4 213ML5-R0 Data Exchange LED Definitions

2.5 213ML5-R0 Digital Multivariable Sensor: Raw Vibration Signal Output Description and Workflow

2.5.1 213ML5-R0 Digital Multivariable Sensor Raw Vibration Signal Output Description

The 213ML5-R0 utilizes Command over RS485 communication to transmit raw vibration signals to various connected gateways. This section introduces its command output workflow.

The data from the 213ML5-R0 consists of time-domain signals. Users can export this data for further analysis and diagnosis in basic monitoring applications across various types of low-frequency equipment.

The 213ML5-R0 features a sampling rate of approximately 250 Hz (500 samples per second) for raw vibration signals. Based on these raw signals, users can implement the sensor in basic monitoring applications for various types of low-frequency equipment with bandwidths below 250 Hz.

2.5.2 213ML5-R0 Digital Multivariable Sensor: Raw Vibration Signal Output Workflow

The 213ML5-R0 utilizes a Command over RS485 communication interface to transmit raw vibration signals to various connected edge gateways.

Before reading the raw vibration signals from the 213ML5-R0, please refer to the instructions in Table 2-2 of Section 2.3 to supply power to the 213ML5-R0. Similarly, refer to Table 2-2 of Section 2.3 to establish a physical COM port connection between the 213ML5-R0 and your terminal device or Device Hub. If your terminal device or Device Hub only provides USB ports, you may use any commercially available RS485-to-USB adapter to connect the sensor to the device.

Please simply issue commands according to the 213ML5-R0 raw signal sampling workflow shown in Figure 2-2 on the right to obtain approximately 500 points of raw vibration signals per second.

- CRC16 : The CRC16 algorithm is required for all checksum commands below, and the checksum is generated by combining all data bytes from the Start Bytes up to the Checksum Bytes. If the checksum is incorrect, the sensor will not execute any operation and will not return any response message. For the CRC16 calculation rules, please refer to the following website: <https://cht.nahua.com.tw/software/crc16/index.php> .

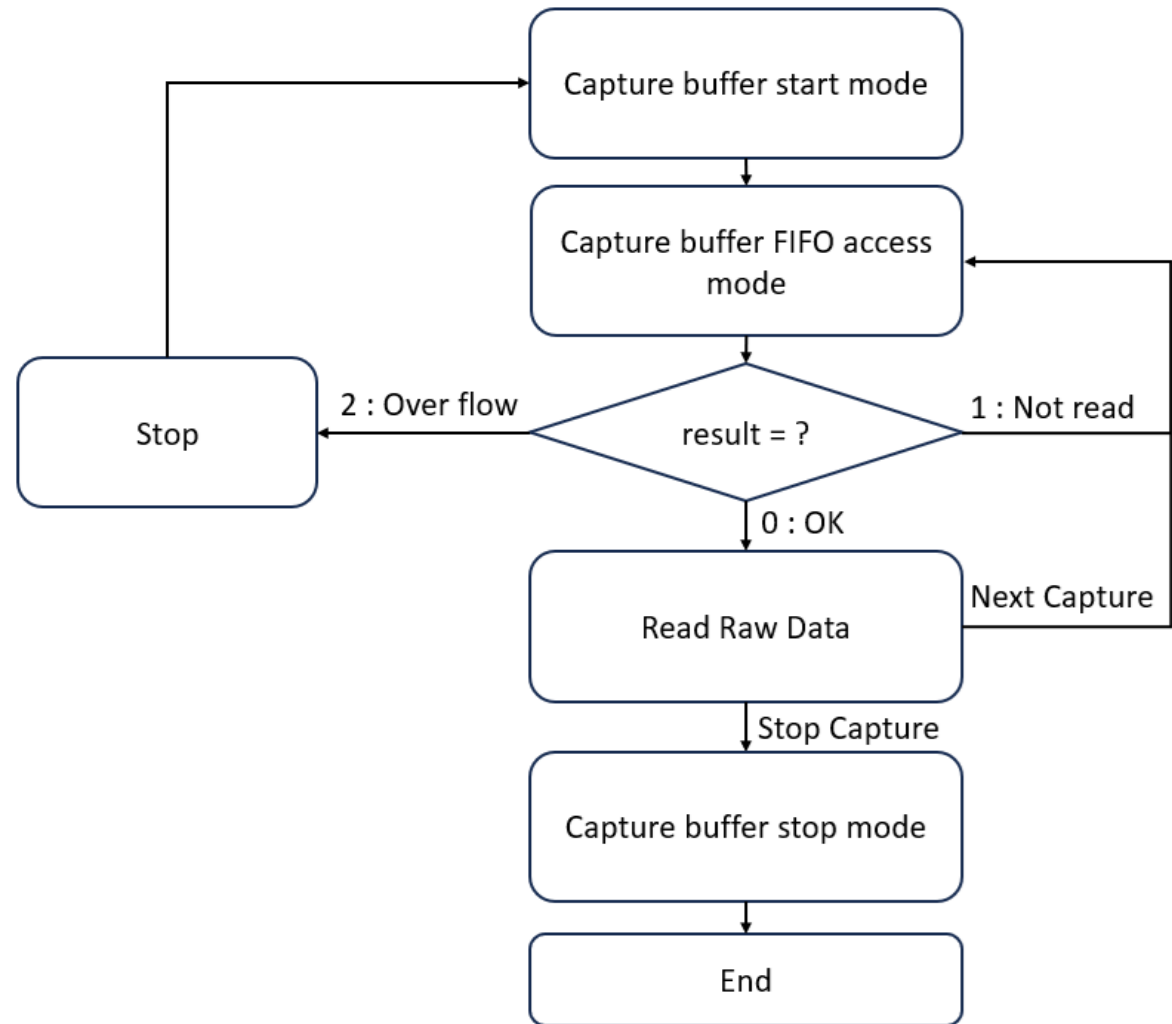


Figure 2-2 213ML5-R0 Raw Vibration Signal Flowchart

Capture buffer start mode: The hexadecimal command used to configure the data acquisition consists of 13 bytes, as shown in Table 2-5, where:

- Start Bytes: Fixed at 5353.
- Length Bytes: Fixed at D(13).
- CMD: Fixed at F11F.
- deltaT: Sensor Data Transmission Interval: (e.g., 01 indicates that approximately 5 data points are transmitted every 10 ms).
- Unit: Raw Vibration Value Output Unit: (e.g., 00 represents that the unit of the value is acceleration in g).
- Buffer Size: If the acquired data exceeds the capacity of the allocated buffer in the sensor, the sensor will trigger a Buffer Overflow signal.
- Checksum: CRC16. The CRC16 checksum generated by combining the 9 bytes of data from the Start Bytes up to the Buffer Size.
- End Bytes: Fixed at 5354 °

Bytes	Name	
2	Start Bytes	0x53 0x53
1	Length Byte	0xD (13)
2	CMD	0xF1 + 0x1F
1	deltaT	0x01 : 10ms 0x02 : 25ms 0x03 : 50ms 0x04 : 100ms 0x05 : 200ms 0x06 : 250ms 0x07 : 500ms (Type : U8)
1	Unit	0x00 : acceleration (g) 0x01 : velocity (mm/s)
2	Buffer Size	Buffer length = deltaT * Buffer Size Buffer length should be less than 64000, which is the upper limit of memory of 213ML5-R0. *Min: 2 *Max: 6400 (when deltaT = 10ms) *Type: U16 *Ex: deltaT = 10ms and Buffer Size = 2, total buffer length is 10ms * 2 = 20ms.
2	Checksum	CRC16
2	End Bytes	0x53 0x54

Table 2-5 213ML5-R0 Capture buffer start mode Send

Upon issuing the command, the sensor will return a 8-byte hexadecimal response, as shown in Table 2-6, where:

- Start Bytes: Fixed at 5B.
- Length Bytes: Fixed at 08.
- CMD: Fixed at F11F.
- CMD result: Command Execution Status: Indicates whether the command was successfully issued/executed.
- Checksum: CRC16 , CRC16 Checksum: Generated by combining the 5 bytes of data from the Start Bytes up to the CMD result.
- End Bytes: Fixed at 5D.

Bytes	Name	
1	Start Bytes	0x5B
1	Length Byte	0x08 (8)
2	CMD	0xF1 + 0x1F
1	CMD result	0x00: OK. 0x01: Wrong deltaT, unit, or buffer size error. 0x02: Failed.
2	Checksum	CRC16
1	End Bytes	0x5D

Table 2-6 213ML5-R0 Capture buffer start mode Response

Capture buffer FIFO access mode: The hexadecimal command used to start capturing buffer data consists of 10 bytes, as shown in Table 2-7, where:

- Start Bytes: Fixed at 5353.
- Length Bytes: Fixed at A(10).
- CMD: Fixed at F33F.
- CMD Request: Re-read the specific historical data from the sensor or acquire the latest vibration data.
- Checksum: CRC16, CRC16
Checksum: Generated by combining the 6 bytes of data from the Start Bytes up to the CMD Request.
- End Bytes: Fixed at 5D.

Bytes	Name	
2	Start Bytes	0x53 0x53
1	Length Byte	0xA (10)
2	CMD	0xF3 + 0x3F
1	CMD Request	0x00: New Data Request. 0x01: Data resend.
2	Checksum	CRC16
2	End Bytes	0x53 0x54

Table 2-7 213ML5-R0 Capture buffer FIFO access mode Send

When the command is executed, the specific 9-3203 byte hex response from the sensor is structured as shown in Table 2-8, where:

- Start Bytes: Fixed at 5B.
- Length Bytes: If the CMD result is non-zero, the length is fixed at 9 bytes (excluding deltaT, Unit, and FIFO Data information). If it is 0, the length is determined by the FIFO Data.
- CMD: Fixed at F33F.
- CMD result: Upon receiving the command, the sensor returns its current information.
- deltaT: Sensor Data Transmission Interval: (e.g., 01 indicates that approximately 5 data points are transmitted every 10 ms)
- Unit: Raw Vibration Value Output Unit: (e.g., 00 represents that the unit of the value is acceleration in g)
- FIFO Data: Raw Data: Data is output only when the CMD result is 0.

Bytes	Name	
1	Start Bytes	0x5B
2	Length Byte	0x0009-0x0C83 (9-3203)
2	CMD	0xF3 + 0x3F
1	CMD result	0x00: OK. 0x01: Failed. 0x02: Buffer overflow, mode stops.
1	deltaT (If result is OK)	0x01: 10ms (Data size ~= 5 smaples/S) 0x02: 25ms (Data size ~= 13 smaples/S) 0x03: 50ms (Data size ~= 25 smaples/S) 0x04: 100ms (Data size ~= 50 smaples/S) 0x05: 200ms (Data size ~= 100 smaples/S) 0x06: 250ms (Data size ~= 125 smaples/S) 0x07: 500ms (Data size ~= 251 smaples/S) (Type: U8)
1	Unit (If result is OK)	0x00: acceleration (g) 0x01: velocity (mm/s)
60-3192	FIFO Data (If result is OK)	X1 MSB→LSB (4), Y1 MSB→LSB (4), Z1 MSB→LSB (4), X2 MSB→LSB (4), Y2 MSB→LSB (4), Z2 MSB→LSB (4), ... Xn MSB→LSB (4), Yn MSB→LSB (4), Zn MSB→LSB (4), * n is deltaT Samples number * Type is F32 * Scale: 1
2	Checksum	CRC16
1	End Bytes	0x5D

Table 2-8 213ML5-R0 Capture buffer FIFO access mode Response

- Checksum : CRC16, CRC16
Checksum: Generated by combining
the 6-3200 bytes of data from the
Start Bytes up to the FIFO Data.
- End Bytes : Fixed at 5D.

Capture buffer stop mode: The hexadecimal command used to stop the sensor data acquisition consists of 9 bytes, as shown in Table 2-9, where:

- Start Bytes: Fixed at 5353.
- Length Bytes: Fixed at 09(9).
- CMD: Fixed at F22F.
- Checksum: CRC16, CRC16
Checksum: Generated by combining the 5 bytes of data from the Start Bytes up to the CMD.
- End Bytes: Fixed at 5354.

Bytes	Name	
2	Start Bytes	0x53 0x53
1	Length Byte	0x09 (9)
2	CMD	0xF2 + 0x2F
2	Checksum	CRC16
2	End Bytes	0x53 0x54

Table 2-9 213ML5-R0 Capture buffer stop mode Send

Upon issuing the command, the sensor will return a specific 8-byte hexadecimal response, as shown in Table 2-10, where:

- Start Bytes: Fixed at 5B.
- Length Bytes: Fixed at 08(8).
- CMD: Fixed at F22F.
- CMD result: Command Execution Status: Indicates whether the command was successfully executed.
- Checksum: CRC16, CRC16 Checksum: Generated by combining the 5 bytes of data from the Start Bytes up to the CMD.
- End Bytes: Fixed at 5D °

Bytes	Name	
1	Start Bytes	0x5B
1	Length Byte	0x08 (8)
2	CMD	0xF2 + 0x2F
1	CMD result	0x00 : OK. 0x01 : Failed.
2	Checksum	CRC16
1	End Bytes	0x5D

Table 2-10 213ML5-R0 Capture buffer stop mode Response

2.6 Reading Other Information of the 213ML5-R0 Digital Multivariate Sensor

The 213ML5-R0 utilizes a Command-over-RS485 communication interface to transmit the remaining information to various connected edge gateways.

2.6.1 Reading Other Information of the 213ML5-R0 Digital Multivariate Sensor

Read sensor ID : To read the sensor's ID information, a specific 9-byte hexadecimal command is required, as shown in Table 2-11, where:

- Start Bytes: Fixed at 5353.
- Length Bytes: Fixed at 09(9).
- CMD: Fixed at 619A.
- Checksum: CRC16: This is a 2-byte checksum generated by combining a total of 5 bytes from the "Start Bytes" to the "CMD". If the checksum is incorrect, the sensor will not execute any tasks and will not return any response. As shown in Figure 2-3 on the right, the calculation rules for CRC16 can be referred to on the following website: <https://cht.nahua.com.tw/software/crc16/index.php>.
- End Bytes: Fixed at 5354.

Bytes	Name	
2	Start Bytes	0x53 0x53
1	Length Byte	0x09 (9)
2	CMD	0x61 + 0x9A
2	Checksum	CRC16
2	End Bytes	0x53 0x54

Table 2-11 213ML5-R0 Read sensor ID Send

Modbus RTU CRC

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[Homepage](#) [Development/Graphics Control Software](#) [Calculation Modbus RTU Check Code](#)

The RTU checksum (CRC) calculation follows these rules:

- Step 1: Set the 16-bit temporary register (CRC temporary register) to 0xFFFF.
- Step 2: Exclusive OR. The first 8-bit message instruction and the lower 16-bit CRC register are used to perform an Exclusive OR and store the result in the CRC register.
- Step 3: Shift the CRC register one bit to the right and fill the high-order bits with 0.
- Step 4: Check the value shifted to the right. If it is 0, store the new value from Step 3 into the CRC register. Otherwise, use Exclusive OR 0xA001 with the CRC register and store the result into the CRC register.
- Step 5: Repeat steps 3 and 4 to complete all 8-bit operations.
- Step 6: Repeat steps 2 through 5, fetching the next 8-bit message instruction, until all message instructions have been processed. Finally, the value of the CRC register is the CRC checksum. It is important to note that the CRC checksum must be swapped within the checksum of the message instruction.

Enter Modbus data (separated by spaces).	Check Code (CRC)
01 03 00 00 00 01	84 0A

calculate

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Figure 2-3: CRC16 calculation rules

When a command is issued, the sensor will respond with a specific 13-byte hexadecimal command string, as shown in Table 2-12, where:

- Start Bytes: Fixed at 5B.
- Length Bytes: Fixed at 0D(13).
- CMD: Fixed at 619A.
- Sensor ID: Sensor ID.
- Checksum: CRC16: A 2-byte checksum generated by combining a total of 10 bytes from the "Start Bytes" to the "Sensor ID". Users can utilize this checksum to verify the integrity of the read data. As shown in Figure 2-3 on the right, the calculation rules for CRC16 can be referred to on the following website: <https://cht.nahua.com.tw/software/crc16/index.php>.
- End Bytes: Fixed at 5D.

Bytes	Name	
1	Start Bytes	0x5B
1	Length Byte	0x0D (13)
2	CMD	0x61 + 0x9A
6	Sensor ID	XXXXXX
2	Checksum	CRC16
1	End Bytes	0x5D

Table 2-12 213ML5-R0 Read sensor ID Response

Read Firmware Version Number : To read the firmware version information of the sensor, a specific 9-byte hexadecimal command string is used, as shown in Table 2-13, where:

- Start Bytes: Fixed at 5353.
- Length Bytes: Fixed at 09(9).
- CMD: Fixed at 45BC.
- Checksum: CRC16: This is a 2-byte checksum generated by combining a total of 5 bytes from the "Start Bytes" to the "CMD". If the checksum is incorrect, the sensor will not execute any tasks and will not return any response. As shown in Figure 2-4 on the right, the calculation rules for CRC16 can be referred to on the following website:
<https://cht.nahua.com.tw/software/crc16/index.php>.
- End Bytes: Fixed at 5354.

Bytes	Name	
2	Start Bytes	0x53 0x53
1	Length Byte	0x09 (9)
2	CMD	0x45 + 0xBC
2	Checksum	CRC16
2	End Bytes	0x53 0x54

Table 2-13 213ML5-R0 Read Firmware Version Number Send

Modbus RTU CRC

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The RTU checksum (CRC) calculation follows these rules:

- Step 1: Set the 16-bit temporary register (CRC temporary register) to 0xFFFF.
- Step 2: Exclusive OR. The first 8-bit message instruction and the lower 16-bit CRC register are used to perform an Exclusive OR and store the result in the CRC register.
- Step 3: Shift the CRC register one bit to the right and fill the high-order bits with 0.
- Step 4: Check the value shifted to the right. If it is 0, store the new value from Step 3 into the CRC register. Otherwise, use Exclusive OR 0xA001 with the CRC register and store the result into the CRC register.
- Step 5: Repeat steps 3 and 4 to complete all 8-bit operations.
- Step 6: Repeat steps 2 through 5, fetching the next 8-bit message instruction, until all message instructions have been processed. Finally, the value of the CRC register is the CRC checksum. It is important to note that the CRC checksum must be swapped within the checksum of the message instruction.

Enter Modbus data (separated by spaces).	Check Code (CRC)
01 03 00 00 00 01	84 0A
calculate	

Download Modbus RTU test software

Figure 2-4 CRC16 calculation rules

When a command is issued, the sensor will respond with a specific 15-byte hexadecimal command string, as shown in Table 2-14, where:

- Start Bytes: Fixed at 5B.
- Length Bytes: Fixed at 0F(15).
- CMD : Fixed at 45BC.
- Firmware Version Number: Sensor firmware version information, such as: 0x00002001 (V2.0.0.2).
- Checksum: CRC16, A 2-byte checksum generated by combining a total of 12 bytes from the "Start Bytes" to the "Firmware Version Number". Users can utilize this checksum to verify the integrity of the read data. As shown in Figure 2-4 on the right, the calculation rules for CRC16 can be referred to on the following website:
<https://cht.nahua.com.tw/software/crc16/index.php>.
- End Bytes: Fixed at 5D.

Bytes	Name	
1	Start Bytes	0x5B
1	Length Byte	0x0F (15)
2	CMD	0x45 + 0xBC
8	Firmware Version Number	Ex:0x00002001 (V2.0.0.2)
2	Checksum	CRC16
1	End Bytes	0x5D

Table 2-14 213ML5-R0 Read Firmware Version Number Response

Read Temperature : To read the temperature information of the sensor, a specific 9-byte hexadecimal command string is used, as shown in Table 2-15, where:

- Start Bytes: Fixed at 5353.
- Length Bytes: Fixed at 09(9).
- CMD: Fixed at 34CD.
- Checksum: CRC16, A 2-byte checksum generated by combining a total of 5 bytes from the "Start Bytes" to the "CMD". If the checksum is incorrect, the sensor will not execute any tasks and will not return any response. As shown in Figure 2-5 on the right, the calculation rules for CRC16 can be referred to on the following website:
<https://cht.nahua.com.tw/software/crc16/index.php>.
- End Bytes: Fixed at 5354.

Bytes	Name	
2	Start Bytes	0x53 0x53
1	Length Byte	0x09 (9)
2	CMD	0x34 + 0xCD
2	Checksum	CRC16
2	End Bytes	0x53 0x54

Table 2-15 213ML5-R0 Read Temperature Send

Modbus RTU CRC

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The RTU checksum (CRC) calculation follows these rules:

- Step 1: Set the 16-bit temporary register (CRC temporary register) to 0xFFFF.
- Step 2: Exclusive OR. The first 8-bit message instruction and the lower 16-bit CRC register are used to perform an Exclusive OR and store the result in the CRC register.
- Step 3: Shift the CRC register one bit to the right and fill the high-order bits with 0.
- Step 4: Check the value shifted to the right. If it is 0, store the new value from Step 3 into the CRC register. Otherwise, use Exclusive OR 0xA001 with the CRC register and store the result into the CRC register.
- Step 5: Repeat steps 3 and 4 to complete all 8-bit operations.
- Step 6: Repeat steps 2 through 5, fetching the next 8-bit message instruction, until all message instructions have been processed. Finally, the value of the CRC register is the CRC checksum. It is important to note that the CRC checksum must be swapped within the checksum of the message instruction.

Enter Modbus data (separated by spaces).	Check Code (CRC)
01 03 00 00 00 01	84 0A
calculate	

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Figure 2-5 CRC16 calculation rules

When a command is issued, the sensor will respond with a specific 11-byte hexadecimal command string, as shown in Table 2-16, where:

- Start Bytes: Fixed at 5B.
- Length Bytes: Fixed at 0B(11).
- CMD : Fixed at 34CD.
- Temperature: Current sensor temperature
- Checksum: CRC16, A 2-byte checksum generated by combining a total of 8 bytes from the "Start Bytes" to the "Temperature". Users can utilize this checksum to verify the integrity of the read data. As shown in Figure 2-5 on the right, the calculation rules for CRC16 can be referred to on the following website: <https://cht.nahua.com.tw/software/crc16/index.php>.
- End Bytes: Fixed at 5D.

Bytes	Name	
1	Start Bytes	0x5B
1	Length Byte	0x0B (11)
2	CMD	0x34 + 0xCD
4	Temperature	MSB → LSB 、 Type is U32 、 Scale : 0.001
2	Checksum	CRC16
1	End Bytes	0x5D

Table 2-16 213ML5-R0 Read Temperature Response

2.7 Control the LED of the 213ML5-R0 Digital Multivariate Sensor

LED Indicator Identification: To control the LED of the sensor, a specific 10-byte hexadecimal command string is used, as shown in Table 2-17, where:

- Start Bytes: Fixed at 5353.
- Length Bytes: Fixed at 0A(10).
- CMD: Fixed at 23DE.
- Function: The LED indicator light to be displayed by the user.
- Checksum: CRC16, A 2-byte checksum generated by combining a total of 6 bytes from the "Start Bytes" to the "CMD". If the checksum is incorrect, the sensor will not execute any tasks and will not return any response. As shown in Figure 2-6 on the right, the calculation rules for CRC16 can be referred to on the following website:
<https://cht.nahua.com.tw/software/crc16/index.php>.
- End Bytes: Fixed at 5354.

Bytes	Name	
2	Start Bytes	0x53 0x53
1	Length Byte	0x0A (10)
2	CMD	0x23 + 0xDE
1	Function	0x00 : Disable (Default) 0x01 : All LEDs flash every 0.05 seconds 0x02 : TX LED is always on 0x03 : RX LED is always on
2	Checksum	CRC16
2	End Bytes	0x53 0x54

Table 2-17 213ML5-R0 LED indicator identification Send

Modbus RTU CRC

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Homepage Development/Graphics Control Software Calculation Modbus RTU Check Code

The RTU checksum (CRC) calculation follows these rules:

- Step 1: Set the 16-bit temporary register (CRC temporary register) to 0xFFFF.
- Step 2: Exclusive OR. The first 8-bit message instruction and the lower 16-bit CRC register are used to perform an Exclusive OR and store the result in the CRC register.
- Step 3: Shift the CRC register one bit to the right and fill the high-order bits with 0.
- Step 4: Check the value shifted to the right. If it is 0, store the new value from Step 3 into the CRC register. Otherwise, use Exclusive OR 0xA001 with the CRC register and store the result into the CRC register.
- Step 5: Repeat steps 3 and 4 to complete all 8-bit operations.
- Step 6: Repeat steps 2 through 5, fetching the next 8-bit message instruction, until all message instructions have been processed. Finally, the value of the CRC register is the CRC checksum. It is important to note that the CRC checksum must be swapped within the checksum of the message instruction.

Enter Modbus data (separated by spaces).	Check Code (CRC)
01 03 00 00 00 01	84 0A
calculate	

Download Modbus RTU test software

Figure 2-6: CRC16 calculation rules

When a command is issued, the sensor will respond with a specific 8-byte hexadecimal command string, as shown in Table 2-18, where:

- Start Bytes: Fixed at 5B.
- Length Bytes: Fixed at 08(8).
- CMD: Fixed at 23DE.
- Result: Indicates whether the status of the LED read is OK or NG.
- Checksum: CRC16, A 2-byte checksum generated by combining a total of 5 bytes from the "Start Bytes" to the "Result". Users can utilize this checksum to verify the integrity of the read data. As shown in Figure 2-6 on the right, the calculation rules for CRC16 can be referred to on the following website:
<https://cht.nahua.com.tw/software/crc16/index.php>.
- End Bytes: Fixed at 5D.

Bytes	Name	
1	Start Bytes	0x5B
1	Length Byte	0x08 (8)
2	CMD	0x23 + 0xDE
1	Result	0x00 : OK! 0x01 : Fail!
2	Checksum	CRC16
1	End Bytes	0x5D

Table 2-18 213ML5-R0 LED indicator identification Response

3 213ML5-R0 Digital Multivariable Sensor Deployment Guide

The deployment of the 213ML5-R0 Digital Multivariable Sensor includes on-site installation/mounting and on-site wiring. Please refer to the following sections for detailed information on each task.

3.1 On-site Mounting of the Smart Sensor

The mounting fixtures for the smart sensor include two types: a magnetic base and a standard base.

The magnetic base is intended for temporary testing purposes and is not suitable for long-term monitoring. The mounting surface of the equipment must be magnetic. To use it, simply screw and secure the fixture to the smart sensor, then place it on the magnetic machine surface, as shown in Figure 3-1.

For official long-term monitoring, please use the mounting base to secure the smart sensor onto the equipment surface. As shown in Figure 3-2, the base assembly includes a metal mounting base and a pair of M3 screws. °



Figure 3-1 magnetic base



Figure 3-2 Base Assembly

The mounting base is secured to the equipment surface using an AB epoxy designed for metal. As shown in Figure 3-3, it is recommended to use PowerBon® Resin series AB epoxy.



Figure 3-3 Recommended AB Epoxy Brand and Model

As shown in Figure 3-4, before applying the AB epoxy to the base, pre-screw the screws into the screw holes, leaving a clearance of one to two threads. This prevents excess AB epoxy from being squeezed into the screw holes during fixing.



Figure 3-4 Pre-screwing Screws

As shown in Figure 3-5, mix the AB epoxy evenly at a 1:1 ratio and apply it to the base. The application thickness should be approximately 1 mm; avoid applying it too thin or too thick to prevent insufficient bonding or excessively long curing times.



Figure 3-5 Applying AB Epoxy to the Base

As shown in Figure 3-6, fix the fixture onto the equipment surface and apply pressure for at least 10 minutes. If an alternative AB epoxy brand or model is used, apply pressure for at least twice the duration recommended by that specific brand to ensure bonding quality.



Figure 3-6 Securing the Base to the Equipment Surface

As shown in Figure 3-7, wait for the AB epoxy to cure. The required curing time varies depending on the brand, ranging from 1 to 24 hours, and no pressure needs to be applied during this period. Once fully cured, the 213ML5-R0 smart sensor can be screwed and secured onto the base.



Figure 3-7 Waiting for the AB Epoxy to Cure

The 213ML5-R0 and the 3838 base are secured together by a pair of M3 hex socket screws, with the screw hole positions shown in Figure 3-8. Align the holes of the smart sensor with those on the mounting base or magnetic base, then lock and secure them using a hex key to complete the installation.

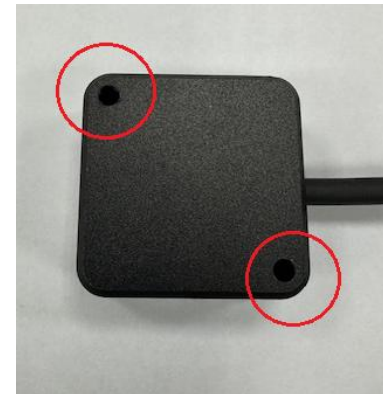


Figure 3-8 Hex Socket Cap Screw Locking

Figure 3-9 shows the result of the 213ML5-R0 successfully installed on the surface of the equipment motor.



Figure 3-9 Successful Installation of the 213ML5-R0 Digital Multivariable Sensor

3.2 Field Wiring

Please refer to Table 2-2 for wiring definitions to configure a 12 - 24 VDC power supply for the 213ML5-R0, where the red wire is positive (+) and the black wire is negative (-). Additionally, connect the green wire (RS485 DATA+) and the yellow wire (RS485 DATA-) to any brand of device hub you have selected.

The brown wire is the force-factory-reset trigger wire, which must be used offline and externally; do not connect this wire during field wiring. Ensure it is well-insulated and fully waterproofed on-site.

4 Customer Service

Taiwan Link Solution Co., Ltd. would like to express our deepest appreciation to you for choosing the 213ML5-R0 Smart Vibration Sensor.

We sincerely hope that this product fully meets your operational needs. We also hope this user manual provides quick and clear answers to any questions you may have regarding the installation and operation of the 213ML5-R0.

If you encounter any installation issues due to ambiguities in this user manual, or if you have any suggestions for product improvement, please feel free to contact TEXOL at any time through the following channels. We will do our utmost to resolve your concerns as quickly as possible.

- ✓ Contact Number: +886-3-6579836
- ✓ E-mail: customer.support@twlnlsc.com

AppendixA. Datasheet

Model			213ML5-R0
Vibration measurement capability	Measurement direction		Triaxial (X, Y and Z)
	Amplitude		+/- 16 g
	Sensitivity		0.488 mg / LSB
	Frequency response		2 -250Hz
	ADC resolution		16-bit
Temperature measurement capability	Measurement Range		-20°C – 85 °C
	Sensitivity		256 LSB/ °C
	ADC resolution		16-bit
Environmental resistance	Temperture		-20°C – 85 °C
	IP grade		IP65
Power supply	Power voltage		12 - 24 VDC
	Power consumption		0.45 W
	Reverse voltage protection		V
Sampling	Sampling rate		~ 500 S/s
	Data Length per Update V ^{1*}	Speed level 7st	500 ms
		Speed level 6st	250 ms
		Speed level 5st	200 ms
		Speed level 4st	100 ms
		Speed level 3st	50 ms
		Speed level 2st	25 ms
		Speed level 1st	10 ms
	Sampling Signal	Acceleration Signal (g)	V ^{1*}
		Velocity Signal (mm/s)	V ^{1*}
	Triggered Sampling	Software Trigger	X
		Hardware Trigger	X
	Time domain data cleaning		V
Communication	Method		RS485
	Protocol		Proprietary command
	Distance		100m
	Upload	Acceleration Signal	V ^{1*}
		Velocity Signal	V ^{1*}
Appearance	Dimensions		38 x 38 x 18.1 mm
	Housing material		Aluminum alloy
	Water-proof method		Seal
	Wire		Flexible, insulated, 1m
	Wire connector		Pigtail V ^{2*}
	LED for running status		V ^{3*}
	LED for communication status		V ^{4*}
Device Management	FOTA		V ^{5*}

1* Via API Commands

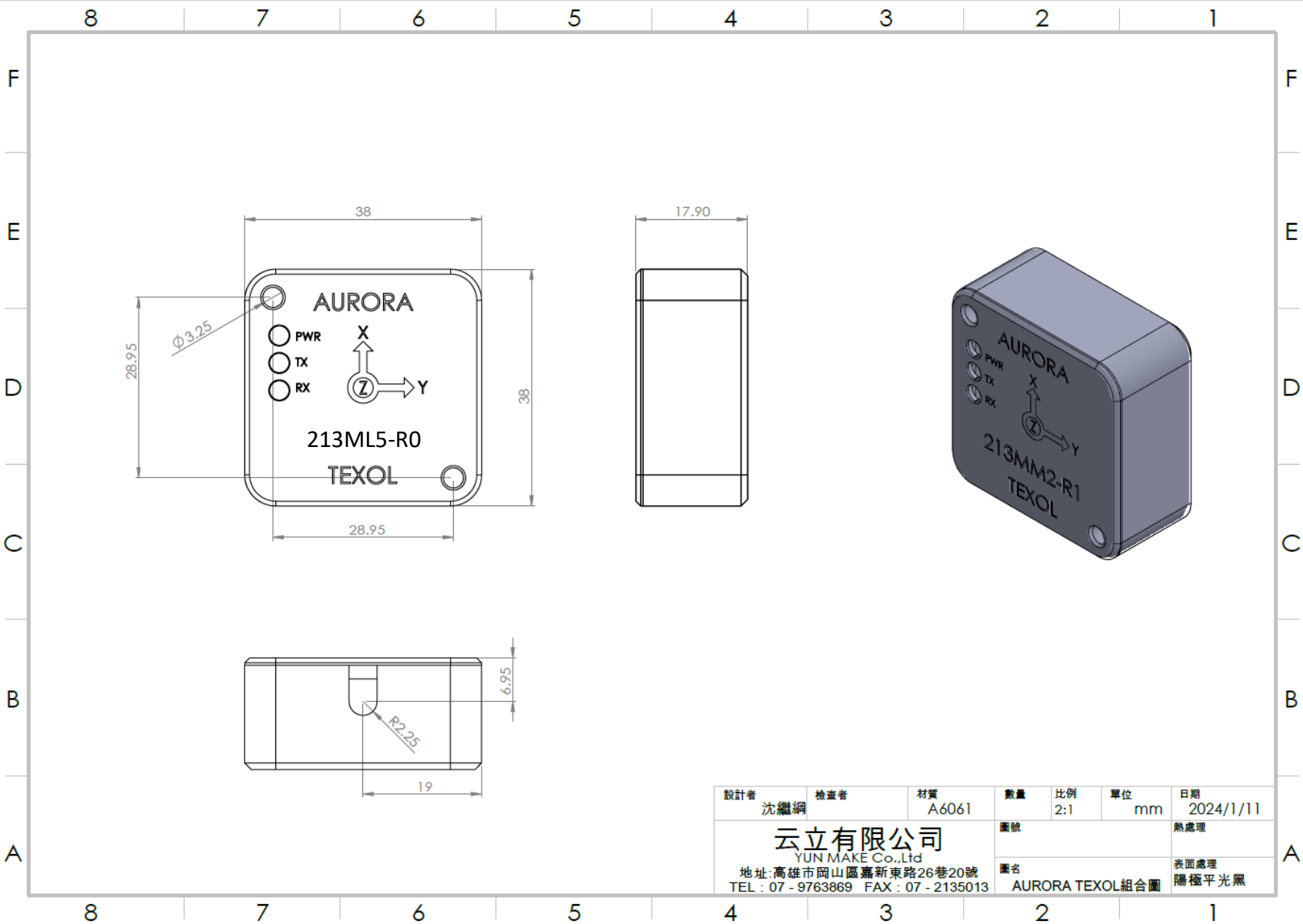
2* Red: 12-24 VDC , BLACK: GND , Green: DATA⁺ , Yellow: DATA⁻ , Blue: N/A , Brown: Factory Reset (TTL) , Thick Black: Shield

3* GREEN LED Flash

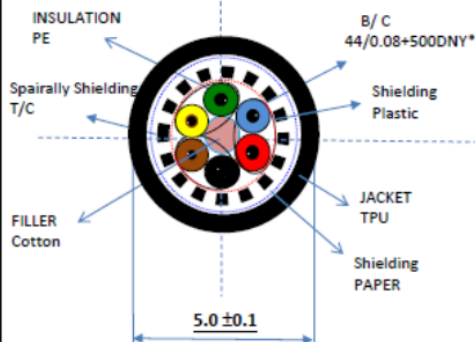
4* RED and Orange LED Flash

5* Manage through device management utility

AppendixB. Dimensions



AppendixC. Aurora Wire Specifications

DRAWING NO :YF200103				A1		SPECIFICATION					
REMARKS :						CONDUCTORS	Material		Bare Copper		
1. RoHS COMPLIANT					AWG		#24 * 3P				
2. REACH					Construction		44/0.08+500DNY				
					Material		PE				
						INSULATION	O. D.		0.85±0.05 mm		
					Color		1. BR*BK 2. YL*GN 3. BL*RD				
					Material		Plastic Myla				
						Shielding		Coverage		25% ↑	
						Spirally Shielding		Material		Tinned Copper	
								Coverage		90% ↑	
						FILLER		Material		Cotton	
						Shielding		Material		PAPEER	
								Coverage		25% ↑	
						JACKET		Material		TPU	
								THICKNESS AVG.		0.5 mm ↑	
								O. D.		5.0 ±0.1 mm	
								Color		BLACK	
						ELECTRIC CHARACTERS					
Rated Voltage		300 (V-AC)									
Resistance of Insulation		10 MΩ/300m									
製圖:	May	審核:	Philli	日期:	2020.03.02	Withstand Voltage Spark		1 KV/sec			

AppendixD. Appendix D Document Revision History

[illegible]