

Radar Level Transmitter

Communication Protocol Specification

Modbus RTU & ASCII Text Protocol

Document version: V1.0

Revision date: 2025-07-15

Applicability: JJY series radar level transmitters (serial TTL interface)

Revision History

Date	Description of changes	Remarks
2023-09-28	1. Protocol V1.0 released	
2023-11-25	1. Changed the representation of the abnormal microwave status in the Modbus protocol	
2023-12-11	1. Added operating instructions for viewing the echo waveform (Appendix) 2. Added application diagram	
2025-04-24	1. Added PLC integration case study (Appendix) 2. Added peak frequency-bin prediction interface and spectrum data packet format	
2025-06-06	1. Added reference level parameter, supporting negative level display	
2025-06-21	1. Replaced the peak frequency-bin prediction interface with retrieval of the ranging results of all currently detected echo targets	
2025-07-15	1. Real-time ullage output extended: mm and cm integer values in addition to the float value	

Contents

Application Diagram	4
Part I Modbus Protocol	5
1 Hardware interface parameters	5
2 Frame format	5
3 Register map (default configuration)	6
4 Command description	7
4.1 Read measurement data — function code 0x04	7
4.2 Read configuration — function code 0x03	9
4.3 Write commands — function code 0x10	13
Part II Text (AT) Protocol	16
1 Hardware interface parameters	16
2 Command description	16
Part III Appendix	22
A Converting between IEEE-754 floats and hexadecimal representation	22
B PLC integration example	22
C Viewing the echo waveform	25
D Ranging results of all current echo targets	26
E Spectrum data packet format	27

Application Diagram

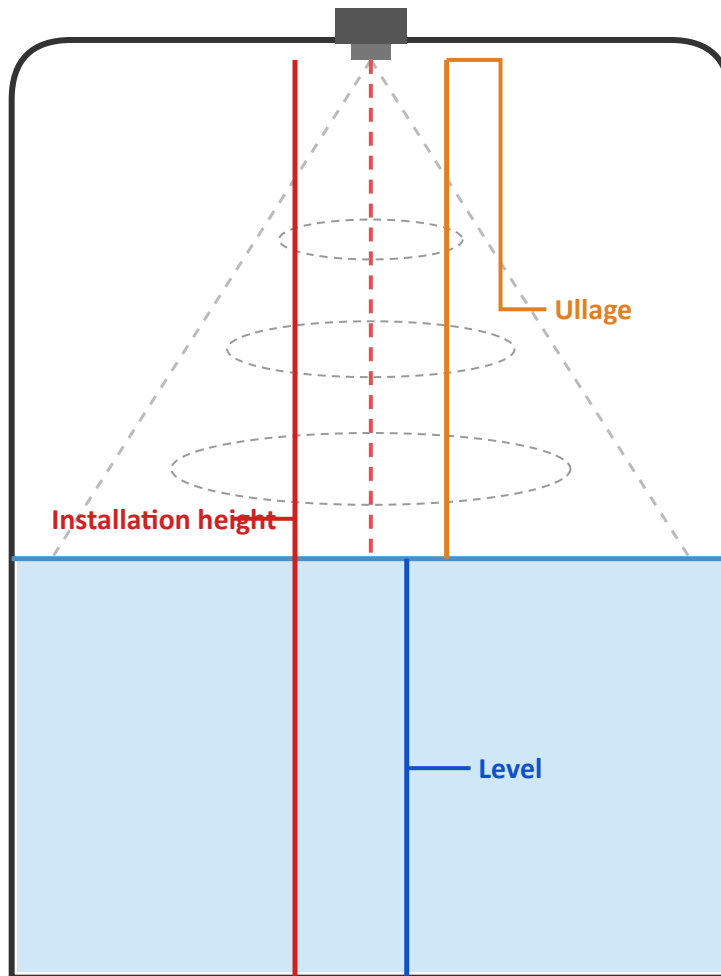


Figure 1 Measurement geometry

Ullage — distance from the radar sensor to the liquid surface.

Level — distance from the tank bottom (zero reference) to the liquid surface.

Installation height — distance from the radar sensor to the tank bottom.

Level = Installation height – Ullage

Part I Modbus Protocol

1 Hardware Interface Parameters

The transmitter communicates over a serial (UART) port with the following default settings:

Communication parameter	Value
Serial level	TTL
Baud rate	9600
Parity	None
Data bits	8
Stop bits	1

Response timeout: 250 ms.

Note: The Modbus slave address, register addresses and function codes are customisable. They can be changed either with the **RadarBLE** app (Android / iOS, Bluetooth) or with the Windows host (PC) configuration software.

2 Frame Format

The transmitter uses the Modbus RTU protocol. Every complete frame consists of: **address field, function code, data and CRC**. The CRC is a CRC-16 (Modbus) checksum appended low byte first, high byte last. The factory-default slave address of the transmitter is `0x7F`.

The request and response frame formats are as follows:

(1) Parameter read — function code 0x03

Request:

Device address	Function code	Register address	Register quantity	CRC
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Response:

Device address	Function code	Byte count	Data	CRC
1 byte	1 byte	1 byte	2N bytes	2 bytes

N: register quantity.

(2) Parameter read — function code 0x04

Request:

Device address	Function code	Register address	Register quantity	CRC
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Response:

Device address	Function code	Byte count	Data	CRC
1 byte	1 byte	1 byte	2N bytes	2 bytes

N: register quantity.

(3) Parameter write — function code 0x10

Request:

Device address	Function code	Register address	Register quantity	Byte count	Data	CRC
1 byte	1 byte	2 bytes	2 bytes	1 byte	2N bytes	2 bytes

Response:

Device address	Function code	Register address	Register quantity	CRC
1 byte	1 byte	2 bytes	2 bytes	2 bytes

N: register quantity.

3 Register Map (Default Configuration)

Parameter	Register address	PLC / HMI address	Supported function codes	Data type	Remarks
Slave address	0x2001	48194	0x03, 0x10	int16	int16: 2-byte signed integer (AB, big-endian). int32: 4-byte signed integer, high word first (ABCD, big-endian).
Baud rate	0x2002	48195	0x03, 0x10	int32	
Version	0x2004	48197	0x03	int32	
Calibration parameter	0x2052	48275	0x03, 0x10	int16	
Auto-report interval	0x2053	48276	0x03, 0x10	int16	
Blind zone	0x2044	48261	0x03	float(little16)	float(little): 4-byte IEEE-754 single-precision float, low word first (CDAB).
Measuring range	0x2046	48263	0x03	float(little16)	
Water depth at installation	0x2048	48265	0x03, 0x10	float(little16)	
Installation height	0x204A	48267	0x03, 0x10	float(little16)	
Real-time level	0x0A0B	32572	0x04	float(little16)	
Real-time ullage	0x0A0F	32576	0x04	float(little16)	int16: 2-byte signed integer (AB, big-endian).
Real-time ullage (mm — standard unit)	0x0000	0x4001	0x03	int16	
Real-time ullage (cm)	0x0001	0x4002	0x03	int16	

Note: The register addresses and data types of some parameters can be modified with the host (PC) software. After a register address or data type has been changed, the corresponding Modbus command changes accordingly. For example, the default ullage read command is `7F 04 0A 0F 00 02 48 0E` ; if the ullage register is changed to `00 01` , the ullage read command becomes `7F 04 00 01 00 02 2A 15` . Ullage is expressed in **millimetres (mm)** as the standard unit throughout this document; register `0x0001` provides the same value in centimetres (cm) for PLCs that require integer-centimetre resolution.

4 Command Description

Important:

- a. The device address defaults to `0x7F` ;
- b. float values use the IEEE-754 binary floating-point standard, low 16 bits first (CDAB word order);
- c. All register addresses in this document are the default addresses. If a register address has been changed with the host software, the register address in the Modbus command must be changed accordingly;
- d. The data definition (data type / unit) of each parameter is interpreted according to the default configuration. If the data type / unit has been changed with the host software, the read-out and parsing must be adapted accordingly. For example, when the data type is switched from float to integer, pay special attention to changing the unit to centimetres or millimetres. Assume the current real-time value is 1.23 m with data type float and unit metres — the Modbus read-out returns 1.23 m. If the data type is changed to integer while the unit remains metres, the read-out returns 1 m; with the unit set to centimetres, the read-out returns 123 cm.

4.1 Read Measurement Data — Function Code 0x04

4.1.1 Read measurement result — level (= installation height – ullage)

Request:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x04	0x0A 0B	0x00 02	0x09 CF

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x04	0x04	0x00 00 41 30	0x55 C7

Data definition: data type float(little16) by default, unit metres (m), 4 bytes, low 16 bits first.

Level error codes:

Output value	Meaning
-0.001 m	Insufficient echo energy
-0.002 m	Sensor is inside the blind zone
-0.003 m	Measurement result exceeds the measuring range
-0.004 m	Installation height not set — level cannot be calculated

Note: When reading real-time data from the sensor, check the value against the error codes above. A value equal to an error code carries no measurement meaning and only indicates an abnormal state.

Example 1

Request: 7F 04 0A 0B 00 02 09 CF

Response: 7F 04 04 00 00 41 30 55 C7

The data field 00 00 41 30 converts to the float value 11.00 m.

Example 2

Request: 7F 04 0A 0B 00 02 09 CF

Response: 7F 04 04 9B A5 BB 44 28 47

The data field 9B A5 BB 44 converts to the float value -0.003 m, i.e. the measurement is out of range.

4.1.2 Read measurement result — ullage

Request:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x04	0x0A 0F	0x00 02	0x48 0E

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x04	0x04	0x31 13 40 10	0xAA B6

Data definition: data type float(little16) by default, unit metres (m), 4 bytes, low 16 bits first.

Ullage error codes:

Output value	Meaning
0.001 m	Insufficient echo energy
0.002 m	Sensor is inside the blind zone
0.003 m	Measurement result exceeds the measuring range

Note: When reading real-time data from the sensor, check the value against the error codes above. A value equal to an error code carries no measurement meaning and only indicates an abnormal state.

Example 1

Request: 7F 04 0A 0F 00 02 48 0E

Response: 7F 04 04 31 13 40 10 AA B6

The data field 31 13 40 10 converts to the float value 2.253 m.

Example 2

Request: 7F 04 0A 0F 00 02 48 0E
Response: 7F 04 04 12 6E 3A 83 52 27
The data field 12 6E 3A 83 converts to the float value 0.001 m, i.e. insufficient echo energy.

4.2 Read Configuration — Function Code 0x03

4.2.1 Broadcast query of the slave address

Request:

Device address	Function code	Register address	Register quantity	CRC
0x00 (broadcast)	0x03	0x20 01	0x00 01	0xDF DB

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x03	0x02	0x00 7F	0xD1 AE

Data definition: data type int16, 2 bytes.

Example

Request: 00 03 20 01 00 01 DF DB
Response: 7F 03 02 00 7F D1 AE
The data field 00 7F converts to the integer 127, i.e. 0x7F .

4.2.2 Query the serial baud rate

Note: Supported baud rates are: 4800, 9600, 19200, 38400, 115200.

Request:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x03	0x20 02	0x00 02	0x64 15

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x03	0x04	0x00 00 25 80	0x7F 04

Data definition: data type int32 (big-endian), 4 bytes.

Example

Request: 7F 03 20 02 00 02 64 15
Response: 7F 03 04 00 00 25 80 7F 04
The data field 00 00 25 80 converts to the integer 9600.

4.2.3 Query the version information

Request:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x03	0x20 04	0x00 02	0x84 14

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x03	0x04	0x20 23 09 08	0x99 A8

Data definition: data type int32, 4 bytes. The version number is BCD-encoded.

Example

Request: 7F 03 20 04 00 02 84 14

Response: 7F 03 04 20 23 09 08 99 A8

The data field 20 23 09 08 is BCD-encoded; the version number is 20230908.

4.2.4 Query the calibration parameter

Request:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x03	0x20 52	0x00 01	0x24 05

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x03	0x02	0x00 10	0x91 82

Data definition: data type int16, unit millimetres (mm), 2 bytes.

Example

Request: 7F 03 20 52 00 01 24 05

Response: 7F 03 02 00 10 91 82

The data field 00 10 converts to the integer 16 mm.

4.2.5 Query the auto-report (push) interval

Note: When the auto-report interval is ≥ 500 ms, the sensor pushes data automatically. If the installation height is not set (level cannot be calculated), ullage data is pushed; if the installation height is set, level data is pushed.

Request:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x03	0x20 53	0x00 01	0x75 C5

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x03	0x02	0x03 E8	0x90 F0

Data definition: data type int16, unit milliseconds (ms), 2 bytes.

Example

Request: 7F 03 20 53 00 01 75 C5

Response: 7F 03 02 03 E8 90 F0

The data field 03 E8 converts to the integer 1000 ms.

4.2.6 Query the blind zone**Request:**

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x03	0x20 44	0x00 02	0x85 C0

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x03	0x04	0x6D B7 3E AB	0x99 61

Data definition: data type float(little16) by default, unit metres (m), 4 bytes.

Example

Request: 7F 03 20 44 00 02 85 C0

Response: 7F 03 04 6D B7 3E AB 99 61

The data field 6D B7 3E AB converts to the float value 0.334 m.

4.2.7 Query the measuring range**Request:**

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x03	0x20 46	0x00 02	0x24 00

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x03	0x04	0x00 00 42 20	0x55 4C

Data definition: data type float(little16) by default, unit metres (m), 4 bytes.

Example

Request: 7F 03 20 46 00 02 24 00

Response: 7F 03 04 00 00 42 20 55 4C

The data field 00 00 42 20 converts to the float value 40.0 m.

4.2.8 Query the water depth at installation

Note: The water depth at installation is used to derive the installation height: installation height = water depth at installation + ullage at the moment of installation. When the water depth at installation is set, the installation height is calculated automatically and stored in the configuration.

Request:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x03	0x20 48	0x00 02	0x45 C3

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x03	0x04	0x47 AE 40 B1	0xE0 D5

Data definition: data type float(little16) by default, unit metres (m), 4 bytes.

Example

Request: 7F 03 20 48 00 02 45 C3

Response: 7F 03 04 47 AE 40 B1 E0 D5

The data field 47 AE 40 B1 converts to the float value 5.54 m.

4.2.9 Query the installation height

Note: The installation height is used to calculate the level: real-time level = installation height – real-time ullage. Also, installation height = water depth at installation + ullage at the moment of installation. When the installation height is set, the water depth at installation is calculated automatically and stored in the configuration.

Request:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x03	0x20 4A	0x00 02	0xE4 03

Response:

Device address	Function code	Byte count	Data	CRC
0x7F	0x03	0x04	0x8A 64 41 2A	0xBE 7C

Data definition: data type float(little16) by default, unit metres (m), 4 bytes.

Example

Request: 7F 03 20 4A 00 02 E4 03

Response: 7F 03 04 8A 64 41 2A BE 7C

The data field 8A 64 41 2A converts to the float value 10.65 m.

4.3 Write Commands — Function Code 0x10**4.3.1 Set the slave address****Request:**

Device address	Function code	Register address	Register quantity	Byte count	Data	CRC
0x7F	0x10	0x20 01	0x00 01	0x02	0x00 01	0x6E 21

Response:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x10	0x20 01	0x00 01	0x51 D7

Data definition: data type int16, 2 bytes.**Example**

Request: 7F 10 20 01 00 01 02 00 01 6E 21

The data field 00 01 converts to the integer 1, i.e. 0x01.

Response: 7F 10 20 01 00 01 51 D7

4.3.2 Set the serial baud rate**Note:** Supported baud rates are: 4800, 9600, 19200, 38400, 115200.**Request:**

Device address	Function code	Register address	Register quantity	Byte count	Data	CRC
0x7F	0x10	0x20 02	0x00 02	0x04	0x00 01 C2 00	0x75 3E

Response:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x10	0x20 02	0x00 02	0xE1 D6

Data definition: data type int32, 4 bytes.**Example**

Request: 7F 10 20 02 00 02 04 00 01 C2 00 75 3E

The data field 00 01 C2 00 converts to the integer 115200.

Response: 7F 10 20 02 00 02 E1 D6

4.3.3 Set the calibration parameter

Request:

Device address	Function code	Register address	Register quantity	Byte count	Data	CRC
0x7F	0x10	0x20 52	0x00 01	0x02	0x00 10	0xA2 4E

Response:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x10	0x20 52	0x00 01	0xA1 C6

Data definition: data type int16, unit millimetres (mm), 2 bytes.

Example

Request: 7F 10 20 52 00 01 02 00 10 A2 4E

The data field 00 10 converts to the integer 16 mm.

Response: 7F 10 20 52 00 01 A1 C6

4.3.4 Set the auto-report (push) interval

Note: When the auto-report interval is ≥ 500 ms, the sensor pushes data automatically. If the installation height is not set (level cannot be calculated), ullage data is pushed; if the installation height is set, level data is pushed.

Request:

Device address	Function code	Register address	Register quantity	Byte count	Data	CRC
0x7F	0x10	0x20 53	0x00 01	0x02	0x03 E8	0xA2 ED

Response:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x10	0x20 53	0x00 01	0xF0 06

Data definition: data type int16, unit milliseconds (ms), 2 bytes.

Example

Request: 7F 10 20 53 00 01 02 03 E8 A2 ED

The data field 03 E8 converts to the integer 1000 ms.

Response: 7F 10 20 53 00 01 F0 06

4.3.5 Set the water depth at installation

Note: The water depth at installation is used to derive the installation height: installation height = water depth at installation + ullage at the moment of installation. When the water depth at installation is set, the installation height is calculated automatically and stored in the configuration.

Request:

Device address	Function code	Register address	Register quantity	Byte count	Data	CRC
0x7F	0x10	0x20 48	0x00 02	0x04	0x47 AE 40 B1	0x75 30

Response:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x10	0x20 48	0x00 02	0xC0 00

Data definition: data type float(little16) by default, unit metres (m), 4 bytes.

Example

Request: 7F 10 20 48 00 02 04 47 AE 40 B1 75 30

The data field 47 AE 40 B1 converts to the float value 5.54 m.

Response: 7F 10 20 48 00 02 C0 00

4.3.6 Set the installation height

Note: The installation height is the distance from the sensor to the zero level. For example, if the current water depth is 2 m and the ullage is 4 m, the installation height is 6 m. The installation height is used to calculate the level: real-time level = installation height – real-time ullage. Also, installation height = water depth at installation + ullage at the moment of installation. When the installation height is set, the water depth at installation is calculated automatically and stored in the configuration.

Request:

Device address	Function code	Register address	Register quantity	Byte count	Data	CRC
0x7F	0x10	0x20 4A	0x00 02	0x04	0x8A 64 41 2A	0xAA 40

Response:

Device address	Function code	Register address	Register quantity	CRC
0x7F	0x10	0x20 4A	0x00 02	0x61 C0

Data definition: data type float(little16) by default, unit metres (m), 4 bytes.

Note: Setting the installation height to 0 clears both the installation-height and the water-depth-at-installation configuration.

Example

Request: 7F 10 20 4A 00 02 04 8A 64 41 2A AA 40

The data field 8A 64 41 2A converts to the float value 10.65 m.

Response: 7F 10 20 4A 00 02 61 C0

Part II Text (AT) Protocol

1 Hardware Interface Parameters

The transmitter communicates over a serial (UART) port with the following default settings:

Communication parameter	Value
Serial level	TTL
Baud rate	9600
Parity	None
Data bits	8
Stop bits	1

Inter-frame timeout: 250 ms.

2 Command Description

Note: “\n” denotes a line feed, hexadecimal `0x0A` . After a set command has been executed successfully, the configuration is saved in flash memory and does not need to be re-entered after a power cycle.

Error responses to invalid commands:

Error response	Meaning
This AT cmd is error\n	The command is malformed
This AT cmd is no exist\n	The command does not exist
This AT cmd is exist,but not allow to operate\n	The command exists but the operation is not permitted
This AT cmd is exist,but value is error\n	The parameter passed to the command is invalid

2.1 Read the real-time ullage

Unit: metres (m)

	Command	Meaning
Send	AT+REALAIRHEIGHT\n	Read the real-time ullage
Response	REALAIRHEIGHT=2.212m\n	Real-time ullage is 2.212 m
Response	REALAIRHEIGHT=OutOfRange\n	Out of measuring range
Response	REALAIRHEIGHT=InBlindZone\n	Sensor is inside the blind zone
Response	REALAIRHEIGHT=LackEnergy\n	Insufficient echo energy

2.2 Read the real-time level

Unit: metres (m). The level is calculated as: installation height – ullage.

	Command	Meaning
Send	AT+REALWATERDEPTH\n	Read the real-time level
Response	REALWATERDEPTH=7.789m\n	Real-time level is 7.789 m
Response	REALWATERDEPTH=OutOfRange\n	Out of measuring range
Response	REALWATERDEPTH=InBlindZone\n	Sensor is inside the blind zone
Response	REALWATERDEPTH=LackEnergy\n	Insufficient echo energy
Response	REALWATERDEPTH=No Set InstallHeight\n	Installation height not set

2.3 Water depth at installation

Unit: metres (m)

Note: The water depth at installation is used to derive the installation height (installation height = water depth at installation + ullage at the moment of installation), and the installation height is in turn used to calculate the level (real-time level = installation height – real-time ullage). When the water depth at installation is set, the installation height is calculated automatically and stored in the configuration. If the sensor is in an abnormal state (e.g. inside the blind zone), the installation height cannot be calculated and setting the water depth at installation has no effect.

Read the water depth at installation:

	Command	Meaning
Send	AT+INSTALLWATERDEPTH\n	Read the water depth at installation
Response	INSTALLWATERDEPTH=4.60m\n	Water depth at installation is 4.60 m

Set the water depth at installation:

	Command	Meaning
Send	AT+INSTALLWATERDEPTH=4.6\n	Set the water depth at installation to 4.6 m
Response	AT+INSTALLWATERDEPTH=4.6\n OK\n	Successful

2.4 Installation height

Unit: metres (m)

Note: The installation height is used to calculate the level (real-time level = installation height – real-time ullage). Also, installation height = water depth at installation + ullage at the moment of installation. When the installation height is set, the water depth at installation is calculated automatically and stored in the configuration. If the sensor is in an abnormal state (e.g. inside the blind zone), the installation height can still be set; in that case the water depth at installation cannot be calculated or recorded and defaults to 0, which does not affect the level calculation.

Read the installation height:

	Command	Meaning
Send	AT+INSTALLHEIGHT\n	Read the installation height
Response	INSTALLHEIGHT=9.72m\n	Installation height is 9.72 m

Set the installation height:

	Command	Meaning
Send	AT+INSTALLHEIGHT=9.72\n	Set the installation height to 9.72 m
Response	AT+INSTALLHEIGHT=9.72\n OK\n	Successful

Note: Setting the installation height to 0 clears both the installation-height and the water-depth-at-installation configuration.

2.5 Read the version number

	Command	Meaning
Send	AT+VERSION\n	Read the version number
Response	VERSION=20230908\n	Version number is 20230908

2.6 Read the measuring range

Unit: metres (m)

	Command	Meaning
Send	AT+RANGE\n	Read the measuring range
Response	RANGE=40.00m\n	Measuring range is 40 m

2.7 Read the blind zone

Unit: metres (m)

	Command	Meaning
Send	AT+BLINDZONE\n	Read the blind zone
Response	BLINDZONE=0.335m\n	Blind zone is 0.335 m

2.8 Software reset (restart)

	Command	Meaning
Send	AT+BOOT\n	Perform a software reset
Response	AT+BOOT\n OK\n	Successful

2.9 Restore factory settings

	Command	Meaning
Send	AT+DEFAULT\n	Restore factory settings
Response	AT+DEFAULT\n OK\n	Successful

2.10 Acquisition interval

Unit: milliseconds (ms)

Note: The default acquisition interval is 200 ms; the shortest settable interval is 160 ms. (If the acquisition interval is set too short, responses to commands become slower, and truncated commands may go unanswered. If this happens, simply resend the command.)

Read the acquisition interval:

	Command	Meaning
Send	AT+COLLECTFREQ\n	Read the acquisition interval
Response	COLLECTFREQ=200\n	Acquisition interval is 200 ms per cycle

Set the acquisition interval:

	Command	Meaning
Send	AT+COLLECTFREQ=500\n	Set the acquisition interval to 500 ms per cycle
Response	AT+COLLECTFREQ=500\n OK\n	Successful

2.11 Baud rate

Read the baud rate:

	Command	Meaning
Send	AT+BAUDRATE\n	Read the baud rate
Response	BAUDRATE=9600\n	Baud rate is 9600

Set the baud rate:

	Command	Meaning
Send	AT+BAUDRATE=115200\n	Set the baud rate to 115200
Response	AT+BAUDRATE=115200\n OK\n	Successful

2.12 Calibration parameter

Unit: millimetres (mm)

Real-time ullage = sampled value – calibration parameter. Therefore, if the real-time ullage reads consistently too high by a fixed amount, the reading can be corrected by increasing the calibration parameter.

Read the calibration parameter:

	Command	Meaning
Send	AT+CALIBRATION\n	Read the calibration parameter
Response	CALIBRATION=16mm\n	Calibration parameter is 16 mm

Set the calibration parameter:

	Command	Meaning
Send	AT+CALIBRATION=30\n	Set the calibration parameter to 30 mm
Response	AT+CALIBRATION=30\n OK\n	Successful

2.13 Auto-report interval

Unit: milliseconds (ms)

Note: When the auto-report interval is ≥ 500 ms, the sensor reports real-time data automatically. If the installation height (or the water depth at installation) is set, the reported real-time data is the level; if it is not set, the reported real-time data is the ullage.

Read the auto-report interval:

	Command	Meaning
Send	AT+AUTOOUTDATA CYCLE\n	Read the auto-report interval
Response	AUTOOUTDATA CYCLE=100\n	Auto-report interval is 100 ms (no automatic data report below 500 ms)

Set the auto-report interval:

	Command	Meaning
Send	AT+AUTOOUTDATA CYCLE=500\n	Set the auto-report interval to 500 ms
Response	AT+AUTOOUTDATA CYCLE=500\n OK\n	Successful

2.14 Auto-report protocol type

Note: When the auto-report interval is ≥ 500 ms, the sensor pushes data automatically; otherwise no automatic data push takes place. If the installation height (or the water depth at installation) is set, the reported real-time data is the level; if it is not set, the reported real-time data is the ullage.

Two protocol types are available for the auto-reported frames: 0 — Modbus, 1 — text protocol.

Read the auto-report protocol type:

	Command	Meaning
Send	AT+PROTOCOLTYPE\n	Read the auto-report protocol type
Response	PROTOCOLTYPE=0\n	Auto-report protocol type is 0 — Modbus

Set the auto-report protocol type to the text protocol:

	Command	Meaning
Send	AT+PROTOCOLTYPE=1\n	Set the auto-report protocol type to the text protocol
Response	AT+PROTOCOLTYPE=1\n OK\n	Successful

2.15 Reference installation height

Unit: metres (m)

Note: The reference installation height is provided for convenient calculation of negative level values (reference level = reference installation height – real-time ullage).

Read the reference installation height:

	Command	Meaning
Send	AT+REFINSTALLHEIGHT\n	Read the reference installation height
Response	REFINSTALLHEIGHT=0m\n	Reference installation height not set

Set the reference installation height:

	Command	Meaning
Send	AT+REFINSTALLHEIGHT=1\n	Set the reference installation height to 1 m
Response	AT+REFINSTALLHEIGHT=1\n OK\n REFINSTALLHEIGHT=1.00m\n	Successful; reference installation height is 1 m

2.16 Reference level

Unit: metres (m)

The reference level is calculated as: reference level = reference installation height – real-time ullage.

Read the reference level:

	Command	Meaning
Send	AT+REALREFWATERDEPTH\n	Read the reference level
Response	REALREFWATERDEPTH=No Set InstallHeight\n	Reference installation height not set
Response	REALREFWATERDEPTH=0.200m\n	Reference level is 0.200 m

Part III Appendix

A Converting Between IEEE-754 Floats and Hexadecimal Representation

Method: depending on the data storage format (endianness) of the development platform, store the hexadecimal representation of the float into a float variable byte by byte.

For example: the float 12.34 converts to the hexadecimal `0x 41 45 70 A3` (high byte first, i.e. ABCD order). The sensor stores floats with the low 16 bits first, i.e. CDAB order, so the frame carries `0x 70 A3 41 45`.

STM32 and Windows both use little-endian storage, low 8 bits first, i.e. DCBA order. On an STM32 or Windows platform, converting `0x 70 A3 41 45` into a float therefore means converting the CDAB storage order into the DCBA storage order:

```
uint8_t frame[4] = {0x70,0xA3,0x41,0x45};
float data = 0;
for (uint8_t i = 0, j = 0; i < sizeof(data); i++)
{
    j = (i % 2) ? (i - 1) : (i + 1);
    *((uint8_t *)&data + i) = frame[j];
}
```

B PLC Integration Example

This example uses a Siemens S7-200 SMART to read the ullage (PLC/HMI address 32576, data type Float-little16):

Initialisation (MBUS_CTRL):

- (1) Slave: slave address `0x7F` converted to decimal = 127;
- (2) RW: read/write flag, 0 = read, 1 = write;
- (3) Addr: PLC address;
- (4) Count: number of registers to operate on (one register = 16 bits);
- (5) DataPtr: storage location of the data read.

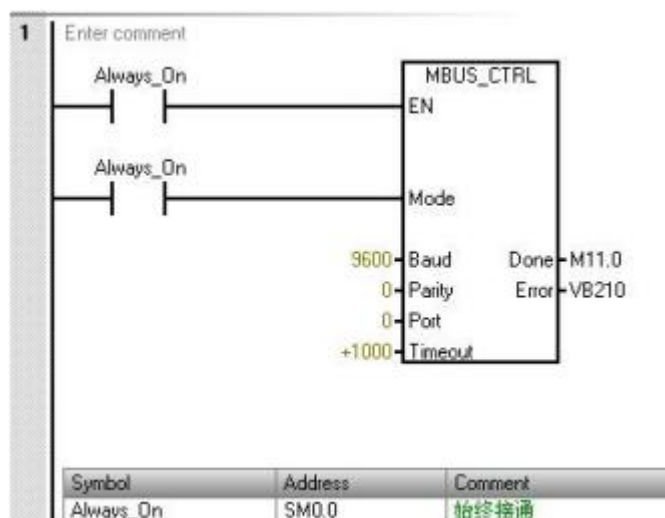


Figure 2 MBUS_CTRL initialisation block

Configuration (MBUS_MSG):

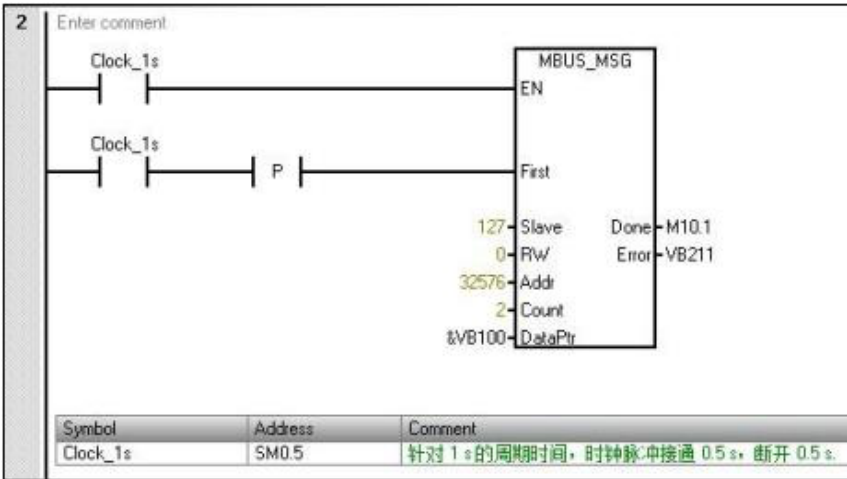


Figure 3 MBUS_MSG read block (Slave 127, RW 0, Addr 32576, Count 2, DataPtr &VB100)

Data word-swap conversion:

In this protocol the ullage data is a float with the low 16 bits first (CDAB). The data read via Modbus must therefore be word-swapped into ABCD order before the PLC can parse it correctly.

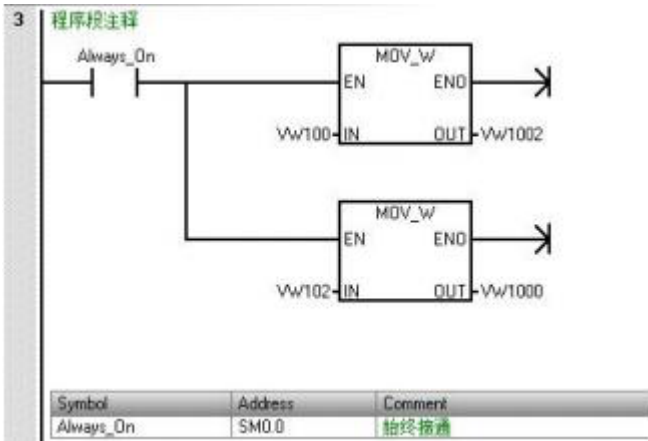


Figure 4 Word-swap conversion (VW100 ↔ VW102)

Read result:

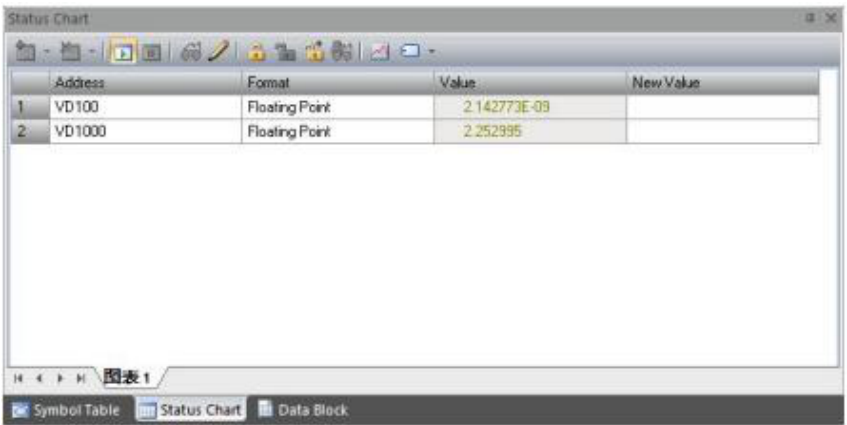


Figure 5 Status chart: VD1000 holds the correctly converted ullage value

Appendix B-1: PLC integration case files — scan the QR code below with WeChat to download:



Figure 6 QR code — PLC integration case download (WeChat)

Note: On an iPhone the file can be downloaded directly inside WeChat. On an Android phone, after scanning the QR code with WeChat, open the link in a browser to download.

Appendix B-2: The PLC program cases can also be downloaded inside the **RadarBLE** app (Android / iOS) — Bluetooth versions only:

 管理员功能	>
 4-20mA输出校准	>
 联动控制	>
 调试日志	>
 设备信息	>
 FFT频谱	>
 PLC对接数据格式	>
 modbus	>
 蓝牙名称	>
 PLC对接例程	>
 通讯协议	>

Figure 7 RadarBLE app menu — “PLC对接例程” (PLC integration examples)

Appendix B-3: Contents of the PLC program cases — example projects for mainstream PLCs (Mitsubishi FX3U / FX5U, Delta EH3 / ES2, Inovance H3U / H5U, Xinje XC / XD, Weintek, MCGS, etc.):

名称	修改日期	类型	大小
汇川H3U与雷达液位计通讯	2025/3/11 16:56	文件夹	
汇川H5U与雷达液位计通讯	2025/3/11 16:56	文件夹	
昆仑通态与雷达液位计通讯	2025/3/14 15:44	文件夹	
领控PLC与雷达液位计通讯	2025/3/11 23:02	文件夹	
三菱FX3U与雷达液位计通讯-485BD	2025/3/11 16:55	文件夹	
三菱FX3U与雷达液位计通讯-FX3U-ADP-...	2025/3/11 23:03	文件夹	
三菱FX5U与雷达液位计通讯	2025/3/11 16:56	文件夹	
台达EH3与雷达液位计通讯	2025/3/11 23:00	文件夹	
台达ES2与雷达液位计通讯	2025/3/11 16:56	文件夹	
威纶通与雷达液位计通讯	2025/3/11 23:23	文件夹	
信捷XC与雷达液位计通讯	2025/3/11 16:56	文件夹	
信捷XD与雷达液位计通讯	2025/3/11 16:56	文件夹	

Figure 8 PLC example program folder list

C Viewing the Echo Waveform

1. Change the configuration: connect the sensor with the host (PC) software and click “**检测当前设备**” (**Detect current device**) to read the current configuration; then set the baud rate to 115200, set the communication mode to **query-response**, and click **save configuration**.
2. Send the text command AT+OUTRAWDATA=1\n to enable raw data push (AT+OUTRAWDATA=0\n disables it).
3. Open the plotting page in the host software:

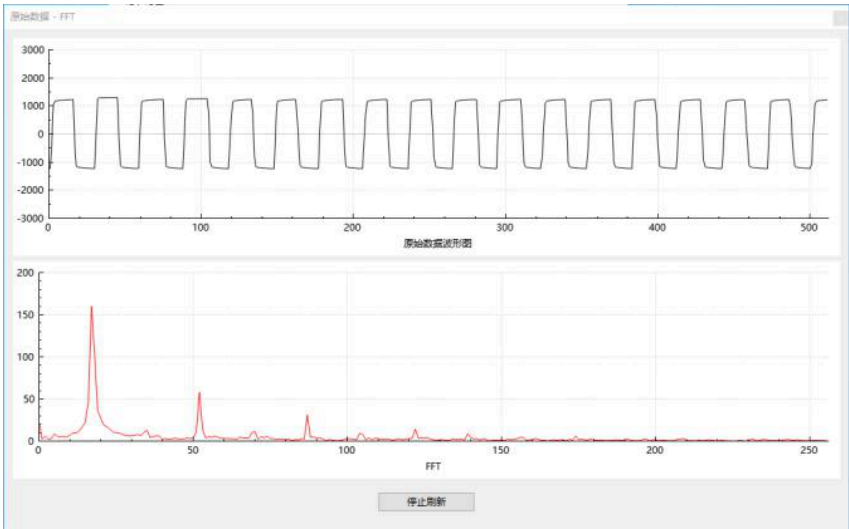


Figure 9 Host software — configuration for raw data output

The first chart shows the raw data waveform; the second chart shows the spectrum of the raw data after a Fourier transform.



Figure 10 Raw data waveform (top) and FFT spectrum (bottom)

D Ranging Results of All Current Echo Targets

Send: AT+PEAKSDISTANCE\n

Response: PEAKSDISTANCE=0.104,0.279,0.462,2.242,3.960,4.492

The six values 0.104, 0.279, 0.462, 2.242, 3.960, 4.492 are the ranging results of all targets currently detected. Select the appropriate target result according to the actual application.

E Spectrum Data Packet Format

The spectrum data packet has the following format:

```
"FFT" + 256*peakValue(float) + "RTD" + peakIndex(uint8_t) + AirHeight(float)
      + RangeRes(float) + CRC(uint16_t) + '\0'
```

Total: 1042 bytes. The legacy version was:

```
"FFT" + 256*peakValue(float) + "RTD" + peakIndex(uint8_t) + AirHeight(float)
      + CRC(uint16_t) + '\0'
```

Total: 1038 bytes.

Where: “FFT” / “RTD” are ASCII markers; **peakValue** is the value of each frequency bin (little-endian, ordered from left to right); **peakIndex** is the frequency bin used in the algorithm; **AirHeight** is the algorithm result (before the ullage offset is subtracted); **RangeRes** is the radar sweep frequency resolution (this parameter may be ignored); **CRC** is the packet integrity checksum.

Legacy ADC sampling data output format:

```
/* Data format:
 * "0x01 0x02 0x03 0x04 0x05 0x06 0x07 0x08 0x00 0x00 0x00 0x00"
 *   + adcData (1024 bytes)
 * Total: 1036 bytes
 */
```

The first 12 bytes are the packet header; the remaining 1024 bytes are the raw data.