

Modbus RTU Protocol Manual

(ver1.1)

Product : 60Ghz Level Measurement Sensor

Model : V-PR100



Designed	CHECKED	APPROVAL
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1. Introduction

This document describes the protocol detail of Modbus for V-PR100

- ✓ Hardware interface
 - The interface on the sensor is RS-232
 - Hardware named RX, TX, GND
- ✓ RS-232 Slave Address, Baud rate, Data format
 - Slave Address : 1~247
 - Baud rate : 9600, 19200, 38400, 57600, 115200
 - Parity : None, Even
 - Data length : 8 bit
 - Stop bit : 1 bit
 - Default Address = 28, Data format = 115200, N81
- ✓ About Modbus (ref PI-MBUS-300)
 - Support RTU mode
 - Bit addressable items (i.e. Coils and Discrete inputs) will not be implemented
 - Measurement Values are represented in IEEE 754 single-precision 32-bit floating point type
 - Modbus protocol structure :
 - 1st byte : Address (1~247)
 - 2nd byte : Function code (1 byte)
 - 3~Nth bytes : Data bytes
 - N+1th ~ N+2th byte : CRC (16 bits), LSB first

1.1 Outline

Using purpose : It is used to measure the height of internal storage such as factory, farm water tank, swimming pool, industrial water, grain warehouse, silo, etc. The sensor emits electromagnetic waves to analyze reflected waves and travel time to measure the height of the stored object (an object made of water, liquid, grain, powder, etc.).

How to use : Fix the product to the ceiling, and Power supply to the product. Use the Modbus-RTU serial communication method to know the height of the reservoir, the distance to the reservoir, and the strength of the reflected signal. The same information can be found in images visualized through the BLE Android App via wireless communication.

ATTACHMENT POSITION : Assemble the V-PR100 to the casing and screw it into a tank, silo, or outdoor ceiling structure. Installation must be at least 200mm apart from the wall.

2. Instrument Holding Registers for application engineering (ex: ModScan)

Item No.	Address	Address HEX	Parameter	Point Type	Data Type	Value
1	0017	0011H	Update rate	HOLDING REGISTER	Unsigned integer	second
2	0018	0012H	Threshold	HOLDING REGISTER	Unsigned integer	
3	0019	0013H	Cutoff meter	HOLDING REGISTER	Floating Pt.	meter
4	0021	0015H	Bottom	HOLDING REGISTER	Floating Pt.	meter
5	0023	0017H	Distance	HOLDING REGISTER	Floating Pt.	meter
6	0025	0019H	Level	HOLDING REGISTER	Floating Pt.	meter
7	0028	001CH	Amplitude	HOLDING REGISTER	Unsigned integer	

3. Instrument Holding Registers for software engineering

Item No.	Starting Address		Parameter	R/W	Data Bytes	Point Type	Data Type	Value
	Hi byte	Lo byte						
Information								
1	00	00-03	Firmware Version	R	8bytes	HOLDING REGISTER	ASCII	
2	00	04-0B	Serial Number	R	16bytes	HOLDING REGISTER	ASCII	
RS-XXX Slave Address, Baudrate, Data format								
3	00	0C	Slave Address	R/W	1byte	HOLDING REGISTER	unsigned integer	1-247
4	00	0D	Baud rate	R/W	1byte	HOLDING REGISTER	unsigned integer	0 : 9600 1 : 19200 2 : 38400 3 : 57600 4 : 115200
5	00	0E	Data type	R/W	1byte	HOLDING REGISTER	unsigned integer	0 : N81 1 : E81
Measurement value, Setting range								
6	00	0F	Measure_set	R/W	1byte	HOLDING REGISTER	unsigned integer	0 : OFF 1 : ON
7	00	11	Update_rate	R/W	1byte	HOLDING REGISTER	unsigned integer	1~60 (second)
8	00	12	Threshold	R/W	2bytes	HOLDING REGISTER	unsigned integer	50~60000

9	00	13	Cutoff_meter	R/W	4bytes	HOLDING REGISTER	float	0.0 ~ 12.7 (meter)
10	00	14	Bottom	R/W	4bytes	HOLDING REGISTER	float	0.0 ~ 12.7 (meter)
11	00	16	Distance	R	4bytes	HOLDING REGISTER	float	0.0 ~ 12.7 (meter)
12	00	18	Level	R	4bytes	HOLDING REGISTER	float	0.0 ~ 12.7 (meter)
13	00	1A	Detect	R/W	1byte	HOLDING REGISTER	unsigned integer	0 : Default 1 : Detect 2 : Write
14	00	1B	Amplitude	R	2bytes	HOLDING REGISTER	unsigned integer	0~60000

Item No.	Address		Parameter	R/W	Data Bytes	Point Type	Data Type	Value
	ADDR DEC	ADDR HEX						
Information								
1	40001	0001H	Firmware Version	R	8bytes	HOLDING REGISTER	ASCII	
2	40005	0005H	Serial Number	R	16bytes	HOLDING REGISTER	ASCII	
RS-XXX Slave Address, Baudrate, Data format								
3	40013	000DH	Slave Address	R/W	1byte	HOLDING REGISTER	unsigned integer	1~247
4	40014	000EH	Baud rate	R/W	1byte	HOLDING REGISTER	unsigned integer	0 : 9600 1 : 19200 2 : 38400 3 : 57600 4 : 115200
5	40015	000FH	Data type	R/W	1byte	HOLDING REGISTER	unsigned integer	0 : N81 1 : E81
Measurement value, Setting range								
6	40016	0010H	Measure_set	R/W	1byte	HOLDING REGISTER	unsigned integer	0 : OFF 1 : ON
7	40017	0011H	Update_rate	R/W	1byte	HOLDING REGISTER	unsigned integer	1~60 (second)
8	40018	0012H	Threshold	R/W	2bytes	HOLDING REGISTER	unsigned integer	50~60000

9	40019	0013H	Cutoff_meter	R/W	4bytes	HOLDING REGISTER	float	0.0 ~ 12.7 (meter)
10	40021	0015H	Bottom	R/W	4bytes	HOLDING REGISTER	float	0.0 ~ 12.7 (meter)
11	40023	0017H	Distance	R	4bytes	HOLDING REGISTER	float	0.0 ~ 12.7 (meter)
12	40025	0019H	Level	R	4bytes	HOLDING REGISTER	float	0.0 ~ 12.7 (meter)
13	40027	001BH	Detect	R/W	1byte	HOLDING REGISTER	unsigned integer	0 : Default 1 : Detect 2 : Write
14	40028	001CH	Amplitude	R	2bytes	HOLDING REGISTER	unsigned integer	0~60000

4. Data format

4.1 ASCII format, Item No. 1-2

1st Word		2nd Word		3rd Word		4th Word		5th Word		6th Word		7th Word		8th Word	
Hi byte	Lo Byte	Hi byte	Lo Byte	Hi byte	Lo Byte	Hi byte	Lo Byte	Hi byte	Lo Byte	Hi byte	Lo Byte	Hi byte	Lo Byte	Hi byte	Lo Byte

"ABCDEF0123456789" is represented as

<41> <42> <43> <44> <45> <46> <30> <31> <32> <33> <34> <35> <36> <37> <38> <39>

4.2 IEEE754 format, Item No. 9-12

Data Hi Word, Hi Byte	Data Hi Word, Lo Byte	Data Lo Word, Hi Byte	Data Lo Word, Lo Byte
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM

Where

S represents the sign bit where 1 is negative and 0 is positive.

E is the two's complement exponent with an offset of 127 i.e. an exponent of zero is represented by 127, an exponent of 1 by 128 etc.

M is the 23-bit normal mantissa. The highest bit is always 1 and, therefore, is not stored.

Using the above format the floating point number 12.7 is represented as <41> <4B> <33> <33>:

Data Hi Word, Hi Byte	Data Hi Word, Lo Byte	Data Lo Word, Hi Byte	Data Lo Word, Lo Byte
0x41	0x4B	0x33	0x33

5. Communication Examples

5.1 Read Distance Measurement Value

Request the host (PC or PLC) to polling the data of V-PR300			
Field Name	Value	Type	Byte
Slave Address	1~247	Byte	1
Read Holding registers	03	Byte	1
Starting Address Hi	00	Byte	1
Starting Address Lo	16	Byte	1
No. of registers Hi	00	Byte	1
No. of registers Lo	02	Byte	1
CRC Lo	CRC Lo	Byte	1
CRC Hi	CRC Hi	Byte	1

*Registers of Distance are 0x0016 ~ 0x0017

Response V-PR300 response data to the host (PC or PLC)			
Field Name	Value	Type	Byte
Slave Address	1~247	Byte	1
Read Holding registers	03	Byte	1
Byte Count	04	Byte	1
IEEE 754 Data Lo Word, Hi Byte	0xDD	Byte	1
IEEE 754 Data Lo Word, Lo Byte	0x2F	Byte	1
IEEE 754 Data Hi Word, Hi Byte	0x40	Byte	1
IEEE 754 Data Hi Word, Lo Byte	0x64	Byte	1
CRC Lo	CRC Lo	Byte	1
CRC Hi	CRC Hi	Byte	1

*the floating point number 3.576 is represented as <40> <64> <DD> <2F>

5.2 Read Level Measurement Value

Request the host (PC or PLC) to polling the data of V-PR300			
Field Name	Value	Type	Byte
Slave Address	1~247	Byte	1
Read Holding registers	03	Byte	1
Starting Address Hi	00	Byte	1
Starting Address Lo	18	Byte	1
No. of registers Hi	00	Byte	1
No. of registers Lo	02	Byte	1
CRC Lo	CRC Lo	Byte	1
CRC Hi	CRC Hi	Byte	1

*Registers of Level are 0x0018 ~ 0019

Response V-PR300 response data to the host (PC or PLC)			
Field Name	Value	Type	Byte
Slave Address	1~247	Byte	1
Read Holding registers	03	Byte	1
Byte Count	04	Byte	1
IEEE 754 Data Lo Word, Hi Byte	0xC8	Byte	1
IEEE 754 Data Lo Word, Lo Byte	0xB4	Byte	1
IEEE 754 Data Hi Word, Hi Byte	0x41	Byte	1
IEEE 754 Data Hi Word, Lo Byte	0x26	Byte	1
CRC Lo	CRC Lo	Byte	1
CRC Hi	CRC Hi	Byte	1

*the floating point number 10.424 is represented as <41> <26> <C8> <B4>

5.3 Read Serial No.

Request the host (PC or PLC) to polling the data of V-PR300			
Field Name	Value	Type	Byte
Slave Address	1~247	Byte	1
Read Holding registers	03	Byte	1
Starting Address Hi	00	Byte	1
Starting Address Lo	04	Byte	1
No. of registers Hi	00	Byte	1
No. of registers Lo	08	Byte	1
CRC Lo	CRC Lo	Byte	1
CRC Hi	CRC Hi	Byte	1

*Registers of Serial No. are 0x0004 ~ 0x000B

Response V-PR300 response data to the host (PC or PLC)			
Field Name	Value	Type	Byte
Slave Address	1~247	Byte	1
Read Holding registers	03	Byte	1
Byte Count	10	Byte	1
1st Word, Lo byte	0x36	Byte	1
1st Word, Hi byte	0x30	Byte	1
2nd Word, Lo byte	0x50	Byte	1
2nd Word, Hi byte	0x30	Byte	1
3rd Word, Lo byte	0x4B	Byte	1
3rd Word, Hi byte	0x52	Byte	1
4th Word, Lo byte	0x36	Byte	1
4th Word, Hi byte	0x42	Byte	1
5th Word, Lo byte	0x30	Byte	1
5th Word, Hi byte	0x31	Byte	1
6th Word, Lo byte	0x30	Byte	1
6th Word, Hi byte	0x30	Byte	1
7th Word, Lo byte	0x00	Byte	1
7th Word, Hi byte	0x44	Byte	1
8th Word, Lo byte	0x00	Byte	1
8th Word, Hi byte	0x00	Byte	1
CRC Lo	CRC Lo	Byte	1
CRC Hi	CRC Hi	Byte	1

*example of Serial No. is "060PRKB61000D"

5.4 Read Firmware Version

Request the host (PC or PLC) to polling the data of V-PR300			
Field Name	Value	Type	Byte
Slave Address	1~247	Byte	1
Read Holding registers	03	Byte	1
Starting Address Hi	00	Byte	1
Starting Address Lo	00	Byte	1
No. of registers Hi	00	Byte	1
No. of registers Lo	04	Byte	1
CRC Lo	CRC Lo	Byte	1
CRC Hi	CRC Hi	Byte	1

*Registers of Firmware Version are 0x0000 ~ 0x0003

Response V-PR300 response data to the host (PC or PLC)			
Field Name	Value	Type	Byte
Slave Address	1~247	Byte	1
Read Holding registers	03	Byte	1
Byte Count	08	Byte	1
1st Word, Lo byte	0x30	Byte	1
1st Word, Hi byte	0x56	Byte	1
2nd Word, Lo byte	0x30	Byte	1
2nd Word, Hi byte	0x30	Byte	1
3rd Word, Lo byte	0x2E	Byte	1
3rd Word, Hi byte	0x31	Byte	1
4th Word, Lo byte	0x30	Byte	1
4th Word, Hi byte	0x30	Byte	1
CRC Lo	CRC Lo	Byte	1
CRC Hi	CRC Hi	Byte	1

*example of Firmware Version is "V0001.00"

6. Activation methods

6.1 Default Communication setting

Default Address = 28, Baudrate : 115200, N81

Measure set : 0 (0 : Not measure, 1 : Measure)

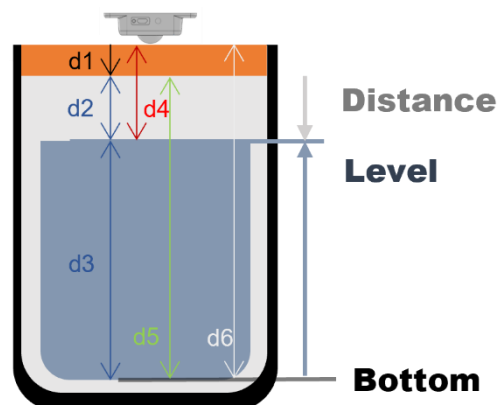
Update rate : 1 sec (distance, level, amplitude value out rate)

Threshold : 100 (Radar measure minimum value set)

Cutoff meter : 0.3 meter (Range that doesn't matter if you don't measure it)

Bottom Level : 12.4 meter (12.7 – cutoff meter)

Detect : 0 (1 : Bottom distance detect, 2 : Write Bottom distance)



[Fig 1. Distance level differentiation]

- **Measurement value explanation**

Cutoff meter : Range that doesn't matter if you don't measure it. (@Fig 1 – d1)

Bottom : The distance from V-PR300 model's antenna to floor. (@ Fig 1 – d5)

Distance : The distance from V-PR300 model's antenna to object target. (@ Fig 1 – d2)

Level : The distance from the object to floor. (@ Fig 1 – d3)

Amplitude : The radar's signal intensity. (high value is high signal intensity)

Threshold : Set the radar's minimum signal intensity. (To detect the object target except for noise signals)

- Bottom value (d5) = d6 – d1(cutoff meter)
- Distance value (d2) = d4 – d1(cutoff meter)

6.2 2 Methods activation (know the distance to floor or not)

1. When know the distance to the floor
 - 1) Set the parameter "detect(starting address : 001A)" value '2' to write bottom value.
 - 2) Write the floor distance value 'X.XXX'(IEEE 754 floating pt. ex. 10.8, the unit is 'meter') value to parameter "bottom(starting address : 0014)".
 - 3) Write the cutoff meter value 'X.XXX'(IEEE 754 floating pt. ex. 1.0, the unit is 'meter') value to parameter "Cutoff_meter(starting address : 0013)".
 - 4) When the setting is done, set the parameter "Measure_set(starting address : 000F)" value '1' to radar activation.

2. If Need to measure the distance to the floor
 - 1) Please empty the contents inside the tank(or silo) to detect floor distance exactly.
 - 2) Write the cutoff meter value 'X.XXX'(IEEE 754 floating pt. ex. 1.0, the unit is 'meter') value to parameter "Cutoff_meter(starting address : 0013)".
 - 3) Set the parameter "detect(starting address : 001A)" value '1' to detect floor distance.
 - 4) During detect floor distance, do not communicate to V-PR300, there be required few seconds.
 - 5) After detect floor distance, the 'Bottom' distance value would be change(starting address : 0014)" automatically.
 - 6) Also set the parameter "Measure_set(starting address : 000F)" value '1' automatically.

6.3 Exception error code

***Exception code is 36(decimal), 0x24(HEX).**

*If it is out of the range the system setting value, the corresponding exception code(0x24) is place to Function code.

e.g. cutoff meter set the range between 0.3 to bottom value. if cutoff meter set to '0.2' is out of the range, the result is <Slave Address> <24> <00> <00> <CRC Lo> <CRC Hi>.

FCC Approval

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device should be installed and operated with minimum 20Cm between the radiator and your body.

INTEGRATION INSTRUCTIONS**List of applicable FCC rules**

This module complies with Part 15.247, 15.255 of the FCC rules.

Summarize the specific operational use conditions

This module contains the 60GHz Object detection Sensor.

15.255(a) Operation under the provisions of this section is not permitted for the following products:

(1) Equipment used on satellites.

(2) Field disturbance sensors, including vehicle radar systems, unless the field disturbance sensors are employed for fixed operation, or used as short-range devices for interactive motion sensing. For the purposes of this section, the reference to fixed operation includes field disturbance sensors installed in fixed equipment, even if the sensor itself moves within the equipment.

The module is limited to installation in fixed applications only.

Limited module procedures

Not applicable

Trace antenna designs

Not applicable

RF exposure considerations

This module complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This device should be installed and operated with minimum 20Cm between the radiator and your body. The host manual shall include the RF exposure statements.

If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

Antennas

The chip antenna is permanently attached internal PCB.

Label and compliance information

The module is labeled with its own FCC. If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following: "Contains FCC ID: 2A8FDVPR100"

The host manual shall include the following regulatory statement:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device should be installed and operated with minimum 20Cm between the radiator and your body.

Information on test modes and additional testing requirements

Testing of the host product with all the transmitters installed - referred to as the composite investigation test- is recommended, to verify that the host product meets all the applicable FCC rules. The host manufacturer can use the software to control the RF signal during test.

For more information, please contact us.

Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

The host product may need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

Note EMI Considerations

Note that a host manufacture is recommended to use D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

How to make changes

only Grantees are permitted to make permissive changes.

For more information, please contact us.

Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

The host product may need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

7. Revision History

- V1 2022. 09. 30 Initial
- V1.1 2022. 11. 29 First Revision FCC rules attached.