WR-01

Wind and Rain Sensor Interface

MANUAL

Revised 27 May 2025

Firmware revision 1

Table of Contents

Warranty

If this product fails due to defects in materials or workmanship during the period of one year from the date of purchase, Argent Data Systems will repair or replace the device, at our option.

This warranty covers defects in manufacturing discovered while using the product as recommended by the manufacturer. The warranty does not cover loss or theft, nor does coverage extend to damage caused by misuse, abuse, unauthorized modification, improper storage conditions, lightning, or natural disasters.

Should the product fail, your sole recourse shall be repair or replacement, as described in the preceding paragraphs. We will not be held liable to you or any other party for any damages that result from the failure of this product. Damages excluded include, but are not limited to, the following: lost profits, lost savings, lost data, damage to other equipment, and incidental or consequential damages arising from the use, or inability to use this product. In no event will Argent Data Systems be liable for more than the amount of your purchase price, not to exceed the current list price of the product, and excluding tax, shipping and handling charges.

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This product is not intended for safety-critical applications, including but not limited to emergency stop systems, machinery safety interlocks, human hazard mitigation systems, and life-safety equipment. Users are responsible for evaluating its suitability in any given application.

Intended Audience

The WR-01 device and this manual are intended for professionals and hobbyists with a basic knowledge of serial interface formats and electronics concepts.

Introduction

The Argent Data Systems WR-01 provides a simple yet powerful interface for compatible wind and rain sensors. This manual primarily covers the use of the WR-01 with its companion sensors (Argent's p/n 80422) but also provides information on using the WR-01 with compatible sensors from other vendors.

The WR-01 features two independent serial ports. The first uses 3.3V TTL signaling, and also provides a second, inverted copy of the output that swings from 0V to the V+ supply voltage, making it compatible with RS-232 ports. The second port uses RS-485 signaling suitable for very long cable runs and for interfacing directly with PLCs.

Both ports support the Modbus RTU protocol for accessing measurements and configuration registers, as well as easily-parsed CSV and JSON text output formats. This variety of electrical interfaces and output formats makes the WR-01 simple to use with PLCs, embedded devices including Arduino boards, and single-board computers like the Raspberry Pi. While example code is provided, no special drivers or libraries are required.

The WR-01's alarm and analog output features also allow it to be used without any external controller. The alarm output can be configured to close a circuit when a specified condition or set of conditions are met, for example to disable a sprinkler system when rain is detected, or to signal when the wind is blowing in a particular direction and above a certain speed. The analog output can be configured to reflect any single measured parameter, producing a 0 to 3.3V signal proportional to that parameter over a specified range.

Features

- Suitable for use with PLCs, PCs, SBCs (including Raspberry Pi) and MCUs
- Wide supply voltage range (3.8 to 24 volts) and low current (8 mA)
- RS-485, TTL serial, and RS-232-compatible interfaces
- Supports Modbus RTU and multiple output formats including a JSON and a simple CSV format
- No special drivers or libraries required
- Configurable alarm output supports multiple parameters with AND and OR conditions
- Configurable 0 to 3.3V analog output for any single parameter

Specifications

Supply Voltage	3.8 to 24 volts DC
Supply Current	7-8 mA average, 20 mA peak
Max Wind Speed	Tested up to 106 MPH
Rain Gauge Resolution	0.011 inch / 0.2794 mm
Operating Temperature	-40 C to 105 C
Alarm Sink Current	50 mA continuous, up to 100 mA depending on heat dissipation
Analog Output Range	0 to 3.3 volts
RS-485 Levels	EIA-485 compliant
TTL Serial Levels	0 to 3.3 volts
RS-232 Levels	0 volts to supply voltage

Quick Start

Sensor Installation

Attach the anemometer and wind vane to the horizontal arm using one self-tapping screw each. Pay attention to the direction markings on the wind vane, molded in to the plastic below the rotating portion - the N marking should face north when installed. Route the cable from the anemometer through the clips on the underside of the arm and connect it to the wind vane. Mount the arm on the mast using a screw and nut, and route the cable from the wind vane down the mast. Hose clamps are provided to secure the mast to a larger mast or post and the provided cable ties can be used to secure the cables to the mast.

The rain gauge is provided with its own mounting arm. This can be attached to the mast lower down, positioned so that the sensors above are not shielding it from rainfall. When mounting the sensors on a tall mast that might sway in the wind, we recommend not using the rain gauge mounting arm and instead mounting the rain gauge directly to a stable, level surface. The rain gauge is a tipping bucket type and excessive swaying can cause false measurements. Mounting the rain gauge to a flat surface also helps to keep spiders from taking up residence and spinning webs that can prevent the mechanism from moving, which is occasionally an issue in some regions.

Connecting the Interface

The WR-01 interface is housed in a waterproof junction box. To connect it, unscrew the five screws

that hold on the lid and remove the lid and the circuit board. Note the WIND and RAIN markings next to the black connectors on the circuit board. Unscrew all three cable gland nuts and remove the yellow rubber gaskets.

Pass the rain gauge cable (the thinner one with only two wires visible in the connector) through one of the cable gland nuts and then through a gasket, then through the cable gland and connect it to the connector marked RAIN. The gasket should have its flat side facing outward and its chamfered side facing inward, toward the connector. Carefully slide the gasket back into the cable gland. Screw the nut back on but leave it loose enough that the cable can slide through easily. Repeat this procedure with the wind sensor cable and the connector marked WIND.

Your own cable will pass through the third cable gland where you'll make connections to the terminal block as appropriate for your application - a typical minimal installation needs power and ground and a serial interface connected. Turn the screws on the terminal block counterclockwise to open and clockwise to clamp down on the wire.

Once all of the connections have been made, place the circuit board back in the housing and tighten the cable gland nuts until they make a waterproof seal around each cable, and then reinstall the lid.

Terminal Block Connections

Connections to the WR-01 are provided on a 12-pin screw terminal block. All grounds are connected internally, with the extras provided to simplify wiring.

GND	Ground
ALM	Alarm output (open drain, 30V max, up to 100 mA)
ANA	Analog output (0 - 3.3V, 1 mA max load)
GND	Ground
TXI	Serial TX, inverted (for RS-232 compatibility, 0 to V+)
RX	TTL serial RX (data in, 3.3V, default 115200 baud)
TX	TTL serial TX (data out, 3.3V, default 115200 baud)
B	RS-485 B (default 9600 baud)
A	RS-485 A (default 9600 baud)
GND	Ground
3.3V	3.3V (input or regulator output)
V+	Power input (3.8V to 24V, 50 mA max)

ALM is an open drain alarm output. When the alarm is active, ALM is connected to ground

through a MOSFET, which can handle up to 30 volts with a maximum current of 100 mA, though we recommend limiting continuous loads to 50 mA. If the ALM output is used to drive an inductive load like a relay, be sure to use a suitable snubber diode for protection.

The ANA analog output terminal has a swing of 0 to 3.3V and can drive a load of up to 1 mA. For larger loads, use an external buffer.

RX and TX are the TTL serial input and output terminals. Do not exceed 3.5V on RX; this input is not 5V tolerant. The maximum usable cable length depends on the baud rate and cable type, but we recommend not exceeding several feet (a few meters) using this port.

The TXI output mirrors the TX pin, but instead of 0 to 3.3V, TXI swings from 0 to V+ and has inverted polarity. This lets you connect the output directly to a common RS-232 serial port, and distances of around 100 feet (30 meters) are possible.

A and B comprise the RS-485 serial port's differential pair. This is a half-duplex, bidirectional port. Depending on speed and cable type, distances of a few thousand feet are possible.

The 3.3V terminal can be used to supply 3.3V power to the WR-01, or if the WR-01 is powered via V+, this terminal provides a regulated 3.3V output capable of supplying up to 100 mA of current to an external device. If the WR-01 is to be powered permanently through the 3.3V pin and the regulator is not required, cut the trace between the pads of the solder jumper marked REG in the lower left corner of the circuit board to disconnect the regulator.

V+ is the main power input. This terminal accepts a wide voltage range, from 3.8 to 24 volts DC. If the TXI output is used, power must be supplied via V+.

Configuration

The WR-01 defaults to 9600 baud with no parity and one stop bit for the RS-485 interface and 115200 baud with no parity and one stop bit for the TTL/RS-232 interface. The default Modbus slave address is 1.

The TTL/RS-232 interface will default to sending plain text reports once per second and the RS-485 interface will by default only respond to commands and will not automatically send data. Each port can be configured to send any combination of report formats at a user-configured interval.

Either interface will accept both Modbus RTU and plain text commands. Sending any command

to an interface will disable automatic reports on that interface for three seconds.

Plain Text Command Format

While the WR-01's configuration scheme is designed primarily with Modbus in mind, it also provides a set of simple plain text commands for convenience:

`!<register>=<value>`	Sets a holding register to the specified value
`?<register>`	Queries the value of a holding register
`!enable`	Enables writes to protected registers for 60 seconds
`!save`	Saves settings to non-volatile memory
`!defaults`	Restores all configuration settings to defaults
`!reset`	Reboots the device

All plain text commands are terminated with a carriage return or linefeed character. When typing in commands through a terminal emulator like PuTTY, keep in mind that plain text commands have a three-second inactivity timeout.

All configuration options are set via Modbus holding registers. These are listed under "holding registers" in the register map section of this manual. All changes are temporary until saved to non-volatile memory. Do this with the `!save` command or by writing the value 1000 to holding register 1000.

Commands that affect serial communications parameters only take effect after a restart. Save the settings to non-volatile memory first and then use the `!reset` command or write the value 5522 to holding register 1000.

Common Setup Examples

For Modbus RTU operation over RS-485, the default 9600-N-8-1 settings are appropriate for most installations. For 19200-N-8-1, set holding register 10 to 192 and write 1000 to register 1000 to save. To change the slave address from its default of 1, write the new address to holding register 3, save, and restart.

For automatic output modes, the format selection may need to be changed depending on your needs. The format settings are bitmaps - each available format is enabled independently by setting a single bit. The values are added to select more than one format option. The default setting is 15 (1 + 2 + 4 + 8), which includes CSV output for instantaneous readings, 2-minute

averages, 10-minute averages, and user-configured averages (default 60 seconds).

To switch to JSON output on the TTL port (a common choice for interfacing with a Raspberry Pi) set register 20 to 32.

Register Map

The WR-01 has two sets of 16-bit registers, one for wind and rain readings and various other live parameters, and another for configuration and device status information. In Modbus terminology, the readings are input registers and the rest are holding registers.

Modbus register numbering can be confusing. In the traditional Modicon scheme, the first input register is numbered 30001 and the first holding register is 40001. We've chosen to use the short form of the register numbers. This means that 30001 is input register 1, accessed via Modbus command 0x04 "Read Input Registers" (address 0000 on the bus if you're using low-level tools). 40001 is holding register 1 (address 0000 on the bus), accessed via Modbus commands 0x03 "Read Holding Registers" and 0x06 "Write Single Register". The WR-01 does not support the 0x10 "Write Multiple Registers" command.

If you're new to Modbus and need a Modbus master application for testing, we recommend the free QModMaster, which is available for Windows and Linux and uses the same 1-based short address format.

Input Registers

The WR-01's readings are replicated across four ranges of registers with different units. The 100s place of the register number selects the units - 0 for wind in meters/second and rain in millimeters, 1 for wind in KPH and rain in millimeters, 2 for wind in MPH and rain in inches, and 3 for wind in knots and rain in inches.

Because the registers are 16-bit unsigned integer values (with a range of 0 to 65535), some units are scaled up by a factor of 100 or 1000, as noted in the register descriptions.

Bank 0 (meters per second and mm)

1	Instantaneous wind direction in degrees
2	Wind direction 2-minute average in degrees
3	Wind direction 10-minute average in degrees
4	Wind direction user-defined average in degrees
5	Wind direction average since last read in degrees
6	Raw wind vane reading in degrees
7	Wind speed instantaneous reading in meters/second x 100
8	Wind speed 2-minute average in meters/second x 100
9	Wind speed 10-minute average in meters/second x 100
10	Wind speed user-defined average in meters/second x 100
11	Wind speed average since last read in meters/second x 100
12	Peak wind speed in past 10 minutes in meters/second x 100
13	Peak wind speed over custom period in meters/second x 100
14	Peak wind speed since last read in meters/second x 100
15	Rainfall in past hour in mm x 100
16	Rainfall in past 24 hours in mm x 100
17	Rainfall since last read in mm x 100
18	Rainfall since last reset in mm x 100
19	Minutes since last rain detection

Bank 1 (kilometers per hour and mm)

101	Instantaneous wind direction in degrees
102	Wind direction 2-minute average in degrees
103	Wind direction 10-minute average in degrees
104	Wind direction user-defined average in degrees
105	Wind direction average since last read in degrees
106	Raw wind vane reading in degrees
107	Wind speed instantaneous reading in KPH x 100
108	Wind speed 2-minute average in KPH x 100
109	Wind speed 10-minute average in KPH x 100
110	Wind speed user-defined average in KPH x 100
111	Wind speed average since last read in KPH x 100
112	Peak wind speed in past 10 minutes in KPH x 100
113	Peak wind speed over custom period in KPH x 100
114	Peak wind speed since last read in KPH x 100
115	Rainfall in past hour in mm x 100
116	Rainfall in past 24 hours in mm x 100
117	Rainfall since last read in mm x 100
118	Rainfall since last reset in mm x 100
119	Minutes since last rain detection

Bank 2 (miles per hour and inches)

201	Instantaneous wind direction in degrees
202	Wind direction 2-minute average in degrees
203	Wind direction 10-minute average in degrees
204	Wind direction user-defined average in degrees
205	Wind direction average since last read in degrees
206	Raw wind vane reading in degrees
207	Wind speed instantaneous reading in MPH x 100
208	Wind speed 2-minute average in MPH x 100
209	Wind speed 10-minute average in MPH x 100
210	Wind speed user-defined average in MPH x 100
211	Wind speed average since last read in MPH x 100
212	Peak wind speed in past 10 minutes in MPH x 100
213	Peak wind speed over custom period in MPH x 100
214	Peak wind speed since last read in MPH x 100
215	Rainfall in past hour in inches x 1000
216	Rainfall in past 24 hours in inches x 1000
217	Rainfall since last read in inches x 1000
218	Rainfall since last reset in inches x 1000
219	Minutes since last rain detection

Bank 3 (knots and inches)

301	Instantaneous wind direction in degrees
302	Wind direction 2-minute average in degrees
303	Wind direction 10-minute average in degrees
304	Wind direction user-defined average in degrees
305	Wind direction average since last read in degrees
306	Raw wind vane reading in degrees
307	Wind speed instantaneous reading in knots x 100
308	Wind speed 2-minute average in knots x 100
309	Wind speed 10-minute average in knots x 100
310	Wind speed user-defined average in knots x 100
311	Wind speed average since last read in knots x 100
312	Peak wind speed in past 10 minutes in knots x 100
313	Peak wind speed over custom period in knots x 100
314	Peak wind speed since last read in knots x 100
315	Rainfall in past hour in inches x 1000
316	Rainfall in past 24 hours in inches x 1000
317	Rainfall since last read in inches x 1000
318	Rainfall since last reset in inches x 1000
319	Minutes since last rain detection

System Status Registers

1000	System uptime, minutes portion
1001	System uptime, days portion
1002	Supply voltage in volts x 100

Holding Registers

1	Device type (WR-01 always reports 0x5752 / 22354)
2	Firmware version
3	Modbus slave address (1 - 247, default 1, must save and restart to apply)
4	Modbus CRC error count
5	Fault status bitmap (since last read) 1 = wind vane failure detected 2 = anemometer failure detected
6	Fault status bitmap (currently active) 1 = wind vane failure detected 2 = anemometer failure detected
7	Custom wind direction averaging period in seconds (default 60, max 900)
8	Custom wind speed averaging period in seconds (default 60, max 900)
9	Custom gust measurement period in seconds (default 60, max 900)
10	Baud rate for RS-485 port (/100 baud) Supported speeds are 12, 24, 48, 96, 144, 192, 384, 576, 1152
11	RS-485 port parity (0 = none, 1 = odd, 2 = even)
12	Baud rate for TTL/RS-232 port (/100 baud) Supported speeds are 12, 24, 48, 96, 144, 192, 384, 576, 1152
13	TTL/RS-232 port parity (0 = none, 1 = odd, 2 = even)
14	Analog output parameter selection (input register number)
15	Analog output lower limit value
16	Analog output upper limit value
17	RS-485 port automatic output interval in seconds (0 disables)
18	RS-485 port output format bitmap (default 15) 1 = CSV format, instantaneous readings 2 = CSV format, 2 minute averaging period 4 = CSV format, 10 minute averaging period 8 = CSV format, user-defined averaging period 16 = Peet Bros Ultimeter 2000 format 32 = JSON format
19	TTL/RS-232 port automatic output interval in seconds (0 disables)
20	TTL/RS-232 port output format bitmap (default 0) 1 = CSV format, instantaneous readings 2 = CSV format, 2 minute averaging period 4 = CSV format, 10 minute averaging period 8 = CSV format, user-defined averaging period 16 = Peet Bros Ultimeter 2000 format 32 = JSON format

100	Wind speed calibration value, m/s * 1000 per Hz, default 667 (protected)
101	Wind vane offset in degrees CW from north (protected)
102	Rain gauge calibration value, 1/1000 mm per closure, default 2794 (protected)
200	Alarm condition register A1R
201	Alarm condition register A2R
202	Alarm condition register A3R
203	Alarm condition register B1R
204	Alarm condition register B2R
205	Alarm condition register B3R
206	Alarm condition register C1R
207	Alarm condition register C2R
208	Alarm condition register C3R
209	Alarm condition register D1R
210	Alarm condition register D2R
211	Alarm condition register D2R
300	Alarm condition value A1V
301	Alarm condition value A2V
302	Alarm condition value A3V
303	Alarm condition value B1V
304	Alarm condition value B2V
305	Alarm condition value B3V
306	Alarm condition value C1V
307	Alarm condition value C2V
308	Alarm condition value C3V
309	Alarm condition value D1V
310	Alarm condition value D2V
311	Alarm condition value D3V
1000	Command register 1 = Reset rain count 1000 = Save configuration 1001 = Calibration register write enable (for 60 seconds) 5522 = Reboot 9999 = Reset to factory defaults

Calibration Settings

Holding registers 100-102 define the relationship between raw sensor inputs and their measurements. These registers are write-protected to prevent accidental changes. To change their values, first enable writes by writing 1001 to register 1000 or send the plain text command `!enable`. Writes are automatically disabled again after 60 seconds.

When using the Argent sensors, the only one of these registers that may need to be adjusted is the wind vane offset (register 101). If the wind vane is not oriented with its N marking facing north, set this register to the actual heading of the marking. For example, if the N marking is facing due east, set the register to 90.

The WR-01 can be used with other anemometers and rain gauges that use a dry contact closure. Set register 100 to the wind speed in meters/second x 1000 represented by a closure rate of 1 Hz, and set register 102 to the amount of rain in 1/1000mm that triggers one closure of the rain gauge switch.

Data Formats

CSV Format

The default output format uses comma-separated values (CSV) and provides readings in MPH, meters/second, inches, and millimeters with the following field order:

Averaging period (I = instantaneous, 2M = 2 minute, 10M = 10 minute, C = custom)
Wind speed mph
Wind speed m/s
Rain in past hour, inches
Rain in past 24 hours, inches
Rain total, inches
Rain in past hour, mm
Rain in past 24 hours, mm
Rain total, mm
Time since last rain in minutes

By default all four averaging periods are sent. Example:

```
I,4.72,mph,2.11,m/s,87,0.033,0.033,0.033,in,0.83,0.83,0.83,mm,4
2M,3.21,mph,1.43,m/s,84,0.033,0.033,0.033,in,0.83,0.83,0.83,mm,4
10M,0.64,mph,0.28,m/s,35,0.033,0.033,0.033,in,0.83,0.83,0.83,mm,4
C,4.15,mph,1.85,m/s,85,0.033,0.033,0.033,in,0.83,0.83,0.83,mm,4
```

All lines are terminated by a CR/LF. For simple data logging, selecting a single averaging period

option will produce a stream of data that can be easily loaded into a spreadsheet. Units ('mph', 'm/s', 'in', and 'mm') are provided in the CSV data to improve readability.

JSON Format

The JSON (JavaScript Object Notation) output option is extremely simple to parse with modern high-level languages like Python and JavaScript. The WR-01 sends each JSON object as a single line of text, terminated with a CR/LF. For brevity, only a single set of units - meters/second for wind speeds and millimeters for rain - are provided in this format, since any system capable of parsing JSON can easily handle unit conversions. Expanded for readability, the format looks like this:

```
{
    "instant": {
        "wind_dir": 85,
        "wind_speed": 1.41
    },
    "2min": {
        "wind_dir": 84,
        "wind_speed": 0.68
    },
    "10min": {
        "wind_dir": 26,
        "wind_speed": 0.13
    },
    "custom": {
        "wind_dir": 85,
        "wind_speed": 1.36
    },
    "rain_1hr": 0.83,
    "rain_24hr": 0.83,
    "rain_total": 0.83,
    "last_rain": 3
}
```

Notes on Wind Direction Measurement

The WR-01's companion wind vane uses eight magnetic switches to detect the vane's current direction. Because the switches have small overlapping regions, up to 16 discrete positions can be detected. While this would seem to limit the resolution to 22.5 degrees, the wind vane is able to achieve much better accuracy through the use of dithering. The vane is designed to oscillate slightly in the wind, causing it to constantly move between adjacent positions. Readings are taken at 10 Hz and an averaging algorithm is applied to determine the actual wind direction.

Because of this averaging requirement, the "instantaneous" wind direction readings actually reflect a 5-second moving average. An additional "raw" reading is available that represents the actual instantaneous position of the vane, with no more than 16 possible values, and this may be used for diagnostic purposes or when the user wishes to apply their own averaging.

The body of the vane has cardinal directions molded in just below the rotating portion. If possible, the 'N' marking should be oriented due north. If the vane is not oriented due north, be sure to set the vane offset register to the actual compass heading of the 'N' marking.

The WR-01 reports a value of 360 degrees for due north. A value of 0 indicates an invalid reading, possibly due to an unplugged or damaged wind vane.

Alarm

The WR-01 has a single alarm output terminal that can be configured to activate on given condition or combination of conditions. This is an open-dran output, meaning that when the alarm is not active the terminal is effectively disconnected. When the alarm is active, the terminal is connected to ground and can sink up to 100 mA of current at up to 30 V.

The alarm is configured using two sets of holding registers, 200-211 and 300-311, as shown in the holding register table. The “alarm condition register” settings select an input register and the corresponding “alarm condition value” settings hold the value to compare against that input register. The alarm logic is as follows:

(register A1R > A1V) OR (register A2R > A2V) OR (register A3R > A3V)

AND

(register B1R > B1V) OR (register B2R > B2V) OR (register B3R > B3V)

AND

(register C1R > C1V) OR (register C2R > C2V) OR (register C3R > C3V)

AND

(register D1R > D1V) OR (register D2R > D2V) OR (register D3R > D3V)

Any xxR registers set to 0 are not considered. Most alarm setups will need only one or two conditions configured. For example, to set the alarm when the 2-minute wind speed average in MPH (holding register 208) exceeds 20.00 MPH, you would set A1R = 208 and A1V = 2000.

To change the comparison from “greater than” to “less than or equal to”, add 10000 to the holding register number. Applying this to the example above, setting A1R = 10208 and A1V = 2000 sets the alarm condition to a 2-minute wind speed average less than or equal to 20.00 MPH.

To give a slightly more complex example, if we need to trigger the alarm when the 2-minute wind average is over 20 MPH and the wind direction (holding register 2) is between 90 and 270 degrees, we would use three conditions:

A1R = 208, A1V = 2000 (2-minute wind speed > 20 MPH)

B1R = 2, B1V = 90 (2-minute wind direction > 90)

C1R = 10002, C1V = 270 (2-minute wind direction <= 270)

If our wind direction range crosses 360 degrees, we have to use an OR comparison. For example, to trigger on wind over 20 MPH and a direction between 315 and 45 degres:

A1R = 208, A1V = 2000 (2-minute wind speed > 20 MPH)

B1R = 2, B1V = 315 (2-minute wind direction > 315)

B2R = 10002, B2V =45 (2-minute wind direction <= 45)

B1 and B2 are OR'd together while the A and B groups are AND'd together - the wind speed must be over 20 MPH AND either the wind direction must be greater than 315 degrees OR less than or equal to 45 degrees.

Trademarks

MODBUS is a registered trademark of Schneider Electric USA, Inc.

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