

## 1. Introduction

The VPFlowScope product line communicates via RS485 (Modbus RTU). Which offers you flexibility and full access to all parameters. Modbus RTU is an open protocol, which is supported by many PLC's, SCADA systems and energy management platforms. All information on how to connect the VPFlowScope can be found in the user manual. In this tech note we want to talk about some common issues: the maximum number of VPFlowScope's and some tips regarding how to play with the command set. Modbus issues can be split up in three main topics:

1. Issues with the physical communication layer (cables, boxes etc)
2. The basic configuration (Baud rate, communication parameters)
3. Issues with the protocol: which commands to use and how to interpret the data

## 2. Physical communication layer

### 2.1. Cable length and voltage drop

For Modbus, it is mandatory to use twisted pair shielded cable. Check the cable specifications to make sure that the cable is suitable for Modbus RS485 networks. At least the cable should be: Shielded, twisted pair, rated for the total power consumption and qualified for the industrial environment (may vary per industry). But be careful: all the sensors together will draw power. This will result in a voltage drop. With long cables, the voltage drop might become too large. As a result, the last device in the chain will not receive sufficient power.

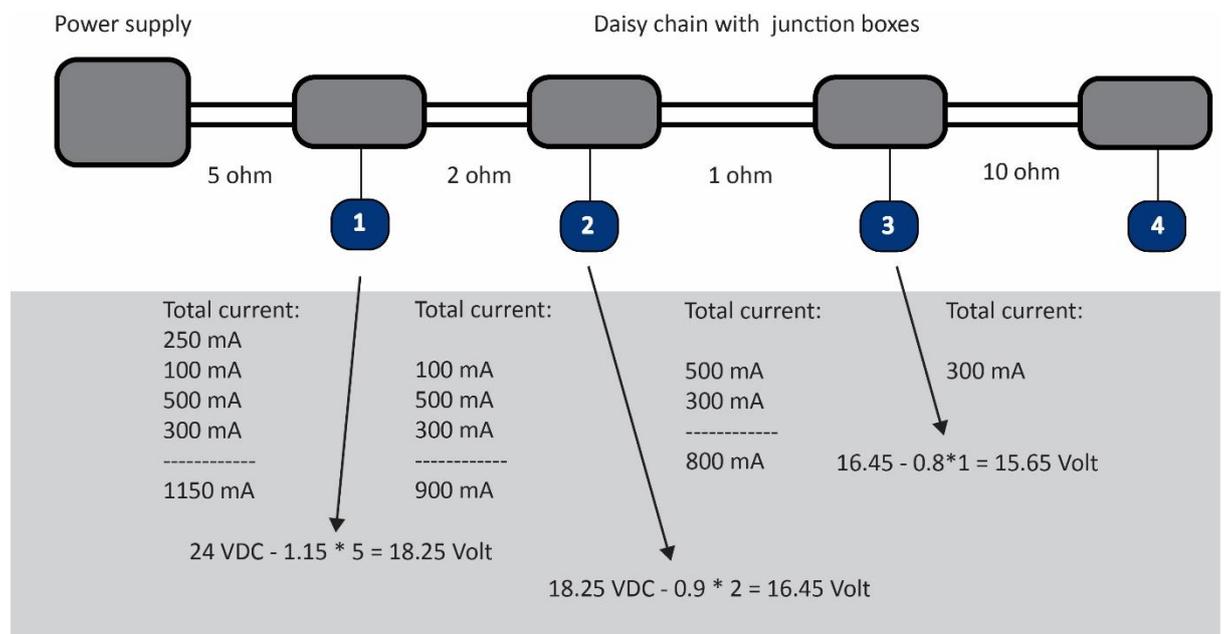


Figure above: to calculate voltage drop, make a sum of the rated current under maximum power circumstances for all flow meters (and other devices) attached to the Modbus daisy chain.

Draw the schematic and add the current as shown in the picture. In this example you can see that the third sensor is getting 15.65 Volt. Still enough (minimum = 12 volt) , but what about device number 4?

We are familiar with the Belden 1502R cable and would recommend it if you are not sure which cable to use. The Belden 1502R cable consists of two thicker wires for the power supply of the device and two wires for the RS485 signal. However, feel free to use any cable you would like. If the cable meets the requirements as mentioned it will work as well.

## 2.2. Star vs multi-drop

There is a lot of discussion on issues caused by star network configurations. From experience, we see that when the flow meters are relatively close to the master, a star network can work, for example when you want to test communications in your office. But if you want to play it safe: follow the rules, and create a network with junction boxes, and one termination resistor at the far end. The termination resistor is included in each junction box; you can enable the resistor in the last box.

## 2.3. The max number is 8!

When you connect 8 VPFlowScope devices to one master, the master has to ask  $8 * 4 = 32$  parameters from these devices: flow, pressure, temperature and totalizer. At the lowest baud rate (9600) each parameter takes about 30 milliseconds to fetch.

TIP: When experiencing issues with communication, disconnect all devices, and start connecting them back one at a time, until you find the sensor/ cable section causing the issue.

If you add more than 8 devices, the data cannot be retrieved within one second, causing gaps in the measurements. Pay also attention to the maximum power: The power supply in our VPVision M and remote IO modules is 24 VDC, 4 Amps. In the VPVision M unit, we have 3 Amps allocated to the sensors and IO modules. When starting up, 8 flowmeters can draw a peak current of  $8 * 0.3 = 2.4$  Amps.

## 3. Basic configuration

For proper communication between two devices (master and slave), they need to be 'on the same page'. When using a Modbus RS485 to Ethernet, the converter also needs to be 'on the same page' with the devices connected to it. When using different brand products, for example Modbus pressure sensors or third party flow meters, make sure that the baud rate is the same for all devices.

### 3.1. VPFlowScope

The VPFlowScope is flexible, it can be configured via VPStudio. You can change the following parameters: The bold printed parameters are factory default.

Baud rate : 9600, 19200, **38400**  
 Stop bits : **1**, 2  
 Parity : **none**, even, odd

TIP: When changing the parameters via VPStudio, remember that VPStudio will adapt itself to the new situation. If you take a next VPFlowScope out of the box, you need to set VPStudio back to factory default parameters to establish a connection.

### 3.2. Modbus RS485 to Ethernet converters

The converter has a built-in webpage. You can surf to that page, and make the changes in the configuration. The configuration is identical to our factory default settings. So you only have to change these rate when there is another brand sensor in the box.

## 4. Protocol & modpoll

The VPFlowScope Modbus commands can be found in the user manual. Did you know that you can also write some parameters via Modbus? This enables third party software to communicate with the VPFlowScope on a deeper level. You can set the diameter, change 4 ... 20 mA settings and reset the totalizer.

### 4.1. Protocol

Each meter has a hardware/ modbus address. This address must be unique: each device in the daisy chain has it's own. By default, the address is 9. The data is available in 2 formats: floating point and integer. The function code we use is 3, this is for reading out "holding registers". The length parameter is always "2". This means you can read out one register at a time. And the data is in little endian mode. See the user manual for full details.

### 4.2. Modpoll

If you want to test commands, we recommend modpoll.exe. It is a little program that can simulate a Modbus master. We placed it in the downloads section of our website, together with some examples, for Modbus TCP and Modbus RS485. A quick overview of the commands we use:

TIP: Modpoll -h provides help on the entire command set.

```
-m          : the protocol mode (RTU or encapsulated over TCP)
-a          : the device address
-r          : the register (in this case it's m/sec)
-t4:float   : the data type (floating point)
-b38400     : the baud rate
-p          : parity or port (depending on which protocol you are using)
-s          : stop bits
COM1       : at the end of the line: the COM port number or IP address
RS485 example: (direct connected to your laptop via a JB5 kit, make sure to close VPStudio first)
Modpoll -m rtu -a 9 -r 25 -t4:float -b 34800 -p none -s 1 COM1
```

```
Modbus via TCP/IP using a serial to Ethernet converter (for example using the Atop SE5001)
Modpoll -m enc -a 9 -r 25 -t4:float -p 4660 192.168.1.5
```

## 5. Termination and polarization

The RS485 specification says termination is required. This is true for very long networks and/or very high baud rates. Otherwise you may skip it.

Line bias (or polarization) is generally required for proper operation. This is because when the transmitter is switched into transmit mode on an unbiased idle line, the turn-on will look like a start

of character to the receiving UART and cause character errors that might not be recovered in time to catch the actual start of character.

Bias is created by placing a pullup resistor to +5V on the Data B (NET+) line, and a pulldown resistor to ground on the Data A (NET-) line. The resistor value depends on the actual bias voltage, the desired bias voltage and the number of devices on the line. The bias voltage must be such that 200mV differential between the A and B lines is maintained when the line is idle.

The Modbus protocol specification says line termination may be 150 ohms, and line bias resistors must be between 450 and 650 ohms if used.

### 5.1. Junction boxes for your convenience

To make installation of VPVision projects easy, we integrated the bias resistors in our Modbus Junction boxes (part number VPA.5030.020) and optimized the resistor value for an RS485 network with up to 8 VPFlowScopes.

! Important: Line bias (polarization) must be placed at only one location on the network, and does not have to be at the end of the network. Termination must be at each end of the network.



#### 5.1.1. Keep the stubs short

It is also important that “stubs” or taps (the cables between the individual VPFlowScope and each junction box) to be very short. The network must be wired in daisy chain style. The stubs are branches off the main network used to connect devices. Keep stubs or taps under 1 meter in length.

Length of network permitted depends on baud rate, wire gauge, and number of devices on the network (or load on network, including bias and termination). As an example, at 9600 baud with AWG26 wire, termination and bias, and 4 devices, the maximum length is 1000 meters according to the Modbus specification for serial line implementation. Other references are going to indicate somewhat different maximum lengths, but 1000 meters is still going to be a reasonable approximation.

## 6. Further reading:

This tech note would become a book when we would describe all aspects of Modbus. For a complete instruction on the Modbus standard, we refer you to [www.modbus.org](http://www.modbus.org).