

TITAN ROUTER

Application Note 71

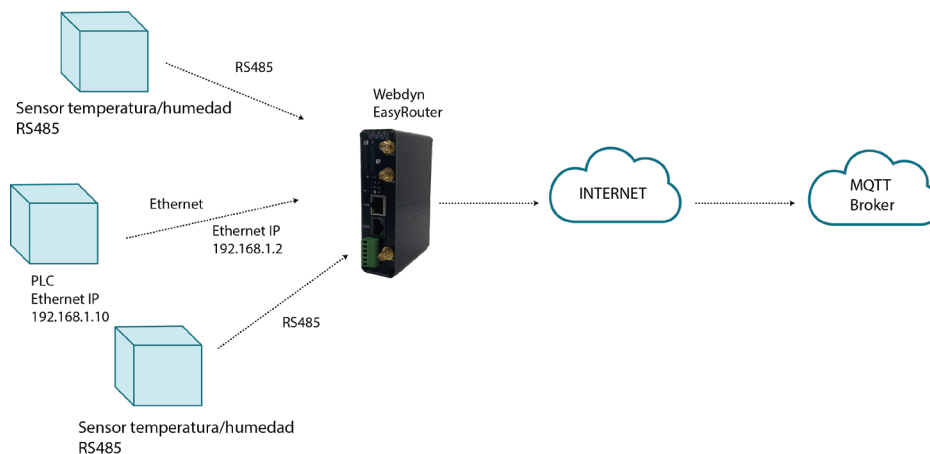
Reading Modbus devices using the
advanced Modbus-Expert feature

1. Scenario Details

TITAN routers offer all the typical functionalities of 4G/3G/2G routers, as well as a series of added features that make them one of the most advanced routers on the market. One of these additional features is their ability to read Modbus protocol devices. Using the Modbus-Expert function of the Titan router, complex templates can be defined for reading devices, sending telemetry and facilitating interaction between them.

2. Description of the Scenario in the Example

- A Webdyn-Easy-Router device (hereinafter referred to as the Titan router) is connected to the Internet via a SIM card.
- The Titan router will have 3 devices connected: two Modbus RTU temperature and humidity sensors (connected via RS485) and a Modbus ETH PLC (connected via Ethernet cable).
- The Titan router must continuously read two temperature and humidity sensors. When it detects a temperature above 30 °C, it must write a “1” to a specific register in the PLC. When the temperature drops below 29 °C, you must write a “0”. In addition, the Titan router must send the average temperatures and humidities from both sensors every 15 minutes to a web platform via the MQTT protocol.



3. Description of the Modbus registers of the devices

The memory map would look like this. For the two temperature/humidity sensors, which are the same, the memory map is as follows:

| Register | Date | Command | Register type | Comments |
|----------|-------------|---------|---------------|--|
| 30000 | Temperature | 3 | Int16 | Example. A value of 325 indicates a temperature of 32.5 °C |
| 30001 | Humidity | 3 | Int16 | Example. A value of 607 indicates a humidity of 60.7% |

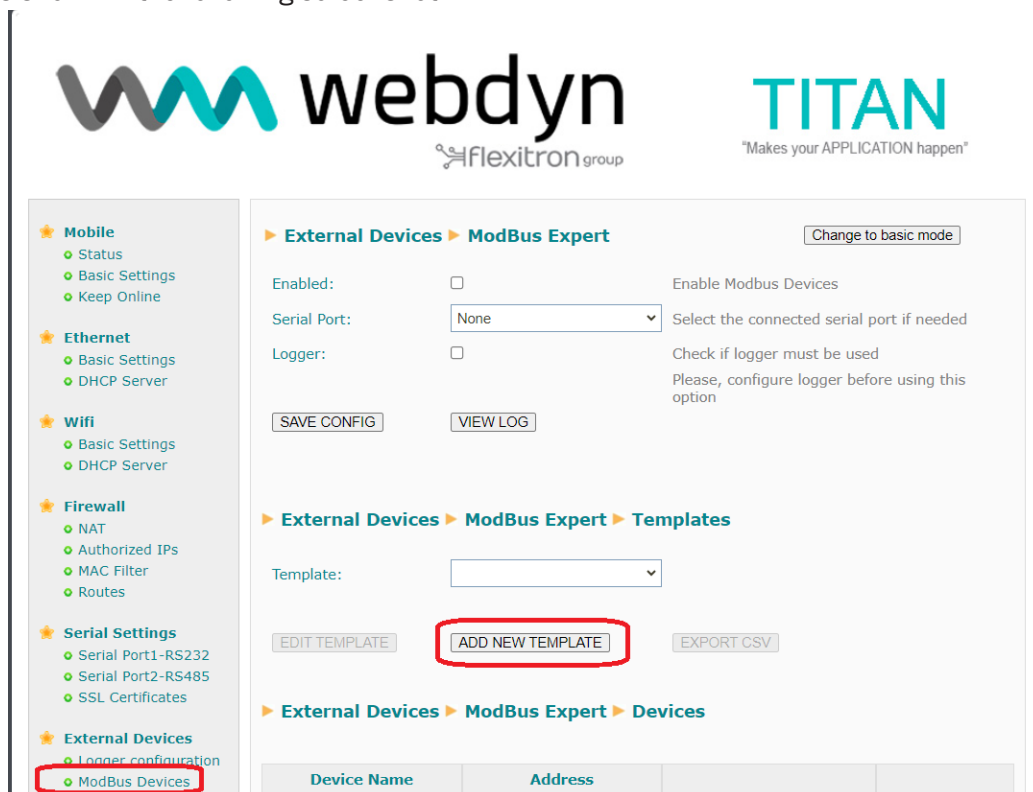
The memory map of the PLC where “1” must be written in the case of exceeding 30 °C or “0” if it falls below 29 °C:

| Register | Date | Command | Register type | Comments |
|----------|----------------|---------|---------------|--|
| 10000 | Fan 1 | 1 | Bit | Register to be written according to the temperature read by sensor 1 |
| 10001 | Fan 2 | 1 | Bit | Register to be written according to the temperature read by sensor 2 |
| 42122 | Supply voltage | 3 | Float | PLC supply voltage |

4. Creating device templates

As we are going to install 2 temperature/humidity sensors, and in anticipation of including more of the same devices in the future, it is a good idea to create a Modbus device template. That way, every time we want to introduce an additional temperature/humidity device into the scenario, the creation will be much faster.

To create a template, access the menu “Other -> Modbus Devices” and click on the “ADD NEW TEMPLATE” button, as shown in the following screenshot:



Once in that section, the make and model of the device in question must be entered and the table of registers completed according to the specifications indicated in the table above.

External Devices ▶ ModBus Expert ▶ Template

Brand: Template brand

Model: Template model

File: modbust-0.csv Select v[x] range: 0 - 49

| v[x] | register | type | flip | com. | name | units | mode |
|------|---------------|--------|---------|-----------------|-------------|---------|----------|
| 0 | 30000 | Int16 | No | 3 | Temperature | Celsius | Average |
| | Period factor | 1 | Script: | return v[0]/10; | | | |
| 1 | 30001 | Int16 | No | 3 | Humidity | % | Average |
| | Period factor | 1 | Script: | return v[1]/10; | | | |
| 2 | | UInt16 | No | 3 | | | Not used |
| | Period factor | 1 | Script: | | | | |
| 3 | | UInt16 | No | 3 | | | Not used |
| | Period factor | 1 | Script: | | | | |
| 4 | | UInt16 | No | 3 | | | Not used |

Register “30000”: the address of the Modbus register where the temperature is located.

Type “Int16”: The data type provided by the sensor, in this case, is a 16-bit integer. The sensor will return the temperature in the range of -200 to 900 (-20.0 °C to +90.0 °C).

Flip “no”: No word or byte exchanges are necessary in this case.

Com “3”: The Modbus command to be used for reading is 0x03.

Name “temperature”: Optional. The name of the register to be included in the JSON sent with the data to the MQTT platform.

Unit “celsius”: Optional. The name of the units to be included when sending the JSON with the data to the MQTT platform.

Script: Optional. Since the sensor returns data in integer format (no decimals), but you want to send the data to the platform in decimal format, each register must be divided by 10. Therefore, in the script, we indicate:

```
return v[0]/10;
```

where v[0] obviously indicates that it refers to the register v[0].

- NAT
- Authorized IPs
- MAC Filter
- Routes

- Serial Settings
 - Serial Port1-RS232
 - Serial Port2-RS485
 - SSL Certificates

File: modbus-0.csv
Select v[x] range: 0 - 49

| v[x] | register | type | flip | com. | name | units | mode |
|------|---------------|-------|---------|-----------------|-------------|---------|---------|
| 0 | 30000 | Int16 | No | 3 | Temperature | Celsius | Average |
| | Period factor | 1 | Script: | return v[0]/10; | | | |
| 1 | 30001 | Int16 | No | 3 | Humidity | % | Average |
| | Period factor | 1 | Script: | return v[1]/10; | | | |

5. Creating the Modbus devices

The three Modbus devices involved in the scenario must now be created: the two sensors and a PLC. Since there is only one PLC, the device will be created directly without the need to create a template for it. To start creating the sensors, in the main Modbus Expert screen, select the template to be used and click on the ADD NEW DEVICE FROM TEMPLATE button.

- Firewall
 - NAT
 - Authorized IPs
 - MAC Filter
 - Routes
- Serial Settings
 - Serial Port1-RS232
 - Serial Port2-RS485
 - SSL Certificates
- External Devices
 - Logger configuration
 - ModBus Devices
 - Generic Serial Device
 - Temperature Sensor
 - IEC102 Meter
 - GPS Receiver

External Devices > ModBus Expert > Templates

Template: ExpertSensor - STH_11778

EDIT TEMPLATE ADD NEW TEMPLATE EXPORT CSV

External Devices > ModBus Expert > Devices

| Device Name | Address |
|------------------|---|
| Device template: | ExpertSensor - STH_11778 ADD NEW DEVICE FROM TEMPLATE |

Once on the new screen, the rest of the data must be filled in:

- Mobile
 - Status
 - Basic Settings
 - Keep Online
- Ethernet
 - Basic Settings
 - DHCP Server
- Wifi
 - Basic Settings
 - DHCP Server
- Firewall
 - NAT
 - Authorized IPs
 - MAC Filter
 - Routes
- Serial Settings
 - Serial Port1-RS232
 - Serial Port2-RS485
 - SSL Certificates
- External Devices
 - Logger configuration
 - ModBus Devices

External Devices > ModBus Expert > Device

Name: Device1 Device Name

Template Brand: ExpertSensor From original template (non-editable)

Template Model: STH_11778 From original template (non-editable)

Address: 1 RTU or IP@ID:PORT

Period: 15 Data will be saved each period (minutes)

SAVE DEVICE DELETE DEVICE RETURN TO MODBUS PAGE

File: modbusd-0.csv
Select v[x] range: 0 - 49

| v[x] | register | type | flip | com. | name | units | mode |
|------|---------------|--------|---------|--|-------------|---------|----------|
| 0 | 30000 | Int16 | No | 3 | Temperature | Celsius | Average |
| | Period factor | 1 | Script: | if (v[0]>=300) mtm.modbusTCPSetBit(192.168.1.10,502,5,10); | | | |
| 1 | 30001 | Int16 | No | 3 | Humidity | % | Average |
| | Period factor | 1 | Script: | return v[1]/10; | | | |
| 2 | | UInt16 | No | 3 | | | Not used |

Enter the device name (e.g. Device1), the Modbus RTU address (1) and the base time interval at which you want to send the read registers to the platform (every 15 minutes).

It is important to note that the v[0] register script has also been modified. In the script, it must be added that, in case the register read is ≥ 300 (30 degrees), a 1 is written to PLC register 10000. If the register is ≤ 290 (29 degrees), then a 0 must be written. Therefore, the script introduced is as follows:

```
if (v[0] $\geq$ 300)

    mtx.modbusTCPSetBit(192.168.1.10,502,5,10000,1);

else if (v[0] $\leq$ 290)

    mtx.modbusTCPSetBit(192.168.1.10,502,5,10000,0);

return v[0]/10;
```

For the second temperature/humidity sensor, exactly the same should be done.

External Devices > ModBus Expert > Templates

Template: ExpertSensor - STH_11778

EDIT TEMPLATE ADD NEW TEMPLATE EXPORT CSV

External Devices > ModBus Expert > Devices

| Device Name | Address | |
|-------------|---------|-------------|
| Device1 | 1 | EDIT DEVICE |

Device template: ExpertSensor - STH_11778 ADD NEW DEVICE FROM TEMPLATE

Although the script is slightly different in this case.

External Devices > ModBus Expert > Device

Name: Device2 Device Name

Template Brand: ExpertSensor From original template (non-editable)

Template Model: STH_11778 From original template (non-editable)

Address: 2 RTU or IP@ID:PORT

Period: 15 Data will be saved each period (minutes)

SAVE DEVICE DELETE DEVICE RETURN TO MODBUS PAGE

File: modbusd-1.csv Select v[x] range: 0 - 49

| v[x] | register | type | flip | com. | name | units | mode |
|---|----------|-------|------|------|-------------|---------|---------|
| 0 | 30000 | Int16 | No | 3 | Temperature | Celsius | Average |
| Period factor 1 Script: if (v[0] \geq 300) mtx.modbusTCPSetBit(192.168.1.10,502,5,10000,1); | | | | | | | |
| 1 | 30001 | Int16 | No | 3 | Humidity | % | Average |

For this second sensor, the device must write to register 10001 instead of register 10000, i.e. this is the difference from sensor 1.

```
if (v[0]>=300)
```

```
    mtx.modbusTCPSetBit(192.168.1.10,502,5,10001,1);
```

```
else if (v[0]<=290)
```

```
    mtx.modbusTCPSetBit(192.168.1.10,502,5,10001,0);
```

```
return v[0]/10;
```

For the PLC, as there is only 1 unit, it can be created without using a template.

Serial Settings

- Serial Port1-RS232
- Serial Port2-RS485
- SSL Certificates

External Devices

- Logger configuration
- ModBus Devices**
- Generic Serial Device
- Temperature Sensor
- IEC102 Meter
- GPS Receiver

VPN

- IPSec

EDIT TEMPLATE ADD NEW TEMPLATE EXPORT CSV

External Devices ▶ ModBus Expert ▶ Devices

| Device Name | Address | |
|-------------|---------|-------------|
| Device1 | 1 | EDIT DEVICE |
| Device2 | 2 | EDIT DEVICE |

Device template: No template ADD NEW DEVICE FROM TEMPLATE

Indicate “PLC” as the name. As for the address, since this is a Modbus TCP device, indicate “192.168.1.10@1:502” (the PLC uses ID 1). The register submission period shall also be set at 15 minutes.

External Devices ▶ ModBus Expert ▶ Device

Name: PLC Device Name

Template Brand: From original template (non-editable)

Template Model: From original template (non-editable)

Address: 192.168.1.10@1:502 RTU or IP:ID:PORT

Period: 15 Data will be saved each period (minutes)

SAVE DEVICE DELETE DEVICE RETURN TO MODBUS PAGE

File: modbusd-2.csv Select v[x] range: 0 - 49

| v[x] | register | type | flip | com. | name | units | mode |
|------|---------------|--------|---------|------|-------|-------|----------|
| 0 | 32122 | Float | No | 3 | Power | V | Instant |
| | Period factor | 1 | Script: | | | | |
| 1 | | UInt16 | No | 3 | | | Not used |
| | Period factor | 1 | Script: | | | | |

The PLC directly returns the value of its supply voltage in “float” format in register “32122”, so in this case we will not use a conversion script.

Returning to the main Modbus devices screen, the serial port to be used by the Modbus Expert service must be selected. In this case, the RS485 serial port (Serial Port 2) is being used and the Logger will also be activated, as it is intended to send the data to an MQTT platform.

webdyn flexitron group **TITAN** "Makes your APPLICATION happen"

Mobile

- Status
- Basic Settings
- Keep Online

Ethernet

- Basic Settings
- DHCP Server

Wifi

- Basic Settings
- DHCP Server

Firewall

- NAT
- Authorized IPs
- MAC Filter
- Routes

Serial Settings

- Serial Port1-RS232
- Serial Port2-RS485
- SSL Certificates

External Devices

- Logger configuration
- ModBus Devices**
- Generic Serial Device
- Temperature Sensor
- IEC102 Meter
- GPS Receiver

External Devices > ModBus Expert Change to basic mode

Enabled: ☒ Enable Modbus Devices
Serial Port: Serial Port 2 Select the connected serial port if needed
Logger: ☒ Check if logger must be used
SAVE CONFIG VIEW LOG Please, configure logger before using this option

External Devices > ModBus Expert > Templates

Template: ExpertSensor - STH_11778
EDIT TEMPLATE ADD NEW TEMPLATE EXPORT CSV

External Devices > ModBus Expert > Devices

| Device Name | Address | |
|-------------|--------------------|--------------------------|
| Device1 | 1 | EDIT DEVICE |
| Device2 | 2 | EDIT DEVICE |
| PLC | 192.168.1.10@1:502 | EDIT DEVICE |

6. Configuring the RS485 serial port

In the previous screen, Serial Port 2 (RS485 port) was selected as the serial port to be used with the Modbus Expert service. In this section, we will configure it. To do this, go to the menu “Serial Settings> Serial Port2-RS485”.

The serial port speed in this scenario will be 9600 baud, with 8 data bits, no parity (N), and 1 stop bit (1).

Mobile

- Status
- Basic Settings
- Keep Online

Ethernet

- Basic Settings
- DHCP Server

Wifi

- Basic Settings
- DHCP Server

Firewall

- NAT
- Authorized IPs
- MAC Filter
- Routes

Serial Settings

- Serial Port1-RS232
- Serial Port2-RS485**

Serial Gateway > Com2 Settings

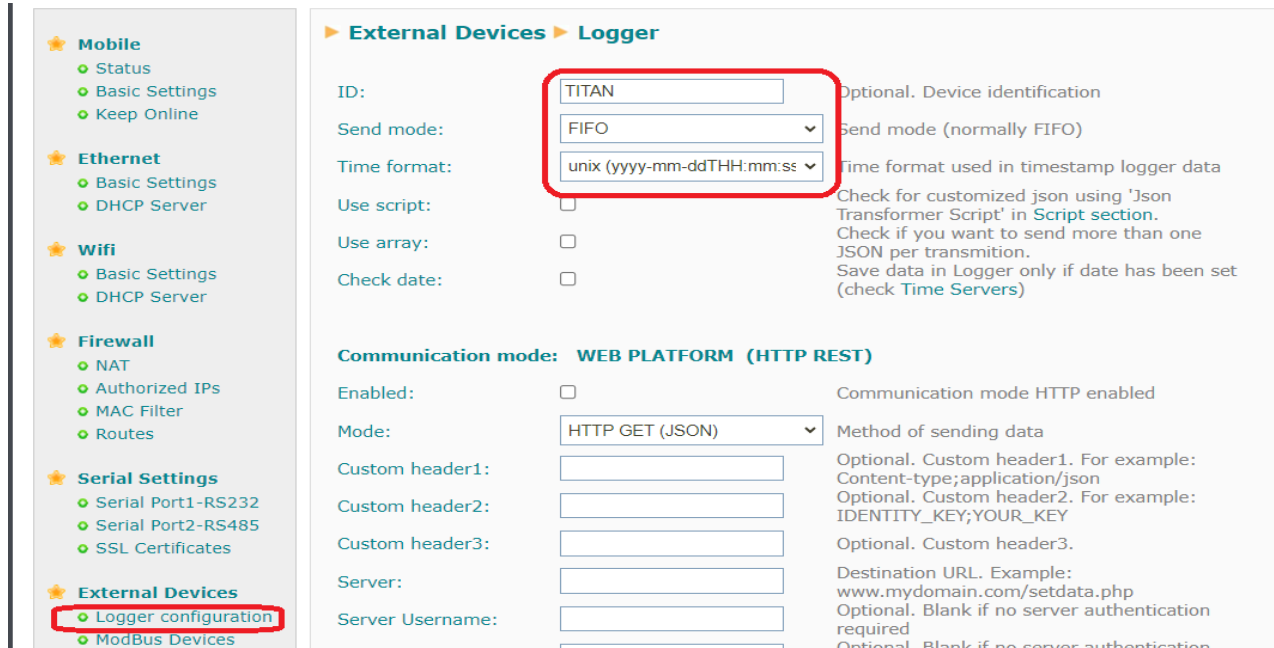
Baudrate: 9600 Baudrate of serial port
Data bits: 8 Number of data bit
Parity: none Parity
Stop bits: 1 Number of stop bits
Timeout ms: 50 msec without serial data before sending (default: 50)

☐ Allow local embedded AT commands Ex.: <MTXTUNNEL>AT</MTXTUNNEL>
☐ Allow remote embedded AT commands Ex.: <MTXTUNNELR>AT</MTXTUNNELR>
☐ Allow incoming GSM call (CSD Data Call) Only TCP Server and TCP Client functions or Nothing. 2G (CSD) network required.

☒ Function: Nothing or used by External Device or Script

7. Configuring the datalogger

The Logger section must also be configured, as we want the router to read the Modbus registers autonomously and, every 15 minutes, these are sent to an MQTT platform. The Logger is configured in the menu 'External Devices -> Logger Configuration'.



External Devices > Logger

ID: Optional. Device identification

Send mode: Send mode (normally FIFO)

Time format: Time format used in timestamp logger data

Use script: ☐ Check for customized json using 'Json Transformer Script' in **Script** section.

Use array: ☐ Check if you want to send more than one JSON per transmission.

Check date: ☐ Save data in Logger only if date has been set (check **Time Servers**)

Communication mode: WEB PLATFORM (HTTP REST)

Enabled: ☐ Communication mode HTTP enabled

Mode: Method of sending data

Custom header1: Optional. Custom header1. For example: Content-type;application/json

Custom header2: Optional. Custom header2. For example: IDENTITY_KEY;YOUR_KEY

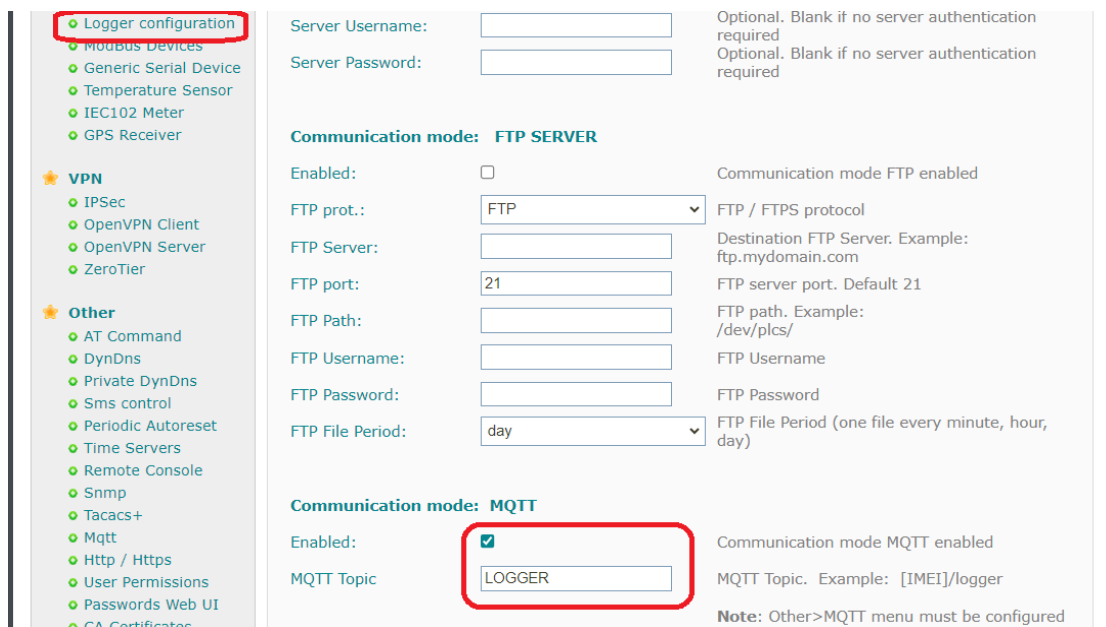
Custom header3: Optional. Custom header3.

Server: Destination URL. Example: www.mydomain.com/setdata.php

Server Username: Optional. Blank if no server authentication required

Optional. Blank if no server authentication required

At the bottom of the same screen, the MQTT topic to which the data will be sent must be indicated. In this example, the topic with the text 'LOGGER' will be used.



Logger configuration

Server Username: Optional. Blank if no server authentication required

Server Password: Optional. Blank if no server authentication required

Communication mode: FTP SERVER

Enabled: ☐ Communication mode FTP enabled

FTP prot.: FTP / FTPS protocol

FTP Server: Destination FTP Server. Example: ftp.mydomain.com

FTP port: FTP server port. Default 21

FTP Path: FTP path. Example: /dev/plcs/

FTP Username: FTP Username

FTP Password: FTP Password

FTP File Period: FTP File Period (one file every minute, hour, day)

Communication mode: MQTT

Enabled: ☒ Communication mode MQTT enabled

MQTT Topic: MQTT Topic. Example: [IMEI]/logger

Note: Other>MQTT menu must be configured

Press the "SAVE CONFIG" button to save the Logger configuration.

8. MQTT Configuration

As the data will be sent to an MQTT broker, the connection to said broker needs to be configured beforehand. Configuration is done via the menu 'Other > MQTT'. In this case, the basic data is being configured.

Firewall

- NAT
- Authorized IPs
- MAC Filter
- Routes

Serial Settings

- Serial Port1-RS232
- Serial Port2-RS485
- SSL Certificates

External Devices

- Logger configuration
- ModBus Devices
- Generic Serial Device
- Temperature Sensor
- IEC102 Meter
- GPS Receiver

VPN

Other > MQTT Client

Enabled: ☒ Enable MQTT client

MQTT Broker:

MQTT Username: MQTT Username (blank if not used)

MQTT Password: MQTT Password (blank if not used)

MQTT ID: Device identification

MQTT Qos: MQTT Quality Of Service (0 ... 2)

MQTT Keepalive: Seconds for keepalive (30 ... 3600)

MQTT Persistence: ☐ Data persistence

At the end of the configuration, press the "SAVE CONFIG" button to save the MQTT configuration

9. Configuring the NTP time server

The Modbus registers read by the Titan router shall be stored in the internal datalogger and a timestamp with the router's own time will be added. It is therefore interesting to configure a time server so that the Titan router's time will always be correct and consequently the timestamp will also be correct. The time servers are configured from the configuration menu: "Other > Time servers"

Mobile

- Status
- Basic Settings
- Keep Online

Ethernet

- Basic Settings
- DHCP Server

Wifi

- Basic Settings
- DHCP Server

Firewall

- NAT
- Authorized IPs
- MAC Filter
- Routes

Other > Time Servers (NTP)

Enabled: ☒ Enable NTP

NTP Server 1: IP or DNS address

NTP Server 1 port: UDP port. Default 123

NTP Server 2: IP or DNS address

NTP Server 2 port: UDP port. Default 123

Time zone: Select the timezone

Current Time: 02-10-2023 16:10:43 Current date & time of the system

SAVE CONFIG

When configuration is complete, press the "SAVE CONFIG" button to save the configuration.

10. Configuring the Mobile Section

Finally, the “Mobile” section must be configured (in the menu “Mobile -> Basic Settings”), where the parameters of the SIM card(s) to be used by the Titan router will be specified. In this example, only SIM number 1 will be used. Once configuration of this section is complete, as usual, click on the “SAVE CONFIG” button.

Mobile Basic Settings

Mobile WAN: Enabled (IP active) Enable Wireless WAN interface

Sim Mode: SIM1 Sim selection

SIM1 APN: movistar.es SIM Card 1 APN

SIM1 Username: MOVISTAR SIM Card 1 username

SIM1 Password: SIM Card 1 password

SIM1 Pin: SIM Card 1 PIN

SIM1 Auth: Auto (PAP or CHAP) SIM card 1 authentication

11. Testing the example

Finally, all that remains is to reboot the Titan router to get the new configuration up and running. The reboot can be carried out via the menu ‘Other -> Reboot’. After reboot, the Modbus Expert configuration page can be accessed in the menu ‘External Devices -> Modbus Devices’. The best way to verify that everything is working correctly is to click on the ‘VIEW LOG’ button.

webdyn flexitron group **TITAN** "Makes your APPLICATION happen"

External Devices ModBus Expert Change to basic mode

Enabled: ☒ Enable Modbus Devices

Serial Port: Serial Port 2 Select the connected serial port if needed

Logger: ☒ Check if logger must be used
Please, configure logger before using this option

SAVE CONFIG **VIEW LOG**

External Devices ModBus Expert Templates

Template: ExpertSensor - STH_11778

EDIT TEMPLATE ADD NEW TEMPLATE EXPORT CSV

External Devices ModBus Expert Devices

In the log screen, the query/response Modbus frames can be seen.

The screenshot shows the webdyn TITAN interface. The sidebar on the left contains navigation links for Mobile, Ethernet, Wifi, Firewall, Serial Settings, and External Devices. The main content area is titled 'Z-Other Log Modbus Expert' and displays a log of Modbus frames. The log entries show timestamps (e.g., 03/10/2023 11:35:34) and the direction of the frame (sent or received) along with the hex data. At the bottom of the log area, there are buttons for 'REFRESH LOG' and 'RETURN TO MODBUS PAGE'.

Also, if everything is correct, the MQTT frames arriving at the Topic Logger can be verified, as shown in the following example:

The screenshot shows the MQTT interface. The 'Connection' status is 'connected'. The 'Publish' section has a 'Topic' field, a 'QoS' dropdown set to '0', and a 'Retain' checkbox. The 'Subscriptions' section shows a subscription to the 'LOGGER' topic. The 'Messages' section displays a list of received MQTT messages. Each message entry includes a timestamp (e.g., 2023-10-03 13:37:03), the topic (e.g., 'LOGGER'), the QoS (e.g., '1'), and the payload (e.g., '{"IMEI":"865583042283167","TYPE":"MODB2","TS":"2023-10-03T11:37:00Z","P":"TITAN","ID":"Device2","A":"2","data":{"R":"30000","V":"30.0","N":"Temperature","M":"3","U":"Celsius","S":"OK"},{"R":"30001","V":"40.0","N":"Humidity","M":"3","U":"%","S":"OK"}}').

The description of the JSON would be as follows:

```
{ "IMEI": "865583042283167", "TYPE": "MODB2", "TS": "2023-10-03T11:46:00Z", "P": "TITAN", "ID": "Device2", "A": "2", "data": [{ "R": 30000, "V": "30.0", "N": "Temperature", "M": "3", "U": "Celsius", "S": "OK" }, { "R": 30001, "V": "40.0", "N": "Humidity", "M": "3", "U": "%", "S": "OK" } ] }
```

Where:

IMEI: the router's IMEI

TYPE: type of frame

TS: timestamp of the time the Modbus register was read.

P: "ID" field of the "Logger" configuration section

ID: "ID" field of the Modbus device section

A: Modbus address of the device

R: Register address

V: Register value

N: Register name

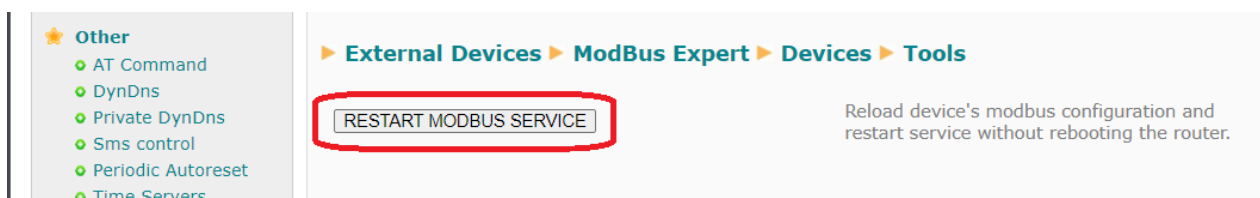
M: Register mode (2: instantaneous value, 3: average value, 4: max value, 5: min value)

U: Units

S: Reading status (OK: correct reading, ERR: incorrect reading)

12. Other considerations

a) If the register configuration of any Modbus device needs to be changed or modified at any time, the Titan router does not need to be completely rebooted for it to take the new configuration. Simply press the "RESTART MODBUS SERVICE" button. This action will reload the configuration of all devices and restart the Modbus Expert service (if it was already started).



b) If you need to disable reading of any Modbus device (e.g. due to malfunction or to facilitate the correct operation of other devices in a more agile way), just enter a “0” in its “Address” change.

External Devices > ModBus Expert > Device

Name: Device Name

Template Brand: From original template (non-editable)

Template Model: From original template (non-editable)

Address: RTU or IP@ID:PORT

Period: Data will be saved each period (minutes)

Any questions?

Please direct your enquiries to iotsupport@mtxm2m.com