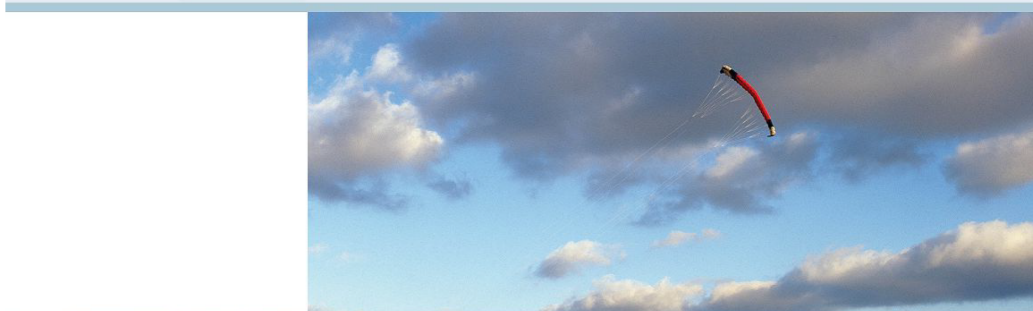


TAC5

TAC5 + MODBUS TCP/IP

Installation and user's manual



 **P.LEMMENS**
AIR MOVEMENT COMPANY



TAC5 + MODBUS TCP/IP

Installation and user's manual

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1 Overview

1.1 Scope

TAC5 DG regulations for HRglobal/HRup/HRflat fans units, DT for HRtotal, DM for HRmural, TAC5 SC for single flow COMPO and TAC5 F for control of one or two fans (forward or backward).

The MODBUS TCP/IP communication with the TAC5 regulation boards requires an additional satellite circuit being used as interface of communication:

- SAT WIFI option:
 - Remote control with specific Lemmens App for tablet and smartphone.
 - Enables MODBUS TCP/IP protocol on wireless Wi-Fi network.

- SAT ETHERNET option:
 - Remote control with specific Lemmens App for tablet and smartphone (with a Wi-Fi router/bridge to Ethernet).
 - Enables MODBUS TCP/IP protocol on Ethernet over twisted pair 10 BASE T/100Base-TX IEEE 802.3 network.

The features of each TAC5 regulation are plainly explained in their specific user manual (MI Regulation TAC5 DG + RC, MI Regulation TAC5 DT + RC, MI Regulation TAC5 DM and MI Regulation TAC5 F).

1.2 Plugging the satellite module

The assembly must be carried out with the power OFF. The satellite module must be plugged on the « SAT MODBUS » plug of the TAC5 regulation board.

Caution: A bad positioning of the satellite module on circuit TAC5 can fatally damage both circuits!

The following figure shows the installation of SAT ETHERNET and SAT WIFI on TAC5 control boards.

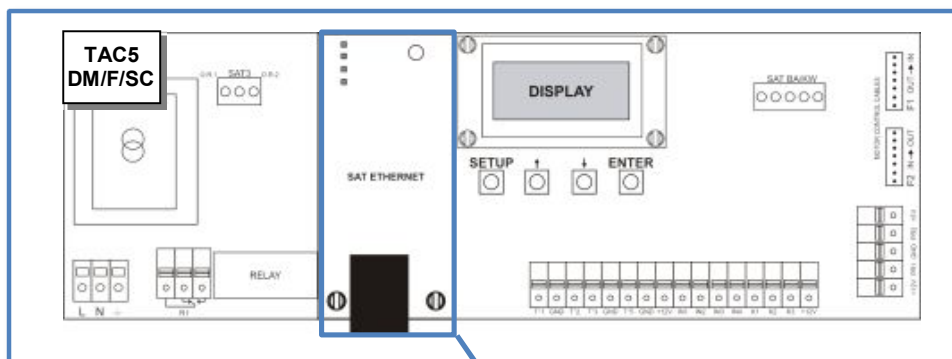


Figure 1 - Installation of SAT ETHERNET on TAC5 DM or TAC5 F or TAC5 SC circuit

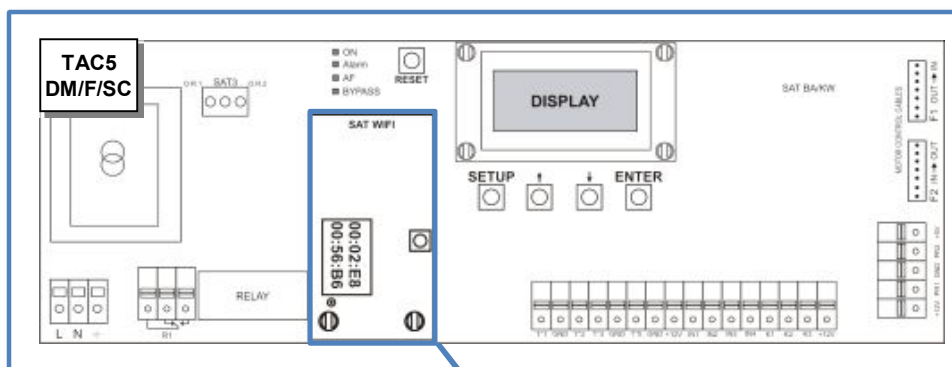


Figure 2 - Installation of SAT WIFI on TAC5 DM or TAC5 F or TAC5 SC circuit

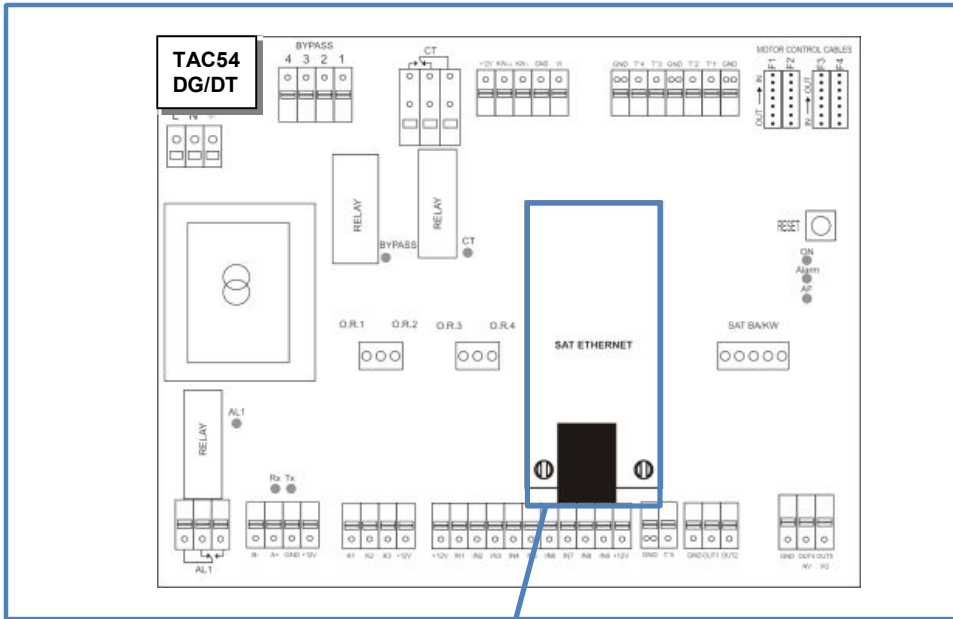


Figure 3 - Installation of SAT ETHERNET on TAC5 DG or TAC5 DT circuit

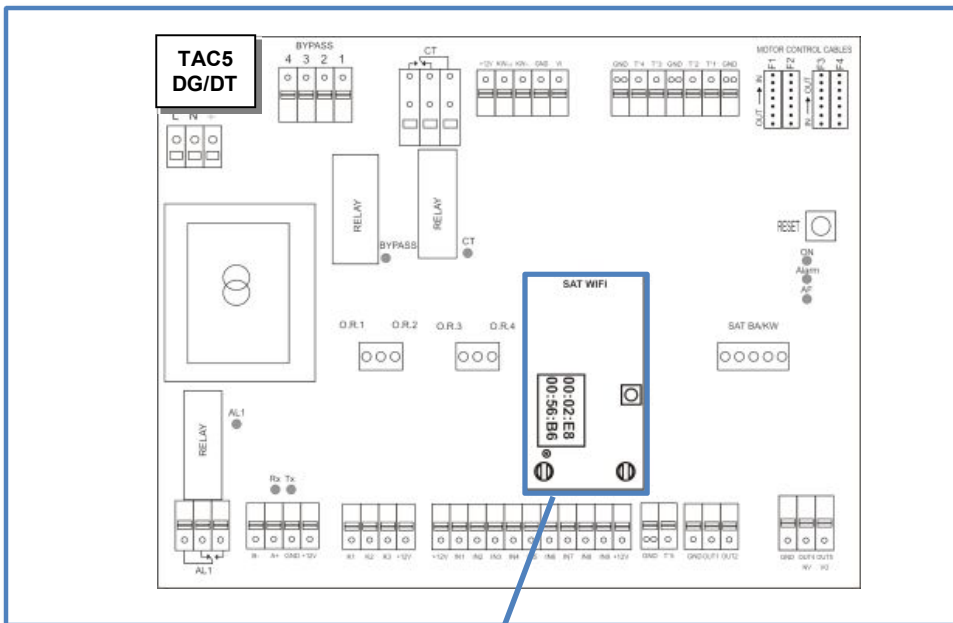


Figure 4 - Installation of SAT WIFI on TAC5 DG or TAC5 DT circuit

1.3 Connections of the SATELLITE MODULES

1.3.1 SAT ETHERNET connection

The SAT Ethernet can be connected either to an existing local area network (LAN, see figure 5), or directly to a PC in a Point-to-point link (see figure 6).

Just plug the Ethernet cable into the RJ45 connector on SAT ETHERNET and, only for Point-to-point connection with a PC, connect the other extremity of the cable to the Ethernet network adapter of the PC.

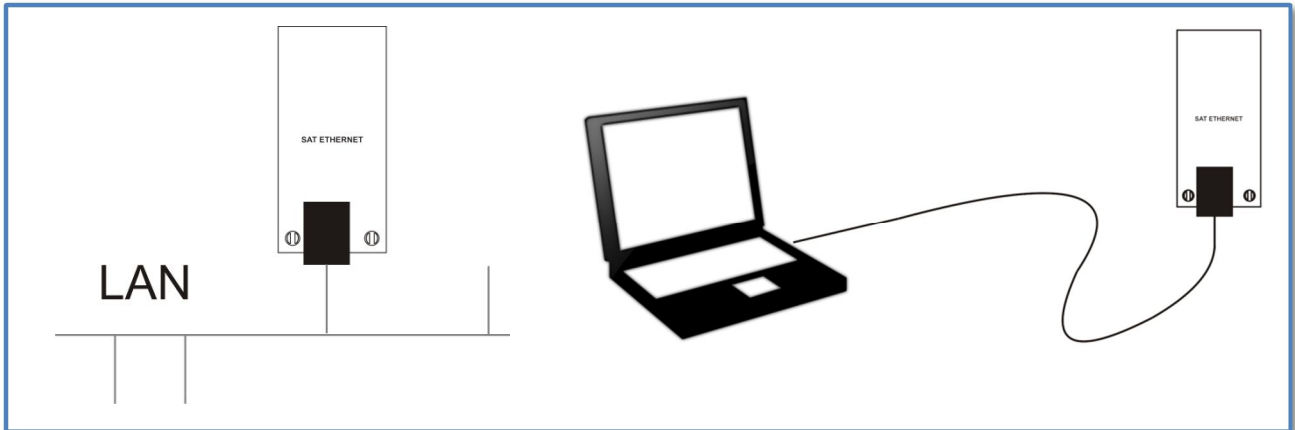


Figure 5 - SAT ETHERNET connection in a LAN

Figure 6 - SAT ETHERNET Point-to-point connection with a PC

Cable Specifications:

- Ethernet cable, UTP category 5, 5e or 6 with RJ45 male connectors (figure 7).
- Maximal length = 100m.

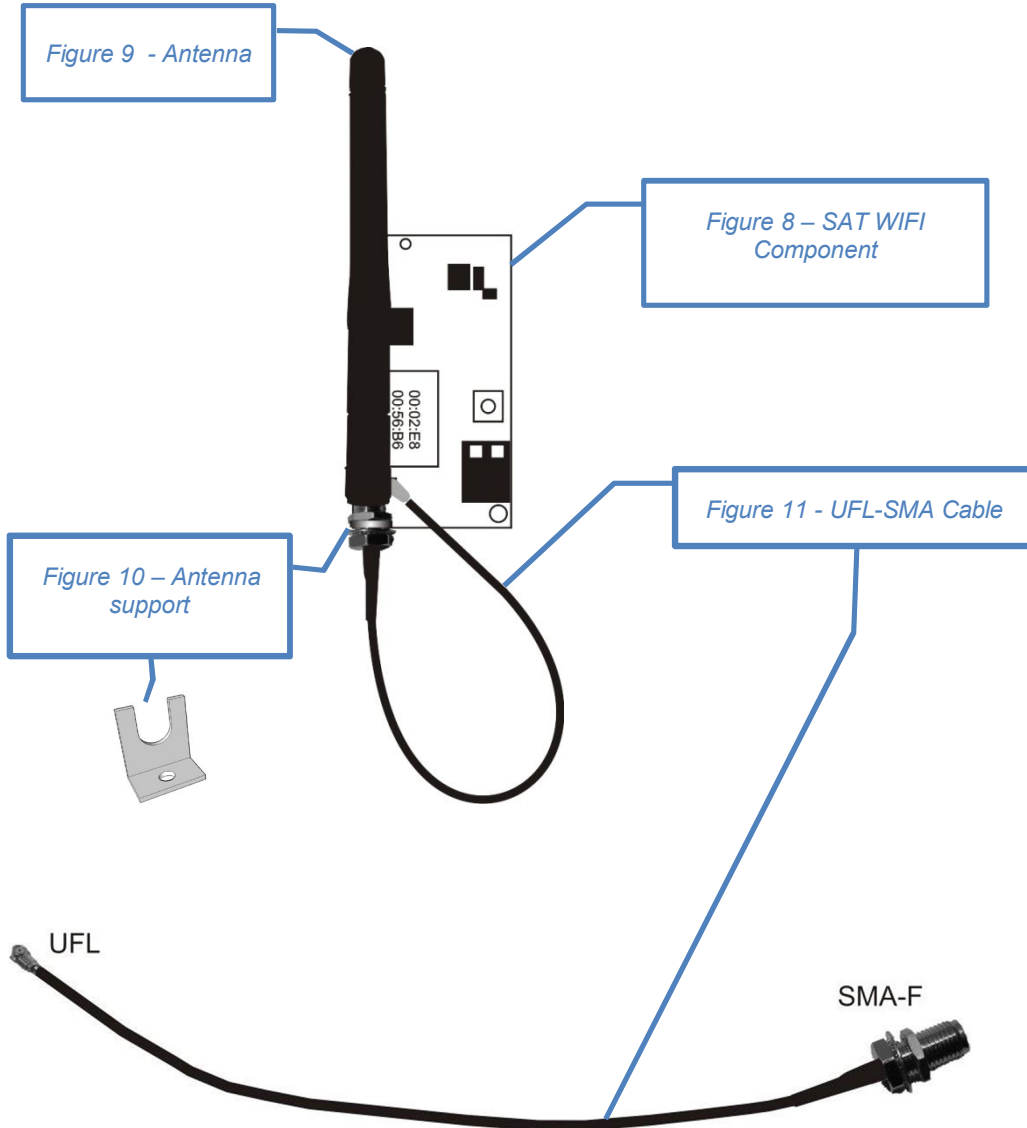


Figure 7 - Example of UTP category 5 cable with RJ45 male connectors

1.3.2 SAT WIFI connection

The SAT WIFI comes preassembled and no additional wiring is necessary. It includes:

- 1 SAT WIFI component with a label reporting its unique MAC address (6x2 digits) and UFL male connector (figure 9)
- 1 metallic support for the antenna (figure 11).
- 1 antenna with SMA male connector (figure 8)
- 1 UFL female-SMA female antenna cable to connect the SAT WIFI component to the antenna (figure 10)



2 Definition of the MODBUS TCP/IP communication

2.1 MODBUS TCP/IP Protocol

The TAC5 controllers use the communication protocol MODBUS TCP/IP in one server, the satellite board, to multiple clients (maximum 3) architecture. The server is addressed by the client thanks to its IP address and communication port number which is 502.

Each message has the same structure: the frame is made of the transaction identifier, protocol identifier, length field, unit identifier, the function code (writing or reading) and the data bytes.

Main specifications:

- MODBUS TCP/IP protocol
- Physical layer:
 - o Ethernet over twisted pair 10 BASE T for SAT ETHERNET,
 - o Compatible Wi-Fi 802.11b/g/n for SAT WIFI.

2.2 MODBUS TCP/IP frame

The MODBUS frame is presented in the following way:

Transaction identifier	Protocol identifier	Length field	unit identifier	Function code	Data
2 bytes	2 bytes	2 bytes	1 bytes	1 byte	N bytes

Transaction identifier: Used for synchronization between messages of server and client

Protocol identifier: Always 0 for Modbus TCP/IP

Length field: Number of remaining bytes in this frame

Unit identifier: This is the Modbus address of the SAT module device. 1 must be used and only this address will be accepted since the SAT ETHERNET and WIFI are not Modbus TCP/IP bridges to Modbus RTU.

Function code:

- Supports function code 3 (decimal) for reading multiple holding registers.
- Supports function code 6 (decimal) for writing a single holding registers.
- Supports function code 16 (decimal) for writing multiple holding registers.

Data: All TAC5 data is in 16-bit modbus holding registers. Modbus coils, discrete inputs or input registers are not used. The modbus communication buffers size is sufficient for reading 125 registers at once or writing 123 registers at once.

In the Modbus.org standard documents, holding register addresses are given a prefix of "4" to distinguish them from other register types. For example, in their documentation a holding register at address 1001 is referred to by "41001". However, the leading "4" is not really part of the address. Also, the Modbus.org standard documents refer to register addresses using "one-based" numbering. However, the addresses that are actually sent in a Modbus command message are "zero-based". For example, to read register 1001, the address that is actually sent in the command message is 1000.

2.3 MODBUS exception

The TAC5 modbus protocol may respond with an exception code if the read or write command was invalid. Possible exceptions are:

- 01 ILLEGAL FUNCTION: The function code received in the query is not an allowable action for the slave.
- 02 ILLEGAL DATA ADDRESS: The data address received in the query is not an allowable address for the slave. Or the combination of data address and transfer length is not allowable.
- 03 ILLEGAL DATA VALUE: The master attempted to write a non-allowed value into a register. Which values are allowed may depend on configuration settings of other registers.

When a write of multiple registers is executed, the execution stops at the first invalid data address or invalid value.

2.4 MODBUS values

All values are signed values.

As usual, all modbus words are in big endian byte order.

Some registers act as bitmaps with 16 status bits.

Some values are 32-bit. They are transferred as two 16-bit registers, first low word, and then high word.

When reading, the client must combine two 16-bit words into one 32-bit value. With shift:

$Val32 = (((long)HIGH) \ll 16) | LOW$. With math: $Val32 = HIGH * 65536 + LOW$. For example: Reg1=33041, Reg2=13: Val32=885009.

When writing a 32-bit parameter, the server first buffers the low word. Then, when the high word is written, the 32-bit parameter is updated. This low-word buffer is shared for all 32-bit parameters.

2.5 Write cycles limitation

The controller stores all setup parameters and some control parameters in non-volatile EEPROM memory to protect against power failure. This EEPROM memory has an endurance of 100 000 write cycles. Therefore, these parameters should not be changed too often! Writing a parameter with the same value is not a change. Changing a parameter once per hour would result in 8760 writes per year or 100 000 writes in 11 years. Changing a setup parameter once per minute would result in 100 000 writes in only 69 days!

Those parameters are marked as "E1" in the MODBUS map.

Some parameters are stored in a non-volatile RAM memory. Those parameters have no writing limitation and their value is not lost in case of power break.

Those parameters are marked as "R" in the MODBUS map.

3 Setup

3.1 SAT ETHERNET SETUP

3.1.1 Configuration for LAN

The IP address of SAT ETHERNET has to be configured and can be either a static IP address or a dynamic address assigned by the DHCP server of the LAN to which the SAT is connected to. The netmask and gateway of the Ethernet network have also to be setup.

The setup is done through the advanced setup with the RC (Remote control) for TAC5 DT/DG control boards or with the integrated interface for TAC5 DM, SC, F.

Menu	Value
IP CNFG?	Select DHCP if the IP address of the unit is assigned dynamically, select MANUAL to enter a static IP address. Default is DHCP.
IP address? 1/4 xxx	If IP CNFG= MANUAL, enter the static IP address in 4 steps (1/4, 2/4, 3/4, 4/4). Example: if IP address is 193.100.0.23, enter at step 1:193, step 2:100, step 3:000 and step 4:023.
netmask? 1/4 xxx	If IP CNFG= MANUAL, enter the netmask (same principle as for ip address).
gateway? 1/4 xxx	If IP CNFG= MANUAL, enter the gateway (same principle as for ip address).

3.1.2 Configuration for point-to-point connection with a PC

- If the Ethernet network adapter of the PC has already a static address, no setting on the PC is necessary.
- If the Ethernet network adapter of the PC has not a static IP address, configure the address 192.168.1.2 and the subnet mask 255.255.255.0 as in the example of figure 12 with Windows 8 © operating system.

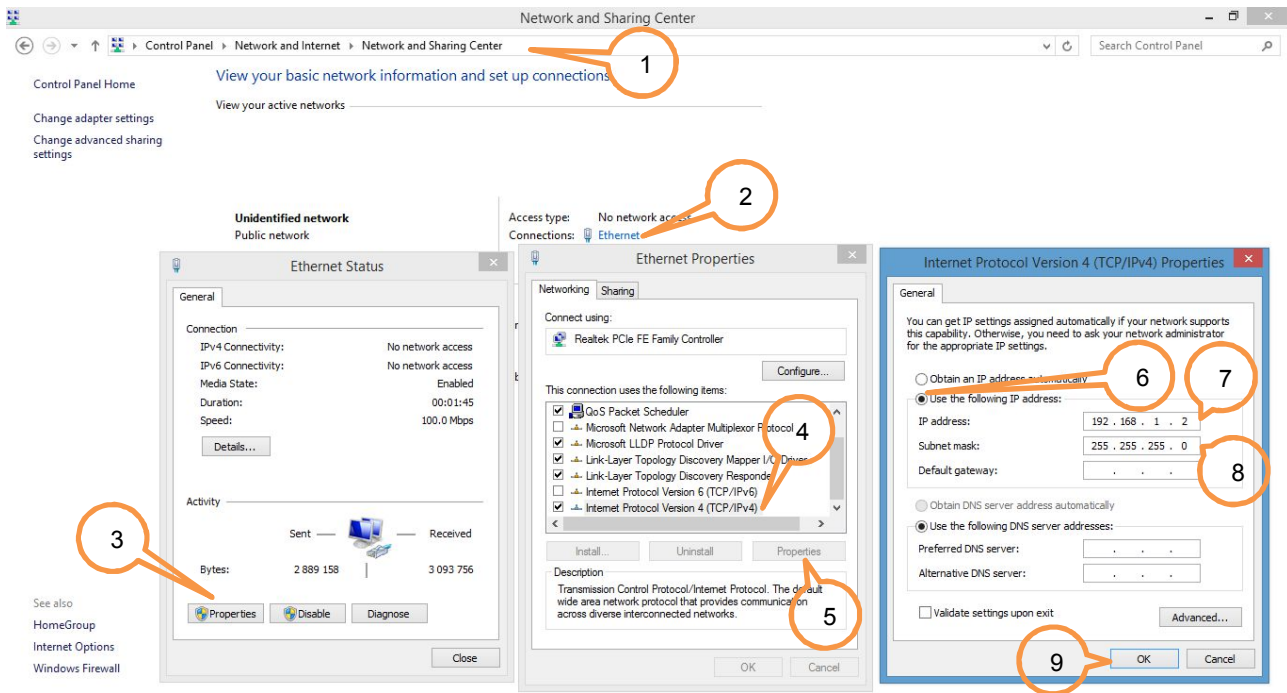


Figure 12 - Example of Static IP configuration on PC for poit-to-point connection

The IP address of SAT ETHERNET has to be configured with the same static IP address of the computer plus 1 added at the last part, so, if figure 12 example is considered, it would be 192.168.1.3.

The net mask will be the same as the one of the PC, with same example, it would be: 255.255.255.0.

The gateway is not used so 0.0.0.0.

The setup is done through the advanced setup with the RC (Remote control) for TAC5 DT/DG control boards or with the integrated interface for TAC5 DM, SC, F:

Menu	Value
IP CNFG?	Select MANUAL to enter a static IP address
IP address? 1/4 xxx	Enter the static IP address in 4 steps (1/4, 2/4, 3/4, 4/4). Example of figure 12: IP address is 192.168.1.3, enter at step 1:192, step 2:168, step 3:001 and step 4:003.
Netmask? 1/4 xxx	Enter the netmask in 4 steps (1/4, 2/4, 3/4, 4/4). Example of figure 12: netmask is 255.255.255.0, enter at step 1:255, step 2:255, step 3:255 and step 4:000.
Gateway? 1/4 xxx	Enter the gateway in 4 steps (1/4, 2/4, 3/4, 4/4). Example of figure 12: gateway is 0.0.0.0, enter at step 1:000, step 2:000, step 3:000 and step 4:000.

3.2 SAT WIFI SETUP

The SAT WIFI configuration is done through web pages provided by the SAT WIFI integrated web server. The SAT WIFI is by default access point (AP) of a Wi-Fi network and can be directly be used in this maneer without any configuration.

As AP, no pre-existing network is required because the SAT WIFI automatically creates its own network allowing up to 5 connections.

Alternatively, it can also be configured as station of another existing Wi-Fi network (which can be another SAT WIFI access point).

In order to access the web pages to perform the configuration, the reset button of the SAT WIFI must be pressed for 20 seconds. Then, the SAT WIFI will be by default an access point of a Wi-Fi network which SSID (Service Set Identifier) is composed by the prefix "SatWifi_" and a suffix which is the unique MAC address of the SAT WIFI reported on the sticker above the component.

Example: The sticker on the SAT WIFI reports "00:02:E8:00:56:B6", that is its MAC address, so the SAT WIFI will be the access point of the Wi-Fi network which SSID is "SatWifi_0002E80056B6". See figure 13:

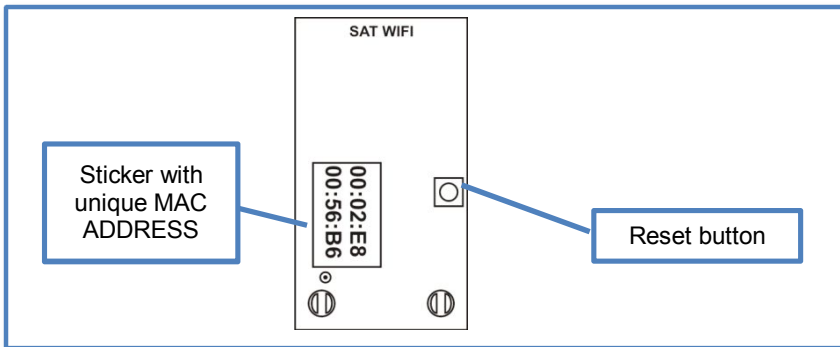


Figure 13 – Default SSID of SAT WIFI as access point

Connect to this Wi-Fi network with a pc, tablet or smartphone that has Wi-Fi access and navigate with a web browser to address <http://192.168.1.1/>. The home page will appear where the current configuration of the SAT WIFI is displayed:

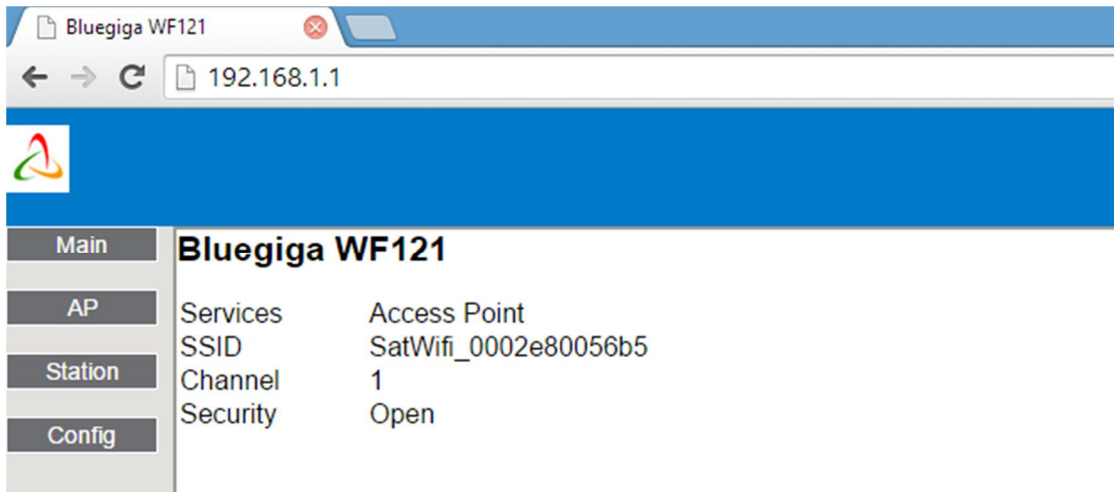


Figure 14 - SAT WIFI configuration Web Server - Home Page

3.2.1 Access Point Configuration

Press “AP” button in the left menu to configure the SAT WIFI as an access point:

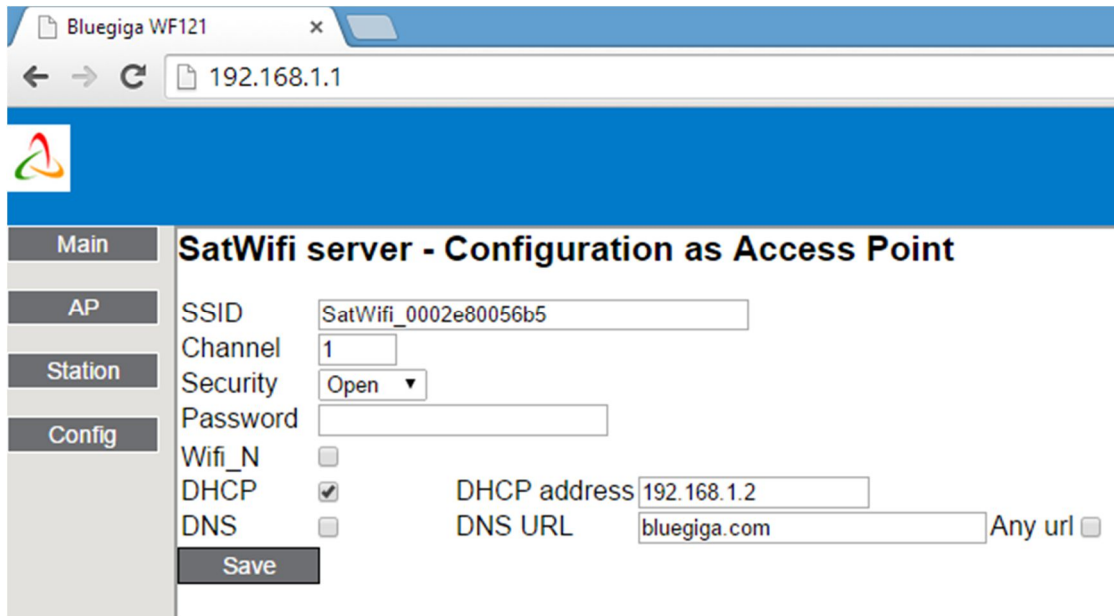


Figure 15 - SAT WIFI configuration Web Server - Access Point Configuration Page

It is recommended to choose “WPA2” in “Security” Field with a password with at least 8 characters and not more than 16. The other parameters should be change only by expert user. Press then the “SAVE” button.

3.2.2 Station Configuration

Press “Station” button in the left menu to configure the SAT WIFI as a station of an existing Access Point:

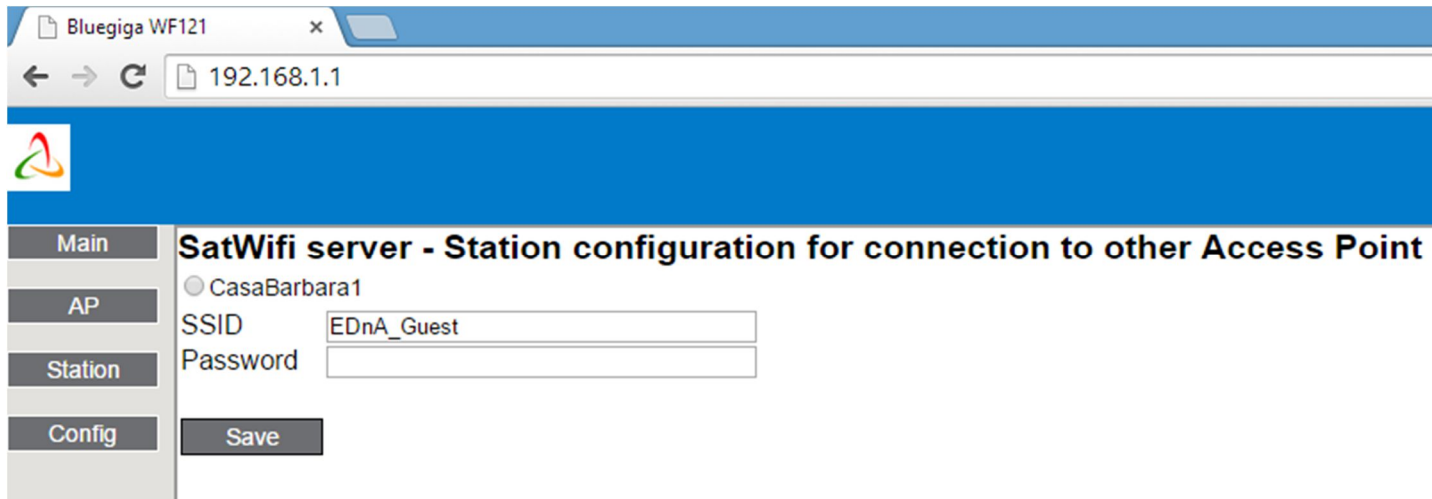


Figure 16 - SAT WIFI configuration Web Server - Station Configuration Page

Select in the top list the Wi-Fi network to which the SAT WIFI will connect to as station, the SSID text box will then be refreshed with the name of the selected Access Point. Insert the password for the connection to this Wi-Fi network. Press then the “SAVE” button.

3.2.3 TCP/IP Parameters Configuration

Press "Config" button in the left menu to configure the TCP/IP parameters of the SAT WIFI (both AP and station).

Figure 17 - SAT WIFI configuration Web Server - TCP/IP Configuration Page

- If the SAT WIFI is an Access Point, enter the parameters as in Figure 17.
- If the SAT WIFI is a station of a Wi-Fi network
 - o with DHCP server (dynamic IP address assignation), enter the value 0.0.0.0 for IP address, Netmask and gateway fields.
 - o without DHCP server, enter that value in the IP address field and also the netmask and gateway. These values should be provided by the local network administrator.

Press then the "SAVE" button.

Once the configuration is done, press "Reboot" button and wait 2 minutes. The changes will be applied after the reboot.

3.2.4 Connecting a client application to Access Point SAT WIFI

On the device where the client application runs, select the Wi-Fi network with the SSID of the SAT WIFI Access Point. The client should now be able to connect to the IP address configured at point 3.2.3 at port number 502 or, alternatively, to obtain automatically the IP addresses of all the SAT WIFI available on the network thanks to the «Discovery» feature (see point 4).

Under normal conditions, the signal quality should be good at 20 m from the unit. If the signal is not enough strong at a location from where the application would be normally used, one of the following solutions should strengthen the signal:

1. Use of an antenna extender 1,25 m length with a SMA-female connector that will be connected to the antenna and a SMA-male connector at the other extremity linked to the SMA-female connector of the UFL-SMA cable.
2. Use commercial Wi-Fi repeater.
3. A combination of the 2 solutions for very particular situation.

3.2.5 Connecting a client application to station SAT WIFI

The device where the client application runs must be connected to the same Wi-Fi network than the SAT WIFI. The client should now be able to connect to the IP address configured at point 3.2.3 at port number 502 or, alternatively, to obtain automatically the IP addresses of all the SAT WIFI available on the network thanks to the «Discovery» feature (see point 4).

If the unit is placed in a location from where the signal reception of the existing AP is not good enough, one of the following solutions should strengthen the signal that will arrive to the SAT WIFI:

1. Use of an antenna extender 1,25 m length with a SMA-female connector that will be connected to the antenna and a SMA-male connector at the other extremity linked to the SMA-female connector of the UFL-SMA cable.
2. Use commercial Wi-Fi repeater.
3. A combination of the 2 solutions for very particular situation.

4 “Discovery” Feature

This feature, available on the SAT ETHERNET as well as on the SAT WIFI, enables a client application to obtain automatically the IP addresses of all the SAT ETHERNET/SAT WIFI on the network. Then, just select the one to wish the access must be established even if the address is unknown at priori.

5 Remote Access

SAT Ethernet and SAT WIFI can be remote accessed provided that:

- They are connected to a router in their local area network (LAN). For the SAT WIFI, that implies that the router must have a Wi-Fi network and that the SAT WIFI must be configured as station of that Wi-Fi network (see point 3.2.2).
- Their IP addresses are static or, in DHCP network, to have reserved fixed IP addresses associated with their MAC addresses.
- a public IP address has been requested and supplied by the ISP (Internet Service Provider) of the access media (ADSL line, 3 or 4G mobile networks, optic fibre) to which the wide area network (WAN) connection of the router is linked to.
- For each SAT ETHERNET/WIFI, a port of this IP address is forwarded to the port 502 of its IP address thanks to the router configuration.
- The public IP address and these last ports are used to establish the connection with the SAT ETHERNET/WIFI.

6 Topologies

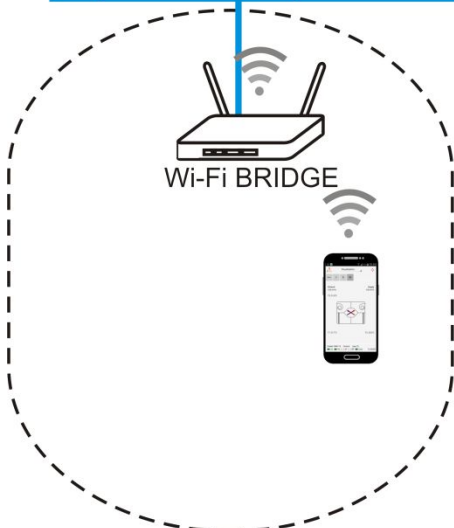
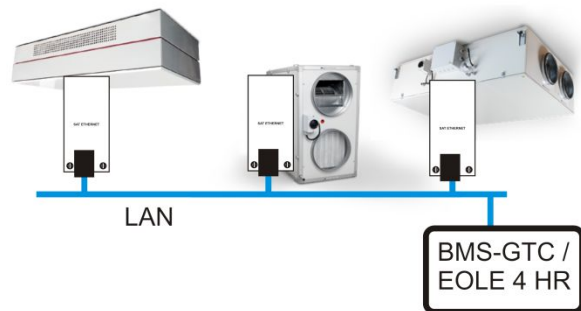
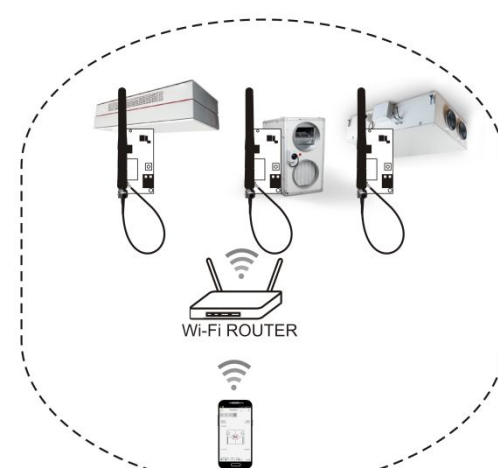
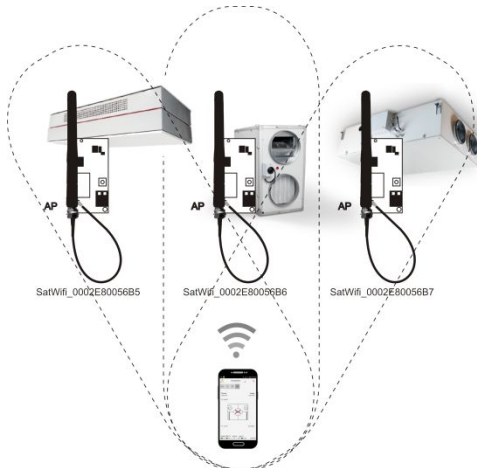
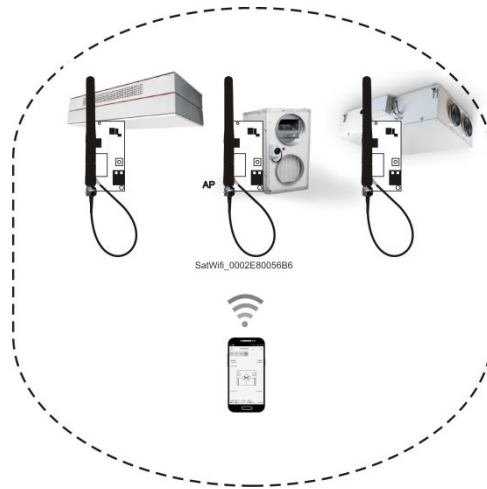
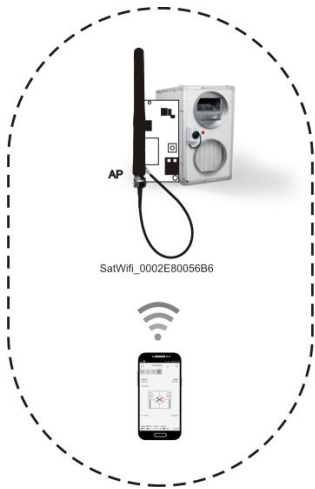
For information purposes, Appendix 1 offers a range of possible network topologies examples with different combinations of SAT WIFI and Ethernet.

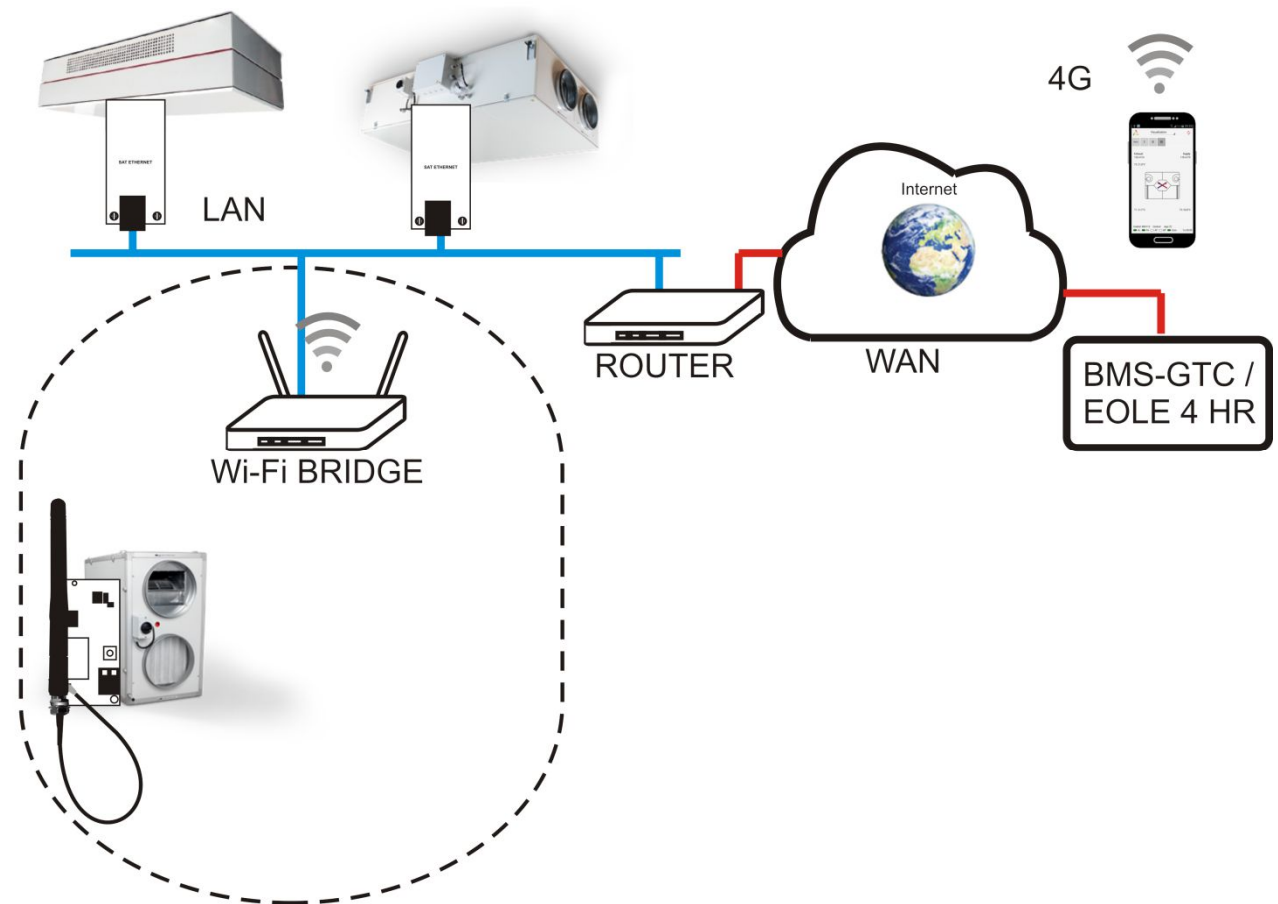
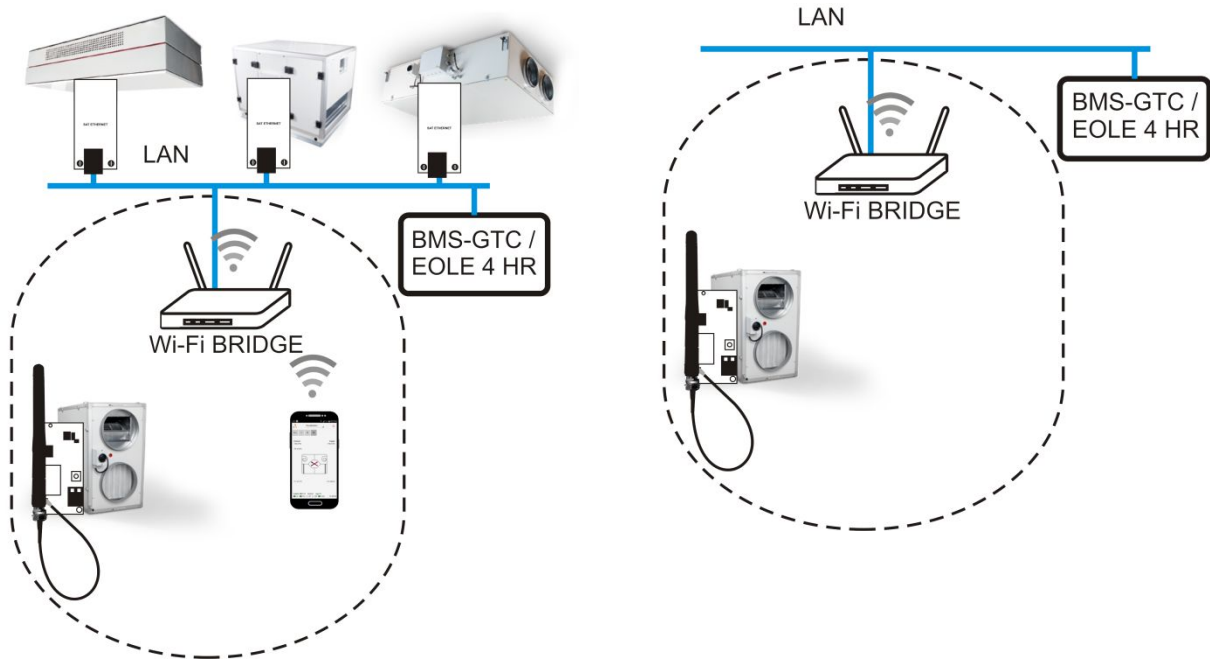
7 Modbus Registers

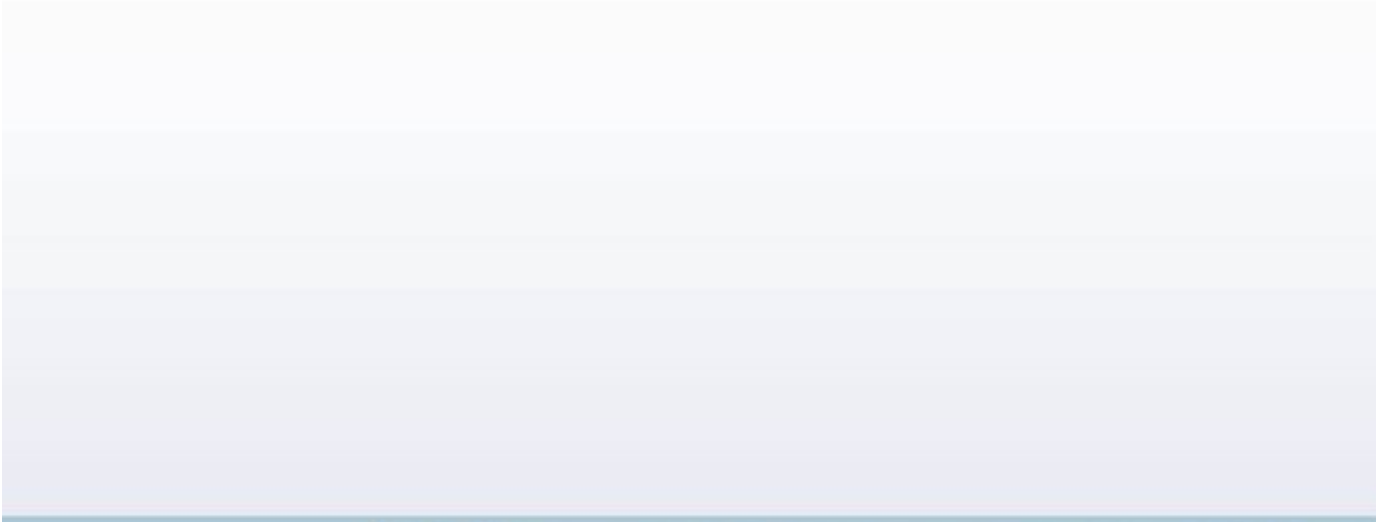
Please refer to documentation “MI Regulation TAC5 + MODBUS TABLE” for a complete and detailed description of the Modbus registers and their organization in tables.

Although we put a lot of care in the making of our documentation, we cannot be held responsible for any error and/or omissions that could have slipped in.

Appendix 1: examples of networking







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