IntesisBox® BACnet/IP Server

Modbus TCP Master

User's manual

Issue Date: 17/12/2012

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Gateway for the integration of Modbus TCP slave devices into BACnet/IP control systems.

Models available for this gateway, with their following **Order codes**:

IBOX-BAC-MBTCP-100
Tiny model with capacity of 110 internal datapoints.

IBOX-BAC-MBTCP-A
Basic model with capacity of 500 internal datapoints.

IBOX-BAC-MBTCP-B
Extended model with capacity of 3000 internal datapoints.

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1. Description

1.1 Introduction

This document describes the integration of Modbus TCP systems with BACnet ASHRAE 135 – 2001 Annex J - BACnet protocol compatible devices or systems using the gateway IntesisBox BACnet/IP Server - Modbus TCP Master.

This document assumes that the user is familiar with Modbus TCP and BACnet/IP technology and technical terms.

From now on, and with the aim of easy the read of this document, the words "gateway" or "IntesisBox" are used instead of IntesisBox BACnet/IP Server - Modbus TCP Master. Any other use of the word "gateway" not meaning IntesisBox BACnet/IP Server - Modbus TCP Master will be specifically indicated.

The aim of this integration is to make accessible Modbus TCP system signals and resources from a BACnet/IP based control system or device, as if it was a part of the own BACnet system and vice-versa. For this, the gateway acts as a BACnet/IP Server device in its BACnet interface, allowing other BACnet/IP devices to perform subscription (COV) requests, and also read and write its internal points. From the Modbus TCP system point of view, IntesisBox simulates a Modbus master device, the readings of the Modbus TCP slave device(s) is performed by IntesisBox by automatic continuous polling.

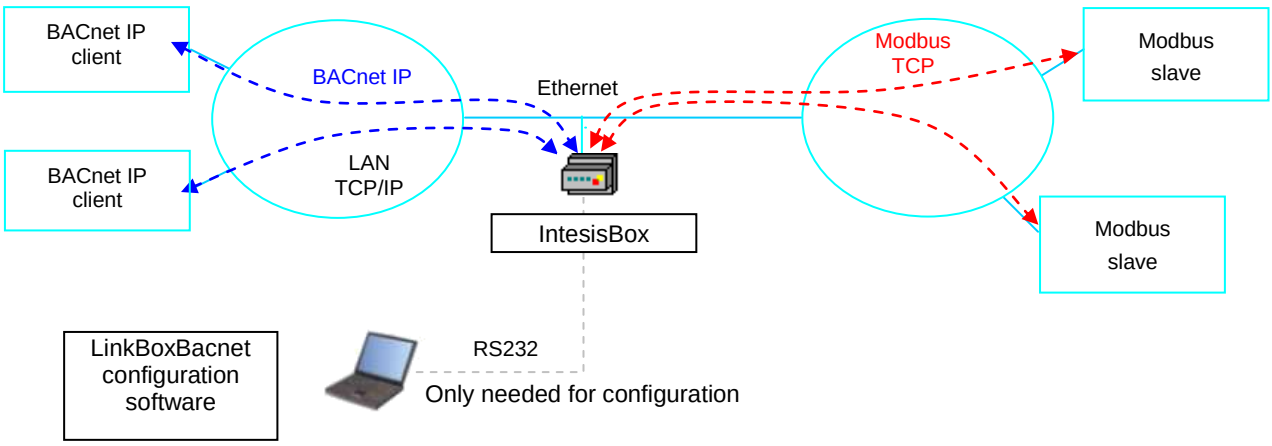


Figure 1.1 Integration of Modbus TCP and BACnet/IP using *IntesisBox BACnet/IP Server - Modbus TCP Master* gateway

1.2 Functionality

The integration operation is as follow:

From the Modbus TCP system point of view, after the start up process, IntesisBox reads continuously the points configured to be read in the Modbus TCP slave devices, and updates in its memory all the values received from the Modbus TCP system.

From the BACnet system point of view, after the start up process, the gateway listen for any subscription (COV) request, serves any polling request, or performs any writing request of its internal points received from BACnet system. The values received from BACnet are immediately written in the associated register of the corresponding Modbus TCP slave device.

Every one of the Modbus TCP registers in the slave devices is associated to a *BACnet object*, with this, all the Modbus TCP system (all the slave devices) is seen as *a single BACnet device with many objects* from the BACnet system point of view, each object corresponding to a Modbus TCP slave/register address.

When a new value is read from Modbus TCP for a given register, the new value is updated in the gateway's memory and, if this signal is associated to a BACnet active subscription then the new value will be sent to the subscripted BACnet device(s).

In the continuous polling of the Modbus TCP devices, if a non response of the Modbus TCP device is detected, the corresponding virtual signal inside IntesisBox will be activated indicating communication error with the Modbus TCP device. These virtual signals indicating communication status in real time with the Modbus TCP devices are also accessible from BACnet, like the rest of the points of IntesisBox.

1.3 Capacity of IntesisBox

Element	Tiny version	Basic version	Extended version	Notes
Type of BACnet devices				Only those supporting BACnet/IP.
Number of BACnet points	110	500	3000	Maximum number of points that can be defined in the virtual BACnet device inside the gateway.
Number of BACnet subscribers	8	8	8	Maximum number of BACnet subscribers accepted by the gateway.
Number of BACnet subscriptions (COV) requests	220	1000	6000	Maximum number of BACnet subscriptions (COV) requests accepted by the gateway.
Type of Modbus TCP slave devices				Those supporting Modbus TCP *protocol*. Communication over TCP/IP.
Number of Modbus TCP Slave devices	5	5	5	Number of Modbus TCP Slave devices supported by the device

There are different models of *IntesisBox BACnet/IP Server - Modbus TCP Master,* with different capacity every one of them.

- Tiny model with capacity of 110 internal data points.
  Ref.: IBOX-BAC-MBTCP-100.

- Basic model with capacity of 500 internal data points.
  Ref.: IBOX-BAC-MBTCP-A.

- Extended model with capacity of 3000 internal data points.
  Ref.: IBOX-BAC-MBTCP-B.

2. Interfaces

This section gives the reader an idea on how a Modbus TCP system/installation is integrated with IntesisBox BACnet. It is not meant to provide an in-depth explanation on how BACnet or Modbus TCP technology work as understanding the protocol principles is assumed throughout this document.

The IntesisBox behaves as a regular BACnet device inside the BACnet system integrating all the KNX devices. Note that each datapoint defined on IntesisBox will have two associated data types:

- One data-type, related to the BACnet/IP protocol of the IntesisBox
- And another data-type, related to Modbus TCP side of IntesisBox

Conversions of data values from Modbus TCP to BACnet/IP data-types (and vice versa) are internally performed at application level of IntesisBox, and keeping the highest possible level of precision, with the restrictions of the data-type itself. Further detail on behavior and data-types of the BACnet/IP and Modbus TCP interfaces of IntesisBox is given in the following sections.

All configuration of IntesisBox BACnet is done using software tool *LinkBoxBacnet*. This tool, covered in depth in section 5, is used to define the Modbus TCP and BACnet related parameters on each of the datapoints defined in IntesisBox.

2.1 BACnet

The IntesisBox integrates all the Modbus TCP devices in a single BACnet device. The communication with the other BACnet devices is done via the Ethernet port of the gateway which implements the BACnet ASHRAE 135 – 2001 Annex J - BACnet protocol.

The supported BACnet Objects and Building Blocks can be found in the PICS document available on the web:

http://www.intesis.com/pdf/IntesisBox_BACnet_IP_Server_Modbus_TCP_master_PICS.pdf

Configuration of all BACnet/IP parameters of IntesisBox and their links to Modbus TCP using LinkBoxBacnet software tool is covered in section 5.1.

2.2 Modbus TCP

Modbus TCP communication is characterised basically by the embedding of the Modbus RTU protocol into TCP/IP frames. This communication over TCP/IP allows faster communication and a longer distance between master and slave devices in comparison with RTU communication over serial line, and can use common TCP/IP infrastructure in buildings as well as communication over WAN or internet. It allows also the co-existence of one or more masters and of course one or more slave devices in a given network, all of them interconnected through a TCP/IP based network.

IntesisBox acts as master in the Modbus TCP network, and the other Modbus devices connected to the network communicating with IntesisBox must be always slave devices.

Up to 5 Modbus TCP slave devices can be defined in IntesisBox, to communicate with them.

For each point defined that belongs to a defined Modbus TCP slave device, a slave address from 0 to 255 can be also freely configured, this feature allows great flexibility, for example to integrate Modbus RTU slave devices connected in a serial line and with an RTU/TCP converter on top of this serial line, enabling the access to the RTU slaves' points through TCP/IP, in this case the RTU/TCP converter communicating in TCP identifies the destination of the point (slave address in the RTU network) by the contents of the slave address field.

Modbus TCP slave devices are characterised by their IP address, and their predefined *registers address map*, this address map specifies the address, type and characteristics of each internal point (commonly called *register*) of the Modbus slave device, these registers being accessible using Modbus TCP protocol.

Communication parameters of IntesisBox Modbus TCP interface (IP address, Net Mask, Default router address, and TCP port) are fully configurable to adapt to any IP network and slave device.

Modbus TCP protocol defines different types of function codes to use to read/write different type of registers that can be found in Modbus devices, and also different data formats to encode values.

Also the data encoding used for 16 bits registers (big-endian or little-endian) can be configured in IntesisBox Modbus interface. This is the byte order for data encoding (MSB..LSB or LSB..MSB). This data encoding, although is specified as big-endian in Modbus protocol specification, it varies depending on manufacturer/type of slave.

All this gives great flexibility to integrate a wide range of Modbus slave devices that can be found in the market.

3. Quick Setup

1. Install LinkBoxBacnet. Details in section 5
2. Install IntesisBox in the desired installation site (DIN rail mounting inside a metallic industrial cabinet connected to ground is recommended).
3. Power up and connect the communication cables. Details in section 4.
4. Open LinkBoxBacnet, open a project or create a new one. Details in section 5.
5. Connect to the IntesisBox (details in section 5).
6. (optional) Configure the IntesisBox. Details in section 5.1.
7. Check if there is communication in both BACnet and Modbus TCP buses (section 5)
8. The IntesisBox is ready to be used in your system.

4. Connection

The device uses a standard enclosure allowing DIN EN60715 TH35 rail mounting. Its plastic meets standard PC UL 94 V0.

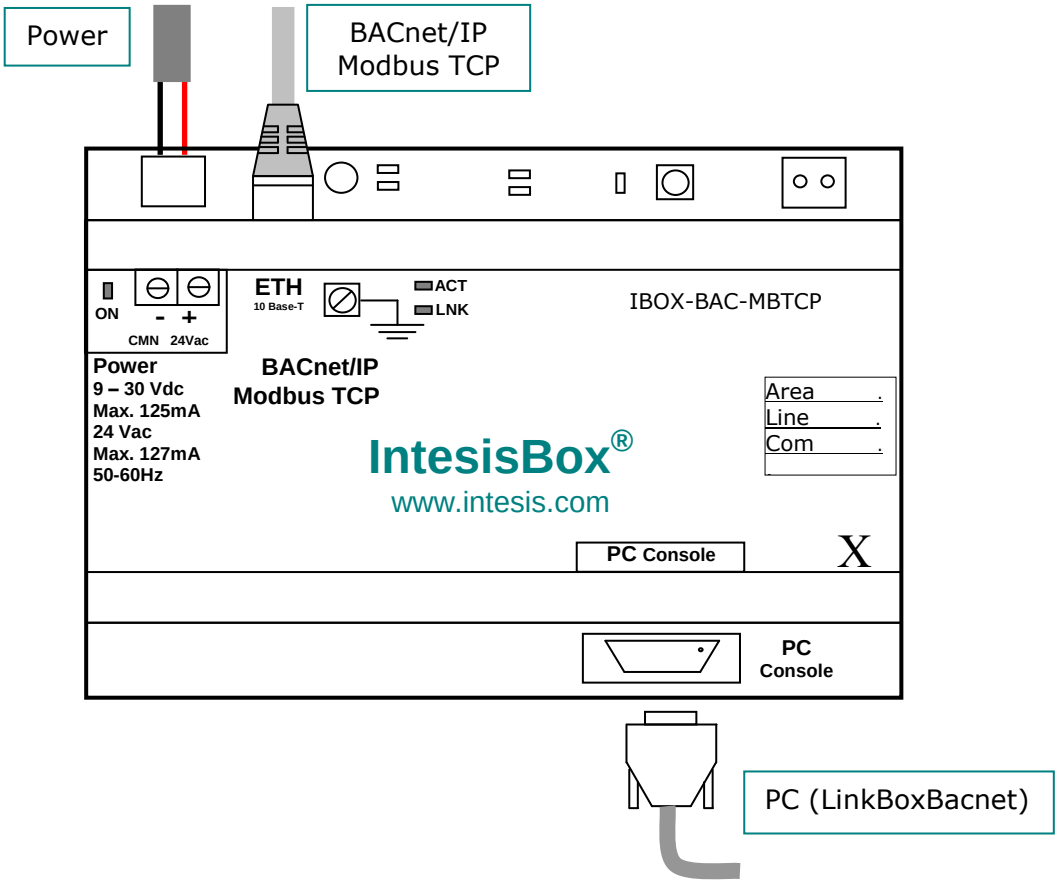


Figure 4.1 Device connection diagram

Ensure proper space for all connectors when mounted.

The items supplied by Intesis Software for this integration are:

- IntesisBox BACnet/IP Server - Modbus TCP Master hardware
- Console cable. Standard DB9F-DB9M cable 1.8 meter long.
- Installation sheet, containing a link to the LinkBoxBacnet software and this manual.

4.1 Power device

The first step to perform is to power up the device. To do so a power supply working with any of the voltage range allowed is needed (check section 6). Once connected the ON led (Figure 4.1) will turn on.

WARNING! In order to avoid earth loops that can damage the gateway and/or any other equipment connected to it, we strongly recommend:

- The use of DC power supplies, floating or with the negative terminal connected to earth. **Never use a DC power supply with the positive terminal connected to earth**.
- The use of AC power supplies only if they are floating and not powering any other device.

4.2 Connect to Modbus TCP

Connect the communication cable coming from the network hub or switch to the ETH port (Figure 4.1) of IntesisBox. The cable to be used depends on where the IntesisBox is being connected:

- Connecting directly to a Modbus TCP device: crossover Ethernet UTP/FTP CAT5 cable
- Connecting to a hub or switch of the LAN of the building: a straight Ethernet UTP/FTP CAT5 cable

How to check if there is communication with the Modbus TCP bus is explained in the LinkBoxBacnet Manual (section 5).

4.3 Connect to BACnet

Connect the communication cable coming from the network hub or switch to the ETH port (Figure 4.1) of IntesisBox. The cable to be used depends on where the IntesisBox is being connected:

- Connecting directly to a BACnet/IP device: crossover Ethernet UTP/FTP CAT5 cable
- Connecting to a hub or switch of the LAN of the building: a straight Ethernet UTP/FTP CAT5 cable

In case there is no response from the BACnet devices to the frames sent by IntesisBox, check that they are operative and reachable from the network connection used by IntesisBox. Check the IntesisBox Ethernet interface sending Pings to its IP address using a PC connected to the same Ethernet network.

4.4 Connect to PC (LinkBoxBacnet)

This action allows the user to have access to configuration and monitoring of the device (more information can be found in the LinkBoxBacnet User Manual [section 5]). Two methods to connect to the PC can be used:

- Ethernet: Using the ETH port (Figure 4.1) of IntesisBox. How to check connectivity is explained in section 4.3.
- Serial cable: To connect the device to the PC the serial cable supplied should be plugged to the PC console port (Figure 4.1).

  The cable is a RS-232 straight cable and its pinout is at explained in Table 4.1.

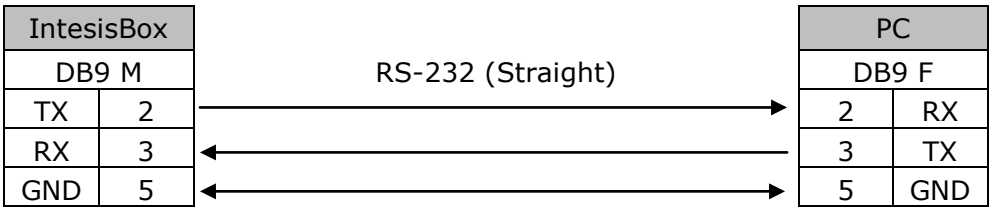


Table 4.1 Configuration serial cable pinout

5. LinkBoxBacnet. Configuration & monitoring of IntesisBox BACnet series

How to install and use the LinkBoxBacnet is explained in its Manual. It can be found in the installation folder (if the Software is already installed) or it can be downloaded from the link that can be found in the installation sheet supplied with the IntesisBox.

In this section only the specific project configuration for IntesisBox BACnet/IP Server - Modbus TCP Master is going to be explained.

The External Protocol in this IntesisBox is Modbus TCP

5.1 Project configuration

To configure the integration connection parameters, and the points list, click on *Config* in the *Button Bar (*Figure 5.1*).* The Modbus TCP *Configuration* window will be opened. For integrations with a large number of points an alternative CSV based configuration method is explained in the LinkBoxBacnet Manual.

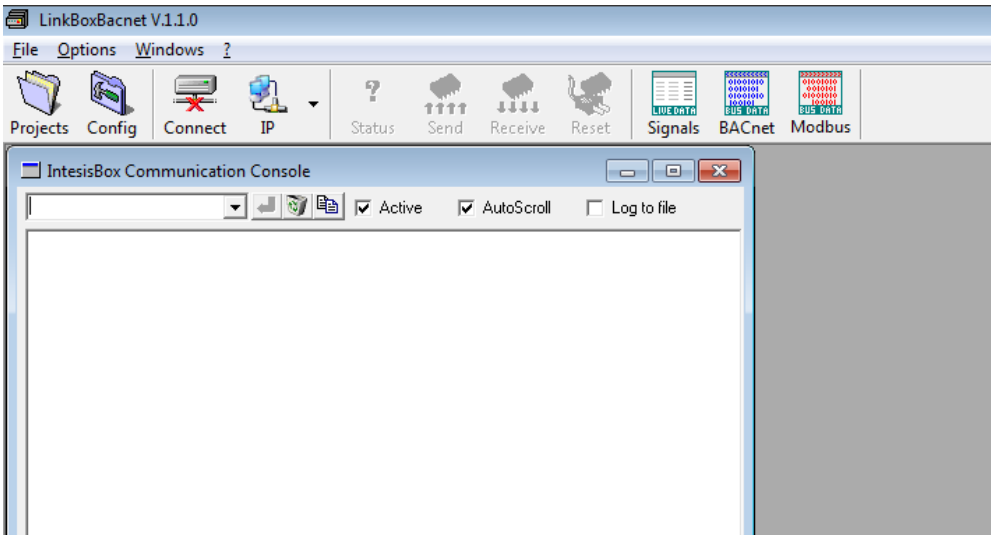


Figure 5.1 Menu and Button Bar in LinkBoxBacnet

5.1.1 Connection configuration

Two subsets of information are configured using this window, the BACnet/IP parameters of the IntesisBox, and the parameters of the Modbus TCP interface.

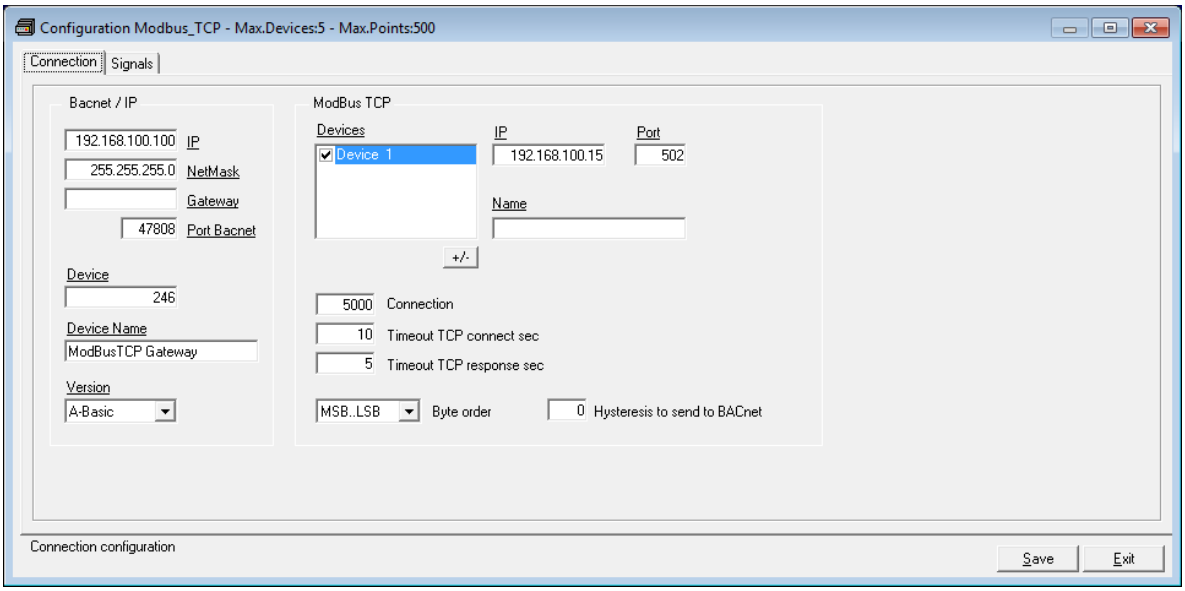


Figure 5.2 Configuration: Connection Tab

BACnet/IP interface configuration parameters:

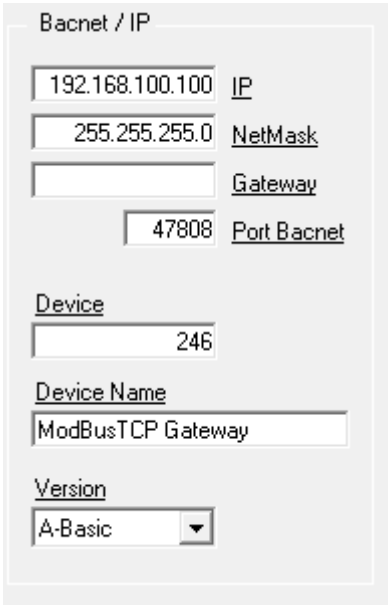


Figure 5.3 BACnet/IP interface Configuration

- **IP:** Enter the IP address for the gateway (supplied by the network administrator).
- **NetMask**: Enter the IP NetMask for the gateway (supplied by the network administrator).
- **Gateway:** Enter the Default Gateway address (router address) in case the gateway (IntesisBox) is in a different sub network than other BACnet devices (supplied by the network administrator). Leave blank if there is no need of router address.
- **BACnet Port:** Enter the BACnet port number used by the gateway (by default 47808, which is BAC0).

- **Device**: Enter the BACnet device number for the gateway (must be unique inside the BACnet system).
- **Device Name:** Select the BACnet device name for the gateway (by default "Modbus TCP Gateway"). This name will be collected by BACnet browsers among others.
- **Version:** Select the gateway model used: tiny,basic or extended. You can check the gateway model in the identification given by the device when it connects to LinkBoxBacnet, it appears in the IntesisBox Communication Console window once connected to the gateway

IntesisBox_Bacnet_Modbus TCP-**100**… → Tiny model
IntesisBox_Bacnet_Modbus TCP-**A**… → Basic model
IntesisBox_Bacnet_Modbus TCP-**B**… → Extended model

Modbus TCP interface configuration parameters:

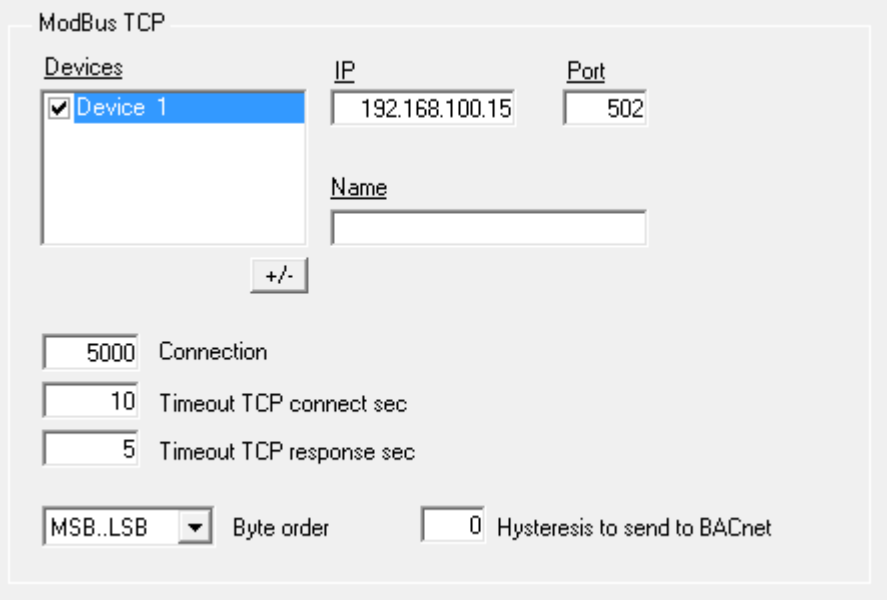


Figure 5.4 Modbus TCP interface Configuration

- **Devices:** List of Modbus TCP slave devices to communicate to. Check the devices you want to activate. Select a device to configure its properties.
- **+/- :** Use this button to define the number of Modbus TCP slave devices to communicate to (Up to 254 devices)

For every Modbus TCP device defined, the following properties must be entered:

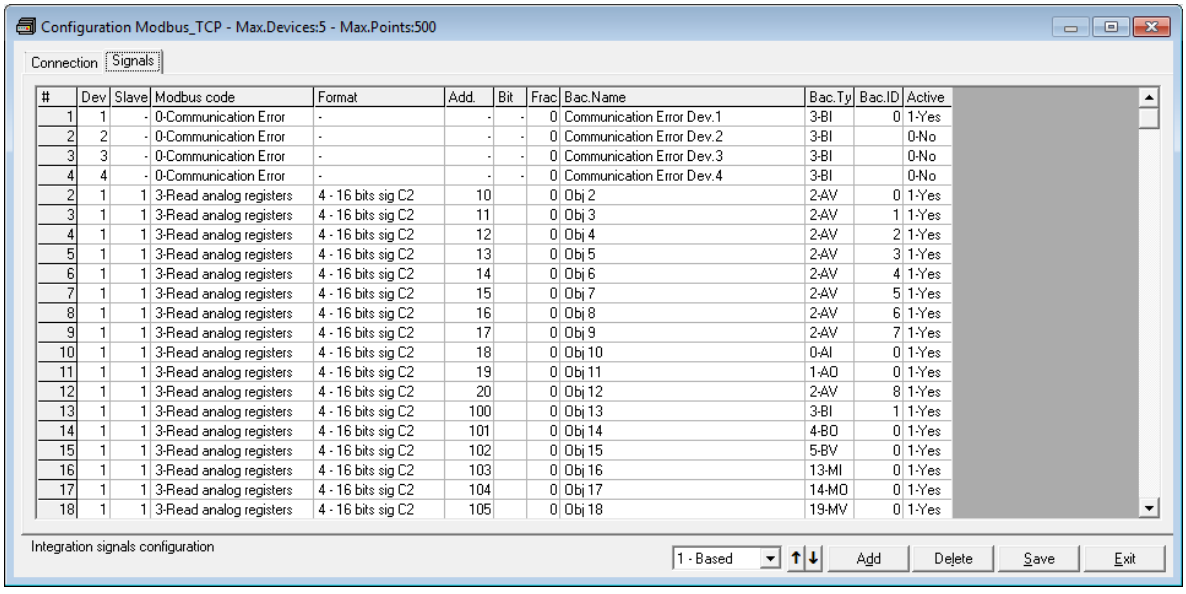
- **IP:** IP of each slave device
- **Port:** Port of each slave device
- **Name:** Enter the device name (optional, just for identification purposes).
- **Timeout between Connections (ms):** time to wait before retrying the connection again if it failed

- **Timeout TCP connect (sec):** timeout to decide that a connection was not successful**.**
- **Timeout TCP response (sec):** timeout to decide that a the device has not replied.
- **Byte order** (Modbus TCP endianism)**:** Byte order for data fields inside Modbus TCP telegrams (LSB..MSB or MSB..LSB). It will depend on the slaves, consult the slave documentation for details. If unknown just try the two possible choices and see if the read values make sense. This affects to all data fields of all slaves defined.
- **Hysteresis to send to BACnet:** Amount that a Modbus TCP value needs to change to be sent to the BACnet COV subscriptions

5.1.2 Signals configuration

Select the Signals tab (Figure 5.5) to configure the signals list (the IntesisBox internal points). More information about the meaning of the columns can be found in the tables below.

Every row in the grid corresponds to a signal (point). Signals (rows in the grid) can be added or deleted selecting the desired row and clicking Add or Delete buttons. Multiple consecutive rows can be deleted too.



#	Dev	Slave	Modbus code	Format	Add.	Bit	Frac	Bac.Name	Bac.Ty	Bac.ID	Active
1	1	-	0-Communication Error	-	-	-	0	Communication Error Dev.1	3-BI	0	1-Yes
2	2	-	0-Communication Error	-	-	-	0	Communication Error Dev.2	3-BI		0-No
3	3	-	0-Communication Error	-	-	-	0	Communication Error Dev.3	3-BI		0-No
4	4	-	0-Communication Error	-	-	-	0	Communication Error Dev.4	3-BI		0-No
2	1	1	3-Read analog registers	4 - 16 bits sig C2	10		0	Obj 2	2-AV	0	1-Yes
3	1	1	3-Read analog registers	4 - 16 bits sig C2	11		0	Obj 3	2-AV	1	1-Yes
4	1	1	3-Read analog registers	4 - 16 bits sig C2	12		0	Obj 4	2-AV	2	1-Yes
5	1	1	3-Read analog registers	4 - 16 bits sig C2	13		0	Obj 5	2-AV	3	1-Yes
6	1	1	3-Read analog registers	4 - 16 bits sig C2	14		0	Obj 6	2-AV	4	1-Yes
7	1	1	3-Read analog registers	4 - 16 bits sig C2	15		0	Obj 7	2-AV	5	1-Yes
8	1	1	3-Read analog registers	4 - 16 bits sig C2	16		0	Obj 8	2-AV	6	1-Yes
9	1	1	3-Read analog registers	4 - 16 bits sig C2	17		0	Obj 9	2-AV	7	1-Yes
10	1	1	3-Read analog registers	4 - 16 bits sig C2	18		0	Obj 10	0-AI	0	1-Yes
11	1	1	3-Read analog registers	4 - 16 bits sig C2	19		0	Obj 11	1-AO	0	1-Yes
12	1	1	3-Read analog registers	4 - 16 bits sig C2	20		0	Obj 12	2-AV	8	1-Yes
13	1	1	3-Read analog registers	4 - 16 bits sig C2	100		0	Obj 13	3-BI	1	1-Yes
14	1	1	3-Read analog registers	4 - 16 bits sig C2	101		0	Obj 14	4-BO	0	1-Yes
15	1	1	3-Read analog registers	4 - 16 bits sig C2	102		0	Obj 15	5-BV	0	1-Yes
16	1	1	3-Read analog registers	4 - 16 bits sig C2	103		0	Obj 16	13-MI	0	1-Yes
17	1	1	3-Read analog registers	4 - 16 bits sig C2	104		0	Obj 17	14-MO	0	1-Yes
18	1	1	3-Read analog registers	4 - 16 bits sig C2	105		0	Obj 18	19-MV	0	1-Yes

Figure 5.5 Signal list

# (Signal's number)	
Description	Enumeration of the rows in the grid (signals). If clicked on them the whole row will be selected (↑↓ to be used to delete/add rows)
Restrictions	Cannot be edited

Dev	
Description	Device number to which belongs the point. Referenced to the list of devices defined in *Connection Tab (*Figure 5.4*)*
Values	From 1 to 5
Edit mode	Text edit or AutoEnumeration
Comments	This is not the slave number configured in the Modbus TCP device itself, it is just the order of the device (from top to bottom) in the devices list

Slave	
Description	Modbus Slave number
Values	From 1 to 255
Edit mode	Text edit or AutoEnumeration

Modbus *Code*	
Description	Modbus function code to be used by IntesisBox to read, to write or to read/write the point in the slave device.
Values	0- Communication Error 1- Read digital outputs 2- Read digital inputs 3- Read analog registers 4- Read analog inputs 5- Write 1 digital output 6- Write 1 analog register 7- Write multiple digital output *8*- Write multiple analog registers
Restrictions	For *Read only* points function codes 1, 2, 3 or 4 can be used For *write only points*, function codes 5, 6, 15 or 16 can be used For *read/write points*, see section 5.1.3
Edit mode	Single / Multiple Values selection.
Comments	*Consult documentation of Modbus device(s) to integrate for information about function codes supported to read/write their internal points.*

Format	
Description	Modbus TCP data format for the point.
Values	1. 1 bit. 2. 16 bits uns: 16 bits unsigned. 3. 16 bits sig: 16 bits signed. The MSbit represents the sign. 4. 16 bits sig C2:16 bits signed (two's complement). 5. 32 bits uns: 32 bits unsigned. 6. 32 bits sig: 32 bits signed. 7. 32 bits sig C2: 32 bits signed (two's complement). 8. 32 bits IEEE: IEEE Standard for Floating-Point Arithmetic (IEEE 754). 9. 32 bits IEEE inv: 32 bits IEEE inverted (LSB..MSB). 10. 32 bits IEEE Winv: 32 bits IEEE word inverted (LSW..MSW). *Device Specific:* 11. 16 bits digital: Bit coded into 16 bits register. 12. 32 bits Mod10K uns: Integer N as 2 16-bit integers A and B. where N= (A * 10.000) + B 13. 48 bits Mod10K uns: Integer N as 3 16-bit integers A, B and C where N= (A * 10.000^2) +(B * 10.000) + C 14. 64 bits Mod10K uns: Integer N as 4 16-bit integers A, B, C and D where N= (A * 10.000^3) + (B * 10.000^2) +(C * 10.000) + D 15. 32 bits Mod10K sig: as the unsigned but the MSb represents the sign. 16. 48 bits Mod10K sig: as the unsigned but the MSb represents the sign. 17. 64 bits Mod10K sig: as the unsigned but the MSb represents the sign. 18. 32 bits Mod10K ION: to be used with ION devices. 19. 32 bits ION sig: to be used with ION devices. 20. 32 bits Invertomatic: to be used with Invertomatic devices. *21.* MSB*100 + LSB.
Restrictions	1 bit format can only be used with digital Modbus TCP codes (1,2,5 and 6) All the other formats cannot be used with the abovementioned codes
Edit mode	Single / Multiple Values selection.
Comments	Formats 1 to 9 are generic Modbus TCP data formats while formats 10 to 20 are *Device specific*.

	Consult documentation of Modbus device(s) to integrate for information about Modbus data format of the points desired to integrate.

Address	
Description	It's the Modbus TCP register address to use by IntesisBox to read/write the point into the Modbus TCP device.
Edit mode	Text edit or AutoEnumeration
Comments	*Consult documentation of Modbus device(s) to integrate for information about register addresses of the points desired to integrate.*

Bit	
Description	Bit used inside the Modbus TCP register to encode the digital value for the point. IntesisBox allows bit decoding from generic 16 bits input/holding Modbus TCP registers. Bit coding into 16 bit input/holding Modbus TCP registers is used for some devices to encode digital values into this type of registers.
Values	0 to 15
Restrictions	Only used with Format=11 (16 bits digital) and Code= 3 or 4 (read holding/input registers). To decode more than one of the bits of the 16 bits register all the decoding rows should be grouped together in the table
Edit mode	Text edit

Frac	
Description	Fractional part to consider for the point's value when read/write. Some devices encode for example temperature values (integer + fractional part) in common 2-bytes Modbus TCP registers (using data format 16 bits signed two's complement for example); the problem of using 2-bytes registers is that no fractional part can be encoded. To avoid this problem, the real value in the device is sent multiplied by 10 as just integer part (a real value of 25.1 will be sent as 251). For this kind of points for example you can specify a value of 1 in *Frac* column. Then the value decoded by IntesisBox from the slave will be divided by 10, and the value will be multiplied by 10 before writing to the slave, thus will be the real value in the device (including integer and fractional part).
Edit mode	Text edit or AutoEnumeration

Bac.Name	
Description	BACnet object name for the signal. This name is included into the BACnet's *Object_name* property for the point and it will be collected by any BACnet explorer.
Restrictions	Maximum 30 characters
Edit mode	Text edit
Comments	Recommended to give a descriptive name to each point with indication of the Modbus TCP slave/register associated

Bac.Type	
Description	BACnet object type for the signal.
Values	• AI = Analog Input. • AO = Analog Output. • AV = Analog Value. • DI = Digital Input. • DO = Digital Output. • DV = Digital Value. • MI = Multistate Input. • MO = Multistate Output. • MV = Multistate Value.
Edit mode	Single / Multiple Values selection.
Comments	Edit using the mouse right-button-click pop-up menu

Bac.ID	
Description	BACnet object instance number for the point. It can be manually entered by the user or can be automatically assigned by LinkBoxBacnet when saving the configuration (section 5.1.4)
Restrictions	All the object instance numbers for objects of the same type must be different
Edit mode	Text edit or AutoEnumeration
Comments	It is recommended to let LinkBoxBacnet assign automatically object instance numbers for the points

Active	
Description	Indicates if the signal is active or not for the integration
Values	• 0: Not active • 1: Active
Edit mode	Text edit or AutoEnumeration

0 / 1 based register	
Description	Some Modbus TCP devices use 0-based register addresses (also referred as Jbus), while others use 1-based register addresses (also referred as Modbus TCP), in the Modbus TCP communication (for 1-based devices, the register address 100 is specified as 99 in the Modbus TCP communication frames). Select *0-Based* if your Modbus TCP devices use 0-based address map (like PLCs), or select *1-Based* if your Modbus TCP devices use 1-based address map.

↑↓	
Description	Buttons to move the selected row (or rows) up or down inside the grid. To move up or down inside the grid a single row or a group of consecutive rows, just select the row or rows using the left button of the mouse and push the desired up or down button.
Comments	This can be done also using the key combinations *ALT+arrow up* or *ALT+arrow down* instead of up or down buttons

Add	
Description	Button that adds a row under the selected one.

Delete	
Description	Buttons to delete the selected row (or rows).

Save	
Description	Save the configuration (details in section 5.1.4)

Exit	
Description	Exits the configuration window (details in section 5.1.4)

5.1.3 How to configure read/write points

First of all is important to take into account that different names for Modbus TCP function codes, are used in technical literature depending on the manufacturer of the Modbus TCP device. The following table shows the equivalence between nomenclature for function codes, used by Intesis Software in IntesisBox and the used in Modbus TCP protocol specification.

Function code	IntesisBox	Modbus TCP protocol specification
01	Read digital outputs	Read Coils
02	Read digital inputs	Read Discrete Inputs
03	Read analog registers	Read Holding Registers
04	Read analog inputs	Read Input Registers
05	Write 1 digital output	Write Single Coil
06	Write 1 analog register	Write Single Register
15	Write multiple digital outputs	Write Multiple Coils
16	Write multiple analog registers	Write Multiple Registers

Given a point in a Modbus TCP slave device, if this point allows to be read and written, different Modbus TCP function codes must be used for read and for write actions (consult the slave documentation for details of what function codes must be used for read and for write). Use the following criteria for configuration of this kind of points in IntesisBox:

1. If the Modbus TCP function code to use for read is *03* and the function code to use for write is *06* (which is very common), then select the function code *3-Read analog registers* in column Modbus TCP *Code* and select a BACnet Type *Output* or *Value* for the point (i.e. AO, AV, BO, BV, MO, MV). With this, IntesisBox will use function code 03 for read the point in every polling cycle, and whenever a new value for the point is received from BACnet, the new value will be written in the Modbus TCP slave device using function code 06.

2. If the Modbus TCP function code to use for read is *01* and the function code to use for write is *05* (which is also very common), then select the function code *1-Read digital outputs* in column Modbus TCP *Code* and select a BACnet Type *Output* or *Value* for the point (i.e. AO, AV, BO, BV, MO, MV). With this, IntesisBox will use function code 01 for read the point in every polling cycle, and whenever a new value for the point is received from BACnet, the new value will be written in the Modbus TCP slave device using function code 05.

3. If the Modbus TCP function code to use for read and the function code to use for write are different than 01-05 or 03-06 (sometimes found with specific devices), then you have to declare two points in IntesisBox to perform the read and the write separately. The way to configure this is better explained using an example.

   Imagine you have a device, in which a given analog point (register address 100 for example) of type read/write must be read using function code 03, and must be write using function code 16.

   To be able to read and write this Modbus TCP point from BACnet, you must define two separate points into IntesisBox, one for read and one for write like the following:

Nb	Dev	Modbus Code	Format	Add.	Bit	Frac	Bac.Name	Bac.Type	Bac.ID	Active
1	1	3-Read analog registers	4 - 16 bits sig C2	100		0	AI - example of Read Modbus point	0 -AI	0	1-Yes
2	1	16-Write multiple analog registers	4 - 16 bits sig C2	100		0	AO - example of Write Modbus point	1-AO	0	1-Yes

The important configuration parameters to obtain the desired functionality are highlighted in green colour, the rest of configuration parameters are irrelevant in this example. Note that both points must have the same Modbus TCP Address and the same Modbus TCP Format.

5.1.4 Saving the configuration

When the configuration of the project is finished follow the next steps:

1. Click the button *Save.* Once accepted the pop-up message, that will save the project in the folder on hard disk (more information in LinkBoxBacnet Manual).

2. You will be prompted to generate the configuration file to be sent to the gateway,

    a. If *YES* is selected, the binary file (Modbus TCP.LBOX) containing the configuration for the gateway will be generated and saved also into the project folder.

    b. If *NO* is selected the binary file needs to be created before following the next steps. To do so open the Configuration window (section 5.1) and restart from step 1

3. A pop-up message will show up asking if you want to **preserve the Object instance numbers. BE CAREFUL** using this feature.

    a. If ***NO*** is selected all the object instance numbers for the points will be automatically reconstructed and thus loosing previous instance numbers, if defined. **ONLY** USE this option **for a brand new configuration** not previously running in the gateway and therefore not yet integrated into the BACnet system

    b. Select **Yes** for configurations **previously running** in the gateway and **already integrated into the BACnet system** that had been extended with a few more points that **must respect the previously defined object instance numbers**. All the points with object instance numbers defined will be respected. LinkBoxBacnet will automatically assign object instance numbers to ones without it.

4. As the final step, a pop-up message will ask if you want to see the BACnet points list report, If you select *Yes,* a text file called *Modbus TCP- BACNET OBJECT LIST.TXT* will be generated and saved into the project folder containing a report of all the point's BACnet information (for informative purposes at user level). The file will be also opened in the notepad, it looks like this:

ObjIdent	ObjType	OInst	ObjName
00000000	0-AI	0000	AI_1_read
00000001	0-AI	0001	AI_2_read
04194304	1-AO	0000	AO_1_read_write
04194305	1-AO	0001	AO_2_read
04194306	1-AO	0002	AO_3_write
08388608	2-AV	0000	AV_1_read_write
08388609	2-AV	0001	AV_2_read
12582912	3-BI	0000	Communication Error Dev.1
12582913	3-BI	0001	BI_1_read
12582914	3-BI	0002	BI_2_read
12582915	3-BI	0003	BI_10
12582916	3-BI	0004	BI_11
16777216	4-BO	0000	B0_1_read_write
16777217	4-BO	0001	BO_2_read_write
20971520	5-BV	0000	BV_1_read_write

5. Once in the configuration window again, click on exit. The configuration is ready to be sent to the IntesisBox (check LinkBoxBacnet Manual)

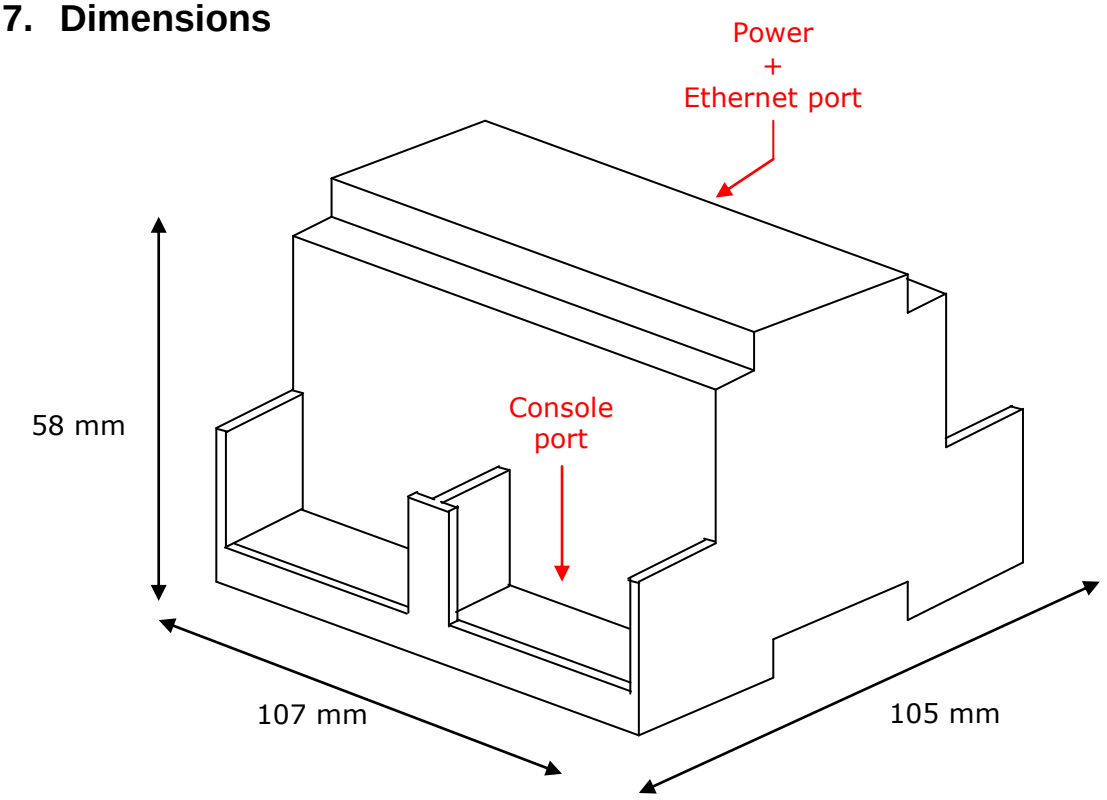
The configuration cannot be received from the gateway to* LinkBoxBacnet*, it can only be sent.

6. Mechanical & electrical characteristics

Enclosure	Plastic, type PC (UL 94 V-0). Dimensions: 107mm x 105mm x 58mm.
Colour	Light Grey. RAL 7035.
Power	9 to 30Vdc +/-10%, Max.: 125mA. 24Vac +/-10% 50-60Hz, Max.: 127mA Must use a NEC Class 2 or Limited Power Source (LPS) and SELV rated power supply. Plug-in terminal block for power connection (2 poles).
Terminal wiring (for power supply and low-voltage signals)	Per terminal: solid wires or stranded wires (twisted or with ferrule) 1 core: 0.5mm^2… 2.5mm^2 2 cores: 0.5mm^2… 1.5mm^2 3 cores: not permitted
Mounting	Wall. DIN rail EN60715 TH35.
Modbus TCP & BACnet/IP port	1 x Ethernet 10Base-T (RJ45).
LED indicators	1 x Power. 2 x Ethernet port link and activity (LNK, ACT).
Console port	EIA232. (DB9 female connector, DCE). SELV
Configuration	Via console port.[1]
Firmware	Allows upgrades via console port.
Operational temperature	0°C to +70°C
Operational humidity	5 to 95%, non condensing
Protection	IP20 (IEC60529).
RoHS conformity	Compliant with RoHS directive (2002/95/CE).
Norms and standards	CE conformity to EMC directive (2004/108/EC) and Low-voltage directive (2006/95/EC) EN 61000-6-2 EN 61000-6-3 EN 60950-1 EN 50491-3

[1] Standard cable DB9male-DB9female 1,8 meters long is supplied with the device for connection to a PC COM port for configuring and monitoring the device. The configuration software, compatible with Windows® operating systems, is also supplied.

7. Dimensions



Free space recommended to install the device into a cabinet (wall or DIN rail mounting), with space enough for external connections: