⊞ IntesisBox®
ME-AC-MBS-1   v.1.16
ME-AC-MBS-1_2I1O v.1.16

MODBUS RTU (RS-485) Interface for Mitsubishi Electric air conditioners. Compatible with all models of Domestic & Mr.Slim lines.

User Manual
Issue Date: 03/2013

Order Codes:

ME-AC-MBS-1: Modbus RTU Interface for Mitsubishi Electric air conditioners
ME-AC-MBS-1_2I10: Modbus RTU Interface for Mitsubishi Electric air conditioners with two digital inputs and one digital output

URL	http://www.intesis.com
Email	info@intesis.com
tel	+34 938047134

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Intesis Software S.L.
Milà i Fontanals, 1 bis
08700 Igualada
Spain

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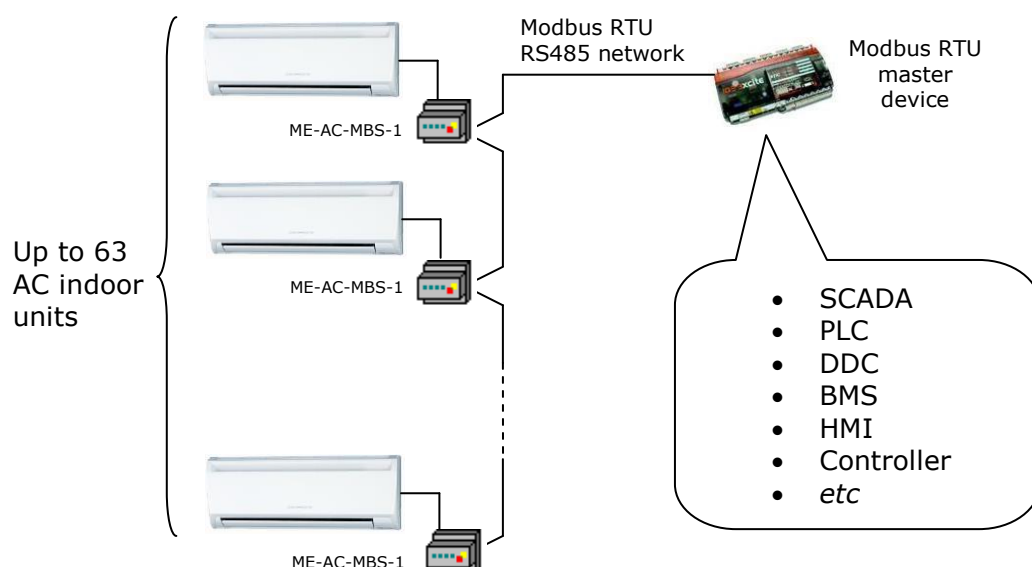
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1. Presentation

The ME-AC-MBS-1 and ME-AC-MBS-1_2I10 interfaces allow a complete and natural integration of *Mitsubishi Electric* air conditioners into Modbus RTU (RS-485) networks.

Compatible with all models of Domestic and Mr.Slim line (section 5).

- Reduced dimensions. 93 x 53 x 58 mm.

- Quick and easy installation.
  Mountable on DIN rail, wall, or even inside the indoor unit in some models of AC.

- External power not required.

- Direct connection to MODBUS RTU (RS-485) networks. Up to 63 ME-AC-MBS-1 devices can be connected in the same network.
  ME-AC-MBS-1 is a Modbus slave device.

- Direct connection to the AC indoor unit.
  The cable for this connection is also supplied.

- Configuration from both on-board DIP-switches and MODBUS RTU.

- Total Control and Supervision.

- Real states of the AC unit's internal variables.

- Allows using simultaneously the IR remote control and MODBUS RTU.

- 2 general purpose digital inputs plus 1 relay output available through Modbus registers[1].

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[1] In the ME-AC-MBS-1_2I1O version

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2. Connection

The interface comes with cable + connectors for direct connection to the AC indoor unit, and with a plug-in terminal block of 2 poles for connection to a Modbus RTU RS-485 network.

### 2.1 Connect to the AC indoor unit

To connect the ME-AC-MBS-1 interface to the AC indoor unit follow these steps:

Disconnect mains power from the AC unit. Open the front cover of the indoor unit in order to have access to the electronic circuit. In the electronic circuit locate the socket connector marked as:

CN92 in Mr.Slim models, or **CN105** in the rest of models.

Using the cable that comes with the interface, insert one of its connectors, the one installed in the shortest uncovered part, into the socket of the ME-AC-MBS-1, and the other connector, the one installed in the largest uncovered part, to the socket **CN92** or **CN105** of the AC unit's electronic circuit. You can place the ME-AC-MBS-1 inside or outside the AC indoor unit depending on your needs, remember that ME-AC-MBS-1 must be also connected to the Modbus RTU RS-485 network. Close the AC indoor unit's front cover again.

Do not modify the length of the cable supplied with the interface, it may affect to the correct operation of the interface.
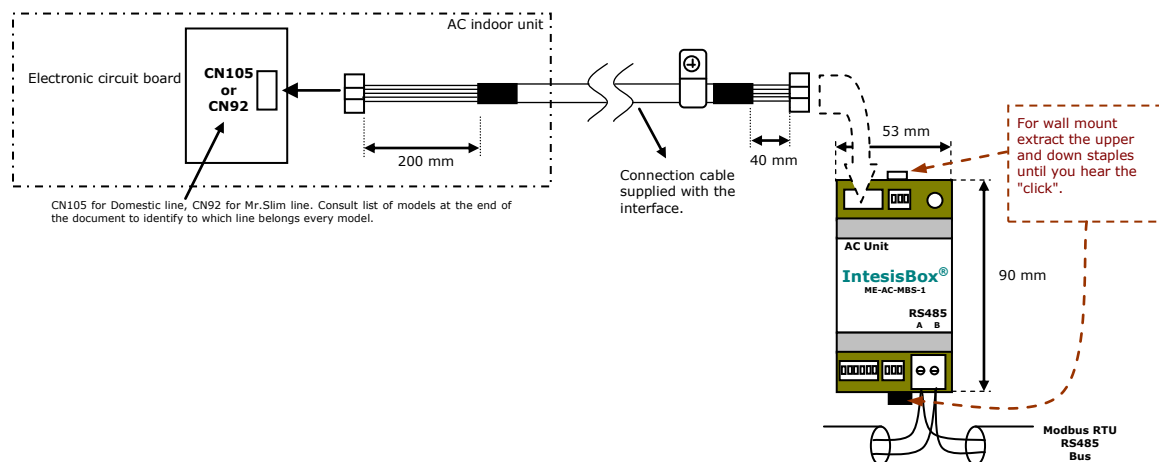
2.2 Connection to the RS485 bus

Connect the RS485 bus wires to the plug-in terminal block (the one of two poles) of ME-AC-MBS-1, respect the polarity on this connection (A+ and B-). Respect the maximum distance of 1.200 meters for the bus, no loop or star topologies are allowed for RS485 bus, a terminator resistor of 120 must be present at each end of the bus to avoid signal reflections and also a fail-safe biasing mechanism (see section 3.7 for more details).

2.3 Connection of the general purpose digital inputs and output [*]

Connect dry contacts of other devices to the 2 digital inputs of ME-AC-MBS-1-2I1O as shown below. *Connect only dry contacts of other devices as internal polarization is given by ME-AC-MBS-1-2I1O.*
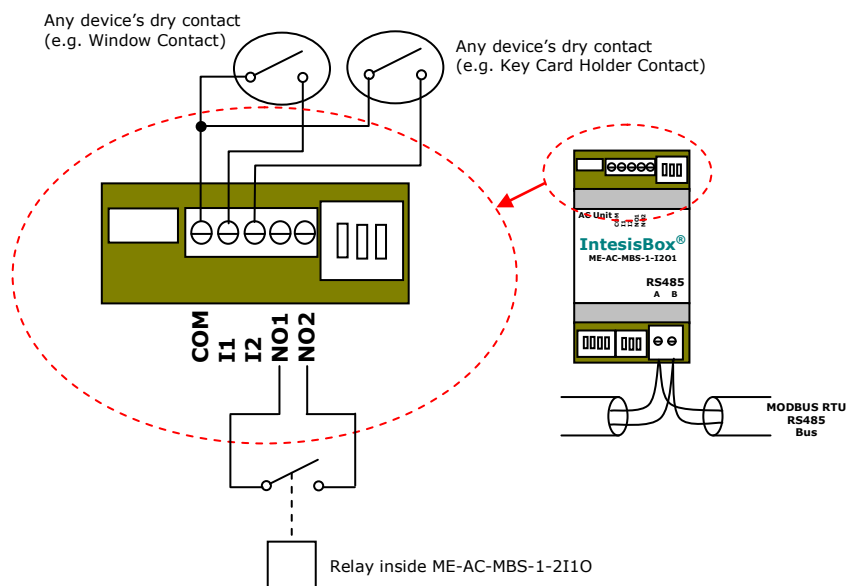
The relay output is also a dry contact normally open that can actuate any device with the following restrictions: 30VDC/5A, or 250VAC/5A max.

The monitoring of the state of the inputs as well as the activation/deactivation of the relay can be done using Modbus registers of ME-AC-MBS-1-2I1O (see section 3.2.3 for details).

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[*] Only available in the ME-AC-MBS-1_2I1O

3. Modbus Interface Specification

3.1 Modbus physical layer

ME-AC-MBS-1 implements a MODBUS RTU (slave) interface, to be connected to an RS-485 line. It performs 8N2 (8N1-compatible) communication (8 data bits, no parity and 2 stop bit) with several available baudrates (2400 bps, 9600 bps -default-, 19200 bps and 57600 bps).

3.2 Modbus Registers

All registers are of type "16-bit unsigned Holding Register", in standard ModBus' big endian notation.

3.2.1 Control and status registers

Register Address (protocol address)	Register Address (PLC address)	R/W	Description
0	1	R/W	AC unit On/Off ▪ 0: Off ▪ 1: On
1	2	R/W	AC unit Mode [2] ▪ 0: Auto ▪ 1: Heat ▪ 2: Dry ▪ 3: Fan ▪ 4: Cool
2	3	R/W	AC unit Fan Speed [2] ▪ 0: Auto ▪ 1: Low ▪ 2: Mid-1 ▪ 3: Mid-2 ▪ 4: High
3	4	R/W	AC unit Vane Position [2] ▪ 0: Auto ▪ 1: Horizontal ▪ 2: Position-2 ▪ 3: Position-3 ▪ 4: Position-4 ▪ 5: Vertical ▪ 6: Swing
4	5	R/W	AC unit Temperature Setpoint [3,4] ▪ 16..32ºC (ºC/x10ºC) ▪ 60..90ºF
5	6	R	AC unit Ambient Temperature [3,4] ▪ 10..38ºC (ºC/x10ºC) ▪ 50..100ºF

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[2] See Section 5 for detail on indoor unit model differences and function availability
[3] Magnitude for this register can be adjusted to Celsius x 1ºC, Celsius x 10ºC (default) or Fahrenheit through DIP switches P5
[4] See section 3.2.4 for more information.

Register Address (protocol address)	Register Address (PLC address)	R/W	Description
6	7	R/W	Window Contact ▪ 0: Closed ▪ 1: Open
7	8	R/W	Device Disablement[5] ▪ 0: ME-AC-MBS-1 enabled ▪ 1: ME-AC-MBS-1 disabled
8	9	R/W	IR Remote Command Disablement[5] ▪ 0: Remote Command enabled ▪ 1: Remote Command disabled
9	10	R/W	AC unit Operation Time[5] ▪ 0..65535 (hours). Counts the time the AC unit is in "On" state.
10	11	R	AC unit Alarm Status ▪ 0: No alarm condition ▪ 1: Alarm condition
11	12	R	Error Code[6] ▪ 8000: No error present ▪ 8001: Error in the communication of ME-AC-MBS-1 against the AC unit ▪ 65535 (-1 if read as signed value): Status of AC error has not been obtained yet (initialization value) ▪ Any other: Error present. See table at the end of this document.
22	23	R/W	Indoor unit ambient temperature from external sensor (at Modbus side) [7] ▪ -32768: Default value. No temperature is being provided from an external sensor. ▪ Any other: (ºC/x10ºC/ºF)[8]
23	24	R	AC setpoint temperature [7] ▪ When no external temperature is provided, this read-only register will have same value as register 5 (PLC addressing). In all cases will show the current setpoint in the indoor unit. ▪ 16..32ºC (ºC/x10ºC)[6] ▪ 60..90ºF

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[5] This value is stored in non-volatile memory
[6] See Section 6 for possible error codes and its explanation
[7] See Section 3.2.4 for more information
[8] Magnitude for this register can be adjusted to Celsius x 1ºC, Celsius x 10ºC (default) or Fahrenheit through DIP switches S4

3.2.2 Configuration Registers

Register Address (protocol address)	Register Address (PLC address)	R/W	Description
12	13	R/W	AC Model* * For firmware versions 1.10 onwards (value 266 in register 51) it is NOT needed to setup AC model on the interface, so this register is not used (its value is always "0")
13	14	R/W	"Open Window" switch-off timeout[9], ▪ 0..30 (minutes) ▪ Factory setting: 30 (minutes)
14	15	R/W	Modbus RTU baud-rate[10] ▪ 0: 2400 bps ▪ 1: 9600 bps ▪ 2: 19200 bps ▪ 3: 57600 bps ▪ Factory setting: 1 (9600 bps) ▪ For this setting to take effect, DIP-switch P5-1 needs to be set in OFF position. ▪ *See section "3.3 - DIP-switch Configuration Interface".*
15	16	R/W	Device's Modbus slave address [8] ▪ 1..255 ▪ Factory setting: 0 (no address / configured at DIP-switch)
50	51	R	Software version

3.2.3 Auxiliary Registers

These registers are only going to be operative when using the ME-AC-MBS-1_2I1O

Register Address (protocol address)	Register Address (PLC address)	R/W	Description
16	17	R	Digital Input I1 ▪ 0: Open contact ▪ 1: Closed contact
17	18	R	Digital Input I2 ▪ 0: Open contact ▪ 1: Closed contact
18	19	R/W	Relay Output O1 ▪ 0: Relay deactivated (contact open) ▪ 1: Relay activated (contact closed)

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[9] Once window contact is open, a count-down to switch off the AC Unit will start from this configured value
[10] This value is stored in non-volatile memory

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3.2.4 Considerations on Temperature Registers

- **AC unit Temperature Setpoint (R/W)** (register 5 – in PLC addressing): This is the adjustable temperature setpoint meant to be required by the user. This register can be read (Modbus function 3 or 4) or written (Modbus functions 5 or 16). A remote controller connected to the Mitsubishi indoor unit will report the same temperature setpoint value as this register <u>only when no AC unit external reference is provided from ME-AC-MBS-1</u> (see detail for register 23 below).

- **AC unit ambient temperature temperature (R)** (register 6 – in PLC addressing): This register reports the temperature that is actually used by the Mitsubishi indoor unit as reference of its own control loop. Depending on the configuration of the indoor unit, this can be the temperature reported by the sensor in in the return path of the Mitsubishi indoor unit or the sensor of its remote controller. It is a read-only register (Modbus functions 3 or 4).

- **AC unit external temperature reference (R/W)** (register 23 – in PLC addressing): This register allows providing an external temperature reference from Modbus side. Mitsubishi indoor unit does not directly allow for devices like ME-AC-MBS-1 to directly provide a temperature to be used as reference of the control loop of the AC indoor unit. In order to overcome that limitation and enable usage of an external temperature sensor (i.e. in Modbus side), ME-AC-MBS-1 applies following mechanism (if and only if "external reference temperature" is being used):

  - After a couple of values are entered in the "AC unit external reference temperature" (register 23) and "AC unit temperature setpoint" (register 5), ME-AC-MBS-1 will calculate the temperature demand they imply. (e.g. if a "temperature setpoint (register 5)" of **22ºC**, and an "external temperature reference (register 23)" of **20ºC** are entered, ME-AC-MBS-1 will assume that the user is demanding a **+2ºC** increase in temperature).

  - By knowing at all times the ambient temperature actually used by the indoor unit to control its own operation (register 6), ME-AC-MBS-1 can calculate the required setpoint so to apply the demand desired by the user (following the example above, if ME-AC-MBS-1 reads an "ambient temperature" (register 6) of **24ºC** in the indoor unit, it will apply a final setpoint of **24ºC + 2ºC = 26ºC**).

  - From this point on, whenever ME-AC-MBS-1 detects that the ambient temperature reported by the indoor unit changes (register 6), it will also change the required setpoint accordingly, in order to keep the demand required by the user at any time (following the example above, if ME-AC-MBS-1 receives a new value for temperature coming from the indoor unit of **25ºC**, ME-AC-MBS-1 will automatically adjust the setpoint required to the AC indoor unit to **25ºC + 2ºC = 27ºC**).

  - In general, ME-AC-MBS-1 is constantly applying the following formula:

$$S_{AC} = S_u - (T_u - T_{AC})$$

Where:

S_{AC} - setpoint actually applied to the indoor unit
S_u - setpoint written at Modbus side (register 5)
T_u - external temperature reference written at Modbus side (register 23)

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T_{AC} - ambient temperature that the indoor unit is using as reference of its own control loop (register 6)

Whenever ME-AC-MBS-1 detects a change in any of the values of { S_u , T_u , T_{AC} }, it will send the new corresponding setpoint (S_{AC}) to the indoor unit.

- o After startup, value for "external temperature reference" (register 23) has value -32768 (0x8000). This value means that no external temperature is being provided through ME-AC-MBS-1. In this scenario, setpoint shown or written in register 5 will always have same value as the actual setpoint of the indoor unit.
- o Note that, using the "external temperature reference" (register 23) (i.e. writing a value different from -32768 / 0x8000 in it) has following relevant consequences:

  - ▪ <u>Setpoint reported by any additional remote controller or monitoring device from Mitsubishi connected to the indoor unit, in general will be different from the one entered in register 5 of ME-AC-MBS-1</u>, since the mechanism above is being applied.
  - ▪ <u>User will not be able to change setpoint using any remote controller from Mitsubishi</u>, as setpoint of the indoor unit will become exclusively controlled by the mechanism explained above (i.e. the setpoint obtained in that mechanism will always be enforced in the indoor unit).

- • **Current setpoint in AC indoor unit (R)** (register 24 – in PLC addressing)**:** As detailed in previous point, actual setpoint in the indoor unit and setpoint requested from ME-AC-MBS-1 might differ (when a value in register 23 – "external temperature reference" is put). This register always informs of the actual setpoint being used by the indoor unit – this is also the setpoint that will show a additional remote controller from Mitsubishi connected to the indoor unit, if present.

Additionally, note that temperature values all these three registers are expressed according to the temperature format configured through its onboard DIP-Switches (See "3.3 - DIP-switch Configuration Interface"). Following formats are possible:

- • Celsius value: Value in Modbus register is the temperature value in Celsius (i.e. a value "22" in the Modbus register must be interpreted as 22ºC)
- • Decicelsius value: Value in Modbus register is the temperature value in decicelsius (i.e. a value "220" in the Modbus register must be interpreted as 22.0ºC)
- • Fahrenheit value: Value in Modbus register is the temperature value in Fahrenheit (i.e. a value "72" in the Modbus register must be interpreted as 72ºF (~22ºC).

3.3   DIP-switch Configuration Interface

All configuration values on ME-AC-MBS-1 can be written and read from ModBus interface. Though, some of them can also be setup from its on-board DIP-switch interface. The devices have DIP-switches P5, P6* and P7, in the following locations:
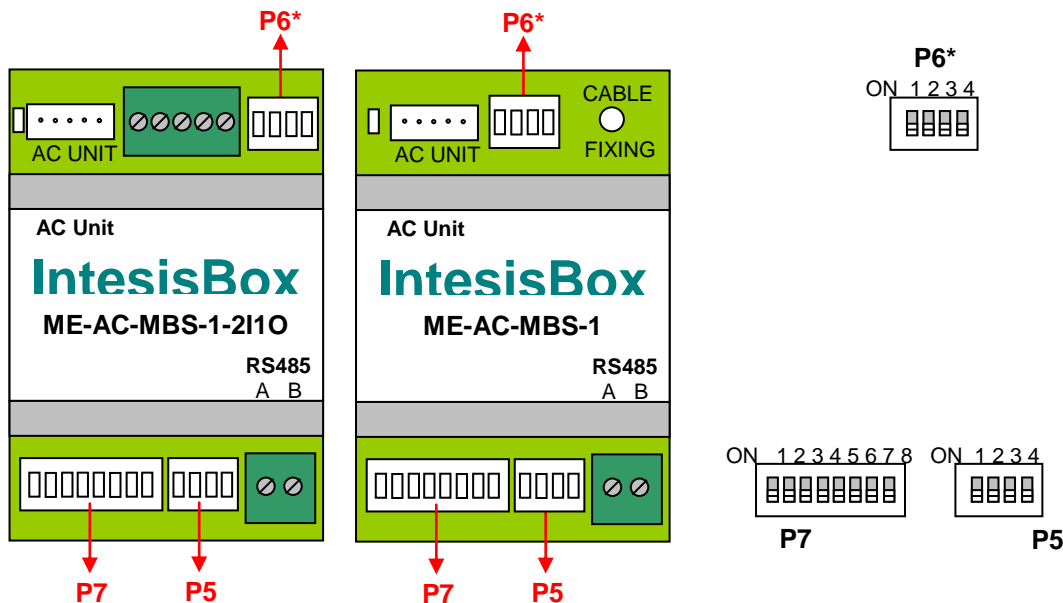
The following table applies for configuration of the interface through these DIP-switches:

DIP SWITCH	Binary value	Decimal value	Switch Position	Description
P7 (Modbus address)	00000000	0	1 2 3 4 5 6 7 8 ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	Slave Address configured through Modbus register 15 (and not through DIP-Switch interface)
	1 2........8 $b_0 b_1 ...... b_7$	X	1:b_0 … 8:b_7 ▪ OFF ↓ for 0 ▪ ON ↑ for 1	Slave Address[11], 1..255(in binary)
P5 (Baudrate)	0xxx	0	1 2 3 4 ↓ x x x	Baudrate configured through Modbus register 14 (and not through DIP-Switch interface)
	1xxx	1	1 2 3 4 ↑ x x x	9600 bps
P5 (temperature magnitude)	x0xx	0	1 2 3 4 x ↓ x x	Temperature magnitude in register addresses 5, 6, 23 and 24 is Celsius (default – factory value)
	x1xx	1	1 2 3 4 x ↑ x x	Temperature magnitude in register addresses 5, 6, 23 and 24 is Fahrenheit (value for P5-3 (x1/x10) is ignored)
P5 (Celsius 1x/10x)	xx0x	0	1 2 3 4 x x ↓ x	Temperature magnitude in register addresses 5, 6, 23 and 24 is are represented in degrees (x1) (default value)
	xx1x	1	1 2 3 4 x x ↑ x	Temperature magnitude in register addresses 5, 6, 23 and 24 is are represented in decidegrees (x10)
5 (Modbus Termination)	xxx0	0	1 2 3 4 x x x ↓	EIA485 bus without termination resistor (default value)
	xxx1	1	1 2 3 4 x x x ↑	Internal termination resistor of 120Ω connected to EIA485 bus[12]

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[11] Device comes from factory with no configured slave address. It must be set up during first installation (either in DIP-switch interface, or by using modbus broadcast messages). See section 3.5

[12] Only in the interfaces connected at both ends of the bus must be activated the termination resistor. More information in section 3.7

3.4 Implemented Functions

ME-AC-MBS-1 implements the following standard MODBUS functions:

- 3: Read Holding Registers

- 4: Read Input Registers

- 6: Write Single Register

- 16: Write Multiple Registers (Although this function is allowed, the interface does not allow write operations on more than 1 register with the same request, this means that length field should always be 1 when using this function for writes)

3.5 Configuration of the device

During first installation, it is necessary to appropriately set-up, at least, the following configuration parameters (in parenthesis its default / factory value):

- Modbus Slave Address (0 / no address)

- Modbus Baudrate (9600 bps)

All of them can be setup from both, Modbus registers or P5 and P7 DIP-Switch interfaces.

Device comes from factory with all DIP-Switches set at low level (all zero / position OFF↓). At this point, the device can be configured by following one of the two following methods:

- Start an RS-485 8N1 communication at 9600 bps with the device, and setup registers 15 (Slave Address) and 14 (Baudrate) by sending broadcast messages (with Slave Address field = 0). Note that ME-AC-MBS-1 always receives broadcast messages, though they are never answered back (to avoid collisions).

- Configure DIP-Switch interface using values shown in Section 3.3

Note that, setting up a different baudrate than 9600 bps must be done from Modbus interface. This implies that, once this value has been changed to another baudrate, Modbus interface will cease receiving data at previous baudrate (as new baudrate configuration immediately applies). So, immediately after changing baudrate configuration, remember to change the baudrate of the Modbus master communicating with ME-AC-MBS-1.

In case that it is desired to configure the interface using its Modbus configuration registers (instead of DIP-Switches), remember to keep all microswitches at low level (all zero / position ↓). Otherwise, configuration at DIP-Switches will prevail over the values configured at Modbus registers.

3.6   Device LED indicator

The device includes a LED indicator to signal its different possible operational states. In the following table are presented the different indications it can perform and its meaning.

Device status	LED indication	ON / OFF Period	Meaning
On power-up	LED pulse	ON for 5 seconds / OFF after	Device reset / power-up
During normal operation	LED flashing	200ms ON / 2s OFF	Device correctly configured and working
During normal operation	LED OFF	OFF continuously	No Modbus slave address configured
During normal operation	LED blinking	200ms ON / 200ms OFF	Communication Error with the AC unit

3.7   RS485 bus. Termination resistors and Fail Safe Biasing mechanism

RS485 bus requires a 120Ω terminator resistor at each end of the bus to avoid signal reflections.

In order to prevent fail status detections by the receivers *"listening"* the bus when all the transmitters outputs are in three-state (high impedance), it is also required a fail-safe biasing mechanism. This mechanism provides a safe status (a correct voltage level) in the bus when all the transmitters' outputs are in three-state.

The ME-AC-MBS-1 device includes an on-board terminator resistor of 120Ω that can be connected to the RS485 bus by using DIP-switch P5 (see below).
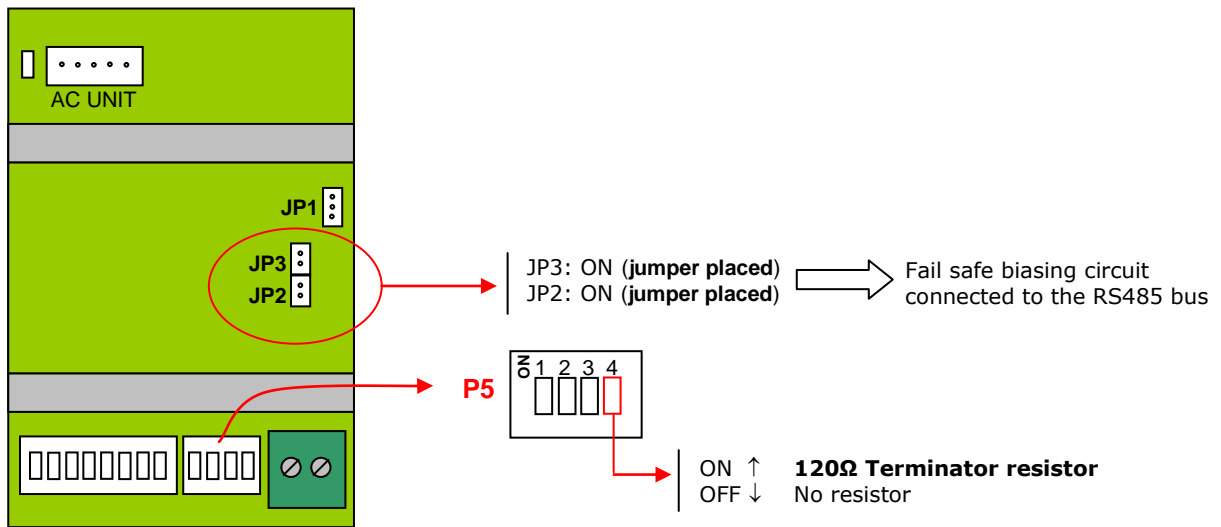
A fail safe biasing circuit has also been included in the board of ME-AC-MBS-1, it can be connected to the RS485 bus by placing the internal jumpers JP2 and JP3 (see details below).
This fail safe biasing of the RS485 bus must only be supplied by one of the devices connected to the bus. As this fail safe biasing circuit also provides a termination resistance, only one of both must be selected in the ME-AC-MBS-1 device, fail safe biasing (*jumpers JP2 and JP3 placed*) or terminator resistor (*DIP-switch P5 position 4 to ON*).

The device providing fail safe biasing or terminator resistor should be the one connected at one end of the bus. At the other end of the bus, if there is also a ME-AC-MBS-1 device, select the 120Ω terminator resistor through DIP-switch P5, or if there is a master device not providing internal 120Ω terminator resistor, connect an external 120Ω resistor in the bus terminal block connection of such master device.

Some Modbus RTU RS485 master devices can provide also internal 120Ω terminator resistor and/or fail safe biasing (consult the technical documentation of the master device connected to the RS485 network in every case).

Location of jumpers and DIP-switches for RS485 bus Termination resistor or Fail Safe Biasing selection:

AC UNIT

JP1

JP3
JP2

JP3: ON (**jumper placed**)
JP2: ON (**jumper placed**)

Fail safe biasing circuit connected to the RS485 bus

P5

ON 1 2 3 4

ON ↑ **120Ω Terminator resistor**
OFF ↓ No resistor

To access to internal jumpers JP2 and JP3, extract the top cover of the interface inserting a small screw-driver or clip in the holes located at both sides of the cover.

AC UNIT

AC Unit

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ME-AC-MBS-1

RS485
A   B
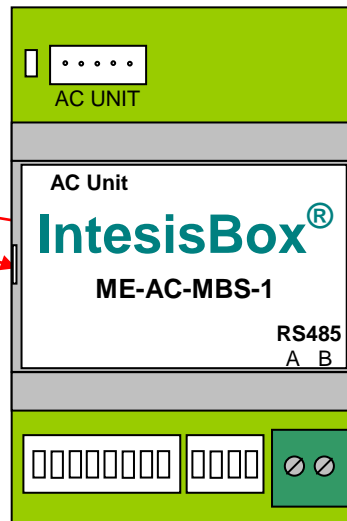
4. Specifications

Dimensions:	*93 x 53 x 58 mm*
Weight:	*85 g*
Operating Temperature:	*-40 . . . 85ºC*
Stock Temperature:	*-40 . . . 85ºC*
Operating Humidity:	*<95% RH, non-condensing*
Stock Humidity:	*<95% RH, non-condensing*
Isolation voltage:	*1000 VDC*
Isolation resistance:	*1000 MΩ*
Modbus Media:	*Compatible with Modbus RTU - RS485 networks*
Digital inputs*	*For connection of dry contacts of other devices. Internal polarization is given by ME-AC-MBS-1-2I1O.*
Relay output*	*Dry contact. 35VDC/5a or 250VAC/5A max.*
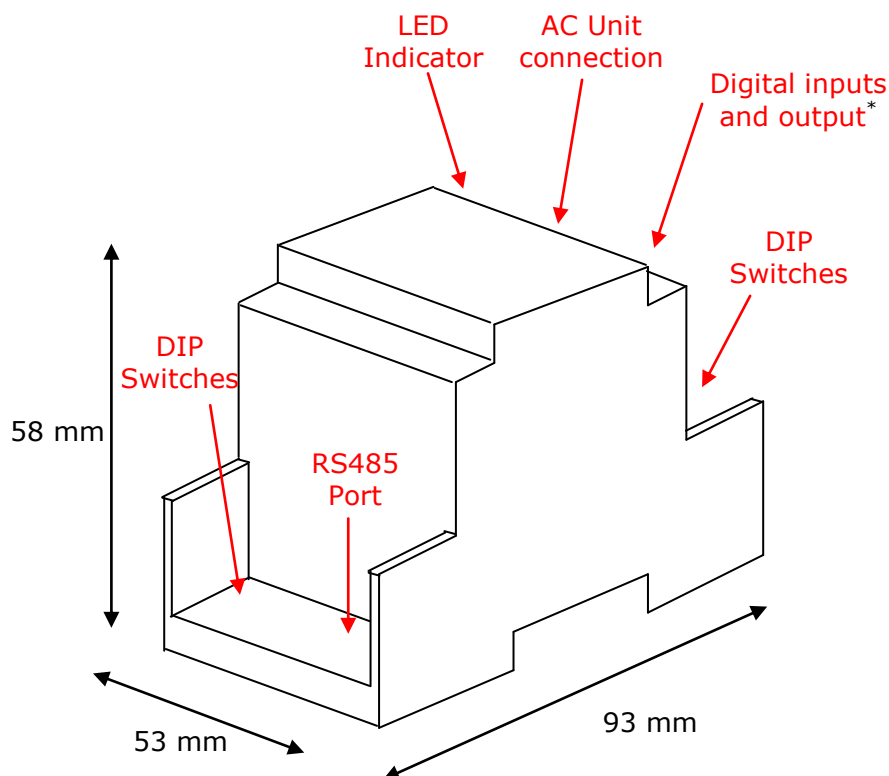
5. List of supported AC Unit Types.

A list of Mitsubishi Electric indoor unit model references compatible with ME-AC-MBS-1 and their available features can be found in:

http://www.intesis.com/pdf/IntesisBox_ME-AC-xxx-1_AC_Compatibility.pdf

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* Only available in the ME-AC-MBS-1_2I10

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6. Error Codes

Code	Description
8000	No active error
1102	Discharge Temperature high
1108	Internal thermostat detector working (49C)
1110	Outdoor unit fail
1300	Pressure low
1302	Pressure high (High pressure probe working 63H)
1503	Protection against freeze or battery high temperature
1504	Protection against freeze or battery high temperature
1504	Overheating protection
1509	High pressure error (ball valve closed)
1520	Super heating anomaly due to low temp. of discharge. (TH4)
2500	Erroneous operation of drain pump
2502	Erroneous operation of drain pump
2503	Drain sensor anomaly (DS)
4030	Serial transmission error
4100	Compressor pause due to excess of current (initial block)
4101	Compressor pause due to excess of current (overload)
4102	Phase detection opened
4103	Anti-phase detection
4108	Phase opened in phase L2 or connector 51CM opened
4118	Error in the anti-phase detector (electronic board)
4124	Connector 49L opened
4210	Cut due to over-current of compressor
4220	Voltage anomaly
4230	Radiator panel temperature anomaly (TH8)
5101	Ambient temperature probe anomaly (TH1), indoor unit
5102	Liquid probe anomaly (TH2)
5102	Cond/Evap probe anomaly (TH5)
5104	Error detection in discharge temperature
5105	Outdoor probe error TH3
5106	Outdoor probe errorTH7
5107	Outdoor probe errorTH6
5110	Outdoor probe errorTH8
5202	Connector 63L opened
5300	Current probe error
6600	MNET duplicated address definition
6602	MNET Line transmission hardware error
6603	MNET BUS busy
6606	MNET Line transmission error
6607	MNET transmission error
6607	MNET without ack
6608	MNET transmission error
6608	MNET without response
6831	IR remote control transmission error (reception error)
6832	IR remote control transmission error (transmission error)
6840	Transmission error with the indoor/outdoor unit (reception error)
6841	Transmission error with the indoor/outdoor unit (transmission error)
6844	Error in inter-connection cable in the indoor/outdoor unit, indoor unit number deactivated (5 min or more)
6845	Error in inter-connection cable in the indoor/outdoor unit (cabling error, disconnection)
6846	Initial timer deactivated
8001	ME-AC-MBS-1 device communication error
65535 (-1 if read as a signed value)	Status of error has not been obtained from AC yet (initialization value)

In case you detect an error code not listed, contact your nearest Mitsubishi Electric technical support service.