

# **IntesisBox<sup>®</sup>**

## **LG-RC-MBS-1 v.1.1**

Modbus RTU (EIA485) Interface for LG air conditioning units.

**User's Manual**

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r0.1

Order Code: **LG-RC-MBS-1**

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## 1. Presentation

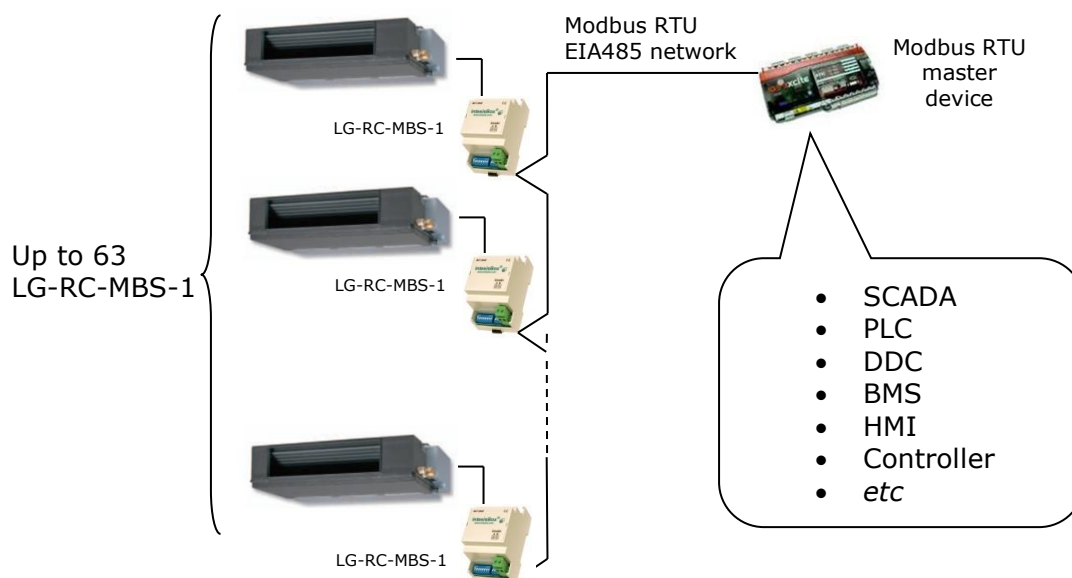


LG-RC-MBS-1 device

The LG-RC-MBS-1 interface allows a complete and natural integration of **LG** air conditioning units into Modbus RTU (EIA485) networks.

### Main features:

- 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 (EIA485) networks. Up to 63 LG-RC-MBS-1 devices can be connected in the same network (See Figure 1.1).  
*LG-RC-MBS-1 is a Modbus slave device.*
- Direct connection to the AC indoor units.
- 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 and wired remote controls and Modbus RTU.



**Figure 1.1** LG-RC-MBS-1 Connection capabilities

## 2. Connection

### 2.1 Connection of the interface to the AC indoor unit

The LG-RC-MBS-1 connects directly to the LG 3-wire cable bus. Depending on which controllers are available the recommended connection methods are the following (details in Figure 2.1):

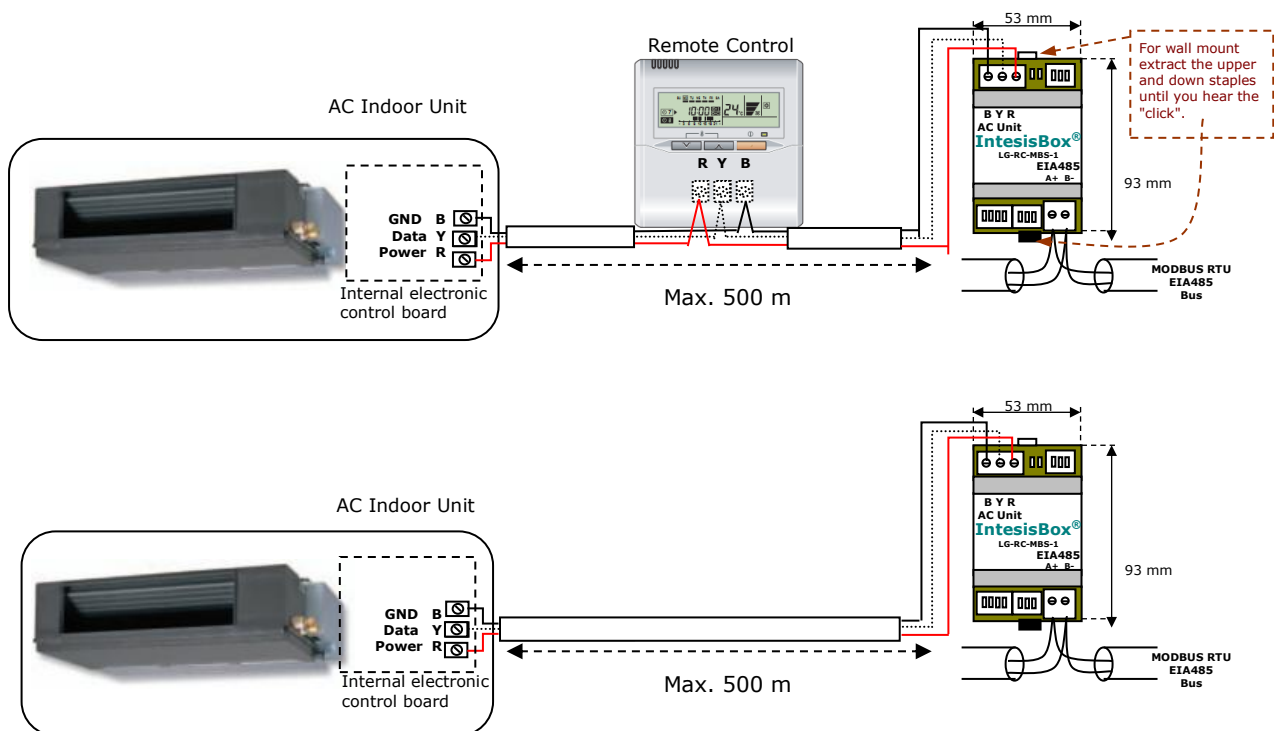
- **Wired remote control available.** Connect the gateway as Slave in parallel with the wired remote controllers (Wall controller acts as master).
- **Infrared remote control available.** Connect the gateway as Master.
- **No remote control available** Connect the gateway directly to the 3-wire bus of the indoor unit as Master when there is no LG remote control.

Disconnect power supply from the AC unit and use a 3-wire cable for the connection of LG-RC-MBS-1, LG wired remote controller and its corresponding indoor unit. Screw the suitably peeled cable ends in the corresponding terminals of each device, as summarized in Figure 2.1.

Maximum connection bus length is 500 meters and has polarity.

### 2.2 Connection of the interface to Modbus

Use the EIA485 connector in the LG-RC-MBS-1 to connect to the Modbus network.



**Figure 2.1** LG-RC-MBS-1 connection diagram

**Attention:** The LG units Type A not allows to install a remote controller and LG-RC-MBS-1 device together.

## **2.3 Power-up**

After the LG-RC-MBS-1 is properly connected, AC unit's main power can be connected again.

Then, it will start an initialization process which can take around 2 minutes before the normal operation starts.

While the initialization is ongoing, some Modbus registers will indicate an undetermined value (see section 3.2). Once the normal operation starts, they will acquire its corresponding value.

It is important to bear in mind that changes made during the initialization process will not have effect until it finishes.

## 3. Modbus Interface Specification

### 3.1 Modbus physical layer

LG-RC-MBS-1 implements a Modbus RTU (slave) interface, to be connected to an EIA485 line. It performs 8N2 (8N1-compatible) communication (8 data bits, no parity and 2 stop bit) with several available baudrates (2400 bps, 4800 bps, 9600 bps -default- and 19200 bps).

### 3.2 Modbus Registers

All registers are of type "16-bit unsigned register", in standard Modbus' big endian notation. The registers are accessible as "Holding registers" or "Inputs registers".

#### 3.2.1 Control and status registers

Register Addr (protocol address)	Register Addr (PLC address)	R/W	Description
0	1	R/W	AC unit On/Off <ul style="list-style-type: none"> <li>0: Off</li> <li>1: On</li> </ul>
1	2	R/W	AC unit Mode <ul style="list-style-type: none"> <li>0: Auto</li> <li>1: Heat</li> <li>2: Dry</li> <li>3: Fan</li> <li>4: Cool</li> </ul>
2	3	R/W	AC unit Fan Speed <sup>1</sup> <ul style="list-style-type: none"> <li>0: Auto</li> <li>1: Super Low</li> <li>2: Low</li> <li>3: Med</li> <li>4: High</li> <li>5: Super High</li> </ul>
3	4	R/W	AC unit Vane Position <sup>1</sup> <ul style="list-style-type: none"> <li>0: No Swing</li> <li>1: Swing</li> <li>2: Swirl</li> </ul>
4	5	R/W	AC unit Temperature Setpoint <sup>2,3</sup> <ul style="list-style-type: none"> <li>16..30 (°C) (0 = undetermined)</li> <li>61..104 (°F) (0 = undetermined)</li> </ul>
5	6	R	Indoor Unit Reference Temperature <sup>3</sup> <ul style="list-style-type: none"> <li>16..40 (°C) (0 = undetermined)</li> <li>61..86 (°F) (0 = undetermined)</li> <li>0x8000 There is no temperature sent from the Remote controller.</li> </ul>
6	7	R/W	Window Contact <sup>4</sup> <ul style="list-style-type: none"> <li>0: Closed</li> <li>1: Open</li> </ul>
7	8	R/W	Device Disablement <sup>4</sup> <ul style="list-style-type: none"> <li>0: LG-RC-MBS-1 enabled</li> <li>1: LG-RC-MBS-1 disabled</li> </ul>
8	9	R/W	Remote Controller Disablement <sup>4</sup> <ul style="list-style-type: none"> <li>0: Remote Controller enabled</li> <li>1: Remote Controller disabled</li> </ul>

<sup>1</sup> Configurable according to Table 3.1

<sup>2</sup> Magnitude for this register can be adjusted through DIP switch (Check Table 3.4)

<sup>3</sup> More information in section 3.5.2

<sup>4</sup> See explanation of this functionality in section 3.5

Register Addr (protocol address)	Register Addr (PLC address)	R/W	Description
9	10	R/W	AC unit Operation Time <sup>5</sup> <ul style="list-style-type: none"> <li>0..65535 (hours). Counts the time the AC unit is in "On" state.</li> </ul>
10	11	R	AC unit Alarm Status <ul style="list-style-type: none"> <li>0: No alarm condition</li> <li>1: Alarm condition</li> </ul>
11	12	R	Error Code <ul style="list-style-type: none"> <li>-1 Communication error.</li> <li>Other look in section 6</li> </ul>
22	23	R/W	External temperature sensor Ranges are manufacturer specific Can be °C or °F, x1 or x10 0x8000 (-32768d) means "no input sensor"
23	24	R	AC real setpoint Ranges are manufacturer specific Can be °C or °F, x1 or x10
24	25	R	Current AC MAX setpoint Ranges are manufacturer specific Can be °C or °F, x1 or x10
25	26	R	Current AC min setpoint Ranges are manufacturer specific Can be °C or °F, x1 or x10
26	27	R/W	Vane L/R position <ul style="list-style-type: none"> <li>0 - AUTO; 1-POS1 ... 9 - POS9; 10-SWING</li> </ul>
65	66	R	Input reference temperature Can be °C or °F, x1 or x10

### 3.2.2 Configuration Registers

Register Address (protocol address)	Register Address (PLC address)	R/W	Description
13	14	R/W	"Open Window" switch-off timeout <sup>6, 7</sup> <ul style="list-style-type: none"> <li>0..30 (minutes)</li> <li>Factory setting: 30 (minutes)</li> </ul>
14	15	R	Modbus RTU baudrate (bps) <sup>7</sup> <ul style="list-style-type: none"> <li>2400, 4800, 9600, 19200</li> </ul>
15	16	R	Device's Modbus slave address <ul style="list-style-type: none"> <li>1..63</li> </ul>
21	22	R	Max number of fan speeds <ul style="list-style-type: none"> <li>1..5: must be configured according to the number of fan speeds supported by the AC unit</li> </ul>
48	49	R	Switch value
49	50	R	Device Identification <ul style="list-style-type: none"> <li>LG-RC-MBS-1: 0x0F00</li> </ul>
50	51	R	Software version

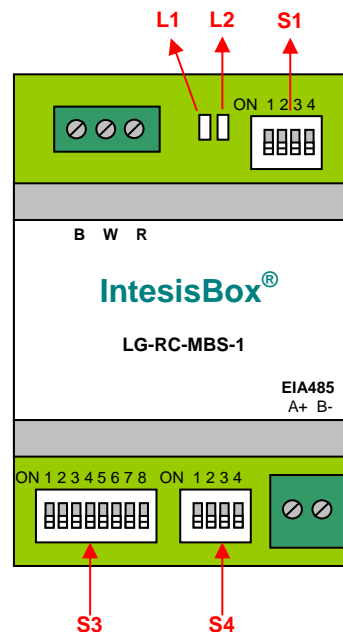
<sup>5</sup> This value is stored in non-volatile memory.

<sup>6</sup> Once window contact is open, a count-down to switch off the AC Unit will start from this configured value

<sup>7</sup> Configurable through S3 (See Table 3.3)

### 3.3 DIP-switch Configuration Interface

In this section, values of the configuration switches and their meaning are specified:



**Figure 3.1** LG-RC-MBS-1

**S1** – AC unit configuration: Master/Slave, Slave of Operating Mode and Machine Type

Binary value $b_3...b_0$	Decimal value	Switches 1 2 3 4	Description
0xxx	0	↓ x x x	Slave (default value) – A LG Controller must be present in the bus, configured as Master.
1xxx	1	↑ x x x	Master in the bus – LG Controller not needed in the bus. If existing, it must be configured as Slave.
x0xx	0	x ↓ x x	Error Type_B (default value)
x1xx	1	x ↑ x x	Error Type_A
xx0x	0	x x ↓ x	Min ambient temp not applied
Xx1x	1	x x ↑ x	Min ambient temp applied
xxx0	0	x x x ↓	KEEP SWITCH IN THIS POSISIONT (default value)
xxx1	1	x x x ↑	DO NOT TURN SWITCH INTO THIS POSITION (not applicable).

**Table 3.1** S1 Switch configuration

**S3 – Modbus protocol: Slave address and baudrate**

Add	Switches 1 2 3 4 5 6 7 8	Add	Switches 1 2 3 4 5 6 7 8	Add	Switches 1 2 3 4 5 6 7 8	Add	Switches 1 2 3 4 5 6 7 8
0	↓ ↓ ↓ ↓ ↓ ↓ x x	16	↓ ↓ ↓ ↓ ↑ ↓ x x	32	↓ ↓ ↓ ↓ ↓ ↑ x x	48	↓ ↓ ↓ ↓ ↑ ↑ x x
1*	↑ ↓ ↓ ↓ ↓ ↓ x x	17	↑ ↓ ↓ ↓ ↓ ↓ x x	33	↑ ↓ ↓ ↓ ↓ ↑ x x	49	↑ ↓ ↓ ↓ ↑ ↑ x x
2	↓ ↑ ↓ ↓ ↓ ↓ x x	18	↓ ↑ ↓ ↓ ↓ ↓ x x	34	↓ ↑ ↓ ↓ ↓ ↑ x x	50	↓ ↑ ↓ ↓ ↑ ↑ x x
3	↑ ↑ ↓ ↓ ↓ ↓ x x	19	↑ ↑ ↓ ↓ ↓ ↓ x x	35	↑ ↑ ↓ ↓ ↓ ↑ x x	51	↑ ↑ ↓ ↓ ↑ ↑ x x
4	↓ ↓ ↑ ↓ ↓ ↓ x x	20	↓ ↓ ↑ ↓ ↓ ↓ x x	36	↓ ↓ ↑ ↓ ↓ ↑ x x	52	↓ ↓ ↑ ↓ ↑ ↑ x x
5	↑ ↓ ↑ ↓ ↓ ↓ x x	21	↑ ↓ ↑ ↓ ↓ ↓ x x	37	↑ ↓ ↑ ↓ ↓ ↑ x x	53	↑ ↓ ↑ ↓ ↑ ↑ x x
6	↓ ↑ ↑ ↓ ↓ ↓ x x	22	↓ ↑ ↑ ↓ ↓ ↓ x x	38	↓ ↑ ↑ ↓ ↓ ↑ x x	54	↓ ↑ ↑ ↓ ↑ ↑ x x
7	↑ ↑ ↑ ↓ ↓ ↓ x x	23	↑ ↑ ↑ ↓ ↓ ↓ x x	39	↑ ↑ ↑ ↓ ↓ ↑ x x	55	↑ ↑ ↑ ↓ ↑ ↑ x x
8	↓ ↓ ↓ ↑ ↓ ↓ x x	24	↓ ↓ ↓ ↑ ↓ ↓ x x	40	↓ ↓ ↓ ↑ ↓ ↑ x x	56	↓ ↓ ↓ ↑ ↑ ↑ x x
9	↑ ↓ ↓ ↑ ↓ ↓ x x	25	↑ ↓ ↓ ↑ ↓ ↓ x x	41	↑ ↓ ↓ ↑ ↓ ↑ x x	57	↑ ↓ ↓ ↑ ↑ ↑ x x
10	↓ ↑ ↓ ↑ ↓ ↓ x x	26	↓ ↑ ↓ ↑ ↓ ↓ x x	42	↓ ↑ ↓ ↑ ↓ ↑ x x	58	↓ ↑ ↓ ↑ ↑ ↑ x x
11	↑ ↑ ↓ ↑ ↓ ↓ x x	27	↑ ↑ ↓ ↑ ↓ ↓ x x	43	↑ ↑ ↓ ↑ ↓ ↑ x x	59	↑ ↑ ↓ ↑ ↑ ↑ x x
12	↓ ↓ ↑ ↑ ↓ ↓ x x	28	↓ ↓ ↑ ↑ ↓ ↓ x x	44	↓ ↓ ↑ ↑ ↓ ↑ x x	60	↓ ↓ ↑ ↑ ↑ ↑ x x
13	↑ ↓ ↑ ↑ ↓ ↓ x x	29	↑ ↓ ↑ ↑ ↓ ↓ x x	45	↑ ↓ ↑ ↑ ↓ ↑ x x	61	↑ ↓ ↑ ↑ ↑ ↑ x x
14	↓ ↑ ↑ ↑ ↓ ↓ x x	30	↓ ↑ ↑ ↑ ↓ ↓ x x	46	↓ ↑ ↑ ↑ ↓ ↑ x x	62	↓ ↑ ↑ ↑ ↑ ↑ x x
15	↑ ↑ ↑ ↑ ↓ ↓ x x	31	↑ ↑ ↑ ↑ ↓ ↓ x x	47	↑ ↑ ↑ ↑ ↓ ↑ x x	63	↑ ↑ ↑ ↑ ↑ ↑ x x

**Table 3.2 S3 Modbus Slave address**

Binary value b <sub>0</sub> ...b <sub>7</sub>	Decimal value	Switches 1 2 3 4 5 6 7 8	Description
xxxxxx00	0	x x x x x x ↓ ↓	2400bps
xxxxxx10	1	x x x x x x ↑ ↓	4800bps
xxxxxx01	2	x x x x x x ↓ ↑	9600bps (- default value)
xxxxxx11	3	x x x x x x ↑ ↑	19200bps

**Table 3.3 S3 Modbus baudrate****S4 – Temperature and termination: Degrees/Decidegrees (x10), temperature magnitude (°C/°F), number of fan speeds and EIA485 termination resistor.**

Binary value b <sub>0</sub> ...b <sub>3</sub>	Decimal value	Switches 1 2 3 4	Description
0xxx	0	↓ x x x	Temperature values in Modbus register are represented in degrees (x1) (default value)
1xxx	1	↑ x x x	Temperature values in Modbus register are represented in decidegrees (x10)
x0xx	0	x ↓ x x	Temperature values in Modbus register are represented in Celsius degrees (default value)
x1xx	1	x ↑ x x	Temperature values in Modbus register are represented in Fahrenheit degrees
xx0x	0	x x ↓ x	KEEP SWITCH IN THIS POSISIONT (default value)
xx1x	1	x x ↑ x	DO NOT TURN SWITH INTO THIS POSITION (not applicable).
xxx0	0	x x x ↓	EIA485 bus without termination resistor (default value)
xxx1	1	x x x ↑	Internal termination resistor of 120Ω connected to EIA485 bus**

**Table 3.4 S4 Temperature and termination configuration**

\* Default value

\*\* The termination resistor must only be activated in the interfaces connected at both ends of the bus, not in the rest. The EIA485 bus can be biased through internal jumpers JP2 and JP3. See section 3.7.

### 3.4 Implemented Functions

LG-RC-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 of more than 1 register with the same request, this means that length field should always be 1 when using this function for writes)

The maximum number of registers that can be read in a single request is 100.

### 3.5 Special behaviors

#### 3.5.1 Window contact

The LG-RC-MBS-1 has the functionality of automatically control the turning off of the AC indoor unit depending on the state of the window contact register.

The AC indoor unit will be turned OFF if the window contact register indicates “window opened” for a certain period of time (default value: 30 minutes).

If the AC unit is turned on through either the remote controller or the On/Off register and the window contact is still indicating “window opened”, it will restart the countdown of the 30 minutes and after that it will turn OFF the AC unit again.

If the window contact register is indicating “window closed”, this functionality will have no effect to the normal operation.

#### 3.5.2 Considerations on LG-RC-MBS-1 temperature registers

LG-RC-MBS-1 implements two registers containing temperature values:

- **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 3-wire bus of the LG indoor unit will report the same temperature setpoint value as this register.
- **AC unit external reference temperature (R/W)** (register 23 – in PLC addressing): This register allows providing an external temperature reference from Modbus side. If an external temperature is provided through this register, indoor unit will use it as reference for its temperature control loop.
  - This register will have no effect in those LG RAC / domestic line splits Air-Conditioning units – this is, those models requiring an additional communication accessory enabling communication with LG-RC-MBS-1.
  - For this temperature to take effect it is required that the LG AC indoor unit is configured in such a way that it uses the “thermostat sensor in the remote controller” (this is, LG-RC-MBS-1 will act as thermostat sensor providing a temperature sensor reading).
  - This configuration is done via a LG remote controller connected to the indoor unit (Function number “42” – setting value “1” / operation of Thermosensor button) and must be done by LG authorized installers at the time of the installation of the AC.
  - Register value after LG-RC-MBS-1 startup is -32768, which means that no temperature reference is provided to the AC indoor unit. In that case, AC indoor unit will use its own return path temperature sensor as reference for its control loop.

Additionally, note that temperature values from all these three registers are expressed according to the temperature format configured through its onboard DIP-Switches (See 0). 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 22°C)
- 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 22.0°C)
- 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 72°F (~22°C).

### 3.5.3 Device disablement

If the device disablement register is set to 1, it will not allow the LG-RC-MBS-1 to change the state of the AC unit. All the Modbus registers will show the current state of the AC unit as if they were "Read Only registers".

### 3.5.4 Remote controller disablement

When the remote controller is disabled, changes made by the remote controller will be corrected by the LG-RC-MBS-1 setting the previous value. In this way, the LG-RC-MBS-1 will prevent the remote controller from changing the state of the AC unit.

## 3.6 Device LED indicator

The device includes two LED indicators (check Figure 3.1) to signal its different possible operational states. Their meaning is explained in this section:

L1 (green)			
Operation	ON	OFF	Meaning
Blinking	500 ms	500 ms	Error
Flashing	100 ms	1900 ms	Normal operation (configured and working)

L2 (red)			
Operation	ON	OFF	Meaning
Pulse	3 sec	--	Undervoltage

L1 (green) & L2 (red)			
Operation	ON	OFF	Meaning
Pulse	5 sec	--	Device start-up
Alternate blinking	500 ms	500 ms	Flash checksum not OK

### 3.7 EIA485 bus. Termination resistors and Fail Safe Biasing mechanism

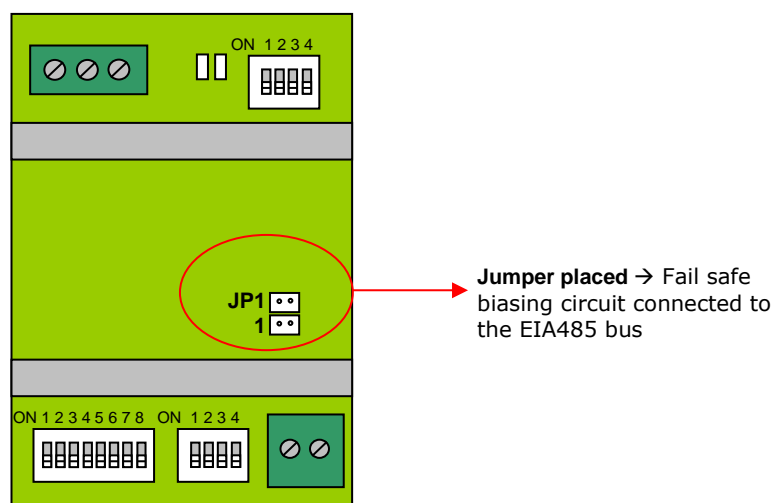
EIA485 bus requires a 120Ω terminator resistor at each end of the bus to avoid signal reflections.

The LG-RC-MBS-1 device includes an on-board terminator resistor of 120Ω that can be connected to the EIA485 bus by using DIP-switch (Table 3.4).

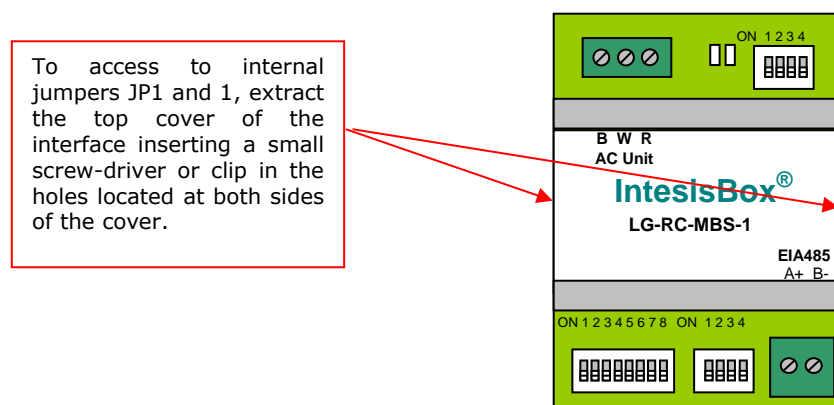
A fail safe biasing circuit has also been included in the board of LG-RC-MBS-1, it can be connected to the EIA485 bus by placing internal JP1 and 1 jumpers (see details in Figure 3.2). This fail safe biasing of the EIA485 bus must only be supplied by one of the devices connected to the bus.

*Some Modbus RTU EIA485 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 EIA485 network in every case).*

Location of jumper and DIP-switches for EIA485 bus Termination resistor or Fail Safe Biasing selection:



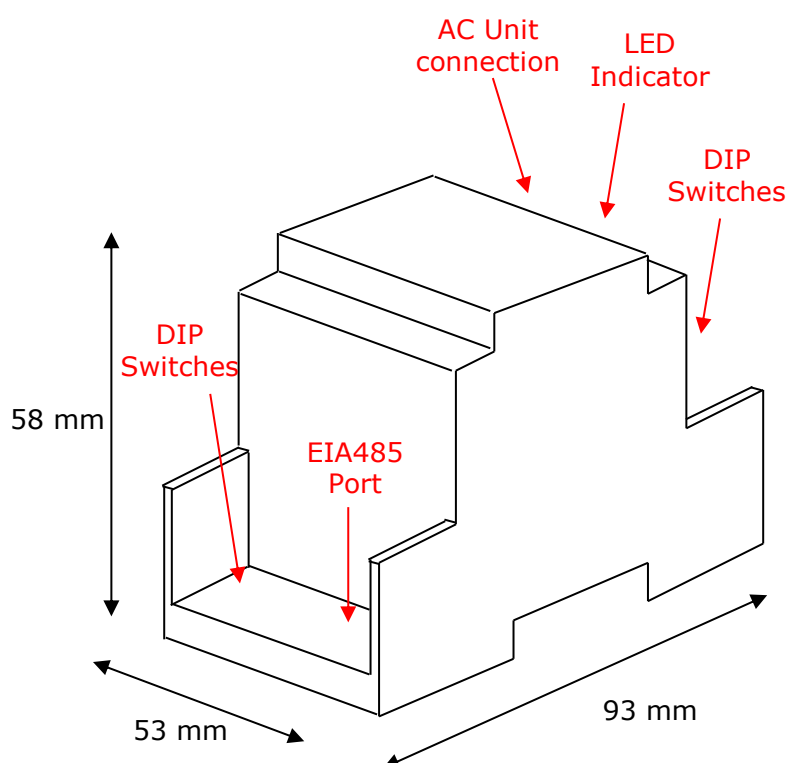
**Figure 3.2** Fail Safe jumper



**Figure 3.3** Accessing the jumper

## 4. Specifications

<b>Dimensions:</b>	93 x 53 x 58 mm
<b>Weight:</b>	85 g
<b>Consumption Current:</b>	80 mA
<b>Operating Temperature:</b>	0 . . . 40°C
<b>Stock Temperature:</b>	-40 . . . 85°C
<b>Operating Humidity:</b>	<95% RH, non-condensing
<b>Stock Humidity:</b>	<95% RH, non-condensing
<b>Isolation voltage:</b>	1000 VDC
<b>Isolation resistance:</b>	1000 MΩ
<b>Modbus Media:</b>	Compatible with Modbus RTU - EIA485 networks



**Figure 4.1** LG-RC-MBS-1 external sketch

## 5. AC Unit Types Compatibility

A list of LG indoor unit model references compatible with LG-RC-MBS-1 and their available features can be found in:

[http://www.intesis.com/pdf/IntesisBox\\_LG-RC-xxx-1\\_AC\\_Compatibility.pdf](http://www.intesis.com/pdf/IntesisBox_LG-RC-xxx-1_AC_Compatibility.pdf)

## 6. Error Codes

In order to get the right values regarding AC error codes, remember that you have to select the proper switch configuration. Find below a summary table of the different AC systems and the switch configuration for each of them to be selected.

Please check your LG manual for more details on the error codes.