DM-108
User's Manual

ADV. Products

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1. GENERAL DESCRIPTION

DM-108 is a DIN-rail installable device which acts as wireless bridge, in the band of 868MHz, inside traditional wired RS485 Modbus RTU installations, providing the limited point-to-point RS485 networks with the versatility and ease of installation of wireless sensor networks (WSN).

The DM-108 is auto routable, which means that each node automatically selects the best route to forward the data packets, effectively disseminating the Modbus commands to all connected devices. The net is based on the topology Coordinator-endpoint, where the endpoints could be act automatically as repeaters at the same time to connect with others DM-108. It is only possible to have one coordinator in each net or group ID. The maximum number of hops between nodes is five.

For the correct dissemination and installation of the DM108, each one has a RSSI Table where saves for each communication the Radio ID (of whom had transmitted a radio frame) and the respective RSSI and LQI.

Once installed, the DM-108 are transparent devices inside the RS485 network, not only maintaining the electric requirements of the bus but also the integrity of Modbus RTU packet frames transmitted.

It can be adapted to other industrial protocols of communications.

Apart from the wireless bridge functionality, DM-108 act as pulse counter and with its open drain output, could it be used as power manager for other devices.

Figure 1: DM-108

Note: Between registers request and writing, the minimum interval should be at least 800 milliseconds. This is mandatory to avoid errors due to the inherent wireless delays.

2. FEATURES

Feature	Description
Electric	
Main Power Source	9Vdc@80mA ⇔ 30Vdc@24mA
Wet contact pulse maximum voltage	30Vdc
Power Consumption	< 1W
Interfaces	
Radio	869 MHz –SMA external connector
RS485	Interface RS485 Half duplex.
USB	USB serial emulation for connect to PC
Communication Protocol	Modbus RTU. Adaptable to others industrial protocols.
Pulses Input	With edge pulse configurable, it is possible to count up to $2^{32} - 1$.
Open Drain Output	Driving up to 2A, it could manage other power supplies, relays or Circuit Breakers.
Mechanical	
Dimensions	18x89x59 mm
Material	PC/ABS
IP Class	IP20
Verified Certifications	
CE	UNE-EN 60950-1:2007 +Corr:2007+A11:2009+A1:2011 +A12:2011/AC2012(Partial) UNE-EN 61000-6-1:2007 UNE-EN 61000-6-3:2007 UNE-EN 55 022:2011 + Err (UNE-EN55022:2011/AC) UNE-EN 55 024:2011 EN 301489-1 v1.8.1 (2008-02)(Partial)(1 – 6 GHz Band)

3. DM-108 CONNECTIONS

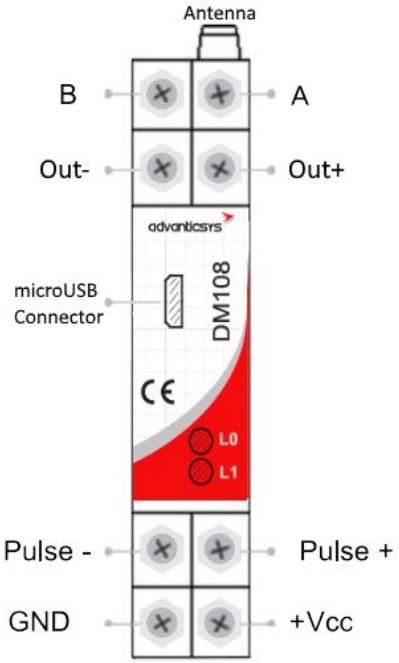

Figure 2: DM108 connections

- **Power Supply**. It is powered between 9 and 30 Vdc. It is mandatory to follow the polarity of the connection to avoid damages in the device. The negative pole must be connected to GND terminal and the positive pole to VCC terminal.
  Important: In idle state, the DM-108 consumes around 170 mW. When the radio is transmitting there will be peaks of 700mW, so the power supply must be within these limits for a correct performance.
- **MicroUSB Connector**. May be used as UART to recover a configuration. Also for a firmware updating.
- **Pulse input**. The positive pole will be connected to *Pulse+* terminal, and the negative to *Pulse-* terminal.
  The DM-108 can be configured to receive different types of electrical pulses: open collector, open emitter and wet contact pulse (up to 30Vdc). For dry contacts, the configuration will be the same as the open collector.

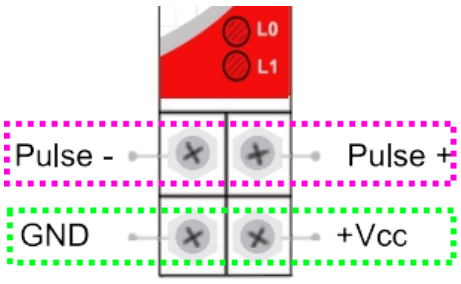

Figure 3: Power supply and pulse connections

- **RS485 bus.** The A line is connected to terminal A, and the B line to terminal B.
- **Output.** The output positive terminal connects the drain of the driver, and the negative terminal is internally connected to the ground, so the common of the output must be connected to this terminal.

- **Antenna.** In the SMA connector of the DM-108 any antenna compatible with the 868MHz band could be connected.
  Important: For reach 1Km LoS, the antenna should have at least **3dBi** in the band of 868MHz.

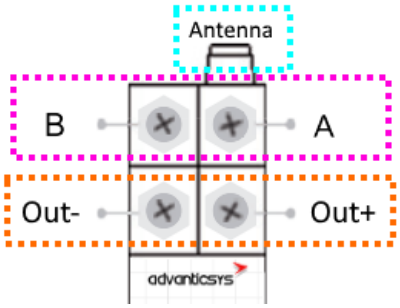

Figure 4: Output, RS485 bus and antenna connections

4. USB CONNECTION

Figure 5: DM108 microUSB connector

The microUSB connector is used only for two purposes:

- Updating firmware: Advantic Sys has an application to update the DM108 firmware via USB. This application will only be provided in case of the existence of a new firmware version.
- Use with the **WM Config Tool** for the recovery of the configuration in case of unknown configuration. Because the UART generated, when an USB is connected, has a fixed 19200bps, 8 bits, none parity and one stop bit, you can recover any DM108 when their configuration is unknown or when you can recover over the RS485 port.

Figura 6: USB connected

Warning!

If you are going to connect the DM108 for the first time to a PC, it is mandatory to change two features when Windows creates the PORT COMM. Please, follow the next steps after the DM108 has been connected to the PC via USB:

1. Once the PC detect the new COM PORT:
2. Go to Panel Control>Device Manager>Ports (COM & LPT).
3. Select the new COM port created and go to Properties, clicking on rigth mouse button.
4. Go to TAB Port Settings.

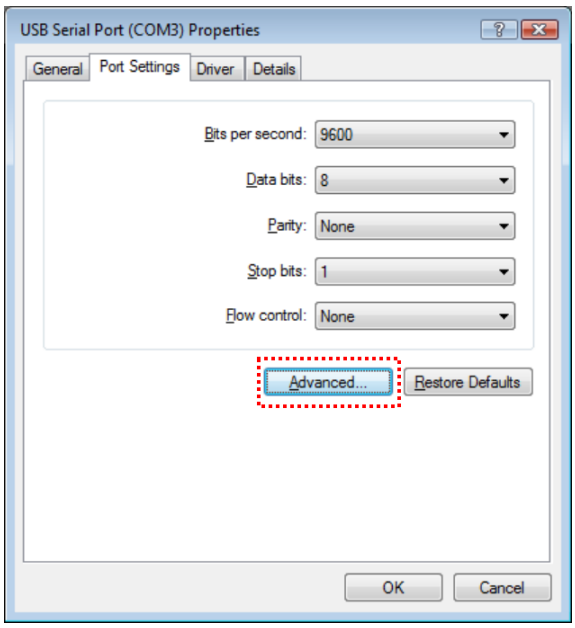

Figure 7: Port COM Properties on Windows PC

5. Click on ***Advanced*** button and then perform next actions:

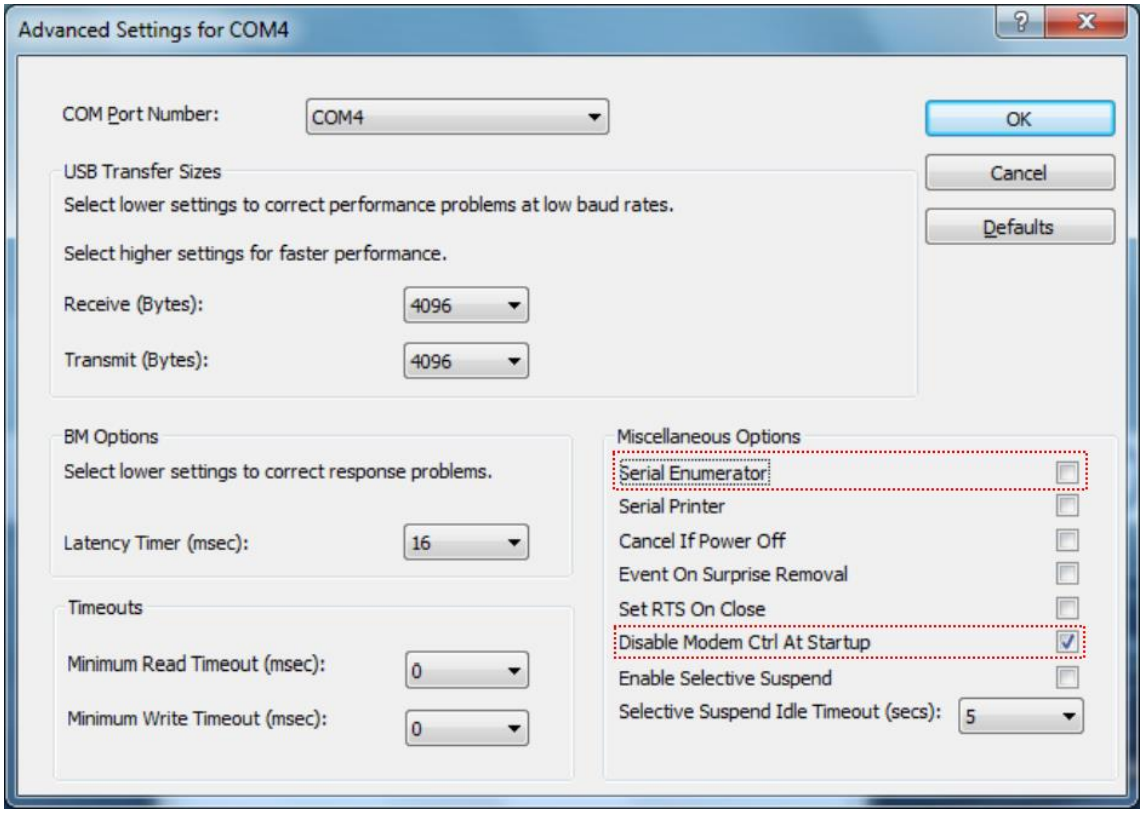

Figure 8: Advanced Settings for COM PORT

i. **Uncheck the Serial Enumerator BOX.**
ii. **Check the Disable Modem Ctrl at Startup**

6. Click on **OK** and close Control Panel

5. PULSE INPUT CONFIGURATION

By default, the DM-108 is configured for wet contact pulses, so, if it is necessary to change the type of pulse input, the DM-108 can be opened as shown below:

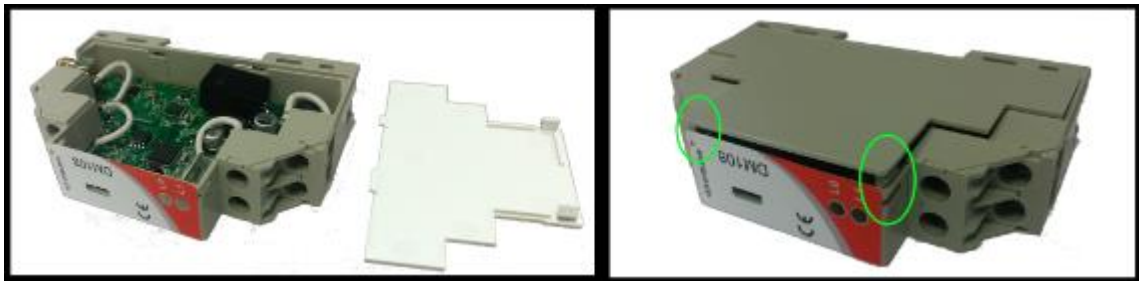

Figure 9: DM-108 opening

Internally, the DM-108 has a pin block (JP1) which configures the type of pulse input depending on the jumper connection. There are three electrical pulses that would be connected to DM-108:

- Open collector. The jumper should be connected on position 1 of the block JP1. This configuration is also valid for dry contact pulses.

Figure 10: Jumper position for open collector or dry contact pulses

- Open emitter. The jumper must be positioned in pos 3.

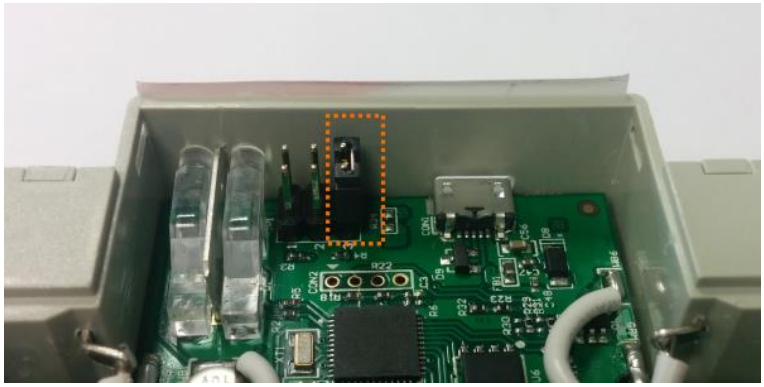

Figure 11: Jumper position for open emitter

- Wet contact pulse. In this case, the jumper will be connected on position 2.

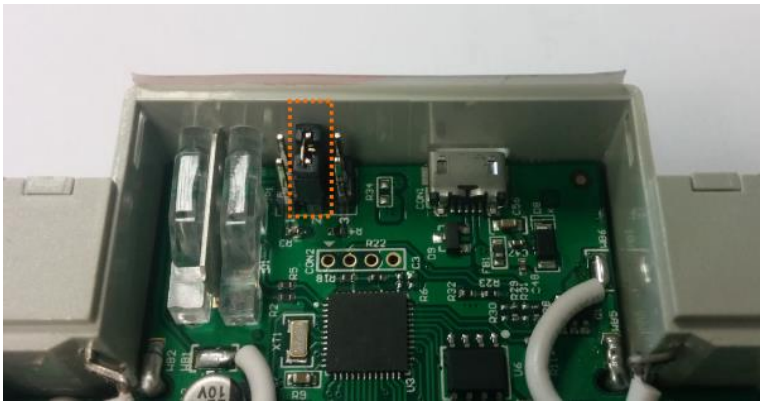

Figure 12: Jumper position for wet contact pulses

6. CONFIGURING DM-108 WITH WM CONFIG TOOL

There are two methods for configuring the DM-108: writing the configuration registers or using the Advantic software ***WM Config Tool***. It is recommended to use this last option, which is described in the annex.

Critical parameters:

- **Modbus Id**. It is the Modbus identification number for the network communications. In the same net, each DM-108 or Modbus device must have different Id. The Id 0 and the ID's from 248 to 255 are forbidden.
- **Radio Id**: Is the radio identification for the wireless communication. By default, it is generated internally, using the UID of the RTC chip. It is recommended not to change it. The only specific ID is the Coordinator id which is 257 so any endpoint can't get this radio ID. The ID Radio range is between 257 and 65279.
- **Node Role**. If the **Coordinator** checkbox is active, the DM-108 role will be coordinator, being the main node of the network. **There can only be a coordinator** within each net or group. If the checkbox is deactivated the role of the DM-108 will be *endpoint*. When is activated the coordinator option, automatically the radio ID changes to 257.
- **Group Id**. This identification sets different net groups into the same channel radio. Each group must have a coordinator.
- **Radio Channel.** This parameter defines the physical radio channel in the 869MHz band. Each channel has 150 KHz of separation. There are 10 channels, 0 to 9.
- **AES Encryption Enabled**. This option enables or disables the wireless messages encryption by the AES 128 bit algorithm. Its activation reduces the communication speed. Warning: all the devices must have the same option, because if there are any device with different AES configuration, will produce fatal errors in the Wireless network.
- **RS485**. The RS485 port can be configured with the next options:
    - **Baud rate**. Between 2400 to 19200 bps.
    - **Parity**. No parity, Odd parity or Even parity.
    - **Data bits**. Seven or eight bits of data.
    - **Stop bits**. Two stop bits or one.

Other parameters:

- **TX Power.** Sets the Radio power transmission of DM-108.It is possible to choose between -2dBm and +26dBm. The maximum power is recommended only for distances above 50 meters.

- **ACK Enabled.** This option enables or disables the wireless messages control through acknowledges.
    - **ACK Timeout.** Sets the time (in milliseconds) that it has to pass for consider a wireless message lost, and then proceed to the transmission retries.
    - **ACK Retries.** Sets the number of the transmission retries after ACK timeouts.
- **Routing Retries.** This option is only accessible for the coordinator. It indicates the number of retries to be done following a communication route when that route fails. Once the retries had been completed, the coordinator will search another route to stablish a communication.

These parameters have to be correctly defined taking into account the timeouts and retries of the Modbus master. The ACK timeouts and retries should be less than the Modbus Master timeouts.

7. MODBUS REGISTERS

Due to the wireless physical layer, the **maximum number of registers** that could be **read** in one request is **20**, and the maximum number registers that could be **written** in one order is **16**.

Also, as we already commented in the first point, the minimum interval between Modbus orders should be two seconds, even for writing orders should be upper. The Modbus timeouts must be respect this timing to avoid the collapsing of the wireless communications.

The user could change the timing and retries of the radio ACKs to accelerate the communications, but it will be under the user responsibility.

The DM-108 itself has accessible some MODBUS registers for its own configuration, for the pulse counter interface and the RSSI Table.

8. PULSE COUNTER

The pulse counter interface within the DM-108 has four MODBUS registers that are stored in non-volatile memory. These registers can be written (for erase or edit a new value) or read.

The first two registers store the count of pulses, forming a 32 bit variable. In case of overflow of the pulse count, the counter begins in zero value.

The third register stores the pulse input value in real time, so it is possible to know anytime the input value.

And the last register, depending on its value, configures the edges to have in account for the count of pulses:

- 0: Falling edge
- 1: Rising edge
- 2: Both edges

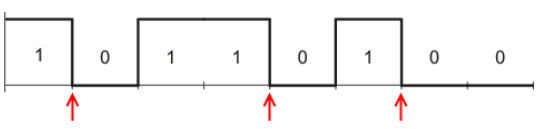

Figure 13: Falling edges of pulses input

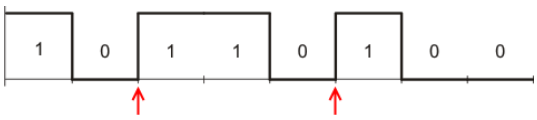

Figure 14: Rising edges of pulses input

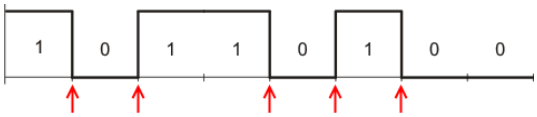

Figure 15: Both edges of pulses input

DM-108 type of pulses:

- Open collector:

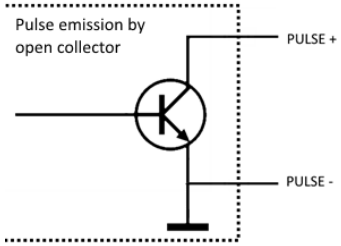

Figure 16: Open collector output

- Open emitter: The philosophy of this type is the same as the open collector, but in this case the circuit which must be closed is the emitter of the transistor of the transmitter of pulses.
- Wet contact pulse:

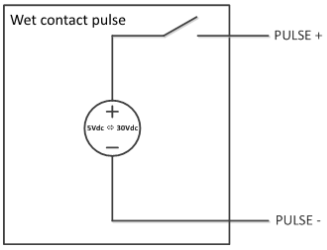

Figure 17: Wet contact pulse

- Dry contact pulse. In this case, as we see in the configuration of the jumper, it is used the same configuration of the open collector.

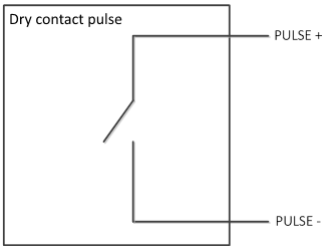

Figure 18: Dry contact pulse

Table with the Modbus registers associated to Pulses input:

MODBUS REGISTER	MODBUS Function	Description	Range
4096	F3, F16	32bit pulse counter value	From 0 to (2^{32} – 1)
4097	F3, F16		
4098	F3, F16	Pulse value in real time	0: 0V input 1: Active input
4099	F3, F16	Selection edge for the count of pulses	0: Falling edge 1: Rising edge 2: Both edges

9. OUTPUT

The DM108 has one **Open Drain output**, which could manage power supplies, relays or Circuit Breakers. Also, could be used as open collector output to use with a digital input of any device. The maximum current that the output is capable to drive is **2 amperes**.

The OUT- pole is internally connected to GND, so it is mandatory to be aware about the output connections to avoid permanently damages on DM108.

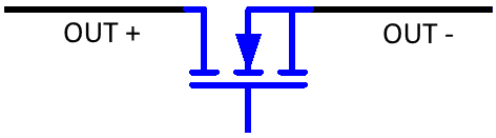

Figure 19: DM108 Open Drain Output

The Modbus **register 99** permits to view the actual state of the output: activated or deactivated.

Output Modes:

The output could be use with 3 different modes, as user desires. When one mode is activated, the others are deactivated automatically if there are any of them activated:

- Continuous mode: The user can activate or deactivate permanently the output, changing the state with the register **100**.
- Unique pulse mode: There are two registers that manage this mode: register **103** describes the width length of the pulse, and the register **102** activates the unique pulse. Once the width of the pulse is reached, the output state goes to deactivated state. The minimum pulse width admitted is **10 milliseconds**.

Figure 20: Unique Pulse output mode

- Pulse Width Modulation: This mode is managed by the registers **101, 104 and 105**. The registers **104** and **105** describes the duty cycle of the PWM, being the register 104 which stablish the **OFF cycle** and the register 105 the **ON cycle**. The minimum cycle width is **10 milliseconds**.

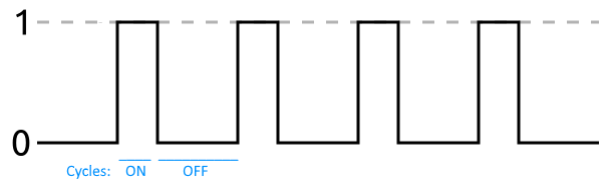

Figure 21: PWM Output Mode

Examples of use:

- Managing a Power Supply as a switch. In this case, the Dm108, with its Modbus registers, can control the supply of other electronic devices as long as the current to drive doesn't :

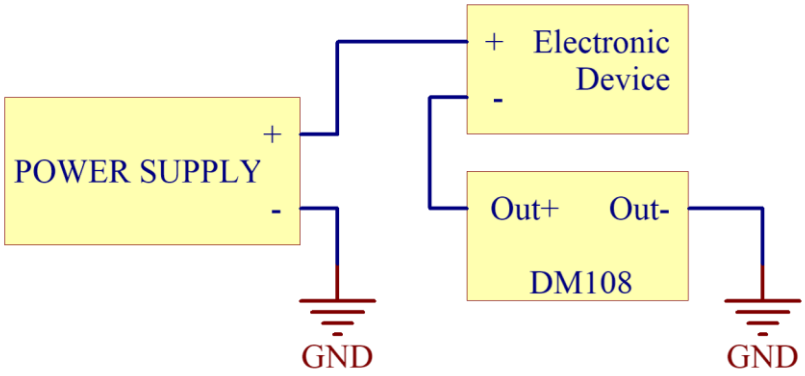

Figure 22: DM108 as a Power Switch

- Managing the coil of a Relay. In this case, the DM108 drives or stop the current of the relay's coil.

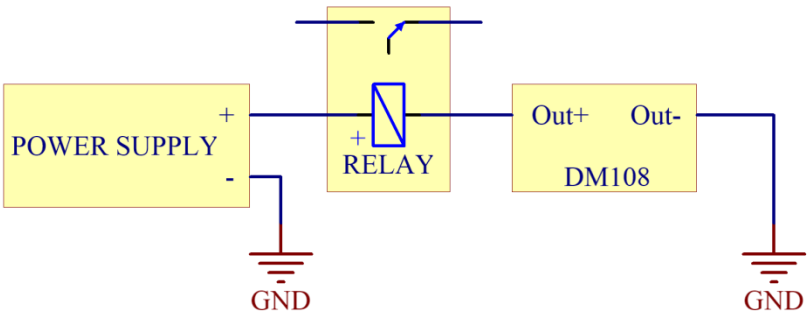

Figure 23: DM108 managing a relay

- Managing a Circuit Breaker. It is the same case as the relay managing.

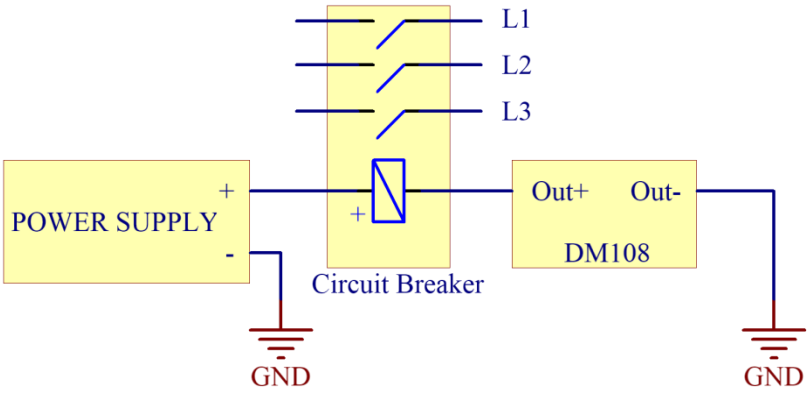

Figure 24: DM108 managing a circuit breaker

- Acting as digital output. With a simple pull up resistor connected between the OUT+ and the positive pole of the power supply connected to the device, the DM108 could activate or deactivate digital inputs.

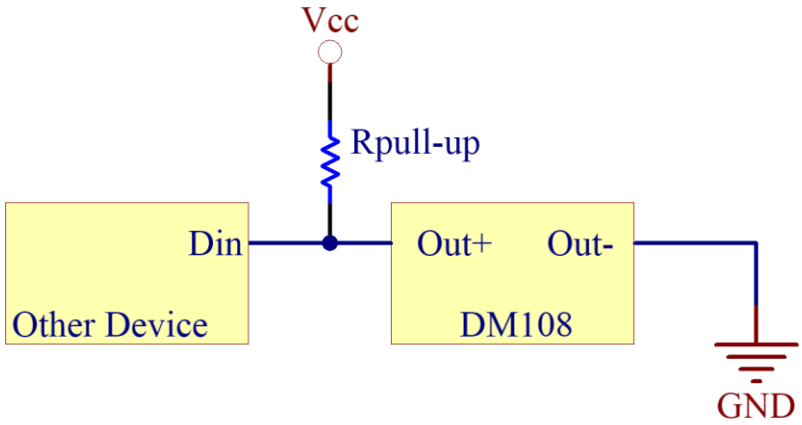

Figure 25: DM108 output connected to a digital input

Table with the Modbus registers associated to Pulses input:

MODBUS Register	MODBUS Function	Description	Range
99	**F3**	**Actual Output State**	0 = Output deactivated 1 = Output activated
100	**F3, F16**	**Continuous mode out**	0 = Output deactivated 1 = Output activated
101	**F3, F16**	**PWM mode out**	0 = PWM deactivated 1 = PWM activated
102	**F3, F16**	**Single Pulse mode out**	0 = Output deactivated 1 = One pulse generated
103	**F3, F16**	**Single Pulse Width**	10 to (2^{16} - 1) milliseconds
104	**F3, F16**	**PWM Off Cycle width**	10 to (2^{16} - 1) milliseconds
105	**F3, F16**	**PWM On Cycle width**	10 to (2^{16} - 1) milliseconds

Writing these Modbus registers can only be done one at a time.

10. CONFIGURATION REGISTERS

As we see in point 6, the DM-108 configuration can be performed writing the corresponding registers.

- Register **4224**:
  - High byte. Represents the **Group ID**. It has a range between 0 and 255.
  - Low byte. It is the **channel radio**. It has a range between 0 and 9.
- Register **4225**:
  - High byte. It has **Modbus ID** and its range is between 1 and 254. 0 and 255 are forbidden.
  - Low byte. Here is defined the DM-108 **role**. If the value is 1, the role is **COORDINATOR**; if it is 0, the role is **ENDPOINT**.
- Register **4226**:
  - High byte. **Routing Retries**. ONLY FOR COORDINATOR: Is the number of retries to stablish communication between a Coordinator and other modbus device following the route stablished in the routing table of the Coordinator. After a fail in the las retry, the Coordinator will search another route. Range: from 1 to 200
  - Low byte. **RS485 port configuration**:

Bit 7	0	**Bit 6**	0	2400bps
	0		1	4800bps
	1		0	9600bps
	1		0	19200bps
Bit 5	0	**Bit 4**	-	No parity
	1		0	Odd parity
	1		1	Even parity
		Bit 3	0	1 Stop bit
			1	2 Stop bits
		Bit 2	0	7 data bits
			1	8 data bits
		Bit 1	X	X
		Bit 0	X	X

    For example, if we want to set up the following configuration parameters: 9600bps, 8, Even parity and 1 stop bit, the low byte should have the next value: 180 (0xB4 or 0b10110100).
- Register **4227**: It is the Radio ID, which value is between 257 and 65279. The ID **257** is reserved exclusively for the **COORDINATOR**.
- Register **4228**:
  - High byte. This activates or deactivates the radio messages *ACKNOWLEDGES*:
    - 0 -> Deactivated.
    - 1 -> Activated.
  - Low byte. This byte activate or deactivate the AES encryption:
    - 0 -> Deactivated.
    - 1 -> Activated.
- Register **4229**:
  - High byte. Power transmission of the 869MHz radio:
    - -2dBm: The byte value is 3.
    - +7.5dBm: Value = 23.
    - +12.5dBm: 29.
    - +18dBm: 38.
    - +22dBm: 55.
    - +25dBm: 80.

        - +26dBm: 134.
    - Low byte. Reserved.
- Register **4230**:
    - High byte. Reserved.
    - Low byte. Number of transmission retries after an ACK timeout.
- Register **4231**: This register is reserved
- Register **4232**: This register saves the milliseconds for the ACK timeout. Its range is between from 0 to 65535. Important: the value of this register must be multiplied by 2 to get the real timeout. For example, 100ms of timeout means 50 in this register.

MODBUS REGISTER	MODBUS Function	Description	Range
4224	F3, F16	**High byte: Group Id**	From 0 to 255
		Low byte: Radio Channel	From 0 to 9
4225	F3, F16	**High byte: Modbus Id**	From 1 to 254
		Low byte: Roll Node	0 = Endpoint 1 = Coordinator
4226	F3, F16	**High byte: RESERVED**	
		Low byte: Uart Configuration	Depends on the bits for stablish a configuration
4227	F3, F16	**Radio Id**	Range between 257 and 65279. The ID 257 is reserved for the Coordinator.
4228	F3, F16	**High byte: ACK Enable**	0 = ACK deactivated 1 = ACK Activated
		Low byte: AES Enable	0 = AES deactivated 1 = AES activated
4229	F3, F16	**High byte: Radio POWER**	Power between -2dBm and +26dBm
		Low byte: RESERVED	
4230	F3, F16	**High byte: RESERVED**	
		Low byte: Retries after ACK fail.	From 0 to 255 retries
4231	F3, F16	**RESERVED**	
4232	F3, F16	**Timeout ACK**	From 0 to 65535 milliseconds

11. MODBUS NETWORK TOPOLOGY

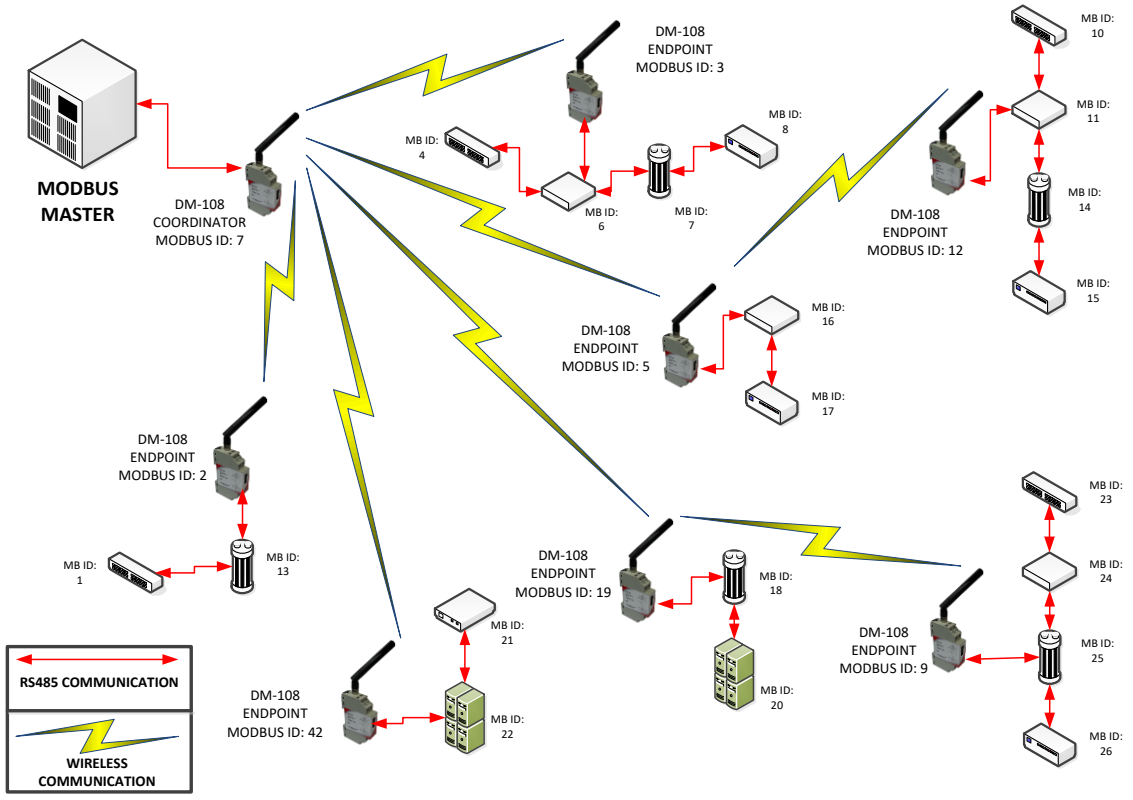

Figure 26: Wireless MODBUS Network

To perform a Wireless MODBUS network with the DM-108, it is necessary to configure one DM-108 as COORDINATOR, leaving the rest as endpoints. The MODBUS master should be connected to the Coordinator being this one the wireless bridge to the other Modbus slaves, which will be connected to the rest of the DM-108.

Important: One network can have up to 50 modbus devices.

The topology has a star shape, where all the wireless communications will converge to the DM-108 Coordinator, which translate all the Modbus frames to the Modbus Master. The wireless hops will take place automatically when the Coordinator has not direct link to the targetted DM-108 which has the Modbus slave connected to its RS485 bus.

Given that the Wireless communications need security mechanisms and acknowledges for stable networks, the Modbus requests and their responses will be slower than in a wired communication, so in order to avoid errors, the minimum time between Modbus requests should be one second. Below this value, the Modbus performance may be erratic. In addition, if there are hops in the wireless communication, the speed of the transactions will be even slower, thus, it is mandatory to be careful with the time between requests. Above one second, Modbus network will be stable.

The DM-108 have MODBUS ID, so we must have care with all the ID's of the slave which would be connected to the DM-108. For example, if we have a network formed by 64 DM-108 apart from the Coordinator, the number of Modbus devices that could be connected is: 247 – 65 = **182**.

For installations where it is necessary to use several nets, each one with its Coordinator, there is two ways to do it, depending on the installations necessities:

- The first one is to configure different radio channels for each net. This method permits 10 nets because the DM-108 has 10 physical channels in its radio.
- The second one permits 256 nets in the same installation. The Group ID byte is an extra identification byte for the net, so, independently of the radio channel, the devices with different Group ID will not communicate between them.

12. RSSI TABLE

The DM108 has a RSSI table where saves the Radio ID of anyone who had communicated with it and the RSSI and LQI level, associated to that Radio ID.

The table is totally accessible via Modbus registers: from register 4100 to 4200.

The first register, 4100, stores the number of Radio IDs saved in the table. When in this register is written a zero, the entire table is erased.

The rest of registers are grouped two by two, where the first register will store the Radio ID, and the next register the RSSI in the MSB and the LQI the LSB.

This table is helpful for the installation, easing to view which are the best positions for the DM108's position or to view the best place and orientation of the antenna.

MODBUS REGISTER	MODBUS Function	Description	Range
4100	F3, F16	Number of Radios stored in the table	From 0 to 50.
4101	F3, F16	RADIO ID of one DM108 who has communicated with this DM108	From 257 to 65279. This register will value 65535(0xFFFF) when it doesn't have any Radio ID stored.
4102	F3, F16	High byte: represents the RSSI level.	The RSSI is represented as absolute value; in fact it is a negative value, so the value stored in the high byte of this register must be represent with a negative signal.
		Low byte: represents the LQI level.	The LQI is represented between 0 and 255. Low values indicate a good link quality.
4103	F3, F16	RADIO ID of one DM108 who has communicated with this DM108	From 257 to 65279. This register will value 65535(0xFFFF) when it doesn't have any Radio ID stored.
4104	F3, F16	High byte: represents the RSSI level.	The RSSI is represented as absolute value; in fact it is a negative value, so the value stored in the high byte of this register must be represent with a negative signal.

		Low byte: represents the LQI level.	The LQI is represented between 0 and 255. Low values indicate a good link quality.
…	**F3, F16**	**RADIO ID of one DM108 who has communicated with this DM109**	…
…	**F3, F16**	**High byte: represents the RSSI level.**	…
		Low byte: represents the LQI level.	…
4199	**F3, F16**	**RADIO ID of one DM108 who has communicated with this DM110**	From 257 to 65279. This register will value 65535(0xFFFF) when it doesn't have any Radio ID stored.
4200	**F3, F16**	**High byte: represents the RSSI level.**	The RSSI is represented as absolute value; in fact it is a negative value, so the value stored in the high byte of this register must be represent with a negative signal.
		Low byte: represents the LQI level.	The LQI is represented between 0 and 255. Low values indicate a good link quality.

When there is not a Radio ID in a position of this table, the value of the register will be 0xFFFF, and so it is with the RSSI and LQI register.

13. ANNEX

- *WM CONFIG TOOL*

  Using an USB to RS485 converter, we can connect the DM-108 to a PC. By default, the serial port has the configuration 19200-8-N-1.

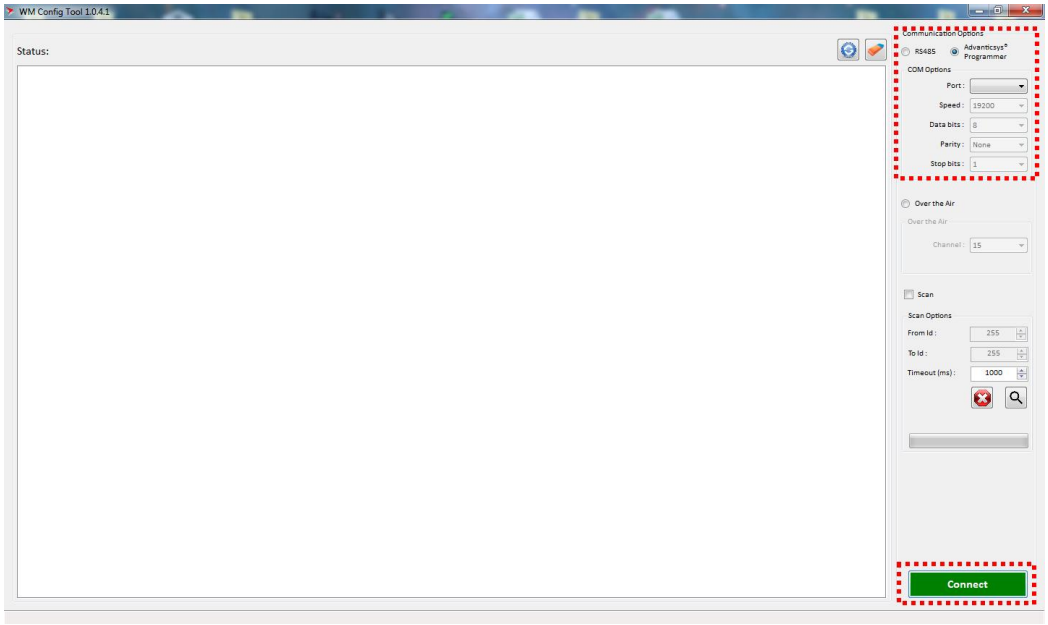

Figure 27: Main window of WM Config Tool

Once the software have been connected to the serial port via **CONNECT** button, we can access to the DM108's info by two ways:

- **Scan** unchecked. If the Scan is not selected and we press the button  , the tool will send a broadcast. If it is a Coordinator who is connected to the PC then most DM108 connected to the coordinator will respond to that order, so the WM Config Tool will show in tabs the configuration of each DM108 who had responded. Although none all the DM-108 will be showed because with the broadcast, all the devices would respond at the same time, so the application will not be able to take all the responses. If we want to view all the DM-108, is recommendable to use the known ID of each one. For this case, we must check the **Scan**, as we can read below.

  If an endpoint is who is connected to the PC, only it will respond to the broadcast.
- **Scan** checked. In this case we can search a range of Modbus IDs. For example, if you want to view only one device, you must write its Modbus ID in the box **From Id** and in the box **To Id.** If you want to search all the possible Modbus devices in the net, you can put from 1 to 247. In this case, depending on the Modbus timeout, the time spent could be too long.

The button  starts the search. If you want to stop it in anytime, you can press the button  . The timeout (in milliseconds) specifies the time that the application is going to wait for the Modbus responses about the configuration requests.

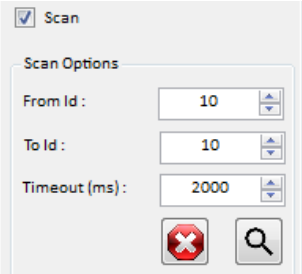

Figure 28: Scan Options

When a DM108 responds to the tool, it will show in a tab all of its information and configuration.
The viewing of the RSSI table is manual, as well as its refreshing. This means that it is necessary to press the button  that is near from the tittle **RSSI Table**.

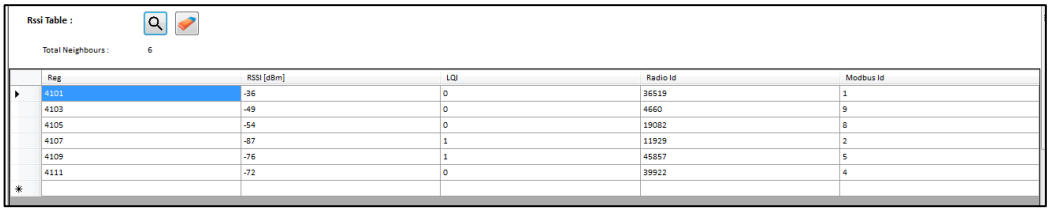

Figure 29: RSSI Table

When a DM108 has a communication with other DM108, the RSSI value is always refreshed.
If we want to erase the table from the DM108 we must press the button  .

For the other parameters, when anyone had been changed, to make the change effective, you must press the button **UPDATE**.

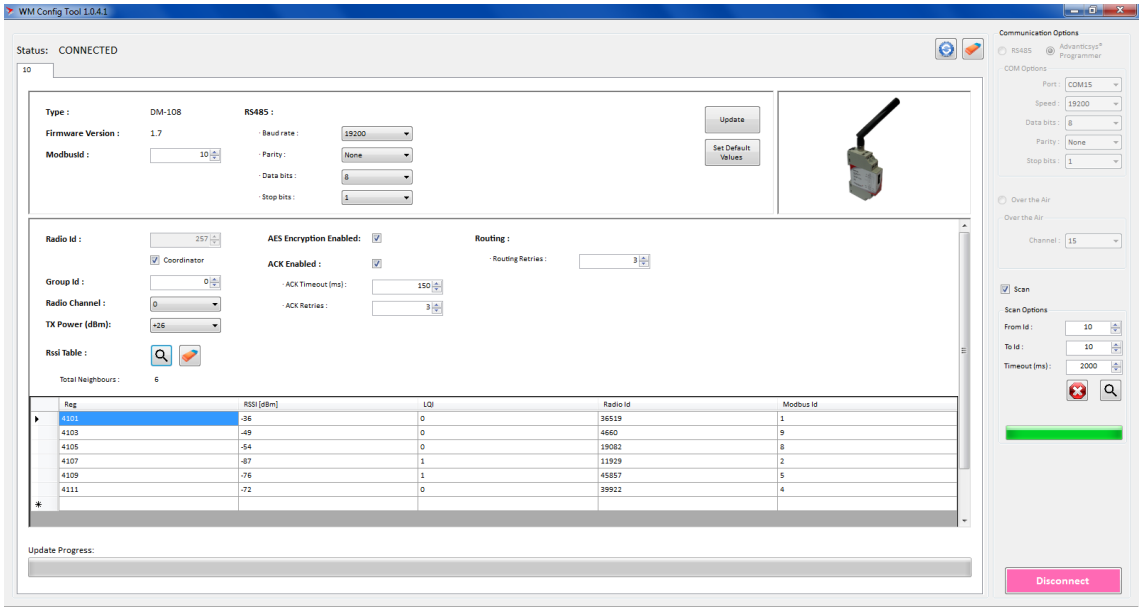

Figure 30: DM108 Config Tab