RF-G5P MCP

Multilayer Communication Protocol

Talgil computing and control LTD

Naaman Center, Haifa-Aco road 7000

P.O.BOX 775 KIRYAT MOTZKIN 2610701, ISRAEL

TEL: 972-4-9506050, Fax: 972-4-8775949

Email:talgil33@netvision.net.il

Installation instructions

& Quick user manual V1.0

Firmware versions

June 2023

RF_Master_G5P_V1.1

ECO_G5P_V1.1

RTU RF MODULAR - RFU_G5P_V1.1

- EXECUTER part Version 1.01

SNIFFER Version V1.8

Dream 2 Version 4.105

Table of content

Contents

FCC statement
for internal RF module, model RF-MODULE-G5P
FCC ID: 2AC2T-RF-MODULE-G5P

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and use in accordance with the instructions, may cause harmful interference to radio communications. However, there is not guarantee that the interference will not occur in particular installation. If this equipment does harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to connect the interference by one or more of following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer on the experienced radio/TV technician to help.

To assure continue compliance, any changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate this equipment. (Example- use only shielded interface cables when connecting to computer or peripheral devices).

This equipment complies with Part 15 off the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may be cause-undesired operation.

FCC Radiation Exposure Statement:

This equipment complies with FCC Radiation exposure limits set forth for uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

RF G5P MCP RADIO RTU SYSTEM

The G5P radio RTU (Remote Terminal Unit) system of TALGIL offers a perfect solution for controlling large scale distributed irrigation systems. The G5P radio system utilizes low transmission power and free frequency band, therefore no licensing is required. When having line of sight the distance between two nodes of the system can reach about 3-4 km, but the full coverage of the system is much bigger since the G5P RTUs can be easily turned into ROUTERs which enable remote RTUs to communicate through them. There can be 11 levels of repetition. The bidirectional communication between the RTUs and the control center enables not only activating remote outputs, but also reading remote inputs both digital and analog. To assure information integrity, each communication packet is expected to be acknowledged by the consignee and failure will force the originating unit to retry transmission. A G5P radio RTU system channel may handle up to 999 RTUs.

General features

- Point to point distance of 3-4 km with up to 11 levels of repetitions.
- Up to 999 RTUs per one system.
- Bidirectional communication.
- Automatic frequency selection.
- Automatic routing.
- Special Beacon mode for energy saving and reducing air occupancy.
- Transmission failures solved by retries.
- License exempt.
- Asynchronous communication
- I/O test mode
- Automatic shutdown of outputs on communication loss.
- Visual and sound signaling of statuses by LEDs and buzzer
- Reporting RTU low battery
- Configurable wakeup signals.
- Efficient diagnostic tools.
- Powering by battery or solar energy.

Requirements of KDB 996369 D03

- Applicable FCC rules: CFR 47 Part 15 Subpart C sections: 15.203, 15.205, 15.207, 15.209 and 15.247.
- Operating conditions: open air, temperature 0 - 50°C.
- Modules are tested for frequency accuracy and power compliance.
- The antenna is screwed into the SMA connector of the module.
- Radiation levels are considered within safe limits.
- Antenna: SAA31621A, antenna gain 2dbi.
- FCC ID labels are affixed to the modules.
- Modules are tested in receive and transmit modes.
- Additional testing, Part 15 Subpart B disclaimer.

Figure 1 - a G5P Economical RTU

PRINCIPLE OF OPERATION

All RTUs are expected to communicate to the center. The central receiver/transmitter is known as the MASTER.

All RTUs and the MASTER that belong to the same system must have a common NETWORK ID that will differentiate the particular system from other neighbring systems.

The MASTER is the one who decides about the frequency to be used by all the members of the system. When the MASTER is powered up it starts scanning the area looking for a frequency that is free enough to be utilized. During the frequency scanning the NET LED of the MASTER keeps blinking and when the frequency is selected the NET LED turns OFF. During operation the MASTER may decide that the selected frequency is no longer free enough and then it will repeat the scanning procedure as explained above.

When the RTU is powered up it starts seding TEST signals expecting to receive RESPONSE signals from the MASTER or the surrounding ROUTERs . if no RESPONSE is received, then after 3 failing TEST signals the RTU will move to the next frequency, repeating the same procedure, until receiving the expected RESPONSE signal.

The RESPONSE signal may arrive from several ROUTERs and the MASTER simultaneously. The RTU will prefer to be connected to the MASTER in the shortest path, provided that the RSSI of the connection is good enough. If the RESPONSE signal of the MASTER was strong enough then the RTU will ask to be connected directly to the MASTER and then it will be considered to be on LAYER 1. If the signal of the MASTER was not strong enough, or could not be heared at all, the RTU will ask to be connected to the ROUTER that is on the lowest layer but still has a strong enough RSSI picked by the RTU. If the ROUTER is on LAYER N the RTU will belong to LAYER N+1. The same happens when it is a ROUTER that is trying to connect into the system.

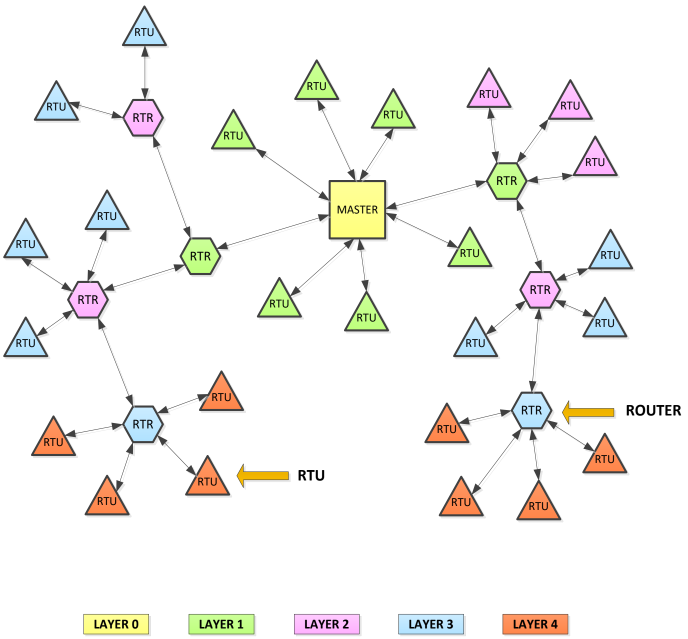


Figure 2 - The G5P system topology

For saving energy the RTUs unlike the ROUTERs are most of the time in low power mode and with the receiver switched off. The RTUs wake up periodically to indicate that they are alive. This is the reason why RTUs can be powered by 4 alkaline batteries for a whole year but this is also the reason why RTUs cannot be communicated randomly, but only after they report being awake. The ROUTERs and the MASTER need to be continuously ready to receive/transfer transmissionsm, that's why they are a higher energy consumers.

How is the system integrity maintained?

In order to make sure that all RTUs and ROUTERs remain connected to their ancestors, they are expected to send a WAKEUP string every predefined period. If the WAKEUP string fails to arrive within 1 minute, the unit will be deleted from the system and will have to reconnect as a new system member.

The WAKEUP period is defined by the WAKEUP parameter which is included in the list of parameters of each RTU/ROUTER and it has to be in the range 1-50 sec. By default the WAKEUP parameter is set to 10 sec, but it depends on the number of RTUs included in the network. It is the technician's responsibility to set the value of the WAKEUP parameter depending on the number of RTUs in the system and on the mode of operation whether REGULAR or BEACON and the modulation pattern whether SPREAD SPECTRUM or GFSK (will be explained later).

The desired WAKEUP period as subject of the number of RTUs				
WAKEUP period	Regular mode		Beacon mode	
	Number of RTUs in the system		Number of RTUs in the system	
	SPREAD SPECTRUM		SPREAD SPECTRUM	
5	20		43	
10	40		86	
15	60		129	
20	80		172	
25	100		215	
30	120		256	
35	140		302	
40	160		345	
45	180		388	
50	200		431	

It is important to notice that it is always the RTU/ROUTER that initiates the link with the MASTER and it is the RTU/ROUTER who keeps it alive by regularly sending the WAKEUP signals .

Another important point that helps to maintain the network integrity is the fact that each signal directed towards any system member, must be acknowledged by the recipient. Failing to receive the acknowledge signal will cause retransmission of the information several times, as defined by the RETRIES parameter.

In order to minimize the communication failures due to transmission colisions, the LBT (Listen Before Transmission) method is implemented.

How are commands of the MASTER sent to their final destination?

The MASTER keeps a table of all the network members and their role in the system whether they are RTUs or ROUTERs and each ROUTER keeps such a table about the network members linked to it. When the MASTER wants to send a command to open/close an output residing in one of the network members, it checks whether this member is in LAYER 1, if it is, it checks whether the output resides in an RTU or a ROUTER. If it resides in a ROUTER the command is sent right away, but if it resides in an RTU it will have to wait for the WAKEUP string of the RTU and only then it will be able to send the command to the RTU. If the member belongs to a higher layer, the command will be transferred with no delay right up to the last ROUTER in the path that either has the output on it, or it is the ancestor of the RTU to which the output belongs. The outcome of this discussion is that commands sent to outputs that belong to ROUTERs will be carried out with no delay, but outputs that belong to RTUs may suffer a delay of the WAKEUP time.

How are changes of inputs transferred to the MASTER?

When there is a change of status of a digital input or a change of a value of an analog input, the change is immediately transferred all the way to the MASTER with no delay, since all the ROUTERs and the MASTER are continuously ready to receive/transfer data. The string by which the state of inputs is transferred is called SANITY string, it contains also the status of the RTU and the status of the outputs. The SANITY string is also transferred periodically every predefined period (by default 300 sec). The SANITY period is a parameter that can be defined per each RTU/ROUTER individually.

THE BUILDING BLOCKS OF THE SYSTEM

The MASTER / INTERFACE

The MASTER is the heart of the MCP communication system, actually it fulfils two functions:

1. It is the MAIN RECEIVER/TRANSMITTER through which all the information to and from all the RTUs is flowing.
2. It serves also as an INTERFACE between the controller (DREAM2, SAPIR2) and the RTUs.

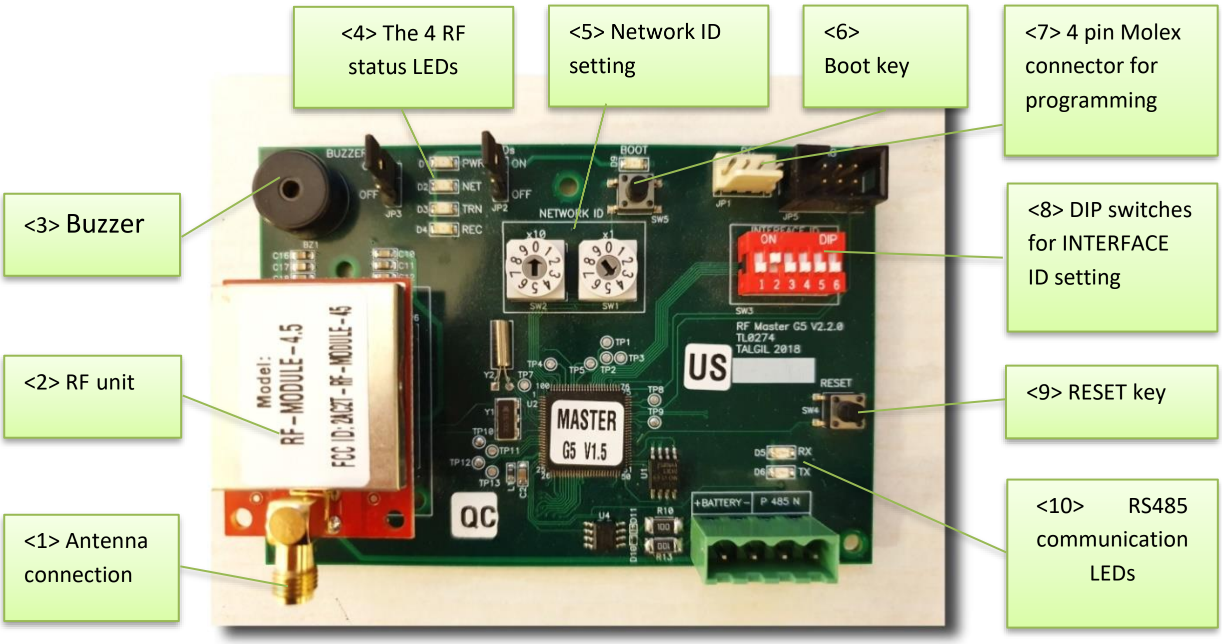


Figure 3 - the MASTER/INTERFACE board

As an INTERFACE it communicates by two wired RS485 line connected to the P and N points of the green connector. The polarity is important. The RS485 communication LEDs (Figure 3 <10>), RX and TX are supposed to blink every second when the communication between the controller and the INTERFACE is taking place. The INTERFACE is the channel through which the MASTER is reporting the host controller about the statuses of the RTUs and the statuses of the inputs, receiving back from the controller commands to be transferred to the RTUs.

The INTERFACE ID setting

Similarly to any other interface connected to the host controller, the MASTER/INTERFACE must have a unique ID by which it will be recognized. The ID setting is done by the block of the 6 DIP switches (Figure 3 <8>) using a binary coding.

Talking about setting the address of the MASTER/INTERFACE forces us to explain that the whole G5P system can function in two different modes: lets call one mode as G5P-4 and the other mode G5P-5. In the G5P-4 mode the system is imitating the previous generation G4 of TALGIL RF system which could handle up to 60 RTUs, the same is true with the G5P-4 mode as well, but in this case the INTERFACE can actually play the role of up to 10 G4 INTERFACES. The ID of the first interface will always be dictated by the setting of the INTERFACE ID DIP switches (Figure 3 <8>), the second interface (virtual) will get the ID following the first one and so on…Each virtual INTERFACE can handle another 60 RTUs. The number of virtual INTERFACES in use is designated by the parameter SUBSYSTEMS included in the list of parameters of the INTERFACE/MASTER. The IDs of those virtual INTERFACES even when not being utilized are considered occupied and cannot be used by other interfaces of the system. To be on the safe side, it is better to give the G5P-4 INTERFACE the highest ID in the system.

It is important to point out that from the controller side (SAPIR 2, DREAM 2) there is no difference between INTERFACE G5P-4 or the G4 type, the controller cannot even recognize which type of interface is connected to it.

In the G5P-5 mode there are no dummy interfaces and there is no division to groups of 60 RTUs, the interface occupies only one ID and the RTUs ID will be sequential between 1 and 999.

Setting up the MASTER/INTERFACE

1. **Setting the NETWORK ID** – Use the rotary switches (Figure 4 <1>) to set the NETWORK ID. Make sure to select a unique ID which does not exist in neighboring systems.
2. **Setting the INTERFACE ID** – Use the DIP switches (Figure 4 <2>) to set the INTERFACE ID as explained above. Remember to use binary coding.
3. **Placing the antenna** – The antenna of the MASTER (Figure 4 <3>) should be installed in a high place at which there will be clear line of sight with as many RTUs/ ROUTERs as possible. It should be placed in vertical position. Make sure that the body of the antenna will be above any metal part.
4. **Connection with the host controller** – the connection with the host controller is made by 2 pairs of wires (Figure 4 <4>). The red and black supply the +12v DC and -12v DC that energize the MASTER/INTERFACE board. The green (P) and the white (N) wires are the Positive and Negative of the RS485 communication line connecting between the host controller and the MASTER/INTERFACE.

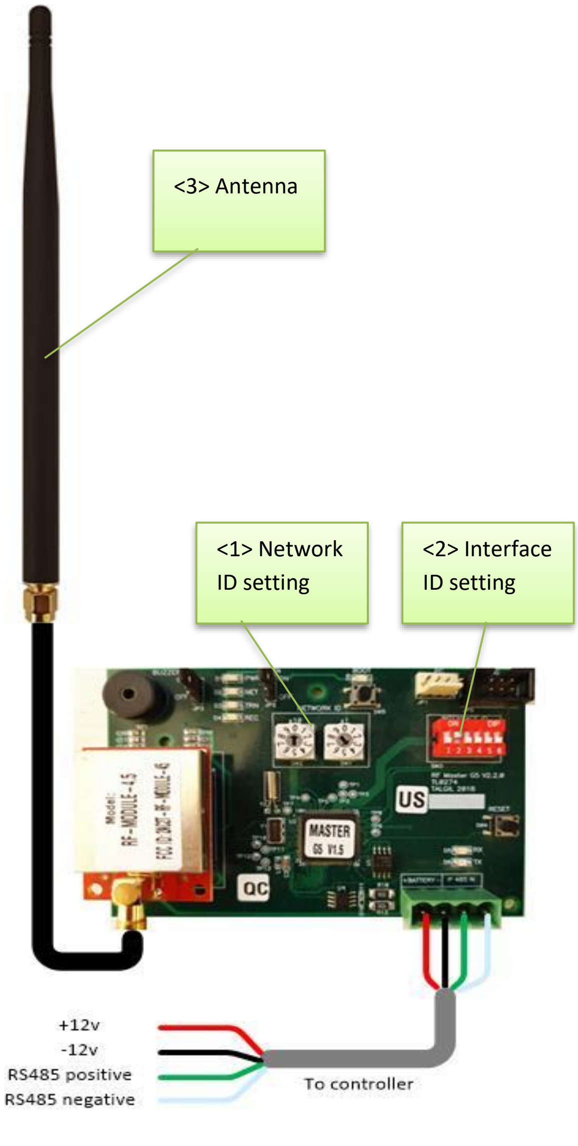


Figure 4

The indication of the MASTER's 4 status LEDs

The status LEDs of the MASTER (Figure 3 <4>) behave as follows:

- PWR LED – indicates that the unit is energized, under normal conditions it will be blinking.
- NET LED – indicates the RF communication status of the MASTER:
  - Blinking - indicates that the MASTER is looking for the frequency to be used. At this stage the buzzer will sound double beeps every few seconds.
  - Turns OFF - when the MASTER gets locked on the frequency to be used.
  - Turns ON - when at least one RTU has established communication with the MASTER.
- RX LED – Blinking when the unit is receiving data.
- TX LED – Blinking when the unit is transmitting data.

VARIOUS RTU TYPES

The MCP system offers various types of RTUs that can be selected according to the specific needs.

ECONOMICAL RTU

The ECONOMICAL RTU can be ordered in the following combinations:

- No. of outputs and digital inputs – 0, 1 or 2 (the outputs are 2 wired 12v DC latching, the inputs are dry contacts).
- No. of analog inputs – 2 (4-20mA or 0-5V. The analog inputs are always included).

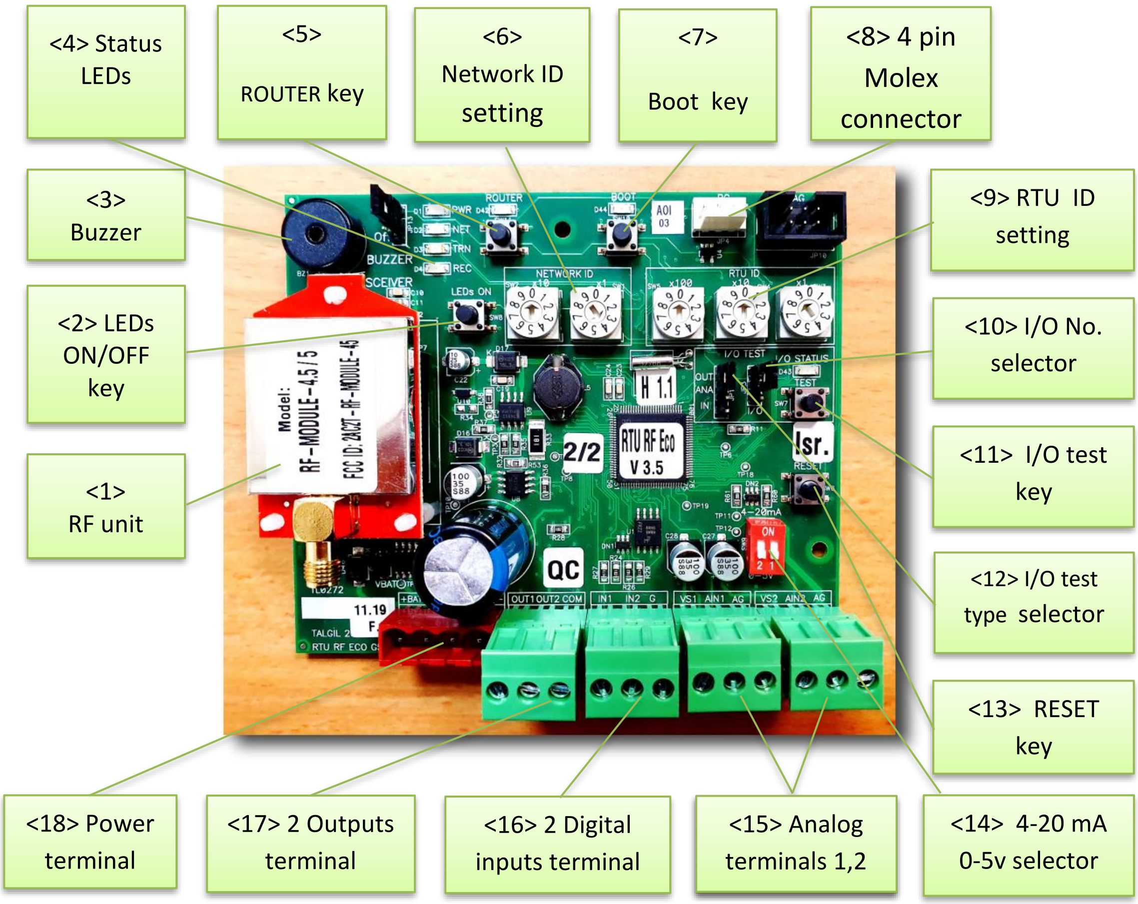


Figure 5 - ECONOMICAL RTU

Energizing the ECO RTU

The ECONOMICAL RTU can be energized in two ways. When serving as a regular RTU it has a very low power consumption therefore it can be energized either by 6v DC obtained from 4 alkaline batteries of 1.5v size “C” or by 12v DC obtained from rechargeable battery of 1.3 Ah charged by a solar panel of 2.5 Watt. When serving as a ROUTER, or when having to read internally energized analog inputs the 12v feeding should be selected.

Add pictures of energizing the ECO RTU

Setting up the communication at the RTU

1. **Setting the NETWORK ID** – Use the rotary switches (Figure 5 <6>) to set the NETWORK ID. The NETWORK ID must be the same as set at MASTER.
2. **Setting the RTU ID** – Use the rotary switches (Figure 5 <7>) to set the RTU ID as defined at the connections list of the host controller. We have to remember that there is a difference between the way the ID of the RTUs is defined in the two operation modes G5P-4 and G5P-5 as explained above. In the G5P-4 mode we allocate up to 60 RTUs to each INTERFACE as in the following table, while in the G5P-5 mode the numeration will be sequential.

The address of the INTERFACE	The ID of the RTUs allocated to each INTERFACE address
N	1 - 60
N+1	101 – 160
N+2	201 – 260
N+3	301 – 360
N+4	401 – 460
N+5	501 – 560
N+6	601 – 660
N+7	701 – 760
N+8	801 – 860
N+9	901 - 960

3. **Placing the antenna** – The antenna of the RTU should be installed in a high place at which there will be clear line of sight with its potential ancestors. The antenna should be placed in vertical position and above any metal parts.

4. Use the **WORKBENCH** software (Figure 6 <1>) and the **PROGRAMMER INTERFACE** (Figure 6 <2>) to set the following parameters:

<3> The Economical RTU

Figure 6 - Programming the ECO RTU

- a. **WAKEUP –** the rate at which the RTU will send its wakeup signals.
- b. **SANITY –** the rate at which the RTU will send its sanity strings.
- c. **RSSI LINK –** the required RSSI that the RTU should seek for connection. By setting the RSSI LINK the user can force the RTU not to prefare the shortest path to the MASTER but the more stable one.
- d. **PULSE DIVIDERS –** how many changes of the digital input to count before transmitting one change.
- e. **ANALOG INPUTS –** enable the desired number of analog inputs and set the parameters accordingly.

Name	Value	Comment
*************	UNIT AND RADIO COMMON DESCRIPTION	*************
Descriptor	RTU RF ECO G5 TL0272, TL0308 V4.2-24	Device type, HW, version (RO)
RF settings	IDN LoRa HF LP	Country, modulation, power (RO)
Noise level	high	Noise immunity: high or low
Node type	rtu	Node type:router or rtu
Network ID	3	Network ID 1…99 (RO)
Unit ID	120	Unit ID 1…999 (RO)
I/O number	2	Number of inputs/outputs. 0 (router),1,2 (RO)
Wakeup period	20	RF wake-up period. 1..50 sec
Sanity period	300	Sanity packets period. 10..3600 sec
Link RSSI	-96	Link RSSI limit. -80…-110 dbm
Number of retries	5	Number of retries to send packet 3…10
Interval between retries	100	Interval between retries 100…1000 ms
Current layer	1	Current network layer (RO)
Current net address	2	Network address (RO)
Current RSSI	-48dbm	RSSI (RO)
*************	IO DATA AND PARAMETERS	*************
Battery voltage	11.91 volt	Current battery voltage(RO)
Outputs state	0	Outputs state. LS bit - output 1(RO)
Auto close period	60	Auto-close period.0-no. 15-65635 sec
Solenoide voltage	16	Solenoid energizing voltage. 6-18V
Solenoide pulse time	70	Solenoid energizing period. 30-120 ms
Inputs state	0	Inputs state. LS bit - input 1(RO)
Inputs after division	0	Inputs state after division. LS bit - input 1(RO)
Input 1 divider	1	Input 1 divider. 1…100
Input 2 divider	1	Input 2 divider. 1…100
*************	ANALOGUE INPUT -- 1 -- DATA AND PARAMETERS	*************
Value	0.794V or 3.971mA	Input voltage/current(RO)
Status	enabled	Analog input 1. Use enable/disable
Period	10	Interval between measurements 1-65635 sec,0-no periodic
Hysteresis	2	Sufficient change in %. 0-100%
Powering period	1.0	Sensor excitation time(in 0.1 sec). 1…254,0-no,255-alway
Acumulation number	4	Number of measurements at once. 1…16
*************	ANALOGUE INPUT -- 2 -- DATA AND PARAMETERS	*************
Value	1.033V or 5.164mA	Input voltage/current(RO)
Status	enabled	Analog input 2. Use enable/disable
Period	10	Interval between measurements 1-65635 sec,0-no periodic
Hysteresis	2	Sufficient change in %. 0-100%
Powering period	1.0	Sensor excitation time(in 0.1 sec). 1…254,0-no,255-alway
Acumulation number	4	Number of measurements at once. 1…16

Figure 7 - WORKBENCH of ECO RTU

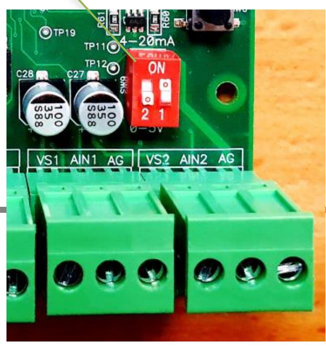
5. Define the role of the RTU, whether it will function as a regular RTU or as a ROUTER. This can be done either by setting the NODE TYPE parameter through the WORKBENCH, or by pushing the LEDS ON button (Figure 5 <2>) and while the LEDS are lighting push the ROUTER key (Figure 5 <5>) to set the desired role for the RTU. When the LED next to the ROUTER key is on the RTU will function as a ROUTER otherwise it will function as a regular RTU.

Connecting outputs to the ECO RTU

Connecting digital inputs to the ECO RTU

Connecting analog inputs to the ECO RTU

<1> 4-20 mA 0-5v selector



1. The ECO RTU is equipped with 2 analog inputs. The inputs can be set to read analog sensors of 0-5 v or 4-20 mA. The setting of the DIP switches (Figure 8 <1>) defines which type of sensor is going to be connected to each input. **Notice that the right DIP switch is in charge of input 1 and the left one is in charge of input 2.** When set in ON position the 4-20 mA is selected, otherwise it will be 0-5v.

2. Analog sensors require energizing. The energizing can come from an external source or internally from the RTU itself. When the internal energizing is selected (more convenient) then the energy to the sensor is not supplied continuously but periodically, it arrives from terminals VS1, VS2 (Figure 8 <2>) a short while before measurement, in order to reduce energy consumption.

Figure 8

<2> internal energy source

<3> Analog signal input

<4> Analog ground

In the following picture ANALOG SENSOR 1 (Figure 9 <1>) is internally energized and it is of 4-20 mA type while ANALOG SENSOR 2 (Figure 9 <2>) is externally energized and it is of 0-5v type.

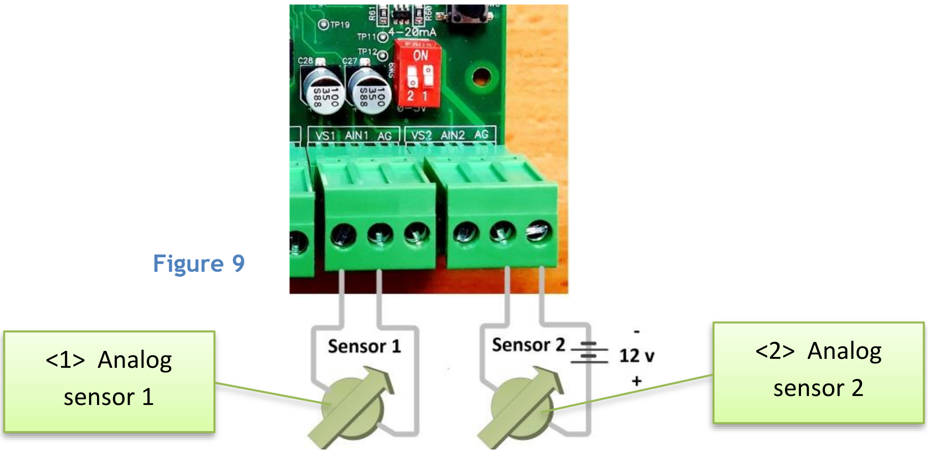


Figure 9

3. For setting the parameters of the analog sensors the WORKBENCH has to be used as follows:

a. **ENABLE SENSOR** - The analog input has to be enbled by writing "enable"

b. **SAMPLING PERIOD**– The period is defined in seconds, longer period is more energy saving.

c. **HYSTERESIS** – Defines the change in % out of the full scale that is considered a change of the value that has to be reported.

d. **POWERING PERIOD** – defines the excitation time required by the sensor prior to measuring.

e. **NUMBER OF SAMPLES** – The period of sampling will be divided to the number of samples, and the actual value will be the average of the intermediate values.

Name	Value	Comment
*************	UNIT AND RADIO COMMON DESCRIPTION	*************
Descriptor	RTU RF ECO G5 TL0272, TL0308 V4.2-24	Device type, HW, version (RO)
RF settings	IDN LoRa HF LP	Country, modulation, power (RO)
Noise level	high	Noise immunity: high or low
Node type	rtu	Node type:router or rtu
Network ID	3	Network ID 1...99 (RO)
Unit ID	120	Unit ID 1...999 (RO)
I/O number	2	Number of inputs/outputs. 0 (router),1,2 (RO)
Wakeup period	20	RF wake-up period. 1..50 sec
Sanity period	300	Sanity packets period. 10..3600 sec
Link RSSI	-96	Link RSSI limit. -80...-110 dbm
Number of retries	5	Number of retries to send packet 3...10
Interval between retries	100	Interval between retries 100...1000 ms
Current layer	1	Current network layer (RO)
Current net address	2	Network address (RO)
Current RSSI	-48dbm	RSSI (RO)
*************	IO DATA AND PARAMETERS	*************
Battery voltage	11.91 volt	Current battery voltage(RO)
Outputs state	0	Outputs state. LS bit - output 1(RO)
Auto close period	60	Auto-close period.0-no. 15-65635 sec
Solenoide voltage	16	Solenoid energizing voltage. 6-18V
Solenoide pulse time	70	Solenoid energizing period. 30-120 ms
Inputs state	0	Inputs state. LS bit - input 1(RO)
Inputs after division	0	Inputs state after division. LS bit - input 1(RO)
Input 1 divider	1	Input 1 divider. 1...100
Input 2 divider	1	Input 2 divider. 1...100
*************	ANALOGUE INPUT -- 1 -- DATA AND PARAMETERS	*************
Value	0.794V or 3.971mA	Input voltage/current(RO)
Status	enabled	Analog input 1. Use enable/disable
Period	10	Interval between measurements 1-65635 sec,0-no periodic
Hysteresis	2	Sufficient change in %. 0-100%
Powering period	1.0	Sensor excitation time(in 0.1 sec). 1...254,0-no,255-alway
Acumulation number	4	Number of measurements at once.1...16
*************	ANALOGUE INPUT -- 2 -- DATA AND PARAMETERS	*************
Value	1.033V or 5.164mA	Input voltage/current(RO)
Status	enabled	Analog input 2. Use enable/disable
Period	10	Interval between measurements 1-65635 sec,0-no periodic
Hysteresis	2	Sufficient change in %. 0-100%
Powering period	1.0	Sensor excitation time(in 0.1 sec). 1...254,0-no,255-alway
Acumulation number	4	Number of measurements at once.1...16

The indication of the RTU’s 4 status LEDs

The status LEDs of the RTU (Figure 5 <4>) behave as follows:

- PWR LED – Indicates that the unit is energized, under normal conditions it will be blinking.
- NET LED – Indicates the communication status:
  - Blinking while the RTU is looking for connection to the network. At this stage the buzzer will sound doble beeps every few seconds.
  - Turns ON when the RTU has aquired a stable connection to the network. The buzzer sounds a single beep every few seconds. If the connection is weak the NET LED will start blinking. The rate of blinking gets slower as the signal gets weaker.
- RX LED – Blinking when the unit is receiving data.
- TX LED – Blinking when the unit is transmitting data.

The I/O test

1. **TESTING OUTPUTS** –
   a. Move the I/O TYPE SELECTOR (Figure 10 <1>) to the upper position.
   b. Use the I/O No. SELECTOR (Figure 10 <2>) to select the desired output. UP=1; DOWN=2.
   c. Push the I/O TEST BUTTON (Figure 10 <3>). First push will turn on the I/O TEST LED (Figure 10 <4>), the PWR and NED LEDs, will open the output and will sound a single beep. Second push will close the output and will sound a double beep.

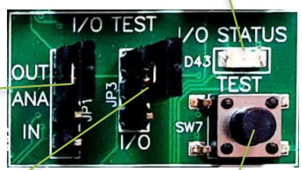


Figure 10

2. **TESTING DIGITAL INPUTS** –
   a. Move the I/O TYPE SELECTOR (Figure 10 <1>) to the lowest position.
   b. Use the I/O No. SELECTOR (Figure 10 <2>) to select the desired input. UP=1; DOWN=2.
   c. Push the I/O TEST BUTTON (Figure 10 <3>) the PWR and NED LEDs will turn on.
   d. Make a short circuit at the selected input. It will turn on the I/O TEST LED (Figure 10 <4>) and make a single beep. Remove the short circuit and the I/O TEST LED will turn off and it will sound a double beep.
3. **TESTING ANALOG INPUTS –**
   a. Move the I/O TYPE SELECTOR (Figure 10 <1>) to the mid position.
   b. Use the I/O No. SELECTOR (Figure 10 <2>) to select the desired input. UP=1; DOWN=2.
   c. Push the I/O TEST BUTTON (Figure 10 <3>) the PWR and NED LEDs will turn on.
   d. Apply a voltage of ……….. at the selected input. It will turn on the the I/O TEST LED (Figure 10 <4>) and make a single beep. Remove the applied voltage and the I/O TEST LED will turn off and it will sound a double beep.

MODULAR RTU

The MODULAR RTU can be ordered in the following combinations:

- No. of outputs – 0,2,4,6 or 8 (2 wired latching).
- No. of digital inputs – 0,4 or 8.
- No of analog inputs – 0,1 or 4.

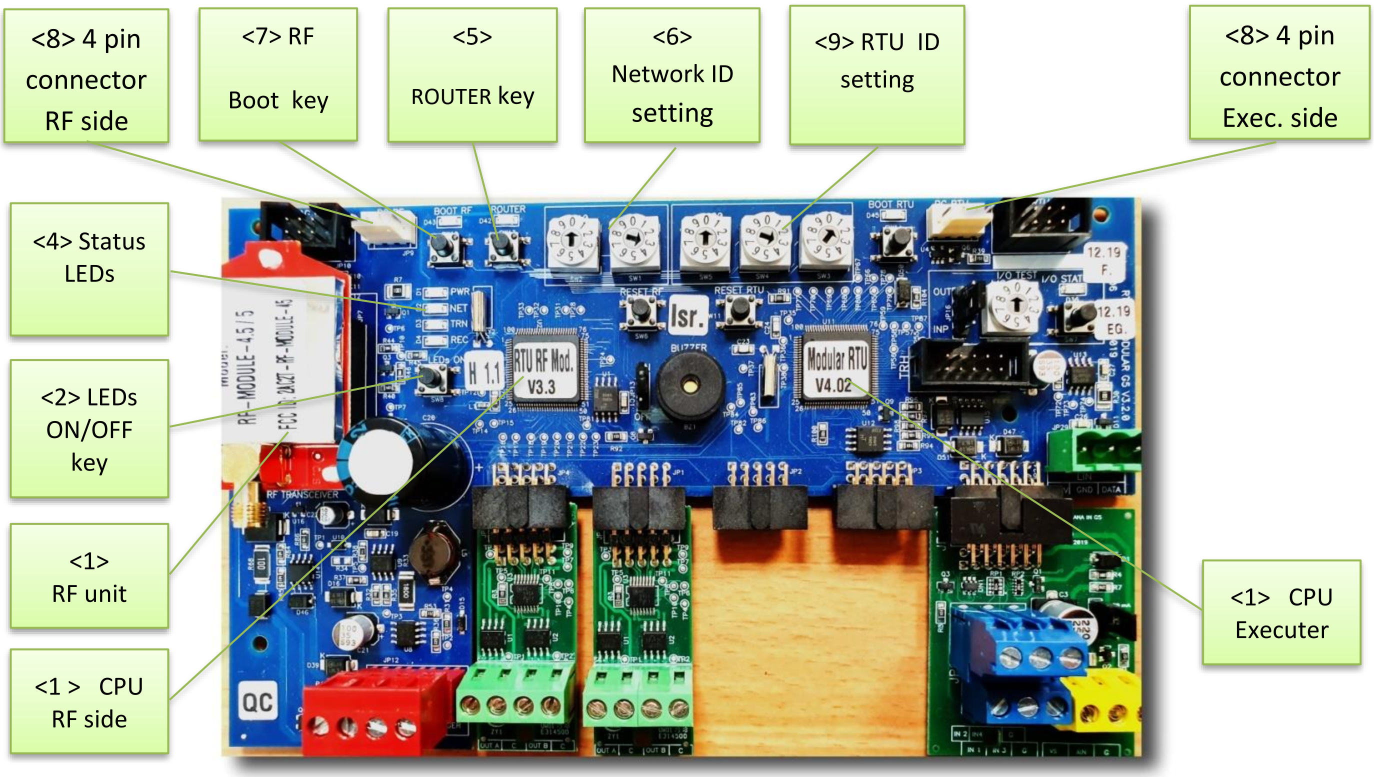


Figure 11 - MODULAR RTU

Analog inputs RTU

- No. of analog inputs – 4 (4-20mA or 0-5V)

UPGRADING FIRMWARE OF RTUs ON THE AIR

In large systems containing many RTUs, upgrading the firmware may become a painful process. Each RTU has to be visited and programmed individually. With the OTA system, the RTUs are upgraded “On The Air”, multiple RTUs in parallel, so obviously it is a great step ahead.

Naturally, because of the difference in the firmware of the various RTU types, the upgrading is executed per each RTU type separately, Economical RTUs, Modular RTUs RF side and Modular RTUs executer side, one type at a time.

The process is carried out in two steps. In the first step we use the COMPOSER software to prepare the firmware file for loading, In the second step we use the LAUNCHER for starting the OTA upgrade process.

The COMPOSER

As explained above the task of the COMPOSER is to prepare the firmware file for loading and there are two options:

a. The first option is meant to be used when we are not sure about the version currently existing in the RTUs, or when not all RTUs have the same version. In these cases we have no alternative but to send the whole firmware file to replace the existing one. In this case we shall have to check the checkbox saying “NO SOURCE VERSION” (Figure 12 -1) and load only a DESTINATION VERSION (Figure 12 -2) to be processed by the COMPOSER. Push the COMPOSE (Figure 12 -3) button to prepare the file to be used by the LAUNCHER.

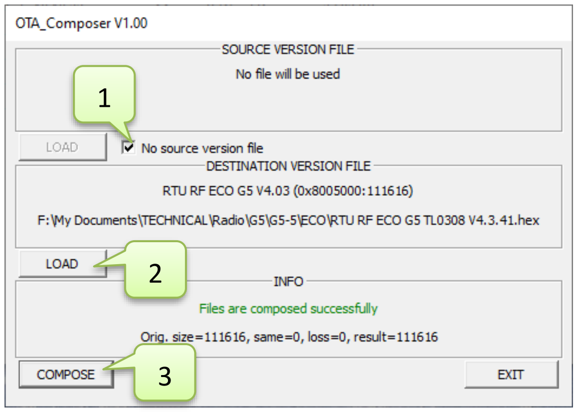


Figure 12 - Composer with no source version

b. In the second option when we know for sure the version currently loaded and we know it is the same for all RTUs, we can save plenty of time by loading only the differences between the SOURCE VERSION and the DESTINATION VERSION. In this case we shall uncheck the “NO SOURCE VERSION” (Figure 13 -1) checkbox, load the file containing the SOURCE VERSION (Figure 13 -2) and load the file with the DESTINATION VERSION (Figure 13 -3) and push the COMPOSE (Figure 13 -4) button to prepare the file to be used by the LAUNCHER.

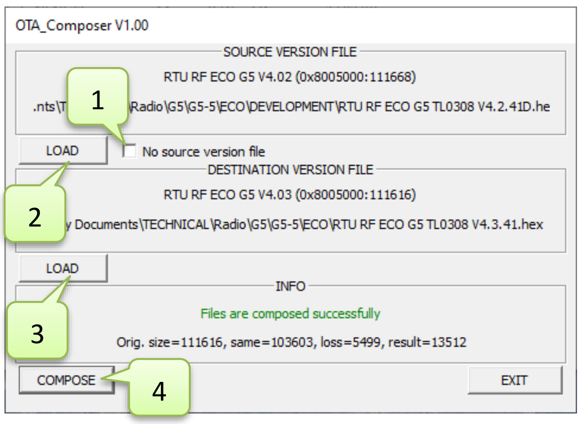


Figure 13 - Composer with source and destination

In both cases the resulting file will be placed at the folder “result” residing in the same directory at which the COMPOSER software is placed. The resulting firmware files to be used by the OTA LAUNCHER will get names that describe quite clearly how they were created. The file names are constructed by the following rules:

The final file name consists of two parts separated by underline “_”. The first part contains the file name of the SOURSE and the other part contains the file name of the DESTINATION. If there is no SOURCE like in option “a” above, the final file name will start with “0” otherwise it will start with the name of the SOURCE VERSION.

- SOURCE/DESTINATION name that starts with **10** is of an RFU
- SOURCE/DESTINATION name that starts with **20** is of an ECO RTU
- SOURCE/DESTINATION nane that starts with **30** is of the EXECUTER side of a MODULAR RTU

The rest of the SOURCE/DESTINATION name includes the version of the firmware.

Examples of SOURCE/DESTINATION names: **10**401 is of RFU version 4.01

20402 is of ECONOMICAL RTU version 4.02

30405 is of the EXECUTER of MODULAR RTUs including version 4.05

Examples of final file-names: 0_10401 is the file for RFU with no SOURCE, containing the full DESTINATION file, result of option “a” above.

20401_20402 is the file for ECONOMICAL RTUs and it contains the difference between the SOURCE version 4.01 and the DESTINATION version 4.02, result of option “b” above.

The LAUNCHER

The computer running the LAUNCHER software **(Figure 14 -1)** will be connected to the MASTER **(Figure 14 -2)** using the PROGRAMMER interface **(Figure 14 -3)** as in the following drawing.

Select the appropriate COM PORT **(Figure 15 -1)** and push the START WORK button **(Figure 15 -2)**. The software will start communicating with the MASTER, receiving from the MASTER the list of all RTUs connected to it **(Figure 15 -3)** as in the screenshot below:

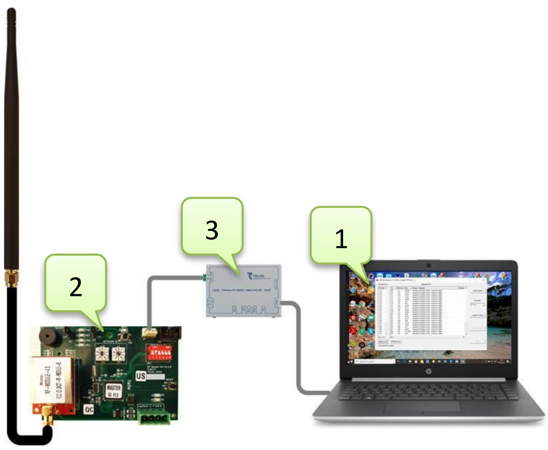


Figure 14 -Connecting the LAUNCHER to the MASTER

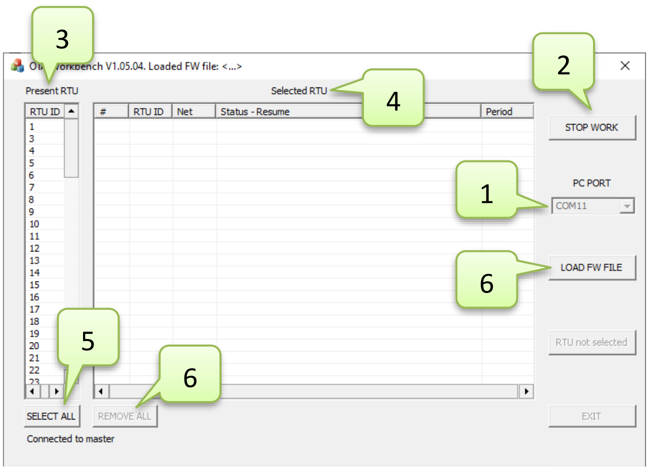


Figure 15 - the LAUNCHER software

The next step will be the selection of the RTUs from the "Present RTU" list (Figure 15 -3) to be included in the OTA session. Selecting RTUs one by one is accomplished by double clicking on the RTU ID in the list, the RTU will be moved from the "Present RTU" list into the "Selected RTU" list (Figure 15 -4). There is an option to include all the RTUs in the OTA session by hitting the SELECT ALL button (Figure 15 -5). Removing RTUs from the "Selected RTU" list is done in a similar way, double clicking on the RTU ID removes a single RTU, and hitting REMOVE ALL (Figure 15 -6) will move all RTUs back to the "Present RTU" list.

The following step will be the selection of the firmware file to be transmitted OTA. Hit LOAD FW FILE (Figure 15 -7) and select the file prepared earlier by the COMPOSER.

When the whole firmware file is loaded into the MASTER we can launch the OTA process by hitting START OTA (Figure 16 -1).

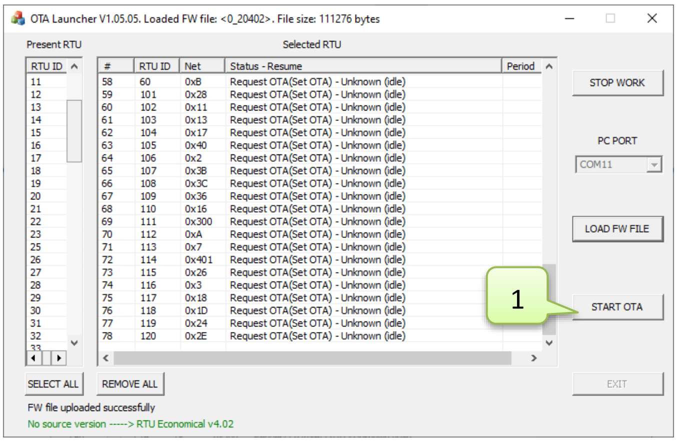
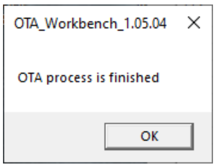


Figure 16 - Launching the OTA process

During the OTA transmission the LAUNCHER keeps showing per each RTU the elapsed time from the beginning of the process and the status each RTU has reached. The end of the process is indicated by the elapsed time counters stopping the count and by the following termination message.



Unless you want to interrupt and terminate the OTA process in the middle, be patient and wait until you get the termination message.

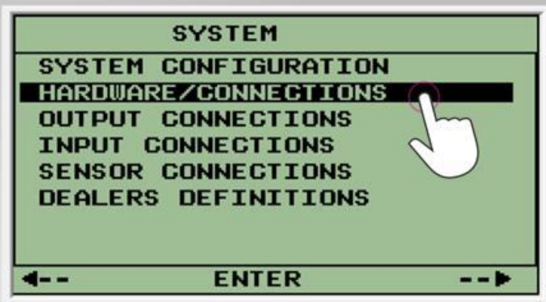
Important remarks:

- **During the OTA process RTUs not included in the "Selected RTU" list may continue normal operation, including opening and closing outputs and reporting statuses of inputs.**
- **After the START OTA button had been pushed, the connection of the programmer to the MASTER can be removed and the LAUNCHER software can be stopped. Later on the LAUNCHER can be restarted and the programmer reconnected, the LAUNCHER will get updated and show the status each RTU has reached, even if the OTA process has already terminated.**
- **Trying to load incorrect firmware into an RTU will be eliminated by the RTU.**

Sometimes some of the RTUs may fail the OTA process for some reason, in that case we can remove from the "Selected RTU" list all the RTUs except those that had failed and a new OTA process can be initiated.

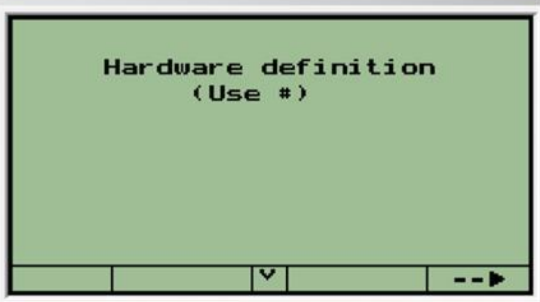
RF G5 – Hardware Definitions on Dream 2.

Screenshot 1- Select the SETUP submenu.

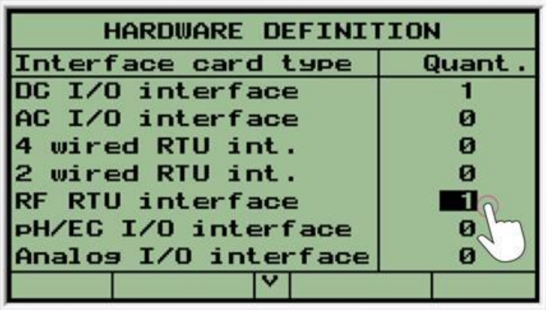


Screenshot 2- Select HARDWARE/CONNECTIONS.

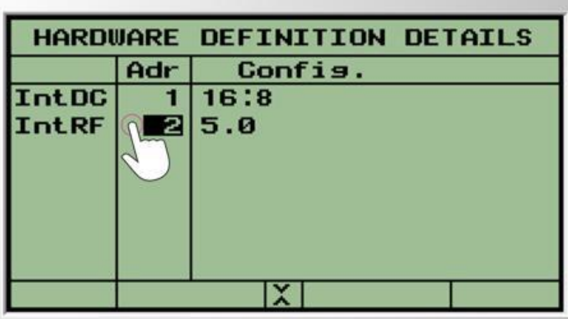
Screenshot 3- Enter the "247" password.



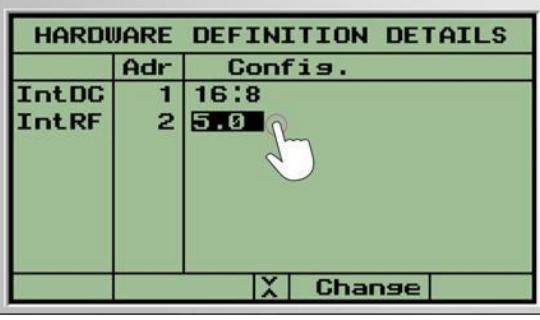
Screenshot 4- Click the Page Down button



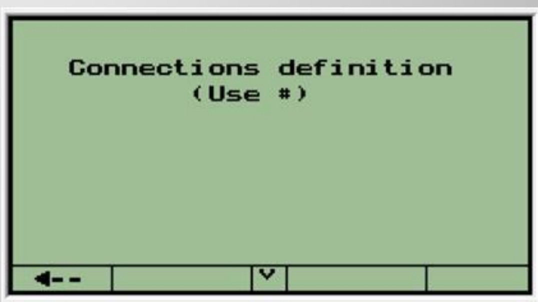
Screenshot 5-Add one RF RTU Interface, then press the Page down button.



Screenshot 6- Select available address for the Interface RF. Make sure to set the highest address for the Interface RF.



Screenshot 7- The number on the right side of the Int. RF address is not relevant. Leave it as 5. To exit, Press P. Down and F4 buttons.



Screenshot 8- In order to set the Outputs and Inputs connection definition, press the Page Down button.

Image 1 – Hardware Definitions on Dream 2.

Defining the G5P system on Dream 2 controllers

Like any other interface type the RF G5P is introduced to the Dream controller during the Hardware Definitions. Image 1 describes the procedure step by step. We start by selecting **Setup** at the menu (Screenshot 1), then we select the **Hardware/Connection** option (Screenshot 2)**.** For changing the **Hardware Definitions,** press **Enter** and insert the "**247"** password (Screenshot 3)**.** At the **Hardware Definition** screen press **Page Down** button (Screenshot 4).

At the **RF G5P** the interface is actually included in the Master card so the **RF Master G5P** card serves both as a **Master** and as an **Interface**. Add one **RF RTU Interface** and press the **Page Down** button (Screenshot 5). Select an available address for the **Interface RF** (Screenshot 6).

The **Interface RF** address must be set higher than the addresses of all other Interfaces connected to the **Dream 2**. The reason is, that the **Interface RF** occupies actually the next nine addresses following its own address.

On the right side of the **Interface RF Address** (Screenshot 6) there is the **Polling rate** number. The **Polling rate** is not relevant in the **RF G5P** system. You can leave it as 5 (Default) as described in screenshot 7. In order to exit from **Hardware Definition** screen, press the **Page down** and **F4** button. The **Connections Definition** screen will appear (Screenshot 8).

The following step will be to define the **Outputs and Inputs connections** which describes where each of the outputs and inputs are physically connected to the **RF RTUs** in the field.

In addittion to the functions described above the MASTER can also be used as a SNIFFER that can monitor and report about the activity of the network. The result of this report is a log-file that can later be analized in order to learn about the quality of the communication. To utilize this function we have to connect the PROGRAMMER interface to the 4 pin Molex connector of the MASTER board and on the other end to a laptop on which the TREEVIEW software is running.

Explanation about the TREEVIEW software can be found at the tools paragraph below.

RF G5 RTU – Installation instructions.

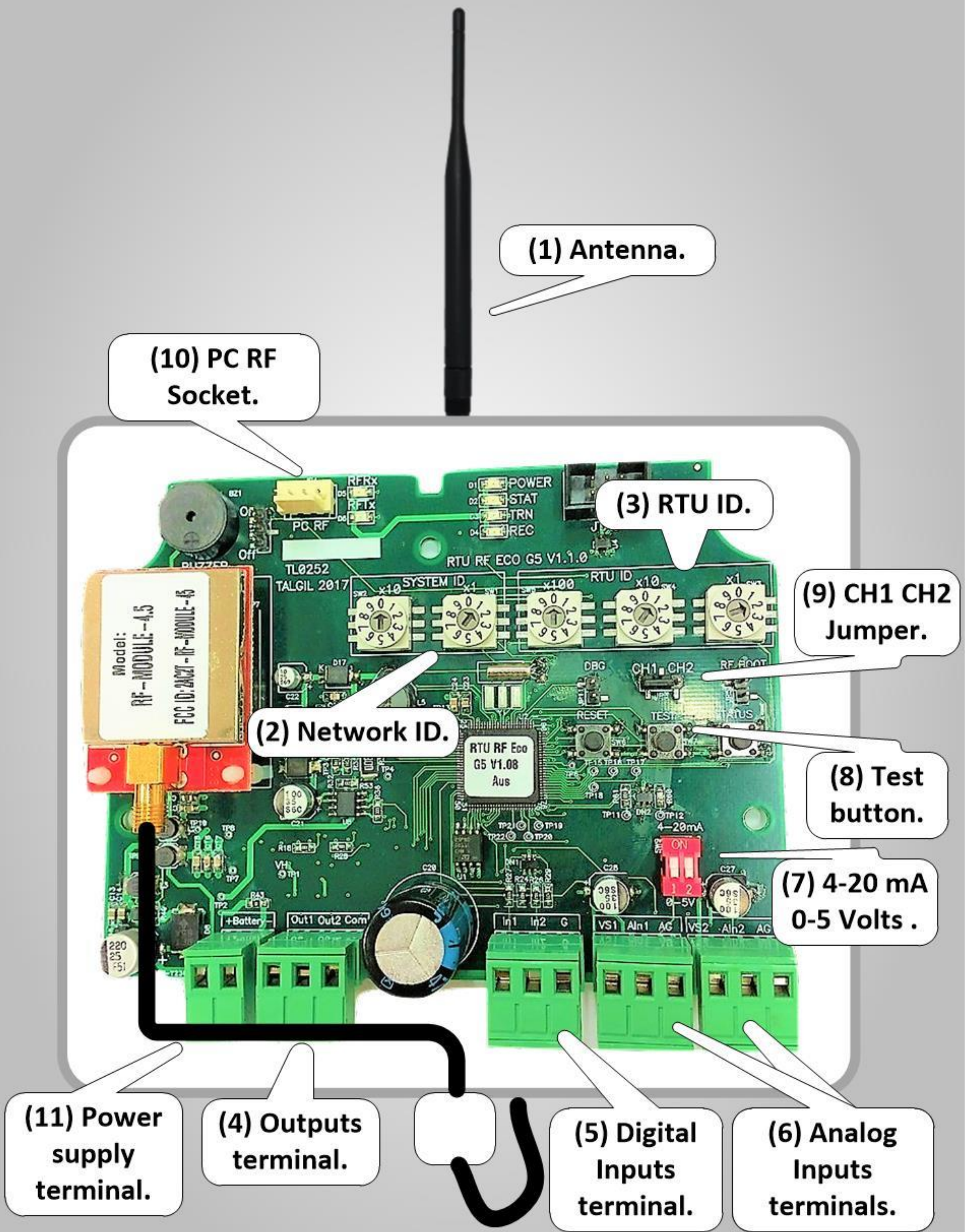


Image 3 – Installation of RF G5 Master and wiring to the Dream 2 controller.

Installing the RF G5P RTU

1. In order to improve the **RF** reception, install the **RF G5P RTU Antenna** (Pointer 1) in a high place. The top of the **RF G5P RTU Antenna** must be installed on a pipe made of non-metallic material.
2. Set the **NETWORK ID** of the **RF G5P** system. In order to set the **RF G5P NETWORK ID,** use the **NETWORK ID** rotary switches (Pointer 2).
3. Set the **RTU ID** (RTU address). In order to set the **RF G5P RTU ID,** use the **RTU ID** rotary switches (Pointer 3).
4. Connect the solenoids (Or other output devices) to the **Outputs terminal** (Pointer 4).
5. If you have digital inputs, connect the **Digital Inputs** to the **Digital Inputs terminal** (Pointer 5).
6. If you have analog inputs, connect the **Analog Inputs** to the **Analog Inputs terminals** (Pointer 6).
7. If you have analog inputs, set the appropriate analog sensor type. In order to set the analog sensor type**,** use the **4-20 mA or 0-5 V** dip switches (Pointer 7).
8. For your convenience, there is a **Test outputs** button which helps to test the outputs. In order to test an output, set the **CH1 CH2 Jumper** (Pointer 9) to your preferred test output and press and hold the **Test** button (Pointer 8) until you will hear one long beep, then, every short click on the **Test** button will open or close the output which selected on **CH1 CH2 Jumper.**
9. Connect an **RF Programmer** to the **PC RF** socket (Pointer 10) to program the RTU function (Router or End unit), the Wakeup period, Outputs, Inputs, dividers and other definitions.
10. Finally, connect the power supply to the **Power supply terminal.** End unit can be fed from four batteries 1.5 Volts size C. If the RTU has been defined as Router or handles an **Analog inputs** connect **12 V DC** power supply (Solar panel and rechargeable battery)**.**

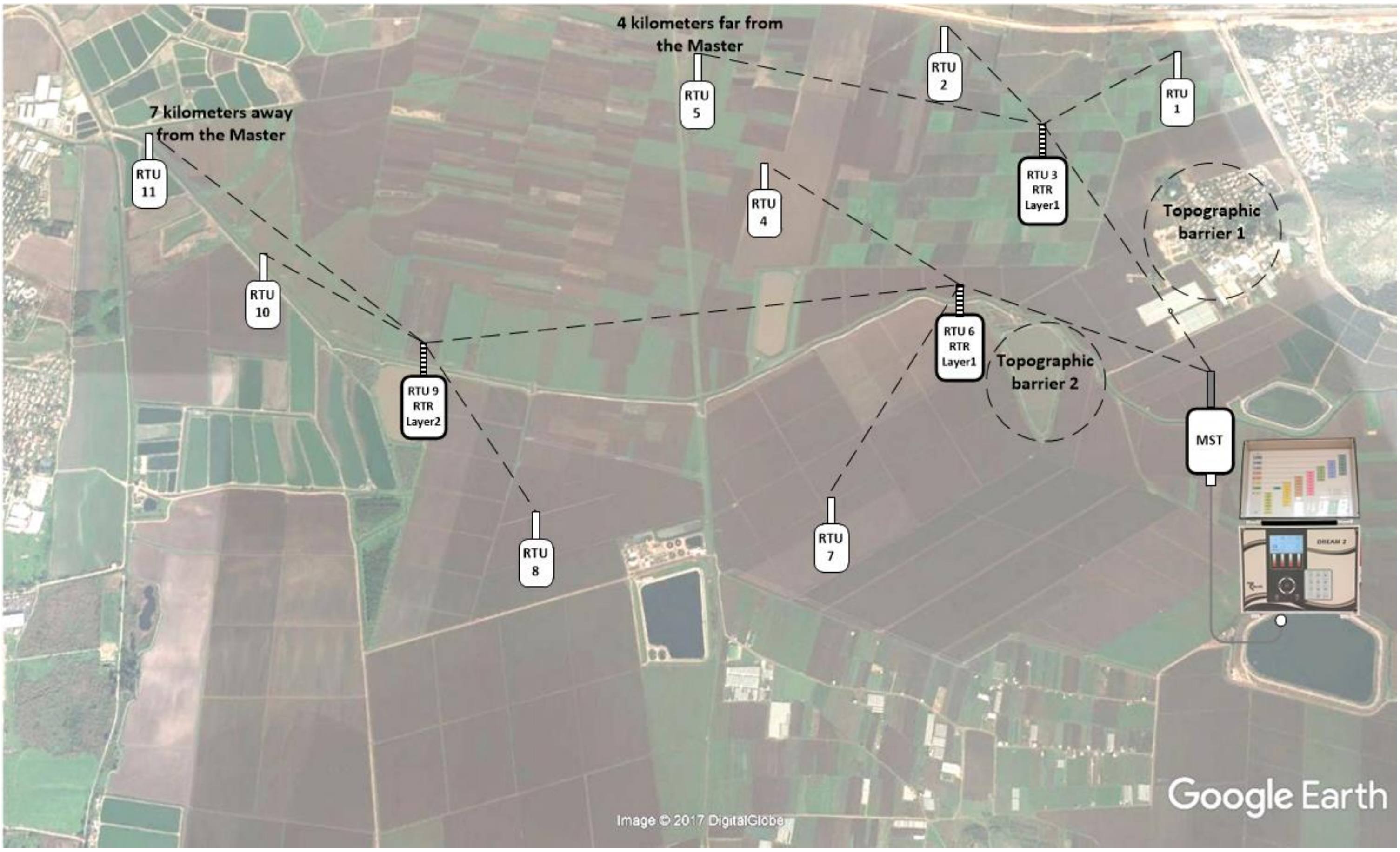


Image 4- A map with description of RF G5P MCP system.

Introduction to RF G5P MCP SYSTEM

The **MCP** (wirelesses Multilayer Communication Protocol) used to convey information between the Master unit and RF RTU. The RF G5P system units used to operate irrigation heads which installed far from the Dream 2. The advantage of the RF G5P on the previous RF generations is the ability to add to the RF system up to 11 layers. It means that the user can define a repeater to repeater up to eleven layers. In this way, the RF system can handle an irrigation head very far from the Dream 2. Another advantage is that the RF G5P system uses an asynchronous communication protocol. In other words, the RF G5P system transmits information when there is a change in outputs or inputs state. In this way, we save energy and do not send unnecessary information to the air. In order to make a good RF communication between the **Master** to the End unit, three preconditions (FDL) must be met:

1. Free frequency-the frequency which has been used by the system must be free and clear.
2. Distance- the Distance between the **RF Master** to between the **Router** or **End unit** which communicate directly with the **RF** Master, must be no more than 2.5 kilometers.
3. Line of sight- There must be **Line of sigth** Between the **RF Master** to a **Router** or **End unit** which communicates directly with the **RF Master**.

The RF G5P system chooses automatically the frequency. But, if the distance between the **Master** to the **End unit** is far from 2.5 kilometers or there is no line of sight between the **Master** to the **End unit,** the user can program any RTU and set it to work as a **Router.** A **Router** can use as an **end unit** and can help to other **RTUs** in the field and improve the communication Between the **Master** to them. In order to define a **Router**, the user should connect the **RF Programmer** device to the **End unit** and set it to **Router.** The system decides the links between the **End units** and

Routers and finds the best **Router** for improvement of the problematic **End unit.**

Image 4 describes an example of **RF G5P MCP** system. **RTU** number **1** cannot communicate directly with the Master because of a **topographic barrier** (There is no line of sigth). In addition, RTU number 2 is far from the Dream 2 (More than 2.5 kilometers) Therefore, the installer defined a **Router** (RTU number 3) in the middle of the way between the **Master** and **RTUs 1** and **2.**

There is no need to define the **layer** or the number of **RTUs** to serve or a special arrangement of addresses (Like previous **RF** generations). It is defined automatically. The same about **RTUs 4** and **7** which use **RTU** number **6** as a Router. **RTU** number **9** used as a Router on **layer 2**. **RTUs 8, 10** and **11** use the **Router** because of the high distance between the **Master** to them.

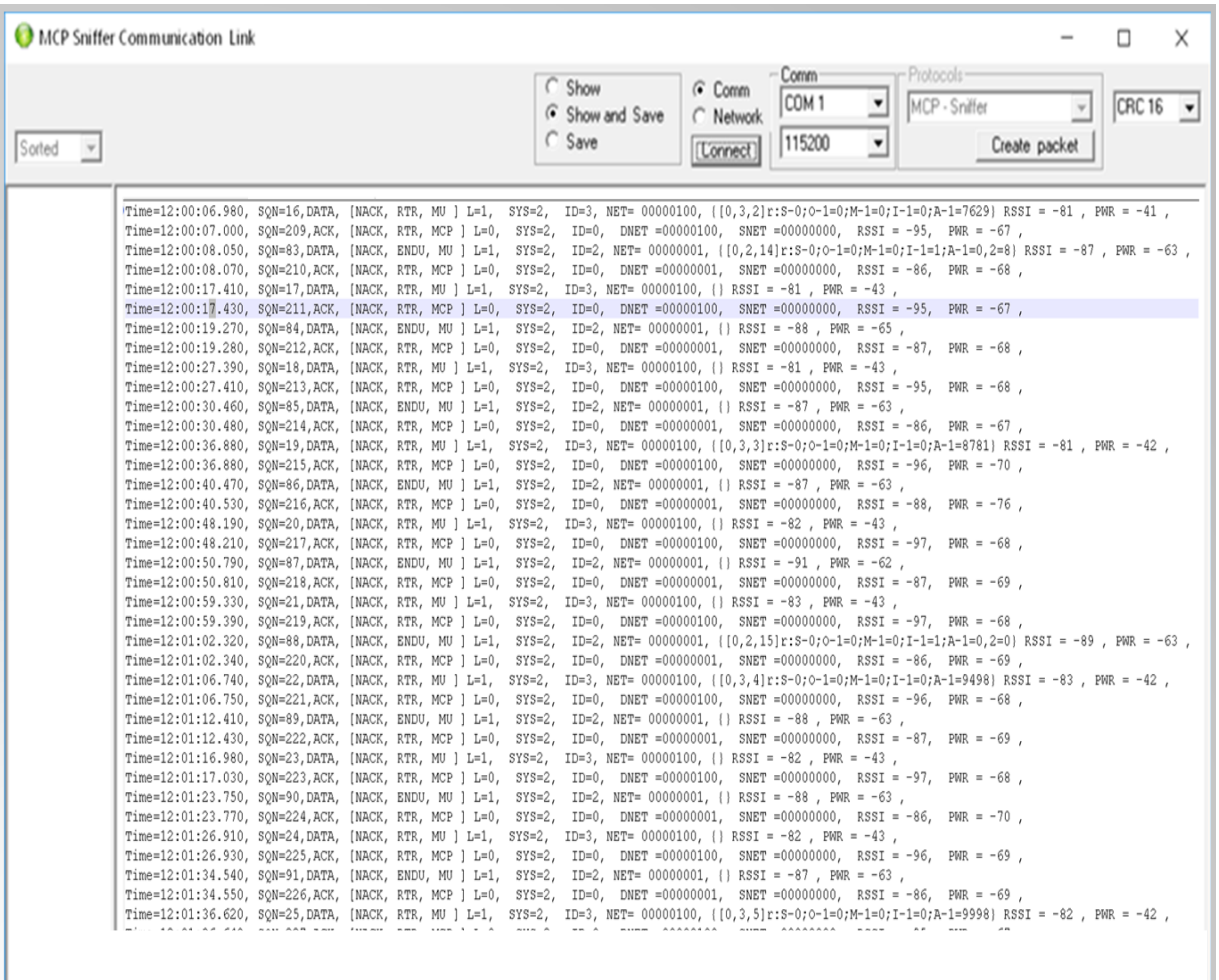


Figure 5 – The Sniffer software.

The Sniffer

Since the **RF** transmission is invisible, Talgil computing and control ltd developed a troubleshooting tool which helps to identify, examine and see what is happening in the air.

This tool called **Sniffer**. The **Sniffer** listens to the **RF** communication and writes the results on the **MCP Sniffer** software. The user can read and examine the results and understand where the problem is. The **Sniffer** and the **RF G5P Master** have the same hardware but different firmware. In order to connect the Sniffer to the PC, connect an **RF programmer** device to the Sniffer's **PC RF** socket. In order to start to hear to the RF communication, select the com. Port, then set the baud rate to 115200 then select the RF unit to hear. Finally, click on the **Connect** button.

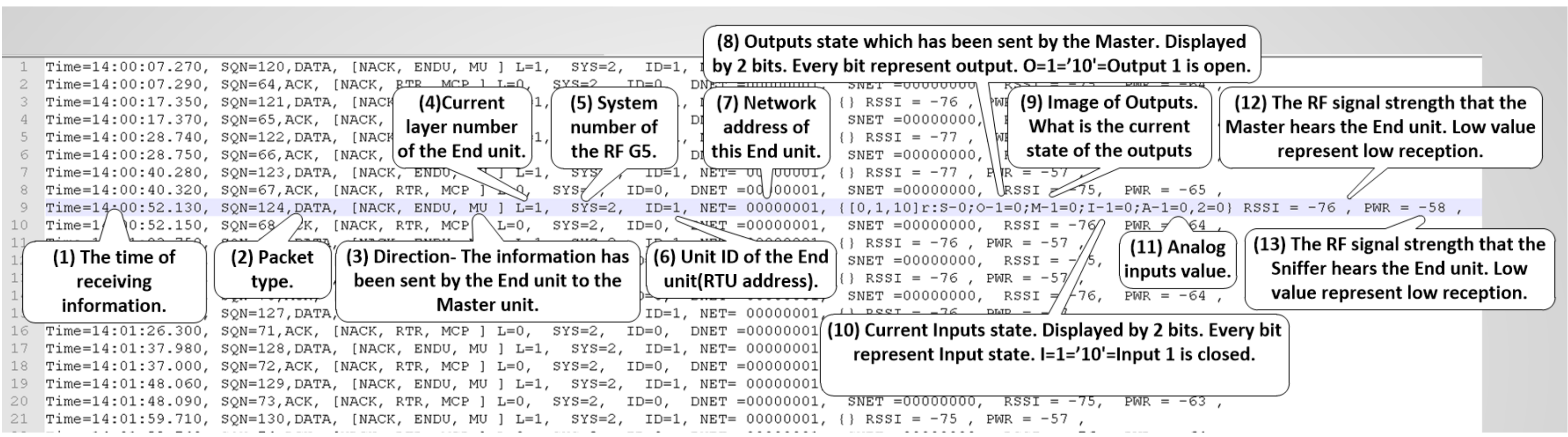


Figure 6- Description of the Sniffer results.

Description of the Sniffer results

Figure 6 describes an example of a packet that has been sent by the **End unit** number 1 to the **Master unit**. Here are the terms and their explanations:

1. **Time-**Every packet starts with the time of receiving the information.
2. **Type-**Every packet has been classified by type. Figure 6 describes a **DATA** type. It means that the **End unit** sends information about Outputs, Digital and Analog Inputs state.
3. **Direction-**Describes the packet direction. The **End unit** sends information to the **Master unit**.
4. **Layer-**Determine the **End unit** layer. Layer 0 represent packets which coming from the **Master unit**. Layer 1 represent **End unit** or **Router** which communicating directly with the **Master unit.** Layer 2 means that there is a **Router** in layer 1 which helps to the **End unit** on layer 2.
5. **System number-** Represent the RF G5P system number.
6. **Unit ID-** Represent the **End** unit address (RTU address).
7. **Network address-** Determines the address that the **MCU** grant to the **End unit.**
8. **Outputs State-** The outputs state which has been sent to the **Master unit**. The value represents a decimal conversion of two bits. The possibilities are:
   0= ‘00’- Two outputs are closed.
   1= ‘10’- Output 1 is open.
   2= ‘01’-Output 2 is open.
   3=‘11’-Outputs 1 and 2 are open.
9. **Image of Outputs**- Represents the current outputs state on the **End unit**. The **Image of Outputs** should be the same as the **Outputs state.**

10. **Inputs State-** The current Inputs state of the **End unit**. The value represents a decimal conversion of two bits. The possibilities are:
0= '00'- the two Inputs are opened.
1= '10'- Input 1 is closed.
2= '01'- Input 2 is closed.
3='11'- the two Inputs are closed.

11. **Analog inputs**- represent the value of the two analog inputs measurements. A-1 =Analog input 1. A-2=Analog input 2.
12. **RSSI-** Received signal strength indication. Determine how the **Master unit** hears the **End unit.**
13. Power- Determine how the **Sniffer** hears the **End unit.**

Revision History

The table below describes the changes which have been made to this document.

Date	Change	Description
9 November 17		Writing the user manual.