IoT Starter Kit – Part 1: Build your IQRF network

1 Understand the components in the Development Set for IoT (DS-IOT-01)
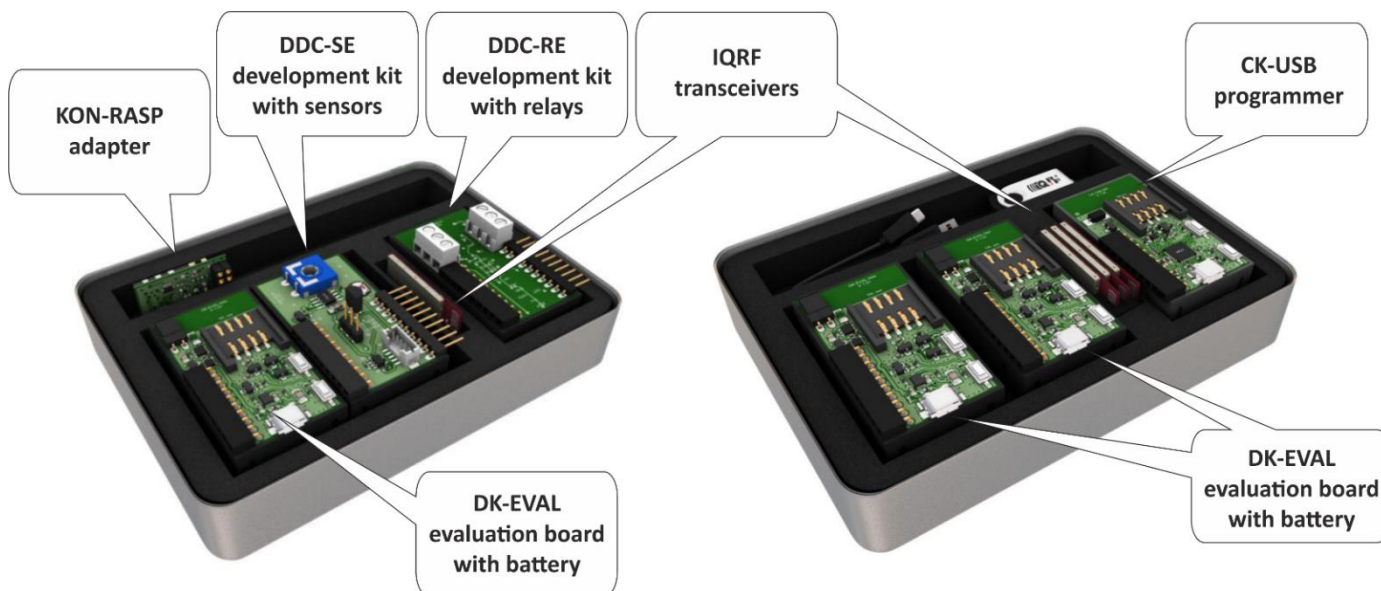
1. Set the box with the UP board aside for use in **Step 2: Install Your IQRF Gateway**.
2. Open the two small boxes containing the **IQRF technology** components (DS-IOT-01).

3. Review the key features, switches and connectors for each component.

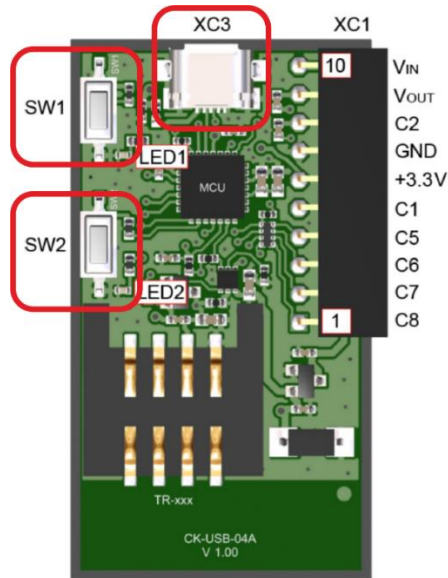### 1.1 IQRF components

Inside the two IQRF boxes, you will find:

- one gray box called **CK-USB** – the programmer,
- three black boxes called **DK-EVAL** – evaluation kits for powering wireless transceivers,
- one **DDC-SE** development kit with three sensors - the Dallas thermometer, the light sensor and the potentiometer,
- one **DDC-RE** development kit with two relays,
- four **IQRF transceivers** for creating a basic IQRF network,
- one **micro USB cable** for CK-USB connection to a computer,
- one **KON-RASP** adapter for connection of an IQRF transceiver to the UP board.

1.1.1 CK-USB

This development kit is for programming and debugging of IQRF transceivers. You will connect this tool to a computer USB port with the micro USB cable connected to an XC3 connector.

SW1 and **SW2** are pushbuttons for USB mode selection and other purposes. Find details about it here: https://www.iqrf.org/products/development-tools/development-kits/ck-usb-04a
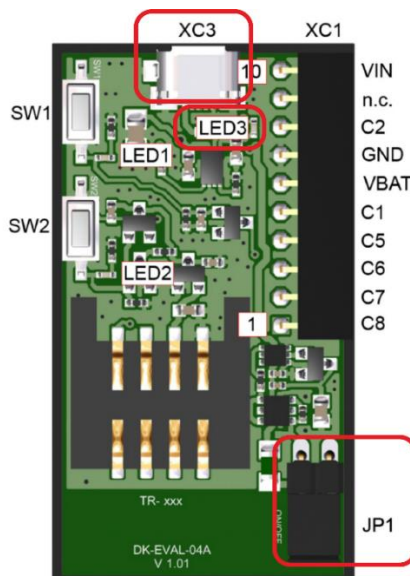

Caution: The IQRF transceiver can be plugged into / unplugged from the SIM connector while powered off only. The SIM connector is not powered while the SW2 pushbutton is held. Press and hold it always when you are plugging an IQRF transceiver to or you are unplugging it from the SIM connector of CK-USB.
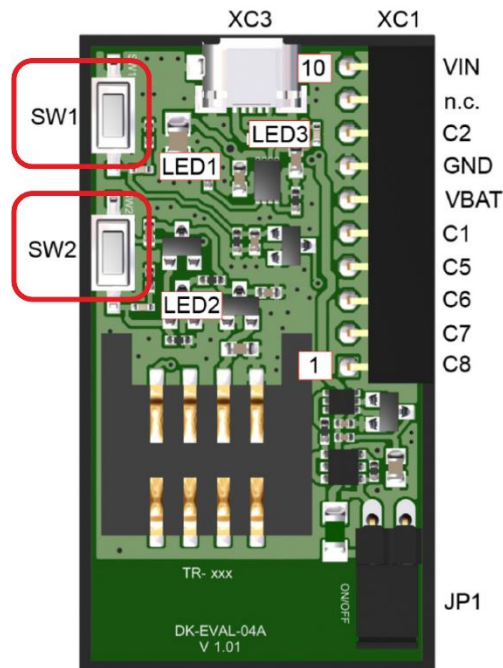
1.1.2 DK-EVAL

This development kit is supplied from the internal accumulator (battery) or from an external power source via micro USB connector **XC3** which also serves as a charger. Charging is indicated by red **LED3**. The accumulator (battery) should be kept charged. Charging takes up to 8 hours when the battery was empty.

The TR transceiver is supplied when jumper **JP1** is turned on.

SW1 is a **User** pushbutton which is connected to pin C5 of the transceiver. It will be used here for bonding (adding to a network) in next steps.

SW2 is a **Reset** pushbutton. A transceiver is disconnected from the power supply when the SW2 pushbutton is pressed.
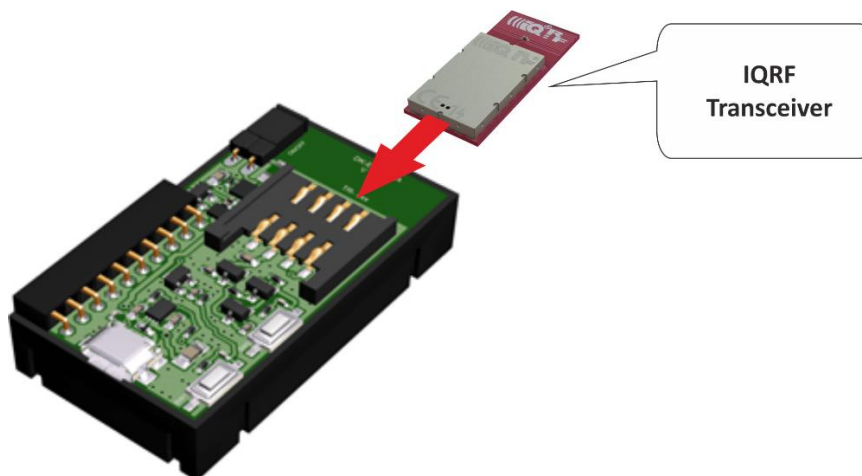

Caution: SW2 must be pressed always when you are plugging or unplugging the transceiver to/from the SIM connector.

Find details about this tool here: https://www.iqrf.org/products/development-tools/development-kits/dk-eval-04a.
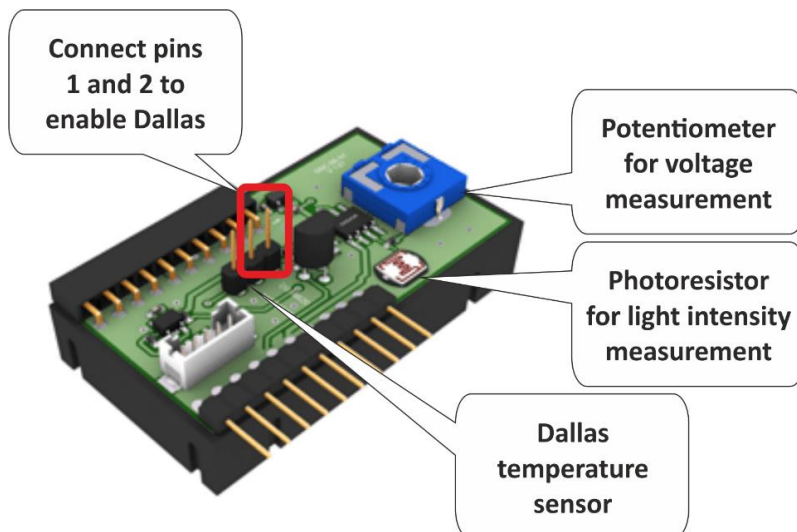
1.1.3 IQRF Transceiver

TR-72DAT (version of IQRF transceivers with temperature sensor and an on-board antenna) is a family of IQRF transceiver modules operating in the 868 MHz and 916 MHz license-free ISM frequency band. It is highly integrated ready-to-use design containing MCU, RF circuitry, integrated LDO regulator, serial EEPROM, temperature sensor and an on-board antenna.

Press and hold the SW2 button (Reset button) on a CK-USB or DK-EVAL always when you are plugging an IQRF transceiver to or you are unplugging it from the SIM connector. Be sure you connect an IQRF transceiver into a CK-USB or DK-EVAL in the right direction (the antenna is outside the SIM connector).
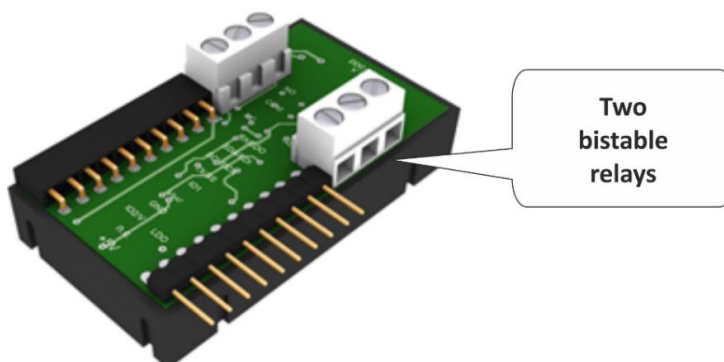
1.1.4   DDC-SE

A sensor development kit contains a potentiometer for voltage measurement, a photoresistor for light intensity measurement and a Dallas 18B20 temperature sensor. Connect pins 1 and 2 with a jumper to select reading values from Dallas 18B20 sensor. Connect DDC-SE with DK-EVAL to be charged and to read values from it through IQRF transceiver. It is compatible with other DDC (Development Daisy Chain) kits.
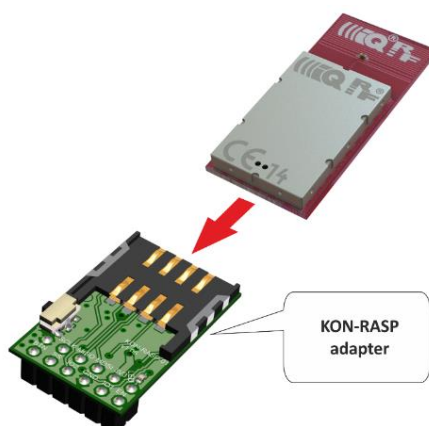

1.1.5   DDC-RE

A relay development kit contains two bistable (latching) relays. Connect this tool to DK-EVAL to be charged and with IQRF transceiver to control relays. It is compatible with other DDC (Development Daisy Chain) kits.
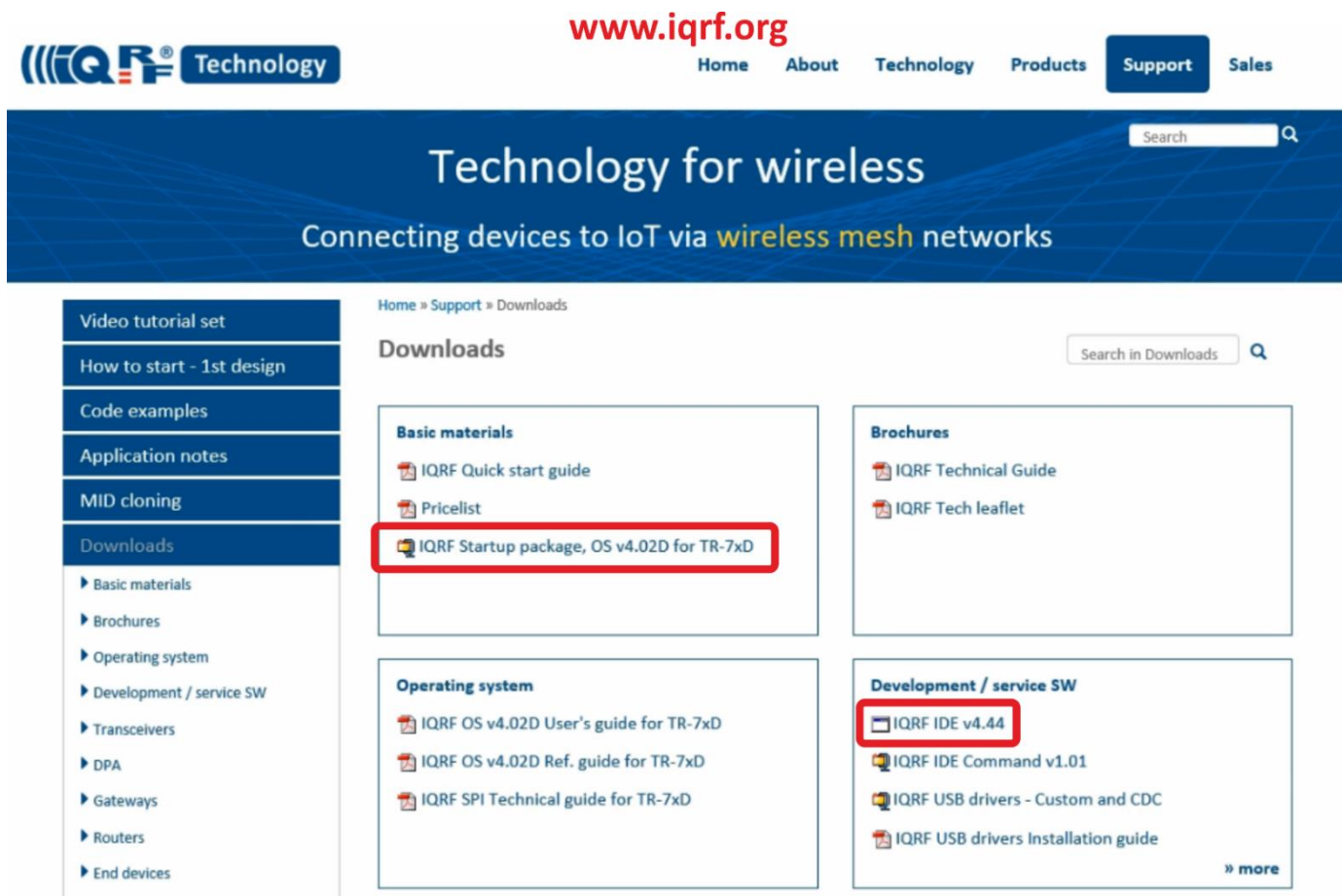

1.1.6   KON-RASP

This is an adapter for a connection of an IQRF wireless transceiver to the UP board. It will be described in more detail in Part 2 – IQRF Gateway.

2 Create the IQRF Network

2.1 IQRF IDE installation

If you haven't done it yet, download the startup-package from www.iqrf.org and install the last version of the IQRF IDE.

In the startup package, in the **Examples/DPA/IoT-Starter-Kit-01** folder, you will find the **IoT-StarterKit-01-demo** file. Double-click the file to launch the IQRF IDE with all necessary files.

Note: The IQRF IDE environment is tested for Windows 10, Windows 8.x, Windows 7 and Vista. Windows installation in a virtual machine is not tested and it is not recommended. The following minimum configuration is required to run IQRF IDE:
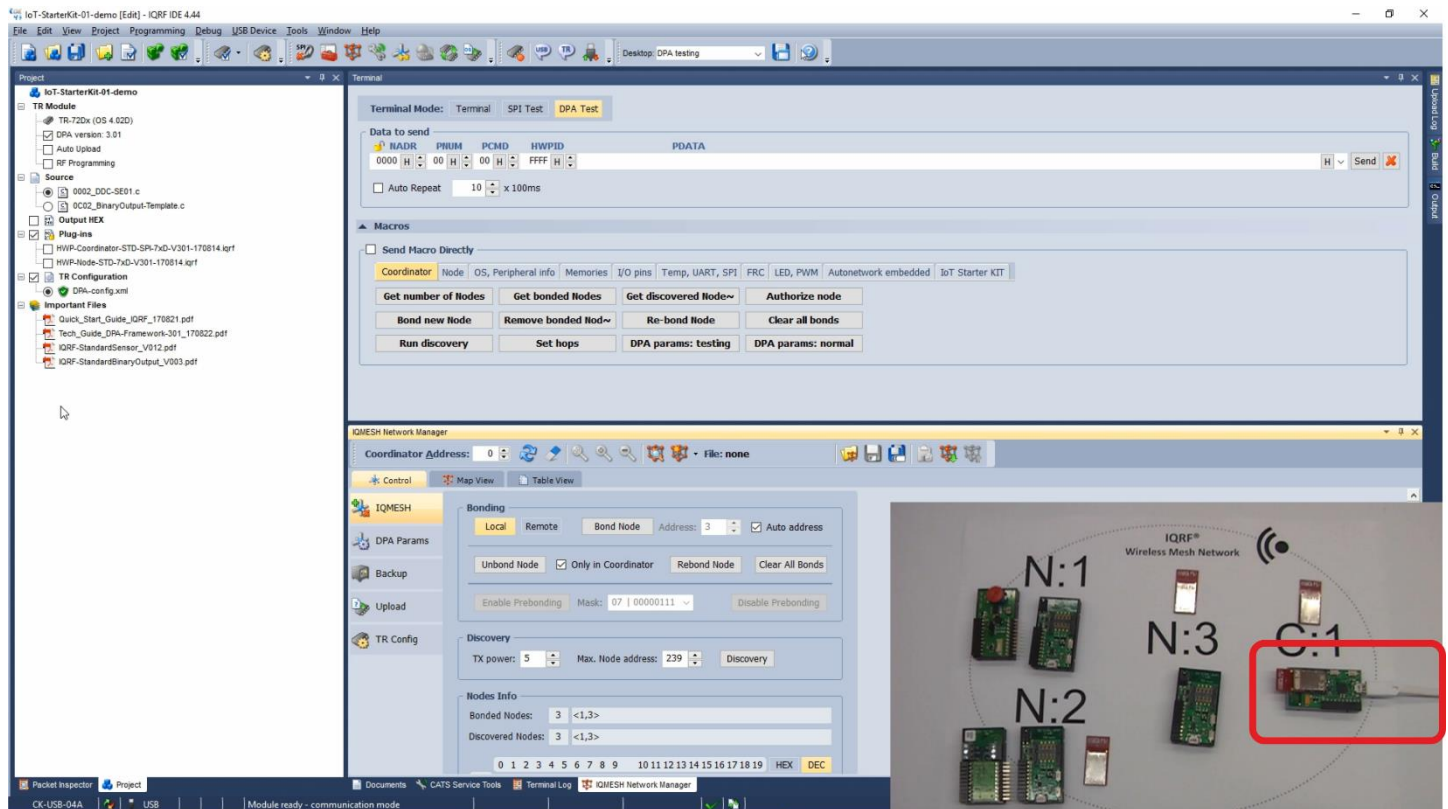
- Processor PC-compatible running on 1 GHz or higher
- 512 MB memory
- 30 MB of hard disk space
- 1 USB port

- Vista, Windows 7 (32 bit, 64 bit), Windows 8.x (32 bit, 64 bit), Windows 10 (32 bit, 64 bit)
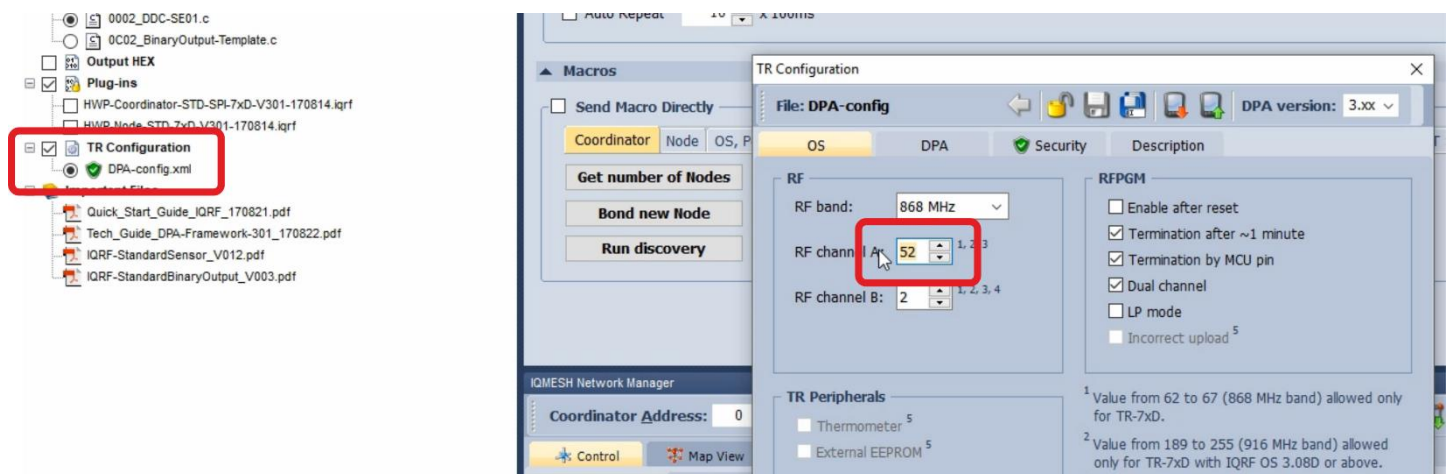- Internet Explorer 7.0 or higher or other suitable browsers for Help

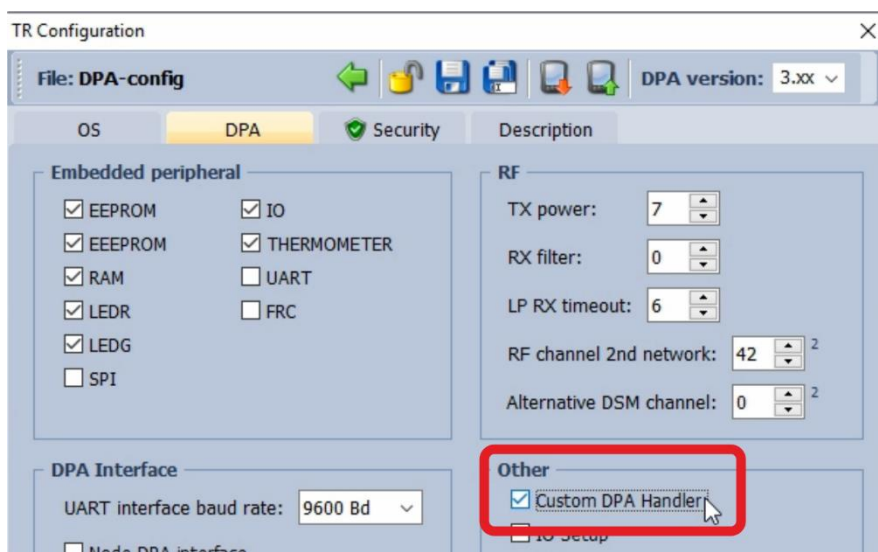## 2.2 IQRF Nodes

2.2.1 Node #1 – connected to sensors

Press the SW2 button (Reset button) on a CK-USB always when you are plugging an IQRF transceiver to or you are unplugging it from the SIM connector. Connect the CK-USB programmer to your computer and insert the first transceiver.
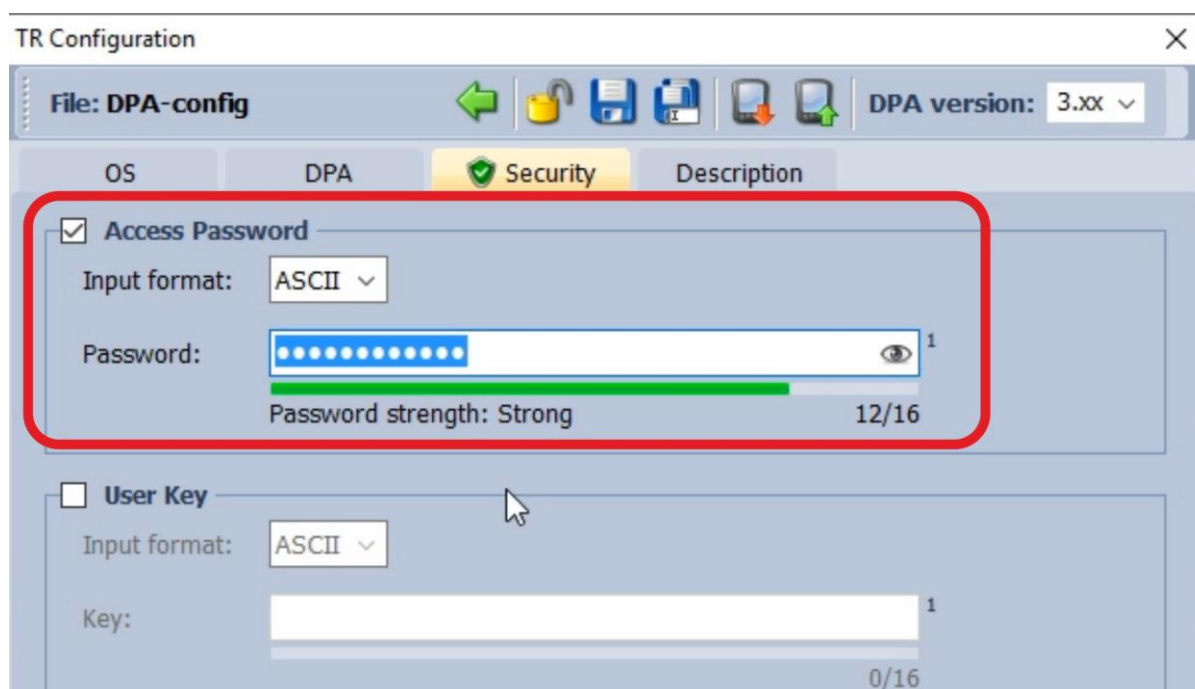

On the left-hand side, you double-click on the configuration. Don't change the selected channel 52, because all devices you will connect to the network later will have the default channel 52 as well.

On the **DPA** tab allow usage of a **Custom DPA Handler** because you will upload one into the transceiver in one of the next steps.
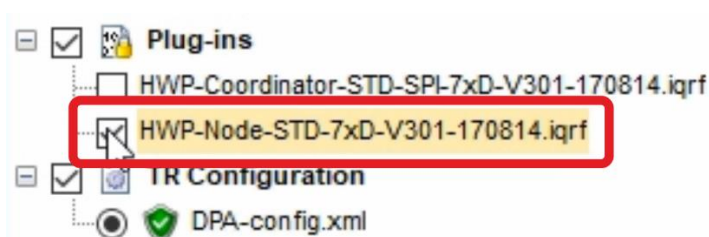

On the **Security** tab, you can set your access password. Don't forget that the same access password must be configured in all devices in your network including coordinator. The user key is for optional payload data encryption, but this is something we will not use now.
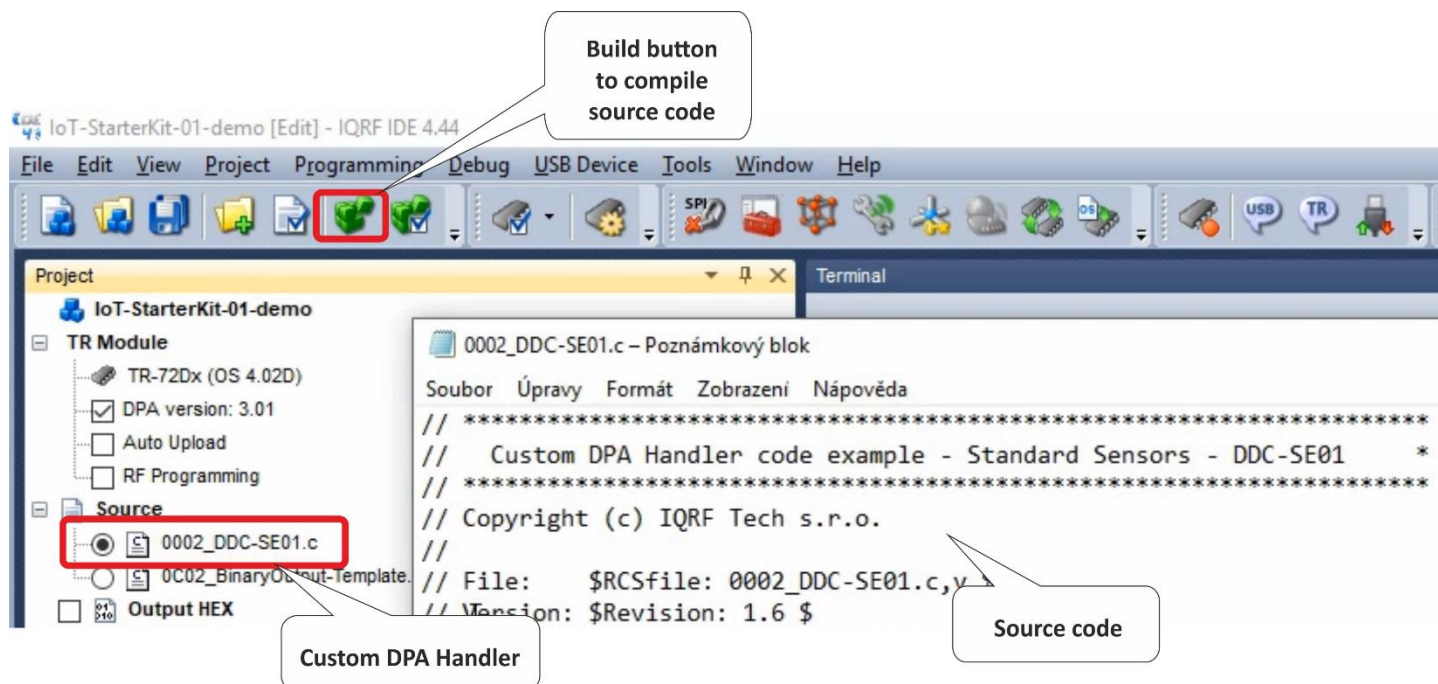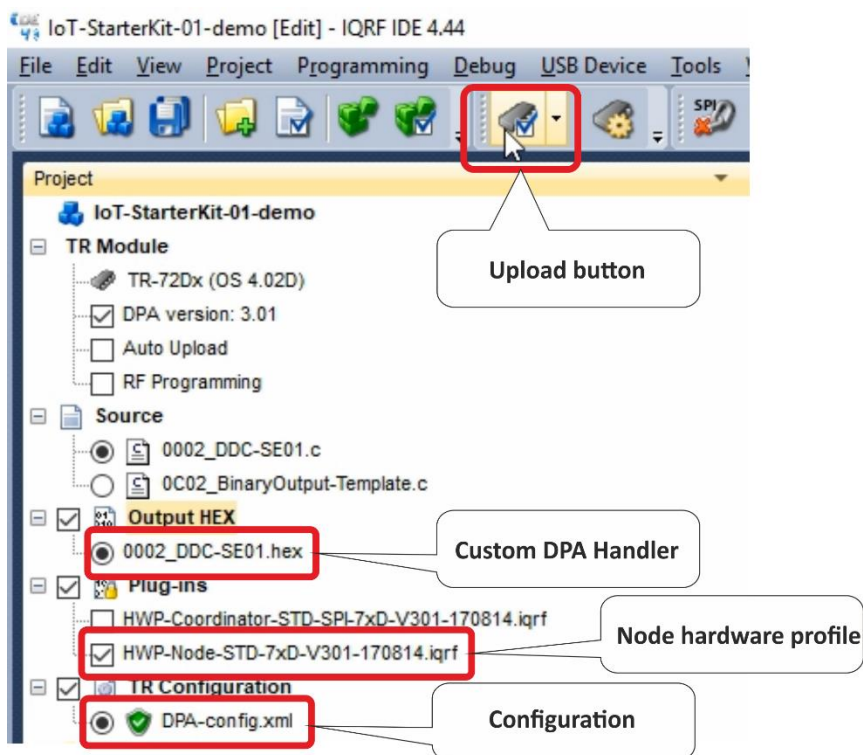

Save the configuration and close it.

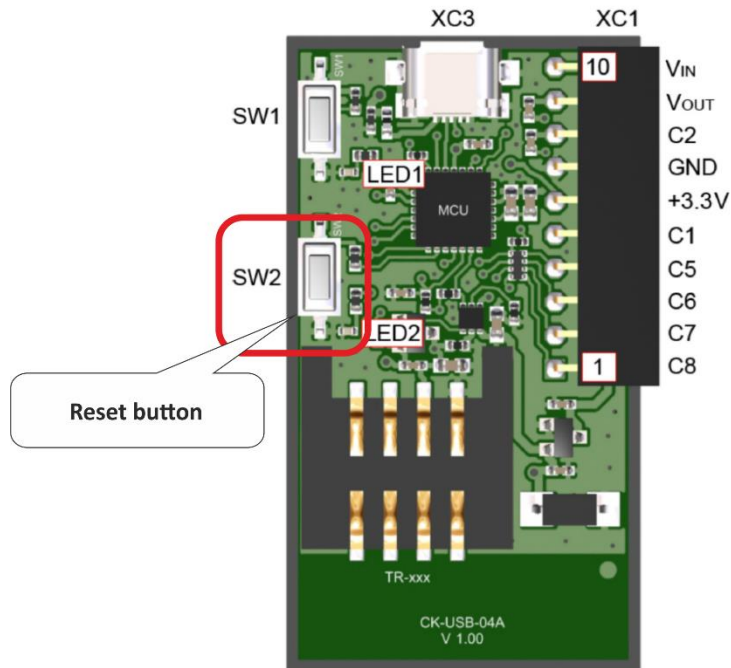Next, select the Node plugin (HWP-Node-…) so the transceiver supports the DPA protocol and features.

Custom DPA Handler is used to customize the behavior of a transceiver. In the **DDC-SE01.c** Custom DPA Handler "c file" you will find the source code that is written according to the IQRF Interoperability standard. To compile the source code, click on the **Build button** or push **F10**.

Make sure you have all three files selected - the **HEX** file of the DDC-SE01 Custom DPA handler, the **Node hardware profile** and the **configuration**. Upload the selected files using **Upload button** or by pushing **F5**.
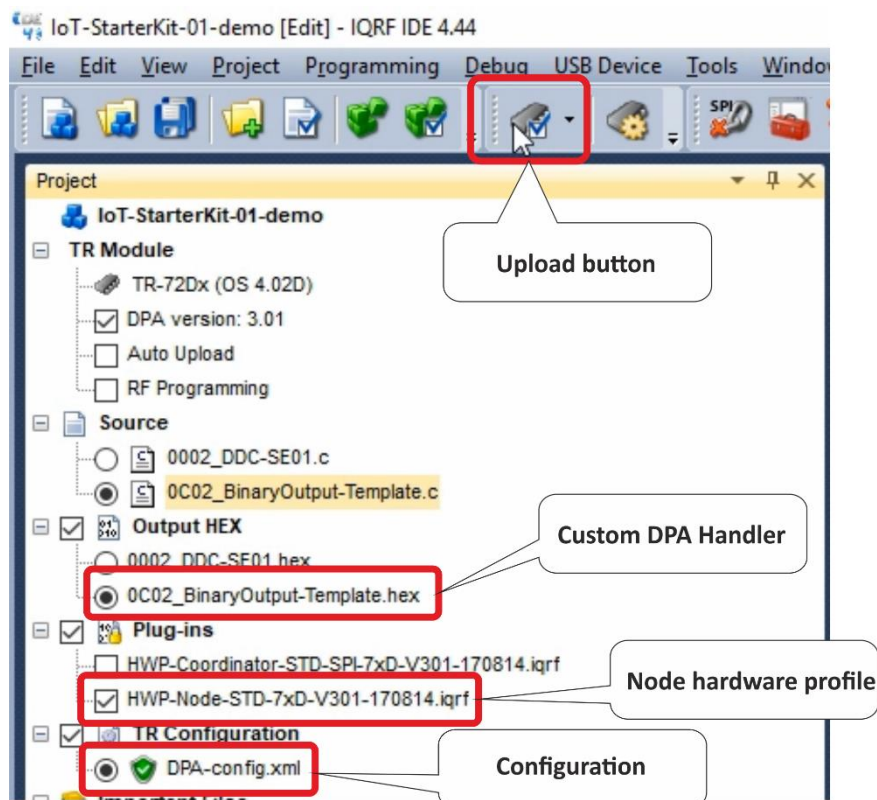
For safe replacement of a transceiver press and hold the Reset button (**SW2**) on your programmer. Now remove the connected transceiver and place it next to the Sensor kit.
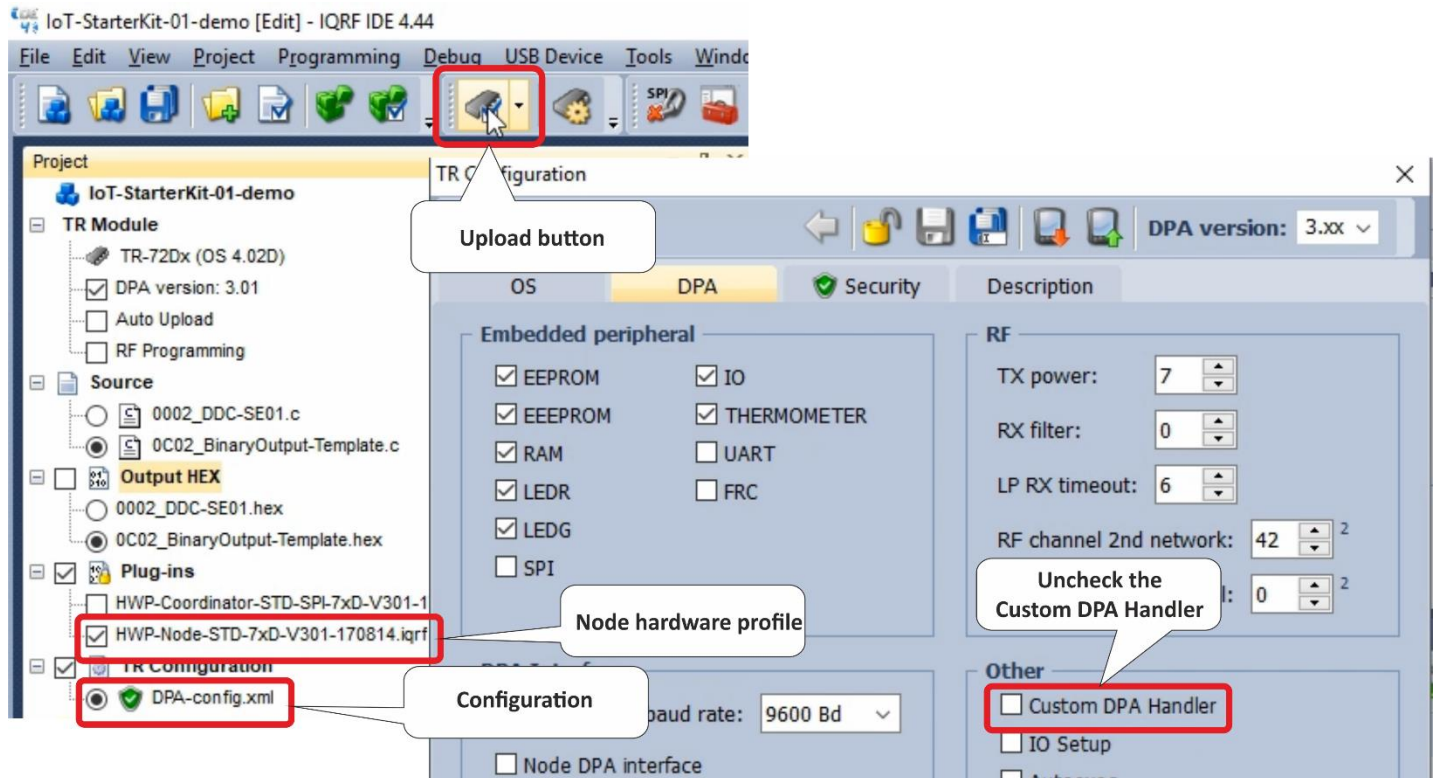

2.2.2 Node #2 – connected to relays

Insert the second transceiver. Keep the same **configuration** and the same **hardware profile**. Compile the **BinaryOutput Custom DPA Handler** designed to control the relay kit and upload these three files to the second transceiver.

2.2.3 Node #3 - repeater

For safe replacement of a transceiver press and hold the Reset button (**SW2**) on your programmer. Replace the second transceiver with the third one.
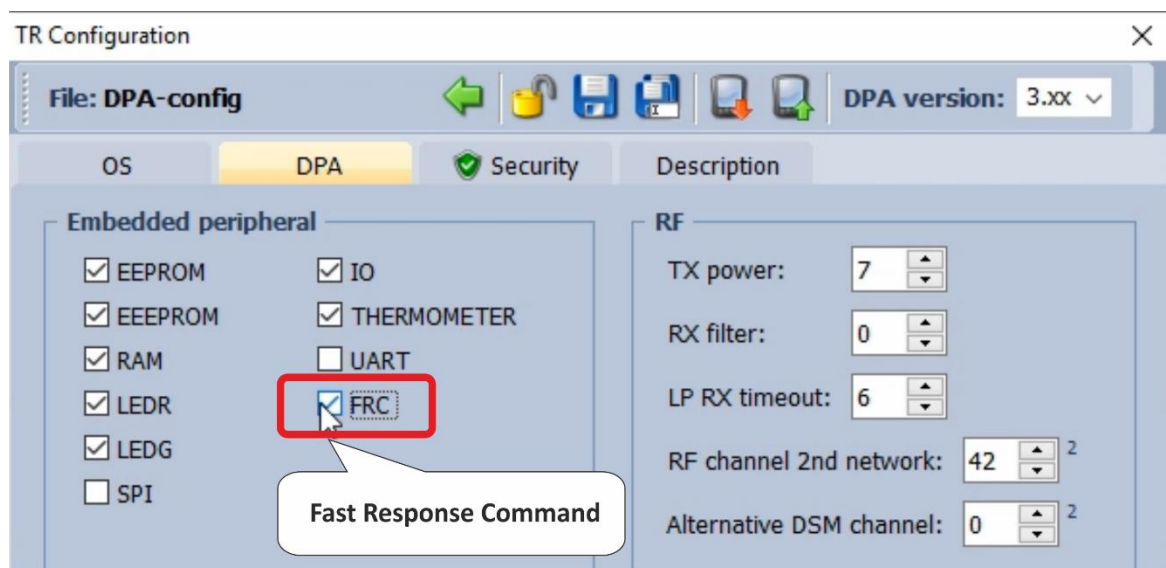
This transceiver will work only as a repeater so it won't contain any Custom DPA Handler. Uncheck the Custom DPA Handler checkbox in the Configuration window. Don't change any other parameters here. Upload the **configuration** and the **Node hardware profile** to the transceiver. Do not upload a HEX file here.
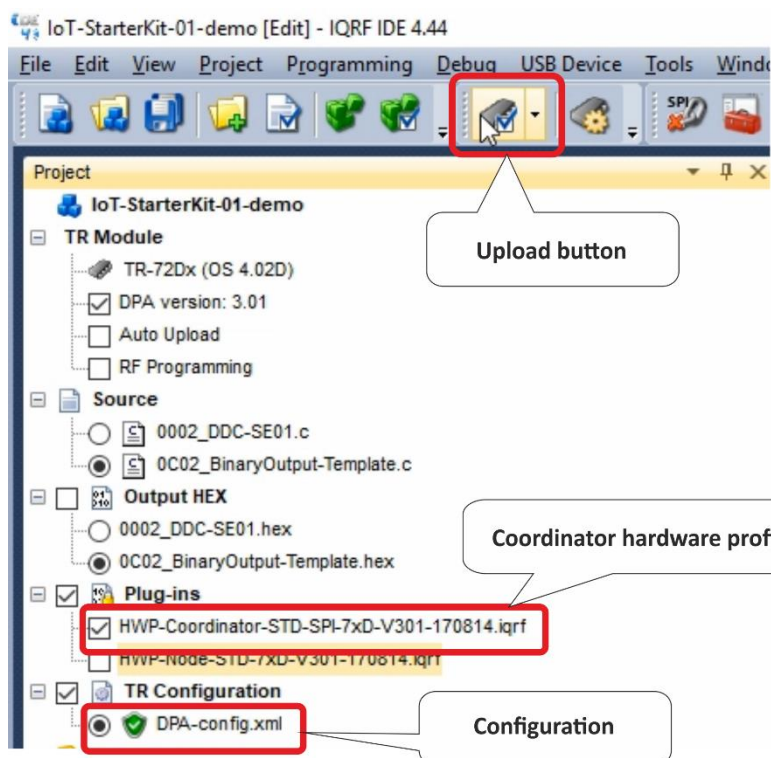

2.3 IQRF Coordinator

For safe replacement of a transceiver press and hold the Reset button (SW2) on your programmer. Now remove the third transceiver and insert the last one which will work as a Coordinator.

In the configuration, enable the **FRC** - Fast Response Command used for fast data collection. This is a periphery of the coordinator, so it didn't make sense to enable it in the Nodes. We will not upload any Custom DPA Handler to the Coordinator, so there is no need to enable it. Save the configuration and close it.

Select the **coordinator hardware profile** and the **configuration**, and upload them.
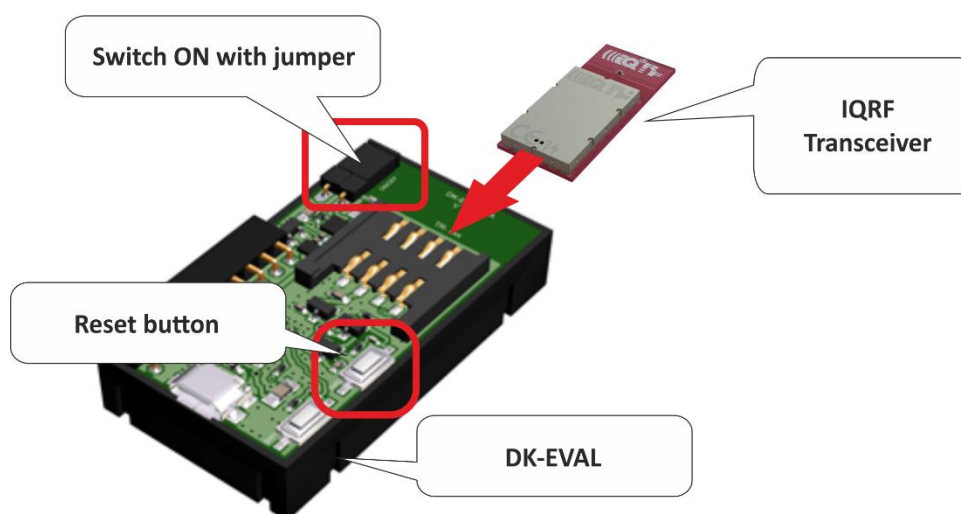

Now you have your coordinator ready so leave it connected to your computer through the programmer.

2.4   Bonding and unbonding

Adding a node to a network is called **bonding**. Removing a node from a network is called **unbonding**.
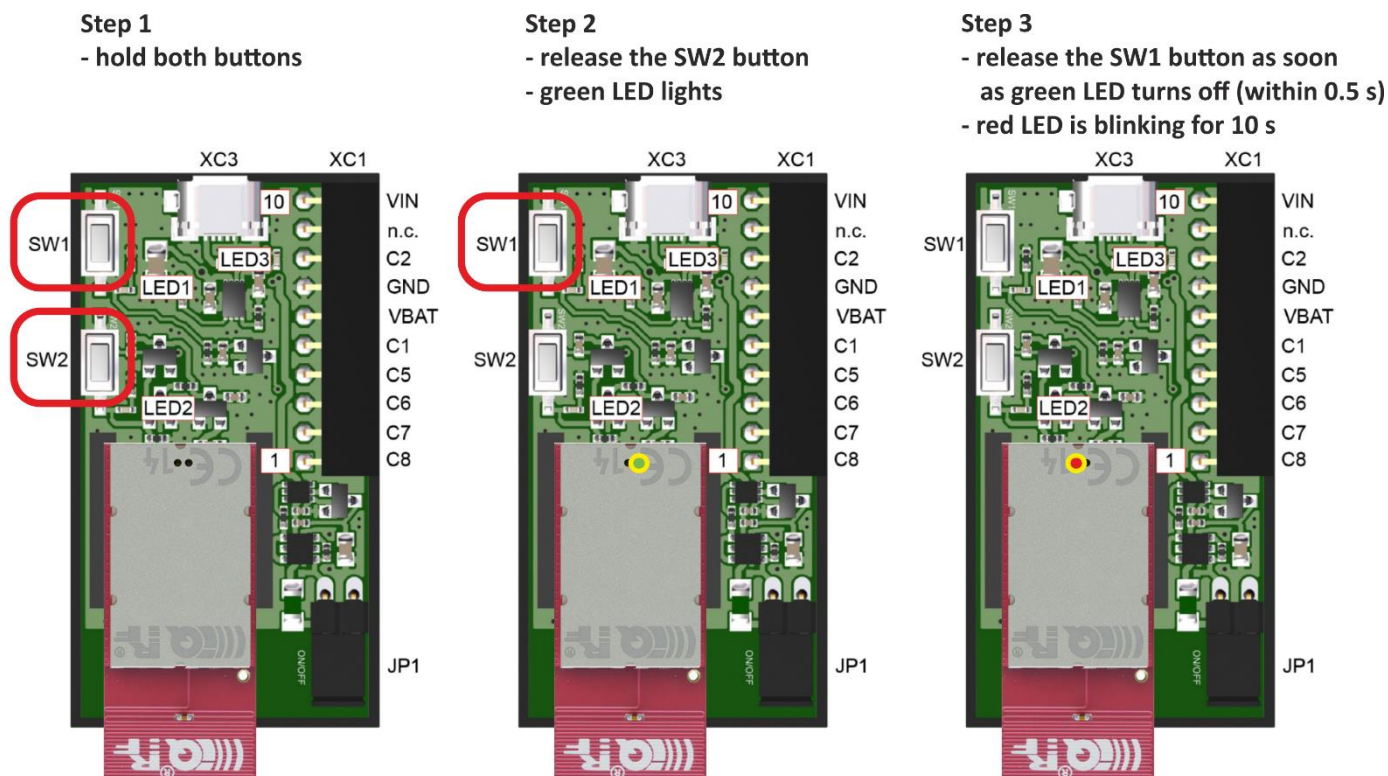
For safe replacement of a transceiver press and hold the Reset button (SW2) on the evaluation board. Put the prepared transceivers into the evaluation boards and switch them on with jumpers.
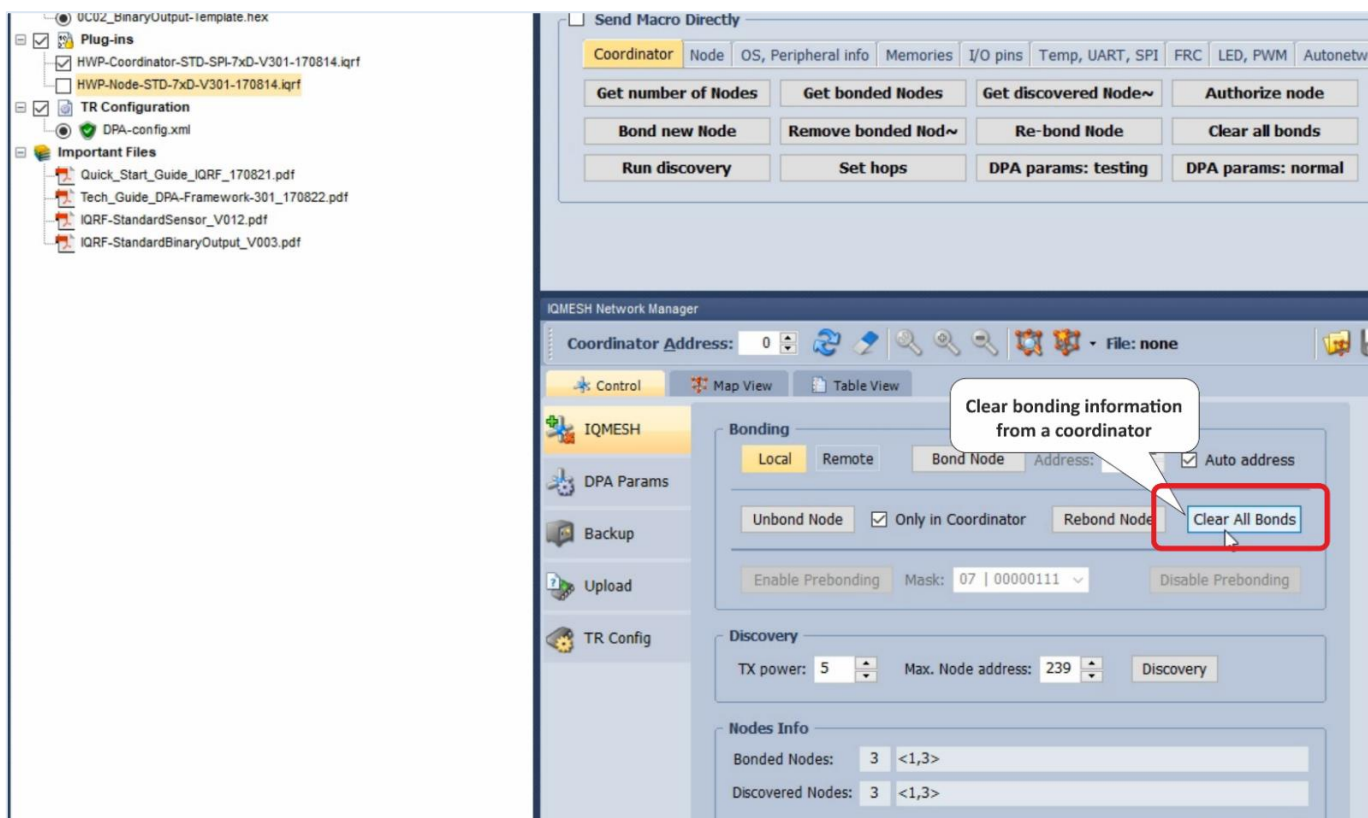

If the red LED on the IQRF transceiver is flashing, it means it has no previous bonding information stored. If this is not the case, you must unbond the node. We will do it here manually.

2.4.1 Unbonding

You can unbond the node by following this procedure: press both Reset (SW2) and user (SW1) buttons on the evaluation board, release the Reset button, the green LED lights for 1 second, once it goes out you have a half a second to release the user button. If the Red LED starts blinking, your node was successfully unbonded.

Step 1
- hold both buttons

Step 2
- release the SW2 button
- green LED lights

Step 3
- release the SW1 button as soon as green LED turns off (within 0.5 s)
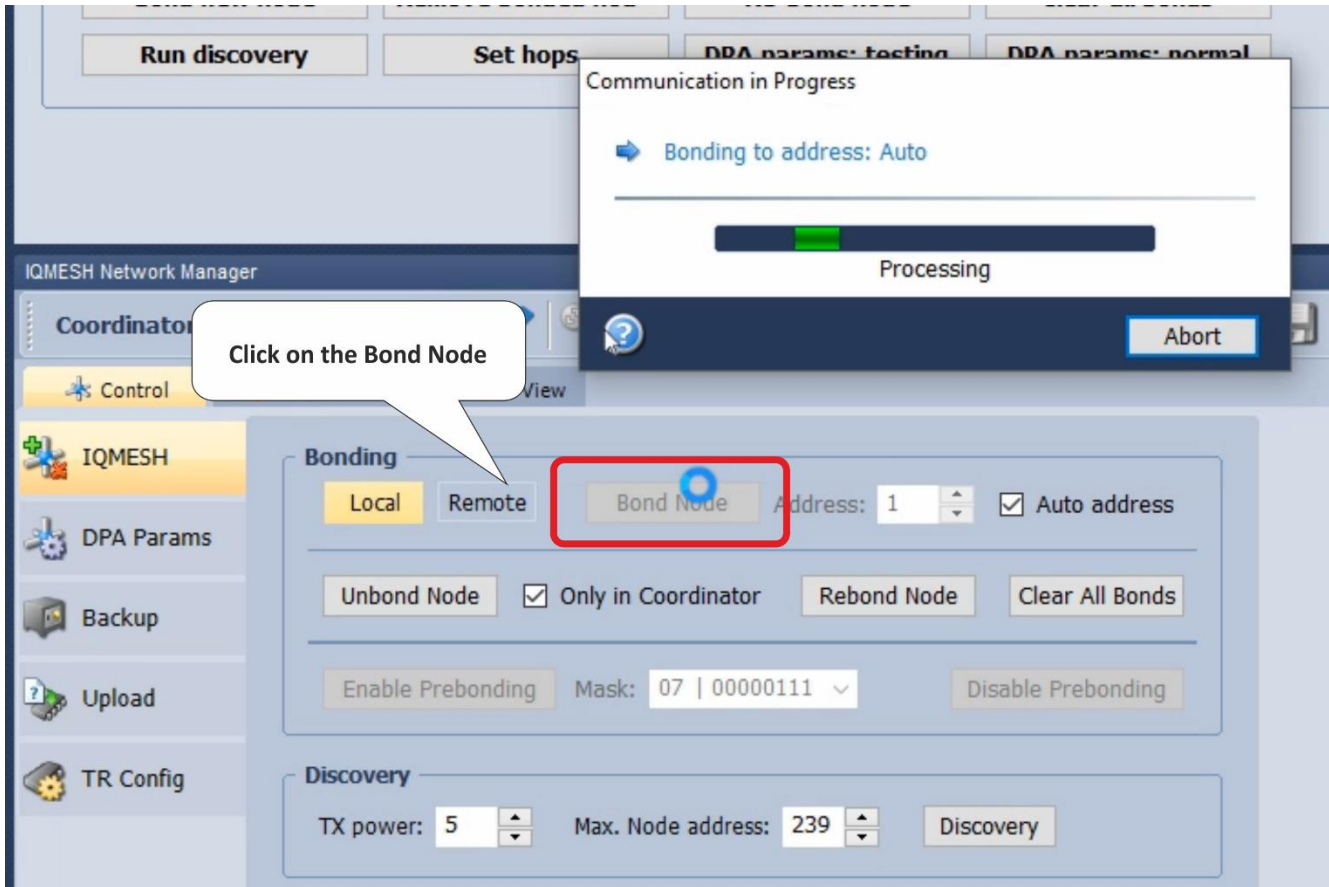- red LED is blinking for 10 s

Once you have all three nodes ready, delete any residual bonding information from the **coordinator**. Click the **Clear All Bonds** button on the **IQMESH Network Manager – Control** tab.
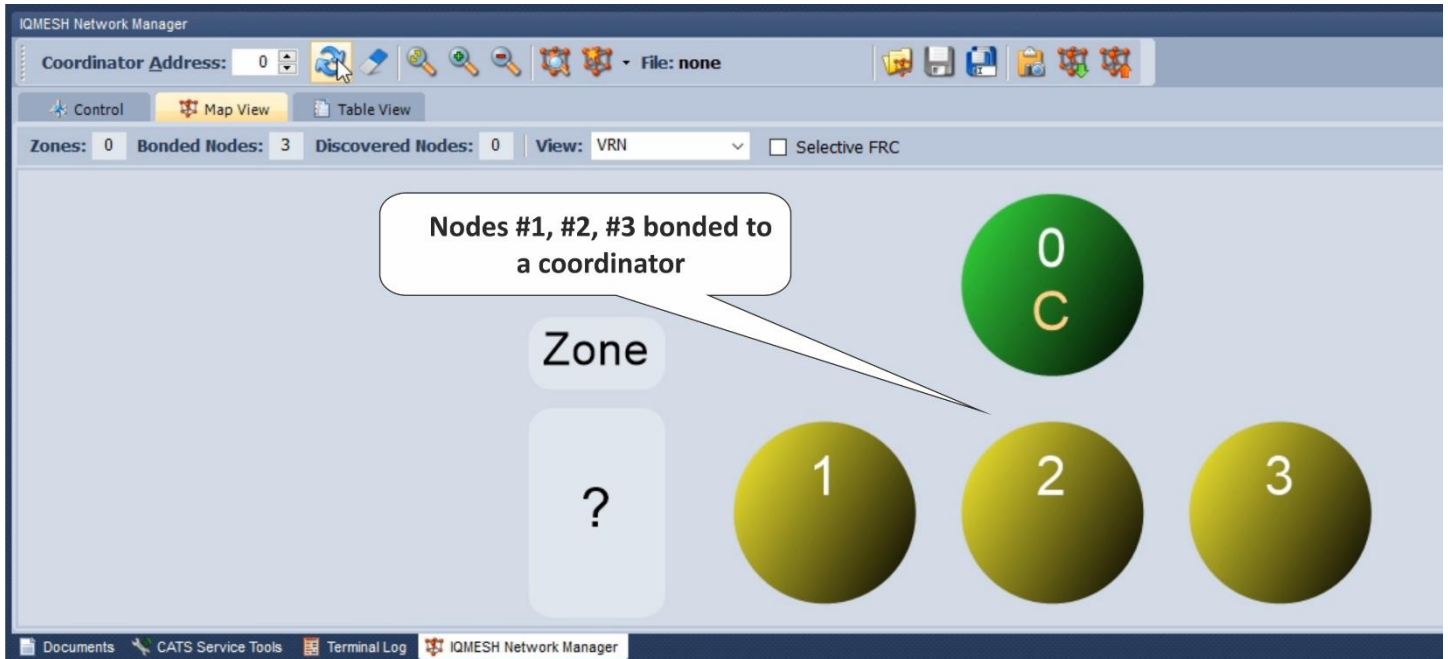
2.4.2 Bonding

Now build your wireless network. Click on the **Bond node** button to run the Coordinator listening for a new Node request.

During this ten-second period, press the User (SW1) button on the evaluation board with the transceiver configured for communication with the sensor kit.
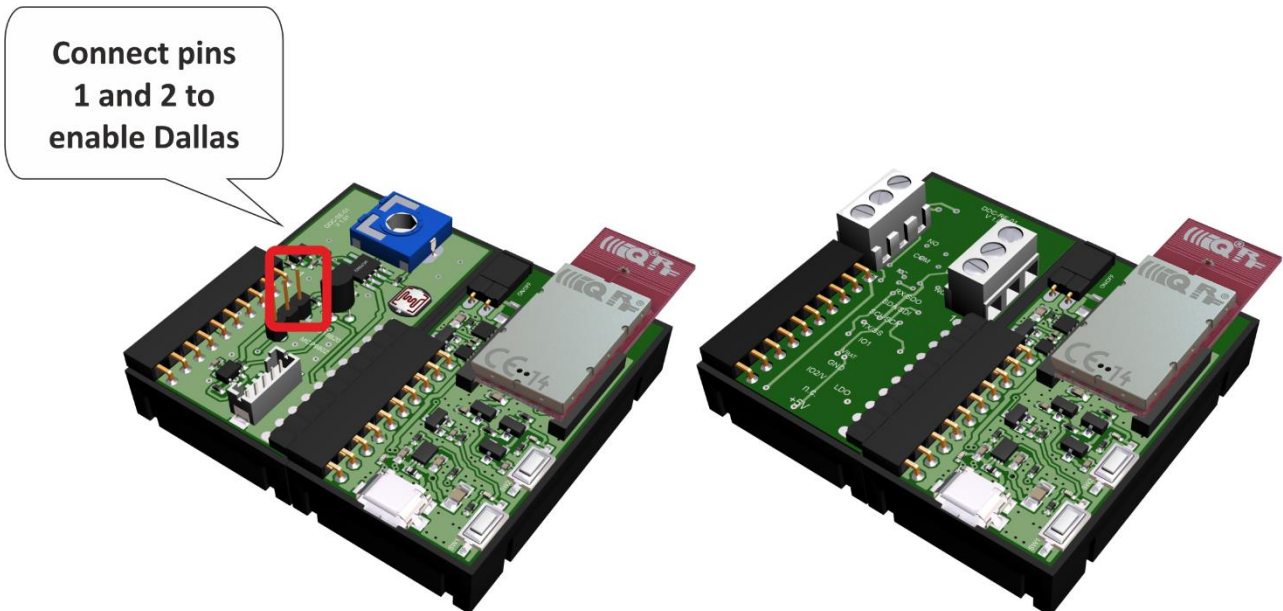
Bond the transceiver with the Custom DPA Handler for communication with relays as a node number 2 following the same procedure. The last transceiver will be bonded as number 3. You can see the current network in the **Map View**.
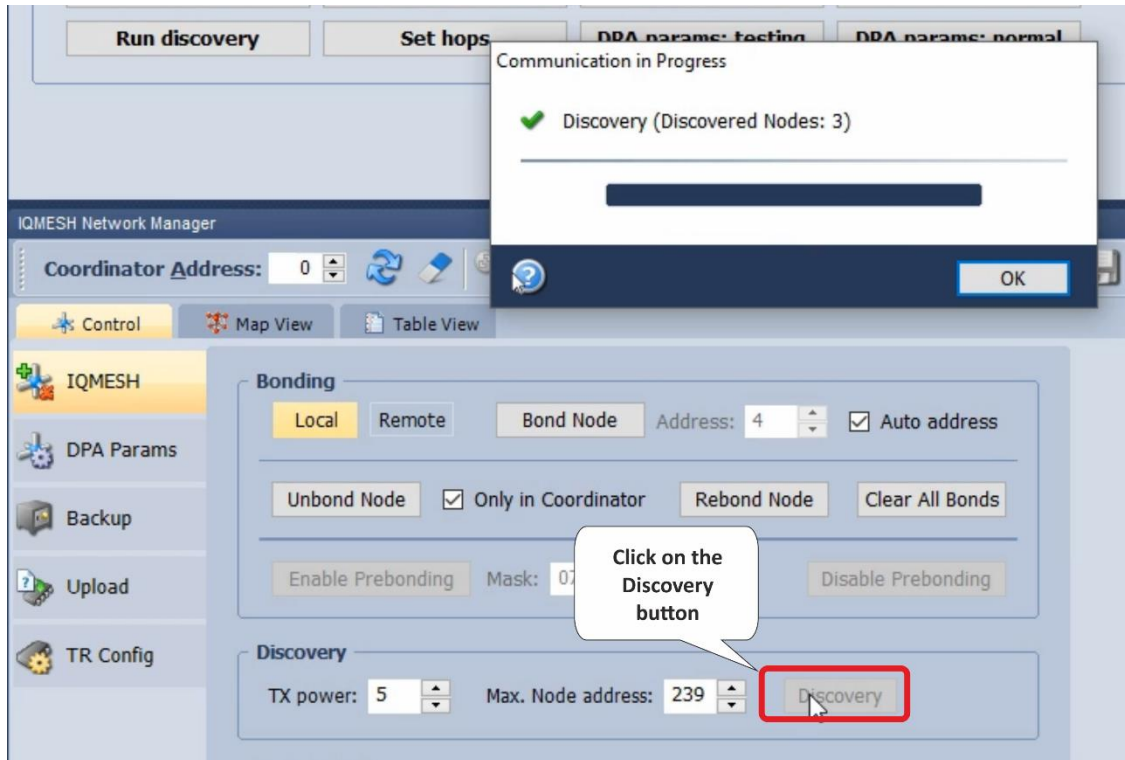

2.5 DDC kits adding

Connect the node number 1 to the sensor kit and the node number 2 to the relay kit. Connect pins 1 and 2 on the sensor kit with the jumper to select the Dallas temperature sensor.
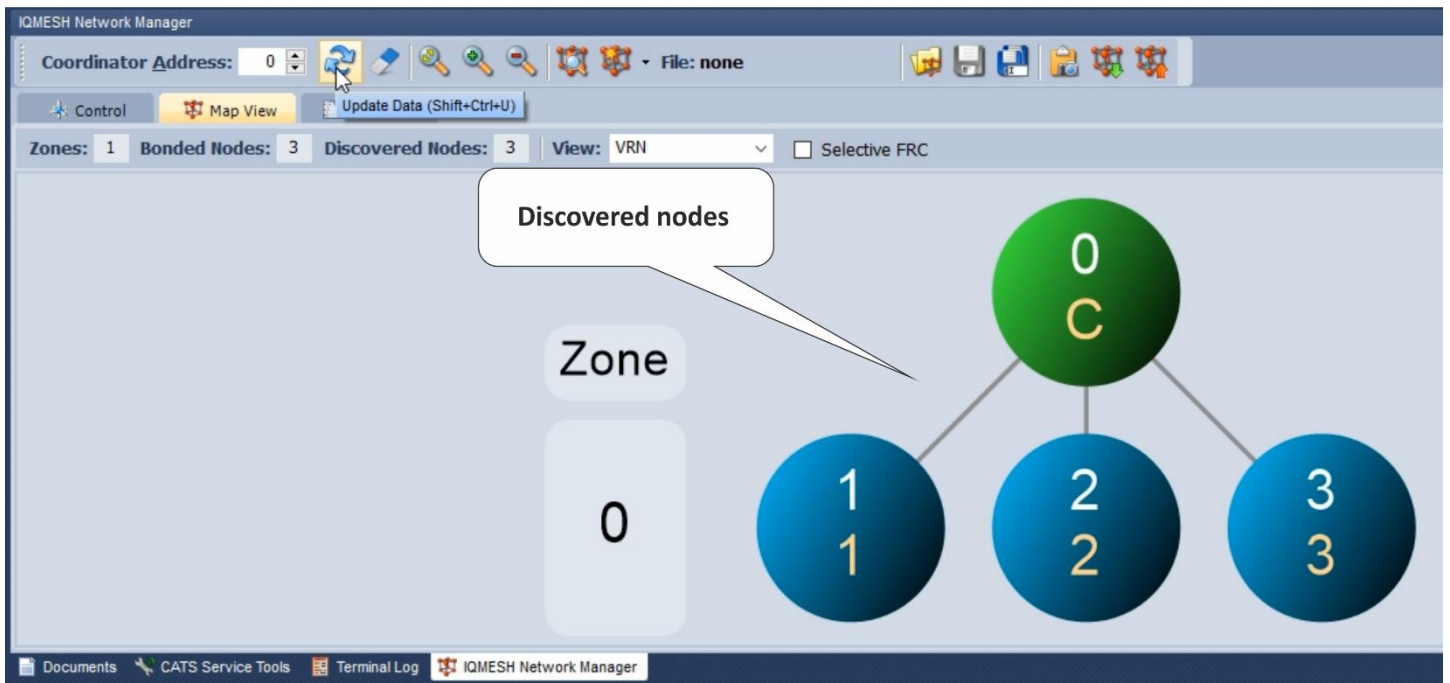
2.6 Discovery

Now place the nodes on their final destination and run discovery. Discovery will automatically set up routing topology of the network.
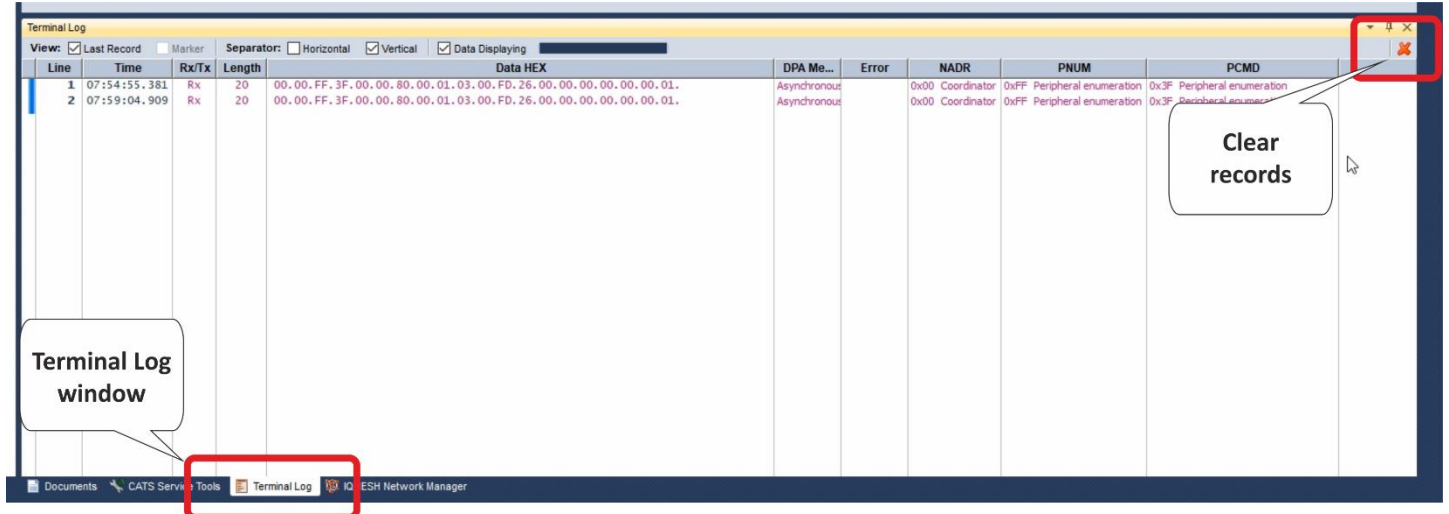

Check the **Map View** again. Discovered nodes have virtual routing addresses and are marked with blue color.
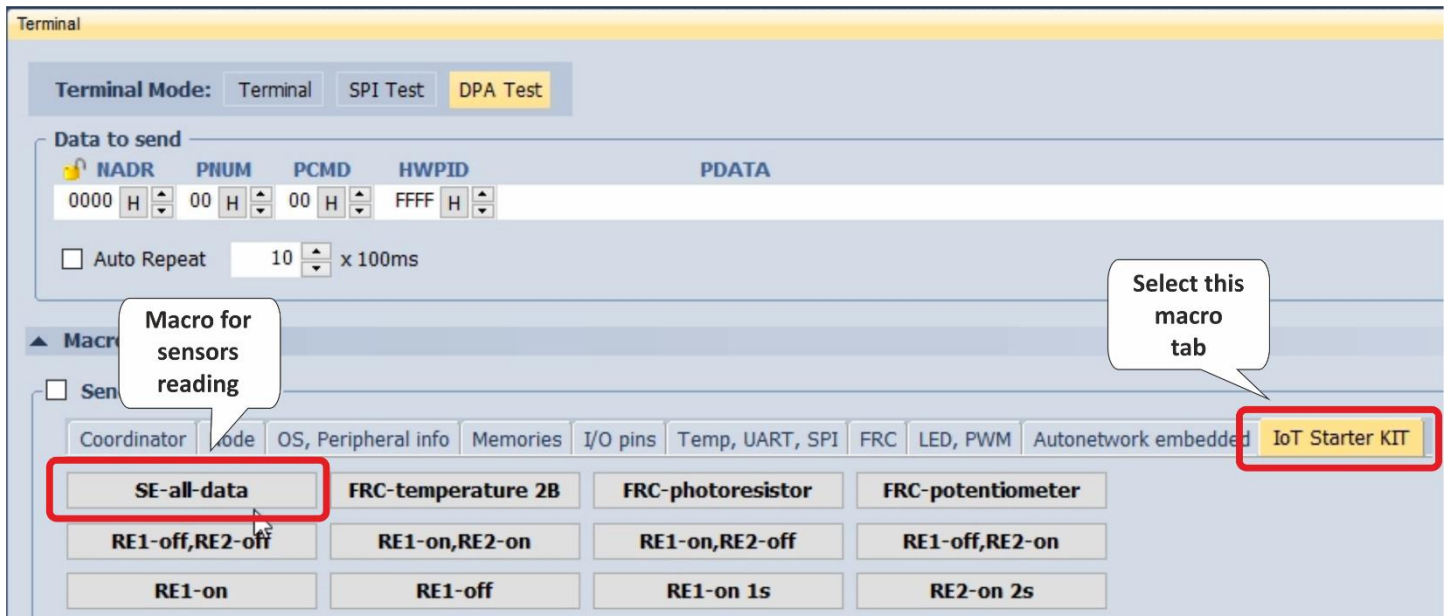
2.7   Test the wireless communication

2.7.1   Terminal log

Go to the Terminal log located at the bottom of the IQRF IDE next to the IQMESH Network manager and clear the current log.

2.7.2   Macros

On the **IoT Starter Kit macro** tab, there are prepared macros containing commands for Custom DPA Handlers used in the Starter Kit. Select the first macro that contains the command to read all sensory data from the sensor kit connected to the node number 1.
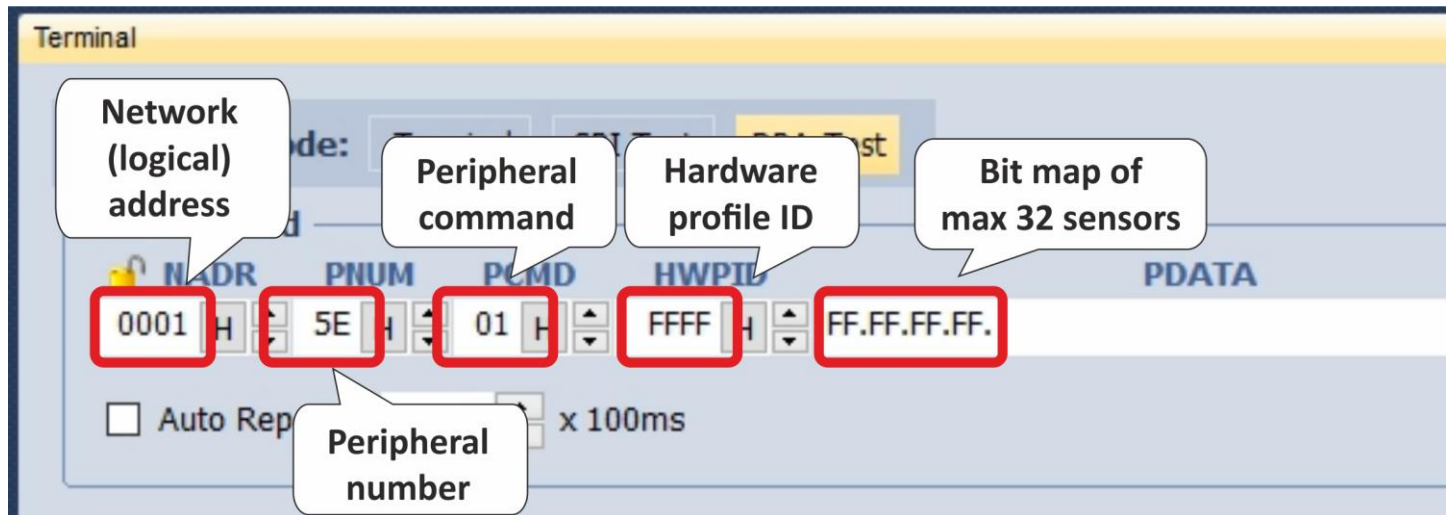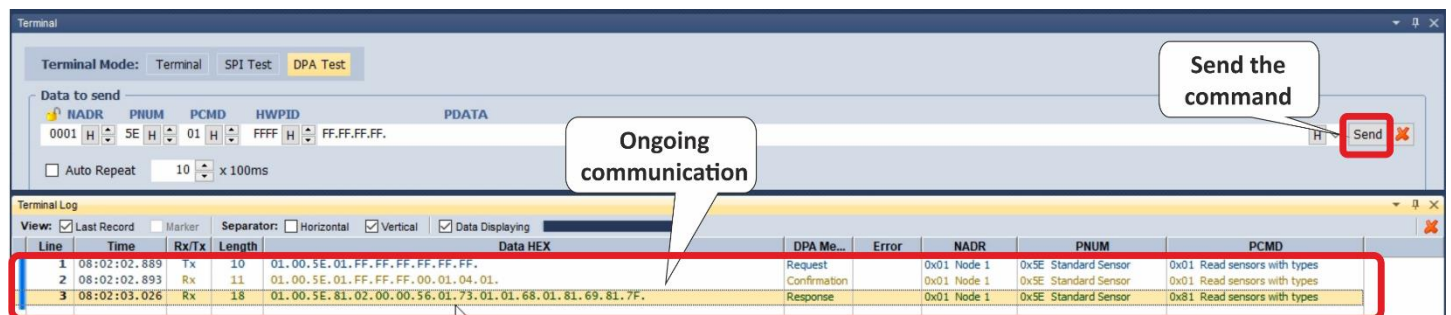
2.7.3 DPA packet parts

Note the individual parts of the DPA packet. The first part is the **network (logical) address** of the node you want to communicate with. Here we use the logical address **#1** which corresponds to the node with the sensor kit.

5E is the hexadecimal representation of the **Standard sensor periphery**. The number **01** in the **peripheral command** field corresponds to the command for collecting types of sensors and their values. The **FF.FF** in the **hardware profile ID** field indicates that there is no hardware profile filtering.

In the **PDATA** field, there is a bitmap of **maximum 32 sensors** you want to communicate with on the specific node. Here we want to read all sensors available.
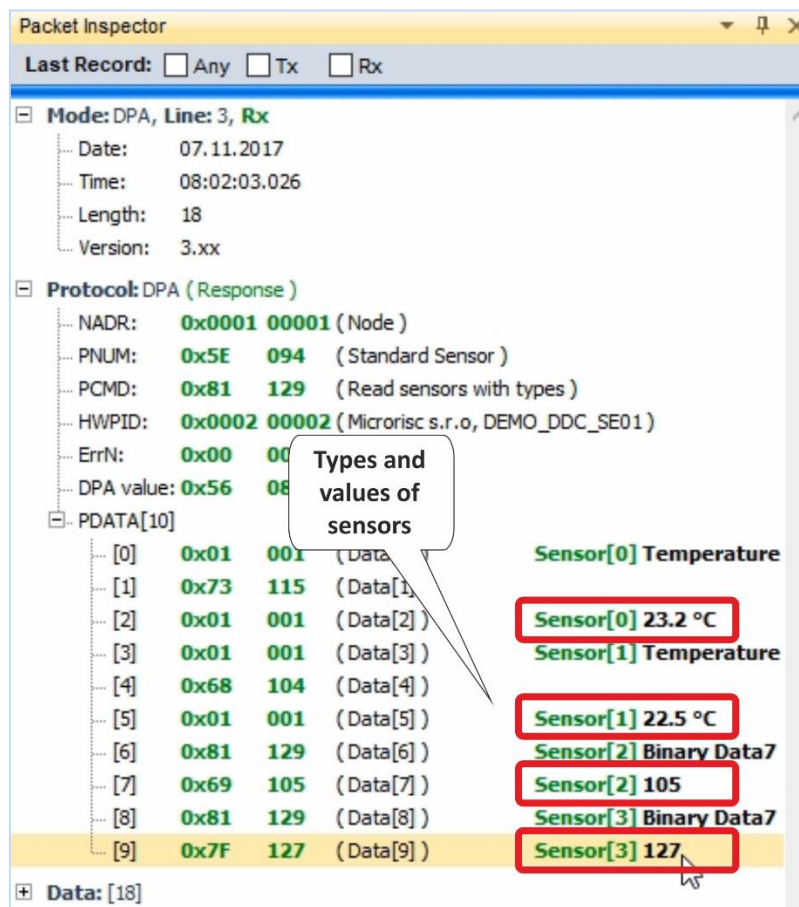

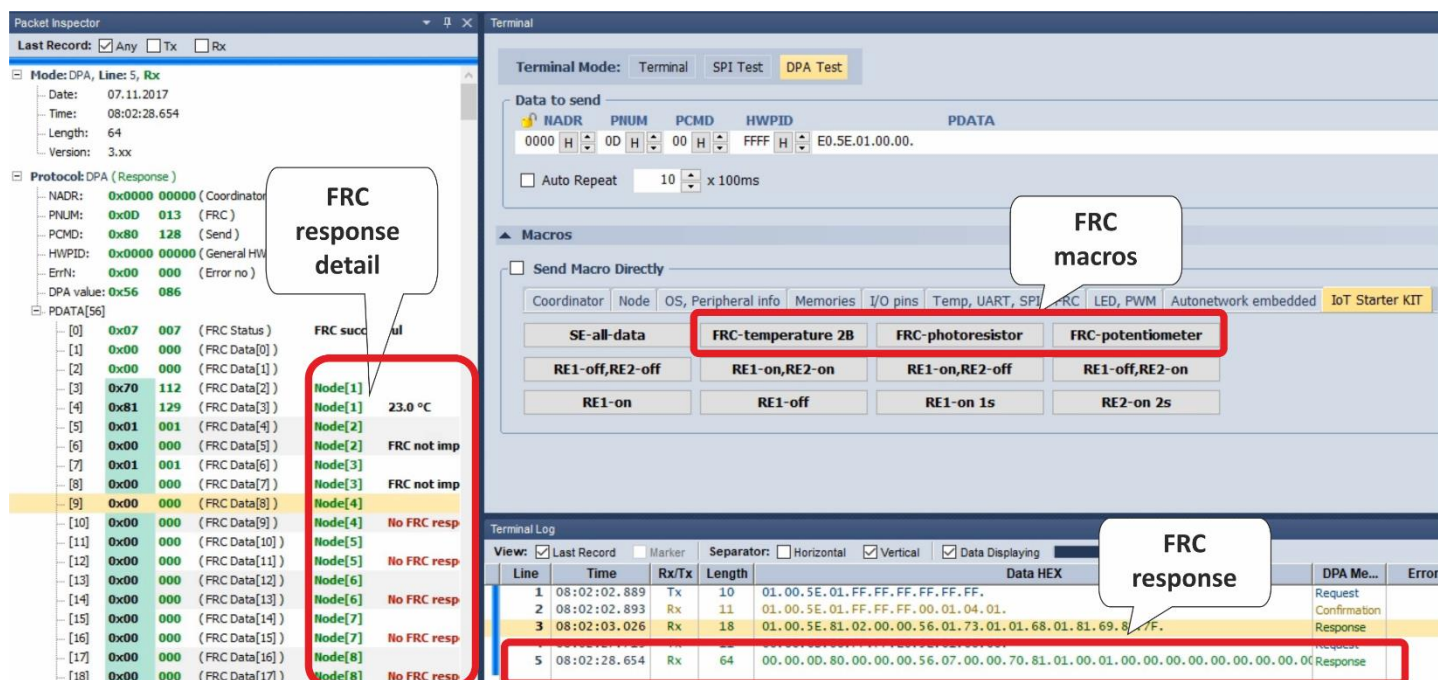**Send** the command and see the ongoing communication in **Terminal Log**.

Note: DPA protocol is in detail here described: https://www.iqrf.org/support/download&kat=54&ids=511. IQRF Standard manual is here available: www.iqrfalliance.org/techDocs/.
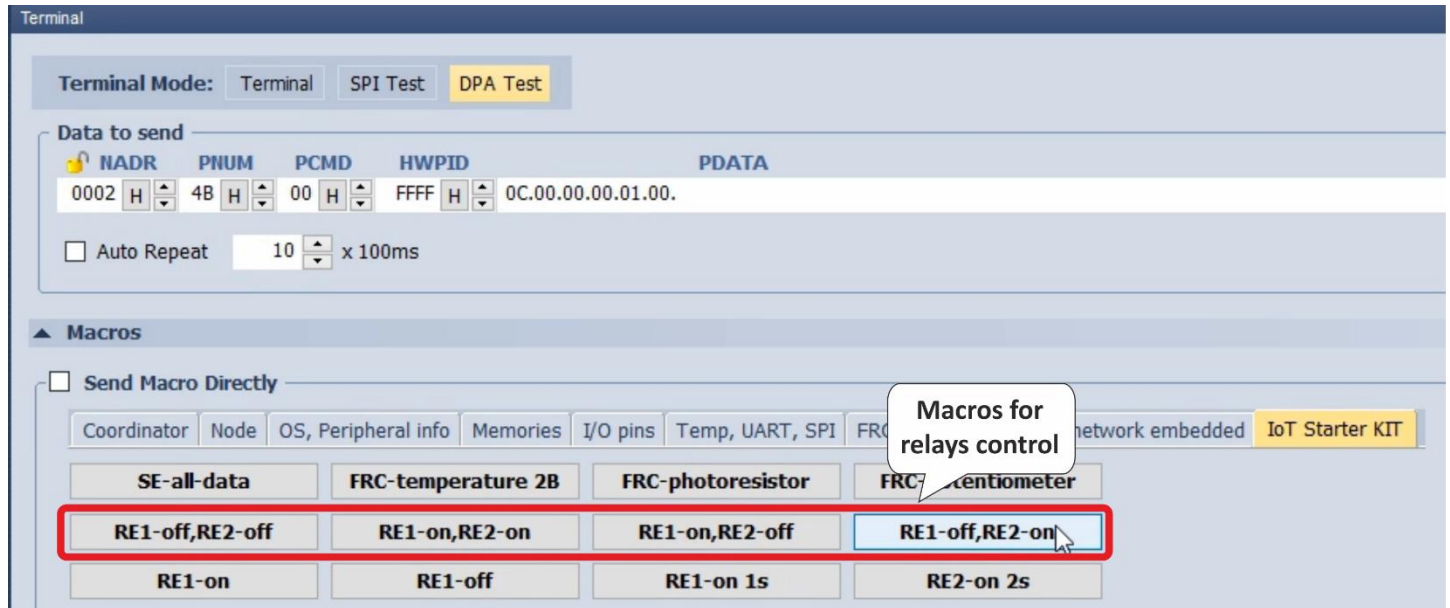
2.7.4 Inspect the packet

Double-click on the response to see the details of the sensor data. In the Packet Inspector, you can see values measured by the individual sensors and types of the sensors according to the IQRF Interoperability Standard.

If you have more sensors of the same type in the network, you can collect measured values at once using the **FRC** (Fast Response Command). In the macros, three **FRC** commands are prepared to collect **temperatures**, **light intensity** from **photoresistors** and **potentiometer** values.
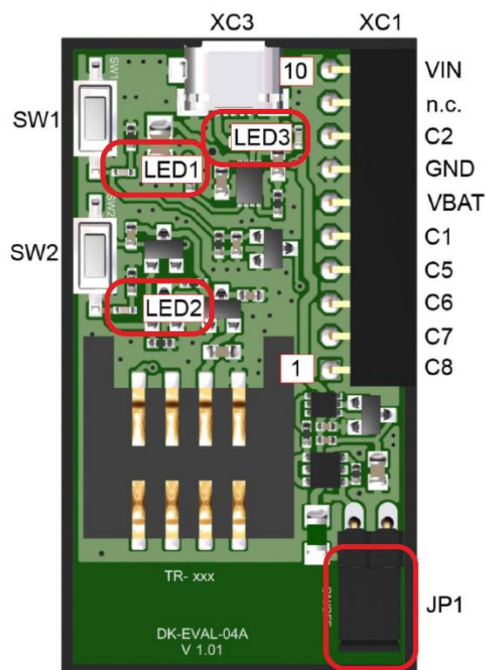
The other macros prepared here are used to **control the two relays** on the relay kit. You can test individual commands and inspect the ongoing records in the terminal log. If everything works well, you should be able to hear clicks of your relays.

3 Status of the evaluation board (DK-EVAL)

If the evaluation board DK-EVAL is charged and turned on (the jumper JP1 is set) and you press the pushbutton (SW1 or SW2), the appropriate red LED (LED1 or LED2) will light on. Otherwise, DK-EVAL is discharged.
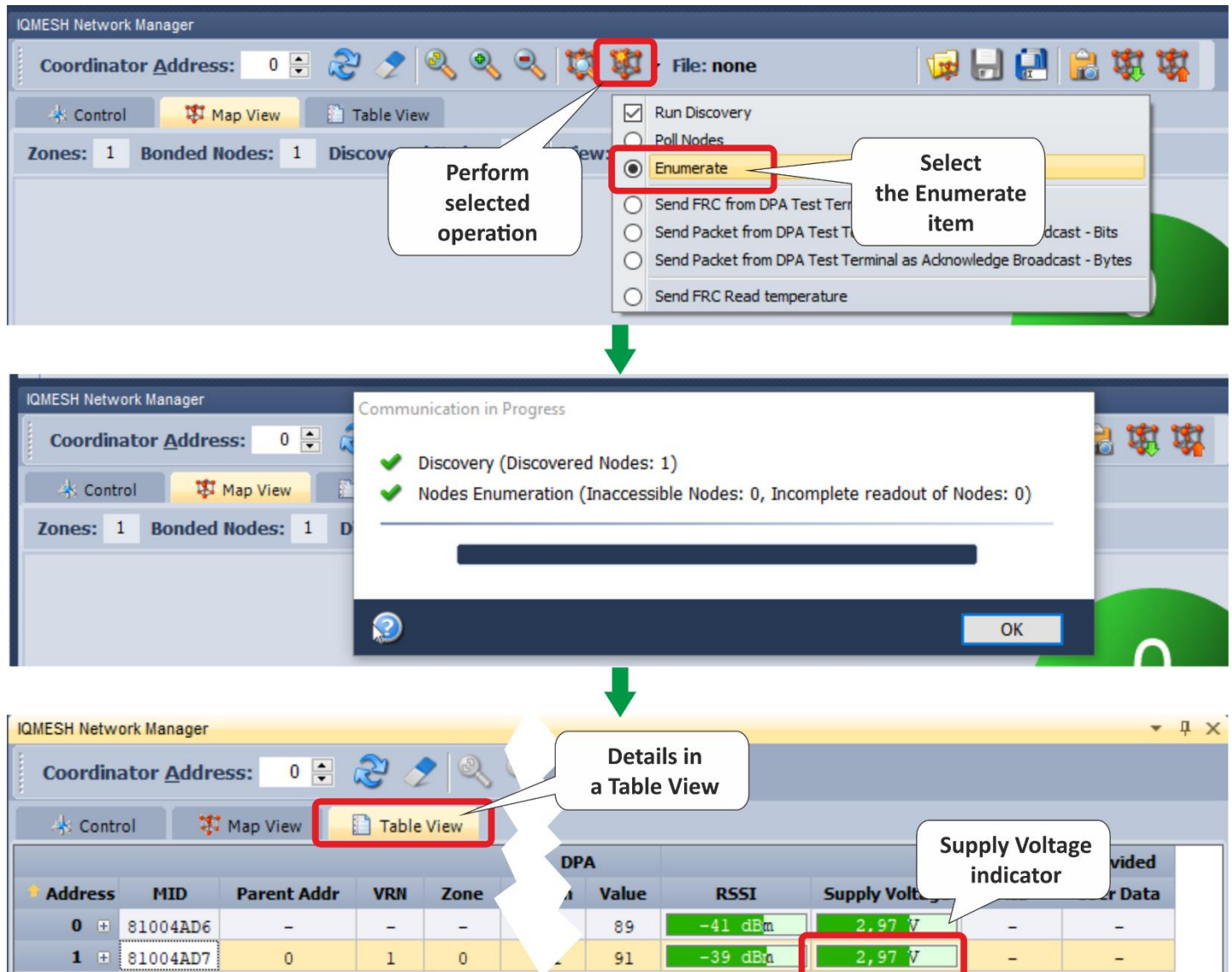
LED3 is on during charging and switched off when fully charged.

When you have your network created, you can use the features of the IQRF IDE environment to show the supply voltage of the accumulator (battery) inside the DK-EVAL.

Open the **Perform selected operation** menu in the IQMESH Network Manager. Select the **Enumerate** item and then click on the **Perform selected operation** button. Your network will be enumerated, nodes will be asked for detailed information.

In the **Table View** tab, you will find all detailed information about your network. In the **Supply Voltage** column, you will find the information about the accumulator (battery) inside the DK-EVAL boards. If the color is red (supply voltage less than 2.9 V), DK-EVAL should be charged.

4   Summary

You have your IQRF network working and it is controlled by the IQRF IDE. Be sure, you can collect sensory data from DDC-SE and control relays – see the chapter 2.7.

The next step is to make the UP board working as an IQRF Gateway. The installation and configuration of the gateway is the subject of Part 2 – IQRF Gateway.