Content

Important Warnings

This document is intended for NLB sensors with **FW 205 and higher** as well as IQRF modules with **OS 4.03D and DPA 401 and higher.**

Modules are operated in LP mode; therefore, it's necessary to set-up the Coordinator for LP + STD network operation.

For accurate measurement and long battery life, the IQRF modules must be put to sleep when there is no need to communicate. To do this, use the **Sleep command** of the IQRF OS peripheral

Introduction to IQRF

IQRF is a wireless communication platform using a low power consumption and low data rate MESH network, suitable for smaller volumes of data, with a range of tens to hundreds of metres (up to several kilometres in special cases). Suitable for telemetry, industrial control, automation of buildings and cities, etc. It can be used with any electronic device that requires wireless transmission. For example, for wireless control, to monitor remote data, or connect other devices to a wireless network. The implementation of IQRF is very easy. The radio frequency bands are used for communication: free ISM **868 MHz**, **916 MHz**, and **433 MHz**.

Each communication module contains a built-in operating system, which ensures the communication itself. In addition to the axes, DPA plugins (for each node device and coordinator a different plugin) are loaded into the modules. These plugins provide a basic extension of the axes if it's necessary to add a programme in C language using DPA commands and OS functions.

Basic terms in IQRF

node	IQRF module configured as a network node that can participate in delivering a message to a target node.
coordinator	IQRF module configured as a network control element, also serving as an exit point from the network.
bonding	pairing process between a coordinator device and a node device.
discovery	process of discovering a network topology, consisting of bond node devices and a coordinator.

Integrating sensor into the IQRF network

Three basic steps are required to create a fully functioning network. The first step is to set the coordinator module and node (sensors) to the same frequency band and the same RF channel. The second is to connect the sensor to the coordinator. The third step is to perform a discovery on the coordinator. We only perform the discovery process when we have all the network elements bonded and placed in positions that they will occupy during operation.

The PAIR button located on the left edge of the inside of the sensor is used for the bonding process, possibly in some cases of unbonding (see Fig.).
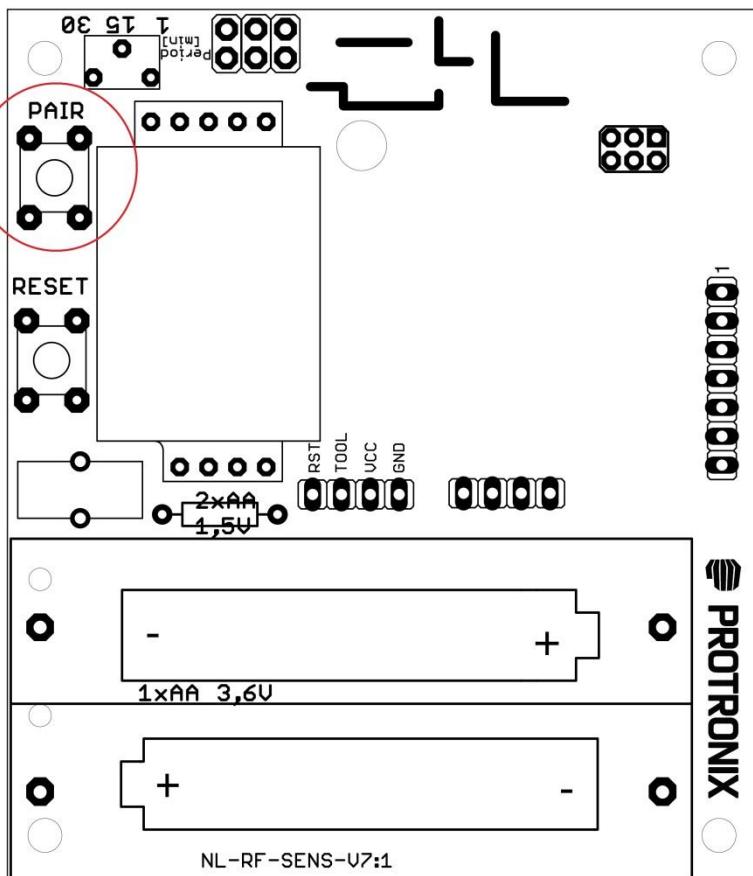
Change of RF band, RF communication channel

The factory produces IQRF modules in sensors with the following configuration:

RF band: 868 MHz
RF channel A: 52
TX power: 7
RX filter: 20
LP RX timeout: 255
Alternative DSM channel: 0

If any of the parameters need to be changed, such changes can be made from the IQRF IDE environment (see www.iqrf.org) under the condition that you own any of the products that work with this environment (gateways, development kits) (see www.iqrf.org).

1) Change of locally connected IQRF module

If the module can be inserted directly into these devices, after creating a new project in the IQRF IDE, the configuration can be changed locally in the menu by pressing CTRL G. Here, first download the current module configuration using the Download button (see figure below).
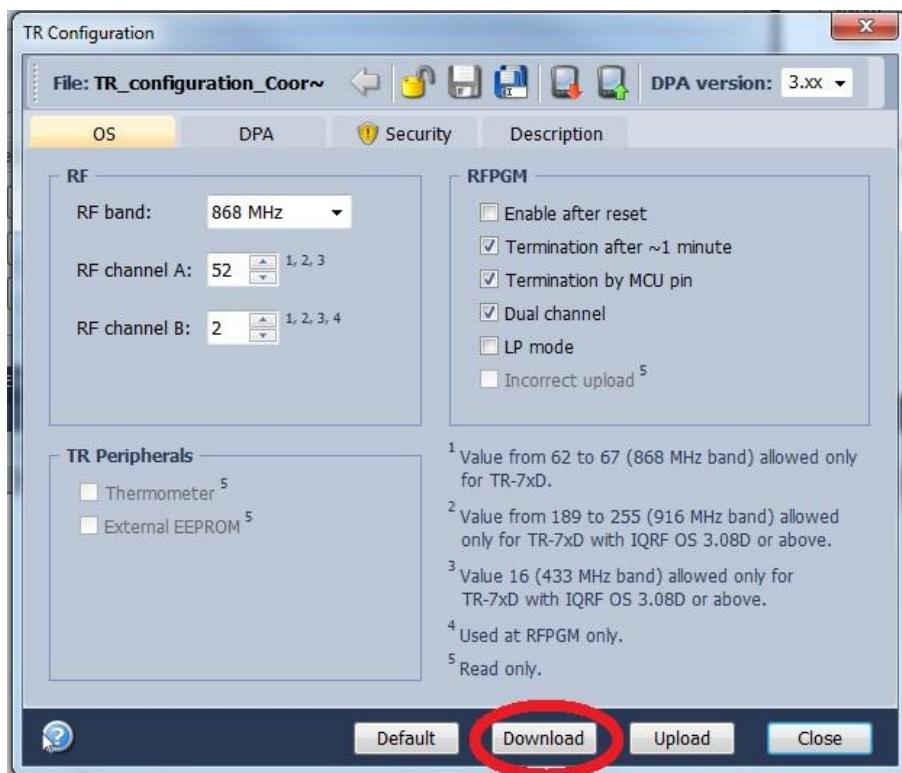
Now make the necessary changes and upload the configuration into the module using the Upload button.

2) Change of remotely connected IQRF module (CATS)

If it's not possible to insert the module directly into the connected device, it's possible to use the CATS service tools by pressing CTRL ALT C. However, first back-up the plugins, configuration, and user code on the device, which will consequently have to be restored. In CATS, enter the default parameters by pressing the Default button and then create CATS by clicking Create CATS (see figure below).
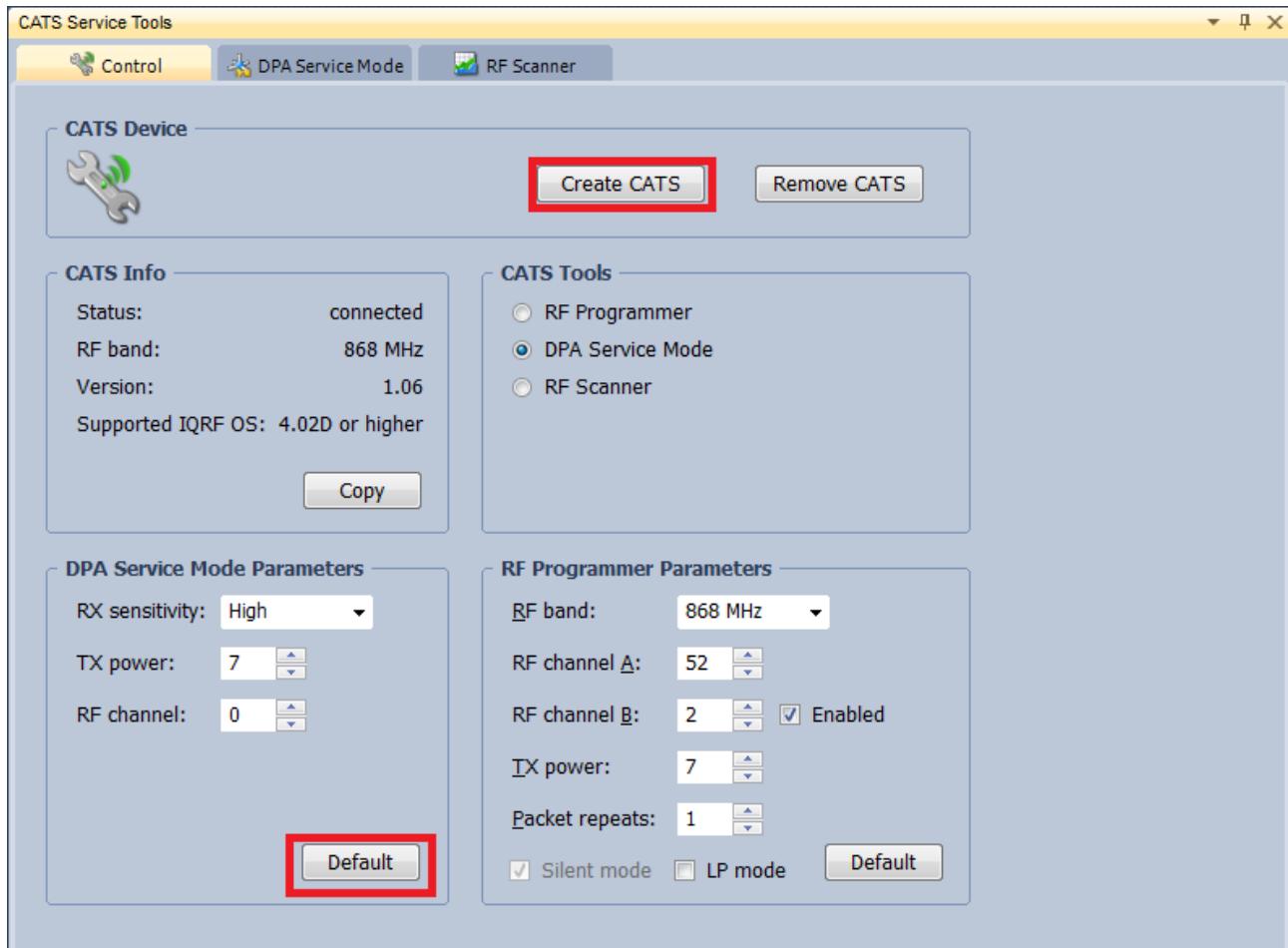
Then confirm the pop-ups and create a diagnostic device. Now, at the top of the CATS Service TOOLS, switch to the DPA Service Mode tab. Here select MID: First available and then click connect (see figure below). Leave the password field blank

Now disconnect and connect power to the sensor. Then the sensor is read in SW. After clicking Configure TR, it is possible to change the required settings (see figure below).
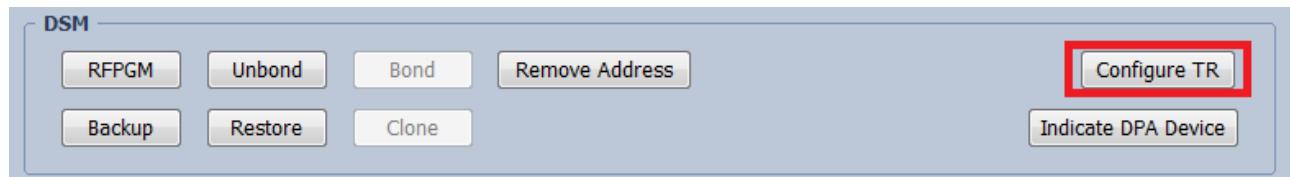
Here, download the current configuration with the Download button, then make the required changes and finally upload the new configuration to the module with the Upload button.
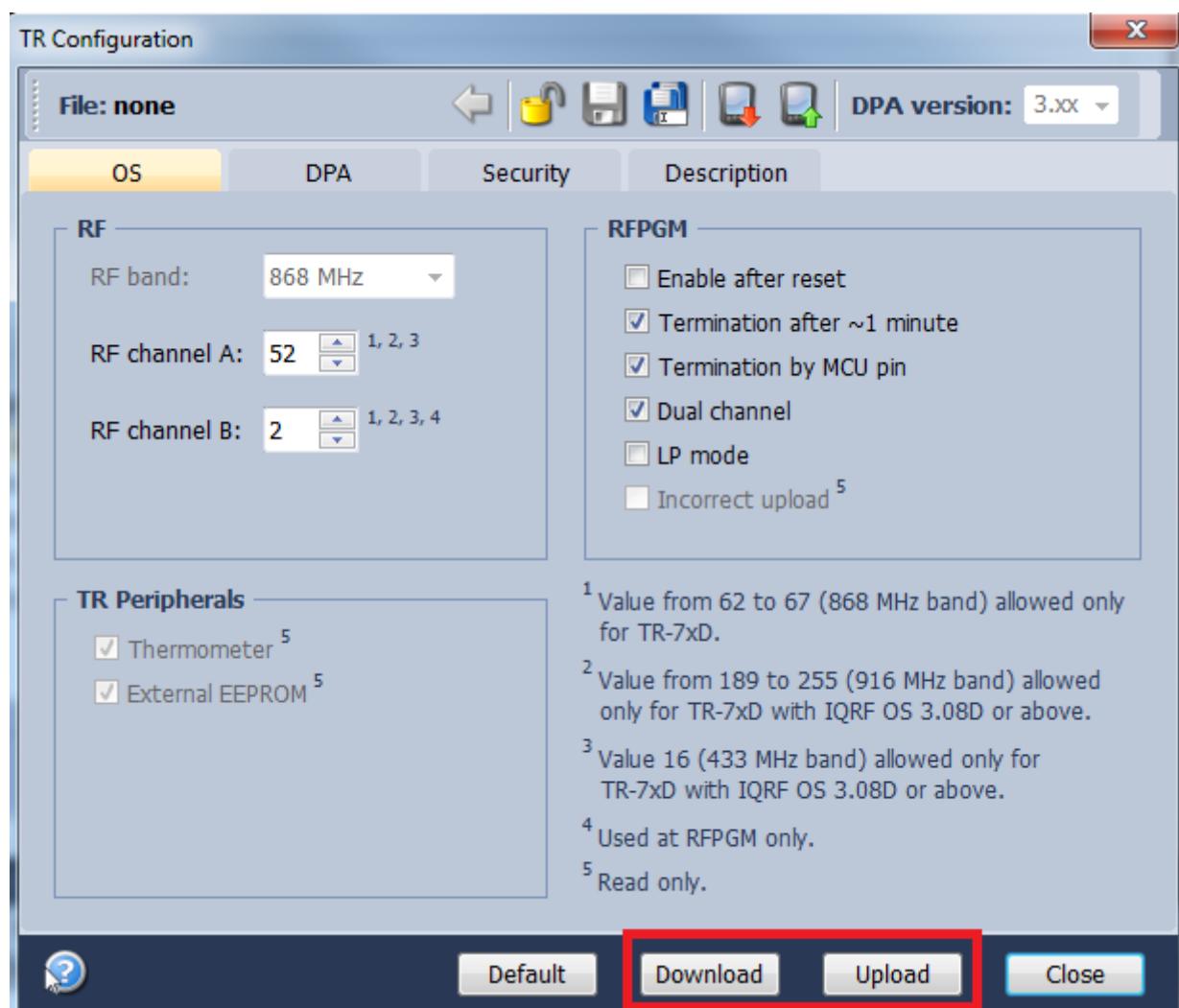
Finally, disconnect the remote sensor using the Disconnect button, switch to the Control tab, and press Remove CATS. This completes the change, now restore the backed-up plugins, configuration, and user code if necessary.

Local Bonding

Before the bonding process itself, it's necessary to verify that the node module (our sensor) has not already been bonded to a coordinator (the sensor leaves the factory unbonded). If the module isn't bonded, after supplying power is brought to the sensor, a red light starts flashing for 10s on the IQRF module in the place of two small holes on the sheet metal surface. If no light is on, the module is still bonded to a coordinator. In this case, first unbond the module according to chapter Unbonding.

1) Activate the bonding process on the coordinator module according to the device manufacturer's documentation for coordinators
2) Press and hold the bonding button (PAIR) on the sensor
3) Successful bonding is signalled by a flashing green light on the module. Now release the button.
4) In case of failure repeat the process from point 1)

If the coordinator module is connected to IQRF IDE, the process of local bonding can be induced from IQMESH network manager under the bookmark Control/IQMESH/Local. Here we set Virtual address of node module and start the pairing on the coordinator side by clicking on Bond node.
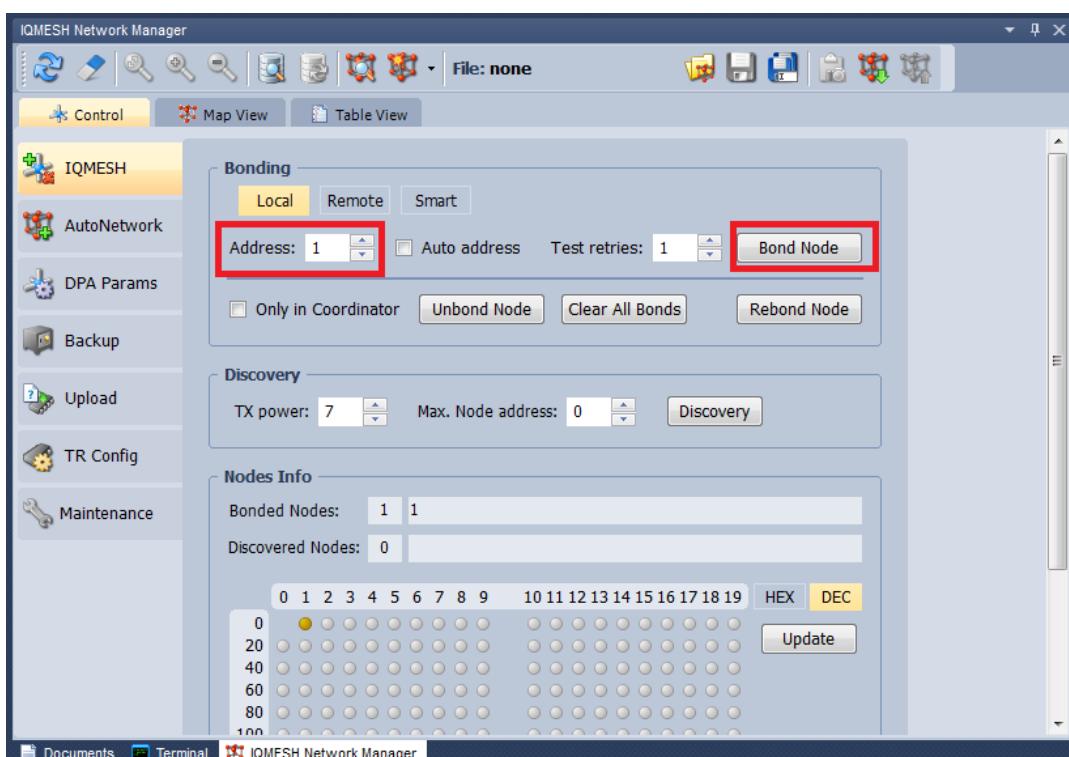
IQRF Smart connect Bonding

If you have the opportunity to connect the coordinator module to IQRF IDE, either directly by USB or by local Ethernet network (e.g. in case of Ethernet Gateway), then it is possible to do the pairing by Smart Connect. Similarly it is possible to use the mobile app IQRF Network Manager.

In IQRF IDE in Tools menu go to IQMESH Network Manager. Choose the bookmarks Control/IQMESH/Smart. After that fill in the box IQRF Smart connect code and/or IBK and MID code and click on Bond node. During this process the sensor with node module must be turned on. Now the bonding should be successfully performed.
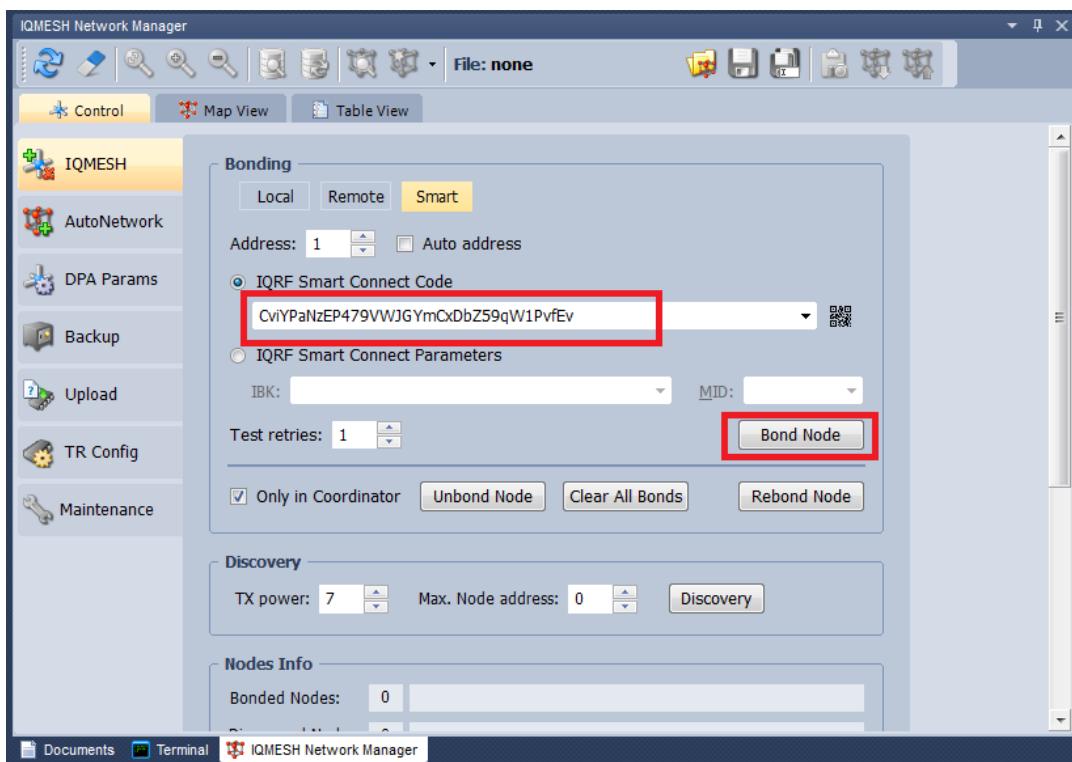
Unboding

On the side of the coordinator and node

1) If the coordinator device supports this unbonding option, apply power to the sensor and follow the device manufacturer's instructions for coordinators.
2) Successful unbonding is signaled by flashing red light for 10s.

The unbonding on the side of IQRF IDE connected coordinator module can be induced in IQMESH Network Manager under the bookmark Control/IQMESH/Local. Set the virtual address of the Node, which you will unbond and click on Unbond node.
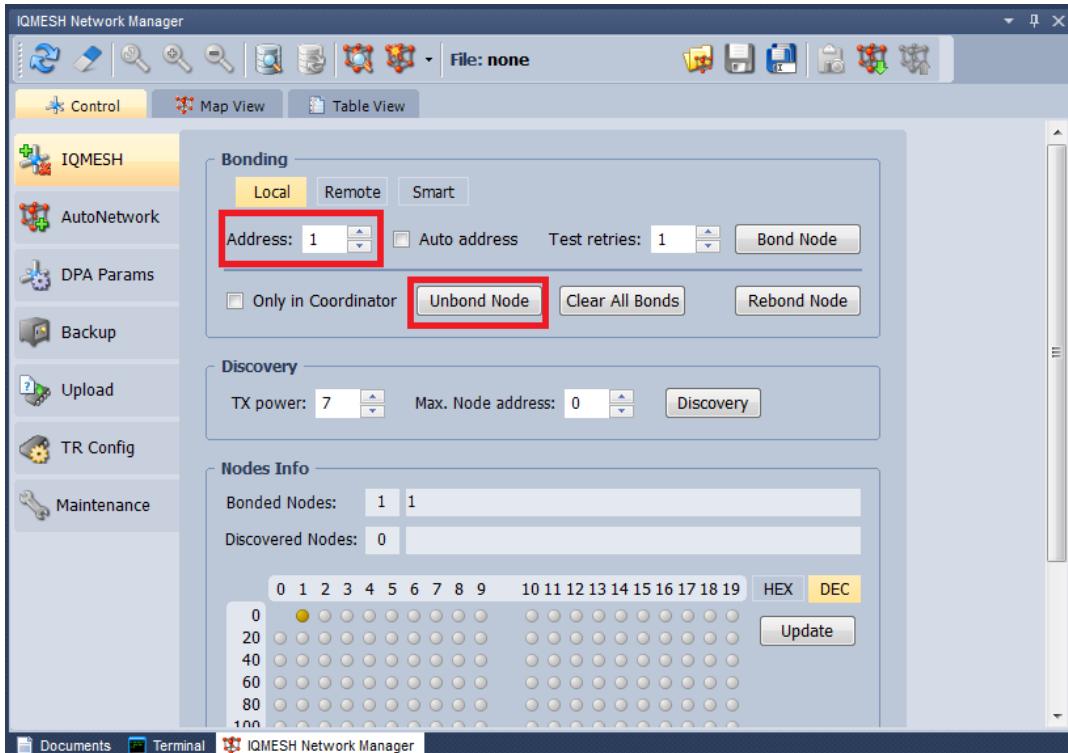
Only on the side of the node

1) Press the bonding button
2) Press the reset button
3) A green light will light up on the module
4) Hold down the bonding button while the green light is on
5) Release the button immediately after the green light switches off
6) Successful unbonding is signaled by a short flash of red light followed by 10s flashing.

Discovery

After successful bonding of all the nodes and placing the modules according to normal use, start the Discovery process according to the device manufacturer's instructions for coordinators.

In case of ownership of one of the devices connectable to the IQRF IDE visit www.iqrf.org for further information.

Communication with sensor

Communication with the sensor is mediated by the IQRF module, which the customer accesses wirelessly via DPA messages (frames).

DPA uses little-endian; that is, parts of a frame longer than 1B are transmitted from the lowest to the highest byte. In the following frames, the data is written in such a way that it is necessary to **rearrange** the multiple frame byte items **by using little-endian**.

The communication is based on the standard IQRF sensor protocol. See the document IQRF-StandardSensor-Vxxx at http://www.iqrfalliance.org/techDocs/. Below are some application examples. Further examples, including details, can be found in the previously mentioned document.

Types of DPA frames

We distinguish three types of DPA frames. The first is the DPA Request, through which the control system sends requests to the nod module via the coordinator. This is followed by DPA Confirmation, which is sent back by the coordinator to the control system and acknowledges receipt of the DPA request. Finally, a DPA Response is sent by the node, which is a response to the DPA Request. More information is available here: https://www.iqrf.org/DpaTechGuide/

General framework structure

NADR	PNUM	PCMD	HWPID	Pdata
(2B)	(1B)	(1B)	(2B)	(0-56B)

NADR	Module network address (node 1 to 239)
PNUM	Peripheral address
PCMD	Command specifying the required operation for a given peripheral
HWPID	Value for hardware node device filter, command processed only for identical HWPID (0xFFFF - check omitted, always processed) Sensor **HWPID depends on the sensor type**:

NLB-CO2+RH+T-5-IQRF	**HWPID=0x4001**
NLB-RH+T--IQRF	**HWPID=0x5001**

PData	Data part dependent on the frame type, PNUM, PCMD

Standard IQRF function Enumeration of sensors

It's used to determine the types of sensors that can be used with the device

Form of DPA Request:

NADR	PNUM	PCMD	HWPID
address	0x5E	0x3E	according to the sensor
(2B)	(1B)	(1B)	(2B)

NADR	Module network address (node 1 to 239)
PNUM	Peripheral address (0x5E - Peripheral sensor)
PCMD	Command specifying the operation for a given peripheral (0x3E – Sensor Enumeration)
HWPID	Value for the Hardware node device filter

Form of DPA Response:

NADR	PNUM	PCMD	HWPID	ErrN	DpaValue	PData
address	0x5E	0xBE	according to the sensor	0	?	sensory
(2B)	(1B)	(1B)	(2B)	(1B)	(1B)	(max 32B)

NADR   Module network address (node 1 to 239)
PNUM   Peripheral address (0x5E – Peripheral sensor)
PCMD   Operation code for a given peripheral (0xBE– Enumeration of response sensors)
HWPID   Sensor hardware ID
ErrN   Error code, 0-no error
DpaValue   DPA code, see the IQRF DPA documentation
PData (sensory)   Byte array, where each byte identifies the sensor type according to the IQRF
                           standard. At the moment, some of the following sensors are defined in our sensors:
                           0x01 – Temperature sensor
                           0x02 – CO2 sensor
                           0x03 – VOC sensor
                           0x80 – Relative humidity sensor

Reading measured values by individual sensors in the sensor

According to the previous Enumeration of sensors, or according to HWPID, it's possible to determine which sensors are located in the sensor clearly. According to this information, we can then read the measured values of these sensors

Form of DPA Request:

NADR	PNUM	PCMD	HWPID	PData
address	0x5E	0x01	according to the sensor	sensory
(2B)	(1B)	(1B)	(2B)	(4B)

NADR   Module network address (node 1 to 239)
PNUM   Peripheral address (0x5E – Peripheral sensor)
PCMD   Operation code for a given peripheral (0x01 - reading of sensors with its type)
HWPID   HWPID Value for the Hardware node device filter
PData(sensory)   Bitmap for read sensors. If we want to read all of them, we can enter 0xFF, 0xFF,
                           0xFF, 0xFF

Form of DPA Response:

NADR	PNUM	PCMD	HWPID	ErrN	DpaValue	PData
address	0x5E	0x81	according to the sensor	0	?	types and values
(2B)	(1B)	(1B)	(2B)	(1B)	(1B)	(max 32B)

NADR   Module network address (node 1 to 239)
PNUM   Peripheral address (0x5E – Peripheral sensor)
PCMD   Operation code for a given peripheral (0x81– Reading response sensors)
HWPID   Sensor hardware ID
ErrN   Error code, 0-no error
DpaValue   DPA code, see the IQRF DPA documentation
PData (types and values)   Array of pairs, type, and value

The types have the same codes as in enumeration and thus are the following:

> 0x01 – Temperature sensor
> 0x02 – CO_2 sensor
> 0x03 – VOC sensor
> 0x80 – Relative humidity sensor

In sensors used by us, the values itself can have a length of 1B and 2B. If the value is 2B, the higher byte is first transmitted within the frame.
The lengths of the individual values and the units in which the values are given are as follows:

> Temperature – length 2B (value in binary option), unit is 0.0625 °C
> CO_2 – 2B (positive values only), unit is 1 ppm
> VOC – 2B (positive values only), unit is 1 ppm
> Relative humidity – 1B, unit is 0.5%

Setting and reading of sensor values beyond standard IQRF CMD

Our sensor offers settings beyond the IQRF standard, such as LED signalling settings or measurement periods. For these purposes, the non-standard IQRF CMD 0x40 of the Standard Sensor (0x5E) peripheral is implemented in the IQRF module of our sensor, which forwards the values from the PData data part to the sensor. However, our sensor expects Modbus data protocol, which must be implemented by the User. See document um-NLB-Modbus-Communication.

Form of DPA Request:

NADR	PNUM	PCMD	HWPID	PData
address	0x5E	0x40	according to the sensor	Modbus frame
(2B)	(1B)	(1B)	(2B)	(max 24B)

NADR	Module network address (node 1 to 239)
PNUM	Peripheral address (0x5E - Peripheral sensor)
PCMD	Operation code for a given peripheral (0x40 - raw data forwarding)
HWPID	Value for the Hardware node device filter
PData (Modbus frame)	Concrete data forming the Modbus request frame for our sensor

Form of DPA Response:

NADR	PNUM	PCMD	HWPID	ErrN	DpaValue	PData
address	0x5E	0xC0	according to the sensor	0	?	Modbus frame
(2B)	(1B)	(1B)	(2B)	(1B)	(1B)	(max 24B)

NADR	Module network address (node 1 to 239)
PNUM	Peripheral address (0x5E - Peripheral sensor)
PCMD	Operation code for the given peripheral (0xC0 - forwarding raw data response)
HWPID	Sensor hardware ID
ErrN	Error code, 0-no error
DpaValue	DPA code, see the IQRF DPA documentation
PData (Modbus frame)	Concrete sensor response to previous Modbus request

Example of sensor reading of the sensor NLB-CO2+RH+T-5-IQRF

Form of DPA Request:

NADR	PNUM	PCMD	HWPID	PData
address	0x5E	0x01	**0x4001**	0xFF, 0xFF, 0xFF, 0xFF
(2B)	(1B)	(1B)	(2B)	(4B)

NADR	Module network address (node 1 to 239)
PNUM	Peripheral address (0x5E - Peripheral sensor)
PCMD	Operation code for a given periphery (0x01 - reading of sensors with its type)
HWPID	**0x40001 – sensor NLB-CO2+RH+T-5-IQRF**
PData(sensory)	We want to read all sensors; thus, we enter 0xFF, 0xFF, 0xFF, 0xFF

Form pf DPA Response:

NADR	PNUM	PCMD	HWPID	ErrN	DpaValue	PData
address	0x5E	0x81	**0x4001**	0x00	0x5E	**0x01, 0x40, 0x01, 0x80, 0xA0, 0x02, 0xE8, 0x03**
(2B)	(1B)	(1B)	(2B)	(1B)	(1B)	(max 32B)

NADR	Module network address (node 1 to 239)
PNUM	Peripheral address (0x5E - Peripheral sensor)
PCMD	Operation code for given peripheral (0x81 - Reading response sensors)
HWPID	**0x4001 – sensor NLB-CO2+RH+T-5**
ErrN	0 – no error
DpaValue	see IQRF DPA documentation
PData	Array of pairs, type, and value

Breaking down the PData field meaning:

First of all, the type of sensor is specified and then its value as mentioned above. In this case, these are the following pairs:

Type= **0x01** – Temperature   lower B= **0x40**   higher B= **0x01**   result= 0x140= 320*0.0625 °C= **20 °C**
Type= **0x80** – Relative humidity   value (1B)= **0xA0**   result= 160*0.5 %= **80 %**
Type= **0x02** – CO_2 lower B= **0xE8**   higher B= **0x03**   result= 0x3E8= 1000*1 ppm= **1000 ppm**

Example of enabling complete LED signalling of NLB-CO2 + RH + T-5-IQRF sensor

As an example, let's imagine we would like to allow all available LED signals.
In the manual um-NLB-Modbus-komunikace we find out that for this function, it's necessary to write the following values in the following register: Enable LED indication = 15

To do this, we use the Modbus function   0x10 - Function Write multiple holding registers

Form of DPA Request:

NADR	PNUM	PCMD	HWPID	PData
address	0x5E	0x40	0x0001	0x01, 0x10, 0x9C, 0x42, 0x00, 0x01, 0x02, 0x00, 0x0F, 0xB5, 0x7F
(2B)	(1B)	(1B)	(2B)	(11B)

NADR   Module network address (node 1 to 239)
PNUM   Peripheral address (0x5E - Peripheral sensor)
PCMD   Operation code for the peripheral (0x40 - raw data forwarding)
HWPID   Value for the Hardware node device filter
PData (Modbus frame)   Concrete data forming the Modbus request frame for our sensor

Form of DPA Response:

NADR	PNUM	PCMD	HWPID	ErrN	DpaValue	PData
address	0x5E	0xC0	according to the sensor	0x00	0x5E	0x01, 0x10, 0x9C, 0x42, 0x00, 0x01, 0xBE, 0x4E
(2B)	(1B)	(1B)	(2B)	(1B)	(1B)	(8B)

NADR   Module network address (node 1 to 239)
PNUM   Peripheral address (0x5E - Peripheral sensor)
PCMD   Operation code for a given peripheral (0xC0 - forwarding raw response data)
HWPID   Sensor hardware ID
ErrN   0 – no error
DpaValue   see IQRF DPA documentation
PData (Modbus frame)   Concrete sensor response to previous Modbus request

Sensor commissioning process summary

1) Setting the RF module sensor parameters, if necessary
2) Bonding the sensor (module node) to your coordinator
3) Performing the Discovery process
4) Communication with the sensor using a standard IQRF sensor peripheral