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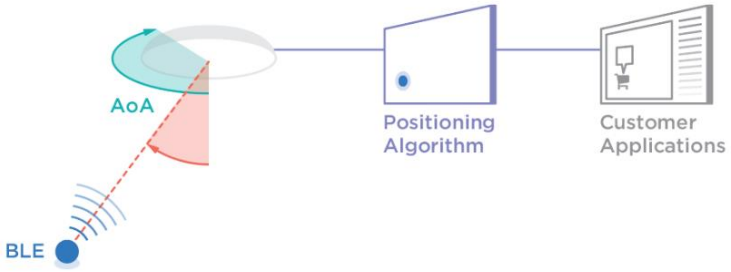
1. CONCERNED PRODUCTS

DESIGNATION	*PRODUCT REFERENCE*
Blue LITE ID QUUPPA	IDF28540X
Blue SLIM ID QUUPPA	IDF03540X
BLUE COIN ID QUUPPA	IDF10540X
AERO ID QUUPPA	IDF10550X
BLUE PUCK ID QUUPPA	IDF25540X
BLUE PUCK BUZZ QUUPPA	IDF31545X

2. GENERAL INFORMATION ABOUT QUUPPA TECHNOLOGY

2.1 ANGLE OF ARRIVAL LOCALIZATION

Quuppa is a tag localization system with an approach based on the wireless signal's "angle of arrival" combined with advanced proprietary algorithms.



The Quuppa system leverages Bluetooth Low Energy (BLE) technology. This offers several advantages, including very long battery life , compatibility with mobile devices, and the possibility of transmitting sensor data at the same time as positioning information.

The concept underlying the Quuppa system is a combination of Bluetooth technology and the angle of arrival signal detection method, providing greater positioning accuracy than other technologies based on signal strength (RSSI).

2.2 DOWNLINK COMMANDS

Unlike equipment that relies on BLE advertising frames, which include identifiers and/or data only in the uplink direction (i.e. tags towards receiver), the Quuppa system enables commands to be *sent* to tags.

2.3 OPERATION OF TAGS WITH QUUPPA TECHNOLOGY

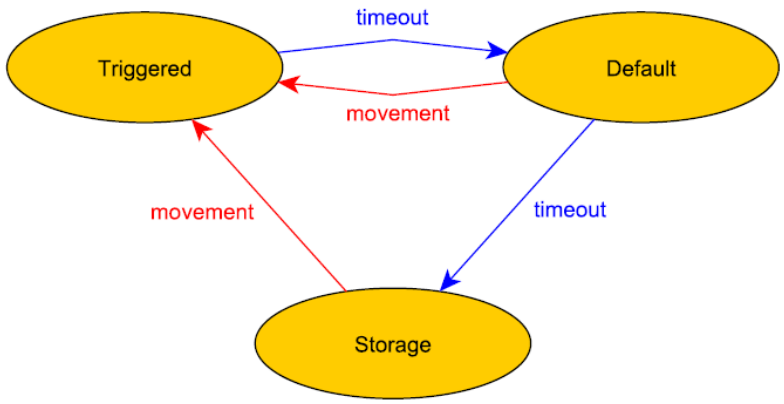
Tags with Quuppa technology are designed to react to movement while conserving energy during idle periods. The Quuppa system updates a tag's position while the tag is in motion and remembers the tag's last position when the tag is inactive.

The different tag reaction levels are described by three states:

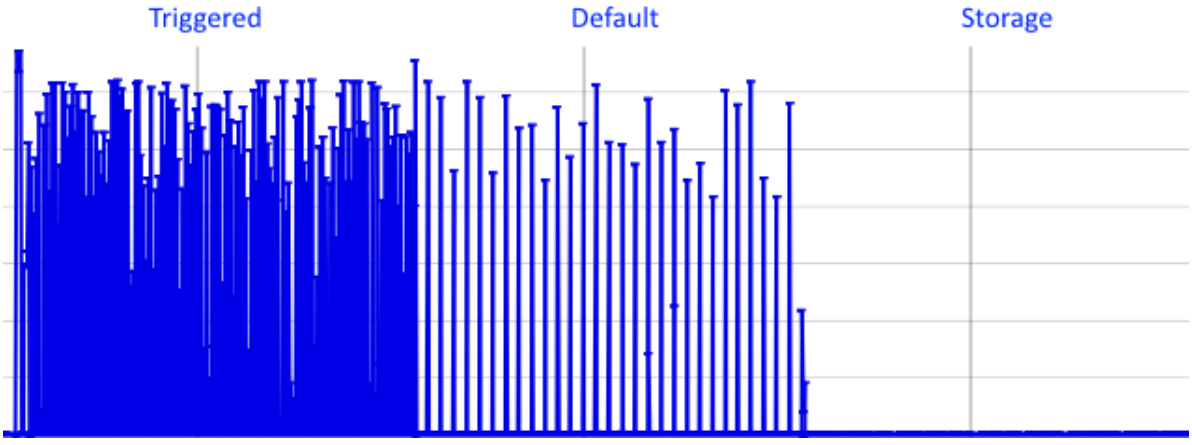
- "**Triggered**" state: the tag is awake and emitting regularly
- "**Default**" state: tag emissions are slowed down
- "**Storage**" state: the tag switches to standby mode and no longer emitting at all, until movement is detected

The change from one state to another takes place after a defined period. When movement is detected, the tag necessarily changes to the "Triggered" state.

This operation is defined by the Quuppa state machine:



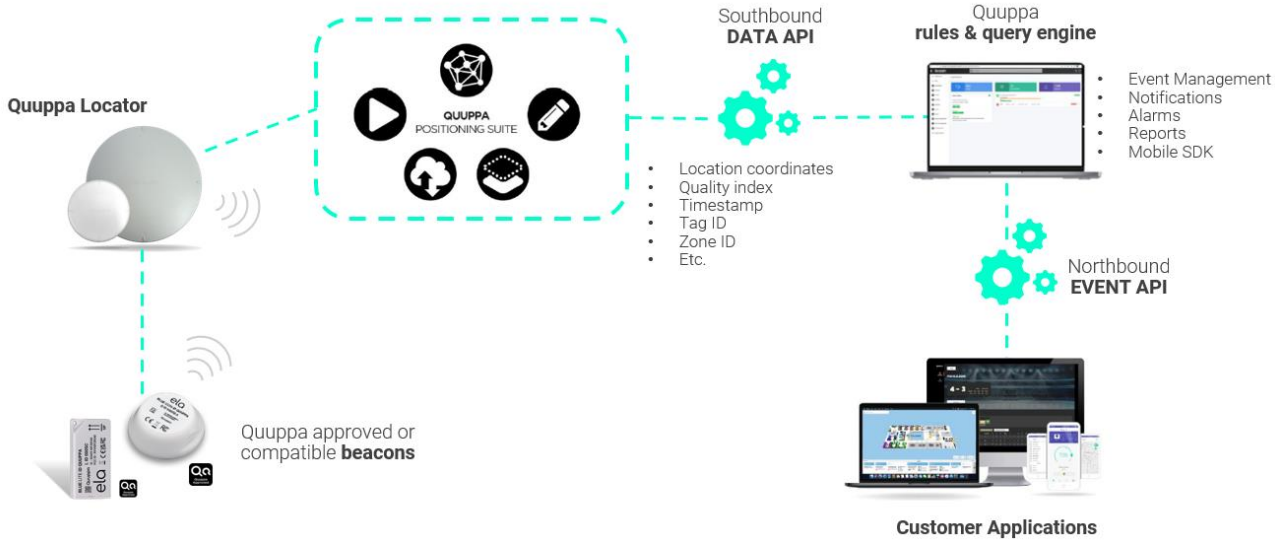
The density of wireless activity is shown on the following graph:



2.4 QUUPPA NETWORK

The Quuppa system requires installed infrastructure to operate. This includes:

- A physical server, running an instance of the Quuppa Positioning Engine software
- Localization antennas called “Quuppa Locators”
- A dedicated cabled network



Antennas are positioned in a mesh layout, which can be more or less spread out depending on the desired localization accuracy (i.e. only presence detection, zoning, precise location).

Infrastructure must first be installed, and then defined and configured in the Quuppa Site Planner software. More information about infrastructure and installation is provided on the Quuppa website: https://quuppa.com/

3. TAG CONFIGURATION

Tag configuration involves two steps:

- Quuppa information configuration
- ELA Innovation information configuration

3.1 QUUPPA CONFIGURATION

Quuppa configuration enables you to configure the settings for each tag's machine state.

Quuppa configuration enables you to configure the settings for each tag's machine state.

Hardware

- Computer with an Ethernet network plug
- Quuppa Focusing Locator Antenna (not the same as localization antennas)
- Ethernet crossover cable, or network cables & Ethernet switch

Software

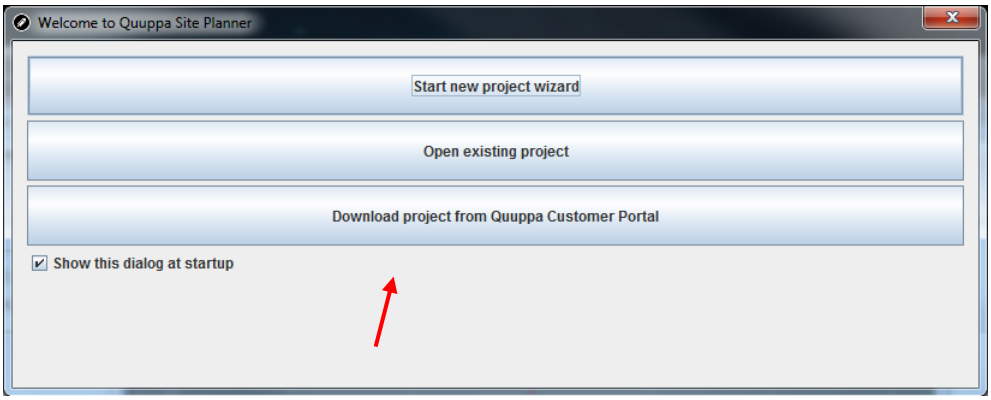
- Quuppa Site Planner

Method

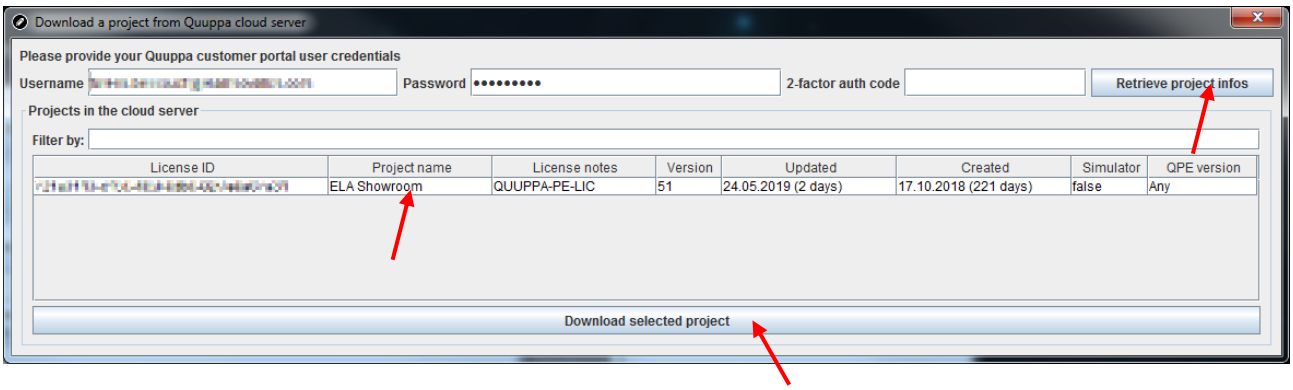
In order to use a tag with Quuppa technology, the tag must be integrated in the infrastructure as defined in § 2D.

Launch the Quuppa Site Planner (QSP) software and open a previously created project. If the project was created on a different computer, you must download it via the Quuppa Customer Portal after it was submitted by the first computer.

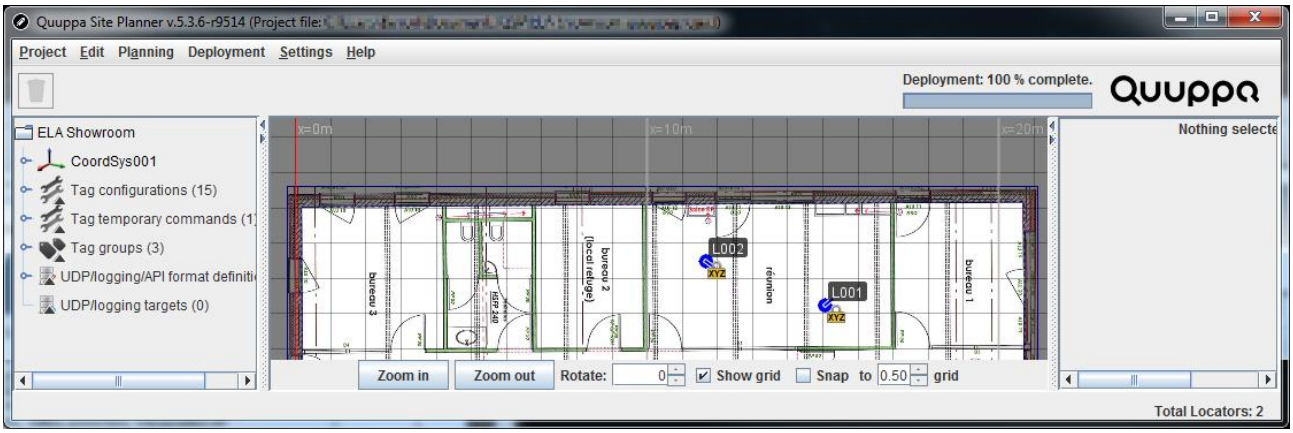
More information about site configuration is provided on the Quuppa website: https://quuppa.com/



Enter the required identifiers, then click on “Retrieve project information”. Choose the project and click on “Download selected project.”

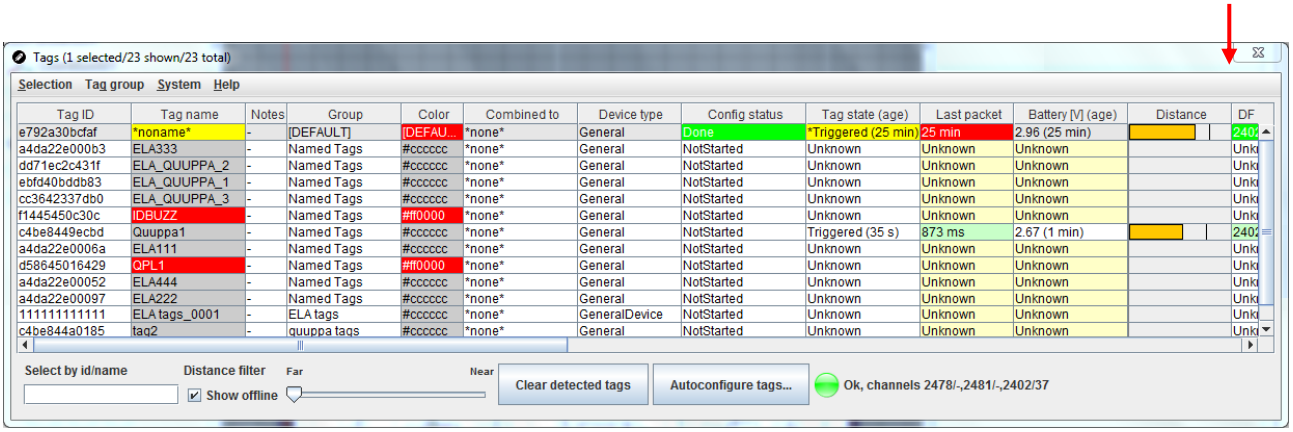


The main screen of the QSP application shows a map that you will use to show tag locations. The map also shows Quuppa Locator antennas.

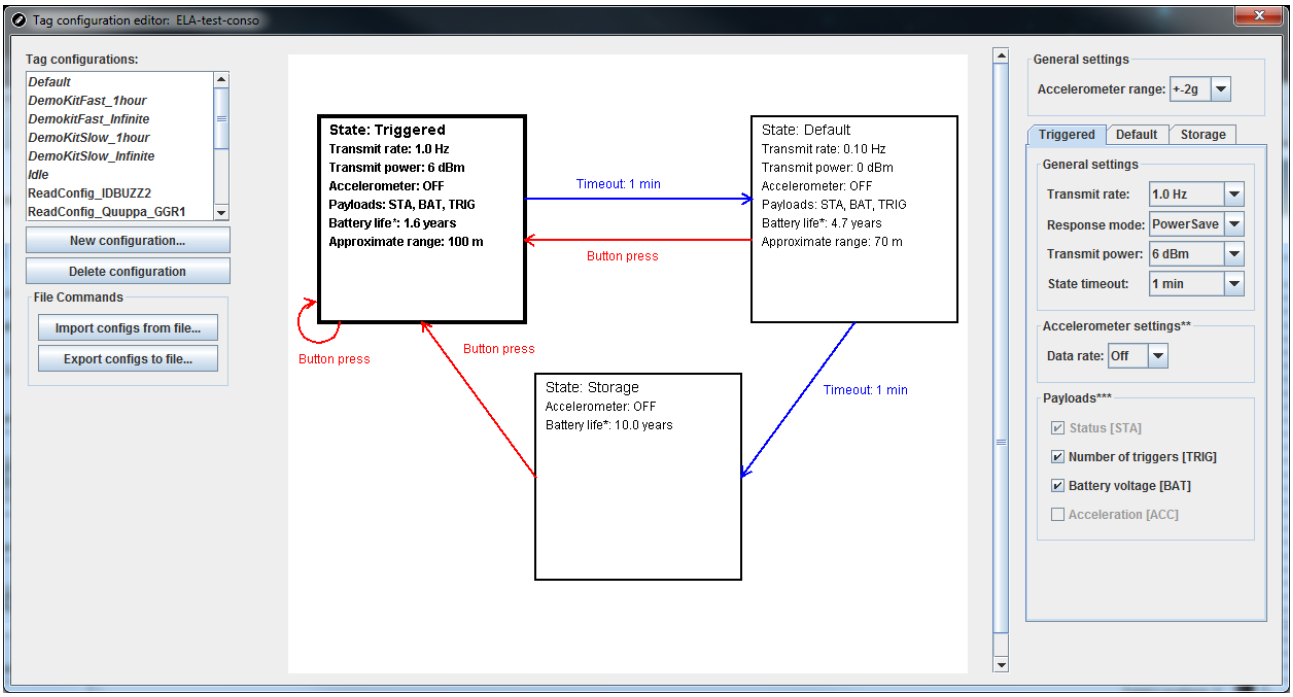


In the “Deployment / Tag Configurator Tool”:

The list of known tags is shown in the window, along with those currently visible by the Quuppa Focusing Locator antenna. The “Distance” column shows the proximity of each tag with respect to the antenna, which enables you to identify the tag you want to configure.



Quuppa state machines may be configured via the menu: “System / Tag configuration editor”.



This window enables you to create Quuppa state machine configurations that will be used to set up tags.

Each state is defined by the following parameters:

- **Triggered** state:
  - *Transmit rate*: emission recurrence, adjustable from 9Hz to 1Hz
  - *Response mode*: response speed for downlink commands, adjustable from “fast” to “PowerSave”
  - *Transmit power*: emission power, adjustable from -24dBm to +6dBm

- *State timeout*: time after which the tag switches to the Default state, adjustable from 1 sec. to 24 hrs
- *Accelerometer settings*: not used (set to Off)

➢ **Default** state:

- *Transmit rate*: emission recurrence, adjustable from 1Hz to 0.1Hz
- *Response mode*: response speed for downlink commands, adjustable from "fast" to "PowerSave"
- *Transmit power*: emission power, adjustable from -24dBm to +6dBm
- *State timeout*: time after which the tag switches to the Storage state, adjustable from 20 seconds to infinity
- *Accelerometer settings*: not used (set to Off)

➢ **Storage** state:

- No wireless emission in this state
- *Accelerometer settings*: not used (set to Off)

In the "Tag Configurator Tool" window, the process configuring a tag with a predefined state machine is as follows:

- Place the tag on the Quuppa Focusing Locator antenna
- Select the tag to configure (the distance bar enables you to identify it in the list)
- Open the menu "Selection / Configure selected tags"
- In the window that opens, select the state machine to assign as well as the channel (BLE or proprietary)

3.2 ELA INNOVATION CONFIGURATION

ELA configuration enables you to define settings other than those for the Quuppa state machine.

Hardware

- PC with available USB port and Windows 10 (recommended)
- NFC USB reader (for example: ACR122U - ELA ref.: ACIOM177)

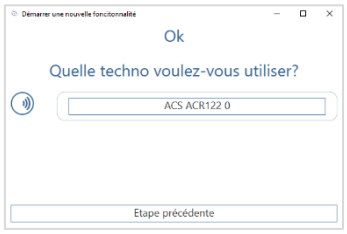
Software

- Device Manager Software - ELA Innovation (download via Software section on our website: https://elainnovation.com/downloads.html?cat=95). Use version 2.1.0 or higher.

Method

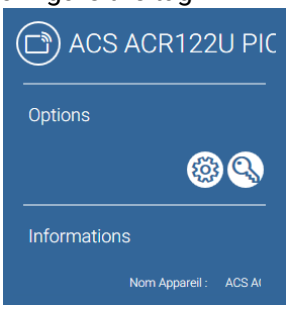
- Connect the NFC reader to the PC
- Launch the Device Manager application
- Open the Programmer section
- Launch the NFC widget by clicking on the icon 

- Click on the name of your NFC reader

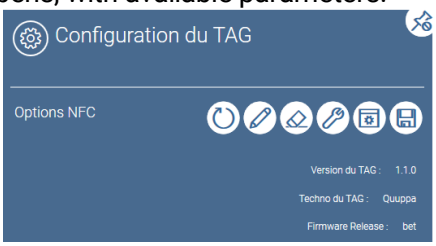


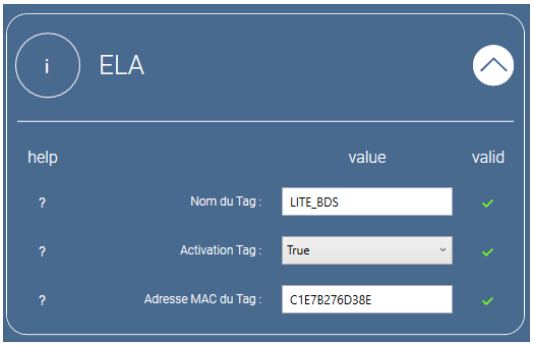
- Place the tag towards the bottom of the reader, with the tag's label facing the reader

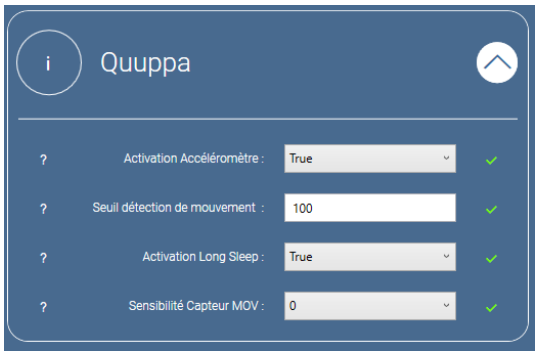
- Click on the  icon to configure the tag



- The following window opens, with available parameters:







Parameter list

This section describes the details of the parameters used to configure Quuppa tags.

Parameter	Since version	Restrictions	Default values	Description
Firmware version	1.0.0	-	ELA firmware version	Non-modifiable field
Name	1.0.0	0 to 12 characters	ELA_TAG	Tag name
Activation	1.0.0	True/False	True	Tag activation / deactivation (storage mode)
MAC address	1.0.0	12 hexadecimal characters of type: [0-9] [A-F]	Hardware address of the nRF chip	Non-modifiable field
Acc. Activation	1.0.0	True/False	True	Activation / deactivation of tag wakeup via accelerometer
Acc. Latency	1.1.0	0 or 1	0	0=low consumption 1=high reactivity
Acc. threshold	1.1.0	32 to 8000	100	Accelerometer trigger level, in milli-g
Long Sleep	1.0.0	True/False	True	Activation / deactivation of long sleep during Storage state

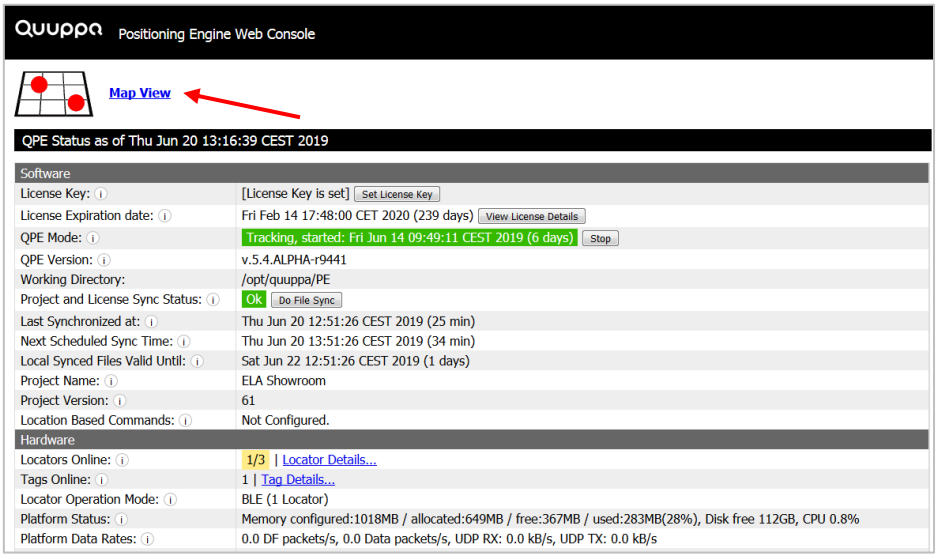
Parameter details

- Firmware version:
  - Read-only value: provides the tag's current firmware version
- Name:
  - Tag name for internal use; unrelated to the tag name as seen by the QPE server.
- Activation:
  - True: tag is activated and operating normally.
  - False: tag is inactive and may be stored.
- MAC address:
  - Read-only value: provides the tag's unique address; this value is used to identify the tag in the Quuppa network.
- Acc. Activation:
  - The accelerometer is used to wake up the tag when movement is detected.
  - True: accelerometer activated (default behavior).
  - False: tag no longer wakes upon movement. Attention: this setting will lead to an infinite duration of the Quuppa "Default" state.
- Acc. Latency:
  - 0: low consumption. Slow sampling frequency.
  - 1: high reactivity. High sampling frequency.
- Acc. threshold:
  - Acceleration threshold for triggering the tag; value in milli-g; hexadecimal value (minimum 32mg, maximum 8000mg)
- Long sleep:
  - Switching the tag to long sleep during the Storage state preserves battery life during that phase, but the tag must reboot upon movement. This setting is thus beneficial if the tag is not used frequently (less than about 30 times per day).
  - True: activates long sleep during Storage state.
  - False: deactivates long sleep during Storage state.

4. VIEWING TOOL

Installed to manage Quuppa system infrastructure, the Quuppa Positioning Engine server provides a Web service that shows a graphical view of tags positions, accessible via your regular web browser application.

Enter the following address to connect to the service: `http://<ip-du-serveur>:8080/qpe`



Click on the “Map view” link at the top of the page to open a visual layout indicating tag positions.

5. DOWNLINK COMMANDS

The Quuppa system enables you to send commands to tags via the Quuppa Positioning Engine’s “back channel”. These commands are used to trigger actions on one or more tags, or to request information from tags.

Tags must be in either the Triggered or Default state in order to receive commands. Tags in the Storage state do not listen for incoming commands. A tag switches to Triggered state upon receiving a command.

5.1 HTTP COMMAND REQUEST

To send a command to a tag, an HTTP request must be sent to the QPE Web API, in the format:

```
http://<ip-du-
serveur>:8080/qpe/sendQuuppaRequest?tag=f1a45f56c30c&requestData=

0xFF3700C003000000000000000000000000&time=60000&humanReadable
```

This command targets the desired tag and sends a command to it.

Parameter list for HTTP request:

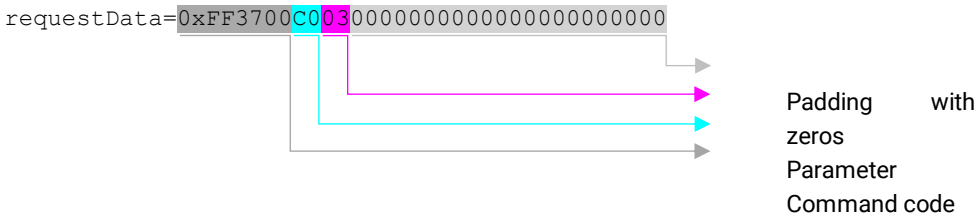
Parameter	Restrictions	Description
tag	Required parameter. Tag ID(s), separated by a comma (,) without spaces if several. Example: tag=f1a45f56c30c,fd5c29a1d531	List of tags to address.
requestData	Required parameter. Fixed part "0xFF3700", followed by 13 bytes (26 hexadecimal characters of type: [0-9] [A-F]) for the command. Example: requestData=0xFF3700C003000000000000000000000000	Command to be sent to tag(s). See details below.
time	Optional. Time in milliseconds (ms). Example: time=120000	Time during which the system attempts to contact the tag(s). Default: 60000ms
humanReadable	Optional. No value. Example: humanReadable	Format the response in a form that is easy to read.

5.2 COMMAND DETAILS

The "requestData" field in the above request is constructed as follows:

- 0xFF3700: fixed part (required)
- 13 bytes (that is, 26 hexadecimal characters [0-9] [A-F]): command code + parameters (as needed) + padding with zeros (as needed)

Example:



Details for the available command codes and their parameters are provided in the table below.

	Command	Since version	1st byte code	Parameters (subsequent bytes)	Parameter details	Description
Actions	LED on	1.0.0	C0	**n**: 1 byte	**n** = 00 to FF (00 = infinite)	Blink LED **n** times. Attention: turning on the LED consumes a lot of battery power. May significantly reduce battery life.
	LED off	1.0.0	C1	-	-	Stop LED
	BUZZER on	1.0.0	C2	**n**: 1 byte	**n** = 00 to FF (00 = infinite)	Active the buzzer **n** times. Attention: using the buzzer consumes a lot of battery power. May significantly reduce battery life.
	BUZZER off	1.0.0	C3	-	-	Stops buzzer
Write	Set tag name	1.0.0	51	**name**: 12 bytes	**name**: 12 characters (ASCII hex. codes)	Sets the tag name
	Set accelerometer threshold	1.1.0	53	**thr**: 2 bytes (MSB first)	**thr** = 32 to 8000 (32mg to 8g)	Sets the accelerometer threshold Decimal value in mg must be converted in hexadecimal : *(excel)=DECHEX(256/1000*DESIRED_THRESHOLD;4)* *0x07FF=8G (max)* *0x0100=1G* *0x0030=185mG* *0x0008=32mG* (min)
	Set mov latency	1.1.0	59	**hi_reactivity** = 1 octet	**hi_reactivity** = 1/0	Select the accelerometer sampling mode
Read	Get tag name	1.0.0	91	-	-	Request to retrieve tag name
	Get accelerometer threshold	1.1.0	93	-	-	Request to retrieve current accelerometer threshold
	Get firmware version	1.0.0	94	-	-	Request to retrieve firmware version
	Get mov latency	1.1.0	99	-	-	Request to retrieve current accelerometer sampling mode
Supply	Reboot to DFU	1.0.1	E0	-	-	Tag reboots in "device firmware upgrade" mode (DFU)

For each command received, the QPE server returns similar information (indicating that the server received the request, without specifying that the tag received it):


```
{
  "code": 0,
  "command":
"http://192.168.0.146:8080/qpe/sendQuuppaRequest?tag=d7488f98981e&requestData=0xFF3700C00300000000000000000000&humanReadable",
  "message": "Commanding 1 tag(s)",
  "responseTS": 1561047958776,
  "status": "Ok",
  "tags": [{
    "sequenceNumber": 0,
    "name": null,
    "id": "d7488f98981e"
  }],
  "version": "1.0"
}
```


5.3 DETAILS ON RETURNED INFORMATION

Most commands return information or acknowledgment of reception. Returned information may be read via another HTTP request sent to the QPE Web API, of the type:

```
http://192.168.0.146:8080/qpe/getTagPayloadData?tag=f1445450c30c&humanReadabe
```

This command addresses the desired tag(s) and reads the information that it (or they) returned. Returned information is in JSON format.

There may be a time delay between the first request and the tag's response. This is due to the intermittent aspect of wireless transmission and the tag's current state (Triggered or Default). Responsiveness is also impacted by the value provided for the "response mode" parameter in the Quuppa state machine.

All responses are returned in the same format. The system keeps the 16 latest responses sent by the tag. Here is an example of returned information:

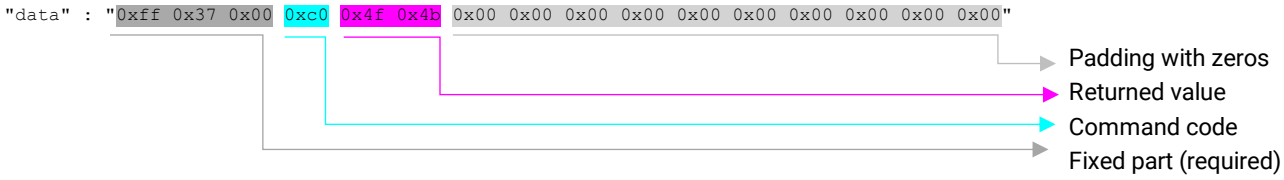

```
{
  "code": 0,
  "command": "http://192.168.0.146:8080/qpe/getTagPayloadData?tag=d7488f98981e&humanReadable&version=2",
  "message": "TagPayloadData",
  "responseTS": 1561048075598,
  "status": "Ok",
  "tags": [{
    "name": null,
    "id": "d7488f98981e",
    "payloadData": [
      null,
      {
        "data": "0xff 0x37 0x00 0xc0 0x4f 0x4b 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00",
        "dataTS": 1561047996128
      },
      null,
      null,
      …
    ]
  }],
  "version": "1.0"
}
```


The data returned by the tag is in the field tags[x].payloadData[n].data. If several tags are addressed, the response includes the 16 latest payloads for each tag.

The response payload is constructed as follows:

- 0xFF 0x37 0x00: fixed part (required)
- 13 bytes (that is, 26 hexadecimal characters [0-9] [A-F]): reminder of command tag is responding to + returned value + padding with zeros (as needed)

Example:



List of commands as associated responses:

	Command	Since version	1st byte code	Returned values (subsequent bytes)	Details Returned values	Description
Actions	LED on	1.0.0	C0	**status**: 2 bytes	4F4B = "OK"	Receipt acknowledgment
	LED off	1.0.0	C1	**status**: 2 bytes	4F4B = "OK"	Receipt acknowledgment
	BUZZER on	1.0.0	C2	**status**: 2 bytes	4F4B = "OK"	Receipt acknowledgment
	BUZZER off	1.0.0	C3	**status**: 2 bytes	4F4B = "OK"	Receipt acknowledgment
Write	Set tag name	1.0.0	51	**status**: 2 bytes	4F4B = "OK"	Receipt acknowledgment
	Set accelerometer threshold	1.1.0	53	**status**: 3 bytes	• 4F4B = "OK" • 4E4F4B = "NOK"	If accelerometer activated Otherwise
	Set mov latency	1.1.0	59	**status**: 3 bytes	• 4F4B = "OK" • 4E4F4B = "NOK"	If accelerometer activated Otherwise
Read	Get tag name	1.0.0	91	**name**: 12 bytes	Tag name (ASCII character string)	Tag name, hex. ASCII characters
	Get accelerometer threshold	1.1.0	93	**thr**: 2 bytes (MSB first)	• 32 to 8000 (32mg to 8g) • 4E4F4B = "NOK"	If accelerometer activated: current threshold Otherwise
	Get firmware version	1.0.0	94	**version**: 12 bytes	"1.1.0" (ASCII character string)	Firmware version, hex. ASCII characters
	Get mov latency	1.1.0	99	**status**: 1-3 bytes	• 0 or 1 • 4E4F4B = "NOK"	If accelerometer activated: current sampling mode Otherwise

Supply	Reboot to DFU	1.0.1	E0	No return		Tag reboots in "device firmware upgrade" mode (DFU)

6. FIRMWARE VERSIONS

6.1 AVAILABLE VERSIONS

ELA firmware version	Quuppa stack version	Device Manager minimal version
1.0.0	1.0 / 10.024	1.3.0
1.0.1	1.1 / 10.028	1.3.0
1.1.0	1.1 / 10.028	2.1.0

6.2 UPDATE VIA OTAP (OVER THE AIR PROGRAMMING)

Starting with ELA firmware version 1.0.1, tags support remote updates to higher firmware versions, without any physical connection or having to open the casing. Device firmware updates (DFU) are programmed using a computer running Windows, Mac OS, or Linux.

Required hardware:

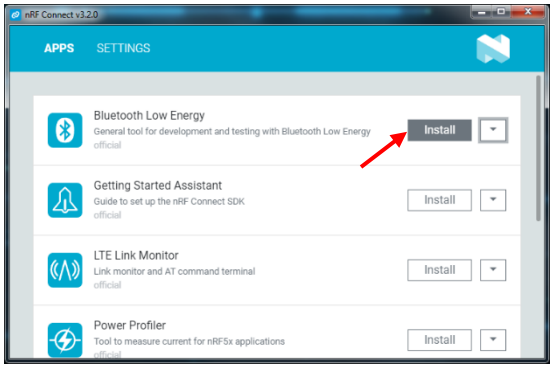
Nordic Seminconductor NRF52840 dongle connected to programming computer's USB port.

Software required on programming computer

nRF Connect software (free) must be installed. The software is available for download at this address:

https://www.nordicsemi.com/Software-and-tools/Development-Tools/nRF-Connect-for-desktop/Download#infotabs

When you open the software, the “Bluetooth Low Energy” application must be installed and then opened:



The software proposes to update the NRF52840 dongle in order to communicate with tags. This update is required.

The dongle is then detected and can be used as a communication port (COMxx).

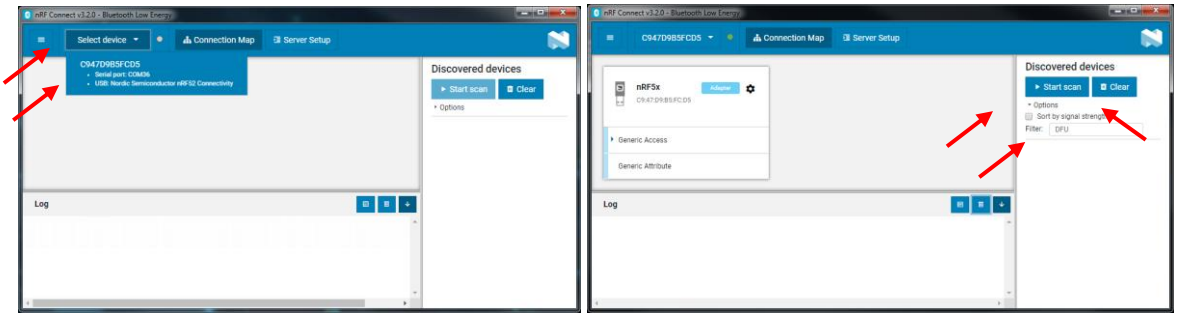
Switch tag to DFU mode

To switch the tag to Device Firmware Update mode, the tag must be rebooted in DFU using the command “Reboot to DFU” (described in § 5B). The tag is then detectable with a standard Bluetooth scanner, with the name “Quuppa_DFU”.

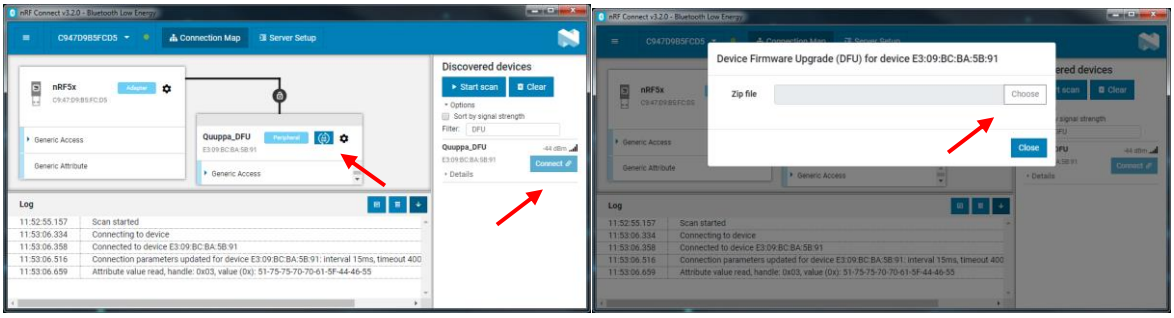
Programming process:

Open the nRF Connect software and launch the “Bluetooth Low Energy” application.

Click on “Select device” and select the nRF dongle. Open the “Options” menu and type “DFU” in the “Filter” field. Then launch the scan by clicking on the “Start scan” button.

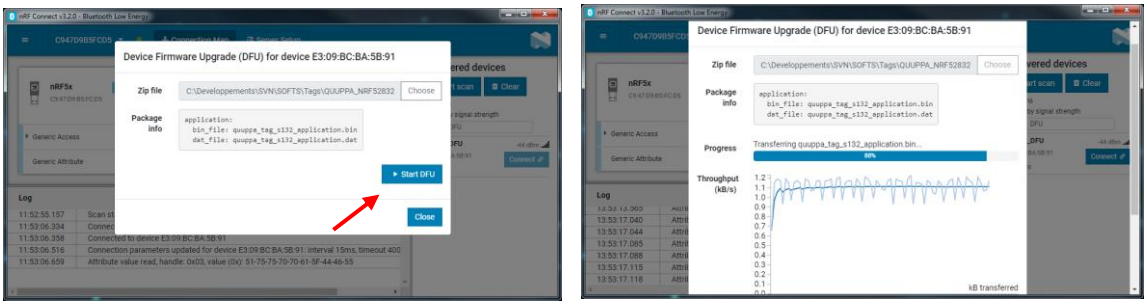


The tag named “Quuppa_DFU” should appear in the list of detected objects. Click on “Connect”, then on the secure update symbol (padlock in a circle with arrows):



Then choose the update file provided by ELA (file in the format xxxx.dfu.zip).

Click on “Start DFU” to begin the update. A progress bar shows data flow to the tag.



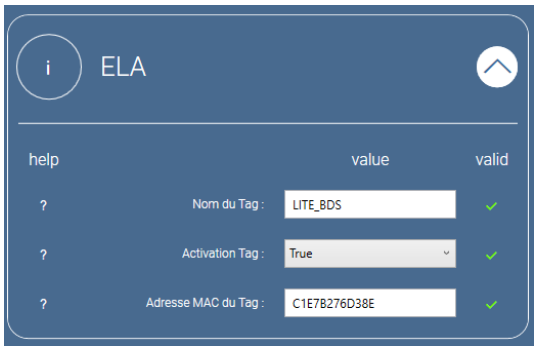
When update is complete, the tag reboots in Quuppa mode with the new firmware. Attention: Quuppa state settings are reinitialized (i.e. emission frequency, power, timeout). A new configuration may be sent using QSP (as described in § 3A).

7. QUICK START

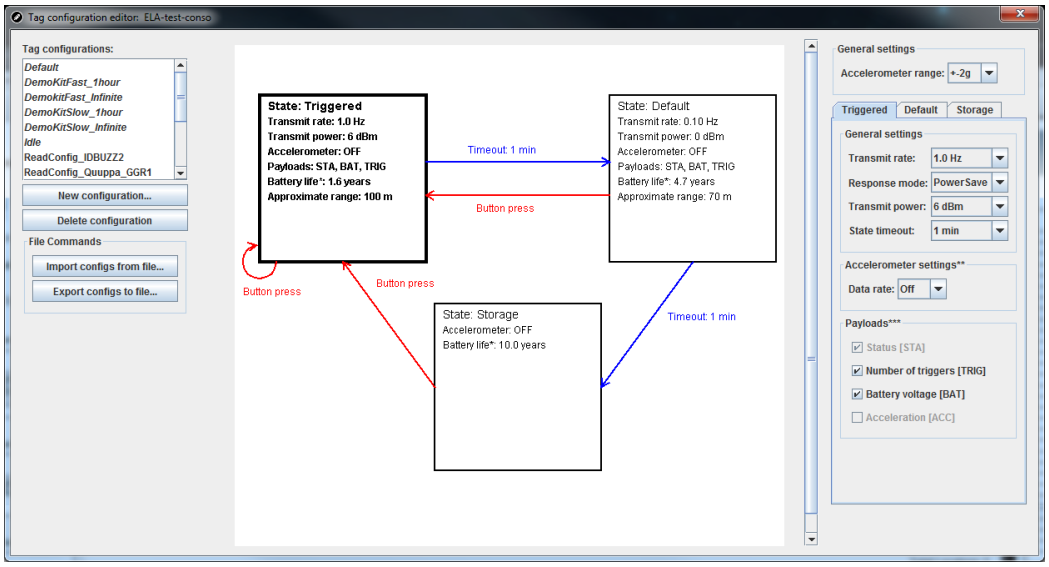
In order to function, a Quuppa technology tag must be added to an existing Quuppa network (as described in § 2D).

The following steps are required when adding a tag to a Quuppa network:

- Tag activation and configuration as necessary (as described in § 3B):
  - Software: Device Manager
  - Set “Activation” field to “True”

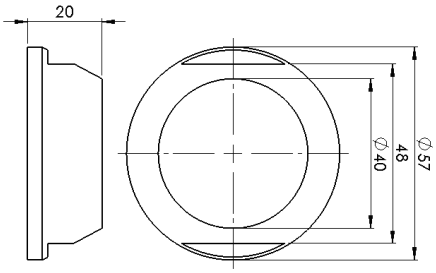


- Quuppa state settings (i.e. emission frequency, power, timeout):
  - Software: Quuppa Site Planner
  - Default settings:
    - Triggered state: 5Hz, -6dBm, 30s
    - Default state: 1Hz, -6dBm, 30s
    - Storage state
  - Modification of this setting is described in § 3A

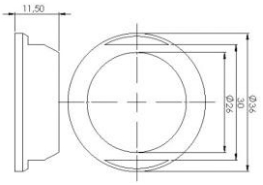


8. MECHANICAL SPECIFICATIONS

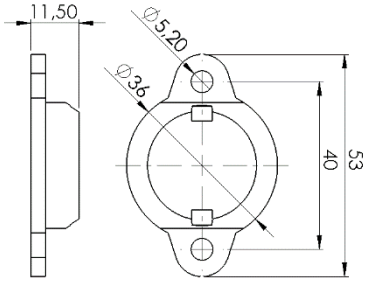
PUCK Format



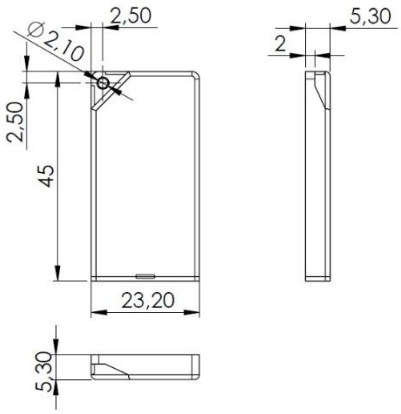
COIN Format



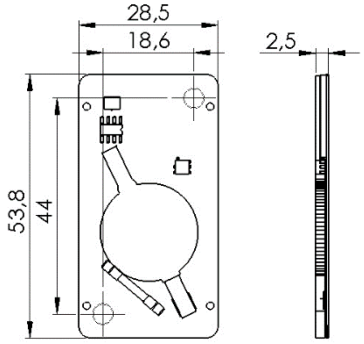
AERO Format



LITE Format



SLIM Format



9. NORMS & STANDARDS

- **FCC Statement**

This device complies with Part 15 of 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 cause undesired operation.

- **Industry Canada Statement**

This device complies with ISED's licence-exempt RSSs. 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 cause undesired operation.

Le présent appareil est conforme aux CNR d'ISED applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

3. Le dispositif ne doit pas produire de brouillage préjudiciable, et
4. Ce dispositif doit accepter tout brouillage reçu, y compris un brouillage susceptible de provoquer un fonctionnement indésirable.

Quuppa Technology

ISED Mark

Innovation, Science and Economic Development Canada

CE Mark

RoHS (2002/95/CE)

FCC Mark

WEEE (2002/96/CE)