

Introduction

This document describes the ST25RU3993 Reader Suite, a graphical user interface (GUI) software (STSW-ST25RU001) for the ST25RU3993 evaluation boards.

The ST25RU3993 evaluation board is ST's fully integrated Gen2/ISO18000-63 compatible UHF RFID reader ICs.

Additionally, a quick start guide includes a list of basic steps recommended to configure the demonstration reader for the most common applications.

Contents

1	Quick start guide	7
1.1	Hardware preparations	7
1.2	Software installation	8
1.3	First connection	9
1.4	Firmware (FW) update	12
2	Main window	13
2.1	Reader and Scan information	14
2.1.1	Reader information	14
2.1.2	Scanned tags	14
2.1.3	Tag information	15
2.2	Inventory Statistics	16
2.3	Scan panel	17
2.4	Select panel	17
2.5	Control panel	18
2.6	Region info	19
2.7	Menu	20
2.7.1	Control	20
2.7.2	View	21
2.7.3	Help	22
2.8	Tools	23
2.8.1	Trace browser	23
2.8.2	Unique Tag plot dialog	24
2.8.3	Tag list	25
2.8.4	Tag Associations - Global Actions	26
2.8.5	Settings	27
2.9	Toolbar	28
2.10	Context menu	28
2.10.1	ST25RU3993 Reader	29
2.10.2	Scanned Tags	30
3	Register map	31

4	Reader Settings	33
4.1	Settings tab	34
4.1.1	General panel	35
4.1.2	Frequency selection panel	37
4.1.3	Frequency hopping panel	39
4.1.4	Tx Options panel	40
4.1.5	Carrier Sense panel	41
4.1.6	Rx Options panel	41
4.1.7	Gen2 settings panel	44
4.1.8	Gen2 Anti-collision settings panel	45
4.2	Diagnostics	47
4.2.1	Diagnostic Sweep Function panel	48
4.2.2	Frequency Diagnosis panel	49
4.2.3	Direct Commands panel	49
4.2.4	Supply Options panel	49
4.3	Tuning	50
4.3.1	Tuning File panel	50
4.3.2	Automatic PreTuning before Scan panel	51
4.3.3	Automatic re-tuning during Scan panel	52
4.3.4	Manual tuning (Reflected power radar)	53
5	Tag settings	55
5.1	Information panel	56
5.2	Functions panel	56
5.2.1	Access Password	56
5.2.2	Tag Memory	56
5.2.3	Set EPC	57
5.2.4	Set Password	58
5.2.5	Lock	59
5.2.6	Kill	60
5.2.7	Generic command	60
5.2.8	Tag authenticate	63
6	Revision history	66

List of figures

Figure 1.	Hardware configuration of evaluation board	7
Figure 2.	ST25RU3993 GUI software installation wizard steps	8
Figure 3.	ST25RU3993 Reader Suite desktop icon	9
Figure 4.	ST25RU3993 Reader Suite - Connect Reader.	9
Figure 5.	ST25RU3993 Reader Suite - Connected	10
Figure 6.	Communication problem.	10
Figure 7.	Device manager - Detected ST25RU3993 reader board	11
Figure 8.	ST25RU3993 Reader Suite - Firmware Update	12
Figure 9.	ST25RU3993 firmware upgrade - Manual Device selection	12
Figure 10.	ST25RU3993 Reader Suite - Main window	13
Figure 11.	Reader information	14
Figure 12.	Reader and Scan information - Scanned tags	15
Figure 13.	Scanned tags - Tag information	15
Figure 14.	Inventory - Round info panel.	16
Figure 15.	Scan panel	17
Figure 16.	Select panel	18
Figure 17.	Control panel	18
Figure 18.	Region panel - EU	19
Figure 19.	Control menu	20
Figure 20.	View menu	21
Figure 21.	Help menu	22
Figure 22.	Trace browser.	23
Figure 23.	Unique Tag plot	24
Figure 24.	Tag list	25
Figure 25.	Tag Associations - Global Actions	26
Figure 26.	Settings window	27
Figure 27.	Toolbar	28
Figure 28.	Context menu - ST25RU3993 Reader	29
Figure 29.	Context menu – Scanned Tags	30
Figure 30.	Register Map	32
Figure 31.	Reader Settings - Settings tab	34
Figure 32.	Alternate antenna selection	35
Figure 33.	TID location in Scanned Tags - Tag information	36
Figure 34.	Frequency panel	37
Figure 35.	Channel list dialog	38
Figure 36.	Frequency hopping panel	40
Figure 37.	Tx Option panel	40
Figure 38.	Carrier sense panel	41
Figure 39.	Adjust Sensitivity dialog	42
Figure 40.	RX filter dialog	43
Figure 41.	Rx option panel	43
Figure 42.	Gen2 link setting	44
Figure 43.	Gen2 Anti-collision setting	45
Figure 44.	Adjust Q configuration dialog	46
Figure 45.	Reader Settings - Diagnostics tab	47
Figure 46.	Diagnostic sweep	48
Figure 47.	Reader Settings - Tuning tab	50
Figure 48.	Reflected Power Radar.	53

Figure 49.	Reflected Power Radar - Tuned	54
Figure 50.	Tag Settings dialog window	55
Figure 51.	Tag memory table	56
Figure 52.	Tag memory additional information table	57
Figure 53.	Set EPC	57
Figure 54.	Set Password	58
Figure 55.	Lock	59
Figure 56.	Kill	60
Figure 57.	Generic command	60
Figure 58.	Bit Sequence Editor	61
Figure 59.	Tag Authenticate	63
Figure 60.	ISO29167-10 TAM1 Tag Authenticate Editor	63
Figure 61.	ISO29167-10 TAM2 Tag Authenticate Editor	64
Figure 62.	ISO29167-13 TA.1 Tag Authenticate Editor	64
Figure 63.	ISO29167-13 TAR Tag Authenticate Editor	65

List of tables

Table 1. Document revision history 66



1 Quick start guide

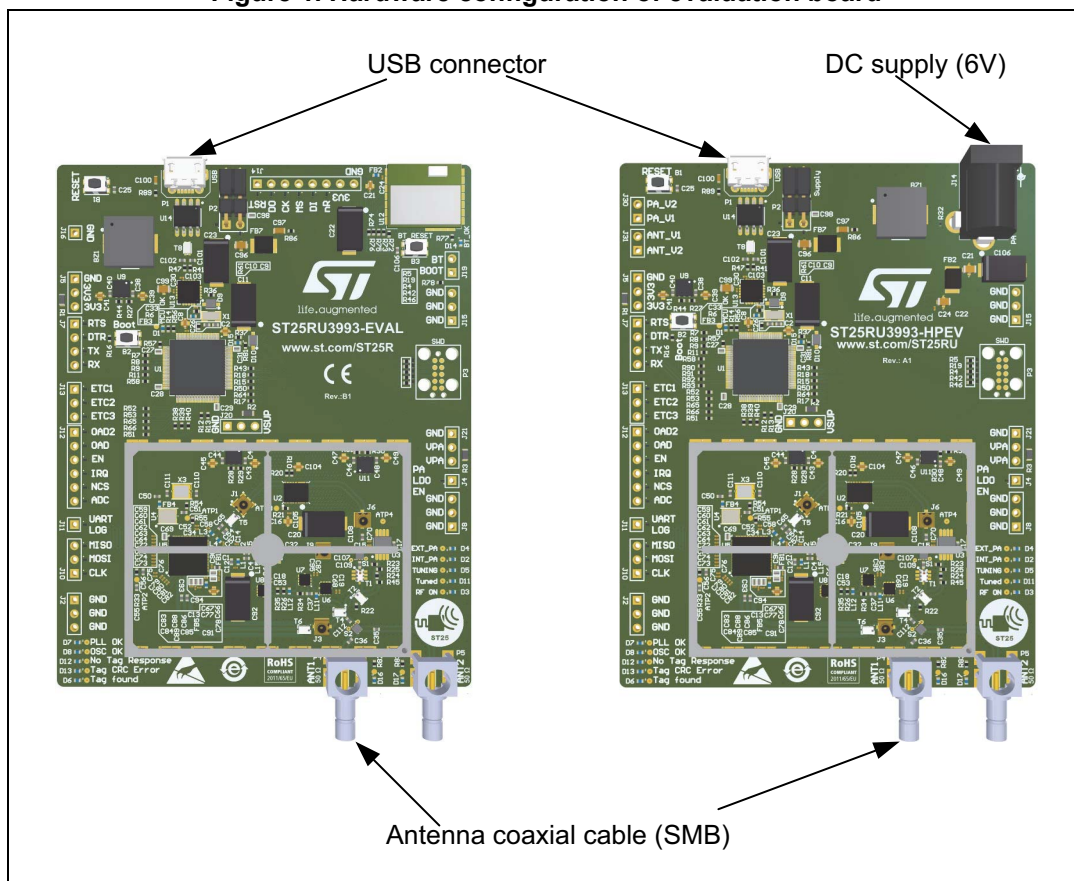
1.1 Hardware preparations

- Connect the coaxial cable with the antenna and with the antenna port 1 on the reader. The antenna port 1 is activated by default. The antenna port 2 can be used as well but it needs to be configured as output in the reader settings dialog.
- Connect the ST25RU3993 evaluation board to the host PC running the GUI via a micro-USB cable.

Additionally, the ST25RU3993-HPEV requires to connect the DC power supply to the DC jack (J14).

Note: Always make sure that a 50 Ω antenna or some other 50 Ω load is connected to the active antenna port when RF power is switched ON.

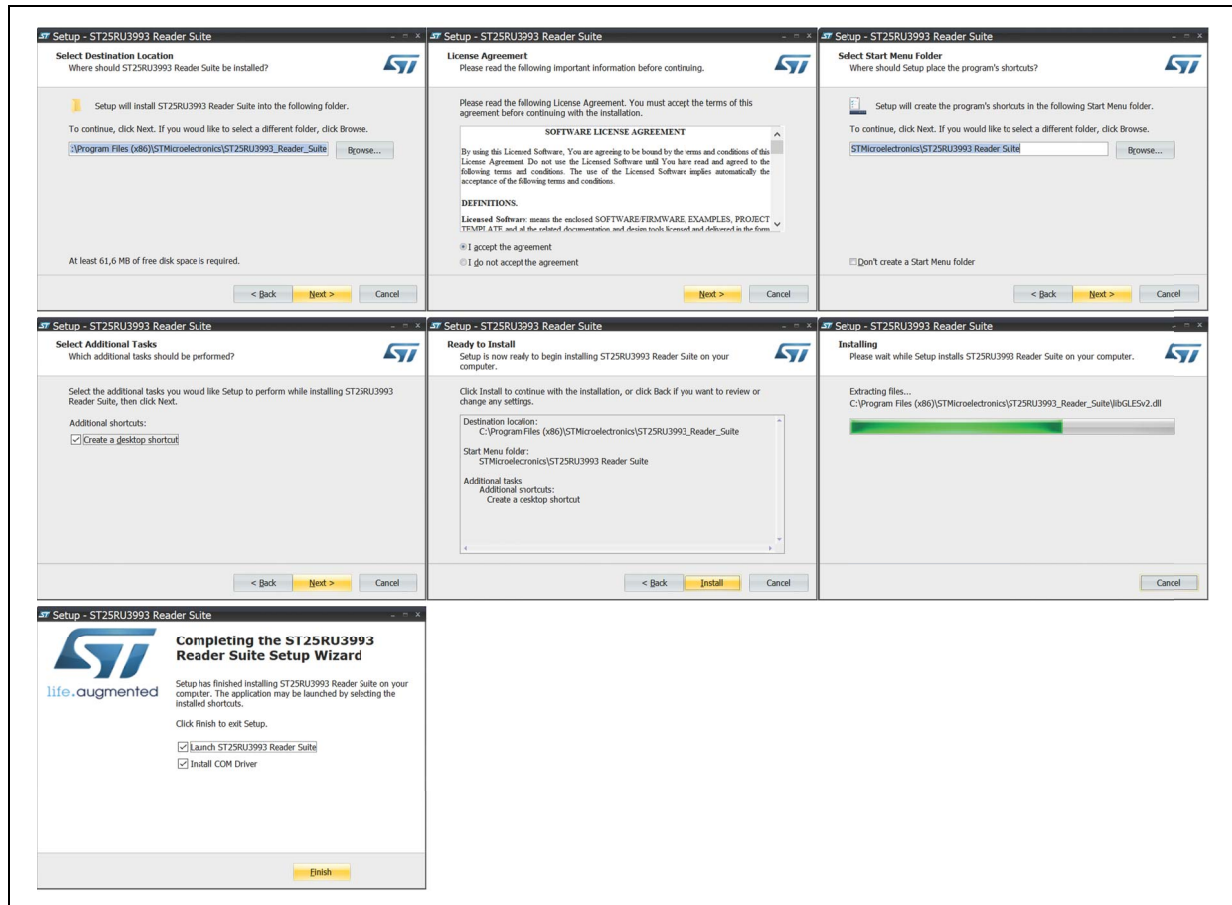
Figure 1. Hardware configuration of evaluation board



1.2 Software installation

- To install the ST25RU3993 Reader Suite software, click on the installation file ST25RU3993_GUI_vx-x-x.exe
- Follow the instructions of the software installation wizard
- Clicking on Finish at the end of the installation process, per default it starts the ST25RU3993 Reader Suite

Figure 2. ST25RU3993 GUI software installation wizard steps



1.3 First connection

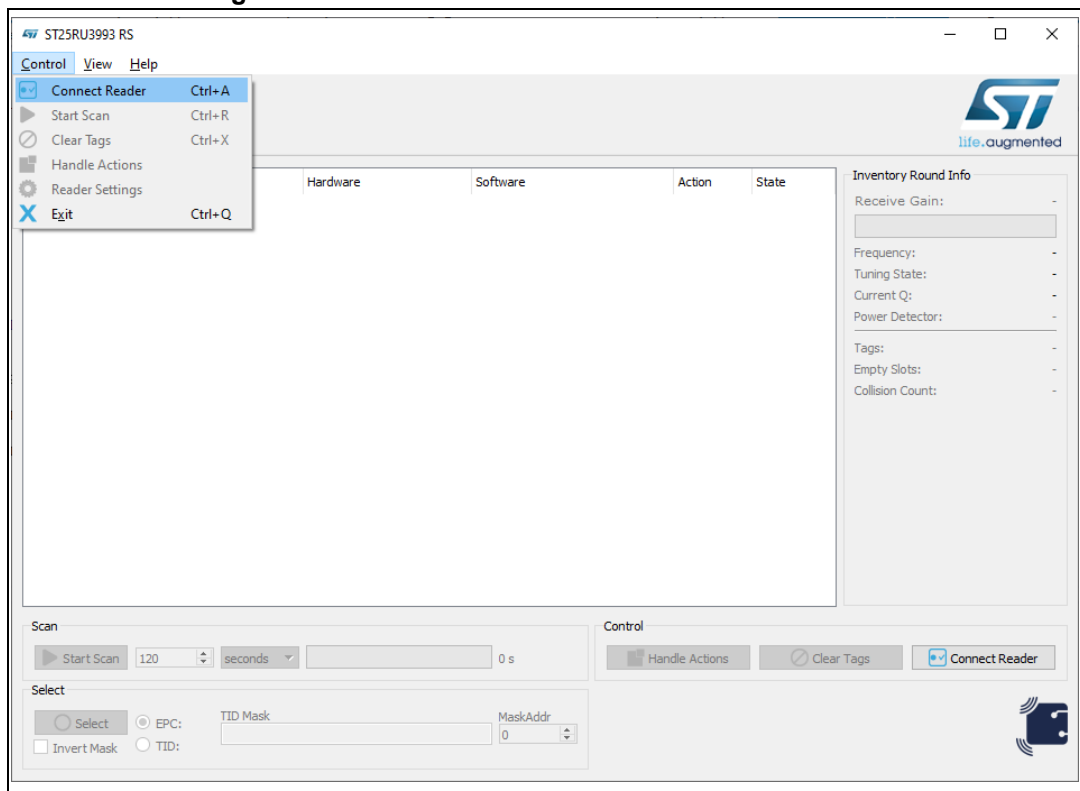
In case the ST25RU3993 Reader Suite is not already running, start the ST25RU3993 Reader Suite.

Figure 3. ST25RU3993 Reader Suite desktop icon



Click on the Connect Reader button on the lower right corner of the main window, or go to the menu Control and select Connect Reader. Alternatively, use the keyboard shortcut key by pressing [Ctrl+A].

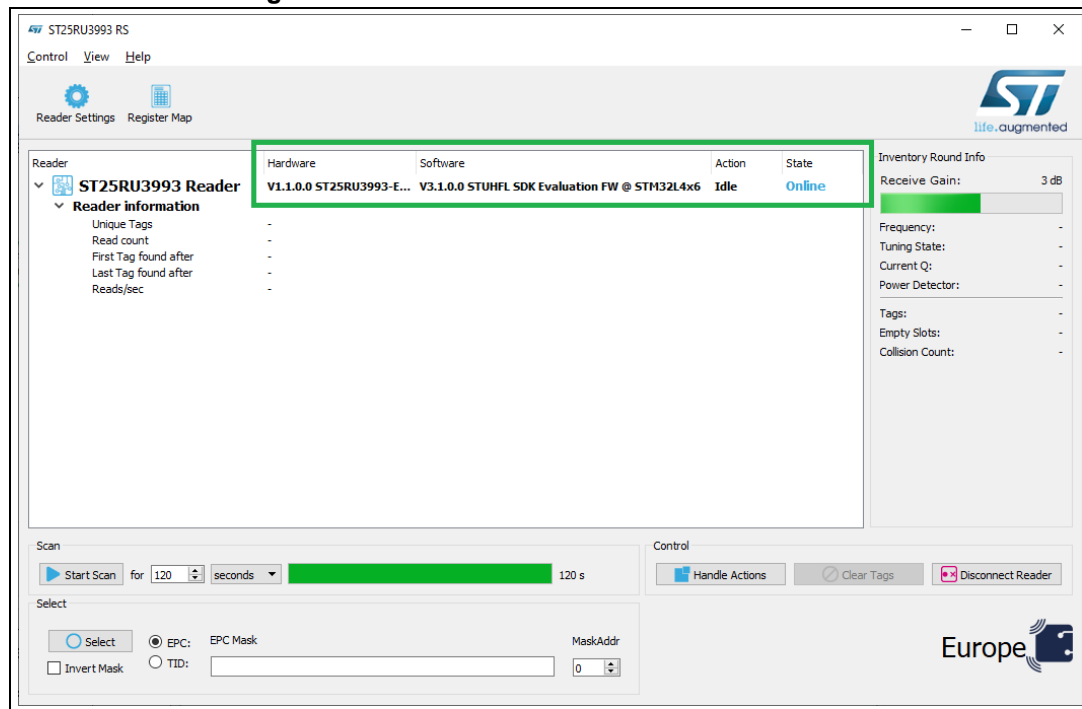
Figure 4. ST25RU3993 Reader Suite - Connect Reader



The application automatically scans all available COM ports for a connected ST25RU3993 evaluation board and displays the first detected connected board.

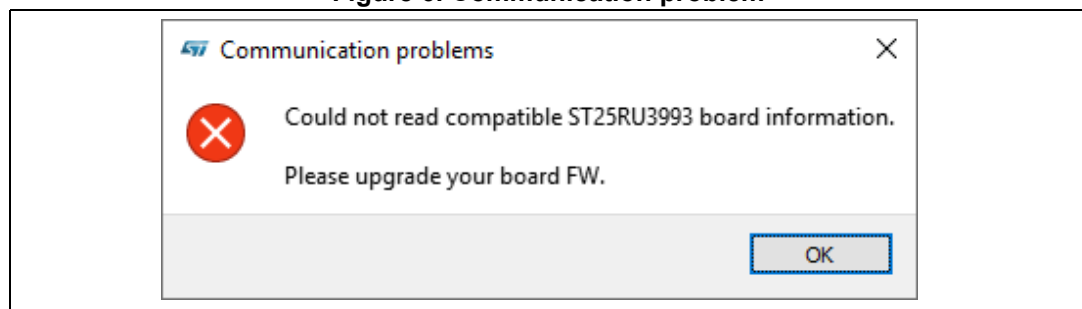
The ST25RU3993 Reader Suite also displays the version information and the status of the connected board.

Figure 5. ST25RU3993 Reader Suite - Connected



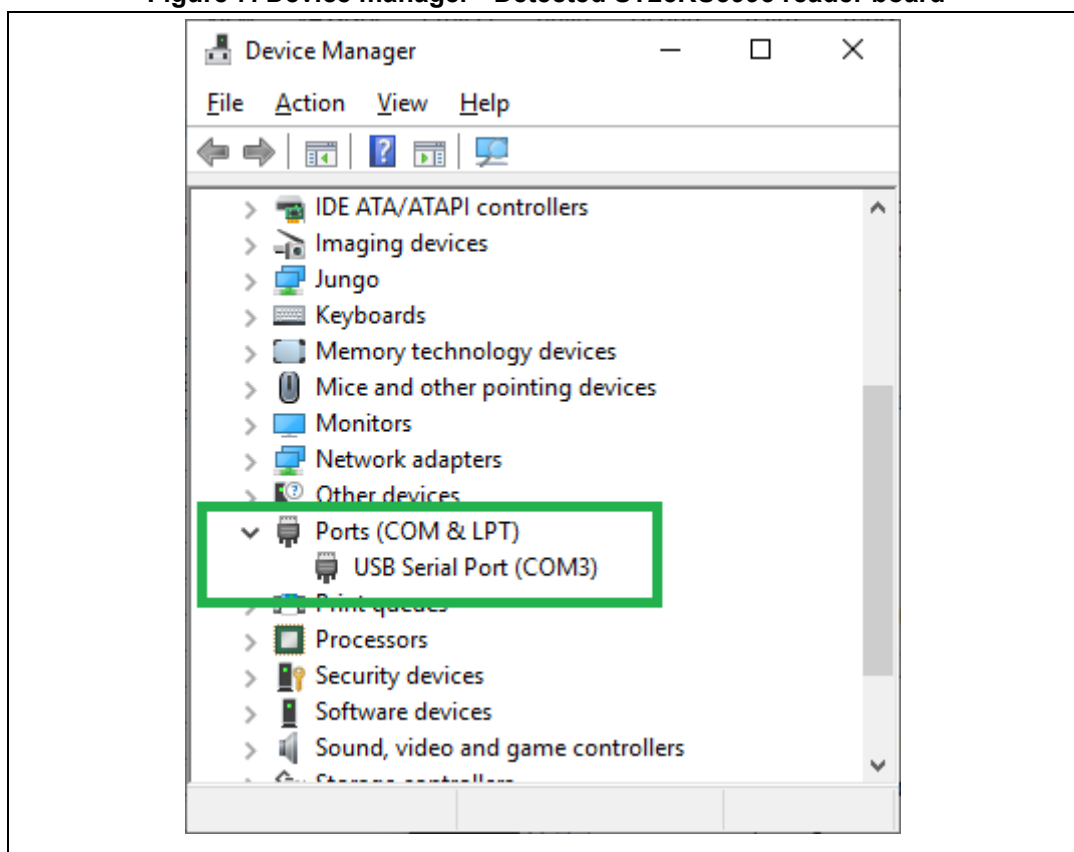
Note: The ST25RU3993 Reader Suite and the firmware of the connected board must have the same version number. The version number of the GUI can be found by clicking on 'About' from the Help Menu. If version numbers do not match, the GUI prompts a notification to update FW of the board. Follow the on-screen information and upgrade the FW using the binary file located in the Firmware folder of the GUI installation folder. If no ST25RU3993 based evaluation reader board is detected, an error notification is displayed.

Figure 6. Communication problem



If the FW version is matching and still an error notification is displayed, check the USB cable and verify that the ST25RU3993 evaluation reader is detected by the Windows® Device Manager.

Figure 7. Device manager - Detected ST25RU3993 reader board

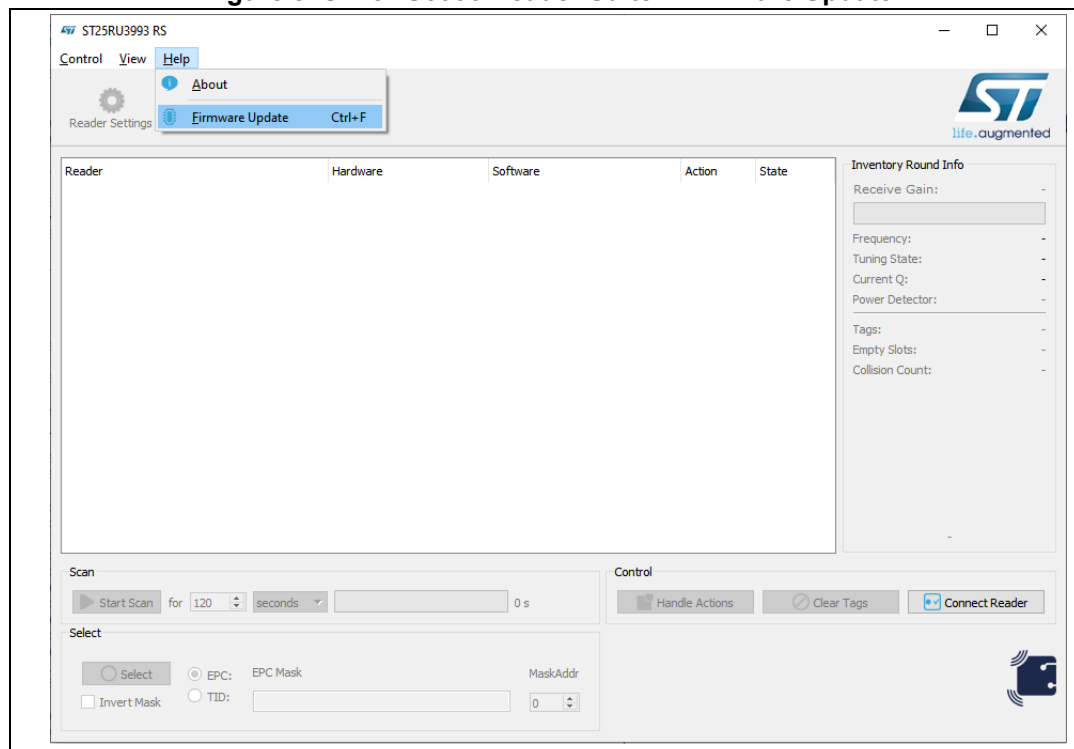


1.4 Firmware (FW) update

To update the firmware of the ST25RU3993 evaluation reader:

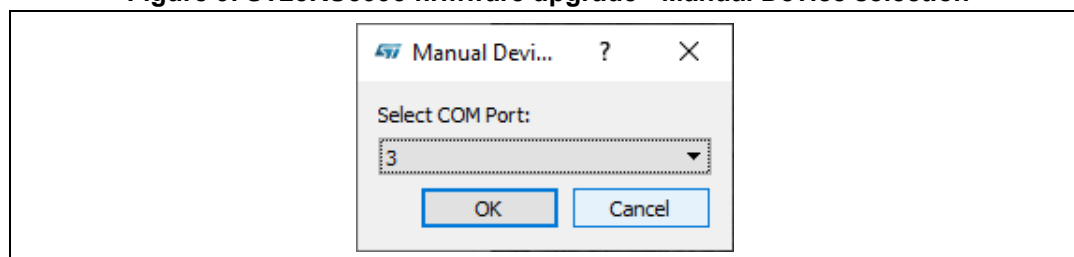
- Connect the ST25RU3993 reader board to the PC.
- Launch the firmware upgrade process by clicking on “Firmware Update”, which is located in the ‘Help’ menu. Alternatively use the keyboard shortcut key [ALT+F].

Figure 8. ST25RU3993 Reader Suite - Firmware Update



- Follow the on-screen instructions.
- Select the COM port to which the ST25RU3993 board is connected to.

Figure 9. ST25RU3993 firmware upgrade - Manual Device selection



- After selecting the FW binary file that should be programmed, the update progress bar displays the remaining time until finished.

Note: It is not required to click on the connect reader button in the GUI prior to the update of the board FW.

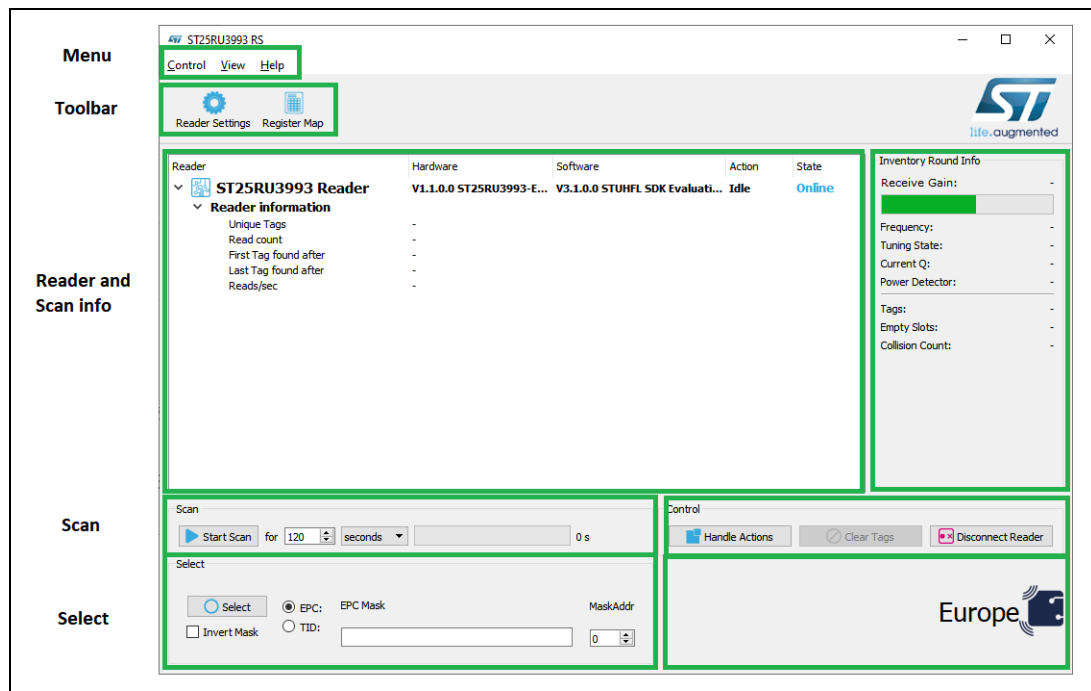
Note: While the update process is ongoing do not disconnect the reader from the host computer. If the update process is interrupted or fails the FW update can be restarted since STM32's on-board ROM bootloader is used.

2 Main window

The ST25RU3993 Reader Suite is a dialog-based Windows GUI with the main window as central user interface element. The main window is structured into the following GUI groups

- **Menu**
- **Toolbar**
- **Reader and Scan info:** Information of most recent inventory scan
- **Inventory statistics:** Reader and inventory configuration settings as well as real time inventory round statistics
- **Scan:** Start/Stop inventory scan
- **Control:** Control actions
- **Select:** Configuration of the Gen2/ISO18000-63 or GBT29768 Select command to pre-filter tags during the inventory scan
- **Region:** Shows the currently active region

Figure 10. ST25RU3993 Reader Suite - Main window




2.1 Reader and Scan information

2.1.1 Reader information

It shows the information related to the current scan activity.

Figure 11. Reader information

Reader	Hardware	Software	Action	State
<div>  ST25RU3993 Reader </div> <div> Reader information <ul style="list-style-type: none"> Unique Tags: 128 Read count: 274 First Tag found after: 11 msec Last Tag found after: 2198 msec Reads/sec: 124.89 (Max: 128.51) </div>	V1.1.0.0 ST25RU3993-E...	V2.3.0.0 STUHFL SDK Evaluati...	Idle	Online

Where:

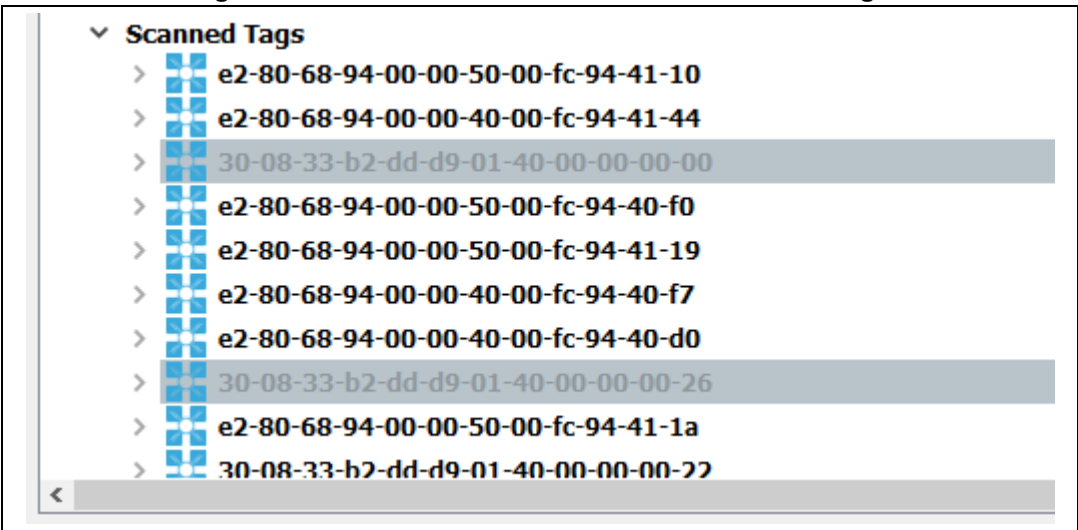
- **Unique Tags:** Number of unique tags found by the reader during current or last scan
- **Read count:** Number of tag reads performed since application start or last reset of the tag list.
- **First Tag found after:** Timestamp of first found Tag during this inventory scan. The timestamp is relative to the inventory scan start.
- **Last Tag found after:** Timestamp of the tag found last.
- **Reads per second [tags reads/sec]:** Actual tag read rate averaged across all inventoried tags of the current scan.

With a right click on the reader entry (ST25RU3993 Reader) a pop-up menu appears providing access to the Reader Settings, the Register Map and allows to save and recall reader settings. Conveniently the Reader Settings and the Register. The map can be accessed through the buttons above the main window as well.

2.1.2 Scanned tags

The scanned Tags list shows the list of the inventoried Tags EPC values found during the current scan. The list is updating itself and removes EPC entries from tags that couldn't be read anymore for a certain time. Before EPC entries are removed from the list, the entries become grayed out.

Figure 12. Reader and Scan information - Scanned tags

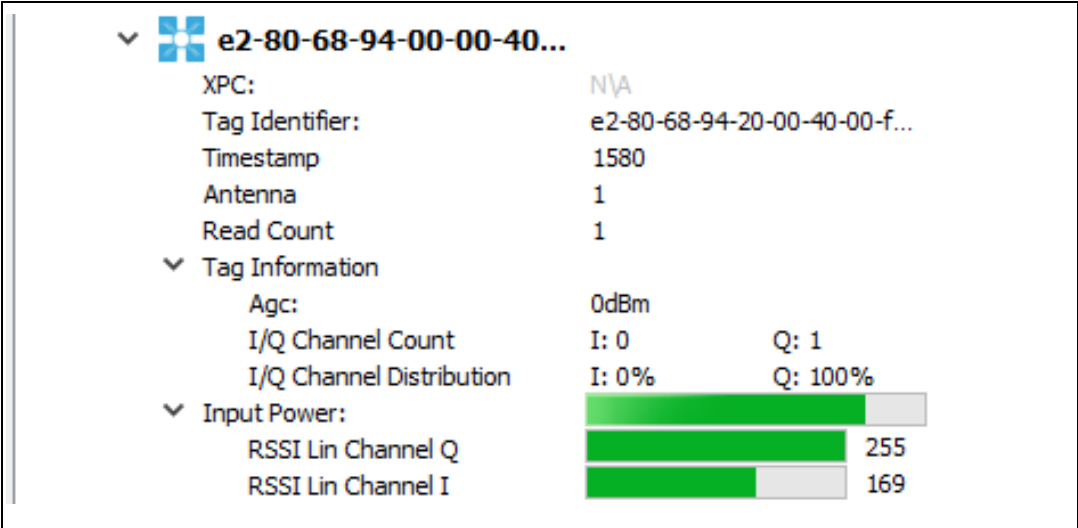


The EPC entries are organized in a tree-view and further Tag information can be accessed by expanding the EPC entries.

2.1.3 Tag information

By expanding an EPC entry in the Scanned tags list further information about the Tag can be accessed. The content of the additional information can be configured via the View menu.

Figure 13. Scanned tags - Tag information



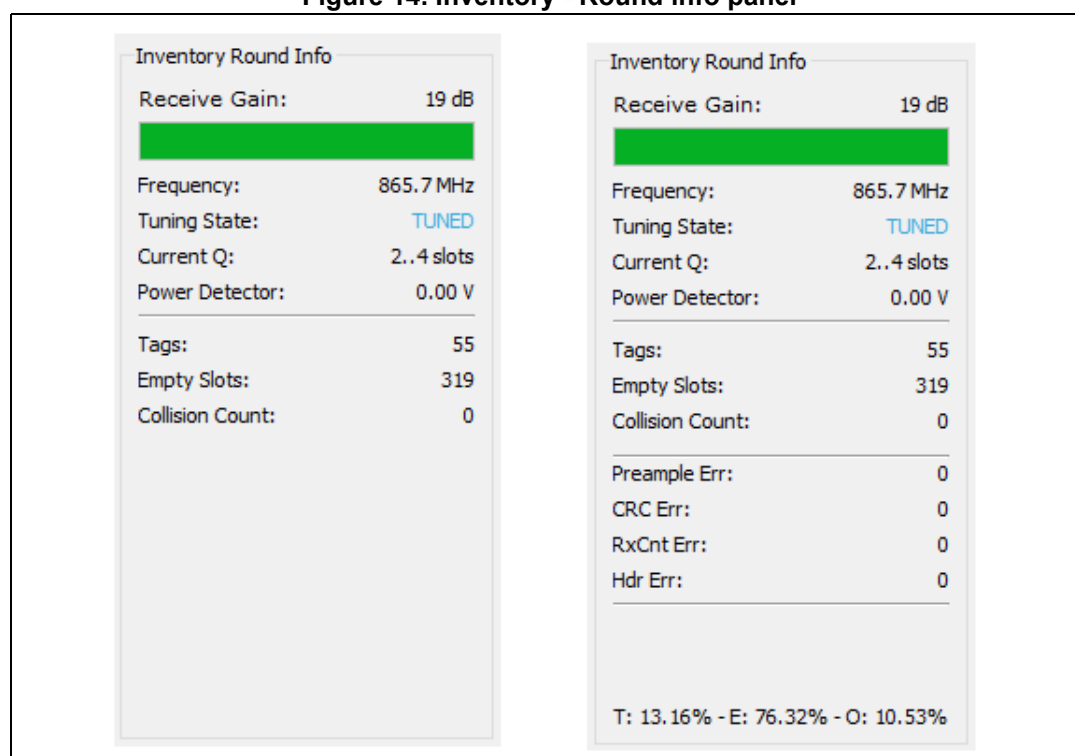
Where:

- **XPC:** If supported by the Tag, the XPC value is displayed.
- **Tag Identifier:** The Tag TID information is displayed only if the protocol selection option in the Reader Settings is switched to either:
 - Gen2 – N with TID
 - GB – 29768 with TID
- **Timestamp:** The last time the tag was inventoried relative to the start of the inventory scan operation.
- **Read Count:** Number of inventories for this Tag
- **Tag Information:** AGC and I/Q values for this Tag
- **Input Power:** Either the linear or logarithmic RSSI value information for this Tag. The values can be switched with the View menu

2.2 Inventory Statistics

The Inventory Statistics give real time information of reader parameters and anti-collision slot status during an active scan.

Figure 14. Inventory - Round info panel



Where:

- **Receiver Gain:** The current receiver gain. The receiver gain value may change when adaptive sensitivity is enabled during scan
- **Frequency:** The current RF carrier frequency that is used. The RF carrier frequency changes with the defined allocation time when frequency hopping is enabled.

Note: When exercising radiated transmissions local radio regulations and requirements must be followed.

- **Tuning State:** Current status of carrier cancellation circuit
- **Current Q:** Current Q value of the anti-collision algorithm.
- **Power Detector:** DC Voltage of power detector.
- **Empty Slots:** Total number of empty slots during the inventory scan
- **Collision Count:** Number of slots with Tag collisions in total.

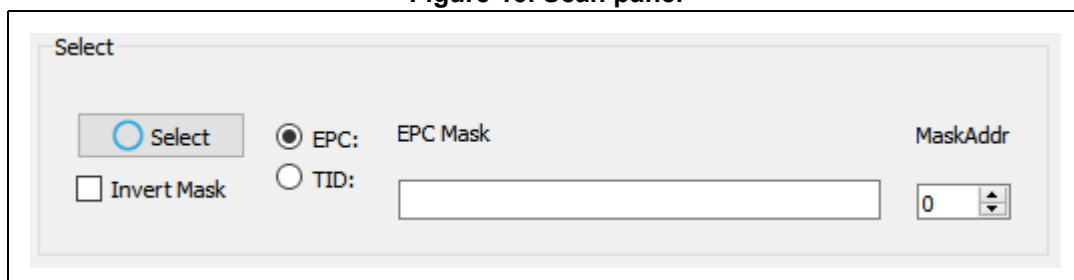
By enabling the extended statistic display from Menu view and clicks on Round Statistics, more details are shown:

- Preamble Err: Number of detected Gen2 preamble communication errors in total.
- CRC Err: Number of detected CRC communication errors in total
- RxCnt Err: Number of detected RxCnt communication errors in total
- Hdr Err: Number of detected Header errors in total.

2.3 Scan panel

By clicking on the Start Scan button the reader starts to scan for tags.

Figure 15. Scan panel



On the right-hand side of the scan button there is an entry field to define the duration of the scan operation after which transmission is stopped again.

There are two options:

- **Seconds:** After the defined time the scan operation is stopped automatically. The maximum number that can be entered is 600.

Note: If a zero value is entered the scanning operation continues indefinitely.

- **#rounds:** After the defined number of inventory rounds are completed the scan operation is stopped. The maximum number that can be entered is 600.

The progress bar indicates how much time or how many inventory rounds are left, to perform, until the scanning automatically stops.

2.4 Select panel

With the select panel a Gen2 select command can be configured. The select command can be configured either for EPC or TID values. The user can enter a mask, a mask start address, and a length parameter. The Select command is sent before each inventory round to pre-filter tags.

Figure 16. Select panel

Where:

- **Select:** Enables/disables the selection of tags depending on the EPC/TID mask entered
- **EPC or TID:** Defines the tag memory bank mask is compared
- **Start address:** Starts the byte at which the tag memory bank is compared. The default value is 0.
For example: tag EPC = 2e-11-33; to select 11-33, the starting address is 1.
- **Invert Mask:** Allow to use the ~SL flag in query command SEL field

2.5 Control panel

Figure 17. Control panel

The control panel allows to trigger the following actions:

- **Handle Actions:** Activate/Deactivate tag actions if associated in the Global Actions window. The user may associate a certain action if a tag has been successfully read.
For example: Play a sound if a certain tag has been read.
- **Clear Tags:** Clears tag entries from the main window. Useful to refresh the tag entries while scanning for tags.
- **Disconnect/Connect Reader:** Disconnects or Connects a reader via UART.

2.6 Region info

The ST25RU3993 Reader Suite automatically selects the frequency profiles, which is needed to comply with local radio regulations and displays the current detected region in the Region info area. The following image show the icon displayed when the ST25RU3993 Reader Suite is used in Europe.

Figure 18. Region panel - EU



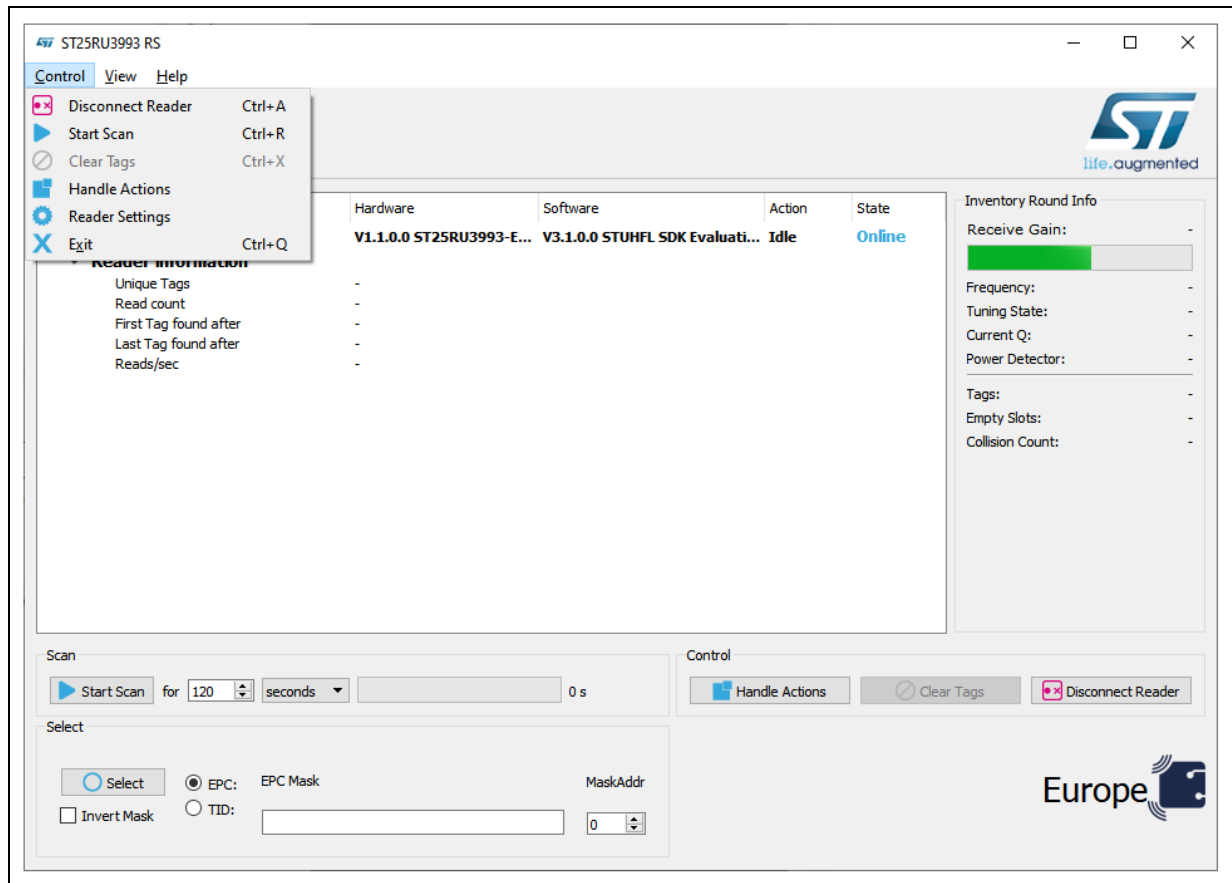
It is possible to override the regional configuration within the Reader Settings dialog.

Note: When exercising radiated transmissions, local radio regulations and requirements must be followed.

2.7 Menu

2.7.1 Control

Figure 19. Control menu



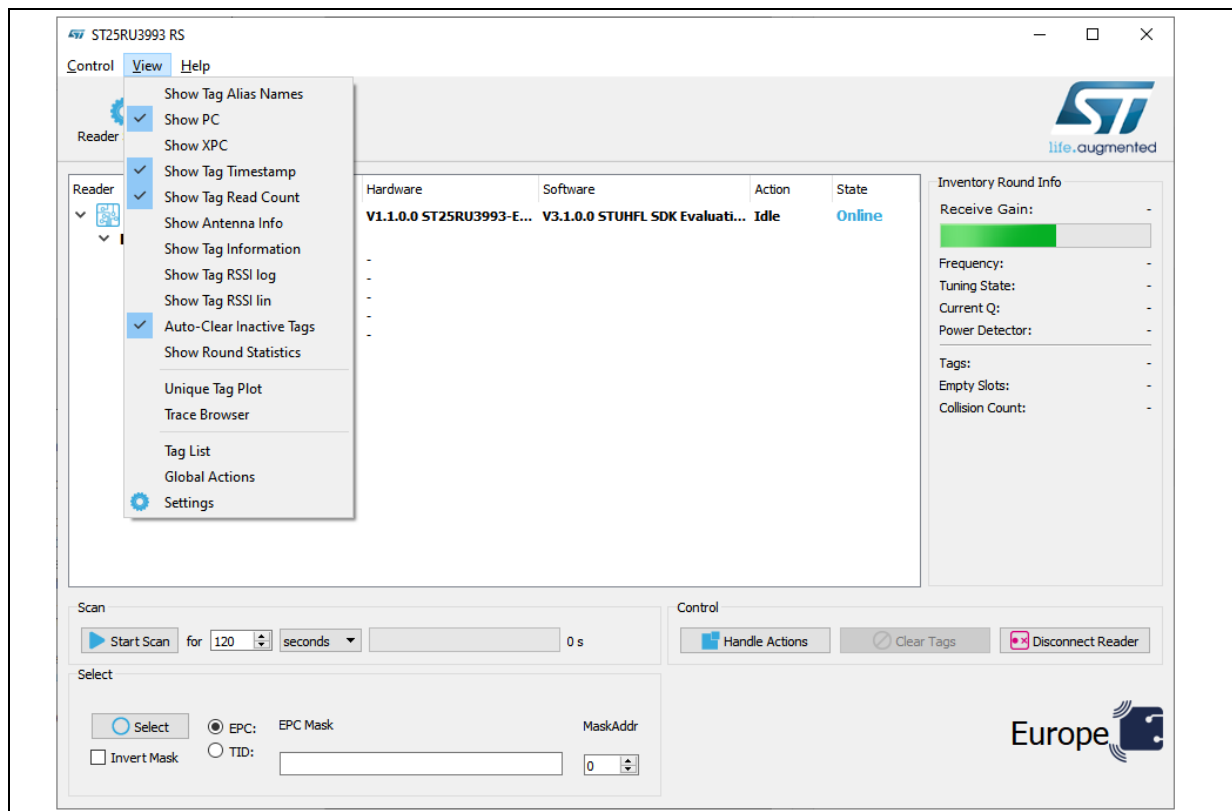
Where:

- **Connect/Disconnect Reader:** Connects or disconnects the ST25RU3993 Reader Suite with the ST25RU3993 evaluation board. Depending on the connection status, the button connects or disconnects from the board.
- **Start Scan:** Starts scanning for tags.
- **Clear Tags:** Clears tag entries.
- **Handle Actions:** Enables GUI actions that could be associated with tags. For example: GUI displays a picture or plays a sound upon reading a specific tag EPC.
- **Reader Settings:** Set the Reader configuration

2.7.2 View

The view menu allows to show/hide several elements in inventoried TAGs list and open additional tool dialogs.

Figure 20. View menu



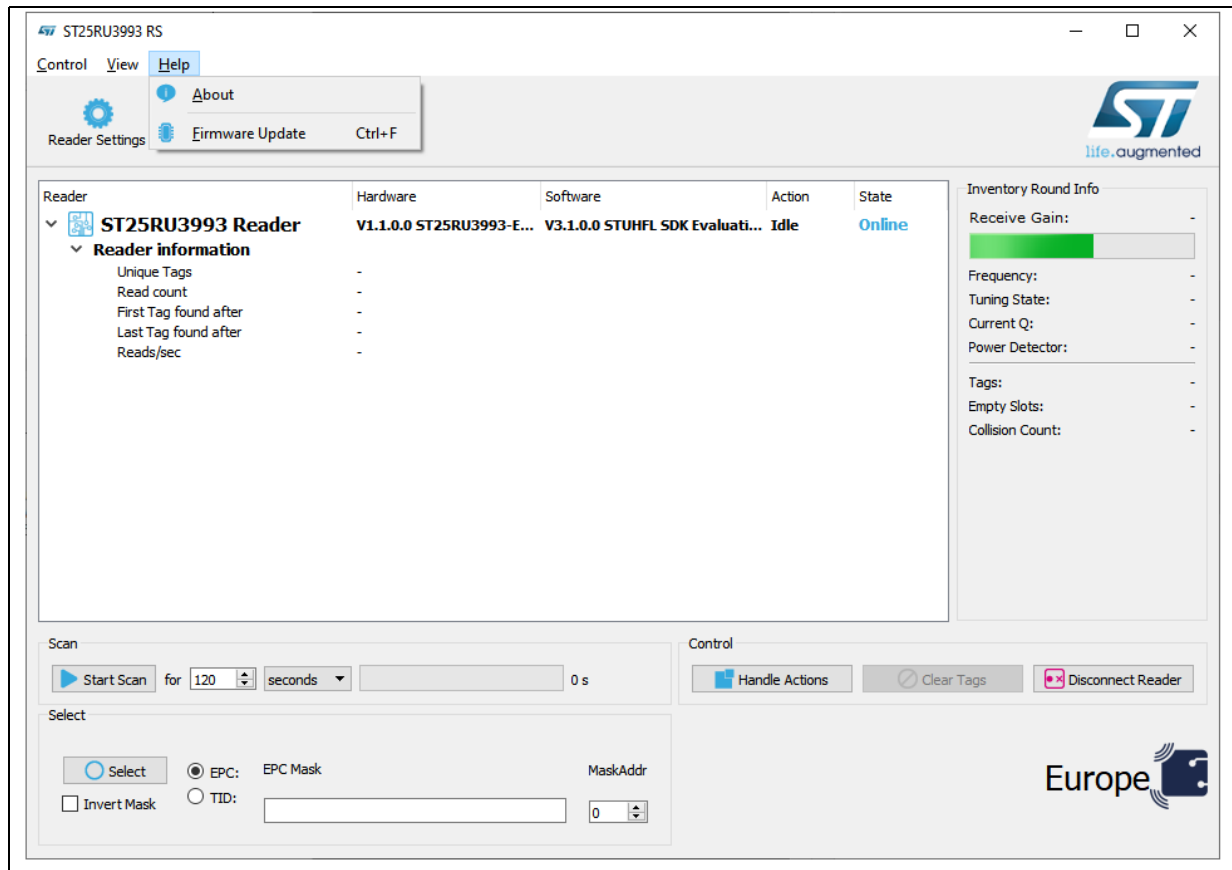
Where:

- **Show Tag Alias Names:** Displays the user defined alias name instead of the EPC number of a tag.
- **Show Tag Read Count:** Displays the number of times each tag is inventoried by the reader.
- **Show Tag Information:** Displays additional information about the tag.
- **Show Tag RSSI log:** Displays received tag RSSI in logarithmic scale.
- **Show Tag RSSI lin:** Displays received tag RSSI in linear scale.
- **Auto-Clear Inactive Tags:** Applies the timing information for the tag list of the main window defined in the Settings window (see GUI Settings).
- **Unique Tag Plot:** Opens a plot dialog to display the evolving of found unique Tags over time during scanning.
- **Trace Browser:** The Trace Browser window appears at the bottom of the main window. It extends the main window by the Trace Browser. The Trace Browser is detachable.
- **Tag List:** Displays a configurable tag list.
- **Global Actions:** Displays the Global Action dialog to define Actions when a new Tag is read.
- **Settings:** Opens the general GUI settings

2.7.3 Help

The help menu gives access to the “about” dialog and allows to start a firmware update process.

Figure 21. Help menu



Where:

- **About:** Displays the About dialog.
- **Firmware Update:** Allows to select a firmware file, and to update the connected reader with the new firmware. The firmware file (ST25RU3993 FW vx-x-x-x.bin) is located in the firmware folder inside the installation directory of the ST25RU3993 Reader Suite.

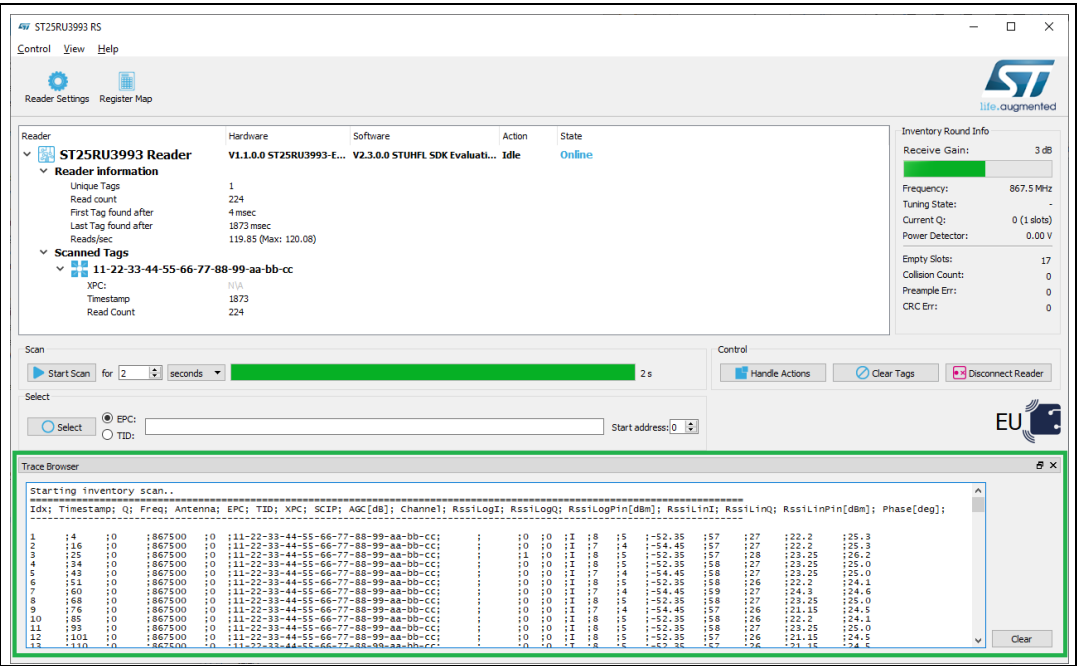
2.8 Tools

The following additional tool windows and dialogs can be visualized with the View menu.

2.8.1 Trace browser

The trace browser logs all found TAGs during a running inventory scan. The log information beside the scanned EPC includes several additional recorded information when a TAG was identified.

Figure 22. Trace browser

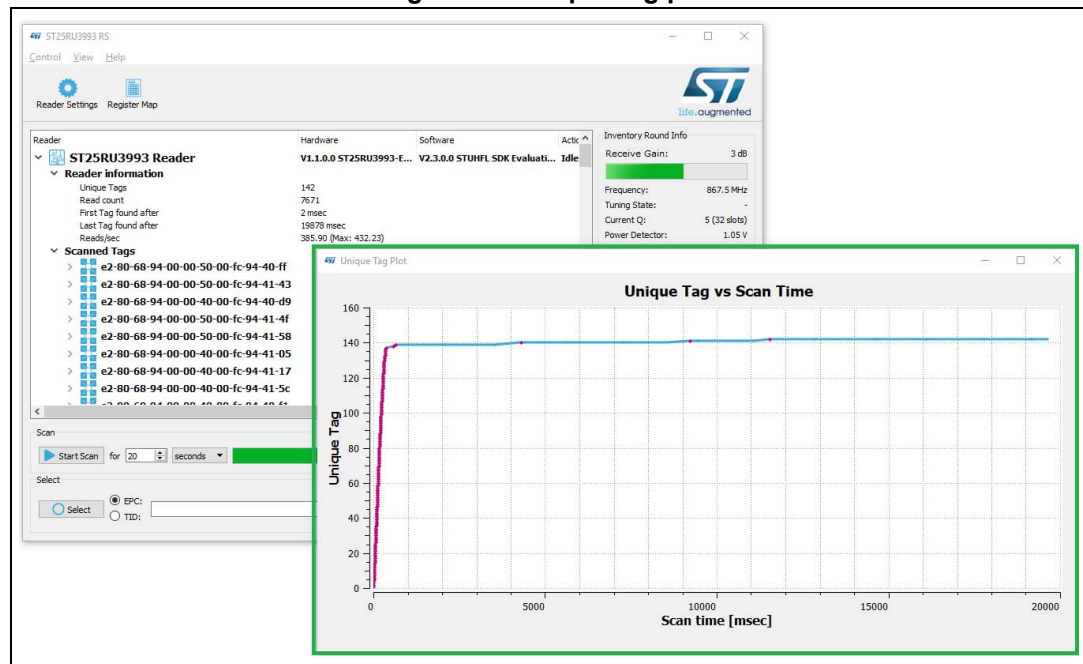


2.8.2 Unique Tag plot dialog

The unique tag plot dialog records the unique tag EPCs found during the real time inventory scan.

Each magenta dot on the blue curve symbolizes a tag inventory with an EPC discovered for the first time. By moving the mouse pointer over the dots, the timing information of the corresponding TAG inventory is displayed. The plot automatically resizes to fit into the drawing areas. Using the mouse wheel and left mouse button the curve can be zoomed and panned.

Figure 23. Unique Tag plot

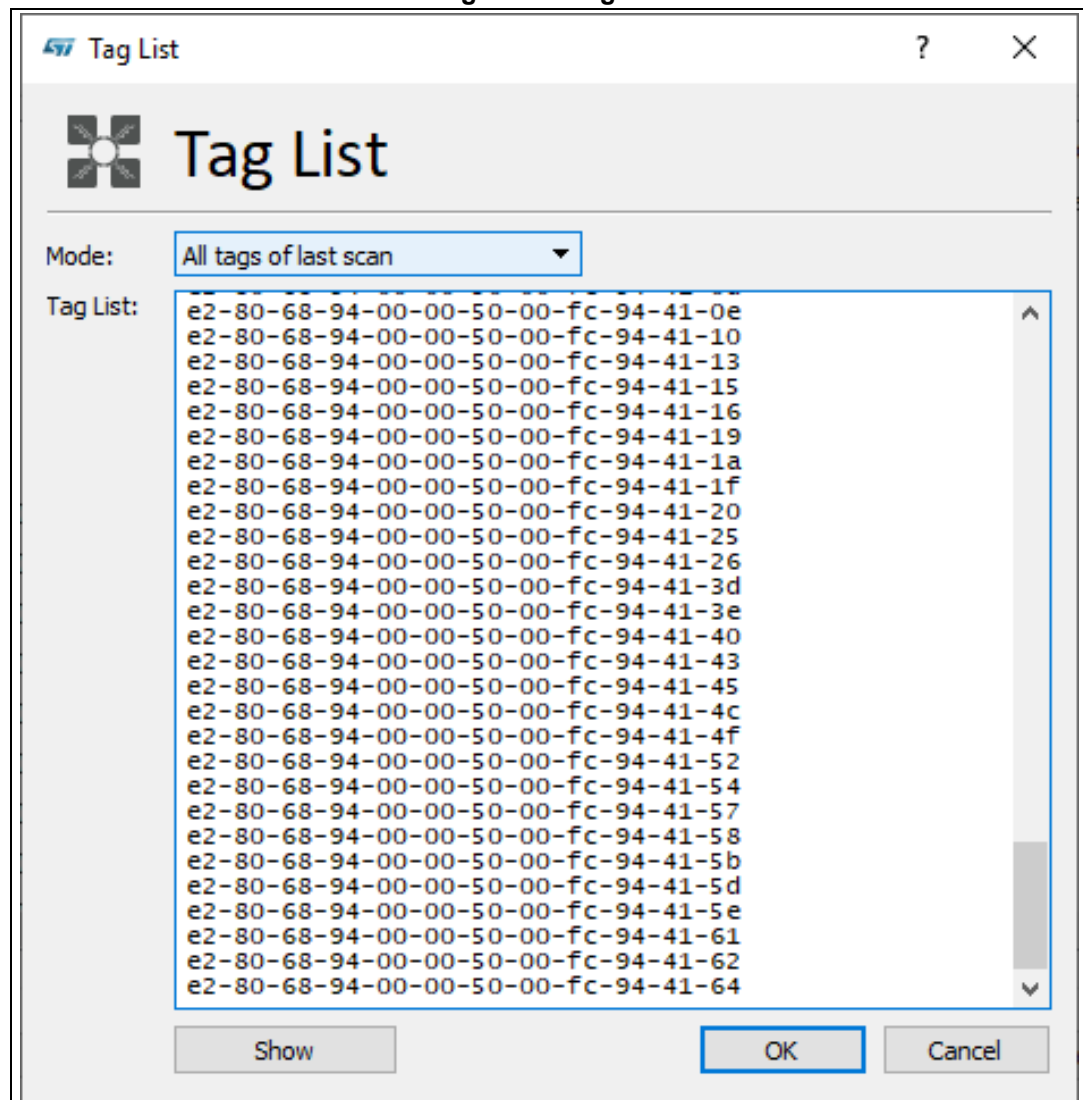


Right-clicking on the Unique Tag plot shows a pop-up menu, which allows to store the last measurement as a reference for other measurements.

2.8.3 Tag list

The TAG list dialog displays a list of found TAGs. The list can be displayed in three different modes described below.

Figure 24. Tag list



Where:

- **Mode:** Defines which tags are going to be displayed in the tag list window. The options are:
 - All tags since application start
 - All tags of last scan
 - All current tags

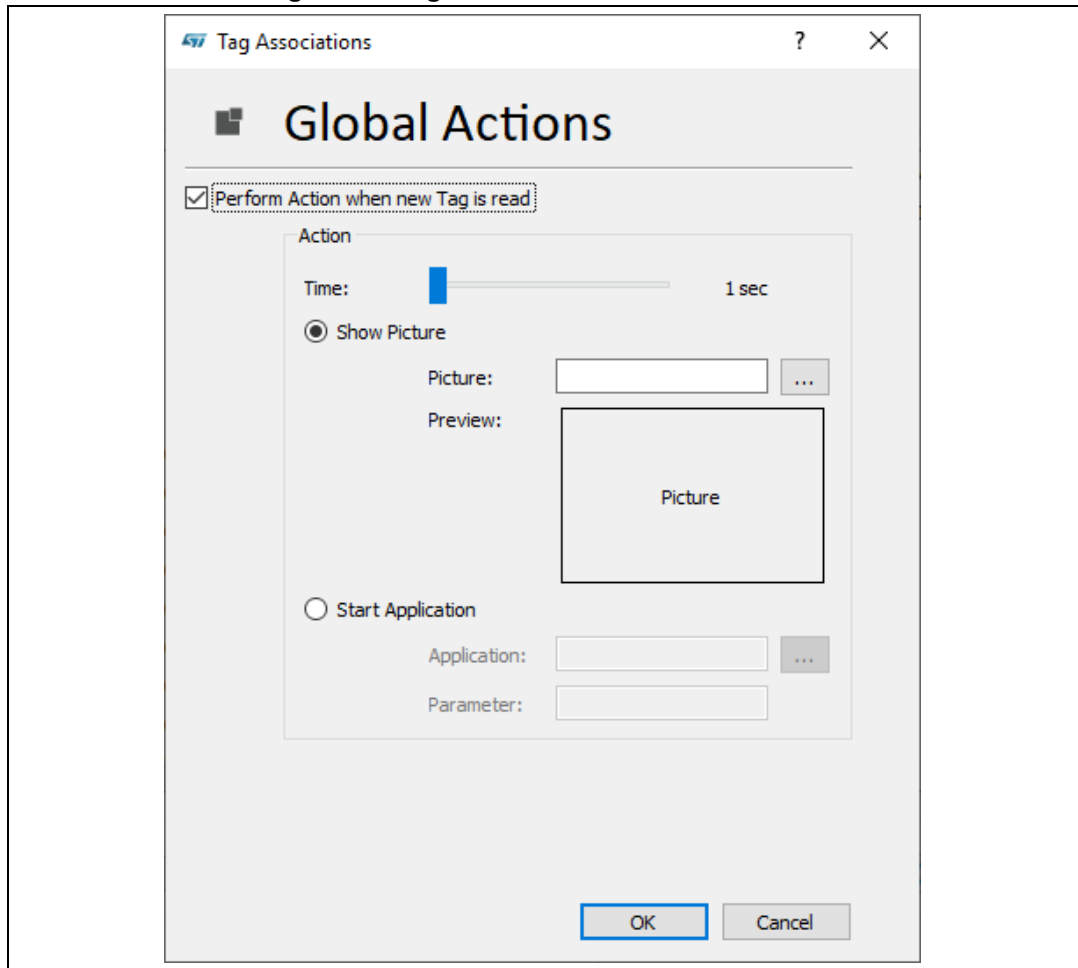
The Show button refreshes the list according to the current settings.

Note: Tags are not listed by their alias names.

2.8.4 Tag Associations - Global Actions

The Global Actions dialog defines a custom action whenever a tag is found.

Figure 25. Tag Associations - Global Actions



Where:

- **Time:** Sets the duration of the defined action.
- **Show Picture:** Displays a picture upon a tag read.
 - **Picture:** Allows to browse the computer to select the picture used for the tag action
 - **Preview:** Shows a preview of the picture used for the tag action.
- **Start Application:** Starts an external application upon a tag read. Example: Play a sound:
- **Application:** Browse the computer to select the external application used for the tag action.
- **Parameter:** Additional command field used for the external application.

Note: Any action needs to be activated by the Handle Actions button in the main window.

2.8.5 Settings

The settings dialog allows to customize the display settings of the TAGs list found in the main window and the trace output.

The settings dialog window is divided in three parts:

- Display Settings
- Trace
- Logging

Figure 26. Settings window

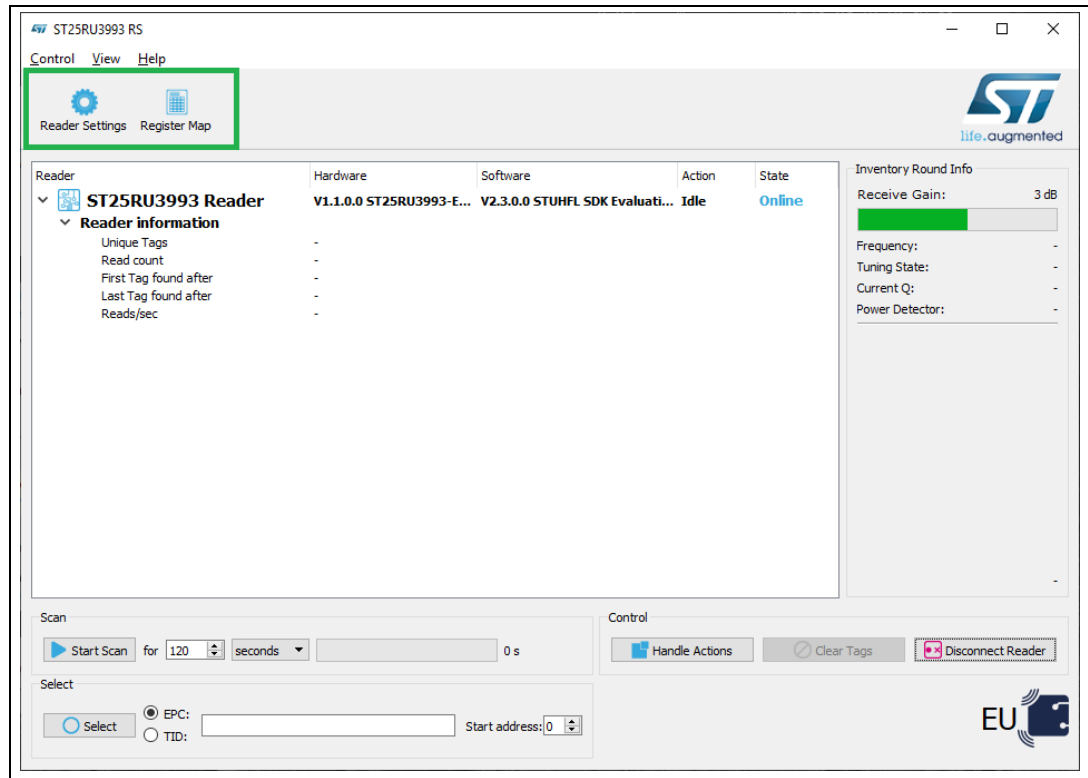


- **Display Settings:**
 - **Use Time to Live:** Activate/Deactivate the timing definitions for tags entries displayed in the main window.
 - **Show tag inactive after:** Timing definition for a tag entry, which is currently not read and is considered inactive. Tag entry is shaded.
 - **Show tag out of range after:** Timing definition for a tag entry that has not been read for an extended period of time. Once the timer elapses the tag entry font is “grayed-out”.
 - **Delete tag after:** Timing definition of a tag entry after which it is removed from the tag entry list in the main window.
 - **Show alias name if exists:** Displays a user defined alias name instead of the EPC number.
- **Logging:**
 - **Enable slot logging:** Activate logging of event information for each query round
 - **Append timestamp to filename:** If checked, timestamp information is appended to log filename when the log file is generated.
 - **Filename:** filename of query slot logging information

2.9 Toolbar

The toolbar gives the quick access to the Reader Settings and the Register Map of the ST25RU3993. More details about the Reader Settings are described below.

Figure 27. Toolbar

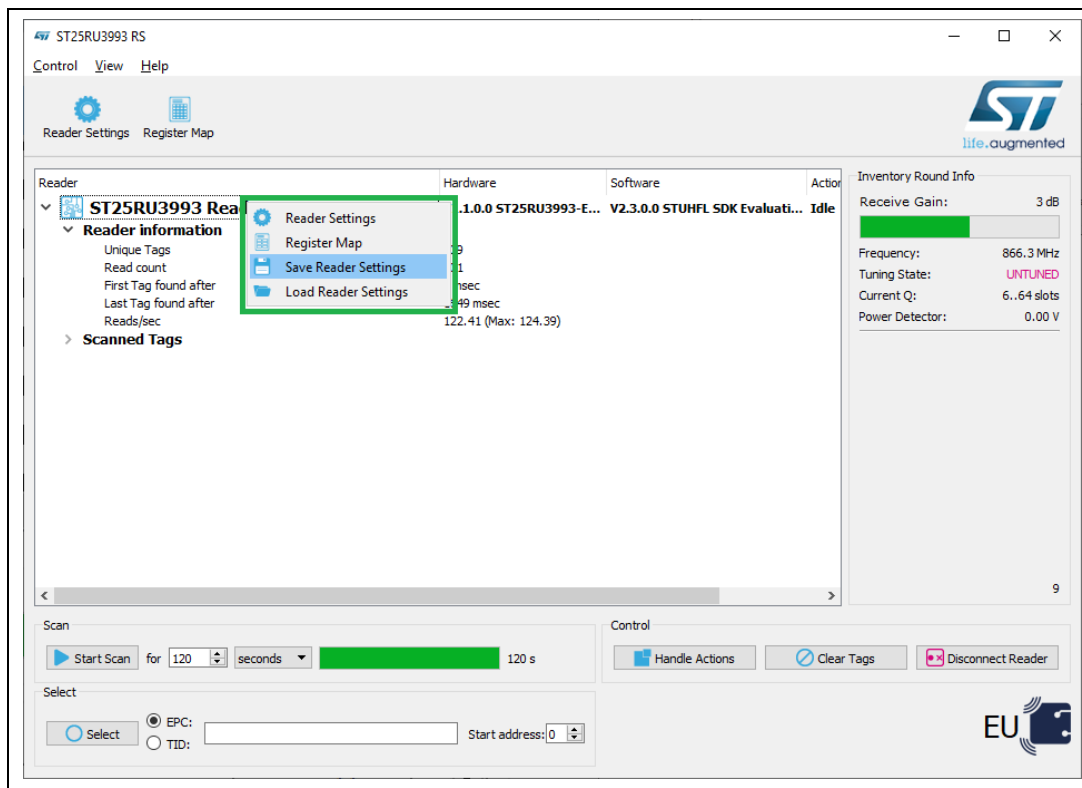


2.10 Context menu

The Main screen offers two locations to enable a context menu for quick access to selected functionalities within the ST25RU3993 Reader information and Scanned Tags Tree view widget.

2.10.1 ST25RU3993 Reader

Figure 28. Context menu - ST25RU3993 Reader

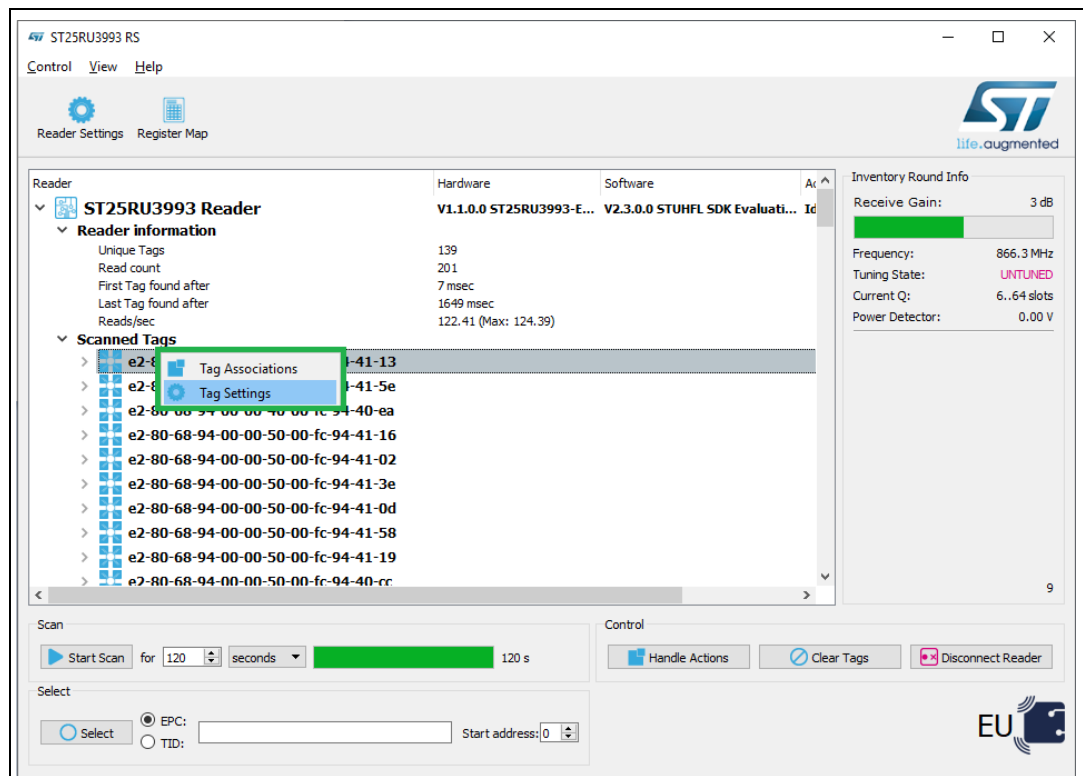


Where:

- **Reader Settings:** Opens the Reader Settings dialog window. Further details about the Reader Settings dialog are described in [Section 4: Reader Settings](#).
- **Register Map:** Open the Register Map window.
- **Save Reader Settings:** This entry allows to save the current reader settings to a file. This file contains the full register mapping as well as the reader configuration parameters. These parameters are listed in the file with STUHFL API fields. This way a user can define optimal settings with the aid of the GUI and reuse these values with the API in his own application.
- **Load Reader Settings:** This entry allows to recall the reader settings from a file.

2.10.2 Scanned Tags

Figure 29. Context menu – Scanned Tags



Where:

- **Tag Associations:** This entry opens the Tag Association dialog. See [Section 2.8.4: Tag Associations - Global Actions](#).
- **Tag Settings:** This entry opens the Tag Settings dialog. See [Section 5: Tag settings](#).

3 Register map

The Register Map gives access to the ST25RU3993 registers. A detailed description of all ST25RU3993 registers is available in the ST25RU3993 datasheet. By default, the register map is configured to automatically update the register contents automatically. For reader performance reasons, and to avoid high communication traffic between the ST25RU3993 Reader Suite and the ST25RU3993 Evaluation board, the update of the register map is not done in real time. An update can be forced by pressing the keyboard the shortcut key [Ctrl + R], or read out only the selected register [Ctrl + Shift + R] can be used.

The Register Map window allows to manipulate writable registers by modifying individual bits or writing the register content to the value field on the right side of each register. By placing the mouse pointer over a bit field of a register a tool-tip text with detailed information about the register content is provided.

The complete content of the register map window or selected registers can be easily copied to the clipboard with [Ctrl + C] or [Ctrl + Shift + C]. It is also possible to save the complete content of the register map to a file with [Ctrl + S] or load from a file with the shortcut [Ctrl + L].

Figure 30. Register Map

Register Map

File View

	Addr.	7	6	5	4	3	2	1	0	Value
Device Status Control Register	0x00	0	0	0	0	0	0	0	0	0x00
Protocol Selection Register	0x01	0	0	0	0	0	0	0	0	0x00
TX Options Register	0x02	0	0	1	0	0	0	1	0	0x22
RX Options Register	0x03	1	0	0	1	1	0	1	1	0x9b
TRcal High Register	0x04	0	0	0	0	0	0	1	1	0x03
TRcal Low Register	0x05	0	1	0	0	0	0	0	1	0x41
AutoACK Wait Time	0x06	0	0	0	0	0	1	0	1	0x05
RX No Response Time Register	0x07	0	0	0	0	0	1	0	1	0x05
RX Wait Time Register	0x08	0	0	0	0	1	0	1	1	0x0b
RX Filter Setting Register	0x09	0	0	1	1	0	1	0	0	0x34
RX Mixer and Gain Register	0x0a	0	1	1	0	0	0	0	0	0x60
Regulator and PA Bias Register	0x0b	0	0	0	1	1	0	1	1	0x1b
RF Output and LO Control Register	0x0c	1	0	0	0	0	0	1	0	0x82
Miscellaneous Register 1	0x0d	0	0	1	1	0	0	0	0	0x30
Miscellaneous Register 2	0x0e	0	1	0	0	0	0	0	0	0x40
Measurement Control Register	0x10	1	0	0	0	0	0	0	0	0x80
VCO Control Register	0x11	0	1	0	0	1	0	0	0	0x48
CP Control Register	0x12	0	0	1	1	0	1	0	1	0x35
Modulator Control Register 1	0x13	0	0	1	0	0	0	0	0	0x20
Modulator Control Register 2	0x14	1	1	1	0	1	1	1	1	0xef
Modulator Control Register 3	0x15	0	0	0	0	0	0	1	0	0x02
Modulator Control Register 4	0x16	1	0	0	0	1	0	0	1	0x89
PLL Main Register	0x17	0	1	1	0	0	1	0	0	0x64
PLL Main Register	0x18	0	1	0	0	1	1	0	1	0x4d
PLL Main Register	0x19	0	0	0	0	0	0	1	0	0x02
PLL Auxiliary and Auto-Hop Wait Register	0x1a	0	0	0	0	0	1	0	0	0x04
PLL Auxiliary Register	0x1b	0	1	1	0	0	0	0	1	0x61
PLL Auxiliary Register	0x1c	0	0	0	1	1	0	0	0	0x18
Interrogator Collision Detection and IQ Selection Register	0x1d	0	0	0	0	0	0	0	0	0x00
Emitter-Coupled Mixer Options	0x22	0	0	0	0	0	0	0	0	0x00
Status Readout Page Setting Register	0x29	0	0	0	1	0	0	0	0	0x10
AGC and Internal Status Display Register	0x2a	1	0	0	0	1	0	1	1	0x8b
RSSI Display Register	0x2b	1	0	0	0	1	0	0	0	0x88
AGL/VCO/F_CAL/PilotFreq Status Display Register	0x2c	1	0	0	0	1	0	0	0	0x88
ADC Readout/Regulator Setting Display Register	0x2d	0	0	0	0	0	0	0	0	0x00
Command Status Display Register	0x2e	0	0	1	1	0	0	0	0	0x30
Version Display Register	0x33	0	1	1	0	0	0	0	1	0x61
Enable Interrupt Register	0x35	0	1	1	1	1	1	1	1	0x7f
Enable Interrupt Register	0x36	0	0	0	0	0	1	1	1	0x07
Interrupt Register 1	0x37	0	0	0	0	0	0	0	0	0x00

4 Reader Settings

The Reader Suite automatically selects the frequency profile, which is needed to comply with local radio regulations. The reader settings and diagnostic tools are accessible through the reader settings dialog.

To access the Reader Settings dialog, click on the Reader Settings button above the main window. Alternatively, a right-click on the reader entry displays a context menu. Click on Reader Settings to enter the reader settings dialog. Also, a keyboard shortcut is defined. By pressing [Ctrl+S] the Reader Settings dialog opens as well.

The Reader Settings window is organized in three tabs:

- **Settings:** Changes/modifys reader settings.
- **Diagnostics:** Contains tools and features that are useful for analyzing the RFID reader system. For instance, activation of a continuous modulation of the RF carrier or outputting a constant wave signal of the RF carrier.
- **Tuning:** Allows to control the carrier cancellation circuitry.

This section describes all tabs and panels.

4.1 Settings tab

Figure 31. Reader Settings - Settings tab

Reader Settings

SettingsDiagnosticsTuning

General

Scan mode

Gen2 - Fast

RSSI mode

2nd Byte RSSI

Active antenna

Antenna 1

Inventory delay

0 ms

Alternate Interval [rounds]

1

Frequency selection

Reference divider

50 kHz

Profile

Europe

Configure Custom Profile

Frequency hopping

Hop Mode

Wait

Minimum sending time

4000 ms

Maximum sending time

4000 ms

Tx Options

PA selection

External PA

Modulation

PR-ASK

Output level

-2

Carrier Sense

☐ Enable carrier sense

RSSI threshold

-47 dBm

Listen time

1 ms

Idle time

0 ms

Rx Options

Initial Receive Gain

3

☒ Adaptive RX Gain

Configure

Configure RxFilter

☐ AGC mode

Gen2 Link Settings

Link frequency

256 kHz

Tari

25 us

Coding

Miller 8

Session

Repeated Search (S0)

☒ Long Preamble

Target

A

☒ Toggle Target

☐ Target depletion mode

Gen2 Anticollision Settings

Initial Q

4

☒ Adaptive Q

Configure

Log

+ OK + Get_TxRxCfg(txoutputLevel: -2, rxSensitivity: 3, usedAntenna: 0, alternateAntennaInterval: 1) = 0

Close

4.1.1 General panel

- **Active antenna:** Selects either Antenna 1 or Antenna 2 as the active antenna port depending on the antenna configuration. If “Alternate” is selected, the “Interval [rounds]” field is displayed which defines the number of inventory rounds after which the active antenna port is toggled.

Figure 32. Alternate antenna selection

The screenshot shows a 'General' settings panel with the following controls:

- Scan mode:** A dropdown menu currently set to 'Gen2 - Fast'.
- RSSI mode:** A dropdown menu currently set to '2nd Byte RSSI'.
- Active antenna:** A dropdown menu currently set to 'Antenna 1'.
- Inventory delay:** A numeric input field set to '0 ms'.
- Alternate Interval [rounds]:** A numeric input field set to '1'.

The maximum number that can be entered is 99 rounds.

- **RSSI mode:** Defines when the RSSI of the tag is measured:
 - Pilot RSSI
 - 2nd Byte RSSI
 - Peak RSSI
- **Scan mode:** Defines the protocol being used (Gen2/ISO18000-63 or GBT-29768) and which reader command is used to complete an anti-collision slots once a tag has successfully responded with its EPC / Coding.
 - Gen2 - (F)ast: During an inventory scan, the reader sends a QueryRep command once the Tag responds with its EPC.
 - Gen2 - (N)ormal: During an inventory scan, the reader sends a ReqRN once the Tag responds with its EPC. The reader awaits the Tag's HANDLE and subsequently sends a QueryRep command.
 - Gen2 - N with TID: Same as the Gen2 - (N)ormal option but reads the TID in addition to the EPC. If this option is selected, the “Tag identifier” entry is added to Scanned tags details. See the below figure:

Figure 33. TID location in Scanned Tags - Tag information

Reader	Hardware	Software
<div> <div>ST25RU3993 Reader</div> <div> <div>Reader information</div> <div> <div>Unique Tags</div> <div>Read count</div> <div>First Tag found after</div> <div>Last Tag found after</div> <div>Reads/sec</div> </div> </div> </div>	<div> <div>V1.1.0.0 ST25RU3993-EVAL Board</div> <div>V2.3.0.0 STUHF</div> </div>	
<div> <div>Scanned Tags</div> <div> <div>cd-11-cd-22</div> <div>cd-11-22-33-44-55-66-77-88-99-aa-c...</div> <div>e0-08-33-b2-dd-d9-01-40-35-05-00-00</div> <div>f2-00-00-1a-07-16-02-58-12-00-e8-59</div> </div> </div>		
<div> <div>XPC:</div> <div>Tag Identifier:</div> <div>Timestamp</div> <div>Antenna</div> <div>Read Count</div> <div>Tag Information</div> <div>Input Power:</div> </div>	<div> <div>N/A</div> <div>e2-00-34-12-01-37-01-00-03-97-57-25</div> <div>1817</div> <div>4</div> </div>	

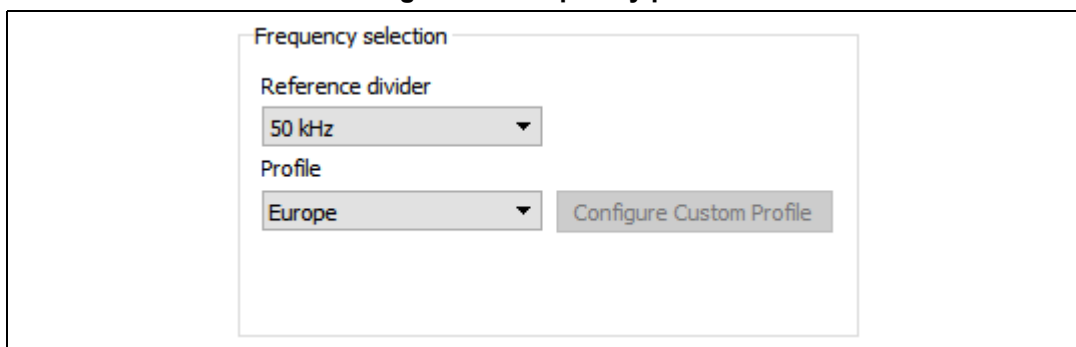
Where:

- Gen2 - F with AutoACK:** Same as the Gen2 - (F)ast option, but with the AutoACK feature being enabled. With the autoACK feature being enabled, ST25RU3993 without any MCU activity, autonomously sends the ACK command after receiving a valid RN16 tag reply.
- Gen2 - N with AutoACK:** Same as the Gen2 - (N)ormal option but with the AutoACK feature being enabled. With the autoACK feature being enabled, ST25RU3993 without any MCU activity, autonomously sends the ACK command after receiving a valid RN16 tag reply. In this mode ST25RU3993 in addition sends the ReqRN command after the EPC response of the tag autonomously.
- Inventory Delay:** By changing the inventory delay [ms], an additional wait time is introduced which is effective between two consecutive inventory rounds. The maximum value is 20000 ms.

4.1.2 Frequency selection panel

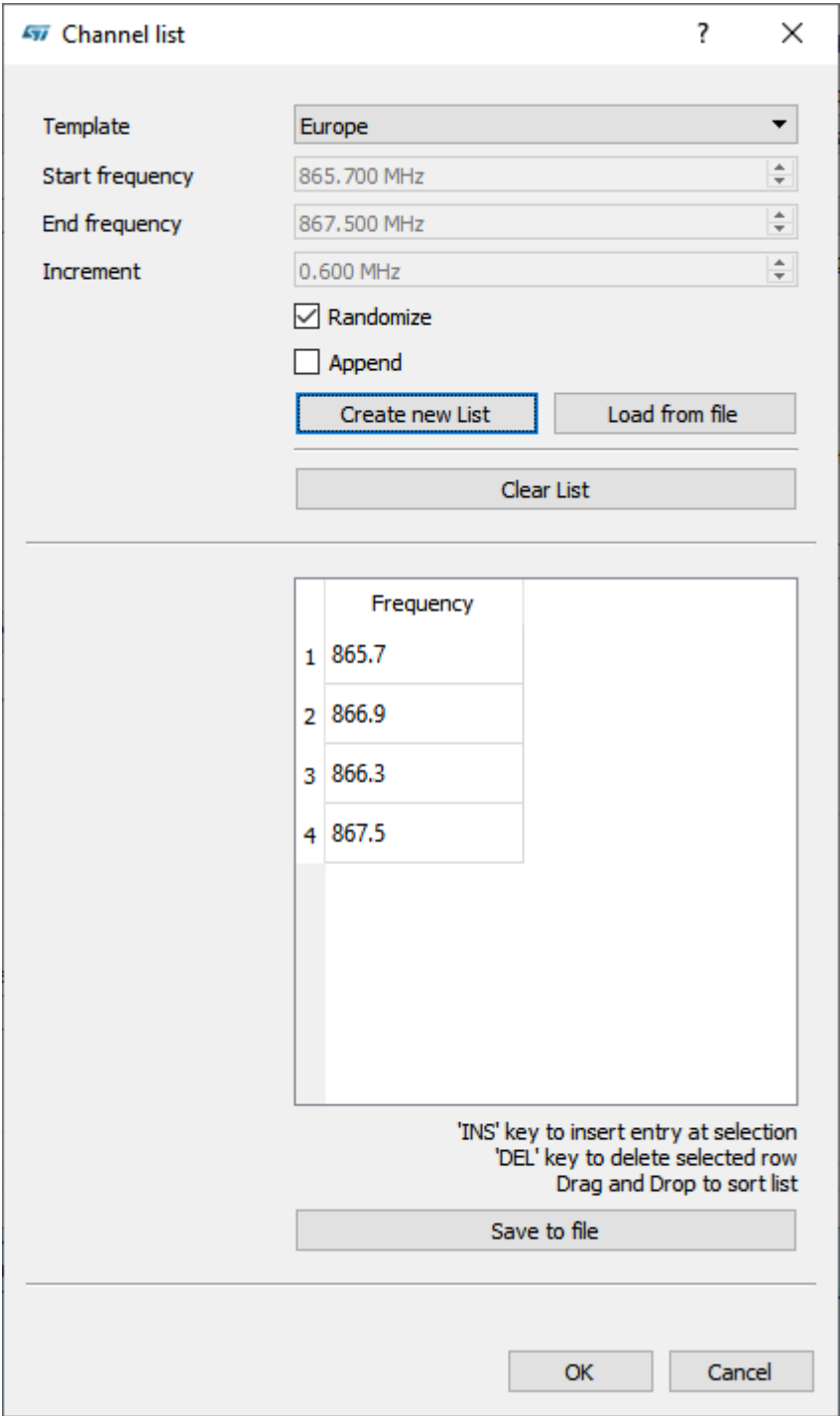
- **Reference divider:** Frequency reference divider used by the internal PLL. This value defines the smallest frequency step of the RF carrier:
 - 25 kHz
 - 50 kHz
 - 100 kHz
- **Profile:** Defines the region-specific frequency profile to be used by the reader.
 - **Europe:** Defines 4 frequency channels ranging from 865.700 MHz to 867.500 MHz with a frequency step of 600 kHz.
 - **USA:** Set the 50 frequencies from 902.750 MHz to 927.250 MHz with a frequency step of 500 kHz.
 - **Japan:** Set the 9 frequencies from 920.500 MHz to 922.100 MHz with a frequency step of 200 kHz.
 - **China lower band:** Set the 16 frequencies from 840.625 MHz to 844.375 MHz with a frequency step of 250 kHz.
 - **China upper band:** Set the 16 frequencies from 920.625 MHz to 924.375 MHz with a frequency step of 250 kHz.

Figure 34. Frequency panel



- **Configure Custom profile:** Allows to configure the custom frequency profiles by opening the "Channel list" dialog.

Figure 35. Channel list dialog



The Channel list dialog box is a window with a title bar containing the ST logo, the text "Channel list", and standard window controls (help, close). The dialog is divided into two main sections. The top section contains configuration options: a "Template" dropdown menu set to "Europe", and three frequency input fields with up/down arrows: "Start frequency" (865.700 MHz), "End frequency" (867.500 MHz), and "Increment" (0.600 MHz). Below these are two checkboxes, "Randomize" (checked) and "Append" (unchecked). There are three buttons: "Create new List" (highlighted with a blue border), "Load from file", and "Clear List". The bottom section features a table with a single column header "Frequency". The table contains four rows of data: 1 865.7, 2 866.9, 3 866.3, and 4 867.5. Below the table, there is instructional text: "'INS' key to insert entry at selection", "'DEL' key to delete selected row", and "Drag and Drop to sort list". A "Save to file" button is located below the text. At the bottom right of the dialog are "OK" and "Cancel" buttons.

Channel list

Template: Europe

Start frequency: 865.700 MHz

End frequency: 867.500 MHz

Increment: 0.600 MHz

☒ Randomize

☐ Append

Create new List Load from file

Clear List

	Frequency
1	865.7
2	866.9
3	866.3
4	867.5

'INS' key to insert entry at selection
'DEL' key to delete selected row
Drag and Drop to sort list

Save to file

OK Cancel

- **Template:** Selection of a predefined frequency channel list
- **Start freq:** Start frequency in MHz when using the custom template
- **End freq:** End frequency in MHz when using the custom template
- **Increment:** Frequency increment in MHz when using the custom template
- **Randomize:** If activated, the frequencies in the channel list are randomized when “Create new List” or “Load from file” is selected
- **Append:** If activated new frequencies are appended to the current channel list. If deactivated, the new frequencies overwrite the current channel list.
- **Create new List:** Creates a frequency channel list depending on the parameter: “Template”, “Start Frequency”, “End Frequency” or “Increment”.
- **Load from file:** Load frequency channel list from file
- **Clear list:** Clear current list
- **Save to file:** Save current list to file

Note: The frequency channel list is applied only when “OK” is pressed.

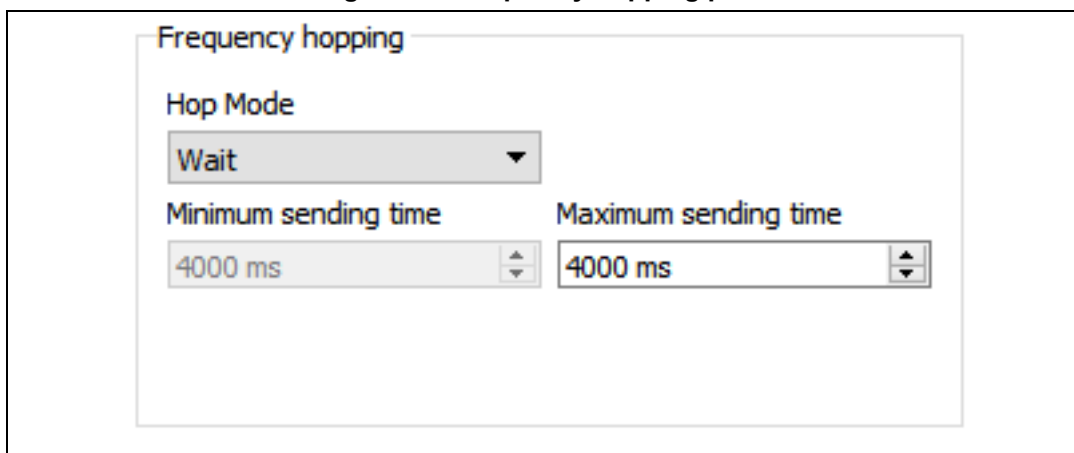
4.1.3 Frequency hopping panel

- **Hop mode:** Selection of frequency hopping modes:
 - **Wait:** Transmit on the current frequency channel until the maximum sending time has expired.
 - **Power Save:** Stop transmission if the inventory round no longer produces TAGs, or if the user minimum sending value expires. The frequency hop happens after the maximum sending time has expired.

Note: This hopping mode can be used for ETSI and FCC frequencies.

- **Fast:** Perform an immediate frequency hopping if the inventory round does not produce additional TAGs, or if the user defined min/max send time values expire.
- **Fast FCC:** Perform immediate frequency hop if inventory round no longer produces TAGs, or if the user defined min/max send values expire. The implementation takes care that within an interval of 20 sec each frequency channel is used 400 ms for transmission.
- **Minimum sending time:** Minimum transmission time on a frequency channel. If no TAG is detected for the duration of the minimum sending time, a new frequency channel is selected.
- **Maximum sending time:** Maximum transmit time on a frequency channel. When the maximum sending time is expired the reader hops to the next frequency channel. The maximum sending time value must follow local radio regulation requirements.

Figure 36. Frequency hopping panel



Frequency hopping

Hop Mode

Wait

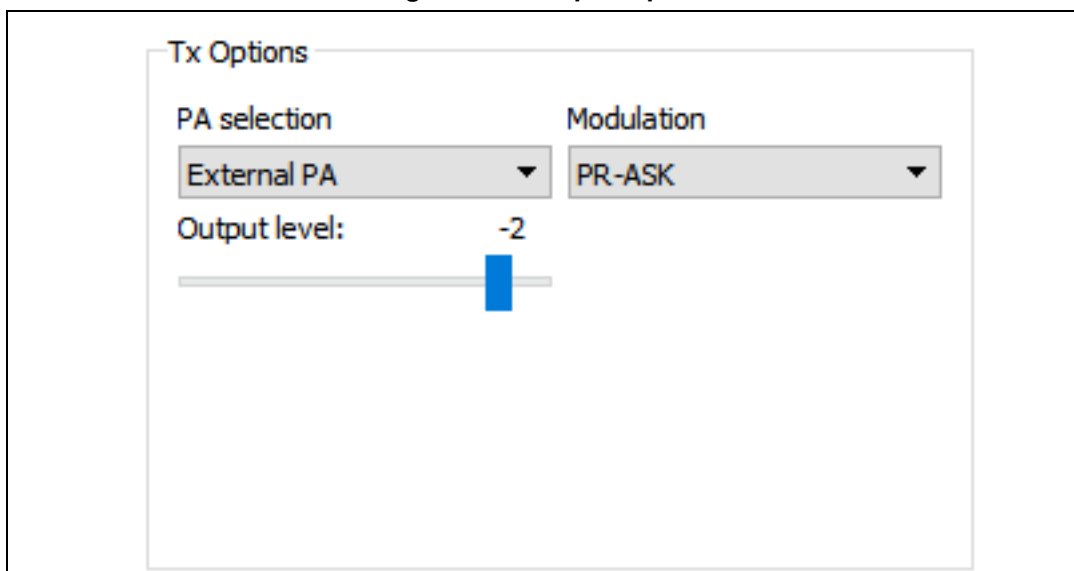
Minimum sending time

4000 ms

Maximum sending time

4000 ms

Figure 37. Tx Option panel



Tx Options

PA selection

External PA

Modulation

PR-ASK

Output level:

-2

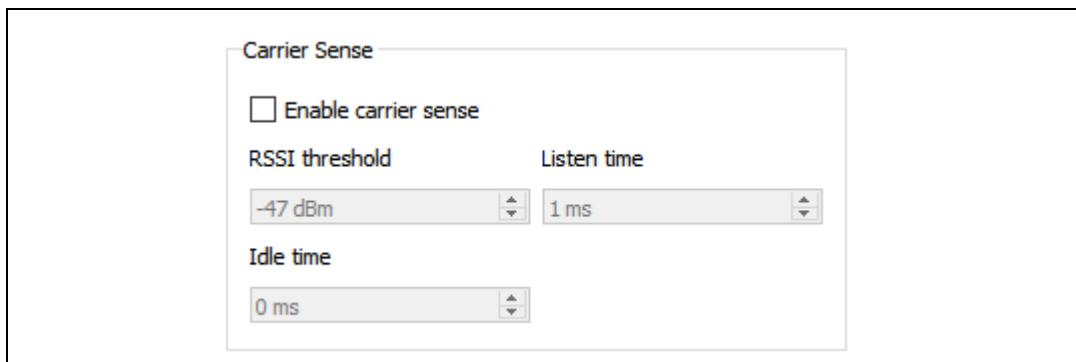
4.1.4 Tx Options panel

- **PA Selection:** Selects the internal power amplifier (PA) or external PA for transmission.
 - Internal PA
 - External PA
- **Output level:** The Output level slider changes the RF output power of the reader IC ST25RU3993. It defines the input power for the external PA and the output power of the internal PA. This slider changes the contents of register 0x15, bits [4:0]. Each increment of the output power slider changes the output power by 1 dB typically.
- **Modulation:** Define modulation scheme:
 - ASK: Amplitude Shift Keying (double sided)
 - PR-ASK: Phase Reversal Amplitude Shift Keying (double sided)

4.1.5 Carrier Sense panel

If enabled the reader detects if the next transmit frequency channel is free or already occupied by another reader.

Figure 38. Carrier sense panel

The image shows a 'Carrier Sense' configuration panel. It contains a checkbox labeled 'Enable carrier sense' which is currently unchecked. Below this are three input fields: 'RSSI threshold' set to '-47 dBm', 'Listen time' set to '1 ms', and 'Idle time' set to '0 ms'. Each input field has up and down arrow buttons for adjustment.

Where:

- **RSSI threshold:** If the signal strength of the sensed carrier is below this threshold, the slot is considered free, and therefore is used by the reader. The RSSI threshold can be entered from -40 dBm down to - 77 dBm.
- **Listen time:** Carrier Sense duration. During this time, the RSSI is measured repeatedly. The maximum value is then checked for threshold crossing.
- **Idle time:** Wait time between transmit frequency channel switch and performing Carrier Sense.

4.1.6 Rx Options panel

- **Initial Receive Gain:** The receive gain slider adjusts the receive gain and/or receive attenuation of the reader. The slider affects register 0x0A.
- **Adaptive RX Gain:** This section allows to activate adaptive receive gain/attenuation change. The basic procedure to automatically adapt RX gain is to count slot events and change the sensitivity when the counter hit upper and lower threshold values. The counter start with zero and is reset to zero with any sensitivity change. Every slot event has its own increment value, which can either be positive or negative. The sum is of these increments is cumulated with every slot event and is stored in an internal event counter. As soon the event counter reaches either the lower or the upper threshold the sensitivity is adopted.

Figure 39. Adjust Sensitivity dialog

Adjust Sensitivity

Event increment values

Tag found	Empty slot	Collision	Preamble err	CRC err	Header err	RxCount err	StopBit err	ResendACK	NoiseSuspi
0	8	-1	-7	0	0	-7	0	0	0

Thresholds

Decrement: -120 Increment: 100

```

graph TD
    Start([eventCnt = 0.0]) --> Query[Query[Rep|AdjUp|AdjDwn|NIC]]
    Query --> Reply{#TAG reply}
    Reply -- TAG --> Add[eventCnt += ivEventX]
    Reply -- COL --> Add
    Reply -- EMP --> Add
    Reply -- ResendACK --> Add
    Reply -- StopBit --> Add
    Reply -- ERR --> Add
    Add --> DecThresh{eventCnt <= decThreshold}
    Add --> IncThresh{eventCnt >= incThreshold}
    DecThresh -- YES --> Decrease[Decrease Sensitivity]
    DecThresh -- NO --> Query
    IncThresh -- YES --> Increase[Increase Sensitivity]
    IncThresh -- NO --> Query
    Decrease --> Start
    Increase --> Start
  
```

Description

The basic procedure to automatic adapt sensitivity is to count slot events and change the sensitivity when the counter hit upper and lower threshold values.

The counter start with zero and is reset to zero with any sensitivity change. Every event has its own increment value, which can either be positive or negative.

The sum of these increments is cumulated with every event and stored in an internal event counter. As soon the event counter reaches either the lower or the upper threshold the sensitivity is adopted.

OK Cancel

- **AGC Mode:** Enables/Disables the automatic gain control feature of the ST25RU3993.
- **Configure RX Filter:** Open a dialog to modify ST25RU3993 Rx filter and calibration values.

Figure 40. RX filter dialog

RxFilter

Rx Filter and Filter Calibration Table

Load from file Read from board

RX Filter - BLF [kHz] / Coding					Filter Calibration				
	FM0	M2	M4	M8		FM0	M2	M4	M8
40	FF	FF	FF	FF	40	88	88	88	88
160	BF	3F	3F	3F	160	88	88	88	88
213	37	37	34	34	213	88	88	88	88
256	37	37	34	34	256	88	88	88	88
320	27	27	24	24	320	88	88	88	88
640	2	2	2	2	640	88	88	88	88

Save to file Write to board

OK Cancel

Figure 41. Rx option panel

Rx Options

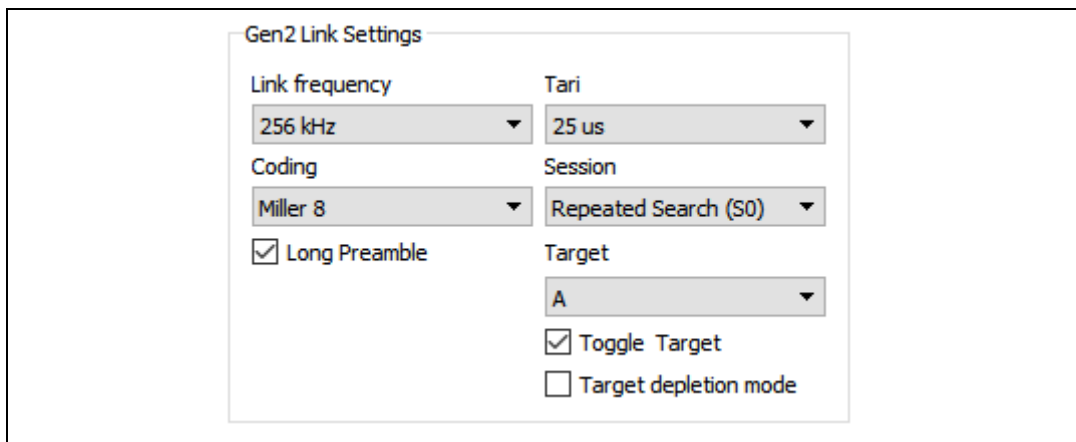
Initial Receive Gain: 3 ☒ Adaptive RX Gain

Configure

Configure RxFilter ☐ AGC mode

4.1.7 Gen2 settings panel

Figure 42. Gen2 link setting



Gen2 Link Settings

Link frequency	Tari
256 kHz	25 us
Coding	Session
Miller 8	Repeated Search (S0)
<input checked="" type="checkbox"/> Long Preamble	Target
	A
	<input checked="" type="checkbox"/> Toggle Target
	<input type="checkbox"/> Target depletion mode

Where:

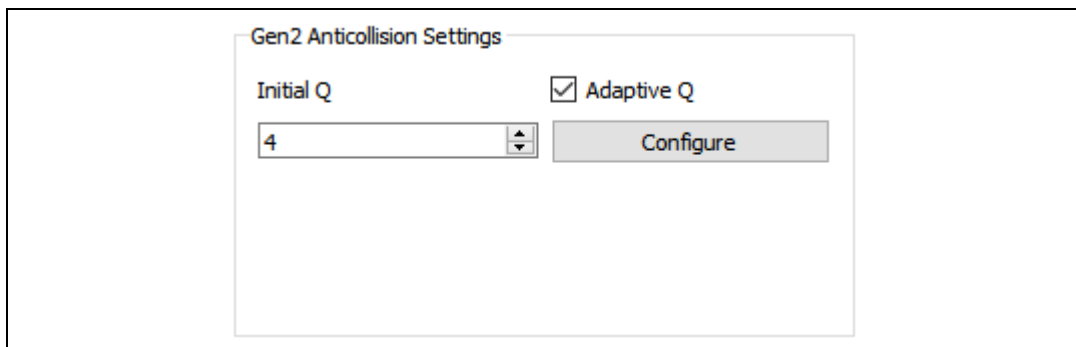
- **Link frequency:** Changes the backscatter link frequency to:
 - 40 kHz
 - 160 kHz
 - 213 kHz
 - 256 kHz
 - 320 kHz
 - 640 kHz
- **Coding:** Changes the coding to:
 - FM0
 - Miller 2
 - Miller 4
 - Miller 8
- **Target:** Tags whose inventory flag match this parameter participate in the inventory round. The target value can be fixed to either A or B or alternating starting with A or with B:
 - A
 - B
- **Session:** Defines the session parameter of the query command and hence changes the persistence time of the inventoried flags of tags:
 - Repeated Search (S0): The inventoried flag state is maintained if the tag remains powered. If the tag loses power the inventoried flag state is reset to A. Once inventoried, tags respond again if the target is switched or when the RF power is cycled.
 - Multiple Search (S1): The inventoried flag state is kept for at least 500 ms and 5 seconds at most, regardless of the tag being powered or not. Tags participate less frequently in inventory rounds unless the target is switched.
 - Single Search (S2, S3): The inventoried flag state is maintained if the tag remains powered or for at least 2 seconds after losing power. As there is no maximum time defined, tags may keep the inventoried flag state for an extended period. Once

inventoried, tags respond again if the target is switched or when the tag is not powered for a long time.

- **Long Preamble:** Disables/Enables the extended tag response pre-amble.
- **Target Depletion mode:** If enabled, additional inventory rounds is executed before the target is toggled until no further tags are found. Only applies if target toggling is enabled. This gives transponders with a “weak” response signal a chance to reply and therefore increases the tag inventory success rate.
- **TARI:** Defines the symbol length of the transmit encoding. The values shown are the TX-Zero length. (The TX-One length is derived from the zero value according to the Gen2 protocol definition. ST25RU3993 allows to change the TX-One length in the register 0x02). Possible values are:
 - 6.25 μ s
 - 12.5 μ s
 - 25 μ s

4.1.8 Gen2 Anti-collision settings panel

Figure 43. Gen2 Anti-collision setting



Where:

- **Q:** Defines the number of available anti-collision slots (2^Q slots) for the first query command of the start of the inventory scan. The maximum value that can be entered is 15.
- **Adaptive Q:** If enabled, Q is dynamically adjusted based on the number of tags present tags in the read-zone of the reader. The reader attempts to minimize the number of empty anti-collision slots and the number of tag response collisions (preamble and CRC errors or no response after ACK).
- **Configure Q adjustment:** Opens the following dialog window for anti-collision parameters fine tuning:

Figure 44. Adjust Q configuration dialog

Adjust Q

C1 .. Q adjustment for empty slots

☐ All same

Q 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

C1 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15

C2 .. Q adjustment for collisions

☐ All same

Q 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

C2 0,35 0,35 0,35 0,35 0,35 0,35 0,35 0,35 0,35 0,35 0,35 0,35 0,35 0,35 0,35

Options

Q min: 0 Q max: 15

☐ Reset Q to InitialQ after round ☐ Use Cell/Floor instead of round

☐ One QueryAdjust per round ☐ Use QueryAdjust NIC

Description

The algorithm starts by sending a Query command with the initial selected Q value. In most cases the initial value of Q should be chosen as 4.

With the TAG reply the adjustment of Q is dependent on the occurred of collisions and empty slots. In case of an empty slot: $Q_{fp} = \max(0, Q_{fp} - C_1)$ and in case of an collision: $Q_{fp} = \min(15, Q_{fp} + C_2)$.

The new floating point Q_{fp} is casted to an integer Q value, by apply a round operation on the value, when the Q value has changed compared to the current used Q value a QueryAdjust command is send for the next slot, otherwise a QueryRep is executed.

Flowchart:

```

graph TD
    Start([Qfp = Initial value]) --> Query([Query(Qfp)])
    Query --> Reply{#TAG reply}
    Reply -->|> 1| AdjustUp[Qfp = min(15, Qfp + C2)]
    Reply -->|= 0| AdjustDown[Qfp = max(0, Qfp - C1)]
    Reply -->|= 1| QueryRep[QueryRep]
    AdjustUp --> Round[Q = Round(Qfp)]
    AdjustDown --> Round
    Round --> Update{Update Q}
    Update -- Yes --> QueryAdjust[QueryAdjust]
    QueryAdjust --> Reply
    Update -- No --> QueryRep
  
```

OK Cancel

- **C1 Q adjustment for empty slots panel:** Defines adjustment parameters for empty slots (C1) for each Q value. The “All same” check box copies C1 of the Q=0 value to all other Q values.
- **C2 Q adjustment for collisions slots panel:** Defines adjustment parameters for collision slots (C2) for each Q values. The “All same” check box copies C1 of the Q=0 value to all other Q values.
- **Q min:** Minimal value for adaptive Q.
- **Q max:** Maximal value for adaptive Q.
- **Reset Q to InitialQ after round:** If enabled, Q is reset to its initial value after each round.
- **One QueryAdjust per round:** If enabled each inventory round allows only one query adjust command.
- **Use QueryAdjust NIC:** Use the Gen2 Query adjust NIC command instead of Query Rep for empty slots.

4.2 Diagnostics

Figure 45. Reader Settings - Diagnostics tab

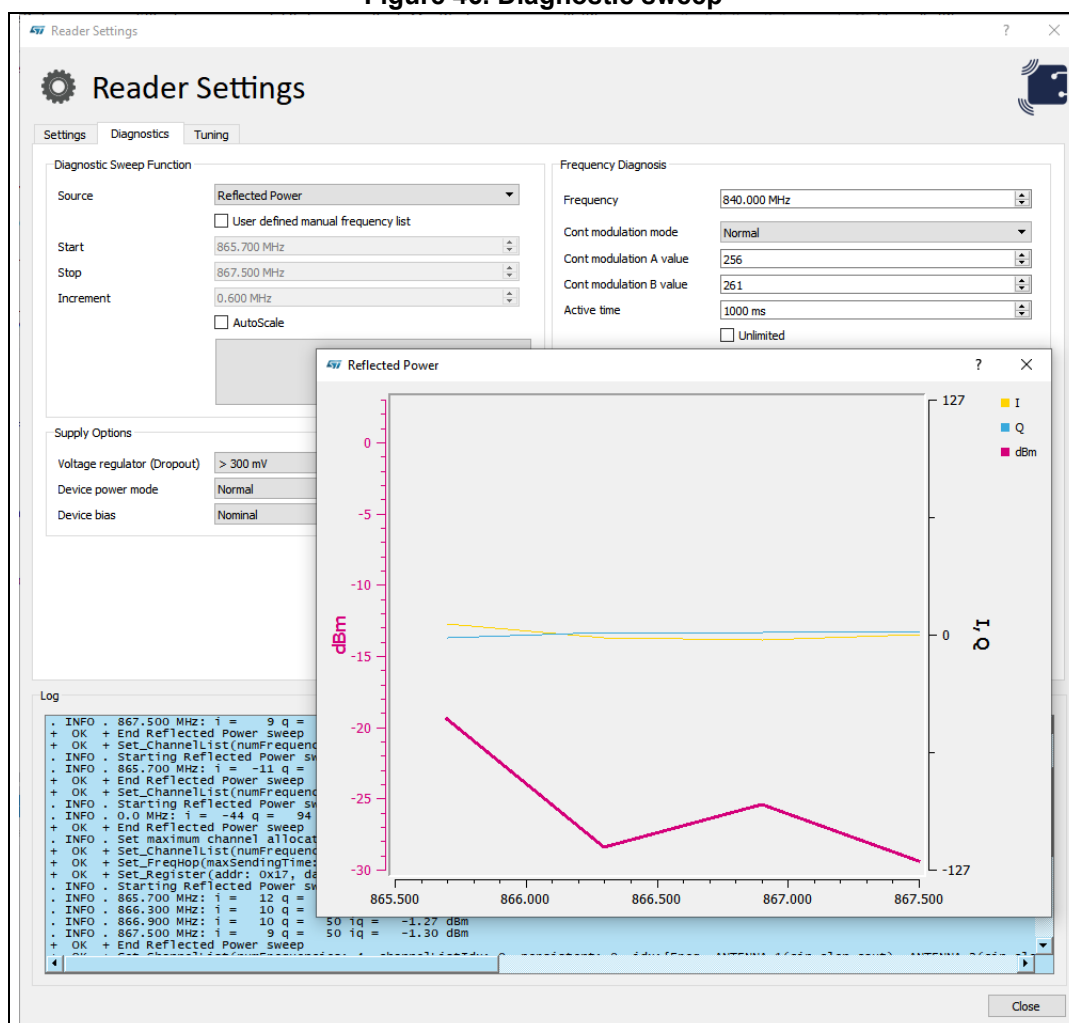


4.2.1 Diagnostic Sweep Function panel

In the Diagnostic Sweep Function panel, it is possible to run reflected power sweep measurements across the select frequency range, or scan for the presence of an external carrier or disturber.

- **Source:** Select one of the two available frequency sweep sources:
 - Reflected Power
 - Ext. Signal source.
- **Start:** Start frequency of the frequency sweep in MHz.
- **User defined manual frequency list:** By default the frequency sweep is done over the current selected channel list of the reader. If checked, a user defined frequency sweep could be executed.
- **Stop:** Stop frequency in MHz, where the sweep should stop.
- **Increment:** Defines the frequency step size for each consecutive measurement in MHz.
- **Sweep:** Starts the frequency sweep with the defined source and frequency range. Once the measurement is completed the result is displayed in a dedicated window:

Figure 46. Diagnostic sweep



4.2.2 Frequency Diagnosis panel

- **Frequency:** Defines the frequency at which the CW or modulated carrier is output
- **Cont Modulation mode:**
 - **Normal:** the reader continuously transmits a NAK command at the specified frequency for a given duration.
 - **Pseudo Random:** the reader outputs the carrier modulated by pseudo random.
 - **ETSI Test Mode:** the reader outputs the test signal defined in EN 302 208.
- **Cont Modulation A value:** Display the decimal value of the PLL A register
- **Cont Modulation B value:** Displays the decimal value of the PLL B register
- **Active time:** Defines the duration the TX output is ON. When the timer expires TX output is automatically switched OFF.
- **Unlimited:** Manually control of the TX output ON and OFF state.

Note: Leaving TX output ON for an extended period generates a significant amount of heat generation on the external power amplifier.

- **Continuous Modulation:** Generates a continuous modulation at the selected frequency.
- **Continuous Wave (CW):** Generates a continuous carrier wave at the selected frequency.

4.2.3 Direct Commands panel

- **Command:** A selection menu which lists ST25RU3993 direct commands that can be used.
- **Send:** Sends the selected command to ST25RU3993 which then carries out the corresponding function.

4.2.4 Supply Options panel

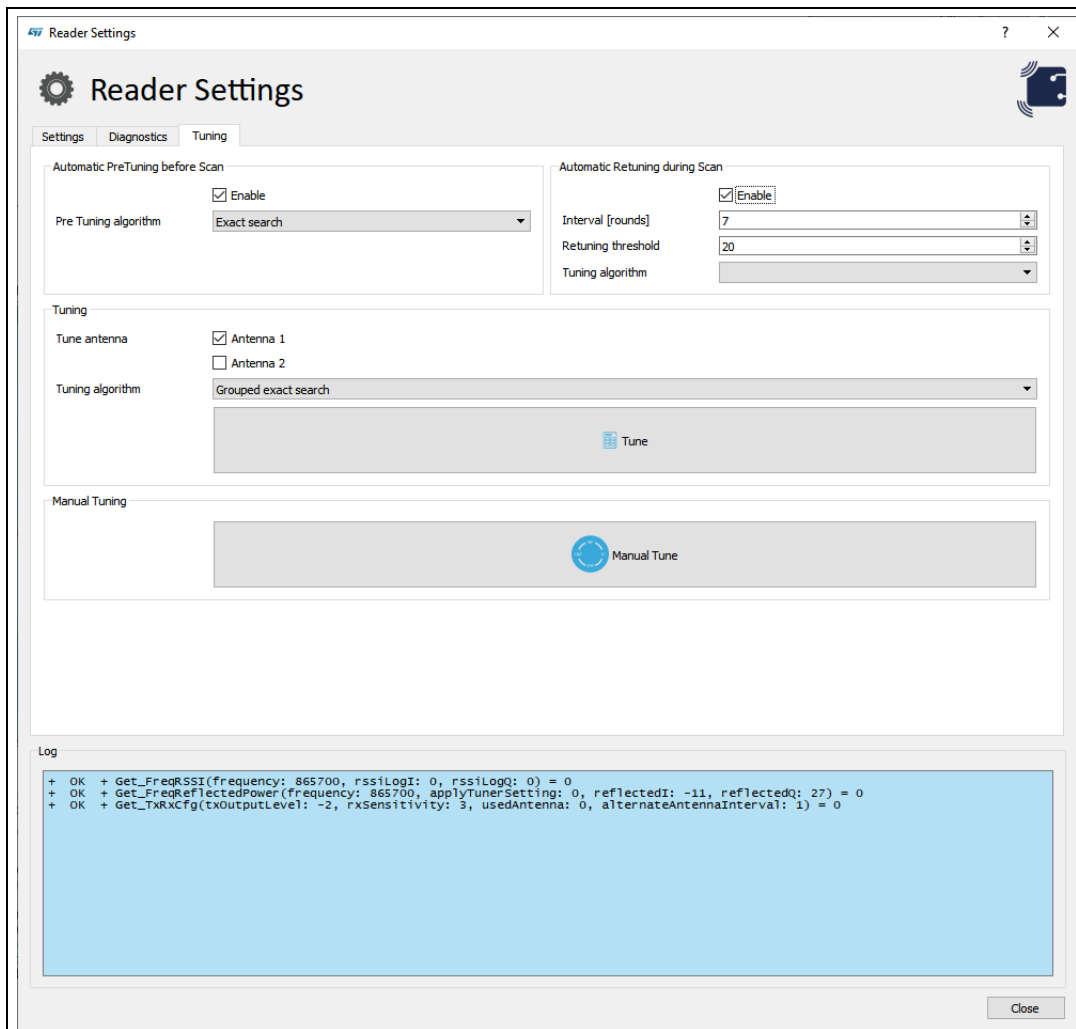
To measure the power consumption of the ST25RU3993 reader IC, the device power mode and settings can be changed here.

- **Voltage regulator (Dropout):** Internal voltage regulators maintain a specified drop-out voltage while the supply/battery voltage may change.
- **Device power mode:** Allows to bring the reader IC into various supply power states.
- **Device Bias:** Allows to tweak the main bias setting of ST25RU3993 reducing the current consumption at the expense of lower output power and receive sensitivity.

4.3 Tuning

To control the carrier cancellation circuit (CCC), the GUI offers a dedicated tuning tab.

Figure 47. Reader Settings - Tuning tab



4.3.1 Tuning File panel

- **Tune antenna:** Activating the check box for Antenna 1 or Antenna 2 includes the corresponding antenna in the tuning table creation, used for the CCC.

Note: Add a 50 Ω antenna or load to the antenna port selected here.

- **Tuning algorithm**
 - **Fast search:** This tuning algorithm seeks to find an optimized CCC setting (= minimal reflected power). This algorithm starts at the current CCC setting and modifies the tunable capacitors until a new setting with a lower reflected power is found. The algorithm stops, when all new CCC settings, that are tested, lead to a higher reflected power.

Note: Although this algorithm does not get stuck at the first local minimum of reflected power it encounters the focus lies on convergence speed. Therefore, this algorithm might not find

the CCC setting resulting to the absolute lowest reflected power possible. Check that the other implemented algorithms consider the reflected power suppression be deemed more important than convergence speed.

- **Exact search:** This algorithm tries to find an optimized CCC setting (= minimal reflected power). The algorithm segments the 3-dimensional search-space (spanned by Cin, Clen and Cout) into a number of equal-sized smaller sub-search spaces. Then each segment is tuned using FAST (OneHillClimb) in order to find a CCC setting that results to lower reflected power levels. All the resulting reflected power levels of each tuned segment are compared against each other. The CCC setting for which with the overall lowest reflected power can be achieved is ultimately applied to the tunable capacitors of the CCC.

Note: Although this algorithm has a much higher chance in finding the lowest reflected power setting, its convergence speed is significantly longer. Especially if both antennas are activated and the number of transmit frequencies is high (for instance FCC).

- **Grouped fast search:** This algorithm is based on FAST (OneHillClimb) but exploits the fact that neighboring frequency channels typically receive similar CCC settings when tuned. Once being run, the best CCC setting found is copied to neighboring frequency channels (1 up/1 down for EUROPE, 5 up/5 down for others frequency profiles).
- **Grouped exact search:** This algorithm tries to find an optimal CCC setting similar to the EXACT (MultiHillClimb) algorithm resulting to a minimal reflected power. Again, the algorithm segments the 3-dimensional search-space (spanned by Cin, Clen and Cout) into a number of smaller equal-sized sub-search spaces. The central point of each sub-search space is first tested for the reflected power level. The FAST algorithm is then only applied those three sub-search spaces that initially yielded the lowest reflected power. The CCC setting (point in tuner-setting-space) which has the lowest reflected power is then finally applied to the CCC. This algorithm has a much higher probability to find the CCC setting with the lowest reflected power than the FAST algorithm and at the same time is faster than the exact search algorithm.
- **Trench search:** This algorithm is a combination of the SLOW and FAST tuning algorithms. This algorithm first applies the exact search tuning on first frequency channel. The resulting CCC settings is then used as the starting point for a fast tuning algorithm which is applied for the next higher frequency channel. The remaining frequency channels are then also sequentially tuned with the fast tuning algorithm while the tuning result of the previous frequency channel serves as the starting point for the current frequency channel to be tuned. This algorithm exploits the fact that neighboring frequency channels typically have similar CCC settings.
- **Tune:** Run tuning process over all channel frequencies of current loaded frequency channel list.

4.3.2 Automatic PreTuning before Scan panel

- **PreTuning before Scan:** Enables the pre-tuning of the carrier cancellation circuit (CCC). A pre-tuning of the CCC is performed prior any inventory scan. The pre-tuning is carried out using the parameters listed below:
- **Tuning algorithm:** Selects the tuning algorithm which is used for the pre-tuning. Please refer to Tuning algorithm description in section 4.3.1 Tuning file panel for more details regarding the various tuning algorithms.

4.3.3 Automatic re-tuning during Scan panel

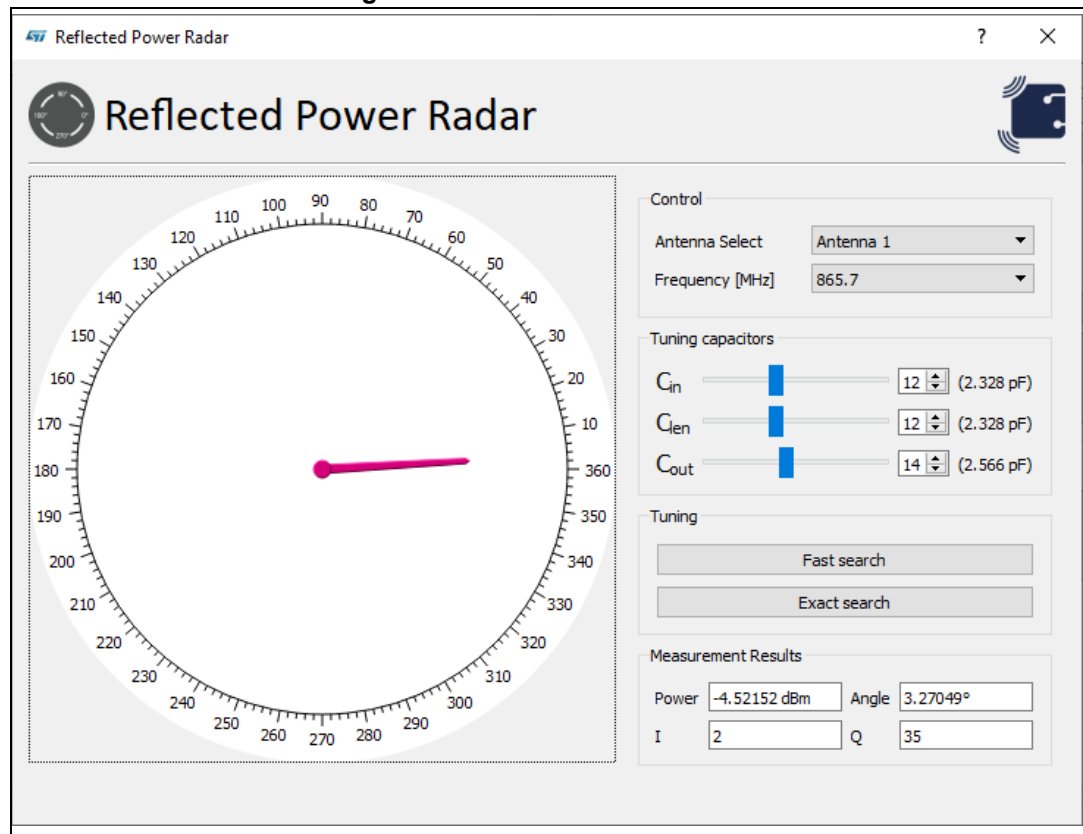
The retuning tries to compensate for any changes of the antenna environment that may have happened after the tuning file has been created and which resulted to an increase in the reflected power level. Once a frequency channel has been re-tuned, the tuning lookup table is updated and stored in the memory of the microcontroller until the power up.

- **Enable:** Enables the automatic re-tuning of the carrier cancellation circuit (CCC) during the inventory scan. Enabling this feature slightly influences the read rate performance ([tags/sec]) as the re-tuning takes some time to complete and as during re-tuning no tag can be read.
- **Interval:** Defines the number of inventory rounds after which a reflected power measurement is performed. The maximum value that can be entered is 99.
- **Retuning Threshold:** Defines the maximum difference of the reflected power level which has been measured at the re-tuning interval from the stored value in the look-up table. If the difference exceeds the defined Deviation value an automatic retuning of the CCC is performed.
- **Tuning algorithm:** Selects the tuning algorithm which is used for the re-tuning. Please refer to Tuning algorithm description in section 4.3.1 Tuning file panel for more details regarding the various tuning algorithms.

4.3.4 Manual tuning (Reflected power radar)

The Reflected Power Radar shows a real-time representation of the reflected power. The length of the arrow in the reflected power radar correspond to the magnitude of the reflection (the smallest, the best) while the angle of the arrow represents the phase relative to the local oscillator (LO) signal.

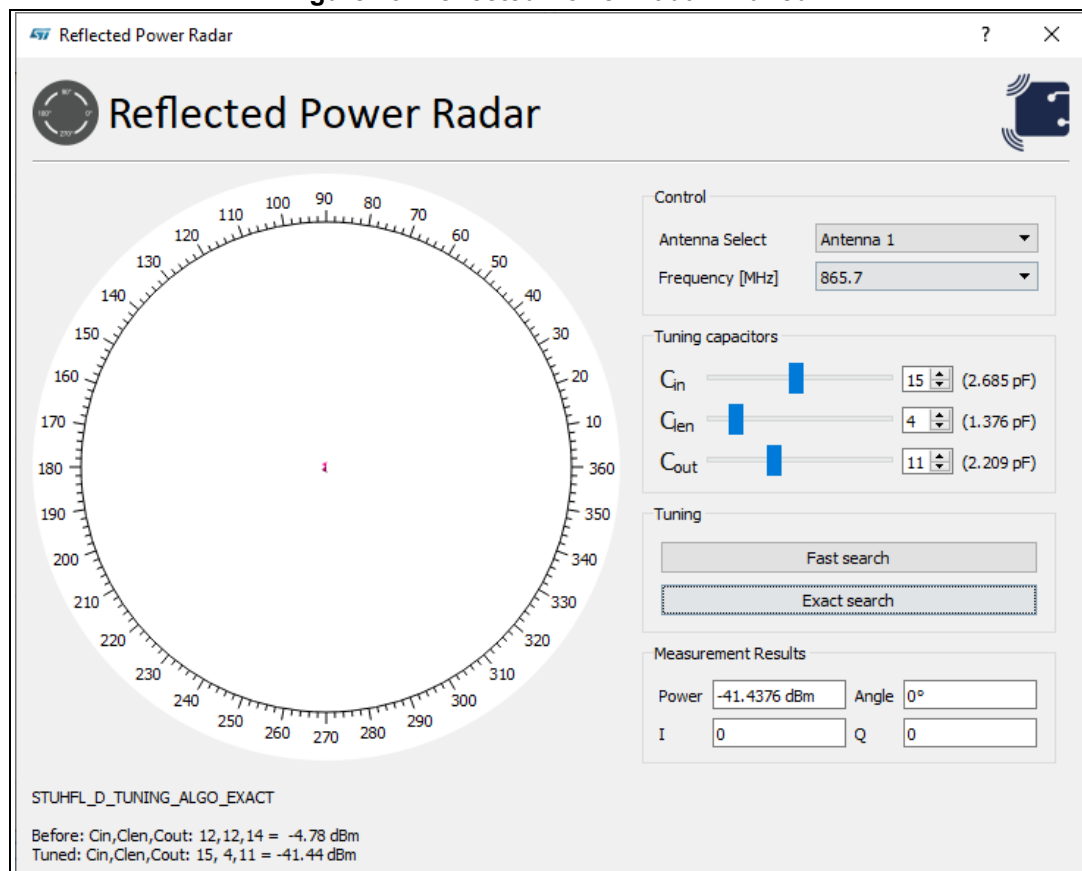
Figure 48. Reflected Power Radar



- **Control panel**
 - **Antenna Select:** The active antenna port can be selected here.
 - **Frequency:** The frequency for which the reflected power should be tuned.
- **Tuning capacitors panel**
 - **C_{in}:** This slider changes the capacitance value of the input shunt capacitor of the carrier cancellation circuit.
 - **C_{len}:** This slider changes the capacitance value of the series capacitor of the carrier cancellation circuit.
 - **C_{out}:** This slider changes the capacitance value of the output shunt capacitor of the carrier cancellation circuit.
- **Tuning panel**
 - **Tuning algorithms:** Tune current frequency with selected algorithm, please refer to Tuning algorithm description in section 4.3.1 Tuning file panel.

Impact of selected tuning is visible on arrow length and orientation. The tuning capacitors changes are listed on the right bottom corner.

Figure 49. Reflected Power Radar - Tuned



- Measurement Results panel
 - **Power:** Shows the reflected power measurement result in a numeric form. The reflected power measurement is performed by ST25RU3993.
 - **Angle:** Shows the phase of the reflected power relative to the local oscillator signal.
 - **I:** ADC results for the in-phase component of the reflected power measured by ST25RU3993
 - **Q:** ADC results for the quadrature component of the reflected power measured by ST25RU3993

5 Tag settings

In the tag settings dialog, more information about the tag can be retrieved and tag access operations can be performed.

To access the tags Settings dialog, right-click on a tag entry in the main window to show a pop-up menu from which the Tag Settings can be selected.

Figure 50. Tag Settings dialog window

Gen2 - Tag Settings

Tag Settings

EPC Memory bank

EPC

e2-11-42-17-94-40-60-15-00-95-2b-64

Stored PC

34-00

XPC

TID Memory bank

Manufacturer

Alien Technology

User Memory Size

-

Model Number

0x000811

Serial number

60 00 60 15 00 95 2b 64 01 01 00 00 0a 01 00 fb

Refresh

Functions

☒ Tag Memory

☐ Set EPC

☐ Set Password

☐ Lock

☐ Kill

☐ Generic Command

☐ Tag Authenticate

☐ Access Password

00-00-00-00

Tag Memory

0001020304050607

Memory Bank

Reserved

Memory Size:

0 Bytes

Copy2Clipboard

Read

Log

OKAY: Read tag information

OK

5.1 Information panel

- **EPC:** Shows the EPC code of the actual tag
- **Manufacturer:** Shows the name of the tag manufacturer of the actual tag.
- **Model Number:** Shows the tag model number for the actual tag.
- **User Memory Size:** If the tag implements a tag user memory; the memory size is displayed here.
- **Serial Number:** Shows the TID number of the actual tag
- **Refresh:** Re-reads the actual tag information.

5.2 Functions panel

5.2.1 Access Password

Enter the assigned access password of the actual tag if non-zero.

For example: If the EPC memory bank is locked then the access password needs to be entered here in order to make changes to the EPC possible.

5.2.2 Tag Memory

- **Read:** The memory bank pull-down menu allows the user to select the following memory banks:
 - Reserved
 - EPC:
TID
User
- **Memory Size:** Shows the size of the memory bank in Bytes.
- **Read:** Reads and displays information from the selected memory bank.

Figure 51. Tag memory table

Functions

- ☒ Tag Memory
- ☐ Set EPC
- ☐ Set Password
- ☐ Lock
- ☐ Kill
- ☐ Generic Command
- ☐ Tag Authenticate

☐ Access Password 00-00-00-00

Tag Memory

	00	01	02	03	04	05	06	07
1	00	00	00	00	00	00	00	00

Memory Bank: Reserved

Memory Size: 8 Bytes

Copy2Clipboard

Read

Note: If EPC memory bank is selected, a panel dedicated to the full description of bank content (StoredCRC, StoredPC, EPC, XPC1/2) is provided. Each value is read-only.

Figure 52. Tag memory additional information table

Functions

☒ Tag Memory

☐ Set EPC

☐ Set Password

☐ Lock

☐ Kill

☐ Generic Command

☐ Tag Authenticate

☐ Access Password

00-00-00-00

Tag Memory

	00	01	02	03	04	05	06	07
1	23	44	34	00	e2	11	42	17
2	94	40	60	15	00	95	2b	64
3	00	11	00	00				

Memory Bank

EPC

Memory Size:

20 Bytes

Copy2Clipboard

Read

StoredCRC

23-44

StoredPC

34-00 =>

L

06

☒ UMI

☐ XI

☐ T = GS1

RFU

00

EPC

e2-11-42-17-94-40-60-15-00-95-2b-64

XPC_W1

- =>

☐ XEB

RFU

☐ B

☐ C

☐ SLI

☐ TN

☐ U

☐ K

☐ NR

☐ H

XPC_W2

-

5.2.3 Set EPC

Figure 53. Set EPC

Functions

☐ Tag Memory

☒ Set EPC

☐ Set Password

☐ Lock

☐ Kill

☐ Generic Command

☐ Tag Authenticate

☐ Access Password

00-00-00-00

Set EPC

EPC length [words]

6

New EPC

e2-11-42-17-94-40-60-15-00-95-2b-64

Execute

- **EPC Length:** The length of the new EPC number can be defined here. The EPC length is defined as the number of words.
- **New EPC:** The new EPC number of the actual tag can be entered here.
- **Execute:** By clicking on the Execute button the new EPC number is written to the actual tag.

5.2.4 Set Password

Figure 54. Set Password

The screenshot shows a software interface for setting a password. On the left, under the 'Functions' header, there is a list of radio buttons: 'Tag Memory', 'Set EPC', 'Set Password' (which is selected), 'Lock', 'Kill', 'Generic Command', and 'Tag Authenticate'. To the right of this list, there is a section for 'Access Password' with a checkbox and a text field containing '00-00-00-00'. Below this is the 'Set Password' section, which includes a 'Password Type' dropdown menu currently set to 'Access', and a 'New Password' text field containing '00-00-00-00'. At the bottom of the interface is a large 'Execute' button.

- **Password Type:** This drop-down menu defines the password type for the new password. Options are:
 - Kill
 - Access
- **New Password:** The new password information can be entered here.
- **Execute:** By clicking on the Execute button the new password is written to the actual tag.

5.2.5 Lock

Figure 55. Lock

The screenshot shows a software interface for configuring a tag. On the left, under 'Functions', there are radio buttons for 'Tag Memory', 'Set EPC', 'Set Password', 'Lock' (which is selected), 'Kill', 'Generic Command', and 'Tag Authenticate'. To the right of the 'Lock' selection, there is an 'Access Password' checkbox and a text field containing '00-00-00-00'. Below this, the 'Lock' section contains a 'Memory Bank' dropdown menu set to 'User' and an 'Action' dropdown menu set to 'Unlock'. A note states: 'Associated memory bank is writeable from either the open or secured states.' At the bottom of the interface is a large 'Execute' button.

- **Memory Bank:** The memory bank for which the lock status is going to be changed can be selected here. Options are:
 - User
 - EPC
 - TID
 - Access Password
 - Kill Password
- **Action:** Select the type of lock status change here. Options are:
 - Unlock: Unlocks the selected memory bank
 - Permanently Unlock: Permanently prevents the selected memory bank from being locked ever again.
 - Lock: Locks the selected memory bank
 - Permanently Lock: Permanently locks the selected memory bank. No subsequent unlocking of the selected memory bank is possible anymore.
- **Execute:** By clicking on the Execute button the new lock status is written to the actual tag.

5.2.6 Kill

Figure 56. Kill

Functions

☐ Tag Memory

☐ Set EPC

☐ Set Password

☐ Lock

☒ Kill

☐ Generic Command

☐ Tag Authenticate

☐ Access Password

Kill

Kill password

- **Insert Kill Password:** Enter the Kill password in this entry field.

Note: A zero-valued kill password does not lead to a successful kill operation.

- **Execute:** By clicking on the Execute button, the actual tag is killed.

5.2.7 Generic command

Figure 57. Generic command

[illegible]

- **Direct Command:** The type of ST25RU3993 transmit command can be selected here. It defines if ST25RU3993 shall handle CRC processing, if CRC is not handled by

ST25RU3993 it must be generated upfront and manually verified afterwards. Options are:

- CMD_TRANSMCRC: (0x90)
- CMD_TRANSMCRCEHEADC: (0x91)
- CMD_TRANSM (0x92)

- **TX Bit Length:** Defines the total number of bits in the transmit command.

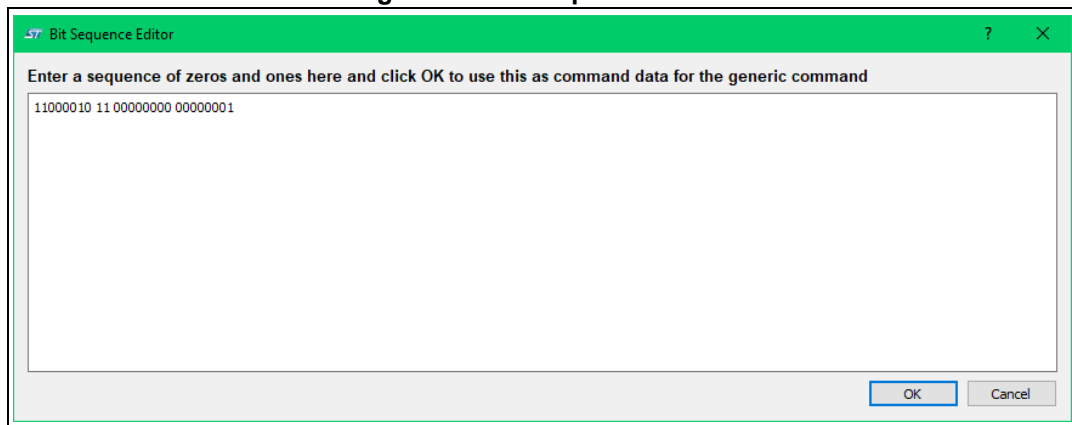
Note: Neither the CRC bits (16 bits) nor the appended RN16 bits (if applicable, cf below) must be included in TX Bit Length as automatically handled by ST25RU3993.

- **RX Bit Length:** Defines the total number of bits that are expected to be received from the tag. Depending on selected Direct command, the RX Bit Length must be defined as follows:
 - CMD_TRANSMCRC: Full command length without trailing CRC (16 bits)
 - CMD_TRANSMCRCEHEAD: Full command length without trailing CRC nor Header bit (17 bits)
 - CMD_TRANSM: Full command length
- **Append RN16:** Defines if the RN16 (handle) retrieved from the tag response shall be automatically appended to the command.
- **RX No Resp. Timeout:** Defines the timeout after which the reception of the tag response is aborted. The no response timeout used by the ST25RU3993 has the value x 25.6us.

Note: If set to 255, the no response timeout is forced to 26 ms instead of 6.5 ms.

- **Command Data:** Defines the data to be transmitted in hexadecimal format (cf Example below).
- **Bit Sequence Editor:** Allows to enter a series of ones and zeros which are converted to hexadecimal and inserted in the Command Data field.

Figure 58. Bit Sequence Editor



- **Execute:** By clicking on the Execute button the generic command is transmitted to the actual tag. This screen allows the user to view and change tag data.

Example

By default, the “Generic Command” is pre-configured to Gen2 Read command: reading the first word in TID memory from address 0.

As a reminder, the EPC global Gen2 Read command is specified as follows:

Command:

Cmd Read (8bit)	MemBank (2bit)	WordPtr (EBV)	WordCount (8bit)	RN (6bit)	CRC (16bit)
--------------------	-------------------	------------------	---------------------	--------------	----------------

Answer:

Header (1bit)	Memory Words	RN (16bit)	CRC (16bit)
------------------	--------------	---------------	----------------

The following parameters should be set depending on Direct command scheme:

CMD_TRANSMCRC (0x90):

- Append RN16: yes
- Tx Bit Length: 26 bits (as RN16 bits are automatically handled by MW, CRC bits are handled by chip)
- Rx Bit Length: 33 bits (as read 2 bytes and waits for Header and RN16 bits, CRC bits are handled by chip)
- Command Data: 0xC2 80 00 40

CMD_TRANSMCRCEHEAD (0x91):

- Append RN16: yes
- Tx Bit Length: 26 bits (as RN16 bits are automatically handled by MW, CRC bits are handled by chip)
- Rx Bit Length: 32 bits (as read 2 bytes and waits only for RN16 bits, CRC and Header bits are handled by chip)
- Command Data: 0xC2 80 00 40

CMD_TRANSM (0x92):

Not applicable as RN16 and CRC cannot be anticipated at this stage

5.2.8 Tag authenticate

Figure 59. Tag Authenticate

- CSI:** As defined in EPC Gen2/ISO18000-63 UHF RFID standard, the CSI selects the cryptographic suite that Tag and Interrogator use for the authentication as well as for all subsequent communications (until the Interrogator initiates another authentication with a different CSI or the Tag leaves the open or secured state).
 Current available authentication methods are
 - CSI 0: ISO29167-10 TAM1: AES128 Tag authentication without custom data
 - CSI 0: ISO29167-10 TAM2: AES128 Tag authentication with custom data
 - CSI 3: ISO29167-13 TA.1: Grain128A Tag authentication
 - CSI 3: ISO29167-13 TAR: Grain128A Tag authentication with Read
- Message:** EPC Gen2 UHF RFID standard Authentication parameter command message field.
- Edit Button:** Open Tag authentication editor. The Tag authentication editor depends on the selected CSI and easy the generation of the Tag authentication message.
 - **CSI 0:** ISO29167-10 TAM1

Figure 60. ISO29167-10 TAM1 Tag Authenticate Editor

Where:

- **Custom Data:** For TAM1 must set to 0
- **RFU:** Reserved, must set to 0
- **KeyID:** KeyID is used by Tag for authentication procedure
- **ICChallenge:** 80 bit interrogator challenge
- **Randomize:** Generate a randomized 80 bit ICChallenge

CSI 0: ISO29167-10 TAM2: AES128 Tag authentication with custom data

Figure 61. ISO29167-10 TAM2 Tag Authenticate Editor

Where:

- **CustomData:** For TAM2 must set to 1
- **BlockSize:** Specify block size of custom data. Can be 64 or 32bit.
- **Rev:** TAM2 Revision. (the revision depends on the tag type and the manufacturer)
- **RFU:** Reserved, must set to 0
- **KeyID:** To be used by tag for authentication procedure
- **Profile:** Memory profile for custom data
- **Offset:** Memory offset, specified in blocks
- **Block Count:** Block count
- **ICChallenge:** 80 bit Interrogator challenge
- **Randomize:** Generate a randomized 80 bit ICChallenge

CSI 3: ISO29167-13 TA.1: Grain128A Tag authentication

Figure 62. ISO29167-13 TA.1 Tag Authenticate Editor

Where

- **AuthMethod:** 0 for TA.1
- **Step:** 0 for TA.1
- **Options:** Authentication options. The options may depend on the Tag capabilities
- **KeyID:** KeyID used by Tag for authentication procedure
- **ICallenge:** 48 bit Interrogator challenge
- **Randomize:** Generate a randomized 48 bit ICallenge

CSI 3: ISO29167-13

Figure 63. ISO29167-13 TAR Tag Authenticate Editor

Where:

- **AuthMethod:** 0 for TAR
- **Step:** 0 for TA.1
- **Options:** Authentication options. The options may depend on the Tag capabilities
- **KeyID:** KeyID used by Tag for authentication procedure
- **Profile:** Memory profile for read data
- **Word Ptr:** Starting word offset for data read
- **Word Count:** Number of words to read – 1 (for instance 0 = 1 word to read)
- **ICallenge:** 48 bit Interrogator challenge
- **Randomize:** Generate a randomized 48 bit ICallenge
- **Send response:** EPC Gen2 UHF RFID standard Authentication parameter to specifies whether a Tag backscatters its response or stores the response in its ResponseBuffer.
- **Include response length:** EPC Gen2 UHF RFID standard Authentication parameter to specifies whether a Tag omits or includes length in its reply. If unchecked then a Tag omits length from its reply, if checked then the Tag includes length in its reply.
- **Expected response length:** Expected response length
- **Authenticate button:** Execute the Tag authentication
- **Response:** Gen2 Authenticate response

6 Revision history

Table 1. Document revision history

Date	Revision	Changes
27-Mar-2018	1	Initial release.
12-Apr-2018	2	Updated: – Introduction
29-Nov-2018	3	Added: – Section 4.5: Reader setting - USA profile – Section 4.4.1: EU profile settings tab – Section 4.4.2: Eu profile diagnostics tab – Section 4.4.3: EU profile: Tuning tab – Section Figure 46.: Reflected Power Radar – Section 4.6: Reader settings - JAPAN profile – Section 4.5.1: USA profile settings tab – Section 4.5.2: USA profile diagnostics tab – Section 4.5.3: USA profile tuning tab – Section 4.5.4: USA profile reflected Power Radar – Section 4.7: Eval mode – Section 4.7.1: Eval mode settings tab – Section 4.7.2: Eval mode diagnostics tab – Section 4.7.3: Eval mode tuning tab – Section 4.7.4: Eval mode Reflected Power Radar Updated: – Introduction – Figure 1: Hardware configuration of evaluation board – Figure 64: EU profile Reflect Power window – Section 4.4: Reader settings - EU profile – Section 4.5: Reader setting - USA profile – Section 4.6: Reader settings - JAPAN profile
04-Feb-2021	4	Updated: – Introduction – Section 1.1: Hardware preparations – Figure 1: Hardware configuration of evaluation board – Section 1.2: Software installation – Figure 3: ST25RU3993 GUI software installation wizard steps (2/2) – Section 1.3: First connection – Section 2: Main window Added: – Figure 3: ST25RU3993 Reader Suite desktop icon – Section 1.4: Firmware (FW) update – Section 3: Register map – Section 4: Reader Settings – Section 5: Tag settings

Table 1. Document revision history

Date	Revision	Changes
22-Mar-2021	5	Updated: <ul style="list-style-type: none"> – Section 1.1: Hardware preparations – Section 1.3: First connection – Section 2.7.1: Control
31-Mar-2022	6	Updated: <ul style="list-style-type: none"> – Introduction – Section 1.3: First connection – Figure 4: ST25RU3993 Reader Suite - Connect Reader – Figure 5: ST25RU3993 Reader Suite - Connected – Figure 10: ST25RU3993 Reader Suite - Main window – Section 2.2: Inventory Statistics – Figure 14: Inventory - Round info panel – Figure 15: Scan panel – Section 2.4: Select panel – Figure 16: Select panel – Figure 18: Region panel - EU – Figure 19: Control menu – Figure 20: View menu – Section 2.8.2: Unique Tag plot dialog – Section 2.8.5: Settings – Figure 26: Settings window – Figure 31: Reader Settings - Settings tab – Section 4.1.1: General panel – Section 4.1.7: Gen2 settings panel – Section 4.1.8: Gen2 Anti-collision settings panel – Section 4.2.1: Diagnostic Sweep Function panel – Section 4.2.3: Direct Commands panel – Section 4.3.1: Tuning File panel – Section 4.3.2: Automatic PreTuning before Scan panel – Section 4.3.3: Automatic re-tuning during Scan panel – Section 4.3.4: Manual tuning (Reflected power radar) – Section 5: Tag settings Added: <ul style="list-style-type: none"> – Section 4.1.2: Frequency selection panel – Figure 34: Frequency panel – Figure 35: Channel list dialog – Section 4.1.3: Frequency hopping panel – Section 4.1.6: Rx Options panel – Section 5.2.8: Tag authenticate Deleted: <ul style="list-style-type: none"> – Figure 3: ST25RU3993 GUI software installation wizard steps (2/2) – Section 4.1.3: Profile selection panel – Figure 38: "Set" notification when modified menu – Section 4.1.9: GB29768 Settings panel – Figure 46: Reader Settings - GB29768 settings

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