UM2268
User manual

ST25RU3993 evaluation board software

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.

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1 Quick start guide

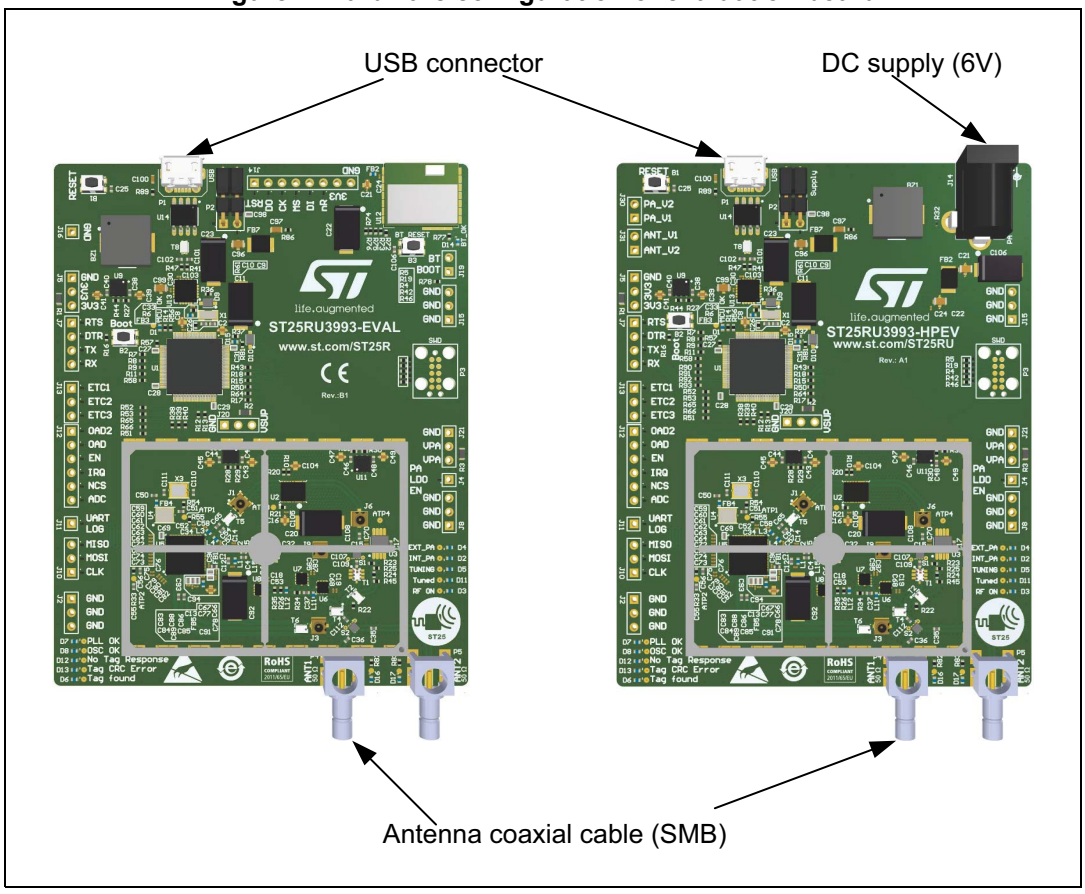
1.1 Hardware preparations

- 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.

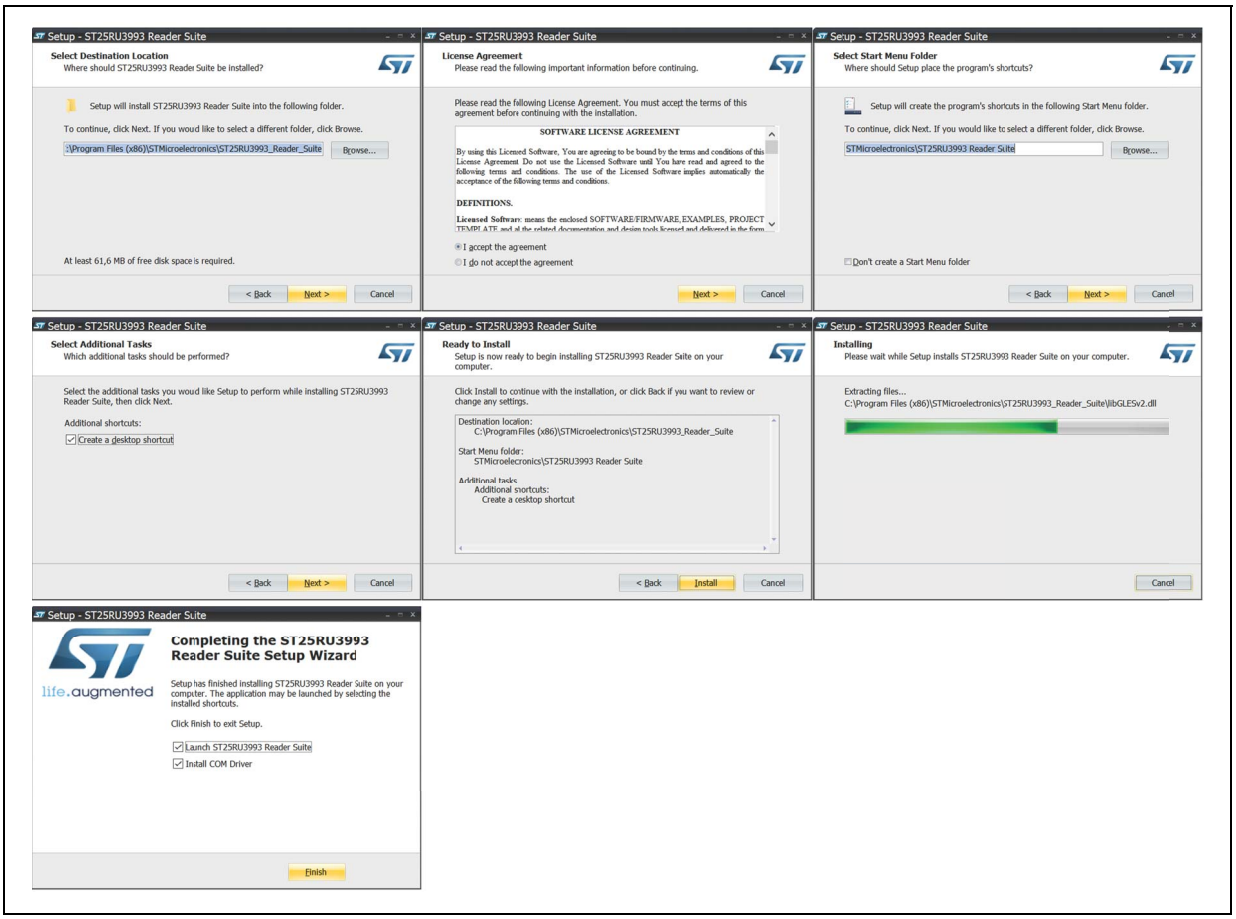
Figure 1. Hardware configuration of evaluation board



1.2 Software installation

- To install the ST25RU3993 Reader Suite software, click on the installation file ST25RU3993_GUI_vx-x-x-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

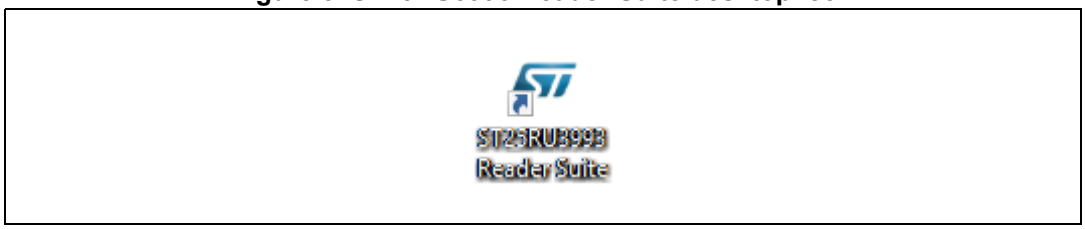
Figure 2. ST25RU3993 GUI software installation wizard steps



1.3 First connection

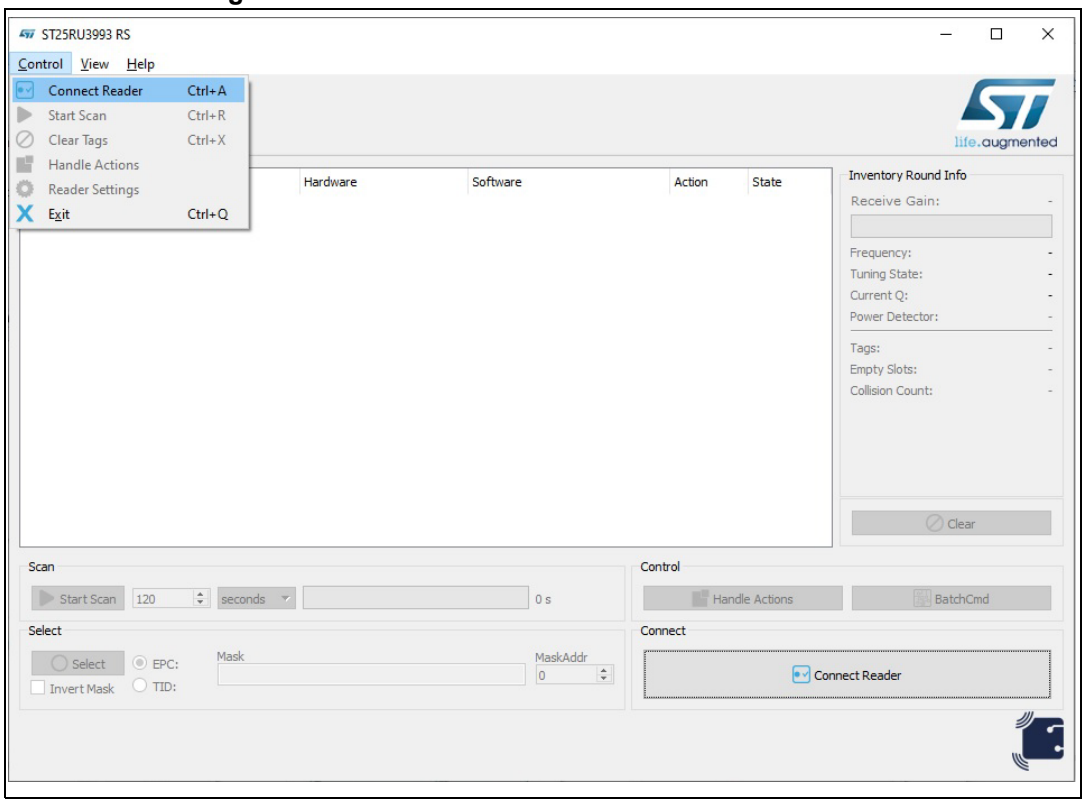
In case the ST25RU3993 Reader Suite is not already running, start the ST25RU3993 Reader Suite.

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].

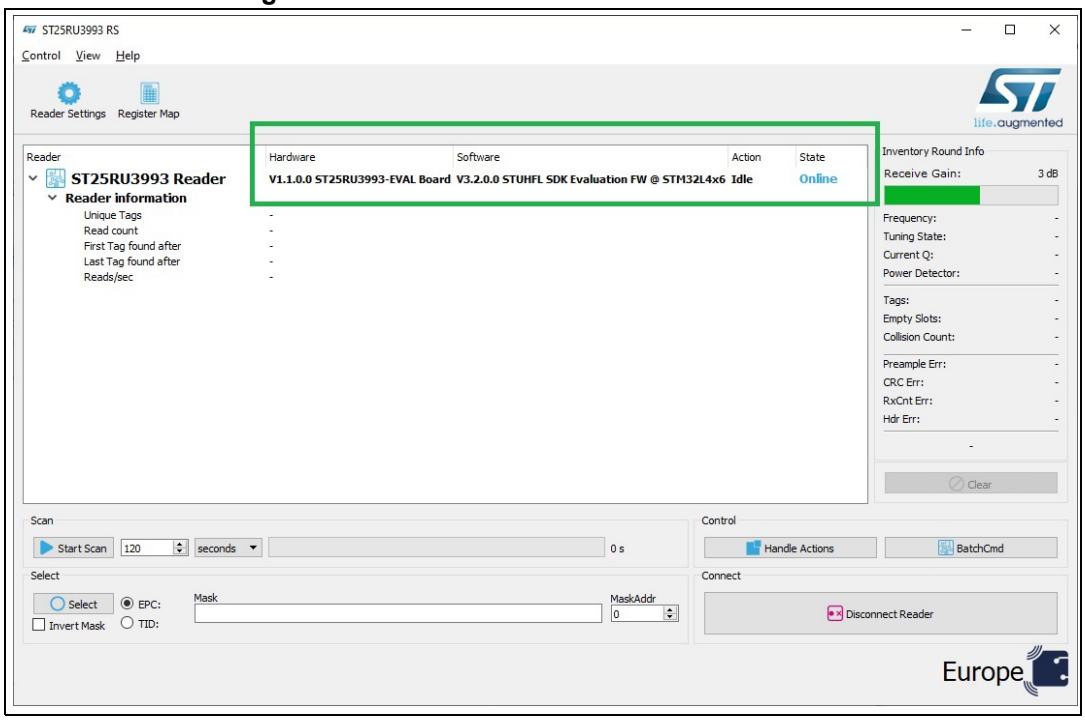
Figure 4. ST25RU3993 Reader Suite - Connect Reader



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

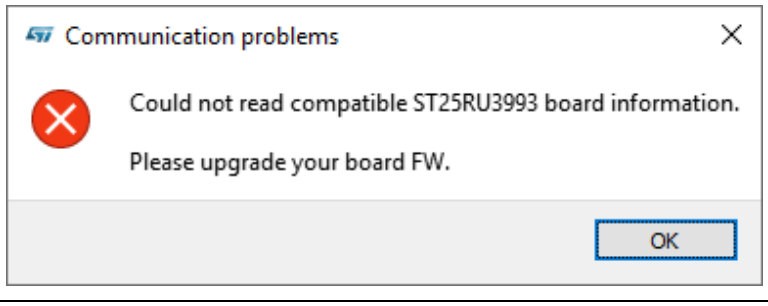
The ST25RU3993 Reader Suite also displays the version information and the status of the connected board.

Figure 5. ST25RU3993 Reader Suite - Connected



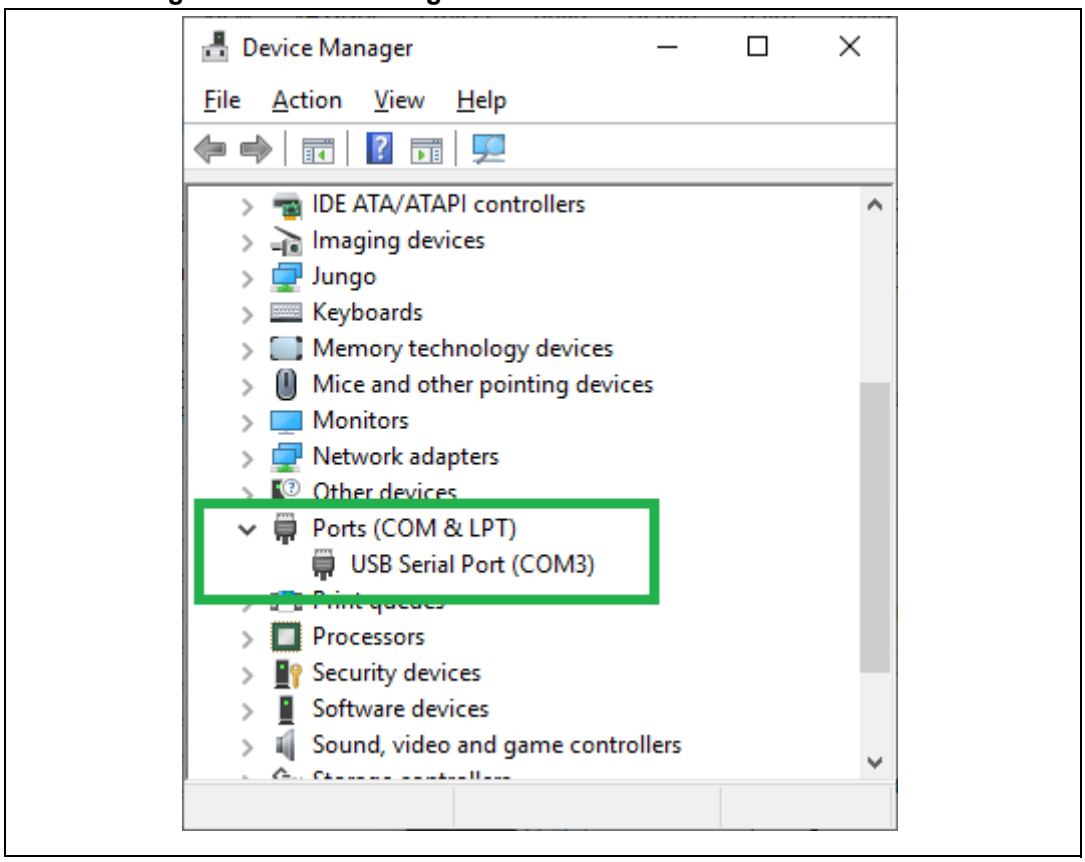
Note: The ST25RU3993 Reader Suite and the firmware of the connected board must have the same version number. The version number of the GUI can be found by clicking on 'About' from the Help Menu. If version numbers do not match, the GUI prompts a notification to update FW of the board. Follow the on-screen 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

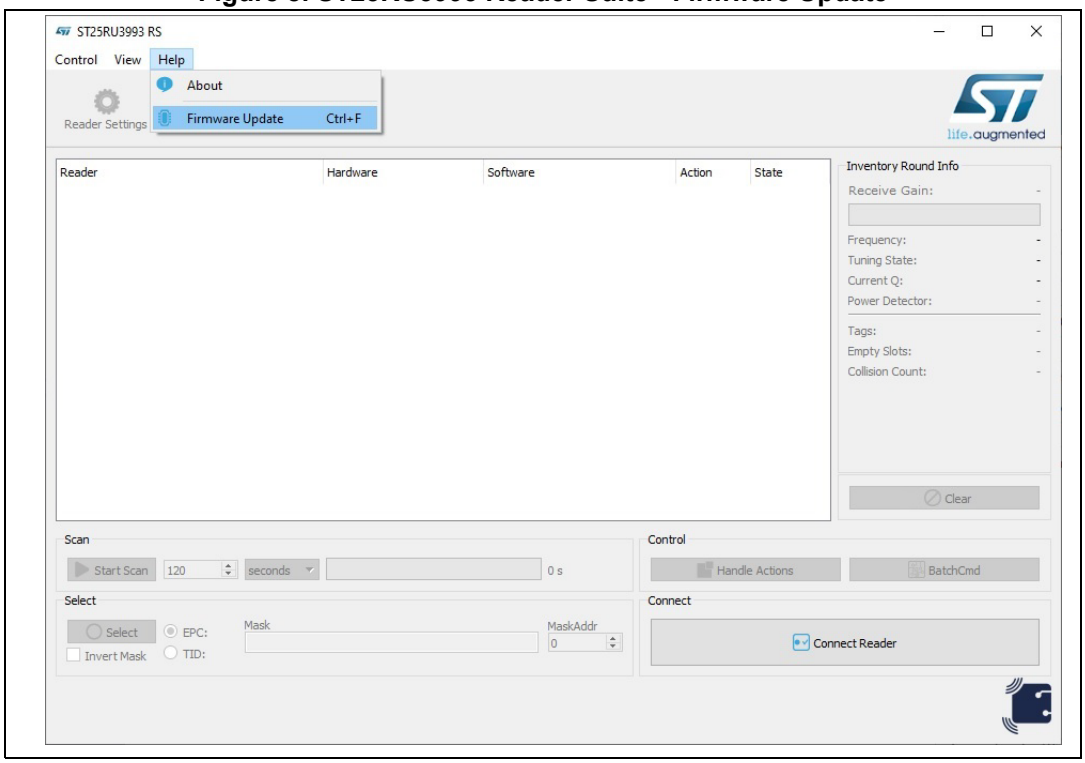


1.4 Firmware (FW) update

To update the firmware of the ST25RU3993 evaluation reader:

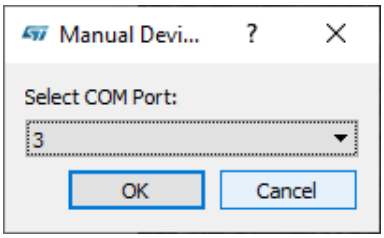
- Connect the ST25RU3993 reader board to the PC.
- Launch the firmware upgrade process by clicking on Firmware Update, which is located in the ‘Help’ menu. Alternatively use the keyboard shortcut key [ALT+F].

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.

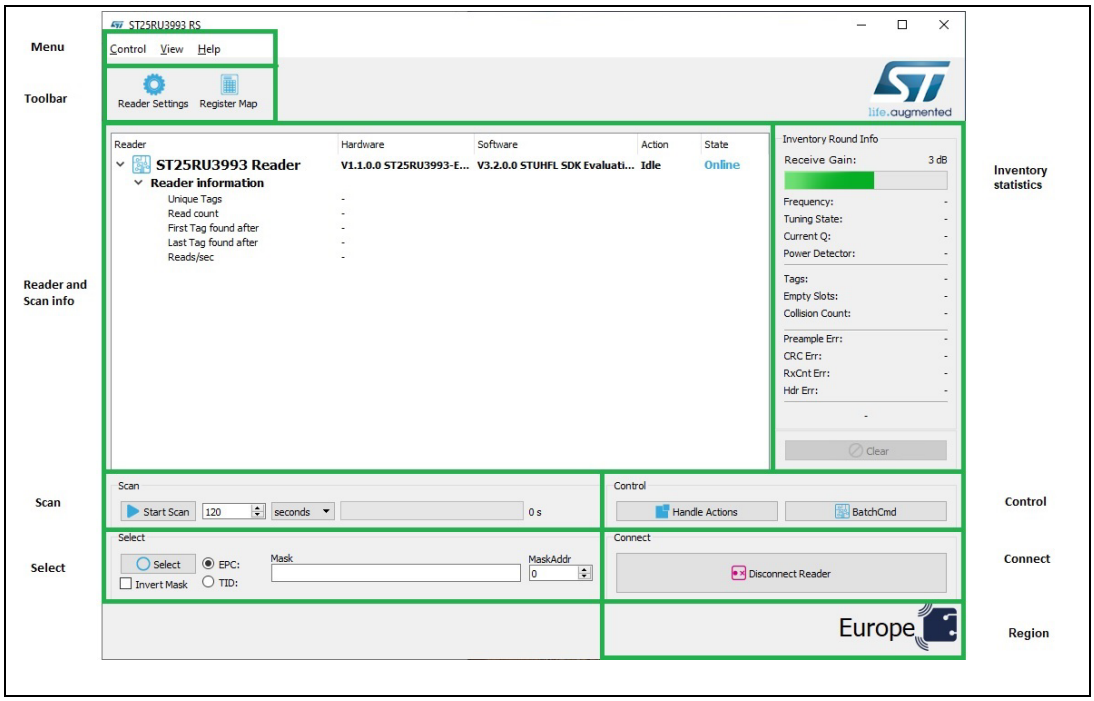
Note: While the update process is ongoing do not disconnect the reader from the host computer. If the update process is interrupted or fails the FW update can be restarted since STM32’s on-board ROM bootloader is used.

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
- **Connect**: Control connection to the ST25RU3993 evaluation board.
- **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

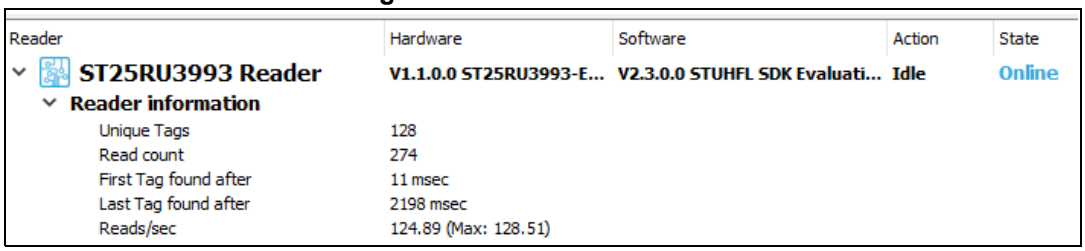


2.1 Reader and Scan information

2.1.1 Reader information

It shows the information related to the current scan activity.

Figure 11. Reader information



Where:

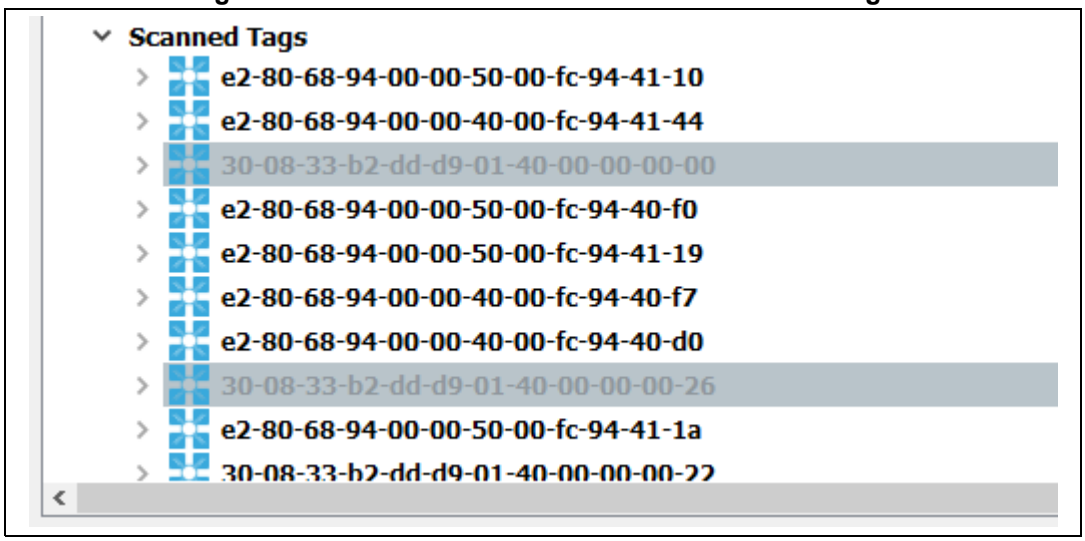
- **Unique Tags**: Number of unique tags found by the reader during current or last scan
- **Read count**: Number of tag reads performed since application start or last reset of the tag list.
- **First Tag found after**: Timestamp of first found Tag during this inventory scan. The timestamp is relative 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 could not 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

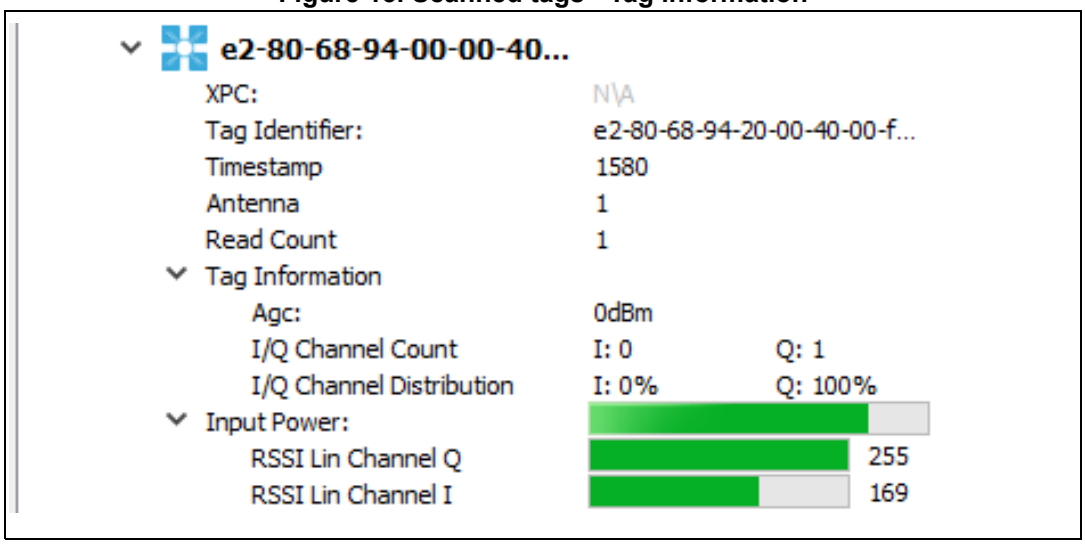


The EPC entries are organized in a tree-view and additional tag information can be accessed by expanding the EPC entries.

2.1.3 Tag information

By expanding an EPC entry in the Scanned Tags list additional 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



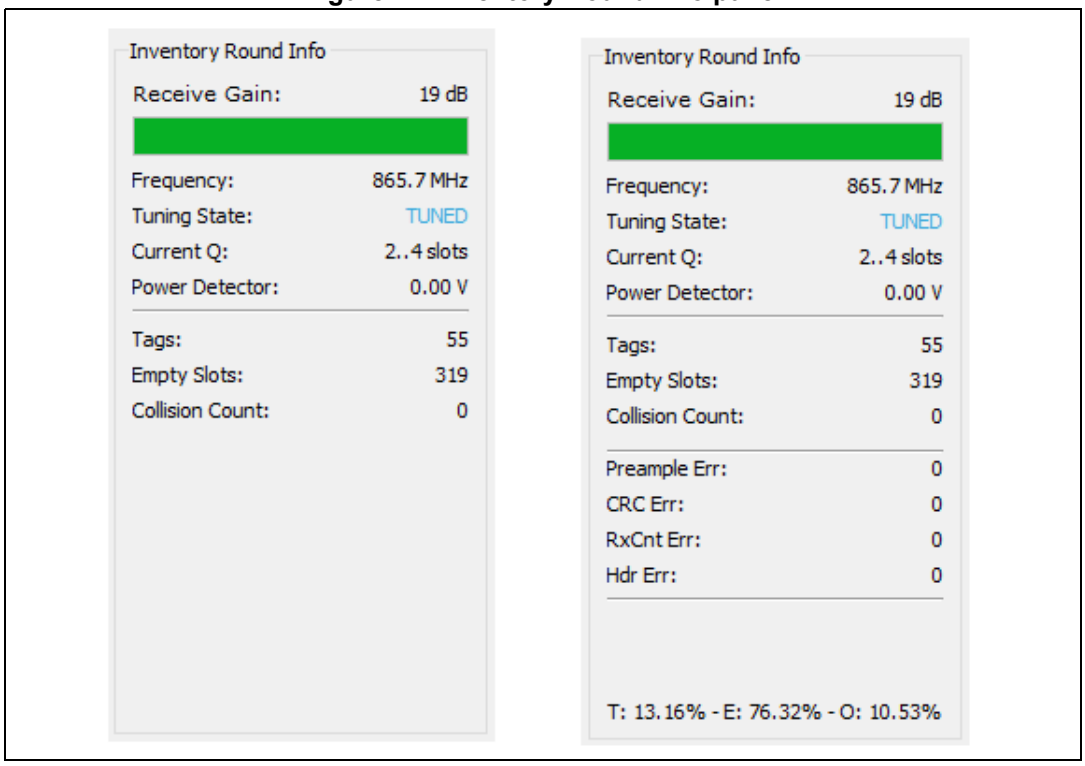
Where:

- **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**: Shows 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.

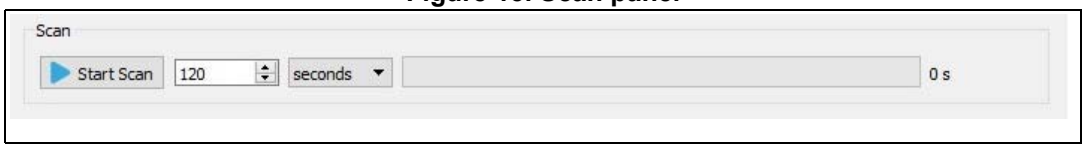
By enabling the extended Inventory Round Info display from menu View, more details are shown:

- 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 stops.

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.

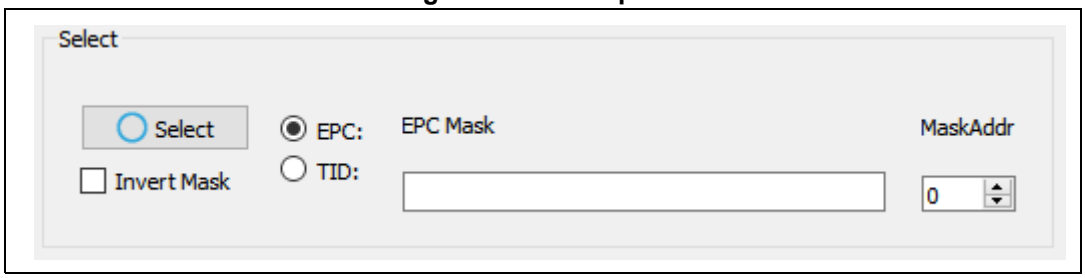
- **#rounds**: After the defined number of inventory rounds are completed the scan operation is stopped. The maximum number that can be entered is 600.

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. If enabled the Select command is sent before each inventory round to pre-filter tags.

Figure 16. Select panel

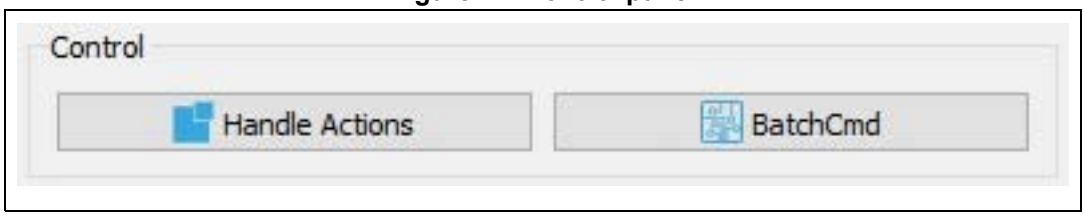


Where:

- **Select**: Enables/disables the selection of tags depending on the EPC/TID mask entered.
- **EPC or TID**: Defines the tag memory the bank mask is applied to.
- **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 the Query command SEL field.

2.5 Control and Connect panel

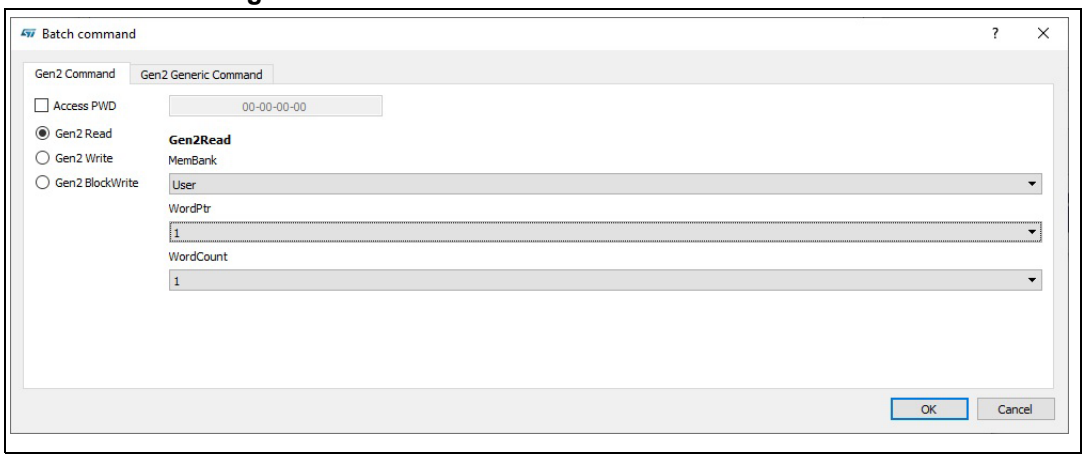
Figure 17. Control panel



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.
- **BatchCmd**: Activate/Deactivate batch command processing. If batch command processing is enabled a user defined batch command will be executed whenever a transponder is found. When activating the batch command processing a dialog will be shown to configure the command that shall be executed.
  The executed batch command can either be an EPC RFID Gen2/ISO18000-63 defined command or a generic command. To use an EPC RFID Gen2/ISO18000-63 command select the Tab “Gen2 Command” and configure one of the following commands.
  – Gen2 Read:
  MemBank: Memory Bank (Reserved, EPC, TID, USER) data is read from.
  WordPtr: Word address at which the data read starts.
  WordCount: Number of words to be read.

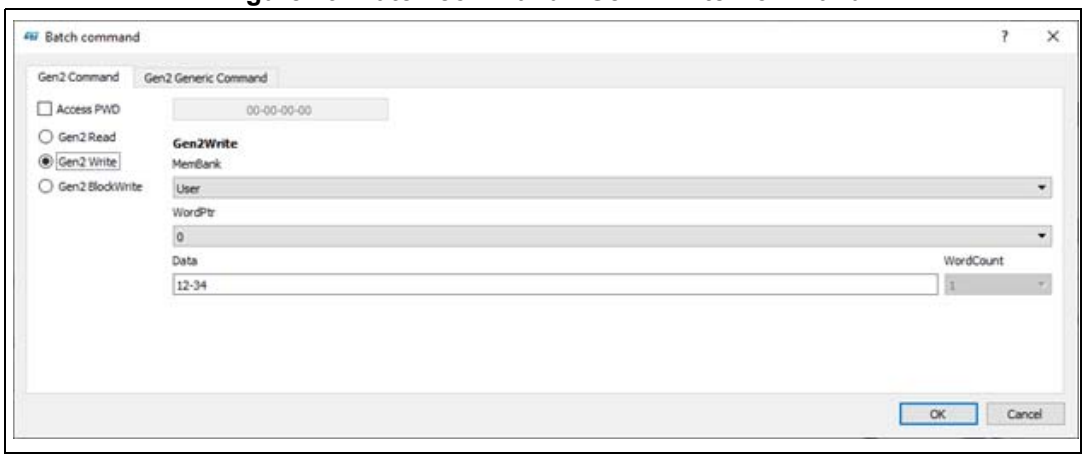
Figure 18. Batch command - Gen2 Read Command



– Gen2 Write
MemBank: Memory Bank (Reserved, EPC, TID, USER) data is written to.
WordPtr: Start word address to write data to.
Data: Data word to be written
WordCount: Number of words to be written.

Note: The Gen2 Write command defined by EPC RFID Gen2/ISO18000-63 only allow to write 1 word at a time.

Figure 19. Batch command - Gen2 Write Command



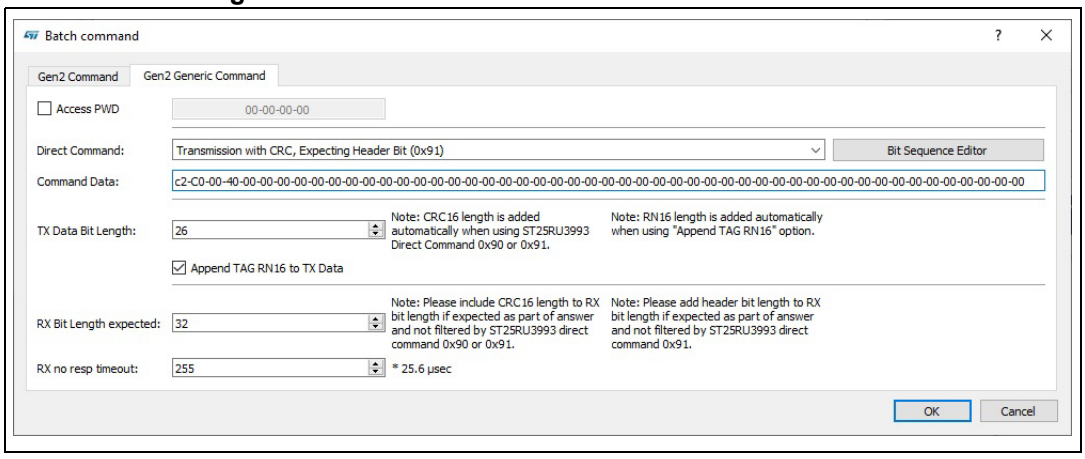
– Gen2 BlockWrite
MemBank: Memory Bank (Reserved, EPC, TID, USER) data is written to.
WordPtr: Start word address to write data to.
Data: Data word(s) to be written.
WordCount: Number of words to be written.

Figure 20. Batch command - Gen2 BlockWrite Command

Note: All commands can be executed from the tag's "Secured" state instead its "Open" state by specifying an access password. If an access password is specified a Gen2Access procedure is added before the specified batch command is executed.

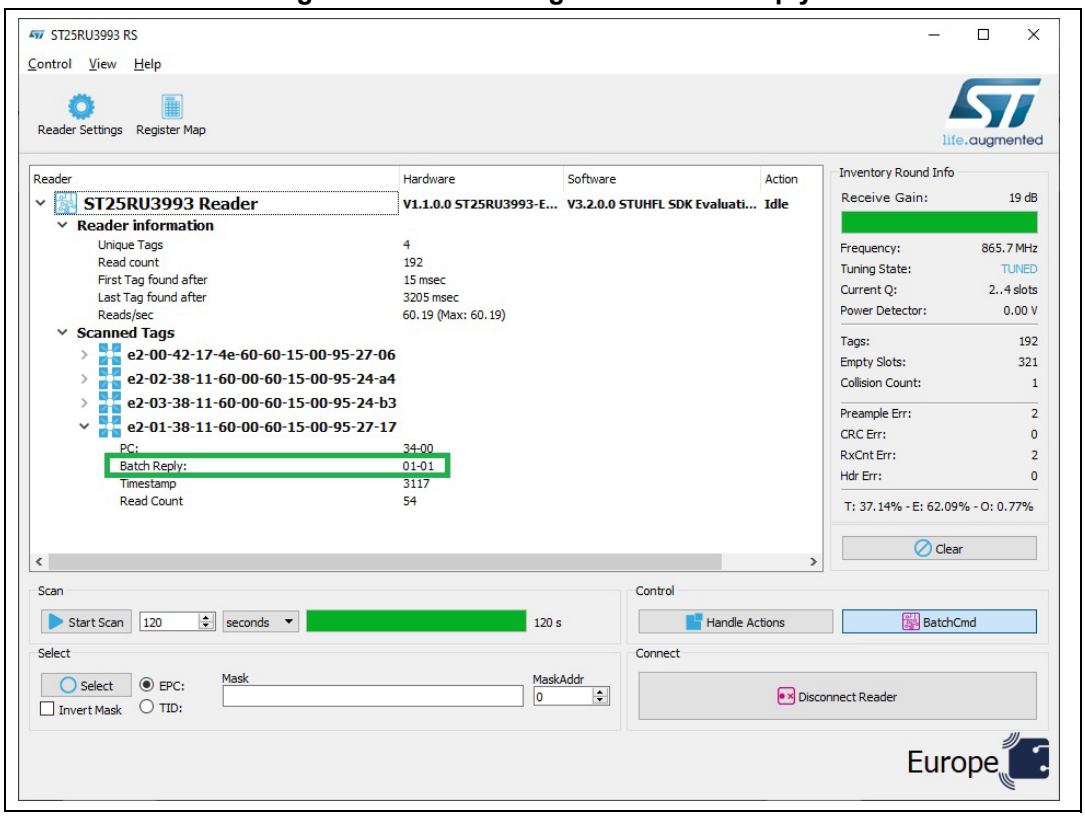
To use a custom generic command as the batch command, select the Tab "Gen2 Generic Command". For further details on the usage of generic commands see *Section 5.2.7: Generic command*

Figure 21. Batch command - Gen2 Generic Command



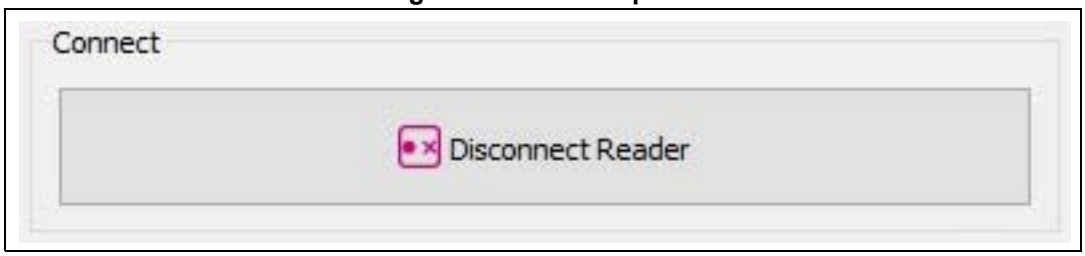
If batch command processing is enabled the Batch command is exchanged with each tag. The result of the command is displayed as part of the scan info for each tag. The following image shows the "Batch Reply" info when executing a Gen2Read command as a Batch command that reads one word from the user memory starting from word address 0.

Figure 22. Scanned tags info - Batch Reply



2.6 Connect panel

Figure 23. Connect panel



The Connect panel allows to control the following actions:

- Disconnect/Connect Reader: Disconnects or connects the reader via UART.

2.7 Region panel

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

Figure 24. Region panel - EU

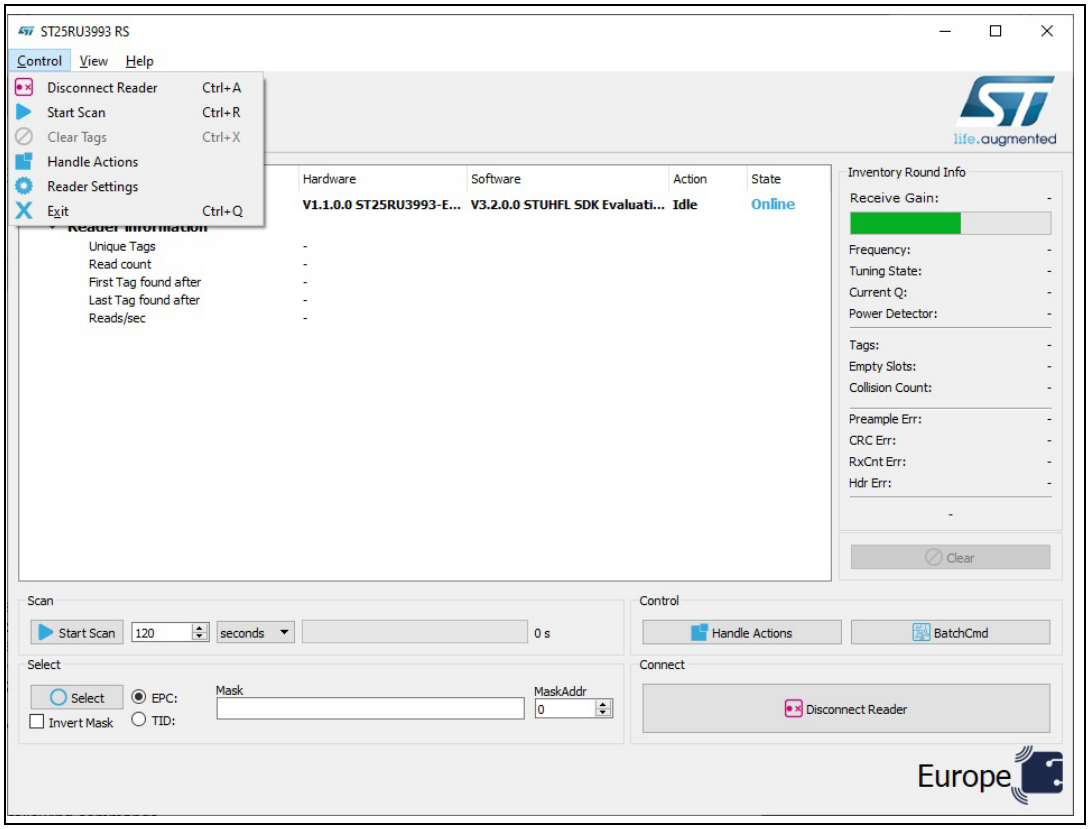
It is possible to override the regional configuration within the Reader Settings dialog.

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

2.8 Menu

2.8.1 Control

Figure 25. Control menu



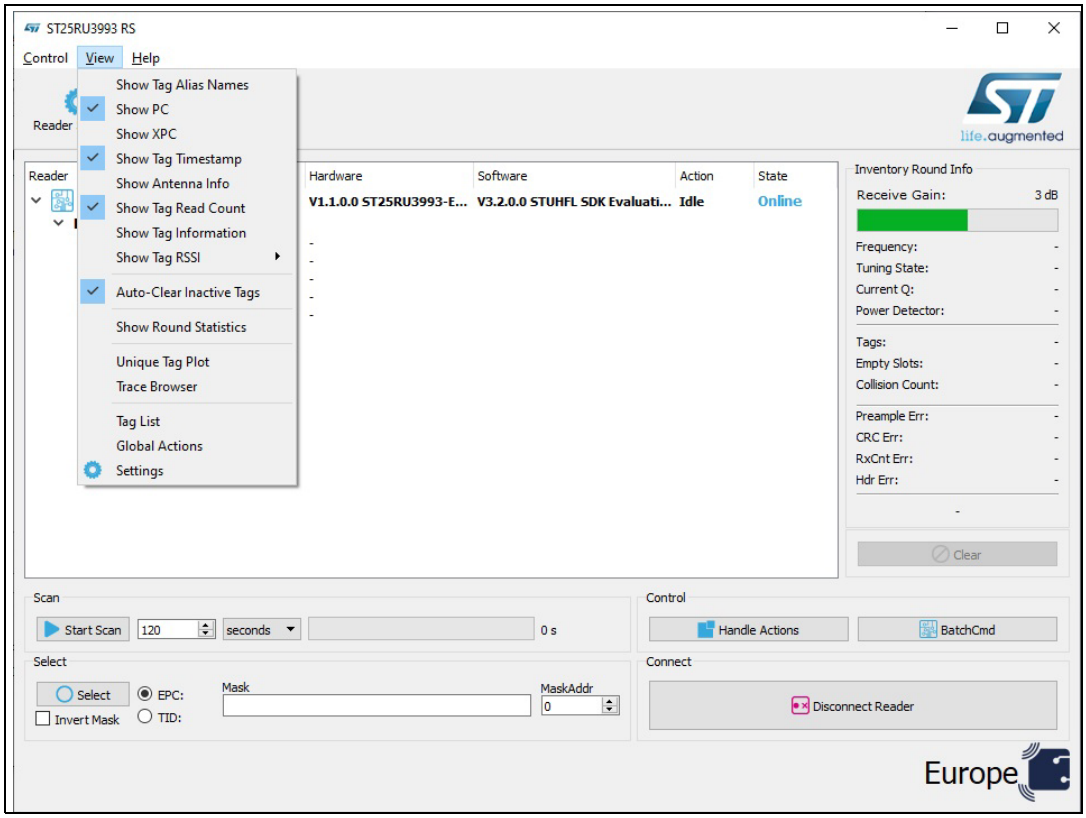
Where:

- **Connect/Disconnect Reader**: Connects or disconnects the ST25RU3993 Reader Suite with the ST25RU3993 evaluation board. Depending on the connection status, the menu item 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**: Displays the reader configuration dialog

2.8.2 View

The View menu allows to show/hide several elements in inventoried TAG list and opens additional tool dialogs.

Figure 26. View menu



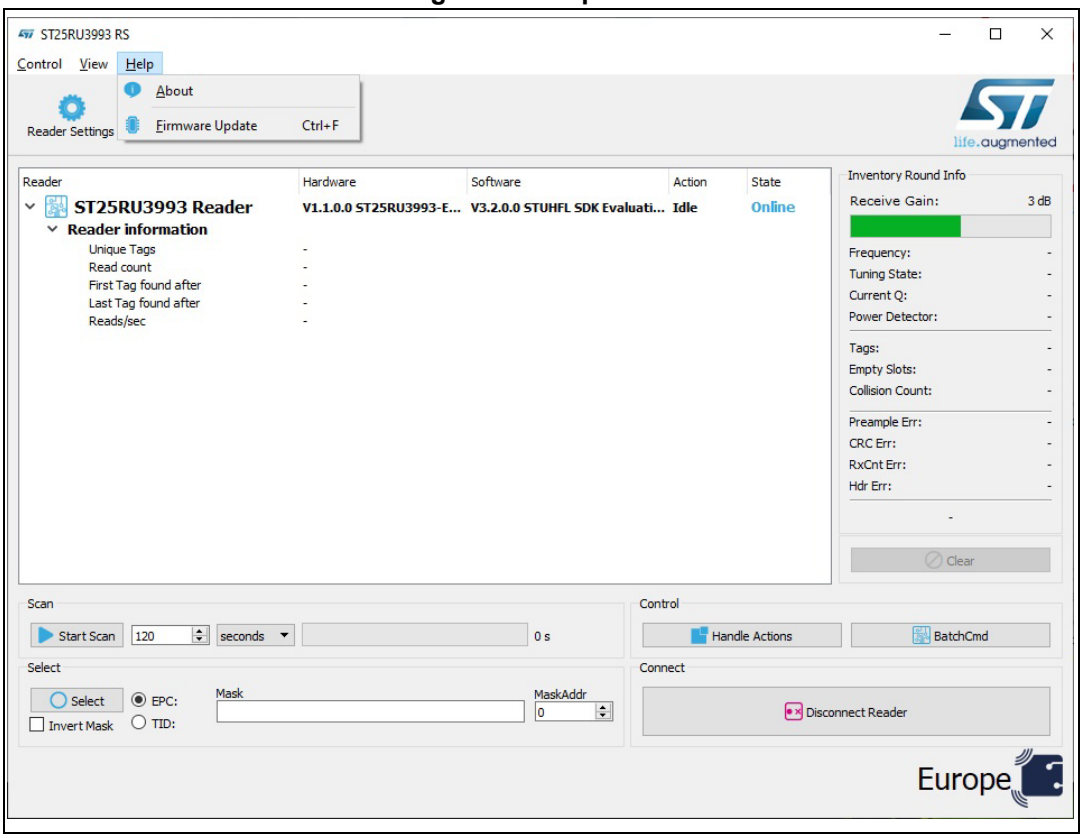
Where:

- **Show Tag Alias Names**: Displays the user defined alias name instead of the EPC number of a tag.
- **Show PC**: Display protocol control word (PC) information of tag.
- **Show XPC**: Display extended protocol control word (XPC) information of tag.
- **Show Tag Timestamp**: Display timestamp information when tag was inventoried. The timestamp time is the time elapsed time since the scan operation started.
- **Antenna Info**: Display information at which antenna tag was inventoried.
- **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 configuration for the tag list of the main window defined in the Settings window (see GUI Settings).
- **Show Round Statistics**: Display detailed information of scan progress in “Inventory Round Info” panel.
- **Unique Tag Plot**: Opens a plot dialog that displays the number of identified unique tags versus the scan duration.
- **Trace Browser**: The Trace Browser window appears at the bottom of the main window. The Trace Browser window is detachable.
- **Tag List**: Displays a configurable list of identified tags.
- **Global Actions**: Displays the Global Actions dialog to define actions when a new tag is read.
- **Settings**: Opens the general GUI settings

2.8.3 Help

The help menu gives access to the About dialog and allows to start the firmware update process.

Figure 27. Help menu



Where:

- **About**: Displays the About dialog providing GUI version information.
- **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.

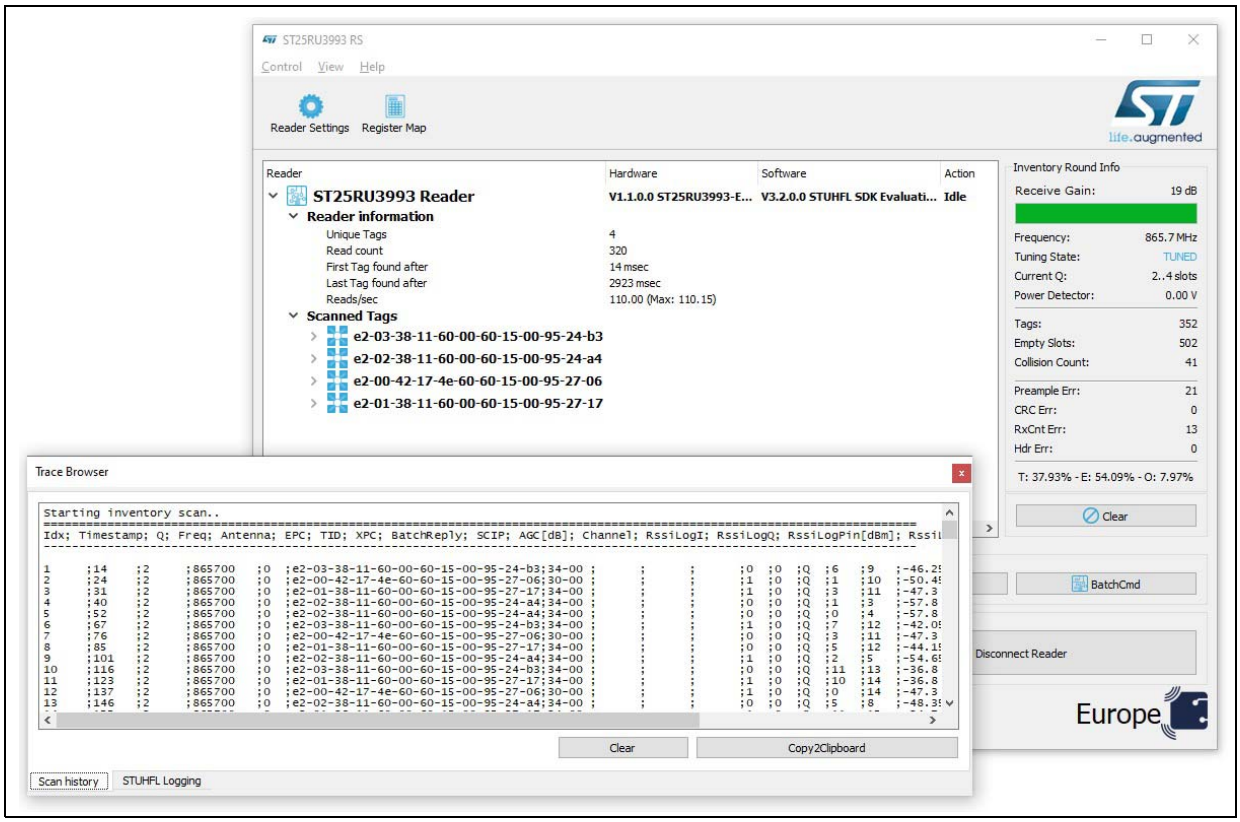
2.9 Tools

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

2.9.1 Trace browser

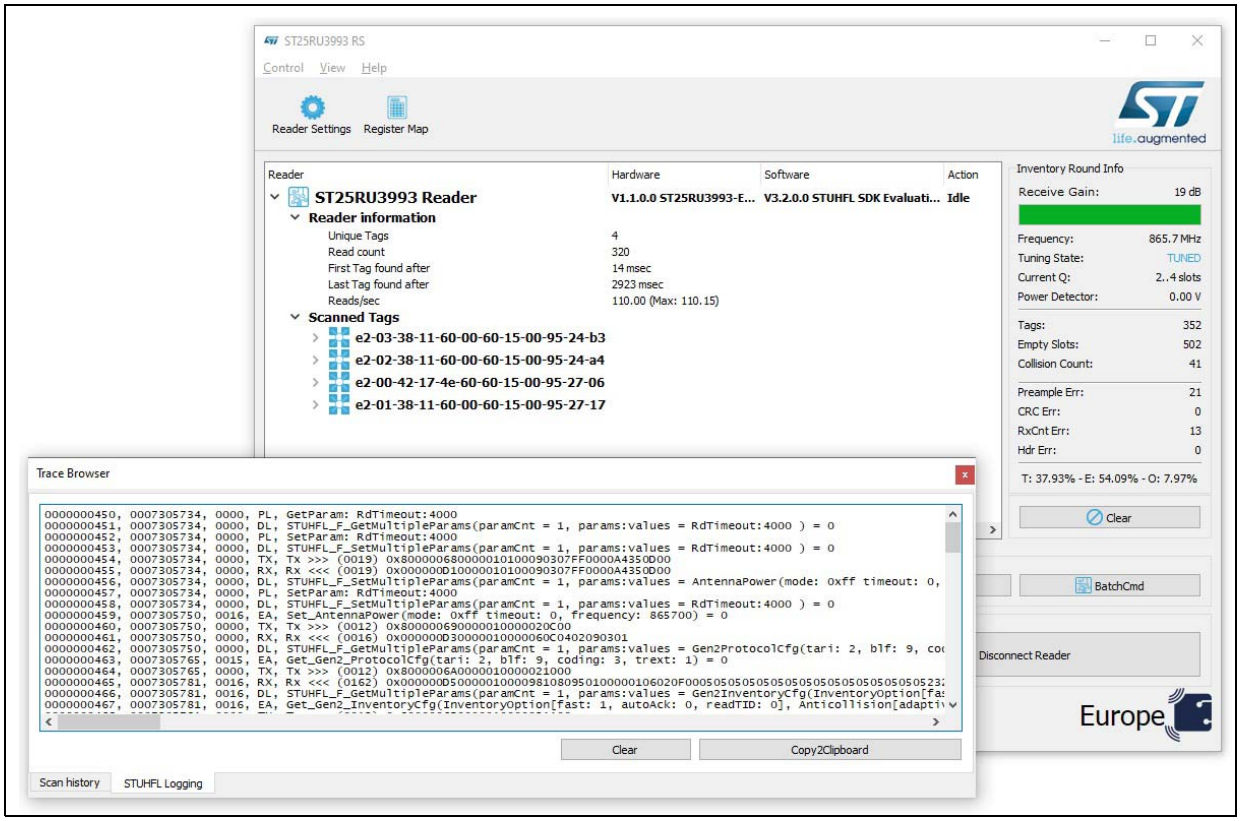
The Trace browser is used to record all communication information between the Reader Suite GUI and the ST25RU3993 evaluation board. On the Scan history tab, the trace browser logs all found tag EPCs and additional information during a running inventory scan.

Figure 28. Trace browser - Scan history



The tab “STUHFL Logging” records the STUHFL SDK communication. Here, all SDK commands are listed that are exchanged between the GUI and the ST25RU3993 evaluation board when the user interacts with GUI elements.

Figure 29. Trace browser - STUHFL logging

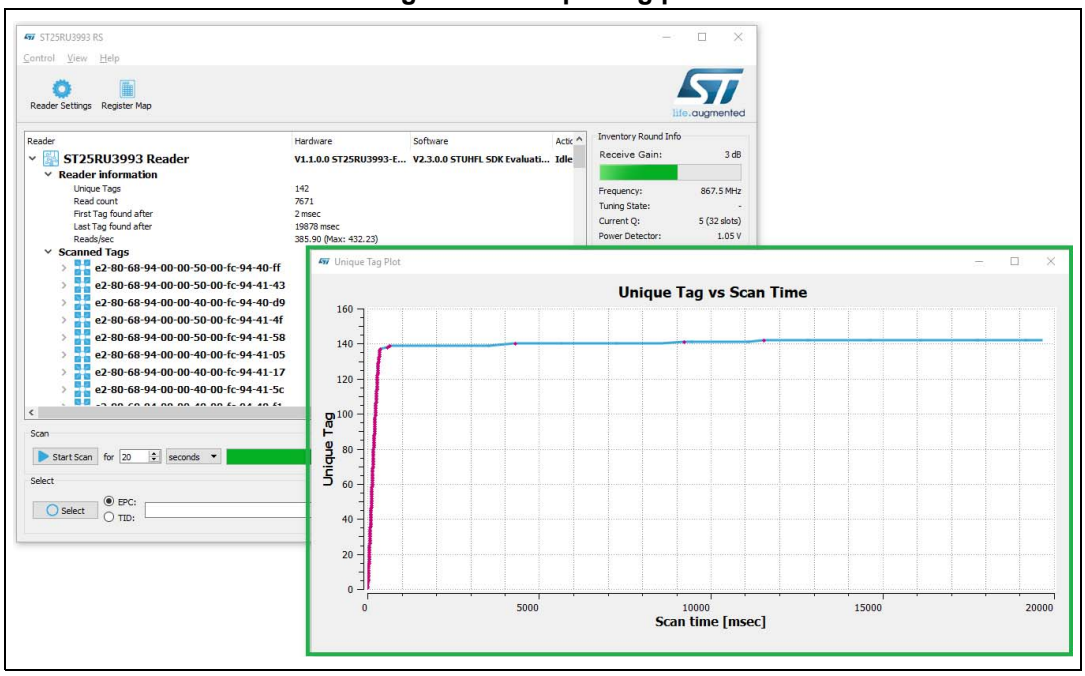

ST25RU3993 RS
Control View Help
Reader Settings
Register Map
life.augmented
Reader
Hardware
Software
Action
ST25RU3993 Reader
V1.1.0.0 ST25RU3993-E...
V3.2.0.0 STUHFL SDK Evaluati...
Idle
Reader information
Unique Tags 4
Read count 320
First Tag found after 14 msec
Last Tag found after 2923 msec
Reads/sec 110.00 (Max: 110.15)
Scanned Tags
e2-03-38-11-60-00-60-15-00-95-24-b3
e2-02-38-11-60-00-60-15-00-95-24-a4
e2-00-42-17-4e-60-60-15-00-95-27-06
e2-01-38-11-60-00-60-15-00-95-27-17
Inventory Round Info
Receive Gain: 19 dB
Frequency: 865.7 MHz
Tuning State: TUNED
Current Q: 2..4 slots
Power Detector: 0.00 V
Tags: 352
Empty Slots: 502
Collision Count: 41
Preample Err: 21
CRC Err: 0
RxCnt Err: 13
Hdr Err: 0
T: 37.93% - E: 54.09% - O: 7.97%
Clear
BatchCmd
Disconnect Reader
Europe
Trace Browser
0000000450, 0007305734, 0000, PL, GetParam: RdTimeout:4000
0000000451, 0007305734, 0000, DL, STUHFL_F_GetMultipleParams(paramCnt = 1, params:values = RdTimeout:4000) = 0
0000000452, 0007305734, 0000, PL, SetParam: RdTimeout:4000
0000000453, 0007305734, 0000, DL, STUHFL_F_SetMultipleParams(paramCnt = 1, params:values = RdTimeout:4000) = 0
0000000454, 0007305734, 0000, TX, Tx >>> (0019) 0x8000006800000101000903 07FF0000A4350D00
0000000455, 0007305734, 0000, RX, Rx <<< (0019) 0x0000000D1000001010009030 7FF0000A4350D00
0000000456, 0007305734, 0000, DL, STUHFL_F_SetMultipleParams(paramCnt = 1, params:values = AntennaPower(mode: 0xff timeout: 0,
0000000457, 0007305734, 0000, PL, SetParam: RdTimeout:4000
0000000458, 0007305734, 0000, DL, STUHFL_F_SetMultipleParams(paramCnt = 1, params:values = RdTimeout:4000) = 0
0000000459, 0007305750, 0016, EA, Set_AntennaPower(mode: 0xff timeout: 0, frequency: 865700) = 0
0000000460, 0007305750, 0000, TX, Tx >>> (0012) 0x8000006900000100000020C00
0000000461, 0007305750, 0000, RX, Rx <<< (0016) 0x000000D3000001000006OC0402090301
0000000462, 0007305750, 0000, DL, STUHFL_F_GetMultipleParams(paramCnt = 1, params:values = Gen2ProtocolCfg(tari: 2, blf: 9, co
0000000463, 0007305765, 0015, EA, Get_Gen2_ProtocolCfg(tari: 2, blf: 9, coding: 3, trext: 1) = 0
0000000464, 0007305765, 0000, TX, Tx >>> (0012) 0x8000006A0000010000021000
0000000465, 0007305781, 0016, RX, Rx <<< (0162) 0x0000000D5000001000098108095010000010602OF0005050505050505050505050505233
0000000466, 0007305781, 0016, DL, STUHFL_F_GetMultipleParams(paramCnt = 1, params:values = Gen2InventoryCfg(InventoryOption[fa
0000000467, 0007305781, 0016, EA, Get_Gen2_InventoryCfg(InventoryOption[fast: 1, autoAck: 0, readTID: 0], Anticollision[adaptiv
Clear
Copy2Clipboard
Scan history
STUHFL Logging

2.9.2 Unique Tag plot dialog

The Unique Tag plot dialog records the number of unique tag EPCs found during the inventory scan in real time.

Each magenta colored dot on the blue curve symbolizes an unique tag when it is 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 30. Unique Tag plot

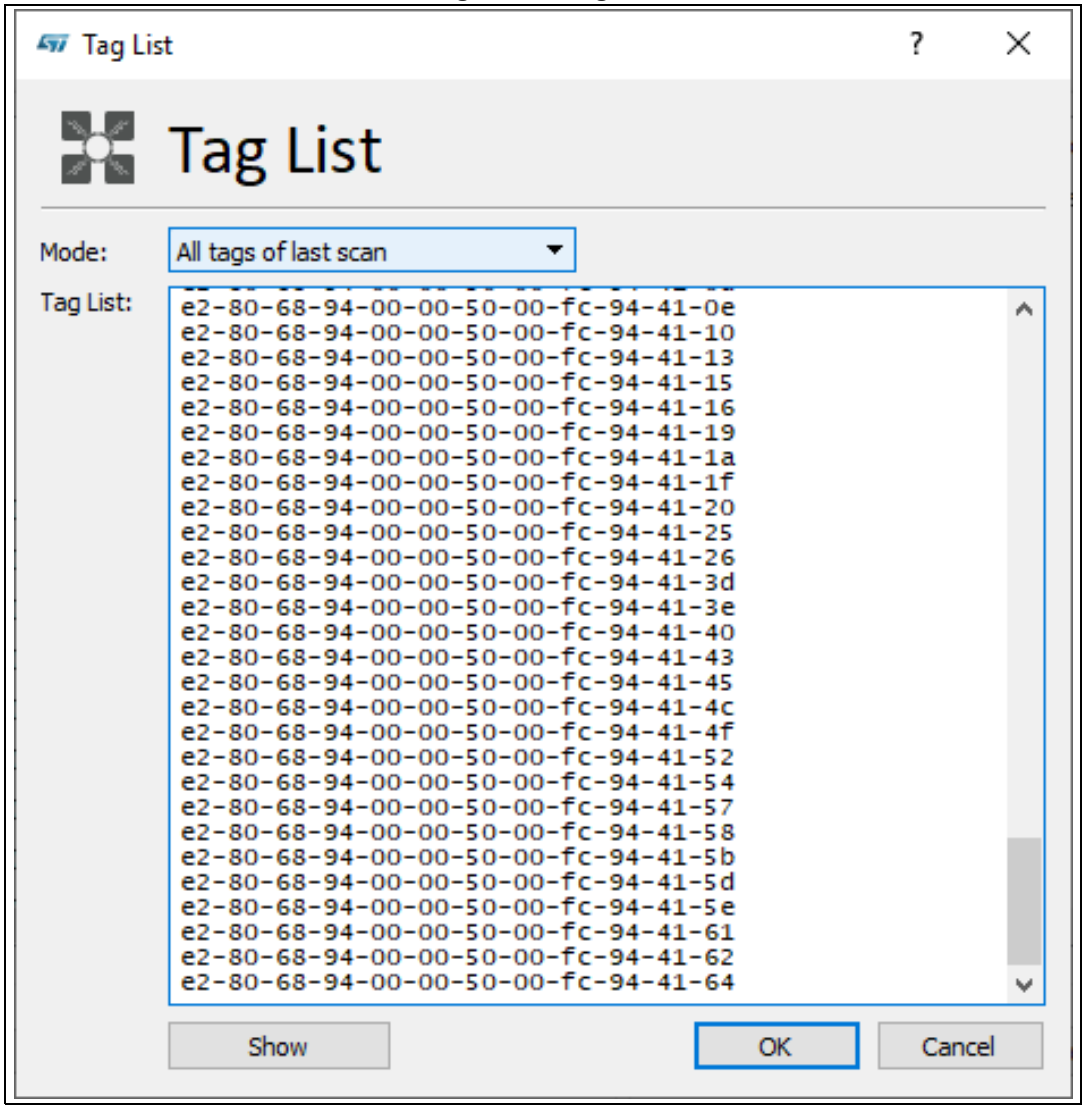


Right-clicking into the Unique Tag plot shows a pop-up menu, which allows to store the last measurement trace as a reference for following scans.

2.9.3 Tag list

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

Figure 31. 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

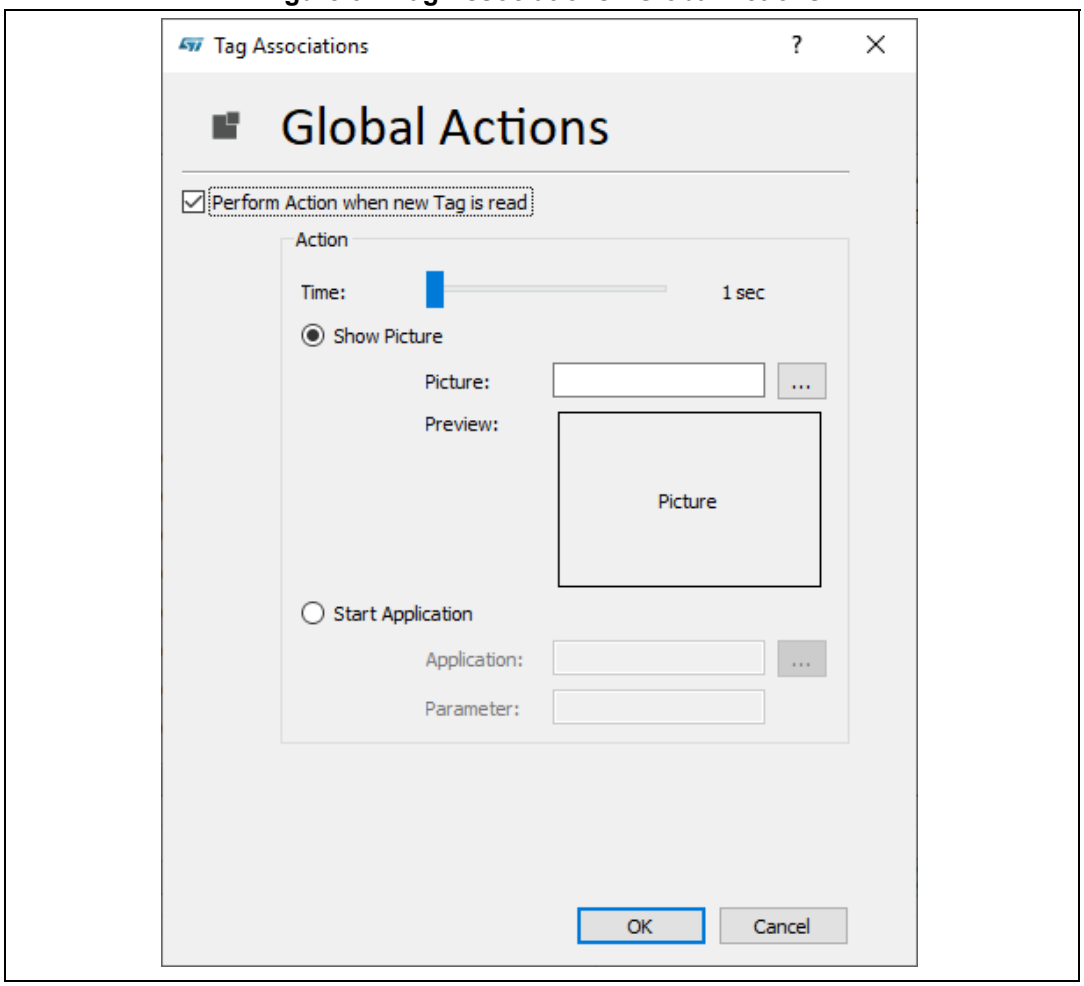
The Show button refreshes the list according to the current settings.

Note: Tags are never listed by their alias names.

2.9.4 Tag Associations - Global Actions

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

Figure 32. 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.

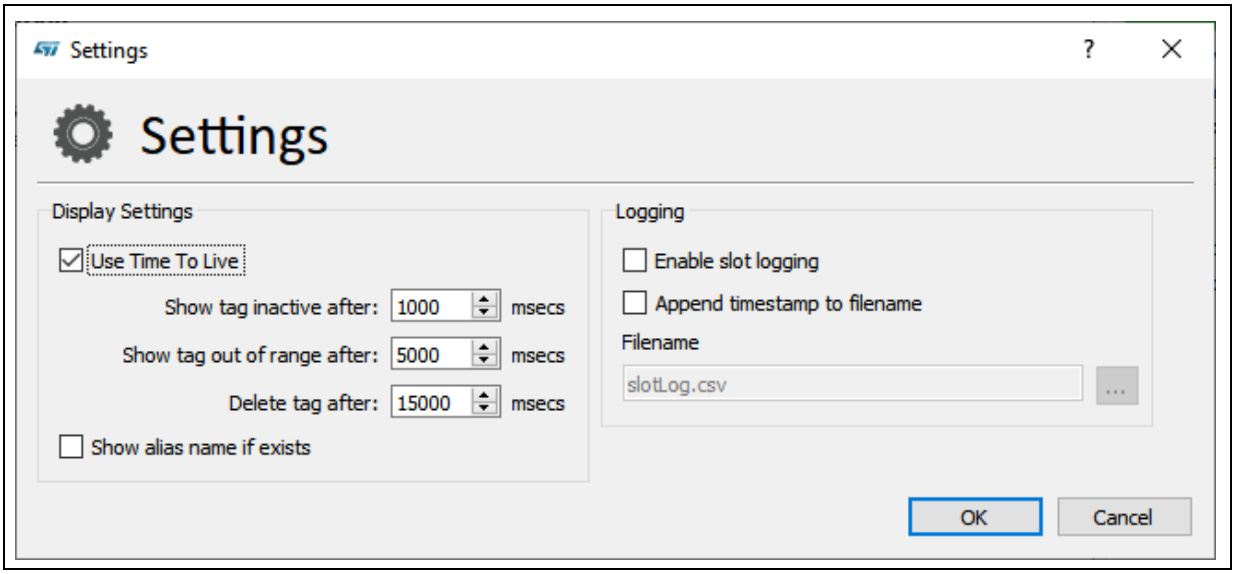
2.9.5 Settings

The Settings dialog allows to customize the display settings of the tag list found in the main window and the logging behavior.

The Settings dialog has two panels:

- Display Settings
- Logging

Figure 33. Settings window

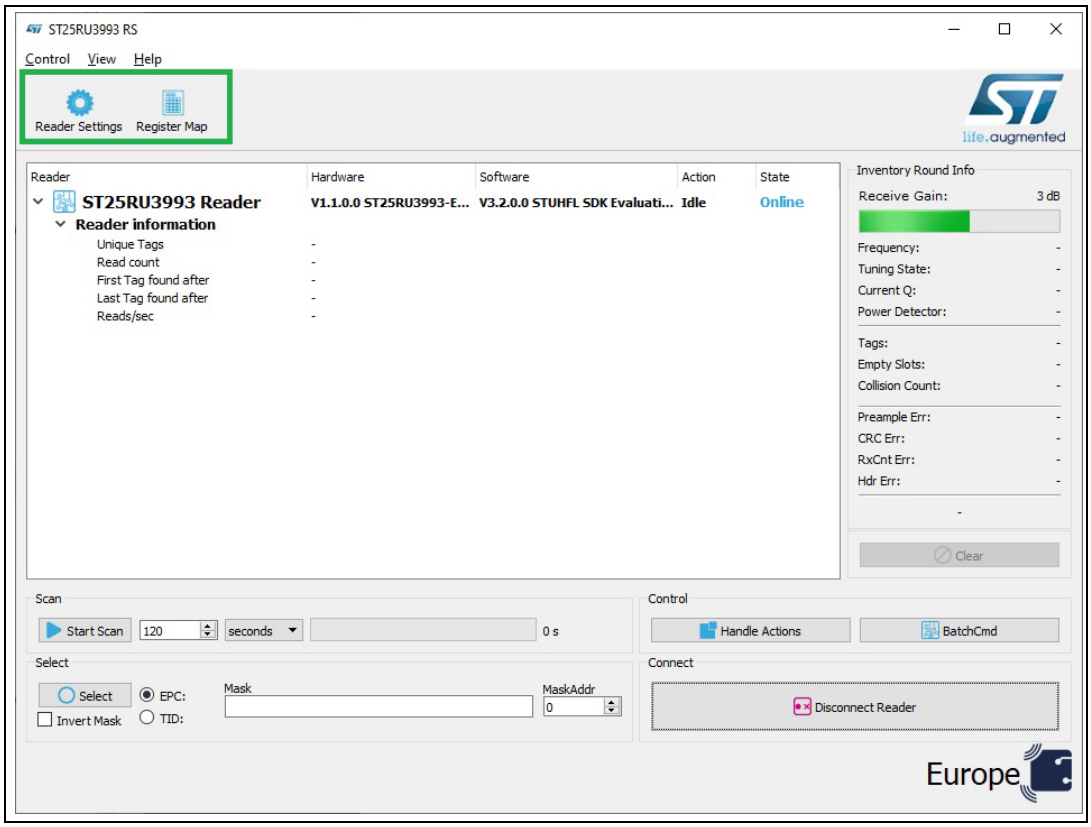


- **Display Settings:**
  - **Use Time to Live**: Activate/Deactivate the timing definitions for tag entries displayed in the main window.
  - **Show tag inactive after**: Timing definition for a tag entry, which is currently not read and is considered inactive. After this time has elapsed that tag entry appears shaded in the main window.
  - **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 inventory round
  - **Append timestamp to filename**: If checked, timestamp information is added to log filename when the log file is created.
  - **Filename:** filename of query slot logging information

2.10 Toolbar

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

Figure 34. Toolbar

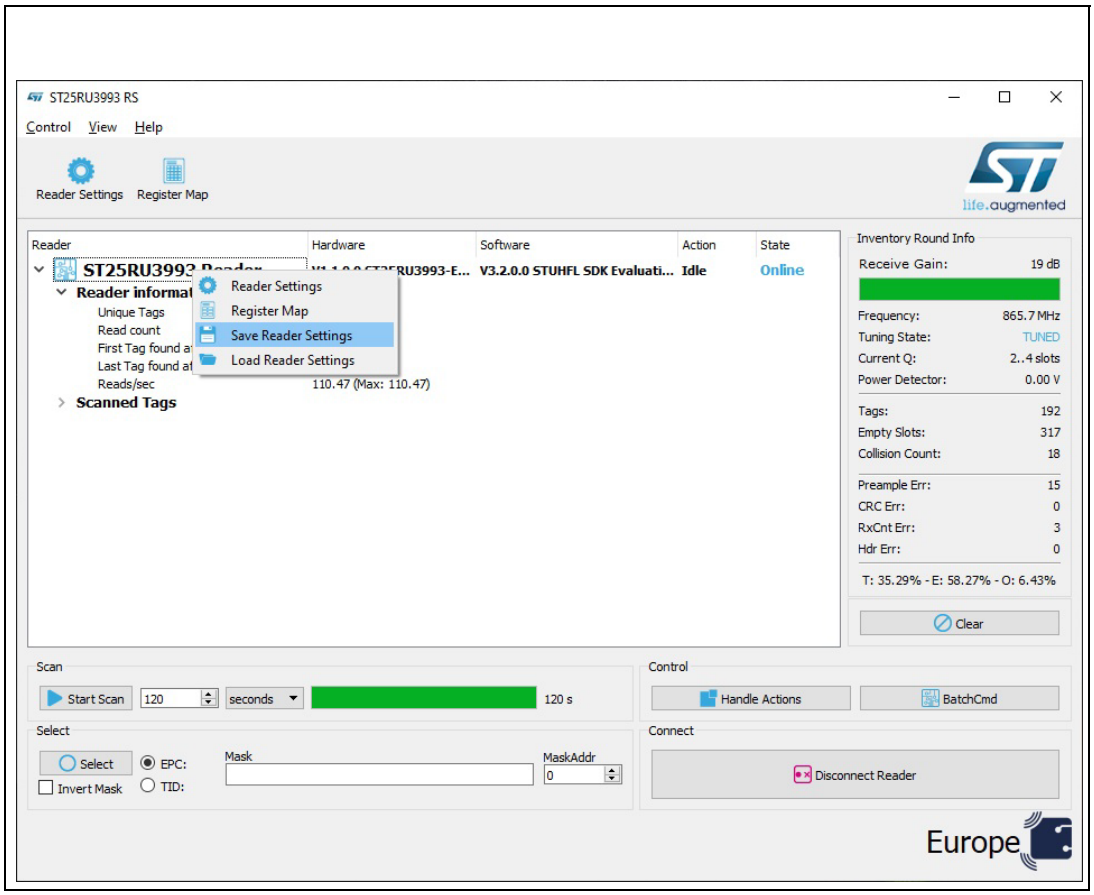


2.11 Context menues

The Main screen offers two locations to access a context menu for quick access to selected functionalities. The first location is the ST25RU3993 Reader information line. The second location is each EPC entry in the scanned tags tree view.

2.11.1 Context menu ST25RU3993 Reader

Figure 35. Context menu - ST25RU3993 Reader

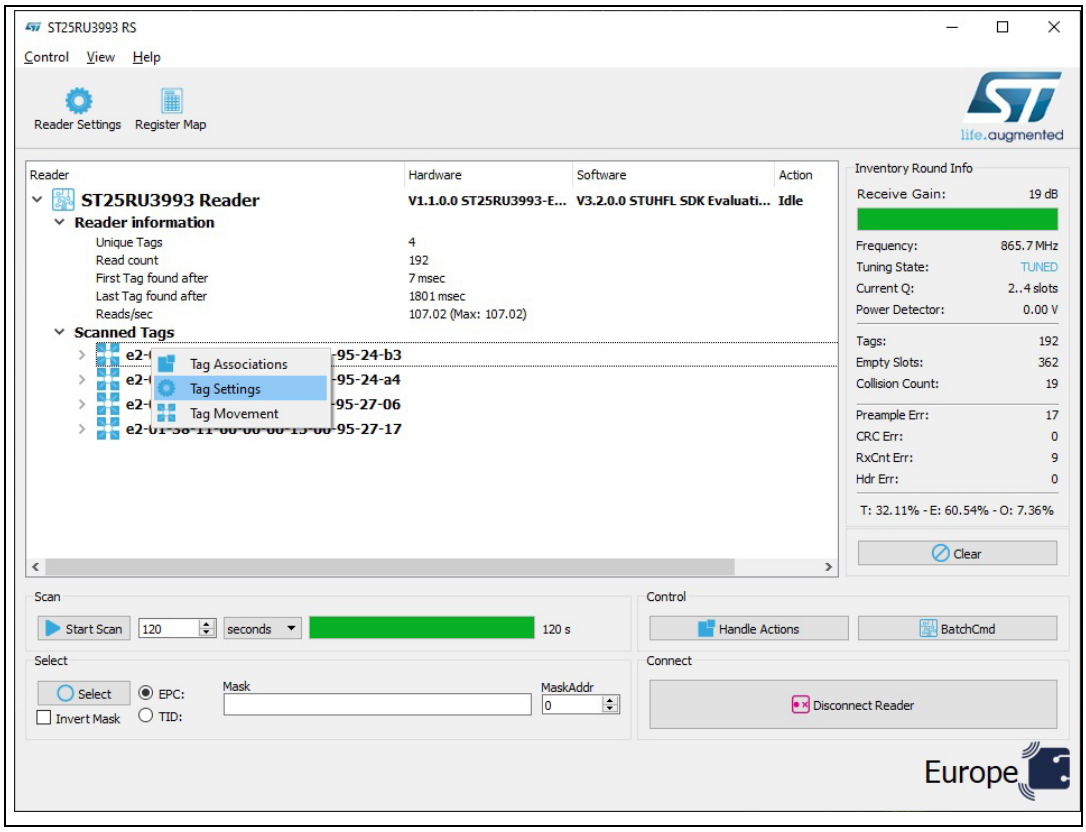


Where:

- **Reader Settings**: Opens the Reader Settings dialog window. Further details about the Reader Settings dialog are described in *Section 4: Reader Settings*.
- **Register Map**: Opens 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 reader settings from a file.

2.11.2 Context menu - Scanned Tags

Figure 36. Context menu – Scanned Tags



Where:

- **Tag Associations**: This entry opens the Tag Associations dialog. See *Section 2.9.4: Tag Associations - Global Actions*.
- **Tag Settings**: This entry opens the Tag Settings dialog. See *Section 5: Tag Settings*.

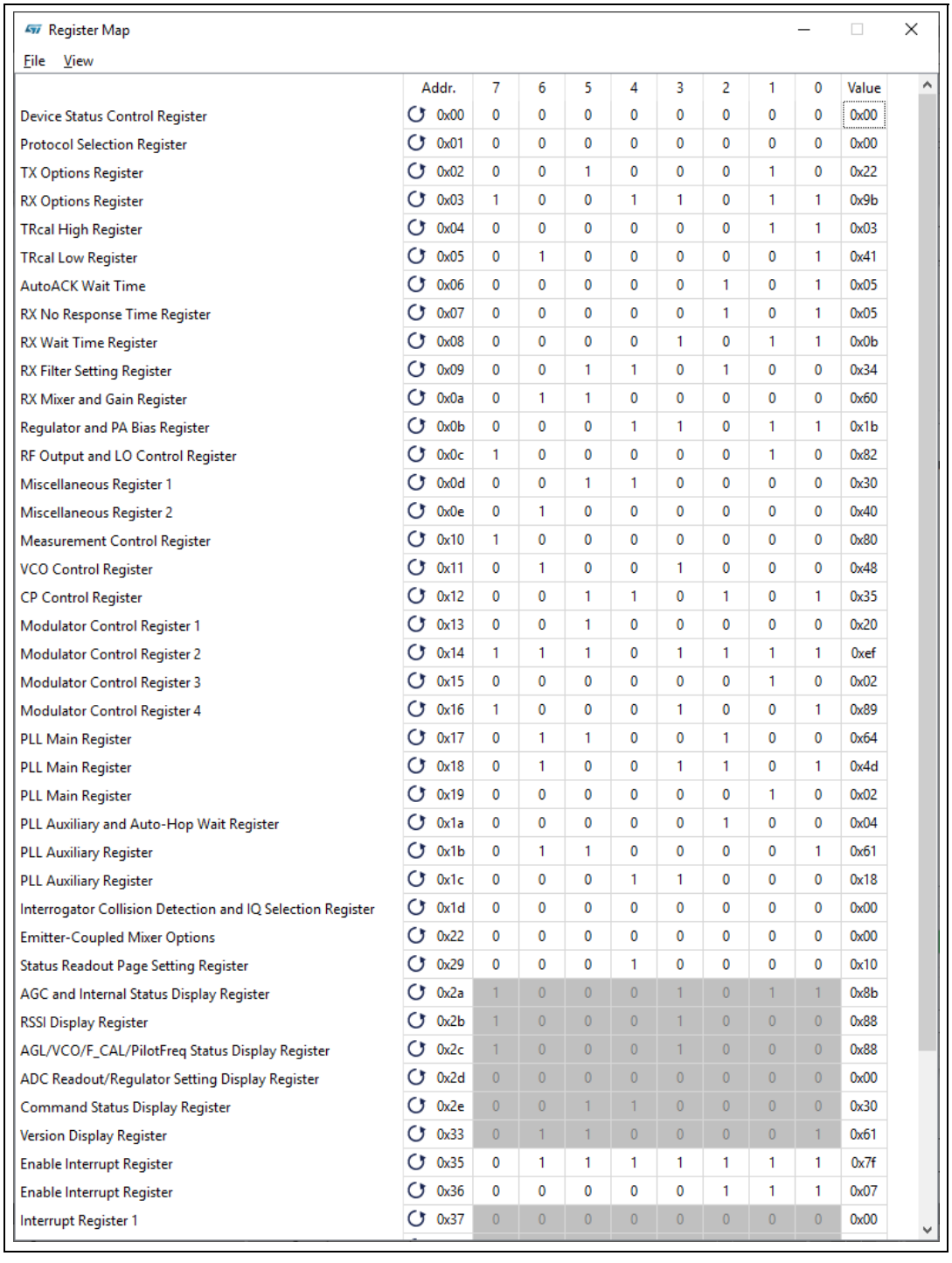
3 Register map

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. 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 of the 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 37. Register Map



	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

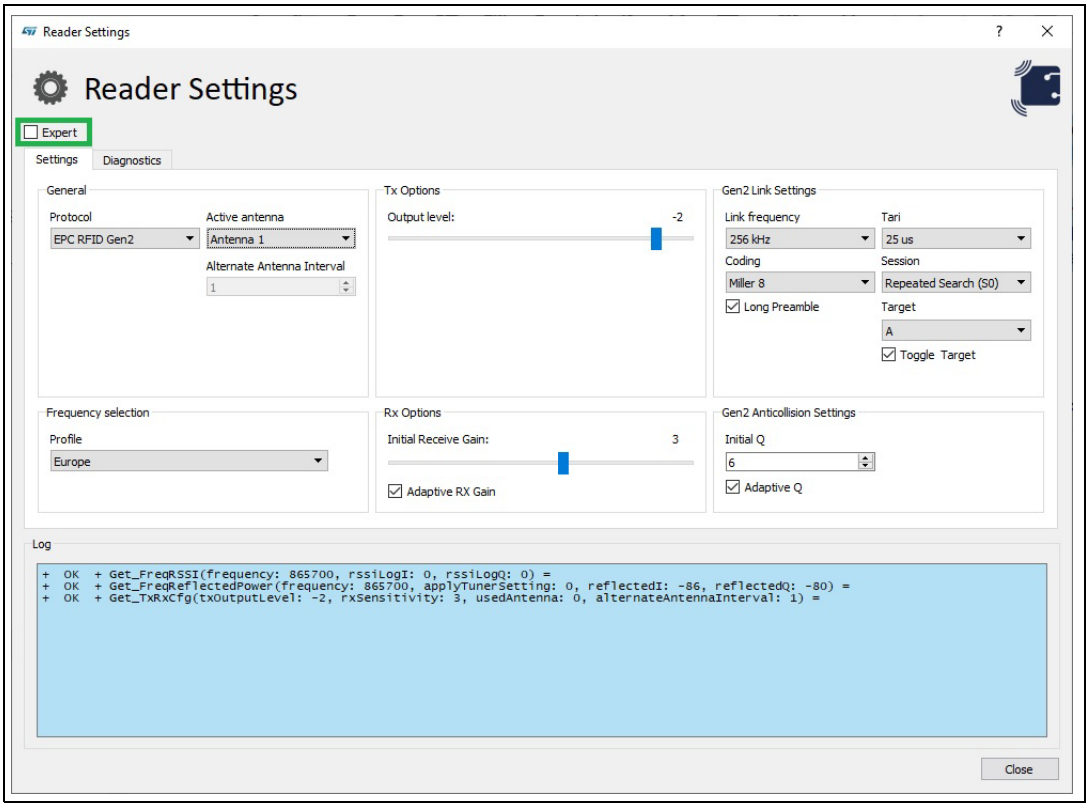
4 Reader Settings

The Reader Settings dialog allows to configure the ST25RU3993 evaluation board for different use cases.

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.

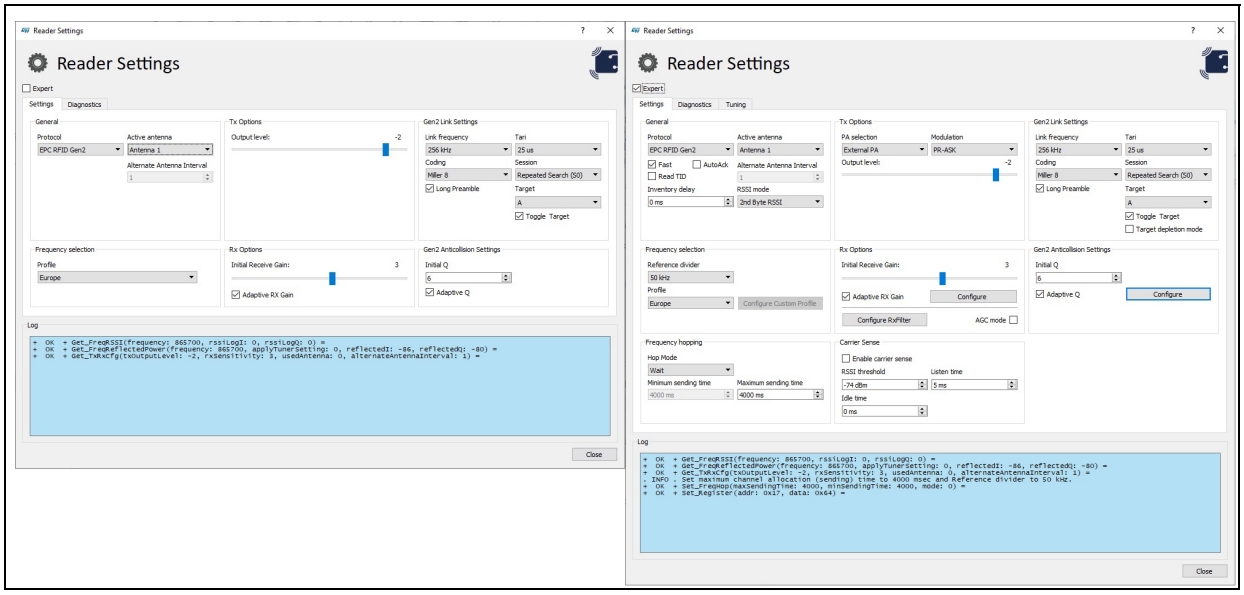
When opening the Reader Settings dialog, by default a simplified view of the reader configuration and settings is shown. This simplified view gives access to the most frequently used reader settings for the ST25RU3993 evaluation board.

Figure 38. Expert mode switch



If access to all possible configurations and settings is needed activate the “Expert” checkbox.

Figure 39. Default (simplified) view versus Expert view



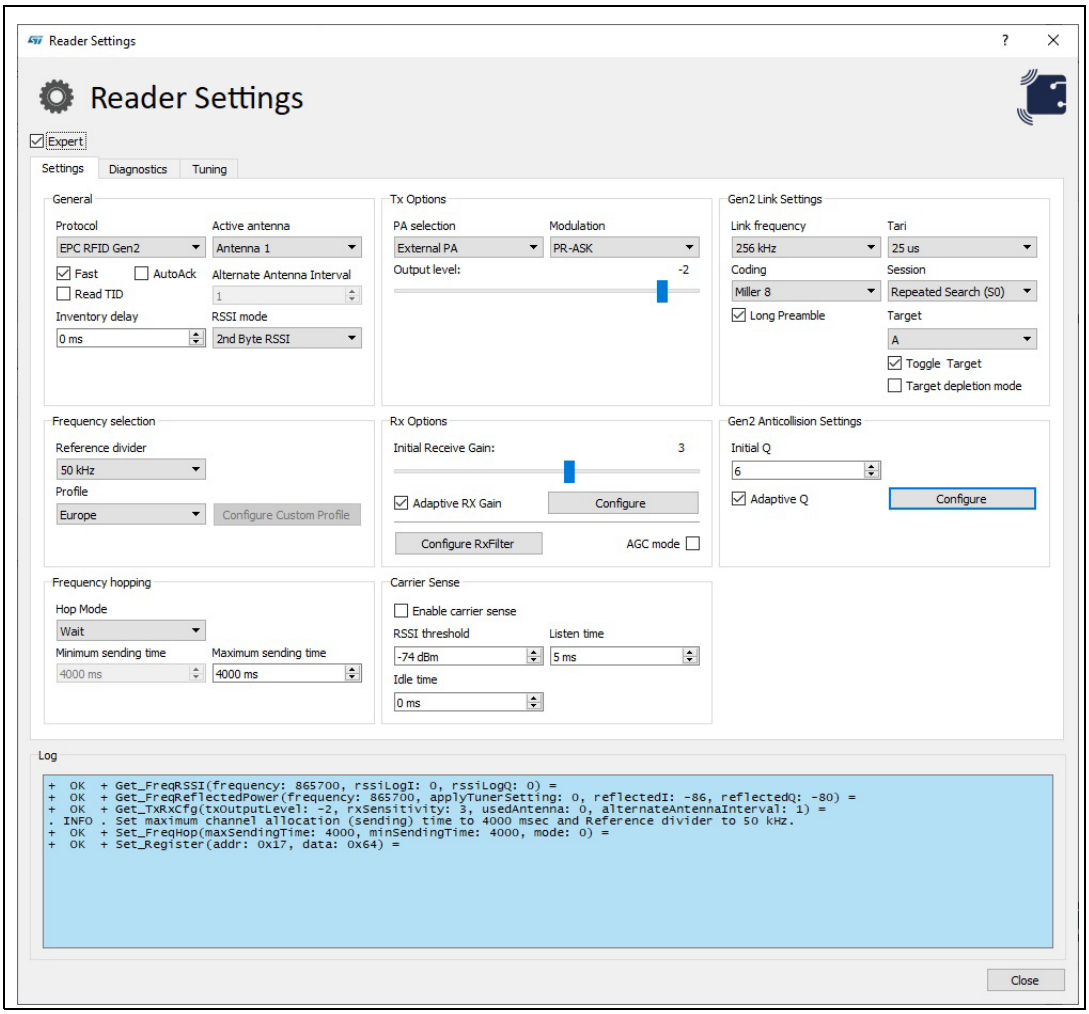
The expert mode provides access to all possible configuration and settings elements of the GUI. The following section describes the Reader Settings dialog with activated expert mode.

The Reader Settings window is organized in three tabs:

- Settings: Changes/modifies 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 (CW) signal of the RF carrier.
- Tuning: Allows to control the carrier cancellation circuitry

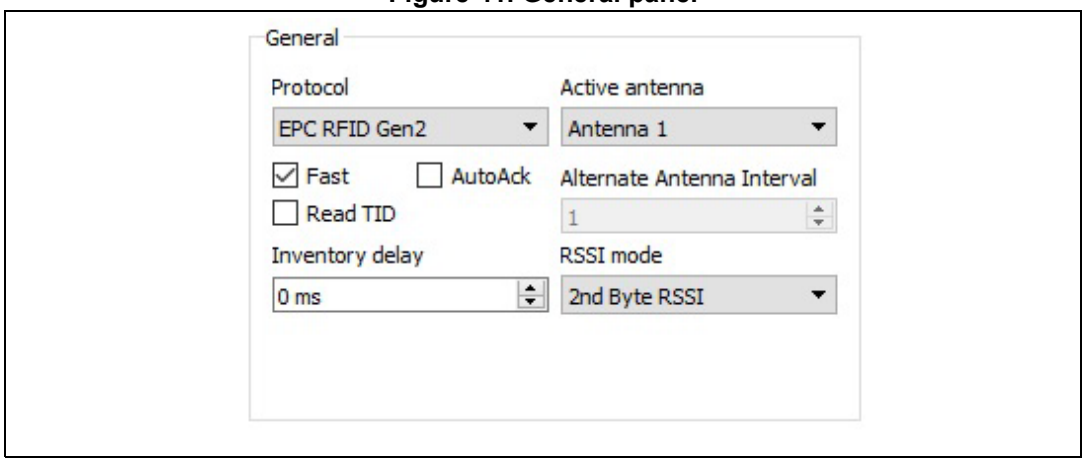
4.1 Settings tab

Figure 40. Reader Settings - Settings tab



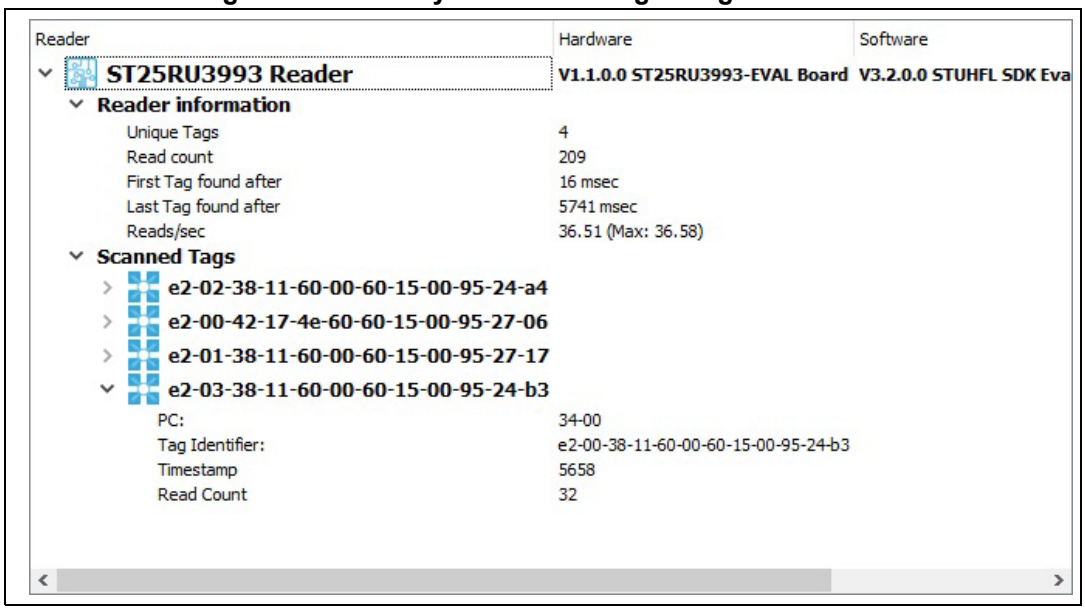
4.1.1 General panel

Figure 41. General panel



- **Protocol**: Defines the protocol being used for reader – transponder communication. Supported protocols are the following.
  - EPC RFID Gen2/ISO18000-63
  - GBT-29768
  - ISO18000-6B
- **Active antenna**: Configures the active antenna port to be used during tag inventory. Selects either Antenna 1 or Antenna 2 as the active antenna port. If “Alternate” is selected, the “Interval [rounds]” field is enabled which defines the number of inventory rounds after which the active antenna port is toggled.
- **Fast**: During an inventory scan, the reader sends a QueryRep command once the Tag responds with its EPC. If disabled, the reader sends a ReqRN once the Tag responds with its EPC and waits for the tag’s Handle. Only then a QueryRep command is sent.
- **AutoAck**: With the autoACK feature being enabled, ST25RU3993 autonomously sends the ACK command after receiving a valid RN16 tag reply without any MCU activity. With the Fast checkbox deactivated this mode instructs the ST25RU3993 to autonomously send also a ReqRN command after the EPC response of the tag.
- **Read TID**: Reads the TID in addition to the EPC during inventory scan. If this option is selected, the “Tag Identifier” entry is added to Scanned tags details. See the below figure:

Figure 42. TID entry in Scanned Tags - Tag information

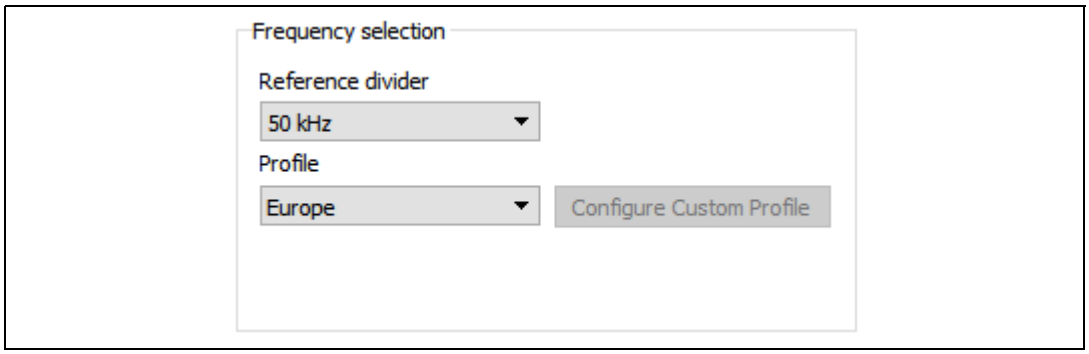


- **Alternate Antenna Interval**: Defines the number of inventory rounds after which the active antenna port is toggled. This field is only enabled when Active antenna is set to Alternate.
- **Inventory Delay**: By changing the Inventory Delay, an additional wait time [ms] is introduced which is effective between two consecutive inventory rounds. The maximum value is 20000 ms.
- **RSSI mode**: Defines when the RSSI of the tag is measured:
  - Pilot RSSI
  - 2nd Byte RSSI
  - Peak RSSI

4.1.2 Frequency selection panel

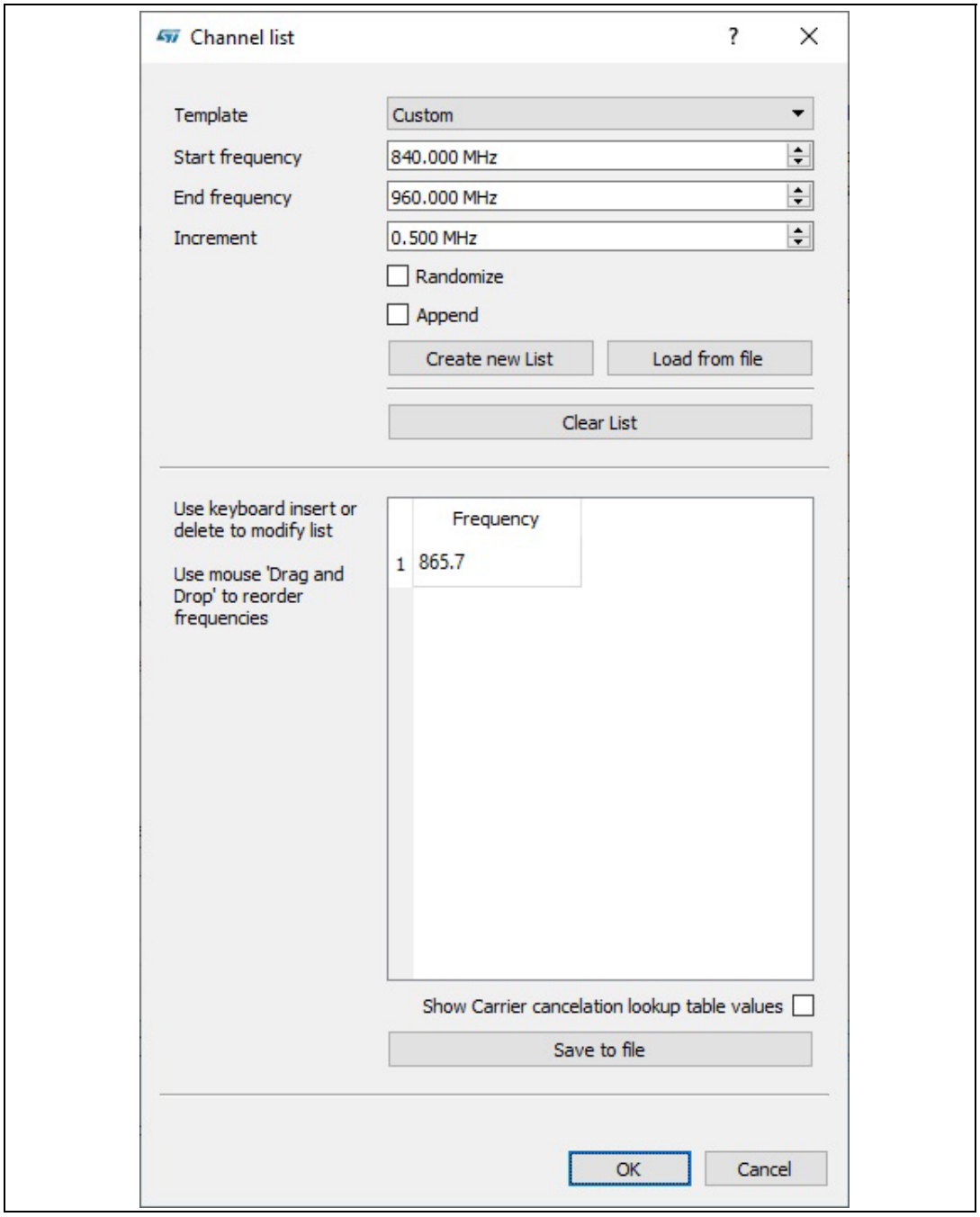
- **Reference divider**: Frequency reference divider used by the internal PLL. This value defines the smallest frequency step of the RF carrier:
  - 25 kHz
  - 50 kHz
  - 100 kHz
- **Profile**: Defines the region-specific frequency profile to be used by the reader.
  - **Europe**: Defines 4 frequency 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 43. Frequency panel



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

Figure 44. Channel list dialog



- **Template**: Selection of a predefined frequency channel list
- **Start freq**: Lowest frequency in MHz when using the custom template
- **End freq**: Highest frequency in MHz when using the custom template
- **Increment**: Frequency increment in MHz when using the custom template
- **Randomize**: If activated, the frequencies added to the channel list are randomized when “Create new List” or “Load from file” is selected
- **Append**: If activated new frequencies are appended to the end of the current channel list. If deactivated, the new frequencies overwrite the current channel list.
- **Create new List**: Creates a new 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**: The reader transmits on the current frequency channel until the maximum sending time has expired.
  - **Power Save**: The reader stops transmission if the inventory round no longer identifies additional tag, 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 immediate frequency hopping if the inventory round does not identify additional Tags, or if the user defined min/max sending time values expires.
  - **Fast FCC**: Perform an immediate frequency hop if the inventory round no longer produces, 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 transmission 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 45. Frequency hopping panel

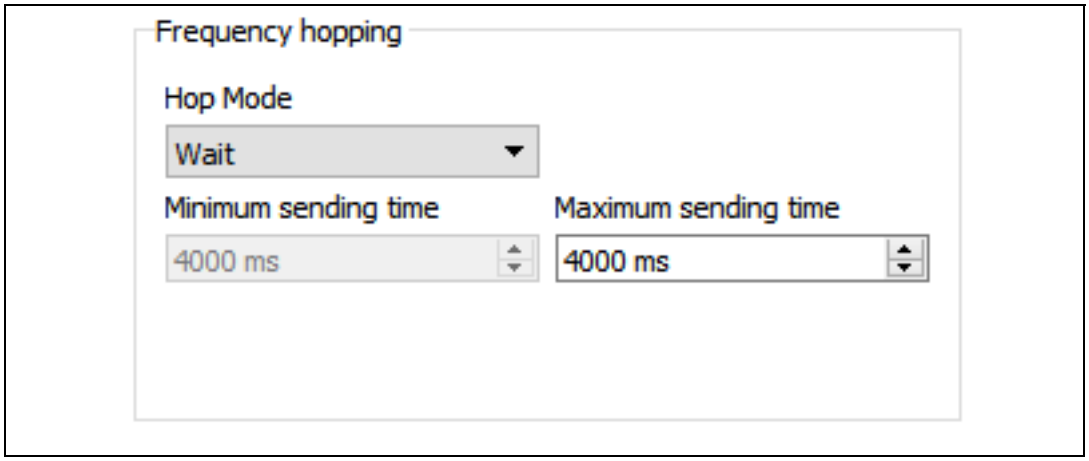
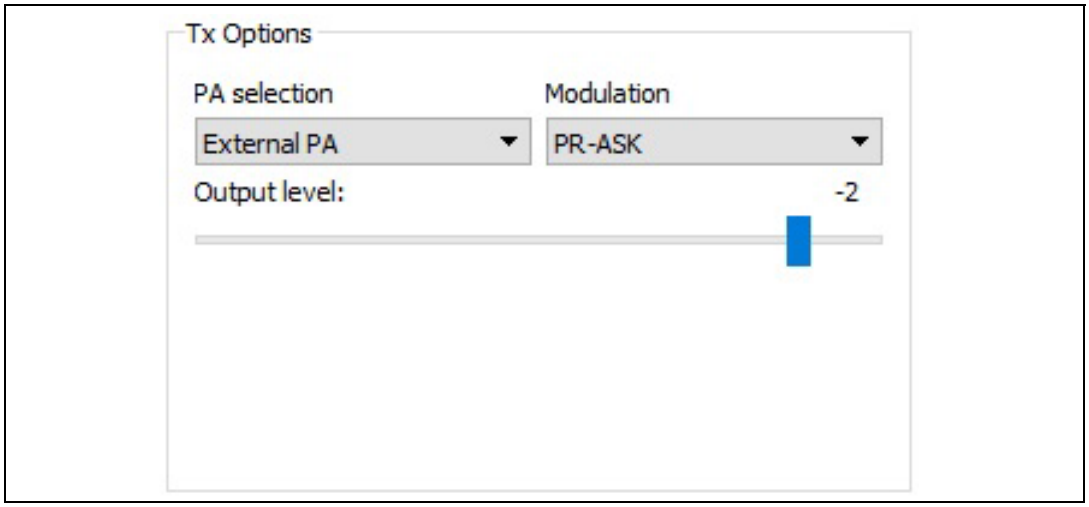


Figure 46. Tx Option panel



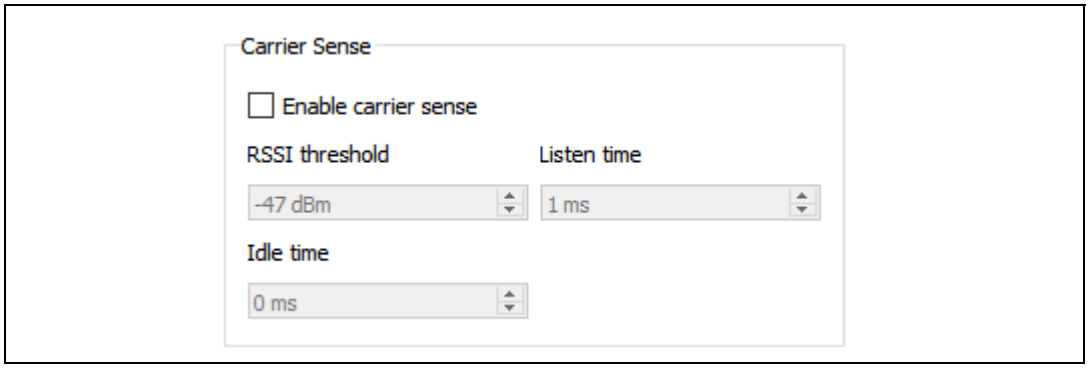
4.1.4 Tx Options panel

- **PA Selection**: Selects the internal power amplifier (PA) or the 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 47. Carrier sense panel



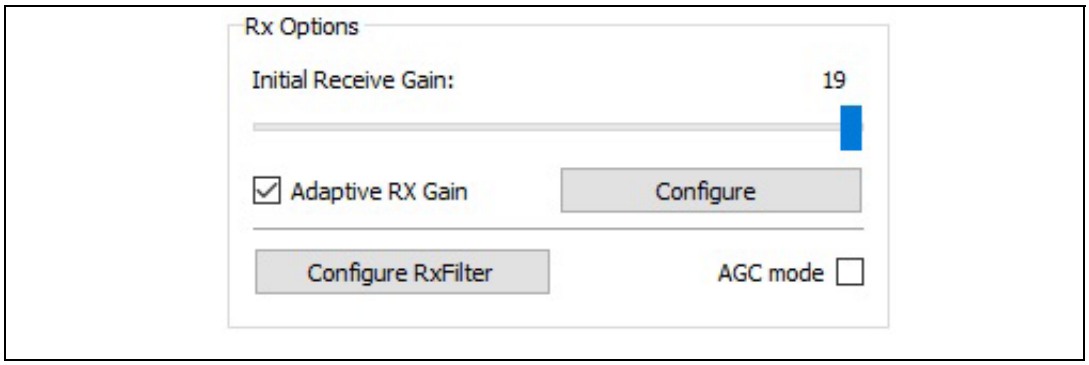
Where:

- **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 against the RSSI threshold.
- **Idle time**: Wait time between a frequency hop and Carrier Sense.

4.1.6 Rx Options panel

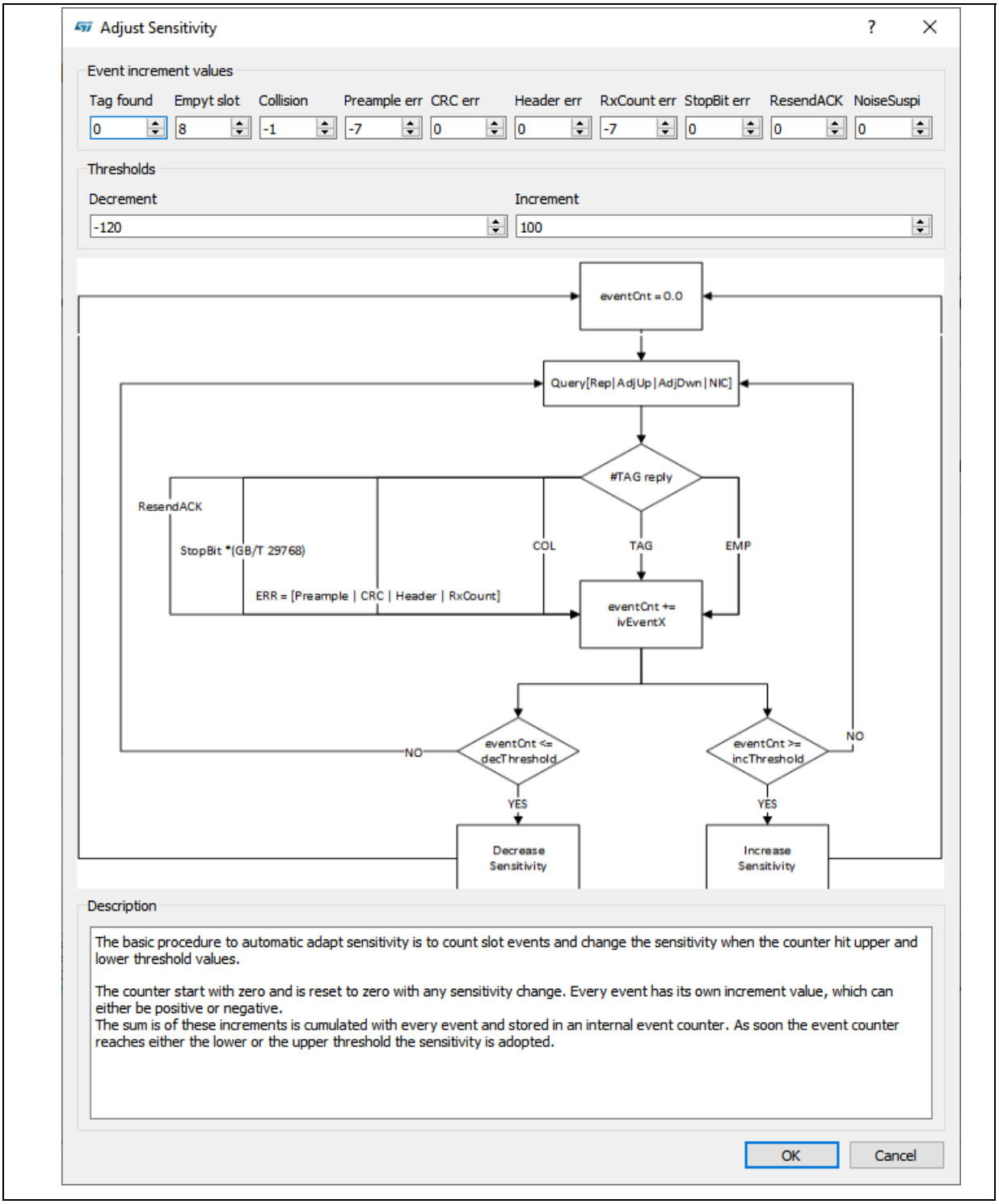
- **Initial Receive Gain**: The Initial Receive Gain slider adjusts the receive gain and/or receive attenuation of the reader. The slider affects register 0x0A.

Figure 48. Rx option panel



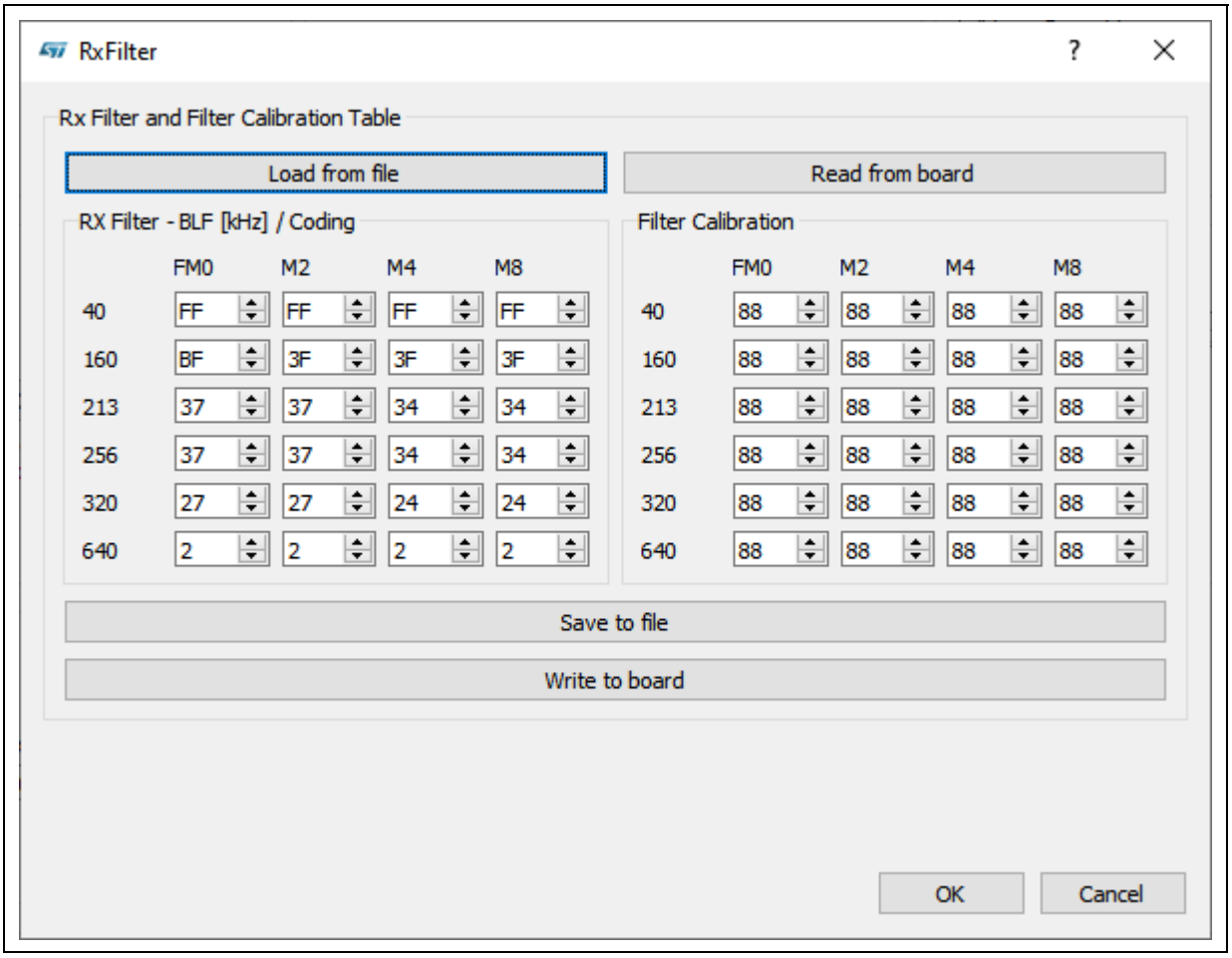
- **Adaptive RX Gain**: This section allows to activate adaptive receive gain/attenuation change. The basic procedure to automatically adapt RX gain is to count slot events and change the sensitivity when the counter hits an upper and a lower threshold values. The counter start with zero and is reset 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 adjusted.

Figure 49. Adjust Sensitivity dialog



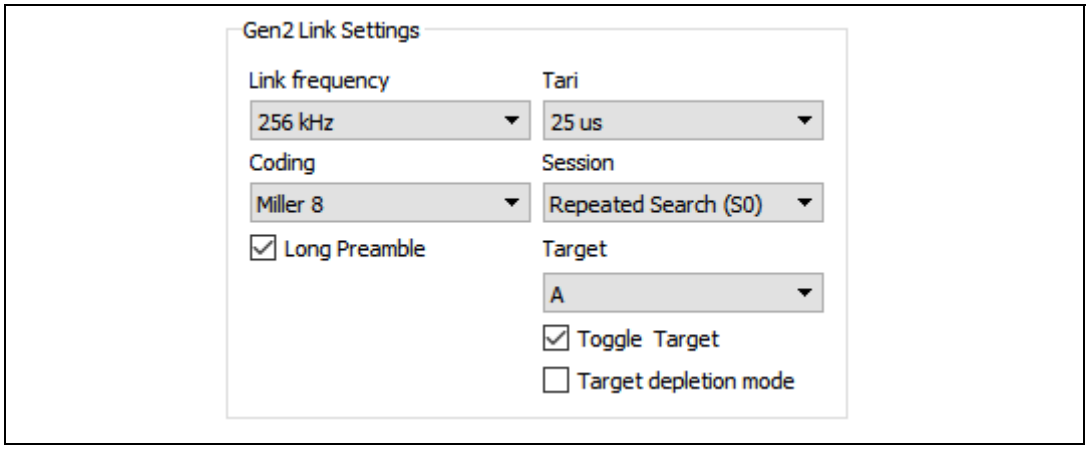
- **AGC Mode**: Enables/Disables the automatic gain control feature of the ST25RU3993.
- **Configure RX Filter**: Opens a dialog to modify ST25RU3993 Rx filter and calibration values.

Figure 50. RX filter dialog



4.1.7 Gen2 settings panel

Figure 51. Gen2 link setting

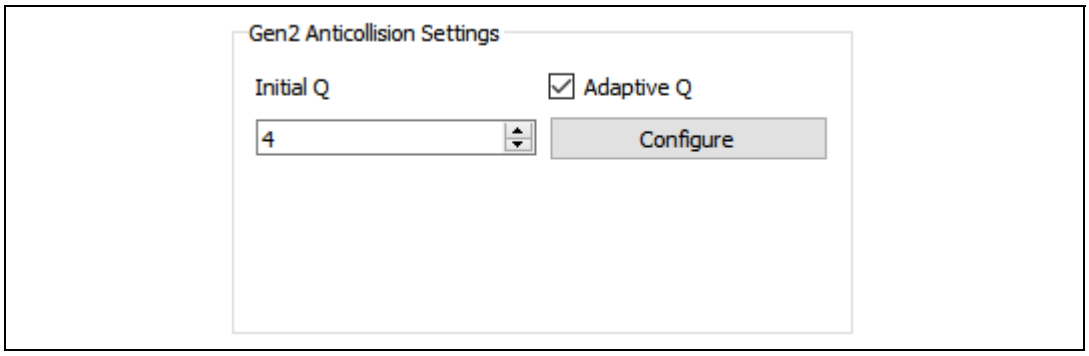


Where:

- **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 matches 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 has not been powered for a long time.
- **Long Preamble**: Disables/Enables the extended tag response preamble.
- **Target Depletion mode**: If enabled, the target is toggled only if the inventory rounds do not yield any additional tags. 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 for TARI are:
- 6.25 µs
- 12.5 µs
- 25 µs

4.1.8 Gen2 Anticollision Settings panel

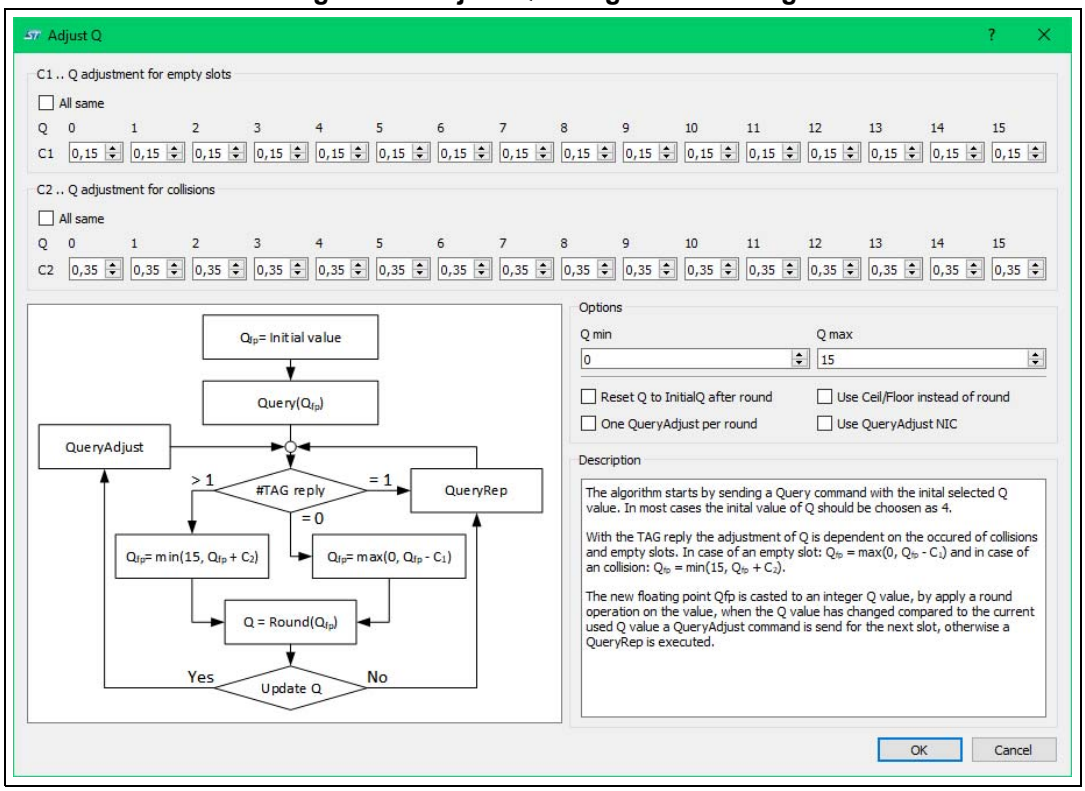
Figure 52. Gen2 Anticollision setting



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 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 53. Adjust Q configuration dialog



- **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.

4.2 Diagnostics

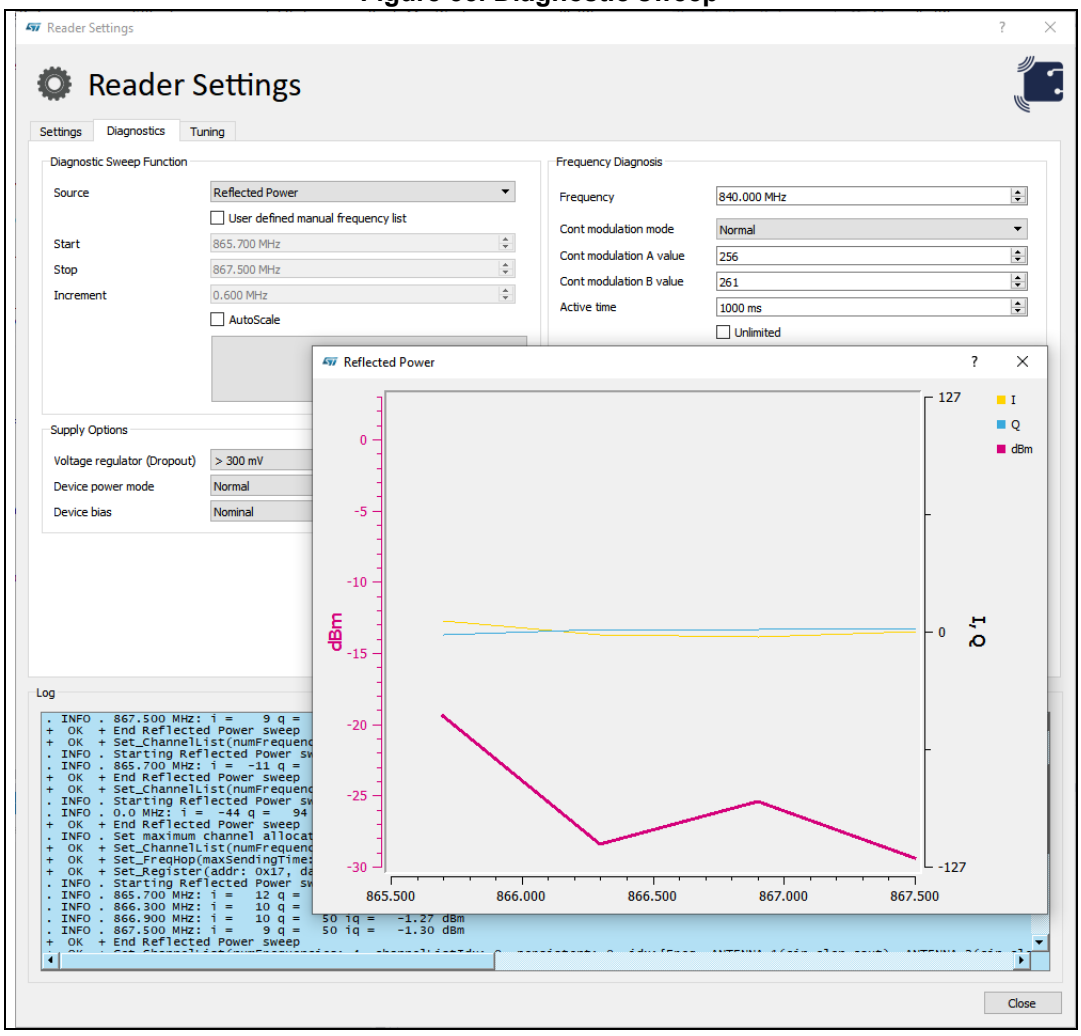
Figure 54. Reader Settings - Diagnostics tab

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**: Lowest 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**: Highest frequency of the frequency sweep in MHz.
- **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 55. 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 sequence as 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 at 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

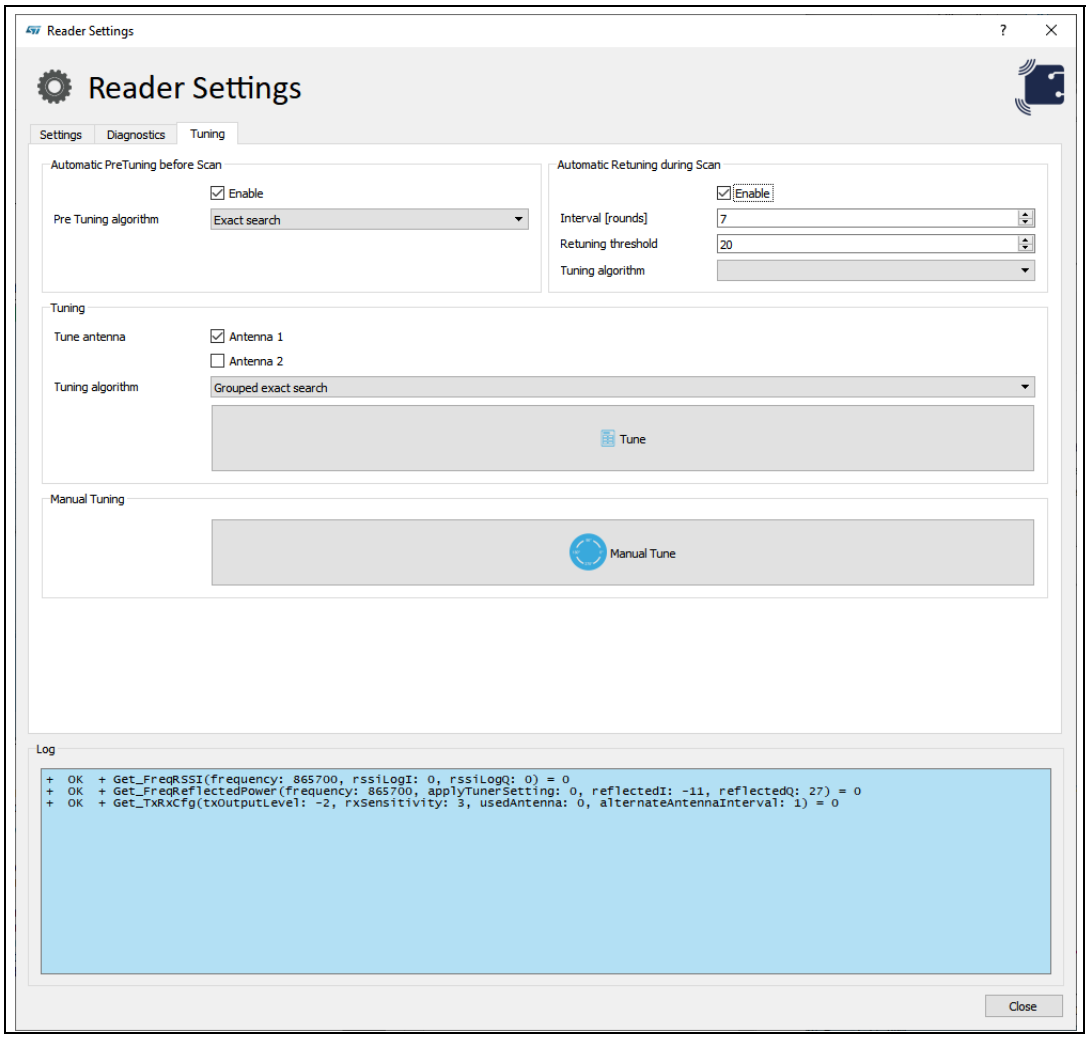
To measure the power consumption of the ST25RU3993 reader IC, the device power mode and settings can be changed here.

- **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 56. Reader Settings - Tuning tab



4.3.1 Tuning 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 resulting to 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 stop 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. Note that the other implemented algorithms put more focus on the reflected power suppression 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 could 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 using the selected tuning algoritm.

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

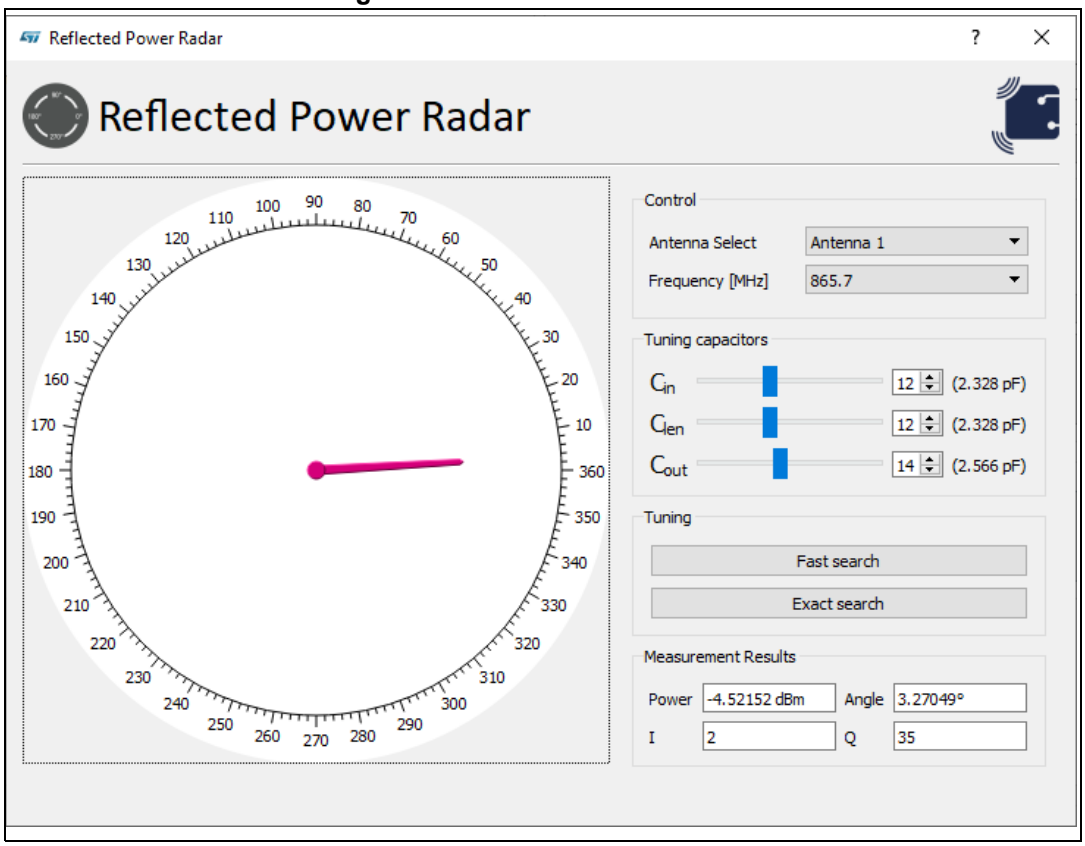
The retuning tries to compensate for any changes of the antenna environment that may have happened after the tuning file has been created and which resulted to an increase in the reflected power level. Once a frequency channel has been re-tuned, the tuning lookup table is updated and stored in the memory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

- **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.
- **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 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 smaller, the better) while the angle of the arrow represents the phase relative to the local oscillator (LO) signal.

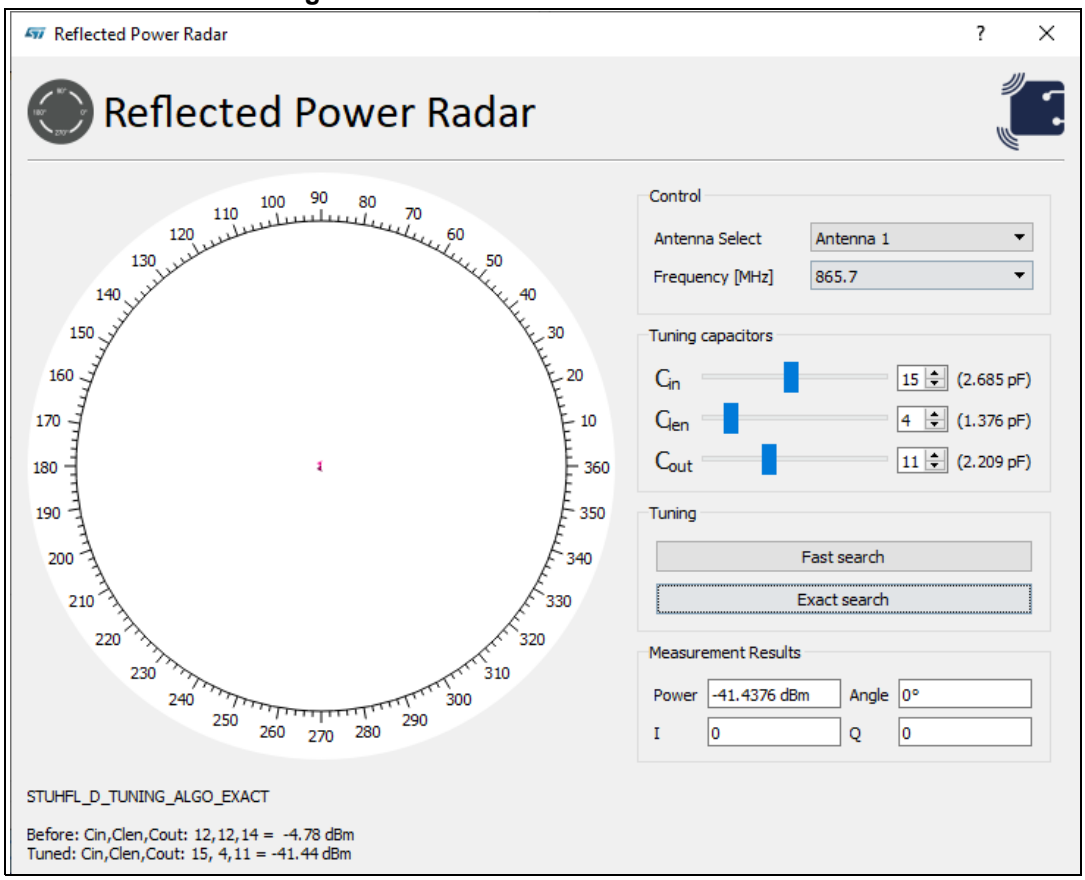
Figure 57. Reflected Power Radar



- **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**
  - **Cin**: This slider changes the capacitance value of the input shunt capacitor of the carrier cancellation circuit.
  - **Clen**: This slider changes the capacitance value of the series capacitor of the carrier cancellation circuit.
  - **Cout**: 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 58. Reflected Power Radar - Tuned



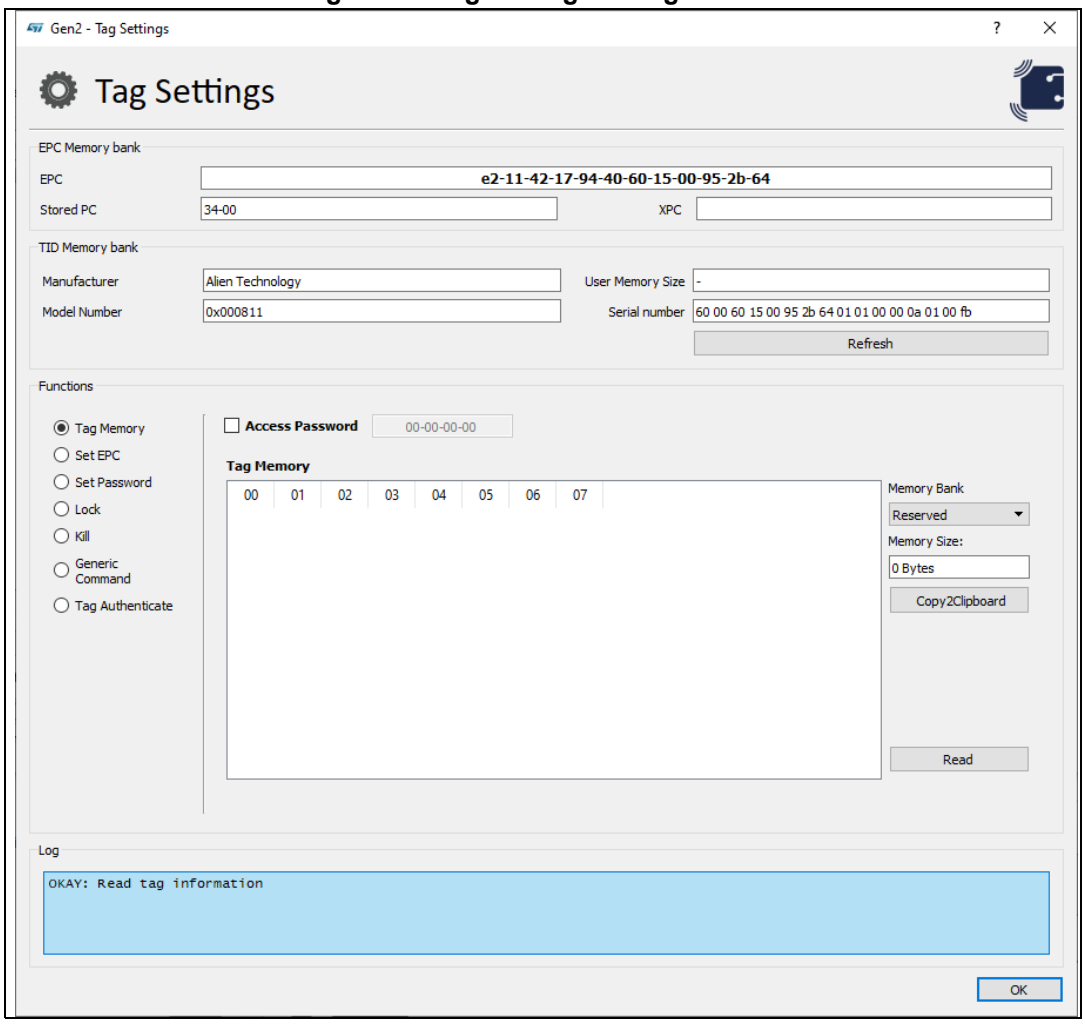
- Measurement Results panel
  - **Power**: Shows the reflected power measurement result in a numeric form. The reflected power measurement is performed by ST25RU3993.
  - **Angle**: Shows the phase of the reflected power relative to the local oscillator signal.
  - **I**: ADC results for the in-phase 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 59. Tag Settings dialog window



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

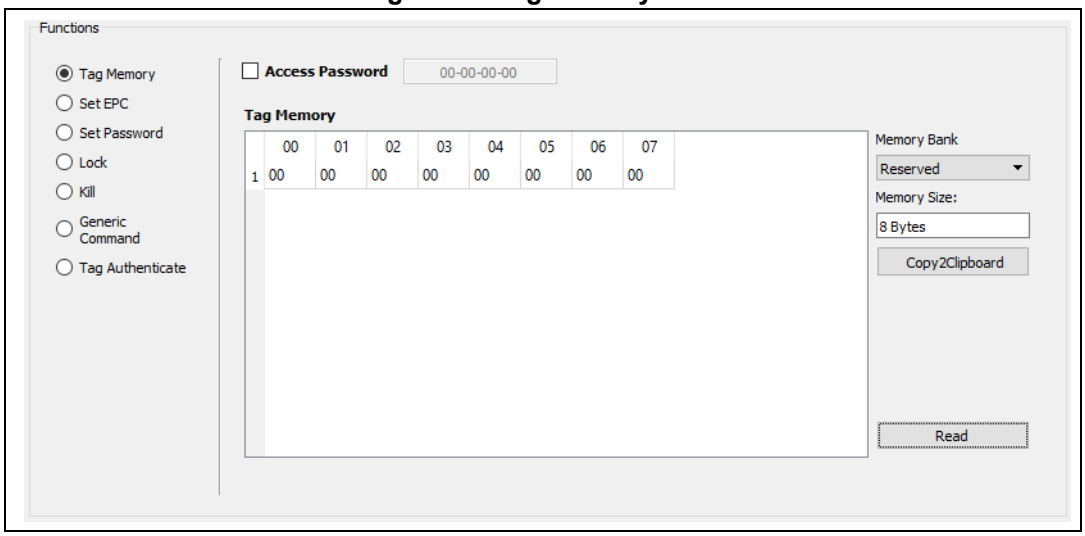
Enter the assigned access password of the actual tag if non-zero.

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

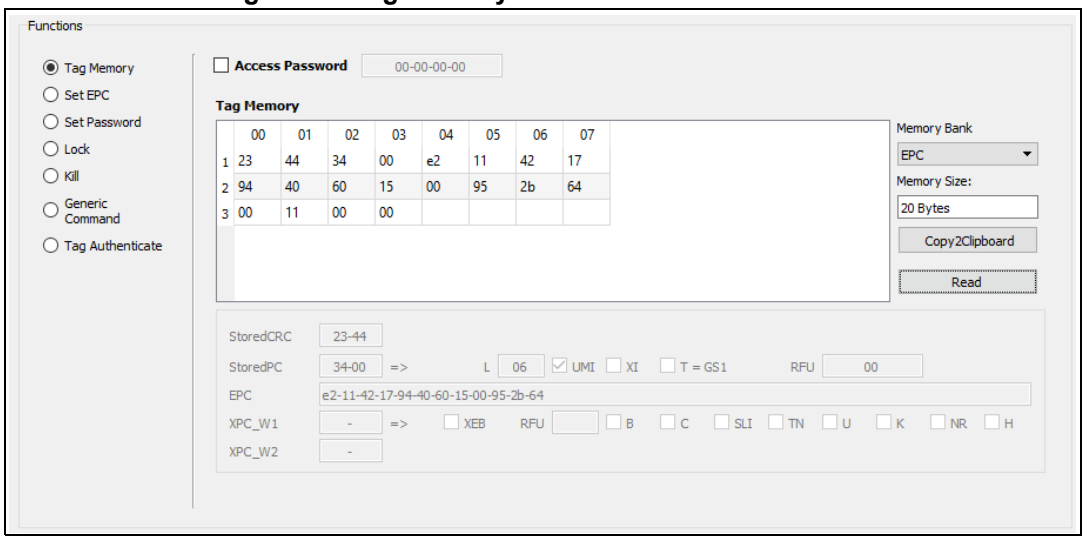
- **Read**: The memory bank pull-down menu allows the user to select the following memory banks:
  - Reserved
  - EPC:
    TID
    User
- **Memory Size**: Shows the size of the memory bank in Bytes.
- **Read**: Reads and displays information from the selected memory bank.

Figure 60. Tag memory table



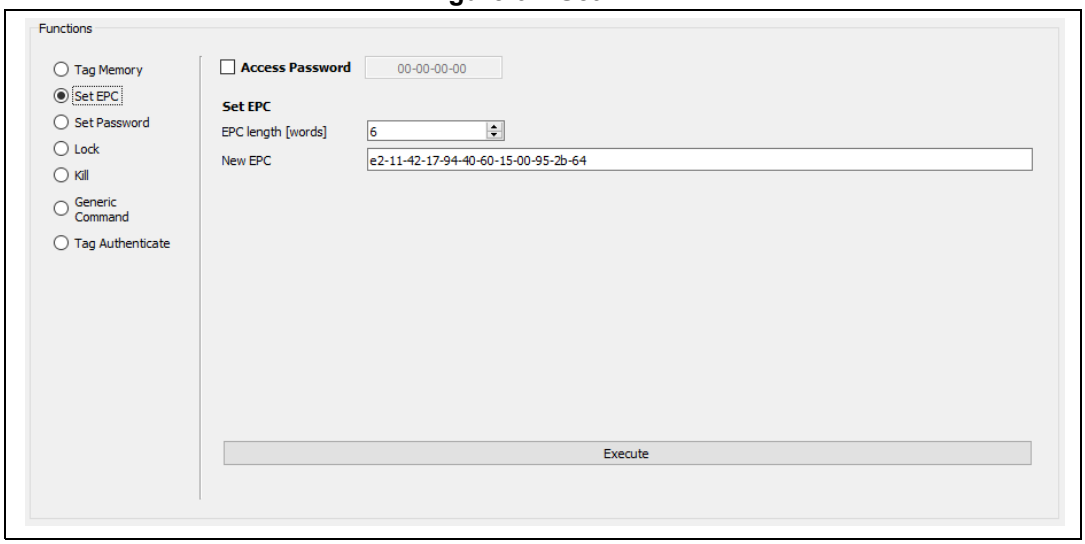
Note: If EPC memory bank is selected, a panel dedicated to the full description of bank content (StoredCRC, StoredPC, EPC, XPC1/2) is provided. Each value is read-only.

Figure 61. Tag memory additional information table



5.2.3 Set EPC

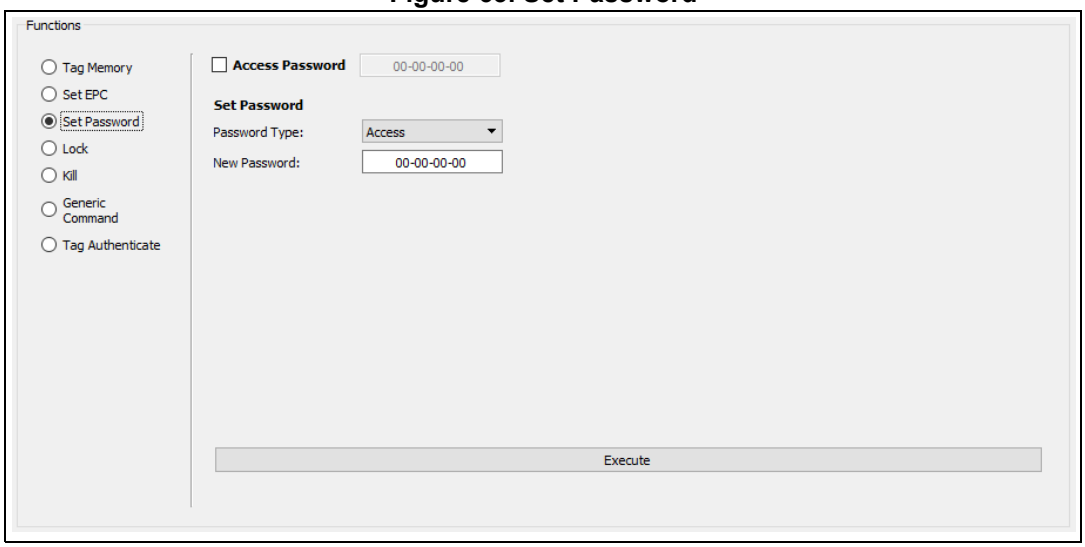
Figure 62. Set EPC



- **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

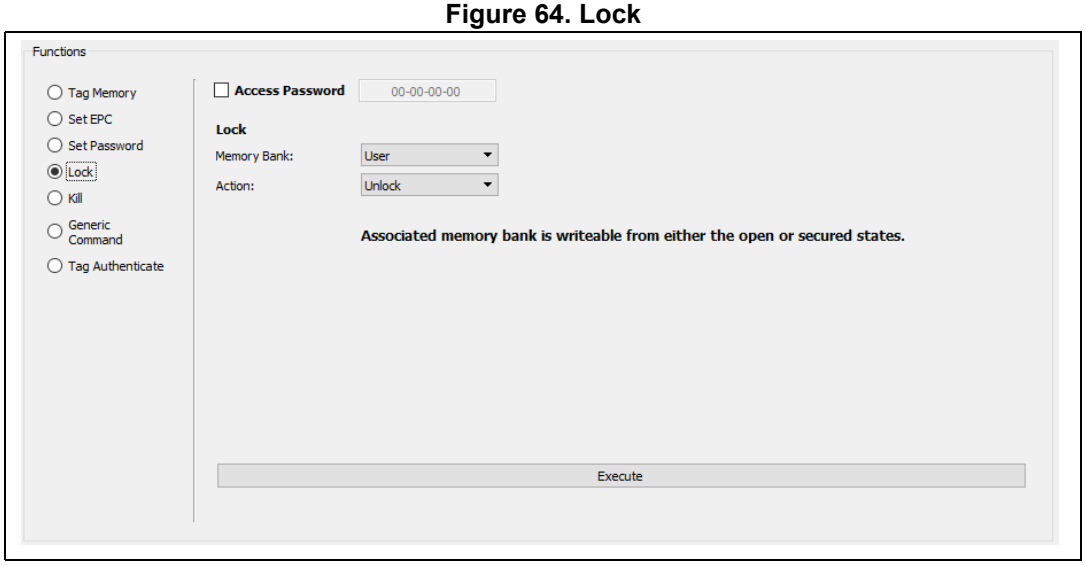
Figure 63. Set Password



- **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

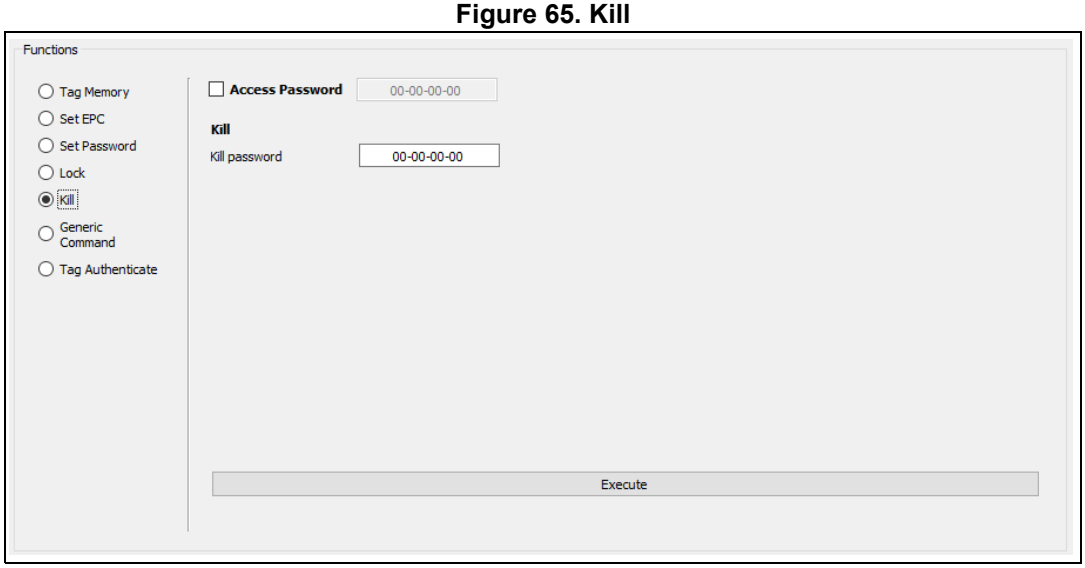
Figure 64. Lock



- **Memory Bank**: The memory bank for which the lock status is going 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 form 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 65. Kill



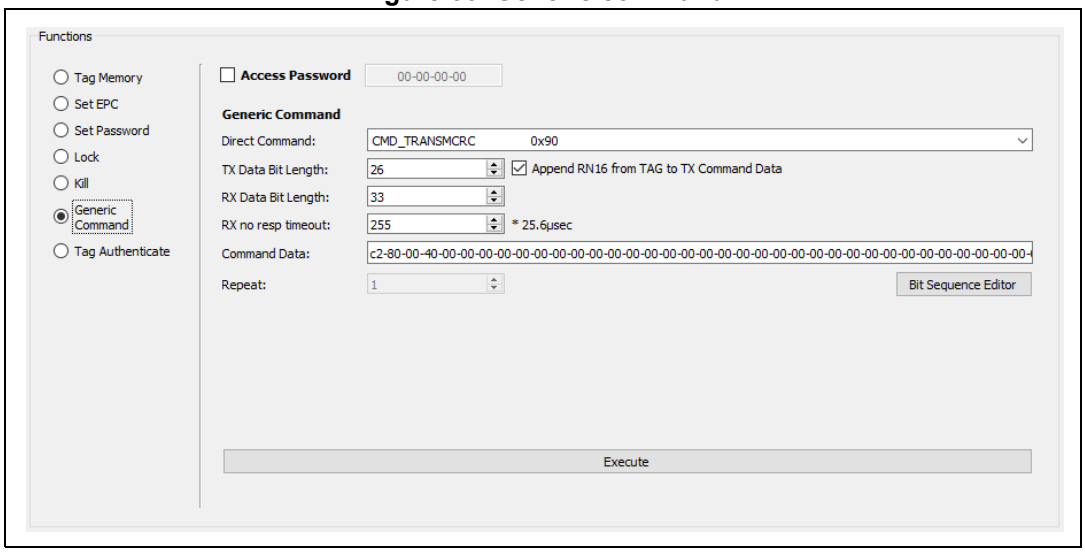
- **Insert Kill Password:** Enter the Kill password in this entry field.

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 66. Generic command



- **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.

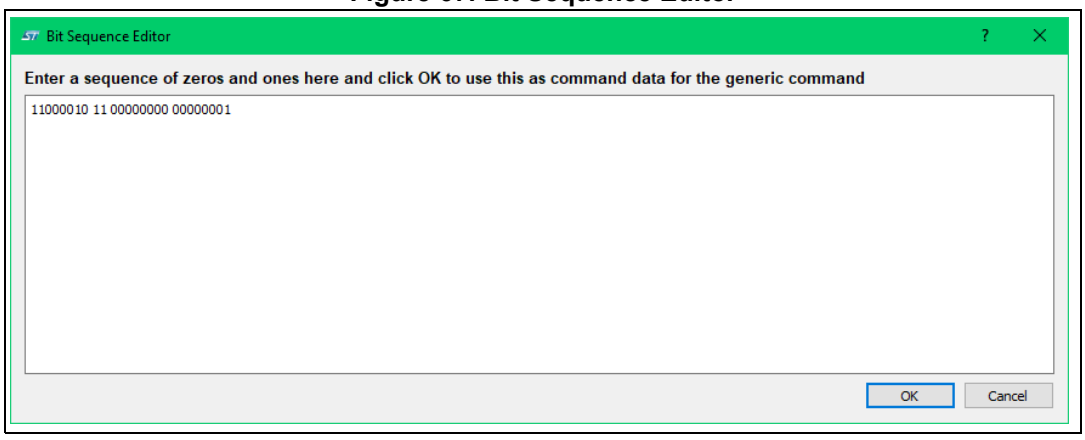
Note: Neither the CRC bits (16 bits) nor the appended RN16 bits (if applicable, cf below) must be included in TX Bit Length as automatically handled by ST25RU3993.

- **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 67. 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):

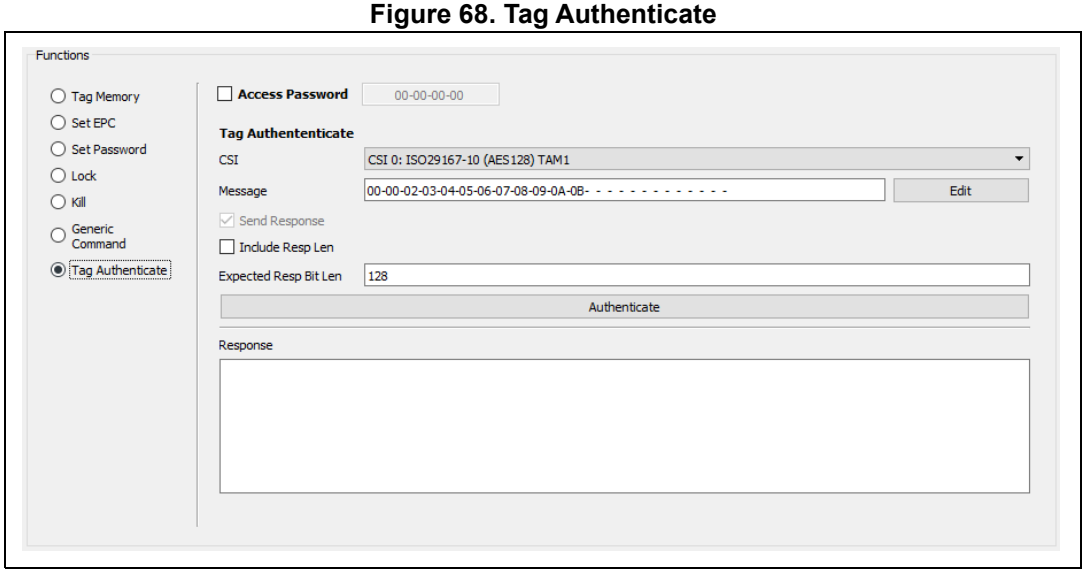
- Append RN16: yes
- Tx Bit Length: 26 bits (as RN16 bits are automatically handled by MW, CRC bits are handled by chip)
- Rx Bit Length: 32 bits (as read 2 bytes and waits only for RN16 bits, CRC and Header bits are handled by chip)
- Command Data: 0xC2 80 00 40

CMD_TRANSM (0x92):

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

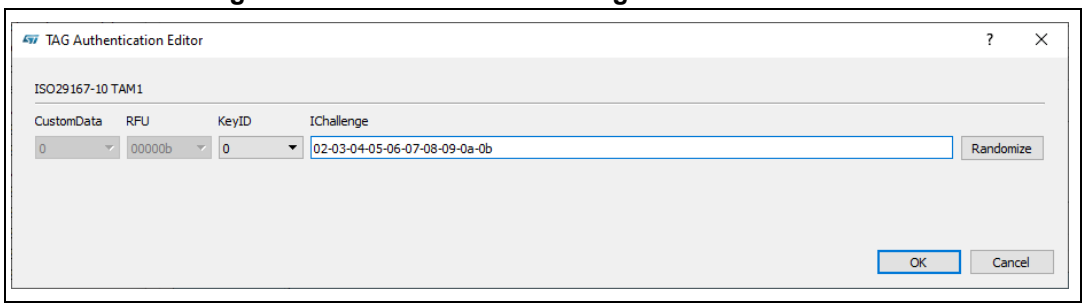
5.2.8 Tag Authenticate

Figure 68. 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 communication (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**: Opens the 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 69. ISO29167-10 TAM1 Tag Authenticate Editor

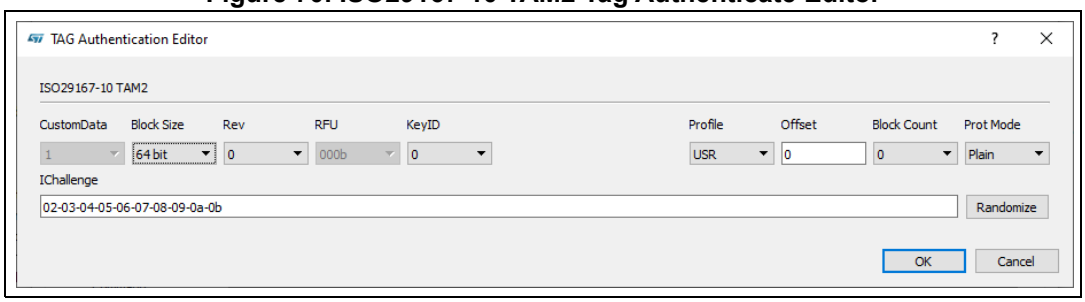


Where:

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

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

Figure 70. ISO29167-10 TAM2 Tag Authenticate Editor

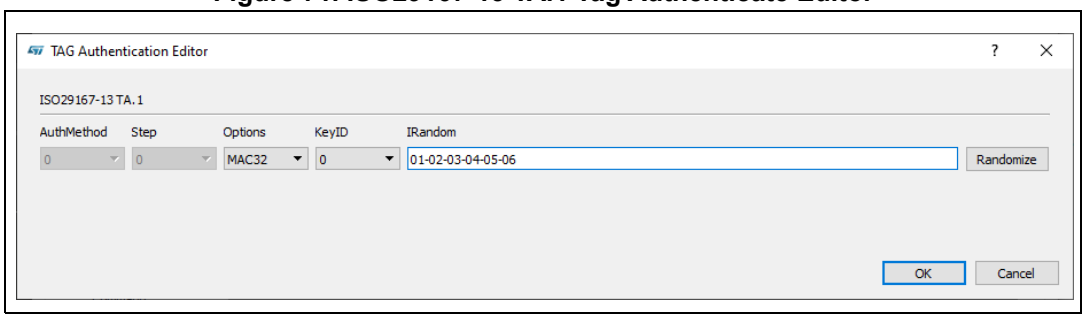


Where:

- **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
- **IChallenge**: 80 bit Interrogator challenge
- **Randomize**: Generate a randomized 80 bit IChallenge

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

Figure 71. ISO29167-13 TA.1 Tag Authenticate Editor

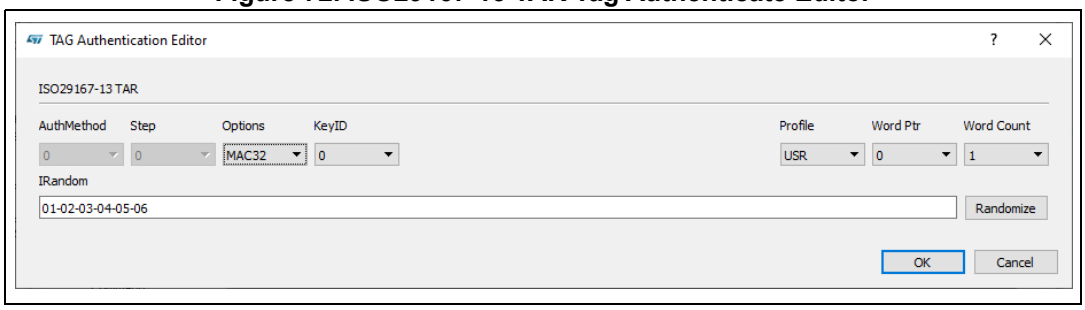


Where

- **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
- **IChallenge**: 48 bit Interrogator challenge
- **Randomize**: Generate a randomized 48 bit IChallenge

CSI 3: ISO29167-13

Figure 72. 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)
- **IChallenge**: 48 bit Interrogator challenge
- **Randomize**: Generate a randomized 48 bit IChallenge

- **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 tu0.file* – *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*
22-Mar-2021	5	Updated: – *Section 1.1: Hardware preparations* – *Section 1.3: First connection* – *Section 2.8.1: Control*

Table 1. Document revision history

Date	Revision	Changes
31-Mar-2022	6	Updated: – *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 24: Region panel - EU* – *Figure 25: Control menu* – *Figure 26: View menu* – *Section 2.9.2: Unique Tag plot dialog* – *Section 2.9.5: Settings* – *Figure 33: Settings window* – *Figure 40: Reader Settings - Settings tab* – *Section 4.1.1: General panel* – *Section 4.1.7: Gen2 settings panel* – *Section 4.1.8: Gen2 Anticollision Settings panel* – *Section 4.2.1: Diagnostic Sweep Function panel* – *Section 4.2.3: Direct Commands panel* – *Section 4.3.1: Tuning 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: – *Section 4.1.2: Frequency selection panel* – *Figure 43: Frequency panel* – *Figure 44: Channel list dialog* – *Section 4.1.3: Frequency hopping panel* – *Section 4.1.6: Rx Options panel* – *Section 5.2.8: Tag Authenticate* Deleted: – *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*

Table 1. Document revision history

Date	Revision	Changes
05-Sep-2022	7	Updated: – *Figure 4: ST25RU3993 Reader Suite - Connect Reader* – *Figure 5: ST25RU3993 Reader Suite - Connected* – *Figure 10: ST25RU3993 Reader Suite - Main window* – *Figure 15: Scan panel* – *Section 2.5: Control and Connect panel* – *Figure 17: Control panel* – *Figure 25: Control menu* – *Figure 26: View menu* – *Figure 27: Help menu* – *Section 2.9.1: Trace browser* – *Figure 35: Context menu - ST25RU3993 Reader* – *Figure 36: Context menu – Scanned Tags* – *Section 4: Reader Settings* – *Figure 38: Expert mode switch* – *Figure 39: Default (simplified) view versus Expert view* – *Section 4.1.1: General panel* – *Figure 41: General panel* – *Figure 42: TID entry in Scanned Tags - Tag information* – *Figure 44: Channel list dialog* – *Figure 46: Tx Option panel* – *Figure 48: Rx option panel* Added: – *Figure 18: Batch command - Gen2 Read Command* – *Figure 19: Batch command - Gen2 Write Command* – *Figure 20: Batch command - Gen2 BlockWrite Command* – *Figure 21: Batch command - Gen2 Generic Command* – *Figure 22: Scanned tags info - Batch Reply* – *Section 2.6: Connect panel* – *Figure 23: Connect panel* – *Figure 28: Trace browser - Scan history* – *Figure 29: Trace browser - STUHFL logging*