



Application Note

ST25RU3993

Demo Software Description

Content Guide

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1 General Description

This document describes the functionality of the graphical user interface (GUI) which is used to operate the UHF RFID demo readers based on ams' fully integrated Gen2 compliant reader IC, AS3993. In addition a quick start guide is provided which lists basic steps needed to configure the demo reader suitable for most common applications.

2 Quick Start Guide

2.1 Software Installation

1. To install the AS3993 Reader Suite software click on *AS3993ReaderSuite_x-x-x-x.exe*
2. Follow the instructions of the software wizard
3. Start the AS3993 Reader Suite.

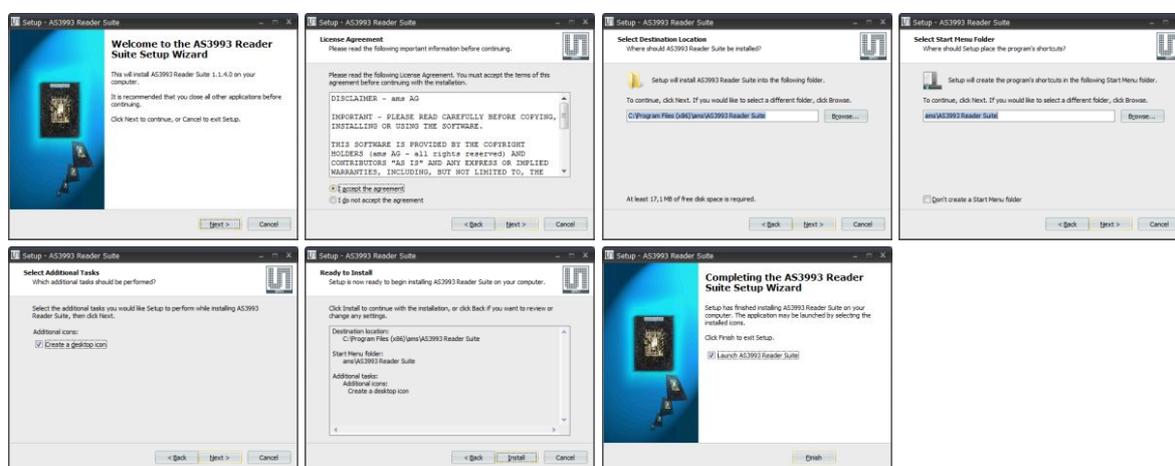


Figure 1 Reader Suite Installation

2.2 Reader Hardware Preparations

1. Connect the antenna(s) to the antenna ports using the coax cable(s)
 - ➔ Note: Always make sure that an antenna or at least a 50 Ohm load is connected to the antenna port when transmitting RF power.
2. Connect the external power supply (if necessary) to the reader system
3. Connect Host-USB cable to the reader

2.3 Reader Configuration

1. Enter *Reader Settings and Diagnostics* by right clicking on the reader entry (see Section **Error! Reference source not found.**)
2. Select the frequency *Profile* suitable for local regulations
3. If available change to the *Tuner* tab and click on *Reflected Power Radar*
4. If available select the desired antenna port
5. Select from *Auto* the tuning algorithm *Climb Points(2)* wait until the tuning completes
 - ➔ Note: The antenna environment should not be changed afterwards. Otherwise a new tuning run might be necessary.
6. Close the *Reflected Power* window and the *Advanced Reader Settings*
7. Press *Start Scan* to start reading tags.

3 GUI

This section gives detailed information about all functions available in the GUI and illustrates the structure of the application.

The GUI is a Windows 7 application and communicates with the demo reader via HID USB and is able to host multiple readers at the same time.

3.1 Main Window

At start-up the AS3993 Reader Suite shows the main window:

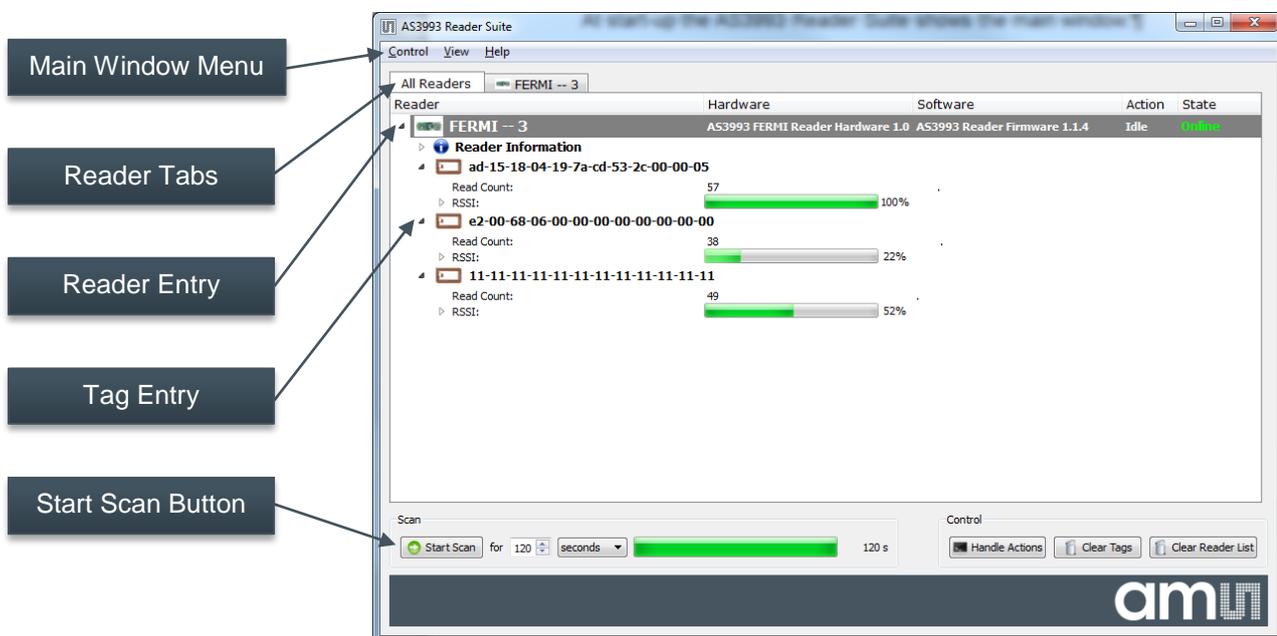


Figure 2 AS3993 Reader Suite Main Window

3.1.1 Main Window Menu

3.1.1.1 Control

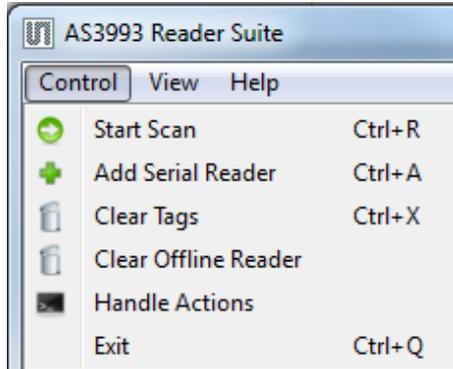


Figure 3 - Control Menu

- Start Scan:.....Starts scanning for tags
- Add Serial Reader:.....If UART host interface is used.
- Add TCP Reader:.....Not implemented
- Clear Tags:.....Clears tag entries. Useful to refresh the tag entries.
- Clear Offline Reader:.....Clears reader entries which went offline.
- Handle Actions:.....Enables actions which could be associated with tags.

3.1.1.1.1 View Menu

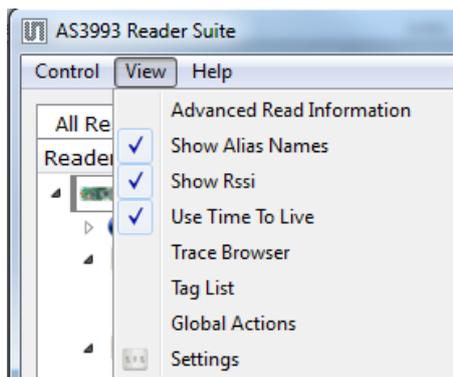


Figure 4 - View Menu

3.1.1.1.2 Advanced Read Information

Extends the main window to show additional information about reader and tag counts.

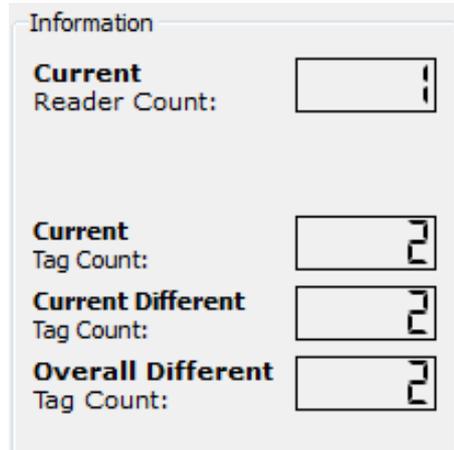


Figure 5 - Side Bar - Advanced Read Information

3.1.1.1.3 Show Alias Names

Displays the user defined alias name instead of the EPC number. Alias must be enabled in the Settings window (see section 3.1.1.1.9).

3.1.1.1.4 Show RSSI

Displays the RSSI level next to each tag entry

3.1.1.1.5 Use Time to Live

Apply the timing information for the tag list of the main window defined in the Settings window (see section 3.1.1.1.9).

3.1.1.1.6 Trace Browser

Extends the main window by the tag browser. The tag browser is detachable.

3.1.1.1.7 Tag List

Displays a configurable tag lists.

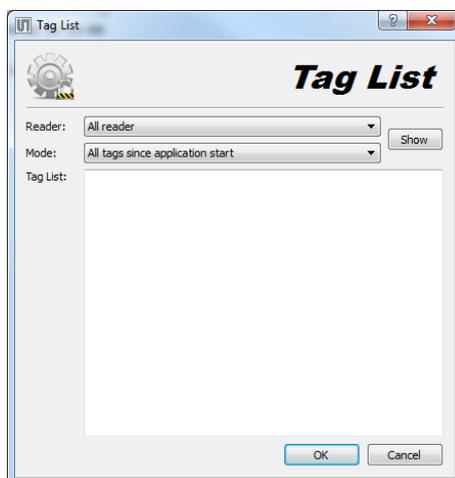


Figure 6 Tag List Window

- **Reader:** Selects to which reader the tag list corresponds. Per default All Reader is selected.
- **Mode:** Defines which tags are going to be displayed in the tag list window. Options are:
 - All tags since application start
 - All tags of last scan
 - All current tags

The *Show* button applies the settings.

3.1.1.1.8 Global Actions

- **Perform Action when a new Tag is read:** Allows defining an action upon a tag read.



Figure 7 Global Actions Window

Action:

- **Time:** Sets the duration of the defined action.
- **Show Picture:** Enables to display a tag upon a tag read.
 - **Picture:** Browse computer to select the picture used for the tag action
 - **Preview:** Shows an image 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 computer to select the external application used for the tag action.
 - **Parameter:** Additional command field used for the external application.

Note: Needs to be activated by the Handle Actions button in the main window.

3.1.1.1.9 Settings

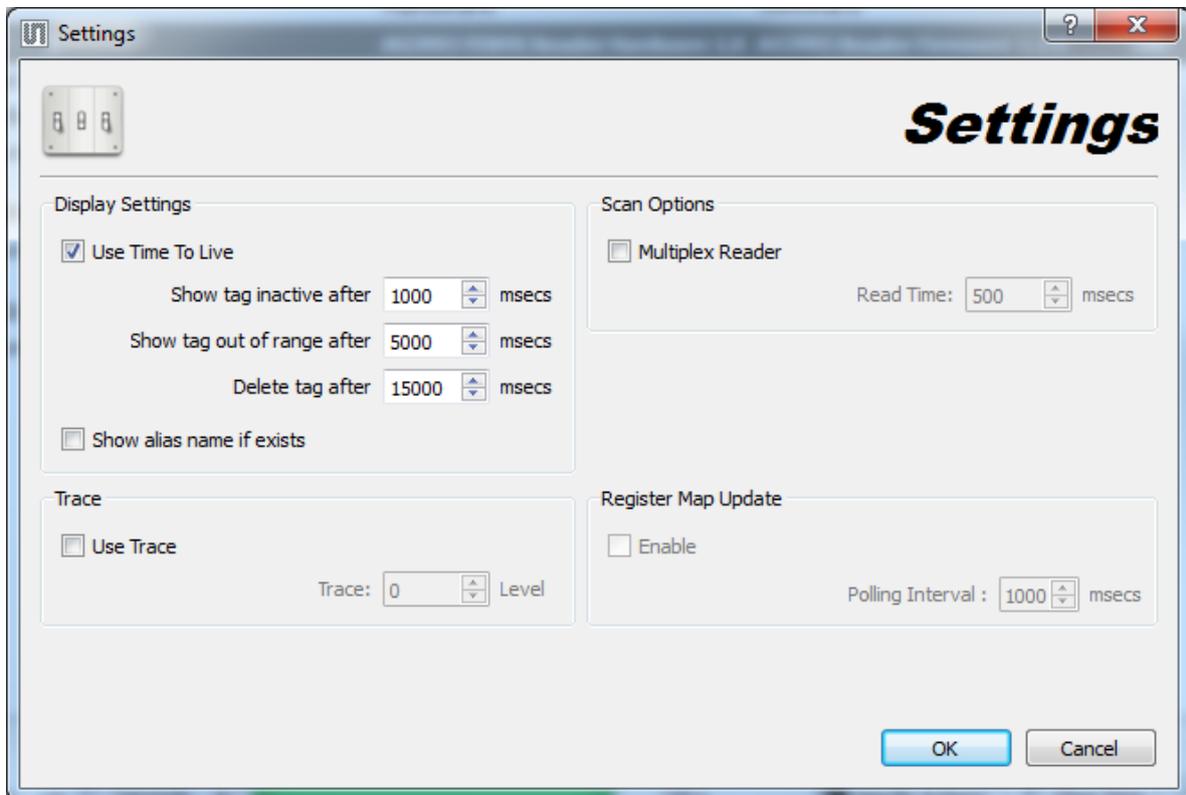


Figure 8 AS3993 Reader Suite Settings Window

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 extend period of time. Tag entry is defined to be outside the reader field. 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:** Use a user defined alias name instead of the EPC number.

Trace:

- **Use Trace:** Activates/Deactivates the communication trace.
- **Trace Level:** Sets the verbose level of the trace browser.

Scan Options:

- **Multiplex Reader:** In case multiple readers are connected to one host system the reader may be set to interleaving scan operation.
- **Read Time:** Defines the time slot each multiplexed reader is allowed to scan for tags.

Register Map Update:

- **Enable:** Activate an automatic register contents refresh in the Register Map.
- **Polling Interval:** Defines the refresh rate of the register contents in the Register Map.

3.1.1.2 Help



Figure 9 - Help Menu

3.1.1.2.1 About Reader Tool

About Reader Tool displays GUI version and contact information

3.1.1.2.2 Update Firmware

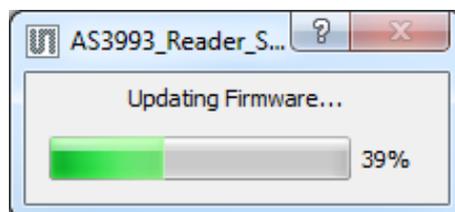


Figure 10 Update Firmware Progress

This function allows to select a firmware file and to update the connected reader with the new firmware. The FW file is located in the Firmware folder within the installation directory of the AS3993 Reader Suite.

3.1.2 Main Window Control

3.1.2.1 Reader Tabs

The main window is organized in tabs. The default view is the *All Readers* tab. In this tab all readers which are connected to the host system are displayed. Tag EPC numbers are also displayed in this tab.

Additionally each reader has its own reader tab. Inventoried tag information related to the reader is display in the individual tabs.

3.1.2.2 Reader Entry

By expanding the *Reader Information* line of a reader entry information about the tag read-performance is displayed.

- **Different Tags:** Number of different tags found by the reader.
- **Read Count:** Number of tag reads performed since application start or last reset.
- **Reads per second [tags reads/sec]:** Current tag read rate over all current tags.

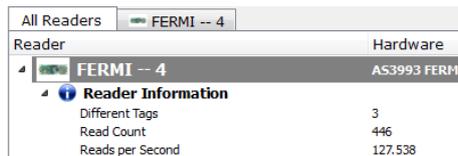


Figure 11 - Main Window - Reader Entry

With a right click on the reader entry the *Reader Settings Diagnostics* window and the *Register Map* can be accessed.

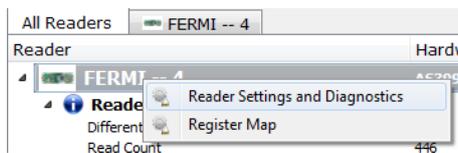


Figure 12 - Pop-up Menu – Reader Entry

3.1.2.3 Tag Entry

Once a tag is read by the reader its EPC number is displayed in the main window. With a right click on the tag entry the *Tag Associations* and *Advanced Tag Settings* dialog can be opened.



Figure 13 - Pop-up Menu - Tag Entry

3.1.2.4 Start Scan

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

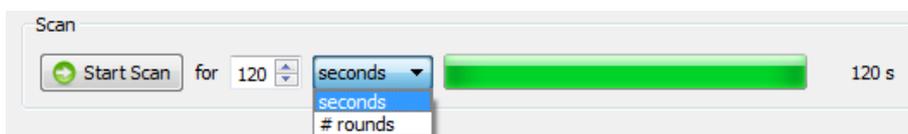


Figure 14 – Main Window - Start Scanning for Tags

On the right hand side of the scan button is an entry field to set the time duration for the scan operation. If *#rounds* is selected the entered number corresponds to the number of inventory rounds. The progress bar will indicate how much time is left until the scanning automatically stops. If a zero value is entered the scanning operation will continue endlessly.

3.1.2.5 Control

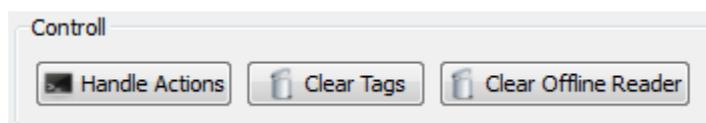


Figure 15 - Main Window - Control

- **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. Useful to refresh the tag entries during scanning for tags.
- **Clear Offline Readers:** Clears reader entries which went offline

3.2 Reader Configuration

By right-clicking the reader entry a pop-up menu is displayed. Click on *Reader Settings and Diagnostics* to enter the reader configuration:

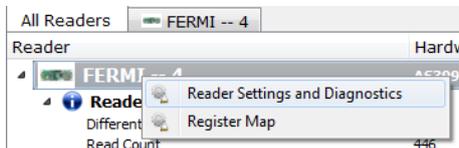


Figure 16 - Entering Reader Settings and Diagnostics

The *Advanced Reader Settings* window is organized in three tabs:

- *Settings*: Change/modify basic reader settings.
- *Diagnostics*: Contains features that are useful to analyze the RFID reader system. For instance activate a continuous modulation or outputting a CW signal.
- *Tuner*: Allows to control the tuner circuitry

3.2.1 Tag Entry

Once a tag is read by the reader its EPC number is display in the main window.

With a right click on the tag entry the *Tag Settings* and *Advanced Tag Settings* dialog can be opened.



Figure 17 - Pop-up Menu - Tag Entry

3.2.2 Start Scan

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



Figure 18 – Main Window - Start Scanning for Tags

On the right hand side of the scan button is an entry field in order to set the time for automatically stopping the scanning function. If *#rounds* is selected the entered number corresponds to the number of inventory rounds.

The progress bar will indicate how much time is left until the scanning stops automatically.

If a zero value is entered the scanning function will continue endlessly.

3.2.3 Control

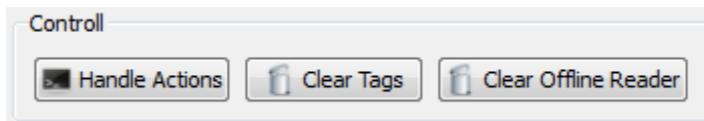


Figure 19 - Main Window - Control

- **Handle Actions:** Activate/Deactivate tag actions if associated in the Global Actions window (see section **Error! Reference source not found.**). 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. Useful to reset the tag entries during scanning for tags.
- **Clear Offline Readers:** Clears reader entries which went offline

3.2.4 Settings Tab

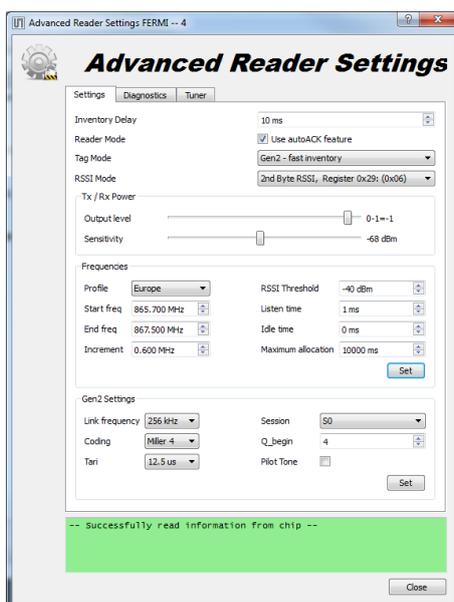


Figure 20 - Reader Settings Tab

Inventory Delay: By changing the *Inventory Delay* [ms] an additional wait time is inserted between two consecutive inventory rounds. To confirm a new value press the *Set* button. Note: The minimal inventory delay value is 10 ms results to an effective inventory delay of 40 ms due to system constraints.

Reader Mode: Enables the autoACK feature for tag inventories which automates sending the ACK command or ACK and ReqRN command according to the Gen2 protocol. Depending on the Tag Mode selection below AutoACK or AutoACK+ReqRN is used.

Tag Mode: Defines if the tag inventory procedure is completed after the tag replies its EPC number or the HANDLE.

Options are:

- *Gen2 – fast inventory*.....Tag sends EPC number and reverts to READY state.
- *Gen2 – normal inventory*.....Tag sends HANDLE and reverts to READY state.

Output level: The *Output level* slider changes the output power for the 0-dBm and the internal PA output (register 0x15, bit 4:0). The output power may be changed by nominal 1 dB per step.

Sensitivity: The sensitivity slider adjusts the sensitivity of the receiver. The sensitivity slider affects register 0x0A. Depending on the receiver configuration (single-ended, differential) the maximum sensitivity may vary.

Profile: The *Profile* pull- down menu offers various UHF RFID frequency band allocations. By changing the frequency profile all other entries in the *Frequencies* section are preset accordingly.

Profile options are shown in the following table:

| Profile | Start freq [MHz] | End freq [MHz] | Increment [MHz] | RSSI Threshold. [dBm] | Listen time [ms] | Idle time [ms] | Max. allocation [ms] |
|------------------|---------------------|-------------------|--------------------|-----------------------------|------------------------|----------------------|-------------------------|
| Europe | 865.7 | 867.5 | 0.6 | -40 | 1 | 0 | 10000 |
| Japan | 952.4 | 953.6 | 1.2 | -87 | 10 | 100 | 4000 |
| USA | 902.75 | 927.25 | 0.5 | -40 | 1 | 0 | 400 |
| China 920.625 | 920.625 | 924.375 | 0.75 | -40 | 1 | 0 | 10000 |
| China 840.125 | 840.125 | 844.875 | 0.25 | -40 | 1 | 0 | 10000 |
| Korea | 917.3 | 920.3 | 0.6 | -40 | 1 | 0 | 10000 |

Table 1: Frequency Profiles

The frequency profiles are defined in a CSV file located in the installation directory of the AS3993 Reader Suite. The “profiles.csv” file may be modified or extended by new frequency settings. The syntax for adding a new profile is defined as follows:

Name,StartFreq,StopFreq,Increment,dBm,listenTime,IdleTime,maxAllocationTime

For example the European frequency profile is defined as:

Europe,865.7,867.5,0.6,-40,1,0,10000

Link frequency: Changes the backscatter link frequency to:

- 40 kHz
- 160 kHz
- 213 kHz
- 256 kHz

- 320 kHz
- 640 kHz

To apply changes press the *Set* button.

Coding: Changes the coding to:

- FM0
- Miller 2
- Miller 4
- Miller 8

To apply changes press the *Set* button.

TARI: Changes the TX Zero length to:

- 6.25 μs
- 12.5 μs
- 25 μs

To apply changes press the *Set* button.

Session: Selects the Session and hence changes the behavior of the inventoried flags of tags. Options are:

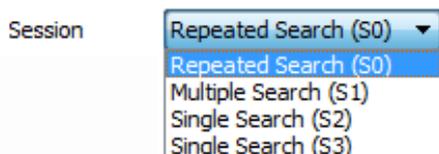


Figure 21 - Session Selection

- **Repeated Search:**.....Tags take part in every inventory round.
- **Multiple Search:**Once inventoried tags do not take part in inventory round for at least 500 ms.
- **Single Search:**.....Once inventoried the tag is read it does not take part in inventor rounds unless the tag is not energized for a time longer than its persistence time.

To apply changes press the *Set* button.

Q_begin: Defines the initial number of available anti-collision slots according the function 2^Q .

To apply changes press the *Set* button.

Pilot tone: Disables/Enables the pilot tone.

To apply changes press the *Set* button.

3.2.5 Diagnostics Tab

In the *Sweep* section it is possible to run a reflected power measurement sweep measurements across the select frequency range.

Start [MHz]: Start frequency of the frequency sweep.

Stop [MHz]: Enter a stop frequency where the sweep should stop.

Mode: Select one of the two available frequency sweep modes:

- *Reflected Power*
- *RSSI*

Increment [MHz]: Defines the number of measurement points.

Sweep: Starts the frequency sweep for the defined Mode.

Once the measurement is completed the result is displayed in a new window.

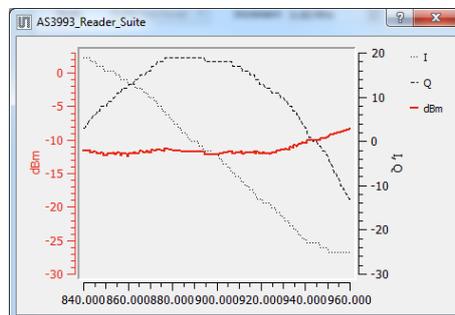


Figure 22 – Reflected Power Sweep

Continuous Modulation: In this mode the reader continuously transmits a NAK command at the specified frequency for a given period of time.

Pseudo Random: If this option is selected the reader outputs pseudo random data instead of a NAK command.

Direct Commands: A selection menu from which direct commands may be selected and transmitted.

3.2.6 Tuner Tab

For controlling the tuner circuit the GUI offers a special Tuner-tab.

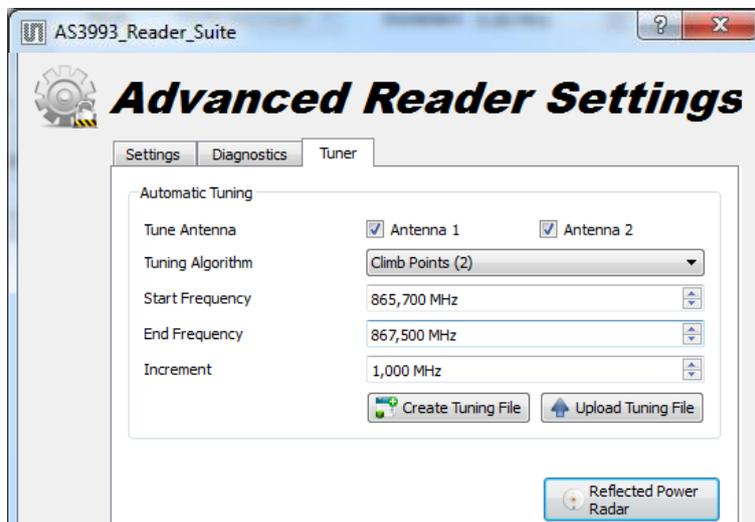


Figure 23 - Tuner-Tab

By the *Create Tuning File* button a CSV¹ file is created depending on:

- *Tune Antenna* selection: Selects the antenna type included in the tuning file.
- *Tuning Algorithm*: Selects the fast or the more accurate tuning algorithm.
- *Start Frequency*: Defines the tuning start frequency.
- *End Frequency*: Defines the tuning stop frequency.
- *Increment*: Defines the tuning frequency increment.

The format of the tuning file is defined as follows:

| # Frequency | TuneEnableAntenna1 | Cin1 | Clen1 | Cout1 | i*i+q*q | ReflectedPower1 | TuneEnableAntenna2 | Cin2 | Clen2 | Cout2 | i*i+q*q | ReflectedPower2 |
|-------------|--------------------|------|-------|-------|---------|-----------------|--------------------|------|-------|-------|---------|-----------------|
|-------------|--------------------|------|-------|-------|---------|-----------------|--------------------|------|-------|-------|---------|-----------------|

Figure 24 - Tuning File Structure

Tuning Entry - Example:

| # Frequency | TuneEnableAntenna1 | Cin1 | Clen1 | Cout1 | i*i+q*q | ReflectedPower1 | TuneEnableAntenna2 | Cin2 | Clen2 | Cout2 | i*i+q*q | ReflectedPower2 |
|-------------|--------------------|------|-------|-------|---------|-----------------|--------------------|------|-------|-------|---------|-----------------|
| 902750 | 1 | 30 | 0 | 3 | 9 | -18,757 | 1 | 13 | 2 | 2 | 2 | -25,2892 |

Figure 25 - Tuning File Example

The number of tuning entries in the CSV file is limited to 40.

If the channel frequency during tag-scanning does not exactly match a frequency in the tuning file the closest match between those frequencies is used instead.

¹ Delimited by semicolon

By the *Upload Tuning File* button the tuning file is uploaded to the Reader and used while scanning for tags. Please note that the tuning table on the reader is volatile and has to be uploaded again after reset/power up.

The *Reflected Power Radar* shows a real-time representation of the reflected power. The length of the arrow in the reflected power radar gives information about the magnitude of the reflection while the angle of the arrow represent the phase relative to the local oscillator (LO) signal.

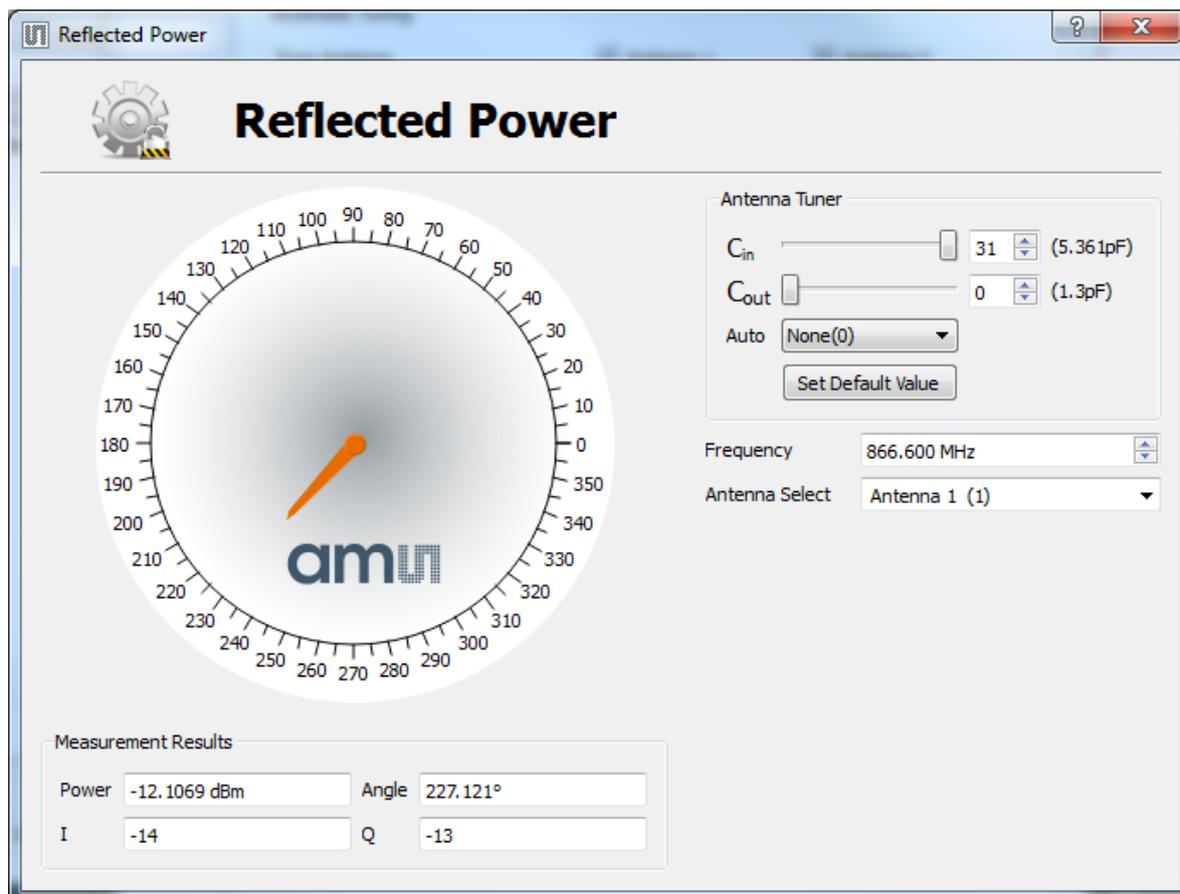


Figure 26 - Reflected Power Radar

In the upper right corner two DTCs can be modified by changing the steps from 0 (1.05 pF) to 31(5.1 pF) - one step is 131 fF.

Auto lets the user select which algorithm for the automatic tuning should be used and *Set Default Value* restores the default value (15) of the DTCs.

The *Frequency* entry defines for which frequency the tuning should be done and the *Antenna Select* sets the output antenna port.

Per default *Frequency* is set to the center of the selected *Start Frequency* and *End Frequency*.

In the lower left corner the calculated reflected power and the phase are displayed by numeric values and also the ADC result for I and Q channel is provided as additional information.

3.3 Register Map

Right click the reader entry which displays a pop-up menu from which the *Register Map* can be opened:

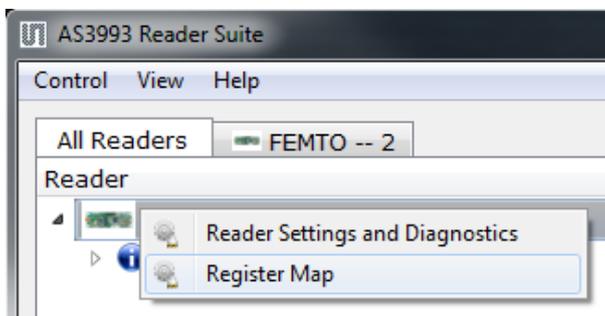


Figure 27 - Entering the Register Map

On a click-and-toggle basis the register content can be modified. Gray register contents are read-only. Mouse pointer tool tips explain the purpose of most bits.

| | Addr. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Value |
|-----------------------------------|-------|---|---|---|---|---|---|---|---|-------|
| Device Status Control Register | 0x0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0x00 |
| Protocol Selection Register | 0x1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0x00 |
| TX Options Register | 0x2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0x30 |
| RX Options Register | 0x3 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0x0b |
| TRcal High Register | 0x4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0x02 |
| TRcal Low Register | 0x5 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0x9b |
| AutoACK Wait Time | 0x6 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0x04 |
| RX No Response Time Register | 0x7 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0x0f |
| RX Wait Time Register | 0x8 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0x07 |
| RX Filter Setting Register | 0x9 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0x24 |
| RX Mixer and Gain Register | 0xa | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0x21 |
| Regulator and PA Bias Register | 0xb | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0xbf |
| RF Output and LO Control Register | 0xc | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0x68 |
| Miscellaneous Register | 0xd | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0x84 |
| Miscellaneous Register | 0xe | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0x40 |
| Measurement Control Register | 0x10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0x00 |
| VCO Control Register | 0x11 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0x40 |
| CP Control Register | 0x12 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0x35 |
| Modulator Control Register 1 | 0x13 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0x40 |
| Modulator Control Register 2 | 0x14 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0xdd |

Figure 28 - Reader Register Map

3.4 Tag Settings

By right-clicking a tag entry the *Tag Setting* window may be opened.



Figure 29 - Entering Tag Settings

Within the *Tags Settings* window the user may assign an alias name and/or an action to a tag. The action may either be that a tag is represented by a picture or an application start. The duration of the activation time can be specified in the range of 1sec to 30min.

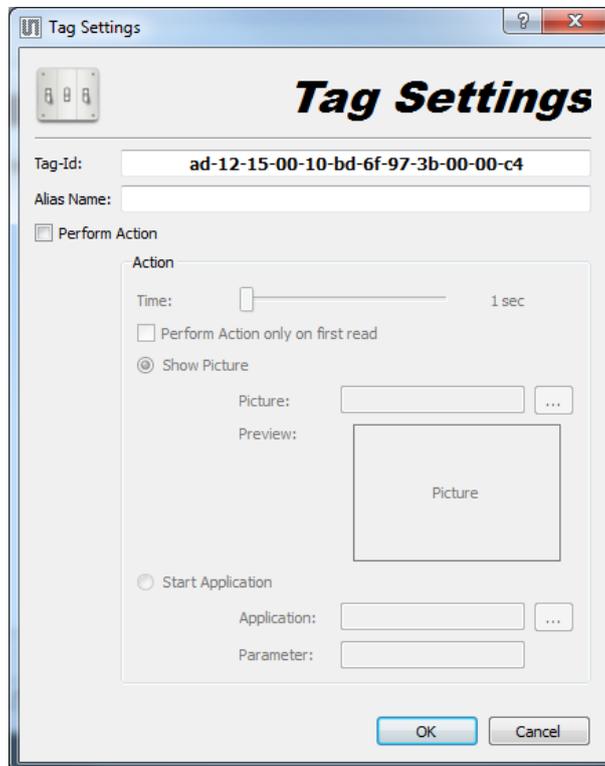


Figure 30 - Tag Settings Window

In order to display the tag in the main window by its alias name, the option *Show Alias Name* in the *View* menu or in the *Settings* window from the *Edit* menu should be selected.

To activate the assigned tag action the button *Handle Actions* should be clicked.

3.5 Advanced Tag Settings

By right-clicking a tag entry the *Advanced Tag Settings* window may be opened.

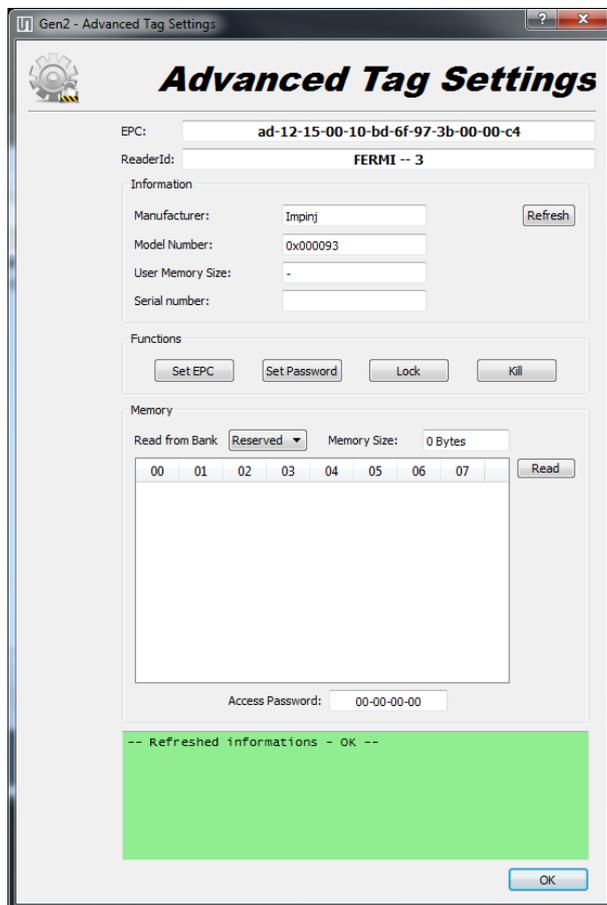


Figure 31 - *Advanced Tag Settings* Window

This screen offers to view and change tag data.

3.5.1 SET EPC

In this window the contents and the length of the tag EPC can be changed.

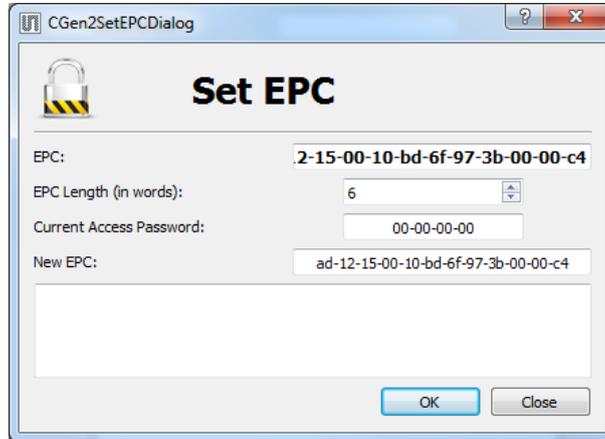


Figure 32 - Set New EPC

3.5.2 Set Password

The user may assign a password for a tag. The types of passwords are:

- Access
- Kill



Figure 33 - Set Tag Password

3.5.3 Lock Tag

The user may perform certain security actions like locking and unlocking certain memory spaces of a tag. Options are:

- *Kill password*
- *Access password*
- *EPC*
- *TID*
- *User*

The security actions are:

- *Unlock* (Associated memory bank is writeable from either the open or secured states)
- *Lock* (Associated memory bank is writeable from the secured state but not from the open state)
- *Permalock* (Associated memory bank is permanently writeable from either the open or secured states and may never be locked)
- *Lock & Permalock* (Associated memory bank is not writeable from any state)



Figure 34 - Lock and Unlock Tag Memory

3.5.4 KILL

The user may kill a tag by entering the *Kill Password*.

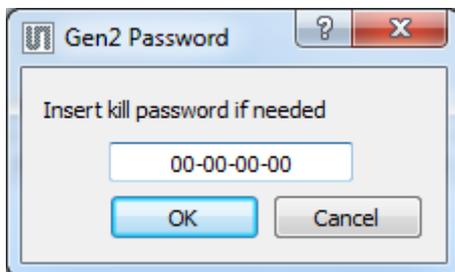


Figure 35 - Killing a Tag

The user may read or set various memory banks of a tag. The *Read from Bank* pull-down menu offers following memory banks to be selected:

- Reserved
- EPC
- TID
- User

By pressing the *Read* button the contents of the memory bank is displayed. The *Memory Size* field shows the size of the respective memory bank in bytes.

The *User* memory bank may be changed by the user (if proper security settings are set) by entering the desired data into the memory table and pressing *Set* button.

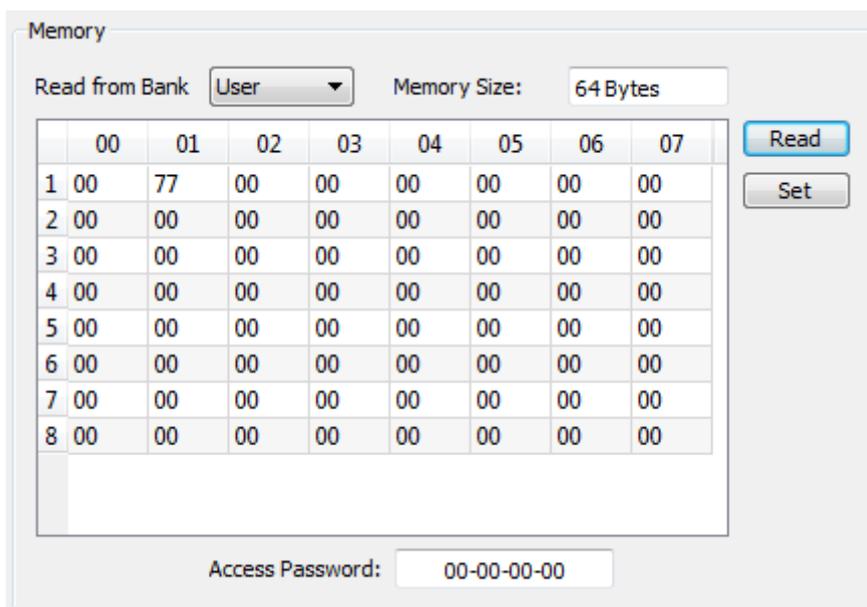


Figure 36 - Reading and Setting Tag Memory Banks

4 Contact Information

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5 Note

6 Revision Information

| Changes from 1-00 (2017-Aug-30) to current revision 1-01 (2018-Jul-14) | Page |
|--|------|
| Update to corporate format | 1-31 |

Note: Page numbers for the previous version may differ from page numbers in the current revision.