Application Note

AS3911

General Purpose Demo V3.0

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1 General Description

This application note describes the hardware, software and features of the AS3911 General Purpose V3.0 demo board.

Further simulation and measurements results and layout design recommendations regarding EMC are introduced.

2 Hardware

2.1 Overview

The demo board is powered and controlled via USB. Figure 1 shows the block diagram of the board.

It can be separated into four main sections:

1. PCB power supply: An LDO supplies the micro controller with 3V3 and the AS3911 IC can be supplied with 3V3 or 5V.
2. Microcontroller: The PIC24FJ64GB002 controls the AS3911 via SPI
3. HF reader IC AS3911:

   This section consists of three sub – sections:

   a. Power supply system: Decoupling capacitors of the internal regulators are placed next to the chip.

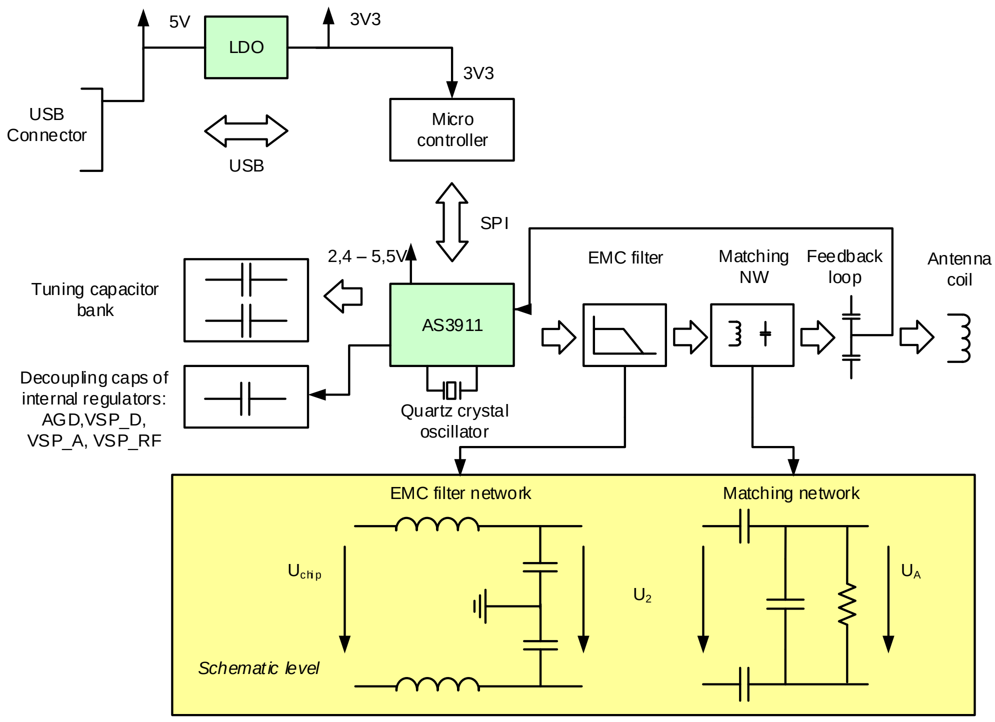
   b. Capacitive wake up: The CSI / CSO pins are used for the capacitive wake up feature.

   c. Filter and matching network: This sub – section converts the rectangular output signal of the IC push pull driver into a sine shape one and converts the AS3911 output impedance to the antenna impedance.

      Furthermore the matching network consists of the tuning capacitor bank for the AAT (Automatic Antenna Tuning) and the Feedback loop (RX line) with the capacitive voltage divider.

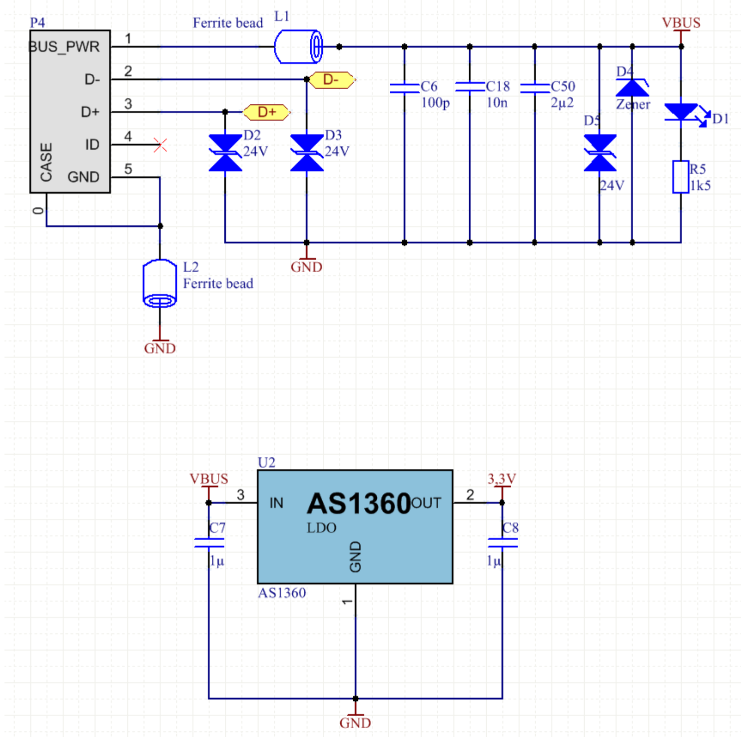
4. Antenna and capacitive wake up electrodes: The antenna, which is coupled to the matching network generates the magnetic field strength and the electrodes are used to measure the capacitive differences.

Figure 1: Block diagram of the demo board



2.1.1 PCB power supply

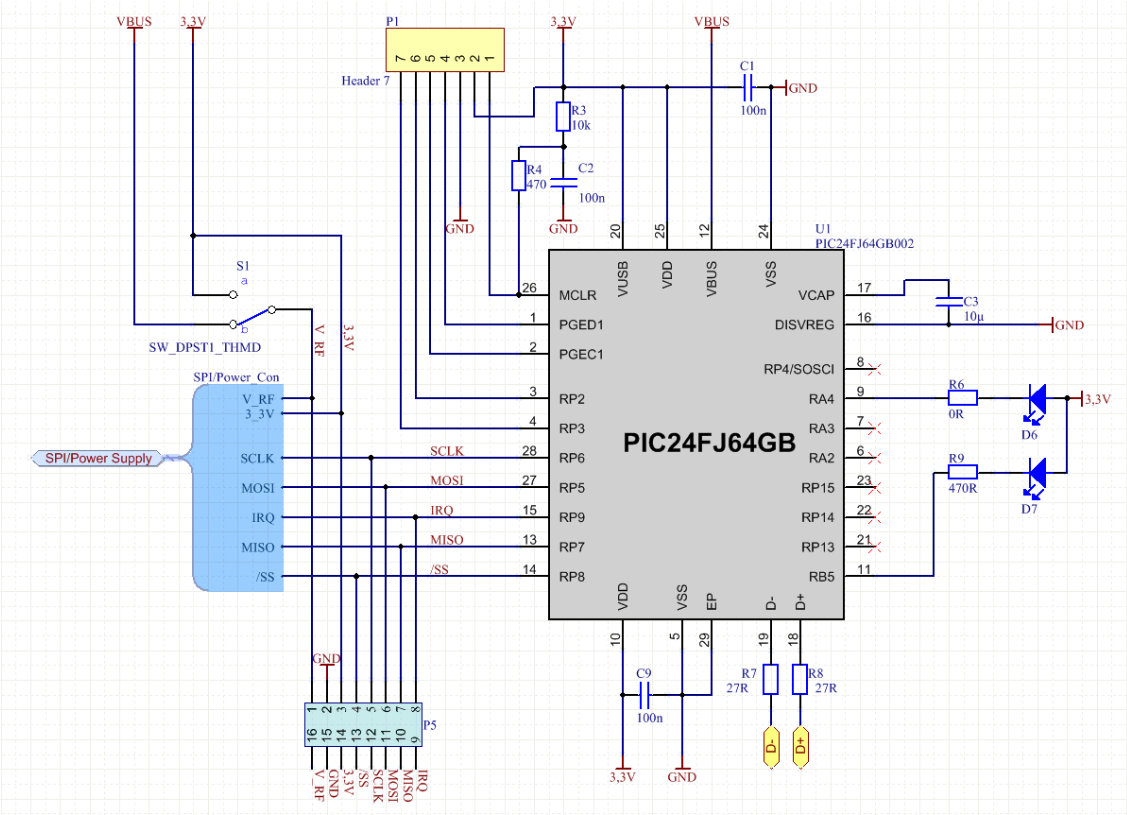
Figure 2: PCB power supply schematic



- Ferrite beads (L1, L2) and decoupling capacitors (C6, C18, and C50) are placed between USB connector and power/GND plane of the demo board in order to reject unwanted emissions of the AS3911 HF driver stages. If these emissions would not be damped, the USB cable would act as an antenna and radiate out the unwanted emissions.
- ESD suppressors D2, D3, D5 are used to protect the USB power and the data connections.
- The Zener diode D4 protects the input of the voltage regulator.
- This section also contains an LDO to convert the 5V USB voltage to 3V3.
- LED D1 is used to indicate the USB power connection.

2.1.2 Microcontroller

Figure 3: Microcontroller schematic



- The microcontroller is a PIC24FJ64GB002 with internal USB.
- The connector P1 is used for programming the microcontroller.
- The switch S1 allows the AS3911 to operate with 5V or 3V3.
- The diodes D6 (Receive) and D7 (Transmit) indicate the input and output signals of the RFID communication.
- The connector P5 is a solder bridge. It is possible to drive an external AS3911 board with the microcontroller and the Demo GUI of this demo board or vice versa.
- The remaining capacitors and resistors are placed according the PIC24FJ64GB004 Family datasheet (chapter 2.0).

2.1.3 AS3911

2.1.3.1 Power supply system

Figure 4 shows the schematic of the AS3911 power supply system.

The internal LDO needs to be decoupled with two capacitors in parallel. These pins are:

- AGD (analog ground)
- VSP_D (to supply the digital part)
- VSP_A (to supply the analog part)
- VSP_RF (to supply the driver stage)

The AS3911 contains an internal level shifter that enables the connection to a microcontroller with different VDD. But Pin 1 should be connected to the same voltage as the supply of the microcontroller.

The ferrite bead L4 is mounted in the supply line V_RF to reject unwanted emissions of the HF driver stages.

Jumper J3 can be used to measure the current consumption of the HF reader IC.

The decoupling caps of the VDD and the VDD_IO line are also used to reject unwanted emissions of the HF driver stages.

Figure 4: Power supply system & capacitive wake up schematic

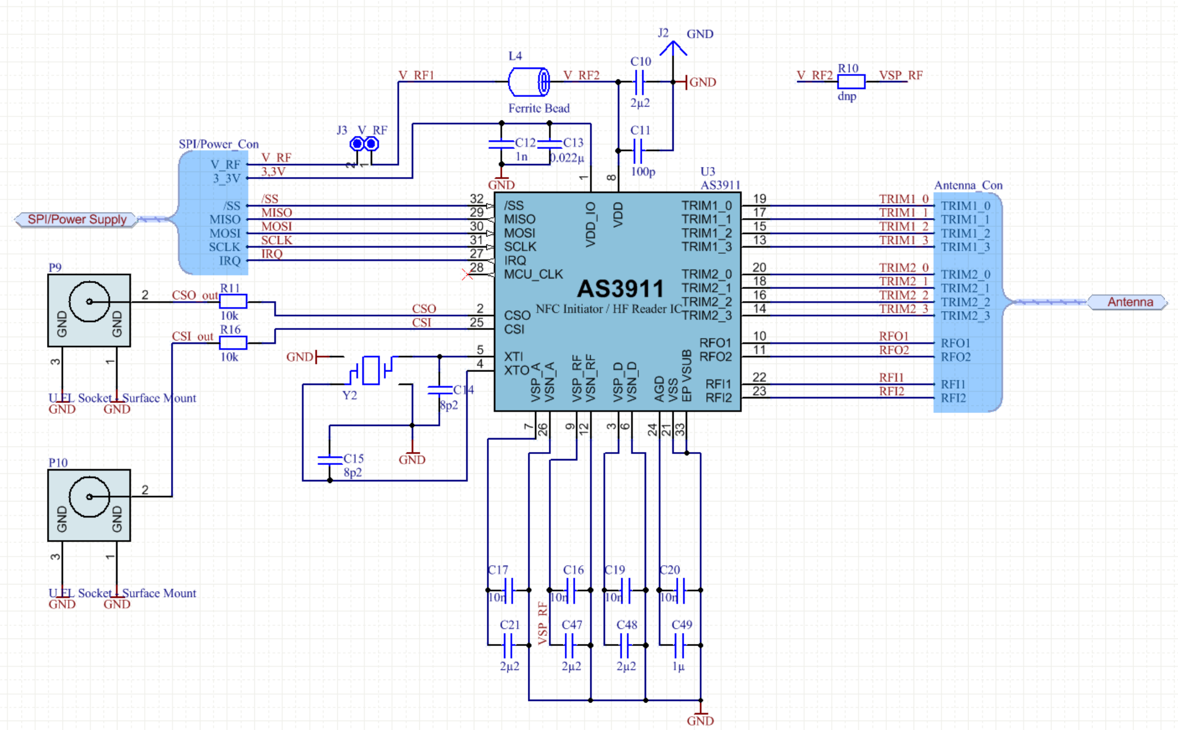
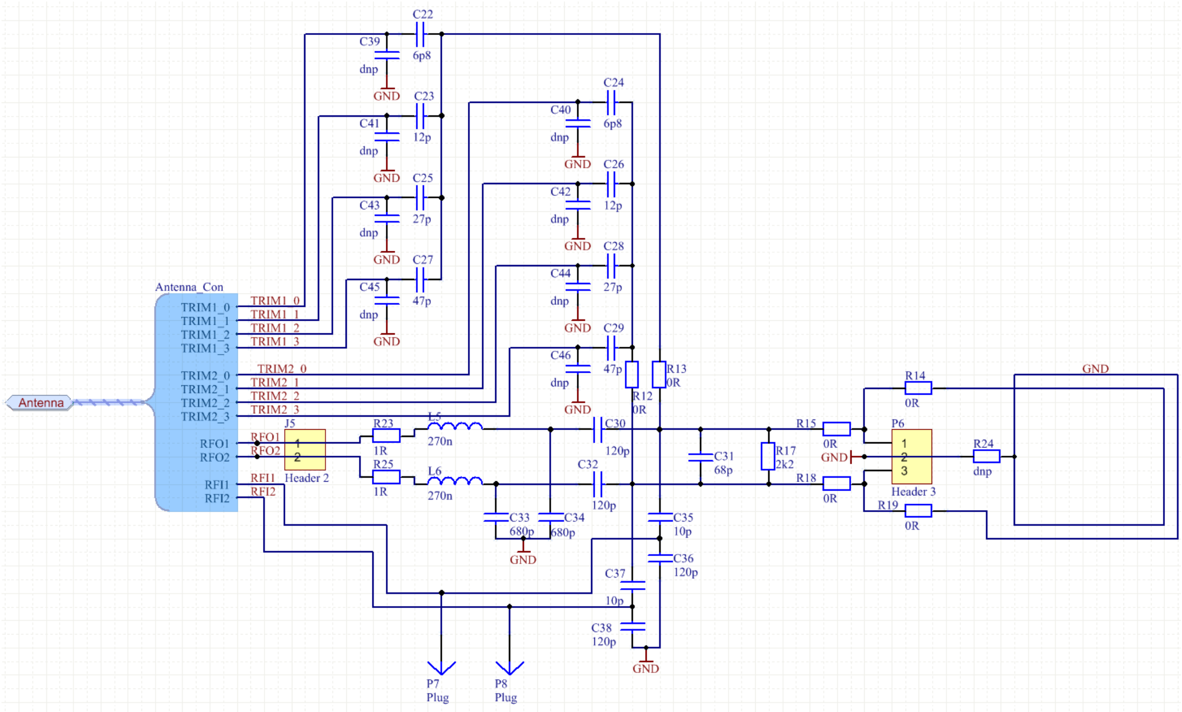


Figure 5: Filter and matching network



2.1.3.2 Capacitive wake up

Figure 4 also shows the schematic of the capacitive wake up function.

The CSI / CSO pins of the reader IC are connected to the capacitive electrodes, which are needed for the capacitive difference measurements and further for the capacitive wake up feature.

Details about this feature can be found in the application note:" AS3911 AN Wakeup modes 2V0". This application note is available on request from ams sales representatives at www.ams.com/Contact-Us/Sales-Offices.

Ultra Small Surface Mount Coaxial Connectors (U.FL Series) are also mounted on the CSI / CSO line in order to connect external wake up electrodes.

2.1.3.3 Filter and matching network

Figure 5 shows the schematic of the filter and matching network, the return path to the receiver, the tuning capacitor bank and the antenna connection.

The AS3911 is driven with a differential output. There is the option to drive the Reader IC single – ended, too. This is described in detail in the application note: "AS3911 AN 50 Ohm single ended V2". This application note is available on request from ams sales representatives at www.ams.com/Contact-Us/Sales-Offices.

- 2-pin connector J5: It is placed between the IC output and the EMC-filter in order to measure the designed target impedance of the whole network.
- EMC filter: It consists of the components: R23/25, L5/6 & C33/34. The resistor is needed to reach a higher ohmic area for the AAT. R23/25 define basically the impedance operation point of reader matching with AAT. Suitable inductors with lower Q could also be used.

  The inductors were chosen regarding self-resonance frequency, Q – factor, rated current, filter cut off frequency and target impedance behavior.

  The capacitors were chosen regarding filter cut off frequency and target impedance behavior.

  Detailed information about the EMC filter design can be found in the application note:"AS3911 AN Antenna Design Guide V1.4". This application note is available on request from ams sales representatives at www.ams.com/Contact-Us/Sales-Offices.

- Matching network: It consists of the capacitors C30 to C32.

  The rated voltage of C31 should be higher than the differential antenna voltage!

  More detailed information can be found in the application note:"AS3911 AN Antenna Design Guide V1.4". This application note is available on request from ams sales representatives at www.ams.com/Contact-Us/Sales-Offices.

- Return path (RX line): It consists of the capacitive voltage divider (C35 to C38), which brings the input voltage to around $2.5V_{pp}$.

  Further 1-pin connectors (P7 & P8) are places in the two return lines to be able to measure the input voltage.

- Tuning capacitor bank: The capacitors C22, C23, C25 & C27 belong to the line Trim1 and RFO1. C24, C26, C28 & C29 belong to the line Trim 2 and RFO2.

  The not placed capacitors C39 to C46 are for a possible voltage divider option, if the antenna differential voltage exceeds $40V_{pp}$.

- Antenna connection: This 3-pin connector enables the connection of external antennas. In this case R14 & R19 have to be removed.

  The not placed R24 can be used for electrical compensation of the antenna. This helps to reduce unwanted emissions in combination with the possible voltage divider option (adding C39 to C46)

3 Antenna and capacitive electrodes

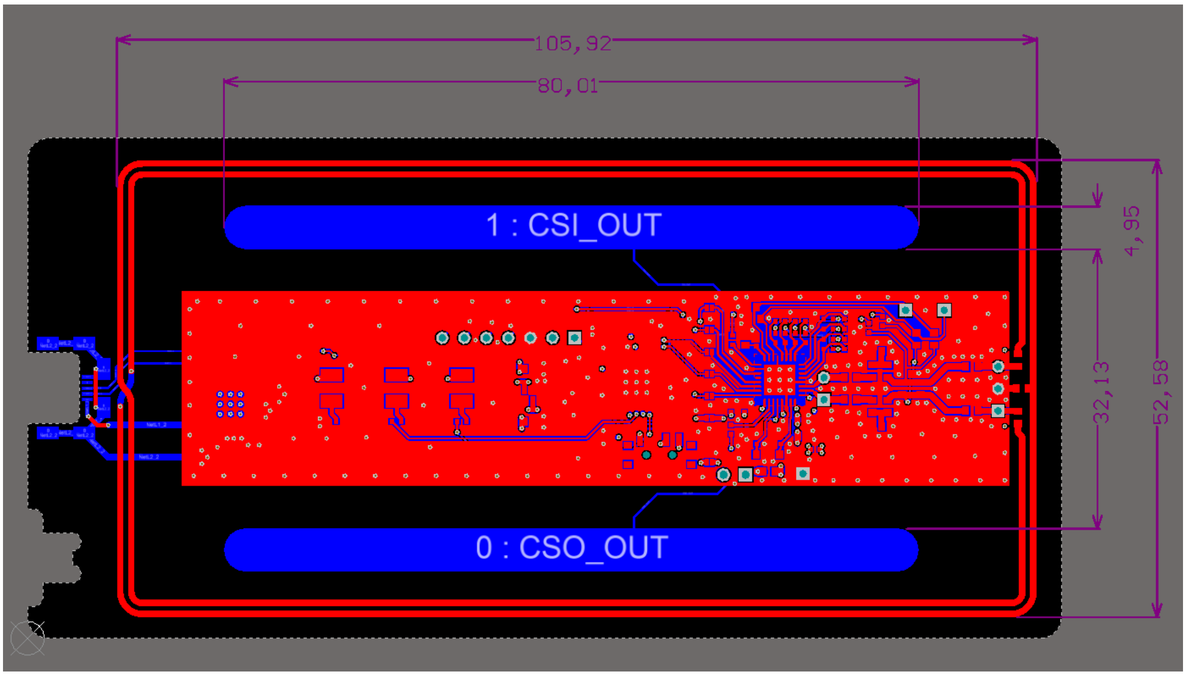
3.1 PCD antenna

A symmetrical 2 – turn coil antenna was chosen (see Figure 6).

Dimensions:

- Length: 105.9 mm
- Width: 52.6 mm
- Trace width: 0.762 mm
- Gap width: 0.51 mm

Figure 6: PCD antenna (top layer) and capacitive electrodes (bottom layer)



The electrical antenna parameter can be found in chapter 5.1.

There is the option for electrical compensation of this antenna by mounting R 24. Details can be found in chapter 2.1.3.3.

The antenna covers the outer edge of the PCB in order to have the biggest area and to be as far as possible away from the electrical circuits and capacitive electrodes.

The antenna is larger than a Class 1 PICC to reduce the coupling between PCD and PICC antenna.

The corners of the antenna are rounded to reduce the inner resistance and to obtain a more homogeneous magnetic field radiation. Be aware, that a round or a quadratic antenna would have the most homogeneous magnetic field radiation.

3.2 Capacitive electrodes

Figure 6 shows these electrodes and its dimensions, too. They are needed to measure the capacitive differences between the CSI / CSO pins. Details can be found in chapter 2.1.3.2

A guide line and simulations regarding the electrode dimensions can be found in the application note "AS3911 AN Wakeup Electrodes V1". This application note is available on request from ams sales representatives at www.ams.com/Contact-Us/Sales-Offices.

Basically the bigger the electrodes and the electrode distance is, the higher the capacitive difference and the detection range.

4 Simulation

QUCS (Quite universal circuit simulator) is used for designing the filter and matching network.

Detailed information about this software tool and the used models can be found in the application note: “AS3911 AN Antenna Design Guide V1.3”

4.1 Models

Figure 7: S- Parameter model

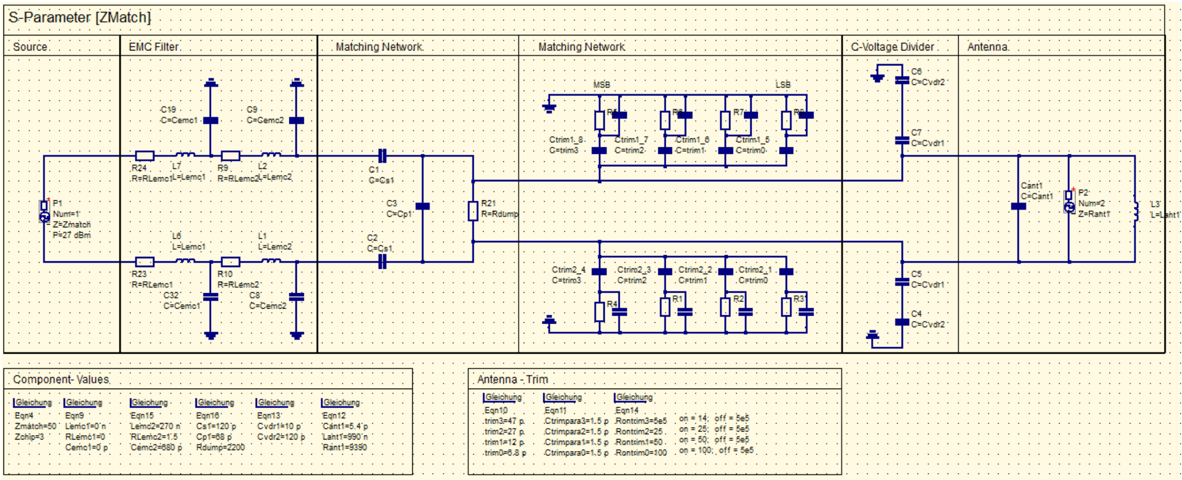
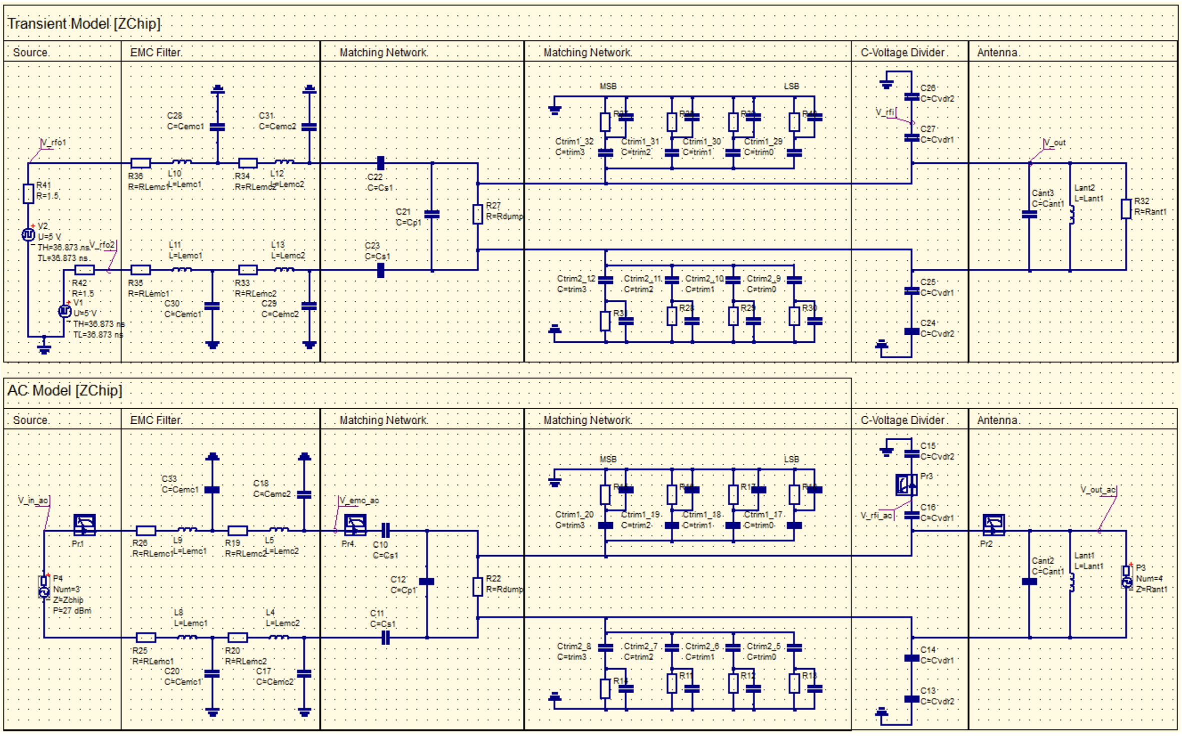


Figure 8: Transient & AC model



4.2 Results

Figure 9 shows the results of the reflection factor S11, the transmission factor S21, the target matching impedance in the Smith chart and the system Q – factor.

Only the antenna resonance can be seen in this view, because the simulation bandwidth was limited to 12 MHz but the EMC filter resonance frequency is around 11 MHz.

Further the target matching impedance is calculated with 11.56-j2.02Ω and the system Q – factor results in 14.4.

Figure 9: S – parameter simulation results

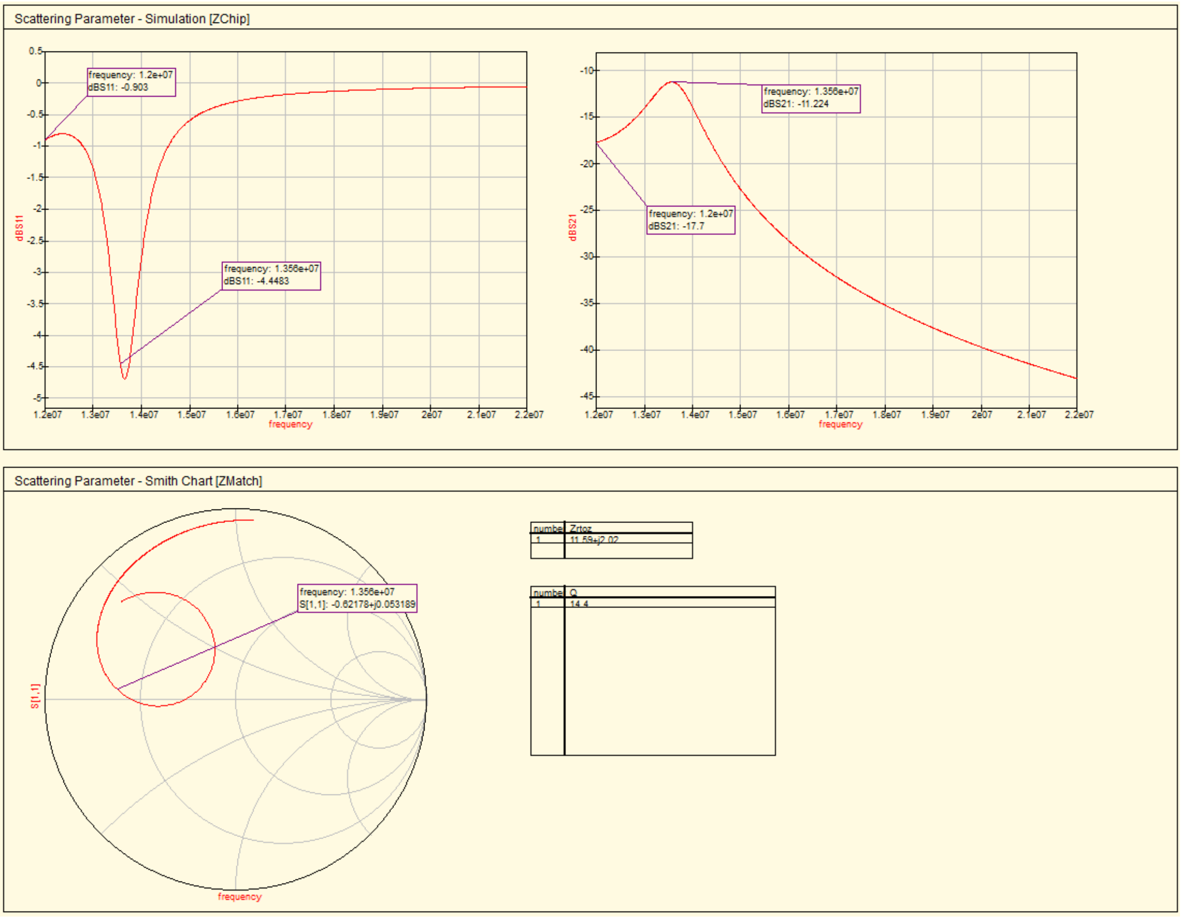
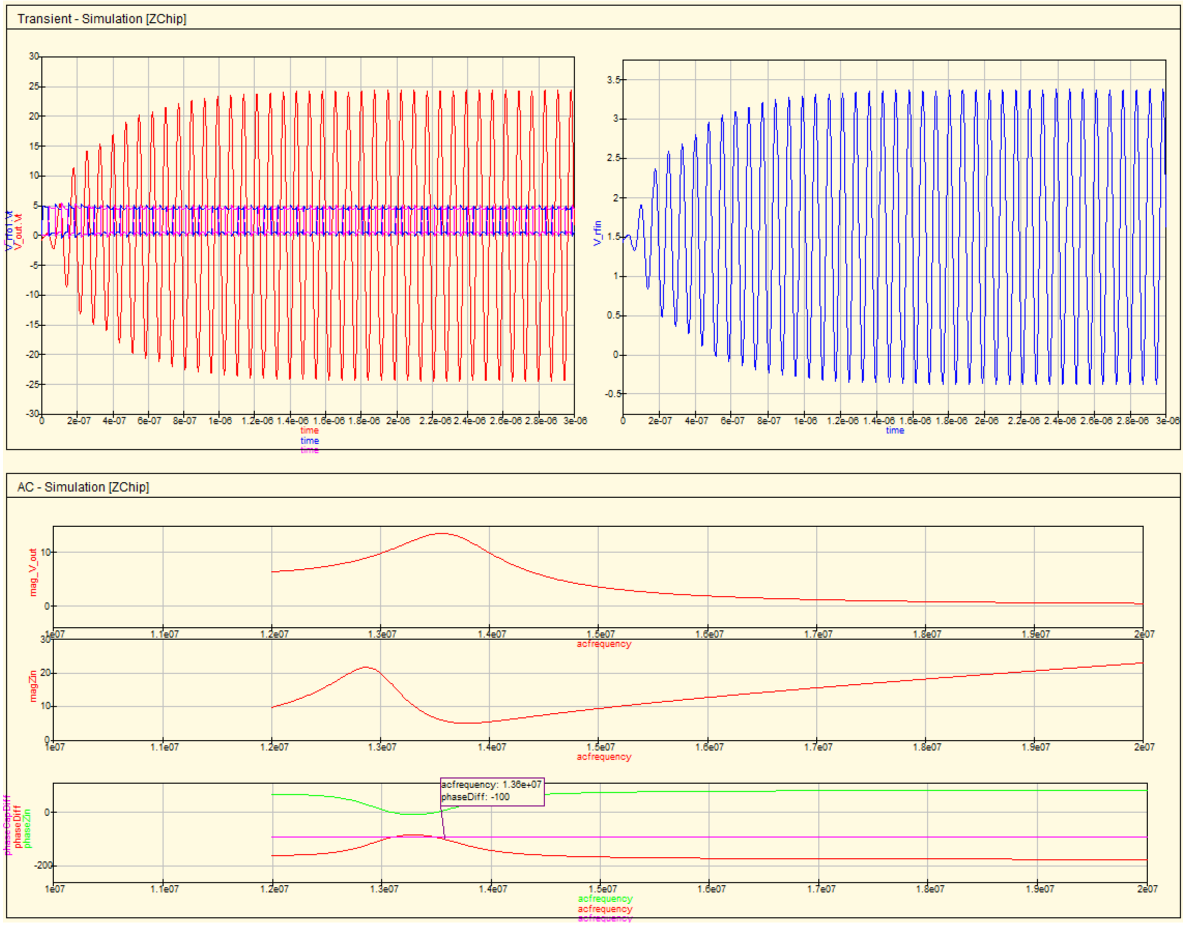


Figure 10 shows in the transient simulation the wave shape of the output signal (red) in comparison to the rectangular output voltage of the driver. There should be no significant overshoot, which is realized here.

The blue curves show the input voltage after the capacitive voltage divider. This voltage should not exceed 2.5 V_{pp}. The results here show more than 3 V_{pp}, because of the certain inaccuracy of the simulation.

The phase difference diagram of the AC simulation results is the most important one. It gives a good indication, whether the phase difference is in a range where it is measurable (±30° to 150°). This is also realized here (-100°).

Figure 10: Transient & AC simulation results



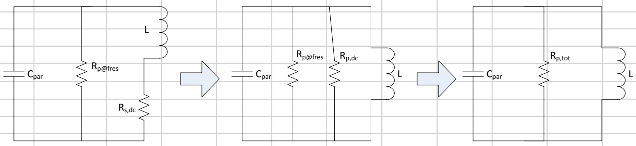
5 Measurements

Most of the measurements are described in the application note: “AS3911 AN Antenna Design Guide V1.4”. All others are described in this document. This application note is available on request from ams sales representatives at www.ams.com/Contact-Us/Sales-Offices.

5.1 Antenna parameters

Figure 11: Measured antenna parameters

Equivalent circuit			
L	990	nH	Measured inductivity@1 MHz
Rs,dc	600	mOhm	Measured serial DC resistance@1 MHz
fwork	13,56	MHz	Working frequency
fres	69	MHz	Measured self-resonance frequency
Rp@fres	20	kOhm	Measured parallel resitor caused by the Skin effect@fres
Cpar	5,37	pF	Parasitic capacitance
K	2,26		Correctur value for Skin effect
Rp@fwork	45,12	kOhm	Parallel resitor caused by the Skin effect@fwork
Rp,dc	11,86	kOhm	Parallel resistor calculated out of the serial DC resistance@1 MHz
Rp,tot	9,39	kOhm	Total parallel resistor (Rp//Rpdc)
Qb	111		Basic Quality- factor of the antenna



The three parameters for the parallel equivalent circuit are:

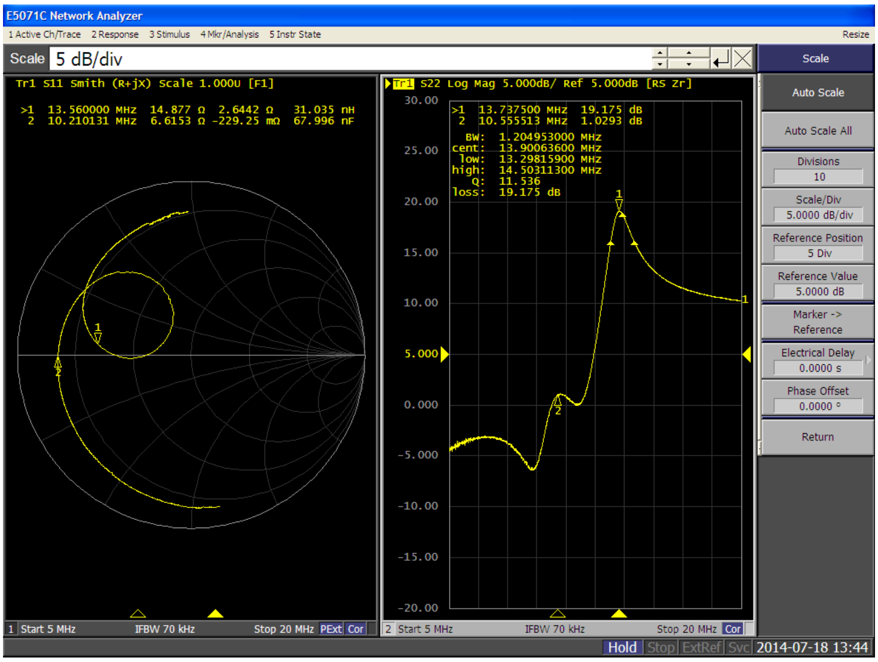
- L= 990 nH
- C_{par}= 5.4 pF
- $R_{p, tot}$= 9.39 kΩ

These values were used for the simulations.

5.2 Target matching impedance & Q – factor

Figure 12 shows the measurement results. The matching impedance is around 14.9+j2.6Ω. The Q is around 11.5. Both values fit well in terms of current consumption, different data rates and wave shapes. The EMC filter resonance frequency is around 10.5 MHz.

Figure 12: Target matching impedance & Q – factor



5.3 Current consumption

The power consumption is measured in CW mode, the antenna was calibrated to a trim value of eight, the operation voltage is adjusted to 4.5V and the Jumper J3 is used to connect the Multimeter.

Table 1: Current consumption

Working condition (register settings)	Current consumption [mA]
0x2: en=1, rx_en=1, tx_en=1	184

The measurement was performed without card close to the PCD antenna.

If there is a card close to the PCD antenna, the current consumption will decrease to around 100 mA.

5.4 Wave shapes, ISO / IEC 14443

The measurements were carried out unloaded with a calibration coil.

Figure 13: Type A, 106 kbps

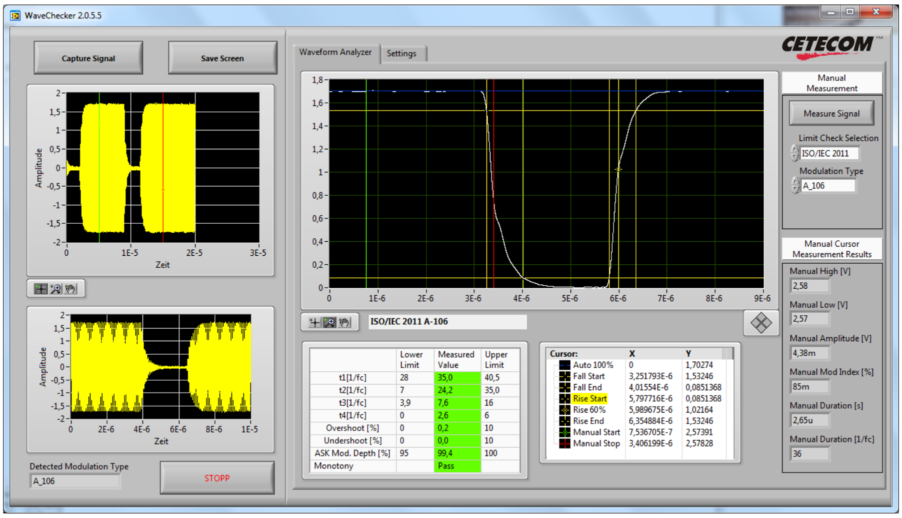


Figure 14: Type A, 212 kbps

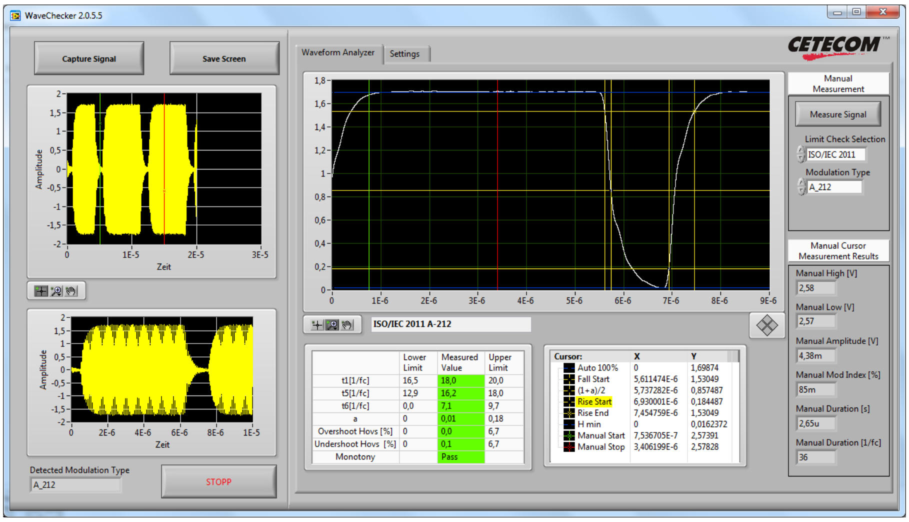


Figure 15: Type A, 424 kbps

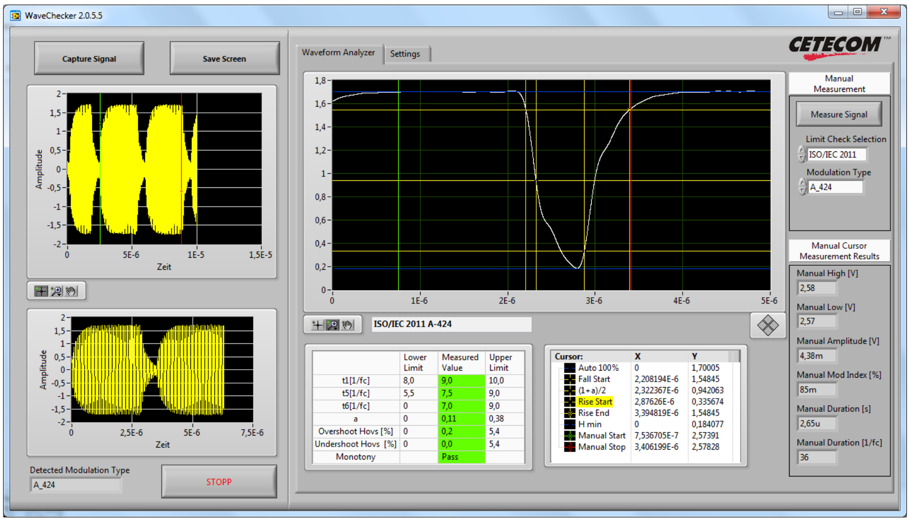


Figure 16: Type A, 848 kbps

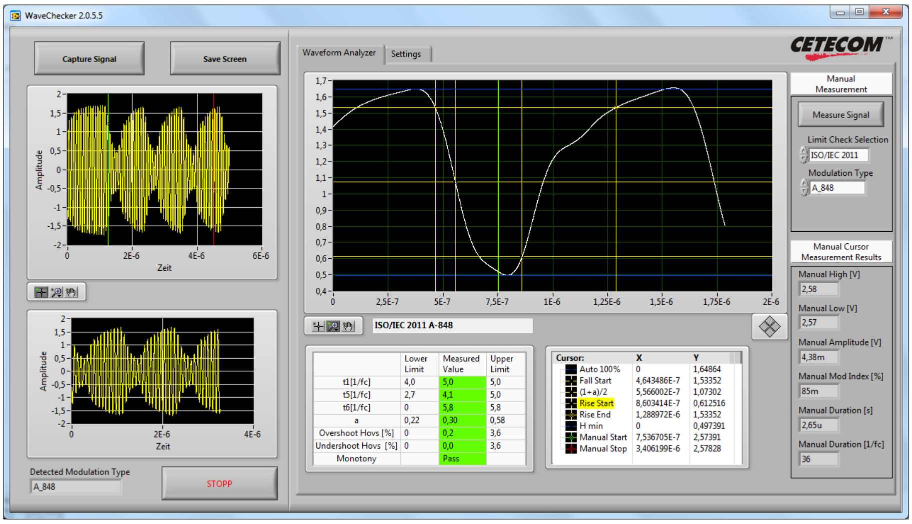


Figure 17: Type B, 106 kbps

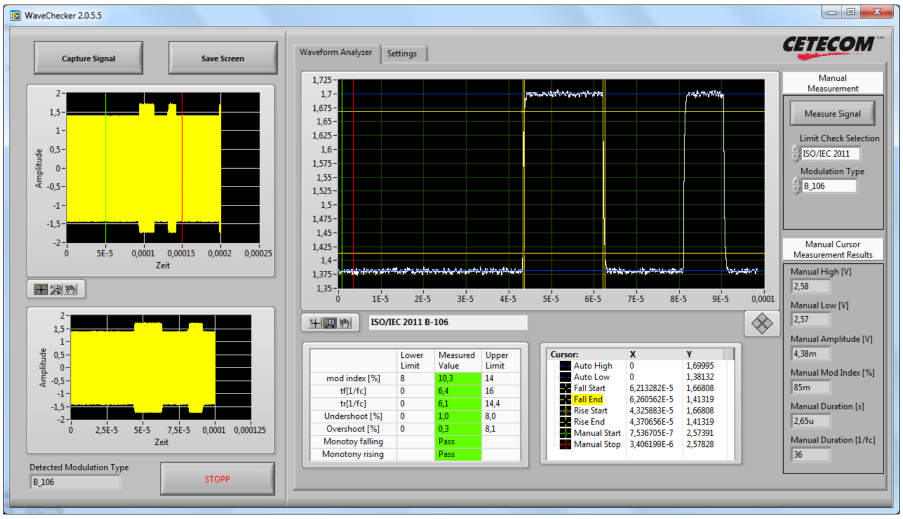


Figure 18: Type B, 212kbps

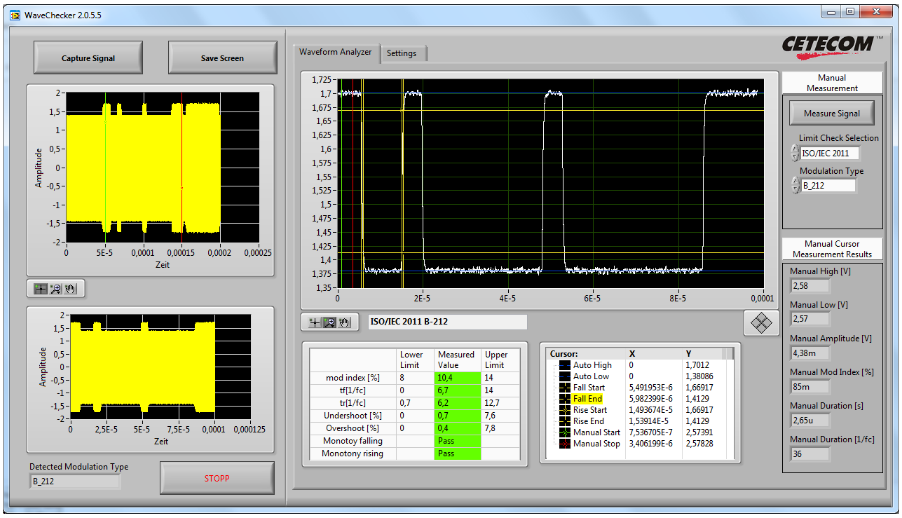


Figure 19: Type B, 424 kbps

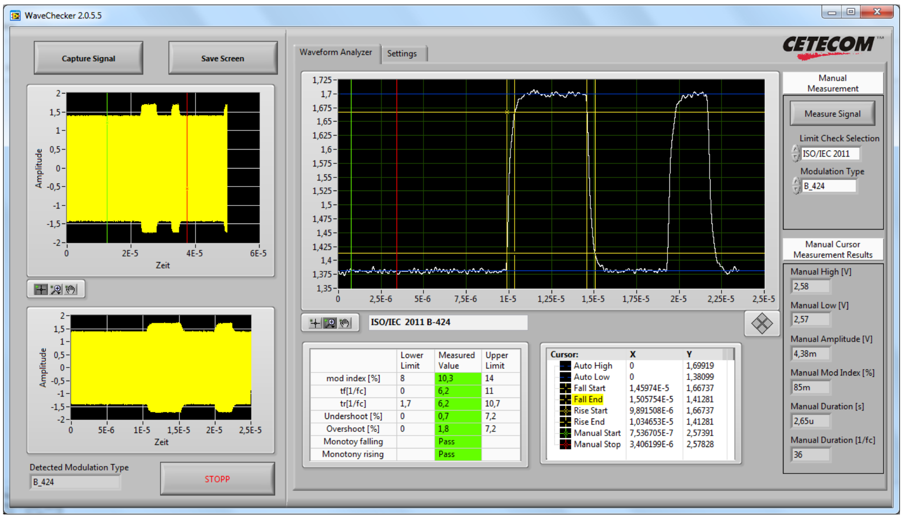
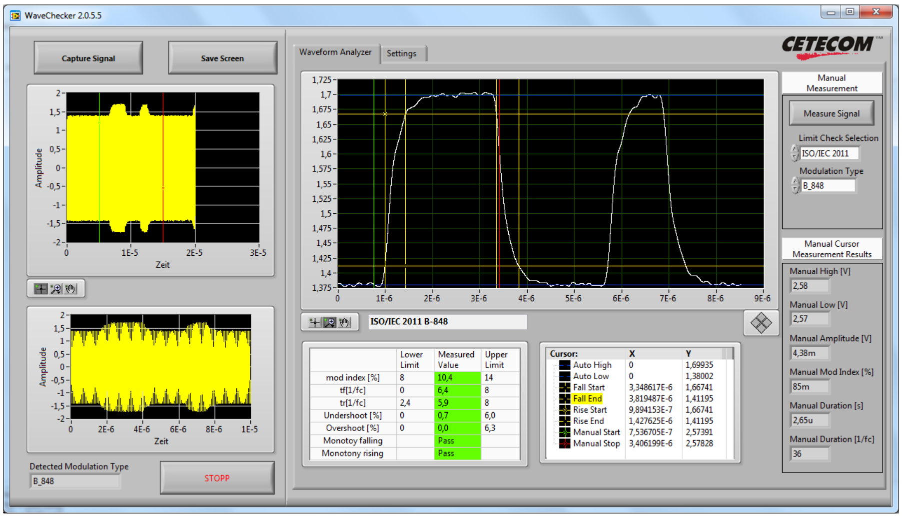


Figure 20: Type B, 848 kbps



5.5 ISO / IEC compliance

These compliance tests were done with commercial available setups made by Micropross.

5.5.1 ISO / IEC 14443

5.5.1.1 Class 1

Figure 21: Result overview of the ISO 14443 Class 1 tests

	Name	Description	Result
1	Alternating magnetic field	This test determines that the PCD generates a field not higher than the average value specified in ISO/IEC 14443-1:2010, in any possible position.	PASSED
2	Procedure for Hmax	This test determines that the DUT with its specified antenna generates a field not higher than the value Hmax	PASSED
3	Procedure for Hmin	This test determines that the DUT is able to supply a field strength of at least Hmin to power the reference device placed anywhere within the defined operating volume	PASSED
4	Type A	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
5	Type B	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
6	Type A at 106 kbps	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
7	Type A at 212 kbps	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
8	Type A at 424 kbps	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
9	Type A at 848 kbps	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
10	Type B at 106 kbps	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
11	Type B at 212 kbps	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
12	Type B at 424 kbps	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
13	Type B at 848 kbps	This test determines the modulation index of the PCD field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 14443-2 within the defined operating volume.	PASSED
14	Setting	The purpose of this setting is to find the limit of understanding of the PCD under test.	PASSED
15	Measurement	The purpose of this measurement is to measure the PCD load modulation sensitivity for the tested positions	PASSED

	Name	Description	Result
16	Setting	The purpose of this setting is to find the limit of understanding of the PCD under test.	PASSED
17	Measurement	The purpose of this measurement is to measure the PCD load modulation sensitivity for the tested positions	PASSED

5.6 EMC

FCC Title 47 Part 15, Class B pre - scans were done to evaluate the EMC of the demo board.

The demo board conditions (GUI adjustment) are as follows:

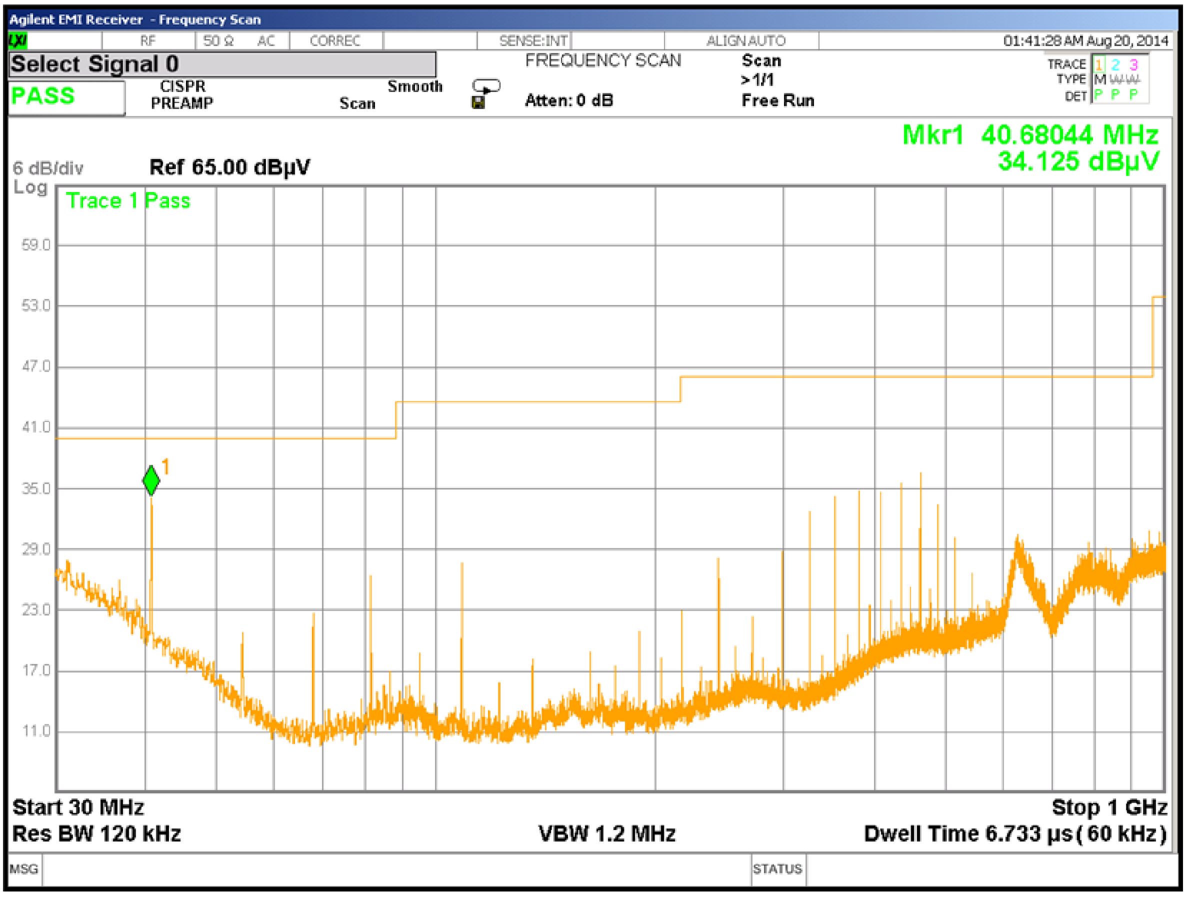
1. Battery pack - power supply (4 x 1.2V, AA) is connected between USB connector and ferrite beads L1 & L2 (see Figure 2)
2. “Demo Board Check” button pressed
3. “Calibrate Antenna” button pressed (trim value: 8)
4. Adjust regulator button pressed
5. Repeat steps 3 & 4 to make sure that the voltage level is adjusted correctly

Figure 22 shows that the highest unwanted emissions of the demo board are at the 3rd harmonics of the 13.56 MHz (40.68 MHz) and several frequencies between 200 and 500 MHz.

All emissions are clearly under the FCC spectrum mask.

This measurement was done without a transponder in the reader field.

Figure 22: FCC Title 47 Part 15, Class B pre - scan



6 Layout recommendations regarding EMC

This chapter describes the countermeasures against unwanted emissions on the General Purpose Demo Board V3. More detailed information about this topic can be found in the application note: "AN PCB layout recommendation".

6.1 Layer stack up

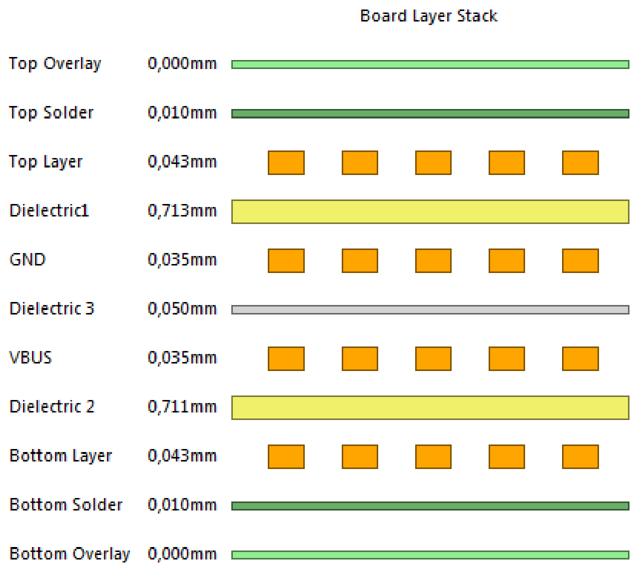
At least a 4 – layer stack is recommended for an AS3911 PCB in terms of EMC performance.

The 4 – layer of the General Purpose Demo Board V3 demo are:

- Top layer (Signal)
- GND plane (GND)
- Power plane (VBUS)
- Bottom layer (Signal)

The detailed stack can be found in Figure 23. A 4 – layer design was chosen to have a good compromise between costs and EMC performance.

Figure 23: GP V3, PCB layer stack



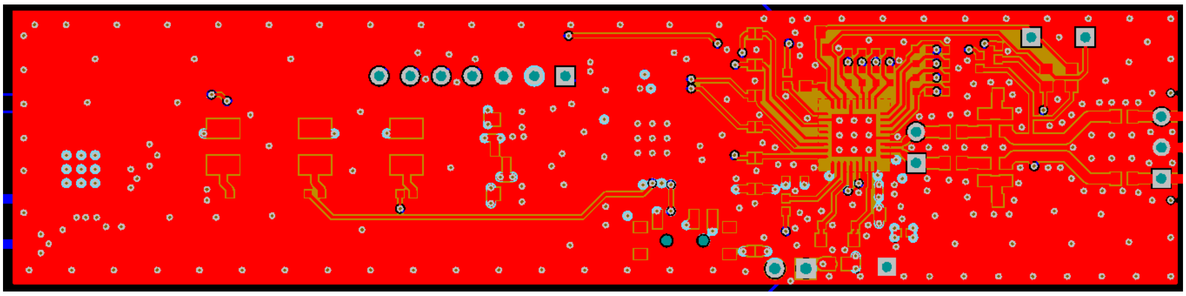
Remark:

The GND - & power plane were designed to get a low-impedance GND/power – system. They are the inner layers, because this system can be shielded by the outer signal layers. Furthermore the distance between the GND and the power plane **should be reduced to a minimum (50µm)** to increase the capacitance between the planes. This increased capacitance supports the recharging process of the GND/power – system to avoid a too strong jitter of the supply voltage.

The GND/power plane combination acts as a waveguide. Therefore a fence of vias (GND & signals) was installed to avoid the emission radiation out of the plane edges.

Figure 24 shows the realization on the demo board.

Figure 24: Via - fence on the plane edges

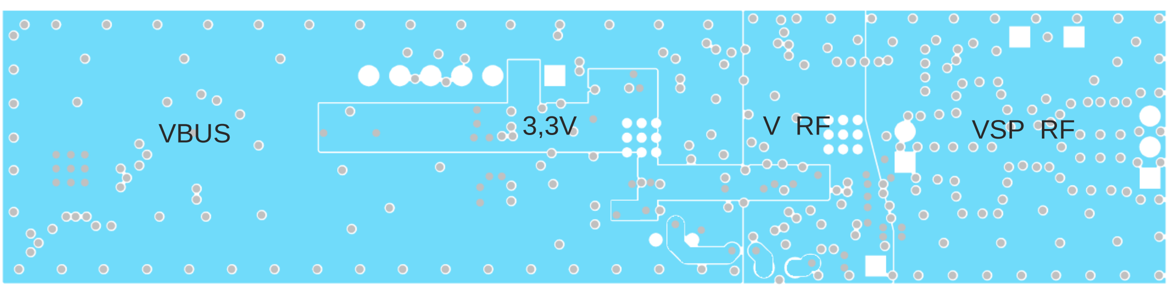


6.2 Routing

- Fast switching signal traces should be as short as possible.
- Current return paths should be as short as possible.
- GND plane should not be slotted.
- Dead copper should be grounded.
- Component GND pads and vias are directly connected to GND to achieve the shortest possible current paths.
- Power plane:

  This demo board has four sub – planes (see Figure 25):
  - VBUS
  - 3.3V
  - V_RF
  - VSP_RF

Figure 25: The four sub – planes of the power plane

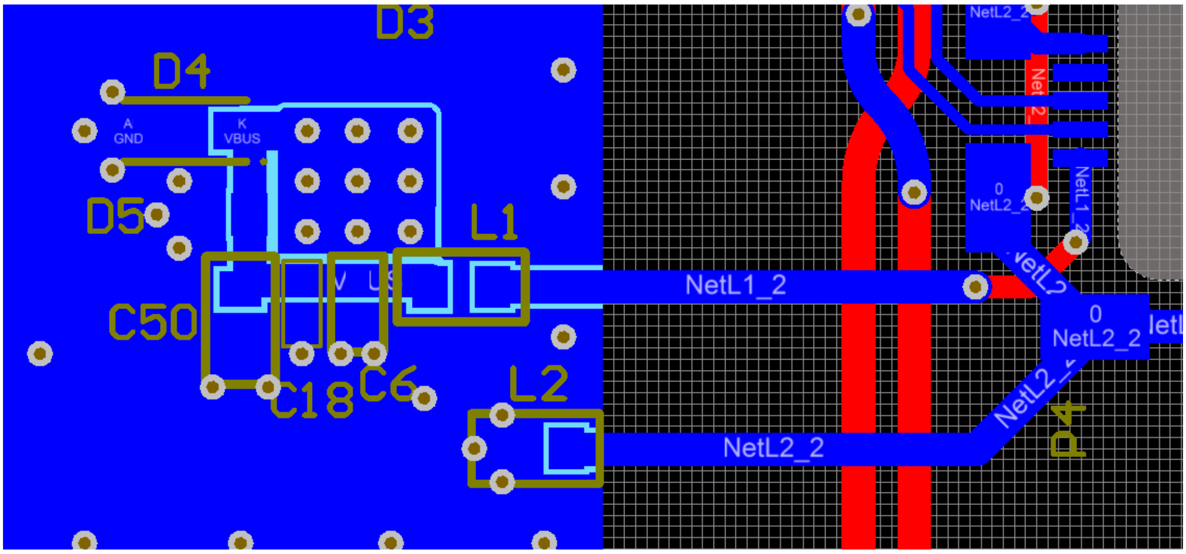


- The differential filter – and matching network should be designed symmetrical.

6.3 Component placement

- Placing the decoupling capacitors as close to the IC´s as possible (small loop areas, small inductance).
- Component GND pads should be as close to the IC as possible (short current return paths)
- Clear arrangement between digital and analog areas.
- The component placement of the USB power connection is shown in Figure 26.

Figure 26: USB power connection to the power plane



EMC measurement results like in chapter 5.6 can be achieved with all these design rules.

7 Software

7.1 Main features

- Supported protocols:
  - ISO 14443
  - ISO 15693
  - Felica
  - NFC Type 2
  - ISO 18092 (NFCIP-1) Active P2P
  - Topaz
  - iCLASS
  - Kovio
- Automatic Antenna tuning (AAT)
- Wake up (capacitive & inductive)
- Multi transponder detection
- Easy access to the register map

7.2 Getting started

7.2.1 Demo board installation

Plug in the reader on a USB port. For AS3911 general purpose board you need a USB Port that can provide >200 mA since the AS3911 is using USB power. Usually those ports are direct on the PC or use the Laptop or on a powered Hub.

7.2.2 GUI installation

Follow the GUI install procedure by running application file: AS3911GUIv2_2-3-0-0.exe.

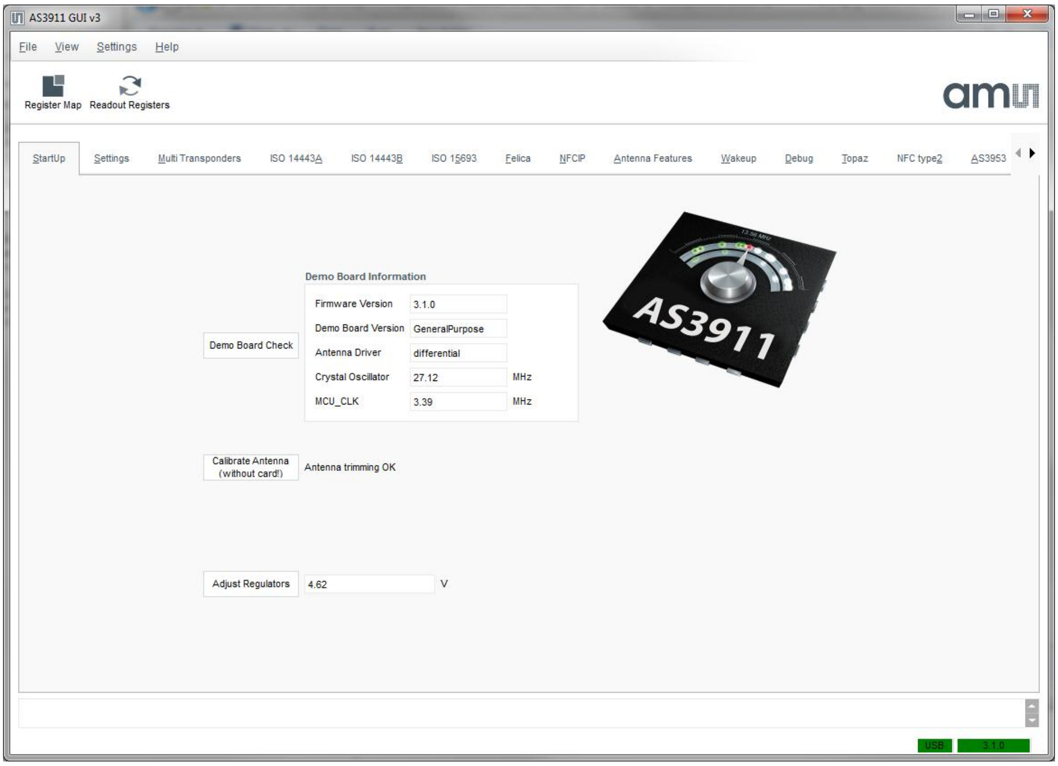
7.3 Graphical user interface (GUI)

7.3.1 Startup tab

When the GUI is started, the window in Figure 27 appears. The indicator on the right bottom corner shows the connection status. If the board is successfully connected via USB, then the status turns to green and displays the version of the firmware.

Click of the button “Demo Board Check” read status information of the Demo board and checks whether a firmware update is needed. The configuration of the AS3911 is done based on this information.

Figure 27: Startup window



The next step is to press the “Calibrate Antenna” button to tune the antenna to 13.56 MHz.

Afterwards the “Adjust Regulators” button has to be pressed in order set the internal regulators to improve system Power Supply Rejection Ratio (PSRR).

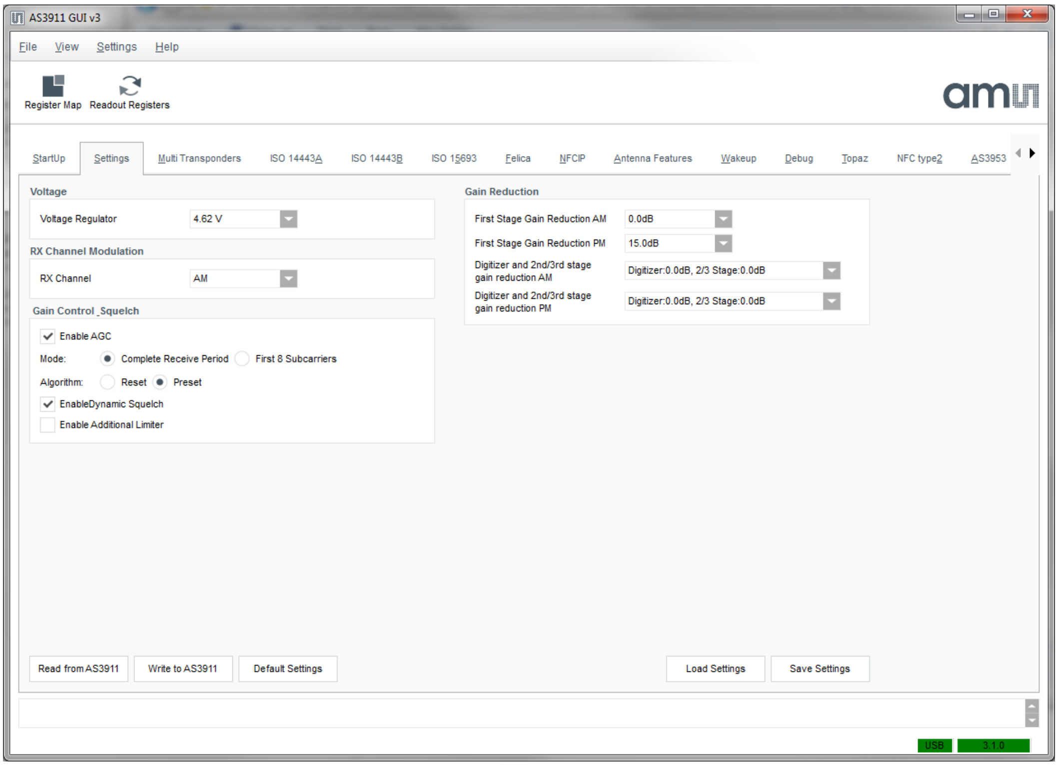
Remark:

The “Adjust Regulators” button has to be pressed always after the “Calibrate Antenna” button to obtain the real power consumption of the AS3911 during operation.

7.3.2 Settings tab

Figure 28 shows the Settings window. Some important register settings can be modified here. Furthermore it is possible to read out the current settings, load and save them.

Figure 28: Settings window



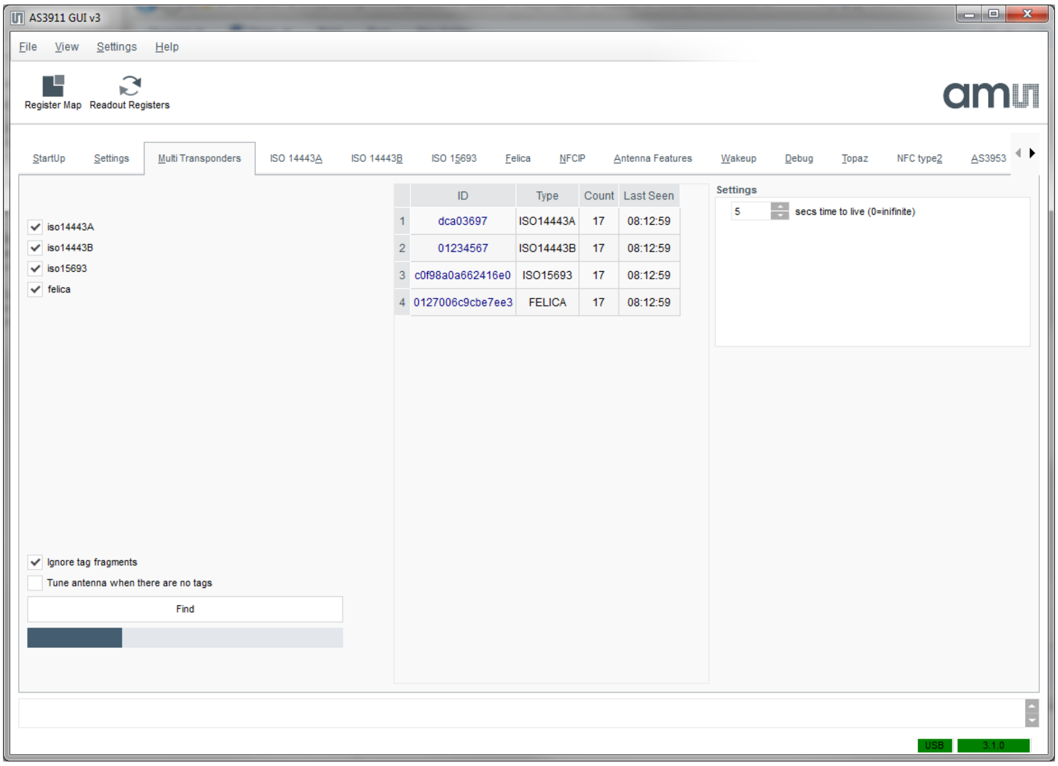
7.3.3 Multi Transponders tab

This tab shows the anti-collision and multi-protocol feature of AS3911 board (see Figure 29)

On opening, all standards are active and by press the “Find” button, the reader start to scan for tags that are in the proximity of the reader. Press the “Find” button during the interrogation process to stop the interrogation process.

The log screen shows the UIDs or PUPIs, the type and how often the transponder is scanned. The time stamp shows the last scan.

Figure 29: Multi Transponder window



Additional the following protocols are supported:

- Kovio Barcode 128/256 bit (ISO 14443A checkbox)
- iCLASS (ISO 15693 checkbox)

7.3.4 ISO 14443A tab

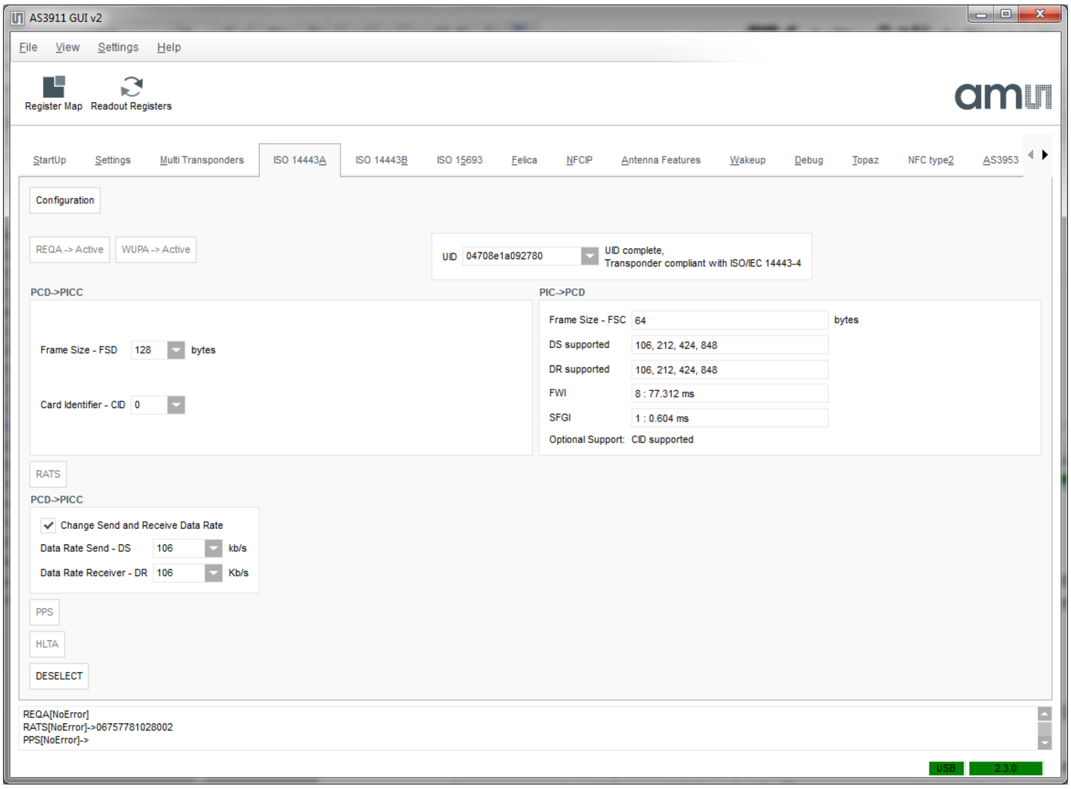
In this tab the IS014443A operation of the AS3911 is demonstrated. Figure 30 shows the ISO 14443-A window of the GUI.

After clicking the button “Configuration”, an IS014443A transponder can be placed into the reader field. The button “REQA ->Active” or “WUPA ->Active” starts the anti-collision procedure and the UID number of the transponder is displayed.

If the card/tag supports ISO 14443-4, further commands like RATS or PPS can be carried out.

After RATS or PPS – button was pressed, APDU frames can be sent by using “Debug” tab (see chapter 7.3.11)

Figure 30: ISO 14443A window



7.3.5 ISO 14443B tab

In this tab the IS014443A operation of the AS3911 is demonstrated. Figure 31 shows the ISO 14443-B window of the GUI.

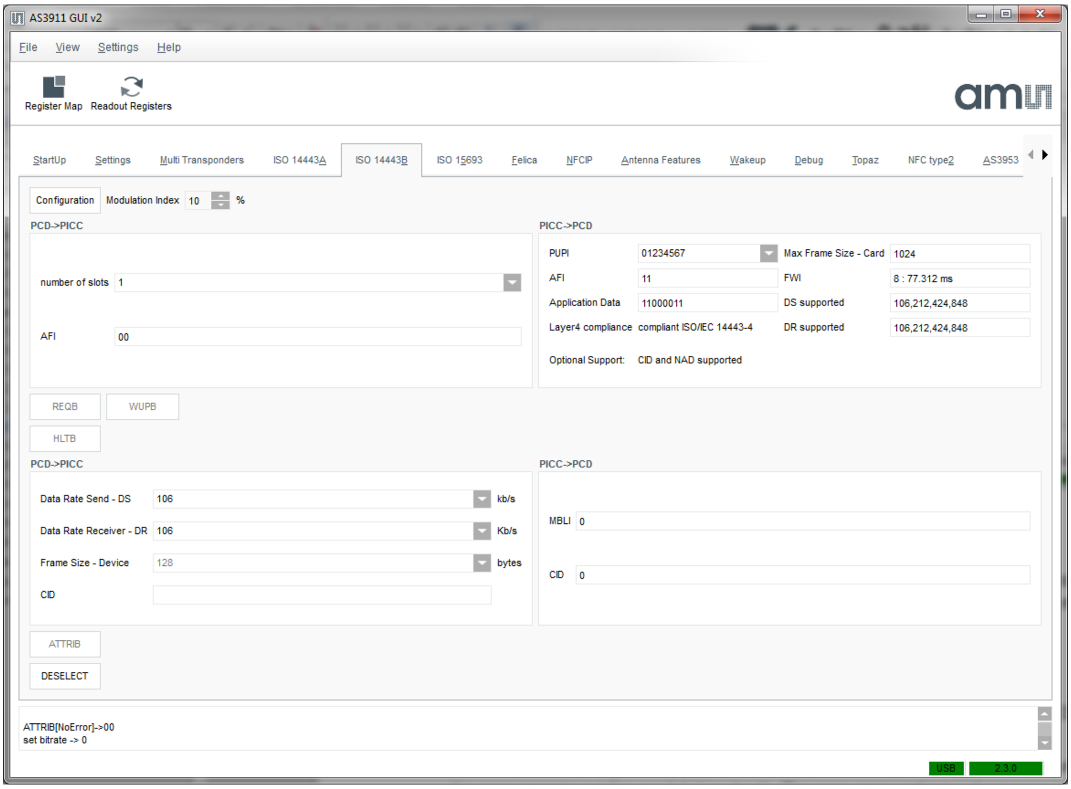
The command “configuration” prepares the board for ISO 14443-B communication and start the sequence to set the modulation depth. The sequence activates the transmission, measures the modulation depth and adapts it to comply with the modulation depth specified in the box “Modulation Index”. See AS3911 Datasheet, section AM modulation depth definition using direct command calibrate modulation depth.

After clicking the button “Configuration”, an ISO14443-B transponder can be placed in the reader filed. Clicking button “REQB” or “WUPB” starts the interrogation procedure and the “PUPI” number of the transponder is displayed.

If the card/tag supports ISO 14443-4, further commands like ATTRIB can be carried out.

After ATTRIB – button was pressed, APDU frames can be sent by using “Debug” tab (see chapter 7.3.11)

Figure 31: ISO 14443B window



7.3.6 ISO 15693 tab

In this tab the IS0 15693 operation of the AS3911 is demonstrated. Figure 32 shows the ISO 15693 window of the GUI.

The command “Configuration” prepares the board for ISO 15693 communication. This configuration starts a firmware sequence to set the modulation depth as described in chapter 7.3.5 (ISO14443 Type B).

It sets as well ISO 15693 parameter for the receive data rate and the number of slots that are used in the anti-collision round in the firmware.

The button “Inventory” start the interrogation and scan for the Vicinity Integrated Circuit Card (VICC).

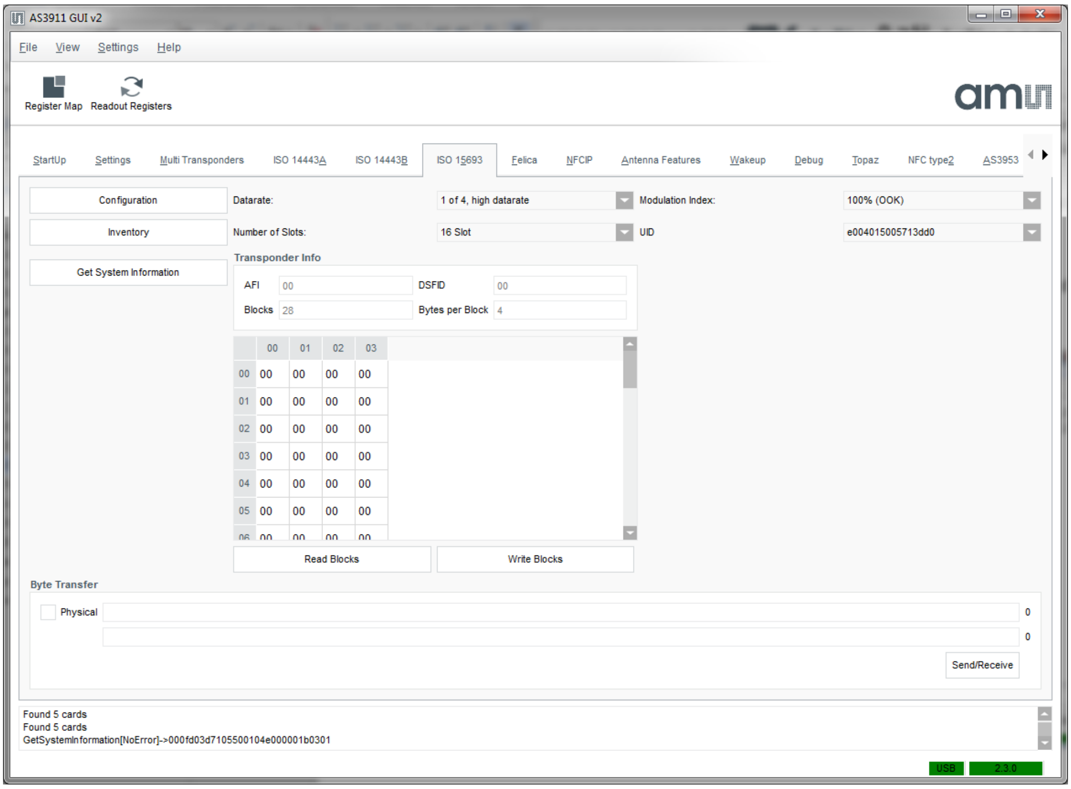
After end of the Interrogation process, a Tag can be picked by UID and the “Get System Information” can be issued which will request the VICC for supported features.

The command “Read blocks” will read out and display the memory blocks of the VICC.

Remark:

Not all vicinity cards support “Get System Information” command.

Figure 32: ISO 15693 window



7.3.7 FeliCa tab

In this tab the FeliCa functionality of the AS3911 is demonstrated. Figure 33 shows the FeliCa window of the GUI.

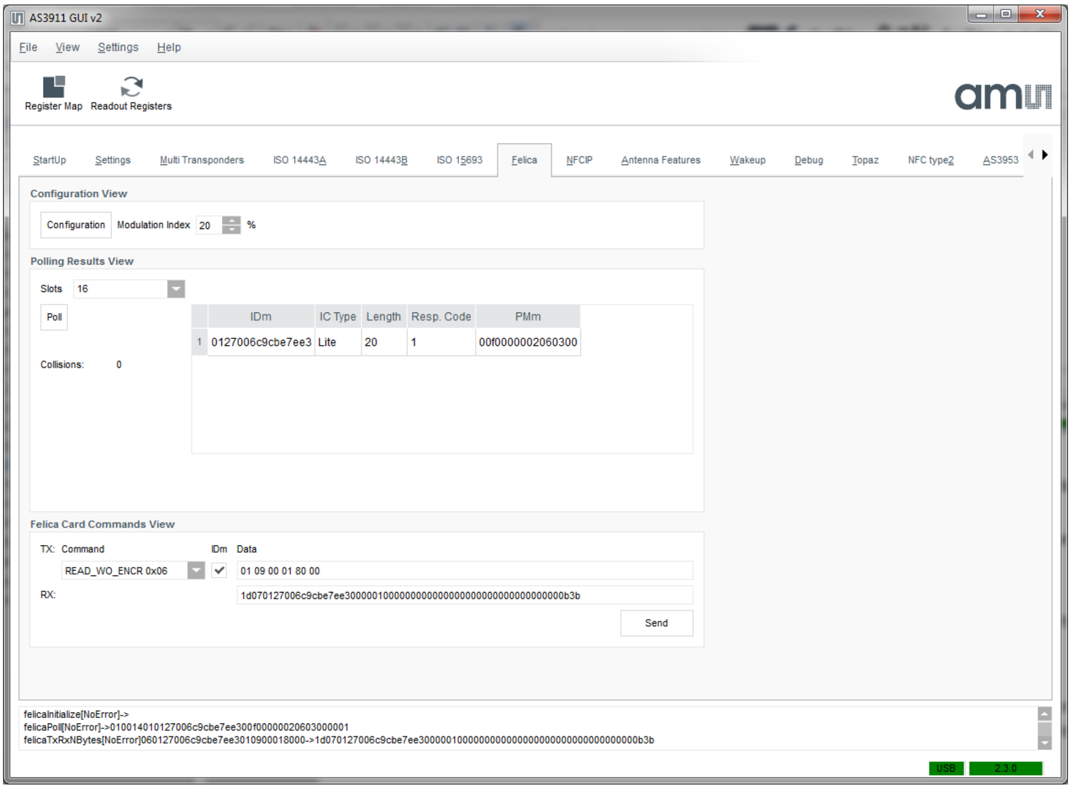
The command "Configuration" prepares the board for FeliCa communication. This configuration starts a firmware sequence to set the modulation depth as described in chapter 7.3.5 (ISO14443 Type B).

The number of slots that are used in the anti-collision round in the firmware can also be set.

The button "Poll" starts the interrogation and scans for FeliCa transponder.

FeliCa Lite features can be shown with the default content of the "Felica Card Commands View" group box.

Figure 33: Felica window



7.3.8 NFCIP tab

In this tab the active peer – to peer functionality of the AS3911 is demonstrated. Figure 34 shows the NFCIP window of the GUI.

Please note that this feature requires a NFC enabled smart phone or tablet.

The AS3911 is initially configured to cycle through the initiator and target mode. The default setting for the bitrate is 424kbps. The communication starts automatically, when tab is selected.

Once the link is established, the initial grey phone picture on the GUI is replaced by a colored one.

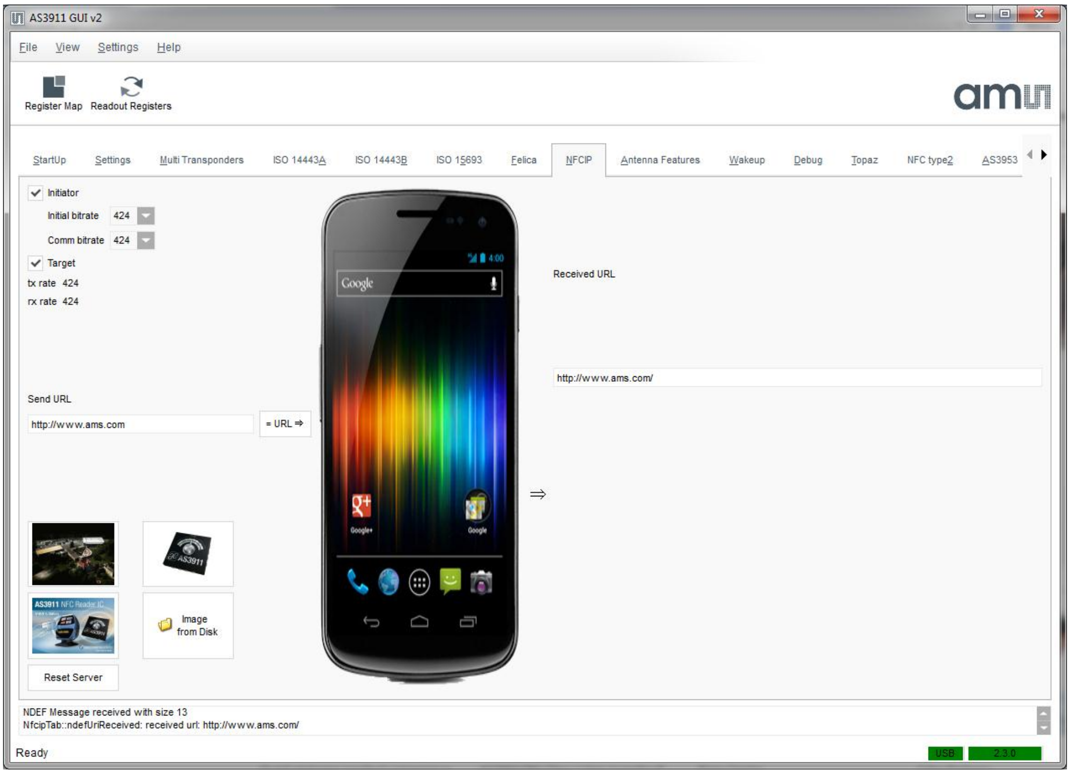
It is possible to transfer an URL to the phone by using the established connection.

The command "=URL =>" starts the transfer and the browser in the phone will open the requested URL.

Furthermore it is possible to transfer pictures to the phone. Three sample pictures are provided by the GUI and a further option "Image from Disk" provides an individual option to select a file. After a click on one picture the transfer is started. Please note that the transfer of the picture takes several seconds since it contains a large amount of data. Please wait till the picture is transferred. You should not interrupt the transfer.

The phone will display the received picture with the comment "new Tag received".

Figure 34: NFCIP window



7.3.9 Antenna features tab

The automatic antenna tuning feature of the AS3911 is demonstrated in this tab. Figure 35 shows Antenna feature window of the GUI.

The antenna resonates at 13,56MHz, if the pointer shows maximum input signal amplitude. A target phase can be chosen to use it as a reference for the internal algorithm.

After activating the command “Measure Antenna” the amplitude of the input signals and the phase differences between output and input signal is measured and displayed on the graph and the command line on the bottom.

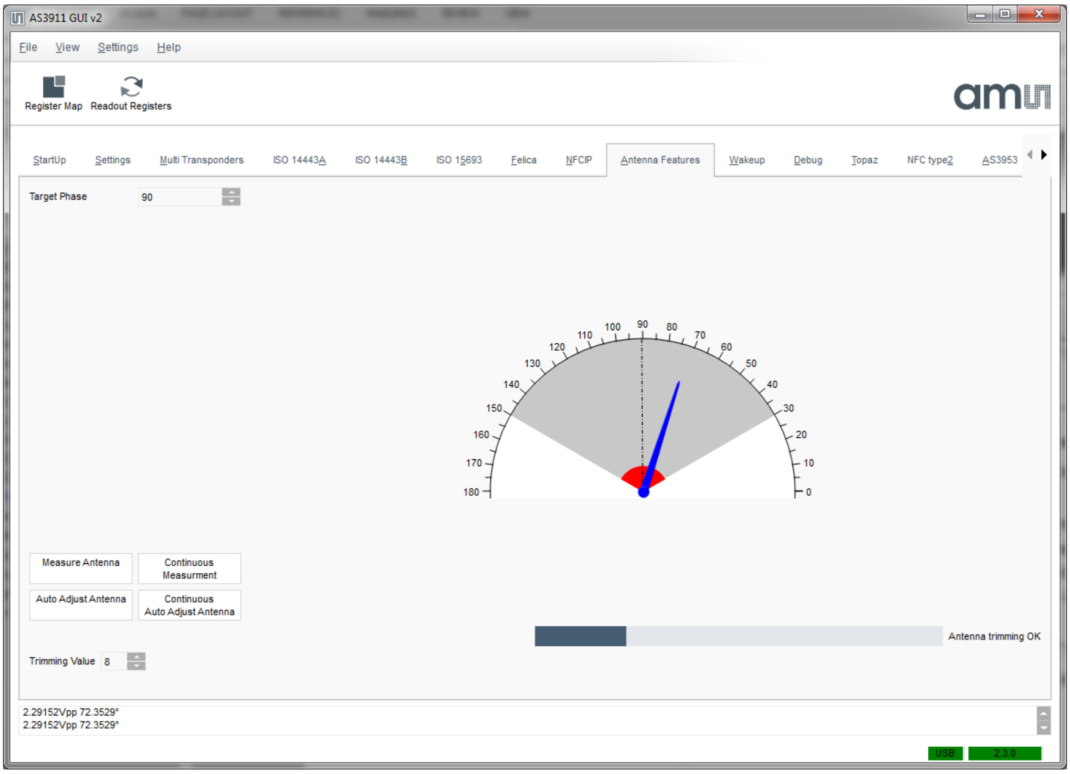
Input amplitude and phase difference can be continuously monitored by using the command “Continuous Measurement”. Once this option is activated, a detuning effect can be seen while approaching a piece of metal to the antenna.

The antenna can be tuned by the button “Auto Adjust Antenna”. This can be done continuously by using the button “Continues Adjust Antenna”.

It is possible to manually adjust the trim value with the List Box “Trimming values”. It is recommended to use the “Continues Measurement” for this investigation. Note that the value of -1 will not change the settings.

The antenna feature tab can be easily used for matching network evaluation of other AS3911-based readers. Chapter 2.1.2 describes the realization of an SPI - connection between the µC of the GP V3.0 and an AS3911 on an external reader board.

Figure 35: Antenna Feature (Automatic Antenna Tuning) window



7.3.10 Wakeup tab

The wakeup Tab is designed to demonstrate the low power wakeup modes of AS3911 (capacitive or inductive wakeup). The AS3911 offers three wake up modes that generate an interrupt to the microcontroller in deep sleep.

Remark:

Since this demonstrator is for evaluation purposes, there are continuous measurements update enabled which result in extra current consumption. To avoid interaction with the AS3911 during the deep sleep mode, the user can avoid that update and minimize the current consumption by enable the "read at interrupt only" switch.

7.3.10.1 Capacitive Wakeup

Figure 36 shows the wakeup window with the capacitive wakeup enabled.

This method observes the capacitance across two electrodes. Since parasitic capacitances influence need to be rejected for that measurement, a calibration needs to be done first.

This calibration is easily done by activating the “AutoCalibrate” button. Alternatively, it is possible to manually set the calibration value.

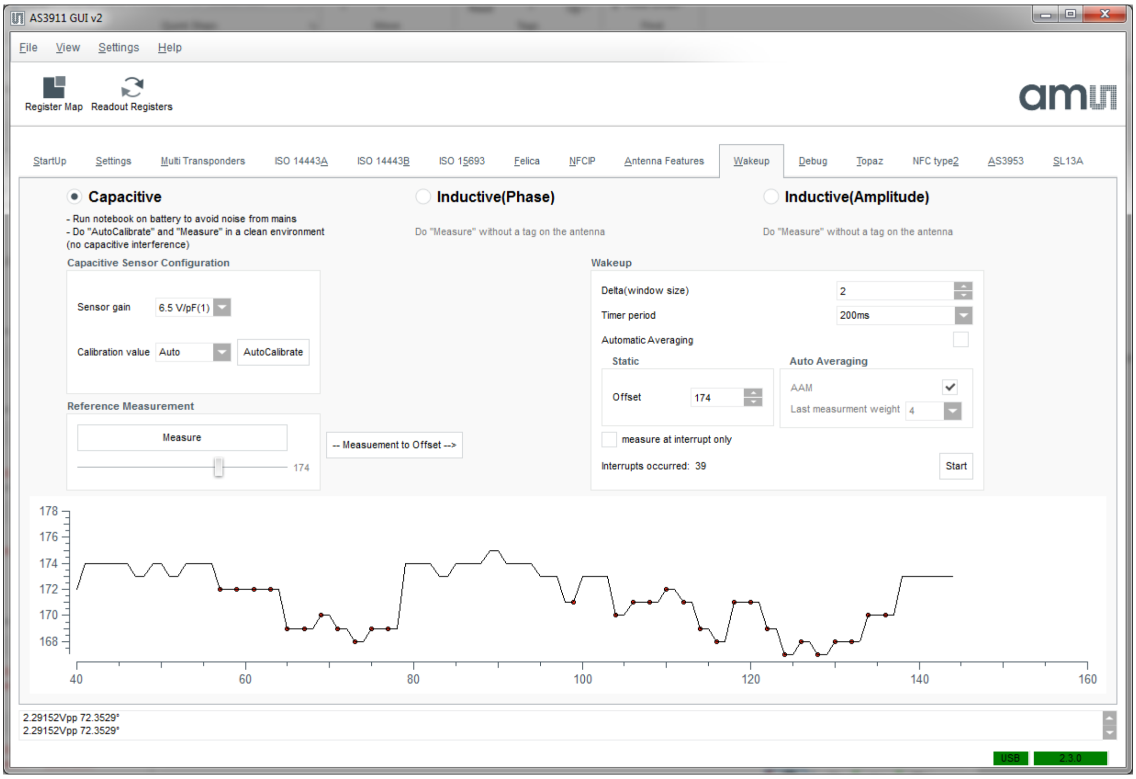
Remark:

The “AutoCalibrate” button only works in the auto-position.

Before the scan is started, the initial status (Offset) of the system needs to be set. That step is executed by clicking on the “Measure” button and “Measurement to Offset” button.

The wakeup detection starts with the “Start” button, the actual measurement values are shown in Figure 36. An interrupt is indicated by a red dot.

Figure 36: Wakeup window – Capacitive wake up enabled



The additional parameters define the window in which no interrupt is generated (Delta window size). In case the actual measured value is within the window range, no interrupt will be generated.

The Timer period defines how often the measurement procedure is executed.

The selection box “Automatic averaging” selects an automatic or static offset value. In case of an auto averaging, the offset is dynamically adjusted to the environment condition. If this option is active, the offset changes dynamically with a weighted factor which can be selected. The weight option defines how fast the offset value is being adapted to the new environment condition.

7.3.10.2 Inductive wakeup

The inductive wakeup scans periodically the input signal amplitude and the phase difference of the output and input signal. If there is change of one of these two antenna tuning parameters, an interrupt is generated.

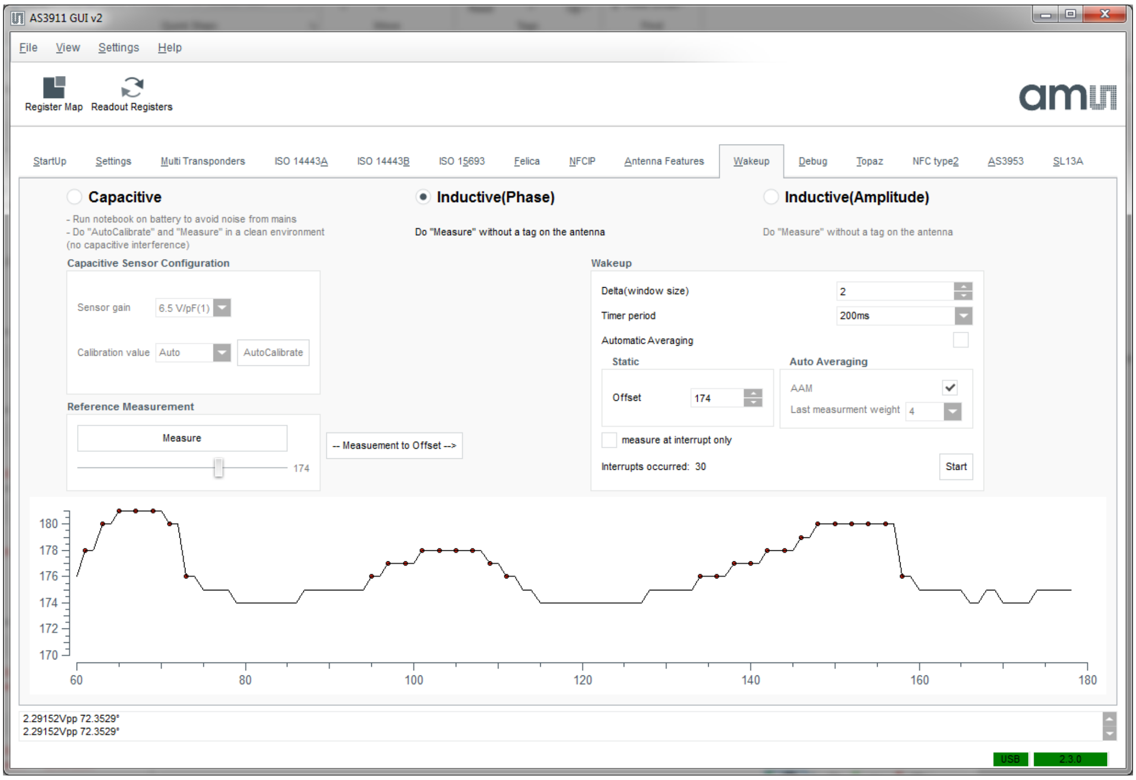
Remark:

The antenna needs to be tuned before starting the inductive wakeup procedure.

Figure 37 shows the wakeup window with the phase differences measurement.

The same procedure is used to obtain the offset level than for the capacitive wakeup in chapter 7.3.10.1.

Figure 37: Wakeup window – Inductive (phase) wake up enabled

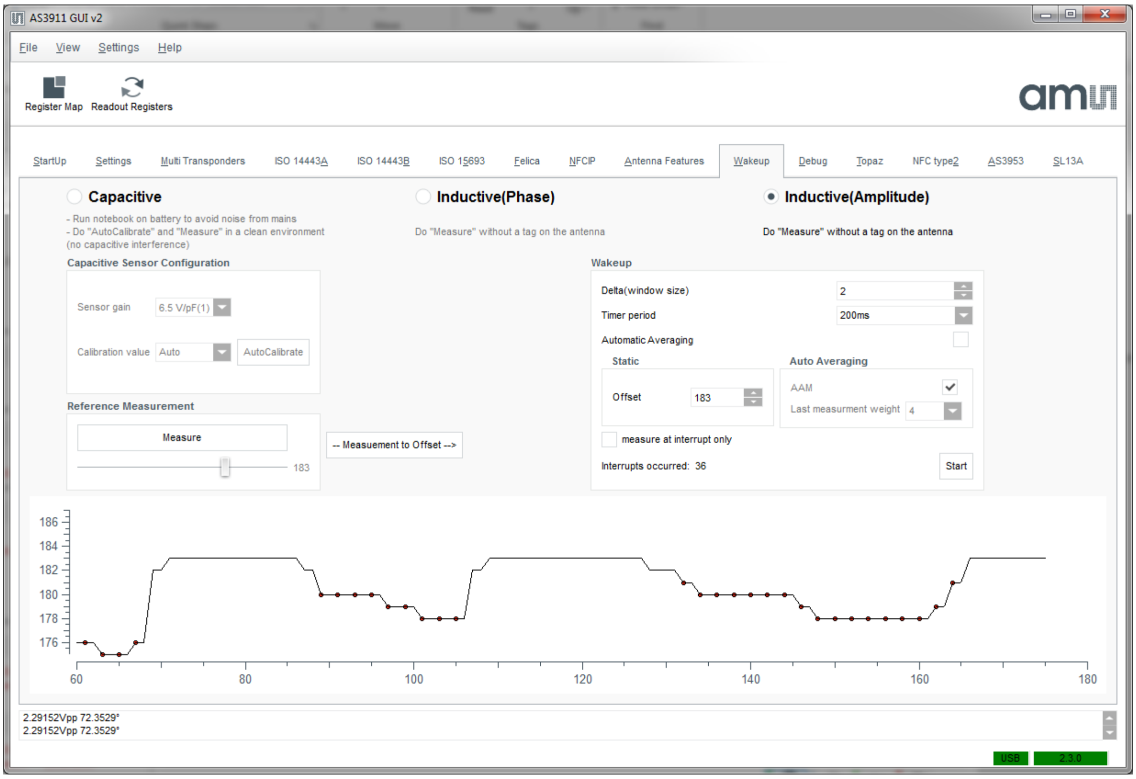


The wakeup window with the input signal amplitude measurement is shown in Figure 38.

Remark:

Different wakeup ranges can be achieved with the phase or amplitude method. This depends basically on the antenna matching network.

Figure 38: Wakeup window – Inductive (amplitude) wake up enabled

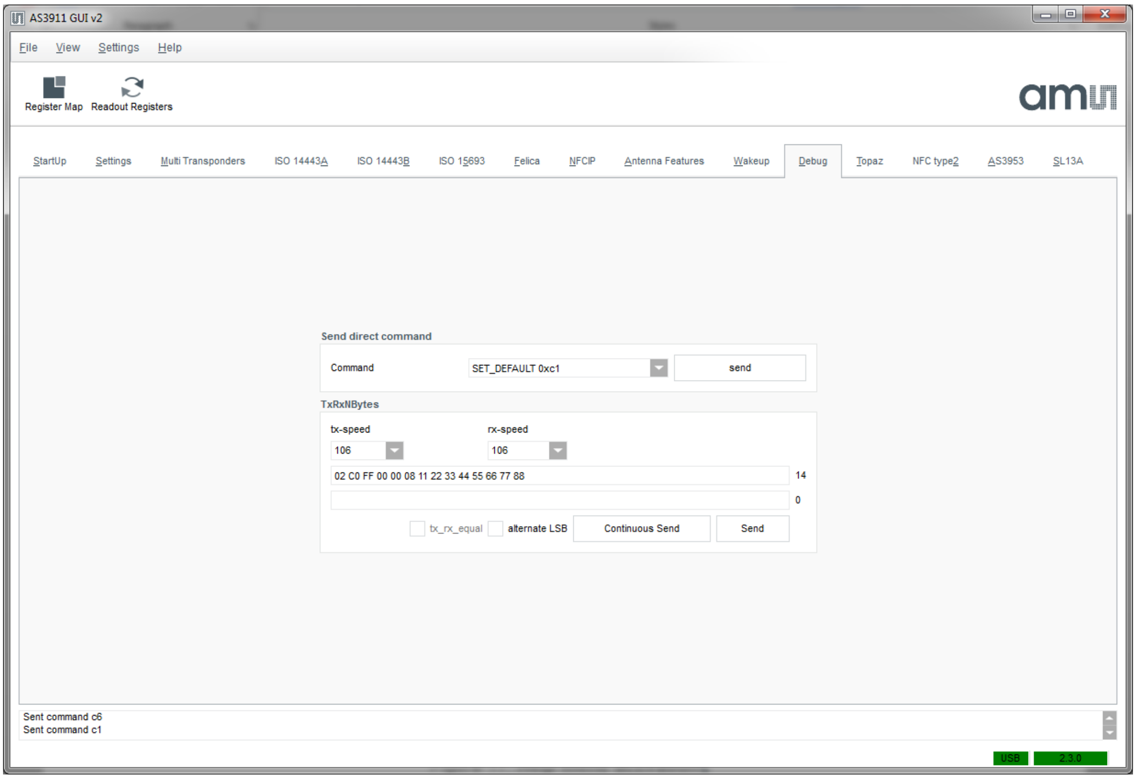


7.3.11 Debug tab

The debug is split into two group boxes:

- "Send Direct Command" allows sending AS3911 direct commands. Please note that it only makes sense to play around with these commands when you have read and understood the AS3911 data sheet.
- "TxRxNBytes" allows sending of arbitrary hex-encoded byte strings with the previously selected protocol directly through the FIFO. Please note that this is not possible for ISO15693 since there the firmware has to do the bit coding.

Figure 39: Debug window



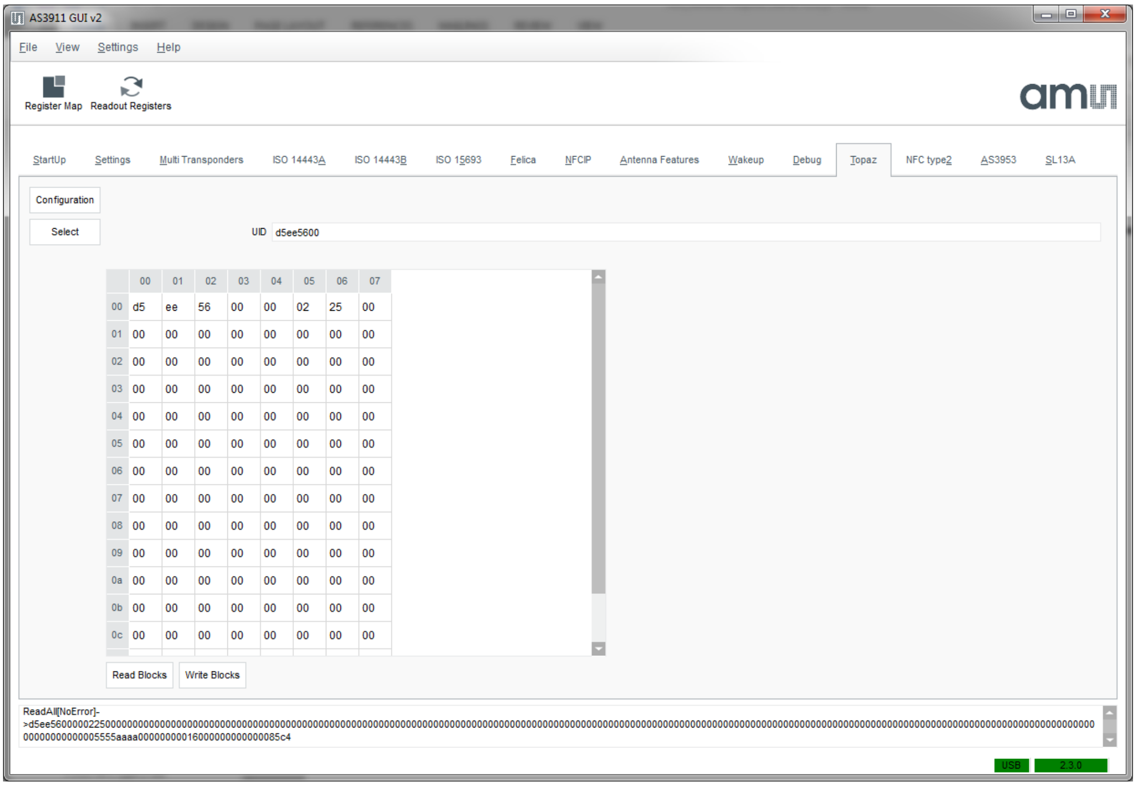
7.3.12 Topaz tab

This tab shows the Topaz (Type 1Tag) functionality. Pressing “Configuration” sets the reader in CW (continuous wave) mode.

After pressing the “Select” button (sending a WUPA) the UID of the Type 1 Tag is shown and reading and writing in the memory blocks is possible.

The Topaz window of the GUI is shown in Figure 40.

Figure 40: Topaz window



7.3.13 NFC type 2 tab

The NFC type 2 tag application is demonstrated in this tab. Figure 41 shows the GUI window.

The reader has to be set with the button “Configuration”, because this is a 14443-A application.

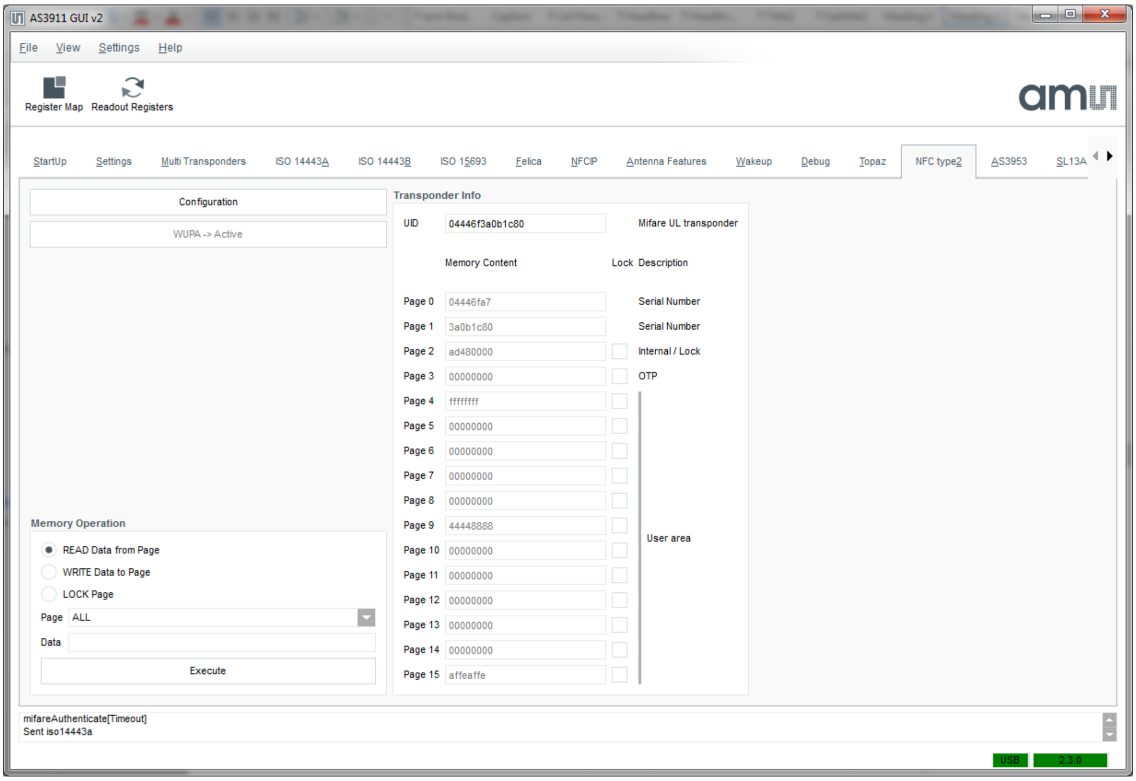
The interrogation for cards will be started with the command “WUPA->Active”.

Reading of the card memory content is initiated with the command “Execute” while the radio button “READ Data from Page” is active.

Writing to the memory is initiated with the command “Execute” while the radio button “WRITE Data from Page” is active.

Locking a page can be initiated with the command “Execute” while the “LOCK Page” is active.

Figure 41: NFC Type 2 window



7.3.14 AS3953 tab

The AS3953 tab allows to perform some demonstrations with the AS3953 NFC Interface demo tag.

Remark:

An AS3953 demo kit has to be placed in the reader field, it has to be connected to a PC and the AS3953 GUI should be opened.

This tab consists of four sub – tabs:

- File transfer
- EEPROM
- E- Paper Reference Design

7.3.14.1 File transfer tab

Figure 42 shows the File transfer window.

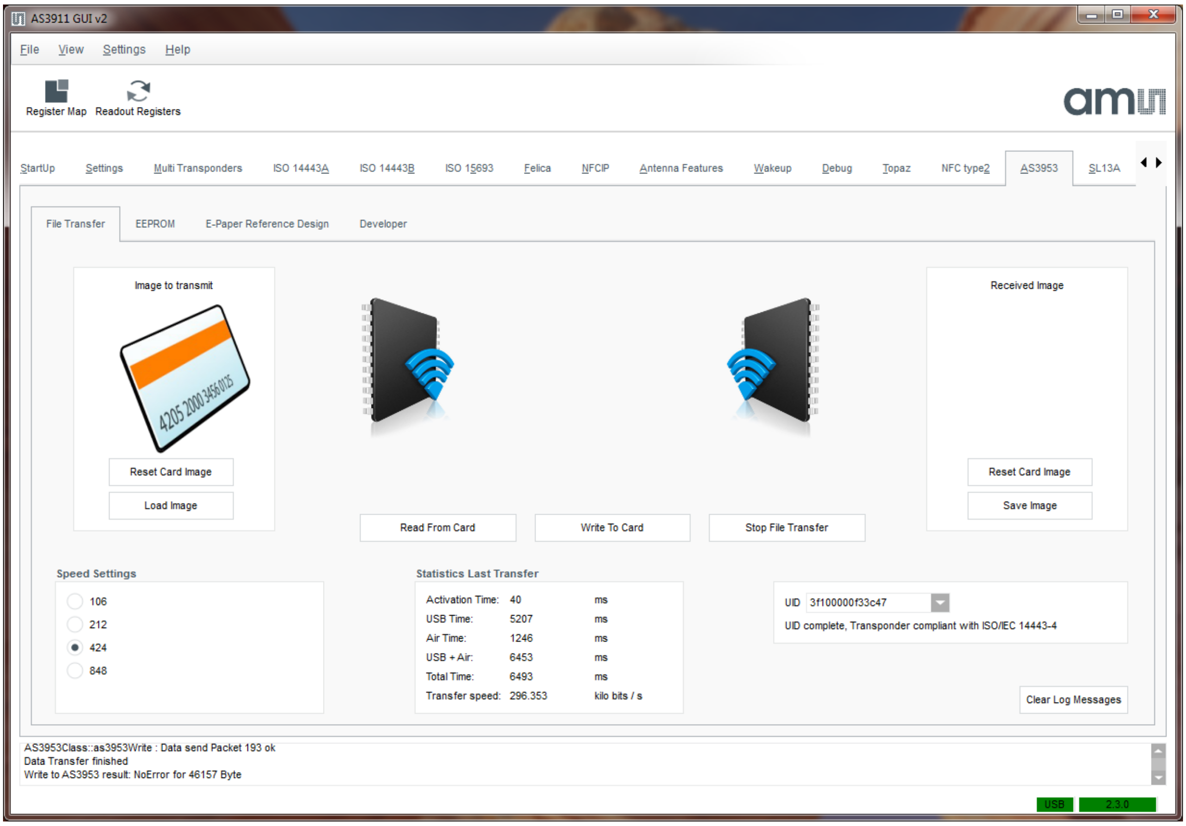
To transmit from AS3911 (Reader) to AS3953 (NFiC):

On AS3911 GUI select “load image”, select “speed settings” and click on “Write to Card” to execute the file transfer.

To transmit from AS3953 (NFiC) to AS3911 (Reader):

On AS3953 GUI select “load Image”. On AS3911 GUI, select “speed settings” and click on “Read from Card” to execute the file transfer.

Figure 42: AS3953 File transfer window



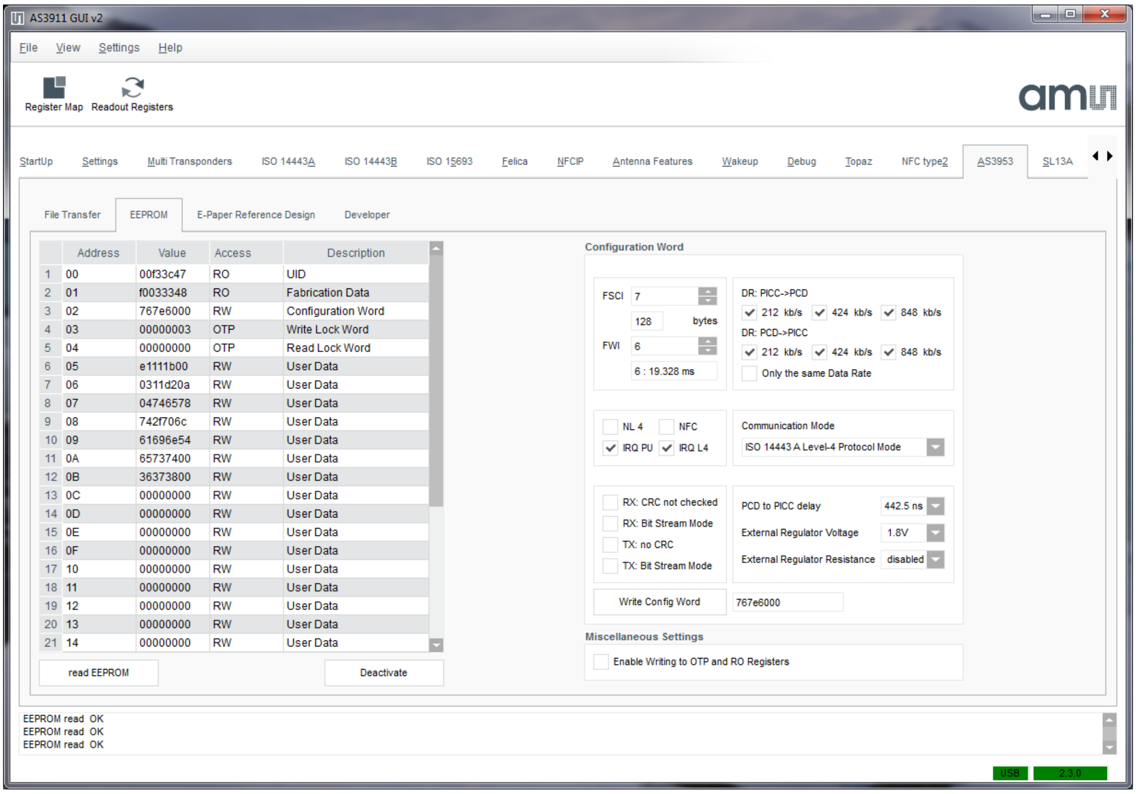
7.3.14.2 EEPROM

Figure 43 shows the EEPROM window.

EEPROM Read/write (from RF Field):

Click on "Read EEPROM" to read out the configuration word.

Figure 43: AS3953 EEPROM window



7.3.14.3 E-Paper Reference Design

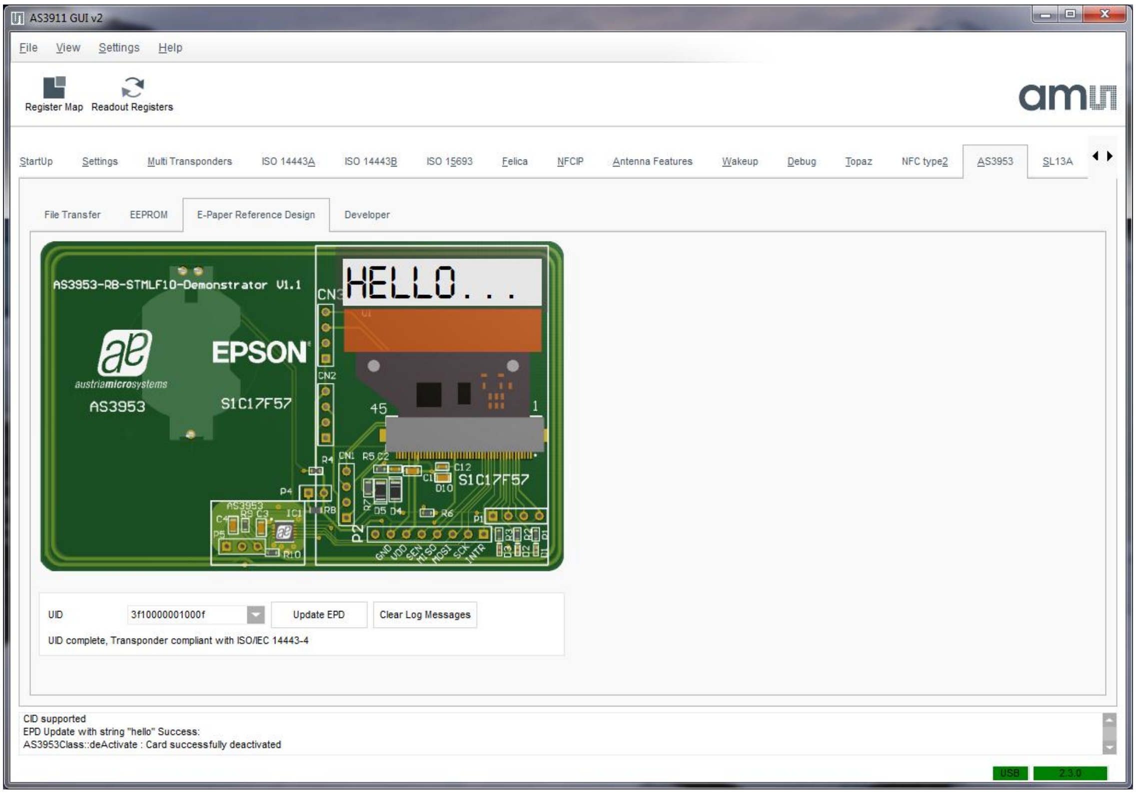
Figure 44 shows the window of the E – Paper Reference design.

The Reference design should be placed on the AS3911 reader.

Click in the display section of the shown E-Paper demo picture and write something in the display.

Press "Update EPD" and the E-Paper Reference design will display the made changes.

Figure 44: AS3953 E-Paper Reference Design window



7.3.15 SL13A tab

The SL13A windows in Figure 45 & Figure 46 demonstrate the features of this smart sensory tag IC.

The whole Cool Log command set is shown the sub – tab “General” (see Figure 45). Here it is possible to execute after an Inventory – Command all these commands. A detailed description of the commands is shown on the right hand side.

The “Demo” sub-tab shows the temperature measurement capability in the active or passive mode.

The temperature information can be stored in the EEPROM (non-volatile) in the active mode.

The passive mode stores the temperature in the EEPROM (volatile).

Figure 45: SL13A General window

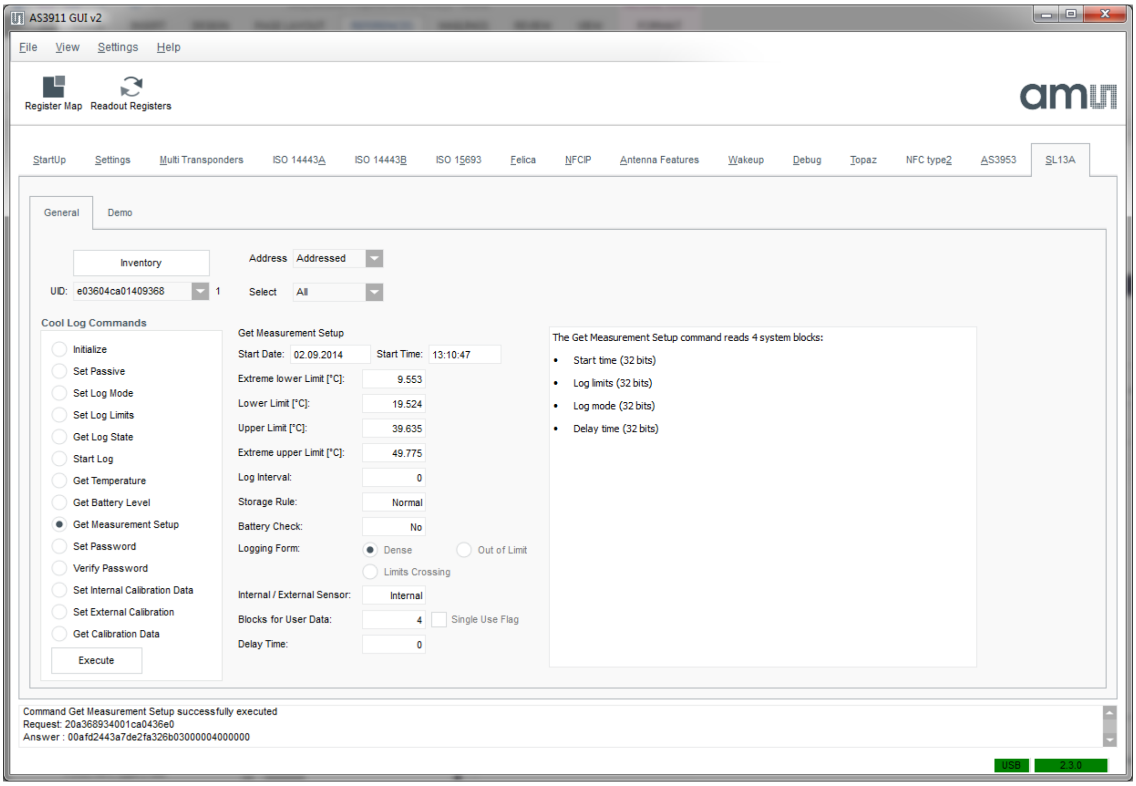


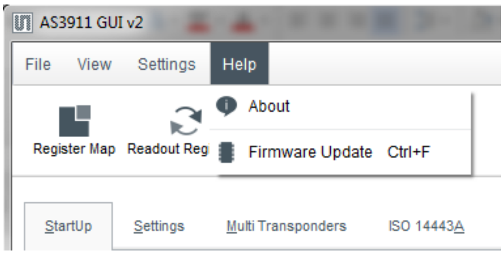
Figure 46: SL13A Demo window

7.3.16 Firmware update

The firmware can be updated by the GUI once the board is connected.

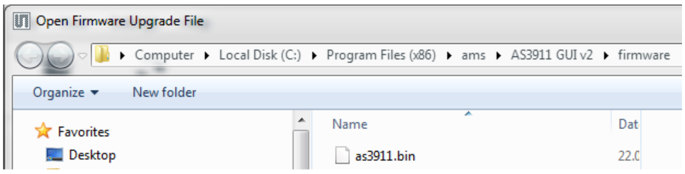
In the menu button "Help" provide a menu item "Firmware Upgrade" that will guide you through the update procedure (see Figure 47).

Figure 47: Menu --> Firmware update



After activate the Firmware Update, the GUI opens a file dialogue box which allows you to select the bin file (see Figure 48).

Figure 48: GUI firmware selection



The GUI files can be found on the FTP server:

File location	http://www.space4ams.at/user/AS3911GP_GUI/default.php
User	GPgui
Password	hgewdt3

8 References

Application notes:

- AS3911 AN Wakeup modes 2V0
- AS3911 AN Wakeup Electrodes V1
- AS3911 AN Antenna Design Guide V1.4
- AS3911 AN 50 Ohm single ended V2
- AN PCB layout recommendation

This application notes are available on request from ams sales representatives at www.ams.com/Contact-Us/Sales-Offices.

Standards:

- ISO / IEC 14443
- ISO / IEC 18092
- ISO / IEC 22536
- ISO / IEC 10373-6
- FCC Title 47 Part 15

9 Ordering & Contact Information

Ordering Code	Description
990600495	AS3911 Demo Kit Standard Board

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10 Copyrights & Disclaimer

11 Revision Information

Initial version 1-00

Changes from previous version to current revision 1-02 (2015-Sep-07)	Page
Changing footer	1-51
Updated Figure 27	28
Updated Figure 28	29
Updated Figure 29	30
Adding Revision Information Table	51
Adding sales information	1-51

Note: Page numbers for the previous version may differ from page numbers in the current revision.
Correction of typographical errors is not explicitly mentioned.