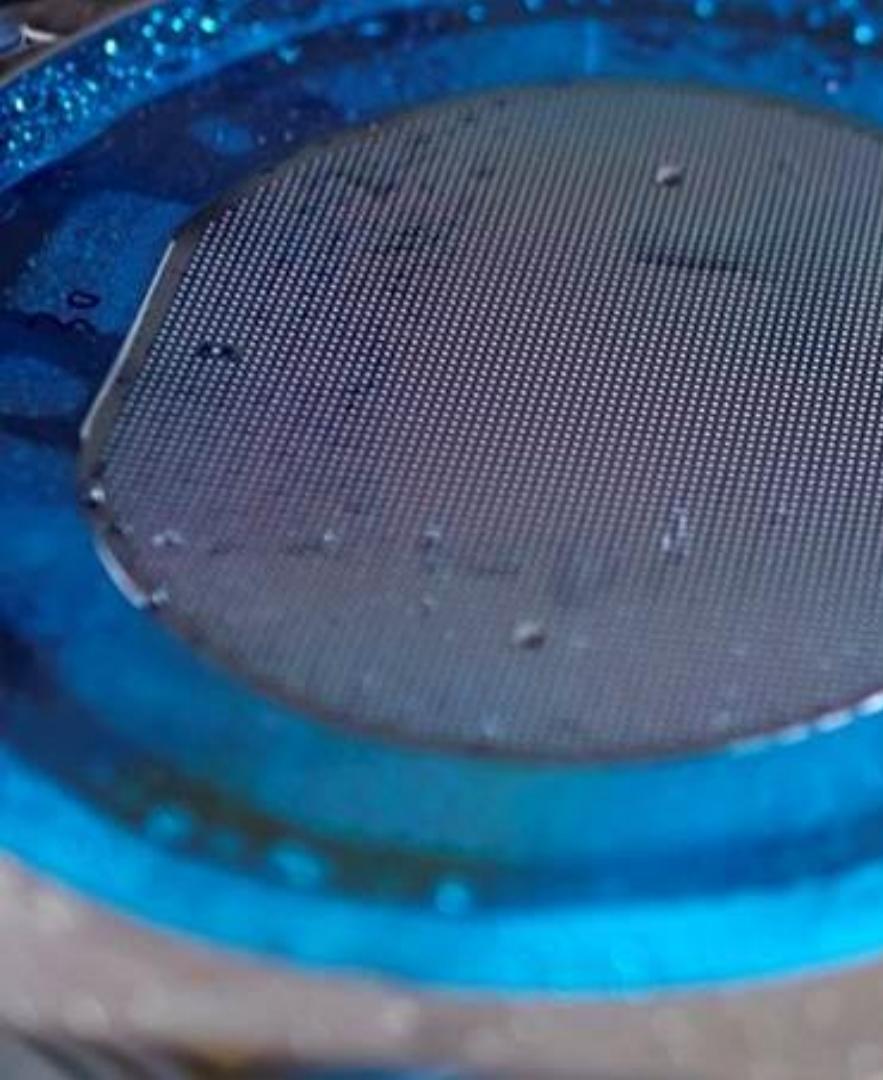


DESIGN AND IMPLEMENT NFC APPLICATIONS

SESSION 3: THE NFC COCKPIT THE COMPLETE DESIGN TOOL FOR ENGINEERS

October 2016





Agenda

Design and implement NFC applications

Session I, 7th September

Product support package for NXP NFC readers

<https://attendee.gotowebinar.com/rt/2329750067403618817>

Session II, 28th September

Antenna design considerations for NXP NFC reader solutions

<https://attendee.gotowebinar.com/rt/282682617345186049>

Session III, 18th October

The NFC Cockpit - the complete design tool for engineers

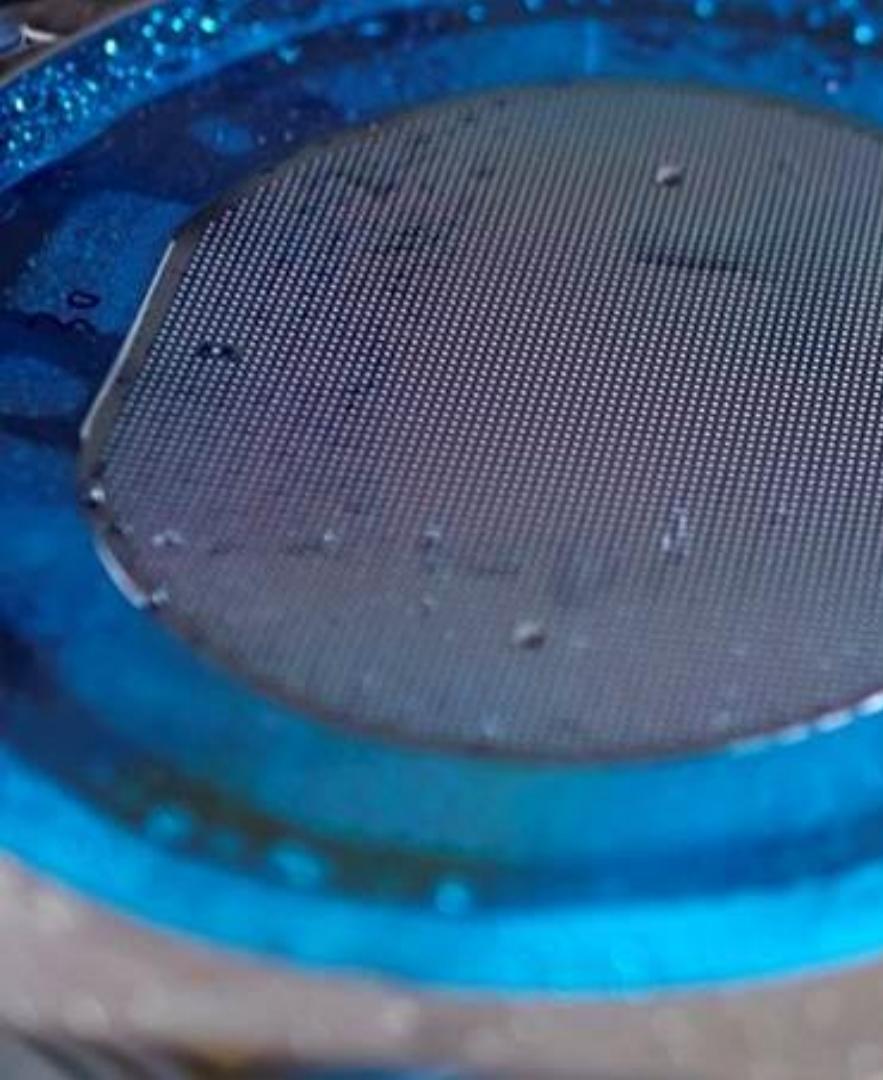
<https://attendee.gotowebinar.com/rt/4665515186055692545>

Session IV, 31th October

NFC Reader Library - SW support for NFC frontend solutions

<https://attendee.gotowebinar.com/rt/7151741873899128067>





Agenda

Design and implement NFC applications

Session 3, 18th October

The NFC Cockpit: The complete design tool for engineers

- ▶ Link with last session
- ▶ DPC: Dynamic Power Control
 - ▶ Parameters to define DPC
- ▶ NFC Cockpit
 - ▶ DPC Configuration
 - ▶ Correlation test
 - ▶ Adjust RRx
 - ▶ DPC calibration
 - ▶ TX shaping
- ▶ Summarize

ANTENNA DESIGN CONSIDERATIONS REVIEW

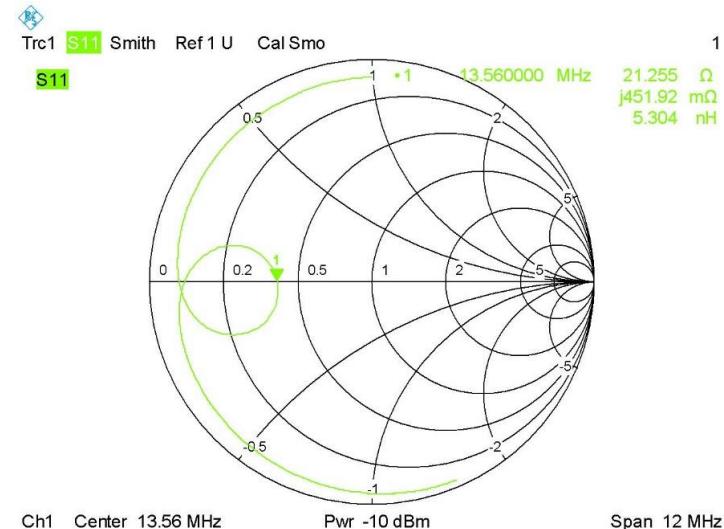


Antenna Matching

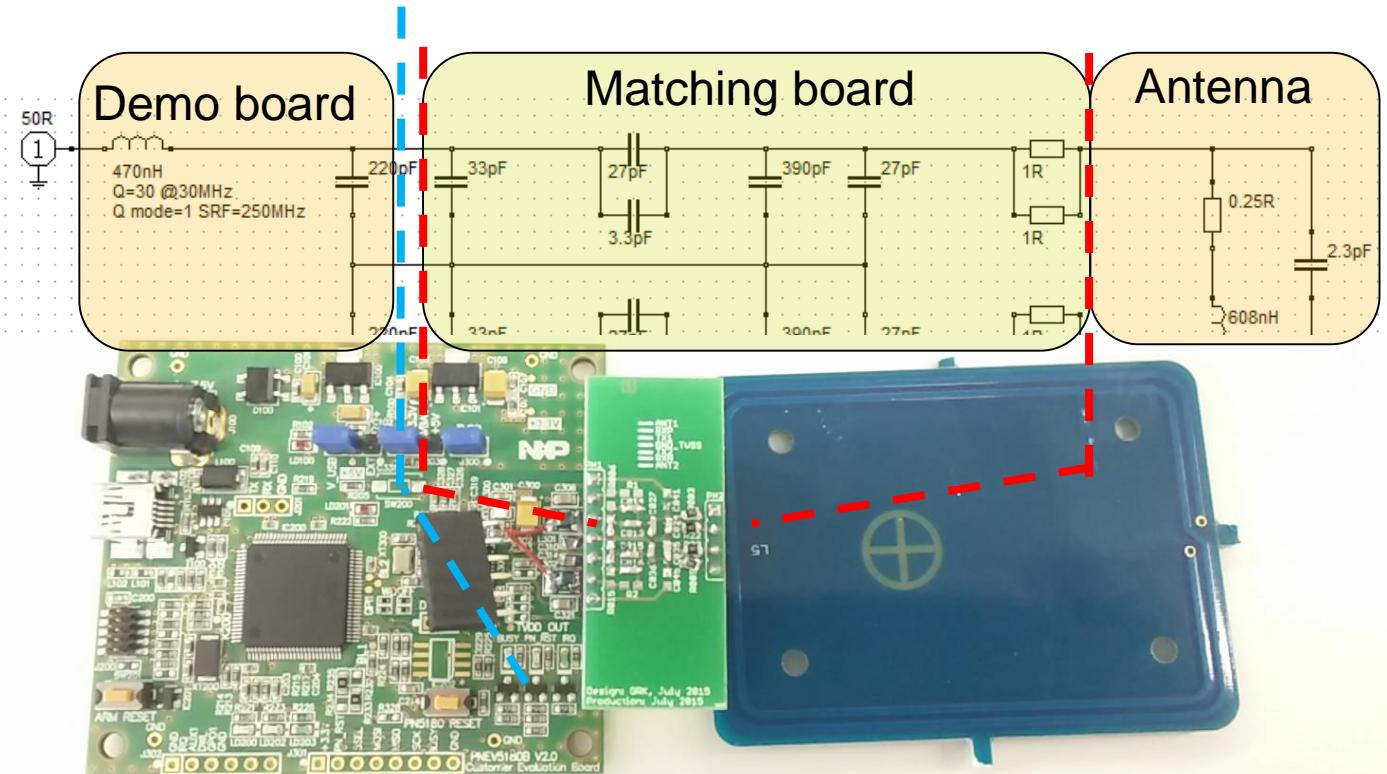
Asymmetric matching



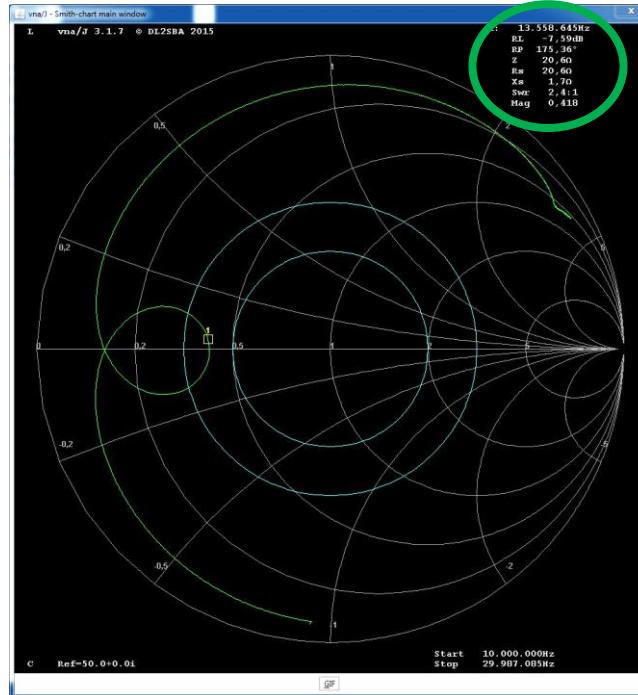
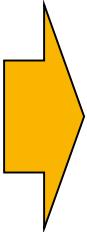
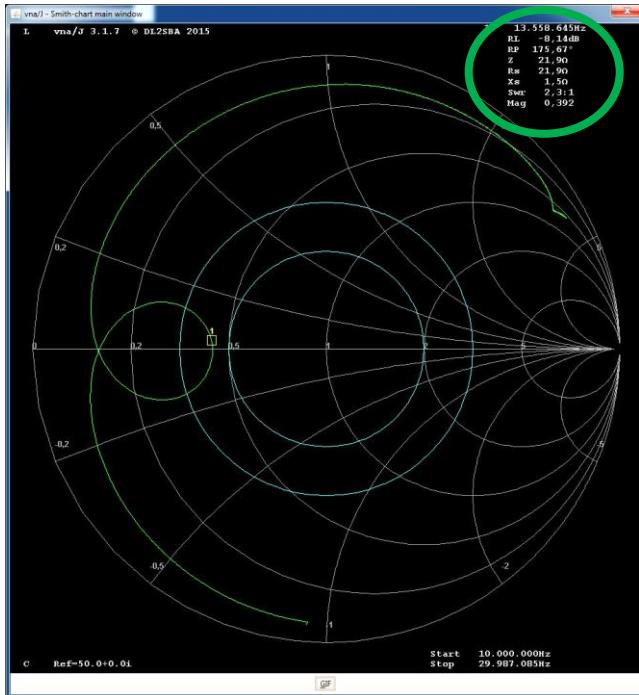
Symmetric matching



Final assembly



Final antenna tuning measurement results

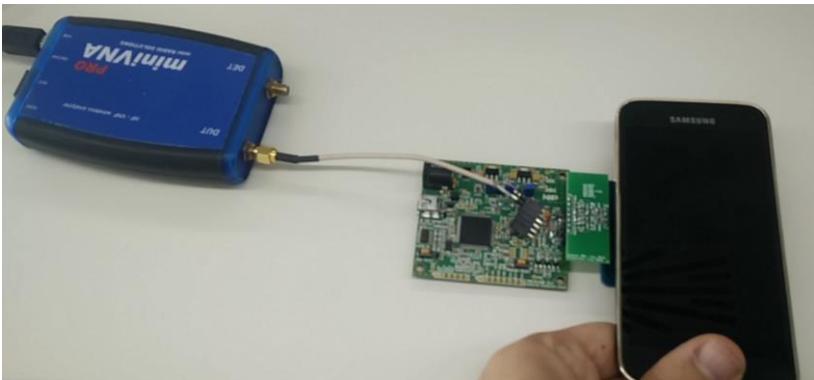


First matching: $Z = 21.9 + j1.5\Omega$

Fine tuned: $Z = 20.6 + j1.5\Omega$

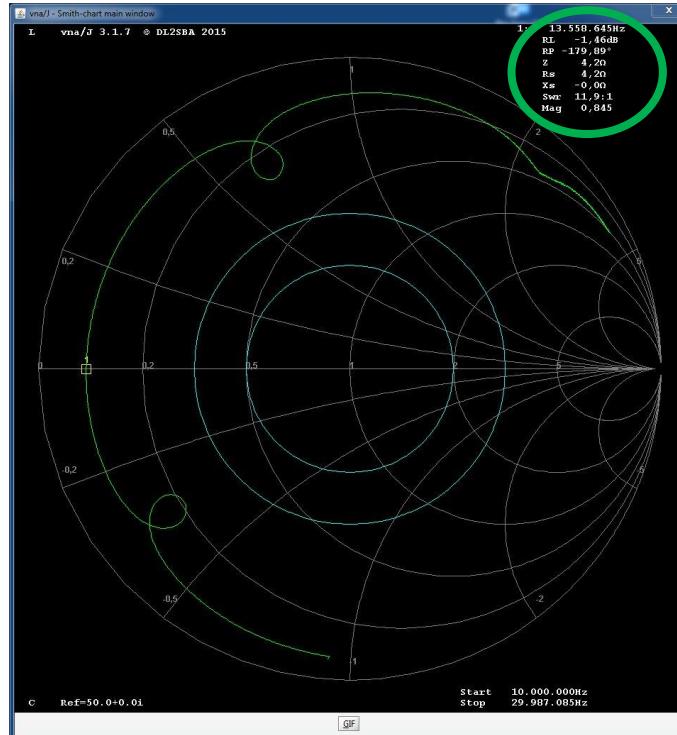
Antenna loading & detuning

Metal (smartphone)



$$Z = 4.2 + j0 \Omega$$

Due to symmetric matching, Z decreases => I_{TVDD} increases



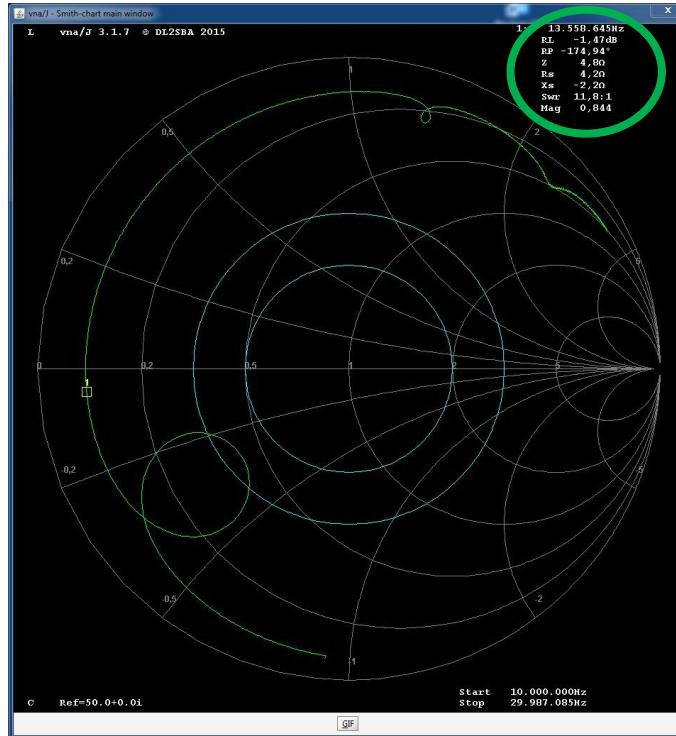
Antenna loading & detuning

Reference PICC



$$Z = 4.8 + j2.2\Omega$$

Due to symmetric matching, Z decreases => I_{TVDD} increases



DPC: DYNAMIC POWER CONTROL



What is DPC?

Dynamic Power Control

Allows software controlled transmitter current limitation

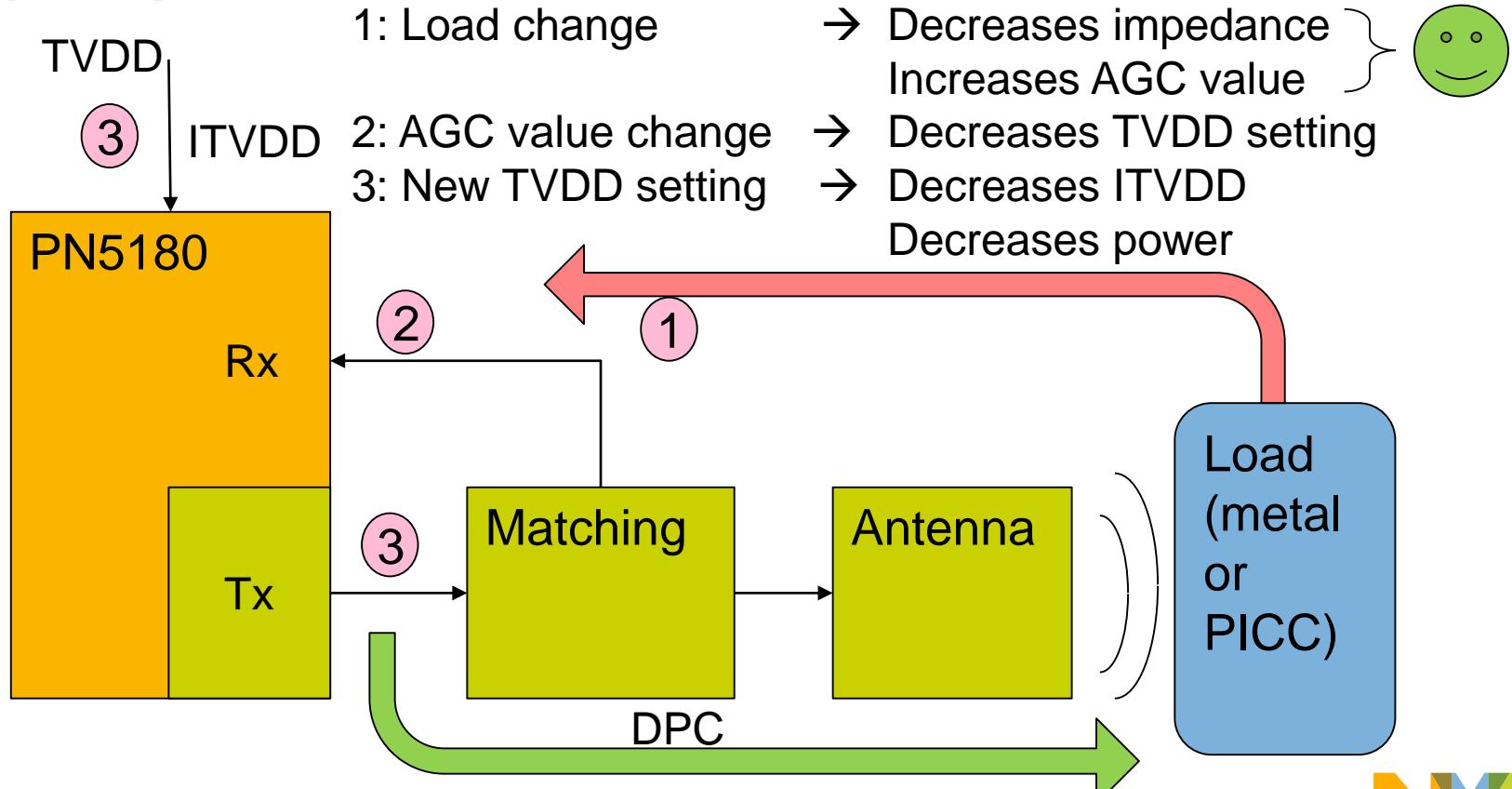
Allows power control

Allows improved antenna tuning

Allows increased Q

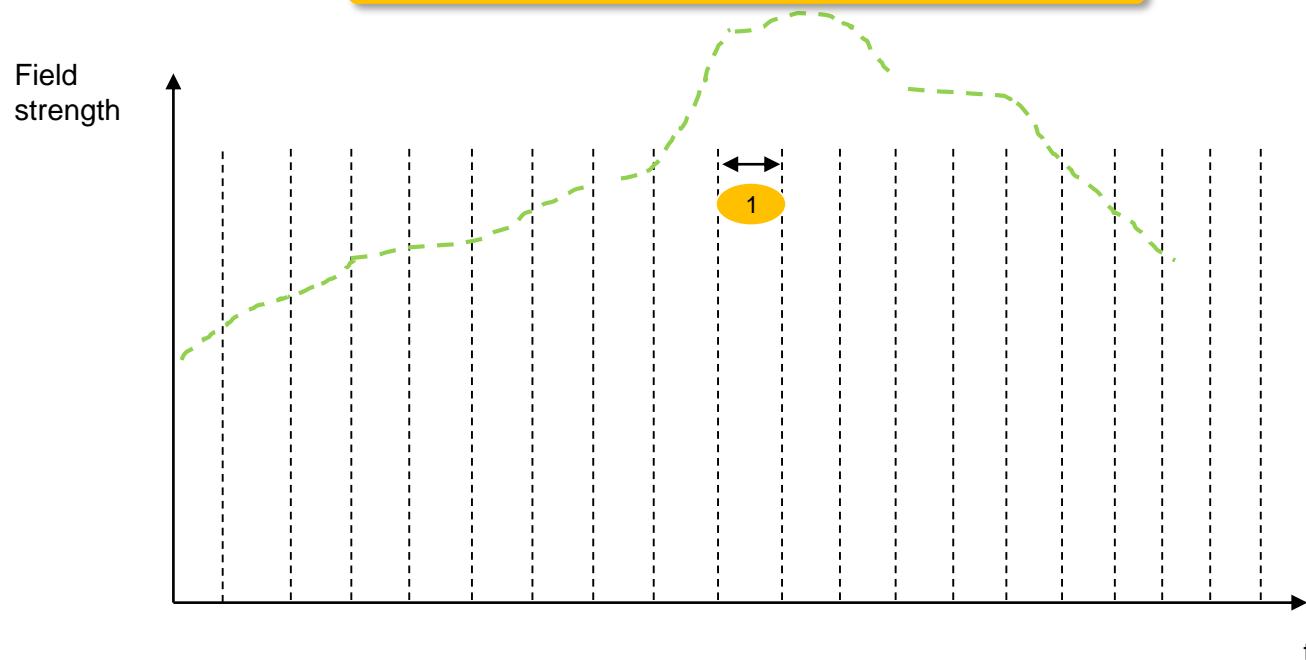
Allows smaller antennas

DPC principle



DPC gears principle

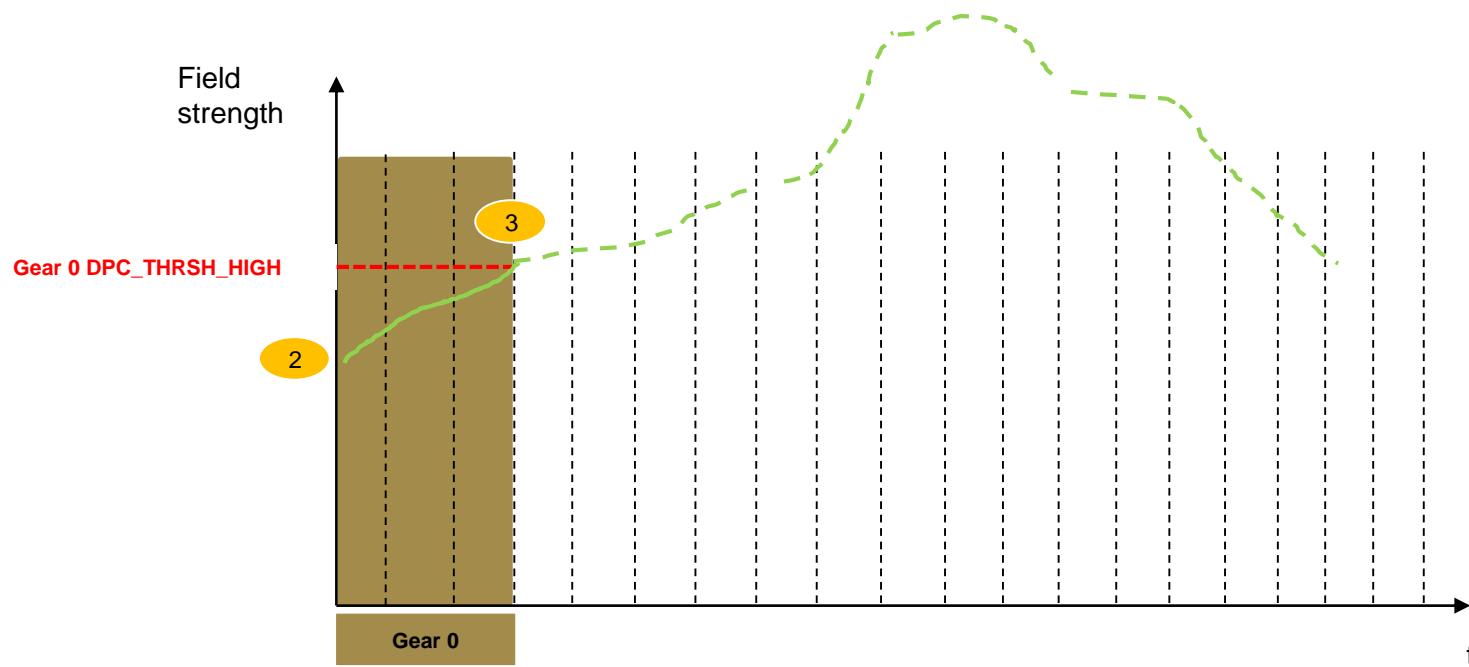
The PN5180 DPC dynamically measures the AGC value. The default time interval of this measurement is defined in DPC_TIME register.
It is recommended to leave this interval as defined by default



DPC gears principle

2 In our example, we start operating at gear 0

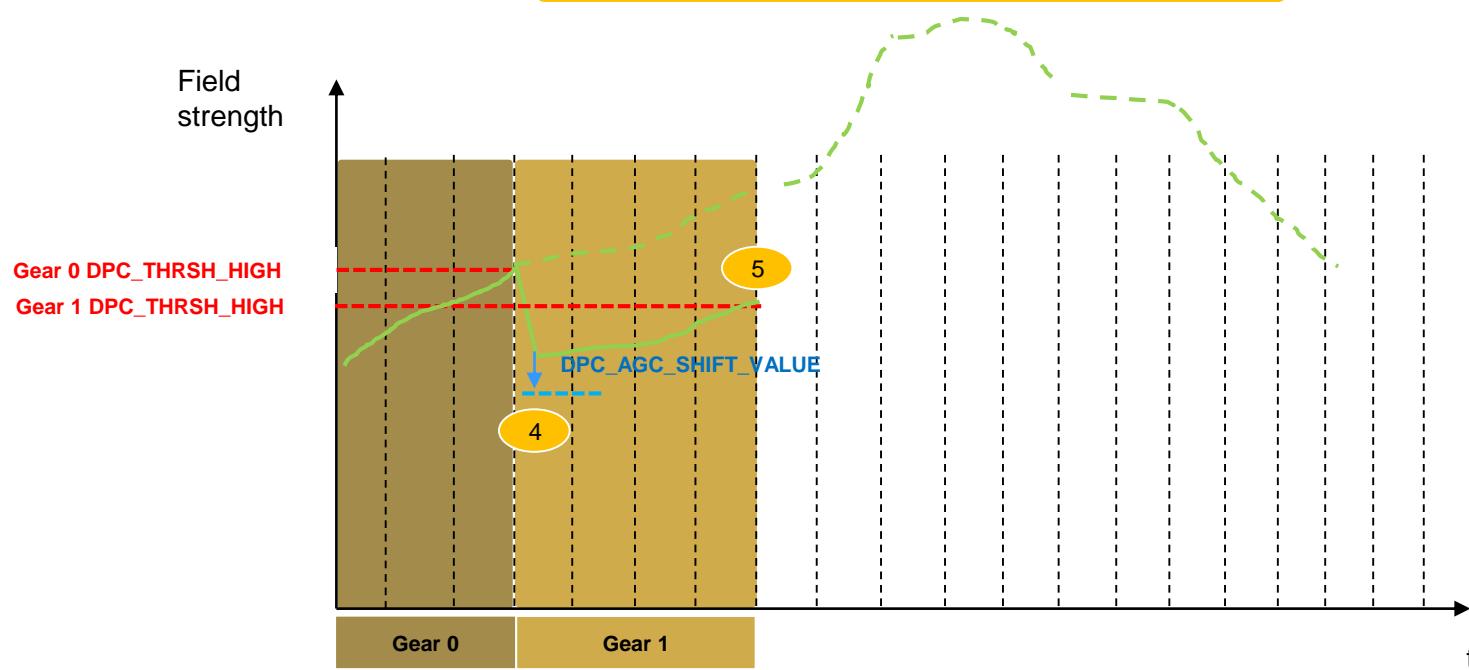
3 The high threshold defined by Gear 0 is exceeded, DPC shifts to Gear 1



DPC gears principle

4 DPC defines the low threshold (to shift back to Gear 0) due to the first measurement after switching to Gear 1

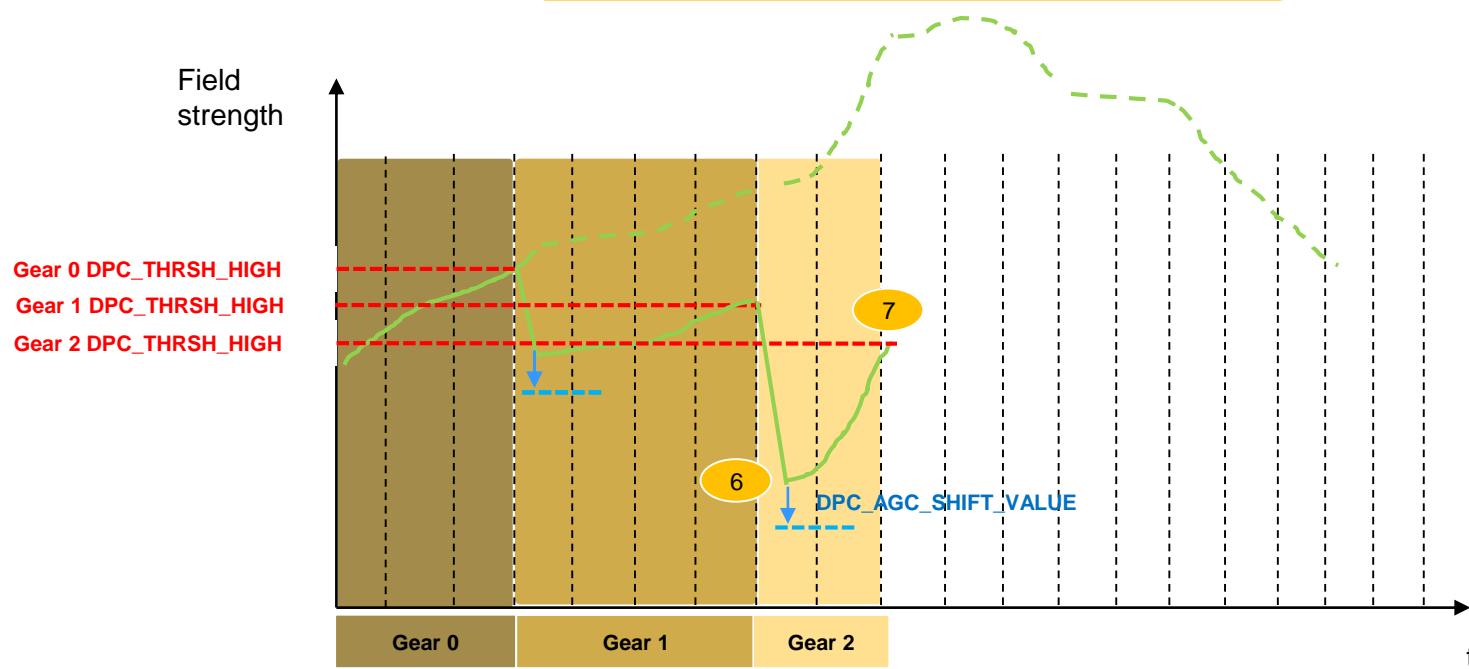
5 The high threshold defined by Gear 1 is exceeded, DPC shifts to Gear 2



DPC gears principle

6 DPC defines the low threshold (to shift back to Gear 1) due to the first measurement after switching to Gear 2

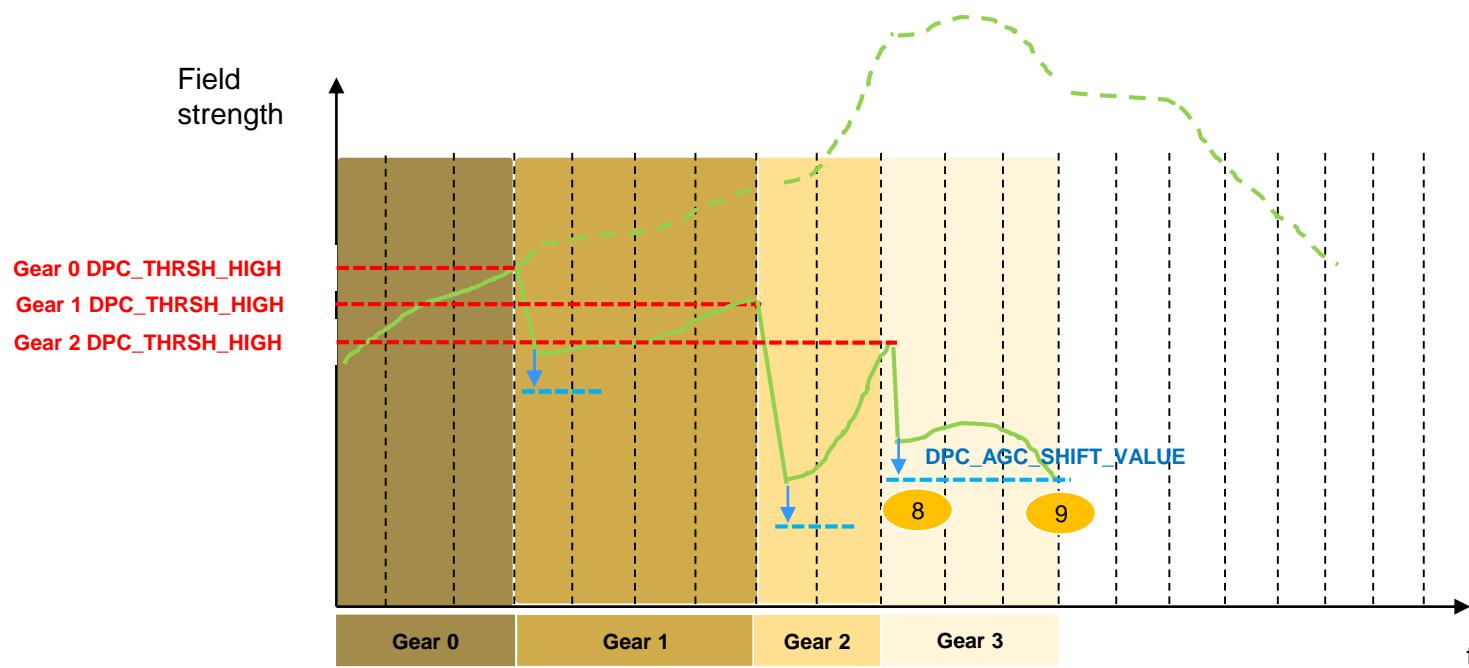
7 The high threshold defined by Gear 2 is exceeded, DPC shifts to Gear 3



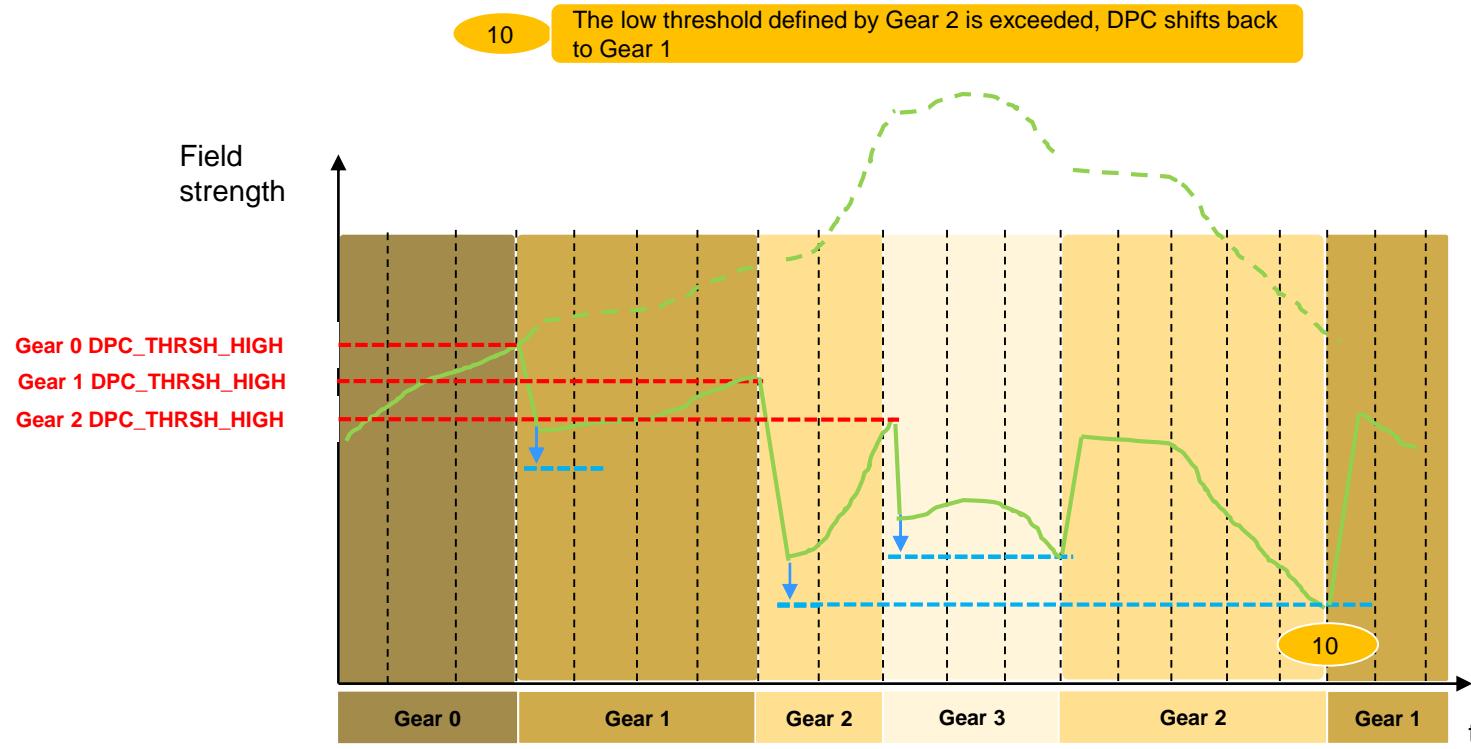
DPC gears principle

8 DPC defines the low threshold (to shift back to Gear 2) due to the first measurement after switching to Gear 3

9 The low threshold defined by Gear 3 is exceeded, DPC shifts back to Gear 2



DPC gears principle



PARAMETERS TO DEFINE DPC

Parameters to define DPC

1. **Number of gears (DPC_AGC_GEAR_LUT_SIZE, 0x81)**
 - Defines the number of gears (1 Byte)
 - Value: 1...15 (decimal)
2. **Tx settings per gear (DPC_AGC_GEAR_LUT, 0x82 ... 0x90)**
 - Defines the output power settings per gear
 - Details see next slides
3. **AGC HIGH threshold (DPC_THRSH_HIGH, 0x5F ... 0x7C)**
 - One AGC high threshold (2 Bytes) per gear -> DPC_THRSH_HIGH
 - Defines the maximum AGC value per gear
 - The DPC switches to the next gear, as soon as AGC Value > DPC_THRSH_HIGH

NFC COCKPIT



NFC Cockpit

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NFC and Reader ICs

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The diagram is a circle divided into four quadrants:

- Contact Smart Card Reader ICs** (Top Left)
- Connected Tag Solutions** (Top Right)
- HITAG Reader ICs** (Bottom Left)
- NFC Frontend Solutions** (Bottom Right)

NFC Frontend Solutions
All our frontend solutions reflect our active involvement with regulatory bodies, including the FCC, CE, Paypass, and EMVCo, and build on our deep commitment to interoperability and environmental quality.

NFC Controller Solutions

MIFARE SAMs for Reader Systems

Interface and Connectivity
Media and Audio Processing
Power Management

NFC Cockpit

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MIFARE ICs

Secure Controller ICs

Smart Label and Tag ICs

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Interface and Connectivity

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RF

Sensors

Single Chip Modules

Automotive Products

APPLICATIONS

SUPPORT

ABOUT

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NFC Frontend Solutions

Overview Products

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Products/Parts	Order	Recommended application	RF driver supply [mA] (V)	RF driver supply [mA] (V)	RF driver current [mA] (mA)	Temp [min] (°C)	Host interfaces	Supported Standards
Comparing: 3			<input type="checkbox"/> 2.5	<input type="checkbox"/> 2.5	<input type="checkbox"/> 100.0		<input type="checkbox"/> UART, I _C , SPI	<input type="checkbox"/> ISO/IEC 14443A <input type="checkbox"/> ISO/IEC 14443A <input type="checkbox"/> ISO/IEC 14443B <input type="checkbox"/> ISO/IEC 14443A <input type="checkbox"/> ISO/IEC 14443B <input type="checkbox"/> ISO/IEC 14443B <input type="checkbox"/> ISO/IEC 14443A <input type="checkbox"/> ISO/IEC 14443B <input type="checkbox"/> ISO/IEC 14443B <input type="checkbox"/> ISO/IEC 14443A <input type="checkbox"/> ISO/IEC 14443B <input type="checkbox"/> ISO/IEC 14443B
PN5180	Read View All	PN5180 is optimized for point of sales terminals and implements a high-power NFC frontend to achieve EMV compliance without additional components.						
PN5180A	<input checked="" type="checkbox"/> PN5180 Product Overview Sample / Buy Data Sheet Documentation Software & Hardware Tools Package / Quality							
PN5180AD								



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PN5180: High-performance multi-protocol full NFC Forum-compliant frontend

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Reference Designs (1)



Point of Sale (POS) Reader Solution
Point of Sale (POS) Reader Solution. The SLN-POS-RDR Point of Sale (POS) Reader Solution enables you to quickly add a PCI®- and...

Evaluation/Development Boards and Systems (1)



PN5180 NFC Frontend Development Kit for POS Terminal Applications
PN5180 NFC Frontend Development Kit for POS Terminal Applications. OM25180FDK is a flexible and easy to use frontend development kit for PN5180. It...

Software (4)



NFC Reader Library - Software support for NFC Frontend solutions
Feature complete software support library for NFC Frontend ICs. Designed to give developers a faster and simpler way to deliver NFC-enabled products...



NFC Reader Library V4.030.00.001627 R1 for PNEV5180B including all software examples (REV 1.3) NFC Reader Library V4.030.00.001627 R1 for PNEV5180B including all software examples.
 ZIP (38.7 MB) SW3522 Download

8/3/2016



Installer package PN5180 NFC Cockpit 2.3 (REV 1.1) Installer package PN5180 NFC Cockpit 2.3.
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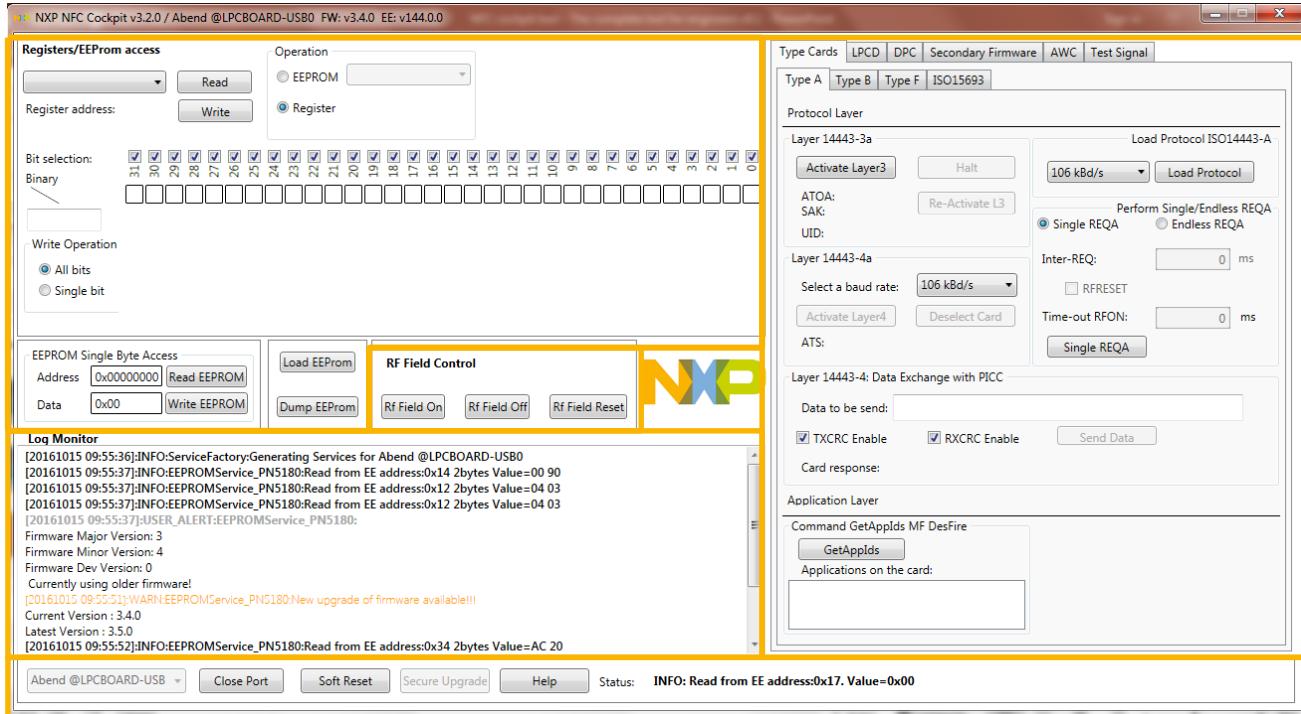
4/7/2016

More



NFC Cockpit

Start

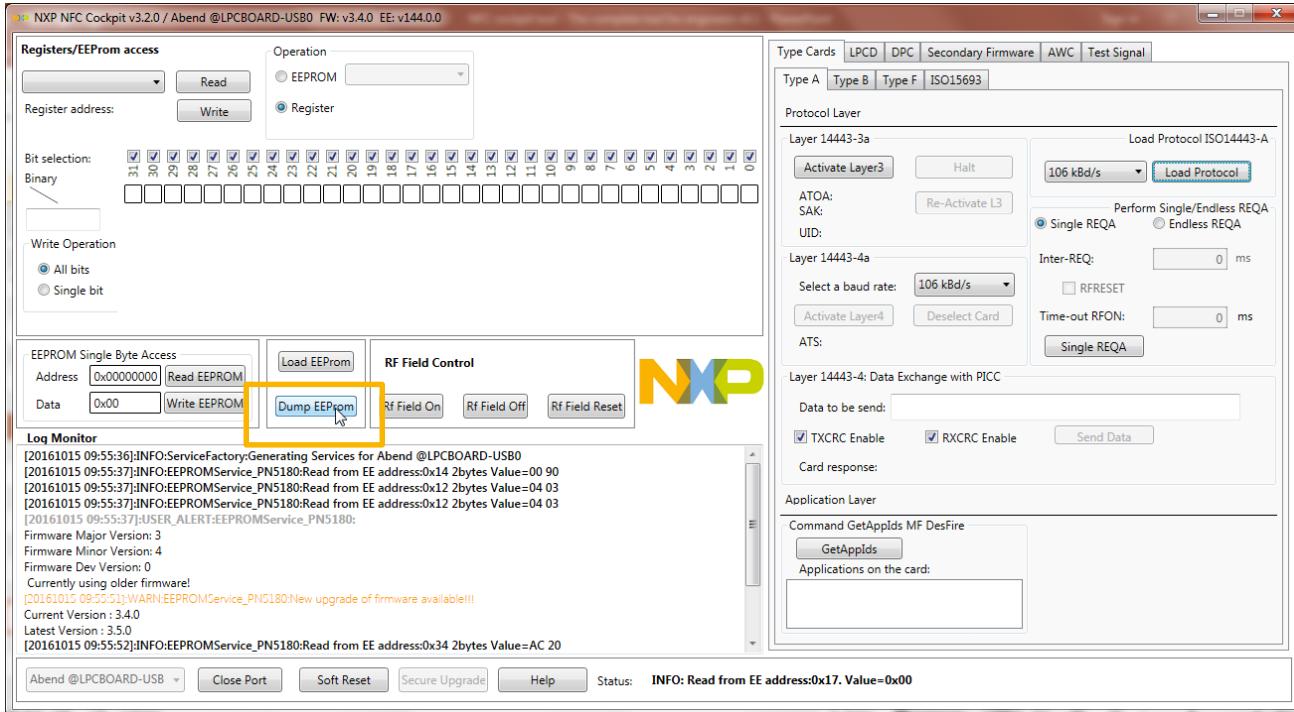


BACKUP EEPROM



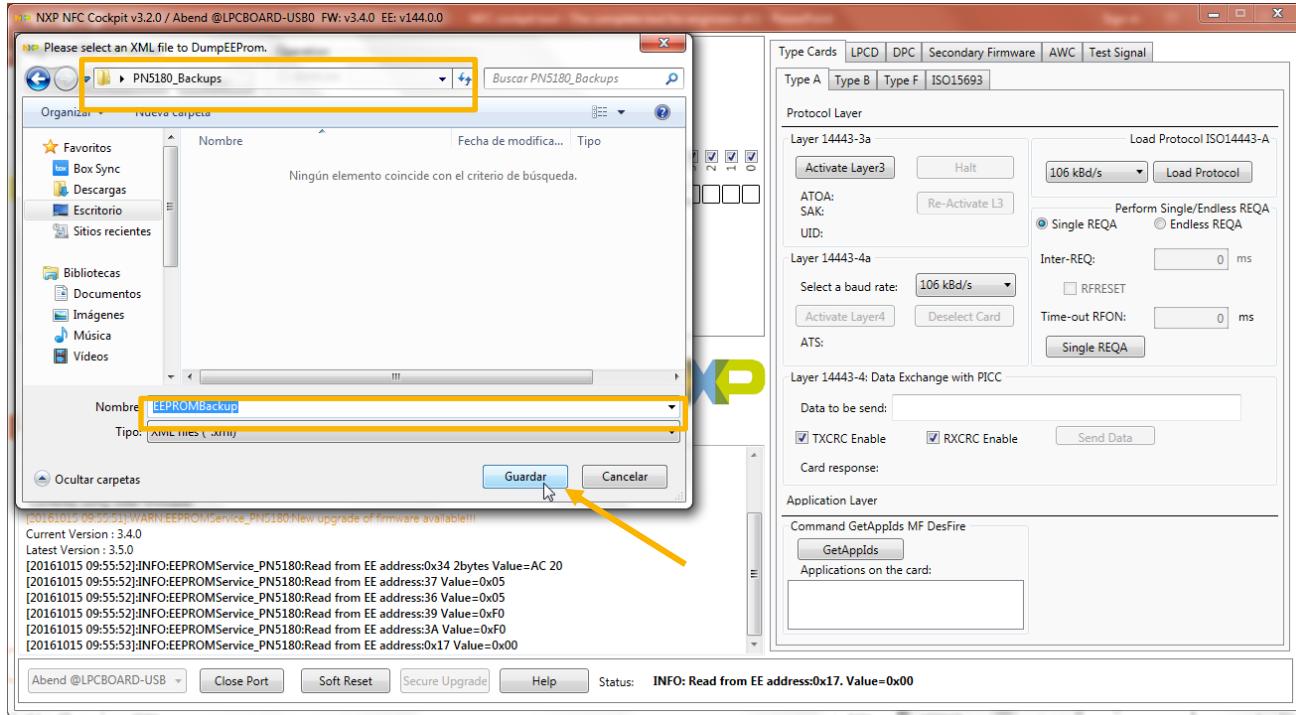
NFC Cockpit

Start



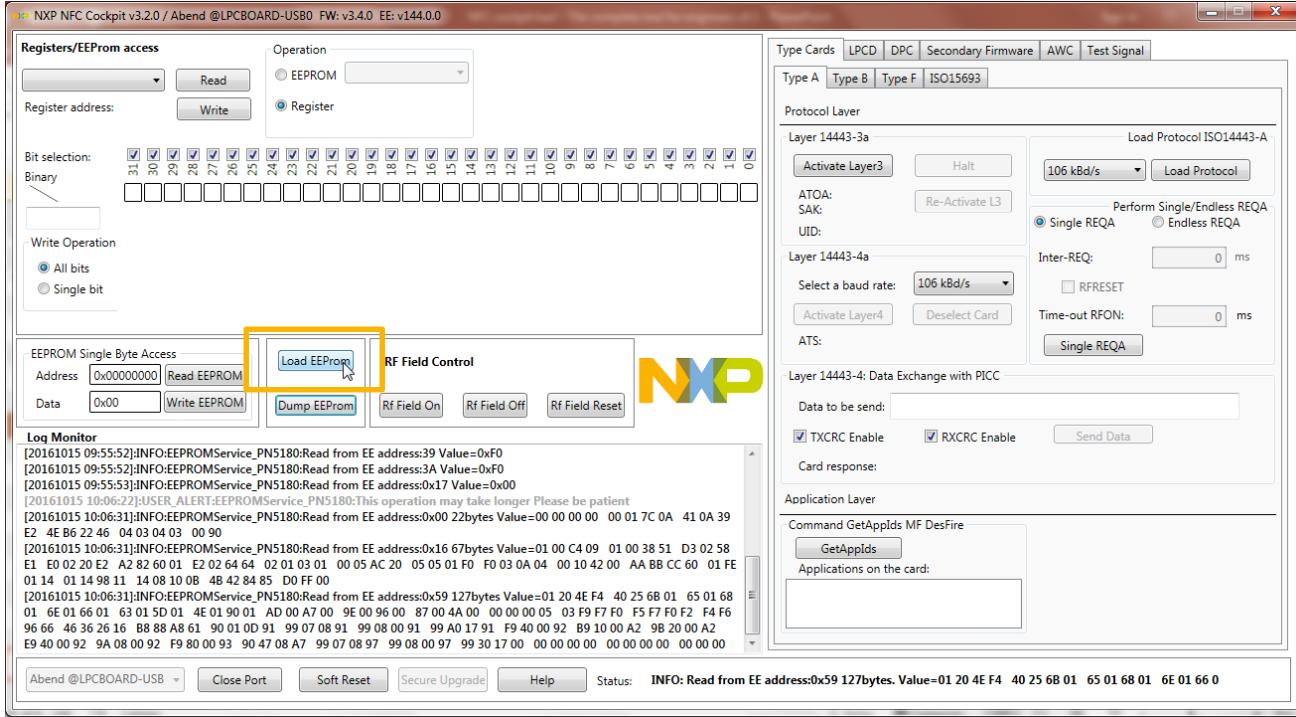
NFC Cockpit

Start



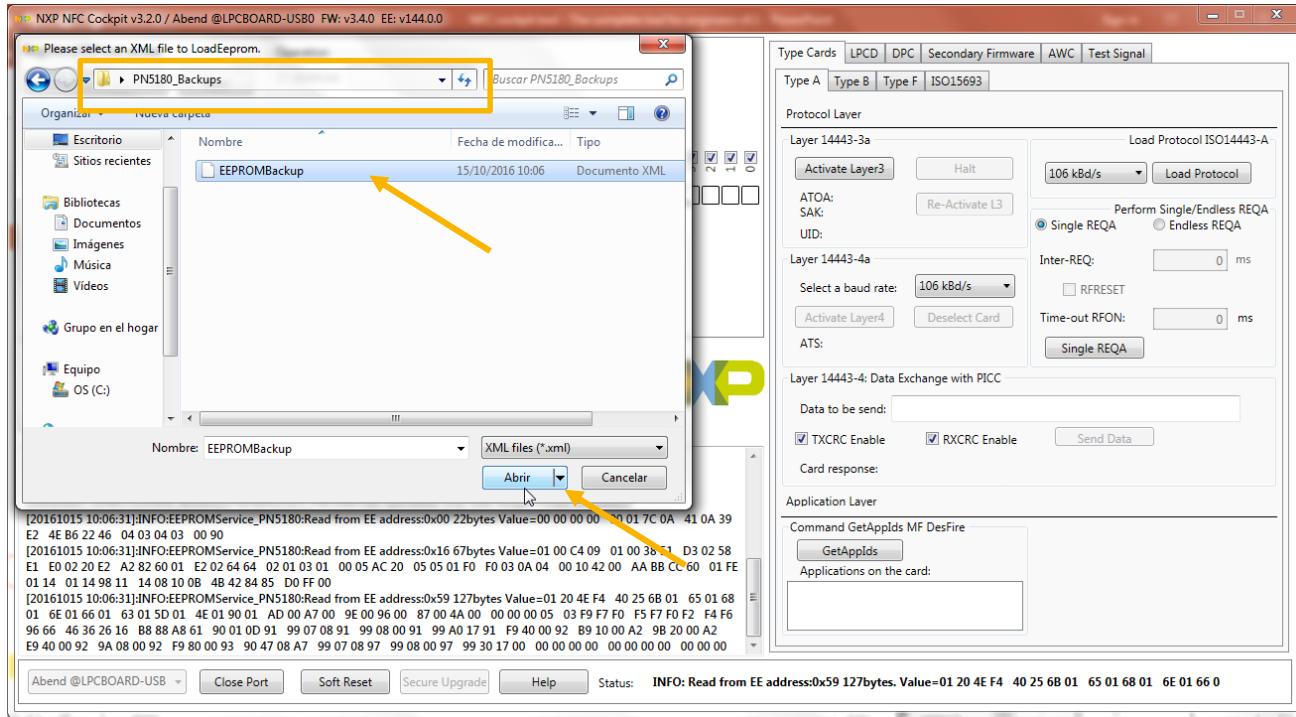
NFC Cockpit

Start



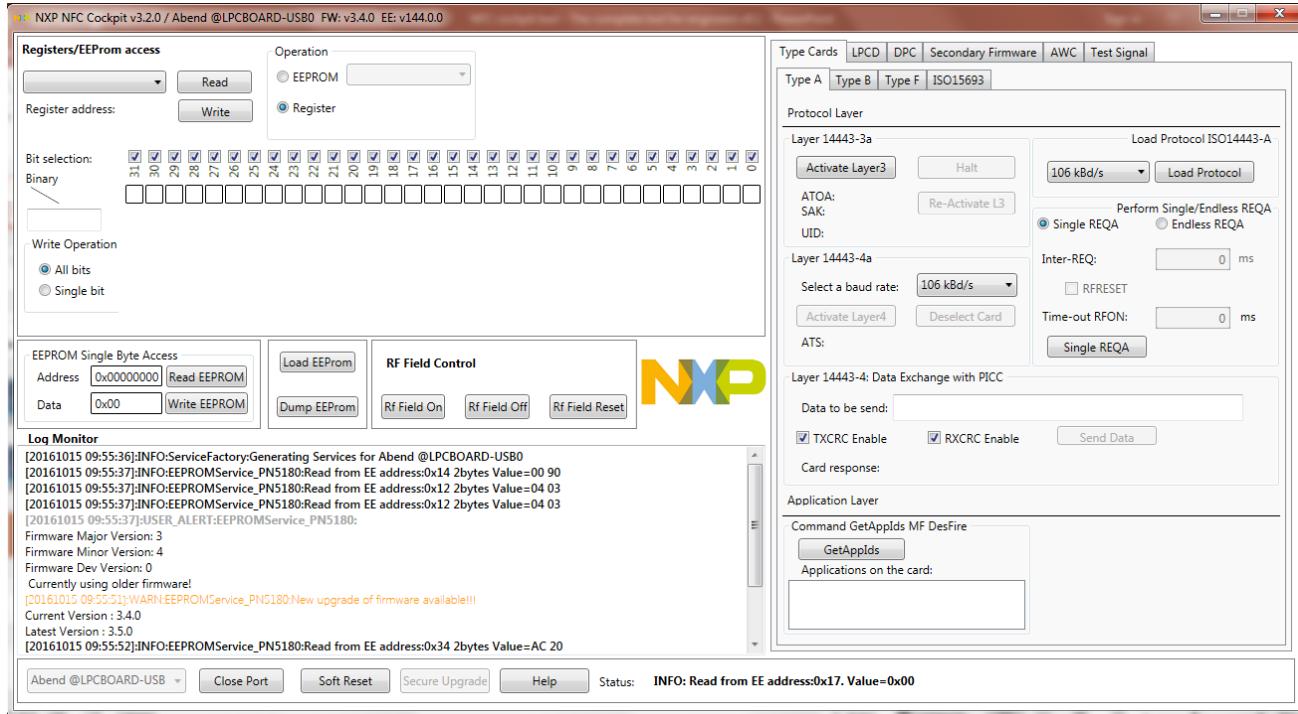
NFC Cockpit

Start



NFC Cockpit

Start



DPC CONFIGURATION

NFC Cockpit

DPC Configuration

Prerequisites

1. "Symmetrical" antenna tuning (to e.g. 20Ω) **DONE**
2. Ensure a good correlation between AGC & ITVDD
3. Adjust RRx to achieve
 - AGC value = appr. 300dec unloaded (full NFC)
 - AGC value = appr. 600dec unloaded (pure Reader mode)



Define

1. Number of gears (e.g. 5 seems to be good for standard EMVCo POS)
2. Tx settings per gear (DPC_AGC_GEAR_LUT)
3. ITVDD switch (e.g. 205mA)

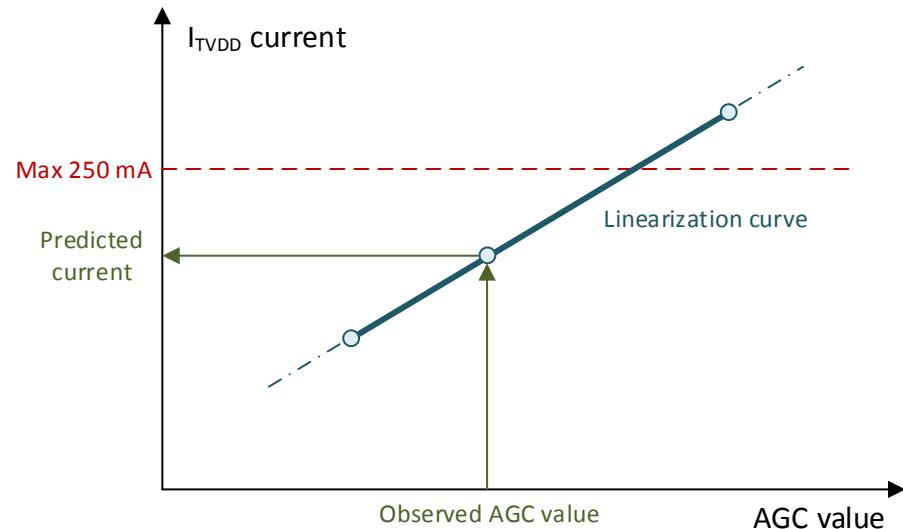
CORRELATION TEST

NFC Cockpit

Correlation test

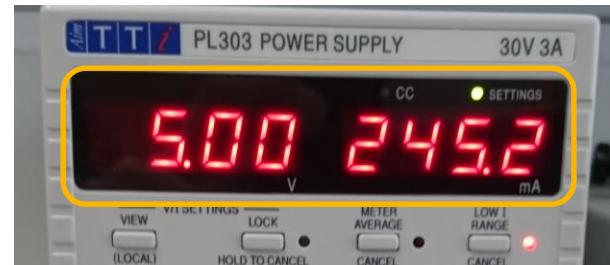
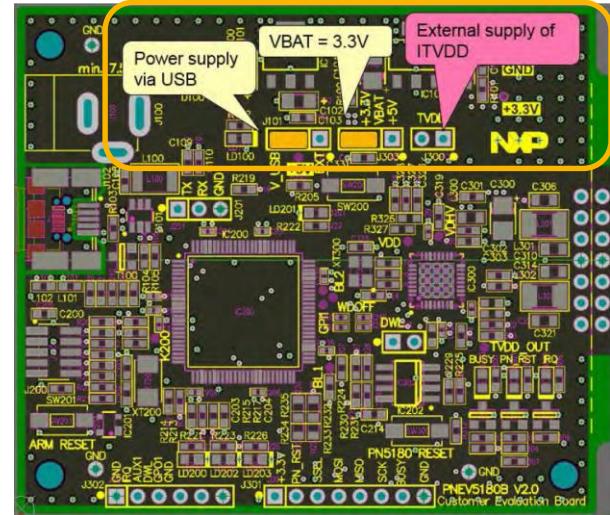
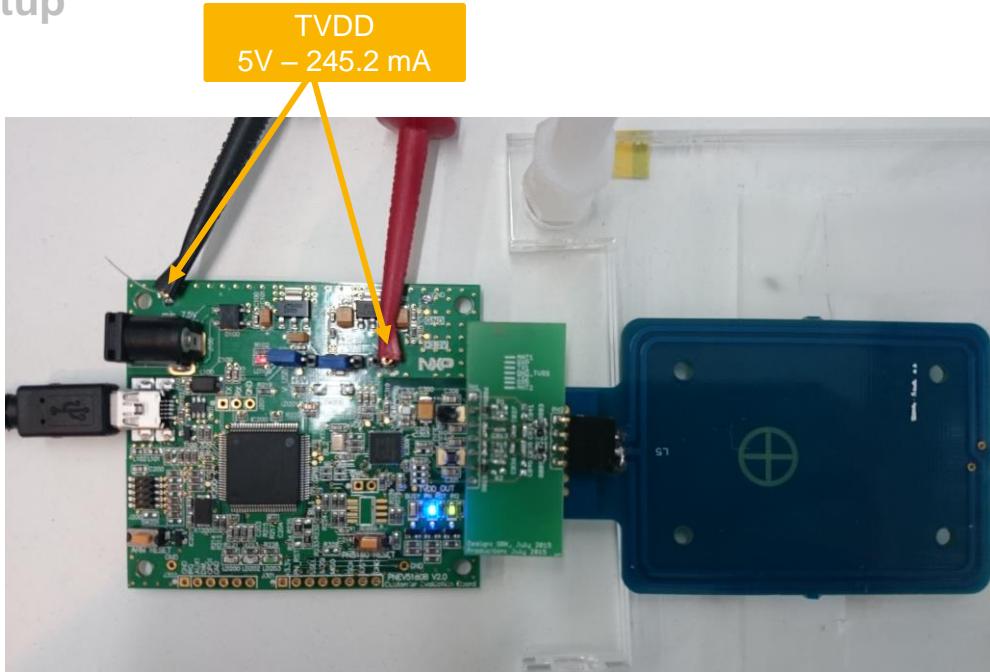
Precondition for DPC:

- Linear link between AGC value and ITVDD current
- Requires “symmetric” antenna matching and $L_0 > L_{ant}/2$



NFC Cockpit

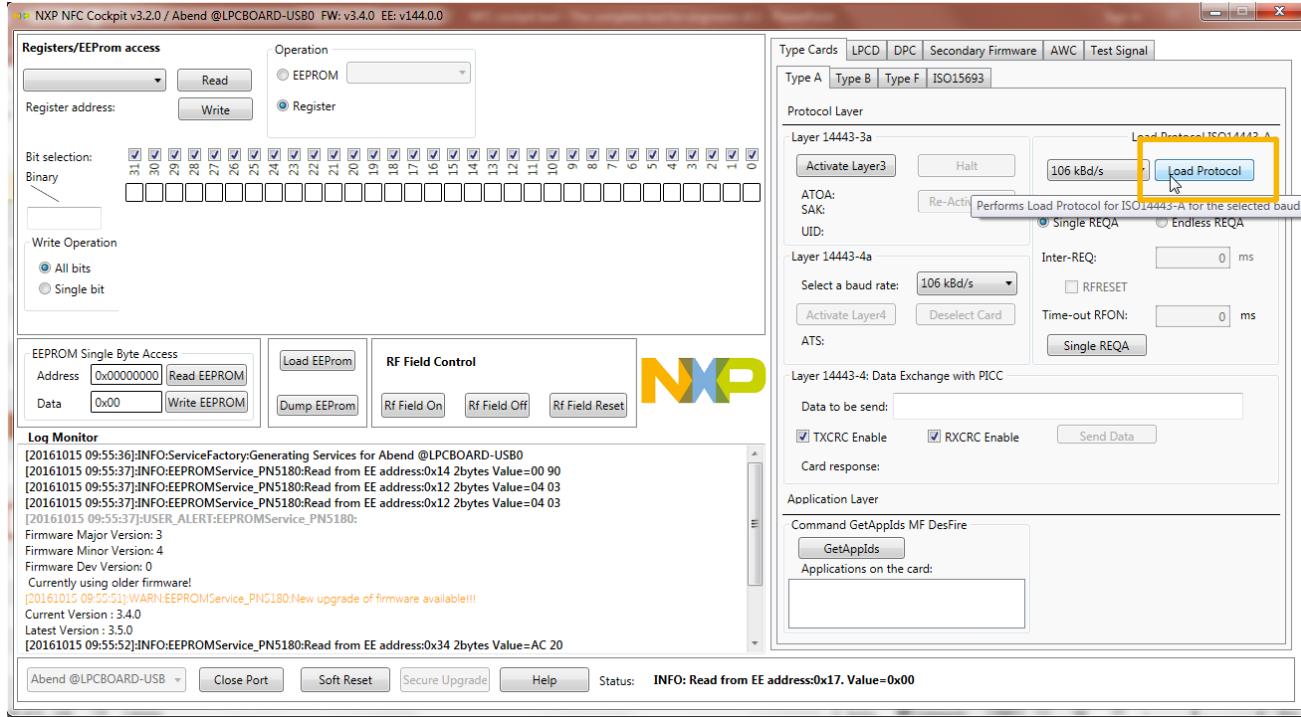
Setup



NXP

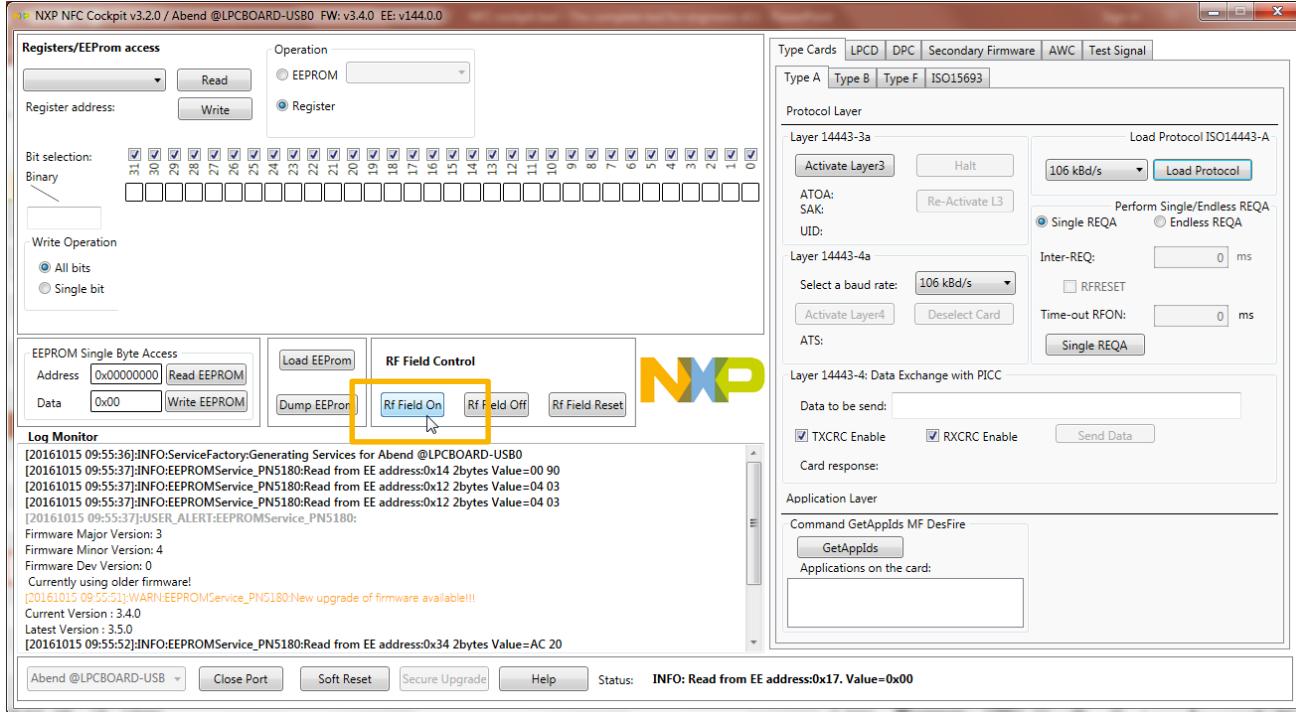
NFC Cockpit

Start



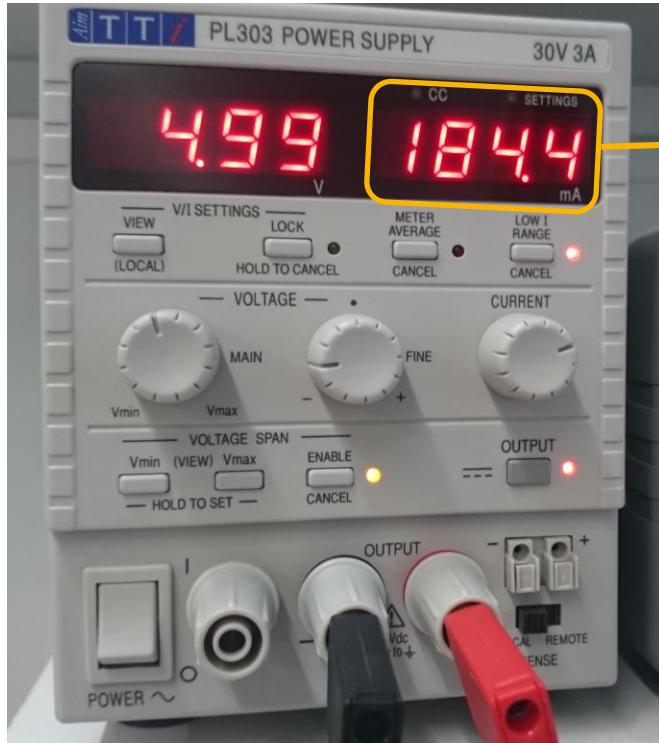
NFC Cockpit

Start



NFC Cockpit

Correlation test



Screenshot of the NFC Cockpit software interface for the 'CORRELATION TEST' tab. The interface includes the following fields:

- ITVDD unloaded: 184 mA
- ITVDD Step Size: 10 (0 to 20)
- ITVDD Max: 230 mA
- Number of Loading Case: 2
- AGC Value: (empty field)
- Current ITVDD: mA (empty field)
- Start Loading button
- Save AGC Value button
- AGC Values In Hex and Dec for each Loading Case: (empty table)
- Note: ITVDD and ITVDDMax value ranges from 0 to 250
- Export AGC Value button

Yellow boxes and arrows highlight the 'ITVDD unloaded' field, the 'Number of Loading Case' dropdown, the 'ITVDD Step Size' field, the 'ITVDD Max' field, and the 'Start Loading' button.

NFC Cockpit

Correlation test



PL303 POWER SUPPLY 30V 3A

4.99 000V

Type Cards | LPCD | DPC | Secondary Firmware | AWC | Test Signal

CORRELATION TEST | DPC Calibration | DPC Trim

ACG vs ITVDD

ITVDD unloaded: 184 mA Number of Loading Cases: 2

ITVDD Step Size: 10 (0 to 20) AGC Value:

ITVDD Max: 230 mA Current ITVDD: mA

Start Loading | Save AGC Value

AGC Values In Hex and Dec for each Loading Case

Loading case Name: RefPICC

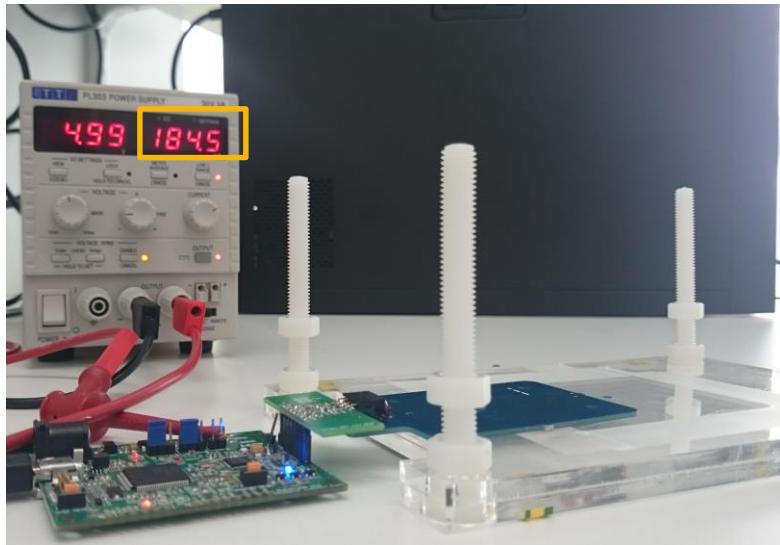
Yes | No

Note: ITVDD and ITVDDMax value ranges from 0 to 250 | Export AGC Value

This screenshot shows the 'CORRELATION TEST' tab of the NFC Cockpit software interface. It includes fields for setting ITVDD values, starting the loading process, and saving AGC values. A modal dialog box is displayed, asking for confirmation to save an 'AGC Value' under the name 'RefPICC'. The 'Yes' button is highlighted with a yellow arrow.

NFC Cockpit

Correlation test



Screenshot of the NFC Cockpit software interface during a correlation test.

The interface includes tabs for Type Cards, LPCD, DPC, Secondary Firmware, AWC, and Test Signal. The DPC tab is selected, showing the CORRELATION TEST sub-tab.

Configuration parameters:

- ITVDD unloaded: 184 mA
- Number of Loading Cases: 2
- ITVDD Step Size: 10 (0 to 20)
- AGC Value: 0x00000145
- ITVDD Max: 230 mA
- Current ITVDD: 0 mA

Buttons: Stop Loading, Save AGC Value (highlighted by a yellow arrow).

A modal dialog box displays the following information:

AGC Value :0x00000146.
Current ITVDD :0x000000C2

Buttons: Aceptar (highlighted by a yellow arrow) and Cerrar.

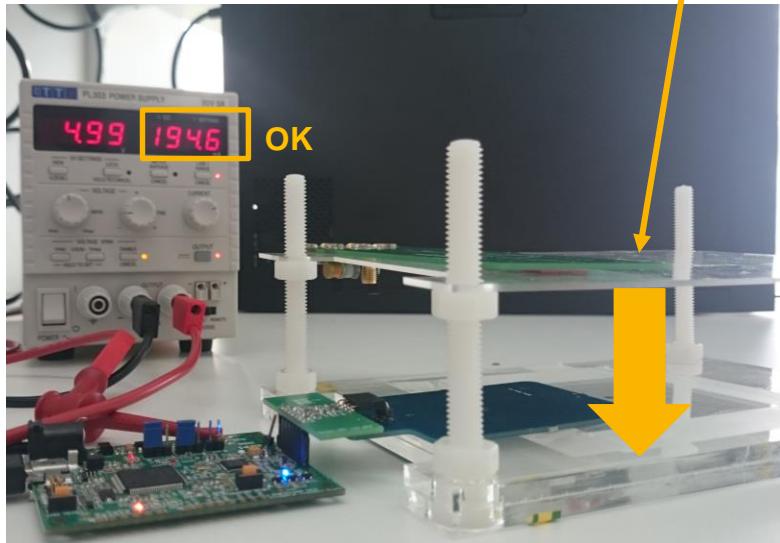
Note: ITVDD and ITVDDMax value ranges from 0 to 250

Buttons: Export AGC Value.

NFC Cockpit

Correlation test

Load 1: Ref PICC



Target ITVDD = 184 mA + 10 mA

Type Cards | LPDC | DPC | Secondary Firmware | AWC | Test Signal

CORRELATION TEST | DPC Calibration | DPC Trim

ACG vs ITVDD

ITVDD unloaded: 184 mA Number of Loading Cases: 2

ITVDD Step Size: 10 (0 to 20) AGC Value: 0x00000153

ITVDD Max: 230 mA Current ITVDD: mA

Stop Loading | Save AGC Value

AGC Values In Hex and Dec for each Loading Case

X

AGC Value :0x00000152.
Current ITVDD :0x000000CC

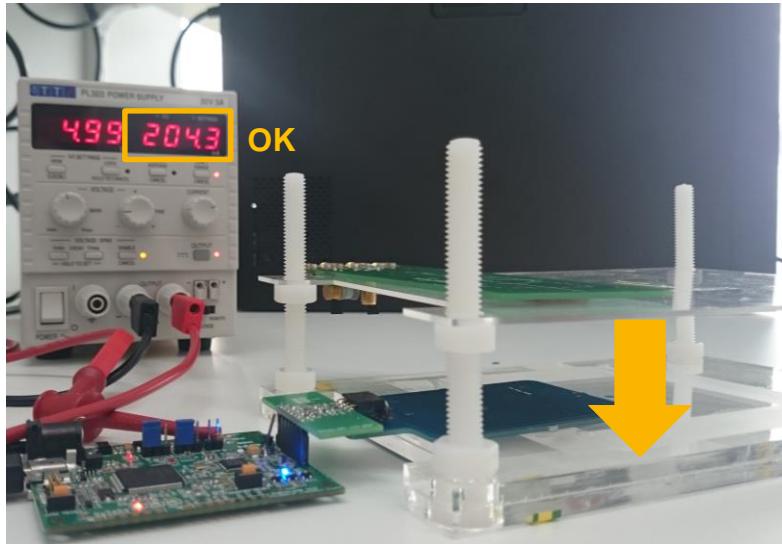
Aceptar

Note: ITVDD and ITVDDMax value ranges from 0 to 250

Export AGC Value

NFC Cockpit

Correlation test



Target ITVDD = 184 mA + 20 mA

ITVDD unloaded: 184 mA Number of Loading Cases: 2

ITVDD Step Size: 10 (0 to 20) AGC Value: 0x00000160

ITVDD Max: 230 mA Current ITVDD: mA

Stop Loading Save AGC Value

AGC Values In Hex and Dec for each Loading Case

X

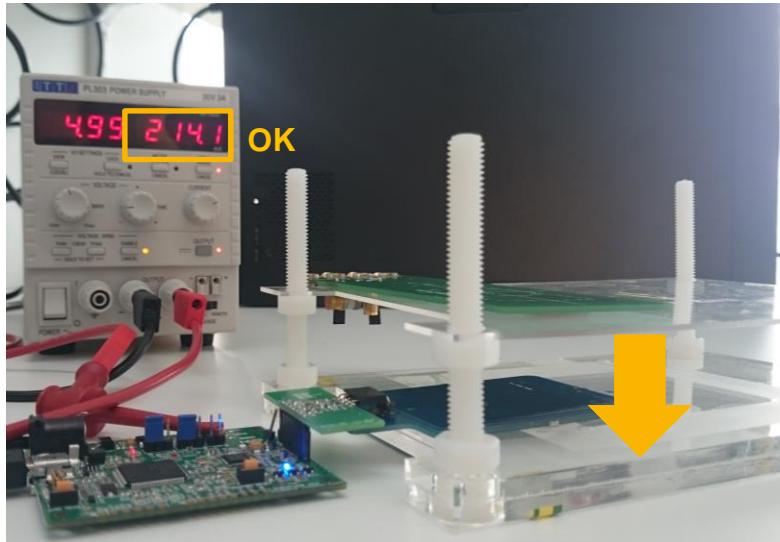
AGC Value :0x00000160.
Current ITVDD :0x000000D6

Aceptar

Note: ITVDD and ITVDDMax value ranges from 0 to 250 Export AGC Value

NFC Cockpit

Correlation test



Target ITVDD = 184 mA + 30 mA

Type Cards | LPCD | DPC | Secondary Firmware | AWC | Test Signal

CORRELATION TEST | DPC Calibration | DPC Trim

ACG vs ITVDD

ITVDD unloaded: 184 mA Number of Loading Cases: 2

ITVDD Step Size: 10 (0 to 20) AGC Value: 0x0000016E

ITVDD Max: 230 mA Current ITVDD: mA

Stop Loading | Save AGC Value

AGC Values In Hex and Dec for each Loading Case

X

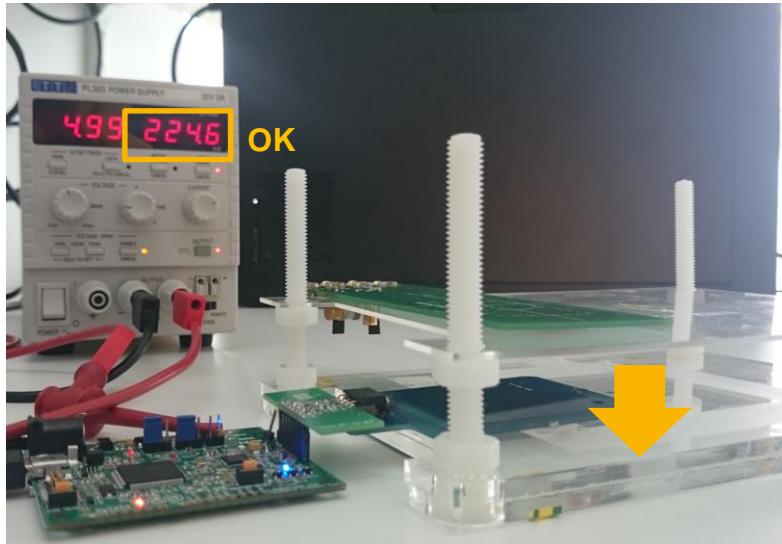
AGC Value :0x0000016D,
Current ITVDD :0x000000E0

Aceptar

Note: ITVDD and ITVDDMax value ranges from 0 to 250 | Export AGC Value

NFC Cockpit

Correlation test



Target ITVDD = 184 mA + 40 mA

Screenshot of the NFC Cockpit software interface during a correlation test.

The main window shows the following parameters:

- ITVDD unloaded: 184 mA
- ITVDD Step Size: 10 (0 to 20)
- ITVDD Max: 230 mA
- Number of Loading Cases: 2
- AGC Value: 0x0000017D

Buttons: Stop Loading, Save AGC Value (highlighted with a yellow arrow).

A modal dialog box displays the following information:

AGC Value :0x0000017C.
Current ITVDD :0x000000EA

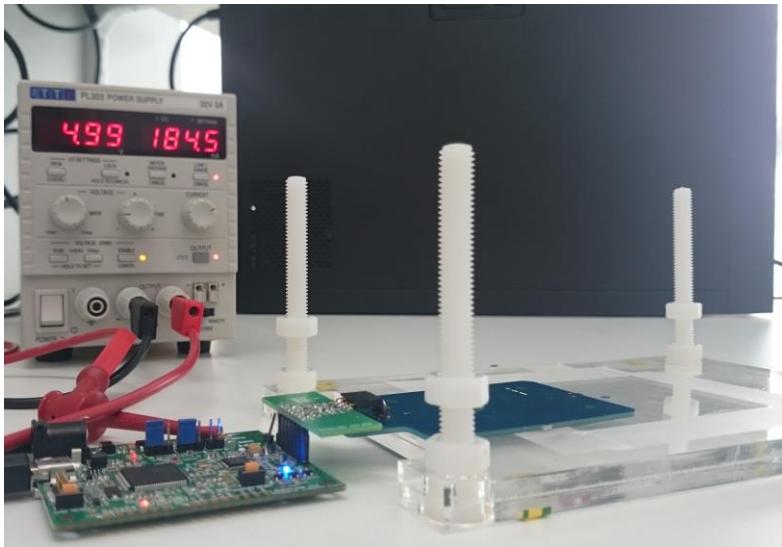
Buttons: Aceptar (highlighted with a yellow arrow).

Notes at the bottom:

- Note: ITVDD and ITVDDMax value ranges from 0 to 250
- Export AGC Value

NFC Cockpit

Correlation test



Type Cards | LPCD | DPC | Secondary Firmware | AWC | Test Signal

CORRELATION TEST | DPC Calibration | DPC Trim

ACG vs ITVDD

ITVDD unloaded: mA Number of Loading Cases:

ITVDD Step Size: (0 to 20) AGC Value: 0x00000017C

ITVDD Max: mA Current ITVDD:

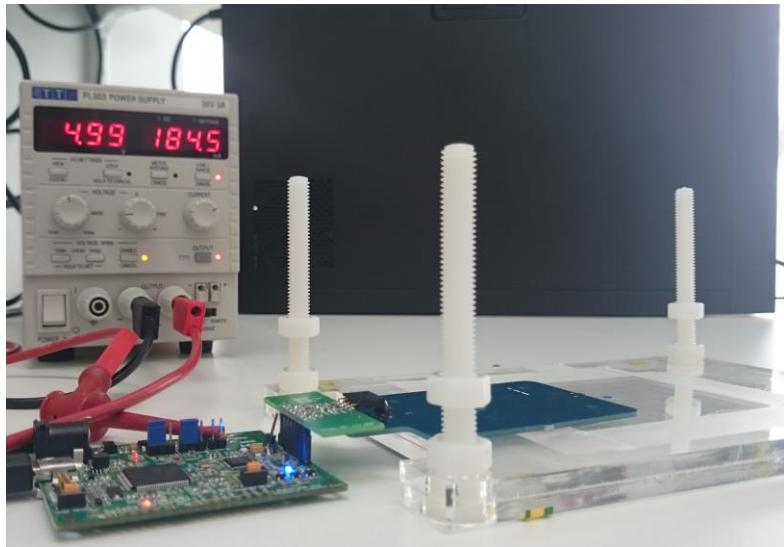
AGC Values In Hex and Dec for each Loading Case

ITvdd	RefPICCA	RefPICCA
184	326	
194	338	
204	352	
214	365	
224	380	

Note: ITVDD and ITVDDMax value ranges from 0 to 250

NFC Cockpit

Correlation test



Software interface for Correlation Test:

Top navigation bar: Type Cards, LPCD, DPC, Secondary Firmware, AWC, Test Signal.

Sub-navigation tabs: CORRELATION TEST, DPC Calibration, DPC Trim.

ACG vs ITVDD section:

- ITVDD unloaded: 184 mA
- Number of Loading Cases: 2
- ITVDD Step Size: 10 (0 to 20)
- AGC Value: 0x00000149
- ITVDD Max: 230 mA
- Current ITVDD: mA

Buttons: Stop Loading, Save AGC Value.

AGC Values In Hex and Dec for each Loading Case:

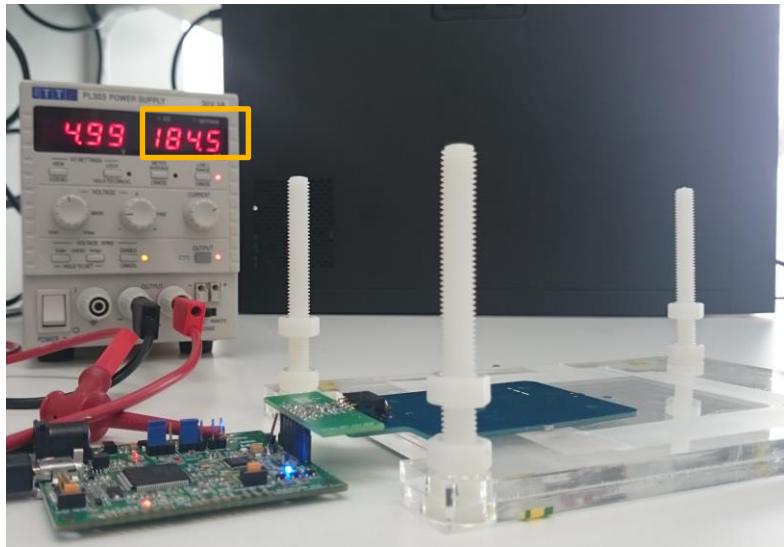
ITvdd	RefPICCA	RefPICCA	Loading case Name:
184	336		<input type="text" value="Phone"/>
194	330		<input type="button" value="Yes"/>
204	341		<input type="button" value="No"/>
214	358		
224	368		

Note: ITVDD and ITVDDMax value ranges from 0 to 250

Buttons: Export AGC Value.

NFC Cockpit

Correlation test



Screenshot of the NFC Cockpit software interface during a Correlation Test.

The interface includes tabs for Type Cards, LPCD, DPC, Secondary Firmware, AWC, and Test Signal. The DPC tab is selected, showing the CORRELATION TEST sub-tab.

Configuration parameters for the test:

- ITVDD unloaded: 184 mA
- Number of Loading Cases: 2
- ITVDD Step Size: 10 (0 to 20)
- AGC Value: 0x00000140
- ITVDD Max: 230 mA
- Current ITVDD: mA

Buttons: Stop Loading, Save AGC Value (highlighted with a yellow arrow).

Text: AGC Values In Hex and Dec for each Loading Case.

ITvdd	RefPICCA	RefPICCA
184	326	
194	338	
204	352	
214	365	
224	380	

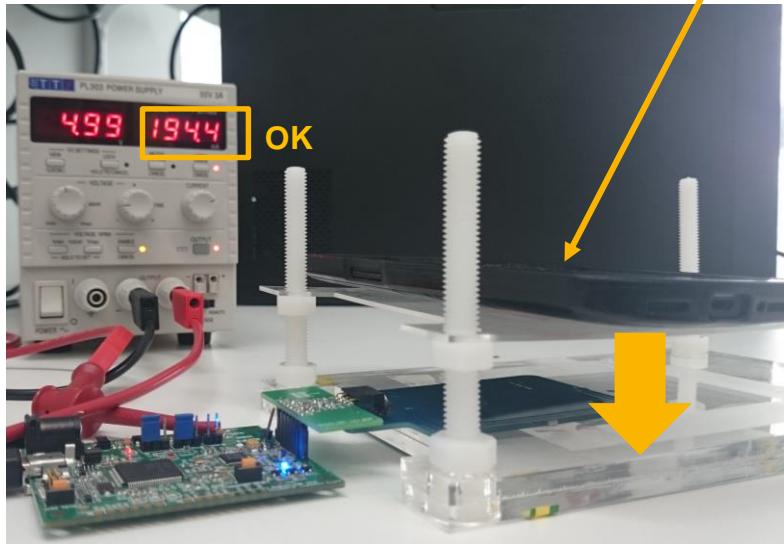
A modal dialog box displays the current AGC Value (0x00000141) and Current ITVDD (0x000000C2), with an Acceptar button (highlighted with a yellow arrow).

Note: ITVDD and ITVDDMax value ranges from 0 to 250. Export AGC Value button.

NFC Cockpit

Correlation test

Load 2: Phone



Target ITVDD = 184 mA + 10 mA

Software interface for Correlation Test:

ACG vs ITVDD

ITVDD unloaded	184 mA	Number of Loading Cases	2
ITVDD Step Size	10 (0 to 20)	AGC Value:	0x0000014A
ITVDD Max	230 mA	Current ITVDD:	mA

Buttons: Stop Loading, Save AGC Value

AGC Values In Hex and Dec for each Loading Case

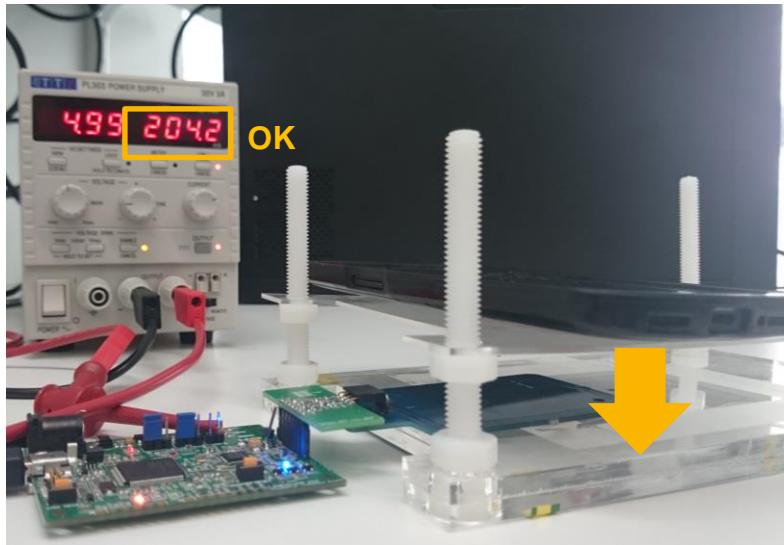
ITvdd	RefPICCA	RefPICCA
184	326	
194	338	
204	352	
214	365	
224	380	

Message Box: AGC Value :0x0000014B, Current ITVDD :0x000000CC
Aceptar

Note: ITVDD and ITVDDMax value ranges from 0 to 250
Export AGC Value

NFC Cockpit

Correlation test



Target ITVDD = 184 mA + 20 mA

Type Cards | LPCD | DPC | Secondary Firmware | AWC | Test Signal

CORRELATION TEST | DPC Calibration | DPC Trim

ACG vs ITVDD

ITVDD unloaded	184	mA	Number of Loading Cases	2
ITVDD Step Size	10	(0 to 20)	AGC Value:	0x0000015B
ITVDD Max	230	mA	Current ITVDD:	mA

Stop Loading | Save AGC Value

AGC Values In Hex and Dec for each Loading Case

ITvdd	RefPICCA	RefPICCA
184	326	
194	338	
204	352	
214	365	
224	380	

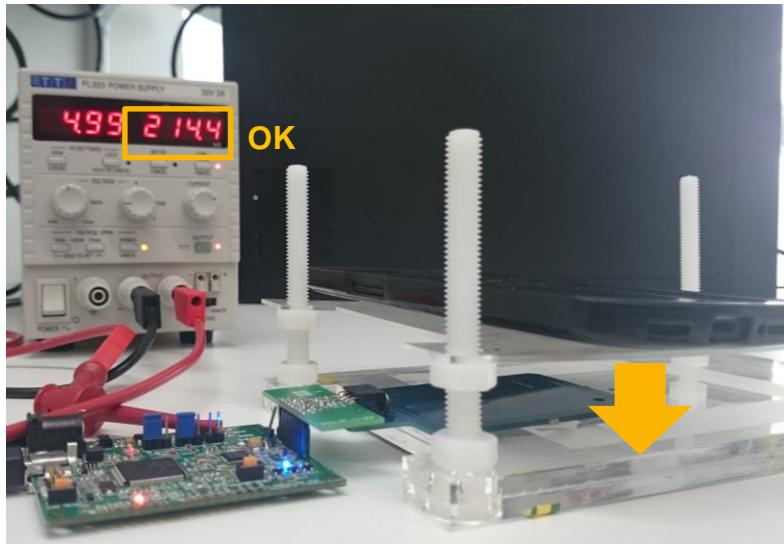
AGC Value :0x0000015C.
Current ITVDD :0x000000D6

Aceptar

Note: ITVDD and ITVDDMax value ranges from 0 to 250 | Export AGC Value

NFC Cockpit

Correlation test



Target ITVDD = 184 mA + 30 mA

Type Cards | LPCD | DPC | Secondary Firmware | AWC | Test Signal

CORRELATION TEST | DPC Calibration | DPC Trim

ACG vs ITVDD

ITVDD unloaded: 184 mA | Number of Loading Cases: 2

ITVDD Step Size: 10 (0 to 20) | AGC Value: 0x0000016E

ITVDD Max: 230 mA | Current ITVDD: mA

Stop Loading | Save AGC Value

AGC Values In Hex and Dec for each Loading Case

ITvdd	RefPICCA	RefPICCA
184	326	
194	338	
204	352	
214	365	
224	380	

AGC Value :0x0000016C.
Current ITVDD :0x000000E0

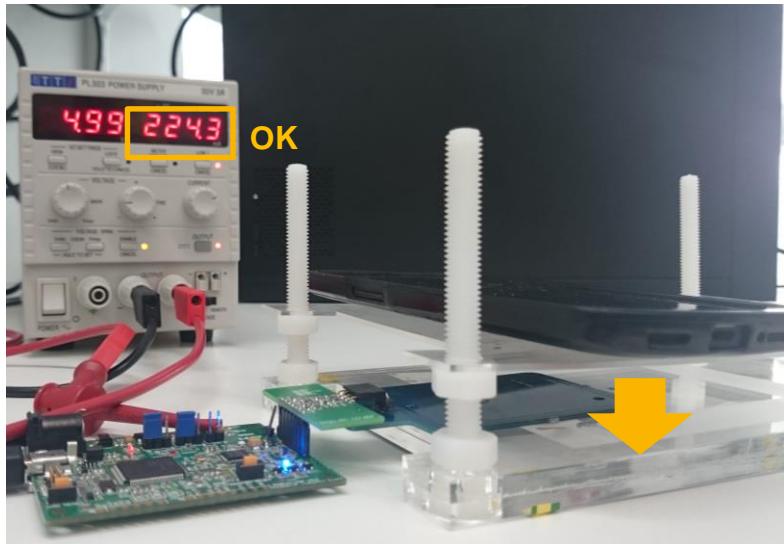
Aceptar

Note: ITVDD and ITVDDMax value ranges from 0 to 250

Export AGC Value

NFC Cockpit

Correlation test



Target ITVDD = 184 mA + 40 mA

ITVdd	RefPICCA	RefPICCA
184	326	
194	338	
204	352	
214	365	
224	380	

AGC Value :0x0000017F.
Current ITVDD :0x000000EA

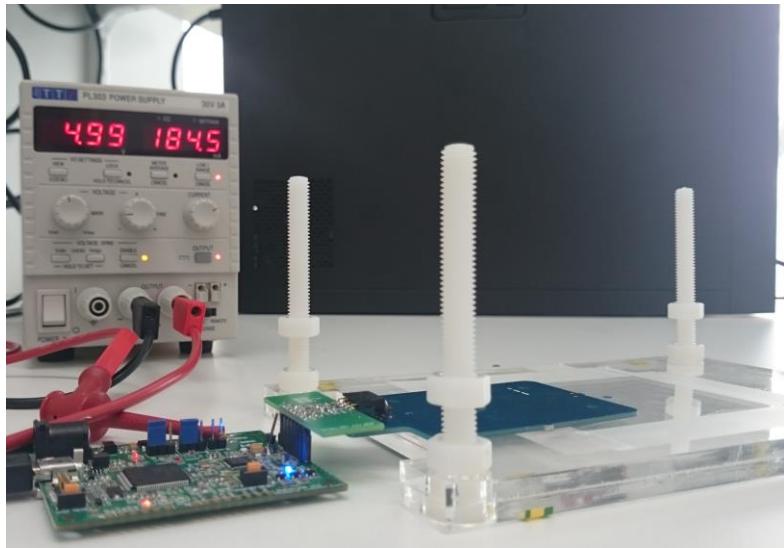
Aceptar

Note: ITVDD and ITVDDMax value ranges from 0 to 250

Export AGC Value

NFC Cockpit

Correlation test



Type Cards | LPCD | DPC | Secondary Firmware | AWC | Test Signal

CORRELATION TEST | DPC Calibration | DPC Trim

ACG vs ITVDD

ITVDD unloaded: 184 mA | Number of Loading Cases: 2

ITVDD Step Size: 10 (0 to 20) | AGC Value: 0x00000017F

ITVDD Max: 230 mA | Current ITVDD: mA

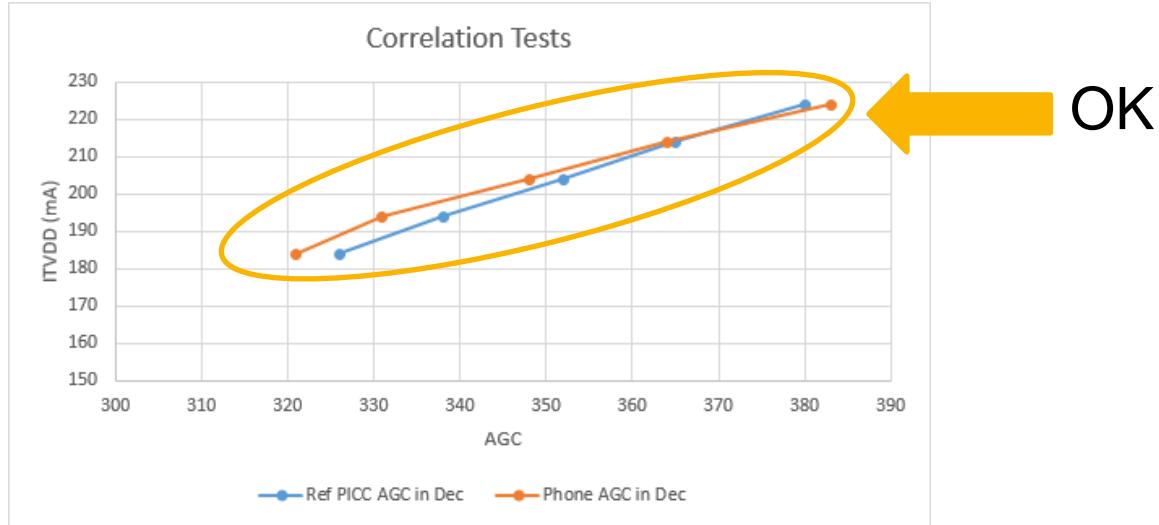
AGC Values In Hex and Dec for each Loading Case

ITvdd	RefPICCA	RefPICCA	PhoneAg1	PhoneAg1
184	326		321	
194	338		331	
204	352		348	
214	365		364	
224	380		383	

Note: ITVDD and ITVDDMax value ranges from 0 to 250

NFC Cockpit

Correlation test



NFC Cockpit

DPC Configuration

Prerequisites

1. “Symmetrical” antenna tuning (to e.g. 20Ω) **DONE**
2. Ensure a good correlation between AGC & ITVDD **DONE**
3. Adjust RRx to achieve
 - AGC value = appr. 300dec unloaded (full NFC)
 - AGC value = appr. 600dec unloaded (pure Reader mode)



Define

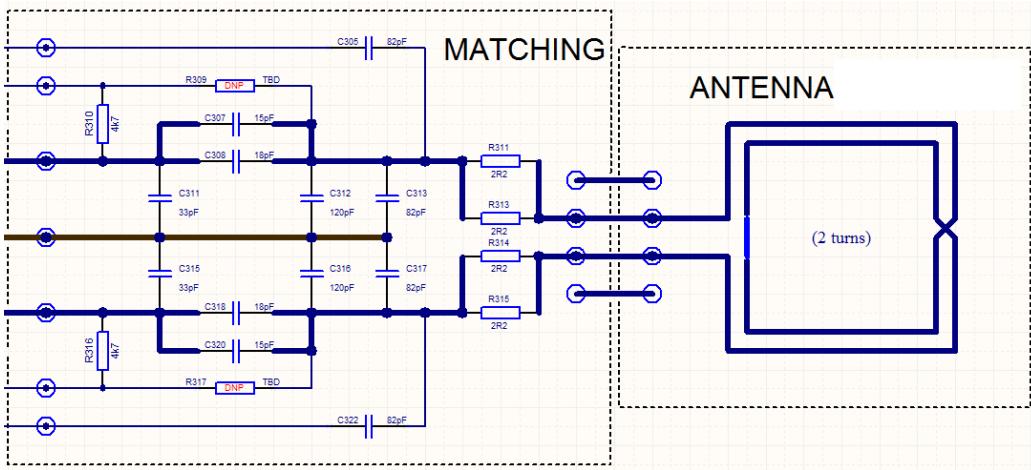
1. Number of gears (e.g. 5 seems to be good for standard EMVCo POS)
2. Tx settings per gear (DPC_AGC_GEAR_LUT)
3. ITVDD switch (e.g. 205mA)

ADJUST RRX



NFC Cockpit

Adjust RRx



Type Cards	LPCD	DPC	EMVCo Loopback	AWC	
CORRELATION TEST					
DPC Calibration					
ACG vs ITVDD					
ITVDD unloaded	184 mA	Number of Loading Cases	2		
ITVDD Step Size	10 (0 to 20)	AGC Value:	0x017A Hex		
ITVDD Max	230 mA	Current ITVDD:	224 mA		
<input type="button" value="Start Loading"/> <input type="button" value="Save AGC Value"/>					
AGC Values In Hex and Dec for each Loading Case					
ITVDD	Ref PICC	Ref PICC	Phone AC	Phone AC	
184	324	0x0144	332	0x014C	OK
194	340	0x0154	330	0x014A	
204	351	0x015F	348	0x015C	
214	365	0x016D	363	0x016B	
224	382	0x017E	378	0x017A	

Note: ITVDD and ITVDDMax value ranges from 0 to 250

NFC Cockpit

DPC Configuration

Prerequisites

1. “Symmetrical” antenna tuning (to e.g. 20Ω) **DONE**
 2. Ensure a good correlation between AGC & ITVDD **DONE**
 3. Adjust RRx to achieve
 - AGC value = appr. 300dec unloaded (full NFC)
 - AGC value = appr. 600dec unloaded (pure Reader mode)
- }
- DONE**

Define

1. Number of gears (e.g. 5 seems to be good for standard EMVCo POS)
2. Tx settings per gear (DPC_AGC_GEAR_LUT)
3. ITVDD switch (e.g. 205mA)

NFC Cockpit

DPC Configuration

Prerequisites

1. “Symmetrical” antenna tuning (to e.g. 20Ω) **DONE**
2. Ensure a good correlation between AGC & ITVDD **DONE**
3. Adjust RRx to achieve
 - AGC value = appr. 300dec unloaded (full NFC)
 - AGC value = appr. 600dec unloaded (pure Reader mode)

DONE

Define

1. Number of gears (e.g. 5 seems to be good for standard EMVCo POS)
2. Tx settings per gear (DPC_AGC_GEAR_LUT)
3. ITVDD switch (e.g. 205mA)



DPC CALIBRATION



NFC Cockpit

DPC Calibration

Gear #	EEPROM	TX power setting (hex)	Driver voltage (V)
	0x81	0F	
0	0x82	F9	5.0
1	0x83	F1	4.85
2	0x84	F3	4.75
3	0x85	F5	4.5
4	0x86	F7	4.0
5	0x87	F0	2.85
6	0x88	F2	2.75
7	0x89	F4	2.5
8	0x8A	F6	2.0
9	0x8B	96	2.0
10	0x8C	66	2.0
11	0x8D	46	2.0
12	0x8E	36	2.0
13	0x8F	26	2.0
14	0x90	16	2.0

Tool interface showing DPC Calibration parameters and gear settings:

DPC AGC GEAR LUT SIZE, 0x81

Number of Gears: 3	<input type="checkbox"/> Clear Gear AGC Threshold values		
ITVDD Limit: 210 mA	<input type="checkbox"/> Clear Gear TX Settings		
AGC Value:			
Gear Number	Gear Tx Setting	Agc Value In Decimal	Agc Value In Hex
1	F9		
2	F7		
3	F0		

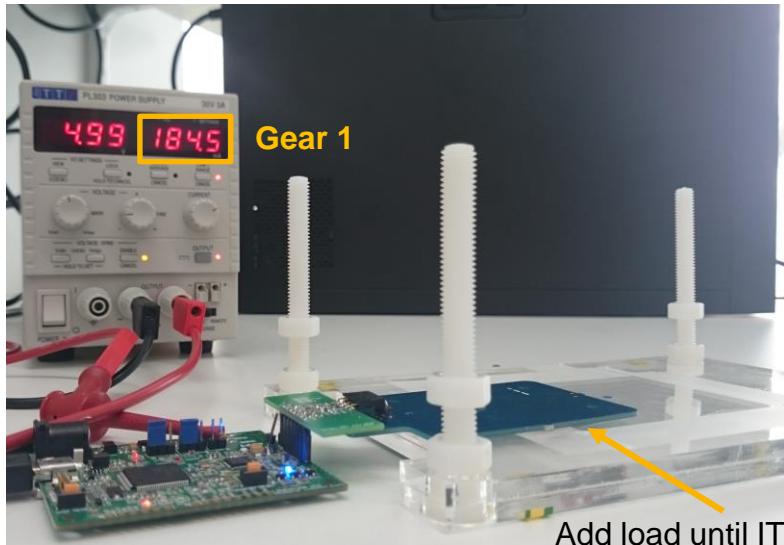
Tx settings per gear (DPC_AGC_GEAR_LUT, 0x82 ... 0x90)

Buttons at the bottom:

- Start Calibration
- ITVDD Limit Gear
- Update Gear AGC

NFC Cockpit

DPC Calibration



Add load until ITVDD = 210 mA

Screenshot of the NFC Cockpit software interface during DPC Calibration.

Top navigation bar: Type Cards, LPCD, DPC, Secondary Firmware, AWC, Test Signal.

Sub-navigation tabs: CORRELATION TEST, DPC Calibration (selected), DPC Trim.

Configuration settings:

- Number of Gears: 3
- ITVDD Limit: 210 mA
- AGC Value: (input field)
- Checkboxes: Clear Gear AGC Threshold values, Clear Gear TX Settings, Clear Gear Values.

Data table:

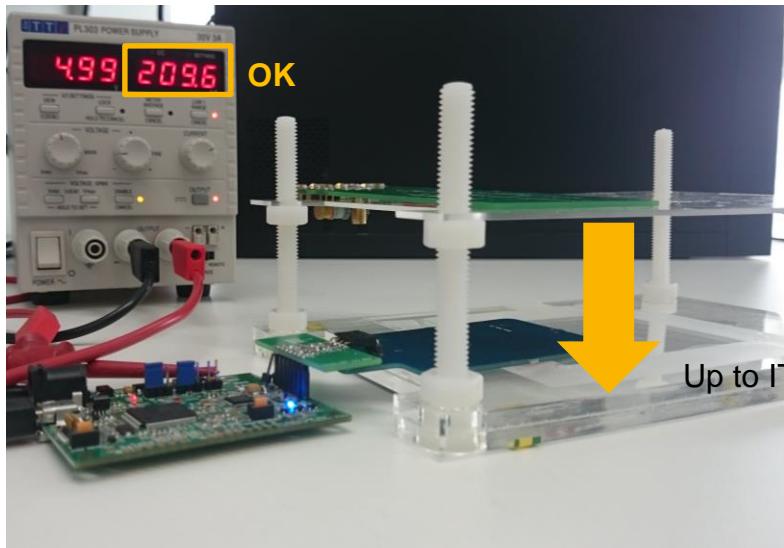
Gear Number	Gear Tx Setting	Agc Value In Decimal	Agc Value In Hex
1	F9		
2	F7		
3	F0		

Buttons at the bottom:

- Stop Calibration
- ITVDD Limit Gear (highlighted in blue)
- Update Gear AGC

NFC Cockpit

DPC Calibration



Up to ITVDD = 210 mA

Screenshot of the NFC Cockpit software interface during DPC Calibration.

The interface includes tabs for Type Cards, LPCD, DPC (selected), Secondary Firmware, AWC, and Test Signal. Sub-tabs under DPC include CORRELATION TEST, DPC Calibration (selected), and DPC Trim.

Configuration settings:

- Number of Gears: 3
- ITVDD Limit: 210 mA
- AGC Value: (input field)
- Checkboxes: Clear Gear AGC Threshold values, Clear Gear TX Settings, Clear Gear Values

Data table:

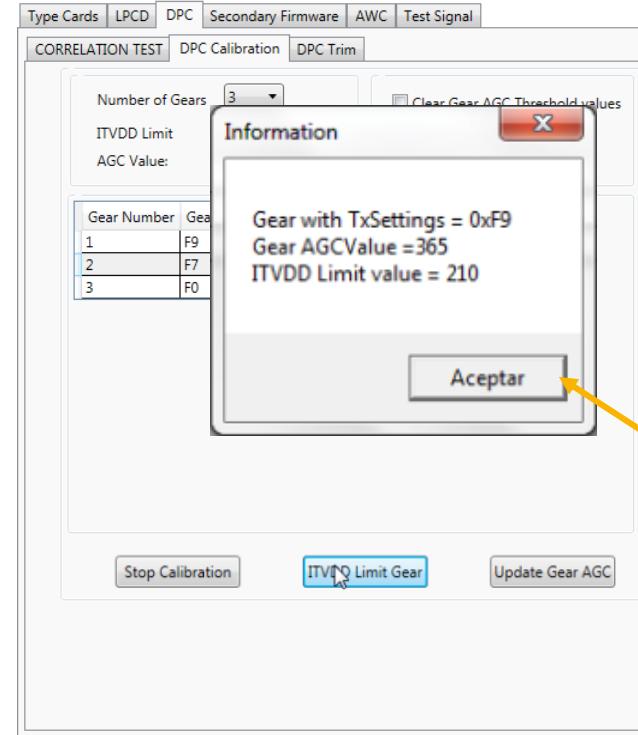
Gear Number	Gear Tx Setting	Agc Value In Decimal	Agc Value In Hex
1	F9		
2	F7		
3	F0		

Buttons at the bottom:

- Stop Calibration
- ITVDD Limit Gear (highlighted with a blue box and orange arrow)
- Update Gear AGC

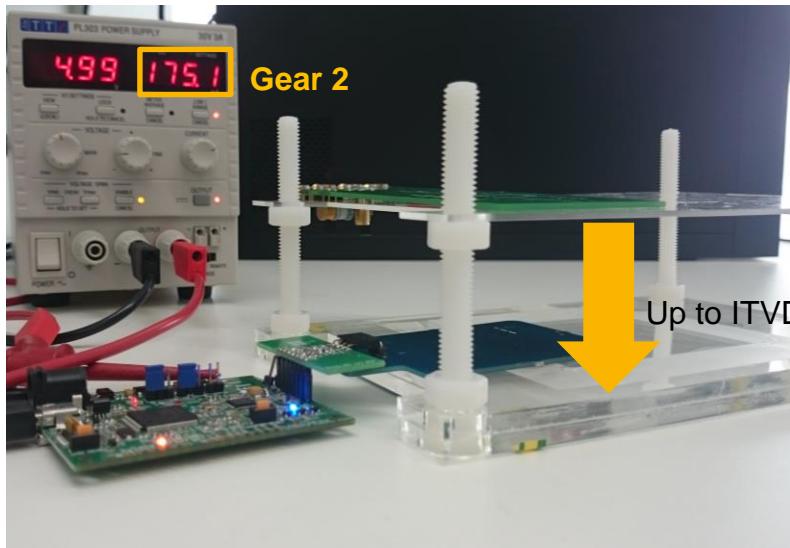
NFC Cockpit

DPC Calibration



NFC Cockpit

DPC Calibration



Screenshot of the NFC Cockpit software interface during DPC Calibration.

Top navigation bar: Type Cards, LPCD, **DPC**, Secondary Firmware, AWC, Test Signal.

Sub-navigation tabs: CORRELATION TEST, **DPC Calibration**, DPC Trim.

Configuration settings:

- Number of Gears: 3
- ITVDD Limit: 210 mA
- AGC Value: (input field)
- Checkboxes: Clear Gear AGC Threshold values, Clear Gear TX Settings, Clear Gear Values.

Data table:

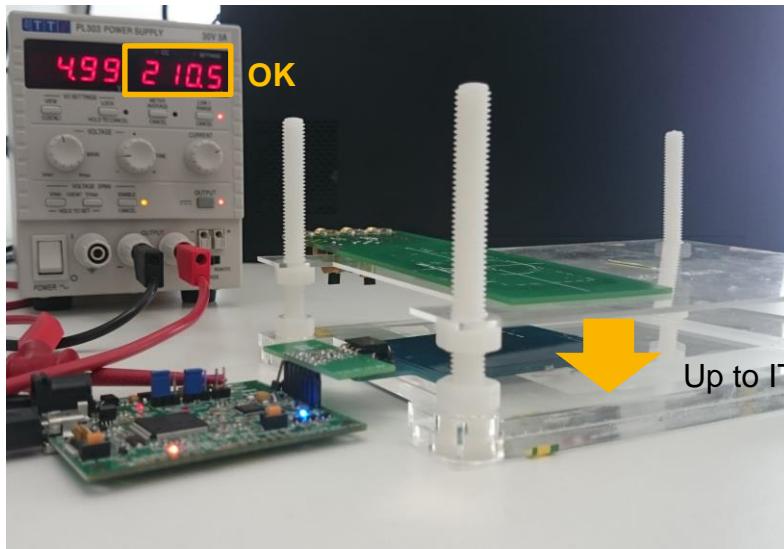
Gear Number	Gear Tx Setting	Agc Value In Decimal	Agc Value In Hex
1	F9	365	
2	F7		
3	F0		

Buttons at the bottom:

- Stop Calibration
- ITVDD Limit Gear** (highlighted in blue)
- Update Gear AGC

NFC Cockpit

DPC Calibration



Screenshot of the NFC Cockpit software interface during DPC Calibration.

The interface includes tabs for Type Cards, LPCD, DPC (selected), Secondary Firmware, AWC, and Test Signal. Sub-tabs under DPC include CORRELATION TEST, DPC Calibration (selected), and DPC Trim.

Configuration settings:

- Number of Gears: 3
- ITVDD Limit: 210 mA
- AGC Value: (not explicitly shown)

Table showing Gear Number, Gear Tx Setting, Agc Value In Decimal, and Agc Value In Hex:

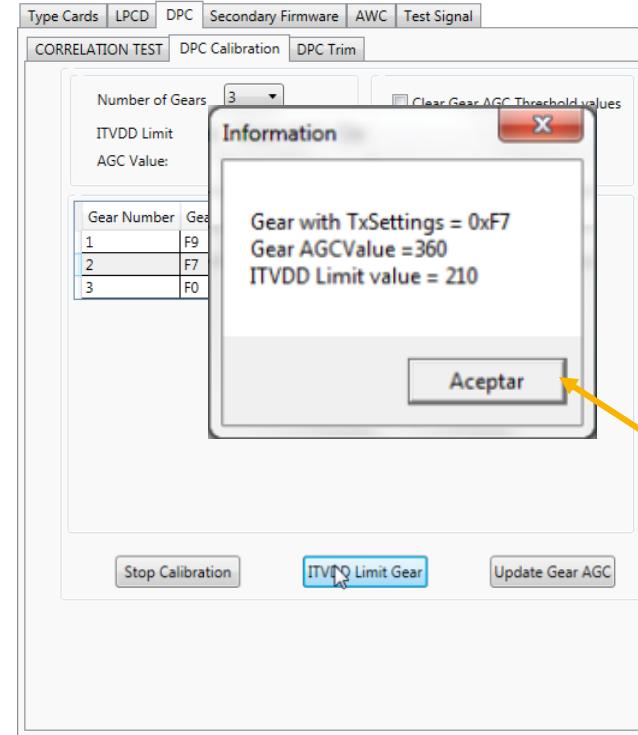
Gear Number	Gear Tx Setting	Agc Value In Decimal	Agc Value In Hex
1	F9	365	
2	F7		
3	F0		

Buttons at the bottom:

- Stop Calibration
- ITVDD Limit Gear (highlighted with a blue box and orange arrow)
- Update Gear AGC

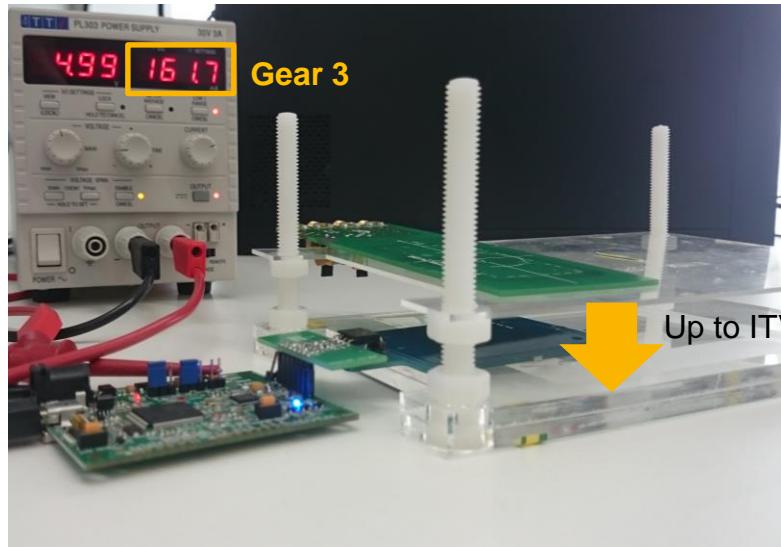
NFC Cockpit

DPC Calibration



NFC Cockpit

DPC Calibration



Software interface for DPC Calibration:

Top navigation bar: Type Cards, LPCD, **DPC**, Secondary Firmware, AWC, Test Signal

Sub-navigation tabs: CORRELATION TEST, **DPC Calibration**, DPC Trim

Configuration section:

- Number of Gears: 3
- ITVDD Limit: 210 mA
- AGC Value: (input field)
- Checkboxes: Clear Gear AGC Threshold values, Clear Gear TX Settings
- Clear Gear Values button

Data table:

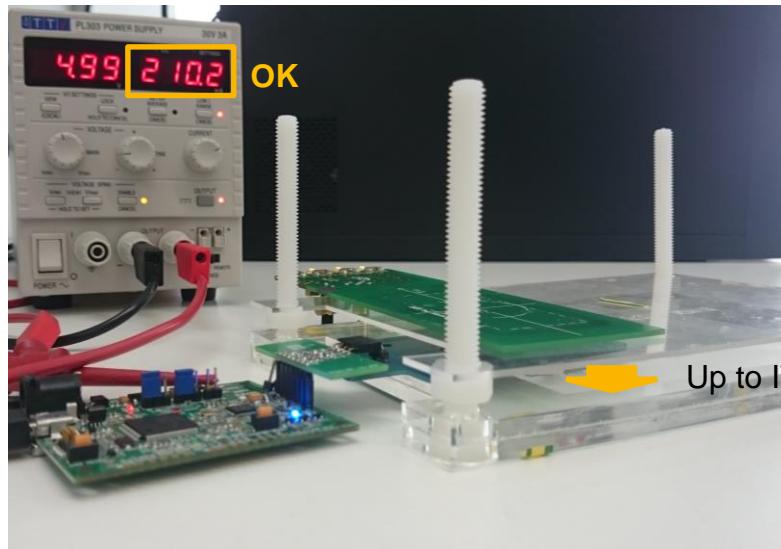
Gear Number	Gear Tx Setting	Agc Value In Decimal	Agc Value In Hex
1	F9	365	
2	F7	360	
3	F0		

Buttons at the bottom:

- Stop Calibration
- ITVDD Limit Gear (highlighted in blue)
- Update Gear AGC

NFC Cockpit

DPC Calibration



Screenshot of the NFC Cockpit software interface during DPC Calibration.

The top navigation bar includes tabs: Type Cards, LPCD, DPC (which is selected), Secondary Firmware, AWC, and Test Signal.

The sub-navigation bar under DPC includes: CORRELATION TEST, DPC Calibration (which is selected), and DPC Trim.

Configuration settings in the DPC Calibration tab:

- Number of Gears: 3
- ITVDD Limit: 210 mA
- AGC Value: (empty field)
- Checkboxes: Clear Gear AGC Threshold values, Clear Gear TX Settings, Clear Gear Values

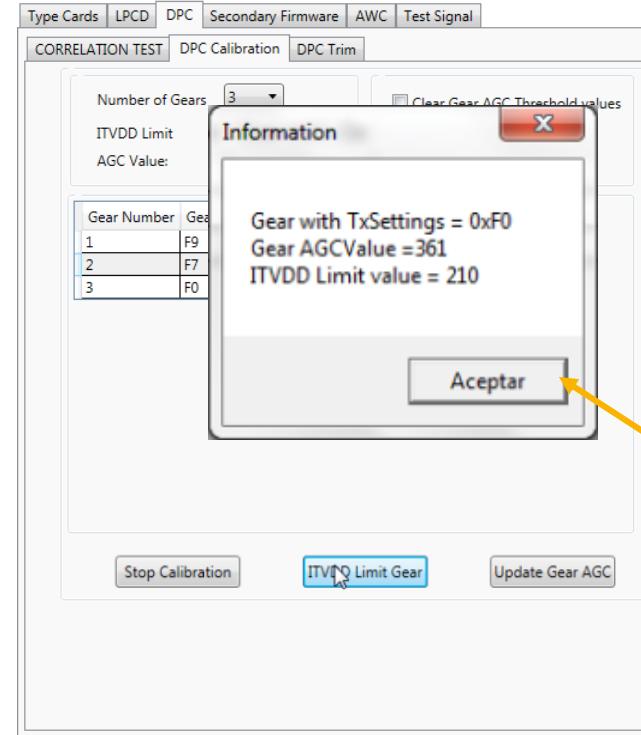
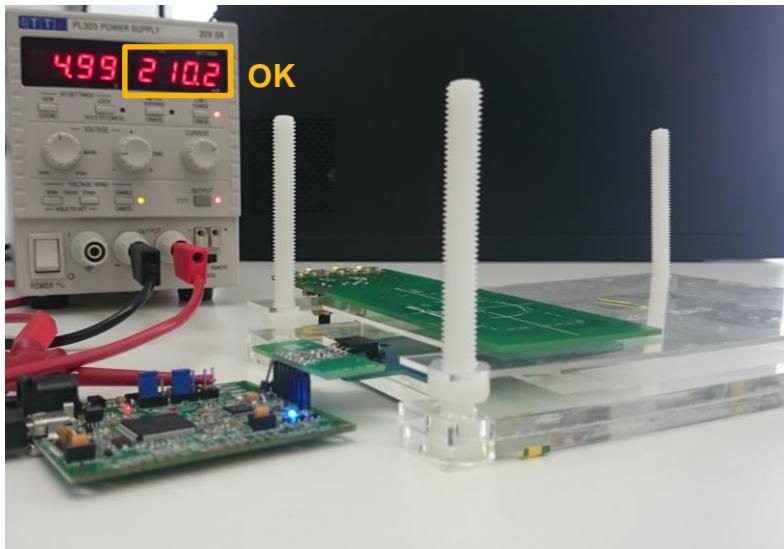
A table displays gear settings:

Gear Number	Gear Tx Setting	Agc Value In Decimal	Agc Value In Hex
1	F9	365	
2	F7	360	
3	F0		

At the bottom of the calibration screen are three buttons: Stop Calibration, **ITVDD Limit Gear** (highlighted with a blue box and an orange arrow), and Update Gear AGC.

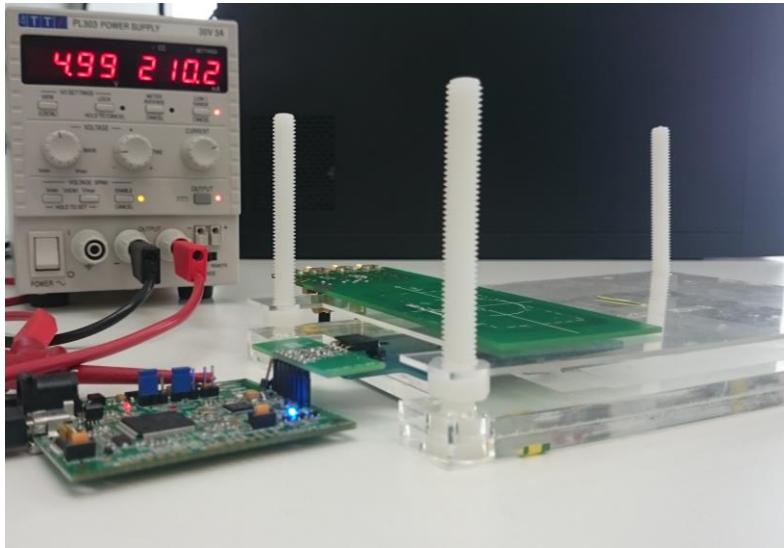
NFC Cockpit

DPC Calibration



NFC Cockpit

DPC Calibration



Screenshot of the NFC Cockpit software interface showing the DPC Calibration tab.

Software UI Elements:

- Top navigation bar: Type Cards, LPCD, DPC, Secondary Firmware, AWC, Test Signal.
- Sub-navigation tabs: CORRELATION TEST, DPC Calibration (selected), DPC Trim.
- Form fields:
 - Number of Gears: 3
 - ITVDD Limit: 210 mA
 - AGC Value:
- Checkboxes:
 - Clear Gear AGC Threshold values
 - Clear Gear TX Settings
- Buttons:
 - Clear Gear Values
 - Stop Calibration
 - ITVDD Limit Gear (highlighted with a blue border)
 - Update Gear AGC (highlighted with a yellow arrow)

Data Table:

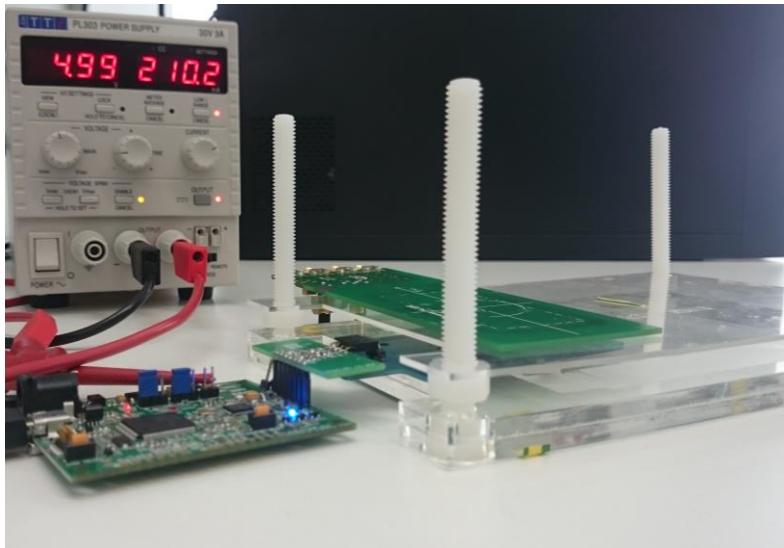
Gear Number	Gear Tx Setting	Agc Value In Decimal	Agc Value In Hex
1	F9	365	
2	F7	360	
3	F0	361	

Yellow callout box:

AGC HIGH threshold
(DPC_THRSH_HIGH, 0x5F ... 0x7C)

NFC Cockpit

DPC Calibration



Screenshot of a software interface for DPC Calibration. The top navigation bar includes tabs: Type Cards, LPCD, DPC, Secondary Firmware, AWC, and Test Signal. The DPC tab is selected, showing sub-tabs for CORRELATION TEST, DPC Calibration (which is active), and DPC Trim.

The main configuration area includes:

- Number of Gears: Set to 3.
- ITVDD Limit: Set to 210 mA.
- AGC Value: An input field.
- Checkboxes for Clear Gear AGC Threshold values and Clear Gear TX Settings.
- A "Clear Gear Values" button.

A table displays gear settings:

Gear Number	Gear Tx Setting	Agc Value In Decimal	Agc Value In Hex
1	F9	365	
2			
3			

An alert dialog box is shown, stating "EEPROM updated with AGC values" with an "Aceptar" button, which has a yellow arrow pointing to it.

At the bottom are buttons for Stop Calibration, ITVDD Limit Gear (highlighted in blue), and Update Gear AGC.

NFC Cockpit

DPC Configuration

Prerequisites

1. “Symmetrical” antenna tuning (to e.g. 20Ω) **DONE**
2. Ensure a good correlation between AGC & ITVDD **DONE**
3. Adjust RRx to achieve
 - AGC value = appr. 300dec unloaded (full NFC) **DONE**
 - AGC value = appr. 600dec unloaded (pure Reader mode)

Define

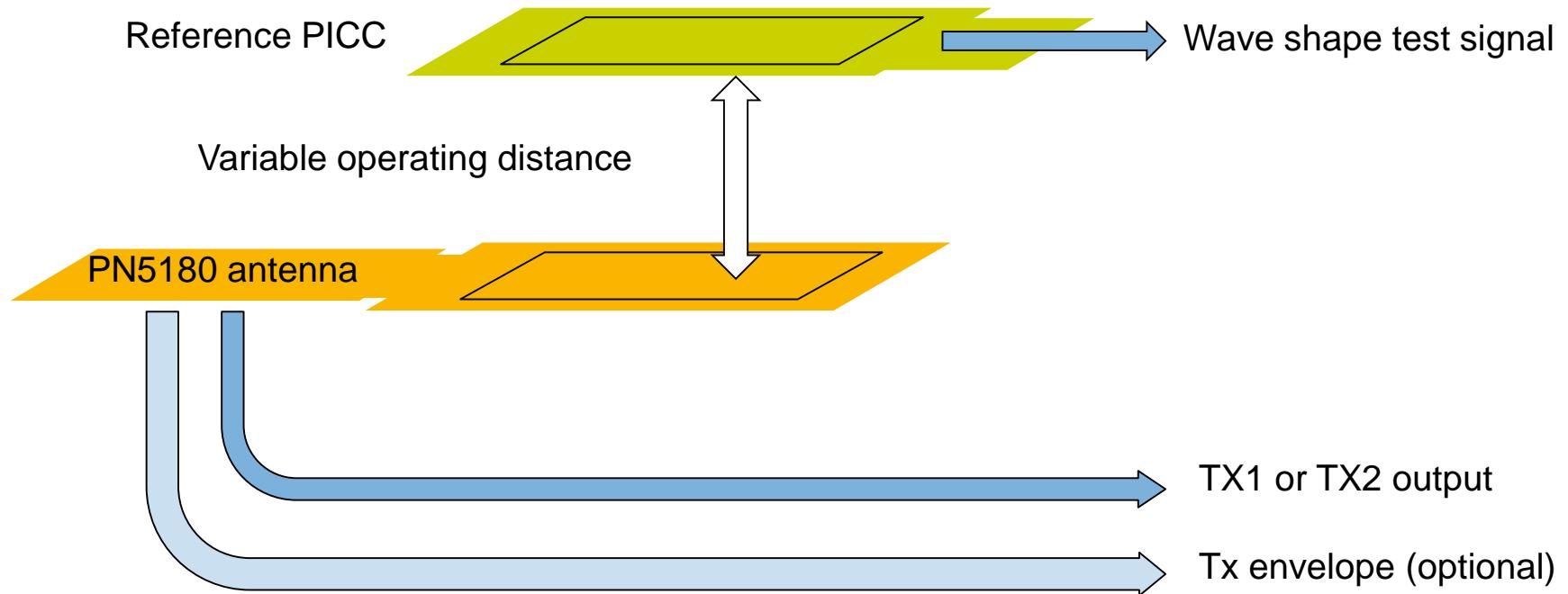
1. Number of gears (e.g. 5 seems to be good for standard EMVCo POS)
 2. Tx settings per gear (DPC_AGC_GEAR_LUT)
 3. ITVDD switch (e.g. 205mA)
- 
- DONE**

TX SHAPING



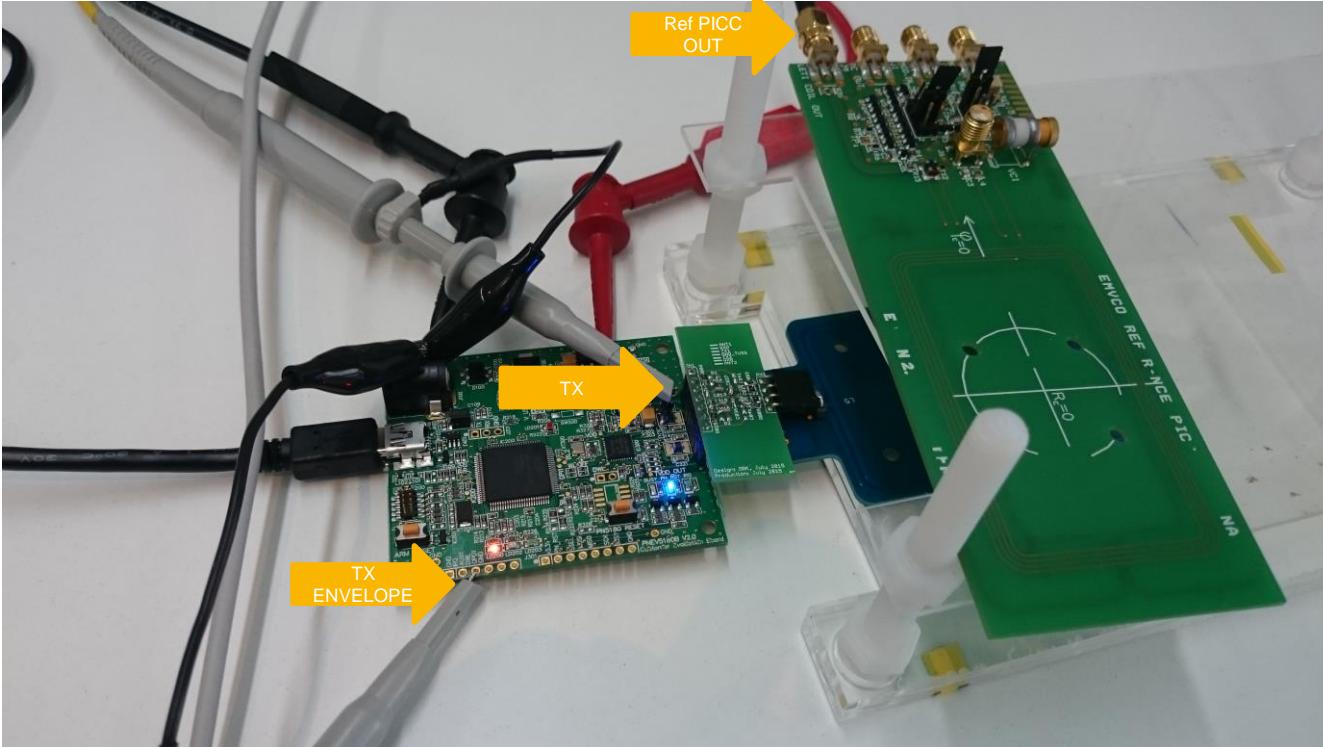
NFC Cockpit

TX shaping



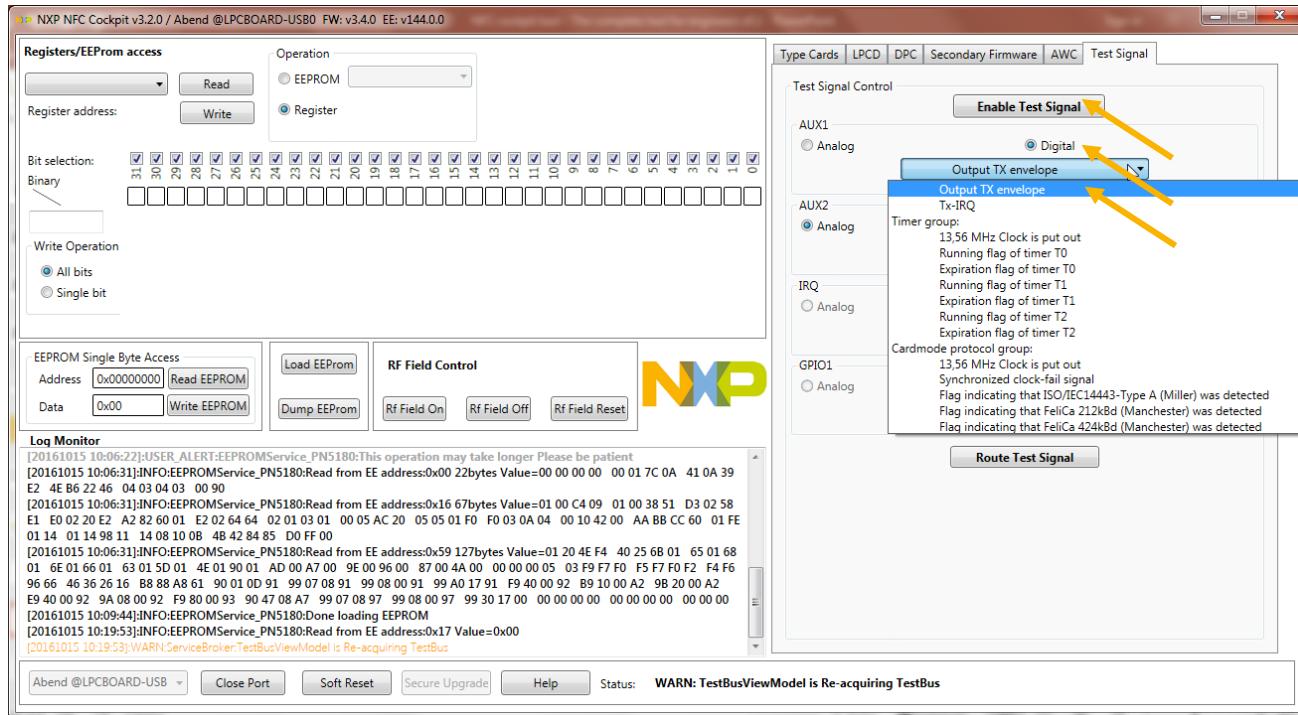
NFC Cockpit

TX shaping



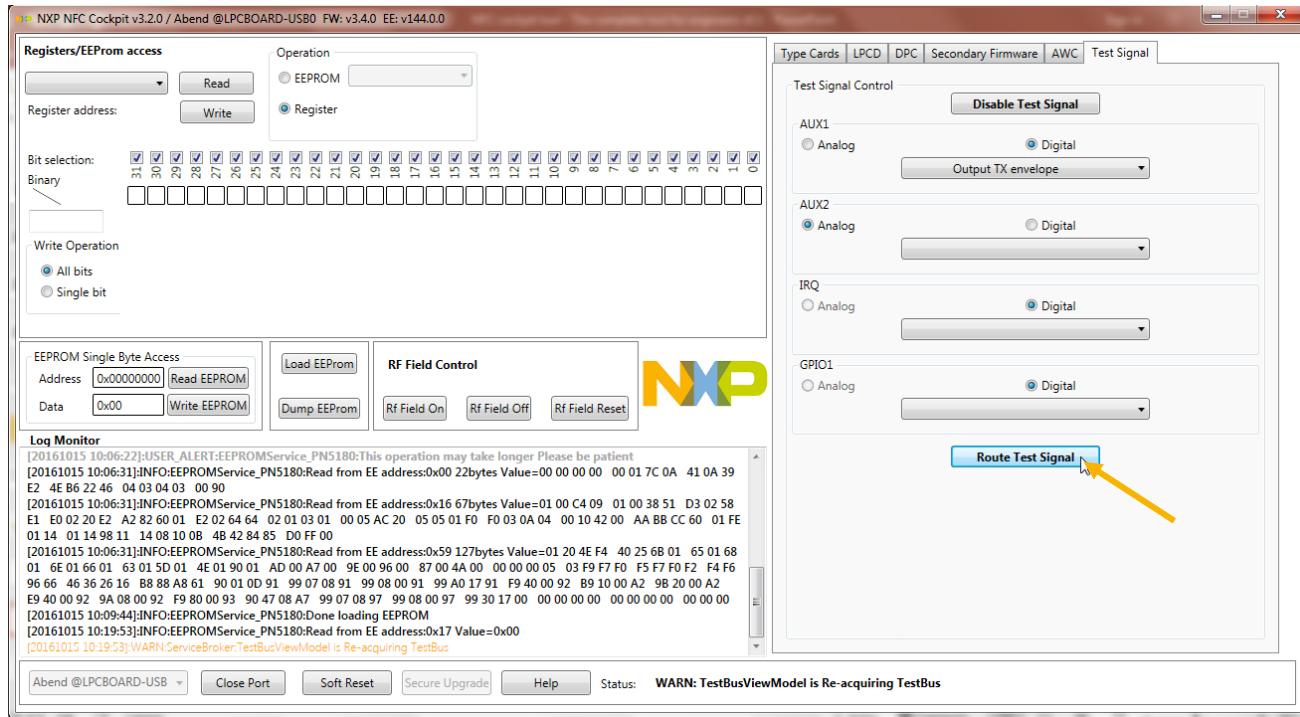
NFC Cockpit

TX shaping



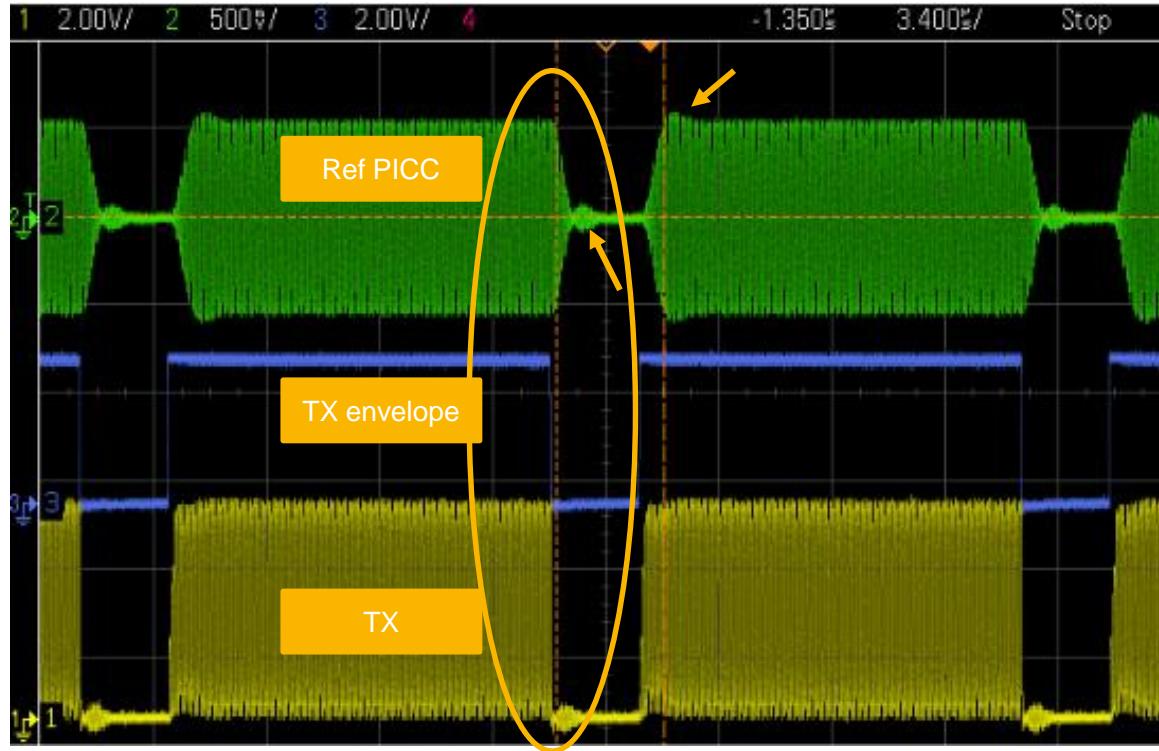
NFC Cockpit

TX shaping



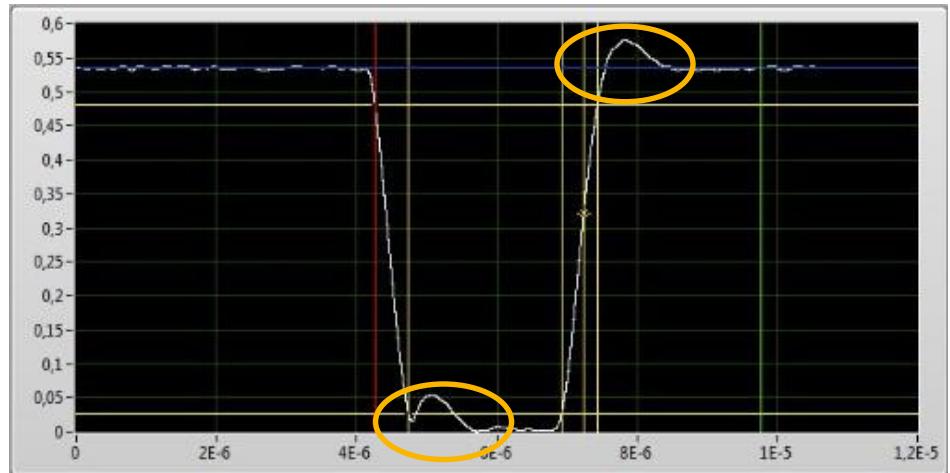
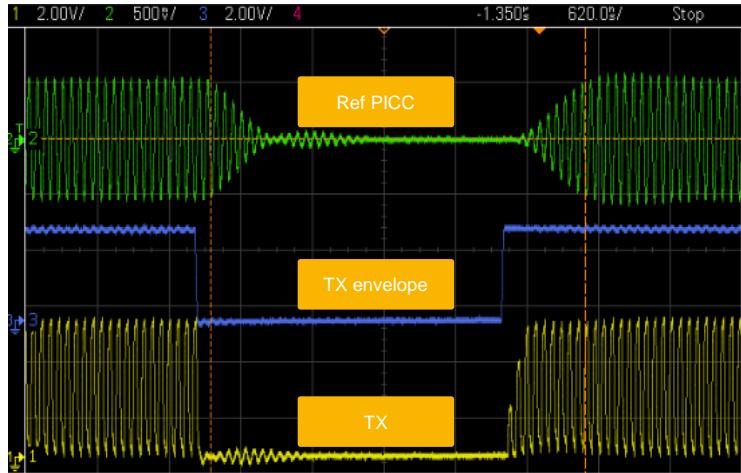
NFC Cockpit

TX shaping



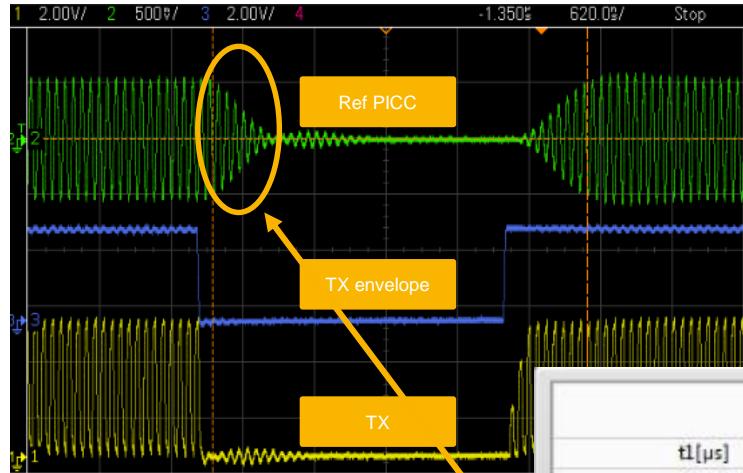
NFC Cockpit

TX shaping



NFC Cockpit

TX shaping



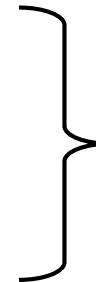
	Lower Limit	Measured Value	Upper Limit
t1[μs]	2.06	2.86	2.99
t2[μs]	0.52	2.18	2.66
t3[μs]	0	0.51	1.18
t4[μs]	0	0.31	0.34
Overshoot [%]	0	7.81	10
Undershoot [%]	0	0.53	10
ASK Mod. Depth [%]	95	99.30	100
Monotony		Fail	

NFC Cockpit

TX shaping

Option 1: change the antenna tuning

- Hardware change: quite a lot of effort
- Reduce Q-factor: reduces operating distance



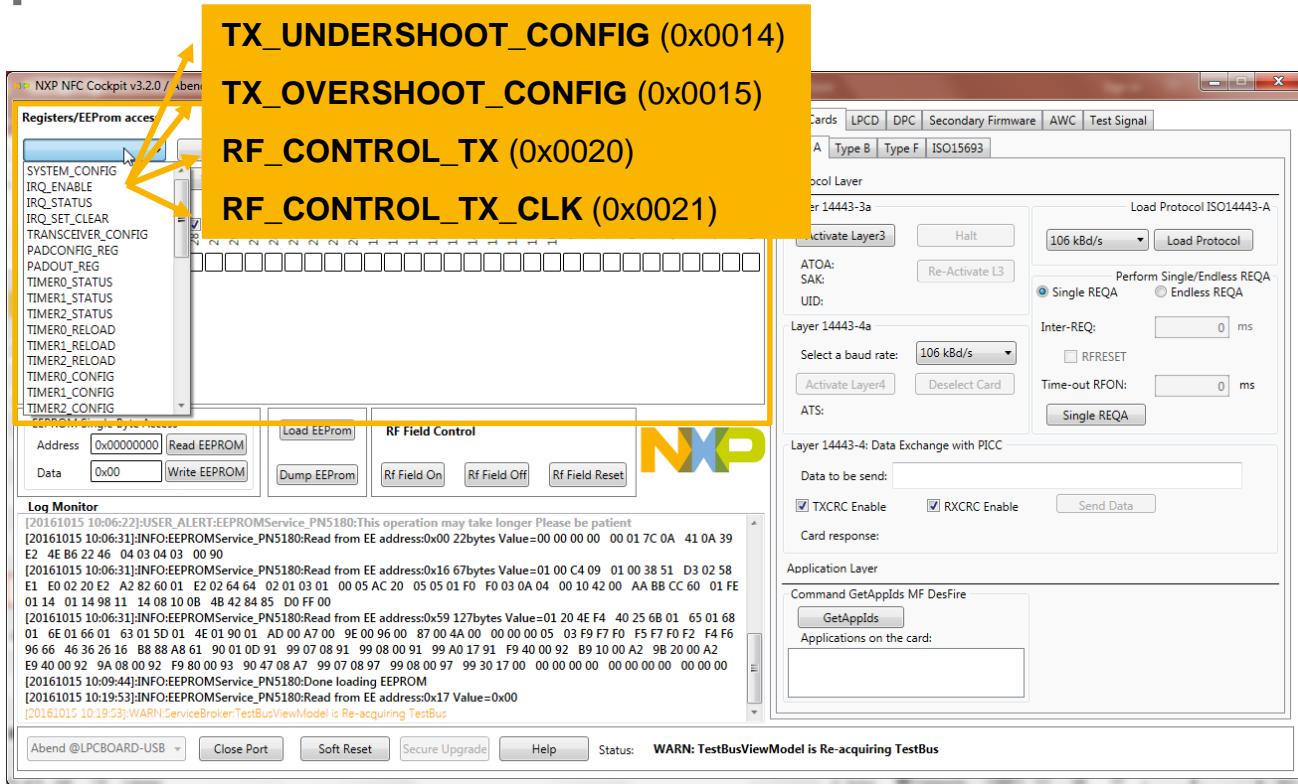
Typically the only option for standard antenna tuning.

Option 2: use Tx Shaping

- EEPROM change: low effort
- No change of antenna tuning: same operating distance

NFC Cockpit

TX shaping



NFC Cockpit

TX shaping

- **TX_UNDERSHOOT_CONFIG** (0x0014)
 - TX_UNDERSHOOT_PATTERN_LEN
 - TX_UNDERSHOOT_PROT_ENABLE
- **RF_CONTROL_TX** (0x0020)
 - TX_RESIDUAL_CARRIER
 - TX_SET_BYPASS_SC_SHAPING
 - TX_SET_TAU_MOD_FALLING
 - TX_SET_TAU_MOD_RISING
- **RF_CONTROL_TX_CLK** (0x0021)
 - TX_CLK_MODE_OVUN_PREV
 - TX_CLK_MODE_RM → for type A it is typically 001, for type B it must be 111

NFC Cockpit

TX shaping

Registers/EEProm access

TX_UNDERSHOOT_CO ▾ Read

Register address: 0x14 Write

Bit selection: Binary
00000017

Write Operation: All bits Single bit

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0

Registers/EEProm access

RF_CONTROL_TX ▾ Read

Register address: 0x20 Write

Bit selection: Binary
00DBCF43

Write Operation: All bits Single bit

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	1	1	1	0	0	1	1	1	1	0	1	0	0	0	1	1	1	1	1	0

Registers/EEProm access

RF_CONTROL_TX_CLK ▾ Read

Register address: 0x21 Write

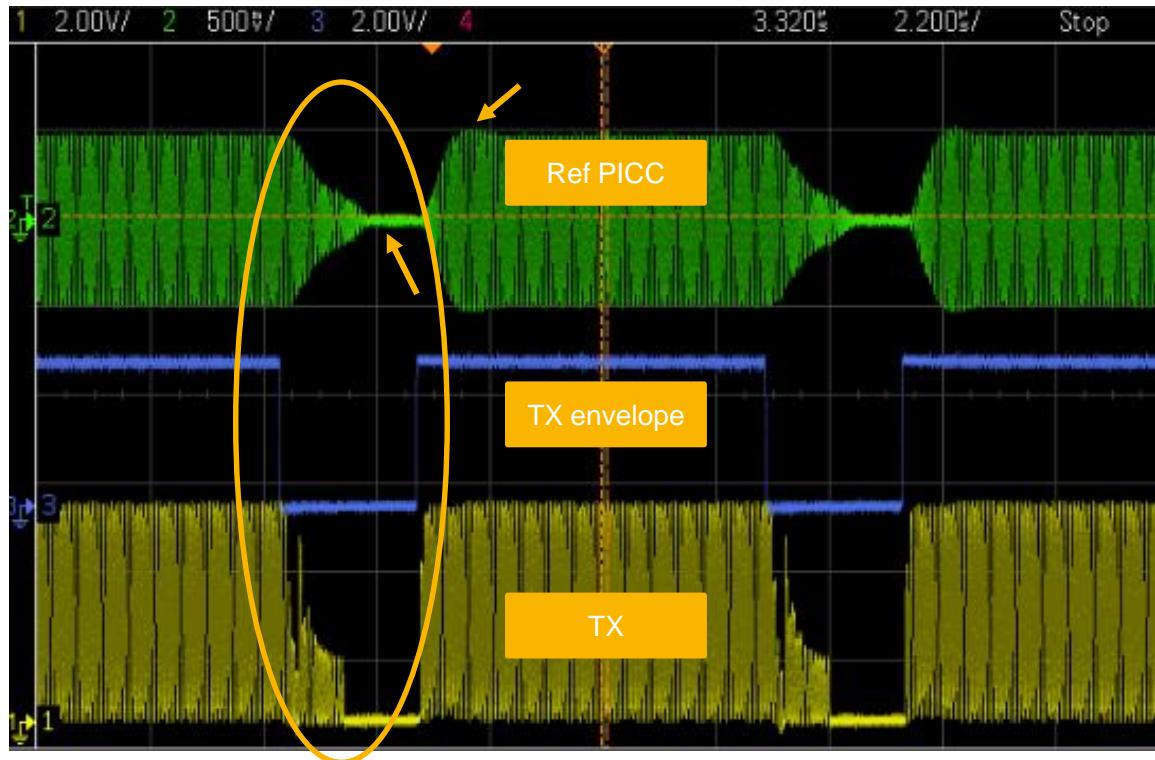
Bit selection: Binary
00000782

Write Operation: All bits Single bit

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0

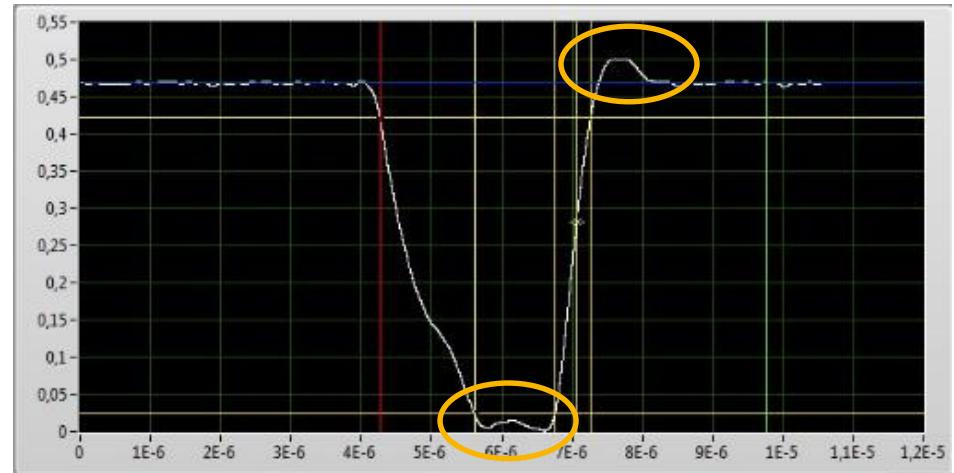
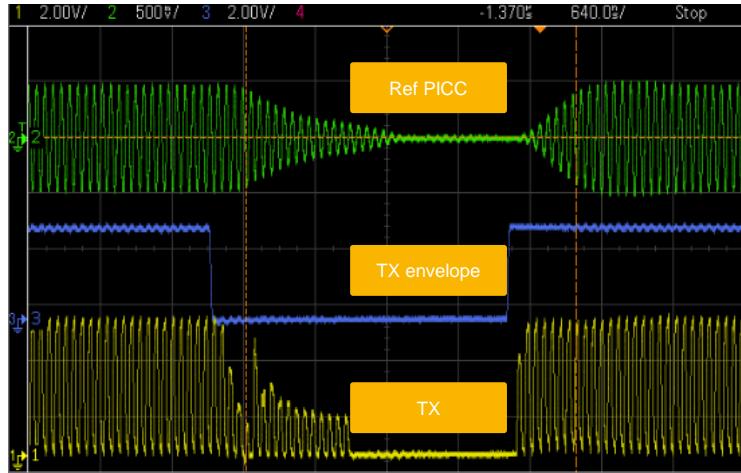
NFC Cockpit

TX shaping



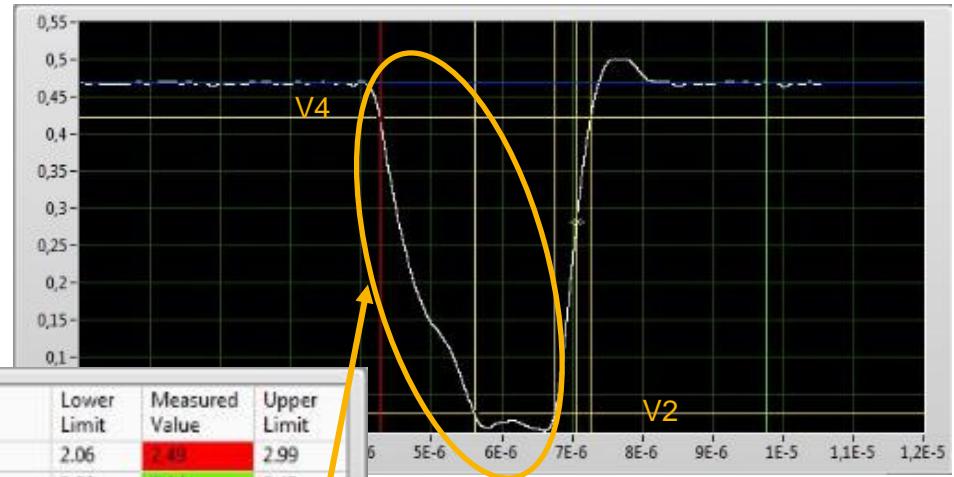
NFC Cockpit

TX shaping



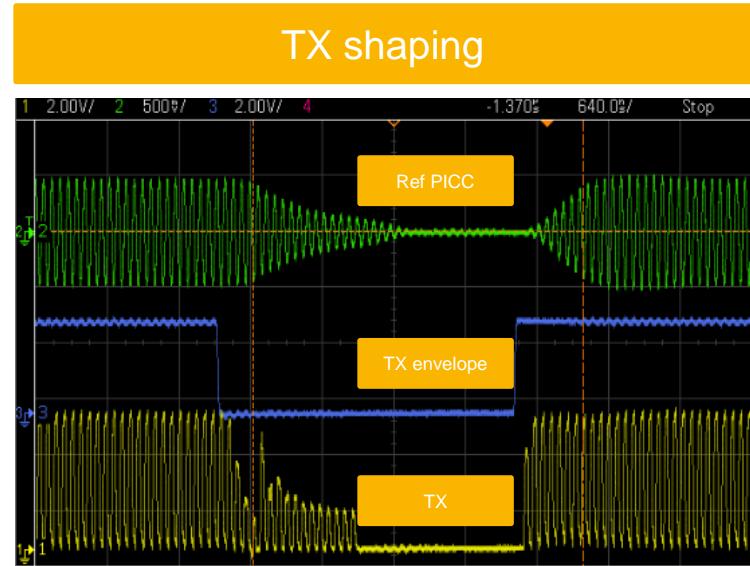
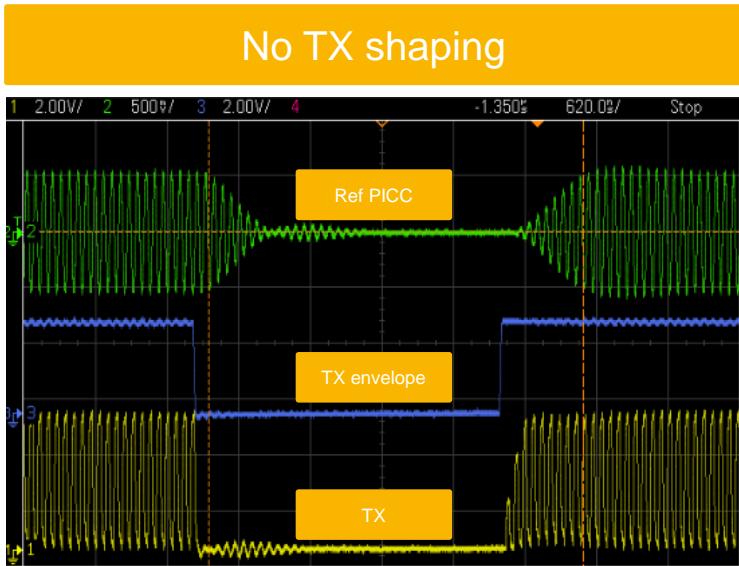
NFC Cockpit

TX shaping



NFC Cockpit

TX shaping



SUMMARIZE

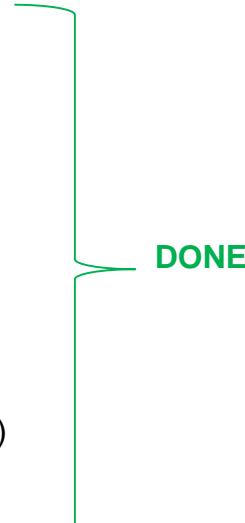


Summarize

- **DPC Configuration**

- **Prerequisites**

1. “Symmetrical” antenna tuning (to e.g. 20Ω)
2. Ensure a good correlation between AGC & ITVDD
3. Adjust RRx to achieve
 - AGC value = appr. 300dec unloaded (full NFC)
 - AGC value = appr. 600dec unloaded (pure Reader mode)
4. Ensure wave shapes are ok.



- **Define**

1. Number of gears (e.g. 5 seems to be good for standard EMVCo POS)
2. Tx settings per gear (DPC_AGC_GEAR_LUT)
3. ITVDD switch (e.g. 205mA)



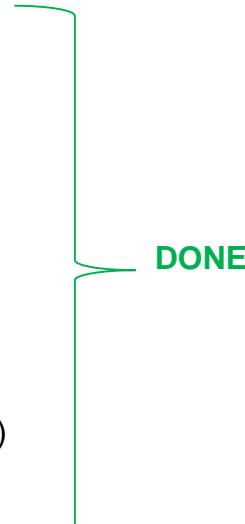
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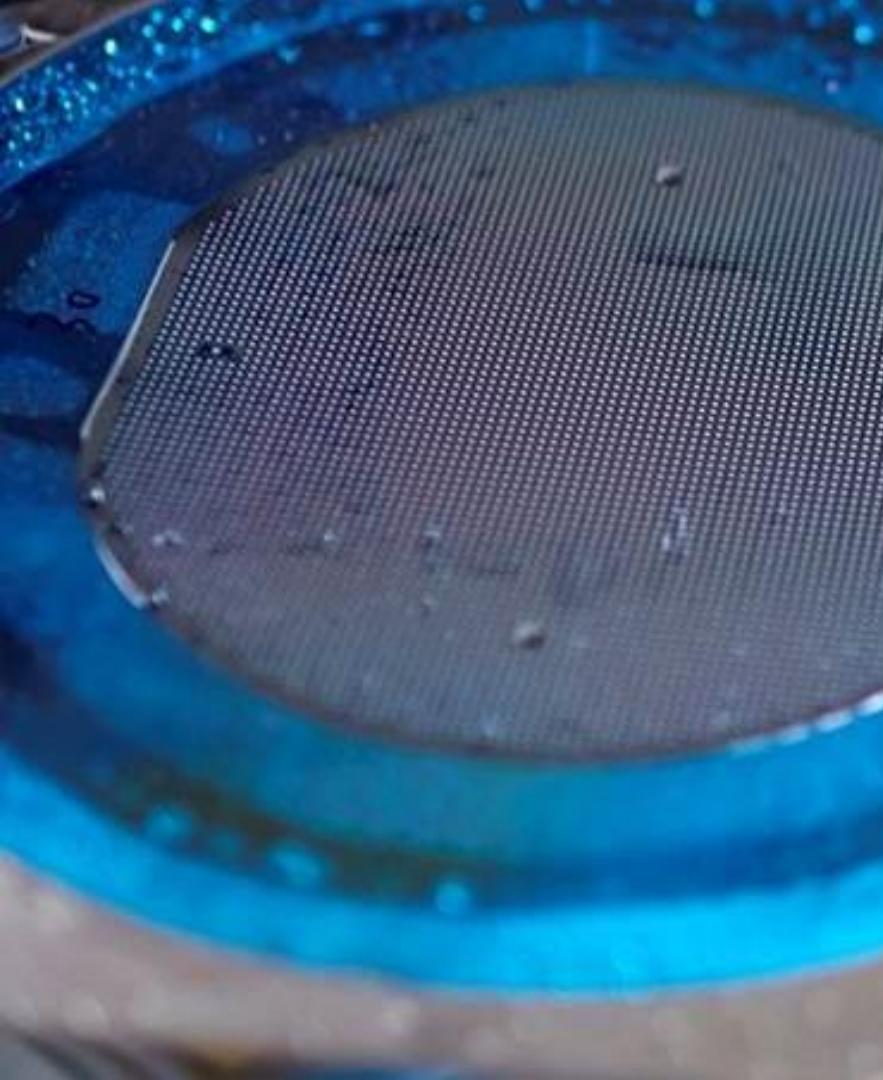


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- **TX shaping**



Coming sessions

Design and implement NFC applications

Session I, 7th September

Product support package for NXP NFC readers

<https://attendee.gotowebinar.com/rt/2329750067403618817>

Session II, 28th September

Antenna design considerations for NXP NFC reader solutions

<https://attendee.gotowebinar.com/rt/282682617345186049>

Session III, 18th October

The NFC Cockpit - the complete design tool for engineers

<https://attendee.gotowebinar.com/rt/4665515186055692545>

Session IV, 31th October

NFC Reader Library - SW support for NFC frontend solutions

<https://attendee.gotowebinar.com/rt/7151741873899128067>



Software development in Android and iOS

Embedded software for MCUs

JCOP, Java Card operating Systems

Hardware design and development

Digital, analog, sensor acquisition, power management

Wireless communications WiFi, ZigBee, Bluetooth, BLE

Contactless antenna RF design, evaluation and testing

MIFARE applications

End-to-end systems, readers and card-related designs

EMVco applications

Readers, cards, design for test compliancy (including PCI)

Secure Element management

GlobalPlatform compliant backend solutions

Secure services provisioning OTA, TSM services



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Design and implement NFC applications

Session 3: The NFC Cockpit – the complete design tool for engineers

Cristina Llabrés (Speaker)

Angela Gemio (Host)

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