Training Mobile Knowledge

PN5180 – The best full NFC frontend on the market

Product support package

Public
MobileKnowledge
January 2016

Agenda

Session 13th January: *PN5180 Introduction*

Watch recording

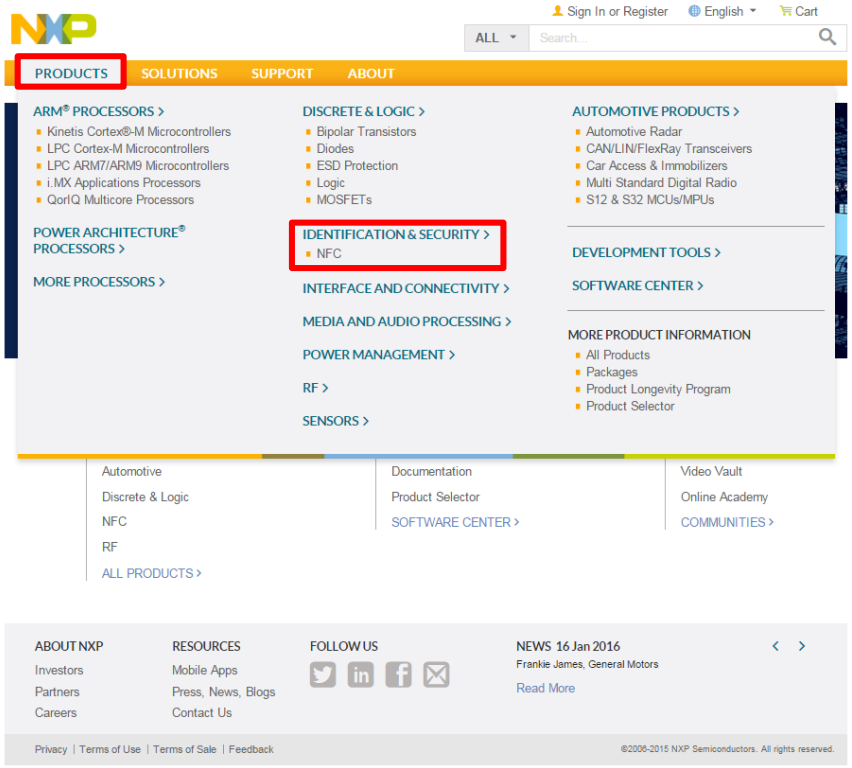
- Positioning within the NFC portfolio and overview
- Target markets and benefits
- Product description and key features, including the outstanding Dynamic Power Control
- PN5180 design tools, documentation and ordering details

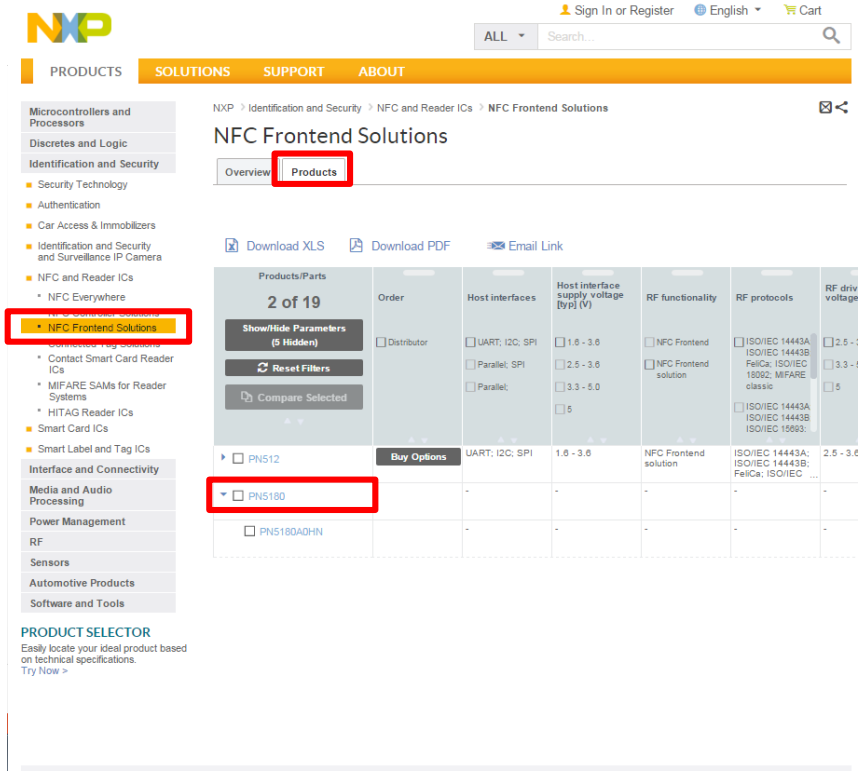
Session 27th January: *PN5180 product support package*

- Where to find PN5180 documentation
- OM25180FDK demokit, PNEV5180B and SW driver installation
- PN5180 NFC Cockpit application
- PN5180 SW development environment, NFC Reader Library and available SW examples
- Datasheet, application notes, user manuals and other tools

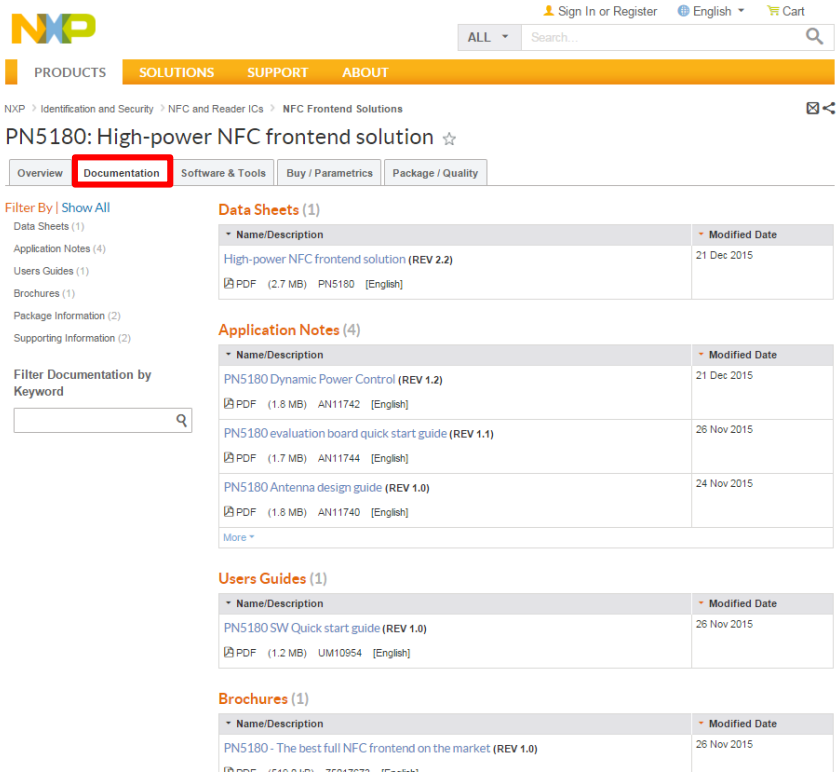
NXP Training Mobile Knowledge

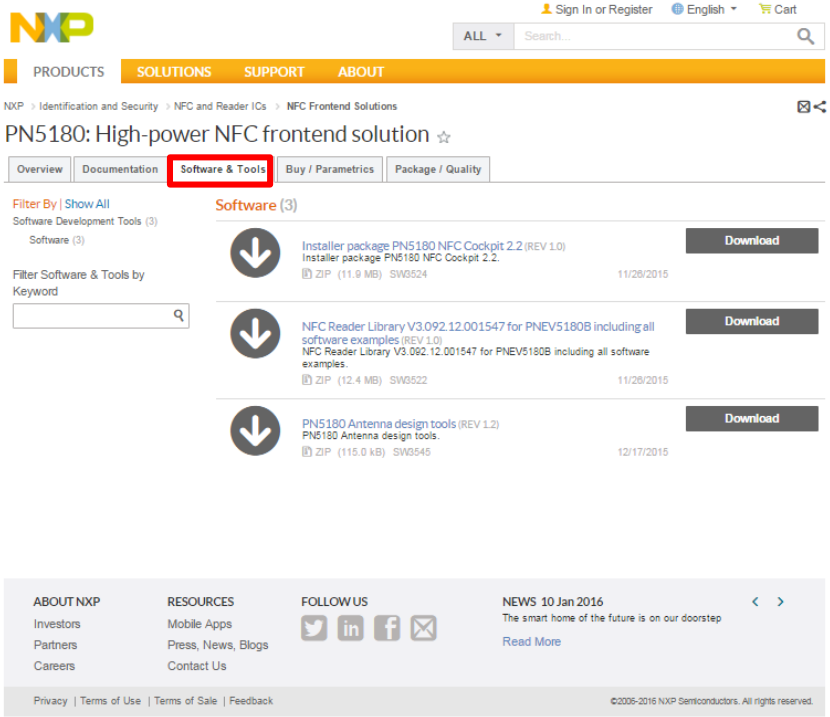
Where to find PN5180 documentation





Where to find PN5180 documentation



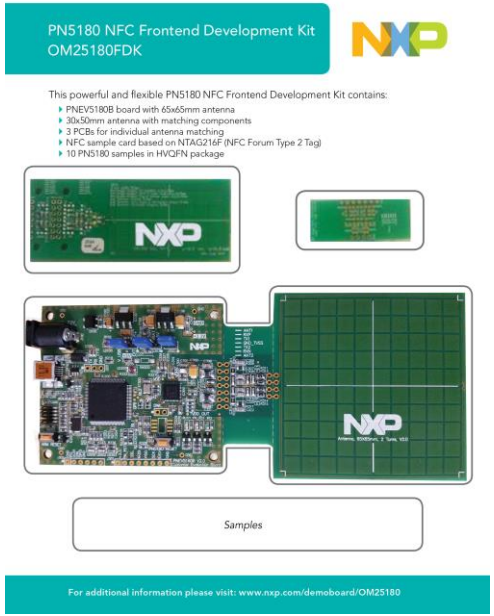


PN5180 product support package in a nutshell

Demokit	› PN5180 NFC frontend development kit OM25180FDK
NFC Cockpit	› SW3524 - Installer package PN5180 NFC Cockpit v2.2
NFC Reader Library	› SW3522 - NFC Reader Library for PNEV5180B including all SW examples
Documentation	› 75017673 - PN5180 leaflet › PN5180 - Product datasheet › AN11742 - PN5180 Dynamic Power Control › AN11744 - PN5180 evaluation board quick start guide › AN11740 - PN5180 antenna design guide › AN11741 - How to design an antenna with DPC › UM10954 - PN5180 SW quick start guide › SW3545 - PN5180 antenna design tools

PN5180 NFC frontend development kit OM25180FDK

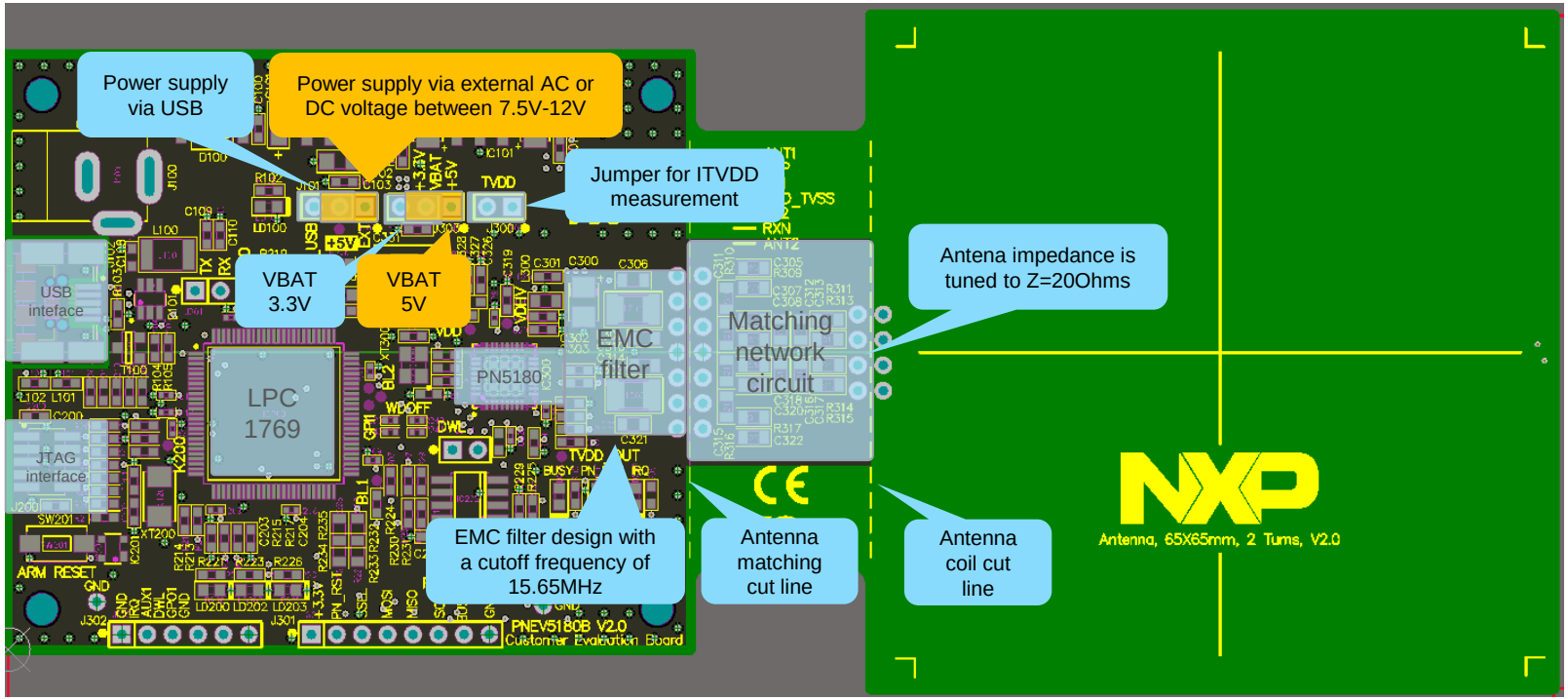
- PNEV5180B Evaluation board embeds the high-performance, full NFC Forum-compliant frontend PN5180.
- PNEV5180B can be used for SW development, hardware design, to explore PN5180 functionality and perform RF and antenna design related tests.
- PNEV5180B board with 65x65mm antenna and 30x50mm antenna with matching components.
- LPC1769 uC mounted fix on the board. SPI interface accessible for connection of other uC.
- CE/FCC certified PNEV5180B board.



Demokits at edemoboard portal and distis

Reference	12NC	Product description
OM25180FDK	935307319699	PN5180 NFC frontend development kit

PNEV5180B v2.0 hardware introduction



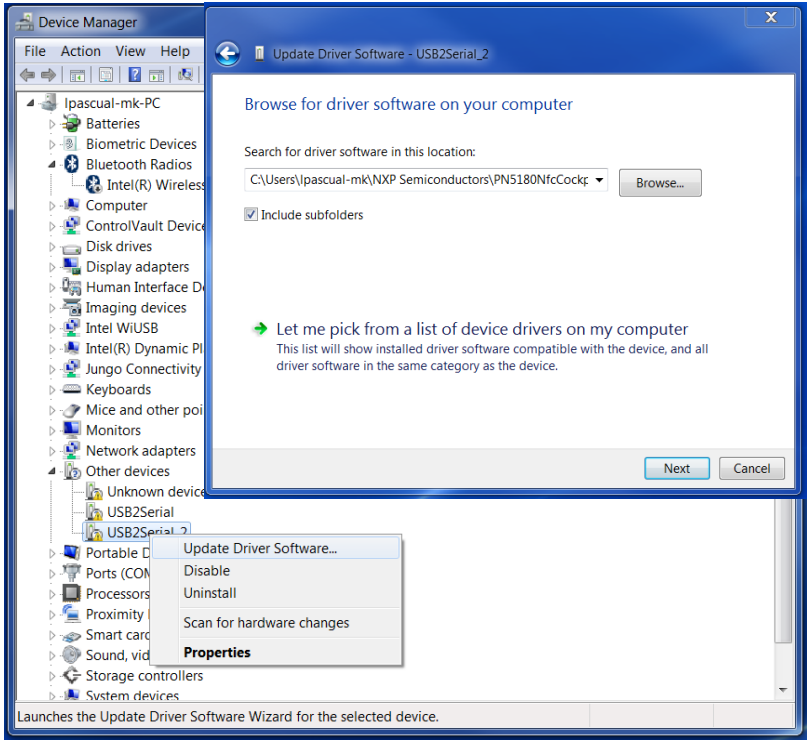
PNEV5180B Windows driver installation

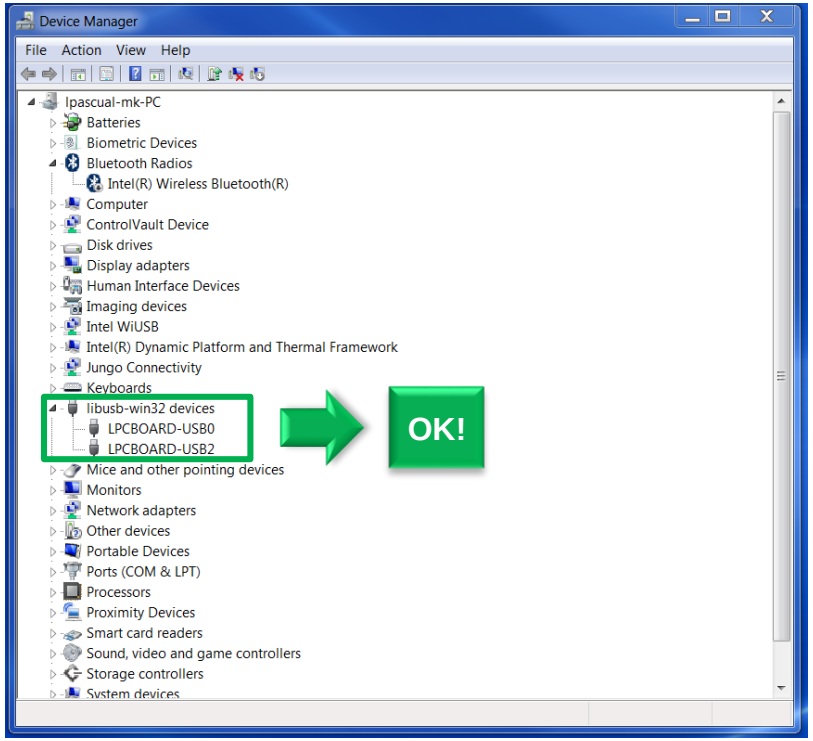
- At first connection of the PNEV5180B to the PC, the NXP LPC USB driver for Windows needs to be installed.
- The PNEV5180 is delivered with LPC FW installed (ready to use). Simply connect the PNEV5180B to a Windows PC via USB.

1. Download and run *SW3524 file*
   Installer package PN5180 NFC Cockpit v2.2
2. Manually install the Windows USB driver.
   Driver must be chosen from \LPCBOARD_DRIVER_WIN
3. Start the PN5180 NFC Cockpit.
   PNEV5180B v1.0 or higher required

PNEV5180B Windows driver installation

Step 2: Manually install the LPC USB driver for Windows.





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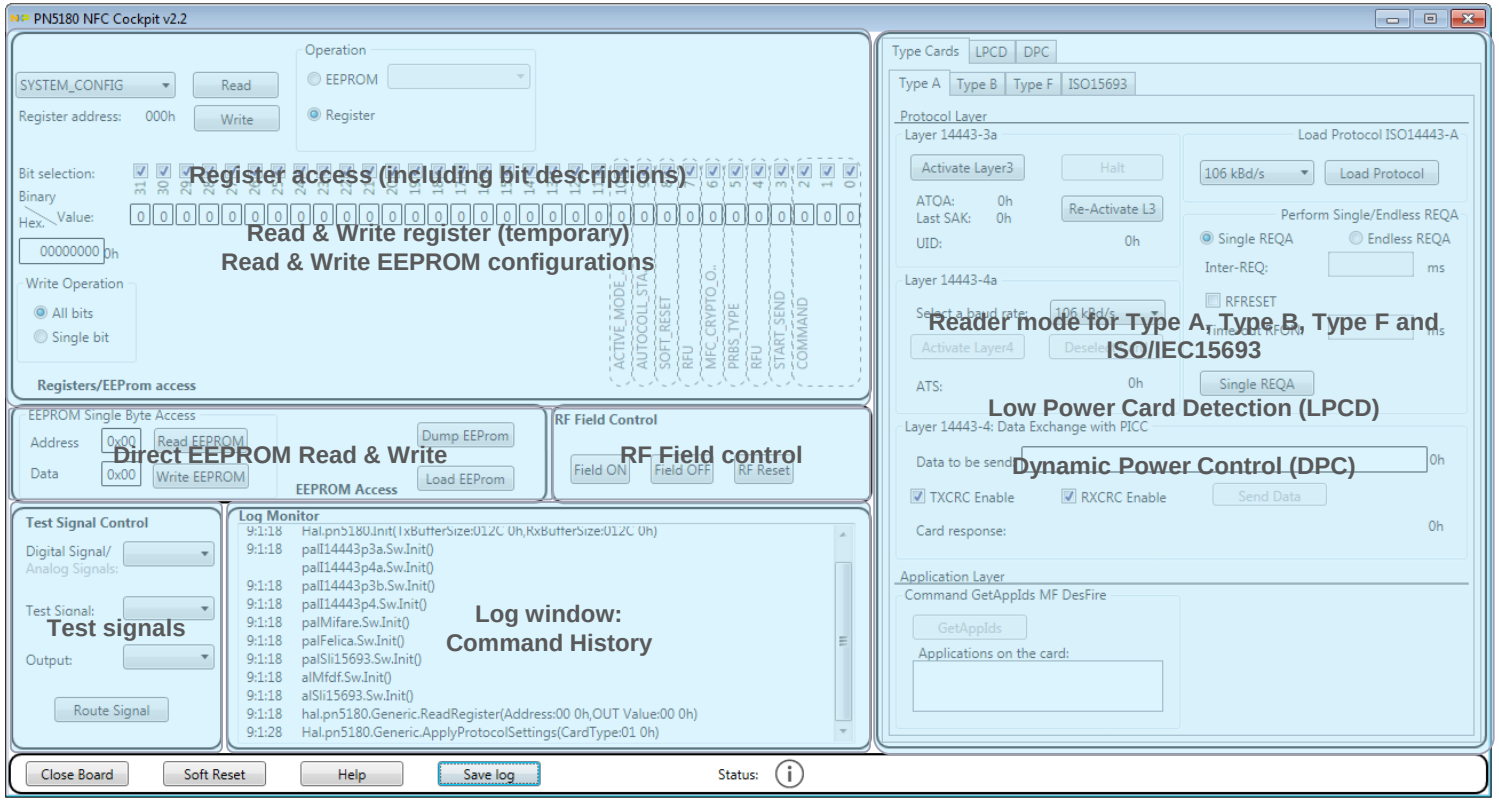
PN5180 NFC Cockpit

GUI overview

PN5180 NFC Cockpit: *The complete design tool for engineers*



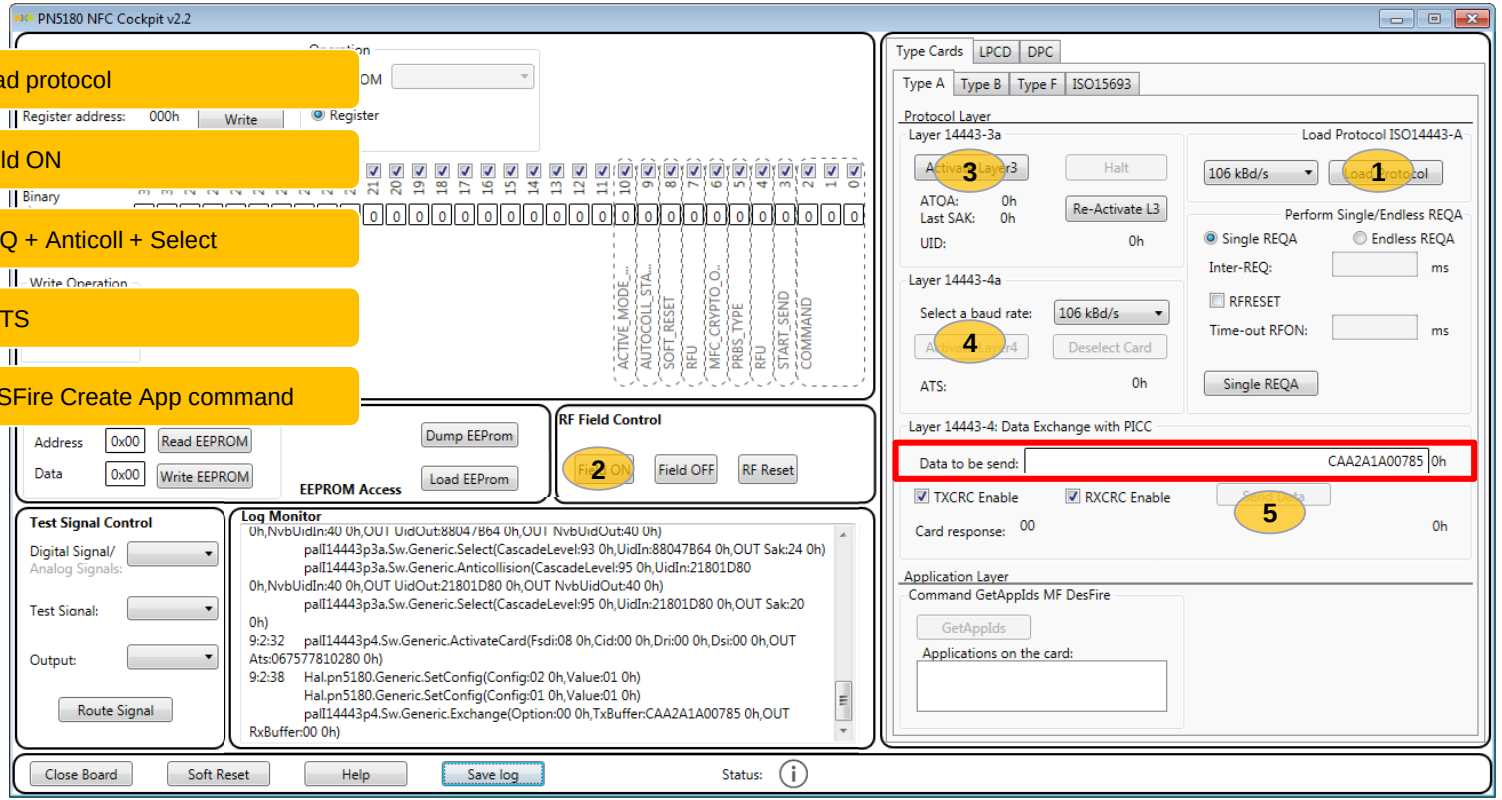
PN5180 NFC Cockpit

Used as a simple standard reader

PN5180 NFC Cockpit: *Reader mode*

"*Create application*" command to a MIFARE DESFire card

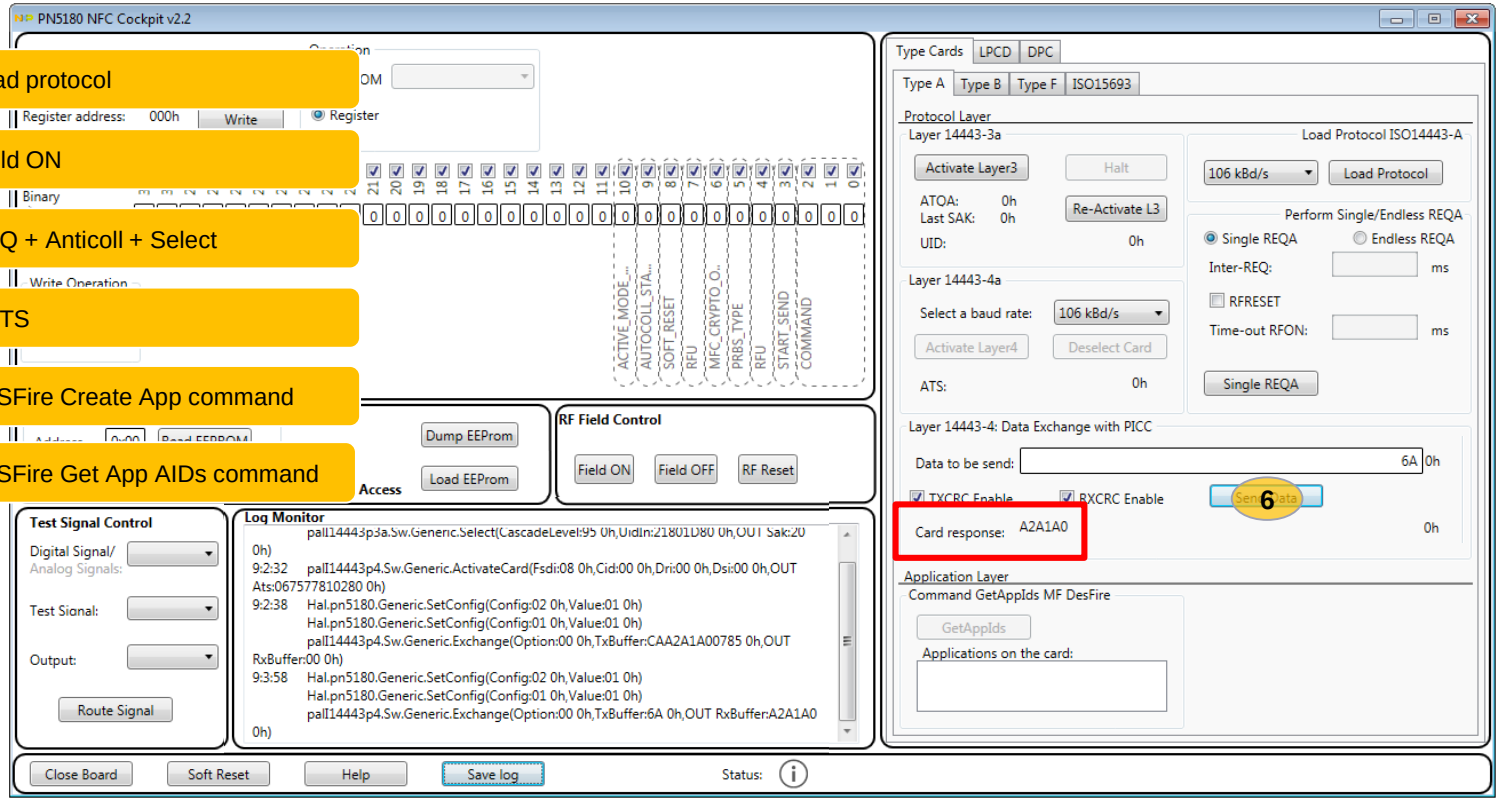
1. Load protocol
2. Field ON
3. REQ + Anticoll + Select
4. RATS
5. DESFire Create App command



PN5180 NFC Cockpit: *Reader mode*

"Get Application AIDs" command to a MIFARE DESFire card

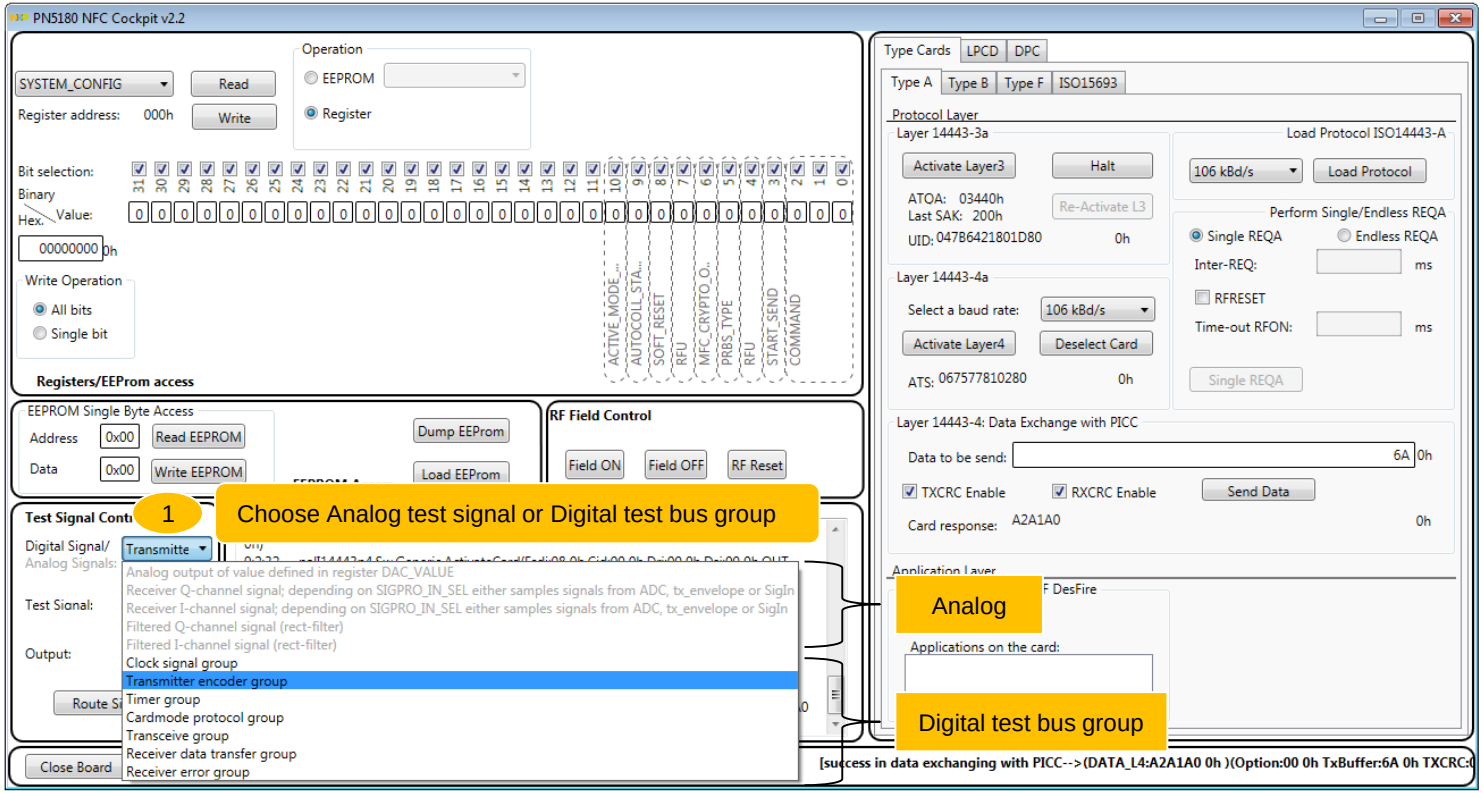
1. Load protocol
2. Field ON
3. REQ + Anticoll + Select
4. RATS
5. DESFire Create App command
6. DESFire Get App AIDs command



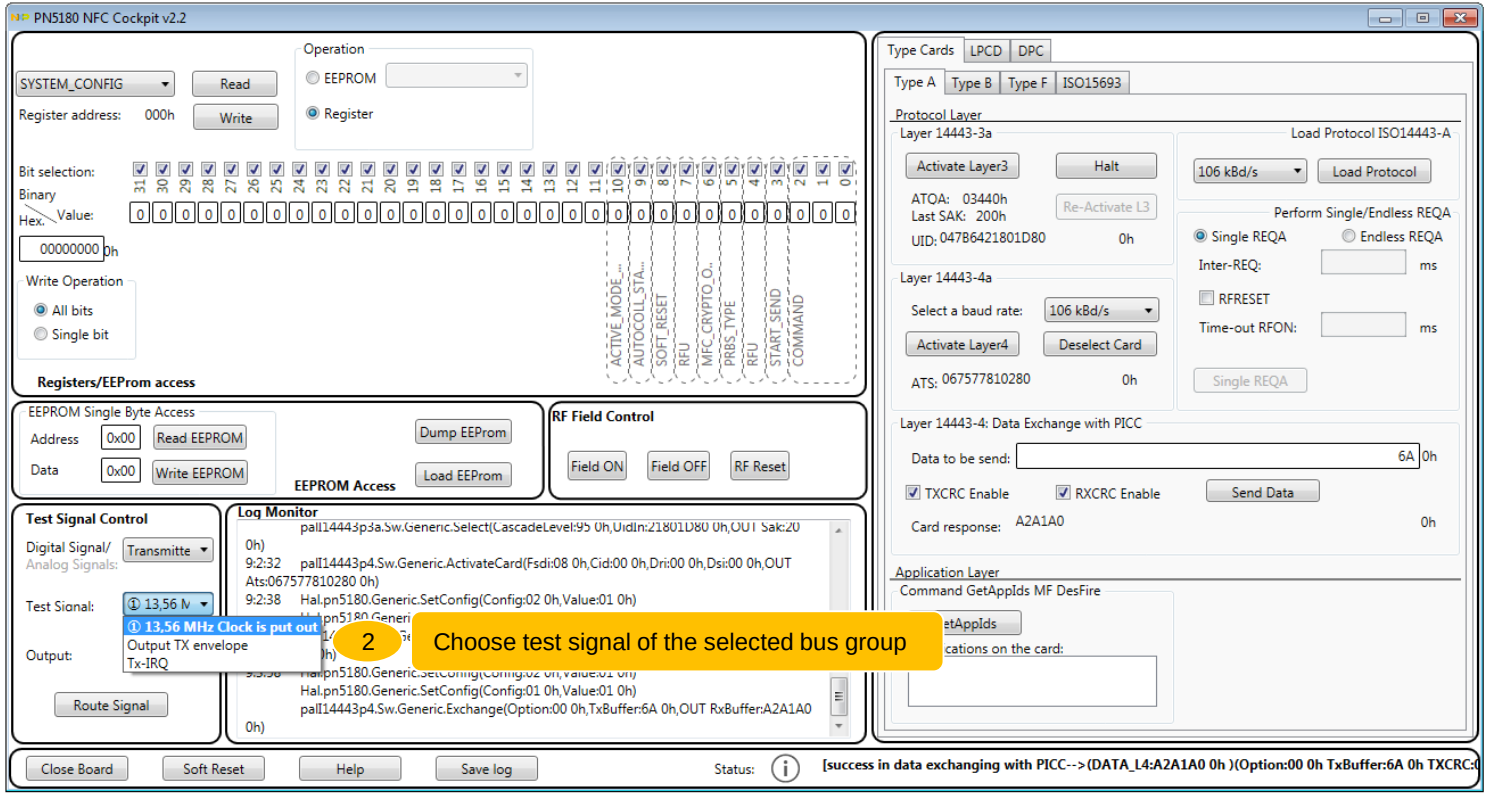
PN5180 NFC Cockpit

Analog and digital test signals

PN5180 NFC Cockpit: *Analog and digital test signals*

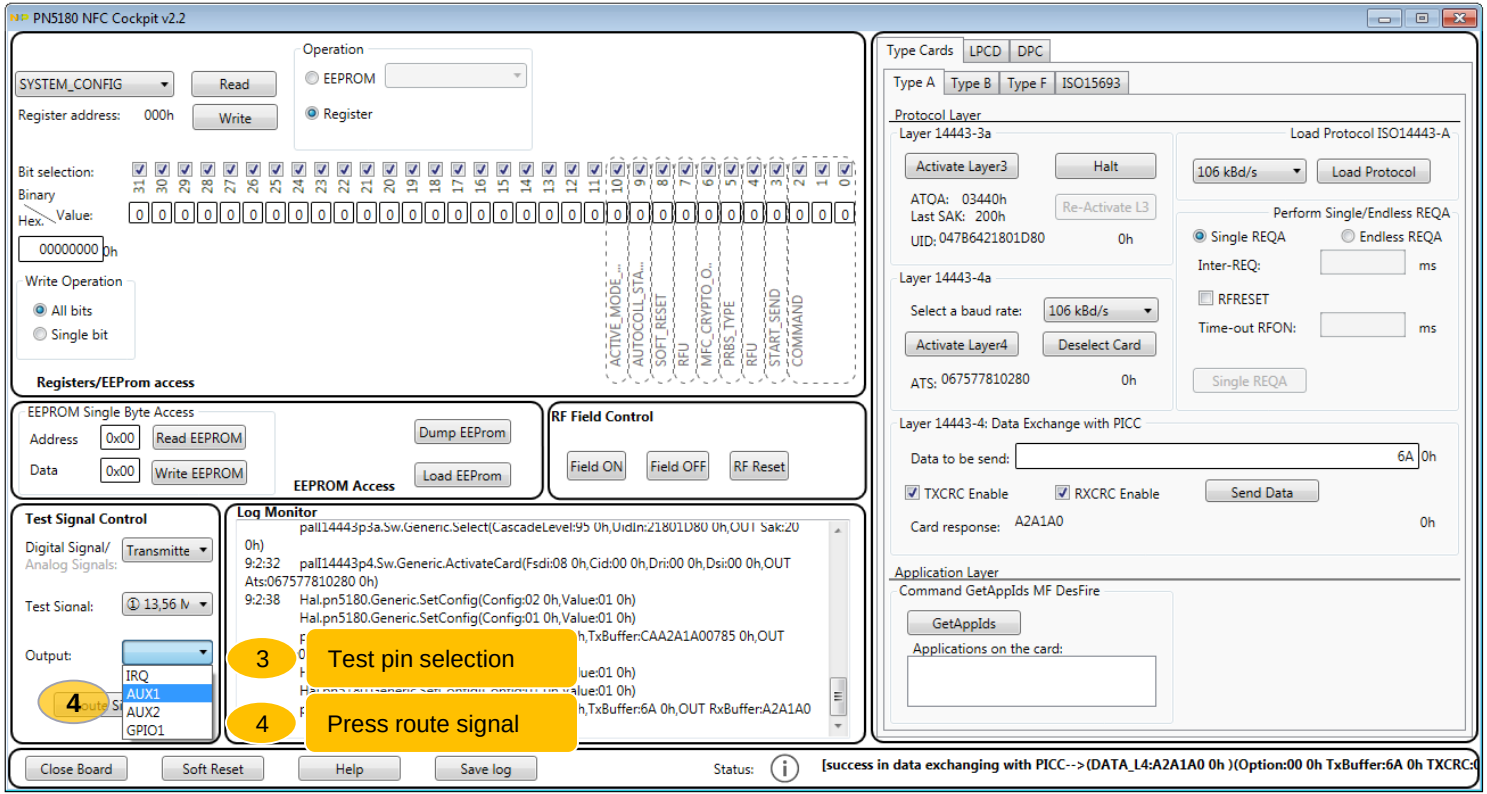


PN5180 NFC Cockpit: *Analog and digital test signals*



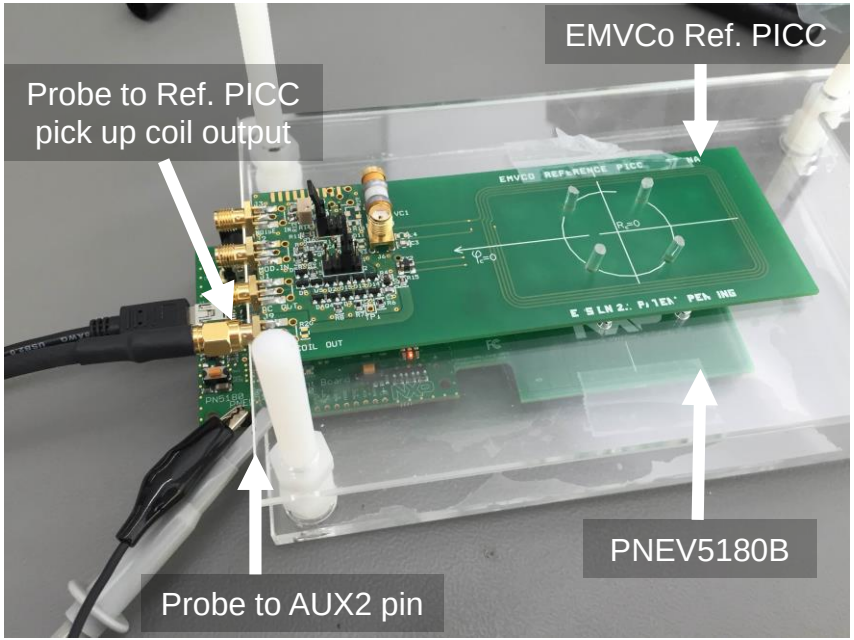
2 Choose test signal of the selected bus group

PN5180 NFC Cockpit: *Analog and digital test signals*



PN5180 NFC Cockpit: *Analog and digital test signals*

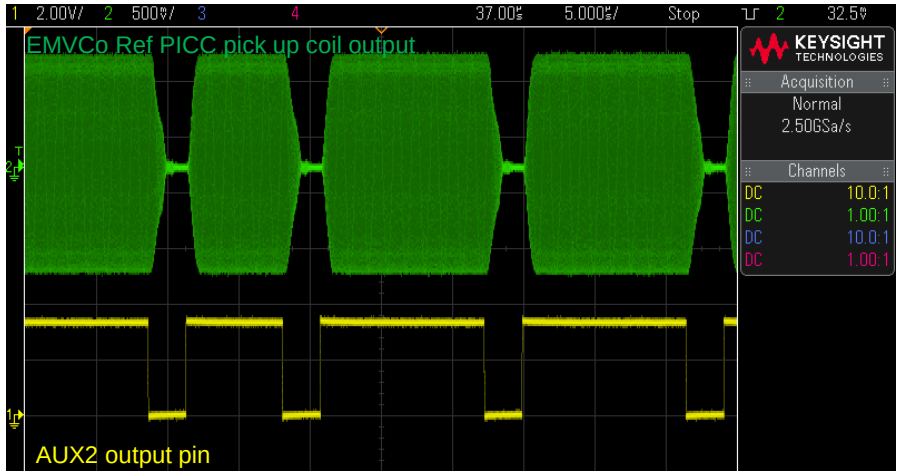
e.g. Output Tx envelope test signal



***Digital signal**: Transmitter encoder group*

***Test signal:** Output Tx envelope*

***Output**: AUX2*



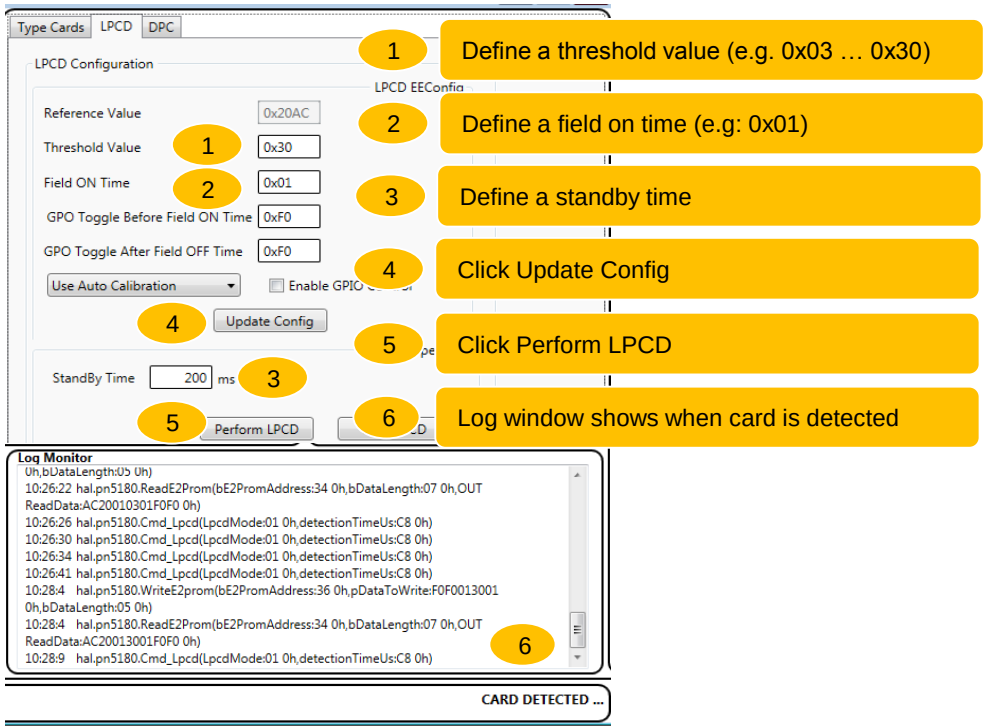
PN5180 NFC Cockpit

Low-power card detection (LPCD)

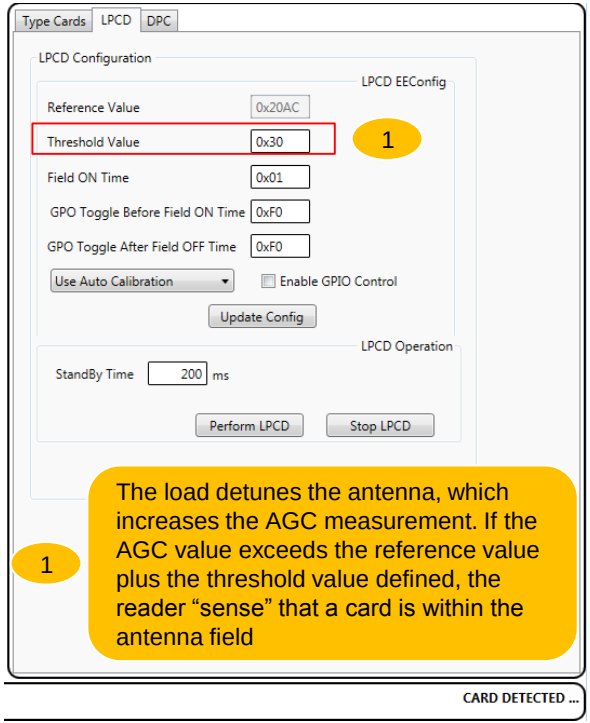
PN5180 NFC Cockpit: *Low-power card detection (LPCD)*

- The low-power card detection (LPCD) is an energy saving configuration option for the PN5180.
- The LPCD works in two phases:
  - **Standby phase**: Controlled by a wake-up counter and which timing can be defined
  - **Detection phase**: The RF field is switched on for a defined internal and the current AGC value is compared against a reference value.
    - If the current AGC value exceeds the reference value + the defined threshold → card detected
    - Otherwise, chip moves to standby phase again.

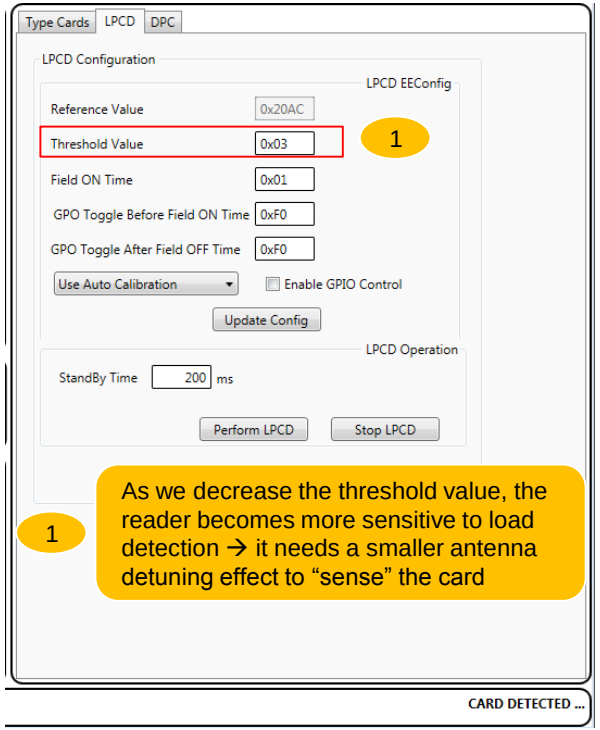
For more details about LPCD, refer to PN5180 datasheet

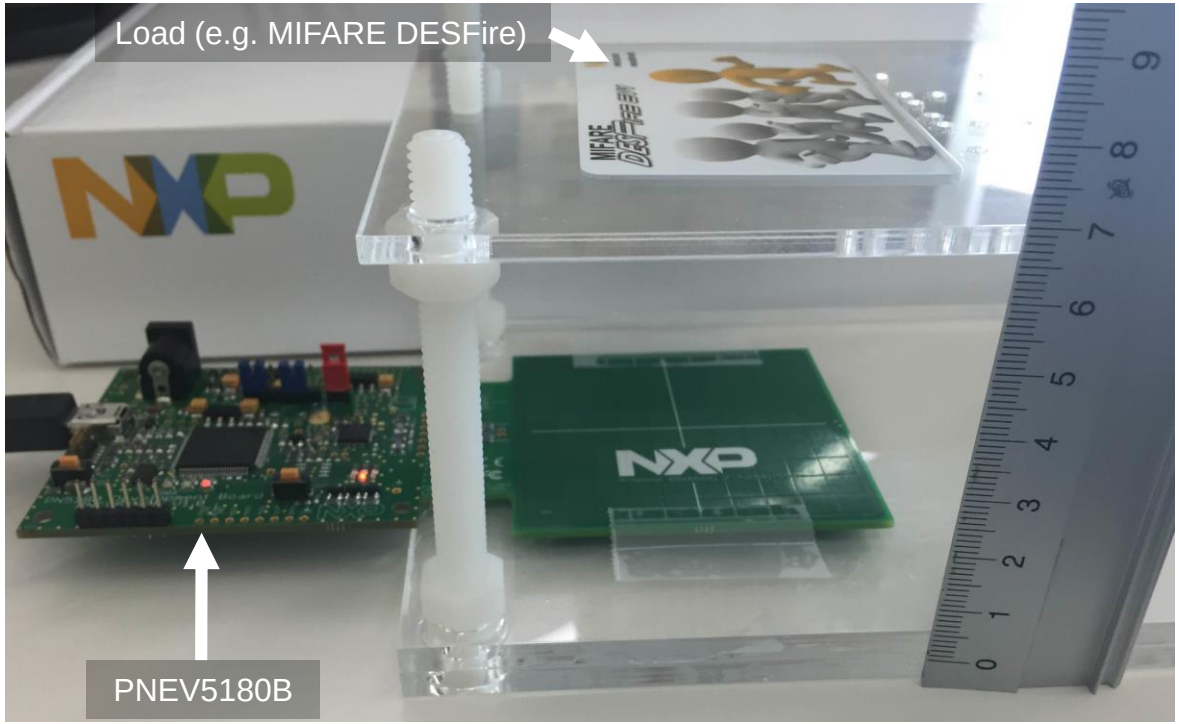


PN5180 NFC Cockpit: *Low-power card detection (LPCD)*



PN5180 NFC Cockpit: *Low-power card detection (LPCD)*





PN5180 NFC Cockpit

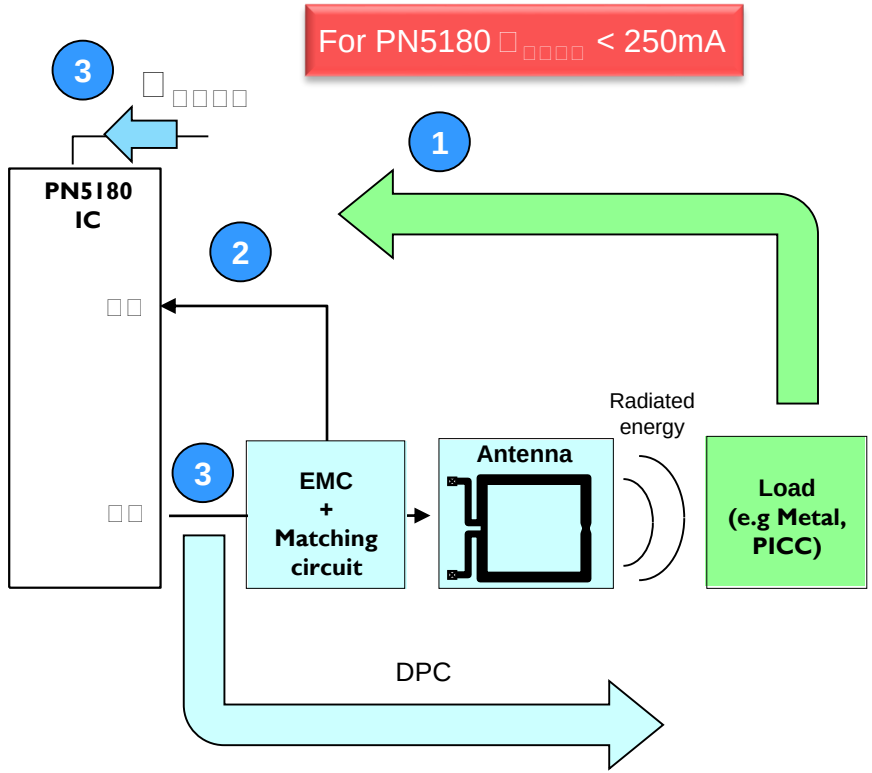
Dynamic Power Control (DPC)

How does DPC work?

“Symmetrical” antenna with DPC

1. A load change decreases the impedance, i.e. increases ITVDD and field strength
2. The DPC uses the changed Automated Gain Control (AGC) value to change TVDD settings
3. The changed TVDD settings reduce the ITVDD and power and field strength

DPC uses gears to control the Tx output power and consequently, controls current / field strength



What needs to be defined for DPC

0 **Perform correction test**
- Ensure linear relationship between AGC value and ITVDD current

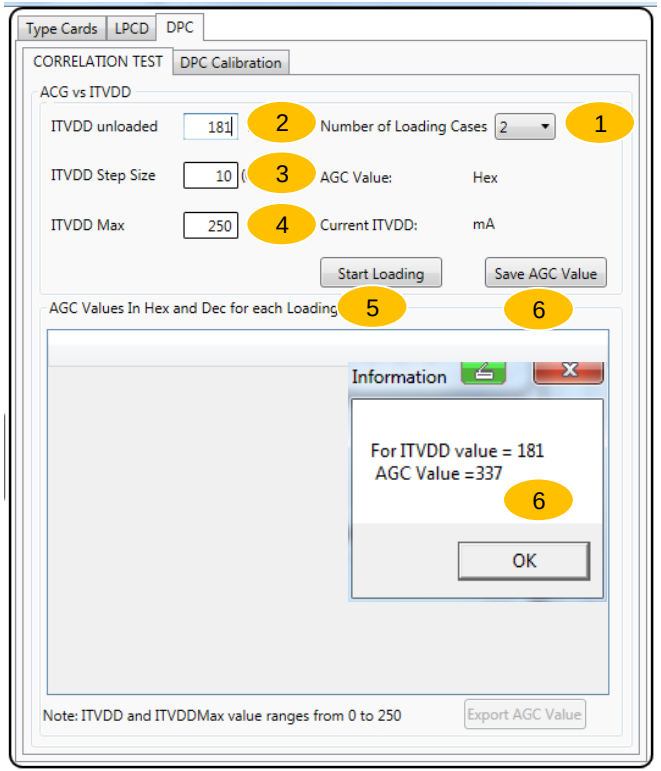
1 **Define number of gears (DPC_AGC_GEAR_LUT_SIZE)**
- Up to 15 gears can be stored (i.e. Up to 15 output powe steps can be defined)

2 **Define Tx settings per gear (DPC_AGC_GEAR_LUT)**
- It defines the output power settings per gear.

3 **Define high threshold value per gear (DPC_THRSH_HIGH)**
- It defines the maximum measured field strength per gear. The DPC switches to the next gear as soon as this threshold is achieved.

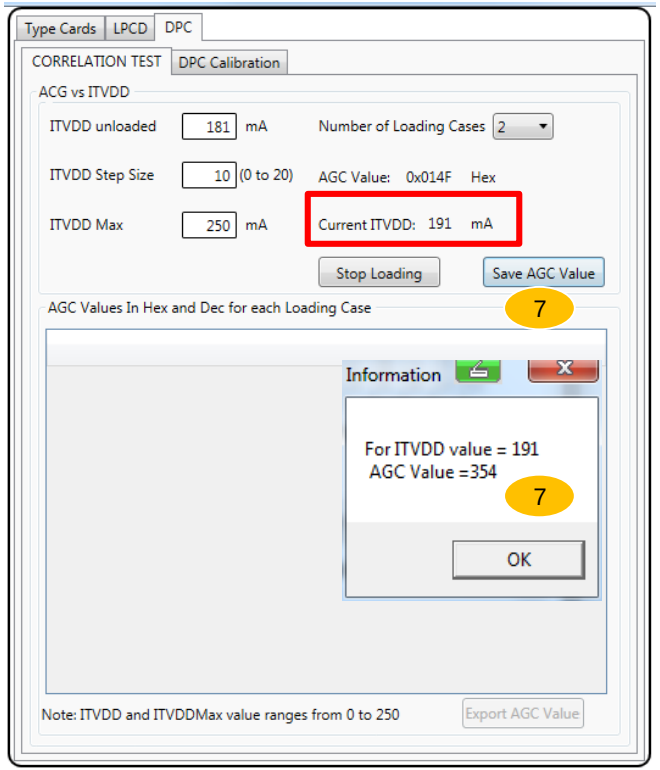
4 **Define a shift value to set the low threshold (DPC_AGC_SHIFT_VALUE)**
- For switching back from a lower to a higher output power, the field strength needs to become lower than the low threshold.

PN5180 NFC Cockpit: *Correlation test*



1. Define two loading conditions (e.g. Ref PICC and metal loading)
2. Measure and type ITVDD value in unloaded condition
3. Define ITVDD step (e.g 10mA)
4. Define maximum ITVDD (e.g 250mA)
5. Click start loading
6. Save the first measurement (ITVDD – unloaded condition)

PN5180 NFC Cockpit: *Correlation test*



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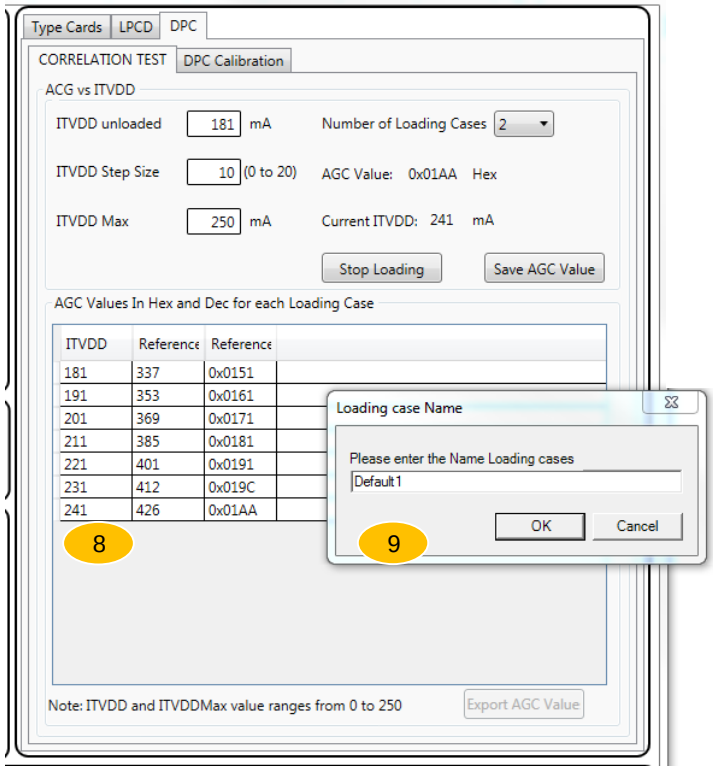
4. Define maximum ITVDD (e.g 250mA)
5. Click start loading
6. Save the first measurement (ITVDD – unloaded condition)
7. Save the second measurement when ITVDD = ITVDDunloaded + 10 mA

PN5180 NFC Cockpit: *Correlation test*



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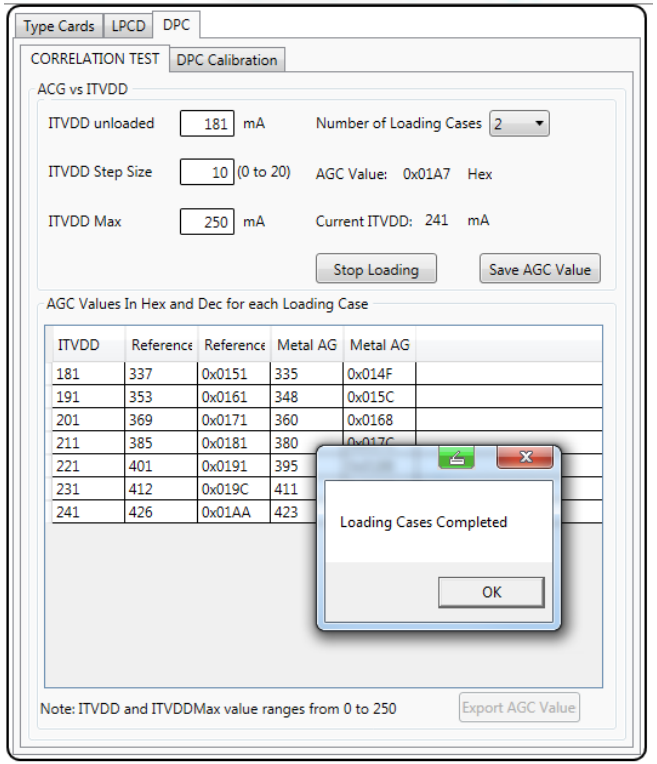
4. Define maximum ITVDD (e.g 250mA)
5. Click start loading
6. Save the first measurement (ITVDD – unloaded condition)
7. Save the second measurement when ITVDD = ITVDDunloaded + 10 mA
8. Repeat the process until ITVDD max is reached
9. Start with the second loading condition (e.g Metal loading)

PN5180 NFC Cockpit: *Correlation test*



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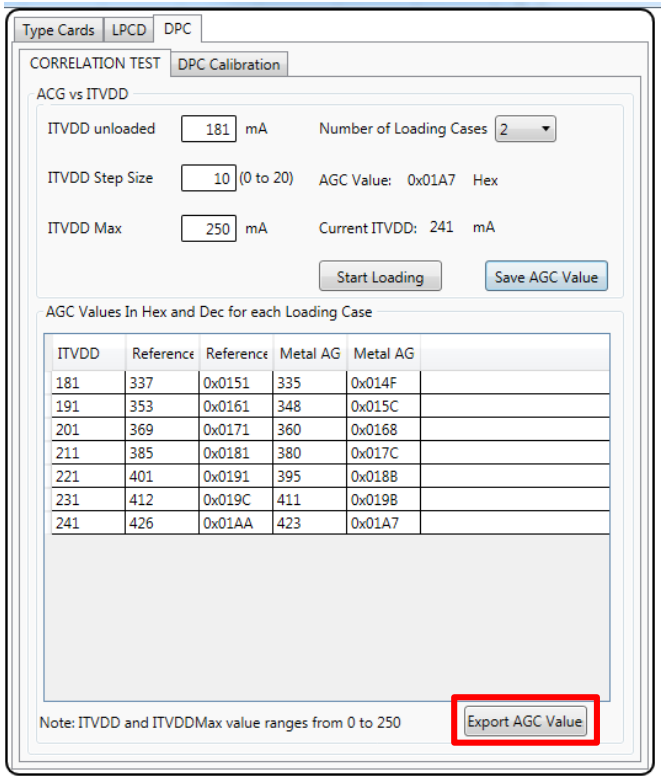
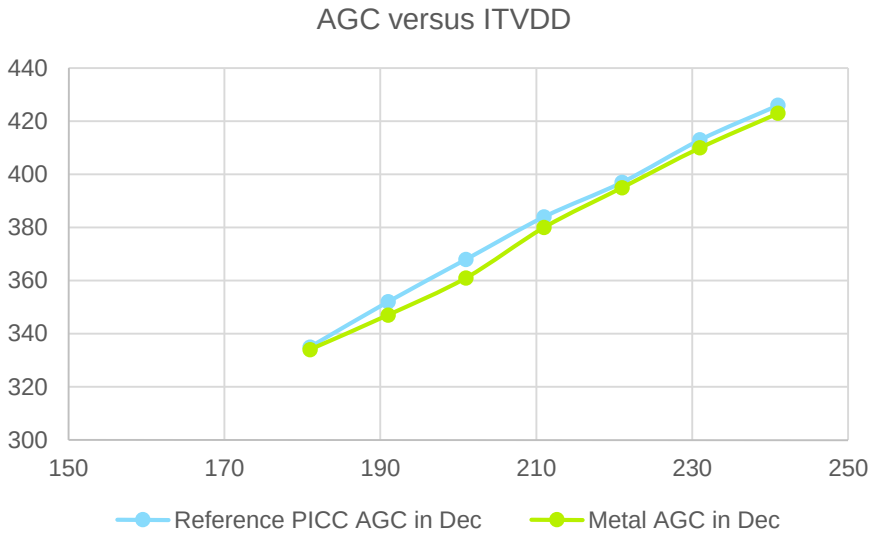
7. Save the second measurement when ITVDD = ITVDDunloaded + 10 mA
8. Repeat the process until ITVDD max is reached
9. Start with the second loading condition (e.g Metal loading)

Repeat steps 6 to 8 for second loading condition

PN5180 NFC Cockpit: *Verify ITVDD-AGC linear relationship*





Plot the results and verify it exists a linear relation between AGC and ITVDD

More info about how to perform a correlation test AN11742 Dynamic Power Control

What needs to be defined for DPC

0 **Perform correction test**
- Ensure linear relationship between AGC value and ITVDD current

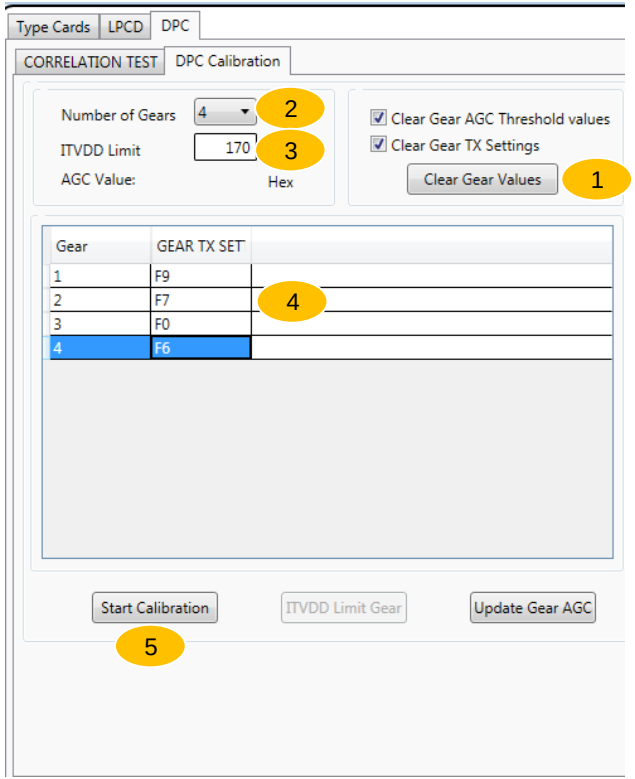
1 **Define number of gears (DPC_AGC_GEAR_LUT_SIZE)**
- Up to 15 gears can be stored (i.e. Up to 15 output powe steps can be defined)

2 **Define Tx settings per gear (DPC_AGC_GEAR_LUT)**
- It defines the output power settings per gear.

3 **Define high threshold value per gear (DPC_THRSH_HIGH)**
- It defines the maximum measured field strength per gear. The DPC switches to the next gear as soon as this threshold is achieved.

4 **Define a shift value to set the low threshold (DPC_AGC_SHIFT_VALUE)**
- For switching back from a lower to a higher output power, the field strength needs to become lower than the low threshold.

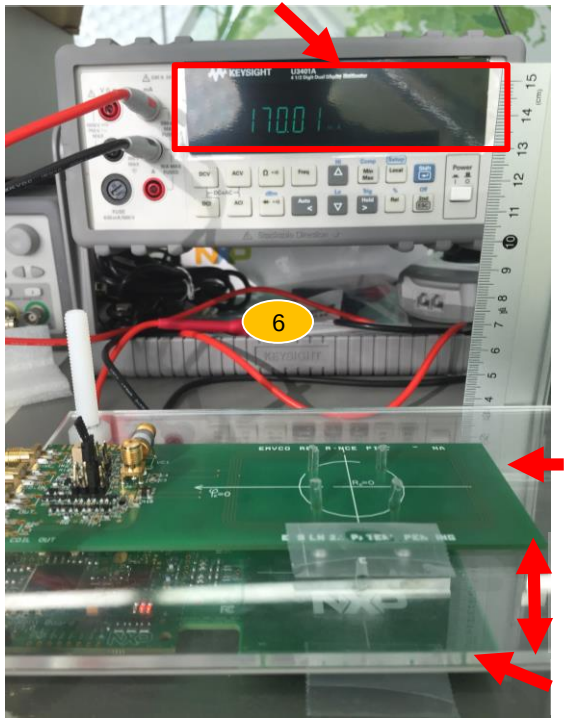
PN5180 NFC Cockpit: *DPC calibration*



1. Clean DPC part of the EEPROM
2. Choose number of gears
3. Choose ITVDD switch value, which then makes the DPC switch to the next gear
4. Enter the Tx setting per Gear. Each Gear TX SET correspondts to a voltage level at TVDD
5. Click start calibration

PN5180 NFC Cockpit: *DPC calibration setup*

Ampermeter connected to the ITVDD jumper



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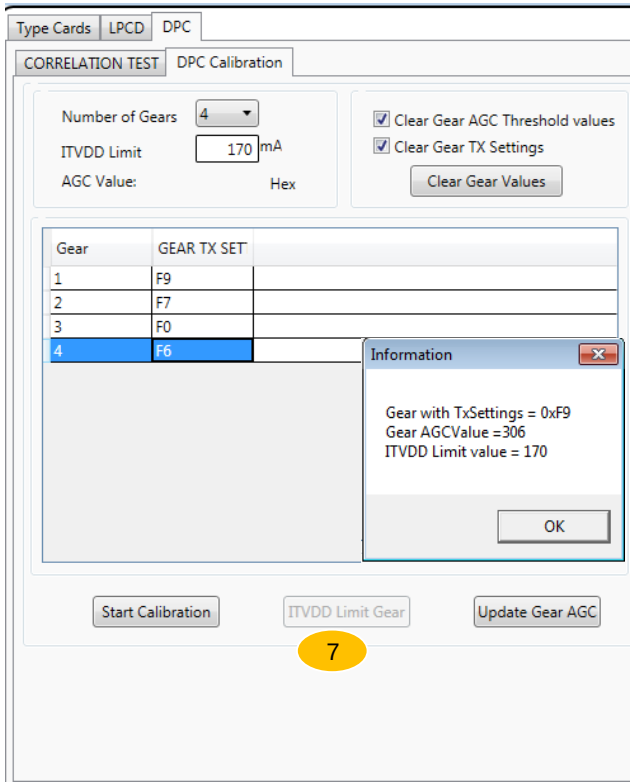
2. Choose number of gears
3. Choose ITVDD switch value, which then makes the DPC switch to the next gear
4. Enter the Tx setting per Gear. Each Gear TX SET correspondts to a voltage level at TVDD
5. Click start calibration
6. Change load until the ITVDD reach the limit (e.g. 170mA)

PN5180 NFC Cockpit: *DPC calibration*



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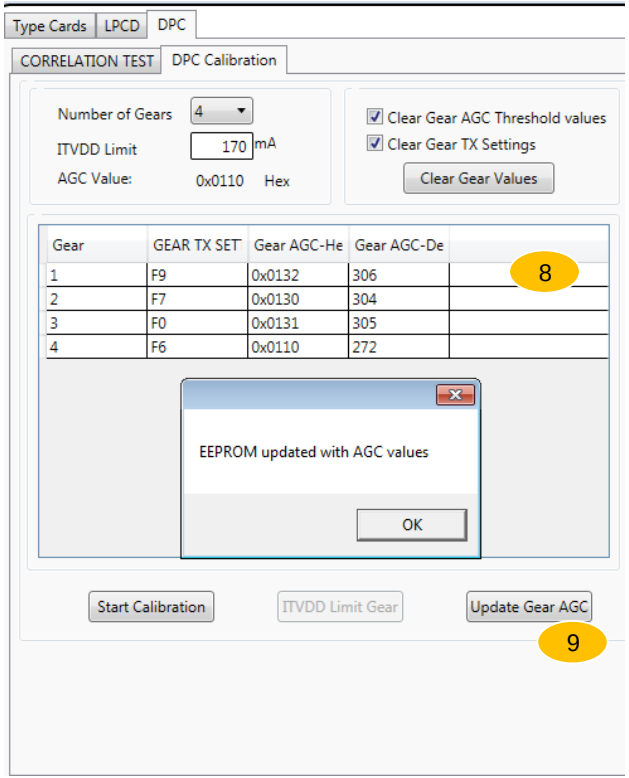
3. Choose ITVDD switch value, which then makes the DPC switch to the next gear
4. Enter the Tx setting per Gear. Each Gear TX SET correspondts to a voltage level at TVDD
5. Click start calibration
6. Change load until the ITVDD reach the limit (e.g. 170mA)
7. Click ITVDD Limit Gear and take AGC threshold value

PN5180 NFC Cockpit: *DPC calibration*



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2. Choose number of gears
3. Choose ITVDD switch value, which then makes the DPC switch to the next gear
4. Enter the Tx setting per Gear. Each Gear TX SET correspondts to a voltage level at TVDD
5. Click start calibration
6. Change load until the ITVDD reach the limit (e.g. 170mA)
7. Click ITVDD Limit Gear and take AGC threshold value
8. Repeat the process for all Gears until the table is completed
9. Click Update Gear AGC

PN5180 NFC Cockpit: *DPC calibration in action*

After successful DPC calibration, the PN5180 **automatically** switches the Gear (Tx power setting) when ITVDD hits the configured limit (e.g. 170mA)

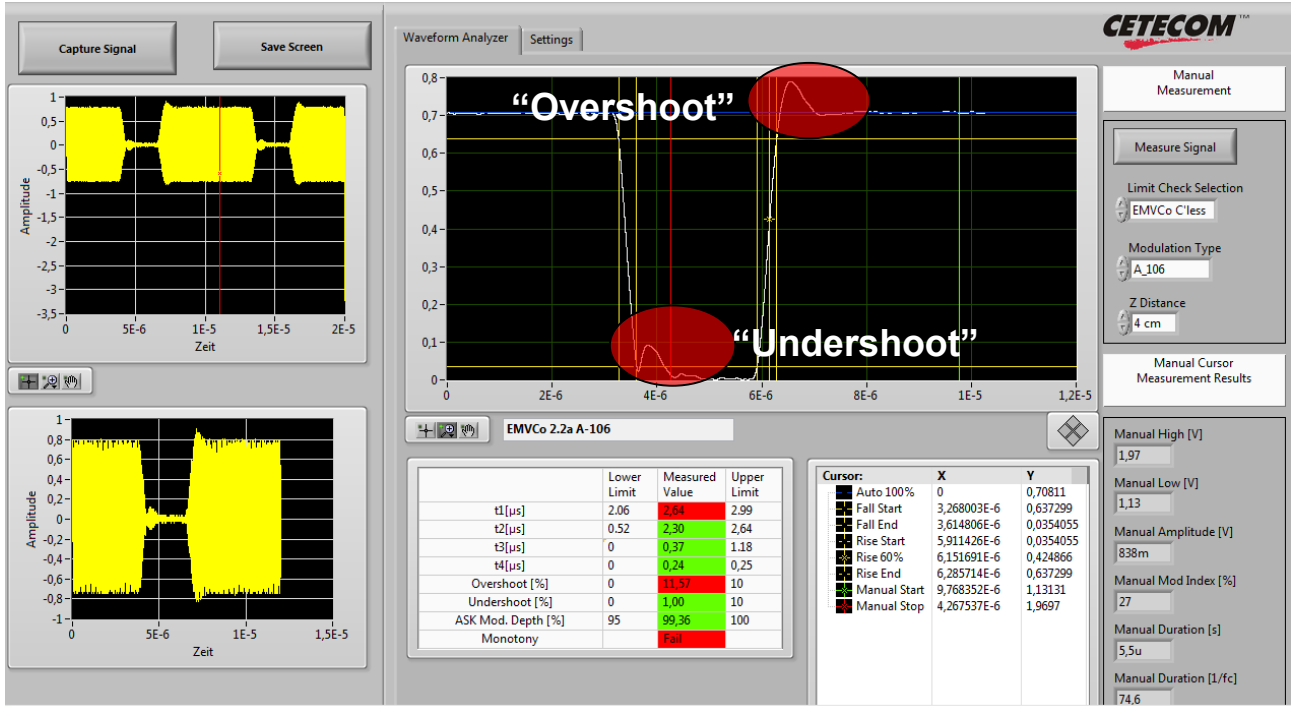
More info about how to perform a DPC calibration in AN11742 Dynamic Power Control

PN5180 NFC Cockpit

DPC Tx shaping

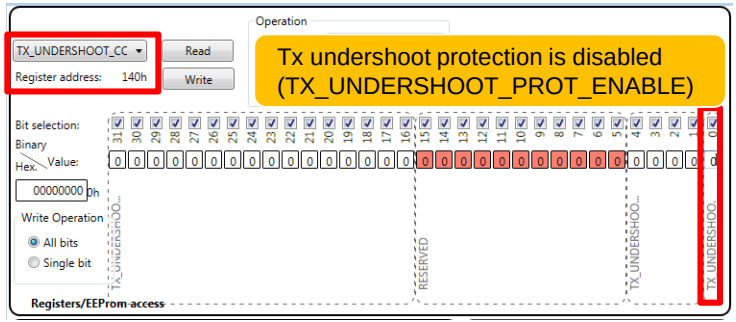
Why do we need DPC Tx shaping?

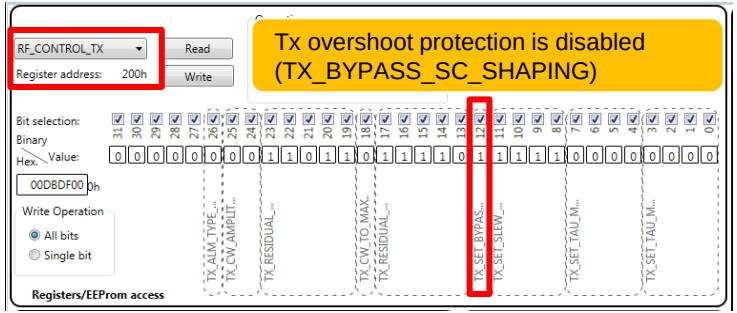
- **OPTION 1: Change antenna tuning**
  - HW change: time consuming
  - Reduce Q-factor: decreases operating distance
- **OPTION 2: Use DPC Tx shaping**
  - EEPROM change: Low effort
  - No change of antenna tuning: same operating distance

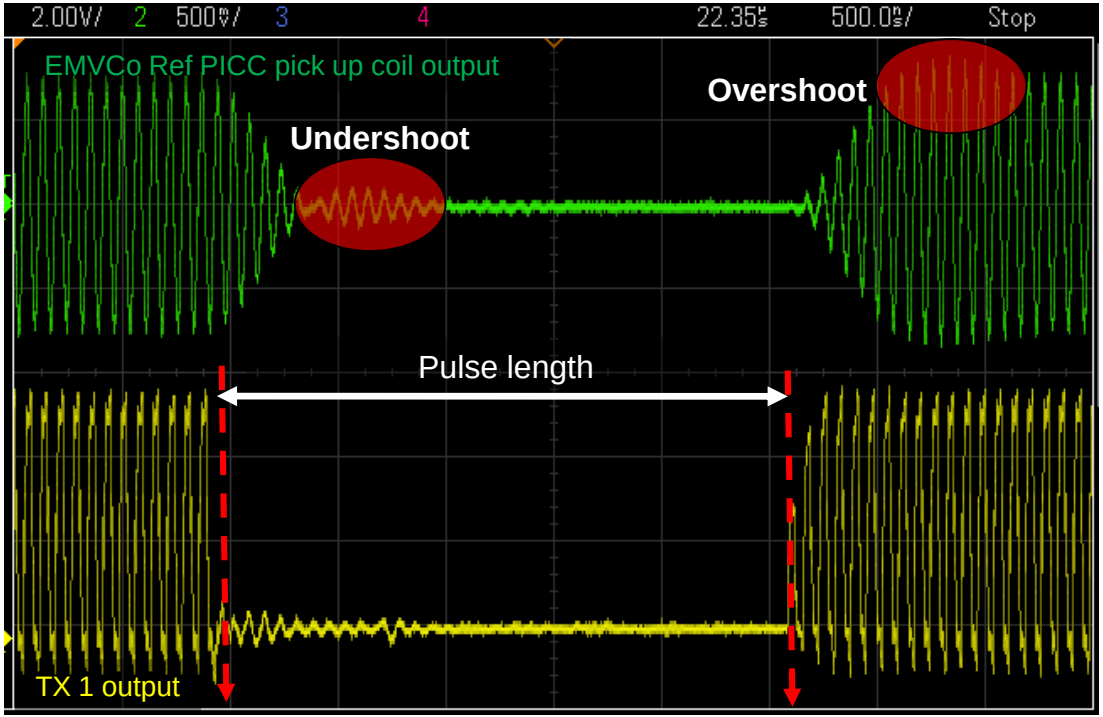


PN5180 NFC Cockpit: *DPC Tx shaping for a standard Type A pulse*

Without DPC Tx shaping applied

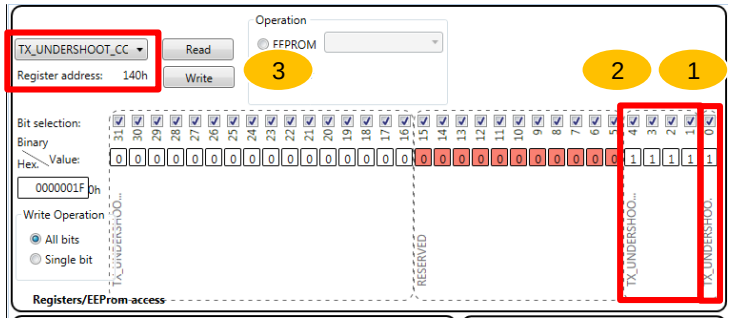




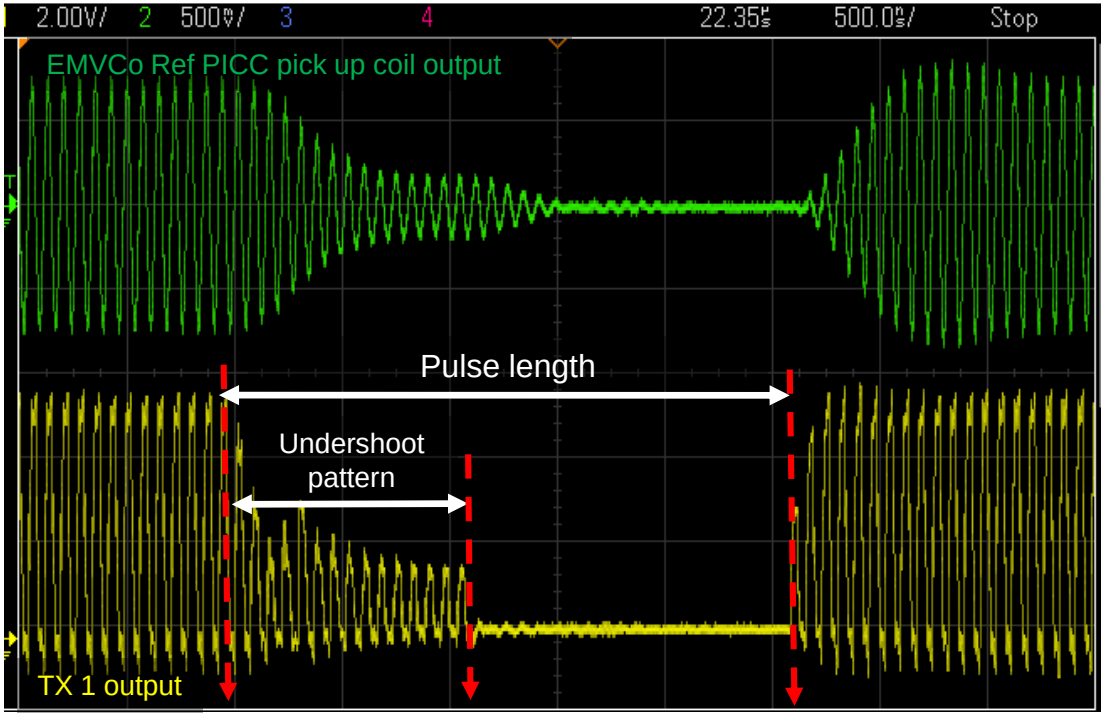


PN5180 NFC Cockpit: *DPC Tx shaping for a standard Type A pulse*

DPC Tx undershoot shaping pattern applied

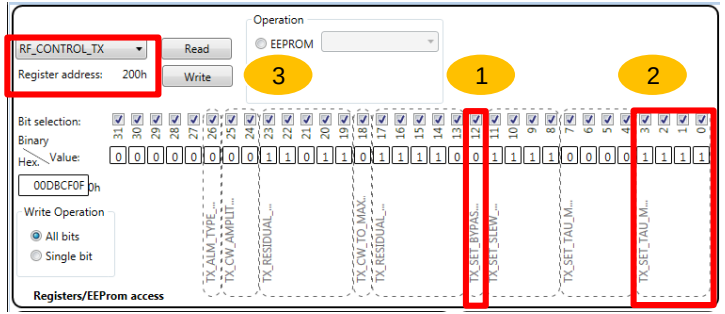


1. Enable Tx undershoot protection (TX_UNDERSHOOT_PROT_ENABLE)
2. Define Tx undershoot pattern length (0x00 … 0x0F)
3. Write new register configuration

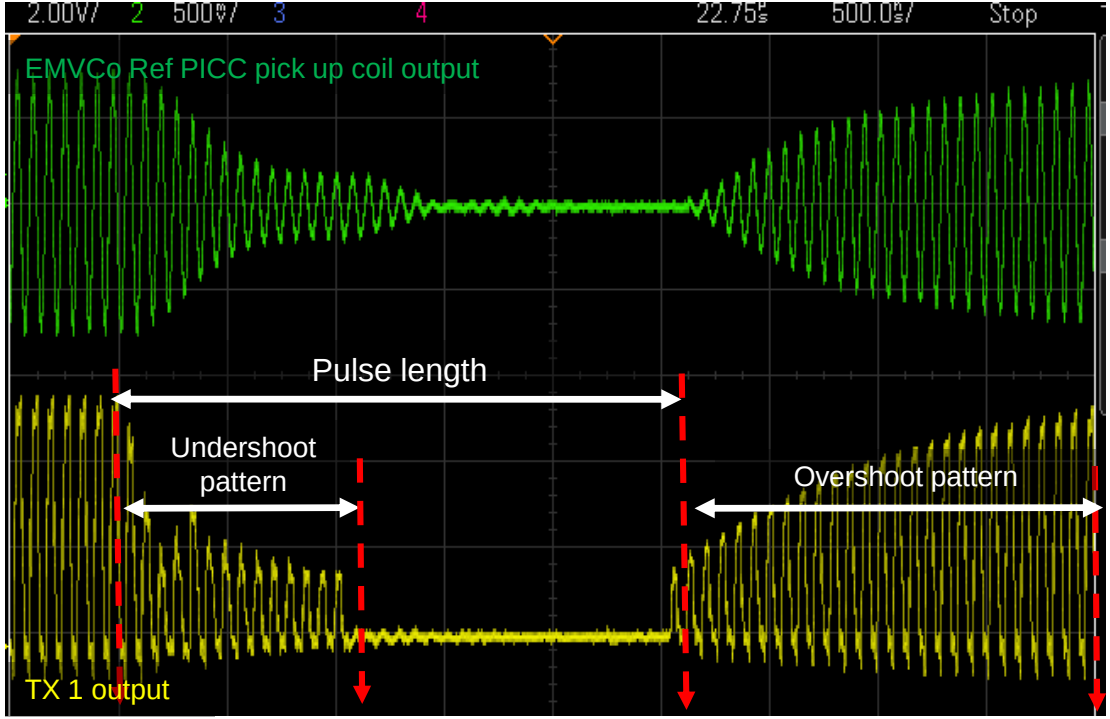


PN5180 NFC Cockpit: *DPC Tx shaping for a standard Type A pulse*

DPC Tx SC shaping pattern applied

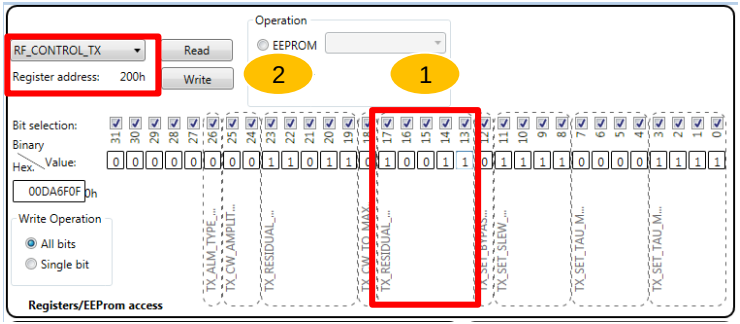


1. Enable Tx overshoot protection (TX_BYPASS_SC_SHAPING)
2. Define a overshoot protection pattern by tuning the rise time behavior (0x00 … 0x0F) (TAU_MOD_RISING)
3. Write new register configuration

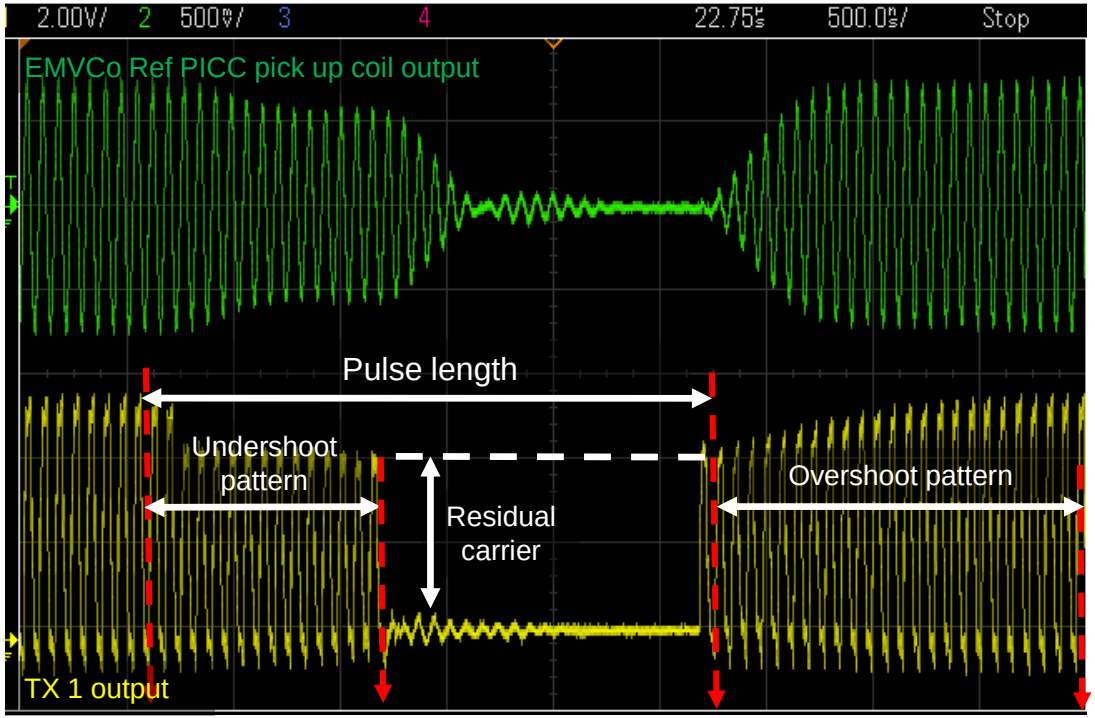


PN5180 NFC Cockpit: *DPC Tx shaping for a standard Type A pulse*

DPC Tx Residual carrier shaping pattern applied



1. Define the carrier level at the end of the undershoot pattern and at the end of the pulse (when the rise time of the pulse starts)
2. Write new register configuration

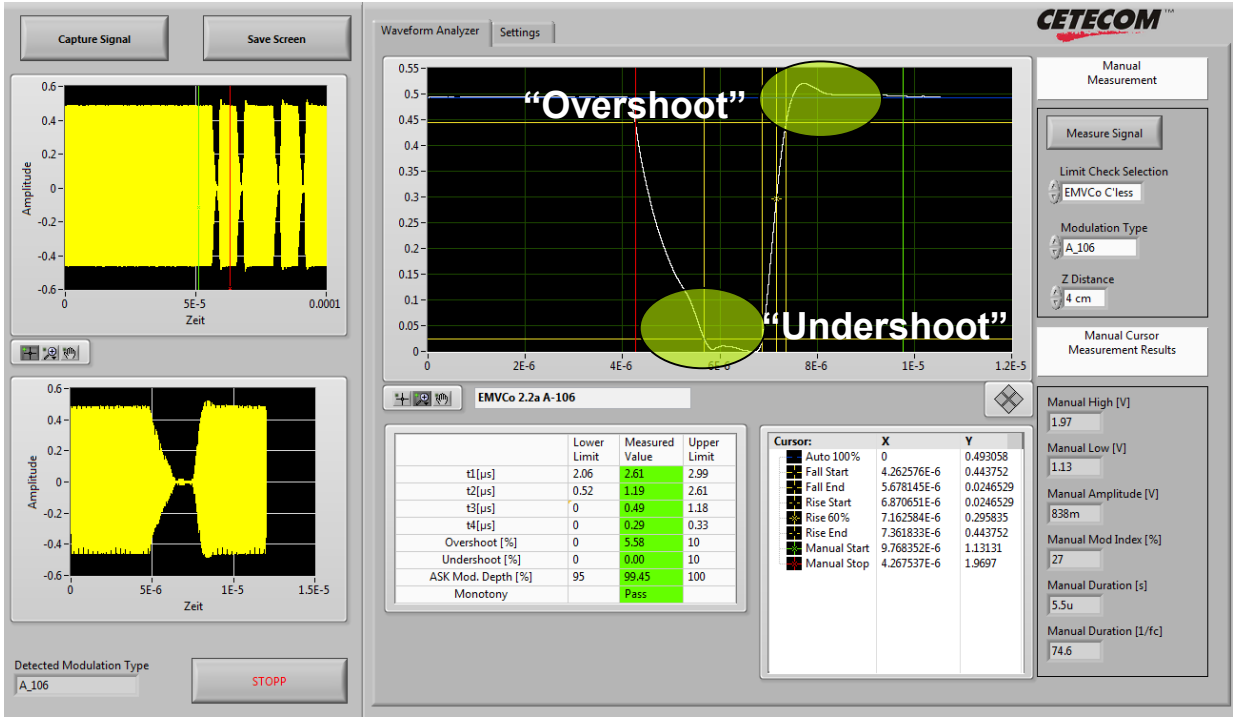


PN5180 NFC Cockpit: *DPC Tx shaping for a standard Type A pulse*

DPC Tx shaping result after fine tuning

After a proper Tx shaping register tune, we can manage to reduce overshoot and overshoot and therefore, pass EMVCo certification without any HW modification

More info about Tx shaping recommended settings in AN11742 Dynamic Power Control

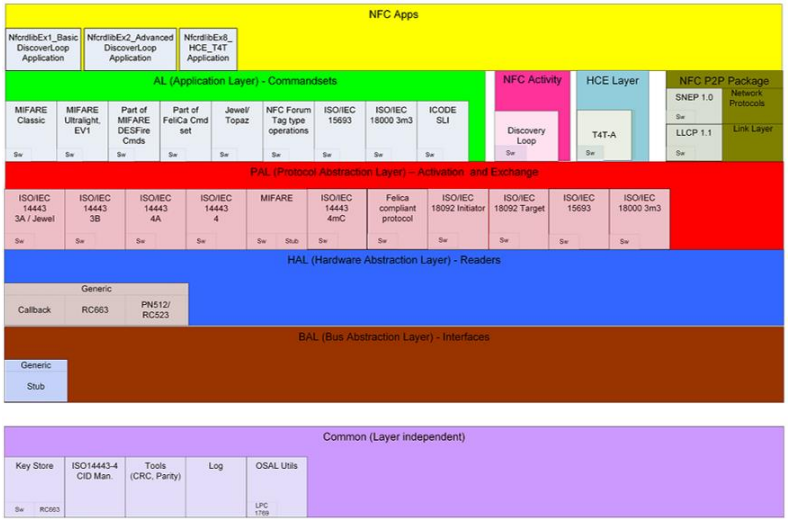


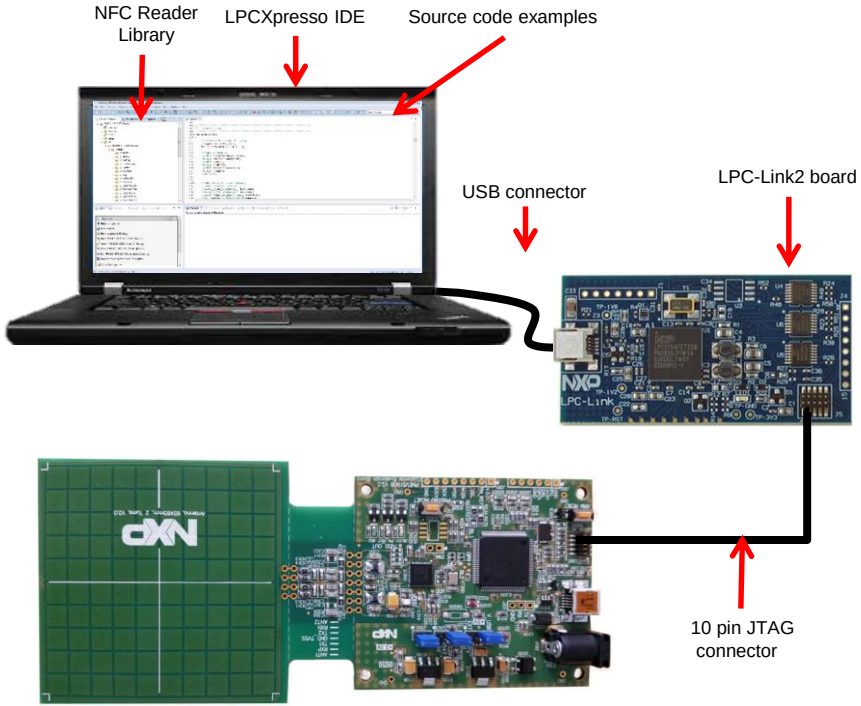
PN5180 product support package in a nutshell

Demokit	› PN5180 NFC frontend development kit OM25180FDK
NFC Cockpit	› SW3524 - Installer package PN5180 NFC Cockpit v2.2
NFC Reader Library	› SW3522 - NFC Reader Library for PNEV5180B including all SW examples
Documentation	› 75017673 - PN5180 leaflet › PN5180 - Product datasheet › AN11742 - PN5180 Dynamic Power Control › AN11744 - PN5180 evaluation board quick start guide › AN11740 - PN5180 antenna design guide › AN11741 - How to design an antenna with DPC › UM10954 - PN5180 SW quick start guide › SW3545 - PN5180 antenna design tools

Easy test and debugging based on NFC Reader Library examples

- The NFC Reader Library is encapsulated into layers and components written in ANSI C.
  - Each layer consists of different components having a generic interface and a specific implementation
- The library structure provides a modular way of programming and setting up the reader interface.

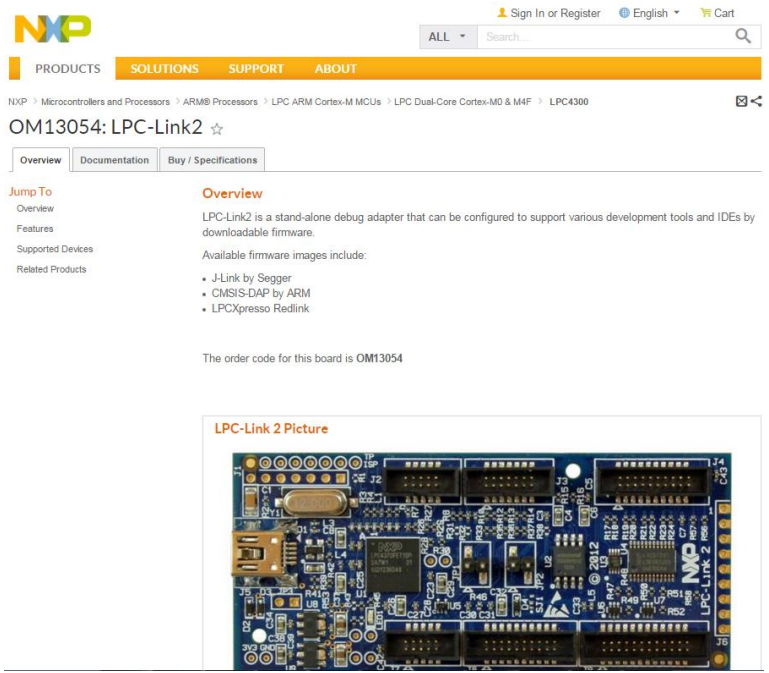




Getting started with SW development

1

Acquire a LPC-Link2 board
Available at eDemoboard and Distis



Reference	12NC	Product description
OM13054	935300265598	LPC-Link2

Getting started with SW development

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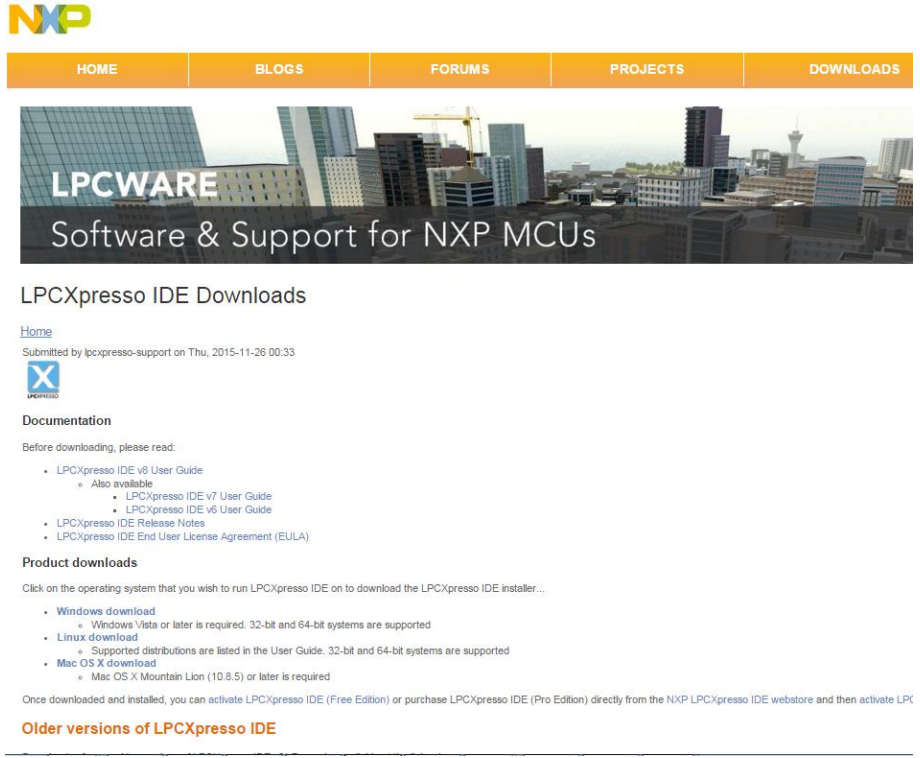
2. Download and install LPCXpresso IDE
   Free download at LPCware website



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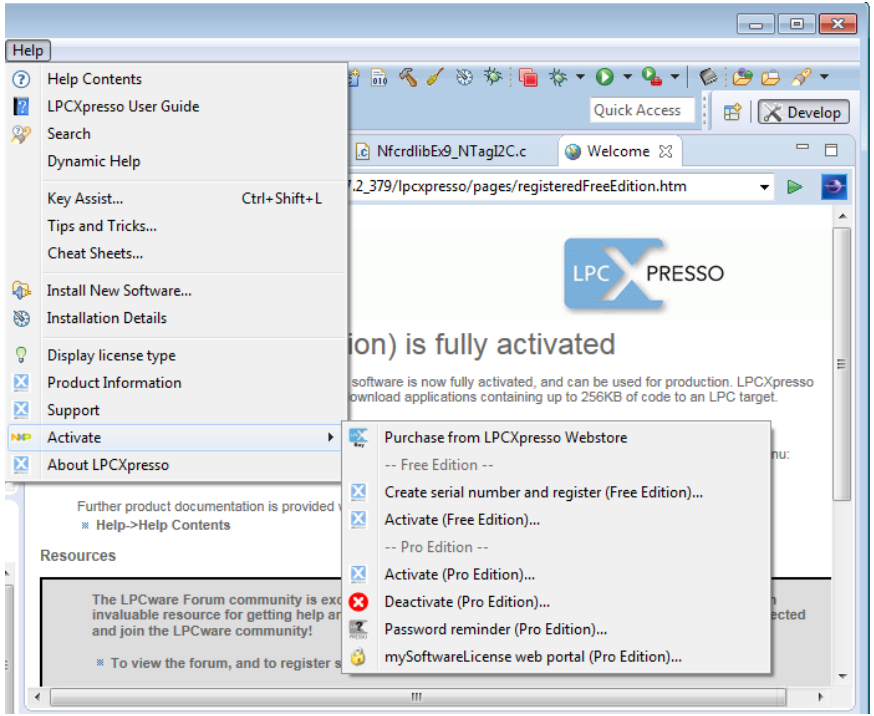

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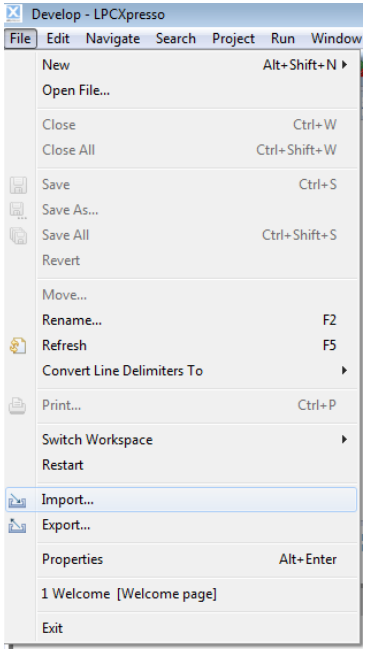
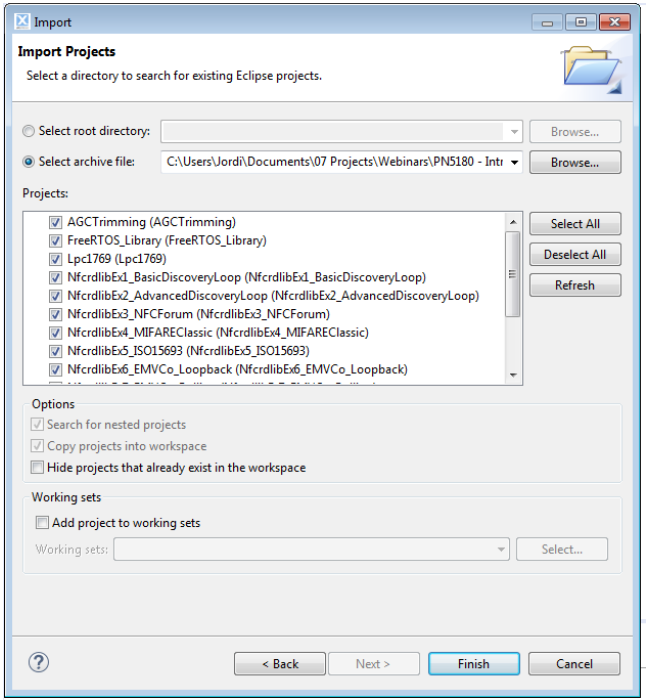
4. Importing provided SW example projects
   Download and unzip SW3522 package





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SW example	Description
NfcrdlibEx1 Basic Discovery Loop	Shows how to poll for different technologies (P2P,Tag,HCE), detect and report them
NfcrdlibEx2 Advanced Discovery Loop	Shows how to poll for different technologies (P2P,Tag,HCE), detect and report them
NfcrdlibEx3 NFCForum	Shows both the P2P and reader function to detect Type A, B, F and V.
NfcrdlibEx4 MIFAREClassic	Shows the usage of standard MIFARE commands
NfcrdlibEx5 ISO15693	Shows the usage of ISO15693 technology and the most common commands
NfcrdlibEx6 EMVCo_Loopback	Application used for EMVCo L1 PCD certification
NfcrdlibEx7 EMVCo_Polling	Shows how to poll for EMVCo payment cards
NfcrdlibEx8 HCE_T4T	Demonstrate the card emulation of a Type 4 Tag
NfcrdlibEx9 NTAG_I2C	Shows the usage of NTAG I2C specific commands
NfcrdlibEx10 ISO18000_3M3	Shows how to detect this type of cards and displays tag info like UID.
AGC Trimming	Shows how to perform measurements to determine right XI value for the antenna

Getting started with SW development

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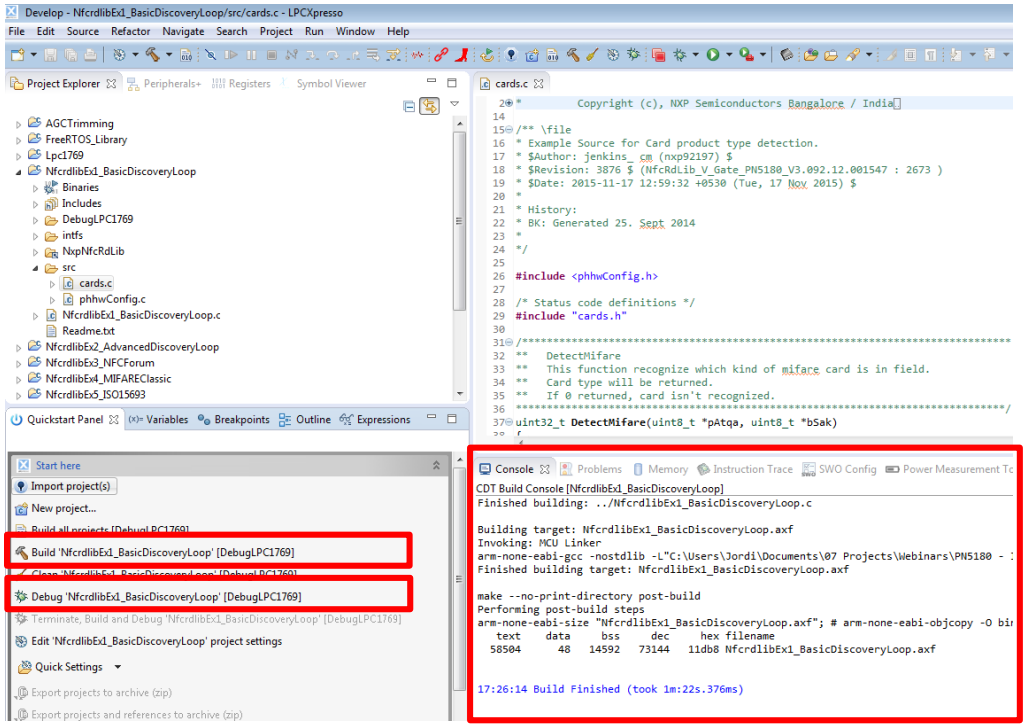
4. Importing provided SW example projects
   Download and unzip SW3522 package
5. Compile, run and debug your application
   Using LPCXpresso IDE

After new SW has been loaded into the PNEV5180, the default SW needs to be flashed in order to use again NFC cockpit. More info in AN11744 Evaluation board quick start guide



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Datasheet, application notes, user manuals and other tools

Doc ID	Doc Name	Description
75017673	PN5180 leaflet	High performance full NFC Forum compliant frontend
PN5180	PN5180 product datasheet	This document describes the functionality and electrical specification of the PN5180 NFC frontend
AN11742	PN5180 Dynamic Power Control	This document describes how to use the Dynamic Power Control feature
AN11744	PN5180 evaluation board quick start guide	This document describes the PN5180 evaluation board and how to use it. It describes the NFC Cockpit v2.2 which allows an easy basic access to the PN5180 registers and EEPROM in combination with basic reader functionality
AN11740	PN5180 antenna design guide	This document describes the “standard” antenna design and tuning related to the PN5180
AN11741	How to design an antenna with DPC	This document describes the “symmetrical” antenna design, which must be used together with the Dynamic Power Control (therefore, called DPC antenna tuning).
UM10954	PN5180 SW quick start guide	This User Manual is related to the installation procedures of the PN5180 evaluation board, SW sample projects as well as the re-installation of the original LPC firmware to run the NFC Cockpit. It describes the steps to be done to become acquainted with the demo reader especially for the SW development
SW3545	PN5180 antenna design tools	This file contains an **Excel sheet** for the calculation of the matching and tuning components for an NFC Reader antenna, including a macro for **RFSIM99**

Final remarks

PN5180 is supported by advanced tools that make it easier than ever to develop a design

NFC frontend development kit OM25180FDK
Available at eDemoboard and Distis

NFC Cockpit design tool
A professional GUI tool for engineers that ease design process, antenna tuning and waveform shaping

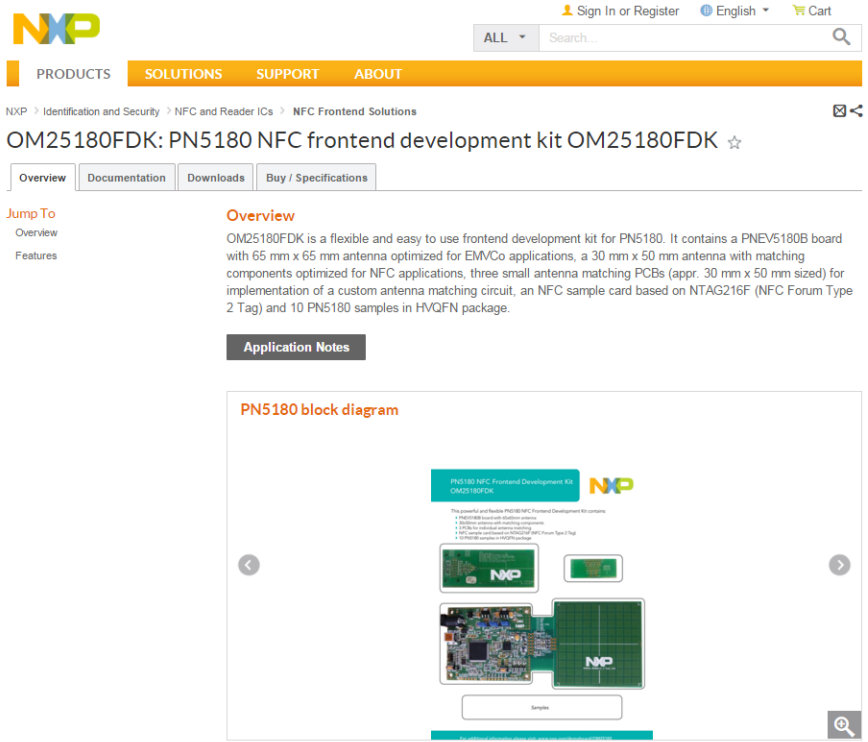
Dynamic Power Control
Delivering robust performance while controlling antenna current, RF power and the related waveforms to deliver optimized RF performance even under detuned conditions

NFC Forum, EMVCo and ISO/IEC compliant library
Modular, easily readable and quickly portable SW library complemented by ready-to-use SW examples and tested against standardized tests.

Do you need more?

Resources and useful links

- NFC Everywhere
  http://www.nxp.com/nfc
- PN5180 product website
  http://www.nxp.com/products/identification-and-security/nfc-and-reader-ics/nfc-frontend-solutions/high-power-nfc-frontend-solution:PN5180
- OM25180FDK demokit website
  www.nxp.com/board/OM25180FDK.html
- NFC innovation lab video to get a quick intro into the new features that come along with the PN5180
  https://www.youtube.com/watch?v=Q0jFC27TLEQ
- NXP Tech community
  http://nxpcommunity.force.com/community/CommunityOverview



PN5180 – The best full NFC frontend on the market

Jordi Jofre (Speaker) / Eric Leroux (Host)

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