AN13669

PN5190 questions and answers

Rev. 2.1 — 12 February 2025 | Application note

Document information

Information	Content
Keywords	PN5190, output power, VDDPA, target current, TX Wave shape, RX Level, DPC calibration, CE, FCC, MIC, settings, EEPROM configuration
Abstract	This document provides a collection of tips and tricks for the PN5190.

1 Introduction

This document provides a collection of tips and tricks for the PN5190.

2 How to reduce maximum output power

Normally the DPC of the PN5190 is calibrated in a way to provide the maximum possible output power. This means that the unloaded antenna is driven with the VDDPA = 5.7 V and a current close to the target current. In this case, the antenna impedance defines the output power.

Sometimes, it can be necessary to reduce the maximum output power after the antenna hardware design and the related DPC calibration is completed.

The PN5190 DPC offers two independent options to reduce the maximum output power:

1. The target current can be reduced.
2. The maximum VDDPA can be reduced.

2.1 Reduce target current

Reducing the target current the **overall** output power (field strength in all distances), since the target current defines not only the maximum output power. But via current reduction, which is related to the target current, it also reduces the output power at all other loading conditions. The target current is stored in EEPROM: DPC_TARGET_CURRENT (077h).

The reduction of the target current has a similar effect as an increase of the antenna impedance.

Note: *The current reduction lookup table uses relative settings, which always refer to the target current. Changing the target current changes the current levels in all VDDPA steps.*

2.2 Reduce maximum VDDPA

Reducing the maximum VDDPA only reduces the **maximum available** output power (field strength at maximum distance). The field strength at lower distances does not change, since the DPC controls the output power independently from the maximum available VDDPA at lower VDDPA levels.

By reducing the maximum VDDPA, the **maximum available** output power (field strength at maximum distance) is reduced. The field strength remains unchanged at lower distances, due to the DPC controlling the output power independently from the maximum available VDDPA at lower voltage levels.

The maximum VDDPA setting is stored in the EEPROM: TXLDO_VDDPA_MAX_RDR (0008h). The default setting is 0x2A, which correlates to the maximum possible VDDPA = 5.7 V.

The reduction of the maximum VDDPA has the same effect as reducing the supply voltage of the TX driver.

Note: *The change of the maximum VDDPA does not change the DPC, but limits the maximum available power level.*

3 How to adjust TX wave shapes

The PN5190 is delivered with default settings. The default settings are prepared for the operation as an ISO/IEC 14443 reader device with the 45 mm x 45 mm antenna of the PNEV5190BP (refer to [5]). The NFC Cockpit ([6]) provides a second set of settings, optimized for EMVCo operation. These settings can be loaded using the NFC Cockpit <Load EEPROM> command, as shown in Figure 1.

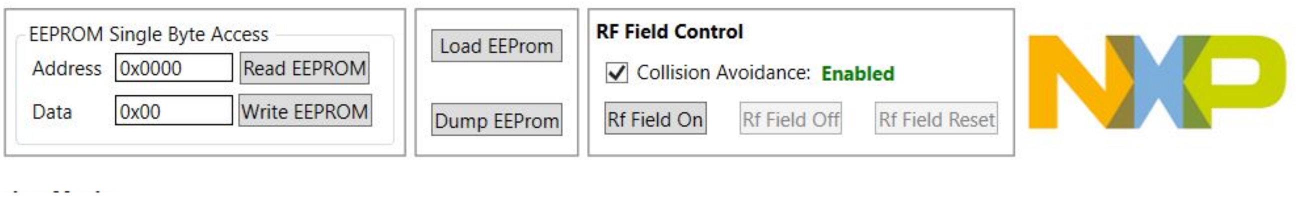

Figure 1. NFC Cockpit: Load and Dump EEPROM

The default settings provide basic TXShaping settings, which are intended for typical antenna configurations. Significant changes to the overall Q-factor or strong coupling effects increasing the influence of TestPICCs, can cause the wave shape tests to fail in certain positions. To avoid such failure, the TX wave shape settings can be adapted via the DPC Calibration of the NFC Cockpit.

After starting the calibration (<Start Calibration>), switch to the TXShaping tab. In this menu, protocol configurations (technology and bit rate) can be selected via <Load Protocol>. This automatically enables the RF field (using the DPC). The Figure 2 shows an example with the ISO/IEC14443A at 106 kbit/s. The field is enabled, as is shown through the VDDPA and Current reading.

The Figure 2 shows an example with the ISO/IEC14443A at 106 kbit/s. The field is enabled, as can be seen through the VDDPA and Current reading.

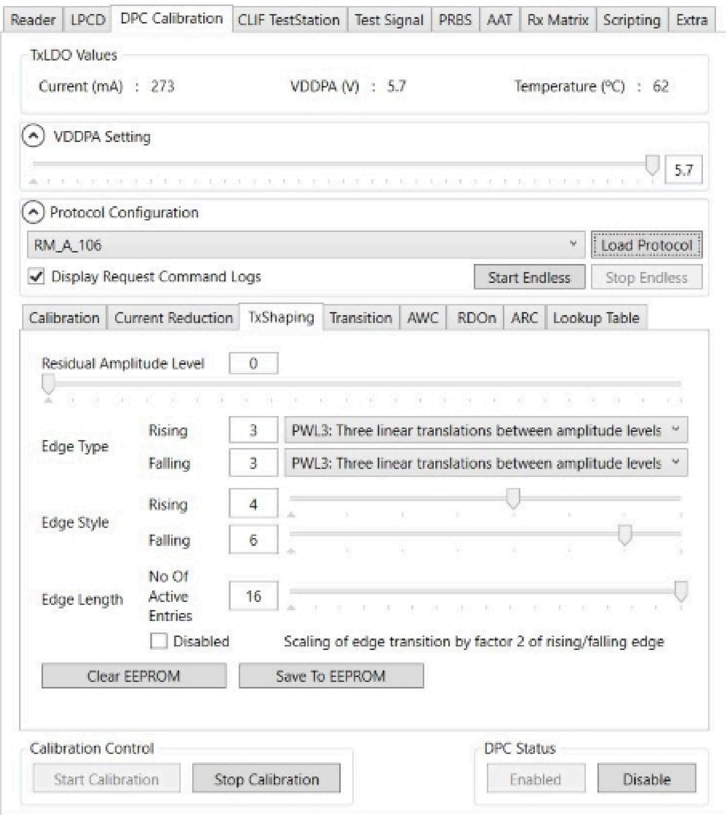

Figure 2. NFC Cockpit: TXShaping

For testing, use <Start Endless> in the NFC Cockpit, which continuously sends a request or a similar command. Check the TX pulse shape.

The PN5190 offers two types of TxShaping (for details refer to [3]). The TxShaping adjustment depends on the chosen type.

3.1 With FW-based shaping

The NFC Cockpit TXShaping tab provides the adjustment options for FW-based shaping (see Figure 2). The Edge Type as well as the related Edge Style can be selected and modified.

With the adjustments in the DPC Calibration menu, the NFC Cockpit emulates the PN5190 FW behavior, according to the chosen Edge Type or Edge Style. This emulation recalculates the values for the SS_TX1_RTRANS and SS_TX1_FTRANS registers and writes them into the registers. This temporarily overrules the PN5190 FW, but does not change the EEPROM settings. To change the EEPROM settings permanently to the current (temporary) settings, use <Save to EEPROM>.

The second video tutorial (refer to [7]) shows an example of the FW-based TXShaping adjustment, using the PNEV5190BP with an EMVCo debug test setup.

This TXShaping setting is the **static** setting. The PN5190 FW applies these settings when the related protocol is loaded. In addition to the static settings, the DPC offers the AWC, which allows the dynamic adaption of settings. To adjust the dynamic settings in the NFC Cockpit, go to the AWC tab, as shown in Figure 3.

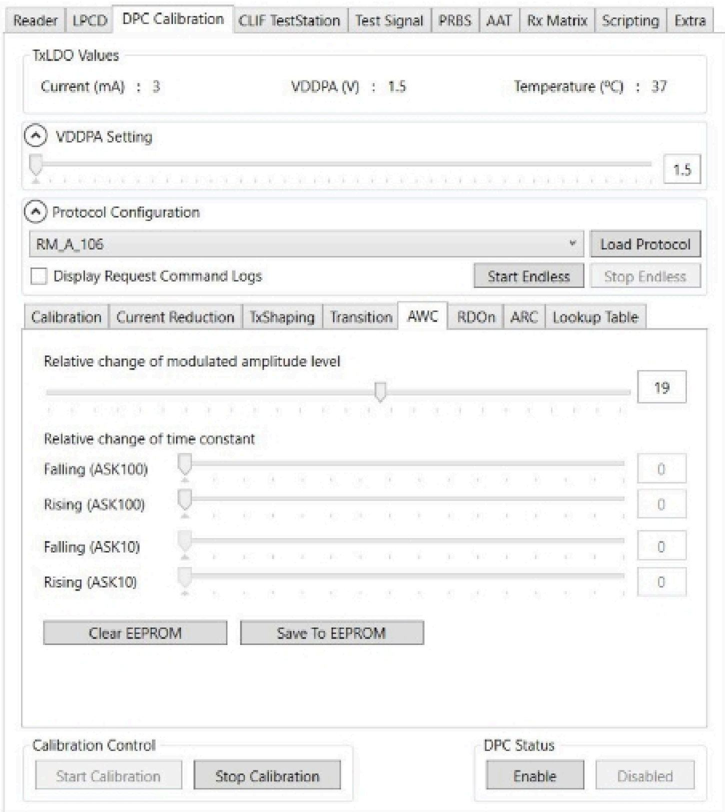

Figure 3. NFC Cockpit: AWC

Note: *The dynamic settings need one additional entry per VDDPA. The NFC Cockpit automatically disables the DPC when switching to the AWC tab to allow the manual VDDPA control. The AWC applies changes to the static settings (relative values).*

3.2 With LUT-based shaping

When using the LUT-based shaping (Look-up-table), Edge Type settings can be chosen to be option 3, 4, or 5 as shown in Figure 4. The Edge Style defines the LUT, which is taken from the PN5190 FW to load the SS_TX1_RTRANS and SS_TX1_FTRANS registers.

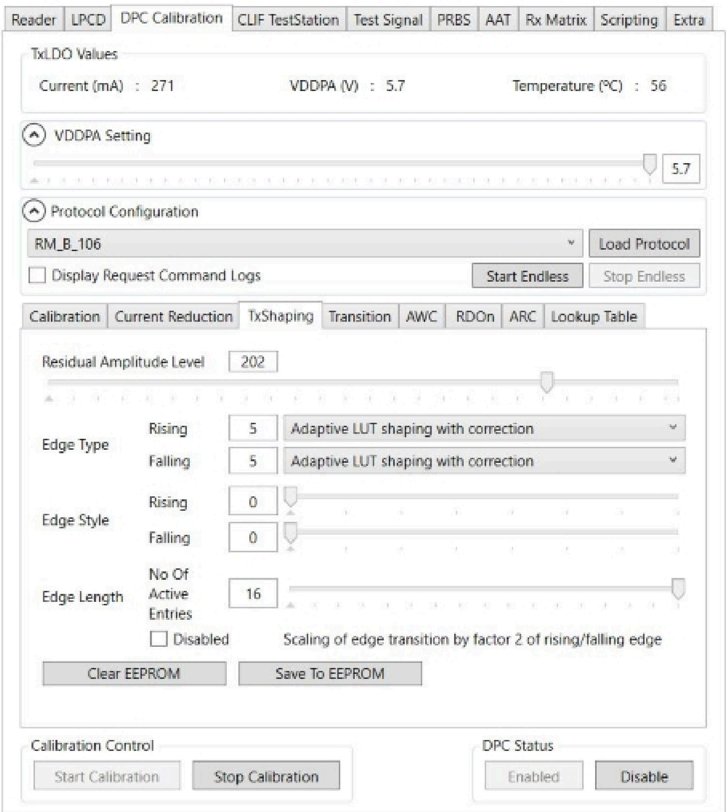

Figure 4. NFC Cockpit: LUT based Shaping

The LUT can be manually written, using the <Write EEPROM>. TheNFC Cockpit can also be used to adjust the registers and write a complete LUT to the EEPROM. To adjust the registers and then save the complete LUT, use the Transition tab as shown in Figure 5. Select the relevant protocol and use <Load Protocol>. The PN5190 FW applies the TXShaping settings, and loads the SS_TX1_RTRANS and SS_TX1_FTRANS registers. Using <Read Registers> loads the current register values into the NFC Cockpit tab.

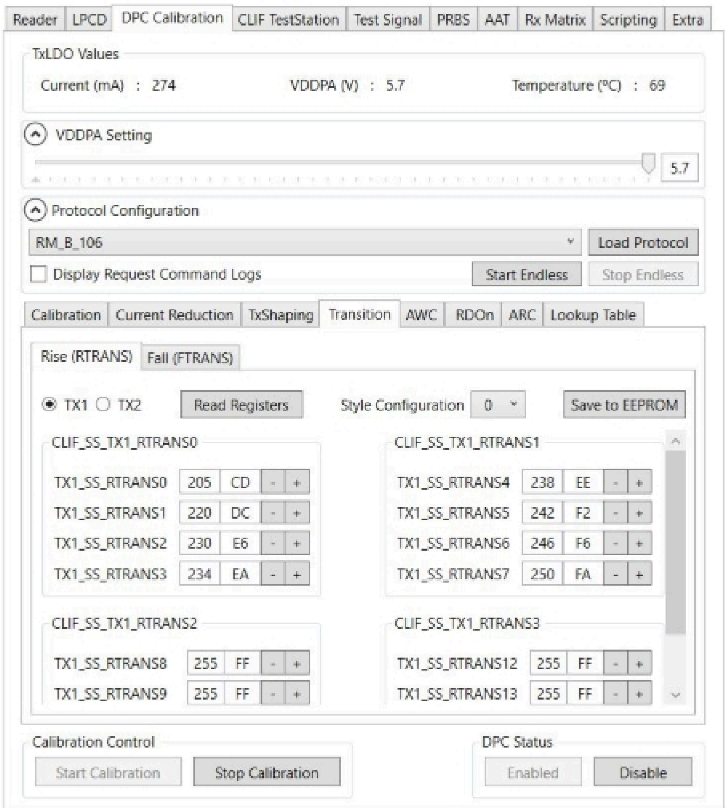

Figure 5. NFC Cockpit: Transition

<Start Endless> can be activated to test the TXShaping with a continuous command being sent. The register values can now be modified, either by entering a new value between 0 and 0xFF, or by using the +/- buttons. The effects can be observed in the TX Shape, as the NFC Cockpit writes every new register value into the corresponding register.

When the TXShaping is as intended, the complete registers can be written into one of the four available LUTs, using the Edge Style value from 0 to 3 and clicking <Save to EEPROM>. The Edge Style values in the tabs Transition and TXShaping must match for this protocol.

The third video tutorial [7] shows an example of LUT-based shaping.

Note: *The details of TXShaping are described in [3].*

4 How to adjust the RX level

The PN5190, as delivered by NXP, uses default RX settingsRX settings for each protocol. For ISO/IEC 14443 and EMVCo, two sets of settings optimized for a 45 mm x 45 mm antennas are available in the NFC Cockpit package. Other antenna sizes might require adjustment of the RX settings.

Note: *Ensure that the HFAttenuator value is set properly by using the correct RX coupling resistor. Refer to [2] for details.*

For adjustment of the PN5190 RX, two start options are available:

- **EMVCo:** For EMVCo, the highest sensitivity is required to pass all analog tests, especially with small antennas. In most cases, EMVCo does not require the use of ARC.
- **ISO/IEC 14443:** ISO/IEC14443 and NFC often require limiting of the sensitivity, for example under strong coupling conditions to meet the EMD low-level requirements. Especially with small antennas, the ARC might be required.

Note: *The PN5190 RX, its test signals and adjustment options are described in [3].*

Starting from the default settings of ISO/IEC14443 or EMVCo, the following RX settings are available:

BBA Gain: The BBA gain shall normally not be changed from default.

MF Gain: The Matched Filter Gain (MFGain) is a 2-bit setting, which controls the gain of the matched filter block.

IIR filter: Enabling the IIR filter attenuates the I and Q channel by several dB.

RXThreshold: The RXThreshold (= "DGRM_SIGNAL_DETECT_TH_ OVR_VAL") is the major setting to adjust the RX sensitivity. Any matched filter output signal lower than the RXThreshold is ignored by the RX decoder.

Note: *MFGain, the IIR filter setting, and the RXThreshold depend on each other: the MFGain in combination with the enabled or disabled IIR filter influence the signal level of the matched filter output, which then has to pass the RXThreshold to start the RX decoding.*

Before performing any changes, it is recommended to check the system noise floor. The PN5190 CTS allows to retrieve analog test signals, while the NFC Cockpit provides the Signal Detection Threshold (SDT) function as part of the CTS tab. Refer to [3] for details.

Note: *The settings for MF Gain, IIR filter and the VDDPA can influence the noise level. Ensure that the RXThreshold is not lower than the SDT with margin 6.*

5 Why the DPC calibration fails

[Figure 6](#) shows an **example** of a nonworking DPC calibration: The target current of 306 mA and the current reduction LUT calibration have not been changed.

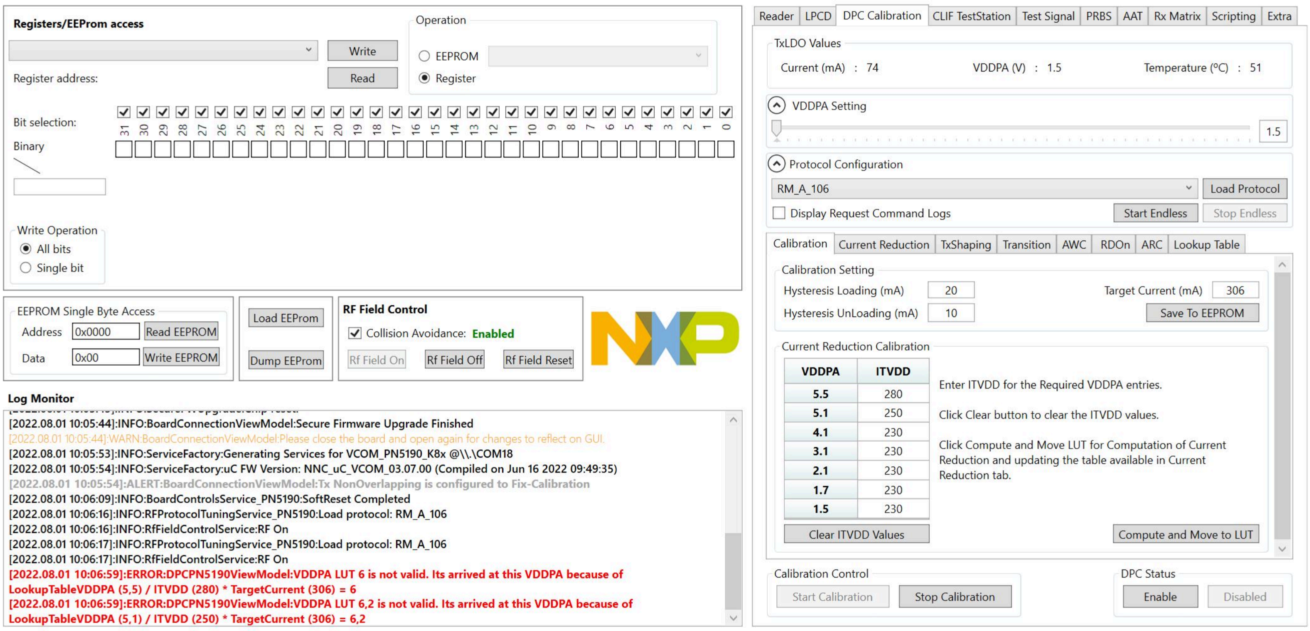

Figure 6. Bad DPC calibration

After the new values for the 7 VDDPA entries have been done, the <Compute and Move to LUT> causes errors. Why?

The DPC, its calibration, and the details about the current reduction look table are described in [2].

The DPC requires a **decreasing load versus decreasing VDDPA**, otherwise there can be ambiguous DPC conditions. In this example, the target current of 306 mA at VDDPA = 5.7 V means a load = 18.63 Ω. The VDDPA = 5.5 V with 280 mA means a load = 19.64 Ω, which conflicts with the requirement of decreasing load versus decreasing VDDPA. Another issue is the LUT entry: with the load = 19.64 Ω and a target current = 306 mA, the VDDPA entry must be at VDDPA = 6.0 V, which does not exist.

Figure 7 shows the calibration with the lowest possible current but using the same target current. The load slowly decreases versus VDDPA, and the first LUT entry is 35 mA for the entry at VDDPA = 5.6 V to get 271 mA at VDDPA = 5.0 V.

Target current:	306	mA

VDDPA [V]	ITVDD [mA]	Power Transfer [V]	Current reduction [mA]	Total load [Ω]	Warning
5,7	306		0	18,63	OK
5,6	301		5	18,60	OK
5,5	296		10	18,58	OK
5,4	291		15	18,56	OK
5,3	286		20	18,53	OK
5,2	281		25	18,51	OK
5,1	276		30	18,48	OK
5,0	271		35	18,45	OK

Current reduction LUT

VDDPA [V]	Current reduction [mA]	hex
5,7	0	0
5,7	0	0
5,7	0	0
5,7	0	0
5,7	0	0
5,7	0	0
5,7	0	0
5,6	35	23

Figure 7. Good DPC LUT

With that calibration, the DPC can now work, and all (shown) entries are unambiguous.

Note: *The excel sheet to allow a more detailed DPC calibration as shown in Figure 7 can be found in [4].*

6 How to support CE, FCC, and MIC tests

The design recommendations (see [2]) provide guidelines to meet the requirements to support CE, FCC, and MIC certification. To prove compliance, the functions of the PN5190 and the NFC Cockpit can be used for testing.

6.1 CE and FCC tests

To measure the levels of unwanted radiated harmonics for the CE or FCC test of an NFC reader device, it is required to enable the RF carrier and send data with a typical modulation. In most testing scenarios, a card is placed in the operating volume to enable a reasonable use case.

Figure 8 shows a typical configuration for operating the PN5190. The related protocol settings are loaded via <Load Protocol> and the RF carrier is enabled (<RF Field On>). Choose a cycle time, for example, 200 ms. Select <Endless REQA>. Execute <Start REQA>.

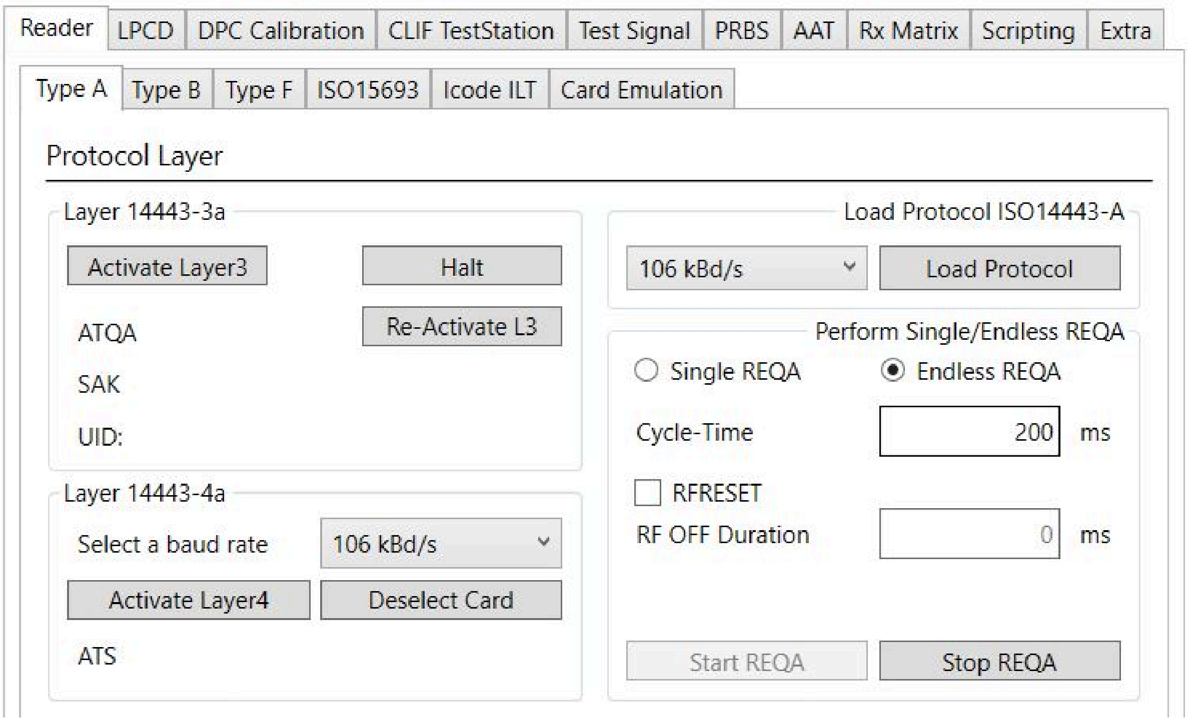

Figure 8. NFC Cockpit: Endless REQA

To analyze the immunity behavior of the device, place an ISO/IEC 14443 type A card into the operating volume. The device returns a valid ATQA every second command.

Note: *NFC and HF RFID systems require the* ***RF carrier being enabled*** *to operate tags as well as to transmit and receive data.*

Figure 9 shows a screenshot of such a REQA - ATQA communication within a test setup. Channel A (in green) shows the test signal, which is used to trigger the oscilloscope. The channel B (blue) shows the signal of a field probe.

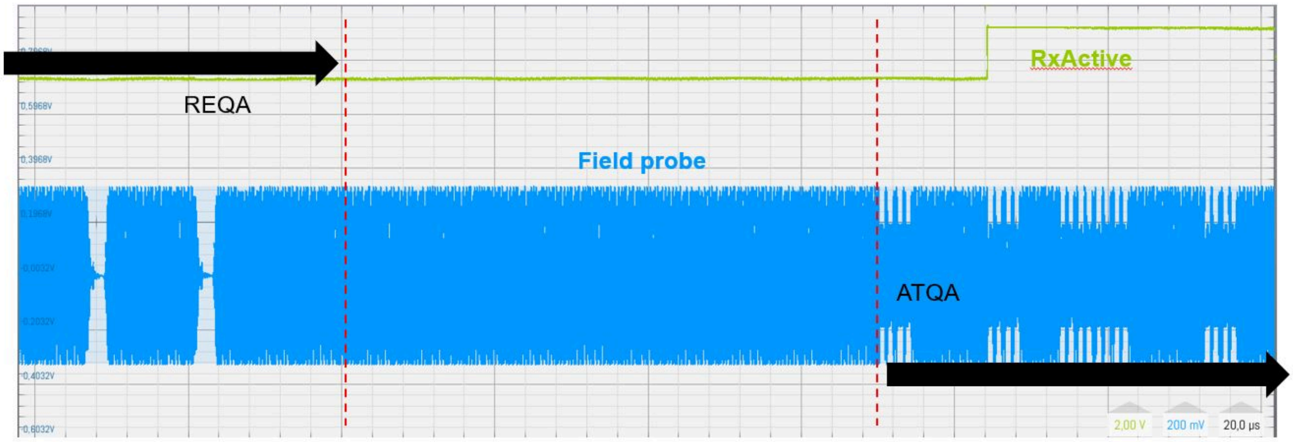

Figure 9. REQA-ATQA example screenshot

6.2 MIC tests

In Japan, the EMC tests require the device under test to send an endless PRBS sequence. For the PN5190, the command PRBS_TEST (refer to [8]) is used for EMC tests.

Figure 10 shows the PRBS settings of the NFC Cockpit. Select the PRBS type, technology, and baud rate. <Start PRBS> loads the protocol settings, enables the RF and executes the PRBS_TEST command until stopped by the user.

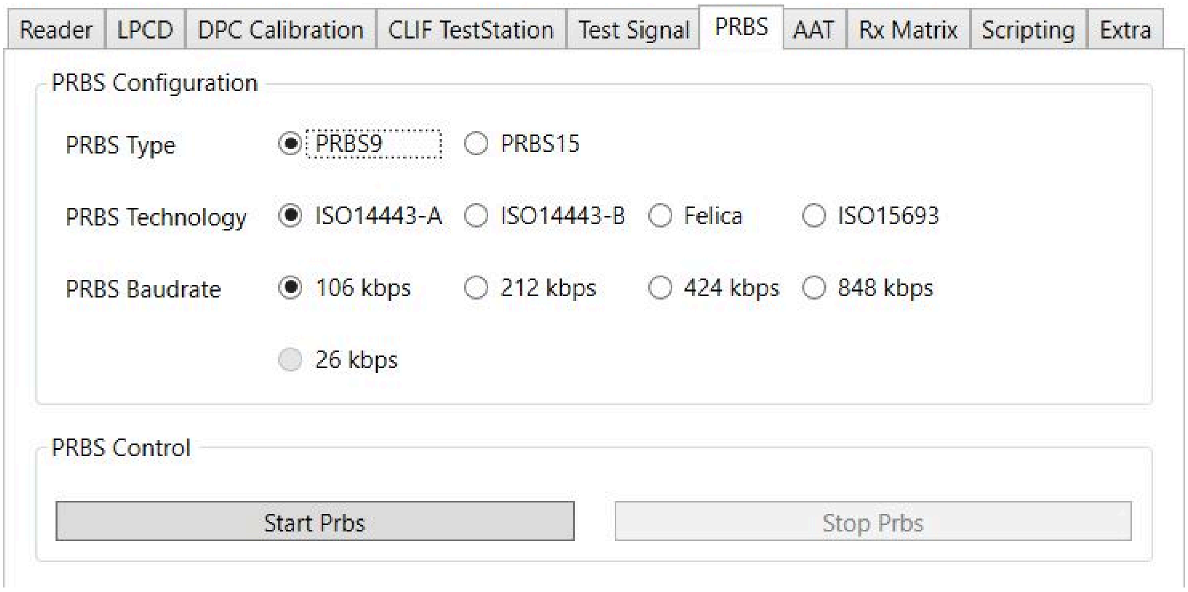

Figure 10. NFC Cockpit: PRBS

7 How to handle configuration settings

Every antenna design typically requires a specific set of analog settings. The PN5190 provides a nonvolatile memory area to store analog settings. The memory is split into two sections:

1. EEPROM configuration area
2. RF configuration area

7.1 EEPROM settings

EEPROM settings are defined and described in detail in section 9.26 of the data sheet ([1]). All settings are used by the PN5190 FW during specific operations. Changing the settings influences the behavior of the PN5190. Therefore, every EEPROM write must be performed with caution.

The NFC Cockpit provides direct **Single Byte Access** to read and write the EEPROM as shown in Figure 11.

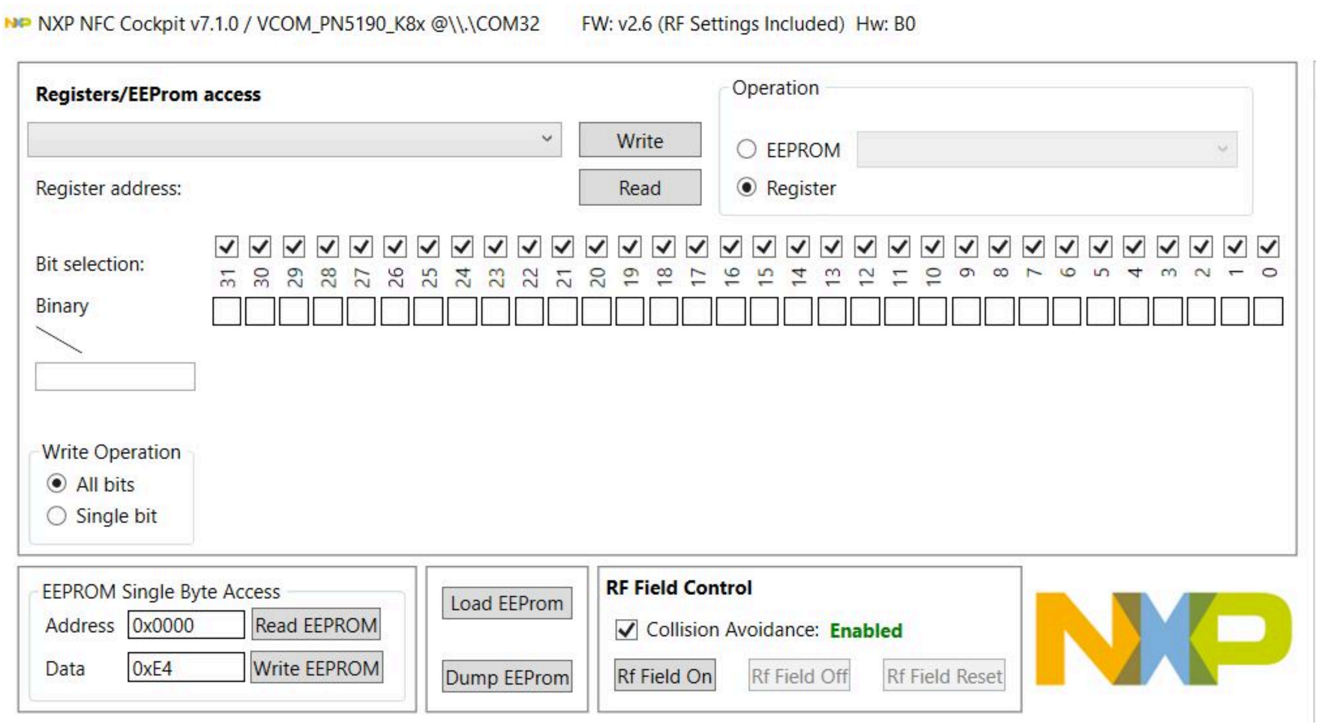

Figure 11. NFC Cockpit: Direct EEPROM Access

The NFC Cockpit functionality also provides indirect read-and-write-access linked to the high-level function in use, for example, the DPC calibration.

7.2 RF configuration settings

Settings linked to the RF protocol in use are stored in the RF Configuration area, and can be loaded from the EEPROM into the PN5190 registers with <Load Protocol> (LOAD_RF_CONFIGURATION). Each defined protocol has its own set of RF configuration settings for the TX and RX in the RF Configuration area.

For most use cases, the default settings do not require modification. However, the RF configuration settings can be modified, for example, to adjust the modulation index for ISO/IEC 14443 type B communication. The NFC Cockpit provides a direct EEPROM read and write (GET_ RF_CONFIGURATION and UPDATE_RF_CONFIGURATION), as shown for the DGRM_RSSI register in Figure 12.

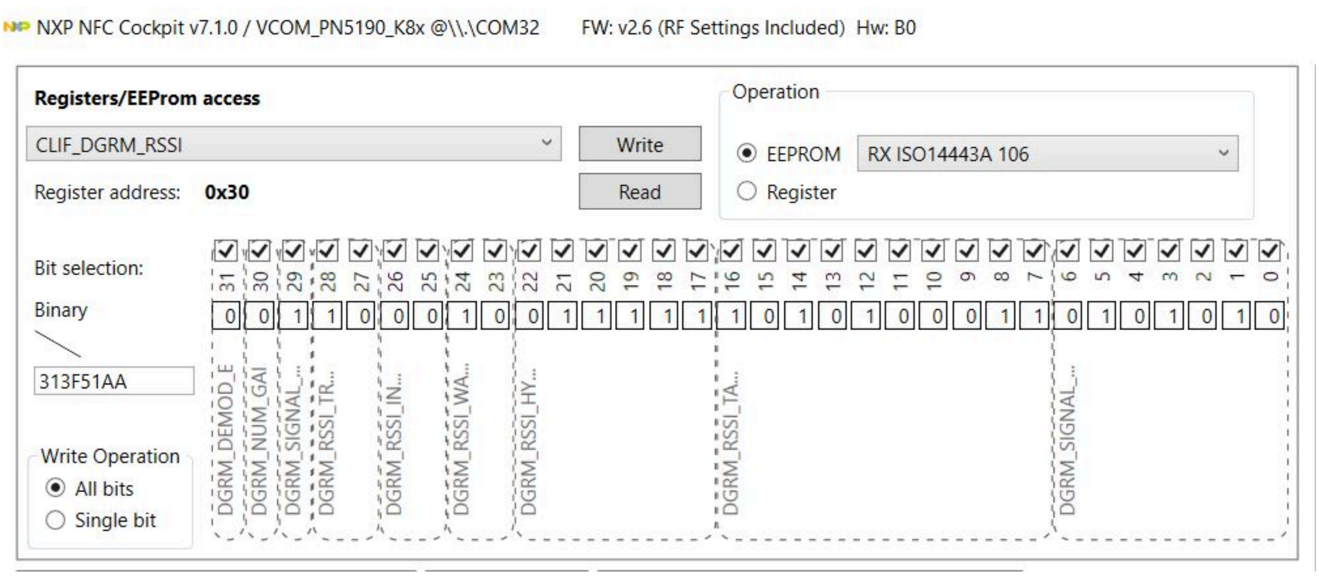

Figure 12. NFC Cockpit: RF configuration access

Select the protocol and a register. After loading the correct RF protocol, read a register directly from the EEPROM or from the register itself before writing settings into the EEPROM. The EEPROM read and write commands (GET_ RF_CONFIGURATION and UPDATE_RF_CONFIGURATION) always contain the full 32 bits of one register.

7.3 Handling during development

To simplify the handling of settings, the NFC Cockpit provides the functions <Dump EEPROM> and <Load EEPROM>. <Dump EEPROM> reads all documented settings from the PN5190 EEPROM and dumps them into an .xml-file. The <Load EEPROM> asks the user to select an .xml-file file and loads its content into the PN5190 EEPROM.

Every antenna design should have its own .xml-file of settings. Loading the complete file into the PN5190 EEPROM enables the proper functionality for the antenna design in use, for example, an EMVCo CL L1 certification. It is recommended to save such a complete file as part of the POS terminal design documentation.

Note: *Updating the FW with a x.**0**x version overwrites all settings and restores the default values. Updating the FW with a 0x**F**x version does not overwrite any settings.*

7.4 Handling during production

When all settings for a design are finalized, they must be written into the production device.

Writing all settings using the WRITE_E2PROM and UPDATE_RF_CONFIGURATION) can take a considerable amount of time. To operate efficiently, it is recommended to write only the modified settings into the device:

1. Dump the device settings, which include customized adjustments.
2. Perform an FW update with an x.0x version to restore the default settings.
3. Dump the default settings with the NFC Cockpit (<Dump EEPROM>).
4. Compare the .xml-files, all differences must be written into the device during production.

8 How to use the RDON function

The DPC uses the TXLDO to reduce the RF output power. In the range of 2.2 V and 5.7 V, this function provides the same function of the TX driver for all VDDPA levels. However, the TX driver function slightly changes below VDDPA = 2.2 V. Normally this has no impact on other functions, but depending on antenna tuning the TX driver might show a different TXShaping at VDDPA < 2.2V.

However, in the case of some critical wave shapes, the limits of rising and falling edges might change, which can require adjustments in the dynamic shaping settings.

An easier solution to keep the same TXShape at strong loading conditions might be the (optional) use of the RDON function. The idea is to limit the minimum VDDPA level to 2.2 V. Then between VDDPA = 2.2 V and VDDPA max everything works without any dynamic shaping settings. This can be done with the DPC_TXLDOVDDPALow (EEPROM address 0x7D).

Then, limiting the minimum available VDDPA to, for example, 2.2 V might then cause still too much current and too much RF field strength with a card in close distance. So, a further RF output power reduction might be required.

This further power reduction (beyond the minimum available VDDPA) can be done via the RDON function. Enabling the DPC_RDON_Control (EEPROM address 0x7F = 0x01) enables the RDON. The RDON mechanism further reduces the TX output power via TX driver settings rather than lowering the VDDPA, as soon as the DPC reaches the lowest allowed VDDPA (DPC_TXLDOVDDPALow) and still needs to further reduce the output power. The RDON then works automatically as part of the DPC and does not need to be configured.

It is not recommended to change the RDON settings.

Note: *The reduction of output power increases the PN5190 internal losses. This is normally covered inside the TXLDO. When the RDON is enabled, the losses inside the TX driver also increase. This can cause overheating, if not covered properly in the PCB layout.*

9 What to consider without the DC-DC converter in use

A typical use of the PN5190 includes the DC-DC, which then is controlled automatically by the DPC. This controlled DC-DC provides the optimum input for the TxLDO, which then results in minimum losses, that is, the minimum self-heating.

When the DC-DC converter is not used, specific settings must be considered.

9.1 TXLDO voltage drop

When the DC-DC converter is not used, the self-heating must be monitored. If the VUP is supplied externally with levels higher than VBAT while the DPC reduces the VDDPA, the TXLDO losses can increase significantly. To avoid overheating, the firmware uses a maximum value for the TXLDO voltage drop.

This voltage drop can be configured in DPC_TXLDO_MAX_DROP (EEPROM address 0x81). The default is set to 3.6 V.When this voltage drop level is reached, the DPC does not reduce the VDDPA further.

Example: The VUP is externally supplied with 5.5 V. Then the VDDPA cannot be lower than 1.9 V, as long as the default DPC_TXLDO_MAX_DROP is used.

Note: *Increasing the DPC_TXLDO_MAX_DROP can cause the PN5190 to overheat in some corner case operation.*

9.2 Maximum VDDPA

If the TXLDO is in use, the maximum VDDPA should only be set to a value of VUP – 300 mV,

A typical use case might be the operation without the DC-DC converter, but with TXLDO, as shown in configuration example 3 in [1]. The VBAT = VUP drives the TXLDO, which provides the VDDPA.

Example: The VBAT is 5.0 V, so the maximum VDDPA (as set in TXLDO_VDDPA_MAX_RDR, EEPROM addr. 0x08) shall not be higher than 0x20 => VDDPAmax = 4.7V.

10 How to improve EMC

The goals of electromagnetic compatibility (EMC) related design are to:

- control electromagnetic interference (EMI),
- decrease the emission of unwanted electromagnetic energy,
- increase the immunity against electromagnetic disturbances.

All this is relevant in the frequency range from 0 Hz up to several GHz for magnetic fields, electrical fields and electromagnetic fields.

The specific challenges for NFC or RFID Reader devices are:

- electrostatic discharge (ESD),
- 13.56 MHz (operating frequency) operation,
- radiation of 27.12 MHz and other harmonics up to the GHz range.

To avoid EMI issues, it is important to understand:

- where each signal is generated,
- how each signal is distributed (conducted and radiated),
- which coupling mechanisms take place (conductive, inductive, capacitive, radiative).

This AN does not replace generic EMI guidelines, but focuses on NFC- and RFID-specific topics. NXP provides an online webinar for NFC antenna design, which contains a session about EMC-related topics (session #6). For details, refer to [9].

10.1 ESD

In regular use cases, electrostatic discharge (ESD) is no significant issue for NFC reader devices, since no electrical contacts are exposed. When parts of the antenna might be detachable and electrical contacts might be exposed, additional ESD protection might be required. An example is shown in Figure 13.

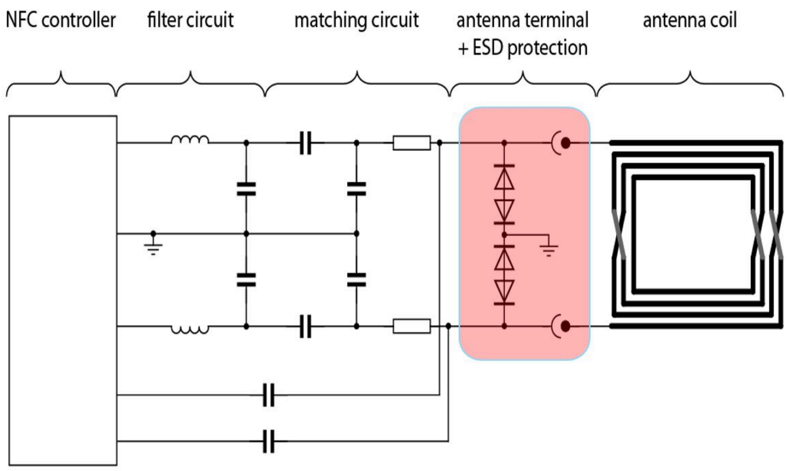

Figure 13. NFC antenna circuit with specific ESD protection

Note: *Attention must be paid to the voltage range limitations of common ESD protection diodes. Limitations might cause saturation and clipping effects, which can disturb NFC functionality and increase the radiation of unwanted harmonics.*

10.2 Radiation of unwanted harmonics

Figure 14 shows the block diagram of an NFC Reader device. The highlighted sections show critical areas, which can be impacted by unwanted harmonics, or where unwanted harmonics are generated and distributed.

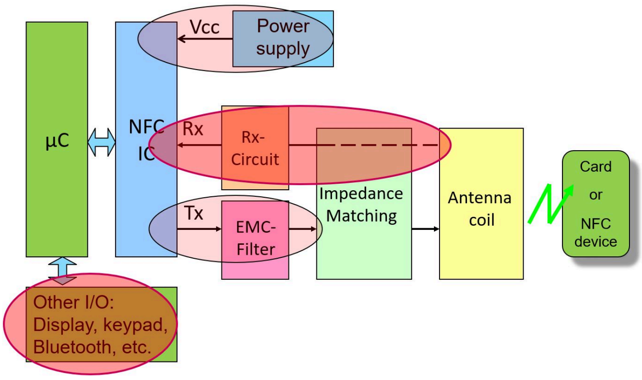

Figure 14. NFC Reader block diagram with EMI critical areas

The greatest amount of RF energy is generated in the output stage of the PN5190. The principle of an efficient output stage to drive up to 2 W output power into an NFC antenna is shown in Figure 15.

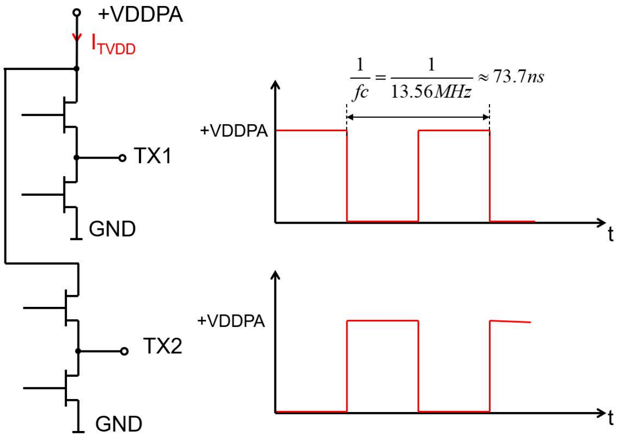

Figure 15. Principle of an efficient NFC TX driver

This principle indicates that at both TX pins the signals contain a high amount of harmonics.

The standard NFC antenna design provides a proper filtering, using a second order low-pass filter connected to each TX pin, as shown in Figure 16.

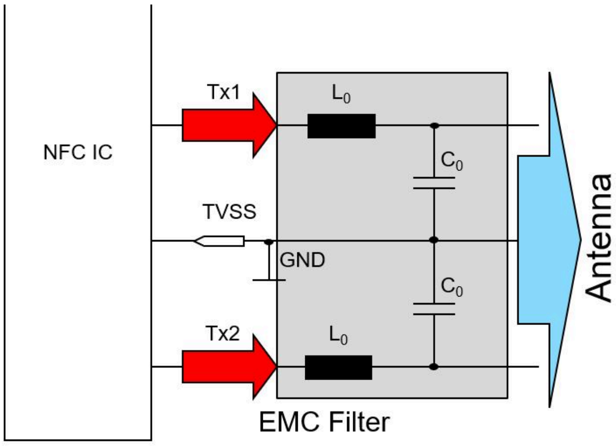

Figure 16. NFC TX EMC filter

The traces and the inductors used must be specified for the expected power level. The capacitors must be NP0 capacitors.

In the layout, the EMC filter must be located as close to the TX pins as possible. The TX and GND traces must be kept as short and as low impedance as possible.

It is highly recommended to use the layout recommendations from [2]. For the PN5190, those layout recommendations include the RF part with TX and RX traces, but also the power supply part. It is obvious that the TX driver as shown in Figure 15 also causes current peaks with a frequency of 13.56 MHz and its harmonics on the related power traces.

Additionally, the PN5190 internal DC-DC can be a source of unwanted radiated harmonics, if the layout is not done properly. Following the design recommendations does not only avoid EMC problems, but also guarantees proper NFC function.

11 How to use PRD pins

The pin removable detection (PRD) is a feature that might be helpful to get a better security grade for EMVCo. Using PRD, an MCU can detect if the PN5190 has been removed has occurred.

Imagine the following scenario: Someone attempts to "hack" the system, and removes the PN5190. Then they connect the SPI, which normally might be hidden inside PCB layers, to an external PN5190 device to emulate the original PN5190. This hacking scenario then allows to trace the SPI communication in all detail. With the PRD, the MCU can detect that the PN5190 has been removed, and then can block the operation.

To support PRD, the PN5190 in the VFBGA64 package features the PRD1 and PRD2 pins. The pins are internally connected. The MCU can send a signal into PRD1, which must then also be visible at PRD2. In case this test fails due to the removal of PN5190, subsequent operations can be blocked by the MCU.

If PRD is not used, the PRD1 and PRD2 pins can be left floating or tied to GND.

12 Why does DownloadLibEx1 fail

To update the PN5190 firmware, NXP provides an example "DownloadEx1" (see [10]).

Using the example, the PN5190 can be updated. The example has to be configured first according to the PN5190 in use. The **B0** and **B1** variants are different compared to **B2** when updating. The B2 variant supports crypto-assisted download, while B0 and B1 do not. For B2, the command codes differ as seen in Figure 17.

This list of op codes is part of the Instruction Layer Manual.

PN5190 B0/ B1 (Legacy download)	PN5190 B2 (Crypto assisted download)	Command Alias	Description
0xF0	0xE5	DL_RESET	Performs a soft reset
0xF1	0xE1	DL_GET_VERSION	Returns the version numbers
0xF2	0xDB	DL_GET_SESSION_STATE	Returns the current session state
0xF4	0xDF	DL_GET_DIE_ID	Returns the die ID
0xE0	0xE7	DL_CHECK_INTEGRITY	Checks and return the CRCs over the different areas as well as pass/fail status flags for each
0xC0	0x8C	DL_SEC_WRITE	Writes **x** bytes to memory starting at absolute address y

Figure 17. List of HDLL command OP codes

Before executing the DownloadLibEx1, ensure that the project configurations and the *Preprocessors* defines are set according to the PN5190 variant in use.

Per default, the DownloadLibEx1 example is configured to support the **B2 variant**, its crypto-assisted download mode and commands. The DownloadLibEx1 example fails if run on the B0 and B1 variants. The returned error code is "0x0B".

Change the *Preprocessors* defines of the "DownloadLibEx1" and "SecureDownloadLib " project. When using B0 or B1, ensure that "PN5190_B2_IC" is **NOT** defined. Delete it from the "Defined symbols (-D)" list of the *Preprocessors* settings. To keep track of this unused capability, it can be added to the "Undefined symbols (-U)" section as seen in Figure 18.

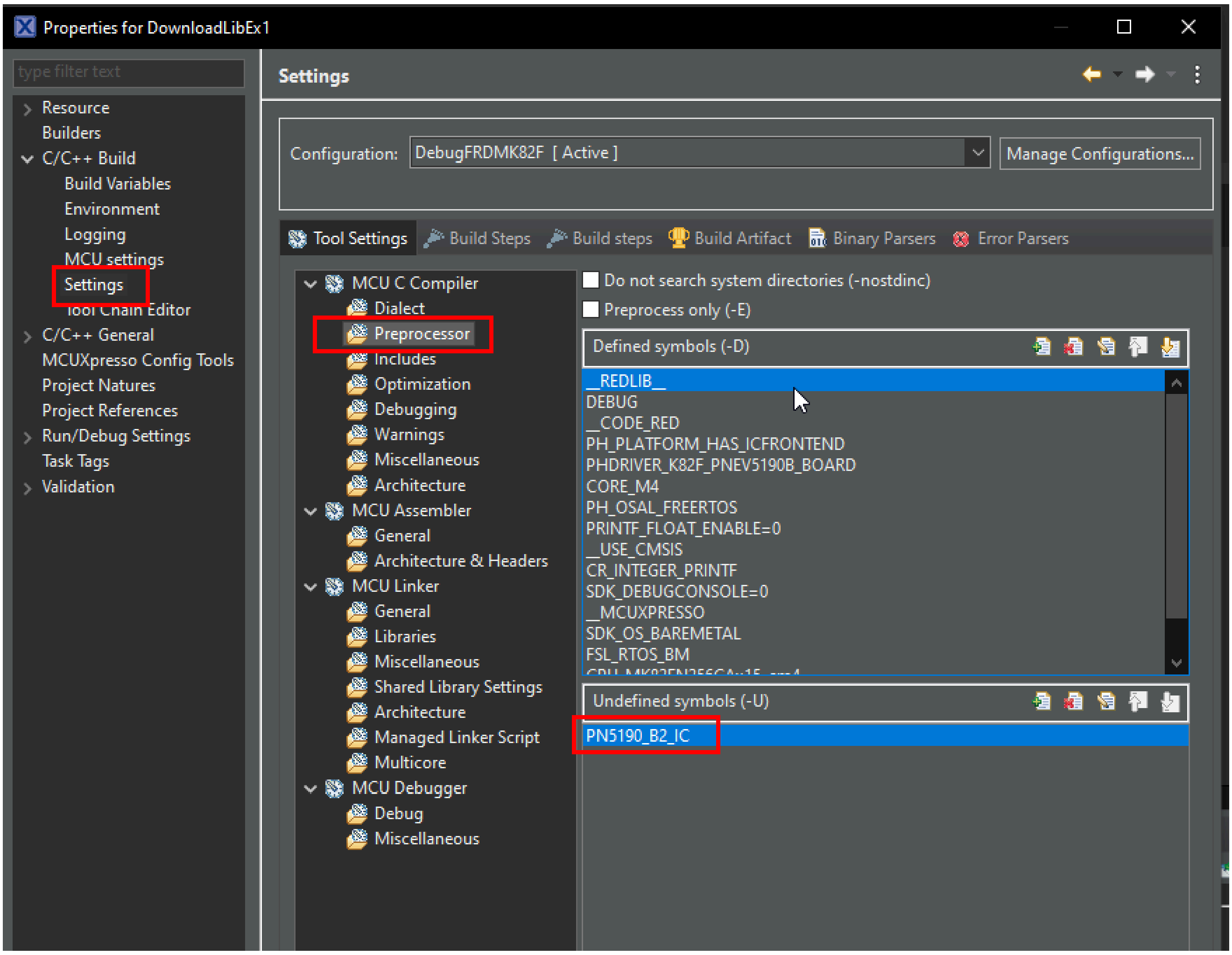

Figure 18. Project properties

13 Abbreviations

Table 1. Abbreviations

Acronym	Description
AWC	adaptive wave control
DPC	dynamic power control
EMC	electromagnetic compatibility
EMI	electromagnetic interference
ESD	electrostatic discharge
FW	firmware, here PN5190 firmware
LUT	lookup table
MF	matched filter
PRBS	pseudo random bit stream
RX	receive, receiver
SDT	signal detection threshold
TX	transmit, transmitter
VDDPA	supply voltage for the TX driver, normally controlled by the PN5190 internal TXLDO

14 References

[1] Data sheet – PN5190 (link)
[2] Application note – AN12549 – PN5190 antenna design guide (link)
[3] Application note – AN12551 – PN5190 design-in recommendations (link)
[4] Resources – PN5190 antenna design tools (link)
[5] Web page – PNEV5190BP – Development Board for PN5190 (link)
[6] Web page – NFC-Cockpit – NFC Cockpit Configuration Tool for NFC ICs (link)
[7] Web page – PN5190 Dynamic Power Control Quick Calibration and TxShaping Demo (link)
[8] User manual – UM11942 – PN5190 Instruction layer (link)
[9] Web page – NFC Antenna Design webinar (link)
[10] Software – SW6592 – PN5190 Secure Firmware Downloader Example Code (link)

15 Revision history

Table 2. Revision history

Document ID	Release date	Description
AN13669 v.2.1	12 February 2025	• Section 14 "References" updated.
AN13669 v.2.0	14 May 2024	• Section 2 "How to reduce maximum output power" updated. • Section 5 "Why the DPC calibration fails" updated. • Section 12 "Why does DownloadLibEx1 fail" added. • Section 14 "References" updated.
AN13669 v.1.0	02 February 2023	• Initial version

Legal information

Definitions

Draft — A draft status on a document indicates that the content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included in a draft version of a document and shall have no liability for the consequences of use of such information.

Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Terms and conditions of commercial sale — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at https://www.nxp.com/profile/terms, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Suitability for use in non-automotive qualified products — Unless this document expressly states that this specific NXP Semiconductors product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NXP Semiconductors accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NXP Semiconductors' warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NXP Semiconductors' specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NXP Semiconductors for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NXP Semiconductors' standard warranty and NXP Semiconductors' product specifications.

HTML publications — An HTML version, if available, of this document is provided as a courtesy. Definitive information is contained in the applicable document in PDF format. If there is a discrepancy between the HTML document and the PDF document, the PDF document has priority.

Translations — A non-English (translated) version of a document, including the legal information in that document, is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

Security — Customer understands that all NXP products may be subject to unidentified vulnerabilities or may support established security standards or specifications with known limitations. Customer is responsible for the design and operation of its applications and products throughout their lifecycles to reduce the effect of these vulnerabilities on customer's applications and products. Customer's responsibility also extends to other open and/or proprietary technologies supported by NXP products for use in customer's applications. NXP accepts no liability for any vulnerability. Customer should regularly check security updates from NXP and follow up appropriately.

Customer shall select products with security features that best meet rules, regulations, and standards of the intended application and make the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP.

NXP has a Product Security Incident Response Team (PSIRT) (reachable at PSIRT@nxp.com) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

NXP B.V. — NXP B.V. is not an operating company and it does not distribute or sell products.

Licenses

Purchase of NXP ICs with NFC technology — Purchase of an NXP Semiconductors IC that complies with one of the Near Field Communication (NFC) standards ISO/IEC 18092 and ISO/IEC 21481 does not convey an implied license under any patent right infringed by implementation of any of those standards. Purchase of NXP Semiconductors IC does not include a license to any NXP patent (or other IP right) covering combinations of those products with other products, whether hardware or software.

Trademarks

Notice: All referenced brands, product names, service names, and trademarks are the property of their respective owners.

NXP — wordmark and logo are trademarks of NXP B.V.

EdgeVerse — is a trademark of NXP B.V.

Tables

Figures

Contents