PTX205R Low-Power Card Detection (LPCD)

Introduction

This application note describes the Low-Power Card Detection (LPCD) mode technology for applications where maximizing battery life is essential , including detailed current consumption references, practical illustrations of LPCD parameters, and guidance on effective tuning.

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1. Acronyms and Terminology

- **LPCD**: Low Power Card Detection
- **NFC**: Near Field Communication
- **EVK**: Evaluation Kit; a set of hardware and software
- **CW**: Continuous Wave
- **MCU**: Microcontroller
- **PICC**: Proximity Integrated Circuit Card, that is, NFC Tag
- **IC**: Integrated Circuit

2. LPCD Overview

Low-Power Card Detection (LPCD) mode is a key technology for applications where maximizing battery life is essential. LPCD is an operating mode that reduces the amount of current consumed by the PTX205R during its operation. As the name implies, this operating mode uses a subset of the PTX205R features to detect a change in the magnetic field with a minimum amount of power consumption. Upon a detection, a regular polling cycle is initiated that could eventually read out an NFC Tag.

In other words, unlike keeping activated a regular polling, which continuously searches for NFC tags and consumes power, LPCD utilizes a subset of features for simply sensing for small changes in the output impedance. This allows the PTX205R, as well as the whole system, to drastically reduce the overall power consumption and activating itself only when an object is present. The object can be an PICC, or even non-NFC device, which impacts the NFC magnetic field.

Sections 2.1 and 2.2 show a comparison between the regular polling scheme and LPCD.

2.1 Regular Polling Cycle

Figure 1. Polling Technology – Regular Polling Cycle

In regular polling cycle, the PTX205R is continuously searching for Tag A, Tag B, Tag F and Tab V, then again Tag A, Tag B and so on forever. In between polling cycles, with all technologies which were enabled, might be a standby state to reduce the current consumption. In the presence of an PICC, this will be activated immediately and NFC data exchange will occur.

The total time duration when the NFC field is emitted depends on how many NFC technologies are enabled. It might be in range of few milliseconds and up to tens of milliseconds.

2.2 LPCD Cycle

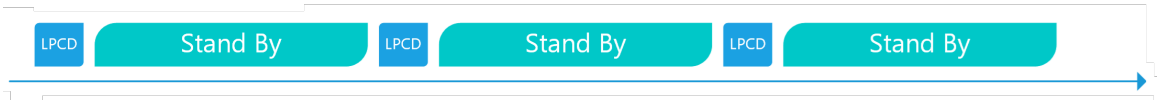

Figure 2. Polling Technology –LPCD Cycle

In LPCD mode, the polling with data for each NFC technology is replaced by very short LPCD pulses, where the presence of an object is checked by detecting small changes in antenna impedance. These short pulses are in the range of µs, thus emitting continuous wave field for that small time will have a high impact in reducing the average current consumption.

Standby is the lowest operating mode, in term of power consumption, while keeping the memory and a few vital parts of the PTX205R still active. In this way it could recover quickly and initiate a regular polling cycle.

LPCD is particularly useful in applications where power efficiency is critical, such as in battery-operated devices.

2.2.1 Normal LPCD Behavior

When the host starts the LPCD routine, an initial polling sequence is called to ensure no card is within the field and to prevent false initial LPCD calibration. The LPCD initial calibration is important into ensuring reliable performance for object detection.

If no card is detected, the system starts the initial LPCD calibration. Once calibration is done, the device is powered down (standby state) for the configured idle time.

After every idle time periods, the system goes through the following steps:

- Wake up
- Initiate short CW pulse with the LPCD wave amplitude
- Check the received signal strength against a moving average of the last measurements
- In case the difference in received signal strength is greater than the detection threshold, then initiate a complete polling cycle
- Otherwise, go back to standby

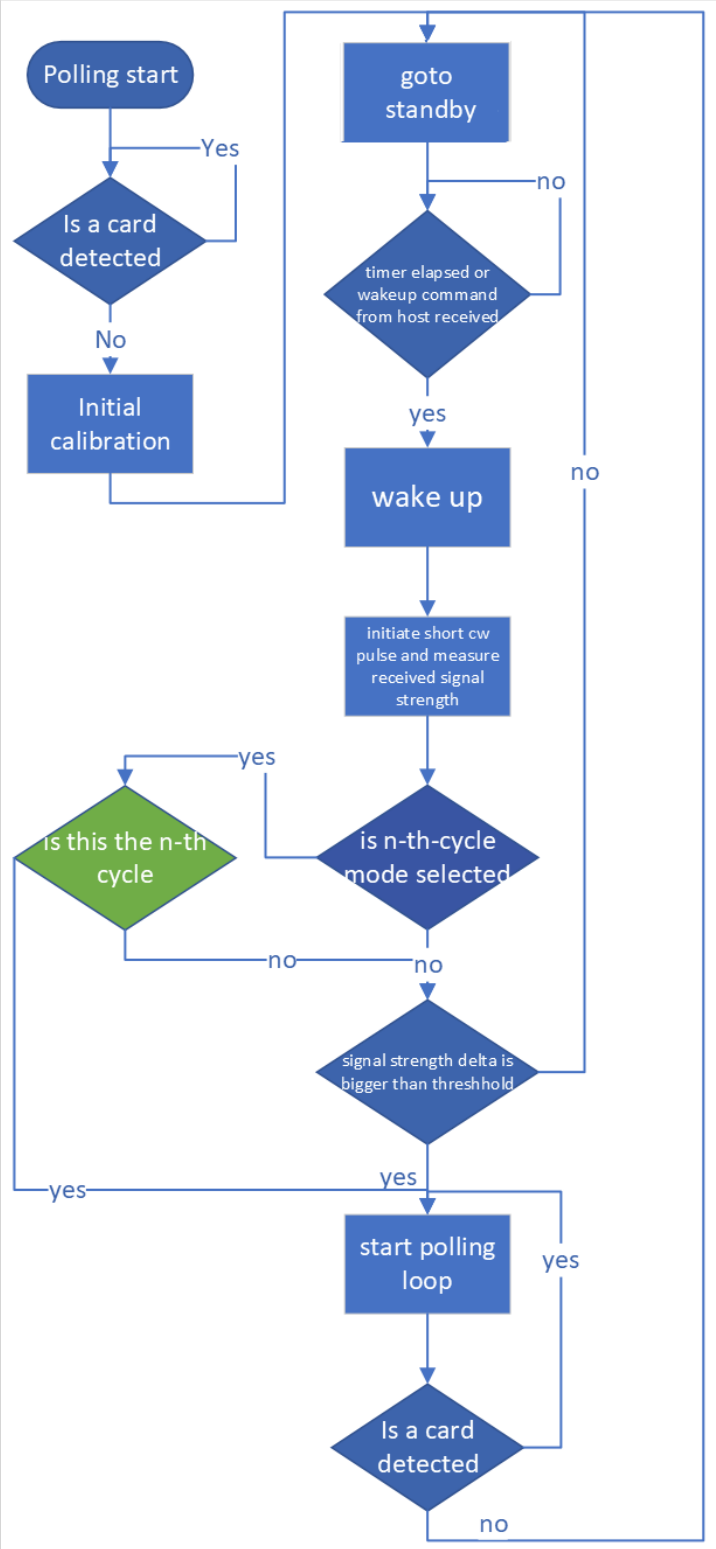

Figure 3. Normal LPCD Behavior Flow Diagram

2.2.2 Every n-th Cycle LPCD Behavior

Additionally, to the above-described behavior, this mode replaces every n-th LPCD cycle with a full polling cycle (green decision box is active). This hybrid mode allows detection of cards that do not meet the LPCD detection criteria. This mode incurs a power consumption penalty since a full polling cycle draws more current then an LPCD cycle.

3. LPCD Configuration

In the **Polling Settings** tab of the PTX2xxR RUL Config Tool (see Figure 4), there are settings for **Discovery loop** and **Idle Time between poll cycles (millisec)**.

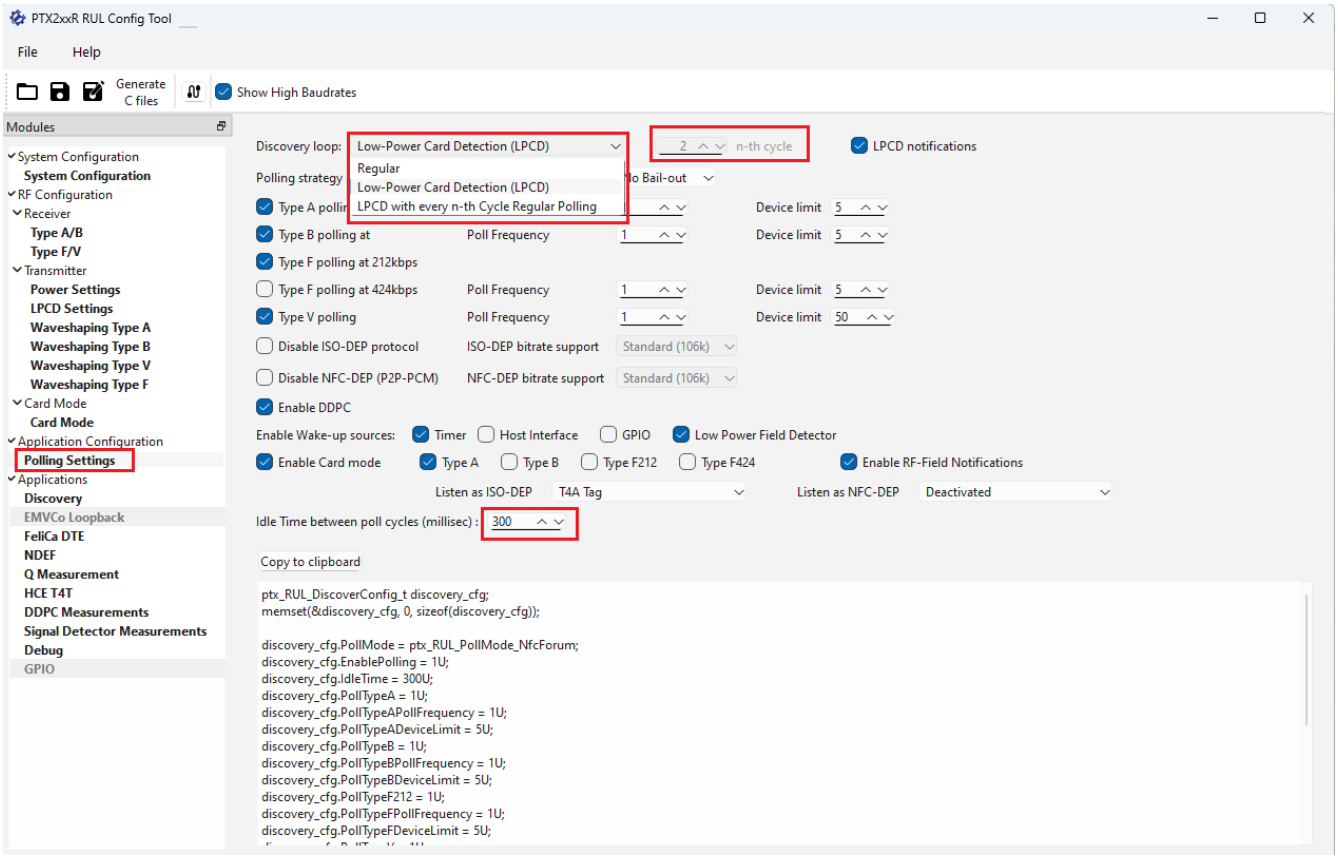

Figure 4. PTX2xxR RUL Config Tool – Polling Settings Tab

The idle time refers to the time between two consecutive NFC data pulses, or LPCD pulses. During this time, the PTX205R will be in Standby state. The idle time can be adjusted according to the required reaction time of the system.

For **Discovery loop**, there are three possible configurations to be selected from the drop-down menu:

- **Regular**: LPCD mode is deactivated for this configuration. Only regular polling with NFC data for the selected technologies is executed.
- **Low-Power Card Detection (LPCD)**: This configuration activates the LPCD with the "normal LPCD behavior".
- **LPCD with every n-th Cycle Regular Polling**: This configuration activates the LPCD with the "Every n-th Cycle LPCD behavior". The n-number represents a natural number which can be configured from 2 to 255 range.

In the **LPCD Settings** tab (see Figure 5), the following parameters can be configured:

- LPCD Wave amplitude
- LPCD Detection Threshold
- LPCD Settling Time

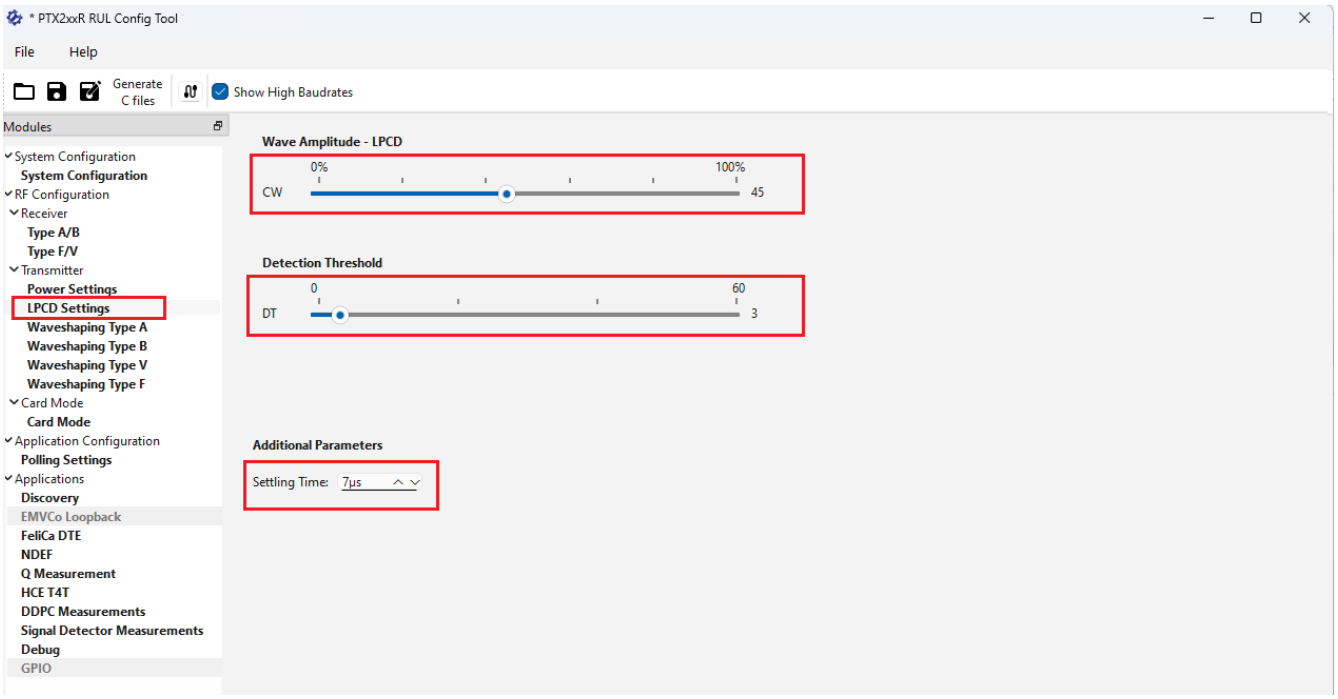

Figure 5. PTX2xxR RUL Config Tool – LPCD Settings Tab

3.1 LPCD Parameters

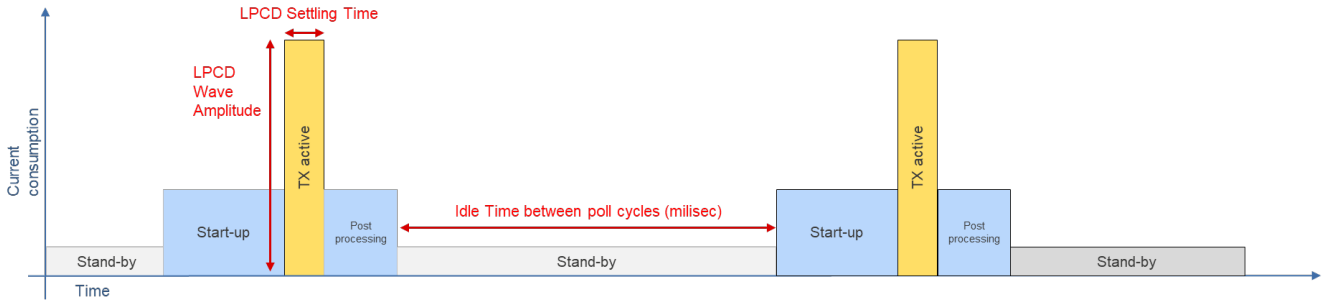

Figure 6. LPCD Parameters – Wave Amplitude, Detection Threshold and Settling Time

3.1.1 Wave Amplitude

The amplitude of the CW pulse that is emitted during the LPCD phase. The higher the wave amplitude, the higher the detection range. This directly impacts power consumption; higher amplitude will lead to increased current delivered into antenna.

Value can be set from 0 to 100%.

3.1.2 Detection Threshold

This threshold determines how big a change in the field is necessary to detect a card. Lower values require less field change. Values that are too low may trigger a false card detection even if no card is present.

Can be set between 0x01 and 0x3C.

3.1.3 Settling Time

Settling time for the RX signal chain before the ADC measurement is taken. A higher value can help in case of additional noise but is typically not needed.

This parameter dictates the duration of the transmitted pulse (TX active time) which impacts the power consumption, so only increase the value in case of high environmental noise.

Value can be set from 7µs to 255µs.

4. LPCD Tuning

Fine tuning of the LPCD parameters may be necessary to better fit the specific application. The main steps of the fine tuning procedure are explained below:

4.1 Step 1: Determine the Reading Distance

First, it is important to measure/know the reading distance with different NFC counterparts, then to adjust the LPCD parameters to have the detection range as close as possible to the reading distance.

From the Config Tool > Polling Settings, set the **Discovery loop** to "Regular". This will disable the LPCD function.

Measure the reading distances with different NFC listeners which are in focus.

After the reading distances are determined, activate the LPCD by selecting in **Discovery loop** the "Low-Power Card Detection (LPCD)" and start adjusting the LPCD parameters.

4.2 Step 2: Settling Time

Set the **Settling Time** to minimum if current consumption is important, there is no noisy environment, or no other specific requirements are to be ensured (for example, precise timing for LPCD assistance requirements).

4.3 Step 3: Detection Threshold

Set the **Detection Threshold** at the minimum value. This will be later adjusted based on the presence of false LPCD trigger events.

4.4 Step 4: Wave Amplitude

Start with low values of wave amplitude and gradually increase them until the detection range is maximized, or false LPCD trigger events are occurring.

In case of false LPCD trigger events, then increase the detection threshold value as noted in step 3.

Stop the adjustment of these parameters when the detection range is sufficient and no false LPCD trigger events are visible.

4.5 Optimization

After a set of parameters are determined from the previous steps, perform the fine adjustment as described in the table below, depending on the behavior of the system:

Behavior	Suggested Change in the Configuration
High false alarm rate (within wanted detection range)	Increase Detection Threshold
High false alarm rate (outside wanted detection range)	Reduce LPCD Wave Amplitude Increase Detection Threshold
Good false alarm rate but short detection distance	Decrease Detection Threshold Increase LPCD Wave Amplitude

4.6 LPCD Notification in the Config Tool

In the **Polling Settings** section of the Config Tool, check the LPCD notification box and a notification will report an LPCD trigger event (see Figure 7).

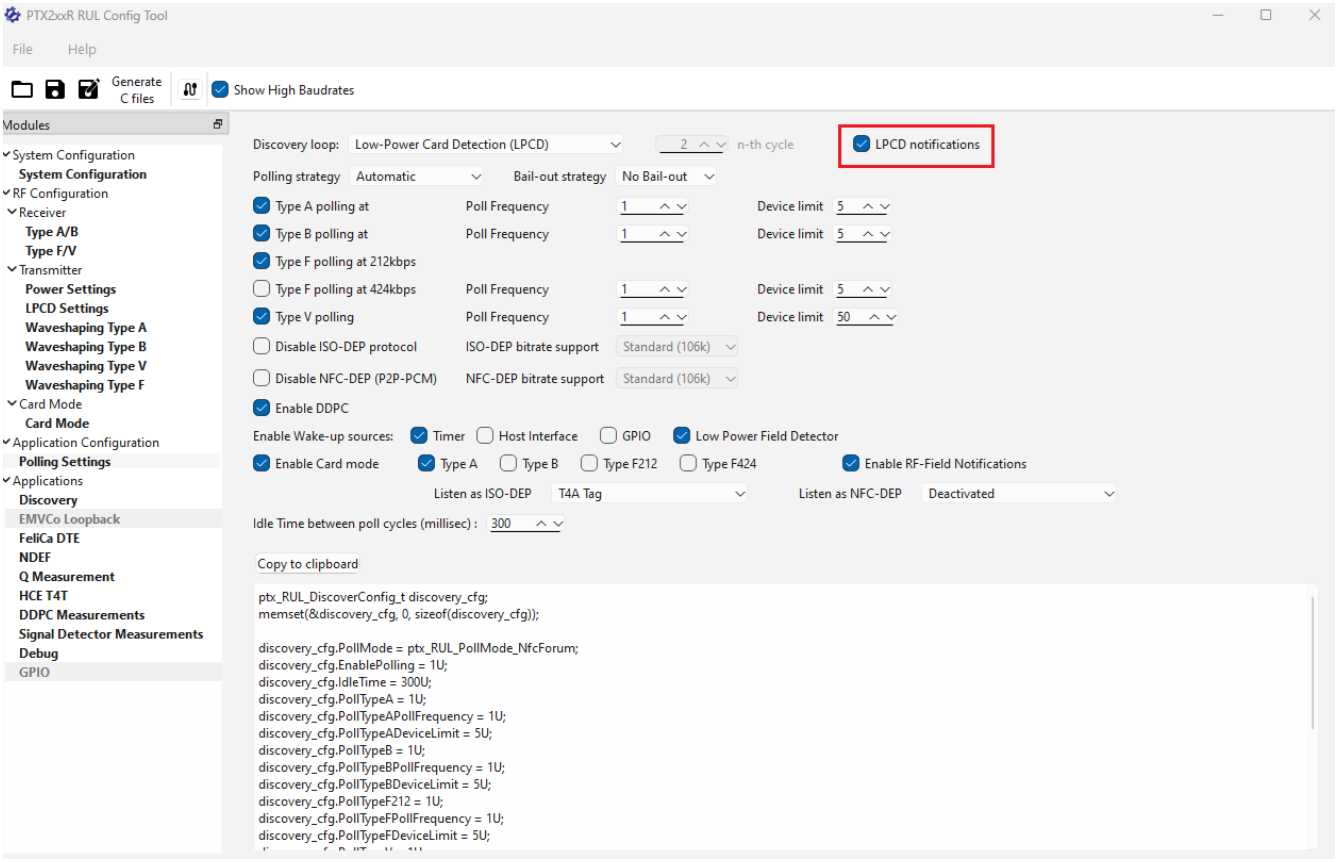

Figure 7. Polling Settings – LCPD Notifications

Once the discovery loop is started, it is possible to see the number of LPCD notifications on the lower sidebar.

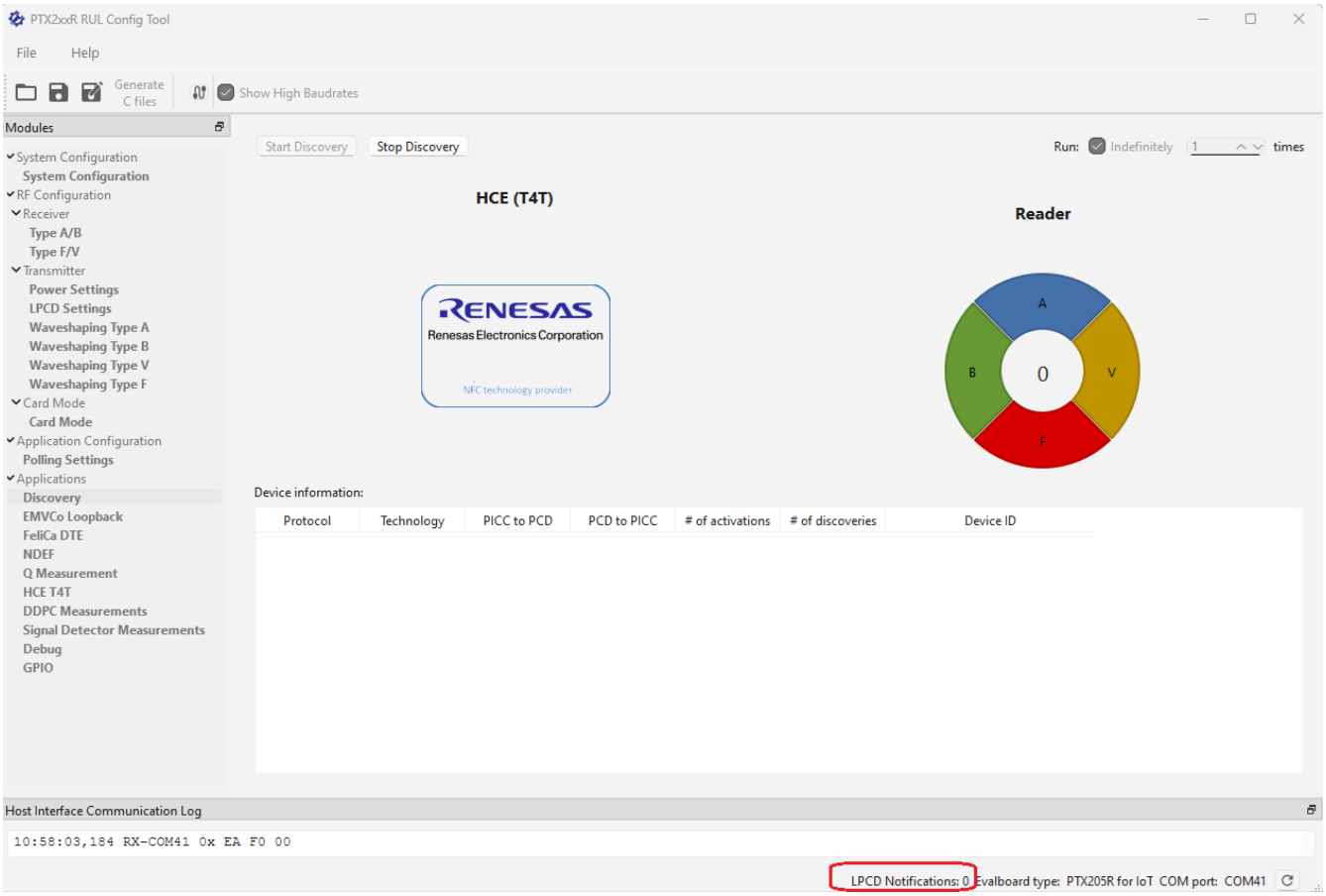

Figure 8. Viewing the Number of LPCD Notifications

The LPCD notification should indicate 0 when there is no NFC card in proximity of the reader.

This is the condition when there are no false detections. The counter should start increasing if a conductive object is moved close to the reader antenna.

When the number is increasing without having an object on top of the antenna, this means that false LPCD trigger events are present and the LPCD parameters need to be adjusted.

Note: This number will not increase if a card is correctly detected.

5. Practical Example

5.1 LPCD Optimization and Current Budget Evaluation

The **PTX205R EVK** board and a suitable **power analyzer** could be used as the setup for measuring the current consumption.

This is in general an important point for battery powered applications. Therefore, the values and method explained in the following sections are designed to easily replicate either in terms of effort as well as required tools.

As a reference, the following table shows the average of the combined currents for the PTX205R and are measured for different **LPCD Wave Amplitude** and **Idle time**. In other words, each value in the table represents the averaged values of I_VDD_TX+I_VBAT+I_VDDIO.

The rest of the settings were left with the default values as related to the PTX205R EVK:

- LPCD Detection Threshold = 3
- LPCD Settling Time = 7µs

Table 1. PTX205R Current Consumption [µA]

		Discovery Idle Time [ms]				
		100	250	300	500	1000
LPCD Wave Amplitude [%]	100	101	48	42	31	22
	80	96	46	40	30	21
	60	93	45	39	29	21
	45	91	44	38	28	20
	30	88	43	37	27	20

The values in the table are referring to the following power supply configuration:

VDD_TX = VDDIO = VBAT = 3.3V

The measurements were conducted at room temperature. Each measurement value is an average of the current acquisition over 10 seconds.

The current acquisition is turned on once the LPCD mode is set and running to avoid collecting data while the PTX205R is in initialization phase, or initial calibration.

5.1.1 Measuring LPCD Current Consumption

Due to the highly dynamic range, a fast-sampling rate measurement system is required to properly capture the short current pulses over certain amount of time. For current measurement, a "JouleScope" with 2MHz sampling rate was used and as already mentioned, each acquisition was done for at least 10 seconds in order to have a significative measured result.

For this measurement, the referenced PTX205RIOTEB - Evaluation Kit Manual is the complementary document that explains the power supply configuration of PTX205R EVK, and is used to easily carry out the current acquisition for each power domains. Figure 9 shows the jumper configuration for measuring the currents: **I_VBAT, I_VDDIO** and **I_VDD_TX**.

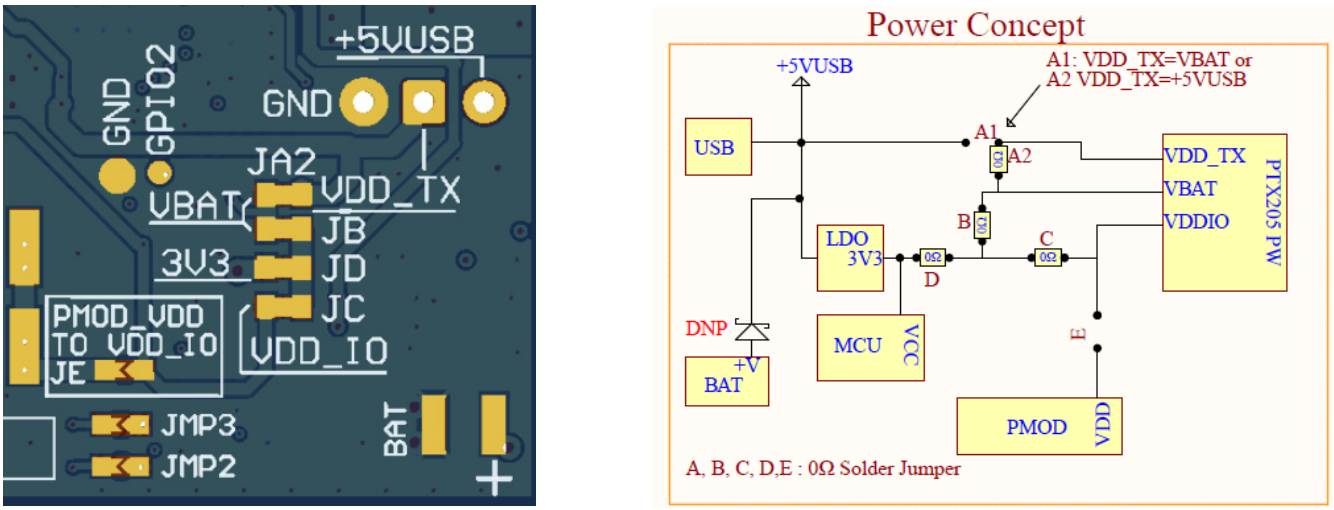

Figure 9. Jumper Configuration for Measuring Currents

In the default configuration of the EVK, the VDD_TX, VBAT and VDDIO voltage rails are all supplied from the 3.3V LDO, so by disconnecting the jumper **D** and connecting an amp-meter, there is enough to measure the sum of all the currents consumed by PTX205R IC domain.

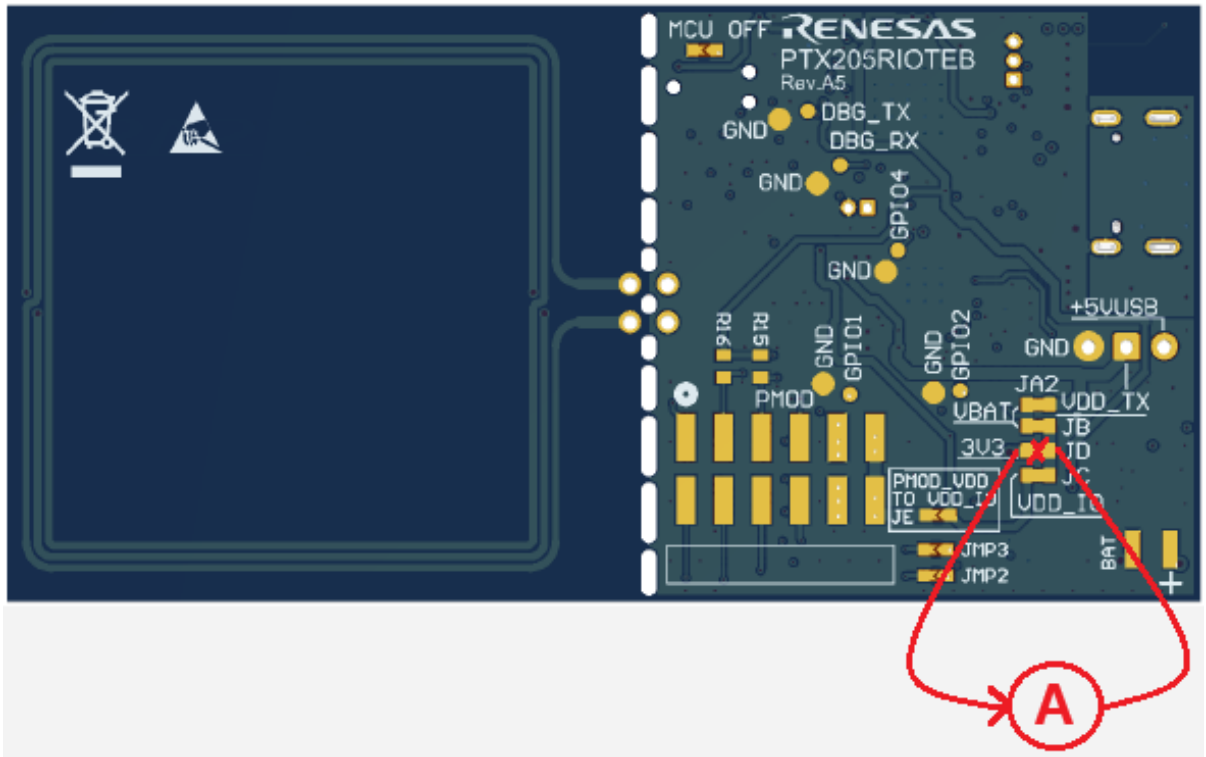

Figure 10. Connecting an Amp-Meter to Jumper D

5.1.2 Measuring the Current

The current measured for **I_VDD_TX+I_VBAT+I_VDDIO** is represented in:

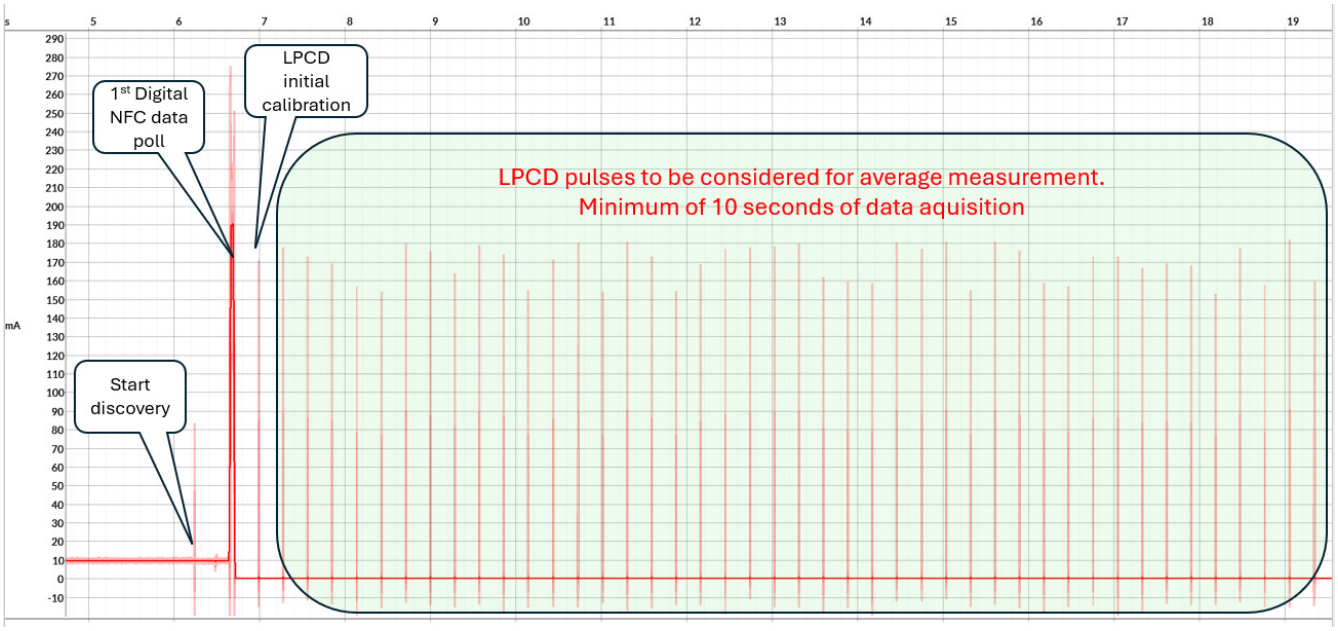

Figure 11. Current Measured for I_VDD_TX+I_VBAT+I_VDDIO

As can be observed, after the discovery loop is enabled there is an initialization phase, followed by an NFC digital data poll, which checks for potential tag presence. If no NFC tag detected, then the LPCD initial calibration is executed. These are to be excluded from the average calculation for LPCD since they are one-time only events.

5.2 LPCD Detection and NFC Read Ranges

Considering the default settings for LPCD, which provides the best trade-off between power consumption during LPCD and detection range, the reading distances versus LPCD detection distances for different tag technologies are represented on the chart in Figure 12:

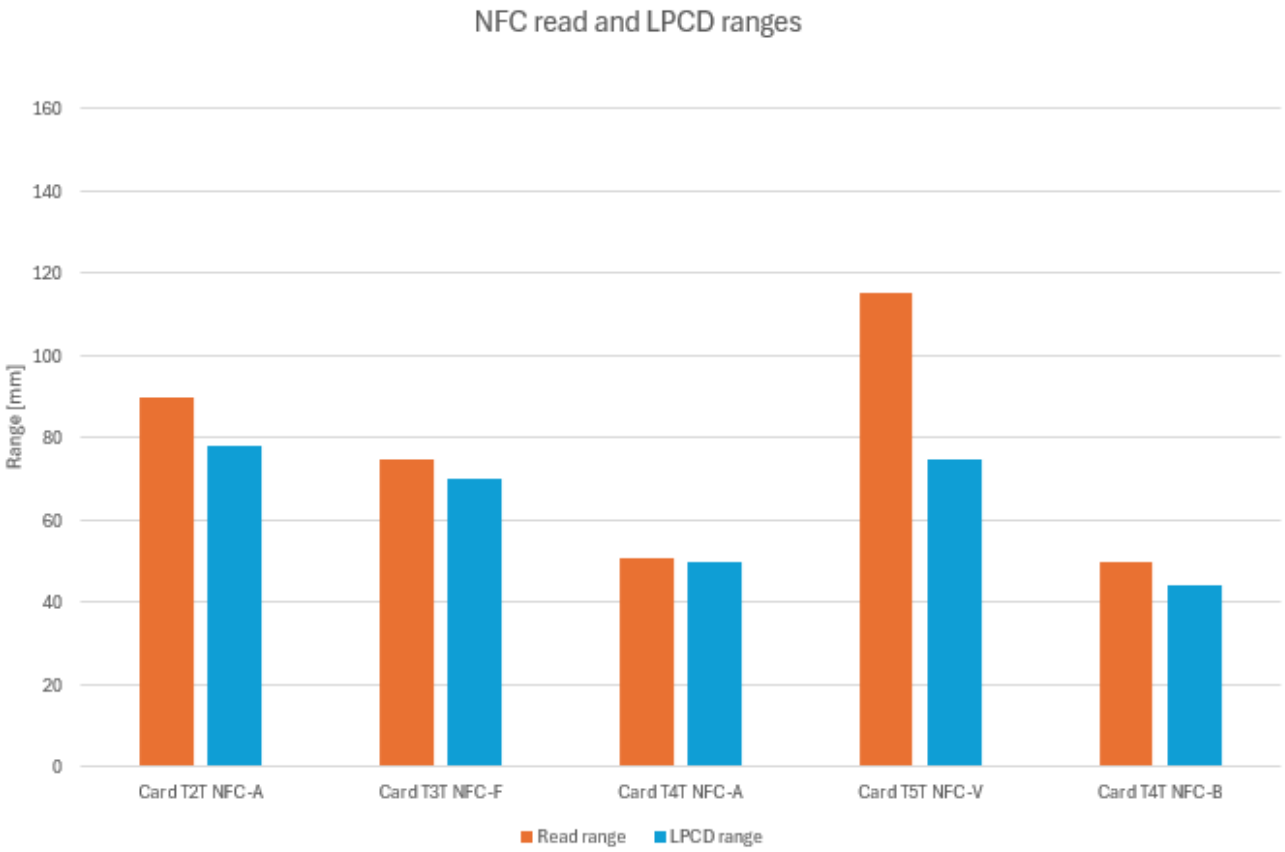

Figure 12. NFC Read and LPCD Ranges

Optimized parameters for LPCD settings:

- LPCD Detection Threshold = 3
- LPCD Settling Time = 7µs
- LPCD Wave amplitude = 45%
- Idle time = 300ms

These optimized parameters were obtained following the procedure described in section 4.

6. Revision History

Revision	Date	Description
1.00	Feb 25, 2026	Initial release.

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