Register setting configuration (PTX1xxR IOT Config Tool-based)

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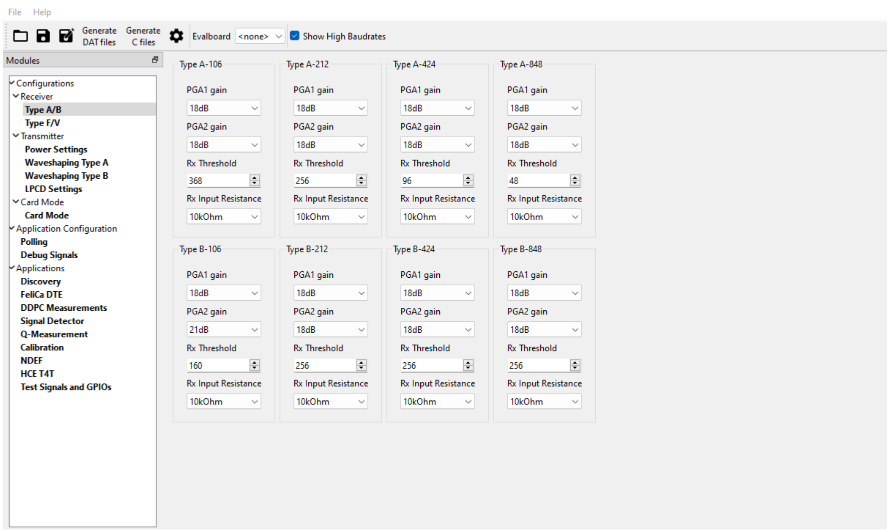
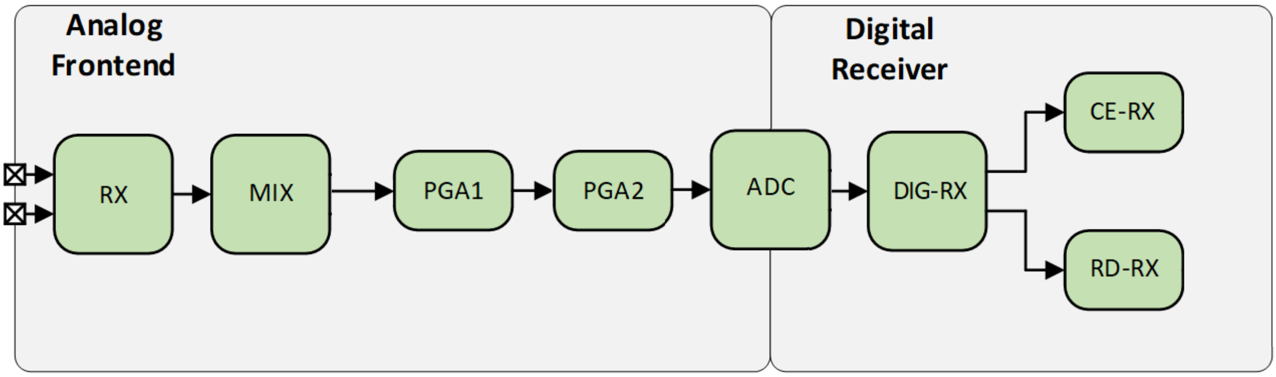
The purpose of this document is to provide a guide for the user to modify and optimize the RF performance of the PTX100R, PTX105R and PTX130R via various register settings. In addition to the antenna matching, the RF performance can also be fine-tuned by settings using the PTX1xxR IOT Config Tool (further called GUI).



1 Configuration of receiver settings

In the PTX1xxR an IQ receiver architecture is used to cover all the various supported technologies, consisting of an analogue frontend and a digital baseband.

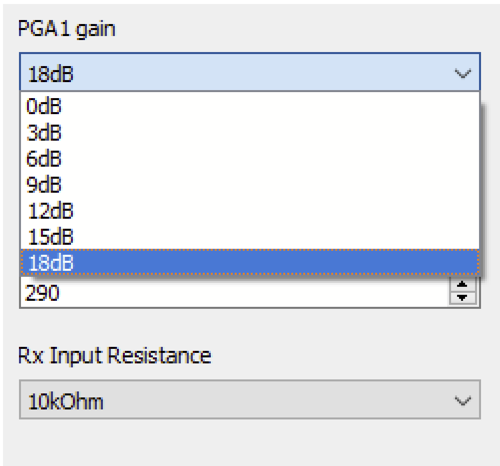


1.1 Analog frontend gain settings

Configuration of the gain in reader mode is very simple, because of applied modulation and coding schemes. This allows the input signal to be clipped and therefore the gain can be set to the highest possible value. However, this maximum value depends on the board and antenna setup and it must be taken care that the gain is not too high so that the noise on it's own is not already clipping the system.

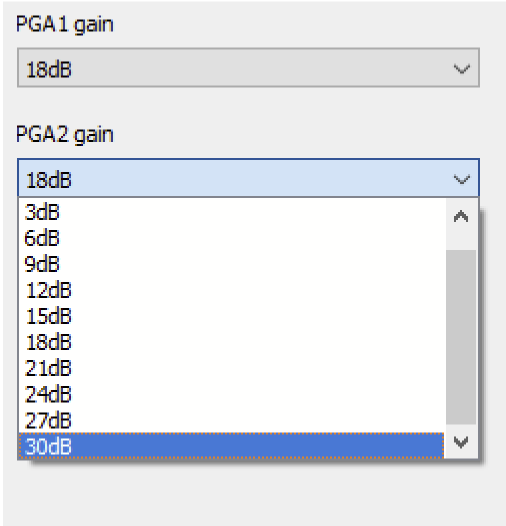
1.1.1 Programmable Gain Amplifier 1 (PGA1)

PGA1 gain is set in a range from 0dB to 18dB with a step size of 3dB. For reader mode it can be set as high as possible (max. value is 18dB) taking into account the noise level. If the gain is too high the noise level alone can already clip the system and no data signal can be demodulated.



1.1.2 Programmable Gain Amplifier 2 (PGA2)

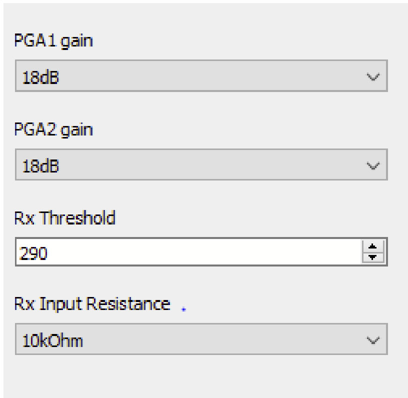
PGA2 gain is set in a range from 0dB to 30dB with a step size of 3dB. For reader mode it can be set as high as possible taking into account the noise level. If the gain is too high the noise level alone can already clip the system and no data signal can be demodulated.



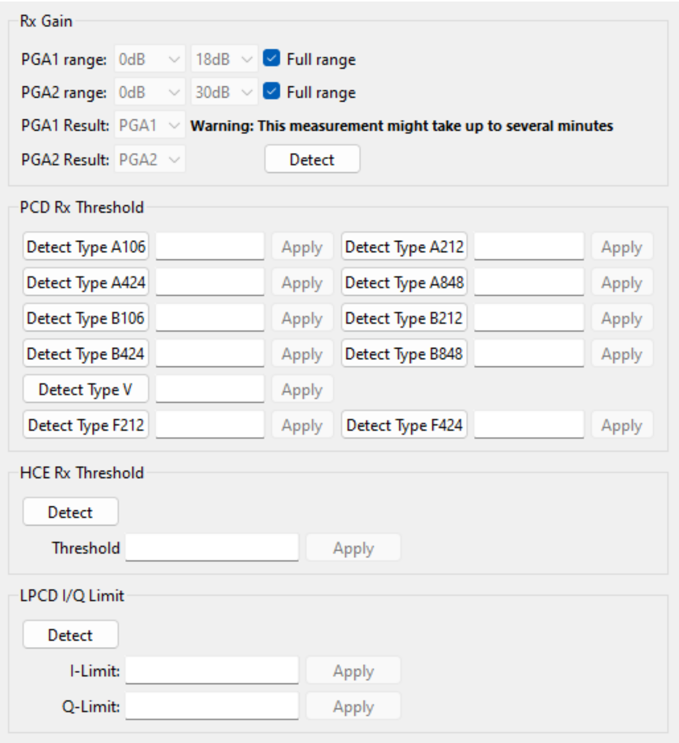
1.1.3 Signal detection threshold

Signal detection is the process of comparing the level of the filtered and processed input signal against a configurable threshold. This is needed in order to prevent the system from decoding pure noise as data when there is no actual signal present.

RX Threshold is in a range from 0 to 32767 with a step size of 1.



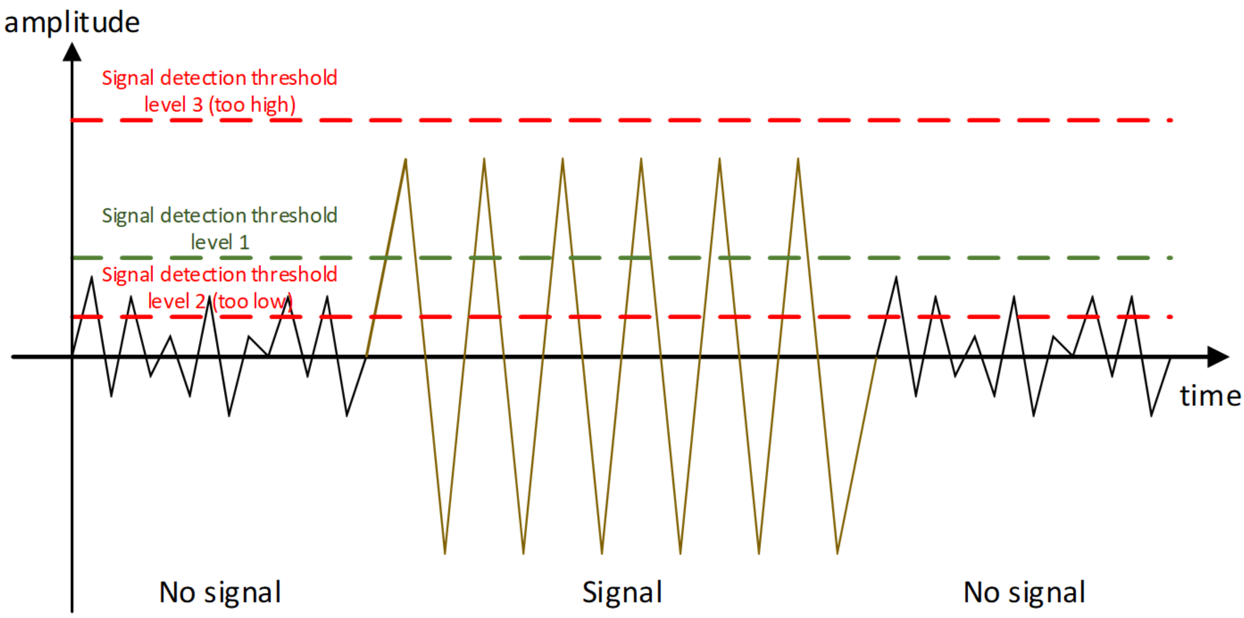
A debug function (section Applications / Signal Detector) is implemented in the GUI, which helps to fine tune the settings based on the HW configuration.



The signal detection threshold measurement has been developed in order to find the optimum value for this register based self diagnose test. Any change in the receiver settings requires a new value for this register.

The matching, antenna size and geometry and in general the overall system strongly influence the input level of the received signal at the RX pins of the PTX1xxR. Furthermore, processing and filtering of the signals in the digital receiver varies for different technologies. Therefore, the register values of the detection threshold must be changed individually for each technology.

1.1.4 Data signal and detection thresholds

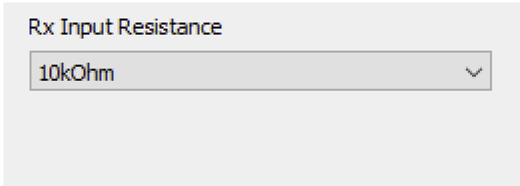


In the figure shown above the signal detection threshold level 1 is the correct one, as it clearly separates the signal from the low level noise. One has to keep in mind that the input signal levels will also vary a lot depending on the position of the card in the field of the reader. If the detection threshold is set too low the system will start decoding noise and a lot of error notifications will be generated by the SW stack and forwarded to the application. In the opposite case, if the detection threshold is set too high, the system will never detect any signal.

1.2 RX Input resistance

The first component that is used to set the gain is the input resistor.

The selectable values are 5 and 10kOhm. Again, the proper setting depends on the board, antenna and the expected input voltages. Generally, in reader mode either the 5kOhm or 10kOhm should be used. The 5 and 10kOhm values are implemented as a polyphase network.



2 Configuration of transmitter settings

2.1 Power Settings

In the section Configurations / Transmitter / Power Settings is it possible to set the **CW** (continuous wave amplitude) and **MOD** (modulation index for Type B), for both **high power** mode and **reduced power** mode.

The **Dynamic Digital Power Control** (DDPC) is used to reduce the power level delivered from the output drivers of the PTX1xxR to the antenna based on the load condition.

The **TX Dynamic Power Control** box is used to enable (checked) or disable (unchecked) this feature.

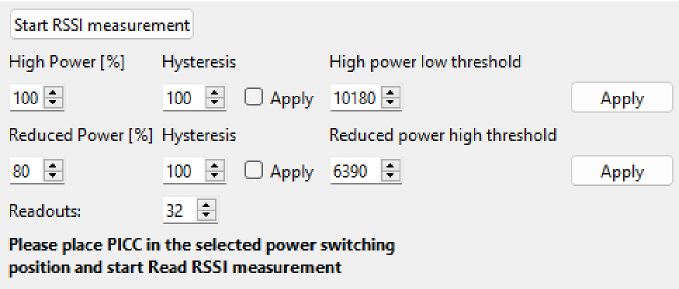
The power switching mechanism is based on the measured receiver signal (RSSI) which reflect the coupling condition between the reader and the tag.

Upper Threshold is needed to switch to the High-Power wavebank, if the measured RSSI is above the defined value.

Lower Threshold is used to switch to the Reduced-Power wavebank, if the measured RSSI is below the defined value.

The two threshold values need to be determined by measuring the RSSI, with the reader and tag in the desired switching position, by setting the output drivers in high and low power condition.

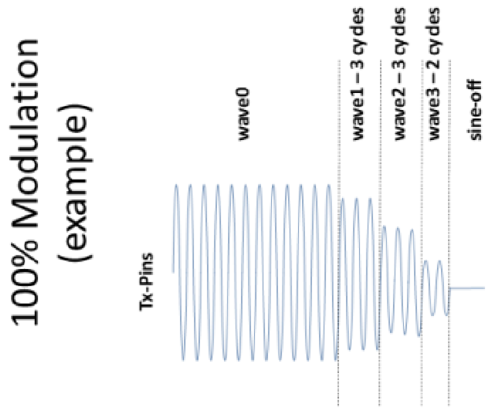
A debug function is implemented in the GUI (section Applications / DDPC Measurements), which helps to fine tune this setting based on the HW configuration.

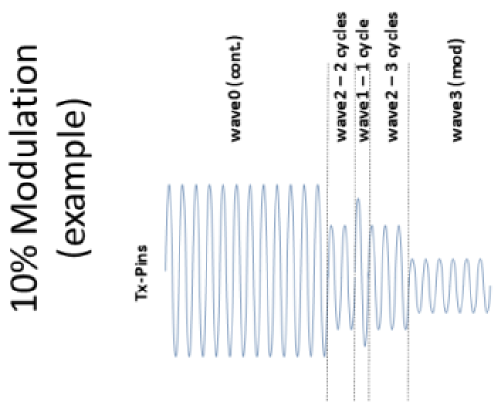


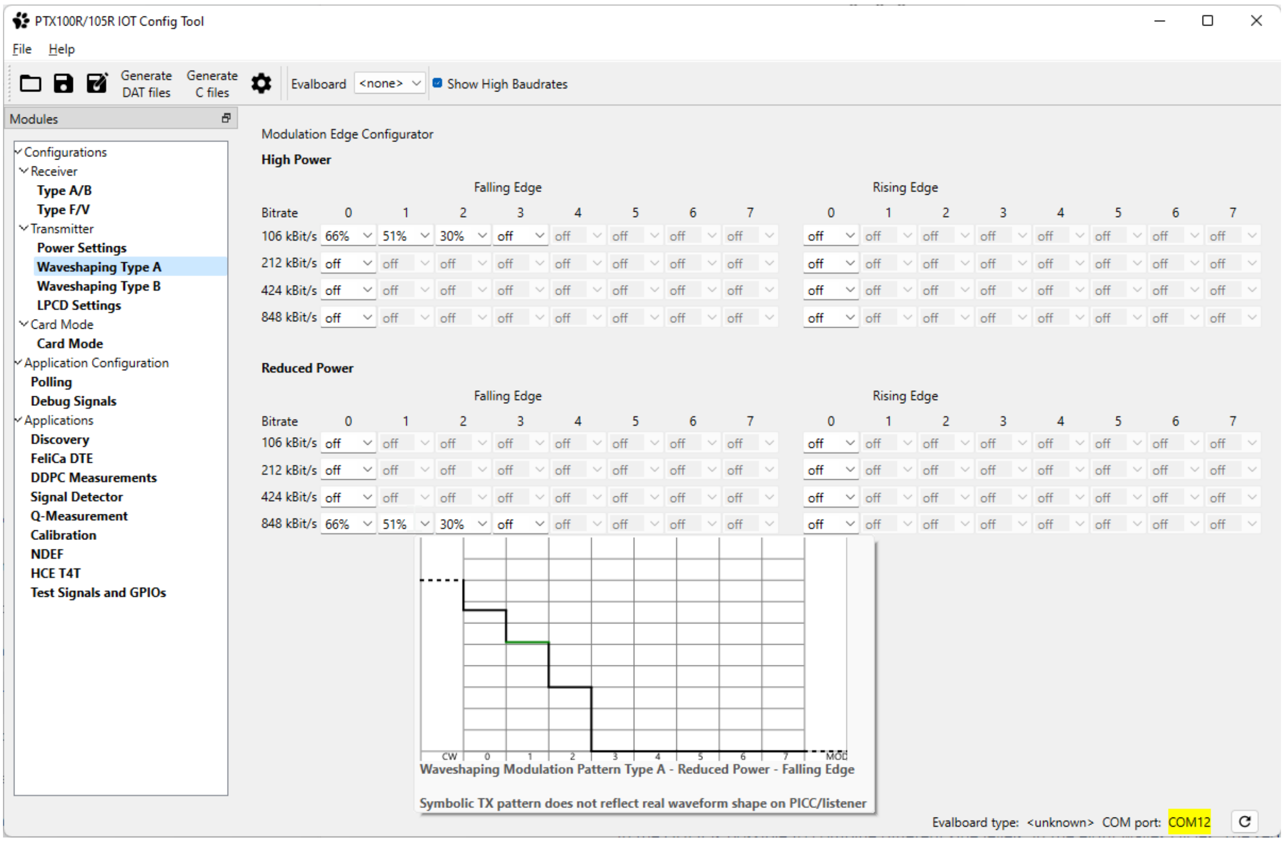
The Read RSSI measurement will return the values to be used to set up the upper and lower threshold for switching between the high and low power levels. The hysteresis can be applied if the configured value is triggered unintentionally and uncontrolled switching between high and low power mode occurs.

2.2 Waveshaping

This feature shapes the pause pulses for type A and B separately. The falling and the rising edge of a pause pulse can be shaped within a range of 8 samples. It is used to get rid of over/undershoots as well as timing issues within the pulse (e.g. T3, T4 timings).

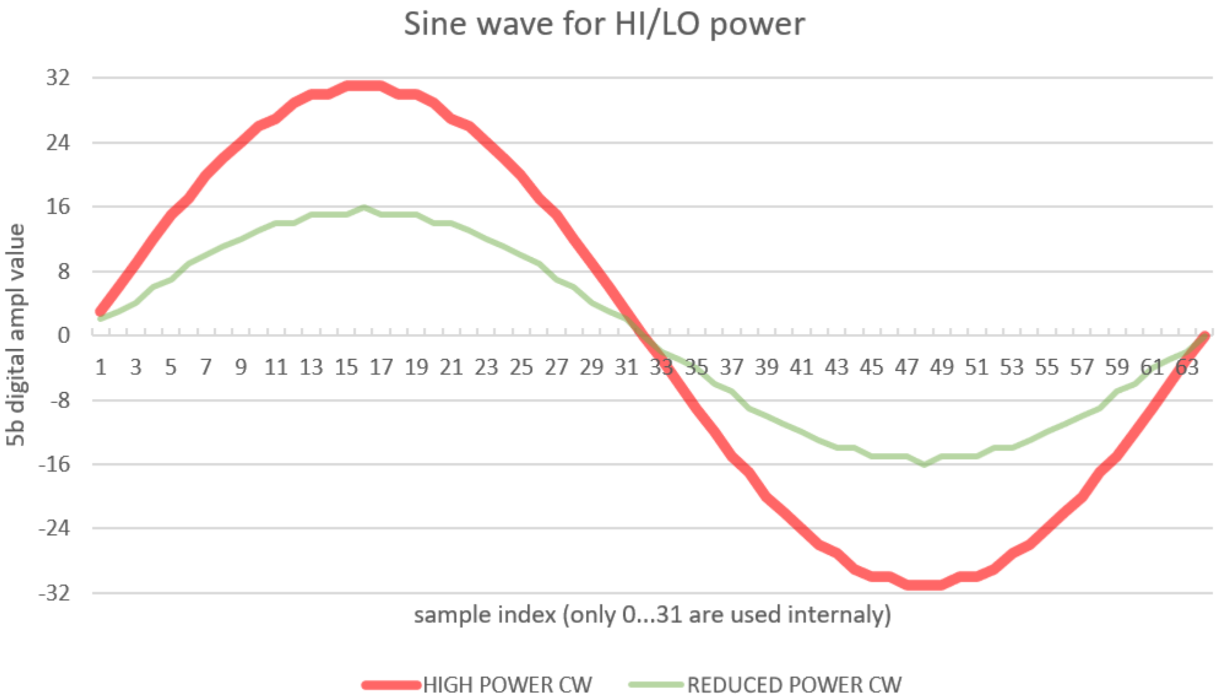






In the GUI it is possible to combine different sine levels, in the eight wave cycles by specifying an amplitude value. Amplitudes for Type A and Type B can be set separately. By changing the wave amplitudes for the wave cycles, the output power can be fine-tuned, which makes it possible to model the wave shape to pass specific standard requirements.

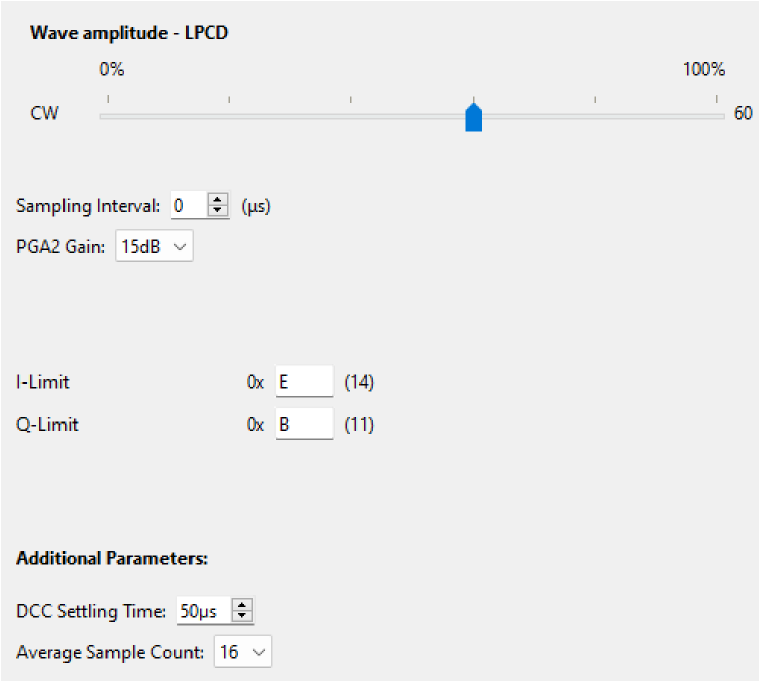
In the example below, the sine wave is set to 100% for high power mode and 50% for reduced power.



Three wavebanks are available for TypeA and two for TypeB, where High- and Reduced power mode are independently configured. This means, 3 (TypeA) and 2 (TypeB) different wave amplitudes may be set for the wave cycles for each bitrate and power mode, but alltogether, the number of different amplitudes set is limited to a certain value.

3 Low Power Card Detection

In the section Configurations / Transmitter / LPCD Settings is it possible to set the parameters for tuning the low power card detection feature of the PTX1xxR.



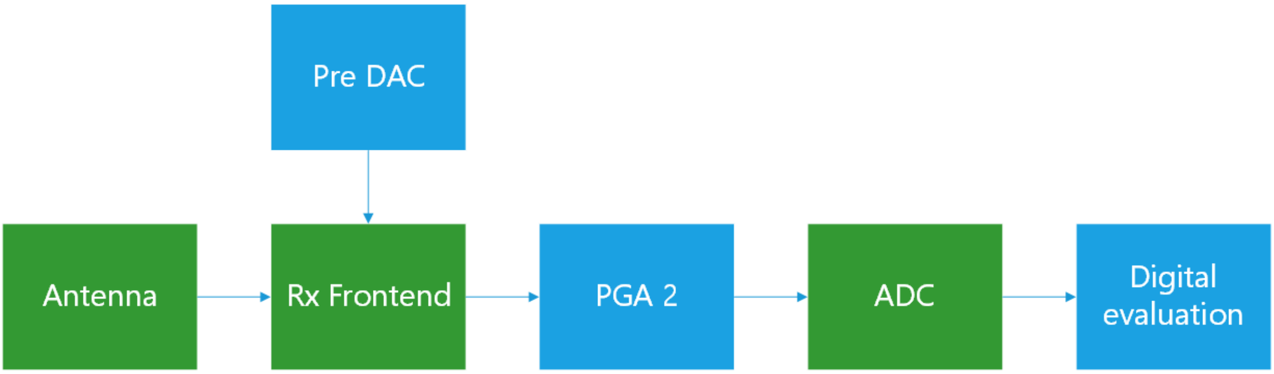
3.1 Overall Description / Principle

Low Power Card Detection (LPCD) is thought to reduce the amount of current consumed by the PTX during reader mode. With this mode enabled, the device can be active for a long time also in battery mode.

To achieve this the PTX uses only a reduced set of analogue and digital blocks during this mode and for a shorter time compared to default polling mode.

The following blocks are used during LPCD

- Transmitter on with **C**ontinuous **W**ave (CW)
- Rx Frontend → configured during Start-up
- PREDAC → configured during Start-up
- PGA2 → User specific configuration (Detection Range)
- ADC
- Digital Evaluation → User specific configuration (Sensitivity)



Compared to a normal polling procedure as shown in the figure below - Mode Nr 1/2/3 the LPCD can also use the standby mode (5) instead of the idle mode to further reduce current consumption between detection cycles.

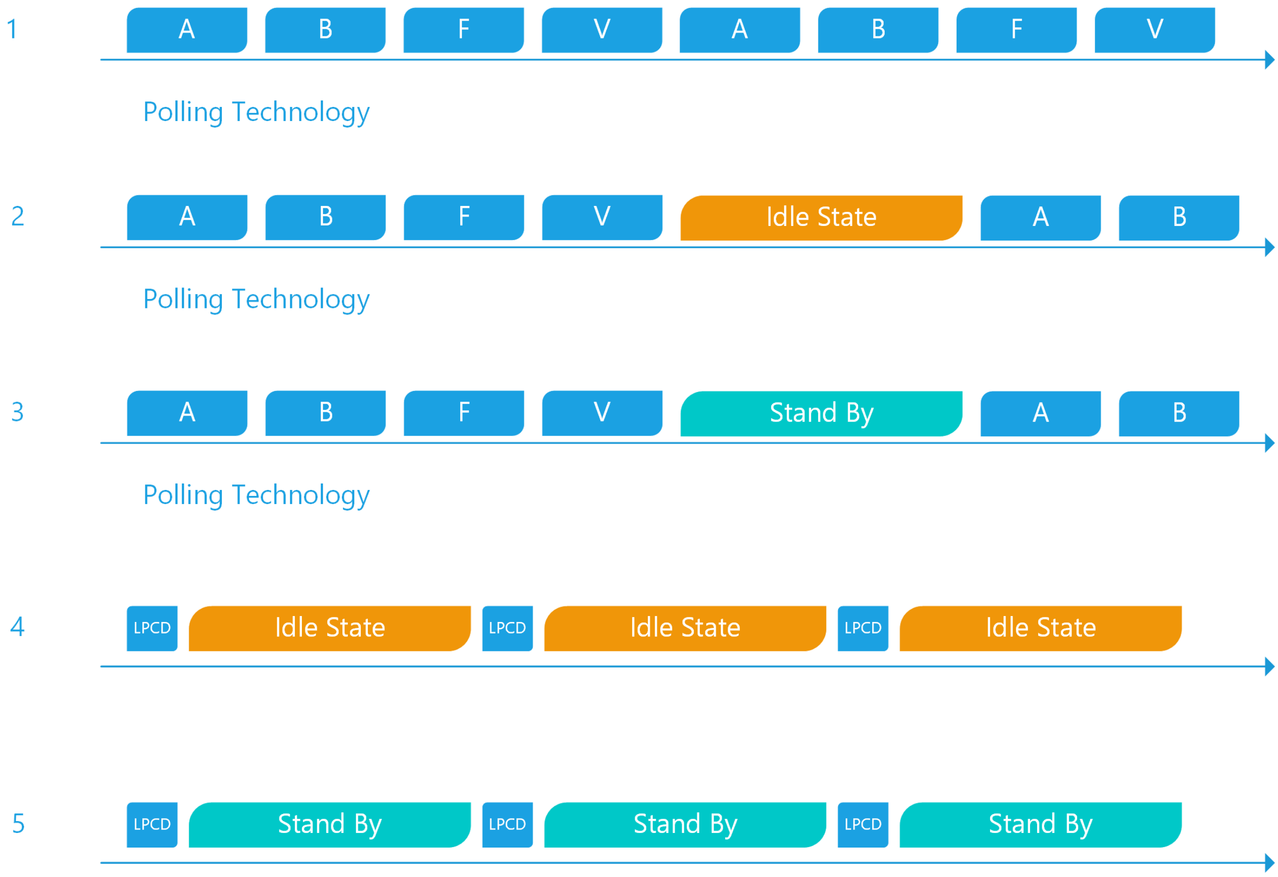


Figure 1 Different configurable polling/LPCD modes

3.2 Normal LPCD Behavior

When the host starts the LPCD routine (Mode 4 & 5) an initial polling sequence is called to ensure no card is within the field and prevent false initial LPCD calibration.

If no card was detected the system starts the initial LPCD calibration (PRE-DAC). Directly after that the recalibration is called which sets the ADC to an already good start value (center). During the first few LPCD calls the recalibration is performed several times to compensate thermal and noise drifts. If a stable state is reached the device gets powered up from the stand-by periods only for the short LPCD pulses (~75us) which dramatically reduces the current consumption.

3.3 Configuration

The configuration of the key parameters of the LPCD is done in the section Configurations / Transmitter / LPCD Settings of the GUI.

The four essential parameters are:

- Sampling Interval
- PGA2 Gain
- I-Limit
- Q-Limit

The transmitter sine amplitude can be adjusted for further current consumption reduction.

3.4 Parameter Details

3.4.1 Sampling Interval

To reduce influence of distortion over RF field/Supply the sampling interval between LPCD ADC samples can be increased from 0us (default) up to 255us.

The resulting LPCD pulse width increases by 32 * LPCD_Sampling_Interval + ~75us.

3.4.2 PGA2 Gain

This Parameter specifies the gain setting for I- and Q-branch which goes hand in hand with the detection range. Should be set between 15dB and 27dB.

3.4.3 I-Limit and Q-Limit

The I and Q Limits are used to adjust the sensitivity where the Q value should be lower than the I limit due to differently balanced detection path.

3.5 Configuration Procedure

3.5.1 1. Desired Sine Amplitude

For easier decision the following table shows the current consumption behavior for different amplitude and Standby/Idle time settings

Relative Current Consumption [%]		**Sine Amplitude [%]**				
		100	**80**	**60**	**50**	**40**
Discovery Idle time [s]	**0,1**	100	84	71	65	59

	0,33	32	27	23	21	19
	0,5	22	18	16	15	13
	0,75	16	13	11	11	9
	1	12	10	9	8	8

3.5.2 2. Sampling Interval Setting

Set Sampling Interval to 0us → lowest current consumption.

3.5.3 3. PGA2 Gain Setting

Set initial LPCD_I/Q_Limits values to 0x0E for I-Limit and 0x0B for Q-Limit.

Now increase the PGA2 Gain setting step by step to increase the detection range and take a look on the false alarms. The value for PGA2 should start at 15dB and should be highest 27dB.

3.5.4 4. I-Limit and Q-Limit Setting

If the detection range from previous steps is already satisfying continue with the fine-tuning by adjusting the I-/Q-limits. Caused by the fact of wanted asymmetry in I and Q branches the I-branch should be held higher than Q-branch.

Start by setting both branches to a value where no false alarm occurs. Then start decreasing the Q branch limit. Last step will be the I branch adjustment.

3.6 Parameter Tuning

If the previous steps do not result in a good detection performance, depending on behavior following tweaks can be done.

Behavior	Suggested configuration change	Impact
High false alarm rate / within wanted detection range	lower PGA 2 gain	lower noise, lower field change impact, decreases detection distance
	lower Q - limit	increases sensitivity on amplitude change
	lower I - Limit	
High false alarm rate / outside wanted detection range	increase Q - limit	higher ADC fluctuations are tolerated
	increase I - limit	

Behavior	Suggested configuration change	Impact
	increase SAMPLING_INTERVAL	more robust against distortions
	increase PGA 2 gain	higher field change impact; increases detection distance
	increase sine amplitude	higher field change impact
Good false alarm rate but short detection distance	increase PGA 2 gain	higher sensitivity
	decrease Q- and I - Limit	faster detection response, higher sensitivity
	increase sine amplitude	higher field change impact

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