AN11785

PN7462AU LPCD and Standby mode

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Application note
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1. Introduction

This document describes the principle of low power card detection (LPCD) offered by the PN7462AU. It describes how to use LPCD and how to optimize the related settings.

The basic idea of LPCD is to provide a function which turns off the RF field when no card is used. This saves energy and allows battery powered NFC Reader designs. This function must detect cards as soon as they are attached to the reader antenna. The overall reader design must allow a low power functionality, i.e. the leakage currents in low power mode must be as low as possible. At the same time the detection of cards must work properly within the required parameters like detection speed and detection range.

2. Principle of LPCD

The low power card detection provides a functionality, which allows to power down the reader for a certain period of time to safe the energy. After this time the reader must become active again to poll for the cards. If no card has been detected, the reader can go back to the power down state. This operation principle shown in Fig 1

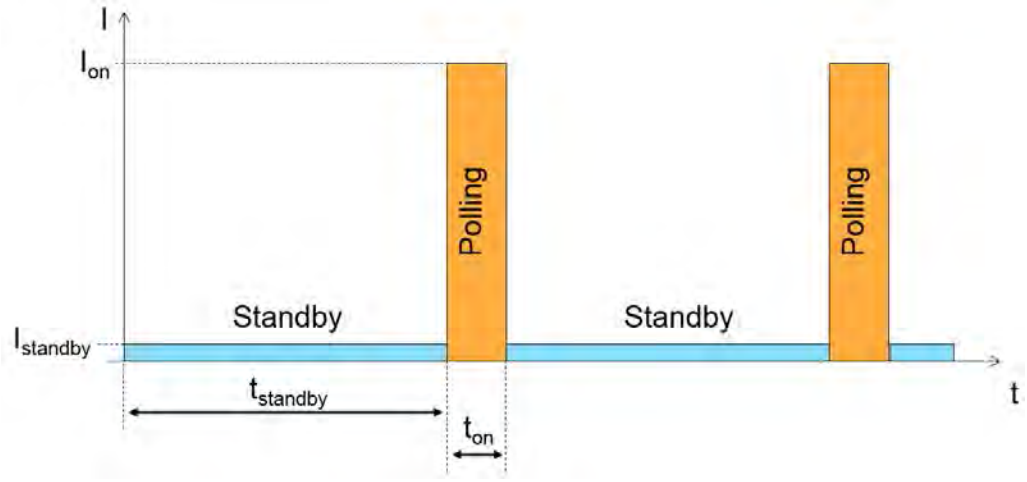


Fig 1. LPCD principle in general

The average current can be calculated as follows:

$$I_{average} = \frac{I_{standby} \cdot t_{standby} + I_{on} \cdot t_{on}}{t_{standby} + t_{on}} \quad (1)$$

where:

$I_{standby}$ = current consumption in standby or power down mode

I_{on} = current consumption during the “normal” operation

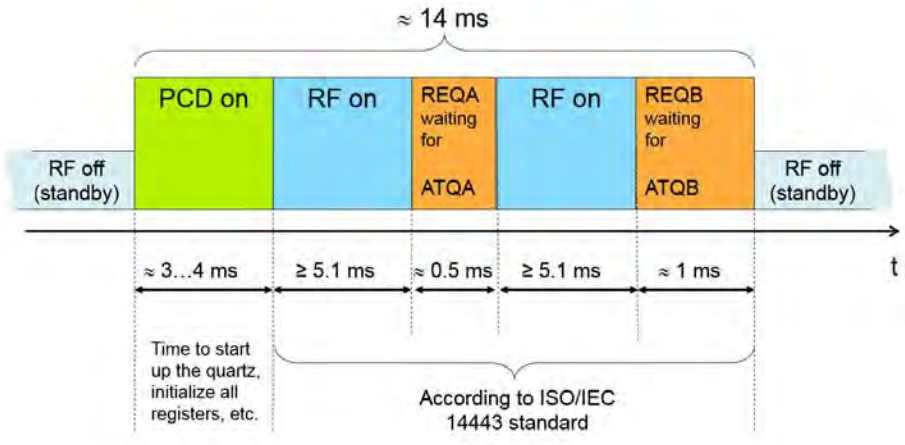
$t_{standby}$ = time period when the reader is in power down (no function)

t_{on} = duration of the polling operation

The LPCD mode can be configured according to the requirements of a particular application. In some applications the energy saving is the major criterion, e.g. because a battery life time must be increased as much as possible. In some other applications the detection speed or the detection range might be more important.

2.1 Standard polling without LPCD

The ISO/IEC 14443 standard defines very precisely the timing requirements for the polling sequence performed by the reader (PCD). Fig 2 shows such a sequence with corresponding durations of single commands. Typically, the reader stays active for t_{on} ≈ 14 ms. Asumming the standby time of $t_{standby}$ ≈ 300 ms, the standby current of $I_{standby}$ = 18 µA and the polling current of I_{on} ≈ 150 mA, the average current consumption is quite high: $I_{average}$ ≈ 5 mA



(1) This timing is based on ISO/IEC 14443 requirements.

Fig 2. PCD card polling timing

2.2 Parameters of LPCD

2.2.1 LPCD current consumption

In general, the current consumption depends on many parameters. However, the standby current during the standby time and the duration of the RF pulse are the most important parameters influencing the average current.

In order minimize the standby current it is important to properly connect the pins of the PN7462AU. Otherwise the leakage current e.g. through a pull up resistor might increase the standby current by 100 µA. That would increase the average current more or less by the same amount.

The duration of the RF pulse needs to be long enough to properly detect any card, but it should not be too long, since it increases the average current consumption.

The slower the detection speed, the lower the average current.

2.2.2 LPCD detection range

The LPCD detection range depends on the detuning and loading of the reader antenna. The bigger the coupling, the bigger the detuning effect, which is required to detect cards

Normally, the standard antenna is designed to minimize the loading and detuning effect as much as possible in order to offer consistent read performance

In some cases the operating distance is (much) larger than the detection distance. Especially for cards, which have very low load, this can happen. This might be the case e.g. for ISO/IEC 15693 cards or MIFARE Classic or MIFARE Ultralight cards.

As already stated, the stronger the coupling between reader and card, the better the detection range. Therefore, typically small reader antennas show a better LPCD detection range than large antennas. On the other side, small tag antennas typically detune the reader less than ID1 size cards, and therefore show a smaller detection range, even if the operating range is large.

Reader antennas with higher Q (i.e. designed only for 106 kbit/s) can show a better detection range than antennas with a very low Q (e.g. due to an LCD in the antenna area or due to the higher bit rate design).

The PN7462A was designed to ensure robust detection, and therefore typically has a detection range which is similar to the ISO/IEC 14443 operating distance. Example values are shown in Table 1.

Table 1. LPCD detection range example

Read range for REQA/REQB only, tested with ID1 size cards, LPCD Threshold 2

	MIFARE Plus	MIFARE Classic	MIFARE UL	MIFARE DESFIRE EV1	ISO Ref PICC
Read range [mm]	78mm	77mm	81mm	62mm	42mm
LPCD range [mm]	78mm	77mm	81mm	62mm	42mm

3. The PN7462AU LPCD

3.1 Low power design

To ensure the minimum current consumption the unused Pins needed to be set to a dedicated connection or in case they are internally connected to a specific level, they can stay open.

3.1.1 PN7462AU unused pins

Following Table (Table 2) gives a recommendation for the connection of unused Pins. In case they are used the connection is defined by the application.

Recommendation if CT is not used

Table 2. Connection of unused pins

Pin	Connection if not used
VBUSP	Connect to VBUS
SCVDD	Leave it open, no cap needed
VUP	Leave it open, no cap needed
VCC	Leave it open, no cap needed
CLK, RST, IO, C4, C8	Leave it open
GNDP, GNDC	Connect to ground

3.2 The LPCD function

3.2.1 Function

This function is used to perform low power card detection before actual polling. The duration of the LPCD is controlled by the application using the EEPROM parameter. See dwLCPDDurations parameter of \ref phCfg_EE_HW_RfInitUserEE::dwLCPDDurations. It is the responsibility of the application to provide proper AGC reference value and threshold for the card detection based on respective system design. If the application passes 0xFF for the AGC reference value or for threshold, the HAL retrieves the value from the EEPROM.

```
* @param dwLPCDThreshold The Threshold
* @param dwLPCDRefValue
* @param pdwLPCDAgcValue
*
* @return
*/
phStatus_t phhalRf_LPCD(uint32_t dwLPCDThreshold, uint32_t
dwLPCDRefValue, uint32_t * pdwLPCDAgcValue);
```

3.2.1.1 Configuration parameters

```
(void)phhalHw_SetConfig(psDiscLoopParams->pHalDataParams,
PHHAL_HW_CONFIG_PN7462AU_LPCD_DURATION, 30);

(void)phhalHw_SetConfig(psDiscLoopParams->pHalDataParams,
PHHAL_HW_CONFIG_PN7462AU_LPCD_THRESHOLD, 2);

(void)phhalHw_SetConfig(psDiscLoopParams->pHalDataParams,
PHHAL_HW_CONFIG_PN7462AU_LPCD_REF_VALUE, (uint16_t)PH_REG_GET(
PCR_GPREG1_REG));
```

LPCD_DURATION:	Time period while RF is on and AGC is measured
LPCD_THRESHOLD:	The threshold is used to calculate minimum and maximum border for a detection (needs to be adopted like minlevel)
LPCD_REF_VALUE:	Read the last measured value from GPREG1 and set as reference value.

3.2.1.2 API return values

The API returns the status of the LPCD and the current AGC Value.

The Application needs to call the API again with the returned AGC value if the previous tag detection was false.

3.2.1.3 AGC Based LPCD

The Nominal value (Reference value) is loaded into the Card Mode AGC Value registers. The Card Mode is used since the AGC needs to detect variations in the self-generated field.

After the sampling, a difference between the current AGC value and Reference value (absolute difference) is determined and compared with the LPCD_THRESHOLD

- Greater means Tag is detected
- Lesser means Tag is not detected

If the Tag has been detected, but the polling does not return any responses then to avoid repeated false detections, the current AGC value is to be taken as new Reference Value.

3.2.2 Optimization

The LPCD should only be used with disabled DPC.

The LPCD can be optimized by starting the LPCD function and decreasing the LPCD_THRESHOLD. The thresholds needs to be decreased until a value where the LPCD starts to detect a card without any in the field. This value needs to be added with a margin of 1-4 (depends on the noise of the reader) to guarantee a stable LPCD without fail detection.

The optimized value then can be set and the LPCD can be performed. If this is done the LPCD should not wakeup until a card or a detuning is seen. If the reader still wakes up without any detuning in the field the threshold needs to be checked again and in case it is needed the value needs to be increased.

The higher the LPCD_THRESHOLD is the more robust the LPCD and the lower the detection range.

The LPCD_DURATION can stay on the default value (30) as this is the minimum time for the detection. If a lower value is set the field on time will not change. If the value is increased the RF on time will also increase. By increasing the RF on time the current consumption will also raise.

To optimize the LPCD cycle as well as the current consumption the wWakeUpTimerVal can be changed
phhalPcr_WakeUpConfig.wWakeUpTimerVal = 500;

This timer sets the standby time between two LPCD pulses and is only considered if the #define PHFL_ENABLE_STANDBY is set in APP_NxpBuild.h.

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