

# AN11785

## PN7462AU LPCD and Standby mode

Rev. 1.0 — 9 March 2016  
358410

Application note  
COMPANY PUBLIC

### Document information

Info	Content
Keywords	LPCD, PN7462AU
Abstract	Low Power Card Detection



## Revision history

Rev	Date	Description
1.0	20160309	Initial version

## Contact information

For more information, please visit: <http://www.nxp.com>

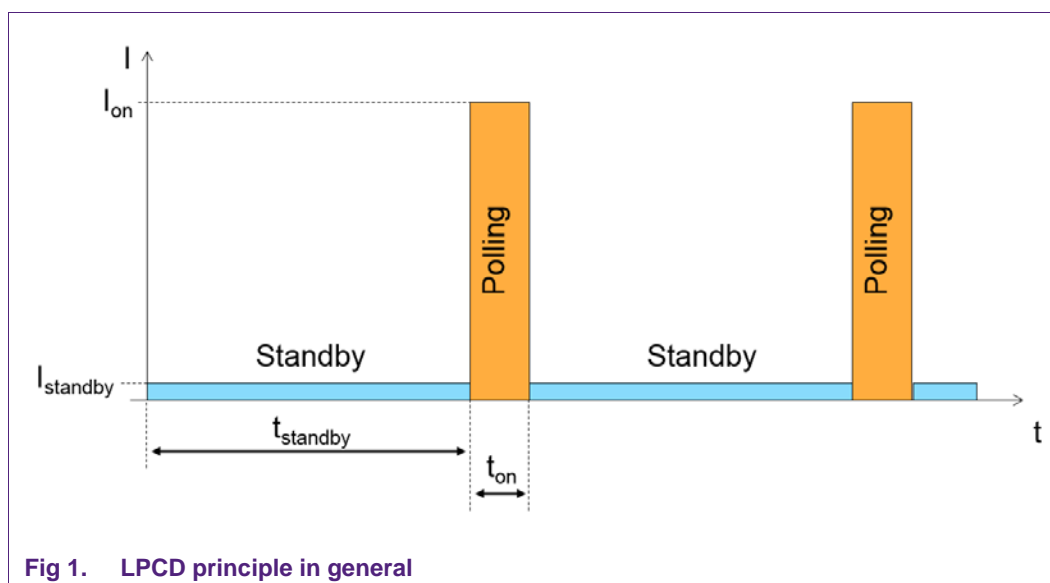
## 1. Introduction

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 save 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 is shown in Fig 1



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

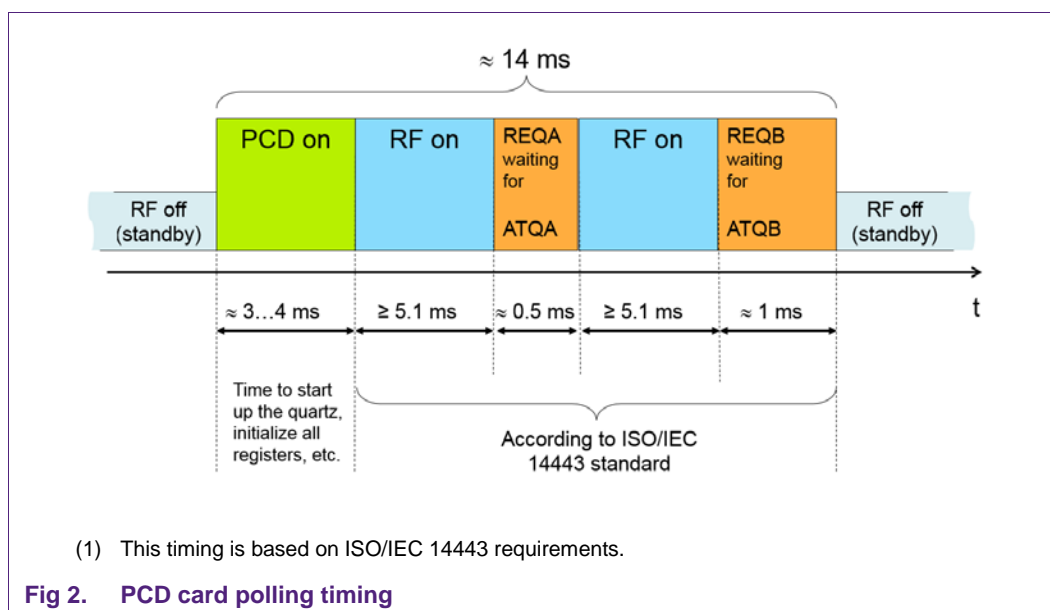
$t_{standby}$  = time period when the reader is in power down (no function)

$t_{on}$  = 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  $t_{on} \approx 14$  ms. Assuming the standby time of  $t_{standby} \approx 300$  ms, the standby current of  $I_{standby} = 18$   $\mu$ A and the polling current of  $I_{on} \approx 150$  mA, the average current consumption is quite high:  $I_{average} \approx 5$  mA



## 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 to 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  $\mu$ A. 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.



## 4. Legal information

### 4.1 Definitions

**Draft** — The document is a draft version only. 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 herein and shall have no liability for the consequences of use of such information.

### 4.2 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.

**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.

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

**Evaluation products** — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer.

In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out of the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages.

Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US\$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

### 4.3 Licenses

#### Purchase of NXP ICs with ISO/IEC 14443 type B functionality



This NXP Semiconductors IC is ISO/IEC 14443 Type B software enabled and is licensed under Innovatron's Contactless Card patents license for ISO/IEC 14443 B.

The license includes the right to use the IC in systems and/or end-user equipment.

#### RATP/Innovatron Technology

#### 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.

### 4.4 Trademarks

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

**MIFARE** — is a trademark of NXP Semiconductors N.V.

## 5. Contents

---

<b>1.</b>	<b>Introduction .....</b>	<b>3</b>
<b>2.</b>	<b>Principle of LPCD .....</b>	<b>3</b>
2.1	Standard polling without LPCD .....	4
2.2	Parameters of LPCD .....	4
2.2.1	LPCD current consumption .....	4
2.2.2	LPCD detection range.....	5
<b>3.</b>	<b>The PN7462AU LPCD .....</b>	<b>6</b>
3.1	Low power design .....	6
3.1.1	PN7462AU unused pins.....	6
3.2	The LPCD function.....	6
3.2.1	Function .....	6
3.2.1.1	Configuration parameters.....	7
3.2.1.2	API return values.....	7
3.2.1.3	AGC Based LPCD.....	7
3.2.2	Optimization .....	7
<b>4.</b>	<b>Legal information .....</b>	<b>9</b>
4.1	Definitions .....	9
4.2	Disclaimers.....	9
4.3	Licenses.....	9
4.4	Trademarks.....	9
<b>5.</b>	<b>Contents.....</b>	<b>10</b>

---

Please be aware that important notices concerning this document and the product(s) described herein, have been included in the section 'Legal information'.

---