AN11145

CLRC663, MFRC631, MFRC 630, SLRC610 Low Power Card Detection

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Abstract	This document describes the principle of the low power card detection (LPCD) offered by the CLRC663, MFRC631, MFRC630 and SLRC610. It describes how to use the LPCD and how to optimize the related settings.

Revision history

Rev	Date	Description
2.0	20150504	Complete new structure and updated content.
1.1	20150116	Detailed description of LPCD added and how it can be used
1.1	20120717	CLRC663 derivatives added
1.0	20111212	Initial version

Contact information

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

1. Introduction

This document describes the principle of the low power card detection (LPCD) offered by the CLRC663, MFRC631, MFRC630 and SLRC610. It describes how to use the LPCD and how to optimize the related settings.

The basic idea of the 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 approached 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.

The CLRC663 offers a standalone LPCD function, which replaces the normal active card polling, which must be triggered by the host uC.

In the section 2 the principle of the LPCD and its related parameters is described. In the section 3 the usage of the LPCD with the CLRC663 is described. This includes some hints on how to optimize the LPCD towards the own application requirements.

Note: In this document the name of the CLRC663 is used, but all content is valid for the CLRC663, the MFRC631, the MFRC630 and the SLRC610, if not otherwise stated.

2. Principle of LPCD

The standard NFC or RFID communication requires the reader to poll for the cards, i.e. it requires the reader to stay active. The card itself stays mute, until the reader provides the required power (field strength) and the sends the correct command (e.g. REQA or REQB for ISO/IEC 14443 communication).

In general the low power card detection provides a functionality, which allows to power down the reader for a certain amount of time to safe energy. After some time the reader must become active again to poll for cards. If no card is detected, the reader can go back to the power down state. This is shown in Fig 1.

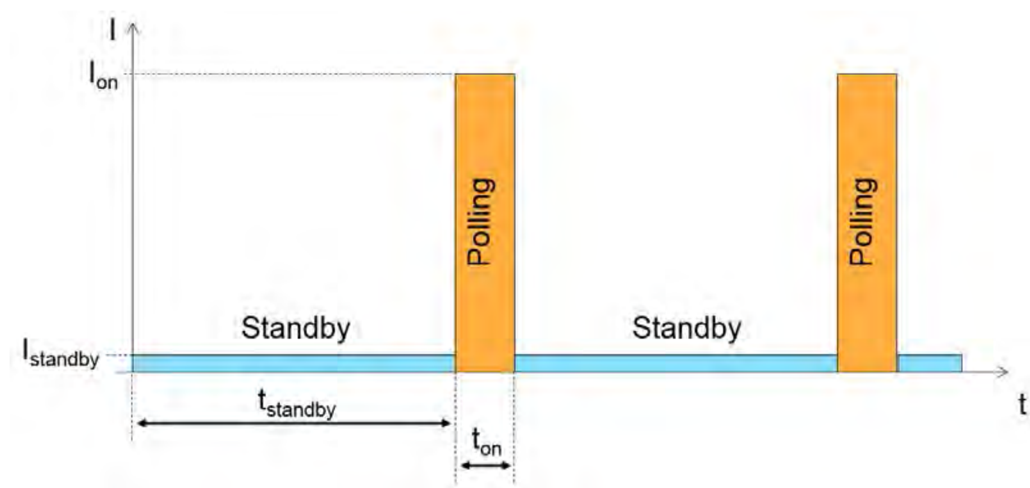


Fig 1. LPCD principle in general

The average current can be calculated:

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

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

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

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

t_{on} = time of the polling operation

Before looking into the technical details of the LPCD function of the CLRC663, the major parameters must be defined to allow an optimization of the LPCD. In some applications the energy saving is the major parameter, 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 Polling versus LPCD

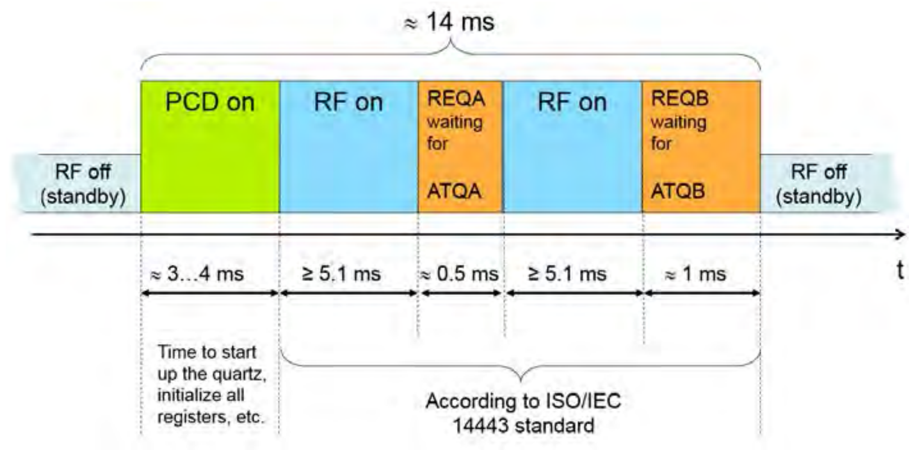
A standard polling executes the commands as requested by the corresponding standard, i.e. REQA and REQB for ISO/IEC 14443 polling. The LPCD detects the detuning and loading of the reader antenna before even starting any command sequence.

2.1.1 Standard polling without LPCD

For a standard ISO/IEC 14443 reader (PCD) the normal polling sequence must use the timing requirements of the standard. This timing requirement ends up in a polling sequence as shown in Fig 2, where the reader typically stays active for $t_{on} \approx 14$ ms.

Using a standby time of $t_{standby} \approx 300$ ms, a standby current of $I_{standby} = 5$ µA and a polling current of $I_{on} \approx 150$ mA, the average current consumption is quite high: $I_{average} \approx 5$ mA

This calculation does not include the current consumption of the host µC, which is required to control this polling sequence.



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

Fig 2. PCD card polling timing

2.1.2 LPCD function of the CLRC663

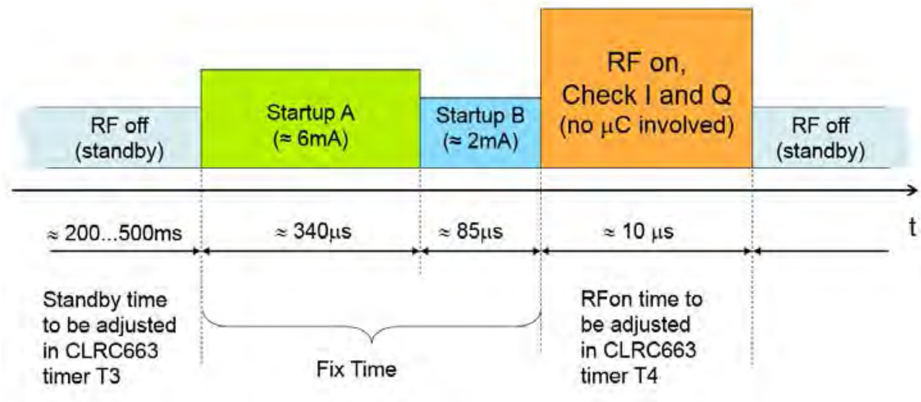
The LPCD function of the CLRC663 offers an easy to use detection with a much lower current consumption. This LPCD uses the detuning of the antenna for the card detection. After calibration the host µC puts the CLRC663 into LPCD detection.

Then the CLRC663 goes into a temporary standby mode, which is controlled by the timer T3, as shown in Fig 3. When the Timer T3 elapses, the CLRC663 starts up with limited functionality (Startup A and B) and then sends a short RF pulse. The duration of the RF pulse is controlled by the timer T4. During this pulse either no card is detected ort a possible detuning wakes up the CLRC663. If no card is detected, the CLRC663 goes into the temporary standby mode again and the Timer T3 starts again. For more details refer to section 3

The LPCD runs forever, unless the CLRC663 is reset or a card is being detected. During the LPCD the host interface (e.g. SPI) is disabled and cannot and shall not be used.

Using a standby time of $t_{standby} \approx 300$ ms, a standby current of $I_{standby} = 5$ µA and a polling current of $I_{on} \approx 150$ mA, the average current consumption is quite low now: $I_{average} \approx 17$ µA

This calculation does not include the current consumption of the host µC, which is **not** required to control this LPCD sequence.



(1) This timing is based on CLRC663.

Fig 3. LPCD timing

2.2 Parameters of LPCD

The LPCD can be designed for different target applications. In battery powered readers the current consumption in combination with the detection failure rate is the major parameter. In a standard access control reader the detection range and especially the detection speed are more important.

The details of the current calculation and optimization including some examples is shown in section 3.

2.2.1 LPCD current consumption

The current consumption depends on many parameters. Mainly the standby current during the **standby time** and the **duration of the RF pulse** are the most important parameters influencing the average current.

For the minimization of the standby current it is important to properly connect the pins of the CLRC663. Otherwise the leakage current e.g. through a pull up resistor might increase the standby current by some 10 or even 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 this 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 antenna. Normally the standard antenna design is made to minimize the loading and detuning effect as much as possible, but for the LPCD the loading and detuning is required to detect cards.

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.

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. 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).

Without knowing the antenna it is difficult to specify numbers. But the CLRC663 was designed to show a 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 2 and Table 3.

2.2.3 LPCD detection speed

The detection speed depends mainly on the standby time. For the CLRC663 the Timer T3 is used to specify this time. This time has a direct impact on the average current consumption.

When a card is being detected with the LPCD, the CLRC663 wakes up the host µC, which then has to start a standard polling sequence to select and activate the card for the required card operation.

2.2.4 LPCD detection failure rate

The inductive LPCD has the advantage that the detuning and loading of the antenna is taken to detect cards. Other devices, which do not detune or load the reader antenna, do not wake up the reader at all. Especially for handheld reader devices this reduces the number of failure detections enormously compared to a capacitive detection.

The number of failure detections as a direct impact on the average current consumption.

3. The CLRC663 LPCD

The LPCD of the CLRC663 contains two phases:

1) LPCD Calibration
2) LPCD Detection

During the LPCD Calibration the antenna circuit is calibrated for the “no card” state. This calibration must be done at least once, but might done automatically every once a while. The application might even use a smart handling of the calibration to avoid multiple failure detections e.g. due to a changed environment. A re-calibration is required after the antenna loading condition has changed (for whatever reason).

The LCPD Calibration derives certain register values, which correspond the “no card” state. After the LPCD Calibration the window values, which correspond to the “no card” state, must be written into the CLRC663, the Timer T3 and T4 must be set, and then the LPCD Detection can be started.

Note: Even with a card on the antenna, the LPCD Calibration might be performed. Then the “no card” state is calibrated together with this card on the antenna. Starting the LPCD Detection in such case results in “no card” as long as the card stays on the antenna. In this case “a card is detected”, as soon as the card is removed.

During the LCPD Detection the CLRC663 disables the host interface and runs the LPCD function as shown in Fig 3. As soon as a card detunes the antenna from the “no card” state, the CLRC663 wakes up and sends an IRQ to wake up the host µC.

3.1 The low power design

For the low power design the correct circuitry around the CLRC663 is important. Especially the correct connection of “unused” pins is a major topic.

3.1.1 CLRC663 unused pins

One important factor to realize a low average current consumption is the standby current. The low standby current can only be achieved, if every pin of the CLRC663 is connected properly. Otherwise a leakage current, caused by a floating pin or a high resistance pull up resistor might cause an enormously overall increased current consumption.

The Table 1 shows the recommended settings of unused pins. Those recommendations are valid for the UART interface, for I2C, for SPI and I2C-L. The only difference between the different interfaces is the use of the IF0, IF1, IF2 and IF3.

Note: the corresponding register settings must be checked and set properly, otherwise “artificial” shortcuts can increase the current consumption. Example SIGOUT: it does not make sense to set the SIGOUT internally to “1” and then connect externally to GND.

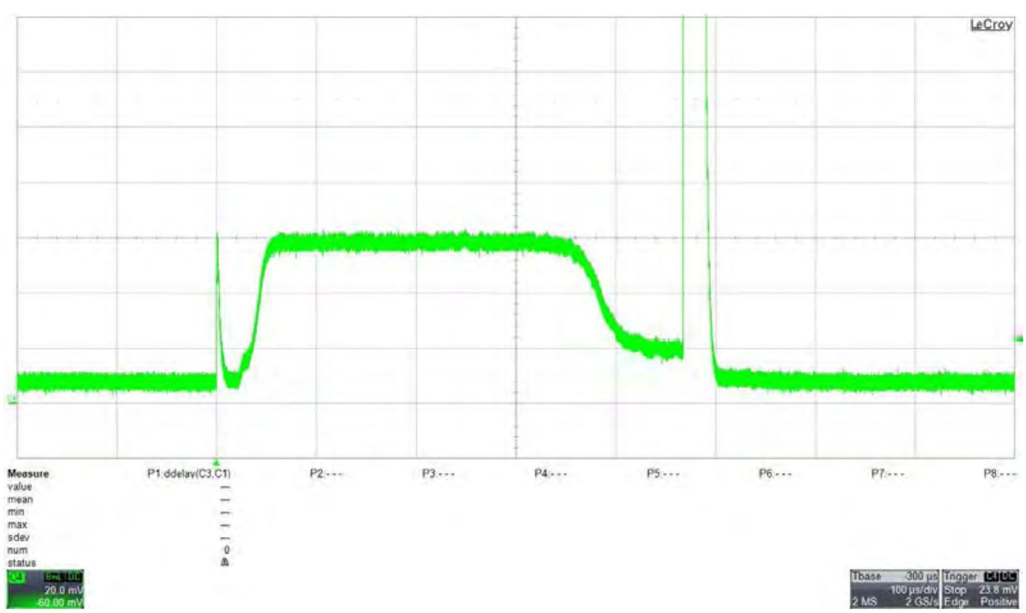
Table 1. CLRC663 unused pins

Pin #	Pin name	Type	Supply	Pin configuration
22	CLKOUT	O	PVDD, DVDD	GND
28	IF0	I/O	PVDD, DVDD	/Rx
29	IF1	I/O	PVDD, DVDD	PVDD
30	IF2	I/O	PVDD, DVDD	Open or PVDD
31	IF3	I/O	PVDD, DVDD	PVDD
26	IFSEL0	I	PVDD, DVDD	GND
27	IFSEL1	I	PVDD, DVDD	GND
24	SDA	I/O	PVDD, DVDD	GND
23	SCL	O	PVDD, DVDD	GND
32	IRQ	O	PVDD, DVDD	GND / IRQ
21	PDOWN	I	PVDD, DVDD	GND
6	SIGOUT	O	PVDD	GND
4	TCK	I	PVDD, DVDD	Open or PVDD
2	TDI	I	PVDD, DVDD	Open or PVDD
1	TDO	O	PVDD, DVDD	GND
3	TMS	I	PVDD, DVDD	Open or PVDD

Pin #	Pin name	Type	Supply	Pin configuration
10	AUX1	O	AVDD	GND
11	AUX2	O	AVDD	GND
5	SIGIN	I	PVDD, DVDD	GND

3.1.2 CLRC663 current measurement

To control the proper function of the low power design a current measurement is very useful. The problem of measuring the average current consumption of only a few µA is related to the LPCD cycle, which on one hand causes a current consumption of up to 200 mA (during the short t_{RFOn}), and on the other hand a current consumption of typically $I_{Standby}$ = 3 µA, as can be seen in Fig 4.



(1) Measured with differential probe

Fig 4. Current consumption during the CLRC663 LPCD detection

3.1.2.1 Current measurement option 1:

Typically the dynamic range of a high accurate source meter allows a maximum current of up to 100 mA while measuring with a resolution of 0.1 µA. So in this case the most reasonable measurement can be done with the following adaptation:

Reduce the I_{RFOn} and increase the $t_{Standby}$. For the standby current measurement the I_{RFon} does not matter, so for this measurement the TX-outputs can be left open. This reduces the I_{RFOn} to less than 100 mA.

Then it might be helpful to increase the standby time (Timer T3) to some seconds to allow a proper current measurement.

3.1.2.2 Current measurement option 2:

Use the standby mode of the CLRC663 to measure the standby current consumption. The current consumption in the standby mode is the same like the standby current during the $t_{Standby}$ of the LPCD. In this case the dynamic range of the current measurement device does not matter.

3.2 The LPCD calibration

During the LPCD Calibration the CLRC663 defines the I- and Q-channel signal levels for the “no card” state, and stores it in the Register 0x42 and 0x43:

Register 0x42: LPCD_Result_I register

Register 0x43: LPCD_Result_Q register

3.2.1 Reading I and Q values

The following script shows the operation of calibration, which sets the relevant Tx and Rx register, sets T3 and T4 (with default values), executes the AutoLPCD and AutoRestart, and reads the I and Q values for the “no card“ state:

```
CLL
CHB 115200
//> =============================================
//> Part-1, Configurate LPCD Mode
//> Please remove any PICC from the HF of the reader.
//> "I" and the "Q" values read from:
//>      LPCD_Result_i_Reg(42)
//>      LPCD_Result_q_Reg(43)
//> shall be used in Part-2 "Detect PICC".
//> =============================================
// reset CLRC663 and idle
SR 00 1F
SLP 50
SR 00 00
// Disable IRQ0, IRQ1 interrupt sources
SR  06 7F
SR  07 7F
SR  08 00
SR  09 00
SR  02 B0 // Flush FIFO
//> LPCD_Config
//> =============================================
SR  3F C0 // Set Qmin register
SR  40 FF // Set Qmax register
SR  41 C0 // Set Imin register
SR  28 89 // set DrvMode register
// -----------------------------------------
// Execute trimming procedure
SR  1F 00 // Write default. T3 reload value Hi
SR  20 10 // Write default. T3 reload value Lo
```



```
31    SR  24 00 // Write min. T4 reload value Hi
32    SR  25 05 // Write min. T4 reload value Lo
33    SR  23 F8 // Config T4 for AutoLPCD&AutoRestart.Set AutoTrimm bit.Start T4.
34    SR  43 40 // Clear LPCD result
35    SR  38 52 // Set Rx_ADCmode bit
36    SR  39 03 // Raise receiver gain to maximum
37    SR  00 01 // Execute Rc663 command "Auto_T4" (Low power card detection and/or
      Auto trimming)
38    // Flush cmd and Fifo
39    SR  00 00
40    SR  02 B0
41    SR  38 12 // Clear Rx_ADCmode bit
42    //> ------------ I and Q Value for LPCD ----------------
43    //> ----------------------------------------------------
44    GR  42    //> Get I
45    GR  43    //> Get Q
46    //> --------------LPCD_Config - done. -------------------
```

The I and Q values can be read from the lines 44 and 45.

3.2.2 Calculation of the detection window values

These values I and Q can then be read and taken as input for the calculation of the detection window. For this calculation a threshold must be defined. The recommendation uses the threshold value TH = 1.

With this threshold TH the minimum and maximum I and Q values can be calculated:

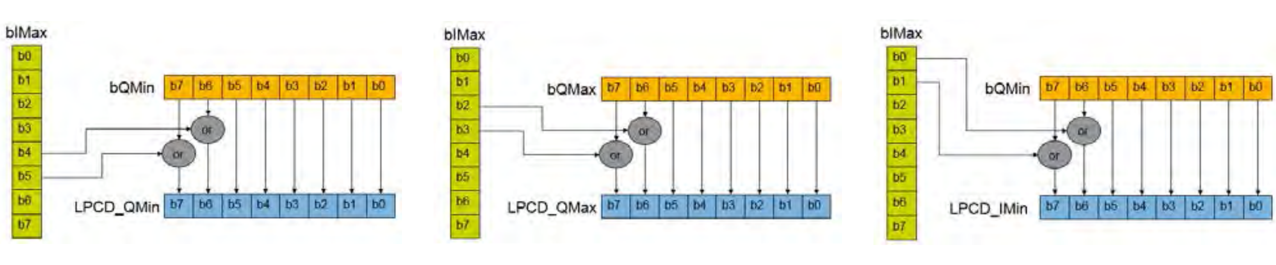
$$bQMin = Q - TH \quad (2)$$

$$bQMax = Q + TH \quad (3)$$

$$bIMin = I - TH \quad (4)$$

$$bIMin = Q + TH \quad (5)$$

With these four values the final window values can be prepared as shown in Fig 5.



a. LPCD_QMin   b. LPCD_QMax   c. LPCD_IMin

Fig 5. Calculation of the LPCD_QMin, LPCD_QMAx, and LPCD_IMin

These three values must then be stored in the three register 0x3F, 0x40 and 0x41:

Register 0x3F: LPCD_Qmin register

Register 0x40: LPCD_QMax register

Register 0x41: LPCD_IMin register

The calibration itself is supported by the NFC Reader Library. The principle of the LPCD calibration and detection can be tested with the script file as shown in section 3.4.1.

Note: The I- and Q-channel function in LPCD is different than during normal Rx mode.

3.3 The LPCD detection

After the window values are written into the three registers as described in section 3.2, the Timer T3 and T4 have to be programmed properly. Timer T3 defines the standby time ($t_{standby}$), while Timer T4 defines the RFon time (t_{RFon}). With these two times the detection speed as well as the average current consumption is defined:

$$I_{average} = \frac{I_{standby} \cdot t_{standby} + I_{StartupA} \cdot t_{StartupA} + I_{StartupB} \cdot t_{StartupB} + I_{RFon} \cdot t_{RFon}}{t_{standby} + t_{StartupA} + t_{StartupB} + t_{RFon}} \quad (6)$$

with

$I_{standby}$ = current consumption in standby or power down mode ≤ 5 µA

$I_{StartupA}$ = current consumption during StartupA ≈ 6 mA

$I_{StartupB}$ = current consumption during StartupA ≈ 2 mA

I_{RFon} = current consumption during the “normal” operation ≤ 200 mA

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

$t_{StartupA}$ = time for StartupA ≈ 340 µs

$t_{StartupB}$ = time for StartupA ≈ 85 µs

t_{RFon} = time of the RF carrier switched on

The standby current $I_{Standby}$ depends on the correct definition of unused pin (see section 3.1.) Typically this current is

$I_{Standby}$ ≈ 3 µA

The current consumption during RFon (t_{RFon}) is defined due to the overall antenna design. Typically this current with unloaded antenna is

I_{RFon} ≈ 100… 150 mA (high output power reader)

I_{RFon} ≈ 60… 100 mA (battery powered reader)

The average current is mainly defined with the two times for the LPCD:

$t_{Standby}$ and t_{RFon}.

The standby time defines the detection speed and typically is

$t_{Standby} \approx$ 200…300 ms (fast reader)

$t_{Standby} \approx$ 300…1000 ms battery powered reader)

The RFon time depends on the antenna design and must be long enough to allow a proper detection. A longer time does neither improve nor disturb the functionality, but increases the average current consumption. Typically this time can be

$t_{RFon} \leq 10\ \mu s$

Note: Normally it makes sense to start with $t_{RFon} = 10\ \mu s$, and try lower values, until the detection fails. Typically this might happen at $t_{RFon} \leq 2\ \mu s$. Then a margin must be considered for the final chosen value, since on one hand there are tolerances in the overall antenna circuitry, and on the other hand the low power clock for the timer T3 and T4 during the LPCD is not very accurate.

Then with these values the LPCD Detection can be started.

3.4 General examples

Main powered reader, which needs to be fast:

$t_{RFon} = 10\ \mu s$

$t_{Standby} = 200$ ms

$I_{RFon} = 150$ mA

➔ $I_{average} \approx 22\ \mu A$

Battery powered reader:

$t_{RFon} = 7\ \mu s$

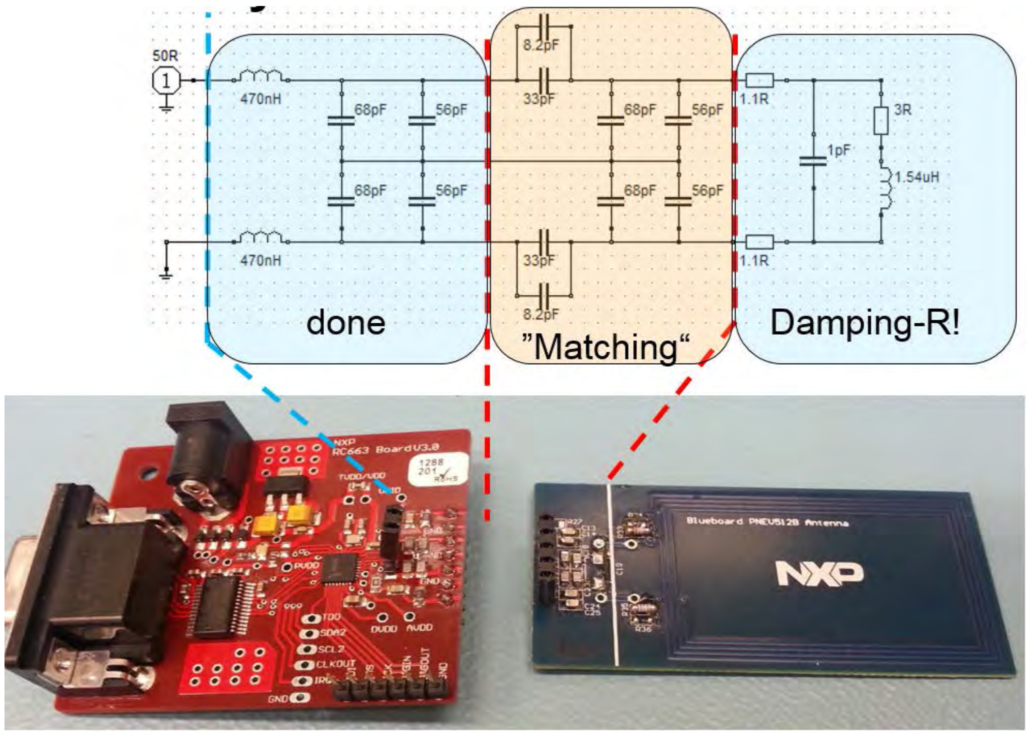
$t_{Standby} = 400$ ms

$I_{RFon} = 80$ mA

➔ $I_{average} \approx 10\ \mu A$

3.4.1 Example with script file

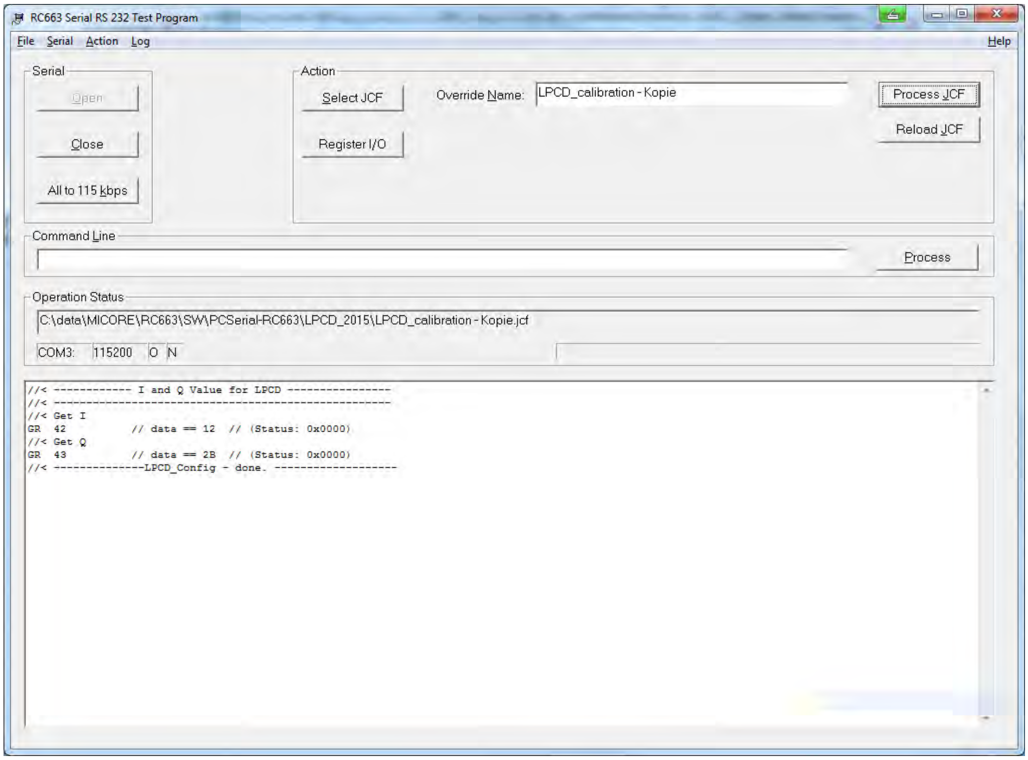
This example shows the LPCD with the CLRC663 red board, using the PN512 blue board antenna. The board and the corresponding tuning is shown in Fig 6.



(1) Antenna tuning as demonstrated in the antenna design webinar #2

Fig 6. CLRC663 red board with PN512 blue board antenna

After powering the calibration must be done with the configuration or calibration script file (part 1). As shown in Fig 7 the I and Q values can be read.

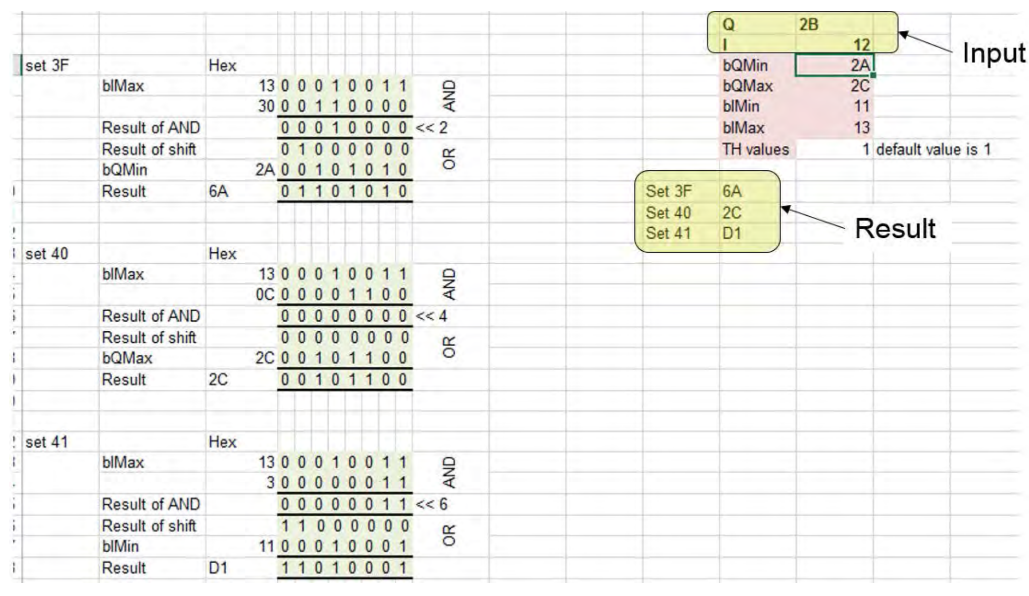


(1) LPCD_Result_I = 0x12

(2) LPCD_Result_Q = 0x2B

Fig 7. PC Serial with calibration result

With these values the calculation can be done, as shown in Fig 8.



(1) Using the excelsheet.

Fig 8. Calculation of LPCD_Qmin, LPCD_QMax, and LPCD_IMin

These three values must be entered in the LPCD detection script file (part 2) in the lines 9, 10 and 11:

```
1     CLL
2     CHB 115200
3     //> =============================================
4     //> Part-2  Detect PICC
5     //> Before staring the script please ensure that
6     //> the register values for QMin,QMax and IMin are properlyy calculated.
7     //> The values "I" and "Q" are dependent from the current physical conditions
8     //> and shall be taken from Part-1 (LPCD_Mode_Config.jcf).
9     SR  3F 6A // Set QMin register!!!!!
10    SR  40 2C // Set QMax register!!!!!
11    SR  41 D1 // Set IMin register!!!!!
12    //> Prepare LPCD command, power down time 10[ms]. Cmd time 150[µsec].
13    SR  1F 07 // Write T3 reload value Hi
14    SR  20 F2 // Write T3 reload value Lo
15    SR  24 00 // Write T4 reload value Hi
16    SR  25 13 // Write T4 reload value Lo
17    SR  23 DF // Configure T4 for AutoLPCD and AutoRestart/Autowakeup. Use 2Khz LFO,
      Start T4
18    SR  43 40 // Clear LPCD result
19    SR  38 52 // Set Rx_ADCmode bit
20    GR  39    // Backup current RxAna setting
21    SR  39 03 // Raise receiver gain to maximum
22    // Wait until T4 is started
23       ::: L_WaitT4Started
24       GR  23    // Response:  9F
```

```
   JNM IOR 80 80 L_WaitT4Started
// Flush cmd and FIFO. Clear all IRQ flags
SR  00 00
SR  02 B0
SR  06 7F
SR  07 7F
// Enable IRQ sources: Idle and PLCD
SR  08 10
SR  09 60
SR  00 81 //> Start RC663 cmd "Low power card detection". Enter PowerDown mode.
// Wait until an IRQ occurs.
// Power-down causes IC not to respond and script ops end with error.

   ::: L_StandBy
  GR  00  // Read command register(00). If error - Stand-by.
  JNE IOE 00 L_StandBy
  JNM IOR 80 80 L_Continue
  JMP L_StandBy
   ::: L_Continue
   GR  07
   JNM IOR 20 20 L_StandBy

// Flush any running command and FIFO
SR  00 00
SR  08 00
SR  09 00
GR  06    // Get Irq0 status, Response:  20
SR  02 B0
GR  0A    // Read error statut register, Response:  00
SR  39 00 // Restore RxAna register
SR  38 12 // Clear Rx_ADCmode bit
SR  23 5F // Stop Timer4
GR  07    // Check if LPCD-Irq1(bit5) is set. PICC detected in PLCD sequence,
Response:  38
//> DONE
```

Then the script can be loaded and started. The CLRC663 is put to LPCD mode. As soon as a card is placed on the antenna, the CLRC663 wakes up and quits the LPCD detection, as shown in Fig 9.

Note: The script polls for IRQ status register via the UART, which does not make much sense in a real application and typically is replaced with a real IRQ connection between CLRC663 and host µC. The reading of any register during the LPCD returns random values and might even disturb the LPCD, since the communication between CLRC663 and host µC is disabled.

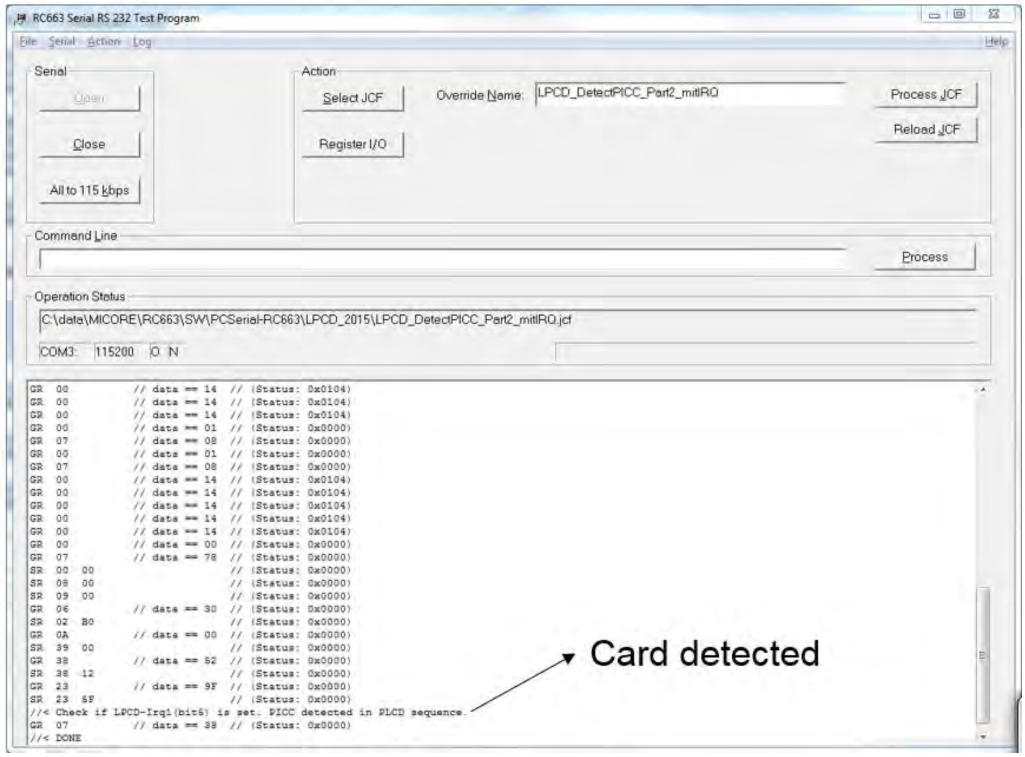


Fig 9. PC Serial LPCD detection

The Table 2 shows the read range of the CLRC663 connected to the PN512 blue board antenna, tested with REQA/REQB only, i.e. no crypto operation has been enabled on the card. And it shows the corresponding LPCD range tested with the same cards.

The “read range” of the ISO/IEC 10373-6 Class 1 Reference PICC is defined with the minimum field strength of 1.5 A/m, i.e. corresponds with ISO/IEC 14443 operating distance.

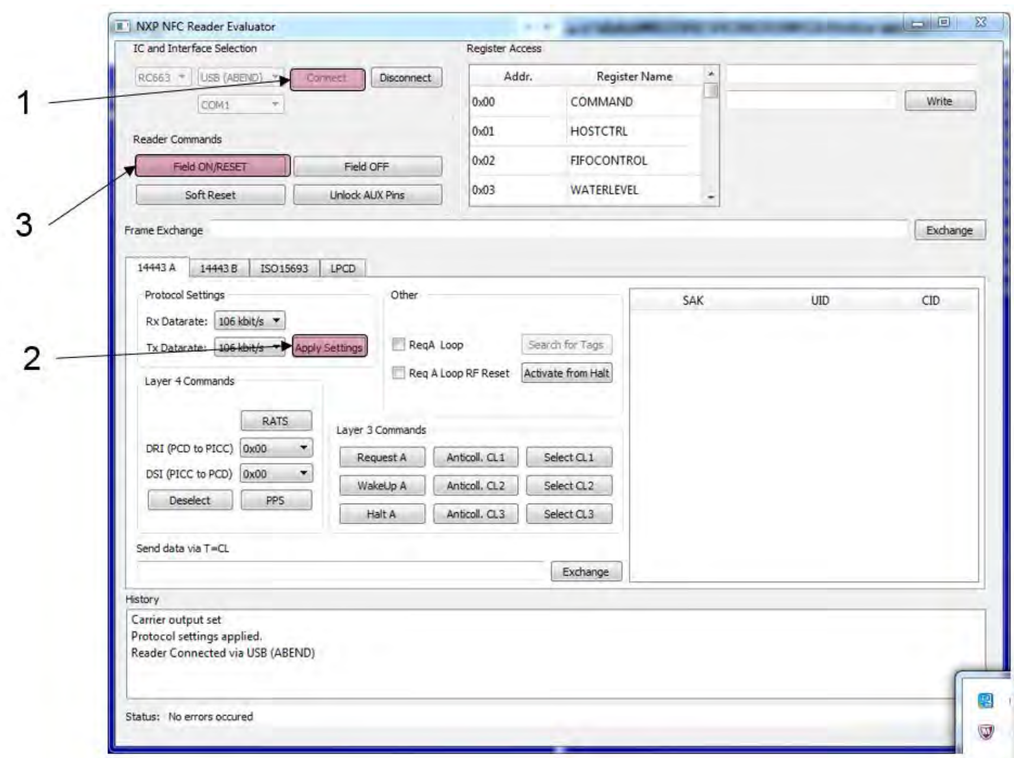
Table 2. LPCD detection range example with small antenna

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

	MIFARE Plus	**JCOP card**	**MIFARE Classic**	**MIFARE UL**	**Type B sample**	**ISO Ref PICC**
Read range [mm]	78	68	78	80	46	**46**
LPCD range [mm]	35	30	36	39	42	**42**

3.4.2 Example with NFC GUI

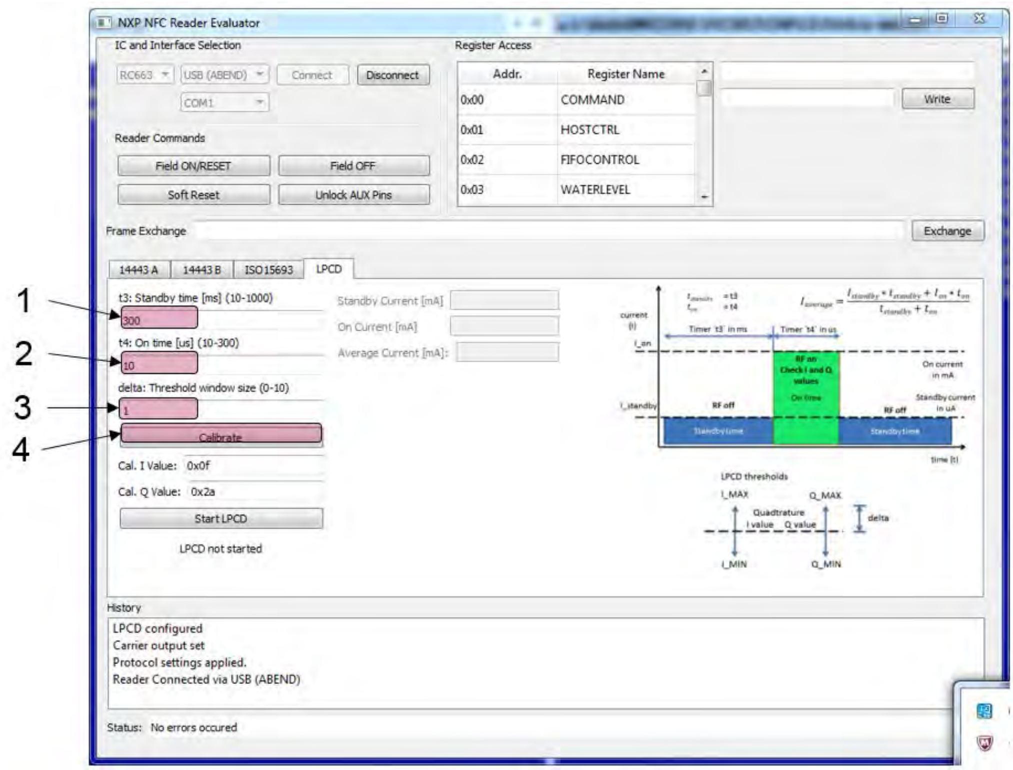
The NFC GUI (“NFC Reader Evaluator”) provides a LPCD test, which allows to test the LPCD performance. After starting the NFC GUI, the interface must be opened as shown in Fig 10. Then the CLRC663 Load Protocol should be applied to initialize the CLRC663. Then the RF field must be enabled.



(1) 3 steps to start the tool and the CLRC663.

Fig 10. NFC GUI for the CLRC663 BB5.0 (Initialisation)

The next step is the LPCD Calibration to execute the LPCD, and is shown in the Fig 11. For the calibration the timer values (Timer T3 for $T_{Standby}$ and Timer T4 for T_{RFOn}) and the threshold value TH must be defined. Afterwards the tool indicates the I and Q value (LPCD_Result_I register and LPCD_Result_Q register) and calculates the corresponding values for the LPCD_Qmin register, the LPCD_QMax register and the LPCD_IMin register.



(1) 4 steps to calibrate the CLRC663 for LPCD

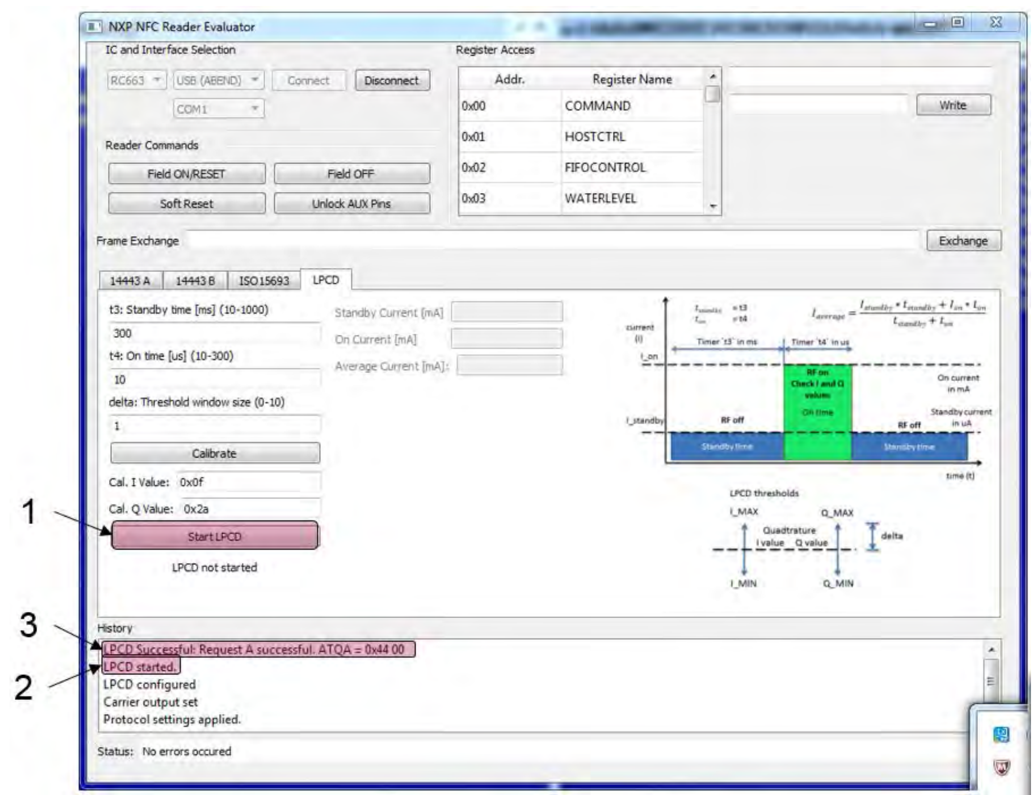
Fig 11. NFC GUI for the CLRC663 BB5.0 (LPCD Calibration)

In the last step then the LPCD is started as shown in Fig 12. This puts the CLRC663 into LPCD detection, i.e. there is no communication possible between the PC GUI and the CLRC663, unless the CLRC663 detects a card.

After detecting a card, automatically a standard ISO/IEC REQA is executed.

This NFC GUI can be downloaded via this link:
www.nxp.com/redirect/nxp.box.com/s/nvn4t7dxpkett7w364pbijjx88pspisi

Note: The provided NFC GUI is not qualified and not released by NXP Semiconductors. NXP Semiconductors reserves the right to make any changes on the SW without notice.



(1) Detection, when a card is placed on the antenna.

Fig 12. NFC GUI for the CLRC663 BB5.0 (LPCD Detection)

The Table 3 shows the read range of the CLRC663 BB 5.0, tested with REQA/REQB only, i.e. no crypto operation has been enabled on the card. And it shows the corresponding LPCD range tested with the same cards.

The “read range” of the ISO/IEC 10373-6 Class 1 Reference PICC is defined with the minimum field strength of 1.5 A/m, i.e. corresponds with ISO/IEC 14443 operating distance.

Table 3. LPCD detection range example

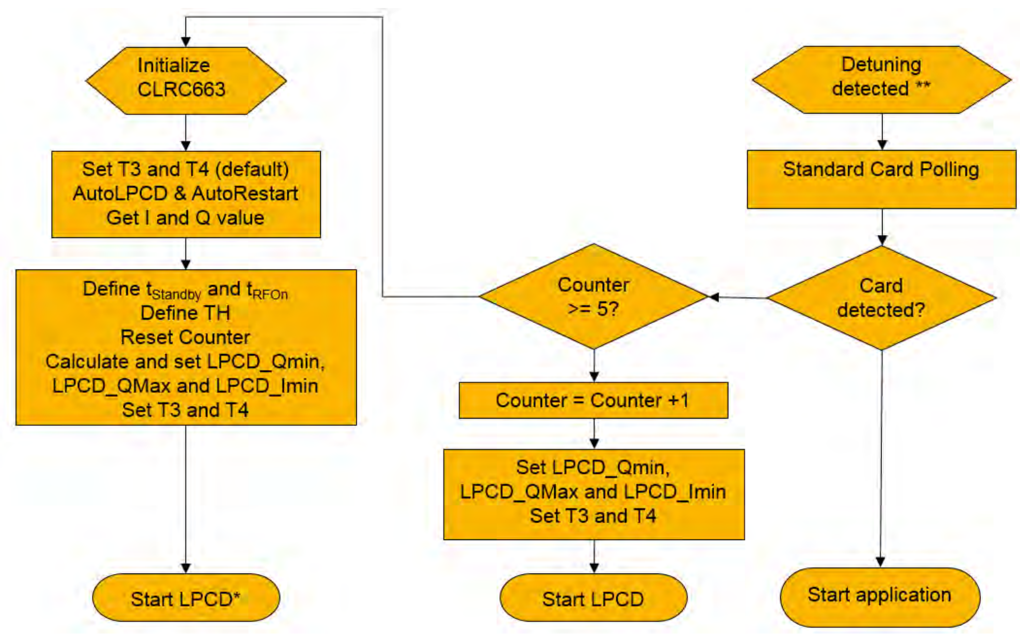
Read range for REQA/REQB only, tested with ID1 size cards

	MIFARE Plus	JCOP card	MIFARE Classic	MIFARE UL	Type B sample	ISO Ref PICC
Read range [mm]	80	80	90	95	55	**48**
LPCD range [mm]	35	30	35	35	40	**48**

3.4.3 Example flow chart

The Fig 13 shows a flow chart of the LPCD. The LPCD itself is done without host µC interaction. The CLRC663 raises an IRQ, as soon as a card is being detected, if the IRQ is setup properly before.

Note: The LPCD can only be stopped either with a card, which is detected by the CLRC663 itself or by the host µC, executing a CLRC663 reset.



(1) * The LPCD quits the communication between CLRC663 and host µC.

(2) ** The LPCD automatically wakes up the CLRC663 (and host µC) and raises an IRQ, if the corresponding IRQ is enabled.

Fig 13. CLRC663 LPCD flow chart

4. References

[1] CLRC663 datasheet, www.nxp.com

[2] CLRC663 script files, www.nxp.com

[3] NXP NFC Reader Library, www.nxp.com

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