

# PN7160\_PN7161

Near Field Communication (NFC) controller

Rev. 4.0 — 5 September 2024

Product data sheet



## 1 Introduction

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This data sheet describes the PN7160 and PN7161 NFC controllers with NCI interface and integrated firmware.

The PN7161 supports all features of PN7160 plus "Enhanced Contactless Polling" (ECP) by Apple (see Ref. [\[13\]](#)). Please note, that the ECP feature is available after formal authorization only.

In the following document PN7160 refers to PN7160 and PN7161, otherwise stated.

This data sheet requires additional documents for functional chip description and design in. Refer to the references listed in this document for full list of documentation provided by NXP.



## 2 General description

PN7160 is an NFC controller designed for integration in mobile devices and devices compliant with NFC standards (NFC Forum, NCI).

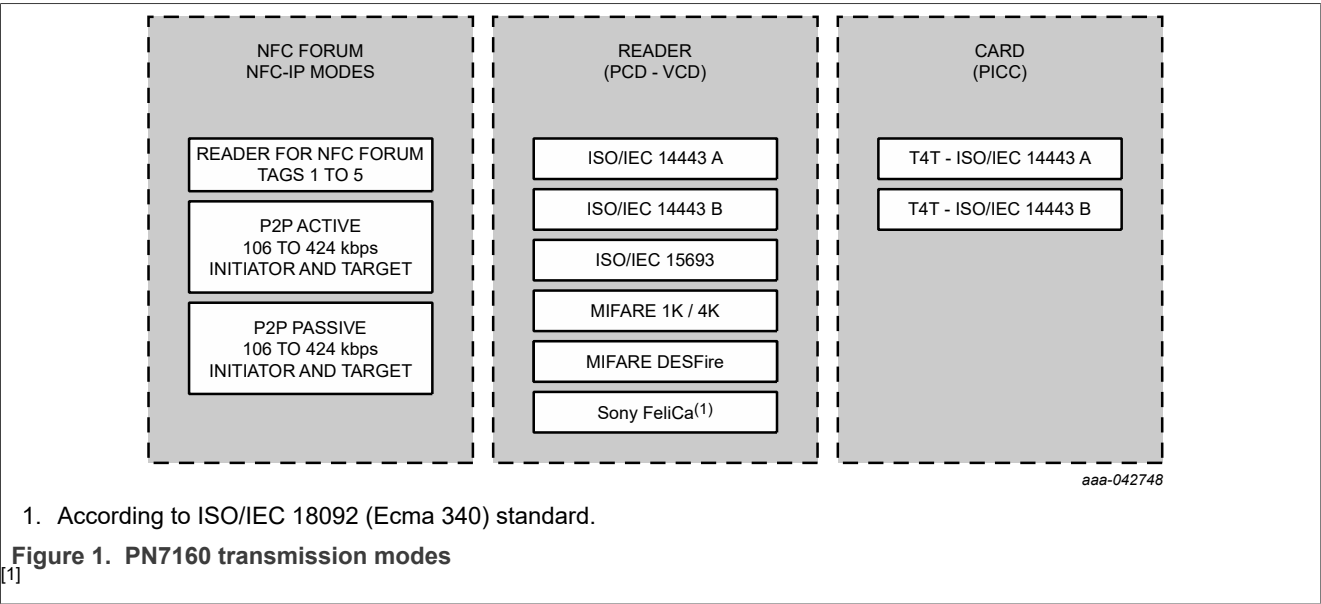
PN7160 is designed based on experience from previous NXP NFC device generation to ease the integration of NFC technology in mobile devices by providing:

- A low PCB footprint and a reduced external Bill of Material
- An optimized architecture for low-power consumption in different modes (Standby, low-power polling loop)
- A highly efficient integrated power management unit allowing direct supply from an extended battery supply range (2.8 V to 5.5 V).
- Support of an external DC-to-DC like NXP PCA941xA (with x = 0, 1 and 2), to provide more output power.

PN7160 embeds a new generation RF contactless front-end, supporting various transmission modes according to NFCIP-1 (see Ref. [9]) and NFCIP-2 (see Ref. [11]), ISO/IEC14443 (see Ref. [3]) , ISO/IEC 15693 (see Ref. [10]), MIFARE and FeliCa specifications. This new contactless front-end design brings a major performance step-up with on one hand a higher sensitivity and on the other hand the capability to work in active load modulation communication enabling the support of small antenna form factor. It also allows to provide a higher output power by supplying the transmitter output stage from 2.7 V to 5.25 V.

- Enhanced Dynamic LMA (DLMA) to optimize and to enhance load modulation amplitude depending on external field strength. It allows higher range communication distance in card mode.
- Independent LMA phase adjustment by step of 5° for type A, B and F
- Dynamic power control which allows to make use of the maximum power in reader mode without exceeding the maximum power allowed by the standard in 0 distance.
- Card mode receiver sensitivity of 20 mV<sub>(p-p)</sub>
- Support of single ended receiver
- 1.3 W output transmitter power

Supported transmission modes are listed in [Figure 1](#). For contactless card functionality, the PN7160 can act autonomously if previously configured by the host in such a manner. PICC functionality can be supported without host being turned on.



### 3 Features and benefits

- Highly integrated demodulator and decoder
- Buffered output drivers to connect an antenna with minimum number of external components
- Integrated RF level detector
- Integrated Polling Loop for automatic device discovery
- RF protocols supported
  - ISO/IEC 14443A, ISO/IEC 14443B PICC mode
  - ISO/IEC 14443A, ISO/IEC 14443B PCD mode designed according to NFC Forum digital protocol T4T platform and ISO-DEP (see Ref. [1])
  - FeliCa PCD mode
  - MIFARE PCD encryption mechanism (MIFARE 1K/4K)
  - NFC Forum tags T1T, T2T, T3T, T4T and T5T (see Ref. [1])
  - NFCIP-1, NFCIP-2 protocol (see Ref. [9] and Ref. [11])
  - *Only up to Firmware version 12.50.0A*: NFC Forum certification for P2P, reader and card mode (see Ref. [1])
  - ISO/IEC 15693/ICODE VCD mode (see Ref. [10])
  - NFC Forum-compliant embedded T4T for NDEF short record
  - Support for "Enhanced Contactless Polling" by Apple (see Ref. [13]) (PN7161 only)
- Supported host interfaces
  - NCI 2.0 protocol interface according to NFC Forum standardization (see Ref. [2])
  - I<sup>2</sup>C-bus High-speed mode (see Ref. [4])
  - SPI-bus (see Ref. [5])
- Flexible clock supply concept to facilitate PN7160 integration
  - Internal oscillator for 27.12 MHz crystal connection
  - Integrated PLL unit to make use of device reference clock and facilitate PN7160 integration
- Integrated power management unit
  - Direct connection to a battery (2.5 V to 5.5 V voltage supply range)
  - Support different low-power states configuration: Hard Power-Down state and Standby state activated by firmware
  - Autonomous mode when host is shut down
- Automatic wake-up via RF field, internal timer, and host interfaces
- Integrated non-volatile memory to store data and executable code for customization
  - Anti tearing support to recover from tearing events
- Standards compliance
  - NFC Forum Device Requirements (see Ref. [1])
  - NCI 2.0

## 4 Applications

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- Mobile devices
- Portable equipment (personal digital assistants, tablet, notebook, wearable)
- Consumer devices
- Smart home gateways

5 Quick reference data

Table 1. Quick reference data

| Symbol                | Parameter                                | Conditions                                                                                                                                                               |            | Min  | Typ  | Max  | Unit |
|-----------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|------|------|------|
| V <sub>BAT</sub>      | battery supply voltage                   | Card Emulation and Passive Target; V <sub>SS</sub> = 0 V                                                                                                                 | [1]        | 2.5  | -    | 5.5  | V    |
|                       |                                          | Reader, Active Initiator and Active Target; V <sub>SS</sub> = 0 V                                                                                                        | [1]        | 2.8  | -    | 5.5  | V    |
| V <sub>DD(UP)</sub>   | V <sub>DD(UP)</sub> input supply voltage | Reader, Active Initiator and Active Target; V <sub>SS</sub> = 0 V                                                                                                        | [1]        | 2.8  | -    | 5.8  | V    |
|                       |                                          | All other cases except Hard Power Down state; V <sub>SS</sub> = 0 V                                                                                                      | [1]<br>[2] | 2.5  | -    | 5.8  | V    |
| V <sub>DD(PAD)</sub>  | V <sub>DD(PAD)</sub> supply voltage      | supply voltage for host interface; V <sub>SS</sub> = 0 V                                                                                                                 | [1]        | 1.65 | 1.8  | 1.95 | V    |
|                       |                                          |                                                                                                                                                                          |            | 3.0  | 3.3  | 3.6  | V    |
| I <sub>BAT</sub>      | battery supply current                   | in Hard Power Down state; V <sub>BAT</sub> = 3.6 V; T = 25 °C                                                                                                            | [3]        | -    | 10.5 | 16   | µA   |
|                       |                                          | in Standby state; V <sub>BAT</sub> = 3.6 V                                                                                                                               |            |      |      |      |      |
|                       |                                          | enhanced RF detector                                                                                                                                                     |            | -    | 32   | 52   | µA   |
|                       |                                          | low sensitivity RF detector                                                                                                                                              |            | -    | 21   | 36   | µA   |
|                       |                                          | in low-power polling loop; V <sub>BAT</sub> = 3.6 V; T = 25 °C; loop time = 500 ms                                                                                       |            | -    | 100  | -    | µA   |
|                       |                                          | continuous total current consumption in PCD mode at V <sub>BAT</sub> = 3.6 V                                                                                             | [4]        | -    | -    | 290  | mA   |
| I <sub>th(Ilim)</sub> | current limit threshold                  | current limiter on transmitter                                                                                                                                           | [4]        | 270  | 300  | 330  | mA   |
| P <sub>tot</sub>      | total power dissipation                  | PCD mode at typical V <sub>DD(TX)</sub> = 5.25 V, V <sub>DD(UP)</sub> = 5.8 V and V <sub>BAT</sub> = 3.6 V; includes power from V <sub>BAT</sub> and V <sub>DD(UP)</sub> |            | -    | -    | 620  | mW   |
| T <sub>amb</sub>      | ambient operating temperature            | JEDEC PCB-0.5                                                                                                                                                            |            | -30  | -    | +85  | °C   |

[1] V<sub>SS</sub> represents V<sub>SS(PAD)</sub> and V<sub>SS(TX)</sub>.  
[2] When V<sub>DD(UP)</sub> is below 2.8 V the TXLDO can be in follower mode (see [Section 11.4.3](#)), there will be no more V<sub>DD(UP)</sub> noise rejection. Any noise below 848 kbit/s will affect the performance.  
[3] External clock on NFC\_CLK\_XTAL1 must be LOW.  
[4] This is considering an antenna tuned to sink maximum 250 mA continuous current from the transmitter. The antenna shall be tuned to never exceed this 250 mA maximum current.

## 6 Firmware versions

### 6.1 Firmware version and model ID retrieval

It is possible to identify a dedicated installed firmware version.

In addition, the product versions PN7160 and PN7161 can be differentiated thanks to the model ID.

- model ID value 0x61 indicates PN7160
- model ID value 0x71 indicates PN7161

The 9th byte of the CORE\_RESET\_NTF indicates the model ID. The 10th, 11th, and 12th bytes of the CORE\_RESET\_NTF indicate the installed FW version.

*Example:*

The model ID is retrieved from the CORE\_RESET\_NTF following CORE\_RESET\_CMD/RSP sequence (first NCI exchanges when initializing PN7160/PN7161).

In the following NCI exchange sequence:

```
>> 20 00 01 00 // CORE_RESET_CMD
<< 40 00 01 00 // CORE_RESET_RSP
<< 60 00 09 02 00 20 04 04 71 12 50 05 // CORE_RESET_NTF
```

The 9th byte of the CORE\_RESET\_NTF indicates the model ID (0x71 in the example above == PN7161).

The 10th, 11th, and 12th bytes of the CORE\_RESET\_NTF indicate the FW version (0x12, 0x50, 0x05 point to FW version 12.50.05).

### 6.2 Version 12.50.0E

Changes in this version:

- Fixed stability issues during handling of RF\_DEACTIVATE\_CMD (to IDLE) and RF\_DEACTIVATE\_RSP.

### 6.3 Version 12.50.0D

Changes in this version:

- Added support for custom cards with specific SAK value. API added is: 0xA0 0x6E.

### 6.4 Version 12.50.0C

Changes in this version:

- Added support for dynamic ECP configuration.

## 6.5 Version 12.50.0B

Changes in this version:

- Optimized the flash contents, removed not required features for longer serviceability of PN7160:
  - Type-F card mode support removed.
  - Support for P2P not claimed.

## 6.6 Version 12.50.0A

Changes in this version:

- T4T Card emulation (NFCEE\_NDEF) update. (Now allowing NDEF WRITE from RF side, working with TagWriter application on Android).

## 6.7 Version 12.50.09

Changes in this version:

- NDEF write from NFC supported, when the device is in Autonomous NDEF mode.
- ECP supported in EMVCo profile (PN7161 only).
- Optimized card removal procedure when ECP is enabled (PN7161 only).
- Added PRBS support for ISO/IEC 15693.
- This version is not available on hardware, only as a firmware update file.

## 6.8 Version 12.50.08

Changes in this version:

- Resolved an issue in which the IC is hung with RF ON when a Type B card is placed during the discovery process when ECP is enabled for NFC Forum profile.

## 6.9 Version 12.50.07

Changes in this version:

- ECP is supported in EMVCo profile.

## 6.10 Version 12.50.06

Changes in this version:

- Changes to support NFC Forum CR12.
- Added helper command to configure the Dynamic Power Control (DPC).
- This version is not available on hardware, only as a firmware update file.

## 6.11 Version 12.50.05

Initial version

Production samples will have 12.50.05 firmware.

7 Ordering information

Table 2. Ordering information

| Type number                                                  | Package |                                                                              |           |
|--------------------------------------------------------------|---------|------------------------------------------------------------------------------|-----------|
|                                                              | Name    | Description                                                                  | Version   |
| PN7160xyzz/C100 <sup>[1]</sup> <sup>[2]</sup> <sup>[3]</sup> | VFBGA64 | plastic very thin fine-pitch ball grid array package; 64 balls               | SOT1860-1 |
|                                                              | HVQFN40 | plastic thermal enhanced very thin quad flat package; no leads; 40 terminals | SOT618-1  |
| PN7161xyzz/C100 <sup>[1]</sup> <sup>[2]</sup> <sup>[3]</sup> | VFBGA64 | plastic very thin fine-pitch ball grid array package; 64 balls               | SOT1860-1 |
|                                                              | HVQFN40 | plastic thermal enhanced very thin quad flat package; no leads; 40 terminals | SOT618-1  |

[1] x: A = I<sup>2</sup>C-bus interface; B = SPI-bus interface.  
[2] y: correspond to firmware variant.  
[3] zz: correspond to package variant. HN = HVQFN40 package; EV = VFBGA64 package.

PN7160 is available in different configurations:

Table 3. Product variants PN7160

| Part number     | Control interface / firmware version | Package | Packing | MOQ  | Marking | 12NC           |
|-----------------|--------------------------------------|---------|---------|------|---------|----------------|
| PN7160A1EV/C100 | I <sup>2</sup> C / 12.50.05          | VFBGA64 | Reel    | 4500 | 71601   | 9354 166 64518 |
| PN7160A1EV/C100 | I <sup>2</sup> C / 12.50.05          | VFBGA64 | 5-Tray  | 2450 | 71601   | 9354 166 64557 |
| PN7160A1HN/C100 | I <sup>2</sup> C / 12.50.05          | HVQFN40 | Reel    | 4000 | 71601   | 9354 166 65518 |
| PN7160A1HN/C100 | I <sup>2</sup> C / 12.50.05          | HVQFN40 | 1-Tray  | 490  | 71601   | 9354 166 65551 |
| PN7160B1EV/C100 | SPI / 12.50.05                       | VFBGA64 | Reel    | 4500 | 71602   | 9354 237 43518 |
| PN7160B1EV/C100 | SPI / 12.50.05                       | VFBGA64 | 5-Tray  | 2450 | 71602   | 9354 237 43557 |
| PN7160B1HN/C100 | SPI / 12.50.05                       | HVQFN40 | Reel    | 4000 | 71602   | 9354 237 44518 |
| PN7160B1HN/C100 | SPI / 12.50.05                       | HVQFN40 | 1-Tray  | 490  | 71602   | 9354 237 44551 |



Table 4. Product variants PN7161

| Part number     | Control interface/firmware version | Package | Packing | MOQ  | Marking | 12NC           |
|-----------------|------------------------------------|---------|---------|------|---------|----------------|
| PN7161A1EV/C100 | I <sup>2</sup> C / 12.50.05        | VFBGA64 | Reel    | 4500 | 71611   | 9354 237 58518 |
| PN7161A1EV/C100 | I <sup>2</sup> C / 12.50.05        | VFBGA64 | 5-Tray  | 2450 | 71611   | 9354 237 58557 |
| PN7161A1HN/C100 | I <sup>2</sup> C / 12.50.05        | HVQFN40 | Reel    | 4000 | 71611   | 9354 237 59518 |
| PN7161A1HN/C100 | I <sup>2</sup> C / 12.50.05        | HVQFN40 | 1-Tray  | 490  | 71611   | 9354 237 59551 |
| PN7161B1EV/C100 | SPI / 12.50.05                     | VFBGA64 | Reel    | 4500 | 71612   | 9354 237 61518 |
| PN7161B1EV/C100 | SPI / 12.50.05                     | VFBGA64 | 5-Tray  | 2450 | 71612   | 9354 237 61557 |
| PN7161B1HN/C100 | SPI / 12.50.05                     | HVQFN40 | Reel    | 4000 | 71612   | 9354 237 62518 |
| PN7161B1HN/C100 | SPI / 12.50.05                     | HVQFN40 | 1-Tray  | 490  | 71612   | 9354 237 62551 |

8 Marking

8.1 Marking VFBGA64

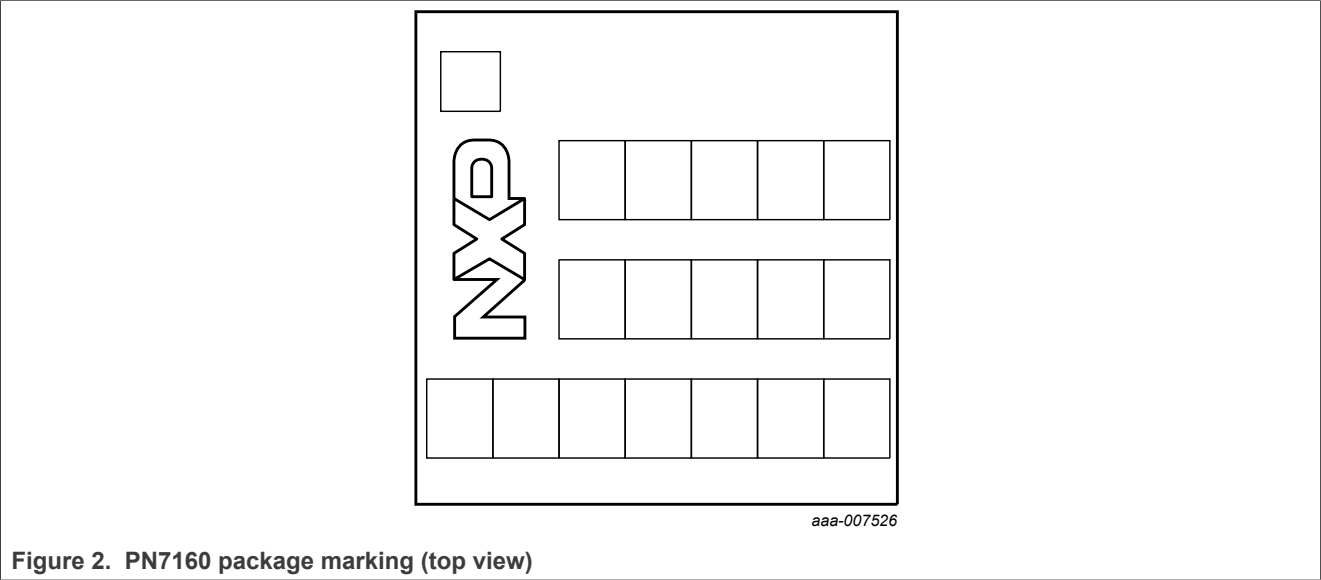


Table 5. Marking code

| Line number | Marking code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Line 1      | product version identification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Line 2      | diffusion batch sequence number + assembly lot ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Line 3      | manufacturing code including: <ul style="list-style-type: none"><li>• diffusion center code:<ul style="list-style-type: none"><li>– S: Power chip (PTCT)</li></ul></li><li>• assembly center code:<ul style="list-style-type: none"><li>– S: ATKH</li></ul></li><li>• RoHS compliancy indicator:<ul style="list-style-type: none"><li>– D: Dark Green; fully compliant RoHS and no halogen and antimony</li></ul></li><li>• manufacturing year and week, 3 digits:<ul style="list-style-type: none"><li>– Y: year</li><li>– WW: week code</li></ul></li><li>• product life cycle status code:<ul style="list-style-type: none"><li>– X: means not qualified product</li><li>– nothing means released product</li></ul></li></ul> |

8.2 Marking HVQFN40

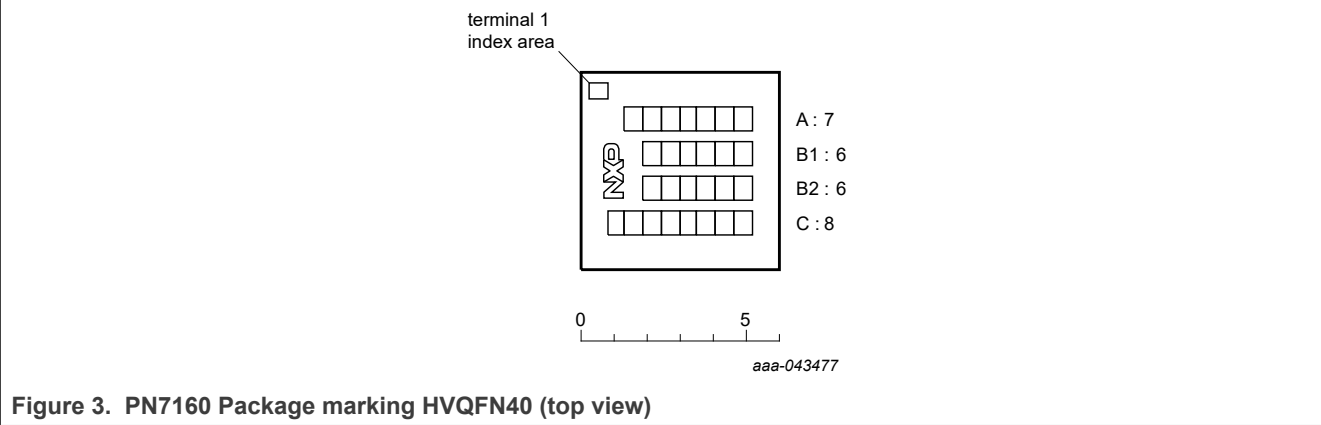


Figure 3. PN7160 Package marking HVQFN40 (top view)

Table 6. Marking codes

| Type number       | Marking code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Line A            | 7 characters used: product version identification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Line B1 + Line B2 | Diffusion Bath ID (9 digits) + space + assembly ID number (2 digits)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Line C            | 8 characters used: manufacturing code including: <ul style="list-style-type: none"><li>• diffusion center code:<ul style="list-style-type: none"><li>– S: Power chip (PTCT)</li></ul></li><li>• assembly center code:<ul style="list-style-type: none"><li>– S: ATKH</li></ul></li><li>• RoHS compliancy indicator:<ul style="list-style-type: none"><li>– D: Dark Green; fully compliant RoHS and no halogen and antimony</li></ul></li><li>• manufacturing year and week, 3 digits:<ul style="list-style-type: none"><li>– YY: year</li><li>– WW: week code</li></ul></li><li>• product life cycle status code:<ul style="list-style-type: none"><li>– X: means not qualified product</li><li>– nothing means released product</li></ul></li></ul> |

9 Block diagram

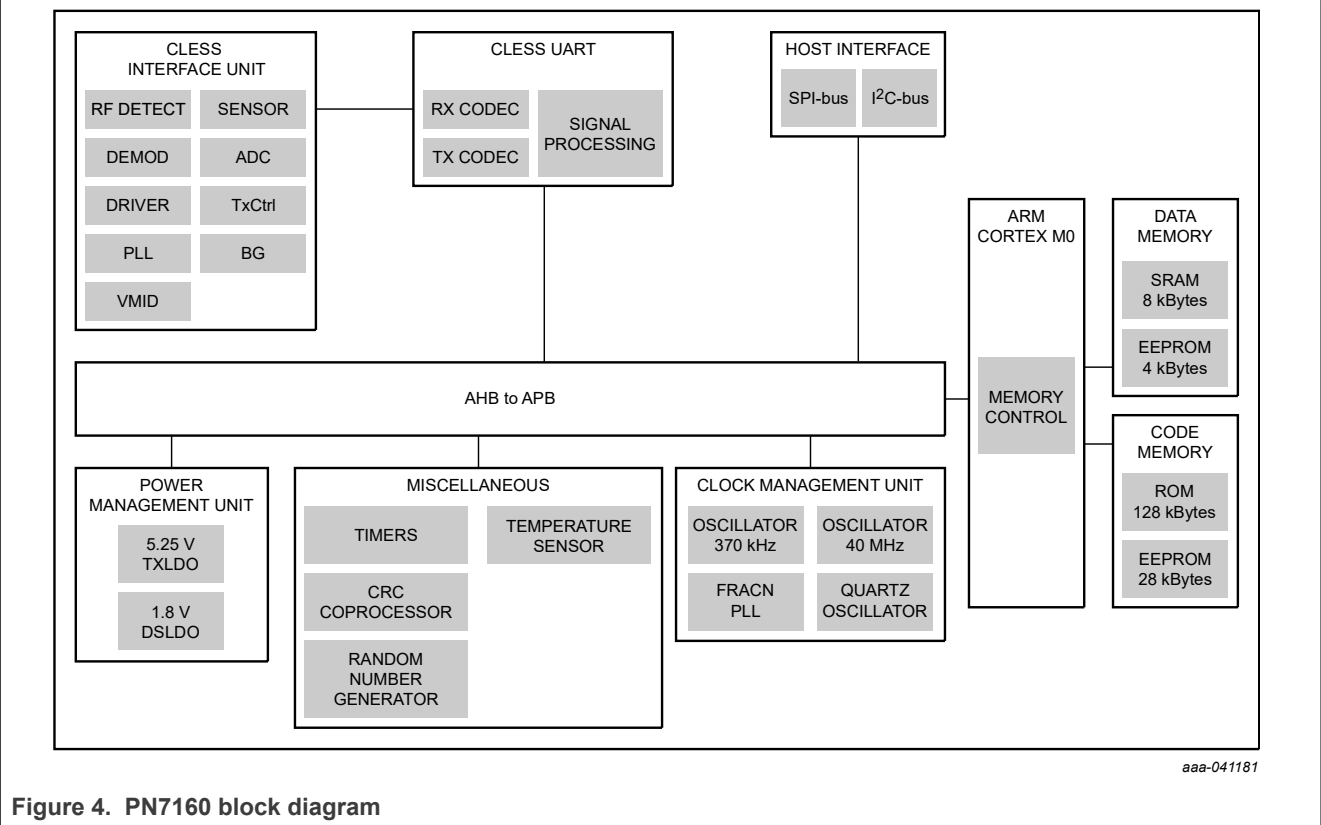


Figure 4. PN7160 block diagram

10 Pinning information

10.1 Pinning

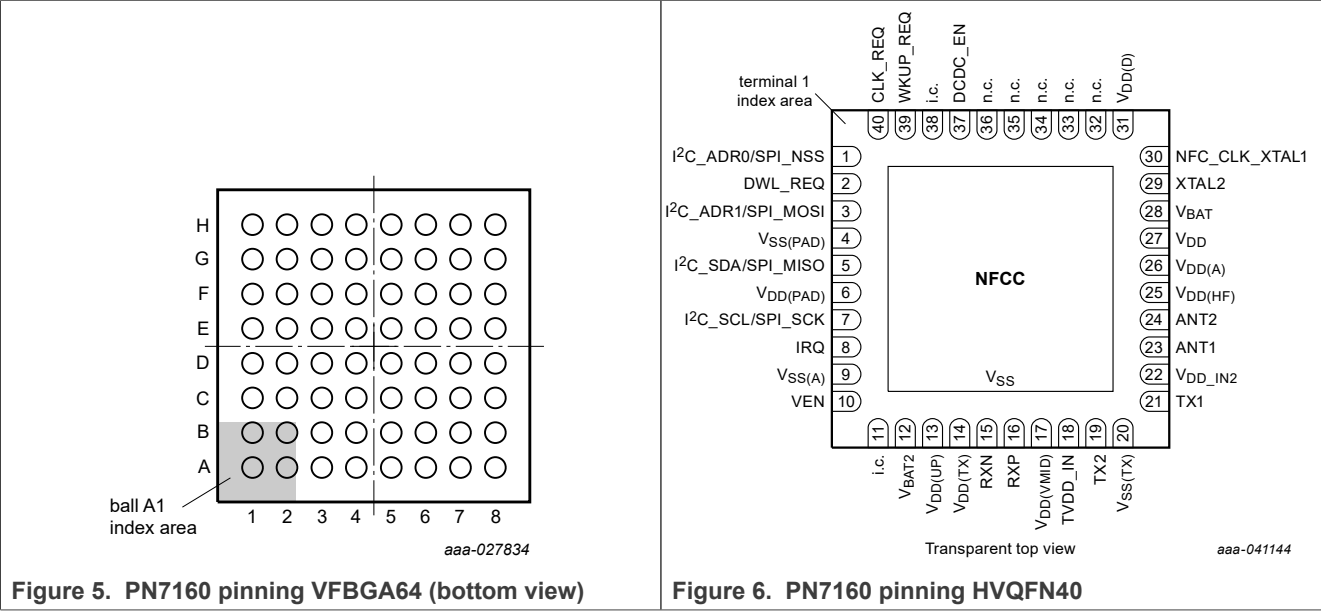


Table 7. PN7160 pin description

| Symbol                         | Pin HVQFN40 | Pin VFBGA64 | Type <sup>[1]</sup> | Refer                 | Description                                                                                          |
|--------------------------------|-------------|-------------|---------------------|-----------------------|------------------------------------------------------------------------------------------------------|
| I <sup>2</sup> C_ADR0/SPI_NSS  | 1           | C3          | I/O                 | V <sub>DD</sub> (PAD) | Host interface pin 1                                                                                 |
| DWL_REQ                        | 2           | D3          | I                   | V <sub>DD</sub> (PAD) | Firmware download control pin                                                                        |
| I <sup>2</sup> C_ADR1/SPI_MOSI | 3           | D1          | I/O                 | V <sub>DD</sub> (PAD) | Host interface pin 2                                                                                 |
| V <sub>SS</sub> (PAD)          | 4           | C1          | G                   | n/a                   | Pad ground. Must be connected to ground.                                                             |
| I <sup>2</sup> C_SDA/SPI_MISO  | 5           | E1          | I/O                 | V <sub>DD</sub> (PAD) | Host interface pin 3                                                                                 |
| V <sub>DD</sub> (PAD)          | 6           | D2          | P                   | n/a                   | Pad supply voltage                                                                                   |
| I <sup>2</sup> C_SCL/SPI_SCK   | 7           | E2          | I/O                 | V <sub>DD</sub> (PAD) | Host interface pin 4                                                                                 |
| IRQ                            | 8           | E3          | O                   | V <sub>DD</sub> (PAD) | Interrupt request output                                                                             |
| V <sub>SS</sub> (A)            | 9           | G3          | G                   | n/a                   | Analog ground supply voltage                                                                         |
| VEN                            | 10          | H1          | I                   | V <sub>BAT</sub>      | Reset pin. Set the device in Hard Power Down.                                                        |
| i.c.                           | 11          | -           | -                   | -                     | Internally Connected. To be left open.                                                               |
| V <sub>BAT2</sub>              | 12          | -           | P                   | n/a                   | Battery supply voltage. Must be connected to V <sub>BAT</sub> . VFBGA package: internally connected. |
| V <sub>DD</sub> (UP)           | 13          | H3          | P                   | n/a                   | TXLDO input supply voltage                                                                           |
| V <sub>DD</sub> (TX)           | 14          | G7          | P                   | n/a                   | Transmitter supply voltage                                                                           |

Table 7. PN7160 pin description...continued

| Symbol                | Pin<br>HVQFN40 | Pin<br>VFBGA64 | Type <sup>[1]</sup> | Refer                | Description                                                                                          |
|-----------------------|----------------|----------------|---------------------|----------------------|------------------------------------------------------------------------------------------------------|
| RXN                   | 15             | H6             | I                   | V <sub>DD(A)</sub>   | Negative receiver input                                                                              |
| RXP                   | 16             | H5             | I                   | V <sub>DD(A)</sub>   | Positive receiver input                                                                              |
| V <sub>DD(VMID)</sub> | 17             | H4             | P                   | n/a                  | Receiver reference input supply voltage                                                              |
| TVDD_IN               | 18             | -              | P                   | n/a                  | Must be connected to V <sub>DD(TX)</sub> and TVDD_IN2. VFBGA package: internally connected.          |
| TX2                   | 19             | H7             | O                   | V <sub>DD(TX)</sub>  | Antenna driver output                                                                                |
| V <sub>SS(TX)</sub>   | 20             | H8             | G                   | n/a                  | Contactless transmitter ground. Must be connected to ground.                                         |
| TX1                   | 21             | G8             | O                   | V <sub>DD(TX)</sub>  | Antenna driver output                                                                                |
| TVDD_IN2              | 22             | -              | P                   |                      | Must be connected to V <sub>DD(TX)</sub> and TVDD_IN. VFBGA package: internally connected.           |
| ANT1                  | 23             | F7             | P                   | n/a                  | Antenna connection for wake-up                                                                       |
| ANT2                  | 24             | E7             | P                   | n/a                  | Antenna connection for wake-up                                                                       |
| V <sub>DD(HF)</sub>   | 25             | D6             | P                   | n/a                  | Monitor rectifier output voltage                                                                     |
| V <sub>DD(A)</sub>    | 26             | D7             | P                   | n/a                  | Analog supply voltage. Connect to V <sub>DD(D)</sub> .                                               |
| V <sub>DD</sub>       | 27             | -              |                     |                      | Must be connected to AVDD and DVDD. VFBGA package: internally connected.                             |
| V <sub>BAT</sub>      | 28             | E8             | P                   | n/a                  | Battery supply voltage. Must be connected to V <sub>BAT2</sub> .                                     |
| XTAL2                 | 29             | D8             | O                   | V <sub>DD(D)</sub>   | Oscillator output                                                                                    |
| NFC_CLK_XTAL1         | 30             | C8             | I                   | V <sub>DD(D)</sub>   | PLL input                                                                                            |
| V <sub>DD(D)</sub>    | 31             | C7             | P                   | n/a                  | Digital supply voltage for decoupling. Must be connected to V <sub>DD</sub> and V <sub>DD(A)</sub> . |
| n.c.                  | 32             | -              |                     |                      |                                                                                                      |
| n.c.                  | 33             | -              |                     |                      |                                                                                                      |
| n.c.                  | 34             | -              |                     |                      |                                                                                                      |
| n.c.                  | 35             | -              |                     |                      |                                                                                                      |
| n.c.                  | 36             | -              |                     |                      |                                                                                                      |
| DCDC_EN               | 37             | A2             | O                   | V <sub>DD(PAD)</sub> | External DC-DC enable request on V <sub>DD(PAD)</sub>                                                |
| i.c.                  | 38             | B2             |                     |                      | To be left open.                                                                                     |
| WKUP_REQ              | 39             | A1             | I                   | V <sub>DD(PAD)</sub> | Wake-up request when in standby                                                                      |
| CLK_REQ               | 40             | B1             | O                   | V <sub>DD(PAD)</sub> | Clock request pin                                                                                    |
| V <sub>SS</sub>       | Center Pad     | -              | G                   | n/a                  | Pad ground. Must be connected to ground.                                                             |
| i.c.                  | -              | A3             |                     |                      | To be left open.                                                                                     |

Table 7. PN7160 pin description...continued

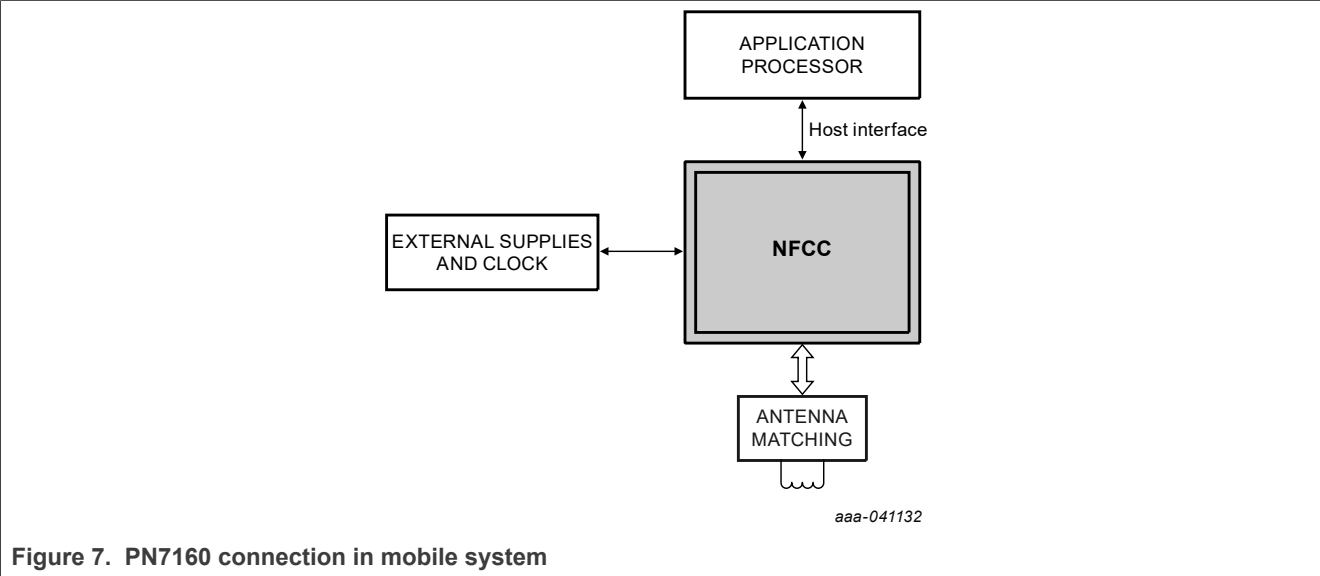
| Symbol             | Pin<br>HVQFN40 | Pin<br>VFBGA64 | Type <sup>[1]</sup> | Refer              | Description                                                 |
|--------------------|----------------|----------------|---------------------|--------------------|-------------------------------------------------------------|
| i.c.               | -              | A4             |                     |                    | Must be connected to ground.                                |
| i.c.               | -              | A5             |                     |                    | To be left open.                                            |
| i.c.               | -              | A6             |                     |                    | To be left open.                                            |
| i.c.               | -              | A7             |                     |                    | Must be connected to ground.                                |
| i.c.               | -              | A8             |                     |                    | To be left open.                                            |
| i.c.               | -              | B3             |                     |                    | To be left open.                                            |
| n.c.               | -              | B4             |                     |                    | To be left open.                                            |
| n.c.               | -              | B5             |                     |                    | To be left open.                                            |
| i.c.               | -              | B6             |                     |                    | To be left open.                                            |
| i.c.               | -              | B7             |                     |                    | To be left open.                                            |
| i.c.               | -              | B8             |                     |                    | To be left open.                                            |
| i.c.               | -              | C2             |                     |                    | To be left open.                                            |
| n.c.               | -              | C4             |                     |                    | To be left open.                                            |
| n.c.               | -              | C5             |                     |                    | To be left open.                                            |
| V <sub>SS(D)</sub> | -              | C6             | G                   | n/a                | Digital ground supply voltage. Must be connected to ground. |
| n.c.               | -              | D4             |                     |                    | To be left open.                                            |
| n.c.               | -              | D5             |                     |                    | To be left open.                                            |
| n.c.               | -              | E4             |                     |                    | To be left open.                                            |
| n.c.               | -              | E5             |                     |                    | To be left open.                                            |
| n.c.               | -              | E6             |                     |                    | To be left open.                                            |
| i.c.               | -              | F1             |                     |                    | To be left open.                                            |
| i.c.               | -              | F2             |                     |                    | To be left open.                                            |
| i.c.               | -              | F3             |                     |                    | To be left open.                                            |
| n.c.               | -              | F4             |                     |                    | To be left open.                                            |
| n.c.               | -              | F5             |                     |                    | To be left open.                                            |
| n.c.               | -              | F6             |                     |                    | To be left open.                                            |
| TX_PWR_REQ         | -              | F8             | O                   | V <sub>DD(D)</sub> | External TX power supply request on V <sub>DD(D)</sub>      |
| i.c.               | -              | G1             |                     |                    | Must be connected to ground.                                |
| i.c.               | -              | G2             |                     |                    | To be left open.                                            |
| n.c.               | -              | G4             |                     |                    | To be left open.                                            |
| V <sub>SS(A)</sub> | -              | G5             | G                   | n/a                | Analog ground supply voltage                                |
| V <sub>SS(A)</sub> | -              | G6             | G                   | n/a                | Analog ground supply voltage                                |
| i.c.               | -              | H2             |                     |                    | To be left open.                                            |

[1] P = power supply; G = ground; I = input; O = output; I/O = input/output

11 Functional description

PN7160 can be connected on a host controller through different physical interfaces (I<sup>2</sup>C-bus and SPI-bus). The logical interface towards the host controller is NCI-compliant Ref. [2] with additional command set for NXP-specific product features. This IC is fully user controllable by the firmware interface described in Ref. [6].

Moreover, PN7160 provides flexible and integrated power management unit in order to preserve energy supporting Power Off mode.



11.1 System modes

11.1.1 System power modes

4 power modes are specified: Full power mode, Autonomous mode, Low-power mode and Power Off mode.

Table 8. System power modes description

| System power mode | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Full power mode   | The battery supply ( $V_{BAT}$ ) as well as the pad supply ( $V_{DD(PAD)}$ ) are available                                                                                                                                                                                                                                                                                                                                                                                                      |
| Autonomous mode   | The battery supply ( $V_{BAT}$ ) as well as the pad supply ( $V_{DD(PAD)}$ ) are available. Via a SW command the host sets the NFC controller in autonomous mode (AutoMode bit is set). In that power mode, the NFC controller will not send any command or signal over $V_{DD(PAD)}$ connected pins.<br>In case of reset via VEN pin the AutoMode bit value is kept unchanged.<br>This mode is useful to present an NDEF message in Card Emulation mode although the main system is shut down. |
| Low-power mode    | The battery supply ( $V_{BAT}$ ) is available but the pad supply ( $V_{DD(PAD)}$ ) is not available. No host communication is available.                                                                                                                                                                                                                                                                                                                                                        |
| Power Off mode    | The system is not supplied from any source or the system is kept Hard Power Down (HPD)                                                                                                                                                                                                                                                                                                                                                                                                          |



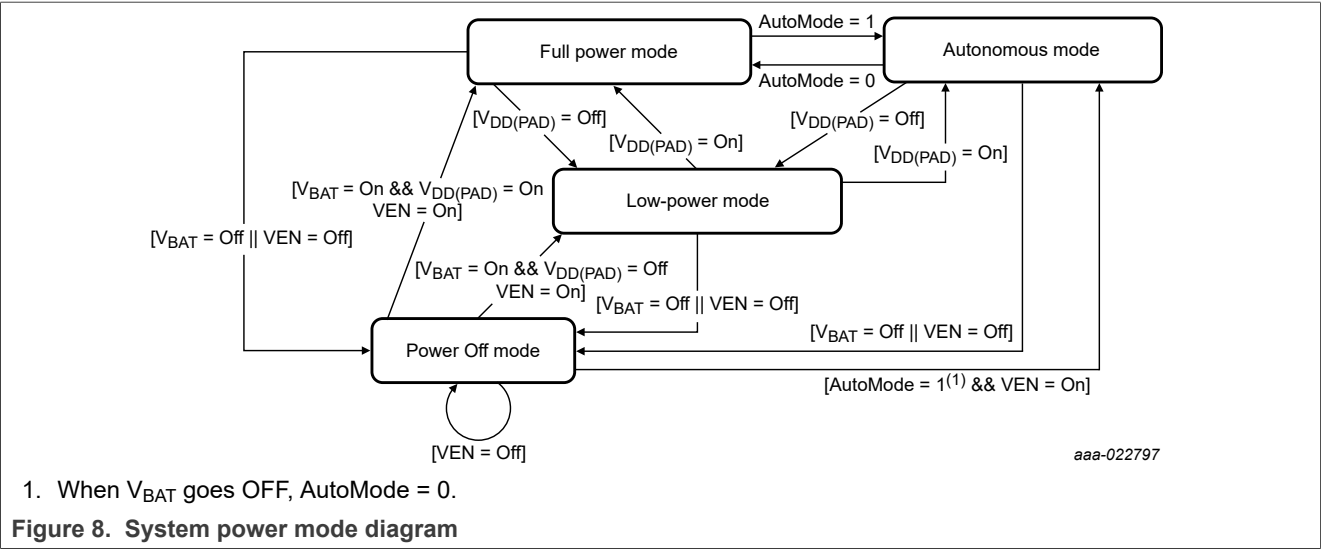


Table 9 summarizes the system power mode of the PN7160 depending on the status of the external supplies available in the system:

Table 9. System power modes configuration

| $V_{BAT}$ | $V_{DD(PAD)}$ | VEN | AutoMode bit | Power mode      |
|-----------|---------------|-----|--------------|-----------------|
| Off       | X             | X   | X            | Power Off mode  |
| On        | X             | Off | X            | Power Off mode  |
| On        | On            | On  | 0            | Full power mode |
| On        | On            | On  | 1            | Autonomous mode |
| On        | Off           | On  | X            | Low-power mode  |

Depending on power modes, some application states are limited:

Table 10. System power modes description

| System power mode                 | Allowed communication modes              |
|-----------------------------------|------------------------------------------|
| Power Off mode                    | not applicable                           |
| Low-power mode<br>Autonomous mode | Card Emulation only                      |
| Full power mode                   | Reader/Writer, Card Emulation, P2P modes |

11.1.2 PN7160 power states

Next to system power modes defined by the status of the power supplies, the power states include the logical status of the system. Thus extend the power modes.

3 power states are specified: Hard Power Down (HPD), Standby, Active.

Table 11. PN7160 power states

| Power state name | Description                                                                                                                                                                                                                            |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hard Power Down  | The PN7160 is supplied by $V_{BAT}$ within its operating range and PN7160 is kept in Hard Power Down ( $V_{EN}$ voltage is kept low by host or SW programming) to have the minimum power consumption. The system mode is in Power Off. |

Table 11. PN7160 power states...continued

| Power state name | Description                                                                                                                                                                                                                                                                                                                                                      |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Standby          | The PN7160 is supplied by V <sub>BAT</sub> within its operating range, VEN voltage is high (by host or SW programming) and minimum part of PN7160 is kept supplied to enable configured wake-up sources which allow to switch to Active state; RF field, Host interface (if V <sub>DD(PAD)</sub> is high). The system mode is Low-power mode or Full power mode. |
| Active           | The PN7160 is supplied by V <sub>BAT</sub> within its operating range, VEN voltage is high (by host or SW programming), V <sub>DD(PAD)</sub> is high and the PN7160 internal blocks are supplied. 3 sub-modes are defined: Idle, Listener and Poller. The system mode is Full power mode.                                                                        |

At application level, the PN7160 will continuously switch between different states to optimize the current consumption (polling loop mode). Refer to [Table 1](#) for targeted current consumption in here described states. The PN7160 is designed to allow the host controller to have full control over its functional states.

11.1.2.1 Hard Power Down (HPD) state

The Hard Power Down state is entered when V<sub>DD(PAD)</sub> and V<sub>BAT</sub> are high by setting VEN voltage < 0.4 V. As these signals are under host control, the PN7160 has no influence on entering or exiting this state.

11.1.2.2 Standby state

Active state is PN7160's default state after boot sequence in order to allow a quick configuration of PN7160. It is recommended to change the default state to Standby state after first boot in order to save power. PN7160 can switch to Standby state autonomously (if configured by host). This state is independent of the V<sub>DD(PAD)</sub> value. In this state, PN7160 most blocks including CPU are disconnected from power supply. Number of wake-up sources exist to put PN7160 into Active state (all host-related wake-up events imply that V<sub>DD(PAD)</sub> is available):

- Host interface wake-up event (I<sup>2</sup>C-bus, SPI-bus)
- Host interface wake-up via WKUP\_REQ pin
- Antenna RF level detector
- Internal timer event when using polling loop (370 kHz Low-power oscillator is enabled)

If wake-up event occurs, PN7160 will switch to Active state. Any further operation depends on software configuration and/or wake-up source.

11.1.2.3 Active state

Within the Active state, the system is acting as an NFC device. The device can be in 3 different power states: Idle, Listener and Poller.

Table 12. Functional modes in active state

| Functional modes | Description                                                                                                                                                                                       |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Idle             | the PN7160 is active and host interface communication is on going. The RF interface is not activated. If Standby state is de-activated PN7160 stays in Idle mode even when no host communication. |
| Listener         | the PN7160 is active and is listening to external device. The RF interface is activated.                                                                                                          |
| Poller           | the PN7160 is active and is in Poller mode. It polls external device. The RF interface is activated.                                                                                              |

## Poller mode

In this mode, PN7160 is acting as Reader/Writer or NFC Initiator, searching for or communicating with passive tags or NFC target. Once RF communication has ended, PN7160 will switch to Idle mode or Standby state to save energy. Poller mode shall be used with  $2.8\text{ V} < V_{\text{BAT}} < 5.5\text{ V}$  and VEN voltage  $> 1.1\text{ V}$ . Poller mode shall not be used with  $V_{\text{BAT}} < 2.8\text{ V}$ .  $V_{\text{DD(PAD)}}$  is within its operational range (see [Table 1](#)).

## Listener mode

In this mode, PN7160 is acting as a card or as an NFC Target. Listener mode shall be used with  $2.8\text{ V} < V_{\text{BAT}} < 5.5\text{ V}$  and VEN voltage  $> 1.1\text{ V}$ . Once RF communication has ended, PN7160 will switch to Idle mode or Standby state to save energy.

### 11.1.2.4 Polling loop

The polling loop will sequentially set PN7160 in different power states (Active or Standby). All RF technologies supported by PN7160 can be independently enabled within this polling loop.

There are 2 main phases in the polling loop:

- Listening phase. The PN7160 can be in Standby power state or Idle mode (called pause in [Figure 9](#); no communication is on-going) or Listener mode (called Emulation in [Figure 9](#); card / target communication is started)
- Polling phase. The PN7160 is in Poller mode

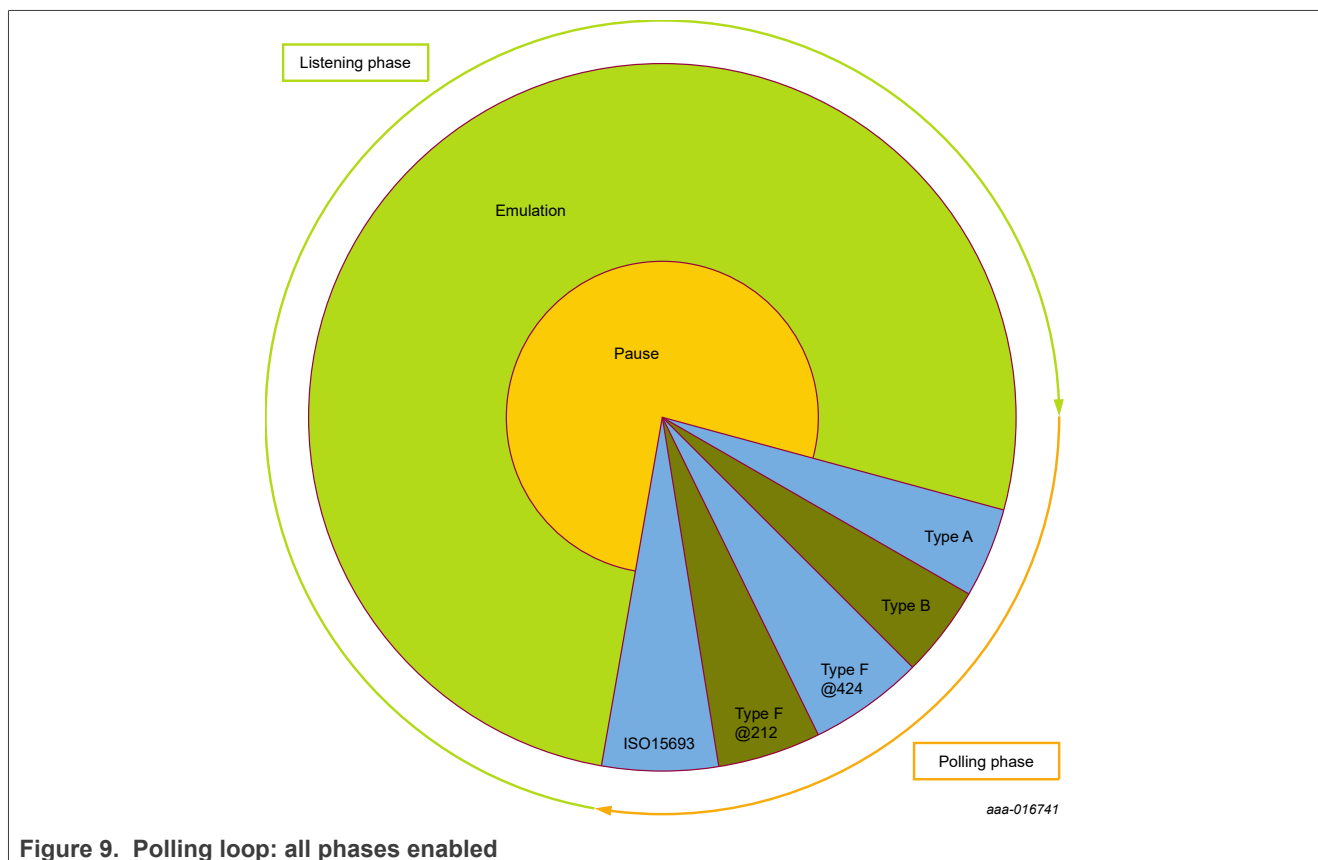


Figure 9. Polling loop: all phases enabled

In Listening phase when no RF field PN7160 is in Standby state if enabled (otherwise it is Idle mode) and is in Listener mode (Emulation) when RF field is detected. When in Polling phase, PN7160 goes to Poller mode.

To further decrease the power consumption when running the polling loop, PN7160 features a low-power RF polling. When PN7160 is in Polling phase instead of sending regularly RF command PN7160 senses with a short RF field duration if there is any NFC Target or card/tag present. If yes, then it goes back to standard polling loop. With 500 ms (configurable duration, see Ref. [6]) listening phase duration, the average power consumption is around 100  $\mu$ A depending on RF matching conditions.

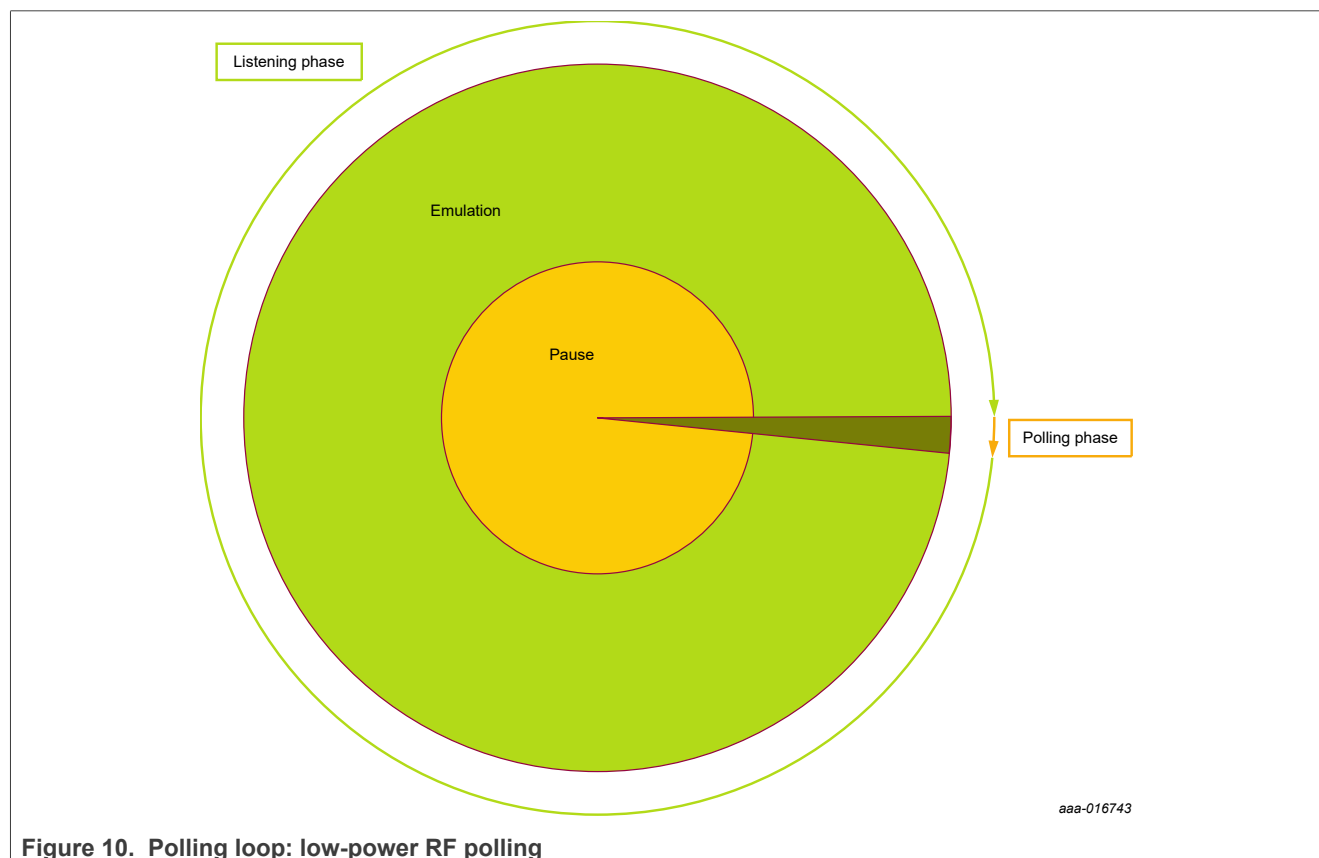


Figure 10. Polling loop: low-power RF polling

Detailed description of polling loop configuration options is given in Ref. [6].

## 11.2 Host interfaces<sup>2</sup>

PN7160 provides the support of the following host interfaces:

- I<sup>2</sup>C-bus Target Interface, up to 3.4 MBaud
- SPI-bus Target Interface, up to 7 MBaud

Only one host interface can be active at a time, as the pins are shared for all interfaces.

The selection between interfaces is fused during IC manufacturing so that different ordering numbers for the I<sup>2</sup>C-bus and SPI-bus version are in place.

The host interfaces are woken-up in the following way:

- wake-up with WKUP\_REQ input pin
- I<sup>2</sup>C-bus: wake-up on I<sup>2</sup>C-bus address
- SPI-bus: transition of NSS serial
- data received on RX line

<sup>2</sup> Updated the terms "Master/Slave" to "Controller/Target" to align with the recommendation of the NXP - I2C standards organization.

To enable and ensure data flow control between PN7160 and host controller, additionally a dedicated interrupt line IRQ is provided which Active state is programmable. See Ref. [6] for more information.

11.2.1 I<sup>2</sup>C-bus interface<sup>2</sup>

The I<sup>2</sup>C-bus interface implements a target I<sup>2</sup>C-bus interface with integrated shift register, shift timing generation and target address recognition.

I<sup>2</sup>C-bus Standard mode (100 kHz SCL), Fast mode (400 kHz SCL) and High-speed mode (3.4 MHz SCL) are supported.

The main hardware characteristics of the I<sup>2</sup>C-bus module are:

- Support target I<sup>2</sup>C-bus
- Standard, Fast and High-speed modes supported
- Wake-up of PN7160 on its address only
- Serial clock synchronization can be used by PN7160 as a handshake mechanism to suspend and resume serial transfer (clock stretching)

The I<sup>2</sup>C-bus interface module meets the I<sup>2</sup>C-bus specification Ref. [4] except General call, 10 bit addressing and Fast mode Plus (Fm+).

11.2.1.1 I<sup>2</sup>C-bus configuration

The I<sup>2</sup>C-bus interface shares four pins with SPI-bus interface also supported by PN7160. When I<sup>2</sup>C-bus is configured in EEPROM settings, functionality of the interface pins changes as described in Table 13.

Table 13. Functionality for I<sup>2</sup>C-bus interface

| Pin name            | Functionality                   |
|---------------------|---------------------------------|
| HIF1                | I <sup>2</sup> C-bus address 0  |
| HIF2                | I <sup>2</sup> C-bus address 1  |
| HIF3 <sup>[1]</sup> | I <sup>2</sup> C-bus data line  |
| HIF4 <sup>[1]</sup> | I <sup>2</sup> C-bus clock line |

[1] HIF3 and HIF4 are not fail-safe and V<sub>DD(pad)</sub> shall always be available when using the SCL and SDA lines connected to these pins.

PN7160 supports 7-bit addressing mode. Selection of the I<sup>2</sup>C-bus address is done by 2-pin configurations on top of a fixed binary header: 0, 1, 0, 1, 0, HIF2, HIF1, R/W.

Table 14. I<sup>2</sup>C-bus interface addressing

| HIF2 | HIF1 | I <sup>2</sup> C-bus address<br>(R/W = 0, write) | I <sup>2</sup> C-bus address<br>(R/W = 1, read) |
|------|------|--------------------------------------------------|-------------------------------------------------|
| 0    | 0    | 0x50                                             | 0x51                                            |
| 0    | 1    | 0x52                                             | 0x53                                            |
| 1    | 0    | 0x54                                             | 0x55                                            |
| 1    | 1    | 0x56                                             | 0x57                                            |

11.2.2 Serial Peripheral Interface bus (SPI-bus)<sup>2</sup>

11.2.2.1 Features

- Synchronous, Serial, Full-Duplex communication, 7 MHz maximum
- Target mode

11.2.2.2 SPI-bus configuration options<sup>2</sup>

In order to select SPI-bus interface for host communication, some EEPROM settings are programmed during production.

The CPOL/CPHA EEPROM settings are fixed as specified in [Table 15](#).

The selection between interfaces is fused during IC manufacturing so that different ordering numbers for the SPI-bus version.

Table 15. SPI-bus configuration

| Connection                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CPHA switch: Clock PHAse: defines the sampling edge of MOSI data <ul style="list-style-type: none"><li>• CPHA = 0: data are sampled on MOSI on the odd clock edges of SCK after NSS goes low</li></ul> |
| CPOL switch: Clock POLarity <ul style="list-style-type: none"><li>• IFSEL1 = 0: the clock is idle low and the first valid edge of SCK will be a rising one</li></ul>                                   |

The SPI-bus interface shares 4 pins with the I<sup>2</sup>C-bus interface. During production of the device, the interface is fixed to SPI or I<sup>2</sup>C and cannot be changed later. The functionality of the interface pins in SPI configuration is described in [Table 16](#).

Table 16. Functionality for SPI-bus interface

| Pin name | Functionality                   |
|----------|---------------------------------|
| HIF1     | NSS (Not Target Select)         |
| HIF2     | MOSI (Controller Out Target In) |
| HIF3     | MISO (Controller In Target Out) |
| HIF4     | SCK (Serial Clock)              |

11.2.2.3 SPI-bus functional description<sup>2</sup>

When a controller device transmits data to PN7160 (target device) via the MOSI line, PN7160 responds by sending data to the controller device via the controllers MISO line. This implies full-duplex transmission with both data out and data in synchronized with the same clock signal.

PN7160 starts sampling when receiving a logic low at pin NSS and the clock at input pin SCK. Thus, PN7160 is synchronized with the controller. Data from the controller is received serially at the target MOSI line and loads the 8-bit shift register. After the 8-bit shift register is loaded, its data is transferred to the read buffer. During a write cycle, data is written into the shift register, then PN7160 waits for a clock train from the controller to shift the data out on the targets MISO line.

- Controller In Target Out (MISO)  
The MISO line is configured as an input in a controller device and as an output in a target device. It is used to transfer data from the target to the controller, with the most significant bit sent first. The MISO line of a target device should be placed in the high impedance state if the target is not selected.

- Controller Out Target In (MOSI)

The MOSI line is configured as an output in a controller device and as an input in a target device. It is used to transfer data from the controller to a target, with the Most Significant Bit (MSB) sent first.

- Serial Clock (SCK)

The serial clock is used to synchronize data movement both in and out of the device through its MOSI and MISO lines. The controller and target devices are capable of exchanging a byte of information during a sequence of eight clock cycles. Since the controller device generates SCK, this line becomes an input on a target device and an output at the controller device.

- Not Target Select (NSS)

The target select input line is used to select a target device. It has to be low prior to data transactions and must stay low of the duration of the transaction. The NSS line on controller side must be tied high.

Both controller and target devices must operate with the same timing. The controller device always places data on the MOSI line a half cycle before the clock edge SCK, in order for the target device to latch the data.

For more information about the SPI-bus functionality, see Ref. [5].

### 11.3 PN7160 clock concept

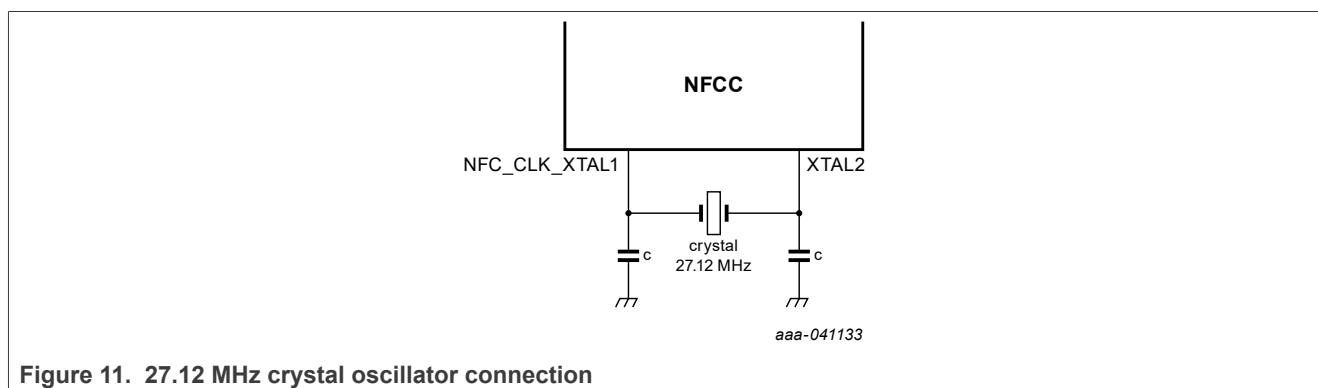
There are 4 different clock sources in PN7160:

- 27.12 MHz clock coming either/or from:
  - Internal oscillator for 27.12 MHz crystal connection on NFC\_CLK\_XTAL1 and XTAL2 pins
  - External reference clock on pin NFC\_CLK\_XTAL1. It is internally forwarded to an integrated PLL which includes a 1 GHz VCO.
- 13.56 MHz RF clock recovered from RF field
- Low-power oscillator 40 MHz
- Low-power oscillator 370 kHz

#### 11.3.1 27.12 MHz quartz oscillator

When enabled, the 27.12 MHz quartz oscillator applied to PN7160 is the time reference for the RF front end when PN7160 is behaving in Reader mode or NFCIP-1 Initiator.

Therefore stability of the clock frequency is an important factor for reliable operation. It is recommended to adopt the circuit shown in [Figure 11](#).



[Table 17](#) describes the levels of accuracy and stability required on the crystal.

Table 17. Crystal requirements

| Symbol             | Parameter                    | Conditions                                |     | Min | Typ   | Max | Unit |
|--------------------|------------------------------|-------------------------------------------|-----|-----|-------|-----|------|
| f <sub>xtal</sub>  | crystal frequency            | ISO/IEC, FCC and FeliCa global compliancy |     | -   | 27.12 | -   | MHz  |
| Δf <sub>xtal</sub> | crystal frequency accuracy   | full operating range                      | [1] | -50 | -     | +50 | ppm  |
| ESR                | equivalent series resistance |                                           |     | -   | 50    | 100 | Ω    |
| C <sub>L</sub>     | load capacitance             |                                           |     | -   | 10    | -   | pF   |
| P <sub>xtal</sub>  | crystal power dissipation    |                                           |     | -   | -     | 100 | μW   |

[1] This requirement is according to FCC regulations (± 100 ppm) and FeliCa global (± 50 ppm) requirements. To meet only ISO/IEC 14443 and ISO/IEC 18092, then ± 14 kHz apply which is equivalent to ± 516 ppm.

11.3.2 Integrated PLL to make use of external clock

When enabled, the PLL is designed to generate a low noise 27.12 MHz from an input clock 19.2 MHz, 26 MHz, 32 MHz, 38.4 MHz and 48 MHz.

The 27.12 MHz of the PLL is used as the time reference for the RF front end.

The input clock on NFC\_CLK\_XTAL1 shall comply with the following phase noise requirements for the following input frequency: 19.2 MHz, 26 MHz, 32 MHz, 38.4 MHz and 48 MHz:

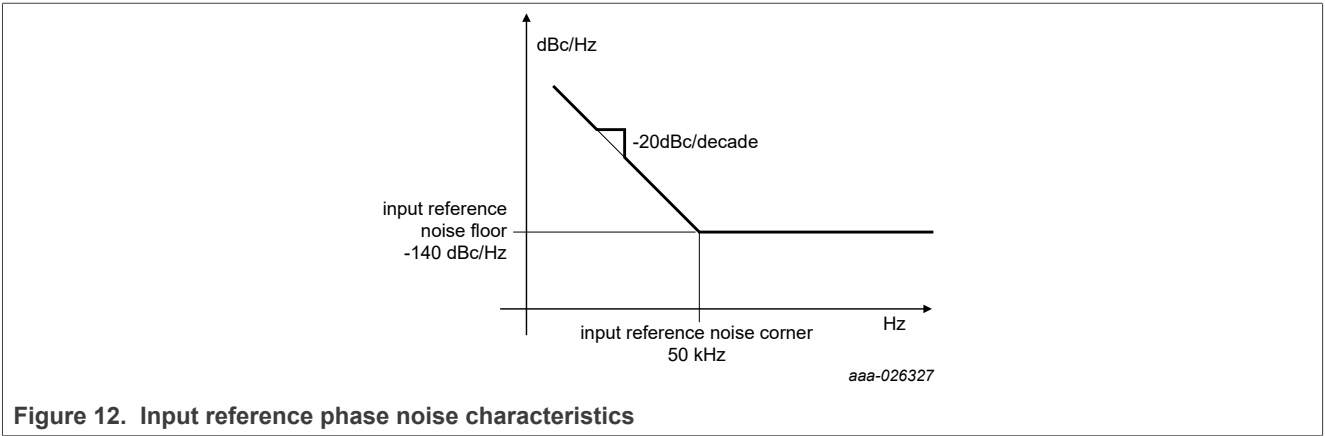


Figure 12. Input reference phase noise characteristics

This phase noise is equivalent to an RMS jitter of 6.23 ps from 10 Hz to 1 MHz. For configuration of input frequency, refer to Ref. [10]. There are 7 pre programmed and validated frequencies for the PLL: 19.2 MHz, 26 MHz, 32 MHz, 38.4 MHz and 48 MHz.

Table 18. PLL input requirements

Coupling: single-ended, AC coupling;

| Symbol           | Parameter       | Conditions                                |  | Min | Typ  | Max | Unit |
|------------------|-----------------|-------------------------------------------|--|-----|------|-----|------|
| f <sub>clk</sub> | clock frequency | ISO/IEC, FCC and FeliCa global compliancy |  | -   | 19.2 | -   | MHz  |
|                  |                 |                                           |  | -   | 26   | -   | MHz  |
|                  |                 |                                           |  | -   | 32   | -   | MHz  |
|                  |                 |                                           |  | -   | 38.4 | -   | MHz  |
|                  |                 |                                           |  | -   | 48   | -   | MHz  |



Table 18. PLL input requirements...continued

Coupling: single-ended, AC coupling;

| Symbol                        | Parameter                          | Conditions                                                                                      |     | Min  | Typ | Max | Unit  |
|-------------------------------|------------------------------------|-------------------------------------------------------------------------------------------------|-----|------|-----|-----|-------|
| $f_{i(\text{ref})\text{acc}}$ | reference input frequency accuracy | full operating range; frequencies typical values: 19.2 MHz, 26 MHz, 32 MHz, 38.4 MHz and 48 MHz | [1] | -20  | -   | +20 | ppm   |
| $\varphi_n$                   | phase noise                        | input noise floor at 50 kHz                                                                     |     | -140 | -   | -   | dB/Hz |
| <b>Sinusoidal shape</b>       |                                    |                                                                                                 |     |      |     |     |       |
| $V_{i(\text{p-p})}$           | peak-to-peak input voltage         |                                                                                                 |     | 0.2  | -   | 1.8 | V     |
| $V_{i(\text{clk})}$           | clock input voltage                |                                                                                                 |     | 0    | -   | 1.8 | V     |
| <b>Square shape</b>           |                                    |                                                                                                 |     |      |     |     |       |
| $V_{i(\text{clk})}$           | clock input voltage                |                                                                                                 | [2] | 0    | -   | 1.8 | V     |

[1] This requirement is according to FCC regulations ( $\pm 100$  ppm) and FeliCa global ( $\pm 50$  ppm) requirements. To meet only ISO/IEC 14443 and ISO/IEC 18092, then  $\pm 7$  kHz apply which is equivalent to  $\pm 516$  ppm.

[2] Overshoot and undershoot shall not exceed 10%.

For detailed description of clock request mechanisms, refer to Ref. [6] and Ref. [7].

### 11.3.3 Low-power 40 MHz $\pm 2.5$ % oscillator

Low-power 40 MHz  $\pm 2.5$  % oscillator is used as system clock of the system.

Output clock 40 MHz is used by default to clock the system.

### 11.3.4 Low-power 370 kHz oscillator

A Low Frequency Oscillator (LFO) is implemented to drive a counter (WUC) waking-up PN7160 from Standby state. This allows implementation of low-power reader polling loop at application level.

Moreover, this 370 kHz is used as the reference clock for write access to EEPROM memory.

## 11.4 Power concept

### 11.4.1 PMU functional description

The Power Management Unit of PN7160 generates internal supplies required by PN7160 out of  $V_{\text{BAT}}$  and  $V_{\text{DD(UP)}}$  input supply voltages:

- $V_{\text{DDA}}$ : analog output supply voltage. It must be connected to  $V_{\text{DDD}}$ .
- $V_{\text{DDD}}$ : digital input supply voltage. It is internally connected to the output of the DSLDO  $V_{\text{DD}}$ .
- $V_{\text{DD(TX)}}$ : output supply voltage for the transmitter. It is internally connected to the transmitter input supply voltage

The [Figure 13](#) describes the main blocks available in PMU:

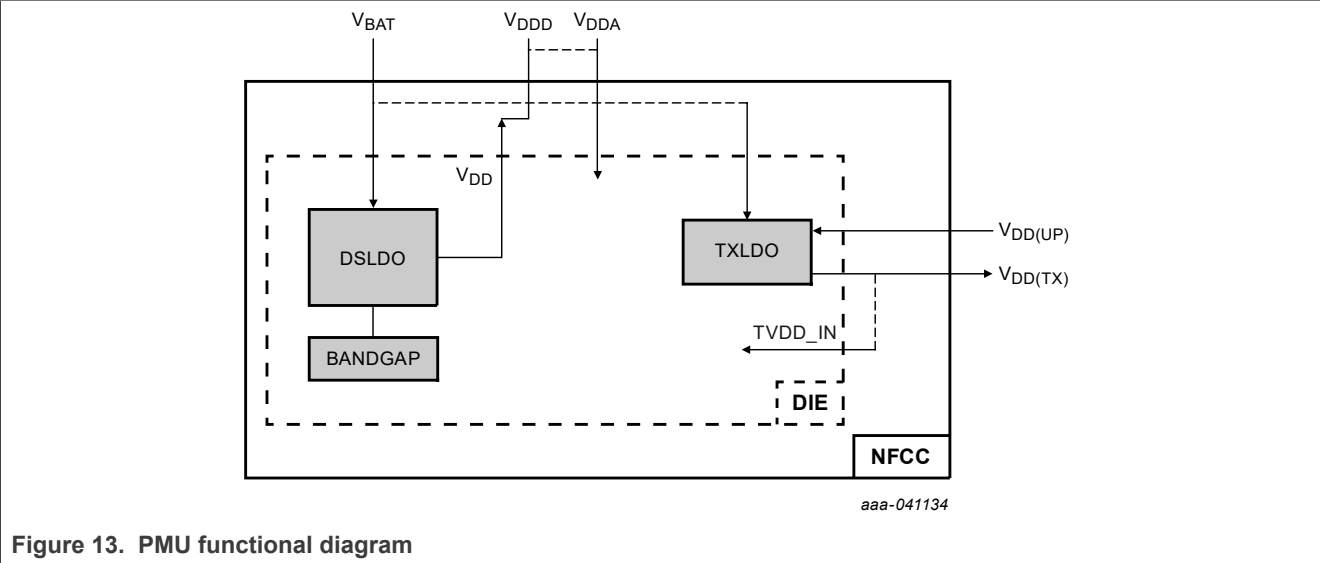


Figure 13. PMU functional diagram

11.4.2 DSLDO: Dual Supply LDO

The input pin of the DSLDO regulator is V<sub>BAT</sub>.  
The output of this regulator (V<sub>DD</sub>) is internally connected to supply the internal digital blocks which are on V<sub>DDD</sub>.  
It must be externally de-coupled and V<sub>DDD</sub> must be connected to V<sub>DDA</sub>.

11.4.3 TXLDO

Transmitter voltage is generated by internal LDO (V<sub>DD(TX)</sub>).  
This TXLDO allows a maximum continuous current load up to 250 mA in order to support ISO/IEC 14443 and NFC Forum standard compliant operations.  
The Low Drop Out regulator has been designed to reject the noise which could interfere with the RF communication.

Table 19. TXLDO

| Symbol                           | Parameter                 | Conditions                                                | Min | Typ | Max | Unit |
|----------------------------------|---------------------------|-----------------------------------------------------------|-----|-----|-----|------|
| V <sub>DD(TXLDO)</sub><br>(drop) | drop TXLDO supply voltage | V <sub>DD(UP)</sub> = 5.3 V; Transmitter current = 250 mA | -   | -   | 0.3 | V    |

The regulator has been designed to work in 2 modes:

11.4.3.1 Configuration 1: the battery voltage is directly used to generate the RF field

The input supply of the regulator is directly the V<sub>BAT</sub> voltage which is connected to V<sub>DD(UP)</sub> the input of the TXLDO.  
The output is called V<sub>DD(TX)</sub>.

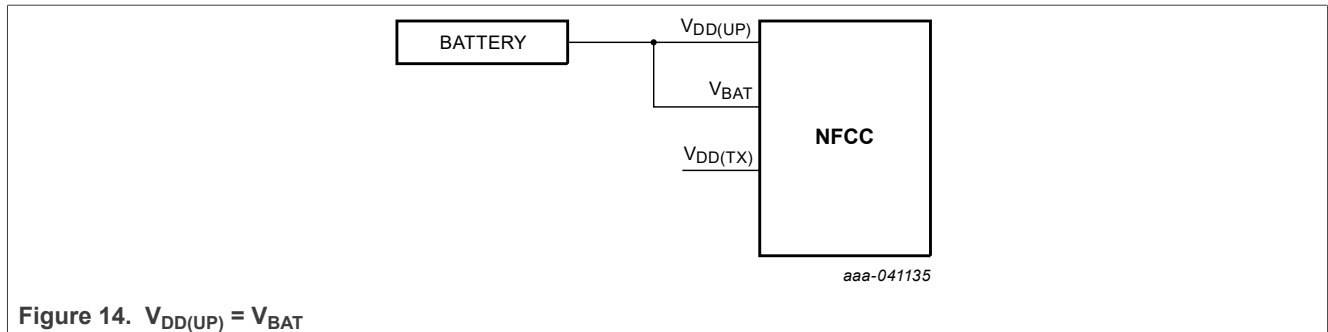


Figure 14.  $V_{DD(UP)} = V_{BAT}$

$V_{BAT}$  acceptable range depends on communication modes to be covered (see [Table 30](#))

The  $V_{DD(TX)}$  value is programmable and shall be chosen according to the minimum targeted  $V_{BAT}$  value for which reader and card modes shall work:  $V_{THRESHOLD}$ .

The TXLDO output voltage is then given by:

$$V_{BAT} \geq V_{THRESHOLD} + V_{DD(TXLDO)(drop)} \Rightarrow V_{DD(TX)} = V_{THRESHOLD}$$

$$V_{THRESHOLD} \geq V_{BAT} - V_{DD(TXLDO)(drop)} \geq 2.8V \Rightarrow V_{DD(TX)} = V_{BAT} - V_{DD(TXLDO)(drop)}$$

[Figure 15](#) shows  $V_{DD(TX)}$  offset disabled behavior for both cases of  $V_{DD(TX)}$  programmed for 3.0 V, 3.3 V or 3.6 V.

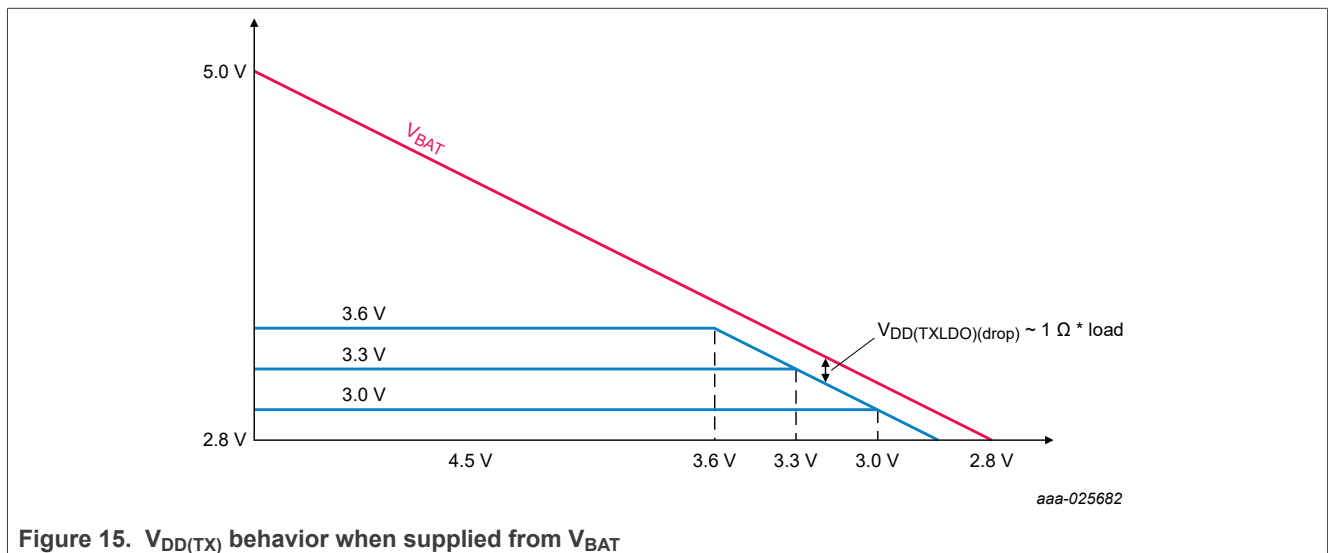
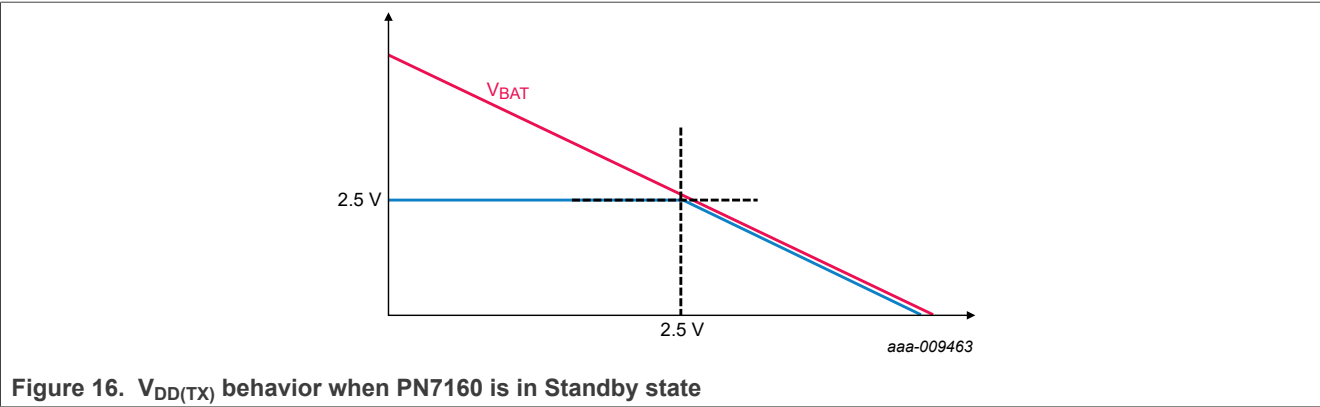


Figure 15.  $V_{DD(TX)}$  behavior when supplied from  $V_{BAT}$

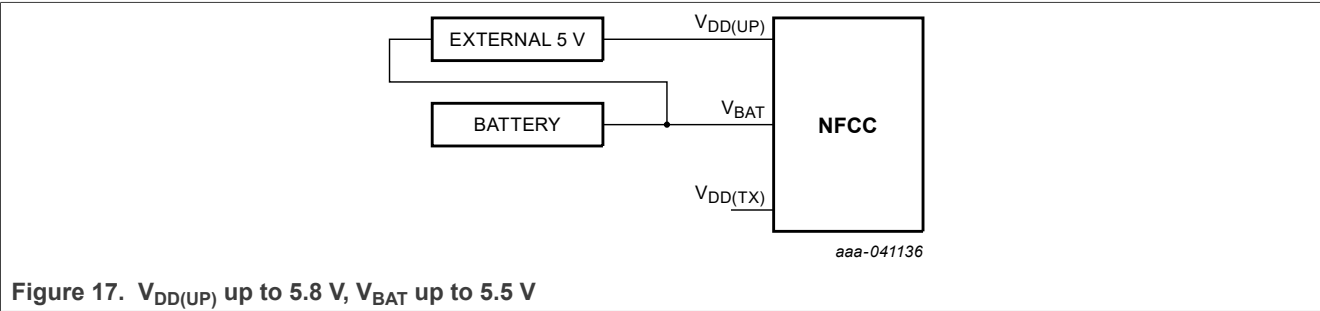
In Standby state, whatever  $V_{THRESHOLD}$  value is configured,  $V_{DD(TX)}$  is regulated at 2.5 V.

[Figure 16](#) shows the case where the PN7160 is in standby state.



11.4.3.2 Configuration 2: an extra external voltage is used to generate the RF field

TXLDO has also the possibility to generate  $V_{DD(TX)}$  up to 5.25 V in case the supply of this regulator is an external supply.

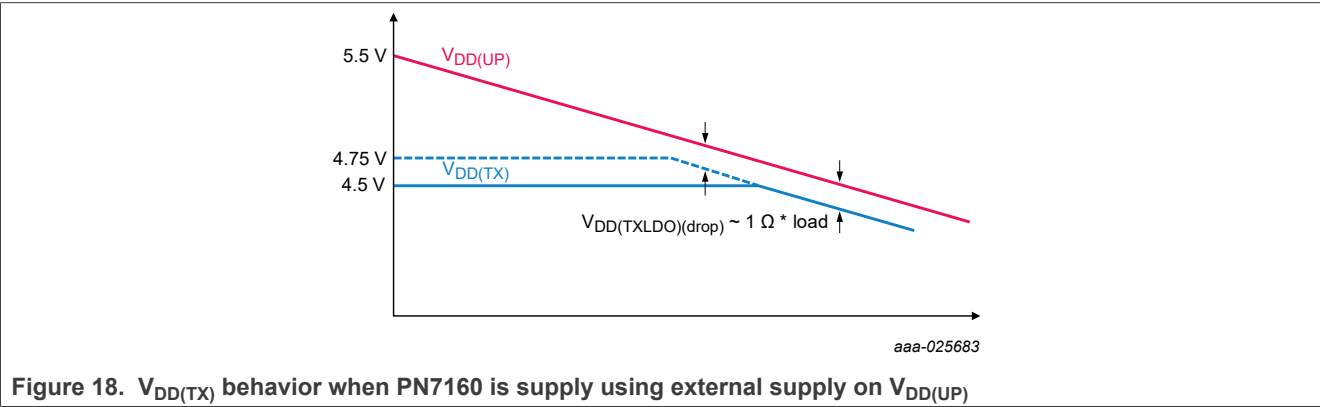


Minimum  $V_{DD(UP)}$  and  $V_{BAT}$  acceptable values depend on communication modes to be covered (see [Table 30](#))  
The TXLDO output voltage is then given by:

$$V_{DD(UP)} \geq V_{THRESHOLD} + V_{DD(TXLDO)(drop)} \Rightarrow V_{DD(TX)} = V_{THRESHOLD}$$

$$V_{THRESHOLD} \geq V_{DD(UP)} - V_{DD(TXLDO)(drop)} \geq 2.8V \Rightarrow V_{DD(TX)} = V_{DD(UP)} - V_{DD(TXLDO)(drop)}$$

[Figure 18](#) shows the behavior of  $V_{DD(TX)}$  depending on  $V_{DD(UP)}$  value.



In Standby state, whatever  $V_{THRESHOLD}$  is configured,  $V_{DD(TX)}$  is regulated at 2.5 V as illustrated by [Figure 16](#).

11.4.3.3 TXLDO limiter

The TXLDO includes a current limiter to avoid too high current within TX1 and TX2.

The current limiter block compares an image of the TXLDO output current to a reference, when the reference is reached the output current gets limited.

The limiting current is 300 mA ± 30 mA, above the specified maximum current allowed for RF operation (250 mA).

11.4.3.4 TXLDO: configuration

Table 20. Configurations using TXLDO

| PN7160 power state | TXLDO config.                       | Mode       | $V_{DD(TX)}$                                                                   |
|--------------------|-------------------------------------|------------|--------------------------------------------------------------------------------|
| Active mode        | configuration 1                     | Full-power | 2.7 V/3 V/3.3 V/3.6 V <sup>[1]</sup>                                           |
|                    | configuration 2                     | Full-power | 2.7 V/3 V/3.3 V/3.6 V/3.9 V/4.2 V/4.5 V/4.7 V/4.75 V/5 V/5.25 V <sup>[1]</sup> |
| Standby            | configuration 1 and configuration 2 | Low-power  | 2.5 V                                                                          |
| Hard-Power down    | configuration 1 and configuration 2 | Power-off  | High impedance                                                                 |

[1] For proper operation, the  $V_{DD(TX)}$  voltage value set shall be below the  $V_{DD(UP)} - 0.3$  V value. The maximum  $V_{DD(UP)}$  value is 5.8 V in configuration 2. In configuration 1, the voltage is given by the battery then the higher voltages might not be usable.

When using an external DC-to-DC with pass-through functionality, the signal TX\_PWR\_REQ is used for control purpose. The DC-to-DC will be in pass-through mode except when high transmitter power is required (by default when RF emission or RF field present).

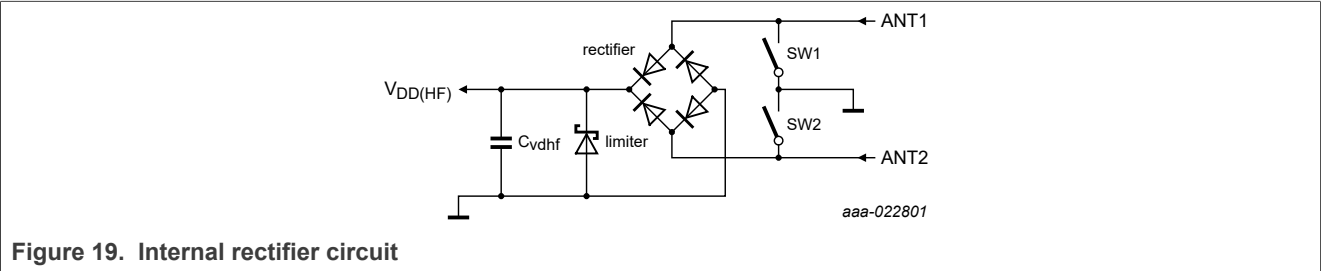
**Note:** the signal TX\_PWR\_REQ is not available on the HVQFN package variant.

Alternatively the signal DCDC\_EN can be used for the same purpose. This signal is available on both package variants. HVQFN and VFBGA.

11.4.4 Very low-power RF field detector

A very specific use case is the RF field detection when the NFCC is in Power Off mode. In this scenario, the NFCC should detect the presence of an external magnetic field and notify the host system about its presence.

[Figure 19](#) shows the internal rectifier circuit. The circuit is built up by the input switches SW1 and SW2 which can disconnect the rectifier from the antenna by creating a short to ground. The rectifier itself is followed by a limiter.



## 11.5 Reset and download concept

### 11.5.1 Resetting PN7160

To enter reset, the  $V_{EN}$  voltage shall be set to low (this is also the Hard Power Down state):

Reset means resetting the embedded FW execution and the registers values to their default values. Parts of these default values are defined from EEPROM data loaded values, others are hardware defined. See Ref. [6] to know which ones are accessible to tune PN7160 to the application environment.

To get out of reset:

- Pulling  $V_{EN}$  voltage high with  $V_{BAT}$  within its operating range

Figure 20 shows reset done via  $V_{EN}$  pin.

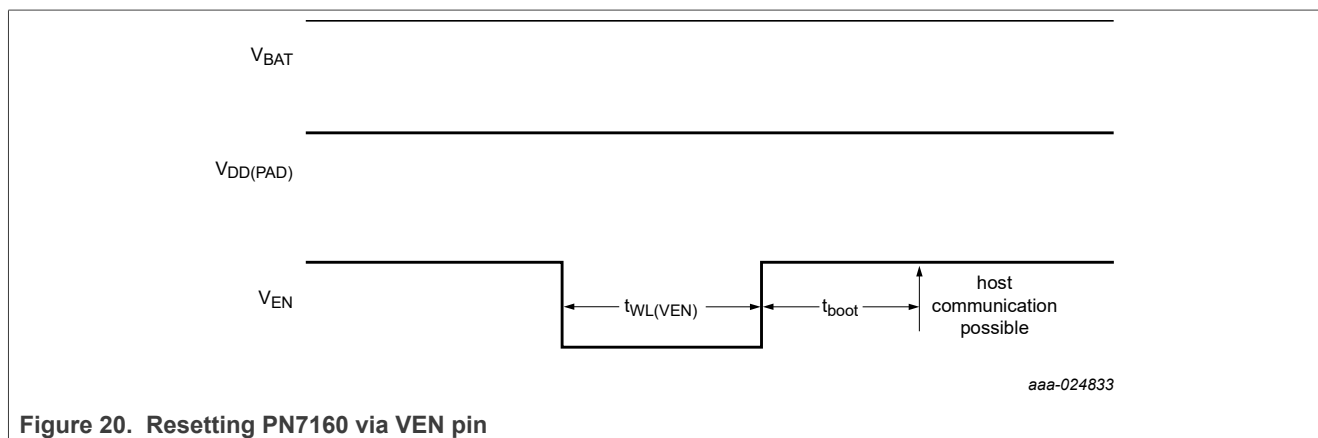


Figure 20. Resetting PN7160 via  $V_{EN}$  pin

See Section 15.2.1 for the timings values.

### 11.5.2 Power-up sequences

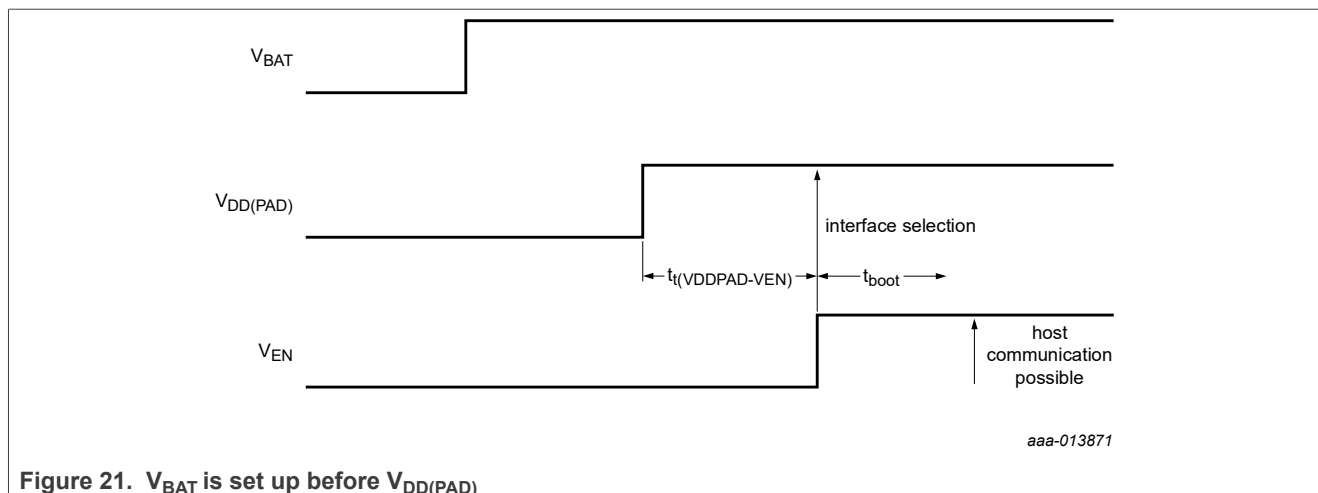
PN7160 allows  $V_{BAT}$  and  $V_{DD(PAD)}$  to be set up independently, therefore different power-up sequences have to be considered.

In all cases, host communication with PN7160 will only be possible after one defined amount of time from the different supply sequence setup and  $V_{EN}$  reset pin.

#### 11.5.2.1 $V_{BAT}$ is set up before $V_{DD(PAD)}$

This is at least the case when  $V_{BAT}$  pin is directly connected to the battery and when PN7160  $V_{BAT}$  is always supplied as soon the system is supplied.

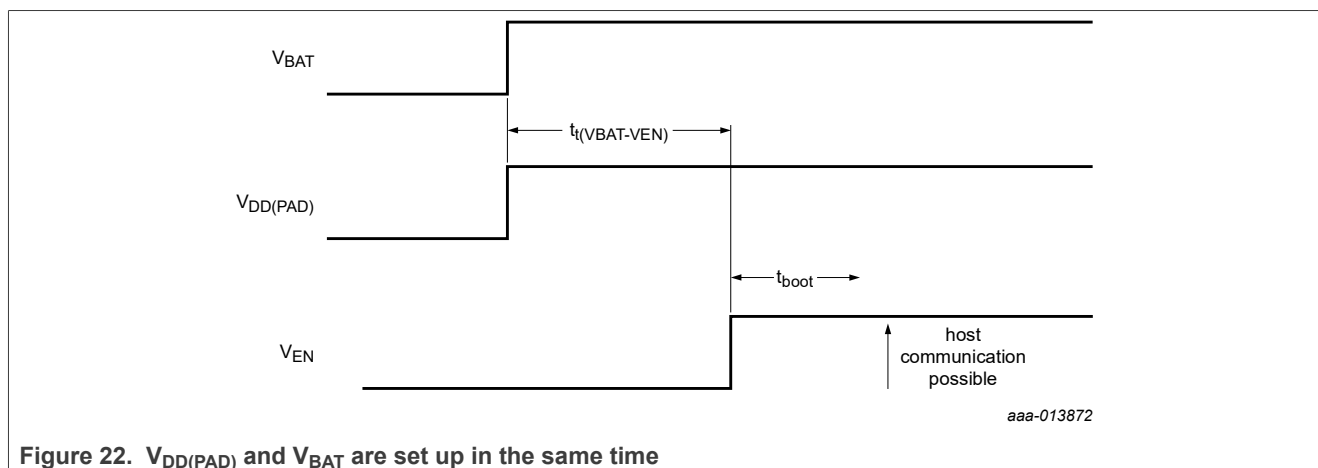
As  $V_{EN}$  pin is referred to  $V_{BAT}$  pin,  $V_{EN}$  shall go high after  $V_{BAT}$  has been set.



See [Section 15.2.1](#) and [Section 15.2.2](#) for the timings values.

### 11.5.2.2 $V_{DD(PAD)}$ and $V_{BAT}$ are set up at the same time

This is the case, when  $V_{BAT}$  pin is connected to a PMU/regulator which also supply  $V_{DD(PAD)}$ .

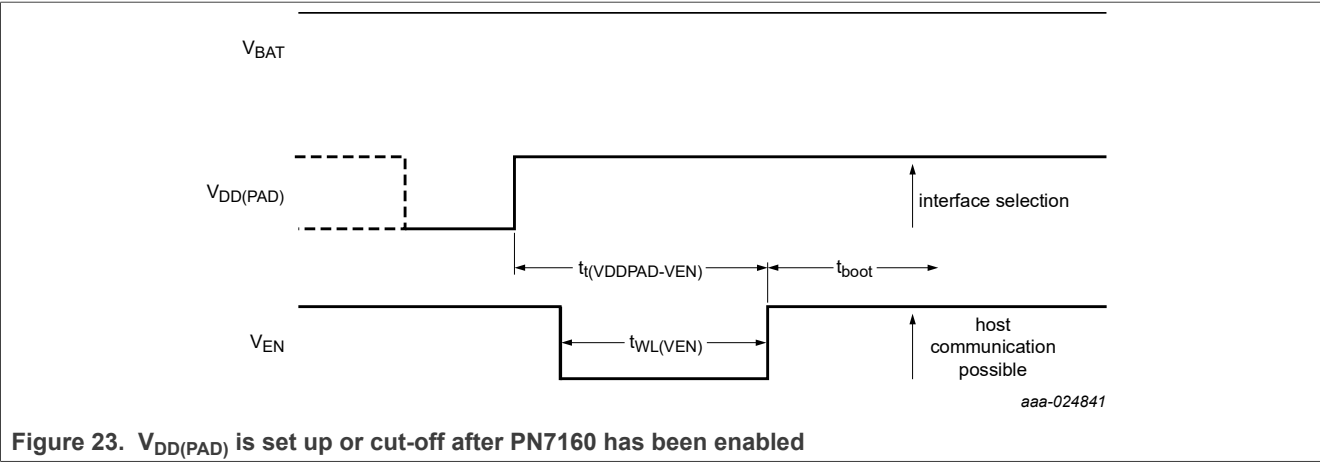


See [Section 15.2.1](#) and [Section 15.2.2](#) for the timings values.

### 11.5.2.3 PN7160 has been enabled before $V_{DD(PAD)}$ is set up or before $V_{DD(PAD)}$ has been cut-off

This can be the case when  $V_{BAT}$  pin is directly connected to the battery and when  $V_{DD(PAD)}$  is generated from a PMU. When the battery voltage is too low, then the PMU might no more be able to generate  $V_{DD(PAD)}$ . When the device gets charged again, then  $V_{DD(PAD)}$  is set up again.

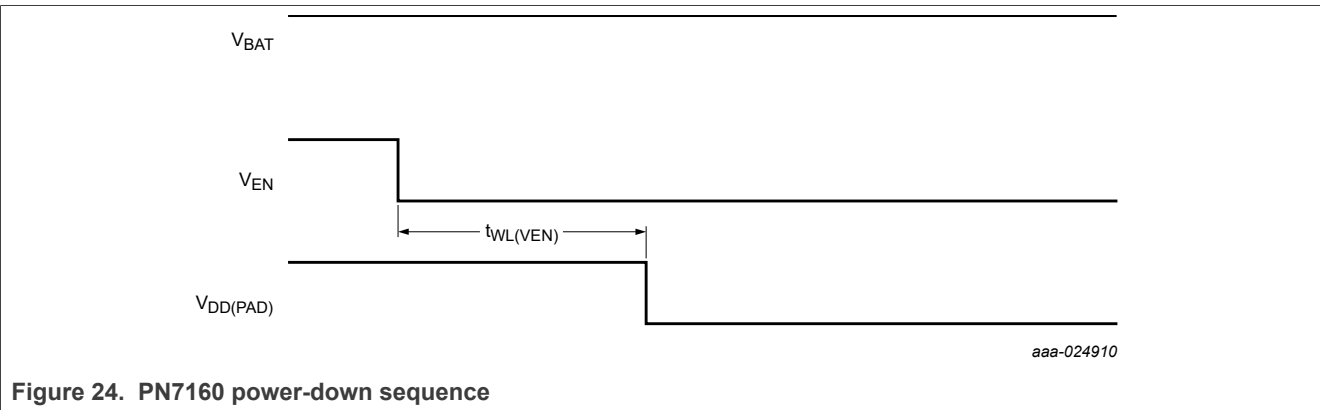
As the pins to select the interface are biased from  $V_{DD(PAD)}$ , when  $V_{DD(PAD)}$  disappears the pins might not be correctly biased internally and the information might be lost. Therefore it is required to make the IC boot after  $V_{DD(PAD)}$  is set up again.



See [Section 15.2.1](#) and [Section 15.2.2](#) for the timings values.

### 11.5.3 Power-down sequences

During power-down sequence, V<sub>EN</sub> shall always be set low before V<sub>DD(PAD)</sub> is shut down.



See [Section 15.2.1](#) for the timings values.

### 11.5.4 Download mode

PN7160 offers the possibility to download EEPROM with upgrades using the host interface commands, see Ref. [\[6\]](#) for more details.

To enter this mode, the pin DWL\_REQ shall be pulled to V<sub>DD(PAD)</sub> before reset via VEN pin is done.



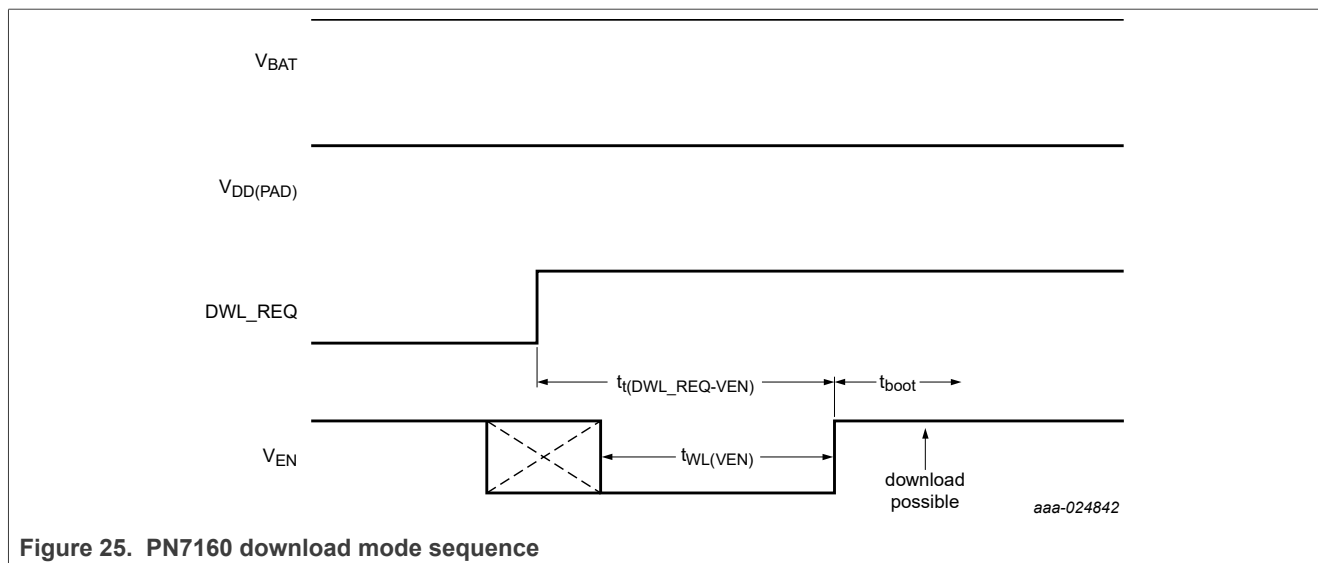


Figure 25. PN7160 download mode sequence

See [Section 15.2.1](#) and [Section 15.2.4](#) for the timings values.

## 11.6 Contactless Interface Unit

PN7160 supports various communication modes at different transfer speeds and modulation schemes. The following chapters give more detailed overview of selected communication modes.

**Remark:** all indicated modulation index and modes in this chapter are system parameters. This means that beside the IC settings a suitable antenna tuning is required to achieve the optimum performance.

### 11.6.1 Reader/Writer communication modes

Generally 5 Reader/Writer communication modes are supported:

- PCD Reader/Writer for ISO/IEC 14443A/MIFARE (NFC Forum Types 2 and 4 Tags)
- PCD Reader/Writer for NFC Forum Type 1 Tag
- PCD Reader/Writer for NFC Forum Type 3 Tag
- PCD Reader/Writer for ISO/IEC 14443B (NFC Forum Type 4 Tag)
- VCD Reader/Writer for NFC Forum Type 5 Tag

#### 11.6.1.1 R/W mode for NFC Forum Type 1 and 2 Tags and Type 4 Tag type A

The R/W mode for NFC Forum Type 1 Tag (T1T), Type 2 Tag (T2T) and Type 4 Tag type A (T4T) is the general reader to card communication scheme according to the ISO/IEC 14443A specification.

[Figure 26](#) describes the communication on a physical level, the communication table describes the physical parameters (the numbers take the antenna effect on modulation depth for higher data rates).

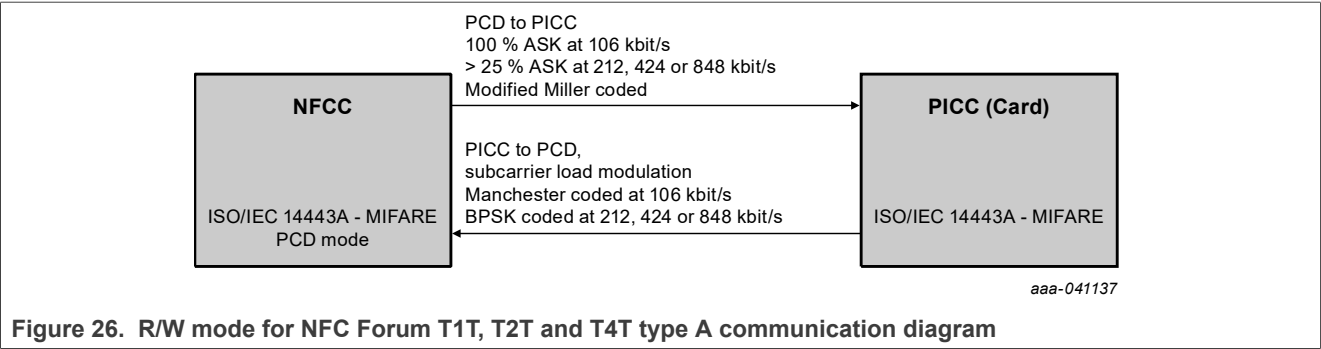


Table 21. Communication overview for NFC Forum T1T, T2T and T4T type A R/W mode

| Communication direction               |                           | ISO/IEC 14443A/<br>MIFARE/<br>NFC Forum T2T<br>and T4T | ISO/IEC 14443A higher transfer speeds |                            |                            |  |
|---------------------------------------|---------------------------|--------------------------------------------------------|---------------------------------------|----------------------------|----------------------------|--|
|                                       | Transfer speed            | 106 kbit/s                                             | 212 kbit/s                            | 424 kbit/s                 | 848 kbit/s                 |  |
|                                       | Bit length                | (128/13.56) μs                                         | (64/13.56) μs                         | (32/13.56) μs              | (16/13.56) μs              |  |
| PN7160 → PICC                         |                           |                                                        |                                       |                            |                            |  |
| (data sent by PN7160 to a card)       | modulation on PN7160 side | 100 % ASK                                              | > 25 % ASK                            | > 25 % ASK                 | > 25 % ASK                 |  |
|                                       | bit coding                | Modified Miller                                        | Modified Miller                       | Modified Miller            | Modified Miller            |  |
| PICC → PN7160                         |                           |                                                        |                                       |                            |                            |  |
| (data received by PN7160 from a card) | modulation on PICC side   | subcarrier load modulation                             | subcarrier load modulation            | subcarrier load modulation | subcarrier load modulation |  |
|                                       | subcarrier frequency      | 13.56 MHz/16                                           | 13.56 MHz/16                          | 13.56 MHz/16               | 13.56 MHz/16               |  |
|                                       | bit coding                | Manchester                                             | BPSK                                  | BPSK                       | BPSK                       |  |

The contactless coprocessor and the on-chip CPU of PN7160 handle the complete ISO/IEC 14443A/MIFARE RF-protocol, nevertheless a dedicated external host has to handle the application layer communication.

11.6.1.2 R/W mode for NFC Forum Type 3 Tag, FeliCa communication mode

The R/W mode for NFC Forum Type 3 Tag (T3T) is the general Reader/Writer to card communication scheme according to the FeliCa specification. [Figure 27](#) describes the communication on a physical level, the communication overview describes the physical parameters.

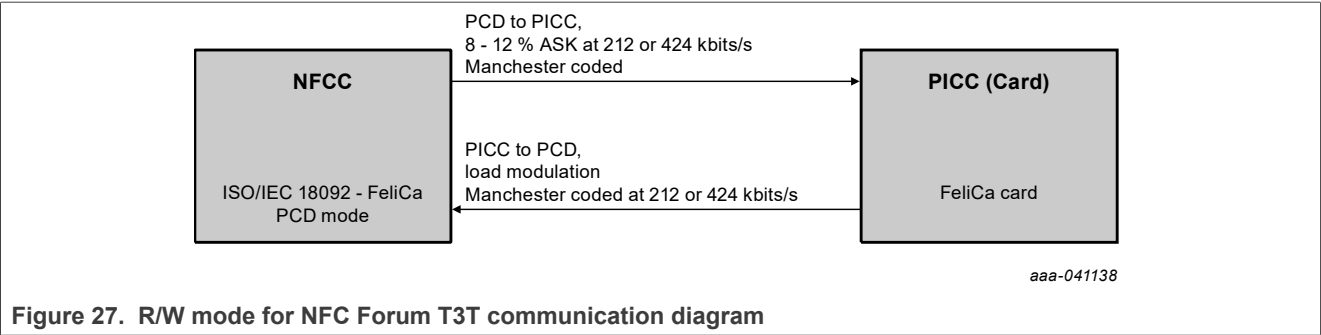


Table 22. Communication overview for NFC Forum T3T R/W mode, FeliCa communication mode

| Communication direction               |                           | FeliCa          | FeliCa higher transfer speeds |
|---------------------------------------|---------------------------|-----------------|-------------------------------|
|                                       | Transfer speed            | 212 kbit/s      | 424 kbit/s                    |
|                                       | Bit length                | (64/13.56) μs   | (32/13.56) μs                 |
| PN7160 → PICC                         |                           |                 |                               |
| (data sent by PN7160 to a card)       | modulation on PN7160 side | 8 % - 12 % ASK  | 8 % - 12 % ASK                |
|                                       | bit coding                | Manchester      | Manchester                    |
| PICC → PN7160                         |                           |                 |                               |
| (data received by PN7160 from a card) | modulation on PICC side   | load modulation | load modulation               |
|                                       | subcarrier frequency      | no subcarrier   | no subcarrier                 |
|                                       | bit coding                | Manchester      | Manchester                    |

The contactless coprocessor of PN7160 and the on-chip CPU handle the FeliCa protocol. Nevertheless a dedicated external host has to handle the application layer communication.

11.6.1.3 R/W mode for NFC Forum type 4 Tag (T4T) type B

The R/W mode for the NFC Forum Type 4 Tag of type B is the general reader to card communication scheme according to the ISO/IEC 14443B specification. [Figure 28](#) describes the communication on a physical level, the communication table describes the physical parameters.

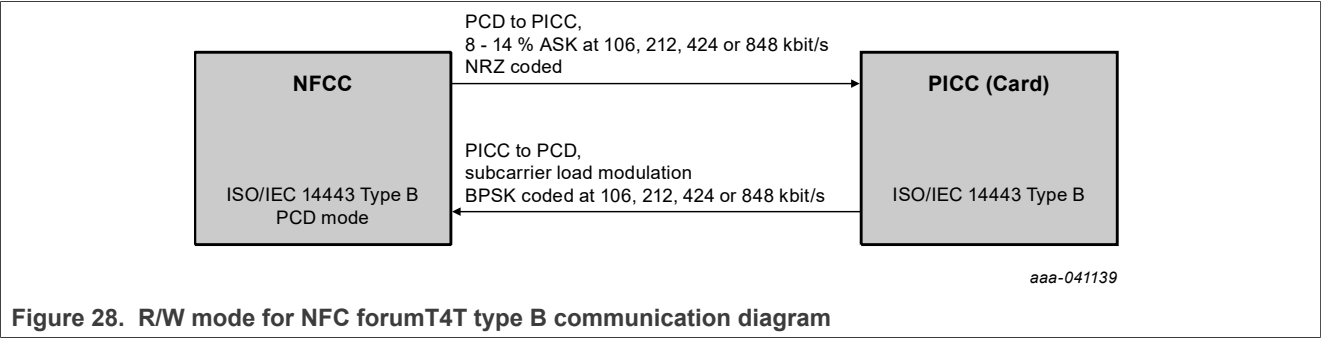


Table 23. Communication overview for NFC Forum T4T type B R/W mode

| Communication direction               |                           | ISO/IEC 14443B             | ISO/IEC 14443B higher transfer speeds |                            |                            |  |
|---------------------------------------|---------------------------|----------------------------|---------------------------------------|----------------------------|----------------------------|--|
|                                       | Transfer speed            | 106 kbit/s                 | 212 kbit/s                            | 424 kbit/s                 | 848 kbit/s                 |  |
|                                       | Bit length                | (128/13.56) μs             | (64/13.56) μs                         | (32/13.56) μs              | (16/13.56) μs              |  |
| PN7160 → PICC                         |                           |                            |                                       |                            |                            |  |
| (data sent by PN7160 to a card)       | modulation on PN7160 side | 8 % - 14 % ASK             | 8 % - 14 % ASK                        | 8 % - 14 % ASK             | 8 % - 14 % ASK             |  |
|                                       | bit coding                | NRZ                        | NRZ                                   | NRZ                        | NRZ                        |  |
| PICC → PN7160                         |                           |                            |                                       |                            |                            |  |
| (data received by PN7160 from a card) | modulation on PICC side   | subcarrier load modulation | subcarrier load modulation            | subcarrier load modulation | subcarrier load modulation |  |
|                                       | subcarrier frequency      | 13.56 MHz/16               | 13.56 MHz/16                          | 13.56 MHz/16               | 13.56 MHz/16               |  |
|                                       | bit coding                | BPSK                       | BPSK                                  | BPSK                       | BPSK                       |  |

The contactless coprocessor and the on-chip CPU of PN7160 handles the complete ISO/IEC 14443B RF-protocol, nevertheless a dedicated external host has to handle the application layer communication.

11.6.1.4 R/W mode for NFC Forum Type 5 Tag

The R/W mode for NFC Forum Type 5 Tag (T5T) is the general reader to card communication scheme according to the ISO/IEC 15693 specification. PN7160 communicates with VICC (Type 5 Tag) using only 26.48 kbit/s with single subcarrier.

PN7160 supports the commands as defined by the ETSI HCI (see Ref. [12]) and on top offers the inventory of the tags (anti-collision sequence) on its own.

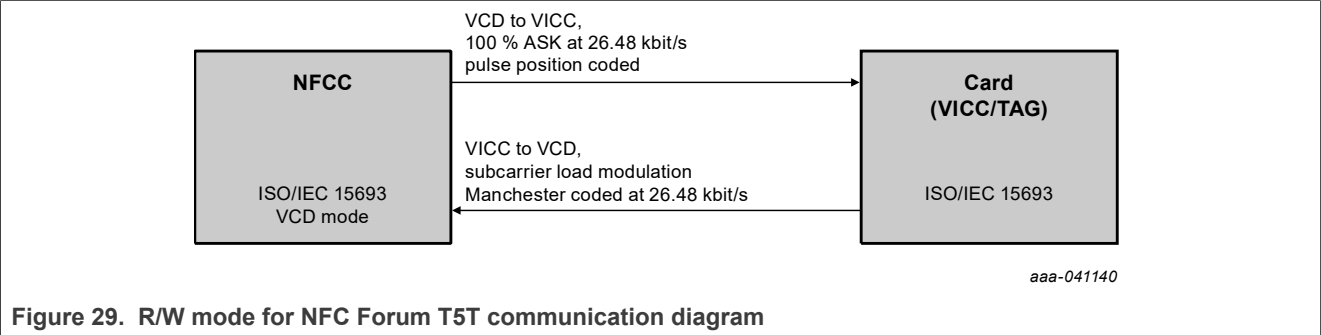


Figure 29 shows the communication schemes used.

The following communication scheme is possible.

Table 24. Communication overview for NFC Forum T5T R/W mode

| Communication direction        |                           |                |
|--------------------------------|---------------------------|----------------|
| PN7160 → VICC                  |                           |                |
| (data sent by PN7160 to a tag) | transfer speed            | 26.48 kbit/s   |
|                                | bit length                | (512/13.56) µs |
|                                | modulation on PN7160 side | 100 % ASK      |

Table 24. Communication overview for NFC Forum T5T R/W mode...continued

| Communication direction              |                         |                                           |
|--------------------------------------|-------------------------|-------------------------------------------|
|                                      | bit coding              | pulse position modulation 1 out of 4 mode |
| VICC → PN7160                        |                         |                                           |
| (data received by PN7160 from a tag) | transfer speed          | 26.48 kbit/s                              |
|                                      | bit length              | (512/13.56) μs                            |
|                                      | modulation on VICC side | subcarrier load modulation                |
|                                      | subcarrier frequency    | single subcarrier                         |
|                                      | bit coding              | Manchester                                |

11.6.2 ISO/IEC 18092, Ecma 340 NFCIP-1 communication modes

Only available up to Firmware version 12.50.0A:

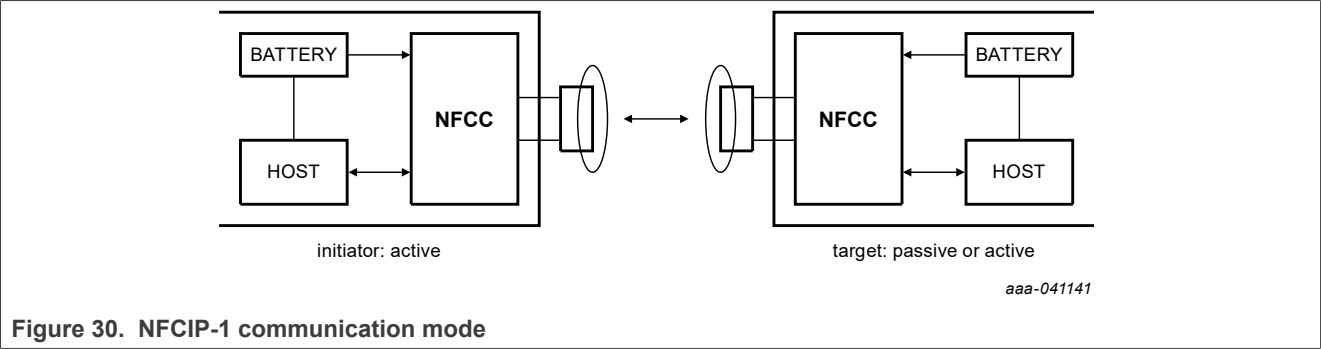
An NFCIP-1 communication takes place between 2 devices:

- NFC Initiator: generates RF field at 13.56 MHz and starts the NFCIP-1 communication.
- NFC Target: responds to NFC Initiator command either in a load modulation scheme in Passive communication mode or using a self-generated and self-modulated RF field for Active communication mode.

The NFCIP-1 communication differentiates between Active and Passive communication modes.

- Active communication mode means both the NFC Initiator and the NFC Target are using their own RF field to transmit data
- Passive communication mode means that the NFC Target answers to an NFC Initiator command in a load modulation scheme. The NFC Initiator is active in terms of generating the RF field.

PN7160 supports the Active Initiator, Active Target, Passive Initiator and Passive Target communication modes at the transfer speeds 106 kbit/s, 212 kbit/s and 424 kbit/s as defined in the NFCIP-1 standard.



The contactless coprocessor of PN7160 and the on-chip CPU handle NFCIP-1 protocol, for all communication modes and data rates, for both NFC Initiator and NFC Target.

Nevertheless a dedicated external host has to handle the application layer communication.

3

3 Since Android 12, P2P functionality is not included by default in the android main package. Moreover, this functionality has never been supported by iOS devices. It can be recognized that P2P is slowly removed from the market. At NFC Forum, the P2P functionality is not available for the Reader device class since CR13 and NXP do not expect any significant changes on the defined functionality. For this reason NXP stops the maintenance of the P2P functionality on this NFC Reader products PN7160 and PN7161 from firmware 12.50.0A onwards. The existing previous product versions (hardware and supporting software) which include the P2P support will still be available.

11.6.2.1 Active communication mode

Active communication mode means both the NFC Initiator and the NFC Target are using their own RF field to transmit data.

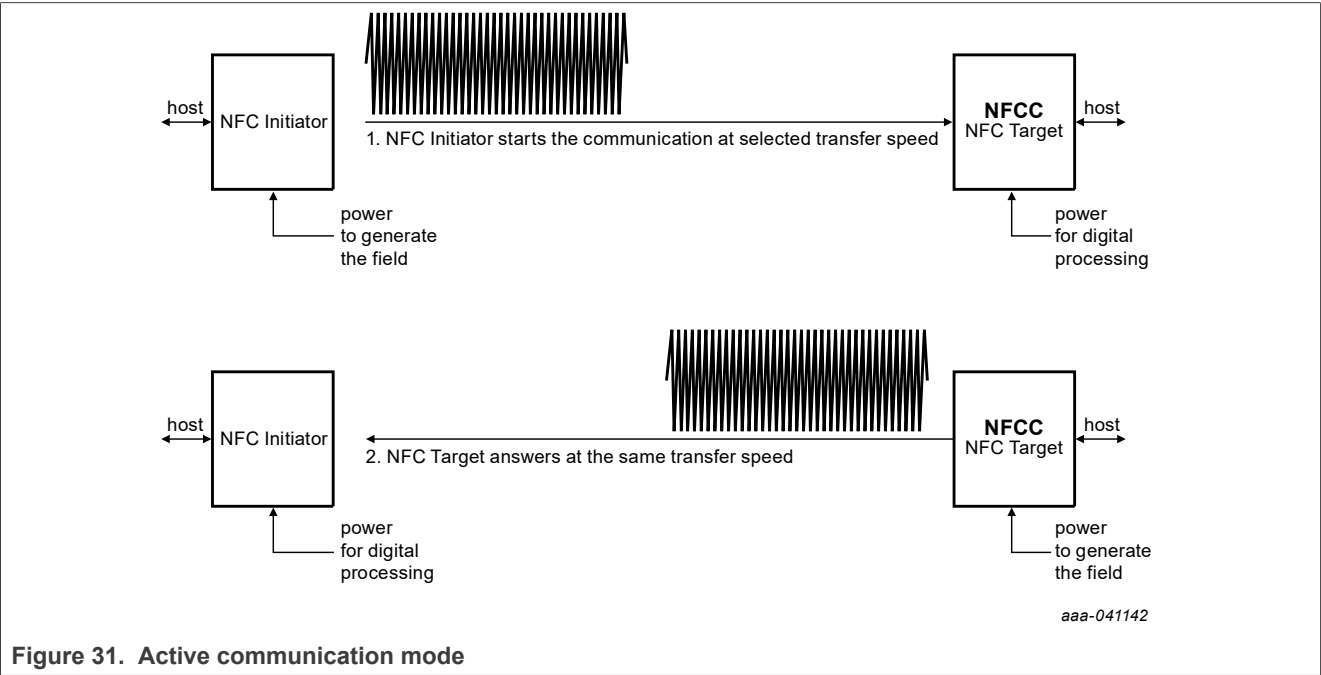


Figure 31. Active communication mode

Table 25 gives an overview of the Active communication modes:

Table 25. Overview for Active communication mode

| Communication direction     | ISO/IEC 18092, Ecma 340, NFCIP-1 |                     |                               |                               |
|-----------------------------|----------------------------------|---------------------|-------------------------------|-------------------------------|
|                             | Baud rate                        | 106 kbit/s          | 212 kbit/s                    | 424 kbit/s                    |
|                             | Bit length                       | (128/13.56) $\mu$ s | (64/13.56) $\mu$ s            | (32/13.56) $\mu$ s            |
| NFC Initiator to NFC Target |                                  |                     |                               |                               |
|                             | modulation                       | 100 % ASK           | 8 % - 30 % ASK <sup>[1]</sup> | 8 % - 30 % ASK <sup>[1]</sup> |
|                             | bit coding                       | Modified Miller     | Manchester                    | Manchester                    |
| NFC Target to NFC Initiator |                                  |                     |                               |                               |
|                             | modulation                       | 100 % ASK           | 8 % - 30 % ASK <sup>[1]</sup> | 8 % - 30 % ASK <sup>[1]</sup> |
|                             | bit coding                       | Miller              | Manchester                    | Manchester                    |

[1] This modulation index range is according to NFCIP-1 standard. It might be that some NFC Forum type 3 cards does not withstand the full range as based on FeliCa range which is narrow (8 % to 14 % ASK). To adjust the index, see [8].

11.6.2.2 Passive communication mode

Passive communication mode means that the NFC Target answers to an NFC Initiator command in a load modulation scheme.

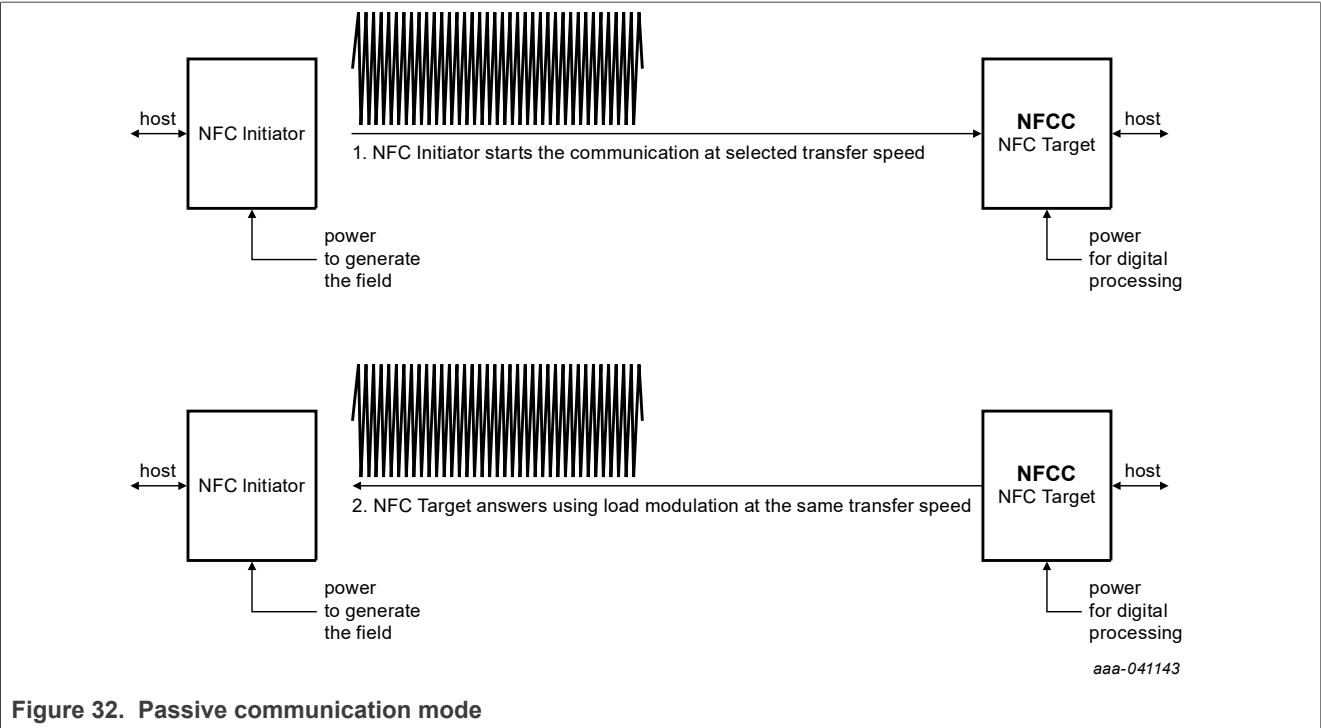


Figure 32. Passive communication mode

Table 26 gives an overview of the Passive communication modes:

Table 26. Overview for Passive communication mode

| Communication direction     | ISO/IEC 18092, Ecma 340, NFCIP-1 |                            |                               |                               |
|-----------------------------|----------------------------------|----------------------------|-------------------------------|-------------------------------|
|                             | Baud rate                        | 106 kbit/s                 | 212 kbit/s                    | 424 kbit/s                    |
|                             | Bit length                       | (128/13.56) $\mu$ s        | (64/13.56) $\mu$ s            | (32/13.56) $\mu$ s            |
| NFC Initiator to NFC Target |                                  |                            |                               |                               |
|                             | modulation                       | 100 % ASK                  | 8 % - 30 % ASK <sup>[1]</sup> | 8 % - 30 % ASK <sup>[1]</sup> |
|                             | bit coding                       | Modified Miller            | Manchester                    | Manchester                    |
| NFC Target to NFC Initiator |                                  |                            |                               |                               |
|                             | modulation                       | subcarrier load modulation | load modulation               | load modulation               |
|                             | subcarrier frequency             | 13.56 MHz/16               | no subcarrier                 | no subcarrier                 |
|                             | bit coding                       | Manchester                 | Manchester                    | Manchester                    |

[1] This modulation index range is according to NFCIP-1 standard. It might be that some NFC Forum type 3 cards does not withstand the full range as based on FeliCa range which is narrow (8 % to 14 % ASK). To adjust the index, see Ref. [8].

11.6.2.3 NFCIP-1 framing and coding

The NFCIP-1 framing and coding in Active and Passive communication modes are defined in the NFCIP-1 standard: ISO/IEC 18092 or Ecma 340.

11.6.2.4 NFCIP-1 protocol support

The NFCIP-1 protocol is not completely described in this document. For detailed explanation of the protocol, refer to the ISO/IEC 18092 or Ecma 340 NFCIP-1 standard. However the datalink layer is according to the following policy:

- Transaction includes initialization, anti-collision methods and data transfer. This sequence must not be interrupted by another transaction.
- PSL shall be used to change the speed between the target selection and the data transfer, but the speed should not be changed during a data transfer.

11.6.3 Card mode

PN7160 can be addressed as an NFC Forum T4T, ISO/IEC 14443A, MIFARE, or ISO/IEC 14443B card. This means that PN7160 can generate an answer in a load modulation scheme according to the ISO/IEC 14443A, and ISO/IEC 14443B interface description.

**Remark:** PN7160 does not support a complete card protocol. This has to be handled by the host controller.

[Table 27](#), [Table 28](#) describe the physical parameters.

11.6.3.1 NFC Forum T4T, ISO/IEC 14443A

Table 27. Overview for NFC Forum T4T, ISO/IEC 14443A card mode

| Communication direction               |                           | ISO/IEC 14443A             | ISO/IEC 14443A higher transfer speeds |                            |
|---------------------------------------|---------------------------|----------------------------|---------------------------------------|----------------------------|
|                                       | Transfer speed            | 106 kbit/s                 | 212 kbit/s                            | 424 kbit/s                 |
|                                       | Bit length                | (128/13.56) $\mu$ s        | (64/13.56) $\mu$ s                    | (32/13.56) $\mu$ s         |
| PCD $\rightarrow$ PN7160              |                           |                            |                                       |                            |
| (data received by PN7160 from a card) | modulation on PCD side    | 100 % ASK                  | > 25 % ASK                            | > 25 % ASK                 |
|                                       | bit coding                | Modified Miller            | Modified Miller                       | Modified Miller            |
| PN7160 $\rightarrow$ PCD              |                           |                            |                                       |                            |
| (data sent by PN7160 to a card)       | modulation on PN7160 side | subcarrier load modulation | subcarrier load modulation            | subcarrier load modulation |
|                                       | subcarrier frequency      | 13.56 MHz/16               | 13.56 MHz/16                          | 13.56 MHz/16               |
|                                       | bit coding                | Manchester                 | BPSK                                  | BPSK                       |

11.6.3.2 NFC Forum T4T, ISO/IEC 14443B card mode

Table 28. Overview for NFC Forum T4T, ISO/IEC 14443B card mode

| Communication direction                 |                        | ISO/IEC 14443B      | ISO/IEC 14443B higher transfer speeds |                    |
|-----------------------------------------|------------------------|---------------------|---------------------------------------|--------------------|
|                                         | Transfer speed         | 106 kbit/s          | 212 kbit/s                            | 424 kbit/s         |
|                                         | Bit length             | (128/13.56) $\mu$ s | (64/13.56) $\mu$ s                    | (32/13.56) $\mu$ s |
| PCD $\rightarrow$ PN7160                |                        |                     |                                       |                    |
| (data received by PN7160 from a Reader) | modulation on PCD side | 8 % - 14 % ASK      | 8 % - 14 % ASK                        | 8 % - 14 % ASK     |
|                                         | bit coding             | NRZ                 | NRZ                                   | NRZ                |



Table 28. Overview for NFC Forum T4T, ISO/IEC 14443B card mode...continued

| Communication direction           |                           | ISO/IEC 14443B             | ISO/IEC 14443B higher transfer speeds |                            |
|-----------------------------------|---------------------------|----------------------------|---------------------------------------|----------------------------|
|                                   | Transfer speed            | 106 kbit/s                 | 212 kbit/s                            | 424 kbit/s                 |
|                                   | Bit length                | (128/13.56) µs             | (64/13.56) µs                         | (32/13.56) µs              |
| PN7160 → PCD                      |                           |                            |                                       |                            |
| (data sent by PN7160 to a Reader) | modulation on PN7160 side | subcarrier load modulation | subcarrier load modulation            | subcarrier load modulation |
|                                   | subcarrier frequency      | 13.56 MHz/16               | 13.56 MHz/16                          | 13.56 MHz/16               |
|                                   | bit coding                | BPSK                       | BPSK                                  | BPSK                       |

11.6.4 Frequency interoperability

When in communication, PN7160 is generating some RF frequencies. PN7160 is also sensitive to some RF signals as it is looking from data in the field.

In order to avoid interference with others RF communication, it is required to tune the antenna and design the board according to Ref. [7].

Although ISO/IEC 14443 and ISO/IEC 18092/Ecma 340 allows an RF frequency of 13.56 MHz ± 7 kHz, FCC regulation does not allow this wide spread and limits the dispersion to ± 100 ppm, which is in line with PN7160 capability, see Table 17 and Table 18.

12 Limiting values

Table 29. Limiting values  
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol               | Parameter                           | Conditions                                      |     | Min | Max  | Unit |
|----------------------|-------------------------------------|-------------------------------------------------|-----|-----|------|------|
| V <sub>DD(PAD)</sub> | V <sub>DD(PAD)</sub> supply voltage | supply voltage for host interface               |     | -   | 4.2  | V    |
| V <sub>DD(UP)</sub>  | V <sub>DD(UP)</sub> supply voltage  | supply voltage for host interface               |     | -   | 7    | V    |
| V <sub>BAT</sub>     | battery supply voltage              |                                                 |     | -   | 6    | V    |
| V <sub>ESD</sub>     | electrostatic discharge voltage     | HBM; 1500 Ω, 100 pF; EIA/<br>JESD22-A114-D      |     | -   | 2    | kV   |
|                      |                                     | CDM; field induced model; EIA/<br>JESC22-C101-C |     | -   | 1    | kV   |
| T <sub>stg</sub>     | storage temperature                 |                                                 |     | -40 | +150 | °C   |
| P <sub>tot</sub>     | total power dissipation             | all modes                                       | [1] | -   | 620  | mW   |
| V <sub>RXN(i)</sub>  | RXN input voltage                   |                                                 |     | 0   | 2.5  | V    |
| V <sub>RXP(i)</sub>  | RXP input voltage                   |                                                 |     | 0   | 2.5  | V    |

[1] The design of the solution shall be done so that for the different use cases targeted the power to be dissipated from the field or generated by PN7160 does not exceed this value.

## 13 Recommended operating conditions

Table 30. Operating conditions

| Symbol        | Parameter                         | Conditions                                                                                                                            |            | Min  | Typ  | Max  | Unit |
|---------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|------------|------|------|------|------|
| $T_{amb}$     | ambient operating temperature     | JEDEC PCB-0.5                                                                                                                         |            | -30  | -    | +85  | °C   |
| $V_{BAT}$     | battery supply voltage            | Card Emulation and Passive Target; $V_{SS} = 0$ V                                                                                     | [1]        | 2.5  | -    | 5.5  | V    |
|               |                                   | Reader, Active Initiator and Active Target; $V_{SS} = 0$ V                                                                            | [1]        | 2.8  | -    | 5.5  | V    |
| $V_{DD(UP)}$  | $V_{DD(UP)}$ input supply voltage | Reader, Active Initiator and Active Target; $V_{SS} = 0$ V                                                                            | [1]        | 2.8  | -    | 5.8  | V    |
|               |                                   | All other cases except HPD state; $V_{SS} = 0$ V                                                                                      | [1]<br>[2] | 2.5  | -    | 5.8  | V    |
| $V_{DD(PAD)}$ | $V_{DD(PAD)}$ supply voltage      | supply voltage for host interface; $V_{SS} = 0$ V                                                                                     | [1]        | 1.65 | 1.8  | 1.95 | V    |
|               |                                   |                                                                                                                                       |            | 3.0  | 3.3  | 3.6  | V    |
| $P_{tot}$     | total power dissipation           | PCD mode at typical $V_{DD(TX)} = 5.25$ V, $V_{DD(UP)} = 5.8$ V and $V_{BAT} = 3.6$ V; includes power from $V_{BAT}$ and $V_{DD(UP)}$ |            | -    | -    | 620  | mW   |
| $I_{BAT}$     | battery supply current            | in Hard Power Down state; $V_{BAT} = 3.6$ V; $T = 25$ °C                                                                              | [3]        | -    | 10.5 | 16   | µA   |
|               |                                   | in Standby state; $V_{BAT} = 3.6$ V                                                                                                   |            |      |      |      |      |
|               |                                   | enhanced RF detector                                                                                                                  |            | -    | 31   | 52   | µA   |
|               |                                   | low sensitivity RF detector                                                                                                           |            | -    | 21   | 36   | µA   |
|               |                                   | in low-power polling loop; $V_{BAT} = 3.6$ V; $T = 25$ °C; loop time = 500 ms                                                         |            | -    | 100  | -    | µA   |
|               |                                   | continuous total current consumption in PCD mode at $V_{BAT} = 3.6$ V                                                                 | [4]        | -    | -    | 290  | mA   |
| $I_{th(lim)}$ | current limit threshold           | current limiter on transmitter                                                                                                        | [4]        | 270  | 300  | 330  | mA   |

[1]  $V_{SS}$  represents  $V_{SS(PAD)}$  and  $V_{SS(TX)}$ .

[2] When  $V_{DD(UP)}$  is below 2.8 V the TXLDO can be in follower mode (see [Section 11.4.3](#)), there will be no more  $V_{DD(UP)}$  noise rejection. Any noise below 848 kbit/s will affect the performance.

[3] External clock on NFC\_CLK\_XTAL1 must be LOW.

[4] This is considering an antenna tuned to sink maximum 250 mA continuous current from the transmitter. The antenna shall be tuned to never exceed this 250 mA maximum current.

## 14 Thermal characteristics

**Table 31. Thermal characteristics VFBGA64 package**

| Symbol        | Parameter                                   | Conditions                                                   | Typ  | Unit |
|---------------|---------------------------------------------|--------------------------------------------------------------|------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air with exposed pad soldered on a 4 layer JEDEC PCB | 52.0 | K/W  |
| $R_{th(j-c)}$ | thermal resistance from junction to case    | -                                                            | 10.0 | K/W  |

**Table 32. Thermal characteristics HVQFN40 package**

| Symbol        | Parameter                                   | Conditions                                                   | Typ  | Unit |
|---------------|---------------------------------------------|--------------------------------------------------------------|------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air with exposed pad soldered on a 4 layer JEDEC PCB | 28.0 | K/W  |
| $R_{th(j-c)}$ | thermal resistance from junction to case    | -                                                            | 13.2 | K/W  |

**Table 33. Junction Temperature**

| Symbol       | Parameter                    | Conditions | Max | Unit |
|--------------|------------------------------|------------|-----|------|
| $T_{j\_max}$ | maximum junction temperature | -          | 125 | °C   |

**Table 34. Thermal Shutdown Temperature**

| Symbol         | Parameter                                                        | Conditions | Typ | Unit |
|----------------|------------------------------------------------------------------|------------|-----|------|
| $T_{shutdown}$ | shutdown of chip due to high temperature detected by temp sensor | -          | 125 | °C   |

15 Characteristics

15.1 Current consumption characteristics

Table 35. Current consumption characteristics for operating ambient temperature range

| Symbol           | Parameter              | Conditions                                                            |     | Min | Typ  | Max | Unit |
|------------------|------------------------|-----------------------------------------------------------------------|-----|-----|------|-----|------|
| I <sub>BAT</sub> | battery supply current | in Hard Power Down state; V <sub>BAT</sub> = 3.6 V; VEN voltage = 0 V |     | -   | 10   | 24  | μA   |
|                  |                        | in Standby state; V <sub>BAT</sub> = 3.6 V;                           | [1] | -   | 20   | 35  | μA   |
|                  |                        | in Idle and Target Active power states; V <sub>BAT</sub> = 3.6 V      |     | -   | 4.55 | -   | mA   |
|                  |                        | in Initiator Active power state; V <sub>BAT</sub> = 3.6 V; RF on      | [2] | -   | 240  | -   | mA   |

[1] Refer to [Section 11.1.2](#) for the description of the power modes.  
[2] For transmitter current tuned at 210 mA unloaded.

15.2 Functional block electrical characteristics

15.2.1 Reset via VEN

Table 36. Reset timing

| Symbol               | Parameter           | Conditions |  | Min | Typ | Max | Unit |
|----------------------|---------------------|------------|--|-----|-----|-----|------|
| t <sub>WL(VEN)</sub> | pulse width VEN LOW | to reset   |  | 10  | -   | -   | μs   |
| t <sub>boot</sub>    | boot time           |            |  | -   | -   | 2.5 | ms   |

15.2.2 Power-up timings

Table 37. Power-up timings

| Symbol                      | Parameter                                                             | Conditions                                     |  | Min | Typ | Max | Unit |
|-----------------------------|-----------------------------------------------------------------------|------------------------------------------------|--|-----|-----|-----|------|
| t <sub>t(VBAT-VEN)</sub>    | transition time from pin V <sub>BAT</sub> to pin VEN                  | V <sub>BAT</sub> , VEN voltages = HIGH         |  | 0   | -   | -   | ms   |
| t <sub>t(VDDPAD-VEN)</sub>  | transition time from pin V <sub>DD(PAD)</sub> to pin VEN              | V <sub>DD(PAD)</sub> , VEN voltages = HIGH     |  | 0   | -   | -   | ms   |
| t <sub>t(VBAT-VDDPAD)</sub> | transition time from pin V <sub>BAT</sub> to pin V <sub>DD(PAD)</sub> | V <sub>BAT</sub> , V <sub>DD(PAD)</sub> = HIGH |  | 0   | -   | -   | ms   |

15.2.3 Power-down timings

Table 38. Power-down timings

| Symbol                | Parameter                        | Conditions |  | Min | Typ | Max | Unit |
|-----------------------|----------------------------------|------------|--|-----|-----|-----|------|
| t <sub>WL(VBAT)</sub> | pulse width V <sub>BAT</sub> LOW |            |  | 20  | -   | -   | ms   |
| t <sub>d</sub>        | delay time                       |            |  | 0   | -   | -   | ms   |

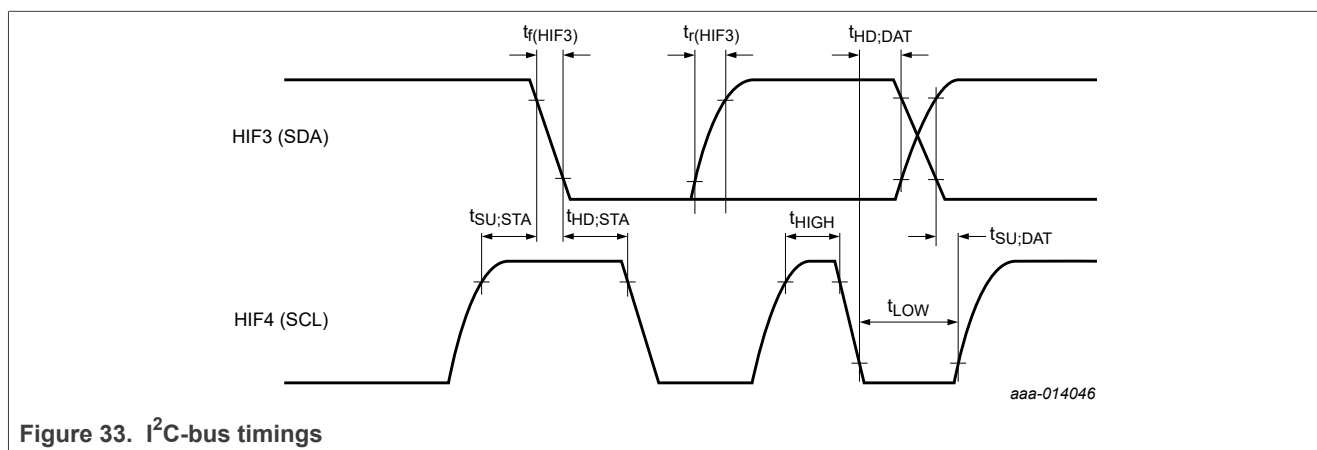
## 15.2.4 Download mode timings

Table 39. Download mode timings

| Symbol               | Parameter                                   | Conditions                   | Min | Typ | Max | Unit |
|----------------------|---------------------------------------------|------------------------------|-----|-----|-----|------|
| $t_{(DWL\_REQ-VEN)}$ | transition time from pin DWL_REQ to pin VEN | DWL_REQ, VEN voltages = HIGH | 0   | 0.5 | -   | ms   |

## 15.2.5 I<sup>2</sup>C-bus timings

Here below are timings and frequency specifications.

Figure 33. I<sup>2</sup>C-bus timingsTable 40. High-speed mode I<sup>2</sup>C-bus timings specification

| Symbol          | Parameter                                  | Conditions                               | Min              | Max | Unit |
|-----------------|--------------------------------------------|------------------------------------------|------------------|-----|------|
| $f_{clk(HIF4)}$ | clock frequency on pin HIF4                | I <sup>2</sup> C-bus SCL; $C_b < 100$ pF | 0                | 3.4 | MHz  |
| $t_{SU;STA}$    | set-up time for a repeated START condition | $C_b < 100$ pF                           | 160              | -   | ns   |
| $t_{HD;STA}$    | hold time (repeated) START condition       | $C_b < 100$ pF                           | 160              | -   | ns   |
| $t_{LOW}$       | LOW period of the SCL clock                | $C_b < 100$ pF                           | 160              | -   | ns   |
| $t_{HIGH}$      | HIGH period of the SCL clock               | $C_b < 100$ pF                           | 60               | -   | ns   |
| $t_{SU;DAT}$    | data set-up time                           | $C_b < 100$ pF                           | 10               | -   | ns   |
| $t_{HD;DAT}$    | data hold time                             | $C_b < 100$ pF                           | 0                | -   | ns   |
| $t_r(HIF3)$     | rise time on pin HIF3                      | I <sup>2</sup> C-bus SDA; $C_b < 100$ pF | 10               | 80  | ns   |
| $t_f(HIF3)$     | fall time on pin HIF3                      | I <sup>2</sup> C-bus SDA; $C_b < 100$ pF | 10               | 80  | ns   |
| $V_{hys}$       | hysteresis voltage                         | Schmitt trigger inputs; $C_b < 100$ pF   | $0.1V_{DD(PAD)}$ | -   | V    |

Table 41. Fast mode I<sup>2</sup>C-bus timings specification

| Symbol          | Parameter                   | Conditions                               | Min | Max | Unit |
|-----------------|-----------------------------|------------------------------------------|-----|-----|------|
| $f_{clk(HIF4)}$ | clock frequency on pin HIF4 | I <sup>2</sup> C-bus SCL; $C_b < 400$ pF | 0   | 400 | kHz  |

Table 41. Fast mode I<sup>2</sup>C-bus timings specification...continued

| Symbol              | Parameter                                  | Conditions                                      | Min                     | Max | Unit |
|---------------------|--------------------------------------------|-------------------------------------------------|-------------------------|-----|------|
| t <sub>SU;STA</sub> | set-up time for a repeated START condition | C <sub>b</sub> < 400 pF                         | 600                     | -   | ns   |
| t <sub>HD;STA</sub> | hold time (repeated) START condition       | C <sub>b</sub> < 400 pF                         | 600                     | -   | ns   |
| t <sub>LOW</sub>    | LOW period of the SCL clock                | C <sub>b</sub> < 400 pF                         | 1.3                     | -   | µs   |
| t <sub>HIGH</sub>   | HIGH period of the SCL clock               | C <sub>b</sub> < 400 pF                         | 600                     | -   | ns   |
| t <sub>SU;DAT</sub> | data set-up time                           | C <sub>b</sub> < 400 pF                         | 100                     | -   | ns   |
| t <sub>HD;DAT</sub> | data hold time                             | C <sub>b</sub> < 400 pF                         | 0                       | 900 | ns   |
| V <sub>hys</sub>    | hysteresis voltage                         | Schmitt trigger inputs; C <sub>b</sub> < 400 pF | 0.1V <sub>DD(PAD)</sub> | -   | V    |

15.2.6 SPI-bus timings

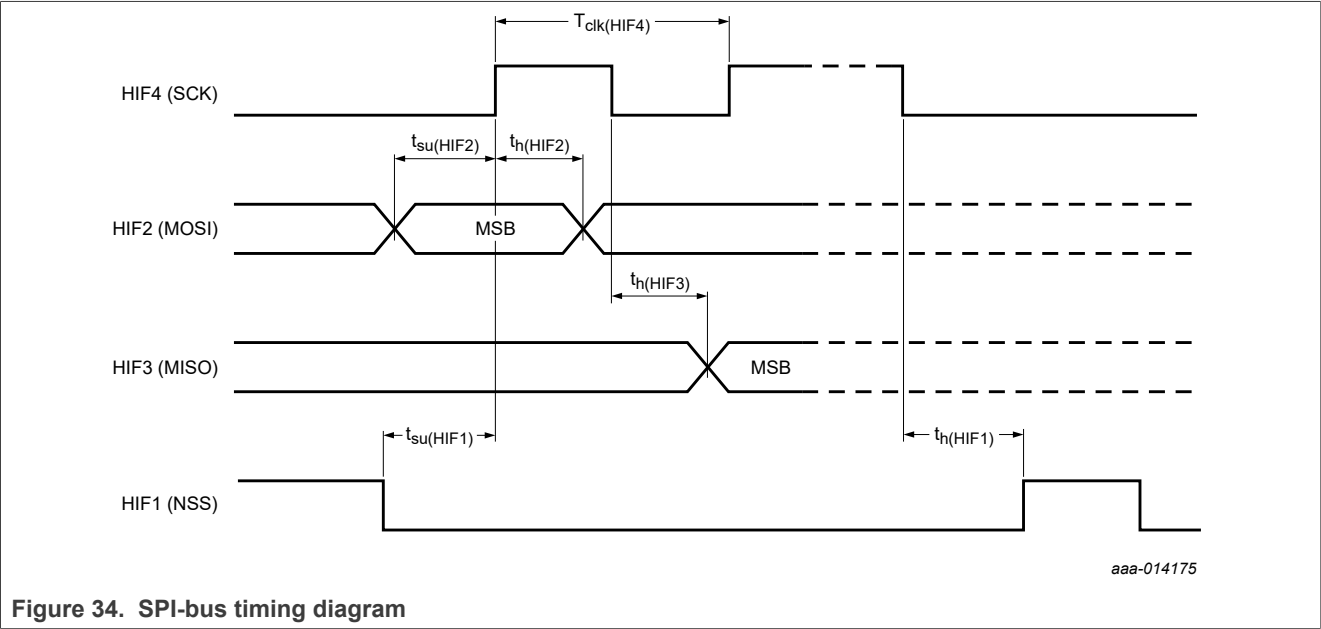


Table 42. SPI-bus timings specification

| Symbol                 | Parameter                | Conditions | Min                | Max | Unit |
|------------------------|--------------------------|------------|--------------------|-----|------|
| T <sub>clk(HIF4)</sub> | clock period on pin HIF4 | SPI SCK    | 142                | -   | ns   |
| t <sub>su(HIF2)</sub>  | HIF2 set-up time         | SPI MOSI   | <sup>[1]</sup> 35  | -   | ns   |
| t <sub>h(HIF2)</sub>   | HIF2 hold time           | SPI MOSI   | <sup>[1]</sup> 35  | -   | ns   |
| t <sub>h(HIF3)</sub>   | HIF3 hold time           | SPI MISO   | <sup>[2]</sup> -   | 37  | ns   |
| t <sub>h(HIF1)</sub>   | HIF1 hold time           | SPI NSS    | <sup>[1]</sup> 37  | -   | ns   |
| t <sub>su(HIF1)</sub>  | HIF1 set-up time         | SPI NSS    | <sup>[1]</sup> 142 | -   | ns   |

[1] Controlled by host.  
[2] Controlled by PN7160.

### 15.2.7 Active load modulation phase

Table 43. Active load modulation phase error

| Symbol     | Parameter   | Conditions                                                                        | Min | Typ | Max | Unit |
|------------|-------------|-----------------------------------------------------------------------------------|-----|-----|-----|------|
| $E_{\phi}$ | phase error | ALM phase error from RXP input to clock recovery output 50 mV < $V_{RX}$ < 500 mV | - 5 | -   | + 5 | °    |

## 15.3 Pin characteristics

### 15.3.1 NFC\_CLK\_XTAL1 and XTAL2 pins characteristics

Table 44. Input clock characteristics on NFC\_CLK\_XTAL1 when using PLL

| Symbol       | Parameter                  | Conditions | Min | Typ | Max | Unit |
|--------------|----------------------------|------------|-----|-----|-----|------|
| $V_{i(p-p)}$ | peak-to-peak input voltage |            | 0.2 | -   | 1.8 | V    |
| $\delta$     | duty cycle                 |            | 35  | -   | 65  | %    |

Table 45. Pin characteristics for NFC\_CLK\_XTAL1 when PLL input

| Symbol            | Parameter                        | Conditions      | Min | Typ | Max      | Unit    |
|-------------------|----------------------------------|-----------------|-----|-----|----------|---------|
| $I_{IH}$          | HIGH-level input current         | $V_I = V_{DD}$  | -1  | -   | +1       | $\mu$ A |
| $I_{IL}$          | LOW-level input current          | $V_I = 0$ V     | -1  | -   | +1       | $\mu$ A |
| $V_i$             | input voltage                    |                 | -   | -   | $V_{DD}$ | V       |
| $V_{i(clk)(p-p)}$ | peak-to-peak clock input voltage |                 | 200 | -   | -        | mV      |
| $C_i$             | input capacitance                | all power modes | -   | 2   | -        | pF      |

Table 46. Pin characteristics for 27.12 MHz crystal oscillator

| Symbol                   | Parameter                       | Conditions       | Min | Typ | Max | Unit |
|--------------------------|---------------------------------|------------------|-----|-----|-----|------|
| $C_{i(NFC\_CLK\_XTAL1)}$ | NFC_CLK_XTAL1 input capacitance | $V_{DD} = 1.8$ V | -   | 2   | -   | pF   |
| $C_{i(XTAL2)}$           | XTAL2 input capacitance         |                  | -   | 2   | -   | pF   |

Table 47. PLL accuracy

| Symbol       | Parameter                 | Conditions                                                                                                | Min | Typ | Max | Unit |
|--------------|---------------------------|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| $f_{o(acc)}$ | output frequency accuracy | deviation added to NFC_CLK_XTAL1 frequency on RF frequency generated; worst case whatever input frequency | -30 | -   | +30 | ppm  |

### 15.3.2 VEN input pin characteristics

Table 48. VEN input pin characteristics

| Symbol   | Parameter                | Conditions | Min | Typ | Max       | Unit |
|----------|--------------------------|------------|-----|-----|-----------|------|
| $V_{IH}$ | HIGH-level input voltage |            | 1.1 | -   | $V_{BAT}$ | V    |



Table 48. VEN input pin characteristics...continued

| Symbol   | Parameter                | Conditions              | Min | Typ | Max | Unit    |
|----------|--------------------------|-------------------------|-----|-----|-----|---------|
| $V_{IL}$ | LOW-level input voltage  |                         | 0   | -   | 0.4 | V       |
| $I_{IH}$ | HIGH-level input current | VEN voltage = $V_{BAT}$ | -1  | -   | +1  | $\mu A$ |
| $I_{IL}$ | LOW-level input current  | VEN voltage = 0 V       | -1  | -   | +1  | $\mu A$ |
| $C_i$    | input capacitance        |                         | -   | 5   | -   | pF      |

### 15.3.3 Output pin characteristics for IRQ, CLK\_REQ

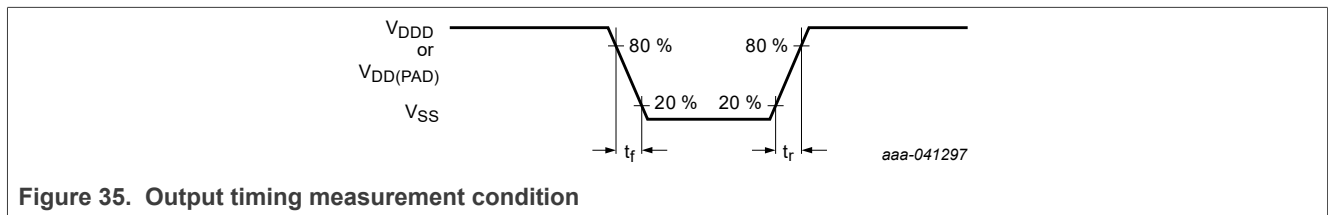


Figure 35. Output timing measurement condition

Table 49. Output pin characteristics for IRQ, CLK\_REQ

| Symbol   | Parameter                 | Conditions                    | Min                 | Typ | Max           | Unit       |
|----------|---------------------------|-------------------------------|---------------------|-----|---------------|------------|
| $V_{OH}$ | HIGH-level output voltage | $I_{OH} < 3 \text{ mA}$       | $V_{DD(PAD)} - 0.4$ | -   | $V_{DD(PAD)}$ | V          |
| $V_{OL}$ | LOW-level output voltage  | $I_{OL} < 3 \text{ mA}$       | 0                   | -   | 0.4           | V          |
| $C_L$    | load capacitance          |                               | -                   | -   | 20            | pF         |
| $t_f$    | fall time                 | $C_L = 12 \text{ pF max}$ [1] | 2                   | -   | 10            | ns         |
| $t_r$    | rise time                 | $C_L = 12 \text{ pF max}$ [1] | 2                   | -   | 10            | ns         |
| $R_{pd}$ | pull-down resistance      | for IRQ and CLK_REQ [2]       | 0.35                | -   | 0.85          | M $\Omega$ |
|          |                           | for IRQ and CLK_REQ [3] [4]   | 55                  | -   | 120           | k $\Omega$ |

[1] See Figure 35.

[2] Pull-down resistance is activated in HPD state.

[3] Pull-down resistance can be activated by firmware in Standby state.

[4] Pull-down resistance can be activated by firmware in Active state.

### 15.3.4 Output pin characteristics for TX\_PWR\_REQ

Table 50. Output pin characteristics for TX\_PWR\_REQ

| Symbol   | Parameter                 | Conditions                    | Min             | Typ | Max       | Unit       |
|----------|---------------------------|-------------------------------|-----------------|-----|-----------|------------|
| $V_{OH}$ | HIGH-level output voltage | $I_{OH} < 3 \text{ mA}$ [1]   | $V_{DDD} - 0.4$ | -   | $V_{DDD}$ | V          |
| $V_{OL}$ | LOW-level output voltage  | $I_{OL} < 3 \text{ mA}$ [1]   | 0               | -   | 0.4       | V          |
| $C_L$    | load capacitance          |                               | -               | -   | 20        | pF         |
| $t_f$    | fall time                 | $C_L = 12 \text{ pF max}$ [2] | 2               | -   | 10        | ns         |
| $t_r$    | rise time                 | $C_L = 12 \text{ pF max}$ [2] | 2               | -   | 10        | ns         |
| $R_{pd}$ | pull-down resistance      | [3]                           | 55              | -   | 120       | k $\Omega$ |
| $R_{pu}$ | pull-up resistance        | [4]                           | 55              | -   | 120       | k $\Omega$ |

[1] TX\_PWR\_REQ active driving is only possible when  $V_{DD(PAD)}$  is present. When  $V_{DD(PAD)}$  is not present, only pull-up or pull-down resistors can be enabled.

[2] See Figure 35.

[3] Unless disable by firmware, pull-down resistance is always activated.  
[4] Can be enabled by firmware.

15.3.5 Output pin characteristics for DCDC\_EN

Table 51. Output pin characteristics for DCDC\_EN

| Symbol          | Parameter                 | Conditions                            | Min                        | Typ | Max                  | Unit |
|-----------------|---------------------------|---------------------------------------|----------------------------|-----|----------------------|------|
| V <sub>OH</sub> | HIGH-level output voltage | I <sub>OH</sub> < 3 mA <sup>[1]</sup> | V <sub>DD(PAD)</sub> - 0.4 | -   | V <sub>DD(PAD)</sub> | V    |
| V <sub>OL</sub> | LOW-level output voltage  | I <sub>OL</sub> < 3 mA <sup>[1]</sup> | 0                          | -   | 0.4                  | V    |
| C <sub>L</sub>  | load capacitance          |                                       | -                          | -   | 20                   | pF   |

[1] DCDC\_EN active driving is only possible when V<sub>DD(PAD)</sub> is present. When V<sub>DD(PAD)</sub> is not present, only pull-up or pull-down resistors can be enabled.

15.3.6 Input pin characteristics for DWL\_REQ, WKUP\_REQ

Table 52. Input pin characteristics for DWL\_REQ, WKUP\_REQ

| Symbol          | Parameter                | Conditions                             | Min                      | Typ | Max                      | Unit |
|-----------------|--------------------------|----------------------------------------|--------------------------|-----|--------------------------|------|
| V <sub>IH</sub> | HIGH-level input voltage | typical 1.8 V interface supply voltage | 0.65V <sub>DD(PAD)</sub> | -   | -                        | V    |
|                 |                          | typical 3.3 V interface supply voltage | 2.0                      |     |                          | V    |
| V <sub>IL</sub> | LOW-level input voltage  | typical 1.8 V interface supply voltage | -                        | -   | 0.35V <sub>DD(PAD)</sub> | V    |
|                 |                          | typical 3.3 V interface supply voltage |                          |     | 0.8                      |      |
| I <sub>IH</sub> | HIGH-level input current |                                        | -1                       | -   | +1                       | μA   |
| I <sub>IL</sub> | LOW-level input current  |                                        | -1                       | -   | +1                       | μA   |
| C <sub>i</sub>  | input capacitance        |                                        | -                        | 5   | -                        | pF   |
| R <sub>pd</sub> | pull-down resistance     | pull-down                              |                          |     |                          |      |
|                 |                          | DWL_REQ pin <sup>[1]</sup>             | 0.35                     | -   | 0.85                     | MΩ   |
|                 |                          | WKUP_REQ pin <sup>[1]</sup>            | 55                       | -   | 120                      | kΩ   |

[1] Activated in HPD state.

15.3.7 Input pin characteristics for RXN and RXP

Table 53. Input pin characteristics for RXN and RXP

| Symbol                     | Parameter                                            | Conditions                 | Min | Typ | Max                     | Unit |
|----------------------------|------------------------------------------------------|----------------------------|-----|-----|-------------------------|------|
| V <sub>RXN(i)</sub>        | RXN input voltage                                    |                            | 0   | -   | V <sub>DDA</sub> - 0.05 | V    |
| V <sub>RXP(i)</sub>        | RXP input voltage                                    |                            | 0   | -   | V <sub>DDA</sub> - 0.05 | V    |
| C <sub>i(RXN)</sub>        | RXN input capacitance                                |                            | -   | 6   | -                       | pF   |
| C <sub>i(RXP)</sub>        | RXP input capacitance                                |                            | -   | 6   | -                       | pF   |
| Z <sub>i(RXN-VDDMID)</sub> | input impedance between RXN and V <sub>DD(MID)</sub> | Reader, card and P2P modes | 0   | -   | 15                      | kΩ   |

Table 53. Input pin characteristics for RXN and RXP...continued

| Symbol              | Parameter                                     | Conditions                                              | Min | Typ | Max              | Unit       |
|---------------------|-----------------------------------------------|---------------------------------------------------------|-----|-----|------------------|------------|
| $Z_{i(RXP-VDDMID)}$ | input impedance between RXP and $V_{DD(MID)}$ | Reader, card and P2P modes                              | 0   | -   | 15               | k $\Omega$ |
| $V_{i(dyn)(RXN)}$   | RXN minimum dynamic input voltage             | Miller coded                                            |     |     |                  |            |
|                     |                                               | 106 kbit/s                                              | -   | -   | 20               | mV(p-p)    |
|                     |                                               | 212 kbit/s to 424 kbit/s                                | -   | -   | 20               | mV(p-p)    |
| $V_{i(dyn)(RXP)}$   | RXP minimum dynamic input voltage             | Miller coded                                            |     |     |                  |            |
|                     |                                               | 106 kbit/s                                              | -   | -   | 20               | mV(p-p)    |
|                     |                                               | 212 kbit/s to 424 kbit/s                                | -   | -   | 20               | mV(p-p)    |
| $V_{i(dyn)(RXN)}$   | RXN minimum dynamic input voltage             | Manchester, NRZ or BPSK coded; 106 kbit/s to 848 kbit/s | -   | -   | 20               | mV(p-p)    |
| $V_{i(dyn)(RXP)}$   | RXP minimum dynamic input voltage             | Manchester, NRZ or BPSK coded; 106 kbit/s to 848 kbit/s | -   | -   | 20               | mV(p-p)    |
| $V_{i(dyn)(RXN)}$   | RXN maximum dynamic input voltage             | All data coding; 106 kbit/s to 848 kbit/s               | -   | -   | $V_{DDA} - 0.05$ | V(p-p)     |
| $V_{i(dyn)(RXP)}$   | RXP maximum dynamic input voltage             | All data coding; 106 kbit/s to 848 kbit/s               | -   | -   | $V_{DDA} - 0.05$ | V(p-p)     |
| $V_{i(RF)}$         | RF input voltage for RF level detector        | RF input voltage detected for 9 mV threshold            | 5.5 | 9   | 15               | mV(p-p)    |
|                     | RF input voltage for NFC level detector       | RF input voltage detected for 15 mV threshold           | 8   | 15  | 23               | mV(p-p)    |

### 15.3.8 ANT1 and ANT2 pin characteristics

Table 54. Electrical characteristics of ANT1 and ANT2

| Symbol | Parameter        | Conditions                                 | Min                | Typ | Max | Unit     |
|--------|------------------|--------------------------------------------|--------------------|-----|-----|----------|
| $R_I$  | input resistance | switches closed; for pins ANT <sub>X</sub> | <sup>[1]</sup> -   | 10  | 17  | $\Omega$ |
| $I_I$  | input current    | for pins ANT <sub>X</sub>                  | <sup>[1]</sup> -50 | -   | +50 | mA       |

[1] With X = 1 or 2.

### 15.3.9 $V_{DD(HF)}$ and $V_{DD}$ pins characteristics

Table 55. Electrical characteristics of  $V_{DD(HF)}$  and  $V_{DD}$ 

| Symbol       | Parameter                     | Conditions        | Min              | Typ | Max  | Unit |
|--------------|-------------------------------|-------------------|------------------|-----|------|------|
| $V_{DD(HF)}$ | $V_{DD(HF)}$ supply voltage   | $I_{ANTX} = 5$ mA | <sup>[1]</sup> - | 2.7 | -    | V    |
| $V_{DD}$     | $V_{DD}$ supply voltage 1.8 V | $V_{SS} = 0$ V    | 1.7              | 1.8 | 1.95 | V    |

[1] With X = 1 or 2.

### 15.3.10 Output pin characteristics for TX1 and TX2

Table 56. Output pin characteristics for TX1 and TX2

| Symbol          | Parameter                 | Conditions                                                                    | Min                       | Typ | Max | Unit |
|-----------------|---------------------------|-------------------------------------------------------------------------------|---------------------------|-----|-----|------|
| V <sub>OH</sub> | HIGH-level output voltage | V <sub>DD(TX)</sub> = 3.3 V and I <sub>OH</sub> = 30 mA; PMOS driver fully on | V <sub>DD(TX)</sub> - 150 | -   | -   | mV   |
| V <sub>OL</sub> | LOW-level output voltage  | V <sub>DD(TX)</sub> = 3.3 V and I <sub>OL</sub> = 30 mA; NMOS driver fully on | -                         | -   | 200 | mV   |

Table 57. Output resistance for TX1 and TX2

| Symbol          | Parameter                    | Conditions                                                                   | Min                 | Typ | Max | Unit |
|-----------------|------------------------------|------------------------------------------------------------------------------|---------------------|-----|-----|------|
| R <sub>OL</sub> | LOW-level output resistance  | V <sub>DD(TX)</sub> - 100 mV; CWGsN = 01h                                    | -                   | -   | 80  | Ω    |
|                 |                              | V <sub>DD(TX)</sub> - 100 mV; CWGsN = 0Fh                                    | -                   | 0.9 | -   | Ω    |
| R <sub>OH</sub> | HIGH-level output resistance | V <sub>DD(TX)</sub> = 5 V; V <sub>(TXn)</sub> = V <sub>DD(TX)</sub> - 100 mV | <sup>[1]</sup> 0.65 | 0.9 | 1.4 | Ω    |

[1] With n = 1 or 2.

### 15.3.11 Input pin characteristics for HIF1 (used as SPI-bus NSS, used as I<sup>2</sup>C-bus address 0), HIF2 (used as SPI-bus MOSI, used as I<sup>2</sup>C-bus address 1), HIF4 (used as SPI-bus SCK)

Table 58. Input pin characteristics for HIF1 (used as SPI-bus NSS, used as I<sup>2</sup>C-bus address 0), HIF2 (used as SPI-bus MOSI, used as I<sup>2</sup>C-bus address 1), HIF4 (used as SPI-bus SCK)

| Symbol          | Parameter                | Conditions                                                                               | Min                      | Typ | Max                      | Unit |
|-----------------|--------------------------|------------------------------------------------------------------------------------------|--------------------------|-----|--------------------------|------|
| V <sub>IH</sub> | HIGH-level input voltage |                                                                                          | 0.65V <sub>DD(PAD)</sub> | -   | V <sub>DD(PAD)</sub>     | V    |
| V <sub>IL</sub> | LOW-level input voltage  |                                                                                          | 0                        | -   | 0.35V <sub>DD(PAD)</sub> | V    |
| I <sub>IH</sub> | HIGH-level input current | V <sub>I</sub> = V <sub>DD(PAD)</sub>                                                    | -1                       | -   | +1                       | μA   |
| I <sub>IL</sub> | LOW-level input current  | V <sub>I</sub> = 0 V                                                                     | -1                       | -   | +1                       | μA   |
| C <sub>i</sub>  | input capacitance        |                                                                                          | -                        | 5   | -                        | pF   |
| R <sub>pu</sub> | pull-up resistance       | HIF1 used as I <sup>2</sup> C-bus address 0; HIF2 used as I <sup>2</sup> C-bus address 1 | <sup>[1]</sup> 55        | -   | 120                      | kΩ   |

[1] Unless disable by firmware, extra pull-up resistance is always activated.

### 15.3.12 Pin characteristics for HIF3 (used as I<sup>2</sup>C-bus SDA) and HIF4 (used as I<sup>2</sup>C-bus SCL)

Table 59. Pin characteristics for HIF3 (used as I<sup>2</sup>C-bus SDA) and HIF4 (used as I<sup>2</sup>C-bus SCL)

| Symbol          | Parameter                | Conditions             | Min              | Typ | Max | Unit |
|-----------------|--------------------------|------------------------|------------------|-----|-----|------|
| V <sub>OL</sub> | LOW-level output voltage | I <sub>OL</sub> < 3 mA | <sup>[1]</sup> 0 | -   | 0.4 | V    |
| C <sub>L</sub>  | load capacitance         |                        | -                | -   | 10  | pF   |

Table 59. Pin characteristics for HIF3 (used as I<sup>2</sup>C-bus SDA) and HIF4 (used as I<sup>2</sup>C-bus SCL)...continued

| Symbol          | Parameter                | Conditions                                                                   |     | Min                     | Typ | Max                     | Unit |
|-----------------|--------------------------|------------------------------------------------------------------------------|-----|-------------------------|-----|-------------------------|------|
| t <sub>f</sub>  | fall time                | C <sub>L</sub> = 100 pF; R <sub>pull-up</sub> = 2 kΩ; Standard and Fast mode | [1] | 30                      | -   | 250                     | ns   |
|                 |                          | C <sub>L</sub> = 100 pF; R <sub>pull-up</sub> = 1 kΩ; High-speed mode        | [1] | 80                      | -   | 110                     | ns   |
| t <sub>r</sub>  | rise time                | C <sub>L</sub> = 100 pF; R <sub>pull-up</sub> = 2 kΩ; Standard and Fast mode | [1] | 30                      | -   | 250                     | ns   |
|                 |                          | C <sub>L</sub> = 100 pF; R <sub>pull-up</sub> = 1 kΩ; High-speed mode        | [1] | 10                      | -   | 100                     | ns   |
| V <sub>IH</sub> | HIGH-level input voltage |                                                                              |     | 0.7V <sub>DD(PAD)</sub> | -   | V <sub>DD(PAD)</sub>    | V    |
| V <sub>IL</sub> | LOW-level input voltage  |                                                                              |     | 0                       | -   | 0.3V <sub>DD(PAD)</sub> | V    |
| I <sub>IH</sub> | HIGH-level input current | V <sub>I</sub> = V <sub>DD(PAD)</sub> ; high impedance                       |     | -1                      | -   | +1                      | μA   |
| I <sub>IL</sub> | LOW-level input current  | V <sub>I</sub> = 0 V; high impedance                                         |     | -1                      | -   | +1                      | μA   |
| C <sub>i</sub>  | input capacitance        |                                                                              |     | -                       | 5   | -                       | pF   |

[1] Only for pin HIF3 (I<sup>2</sup>C-bus SDA), HIF4 (I<sup>2</sup>C-bus SCL) is only used as input.

### 15.3.13 Pin characteristics for HIF3 (used as SPI-bus MISO)

Table 60. Pin characteristics for HIF3 (used as SPI-bus MISO)

| Symbol          | Parameter                 | Conditions                 |  | Min                        | Typ | Max                  | Unit |
|-----------------|---------------------------|----------------------------|--|----------------------------|-----|----------------------|------|
| V <sub>OH</sub> | HIGH-level output voltage | I <sub>OH</sub> < 4 mA     |  | V <sub>DD(PAD)</sub> - 0.4 | -   | V <sub>DD(PAD)</sub> | V    |
| V <sub>OL</sub> | LOW-level output voltage  | I <sub>OL</sub> < 4 mA     |  | 0                          | -   | 0.4                  | V    |
| C <sub>L</sub>  | load capacitance          |                            |  | -                          | -   | 20                   | pF   |
| t <sub>f</sub>  | fall time                 | C <sub>L</sub> = 12 pF max |  |                            |     |                      |      |
|                 |                           | high speed                 |  | 1                          | -   | 3                    | ns   |
|                 |                           | slow speed                 |  | 3                          | -   | 10                   | ns   |
| t <sub>r</sub>  | rise time                 | C <sub>L</sub> = 12 pF max |  |                            |     |                      |      |
|                 |                           | high speed                 |  | 1                          | -   | 3                    | ns   |
|                 |                           | slow speed                 |  | 3                          | -   | 10                   | ns   |

16 Package outline VFBGA64

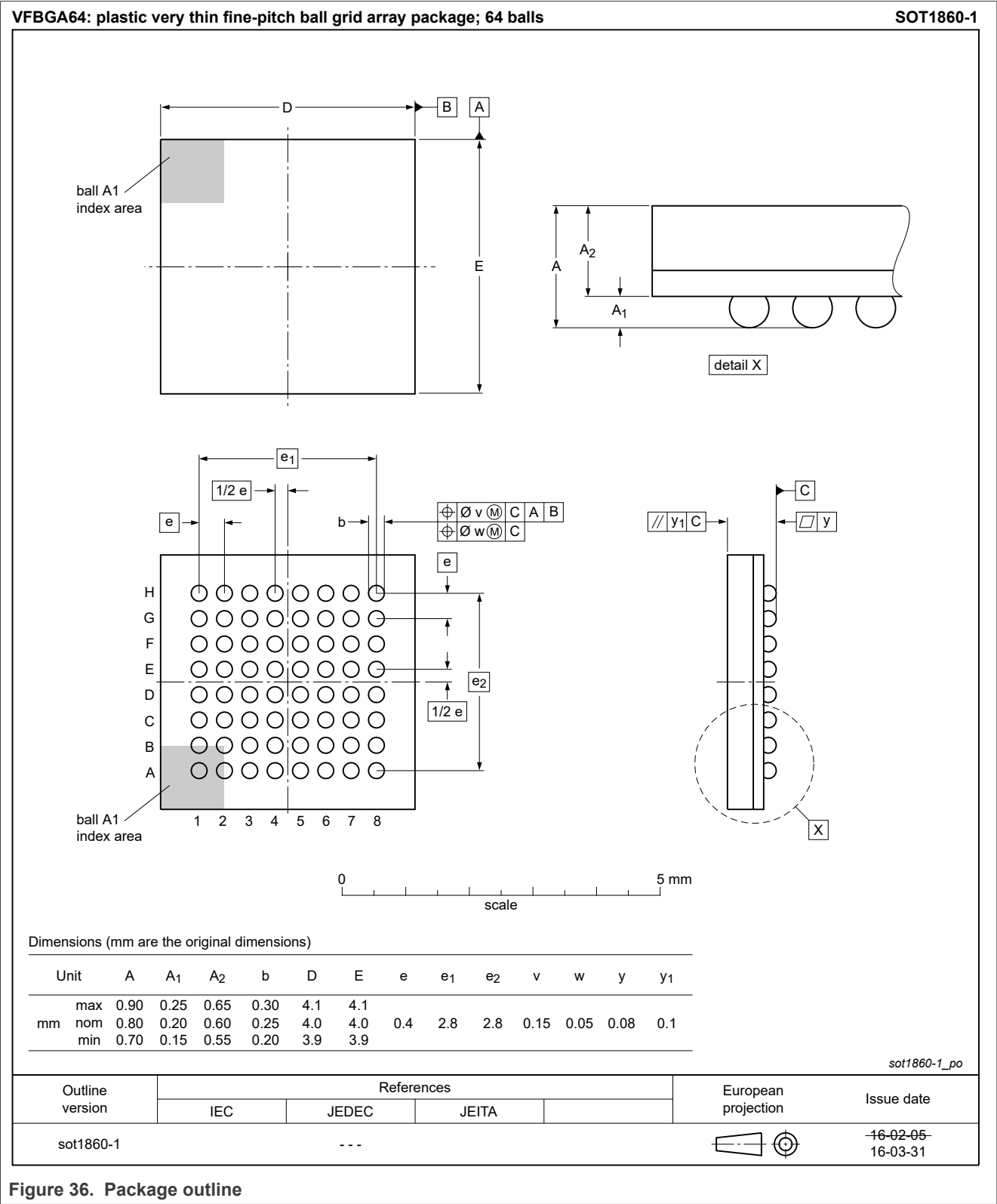
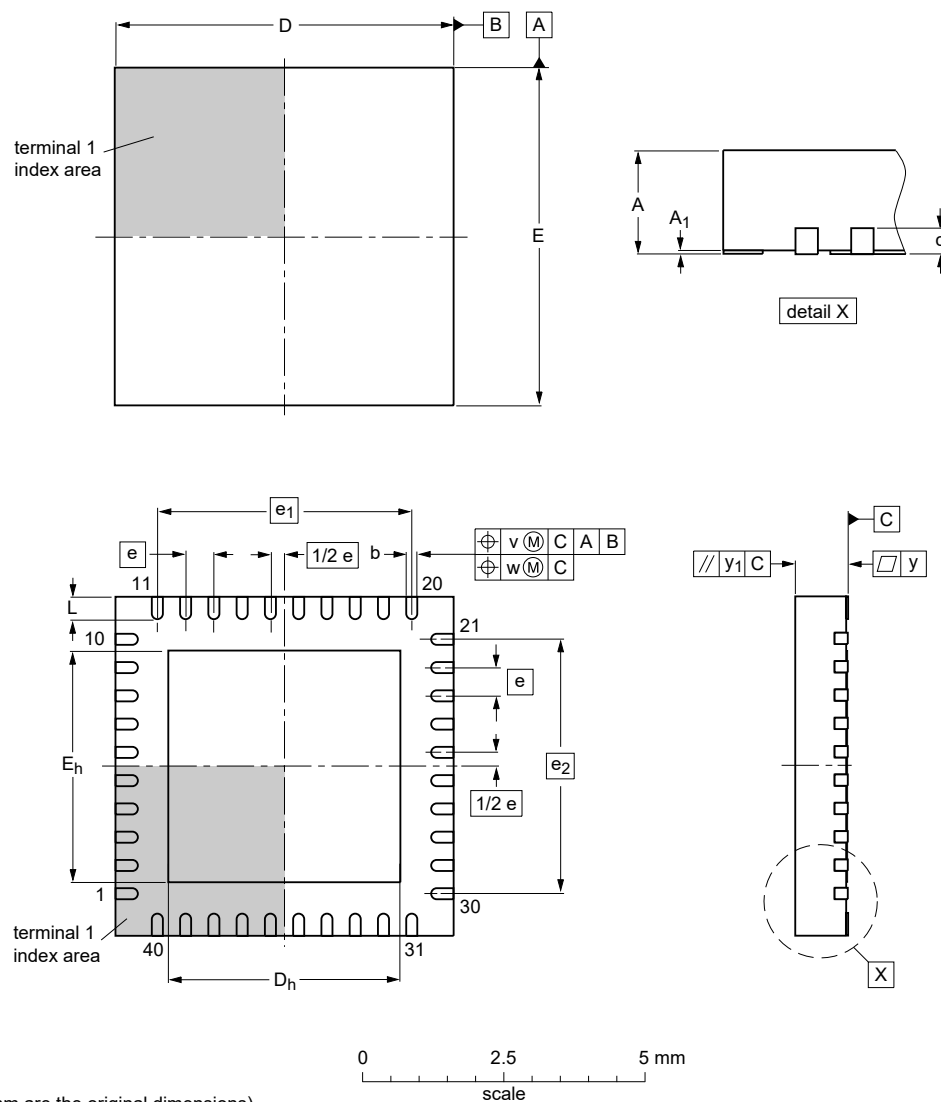


Figure 36. Package outline

## 17 Package outline HVQFN40

**HVQFN40: plastic thermal enhanced very thin quad flat package; no leads; 40 terminals; body 6 x 6 x 0.85 mm**

**SOT618-1**



Dimensions (mm are the original dimensions)

| Unit |     | A <sup>(1)</sup> | A <sub>1</sub> | b    | c   | D <sup>(1)</sup> | D <sub>h</sub> | E <sup>(1)</sup> | E <sub>h</sub> | e   | e <sub>1</sub> | e <sub>2</sub> | L   | v   | w    | y    | y <sub>1</sub> |
|------|-----|------------------|----------------|------|-----|------------------|----------------|------------------|----------------|-----|----------------|----------------|-----|-----|------|------|----------------|
| mm   | max | 1.00             | 0.05           | 0.30 | 0.2 | 6.1              | 4.25           | 6.1              | 4.25           | 0.5 | 4.5            | 4.5            | 0.5 | 0.1 | 0.05 | 0.05 | 0.1            |
|      | nom | 0.85             | 0.02           | 0.21 |     | 6.0              | 4.10           | 6.0              | 4.10           |     |                |                | 0.4 |     |      |      |                |
|      | min | 0.80             | 0.00           | 0.18 |     | 5.9              | 3.95           | 5.9              | 3.95           |     |                |                | 0.3 |     |      |      |                |

Note

1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

sot618-1\_po

| Outline version | References |        |       |  | European projection                                                                   | Issue date                      |
|-----------------|------------|--------|-------|--|---------------------------------------------------------------------------------------|---------------------------------|
|                 | IEC        | JEDEC  | JEITA |  |                                                                                       |                                 |
| SOT618-1        |            | MO-220 |       |  |  | <del>02-10-22</del><br>13-11-05 |

**Figure 37. Package outline, HVQFN40, SOT618-1, MSL3**

## 18 Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

### 18.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

### 18.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

### 18.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

### 18.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see [Figure 38](#)) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board



- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with [Table 61](#) and [Table 62](#)

Table 61. SnPb eutectic process (from J-STD-020C)

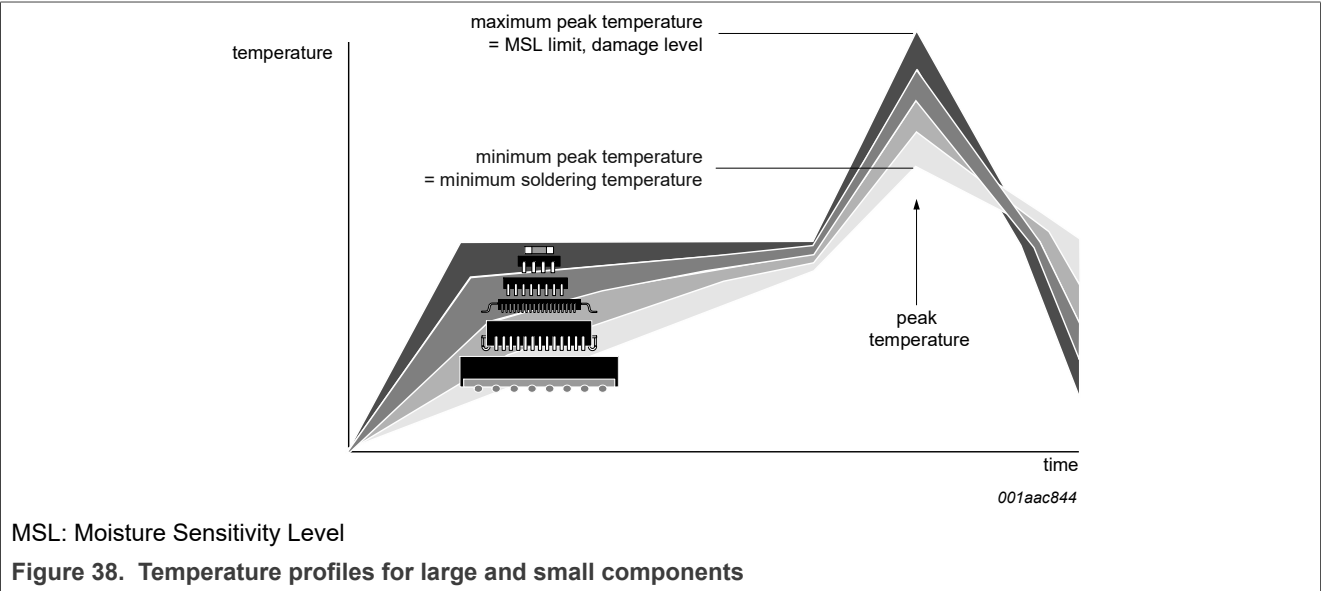
| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm <sup>3</sup> )       |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                  | 235                             | 220   |
| ≥ 2.5                  | 220                             | 220   |

Table 62. Lead-free process (from J-STD-020C)

| Package thickness (mm) | Package reflow temperature (°C) |              |         |
|------------------------|---------------------------------|--------------|---------|
|                        | Volume (mm <sup>3</sup> )       |              |         |
|                        | < 350                           | 350 to 2 000 | > 2 000 |
| < 1.6                  | 260                             | 260          | 260     |
| 1.6 to 2.5             | 260                             | 250          | 245     |
| > 2.5                  | 250                             | 245          | 245     |

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see [Figure 38](#).



For further information on temperature profiles, refer to Application Note *AN10365 "Surface mount reflow soldering description"*.

## 19 Abbreviations

Table 63. Abbreviations

| Acronym                    | Description                                                                                                                                                                                                 |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASK                        | Amplitude Shift keying                                                                                                                                                                                      |
| ASK modulation index       | The ASK modulation index is defined as the voltage ratio $(V_{max} - V_{min}) / (V_{max} + V_{min}) \times 100\%$                                                                                           |
| Automatic device discovery | Detect and recognize any NFC peer devices (NFC Initiator or NFC Target) like: NFC Initiator or NFC Target, ISO/IEC 14443-3, -4 Type A&B PICC, MIFARE Classic and MIFARE Ultralight PICC, ISO/IEC 15693 VICC |
| BPSK                       | Bit Phase Shift Keying                                                                                                                                                                                      |
| Card Emulation             | The IC is capable of handling a PICC emulation on the RF interface including part of the protocol management. The application handling is done by the host controller                                       |
| DEP                        | Data Exchange Protocol                                                                                                                                                                                      |
| DSLDO                      | Dual Supplied LDO                                                                                                                                                                                           |
| FW                         | FirmWare                                                                                                                                                                                                    |
| HPD                        | Hard Power Down                                                                                                                                                                                             |
| LDO                        | Low Drop Out                                                                                                                                                                                                |
| LFO                        | Low Frequency Oscillator                                                                                                                                                                                    |
| MISO                       | Controller In Target Out (for SPI-bus interface)                                                                                                                                                            |
| MOSFET                     | Metal Oxide Semiconductor Field Effect Transistor                                                                                                                                                           |
| MOSI                       | Controller Out Target In (for SPI-bus interface)                                                                                                                                                            |
| MSL                        | Moisture Sensitivity Level                                                                                                                                                                                  |
| NCI                        | NFC Controller Interface                                                                                                                                                                                    |
| NFC                        | Near Field Communication                                                                                                                                                                                    |
| NFCC                       | NFC Controller, PN7160 in this data sheet                                                                                                                                                                   |
| NFC Initiator              | Initiator as defined in ISO/IEC 18092 or Ecma 340: NFCIP-1 communication                                                                                                                                    |
| NFCIP                      | NFC Interface and Protocol                                                                                                                                                                                  |
| NFC Target                 | Target as defined in ISO/IEC 18092 or Ecma 340: NFCIP-1 communication                                                                                                                                       |
| NRZ                        | Non Return to Zero                                                                                                                                                                                          |
| NSS                        | Not Target Select (for SPI-bus interface)                                                                                                                                                                   |
| P2P                        | Peer to Peer                                                                                                                                                                                                |
| PCD                        | Proximity Coupling Device. Definition for a Card reader/writer device according to the ISO/IEC 14443 specification or MIFARE                                                                                |
| PCD -> PICC                | Communication flow between a PCD and a PICC according to the ISO/IEC 14443 specification or MIFARE                                                                                                          |
| PICC                       | Proximity Interface Coupling Card. Definition for a contactless Smart Card according to the ISO/IEC 14443 specification or MIFARE                                                                           |
| PICC-> PCD                 | Communication flow between a PICC and a PCD according to the ISO/IEC 14443 specification or MIFARE                                                                                                          |
| PMOS                       | P-channel MOSFET                                                                                                                                                                                            |
| PMU                        | Power Management Unit                                                                                                                                                                                       |

Table 63. Abbreviations...continued

| Acronym | Description                                                                                                  |
|---------|--------------------------------------------------------------------------------------------------------------|
| PSL     | Parameter SeLection                                                                                          |
| SCK     | Serial Clock (for SPI interface)                                                                             |
| SPI-bus | Serial Peripheral Interface bus                                                                              |
| TXLDO   | Transmitter LDO                                                                                              |
| UM      | User Manual                                                                                                  |
| VCD     | Vicinity Coupling Device. Definition for a reader/writer device according to the ISO/IEC 15693 specification |
| VCO     | Voltage Controlled Oscillator                                                                                |
| VICC    | Vicinity Integrated Circuit Card                                                                             |
| WUC     | Wake-up Counter                                                                                              |

## 20 References

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- [1] NFC Forum Device Requirements V2.0
- [2] NFC Controller Interface (NCI) Technical Specification V2.0
- [3] ISO/IEC 14443 parts 2: 2001 COR 1 2007 (01/11/2007), part 3: 2001 COR 1 2006 (01/09/2006) and part 4: 2nd edition 2008 (15/07/2008)
- [4] I<sup>2</sup>C Specification, UM10204 rev4 (13/02/2012)
- [5] SPI Motorola de-facto standard described in Motorola 68HC11 data sheet
- [6] UM11577 PN7161 NFC controller user manual
- [7] AN12988 PN7160 hardware design guide
- [8] AN13219 PN7160 antenna design and matching guide
- [9] ISO/IEC 18092 (NFCIP-1) edition, 15/03/2013. This is similar to Ecma 340.
- [10] ISO/IEC15693 part 2: 2nd edition (15/12/2006), part 3: 1st edition (01/04/2001)
- [11] ISO/IEC 21481 (NFCIP-2) edition, 01/07/2012. This is similar to Ecma 352.
- [12] ETSI HCI TS 102 622; UICC - Contactless Front-end (CLF) Interface; Host Controller Interface (HCI) (Release 12)
- [13] Apple Enhanced Contactless Polling Specification: Version 1.1.

## 21 Revision history

Table 64. Revision history

| Document ID         | Release date                                                                                                                                                                                                                                                                             | Data sheet status      | Supersedes          |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------|
| PN7160_PN7161 v.4.0 | 05 September 2024                                                                                                                                                                                                                                                                        | Product data sheet     | PN7160_PN7161 v.3.9 |
| Modifications:      | <ul style="list-style-type: none"> <li>• <a href="#">Section 6 "Firmware versions"</a>: added new Firmware versions</li> <li>• <a href="#">Section 6.1 "Firmware version and model ID retrieval"</a>: added</li> </ul>                                                                   |                        |                     |
| PN7160_PN7161 v.3.9 | 08 March 2023                                                                                                                                                                                                                                                                            | Product data sheet     | PN7160_PN7161 v.3.8 |
| Modifications:      | <ul style="list-style-type: none"> <li>• FeliCa card mode removed</li> <li>• Updated the terms "Master/Slave" to "Controller/Target" to align with the recommendation of the NXP - I2C standards organization.</li> </ul>                                                                |                        |                     |
| PN7160_PN7161 v.3.8 | 14 December 2022                                                                                                                                                                                                                                                                         | Product data sheet     | PN7160_PN7161 v.3.7 |
| Modifications:      | <ul style="list-style-type: none"> <li>• <a href="#">Section 5 "Quick reference data"</a> and <a href="#">Section 13 "Recommended operating conditions"</a>: <math>T_{amb}</math> updated to -30°C</li> </ul>                                                                            |                        |                     |
| PN7160_PN7161 v.3.7 | 07 December 2022                                                                                                                                                                                                                                                                         | Product data sheet     | PN7160_PN7161 v.3.6 |
| Modifications:      | <ul style="list-style-type: none"> <li>• <a href="#">Section 6 "Firmware versions"</a> and <a href="#">Section 7 "Ordering information"</a>: updated</li> </ul>                                                                                                                          |                        |                     |
| PN7160_PN7161 v.3.6 | 05 September 2022                                                                                                                                                                                                                                                                        | Product data sheet     | PN7160_PN7161 v.3.5 |
| Modifications:      | <ul style="list-style-type: none"> <li>• <a href="#">Figure 6</a>: Description of Pin 37 updated</li> </ul>                                                                                                                                                                              |                        |                     |
| PN7160_PN7161 v.3.5 | 19 August 2022                                                                                                                                                                                                                                                                           | Product data sheet     | PN7160_PN7161 v.3.4 |
| Modifications:      | <ul style="list-style-type: none"> <li>• Added information about DCDC_EN pin as an alternative to the pin TX_PWR_REQ, see <a href="#">Section 11.4.3.4 "TXLDO: configuration"</a></li> <li>• Clarified voltage level of pin <math>V_{DD}</math>, see <a href="#">Table 55</a></li> </ul> |                        |                     |
| PN7160_PN7161 v.3.4 | 04 August 2022                                                                                                                                                                                                                                                                           | Product data sheet     | PN7160_PN7161 v.3.3 |
| Modifications:      | <ul style="list-style-type: none"> <li>• Functional description SPI interface: Setting of CPHA and CPOL are fixed during production and cannot be changed by customer.</li> </ul>                                                                                                        |                        |                     |
| PN7160_PN7161 v.3.3 | 17 February 2022                                                                                                                                                                                                                                                                         | Product data sheet     | PN7160_PN7161 v.3.2 |
| Modifications:      | <ul style="list-style-type: none"> <li>• <a href="#">Section 7 "Ordering information"</a>: <a href="#">Table 3</a> and <a href="#">Table 4</a> added</li> <li>• <a href="#">Section 6 "Firmware versions"</a>: added</li> </ul>                                                          |                        |                     |
| PN7160_PN7161 v.3.2 | 30 September 2021                                                                                                                                                                                                                                                                        | Product data sheet     | PN7160_PN7161 v.3.1 |
| Modifications:      | <ul style="list-style-type: none"> <li>• Clarified pin naming TVDD vs <math>V_{DD(TX)}</math></li> </ul>                                                                                                                                                                                 |                        |                     |
| PN7160_PN7161 v.3.1 | 13 September 2021                                                                                                                                                                                                                                                                        | Product data sheet     | PN7160_PN7161 v.3.0 |
| Modifications:      | <ul style="list-style-type: none"> <li>• Security status changed into "Company public"</li> </ul>                                                                                                                                                                                        |                        |                     |
| PN7160_PN7161 v.3.0 | 19 August 2021                                                                                                                                                                                                                                                                           | Product data sheet     | PN7160_PN7161 v.2.0 |
| Modifications:      | <ul style="list-style-type: none"> <li>• Data sheet status changed into "Product data sheet"</li> <li>• Security status changed into "Company restricted"</li> </ul>                                                                                                                     |                        |                     |
| PN7160_PN7161 v.2.0 | 09 July 2021                                                                                                                                                                                                                                                                             | Preliminary data sheet | PN7160 v.1.0        |
| Modifications:      | <ul style="list-style-type: none"> <li>• PN7161 included</li> <li>• <a href="#">Section 14 "Thermal characteristics"</a>: updated</li> <li>• Some figures updated</li> </ul>                                                                                                             |                        |                     |
| PN7160 v.1.0        | 08 March 2021                                                                                                                                                                                                                                                                            | Objective data sheet   | -                   |
|                     | <ul style="list-style-type: none"> <li>• Initial version</li> </ul>                                                                                                                                                                                                                      |                        |                     |

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