- PN7150 is in state RFST_W4_ALL_DISCOVERIES, it sends an RF_DISCOVER_NTF to the DH for VICC2 and moves to RFST_W4_HOST_SELECT.
- PN7150 is in state RFST_W4_ALL_DISCOVERIES and waits for the DH to select one of the 2 VICCs. Once it receives the RF_DISCOVER_SELECT_CMD from the DH, PN7150 immediately activates the Frame RF Interface and does not check if the selected VICC is still in the field. That means that PN7150 will not send a CORE_GENERIC_ERROR_NTF (Discovery_Target_Activation_Failed) to the DH if the selected VICC is not in the field anymore. The state is now changed to RFST_POLL_ACTIVE.
- PN7150 is in state RFST_POLL_ACTIVE; it waits for the DH to send some data to transfer over RF. Once it gets this data, PN7150 forwards it over RF. If the selected VICC is not in the field anymore, PN7150 will stay mute and will not send any data back to the DH. The DH has to implement a time-out function, to detect that the VICC is not in the field anymore. Once this timeout is triggered, the DH can de-activate the Frame RF Interface by sending the RF_DEACTIVATE_CMD.

6.5 [PN7150-NCI] extension: KOVIO tags

Kovio tags are very particular tags which use a sub-set of NFC-A technology.

The basic concept is that the tag is powered from RF Field generated by PN7150, and it will spontaneously generate a 16-Byte ID using NFC-A load modulation, although it did not receive any command from PN7150. Once PN7150 has detected a Kovio tag by capturing its ID, PN7150 will send a RF_INTF_ACTIVATED_NTF, transporting the tag ID as RF parameter.

Table 65. Kovio specific RF parameters inside the RF_INTF_ACTIVATED_NF

Payload Field(s)	Length	Value/Description
...		
Length of RF Technology Specific Parameters	1 Octet	16
RF Technology Specific Parameters	16 Octets	Kovio ID
...		

It is then up to the DH to decide when to leave the RFST_POLLING_ACTIVE state, and also to decide if it directly comes back to RFST_DISCOVERY, where the same Kovio Tag may be discovered again, or if it comes back to RFST_IDLE first, in order to wait without any RF activity or re-configuring the RF Discovery so that PN7150 does not poll for a Kovio tag again.

Kovio tags are accessed through the [NCI] Frame RF Interface.

Due to the very particular behavior of the Kovio tags, it is necessary to configure the RF Discovery specifically for these tags, using the NFC-A_KOVIO_POLL_MODE parameter for the RF_DISCOVER_CMD as highlighted in the table below:

Table 66. Config. seq. for R/W of Kovio tags through the Frame RF Intf

Command	Main Parameters	Values
	RF Protocol	PROTOCOL_KOVIO
RF_DISCOVER_MAP_CMD*	Mode	Poll
	RF Interface	Frame RF Interface
CORE_SET_CONFIG_CMD	PA_BAIL_OUT[1]	
RF_DISCOVER_CMD	RF Technology & Mode	NFC_A_KOVIO_POLL_MODE

* Note: RF_DISCOVER_MAP_CMD is optional since the mapping to Frame RF Intf. is done by default

[1] this parameter is not active in PN7150: it can be read/written, but PN7150 will always behave with Bail Out in NFC-A, whatever the value written by the DH to that parameter.

7. Card Emulation Mode

The PN7150 supports Card Emulation hosted by the DH based on either technology NFC-A, NFC-B or NFC-F.

7.1 ISO-DEP card emulation through NFC-A & NFC-B

[NCI] defines all the mechanisms necessary to implement this feature. Two options are possible:

1. The DH wants to manage by itself the ISO-DEP protocol; it SHALL then map the ISO-DEP protocol on the Frame RF Interface.

   ! Not supported in PN7150

2. The DH leaves the ISO-DEP protocol management to the NFCC: it SHALL then map the ISO-DEP protocol on the ISO-DEP interface.

Here are the commands and configuration parameters to prepare the ISO-DEP Card Emulation for technology NFC-A in the DH through the ISO-DEP RF Interface:

Table 67. Config. seq. for CE of ISO-DEP/NFC-A

Command	Main Parameters	Values
	RF Protocol	PROTOCOL_ISO-DEP
RF_DISCOVER_MAP_CMD	Mode	Listen
	RF Interface	ISO-DEP
	LA_BIT_FRAME_SDD	
	LA_PLATFORM_CONFIG	
	LA_SEL_INFO	
CORE_SET_CONFIG_CMD	LA_NFCID1	
	LI_FWI	
	LA_HIST_BY	
	LI_BIT_RATE	
RF_DISCOVER_CMD	RF Technology & Mode	NFC_A_PASSIVE_LISTEN_MODE

Here are the commands and configuration parameters to prepare the ISO-DEP Card Emulation for technology NFC-B in the DH through the Frame RF Interface:

Table 68. Config. seq. for CE of ISO-DEP/NFC-B

Command	Main Parameters	Values
	RF Protocol	PROTOCOL_ISO-DEP
RF_DISCOVER_MAP_CMD	Mode	Listen
	RF Interface	ISO-DEP
CORE_SET_CONFIG_CMD	LB_SENSB_INFO	
	LB_NFCID0	

Command	Main Parameters	Values
	LB_APPLICATION_DATA	
	LB_SFGI	
	LB_ADC_FO	
	LI_FWI	
	LB_H_INFO_RESP [1]	
	LI_BIT_RATE	
RF_DISCOVER_CMD	RF Technology & Mode	NFC_B_PASSIVE_LISTEN_MODE

[1] this parameter is not active in PN7150: it can be read/written, but PN7150 will always behave with empty Higher Layer – Response field in the ATTRIB response, whatever the value written by the DH to that parameter.

7.2 T3T card emulation through NFC-F

7.2.1 Configuring the T3T card emulation

As described in the NFC specification, several Listen F parameters exist to set up T3T with NCI commands.

Table 69. Values to configure the T3T on DH

ID	Length	Values and description
LF_T3T_MAX	1 byte	0 – 16, defines the maximum amount of LF_T3T_IDENTIFIERS supported by the NFCC. PN7150 supports four maximum.
LF_T3T_IDENTIFIERS_1 - 4	10 bytes	Bytes 0 and 1 define the SC to be used by the T3T. Bytes 2 – 10 define the NFCID2 value to be used.

7.2.2 Access through the Frame RF Interface

The Frame RF interface allows emulating a T3T card, assuming that the DH is able to manage the T3T protocol on its own.

Here are the commands and configuration parameters to prepare the T3T Card Emulation for technology NFC-F through the Frame RF Interface:

Table 70. Configuration seq. for ISO-DEP/NFC-A Card Emulation in the DH over Frame RF Interface

Command	Main Parameters	Values
RF_DISCOVER_MAP_CMD *	RF Protocol	PROTOCOL_T3T
	Mode	Listen
	RF Interface	Frame
CORE_SET_CONFIG_CMD	LF_T3T_MAX LF_T3T_IDENTIFIERS_X	See above, used to set SC, NFCID2
RF_DISCOVER_CMD	RF Technology & Mode	NFC_F_PASSIVE_LISTEN_MODE

* Note : RF_DISCOVER_MAP_CMD is optional since the mapping to Frame RF Intf. is done by default

8. P2P Initiator & Target Mode

8.1 P2P Passive mode

[NCI] defines all the mechanisms necessary to implement this feature. Two options are possible:

1. The DH wants to manage by itself the NFC-DEP protocol; it SHALL then map the NFC-DEP protocol on the Frame RF Interface.

   ! Not supported in PN7150

2. The DH leaves the NFC-DEP protocol management to the NFCC: it SHALL then map the NFC-DEP protocol on the NFC-DEP interface.

The NFC-DEP RF interface allows the DH to emulate an NFC-DEP Target or Initiator in P2P Passive, leaving up to the PN7150 to manage the NFC-DEP protocol.

Here are the commands and configuration parameters to prepare the NFC-DEP Target in P2P Passive hosted by the DH, for technologies NFC-A and NFC-F, through the NFC-DEP RF Interface:

Table 71. Config. seq. of NFC-DEP/NFC-A&F Passive Target over NFC-DEP RF Intf

Command	Main Parameters	Values
RF_DISCOVER_MAP_CMD	RF Protocol	PROTOCOL_NFC-DEP
	Mode	Listen
	RF Interface	NFC-DEP
CORE_SET_CONFIG_CMD	LA_BIT_FRAME_SDD	
	LA_PLATFORM_CONFIG	
	LA_SEL_INFO	
	LA_NFCID1	
	LF_CON_BITR_F	
	LF_PROTOCOL_TYPE	
	LN_WT	
	LF_ADV_FEAT[1]	
	LN_ATR_RES_GEN_BYTES	
	LN_ATR_RES_CONFIG	
RF_DISCOVER_CMD	RF Technology & Mode	NFC_A_PASSIVE_LISTEN_MODE
	RF Technology & Mode	NFC_F_PASSIVE_LISTEN_MODE

[1] this parameter is not supported in PN7150

Here are the commands and configuration parameters to prepare the NFC-DEP Initiator for technologies NFC-A and NFC-F in the DH through the Frame RF Interface:

Table 72. Config. seq. of NFC-DEP/NFC-A&F Passive Initiator over NFC-DEP RF Intf

Command	Main Parameters	Values
RF_DISCOVER_MAP_CMD	RF Protocol	PROTOCOL_NFC-DEP
	Mode	Poll
	RF Interface	NFC-DEP
CORE_SET_CONFIG_CMD	PA_BAIL_OUT	
	PF_BIT_RATE	
	PF_RC_CODE	
	PN_NFC_DEP_SPEED	
	PN_ATR_REQ_GEN_BYTES	
	PN_ATR_REQ_CONFIG	
RF_DISCOVER_CMD	RF Technology & Mode	NFC_A_PASSIVE_POLL_MODE
	RF Technology & Mode	NFC_F_PASSIVE_POLL_MODE

8.2 P2P Active mode

All P2P active modes are supported (Initiator for NFC-A & NFC-F and Target for NFC-A & NFC-F).

As for the P2P Passive mode, the PN7150 allow access to P2P Active mode through the NFC-DEP RF Interface, the Frame RF Interface implemented in PN7150 not supporting the NFC-DEP protocol.

The NFC-DEP RF interface allows the DH to emulate an NFC-DEP Target or Initiator in P2P Active, leaving up to the NFCC to manage the NFC-DEP protocol.

Here are the commands and configuration parameters to prepare the NFC-DEP Target in P2P Active hosted by the DH, for technologies NFC-A and NFC-F, through the NFC-DEP RF Interface:

Table 73. Config. seq. of NFC-DEP/NFC-A&F Active Target over NFC-DEP RF Intf

Command	Main Parameters	Values
RF_DISCOVER_MAP_CMD	RF Protocol	PROTOCOL_NFC-DEP
	Mode	Listen
	RF Interface	NFC-DEP
CORE_SET_CONFIG_CMD	LA_BIT_FRAME_SDD	
	LA_PLATFORM_CONFIG	
	LA_SEL_INFO	
	LA_NFCID1	
	LF_CON_BITR_F	
	LF_PROTOCOL_TYPE	
	LN_WT	
	LN_ATR_RES_GEN_BYTES	
	LN_ATR_RES_CONFIG	

Command	Main Parameters	Values
RF_DISCOVER_CMD	RF Technology & Mode	NFC_A_ACTIVE_LISTEN_MODE
	RF Technology & Mode	NFC_F_ACTIVE_LISTEN_MODE

Here are the commands and configuration parameters to prepare the NFC-DEP Initiator for technologies NFC-A and NFC-F in the DH through the Frame RF Interface:

Table 74. Config. seq. of NFC-DEP/NFC-A&F Active Initiator over NFC-DEP RF Intf

Command	Main Parameters	Values
RF_DISCOVER_MAP_CMD	RF Protocol	PROTOCOL_NFC-DEP
	Mode	Poll
	RF Interface	NFC-DEP
CORE_SET_CONFIG_CMD	PA_BAIL_OUT	
	PF_BIT_RATE	
	PN_NFC_DEP_SPEED	
	PN_ATR_REQ_GEN_BYTES	
	PN_ATR_REQ_CONFIG	
RF_DISCOVER_CMD	RF Technology & Mode	NFC_A_ACTIVE_POLL_MODE
	RF Technology & Mode	NFC_F_ACTIVE_POLL_MODE

8.3 Presence check command

As already described in →6.3.3, the PN7150 comes with a proprietary function to allow the DH knowing if the Tag/Card is still present or not. The command description in →6.3.3 also applies in Initiator mode (Active or Passive).

8.4 WTX notification

As already described in →6.3.5, the PN7150 comes with a proprietary notification WTX which indicates that peers are in phase of exchanging RTOX REQ/RESP (NFC DEP equivalent of WTX in ISO DEP) for the configured period of time. The notification description in →6.3.5 also applies in Initiator mode (Active or Passive).

9. RF Discovery Management

9.1 RF Discovery functionalities

This contains the overall RF Discovery concepts applied in PN7150. [NCI] defines the general RF state machine allowing the NFC controller to discover either cards or readers or peers. This RF state machine contains a state called RFST_DISCOVERY where the RF Discovery profile is applied.

In order to ensure standard compliance, the PN7150 supports 2 different RF discovery profiles:

- NFC FORUM profile: implementation of the NFC FORUM polling activity,
  - Either limited to the current technologies defined in this standardization body (NFC-A, NFC-B, NFC-F and P2P passive).
  - Or extended with the additional technologies supported by PN7150, i.e. P2P Active and ISO15693. PN7150 also offers the possibility to extend this profile by polling for both NFC-F 424 and NFC-F 212.
- EMVCo profile: mode allowing the PN7150 to be compliant to the EMVCo polling activity.

In addition to these RF profiles, the PN7150 offers a way to limit the power consumption by applying a tag detector concept. The tag detector can be seen as a precondition to enable a dedicated profile. It means that if the tag detector is triggered, the default profile is automatically started.

Note that [NCI] defines the TOTAL_DURATION of the discovery period independently of the reader phases applied. To simplify the implementation, for the PN7150 it has been decided to apply a timer only during the Listen/pause phase. So depending on the polling phase configuration (1 technology or more), the total duration will vary a bit. This is considered as acceptable and agreed by the NCI task Force in the NFC FORUM.

The following drawing shows the [PN7150-NCI] RF state machine. It differs from [NCI] only by the additions in red.

Here are these additions:

- ✓ A loop-back transition on state *RFST_POLL_ACTIVE*, corresponding to the *RF_PRES_CHECK_CMD* which can be sent by the DH to know if the Card/PICC is still in the field. See the command description in chapter →6.3.3.
- ✓ A new status code used on the *CORE_GENERIC_ERROR_NTF* loop-back transition on state *RFST_DISCOVERY*: this new status code is used when PN7150 is configured to behave as an EMVCo PCD, and it detects collision. See →9.5.1.2 for more details.
- ✓ A new transition from *RFST_POLL_ACTIVE* to *RFST_DISCOVERY*: this transition is triggered by PN7150, when it is configured to behave as an EMVCo PCD and it detects that the RF communication with the PICC is broken. See →9.5.1.2

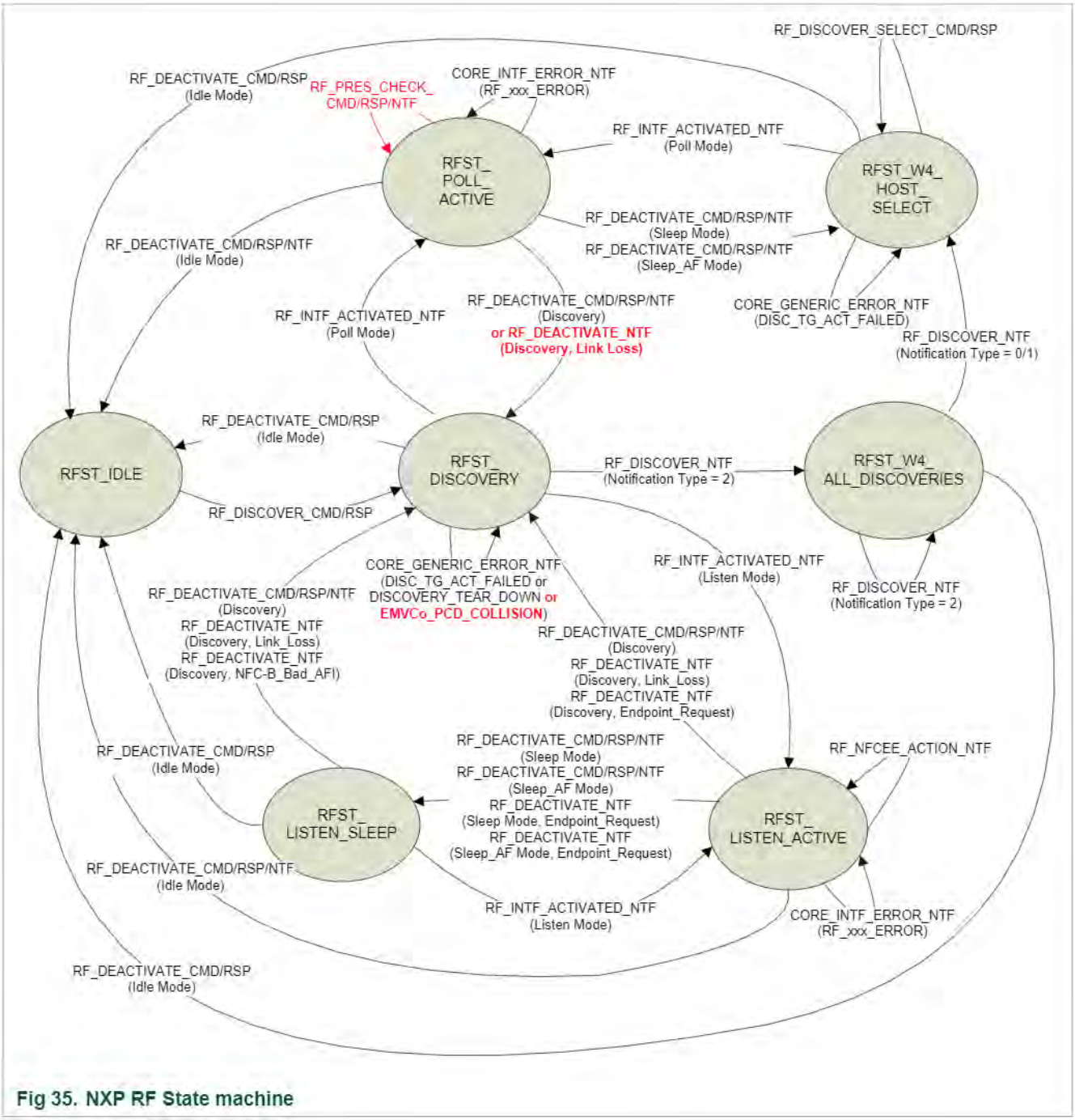

Fig 35. NXP RF State machine

Since the [NCI] RF State Machine is quite complex, it is presented slightly differently in Annex A of the present document: the State Machine is drawn depending on the RF interface to be used. See chapter →13 for further details.

! Since PN7150 does not support Listen Mode using the Frame RF Interface, it does not accept the RF_DEACTIVATE_CMD(Sleep Mode) or

RF_DEACTIVATE_CMD(Discovery) in RFST_LISTEN_ACTIVE or RFST_LISTEN_SLEEP.

9.2 NFC FORUM Profile as defined in [NCI]

The NFC FORUM profile is the implementation of the RF discovery activity as defined in the NFC FORUM (see [ACTIVITY] specification). [NCI] only covers technologies NFC-A, NFC-B & NFC-F. So the basic NFC FORUM profile will poll for these technologies only. Furthermore, for NFC-F, only one bit rate is used during the polling phase. This is configured thanks to the "Poll F parameter" *PF_BIT_RATE* as defined in [NCI], section →6.1.4. So the DH configures if NFC-F is polled at 212kbps or at 424kbps, before it activates the discovery by sending the *RF_DISCOVER_CMD* command.

The figure bellow represents the profile defined by the NFC FORUM, assuming that the DH has enabled the 3 technologies currently supported by the NFC FORUM (NFC-A, NFC-B, NFC-F) in Poll mode & Listen mode. To do so, it has to send the following command:

```
RF_DISCOVER_CMD(    6,
                    [NFC_A_PASSIVE_POLL_MODE,1],
                    [NFC_B_PASSIVE_POLL_MODE,1],
                    [NFC_F_PASSIVE_POLL_MODE,1],
                    [NFC_A_PASSIVE_LISTEN_MODE,1],
                    [NFC_B_PASSIVE_LISTEN_MODE,1],
                    [NFC_F_PASSIVE_LISTEN_MODE,1] )
```

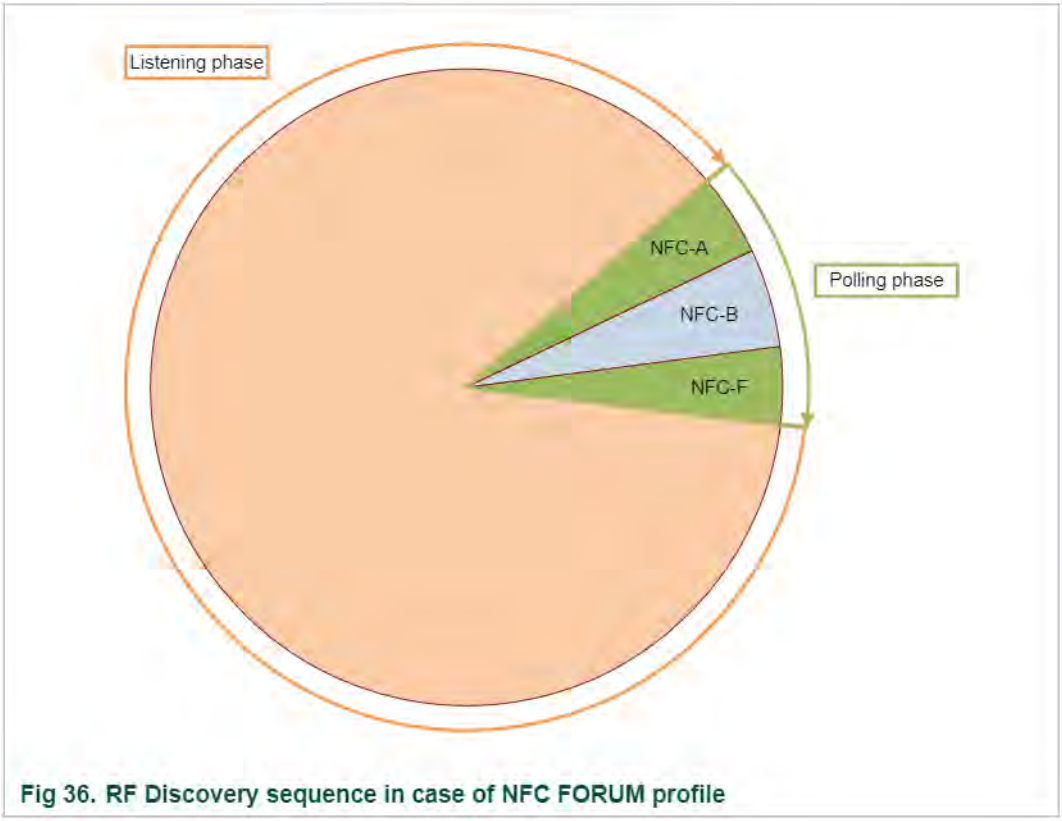

Fig 36. RF Discovery sequence in case of NFC FORUM profile

9.3 [PN7150-NCI] extension: additional technologies not yet supported by the NFC FORUM

PN7150 supports more technologies than currently supported by the NFC FORUM specifications: P2P Active, ISO15693 VCD and KOVIO Reader.

Furthermore, PN7150 offers an additional proprietary value for the configuration parameter PF_BIT_RATE, which allows configuring for both 212 kbps & 424 kbps to be polled in NFC-F in Passive Mode.

Thanks to the *RF_DISCOVER_CMD* and the *PF_BIT_RATE*, the DH has full flexibility to extend the default RF Discovery profile as currently defined in the [NCI] specification. Here is an example how the DH can enable all technologies available in PN7150, for both Poll & Listen Mode:

1. The DH sets PF_BIT_RATE to 0x80, such that the PN7150 polls for 212 & 424 kbps in technology F PASSIVE.

```
CORE_SET_CONFIG_CMD(    NbrParam = 0x01,
                        ID = 0x18,
                        Length = 0x01,
                        Val = 0x80 )
```

2. The DH enables all technologies & modes available in PN7150:

```
RF_DISCOVER_CMD(    11,
                    [NFC_A_PASSIVE_POLL_MODE,1],
                    [NFC_B_PASSIVE_POLL_MODE,1],
                    [NFC_F_PASSIVE_POLL_MODE,1],
                    [NFC_15693_PASSIVE_POLL_MODE,1],
                    [NFC_KOVIO_POLL_MODE,1],
                    [NFC_A_ACTIVE_POLL_MODE*,1],
                    [NFC_A_PASSIVE_LISTEN_MODE,1],
                    [NFC_B_PASSIVE_LISTEN_MODE,1],
                    [NFC_F_PASSIVE_LISTEN_MODE,1],
                    [NFC_A_ACTIVE_LISTEN_MODE,1],
                    [NFC_F_ACTIVE_LISTEN_MODE,1]
                )
```

* *NCI_DISCOVERY_TYPE_POLL_F_ACTIVE is not allowed, see →4.2.4.*

The resulting RF discovery is drawn below (note that KOVIO does not have a specific Poll Phase, since it is based on a Response only, as described in →6.5):

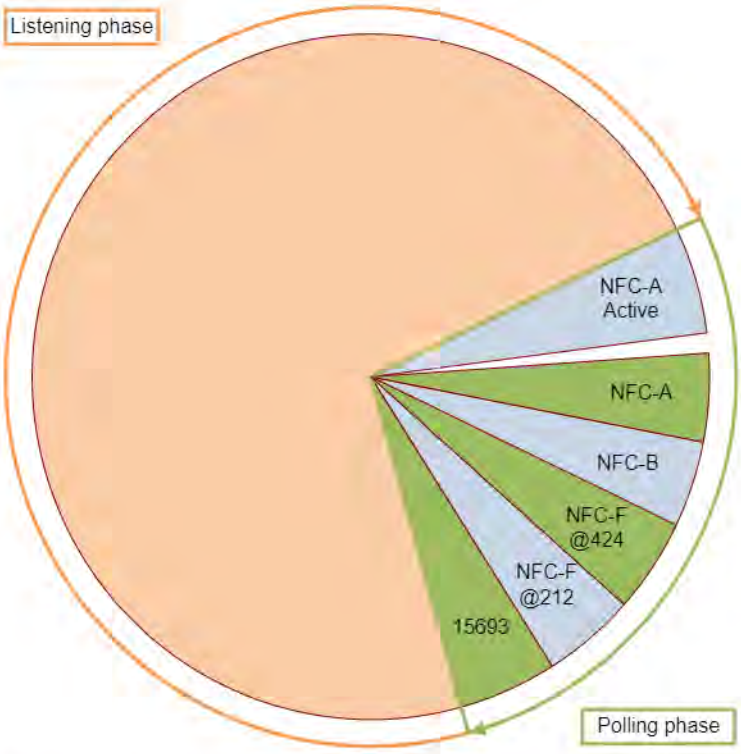

Fig 37. RF Discovery sequence in case of NFC FORUM+ profile

Note: the transition from the Poll NFC-A Active phase to the Poll NFC-A (passive) is done through an RF field off/on sequence.

For more details concerning the different phases duration, guard time, Bailout, please refer to the configuration section (chapter →10.2) where all these parameters are defined.

9.4 [PN7150-NCI] extension: Low Power Card Detector (LPCD) Mode

9.4.1 Description

The Low Power Card Detector is an NXP proprietary extension, which can be used by the DH to reduce the power consumption.

The concept is to avoid using the Technology Detection Activity as defined in [ACTIVITY], which implies to generate an RF Field for several tens of milliseconds and to send technology specific request commands to see if there is a Card/Tag in the field to respond. The more technologies the PN7150 is configured to detect, the longer the RF Field is generated and the higher the current consumption.

The LPCD is based on another concept, which only relies on the antenna characteristics, not on valid responses from a Card/Tag. Indeed, the antenna impedance is influenced by the Card/tag which may enter into its proximity, due to the magnetic coupling between the

2 antennas. The LPCD is therefore monitoring the antenna impedance, to see if there is a significant variation which is interpreted as being caused by a Card/Tag being in proximity.

To achieve that, the LPCD periodically generates very short pulses of RF Field, without any modulation, and measures some antenna characteristics during this pulse. The time between these RF pulses is defined by the *TOTAL_DURATION* parameter, as specified for the RF Discovery in [NCI].

When a Card/Tag enters the field, there is an antenna impedance variation. If this variation is higher than a pre-defined threshold, the NFC FORUM polling loop profile is automatically started (the LPCD is not supported when using EMVCo polling loop profile). The PN7150 is then sending technology specific request commands, expecting a response since the LPCD detected a change on the antenna impedance.

Note: the LPCD may also be triggered by a metal object, which can influence the Antenna impedance in a similar way as a Card/Tag. The PN7150 will anyhow detect that this object is not a contactless device since it immediately starts sending contactless commands to check if a Card/Tag can respond.

The Low Power Card Detector is configured and enabled/disabled thanks to a specific configuration parameter *TAG_DETECTOR_CFG* described in →10.2.1.

The threshold is also defined by an additional configuration parameter *TAG_DETECTOR_THRESHOLD_CFG* described in the same section.

The figure below describes the RF Discovery when the LPCD is enabled:

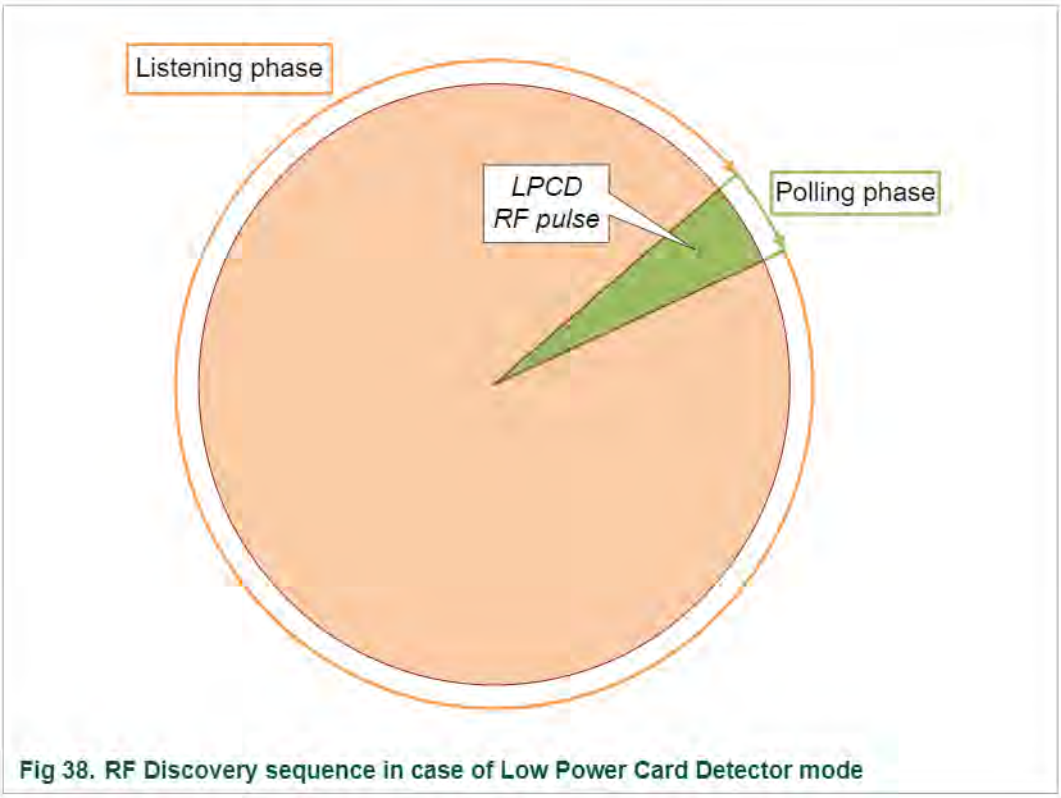

Fig 38. RF Discovery sequence in case of Low Power Card Detector mode

The figure below compares the RF Discovery with the LPCD disabled to the RF Discovery with the LPCD enabled and highlights the impact on the average current consumption (the assumption being here that *TOTAL_DURATION* ~ 300ms):

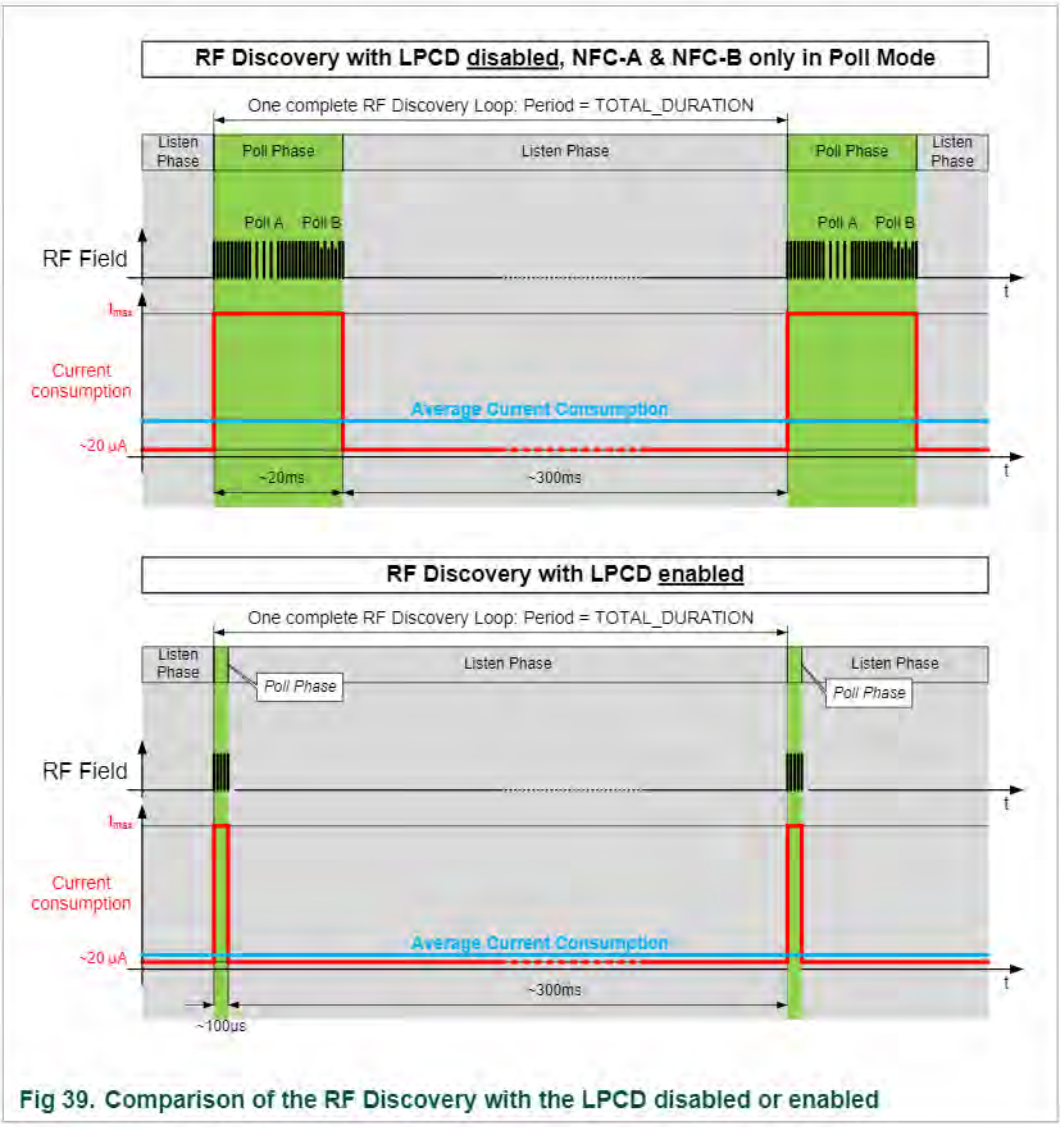

Fig 39. Comparison of the RF Discovery with the LPCD disabled or enabled

A specific application note explains how to properly configure and optimize this LPCD in a given application. See [AN 11757].

9.4.2 Configuration of the Technology Detection Activity when the LPCD has detected an "object"

As described in the previous chapter, once the PN7150 detects a change in the antenna impedance, it performs a Technology Detection as defined in [ACTIVITY] which tries to activate the "object" by sending Request Commands from the different technologies configured for the RF Discovery.

In order to improve the likelihood to catch such a Card/Tag, the PN7150 comes with a retry mechanism which performs several Technology Detection polling cycles before it switches back to LPCD.

During this retry mechanism, a temporary period is used, called *TechDet_PERIOD*. This is specified in steps of 10ms. The number of the retry cycles can also be configured thanks to the *TechDet_NBR_RETRIES* parameter.

Table 75. Parameters used to configure the overall period of the RF Discovery:

LPCD Status	Period between 2 consecutive Technology Detections	Period between 2 consecutive LPCD RF pulses
Enabled	*TechDet_PERIOD*	*TOTAL_DURATION*
Disabled	*TOTAL_DURATION*	Not applicable

The next figure illustrates how these 3 parameters *TOTAL_DURATION*, *TechDet_PERIOD* and *TechDet_NBR_RETRIES* influence the Low Power Card Detector and the RF Discovery:

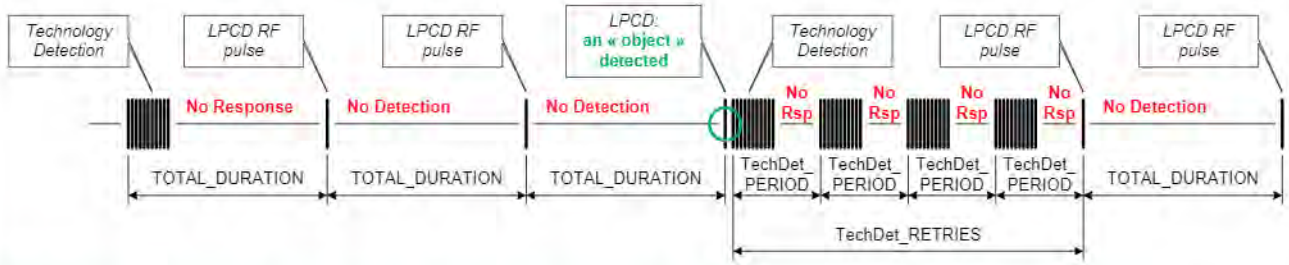

Fig 40. Illustration of the Low Power Card detector and the subsequent Technology Detection cycles

See →10.2.1 for the description of the configuration parameter *TechDet_AFTER_LPCD_CFG* containing the 2 parameters *TechDet_PERIOD* and *TechDet_NBR_RETRIES*.

9.4.3 Notification when the Trace Mode is enabled

The Low Power Card Detector needs to be tuned in each application; it is therefore useful to get some information from PN7150 so that the Low Power Card Detector can be appropriately configured.

The Low Power Card Detector can be configured to enable a Trace Mode, where the following Notification will be sent to the DH by PN7150:

Table 76. RF_LPCD_TRACE_NTF

GID	OID	Numbers of parameter(s)	Description
1111b	0x13	2	PN7150 sends the actual measurement + the threshold

Table 77. RF_LPCD_TRACE_NTF parameters

Payload Field(s)	Length	Value/Description
Reference Value	2 Octets	Reference Value used by Low Power Card Detector function to compare with the measurement value. Coding is little Endian.
Measurement Value	2 Octets	Value measured on the AGC. Coding is little Endian.

9.5 [PN7150-NCI] extension: EMVCo Profile in Poll & Listen Modes

The EMVCo profiles are introduced in PN7150 for EMVCo compliancy. Indeed there are incompatibilities between the RF Discovery activity as defined in the NFC FORUM and the RF discovery defined in EMVCo standard.

9.5.1 EMVCo profile in Poll Mode

9.5.1.1 Configuring PN7150 to implement the EMVCo polling loop profile

To be compliant to the EMVCo certification tests, the RF Discovery has to be configured so that only NFC-A and NFC-B are supported in Poll phase and so that there is no Listen phase. So the DH has to send the following command:

```
RF_DISCOVER_CMD(    2,
                    [NCI_DISCOVERY_TYPE_POLL_A_PASSIVE,1],
                    [NCI_DISCOVERY_TYPE_POLL_B_PASSIVE,1])
```

In addition, PN7150 needs to be aware of the fact that it has to behave according to the EMVCo RF discovery, not according to the NFC FORUM RF discovery based on [ACTIVITY]. A specific configuration parameter *POLL_PROFILE_SEL_CFG* (see 10.2.1) is defined for that purpose, allowing to select the active profile of the RF discovery in Poll Mode. When this parameter is set to 0x01, PN7150 implements a specific discovery algorithm, compliant to the EMVCo standard. The target is to ensure that there is one single card in the field. So PN7150 has to detect any collision inside 1 technology (NFC-A or NFC-B) or to detect if there are multiple cards based on different technologies (i.e. 1 card in NFC-A and 1 card in NFC-B).

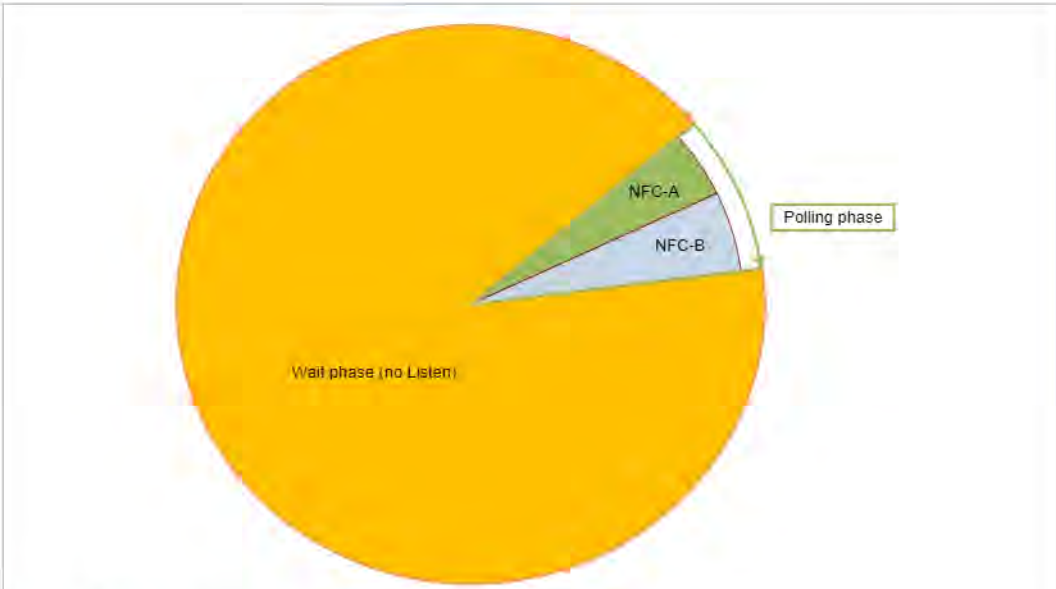

Fig 41. RF Discovery sequence in case of EMVCo profile

If there is a card detected in the field, then the polling sequence is modified by the PN7150, in order to look for another potential card in the field.
This is illustrated by the 2 figures below:

- On the 1st one, there is no card in the RF Field, so PN7150 keeps polling by alternating WUPA & WUPB commands.

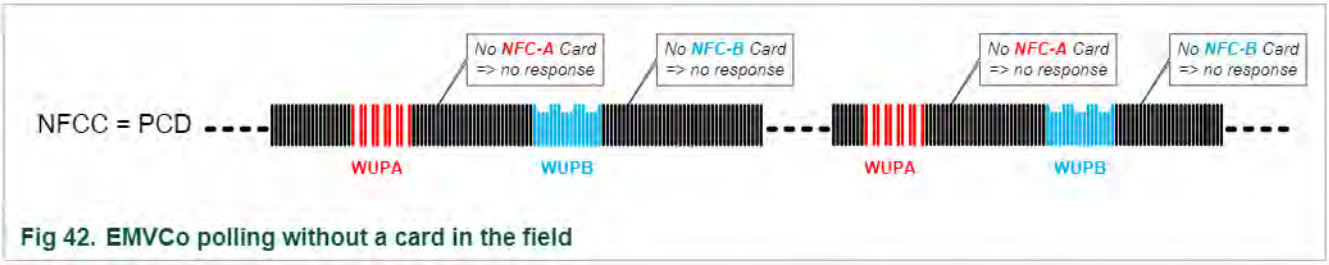

Fig 42. EMVCo polling without a card in the field

- On the 2nd one, an NFC-A card is placed in the RF Field. The PN7150 detects it, activates it and puts it in HALT state and then looks for a potential NFC-B card in the field. Since there is no NFC-B card in the field, the PN7150 activates the NFC-A card again, then the PN7150 activates the ISO-DEP interface and the DH can start to exchange data with the NFC-A card to proceed with the payment application.

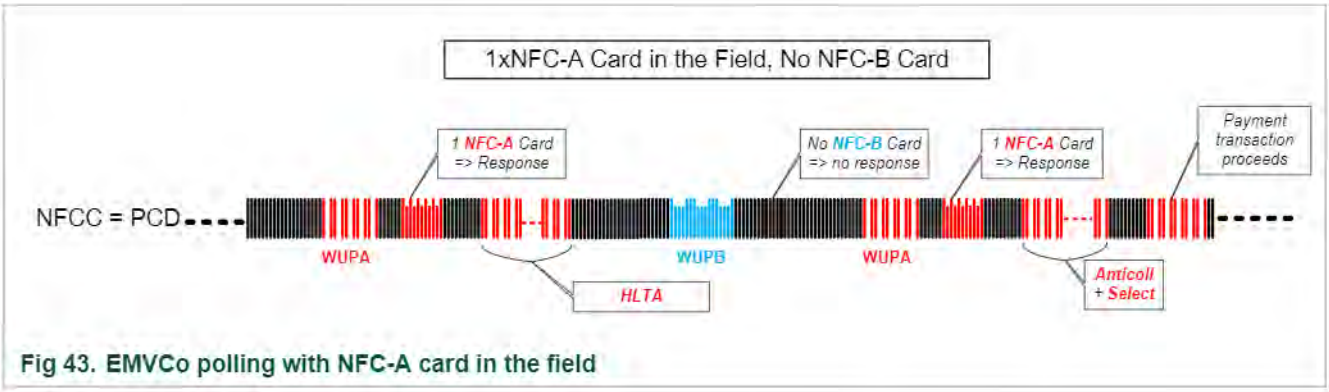

Fig 43. EMVCo polling with NFC-A card in the field

> ! In PN7150 the Low Power Card Detector is automatically disabled when the EMVCo profile is enabled, since these 2 features are conflicting if simultaneously enabled.

9.5.1.2 Notification for RF technology collision

When the EMVCo polling loop profile is activated, PN7150 will activate the ISO-DEP RF Interface through *RF_INTF_ACTIVATED_NTF* only when there is 1 single card in the field, whatever the technology (NFC-A or NFC-B).

When PN7150 detects a collision on RF (either in one technology or between technologies), it will report a special Status in the *CORE_GENERIC_ERROR_NTF*: *STATUS_EMVCo_PCD_COLLISION*. The current state will remain *RFST_DISCOVERY*, as graphically described in Fig 35. The identifier of this proprietary Status is defined in →0.Note that if the cards remain in the RF Field, PN7150 will keep sending the *CORE_GENERIC_ERROR_NTF* with status *STATUS_EMVCo_PCD_COLLISION* at each polling loop: this can be used as a presence check mechanism.

When the EMVCo profile for Poll Mode is activated and PN7150 has detected a single PICC (i.e. no collision) but it is unable to properly activate this PICC, then PN7150 will send a *CORE_GENERIC_ERROR_NTF* with status *DISCOVERY_TARGET_ACTIVATION_FAILED* as defined in [NCI].

9.5.1.3 Modification of the NCI RF State Machine in case of failure during data exchange

When the EMVCo profile for Poll Mode is activated, the PN7150 has to comply with tight timings verified during the EMVCo PCD certification. In case the RF link with the PICC is broken, the regular way to behave according to NCI is that the PN7150 will detect a time-out or an unrecoverable protocol error and send then a *CORE_INTERFACE_ERROR_NTF* with the appropriate status. It is then up to the DH to stop the RF Discovery with *RF_DEACTIVATE_CMD*(*IDLE*) and to restart the RF Discovery with *RF_DISCOVER_CMD*. Unfortunately, the time required to execute this sequence is highly dependent on the DH latency and it is often not possible to match the timings expected and checked by the EMVCo PCD certification.

To solve this issue, NXP has decided to add a transition from the *RFST_POLL_ACTIVE* to *RFST_DISCOVERY*, triggered by the sending of the

RF_DEACTIVATE_NTF(Discovery, Link Loss). In such a way, when PN7150 has detected a timeout or an unrecoverable protocol error during the RF communication with the PICC, it will autonomously come back to *RFST_DISCOVERY*, switching off the RF Field, as requested by EMVCo and then restarting the Polling phase in a timely manner, as requested by EVMCo.

This new transition is graphically described in Fig 35.

9.5.2 EMVCo profile in Listen Mode

To be compliant to the EMVCo certification tests emulating an EMVCo PICC, PN7150 has to behave as a single PICC based on either technology NFC-A or NFC-B.

In order to solve this issue, PN7150 comes with a specific configuration parameter: *LISTEN_PROFILE_SEL_CFG*, detailed in section →10.2.2.

Thanks to this parameter, a specific EMVCo PICC profile can be activated such that PN7150 will "hide" the non-yet-selected technology to the EMVCo PCD. Once this parameter is activated, the PICC selection sequence is as follows (assuming NFC-A is selected first):

- Once NFC-A has been selected by the PCD through the REQA command, PN7150 disables the NFC-B card emulation so that the REQB command sent later on by the EMVCo PCD gets no answer.
- The payment transaction can then successfully go through based on technology NFC-A.
- PN7150 waits then for an RF Field off/on sequence before enabling the non-selected technology (NFC-B) again.

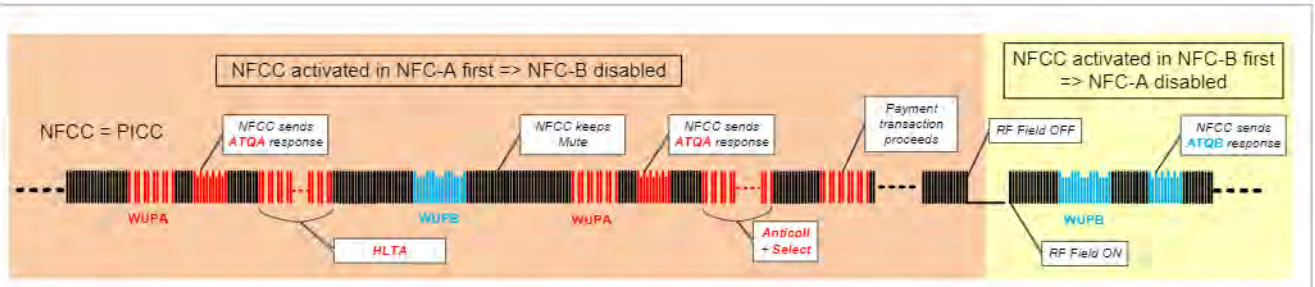

Fig 44. EMVCo Listen with first NFC-A activated by the PCD then NFC-B activated, after field off/on sequence

9.6 [PN7150-NCI] extension: Power optimization

PN7150 offers a standby mode, which can be activated together with the RF Discovery, such that the overall power consumption is significantly reduced.

One dedicated proprietary function is added to enable/disable this standby mode: *CORE_SET_POWER_MODE*.

9.6.1 CORE_SET_POWER_MODE Command/Response

> ! The Standby Mode is enabled by default. Given the very strong impact on the power consumption, disabling the Standby Mode should be restricted to debug sessions.

Table 78. CORE_SET_POWER_MODE_CMD

GID	OID	Numbers of parameter(s)	Description
1111b	0x00	1	Command to request the PN7150 to enable/disable the Standby Mode

Table 79. CORE_SET_POWER_MODE_CMD parameter

Payload Field(s)	Length	Value/Description	
Mode	1 Octet	0x00	Standby Mode disabled
		0x01	Standby Mode enabled
		0x03-0xFF	RFU

Table 80. CORE_SET_POWER_MODE_RSP

GID	OID	Numbers of parameter(s)	Description
1111b	0x00	1	Response to inform the DH of the status of the CORE_SET_POWER_MODE_CMD.

Table 81. CORE_SET_POWER_MODE_RSP parameter

Payload Field(s)	Length	Value/Description	
Status	1 Octet	0x00	STATUS_OK
		0x06	STATUS_SEMANTIC_ERROR
		0x09	STATUS_INVALID_PARAM
		Others	Forbidden

9.6.2 Standby wake-up

The PN7150 wakes-up from standby when one of the following event occurs:

- Regular polling-loop starts. When the DH has served the PN7150 with a *NCI_RF_DISCOVER_CMD* command, the PN7150 enters into the standby mode and automatically leave the low power mode after the period defined by *TOTAL_DURATION*.
- RF level detector triggered. An external field has been introduced in the NFC volume during the standby period of the polling loop and at least one listen phase has been requested by the *NCI_DISCOVER_CMD*.
- Host interface activity detected. See →3.3 section.

10. Configurations

! When the DH needs to update the value of the parameters described hereafter, it shall send a *CORE_RESET_CMD*/*CORE_INIT_CMD* sequence after the *CORE_SET_CONFIG_CMD*, to ensure that the new value is used for the parameters.

If numerous parameters are updated thanks to multiple *CORE_SET_CONFIG_CMD* commands, a single *CORE_RESET_CMD*/*CORE_INIT_CMD* sequence is enough after the last *CORE_SET_CONFIG_CMD*.

! Any *CORE_SET_CONFIG_CMD* to one of the following parameters or to the [NCI] standard parameters will trigger an EEPROM write cycle. Since the PN7150 EEPROM has a limited number of Erase/Write cycles (300 000), it is highly recommended to only use the *CORE_SET_CONFIG_CMD* during the NCI initialization sequence.

10.1 [PN7150-NCI] extension: System configurations

PN7150 offers several parameters used to configure the system aspects.

Table 82. Core configuration parameters

Name & Rights	Description	Ext. Tag	Len.	Default Value
CLOCK_REQUEST_CFG ***RW in E²PROM***	Indicates how the clock is requested to the DH by the PN7150. 0x00: Clock Request is disabled 0x01: Hardware-based Clock Request is enabled: CLKREQ pin set to high when clock requested, otherwise it is set to hi-Z (High Impedance). 0x02-0xFF: RFU	0xA0 0x02	1	0x01

<table>
<tr><th>Name & Rights</th><th>Description</th><th>Ext. Tag</th><th>Len.</th><th>Default Value</th></tr>
<tr><td>CLOCK_SEL_CFG
RW in E²PROM</td><td>Input Clock selection & configuration for the internal 13.56MHz CLOCK
<table>
<tr><th>Bits [4:3]</th><th>Clk Source</th><th>Description</th></tr>
<tr><td>01b</td><td>XTAL</td><td>A 27.12MHz quartz has to be connected to PN7150</td></tr>
<tr><td>10b</td><td>PLL</td><td>A clean clock signal has to be directly provided on the Clock pad (bits [2:0] have to be configured in addition to specify the clock value, see the table below)</td></tr>
<tr><td>11b</td><td>RFU</td><td></td></tr>
<tr><td>00b</td><td>RFU</td><td></td></tr>
</table>
When the PLL is used, the bits [2:0] have to be configured according to the following table, depending on the clock provided to PN7150
<table>
<tr><th>Bits [2:0]</th><th>Clk In</th></tr>
<tr><td>000b</td><td>13.0 MHz</td></tr>
<tr><td>001b</td><td>19.2 MHz</td></tr>
<tr><td>010b</td><td>24 MHz</td></tr>
<tr><td>011b</td><td>26.0 MHz</td></tr>
<tr><td>100b</td><td>38.4 MHz</td></tr>
<tr><td>101b</td><td>52 MHz</td></tr>
<tr><td>110b-111b</td><td>RFU</td></tr>
</table></td><td>0xA0 0x03</td><td>1</td><td>0x08</td></tr>
<tr><td>CLOCK_TO_CFG
RW in E²PROM</td><td>Indicates the timeout value to be used for clock request acknowledgment (from 1.53ms to 10 ms in steps of 330µs).
So the actual Time Out value (in µs) is given by the following formula:TimeOut (µs) = 1200 + (CLOCK_TO_CFG)*330
Minimum value is 01. Value 0x00 SHALL NOT be used, otherwise there is no timeout (no wait time). In this case the PLL is started immediately without waiting for the external sys_clock.
Maximum value to be used is 0x06, to ensure the NFCC is ready to reply 5ms after an external field on.</td><td>0xA0 0x04</td><td>1</td><td>0x01</td></tr>
</table>

<table>
<tr><th>Name & Rights</th><th>Description</th><th>Ext. Tag</th><th>Len.</th><th>Default Value</th></tr>
<tr><td>IRQ_POLARITY_CFG
RW in E²PROM</td><td>Configuration of the IRQ pin polarity
<table>
<tr><th colspan="8">Bit Mask</th><th>Description</th></tr>
<tr><td>b7</td><td>b6</td><td>b5</td><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td>b0</td><td></td></tr>
<tr><td></td><td></td><td></td><td>X</td><td></td><td></td><td></td><td></td><td>I²C transport fragmentation
'1' => enabled,
'0'=> disabled</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td><td>IRQ PIN polarity config.</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td></td><td>0</td><td>0</td><td></td><td>0</td><td>All these bits SHALL be set to logical '0' (RFU)</td></tr>
</table>
b1='0' => PN7150 requests to transmit when IRQ pin = '1'.
b1='1' => PN7150 requests to transmit when IRQ pin = '0'.</td><td>0xA0 0x05</td><td>1</td><td>0x00</td></tr>
<tr><td>VBAT_MONITOR_EN_CFG
RW in E²PROM</td><td>To Enable/Disable the Battery monitor & configure the Threshold
<table>
<tr><th colspan="8">Bit Mask</th><th>Description</th></tr>
<tr><td>b7</td><td>b6</td><td>b5</td><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td>b0</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td>Vbat Monitor Enable</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td><td>Vbat Monitor Threshold</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td></td><td>RFU</td></tr>
</table>
b0: '1' to Enable, '0' to disable.
b1: '1' to set the threshold to 2.3V and '0' to set it to 2.75V.
Note: in NCI_RFST_DISCOVERY state, setting this parameter will be rejected by the NFCC with an INVALID PARAM status '0x09' instead of SEMANTIC ERROR status '0x06'.</td><td>0xA0 0x06</td><td>1</td><td>0x00</td></tr>
<tr><td>VEN_CFG
RW in E²PROM</td><td>Configures the internal VEN signal, in case the VEN pin driver is NOT supplied from PVDD. In such a case, when PVDD is switched OFF, the VEN pin level in unknown, so the internal VEN signal is defined by one bit in an internal register (VEN_Value) while the VEN pin has to be pulled-down (to avoid leakages) thanks to a 2nd bit in the same register (VEN_Pulld) which has then to be set to '1' to activate the Pull Down. These 2 bits can be configured through NCI thanks to VEN_CFG LSbits, according to the following table:
<table>
<tr><th colspan="8">Bit Mask</th><th>Description</th></tr>
<tr><td>b7</td><td>b6</td><td>b5</td><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td>b0</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td>VEN_Value</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td><td>VEN_Pulld</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td></td><td>RFU</td></tr>
</table>
Note, in order to force a certain VEN value to be used internally (no matter which state the external VEN pin level is in) the VEN_Pulld value HAS to be set. Only if VEN_Pulld is set and PVDD is switched off the internal VEN state will be forced to what is specified in VEN_Value.</td><td>0xA0 0x07</td><td>1</td><td>0x03</td></tr>
</table>

<table>
<tr><th>Name & Rights</th><th>Description</th><th>Ext. Tag</th><th>Len.</th><th>Default Value</th></tr>
<tr><td>TO_BEFORE_STDBY_CFG
RW in E²PROM</td><td>Timeout used to wait after last DH-NFCEE communication before going into standby (from 0 to 65.536s in steps of 1ms).
Applies only when the discovery is stopped and standby mode is activated by SET_PWR_MODE_CMD.
Pay attention that the parameter value is defined in little endian (LSB first).</td><td>0xA0 0x09</td><td>2</td><td>0x03E8 (1s)</td></tr>
<tr><td>PAD_SLEW_RATE_CFG
RW in E²PROM</td><td>Parameter used to configure the slew rate of the pads, on a per pad basis:
<table>
<tr><th colspan="8">Bit Mask</th><th>Description</th></tr>
<tr><td>b7</td><td>b6</td><td>b5</td><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td>b0</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td><td>CLK_REQ</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td><td></td><td>IRQ</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td></td><td>0</td><td>RFU</td></tr>
</table>
For each of the pads, '1' => fast slew rate, '0' => slow slew rate.</td><td>0xA0 0x0A</td><td>1</td><td>0x00</td></tr>
<tr><td>RF_TRANSITION_CFG
RW in E²PROM</td><td>TLV parameter to configure the RF transitions: see chapter →10.3</td><td>0xA0 0x0D</td><td></td><td></td></tr>
</table>

<table>
<tr><th>Name & Rights</th><th>Description</th><th>Ext. Tag</th><th>Len.</th><th>Default Value</th></tr>
<tr><td>PMU_CFG
RW in E²PROM</td><td>Configuration of the Power Management Unit (PMU)
Byte 0:
<table>
<tr><th colspan="8">Bit Mask</th><th>Description</th></tr>
<tr><td>b7</td><td>b6</td><td>b5</td><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td>b0</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td><td></td><td>VBAT1 connected to 5V
0 - CFG1, 1 - CFG2</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td>1</td><td>0</td><td>RFU</td></tr>
</table>
Byte 1:
<table>
<tr><th colspan="8">Bit Mask</th><th>Description</th></tr>
<tr><td>b7</td><td>b6</td><td>b5</td><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td>b0</td><td></td></tr>
<tr><td></td><td>X</td><td></td><td></td><td></td><td></td><td></td><td></td><td>TVDD monitoring threshold:
0 - 3.6V (CFG1, CFG2)
1 - 5V (CFG2)</td></tr>
<tr><td></td><td></td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td>TxLDO Voltage in card mode communication:
000: 3V (CFG1, CFG2)
001: 3.3V (CFG1, CFG2)
010: 3.6V (CFG1, CFG2)
011: 4.5V (CFG2)
100: 4.7V (CFG2)</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>TxLDO Voltage in reader mode communication:
000: 3V (CFG1, CFG2)
001: 3.3V (CFG1, CFG2)
010: 3.6V (CFG1, CFG2)
011: 4.5V (CFG2)
100: 4.7V (CFG2)</td></tr>
<tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>RFU</td></tr>
</table>
Byte 2: RFU. Must be 0x00 for CFG1 and 0x01 in CFG2.</td><td>0xA0 0x0E</td><td>3</td><td>0x020900 (CFG1)</td></tr>
<tr><td>DH_EEPROM_AREA_2
RW in E²PROM</td><td>32-Byte EEPROM area dedicated to the DH to store/retrieve non-volatile data. The 32 Bytes have to be read (CORE_GET_CONFIG_CMD) or written (CORE_SET_CONFIG_CMD) is a row: it is not possible to access only a subset of these 32 Bytes.</td><td>0xA0 0x14</td><td>32</td><td></td></tr>
<tr><td>DYN_LMA_SETTINGS_CFG
RW in E²PROM</td><td>Parameter used to Read/write the Configuration as well as the Lookup table for the dynamic LMA feature</td><td>0xA0 0x92</td><td>68</td><td>See Table 84</td></tr>
</table>

Table 83. DYN_LMA_SETTINGS_CFG Description

Bytes	Description	Len.	Default Value
0 … 1	RFU	2	N/A
2	bLutSize: Size of LUT, DO NOT MODIFY this parameter	1	0x10
3	bNbLutEntries: Number of entries in DynLma look up table . bits 0:3 = Number of Entries for Type A/B (0 means LMA disabled for this Type) . bits 4:7 = Number of Entries for Type F (0 means LMA disabled for this Type) The number of entries for Type A/B + Type F shall not exceed the Total number of Entries. The Entries for TypeF follow the ones for Type A/B. This means if number of entries for Type A/B is 8 Entry 8 is the first for TypeF	1	0x00
4	dwLutEntry0: bits 20:18 = TXLDO output voltage: PMU_TXLDO_CONTROL_REG/TXLDO_SELECT bits 17:16 = CLIF_ANA_TX_AMPLITUDE_REG / TX_CW_AMPLITUDE_ALM_CM bit 15 = CLIF_TX_CONTROL_REG / TX_ALM_TYPE_SELECT bits 14:10 = CLIF_ANA_TX_AMPLITUDE_REG / TX_RESIDUAL_CARRIER bits 09:00 = AGC_VALUE	4	0x037C02
…	dwLutEntry…	4	N/A
64 ... 67	dwLutEntryF	4	0x000032

10.2 [PN7150-NCI] extension: RF Discovery configuration

10.2.1 Poll Mode

Several configuration parameters are required for the Poll Mode in RF discovery:

Table 84. Poll Mode configuration

Name & Rights	Description	Ext. Tag	Len.	Default Value
TAG_DETECTOR_CFG ***RW in E²PROM***	Tag detector enabling/disabling as follows: '1' => Enabled; '0' => Disabled	0xA0 0x40	1	0x00
TAG_DETECTOR_ THRESHOLD_CFG ***RW in E²PROM***	Sets the detection level.	0xA0 0x41	1	0x04
TAG_DETECTOR_ PERIOD _CFG ***RW in E²PROM***	Time in steps of 8us to wait before reading the AGC value.	0xA0 0x42	1	0x0F

Bit Mask

b7	b6	b5	b4	b3	b2	b1	b0	Description
							X	Detection based on the AGC
X								Activation of the Trace mode
	0	0	0	0	0	0		RFU

Name & Rights	Description	Ext. Tag	Len.	Default Value
TAG_DETECTOR_FALLBACK_CNT_CFG ***RW in E²PROM***	Parameter used to configure the "Hybrid" mode ton insert a regular Polling cycle every N pulses generated by the LPCD: 0x00: Hybrid mode disabled: LPCD only, no regular Polling cycle unless an "object" is detected by the LPCD. 0x02- 0xFF: Hybrid mode enabled, inserting a regular Polling cycle every 'N' pulses of LPDC. 'N' is coded by the value assigned to *TAG_DETECTOR_FALLBACK_CNT_CFG* in decimal.	0xA0 0x43	1	0x50
POLL_PROFILE_SEL_CFG ***RW in E²PROM***	Discovery profile selection in Poll Mode as follows: 0x00: NFC FORUM profile. All static configurations (Bail-out) will be set to the [NCI] default value (disabled). 0x01: EMVCo profile 0x02- 0xFF: RFU	0xA0 0x44	1	0x00
GT_NFC-AA_CFG ***RW in E²PROM***	Guard time (in steps of 0.59µs) used between the start of unmodulated RF field & 1st command for Poll NFC-A Active (min='0001', max='FFFF')	0xA0 0x46	2	0x21C4 (5.1ms)
GT_NFC-AP_CFG ***RW in E²PROM***	Guard time (in steps of 0.59µs) used between the start of unmodulated RF field & 1st command for Poll NFC-A Passive (min='0001', max='FFFF')	0xA0 0x47	2	0x2219 (5.15ms)
GT_NFC-B_CFG ***RW in E²PROM***	Guard time (in steps of 0.59µs) used between the start of unmodulated RF field & 1st command for Poll NFC-B Passive (min='0001', max='FFFF')	0xA0 0x48	2	0x2219 (5.15ms)
GT_NFC-F_CFG ***RW in E²PROM***	Guard time (in steps of 0.59µs) used between the start of unmodulated RF field & 1st command for Poll NFC-F Passive (min='0001', max='FFFF') Note: If previous phase on polling loop is a FeliCa Poll that fail on Timeout, you will see an additional 5 ms delay due to the FeliCa timeout itself	0xA0 0x49	2	0x878D (20.47ms)
GT_15693_CFG ***RW in E²PROM***	Guard time (in ms) used between the start of unmodulated RF field & 1st command for Poll 15693 Passive (min='0001', max='FFFF')	0xA0 0x4A	2	0x07B8 (1.17ms)
PF_SYS_CODE_CFG ***RW in E²PROM***	Discovery configuration parameters for Poll F: system code	0xA0 0x4C	2	0xFFFF
MFC_KEY-0_CFG ***WO[1] in E²PROM***	Key 0, used in MIFARE Classic Authentication command.	0xA0 0x4D	6	0xA0A1 A2A3 A4A5
MFC_KEY-1_CFG ***WO[1] in E²PROM***	Key 1, used in MIFARE Classic Authentication command.	0xA0 0x4E	6	0xD3F7 D3F7 D3F7
MFC_KEY-2_CFG ***WO[1] in E²PROM***	Key 2, used in MIFARE Classic Authentication command.	0xA0 0x4F	6	0xFFFF FFFF FFFF

Name & Rights	Description	Ext. Tag	Len.	Default Value
MFC_KEY-3_CFG ***WO[1] in E²PROM***	Key 3, used in MIFARE Classic Authentication command.	0xA0 0x50	6	0xFFFF FFFF FFFF
MFC_KEY-4_CFG ***WO[1] in E²PROM***	Key 4, used in MIFARE Classic Authentication command.	0xA0 0x51	6	0xFFFF FFFF FFFF
MFC_KEY-5_CFG ***WO[1] in E²PROM***	Key 5, used in MIFARE Classic Authentication command.	0xA0 0x52	6	0xFFFF FFFF FFFF
MFC_KEY-6_CFG ***WO[1] in E²PROM***	Key 6, used in MIFARE Classic Authentication command.	0xA0 0x53	6	0xFFFF FFFF FFFF
MFC_KEY-7_CFG ***WO[1] in E²PROM***	Key 7, used in MIFARE Classic Authentication command.	0xA0 0x54	6	0xFFFF FFFF FFFF
MFC_KEY-8_CFG ***WO[1] in E²PROM***	Key 8, used in MIFARE Classic Authentication command.	0xA0 0x55	6	0xFFFF FFFF FFFF
MFC_KEY-9_CFG ***WO[1] in E²PROM***	Key 9, used in MIFARE Classic Authentication command.	0xA0 0x56	6	0xFFFF FFFF FFFF
MFC_KEY-10_CFG ***WO[1] in E²PROM***	Key 10, used in MIFARE Classic Authentication command.	0xA0 0x57	6	0xFFFF FFFF FFFF
MFC_KEY-11_CFG ***WO[1] in E²PROM***	Key 11, used in MIFARE Classic Authentication command.	0xA0 0x58	6	0xFFFF FFFF FFFF
MFC_KEY-12_CFG ***WO[1] in E²PROM***	Key 12, used in MIFARE Classic Authentication command.	0xA0 0x59	6	0xFFFF FFFF FFFF
MFC_KEY-13_CFG ***WO[1] in E²PROM***	Key 13, used in MIFARE Classic Authentication command.	0xA0 0x5A	6	0xFFFF FFFF FFFF
MFC_KEY-14_CFG ***WO[1] in E²PROM***	Key 14, used in MIFARE Classic Authentication command.	0xA0 0x5B	6	0xFFFF FFFF FFFF
MFC_KEY-15_CFG ***WO[1] in E²PROM***	Key 15, used in MIFARE Classic Authentication command.	0xA0 0x5C	6	0xFFFF FFFF FFFF
FSDI_CFG ***RW in E²PROM***	Frame Size value for the PN7150 to display in RATS or ATTRIB.	0xA0 0x5D	1	0x08
JEWEL_RID_CFG ***RW in E²PROM***	Parameter used to configure if the RID is sent on RF to the T1T by PN7150 during the RF activation or not: 0x01 => The RID is sent on RF to the T1T 0x00 => The RID is NOT sent on RF to the T1T	0xA0 0x5E	1	0x00

<table>
<tr><th>Name & Rights</th><th>Description</th><th>Ext. Tag</th><th>Len.</th><th>Default Value</th></tr>
<tr><td></td><td>In both cases, the RF_INTF_ACTIVATED_NTF will NOT embed the RID response from the T1T, as defined in [NCI].</td><td></td><td></td><td></td></tr>
<tr><td>FELICA_TSN_CFG
RW in E²PROM</td><td>TSN value transported by the PN7150 in the SENSF_REQ command: the DH defines the number of time slots for collision resolution.
!! This value has to be set to 0x03 for NFC FORUM compliance (DTA/Digital protocol tests) !!</td><td>0xA0 0x5F</td><td>1</td><td>0x00</td></tr>
<tr><td>TechDet_AFTER_LPCD_CFG
RW in E²PROM</td><td>Parameter used to configure the RF Discovery taking place right after the Low Power Card Detector has triggered a detection:
<table>
<tr><th colspan="8">Bit Mask</th><th>Description</th></tr>
<tr><td>b7</td><td>b6</td><td>b5</td><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td>b0</td><td></td></tr>
<tr><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td>TechDet_PERIOD
In steps of 10ms</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>X</td><td>X</td><td>X</td><td>TechDet_NBR_RETRIES</td></tr>
</table>
See →9.4.2 for more details on the use of this parameter.</td><td>0xA0 0x61</td><td>1</td><td>0x00</td></tr>
</table>

[1] WO (Write Only) parameters can only be written, using *CORE_SET_CONFIG_CMD*. PN7150 will always return *CORE_GET_CONFIG_RSP(STATUS_INVALID_PARAM)* to any attempt to read the value of the WO parameter.

10.2.2 Listen Mode

Table 85. Listen Mode Configuration

Name & Rights	Description	Ext. Tag	Len.	Default Value
TO_RF_OFF_CFG ***RW in E²PROM***	Specifies the time out (in ms) applied by PN7150 before it restarts a Polling sequence, after it has detected a Field OFF in Listen Mode	0xA0 0x80	2	0x012C (300 ms)
LISTEN_PROFILE_SEL_CFG ***RW in E²PROM***	Discovery profile selection in Listen Mode, as follows: 0x00 – NFC FORUM profile 0x01 – EMVCo 0x02- 0xFF – RFU	0xA0 0x81	1	0x01
LISTEN_ISODEP_FSCI_CFG ***RW in E²PROM***	Parameter to define the FSC parameter (RF Frame Size for the PICC), as defined in [14443-4]: 0x00 – FSC = 16 0x01 – FSC = 24 0x02 – FSC = 32 0x03 – FSC = 40 0x04 – FSC = 48 0x05 – FSC = 64 0x06 – FSC = 96 0x07 – FSC = 128 0x08 – FSC = 256 0x09- 0xFF – RFU	0xA0 0x83	1	0x08

10.3 [PN7150-NCI] extension: Contactless Interface configurations

PN7150 offers multiple configuration options for the Contactless Interface, to allow an optimum match between the antenna characteristics and the transmitter and receiver in PN7150. A generic TLV mechanism has been defined to write the Contactless Interface settings. It relies on the [NCI] *CORE_SET_CONFIG_CMD* and is described hereafter:

Table 86. Mechanism to configure the RF transitions:

Name & Rights	Description	Ext. Tag	Len.	Default Value
RF_TRANSITION_CFG ***RW in E²PROM***	Parameter to configure one RF transition. • One transition will be coded as: Transition ID (TID) – 1 Byte CLIF register offset (RO) – 1 Byte Register Value (RV) – 1 Byte / 2 Bytes / 4 Bytes	0xA0 0D	3, 4 or 6	N/A

Name & Rights	Description	Ext. Tag	Len.	Default Value
	The list of transition IDs and the appropriate values for the Register offset & its value is available in [AN 11755], as referenced in →15			

! *CORE_SET_CONFIG_CMD* command to set RF Transitions triggers internal EEPROM memory page write operation. To prevent memory corruption, any interruption of this command (between *CORE_SET_CONFIG_CMD* and *CORE_SET_CONFIG_RSP*) by hardware reset or power off MUST be prevented.

Thus, it is recommended to:

- Prevent re-applying RF Transitions parameters when not required (those parameters been stored in non-volatile memory, there are persistent even in case NCI CORE_RESET_CMD with option "reset configuration" is applied).
- Split the RF Transition settings into several *CORE_SET_CONFIG_CMD* commands to limit the time for the command treatment inside PN7150 (*CORE_SET_CONFIG_CMD* with only one RF Transition takes 2.7ms, 5.4ms in the specific case where the RF parameter resides in 2 separate Flash memory blocks)
- Avoid mixing RF Transition parameters with other parameters (not starting with address 0xA00D) in a same *CORE_SET_CONFIG_CMD* command

! PN7150B0HN/C11006 version only allows recovering from such memory corruption. Refer to 4.3.8.3 for more details about this mechanism.

! PN7150 only supports *RF_TRANSITION_CFG* with command *CORE_SET_CONFIG_CMD*. *CORE_GET_CONFIG_CMD* is not supported.

To read out the values a specific command *RF_GET_TRANSITION_CMD* is to be used.

Table 87. RF_GET_TRANSITION_CMD

GID	OID	Numbers of parameter(s)	Description
1111b	0x14	2	The DH asks to read out the value of an RF Transition

Table 88. RF_ GET_TRANSITION_CMD parameters

Payload Field(s)	Length	Value/Description
RF Transition ID	1 Octet	RF Transition Identifier

Payload Field(s)	Length	Value/Description
CLIF Register Offset	1 Octet	Offset of the register to read out from the CLIF

Table 89. RF_ GET_TRANSITION_RSP

GID	OID	Numbers of parameter(s)	Description
1111b	0x14	2	The PN7150 acknowledges the command received from the DH and sends the RF Transition value to the DH.

Table 90. RF_ GET_TRANSITION_RSP parameters

Payload Field(s)	Length	Value/Description
STATUS	1 Octet	One of the following Status codes, as defined in [NCI_Table1] 0x00 STATUS_OK 0x01 STATUS_REJECTED 0x06 STATUS_SEMANTIC_ERROR Others Forbidden
RF Transition Length	1 Octet	Length of the following parameter (RF Transition Value): 0x01 1 Octet to follow 0x02 2 Octets to follow 0x04 4 Octets to follow Others RFU
RF Transition Value	1, 2 or 4 Octets	RF Transition Value ! Value coded in Little Endian.

11. Test Mode

11.1 Test Session

The PN7150 has the ability to generate a continuous PRBS pattern on the RF interface.

Whatever the test command used by the DH, it is necessary to implement a "test session", which isolates the test mode from a regular "NCI session" of PN7150. This test session is defined thanks to the following sequence:

- Reset/Initialize the PN7150 using *CORE_RESET_CMD/CORE_INIT_CMD*
- Launch selected test function
- Get the response transporting executed test status
- Reset/ Initialize the PN7150 using *CORE_RESET_CMD/CORE_INIT_CMD* (except for *TEST_PRBS_CMD*, which requires a HW reset first to stop the pattern generation on RF).

11.2 TEST_PRBS_CMD/RSP

This command is used to start PRBS infinite stream generation:

Table 91. TEST_PRBS_CMD

GID	OID	Numbers of parameter(s)	Description
1111b	0x30	6	Command to start PRBS generation

Table 92. TEST_PRBS_CMD parameters

Payload Field(s)	Length	Value/Description	
PRBS Mode	1 Octet	0x00	Firmware PRBS
		0x01	Hardware PRBS
PRBS type	1 Octet	0x00	PRBS9
		0x01	PRBS15
Technology to stream	1 Octet	0x00	Type A
		0x01	Type B
		0x02	Type F
Bitrate	1 Octet	0x00	106 kbps (Type A,B)
		0x01	212 kbps (Type A,B& F)
		0x02	424 kbps (Type A,B & F)
		0x03	848 kbps (Type A,B)
PRBS series length	2 Octets	A value between 0x0001 – 0x01FF	

Table 93. TEST_PRBS_RSP

GID	OID	Numbers of parameter(s)	Description
1111b	0x30	1	PN7150 reports if the *TEST_PRBS_CMD* is successful or not.

Table 94. TEST_PRBS_RSP parameters

Payload Field(s)	Length	Value/Description	
STATUS	1 Octet	0x00	STATUS_OK
		0x06	STATUS_SYNTAX_ERROR
		0x09	STATUS_INVALID_PARAM
		Others	Forbidden

! The only way to stop the on-going PRBS pattern generation is to apply a HW reset (through the VEN pin).

11.3 TEST_ANTENNA_CMD/RSP

This command is used to execute the antenna self-test measurements, which allow to check that all the discrete components connected between PN7150 and the contactless antenna are properly soldered on the PCB.

Four different measurements are necessary to check the correct connection of all the discrete components, therefore a complete Antenna Self-Test requires to execute the *TEST_ANTENNA_CMD* 4 consecutive times, with a different set of parameters for each execution.

Table 95. TEST_ANTENNA_CMD

GID	OID	Numbers of parameter(s)	Description
1111b	0x3D	2-4	Command to execute antenna self-test measurements.

Table 96. TEST_ANTENNA_CMD parameters

Payload Field(s)	Length	Value/Description	
Measurement ID	1 Octet	0x01	TxLDO current measurement
		0x02	AGC value reading
		0x04	AGC value reading with fixed NFCLD level
		0x20	Switch RF Field On/Off
		0x03, 0x05-0x1F, 0x21-0xFF	RFU
Parameters of individual test measurement	1-3 Octets	For individual test parameters please refer to →Table 98	

Table 97. Parameters to include in TEST_ANTENNA_CMD depending on the measurement to perform

Meas. ID	Measurement Description	Param. number	Parameter name	Length	Description	Typ. value
0x01	TxLDO current measurement	1	Wait_Time	1 Octet	Time to wait (in µs) before capturing the TX-LDO current	0x80
		1	Wait_Time	1 Octet	Time to wait (in µs) before capturing the AGC value	0xC8
0x02	AGC value reading	2	CLIF AGC input [7:0]	1 Octet	Value to write in CLIF AGC input register, bits [7:0]	0x60
		3	CLIF AGC input [9:8]	1 Octet	The 2 LSbits of parameter 3 are mapped on bits [9:8] of CLIF AGC input register. The 6 MSbits of parameter 3 have to be set to '0'.	0x03
0x04	AGC value reading with fixed NFCLD level	1	Wait_Time	1 Octet	Time to wait (in µs) before capturing the AGC value	0x20
		2	CLIF ANA NFCLD value [3:0]	1 Octet	The 4 LSbits of parameter 2 are mapped on bits [3:0] of CLIF ANA NFCLD input register. The 4 MSbits of parameter 2 have to be set to '0'	0x08
		3	Masked PMU TxLDO control bit [5]	1 Octet	bit [5] of parameter 3 is mapped to bit [5] in PMU TxLDO cntrl register. All other bits in parameter 3 ([7:6] & [4:0]) have to be set to '0'	0x20
0x20[1]	Switch RF Field On/Off	1	RF Field Generation	1 Octet	'1' => RF Field is generated '0' => RF Field is not generated	

! [1] Option 0x20 (Switch RF Field On/Off) absolutely requires to first disable the Standby mode, thanks to the *CORE_SET_POWER_MODE_CMD* (see →9.6.1).

Table 98. TEST_ANTENNA_RSP

GID	OID	Numbers of parameter(s)	Description
1111b	0x3D	5	PN7150 returns individual measurement status code and the result of the measurement.

Table 99. TEST_ANTENNA_RSP parameters

Payload Field(s)	Length	Value/Description
STATUS	1 Octet	0x00 STATUS_OK 0x01 Test execution rejected (PN7150 in wrong state) 0x04 STATUS_TEST_EXEC_FAILED 0x09 STATUS_INVALID_PARAM Others Forbidden
Result_Parameter_1	1 Octet	Value depending on the measurement performed : see →Table 101

Payload Field(s)	Length	Value/Description
Result_Parameter_2	1 Octet	Value depending on the measurement performed : see →Table 101
Result_Parameter_3	1 Octet	Value depending on the measurement performed : see →Table 101
Result_Parameter_4	1 Octet	Value depending on the measurement performed : see →Table 101

Table 100. Parameters provided in TEST_ANTENNA_RSP as a result of the measurement performed

Meas. ID	Measurement Description	Param. nbr	Parameter name	Length	Description
0x01	TxLDO current measurement	1	TxLDO output value	1 Octet	Raw value (RawVal) of TxLDO measurement (0x00-0x7F)
		2	Measured range	1 Octet	0x00: 50-100 mA, Absolute value = 0.4 x RawVal + 50 [mA] 0x01: 20-70 mA, Absolute value = 0.4 x RawVal + 20 [mA]
		3	RFU	1 Octet	
		4	RFU	1 Octet	
0x02	AGC value reading	1	AGC Value LSB	1 Octet	
		2	AGC Value MSB	1 Octet	
		3	RFU	1 Octet	
		4	RFU	1 Octet	
0x04	AGC value reading with fixed NFCLD level	1	AGC Value LSB	1 Octet	
		2	AGC Value MSB	1 Octet	
		3	RFU	1 Octet	
		4	RFU	1 Octet	
0x20	Switch RF Field On/Off	4	AGC Value MSB	1 Octet	
		1	RFU	1 Octet	
		2	RFU	1 Octet	
		3	RFU	1 Octet	
		4	RFU	1 Octet	

! RFU Bytes in *TEST_ANTENNA_RSP* can have any value from 0x00 to 0xFF.

11.4 TEST_GET_REGISTER_CMD/RSP

This command is used to retrieve the current Value of the AGC_VALUE_REGISTER.

Table 101. TEST_GET_REGISTER_CMD

GID	OID	Numbers of parameter(s)	Description
1111b	0x33	0	Command to retrieve the Value of the AGC_VALUE_REGISTER

Table 102. TEST_GET_REGISTER_CMD parameters

Payload Field(s)	Length	Value/Description
Fix parameters	4 Octet	The parameters have fixed values and shall be 0x40 0x00 0x40 0xD8.

Table 103. TEST_GET_REGISTER_RSP

GID	OID	Numbers of parameter(s)	Description
1111b	0x33	1	4 Bytes containing the current Value of AGC_VALUE_REG

12. PN7150 Practical approach

12.1 Basic examples for Reader/Writer Mode

12.1.1 R/W Mode with 1 NFC endpoint

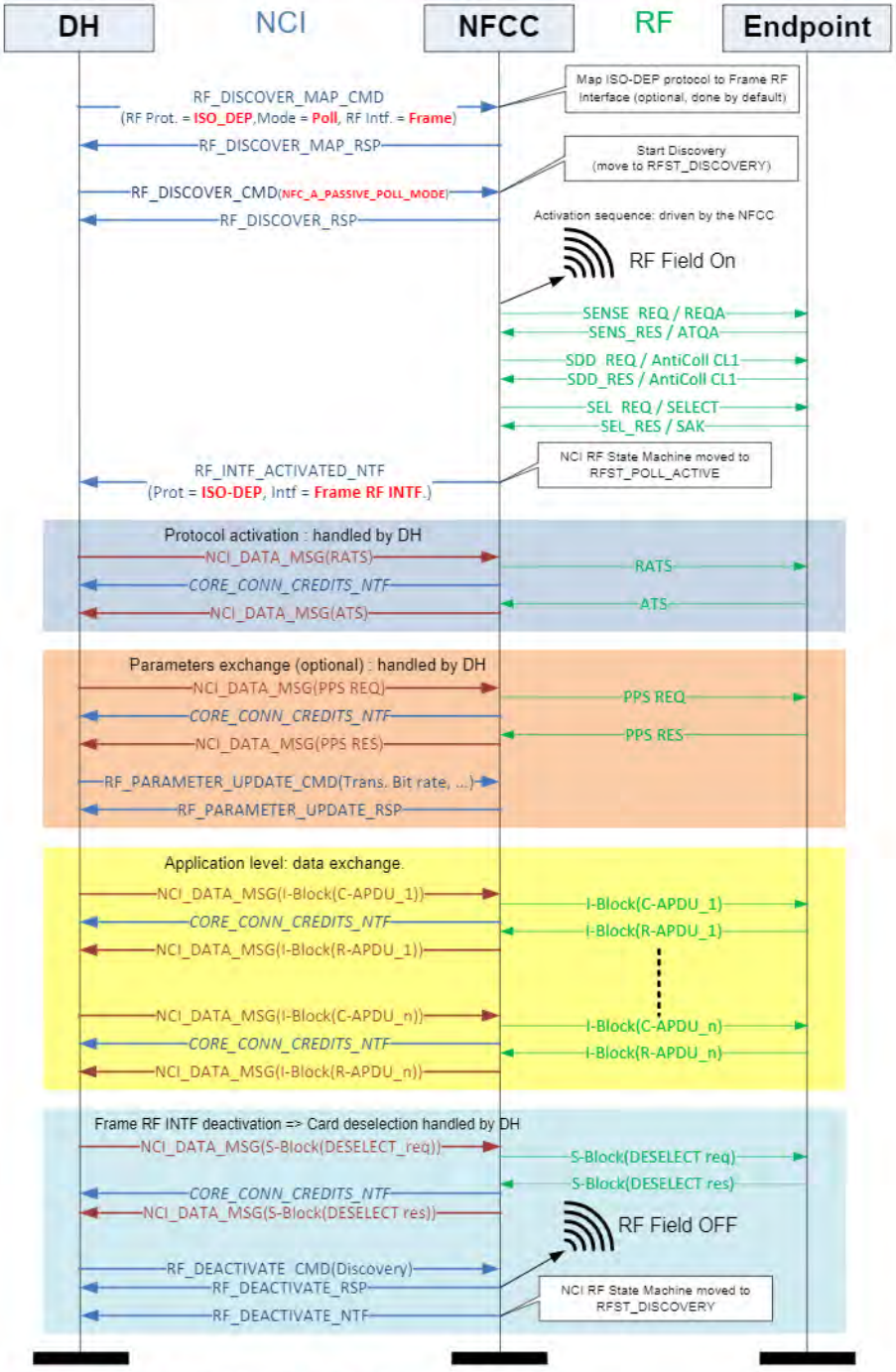

Fig 45. Poll Mode, NFC-A, ISO-DEP protocol / RF Frame Interface

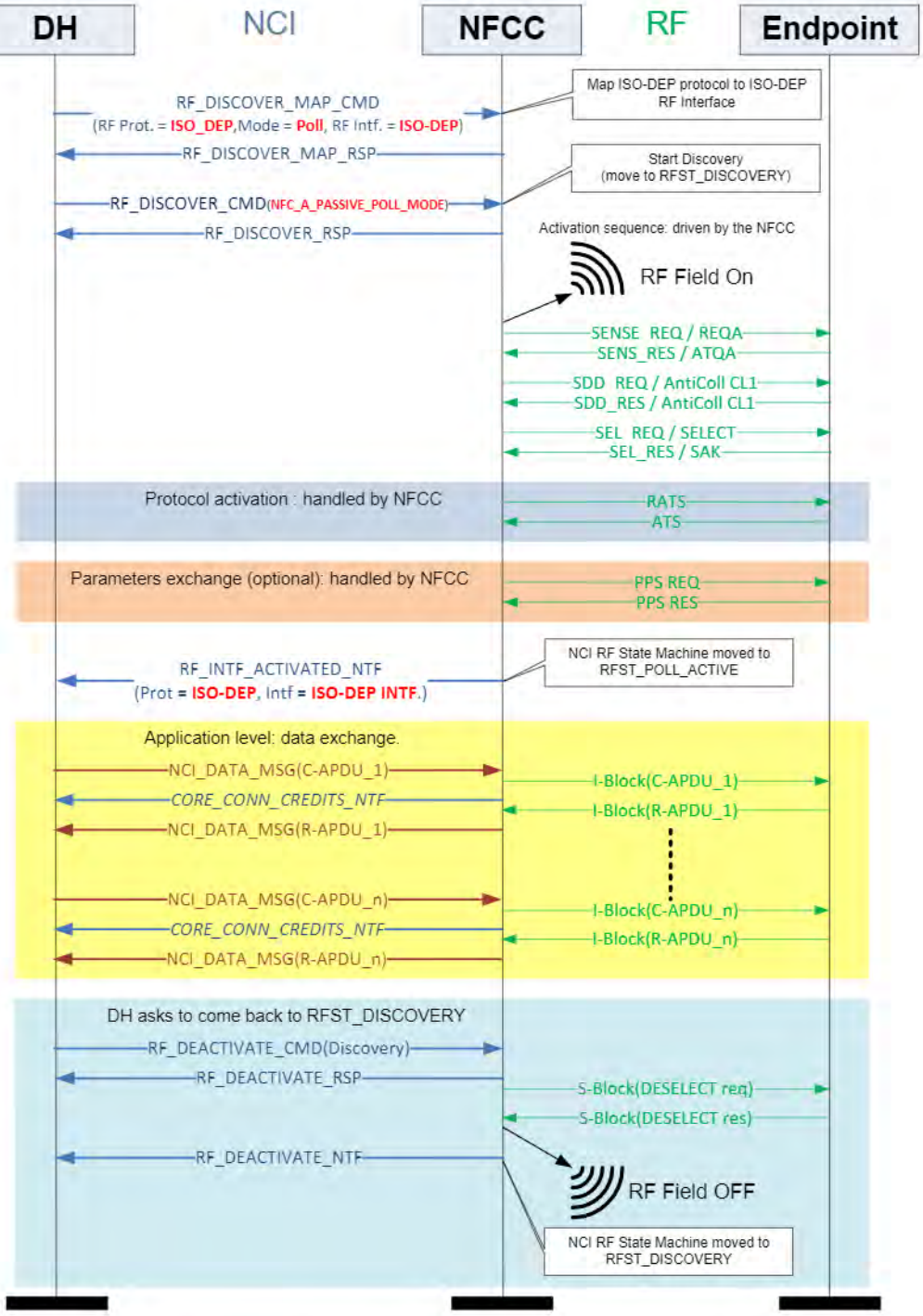

Fig 46. Poll Mode, NFC-A, ISO-DEP protocol / ISO-DEP Interface

12.1.2 R/W Mode with 2 NFC endpoints

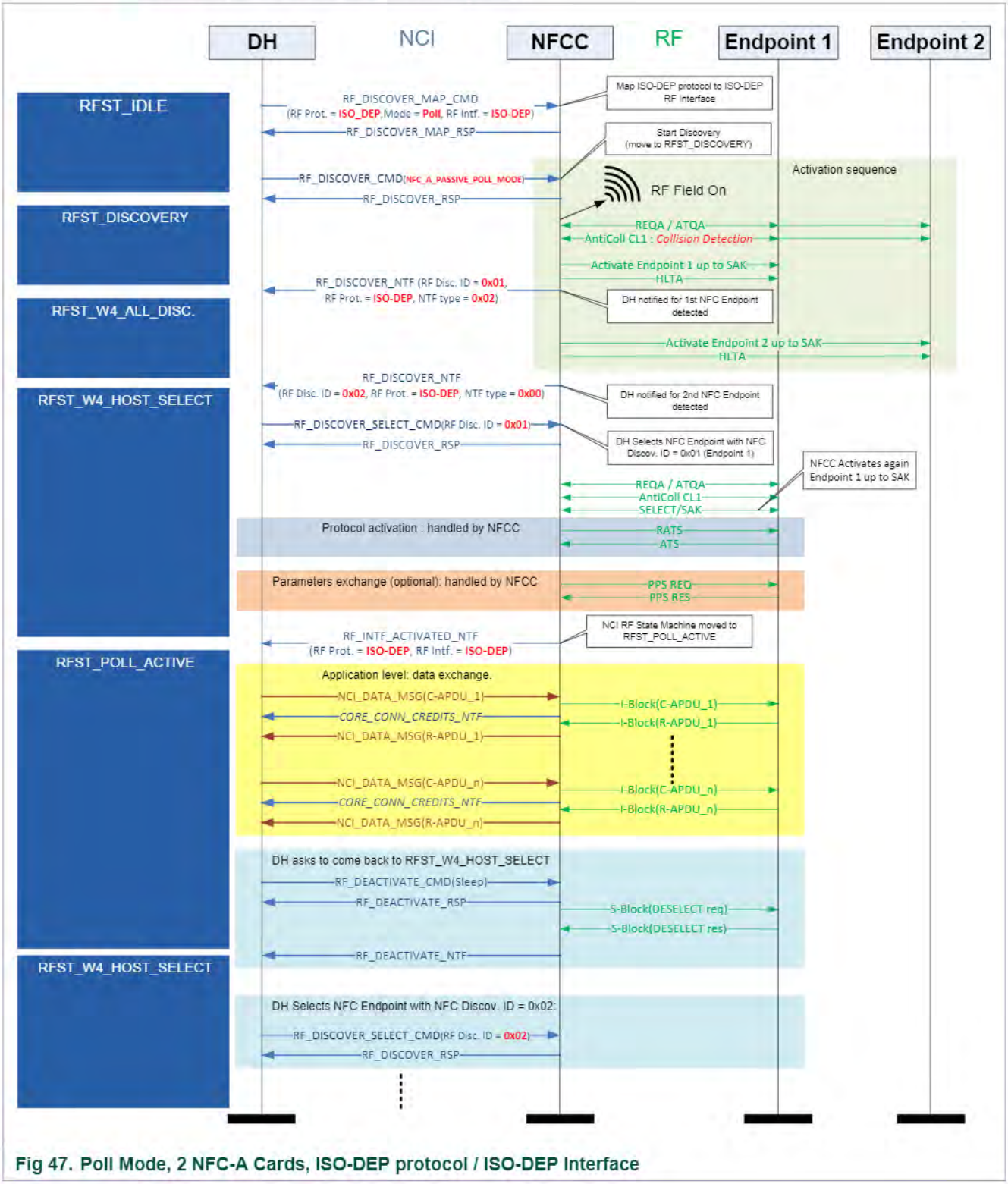

Fig 47. Poll Mode, 2 NFC-A Cards, ISO-DEP protocol / ISO-DEP Interface

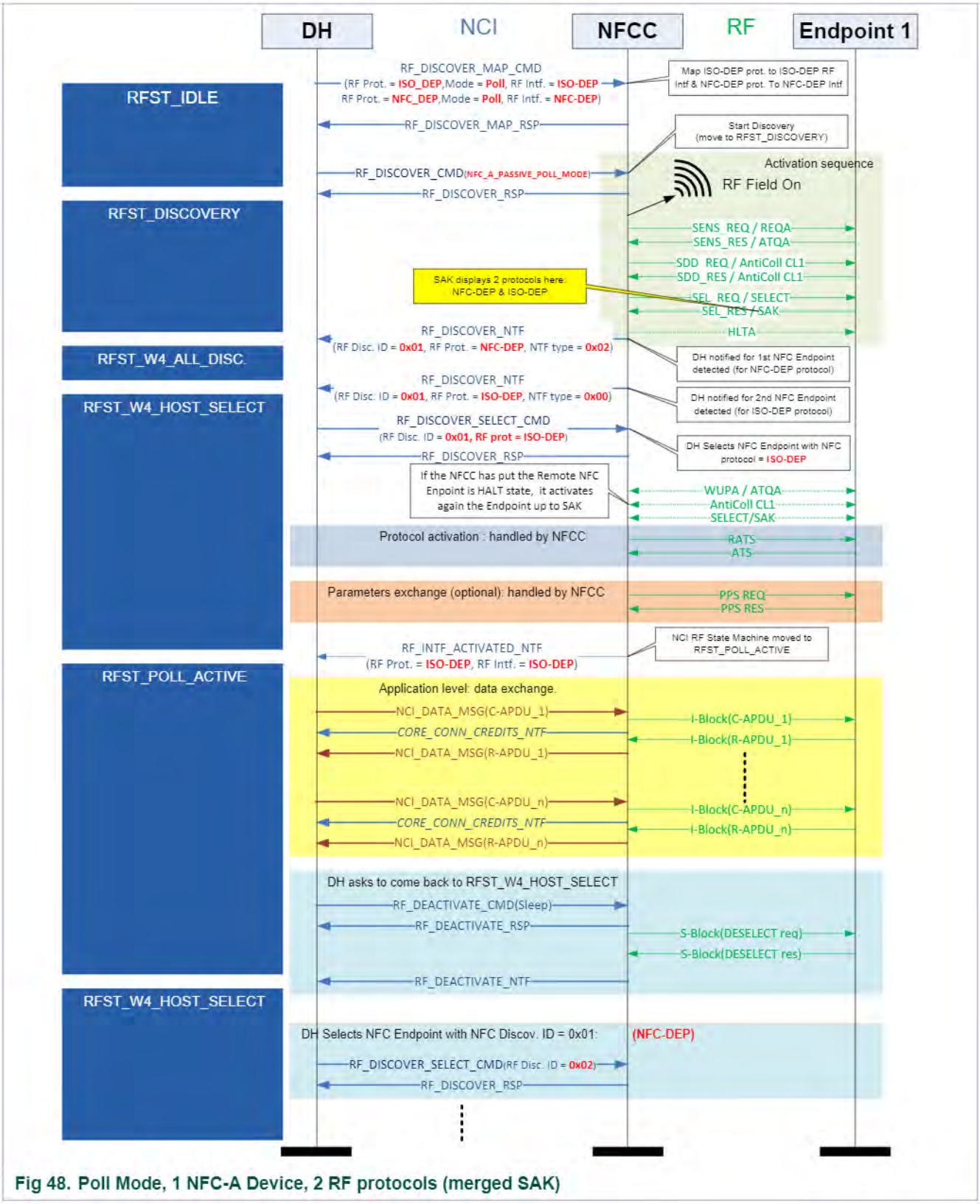

Fig 48. Poll Mode, 1 NFC-A Device, 2 RF protocols (merged SAK)

12.2 Basic examples for Card Emulation Mode

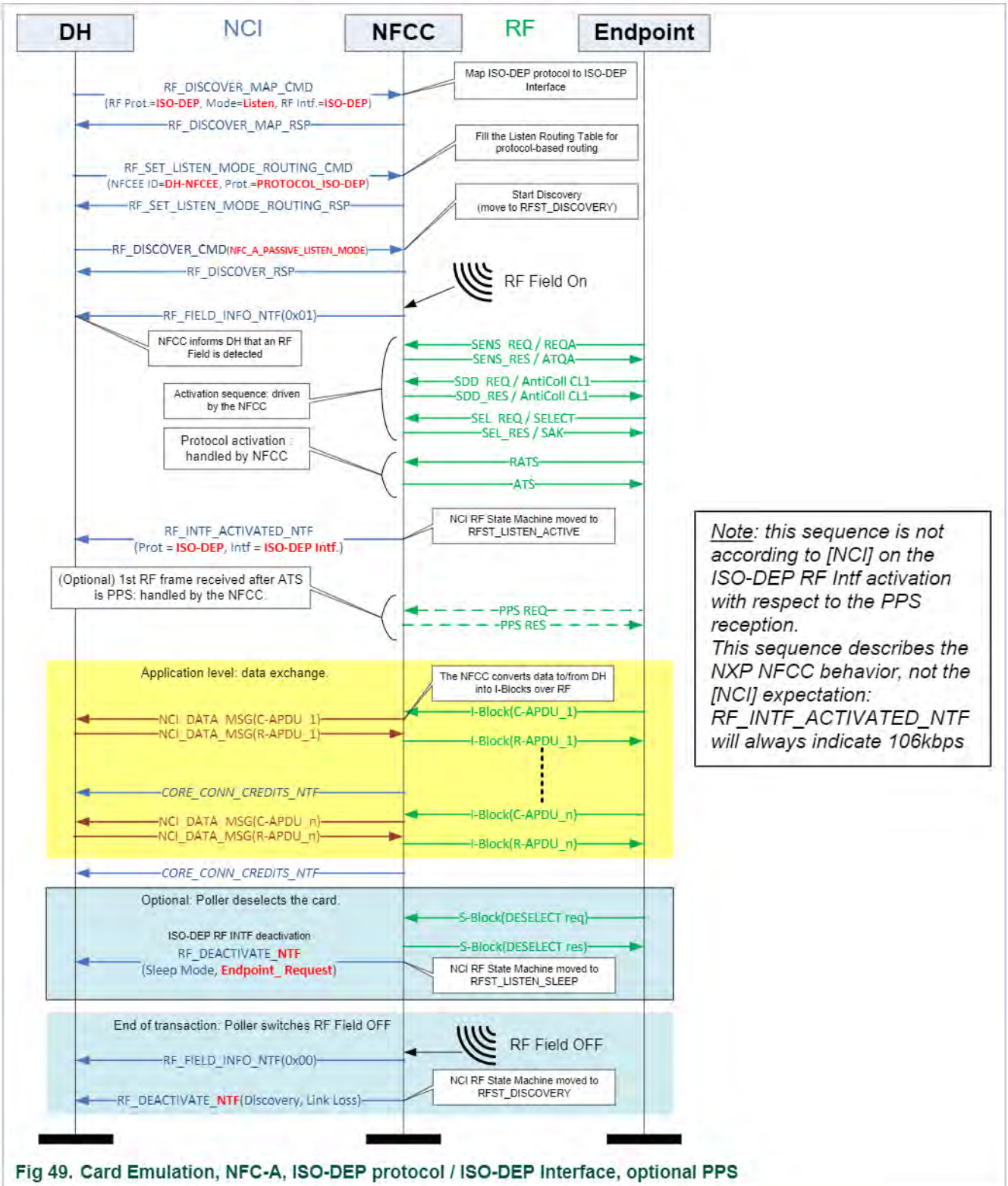

Fig 49. Card Emulation, NFC-A, ISO-DEP protocol / ISO-DEP Interface, optional PPS

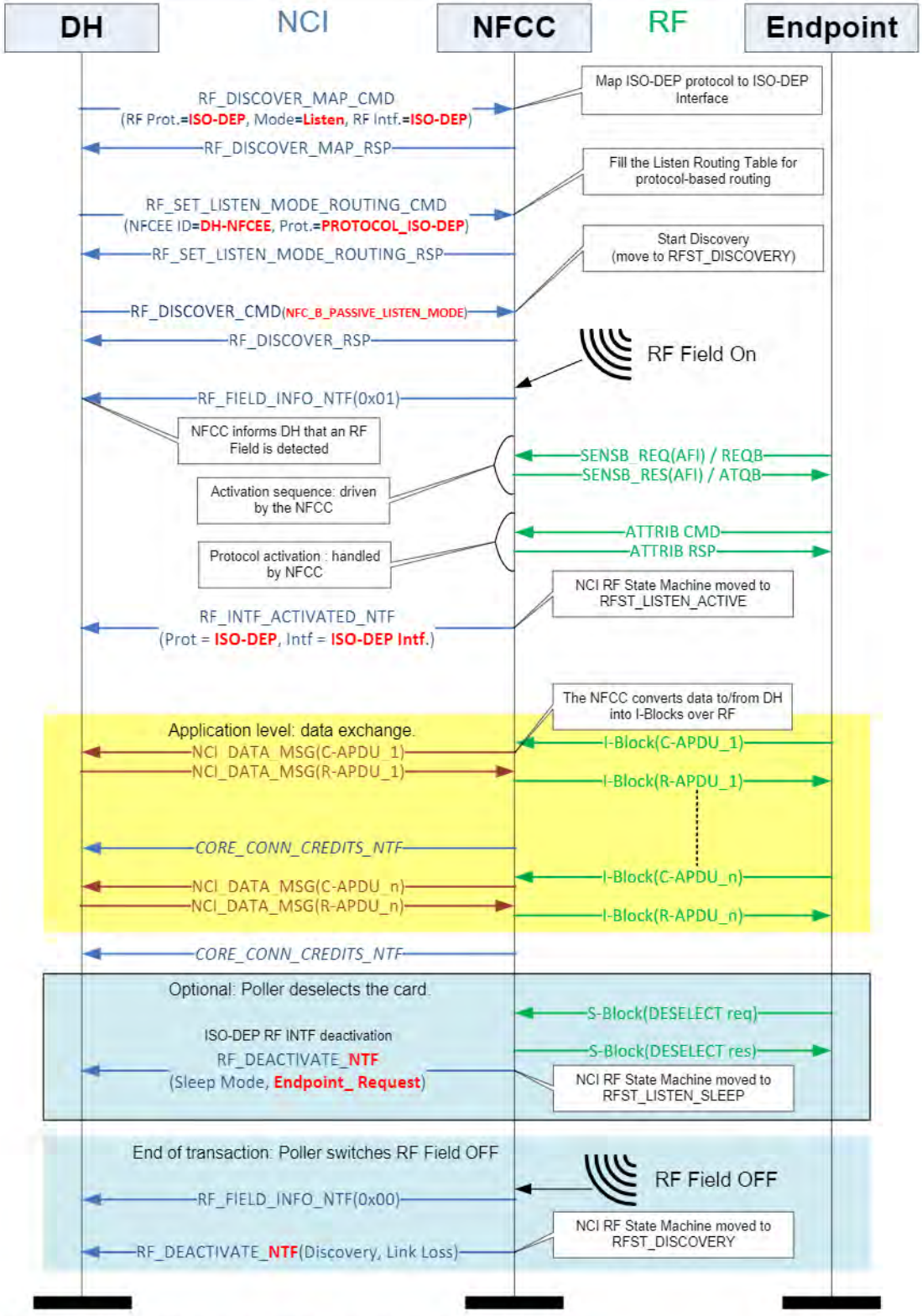

Fig 50. Card Emulation, NFC-B, ISO-DEP protocol / ISO-DEP Interface

12.3 Basic examples for P2P Passive Mode

12.3.1 Target in P2P Passive Mode / NFC-A @ 106kbps

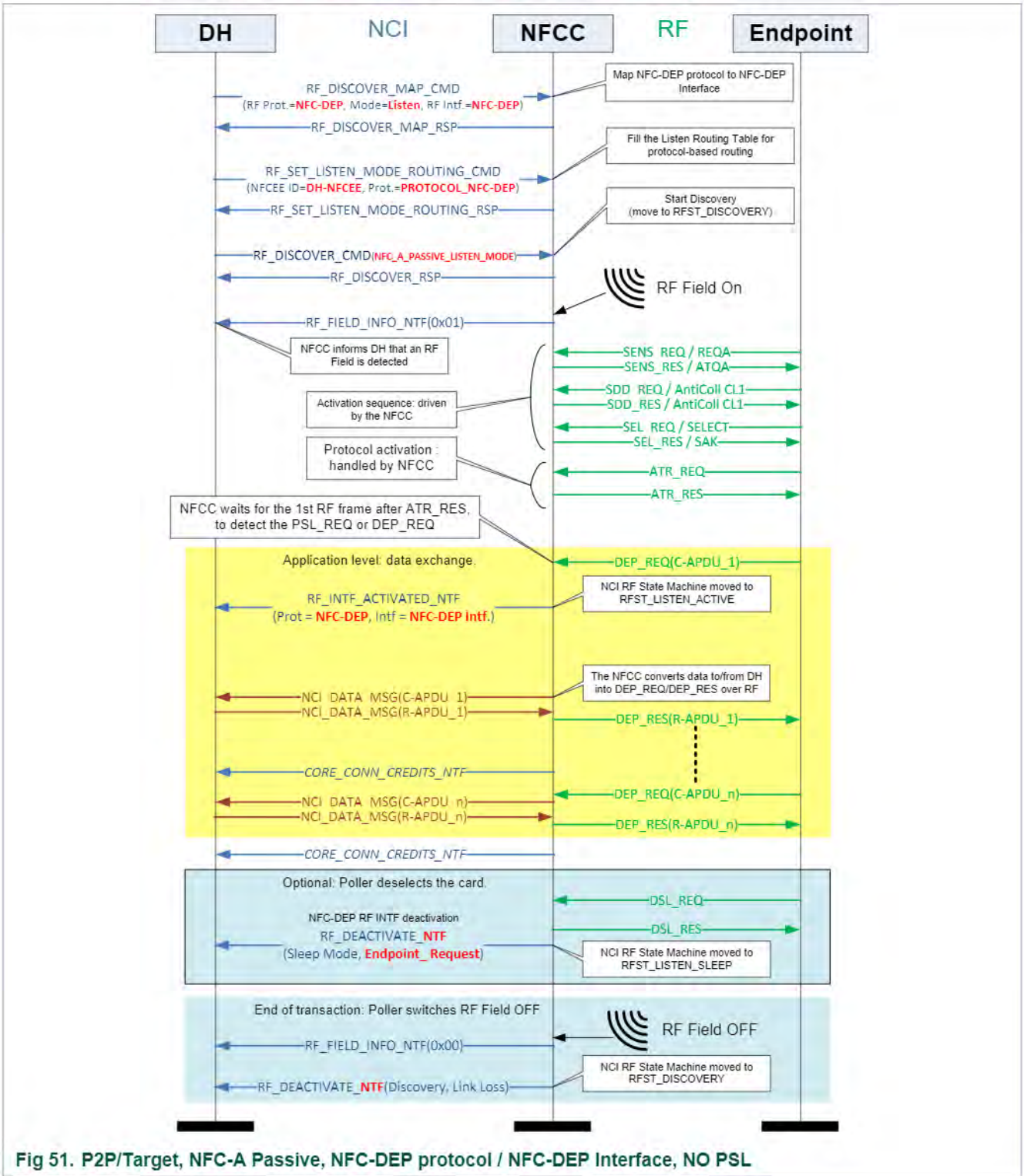

Fig 51. P2P/Target, NFC-A Passive, NFC-DEP protocol / NFC-DEP Interface, NO PSL

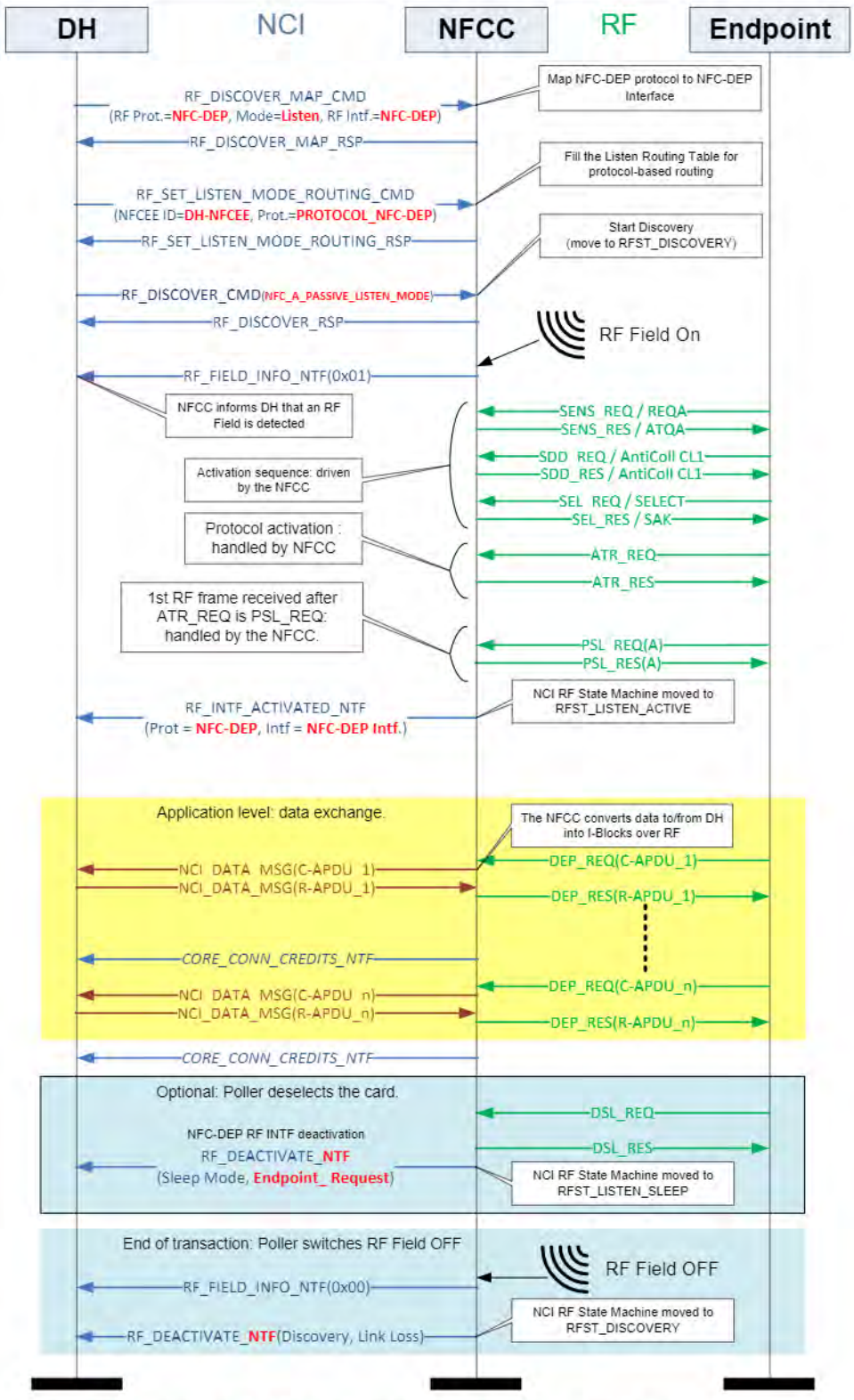

Fig 52. P2P/Target, NFC-A Passive, NFC-DEP protocol / NFC-DEP Interface + PSL

12.3.2 Initiator in P2P Passive Mode

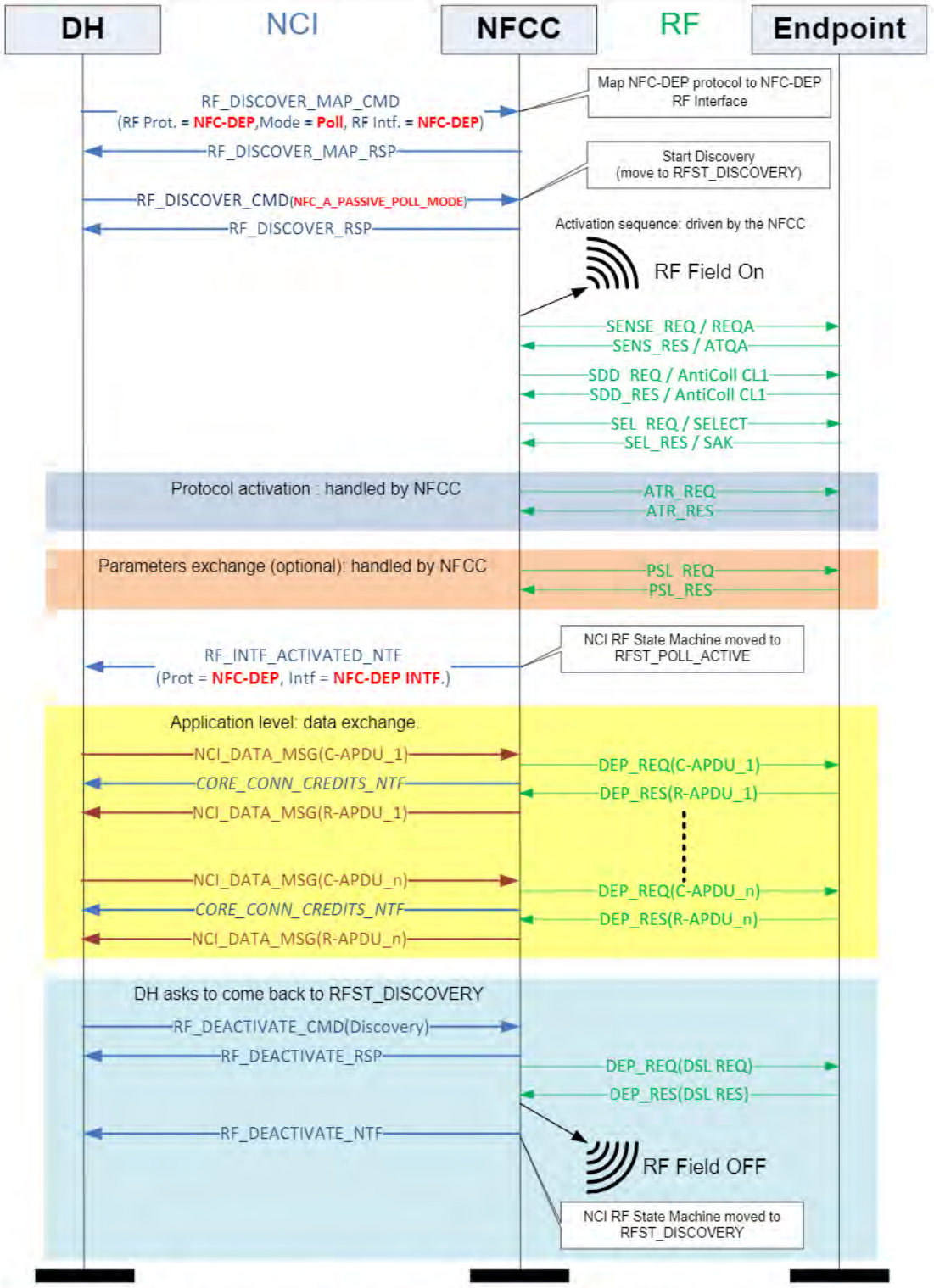

Fig 53. P2P/Initiator, NFC-A Passive, NFC-DEP protocol / NFC-DEP RF Interface

12.4 Basic examples for P2P Active Mode

12.4.1 Target in P2P Active Mode

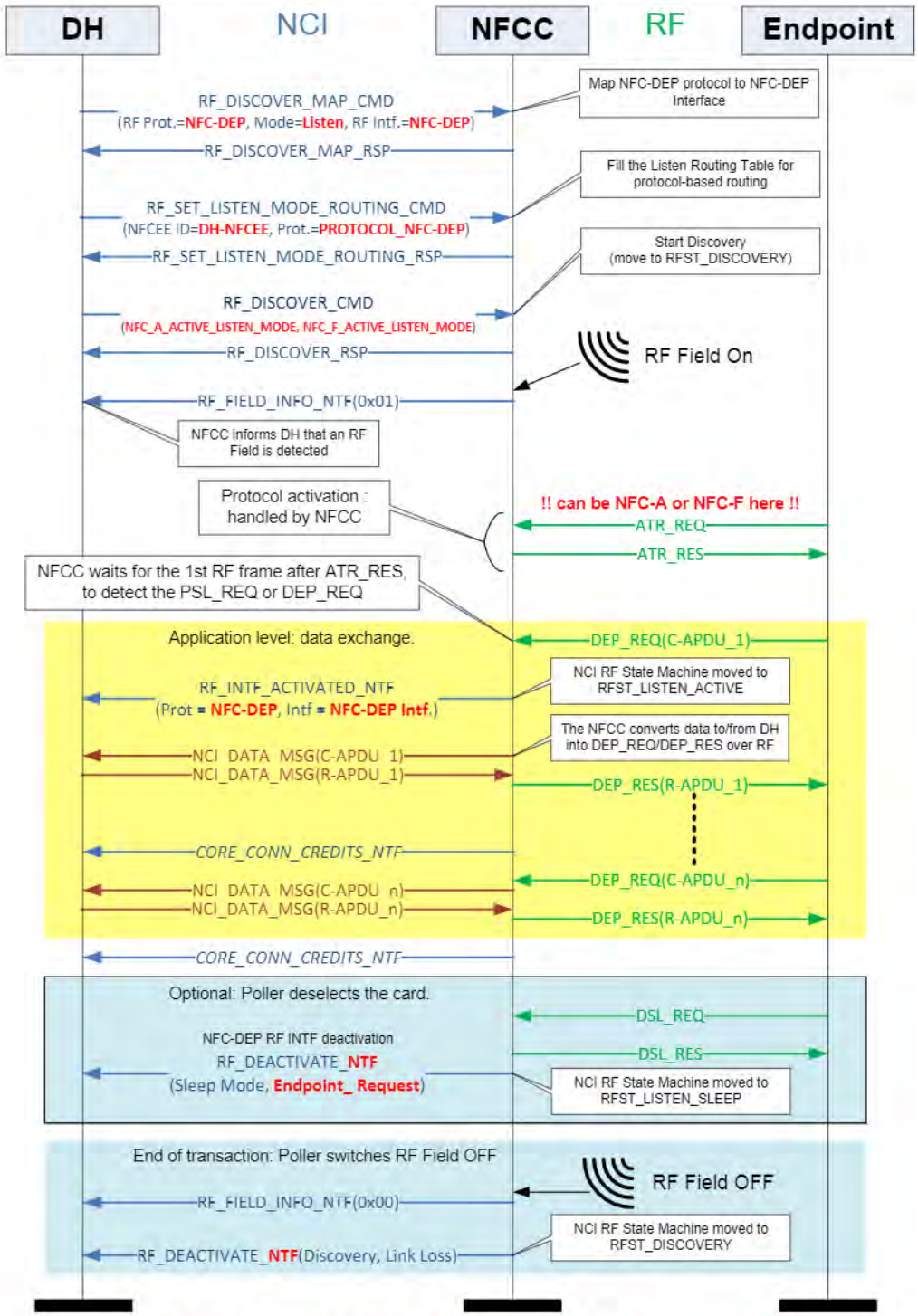

Fig 54. P2P/Target, NFC- A or NFC-F Active, NFC-DEP protocol / NFC-DEP Interface, NO PSL

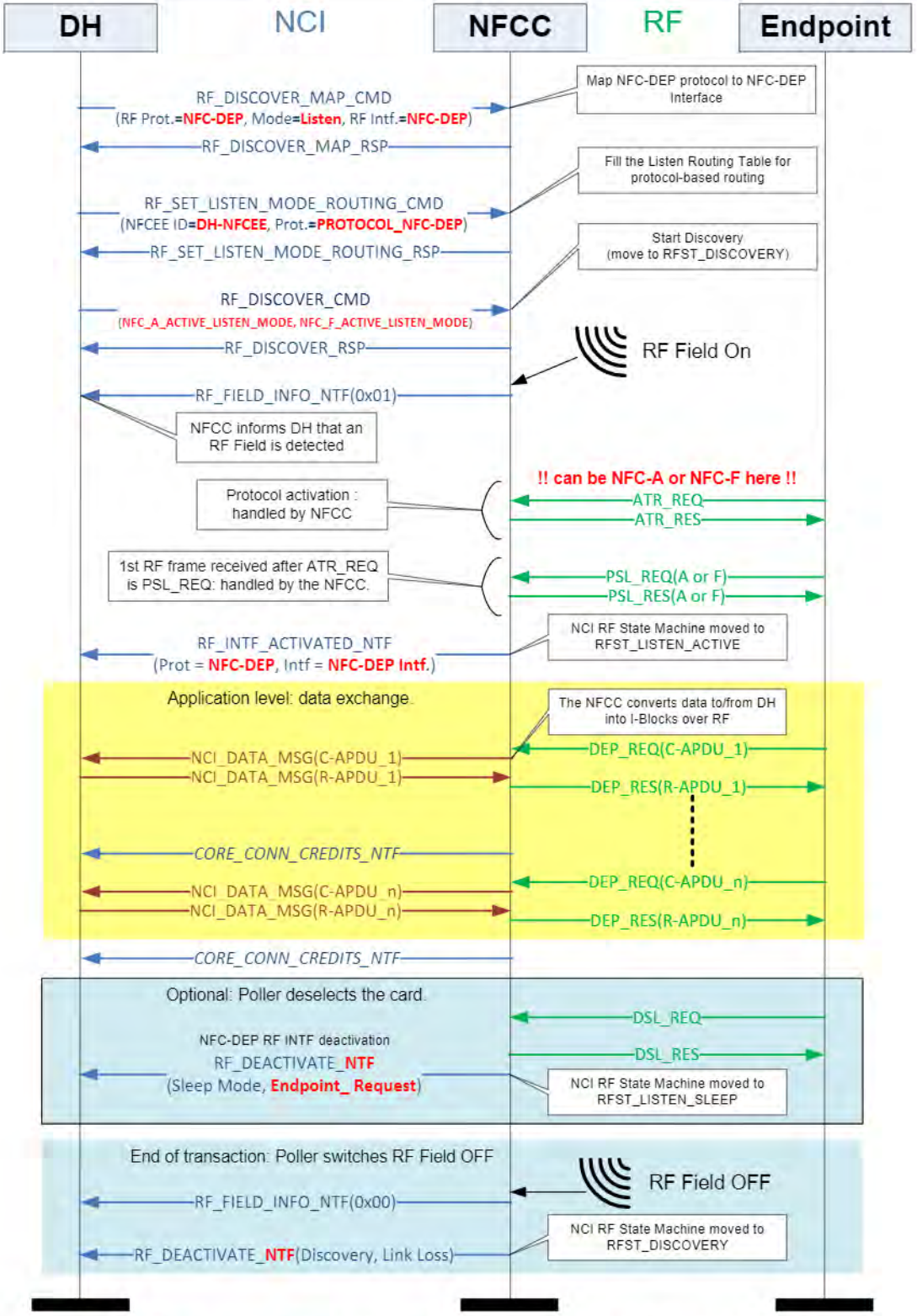

Fig 55. P2P/Target in DH, NFC- A or NFC-F Active, NFC-DEP protocol / NFC-DEP Interface + PSL

12.4.2 Initiator in P2P Active Mode

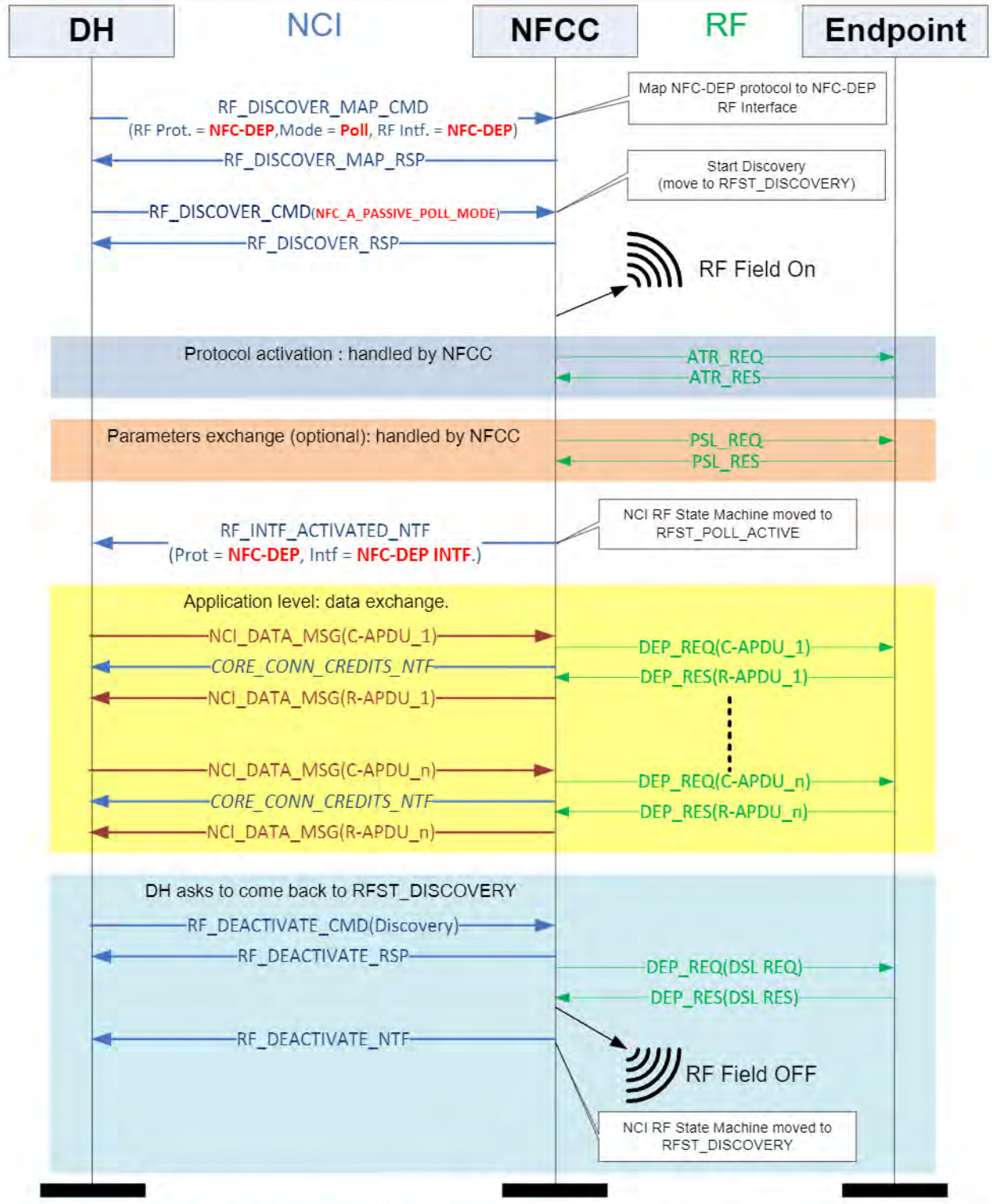

Fig 56. P2P/Initiator in DH, NFC-A Active, NFC-DEP protocol / NFC-DEP RF Interface

13. Annex A: details on RF state machine

The [NCI] RF State Machine is quite complex and the drawing proposed in the NCI technical Specification is combining all the different modes of operation in a single drawing.

For debug purposes, it is convenient to draw this State Machine in a simplified way, depending on the Protocol to RF Interface mapping applied by the DH. This is why the following figures are proposed here:

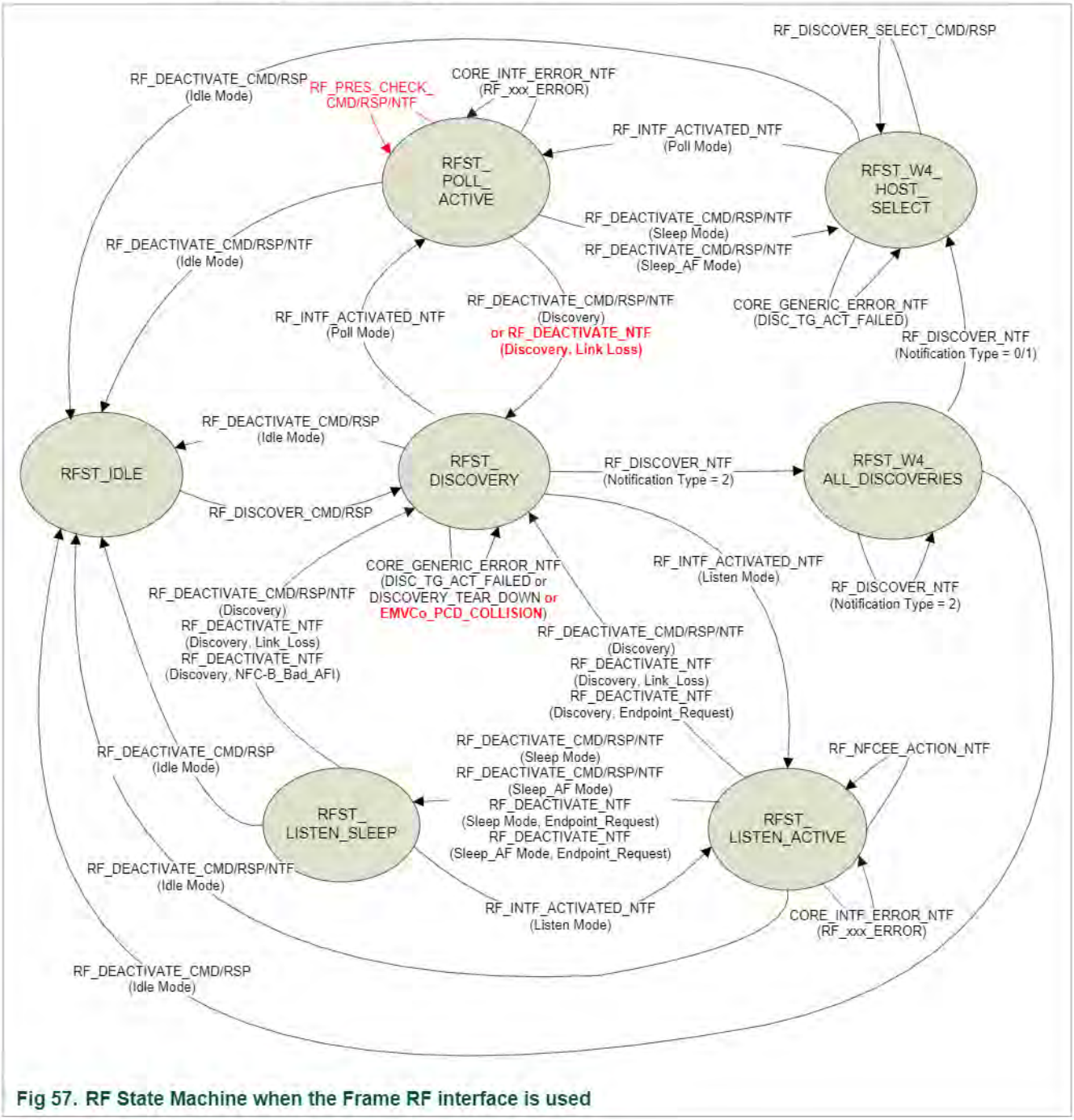

Fig 57. RF State Machine when the Frame RF interface is used

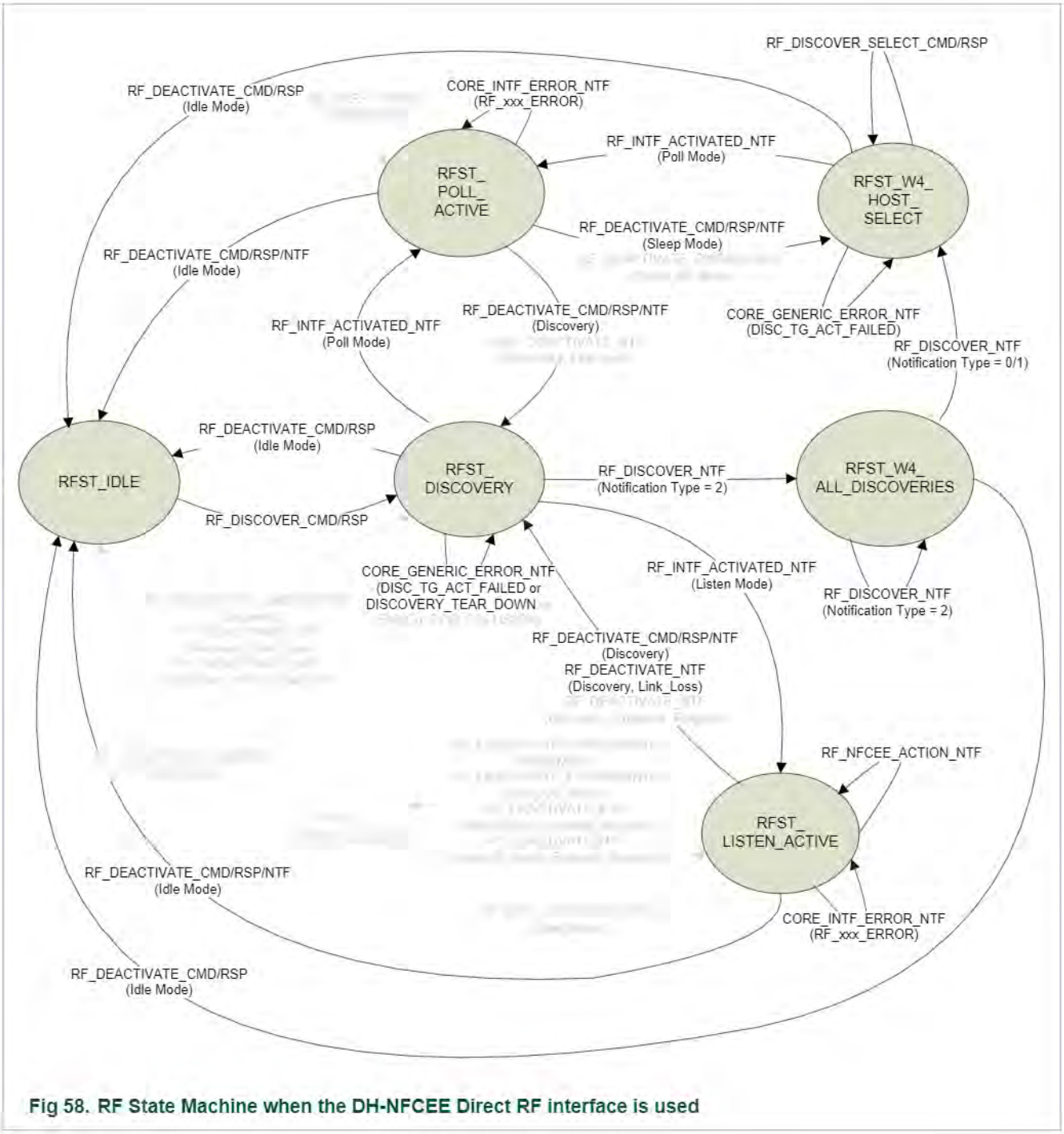

Fig 58. RF State Machine when the DH-NFCEE Direct RF interface is used

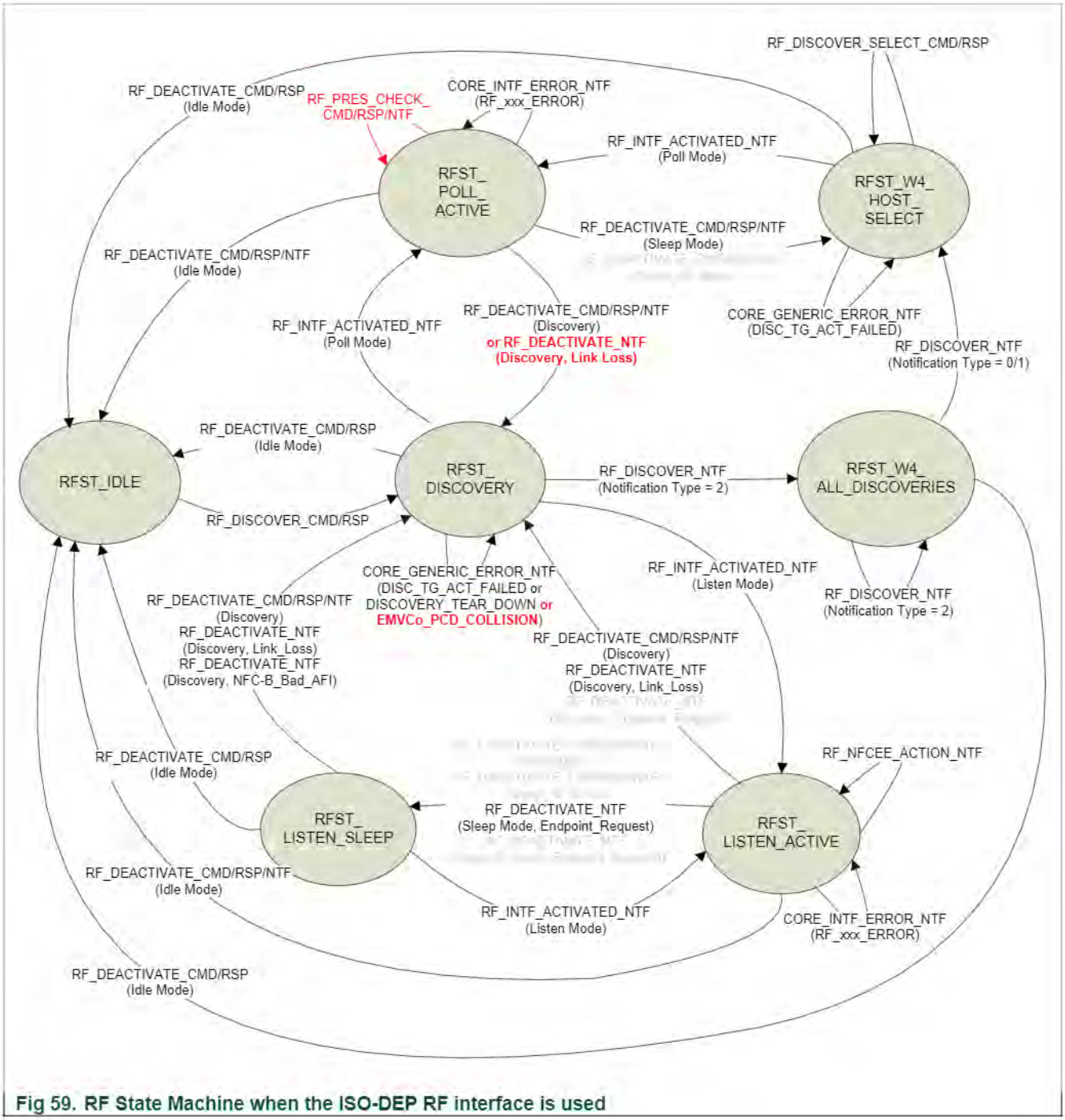

Fig 59. RF State Machine when the ISO-DEP RF interface is used

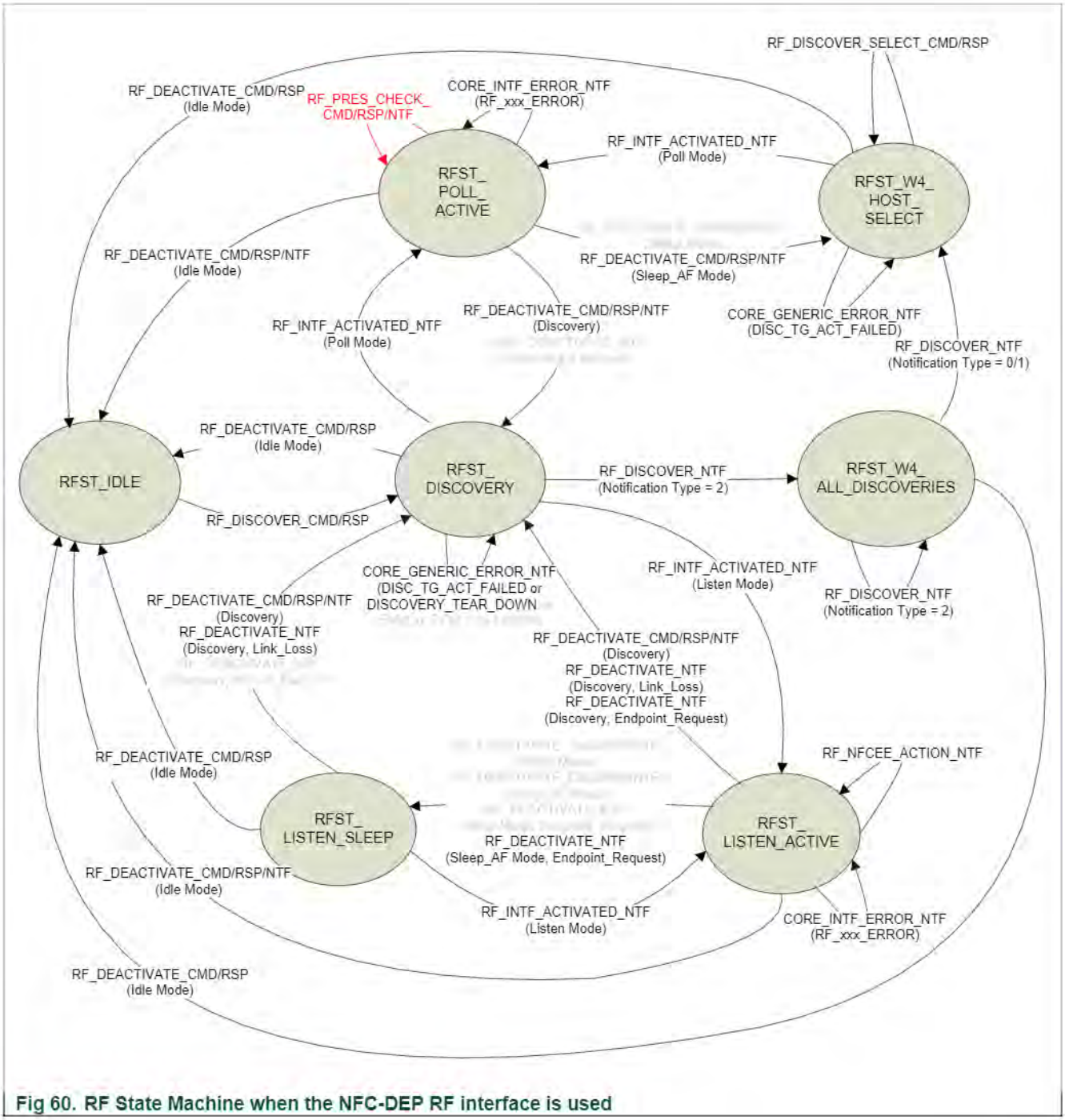

Fig 60. RF State Machine when the NFC-DEP RF interface is used

14. Abbreviations

Table 104. Abbreviations

Acronym	Description
CE	Card Emulation
DH	Device Host
DH-NFCEE	NFC Execution Environment running on the DH
ISO-DEP	ISO-DEP protocol as defined in [DIGITAL]
Listen mode	Listen mode as defined in [Digital]
NCI	NFC Controller Interface
NFC	Near Field Communication
NFC-A	NFC-A technology as defined in [DIGITAL]
NFC-B	NFC-B technology as defined in [DIGITAL]
NFCC	NFC Controller, unless mentioned this is the PN7150
NFC-DEP	NFC-DEP protocol as defined in [DIGITAL]
NFCEE	NFC Execution Environment
NFC-F	NFC-F technology as defined in [DIGITAL]
P2P	Peer To Peer
PCD	Proximity Coupling Device
Peer device	Device which can communicate via P2P mode as defined in [NFC-IP1]
PICC	Proximity Integrated Circuit Card
Poll mode	Poll mode as defined in [Digital]
R/W	Reader/Writer
RF	Radio Frequency
RFU	Reserved For Future Use

15. References

Table 105. References

[14443-4]	ISO/IEC14443-4
[7816-4]	ISO/IEC7816-4
[ACTIVITY]	NFC FORUM Activity Specification 1.0
[AN11755]	PN7150 Antenna and Tuning Design Guide
[AN11756]	PN7150 Hardware Design Guide
[AN11757]	PN7150 Low Power Mode Configuration
[DIGITAL]	NFC FORUM Digital Protocol Specification 1.0
[I²C]	I²C -bus specification and user manual Rev 03, defined by NXP. Last revision from April 2014 can be found here: http://www.nxp.com/documents/user_manual/UM10204.pdf
[NCI]	NFC Controller Interface, version 1.0
[NCI_Chap1]	Discovery and Interface Activation: chapter 8.3.2.2 in [NCI]
[NCI_Chap2]	State Machine: chapter 5.2 in [NCI]
[NCI_Table1]	Status Codes table: table 106 in [NCI]
[NCI_Table2]	RF technologies table: table 107 in [NCI]
[NCI_Table3]	RF Technology & Mode table: table 108 in [NCI]
[NCI_Table4]	Bit Rates table: table 109 in [NCI]
[NCI_Table5]	RF protocols table: table 110 in [NCI]
[NCI_Table6]	RF Interfaces table: table 111 in [NCI]
[NCI_Table8]	Config. parameters table: table 113 in [NCI]
[NCI_Table9]	CORE_RESET_NTF table: table 5 in [NCI]
[NFC-IP1]	ISO/IEC 18092
[PN7150_DS]	PN7150 Datasheet

16. Legal information

16.1 Definitions

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This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

Notice:

Any changes or modifications not expressly approved by the party responsible for compliance could void your authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class

B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful

interference to radio communications. However, there is no guarantee that

interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by

turning the equipment off and on, the user is encouraged to try to correct the

interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/ TV technician for help.

RF exposure statements

- 1. This Transmitter must not be co‐located or operating in conjunction with any other antenna or transmitter.
- 2. This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body or nearby persons..

- Declaration the Restriction of this Limited Module Approval:

- According to FCC Part 15 Subpart C Section 15.212, the radio elements of the modular transmitter must have their own shielding. However, due to there is no shielding for this module, this module is granted as a Limited Modular Approval. When this Module is installed into the end product, a Class II Permissive Change or a New FCC ID submission is required to ensure the full compliance of FCC relevant requirements.

- Notice to OEM integrator

- Must use the device only in host devices that meet the FCC RF exposure category of mobile, which means the device is installed and used at distances of at least 20cm from persons. The end user manual shall include FCC Part 15 compliance statements related to the transmitter as show in this manual.
- Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B. Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host. Must have on the host device a label showing Contains FCC ID: I4LXP01N

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