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Qi Specification version 2.0 –
Part 11: MPP System Specification

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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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Part 11: MPP System Specification

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It is based on *Qi Specification version 2.0, MPP Communications Protocol* and was submitted as a Fast-Track document.

The text of this International Standard is based on the following documents:

Draft	Report on voting
100/4255/FDIS	100/4276/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

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WIRELESS POWER
CONSORTIUM

Qi Specification

MPP Communications Protocol

Version 2.0

April 2023

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RELEASE HISTORY

Specification Version	Release Date	Description
2.0	April 2023	First release of this v2.0 specification.

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Introduction

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1.1 Overview

Magnetic power profile (MPP) is a protocol extension that provides additional messages, new power states/modes, new power transfer contract elements, and aims to provide the following functionalities:

- Operating Frequency Negotiation
- Cloaking (Power Pause)
- Generic Information Exchange
- Simultaneous Data Stream Transactions
- Fast PTx to PRx communication
- Maximum Power and Power Control Profiles Determination
- Extended Power Negotiation
- Extended PTx/PRx Identification and Capabilities
- Extended Control Error Packets and Received Power Packets
- Power Transmitter Battery Level Reporting
- Ecosystem Scalability

A summary of differences between Magnetic Power Profile and EPP is listed below in Table 1.1.

MPP extension allows devices to operate under Restricted mode (no PTx communication) at 360kHz without performing any explicit negotiation with the Power Transmitter. This flexibility enables devices with limited resources (e.g., devices with no FSK support) to take advantage of the frequency change feature.

Table 1.1: MPP Specifications Departure from Qi EPP

Feature	EPP	MPP
PTx Handshake Message	EPP FSK ACK Message	MPP FSK ACK Message (Section 2.3.1)
FSK Parameters Negotiation	EPP allows FSK parameters negotiation	Fixed FSK parameters
Data Streams	Single Stream Transfer	Multiple Concurrent Transfer
Foreign Object Detection	FOD Packet, Calibration, RP	Replaced with MPP Power Loss Accounting Packet

Magnetic Power Profile

2

2.1 Overview

This chapter describes the Power Receiver and Power Transmitter requirements for Magnetic Power Profile and the modes devices may use to communicate.

MPP supports two protocol modes:

1. **Restricted Mode:** One-way communication (PRx to PTx) with limited power levels *(5W PRECT)* using Qi Baseline Protocol
2. **Full Mode**: Supports bi-directional communication and enables negotiation of higher power levels

2.1.1 Restricted Mode

MPP Restricted mode allows PRx to establish a charging session with PTx using one-way communication (PRx to PTx) at 360kHz operating frequency using Qi Baseline Protocol.

PTx and PRx shall follow the Qi Baseline Protocol specifications when operating in Restricted mode.

(Informative)
MPP Restricted mode can be used when PRx is operating under a constrained environment e.g., device is fully discharged

PRx is allowed to transition from MPP Restricted to MPP Full mode to enable bi-directional communication and higher power levels. Refer to Section 4.6 for more details on how to perform the transition.

2.1.2 Full Mode

MPP Full mode enables a charging session with bi-directional communication between PTx and PRx allowing devices to perform more complex operations such as exchange of identification information, devices capabilities, ecosystem scalability coefficients, power negotiation and perform authentication.

In MPP Full mode, devices may transition between different protocol phases such as Negotiation, Power Transfer, Cloak and are able to negotiate higher power levels compared to Restricted mode.

MPP Full mode is based on Qi Extended Power Profile (EPP) protocol. PTx and PRx shall follow the Qi EPP specifications when operating in this mode. Changes to the EPP specifications are explicitly stated in this document.

Changes to specifications include:

1. Added MPP Power Transfer Contract Elements and removed support for EPP RP (Received Power) contract elements
2. Added MPP data packets and removed support for EPP FOD data packets
3. Overriding time parameters

2.2 Power Receiver Requirements

MPP ASK specification is based on Qi EPP, all the timing requirements/specifications specified by Extended Power Profile apply to MPP.

All standard Qi packets used in MPP follow the Qi specifications. Changes to the handling or the definition of the packets are explicitly stated in this document.

2.2.1 Amplitude Shift Keying (ASK)

MPP follows the Qi ASK specifications.

2.2.2 Startup Behavior

An MPP-compatible Power Receiver shall start by sending the following sequence of packets during the ping/configuration phase.

1. Signal Strength (SIG)
2. Identification (ID)
3. Extended Identification (XID)
4. Power Control Hold-Off (PCH) - *Optional*
5. Configuration Packet (CFG)

The packets shall contain the MPP identifiers as described in this section to allow an MPP-compatible Power Transmitter to identify the Power Receiver.

Figure 2.1: MPP ID/CFG Phase Packets

Signal Strength (SIG)

Power Receiver shall report the Signal Strength (SIG) data packet following the Qi specifications.

Identification (ID)

Power Receiver shall report the Identification Packet (ID) with the following parameters as shown in Figure 2.2 and Table 2.1.

	b7	b6	b5	b4	b3	b2	b1	b0
B0	Major				Minor			
B1	PRMC							
B2								
B3	Ext	Random Iden;fier						
B4								
B5								
B6	Mfg Rsvd							

Figure 2.2: MPP ID Packet Structure

Table 2.1: MPP ID Packet Parameters

Field	Value
Major Version	2
Minor Version	0
Manufacturer Code (PRMC)	Assigned PRMC code
Ext	1
Random Identifier	Follows Random Device Identifier Policy
Mfg Reserved	Reserved for Manufacturer's use (Proprietary)

Refer to Qi Communications Protocol section 8.11 for more information on Random Device Identifier policy

Extended Identification (XID)

Power Receiver shall report the MPP-Extended Identification Packet (XID) to advertise MPP support. Detailed packet definition is described in section 7.1.20.

	b7	b6	b5	b4	b3	b2	b1	b0
B0	0xFE							
B1	Restricted	Mfg Rsvd						
B2	Mfg Rsvd							
B3	VRECT							
B4	Alpha0 Rx							
B5	Alpha1 Rx							
B6	Alpha-Kth Rx							
B7	Mfg Rsvd							

Figure 2.3: MPP XID Packet Parameters

Power receiver may choose to advertise MPP-compatibility and operate under MPP restricted mode by setting the Restricted bit as described in Section 7.1.20. Otherwise, the Power Receiver may request to operate under MPP Full mode by setting the Restricted bit to zero.

Power Receiver may choose to not advertise MPP capabilities by performing one of the following:

1. Setting the (XID Sub Header) field to any value other than 0xFE
2. Skipping XID packet, and setting Ext bit to 0 in ID packet

Power Control Hold-Off (PCH) - Optional

Power receiver may choose to operate in Restricted mode and later switch to MPP full mode. This transition requires the Power Receiver to report PCH packet during the configuration phase.

Refer to Section 4.6 for more details on value selection.

Configuration (CFG)

Power Receiver shall report the Configuration (CFG) packet according to the Qi specifications.

2.2.3 Profile Activation

Depending on the selected operating mode in XID packet (Section 2.2.2), Power Receiver shall proceed as follows:

1. **MPP - Restricted**: PRx shall proceed to Restricted Power Transfer Phase at 360kHz (Follows Qi Baseline Protocol)
2. **MPP - Full**: PRx shall enable the FSK decoder, depending on the decoding result:
   a) FSK MPP Pattern: PRx shall proceed to MPP Negotiation Phase (Section 3)
   b) FSK NAK Pattern: PRx shall proceed to MPP Negotiation Phase with MPP error status (Section 3)
   c) Timeout / Else: PRx shall proceed according to the Qi specifications *(BPP/EPP)*

1. FSK pattern response to Configuration (CFG) packets is always transmitted using the default 512 switching cycles.
2. Refer to MPP System Specifications - Communications Physical Layer: FSK (Section 6.2) for more information on FSK parameters.

Figure 2.4 summarizes the flow.

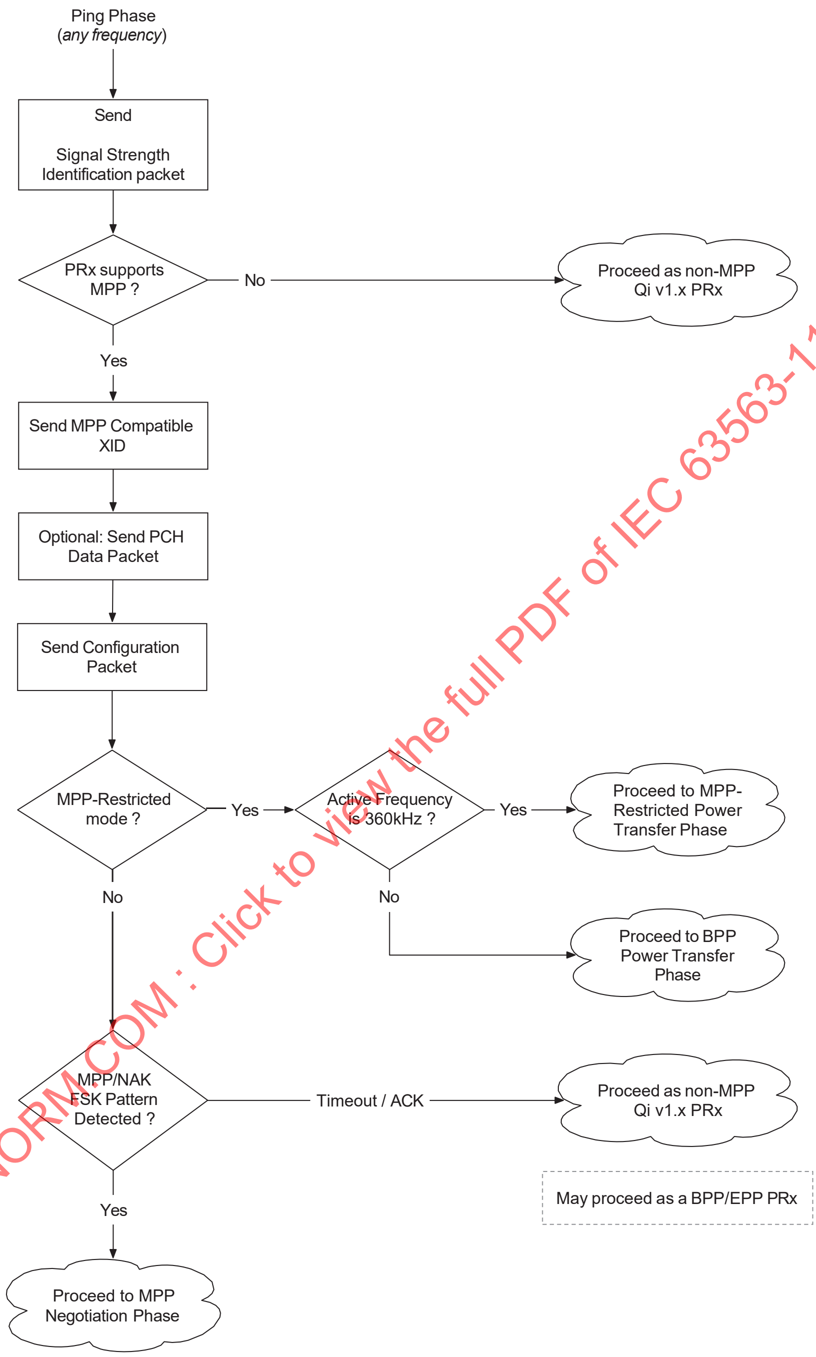

Figure 2.4: MPP Power Receiver Configuration Phase Decision Tree

2.3 Power Transmitter Requirements

MPP FSK specification is based on Qi EPP, all the timing requirements/specifications specified by Extended Power Profile apply to MPP. Updated parameters are explicitly stated in this document.

2.3.1 Frequency Shift Keying (FSK)

Magnetic Power Profile v1.x defines fixed FSK parameters:

Table 2.2: MPP FSK Parameters

Parameter	Value	Notes
Switching Cycles	512 / 128	FSK 512 switching cycles is only used when PTx responds to CFG packet (Section 2.2.3) Otherwise, PTx shall use 128 switching cycles
Preamble	4-bits (1111)	Applies to FSK Packets only (Patterns are excluded)

MPP uses predefined FSK parameters as specified in MPP System Specifications - Communications Physical Layer: FSK (Section 6.2)

Packet Format

MPP FSK Packet structure is shown in Figure 2.5.

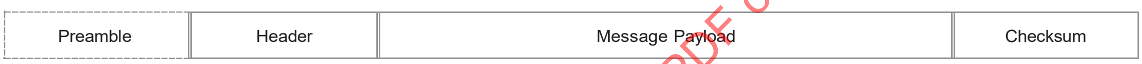

Figure 2.5: MPP FSK Packet Structure

FSK Pattern

MPP extends Qi EPP FSK pattern responses with MPP Pattern (Table 2.3, Figure 2.6).

Table 2.3: MPP FSK Patterns

Response	Pattern b0..b7	Notes
ACK	1111 1111	
NAK	0000 0000	
ND	1010 1010	
ATN	1100 1100	
MPP	1000 1000	MPP Pattern
APP	1111 0000	Reserved proprietary pattern (Note)

Note on *APP* pattern:
The proprietary precursor implementation to MPP uses this pattern. To prevent interoperability problems, use of this pattern is reserved.

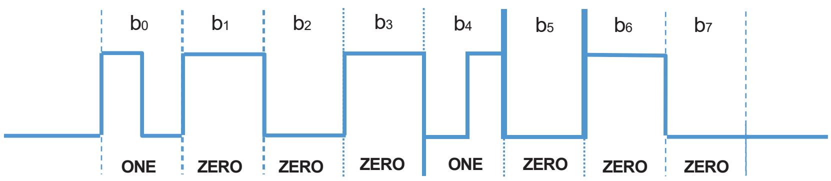

Figure 2.6: MPP FSK Pattern Format

2.3.2 Timings Override

FSK Response Window

Due to the addition of preamble to the FSK packets, the start of the FSK packet now points to the start of preamble of the FSK packet as shown in Figure 2.7.

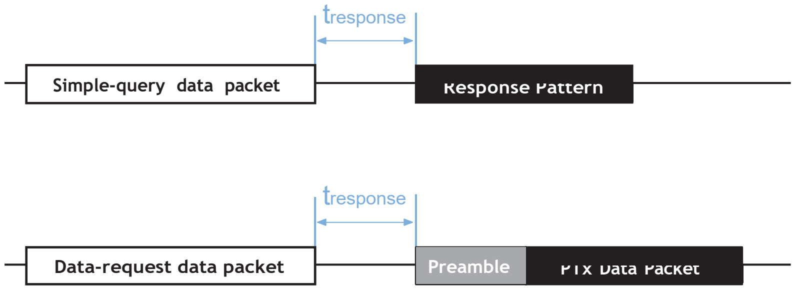

Figure 2.7: MPP FSK Response Timing

No Power Signal Window

Time duration between two consecutive pings ($t_{nopower}$) has been updated. Refer to table 2.4.

Table 2.4: MPP PTx Parameters Override

Parameter	Symbol	Minimum	Target	Maximum	Unit
No Power Signal window	$t_{nopower}$	50	N/A	N/A	ms

2.3.3 Startup Behavior

After detecting PRx placement on the charging surface, MPP PTx shall perform digital ping and identify the Power Receiver using the information embedded in ID and XID packets as described in Section 2.2.2.

From the PTx's perspective, a PRx supports MPP if both of the following conditions are satisfied:

1. **Qi Version:** Qi protocol version in ID packet (Section 2.2.2) is set to (Major=2, Minor=0) or higher.
2. **MPP Support Advertised:** Sub-header (byte 0) in XID packet is set to MPP selector (Section 7.1.20)

If the conditions are not satisfied, the Power Transmitter shall proceed to the next phase according to the Qi specifications.

Depending on the digital ping level used to establish the communication at 128kHz frequency, PTx shall set an internal error status as following:

- **Error = None:** Communication at 128kHz was established using 'Qi_HB_Low' digital ping level
- **Error = digital ping level mismatch:** Otherwise

PTx shall then proceed to the requested MPP operation mode reported in MPP-XID packet as following:

- Activate Restricted Mode: If Restricted flag is set to one.
- Activate Full mode: If Restricted flag is set to zero.

PTx shall clear the error status if it decides to remove the power signal for any reason i.e., error status shall not persist across communication restarts.

MPP Restricted Mode

PRx may choose to operate under MPP- Restricted Power Mode by setting the Restricted field in MPP-XID packet to 1.

PTx shall decode the MPP-XID packet and proceed as following:

- **If active frequency is 360kHz:** Proceed assuming MPP Restricted mode
- **Else:** Proceed depending on the error status

If the error status is not set, PTx shall remove Power Signal and start digital ping using 360kHz as operating frequency after *t_nopower*. Otherwise, PTx shall remove the power signal and perform digital ping again using 128 kHz and 'Qi_HB_Low' digital ping level.

Figure 2.8 describes the frequency change behavior under Restricted mode.

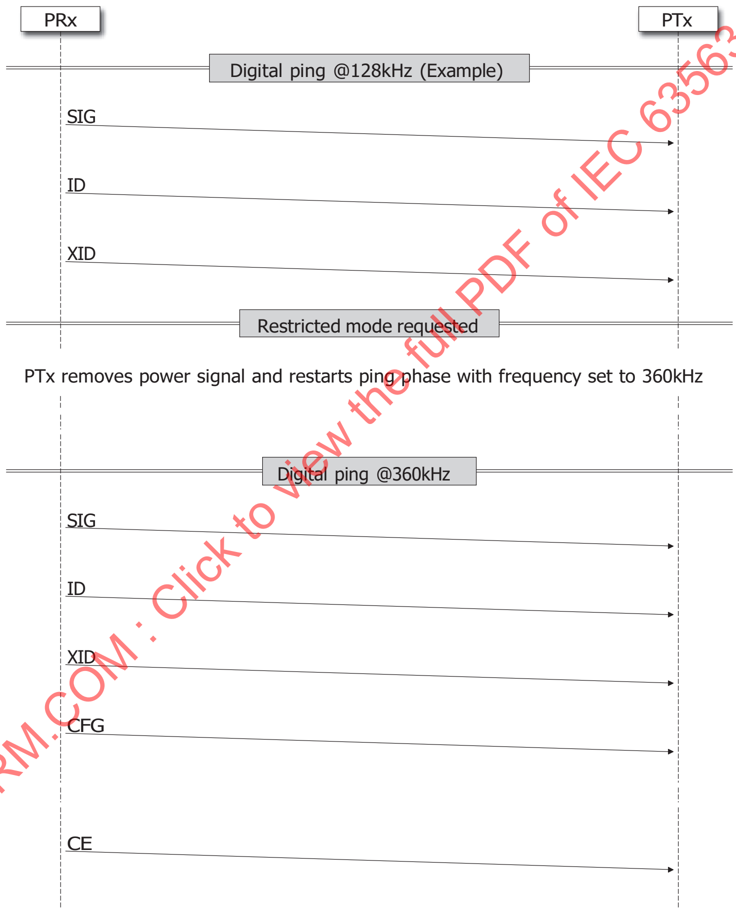

Figure 2.8: MPP Restricted Frequency Change Sequence

MPP Full Mode

PTx shall continue processing all packets in configuration phase and respond to the Configuration (CFG) packet as following:

- FSK MPP Pattern: error status is not set
- FSK NAK Pattern: error status is set

PTx shall generate the FSK response using 512 switching cycles. After responding with FSK, PTx shall proceed to MPP negotiation phase as described above.

FSK patterns are described in Table 2.3

Figures below summarize the 128kHz and 360kHz digital pings behavior for both Restricted and Full modes.

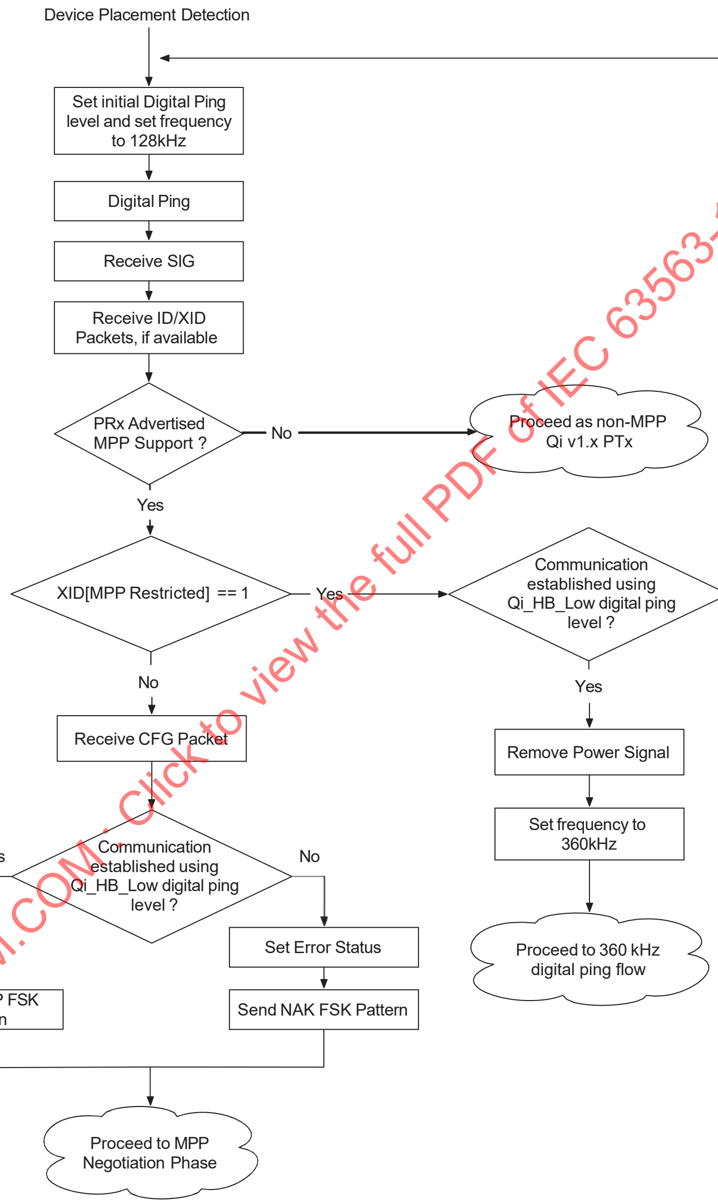

Figure 2.9: MPP Power Transmitter Configuration Phase Decision Tree Flow - 128kHz ping

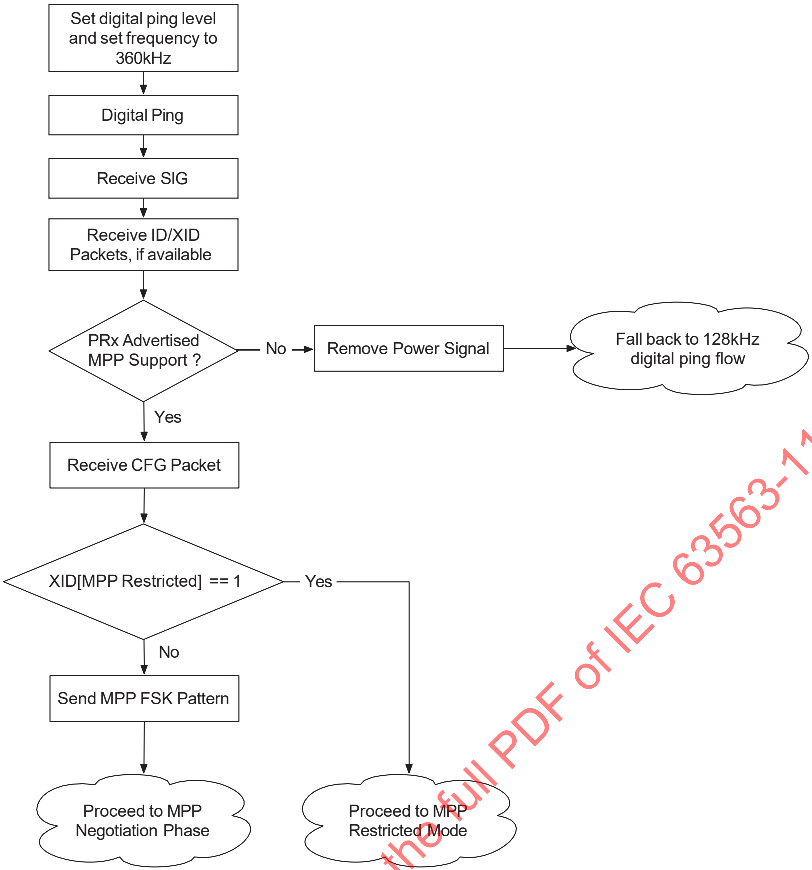

Figure 2.10: MPP Power Transmitter Configuration Phase Decision Tree Flow - 360kHz ping

2.4 Supporting EPP and MPP protocols

Devices may choose to support multiple power profiles / protocols e.g., PRx/PTx may support EPP in addition to MPP. This section discusses how these devices behave when attached to another device that supports EPP, MPP or both.

2.4.1 MPP/EPP Support on PRx

PRx may choose to advertise MPP and EPP support by performing the following:

- MPP Support: Described in section 2.2.2
- EPP Support: Follow the Qi communications protocol specifications

PRx will send the MPP-XID packet to the Power Transmitter, and also properly set the configuration packet to advertise EPP support (e.g. FSK parameters, NEG bit set to 1, etc.).

After sending the CFG data packet, PRx will have to attempt to decode FSK, PRx will proceed depending on the decoding result:

- MPP Supported Patterns received (MPP, NAK): PTx supports MPP, PRx shall proceed using MPP protocol
- ACK Pattern received: PTx supports EPP, PRx shall proceed using EPP protocol
- Timeout: PRx shall proceed using BPP protocol

2.4.2 MPP/EPP Support on PTx

Depending on the data provided by PRx during configuration phase, the PTx will be able to determine which power profile is supported by the PRx.

- MPP Support advertised: PRx advertises MPP support as described in section 2.2.2
- EPP Support advertised: PRx advertises EPP support as described in Qi communications protocol book (e.g., NEG bit is set in CFG packet)

PTx may detect a PRx that supports one or more profiles, PTx shall proceed as following:

- PRx supports MPP and EPP: PTx shall always prioritize MPP protocol by responding with a supported FSK pattern (MPP, NAK) to CFG packet as described in Section 2.3.3
- PRx supports EPP: PTx shall proceed with EPP protocol by responding with ACK pattern to CFG packet as described in Qi communications book

PTx uses fixed FSK parameters when engaged in MPP session. If PTx decides to engage in EPP session, PTx shall use the FSK parameters as described in CFG data packet

Negotiation Phase 3

3.1 Overview

MPP Negotiation phase is based on Qi EPP specifications i.e., EPP timing specifications, packets, and rules apply to MPP negotiation phase. Any changes to the specifications are explicitly stated.

Note on EPP compatibility

MPP does not support **FOD** packet or FOD calibration phase.

3.2 Requirements

After Configuration phase, PRx and PTx shall proceed to negotiation phase if the PRx requested to enable MPP full operating mode.

In this phase, PRx shall only use packets that are allowed to be used in negotiation phase by Qi EPP specifications and MPP specifications (Table 3.1)

If PTx detects a power transfer phase packet e.g. CE packet before completing the MPP negotiation, it shall remove the power signal, and proceed to Ping Phase. Receiving a CE packet after entering MPP negotiation phase indicates that PRx was unable to decode MPP FSK pattern correctly. Removing the power signal allows the PTx to retry activating MPP.

Table 3.1: PRx packets allowed during MPP negotiation phase

Mnemonic	Name	Section
-	Qi negotiation phase packets	
SRQ	Specific Requests	
GET	Get request	7.1.11
EDS	Enabled Data Streams	7.1.12
REPORT	Report	7.1.16
PLAP	Power Loss Accounting Parameters	7.1.19
ECAP	Extended Received Capabilities	7.1.21
PROPn	MPP PRx Proprietary Packets	7.1

PRx negotiation behavior may differ based on the active operating frequency e.g., PRx may perform PTx identification and Frequency Selection at 128kHz negotiation phase, and perform power negotiation after switching to 360kHz base frequency (in MPP negotiation phase).

3.2.1 Negotiation Phase Timings

MPP negotiation phase timings follow the EPP timings as described in Qi communications protocol book with the addition of the following timings parameters:

Table 3.2: MPP Negotiation Phase Timing Parameters

Parameter	Side	Symbol	Minimum	Target	Maximum	Unit
Re-negotiation Timeout	PTx	$t_{renegotiate}$	700	800	900	ms

$t_{renegotiate}$ only applies to renegotiation phase. Timing diagram is shown in Figure 3.1.

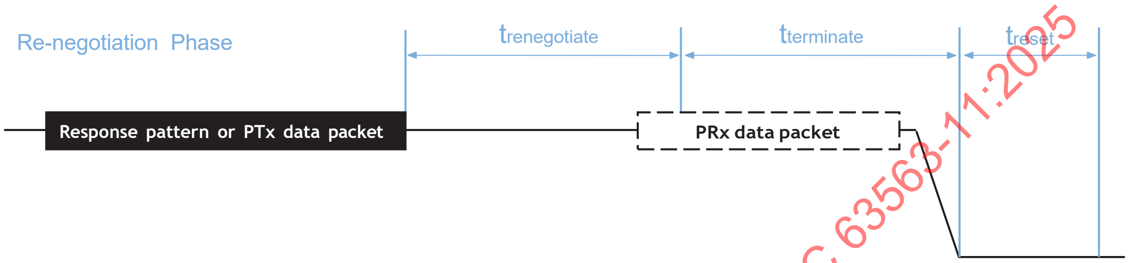

Figure 3.1: Negotiation Phase Timing Parameters - $t_{renegotiate}$

3.2.2 FSK Cycles

PRx and PTx shall update FSK switching cycles to 128 cycles, immediately upon entering MPP negotiation phase.

PRx and PTx shall set FSK cycles to 512 after entering ping phase (e.g., after disconnect).

3.2.3 Entering Negotiation Phase With Error Status

In some scenarios, PTx may decide not to proceed with MPP-Full mode. Reason could be due to the ping configuration used to estimate-k (e.g., digital ping level is not 'Qi_HB_Low'). PTx shall let the PRx know by responding with FSK NAK pattern to CFG data packet as described in Section 2.2.3. After receiving NAK pattern, PRx shall enter negotiation phase with error status.

In negotiation phase, PRx may optionally retrieve any information such as the error status data packet from PTx using *GET [Error Status]*. PTx shall respond with ERR data packet 7.2.1.

When ready, PRx shall request communication restart using *EPT/rst* instead of sending *SRQ/en* to avoid entering Power Transfer Phase.

PTx shall not allow PRx to enter power transfer phase and shall respond to *SRQ/en* with *NAK*.

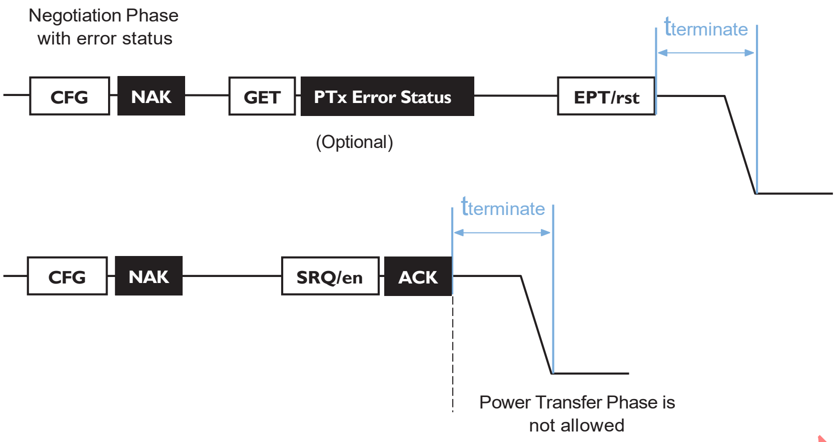

Figure 3.2: Negotiation with error status

3.2.4 Power Transfer Contract Extension

MPP uses Qi EPP power transfer contract elements as a baseline and adds / removes elements as described in this section.

Not supported elements:

1. *Received Power window size*: This element is non-negotiable in this version of the specification. Refer to MPP System Specifications - MPLA PRx Specifications Section 7.3.2.1 for more information.
2. *Received Power window offset*: This element is non-negotiable in this version of the specification. Refer to MPP System Specifications - MPLA PRx Specifications Section 7.3.2.1 for more information.
3. *Reference Power*: This element is non-negotiable and not used in this version of the specification.
4. *Received Power Resolution*: This element is non-negotiable in this version of the specification and it is automatically set to PLA header (0x58). Refer to Qi Communication Protocols Section 6.1 for more information.
5. *FSK Polarity and Modulation depth*: This element is non-negotiable in this version of the specification.
6. *Guaranteed Power*: Replaced by *Extended Guaranteed Power* element, PRx/PTx shall not use this version of the element.
7. *FSK Switching Cycles*: Specifies the number of switching cycles per FSK bit. This element is non-negotiable in this version of the specification.

Supported elements:

1. *Power Control Hold-off*: Refer to Qi Communication Protocols for more information.
2. *Re-ping delay*: Refer to Qi Communication Protocols Section 6.1 for more information.
3. *Potential Load Power*: Refer to Qi Communication Protocols Section 6.1 for more information.
4. *Extended Guaranteed Power*: Allows PRx to negotiate the guaranteed power value in 100mW resolution. This element replaces the Qi Guaranteed Power transfer contract element.
5. *Frequency Selection*: Allows PRx to negotiate a different operating frequency (e.g., negotiate 360kHz when operating at 128kHz)

6. *Cloak Ping Delay*: PRx can request a temporary interruption of power *(cloak)*. This element allows PRx to negotiate the delay between cloak pings.
7. *Cloak Detect Ping Delay*: Allows PRx to negotiate the time delay between subsequent short cloak detect pings.
8. *Power Control Profile*: Allows PRx to select a specific power control profile depending on coupling and other parameters (Refer to MPP System Specifications - Section 5.8.2.2.4).

Default values for the new elements added by MPP are described in Table 3.3.

Refer to Qi Communication Protocols Section 6.1 for more information on the default values of Qi power contract elements

Table 3.3: MPP Power Transfer Contract Elements

Element	Symbol	Unit	Negotiable	Default Value	Details
Frequency Selection	N/A	Hz	Yes	Active frequency	Section 7.1.4
Extended Negotiated Power	N/A	W	Yes	5W	Sections 7.1.5
Cloak Ping Delay	t_{cloak}	ms	Yes	500 ms	Sections 7.1.6, 7.1.7
Cloak Detect Ping Delay	$t_{cloakdetect}$	ms	Yes	0 ms (disabled)	Section 7.1.9
Power Control Profile	N/A	N/A	Yes	0	Section 7.1.8

3.3 Negotiation Phase - 128kHz

3.3.1 Nominal negotiation flow

PRx shall use the 128kHz negotiation phase to select the 360kHz operating frequency using SRQ/freqsel as described in section 3.3.3).

In addition to frequency selection, PRx may perform the following actions before exiting the negotiation phase.

1. **Request PTx ID**: Retrieve Qi protocol version and manufacturer code using GRQ data packet *(Refer to Qi Communications Protocol for more information)*
2. **Request Extended PTx ID**: Retrieve MPP PTx Extended ID using *GET [PTx ID]* Request (Section 7.1.11)
3. **Extend re-ping duration**: Extend the time delay before the next 360kHz ping when PRx sends EPT/rep.

It is recommended to perform power related negotiation at the preferred operating frequency i.e. at 360kHz instead of 128kHz, to avoid losing the negotiated contract elements due to power signal removal caused by operating frequency changes.

After completing the transactions, PRx shall terminate the negotiation using SRQ/en and then send EPT/rep to start the frequency change flow as shown in Figure 3.3.

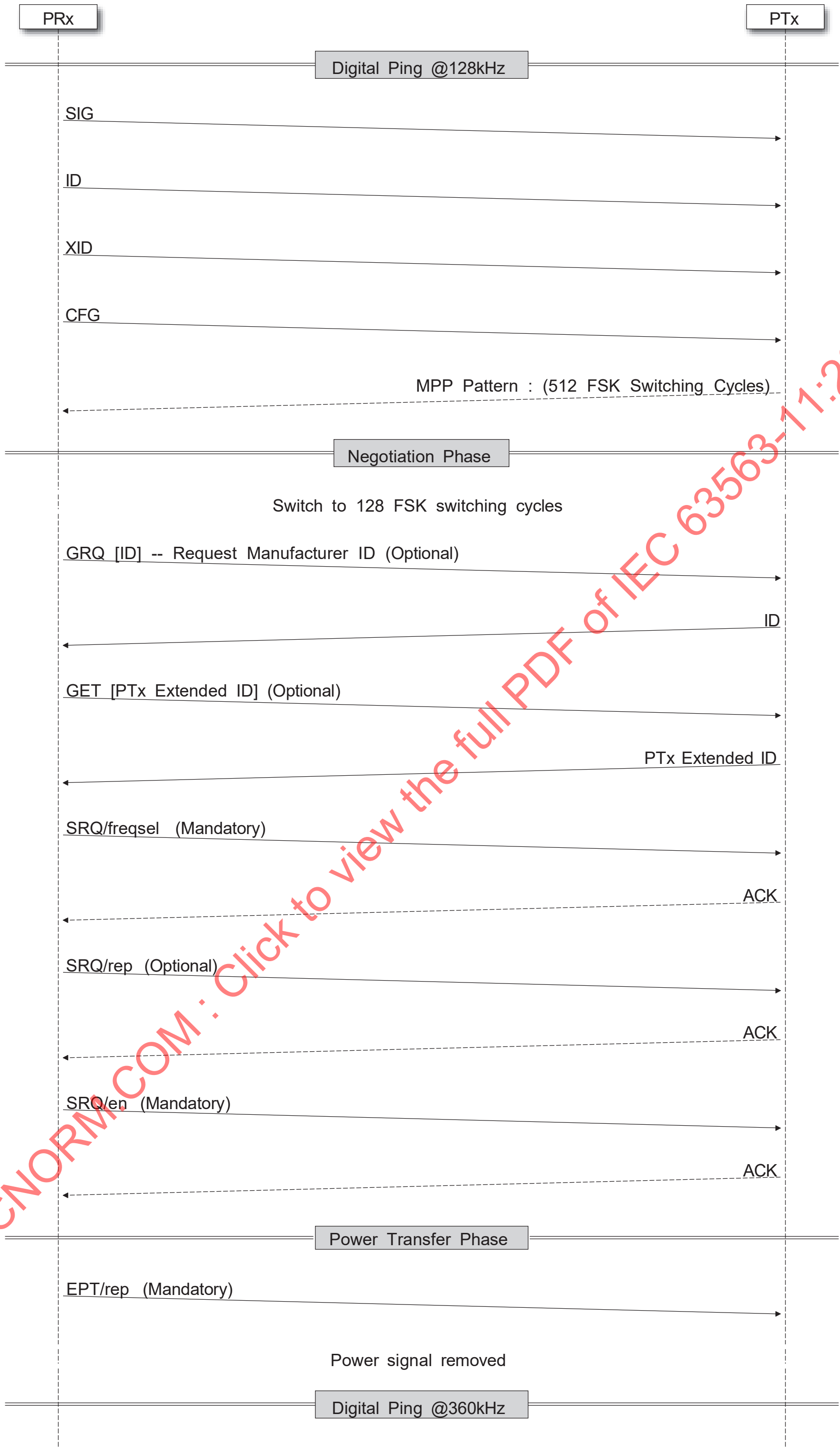

Figure 3.3: MPP Power Negotiation Flow at 128kHz without error

3.3.2 Negotiation flow with PTx error status

Refer to section 3.2.3 for more information.

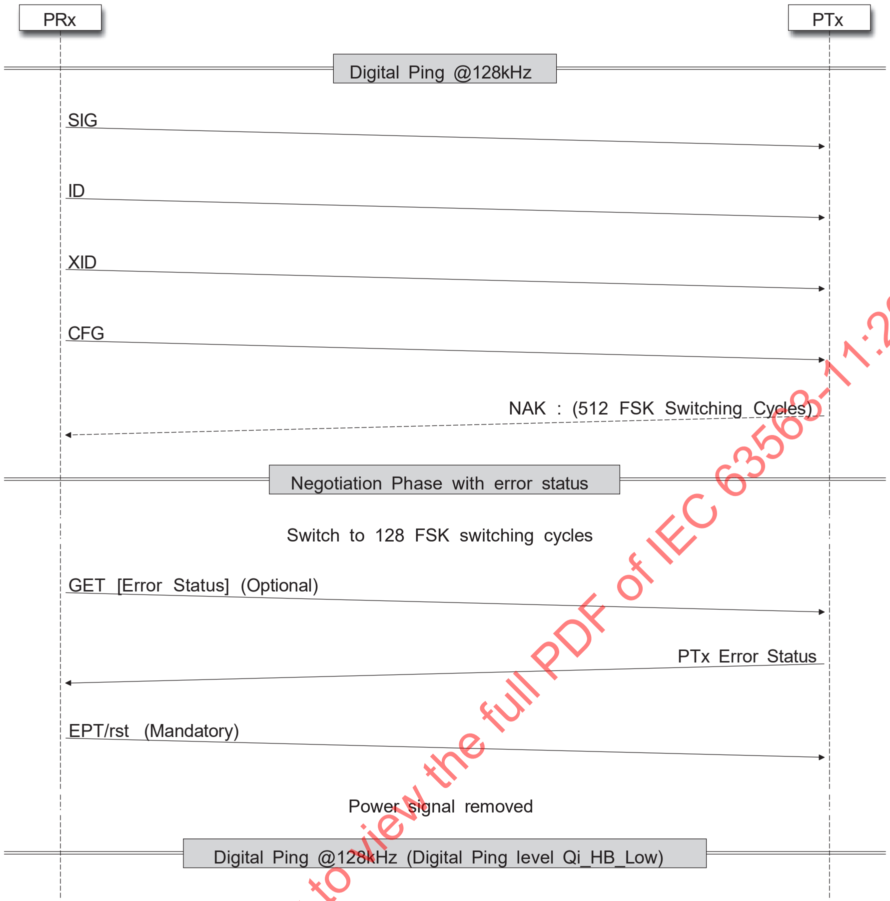

Figure 3.4: MPP Power Negotiation Flow at 128kHz with error status

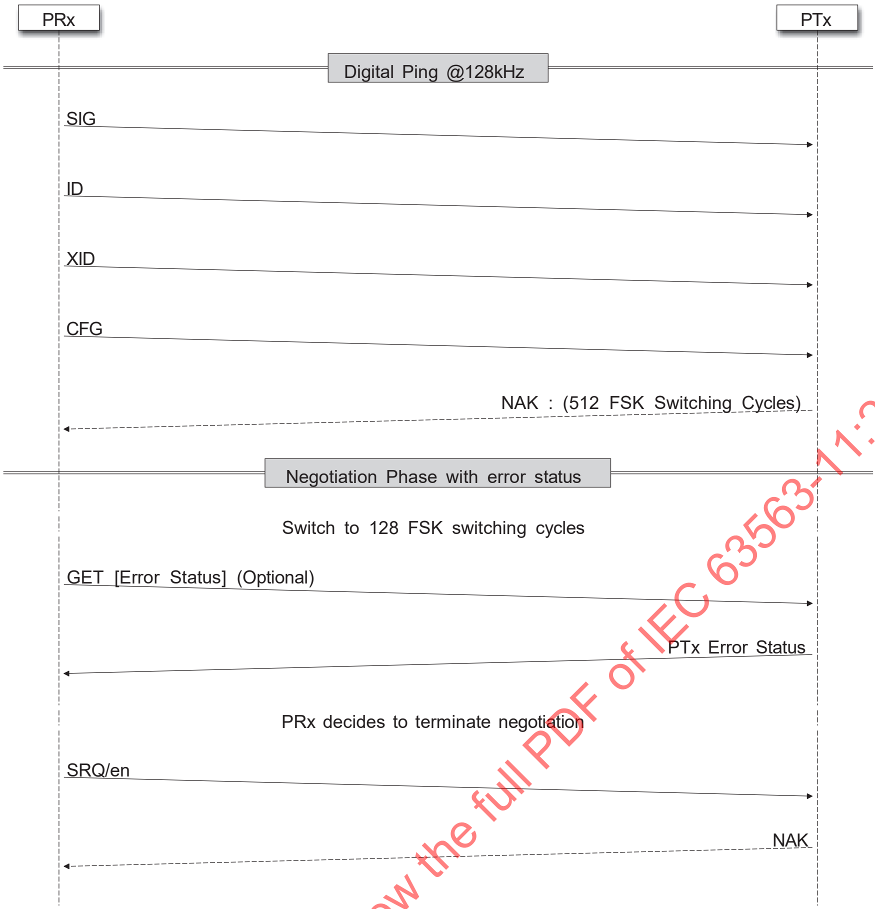

Figure 3.5: MPP Power Negotiation Flow at 128kHz with error status - Misbehaving PRx

3.3.3 Frequency Selection

PRx shall select a new operating frequency (360 kHz) using *SRQ/freqsel* (Section 7.1.4).

After selecting the new frequency and terminating the negotiation using *SRQ/en*, PRx shall request a re-ping using *EPT/rep* to allow PTx to activate the new selected frequency.

1. *EPT/rep* will cause the PTx to remove the power signal, change the operating frequency to the selected value and reset the power contract elements.
2. *EPT/rst* will cause the PTx to remove the power signal, change the operating frequency to 128kHz and reset the power contract elements.

PTx shall follow EPT/rep and EPT/rst timings as specified in Qi Communications Protocol book.

3.4 Negotiation Phase - 360kHz

PRx shall use the 360kHz negotiation phase to negotiate the required power contract elements before entering power transfer phase.

PRx shall perform the following actions in 360kHz negotiation phase:

1. **Send ECAP**: PRx shall send its extended capabilities data packet to PTx (Section 3.4.1)
2. **Request ECAP**: PRx shall request PTx extended capabilities using *GET [ECAP]* Request (Section 7.1.11)
3. **Request PLAP**: PRx shall request PTx power loss accounting parameters using *GET [PLAP]* Request (Section 7.1.11) – PLAP exchange is described in Section 3.4.3.
4. **Send PLAP**: PRx shall send its power loss accounting parameters to PTx using *PLAP* data packet (Section 7.1.19)

PRx may also perform the following actions before exiting the negotiation phase:

1. **Request Extended PTx ID**: Retrieve MPP PTx Extended ID using *GET [PTx ID]* Request (Section 7.1.11)
2. **Power Level Negotiation**: Refer to section 3.4.4.
3. **Exchange Supported Data Streams**: Refer to section 3.4.6.
4. Negotiate other elements described in this chapter

After completing the transactions, PRx shall terminate the negotiation using SRQ/en and transition to Power Transfer Phase as shown in Figure 3.6.

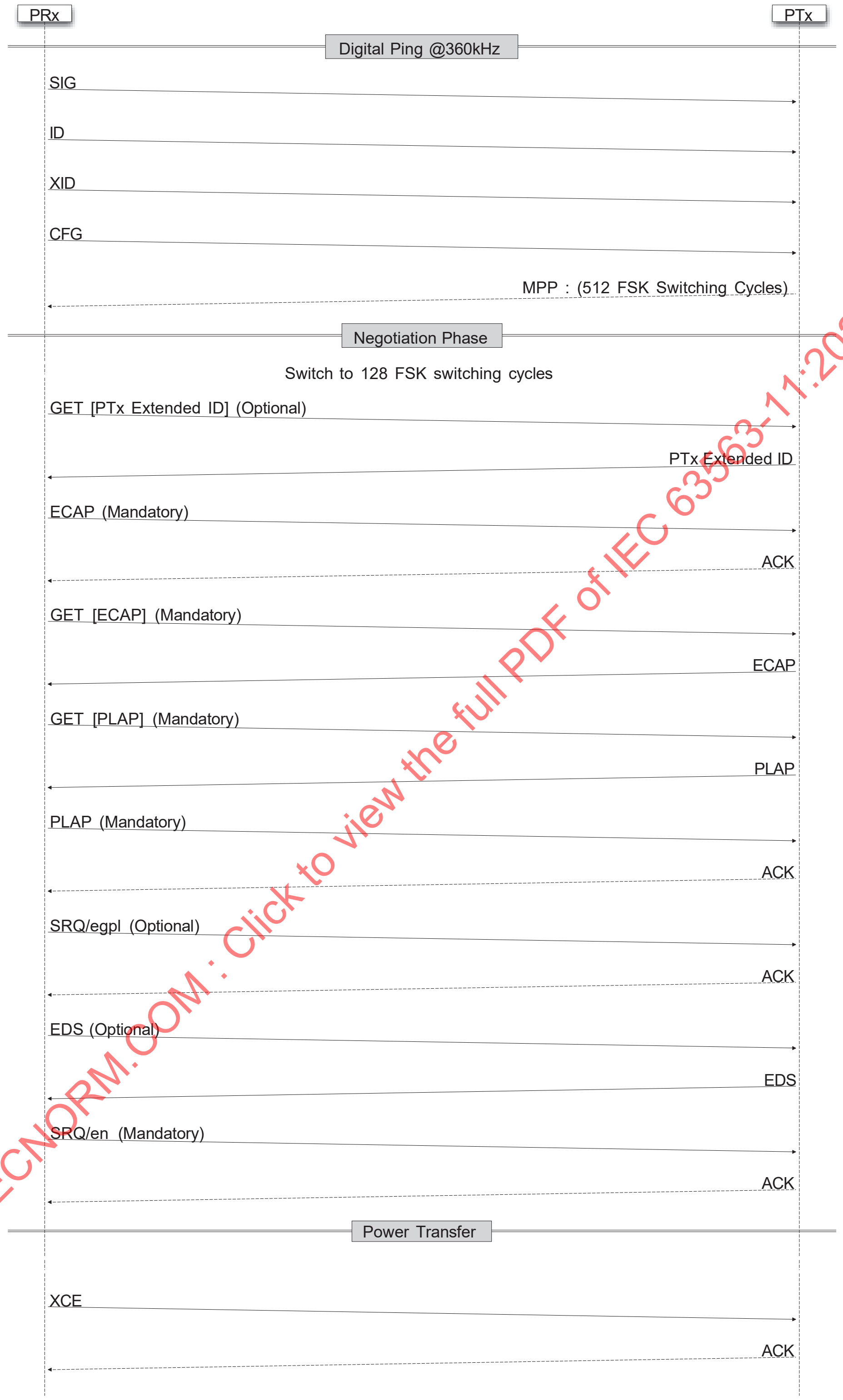

Figure 3.6: MPP Power Negotiation Flow at 360kHz

3.4.1 PRx Extended Capabilities

PRx shall report its capabilities to PTx using the PRx Extended Capabilities packet (Section 7.1.21).

3.4.2 PTx Extended Capabilities

PRx shall request the PTx Extended Capabilities packet using *GET [ECAP]* Request (Section 7.1.11). PTx shall respond with PTx FSK ECAP data packet (Section 7.2.14).

3.4.3 Exchange Power Loss Accounting Parameters

PRx shall request the parameters from the PTx using a *GET [PLAP]* Request (Section 7.1.11). PTx response is described in Section 7.2.12.

After receiving the parameters from the PTx, PRx shall compute the adjusted coefficients and report the values to the Power Transmitter using *Power Loss Accounting Parameters* (Section 7.1.19).

3.4.4 Power Negotiation

MPP Power negotiation is performed by the Power Receiver as following:

1. Request PTx Extended Capabilities using a *GET [ECAP]* Request (Section 7.1.11). PTx response is described in Section 7.2.14.
2. Using *SRQ/egpl*, select a power level ≤ Negotiable Load Power value reported in PTx Extended Capabilities packet.

> 1. MPP uses Qi EPP terms for describing the potential and negotiable load power.
> 2. Power negotiation is not required if selected level is equal to default level specified in Table 3.3

PTx shall report the maximum negotiable power level in the Power Transmitter Extended Capabilities packet based on the available power in the system.

Figure 3.6 shows the power negotiation flow.

3.4.5 Retrieve PTx Extended ID

PRx may request PTx Extended Identification Packet using a *GET [PTx ID]* Request (Section 7.1.11). PTx response is described in Section 7.2.13.

3.4.6 Exchange Enabled Data Streams

PRx should send the Enabled Data Streams packet (Section 7.1.12) to PTx to start exchanging the available (enabled) data streams on each device. PTx shall respond with PTx Enabled Data Streams packet (Section 7.2.6).

> Example: PRx may use the PTx's response to determine if Qi authentication stream is available.

3.4.7 Power Control Profile

PRx may request the PTx to change the active power control profile and set limitations on power control methods using *SRQ/pcp* (Section 7.1.8).

> Power control profile is more likely adjusted during re-negotiation phase.
> Refer to Refer to MPP System Specifications - Section 5.9.2.3.4 for more information.

3.4.8 Cloaking Duration

PRx may negotiate the cloaking period using *SRQ/cloakl,cloakh* requests (Section 7.1.6) and/or enable Detect Ping using *SRQ/detect* (Section 7.1.9)

Cloaking is described in Section 5.1.

3.4.9 MPP Proprietary Requests / Packets

The Power Receiver may set custom parameters *(power contract elements)* in the PTx's contract using *SRQ/MppProp* (Section 7.1.10), or send MPP proprietary packets.

MPP specifications does not control or regulate the proprietary interactions.

3.5 NFC Identification (Informative)

Power Receivers equipped with NFC readers might be interested in performing NFC identification on the PTx or other attached accessories. Due to coexistence issues between wireless power signal and NFC, Power Receiver may request a temporary power signal removal in order to complete the NFC read successfully without any interruptions.

Since the Power Receiver is interested in resuming power transfer after NFC read, it is recommended for the PRx to use *EPT/rep* to instruct the PTx to remove the power signal and restart ping phase after a predefined duration of time.

Since the time to finish the NFC scan might vary depending on the NFC technology, number of available tags, etc., the PRx may negotiate the re-ping time with the PTx during the MPP negotiation phase and renegotiation phase and before asking the Power Transmitter to terminate the power. PRx may use SRQ/rep to negotiate the power pause period in MPP negotiation phase. When PRx is ready to start the scan, it may to send the re-ping request.

Power Receiver should choose a value that is long enough to perform the NFC operations without interruptions, and can also retry again and adjust the timing if the initial requested time was not long enough to perform the NFC operations.

Power Transfer Phase 4

4.1 Overview

MPP Power Transfer phase is based on Qi EPP specifications i.e., EPP timing specifications, packets, and rules apply to MPP power transfer phase with minor differences:

1. **Frequency dependency**: Only 360kHz operating frequency is supported with MPP Power Transfer Phase, PRx shall send *Qi EPT* packets if any other frequency was active.
2. **Power packets**: MPP extends standard CE and RP packets (XCE - Section 4.2, PLA - Section 4.3).

PRx shall issue EPT/rst or EPT/rep when entering MPP power transfer phase if the operating frequency is not 360kHz

4.2 Extended Control Error Packet

MPP Extended Control Error Packet is based on standard Qi CE data packet, with an additional communication window that allows the PTx to communicate with the PRx to either provide feedback (ACK/NAK) or request attention (ATN) for further PTx-to-PRx communication, as described in Section 7.1.2.

(Informative) Allowing the PTx to communicate after every extended control packet improves the latency for some of the PTx-to-PRx communication flows.

4.2.1 Handling

The handling of XCE packet is based on Qi CE packet handling, with the following time adjustments described in Table 4.1.

Figures 4.1 and 4.2 show the timing differences between CE and XCE.

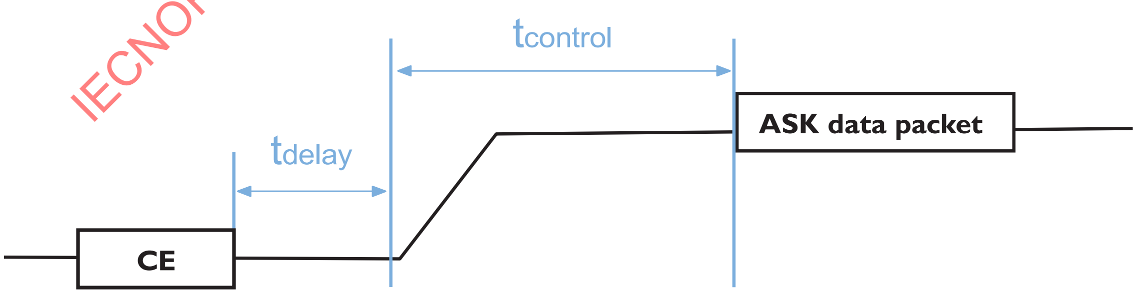

Figure 4.1: Qi CE data packet handling

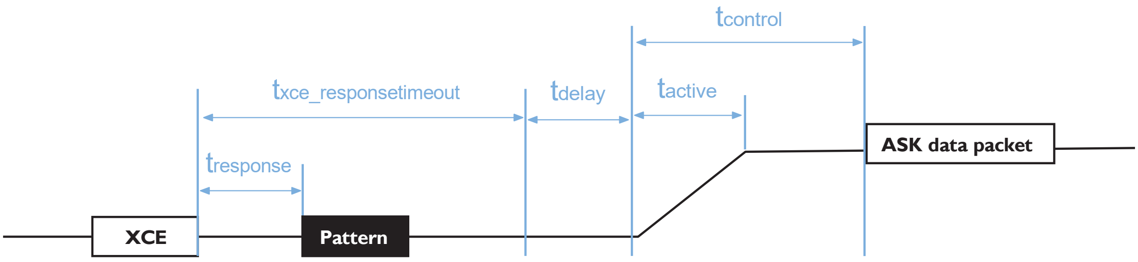

Figure 4.2: MPP XCE handling

Table 4.1: MPP Control Error Parameters

Parameter	Side	Symbol	Minimum	Target	Maximum	Unit
XCE Interval	PRx	$t_{xce\_interval}$	N/A	250	1000	ms
XCE Timeout	PTx	$t_{xce\_timeout}$	2000	N/A	2100	ms
XCE FSK Response Timeout	PRx	$t_{xce\_responsetimeout}$	19	20	21	ms
FSK Response	PTx	$t_{response}$	Same as Qi EPP			

The use of standard control error (CE) data packet is only allowed during MPP-restricted session and it is not allowed during MPP-full session *(illegal)*. MPP PTx shall remove the power signal at $t_{terminate}$ after receiving Qi Control Error (CE) data packet during MPP-Full session.

4.2.2 PTx Response

PTx responses are described in Section 7.1.2. Depending on PTx's response, PRx may proceed as following:

1. **ACK**: PTx accepted the requested voltage update. No additional actions required.
2. **NAK**: PTx rejected the voltage update request. PRx should request the regulation control status packet using GET request (Section 7.1.11) to identify the reason for rejecting the voltage update.
3. **ATN**: PTx requests to communicate. PRx shall follow the attention handling as described in Qi Communications Protocol book.

1. PRx may also request the regulation control status packet if PTx responds with ATN
2. PRx may change its behavior depending on the regulation control status result (e.g. if max/min voltage is reached, PRx may stop to request changes to voltage). The behavior of the PRx is implementation-dependent.

Control status is discussed in Section 4.4.

4.2.3 Example

Figure 4.3 shows an example of a possible XCE interaction.

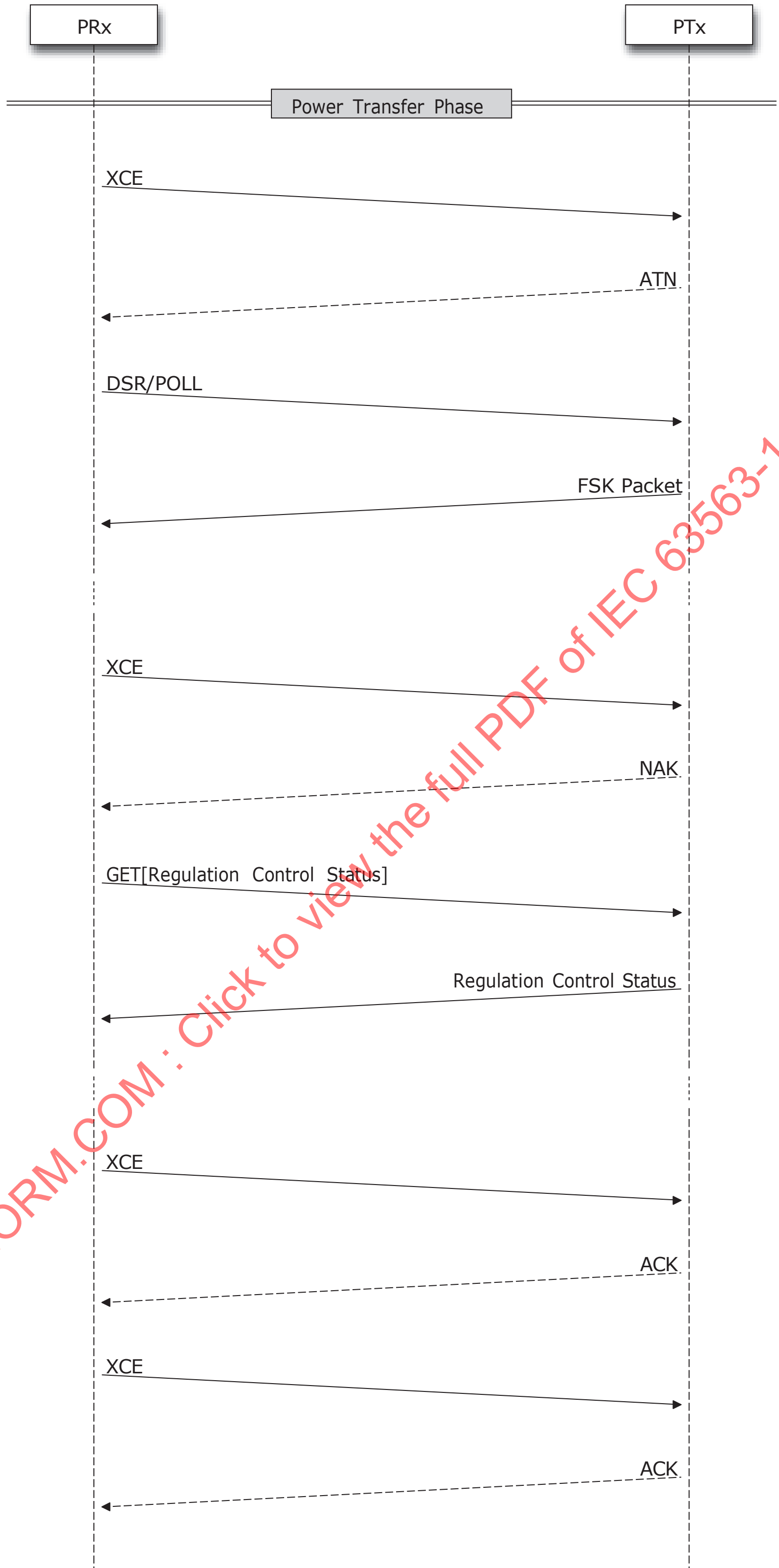

Figure 4.3: Example: MPP XCE Interaction

4.3 Power Loss Accounting Packet

Qi v1.1 introduced power loss accounting for in-power transfer foreign object detection. Modifications are introduced here to extend power loss accounting to 15W power delivery and beyond, without the need for run-time calibrated power loss accounting. This enhanced power loss accounting approach (PLA) will be referred to colloquially as “MPLA”.

PLA is based on standard Qi Received Power packet, with a power throttling window to allow the PTx to try to reduce the power in a predictable fashion. The communication window allows the PTx to communicate with the PRx to either provide feedback (ACK/NAK) or request attention (ATN) for further PTx-to-PRx communication. Power Loss Accounting Packet is described in section 7.1.18.

MPP PTx and PRx shall follow the MPP Power Loss Accounting specifications when performing power measurements, reacting to the received values, and throttling. Refer to MPP System Specifications - Power Loss Accounting (Section 7.3) for more information

4.3.1 Handling

Power Loss Accounting Packet timing specifications are described in Table 4.2.

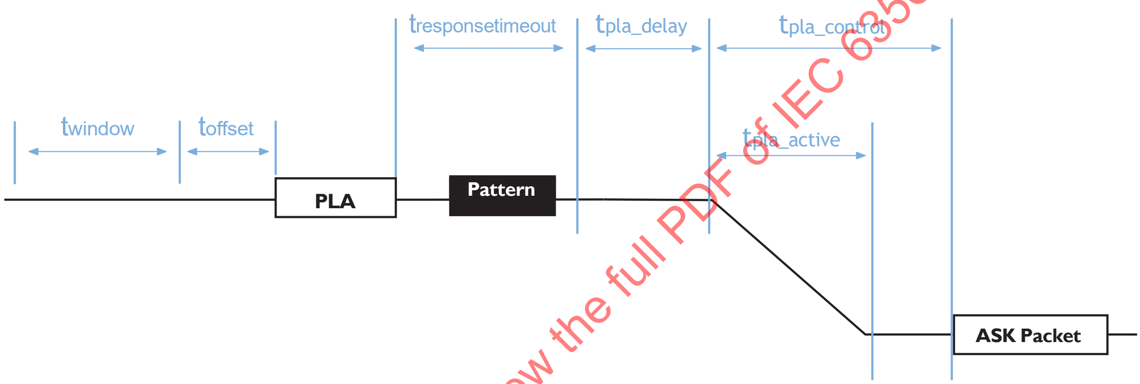

Figure 4.4: MPP Power Loss Accounting Packet Handling

MPP PRx shall send the first PLA data packet at t_{pla_slow} from the start of the power transfer phase. The reference time for the start of the power transfer phase is the start of the SRQ/en data packet in negotiation phase.

PRx shall continue to send Power Loss Accounting data packet with a time interval equal to t_{pla_slow} (slow state) or t_{pla_fast} (fast state) depending on the Power Loss Accounting state (Section 4.3.2).

Table 4.2: Power Loss Accounting Timing Parameters

Parameter	Symbol	Minimum	Target	Maximum	Unit
Power Loss Accounting Period (fast-mode)	t_{pla_fast}	N/A	200	220	ms
Power Loss Accounting Period (slow mode)	t_{pla_slow}	N/A	1500	2050	ms
Power Loss Accounting Power Control Hold-off	t_{pla_delay}	N/A	5	N/A	ms
Power Loss Accounting Power control window (PRx)	$t_{pla\_control}$	24	25	N/A	ms
Power Loss Accounting Power control window (PTx)	t_{pla_active}	N/A	20	21	ms
Power Loss Accounting Timeout (PTx)	$t_{pla\_timeout}$	7600	8000	8400	ms
Power Throttling Capability Update (PTx)	$t_{capupdate}$	N/A	N/A	500	ms

MPP PRx and MPP PTx shall only use MPP Power Loss Accounting data packets for Power Loss Accounting (RP packets defined in Qi are not supported in MPP-Full operation mode).

The use of standard received power (RP) data packet is only allowed during MPP-restricted session and it is not allowed during MPP-full session *(illegal)*. MPP PTx shall remove the power signal at $t_{terminate}$ after receiving Qi Received Power (RP) data packet during MPP-Full session.

4.3.2 PTx Response

Depending on the estimated power loss, PTx may choose to decrease the power level (throttle) in the power update window t_{pla_active} after responding with a NAK as shown in Figure 4.4 *(Refer to MPP System Specifications - Power Loss Accounting (Section 7.3) for more information)*.

PRx shall switch to fast mode t_{pla_fast} after receiving NAK, or if PRx fails to decode the FSK response correctly. Otherwise, it shall switch to Slow Mode t_{pla_slow}.

After completing the power throttling and reaching a safe power level, PTx shall respond with ATN and report the updated negotiable power levels (using PTx ECAP data packet) to PRx within $t_{capupdate}$. PRx shall follow the Qi EPP FSK ATN handling.

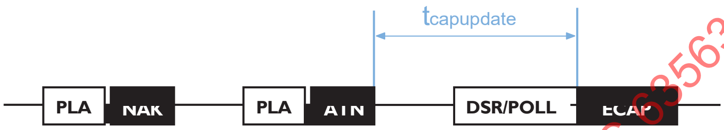

Figure 4.5: PTx reporting updated capabilities after power throttling

Refer to Section 7.1.18 for the other supported responses.

4.4 Control Status

MPP PRx may request the PTx's regulation control status to gain a better understanding of the PTx's state using a *GET* Request (Section 7.1.11). PTx shall respond with Regulation Control Status packet (Section 7.2.3).

PRx may use the information to further optimize its internal charging control loop. Example: PRx may request the information after receiving a NAK to a XCE packet. *(Refer to MPP System Specifications - PTx Control (Section 5.9.2.3.4) for more information)*.

When the control loop state is updated, the PTx may also initiate sending Regulation Control Status packet (Section 7.2.3) if needed.

4.5 GET Request

MPP devices (PRx or PTx) may use the GET request to retrieve specific information from the communication partner (on demand).

4.5.1 PRx Initiated

PRx may use ASK GET request (Section 7.1.11) with parameter field set to a value representing the requested information. PRx may use the GET request in negotiation/renegotiation and power transfer phases.

PTx shall respond to the request within $t_{response}$ as following:

- **Requested Information**: As specified in section 7.1.11.
- **NULL**: If the requested information is not supported.

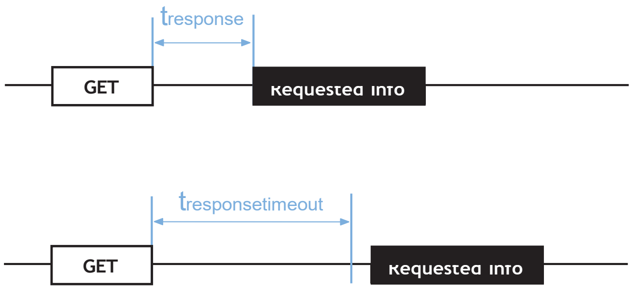

Figure 4.6: GET Request: PRx Initiated

4.5.2 PTx Initiated

PTx may use FSK GET request (Section 7.2.5) with parameter field set to a value representing the requested information. PTx may only use the GET request in power transfer phase.

PRx shall respond to the request within $t_{getresponse}$ as following:

- **Requested Information:** As specified in section 7.2.5.
- **DSR/nd:** If the requested information is not supported.

PTx initiated GET request timing parameters are shown in Table 4.3 and Figure 4.7.

Parameter	Side	Symbol	Minimum	Target	Maximum	Unit
GET Response	PRx	$t_{getresponse}$	N/A	N/A	1000	ms
GET Response Timeout	PTx	$t_{getresponsetimeout}$	1500	N/A	2000	ms

Table 4.3: PTx Initiated GET Timing Parameters

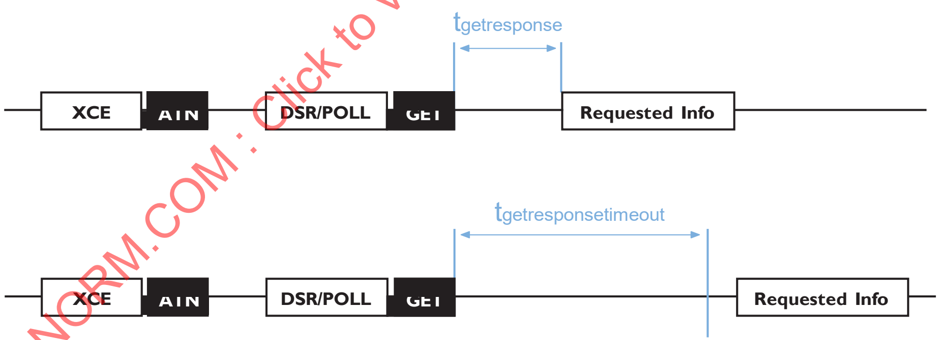

Figure 4.7: GET Request: PTx Initiated

4.5.3 Examples

Examples describing the communication flow for PRx/PTx initiated GET requests are demonstrated below.

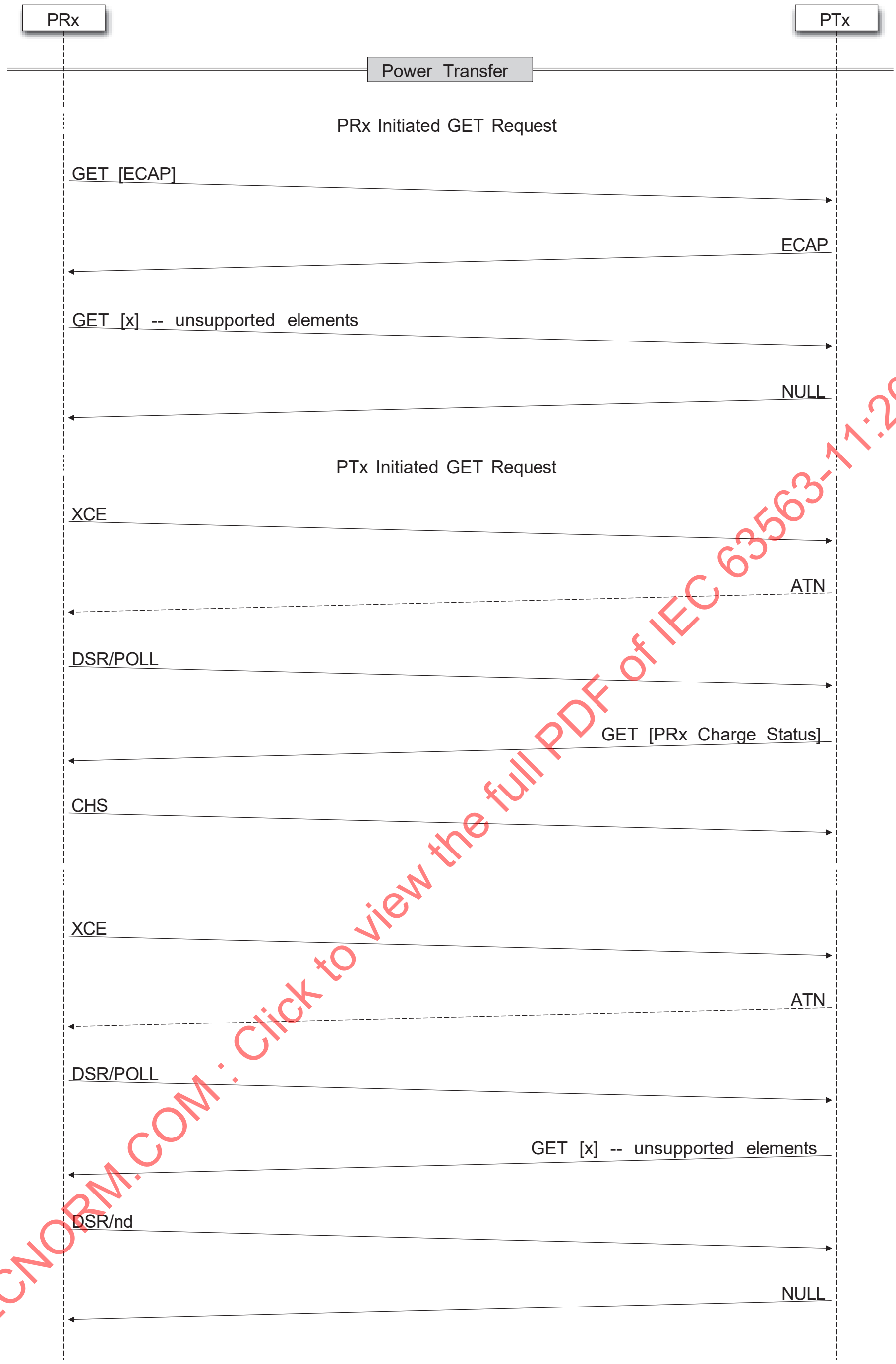

Figure 4.8: GET Request: Example

4.6 MPP-Restricted to Full mode Transition

While operating in MPP-Restricted mode, MPP PRx might decide to switch to MPP-Full mode while in Power Transfer phase.

4.6.1 Transition with power interruption

The Power Receiver may choose to send **EPT/rst** packet to the Power Transmitter resulting in removing the power signal and proceeding to ping phase. After restarting the power, MPP PRx will be able to specify the operation mode as MPP-Full during the configuration phase as described in Section 2.2.2.

4.6.2 Transition without power interruption

The Power Transmitter shall allow the Power Receiver to transition to MPP-Full mode during power transfer without interrupting power transfer.

The Power Transmitter shall continuously advertise MPP capabilities to MPP-capable power receivers only, using the MPP FSK Pattern (Section 2.3.1) after CE packets during the Power Control Hold-Off Time t_{delay} window as shown in Figure 4.9. MPP PRx shall attempt to decode FSK communication in the specified window.

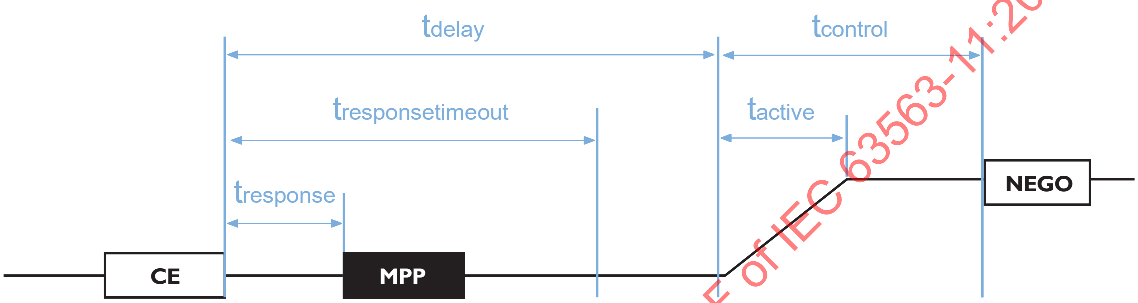

Figure 4.9: MPP PTx Advertising MPP Support

After successfully decoding the MPP Pattern, PRx may send a negotiation request to the Power Transmitter (**NEGO**) to start the negotiation process. PTx shall stop tracking the MPP restricted CE and RP data packet timeouts after entering the MPP Negotiation phase.

After entering negotiation phase, PRx shall perform the mandatory negotiation sequence described in Section 3.4 within $t_{negtransition}$. PTx shall remove the power signal if PRx fails to complete the negotiation after the transition within $t_{negtransitiontimeout}$. Timing parameters are defined in table below.

Table 4.4: MPP Restricted to Full Transition Timing Parameters

Parameter		Side	Symbol	Minimum	Target	Maximum	Unit
Transition Time	Negotiation	PRx	$t_{negtransition}$	N/A	1500	1700	ms
Transition Timeout	Negotiation	PTx	$t_{negtransitiontimeout}$	1800	N/A	2000	ms

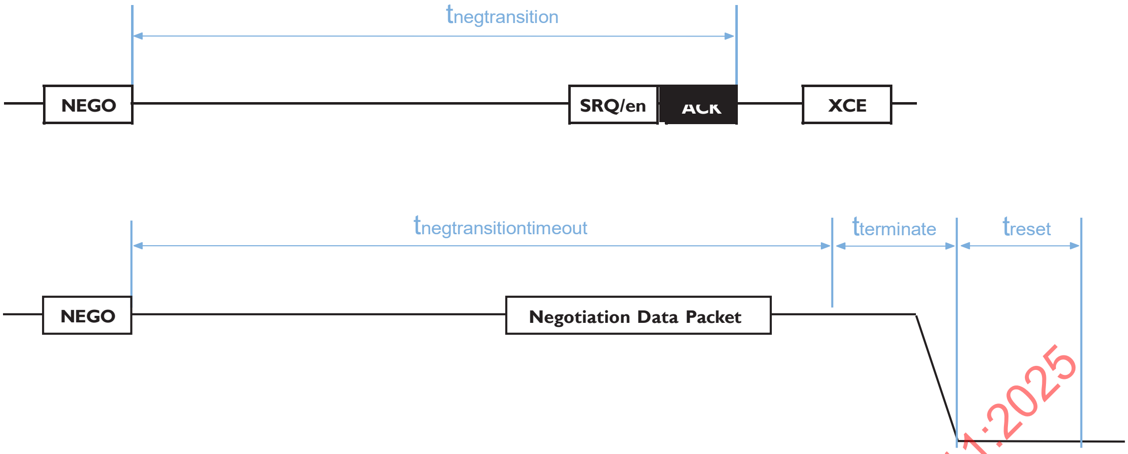

Figure 4.10: Restricted-to-Full Negotiation Timing Constraints

After completing negotiation and entering power transfer phase, PTx will start tracking XCE and PLA timeouts as described in this chapter.

The following requirements must hold in order to allow the Power Transmitter to advertise the MPP capabilities after a CE packet:

1. **PRx**: t_{delay} value set to 20 ms. Power Receiver shall report a PCH packet in the identification/configuration phase (as described in Section 2.2.2)
2. **PTx**: FSK switching cycles set to 128 when transmitting FSK MPP pattern (Section 2.3.1)

Example shown in Figure 4.11.

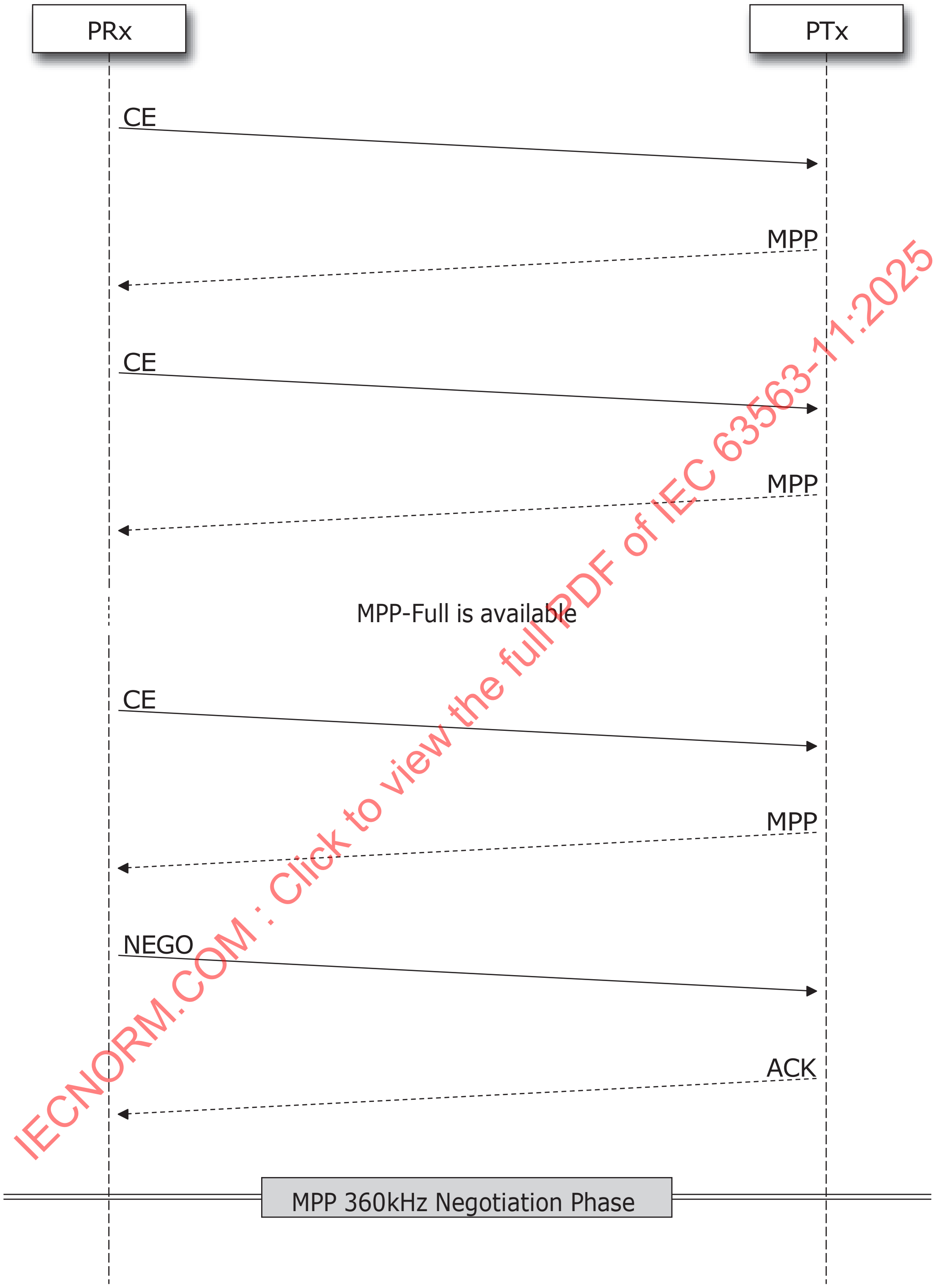

Figure 4.11: PTx MPP Capabilities Advertisement Flow

5 Cloak Phase

5.1 Overview

Cloak is a method for momentarily interrupting power transfer without notifying the user and without resetting the negotiated power transfer contract elements. Power transfer may be interrupted for several reasons including thermal management, power budget changes, coexistence, and many others.

1. Unlike Qi EPT data packets, cloak request allows PTx and PRx to maintain the negotiated power transfer contract elements upon cloak entry/exit.
2. Cloak requires the Power Receiver to have a power storage element (e.g. battery) in order to retain state and other information after the removal of the power signal.

Cloak State can be initiated by PRx or requested by PTx using MPP CLOAK data packets (ASK: Section 7.1.1, FSK: Section 7.2.2).

Cloak State begins once PTx terminates power transfer following the processing of ASK *CLOAK* data packet. Cloak State is a period of power interruption, followed by a brief period of power transfer. The short period of power transfer is known as cloak ping. The Power Receiver may choose to remain in Cloak State by responding to a cloak ping with a CLOAK data packet or may choose to exit cloak state by initiating cloak exit handshake as shown in Figure 5.1.

Cloak exit handshake is described in Section 5.4.

5.2 Cloak Ping Requirements

1. PTx shall use the digital ping configuration (ping level used to establish the connection) when performing the cloak ping to communicate with PRx.
2. PRx shall disconnect its load after detecting the removal of the power signal (power interruption period).

5.3 Cloak Entry

PTx and PRx are allowed to initiate cloak entry at any time in Power Transfer Phase. The procedure is described in the following sections.

While in Cloak Phase, PTx shall abandon the Cloak Phase and proceed to Ping Phase if one of the following error scenarios occur:

1. PTx receives a packet other than CLOAK or cloak exit sequence packets
2. Cloak Timeout Timer $t_{cloaktimeout}$ expires (Table 5.2)

PRx shall abandon the Cloak Phase and proceed to ping phase if a cloak ping did not arrive within $t_{cloakpingtnext}$ duration.

5.3.1 PRx Initiated

PRx initiates cloak by sending CLOAK data packet to PTx. PTx shall respond to CLOAK data packet using one of the following options:

1. **Remove Power Signal:** PTx removes the power signal after receiving *CLOAK* data packet in order reduce the total ping duration, implicitly confirming receiving the cloak request.
2. **FSK - ATN:** PTx requests cloak exit (i.e., not ready to enter cloak state)

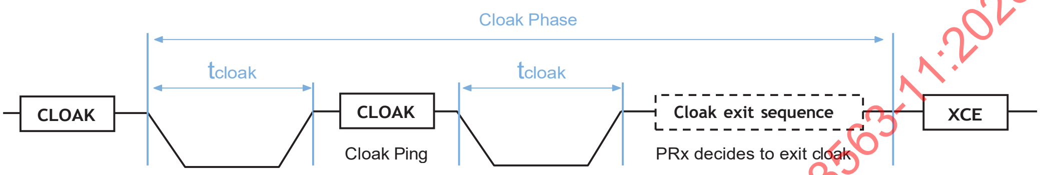

Figure 5.1: Cloak Phase - PRx Initiated

5.3.2 PTx Initiated

PTx initiates cloak by sending a cloak request to PRx using PTx CLOAK data packet (Section 7.2.2).

After successfully receiving the request, PRx shall start the cloak sequence by responding with PRx CLOAK data packet within $t_{ptxcloak}$ (Table 5.2). PTx may choose to re-initiate the request if ASK CLOAK data packet was not received within $t_{ptxcloaktimeout}$ as shown in Figure 5.2

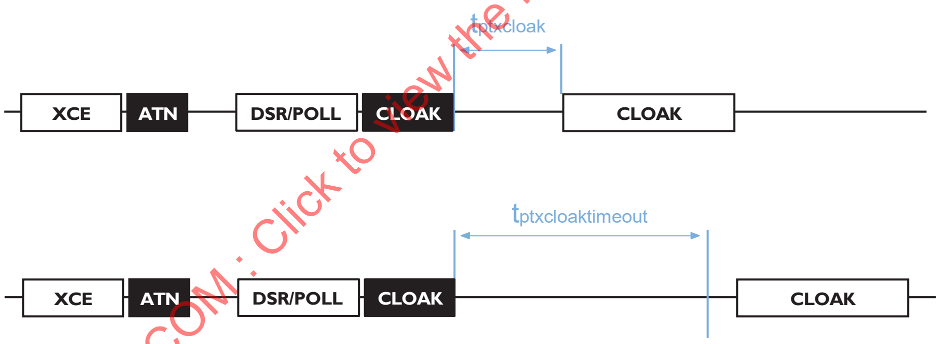

Figure 5.2: Cloak Phase - PTx Initiation Sequence

In PTx initiated cloak scenario, PTx shall always respond to the CLOAK data packet with FSK (ACK or ATN) before removing the power signal as shown in Figure 5.3.

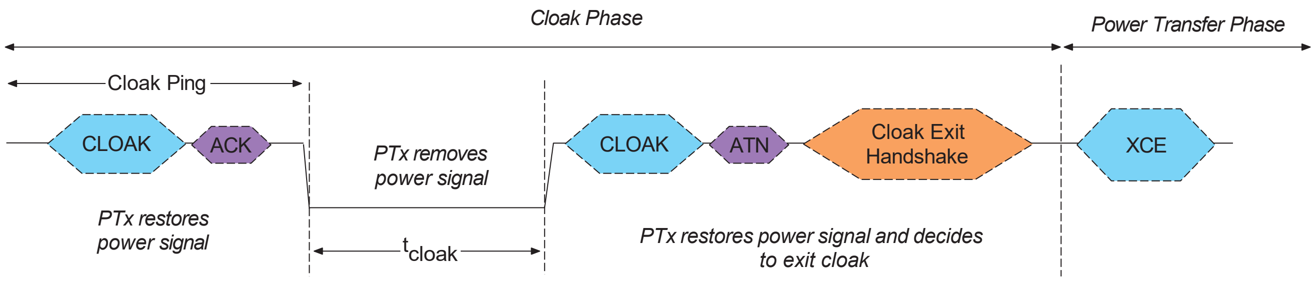

Figure 5.3: Cloak Phase - PTx Initiated - Response

In PTx initiated cloak scenario, If the PRx fails to decode FSK response then PRx shall try to decode on the next cloak ping (retry). PRx shall transition to Ping Phase if FSK decoding continues to fail after retry as shown in Figure 5.4.

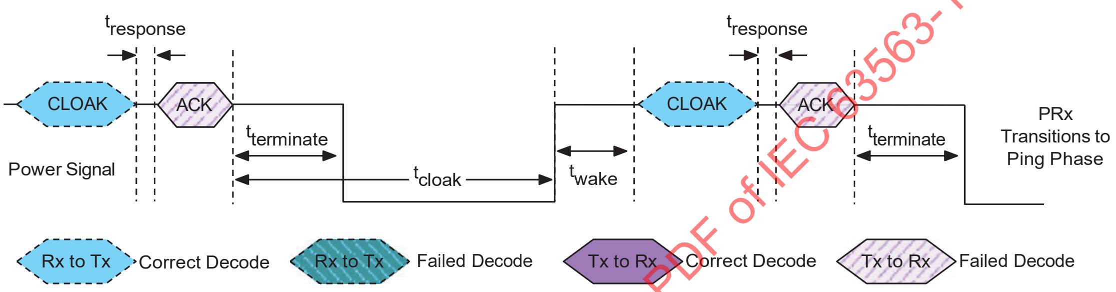

Figure 5.4: PTx Response Decoding Failure for PTx Initiated Cloaking

5.4 Cloak Exit

PRx may decide to exit cloak when ready to resume charging by initiating the cloak exit sequence upon detecting the next cloak ping by sending the following packets:

1. *REPORT [PRx ID]* - Report PRx ID to PTx (Section 7.1.17)
2. *GET [PTx XID]* - Request PTx XID (Section 7.1.11)

Both PTx and PRx shall exit Cloak Phase and transition to Power Transfer Phase after processing the FSK response of GET [PTx ID]. PTx and PRx shall transition to Ping Phase if unexpected identifiers or unexpected (illegal) packets were received.

Exchange of identifiers allows PRx and PTx to detect device swap during cloak

PTx may need to communicate with the PRx in some circumstances during cloak (i.e., change in adapter available power). PTx may request to exit cloak state by responding to CLOAK data packet with FSK ATN pattern. PRx will either service the PTx communication request and start the cloak exit sequence by responding with the PRx ID report packet or deny it by responding with CLOAK[forced] cloak data packet. If PRx decided to honor the cloak exit request, PRx should send DSR/POLL to PTx after entering power transfer phase to allow PTx to send any pending messages.

PTx shall remove power and move to the ping phase (abandoning the cloak) if three consecutive cloak exit requests packets were denied. Otherwise, PTx shall acknowledge receiving CLOAK[forced] data packet and remain in Cloak Phase.

Power transfer phase timeouts are reset after exiting cloak and shall restart counting upon entering power transfer phase.
Example: XCE, PLA, Data Streams, etc. timeouts are reset upon cloak exiting.
The reference time for Power Transfer Phase after exiting cloak is the end of the PTx ID packet.

5.5 Detect ping

Power receivers may choose to increase the cloak period (Section 7.1.6) in order to further decrease the thermal footprint generated by cloak pings. Increasing the cloak period will also increase the device removal detection latency, devices may need to enable Device Presence Detection Ping during cloak to improve the detection latency.

PRx may negotiate the device presence detection mechanism using SRQ/detect (Section 7.1.9) to allow both PTx and PRx to detect the removal or presence of device during long cloak periods as shown in Figure 5.5.

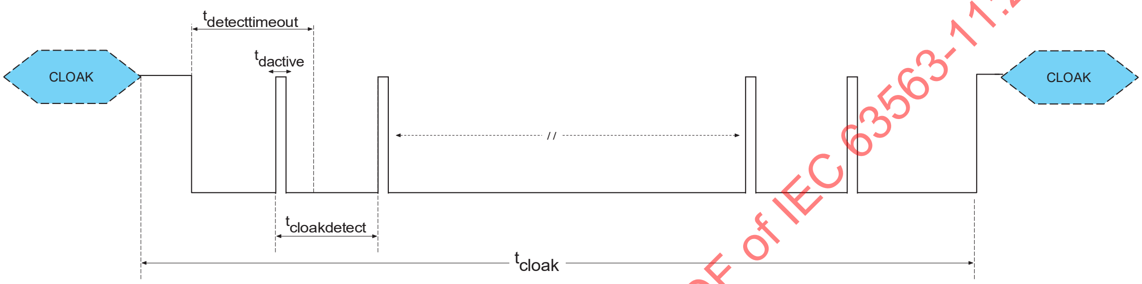

Figure 5.5: Cloak Detect timing diagram

If the detect ping is enabled (negotiated by the Power Receiver), the PTx shall apply a detection mechanism in the $t_{cloakdetect}$ timing period e.g. Object Detection, Low Power Ping, etc., and also apply a short power ping for the time duration specified by $t_{dactive}$ as described in Table 5.2. The short power ping allows the PRx to detect the presence of the PTx as shown Figure 5.5.

If PRx fails to detect the short ping within $t_{detecttimeout}$, PRx shall retry detecting the ping N-times before abandoning the cloak phase and proceeding to ping phase. Parameter *N* is defined in Table 5.1.

Table 5.1: Cloak Detect Parameters

Parameter	Side	Minimum	Target	Maximum
N (Retry limit)	PRx	1	1	Implementation dependent

PTx shall proceed to ping phase (disconnect) if free air response (object removal) is detected.

N does not include the first attempt to detect the ping, i.e., if N = 1, PRx will fail detecting the first ping and then retry one time after.

5.6 State Diagram

The Cloak State Phase state diagram is shown in Figure 5.6. The states are described below:

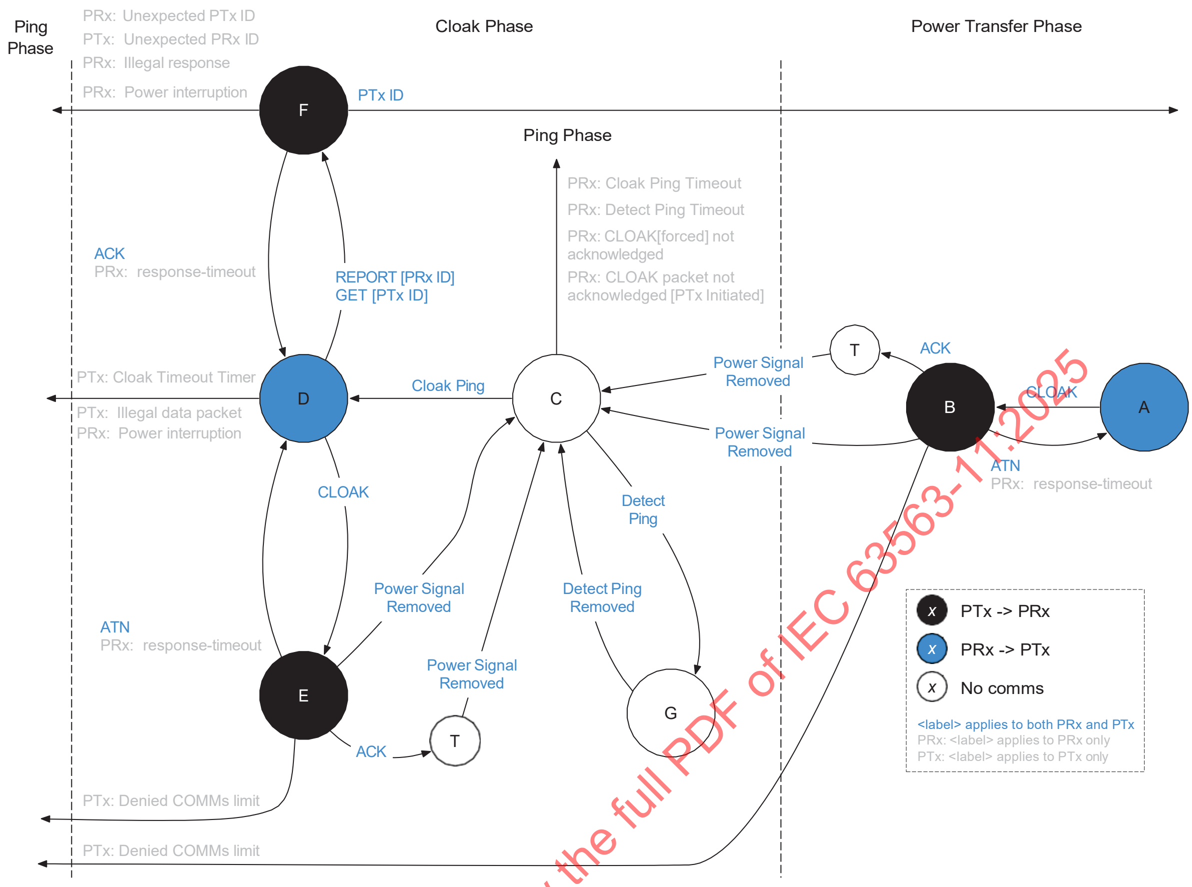

Figure 5.6: Cloak Phase state diagram

State A: PRx and PTx are in Power Transfer Phase. The following transitions are possible:

1. *Both: CLOAK* - PRx sends CLOAK for PRx-initiated or PTx-initiated cloak requests. PRx may send CLOAK[forced] if PTx responded with ATN to a previously sent CLOAK data packet.

State B: PTx receives a cloak request. The following transitions are possible:

1. *Both: power signal removed* - Transition to State C to enter Cloak State.
2. *Both: ATN* - Transition back to State A. PTx replied with ATN. PRx may send DSR/poll to serve the ATN request or send CLOAK[forced].
3. *Both: ACK* - Transition to State T. PRx Received ACK to CLOAK data packet
4. *PRx: response-timeout* - Transition back to State A. PRx may repeat the cloak request.
5. *PTx: denied COMMs limit* - Transition to Ping Phase. All PTx communication attempts were denied.

State T: Transitory state. The following transitions are possible:

1. *Both: power signal removed* - Transition to State C to enter Cloak State.

State C: Main Cloak State. Power signal is absent for time duration specified by t_{cloak}. The following transitions are possible:

1. *Both: cloak ping* - Transition to State D. PTx exits when t_{cloak} timer expires.
2. *Both: detect ping* - Transition to State G. If detect ping is enabled, PTx exits state C when $t_{cloakdetect}$ timer expires.
3. *PRx: cloak ping timeout* - Transition to Ping Phase. PTx failed to perform cloak ping within $t_{cloakpingtnext}$ duration.
4. *PRx: detect ping timeout* - Transition to Ping Phase. PTx failed to perform detect ping within $t_{detecttimeout}$ duration for *N* consecutive times (Table 5.1)
5. *PRx: CLOAK[forced] without ACK* - Transition to Ping Phase. PTx failed to acknowledge CLOAK[forced] request.
6. *PRx: CLOAK packet without ACK [PTx Initiated]* - Transition to Ping Phase. PTx failed to acknowledge CLOAK data packet in PTx initiated cloak scenario.

State D: Cloak ping. PTx restores the power signal to execute the cloak ping. The following transitions are possible:

1. *PTx: cloak timeout* - Transition to Ping Phase. PTx was not able to decode ASK communication within $t_{cloaktimeout}$
2. *PTx: illegal packet* - Transition to Ping Phase. PTx received an illegal packet in response to cloak ping.
3. *PRx: Power interruption* - Transition to Ping Phase. PRx detected an unexpected power removal.
4. *Both: CLOAK* - Transition to State E. PRx sends CLOAK data packet to instruct PTx to stay in cloak phase. PRx may send CLOAK[forced] to instruct PTx to stay in cloak phase as a response to PTx requesting cloak exit.
5. *Both: REPORT[PRx ID]* - Transition to State F. PRx performs the cloak exit sequence by sending PRx ID to PTx.
6. *Both: GET[PTx ID]* - Transition to State F. PRx continues the cloak exit sequence by requesting PTx ID after sending PRx ID to the Power Transmitter.

State E: Stay in cloak. PRx asks PTx to remain in cloak phase. The following transitions are possible:

1. *Both: ATN* - Transition to State D. PTx requests cloak exit.
2. *Both: ACK* - Transition to State T. PTx responds with FSK pattern ACK. PTx accepts cloak request and will remove power signal.
3. *Both: removes power signal* - Transition to State C. PTx removes power signal and remains in cloak phase.
4. *PRx: response-timeout* - Transition to State D. PRx was not able to decode PTx's response.
5. *PTx: denied COMMs limit* - Transition to Ping Phase. All PTx communication attempts were denied.

State F: Cloak Exit. The following transitions are possible:

1. *Both: PTx ID* - Transition to Power Transfer Phase. PTx sent PTx ID. Both PRx and PTx have completed the cloak exit handshake

2. *Both: ACK* - Transition to State D. PTx responded with ACK to REPORT[PRx ID] packet
3. *PRx: Unexpected PTx ID* - Transition to Ping Phase. PRx Received unexpected PTx identifier
4. *PTx: Unexpected PRx ID* - Transition to Ping Phase. PTx Received unexpected PRx identifier
5. *PRx: illegal response* - Transition to Ping Phase. PRx received an illegal response to REPORT[PRx ID] or GET[PTx ID]
6. *PRx: response-timeout* - Transition to State D. PRx was not able to decode PTx's response
7. *PRx: Power interruption* - Transition to Ping Phase. PRx detected an unexpected power removal.

State G: Cloak detects ping. PTx performs cloak detect ping for time duration specified by $t_{dactive}$. The following transitions are possible:

1. *Both: detect ping removed* - Transition to State C. PTx resets $t_{cloakdetect}$ timer and moves back to State C.

5.7 Cloak Timings

The cloak ping duration is limited by the PRx wake-up duration, t_{wake}, the *CLOAK* packet transmission time, and the power termination window $t_{terminate}$.

Qi Communications Protocol defines t_{wake} and $t_{terminate}$ parameters.

Table 5.2: Cloak Time Parameters

Parameter	Side	Symbol	Minimum	Target	Maximum	Unit
Cloak duration	PTx	t_{cloak}		Negotiated value (Section 3.3)		
Cloak ping comms timeout	PTx	$t_{cloaktimeout}$	200	N/A	250	ms
Next Cloak ping timeout	PRx	$t_{cloakpingnext}$	t_{cloak} + 25	N/A	t_{cloak} + 50	ms
Cloak detects active window	PTx	$t_{dactive}$	2	2	5	ms
Cloak detect interval	PTx	$t_{cloakdetect}$		Negotiated value (Section 3.3)		
Cloak detects timeout	PRx	$t_{detecttimeout}$	$t_{cloakdetect}$ + 25	N/A	$t_{cloakdetect}$ + 50	ms
PTx initiated cloak reaction	PRx	$t_{ptxcloak}$	N/A	100	500	ms

Figure 5.8 shows t_{cloak} parameter.

Figure 5.16 shows $t_{cloaktimeout}$ parameter.

Figure 5.5 shows $t_{dactive}$, $t_{cloakdetect}$, $t_{detecttimeout}$ parameters.

Figure 5.7 shows $t_{cloakpingnext}$ parameter.

Figure 5.2 shows $t_{ptxcloak}$ parameter.

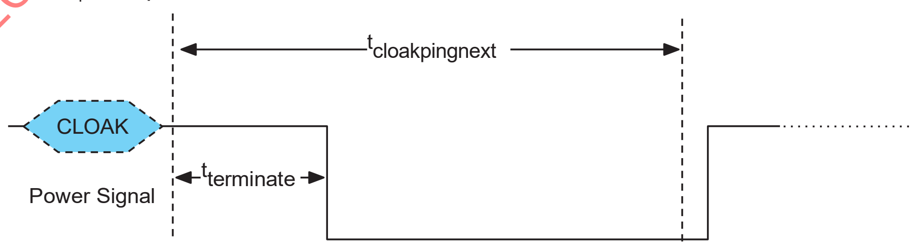

Figure 5.7: Cloak Timings - Next cloak ping timeout

5.8 Examples

Example 1: Devices entering Cloak Phase upon receiving the CLOAK data packet. PRx remains in Cloak Phase by sending CLOAK data packet during Cloak Pings as shown in Figure 5.8.

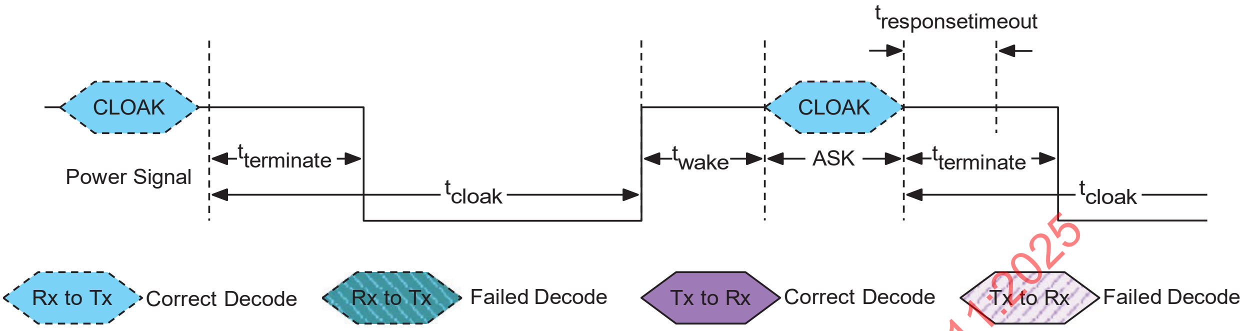

Figure 5.8: Cloak Example 1 - Devices entering and remaining in Cloak Phase

Example 2: Shows PTx requesting communication by responding with an ATN to CLOAK data packet. The PRx accepts the communication request by sending its PRx ID (using PRx ID Report) to initiate cloak exit sequence as shown in Figure 5.9.

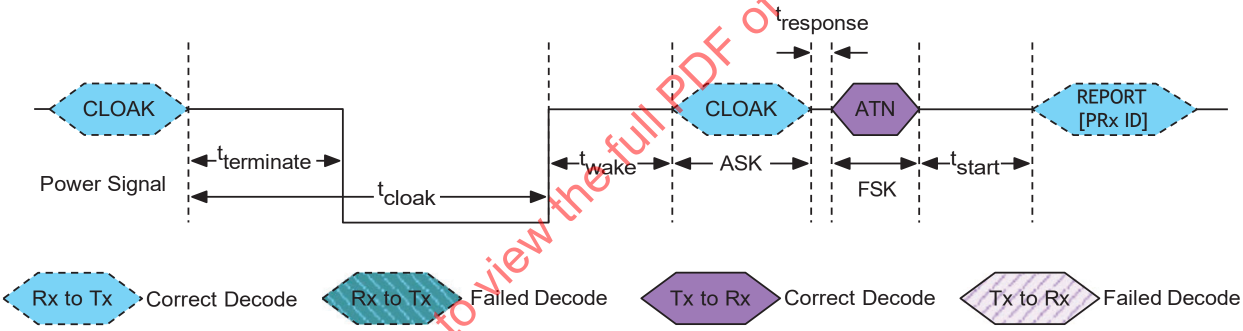

Figure 5.9: Cloak Example 2 - PRx accepts PTx's communication request

Example 3: Shows PTx requesting communication by responding with an ATN to a CLOAK packet. The PRx denies the communication request by sending a CLOAK[forced] packet. PTx decodes the CLOAK[forced] packet and executes the cloak request as shown in Figure 5.10.

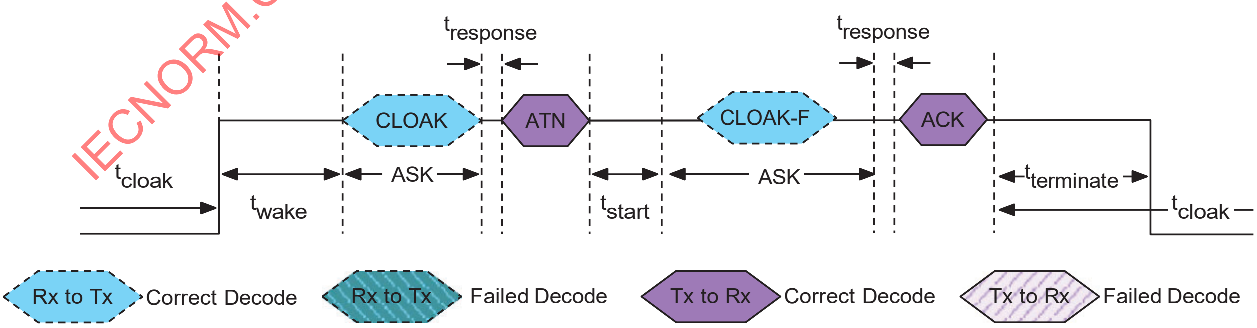

Figure 5.10: Cloak Example 3 - PRx denies PTx's communication request

Example 4: Shows PTx requesting communication with a failed ATN packet decode. The PRx re-sends the

CLOAK data packet to which the PTx responds with another ATN. The PRx denies the communication request by sending a CLOAK[forced]. PTx complies and remains in cloak phase as shown in Figure 5.11.

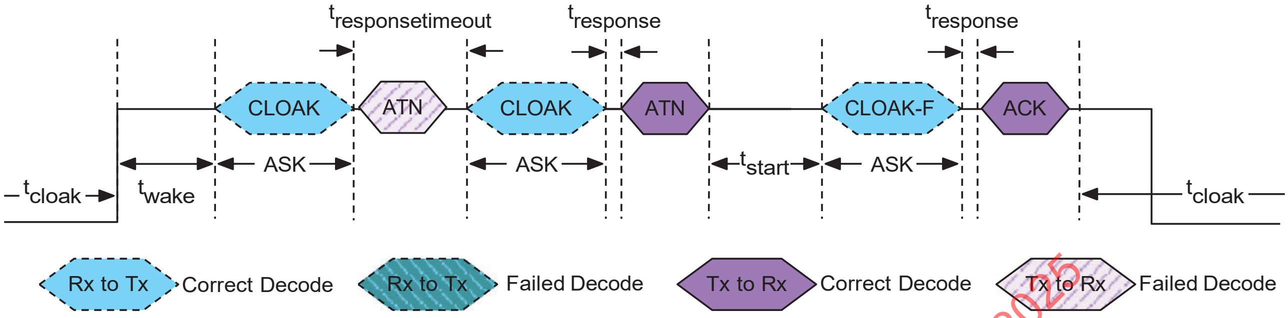

Figure 5.11: Cloak Example 4 - PRx denies PTx's communication request after ATN decode failure

Example 5: Shows PTx maintaining the power signal after failing to decode a CLOAK data packet. The PRx re-sends the CLOAK data packet to which the PTx responds with an ATN. The PRx denies the communication request by sending a CLOAK[forced]. The PTx complies and removes the power signal to resume cloak as shown in Figure 5.12.

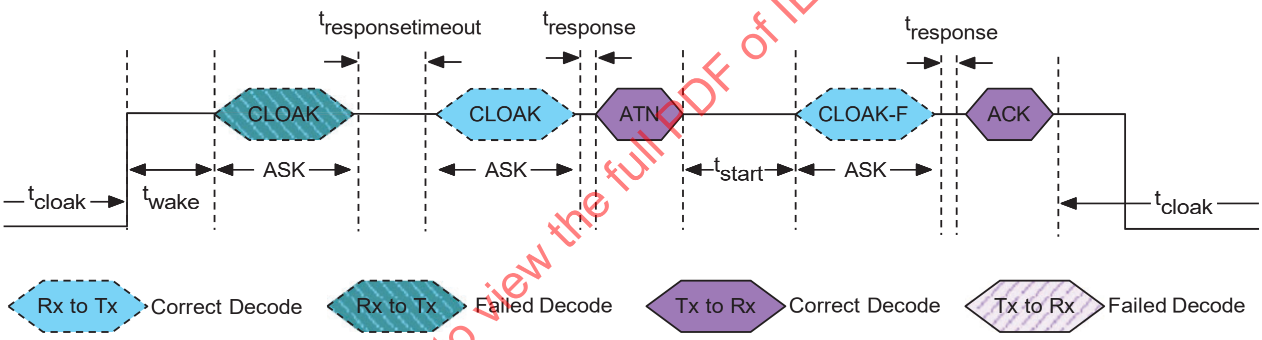

Figure 5.12: Cloak Example 5 - PRx denies PTx's communication request after CLOAK decode failure

Example 6: Shows a PRx exiting Cloak Phase by sending an PRx ID report packet when Cloak Ping is present. PTx acknowledges PRx ID report packet and PRx sends GET[PTx XID] packet requesting PTx XID as shown in Figure 5.13.

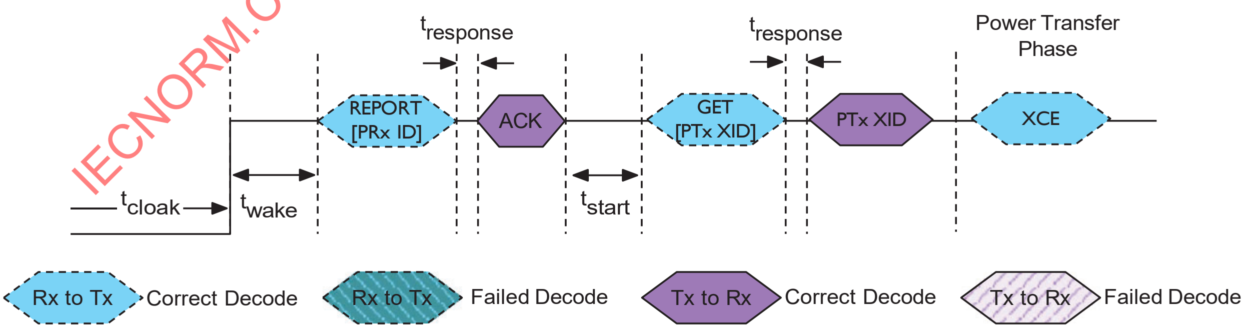

Figure 5.13: Cloak Example 6 - PRx exiting Cloak Phase

Example 7: Shows a PRx exiting Cloak Phase by re-sending PRx ID report packet after the 1st PRx ID report packet is not received or decoded by PTx. PTx acknowledges 2nd PRx ID report packet. PRx sends GET[PTx XID] packet requesting PTx XID.

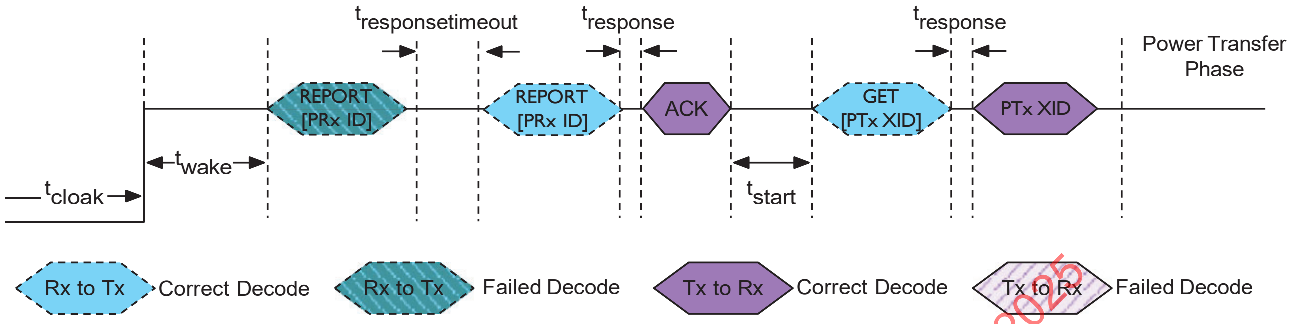

Figure 5.14: Cloak Example 7 - PRx exiting Cloak Phase after 1st PRx ID packet decode failure

Example 8: CE/XCE are illegal data packets while in Cloak Phase. Figure 5.15 shows a PTx interrupting power upon receiving an illegal packet while in Cloak Phase. The initial XCE packet was not decoded by the PTx.

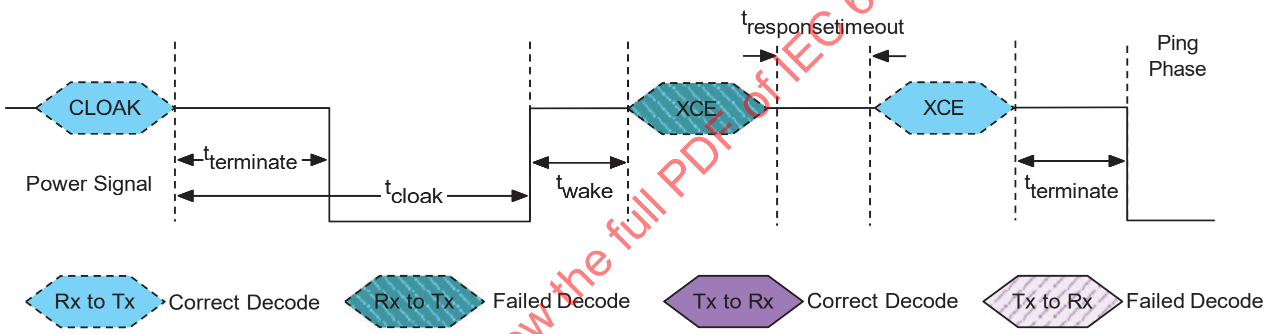

Figure 5.15: Cloak Example 8 - Illegal data packet while in Cloak Phase

Example 9: Shows a PTx interrupting power after the cloak ping timeout timer expires. The PRx sends multiple PRx ID packets that are not decoded by the PTx as shown in Figure 5.16.

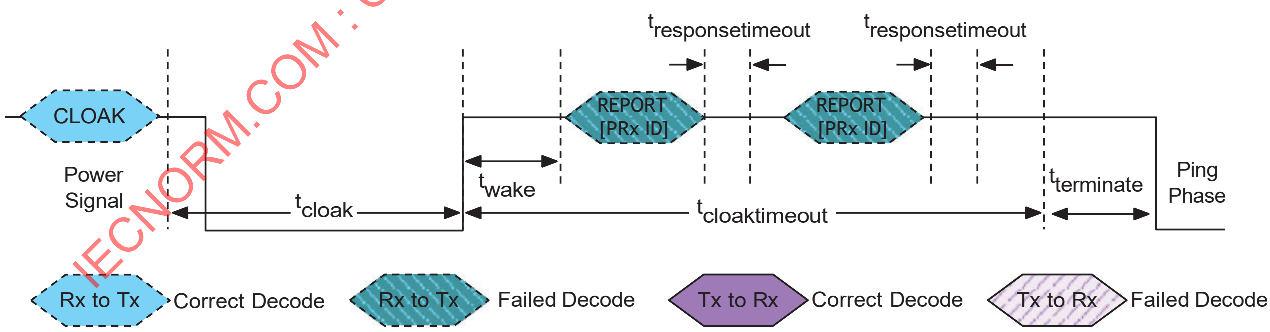

Figure 5.16: Cloak Example 9 - PTx Cloak ping timeout

Example 10: Shows an example how PRx that initiated cloak behaves when removed from MPP PTx charging surface during cloak assuming Detect Ping is not enabled. Example is shown in Figure 5.17.

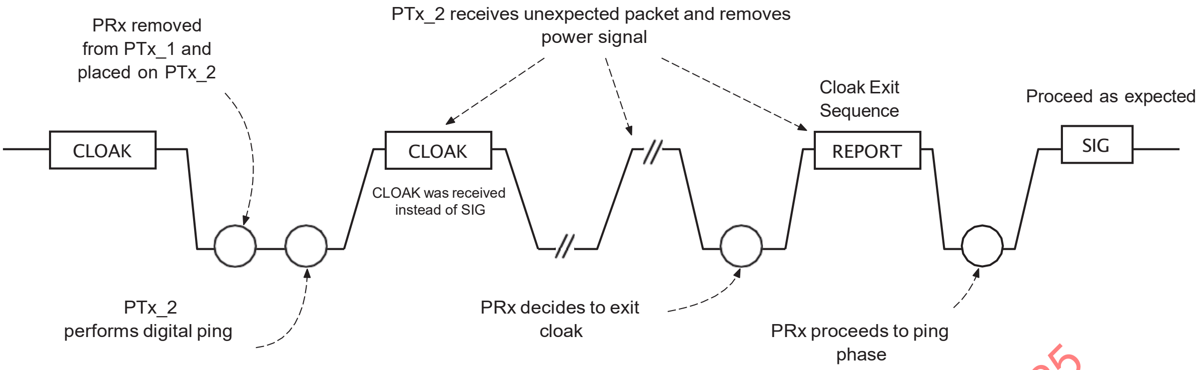

Figure 5.17: Cloak Example 10 - Cloaked PRx removed and placed on a different PTx (PRx Initiated Cloak)

Example 11: Shows an example how PRx behaves when removed from MPP PTx charging surface during cloak when Detect Ping is not enabled. Example shows PTx initiated cloak scenario in Figure 5.18.

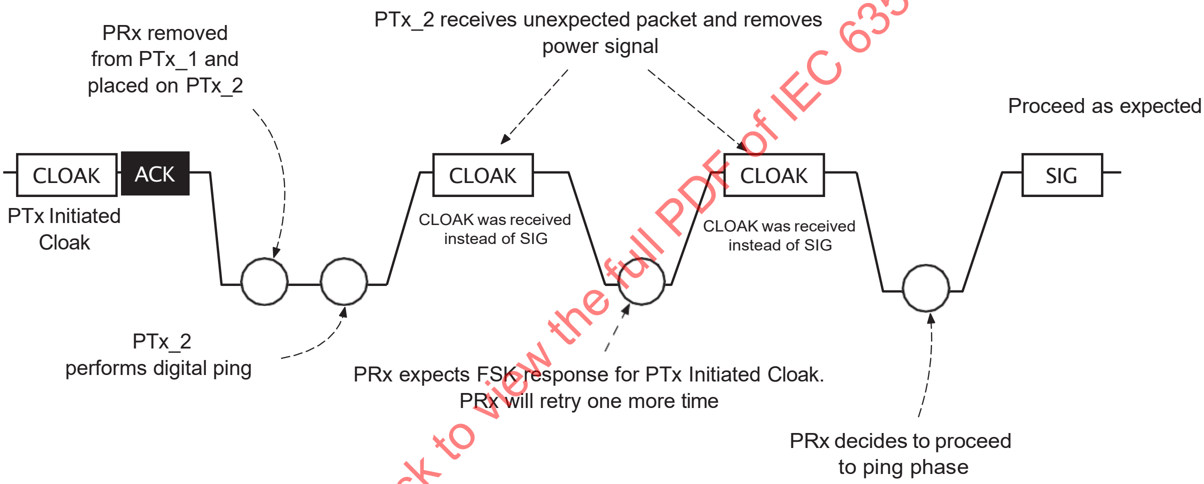

Figure 5.18: Cloak Example 11 - Cloaked PRx removed and placed on a different PTx (PTx Initiated Cloak)

Detect ping (Section 5.5) will allow PRx/PTx to detect the swap and transition to ping phase sooner

Example 12: Shows an example how PTx behaves when a new Power Receiver is placed on charging surface during cloak when Detect Ping is not enabled.

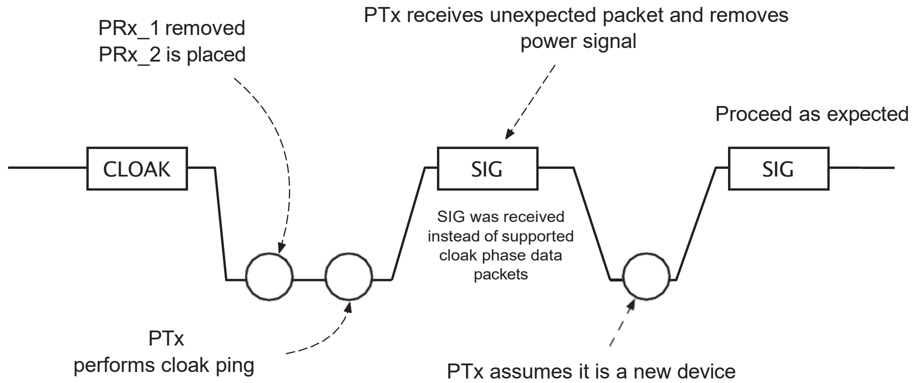

Figure 5.19: Cloak Example 12 - Cloaked PRx removed and a new PRx placed is on the cloaked PTx

Example 13: PTx initiates cloak as shown in Figure 5.20

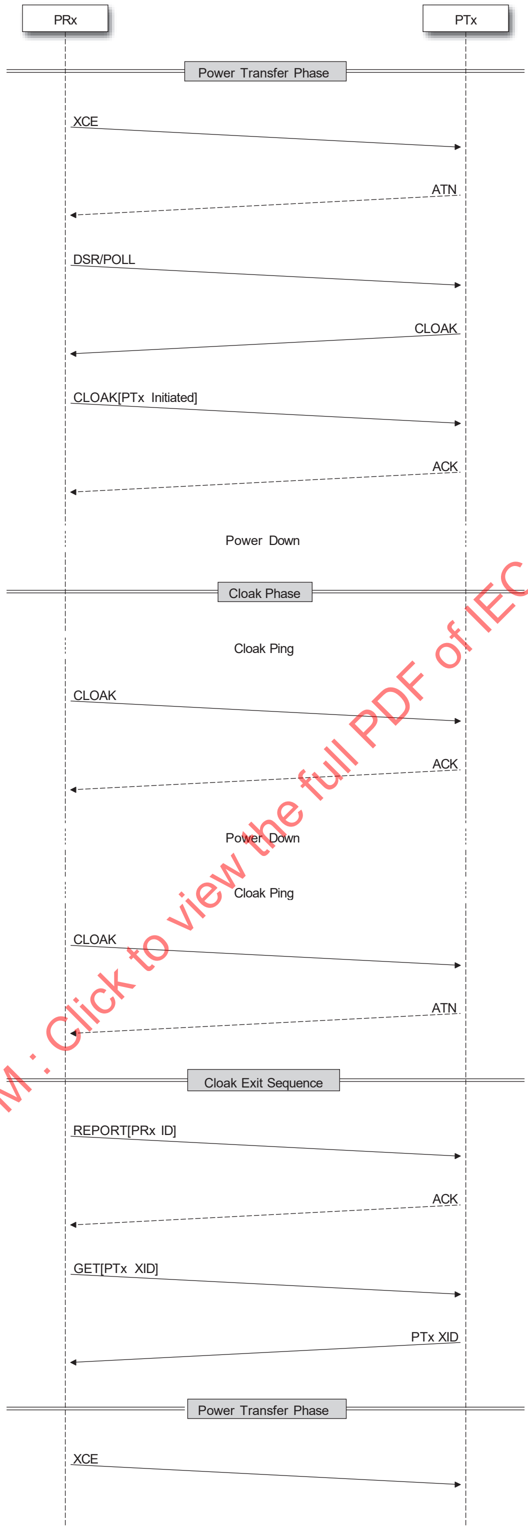

Figure 5.20: Cloak Example 13 - PTx Initiated Cloaking

6 Extended Data Streams

6.1 Overview

MPP extends Qi EPP data stream definition for application-layer data exchange to add support for:

1. **Concurrent Streams:** Allow data transfer across multiple (different) streams concurrently.
2. **Extended Status Codes:** Report different status codes to enable different retry behaviors.
3. **Data Integrity:** Handle data errors in the stream layer and detect errors using CRC-16.
4. **Exchange Supported Streams:** Allow devices to exchange supported streams on both sides.

MPP supported data streams and their unique identifiers are described in the Table 6.1.

Table 6.1: Data Streams Identifiers

Identifier	Stream Number
0	Reserved
1	Qi Authentication
2 - 7	Reserved
8 - 15	Proprietary range

Devices should exchange supported streams by sending Enabled Streams packet (Section 7.1.12) in MPP negotiation phase (Section 3.4.6).

For generic application data transfer, MPP PRx and MPP PTx shall only use MPP Extended Data Streams (the data streams defined in Qi EPP are not supported).

6.2 Simultaneous Data Stream Extension

Concurrent streams support different applications to share the stream bandwidth e.g. if a long stream message is being transferred, a short message from a different stream can be sent concurrently with the long one without having to wait for the long transaction to finish.

Support for concurrent streams is added by introducing a stream header to standard Qi EPP Data Stream packets (Auxiliary Data Control, Data Stream Response, Auxiliary Data Transport) resulting in new packets definition for ADC and DSR. ADT Packets are re-defined such that the first byte of the payload is always assigned to the stream header.

ADT packets with 1-byte payload (i.e., 0x16, 0x17) shall not be used with Simultaneous Data Stream Extension. The size limitation does not allow the packet to carry the stream header and the payload in a single transfer.

The stream header is defined as:

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	Reserved				Stream Number			

Figure 6.1: Stream Header

The simultaneous version of the data stream packets is defined as:

1. **Simultaneous Auxiliary Data Control (S-ADC):** ASK/FSK packets to Reset, Open, and Close a specific data stream (7.1.15, 7.2.11)
2. **Simultaneous Data Stream Response (S-DSR):** ASK/FSK packets to report extended status code (e.g. ACK, ERR_BUSY, ERR_UNEXPECTED, etc.), used as a response by both PRx and PTx to S-ADC (ASK/FSK) packets (7.1.14, 7.2.9) and FSK ADT packets.
3. **Simultaneous Auxiliary Data Transport (S-ADT):** ASK/FSK packets to transfer data payload with stream header.

PTx shall use FSK patterns when responding to ASK S-ADT packets.

Section 6.4 shows examples on how to use and handle data streams.

6.2.1 Error Handling

During a data stream transfer, communication errors might affect the ability to correctly decode ASK/FSK packets, leading to a synchronization issue when handling data streams.

MPP PRx and PTx shall follow the data stream error handling as described in Qi EPP specifications.

When retrying ASK packets, it is important for PRx to handle the following cases:

1. **Retrying S-DSR**: S-DSR Packet shall be retried with standard DSR/POLL to avoid accidentally acknowledging ADT/ADC packets.
2. **Retrying S-ADC / S-ADT**: Packet receiver shall re-acknowledge repeated S-ADC[open/close], ADT requests if applicable.

6.2.2 Timings

MPP extends the Qi EPP data stream timings as described in Table 6.2.

Table 6.2: Extended Data Streams Timing

Parameter	Side	Symbol	Minimum	Target	Maximum	Unit
Data Transport Stream Window	Both	t_{dts}	N/A	N/A	5,000	ms
Data Transport Stream Timeout	Both	$t_{dtstimeout}$	10,000	N/A	N/A	ms

Every active stream shall have dedicated and independent timing parameters t_{dts} and $t_{dtstimeout}$ assigned to it, such that, each stream is tracked separately.

6.2.3 Cloaking Compatibility

If cloaking is initiated during data stream transfer, all active transfers shall be terminated and flagged as incomplete transactions and may be restarted after exiting cloak.

If the device decides to restart the interrupted transaction, then it shall start the transaction from the beginning by opening the stream using SADC, transferring the payload from scratch using SADT packets, closing the stream using SADC.

An example is provided in Figure 6.4.

6.3 Data Integrity Extension

The data stream initiator shall compute and report a CRC value in the S-ADC[Close] request at the end of the data stream transmission. If the data stream recipient detects an error in the data transmission when comparing the computed CRC value against the received one, it shall drop the received data stream payload and report the error to the sender using S-DSR with ERR_CRC code. The data stream initiator should repeat (resend) the payload.

MPP uses CRC-16-CCITT to ensure the integrity of the payload transfer over the inductive link. The polynomial is described as following:

$$x^{16} \oplus x^{12} \oplus x^{5} \oplus \circ \qquad (6.1)$$

Property	Value
Width	16-bits
Truncated polynomial	0x1021
Initial value	0xFFFF
Input data	Not reflected
Output CRC	Not reflected
Final XOR value	0

Table 6.3: Data Stream CRC Properties

Each byte of the payload is processed starting with the most significant bit first. As an example, a payload consisting of 3-bytes {0xAB 0xCD 0xEF} yields a CRC value of 0xED38.

6.4 Examples

Figure 6.2 shows an example of simultaneous data streams initiated by PRx. First, PRx starts by sending S-ADC data packet to request opening stream 0 for communication. PTx acknowledges the request by responding with FSK data packet S-DSR with ACK and Stream 0 as parameters. Indicating successfully opening the stream for incoming data. PRx then sends the first part of the data stream payload using ASK data packet S-ADT (Stream 0, Payload), which is acknowledged by PTx using FSK ACK pattern. PRx sends a request to open another stream (Stream 1) while the transmission on stream 0 is still ongoing. PRx then starts sending different payloads on different streams using ADT data packets targeted towards different streams (Stream 0 and Stream 1). PRx requests closing the data streams after completing the transmission the payloads.

Figure 6.3 shows an example of simultaneous data streams initiated by PTx (similar to previous example but in opposite direction).

Figure 6.4 shows an example of a data stream session interrupted by PRx initiated cloak.

Figure 6.5 shows an example of a data stream re-transmission caused by a CRC error. First, PRx initiates a data stream transfer on Stream 0 and sends the payload over multiple S-ADT data packets. One (or more) of the ADT packets is incorrectly received due to noise in the channel leading to undetectable bit flips. When PTx receives S-ADC data packet with expected CRC-16 value and close parameter, it calculates the CRC-16 on the payload and compares it to the received one. PTx reports the CRC error using S-DSR packet with ERR_CRC as a parameter causing the PRx and PTx to close the stream, and PRx to restart the data stream transfer.

Figure 6.6 shows an example of CRC error for data streams initiated by PTx (similar to previous example but in opposite direction).

Figure 6.7 shows an example of communication issues affecting data stream packets for PRx initiated data stream transfer. Case (1) shows ASK S-ADT or S-ADC data packet failure and PRx retrying the packet due to lack of valid FSK response. Case (2) shows FSK S-DSR data packet failure when PTx responds to ASK data stream packets and PRx retrying the ASK data packet.

Figure 6.8 shows an example of communication issues affecting data stream packets for PTx initiated data stream transfer (similar to previous example but in opposite direction).

1. PTx/PRx shall acknowledge receiving repeated valid S-ADT payload packets with the same header and same stream number without appending the payload to data stream buffer
2. PTx/PRx shall acknowledge receiving repeated valid S-ADC[Open or Close] packets

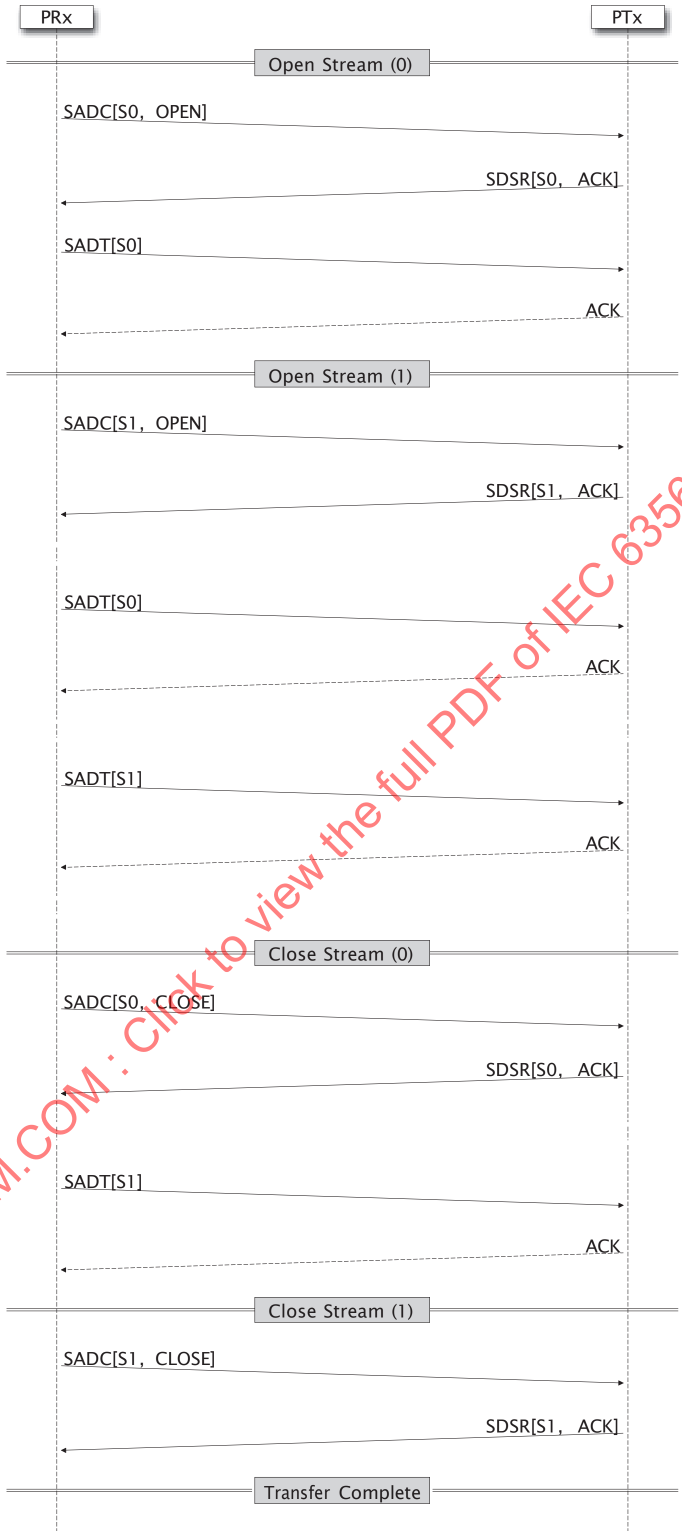

Figure 6.2: PRx-to-PTx Data Stream Example

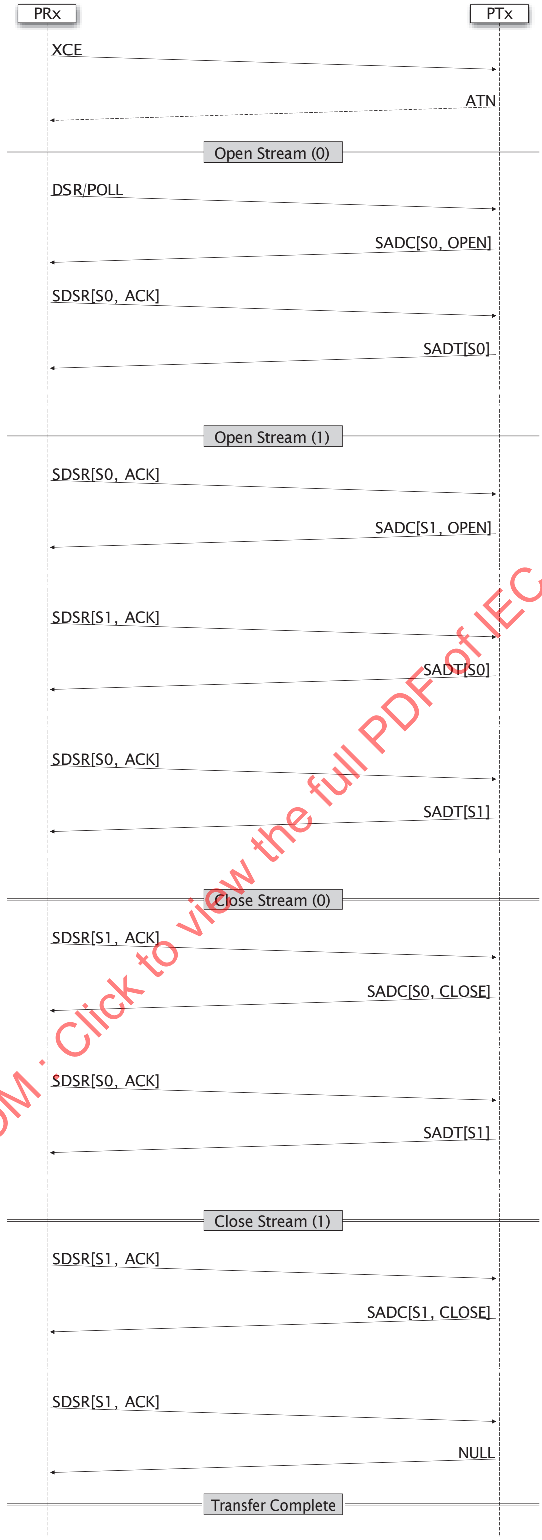

Figure 6.3: PTx-to-PRx Data Stream Example

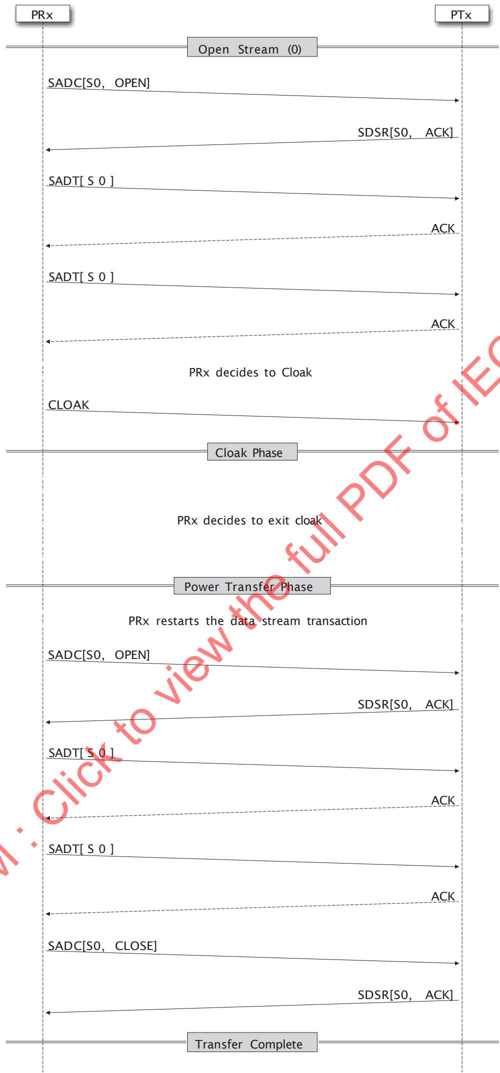

Figure 6.4: Data Stream interrupted by cloak

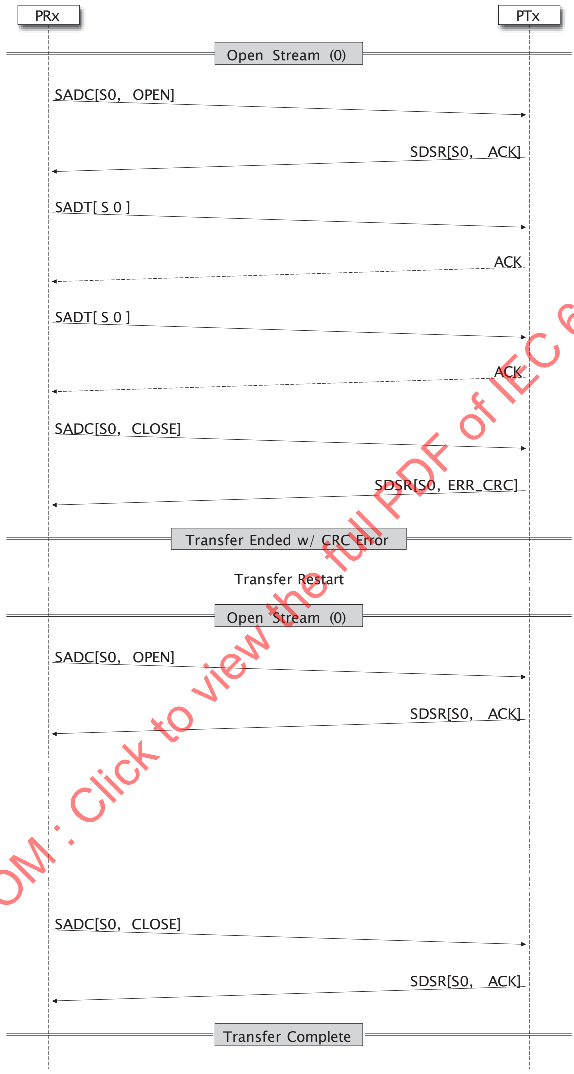

Figure 6.5: PRx-to-PTx CRC Error Example

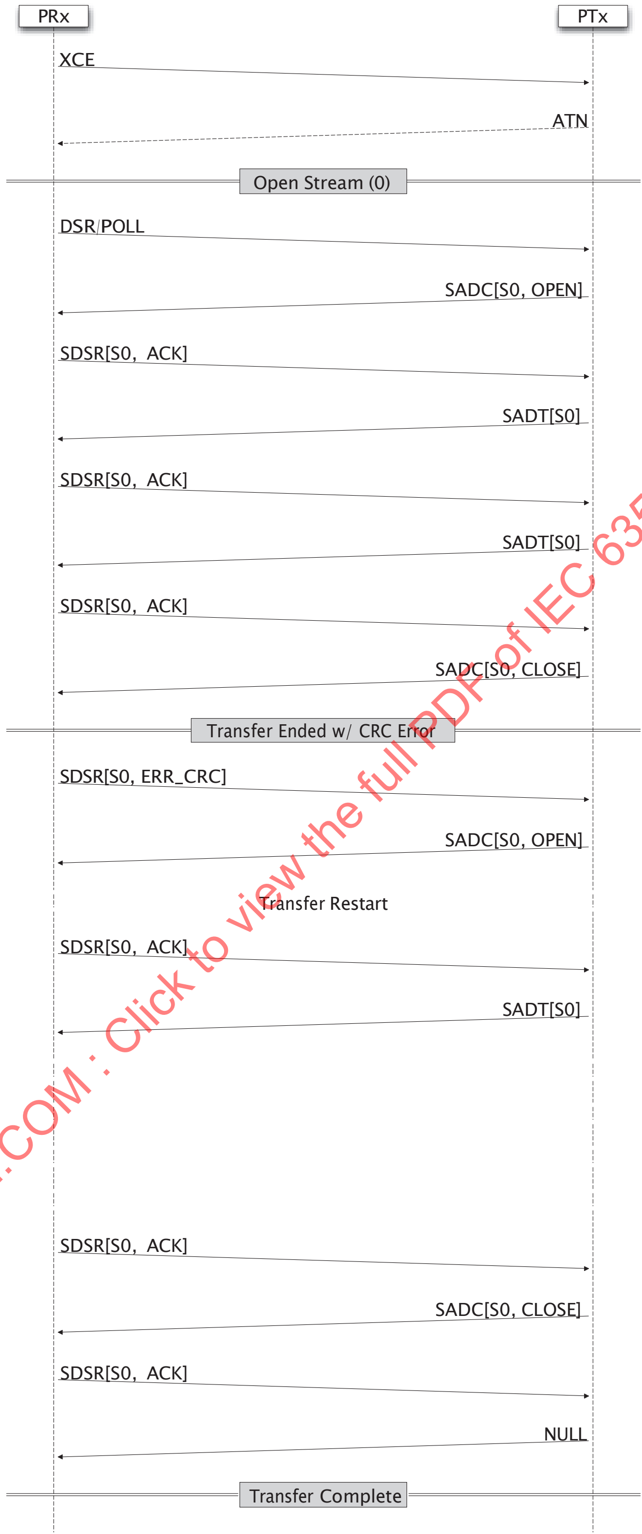

Figure 6.6: PTx-to-PRx CRC Error Example

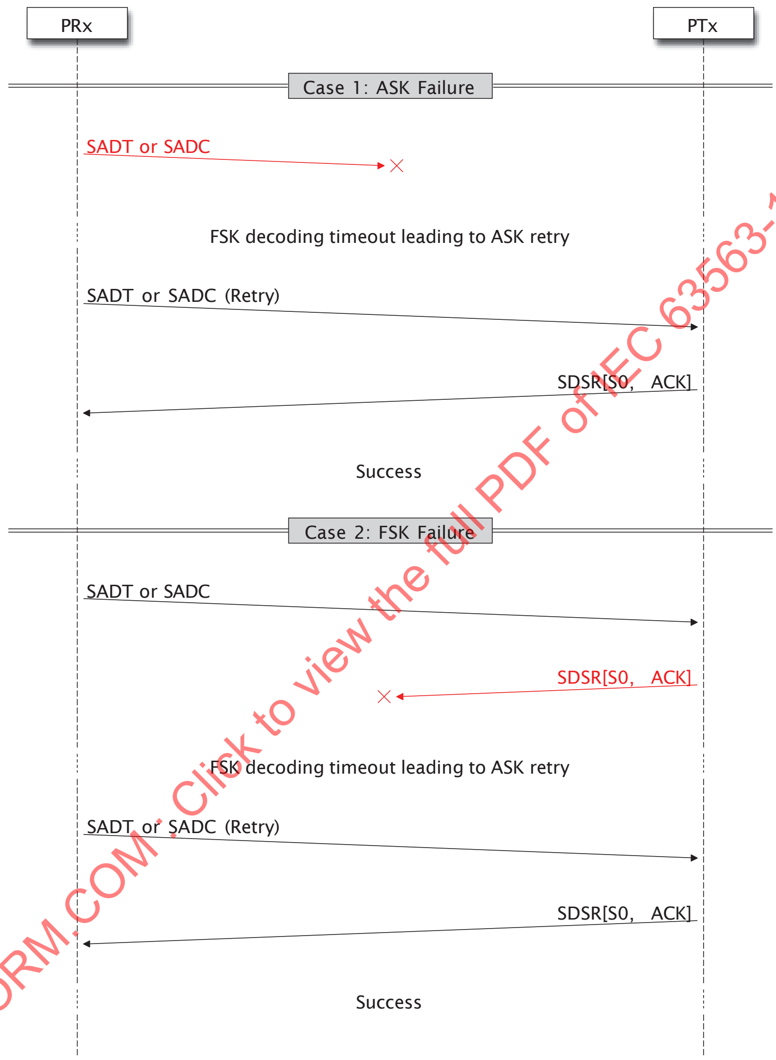

Figure 6.7: PRx-to-PTx Retries Handling Example

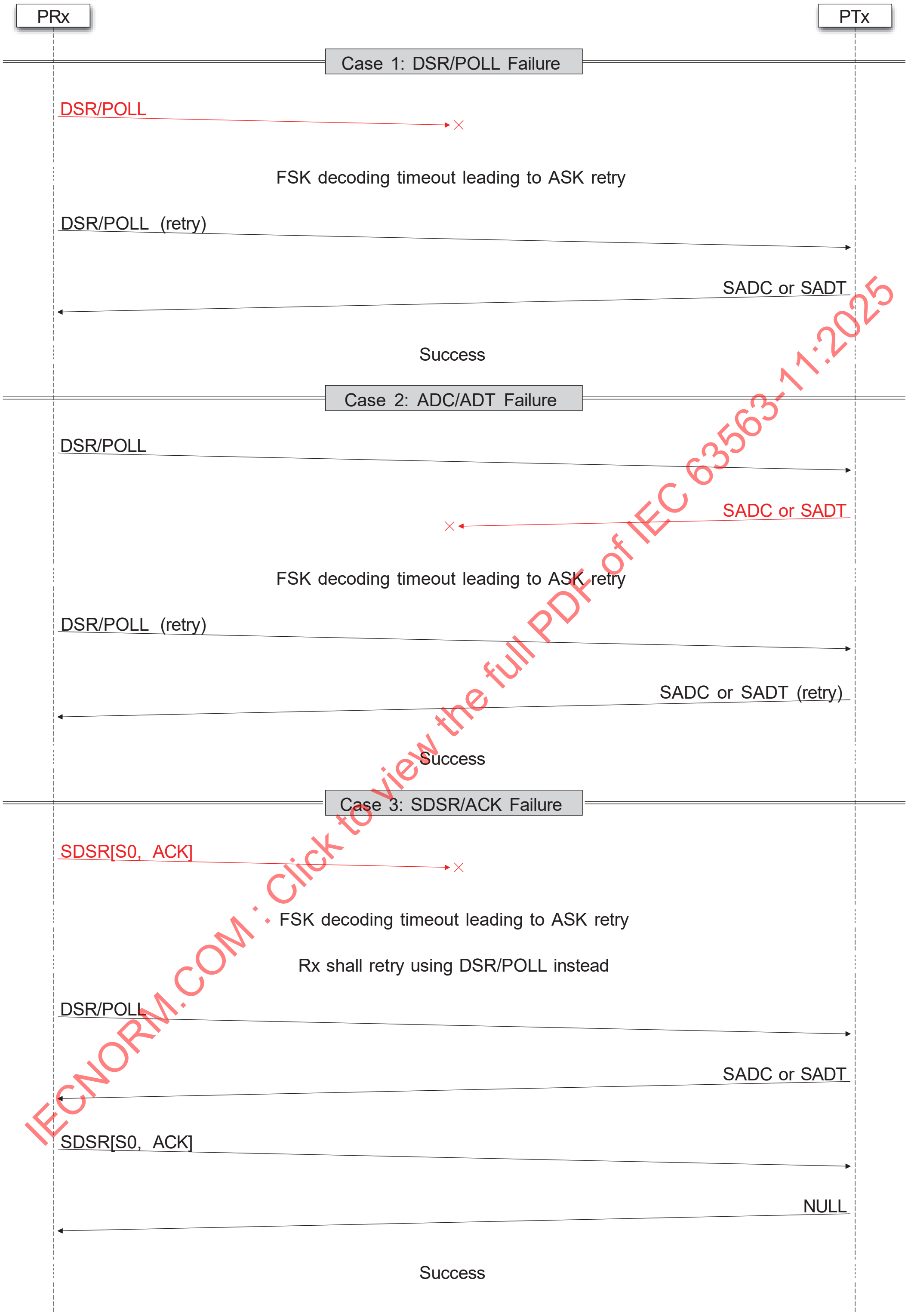

Figure 6.8: PTx-to-PRx Retries Handling Example

7 Packets and Streams

This chapter describes PRx/PTx MPP packets.

MPP extends some of the packet identifiers (headers) by specifying a "selector" field in the packet structure. The combination of header and selector values uniquely define an MPP packet.

7.1 Power Receiver data packets

This section describes the MPP PRx (ASK) packets.

Table 7.1: MPP PRx ASK Packets

Header	Selector	Mnemonic	Name	Section
0x18	N/A	CLOAK	Cloak Request	7.1.1
0x19	N/A	XCE	Extended Control Error	7.1.2
0x1A	N/A	Prop	MPP PRx Proprietary Packet	N/A
0x1B	N/A	Prop	MPP PRx Proprietary Packet	N/A
0x20	0xF0	SRQ/freqsel	Special Request [Freq Selection]	7.1.4
0x20	0xF3	SRQ/egpl	Special Request [Power Level]	7.1.5
0x20	0xF5	SRQ/cloakl	Special Request [Cloak Delay - Low Byte]	7.1.6
0x20	0xF6	SRQ/pcp	Special Request [Power Control Profile]	7.1.8
0x20	0xF7	SRQ/cloakh	Special Request [Cloak Delay - High Byte]	7.1.7
0x20	0xF8	SRQ/detect	Special Request [Cloak Detect Ping]	7.1.9
0x20	0xE0 - 0xEF	SRQ/MppProp	Special Request [Proprietary]	7.1.10
0x26	N/A	SADT/1e	Simultaneous Auxiliary Data Transport (even)	7.1.13
0x27	N/A	SADT/1o	Simultaneous Auxiliary Data Transport (odd)	7.1.13
0x28	N/A	GET	Get request	7.1.11
0x29	N/A	EDS	Enabled Data Streams	7.1.12
0x2A	N/A	Prop	MPP PRx Proprietary Packet	N/A
0x2B	N/A	Prop	MPP PRx Proprietary Packet	N/A
0x36	N/A	SADT/2e	Simultaneous Auxiliary Data Transport (even)	7.1.13
0x37	N/A	SADT/2o	Simultaneous Auxiliary Data Transport (odd)	7.1.13
0x38	N/A	SDSR	Simultaneous Data Stream Response	7.1.14
0x39	N/A	Prop	MPP PRx Proprietary Packet	N/A
0x46	N/A	SADT/3e	Simultaneous Auxiliary Data Transport (even)	7.1.13
0x47	N/A	SADT/3o	Simultaneous Auxiliary Data Transport (odd)	7.1.13
0x48	N/A	SADC	Simultaneous Auxiliary Data Control	7.1.15
0x49	N/A	Prop	MPP PRx Proprietary Packet	N/A
0x56	N/A	SADT/4e	Simultaneous Auxiliary Data Transport (even)	7.1.13
0x57	N/A	SADT/4o	Simultaneous Auxiliary Data Transport (odd)	7.1.13
0x58	0x00	REPORT	Report	7.1.16
0x58	0x01	PLA	Power Loss Accounting	7.1.18
0x59	N/A	Prop	MPP PRx Proprietary Packet	N/A
0x66	N/A	SADT/5e	Simultaneous Auxiliary Data Transport (even)	7.1.13
0x67	N/A	SADT/5o	Simultaneous Auxiliary Data Transport (odd)	7.1.13
0x78	N/A	PLAP	Power Loss Accounting Parameters	7.1.19
0x76	N/A	SADT/6e	Simultaneous Auxiliary Data Transport (even)	7.1.13
0x77	N/A	SADT/6o	Simultaneous Auxiliary Data Transport (odd)	7.1.13
0x79	N/A	Prop	MPP PRx Proprietary Packet	N/A
0x81	N/A	MPP-XID	MPP Extended Identification	7.1.20
0x84	N/A	ECAP	Extended Received Capabilities	7.1.21
0x85	N/A	Prop	MPP PRx Proprietary Packet	N/A

7.1.1 Cloak - CLOAK (0x18)

Cloak data packet allows PRx to initiate Cloak (Section 5.1).

	b7	b6	b5	b4	b3	b2	b1	b0
B0	Reserved					Reason		

Figure 7.1: PRx End Of Power Packet Structure

Reason

The reasons codes are described in Table 7.2.

Table 7.2: PRx End Of Power Reason Codes

Value	Reason
0	Cloak: Generic
1	Cloak: Forced (Denied uncloak request)
2	Cloak: Thermally constrained
3	Cloak: Insufficient Power
4	Cloak: Coex Mitigation (PRx requests cloak to perform an operation that cannot coexist with wireless power presence)
5	Cloak: End of Charge
6	Cloak: PTx initiated
7	Reserved

PTx Responses:

Table 7.3: End Of Power Request FSK Responses

Response	Description
ACK	PTx agrees to start/continue cloaking
NAK	Pattern is not allowed
ND	Pattern sent if PRx used unsupported reason code
ATN	In cloak state: PTx requesting cloak exit Other states: PTx prefers to communicate before cloaking

7.1.2 Extended Control Error - XCE (0x19)

XCE data packets provide feedback about the desired power level.

	b7	b6	b5	b4	b3	b2	b1	b0
B0	Control Error Value							

Figure 7.2: PRx Extended Control Error Packet Structure

Control Error Value

Refer to MPP System specification book - Section 5.9.2.2

FSK Responses

Table 7.4: Extended Control Error FSK Responses

Response	Description
ACK	PTx accepted the voltage change request (includes zero error value)
NAK	PTx rejected the voltage change request (request dropped)
ND	Pattern is not allowed
ATN	PTx prefers to communicate first

PTx behavior is described in Section 4.2.2.

7.1.3 Specific Request - SRQ (0x20)

The SRQ data packet contains a simple request to the Power Transmitter

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	Request							
B_1	Parameter							

Figure 7.3: PRx Specific Request Packet Structure (Proprietary Extension)

Table 7.5: MPP Specific Requests

Value	Mnemonic	Name
0x00	SRQ/en	End negotiation (Refer to Qi Communications Protocol Section 8.18.1)
0x05	SRQ/rep	Re-ping delay (Refer to Qi Communications Protocol Section 8.18.6)
0xF0	SRQ/freqsel	Nominal Power Frequency Selection (Section 7.1.4)
0xF1	Reserved	Reserved
0xF3	SRQ/egpl	Extended Power Level Selection (Section 7.1.5)
0xF5	SRQ/cloakl	Cloak Ping Delay (low Byte) (Section 7.1.6)
0xF6	SRQ/pcp	Power Control Profile (Section 7.1.8)
0xF7	SRQ/cloakh	Cloak Ping Delay (high Byte) (Section 7.1.7)
0xF8	SRQ/detect	Cloak Detect Ping Interval (Section 7.1.9)
0xF9 - 0xFC	Reserved	Reserved
0xE0 - 0xEF	SRQ/MppProp	Proprietary parameter (Section 7.1.10)

7.1.4 Specific Request [Frequency Selection] - SRQ/freqsel (0x20)

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	0xF0							
B_1	Reserved						Frequency Selector	

Figure 7.4: PRx Specific Request - Frequency Selection Packet Structure

Frequency Selector
Different frequency values are described in Table 7.6.

Table 7.6: Specific Request Frequency Selection parameters

Value	Description
0	Reserved
1	360 kHz
2	Reserved
3	Reserved

FSK Responses

Table 7.7: Frequency Selection Request FSK Responses

Response	Reason
ACK	PTx approves the frequency change request
NAK	Pattern is not allowed
ND	Pattern sent if PRx requested a value other than 1 (i.e., 360kHz)
ATN	Pattern is not allowed

Frequency selector in SRQ/freqsel shall be set to (1) i.e. (360kHz) when negotiating operating frequency. Other values are not allowed.

All reserved bits shall be set to 0

7.1.5 Specific Request [Power Level] - SRQ/egpl (0x20)

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	0xF3							
B_1	Load Power							

Figure 7.5: PRx Specific Request - Power Level Selection Packet Structure

Load Power
Power level value represented in 100 mW units.

FSK Responses

Table 7.8: Power Level Selection Request FSK Responses

Response	Reason
ACK	PTx approves the request
NAK	PTx rejects the request
ND	Pattern is not allowed
ATN	Pattern is not allowed

7.1.6 Specific Request [Cloak Ping Delay - Low Byte] - SRQ/cloakl (0x20)

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	0xF5							
B_1	Cloak Ping Delay Value (Low Byte)							

Figure 7.6: PRx Specific Request - Cloak Ping Delay Selection Packet Structure

Cloak Ping Delay (Low Byte)
Low byte of 10-bit cloak delay value. Requested cloak ping delay value {high byte, low byte} is represented in 100 ms units.

FSK Responses

Table 7.9: Cloak Ping Delay Selection Request SRQ/cloakl - FSK Responses

Response	Reason
ACK	PTx approves the request
NAK	Pattern is not allowed
ND	Pattern is not allowed
ATN	Pattern is not allowed

The cloak delay is split across two requests (low, high) bytes to allow longer cloak delays. High byte is described in Section 7.1.7

7.1.7 Specific Request [Cloak Ping Delay - High Byte] - SRQ/cloakh (0x20)

	b7	b6	b5	b4	b3	b2	b1	b0
B0	0xF7							
B1	Reserved						Cloak Delay	

Figure 7.7: PRx Specific Request - Cloak Ping (High) Delay Selection Packet Structure

Cloak Ping Delay

High portion of 10-bit cloak delay value. Requested cloak ping delay value {high byte, low byte} is represented in 100 ms units.

FSK Responses

Table 7.10: Cloak Ping Delay Selection Request SRQ/cloakh - FSK Responses

Response	Reason
ACK	PTx approves the request
NAK	PTx rejects the request
ND	Pattern is not allowed
ATN	Pattern is not allowed

- The cloak delay is split across two requests (low, high) bytes to allow longer cloak delays. Low byte is described in Section 7.1.6
- The final cloak delay is represented as a 10-bit value {High Byte, Low Byte}

All reserved bits shall be set to 0

7.1.8 Specific Request [Power Control Profile] - SRQ/pcp (0x20)

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	0xF6							
B_1	Reserved							Profile

Figure 7.8: PRx Specific Request - Low K Mode Selection Packet Structure

Profile

Table 7.11: Power Control Profile Values

Value	Profile
0	Default profile selected
1	Low-K power profile

FSK Responses

Table 7.12: Power Control Profile Selection Request FSK Responses

Response	Reason
ACK	PTx approves the request
NAK	Pattern is not allowed
ND	Pattern is not allowed
ATN	Pattern is not allowed

Refer to MPP System Specifications - Section 5.9.2.3.4 for more information on Low-K mode

All reserved bits shall be set to 0

7.1.9 Specific Request [Cloak Detect Ping Delay] - SRQ/detect (0x20)

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	0xF8							
B_1	Reserved				Cloak Detect Ping Value			

Figure 7.9: PRx Specific Request - Cloak Detect Ping Delay Selection Packet Structure

Cloak Detect Ping Delay
Requested cloak detect ping delay in 100 ms units.

Setting the delay value to zero disables the cloak detect pings

FSK Responses

Table 7.13: Cloak Detect Ping Delay Selection Request FSK Response

Response	Reason
ACK	PTx approves the request
NAK	Pattern is not allowed
ND	Pattern is not allowed
ATN	Pattern is not allowed

All reserved bits shall be set to 0

7.1.10 Specific Request [Proprietary Parameters] - SRQ/MppProp (0x20)

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	0xE0..0xEF							
B_1	Implementa5on Specific							

Figure 7.10: PRx Specific Request - Proprietary Packet Structure

Implementation Specific
Implementation specific parameter. Not managed by MPP specifications.

FSK Responses

Table 7.14: Proprietary Specific Parameters Request FSK Responses

Response	Reason
ACK	PTx approves the request
NAK	PTx rejects the request
ND	PTx does not support the request
ATN	Pattern is not allowed

The request is implementation dependent and it is not managed by MPP specifications. It is PRx's responsibility to ensure the PTx is compatible and supports the request.

7.1.11 Get Request - GET (0x28)

GET data packets allows PRx to request specific information from PTx.

	b7	b6	b5	b4	b3	b2	b1	b0
B0	Reserved							
B1	Reserved			Parameter				

Figure 7.11: PRx Get Request Packet Structure

Parameter

Requested parameter from the Power Transmitter. Parameter codes are described in Table 7.15.

Table 7.15: PRx Get Request Types

Value	Parameter
0	PTx Extended Identification (Section 7.2.13)
2	PTx Inverter Voltage (Section 7.2.7)
3	PTx Power Loss Accounting Parameters (Section 7.2.12)
4	PTx Extended Capabilities (Section 7.2.14)
5	PTx Regulation Control Status (Section 7.2.3)
6	PTx Charge Status (Section 7.2.4)
7	PTx Estimated K (Section 7.2.10)
9	PTx Error Status (Section 7.2.1)

All other values are reserved. The Power Receiver shall not use those values.

FSK Response

FSK Packet - PTx shall respond with the requested packet

All reserved bits shall be set to 0

7.1.12 Enabled Data Streams - EDS (0x29)

Enabled Data Streams (EDS) data packets report the enabled *(available)* data streams on PRx.

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	Streams Bitmask							
B_1								

Figure 7.12: PRx Enabled Data Streams Packet Structure

Stream Bitmask

Treated as a 16-bit number. Supported streams shall be set to ONE in their corresponding bit index, or ZERO otherwise.

The stream identifiers are used as an index and they are described in Table 6.1.

For example, if stream 1 is enabled then BIT1 shall be set to ONE. The corresponding value of bitmask will be 0x0002

FSK Response

FSK Packet - PTx shall respond with PTx Enabled Data Streams 7.2.6 packet.

7.1.13 Simultaneous Auxiliary Data Transport - SADT (multiple header codes)

SADT data packets carry the application layer messages sent in a data transport stream to a Power Transmitter. SADT data packet stream payload carried within the packet can vary between 1 to 6 bytes, available with odd, even header.

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	Reserved				Stream Number			
B_1	Payload							
.								
.								
B_N								

Figure 7.13: PRx Simultaneous Data Stream Payload Packet Structure

Stream Number

Different streams numbers are described in Table 6.1.

FSK Responses

Table 7.16: Simultaneous Auxiliary Data Transport - SADT FSK Responses

Response	Description
ACK	The Power Transmitter has processed the data in the packet correctly
NAK	The Power Transmitter has not been able to process the data in the packet
ND	The Power Transmitter does not have an incoming data transport stream open
ATN	Pattern is not allowed

All reserved bits shall be set to 0

7.1.14 Simultaneous Data Stream Response - SDSR (0x38)

Simultaneous Data Stream Response data packets sustain the transmission of a data transport stream from PTx.

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	Reserved							
B_1	Reserved				Stream Number			
B_2	Reserved						Type	

Figure 7.14: PRx Simultaneous Data Stream Response Packet Structure

Stream Number

Different streams numbers are described in Table 6.1.

Type

Table 7.17. PRx Simultaneous Data Stream Response

Type	Type Value	Description
ACK	0	Confirms that the last received data stream packet has been processed properly
UNEXPECTED	1	Indicates that the last received data stream packet was not expected
ERR_BUSY	2	Could not process the last received data stream packet (full buffer, all concurrent streams are occupied)
ERR_CRC	3	Data stream transfer rejected due to a CRC error

FSK Responses

PTx may respond with a FSK packet or NULL, if no response is available.

All reserved bits shall be set to 0

7.1.15 Simultaneous Auxiliary Data Control - SADC (0x48)

SADC data packets control the transmission of data transport streams.

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	Reserved					Request		
B_1	Reserved				Stream Number			
B_2	Parameter							
B_3								

Figure 7.15: PRx Simultaneous Auxiliary Data Control Packet Structure

Stream Number

Different streams numbers are described in Table 6.1.

Request

Table 7.18: Simultaneous Auxiliary Data Control Request Field

Value	Description
0	Reset all incoming and outgoing data transports (all streams)
1	Reset incoming and outgoing data transport for stream (specified in stream header)
2	Close and abort data transport (specified in stream header)
3	Close and complete data transport (specified in stream header)
4	Open data transport (specified in stream header)
5 - 7	Reserved

Parameter

Table 7.19: Simultaneous Auxiliary Data Control Parameter Field

Request Field	Parameter Value
2	Parameter shall be set to 0
3	CRC-16 computed on the entire data transport stream payload (Section 6.3)
4	Transfer size in bytes
Other values	Reserved

FSK Response

PTx SDSR data packet (Section 7.2.9).

All reserved bits shall be set to 0

7.1.16 Report - REPORT (0x58:0)

REPORT packet is used to report information to PTx. Content of packet depend on the selected report identifier.

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	0 (Selector)			Reserved			Report ID	
B_1	Report Data (Template Dependent)							
B_2								
B_3								
B_4								

Figure 7.16: PRx Report Packet Structure

Report ID

Different reports are described in Table 7.20.

Table 7.20: Report ID Field

Value	Report
0, 1, 3	Reserved
2	PRx Identification

Report Data

Depends on Report ID field.

FSK Response

FSK Pattern - Only ACK is allowed