

Wireless charge Battery document for SH-04E

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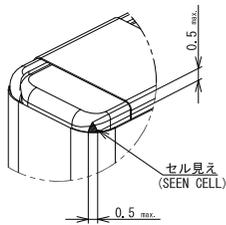
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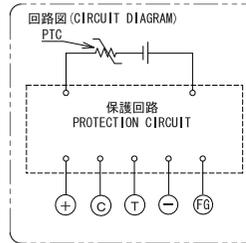
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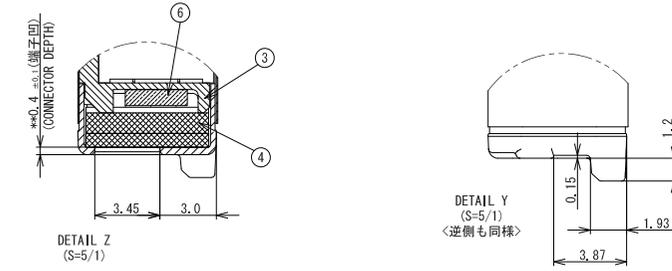
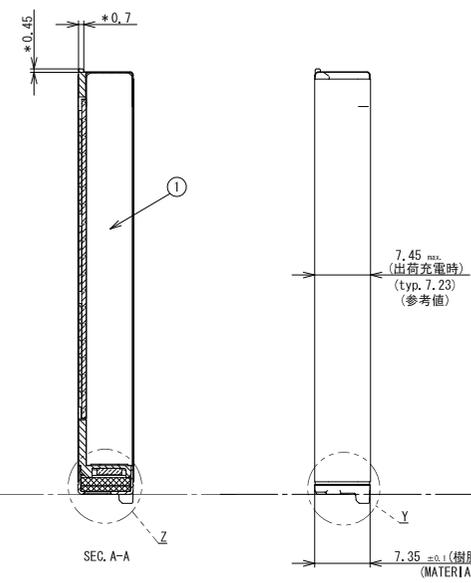
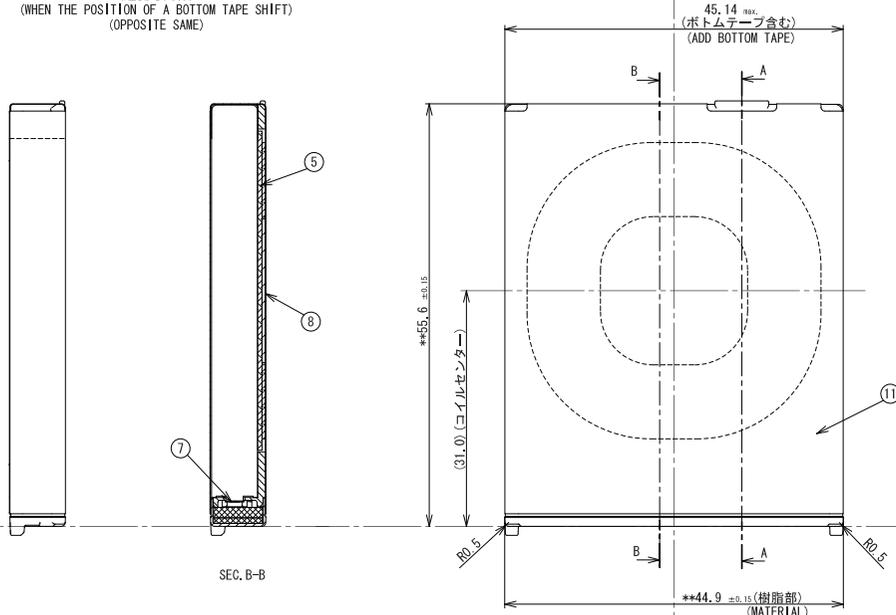
SH37



ボトムテープ最大ズレ時のセル見え量
(逆側も同様)
(WHEN THE POSITION OF A BOTTOM TAPE SHIFT
(OPPOSITE SAME))



NO.	PART NAME	APPLICATION-PART CODE	QTY.	MATERIAL-SPECIFICATION	NOTE
1	素電池 BARE CELL		1	UF644553F	
2	キャップ CAP		1	三菱エンブラ ユーピロン FFR4500 No.88MDP	
3	ホルダー HOLDER		1	MITSUBISHI IUPILON FFR4500 No.88MDP	
4	保護回路基板完組立 PROTECTION CIRCUIT BOARD ASSY		1	ガラスエポキシ GLASS EPOXY	
5	コイル COIL		1		
6	PTC		1	MGPC370 相当 MGPC370 EQUIVALENT	
7	リード板 LEAD PLATE		1	NIP	
8	スペーサー SPACER		1		
9	ボトムテープ BOTTOM TAPE		1	PET	
10	水没判定ラベル WET CHECK LABEL		1	上質紙 HIGH QUALITY PAPER	
11	ラベル LABEL		1	PET	



NOTES
1. LOT No. MUST BE STAMPED ON THE WET CHECK LABEL.
(出荷ロット印は、水没判定ラベル上に印刷表示すること。)

REVISION (A, B, C, ...) NEW: A, CHANGE 1; B, CHANGE 2; C, ...
変更経歴 (A, B, C, ...) 新規: A, 変更1; B, 変更2; C, ...
MONTH (JAN=A, FEB=B, MAR=C, ... DEC=L)
製造月 (1月=A, 2月=B, 3月=C, ... 12月=L)
YEAR (2012=V, 2013=W, ...)
製造年 (2012=V, 2013=W, ...)

EX.) JAN. 2012.....VAA
例) 2012年1月.....VAA

2. EXTERNAL SURFACE MUST BE FREE FROM SCRATCHES AND DISCOLORATION.
(傷及び、汚れ等の不具合のなきこと。)

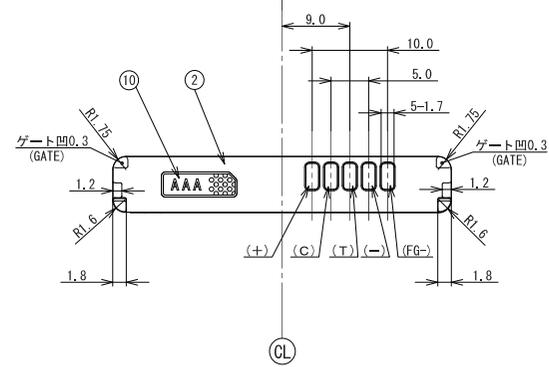
3. DRAFT OF UNSPECIFIED DIMENSIONS TO BE MEASURED AT BASE POINT.
(指示なき抜き勾配での寸法は、すべて根元からの寸法とする。)

4. TOLERANCE TABLE INDICATES TOLERANCES NOT OTHERWISE SPECIFIED.
(指示なき寸法公差は、別表の通りとする。)

5. EACH DIMENSION DOES NOT ACCOUNT FOR WARP.
ADDITIONAL TOLERANCE OF 0.15mm MAX ALLOWS FOR WARP.
(各寸法は反りを含まない出荷時の寸法とする。)
(反りを含む場合は、寸法公差上限+0.15mm MAXとする。)

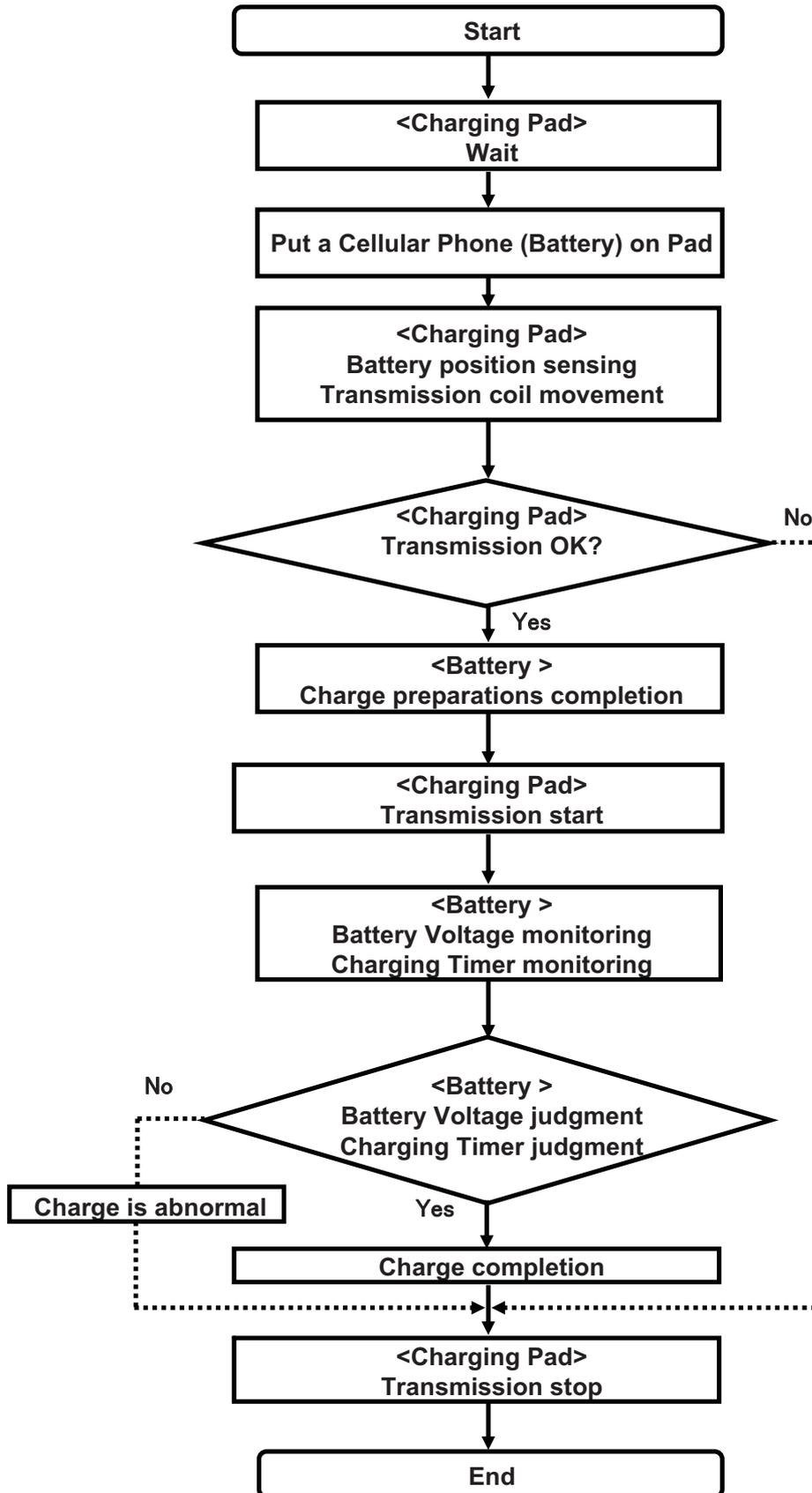
6. DIMENSION * DOES NOT ACCOUNT FOR LABEL.
(* 寸法は、ラベルを含まない寸法とする。)

7. DIMENSION ** DOES PROCESS MANAGEMENT DIMENSION.
(** 寸法は、工程管理寸法とする。)



DATE		REMARK		DATE		DESCRIPTION	
19. JAN. 2012							
D R	T. Washida	MODEL: 1UF644553F-SK (T)-H		材料・規格			
C H K		CUSTOMER CODE: SK (T)		MATERIAL			
		TOLERANCE		処理・加工			
C H K	T. Kawahara	250 <L	±0.5	FINISH			
		<L ≤	±	部品名		組電池	
E N G		50 <L ≤ 250	±0.4	PART NAME		BATTERY PACK	
		18 <L ≤ 50	±0.3	PART CODE			
A P P	T. Matsuda	<L ≤	±0.2	DRAWING NO		1UF644553F-102	
		UNIT		SCALE		Rev.	
		mm		2/1			

Wireless charging Flow chart



5 System Control

5.1 Introduction

From a system control perspective, power transfer from a Power Transmitter to a Power Receiver comprises four phases, namely *selection*, *ping*, *identification & configuration*, and *power transfer*. Figure 5-1 illustrates the relation between the phases. The solid arrows indicate transitions, which the Power Transmitter initiates; and the dash-dotted arrows indicate transitions that the Power Receiver initiates. By definition, if the Power Transmitter is not applying a Power Signal, the system is in the *selection* phase. This means that a transition from any of the other phases to the *selection* phase involves the Power Transmitter removing the Power Signal.

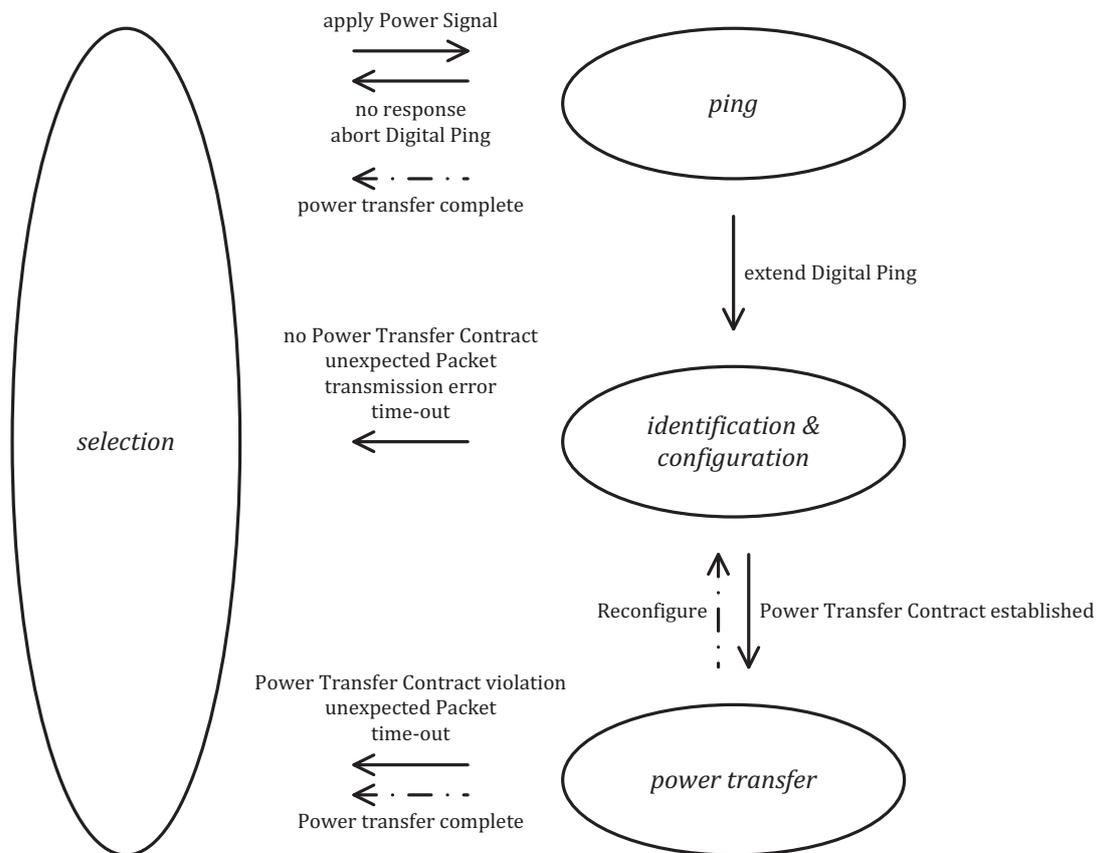


Figure 5-1: Power transfer phases

The main activity in each of these phases is the following:

- selection** In this phase, the Power Transmitter typically monitors the Interface Surface for the placement and removal of objects. The Power Transmitter may use a variety of methods for this purpose. See Annex B for some examples. If the Power Transmitter discovers one or more objects, it should attempt to locate those objects—in particular if it supports Free Positioning. In addition, the Power Transmitter may attempt to differentiate between Power Receivers and foreign objects—keys, coins, etc. Moreover, the Power Transmitter should attempt to select a Power Receiver for power transfer. If initially the Power Transmitter does not have sufficient information for these purposes, the Power Transmitter may repeatedly proceed to the *ping* and subsequently to the *identification & configuration* phases—each time selecting a different Primary Cell—and revert to the *selection* phase after collecting relevant information. See Annex C for examples. Finally, if the Power Transmitter selects a Primary Cell, which it intends to use for

power transfer to a Power Receiver, the Power Transmitter proceeds to the *ping* phase—and eventually to the *power transfer* phase. On the other hand, if the Power Transmitter does not select a Power Receiver for power transfer—and is not actively providing power to a Power Receiver for an extended amount of time—the Power Transmitter should enter a stand-by mode of operation.⁶ See [Part 2] for performance requirements on such a mode of operation.

- *ping* In this phase, the Power Transmitter executes a Digital Ping, and listens for a response. If the Power Transmitter discovers a Power Receiver, the Power Transmitter may extend the Digital Ping, i.e. maintain the Power Signal at the level of the Digital Ping. This causes the system to proceed to the *identification & configuration* phase. If the Power Transmitter does not extend the Digital Ping, the system shall revert to the *selection* phase.
- *identification & configuration* In this phase, the Power Transmitter identifies the selected Power Receiver, and obtains configuration information such as the maximum amount of power that the Power Receiver intends to provide at its output. The Power Transmitter uses this information to create a Power Transfer Contract. This Power Transfer Contract contains limits for several parameters that characterize the power transfer in the *power transfer* phase. At any time before proceeding to the *power transfer* phase, the Power Transmitter may decide to terminate the extended Digital Ping—e.g. to discover additional Power Receivers. This reverts the system to the *selection* phase.
- *power transfer* In this phase, the Power Transmitter continues to provide power to the Power Receiver, adjusting its Primary Cell current in response to control data that it receives from the Power Receiver. Throughout this phase, the Power Transmitter monitors the parameters that are contained in the Power Transfer Contract. A violation of any of the stated limits on any of those parameters causes the Power Transmitter to abort the power transfer—returning the system to the *selection* phase. Finally, the system may also leave the *power transfer* phase on request of the Power Receiver. For example, the Power Receiver can request to terminate the power transfer—battery fully charged—reverting the system to the *selection* phase, or request to renegotiate the Power Transfer Contract—change to trickle charging the battery using a lower maximum amount of power—reverting the system to the *identification & configuration* phase.

Section 5.2 defines the system control protocols in the *ping*, *identification & configuration*, and *power transfer* phases from a Power Transmitter perspective. Section 5.3 defines the system control protocols in these four phases from a Power Receiver perspective. Note that this version 1.0.2 of the System Description Wireless Power Transfer, Volume I, Part 1, does not define the system control protocol in the *selection* phase. Further note that—from a power transfer point of view—the Power Receiver remains passive throughout most of the *selection* phase.

At any time a user can remove a Mobile Device that is receiving power. The Power Transmitter can recognize such an event from a time-out in the communications from the Power Receiver, or from a violation of the Power Transfer Contract. As a result, the Power Transmitter aborts the power transfer and the system reverts to the *selection* phase.

Throughout the *power transfer* phase, the Power Transmitter and Power Receiver control the amount of power that is transferred. The Figure 5-2 illustrates a schematic diagram of the power transfer control loop, which basically operates as follows: The Power Receiver selects a desired Control Point—a desired output current and/or voltage, a temperature measured somewhere in the Mobile Device, etc. In addition, the Power Receiver determines its actual Control Point. Note that the Power Receiver may use any approach to determine a Control Point. Moreover, the Power Receiver may change this approach at any time during the *power transfer* phase. Using the desired Control Point and actual Control Point, the Power Receiver calculates a Control Error Value—for example simply taking the (relative) difference of the two output voltages or currents—such that the result is negative if the Power Receiver requires less power in order to reach its desired Control Point, and positive if the Power Receiver requires more power in order to reach its desired Control Point. Subsequently, the Power Receiver transmits this Control Error Value to the Power Transmitter.

⁶Note that it is up to the Power Transmitter implementation to determine whether this stand-by mode of operation is part of the *selection* phase or is separate from the *selection* phase.

The Power Transmitter uses the Control Error Value and the actual Primary Cell current to determine a new Primary Cell current. After the system stabilizes from the communications of the Control Error Packet, the Power Transmitter has a short time window to control its actual Primary Cell current towards the new Primary Cell current. Within this window, the Power Transmitter reaches a new Operating Point—the amplitude, frequency, and duty cycle of the AC voltage that is applied to the Primary Cell. Subsequently, the Power Transmitter keeps its Operating Point fixed in order to enable the Power Receiver to communicate additional control and status information. See Section 5.2.3.1 for details.

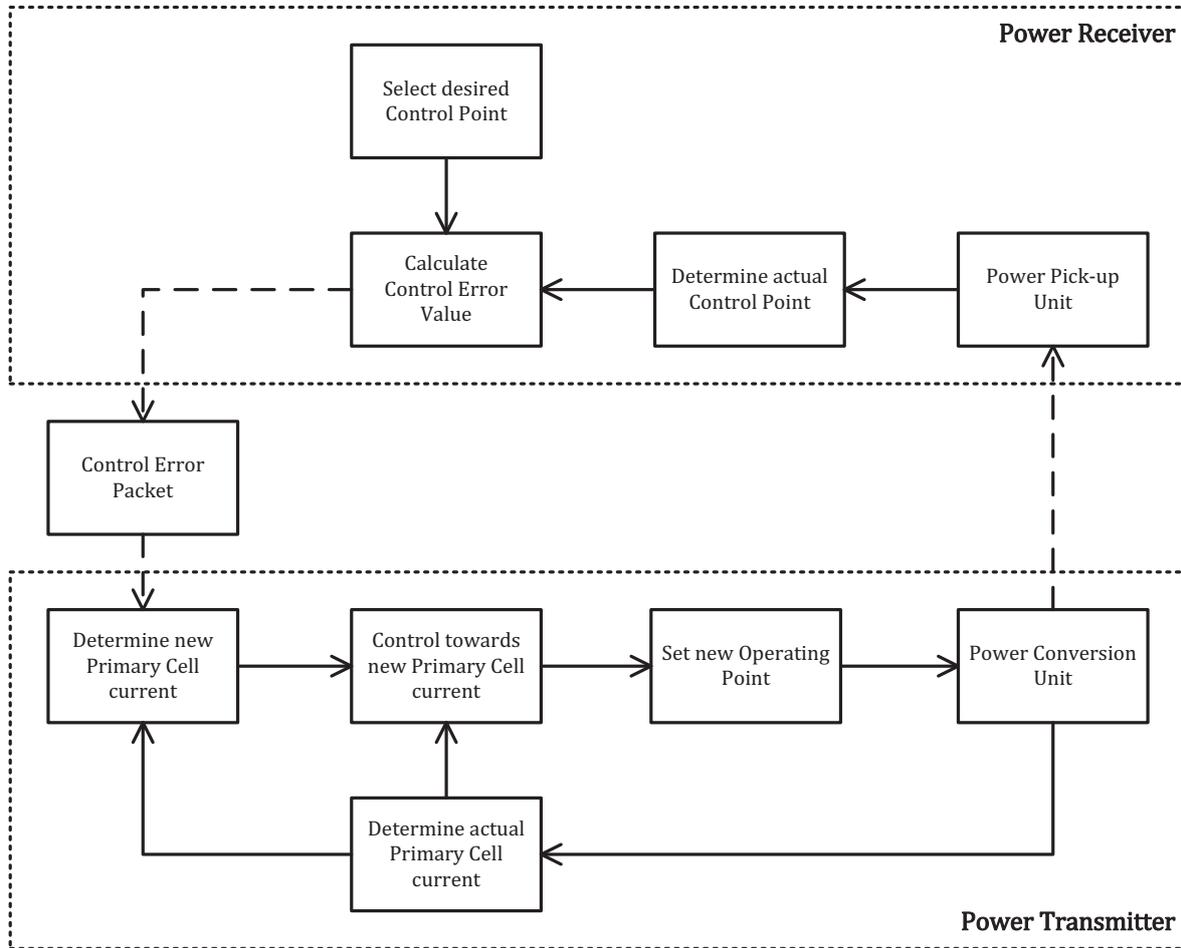


Figure 5-2: Power transfer control loop

5.2 Power Transmitter perspective

Section 5.2.1 defines the protocol that the Power Transmitter shall execute in order to select a Power Receiver for power transfer. This protocol comprises a Digital Ping. Section 5.2.2 defines the protocol that the Power Transmitter shall execute in order to identify the Power Receiver and establish a Power Transfer Contract. This protocol extends the Digital Ping, in order to enable the Power Receiver to communicate the necessary information. Section 5.2.3 defines the protocol that the Power Transmitter shall execute after it has established the Power Transfer Contract. During execution of this protocol, the Power Transmitter controls its Primary Cell current in response to control data that it receives from the Power Receiver.

Many provisions in this Section 5.2 refer to the start and/or the end of a Packet, or the start of a Packet's preamble. For the purpose of those provisions, the start of a Packet is defined as the instant the Power Transmitter receives the first edge of the start bit of the Packet's header byte; the end of a Packet is defined as the instant the Power Transmitter receives the second edge of the stop bit of the Packet's checksum byte; and the start of a Packet's preamble is defined as the instant the Power transmitter receives the first edge of the first preamble bit.

5.2.1 Ping phase

In the *ping* phase, the Power Transmitter shall execute a Digital Ping. This Digital Ping shall proceed as follows, with conditions appearing earlier in this list take precedence over conditions appearing later:

- The Power Transmitter shall apply a Power Signal at the Operating Point defined for the particular Power Transmitter design (see Section 3).
- If the Power Transmitter does not detect the start of a Packet in the time window t_{ping} after the Primary Cell current amplitude reaches 50% of the stable level, the Power Transmitter shall remove the Power Signal (i.e. reduce the Primary Cell current to zero) within $t_{\text{terminate}}$. See Figure 5-3(a).
- If the Power Transmitter correctly receives a Signal Strength Packet, the Power Transmitter may proceed to the *identification & configuration* phase of the power transfer, maintaining the Power Signal at the Operating Point as defined for the particular Power Transmitter design. See Figure 5-3(b). If the Power Transmitter does not proceed to the *identification & configuration* phase, the Power Transmitter shall remove the Power Signal within t_{expire} after the start of the Signal Strength Packet. See Figure 5-3(c).
- If the Power Transmitter does not correctly receive (see Section 6.2.4) the first Packet within the time interval t_{first} after the start of the first Packet, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$. See Figure 5-3(d).
- If the Power Transmitter correctly receives any other Packet than a Signal Strength Packet, and in particular if the Power Transmitter receives an End Power Transfer Packet, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$ after the end of the Packet. See Figure 5-3(e).

If the Power Transmitter does not proceed to the *identification & configuration* phase, the Power Transmitter shall revert to the *selection* phase.

Note that the thick line in Figure 5-3 represents the amplitude of the Power Signal, which is zero at the left-hand side of the diagrams. The dashed line represents possible communications from the Power Receiver, which the Power Transmitter shall ignore—as follows from the above conditions.

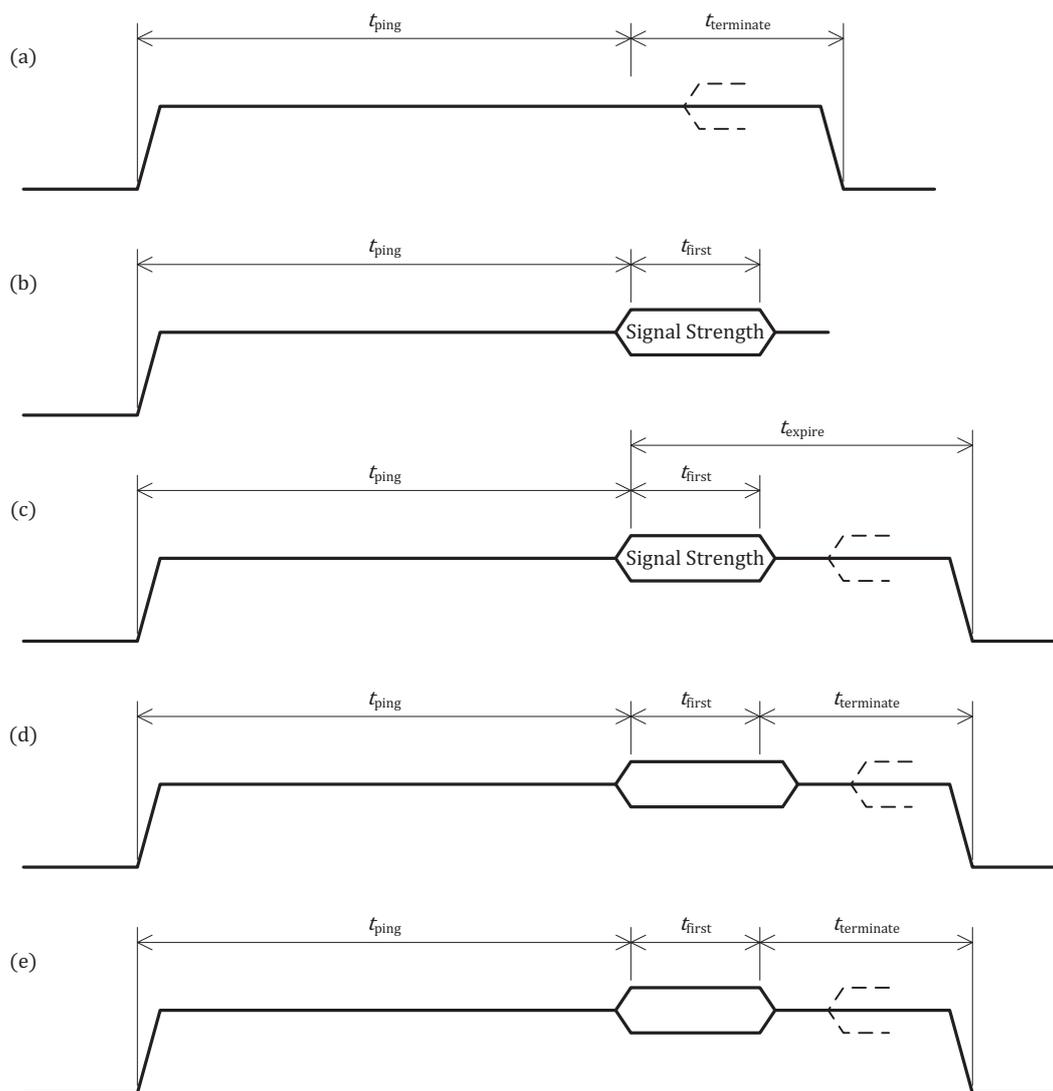


Figure 5-3: Power Transmitter timing in the *ping* phase

Table 5-1: Power Transmitter timing in the *ping* phase

Parameter	Symbol	Minimum	Target	Maximum	Unit
Digital Ping window	t_{ping}	65.0 ₋₀	65	70.0 ⁺⁰	ms
Power Signal termination time	$t_{terminate}$	N.A.	N.A.	28.0 ⁺⁰	ms
First Packet time out	t_{first}	N.A.	N.A.	20.0 ⁺⁰	ms
Power Signal expiration time	t_{expire}	N.A.	N.A.	90.0 ⁺⁰	ms

5.2.2 Identification & configuration phase

In the *identification & configuration* phase, the Power Transmitter shall identify the Power Receiver and collect configuration information. For this purpose, the Power Transmitter shall correctly receive the following sequence of Packets, in the order shown, and without changing its Operating Point:

- If the Power Transmitter enters the *identification & configuration* phase from the *ping* phase, an Identification Packet.
- If the Ext bit of the preceding Identification Packet is set to ONE, an Extended Identification Packet.
- Up to 7 optional configuration Packets from the following set (the order in which the Power Transmitter receives these Packets, if any, is not relevant):
 - A Power Control Hold-off Packet. If the Power Transmitter receives multiple Power Control Hold-off Packets, the Power Transmitter shall retain the Power Control Hold-off Time t_{delay} contained in the last Power Control Hold-off Packet received (see below).
 - Any Proprietary Packet (as listed in Table 6-3). If the Power Transmitter does not know how to handle the message contained in the Proprietary Packet, the Power Transmitter shall ignore that message.
 - Any reserved Packet (as indicated in Table 6-3). The Power Transmitter shall ignore the message contained in the reserved Packet.
- A Configuration Packet. If the number of optional configuration Packets, which the Power Transmitter has received, is not equal to the value contained in the Count field of the Configuration Packet, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$ ms after receiving the stop bit of the Configuration Packet's checksum byte, and return to the *selection* phase.

The Power Transmitter shall receive the above sequence of Packets subject to the following timing constraints:

- If the Power Transmitter does not detect the start bit of the header byte of a next Packet in the sequence within the time interval t_{next} after the end of the directly preceding Packet in the sequence, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$. See Figure 5-4(a). In this context, the directly preceding Packet of the Identification Packet is the Signal Strength Packet, which the Power Transmitter has received in the *ping* phase. In addition, if the Power Transmitter has entered the *identification & configuration* phase from the *power transfer* phase, the directly preceding Packet of the first Packet in the sequence—either the Configuration Packet if the sequence does not contain optional configuration Packets, or the first optional configuration Packet—is the End Power Transfer Packet, which the Power Transmitter has received in the *power transfer* phase.
- If the Power Transmitter does not correctly receive a Packet in the sequence within the time interval t_{max} after the start of that Packet, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$. See Figure 5-4(b).
- If the Power Transmitter correctly receives a next Packet that does not comply with the above sequence, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$ after the end of that Packet. See Figure 5-4(c).

In addition to these timing constraints, if the Power Transmitter does not receive a Packet correctly (see Section 6.2.4), the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$ after detecting the error.

After the Power Transmitter has received the Configuration Packet, the Power Transmitter shall execute the following steps, in the order shown:

- If the relation $t_{\text{delay}}^{(\text{min})} \leq t_{\text{delay}} \leq t_{\text{delay}}^{(\text{max})}$ is not satisfied, the Power Transmitter shall revert to the *selection* phase. Moreover, if the Power Transmitter reverts to the *selection* phase, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$ after the end of the Configuration

Packet. If the Power Transmitter has not received a Power Control Hold-off Packet, the Power Transmitter shall proceed to use $t_{\text{delay}} = t_{\text{delay}}^{(\text{min})}$.

- If the Power Transmitter has correctly received all Packets in the sequence (see Figure 5-4(d)), the Power Transmitter may create a Power Transfer Contract. See below.
- If the Power Transmitter has created a Power Transfer Contract, the Power Transmitter may proceed to the *power transfer* phase. If the Power Transmitter does not proceed to the *power transfer* phase, the Power Transmitter shall remove the Power Signal within t_{expire} after the start of the Configuration Packet. See Figure 5-4(e).
- If the Power Transmitter has removed the Power Signal—and does not proceed to the *power transfer* phase—the Power Transmitter shall revert to the *selection* phase.

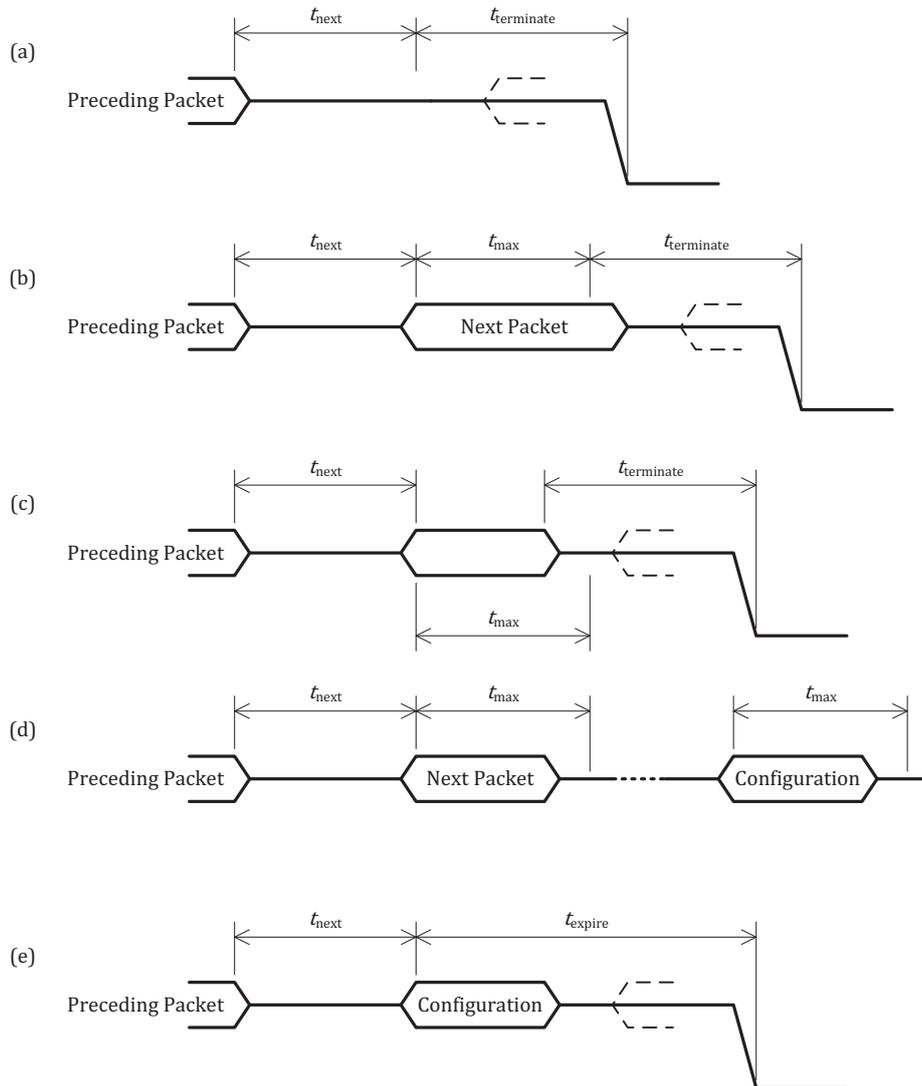


Figure 5-4: Power Transmitter timing in the *identification & configuration* phase

Table 5-2: Power Transmitter timing in the *identification & configuration* phase

Parameter	Symbol	Minimum	Target	Maximum	Unit
Next Packet time out	t_{next}	N.A.	N.A.	21.0 ⁺⁰	ms
Maximum Packet length	t_{max}	N.A.	N.A.	170.0 ⁺⁰	ms

Table 5-3: Power control hold-off time

Parameter	Symbol	Value	Unit
Power Control Hold-off Time	$t_{\text{delay}}^{(\text{min})}$	5	ms
Power Control Hold-off Time	$t_{\text{delay}}^{(\text{max})}$	205	ms

Based on the configuration information received from the Power Receiver, the Power Transmitter can create a Power Transfer Contract. This version 1.0.2 of the System Description Wireless Power Transfer, Volume I, Part 1, does not define the parameters that comprise a Power Transfer Contract. However, it is recommended that the Power Transfer Contract contains at least the following parameters:

- The maximum power that the Power Receiver intends to provide at its output (as obtained from the Maximum Power field of the Configuration Packet).

5.2.3 Power transfer phase

In the *power transfer* phase, the Power Transmitter controls the power transfer to the Power Receiver, in response to control data that it receives from the latter. For this purpose, the Power Transmitter shall receive zero or more of the following Packets:

- Control Error Packet.
- Rectified Power Packet.
- Charge Status Packet.
- End Power Transfer Packet.
- Any Proprietary Packet (as listed in Table 6-3). If the Power Transmitter does not know how to handle the message contained in the Proprietary Packet, the Power Transmitter shall ignore that message.
- Any reserved Packet (as indicated in Table 6-3). The Power Transmitter shall ignore the message contained in the reserved Packet.

The Power Transmitter shall receive the above Packets subject to the following timing constraints:

- If the Power Transmitter does not correctly receive the start of the first Control Error Packet within the time window t_{timeout} after the start of the Configuration Packet, which the Power Transmitter has received in the *identification & configuration* phase, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$. If the Power Transmitter does not correctly receive the start of a Control Error Packet within the time window t_{timeout} after the start of the preceding Control Error Packet, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$. See Figure 5-5(a).
- If the Power Transmitter does not correctly receive the start of the first Rectified Power Packet within the time window t_{power} after the start of the Configuration Packet, which the Power Transmitter has received in the *identification & configuration* phase, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$. If the Power Transmitter does not correctly receive the start of a Rectified Power Packet within the time window t_{power} after the start of the preceding Rectified Power Packet, the Power Transmitter shall remove the Power Signal within $t_{\text{terminate}}$. See Figure 5-5 (f).

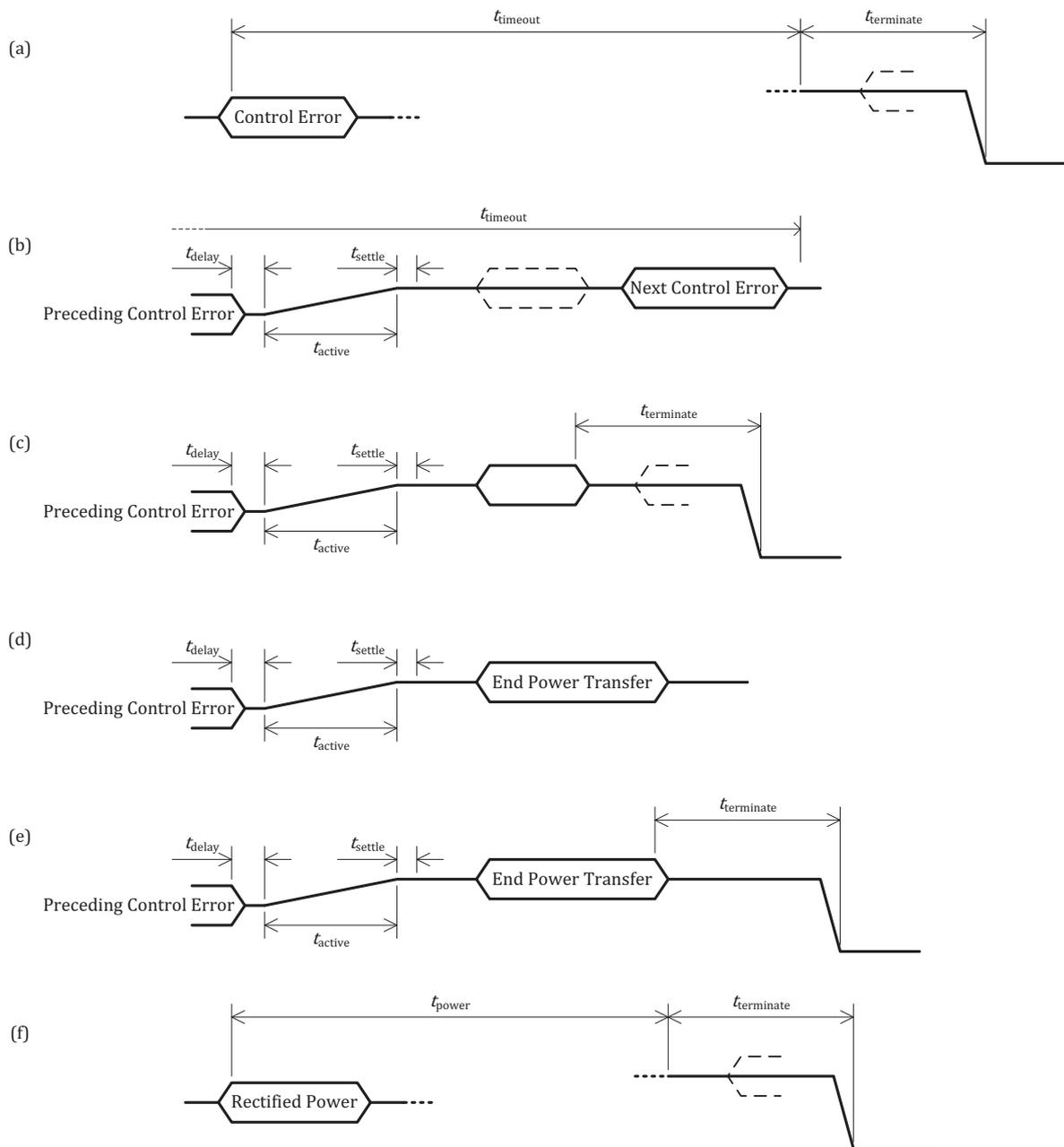


Figure 5-5: Power Transmitter timing in the *power transfer* phase

Table 5-4: Power Transmitter timing in the *power transfer* phase

Parameter	Symbol	Minimum	Target	Maximum	Unit
Control Error Packet time out	t_{timeout}	N.A.	1500	1800.0 ⁺⁰	ms
Power control active time	t_{active}	N.A.	20	21.0 ⁺⁰	ms
Power control settling time	t_{settle}	3.0 ₋₀	5	7.0 ⁺⁰	ms
Rectified Power Packet time	t_{power}	N.A.	35000	36000.0 ⁺⁰	ms

In addition to the above timing constraints, the Power Transmitter shall execute the following actions:

- Upon receiving a Control Error Value, the Power Transmitter shall adjust its Operating Point, as defined in Section 5.2.3.1, during a time window t_{active} . Prior to making any adjustment, the Power Transmitter shall wait for an interval t_{delay} to enable the Primary Cell current to stabilize again after communications. See Figure 5-5 (b).
- If the Power Transmitter correctly receives a Packet that does not comply with the above sequence, the Power Transmitter shall remove the Power Signal within $t_{terminate}$ after the end of that Packet. See Figure 5-5 (c).
- If the Power Transmitter receives an End Power Transfer Packet, the Power Transmitter shall:
 - Revert to the *identification & configuration* phase without changing its Operating Point, if the End Power Transfer Code is 0x07 (reconfigure). See Figure 5-5 (d).
 - Remove the Power Signal within $t_{terminate}$ after the end of the End Power Transfer Packet, if the End Power Transfer Code has any other value than 0x07. See Figure 5-5 (e).
- The Power Transmitter shall monitor the parameters contained in the Power Transfer Contract throughout the *power transfer* phase. If the Power Transmitter detects that the actual value of any of those parameters exceeds the limits contained in the Power Transfer Contract, the Power Transmitter shall remove the Power Signal within $t_{terminate}$.
- If the Power Transmitter has removed the Power Signal, the Power Transmitter shall revert to the *selection* phase.

5.2.3.1 Power transfer control

This version 1.0.2 of the System Description Wireless Power Transfer, Volume I, Part 1, defines a specific method, which the Power Transmitter shall use to control its Primary Cell current towards the new Primary Cell current (see also Section 5.1). This method is based on a discrete proportional-integral-differential (PID) algorithm as illustrated in Figure 5-6.

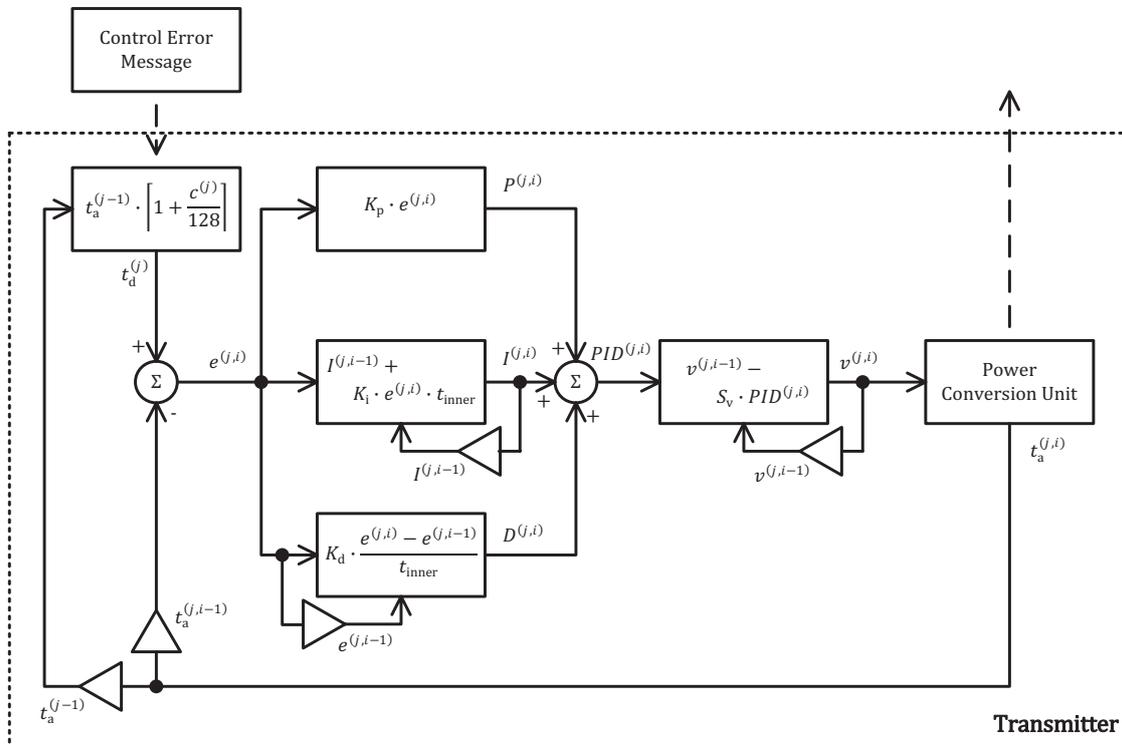


Figure 5-6: PID control algorithm

To execute this algorithm, the Power Transmitter shall execute the steps listed below, in the order of appearance. In the definitions of these steps, the index $j = 1, 2, 3, \dots$ labels the sequence of Control Error Packets, which the Power Transmitter receives.

- Upon receipt of the j^{th} Control Error Packet, the Power Transmitter shall calculate the new Primary Cell current $t_d^{(j)}$ as

$$t_d^{(j)} = t_a^{(j-1)} \cdot \left[1 + \frac{c^{(j)}}{128} \right],$$

where $t_a^{(j-1)}$ represents the actual Primary Cell current—reached in response to the previous Control Error Packet—and $c^{(j)}$ represents the Control Error Value contained in the j^{th} Control Error Packet. Note that $t_a^{(0)}$ represents the Primary Cell current at the start of the *power transfer* phase.

- If the Control Error Value $c^{(j)}$ is non-zero, the Power Transmitter shall adjust its Primary Cell current during a time window t_{active} . For this purpose, the Power Transmitter shall execute a loop comprising of the steps listed below. The index $i = 1, 2, 3, \dots, i_{\text{max}}$ labels the iterations of this loop.
 - The Power Transmitter shall calculate the difference between the new Primary Cell and the actual Primary Cell current as the error

$$e^{(j,i)} = t_d^{(j)} - t_a^{(j,i-1)},$$

Where $t_a^{(j,i-1)}$ represents the Primary Cell current determined in iteration $i - 1$ of the loop. Note that $t_a^{(j,0)}$ represents the actual Primary Cell current at the start of the loop.

- The Transmitter shall calculate the proportional, integral, and derivative terms (in any order):

$$\begin{aligned} P^{(j,i)} &= K_p \cdot e^{(j,i)}, \\ I^{(j,i)} &= I^{(j,i-1)} + K_i \cdot e^{(j,i)} \cdot t_{\text{inner}}, \\ D^{(j,i)} &= K_d \cdot \frac{e^{(j,i)} - e^{(j,i-1)}}{t_{\text{inner}}}, \end{aligned}$$

where K_p is the proportional gain, K_i is the integral gain, K_d is the derivative gain, and t_{inner} is the time required to execute a single iteration of the loop. In addition, the integral term $I^{(j,0)} = 0$, and the error $e^{(j,0)} = 0$. The Power Transmitter shall limit the integral term $I^{(j,i)}$ such that it remains within the range $-M_i \dots + M_i$ —if necessary, the Power Transmitter shall replace the calculated integral term $I^{(j,i)}$ with the appropriate boundary value.

- The Power Transmitter shall calculate the sum of the proportional, integral, and derivative terms:

$$PID^{(j,i)} = P^{(j,i)} + I^{(j,i)} + D^{(j,i)}.$$

In this calculation, the Power Transmitter shall limit the sum $PID^{(j,i)}$ such that it remains within the range $-M_{\text{PID}} \dots + M_{\text{PID}}$.

- The Power Transmitter shall calculate the new value of the controlled variable

$$v^{(j,i)} = v^{(j,i-1)} - S_v \cdot PID^{(j,i)},$$

where S_v is a scaling factor that depends on the controlled variable. In addition, the controlled variable $v^{(j,0)} = v^{(j-1, i_{\text{max}})}$, with $v^{(0,0)}$ representing the actual value of the controlled variable at the start of the *power transfer* phase. The controlled variable is either the Operating Frequency, the duty cycle of the inverter, or the voltage input to the inverter. If the calculated $v^{(j,i)}$ exceeds the specified range (see the definition of the individual Power Transmitter designs in Section 3), the Power Transmitter shall replace the calculated $v^{(j,i)}$ with the appropriate limiting value.

- The Power Transmitter shall apply the new value of the controlled variable $v^{(j,i)}$ to its Power Conversion Unit.
- The Power Transmitter shall determine the actual Primary Cell current $t_a^{(j,i)}$.

The maximum number of iterations of the loop i_{\max} , and the time t_{inner} required to execute a single iteration of the loop shall satisfy the following relation:

$$i_{\max} \cdot t_{\text{inner}} = t_{\text{active}}, \text{ with } 1 \text{ ms} \leq t_{\text{inner}} \leq 5 \text{ ms.}$$

- The Power Transmitter shall determine the Primary Cell current $t_a^{(j)}$ exactly at $t_{\text{delay}} + t_{\text{active}} + t_{\text{settle}}$ after the end of the j^{th} Control Error Packet.

See the definition of the individual Power Transmitter designs in Section 3 for the values of K_p , K_i , K_d , M_I , M_{PID} and S_v .

5.3 Power Receiver perspective

Section 5.3.1 defines the initial response of the Power Receiver to the application of a Power Signal. As part of this initial response, the Power Receiver wakes up its Communications and Control Unit—if that is not already up and running. Section 5.3.2 defines the response of a Power Receiver to a Digital Ping. This response ensures the Power Transmitter that it is dealing with a Power Receiver (rather than some unknown object). Section 5.3.3 defines the response of a Power Receiver to an extended Digital Ping. This response enables the Power Transmitter to identify the Power Receiver and establish a Power Transfer Contract. Finally, Section 5.3.4 defines the protocol that the Power Receiver shall execute in order to control the power transfer from the Power Transmitter.

Many provisions in this Section 5.3 refer to the start and/or the end of a Packet, or the start of a Packet's preamble. For the purpose of those provisions, the start of a Packet is defined as the instant the Power Receiver transmits the first edge of the start bit of the Packet's header byte; the end of a Packet is defined as the instant the Power Receiver transmits the second edge of the stop bit of the Packet's checksum byte; and the start of a Packet's preamble is defined as the instant the Power Receiver transmits the first edge of the first preamble bit.

In addition to the timing constraints given in Sections 5.3.1, 5.3.2, 5.3.3, and 5.3.4, the Power Receiver shall leave the *ping*, *identification & communication*, or *power transfer* phase within the time window t_{reset} (see Table 5-5) after the Power Transmitter removes the Power Signal, where the time window t_{reset} starts from the instant that the Primary Cell current amplitude crosses 50% of the stable level. Note that this version 1.0.2 of the System Description Wireless Power Transfer, Volume I, Part 1, does not define how the Power Receiver should detect that the Power Transmitter removes the Power Signal.

Table 5-5: Power Receiver reset timing

Parameter	Symbol	Minimum	Target	Maximum	Unit
Power Receiver reset time	t_{reset}	N.A.	25	28.0 ⁺⁰	ms

Moreover, notwithstanding the timing constraints given in Sections 5.3.1, 5.3.2, 5.3.3, and 5.3.4, the Power Receiver may stop transmitting Packets to the Power Transmitter at any time. (Informative) *This behavior causes the Power Transmitter to remove the Power Signal, possibly under the assumption that a user has removed the Power Receiver from the Interface Surface. The recommended behavior to cause the Power Transmitter to remove the Power Signal (when a user has not removed the Power Receiver from the Interface Surface) is to transmit an End Power Transfer Packet as defined in Sections 5.3.2 and 5.3.4.*

5.3.1 Selection phase

As soon as the Power Transmitter applies a Power Signal, the Power Receiver shall enter the *selection* phase.⁷ Note that this version 1.0.2 of the System Description Wireless Power Transfer, Volume I, Part 1, does not define how the Power Receiver should detect that the Power Transmitter applies a Power Signal. If the Power Receiver considers the rectified voltage V_r to be sufficiently high, the Power Receiver shall proceed to the *ping* phase, such that the first Packet (see Section 5.3.2) starts at t_{wake} . Here, the time t_{wake} starts from the instant that the Primary Cell current amplitude crosses 50% of the stable level. See Figure 5-7 and Table 5-6.

If the Power Receiver does not proceed to the *ping* phase, the Power Receiver shall not transmit any Packet.

⁷If the Power Receiver is not in the *selection* phase already. Note that if the Power Receiver needs time to start up its Communications and Control Unit, the Power Receiver shall consider itself to be in the *selection* phase during that start-up time. In general, the Power Receiver may consider itself to be in the *selection* phase whenever it is neither in the *ping* phase, nor in the *identification & configuration* phase, nor in the *power transfer* phase.

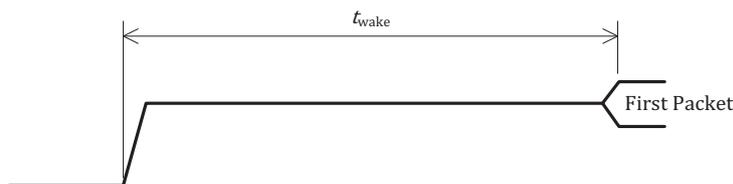


Figure 5-7: Power Receiver timing in the *selection* phase

Table 5-6: Power Receiver timing in the *selection* phase

Parameter	Symbol	Minimum	Target	Maximum	Unit
Wake up time	t_{wake}	19.0 ₋₀	40	64.0 ⁺⁰	ms

5.3.2 Ping phase

If the Power Receiver responds to the Digital Ping, the Power Receiver shall transmit either a Signal Strength Packet, or an End Power Transfer Packet as its first Packet. The Power Receiver shall transmit this first Packet immediately upon entering the *ping* phase.



Figure 5-8: Power Receiver timing in the *ping* phase

After the Power Receiver has transmitted a Signal Strength Packet, the Power Receiver shall proceed to the *identification & configuration* phase. After the Power Receiver has transmitted an End Power Transfer Packet, shall remain in the *ping* phase. In that case, the Power Receiver should transmit additional End Power Transfer Packets.⁸

5.3.3 Identification & configuration phase

In the *identification & configuration* phase, the Power Receiver shall transmit the following sequence of Packets:

- If the Power Receiver enters the *identification & configuration* phase from the *ping* phase, an Identification Packet.
- If the Ext bit of the preceding Identification Packet is set to ONE, an Extended Identification Packet.
- Up to 7 optional configuration Packets from the following set (the order in which the Power Receiver transmits these Packets, if any, is not relevant):
 - A Power Control Hold-off Packet. The Power Control Hold-off Time t_{delay} contained in this Packet shall satisfy the relation $t_{delay}^{(min)} \leq t_{delay} \leq t_{delay}^{(max)}$. See Table 5-3.
 - Any Proprietary Packet (as listed in Table 6-3).
- A Configuration Packet.

The Power Receiver shall transmit the above sequence of Packets subject to the following timing constraints:

- The Power Receiver shall not start the preamble of the next Packet in the sequence within the time interval t_{silent} after the end of the directly preceding Packet in the sequence.

⁸The Power Transmitter can miss the first End Power Transfer Packet, e.g. due to a communications error, and continue to apply the Power Signal.

- (Informative) *The next Packet time-out value t_{next} of the Power Transmitter defined in Section 5.2.2 imposes an upper limit on the time window in which the Power Receiver can send the next Packet in the sequence.*

With respect to the above timing constraints, if the Power Receiver has entered the *identification & configuration* phase from the *ping* phase, the directly preceding Packet of the Identification Packet is the Signal Strength Packet, which the Power Receiver has transmitted in the *ping* phase. In addition, if the Power Receiver has entered the *identification & configuration* phase from the *power transfer* phase, the directly preceding Packet of the first Packet in the sequence—either the Configuration Packet if the sequence does not contain optional configuration Packets, or the first optional configuration Packet—is the End Power Transfer Packet, which the Power Receiver has transmitted in the *power transfer* phase.

See Figure 5-9 and Table 5-7.

After the Power Receiver has transmitted a Configuration Packet, the Power Receiver shall proceed to the *power transfer* phase.

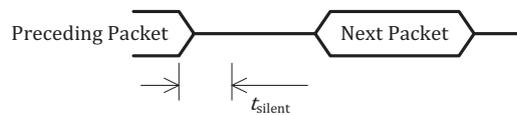


Figure 5-9: Power Receiver timing in the *identification & configuration* phase

Table 5-7: Power Receiver timing in the *identification & configuration* phase

Parameter	Symbol	Minimum	Target	Maximum	Unit
Silent time*	t_{silent}	6.0 ₋₀	7	—	ms

*The maximum possible t_{silent} depends on the number of preamble bits and the next Packet time-out value t_{next} defined in Figure 5-4 and Table 5-2 in Section 5.2.2.

5.3.4 Power transfer phase

In the *power transfer* phase, the Power Receiver controls the power transfer from the Power Transmitter, by means of control data that it transmits to the latter. For this purpose, the Power Receiver shall transmit zero or more of the following Packets:

- Control Error Packet. The Power Receiver shall set the Control Error Value to zero if the actual Control Point is equal to the desired Control Point. The Power Receiver shall set the Control Error Value to a negative value to request a decrease of the Primary Cell current. The Power Receiver shall set the Control Error Value to a positive value to request an increase of the Primary Cell current. See also Sections 5.1 and 5.2.3.1.
- Rectified Power Packet.
- Charge Status Packet.
- End Power Transfer Packet.
- Any Proprietary Packet (as listed in Table 6-3).

The Power Receiver shall transmit the above Packets subject to the following timing constraints:

- The Power Receiver shall not start to transmit the preamble of any Packet within the time window t_{silent} after the end of the directly preceding Packet. As an additional constraint, the preamble of any Packet shall not start within the time window $t_{\text{delay}} + t_{\text{control}}$ after the end of a Control Error Packet, where t_{delay} is the Power Control Hold-off value, which the Power Receiver has transmitted using the last Power Control Hold-off Packet in the *identification & configuration* phase. If the Power Receiver has not transmitted a Power Control Hold-off Packet to the Power Transmitter, the Power Receiver shall use $t_{\text{delay}} = t_{\text{delay}}^{(\text{min})}$ (see Table 5-3).

- The first Control Error Packet shall start within the time window t_{interval} after the start of the Configuration Packet. A next Control Error Packet shall start within the time window t_{interval} after the start of the preceding Control Error Packet.
- It is recommended that the Power Receiver determines its actual Control Point at $t_{\text{delay}} + t_{\text{control}}$ after the end of a Control Error Packet.
- The first Rectified Power Packet shall start within the time window $t_{\text{rectified}}$ after the start of the Configuration Packet. A next Rectified Power Packet shall start within the time window $t_{\text{rectified}}$ after the start of the preceding Rectified Power Packet.

See Figure 5-10 and Table 5-8.

In addition to the above timing constraints, if the Power Receiver has transmitted an End Power Transfer Packet, which contains an End Power Transfer Code of 0x07, the Power Receiver shall revert to the *identification & configuration* phase. Moreover, if the Power Receiver has transmitted an End Power Transfer Packet, which contains any other End Power Transfer Code, the Power Receiver shall remain in the *power transfer* phase, until the Power Transmitter removes the Power Signal. Furthermore, the Power Receiver should transmit additional End Power Transfer Packets if the Power Transmitter does not remove the Power Signal.⁹

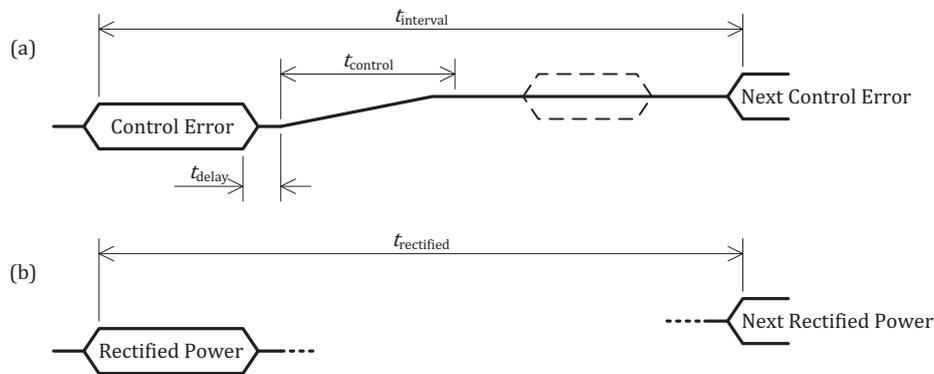


Figure 5-10: Power Receiver timing in the *power transfer* phase

Table 5-8: Power Receiver timing in the *power transfer* phase

Parameter	Symbol	Minimum	Target	Maximum	Unit
Interval*	t_{interval}	—	250	350.0 ⁺⁰	ms
Controller time	t_{control}	24.0 ₋₀	25	N.A.	ms
Rectified Power Packet time*	$t_{\text{rectified}}$	—	5000	6000.0	ms

*The minimum possible interval depends on the value of t_{delay} and the number of preamble bits.

⁹(Informative) *The Power Transmitter can miss the first and possibly subsequent End Power Transfer Packets, e.g. due to communications errors, and continue to apply the Power Signal. However, eventually the Power Transmitter should remove the Power Signal due to a time-out as defined in Section 5.2.3.*

Qi Certificate TUV-10039044

Herewith declares **TUV Rheinland Taiwan Ltd.**, appointed as Qi Compliance Test Laboratory by the Wireless Power Consortium, located at:

11F, No.758, Bade Road, Section 4, Sungshan District, 105 Taipei, Taiwan, R.O.C.

**Smart Phone
SH-04E**

From WPC member:

Sanyo Electric Co., LTD
222-1 Kaminaizen Sumoto
Hyogo 656-8555
Japan

Fully compatible is with:

Compliance Test Specifications:

System Description Wireless Power Transfer
Volume 1: Low Power
Part 3: Compliance Testing
Version 1.0.3 (+addenda)
September 2011
Compliance Report: 10039044 001

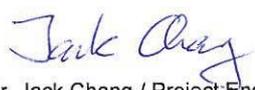
Interoperability Test Specifications:

Qi Interoperability Test Specification
Version: v1.01
December 2011
Interoperability Report: IDD1112093R



Taipei, 22-Nov-2012
Mr. Jan-Willem Vonk / Senior Project Manager

Dz = 0.74 mm.

Prüfbericht - Nr.: 10039044 001 <i>Test Report No.:</i>			Page 1 of 9 Page 1 of 9
Auftraggeber: <i>Client:</i>	Sanyo Electric Co., LTD 222-1 Kaminaizen, Sumoto, Hyogo 656-8555, Japan		
Gegenstand der Prüfung: <i>Test item:</i>	Smart Phone		
Bezeichnung: <i>Identification:</i>	Model: SH-04E	Serien-Nr.: <i>Serial No.:</i>	
Wareneingangs-Nr.: <i>Receipt No.:</i>	TPE78891	Eingangsdatum: <i>Date of receipt:</i>	12.11.2012
Zustand des Prüfgegenstandes bei Anlieferung: Good Condition of test item at delivery:			
Prüfart: <i>Testing location:</i>	TUV Rheinland Taiwan Ltd. 11F., No.758, Bade Road, Section 4, Sungshan District, 105 Taipei, Taiwan		
Prüfgrundlage: <i>Test specification:</i>	System Description Wireless Power Transfer, Part 3: Compliance Testing Version 1.0.3 (+ addenda), September-2011, Volume 1: Low power		
Prüfresultat: <i>Test Result:</i>	Der Prüfgegenstand entspricht oben genannter Prüfgrundlage(n). <i>The test item passed the test specification(s).</i>		
Prüflaboratorium: <i>Testing Laboratory:</i>	TUV Rheinland Taiwan Ltd.		
geprüft/ tested by:		kontrolliert/ reviewed by:	
			
22 November 2012, Mr. Jack Chang / Project Engineer		22 November 2012, Mr. Jan-Willem Vonk / Senior Project Manager	
<u>Datum</u> <i>Date</i>	<u>Name/Stellung</u> <i>Name/Position</i>	<u>Unterschrift</u> <i>Signature</i>	<u>Datum</u> <i>Date</i>
Sonstiges/ Other Aspects: Qi compliance certificate TUV-10039044 consists of compliance test report 10039044 001 and Interoperability test report IDD1112093R.			
Abkürzungen:	<i>P(ass) = entspricht Prüfgrundlage</i>	Abbreviations:	<i>P(ass) = passed</i>
	<i>F(ail) = entspricht nicht Prüfgrundlage</i>		<i>F(ail) = failed</i>
	<i>N/A = nicht anwendbar</i>		<i>N/A = not applicable</i>
	<i>N/T = nicht getestet</i>		<i>N/T = not tested</i>
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report relates to the a. m. test item. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any safety mark on this or similar products.</i>			

1. Administrative Data

1.1. Project Data

Project Responsible: Jan-Willem Vonk
Date of Test Report: 22.11.2012
Date of First Test: 12.11.2012
Date of Last Test: 14.11.2012

1.2. Applicant Data

Company Name: Sanyo Electric Co., LTD
Street: 222-1 Kaminaizen
Sumoto
City: Hyogo 656-8555
Country: Japan

Contact person: Kazuhiro Toyoda
Telephone: +81 799 23 2839
Fax:
E-mail address: toyoda.kazuhiro@jp.panasonic.com

1.3. Test Laboratory Data

The following list shows all places and laboratories involved for test result generation:

TUV Rheinland Taiwan Ltd.

Company Name: TUV Rheinland Taiwan Ltd.
Street: 11F, No.758, Bade Road, Section 4
City: 105 Taipei
Country: Taiwan R.O.C.

Contact person: Jan-Willem Vonk
Tel: +886 2 2172 0000 #1059
Fax: +886 2 2528 0018
E-mail: jwv@twn.tuv.com

Laboratory Details

<i>Identification</i>	<i>Responsible</i>
Wireless Power Test laboratory	Mr. Jan-Willem Vonk

1.4. Signature of the Testing Responsible



Taipei, 22-Nov-2012

Mr. Jack Chang / Project Engineer

1.5. Signature of the Accreditation Responsible



Taipei, 22-Nov-2012

Mr. Jan-Willem Vonk / Senior Project Manager

2. Test Object Data

2.1. General IUT Data

The following list shows all IUT's involved for the test result generation:

IUT:

Type / Model / Family: Smart Phone
Model: SH-04E

Receiver Description:

Manufacturer:

Company name: Sanyo Electric Co., LTD

2.2. Detailed Description of UIT Samples

Sample description:

Sample Number:
Qi ID: TUV-10039044
Sample Description: Smart Phone
Receiver Description:
Order Number: 113163051
HW Version:
SW Version:
Date of Receipt: 12.11.2012
Nominal Voltage: n.a.
Nominal Temperature: n.a.

2.3. Setups used for Testing

Test setup description:

Setup no.	Description	Sample Nr.
001	Test Power Transmitter #1	TPE78891

3. Results

3.1. General

Documentation of tested devices:

Available at the test laboratory

Interpretation of the Test Results:

The results of the inspection are described on the following pages, where 'Conformity' or 'Passed' means that the certification criteria were verified and the tested device is conform the applied standard.

3.2. List of Test Specification

Document Title:

System Description Wireless Power Transfer

Part:

Part 3: Compliance Testing

Version:

Version 1.0.3 (+ addenda)

Date:

September-2011

Additional Information:

Volume 1: Low power

3.3. Summary

Requirement	Date	Verdict
Req#38 Load Modulation	13-Nov-2012	PASS
Digital Ping		
Req#39 Packet Timing	13-Nov-2012	PASS
Req#40 Packet Content	13-Nov-2012	PASS
Req#41 Signal Strength	13-Nov-2012	PASS
Identification and Configuration		
Req#42 Packet Sequence	13-Nov-2012	PASS
Req#43a Packet Timing SS and ID	13-Nov-2012	PASS
Req#43b Packet Timing -CFG and CFG	13-Nov-2012	PASS
Req#44 Packet Content ID packet	13-Nov-2012	PASS
Req#45 Packet Content Power Control Hold-Off		n.a.
Req#46 Packet Content Config packet	13-Nov-2012	PASS
Power Transfer		
Req#48 Packet Sequence	13-Nov-2012	PASS
Req#49a Packet Timing between 2 consecutive packets	13-Nov-2012	PASS
Req#49b Packet Timing after CEP	13-Nov-2012	PASS
Req#50 Packet Timing between CEP	13-Nov-2012	PASS
Req#51 Packet Timing between RPP	13-Nov-2012	PASS
Req#53 Packet Content		n.a.
Receiver Reset		
Req#54 Reset	13-Nov-2012	PASS

4. Test Equipment Details

4.1. List of Used Test Equipment

Single devices used for Qi compliance testing:

<i>Device Name</i>	<i>Model</i>	<i>Serial Number</i>	<i>TUV Nr.</i>	<i>Manufacturer</i>
Mobile Device Test System	TPT#1	MDT/BST-006	001368	Audiodev
Digital Storage Scope	A01604	MY44000101	006216	Agilent
Notebook	5038-RZ3	MP-02608 11-07	001365	Lenovo
Mobile Device Test Firmware	Q100MDT 1.02.5.207			Audiodev
Mobile Device Test Software	CATS MDT 1.02.5.209			Audiodev

4.2. Laboratory Environmental Conditions

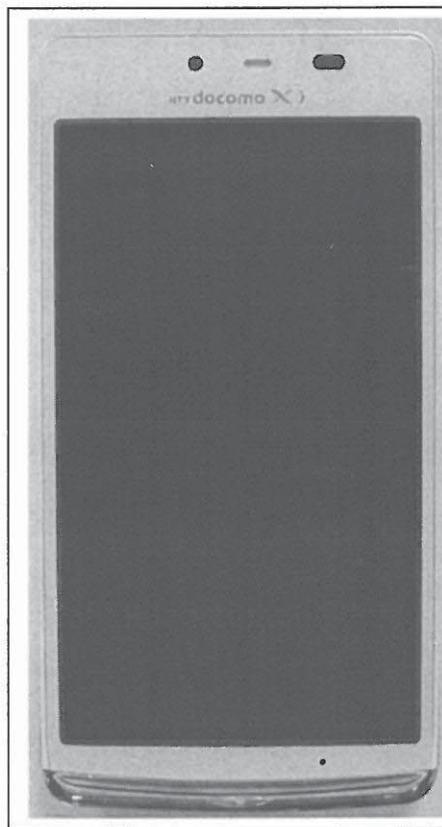
<i>Date</i>	<i>Temperature (C)</i>	<i>Humidity (%)</i>
14.11.2012	23	35

5. Annex

5.1. Additional Information for Sample Description

n.a.

5.2. Product Picture



5.3. Additional Information for Sample Setup

n.a.

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