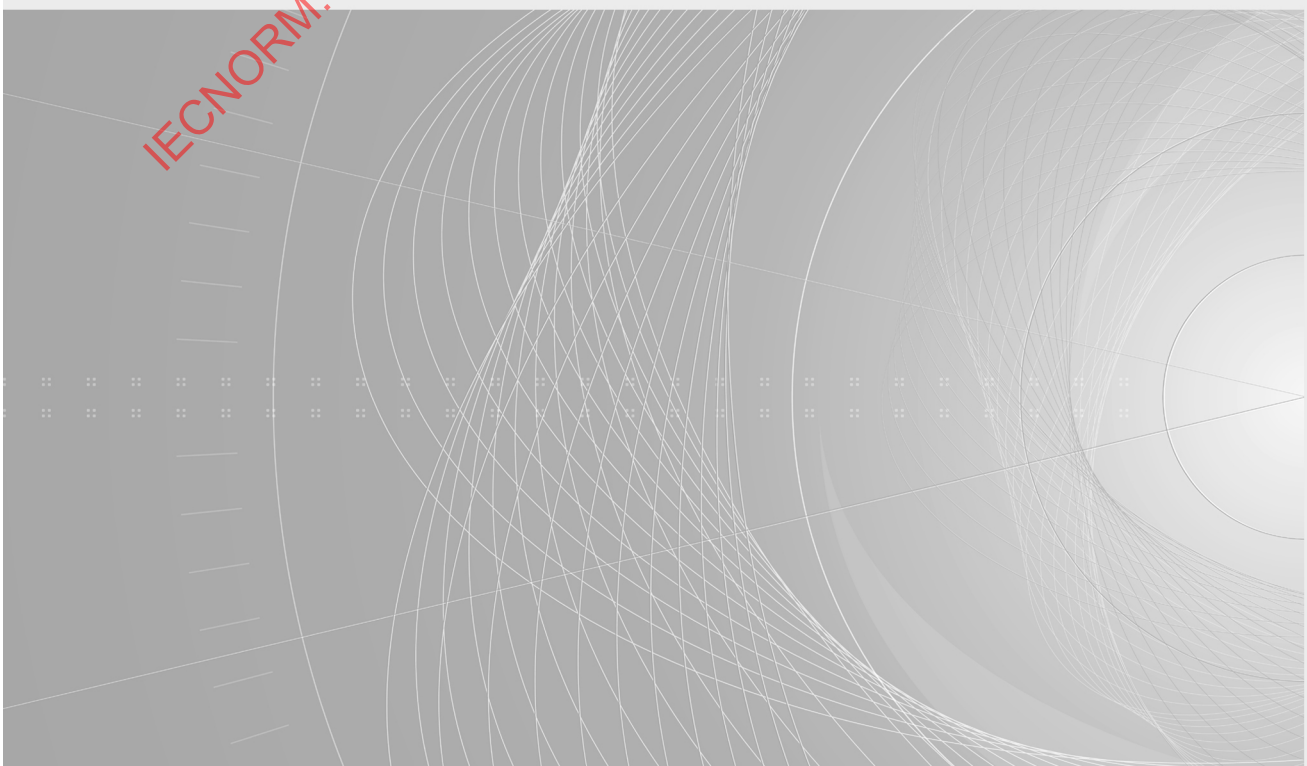
IEC TS 61980-2

Edition 1.0 2019-06

TECHNICAL SPECIFICATION

colour inside

Electric vehicle wireless power transfer (WPT) systems – Part 2: Specific requirements for communication between electric road vehicle (EV) and infrastructure



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Electric vehicle wireless power transfer (WPT) systems – Part 2: Specific requirements for communication between electric road vehicle (EV) and infrastructure

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –

Part 2: Specific requirements for communication between electric road vehicle (EV) and infrastructure

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 61980-2, which is a Technical Specification, has been prepared by IEC technical committee TC 69: Electric road vehicles and electric industrial trucks.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
69/529/DTS	69/585B/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO Directives, Part 2.

In this Technical Specification, the following print types are used:

- *conformity statements: in italic type*;
- **states and messages: bold type**.

A list of all parts of the IEC 61980 series, published under the general title *Electric vehicle wireless power transfer (WPT) systems*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The IEC 61980 series is published in separate parts according to the following structure:

– IEC 61980-1 covers general requirements for electric road vehicle (EV) wireless power transfer (WPT) systems including general background and definitions. (e.g. efficiency, electrical safety, EMC);

– IEC TS 61980-2 covers specific requirements for communication between electric road vehicle (EV) and wireless power transfer (WPT) systems including general background and definitions;

– IEC TS 61980-3 covers specific requirements for electric road vehicle (EV) magnetic field wireless power transfer (MF-WPT) systems including general background and definitions (e.g. efficiency, electrical safety, EMC).

The requirements described in IEC 61980-1 are general. The technical requirements for the various wireless power transfer (WPT) technologies are very different; they are specified in the technology specific parts of the IEC 61980 series. A list of possible WPT technologies is listed in IEC 61980-1. The requirements for magnetic field-wireless power transfer systems (MF-WPT) are described in IEC TS 61980-3. Further parts of the IEC 61980 series will describe other technologies such as power transfer via electric field or via electromagnetic field wireless power transfer systems (EF-WPT) or electromagnetic field-WPT systems, also named microwave-WPT systems (MW-WPT).

Reference to "technology specific parts" always refers to each parts of the IEC 61980 series. The structure of the "technology specific parts" follows the structure of IEC 61980-1.

WPT systems are still under development. For this reason, there is the future but not immediate possibility of an agreement to publish an International Standard. The committee has decided, by following the procedure set out in ISO/IEC Directives, Part 1:2018, 2.3, that the publication of a Technical Specification is appropriate. The reasons for publishing the Technical Specification is a high market need for a first basic technical description.

IEC TS 61980-2, also published as a Technical Specification for the same reasons as IEC TS 61980-3, deals with communication and for this reason has an independent structure. The numbering of the clauses does not follow the numbering of the other parts of the IEC 61980 series.

The electric road vehicles (EV) requirements of the MF-WPT system are covered by ISO/PAS 19363.

ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –

Part 2: Specific requirements for communication between electric road vehicle (EV) and infrastructure

1 Scope

This Part of IEC 61980, which is a Technical Specification, applies to communication between electric road vehicle (EV) and wireless power transfer (WPT) systems when connected to the supply network, at standard supply voltages per IEC 60038 up to 1000 V AC and up to 1500 V DC.

This document also applies to wireless power transfer equipment supplied from on-site storage systems (e.g. buffer batteries) at standard supply voltages per IEC 60038 up to 1000 V AC and up to 1500 V DC.

The aspects covered in this document include

– standards for operational characteristics and functional characteristics of the WPT communication subsystem,
– communication requirements for WPT system while driving, which are under consideration,
– communication requirements for two- and three-wheel vehicles, which are under consideration, and
– communication requirements for bidirectional power transfer are under consideration

This document does not apply to

– safety aspects related to maintenance, and
– trolley buses, rail vehicles and vehicles designed primarily for use off-road.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61980-1, *Electric vehicle wireless power transfer (WPT) systems – Part 1: General requirements*

IEC TS 61980-3:2019, *Electric vehicle wireless power transfer (WPT) systems – Part 3 Specific requirements for the magnetic field wireless power transfer systems*

ISO 15118 (all parts), *Road vehicles – Vehicle to grid communication interface*

ISO 15118-2, *Road vehicles – Vehicle to grid communication interface – Part 2: Network and application protocol requirements*[1]

[1] Second edition under preparation. Stage at the time of publication: ISO/DIS 15118-2:2019.

ISO 15118-8:2018, *Road vehicles – Vehicle to grid communication interface – Part 8: Physical layer and data link layer requirements for wireless communication*

ISO 15118-20, *Road vehicles – Vehicle to grid communication interface – Part 20: 2nd generation network and application protocol requirements*[2]

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61980-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
alignment
relative position in x and y direction of the secondary device to the primary device

3.2
centre alignment point
geometrical centre of the alignment tolerance area

Note 1 to entry: The centre alignment point is always relative to the primary and secondary device combination and is dependent upon magnetic characteristics.

3.3
electric vehicle communication controller
EVCC
on-board component which implements the communication with the SECC

3.4
EV device
on-board component assembly, comprising the secondary device, the EV power electronics and all on-board communication controllers, as well as the electrical and mechanical connections between the assemblies

Note 1 to entry: Ancillary systems used for supporting the operation of MF-WPT are also included (e.g. positioning).

Note 2 to entry: The hardware packaging of the assemblies is up to the discretion of the manufacturer.

3.5
EV device P2PS controller
on-board equipment that controls the EV device's P2PS

3.6
EV power circuit
EVPC
on-board component assembly, comprising the secondary device and EV power electronics, as well as the electrical and mechanical connections

Note 1 to entry: EVPC is here defined specifically for MF-WPT systems.

[2] Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.

3.7
EV signal
P2PS from EV device

3.8
foreign object
object that is not an attached part of the vehicle or the MF-WPT system

3.9
low power excitation
LPE
energizing of the primary device as a P2PS

3.10
MF-WPT system
system comprising the supply device and the EV device to perform MF-WPT

3.11
natural offset
vector from the centre of the primary device to the centre alignment point of the secondary device in x and y direction

3.12
open systems interconnection
OSI
reference model developed by ISO to enable different or similar systems to dialogue with one another

Note 1 to entry: This model constitutes a reference framework for describing data exchanges. Each layer performs a service at the request of the adjacent higher layer, and in turn, requests more basic services from the lower layers. It is described in 7 layers.

Note 2 to entry: Open systems interconnection (OSI) is an international effort to facilitate communications among computers of different manufacture and technology.

[SOURCE: ISO 15784-3:2008, 3.17]

3.13
point to point signal
P2PS
unidirectional wireless link between EV device and supply device

3.14
primary device
off-board component that generates and shapes the magnetic field for power transfer

3.15
rechargeable energy storage system
RESS
rechargeable system that stores energy for delivery of electric energy for the electric drive

EXAMPLE Battery, capacitor, flywheel.

[SOURCE: ISO 6469-1:2009, 3.16, modified – The definition has been rephrased, and the term "flywheel" has been added to the example.]

3.16
secondary device
on-board component that captures the magnetic field

3.17
secondary device ground clearance
vertical distance between the ground surface and the lowest point of the secondary device including the housing

Note 1 to entry: The lower surface does not need to be planar or parallel to the ground surface.

3.18
SR signal
EV signal with a short range that is intended to be received by only one supply device

3.19
supply device
off-board component assembly, comprising the primary device, the supply power electronics, and all off-board communication controllers, as well as the electrical and mechanical connections between the assemblies

Note 1 to entry: Ancillary systems used for supporting the operation of MF-WPT are also included (e.g. LOP, FOD, positioning).

Note 2 to entry: The hardware packaging of the assemblies is up to the discretion of the manufacturer.

3.20
supply device P2PS controller
off-board equipment that controls the supply device's P2PS

3.21
supply equipment
off-board equipment comprising the SECC and one or multiple supply devices working under the control of the same SECC

3.22
supply equipment communication controller
SECC
off-board component that implements the communication with the EVCC(s)

Note 1 to entry: One SECC can control multiple supply devices for certain configurations.

3.23
supply power circuit
off-board component assembly, comprising the primary device and supply power electronics, as well as the electrical and mechanical connections

Note 1 to entry: Supply power circuit is here defined specifically for MF-WPT systems.

3.24
supply power electronics
off-board component that converts the power and frequency from the supply network to the power and frequency needed by the primary device

3.25
wireless local area network
WLAN
network which allows wireless communication between multiple EVCCs with one SECC

3.26
WPT session
WPT activities starting with successful communication setup and ending with terminate communication

3.27
WPT spot
WPT supply site with only one supply device

3.28
WPT supply site
physical location of one or more WPT spots

Note 1 to entry: The WPT supply site contains the supply equipment necessary for power transfer. The SECC can be situated on another physical location, outside the WPT supply site area

4 Abbreviated terms

EV	electric vehicle
EVCC	EV communication controller
FOD	foreign object detection
ID	identifiers
LPE	low power excitation
MAC	media access control (address)
MF-WPT	magnetic field- wireless power transfer
OSI	open systems interconnection
P2PS	point to point signal
UC	use case
WLAN	wireless local area network
WPT	wireless power transfer

5 Communication of WPT systems

5.1 General

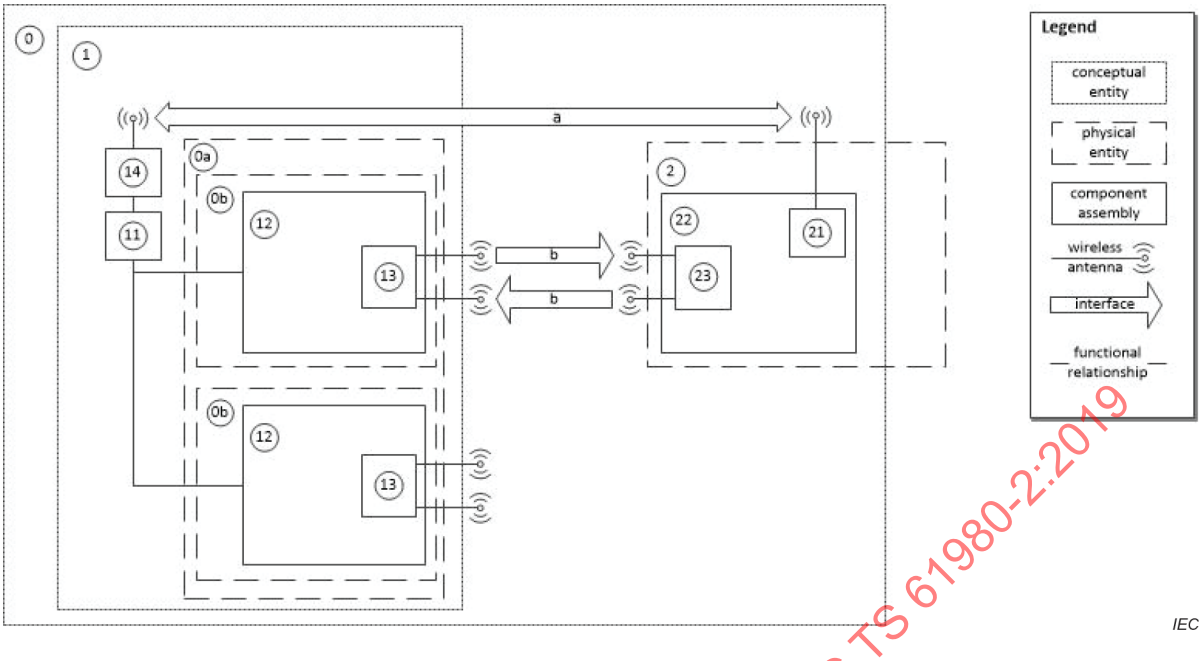
Safety relevant signalling between the supply device and the EV device may be performed via point to point signal (P2PS) or other means such as power transfer monitoring.

The supply device is a placeholder for all equipment installed on the infrastructure side of a single WPT system (see Figure 1). The EV device is a placeholder for all equipment installed on the electric vehicle side of a WPT system. Both terms are used to simplify the text of this document and to give a clear understanding of the situation.

5.2 System architecture

The communication subsystem can be established by a set or subset of the following elements(see Figure 1):

- WLAN;
- EVCC;
- EV device P2PS controller;
- EV device WLAN antenna;
- SECC,
- supply device P2PS controller;
- supply device WLAN antenna.

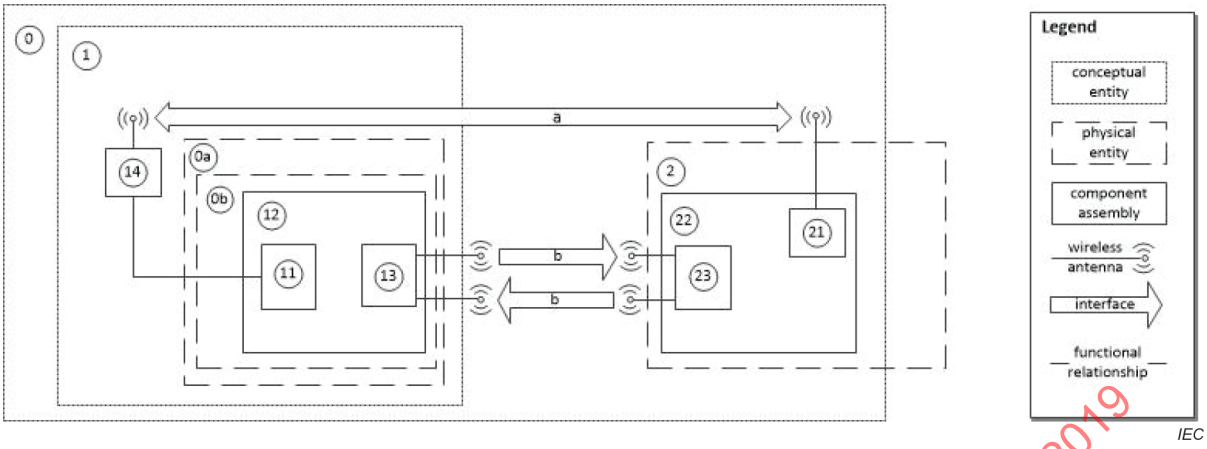


Key	Name	Abbreviations
0	MF-WPT system	
1	supply equipment	
2	electric vehicle	EV
11	supply equipment communication controller	SECC
12	supply device	
13	supply device P2PS controller	
14	supply equipment WLAN access point	WLAN AP
21	electric vehicle communication controller	EVCC
22	EV device	
23	EV device P2PS controller	
a	wireless communication interface	
b	wireless P2PS interface	
0a	WPT supply site	
0b	WPT spot	
NOTE 1 (11) can be partially or fully incorporated in (12) from a physical perspective. NOTE 2 (13) and (23) can be realized by a single hardware component in (11) and (21) respectively.		

Figure 1 – Possible elements of combination in a communication subsystem

The SECC and the supply device P2PS controller may be realized by one single hardware component. The EVCC and EV device P2PS controller may be realized by one single hardware component.

In a configuration for one individual supply device (e.g. for single home applications), the SECC and the supply device P2PS controller may functionally merge (see Figure 2).



NOTE See Figure 1 for the key.

Figure 2 – WPT site with a single supply device

A supply device shall be equipped with P2PS.

Conformance is tested by inspection.

5.3 General system requirements

5.3.1 General

The communication of a WPT system shall be implemented as per ISO 15118-20[3].

NOTE 1 Negotiation and renegotiation are described in ISO 15118-20 and not in this document.

NOTE 2 Negotiation and renegotiation according to ISO 15118-20 is not prohibited by any requirement within this document.

The communication of a WPT system for the WPT process shall support power transfer without any manual interaction by the user.

NOTE 1 Negotiation and renegotiation are described in ISO 15118 (all parts) and not in this document.

NOTE 2 Negotiation and renegotiation according to ISO 15118 (all parts) is not prohibited by any requirement within this document.

Conformance tests are described in ISO 15118 (all parts).

5.3.2 Interoperability requirements

Interoperability of WPT requires that both the power transfer mechanism and the communication can interoperate. The requirements for interoperability of the power transfer functions are given in the technology specific parts of the IEC 61980 series.

This document specifies the requirement for the interoperability of the communication.

5.3.3 System configuration

WPT supply sites shall be able to establish and maintain communication to one or more EV devices simultaneously.

[3] Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.

5.3.4 Communication security

Wireless local area network (WLAN) communication security shall be used in accordance to ISO 15118 (all parts).

5.3.5 Timing

Timing requirements ensure the safe and robust operation of the power transfer process. General safety relevant timing requirements are specified in 6.3 relating to the individual activities. Other timing requirements relevant for a robust and interoperable functionality depend on the technology and implementations.

6 Power transfer process with respect to communication

6.1 General

In general, the power transfer process shall be in accordance with technology specific parts of the IEC 61980 series.

Clause 6 describes the power transfer process with respect to communication. For a detailed description of the mentioned states, see Clause 7 and for the mentioned use cases, see Annex A.

6.2 Overview of operation process activities

Figure 3 shows an overview of the operation process of activities after EV approaching supply device.

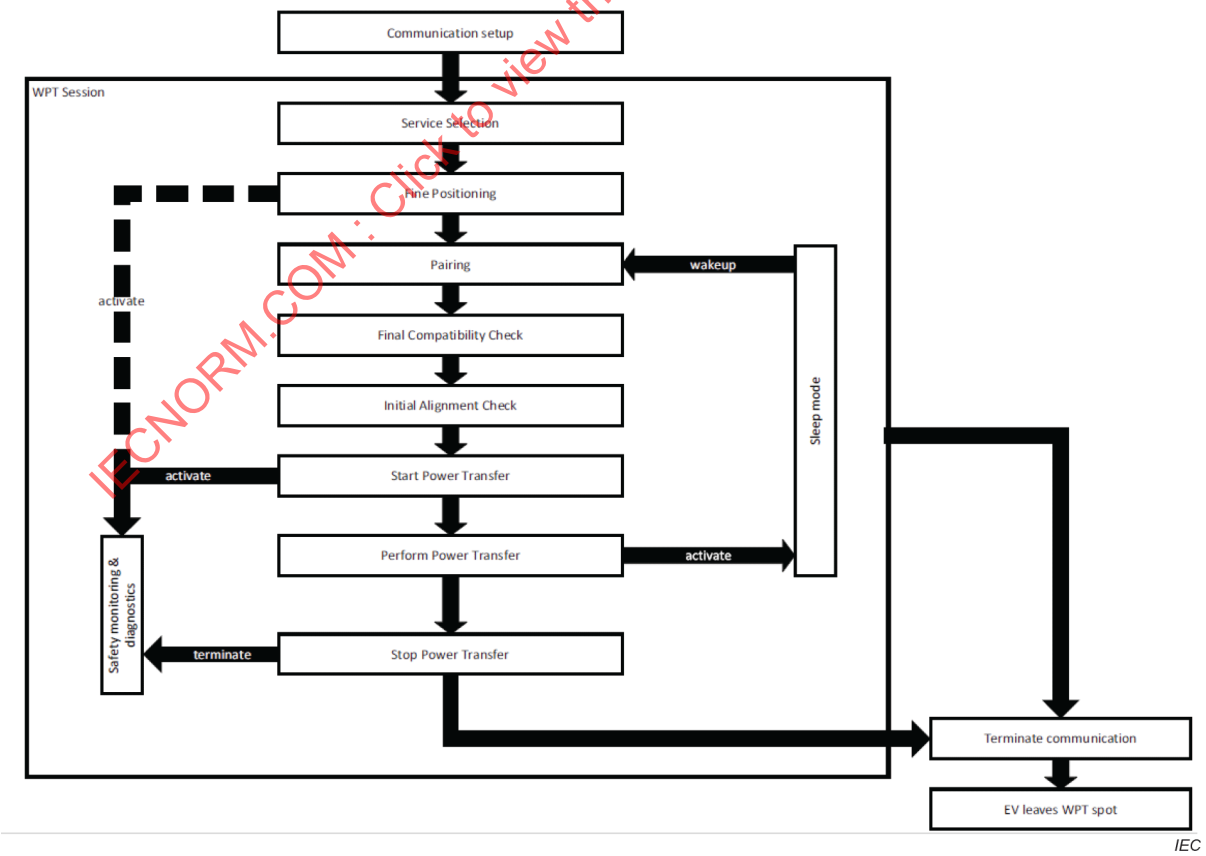


Figure 3 – Operation process of activities for the WPT

6.3 Activities

6.3.1 Communication setup and service selection

Communication setup will be initiated by EVCC.

The EVCC and SECC exchange and negotiate WPT system service parameters, including available alignment and pairing services according to Clause 8.

Communication setup may take place during

– UC select supply device (see Annex A), and
– UC service selection (see Annex A).

The activity "communication setup" takes place within the state **WPT_S_SB** or **WPT_S_STO**, and the activity "service selection" takes place in the state **WPT_S_SI**; see Figure 5 and Figure 6.

The EVCC shall be able to verify communication is properly established.

The SECC shall be able to verify communication is properly established.

Conformance is tested according to ISO 15118 (all parts).

6.3.2 Reject WPT session

The EV device may also reject the WPT session by terminating communication. In this case, the supply device returns into state **WPT_S_SB**.

6.3.3 Fine positioning

Fine positioning begins with the EV approaching the designated WPT spot, and some form of guidance is provided to the EV with the goal of having the secondary device and the primary device positioned within the alignment tolerance.

The fine positioning activity shall have one of the following characteristics:

– fine positioning with non-communication support;
– fine positioning with communication support.

Conformance is checked by support of fine positioning by ISO 15118 messages.

NOTE "Non-communication support" means that communication is not being used for fine positioning.

Fine positioning takes place during:

– UC fine positioning (see Annex A).

The activity "fine positioning" takes place within the state **WPT_S_AA**; see Figure 8.

Actions:

– adjust position.

Post conditions:

– adjustment of position has finished;
– trigger to start pairing.

6.3.4 Pairing

The pairing activity shall enable both the SECC and the EVCC to uniquely identify the primary device on which the EV is placed on.

The pairing activity shall have one of the following characteristics:

– pre-programmed recognition (e.g. private garage with EV device and supply device automatically recognized);
– emission by the supply device of a signal that is recognized by the EV device;
– emission by the EV device of a signal that is recognized by the supply device;

Conformance is checked by support of pairing by ISO 15118 messages.

Pairing take place during:

– UC fine positioning (see Annex A);

The activity "pairing" takes place within the state **WPT_S_AA** and **WPT_S_SLP**; see Figure 8.

Actions:

– perform the pairing process.

Post conditions:

– confirmation of successful pairing by EVCC;
– confirmation of successful pairing by SECC;
– trigger for final compatibility check.

6.3.5 Final compatibility check

After pairing, the EVCC provides its final compatibility check information and requests a final compatibility check to the SECC.

The SECC shall respond to the EVCC with its final compatibility check information and confirmation.

The final compatibility check activity shall exchange and negotiate WPT parameters according to Clause 8 by communication between the EVCC and the SECC.

Conformance is checked by support of final compatibility check by ISO 15118 messages.

Final compatibility check takes place during:

– UC prepare power transfer (see Annex A)

The activity "final compatibility check" takes place within the state **WPT_S_AA**; see Figure 8.

Preconditions:

The following preconditions shall be fulfilled:

– successful pairing confirmation

Actions:

– exchange final compatibility check parameters according to 8.8.2

Post conditions:

– trigger for initial alignment check

EVCC and SECC shall confirm compatibility with each other.

6.3.6 Initial alignment check

The initial alignment check validates that the secondary device is located within the offset range.

In case of MF-WPT, the measurement for proper alignment shall meet requirement of IEC TS 61980-3.

An initial alignment check shall be successfully performed before start of power transfer.

Procedures for performing the initial alignment check are given in Clause C.3.

Initial alignment check takes place during:

– UC prepare power transfer (see Annex A)

The activity initial alignment check takes place within the state **WPT_S_AA** and **WPT_S_SLP**; see Figure 8 and Figure 14.

Preconditions:

– fine positioning completed;
– successful pairing.

Actions:

– perform initial alignment check.

Post conditions:

– confirmation of successful alignment check by EVCC;
– confirmation of successful alignment check by SECC;
– trigger for prepare power transfer.

Conformance is checked by support of initial alignment check by ISO 15118 messages.

6.3.7 Prepare power transfer

Prepare power transfer shall start only after confirmation through communication from EVCC that the EV device is ready for power transfer.

Conformance is tested according to ISO 15118 (all parts).

NOTE This implies that safety monitoring and diagnostics has been activated at the EV device before giving this confirmation to the supply device.

The prepare power transfer activity shall be activated by the corresponding exchange of messages according to ISO 15118-2[4].

Conformance is checked by support of "prepare power transfer" by ISO 15118 messages.

[4] Second edition under preparation. Stage at the time of publication: ISO/DIS 15118-2:2019.

Prepare power transfer takes place during:

– UC prepare power transfer (see Annex A)

The activity "prepare power transfer" takes place within the state **WPT_S_IDLE**; see Figure 9.

The following preconditions shall be fulfilled:

– successful initial alignment check;
– successful final compatibility check;
– successful pairing confirmation.

Actions:

– prepare power transfer trigger by EV device;
– activate safety monitoring and diagnostics.

Post conditions:

– perform power transfer trigger activated;
– safety monitoring and diagnostics active.

6.3.8 Time scheduled power transfer (informative)

6.3.8.1 General

Communication may initiate time scheduled power transfer.

The activity "time scheduled power transfer" takes place within the state **WPT_S_IDLE** and **WPT_S_SLP**; see Figure 11 and Figure 14.

6.3.8.2 Wake-up

In case the EV device and supply device have agreed to use sleep mode, both the EVCC and SECC have agreed upon the length of time for sleep mode.

The wake-up activity takes place within the state **WPT_S_SLP** and **WPT_V_SLP**; see Figure 14.

After wake-up, the pairing activity and the initial alignment shall be performed again.

The wake-up activity shall have one of the following characteristics:

– supply device informs "sleeping" EV device of resuming WPT function;
– EV device informs supply device that sleep mode is finished;
– unexpected wake-up from EV device to supply device (e.g. early wake-up from EV device to supply device).

Actions:

– supply device components and EV device both wake-up;
– perform pairing
– perform Initial alignment check.

Post conditions:

– confirmation of successful alignment check by EVCC;
– confirmation of successful alignment check by SECC.

In the case of the EV device being in sleep mode (**WPT_V_SLP**), the EVCC and SECC will have agreed upon the duration of the sleep cycle. The EVCC will exit **WPT_V_SLP** to state **WPT_V_IDLE** upon the end of the sleep cycle.

6.3.8.3 Sleep

The sleep activity starts within the state **WPT_S_IDLE** and **WPT_V_IDLE**; see Figure 11.

The supply device and the EV device may turn their components into a mode with minimum power consumption. After the components are in sleep mode, the supply device and the EV device starts a timer for the negotiated duration of the sleep cycle.

The supply device shall activate the sleep mode on request of the EV device.

After supply device has confirmed, actions for sleep mode are performed on EV device side and supply device side. The EV device indicates an expected length of time for the sleep mode.

Actions:

– turn on sleep mode for supply device components;

– start sleeping period timer.

Post conditions:

– supply device is in sleep mode showing minimum power consumption.

EV device and supply device remain within the sleep mode until a wake-up trigger is launched.

After the length of time for the sleep mode has been elapsed, the supply device/EV device will do a wake-up check in order to see whether or not to continue sleep mode for another period or to do wake-up.

The wake-up check consists of a simple renegotiation for continuing sleep mode for another sleep cycle. If either the SECC or the EVCC indicates to leave the sleep mode during the negotiation, the wake-up activity is applied. Otherwise, the next sleep cycle is started.

Besides the periodic wake-up check, an event driven by the EV device shall be possible any time during sleep mode.

6.3.9 Perform power transfer

The WPT system shall transfer the power between the primary device and the secondary device upon the request from the EVCC.

The supply device shall be able to exchange information by communication with the EVCC to perform power transfer with the EV device.

Conformance test is described in ISO 15118 (all parts).

The EVCC is able to request the supply device to transfer a specific amount of power, with the power to be specified in watts.

After receiving the power request from the EVCC, the SECC shall respond to that request within a time given in ISO 15118-2.

NOTE 1 It will take some time after the message response for the requested power to be delivered. For MF-WPT system, the ramp up is defined in IEC TS 61980-3.

NOTE 2 The supply device has the freedom to decide the ramp up/down time within the acceptable range specified by the EV device.

If the EVCC requests more than the maximum transferable power, the SECC shall indicate that it is unable to service the request and shall not change the transfer power. If the SECC determines that the maximum transmittable power has changed, then the SECC shall indicate this new value to the EVCC.

Perform power transfer take place during:

– UC perform power transfer (see Annex A);
– UC safety monitoring and diagnostics (see Annex A).

In addition, the use cases according to ISO 15118 (all parts) may be applied:

– UC charging details;
– UC value added service.

The activity "perform power transfer" takes place within the state **WPT_S_PT**; see Figure 12.

Actions:

– adjust output power;
– stop power transfer trigger.

Post conditions:

– stop power transfer trigger detected.

6.3.10 Stop power transfer

Upon the EVCC sending "stop power transfer" message, the supply device shall stop power transfer.

Stop power transfer take place during:

– UC stop power transfer (see Annex A)

In addition, the use cases according to ISO 15118 (all parts) may be applied:

– UC charging details;
– UC value added service.

The activity "stop power transfer" takes place within the state **WPT_S_PT**; see Figure 12.

Actions:

– disable power equipment;
– terminate safety monitoring.

Post conditions:

– power equipment turned off/disabled;
– safety monitoring and diagnostics might be stopped.

Safety monitoring and diagnosis may continue to operate for manufacturer specific options.

NOTE 1 Communication is not terminated.

NOTE 2 WPT spot is still occupied.

6.3.11 WPT session

The WPT session starts upon normal entering of state **WPT_S_SI**.

The activity terminate WPT session takes place within the state **WPT_S_SB** or **WPT_S_STO**; see Figure 10.

Actions:

– the EV device and supply device negotiate the final billing (optional);
– terminate communication.

Post condition:

– communication is terminated;
– WPT spot occupied.

6.3.12 EV leaves WPT spot

The activity EV leaves WPT spot considers the complete removal of the EV from the WPT spot, so that it is available for another EV.

The activity EV leaves WPT spot takes place within the state **WPT_S_STO**; see Figure 13.

Actions:

– EV leaves WPT spot.

Post condition:

– WPT spot is vacant.

NOTE Supply device could detect when vehicle leaves the WPT spot.

6.3.13 Safety monitoring and diagnostics

6.3.13.1 General

WPT systems communication shall support the following safety measures:

– communication link monitoring;
– continuous alignment check;
– failure conditions reporting.

NOTE If time is not safety relevant, 2 000 ms will be used in the whole document.

Technology specific safety monitoring and diagnostics measures may be provided by the annexes of this document and technology specific annexes of IEC 61980 (all parts).

The supply device shall be able to verify the safety measures of the supply device are operating during power transfer.

6.3.13.2 Continuous alignment check

The communication shall be able to exchange continuous alignment check information.

System specific requirements on the alignment check are given by the technology specific technical requirements of the IEC 61980 series and ISO/PAS 19363.

The technical description of continuous alignment check is described in Clause C.4.

6.3.13.3 Communication link monitoring

The communication shall be monitored by the SECC. Loss of communication is when the duration between response and subsequent request is greater than 2 000 ms.

The supply device shall recognize the loss of communication and shall reduce the primary coil current such that emissions are within ICNIRP 2010 restrictions (as if EV were not present) within 2 000 ms.

The communication link monitoring activity shall have one of the following characteristics:

– the ability to determine if the communication is active;
– the ability to measure time between response and subsequent request.

The SECC shall be able to verify the time between messages is within 2 000 ms.

Conformance is tested by verifying power transfer shutdown from loss of communication within 4 000 ms.

6.3.14 Terminate communication

The communication shall be terminated by an exchange of termination messages.

Actions necessary for terminating communication:

– a pair of message exchanged between the EVCC and SECC requesting to terminate communication;
– turn off communication.

Conformance is tested by observation of ISO 15118 message sequence.

6.3.15 Terminate safety monitoring and diagnostics

After stop power transfer and disabling power equipment, safety monitoring and diagnostics may be terminated.

The terminate safety monitoring and diagnostics activity can include deactivation of the following:

– communication link monitoring;
– continuous alignment check;
– FOD/ protection from electromagnetic fields /others;
– failure conditions monitoring.

6.3.16 Wake-up after power outage

In case of power transfer process interruption due to a situation such as a blackout, the EV device shall proceed to **WPT_V_SB** and the supply device shall proceed to **WPT_S_SB**.

After power outage, the supply device shall enter **WPT_S_SB** state.

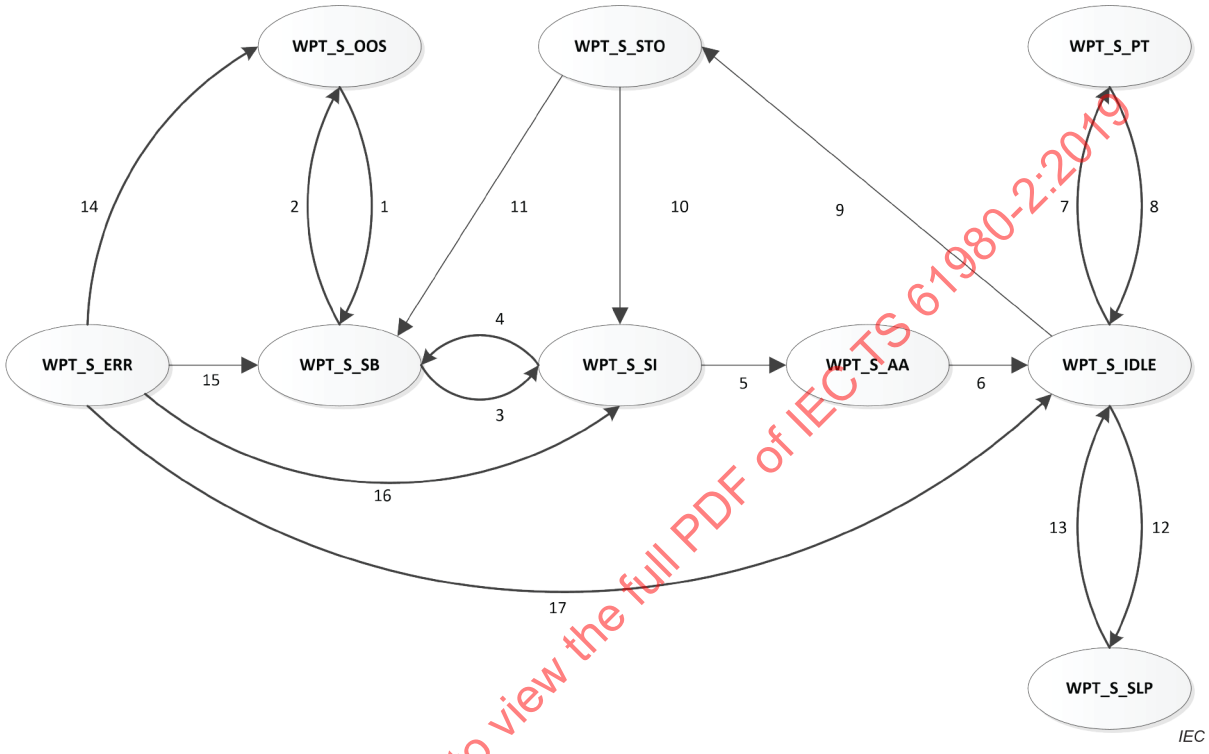
Conformance is tested by observation after power outage.

7 Control process states

7.1 Supply device state definitions

7.1.1 Supply device state diagram

State definitions given here represent the state of the supply device part of the system. An overview is given in the state diagram shown in Figure 4.



Key	Name
1	system turned on
2	system turned off
3	communication established
4	WPT Session rejected
5	alignment initiated
6	alignment confirmed
7	prepare power transfer
8	stop power transfer
9	communication terminated
10	communication re-established
11	vehicle has departed
12	sleep
13	wake-up
14	exception WD 6, reset
15	exception WD 2,4, 8 reset
16	exception WD 3,5,7, reset
17	exception WD9, WD10

Figure 4 – Supply device state diagram

7.1.2 Stand by (WPT_S_SB)

The system is not ready for power transfer, no communication link is established.

In the **WPT_S_SB** state, the supply device is not transferring power and its communications capability is functioning normally. The supply device can advertise its availability and is able to establish a connection with the EVCC. The **WPT_S_SB** state is exited in response to a connection establishment request from an EVCC.

Activities, actions and possible exits are shown in Figure 5.

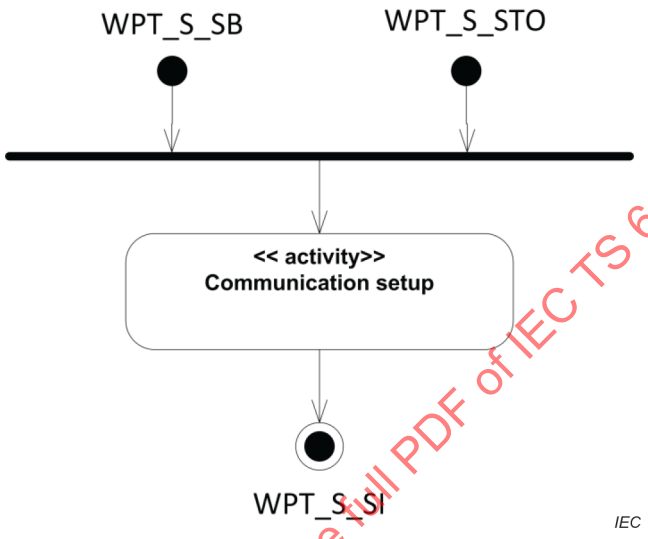


Figure 5 – Activity communication setup

7.1.3 Service initiated (WPT_S_SI)

The system is not ready for power transfer. Communication between the EVCC and the SECC is established.

In the **WPT_S_SI** state, the SECC has communications established with an EVCC.

The EVCC may also request fine positioning support services from the supply device, if provided by the supply device. The state is exited normally upon successful connection and initiation of alignment support.

Activities, actions and possible exits are shown in Figure 6.

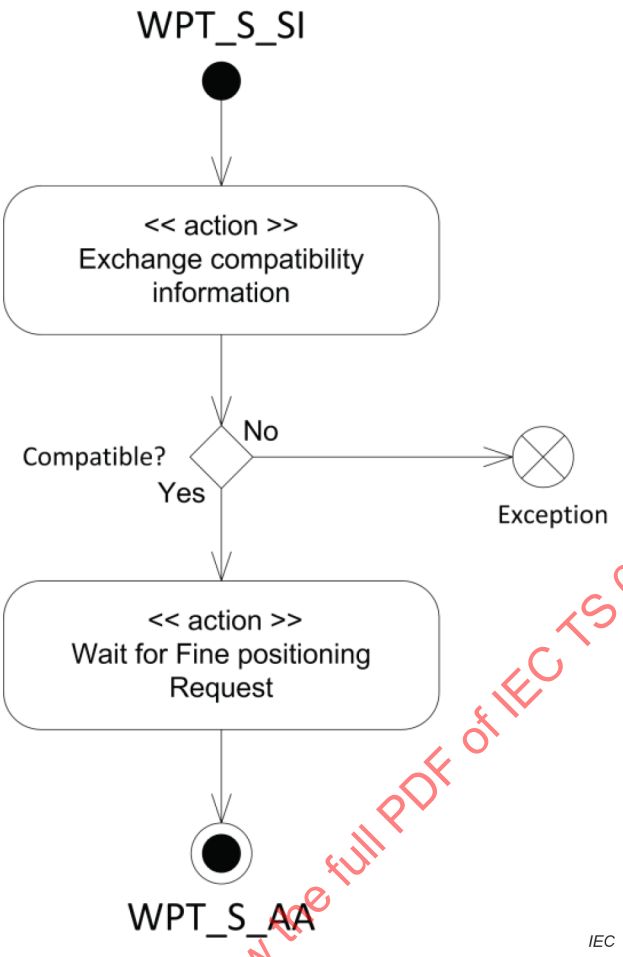


Figure 6 – Activity service selection

7.1.4 WPT session rejected

The EVCC may also terminate communication for any number of reasons. In this case, the state is exited upon terminate communication. See Figure 7.

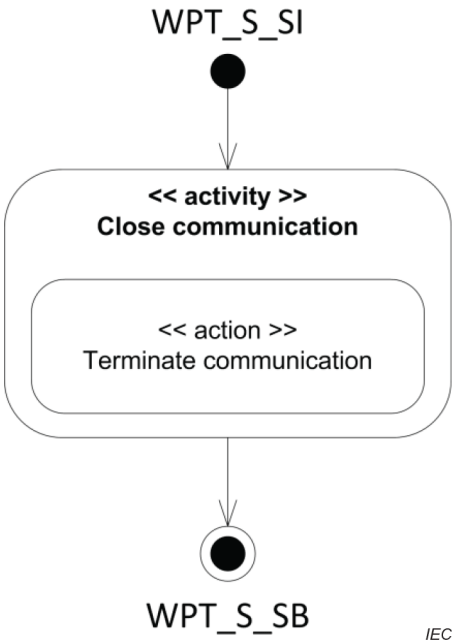


Figure 7 – Activity reject WPT session

7.1.5 Awaiting alignment (WPT_S_AA)

In the **WPT_S_AA** state, the supply device is waiting for the secondary and primary device to be aligned. The state has a normal exit mode upon successful completion of alignment and alignment complete indication from the EV device and pairing process has been successfully completed. Upon normal exit, the WPT session starts.

Activities, actions and possible exits are shown in Figure 8.

Abnormal exits are handled as exceptions (see 8.12).

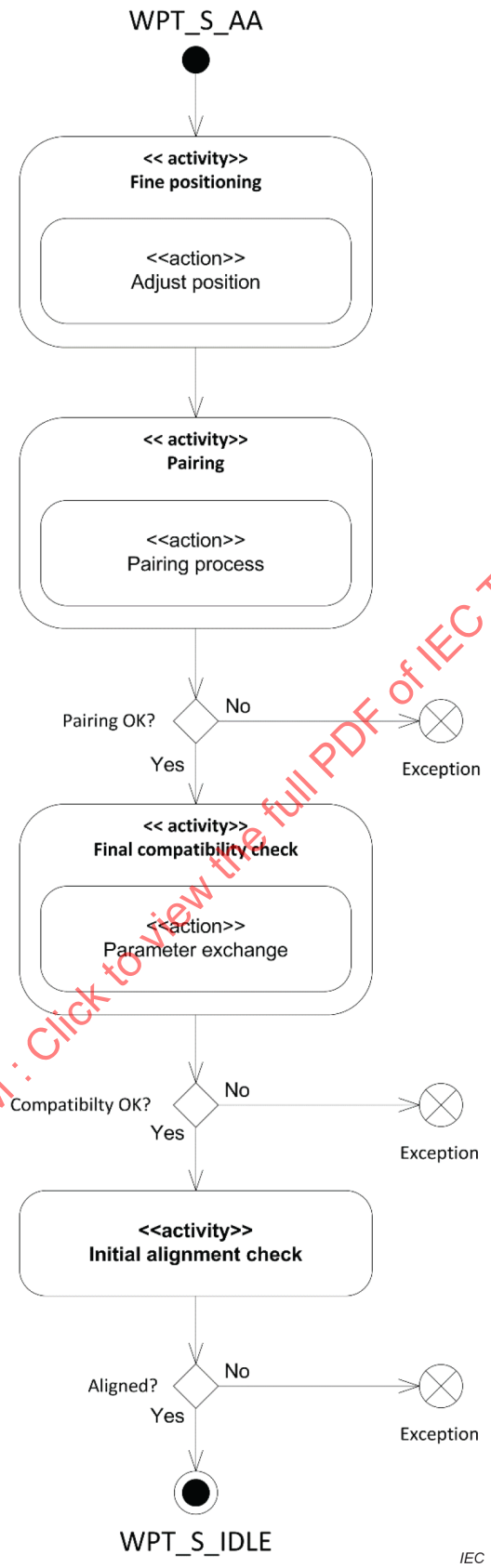


Figure 8 – Activity from fine positioning to initial alignment check

7.1.6 Idle (WPT_S_IDLE)

The state **WPT_S_IDLE** represents the situation on supply device after alignment and pairing has been confirmed, but some parameters for prepare power transfer still need to be exchanged and the safety system needs to be activated. Activities, actions and possible exits are shown in Figure 9, Figure 10 and Figure 11.

Abnormal exits are handled as exceptions (see 8.12).

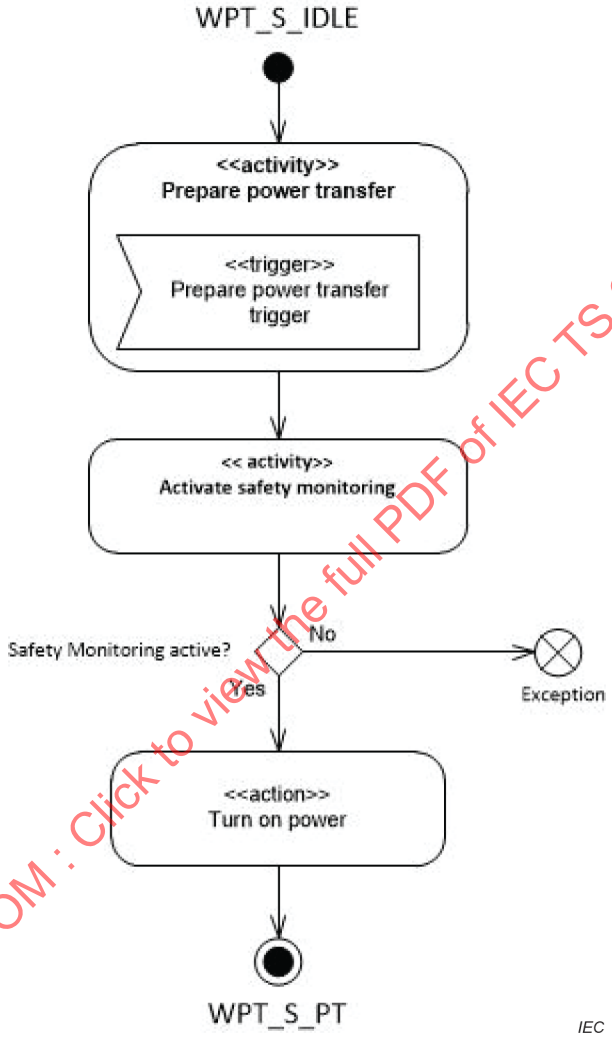


Figure 9 – Activity prepare power transfer

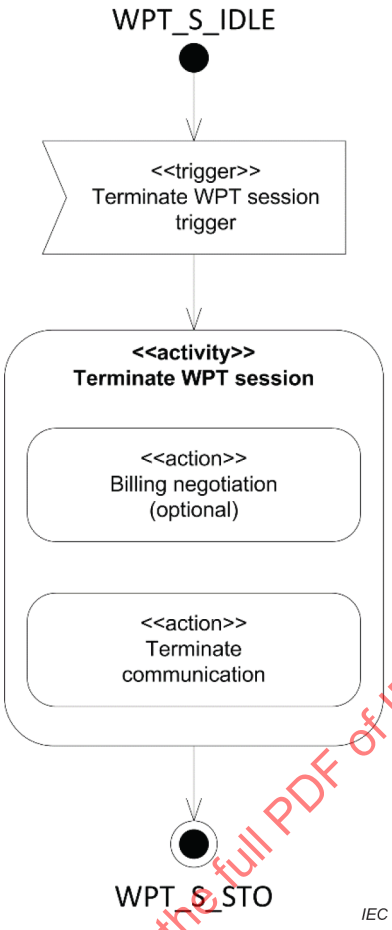


Figure 10 – Activity terminate WPT session

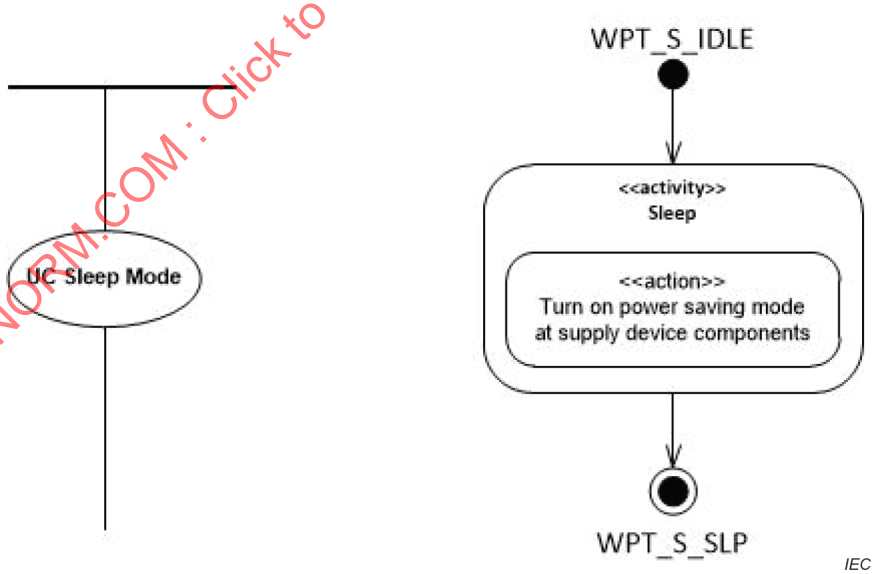


Figure 11 – Activity Sleep

7.1.7 Power transfer (WPT_S_PT)

The system is transferring power between primary device and secondary device.

In the **WPT_S_PT** state, the supply device is transferring power to the EV device and the safety monitoring and diagnostics activity is active to assure the integrity of the power transfer process.

Activities, actions and possible exits are shown in Figure 12.

Within this state, power transfer may be paused by requesting zero amount of power by the EVCC or by setting maximum transferable power to zero by the supply device.

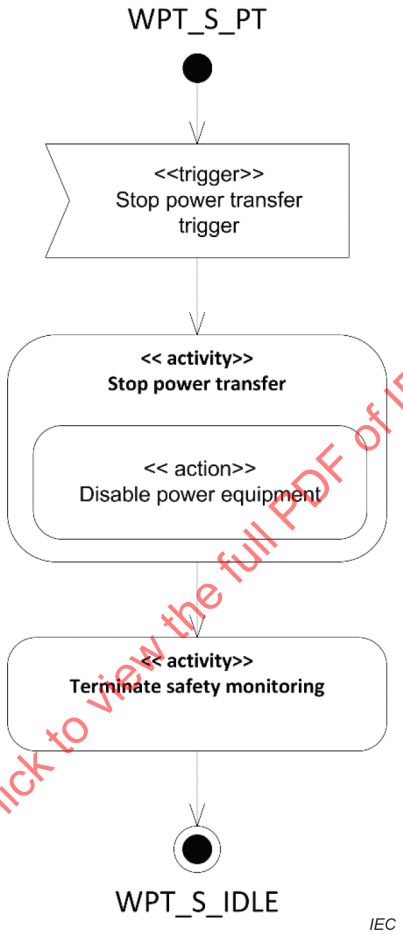


Figure 12 – Activity stop power transfer

7.1.8 Service terminated occupied (WPT_S_STO)

In the **WPT_S_STO** state, the power transfer has been terminated and the communication with the EVCC has been terminated, but the EV still occupies the parking space and the supply device is therefore unable to provide service to another user.

NOTE The vehicle detection method depends upon the implementation.

Activities, actions and possible exits are shown in Figure 13 and Figure 5.

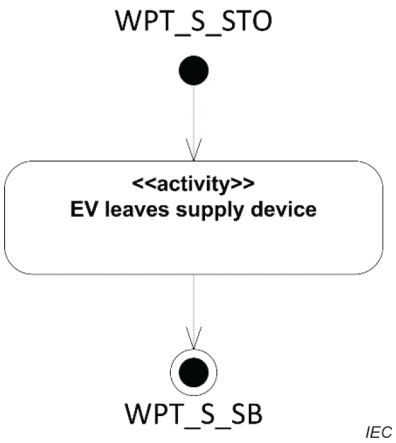


Figure 13 – Activity EV leaves WPT spot

7.1.9 Out of service (WPT_S_OOS)

All components of the supply device are turned off.

In the **WPT_S_OOS** state, the supply device is not available for the transfer of power. The communication channel may be available to indicate that the supply device is in the **WPT_S_OOS** state. The supply device exits this state as soon as it is available to transfer power.

7.1.10 Sleep mode WPT_S_SLP

The sleep state (WPT_S_SLP) represents the power saving mode of the supply device. Within this state, all system components are turned into sleep mode. Communication ability is reduced as much as possible. Safety monitoring and diagnostics is not required within this state.

Activities, actions and possible exits are shown in Figure 14. Abnormal exits are handled as exceptions (see 8.12).

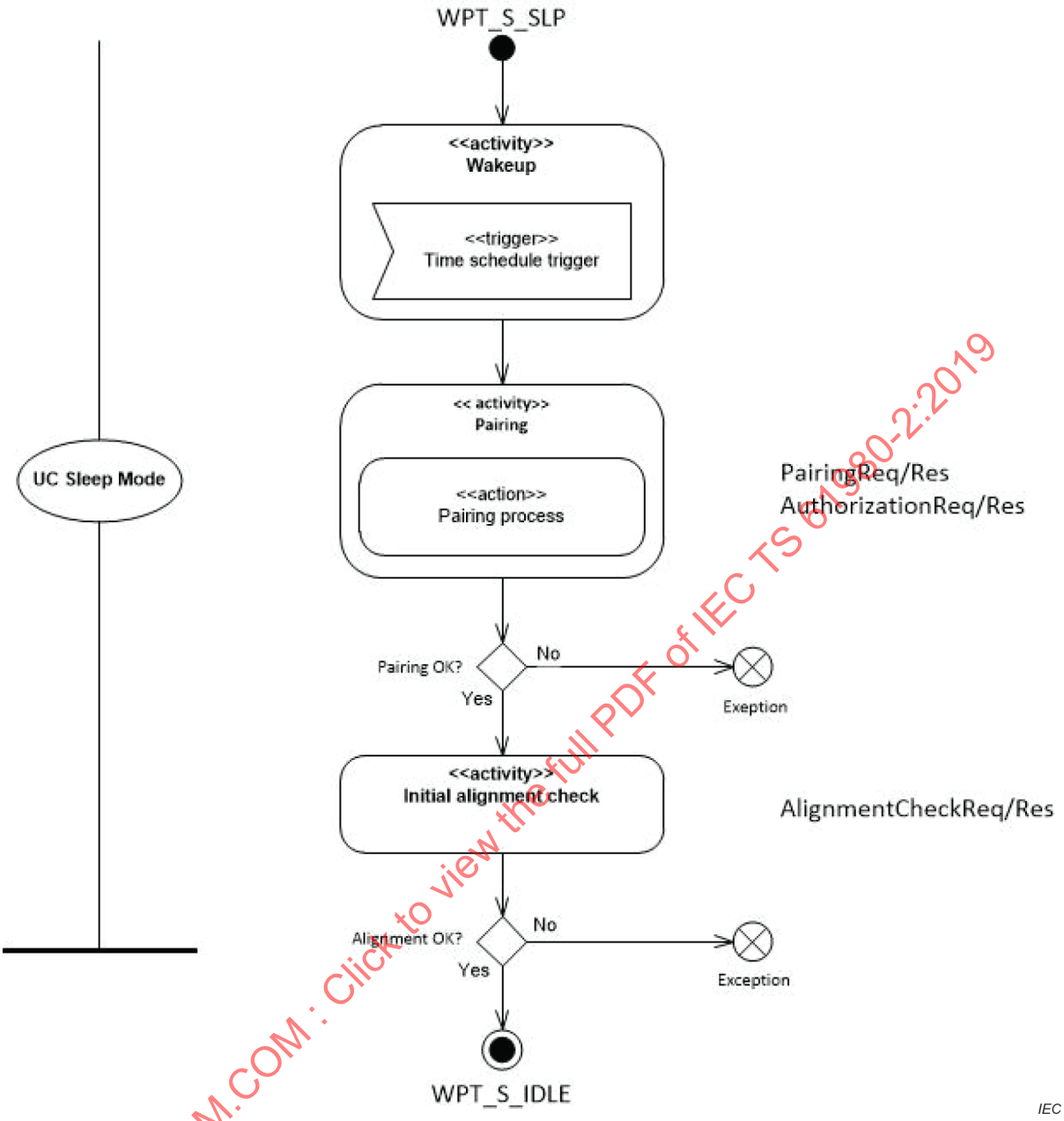


Figure 14 – Activity wake-up

7.2 Supply device state transitions

For supply device state transitions, see Table 1, based on Figure 4.

Table 1 – Supply device state transitions

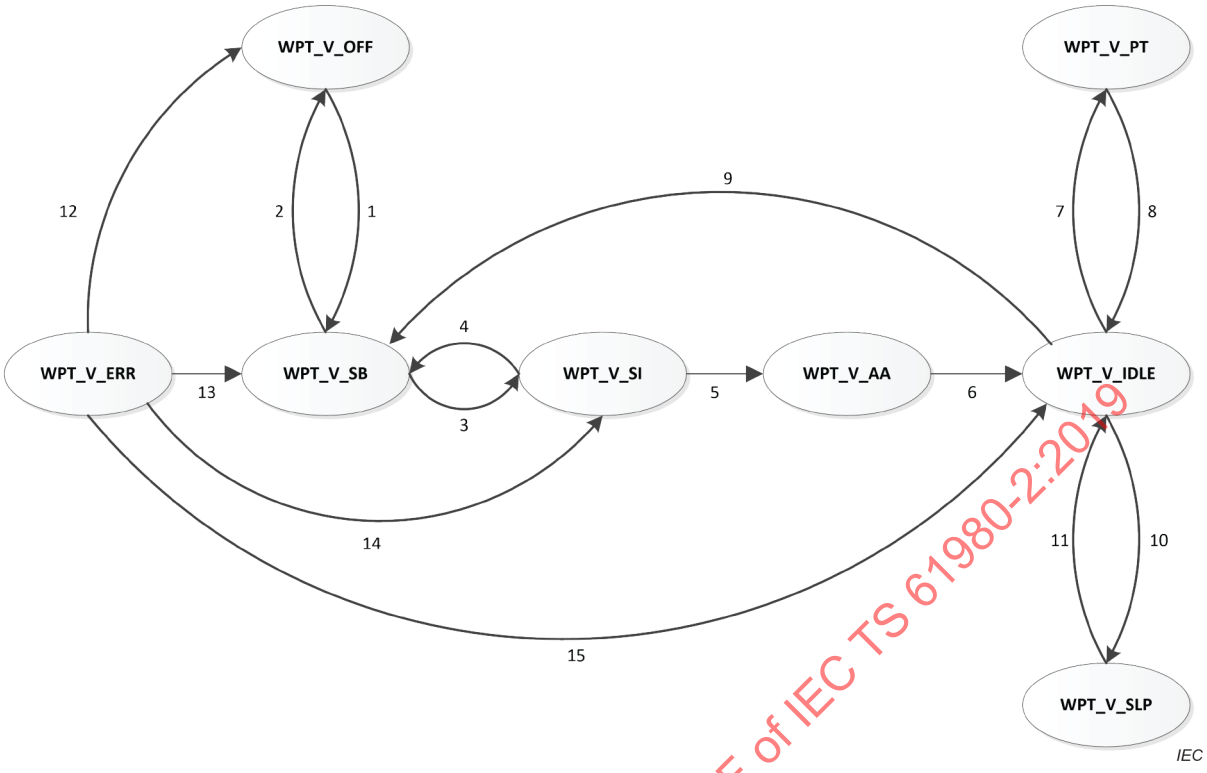
Current state	Target state	Name	Description
WPT_S_OOS	WPT_S_SB	System turn on	System turn on/power up
WPT_S_SB	WPT_S_OOS	System turn off	System turn off
WPT_S_SB	WPT_S_SI	Establish communication	Activity: communication setup See Figure 5
WPT_S_STO	WPT_S_SI	(Re)establish communication	Action: time scheduled trigger Activity: communication setup See Figure 5

Current state	Target state	Name	Description
WPT_S_SI	WPT_S_SB	Reject WPT session	Action: terminate communication Activity: close communication See Figure 7
WPT_S_STO	WPT_S_SB	EV leaves	Activity: EV leaves WPT spot See Figure 13
WPT_S_SI	WPT_S_AA	Initiate alignment	Exchange compatibility information Initiate/request fine positioning See Figure 6
WPT_S_AA	WPT_S_IDLE	Alignment confirmed	Activity: fine positioning Activity: initial alignment check Activity: pairing Activity: final compatibility check See Figure 8
WPT_S_IDLE	WPT_S_PT	Prepare power transfer	Activity: prepare power transfer Activity: activate safety monitoring and diagnostic See Figure 9
WPT_S_PT	WPT_S_IDLE	Stop power transfer	Activity: perform power transfer Action: stop power transfer trigger Action: Disable power equipment Activity: terminate safety monitoring and diagnostic See Figure 12
WPT_S_IDLE	WPT_S_STO	Terminate communication	Activity: terminate WPT session See Figure 10
WPT_S_IDLE	WPT_S_SLP	Sleep	Activity: sleep See Figure 11
WPT_S_SLP	WPT_S_IDLE	Wake-up	Activity: wake-up See Figure 14

7.3 EV device state definitions

7.3.1 EV device state diagram

State definitions given in Figure 15 represent the state of the EV device part of the WPT system.



Key	Name
1	wake-up signal
2	sleep signal
3	communication established
4	WPT session rejected
5	alignment initiated
6	alignment confirmed
7	safety monitoring and diagnostic activated
8	power transfer disabled
9	communication terminated
10	sleep
11	wake-up
12	exception WD 6
13	exception WD 1, 2, 4, 8, reset
14	exception WD 3,5,7,, reset
15	exception WD 9, 10

Figure 15 – EV device state diagram

7.3.2 Stand by (WPT_V_SB)

Power transfer system is activated; the EV device is ready to communicate; no power transfer possible; no communication is established. See Figure 16.

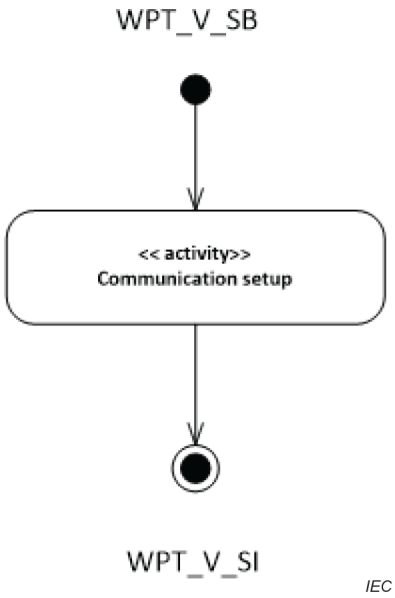


Figure 16 – Activity communication setup (EV device state)

7.3.3 Service initiated (WPT_V_SI)

Communication between the EVCC and the SECC is established.

Within this state, the EVCC checks compatibility, and associates with the SECC. See Figure 17.

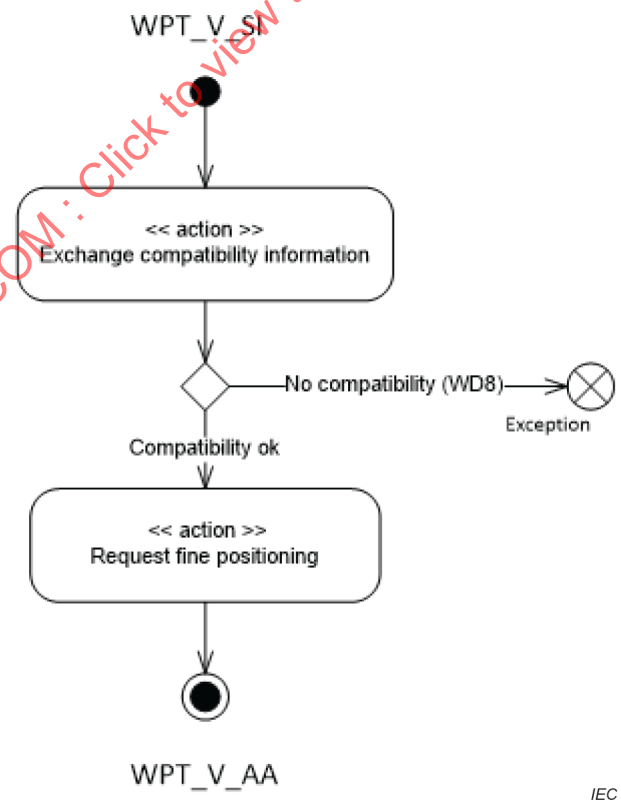


Figure 17 – Activity service selection (EV device state)

7.3.4 Awaiting alignment (WPT_V_AA)

The EV device is waiting for the secondary and primary device to be aligned. See Figure 18.

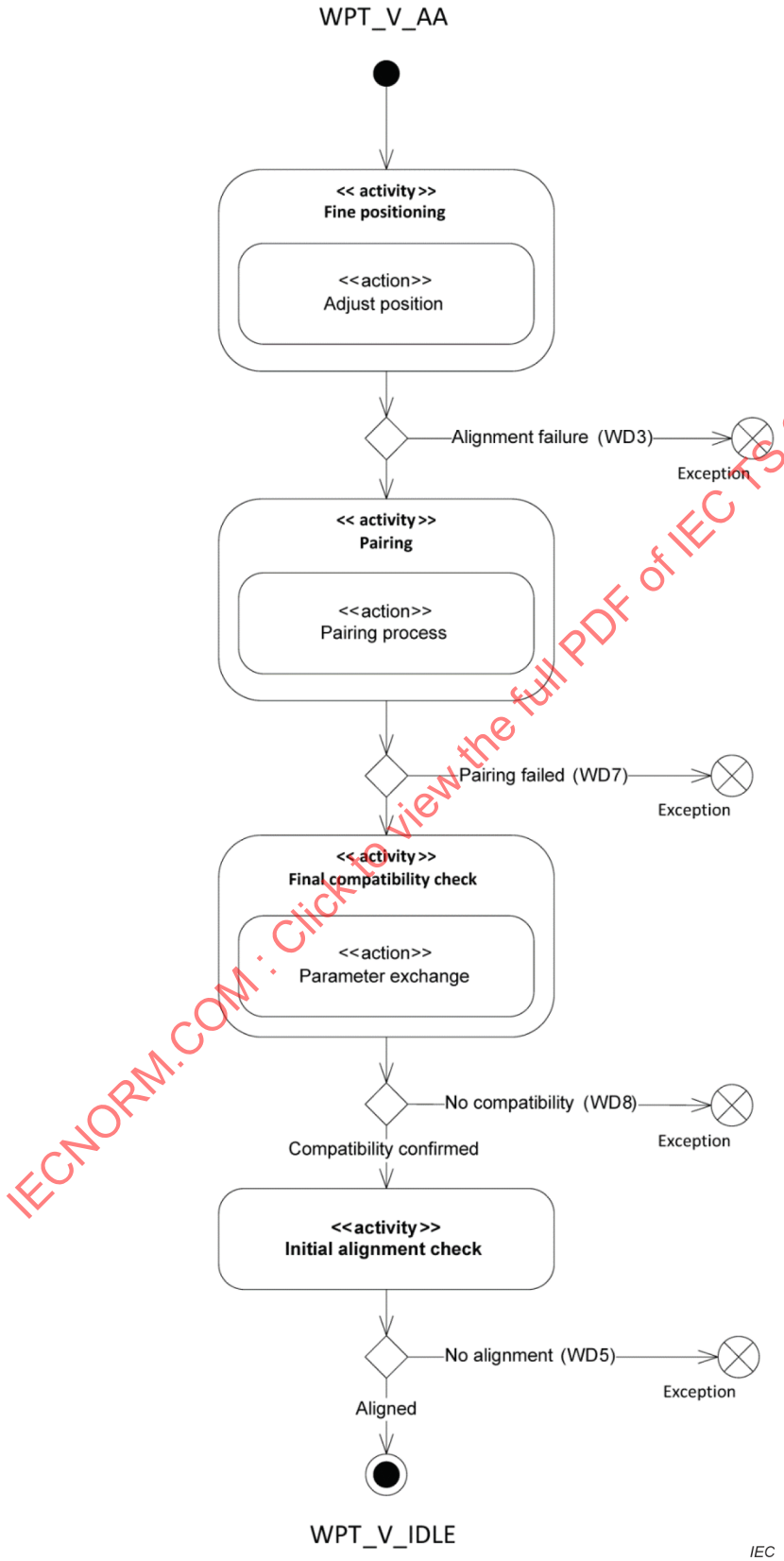


Figure 18 – Activity from fine positioning to initial alignment check (EV device state)

7.3.5 Idle (WPT_V_IDLE)

The EVCC has established communication to the SECC and is paired to the primary device; not ready for power transfer;

The availability of safety functions is checked in the WPT_V_IDLE state. See Figure 19.

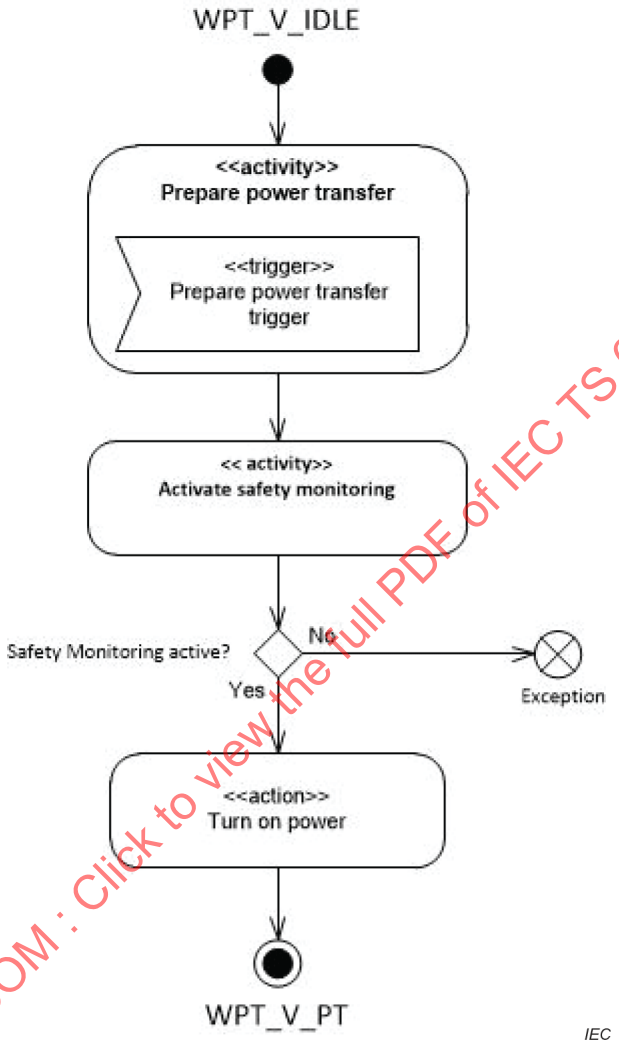


Figure 19 – Activity prepare power transfer (EV device state)

7.3.6 Power transfer active (WPT_V_PT)

The EV is receiving power from the supply device.

7.3.7 Off (WPT_V_OFF)

The power transfer system is not activated; no communication.

7.4 EV state transitions

For EV device state transitions, see Table 2, based on Figure 15.

Table 2 – EV device state transitions

Current state	Target state	Name	Description
WPT_V_SB	WPT_V_SI	Establish communication	Activity communication setup
WPT_V_SI	WPT_V_AA	Initiate alignment	Initiate alignment
WPT_V_AA	WPT_V_IDLE	Aligned and paired	Alignment complete: – alignment confirmed; – pairing confirmed
WPT_V_IDLE	WPT_V_SB	Terminate communication	Terminate communication link
WPT_V_PT	WPT_V_IDLE	Disable power transfer	Deactivate safety monitoring and diagnostics system
WPT_V_IDLE	WPT_V_PT	Power transfer preparation	Activate safety monitoring and diagnostics system
WPT_V_IDLE	WPT_V_SLP	Sleep signal	– turn on sleep mode; – start sleeping period timer.
WPT_V_SLP	WPT_V_IDLE	Wake-up signal	Bus wake-up signal for waking up components relevant for power transfer
WPT_V_SI	WPT_V_SB	Reject WPT Session	Reject WPT session

7.5 Exception handling

7.5.1 General

When an exception is detected by either the EVCC or SECC, special handling is required to resolve the exception.

7.5.2 Supply device exception handling (WPT_S_ERR)

After the supply device has encountered an exception, the supply device turns into the state **WPT_S_ERR.** Within this state, the supply device is not able to operate properly and safety may not be given, so that the supply device shall fail safe. The communication link may be established.

Conformance is tested by observation after forcing an exception.

There are two types of exceptions that may occur: those that are defined as recoverable and those that are unrecoverable (an error).

The errors will result in the state transitioning from the **WPT_S_ERR** state to the **WPT_S_OOS** state.

For the exception, the system may try to recover by verifying that the error condition has cleared. The power transfer may then proceed from an established recovery point. Repeated occurrences of recoverable exceptions in a short time span may be defined as becoming non recoverable.

7.5.3 EV device exception handling (WPT_V_ERR)

The EV device has experienced a malfunction and detected an exception. Handling of the exception will be done in a similar fashion to the supply device (see 7.5.2).

NOTE The EV device exception handling is described in ISO/PAS 19363.

7.5.4 Exception descriptions

Table 3 indicates what exception states conditions the EVCC and SECC are expected to be in for specific exceptions.

Table 3 – Exception handling

Error	Exception description	Return states (EVCC side)	Return states (SECC side)
WD1	EV device and supply device cannot establish communication	WPT_V_SB	WPT_S_SB
WD2	Loss of communication	WPT_V_SB	WPT_S_SB
WD3	Unable to align	WPT_V_SI	WPT_S_SI
WD4	Power transfer failure	WPT_V_SB	WPT_S_SB
WD5	Alignment loss	WPT_V_SI	WPT_S_SI
WD6	Emergency shut down	WPT_V_OFF	WPT_S_OOS
WD7	Pairing failure	WPT_V_SI	WPT_S_SI
WD8	Compatibility check failed	WPT_V_SB	WPT_S_SB
WD9	Thermal condition detected	WPT_V_IDLE	WPT_S_IDLE
WD10	Human detected	WPT_V_IDLE	WPT_S_IDLE

8 Communication parameter for WPT systems

8.1 General

Clause 8 describes requirements for message parameters applying for communication managed through the ISO 15118-2 protocol definition. Several sequences of the WPT power transfer process are detailed. Each sequence describes message requirements and parameters that shall be met for supply device and EV device information exchange.

Further messages of ISO 15118 (all parts) necessary for communication may be optionally used in addition to the specifications of Clause 8.

8.2 General parameters

All messages (between the SECC and the EVCC) shall contain the following general parameters for administrative purposes:

– SessionID: the value shall be set by the SECC and used for the duration of the session;

– before SessionID assignment, the value 0 shall be used.

After pairing, the message exchange shall meet the following requirement:

– supply device and EV device state coordination.

The EV device will provide information to the supply device that enables the supply device to reconstruct the state of the EV device according to Clause 7 (the state does not necessarily need to be transmitted as a parameter itself). Also, the supply device shall provide the same information vice versa.

8.3 Communication setup

The SECC and EVCC initiate communication according to ISO 15118 (all parts).

NOTE ISO 15118 initiation includes WLAN communication setup as well as ISO 15118 protocol selection.

8.4 Service selection

After communication setup, the EVCC and SECC shall perform service selection.

The EVCC will send the service discovery request message, containing the necessary compatibility information for its secondary device. The SECC will respond with the service discovery response message, containing the necessary compatibility information for all of its primary devices. With this information, the EVCC and the SECC are able to discover compatibility and to preselect suitable supply devices, if information for more than one supply device is offered.

See Table 4 and Table 5, according to Clause A.2.

Table 4 – Service selection EVCC request parameters

Element name	Description
EVID	Unique EV device identifier (i.e. MAC address)
EV power circuit (EVPC) power class	Power class of an EVPC defined according to the MF-WPT input power class of the supply device it is designed to operate
Minimum receivable power	Minimum power in watts which WPT vehicle power supply circuit can receive
Maximum receivable power	Maximum power in watts which EVPC can receive
Maximum secondary device ground clearance	Maximum value of secondary device ground clearance in mm
Minimum secondary device ground clearance	Minimum value of secondary device ground clearance in mm
Maximum operating frequency	Maximum value of operating frequency in Hz
Minimum operating frequency	Minimum value of operating frequency in Hz
Type of geometry of the secondary device	Type of geometry of the secondary device: possible values for MF-WPT are "circular", "dd", and "solenoid". Other values may be allowed (see IEC TS 61980-3 for additional information).
Circuit topology	Type of circuit topology of a secondary device: possible values are "parallel" and "series". Other values may be allowed.
Manufacturer ID	String of manufacturer ID
Manufacturer specific data container	Manufacturer specific data container
Specific service provider (optional)	Under consideration

NOTE Methods for fine positioning, pairing and initial alignment check are selected as individual services in ISO 15118-20.

Table 5 – Service selection SECC response parameters

Element name	Description
	For each supply device which the SECC controls, the following information must be sent:
SupplyDeviceID	Optional: Supply Device identifier, to which the given parameters are related to. A List of Supply device identifiers is possible.

Input power class	Power class supported by the primary device. Possible values for MF-WPT input power classes are: MF-WPT1, MF-WPT2, MF-WPT3 and MF-WPT4 according to IEC TS 61980-3
Maximum output power	Maximum power in watts which a supply device can transmit
Maximum supported secondary device ground clearance	Maximum value of supported secondary device ground clearance in mm
Minimum supported secondary device ground clearance	Minimum value of the secondary device ground clearance in mm
Maximum primary device operating frequency	Maximum value of the operating frequency in Hz
Minimum primary device operating frequency	Minimum value of the operating frequency in Hz
Type of geometry of the primary device	Type of geometry of the primary device: possible values are "circular, "dd", and "solenoid". Other values may be allowed.
Primary device circuit topology	Type of circuit topology of the primary device: possible values are "parallel" and "series". Other values may be allowed (see parameters needed by IEC TS 61980-3 for additional possibilities)
Success code	Success code corresponds to the response code in ISO 15118-2
Manufacturer ID	String of manufacturer ID
Model ID	String of model ID Clearly identify known devices with which e.g. some tests have been done. This way, a better specific setup configuration is possible.
Manufacturer specific data container	Optional: Manufacturer specific data container Manufacturer may place specific parameters for configuration. Example: centre alignment point parameters, coil height, z-mover specific parameters Format as parameter list
Specific service provider (optional)	Under consideration

Supported methods by the supply device for fine positioning, pairing, initial alignment check are sent to the EVCC during the service selection as additional services.

Possible values for fine positioning are given in Table 6.

Table 6 – Method list for fine positioning

Element name	Description
Manual	Manual according to C.2.2
LPE	Low power excitation according to C.2.3
LF	LF signal according to C.2.4
MV	Magnetic vector according to C.2.5

Possible values for pairing are given in Table 7.

Table 7 – Method list for pairing

Element name	Description
LPE	Low power excitation according to C.3.3
SR	SR signal according to C.3.4
LF	LF signal according to C.3.5
MV	Magnetic vector according to C.3.6

Possible values for initial alignment check are given in Table 8.

Table 8 – Method list for initial alignment

Element name	Description
LPE	Efficiency check according to C.4.2
RSSI	RSSI method according to C.4.3

8.5 Fine positioning

8.5.1 General

After service selection, the EVCC and SECC shall perform fine positioning. This sequence describes how the EV moves from near the supply device to parking. Different methods for fine positioning shall be supported by the communication protocol.

See UC fine positioning in A.2.3.

NOTE Fine positioning method was chosen by the EVCC during service selection (see 8.4 and 9.4).

Further requirements for fine positioning can be found in Annex C.

8.5.2 Starting fine positioning

To start fine positioning, the EVCC sends the fine positioning setup request message.

If the SECC does not support or recognize the method chosen by the EVCC, the SECC shall reject the request. The SECC shall respond to the request according to Table 9.

Table 9 – Fine positioning response

Element name	Description
Success code	Method activated/not activated
Method specific information [a]	The method may require the EV device to use a specific value (e.g. frequency, target image). This field is optional.
[a] See Annex C for more information.	

8.5.3 Fine positioning data exchange

After the positioning setup has been performed successfully, the exchange of positioning information between the EVCC and the SECC starts by the EVCC sending the fine positioning request.

NOTE The positioning information includes any necessary offset data.

Depending on the fine positioning method chosen, different parameters shall be exchanged with the request.

Information whether the positioning process is ongoing or finished is part of the fine positioning request.

See Annex C for further details about individual fine positioning methods.

8.5.4 Terminating fine positioning

Once the EV is done using the fine positioning method, the EVCC shall send the fine position complete request.

The SECC shall respond with the fine positioning complete response.

8.6 Pairing

8.6.1 General

After fine positioning, the EVCC and SECC shall perform pairing.

As several supply devices may be attached to a single SECC, the EV device needs to be paired to the supply device the EV is actually parked over. See UC fine positioning in A.2.3.

NOTE 1 Pairing takes place after fine positioning.

NOTE 2 Pairing method was chosen by the EVCC during service selection (see 8.4 and 9.4).

Further requirements for pairing can be found in Annex C.

8.6.2 Start pairing

To start pairing, the EVCC shall send the pairing start request message according to Table 10:

Table 10 – Pairing start request

Element name	Description
ID or code emitted by EV device	The ID or code emitted by the signal associated with the method (omitted if not required for the pairing method)

If the SECC does not support or recognize the method chosen by the EVCC, the SECC shall reject the pairing request. The SECC shall respond to the request according to Table 11.

Table 11 – Pairing start response

Element name	Description
ID or code emitted by supply device	The ID or code emitted by the signal associated with the method (omitted if not required for the pairing method)
Success code	Method activated/not activated

As a final confirmation, the EVCC sends the pairing confirmation request and provides pairing information according to Table 12.

Table 12 – Pairing confirmation request

Element name	Description
Received ID or code	The ID or code received by the EV device (omitted if not required for pairing method)

The SECC shall respond to the request according to Table 13.

Table 13 – Pairing confirmation response

Element name	Description
SDID	Supply device ID now paired with the EV device (null if pairing failed)
Success code	Vehicle detected/Vehicle not detected

8.7 Initial alignment check

8.7.1 General

After final compatibility check, the EVCC and SECC shall perform initial alignment check.

Initial alignment check method was chosen by the EVCC during service selection. Communication shall support several initial alignment methods. See Annex C for possible methods.

8.7.2 Initial alignment check request/response

To start initial alignment check, the EVCC shall send the initial alignment check request message according to Table 14.

NOTE Initial alignment check request contains no parameters, since the method has already been chosen during service selection.

The SECC shall respond to the request according to Table 15.

Table 14 – Initial alignment check request

Element name	Description
Target current	The amount of current the supply device is requested to provide to the supply device coil (optional)

Table 15 – Initial alignment check response

Element name	Description
Power transmitted	The amount of power transmitted by the supply device (optional)
Supply device current	The amount of current into the supply device coil (optional)
Signal received	Flag indicating if the directional signal was received (optional)
RSSI values	The RSSI values of the signals received (optional)
Success code	Alignment OK/Alignment FAILED

8.8 Prepare power transfer

8.8.1 General

This sequence describes how the EVCC and SECC negotiate compatibility and initial power settings.

8.8.2 Final compatibility check

After successful pairing, compatibility is confirmed by the EVCC sending parameters according to Table 16. The SECC determines compatibility and generates the success code, and shall send the final compatibility response message to the EVCC according to Table 17.

See UC prepare power transfer in A.2.4.

Table 16 – Final compatibility check request parameters

Element name	Description
Input power classes	Power class of an EVPC defined according to the MF-WPT input power class of the supply device it is designed to operate
Maximum receivable power	Maximum power in watts which EVPC can receive
Maximum secondary device ground clearance	Maximum value of secondary device ground clearance in mm
Minimum secondary device ground clearance	Minimum value of secondary device ground clearance in mm
Minimum operating frequency	Minimum value of operating frequency in Hz
Maximum operating frequency	Maximum value of operating frequency in Hz
Type of geometry of the secondary device	Type of geometry of the secondary device: possible values for MF-WPT are "circular", "dd", and "solenoid". Other values may be allowed (see IEC TS 61980-3 for additional information).
Circuit topology	Type of circuit topology of a secondary device: possible values are "parallel" and "series". Other values may be allowed.
Manufacturer ID	Optional: String of manufacturer ID
Manufacturer specific data container	Optional: Manufacturer specific data container
Specific service provider (optional)	Under consideration

The SECC shall respond to the request according to Table 17.

Table 17 – Final compatibility check response parameters

Element name	Description
Success code	Configuration compatible/Configuration not compatible
MF-WPT input power class	Power class supported by the primary device: possible values for MF-WPT input power classes are: MF-WPT1, MF-WPT2, MF-WPT3 and MF-WPT4 according to IEC TS 61980-3
Minimum power	Minimum deliverable power in watts
Maximum output power	Maximum power in watts which a supply device can transmit
Maximum supported secondary device ground clearance	Maximum value of supported secondary device ground clearance in mm
Minimum supported secondary device ground clearance	Minimum value of the secondary device ground clearance in mm
Maximum primary device operating frequency	Maximum value of the operating frequency in Hz

Element name	Description
Minimum primary device operating frequency	Minimum value of the operating frequency in Hz
Type of geometry of the primary device	Type of circuit topology of the primary device: possible values are "parallel" and "series". Other values may be allowed (see parameters needed by IEC TS 61980-3 for additional possibilities)
Primary device circuit topology	Type of circuit topology of the primary device: possible values are "parallel" and "series". Other values may be allowed (see parameters needed by IEC TS 61980-3 for additional possibilities)
Manufacturer ID	Optional: string of manufacturer ID
Manufacturer specific data	Optional: manufacturer specific data container
Specific service provider (optional)	Under consideration

8.9 Perform power transfer

This sequence describes how the EV device starts, controls or stops power transfer. Perform power transfer includes changing the power demand during operation. See UC perform power transfer in A.2.6 and UC stop power transfer in A.2.7.

The EVCC sends the power transfer message to the SECC according to Table 18.

Table 18 – Perform power transfer request parameters

Element name	Description
PowerRequest	Requested power (watts)
DCPowerOut	Actual DC power out of the EV device given in watts. The value may differ from the requested power demand value in case of e.g. low efficiency, misalignment, bad resonance. The value is measured after the rectifier.

The SECC shall respond to the request according to Table 19.

Table 19 – Perform power transfer response parameters

Element name	Description
InputGridPower	The amount of power consumed from the grid by the supply device given in watts. The vehicle compares the value with the received DCPowerOut in order to detect possible misbehavior. The value is measured between PFC and inverter. This value is for information only without any impact on safety relative reactions.
PowerLimit	Time varying power limit of the supply device. The EVCC should not request more than this amount of power.
MaximumTransmittablePower	Time varying maximum transmittable power limit of the supply device. The EVCC should not request more than this amount of power.
MinimumTransmittablePower	Time varying minimum transmittable power limit of the supply device. The EVCC should not request less than this amount of power, unless it will request 0 W.
ResponseCode	Request accepted/Request rejected

During this phase, the EVCC may request zero power to pause power transfer.

NOTE Zero power request can occur at the start of power transfer.

8.10 Stop power transfer

This sequence describes how the EVCC stops power transfer. See UC stop power transfer in A.2.7.

When the SECC receives the stop power transfer request, the SECC shall turn off all power transfer and respond with the stop power transfer response.

8.11 Terminate communication

Termination of communication between the EVCC and the SECC shall allow for any final communication request/responses followed by a **TerminateCommunication request/response** message pair.

8.12 Exception handling

When an error has been detected by the EVCC and the error condition is not WD1 and not WD2, the EVCC shall send the error detected message to the SECC and shall provide the following according to Table 20.

Table 20 – Error request parameters

Element name	Description
ErrorDetected	Error condition detected (WD1, WD3, WD4, WD7)

When the error condition WD6 has been detected by the EV device, the EVCC may proceed to state **WPT_V_OFF.**

When the error condition WD2 has been detected by the SECC during power transfer, the SECC shall terminate power transfer immediately.

Conformance is tested by forcing a WD2 exception and observation of power transfer termination.

When the error condition WD6 has been detected by the SECC, the supply equipment shall proceed to state **WPT_S_OOS.**

Conformance is tested by forcing a WD6 exception and observing state transition to ***WPT_S_OOS****.*

The SECC shall respond with the error detected response and shall provide the following (as acknowledgement) according to Table 21.

Table 21 – Error respond parameters

Element name	Description
ErrorDetected	Error condition detected (WD1,WD3, WD4, WD7)

When an error has been detected by the SECC, and the error condition is not WD2 and not WD6, the SECC shall respond to the next message from the EVCC with a response code of "error condition detected (WDx)", where the x shall be replaced by the detected error condition.

9 Message sequences of communication with WLAN

9.1 General

Clause 9 describes communication over WLAN. Optional functionality is referred to in Clause 9 as well.

According to the open systems interconnection (OSI) layer architecture, the physical layer of WLAN shall be according to ISO 15118-8.

9.2 Messages of communication for power transfer

Messages exchanged between SECC and EVCC shall follow this sequence:

1) communication setup (see 9.3);
2) service selection (see 9.4);
3) fine positioning (see 9.5);
4) pairing (see 9.6);
5) final compatibility check (see 9.7);
6) initial alignment check (see 9.8);
7) prepare power transfer (see 9.9);
8) perform power transfer (see 9.10);
9) stop power transfer (see 9.11);
10) terminate communication (see 9.12).

9.3 Communication setup

An EV device gets within range of the WLAN of a SECC and will connect to the WLAN via the access point according to ISO 15118-2.

For communication setup, the following ISO 15118-2 messages shall be exchanged between SECC and EVCC:

– **SupportedAppProtocolReq/Res**;
– **SessionSetupReq/Res**.

After the successful exchange of **SessionSetupReq/Res**, the state of the EV device is **WPT_V_SI** and the state of the supply device is **WPT_S_SI**.

9.4 Service selection

After communication setup, the EVCC queries the SECC of its services, and the SECC informs the EVCC about the capabilities of the supply device. The EVCC chooses one of the options from the SECC for each service necessary for WPT (see ISO 15118-2 for necessary services).

If the hardware or billing method is not compatible, then the EVCC will terminate the WPT session, indicating the reason for termination.

NOTE The SECC and the EVCC will confirm the hardware compatibility.

The following message sequence (from ISO 15118-2) shall be performed by the SECC and EVCC:

– **ServiceDiscoveryReq/Res**;
– **ServiceDetailReq/Res**;

– **ServicePaymentSelectionReq/Res**.

After the successful exchange of the messages, state of the EV device is **WPT_V_AA** and the state of the supply device is **WPT_S_AA**.

9.5 Fine positioning

After the service selection, the EV device and supply device shall perform fine positioning. Fine positioning provides support for the EV's secondary device and the primary device to become properly aligned. There are various methods that can be used to support this functionality (see Annex C). The method to be used is determined during service selection.

Further requirements for fine positioning can be found in Annex C.

The following message sequence (from ISO 15118-2) shall be performed by the SECC and EVCC:

– **FinePositioningSetupReq/Res**;
– **FinePositioningReq/Res**.

Note that the message sequence may be repeated as needed to achieve proper alignment.

NOTE It is possible that this could turn into an infinite loop if precautions are not taken.

9.6 Pairing

After successful fine positioning, the EVCC and SECC shall ensure that the primary device and secondary device are uniquely paired. There are various methods that can be used to support this functionality (See Annex C). The method to be used is determined during service selection.

The following message sequence (from ISO 15118-2) shall be performed by the SECC and EVCC:

– **PairingReq/Res**.

The **PairingReq/Res** message sequence may be repeated as needed to achieve successful pairing.

NOTE There can be additional messages used for EIM and/or park and charge.

9.7 Final compatibility check

After successful pairing, the EVCC and SECC shall ensure that the primary device and secondary device are compatible.

The following message sequence (from ISO 15118-2) shall be performed by the SECC and EVCC:

– **ChargeParameterDiscoveryReq/Res**.

Note that failure of final compatibility check results in an exception that will return the states to **WPT_S_SI** and **WPT_V_SI**.

9.8 Initial alignment check

After successful final compatibility check, the EVCC and SECC shall ensure that the primary device and secondary device are properly aligned.

There are various methods that can be used to support this functionality (See Annex C). The method to be used is determined during service selection.

Further requirements for initial alignment check can be found in Annex C.

The following message sequence (from ISO 15118-2) shall be performed by the SECC and EVCC:

– **AlignmentCheckReq/Res**.

EVCC sends the **AlignmentCheckReq** message to supply device.

With sending the successful **AlignmentCheckRes** message, the supply device state turns into **WPT_S_IDLE**.

With receiving the successful **AlignmentCheckRes** message, the EV device state turns into **WPT_V_IDLE.**

9.9 Prepare power transfer

In order to transfer power, the EVCC requests the SECC to prepare power transfer via communication.

The following message sequence (from ISO 15118-2) shall be performed by the SECC and EVCC:

– **PowerDeliveryReq/Res**;

– **PowerDemandReq/Res**.

With sending a **PowerDemandReq** message, the state of the EV device turns into **WPT_V_PT.**

With receiving this message, the supply device will start transfer power. With sending a **PowerDemandRes** message confirming the requested value, the state of the supply device turns into **WPT_S_PT**.

Additional emergency shutdown signals may be negotiated as part of the **PowerDeliveryReq/Res** to be used to ensure that power is transferred only when the signal is active and power has been requested by the EVCC (see Annex C). This emergency shutdown signal may also be used to ensure that the primary and secondary device remain properly aligned.

9.10 Perform power transfer

After successful prepare power transfer, the EVCC requests changes to the power being transferred via communication.

The following message sequence (from ISO 15118-2) shall be performed by the SECC and EVCC:

– **PowerDemandReq/Res**.

By continuously repeating the power demand messages, the power transfer can be controlled and communication reliability checked. The supply device may change the transmittable power limit at any time. The EVCC may request different power levels at any time.

PowerDemandReq/Res is used not only for controlling power being transferred, but also with exchanging amount of power transmitted and received. These values may be used for the continuous alignment check.

The SECC shall indicate to the EVCC how much power is being transmitted. The EVCC indicates to the SECC how much power was received. The supply device shall check the

alignment continuously during wireless power transfer. The EV device may check the alignment continuously during wireless power transfer.

9.11 Stop power transfer

When the EVCC does not want power being transferred, the EVCC requests power to be set to zero, and then shall request stop power transfer via communication.

The following message sequence (from ISO 15118-2) shall be performed by the SECC and EVCC:

– **PowerDemandReq/Res**;

– **PowerDeliveryReq/Res**.

The termination of power transfer is requested by the EVCC by sending a **PowerDeliveryReq** with the flag "ChargeProgress" set to "Stop".

After power ramp down has been finished, the termination of power transfer shall be confirmed by the SECC by sending the **PowerDeliveryRes**. The state of the supply device turns into **WPT_S_IDLE**.

After reception of the successful **PowerDeliveryRes**, the state of the EV device turns into **WPT_V_IDLE**.

9.12 Terminate communication

When the EVCC no longer wishes to maintain the session with the SECC, the EVCC requests the session to terminate via communication.

The following message sequence (from ISO 15118-2) shall be performed by the SECC and EVCC:

– **SessionStopReq/Res**.

After terminate communication, the state of the EV device is **WPT_V_SB** and the state of the supply device is **WPT_S_STO**.

Annex A
(informative)

Use cases

A.1 General

Use cases (UCs) are described by taking into account the following premises:

– these UCs apply to WPT power transfer;
– communication distinguishes between data exchange required for the function control of WPT power transfer and data exchange needed for value-added functions, such as payment or certification purposes;
– communication inside the EV device is not considered in Annex A;
– communication inside the supply device is not considered in Annex A.
– communication between the EV device and the supply device is expected;

Similar to the communication in conductive systems, the system is a client-server architecture, with the server providing a set of functionality to one or more clients. The EV device represents the client; supply device is the server. An overview of the use cases is given in Figure A.1.

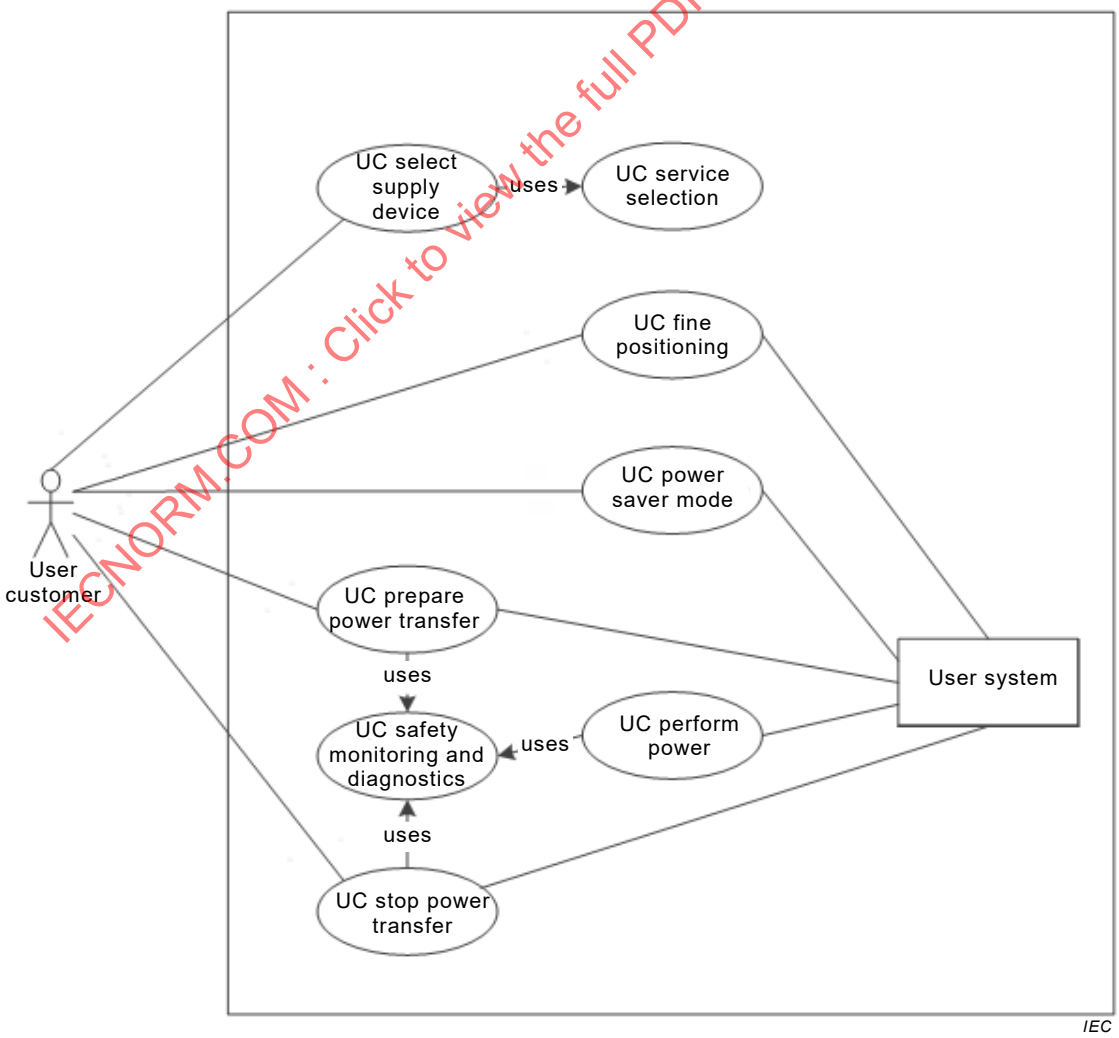


Figure A.1 – Use cases particularly for wireless power transfer

Besides the use cases specifically describing WPT systems aspects, additional use cases describing common power transfer topics can be applied. These uses cases are taken from ISO 15118-1 and are not described here. Refer to ISO 15118-1 for details. See Figure A.2.

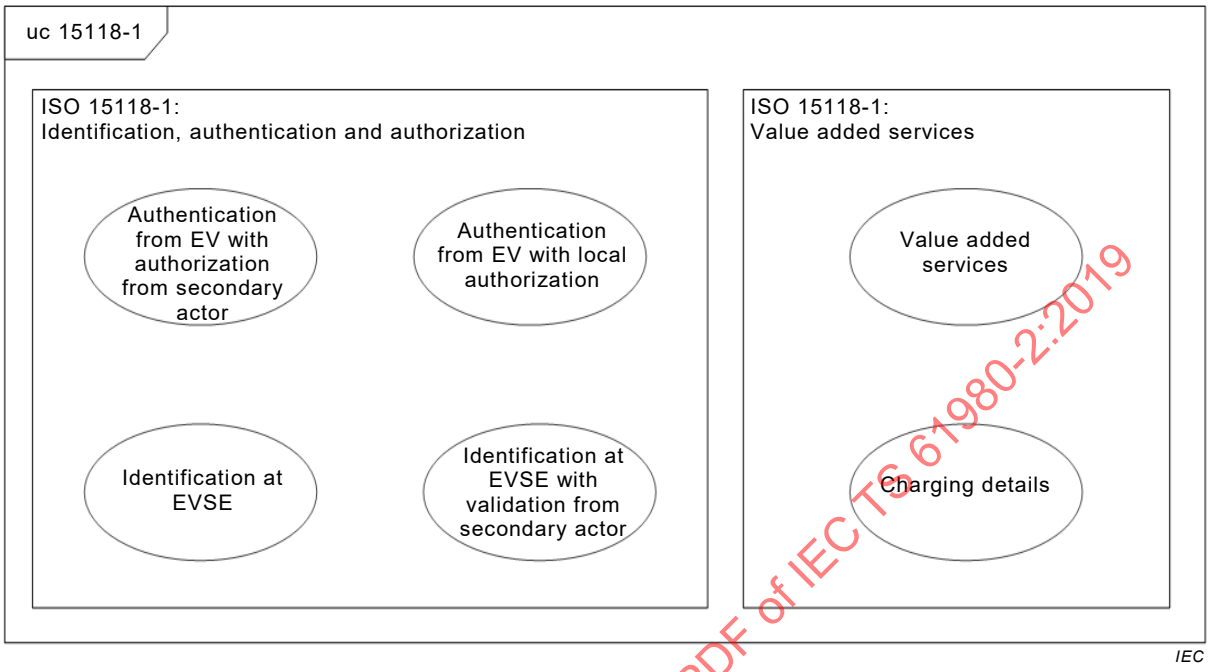


Figure A.2 – Use cases from ISO 15118-1 reusable for WPT systems

The use cases describe system behaviour from user point of view; they do not contain any technical system description.

A.2 Use case descriptions

A.2.1 UC select supply device

For an activity diagram for UC select supply device, see Table A.1 and Figure A.3.

Table A.1 – UC select supply device

Actor	Customer
General	Customer is selecting a supply device, while being within the WPT supply site and within the range of the communication system.
Preconditions	No communication between EV device and WPT supply site established
Post conditions	Communication between EV device and WPT supply site is established. The EV device has selected a dedicated supply device.
Basic scenario	Selection of supply device with WPT supply site support: The customer is moving the EV within an area up to X (adequate) metres around a WPT system. The EV device is starting communication with the SECC of the WPT supply site or of the supply device. UC service selection is applied. Available supply device may be indicated to the customer by the supply site or the EV information system.
Alternative	– selection of a compatible supply device has been done prior to entering parking region by back end Internet service or any other system; – indication/identification if the supply device is done by any means (e.g. signs); – compatibility has to be confirmed as part of the negotiation process.
Exceptions	Communication failure

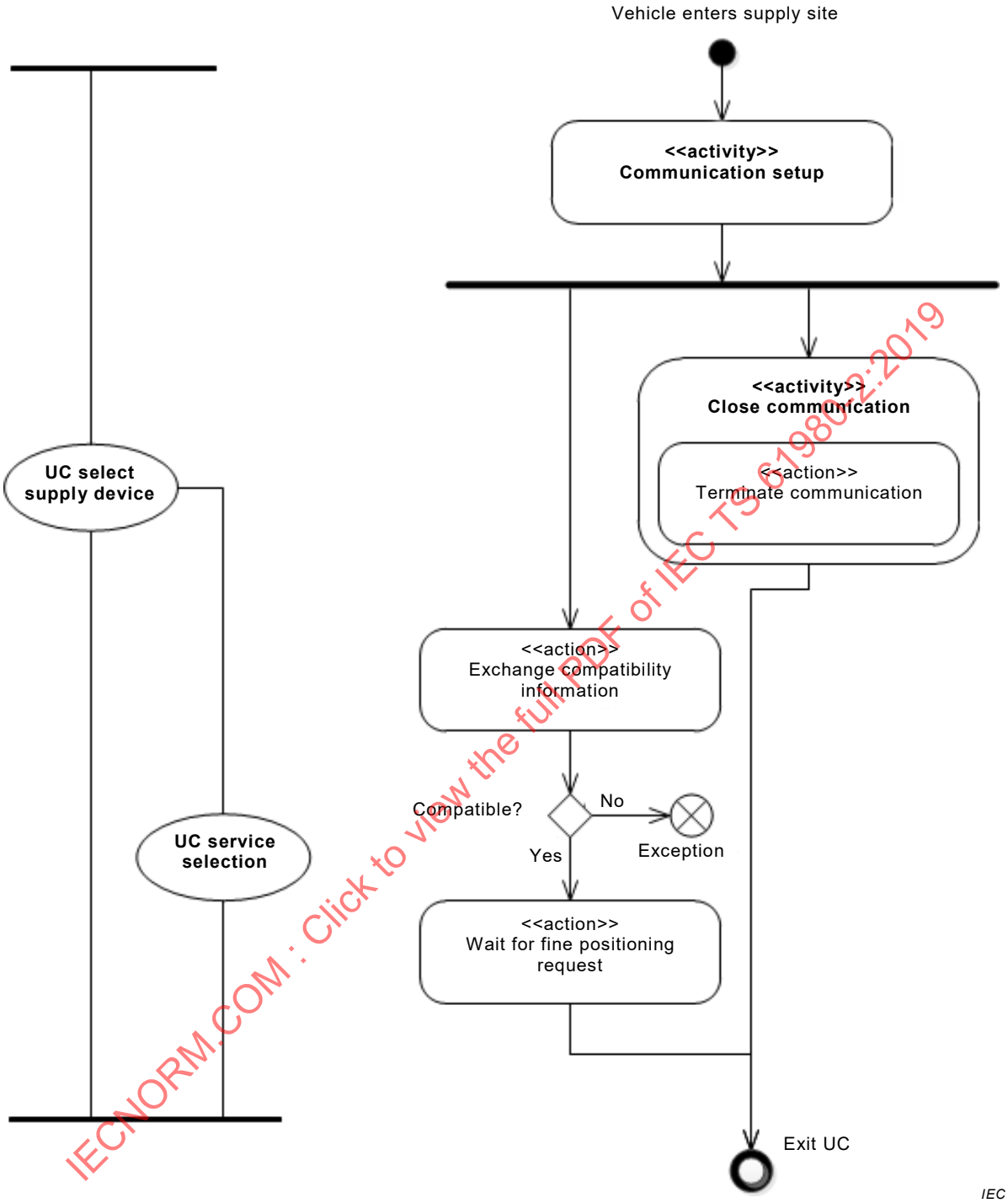


Figure A.3 – Activity diagram for UC select supply device

A.2.2 UC service selection

For an activity diagram for UC service selection, see Table A.2.

Table A.2 – UC service selection

Actor	Customer
General	EV device and supply device are evaluating compatibility.
Preconditions	Communication is established
Post conditions	Potential compatibility is confirmed
Basic scenario	The data being exchanged via the communication link need to contain the following information: – technical parameters for power transfer; – identifier (authentication, identification, authorization); – business model data (payment options, delivery profiles) (optional or only default values). Having confirmed system compatibility, the result is indicated to the customer. Since the result is available on EV side as well as on supply device side, both parts may be able to indicate readiness.
Alternative	n/a
Exceptions	– communication link is broken or other communication failure occurred; – no compatibility confirmed; – supply device or EV device cannot confirm compatibility.

A.2.3 UC fine positioning

For an activity diagram for UC fine positioning, see Table A.3 and Figure A.4.

Table A.3 – UC fine positioning

Actor	Customer/user system
General	Primary and secondary devices are being well positioned so that sufficient system functionality is reached. The positioning status is indicated to the EV device as well as to the supply device, especially the result (success or failure). The customer may be informed about the fine positioning result either by the supply device or EV device (e.g. like the red/green lights at a car wash). The user might choose an optimal positioning to achieve best possible energy efficiency. After fine positioning, the pairing of the EV device to a unique dedicated primary device will be performed. The pairing process ensures that a power request signal sent by the EV device is only accepted by the primary device that is under the EV.
Preconditions	WLAN is established. The EV device and supply device are able to exchange information necessary for the fine positioning process
Post conditions	The EV device and supply device are well positioned to each other. Fine positioning confirmed to relevant actors (e.g. EV, supply device, customer). The unique assignment of an EV device to a dedicated primary device is accomplished and confirmed.
Basic scenario	The secondary device is moved into a position with respect to the primary device so that sufficient system functionality and performance requirements are achieved.
Alternative	The primary device is moved into a position with respect to the secondary device so that sufficient system functionality and performance requirements are achieved. Depending on the implementation, there might exist a system which achieves sufficient alignment without support from the WPT system.
Exceptions	– fine positioning failed; – sufficient position cannot be reached; – communication failure; – pairing signal unavailable; – pairing cannot be confirmed.
NOTE "Sufficient" means the primary and secondary devices are being properly well positioned relative to each other so that they are located with the offset as specified in 7.107 of IEC TS 61980-3:2019.	

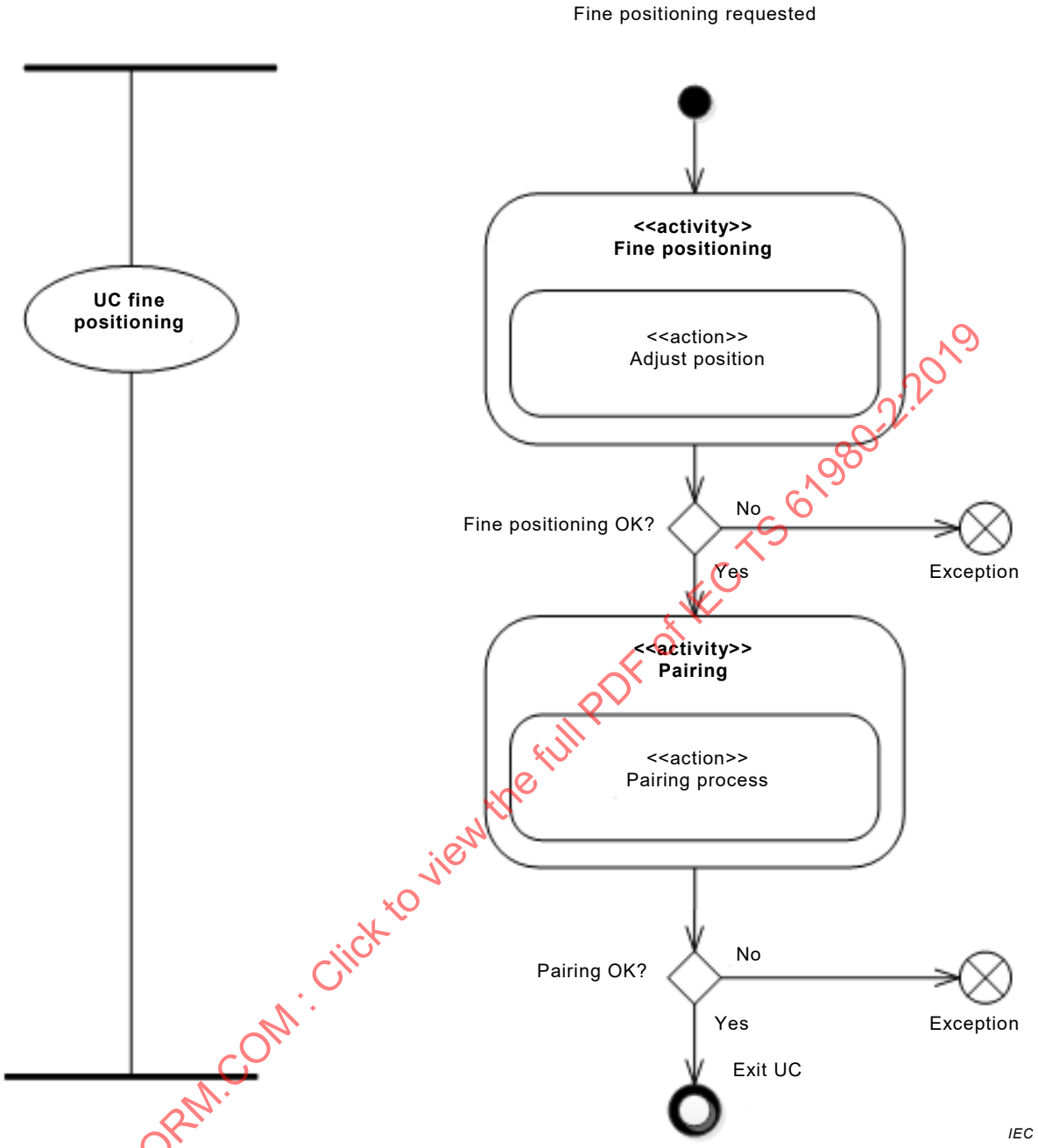


Figure A.4 – Activity diagram for UC fine positioning

A.2.4 UC prepare power transfer

For an activity diagram for UC prepare power transfer, see Table A.4 and Figure A.5.

Table A.4 – UC prepare power transfer

Actor	User system
General	An indication to the system is done that triggers the system to prepare for power transfer. All actions to prepare the WPT system for power transfer are executed in this UC.
Preconditions	– fine positioning has been done successfully; – communication is established; – pairing has been done successfully.
Post conditions	EV device and supply device are able to exchange information necessary for the power transfer process. System is ready to perform power transfer. Safety monitoring systems are activated.
Basic scenario	An indication to the system is done that power transfer may be started. This may happen by any means either on the supply device or EV device side. The final compatibility check is applied. Exchange of parameters (if necessary). The indication triggers a preparation phase, in which supply device and EV device get ready to perform power transfer. An initial alignment check is performed before power transfer is activated. Safety monitoring and diagnostics is activated before power transfer is activated. Additionally information of value added services may be exchanged and acted upon (if needed).
Alternative	Starting indication of this process may be given by the following methods: – button press on supply device; – button press or other user activity on EV side; – automatic indication by EV device; – remote indication by additional user system (e.g. Wi-Fi, cell phone, time schedule).
Exceptions	– communication failure; – compatibility check failure; – safety monitoring failure (e.g. object detection positive, misalignment).

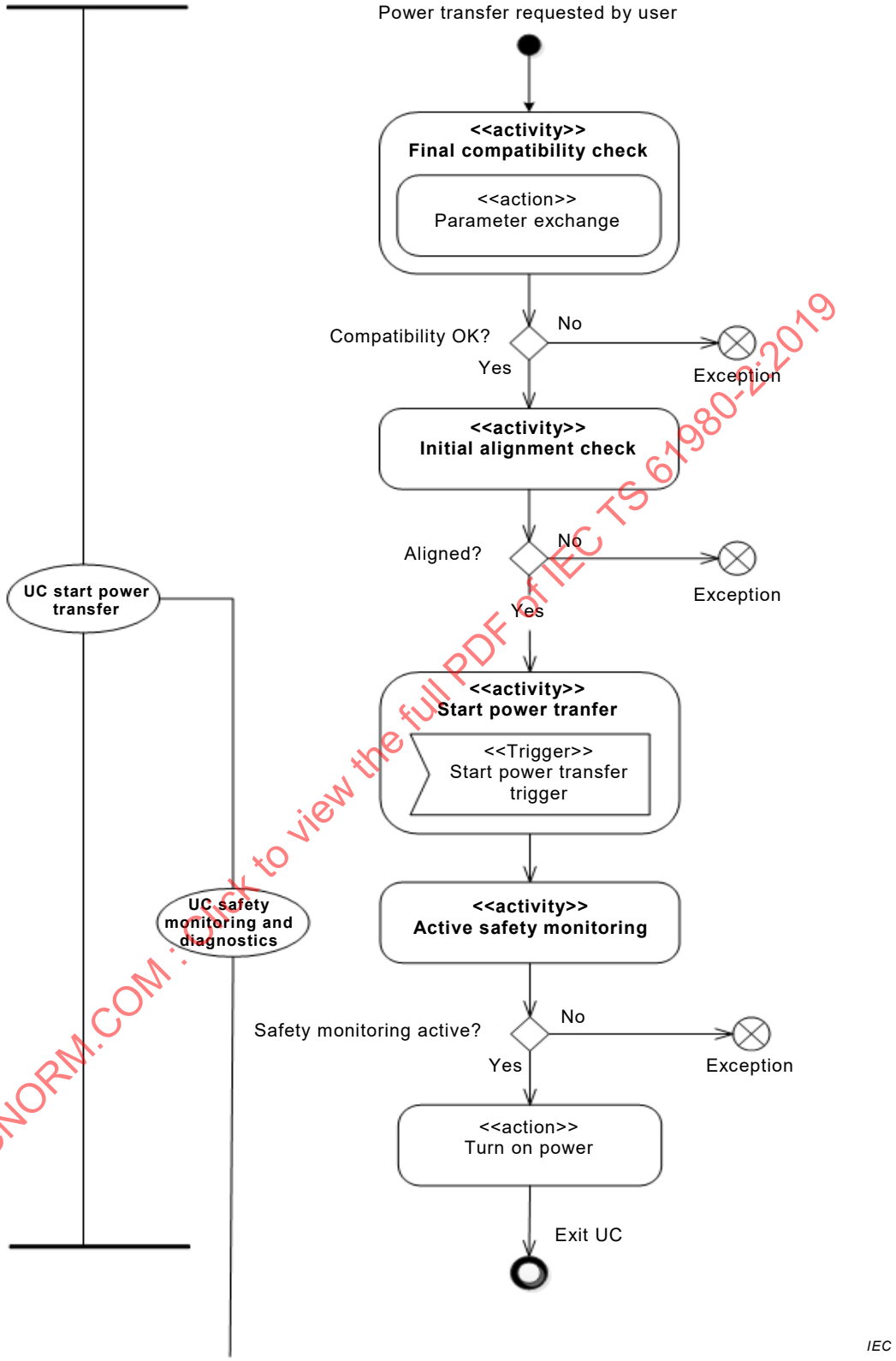


Figure A.5 – Activity diagram for UC prepare power transfer

A.2.5 UC safety monitoring and diagnostics

For a UC safety monitoring and diagnostics, see Table A.5.

Table A.5 – UC safety monitoring and diagnostics

Actor	UC prepare power transfer/UC perform power transfer/UC stop power transfer
General	This use case is applied by all use cases treating safety relevant actions. A monitoring system is supervising the wireless power transfer. In case of a safety hazard condition or a functional failure, the system ensures power transfer to be prevented.
Preconditions	The EV device and primary device are in aligned position.
Post conditions	n/a
Basic scenario	The system is activated prior to power transfer. The system is checking safety conditions and is indicating the safety status to the supply device. If the safety conditions are fine, the system is allowed to transfer power. If safety conditions are detected to be hazardous, the system prohibits power transfer. The system is in operation continuously as long as power transfer is active. After terminating power transfer, the system is shut down.
Alternative	n/a
Exceptions	Self-check of system fails (not able to operate properly).

A.2.6 UC perform power transfer

For an activity diagram for UC perform power transfer, see Table A.5 and Figure A.6.

Table A.6 – UC perform power transfer

Actor	User system
General	The supply device is transferring power wirelessly to the EV device.
Preconditions	– communication is established; – compatibility is approved; – alignment was successful; – pairing of EV device and primary device was successful; – safety monitoring system is established on the supply device side as well as on the EV side.
Post conditions	Power transfer process is ongoing until one of the termination indicators apply.
Basic scenario	The supply device is transferring power to the EV device after request for power transfer by the EV device through communication [a] The power transfer remains active as long as a valid request is present. Adjustment of power during the transfer process is done by communication. UC safety monitoring and diagnostics is applied.
Alternative	n/a
Exceptions	– safety monitoring detects critical situation; – safety monitoring is malfunctioning; – communication failure.
[a] Zero power is defined as power transfer, too.	

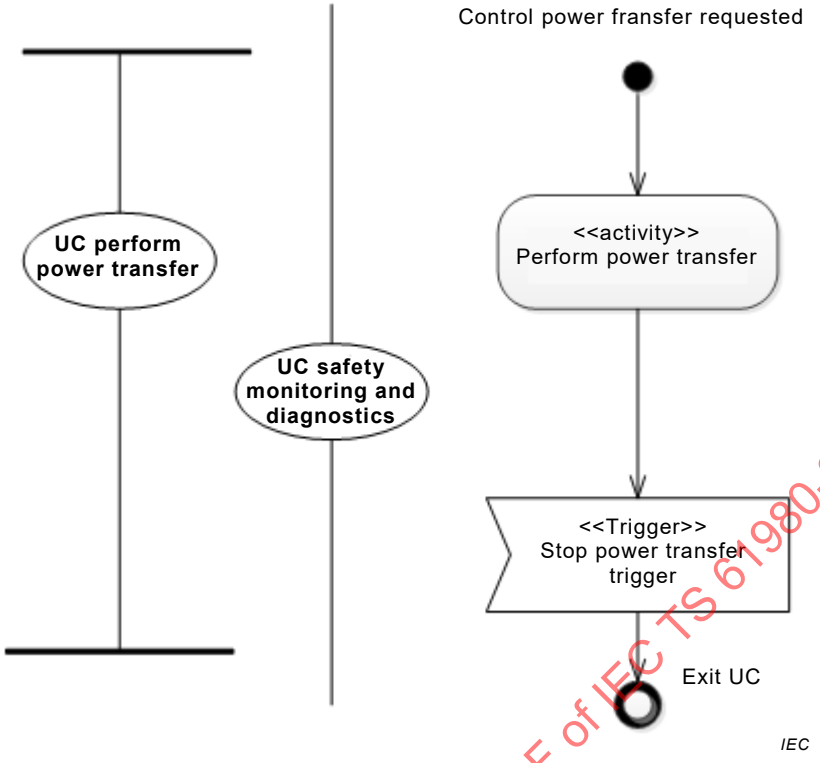


Figure A.6 – Activity diagram for UC perform power transfer

A.2.7 UC stop power transfer

For an activity diagram for UC stop power transfer, see Table A.7 and Figure A.7.

Table A.7 – UC stop power transfer

Actor	Customer/User system
General	The termination sequence for power transfer is initiated and applied.
Preconditions	Performing power transfer
Post conditions	The EV is ready to depart.
Basic scenario	After a trigger situation has occurred, the supply device side is stopping power transfer to the EV device. SECC and EVCC are exchanging information about the power transfer status as well as other features (e.g. metering information) in order to safely decouple supply device and EV device. The trigger situation could be one of the following: – state of charge (SOC) of traction battery (rechargeable energy storage system, RESS) has been reached/ no more power is needed; – stop button pressed or other customer action (HMI) on EV side; – stop button pressed by customer on supply device side; – indication of power transfer stop remote by external system; – detection of EV device misalignment; – failure condition or safety hazard recognition. Monitoring systems are deactivated (UC safety monitoring and diagnostics). Communication is terminated.
Alternative	n/a
Exceptions	– communication failure; – primary device active after removing the EV.

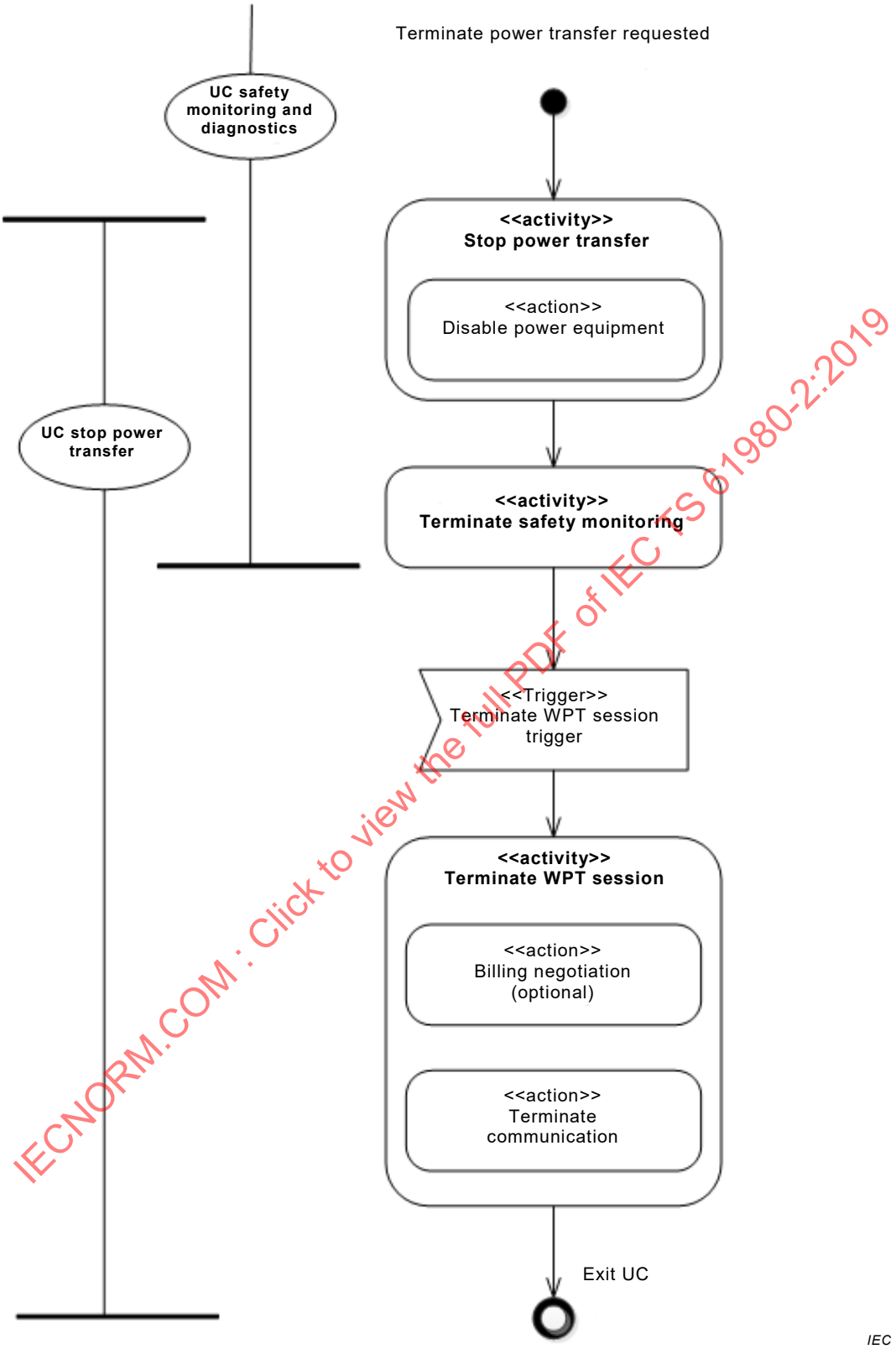


Figure A.7 – Activity diagram for UC stop power transfer

A.2.8 UC sleep mode (optional)

For an activity diagram for UC sleep mode, see Table A.8 and Figure A.8.

Table A.8 – UC sleep mode

Actor	Customer/ user system
General	The supply device and EV device is turned into a state of low power consumption during a period, when no power transfer is requested by the EVCC according to a predefined schedule
Preconditions	Power transfer has stopped. Communication is established
Post conditions	EV device is ready to prepare power transfer.
Basic scenario	According to a predefined time schedule for power transfer, the EV device is expected to not request power transfer for a limited duration of time. The supply device and EV device will be turned into a state of low power consumption. After the expected sleeping time has elapsed, the supply device is waking up and checks if the EV device is asking for continuing the WPT session. In order to assure the preconditions for power transfer, the UC pairing confirmation is applied and the initial alignment check is performed.
Alternative	– The customer may decide to put the WPT system into sleep mode. The EVCC will send a signal or message via communication in order to trigger the start of sleep mode; – While the supply device and EV device are in sleep mode, the EV device wants to receive power unexpectedly. The EVCC sends a signal or message via communication in order to trigger the termination of the sleep mode of the supply device; – While supply device and EV device are in sleep mode, the EV device may decide to suddenly leave the supply site (the customer may have caused the EV device to leave sleep mode). The EVCC sends a signal or message via communication in order to trigger the termination of the sleep mode of the supply device, and then, soon after, terminate the WPT session.
Exceptions	– communication failure; – pairing confirmation fails; – alignment check fails.

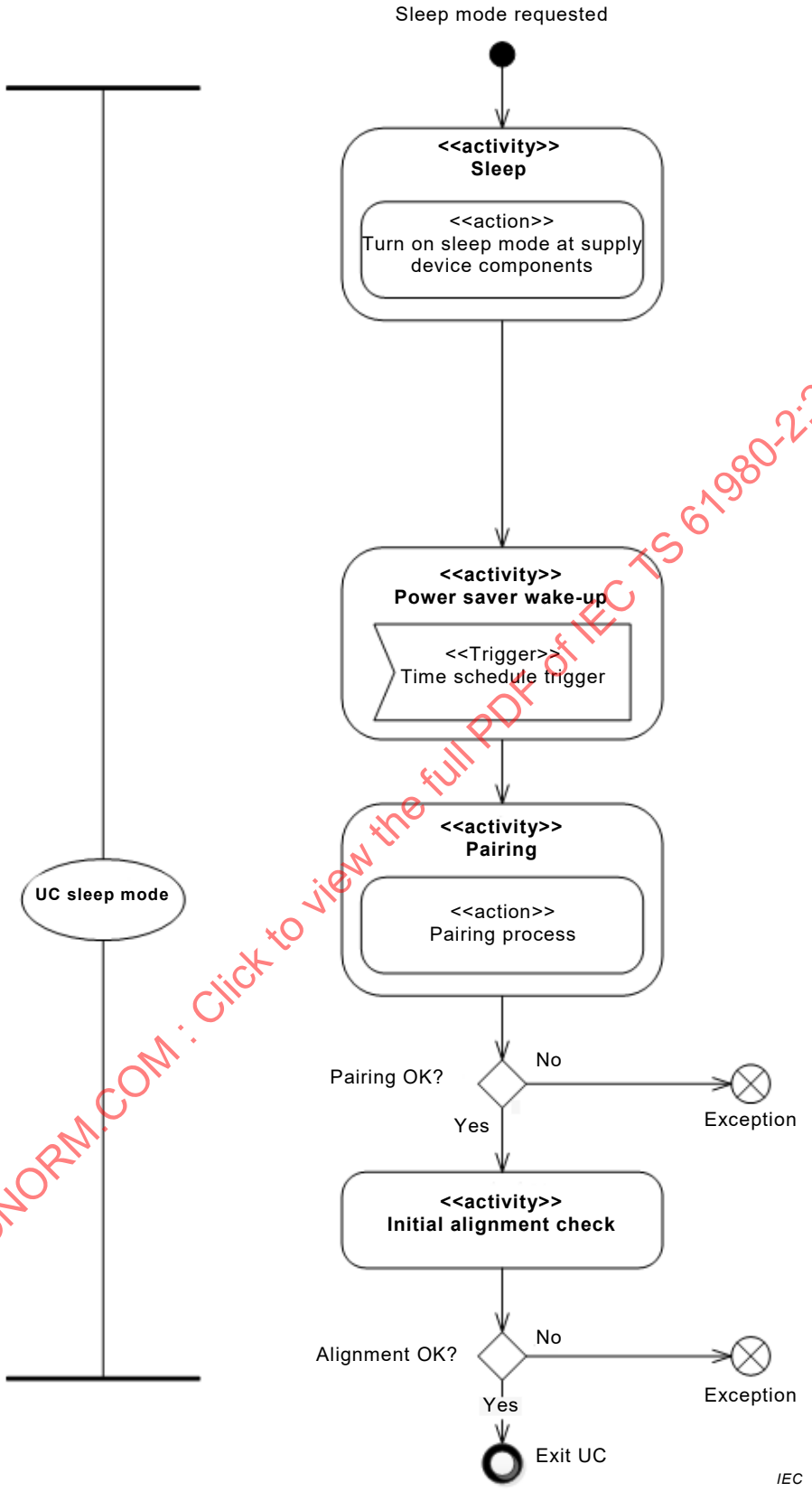


Figure A.8 – Activity diagram for UC sleep mode