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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Management and interfaces for WPT – Device-to-device wireless charging (D2DWC) for mobile devices with wireless power TX/RX module

Gestion et interfaces pour WPT – Chargement sans fil de dispositif à dispositif (D2DWC) pour dispositifs mobiles avec module TX/RX d'énergie sans fil

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Management and interfaces for WPT – Device-to-device wireless charging (D2DWC) for mobile devices with wireless power TX/RX module

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MANAGEMENT AND INTERFACES FOR WPT – DEVICE-TO-DEVICE WIRELESS CHARGING (D2DWC) FOR MOBILE DEVICES WITH WIRELESS POWER TX/RX MODULE

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Draft	Report on voting
100/3799/FDIS	100/3820/RVD

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

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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- withdrawn,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

MANAGEMENT AND INTERFACES FOR WPT – DEVICE-TO-DEVICE WIRELESS CHARGING (D2DWC) FOR MOBILE DEVICES WITH WIRELESS POWER TX/RX MODULE

1 Scope

This document defines the specification and the control protocol of the D2DWC module for the use of wireless power TX and RX functions by a single device. The related antenna physical design examples for sharing information are presented in Annex A.

This document proposes the D2DWC module circuit requirement, which consists of the D2DWC main AP, D2DWC IC, the EMT/WPT antenna unit and the PMIC unit. In Clause 5, the register information and message protocols for WPT control are defined in order to implement the WPT TX function.

In this document, the interface and protocol in the wireless power process of the mobile device can be used in accordance with the corresponding wireless power transfer standard. Any wireless power transfer standard working within the 100 kHz to 350 kHz frequency range can be included in the scope of this document.

This document can be used for mobile wireless power transfer in mobile phones and other mobile devices, IoT devices, micro-sensor industries and related application fields.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions 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 Terms and definitions

3.1.1
D2DWC
device-to-device wireless charging
wireless charging technology that uses a magnetic field-transmission function between mobile devices, which can simultaneously perform wireless power TX and RX functions

3.1.2
D2DWC unit
IC that enables wireless power transmission/reception, and includes a magnetic field-transmission function, mux, which allows the selection of WPT TX, and a transmission inverter

3.1.3
WPT
wireless power transfer
technology that wirelessly sends energy to a load with no transmission line by converting electric energy to electromagnetic waves

Note 1 to entry: To convert electric energy to electromagnetic waves, the electric energy is converted to RF signals of a specific frequency and the energy is transmitted through the electromagnetic waves generated from them.

3.1.4
EMT
elective magnetic transmission
technology for transmitting elective magnetic waves and is currently used to create and send magnetic waves for magnetic billing service of mobile phones

3.1.5
PMIC
power-management IC
device for managing battery charging, which includes a boost function

3.1.6
SPI
serial peripheral interface
synchronized serial data connection standard for operation in full-duplex communication mode

3.1.7
UART
universal asynchronous receiver/transmitter
device for receiving and sending data after converting parallel data to serial data

3.1.8
I^2C Bus
inter-integrated circuit bus
protocol for transmitting clocks, data, and commands

3.1.9
WPC Class 0 specification
specification used to load the battery of devices such as mobile phones, tablets, and small accessories

Note 1 to entry: It has a maximum transmission power of 15 W.

Note 2 to entry: Power class 0 is defined by the WPC (World Power Consortium).

3.2 Abbreviated terms

WPT	wireless power transfer
TX	transmitter
RX	receiver
RFU	reserved for future use
MCU	micro controller unit

4 Operation scenarios

4.1 Architecture

This document proposes the physical definition and control information of modules for wireless power transfer (WPT) between mobile devices that are operated by batteries instead of a constant power supply and simultaneously support wireless power TX and RX. The total architecture for the D2DWC technical standard proposed herein is shown in Figure 1.

To implement the features of the D2DWC, the following components are required:

a) D2DWC unit for performing magnetic field transmission function and wireless charging TX/RX among mobile devices,

b) PMIC unit for battery charging,

c) EMT/WPT antenna unit for both EMT function and WPT TX/RX, and

d) microcontroller unit (MCU) for monitoring and controlling the D2DWC unit.

Among these components, the D2DWC unit consists of an EMT module, a WPT TX/RX module, an EMP/WPT TX mux, and a power amp module. The EMT module can control and transmit magnetic waveforms, and uses the same bandwidth as that of the frequencies specified in the WPT for use in billing services, etc. The WPT TX/RX module has the functions to perform wireless power transfer and reception. For WPT, it determines which magnetic field waveform to send through the EMT module and mux. The EMT/WPT TX mux selects the waveform after selecting the EMT and WPT TX signals. Finally, the power amp module sends the magnetic field waveforms during EMT or WPT TX.

In order to examine each IC and module, for WPT, the D2DWC unit uses the mux to select and send EMT and WPT TX, and a transmission inverter to generate and transmit magnetic fields, which is shared between EMT and WPT. Furthermore, the WPT module can selectively perform the TX/RX function. Outside of the D2DWC unit, there is one EMT/WPT antenna that shall be used for three functions, for which the EMT and WPT functions shall be performed with the same frequency. The antenna is shared for EMT and WPT functions, but the antenna can be switched selectively depending on the EMT frequency. At a given frequency, the same antenna may be used for both EMT and WPT TX. The optional EMT antenna is indicated to show the selective change in the antenna length according to the impedance matching between the TX and RX. Finally, the D2DWC unit is externally connected to the PMIC for battery charging, and battery charging/discharging occurs during wireless power transfer and reception. Information related to regulation and certification is presented in Annex B.

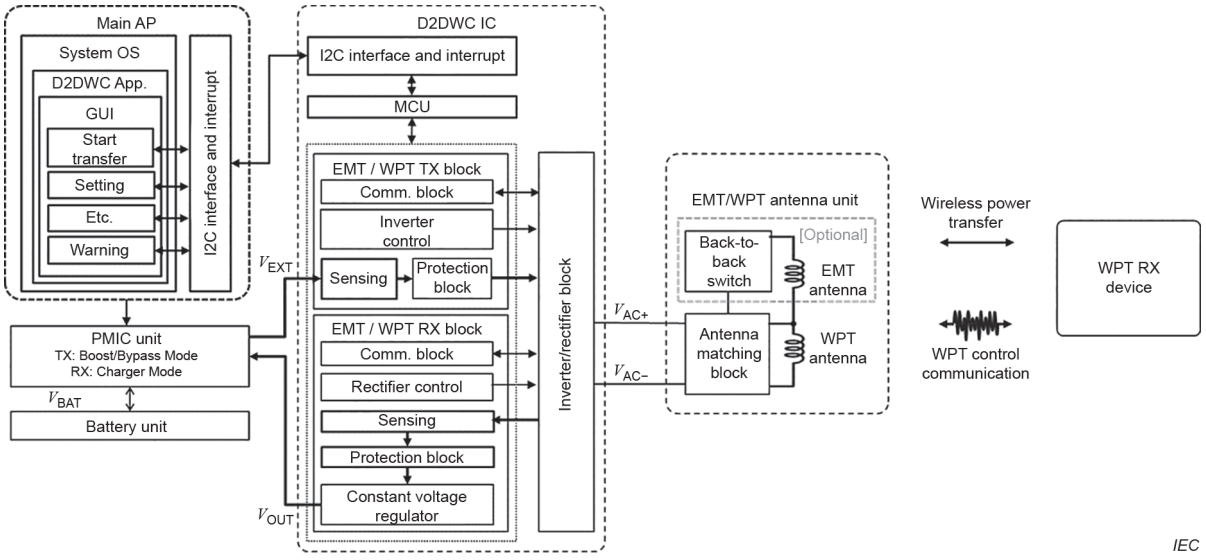


Figure 1 – Overall architecture of the proposed EMT/WPT module

4.2 Communication procedure for D2DWC

4.2.1 General

In this document, WPT can be controlled in accordance with the WPT standard used by the user, and the class 0 WPT in the WPC standard is used as an example. For this case, the total operation procedure of the D2DWC and the WPT TX/RX operations are presented in 4.2.

4.2.2 Total operation scenario of D2DWC

The total operation scenario of D2DWC is shown in Figure 2. The user first makes contact between the coil parts of the TX and RX devices to perform WPT. The D2DWC then sends a command to drive the WPT function to the D2DWC unit connected via the I^2C interface. The D2DWC unit reports the current charging amount to the user, who checks the charging amount of the device's battery and determines the desired charging amount and speed. Once charging starts, the WPT TX device draws power from the battery and applies power to the WPT TX coil and the power is cut off in the RX coil. Wireless charging is performed between the WPT TX and RX devices, which are controlled in accordance with the mobile TX/RX combined device environment proposed in this document. Finally, when the power is transmitted for the amount set in the command, wireless charging is stopped in the WPT TX.

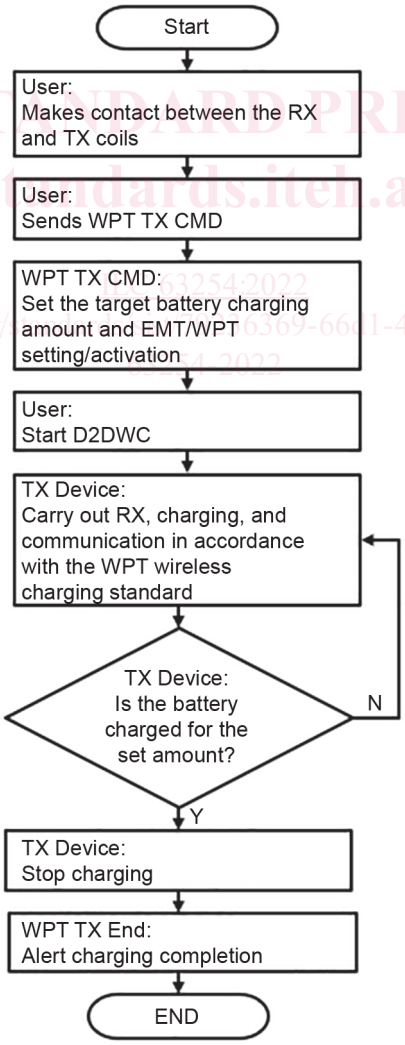
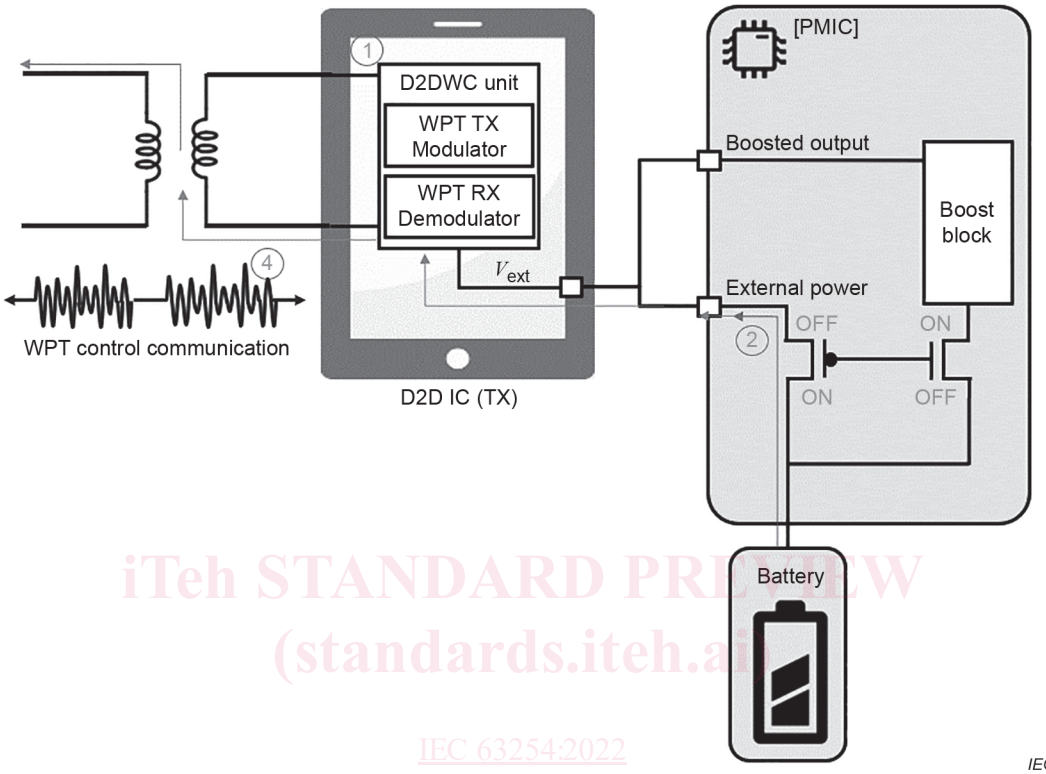


Figure 2 – Operation scenario of D2DWC

4.2.3 TX operation scenario of D2DWC

The TX operation scenarios of D2DWC can be classified depending on the use of the boost circuit of the PMIC module in the mobile device. Figure 3 illustrates the case of using battery power only for the TX operation of D2DWC.



① When the start of WPT is notified by sending the WPT command to the D2DWC unit, the D2DWC operates in TX mode.

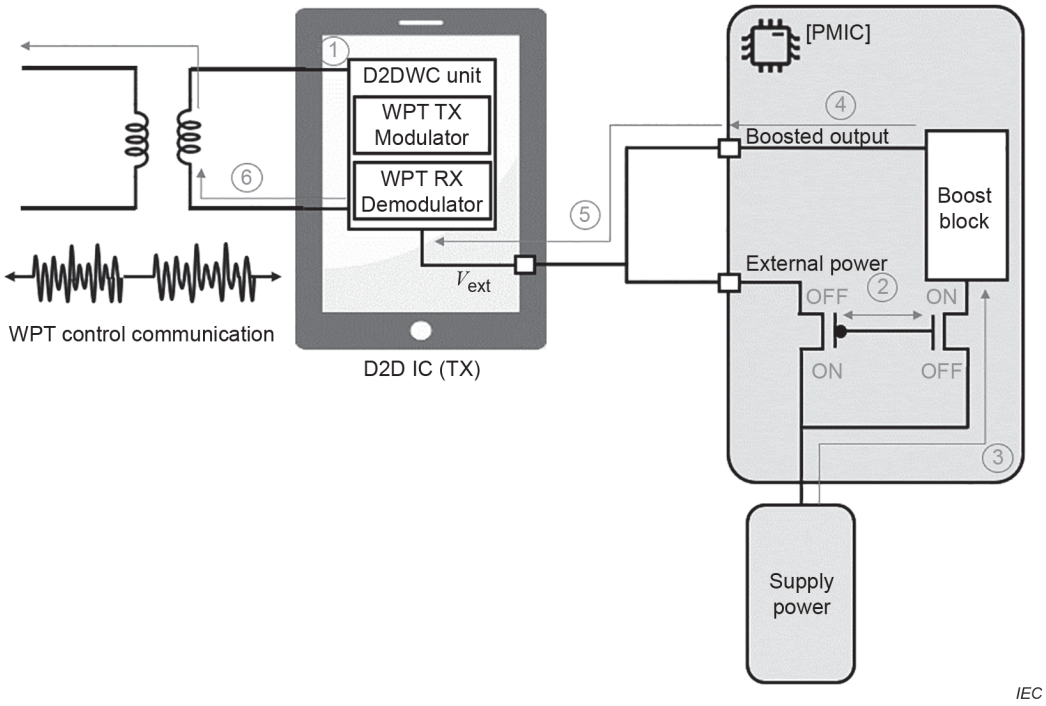
② The D2DWC unit checks the battery connection to the PMIC interface and draws power for WPT.

③ The D2DWC unit carries out power transfer and communication to the RX through the TX coil in accordance with the WPT standard.

④ Once the power specified in the WPT command is transmitted, the D2DWC unit stops sending power.

Figure 3 – TX operation scenario of D2DWC using battery power only

The second case of WPT TX operation is to supply constant power to the PMIC module in the mobile device. Faster and more stable wireless charging is possible when constant power is supplied. The TX operation scenario using a constant power supply is illustrated in Figure 4. The difference from the case of using the battery circuit only is that the battery circuit is directly blocked for wireless charging in the PMIC.



① The WPT command is sent to the D2DWC unit to indicate the start of wireless charging, and the D2DWC operates in TX mode.

② When wireless charging command is issued to the D2DWC unit, the PMIC directly blocks the direct connection of the battery power.

③ The boost circuit of the PMIC powers on.

④ The boosted power is input to Vext of the D2DWC unit, preparing for wireless charging.

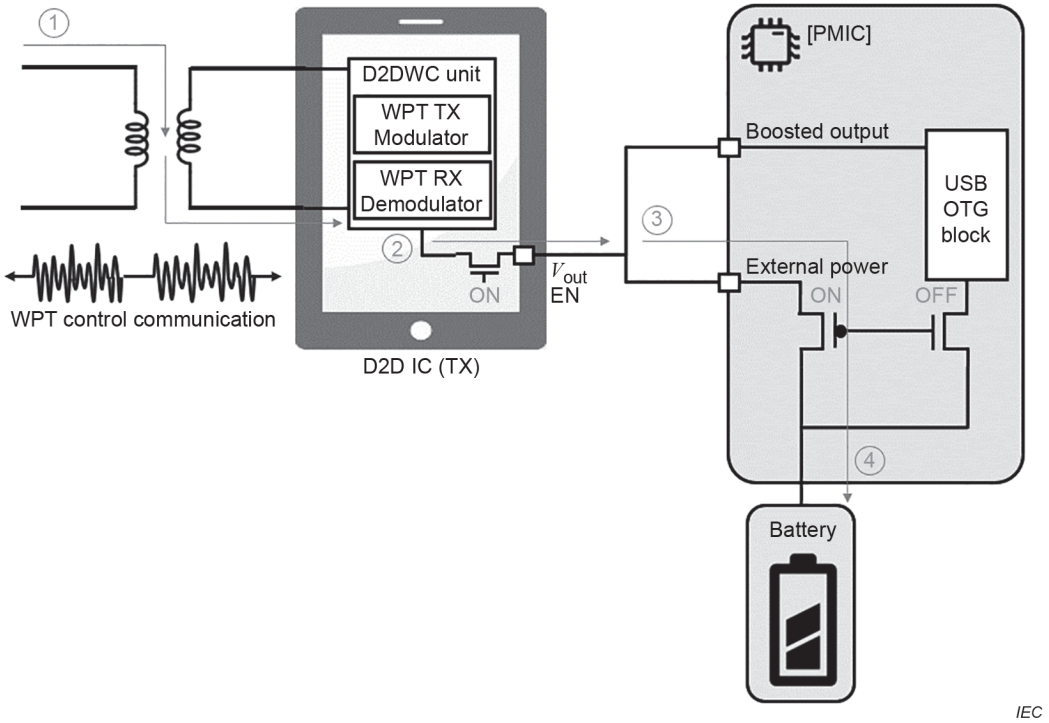
⑤ The D2DWC unit carries out power transfer and communication to the RX through the TX coil in accordance with the WPT standard.

⑥ When the specified amount of power has been transmitted in the WPT command, the D2DWC unit stops power transfer.

Figure 4 – TX operation scenario of D2DWC using constant power supply

4.2.4 RX operation scenario of D2DWC

The RX operation scenario of D2DWC is illustrated in Figure 5. The D2DWC unit is always waiting in RX mode until it receives a separate wireless charging command.



① When power reception and communication occur in TX mode, the D2DWC unit starts preparing to receive wireless power.

② When the power stabilizes, the Vout terminal outputs power.

③ Battery charging begins through the charger IC.

④ Charging is carried out until power transfer from the TX stops.

Figure 5 – RX operation scenario of D2DWC

5 Specifications and control protocol of D2DWC unit

5.1 General control of a D2DWC unit of the TX-RX combined type

5.1.1 General

To aid in understanding, this Clause 5 uses the class-0 specification of the WPC standard and the PMA TX version 1.2 standard as examples. The D2DWC unit, which supports wireless power TX/RX in a single device, requires additional control compared to class-0 of the WPC standard. The D2DWC unit performs WPT in accordance with the WPT standard, but if the TX and RX are combined in one device, conditions such as the voltage, current, and temperature vary and are controlled by the MCU. The D2DWC unit reports the current state to the MCU while carrying out message and data TX and RX for WPT. The MCU monitors the WPT of the D2DWC and stops WPT if the device operates within the scope specified in this document. The overall architecture is shown in Figure 6. During the WPT, the device operates in accordance with the WPT standard. When the D2DWC unit is used, the operations shall be controlled with more detailed specifications because the unit combines WPT TX and RX. This can be controlled by any control unit that can transmit messages, such as I2C, SPI, or UART. In this document, a control protocol using I2C is presented as an example in 5.3.

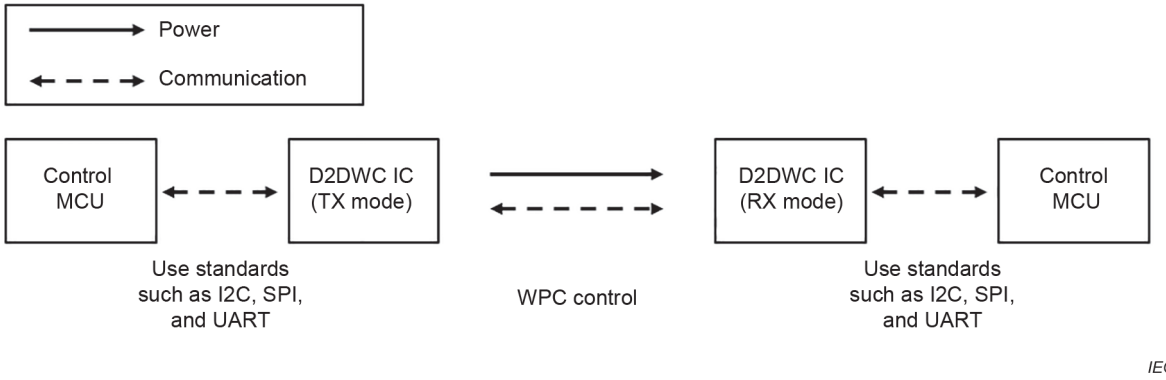


Figure 6 – Wireless charging control architecture of the proposed standard

The specifications when the D2DWC IC is operated in TX mode are listed in Table 1. The specifications for operation based on experimental values were established in accordance with the specifications of EMT TX and WPC TX class-0 of mobile devices and the PMA TX version 1.2. Furthermore, the system operation efficiency defined in this document is presented in Figure 7, which is defined by the ratio of the TX input power to the RX output power.

In this document, the specifications of the D2DWC unit are redefined for medium-power operation of up to 15 W to support charging from a notebook computer to a mobile phone and fast charging for mobile devices. Furthermore, to support the PMA standard, which is a de facto standardization organization, the frequency operation of 100 kHz to 350 kHz, which is a range usable within 400 kHz in the EMT TX module, is redefined.

Table 1 – Specifications for the TX operation of D2DWC unit

		D2DWC (TX mode)	EMT TX	WPC TX (Example)	PMA TX version 1.2 (Example)
Carrier frequency	Min.	**100 KHz**	80 KHz	100 KHz	118 kHz to 153 kHz 277 kHz to 357 kHz
	Max.	**350 KHz**	210 KHz	200 KHz	
AC drive voltage (peak to peak)	Min.	**2 V**	3 V	2 V	2 V
	Avg.	**5 V**	5 V	-	-
	Max.	**12 V**	-	24 V	12 V
Input current	Max.	**1,5 A**	2 A	2 A	1,5 A
Transmit power	Min.	**2 W**	2 W	7,5 W	7,5 W
	Max.	**15 W**	10 W	20 W	15 W
System efficiency	Min.	**40%**	50%	65%	60%
Temperature limit	Min.	**−20 °C (TX surface)**	−40 °C (TX surface)	-20 °C (FOD)	−40 °C
	Max.	**50 °C (TX surface)**	60 °C (TX surface)	60 °C (FOD)	60 °C