

FCC RF Exposure Evaluation

Report Number:

F241004E12

Equipment under Test (EUT):

Steering unit for welding inverters

Einschub TPS/i Touch G3

Applicant:

Fronius International GmbH

Manufacturer:

Fronius International GmbH



Deutsche
Akkreditierungsstelle
D-PL-17186-01-00

References

- [1] **CFR 47 Rule part 1** Practice and Procedure
- [2] **CFR 47 Rule part 2** Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
- [3] **KDB 447498 D01 General RF Exposure Guidance v06**

Assessed and
written by:


Bernward ROHDE
10.10.2025
Signature

Reviewed and
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Bernd STEINER
10.10.2025
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1 Identification

1.1 Applicant

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1.2 Manufacturer

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Manufacturer represented during the test by the following person:	Partly: Mr. Jan HERNDLER

1.3 Test Laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) according to DIN EN ISO/IEC 17025:2018. The accreditation is only valid for the scope of accreditation listed in the annex of the certificate D-PL-17186-01-00. FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

Test object: *	Steering unit for welding inverters
Model name: *	Einschub TPS/i Touch G3
Model number: *	43,0001,1785
Order number: *	-
FCC ID: *	QKWMCU3
IC certification number: *	12270A-MCU3
PMN: *	Einschub TPS/i Touch G3
HVIN: *	V0.3B
FVIN: *	N/A

* Declared by the applicant

	EUT number	
	1	2 (NFC)
Serial number: *	N/A (MCU 3 Radio Sample 4)	N/A (MCU 3 Radio Sample 3)
PCB identifier: *	MCU3	MCU3
Hardware version: *	V0.3B	V0.3B
Software version: *	V4.3.10	V4.3.10

* Declared by the applicant

1.5 Technical Data of Equipment

General EUT data			
Power supply EUT: *	DC		
Supply voltage EUT: *	$U_{nom} = 24 \text{ V}_{DC}$	$U_{min} = 21.6 \text{ V}_{DC}$	$U_{max} = 26.4 \text{ V}_{DC}$
Temperature range: *	-20 °C to +65 °C		
Lowest / highest internal clock frequency: *	20 kHz / 2480 MHz		

* Declared by the applicant

Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
DC mains	Customized	4 mm laboratory plug	≥ 1 m	No
Ethernet *	HSD	RJ45	≥ 1 m	Yes (CAT6)
Speednet *	HSD	RJ45	-	Yes (CAT6)
USB *	USB-A	-	-	Yes

* Declared by the applicant

RFID part	
Operating frequency: *	13.56 MHz
Number of channels: *	N/A
Type of modulation: *	ISO 14443A/B, ISO15693, ISO18092, NFCIP-2
Data rate: *	106-848 kbps
Antenna type: *	PCB antenna
Antenna connector: *	PCB connector

Bluetooth® low energy radio mode			
Fulfil radio specification: *1	Bluetooth® low energy (BLE) 5.3		
Radio module: *1	muRata LBEE5PL2DL		
Antenna type: *2	Dipole antenna		
Antenna name: *2	TAOGLAS FXP831.07.0100C		
Antenna gain: *2	Peak: 3.28 dBi		
Antenna connector: *2	U.FL		
Supply voltage radio module: *1	U _{nom} = 3.3 V _{DC}	U _{min} = 3.14 V _{DC}	U _{max} = 3.46 V _{DC}
Type of modulation: *1	BLE (1 Mbps PHY)	GFSK	
	BLE (2 Mbps PHY)	GFSK	
	BLE (500 kbps coded PHY)	GFSK	
	BLE (125 kbps coded PHY)	GFSK	
Operating frequency range: *1	BLE (1 Mbps PHY)	2402 – 2480 MHz	
	BLE (2 Mbps PHY)	2402 – 2480 MHz	
	BLE (500 kbps coded PHY)	2402 – 2480 MHz	
	BLE (125 kbps coded PHY)	2402 – 2480 MHz	
Number of channels: *1	BLE (1 Mbps PHY)	40 (2 MHz channel spacing)	
	BLE (2 Mbps PHY)	40 (2 MHz channel spacing)	
	BLE (500 kbps coded PHY)	40 (2 MHz channel spacing)	
	BLE (125 kbps coded PHY)	40 (2 MHz channel spacing)	

*1 based on the data sheet "Type 2DL Wi-Fi® + Bluetooth® Module"

*2 based on the antenna data sheet "SPE-11-8-026-K" by TAOGLAS provided by the applicant

Bluetooth® low energy frequencies			
Channel 00	2402 MHz	Channel 01	2404 MHz
Channel 02	2406 MHz	Channel 03	2408 MHz
...	...	...	...
...	...	...	...
Channel 18	2438 MHz	Channel 19	2440 MHz
...	...	...	...
...	...	...	...
Channel 36	2474 MHz	Channel 37	2476 MHz
Channel 38	2478 MHz	Channel 39	2480 MHz

IEEE 802.11 radio mode				
Fulfils radio specification: *1	IEEE 802.11 b IEEE 802.11 g IEEE 802.11 n (20 MHz) IEEE 802.11 n (40 MHz) IEEE 802.11 ax (20 MHz) IEEE 802.11 ax (40 MHz)			
Radio chip: *1	muRata LBEE5PL2DL			
Antenna type: *1	Dipole antenna			
Antenna name: *1	TAOGLAS FXP831.07.0100C			
Antenna gain: *2	Peak: 3.28 dBi			
Antenna connector: *1	-			
Supply voltage WLAN module: *1	U _{nom} =	3.3 V _{DC}	U _{min} =	3.14 V _{DC} U _{max} = 3.46 V _{DC}
Type of modulation: *1	IEEE 802.11b	DSSS (1 Mbps DSSS (2 Mbps DSSS (5.5/11 Mbps	BPSK) DQPSK) CCK)	
	IEEE 802.11g	OFDM (6/9 Mbps OFDM (12 / 18 Mbps OFDM (24/36 Mbps OFDM (48/54 Mbps	BPSK) QPSK) 16-QAM) 64-QAM)	
	IEEE 802.11n 20 MHz (Spatial Stream: 1)	MCS0 MCS1/2 MCS3/4 MCS5/6/7	OFDM (7 Mbps OFDM (14 – 22 Mbps OFDM (28 – 43 Mbps OFDM (58 - 72 Mbps	BPSK) QPSK) 16-QAM) 64-QAM)
	IEEE 802.11n 40 MHz (Spatial Stream: 2)	MCS0 MCS1/2 MCS3/4 MCS5/6/7	OFDM (15 Mbps OFDM (30 / 45 Mbps OFDM (60 – 90 Mbps OFDM (120 - 150Mbps	BPSK) QPSK) 16-QAM) 64-QAM)
	IEEE 802.11 ax20 (Spatial Stream: 1)	MCS0 MCS1/2 MCS3/4 MCS5/6/7 MCS8/9 MCS10/11	OFDM (up to 8.6 Mbps OFDM (up to 25.8 Mbps OFDM (up to 51.6 Mbps OFDM (up to 77.4 Mbps OFDM (up to 103.2 Mbps OFDM (up to 143.4 Mbps	BPSK) QPSK) 16-QAM) 64-QAM) 256-QAM) 1024-QAM)
	IEEE 802.11 ax20 (Spatial Stream: 2)	MCS0 MCS1/2 MCS3/4 MCS5/6/7 MCS8/9 MCS10/11	OFDM (up to 17.2 Mbps OFDM (up to 51.6 Mbps OFDM (up to 103.2 Mbps OFDM (up to 154.9 Mbps OFDM (up to 206.5 Mbps OFDM (up to 286.8 Mbps	BPSK) QPSK) 16-QAM) 64-QAM) 256-QAM) 1024-QAM)
	IEEE 802.11 ax40 (Spatial Stream: 1)	MCS0 MCS1/2 MCS3/4 MCS5/6/7 MCS8/9 MCS10/11	OFDM (up to 17.2 Mbps OFDM (up to 51.6 Mbps OFDM (up to 103.2 Mbps OFDM (up to 172.1 Mbps OFDM (up to 229.4 Mbps OFDM (up to 286.8 Mbps	BPSK) QPSK) 16-QAM) 64-QAM) 256-QAM) 1024-QAM)

IEEE 802.11 radio mode (cont.)			
Type of modulation: *1	IEEE 802.11 ax40 (Spatial Stream: 2)	MCS0 MCS1/2 MCS3/4 MCS5/6/7 MCS8/9 MCS10/11	OFDM (up to 34.4 Mbps BPSK) OFDM (up to 103.2 Mbps QPSK) OFDM (up to 206.5 Mbps 16-QAM) OFDM (up to 344.1 Mbps 64-QAM) OFDM (up to 458.8 Mbps 256-QAM) OFDM (up to 573.5 Mbps 1024-QAM)
Operating frequency range: *1	IEEE 802.11b		2412 – 2462 MHz
	IEEE 802.11g		2412 – 2462 MHz
	IEEE 802.11n 20 MHz		2412 – 2462 MHz
	IEEE 802.11n 40 MHz		2422 – 2452 MHz
	IEEE 802.11ax 20 MHz		2412 – 2462 MHz
	IEEE 802.11ax 40 MHz		2422 – 2452 MHz
Number of channels: *1	IEEE 802.11b		11 (5 MHz channel spacing)
	IEEE 802.11g		11 (5 MHz channel spacing)
	IEEE 802.11n 20 MHz		11 (5 MHz channel spacing)
	IEEE 802.11n 40 MHz		9 (5 MHz channel spacing)
	IEEE 802.11ax 20 MHz		11 (5 MHz channel spacing)
	IEEE 802.11ax 40 MHz		9 (5 MHz channel spacing)

1.5.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
AC adapter *1	UE36LCP1-240150SPA
Test notebook *2	Fujitsu Lifebook U759

*2 Provided by the laboratory

*1 Provided by the applicant

1.6 Additional Information

EUT is installed fixed in a welding unit.

2 Evaluation Methods

2.1 RF exposure test exemptions for single sources

2.1.1 General Exemption CFR 47 §1.1307(b)(3)(i)(A)

The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

2.1.2 SAR Based Exemption CFR 47 §1.1307(b)(3)(i)(B)

The available maximum time-averaged power of effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz inclusive.

For the following separation distances [d] and frequency ranges P_{th} is given by the following formulas

	0.5 cm ≤ d ≤ 20cm	20 cm < d ≤ 40 cm
0.3 GHz ≤ f < 1.5 GHz	$P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 2040f$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm} \sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 2040f$
1.5 GHz ≤ f ≤ 6 GHz	$P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 3060$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm} \sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 3060$

Relaxation for extremities according to 2.1.1 [3]

Finally, when 10-g extremity SAR applies, SAR test exemption may be considered by applying a factor of 2.5 to the SAR-based exemption thresholds.

2.1.3 MPE Based Exemption CFR 47 §1.1307(b)(3)(i)(C)

By using Table 1 and the minimum separation distance (d in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, d must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

RF Source frequency [MHz]	Threshold ERP [W]
0.3 - 1.34	$1920 d^2$
1.34 - 30	$3450 d^2/f^2$
30 - 300	$3.83 d^2$
300 - 1500	$0.0128 d^2/f$
1500 - 100000	$19.2 d^2$

d : Minimal separation distance from antenna to the user

2.1.4 Stand-alone MPE evaluation limits

The human exposure to RF emissions from such devices could be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and / or power density. The limits for General Population / Uncontrolled Exposure are given in the following table from CFR 47 §1.1310(e)1:

Frequency range [MHz]	Electric field strength (E) [V/m]	Magnetic field strength (H) [A/m]	Power density (S) [mW/cm ²]	Averaging time [min]
(i)Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	*(100)	≤6
3.0 – 30	1842/f	4.89/f	*(900/f ²)	<6
30 – 300	61.4	0.163	1.0	<6
300 – 1,500			f/300	<6
1,500 – 100,000			5	<6
(ii)Limits for General Population / Uncontrolled Exposure				
0.3 – 1.34	614	1.63	*(100)	< 30
1.34 – 30	824/f	2.19/f	*(180/f ²)	< 30
30 – 300	27.5	0.073	0.2	< 30
300 – 1500			f/1500	< 30
1500 – 100,000			1.0	< 30

Note: f = frequency in MHz; * Plane – wave equivalent power density

The power density is calculated as follows:

$$S = \frac{P \cdot G \cdot D}{4 \cdot \pi \cdot d^2}$$

Where:

P: conducted power

G: Antenna gain (linear)

D: Duty Cycle

d: Minimal separation distance from antenna to the user

2.2 RF exposure test exemptions for simultaneous transmission sources

2.2.1 1 mW Test Exemption for simultaneous transmission sources

As discussed in CFR 47 §1.1307(b)(3)(ii)(A) [1] the 1 mW exemption intended for single transmitters may be also applied to simultaneous transmission conditions, within the same host device, according one of the following criteria:

- a. When the maximum available power each individual transmitting antenna with the same time averaging period is ≤ 1 mW, and the nearest parts of the antenna structures of the simultaneously operating transmitters are separated by at least 2 cm
- b. When the aggregate maximum available power of all transmitting antennas is ≤ 1 mW in the same time-averaging period

This exemption may not be combined with any other exemption.

2.2.2 Simultaneous transmission SAR based and MPE based test exemptions

As described in detail in CFR 47 §1.1307(b)(3)(ii)(B) that covers the situations where both SAR-based and MPE-based exemption may be considered for test exemption in fixed, mobile, or portable device exposure conditions. For these cases, a device with multiple RF sources transmitting simultaneously will be considered an RF exempt device if the condition of the following formula is satisfied.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

For these test exemptions to apply, the maximum output power, duty factor, and other applicable parameters used in the standalone ERP determination tests, must be the same, or corresponding to a more conservative choice, than those required for simultaneous transmission.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0 , according to calculated/estimated, numerically modelled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

2.2.3 Test exemption based on the SAR to Peak Location Separation Ratio

When the ERP-based condition in the previous section does not apply, a test exemption may be still applicable based on the SAR to peak location separation ratio (SPLSR) procedure.

In this case, the simultaneously transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SPLSR that qualifies for the additional test exemption.

This ratio is defined as:

$$SPLSR = (SAR_1 + SAR_2)^{\frac{1.5}{R_i}}$$

Where: SAR_1 and SAR_2 = highest reported SAR or estimated SAR values for the two sources in the pair i , and R_i is their distance in mm.

When $SPLSR \leq 0.0.4$ (rounded to two decimal digits), for all antenna pairs in the configuration, then the device qualifies for 1 g SAR test exemption.

When 10 g SAR applies (e.g. for extremities) the corresponding test exemption condition is $SPLSR \leq 0.10$.

If any antenna pair does not qualify for simultaneous transmission SAR test exemption, then the device must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Pub. 865664 D01.

3 Results of evaluation

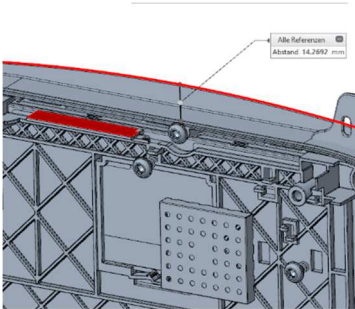
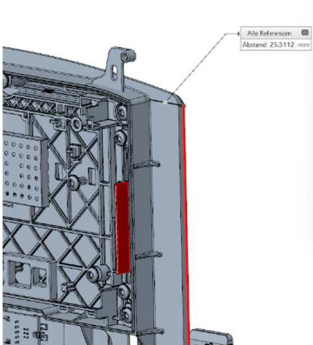
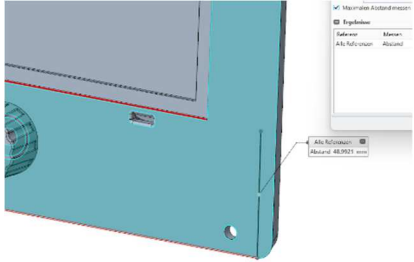
3.1 Used evaluation methods

RF Exposure test exemptions for single sources			
Used	Method	See sub-clause	Comment
☐	General Exemption acc. CFR 47 §1.1307(b)(3)(i)(A)	2.1.1	
☒	SAR Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(B)	2.1.2	-
☐	MPE Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(C)	-	-
☐	MPE Calculation	2.1.4	-

RF Exposure test exemptions for simultaneous transmission sources			
Used	Method	See sub-clause	Comment
☐	Not applicable		No simultaneous possible
☐	1 mW test Exemption acc. 2.2.1 [3]	2.2.1	-
☒	SAR Based Exemption acc. 2.2.2 [3]	2.2.2	
☐	MPE Based Exemption acc. 2.2.2 [3]	2.2.2	
☐	SAR to Peak location separation ratio acc. 2.2.3 [3]	2.2.3	

3.2 Evaluation Distance

According to the CFR47 §2.1091 the device as declared by the applicant is a mobile device which is used at least with the following separation distances between the device and the users.

Antenna		Min separation distance as declared by the applicant
Antenna 0 (BT LE)		14 mm
Antenna 1 (WLAN)		25 mm
Antenna 2 (NFC / RFID)		49 mm
WLAN	BT	NFC
		

3.3 RFID Emissions (Antenna 2)

The following information is based on Test-Report *F241004E8* by PHOENIX TESTLAB GmbH.

General exemption CFR 47 §1.1307(b)(3)(i)(A)

The radiated field strength of the transmitter was measured at a distance of 3 m. The measured field strength at 3 m (= Reading @ 3 m distance + Antenna factor) was 60.4 dBμV/m. This value is converted into an EIRP power value using ANSI C63-10 clause 9.5:

$$EIRP = E_{Meas} + 20 \log(d_{Meas}) - 104.7$$

Where

EIRP is the equivalent isotropically radiated power
 E_{Meas} is the field strength of the emission at the measurement distance, in dBμV/m
 d_{Meas} is the measurement distance, in m

$$EIRP = 60.4 \text{ dB}\mu\text{V/m} + 20 \log(3\text{m}) - 104.7 = -34.8 \text{ dBm}$$

This value is converted into an ERP power with formula according to ANSI C63-10 clause G.5:

$$ERP = EIRP - 2.15 = -36.9 \text{ dBm}$$

The ERP power of the transmitter is -36.9 dBm or 0.20 μW. This is below the 1 mW limit.

3.4 BT LE 2.4 GHz Emissions

Antenna 0 SAR Based Exemption CFR 47 §1.1307(b)(3)(i)(B)

Time averaged results were taken from test report *F241004E16* by PHOENIX TESTLAB GmbH.
1.5 dB tune up range as declared by the applicant was considered.

P _{con} [dBm] incl. Tuneup	P _{con} [mW] incl. Tuneup	Ant. Gain [dBi]	Cable Attenuation [dB]	P _{e.i.r.p} [dBm]	P _{e.i.r.p} [mW]	P _{e.r.p} [dBm]	P _{e.r.p} [mW]
4.9	3.09	3.28	0	8.18	6.58	6.03	4.01
Frequency [GHz]	d [cm]	ERP _{20cm}	x	factor limp worn	P _{th} [mW]	P _{e.r.p.} [mW]	Result
2.44	1.4	3060	1.901	2.5	48.74	4.01	exempted
for $0.5 \text{ cm} \leq d \leq 20 \text{ cm}$ and $1.5 \text{ GHz} \leq f \leq 6 \text{ GHz}$							

3.5 WLAN 2.4 GHz WLAN Emissions

Antenna 1 SAR Based Exemption CFR 47 §1.1307(b)(3)(i)(B)

Time averaged results were taken from test report *F241004E17* by PHOENIX TESTLAB GmbH.
1.5 dB tune up range as declared by the applicant was considered.

P _{con} [dBm] incl. Tuneup	P _{con} [mW] incl. Tuneup	Ant. Gain [dBi]	Cable Attenuation [dB]	P _{e.i.r.p} [dBm]	P _{e.i.r.p} [mW]	P _{e.r.p} [dBm]	P _{e.r.p} [mW]
14.50	28.18	3.28	0	17.78	59.98	15.63	36.57
Frequency [GHz]	d [cm]	ERP _{20cm}	x	factor limp worn	P _{th} [mW]	P _{e.r.p.} [mW]	Result
2.412	2.5	3060	1.899	2.5	147.54	36.57	exempted
for $0.5 \text{ cm} \leq d \leq 20 \text{ cm}$ and $1.5 \text{ GHz} \leq f \leq 6 \text{ GHz}$							

3.6 Estimated SAR

Calculation of the estimated SAR values according to KDB 447498 D01 General RF Exposure Guidance v06
4.3.2. b) 1)

	Frequency [GHz]	Max Power incl Tune up [mW]	min. separation distance [mm]	Estimated 10g SAR [W/kg]
BT LE 2.4 GHz	2.440	4.01	14 (<50)	0.00238542412
WLAN 2.4 GHz	2.412	36.57	25 (<50)	0.1211636454
RFID 13.56 MHz	0.014	0.0002	49 (<50)	0.0000000253

Calculation was done as following:

$$\frac{[(\text{max. power of channel, including tube - up tolerance, mW})]}{\text{min. test separation distance, mm}} \sqrt{\frac{f(\text{GHz})}{x}} \frac{W}{kg} \text{ for test separation distances } \leq 50 \text{ mm}$$

where $x = 7.5$ for 1 - g SAR and 18.75 for 10 - g SAR

1.0 W/kg for 10-g SAR respectively 0.4 W/kg for 1-g SAR for separation distance > 50 mm.

Sum of estimated 10g SAR limit worn according to 2.2.2

$$\sum_{SAR}^{all \text{ TX}} \left(\frac{\text{estimated SAR1}}{4 \text{ W/kg}} + \frac{\text{estimated SAR2}}{4 \text{ W/kg}} + \frac{\text{estimated SAR3}}{4 \text{ W/kg}} + \dots \right) \leq 1$$

$$\sum_1^3 \left(\frac{0.00238542412 \text{ W/kg}}{4 \text{ W/kg}} + \frac{0.1211636454 \text{ W/kg}}{4 \text{ W/kg}} + \frac{0.0000000253 \text{ W/kg}}{4 \text{ W/kg}} \right) = 0.030887 \ll 1$$

4 Conclusion

The "Einschub TPS/i Touch G3" complies in all operational modes to the limits given in CFR 47 §1.1310(e)1 in a separation distance of 14 mm for antenna 0, 25mm for antenna 1 and 49 mm for antenna 2.

5 Report History

Report Number	Date	Comment
F241004E12	10.10.2025	Initial Test Report
-	-	-
-	-	-

---- end of test report ----