RF Exposure Assessment Report

EUT Information	
Manufacturer	PFREUNDT
Model Name	WK60
FCC ID	contains RI7HE910GL and PV7-WIBEAR11N-DF2
IC Number	contains 5131A-HE910GL and 7738A-WB11NDF2
EUT Type	weighting electronics system for application in vehicle control
Intended Use of EUT	☐ < 20 cm distance to human body ☒ > 20 cm distance to human body
EUT Category	☐ portable ☐ mixed mobile/portable ☐ mobile ☒ fixed installation

Prepared by	
Testing Laboratory	IMST GmbH, Test Center Carl-Friedrich-Gauß-Str. 2 – 4 47475 Kamp-Lintfort Germany
Laboratory Accreditation	The Test Center facility 'Dosimetric Test Lab' within IMST GmbH is accredited by the German National 'Deutsche Akkreditierungsstelle GmbH (DAkkS)' for testing according to the scope as listed in the accreditation certificate: D-PL-12139-01-00. The German Bundesnetzagentur (BNetzA) recognizes IMST GmbH as CAB-EMC on the basis of the Council Decision of 22. June 1998 concerning the conclusion of the MRA between the European Community and the United States of America (1999/178/EC) in accordance with § 4 of the Recognition Ordinance of 11. January 2016. The recognition is valid until 20. July 2021 under the registration number: BNetzA-CAB-16/21-14.

Prepared for	
Applicant	PFREUNDT GmbH Robert Bosch Str. 5 46354 Südlohn Germany

Test Specification	
Standard Applied	FCC: 47CFR §1.1310, 47CFR §2.1091 ISED: RSS-102:2015, Issue 5
Exposure Category	☒ general public / uncontrolled exposure ☐ occupational / controlled exposure
Test Result	☒ PASS ☐ FAIL

Report Information	
Data Stored	PFREUNDT_60320_6181030_WK60
Issue Date	September 14, 2018
Revision Date	-
Revision Number	- **A new revision replaces all previous revisions and thus, become invalid herewith.**
Remarks	This report relates only to the item(s) evaluated. This report shall not be reproduced, except in its entirety, without the prior written approval of IMST GmbH. The results and statements contained in this report reflect the evaluation for the certain model described above. The manufacturer is responsible for ensuring that all production devices meet the intent of the requirements described in this report.

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1 Subject of Investigation

The WK60 from PFREUNDT is a weighting electronics system for application in vehicle control with two integrated transmitters and three external antennas. The device supports GSM, WCDMA, Bluetooth and 2.4 GHz WLAN standards for data communication.

1.1 Technical Data of EUT

Product Specifications			
Model Name	PFREUNDT WK60		
Integrated Transmitter	Telit UE910-GL		u-blox ELLA W163-A
Operating Band	GSM 850/1900 (GPRS Class 10); WCDMA B5/2;		Bluetooth and WLAN 2.4 GHz
Antenna Type	1x Delock 12049 (external)		2x Linx ANT-2.4-CW-RCT-CC (external)
Maximum Output Power (Tune-Up Limit)	GSM 850: 33.0 dBm; WCDMA B5: 24.0 dBm	GSM 1900: 30.0 dBm; WCDMA B2: 24.0 dBm	Bluetooth: 10 dBm // WLAN: 19 dBm
Maximum Antenna Gain	1.37 dBi	3.0 dBi	2.2 dBi

Table 1: Product specifications.

1.2 Pictures of EUT

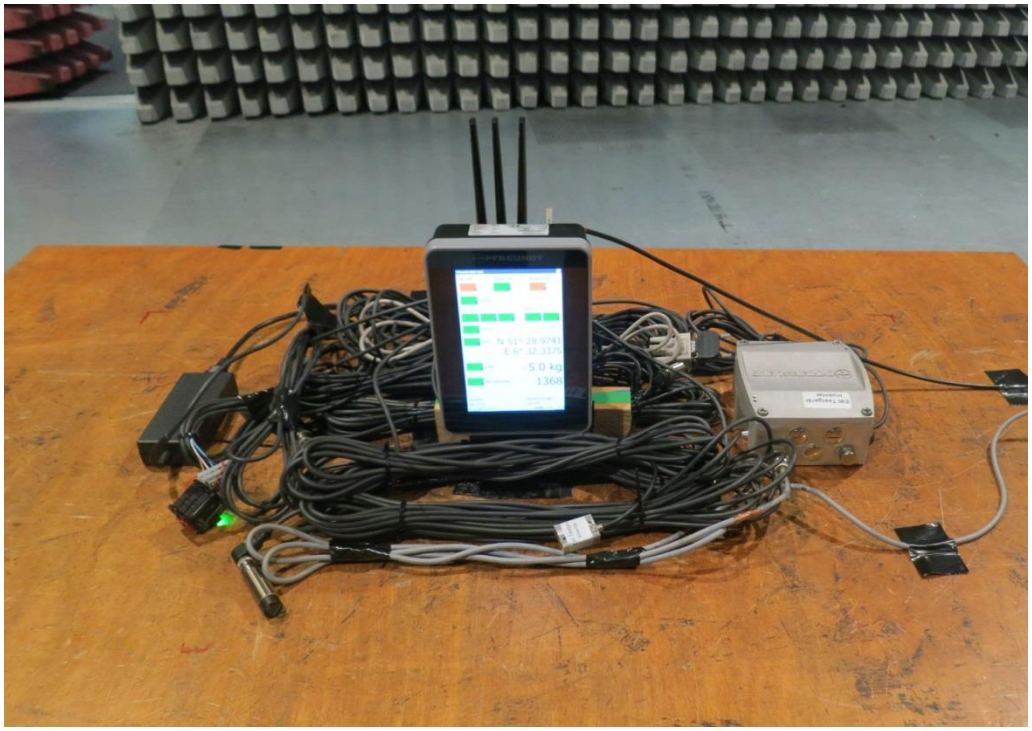

Fig. 1: Picture of the EUT.

1.3 Test Specification / Normative References

The assessment documented in this report has been performed according to the standards and rules described below.

Test Specifications		
Test Standard / Rule	**Description**	**Issue Date**
☒ FCC CFR 47 § 2.1091	Code of Federal Regulations; Title 47. Radiofrequency radiation exposure evaluation: **Mobile Devices.**	October 01, 2010
☒ FCC CFR 47 § 1.1310	Code of Federal Regulations; Title 47. Limits for Maximum Permissible Exposure (MPE)	October 01, 2010
☒ RSS-102, Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)	March, 2015

2 RF Exposure Assessment

2.1 Assessment Procedure

For purposes of analyzing mobile transmitting devices, the time-averaging provisions of the MPE guidelines identified in 47 CFR §1.1310 can be used in conjunction with typical maximum duty factors to determine maximum likely exposure levels. According to 47CFR §2.1091, the WK60 from PFREUNDT has been defined as a fixed device, used in such a way that a separation distance of at least 20 cm is normally maintained between the device and the user. The human exposure to RF emissions from such devices could be evaluated based on the exposure limits adopted by the FCC and ISED shown in Table 4 and Table 6.

2.2 Device Categories

Three different categories of devices are defined and shown in table 2.

Fixed Transmitter
Fixed transmitter is defined as a device physically secured at one location and is not able to be easily moved to another location. *Intended use: ≥ 20 cm separation distance to human body*
Mobile Device
A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. *Intended use: ≥ 20 cm separation distance to human body*
Portable Device
A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. *Intended use: < 20 cm separation distance to human body*

Table 2: Device categories.

2.3 RF Exposure Categories

General Population / Uncontrolled Exposure
General population comprises individuals of all ages and of varying health status, and may include particularly susceptible groups or individuals. In many cases, members of the public are unaware of their exposure to electromagnetic fields. Moreover, individual members of the public cannot reasonably be expected to take precautions to minimize or avoid exposure.
Occupational / Controlled Exposure
The occupationally exposed population consists of adults who are generally exposed under known conditions and are trained to be aware of potential risk and to take appropriate precautions.

Table 3: RF exposure categories.

2.1 RF Exposure Limits adopted by FCC

The following limits are in accordance with 47CFR §1.1310, 47CFR §2.1091.

General Public / Uncontrolled Exposure				
Frequency Range [MHz]	**Electric Field Strength (E) [V/m]**	**Magnetic Field Strength (H) [A/m]**	**Power Density (S) [mW/cm²]**	**Averaging Time $\|E\|^2$,$\|H\|^2$ or S [min]**
0.3 – 3.0	614	1.63	(100)*	30
3.0 – 30	824/f	2.19/f	(180/f)*	30
30 – 300	27.5	0.073	0.2	30
300 – 1,500			f/1500	30
1,500 – 100,000			1.0	

Table 4: Limits for General Population / Uncontrolled Exposure.

Occupational / Controlled Exposure				
Frequency Range [MHz]	**Electric Field Strength (E) [V/m]**	**Magnetic Field Strength (H) [A/m]**	**Power Density (S) [mW/cm²]**	**Averaging Time $\|E\|^2$,$\|H\|^2$ or S [min]**
0.3 – 3.0	614	1.63	(100)*	6
3.0 – 30	1842/f	4.89/f	(900/f)*	6
30 – 300	61.4	0.163	1.0	6
300 – 1,500			f/300	
1,500 – 100,000			5	
Note/s: f = frequency in MHz; * Plane – wave equivalent power density				

Table 5: Limits for Occupational / Controlled Exposure.

2.2 RF Exposure Limits adopted by ISED

The following limits are in accordance with RSS-102:2015, Issue 5.

General Public / Uncontrolled Exposure				
Frequency Range [MHz]	**Electric Field Strength (E) [V/m]**	**Magnetic Field Strength (H) [A/m]**	**Power Density (S) [W/m²]**	**Averaging Time |E|²,|H|² or S [min]**
0.003 - 10	83	90	-	instantaneous*
0.1 - 10	-	0.73/ f	-	6**
1.1 - 10	87/ $f^{0.5}$	-	-	6**
10 - 20	27.46	0.0728	2	6
20-48	58.07/ $f^{0.25}$	0.1540/ $f^{0.25}$	8.944/ $f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	0.02619 $f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10^{-4} $f^{0.5}$	6.67 x 10^{-5} f	616000/$f^{1.2}$
Note/s: * Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

Table 6: Limits for General Population / Uncontrolled Exposure.

Occupational / Controlled Exposure				
Frequency Range [MHz]	**Electric Field Strength (E) [V/m]**	**Magnetic Field Strength (H) [A/m]**	**Power Density (S) [W/m²]**	**Averaging Time |E|²,|H|² or S [min]**
0.003 - 10	170	180	-	instantaneous*
0.1 - 10	-	1.6/ f	-	6**
1.1 - 10	193/ $f^{0.5}$	-	-	6**
10 - 20	61.4	0.163	10	6
20-48	129.8/ $f^{0.25}$	0.3444/ $f^{0.25}$	44.72/ $f^{0.5}$	6
48-300	49.33	0.1309	6.455	6
300-6000	15.60 $f^{0.25}$	0.04138 $f^{0.25}$	0.6455 $f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000/ $f^{1.2}$
150000-300000	0.354 $f^{0.5}$	9.40 x 10^{-4} $f^{0.5}$	3.33 x 10^{-4} f	616000/$f^{1.2}$
Note/s: * Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

Table 7: Limits for General Occupational / Controlled Exposure.

2.3 Assessment Relations

Calculation Formula	
Power Density (S) [mW/cm²]	**Where**
$S = \frac{P \cdot G}{4 \cdot \pi \cdot d^2} = \frac{EIRP}{4 \cdot \pi \cdot d^2}$	S = Power density [mW/cm²] P = maximum RF output power [mW] G = antenna gain [numeric] = $10^{\text{G [dBi]} / 10}$ EIRP = equivalent isotropic radiated power [mW] d = separation distance to the antenna [cm]
Note/s: Power density (s) in units of mW/cm^2 is converted to units of W/m^2 by multiplying by 10. The calculation formula is based on the power density assuming far field conditions. Therefore, the calculation method delivers an overestimation of the radiating near field, the proposed calculation is used as a worst case assumption.	

Table 8: Assessment relations.

2.4 Simultaneous Transmission Considerations

When the assessment has to be accounted for multiple chain devices or for simultaneous transmissions from co-located transmitters the individual transmitters have to be considered separately.

WK60 has one integrated WWAN module with one transmitting external antenna and one integrated BT + WLAN module with two transmitting external antennas. Both modules are able to operate in different modes in parallel. Therefore, a simultaneous transmission scenario has been considered as shown in Table 10 – Table 11 for FCC and Table 13 – Table 14 for ISED.

2.4.1 Simultaneous Transmission in the Frequency Bands with Identical Limit

For simultaneous transmission in the frequency bands with identical limit, the total power density is calculated by summing of the EIRP values of individual transmitter according to the following formula.

$$(EIRP_{Transm.\ 1}) + (EIRP_{Transm.\ 2}) + (EIRP_{Transm.\ n}) = \text{TOTAL EIRP}$$

The TOTAL EIRP is used to calculate the total power density or the compliance separations distance as applicable.

2.4.2 Simultaneous Transmission in the Frequency Bands with Different Limits

For simultaneous transmission in the frequency bands with different limits, the total power density is calculated by summing of the ratios of individual transmitter according to the following formula.

$$(S_{Transm.\ 1}) / (S_{Limit\ Transm.\ 1}) + (S_{Transm.\ 2}) / (S_{Limit\ Transm.\ 2}) + (S_{Transm.\ n}) / (S_{Limit\ Transm.\ n})$$

The sum of the individual ratios has to be less than 1 for demonstrating compliance.

2.5 Assessment Results for FCC

Assessment Results for General Public / Uncontrolled Exposure														
Calculated Power Density for 2G/3G														
Band	**Assessment**		**d**	**Transmission Max. Output Power**		**Max. Duty Cycle**	**Source Based Time Averaged Output Power**		**Antenna Gain**		**Power Density S @ 20 cm**	**Limit of Power Density (S)**	**Margin of Compliance**	**Verdict**
	CH	**f [MHz]**	**[cm]**	**[dBm]**	**[W]**	**[%]**	**[dBm]**	**[W]**	**[dBi]**	**[num]**	**[mW/cm²]**	**[mW/cm²]**	**[%]**	
GPRS 850	128	824.2	**20**	33.0	1.995	25	27.0	0.499	1.37	1.37	0.1360	0.55	**75.24**	Complies
GPRS 1900	512	1850.2	**20**	30.0	1.000	25	24.0	0.250	3.0	2.00	0.0992	1.00	90.08	Complies
WCMDA B2	9262	1852.4	**20**	24.0	0.251	100	24.0	0.251	3.0	2.00	0.0997	1.00	90.03	Complies
WCDMA B5	4132	826.4	**20**	24.0	0.251	100	24.0	0.251	1.37	1.37	0.0685	0.55	87.57	Complies
Note/s: The maximum output power values (tune-up limits) are obtained from the datasheet of the module. The gain of the antenna is declared by its manufacturer.														

Table 9: Assessment results for Telit UE910-GL in combination with one transmitting antenna Delock 12049.

Assessment Results for General Public / Uncontrolled Exposure														
Calculated Power Density for Bluetooth														
Band	**Assessment**		**d**	**Transmission Max. Output Power**		**Max. Duty Cycle**	**Source Based Time Averaged Output Power**		**Antenna Gain**		**Power Density S @ 20 cm**	**Limit of Power Density (S)**	**Margin of Compliance**	**Verdict**
	CH	**f [MHz]**	**[cm]**	**[dBm]**	**[W]**	**[%]**	**[dBm]**	**[W]**	**[dBi]**	**[num]**	**[mW/cm²]**	**[mW/cm²]**	**[%]**	
Bluetooth	0	2402.0	**20**	10.0	0.010	100	10.0	0.010	2.2	1.66	0.0033	1.00	99.67	Complies
Calculated Power Density for WLAN 2.4 GHz														
WLAN 2.4G	1	2412.0	**20**	19.0	0.079	100	19.0	0.079	2.2	1.66	0.0262	1.00	97.38	Complies
Calculated Power Density for Simultaneous Transmission Scenario of BT + WLAN														
										Simultaneous Transmission:	**0.0295**	1.00	**97.05**	Complies
Note/s: The maximum output power values (tune-up limits) are obtained from the datasheet of the module. The gain of the antenna is declared by its manufacturer.														

Table 10: Assessment results for u-blox ELLA W163-A in combination with two transmitting antennas Linx ANT-2.4-CW-RCT-CC.

Assessment Results for General Public / Uncontrolled Exposure							
Calculated Total Power Density of 2G/3G + BT/WLAN Transmitter							
Transmitter 1 *Telit UE910-GL*		**Transmitter 2** *u-blox ELLA W163-A*		**Transmitter 1 + 2**	**Power Ratio Limit**	**Margin of Compliance**	**Verdict**
Max. Power Density S @ 20 cm	**Power Ratio 1 (S/Limit)**	**Max. Power Density S @ 20 cm**	**Power Ratio 2 (S/Limit)**	**Total Power Ratio Σ of (S/Limit)**			
[mW/cm²]		**[mW/cm²]**				**[%]**	
0.1360	0.247	0.0295	0.0295	0.277	1.0	**72.3**	Complies
Note/s: The calculation of the total power ratio is performed in accordance with the formula described in chapter 2.4.2							

Table 11: Assessment results for simultaneous transmission scenario of Telit UE910-GL and u-blox ELLA W163-A in combination with three transmitting antennas of transmitter 1 + 2.

2.6 Assessment Results for ISED

Assessment Results for General Public / Uncontrolled Exposure														
Calculated Power Density for 2G/3G														
Band	**Assessment**		**d**	**Transmission Max. Output Power**		**Max. Duty Cycle**	**Source Based Time Averaged Output Power**		**Antenna Gain**		**Power Density S @ 20 cm**	**Limit of Power Density (S)**	**Margin of Compliance**	**Verdict**
	CH	**f [MHz]**	**[cm]**	**[dBm]**	**[W]**	**[%]**	**[dBm]**	**[W]**	**[dBi]**	**[num]**	**[W/m²]**	**[W/m²]**	**[%]**	
GPRS 850	128	824.2	**20**	33.0	1.995	25	27.0	0.499	1.37	1.37	**1.360**	2.58	**47.19**	Complies
GPRS 1900	512	1850.2	**20**	30.0	1.000	25	24.0	0.250	3.0	2.00	0.992	4.48	77.83	Complies
WCMDA B2	9262	1852.4	**20**	24.0	0.251	100	24.0	0.251	3.0	2.00	0.997	4.48	77.75	Complies
WCDMA B5	4132	826.4	**20**	24.0	0.251	100	24.0	0.251	1.37	1.37	0.685	2.58	73.45	Complies
Note/s: The maximum output power values (tune-up limits) are obtained from the datasheet of the module. The gain of the antenna is declared by its manufacturer.														

Table 12: Assessment results for Telit UE910-GL in combination with one transmitting antenna Delock 12049.

Assessment Results for General Public / Uncontrolled Exposure														
Calculated Power Density for Bluetooth														
Band	**Assessment**		**d**	**Transmission Max. Output Power**		**Max. Duty Cycle**	**Source Based Time Averaged Output Power**		**Antenna Gain**		**Power Density S@20 cm**	**Limit of Power Density (S)**	**Margin of Compliance**	**Verdict**
	CH	**f [MHz]**	**[cm]**	**[dBm]**	**[W]**	**[%]**	**[dBm]**	**[W]**	**[dBi]**	**[num]**	**[W/m²]**	**[W/m²]**	**[%]**	
Bluetooth	0	2402.0	**20**	10.0	0.010	100	10.0	0.010	2.2	1.66	**0.033**	5.35	**99.38**	Complies
Calculated Power Density for WLAN 2.4 GHz														
WLAN 2.4G	1	2412.0	**20**	19.0	0.079	100	19.0	0.079	2.2	1.66	**0.262**	5.37	**95.11**	Complies
Note/s: The maximum output power values (tune-up limits) are obtained from the datasheet of the module. The gain of the antenna is declared by its manufacturer.														

Table 13: Assessment results for u-blox ELLA W163-A in combination with two transmitting antennas Linx ANT-2.4-CW-RCT-CC.

Assessment Results for General Public / Uncontrolled Exposure									
Calculated Total Power Density of 2G/3G + BT/WLAN Transmitter									
Transmitter 1		**Transmitter 2**				**Transmitter 1 + 2**	**Power Ratio Limit**	**Margin of Compliance**	**Verdict**
GPRS 850		*Bluetooth*		*WLAN 2.4 GHz*					
Max. Power Density S @ 20 cm	**Power Ratio 1**	**Max. Power Density S @ 20 cm**	**Power Ratio 2**	**Max. Power Density S @ 20 cm**	**Power Ratio 3**	**Total Power Ratio**			
[W/m²]	**(S/Limit)**	**[W/m²]**	**(S/Limit)**	**[W/m²]**	**(S/Limit)**	**Σ of (S/Limit)**		**[%]**	
1.3604	0.5281	**0.0330**	0.0062	**0.2623**	0.0489	**0.583**	1.0	**41.7**	Complies
Note/s: The calculation of the total power ratio is performed in accordance with the formula described in chapter 2.4.2									

Table 14: Assessment results for simultaneous transmission scenario of Telit UE910-GL and u-blox ELLA W163-A in combination with three transmitting antennas of transmitter 1 + 2.

3 Statement of Compliance

According to the assessment results shown in Table 9 - Table 14, the PFREUNDT WK60 weighting electronics system for application in vehicle control is in compliance with the maximum permissible exposure (MPE) limits for the power density of single and simultaneous transmission given by the FCC and ISED requirements.

Warning statement for keeping at least 20 cm or greater separation distance between the antennas and human body should be included in the product description or user manual.

Prepared by: ..... Reviewed by: .....

Alexander Rahn
Test Engineer

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4 Revision History

Revision History				
Revision	**Description of Revision**	**Date**	**Revised Page**	**Revised By**
/	Initial Release	September 14, 2018	-	-
-		-		

END OF ASSESSMENT REPORT