

RF Exposure Exhibit

EUT Name: Ranger 4.4 Model No.: R44-V11

CFR Part 1.1310

Prepared for:

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1 Test Methodology

In this document, we evaluate the RF Exposure to human body due the intentional transmission from the transmitter (EUT). The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis transmission formula is a far field assumption, the calculated result of that is an overprediction for near field power density. We will take that as the worst case to specify the safety range.

1.1 RF Exposure Limit

According to FCC 1.1310 table 1: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b)

The EUT is rated as operated within uncontrolled conditions. The applied limits are based on the exposure limitations for devices used by the general public within uncontrolled environment.

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (minutes)	
	(A)Limits For (Occupational / Con	trol Exposures		
0.3-1.34	614	1.63	*(100)	6	
1.34-30	1842/f	4.89/f	*(900/f ²)	6	
30-300	61.4	0.163	1.0	6	
30-1500			F/300	6	
1500-100000			1.0	6	
(B)Limits For General Population / Uncontrolled Exposure					
0.3-1.34	614	1.63	*(100)	30	
1.34-30	824/f	2.19/f	*(180/f²)	30	
30-300	27.5	0.073	0.2	30	
30-1500			F(MHz)/1500MHz	30	
1500-100000			1.0	30	

F = Frequency in MHz

*=Plane wave equivalent density

According to RSS-102 Issue 5: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation

RF FIELD STRENGTH LIMITS FOR DEVICES USED BY THE GENERAL PUBLIC (UNCONTROLLED ENVIRONMENT)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	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	$0.158 f^{0.5}$	$4.21 \ge 10^{-4} f^{0.5}$	$6.67 \ge 10^{-5} f$	616000/ f ^{1.2}
Note: <i>f</i> is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

1.3.7 Sample Calculation

Ref. : David K. Cheng, Field and Wave Electromagnetics, Second Edition, Page 640, Eq

The Friss transmission formula: $Pd = (Pout^*G) / (4^*\pi^*R^2)$

Where;

 $Pd = power density in mW/cm^2$

Pout = output power to antenna in mW

G = gain of antenna in linear scale

 $\pi \approx 3.1416$

 \mathbf{R} = distance between observation point and center of the radiator in cm

1.2 EUT Operating Condition

The Ranger 4.4 R44-V11 is a rugged and compact vehicular computer utilizing Bluetooth, Bluetooth LE, WiFi and a cellular. The cellular radio supports LTE technologies

1.3 MPE calculation

1.3.1 Antenna Gain

The declared antennas used are:

- 1. Bluetooth LE 2.4 GHz internal, TUV Test Report 31762446.004 Integral antenna, 1 Chip antenna transceiver, Antenna peak gain: -4 dBi.
- 2. Bluetooth 2.4 GHz internal, TUV Test Report 31762446.004 Integral antenna, 1 Chip antenna transceiver, Antenna peak gain: -4 dBi.
- 3. WiFi 2.4 GHz internal, TUV Test Report 31762446.003 Integral antenna, Flex circuit PCB antenna transceiver, Antenna peak gain: +3 dBi.
- 4. LTE Band 2, 1.910 GHz, TUV Test Report 31762446.002 Integral antenna, Formed metal wideband antenna, maximum rated antenna peak gain: +4.5 dBi.
- LTE Band 4, 1755 GHz, TUV Test Report 31762446.002
 Integral antenna, Formed metal wideband antenna, maximum rated antenna peak gain: +4.5 dBi.
- LTE Band 13, 0.849 GHz, TUV Test Report 31762446.002
 Integral antenna, Formed metal wideband antenna, maximum rated antenna peak gain: +4.5 dBi.

1.3.2 Conducted Output Power

All stated values excluding antenna gain.

- 1. Bluetooth LE 2.480 GHz, TUV Test Report 31762446.004 Rated maximum power: 5 mW (6.99 dBm)
- 2. Bluetooth 2.480 GHz, TUV Test Report 31762446.004 Rated maximum power: 5 mW (6.99 dBm)
- 3. WiFi 2.462 GHz, TUV Test Report 31762446.003 Rated maximum power: 29mW (14.62 dBm)
- 4. LTE Band 2, 1.910 GHz, TUV Test Report 31762446.002 Rated maximum power 200 mW (23.01 dBm)
- LTE Band 4, 1.755 GHz, TUV Test Report 31762446.002 Rated maximum power: 200 mW (23.01 dBm)
- 6. LTE Band 13, TUV Test Report 31762446.002 Rated maximum power: 200 mW (23.01 dBm)

MPE calculation

1.3.3 Output Power into Antenna & RF Exposure value (Non-Beamforming Mode)

01. <u>Bluetooth LE – 2480 MHz:</u>

Calculations for this report are based on highest rated power and its antenna gain identified at 2480 MHz. Result below is Non-Beamforming Mode. Calculation based on maximum rated output power of 6.99 dBm.

FCC:

Highest rated output Power:	6.99	dBm
The Gain of the antenna:	-4.00	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be:	0.005000345	Watts
or:	5.00035	mW
or:	5000.35	μW
or:	6.99	dBm
Frequency range from 10 MHz to 40 GHz: Frequency:	2480	MHz
Power output with DC and antenna Gain (EiRP):		1
Power (dBm):	2.99	•
Power (mW):	1.991	
Power (W):	0.001991	
R = distance in	20	cm
Controlled Exposures Limit -	Б	mM/am^2

Controlled Exposures - Limit =	5	mvv/cm
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.0003960	mW/cm ²
Controlled Margin to Limit =	4.9996	mW/cm ²
Uncontrolled Margin to Limit =	0.9996	mW/cm ²

Highest rated output Power:	6.99	dBm
The Gain of the antenna:	-4.00	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be:	0.005000345	Watts
or	5.00035	mW
or:	5000.35	μW
or:	6.99	dBm
Frequency range from 10 MHz to 40 GHz:		
Frequency:	2480	MHz
Power output with DC and antenna Gain (EiRP):		
Power (dBm):	2.99	
Power (mW):	1.991	
Power (W):	0.001991	
D – distance is	20	l
R = distance in	20	cm
Controlled Exposures to Limit =	32.14564076	W/m ²

Controlled Exposures to Limit =	32.14564076	JW/m²
Uncontrolled Exposures Limit =	5.468947787	W/m ²
Pd =	0.003960	W/m ²
Controlled Margin to Limit =	32.1417	W/m ²
Uncontrolled Margin to Limit =	5.4650	W/m ²

02. <u>Bluetooth – 2480 MHz:</u>

Calculations for this report are based on highest rated power and its antenna gain identified at 2480 MHz. Result below is Non-Beamforming Mode. Calculation based on maximum rated output power of 6.99 dBm.

FCC:

Highest rated output Power:	6.99	dBm
The Gain of the antenna:	-4.00	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be:	0.005000345	Watts
or:	5.00035	mW
or:	5000.35	μW
or:	6.99	dBm
Frequency range from 10 MHz to 40 GHz:	0.400	
Frequency:	2480	MHZ
Power output with DC and antonna Cain (EiPP):		
Power output with DC and antenna Gain (LIRP).	2 00	1
Power (dbff).	2.99	
Power (M/):	0.001001	
	0.001331	l
R = distance in	20	cm
	20	
Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
	0.0000000	NALL 2

Pd =	0.0003960	mW/cm ²
Controlled Margin to Limit =	4.9996	mW/cm ²
Uncontrolled Margin to Limit =	0.9996	mW/cm ²

Highest rated output Power:	6.99	dBm
The Gain of the antenna:	-4.00	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be:	0.005000345	Watts
or:	5.00035	mW
or:	5000.35	μW
or:	6.99	dBm
Frequency range from 10 MHz to 40 GHz: Frequency:	2480	MHz
Power output with DC and antenna Gain (FiRP):		
Power (dBm):	2 99	
Power (mW):	1 991	
Power (W):	0.001991	
	0.001001	1
R = distance in	20	cm
Controlled Exposures to Limit =	32.14564076	W/m ²
Uncontrolled Exposures Limit =	5.468947787	W/m ²
Pd =	0.003960	W/m ²
Controlled Margin to Limit =	32.1417	W/m ²
Uncontrolled Margin to Limit =	5.4650	W/m ²

01. <u>WiFi - 802.11:</u>

Calculations for this report are based on highest rated power and its antenna gain identified at 2480 MHz. Result below is Non-Beamforming Mode. Calculation based on maximum rated output power of 14.62dBm.

FCC:

Highest rated output Power:	14.62	dBm
The Gain of the antenna:	3.00	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be: or: or: or:	0.028973436 28.97344 28973.44 14.62	Watts mW μW dBm
Frequency range from 10 MHz to 40 GHz: Frequency:	2480	MHz
Power output with DC and antenna Gain (EiRP):		
Power (dBm):	17.62	
Power (mW):	57.810	
Power (W):	0.057810	
R = distance in	20	cm
Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.0115009	mW/cm ²
Controlled Margin to Limit =	4.9885	mW/cm ²
Uncontrolled Margin to Limit =	0.9885	mW/cm ²

Highest rated output Power:	14.62	dBm
The Gain of the antenna:	3.00	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
	0.000070.400	
The Power Out would be:	0.028973436	Watts
or:	28.97344	
Or:	28973.44	
Or:	14.62	aBm
Frequency range from 10 MHz to 40 GHz: Frequency:	2480	MHz
Power output with DC and antenna Gain (EiRP):		
Power (dBm):	17.62	
Power (mW):	57.810	
Power (W):	0.057810	
R = distance in	20	cm
Controlled Exposures to Limit =	32.14564076	W/m ²
Uncontrolled Exposures Limit =	5.468947787	W/m ²
Pd =	0.115009	W/m ²
Controlled Margin to Limit =	32.0306	W/m ²
Uncontrolled Margin to Limit =	5.3539	W/m ²

02. <u>LTE Band 2 - 1910 MHz</u>

Calculations for this report are based on highest rated power and its antenna gain. The Limit is based on the assigned upper band edge at 1910 MHz. Result below is Non-Beamforming Mode.

FCC:

Highest rated output Power:	23.01	dBm
The Gain of the antenna:	4.50	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be:	0.199986187	Watts
or:	199.98619	mVV
or:	199986.19	μw
or:	23.01	dBm
Frequency range from 10 MHz to 40 GHz:		
Frequency range from To MHz to 40 GHz.	1010	
r requency.	1910	
Power output with DC and antenna Gain (FiRP).		
Power (dBm):	27.51	
Power (mW):	563.638	
Power (W):	0.563638	
R = distance in	20	cm
Controlled Exposures to Limit =	28.21063944	W/m²
Uncontrolled Exposures Limit =	4.575027423	W/m ²
Pd =	1.121321	W/m ²
Controlled Margin to Limit =	27.0893	W/m ²
Uncontrolled Margin to Limit =	3.4537	W/m ²

MPE calculation

Highest rated output Power:	23.01	dBm
The Gain of the antenna:	4.50	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be: or:	0.199986187 199.98619	Watts mW
01.	199900.19	μνν dBm
01.	23.01	dBIII
Frequency range from 10 MHz to 40 GHz: Frequency: Power output with DC and antenna Gain (EiRP): Power (dBm): Power (mW): Power (W):	<u>1910</u> 27.51 563.638 0.563638	MHz
R = distance in	20	cm
Controlled Exposures to Limit	= 28.2106394	4 W/m ²
Uncontrolled Exposures Limit	= 2.28838714	2_W/m ²
Po	= 1.121321	W/m ²
Controlled Margin to Limit	= 27.0893	W/m ²
Uncontrolled Margin to Limit	= 1.1671	W/m ²

03. LTE Band 4 - 1755 MHz

Calculations for this report are based on highest rated power and its antenna gain. The Limit is based on the assigned upper band edge at 1755 MHz. Result below is Non-Beamforming Mode.

FCC:

Highest rated output Power: The Gain of the antenna: Type of Measurement: Impedance: Measurement Distance: Time weighted Duty Cycle:	23.01 4.50 Conducted 50.00 N/A 100.00	dBm dBi Direct measurement at Antenna Port Ω m %
The Power Out would be: or: or: or:	0.199986187 199.98619 199986.19 23.01	Watts mW μW dBm
Frequency range from 10 MHz to 40 GHz: Frequency:	1755	MHz
Power output with DC and antenna Gain (EiRP): Power (dBm): Power (mW): Power (W):	27.51 563.638 0.563638	
R = distance in	20	cm
Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.1121321	mW/cm ²
Controlled Margin to Limit =	4.8879	mW/cm ²

0.8879

mW/cm²

Uncontrolled Margin to Limit =

Highest rated output Power:	23.01	dBm
The Gain of the antenna:	4.50	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be:	0.199986187	Watts
or:	199.98619	mW
or:	199986.19	μW
or:	23.01	dBm
Frequency range from 10 MHz to 40 GHz: Frequency: Power output with DC and antenna Gain (EiRP): Power (dBm): Power (mW): Power (W):	1755 27.51 563.638 0.563638	MHz
R = distance in	20	cm
Controlled Exposures to Limit =	27.04175084	W/m ²
Uncontrolled Exposures Limit =	4.317918917	W/m ²
Pd =	1.121321	W/m ²
Controlled Margin to Limit =	25.9204	W/m ²
Uncontrolled Margin to Limit =	3.1966	W/m ²

04. LTE Band 13 – 787 MHz

Calculations for this report are based on highest rated power and its antenna gain. The Limit is based on the assigned upper band edge at 787 MHz. Result below is Non-Beamforming Mode.

FCC:

Highest rated output Power:	23.01	dBm
The Gain of the antenna:	4.50	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be:	0.199986187	vvatts
or:	199.98619	mVV
or:	199986.19	μw
or:	23.01	aBm
Frequency range from 10 MHz to 40 GHz		
Frequency:	787	MHz
		I
Power output with DC and antenna Gain (EiRP):		
Power (dBm):	27.51	
Power (mW):	563.638	
Power (W):	0.563638	
R = distance in	20	cm
Controlled Exposures Limit	J 6JJJJJJJJJJ	mW/cm^2
Lincontrolled Exposures - Limit =	0.524666667	mW/cm^2
	0.1121221	mW/am^2
P0 =		

	0.524000007	
Pd =	0.1121321	mW/cm ²
Controlled Margin to Limit =	2.5112	mW/cm ²
Uncontrolled Margin to Limit =	0.4125	mW/cm ²

Highest rated output Power:	23.01	dBm
The Gain of the antenna:	4.50	dBi
Type of Measurement:	Conducted	Direct measurement at Antenna Port
Impedance:	50.00	Ω
Measurement Distance:	N/A	m
Time weighted Duty Cycle:	100.00	%
The Power Out would be:	0.199986187	Watts
or:	199.98619	mW
or:	199986.19	μW
or:	23.01	dBm
Frequency range from 10 MHz to 40 GHz:		
Frequency large form to MHz to 40 GHz.	797	
r requency.	101	
Power output with DC and antenna Gain (EiRP):		
Power (dBm):	27 51	
Power (mW):	563 638	•
Power (W):	0.563638	•
	0.000000	I
R = distance in	20	cm
		•
E E E E E E E E E E E E E E E E E E E		
Controlled Exposures to Limit =	18.10854734	W/m ²

RF Exposure value radios operating simultaneously on all Bands (Non-Beamforming Mode) (Non-Beamforming Mode)

Calculation Based on worst Case combination of simultaneous transmission.

Non-Deamforming Exposure result (PCC)				
Technology	Operating Frequency	Power Density	Limit	Ratio
	(MHz)	(W/m²)	(00/111/)	
BT BLE	2480	0.0003960	1	0.000396
ВТ	2480	0.0003960	1	0.000396
WiFi	2480	0.0115009	1	0.011501
LTE Band 2	1910	0.1121321	1	0.112132
LTE Band 4	1755	0.1121321	1	0.112132
LTE Band 13	787	0.1121321	0.52467	0.213721
		Result	Limit	Sum
Uncontrolled Exposure Limit PASS < 1 0.225618				
Note: Minimum distance from the user must be at 20 cm Values stated in bold stated as simultaneously active and utilized for worst case scenario calculation.				

Non-Beamforming Exposure result (FCC)

Technology	Operating Frequency (MHz)	Power Density (W/m²)	Limit (W/m²)	Ratio
BT BLE	2480	0.003960	5.468949	0.000072
ВТ	2480	0.003960	5.468949	0.000724
WiFi	2480	0.115009	5.468949	0.021029
LTE Band 2	1910	1.121321	4.575027	0.245096
LTE Band 4	1755	1.121321	4.317919	0.259690
LTE Band 13	787	1.121321	2.496000	0.449247
		Result	Limit	Sum
Uncontrolled E	Exposure Limit	PASS	<1	0.498713
Note: Minimum distance from the user must be at 20 cm				

Non-Beamforming Exposure result (ISED)

Note: Minimum distance from the user must be at 20 cm Values stated in bold stated as simultaneously active and utilized for worst case scenario calculation.

As originally tested, the EUT was found to be compliant to the requirements of the test

standard(s). FCC: Minimum distance from the user must be at 20 cm.

ISED: Minimum distance from the user must be at 20 cm.

END OF REPORT