

RF Exposure Exhibit

EUT Name: Flash

Model No.: FLASHV1

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 over-prediction 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 / Control 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/f ²)	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

Sample Calculation

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).

The Friss transmission formula: $P_d = (P_{out} * G) / (4 * \pi * R^2)$

Where;

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

$\pi \approx 3.1416$

R = distance between observation point and center of the radiator in cm

1.2. EUT Operating Condition

The Flash is a smart electric bike consisting of a cellular radio and Bluetooth LE radio. The cellular radio supports WCDMA and LTE technologies

1.3. MPE calculation

1.3.1. Antenna Gain

The antennas used are:

1. Bluetooth 2.4 GHz internal
Integral ceramic antenna, 1 Transceiver, Antenna peak gain: +0 dBi.
2. LTE Band 2, 1.910 GHz, TUV Test Report 31762190.001
Integral antenna, 1 PCB Trace Transceiver, Antenna peak gain: +0 dBi
3. LTE Band 4, 1755 GHz, TUV Test Report 31762190.001
Integral antenna, 1 PCB Trace Transceiver, Antenna peak gain: +0 dBi
4. LTE Band 5, 0.849 GHz, TUV Test Report 31762190.001
Integral antenna, 1 PCB Trace Transceiver, Antenna peak gain: +0 dBi
5. LTE Band 12, 0.716 GHz, TUV Test Report 31762190.001
Integral antenna, 1 PCB Trace Transceiver, Antenna peak gain: +0 dBi
6. WCDMA Band 2, 1.910 GHz, TUV Test Report 31762190.001
Integral antenna, 1 PCB Trace Transceiver, Antenna peak gain: +0 dBi
7. WCDMA Band 5, 1.910 GHz, TUV Test Report 31762190.001
Integral antenna, 1 PCB Trace Transceiver, Antenna peak gain: +0 dBi

1.3.2. Conducted Output Power

All stated values excluding antenna gain.

1. Bluetooth LE 2.480 GHz, TUV Test Report 31762190.003
Rated maximum power: 3 dBm (1.995 mW)
2. LTE Band 2, 1.910 GHz, TUV Test Report 31762190.001
Rated maximum power: 24 dBm (251.2 mW)
3. LTE Band 4, 1.755 GHz, TUV Test Report 31762190.001
Rated maximum power: 24 dBm (251.2 mW)
4. LTE Band 5, 0.849 GHz, TUV Test Report 31762190.001
Rated maximum power: 24 dBm (251.2 mW)
5. LTE Band 12, 0.716 GHz, TUV Test Report 31762190.001
Rated maximum power: 24 dBm (251.2 mW)
6. WCDMA Band 2, 1.910 GHz, TUV Test Report 31762190.001
Rated maximum power: 24 dBm (251.2 mW)
7. WCDMA Band 5, 1.910 GHz, TUV Test Report 31762190.001
Rated maximum power: 24 dBm (251.2 mW)

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

01. Bluetooth LE - 2480:

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

FCC:

Enter the following highlighted variables:

Highest rated output Power:	3.00	dBm
The Gain of the antenna:	0.00	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: 0.001995262 Watts
or: 1.99526 mW
or: 1995.26 μ W
or: 3.00 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 2480 MHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	3.00
Power (mW):	1.995
Power (W):	0.001995

R = distance in 20 cm

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.0003969	mW/cm ²
Controlled Margin to Limit =	4.9996	mW/cm ²
Uncontrolled Margin to Limit =	0.9996	mW/cm ²

02. LTE Band 2 - 1910 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 1910 MHz. Result below is Non-Beamforming Mode.

FCC:

Highest rated output Power:	24.00	dBm
The Gain of the antenna:	0.00	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: 0.251188643 Watts
or: 251.18864 mW
or: 251188.64 μ W
or: 24.00 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 1910 MHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	24.00
Power (mW):	251.189
Power (W):	0.251189

R = distance in 20 cm

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.0499724	mW/cm ²
Controlled Margin to Limit =	4.9500	mW/cm ²
Uncontrolled Margin to Limit =	0.9500	mW/cm 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:	24.00	dBm
The Gain of the antenna:	0.00	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: 0.251188643 Watts
or: 251.18864 mW
or: 251188.64 μ W
or: 24.00 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 1755 MHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	24.00
Power (mW):	251.189
Power (W):	0.251189

R = distance in 20 cm

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.0499724	mW/cm ²
Controlled Margin to Limit =	4.9500	mW/cm ²
Uncontrolled Margin to Limit =	0.9500	mW/cm ²

04. LTE Band 5 – 846.6 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 846.6 MHz. Result below is Non-Beamforming Mode.

FCC:

Highest rated output Power:	24.00	dBm
The Gain of the antenna:	0.00	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: 0.251188643 Watts
or: 251.18864 mW
or: 251188.64 μ W
or: 24.00 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 846.6 MHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	24.00
Power (mW):	251.189
Power (W):	0.251189

R = distance in 20 cm

Controlled Exposures - Limit =	2.822	mW/cm ²
Uncontrolled Exposures - Limit =	0.5644	mW/cm ²
Pd =	0.0499724	mW/cm ²
Controlled Margin to Limit =	2.7720	mW/cm ²
Uncontrolled Margin to Limit =	0.5144	mW/cm ²

05. LTE Band 12 – 715.3 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 715.3 MHz. Result below is Non-Beamforming Mode.

FCC:

Highest rated output Power:	24.00	dBm
The Gain of the antenna:	0.00	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: 0.251188643 Watts
or: 251.18864 mW
or: 251188.64 μ W
or: 24.00 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 715.3 MHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	24.00
Power (mW):	251.189
Power (W):	0.251189

R = distance in 20 cm

Controlled Exposures - Limit =	2.384333333	mW/cm ²
Uncontrolled Exposures - Limit =	0.476866667	mW/cm ²
Pd =	0.0499724	mW/cm ²
Controlled Margin to Limit =	2.3344	mW/cm ²
Uncontrolled Margin to Limit =	0.4269	mW/cm ²

06. WCDMA Band 2 - 1907.6 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 1907.6 MHz. Result below is Non-Beamforming Mode.

FCC:

Highest rated output Power:	24.00	dBm
The Gain of the antenna:	0.00	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: 0.251188643 Watts
or: 251.18864 mW
or: 251188.64 μ W
or: 24.00 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 1907.5 MHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	24.00
Power (mW):	251.189
Power (W):	0.251189

R = distance in 20 cm

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.0499724	mW/cm ²
Controlled Margin to Limit =	4.9500	mW/cm ²
Uncontrolled Margin to Limit =	0.9500	mW/cm ²

07. WCDMA Band 5 - 846.6MHz

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:	24.00	dBm
The Gain of the antenna:	0.00	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: 0.251188643 Watts
or: 251.18864 mW
or: 251188.64 μ W
or: 24.00 dBm

Frequency range from 10 MHz to 40 GHz:

Frequency: 846.4 GHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	24.00
Power (mW):	251.189
Power (W):	0.251189

R = distance in 20 cm

Controlled Exposures - Limit =	5	mW/cm ²
Uncontrolled Exposures - Limit =	1	mW/cm ²
Pd =	0.0499724	mW/cm ²
Controlled Margin to Limit =	4.9500	mW/cm ²
Uncontrolled Margin to Limit =	0.9500	mW/cm ²

RF Exposure value when 2 radios operating simultaneously on all Bands (Non-Beamforming Mode)

Calculation Based on worst Case combination of simultaneous transmission.

Non-Beamforming Exposure result (FCC)

Technology	Operating	Power Density	
BT	2480	0.0003969	
LTE Band 2	1910	0.0499724	
LTE Band 4	1755	0.0499724	
LTE Band 5	847	0.0499724	
LTE Band 12	715	0.0499724	
WCDMA II	1908	0.0499724	
WCDMA V	846	0.0499724	
		0.0503693	Total Power Density (mW/cm²)
		0.4768667	Uncontrolled Exposure Limit (mW/cm²)*
		0.4264974	Margin (mW/cm²)
Note: Minimum distance from the user must be at 20 cm *Based on strictest limit at LTE Band 12 – 715.3MHz			

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.