Exposure Calculation Report

MiX Telematics International (Pty) Ltd.
Models: MiX 46MC-4G-B

In accordance with EN 50665 and FCC CFR 47 Part 2.1091

Prepared for: MiX Telematics International (Pty) Ltd
Blaauwklip Office Park 2
Cnr Strand & Webersvallei Roads
Stellenbosch
7600
South Africa

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Jon Kenny	Senior Engineer	Authorised Signatory	21 April 2021

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EXECUTIVE SUMMARY
The calculation of exposure for this product was found to be compliant at a minimum distance of 20 cm with EN 50665 and FCC CFR 47 Part 2.1091 assuming continuous exposure of 6 minutes or more. If alternative antennas are used with greater gains, the distance must be recalculated.

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TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	21 April 2020
2	Change of address	26 May 2020
3	To include additional declared variants	21 April 2021

Table 1

1.2 Introduction

Applicant	MiX Telematics International (Pty) Ltd.
Manufacturer	MiX Telematics International (Pty) Ltd.
Model Number(s)	MiX 46MC-4G-B
Manufacturer Declared Variant(s)	MiX 46MC-4G MiX 460C-4G-B MiX 460C-4G
Hardware Version(s)	1
Software Version(s)	4.8
Specification/Issue/Date	• EN 50665:2017 Generic standard for assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz) • FCC 47 CFR Part 2.1091: 2019
Order Number Date	P0093369 18 February 2020
Related Document(s)	• EN 62311:2008 Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz) • Directive 2013/35/EU on minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields). • European Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), Official Journal, L199, of 1999-7-30, p.59-70. • OET65:97 Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields • IEEE C95.3:2002 IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to Such Fields, 100 kHz–300 GHz

1.3 Brief Summary of Results

The wireless device described within this report was compliant with the restrictions related to human exposure to electromagnetic fields for both general public and worker/occupational exposures

The calculations shown in this report were made in accordance with the procedures specified in the applied test specifications.

1.4 Manufacturer's Declared Variant(s)

The following product variants (with part numbers) are available:

Part ID	Official Name	Description
440FT0194	MiX 46MC-4G	MiX 4000 LTE with 2G fall back (Model 46MC-4G) Electronic Unit; with Magix 434MHz and 915MHz support.
440FT0195	MiX 46MC-4G-B	MiX 4000 LTE with 2G fall back (Model 46MC-4G-B) Electronic Unit with Battery (plugged in) with Magix 434MHz and 915MHz support.

The variants MiX 46MC-4G and MiX 46MC-4G-B, present the same electrical, physical and electro mechanics characteristics, the same PCB (440AWZ124), layout and components.

The only difference between them is that the model MiX 46MC-4G-B has an internal backup battery, allowing the device to work after the disconnection of the vehicle´s battery.

The following variants use the same PCB (440AWZ124) and circuit (440CDZ192), but it is not utilizing the Short Range Device feature (434 MHz) (components not populated):

Assembly Number	Assembly Name	Description
U0095MT	MiX 460C-4G	MiX 460C-4G Electronic Unit with u-blox SARA-R412M modem; No on-board Magix support
U0097MT	MiX 460C-4G-B	MiX 460C-4G with Backup Battery Electronic Unit with u-blox SARA-R412M modem; No on-board Magix support

1.4.1 Configuration 1 - single transmitter

Regional Requirement	RAT	Calculated RF exposure level at minimum compliance boundary of 0.2 m							
		S Power Density (W/m^2)		E Field (V/m)		H Field (A/m)		B Field (µT)	
		Result	Limit	Result	Limit	Result	Limit	Result	Limit
FCC	SRD 915	0.02	30.07	2.74	N/A	0.0073	N/A	0.0091	N/A
FCC	BLE 2400	0.00	50.00	1.37	N/A	0.0036	N/A	0.0046	N/A
FCC	GSM 850	1.98	27.47	27.35	N/A	0.0726	N/A	0.0912	N/A
FCC	PCS 1900	0.99	50.00	19.34	N/A	0.0513	N/A	0.0645	N/A
FCC	LTE Band 2	0.79	50.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 3	0.79	50.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 4	0.79	50.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 5	0.79	27.47	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 12	0.79	23.30	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 13	0.79	25.90	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 25	0.79	50.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 26	0.79	27.13	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 28	0.79	23.43	17.30	N/A	0.0459	N/A	0.0577	N/A
EU	SRD 434	0.00	N/A	0.87	62.52	0.0023	N/A	0.0029	0.2084
EU	BLE 2400	0.00	N/A	1.37	140.00	0.0036	N/A	0.0046	0.4500
EU	GSM 900	1.98	N/A	27.35	89.00	0.0726	N/A	0.0912	0.2967
EU	DCS 1800	0.99	N/A	19.34	124.06	0.0513	N/A	0.0645	0.4135
EU	LTE Band 3	0.79	N/A	17.30	124.06	0.0459	N/A	0.0577	0.4135
EU	LTE Band 5	0.79	N/A	17.30	86.12	0.0459	N/A	0.0577	0.2871
EU	LTE Band 8	0.79	N/A	17.30	88.99	0.0459	N/A	0.0577	0.2966
EU	LTE Band 20	0.79	N/A	17.30	86.53	0.0459	N/A	0.0577	0.2884
EU	LTE Band 26	0.79	N/A	17.30	85.59	0.0459	N/A	0.0577	0.2853
EU	LTE Band 28	0.79	N/A	17.30	79.49	0.0459	N/A	0.0577	0.2650

Table 2 – Worker/Occupational Exposure Results

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum of 0.2 m.

Regional Requirement	RAT	Calculated RF exposure level at minimum compliance boundary of 0.2 m							
		S Power Density (W/m^2)		E Field (V/m)		H Field (A/m)		B Field (µT)	
		Result	Limit	Result	Limit	Result	Limit	Result	Limit
FCC	SRD 915	0.02	6.01	2.74	N/A	0.0073	N/A	0.0091	N/A
FCC	BLE 2400	0.00	10.00	1.37	N/A	0.0036	N/A	0.0046	N/A
FCC	GSM 850	1.98	5.49	27.35	N/A	0.0726	N/A	0.0912	N/A
FCC	PCS 1900	0.99	10.00	19.34	N/A	0.0513	N/A	0.0645	N/A
FCC	LTE Band 2	0.79	10.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 3	0.79	10.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 4	0.79	10.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 5	0.79	5.49	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 12	0.79	4.66	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 13	0.79	5.18	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 25	0.79	10.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 26	0.79	5.43	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	LTE Band 28	0.79	4.69	17.30	N/A	0.0459	N/A	0.0577	N/A
EU	SRD 434	0.00	2.17	0.87	28.65	0.0023	0.0771	0.0029	0.0959
EU	BLE 2400	0.00	10.00	1.37	61.00	0.0036	0.1600	0.0046	0.2000
EU	GSM 900	1.98	4.40	27.35	40.79	0.0726	0.1098	0.0912	0.1365
EU	DCS 1800	0.99	8.55	19.34	56.86	0.0513	0.1530	0.0645	0.1902
EU	LTE Band 3	0.79	8.55	17.30	56.86	0.0459	0.1530	0.0577	0.1902
EU	LTE Band 5	0.79	4.12	17.30	39.47	0.0459	0.1062	0.0577	0.1320
EU	LTE Band 8	0.79	4.40	17.30	40.79	0.0459	0.1098	0.0577	0.1365
EU	LTE Band 20	0.79	4.16	17.30	39.66	0.0459	0.1067	0.0577	0.1327
EU	LTE Band 26	0.79	4.07	17.30	39.23	0.0459	0.1056	0.0577	0.1312
EU	LTE Band 28	0.79	3.51	17.30	36.43	0.0459	0.0980	0.0577	0.1219

Table 3 – General Public Exposure Results

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum of 0.2 m.

1.4.1 Configuration 2 - multiple transmitters

Regional Requirement	RAT Combination	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
		S Power Density	E Field	H Field	B Field
		Summation for simultaneous exposure; value to be <1			
FCC	GSM 850 + SRD 915 + BLE 2400	0.0730	N/A	N/A	N/A
FCC	PCS 1900 + SRD 915 + BLE 2400	0.0206	N/A	N/A	N/A
FCC	LTE Band 2 + SRD 915 + BLE 2400	0.0166	N/A	N/A	N/A
FCC	LTE Band 3 + SRD 915 + BLE 2400	0.0166	N/A	N/A	N/A
FCC	LTE Band 4 + SRD 915 + BLE 2400	0.0166	N/A	N/A	N/A
FCC	LTE Band 5 + SRD 915 + BLE 2400	0.0297	N/A	N/A	N/A
FCC	LTE Band 12 + SRD 915 + BLE 2400	0.0348	N/A	N/A	N/A
FCC	LTE Band 13 + SRD 915 + BLE 2400	0.0314	N/A	N/A	N/A
FCC	LTE Band 25 + SRD 915 + BLE 2400	0.0166	N/A	N/A	N/A
FCC	LTE Band 26 + SRD 915 + BLE 2400	0.0300	N/A	N/A	N/A
FCC	LTE Band 28 + SRD 915 + BLE 2400	0.0346	N/A	N/A	N/A
EU	GSM 900 + SRD 434 + BLE 2400	N/A	0.0947	N/A	0.0947
EU	DCS 1800 + SRD 434 + BLE 2400	N/A	0.0246	N/A	0.0246
EU	LTE Band 3 + SRD 434 + BLE 2400	N/A	0.0197	N/A	0.0197
EU	LTE Band 5 + SRD 434 + BLE 2400	N/A	0.0406	N/A	0.0406
EU	LTE Band 8 + SRD 434 + BLE 2400	N/A	0.0381	N/A	0.0381
EU	LTE Band 20 + SRD 434 + BLE 2400	N/A	0.0403	N/A	0.0403
EU	LTE Band 26 + SRD 434 + BLE 2400	N/A	0.0411	N/A	0.0411
EU	LTE Band 28 + SRD 434 + BLE 2400	N/A	0.0477	N/A	0.0477

Table 4 – Worker/Occupational Exposure Results

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum of 0.2 m

Regional Requirement	RAT Combination	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
		S Power Density	E Field	H Field	B Field
		Summation for simultaneous exposure; value to be <1			
FCC	GSM 850 + SRD 915 + BLE 2400	0.3650	N/A	N/A	N/A
FCC	PCS 1900 + SRD 915 + BLE 2400	0.1030	N/A	N/A	N/A
FCC	LTE Band 2 + SRD 915 + BLE 2400	0.0832	N/A	N/A	N/A
FCC	LTE Band 3 + SRD 915 + BLE 2400	0.0832	N/A	N/A	N/A
FCC	LTE Band 4 + SRD 915 + BLE 2400	0.0832	N/A	N/A	N/A
FCC	LTE Band 5 + SRD 915 + BLE 2400	0.1483	N/A	N/A	N/A
FCC	LTE Band 12 + SRD 915 + BLE 2400	0.1742	N/A	N/A	N/A
FCC	LTE Band 13 + SRD 915 + BLE 2400	0.1571	N/A	N/A	N/A
FCC	LTE Band 25 + SRD 915 + BLE 2400	0.0832	N/A	N/A	N/A
FCC	LTE Band 26 + SRD 915 + BLE 2400	0.1501	N/A	N/A	N/A
FCC	LTE Band 28 + SRD 915 + BLE 2400	0.1732	N/A	N/A	N/A
EU	GSM 900 + SRD 434 + BLE 2400	0.4524	0.4510	0.4383	0.4478
EU	DCS 1800 + SRD 434 + BLE 2400	0.1175	0.1171	0.1138	0.1163
EU	LTE Band 3 + SRD 434 + BLE 2400	0.0943	0.0940	0.0914	0.0933
EU	LTE Band 5 + SRD 434 + BLE 2400	0.1941	0.1935	0.1881	0.1921
EU	LTE Band 8 + SRD 434 + BLE 2400	0.1818	0.1813	0.1762	0.1800
EU	LTE Band 20 + SRD 434 + BLE 2400	0.1922	0.1917	0.1863	0.1903
EU	LTE Band 26 + SRD 434 + BLE 2400	0.1965	0.1959	0.1904	0.1945
EU	LTE Band 28 + SRD 434 + BLE 2400	0.2276	0.2269	0.2205	0.2253

Table 5 – General Public Exposure Results

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum of 0.2 m.

1.5 Product Information

1.5.1 Technical Description

The MiX 46MC-4G is a fleet product that incorporates the latest market trends. It consists mainly of an on-board computer, a LTE CAT M1 modem with 2G fall-back, a GNSS, an accelerometer, Low Energy Bluetooth, I/O, 2 x CAN, 2 x RS232, 4 x positive drives and 434 / 915 MHz short range transceiver.

1.5.2 Transmitter Description

The following radio access technologies and frequency bands are supported by the equipment under test.

Regional Requirement	Radio Access Technology	Antenna Port	Frequency Band (MHz)	Minimum Frequency (MHz)	Output Power (dBm)	Duty Cycle (%)
FCC	SRD 915	1	902.0 - 928.0	902.0	20.0	10.0
FCC/EU	BLE 2400	2	2402.0 - 2480.0	2402.0	7.0	50.0
FCC	GSM 850	3	824.2 - 848.8	824.2	33.0	25.0
FCC	PCS 1900	3	1850.5 - 1909.8	1850.5	30.0	25.0
FCC	LTE Band 2	3	1850.0 - 1910.0	1850.0	23.0	100.0
FCC/EU	LTE Band 3	3	1710.0 - 1785.0	1710.0	23.0	100.0
FCC	LTE Band 4	3	1710.0 - 1755.0	1710.0	23.0	100.0
FCC/EU	LTE Band 5/26	3	824.0 - 829.0	824.0	23.0	100.0
FCC	LTE Band 12	3	699.0 - 716.0	699.0	23.0	100.0
FCC	LTE Band 13	3	777.0 - 787.0	777.0	23.0	100.0
FCC	LTE Band 25	3	1850.0 - 1910.0	1850.0	23.0	100.0
FCC/EU	LTE Band 26	3	814.0 - 819.0	814.0	23.0	100.0
FCC/EU	LTE Band 28	3	703.0 - 748.0	703.0	23.0	100.0
EU	SRD 434	1	434.3 - 434.3	434.3	10.0	10.0
EU	GSM 900	3	880.2 - 914.8	880.2	33.0	25.0
EU	DCS 1800	3	1710.2 - 1784.8	1710.2	30.0	25.0
EU	LTE Band 8	3	880.0 - 915.0	880.0	23.0	100.0
EU	LTE Band 20	3	832.0 - 862.0	832.0	23.0	100.0

Table 6 – Transmitter Description

1.5.3 Antenna Description

The following antennas are supported by the equipment under test.

Antenna No	Radio Access Technology	Antenna Model	Gain (dBi)	Antenna length (cm)	Minimum Separation Distance (cm)
1	SRD 434	AW1003A-1B	0	5.0	20
1	SRD 915	AW1003A-1B	0	2.5	20
2	BLE 2400	Integrated PCB Antenna	0	1.1	20
3	GSM 850	ANT0047	3	6.5	20
3	GMS900	ANT0047	3	6.5	20
3	DCS 1800	ANT0047	3	6.5	20
3	PCS 1900	ANT0047	3	6.5	20
3	LTE Band 2	ANT0047	3	6.5	20
3	LTE Band 3	ANT0047	3	6.5	20
3	LTE Band 4	ANT0047	3	6.5	20
3	LTE Band 5	ANT0047	3	6.5	20
3	LTE Band 8	ANT0047	3	6.5	20
3	LTE Band 12	ANT0047	3	6.5	20
3	LTE Band 13	ANT0047	3	6.5	20
3	LTE Band 20	ANT0047	3	6.5	20
3	LTE Band 25	ANT0047	3	6.5	20
3	LTE Band 26	ANT0047	3	6.5	20
3	LTE Band 28	ANT0047	3	6.5	20

Table 7 – Antenna description

In the case of more than one type of antenna being supported by the equipment, the calculation is based on the maximum of the antenna gains. If other antennas can be used that have greater gains, the minimum separation distances will need to be recalculated.

1.5.4 Equipment Configuration

Simultaneous transmission in the following technologies and bands:

EU:

GSM 900 + SRD 434 + BLE 2400
DCS 1800 + SRD 434 + BLE 2400
LTE Band 3 + SRD 434 + BLE 2400
LTE Band 5 + SRD 434 + BLE 2400
LTE Band 8 + SRD 434 + BLE 2400
LTE Band 20 + SRD 434 + BLE 2400
LTE Band 26 + SRD 434 + BLE 2400
LTE Band 28 + SRD 434 + BLE 2400

FCC:

GSM 850 + SRD 915 + BLE 2400
PCS 1900 + SRD 915 + BLE 2400
LTE Band 2 + SRD 915 + BLE 2400
LTE Band 3 + SRD 915 + BLE 2400
LTE Band 4 + SRD 915 + BLE 2400
LTE Band 5 + SRD 915 + BLE 2400
LTE Band 8 + SRD 915 + BLE 2400
LTE Band 12 + SRD 915 + BLE 2400
LTE Band 13 + SRD 915 + BLE 2400
LTE Band 25 + SRD 915 + BLE 2400
LTE Band 26 + SRD 915 + BLE 2400
LTE Band 28 + SRD 915 + BLE 2400

2 Assessment Details

2.1 Assessment Method

The assessment method is by calculation of the power density S, electric field strength E, magnetic field strength H or magnetic flux density B.

The calculation uses the spherical model applicable under far field conditions.

$$S = E \times H = \frac{E^2}{\eta} = H^2 \times \eta = \frac{P \times G_i}{4 \times \pi \times r^2}$$

Where:
η - Impedance of free space (377 ohm in far field)
P – Average transmitter power W (P_{av} = P_{max} x Duty Cycle)
G_i – Antenna gain ratio relative to isotropic
r – Separation distance m

The magnetic flux density is related to the magnetic field strength by a constant:

$$B = \mu_o \times H$$

Where:
μ_o – Permeability of free space 4 x π E-7 H/m

This assessment assumes that exposure is continuous for 6 minutes or more in accordance with the averaging time required by the exposure standards at the stated minimum compliance boundary separation distance. Exposures of less than 6 minutes at other separation distances are not addressed by this report.

This assessment method of RF exposure is applicable to separation distances of 20 cm or more. Separation distances of less than 20 cm require a Specific Absorption Rate (SAR) assessment.

The far field region boundary depends on the frequency and wavelength and also on the antenna dimension. The boundary of the far field region is calculated below to demonstrate the validity of using the spherical model.

The result is compared to the limits in Annex A to determine compliance or to calculate the required compliance distance. The calculation is based on the lowest frequency in each band as the most onerous requirement as the limits increase with frequency for frequencies above 10-50 MHz (dependent on region).

2.1.1 Calculation of Exposure at Specified Separation Distance

The frequencies shown in the tables below have been chosen based on the lowest possible frequency that the EUT can transmit. A full list of the regional requirements is shown in Annex A.

Regional Requirement	Antenna Port	RAT	Frequency (MHz)	RF Exposure Level at minimum compliance boundary of 0.2 m							
				S Power Density (W/m^2)		E Field (V/m)		H Field (A/m)		B Field (µT)	
				Result	Limit	Result	Limit	Result	Limit	Result	Limit
FCC	1	SRD 915	902.0	0.02	30.07	2.74	N/A	0.0073	N/A	0.0091	N/A
FCC	2	BLE 2400	2402.0	0.00	50.00	1.37	N/A	0.0036	N/A	0.0046	N/A
FCC	3	GSM 850	824.2	1.98	27.47	27.35	N/A	0.0726	N/A	0.0912	N/A
FCC	3	PCS 1900	1850.5	0.99	50.00	19.34	N/A	0.0513	N/A	0.0645	N/A
FCC	3	LTE Band 2	1850.0	0.79	50.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 3	1710.0	0.79	50.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 4	1710.0	0.79	50.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 5	824.0	0.79	27.47	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 12	699.0	0.79	23.30	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 13	777.0	0.79	25.90	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 25	1850.0	0.79	50.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 26	814.0	0.79	27.13	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 28	703.0	0.79	23.43	17.30	N/A	0.0459	N/A	0.0577	N/A
EU	1	SRD 434	434.3	0.00	N/A	0.87	62.52	0.0023	N/A	0.0029	0.2084
EU	2	BLE 2400	2402.0	0.00	N/A	1.37	140.00	0.0036	N/A	0.0046	0.4500
EU	3	GSM 900	880.2	1.98	N/A	27.35	89.00	0.0726	N/A	0.0912	0.2967
EU	3	DCS 1800	1710.2	0.99	N/A	19.34	124.06	0.0513	N/A	0.0645	0.4135
EU	3	LTE Band 3	1710.0	0.79	N/A	17.30	124.06	0.0459	N/A	0.0577	0.4135
EU	3	LTE Band 5	824.0	0.79	N/A	17.30	86.12	0.0459	N/A	0.0577	0.2871

EU	3	LTE Band 8	880.0	0.79	N/A	17.30	88.99	0.0459	N/A	0.0577	0.2966
EU	3	LTE Band 20	832.0	0.79	N/A	17.30	86.53	0.0459	N/A	0.0577	0.2884
EU	3	LTE Band 26	814.0	0.79	N/A	17.30	85.59	0.0459	N/A	0.0577	0.2853
EU	3	LTE Band 28	702.0	0.79	N/A	17.30	79.49	0.0459	N/A	0.0577	0.2650

Table 8 – Worker/Occupational Individual Transmitter Result

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.2 m.

Regional Requirement	Antenna Port	RAT	Frequency (MHz)	RF Exposure Level at minimum compliance boundary of 0.2 m							
				S Power Density (W/m^2)		E Field (V/m)		H Field (A/m)		B Field (µT)	
				Result	Limit	Result	Limit	Result	Limit	Result	Limit
FCC	1	SRD 915	902.0	0.02	6.01	2.74	N/A	0.0073	N/A	0.0091	N/A
FCC	2	BLE 2400	2402.0	0.00	10.00	1.37	N/A	0.0036	N/A	0.0046	N/A
FCC	3	GSM 850	824.2	1.98	5.49	27.35	N/A	0.0726	N/A	0.0912	N/A
FCC	3	PCS 1900	1850.5	0.99	10.00	19.34	N/A	0.0513	N/A	0.0645	N/A
FCC	3	LTE Band 2	1850.0	0.79	10.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 3	1710.0	0.79	10.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 4	1710.0	0.79	10.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 5	824.0	0.79	5.49	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 12	699.0	0.79	4.66	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 13	777.0	0.79	5.18	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 25	1850.0	0.79	10.00	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 26	814.0	0.79	5.43	17.30	N/A	0.0459	N/A	0.0577	N/A
FCC	3	LTE Band 28	703.0	0.79	4.69	17.30	N/A	0.0459	N/A	0.0577	N/A
EU	1	SRD 434	434.3	0.00	2.17	0.87	28.65	0.0023	0.0771	0.0029	0.0959

EU	2	BLE 2400	2402.0	0.00	10.00	1.37	61.00	0.0036	0.1600	0.0046	0.2000
EU	3	GSM 900	880.2	1.98	4.40	27.35	40.79	0.0726	0.1098	0.0912	0.1365
EU	3	DCS 1800	1710.2	0.99	8.55	19.34	56.86	0.0513	0.1530	0.0645	0.1902
EU	3	LTE Band 3	1710.0	0.79	8.55	17.30	56.86	0.0459	0.1530	0.0577	0.1902
EU	3	LTE Band 5	824.0	0.79	4.12	17.30	39.47	0.0459	0.1062	0.0577	0.1320
EU	3	LTE Band 8	880.0	0.79	4.40	17.30	40.79	0.0459	0.1098	0.0577	0.1365
EU	3	LTE Band 20	832.0	0.79	4.16	17.30	39.66	0.0459	0.1067	0.0577	0.1327
EU	3	LTE Band 26	814.0	0.79	4.07	17.30	39.23	0.0459	0.1056	0.0577	0.1312
EU	3	LTE Band 28	702.0	0.79	3.51	17.30	36.43	0.0459	0.0980	0.0577	0.1219

Table 9 – General Public Individual Transmitter Result

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.2 m.

2.2 Combined Antenna Port RF Exposure Results

As the frequency of operation for each transmitter is not the same, in order to evaluate compliance with the limit, which is dependent on frequency, the fractional exposure value is calculated: The calculated S power density is divided by the limit to get a fractional exposure value. The calculated E and H fields are divided by the limit and squared to get a fractional exposure value. The summation of the fractional RF exposure results for each transmitter provides the combined result. Any values less than one are compliant with the limit.

Calculations are made on an Excel spreadsheet and numbers may not add up exactly due to rounding.

EN 62311 specifies the method of summation in clause 8.3 with results as follows:

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
1	SRD 434	434.3	N/A	0.0002	N/A	0.0002
2	BLE 2400	2402.0	N/A	0.0001	N/A	0.0001
3	GSM 900	880.2	N/A	0.0944	N/A	0.0944
3	DCS 1800	1710.2	N/A	0.0243	N/A	0.0243
3	LTE Band 3	1710.0	N/A	0.0194	N/A	0.0194
3	LTE Band 5	824.0	N/A	0.0404	N/A	0.0404
3	LTE Band 8	880.0	N/A	0.0378	N/A	0.0378
3	LTE Band 20	832.0	N/A	0.0400	N/A	0.0400
3	LTE Band 26	814.0	N/A	0.0409	N/A	0.0408
3	LTE Band 28	702.3	N/A	0.0474	N/A	0.0474
Summation: SRD 434 + BLE 2400 + GSM 900			N/A	0.0947	N/A	0.0947
Summation: SRD 434 + BLE 2400 + DCS 1800			N/A	0.0246	N/A	0.0246
Summation: SRD 434 + BLE 2400 + LTE Band 3			N/A	0.0197	N/A	0.0197
Summation: SRD 434 + BLE 2400 + LTE Band 5			N/A	0.0406	N/A	0.0406
Summation: SRD 434 + BLE 2400 + LTE Band 8			N/A	0.0381	N/A	0.0381
Summation: SRD 434 + BLE 2400 + LTE Band 20			N/A	0.0403	N/A	0.0403
Summation: SRD 434 + BLE 2400 + LTE Band 26			N/A	0.0411	N/A	0.0411
Summation: SRD 434 + BLE 2400 + LTE Band 28			N/A	0.0477	N/A	0.0477

Table 10 – EU Worker/Occupational Combined Exposure

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.2 m.

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
1	SRD 434	434.3	0.0009	0.0009	0.0009	0.0009
2	BLE 2400	2402.0	0.0005	0.0005	0.0005	0.0005
3	GSM 900	880.2	0.4510	0.4496	0.4369	0.4463
3	DCS 1800	1710.2	0.1161	0.1157	0.1124	0.1149
3	LTE Band 3	1710.0	0.0928	0.0926	0.0899	0.0919
3	LTE Band 5	824.0	0.1927	0.1921	0.1867	0.1907
3	LTE Band 8	880.0	0.1804	0.1799	0.1748	0.1786
3	LTE Band 20	832.0	0.1908	0.1903	0.1849	0.1889
3	LTE Band 26	814.0	0.1950	0.1945	0.1890	0.1930
3	LTE Band 28	702.3	0.2262	0.2255	0.2191	0.2238
Summation: SRD 434 + BLE 2400 + GSM 900			0.4524	0.4510	0.4383	0.4478
Summation: SRD 434 + BLE 2400 + DCS 1800			0.1175	0.1171	0.1138	0.1163
Summation: SRD 434 + BLE 2400 + LTE Band 3			0.0943	0.0940	0.0914	0.0933
Summation: SRD 434 + BLE 2400 + LTE Band 5			0.1941	0.1935	0.1881	0.1921
Summation: SRD 434 + BLE 2400 + LTE Band 8			0.1818	0.1813	0.1762	0.1800
Summation: SRD 434 + BLE 2400 + LTE Band 20			0.1922	0.1917	0.1863	0.1903
Summation: SRD 434 + BLE 2400 + LTE Band 26			0.1965	0.1959	0.1904	0.1945
Summation: SRD 434 + BLE 2400 + LTE Band 28			0.2276	0.2269	0.2205	0.2253

Table 11 – EU General Public Combined Exposure

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.2 m.

FCC OET 65 specifies the method of summation in clause; Multiple-Transmitter Sites and Complex Environments; with results as follows:

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
1	SRD 915	902.0	0.0007	N/A	N/A	N/A
2	BLE 2400	2402.0	0.0001	N/A	N/A	N/A
3	GSM 850	824.2	0.0722	N/A	N/A	N/A
3	PCS 1900	1850.5	0.0198	N/A	N/A	N/A
3	LTE Band 2	1850.0	0.0159	N/A	N/A	N/A
3	LTE Band 3	1710.0	0.0159	N/A	N/A	N/A
3	LTE Band 4	1710.0	0.0159	N/A	N/A	N/A
3	LTE Band 5	824.0	0.0289	N/A	N/A	N/A
3	LTE Band 12	699.0	0.0341	N/A	N/A	N/A
3	LTE Band 13	777.0	0.0306	N/A	N/A	N/A
3	LTE Band 25	1850.0	0.0159	N/A	N/A	N/A
3	LTE Band 26	814.0	0.0293	N/A	N/A	N/A
3	LTE Band 28	703.0	0.0339	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + GSM 850			0.0730	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + PCS 1900			0.0206	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 2			0.0166	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 3			0.0166	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 4			0.0166	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 5			0.0297	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 12			0.0348	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 13			0.0314	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 25			0.0166	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 26			0.0300	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 28			0.0346	N/A	N/A	N/A

Table 12 – FCC Worker / Occupational Combined Exposure

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.2 m.

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
1	SRD 915	902.0	0.0033	N/A	N/A	N/A
2	BLE 2400	2402.0	0.0005	N/A	N/A	N/A
3	GSM 850	824.2	0.3612	N/A	N/A	N/A
3	PCS 1900	1850.5	0.0992	N/A	N/A	N/A
3	LTE Band 2	1850.0	0.0794	N/A	N/A	N/A
3	LTE Band 3	1710.0	0.0794	N/A	N/A	N/A
3	LTE Band 4	1710.0	0.0794	N/A	N/A	N/A
3	LTE Band 5	824.0	0.1445	N/A	N/A	N/A
3	LTE Band 12	699.0	0.1704	N/A	N/A	N/A
3	LTE Band 13	777.0	0.1532	N/A	N/A	N/A
3	LTE Band 25	1850.0	0.0794	N/A	N/A	N/A
3	LTE Band 26	814.0	0.1463	N/A	N/A	N/A
3	LTE Band 28	703.0	0.1694	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + GSM 850			0.3650	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + PCS 1900			0.1030	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 2			0.0832	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 3			0.0832	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 4			0.0832	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 5			0.1483	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 12			0.1742	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 13			0.1571	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 25			0.0832	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 26			0.1501	N/A	N/A	N/A
Summation: SRD 915 + BLE 2400 + LTE Band 28			0.1732	N/A	N/A	N/A

Table 13 – FCC General Public Combined Exposure

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.2 m.

2.3 Far Field Region Boundary Results

The far field region boundary calculation result is shown in Table :

Near Field / Far Field Boundary (Ref: IEEE C95.3 Annex B.2, EN 62311 Annex A)			
RAT Name	Frequency MHz	Reactive Near Field Boundary (Wave Impedance Dependent)	Far Field Boundary (Antennas on axis)
		λ/4 (m)	$2D^2/\lambda$ (m)
SRD 434	434.3	0.1727	0.0072
SRD 915	902.0	0.0831	0.0038
BLE 2400	2402.0	0.0312	0.0019
GSM 850	824.2	0.0910	0.0232
GSM 900	880.2	0.0852	0.0248
DCS 1800	1710.2	0.0439	0.0482
PCS 1900	1850.5	0.0405	0.0521
LTE Band 25	1850.0	0.0405	0.0521
LTE Band 3	1710.0	0.0439	0.0482
LTE Band 4	1710.0	0.0439	0.0482
LTE Band 5	824.0	0.0910	0.0232
LTE Band 8	880.0	0.0852	0.0248
LTE Band 12	699.0	0.1073	0.0197
LTE Band 13	777.0	0.0965	0.0219
LTE Band 20	832.0	0.0901	0.0234
LTE Band 25	1850.0	0.0405	0.0521
LTE Band 26	814.0	0.0921	0.0229
LTE Band 28	703.0	0.1067	0.0198

Table 14 – Far Field Boundary

The table below shows the maximum calculated near field / far field region boundaries. No radiating near field region present, therefore the reactive near-field transitions directly into the calculated far field, in this case the reactive near field boundary is used as the far field boundary

The compliance boundary of 0.2 m is in the far field region and therefore, the approach described in section 2.1 is valid.

Field Region	Reactive Near Field Region	Radiating Near Field Region	Far Field Region
Maximum Boundary	< 0.1727 m	N/A	> 0.1727 m
Validity of Regions	Spherical model potential under-estimate: SAR assessment required	Spherical model over-estimate and conservative	Spherical model valid
Compliance Boundary Location	N/A	N/A	0.2 m

Table 15 – Assessment Method Validity

2.4 Uncertainty

The basic computation formulas presented in section 2.1 are conservative formulas for the estimation of RF field strength or power density. No uncertainty estimations are required when using these formulas but there is clear guidance on where and when these formulas are applicable.

For the estimate of S, E or H to be conservative, the transmitter power P and antenna gain G_i values shall be the upper bounds of uncertainty therefore maximum values are used.

The spherical formula is valid under far field conditions which are established in section 2.3.

ANNEX A

REGIONAL REQUIREMENTS

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Magnetic Flux Density (µT)
0.1 - 1	-	610	N/A	2/f
1 - 10	-	610/f	N/A	2/f
10 - 400		61	N/A	0.2
400 - 2000		3*f^0.5	N/A	1E-2*f^0.5
2000 - 6000		140	N/A	0.45
6000 - 300000	50	140	N/A	0.45

Table A.1 – EU: Action levels in Directive 2013/35/EU Annex III Table B1 Worker/Occupational Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Magnetic Flux Density (µT)
0.003 - 0.15	-	87	5	6.25
0.15 - 1	-	87	0.73/f	0.92/f
1 - 10	-	87/f^0.5	0.73/f	0.92/f
10 - 400	2	28	0.073	0.092
400 - 2000	f/200	1.375*f^0.5	0.0037*f^0.5	0.0046*f^0.5
2000 - 300000	10	61	0.16	0.2

Table A.2 – EU: Council Recommendation 1999/519/EC Annex II Table 1 General Public Limits

Frequency Range (MHz)	Power Density (mW/cm^2) Note 1	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	900/f^2	1842/f	4.89/f
30 - 300	1	61.4	0.163
300 - 1500	f/300	-	-
1500 - 100000	5	-	-

Table A.3 – CFR 47 Pt1.1310 Worker/Occupational Limits

Frequency Range (MHz)	Power Density (mW/cm^2) Note 1	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	180/f^2	824/f	2.19/f
30 - 300	0.2	27.5	0.073
300 - 1500	f/1500	-	-
1500 - 100000	1	-	-

Table A.4 – CFR 47 Pt1.1310 General Public Limits