

Report on the Exposure Calculation of:

MiX Telematics International (Pty) Ltd
Vehicle Tracking Fleet Management Device,
Model: MiX 45MC-4G-B

In accordance with FCC 47 CFR Part 1.1310

Prepared for: MiX Telematics Euro Ltd
Cherry Orchard North, Kembrey Park,
Swindon, SN1 2NR, United Kingdom

FCC ID: 2AFMS-45MC4G



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Project Management	Natalie Bennett	19 November 2018	
Authorised Signatory	Matthew Russell	19 November 2018	

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ENGINEERING STATEMENT

The calculations shown in this report were made in accordance with the procedures described in FCC 47 CFR Part 1.1310.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Calculation	Pete Dorey	19 November 2018	

FCC Accreditation

90987 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

The calculation of exposure for this product was found to be compliant at 20 cm with FCC 47 CFR Part 1.1310.

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Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TÜV SÜD Ltd is a
TÜV SÜD Group Company

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

TÜV SÜD Product Service
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	05 November 2018
2	To include a hyphen in the FCC ID	19 November 2018

1.2 Introduction

Objective	To perform electromagnetic field exposure assessment to determine the equipment under test's (EUT's) compliance with the applied specifications.
Applicant	MiX Telematics Euro Ltd
Manufacturer	MiX Telematics International (Pty) Ltd
Model Number(s)	MiX 45MC-4G-B
Declared Variant(s)	MiX45MC-4G
Hardware Version(s)	1
Software Version(s)	1.8.0
Specification/Issue/Date	FCC 47 CFR Part 1.1310: 2017
Order Number	P0089659
Date	21-May-2018
Related Document(s)	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 specification(s).

1.3.1 Configurations 1 to 7 - Single transmitter

Config. No.	Regional Requirement	RAT	RF Exposure Level at 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
1	FCC	LTE Band 2	0.64	50.00	15.54	N/A	0.0412	N/A	0.0518	N/A
2	FCC	LTE Band 4	0.56	50.00	14.51	N/A	0.0385	N/A	0.0484	N/A
3	FCC	LTE Band 12	0.47	23.30	13.37	N/A	0.0355	N/A	0.0446	N/A
4	FCC	LTE Band 5	0.42	27.47	12.53	N/A	0.0332	N/A	0.0418	N/A
5	FCC	LTE Band 13	0.55	25.90	14.37	N/A	0.0381	N/A	0.0479	N/A
6	FCC	BLE	0.01	50.00	1.93	N/A	0.0051	N/A	0.0064	N/A
7	FCC	SRD 915	0.02	30.07	2.74	N/A	0.0073	N/A	0.0091	N/A

Table 1 – 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, 0.2 m.

Config. No.	Regional Requirement	RAT	RF Exposure Level at 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
1	FCC	LTE Band 2	0.64	10.00	15.54	N/A	0.0412	N/A	0.0518	N/A
2	FCC	LTE Band 4	0.56	10.00	14.51	N/A	0.0385	N/A	0.0484	N/A
3	FCC	LTE Band 12	0.47	4.66	13.37	N/A	0.0355	N/A	0.0446	N/A
4	FCC	LTE Band 5	0.42	5.49	12.53	N/A	0.0332	N/A	0.0418	N/A
5	FCC	LTE Band 13	0.55	5.18	14.37	N/A	0.0381	N/A	0.0479	N/A
6	FCC	BLE	0.01	10.00	1.93	N/A	0.0051	N/A	0.0064	N/A
7	FCC	SRD 915	0.02	6.01	2.74	N/A	0.0073	N/A	0.0091	N/A

Table 2 – 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, 0.2 m.



1.3.1 Configurations 8 to 12 - Multiple transmitters

Config. No.	Regional Requirement	Radio Access Technology	Calculated RF exposure level at compliance boundary of 0.2 m			
			S Power Density (W/m ²)	E Field (V/m)	H Field (A/m)	B Field (μT)
			Summation for simultaneous exposure; value to be <1			
8	FCC	LTE Band 2 + SRD915 + BLE	0.0137	N/A	N/A	N/A
9	FCC	LTE Band 4 + SRD915 + BLE	0.0120	N/A	N/A	N/A
10	FCC	LTE Band 12 + SRD915 + BLE	0.0212	N/A	N/A	N/A
11	FCC	LTE Band 5 + SRD915 + BLE	0.0160	N/A	N/A	N/A
12	FCC	LTE Band 13 + SRD915 + BLE	0.0220	N/A	N/A	N/A

Table 3 – 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, 0.2 m.

Config. No.	Regional Requirement	Radio Access Technology	Calculated RF exposure level at compliance boundary of 0.2 m			
			S Power Density (W/m ²)	E Field (V/m)	H Field (A/m)	B Field (μT)
			Summation for simultaneous exposure; value to be <1			
8	FCC	LTE Band 2 + SRD915 + BLE	0.0684	N/A	N/A	N/A
9	FCC	LTE Band 4 + SRD915 + BLE	0.0601	N/A	N/A	N/A
10	FCC	LTE Band 12 + SRD915 + BLE	0.1060	N/A	N/A	N/A
11	FCC	LTE Band 5 + SRD915 + BLE	0.0801	N/A	N/A	N/A
12	FCC	LTE Band 13 + SRD915 + BLE	0.1101	N/A	N/A	N/A

Table 4 – 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, 0.2 m.

1.4 Product Information

1.4.1 Technical Description

The MiX 4000 LTE is a fleet product that incorporates the latest market trends. It consists mainly of an on-board computer, a LTE CAT M1 modem, a GNSS, an accelerometer, Low Energy Bluetooth, I/O, 2 x CAN, 2 x RS232, 4 x positive drives and 434MHz / 915MHz short range transceiver.



1.4.2 Transmitter Description

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

Radio Access Technology	Antenna Port	Frequency Band	Minimum Frequency	Output Power	Duty Cycle
		MHz	MHz	dBm	%
LTE Band 2	Internal	1850-1910	1850	23.01	100
LTE Band 4	Internal	1710-1788	1710	23.01	100
LTE Band 12	Internal	699-716	699	23.01	100
LTE Band 5	Internal	824-849	824	23.01	100
LTE Band 13	Internal	777-787	777	23.01	100
BLE	Internal	2402-2480	2402	8.573	50
SRD 915	Internal	902-928	902	20	10

Table 5 – Transmitter Description

1.4.3 Antenna Description

The following antennas are supported by the equipment under test.

Antenna No	Radio Access Technology	Antenna Model	Gain	Antenna length	Minimum Separation Distance
			dBi	cm	cm
1	LTE Band 2	Internal	2.07	6.5	20
2	LTE Band 4	Internal	1.47	6.5	20
3	LTE Band 12	Internal	0.76	6.5	20
4	LTE Band 5	Internal	0.2	6.5	20
5	LTE Band 13	Internal	1.39	6.5	20
6	BLE	Internal	1.4	1.1	20
7	SRD 915	Internal	0	2.5	20

Table 6 – Antenna description

1.4.4 Equipment Configuration

List of possible (max) configuration combinations:

- Configuration 1 LTE BAND 2*
 - Configuration 2 LTE BAND 4*
 - Configuration 3 LTE BAND 12*
 - Configuration 4 LTE BAND 5
 - Configuration 5 LTE BAND 13
 - Configuration 6 BLE
 - Configuration 7 SRD 915
 - Configuration 8 LTE BAND 2* + SRD915 + BLE
 - Configuration 9 LTE BAND 4* + SRD915 + BLE
 - Configuration 10 LTE BAND 12* + SRD915 + BLE
 - Configuration 11 LTE BAND 5 + SRD915 + BLE
 - Configuration 12 LTE BAND 13 + SRD915 + BLE
- *AT&T, for which this system is destined, uses LTE BAND 2, 4 and 12



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 – Transmitter power W

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:

$$B = \mu_0 \times H$$

Where:

μ_0 – Permeability of free space $4\pi \times 10^{-7}$ H/m

Where additional calculations are required by the regional specifications these are detailed below.

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.

2.2 Individual Antenna Port Exposure Results

2.2.1 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 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	LTE Band 2	1850	0.64	50.00	15.54	N/A	0.0412	N/A	0.0518	N/A
FCC	2	LTE Band 4	1710	0.56	50.00	14.51	N/A	0.0385	N/A	0.0484	N/A
FCC	3	LTE Band 12	699	0.47	23.30	13.37	N/A	0.0355	N/A	0.0446	N/A
FCC	4	LTE Band 5	824	0.42	27.47	12.53	N/A	0.0332	N/A	0.0418	N/A
FCC	5	LTE Band 13	777	0.55	25.90	14.37	N/A	0.0381	N/A	0.0479	N/A



FCC	6	BLE	2402	0.01	50.00	1.93	N/A	0.0051	N/A	0.0064	N/A
FCC	7	SRD 915	902	0.02	30.07	2.74	N/A	0.0073	N/A	0.0091	N/A

Table 7 – Worker/Occupational Individual Transmitter Result

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

Regional Requirement	Antenna Port	RAT	Frequency (MHz)	RF Exposure Level at 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	LTE Band 2	1850	0.64	10.00	15.54	N/A	0.0412	N/A	0.0518	N/A
FCC	2	LTE Band 4	1710	0.56	10.00	14.51	N/A	0.0385	N/A	0.0484	N/A
FCC	3	LTE Band 12	699	0.47	4.66	13.37	N/A	0.0355	N/A	0.0446	N/A
FCC	4	LTE Band 5	824	0.42	5.49	12.53	N/A	0.0332	N/A	0.0418	N/A
FCC	5	LTE Band 13	777	0.55	5.18	14.37	N/A	0.0381	N/A	0.0479	N/A
FCC	6	BLE	2402	0.01	10.00	1.93	N/A	0.0051	N/A	0.0064	N/A
FCC	7	SRD 915	902	0.02	6.01	2.74	N/A	0.0073	N/A	0.0091	N/A

Table 8 – General Public Individual Transmitter Result

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

2.3 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.

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



Configuration 8: LTE BAND 2 + SRD915 + BLE

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 2	1850	0.0128	N/A	N/A	N/A
2	BLE	2402	0.0002	N/A	N/A	N/A
3	SRD 915	902	0.0007	N/A	N/A	N/A
Summation			0.0137	N/A	N/A	N/A

Table 9 – 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, 0.2 m.

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 2	1850	0.0641	N/A	N/A	N/A
2	BLE	2402	0.0010	N/A	N/A	N/A
3	SRD 915	902	0.0033	N/A	N/A	N/A
Summation			0.0684	N/A	N/A	N/A

Table 10 – 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, 0.2 m.

Configuration 9: LTE BAND 4 + SRD915 + BLE

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 4	1710	0.0112	N/A	N/A	N/A
2	BLE	2402	0.0002	N/A	N/A	N/A
3	SRD 915	902	0.0007	N/A	N/A	N/A
Summation			0.0120	N/A	N/A	N/A

Table 11 – 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, 0.2 m.



Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 4	1710	0.0558	N/A	N/A	N/A
2	BLE	2402	0.0010	N/A	N/A	N/A
3	SRD 915	902	0.0033	N/A	N/A	N/A
Summation			0.0601	N/A	N/A	N/A

Table 12 – FCC General Public Combined Exposure

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

Configuration 10: LTE BAND 12 + SRD915 + BLE

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 12	699	0.0203	N/A	N/A	N/A
2	BLE	2402	0.0002	N/A	N/A	N/A
3	SRD 915	902	0.0007	N/A	N/A	N/A
Summation			0.0212	N/A	N/A	N/A

Table 13 – 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, 0.2 m.

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 12	699	0.1017	N/A	N/A	N/A
2	BLE	2402	0.0010	N/A	N/A	N/A
3	SRD 915	902	0.0033	N/A	N/A	N/A
Summation			0.1060	N/A	N/A	N/A

Table 14 – FCC General Public Combined Exposure

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



Configuration 11: LTE BAND 5 + SRD915 + BLE

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 5	824	0.0152	N/A	N/A	N/A
2	BLE	2402	0.0002	N/A	N/A	N/A
3	SRD 915	902	0.0007	N/A	N/A	N/A
Summation			0.0160	N/A	N/A	N/A

Table 15 – 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, 0.2 m.

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 5	824	0.0758	N/A	N/A	N/A
2	BLE	2402	0.0002	N/A	N/A	N/A
3	SRD 915	902	0.0007	N/A	N/A	N/A
Summation			0.0801	N/A	N/A	N/A

Table 16 – 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, 0.2 m.

Configuration 12: LTE BAND 13 + SRD915 + BLE

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 13	777	0.0212	N/A	N/A	N/A
2	BLE	2402	0.0002	N/A	N/A	N/A
3	SRD 915	902	0.0007	N/A	N/A	N/A
Summation			0.0220	N/A	N/A	N/A

Table 17 – 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, 0.2 m.



Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
1	LTE Band 13	777	0.1058	N/A	N/A	N/A
2	BLE	2402	0.0010	N/A	N/A	N/A
3	SRD 915	902	0.0033	N/A	N/A	N/A
Summation			0.1101	N/A	N/A	N/A

Table 18 – FCC General Public Combined Exposure

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

2.4 Far Field Region Boundary Results

The far field region boundary calculation result is shown in Table 8:

Near Field / Far Field Boundary	
RAT Name	Antennas - on axis Far Field Region (Ref: IEEE C95.3 Annex B.2)
	$2D^2/\lambda$ (m)
LTE Band 2	0.0521
LTE Band 4	0.0482
LTE Band 12	0.0197
LTE Band 5	0.0232
LTE Band 13	0.0219
BLE	0.0019
SRD 915	0.0038

Table 19 – Far Field Boundary

The maximum far field boundary is 0.0521 m. The 0.2 m compliance boundary is beyond this distance and in the far field and therefore the approach described in section 2.1 is valid.

2.5 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 0.



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ANNEX A

REGIONAL REQUIREMENTS



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.1 – CFR 47 Pt1.1310 (2016) 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.2 – CFR 47 Pt1.1310 (2016) General Public Limits

Note 1: The calculations and limits presented in this report for power density are in units of W/m². The conversion factor is; 1 mW/cm² = 10 W/m².