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Verification of Maximum Permissible Exposure (MPE) Limits

FCC ID: SDBEZL01

IC: 2220A-EZL01

Report On

Manufacturer: Sensus Metering Systems
Model: 5396390010002

FCC Rule Part: CFR 47 Part 2 Subpart J, Part 1091
ISED Canada's Radio Standards Specification: RSS-102, Issue 5

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REPORT ON	Verification of Maximum Permissible Exposure (MPE) Limits Sensus Metering Systems, Inc. Model: 5396390010002
TEST REPORT NUMBER	RD72131541.200
REPORT DATE	06. October 2017
PREPARED FOR	Sensus Metering Systems, Inc. 639 Davis Drive Morrisville, NC 27560
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DATED	10. October 2017

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SECTION 1

REPORT SUMMARY

Verification of Maximum Permissible Exposure (MPE) Limits
Sensus Metering Systems
Model: 5396390010002

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Sensus Metering Systems, Inc., Model: 5396390010002 to the requirements of the FCC CFR 47 Part 2 Subpart J, Part 1091, and the Canadian ISED Standard RSS-102, Issue 5 for a class 2 permissive change due to the use of a passive duplexer supporting the band 930-931 Mhz.

Objective	To perform Maximum Permissible Exposure (MPE) power density measurements to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Sensus Metering Systems, Inc.
Model Name	Easylink
Part Number(s)	5396390010002
Serial Number(s)	EZ117 (MAC ID: 0006667F1D32)
Number of Samples Tested	1
Date sample(s) received	13. July 2017
Input Voltage Used/Verified	12 VDC
Start of Test	18. September 2017
Finish of Test	21. September 2017
Name of Engineer(s)	Jean Tezil
Related Document(s)	None

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with standards listed in Section 1.1 is shown below.

1.2.1 Standalone transmission

Table 1.2.1-1: Summary of Results

Transceiver	Frequency band (MHz)	# of Test Channels	Passenger (mW/cm^2)	Bystander (mW/cm^2)	Results Pass/Fail
ERT	952-960	1	0.003	0.028	Pass
FlexNet	930-931	1	0.003	0.018	Pass
	940-941.5	(See Original filing for FCC ID: SDBEZL01)			
*Bluetooth	N/A	N/A	N/A	N/A	N/A

*Note Results not required per KDB 447498

1.2.2 Simultaneous transmission

FCC MPE Summation = 0.073 < 1
ISED MPE Summation = 0.163 < 1

Note: See Tests details section 2 for calculations

1.3 REFERENCED STANDARDS AND GUIDELINES

• United States Federal Communications Commission, Code of Federal Regulations; Rule Part 47CFR § 1.1310, § 2.1091 (d) and § 2.1093 for RF Exposure, where applicable.
• Federal Communications Commission, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields", OET Bulletin 65 (Edition 9701), FCC, Washington, D.C.: August 1997.
• American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) C95. 1-1999
• American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) C95. 1-1992. Specific to FCC rules and regulations.
• Institute of Electrical and Electronics Engineers (IEEE) C95.3-2002
• International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
• Ministry of Health (Canada) Safety Code 6 (2015), Limits of Human Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz
• RSS-102 (Issue 5) – Radio Frequency (RF) Exposure Compliance of Radio Communication Apparatus (All Frequency Bands)
• FCC KDB – 447498 D01 General RF Exposure Guidance v06
• FCC KDB – 865664 D02 RF Exposure Reporting v01r02

1.4 POWER DENSITY LIMITS

Table 1.4-1 – General Population / Uncontrolled Exposure Limits

Frequency Range (MHz)	FCC OET Bulletin 65 mW/cm^2	ICNIRP W/m^2	IEEE C95.1 1992/1999 mW/cm^2	IEEE C95.1 2005 W/m^2	RSS-102 Issue 5 2015 W/m^2
10 - 20					2.0
20 – 48					$8.944 / f^{0.5}$
30 – 300	0.2				
48 – 300					1.291
10 – 400		2.0			
100 – 300			0.2		
100 – 400				2.0	
300 – 1,500	f/1,500				
300 – 6000					$0.02619 f^{0.6834}$
400 – 2,000		f/200		f/200	
300 – 15,000			f/1,500		

Table 1.4-1 (Cont.) – General Population / Uncontrolled Exposure Limits

Frequency Range (MHz)	FCC OET Bulletin 65 mW/cm^2	ICNIRP W/m^2	IEEE C95.1 1992/1999 mW/cm^2	IEEE C95.1 2005 W/m^2	RSS-102 Issue 5 2015 W/m^2
1,500 – 15,000					
1,500 – 100,000	1.0				
2,000 – 100,000				10.0	
2,000 – 300,000		10.0			
6,000 – 15,000					10.0
15,000 – 150,000					10.0
150,000 - 300,000					$6.67\times10^{-5} f$

1.4.1 Number of Test Channels

The number of test channels is determined by using Equation 1 below. This equation is available in FCC's KDB 447498. The test channels are appropriately spaced across the antenna's frequency range.

Equation 1 – Number of test channels Nc = Round {[100(fhigh – flow)/fc]0.5 x (fc / 100)0.2}

where Nc is the number of test channels, fhigh and flow are the highest and lowest frequencies within the transmission band, fc is the mid-band frequency, and frequencies are in MHz.

1.5 PRODUCT INFORMATION

1.5.1 EUT General Description

The EasyLink is a Full Duplex Capable XCVR intended for use in drive-by applications. The device is intended to extend the capabilities of the existing Flexnet VGB to allow reading of Itron ERT endpoints. The device incorporates a Flexnet Collector and a ERT Collector into a single enclosure. The device also contains a pre-approved Bluetooth transceiver, FCC ID: T9J-RN42.

Flexnet Antenna: OMNI PCTEL MUF9115 / 3.41dBi
ERT Antenna: OMNI Laird B8965CN / 3dBi
Bluetooth Antenna: Patch (Panel Mount) / 3dBi
Minimum antenna cable length: 12 Ft

Photo 1.5.1-1 – Top View

1.6 EUT TEST CONFIGURATION

1.6.1 Test Configuration Description

Test Configuration	Description
Default	Transmitting continuously.

1.6.2 EUT Exercise Software

The EUT was conditioned by the manufacture's application to transmit a CW continuous signal at the specified frequency.

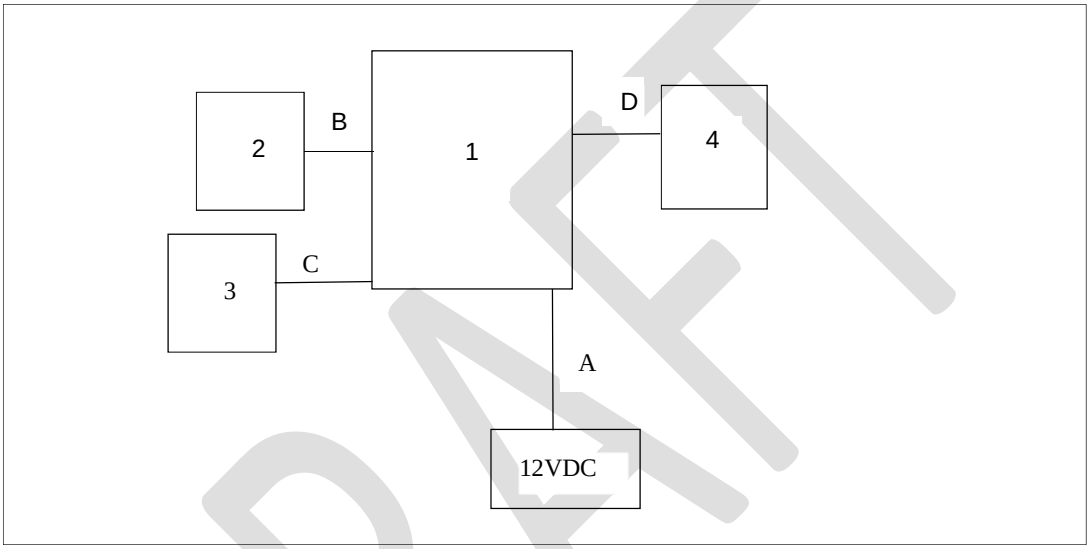

Table 1.6.2-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Sensus	539639001000	0006667F1D32
2	Antenna	LAIRD	B8965CN	TUV 5
3	Antenna	PCTEL	MUF9115	TUV 6
4	Antenna	Trimble	66800-52 D	21172668

Table 1.6.2-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Power Cable	1.8m	No	2 to 1
B	Antenna Cable	3.7m	Yes	3 to 1
C	Antenna Cable	3.7m	Yes	4 to 1
D	Antenna Cable	5.0m	Yes	5 to 1

1.6.3 Deviations from the Standard

No deviations from the standard were taken.

1.6.4 Modification Record

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: 0006667F1D32		
No modifications were required.	N/A	N/A

The table above details modifications made to the EUT during the test program.

1.7 TEST METHODOLOGY

1.7.1 External/Bystander vehicle MPE measurements

The ERT and Flexnet antennas are located at the center of the roof with respect to the sides and front/back of the vehicle. Per the manufacturer, The ERT and the Flexnet may be installed very closed to each other, therefore they were tested at 10cm behind each other, both centered with respect to the car sides.

MPE measurements for bystander (BS) conditions are determined by taking the average of (10) measurements in a 2m vertical line for the test location indicated in Appendix A with 20cm increments at the test distance of 100cm from the antenna under test. The measurement probe is positioned orthogonal to antenna (typically parallel to ground with a vertically mounted antenna) and aimed directly at the antenna's axis. These measurements are representative of persons other than the operator standing next to the vehicle.

Note: Actual test distance was approximately 100cm from centered roof-mounted antenna to the probe element (80cm from antenna to edge of car door and 20cm from the edge of the car door to the probe sensor); this is the closest distance that can be achieved to a centered roof-mounted antenna used for MPE compliance assessment herein.

1.7.2 Internal/Passenger vehicle MPE measurements

The antennas are maintained in the same setup as for the bystander test.

MPE measurements for front seat passenger (FSP) and back seat passenger (BSP) conditions are determined by taking the average of the (3) measurements (Head, Chest, and Lower Trunk) inside the vehicle for both the front and back seats.

The backseat is a bench seat and therefore each position (Head, Chest & Lower Trunk) were scanned across (horizontally) the seat starting from the middle of the seat to the edge of the seat stopping 20 cm from the vehicle door. Similar process was used in the front bucket seat.

The probe handle is oriented parallel (horizontal) to the ground and pointed towards the back of the vehicle. The probe handle is not oriented normal to the seat surface. The probe head (incorporating the field sensors) is scanned continuously (using the max-hold function available in the meter) along three test axes which are parallel to the seat angle (intended as the line determined by the intersection of the plane of the seat and the plane of the backrest) and are 20 cm from the seat surface. One test axis is at the Head height, another is at the Chest height, and another is at the Lower Trunk height. The maximum field level value recorded for each test axis is logged. The MPE is determined by averaging these three maximum values regardless of the geometrical location where they were observed. For instance, the locations of the three maxima may lie on different vertical (relative to ground) lines.

This approach leads to results that are representative of the exposure of vehicle occupants since it is based on an average across the body portions closest to the antenna for both trunk and roof mount positions, and is conservatively biased because the highest results for each test axis are combined, e.g. the highest head exposure could be in the middle of the seat while the highest lower trunk exposure could be closer to the door.

1.7.3 MPE Calculations

The final MPE results for this mobile radio are presented in section 2. These results are based on 100% duty cycle for the FlexNet and ERT.

Below is an explanation of how the MPE results are calculated. Refer to Appendix A for MPE measurement results and calculations.

External to vehicle (Bystander) - 10 measurements are averaged over the body.
Internal to vehicle (Passengers) - 3 measurements are averaged over the body.

The Average over Body test methodology is consistent with IEEE/ANSI C95.3-2002 guidelines.

Therefore;

Equation 1 – Power Density Calculation *(Calc._P.D.)*

Calc._P.D. = (*Average*) *(*probe_cal_factor*) *(Tx_*duty_factor*)

Note1: Linear interpretation was used to determine "probe_cal_factor" for the specific test frequencies.

1.8 TEST FACILITY

1.8.1 FCC – Site Registration

The TÜV SÜD America Inc. (Durham), test facility has been registered with the Federal Communication Commission as an ISO/IEC 17025 accredited test laboratory and assigned the designation number 637011.

1.8.2 Canadian ISED Site Registration

The TÜV SÜD America Inc. (Durham), test facility has been registered with Innovation, Science and Economic Development Canada and assigned the site number 20446.

1.9 MEASUREMENT EQUIPMENT

Table 1.9-1 - Equipment

Asset number	Equipment Type	Model #	S/N	Calibration Date	Calibration Due Date
N/A	Automobile	2017 Honda Civic, 4-Door	N/A	N/A	N/A
3122	Probe – E-field	EMR-300	O-0073; R-0081	04/20/2017	04/20/2018

Power density measurements are in mW/cm^2.

SECTION 2

MAXIMUM PERMISSIBLE EXPOSURE (MPE) TEST DETAILS

Verification of Maximum Permissible Exposure (MPE) Limits
Sensus Metering Systems
Model: 5396390010002

2.1 MAXIMUM PERMISSIBLE EXPOSURE (MPE) POWER DENSITY LEVEL

2.1.1 Specification Reference

CFR 47 Part 2.1091

2.1.2 Test Methodology

KDB 447498 D01 v06

2.1.3 Test Limits

Limits described in Section 1.5 of this test report.

2.1.4 Equipment Under Test and Modification State

Serial No: 0006667F1D32 / Default Configuration

2.1.5 Date of Test/Initial of test personnel who performed the test

21. September 2017/ JET

2.1.6 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 1.1

2.1.7 Environmental Conditions

Ambient Temperature	+35 °C
Relative Humidity	54 %

2.1.8 Test Results

Standalone Transmission:

Table 2.1.8-1 – Maximum Permissible Exposure (MPE) Results - Bystander

Test Position	Angle	Transceiver	Range (MHz)	Tx Pwr (dBm)	Tx Freq (MHz)	Calc. P.D. (mW/cm²)	FCC Limit (mW/cm²)	% To FCC Limit	IC Limit (mW/cm²)	% To IC Limit
BS	0°	ERT	952-960	37.32	952	0.028	0.635	4	0.284	10
		FlexNet	930-931	36.15	930.5	0.018	0.620	3	0.280	6
	30°	ERT	952-960	37.32	952	0.028	0.635	4	0.284	10
		FlexNet	930-931	36.15	930.5	0.017	0.620	3	0.280	6
	60°	ERT	952-960	37.32	952	0.018	0.635	3	0.284	6
		FlexNet	930-931	36.15	930.5	0.008	0.620	1	0.280	3
	90°	ERT	952-960	37.32	952	0.008	0.635	1	0.284	3
		FlexNet	930-931	36.15	930.5	0.005	0.620	1	0.280	2

Table 2.1.8-2 – Maximum Permissible Exposure (MPE) Results - Front Seat Passenger

Test Position	Transceiver	Range (MHz)	Tx Pwr (dBm)	Tx Freq (MHz)	Calc. P.D. (mW/ cm^2)	FCC Limit	% To FCC Limit	IC Limit	% To IC Limit
FSP	ERT	952-960	37.32	952	0.003	0.635	0	0.284	1
	FlexNet	930-931	36.15	930.5	0.003	0.620	0	0.280	1

Table 2.1.8.3 – Maximum Permissible Exposure (MPE) Results - Back Seat Passenger

Test Position	Transceiver	Range (MHz)	Tx Pwr (dBm)	Tx Freq (MHz)	Calc. P.D. (mW/ cm^2)	FCC Limit	% To FCC Limit	IC Limit	% To IC Limit
BSP	ERT	952-960	37.32	952	0.003	0.635	0	0.284	1
	FlexNet	930-931	36.15	930.5	0.003	0.620	1	0.280	1

2.1.9 Assessment of Bluetooth Radio and Simultaneous Transmission

The Bluetooth antenna is located in the control head of the unit therefore Basic Restriction SAR was used for exposure conditions less than 20cm.

Bluetooth transmitter qualifies for the standalone SAR exclusion.

Per guidelines in KDB 447498 section 4.3.1, the following formula was used to determine the test exclusion for standalone Bluetooth transmitter;

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] *[√F(GHz)]

Where for Bluetooth according to the original filing FCC ID: T9J-RN42

Max. power = 5.51dBm or 3.56 mW
Min. test separation distance = 50mm
F(GHz) = 2.402 GHz
= 0.11, which is ≤ 3 for 1-g SAR therefore the standalone exclusion applies for Bluetooth.

Per guidelines in KDB 447498 section 4.3.2, the following formula was used to determine the estimated SAR of an antenna that transmits simultaneously with other antennas:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] *[√F(GHz)/X]

= 0.01 which is < 0.4 W/kg (1g)

Where:
X = 7.5 for 1g-SAR; 18.75 for 10g
Max. power = 3.56 mW
Min. test separation distance = 50 mm
F(GHz) = 2.462 GHz

2.1.9.1 Calculation for the MPE summation for bystanders.

MPE ratio for the ERT radio at 952 MHz for bystander
FCC: 0.028 mW/cm2 / 0.635 mW/cm2 = 0.044
ISED: 0.028 mW/cm2 / 0.284 mW/cm2 = 0.099

MPE ratio for the FlexNet at 930.5 MHz for bystander
FCC: 0.018 mW/cm2 / 0.620 mW/cm2 = 0.029
ISED: 0.018 mW/cm2 / 0.280 mW/cm2 = 0.064

Test Position	Transceiver	FCC MPE Ratio	ISED MPE Ratio
BS	ERT	0.044	0.099
	FlexNet @ 930.5MHz	0.029	0.064
	MPE ratio Summation	**0.073 < 1**	**0.163 < 1**

2.1.9.2 Calculation for the MPE summation for passengers.

Pursuant to the guidance in KDB 447498 Section 7.2, the simultaneous transmission test exclusion applies if:

"The [Σ of (the highest measured or estimated SAR for each standalone antenna configuration, adjusted for maximum tune-up tolerance) / 1.6 W/kg] + [Σ of MPE ratios] is ≤ 1.0."

MPE ratio of the Bluetooth radio at 2402 MHz:
Σ Highest Estimated SAR (Bluetooth) / 1.6 = 0.01 / 1.6 = 0.006

MPE ratio for the ERT radio at 952 MHz for front seat passenger
FCC: 0.003 (mW/cm2) / 0.635 (mW/cm2) = 0.005
ISED: 0.003 (mW/cm2) / 0.284 (mW/cm2) = 0.011

MPE ratio for the FlexNet at 930.5 MHz for front seat passenger
FCC: 0.003mW/cm2 / 0.620 (mW/cm2) = 0.005
ISED: 0.003 (mW/cm2) / 0.280 (mW/cm2) = 0.011

Test Position	Transceiver	FCC MPE Ratio	ISED MPE Ratio
FSP	ERT	0.005	0.011
	FlexNet @ 930.5MHz	0.005	0.011
	Bluetooth	0.006	0.006
	MPE ratio Summation	**0.016 < 1**	**0.028<1**

2.1.10 Test Setup Photos

Photo 2.1.10-1 – Bystander at 0 degree - Test Set-up

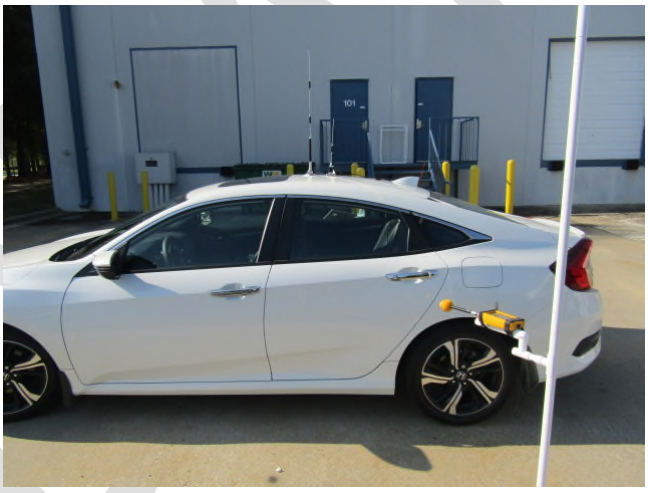

Photo 2.1.10-2 – Bystander at 30 degrees - Test Set-up

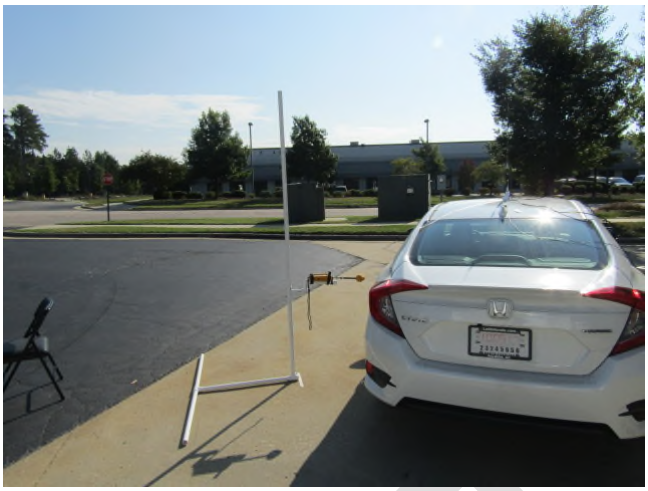

Photo 2.1.10-3 – Bystander at 60 degrees - Test Set-up

Photo 2.1.10-4 – Bystander at 90 degrees - Test Set-up

Photo 2.1.10-5 – Passenger in back seat - Test Set-up

2.2 MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) k = 1.96 which provide confidence levels of 95%.

RF Isotropic E-Field Probes - Triplate -Frequency Response: 10 kHz to 1GHz
CMC** (+/-): 0.89 dB
RF Isotropic E-Field Probes – Anechoic Chamber - Frequency Response (1 to 18) GHz
CMC** (+/-): 1.1 dB

** Calibration and Measurement Capability (CMC)

Appendix A

MPE MEASUREMENT RESULTS AND CALCULATIONS

Table A-1 – Maximum Permissible Exposure (MPE) Results - Bystander

Test Position	Angle	Transceiver	Range (MHz)	Tx Pwr (dBm)	Tx Freq (MHz)	Prob Cal Factor	Tx Duty factor	20 cm	40 cm	60 cm	80 cm	100 cm	120 cm	140 cm	160 cm	180 cm	200 cm	Average	Calc. P.D. (mW/ cm²)
BS	0°	ERT	952-960	37.32	952	0.72	1	0.001	0.002	0.003	0.009	0.007	0.026	0.113	0.115	0.083	0.026	0.038	0.028
		FlexNet	930-931	36.15	930.5	0.67	1	0.001	0.001	0.003	0.005	0.008	0.020	0.036	0.058	0.064	0.075	0.027	0.018
	30°	ERT	952-960	37.32	952	0.72	1	0.001	0.003	0.007	0.012	0.014	0.035	0.092	0.107	0.078	0.039	0.039	0.028
		FlexNet	930-931	36.15	930.5	0.67	1	0.001	0.002	0.004	0.007	0.009	0.025	0.043	0.068	0.048	0.047	0.025	0.017
	60°	ERT	952-960	37.32	952	0.72	1	0.001	0.003	0.005	0.008	0.017	0.028	0.052	0.052	0.053	0.029	0.025	0.018
		FlexNet	930-931	36.15	930.5	0.67	1	0.003	0.001	0.002	0.006	0.008	0.015	0.024	0.014	0.026	0.021	0.012	0.008
	90°	ERT	952-960	37.32	952	0.72	1	0.001	0.002	0.004	0.004	0.006	0.012	0.020	0.032	0.016	0.013	0.011	0.008
		FlexNet	930-931	36.15	930.5	0.67	1	0.000	0.001	0.002	0.002	0.004	0.009	0.013	0.026	0.011	0.011	0.008	0.005

Table A-2 – Maximum Permissible Exposure (MPE) Results - Front Seat Passenger

Test Position	Transceiver	Range (MHz)	Tx Pwr (dBm)	Tx Freq (MHz)	Prob Cal Factor	Tx Duty factor	20 cm	40 cm	60 cm	Average	Calc. P.D. (mW/ cm²)
FSP	ERT	952-960	37.32	952	0.72	1	0.003	0.004	0.007	0.004	0.003
	FlexNet	930-931	36.15	930.5	0.67	1	0.003	0.002	0.008	0.005	0.003

Table A-3 – Maximum Permissible Exposure (MPE) Results - Back Seat Passenger

Test Position	Transceiver	Range (MHz)	Tx Pwr (dBm)	Tx Freq (MHz)	Prob Cal Factor	Tx Duty factor	20 cm	40 cm	60 cm	Average	Calc. P.D. (mW/ cm²)
BSP	ERT	952-960	37.32	952	0.72	1	0.003	0.004	0.007	0.004	0.003
	FlexNet	930-931	36.15	930.5	0.67	1	0.006	0.005	0.005	0.005	0.003

Appendix B

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

TÜV SÜD America Inc.'s reports apply only to the specific sample tested under stated test conditions. It is the manufacturer's responsibility to assure the continued compliance of production units of this model. TÜV SÜD America, Inc. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD America, Inc.'s issued reports.

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