MOTOROLA SOLUTIONS

MS ISO/IEC 17025
TESTING
SAMM No.0826

DECLARATION OF COMPLIANCE: MPE ASSESSMENT Part 1 of 3

Motorola Solutions
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Date of Report: 2/5/2018
Report Revision: B

Responsible Engineer:	Saw Sun Hock (EME Engineer)
Report author:	Saw Sun Hock (EME Engineer)
Date(s) Tested:	2/15/2017-3/27/2017
Manufacturer:	Futurecom Systems Group
Date submitted for test:	01/13/2017
DUT Description:	DVR UHF (380-512 MHz), Digital Vehicular Repeater Companion Mobile: APX8500 mobile All Bands (VHF, UHF, 7/800)
Test TX mode(s):	CW (for FM), 802.11 b/g/n (for WLAN)
Max. Power output:	**DVR:** 10W (100% duty cycle) **Companion Mobile:** 50% duty cycle, PTT with below maximum output power 60W (136-174 MHz), 54W (380-484 MHz), 48W (485-512 MHz), 30W (512-520 MHz), 36W (764-805 MHz), 42W (806-870 MHz); 10mW (Bluetooth); 2.5mW (Bluetooth LE); 63.1 mW (WLAN 802.11b), 20 mW (WLAN 802.11g/n)
TX Frequency Bands:	**DVR:** 380-512 MHz **Companion Mobile:** 136-174 MHz; 380-520 MHz; 764-805 MHz; 806-870 MHz; WLAN 2400-2483.5 MHz; Bluetooth 2402-2480 MHz
Signaling type:	FM, TDMA, 802.11b/g/n (WLAN)
Model(s) Tested:	**DVR:** MOBEXCOM DVRS UHF (DQPMDVR4000P, DQPMDVR5000P, DQPMDVR6000P) **Companion Mobile**: M37TSS9PW1AN
Model(s) Certified:	MOBEXCOM DVRS UHF (DQPMDVR4000P, DQPMDVR5000P, DQPMDVR6000P)
Serial Number(s):	16102684; 16030465; 16102751 (DVR) , KLDORDDUC (Companion Mobile)
Classification:	Occupational/Controlled Environment
FCC ID:	**DVR**: LO6-DVRSUHF 406.1-512 MHz **Companion Mobile**: AZ492FT7089 150.8-173.4 MHz, 406.1-512 MHz, 769-775 MHz, 799-824 MHz, 851-869 MHz, 2402-2480 MHz, 2412-2462 MHz This report contains results that are immaterial for FCC equipment approval, which are clearly identified.
IC:	**DVR**:2098B-DVRSUHF **Companion Mobile**:109U-92FT7089 This report contains results that are immaterial for ISED Canada equipment approval, which are clearly identified.

The MPE results clearly demonstrate compliance with FCC Occupational/Controlled RF Exposure limits. FCC rules require compliance for Passengers and Bystanders to the FCC General Population/Uncontrolled limits.

Based on the information and the testing results provided herein, the undersigned certifies that when used as stated in the operating instructions supplied, said product complies with the national and international reference standards and guidelines listed in section 3.0 of this report. This report shall not be reproduced without written approval from an officially designated representative of the Motorola Solutions Inc. EME Laboratory.
I attest to the accuracy of the data and assume full responsibility for the completeness of these measurements.
This reporting format is consistent with the suggested guidelines of the TIA TSB-159 April 2006
The results and statements contained in this report pertain only to the device(s) evaluated herein.

Tiong Nguk Ing
Digitally signed by Tiong Nguk Ing
Date: 2018.03.07 00:37:06 +08'00'

Tiong Nguk Ing
Deputy Technical Manager
Approval Date: 3/7/2018

Document Revision History

Date	Revision	Comments
5/15/2017	A	Initial release
2/5/2018	B	Multiple sections update based on FCC feedback.

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Appendices

1.0 Introduction

This report details the test setup, test equipment and test results of Maximum Permissible Exposure (MPE) performed at Motorola Solutions' outside test site for DVRS UHF (FCC ID: LO6-DVRSUHF) and Companion Mobile radio (FCC ID: AZ492FT7089).

2.0 FCC MPE Summary

Table 1

DVRS UHF (FCC ID: LO6-DVRSUHF) Trunk Mounted Antenna					
Equipment Class	Frequncy Band (MHz)	Passenger		Bystander	
		Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit
TNB	UHF (406.1 – 512 MHz)	0.163	53.0%	0.041	15.2%
Companion Mobile APX8500 (FCC ID: AZ492FT7089) Roof Mounted Antenna					
Equipment Class	Frequncy Band (MHz)	Passenger		Bystander	
		Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit
TNB	VHF (150.8 – 173.4 MHz)	0.127	63.5%	0.081	40.4%
	UHF1 (406.1-470 MHz)	0.056	19.1%	0.042	14.2%
	UHF2 (450-512 MHz)	0.045	13.6%	0.038	11.1%
	7/800 (769-775 MHz; 799-824 MHz;851-869 MHz)	0.027	5.0%	0.033	6.4%
DTS	WLAN (2412-2462 MHz)	0.030	3.01%	0.030	3.01%
Simultaneous Transmissions					
Simultaneous Transmissions conditions		Passenger		Bystander	
		Highest Combine % of limit		Highest Combine % of limit	
DVRS UHF + WLAN + VHF		**119.5%**		47.5%	
DVRS UHF + WLAN + UHF1		75.1%		20.9%	
DVRS UHF + WLAN + UHF2		68.3%		21.4%	
DVRS UHF + WLAN + 7/800		61.0%		20.8%	

3.0 Abbreviations / Definitions

CNR: Calibration Not Required
CW: Continuous Wave
DUT: Device Under Test
EME: Electromagnetic Energy
FHSS: Frequency Hopping Spread Spectrum
FM: Frequency Modulation
MPE: Maximum Permissible Exposure
GPS: Global Positioning System
LMR: Land Mobile Radio
SAR: Specific Absorption Rate
NA: Not Applicable
BS: Bystander

PB: Passenger Back seat
PF: Passenger Front seat
PTT: Push to Talk
WLAN: Wireless Local Area Network
TDMA: Time Division Multiple Access

4.0 Referenced Standards and Guidelines

This product is designed to comply with the following applicable national and international 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 97-01), 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 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB – 865664 D02 RF Exposure Reporting v01r02

5.0 Power Density Limits

Table 2 – Occupational / Controlled 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					10.0
20 – 48					$44.72 / f^{0.5}$
30 – 300	1.0				
48 – 100					6.455
10 – 400		10.0			
100 – 300			1.0	10.0	
100 – 6,000					$0.6455 f^{0.5}$
300 – 1,500	f/300				
300 – 3,000			f/300	f/30	
400 – 2,000		f/40			
1,500 – 15,000					
1,500 – 100,000	5.0				
2,000 – 300,000		50.0			
3,000 – 300,000			10.0	100.0	
6,000 – 15,000					50.0
15000 – 150,000					50.0
150000 –300,000					$3.33\times10^{-4} f$

Table 3 – 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		
1,500 – 15,000					

Table 3 Continued – 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 – 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					$6.67\times10^{-5}\,f$

6.0 N_c 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

$N_c = \text{Round}\ \{[100(f_{high} - f_{low})/f_c]^{0.5} \times (f_c / 100)^{0.2}\}$

where N_c is the number of test channels, f_{high} and f_{low} are the highest and lowest frequencies within the transmission band, f_c is the mid-band frequency, and frequencies are in MHz.

7.0 Measurement Equipment

Table 4 – Equipment

Equipment Type	Model #	SN	Calibration Date	Calibration Due Date
Automobile	Volvo 240-1988	NA	NA	NA
Survey Meter Probe – E-Field Probe – H-Field	ETS Model HI-2200 ETS Model E100 ETS Model H200	00086316 000153632 00206937	5/16/2016	5/16/2017

E-field measurements are in mW/cm^2.
H field measurements are in A/m.

8.0 Measurement System Uncertainty Levels

Table 5 – Uncertainty Budget for Near Field Probe Measurements

	Tol. (± %)	Prob. Dist.	Divisor	u_i (±%)	v_i
Measurement System					
Probe Calibration	7.1	N	1.00	7.1	∞
Survey Meter Calibration	0.0	N	1.00	0.0	¥
Hemispherical Isotropy	8.0	R	1.73	4.6	∞
Linearity	5.0	R	1.73	2.9	∞
Pulse Response	1.0	R	1.73	0.6	∞
RF Ambient Noise	3.0	R	1.73	1.7	∞
RF Reflections	8.0	R	1.73	4.6	∞
Probe Positioning	10.0	R	1.73	5.8	∞
Test sample Related					
Antenna Positioning	3.0	N	1.00	3.0	∞
Power drift	5.0	R	1.73	2.9	∞
Bystander measurement uncertainty	4.8	N	1.00	4.8	∞
Passenger measurement uncertainty	8.1	N	1.00	8.1	∞
Combined Standard Uncertainty		RSS		15.6	∞
Expanded Uncertainty (95% CONFIDENCE LEVEL)		*k*=2		31	

9.0 Product and System Description

MOBEXCOM DVRS UHF (FCC ID: LO6-DVRSUHF) is Digital Vehicular Repeater (DVR) manufactured by Futurecom System Group. At standalone the DVR operates at a maximum power up to 20W, but when the DVR is interfaced to the APX8500 Mobile radio, the maximum power is 10W as listed in Table 6. For more detailed information refer to the Product Safety and RF Energy Exposure Booklet for DVRS Table 6C, 6D, and 6E.

Companion mobile APX8500 (FCC ID: AZ492FT7089) operate in the LMR bands using either frequency modulation (FM) with 100% transmit duty cycle or TDMA signals with maximum of 50% transmit duty cycle. For conservative assessment, FM signal was tested.

Table 6 – Bands, Duty Cycle and Maximum power

Devices	Bands (MHz)		Duty Cycle (%)	Max power (W)
DVR UHF (FCC ID:LO6- DVRSUHF)	380-512		100% (Repeater)	10
Companion Mobile APX8500 All bands (FCC ID: AZ492FT7089)	136-174 (VHF band)		50% (PTT)	60
	380- 470 (UHF1) 450- 520 (UHF2)	380–484	50% (PTT)	54
		485-512	50% (PTT)	48
		512-520	50% (PTT)	30
	764-805 ; 806-870 (7/800 band)	764-805	50% (PTT)	36
		806-870	50% (PTT)	42
	2400 – 2483.5 (WLAN 802.11 b, g, n)		99. 87% (802.11 b) 99.20% (802.11 g) 99.17% (802.11 n)	0.0631 (802.11 b) 0.020 (802.11 g) 0.020 (802.11 n)

In addition to standalone operation, is capable of interfacing to a companion mobile radio using serial data protocol for audio and control. The DVRS can operate in the following modes: OFF mode– DVRS repeat is not required; LOCAL mode–with portable-to-portable repeat and network monitoring capabilities; and SYSTEM mode – outbound calls received by mobile radio are repeated by DVRS. Inbound calls received by DVRS are repeated locally (portable-to-portable) as well as to the system users (by keying up the mobile radio).

This test report covers the RF exposure performance of the DVR FCC ID: LO6-DVRSUHF interfaced with, and transmitting simultaneously with Companion Mobile radio FCC ID: AZ492FT7089. DVR operate in repeater; transmit with duty cycle up to 100%. A duty factor of 50% applies for companion mobile with PTT operating mode.

Companion mobile can transmitting only one LMR band at once. Table 7 lists all the simultaneous transmission conditions.

Table 7 – Simultaneous transmission conditions

Simultaneous transmission conditions	DVRS UHF	Companion Mobile APX8500 All bands (VHF, UHF, 7/800)				
	UHF [380-512 MHz]	WLAN 2.4 GHz	VHF [136-174 MHz]	UHF1 [380-470 MHz)	UHF2 [450-520 MHz]	7/800 [764-805 MHz; 806-870 MHz]
DVRS UHF + WLAN + VHF	x	x	x			
DVRS UHF + WLAN + UHF1	x	x		x		
DVRS UHF + WLAN + UHF2	x	x			x	
DVRS UHF + WLAN + 7/800	x	x				x

x: Simultaneous transmitting antennas

This device will be marketed to and used by employees solely for work-related operations. User training is the responsibility of these organizations. The Product Safety and RF Energy Exposure Booklet for Digital Vehicular Repeater Systems (DVRS) contains all the information necessary to inform the organization and its employees in safe usage and for creating training materials or conducting instructional sessions for those employees.

Accordingly this product is classified as Occupational/Controlled Exposure. However, in accordance with FCC requirements, the passengers inside the vehicle and the bystanders external to the vehicle are evaluated to the General Population/Uncontrolled Exposure Limits.

(Note that "Bystanders" as used herein are people other than operator)

10.0 Additional Options and Accessories

Not available.

11.0 Test Set-Up Description

Assessments were performed with DVR and companion mobile radio installed in the test vehicle, at the specified distances and test locations indicated in sections 12.0, 13.0 and Appendix A.

All antennas described in Table 8 were considered in order to develop the test plan for this product. Antennas were installed and tested per their appropriate mount locations (Roof / Trunk) and defined test channels. The DVR antenna mounted at center of the trunk (for external/bystander measurement) or toward the center of the trunk at a minimum 85 cm from backseat passenger (for Internal/passenger measurement), and the companion mobile antennas are mounted at the side of the roof (20 cm from the center of the roof).

The system was tested using a low-loss 16' Teflon RG58A/U cable attaching the radio to the transmit antenna. This cable is shorter and lower attenuation than the 17' RG58A/U cables supplied in the customer kits for connecting the radio to the transmit antenna. The cable used in the test setup also has lower attenuation over the test frequency range than the cable provided in the customer kits. The use of a shorter cable with lower attenuation in the test setup ensures that the test data is more conservative with regards to the actual installation. Cable losses are reported in Appendix A.

12.0 Method of Measurement for DVR with trunk mounted antenna(s)

12.1 External/Bystander vehicle MPE measurements

Initially the DVR antenna is located at the center of the trunk. Refer to Appendix A for antenna location and distance.

MPE measurements for bystander (BS) conditions are determined by taking the average of (10) measurements in a 2 m vertical line for each of the (5) bystander test locations indicated in Appendix A with 20 cm height increments, with the distance of 90cm from the test vehicle's body, as stated in the user manual. 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.

12.2 Internal/Passenger vehicle MPE measurements

The DVR antenna is located toward the center of the trunk at a minimum 85 cm from backseat passenger. Refer to Appendix A for antenna location and distance.

MPE measurements for passenger front seat (PF) and backseat (PB) 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 trunk 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.

13.0 Method of Measurement Companion Mobile with roof mounted antenna(s)

Introduction

The installation requirements for this radio indicate that in multiple single-band antenna configurations the antennas should be installed along a transverse line bisecting the roof, with one of the antennas in the center and the remaining two at 8” (20 cm) on each side. We tested all the antennas at one of the lateral positions (8” from the center along the mentioned bisecting line) in order to be closer to the edge of the roof. Additional measurements with antennas placed in the center of the roof are not needed because that placement would increase the distance to bystanders.

13.1 External/Bystander vehicle MPE measurements

Antenna is located at the side of the roof (20 cm from the center of the roof, along the width of the vehicle, driver side). Refer to Appendix A for antenna location and distance.

MPE measurements for bystander (BS) conditions are determined by taking the average of (10) measurements in a 2m vertical line for each of the (5) bystander test locations indicated in Appendix A with 20 cm height increments at the test distance of 90cm from the test vehicle body.
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.

13.2 Internal/Passenger vehicle MPE measurements

Antenna is located at the side of the roof (20 cm from the center of the roof, along the width of the vehicle, driver side). Refer to Appendix A for antenna location and distance. MPE measurements for passenger front seat (PF) and backseat (PB) 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.

14.0 MPE Calculations

The final MPE results for DVR and Companion Mobile are presented in section 16.0. These results are based on 50% duty cycle for Companion Mobile (PTT operation) and 100% duty cycle for DVR (repeater operation).

Below is an explanation of how the MPE results are calculated. Refer to Appendix I for DVR UHF; Appendix J, K, L and M for Companion Mobile LMR bands VHF, UHF1, UHF2 and 7/800.

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

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

Therefore;

Equation 2 – Power Density Calculation *(Calc._P.D.)*

$$Calc.\_P.D. = (Avg\_over\_body) * (probe\_frequency\_cal\_factor) * (duty\_cycle)$$

Note 1: The highest "average" cal factors from the calibration certificates were selected for the applicable frequency range. Linear interpretation was used to determine "probe_frequency_cal_factor" for the specific test frequencies.

Note 2: The E-field probe calibration certificate's frequency cal factors were determined by measuring V/m. The survey meter's results were measured in power density (mW/cm^2) and therefore the "probe_frequency_cal_factor" was squared in equation 2 to account for these results.

Note 3: The H-field probe calibration certificate's frequency cal factors were determined by measuring A/m. The survey meter's results were measured in A/m and therefore the "Avg_over_body" A/m results were converted to power density (mW/cm^2) using the equation 3. H-field measurements are only applicable to frequencies below 300MHz.

Equation 3 – Converting A/m to mW/cm^2

$$mW/cm\text{^}2 = (A/m)\text{^}2 * 37.699$$

Equation 4 – Power Density Maximum Calculation

$$Max\_Calc.\_P.D. = P.D.\_calc * \frac{\max\_output\_power}{initial\_output\_power}$$

Note 4: For initial output power> max_output_power; max_output_power / initial output power = 1

15.0 Antenna Summary

Table below summarizes the tested or evaluated antennas and their descriptions, mount location (roof/trunk), overlap of FCC bands, number of test channels per FCC KDB 447498 (FCC N_c). This information was used to determine the test configurations presented in this report.

Table 8 – Antennas

Antenna No.	Antenna Model	Frequency Range (MHz)	Physical Length (cm)	Gain (dBi)	Remarks	Mount Location (Roof/ Trunk)	Overlap FCC Bands (MHz)	FCC N_c
DVR UHF								
1	HAE6012A	380-433	18.2	2.15	1/4 wave	Trunk	406.1-430	3
2	HAE4003A	450-470	16.0	2.15	1/4 wave	Trunk	450-470	3
4	HAE4004A	470-512	15.0	2.15	1/4 wave	Trunk	470-512	4
Companion Mobile								
5	AN000131A01	136-870	55.7	2.15	1/4 wave	Roof	150.8-173.4 (VHF)	4
						Roof	406.1- 470 (UHF1)	5
						Roof	450-512 (UHF2)	5
						Roof	769-775; 799-824; 851-869 (7/800)	7
6	PMAN5100A	2400-2500	5.7 (L) x 1.9 (W)	6			2412-2462	3

16.0 Test Results Summary

16.1 MPE Test Results Summary for DVR and Companion Mobile (LMR)

Refer to the following appendices for MPE test results for each test configuration: antenna location, test positions (BS1-Bystander test location #1, BS2-Bystander test location #2, BS3-Bystander test location #3, BS4-Bystander test location #4, BS5-Bystander test location #5, PB-Passenger Backseat, PF-Passenger Front seat), E/H field measurements, antenna model & freq. range, maximum output power, initial power, TX frequency, max calculated power density results, applicable FCC/ ISED Canada specification limits and % of the applicable specification limits.

- Appendix D for DVR UHF
- Appendix E, F, G and H for Companion Mobile

Table 9 summarized the highest maximum calculated power density and highest % of the applicable specification limit for each standalone transmitters (DVR, Companion Mobile).

Table 9

Test Positions	DVRS UHF		Companion Mobile APX8500							
	UHF (380-512 MHz)		VHF (136-174 MHz)		UHF1 (380-470 MHz)		UHF2 (450-520 MHz)		7/800 (764-870 MHz)	
	Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit
FCC US										
Passenger, Front Seat (PF)	0.044	16.1%	0.063	31.4%	0.008	2.5%	0.045	13.6%	0.008	1.5%
Passenger, Back Seat (PB)	0.163	53.0%	0.127	63.5%	0.056	19.1%	0.037	12.3%	0.027	5.0%
Bystander #1 (BS-1)	0.010	3.2%	0.081	40.4%	0.042	14.2%	0.038	11.1%	0.033	6.4%
Bystander #2 (BS-2)	0.024	7.2%	0.075	37.3%	0.023	8.0%	0.031	9.0%	0.033	6.3%
Bystander #3 (BS-3)	0.028	9.3%	0.052	26.0%	0.019	6.4%	0.021	6.6%	0.021	4.0%
Bystander #4 (BS-4)	0.041	15.2%	0.049	24.7%	0.007	2.7%	0.011	3.2%	0.014	2.6%
Bystander #5 (BS-5)	0.036	13.2%	0.034	16.8%	0.005	1.7%	0.007	2.1%	0.007	1.5%
ISED Canada										
Passenger, Front Seat (PF)	0.044	27.5%	0.063	48.6%	0.008	4.5%	0.008	4.5%	0.008	3.3%
Passenger, Back Seat (PB)	0.163	94.1%	0.128	99.3%	0.044	27.7%	0.037	21.7%	0.027	10.6%
Bystander #1 (BS-1)	0.010	5.6%	0.081	63.1%	0.029	17.9%	0.030	17.4%	0.033	13.3%
Bystander #2 (BS-2)	0.016	9.8%	0.075	57.8%	0.021	11.9%	0.021	11.9%	0.033	13.3%
Bystander #3 (BS-3)	0.028	16.3%	0.064	49.3%	0.018	10.5%	0.018	10.5%	0.021	8.3%
Bystander #4 (BS-4)	0.045	26.3%	0.049	38.3%	0.007	4.5%	0.007	3.9%	0.014	5.6%
Bystander #5 (BS-5)	0.036	22.5%	0.034	26.0%	0.004	2.0%	0.004	2.0%	0.008	3.3%

16.2 MPE Test Results for Companion Mobile (WLAN)

WLAN antenna PMAN5100A was intended for mounting on the windshield of the vehicle. The antenna should be installed close to the top, and on the front windshield only. Maximum power for WLAN as shown below:

Maximum power for WLAN = 63.02 mW (63.1 mW *99.87 % duty cycle)

MPE calculation was use to determine power density for these transmitters due to lower power. According to FCC's OET Bulletin 65 Edition 97-01 Section 2, calculations can be made to predict RF field strength and power density levels around typical RF sources. Equation (5) is generally accurate in far-field of an antenna.

Equation 5 – Power Density Calculation

$$S = \frac{P_t G}{4\Pi d^2} F$$

Equation (5) accounts for the maximum duty cycle of the signal, and the factor, F, to provide a worst-case prediction of power density per FCC OET Bulletin 65, Edition 97-01 1997.

Where: S = power density (mW/cm^2)
P_t = maximum output power scaled by the maximum duty cycle of the signal
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
d = distance from antenna
F = Enhancement factor [1 or 2.56 for predicting ground-level field strength]

Table 10 summarized the MPE calculation for WLAN.

Table 10

Antenna #	Max Power (W)	Duty Cycle (%)	Tx Frequency (MHz)	Antenna Gain (dBi)	Cable Loss, L (dB)	Dist., d (cm)	Enhance Factor, F	Max Calc. MPE (mW/cm^2)	MPE Spec Limit (mW/cm^2)			
									FCC	% To FCC Spec Limit	ISED limit	% To ISED Spec Limit
PMAN5100A	0.063	99.87%	2412.0	6.00	2.20	20	1.00	0.03	1.00	3.01	0.54	5.60
PMAN5100A	0.063	99.87%	2437.0	6.00	2.20	20	1.00	0.03	1.00	3.01	0.54	5.57
PMAN5100A	0.063	99.87%	2462.0	6.00	2.20	20	1.00	0.03	1.00	3.01	0.54	5.53

Notes:
1) Distance from antenna (d), 20cm for more conservative estimation.
2) Cable loss (L), 2.2 dB with 17' PFP240 cable (attenuation 12.9 dB/100ft).
3) Numeric gain (G), factor in the cable loss with conversion 10^((dBi-L)/10)
4) Enhancement Factor (F), 1 (Ground reflection already factor in during antenna characterization)

16.3 Simultaneous Transmission

DVR will transmit simultaneously with Companion mobile; refer to Table 7 for all simultaneous transmission conditions.

The combine MPE results for DVR and Companion Mobile were calculated base on the percent of MPE limit for each applicable test channels according to the formula below. This is due to the signals emitted by each individual transmitter are statistically uncorrelated; the collective compliance of the transmitters is determined by summing the individual ratios between actual measured power density (S) and maximum allowed MPE exposure. Compliance is achieved if the total exposure (T) is less than one.

Formula:

$$T = \frac{S_1}{MPE_1} + \frac{S_2}{MPE_2} + ... < 1$$

The highest combined power density percentage of the applicable specification limits are indicating in table 11.

Table 11- Highest Combine MPE % of limits

Test Positions	DVRS UHF	Companion Mobile APX8500					Simultaneous Transmission							
	380-512MHz	WLAN (2.4 GHz)	VHF (136-174 MHz)	UHF1 (380-470 MHz)	UHF2 (450-520 MHz)	7/800 (764-870 MHz)	DVRS + WLAN+LMR_VHF		DVRS + WLAN+LMR_UHF1		DVRS + WLAN+LMR_UHF2		DVRS + WLAN+LMR_7800	
	[1] Highest % of Limit	[2] Highest % of Limit	[3] Highest % of Limit	[4] Highest % of Limit	[5] Highest % of Limit	[6] Highest % of Limit	[1]+[2]+[3] Combine % of Limit	Table No.	[1]+[2]+[4] Combine % of Limit	Table No.	[1]+[2]+[5] Combine % of Limit	Table No.	[1]+[2]+[6] Combine % of Limit	Table No.
FCC US														
Passenger, Front Seat (PF)	16.1%	3.01%	31.4%	2.5%	13.6%	1.5%	50.5%		21.6%		32.7%		20.6%	
Passenger, Back Seat (PB)	53.0%	3.01%	63.5%	19.1%	12.3%	5.0%	**119.5%**	**Table12**	75.1%		68.3%		61.0%	
Bystander #1 (BS-1)	3.2%	3.01%	40.4%	14.2%	11.1%	6.4%	46.6%		20.4%		17.3%		12.6%	
Bystander #2 (BS-2)	7.2%	3.01%	37.3%	8.0%	9.0%	6.3%	47.5%		18.2%		19.2%		16.5%	
Bystander #3 (BS-3)	9.3%	3.01%	26.0%	6.4%	6.6%	4.0%	38.3%		18.7%		18.9%		16.3%	
Bystander #4 (BS-4)	15.2%	3.01%	24.7%	2.7%	3.2%	2.6%	42.9%		20.9%		21.4%		20.8%	
Bystander #5 (BS-5)	13.2%	3.01%	16.8%	1.7%	2.1%	1.5%	33.0%		17.9%		18.3%		17.7%	
ISED Canada														
Passenger, Front Seat (PF)	27.5%	5.60%	48.6%	4.5%	4.5%	3.3%	81.7%		37.6%		37.6%		36.4%	
Passenger, Back Seat (PB)	94.1%	5.60%	99.3%	27.7%	21.7%	10.6%	**199.0%**	**Table13**	**127.4%**	**Table13**	**121.4%**	**Table13**	**110.3%**	**Table13**
Bystander #1 (BS-1)	5.6%	5.60%	63.1%	17.9%	17.4%	13.3%	74.3%		29.1%		28.6%		24.5%	
Bystander #2 (BS-2)	9.8%	5.60%	57.8%	11.9%	11.9%	13.3%	73.2%		27.3%		27.3%		28.7%	
Bystander #3 (BS-3)	16.3%	5.60%	49.3%	10.5%	10.5%	8.3%	71.2%		32.4%		32.4%		30.2%	
Bystander #4 (BS-4)	26.3%	5.60%	38.3%	4.5%	3.9%	5.6%	70.2%		36.4%		35.8%		37.5%	
Bystander #5 (BS-5)	22.5%	5.60%	26.0%	2.0%	2.0%	3.3%	54.1%		30.1%		30.1%		31.4%	

Note: Refer to indicated table no. for result in bold to determine configurations that require SAR simulations.

Table 12 – Combined MPE % of FCC US limit, DVR E field (Passenger, Back Seat)

					[1] DVRS UHF Antenna (Trunk Mounted)									
			E/H Field		E Field									
			DVRS Antenna		HAE6012A, 1/4 Wave (380-433MHz)			HAE4003A, 1/4 Wave (450-470MHz)			HAE4004A, 1/4 Wave (470-512MHz)			
			DVR Freq (MHz)		406.5000	417.5000	429.9875	450.0000	460.0000	470.0000	470.0000	484.0000	498.0000	512.0000
	E/H Field	Companion Mobile Antenna	LMR Freq (MHz)	% of FCC Limit	38.4	32.9	22.5	51.1	53.0	38.5	43.3	49.0	28.6	42.1
[2]+[3] Companion Mobile (roof Mounted)	E Field	AN000131A01, 1/4 wave (136-870MHz)	150.8000	57.0	95.4	89.9	79.5	***108.11**	***110.01**	95.5	***100.31**	***106.01**	85.6	99.1
			158.0125	66.5	***104.91**	99.4	89.0	***117.61**	***119.51**	***105.01**	***109.81**	***115.51**	95.1	***108.61**
			165.0125	39.5	77.9	72.4	62.0	90.6	92.5	78.0	82.8	88.5	68.1	81.6
			173.0125	26.3	64.7	59.2	48.8	77.4	79.3	64.8	69.6	75.3	54.9	68.4
	H Field	AN000131A01, 1/4 wave (136-870MHz)	150.8000	60.9	99.3	93.8	83.4	**#112.01**	**#113.91**	99.4	**#104.21**	**#109.91**	89.5	***103.01**
			158.0125	64.7	**#103.11**	97.6	87.2	**#115.81**	**#117.71**	**#103.21**	**#108.01**	**#113.71**	93.3	**#106.81**
			165.0125	31.7	70.1	64.6	54.2	82.8	84.7	70.2	75.0	80.7	60.3	73.8
			173.0125	13.4	51.8	46.3	35.9	64.5	66.4	51.9	56.7	62.4	42.0	55.5

Notes:
* Configurations require SAR simulations.
# Same SAR simulation configurations as companion mobile E Field.

Table 13 – Combined MPE % of ISED Canada limit, DVR E field (Passenger, Back Seat)

					[1] DVRS UHF Antenna (Trunk Mounted)						
			E/H Field		E Field						
			DVRS Antenna		HAE6012A, 1/4 Wave (380-433MHz)			HAE4003A, 1/4 Wave (450-470MHz)			HAE4004A, 1/4 Wave (470-512MHz)
			DVR Freq (MHz)		406.5000	417.5000	429.9875	450.0000	460.0000	470.0000	470.0000
	E/H Field	Companion Mobile Antenna	LMR Freq (MHz)	% of FCC Limit	65.4	56.6	39.1	90.0	94.1	68.7	77.2
[2]+[3] Companion Mobile (roof Mounted)	E Field	AN000131A01, 1/4 wave (136-870MHz)	**VHF**								
			146.0000	104.90	***170.3**	***161.5**	***144**	***194.9**	***199**	***173.6**	***182.1**
			150.8000	89.30	***154.7**	***145.9**	***128.4**	***179.3**	***183.4**	***158**	***166.5**
			158.0125	104.00	***169.4**	***160.6**	***143.1**	***194**	***198.1**	***172.7**	***181.2**
			165.0125	62.20	***127.6**	***118.8**	***101.3**	***152.2**	***156.3**	***130.9**	***139.4**
			173.0125	41.70	***107.1**	98.3	80.8	***131.7**	***135.8**	***110.4**	***118.9**
			UHF R1								
			406.5000	33.30	98.7	89.9	72.4	***123.3**	***127.4**	***102**	***110.5**
			422.0125	21.90	87.3	78.5	61.0	***111.9**	***116**	90.6	99.1
			450.0125	27.30	92.7	83.9	66.4	***117.3**	***121.4**	96.0	***104.5**
			469.9875	23.60	89.0	80.2	62.7	***113.6**	***117.7**	92.3	***100.8**
			UHF R2								
			450.0125	27.30	92.7	83.9	66.4	***117.3**	***121.4**	96.0	***104.5**
			469.9875	23.60	89.0	80.2	62.7	***113.6**	***117.7**	92.3	***100.8**
			7/800								
			770.0125	13.50	78.9	70.1	52.6	***103.5**	***107.6**	82.2	90.7
			775.9125	11.60	77.0	68.2	50.7	***101.6**	***105.7**	80.3	88.8
			806.0125	16.20	81.6	72.8	55.3	***106.2**	***110.3**	84.9	93.4
			823.9875	14.30	79.7	70.9	53.4	***104.3**	***108.4**	83.0	91.5
			851.0125	11.50	76.9	68.1	50.6	***101.5**	***105.6**	80.2	88.7
			862.0125	9.40	74.8	66.0	48.5	99.4	***103.5**	78.1	86.6
			868.8875	7.70	73.1	64.3	46.8	97.7	***101.8**	76.4	84.9
	H Field	AN000131A01, 1/4 wave (136-870MHz)	**VHF**								
			146.0000	83.30	**#148.7**	**#139.9**	**#122.4**	**#173.3**	**#177.4**	**#152**	**#160.5**
			150.8000	95.20	**#160.6**	**#151.8**	**#134.3**	**#185.2**	**#189.3**	**#163.9**	**#172.4**
			158.0125	101.20	**#166.6**	**#157.8**	**#140.3**	**#191.2**	**#195.3**	**#169.9**	**#178.4**
			165.0125	50.00	**#115.4**	**#106.6**	89.1	**#140**	**#144.1**	**#118.7**	**#127.2**
			173.0125	21.70	87.1	78.3	60.8	**#111.7**	**#115.8**	90.4	98.9

Notes:
* Configurations require SAR simulations.
# Same SAR simulation configurations as companion mobile E Field.

17.0 Conclusion

The assessment for DVR and Companion mobile were performed as indicate in section 16.1 with an output power range listed in Table 6 and WLAN MPE calculation in section 16.2. The maximum allowable output power is equal to the upper limit of the final test factory transmit power specification listed in Table 6. The highest power density results for DVR and Companion Mobile scaled to maximum allowable power output are indicated in Table 14 (FCC US) and Table 15 (ISED Canada) for internal/passenger of to the vehicle, and external/bystander to the vehicle.

These MPE results herein demonstrate compliance to FCC, ISED Canada Occupation/Controlled Exposure limit. However, FCC rules required compliance for Passengers and Bystanders to FCC General Population / Uncontrolled limits. Maximum Combined MPE percentage in bold exceed General Population / Uncontrolled limit.

Table 14 – Maximum MPE RF Exposure Summary (FCC US)

DVRS UHF (FCC ID: LO6-DVRSUHF) Trunk Mounted Antenna					
Equipment Class	Frequncy Band (MHz)	Passenger		Bystander	
		Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit
TNB	UHF (406.1 – 512 MHz)	0.163	53.0%	0.041	15.2%
Companion Mobile APX8500 (FCC ID: AZ492FT7089) Roof Mounted Antenna					
Equipment Class	Frequncy Band (MHz)	Passenger		Bystander	
		Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit
TNB	VHF (150.8 – 173.4 MHz)	0.127	63.5%	0.081	40.4%
	UHF1 (406.1-470 MHz)	0.056	19.1%	0.042	14.2%
	UHF2 (450-512 MHz)	0.045	13.6%	0.038	11.1%
	7/800 (769-775 MHz; 799-824 MHz;851-869 MHz)	0.027	5.0%	0.033	6.4%
DTS	WLAN (2412-2462 MHz)	0.030	3.01%	0.030	3.01%
Simultaneous Transmissions					
Simultaneous Transmissions conditions		Passenger		Bystander	
		Highest Combine % of limit		Highest Combine % of limit	
DVRS UHF + WLAN + VHF		**119.5%**		47.5%	
DVRS UHF + WLAN + UHF1		75.1%		20.9%	
DVRS UHF + WLAN + UHF2		68.3%		21.4%	
DVRS UHF + WLAN + 7/800		61.0%		20.8%	

Note: Result in bold required SAR simulation.

Table 15 – Maximum MPE RF Exposure Summary (ISED Canada)

DVRS UHF (IC:2098B-DVRSUHF) Trunk Mounted Antenna				
Frequncy Band (MHz)	Passenger		Bystander	
	Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit
UHF (406.1-430 MHz ; 450-470 MHz)	0.163	94.1%	0.045	26.3%
Companion Mobile APX8500 (IC: 109U-92FT7089) Roof Mounted Antenna				
Frequncy Band (MHz)	Passenger		Bystander	
	Power Density (mw/cm^2)	Highest % of Limit	Power Density (mw/cm^2)	Highest % of Limit
VHF (138-174 MHz)	0.128	99.3%	0.081	63.1%
UHF1 (406.1-430 MHz ; 450-470 MHz)	0.044	27.7%	0.029	17.9%
UHF2 (450-470 MHz)	0.037	21.7%	0.030	17.4%
7/800 (769-775 MHz; 799-824 MHz;851-869 MHz)	0.027	10.6%	0.033	13.3%
WLAN (2412-2462 MHz)	0.030	5.60%	0.030	5.60%
Simultaneous Transmissions				
Simultaneous Transmissions conditions	Passenger		Bystander	
	Highest Combine % of		Highest Combine % of	
DVRS UHF + WLAN + VHF	**199.0%**		74.3%	
DVRS UHF + WLAN + UHF1	**127.4%**		36.4%	
DVRS UHF + WLAN + UHF2	**121.4%**		35.8%	
DVRS UHF + WLAN + 7/800	**110.3%**		37.5%	

Note: Result in bold required SAR simulation.

Although MPE is a convenient method of demonstrating RF Exposure requirements, SAR is recognized as the "basic restriction". For those configurations indicate with "*" in Table 12 and Table 13, compliance to the General Population / Uncontrolled SAR 1g limit of 1.6 W/kg is demonstrated through SAR computational analysis.

The computational results show that this DVR UHF device, when used with Companion Mobile radio APX8500 and specified antennas, exhibit a maximum combine SAR are indicated in the Table 16.

Table 16

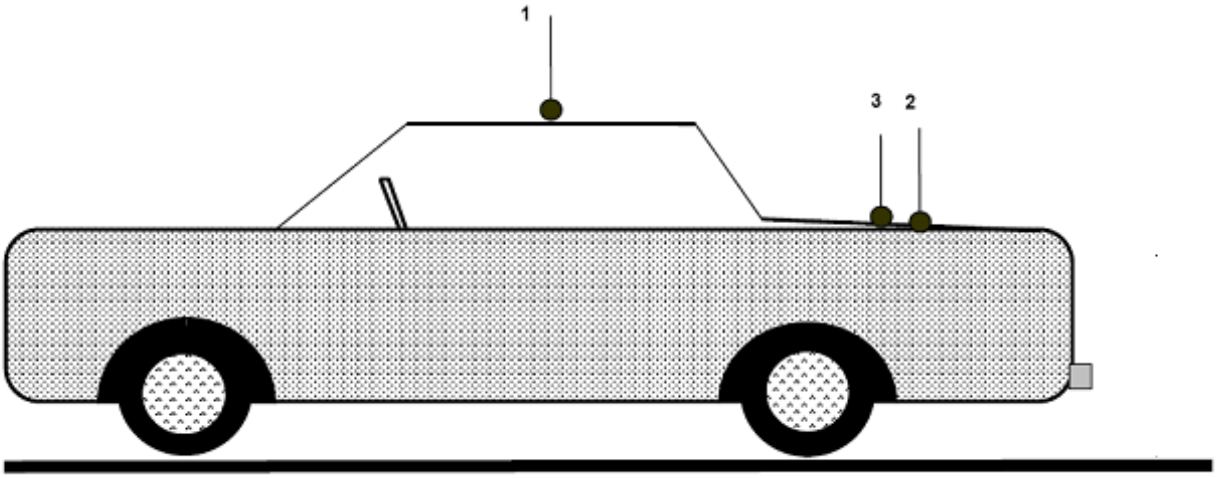
	Exposure Conditions	Combined SAR (W/kg)	
		1-g	WB
FCC	Passenger Back	0.93	0.024
ISED	Passenger Back	1.04	0.035

18.0 User Instructions Considerations

In order to facilitate the requirements for occupational exposure limits), the Safety Manual for this radio requires the radio operator to maintain 90 cm in all directions between the vehicle and external persons while transmitting.

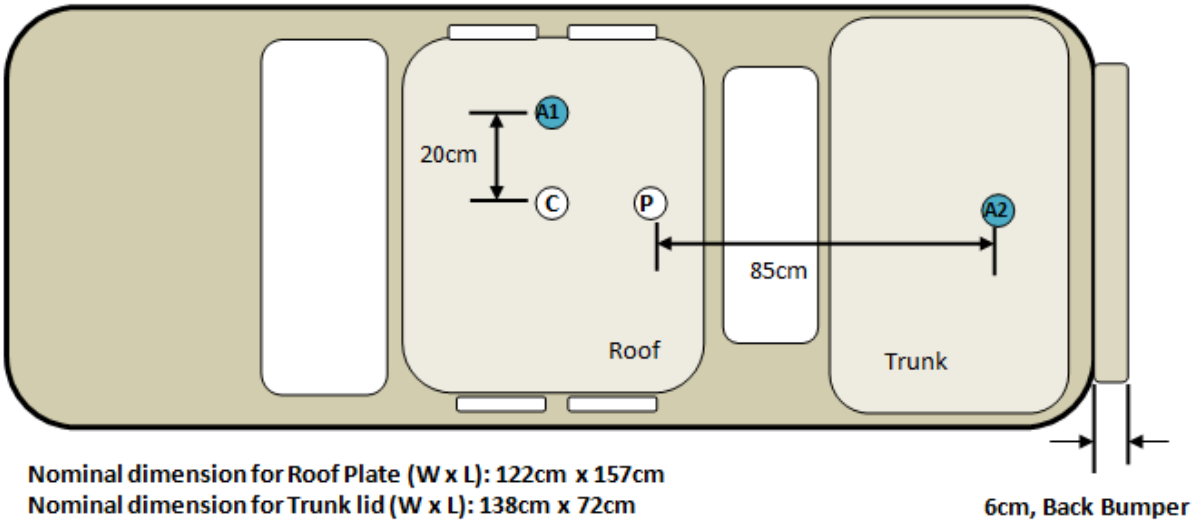
Appendix A - Antenna Locations, Test Distances, and Cable Losses

Antenna locations



1. Roof (20cm from center)
2. Trunk (85cm from back of the back seat)
3. Trunk (center)

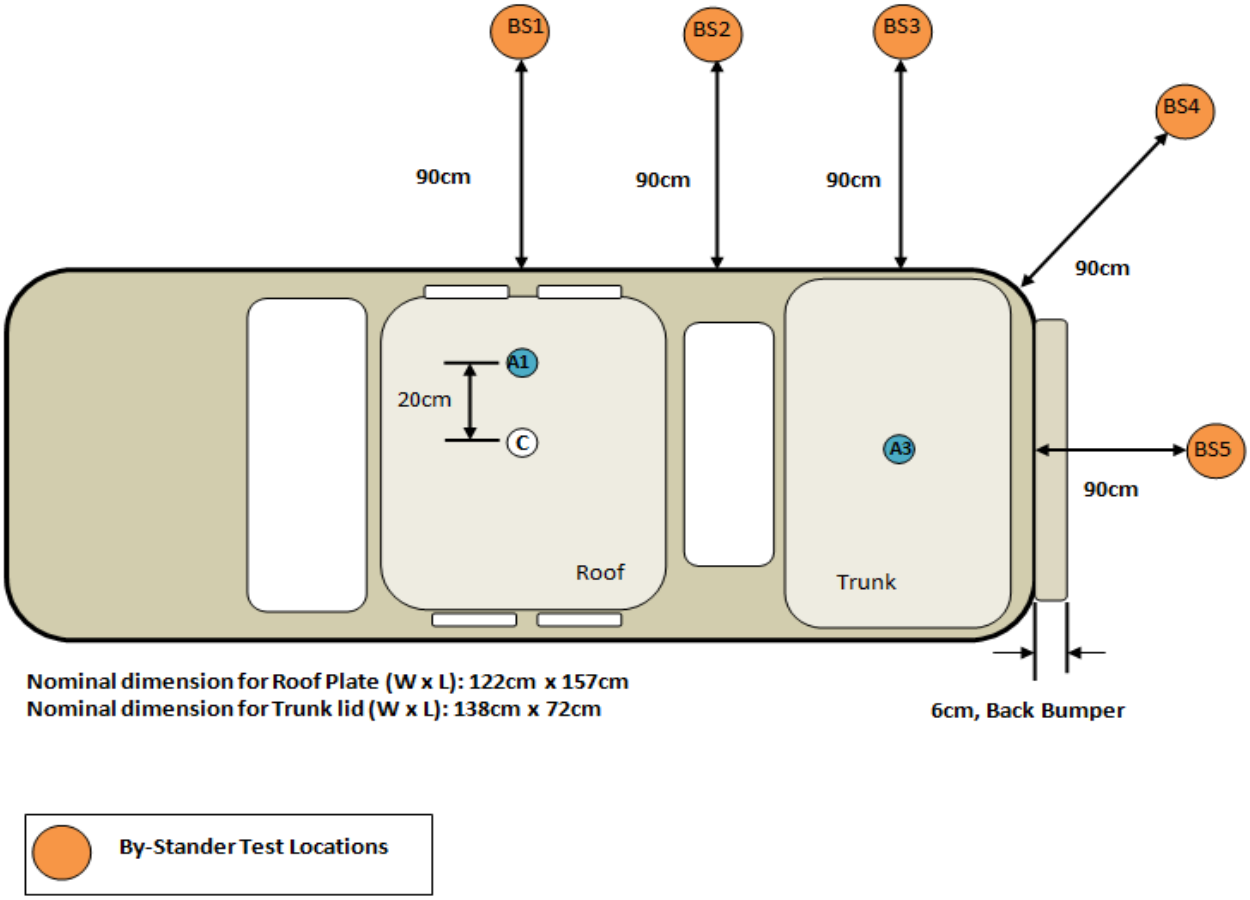
Passenger Antenna mounting



Note:

1.) Antenna location A1: APX mobile radio roof antenna mounting locations for passenger and bystander testing
2.) Antenna location A2: DVR trunk antenna mounting locations for passenger back testing
3.) Total distance between trunk mount antenna and rear passenger is 85cm

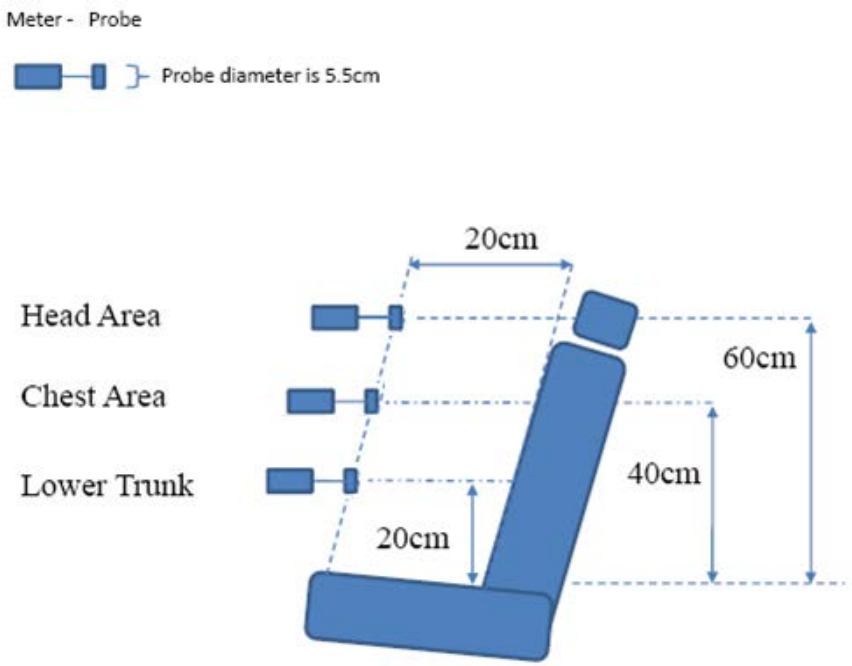
Bystander Antenna mounting and test locations



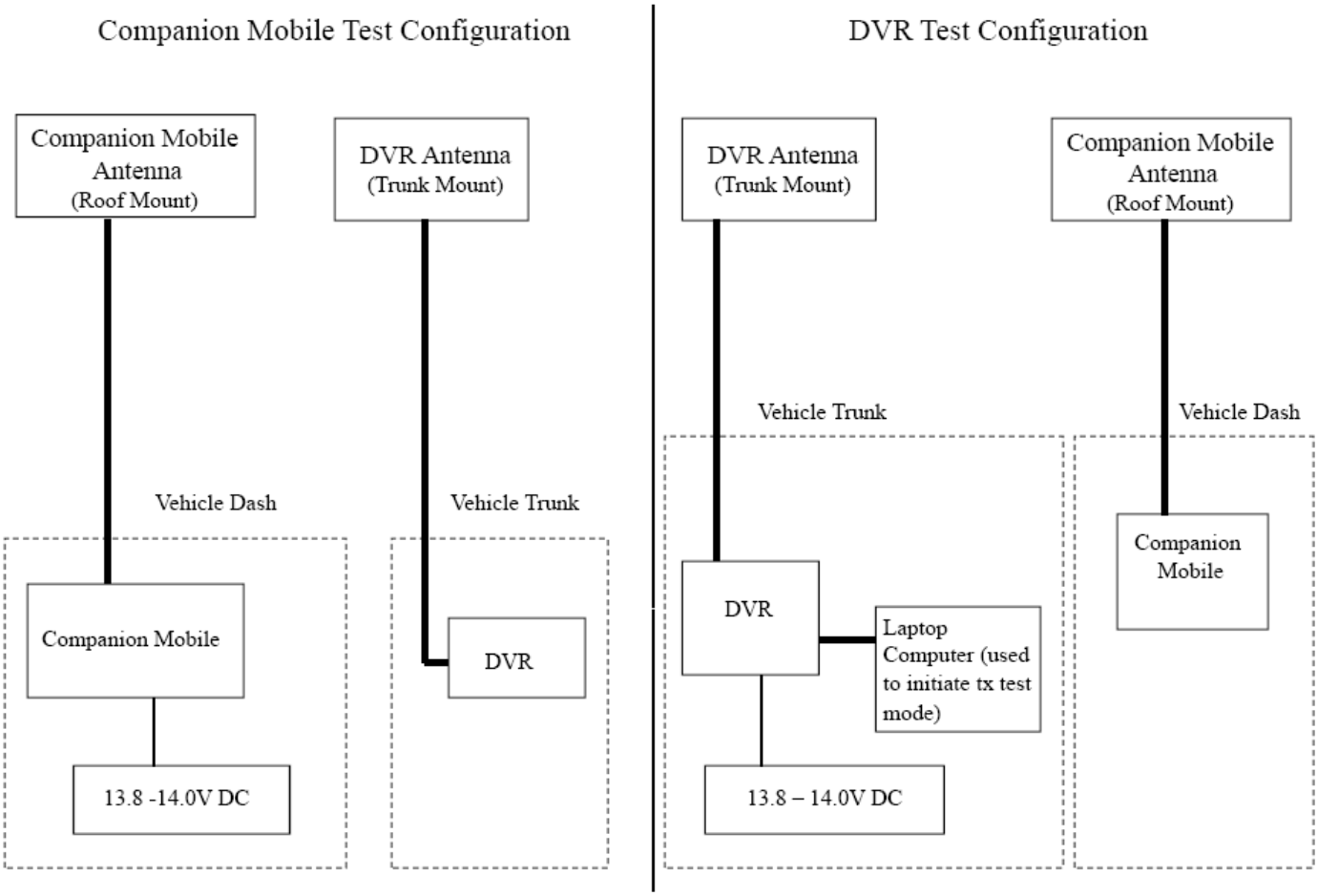
Note:

1.) Antenna location A1: APX mobile radio roof antenna mounting locations for passenger and bystander testing
2.) Antenna location A3: DVR trunk antenna mounting locations for bystander testing
3.) Bystander location BS2: Center point of the bystander test location BS1 and test location BS3
4.) Bystander location BS (1-5): 90cm away from the vehicle body. Apply for both roof and trunk testing

Seat scan areas
(Applicable to both front and back seats)



MPE Test Configuration



Cable Losses

Test Cable

Teflon RG58A/U Loss Per 100 Feet

160 MHz - 5 dB

450 MHz - 9 dB

1 GHz - 13.8 dB

Customer Cable

RG-58A/U Loss Per 100 Feet

136 MHz – 5.5 dB

450 MHz – 9.6 dB

900 MHz – 13.9 dB

PFP 240 Loss Per 100 Feet (For BT/WLAN)

2500 MHz - 12.9 dB

Appendix B - Probe Calibration Certificates

Service Test Report
QAF 1126, 03/11
Report ID: 114201

ETS-LINDGREN
An ESCO Technologies Company
1301 Arrow Point Drive
Cedar Park, Texas 78613
(512) 531-6400

ETS-LINDGREN
An ESCO Technologies Company
Tracking # S000035042
Equipment Check
Attested by GC Date: 16-May-16
www.ets-lindgren.com

Certificate of Test Conformance

Page 1 of 1

Reference: S 000035042

Customer: Keysight Cal Lab C/O Motrola Solutions - 8000 West Sunrise Blvd. Plantation, FL. 33322

The instrument listed below has been tested and verified to Internal Quality Standards. Test data is Not Applicable. Equipment used during instrument testing is controlled by laboratory compliance with ISO/IEC 17025-2005 and ANSI/NCSL Z540-1-1994 using ETS-Lindgren Quality Management System internal procedures.

Manufacturer	ETS-Lindgren
Instrument Type	RF Survey Meter
Model	HI-2200
Serial Number/ID	00086316

Status In
In Tolerance
Date Completed
16-May-16
Status Out
Compliant with Internal Quality Standards

Remarks
Functional test performed with customer's probe S/N 00153632.

I would like to take this opportunity to express our appreciation for using ETS-Lindgren for your EMI test equipment services and I am looking forward to continued business with your organization. Please feel free to contact our offices at (512) 531-6400, if you have any questions regarding this report.

Sincerely,

George Cisneros
Calibration Supervisor

Date Attested: 16-May-16

ETS-LINDGREN
An ESCO Technologies Company
1301 Arrow Point Drive
Cedar Park, Texas 78613
(512) 531-6400

ETS-LINDGREN
Track# S000035042 Lid Cal ☐
By FM Dat 16-May-16
Next Cal Due
www.ets-lindgren.com

Cert I.D.: 114197

Certificate of Calibration Conformance

The Instrument identified below has been individually calibrated in compliance with the following standard(s):
IEEE 1309 - 2013, Institute of Electrical and Electronics Engineers, Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas from 9 kHz to 40 GHz

Environment: Laboratory MTE is maintained in a temperature controlled environment with ambient conditions from 18 to 28 C, relative humidity less than 90%. The instrument under test has been calibrated in a suitable environment using an EMCO TEM Cell 5101C, GTEM! 5305 and an RF Shielded EMC Chamber which is conducive to maintaining accurate and reliable measurement quality.

Manufacturer:	ETS-Lindgren	**Operating Range:**	100kHz - 5GHz
Model Number:	E100	**Instrument Type:**	Isotropic Probe > 1 GHz
Serial Number/ ID:	*00153632*	**Date Code:**	
Tracking Number:	**S 000035042**	**Alternate ID:**	
Date Completed:	16-May-16	**Customer:**	Keysight Cal Lab C/O Motrola Solutions - 8000 West Sunrise Blvd. Plantation, FL. 33322
Test Type:	Standard Field, Field Strength		

Calibration Uncertainty: (k=2, (95% Confidence Level)) Std Field Method 100kHz - 6 GHz, +/-0.7 dB, Isotropicity +/- 0.86

Test Remarks: Probe received in tolerance thus before and after data are the same.

Calibration Traceability: All Measuring and Test Equipment (M/TE) identified below are traceable to the SI units through the National Institute for Standards and Technology (NIST) or other recognized National Metrology Institute. Calibration Laboratory and Quality System controls are compliant with ISO/IEC 17025-2005 and ANSI/NCSL Z540-1-1994.

Standards and Equipment Used:

Make / Model / Name / S/N / Recall Date				
HP	8648C	Signal Generator	3836U02236	25-Feb-17
Marconi	2024	Signal Generator	112343/043	02-Feb-17
Hewlett Packard	E4422B	Signal Generator	US40050591	22-Jul-16
Rohde & Schwarz	SMB 100A	Signal Generator	101558	17-Aug-16
Keysight	E9304A	Power Sensor	MY56100005	18-Mar-17
Agilent	E9304A	Power Sensor	MY41499013	01-Mar-17
Agilent	E9304A	Power Sensor	MY41499012	17-Jun-16
Agilent	E4419B	Power Meter	MY40510693	22-Jan-17
Agilent	E4419B	Power Meter	GB40202754	22-Oct-16
Agilent	U2004A	USB Power Sensor	MY50000280	08-Oct-16
Rohde & Schwarz	857.8008.02	Power Meter NRVD	100451	17-Jul-16
Hewlett Packard	83650L	Synthesized Sweep Gen	3844A00422	21-Jan-17
Rohde & Schwarz	NRV-Z55	Thermal Power Sensor	100037	16-Jul-16
Rohde & Schwarz	NRV-Z55	Thermal Power Sensor	100362	14-Nov-16
Rohde & Schwarz	NRV-Z55	Thermal Power Sensor	100363	18-Aug-16
Rohde & Schwarz	NRP-Z91	Power Sensor	100733	16-Jul-16
Rohde & Schwarz	NRP-Z91	Power Sensor	100732	16-Jul-16

Condition of Instrument Upon Receipt:
In Tolerance to Internal Quality Standards

On Release:
In Tolerance to Internal Quality Standards

Calibration Completed By
Francisco D Maldonado, Calibration Technician

Attested and Issued on 16-May-16
George Cisneros, Calibration Supervisor

CALIBRATION REPORT

Electric Field Sensor

Model	*S/N*
E100	00153632
HI-2200	00086316

Date: 16 May 2016

New Instrument
_ Other
_ Out of Tolerance
X Within Tolerance

Frequency Response

Frequency Response		*Nominal Field*	*Cal Factor**	*Deviation*
	MHz	*V/m*	(Eapplied/Eindicated)	*dB*
1	0.1	20	1.30	-2.26
2	0.5	20	1.08	-0.64
3	1	20	1.08	-0.64
4	3	20	1.01	-0.12
5	15	20	1.00	-0.02
6	27.12	20	1.00	-0.04
7	100	20	1.02	-0.15
8	200	20	1.00	0.03
9	1	20	1.08	-0.64
10	15	20	1.00	-0.02
11	30	20	1.00	-0.04
12	75	20	1.01	-0.11
13	100	20	1.02	-0.15
14	150	20	1.01	-0.06
15	200	20	1.00	0.03
16	250	20	0.99	0.12
17	300	20	0.99	0.10
18	400	20	0.99	0.08
19	500	20	1.03	-0.25
20	600	20	1.04	-0.36
21	700	20	1.07	-0.55
22	800	20	1.08	-0.69
23	900	20	1.03	-0.24
24	1000	20	0.99	0.13
25	2000	20	1.05	-0.40
26	2450	20	1.08	-0.69
27	3000	20	1.06	-0.54
28	3500	20	1.01	-0.12
29	4000	20	1.03	-0.24
30	5000	20	1.32	-2.41
31	5500	20	1.45	-3.25
32	6000	20	1.41	-3.00

* Corrected electric field values (V/m) can be obtained by multiplying the Cal Factor with the indicated E field readings.

Linearity

maximum linearity deviation is 0.34 dB

(measurements taken from 0.3 V/m to 800 V/m at 27.12 MHz)

Test Conditions

Calibration performed at ambient room temperature: 23 ±3°C

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ETS·LINDGREN
An ESCO Technologies Company

PROBE ROTATIONAL RESPONSE

Model	E100
S/N	00153632
Report	S000035042
Date	Date of Calibration 16 May 2016
Time	01:40:27 PM
Isotropy *	+ 0.270 dB/ -0.270 dB

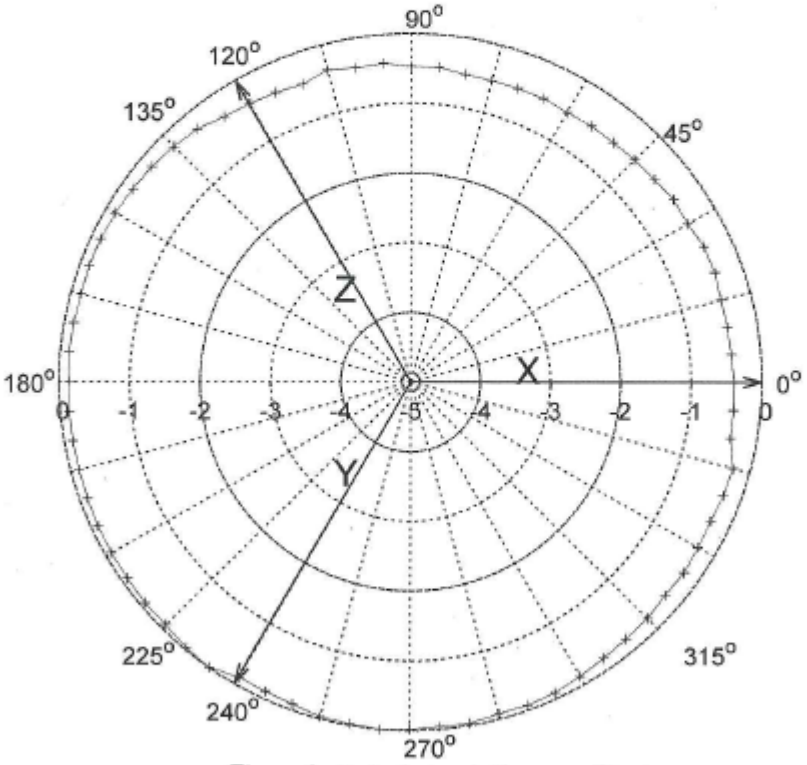

Figure 1: Probe Isotropic Response Chart.

Isotropic response is measured in a 20 V/m field at 400 MHz
*Isotropy is the maximum deviation from the geometric mean as defined by IEEE 1309-2013.

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ETS·LINDGREN
An ESCO Technologies Company
1301 Arrow Point Drive
Cedar Park, Texas 78613
(512) 531-6400

ETS·LINDGREN
An ESCO Technologies Company
Ltd Cal ☐
By FM Date 16-May-16
Next Cal Due
www.ets-lindgren.com

Cert I.D.: 114199

Certificate of Calibration Conformance

The instrument identified below has been individually calibrated in compliance with the following standard(s):
IEEE 1309 - 2013, Institute of Electrical and Electronics Engineers, Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas from 9 kHz to 40 GHz

Environment: Laboratory MTE is maintained in a temperature controlled environment with ambient conditions from 18 to 28 C, relative humidity less than 90%. The instrument under test has been calibrated in a suitable environment using an EMCO TEM Cell 5101C, GTEM! 5305 and an RF Shielded EMC Chamber which is conducive to maintaining accurate and reliable measurement quality.

Manufacturer:	ETS-Lindgren	**Operating Range:**	5-300MHz / 30mA/m-10A/m
Model Number:	H200	**Instrument Type:**	Isotropic Magnetic Field Probe (2)
Serial Number / ID:	00206937		
Date Completed:	16-May-16		
Test Type:	Standard Field, Field Strength		
Calibration Uncertainty:	Direct Field Method 1.15dB		
k=2, (95% Confidence Level)			

Test Remarks:

Calibration Traceability: All Measuring and Test Equipment (M/TE) identified below are traceable to the SI units through the National Institute for Standards and Technology (NIST) or other recognized National Metrology Institute. Calibration Laboratory and Quality System controls are compliant with ISO/IEC 17025-2005 and ANSI/NCSL Z540-1-1994.

Standards and Equipment Used: Make / Model / Name / S/N / Recall Date

HP	8648C	Signal Generator	3836U02236	25-Feb-17
Marconi	2024	Signal Generator	112343/043	02-Feb-17
Hewlett Packard	E4422B	Signal Generator	US40050591	22-Jul-16
Rohde & Schwarz	SMB 100A	Signal Generator	101558	17-Aug-16
Keysight	E9304A	Power Sensor	MY56100005	18-Mar-17
Agilent	E9304A	Power Sensor	MY41499013	01-Mar-17
Agilent	E9304A	Power Sensor	MY41499012	17-Jun-16
Agilent	E4419B	Power Meter	MY40510693	22-Jan-17
Agilent	E4419B	Power Meter	GB40202754	22-Oct-16
Agilent	U2004A	USB Power Sensor	MY50000280	08-Oct-16

Condition of Instrument On Release:
In Tolerance to Internal Quality Standards

Calibration Completed By
Francisco D Maldonado, Calibration Technician

Attested and Issued on 16-May-16
George Cisneros, Calibration Supervisor

CALIBRATION REPORT

Magnetic Field Sensor

Model	*S/N*
H200	00206937
HI-2200	00086316

Date: 16 May 2016

X New Instrument
_ Other
_ Out of Tolerance
Within Tolerance

Frequency Response

Frequency Response		*Nominal Field*	*Cal Factor**	*Deviation*
	MHz	*A/m*	(Eapplied/Eindicated)	*dB*
1	10	30	1.07	-0.58
2	15	30	1.05	-0.42
3	30	30	1.01	-0.09
4	50	30	0.99	0.05
5	75	30	0.96	0.33
6	100	30	0.90	0.94
7	150	30	0.87	1.18
8	175	30	0.84	1.53
9	200	30	0.80	1.94
10	250	30	0.70	3.12
11	300	30	0.56	5.09

* Corrected magnetic field values (A/m) can be obtained by multiplying the Cal Factor with the indicated H field readings.

Linearity

maximum linearity deviation is 0.06 dB

(measurements taken from 30 mA/m to 9 A/m at 27.12 MHz)

Test Conditions

Calibration performed at ambient room temperature: 23 ±3°C

The above sensor was calibrated to factory specifications. This calibration is performed per IEEE 1309 standard. All equipment used are traceable to US National Institute of Standards and Technology (NIST).

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Appendix C - Photos of Assessed Antennas
(All antennas mounted to the vehicle with magnetic mount base)

DVR

Antenna kit number (left to right):

HAE4004A, HAE4003A and HAE6012A

Companion Mobile

All bands Antenna kit number
AN000131A01