MOTOROLA SOLUTIONS

ACCREDITED
TESTING CERT # 2518.01

DECLARATION OF COMPLIANCE: MPE ASSESSMENT

EME Test Laboratory
8000 West Sunrise Blvd
Fort Lauderdale, FL. 33322

Date of Report: February 13, 2015
Report Revision: A

Responsible Engineer:	William M. Elliott (Principal Staff EME Test Engineer)
Report author:	William M. Elliott (Principal Staff EME Test Engineer)
Assessment Date(s):	09/14/2014
Manufacturer/Location:	Motorola Solutions, Reynosa / Schaumberg
Sector/Group/Div.:	AESS - Astro Engineering Subscriber Solutions
Date submitted:	07/29/2014
DUT Description:	APX5000 / 6000 450-520MHz, 1-5.6W 6.25K/12.5K/25K. Capable of digital and analog FM transmission. Also capable of TDMA transmission.
TX mode(s):	FM and TDMA
Max. Power output:	450-520 MHz 5.6 Watts
Nominal Power:	450-520 MHz 5.0 Watts
TX Frequency Bands:	450-520 MHz
Signaling type:	FM and TDMA (UHF)
Model(s) Certified:	H98SDD9PW5AN (NUE1017), H98SDD9PW5AN (NUE1096), H98SDH9PW7AN (NUE1094)
Classification:	Occupational/Controlled Environment
FCC ID:	AZ489FT4858 Part 90 (450 – 512 MHz) Results outside FCC bands are not applicable for FCC compliance demonstration.
IC:	109U-89FT4858 IC bands; (450 - 470MHz) Results outside IC bands are not applicable for IC compliance demonstration.

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 4.0 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.

Deanna Zakharia

Digitally signed by Deanna Zakharia
DN: cn=Deanna Zakharia, o=Motorola Solutions, ou=Regulatory Compliance Lab, email=edc015@motorolasolutions.com, c=US
Date: 2015.02.13 16:26:27 -05'00'

Deanna Zakharia
EME Lab Senior Resource Manager and Laboratory Director

Approval Date: 2/13/2015

Certification Date: 12/9/2014

Certification No.: 141007AD

Document Revision History

Date	Revision	Comments
09/16/2014	O	Initial release
02/13/2015	A	Correct reference to KDB 447498 to most recent version

Table of Contents

1.0 Introduction

This report contains calculated Maximum Permissible Exposure (MPE) results for radio product models presently Certified as portable radio equipment under FCC ID: AZ489FT4858 and IC: 109U-89FT4858 when used in conjunction with vehicle adapter NNTN8527A and antennas listed in Section 8 of this report for vehicular mobile applications.

2.0 FCC MPE Summary

Table 1

Equipment Class	Frequency band (MHz)	Power Density (mW/cm^2)	% of FCC MPE Limit
TNB	450 - 512	0.101	33.7
Simultaneous Results		NA	NA

Results are based on highest percentage of limit.

3.0 Abbreviations / Definitions

C4FM: Continuous Four Level FM
CQPSK: Compatible Differential Offset Quadrature Phase Shift Keying
DUT: Device Under Test
EME: Electromagnetic Energy
FHSS: Frequency Hopping Spread Spectrum
FM: Frequency Modulation
MPE: Maximum Permissible Exposure
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.

- Federal Communications Commission, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields”, OET Bulletin 65, FCC, Washington, D.C.: 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 (2014), Limits of Human Exposure to Radio frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz
- Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), Industry Canada RSS-102 Issue 4, 2010
- FCC KDB – 447498 D01 General RF Exposure Guidance v05r02 (0207/2014)
- FCC KDB – 865664 D02 RF Exposure Reporting v01r01 (05/28/2013)

5.0 Power Density Limits

Table 2 – Occupational / Controlled Exposure Limits

Frequency Range (MHz)	FCC OET Bulletin 65	ICNIRP	IEEE C95.1 1992/1999	IEEE C95.1 2005	RSS 102 issue 4 – 2010	Health Canada Safety Code 6 (2014)
	mW/cm^2	W/m^2	mW/cm^2	W/m^2	W/m^2	W/m^2
10 - 20						10.0
20 – 48						$44.72 / f^{0.5}$
30 – 300	1.0				*10.0	
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				f/30	
300 - 3,000			f/300	f/30		
400 – 2,000		f/40				
1,500 – 15,000					50.0	
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						$3.33\times10^{-4} f$

*Power density limit is applicable at frequencies greater than 100MHz

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 4 – 2010 W/m^2	Health Canada Safety Code 6 (2014) W/m^2
10 - 20						2.0
20 – 48						$8.944 / f^{0.5}$
30 – 300	0.2				*2.0	
48 – 300						1.291
10 – 400		2.0				
100 – 300			0.2			
100 – 400				2.0		
300 – 1,500	f/1,500				f/150	
300 – 6000						$0.02619 f^{0.6834}$
400 – 2,000		f/200		f/200		
300 – 15,000			f/1,500			
1,500 – 15,000					10.0	
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						$6.67\times10^{-5} f$

*Power density limit is applicable at frequencies greater than 100MHz

6.0 Product and System Description

This device operates using digital and analog frequency modulation (FM) as well as TDMA signaling incorporating traditional simplex two-way radio transmission protocol.

Time Division Multiple Access (TDMA) is used to allocate portions of the RF signal by dividing time into two slots. Time allocation enables each unit to transmit its voice information without interference from other transmitting units. Transmission from a unit or base station is accommodated during two time-slot lengths of 30 milliseconds with frame length of 60 milliseconds. C4FM CQPSK modulation is used and includes 12.5kHz channel spacing. The TDMA technique requires sophisticated algorithms and a digital signal processor (DSP) to perform voice compressions/decompressions and RF modulation/demodulation. The maximum duty cycle for TDMA 1:2 is 50%.

The LMR bands in this device operate in a half duplex system. A half duplex system only allows the user to transmit or receive. This device cannot transmit and receive simultaneously. The user must stop transmitting in order to receive a signal or listen for a response, regardless of PTT button or use of voice activated audio accessories. This type of operation, along with the RF safety booklet, which instructs the user to transmit no more than 50% of the time, justifies the use of 50% duty factor for this device.

In the evaluated configuration of the radio models represented in this report, a vehicle adapter is utilized to connect the RF connector of the certified portable radio to external vehicular antennas to form a mobile radio solution.

Table 4 below summarizes the technologies, bands, maximum duty cycles and maximum output powers. Maximum output powers are defined as upper limit of the production line final test station.

Table 4

Radio Type	Band (MHz)	Transmission	Duty Cycle (%)	Max Power (W)
LMR	450 - 520	FM or TDMA	*50 / *25	5.6

Note - * includes 50% PTT operation

This device is capable of operating in the TX frequency range(s), duty cycle(s), maximum output power(s) and antenna gain(s) presented in Table 4 above and Table 5 in section 8.0 MPE Assessment.

7.0 Assessment Method

MPE calculations were used to determine the RF exposure for this device. 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. For example, in the case of a single radiating antenna, a prediction for power density in the far-field of the antenna can be made by use of the general Equations (1) or (2) below. These equations are generally accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction. Equation 2 was used to show compliance for this device.

Equation 1

$$S = \frac{PG}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$$

Where: S = power density (mW/cm^2)
P = power input to the antenna (mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator (dBi)
R = distance to center of radiation of the antenna (cm)
EIRP = equivalent (or effective) isotropically radiated power

Or Equation 2

$$S = \frac{P_t\, G}{4\pi d^2 L}\text{F}$$

Equation (2) 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 (dBi)
d = distance from antenna (cm)
L = cable loss (dB)
F = 1.0

The separation distance chosen to demonstrate compliance with the uncontrolled limits for general population (bystanders) was 90cm for all antennas being offered with the product.

8.0 MPE Assessment

Table 5

MPE Calculation Results

Antenna #	Tx Frequency (MHz)	User Category	MPE Spec Limit (mW/cm^2)			Duty Cycle (%)	Max Power (W)	Antenna Gain (dBi)	Cable Loss, L (dB)	Dist., d (cm)	Max Calc. MPE (mW/cm^2)	Highest Percetage of Lowest Limit
			FCC	ICNIRP	Proposed IC Limits							
HAE4003A	450.0125	Uncontrolled	0.30	0.23	0.17	50%	5.600	2.15	0.00	90	0.045	26.5
HAE4003A	460.0125	Uncontrolled	0.31	0.23	0.17	50%	5.600	2.15	0.00	90	0.045	26.1
HAE4003A	470	Uncontrolled	0.31	0.24	0.18	50%	5.600	2.15	0.00	90	0.045	25.7
HAE4004A	470	Uncontrolled	0.31	0.24	0.18	50%	5.600	2.15	0.00	90	0.045	25.7
HAE4004A	484	Uncontrolled	0.32	0.24	0.18	50%	5.600	2.15	0.00	90	0.045	25.2
HAE4004A	498	Uncontrolled	0.33	0.25	0.18	50%	5.600	2.15	0.00	90	0.045	24.7
HAE4004A	511.9875	Uncontrolled	0.34	0.26	0.19	50%	5.600	2.15	0.00	90	0.045	24.3
HAE4011A	450.0125	Uncontrolled	0.30	0.23	0.17	50%	5.600	5.65	0.00	90	0.101	59.3
HAE4011A	460.0125	Uncontrolled	0.31	0.23	0.17	50%	5.600	5.65	0.00	90	0.101	58.4
HAE4011A	470	Uncontrolled	0.31	0.24	0.18	50%	5.600	5.65	0.00	90	0.101	57.6

Table 5 (Cont.)

Antenna #	Tx Frequency (MHz)	User Category	MPE Spec Limit (mW/cm^2)			Duty Cycle (%)	Max Power (W)	Antenna Gain (dBi)	Cable Loss, L (dB)	Dist., d (cm)	Max Calc. MPE (mW/cm^2)	Highest Percetage of Lowest Limit
			FCC	ICNIRP	Proposed IC Limits							
HAE4012A	470	Uncontrolled	0.31	0.24	0.18	50%	5.600	5.65	0.00	90	0.101	57.6
HAE4012A	482.5	Uncontrolled	0.32	0.24	0.18	50%	5.600	5.65	0.00	90	0.101	56.6
HAE4012A	495	Uncontrolled	0.33	0.25	0.18	50%	5.600	5.65	0.00	90	0.101	55.5
HAE4013A	494	Uncontrolled	0.33	0.25	0.18	50%	5.600	5.65	0.00	90	0.101	55.6
HAE4013A	503	Uncontrolled	0.34	0.25	0.18	50%	5.600	5.65	0.00	90	0.101	54.9
HAE4013A	511.9875	Uncontrolled	0.34	0.26	0.19	50%	5.600	5.65	0.00	90	0.101	54.2

9.0 Conclusion

The MPE results per the assessment in Table 5 are compliant to the FCC General Population/Uncontrolled RF exposure limits in OET Bulletin 65 for every antenna offered with this product.

The MPE results per the assessment in Table 5 are also compliant to the ICNIRP general public exposure limits, per ICNIRP (1998) Guidelines for limiting exposure in time-varying electric, magnetic, and electromagnetic fields (up to 300GHz) and IEEE C95.1-2005.

Finally, the MPE results per the assessment in Table 5 are compliant with the proposed uncontrolled RF exposure limits found in Health Canada Safety Code 6 (2014).

Table 6: Maximum MPE RF Exposure Summary

Designator	Frequency (MHz)	Bystander (mW/cm^2)
Overall	450-520	0.101
FCC	450-512	0.101
IC	450-470	0.101

*Results are based on highest percentage of limit.