MOTOROLA SOLUTIONS

TESTING CERT # 2518.01

DECLARATION OF COMPLIANCE: MPE ASSESSMENT

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

Date of Report: July 24, 2012
Report Revision: O
Report ID: SR10627 MPE MC rpt APX4500 VHF Rev O 120724

Responsible Engineer:	Kim Uong (Principal Staff EME Test Engineer)
Report author:	Kim Uong (Principal Staff EME Test Engineer)
Date(s) Tested:	6/28/2012
Manufacturer/Location:	Motorola Solutions, Schaumburg, IL
Date submitted for test:	06/25/2012
DUT Description:	APX4500 VHF (136 – 174MHz) 15 Watt - Motorcycle Mount option
Test TX mode(s):	CW
Max. Power output:	18W
TX Frequency Bands:	VHF: 136 - 174 MHz
Signaling type:	Analog, APCO 25, and TDMA 1:2 (F2)
Model(s) Tested:	M22KSS9PW1AN (MUD3222) w/option G138 Motorcycle Mount
Model(s) Certified:	M22KSS9PW1AN (MUD3222) w/option G138 Motorcycle Mount
Serial Number(s):	WMVONK002F
Classification:	Occupational/Controlled Environment
FCC ID:	AZ492FT3826 Part 22 & 90: 150.8-173.4 MHz
IC:	109U-92FT3826 (138-144; 148-149.9 and 150.05-174 MHz)

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.

Deanna Zakharia

Deanna Zakharia
EME Lab Senior Resource Manager and Laboratory Director

Approval Date: 7/25/2012

Certification Date: 7/25/2012

Certification No.: L1120708P

Document Revision History

Date	Revision	Comments
07/24/2012	O	Initial release

Table of Contents

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 product model M22KSS9PW1AN (MUD3222) w/option G138 Motorcycle Mount.

2.0 Abbreviations / Definitions

APCO: Association of Public-Safety Communications Officials
BS: Bystander
C4FM: Compatible 4-Level Frequency Modulation
CNR: Calibration Not Required
CQPSK: Compatible Quadrature Phase Shift Keying
CW: Continuous Wave
DUT: Device Under Test
EME: Electromagnetic Energy
F2: 2 slot Time Division Multiple Access
FM: Frequency Modulation
MPE: Maximum Permissible Exposure
NA: Not Applicable
OP: Operator
PTT: Push to Talk
TDMA: Time Division Multiple Access

3.0 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, Supplement C (Edition 01-01), FCC, Washington, D.C.: June 2001.
- 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) C95.1-2005
- 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 (2009), Limits of Human Exposure to Radio frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz

4.0 Power Density Limits

Table 1 – Occupational / Controlled Exposure Limits

Frequency Range (MHz)	FCC OET Bulletin 65 Supplement C	ICNIRP	IEEE C95.1 1992/1999	IEEE C95.1 2005	RSS 102 issue 4 - 2010
	mW/cm^2	W/m^2	mW/cm^2	W/m^2	W/m^2
30 - 300	1.0				*10.0
10 - 400		10.0			
100 - 300			1.0	10.0	
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	

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

Table 2 – General Population / Uncontrolled Exposure Limits

Frequency Range (MHz)	FCC OET Bulletin 65 Supplement C	ICNIRP	IEEE C95.1 1992/1999	IEEE C95.1 2005	RSS 102 issue 4 – 2010
	mW/cm^2	W/m^2	mW/cm^2	W/m^2	W/m^2
30 – 300	0.2				*2.0
10 – 400		2.0			
100 – 300			0.2		
100 – 400				2.0	
300 – 1,500	f/1,500				f/150
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			

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

5.0 N_c Test Channels

The number of test channels are 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.

6.0 Measurement Equipment

Table 3 - Equipment

Equipment Type	Model #	SN	Calibration Date	Calibration Due Date
Motorcycle	2005 Kawasaki KZ1000	NA	NA	NA
Survey Meter Probe – E-Field	ETS Model HI-2200 ETS Model E100	00086887 00126277	06/11/2012	06/11/2013
Survey Meter Probe – H-Field	ETS Model HI-2200 ETS Model H200	00086887 84225	06/11/2012	06/11/2013

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

7.0 Measurement System Uncertainty Levels

Table 4 - Uncertainty Budget for Near Field Probe Measurements

	Tol. (± %)	Prob. Dist.	Divisor	u_i (±%)	v_i
Measurement System					
Probe Calibration	6.0	N	1.00	6.0	∞
Survey Meter Calibration	3.0	N	1.00	3.0	∞
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	∞
Combined Standard Uncertainty		RSS		12.2	∞
Expanded Uncertainty (95% CONFIDENCE LEVEL)		*k*=2		24	

8.0 Product and System Description

Model M22KSS9PW1AN (MUD3222) w/option G138 Motorcycle Mount is a mobile transceiver that utilizes analog, APCO 25 & F2 digital two-way radio communications. The analog modulation scheme uses Frequency Modulation (FM). APCO 25 & F2 digital modes use C4FM of CQPSK family of modulation (Compatible 4-Level Frequency Modulation of Compatible Quadrature Phase Shift Keying). F2 is a TDMA 1:2 protocol that allocates portions of the RF signal by dividing time into two slots (2 slots TDMA). Transmission from a unit or base station is accommodated in time-slot lengths of 30 milliseconds and frame lengths of 60 milliseconds. This product supports voice in analog mode, and both voice and data modes in digital mode.

The maximum duty cycle for TDMA is 1:2 (50%) and is controlled by software. The FM signal is continuous. However, because of hand shaking or Push-To-Talk (PTT) between users and/or base stations a conservative 50% duty cycle is applied. The TDMA mode was not tested because its duty cycle is inherently 50% and would include an additional 50% duty cycle for PTT.

The intended use of the radio is PTT while the device is properly installed on a motorcycle.

This device will be marketed to and used by employees solely for work-related operations, such as public safety agencies, e.g. police, fire and emergency medical. User training is the responsibility of these agencies which can be expected to employ the usage instructions, safety information and operational cautions set forth in the user's manual, instructional sessions or other means.

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

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

9.0 Additional Options and Accessories

Refer to Table 5 for complete list of tested antennas.

10.0 Test Set-Up Description

Assessments were performed with mobile radio installed on the test vehicle while engine was at idle, at the specified distances and test locations indicated in section 11.0 and Appendix A.

All antennas described in Table 5 were considered in order to develop the test plan for this product. Antennas were installed and tested per their defined test channels.

11.0 Method of Measurement for motorcycle mounted antenna(s)

11.1 Bystander vehicle MPE measurements

Antenna is located at the rear of the test vehicle. Refer to Appendix A for antenna location with respect to the bystander.

MPE measurements for bystander (BS) conditions are determined by taking the average of (10) measurements in a 2m vertical line for the bystander test location indicated in Appendix A with 20cm height increments, with antenna to probe sensor separation distance of 60cm directly behind the vehicle. The separation distance used for testing is defined from the antenna where as the RF safety booklet defines the same distance from the vehicle body to ensure that the assessment is applicable to other vehicles 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.

11.2 Operator vehicle MPE measurements

Antenna is located at the rear of the test vehicle. Refer to Appendix A for antenna location with respect to the operator.

MPE measurements for operator (OP) conditions are determined by taking the average of the (3) measurements (Head, Chest and Lower Trunk) at the standard test distance of 30cm from the operators' seat area.

The measurement probe is oriented parallel (horizontal) to the ground and positioned above the motorcycle operator's seat. The probe head is pointed towards the back of the vehicle and aimed directly at the antenna's axis while maintaining a twenty (20) centimeter separation distance between the probe sensor and reradiating structures. These (3) measurements are representative of the operator.

Note; Motorola Solutions' weather proof enclosures provide 30cm separation distance from the antenna to the enclosure's edge. Refer to the installation manual for universal mounting options.

12.0 MPE Calculations

The final MPE results for this mobile radio are presented in section 14.0 Tables 6 & 7. These results are based on 50% duty cycle for PTT.

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

Bystander -10 measurements are averaged over the body (*Avg_over_body*).
Operator - 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.)*

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

Note1: 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

13.0 Antenna Summary

Table 5 below summarizes the tested antennas and their descriptions, overlap of FCC bands, number of test channels per FCC KDB 447498 (FCC N_c) and actual number of tested channels (Actual N_c). This information was used to determine the test configurations presented in this report.

Table 5

#	Antenna Model	Frequency Range (MHz)	Physical Length (cm)	Gain (dBi)	Remarks	Overlap FCC Bands	FCC N_c	Actual N_c
1	RAD4002ARB	136 - 144	51	2.15	¼ Wave, wire	NA	3	3
2	RAD4003ARB	144 – 150.8	48.1	2.15	¼ Wave, wire	150.8	3	3
3	RAD4004ARB	150.8 - 162	44.6	2.15	¼ Wave, wire	150.8 – 162	3	3
4	RAD4005ARB	162 - 174	41.8	2.15	¼ Wave, wire	162 – 173.4	3	3

14.0 Test Results Summary

The following tables below summarize the MPE results for each test configuration: test positions (BS-Bystander, OP-Operator), E/H field measurements, antenna model & freq. range, maximum output power, initial power, TX frequency, max calculated power density results, applicable FCC/IEEE/ICNIRP specification limits and % of the applicable specification limits.

Table 6 - Bystander MPE assessment to General Population / Uncontrolled Exposure Limits

Test Position	E/H Field	Ant. Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC Limit	% To FCC Spec Limit	ICNIRP Limit	% To ICNIRP Spec Limit
BS	E	RAD4002ARB (136-144 MHz)	18	17.8	136.000	0.09	0.20	44.7	0.20	44.7
			18	17.7	140.000	0.11	0.20	52.7	0.20	52.7
			18	17.8	144.000	0.10	0.20	48.7	0.20	48.7
		RAD4003ARB (144-150.8 MHz)	18	17.8	144.000	0.11	0.20	56.7	0.20	56.7
			18	17.8	148.000	0.11	0.20	56.0	0.20	56.0
			18	17.9	150.800	0.11	0.20	53.2	0.20	53.2
		RAD4004ARB (150.8-162 MHz)	18	17.9	150.800	0.11	0.20	54.1	0.20	54.1
			18	18.0	156.200	0.10	0.20	50.2	0.20	50.2
			18	18.1	162.000	0.07	0.20	37.3	0.20	37.3
		RAD4005ARB (162-174 MHz)	18	18.1	162.000	0.06	0.20	32.5	0.20	32.5
			18	18.2	167.700	0.05	0.20	24.6	0.20	24.6
			18	18.1	173.400	0.04	0.20	21.9	0.20	21.9
BS	H	RAD4002ARB (136-144 MHz)	18	17.8	136.000	0.09	0.20	44.2	0.20	44.2
			18	17.7	140.000	0.09	0.20	43.1	0.20	43.1
			18	17.8	144.000	0.08	0.20	37.9	0.20	37.9
		RAD4003ARB (144-150.8 MHz)	18	17.8	144.000	0.09	0.20	43.7	0.20	43.7
			18	17.8	148.000	0.09	0.20	42.9	0.20	42.9
			18	17.9	150.800	0.08	0.20	42.4	0.20	42.4
		RAD4004ARB (150.8-162 MHz)	18	17.9	150.800	0.09	0.20	43.0	0.20	43.0
			18	18.0	156.200	0.08	0.20	39.1	0.20	39.1
			18	18.1	162.000	0.05	0.20	27.0	0.20	27.0
		RAD4005ARB (162-174 MHz)	18	18.1	162.000	0.05	0.20	24.4	0.20	24.4
			18	18.2	167.700	0.03	0.20	14.5	0.20	14.5
			18	18.1	173.400	0.03	0.20	14.4	0.20	14.4

Table 7 - Operator MPE assessment to Occupational / Controlled Exposure Limits

Test Position	E/H Field	Ant. Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC Limit	% To FCC Spec Limit	ICNIRP Limit	% To ICNIRP Spec Limit
OP	E	RAD4002ARB (136-144 MHz)	18	17.8	136.000	0.55	1.00	54.9	1.00	54.9
			18	17.7	140.000	0.54	1.00	54.3	1.00	54.3
			18	17.8	144.000	0.48	1.00	48.3	1.00	48.3
		RAD4003ARB (144-150.8 MHz)	18	17.8	144.000	0.49	1.00	49.2	1.00	49.2
			18	17.8	148.000	0.49	1.00	49.0	1.00	49.0
			18	17.9	150.800	0.50	1.00	49.9	1.00	49.9
		RAD4004ARB (150.8-162 MHz)	18	17.9	150.800	0.58	1.00	58.2	1.00	58.2
			18	18.0	156.200	0.64	1.00	64.2	1.00	64.2
			18	18.1	162.000	0.73	1.00	72.6	1.00	72.6
		RAD4005ARB (162-174 MHz)	18	18.1	162.000	0.65	1.00	65.2	1.00	65.2
			18	18.2	167.700	0.65	1.00	65.4	1.00	65.4
			18	18.1	173.400	0.79	1.00	78.9	1.00	78.9
OP	H	RAD4002ARB (136-144 MHz)	18	17.8	136.000	0.45	1.00	45.2	1.00	45.2
			18	17.7	140.000	0.50	1.00	49.7	1.00	49.7
			18	17.8	144.000	0.45	1.00	45.4	1.00	45.4
		RAD4003ARB (144-150.8 MHz)	18	17.8	144.000	0.48	1.00	47.6	1.00	47.6
			18	17.8	148.000	0.44	1.00	44.0	1.00	44.0
			18	17.9	150.800	0.43	1.00	42.8	1.00	42.8
		RAD4004ARB (150.8-162 MHz)	18	17.9	150.800	0.44	1.00	43.8	1.00	43.8
			18	18.0	156.200	0.43	1.00	43.0	1.00	43.0
			18	18.1	162.000	0.34	1.00	33.6	1.00	33.6
		RAD4005ARB (162-174 MHz)	18	18.1	162.000	0.30	1.00	29.6	1.00	29.6
			18	18.2	167.700	0.24	1.00	24.0	1.00	24.0
			18	18.1	173.400	0.26	1.00	25.6	1.00	25.6

15.0 Conclusion

The assessments for this device were performed with an output power range as indicated in section 14.0 Tables 6 & 7. The maximum allowable output power is equal to the upper limit of the final test factory transmit power specification of 18W. The highest power density results for the mobile device scaled to the maximum allowable power output are indicated in Table 8 for operator and bystander to the vehicle.

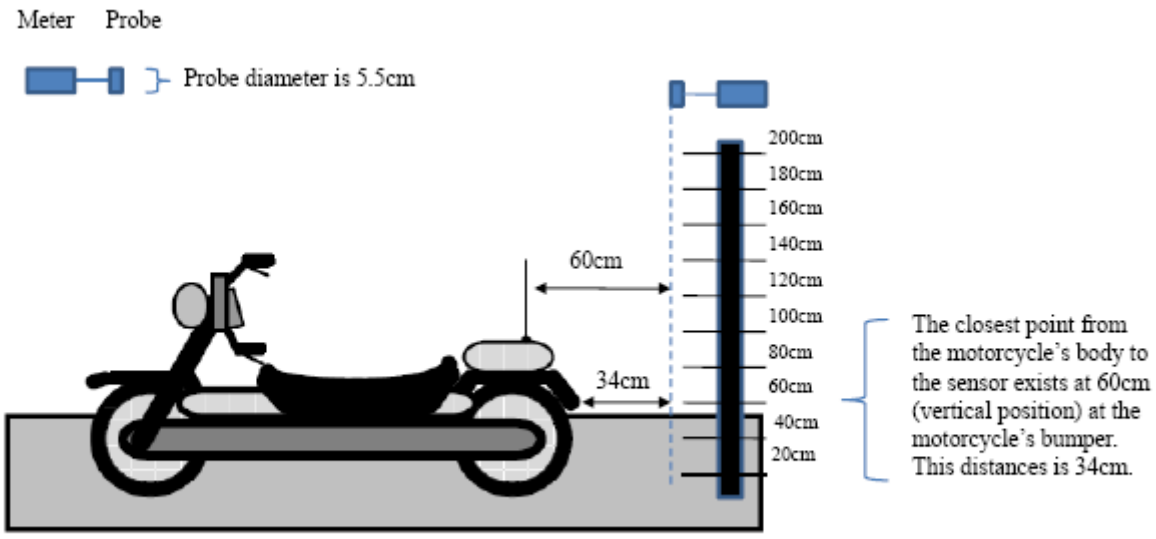
Table 8: Maximum MPE RF Exposure Summary

Designator	Frequency (MHz)	Operator (mW/cm^2)	Bystander (mW/cm^2)
Overall	136 - 174	0.79	0.11
FCC	150.8 – 173.4	0.79	0.11
IC	138 – 173.4	0.79	0.11

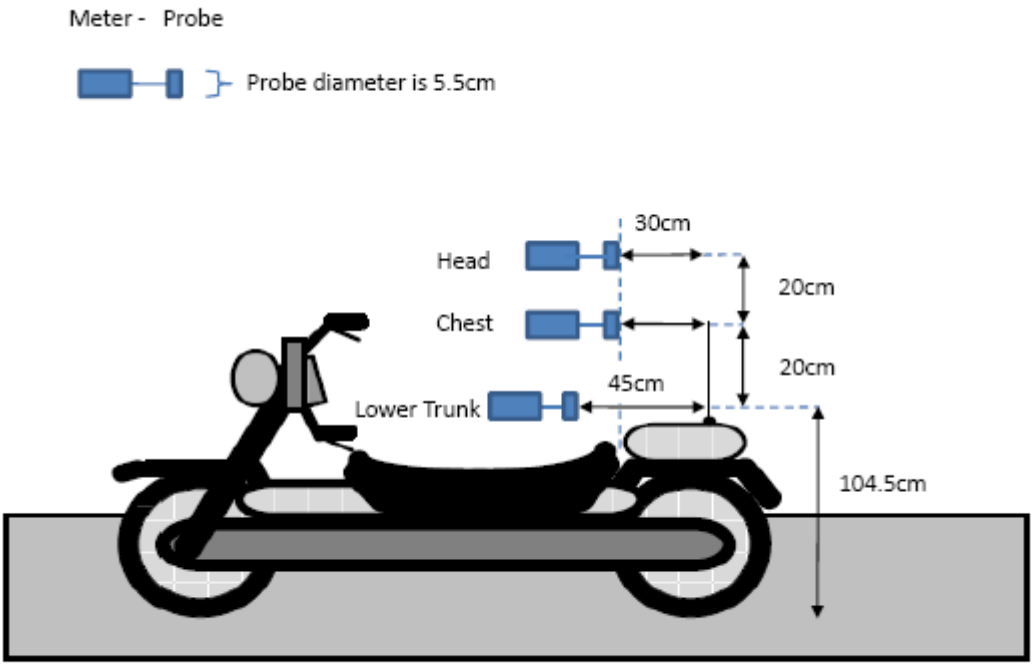
These MPE results herein demonstrate compliance to the FCC/IEEE/ICNIRP Occupational/Controlled Exposure limit. FCC rules require compliance for Bystanders to the FCC General Population/Uncontrolled limits.

Appendix A - Illustration of Antenna Location and Test Distances

Bystander Illustration



Operator Illustration



Note that the Lower Trunk measurement distance (45cm) from the antenna is to achieve 20cm distance from reradiating objects.

Appendix B - Probe Calibration Certificates

Service Test Report
QAF 1126, 03/11
Report ID: 91614

ETS-LINDGREN
An ESCO Technologies Company
1301 Arrow Point Drive
Cedar Park, Texas 78613
(512) 531-6498

ETS-LINDGREN
An ESCO Technologies Company
Tracking # S000025288
Equipment Check
Attested by TDO Date: 11-Jun-12
www.ets-lindgren.com

Certificate of Test Conformance

Reference: S 000025288

Customer: AGILENT/MOTOROLA (FL)

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	00086887

Status In
In Tolerance
Date Completed
11-Jun-12
Status Out
Compliant with Internal Quality Standards

Remarks
Functional test performed.

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,

Terry D. O'Neill
Calibration Manager

Date Attested: 11-Jun-12

ACCREDITED Calibration Laboratory Certificate 1207.01

ETS-LINDGREN™
An ESCO Technologies Company
1301 Arrow Point Drive
Cedar Park, Texas 78613
(512) 531-6498

ETS-LINDGREN
An ESCO Technologies Company
Track# S000025288 Ltd Cal ☐
By GC Date 11-Jun-12
Next Cal Due _____
www.ets-lindgren.com

Cert I.D.: 91609

Certificate of Calibration Conformance

The instrument identified below has been individually calibrated in compliance with the following standard(s):

IEEE 1309 - 2005, 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:	*00126277*	**Date Code:**	
Tracking Number:	**S 000025288**	**Alternate ID:**	
Date Completed:	11-Jun-12	**Customer:**	AGILENT/MOTOROLA (FL)
Test Type:	Standard Field, Field Strength		

Calibration Uncertainty: Std Field Method 10kHz - 18000 MHz, +/-0.7 dB, 26.5GHz - 40GHz,+/- 0.95 dB
k=2, (95% Confidence Level)

Test Remarks: Probe tested with HI-2200 s/n 00086887. Special Calibration - Additional frequency points added per customer request.

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				
Agilent/HP	8648C	Signal Generator	3623A03573	01-Feb-13
Agilent	E4419B	Power Meter	MY45104171	29-Sep-12
Agilent/HP	8648C	Signal Generator	3847A04406	01-Feb-13
Agilent	E4419B	Power Meter	MY45103242	01-Feb-13
Rohde & Schwarz	857.8008.02	Power Meter NRVD	100451	28-Mar-13
Hewlett Packard	83620B	Signal Generator	3722A00541	01-Feb-13
Fluke	6060B	RF Signal Generator	5690204	28-Jun-12

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

On Release:
In Tolerance to Internal Quality Standards

Calibration Completed By
George Cisneros, Calibration Technian

Attested and Issued on 11-Jun-12
Terry D. O'Neill, Calibration Manager

This document provides traceability of measurements to recognized national standards using controlled processes at the ETS-Lindgren Calibration Laboratory. Uncertainties listed are derived from the methods described by NIST Tech Note 1297. This certificate and report may not be reproduced, except in full, without the written approval of ETS-Lindgren Calibration Laboratory in accordance with ISO/IEC 17025-2005 and ANSI/NCSL Z540-1-1994. QAF 1127 (03/11)

CALIBRATION REPORT

Electric Field Sensor

Model	*S/N*
E100	00126277
HI-2200	86887

Date: 11 June 2012

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	1	20	1.40	-2.93
2	15	20	1.10	-0.80
3	30	20	1.02	-0.21
4	75	20	0.98	0.14
5	100	20	0.99	0.05
6	150	20	1.00	0.00
7	200	20	1.00	0.00
8	250	20	0.98	0.15
9	300	20	0.99	0.05
10	400	20	1.00	0.00
11	500	20	1.00	-0.04
12	600	20	1.01	-0.06
13	700	20	1.01	-0.10
14	800	20	1.02	-0.15
15	900	20	1.02	-0.15
16	1000	20	0.98	0.21
17	2000	20	0.95	0.48
18	2450	20	1.01	-0.09
19	3000	20	1.02	-0.17
20	3500	20	0.97	0.30
21	4000	20	1.01	-0.11
22	5000	20	1.37	-2.76
23	5500	20	1.41	-2.95
24	6000	20	1.43	-3.10

* 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 0.1 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

ETS·LINDGREN
An ESCO Technologies Company

PROBE ROTATIONAL RESPONSE

Model	E100
S/N	00126277
Date	Date of Calibration 11 June 2012
Time	12:55:30 PM
Isotropy *	+ 0.304 dB/ -0.304 dB

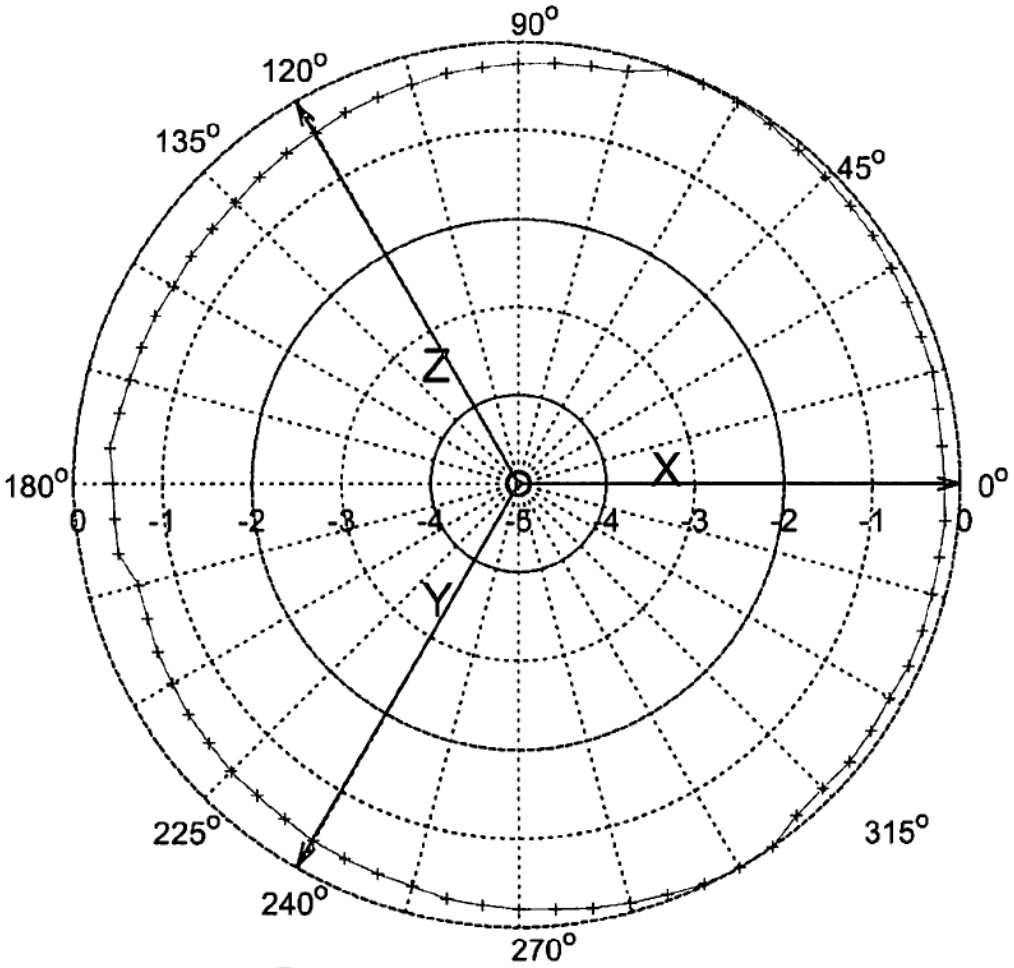


Figure 1: Probe Isotropic Response Chart.

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 1309-2005.

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ETS-LINDGREN
An ESCO Technologies Company
1301 Arrow Point Drive
Cedar Park, Texas 78613
(512) 531-6498

ETS-LINDGREN
An ESCO Technologies Company
Track# S000025288 Ltd Cal ☐
By GC Date 11-Jun-12
Next Cal Due
www.ets-lindgren.com

Cert I.D.: 91613

Certificate of Calibration Conformance

The instrument identified below has been individually calibrated in compliance with the following standard(s):

IEEE 1309 - 2005, 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:	*00084225*	**Date Code:**	
Tracking Number:	**S 000025288**	**Alternate ID:**	
Date Completed:	11-Jun-12	**Customer:**	AGILENT/MOTOROLA (FL)
Test Type:	Standard Field, Field Strength		

Calibration Uncertainty: Direct Field Method 1.15dB
k=2, (95% Confidence Level)

Test Remarks: Probe tested with HI-2200 s/n 00086887.

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	Sig Gen	3836A04299	01-Feb-13
Hewlett Packard	E4419B	Power Meter	US39250717	01-Feb-13

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

On Release:
In Tolerance to Internal Quality Standards

Calibration Completed By
George Cisneros, Calibration Technian

Attested and Issued on 11-Jun-12
Terry D. O'Neill, Calibration Manager

CALIBRATION REPORT

Magnetic Field Sensor

Model	*S/N*
H200	00084225
HI-2200	86887

Date: 11 Jun 2012

As received, the instrument was found: X Within Tolerance
_____ Out of Tolerance
_____ (New Instrument)

Frequency Response

Frequency Response		*Nominal Field*	*Cal Factor**	*Deviation*
	MHz	*A/m*	(Happlied/Hindicated)	*dB*
1	10	0.08	1.04	-0.32
2	15	0.08	1.00	0.00
3	30	0.08	1.00	0.00
4	50	0.08	0.98	0.18
5	75	0.08	0.96	0.34
6	100	0.08	0.93	0.61
7	150	0.08	0.86	1.28
8	175	0.08	0.84	1.53
9	200	0.08	0.82	1.97
10	250	0.08	0.72	3.28
11	300	0.08	0.60	4.56

* 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 0.03 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

Appendix C - Photos of Assessed Antennas

(Refer to Exhibit 7B)

Appendix D – MPE Measurement Results

MPE measurement data for Bystander – E Field

D.U.T. Info.							Probe Info.		Test Pos.	MPE Measurements										DUT Max. TX Factor	Avg. over Body (mW/cm2)	Calc. P.D. (mW/cm2)	Max Calc. P.D. (mW/cm2)
										Bystander (BS) Positions													
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor		20 cm	40 cm	60 cm	80 cm	100 cm	120 cm	140 cm	160 cm	180 cm	200 cm				
MC	RAD4002ARB (136-144 MHz)	2.15	136	18	17.8	CW	E	0.99	BS	0.121	0.221	0.273	0.207	0.136	0.163	0.228	0.205	0.150	0.082	0.5	0.179	0.088	0.09
MC	RAD4002ARB (136-144 MHz)	2.15	140	18	17.7	CW	E	1.00	BS	0.125	0.249	0.334	0.257	0.189	0.202	0.246	0.227	0.149	0.093	0.5	0.207	0.104	0.11
MC	RAD4002ARB (136-144 MHz)	2.15	144	18	17.8	CW	E	1.00	BS	0.124	0.248	0.316	0.233	0.178	0.200	0.227	0.198	0.131	0.071	0.5	0.193	0.096	0.10
MC	RAD4003ARB (144-150.8 MHz)	2.15	144	18	17.8	CW	E	1.00	BS	0.143	0.295	0.362	0.264	0.200	0.229	0.264	0.220	0.142	0.124	0.5	0.224	0.112	0.11
MC	RAD4003ARB (144-150.8 MHz)	2.15	148	18	17.8	CW	E	1.00	BS	0.145	0.311	0.378	0.265	0.199	0.237	0.266	0.209	0.133	0.073	0.5	0.222	0.111	0.11
MC	RAD4003ARB (144-150.8 MHz)	2.15	150.8	18	17.9	CW	E	1.00	BS	0.141	0.296	0.355	0.241	0.190	0.246	0.262	0.198	0.120	0.069	0.5	0.212	0.106	0.11
MC	RAD4004ARB (150.8-162 MHz)	2.15	150.8	18	17.9	CW	E	1.00	BS	0.146	0.310	0.370	0.251	0.192	0.246	0.262	0.193	0.116	0.064	0.5	0.215	0.108	0.11
MC	RAD4004ARB (150.8-162 MHz)	2.15	156.2	18	18.0	CW	E	1.00	BS	0.150	0.299	0.337	0.225	0.203	0.254	0.236	0.165	0.087	0.051	0.5	0.201	0.100	0.10
MC	RAD4004ARB (150.8-162 MHz)	2.15	162	18	18.1	CW	E	1.00	BS	0.119	0.224	0.239	0.177	0.194	0.216	0.169	0.090	0.042	0.020	0.5	0.149	0.075	0.07
MC	RAD4005ARB (162-174 MHz)	2.15	162	18	18.1	CW	E	1.00	BS	0.098	0.186	0.193	0.145	0.175	0.204	0.152	0.083	0.040	0.023	0.5	0.130	0.065	0.06
MC	RAD4005ARB (162-174 MHz)	2.15	167.7	18	18.2	CW	E	1.00	BS	0.080	0.156	0.163	0.128	0.151	0.153	0.089	0.037	0.016	0.009	0.5	0.098	0.049	0.05
MC	RAD4005ARB (162-174 MHz)	2.15	173.4	18	18.1	CW	E	1.00	BS	0.075	0.149	0.161	0.136	0.151	0.119	0.057	0.015	0.005	0.006	0.5	0.087	0.044	0.04

MPE calculations are defined in section 12.0.

MPE measurement data for Bystander – H Field

D.U.T. Info.							Probe Info.		Test Pos.	MPE Measurements										DUT Max. TX Factor	Avg. over Body (mW/cm2)	Calc. P.D. (mW/cm2)	Max Calc. P.D. (mW/cm2)
										Bystander (BS) Positions													
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor		20 cm	40 cm	60 cm	80 cm	100 cm	120 cm	140 cm	160 cm	180 cm	200 cm				
MC	RAD4002ARB (136-144 MHz)	2.15	136	18	17.8	CW	H	0.88	BS	0.073	0.068	0.080	0.096	0.103	0.099	0.087	0.070	0.058	0.040	0.5	0.077	0.087	0.09
MC	RAD4002ARB (136-144 MHz)	2.15	140	18	17.7	CW	H	0.87	BS	0.070	0.066	0.080	0.099	0.107	0.102	0.088	0.072	0.050	0.037	0.5	0.077	0.085	0.09
MC	RAD4002ARB (136-144 MHz)	2.15	144	18	17.8	CW	H	0.87	BS	0.063	0.061	0.078	0.097	0.104	0.097	0.082	0.064	0.046	0.033	0.5	0.073	0.075	0.08
MC	RAD4003ARB (144-150.8 MHz)	2.15	144	18	17.8	CW	H	0.87	BS	0.069	0.066	0.082	0.103	0.110	0.103	0.089	0.069	0.051	0.036	0.5	0.078	0.086	0.09
MC	RAD4003ARB (144-150.8 MHz)	2.15	148	18	17.8	CW	H	0.86	BS	0.065	0.064	0.086	0.108	0.113	0.103	0.087	0.066	0.051	0.037	0.5	0.078	0.085	0.09
MC	RAD4003ARB (144-150.8 MHz)	2.15	150.8	18	17.9	CW	H	0.86	BS	0.062	0.066	0.089	0.110	0.113	0.103	0.085	0.065	0.047	0.038	0.5	0.078	0.084	0.08
MC	RAD4004ARB (150.8-162 MHz)	2.15	150.8	18	17.9	CW	H	0.86	BS	0.064	0.068	0.092	0.112	0.114	0.103	0.084	0.063	0.046	0.037	0.5	0.078	0.085	0.09
MC	RAD4004ARB (150.8-162 MHz)	2.15	156.2	18	18.0	CW	H	0.86	BS	0.061	0.067	0.095	0.114	0.113	0.097	0.077	0.056	0.039	0.030	0.5	0.075	0.078	0.08
MC	RAD4004ARB (150.8-162 MHz)	2.15	162	18	18.1	CW	H	0.85	BS	0.051	0.061	0.087	0.104	0.099	0.082	0.059	0.039	0.026	0.022	0.5	0.063	0.054	0.05
MC	RAD4005ARB (162-174 MHz)	2.15	162	18	18.1	CW	H	0.85	BS	0.049	0.055	0.080	0.097	0.096	0.077	0.057	0.039	0.027	0.021	0.5	0.060	0.049	0.05
MC	RAD4005ARB (162-174 MHz)	2.15	167.7	18	18.2	CW	H	0.85	BS	0.041	0.050	0.073	0.086	0.078	0.056	0.034	0.016	0.014	0.014	0.5	0.046	0.029	0.03
MC	RAD4005ARB (162-174 MHz)	2.15	173.4	18	18.1	CW	H	0.84	BS	0.047	0.060	0.083	0.089	0.074	0.047	0.028	0.013	0.011	0.014	0.5	0.047	0.029	0.03

MPE calculations are defined in section 12.0.

MPE measurement data for Operator – E Field

D.U.T. Info.							Probe Info.			MPE Measurements						
										Operator (MC) Positions						
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	Head	Chest	Lower Trunk	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
MC	RAD4002ARB (136-144 MHz)	2.15	136	18	17.8	CW	E	0.99	OP	1.381	1.156	0.751	0.5	1.096	0.543	0.55
MC	RAD4002ARB (136-144 MHz)	2.15	140	18	17.7	CW	E	1.00	OP	1.384	1.180	0.637	0.5	1.067	0.534	0.54
MC	RAD4002ARB (136-144 MHz)	2.15	144	18	17.8	CW	E	1.00	OP	1.153	1.132	0.579	0.5	0.955	0.477	0.48
MC	RAD4003ARB (144-150.8 MHz)	2.15	144	18	17.8	CW	E	1.00	OP	1.102	1.205	0.610	0.5	0.972	0.486	0.49
MC	RAD4003ARB (144-150.8 MHz)	2.15	148	18	17.8	CW	E	1.00	OP	0.932	1.237	0.741	0.5	0.970	0.485	0.49
MC	RAD4003ARB (144-150.8 MHz)	2.15	150.8	18	17.9	CW	E	1.00	OP	0.859	1.266	0.853	0.5	0.993	0.496	0.50
MC	RAD4004ARB (150.8-162 MHz)	2.15	150.8	18	17.9	CW	E	1.00	OP	1.024	1.517	0.933	0.5	1.158	0.579	0.58
MC	RAD4004ARB (150.8-162 MHz)	2.15	156.2	18	18.0	CW	E	1.00	OP	0.895	1.660	1.297	0.5	1.284	0.642	0.64
MC	RAD4004ARB (150.8-162 MHz)	2.15	162	18	18.1	CW	E	1.00	OP	0.624	1.798	1.936	0.5	1.453	0.726	0.73
MC	RAD4005ARB (162-174 MHz)	2.15	162	18	18.1	CW	E	1.00	OP	0.550	1.623	1.739	0.5	1.304	0.652	0.65
MC	RAD4005ARB (162-174 MHz)	2.15	167.7	18	18.2	CW	E	1.00	OP	0.405	1.514	2.004	0.5	1.308	0.654	0.65
MC	RAD4005ARB (162-174 MHz)	2.15	173.4	18	18.1	CW	E	1.00	OP	0.359	1.608	2.765	0.5	1.577	0.789	0.79

MPE calculations are defined in section 12.0.

MPE measurement data for Operator – H Field

D.U.T. Info.							Probe Info.			MPE Measurements						
										Operator (MC) Positions						
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	Head	Chest	Lower Trunk	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
MC	RAD4002ARB (136-144 MHz)	2.15	136	18	17.8	CW	H	0.88	OP	0.154	0.208	0.163	0.5	0.175	0.447	0.45
MC	RAD4002ARB (136-144 MHz)	2.15	140	18	17.7	CW	H	0.87	OP	0.161	0.218	0.176	0.5	0.185	0.488	0.50
MC	RAD4002ARB (136-144 MHz)	2.15	144	18	17.8	CW	H	0.87	OP	0.150	0.206	0.176	0.5	0.177	0.449	0.45
MC	RAD4003ARB (144-150.8 MHz)	2.15	144	18	17.8	CW	H	0.87	OP	0.153	0.211	0.181	0.5	0.182	0.471	0.48
MC	RAD4003ARB (144-150.8 MHz)	2.15	148	18	17.8	CW	H	0.86	OP	0.138	0.203	0.189	0.5	0.177	0.435	0.44
MC	RAD4003ARB (144-150.8 MHz)	2.15	150.8	18	17.9	CW	H	0.86	OP	0.132	0.197	0.195	0.5	0.175	0.425	0.43
MC	RAD4004ARB (150.8-162 MHz)	2.15	150.8	18	17.9	CW	H	0.86	OP	0.135	0.198	0.197	0.5	0.177	0.435	0.44
MC	RAD4004ARB (150.8-162 MHz)	2.15	156.2	18	18.0	CW	H	0.86	OP	0.126	0.188	0.213	0.5	0.176	0.430	0.43
MC	RAD4004ARB (150.8-162 MHz)	2.15	162	18	18.1	CW	H	0.85	OP	0.102	0.160	0.209	0.5	0.157	0.336	0.34
MC	RAD4005ARB (162-174 MHz)	2.15	162	18	18.1	CW	H	0.85	OP	0.095	0.150	0.197	0.5	0.147	0.296	0.30
MC	RAD4005ARB (162-174 MHz)	2.15	167.7	18	18.2	CW	H	0.85	OP	0.083	0.125	0.190	0.5	0.133	0.240	0.24
MC	RAD4005ARB (162-174 MHz)	2.15	173.4	18	18.1	CW	H	0.84	OP	0.085	0.119	0.212	0.5	0.139	0.256	0.26

MPE calculations are defined in section 12.0.