FCC Certification Test Report

FCC Certification Test Report
for
Mine Safety Appliances
FCC ID: P9R-10031511

July 29, 2002

Prepared for:

Mine Safety Appliances
P.O. Box 427
Pittsburgh, PA 16066

Prepared By:

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7560 Lindbergh Drive
Gaithersburg, Maryland 20879

FCC Certification Test Program

FCC Certification Test Report
for the
Mine Safety Appliances
SCBA HUD (Heads-Up Display) TX
FCC ID: P9R-10031511

July 29, 2002

WLL JOB# 7023

Revised by: Michael Violette, P.E.

Abstract

This report has been prepared on behalf of Mine Safety Appliances to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.209 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a Mine Safety Appliances SCBA HUD (Heads-Up Display) TX.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The Mine Safety Appliances SCBA HUD (Heads-Up Display) TX complies with the limits for an Intentional Radiator device under Part 15.209 of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The Mine Safety Appliances SCBA HUD (Heads-Up Display) TX complies with the limits for an Intentional Radiator device under Part 15.209 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed according to the 1992 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Mine Safety Appliances P.O. Box 427 Pittsburgh, PA 16066
Purchase Order Number:	4500270652
Quotation Number:	59840

1.4 Test Dates

Testing was performed on March 8, 2002.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Chad Beattie
Customer	David Kodrin

1.6 Abbreviations

A	Ampere
Ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	Bandwidth
CE	Conducted Emission
cm	centimeter
CW	Continuous Wave
dB	decibel
dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FM	Frequency Modulation
G	giga - prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10^3 multiplier
M	Mega - prefix for 10^6 multiplier
m	Meter
μ	micro - prefix for 10^{-6} multiplier
NB	Narrowband
LISN	Line Impedance Stabilization Network
RE	Radiated Emissions
RF	Radio Frequency
rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The HUD is a wireless transmitter and receiver system used in fire fighting applications. The transmitter is located on a Self Contained Breathing Apparatus (SCBA) at the same location as the pneumatic pressure gauge, and contains an integral electronic pressure transducer on the gauge line. The transmitter uses magnetic induction to couple to the receiver, which is located in the faceplate lens of the SCBA.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Mine Safety Appliances
FCC ID Number	P9R-10031511
EUT Name:	Heads-Up Display TX
Model:	SCBA HUD
FCC Rule Parts:	§15.209
Frequency Range:	26.7 KHz
Occupied Bandwidth:	3.2 kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Magnetic Induction
Frequency Tolerance:	N/A
Interface Cables:	None
Power Source & Voltage:	3 Vdc from two (2) AAA type batteries

2.2 Test Configuration

The SCBA HUD was configured within a breathing apparatus and with a receiver.

2.3 Testing Algorithm

The SCBA HUD was operated by placing the unit into “calibration mode”, which provides near continuous transmit operation.

Worst-case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2}$ = ±2.3 dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Equipment	Serial Number	Date Calibrated	Calibration Due
Sunol Science, Inc. Biconical Log Periodic Antenna JB1 (Site 1)	A090501	9/21/01	9/21/02
EMCO 6502 Active Loop Antenna	8903-2333	8/21/01	8/21/02
Hewlett-Packard Spectrum Analyzer: HP 8568B (Site 1)	2928A04750	6/29/01	6/29/02
Hewlett-Packard Quasi-Peak Adapter: HP 85650A (Site 1)	3303A01786	6/29/01	6/29/02
Hewlett-Packard RF Preselector: HP 85685A (Site 1)	2817A00744	6/29/01	6/29/02

4 Test Results

4.1 Occupied Bandwidth:

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

At full modulation, the occupied bandwidth was measured as shown in Figure 1:

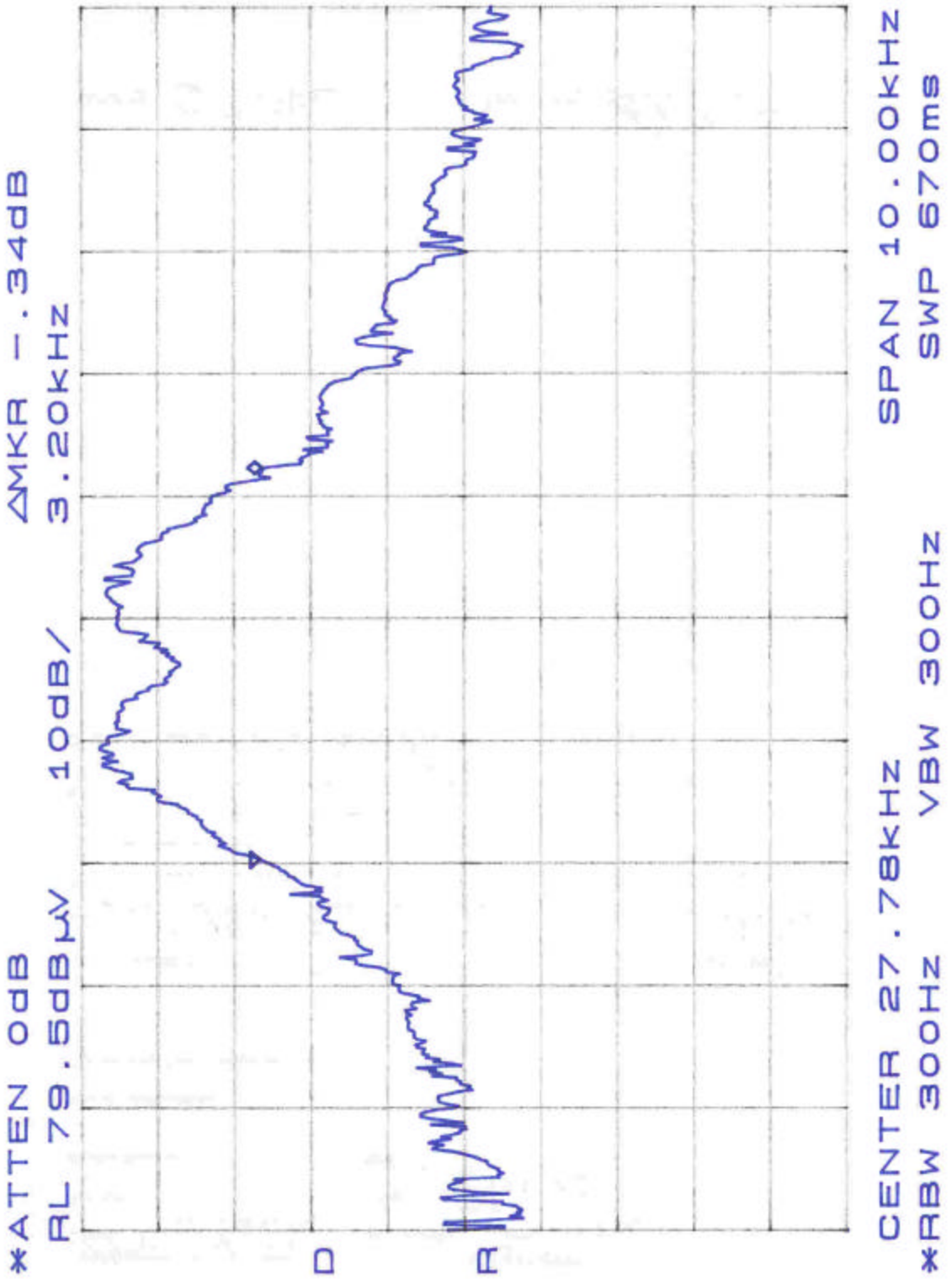

Figure 1. Occupied Bandwidth

4.2 Radiated Spurious Emissions:

The EUT must comply with requirements for radiated spurious emissions. The limits are as shown in the following table.

Table 3. Radiated Spurious Emissions Limits

Compliance Standard: FCC Part 15.209

Compliance Limits		
Frequency (MHz)	Limit (uV/m)	Test Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 - 30	30	30
30 - 88	100	3
88 – 216	150	3
216 – 960	200	3
> 960	500	3

4.2.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-1992. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

Emissions measurements were performed at 1 and 3 meter

Table 4: Radiated Emission Test Data

CLIENT: MSA
MODEL NO: HUD (Heads Up Display)
TYPE/PART: 15.209
DATE: 03.08.02
BY: Chad M. Beattie
JOB #: 7023

Tx Frequency: 26.7 kHz
Limit: 2400/26.7 for 300m = 89.9 uV/m = 39 dBuV/m
Distance Correction Factor: 40 LOG(300/r)
@ 3m Fundamental Limit: 119 dBuV/m = 898876 uV/m
@ 1m Fundamental Limit: 99 dBuV/m = 8011244 uV/m

EUT orientation: Y (standing up on bottom edge)

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc DB/m	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MARGIN dB	
0.0267	Y	180.00	1.0	60.3	13.0	73.3	4623.8	898876	-45.8	3m
0.0267	Y	180.00	1.0	82.7	13.0	95.7	60953.7	8011244	-42.4	1m
0.0533	Y	0.00	1.0	40.2	11.2	51.4	371.5	4011632	-80.7	1m,amb
0.0797	Y	225.00	1.0	45.3	10.8	56.1	638.3	2683817	-72.5	1m
0.1050	Y	0.00	1.0	37.4	10.7	48.1	254.1	2037145	-78.1	1m,amb
0.1331	Y	225.00	1.0	39.0	10.6	49.6	302.0	1607064	-74.5	1m
0.1602	Y	0.00	1.0	30.8	10.5	41.3	116.1	1335207	-81.2	1m,amb
0.1861	Y	225.00	1.0	35.3	10.4	45.7	192.8	1149507	-75.5	1m
0.2136	Y	0.00	1.0	28.6	10.4	39.0	89.1	1001593	-81.0	1m,amb
0.2402	Y	0.00	1.0	27.7	10.4	38.1	80.4	890509	-80.9	1m,amb
0.2670	Y	0.00	1.0	30.1	10.4	40.5	105.9	801124	-77.6	1m,amb

EUT orientation: Y (standing up on bottom edge)

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MARGIN dB	
0.0267	X	180.00	1.0	74.0	13.0	87.0	22387.2	8011244	-51.1	1m
0.0533	X	0.00	1.0	41.3	11.2	52.5	421.7	4011632	-79.6	1m,amb
0.0797	X	225.00	1.0	40.8	10.8	51.6	380.2	2683817	-77.0	1m
0.1050	X	0.00	1.0	37.6	10.7	48.3	260.0	2037145	-77.9	1m,amb
0.1331	X	0.00	1.0	33.7	10.6	44.3	164.1	1607064	-79.8	1m,amb
0.1602	X	0.00	1.0	33.8	10.5	44.3	164.1	1335207	-78.2	1m,amb
0.1861	X	0.00	1.0	32.5	10.4	42.9	139.6	1149507	-78.3	1m,amb
0.2136	X	0.00	1.0	30.1	10.4	40.5	105.9	1001593	-79.5	1m,amb
0.2402	X	0.00	1.0	30.1	10.4	40.5	105.9	890509	-78.5	1m,amb
0.2670	X	0.00	1.0	30.1	10.4	40.5	105.9	801124	-77.6	1m,amb

EUT orientation: X (lying flat on face)

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MARGIN dB	
0.0267	Z	180.00	1.0	74.5	13.0	87.5	23713.7	8011244	-50.6	1m
0.0533	Z	0.00	1.0	40.5	11.2	51.7	384.6	4011632	-80.4	1m,amb
0.0797	Z	225.00	1.0	41.4	10.8	52.2	407.4	2683817	-76.4	1m
0.1050	Z	0.00	1.0	35.9	10.7	46.6	213.8	2037145	-79.6	1m,amb
0.1331	Z	0.00	1.0	34.1	10.6	44.7	171.8	1607064	-79.4	1m,amb
0.1602	Z	0.00	1.0	31.1	10.5	41.6	120.2	1335207	-80.9	1m,amb
0.1861	Z	0.00	1.0	31.4	10.4	41.8	123.0	1149507	-79.4	1m,amb
0.2136	Z	0.00	1.0	31.2	10.4	41.6	120.2	1001593	-78.4	1m,amb
0.2402	Z	0.00	1.0	28.0	10.4	38.4	83.2	890509	-80.6	1m,amb
0.2670	Z	0.00	1.0	28.5	10.4	38.9	88.1	801124	-79.2	1m,amb

EUT orientation: Z (lying flat on side)

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MARGIN dB	
0.0267	Y	180.00	1.0	85.0	13.0	98.0	79432.8	8011244	-40.1	1m
0.0533	Y	0.00	1.0	53.6	11.2	64.8	1737.8	4011632	-67.3	1m,amb
0.0797	Y	180.00	1.0	49.2	10.8	60.0	1000.0	2683817	-68.6	1m
0.1050	Y	0.00	1.0	35.1	10.7	45.8	195.0	2037145	-80.4	1m,amb
0.1331	Y	180.00	1.0	38.7	10.6	49.3	291.7	1607064	-74.8	1m
0.1602	Y	0.00	1.0	30.3	10.5	40.8	109.6	1335207	-81.7	1m,amb
0.1861	Y	180.00	1.0	35.3	10.4	45.7	192.8	1149507	-75.5	1m
0.2136	Y	0.00	1.0	30.3	10.4	40.7	108.4	1001593	-79.3	1m,amb
0.2402	Y	0.00	1.0	31.0	10.4	41.4	117.5	890509	-77.6	1m,amb
0.2670	Y	0.00	1.0	27.9	10.4	38.3	82.2	801124	-79.8	1m,amb

EUT orientation: Z (lying flat on side)

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MARGIN dB	
0.0267	X	135.00	1.0	74.9	13.0	87.9	24831.3	8011244	-50.2	1m
0.0533	X	180.00	1.0	45.9	11.2	57.1	716.1	4011632	-75.0	1m
0.0797	X	180.00	1.0	41.4	10.8	52.2	407.4	2683817	-76.4	1m
0.1050	X	0.00	1.0	37.3	10.7	48.0	251.2	2037145	-78.2	1m,amb
0.1331	X	0.00	1.0	35.4	10.6	46.0	199.5	1607064	-78.1	1m,amb
0.1602	X	0.00	1.0	33.1	10.5	43.6	151.4	1335207	-78.9	1m,amb
0.1861	X	0.00	1.0	31.4	10.4	41.8	123.0	1149507	-79.4	1m,amb
0.2136	X	0.00	1.0	29.7	10.4	40.1	101.2	1001593	-79.9	1m,amb
0.2402	X	0.00	1.0	30.1	10.4	40.5	105.9	890509	-78.5	1m,amb
0.2670	X	0.00	1.0	29.1	10.4	39.5	94.4	801124	-78.6	1m,amb

EUT orientation: Z (lying flat on side)

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MARGIN dB	
0.0267	Z	180.00	1.0	74.7	13.0	87.7	24266.1	8011244	-50.4	1m
0.0533	Z	0.00	1.0	40.8	11.2	52.0	398.1	4011632	-80.1	1m,amb
0.0797	Z	0.00	1.0	42.4	10.8	53.2	457.1	2683817	-75.4	1m
0.1050	Z	0.00	1.0	35.2	10.7	45.9	197.2	2037145	-80.3	1m,amb
0.1331	Z	0.00	1.0	35.4	10.6	46.0	199.5	1607064	-78.1	1m,amb
0.1602	Z	0.00	1.0	34.0	10.5	44.5	167.9	1335207	-78.0	1m,amb
0.1861	Z	0.00	1.0	31.4	10.4	41.8	123.0	1149507	-79.4	1m,amb
0.2136	Z	0.00	1.0	30.7	10.4	41.1	113.5	1001593	-78.9	1m,amb
0.2402	Z	0.00	1.0	28.0	10.4	38.4	83.2	890509	-80.6	1m,amb
0.2670	Z	0.00	1.0	29.3	10.4	39.7	96.6	801124	-78.4	1m,amb

EUT orientation: Y (standing up on bottom edge)

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MARGIN dB	
0.0267	Y	180.00	1.0	82.4	13.0	95.4	58884.4	8011244	-42.7	1m
0.0533	Y	0.00	1.0	42.3	11.2	53.5	473.2	4011632	-78.6	1m,amb
0.0797	Y	180.00	1.0	45.9	10.8	56.7	683.9	2683817	-71.9	1m
0.1050	Y	0.00	1.0	37.4	10.7	48.1	254.1	2037145	-78.1	1m,amb
0.1331	Y	0.00	1.0	36.1	10.6	46.7	216.3	1607064	-77.4	1m,amb
0.1602	Y	0.00	1.0	34.8	10.5	45.3	184.1	1335207	-77.2	1m,amb
0.1861	Y	0.00	1.0	32.7	10.4	43.1	142.9	1149507	-78.1	1m,amb
0.2136	Y	0.00	1.0	29.6	10.4	40.0	100.0	1001593	-80.0	1m,amb
0.2402	Y	0.00	1.0	30.2	10.4	40.6	107.2	890509	-78.4	1m,amb
0.2670	Y	0.00	1.0	28.9	10.4	39.3	92.3	801124	-78.8	1m,amb

EUT orientation: Y (standing up on bottom edge)

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MARGIN dB	
0.0267	X	180.00	1.0	64.2	13.0	77.2	7244.4	8011244	-60.9	1m
0.0533	X	0.00	1.0	41.8	11.2	53.0	446.7	4011632	-79.1	1m,amb
0.0797	X	180.00	1.0	39.8	10.8	50.6	338.8	2683817	-78.0	1m
0.1050	X	0.00	1.0	40.3	10.7	51.0	354.8	2037145	-75.2	1m,amb
0.1331	X	0.00	1.0	35.5	10.6	46.1	201.8	1607064	-78.0	1m,amb
0.1602	X	0.00	1.0	32.2	10.5	42.7	136.5	1335207	-79.8	1m,amb
0.1861	X	0.00	1.0	32.5	10.4	42.9	139.6	1149507	-78.3	1m,amb
0.2136	X	0.00	1.0	30.7	10.4	41.1	113.5	1001593	-78.9	1m,amb
0.2402	X	0.00	1.0	29.1	10.4	39.5	94.4	890509	-79.5	1m,amb
0.2670	X	0.00	1.0	29.9	10.4	40.3	103.5	801124	-77.8	1m,amb

EUT orientation: Y (standing up on bottom edge)

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MARGIN dB	
0.0267	Z	180.00	1.0	82.0	13.0	95.0	56234.1	8011244	-43.1	1m
0.0533	Z	0.00	1.0	53.3	11.2	64.5	1678.8	4011632	-67.6	1m,amb
0.0797	Z	225.00	1.0	46.1	10.8	56.9	699.8	2683817	-71.7	1m
0.1050	Z	0.00	1.0	37.7	10.7	48.4	263.0	2037145	-77.8	1m,amb
0.1331	Z	135.00	1.0	38.3	10.6	48.9	278.6	1607064	-75.2	1m
0.1602	Z	0.00	1.0	33.4	10.5	43.9	156.7	1335207	-78.6	1m,amb
0.1861	Z	0.00	1.0	34.6	10.4	45.0	177.8	1149507	-76.2	1m,amb
0.2136	Z	0.00	1.0	30.4	10.4	40.8	109.6	1001593	-79.2	1m,amb
0.2402	Z	0.00	1.0	31.8	10.4	42.2	128.8	890509	-76.8	1m,amb
0.2670	Z	0.00	1.0	30.8	10.4	41.2	114.8	801124	-76.9	1m,amb