HAC Test Report

FCC Part §20.19

No.: HAC_L3COM_003_MC5725V

for

L-3 Communications

Cell phone / PDA

Model Number: L-3 Guardian TM -C

FCC ID: N7NMC5725

Date of Report:	**2008-07-16**
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Certificate # 2135.01

Bluetooth Qualification Test Facility (BQTF)

LAB CODE 20020328-00

FCC listed# A2LA accredited

IC recognized # 3462B

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Contents

1 Assessment

The L-3 Guardian ™ has been tested in accordance with ANSI C63.19-2007: American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids.

Technical responsibility for area of testing:

Date	Section	Name	Signature
2008-07-16	**EMC & Radio**	**Lothar Schmidt (Director Regulatory & Antenna Services)**	Lothar Schmidt I am approving this document

Responsible for test report and project leader:

Date	Section	Name	Signature
2008-07-16	**EMC & Radio**	**Marc Douat (Project Engineer)**	Marc Douat I am the author of this document

The test results of this test report relate exclusively to the test item specified in Identification of the Equipment under Test. The CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the CETECOM Inc USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the HAC Assessment Report

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Responsible Test Lab Manager:	Lothar Schmidt

2.2 Identification of the Client

Applicant's Name:	L-3 Communications
Address:	1 Federal Street Camden, New Jersey 08103, USA
Contact Person:	Robert Dovi
Phone No.	+1 856 338 3583
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2.3 Identification of the Manufacturer

Manufacturer's Name:	L-3 Communications
Manufacturer's Address	1 Federal Street, Camden, New Jersey 08103, USA

3 Equipment under Investigation (EUI)

3.1 Identification of the Equipment under Investigation

Product Type	Cell phone / PDA
Marketing Name:	L-3 Guardian ™
Model No:	L-3 Guardian ™ -C
Frequency Range:	824 MHz to 849 MHz, 1850 MHz to 1910 MHz
Type(s) of Modulation:	QPSK, HPSK
Telephone category	M4

4 Subject of Investigation

The L-3 Guardian TM -C is a new Cell phone / PDA from L-3 Communications operating in the 824 MHz to 849 MHz, 1850 MHz to 1910 MHz frequency ranges. The objective of the measurements done by CETECOM Inc. was the hearing aid compatibility assessment of the device.

4.1 FCC rules and ANSI Measurement Methods

Chapter 47 of Code of Federal Regulations, Part 20 § 19 specify criteria for Hearing aid-compatible mobile handsets and ANSI C63.19-2007: American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids establish categories for hearing aids and methods of measurement.

4.2 HAC performance and Equipment categorization

AWF : Articulation Weighing Factor

Standard	Technology	AWF
TIA/EIA/IS-2000	CDMA	0
TIA/EIA-136	TDMA (50 Hz)	0
T1/T1P1/3GPP	UMTS (WCDMA)	0
iDEN	TDMA (22 Hz and 11 Hz)	0
J-STD-007	GSM (217 Hz)	-5

4.2.1 Categories of Hearing Aid Compatibility for wireless devices

Telephone RF Parameters < 960 MHz – 850MHz band					
Category	AWF (dB)	Limits for E-Field Emissions		Limits for H-Field Emissions	
		V/m	dBV/m	A/m	dBA/m
M1/T1	0	631.0 to1122.0	51 to 61	1.91 to 3.39	+5.6 to +10.6
	-5	473.2 to 814.4	53.5 to 58.5	1.43 to 2.54	+3.1 to +8.1
M2/T1	0	354.8 to 631.0	51 to 56	1.07 to 1.91	+0.6 to +5.6
	-5	266.1 to 473.2	48.5 to 53.5	0.80 to 1.43	-1.9 to +3.1
M3/T1	0	199.5 to 354.8	46 to 51	0.60 to 1.07	-4.4 to +0.6
	-5	149.6 to 266.1	43.5 to 48.5	0.45 to 0.80	-6.9 to -1.9
M4/T1	0	< 199.5	< 46	< 0.60	< -4.4
	-5	< 149.6	<43.5	< 0.45	< -6.9

Telephone RF Parameters > 960 MHz – 1900 MHz band					
Category	AWF (dB)	Limits for E-Field Emissions		Limits for H-Field Emissions	
		V/m	dBV/m	A/m	dBA/m
M1/T1	0	199.5 to 354.8	41 to 51	0.60 to 1.07	+4.4 to +0.6
	-5	146.6 to 266.1	43.5 to 48.5	0.45 to 0.80	-6.9 to -1.9
M2/T1	0	112.2 to 199.5	41 to 46	0.34 to 0.60	-9.4 to -4.4
	-5	84.1 to 149.6	38.5 to 43.5	0.25 to 0.45	-11.9 to -6.9
M3/T1	0	62.1 to 112.2	36 to 41	0.19 to 0.34	-14.4 to -9.4
	-5	47.3 to 84.1	33.5 to 38.5	0.14 to 0.25	-16.9 to -11.9
M4/T1	0	< 63.1	< 36	< 0.19	< -14.4
	-5	< 47.3	<33.5	< 0.14	< -16.9

5 Measurement Procedure

ANSI has published an American National Standard on June 2007 (C63.19), which establishes categories for hearing aids and for wireless devices, and provide tests that can be used to assess the electromagnetic characteristics of hearing aids and for wireless devices and assign them to these categories.

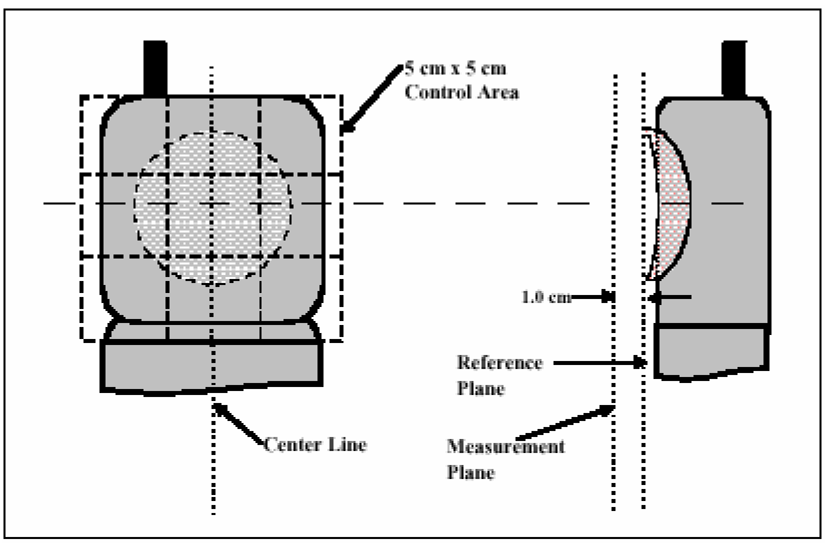
5.1 General Requirements

The testing shall be performed in a laboratory with an environment, which avoids influence on HAC measurements by ambient EM sources and any reflection from the environment itself. The ambient RF noise floor needs to be at least 20dB below the desired limit. The ambient temperature shall be in the range of 20°C to 26°C and 30-70% humidity.

5.2 Testing Position

Test positions of device

The HAC measurements are perform according to the requirements of ANSI C63.19. It allows centering the wireless device inside a 5 x 5 cm control area marked with 4 points for position adjustment. SARA2's robot arm allows an exact adjustment of the measurement distance to 1 cm from the DUT, which also includes the distance of the dipole center to the probe tip.
The measurement probe is centered above the mobile phone speaker inside the control area. (see picture)



and using the robot arm also for adjusting the validation dipole position

Device holder description

The Indexsar phone holder is a skeletal design. It is designed so that most phones can be held from the bottom without putting any plastic materials in contact with the upper part of the EUT. A special mounting block is recommended for use and the phone can be fixed temporarily to the holder using hot-glue gun.

5.3 Scanning Procedure

The SARA2-HAC installation use predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All tests are performed with the same configuration of test steps an in accordance with the requirements described in C63.19-2005 Chapter 4.

1. The HAC test setup holder is placed at the pre-defined position on top of the head SAR phantom holder.
2. A phone holder adjustment and verification is performed, which allows checking the borders and center position of the 5 x 5 cm² control area. The probe tip touches down on center of the control area
3. The wireless device (WD) is oriented in its intended test position (see photo documentation) with the reference plane in the horizontal plane and secured by the device holder. The acoustical output is placed in the centre of the control area.
4. From “Shapes” main menu is selected an image file for the EUT and enter the correct angle of orientation.
5. The DUT is set to transmit at maximum output power at the desired test channel(s).
6. Manually select from the main menu correct probe (H-field or E-field) and software will load the correct probe calibration factors.
7. The „area scan“ measures the electrical or magnetic field strength above the WD on a parallel plane to the surroundings of the control area at the upper end of the HAC test arch. It is used to locate the approximate location of the peak field strength with 2D spine interpolation. The robot performs a stepped movement along one grid axis while the probe measures the local electrical or magnetic field strength. The probe is moving at a distance of 1 cm to a defined plane above the WD during acquisition of measurement values. Standard grid spacing is 5 mm in x- and y- dimension.
8. The automatic data evaluation performed by the software in respect of the requirements of the test standard subdivides the tested area of 5 x 5 cm into 9 squares. Within each square

the maximum electrical or magnetic field strength is detected. For classification of M categories, the three squares with highest field values may be excluded. Among the remaining 6, one of which is the center square, at least 4 squares with highest values both in E-field and in H-field scan must be evaluated. The SARSA2_HAC evaluation software together with the measurement plots automatically exports the results.
The software also respects the articulation weighing factor (AWF), and converts the measured values to peak dBV/m using the probe modulation factor, which is determined by system validation measurements (see chapter …)

The HAC test shall be performed for near field emissions with E-field and H-field probes for each supported frequency band.
For devices with retractable antenna, the HAC test shall be performed in the condition of maximum antenna efficiency, as defined by the manufacture. The HAC test shall be performed at the middle frequency channels of each operating mode.

5.4 Robot system specification

The HAC measurement system being used is the IndexSAR SARA2-HAC system, which consists of a Mitsubishi RV-E2 6-axis robot arm and controller and IndexSAR HAC probes. The robot is use to articulate the probe to programmed positions inside the phantom head to obtain the HAC readings from the DUT.

The system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

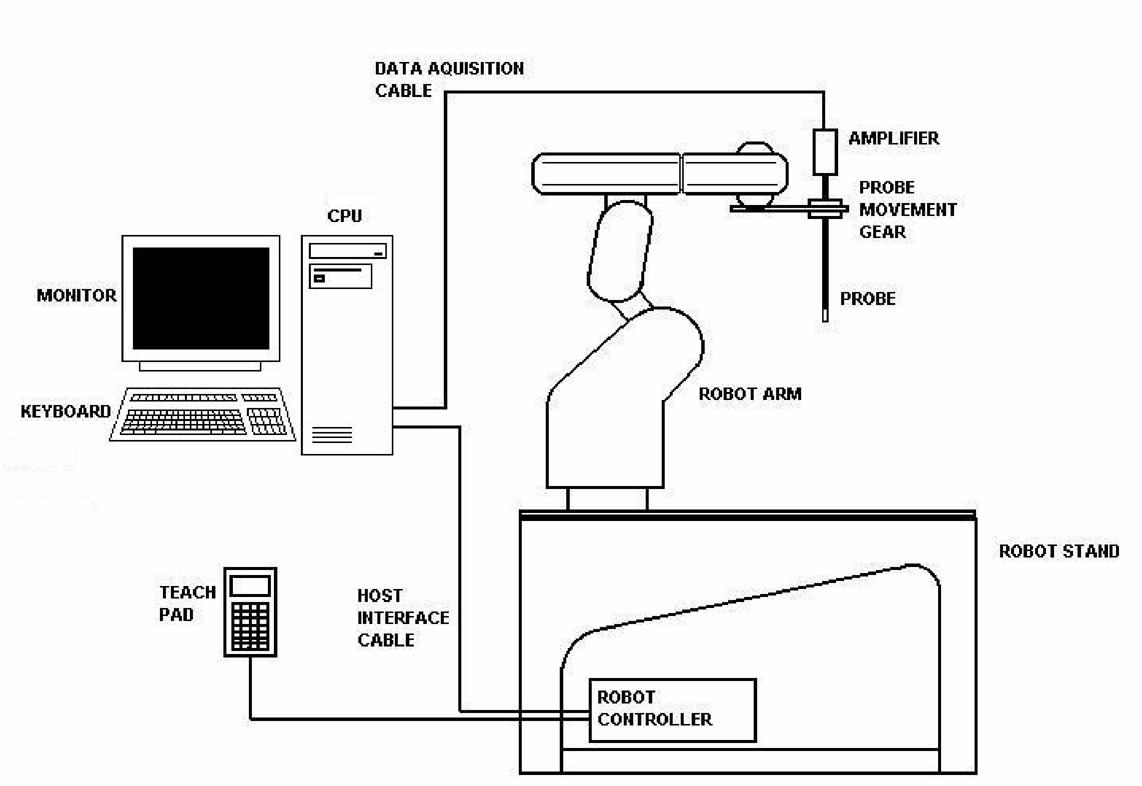


Figure 5: Schematic diagram of the SAR/HAC measurement system

The position and digitised shape of the EUTs are made available to the software for accurate positioning of the probe and reduction of set-up time.

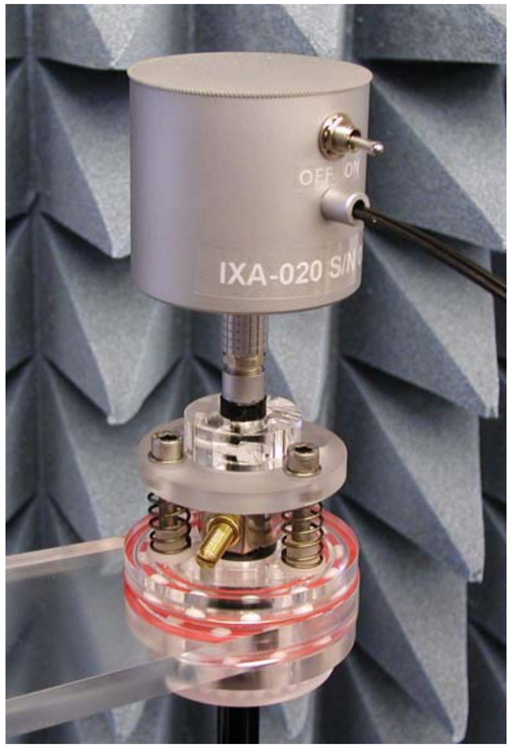
In operation, the system does an area (2D) scan at a fixed distance from the EUT.

5.5 Probe and amplifier specification

5.5.1 Indexsar near-field HAC probes

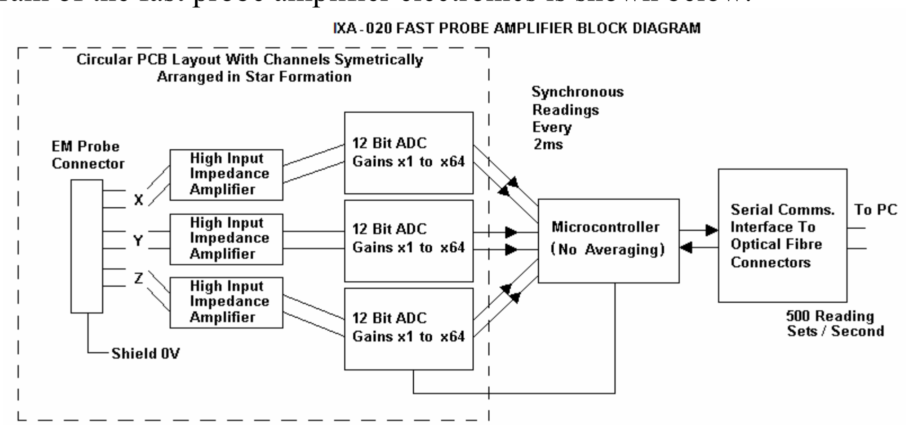
Two separate probes are provided for measuring electric (model IXP-090) and magnetic (model IXP-070) RF fields. The probes have built-in shielding against static charges and are contained within a PEEK cylindrical enclosure material at the tip. Probes calibration is described in the probe's calibration certificate.

5.5.2 The IXA-020 probe amplifier

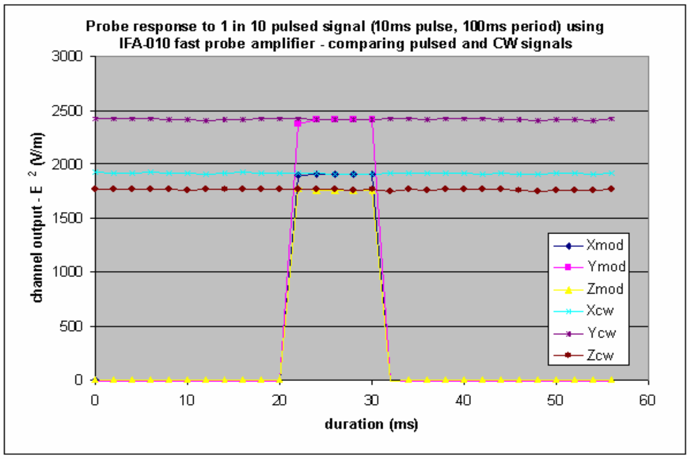


This component is a key component of the measurement system having the basic capability of making simultaneous synchronized measurements of each of the three sensor outputs 500 times per second.

A block diagram of the fast probe amplifier electronics is shown below.



This amplifier has a time constant of approx. 50µs, which is much faster than the RF probe response time. The overall system time constant is therefore that of the probe (<1ms) and reading sets for all three channels (simultaneously) are returned every 2ms to the PC. The conversion period is approx. 1 µs at the start of each 2ms period. This enables the probe to follow pulse modulated signals of periods >>2ms. The PC software applies the linearization procedure separately to each reading, so no linearization corrections for the averaging of modulated signals are needed in this case. It is important to ensure that the probe reading frequency and the pulse period are not synchronized and the behavior with pulses of short duration in comparison with the measurement interval needs additional consideration.



6 Uncertainty Assessment

A measurement uncertainty assessment has been undertaken following guidance given in ANSI C63.19. Indexsar Ltd has supplied a generic uncertainty analysis for the SARA2 system in the form of a spreadsheet.

Some of the uncertainty contributions are site-specific and, for these, Cetecom, Inc. has assessed the uncertainty contributions arising from local environmental and procedural factors.

The resultant uncertainty budget, following the assessment template given ANSI C63.19 is shown below:

6.1 Measurement Uncertainty Budget

Error Sources	Uncertainty Value ±dB	Probability Distribution	Divi-sor	Standard Uncertainty E dB	Standard Uncertainty H dB
Measurement System					
Field Probe calibration	1.4	Normal	1	1.40	1.20
RF reflections *	0.8	Rectangular	√3	0.21	0.21
Field probe Anisotropy	1.25	Rectangular	√3	0.52	0.52
Positioning Accuracy	0.1	Rectangular	√3	0.01	0.01
Positioning Accuracy (10mm)	0.9	Rectangular	√3	0.27	0.27
Probe cable Placement	0.1	Rectangular	√3	0.01	0.01
System repeatability	0.2	Rectangular	√3	0.01	0.01
Test Sample Related					
Device holder and Phantom	0.2	Rectangular	√3	0.01	0.01
Power drift	0.3	Rectangular	√3	0.03	0.03
Combined Std. Uncertainty				**± 1.74**	**± 1.58**
Expanded Std. Uncertainty on Field		**Norm.**	**K=2**	**± 3.47**	**± 3.15**

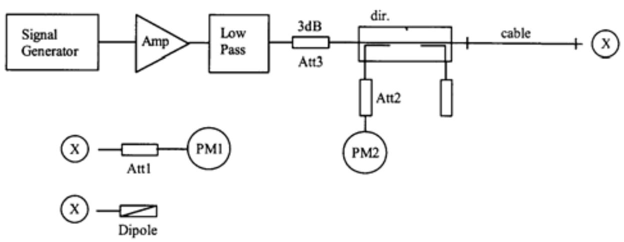
* site specific

7 System Validation

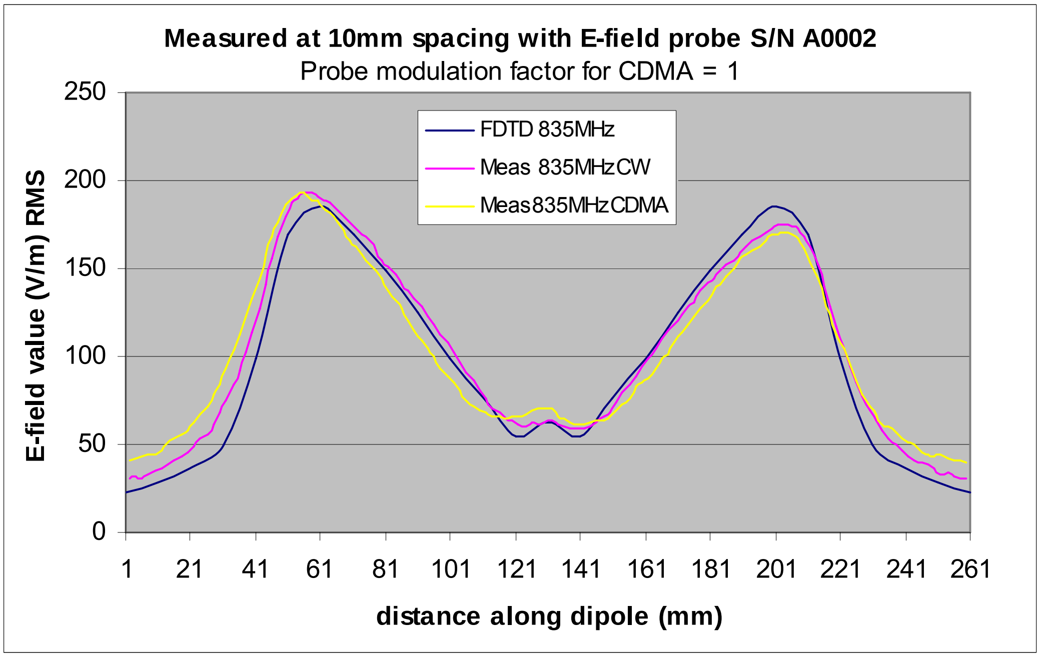
The system validation is performed for verifying the accuracy of the complete measurement system and performance of the software. The following chapters contain validation descriptions as well as results for all frequency bands and both for E- and H-field probes.

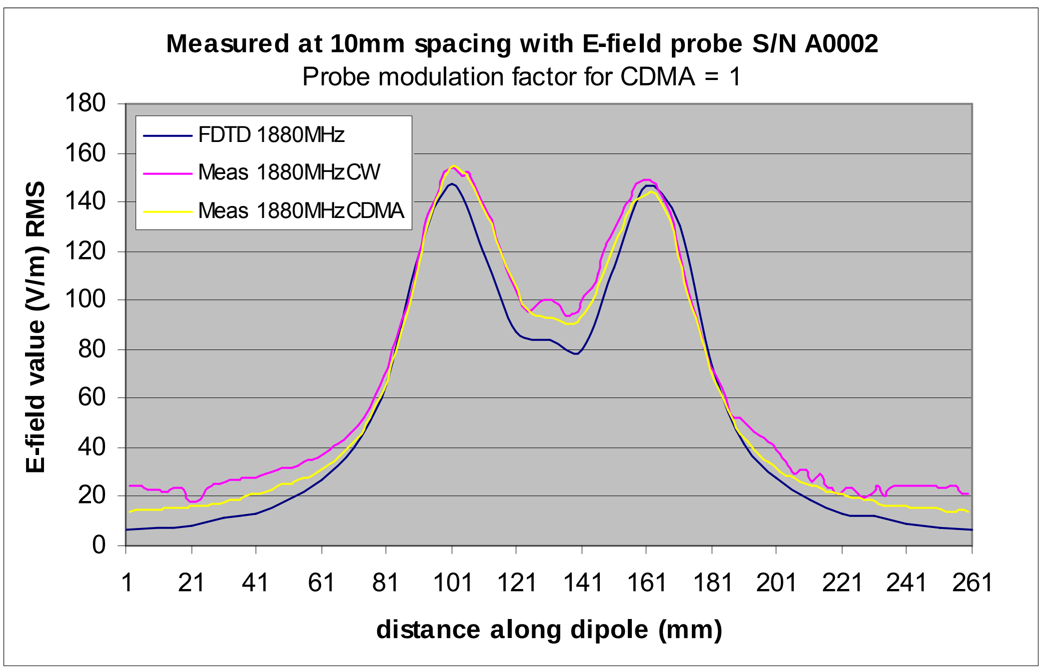
7.1 Validation procedure

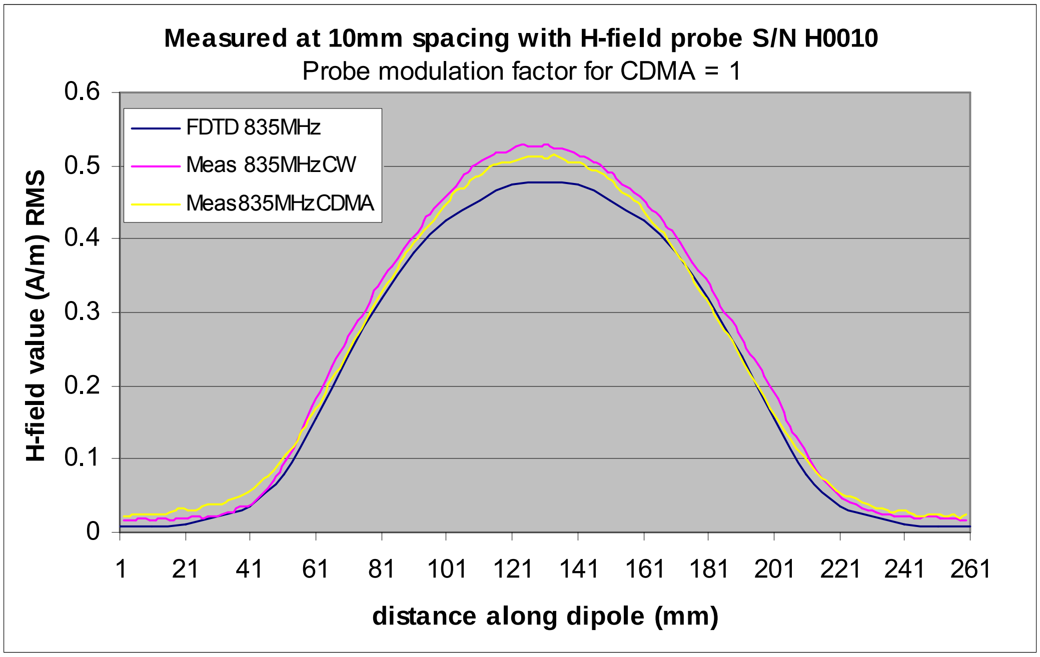
According to the requirements of ANSI C63.19 chapter 4.2.2.1.1 the validation is performed by using a validation dipole, which is positioned parallel to the nylon fiber of the HAC test arch. The dipole is connected to the signal source consisting of signal generator and amplifier via an directional coupler, N-connector cable and adapter to SMA. It is fed with a power of 100 mW (20 dBm). To adjust this power a power meter is used . The power sensor is connected to the cable before the validation to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the validation to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test.
During the validation the measurement system scans a grid along the length of the dipole and the maximum value is recorded.
This validation is performed periodically both with E and H field probes on the center frequencies of the frequency bands used by the wireless device.
Validation results have to be equal or near the values determined during dipole calibration with the same test system set-up.

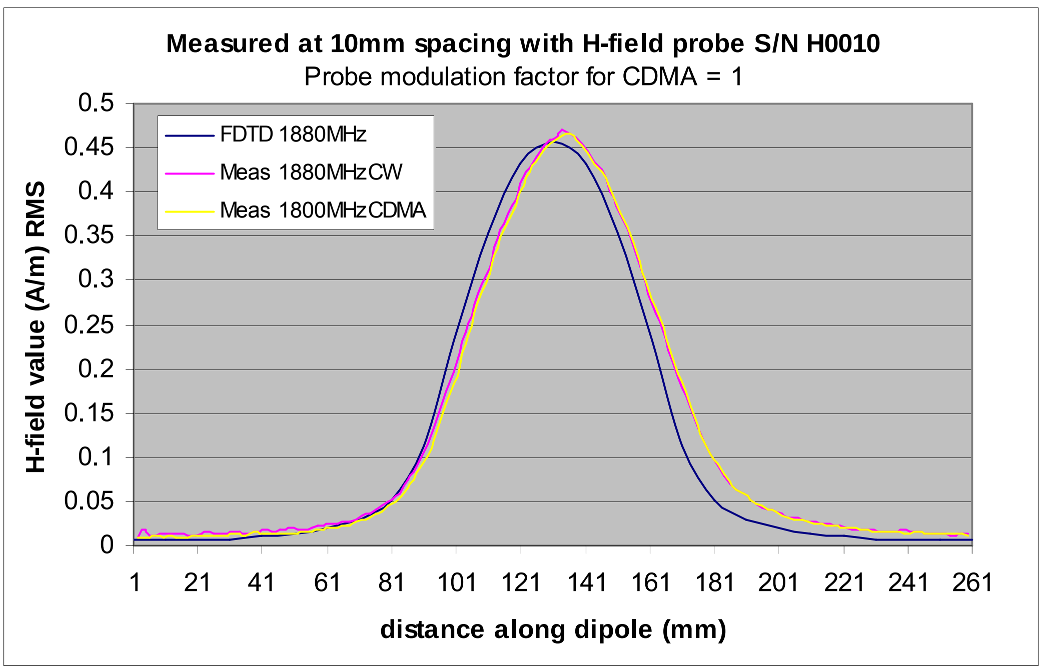


The probe modulation factor indicates the relation between the measured RMS (average) field strength values and the peak field strength of a modulated signal, which will be used by the data evaluation software to calculate from measured RMS values to peak field values for HAC evaluation. It can be determined by comparing a CW signal with a modulated signal having the same peak envelope power as defined in ANSI C63.19 Annex C.3.1.
A spreadsheet is supplied by Indexsar to enable the probe modulation factors to be obtained by comparing the measurements in each case. This spreadsheet also enables the dipole validation results to be compared with the FDTD reference values contained in the standard. If the E-field maxima on either side of the dipole are not at the same level, consider leveling the X-axis robot arm.


Measured at 10mm spacing with E-field probe S/N A0002
Probe modulation factor for CDMA = 1
FDTD 835MHz
Meas 835MHz CW
Meas835MHzCDMA
E-field value (V/m) RMS
0
50
100
150
200
250
1
21
41
61
81
101
121
141
161
181
201
221
241
261
distance along dipole (mm)


Measured at 10mm spacing with E-field probe S/N A0002
Probe modulation factor for CDMA = 1
FDTD 1880MHz
Meas 1880MHz CW
Meas 1880MHz CDMA
E-field value (V/m) RMS
0
20
40
60
80
100
120
140
160
180
1
21
41
61
81
101
121
141
161
181
201
221
241
261
distance along dipole (mm)


Measured at 10mm spacing with H-field probe S/N H0010
Probe modulation factor for CDMA = 1
FDTD 835MHz
Meas 835MHz CW
Meas835MHzCDMA
H-field value (A/m) RMS
0.6
0.5
0.4
0.3
0.2
0.1
0
1
21
41
61
81
101
121
141
161
181
201
221
241
261
distance along dipole (mm)


Measured at 10mm spacing with H-field probe S/N H0010
Probe modulation factor for CDMA = 1
FDTD 1880MHz
Meas 1880MHz CW
Meas 1800MHz CDMA
H-field value (A/m) RMS
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1
21
41
61
81
101
121
141
161
181
201
221
241
261
distance along dipole (mm)

8 Test results summary

8.1 HAC results for L-3 Guardian ™

Test Results – E-field

Operating Band	CHANNEL NUMBER	FREQUENCY (MHz)	Max. E-field (peak) dB V/m	M3 Limit	Category	Air temperature
CDMA 850	MID # 384	836.52	27.3	<48.5	M4	21.3
CDMA 1900	MID # 600	1880.0	23.6	<38.5	M4	21.7

Test Results – H-field

Operating Band	CHANNEL NUMBER	FREQUENCY (MHz)	Max. E-field (peak) dB A/m	M3 Limit	Category	Air temperature
CDMA 850	MID # 384	836.52	-36.0	<-1.9	M4	21.4
CDMA 1900	MID # 600	1880.0	-39.4	<-11.9	M4	21.7

8.2 Plots

E/H Field technical report

Test details: CDMA 850 MHz Band

AWF set to 0

Band set to 835

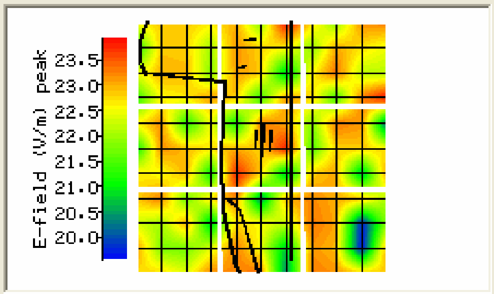
Colour Key

Excluded sub-grids	Max remaining sub-grid	Remaining sub-grids

Note: M1 is bad - M4 is good

1st data-set

Reload | \850_CDMA-RF-E.csv | Probe Modn. Factor 1.00



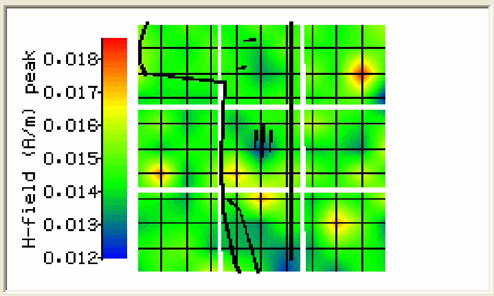
Assigned for E-Field scan : M4

Peak field limits (dB V/m)

Grid 1	Grid 4	Grid 7
27.2 M4	27.3 M4	27.3 M4
Grid 2	**Grid 5**	**Grid 8**
27.2 M4	27.3 M4	27.2 M4
Grid 3	**Grid 6**	**Grid 9**
27.3 M4	27.3 M4	27.3 M4

2nd data-set

Reload | \850_CDMA-RF-H.csv | Probe Modn. Factor 1.00



Assigned for H-Field scan : M4

Peak field limits (dB A/m)

Grid 1	Grid 4	Grid 7
-36.1 M4	-36.7 M4	-35.9 M4
Grid 2	**Grid 5**	**Grid 8**
-36.2 M4	-36.0 M4	-36.3 M4
Grid 3	**Grid 6**	**Grid 9**
-36.1 M4	-36.0 M4	-36.0 M4

Combined Exclusions Map using Method A

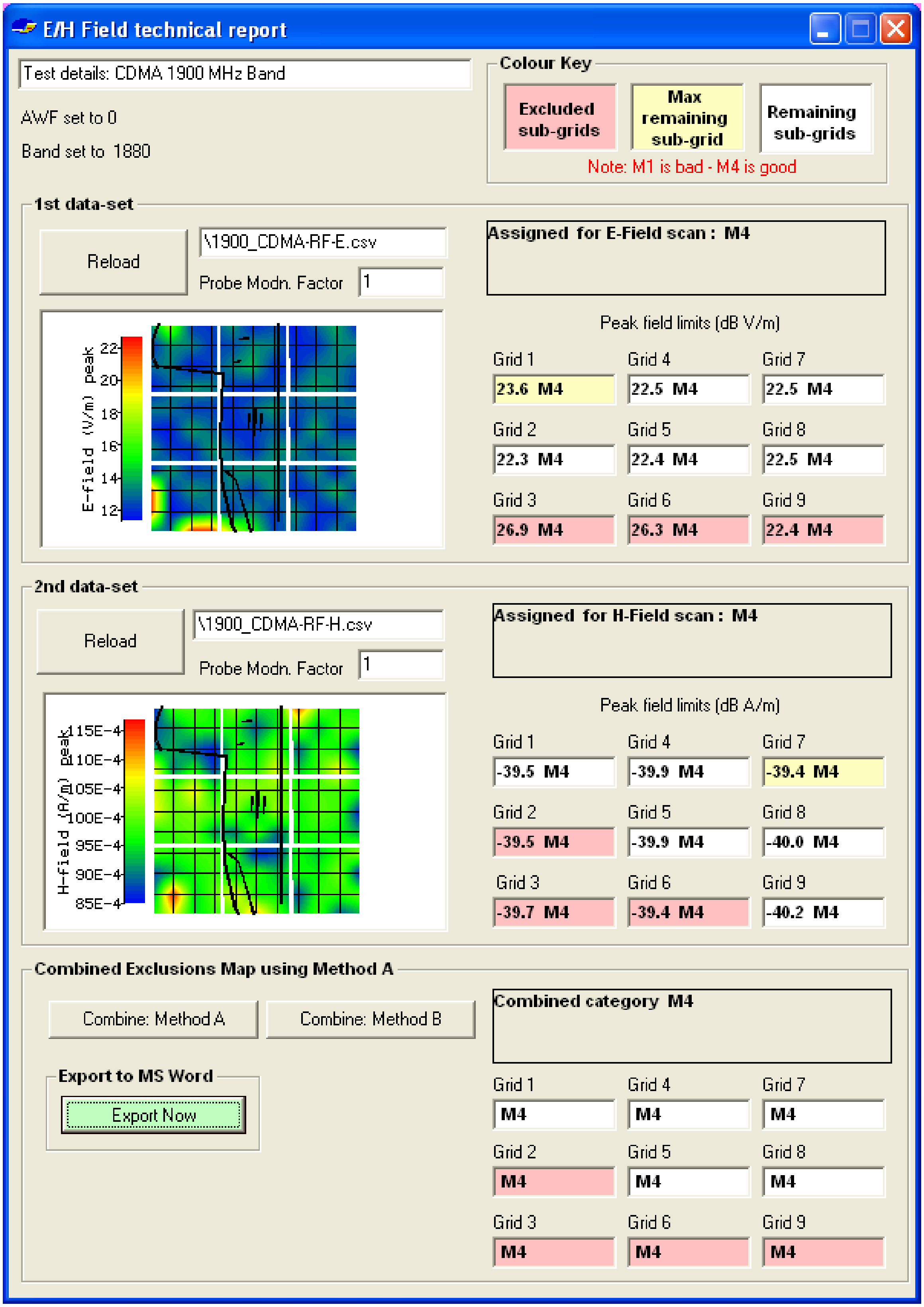
Combine: Method A | Combine: Method B

Export to MS Word

Export Now

Combined category M4

Grid 1	Grid 4	Grid 7
M4	M4	M4
Grid 2	**Grid 5**	**Grid 8**
M4	M4	M4
Grid 3	**Grid 6**	**Grid 9**
M4	M4	M4


E/H Field technical report
Test details: CDMA 1900 MHz Band
AWF set to 0
Band set to 1880
Colour Key
Excluded sub-grids
Max remaining sub-grid
Remaining sub-grids
Note: M1 is bad - M4 is good
1st data-set
Reload
\1900_CDMA-RF-E.csv
Probe Modn. Factor 1
E-field (V/m) peak
22
20
18
16
14
12
Assigned for E-Field scan : M4
Peak field limits (dB V/m)
Grid 1 23.6 M4
Grid 4 22.5 M4
Grid 7 22.5 M4
Grid 2 22.3 M4
Grid 5 22.4 M4
Grid 8 22.5 M4
Grid 3 26.9 M4
Grid 6 26.3 M4
Grid 9 22.4 M4
2nd data-set
Reload
\1900_CDMA-RF-H.csv
Probe Modn. Factor 1
H-field (A/m) peak
115E-4
110E-4
105E-4
100E-4
95E-4
90E-4
85E-4
Assigned for H-Field scan : M4
Peak field limits (dB A/m)
Grid 1 -39.5 M4
Grid 4 -39.9 M4
Grid 7 -39.4 M4
Grid 2 -39.5 M4
Grid 5 -39.9 M4
Grid 8 -40.0 M4
Grid 3 -39.7 M4
Grid 6 -39.4 M4
Grid 9 -40.2 M4
Combined Exclusions Map using Method A
Combine: Method A
Combine: Method B
Combined category M4
Export to MS Word
Export Now
Grid 1 M4
Grid 4 M4
Grid 7 M4
Grid 2 M4
Grid 5 M4
Grid 8 M4
Grid 3 M4
Grid 6 M4
Grid 9 M4

9 References

[1] 47 CFR Part 20 Article 19 – Hearing aid-compatible mobile handsets.

[2] ANSI C63.19-2007, American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids.

[3] INDEXSAR – HAC Test System User's Manual, May 2007.