T-Coil HAC Test Report

FOR:

Manufacturer: Research In Motion Limited
Model Name: RFM121LW
FCC ID: L6ARFM120LW

Test Report #: HAC_CETE4_023_13001_T-Coil

Date of Report: 2013/04/04

ACCREDITED
TESTING LABORATORY
Certificate #2135.01

CTIA Authorized Test Lab
LAB CODE 20020328-00

FCC Listed #:
A2LA Accredited

IC Recognized #
3462B-1

***CETECOM* Inc.**
411 Dixon Landing Road • Milpitas, CA 95035 • U.S.A.
Phone: + 1 (408) 586 6200 • Fax: + 1 (408) 586 6299 • E-mail: info@cetecomusa.com • http://www.cetecom.com
CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

TABLE OF CONTENTS

1. Assessment

The following device was tested against the applicable criteria specified in FCC 20.19 and ANSI C63.19 – 2007 and no deviations were ascertained during the course of the tests performed.

Company	Description	Model #
Research In Motion Limited	Smartphone	RFM121LW

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2013/04/08	Compliance	Sajay Jose (Test Lab Manager)	

Responsible for the Report:

Date	Section	Name	Signature
2013/04/08	Compliance	Josie Sabado (Project Engineer)	

The test results of this test report relate exclusively to the test item specified in Section3.
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 CETECOM Inc. USA.

2. Administrative Data

2.1. Identification of the Testing Laboratory Issuing the HAC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Address:	411 Dixon Landing Road Milpitas, CA 95035 U.S.A.
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Test Lab Director:	Heiko Strehlow
Responsible Project Leader:	Josie Sabado

2.2. Identification of the Client

Applicant's Name:	Research In Motion Limited
Street Address:	305 Phillip Street
City/Zip Code	Waterloo, ON N2L 3W8
Country	CANADA
Contact Person:	Masud Attayi
Phone No.	+1 51 98 88 74 65
Fax:	+1 51 98 88 69 06
e-mail:	mattayi@rim.com

2.3. Identification of the Manufacturer

Same as above client.

3. Equipment under Test (EUT)

3.1. Specification of the Equipment under Test

Prototype/Production:	Identical Prototype
Model No:	RFM121LW
FCC-ID:	L6ARFM120LW
Antenna Type:	Internal
Operating Voltage Range:	Battery 3.8 – 4.35 V, charger 5 Vdc
Operating Temperature Range:	32 - 95 degrees F (0 – 35 degrees C)
Supported Radios:	GSM/GPRS/EGPRS, MS Class 12, Power Class 4/1, Mobile Class A WCDMA/HSDPA/HSUPA Power Class 3, Cat 6 (5.7 Mbps uplink and QPSK) LTE CDMA Bluetooth v2.1 + EDR 802.11 a/b/g/n, HT20, HT40 NFC
Simultaneous Transmission Modes:	CDMA + LTE + WiFi CDMA + LTE + Bluetooth CDMA + Bluetooth CDMA + WiFi GSM/(E)GPRS + WiFi GSM/(E)GPRS + LTE + WiFi GSM/(E)GPRS + LTE + Bluetooth GSM + Bluetooth LTE + WiFi
Date of Testing:	March 10-19, 2013; April 3, 2013
HAC Rated Category:	T4

3.2. Identification of the Equipment Under Test (EUT)

EUT #	Serial Number	HW Version	SW Version
1	0809-3914-5655	CER-53013-001 Rev1-905-00	127.01.3901
2	0809-3929-8650	CER-53013-001 Rev2-905-00	127.0.1.4429

3.3. Identification of Accessory equipment

No accessory equipment

3.4. Supported Air Interfaces

Air Interface	Type(s) of Modulation	Band	Transmit Frequency Range (MHz)	Type	C63.19 Tested	Over the Top Voice Mode
GSM	GMSK	GSM 850	824.2 – 848.8	Voice	Yes	N/A
		PCS 1900	1850.2 – 1909.8			
(E)GPRS	GMSK, 8PSK	GSM 850	824.2 – 848.8	Data	N/A	No
		PCS 1900	1850.2 – 1909.8			
WCDMA	QPSK, 16 QAM	FDD II	1852.4 – 1907.6	Voice	Yes	N/A
		FDD V	826.4 – 846.6			
CDMA	QPSK, HPSK	Band Class 0	824.7 – 848.31	Voice	Yes	N/A
		Band Class 1	1851.25 – 1908.75			
EVDO Rev. A	QPSK, 8PSK, 16 QAM	Band Class 0	824.7 – 848.31	Data	N/A	No
		Band Class 1	1851.25 – 1908.75			
LTE	QPSK, 16 QAM	Band 4	1710.7 – 1754.3	Data	N/A	Yes
		Band 13	779.5 – 784.5			
Bluetooth	GFSK, π/4 DQPSK, 8DPSK	N/A	2402 – 2480	Data	N/A	No
802.11 b/g/n	BPSK, QPSK, 16-QAM, 64-QAM	N/A	2412 – 2462	Data	N/A	Yes
802.11 a/n	BPSK, QPSK, 16-QAM, 64-QAM	Sub-Band 1	5180 – 5240	Data	N/A	Yes
		Sub-Band 2	5260 – 5320			
		Sub-Band 3	5500 – 5700			
		Sub-Band 4	5745 – 5825			

4. Subject of Investigation

The objective of the measurements done by Cetecom Inc. was to determine the HAC rating of the EUT according to requirements in ANSI C63.19 – 2007. The examinations were carried out with the IndexSAR system described in Section 6.

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

4.2.1. Categories of Hearing Aid Compatibility for wireless devices

Category	Telephone parameters WD signal quality [(signal + noise)-to-noise ratio in decibels]
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	>30 dB

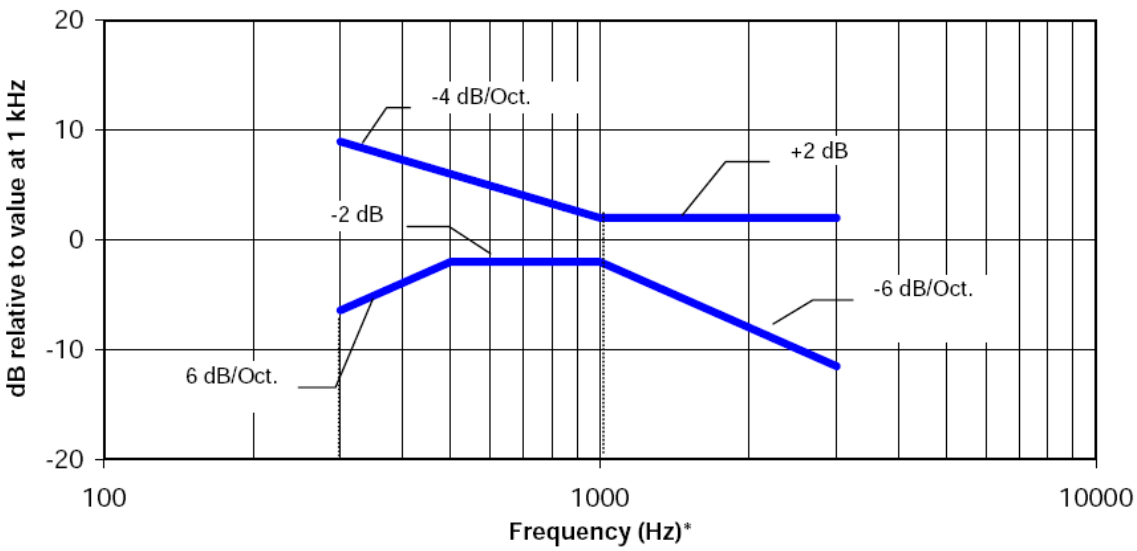
Results in appendix A show note “Signal Quality Category (T1 is band – T4 is good. Depends on AWF setting”. This statement is incorrect because AWF setting is not used in category assignment.

4.2.2. T-Coil Coupling field intensity

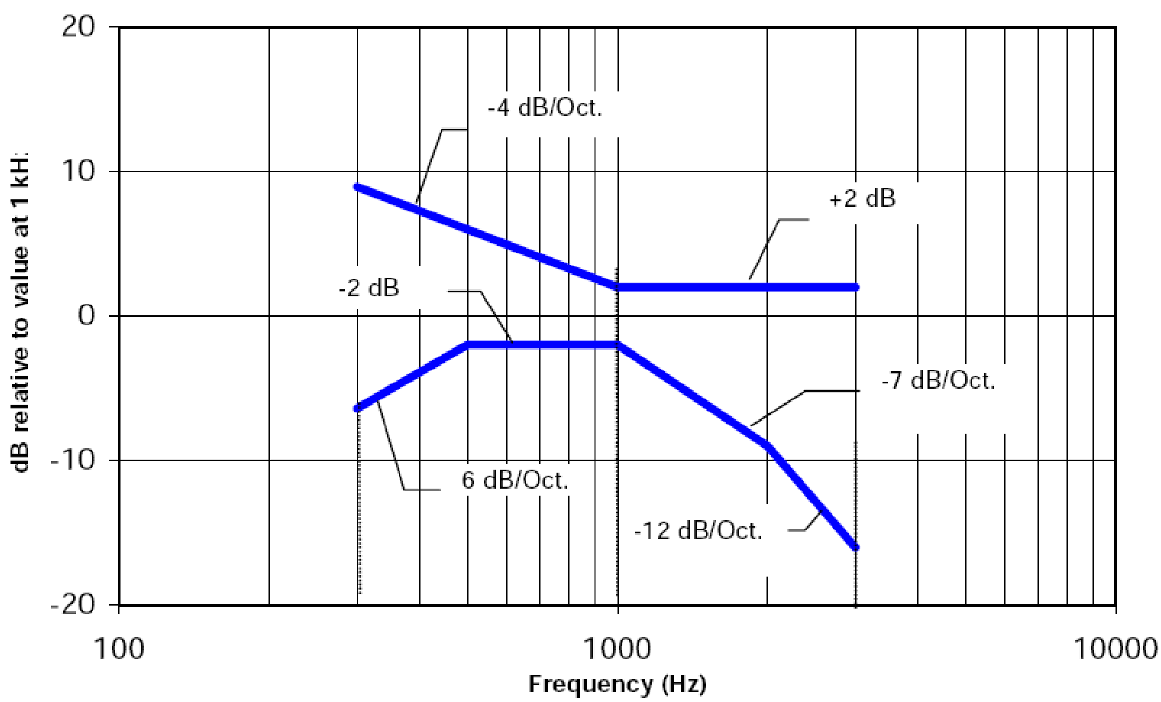
The T-Coil signal shall be ≥ -18 dB (A/m) at 1 kHz for all probe orientations while the wireless device is operating at reference input levels as specified in section 5.4 of this test report.

4.2.3. Magnetic Field Frequency Response

The magnetic field response for wireless devices with a field strength ≤ -15 dB (A/m) at 1 kHz shall be within the constraints of the following plot:



The magnetic field response for wireless devices with a field strength > -15 dB (A/m) at 1 kHz shall be within the constraints of the following plot:



5. Measurement Procedure

ANSI has published an American National Standard (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.

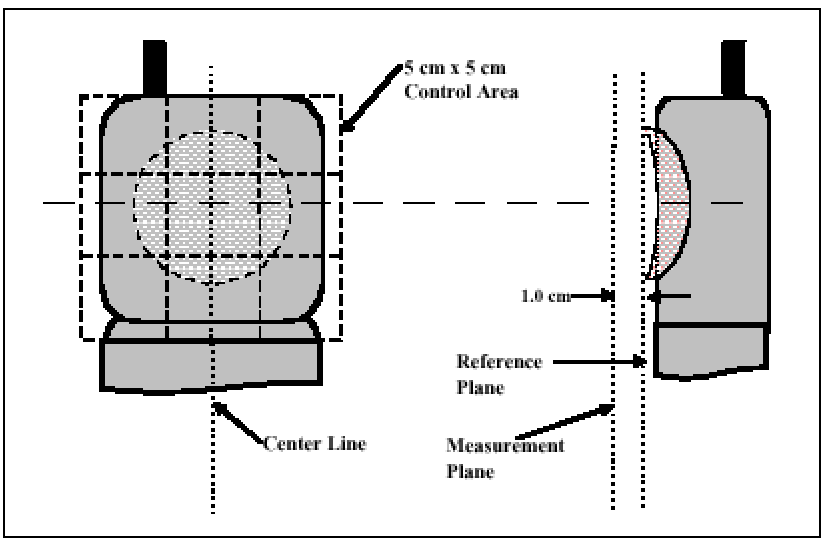
5.1. General Requirements

The test 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 temperature shall be in the range of 20°C to 26°C and 30-70% humidity.

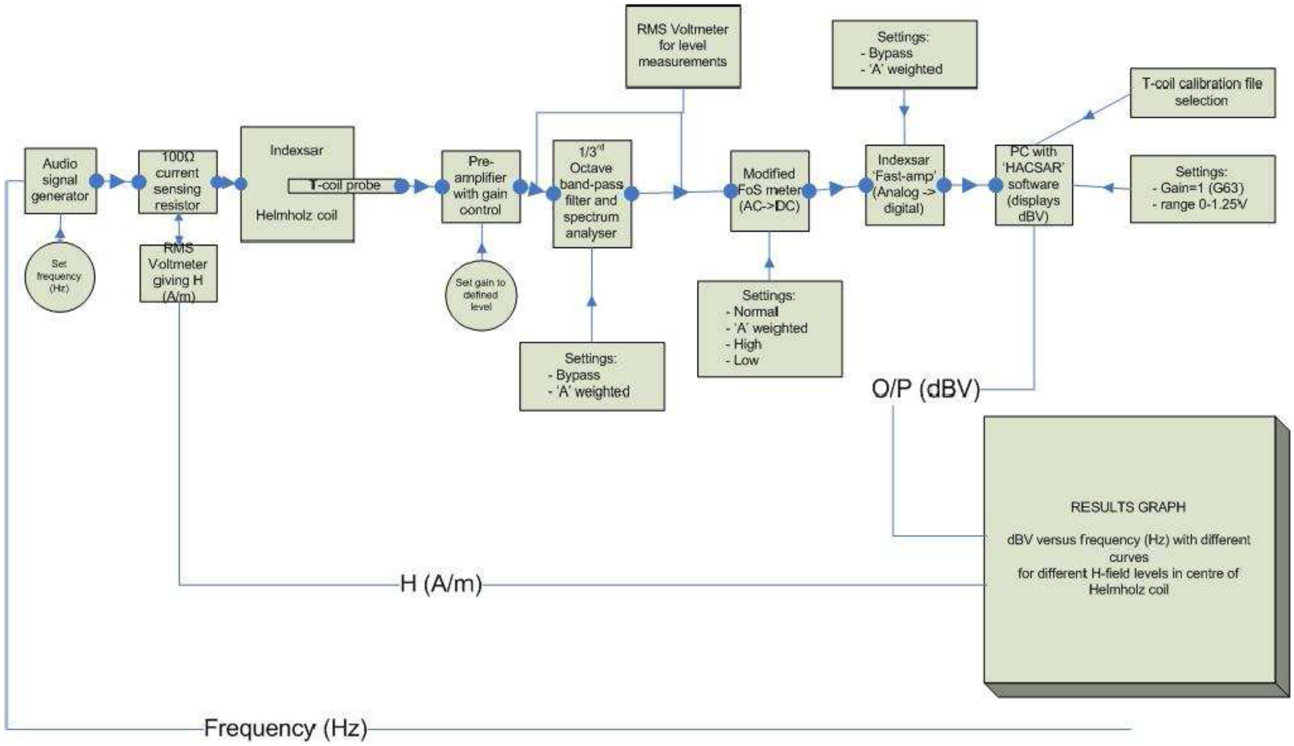
5.2. Configurations

Device holder and positioning 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.

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 from the DUT.
The measurement probe is centered above the mobile phone speaker inside the control area.



5.3. Pre-Measurement Calibration Procedure



1. Generate a 1 kHz and increase the amplitude until the RMS voltmeter measures 1 V across the 100Ω current sensing resistor.
2. Increase the gain of the preamplifier until the software measures 1 A/m.
3. Open a Tcoil Report window in the software.
4. Adjust the signal generator to each 1/3 Octave Band and measure each.
5. Adjust the 1/3rd Octave band-pass filter until the spectrum is flat along the 0 dB relative to 1 kHz axis.

5.4. Audio Signal Preparation

Normal speech input levels are as follows:

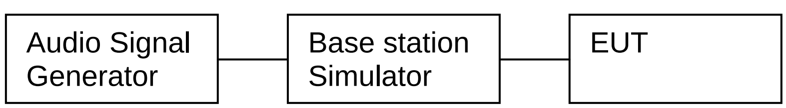
Standard	Technology	Input (dBm0)
TIA/EIA/IS-2000	CDMA	-18
TIA/EIA-136	TDMA (50 Hz)	-18
T1/T1P1/3GPP	UMTS (WCDMA)	-16
iDEN	TDMA (22 Hz and 11 Hz)	-18
J-STD-007	GSM (217 Hz)	-16

5.4.1. GSM/WCDMA

1. Establish a call between the base station simulator and the EUT via a conducted link.
2. Set the voice coder on the base station simulator to “Decoder Cal”. This represents 3.14 dBm0.
3. Measure the voltage at the speech output pin on the speech port of the base station simulator.
4. Calculate the RMS value of the desired input level using the equation
   $(\text{RMS value of Decoder Cal}) * 10^{[3.14 - (\text{desired input level})] / 20}$
5. Change the voice coder to “Encoder Cal”.
6. Using the audio generator of the base station simulator, generate a 1 kHz test signal.
7. Adjust the level of the 1 kHz test signal to match the desired input level calculated in step 4.

5.4.2. CDMA

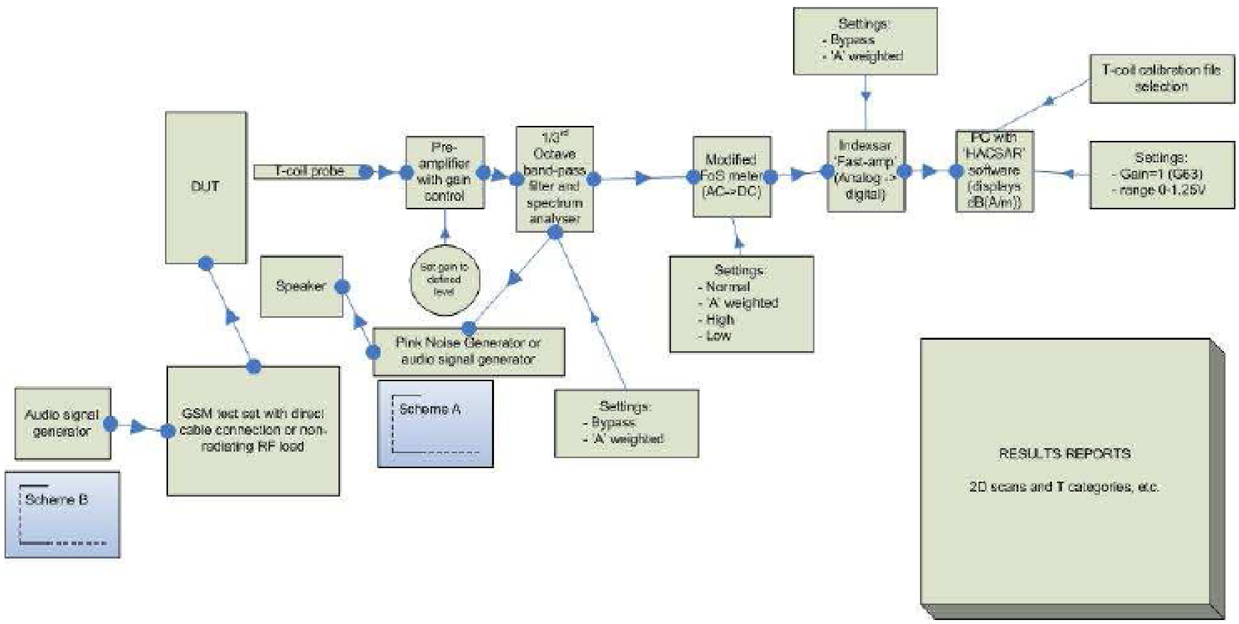
Because accurate results may not be possible with voice coders used with CDMA, a P.50 artificial voice signal is used.



1. Establish a call between the base station simulator and the EUT via a conducted link.
2. Set the voice coder on the base station simulator to “Decoder Cal”. This represents 3.14 dBm0.
3. Using the audio analyzer function of the base station simulator, note the RMS value.
4. Calculate the RMS value of the desired input level using the equation
   $(\text{RMS value of Decoder Cal}) * 10^{[3.14 - (\text{desired input level})] / 20}$
5. Change the voice coder to “Encoder Cal”.
6. Adjust the audio signal generator so that the base station simulator audio analyzer matches the RMS value of the desired input level calculated in step 4.

5.5. EUT Scanning Procedure

All tests are performed with the same configuration of test steps and in accordance with the requirements described in C63.19-2007 Chapter 4.



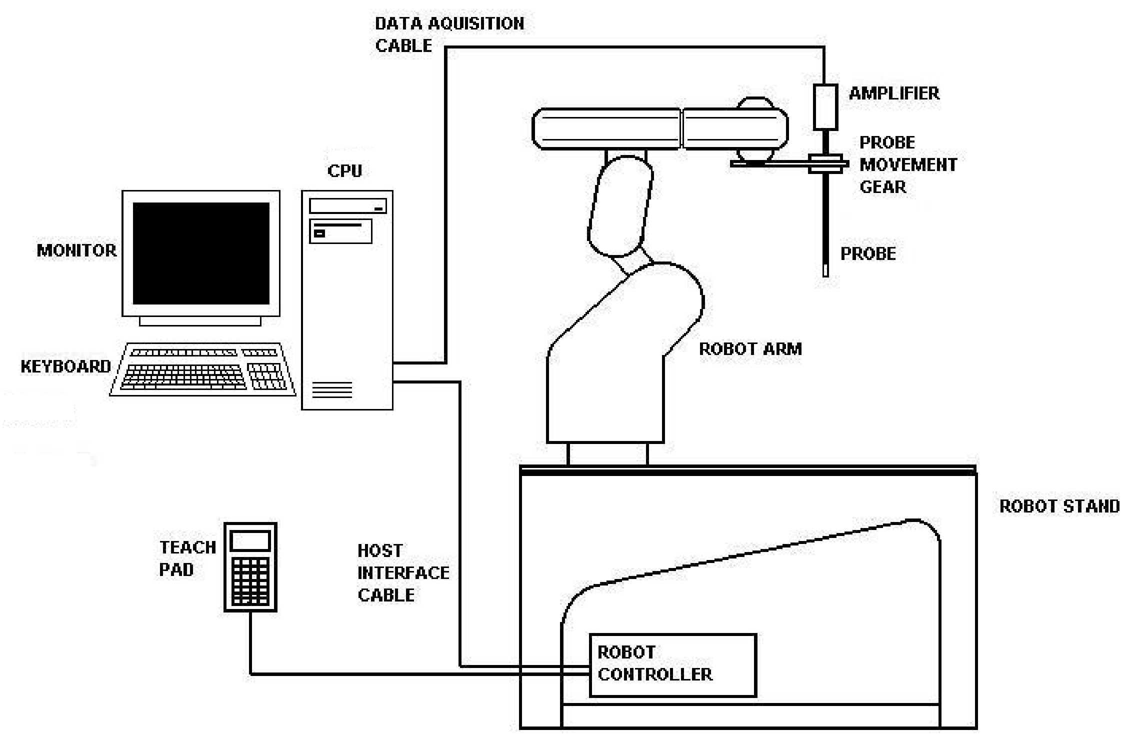
1. Select a probe and place it in the probe holder of the robot.
2. Setup a call at maximum output power on the EUT. Generate the desired audio file at the desired input level.
3. Perform an area scan.
4. Move the probe to the maximum measured point.
5. Measure the ABM1 value with the audio stimulus enabled.
6. Turn off the audio stimulus and measure AMB2.
7. With the axial probe only, perform spectral measurements in each of the 1/3 octave bands.

6. The Measurement System

6.1. 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, IndexSAR HAC probe and amplifier. The robot is used to articulate the probe to programmed positions inside the phantom head to obtain the SAR 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.



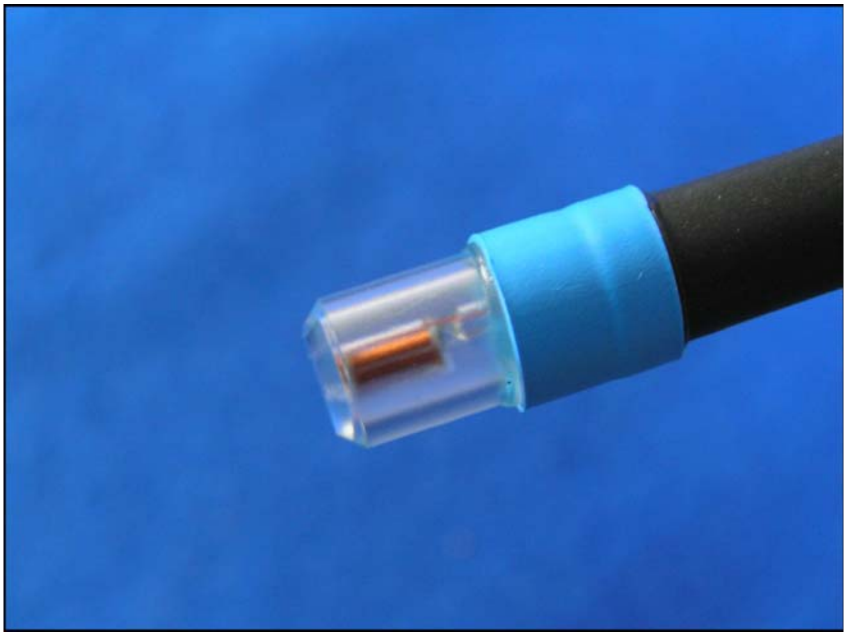
The position and digitized shape of the EUTs are made available to the software for accurate positioning of the probe and reduction of set-up time.

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

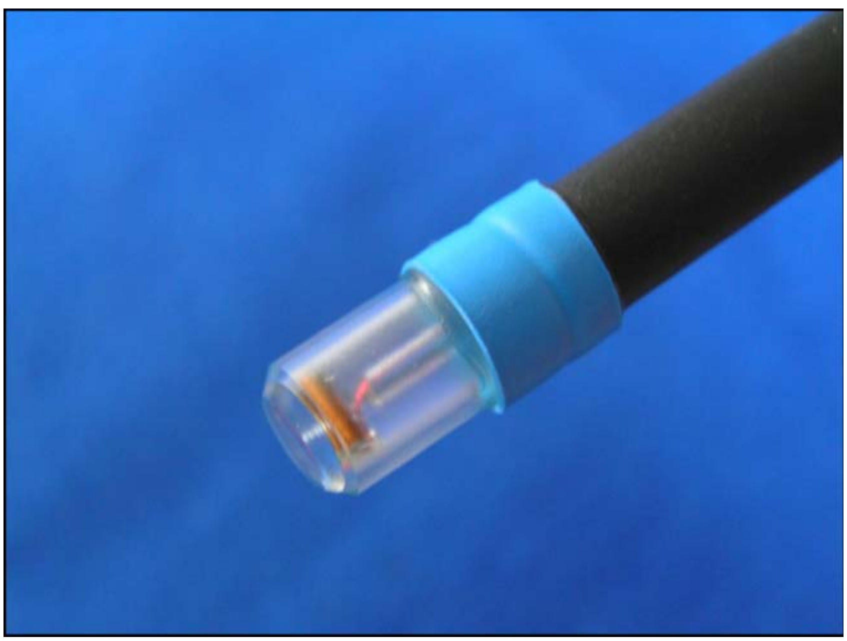
The frequency response of the system, the sensitivity of the probe, and the linearity of the field measurements can all be assessed periodically using the same component setup as used for the routine system calibration.

6.2. Isotropic E-Field Probe for Dosimetric Measurements

Two separate probes are provided for measuring audio frequency magnetic fields in both axial and transverse direction. The probes are measured using associated electronics and positioned by the 3-axis Cartesian robot system and the results are processed and presented using the software application running on a PC.



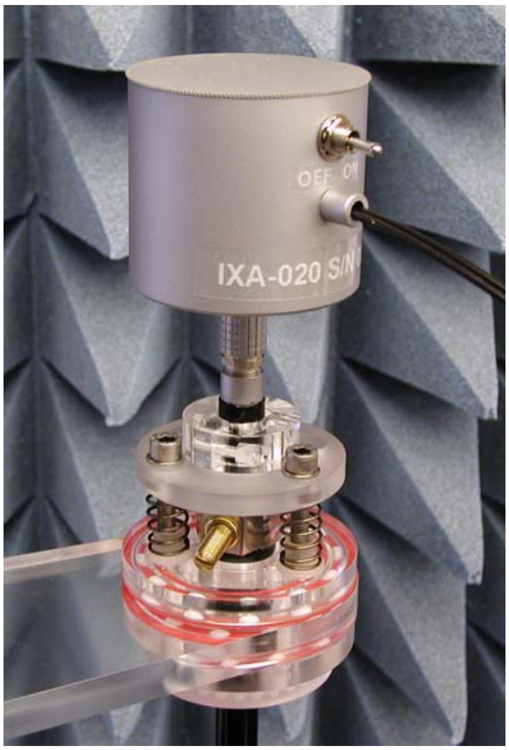
Axial T-coil Probe



Transverse T-coil probe

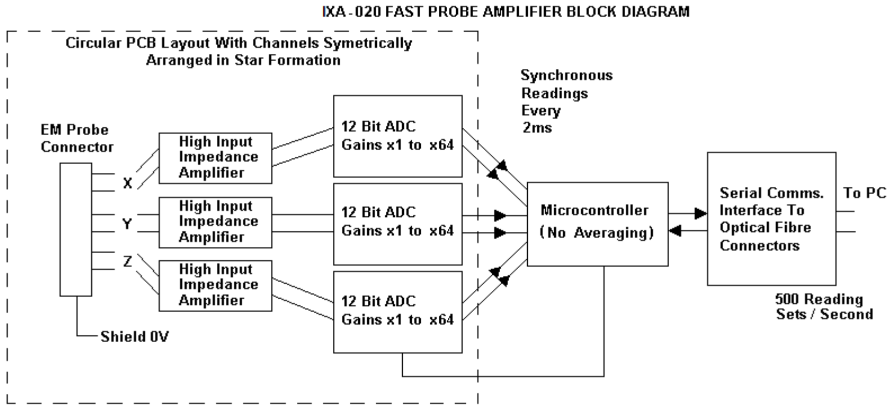
When using the single channel T-coil probes, the fast amplifier is used as a voltmeter to measure the rectified and processed output of the audio-frequency T-coil probes. The calibration file for the T-coil probes is set so that only the output of the X-channel is used and the DCP is set to a high value to disable the linearization correction process. Additionally, the test procedure involves setting the conversion factor of the probe before each test using the variable gain of the pre-amplifier module. Consequently, the actual value of the conversion factor in the calibration file is not critical.

6.3. The IXA-020 probe amplifier

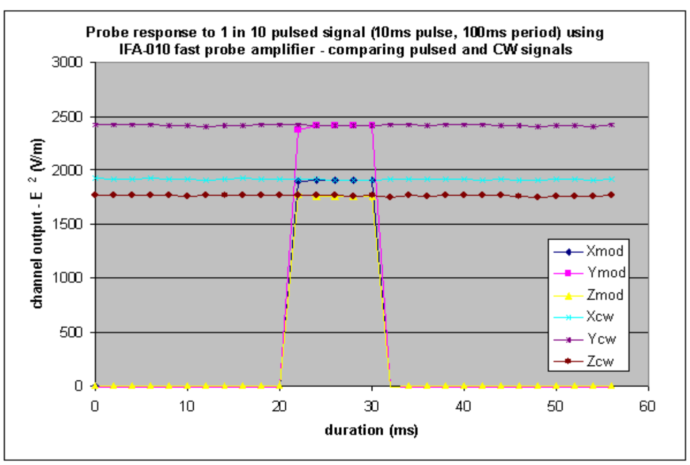


This component is a key component of the measurement system. When used with the T-coil probes, only the X-channel value is used and no linearization procedures are applied.

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.



7. Uncertainty Assessment

Measurement uncertainty values were evaluated for HAC measurements. The uncertainty values for components were evaluated according to the procedures given in ANSI C63.19.

7.1. Measurement Uncertainty Budget

Error Contribution	Uncertainty (+/- %)	Distribution	Div.	C ABM1	C ABM2	Std Unc. ABM1	Std. Unc. ABM2
RF reflections	0.8	rect	1.73	1	1	0.46	0.46
ABM noise	25.89	rect	1.73	0	1	0	14.97
Accuracy of level setting	4.71	rect	1.73	1	1	2.72	2.72
Positioning accuracy	4.7	rect	1.73	1	1	2.71	2.71
Probe coil sensitivity	1.799	rect	1.73	1	1	2.72	2.72
Helmholtz field accuracy	2.33	rect	1.73	1	1	1.35	1.35
Equaliser accuracy	12.20	rect	1.73	1	1	7.05	7.05
Reference level setting on Test Set	4.71	rect	1.73	1	1	2.72	2.72
Stability of ABM electronics	2.33	rect	1.73	1	1	1.35	1.35
					Combined	9.11	17.53
					Expanded (k=2)	18.23	35.05

8. Test results summary

Radial A = East to West Direction
Radial B = North to South Direction

8.1. HAC Results for CDMA BC0

Operation Mode	Channel	Frequency (MHz)	Probe Position	ABM 1 (dB A/m)	ABM 2 (dB A/m)	Category	Results (Appendix A)
CDMA RC3, SO68	**1013**	**824.7**	Axial	5.444	-39.172	T4	Plot 1
			Radial A	5.441	-60.000	T4	
			Radial B	6.086	-34.992	T4	
	384	**836.52**	Axial	5.536	-42.384	T4	Plot 2
			Radial A	6.289	-60.000	T4	
			Radial B	7.752	-35.494	T4	
	777	**848.31**	Axial	5.542	-39.251	T4	Plot 3
			Radial A	6.136	-60.000	T4	
			Radial B	6.993	-60.000	T4	

8.2. HAC Results for CDMA BC1

Operation Mode	Channel	Frequency (MHz)	Probe Position	ABM 1 (dB A/m)	ABM 2 (dB A/m)	Category	Results (Appendix A)
CDMA RC3, SO68	**25**	**1851.25**	Axial	5.421	-60.000	T4	Plot 4
			Radial A	5.888	-60.000	T4	
			Radial B	6.661	-35.918	T4	
	600	**1880**	Axial	6.700	-60.000	T4	Plot 5
			Radial A	7.093	-60.000	T4	
			Radial B	7.181	-34.563	T4	
	1175	**1908.75**	Axial	9.491	-52.041	T4	Plot 6
			Radial A	10.106	-60.000	T4	
			Radial B	9.481	-34.704	T4	

8.3. HAC Results for GSM 850

Operation Mode	Channel	Frequency (MHz)	Probe Position	ABM 1 (dB A/m)	ABM 2 (dB A/m)	Category	Results (Appendix A)
GSM	128	824.2	Axial	9.607	-29.143	T4	Plot 7
			Radial A	9.498	-30.187	T4	
			Radial B	9.486	-60.000	T4	
	190	836.6	Axial	9.608	-29.951	T4	Plot 8
			Radial A	9.469	-31.594	T4	
			Radial B	9.704	-60.000	T4	
	251	848.8	Axial	9.611	-27.351	T4	Plot 9
			Radial A	9.449	-32.985	T4	
			Radial B	9.673	-60.000	T4	

8.4. HAC Results for GSM 1900

Operation Mode	Channel	Frequency (MHz)	Probe Position	ABM 1 (dB A/m)	ABM 2 (dB A/m)	Category	Results (Appendix A)
GSM	512	1850.2	Axial	9.600	-29.499	T4	Plot 10
			Radial A	9.955	-41.012	T4	
			Radial B	9.705	-60.000	T4	
	661	1880	Axial	9.614	-32.918	T4	Plot 11
			Radial A	9.948	-41.210	T4	
			Radial B	9.731	-60.000	T4	
	810	1909.8	Axial	9.610	-28.971	T4	Plot 12
			Radial A	9.948	-38.562	T4	
			Radial B	9.736	-60.000	T4	

8.5. HAC Results for WCDMA FDD II

Operation Mode	Channel	Frequency (MHz)	Probe Position	ABM 1 (dB A/m)	ABM 2 (dB A/m)	Category	Results (Appendix A)
12.2 kbps AMR	9262	1852.4	Axial	9.730	-31.938	T4	Plot 13
			Radial A	9.432	-32.187	T4	
			Radial B	9.805	-60.000	T4	
	9400	1880	Axial	9.727	-31.568	T4	Plot 14
			Radial A	9.449	-35.739	T4	
			Radial B	9.808	-60.000	T4	
	9538	1907.6	Axial	9.727	-32.653	T4	Plot 15
			Radial A	9.454	-35.741	T4	
			Radial B	9.799	-60.000	T4	

8.6. HAC Results for WCDMA FDD V

Operation Mode	Channel	Frequency (MHz)	Probe Position	ABM 1 (dB A/m)	ABM 2 (dB A/m)	Category	Results (Appendix A)
12.2 kbps AMR	4132	826.4	Axial	9.729	-32.616	T4	Plot 16
			Radial A	9.374	-40.446	T4	
			Radial B	9.782	-60.000	T4	
	4183	836.6	Axial	9.722	-31.182	T4	Plot 17
			Radial A	9.389	-33.182	T4	
			Radial B	9.744	-60.00	T4	
	4233	846.6	Axial	9.737	-30.545	T4	Plot 18
			Radial A	9.396	-31.876	T4	
			Radial B	9.756	-42.047	T4	

8.7. System Calibration

Prior to formal testing a system calibration was performed in accordance with IndexSAR user manual. See section 5.3 for details.

Date	Probe	Results (Appendix A)
2013/03/10	Axial	Plot 19
2013/03/19	Axial	Plot 20
2013/03/21	Axial	Plot 21
2013/03/10	Transverse	Plot 22
2013/03/21	Transverse	Plot 23
2013/04/03	Transverse	Plot 24

9. References

1. FCC 47 CFR 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, Version 4.9, December 2007.

10. Test Equipment

Instrument description	Supplier / Manufacturer	Model	Serial No.	Calibration (date)	Calibration Due (date)
Bench top Robot	Mitsubishi supplied by IndexSAR	RV-E2	EA1030108	N/A	N/A
Software	IndexSAR	SARA2_HAC v.1.1.3	N/A	N/A	N/A
Axial T-Coil Probe	IndexSAR	IXP-100	T0005	2005-12-21, 2012-03/20	N/A
Radial T-Coil Probe	IndexSAR	IXP-110	T0006	2005-12-21, 2012-03/20	N/A
Digital Multimeter	Klein Tools	MM200	0710X-A1	2011-05-02	2013-05-02
Preamplifier	ARTcessories	MicroMIX	N/A	N/A	N/A
Waveform Generator	Agilent	33220A	MY43004303	N/A	N/A
Digital Equalizer	Phonic	i SupraCurve	OIA0D20168	N/A	N/A
100 ohm resistor block	IndexSAR	N/A	N/A	N/A	N/A
Helmholtz Coil	IndexSAR	IXT-020	0004	N/A	N/A
FoS Meter	IndexSAR	IXHM-010	0003	N/A	N/A
Probe Amplifier	IndexSAR	IXA-020	0072	N/A	N/A
Audio Analyzer	Rohde & Schwarz	UPL 16	838205/005	May 2011	May 2013
Digital Radio Comm. Tester	Rohde&Schwarz	CMU200	110229	May 2011	May 2013

11. Report History

2013/04/08: Original Report.