

Assessment of Compliance

for

Hearing Aid Compatibility

**Mobile phone, CDMA
TREO 650**

Palm Inc.



August 2005

APREL Project No.: PALB Treo 650-CDMA-HAC 5179

51 Spectrum Way Nepean ON K2R 1E6

Tel: (613) 820-2730 Fax: (613) 820-4161

email: info@aprel.com

Engineering Report

Subject: Assessment of Compliance with respect to
ANSI PC63.19-2005 D3.6
Hearing Aid Compatibility, RF Emissions

Product: Mobile Phone, CDMA

Model: TREO 650

Client: Palm Inc.
950 West Maude Ave
Sunnyvale, CA 94085 USA

Project #: PALB-Treo 650-CDMA-5179

Prepared by: APREL Laboratories
Regulatory Compliance Divisions
51 Spectrum Way
Nepean, Ontario
K2R 1E6, Canada

Approved By:

Jay Sarkar

Director, Standards & Certification

Date:

Aug 19, 2005

HAC Report Contents

Engineering Summary	4
Introduction	5
Equipment Tested	7
Product information	
Batteries	
Antenna description	
Picture of the device	
Test Equipment	8
Performance Criteria ANSI C63.19	11
Methodologies	
System Validation	12
Dipole validation (Part of the system validation)	12
Results for Dipole validation	14
RF Field Probe Modulation Factor	15
Results for Modulation Factors	16
RF Emissions Test Procedure	17
Flow Diagram of Test Instruction	18
Applicable Standards	20
Data Summary	21
Data Plots	22
Appendices	
Calibration Reports of Probes	46
Measurement Uncertainty Tables	62
Equipment List	64
Zero Span & Wideband Plots	66

ENGINEERING SUMMARY

This report contains the results of the engineering evaluation performed on the PALM CDMA mobile phone model TREO 650. The analysis was carried out in accordance with the requirements of ANSI/IEEE C63.19-2005, Rev 3.6, "American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids"

PALM provided APREL laboratories with one prototype model of the Mobile Phone. The TREO 650 Mobile Phone is hereby referred to as the DUT (Device Under Test).

The TREO 650 Mobile Phone was evaluated for RF emissions and in both CDMA and PCS bands. Three channels for each band, CDMA and PCS, were tested. See the summary of the results.

In the **CDMA band**, the category for RF E-field emissions is M3 and for H-field Emissions is M3. The overall M category for the audio coupling is **M3**.

In the **PCS band**, the category for RF E-field emissions is M4 and for H-field Emissions is M3. The overall M category for the audio coupling mode is **M3**.

As such, the overall M category for the TREO 650 is **M3**.

Evaluation data and graphs are presented in this report.

This wireless portable device has been shown to be compatible with hearing aids under the category shown below. In accordance with FCC rule 47 CFR 2.033(d) these test results demonstrate compliance with FCC 47CFR section 20.19 and with PC63.19 – 2005 rd3.6.

ANSI/IEEE C63.19 – 2005 HAC Rated Category: M 3 (RF Emission)

The results presented in this report relate only to the sample evaluated.

INTRODUCTION

General

HAC (Hearing Aid Compatibility) is an industry term introduced in the late 1970's to describe an audio frequency magnetic output of a wireline telephone for the purpose of making it possible to couple a telephone with a hearing aid. In the mid 1990's it was found that the required audio frequency magnetic field may not be usable if excessive RF interference is masking this audio signal. Therefore, new standards for wireless devices HAC, such as IEEE C63.19, which in addition to specification of the audio magnetic field for T-coil coupling also specify the allowable RF interference level for E-field and H-field as a function of hearing aid and RF susceptibility.

The purpose of the categorization (M1, M2 etc.) is to establish categories for hearing aids and for telephones that can indicate to health care practitioners and hearing aid users which hearing aids are compatible with which telephone. Tests are performed to assess the electromagnetic characteristics of hearing aids and telephones and assign them to these categories. In this case, the telephone is tested for the E-field and H-field emissions while the hearing aid is tested for E-field and H-field immunity and based on the results they are categorized. For telephone, Category M4 has lower emission levels than the M1 which means less interference to the hearing aid. For hearing aid, Category M4 has higher immunity level than the M1 which means it can endure higher interference signal level. When this category number of telephone is summed up with the category number of the hearing aid, it provides a total system performance classification. A "M" category sum greater than or equal to 6 provides an excellent performance.

Measurement Facility

The evaluation for compliance was performed for Palm. by APREL Laboratories at APREL's EMI facility located in Nepean, Ontario, Canada. The laboratory operates an (3m and 10m) Open Area Test Site (OATS). The measurement facility is calibrated in accordance with ANSI C63.4-1992.

A description of the measurement facility in accordance with the radiated and AC line conducted test site criteria per ANSI C63.4-1992 is on file with the Federal Communications Commission and is in compliance with the requirements of Section 2.948 of the Commissions rules and regulations. **APREL's registration number is: 90416**

APREL is accredited by Standard Council of Canada ISO 17025..

Standard

The evaluation and analysis were conducted in accordance with **Hearing Aid Standard ANSI PC63.19 2005 D3.6**

.

*Report: This report was written by Jay Sarkar, Technical Director, Standards and Certification.
Tests were performed by J. Lokaj.*

Test Equipment

The test equipment used during the evaluation is listed in Appendix with calibration due dates.

Environmental Conditions

- Temperature: 25 °C $\pm$ 2
- Relative Humidity: 30 - 50 %
- Air Pressure: 101 kPa $\pm$ 3

Product Information

EUT type:	Dual Band CDMA phone
Serial Number:	PTVC0555H4MP
Prototype or Production:	Production
Mode of Operation:	CDMA, PCS
Tx Frequencies:	824.70-848.31 MKz (CDMA) 1851.25-1909.08 MHz (PCS)
Maximum Conducted RF Power (Nominal):	24dBm
Tolerance of Power Calibration::	+/- .5 dB
FCC Classification:	Licensed Transmitter Held to Ear (PCE)

Battery

Type:	LiOn
Part No./Model No.:	157-10014-00
Rated Capacity:	1800maH

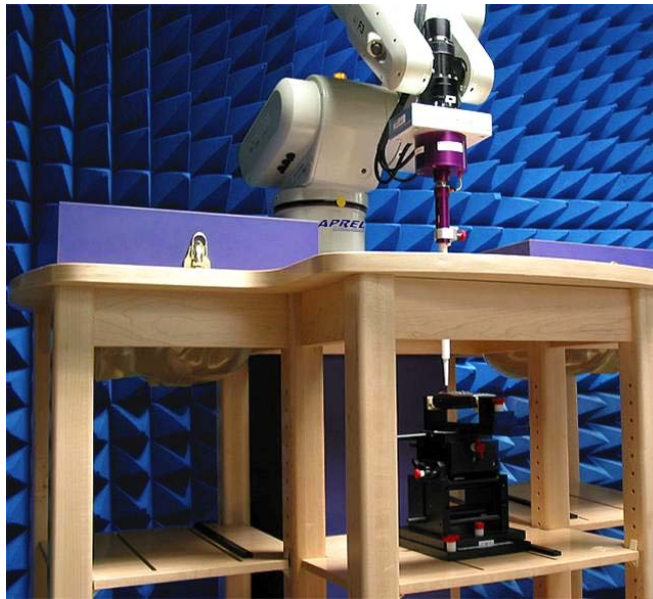
Antenna

Type:	Integral, monopole
Location:	Top of Unit
Configuration:	Current HW/SW/FW configuration



Test System: Hearing Aid Compatibility (HAC)

The scanning and positioning requirements of HAC measurement performed by the ALSAS 10-U HAC system, the use of HAC specific hardware and software allows APREL to meet the existing ANSI C63.19 and its anticipated revision. HAC testing utilizes E and H field probes as they meet the requirements of a diameter less than 10mm and are fully isotropic. These probes are calibrated “in air” for scanning in air.



Axis Articulated Robot



ALSAS-10U utilizes a six axis articulated robot, which is controlled using a Pentium based real-time movement controller. The movement kinematics engine utilizes proprietary (Thermo CRS) interpolation and extrapolation algorithms, which allow full freedom of movement for each of the six joints within the working envelope. Utilization of joint 6 allows for full probe rotation with a tolerance better than 0.05mm around the central axis.

Robot/Controller Manufacturer	Thermo CRS
Number of Axis	Six independently controlled axis
Positioning Repeatability	0.05mm
Controller Type	Single phase Pentium based C500C
Robot Reach	710mm
Communication	RS232 and LAN compatible

Universal Device Positioner



The APREL Laboratories universal device positioner has been developed so as to allow complete freedom of movement of the DUT. Developed to hold a DUT in a free-space scenario any additional loading attributable to the material used in the construction of the positioner has been eliminated. Repeatability has been enhanced through the linear scales which form the design used to indicate positioning for any given test scenario in all major axes. A tilt indicator has been included for accurate positioning. Overall uncertainty for measurements have been reduced due to the design of the Universal device positioner, which allows positioning of a device in as near to a free-space scenario as possible, and by providing the means for complete repeatability.

Length	201mm
Width	140mm
Height	222mm
Weight	1.95kg
Number of Axis	6 axis freedom of movement
Translation Along MB Line	+/- 76.2mm
Translation Along NF Line	+/- 38.1mm
Translation Along Z Axis	+/- 25.4mm (expandable to 500mm)
Rotation Around MB Line (yaw)	+/- 10°
Rotation Around NF Line (pitch)	+/- 30°
Rotation Around Z Axis (roll)	360° full circle
Minimum Grip Range	0mm
Maximum Grip	152mm
Maximum Distance from Device to Positioner Material	40mm
Tilt Movement	Full movement with predefined 15° guide

Performance Criteria ANSI C63.19

The following Tables show the M-rating categories providing the requirements that will allow classification of the wireless devices for RF emissions: Tables 2 and 3 provide telephone near-field categories in linear units and Articulation weighting factor (AWF) which provides the standard transmission protocols. Table 1 provides telephone near field categories in logarithmic units.

Table 1

Category	Telephone RF Parameters				
	AWF	E-Field Emissions (Peak)		H-Field Emissions (Peak)	
Category M1	0	46 – 51	dB (V/m)	-4.4 – 0.6	dB (A/m)
	-5	43.5 – 48.5	dB (V/m)	-6.9 – -1.9	dB (A/m)
Category M2	0	41 – 46	dB (V/m)	-9.4 – -4.4	dB (A/m)
	-5	38.5 – 43.5	dB (V/m)	-11.9 – -6.9	dB (A/m)
Category M3	0	36 – 41	dB (V/m)	-14.4 – -9.4	dB (A/m)
	-5	33.5 – 38.5	dB (V/m)	-16.9 – -11.9	dB (A/m)
Category M4	0	<36	dB (V/m)	<-14.4	dB (A/m)
	-5	<33.5	dB (V/m)	<-16.9	dB (A/m)

Telephone near-field categories in logarithmic units

Table 2

Category	Telephone RF Parameters				
	AWF	E-Field Emissions (Peak)		H-Field Emissions (Peak)	
Category M1	0	199.5 – 354.8	V/m	0.60 – 1.07	A/m
	-5	149.6 – 266.1	V/m	0.45 – 0.80	A/m
Category M2	0	112.2 – 199.5	V/m	0.34 – 0.60	A/m
	-5	84.1 – 149.6	V/m	0.25 – 0.45	A/m
Category M3	0	63.1 – 112.2	V/m	0.19 – 0.34	A/m
	-5	47.3 – 84.1	V/m	0.14 – 0.25	A/m
Category M4	0	<63.1	V/m	<0.19	A/m
	-5	<47.3	V/m	<0.14	A/m

Telephone near-field categories in linear units

Table 3

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

Articulation Weighting Factor (AWF)

Test Methodology

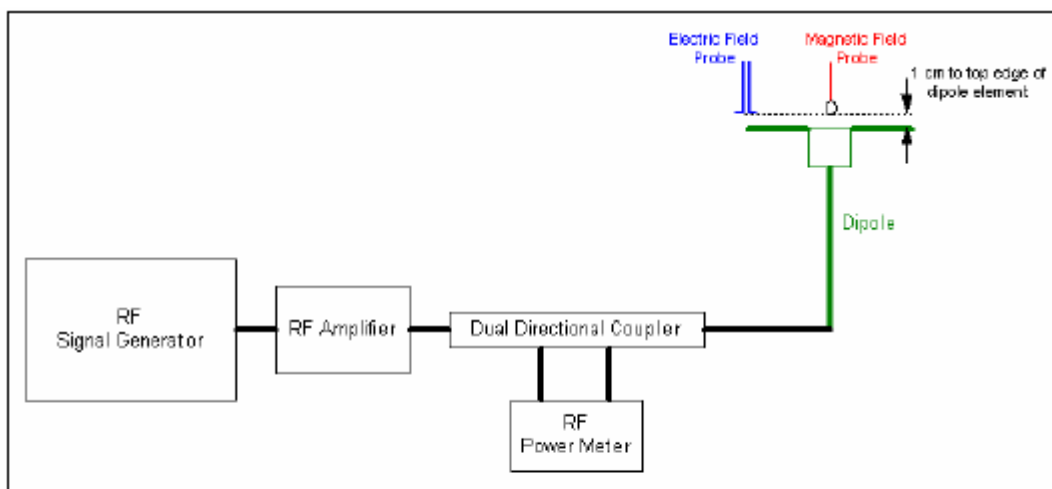
Dipole Validation Procedure

1. Dipole antenna was placed in the position that would be occupied by the WD.
2. The dipole was energized with a 20 dBm un-modulated continuous-wave signal.
3. The length of the dipole was scanned with both E-field and H-field probes and the maximum value for each scan was recorded.
4. The readings were compared to the target values (FDTD simulated values) and were found to be within the allowed tolerance of 10%

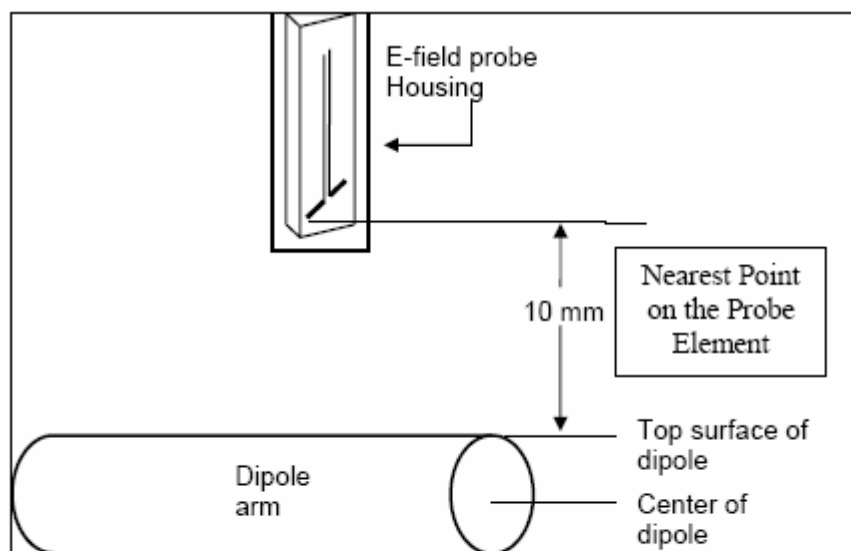
Note: System validation data for all three signal types (CW, WD & 805 AM) are provided. The target values for CW signal had been derived by APREL using FDTD numerical method which is now part of the C63.19. The CW validation data are within 10% of the target value. The measured values for the WD and 80% modulation could not be compared against any theoretical target values as there are none defined. The source for the WD signal was the WD itself. The substitution signal for probe modulation response measurement was generated by a WD with the real time power loop activated and controlled by the Mobile Service Tester.

Validation measurement have been performed for two modulated signals as well: 80% AM modulated with 1 kHz tone and CDMA signal. Only measurement results are presented as no target values exist for modulated signals

Figure 1, Setup



WD dipole calibration procedure



Probe location for WD dipole calibration

The center is aligned with the main axis of the probe. For constructional reasons it is located a small distance, specified as the vertical offset, above the tip of the probe. The actual offset is specified in the probe's calibration certificate to allow for proper referencing to the probe's calibrated center when the probe's vertical position relative to the tested object is set by touching it with the probe's tip.

System Validation Results

Dipole target Values

Frequency (MHz)	E-Field Calculated (Target) Values Peak v/m	H-Field Calculated (Target) Values Peak A/m
835	265	0.673
1880	211	0.645

Dipole FDTD Simulated values
Thick Dipoles

Dipole Validation Results

Signal Type	Frequency (MHz)	Input Power	Measured E-Field Peak (v/m)	E-Field Target Value Peak (v/m)	Deviation
CW	835	100 mW	244	265	-7.9%
CW	1880	100 mW	196	211	-7.1%
80%AM	835	31mW	148	-	-
80%AM	1880	31mW	119	-	-
CDMA	835	31mW	246	-	-
CDMA	1880	31mW	194	-	-

Signal Type	Frequency (MHz)	Input Power	Measured H-Field Peak (A/m)	H-Field Target Value Peak (A/m)	Deviation
CW	835	100 mW	0.707	0.673	5.1%
CW	1880	100 mW	0.687	0.645	6.5%
80%AM	835	31mW	0.430	-	-
80%AM	1880	31mW	0.418	-	-
CDMA	835	31mW	0.672	-	-
CDMA	1880	31mW	0.642	-	-

RF Field Probe Modulation Response

A calibration shall be made of the modulation response of the probe and its instrumentation chain. This calibration shall be performed with the field probe, attached to the instrumentation that is to be used with it during the measurement. The response of the probe system to a CW field at the frequency(s) of interest is compared to its response to a modulated signal with equal peak amplitude. The field level of the test signals shall be more than 10 dB above the ambient level and the noise floor of the instrumentation being used. The ratio of the CW reading to that taken with a modulated field shall be applied to the readings taken of modulated fields of the specified type. This may be done using the following procedure:

1. Fixing the probe in a set location relative to a field generating device, such as a reference dipole antenna or WB TEM, as illustrated in Figure 1.
2. Illuminate the probe with a CW signal at the intended measurement frequency.
3. Record the reading of the probe measurement system of the CW signal.
4. Determine the level of the CW signal being used to drive the field generating device.
5. Substitute a signal using the same modulation as that used by the intended WD for the CW signal.
6. Set the peak amplitude during transmission of the modulated signal to equal the amplitude of the CW signal.
7. Record the reading of the probe measurement system of the modulated signal.
8. The ratio of the CW to modulated signal reading is the modulation factor.

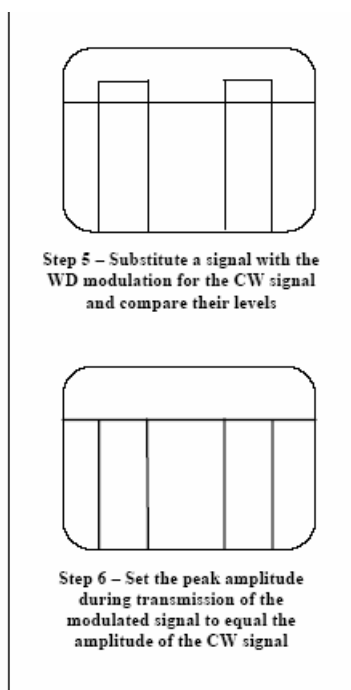


Figure C-1 – Setting the RF levels for the probe modulation response procedure.
Adjusting the peak amplitude to match a WD modulation to a CW signal.

Modulation Factors

Frequency (MHz)	Protocol	E-Field Modulation Factor	H-Field Modulation Factor
835	CDMA	5.1	5.1
835	CW		
1880	CDMA	5.1	5.1
1880	CW		

Note: Modulation factor was derived as ratio of scan result of reference CW signal to scan result of CDMA signal. Both, reference CW and CDMA (IS-95) signals were fed to a dipole antenna with its feed point monitored with a directional coupler and a spectrum analyzer. Both, RBW and VBW of the spectrum analyzer were set to full 3MHz as needed to cover the 20dB bandwidth of the IS-95 signal. Zero-span peak amplitude CDMA signal was adjusted to match the reference CW signal level and it was monitored during measurement.

RF Emissions Test Procedure

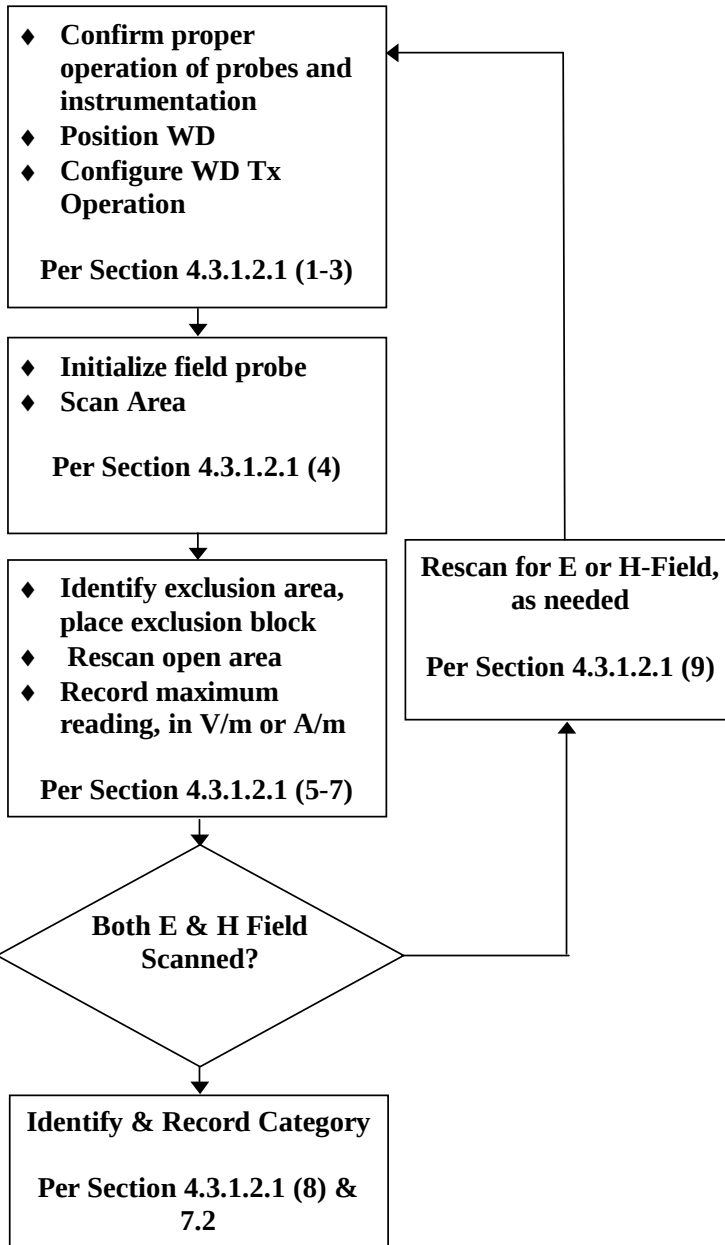
This section describes the procedures used to measure the near field RF emissions performance of the WD. Both E-field and H-field emissions levels have to be measured.

The following summarizes the basic test flow:

1. Confirm proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system.
2. Position the WD in its intended test position.



Test Instructions



From Hearing Aid Compatibility Standard ANSI PC63.19 2005 D3.6

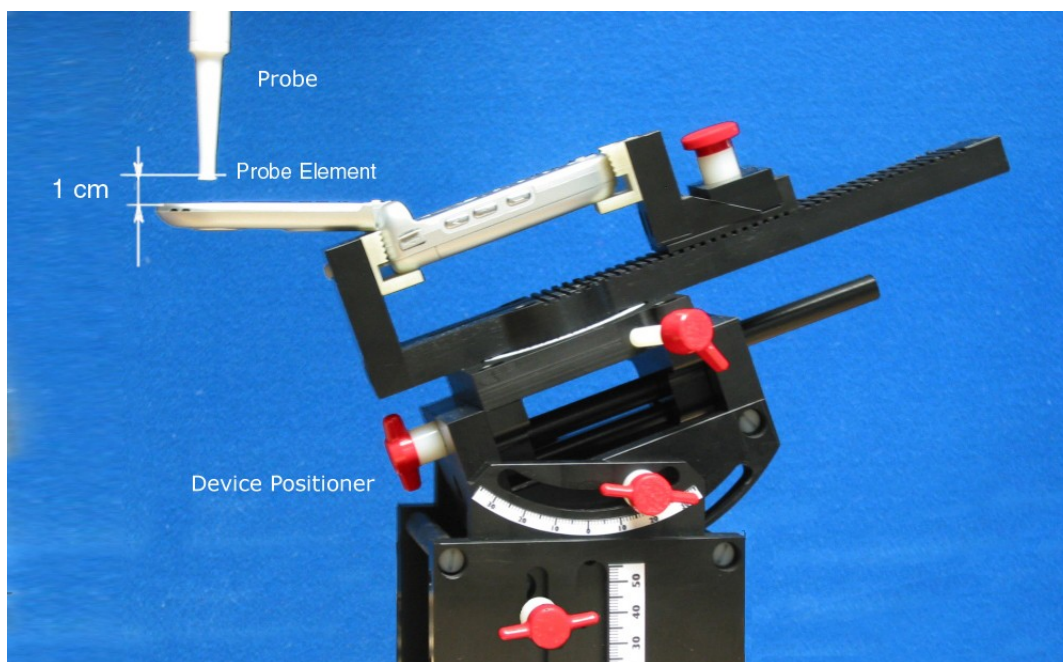
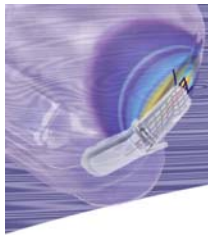


Figure 2 WD test Fixture

3. Configure the WD operation for maximum rated RF output power, at the desired channel and other normal operating parameters, (e.g. – test mode) as intended for the test.
4. The center sub-grid shall be centered on the center of the WD output (acoustic or T-Coil output), as appropriate. Locate the field probe at the initial test position in the 5 x 5 cm measurement plane.
5. Record the reading.
6. Scan the entire 5 x 5 cm region in equally spaced increments and record the reading at each measurement point. The distance between measurement locations shall be sufficient to assure the identification of the peak reading.
7. Identify the five contiguous sub-grids around the center sub-grid with the lowest maximum field strength readings. Please note that a maximum of five sub-grids can be excluded for both E-field and H-field.
8. Identify the highest field reading within the six sub-grids identified in step 7.
9. Convert the highest field strength reading identified in step 8 to peak V/m or A/m, as appropriate.



10. Repeat steps 1-10 for both the E and H-Field measurements. The highest field strength reading identified was converted to peak V/m or A/m as appropriate. This conversion was done using the appropriate factors derived from the probe modulation factor.
11. Compare this reading to the categories in Section 7 of ANSI/IEEE C63.19 and record the resulting category. The lowest category number obtained in step 10 for either E or H field determines the M category for the audio coupling mode assessment. Record the WD category rating.

Probe Rotation

The highest reading reported includes the probe rotation performed at the peak after exclusion.

Applicable Documents

The following documents are applicable to the evaluation performed:

- 1) ANSI/IEEE C63.19, American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
- 2) AISP.4-HACTS v 8.2, Test Plan & Technical Specification for Wireless Phone Compliance Baseline.
- 3) IEEE 1309-1996, IEEE Standard for Calibration Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz.

Test Results – E-field

Mode	Channel	Freq.	Cond. Pwr	Peak E-field	Peak E-field	Reference position	Battery	Cat.
		[MHz]	[dBm]	[V/m]	[dB(V/m)]			
CDMA	991	824	24	77.4	37.7	speaker	1	M3
CDMA	384	836.5	24	82.9	38.3	speaker	1	M3
CDMA	799	849	24	83.3	38.4	speaker	1	M3
CDMA	001	1850	24	56.5	35.4	speaker	1	M4
CDMA	600	1880	24	58.9	35.4	speaker	1	M4
CDMA	1199	1910	24	49.7	33.9	speaker	1	M4

Test Results – H-field

Mode	Channel	Freq.	Cond. Pwr	Peak H-field	Peak H-field	Reference position	Battery	Cat.
		[MHz]	[dBm]	[A/m]	[dB(A/m)]			
CDMA	991	824	24	0.222	-13.1	speaker	1	M3
CDMA	384	836.5	24	0.251	-11.9	speaker	1	M3
CDMA	799	849	24	0.244	-12.3	speaker	1	M3
CDMA	001	1850	24	0.267	-11.5	speaker	1	M3
CDMA	600	1880	24	0.278	-11.11	speaker	1	M3
CDMA	1199	1910	24	0.252	-11.9	speaker	1	M3

Power Drift: The drift was monitored using two methods:

- via air-interface using a combination of horn antenna and a spectrum analyzer. Drift was measured before the start of the test, when the WD started transmitting (for reference purpose), during the test and after the test. There was no drift observed on the spectrum analyzer. The horn antenna was used as a receiver permanently placed aiming towards the WD under test at a safe distance of 3 feet where no reflection is created. The antenna was placed in such a manner such that no obstruction was present in its receiving path. The spectrum analyzer was situated outside the test chamber. It was ensured that during the drift measurement there was no moving object as well as the test engineer was absent inside the test chamber. No object inside the chamber was moved from their original position during the complete test process of the WD.

and the second method: Immediately before the scan the sensor is positioned 10mm above the ERP. E-field level is recorded as “BEFORE”. When the sensor is stopped at the same spot after completing the scan E-field level is again recorded as “AFTER”. The difference is then calculated in terms of radiated power drift.

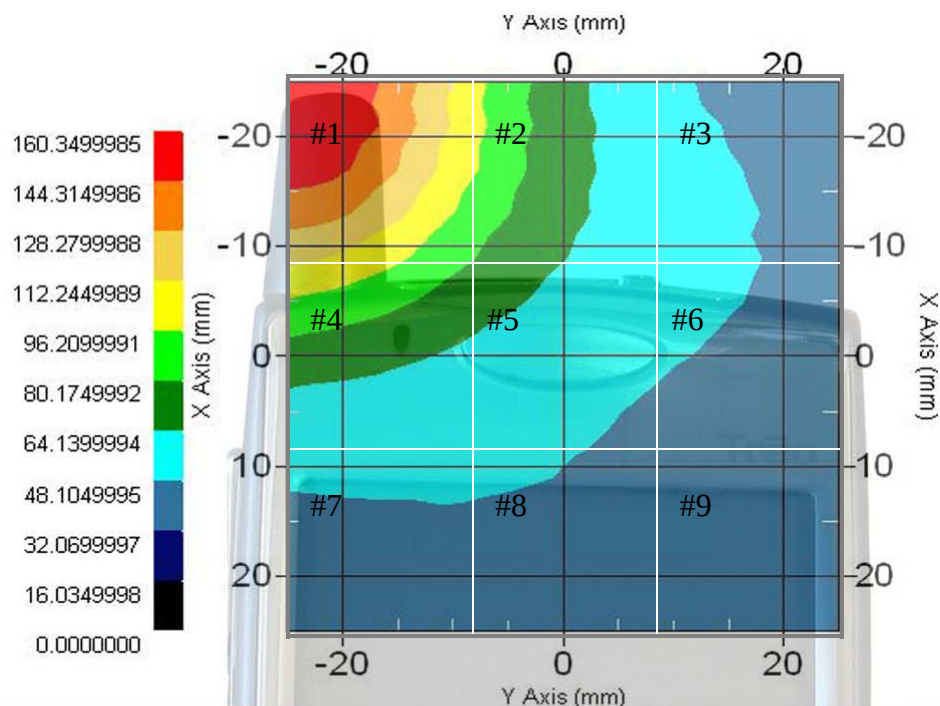
Note: The substitution signal for probe modulation response measurement was generated by a WD with the real time power loop activated and controlled by the Mobile Service Tester. The peak level at the dipole antenna feed point was adjusted to match the CW signal level and then in was monitored continuously with a spectrum analyzer. No drift was detected.

HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 269
 Probe Type : E-field probe
 Probe Model : ALS-E020
 Date Calibrated : 21-May-2005
 Test Frequency : 824 MHz
 Channel Number : CDMA 991
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 1.20 1.20 1.20 $\mu\text{V}/(\text{V}/\text{m})^2$
 Compression Point : 95 mV
 Offset : 1.56 mm
 HAC Test (26x26X1): Measurement grid dx=2, dy=2, dz=10
 E-Field : 77.384 V/m (Peak)
 dB : 37.773 db(V/m) (Peak)
 Category : M3
 Contiguous sub-grids shaded red are excluded.

#1 160.336	#2 101.637	#3 55.265
#4 110.288	#5 77.384	#6 53.805
#7 52.726	#8 50.067	#9 45.744

V/m

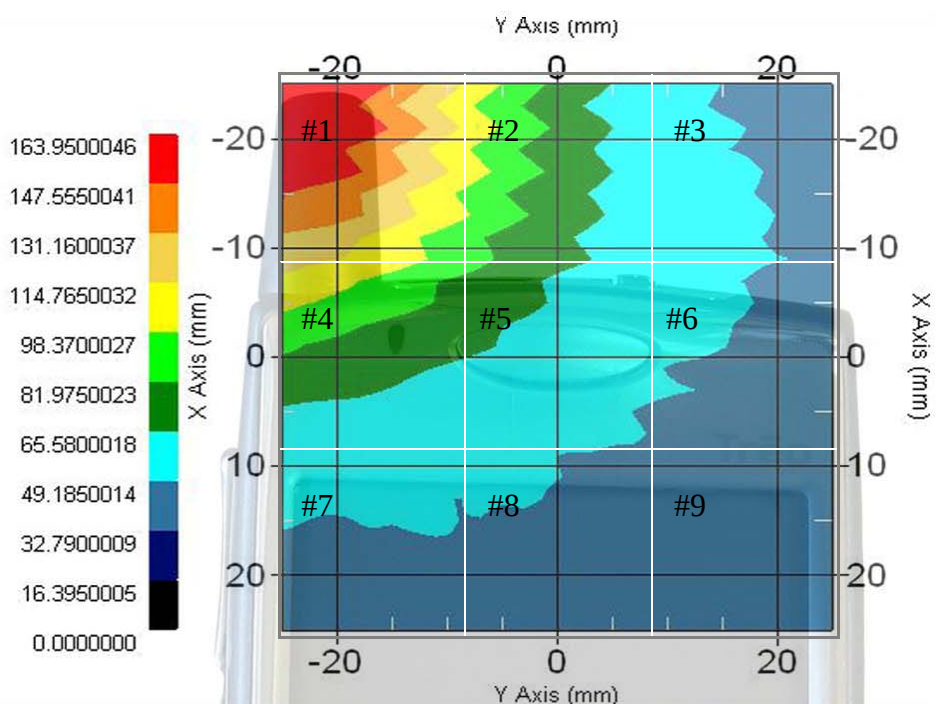


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 269
 Probe Type : E-field probe
 Probe Model : ALS-E020
 Date Calibrated : 21-May-2005
 Test Frequency : 836.5 MHz
 Channel Number : CDMA 384
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 1.20 1.20 1.20 $\mu\text{V}/(\text{V}/\text{m})^2$
 Compression Point : 95 mV
 Offset : 1.56 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 E-Field : 82.934 V/m (Peak)
 dB : 38.375 db(V/m) (Peak)
 Category : M3
 Contiguous sub-grids shaded red are excluded

#1 163.939	#2 111.732	#3 59.699
#4 117.573	#5 82.934	#6 56.774
#7 57.283	#8 53.404	#9 47.993

V/m

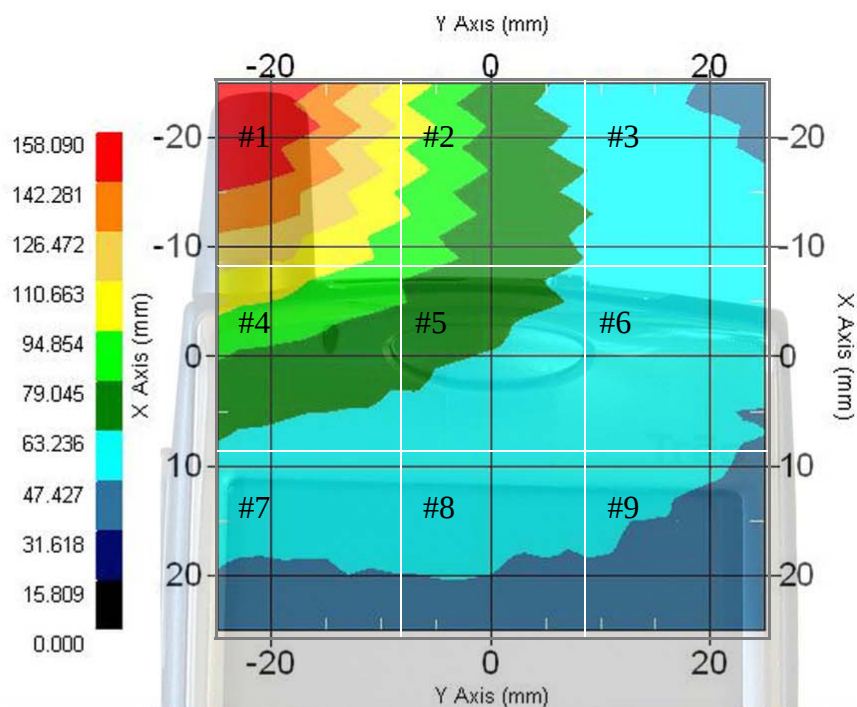


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 269
 Probe Type : E-field probe
 Probe Model : ALS-E020
 Date Calibrated : 21-May-2005
 Test Frequency : 849 MHz
 Channel Number : CDMA 799
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 1.20 1.20 1.20 $\mu\text{V}/(\text{V/m})^2$
 Compression Point : 95 mV
 Offset : 1.56 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 E-Field : 83.367 V/m (Peak)
 dB : 38.420 db (V/m) (Peak)
 Category : M3
 Contiguous sub-grids shaded red are excluded.

#1 158.085	#2 107.697	#3 63.482
#4 113.370	#5 83.367	#6 61.540
#7 59.666	#8 56.353	#9 50.892

V/m

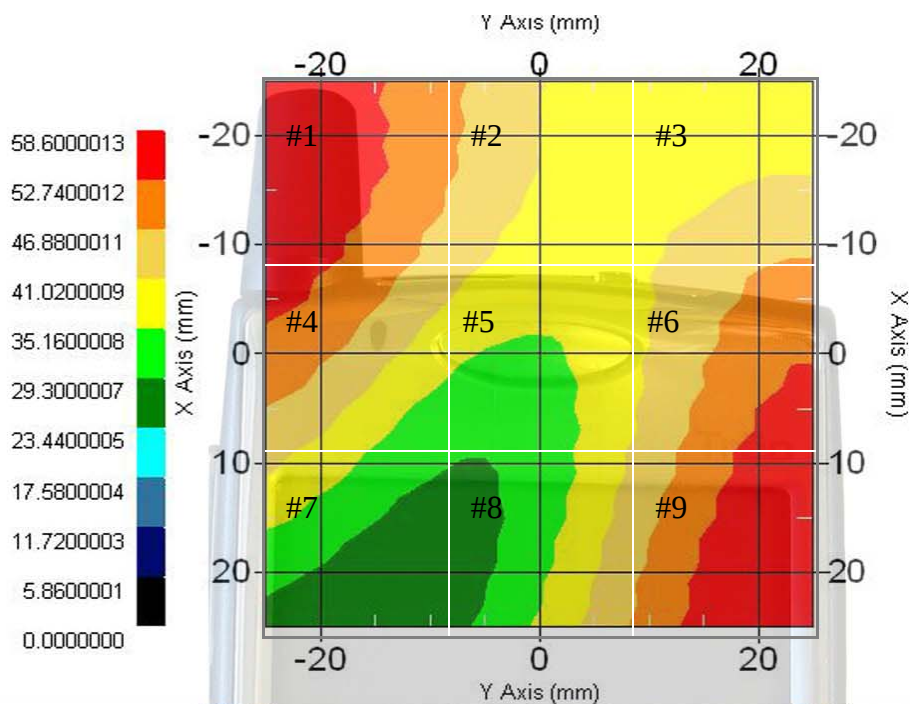


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 269
 Probe Type : E-field probe
 Probe Model : ALS-E020
 Date Calibrated : 21-May-2005
 Test Frequency : 1850 MHz
 Channel Number : PCS 001
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 1.20 1.20 1.20 $\mu\text{V}/(\text{V}/\text{m})^2$
 Compression Point : 95 mV
 Offset : 1.56 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 E-Field : 56.546 V/m(Peak)
 dB : 35.048 db(V/m) (Peak)
 Category : M4
 Contiguous sub-grids shaded red are excluded.

#1 56.546	#2 48.002	#3 46.699
#4 54.947	#5 42.944	#6 55.648
#7 42.701	#8 46.708	#9 58.588

V/m

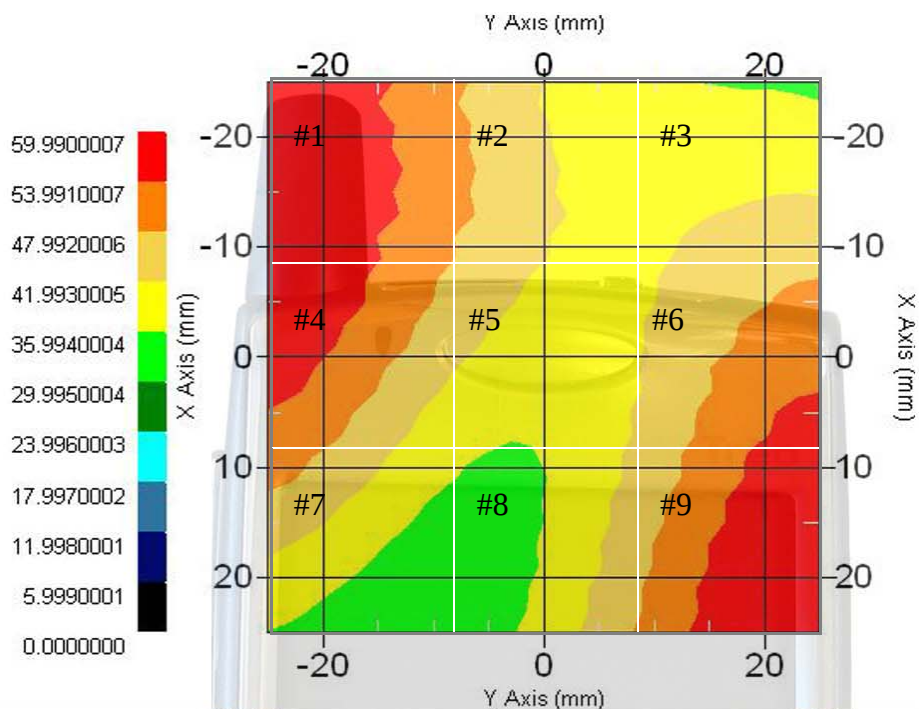


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 269
 Probe Type : E-field probe
 Probe Model : ALS-E020
 Date Calibrated : 21-May-2005
 Test Frequency : 1880 MHz
 Channel Number : PCS 600
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 1.20 1.20 1.20 $\mu\text{V}/(\text{V/m})^2$
 Compression Point : 95 mV
 Offset : 1.56 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 E-Field : 58.963 V/m (Peak)
 dB : 35.412 db (V/m) (Peak)
 Category : M4
 Contiguous sub-grids shaded red are excluded.

#1 58.963	#2 49.666	#3 46.323
#4 58.459	#5 47.179	#6 56.436
#7 50.605	#8 47.897	#9 59.979

V/m

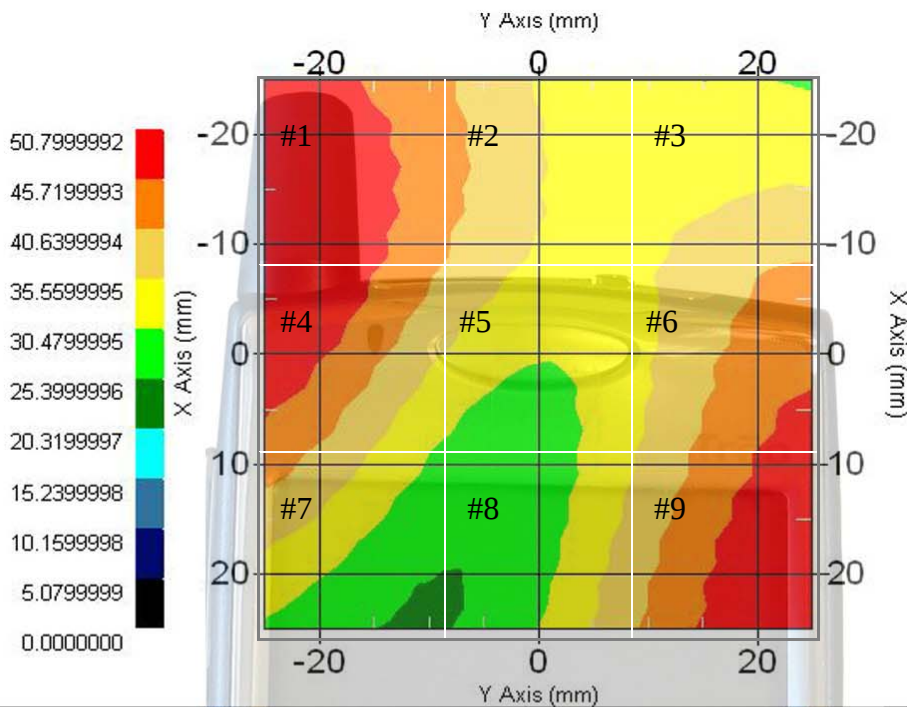


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 269
 Probe Type : E-field probe
 Probe Model : ALS-E020
 Date Calibrated : 21-May-2005
 Test Frequency : 1910 MHz
 Channel Number : PCS 1199
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 1.20 1.20 1.20 $\mu\text{V}/(\text{V/m})^2$
 Compression Point : 95 mV
 Offset : 1.56 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 E-Field : 49.724 V/m (Peak)
 dB : 33.931 db (V/m) (Peak)
 Category : M4
 Contiguous sub-grids shaded red are excluded.

#1 50.786	#2 42.121	#3 40.208
#4 50.703	#5 39.770	#6 47.355
#7 43.002	#8 39.359	#9 49.724

V/m

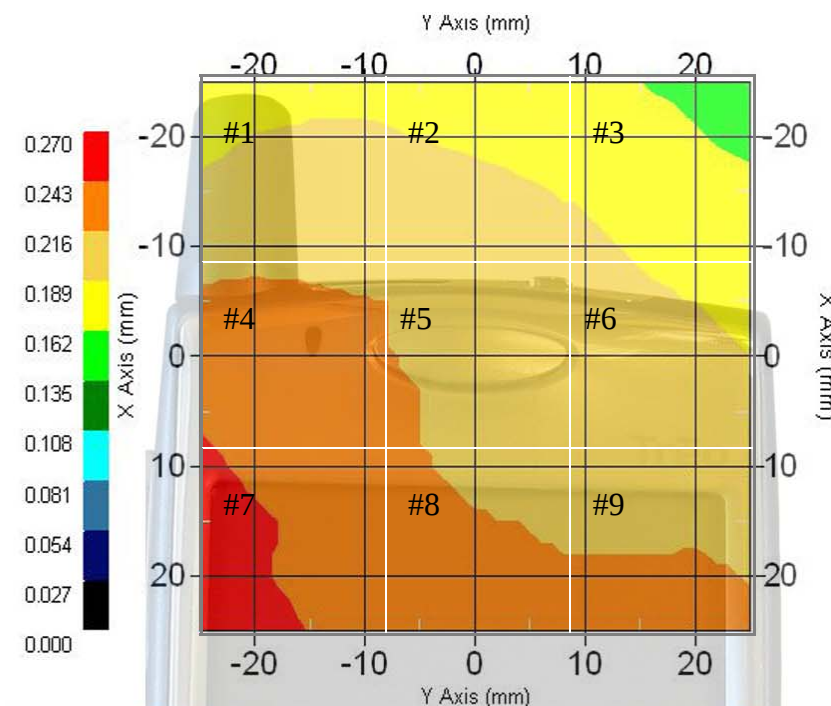


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 101
 Probe Type : H-field probe
 Probe Model : ALS-H020
 Date Calibrated : 02-Oct-2004
 Test Frequency : 824.2 MHz
 Channel Number : CDMA 991
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 84.20 mV/(A/m)²
 Compression Point : 95 mV
 Offset : 3 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 H-Field : 0.222 A/m Peak)
 dB : -13.080 db(A/m) (Peak)
 Category : M3
 Contiguous sub-grids shaded red are excluded.

#1 0.212	#2 0.209	#3 0.196
#4 0.244	#5 0.219	#6 0.208
#7 0.262	#8 0.230	#9 0.222

A/m

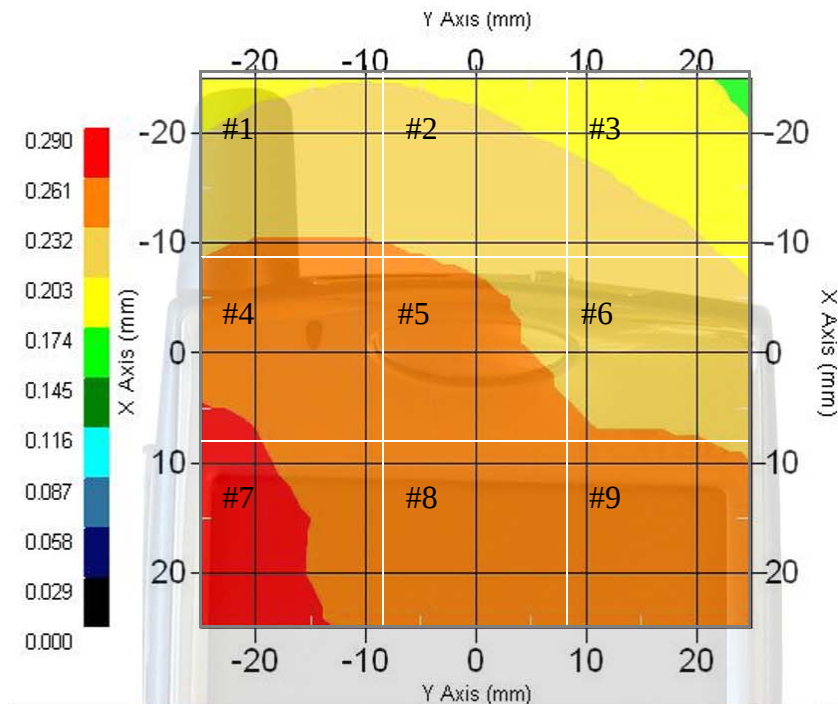


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 101
 Probe Type : H-field probe
 Probe Model : ALS-H020
 Date Calibrated : 02-Oct-2004
 Test Frequency : 836.5 MHz
 Channel Number : CDMA 384
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 86.70 mV/(A/m)²
 Compression Point : 95 mV
 Offset : 3 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 H-Field : 0.251 A/m (Peak)
 dB : -11.998 db(A/m) (Peak)
 Category : M3
 Contiguous sub-grids shaded red are excluded.

#1 0.235	#2 0.233	#3 0.219
#4 0.267	#5 0.243	#6 0.234
#7 0.283	#8 0.254	#9 0.251

A/m

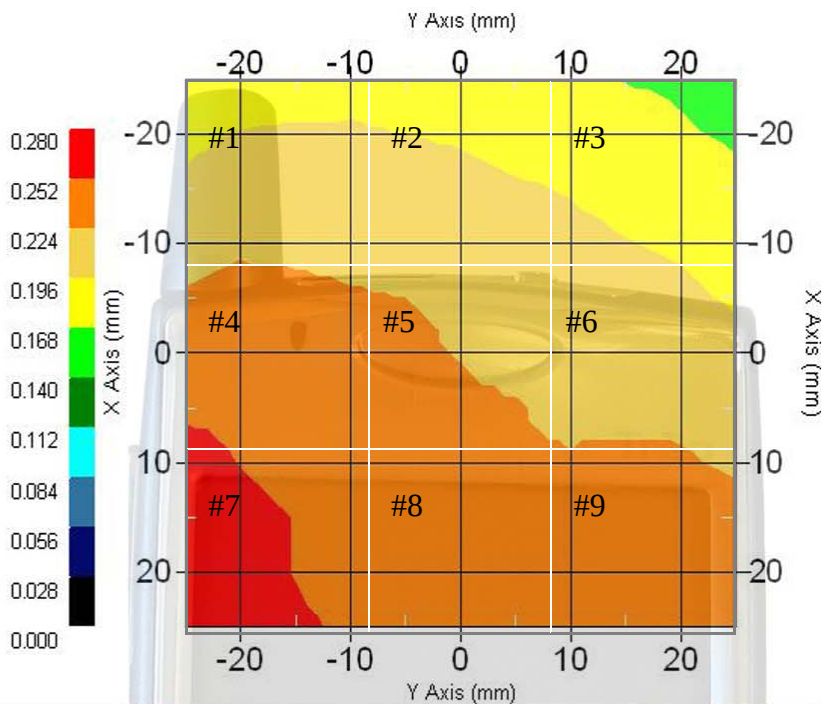


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Type : H-field probe
 Probe Model : ALS-H020
 Date Calibrated : 02-Oct-2004
 Test Frequency : 848.8 MHz
 Channel Number : CDMA 799
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 89.30 mV/(A/m)²
 Compression Point : 95 mV
 Offset : 3 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 H-Field : 0.244 A/m Peak)
 dB : -12.267 db(A/m) (Peak)
 Category : M3
 Contiguous sub-grids shaded red are excluded.

#1 0.223	#2 0.219	#3 0.205
#4 0.255	#5 0.232	#6 0.224
#7 0.273	#8 0.245	#9 0.244

A/m

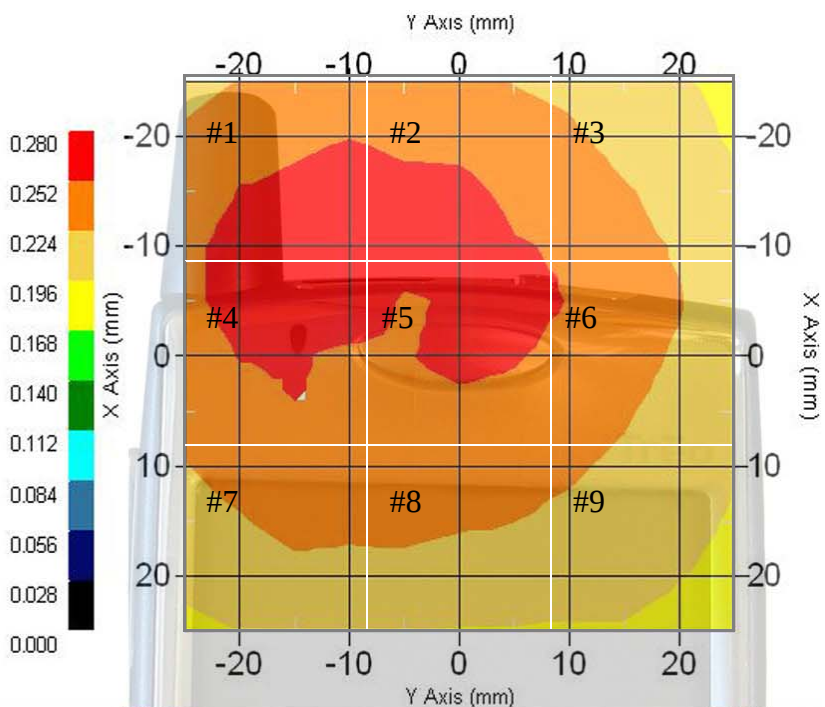


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 101
 Probe Type : H-field probe
 Probe Model : ALS-H020
 Date Calibrated : 02-Oct-2004
 Test Frequency : 1850 MHz
 Channel Number : PCS 001
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 424.10 mV/(A/m)²
 Compression Point : 95 mV
 Offset : 3 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 H-Field : 0.267 A/m (Peak)
 dB : -11.478 db(A/m) (Peak)
 Category : M3
 Contiguous sub-grids shaded red are excluded.

#1 0.272	#2 0.270	#3 0.250
#4 0.272	#5 0.267	#6 0.253
#7 0.244	#8 0.242	#9 0.229

A/m

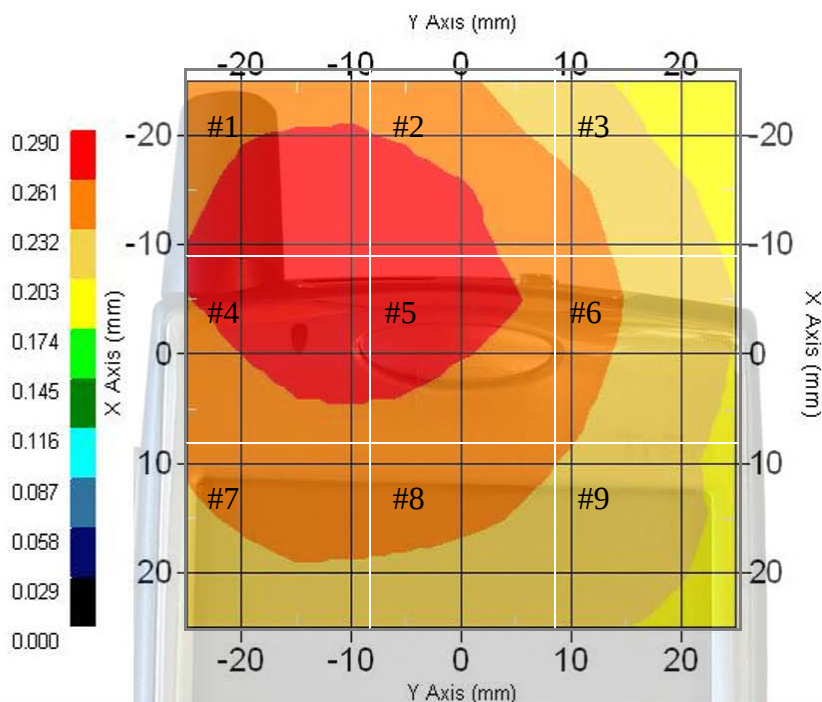


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 101
 Probe Type : H-field probe
 Probe Model : ALS-H020
 Date Calibrated : 02-Oct-2004
 Test Frequency : 1880 MHz
 Channel Number : PCS 600
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 438.00 mV/(A/m)²
 Compression Point : 95 mV
 Offset : 3 mm
 HAC Test (26x26X1) : Measurement grid dx=2, dy=2, dz=10
 H-Field : 0.278 A/m (Peak)
 dB : -11.110 db(A/m) (Peak)
 Category : M3
 Contiguous sub-grids shaded red are excluded.

#1 0.279	#2 0.278	#3 0.247
#4 0.278	#5 0.278	#6 0.254
#7 0.254	#8 0.253	#9 0.233

A/m

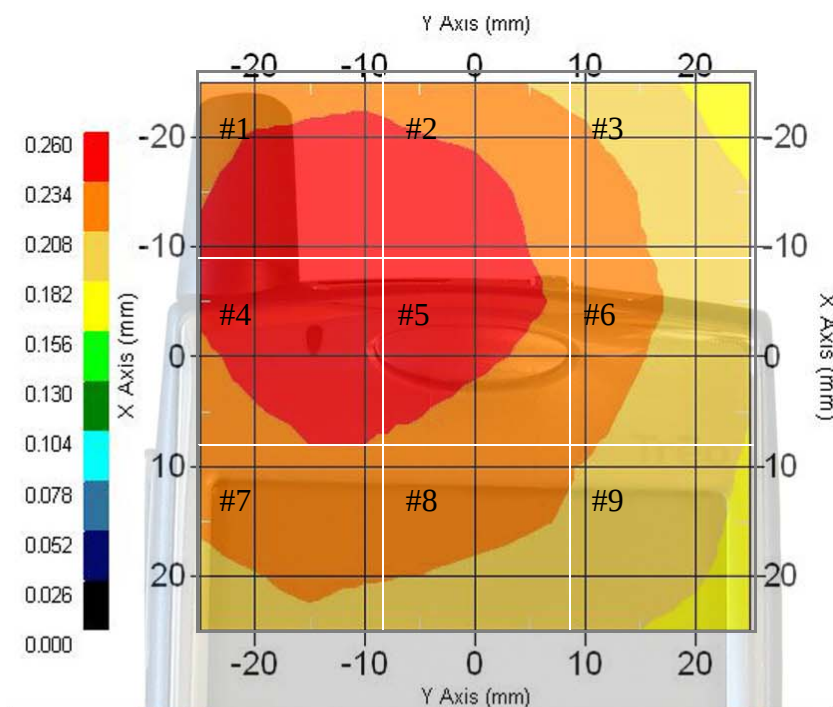


HAC Test Report

Device Type : CDMA
 Device Name : TREO 650
 Device S/N : PTVC0555H4MP
 Probe Serial No. : 101
 Probe Type : H-field probe
 Probe Model : ALS-H020
 Date Calibrated : 02-Oct-2004
 Test Frequency : 1910 MHz
 Channel Number : PCS 1199
 Probe Mod. Factor : 5.1 dB
 Probe Sensitivity : 452.10 mV/(A/m)²
 Compression Point : 95 mV
 Offset : 3 mm
 HAC Test (26x26X1): Measurement grid dx=2, dy=2, dz=10
 H-Field : 0.252 A/m (Peak)
 dB : -11.976 db(A/m) (Peak)
 Category : M3
 Contiguous sub-grids shaded red are excluded.

#1 0.254	#2 0.252	#3 0.228
#4 0.253	#5 0.252	#6 0.230
#7 0.233	#8 0.231	#9 0.210

A/m



Calibration



SAR & HAC Instruments for Wireless • Consulting • Research • Standards • Compliance • Training

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-422

Client.: APREL

C E R T I F I C A T E O F C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic H-field RF Probe

Manufacturer: APREL Laboratories

Model No.: H-020

Serial No.: 101

IN AIR Calibration

Calibration Procedure: SSI/DRB-TP-D01-038

Project No: Internal

Calibrated: 2nd October 2004

Released on: 2nd October 2004

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4161

Introduction

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-038 H-Field Probe Calibration Procedure. The results contained within this report are for APREL H-Field Probe H-020 101.

References

SSI/DRB-TP-D01-038 H-Field Probe Calibration Procedure
IEEE Std 1309-2005 "Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9 kHz to 40GHz".

Conditions

Probe 101 was a new probe taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C

Sensor offset

Each probe is comprised of 3 magnetic sensors and positioned at 90 degree to each other in XYZ arrangement. Their electric center makes the calibrated center of the probe

Calibration Results Summary

Probe Type:	H-Field Probe H-020
Serial Number:	101
Frequencies:	see the table "Sensitivity in Air" below
Sensor Offset:	3.0 mm
Sensor Diameter:	4.0 mm
Tip Enclosure:	Polycarbonate
Tip Diameter:	8 mm
Total Length:	290 mm

Sensitivity in Air

Frequency	Channel X	Channel Y	Channel Z
824.2MHz	84.2mV/(A/m) ²	84.2mV/(A/m) ²	84.2mV/(A/m) ²
836.5MHz	86.7mV/(A/m) ²	86.7mV/(A/m) ²	86.7mV/(A/m) ²
848.8MHz	89.3mV/(A/m) ²	89.3mV/(A/m) ²	89.3mV/(A/m) ²
1850MHz	424.1mV/(A/m) ²	424.1mV/(A/m) ²	424.1mV/(A/m) ²
1880MHz	438.0mV/(A/m) ²	438.0mV/(A/m) ²	438.0mV/(A/m) ²
1910MHz	452.1mV/(A/m) ²	452.1mV/(A/m) ²	452.1mV/(A/m) ²

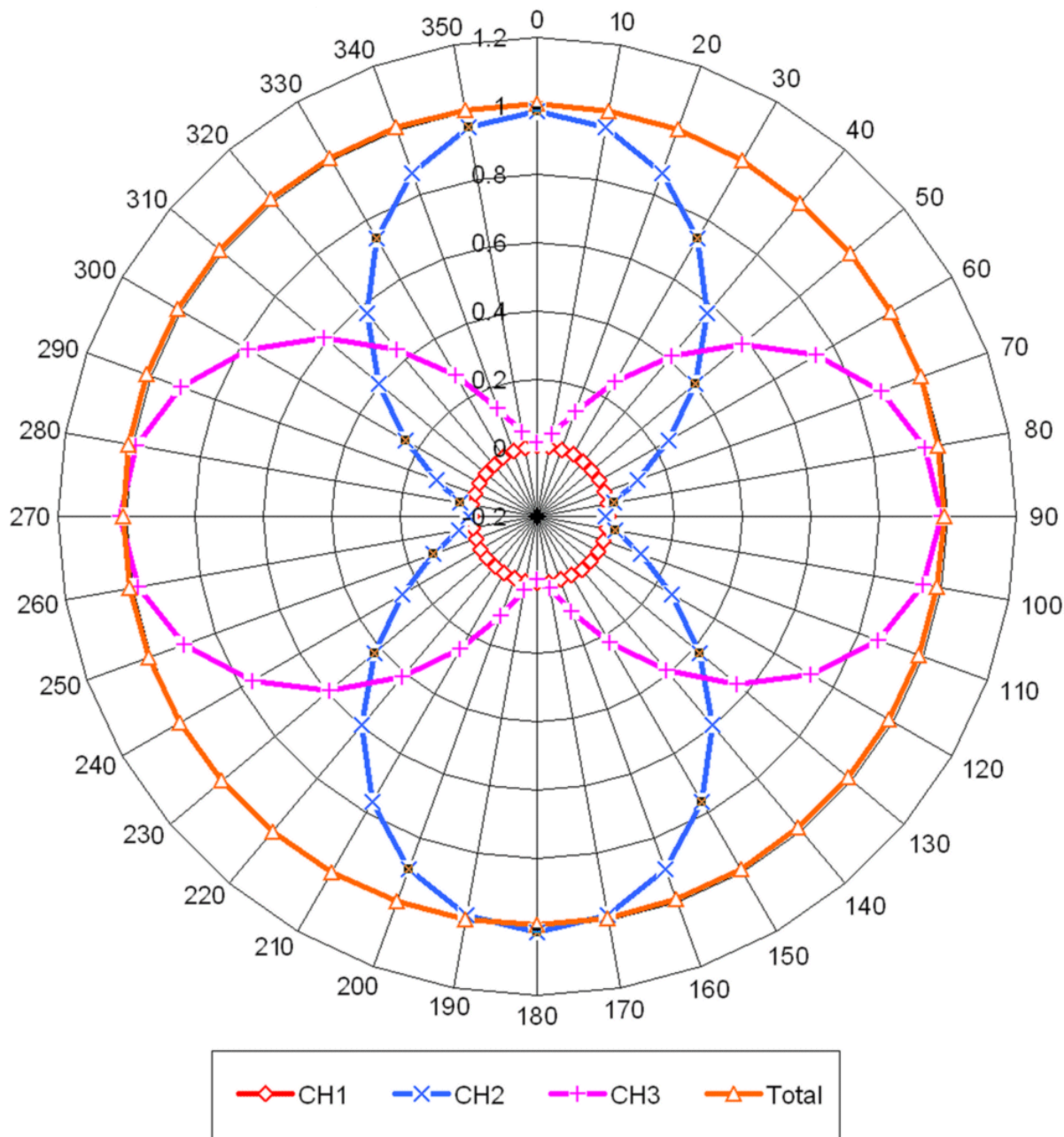
Diode Compression Point: 95 mV

Spatial Resolution:

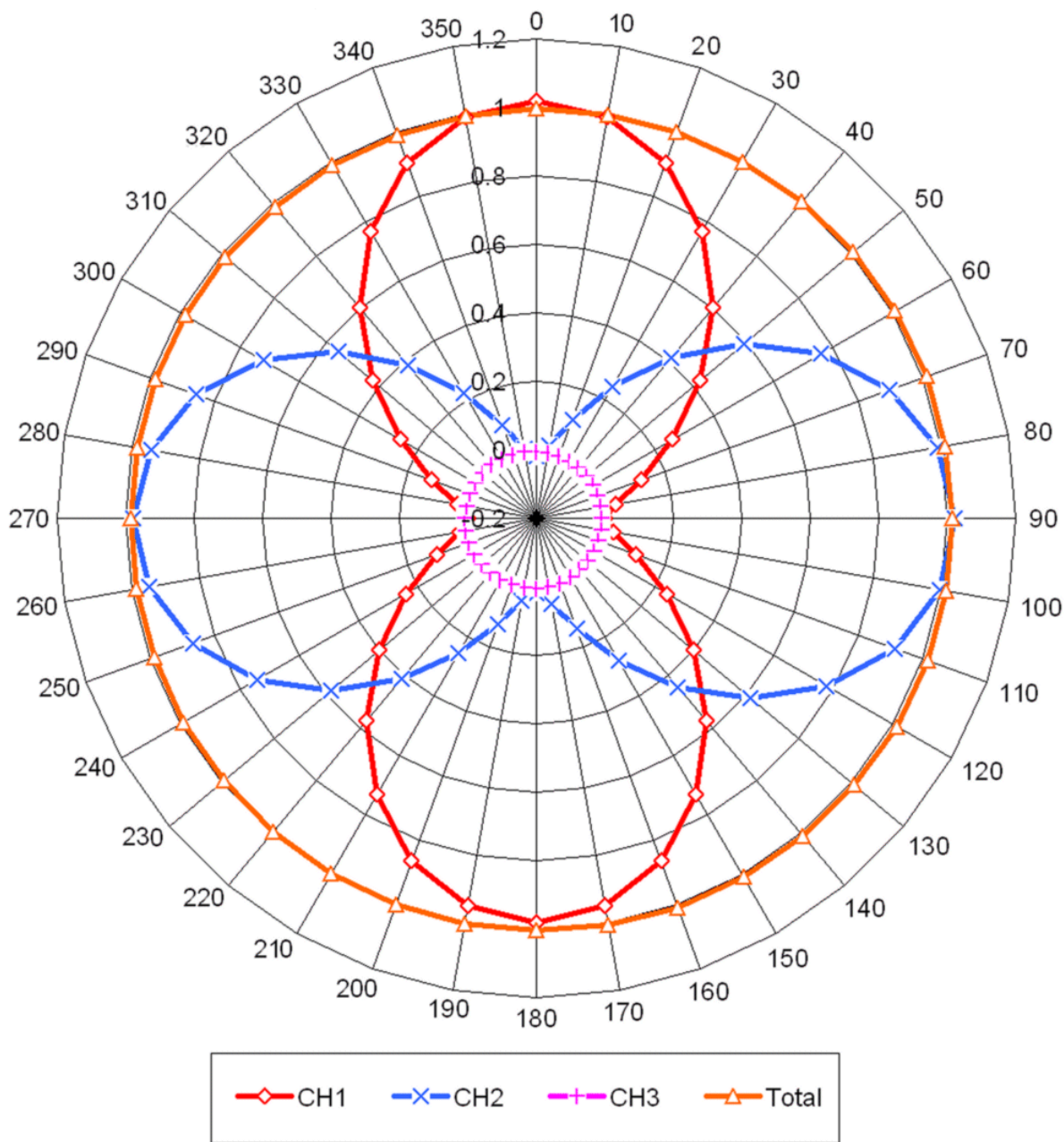
The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

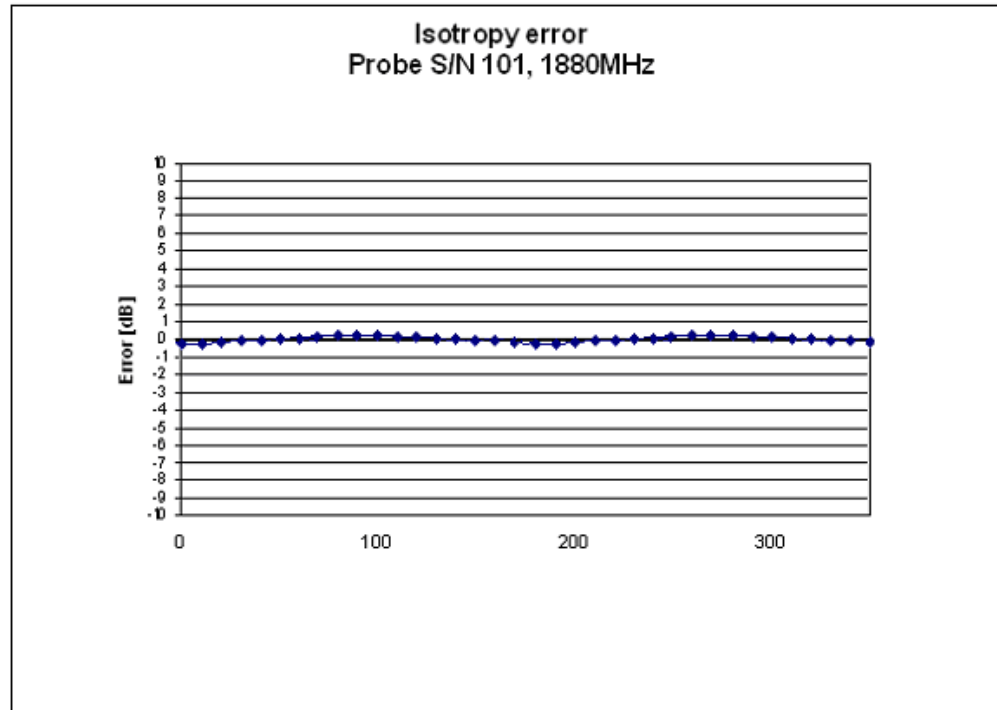
Receiving Pattern at 1880 MHz

Receiving Pattern, Probe S/N 101, 1880MHz

 $\Theta = 90^\circ$


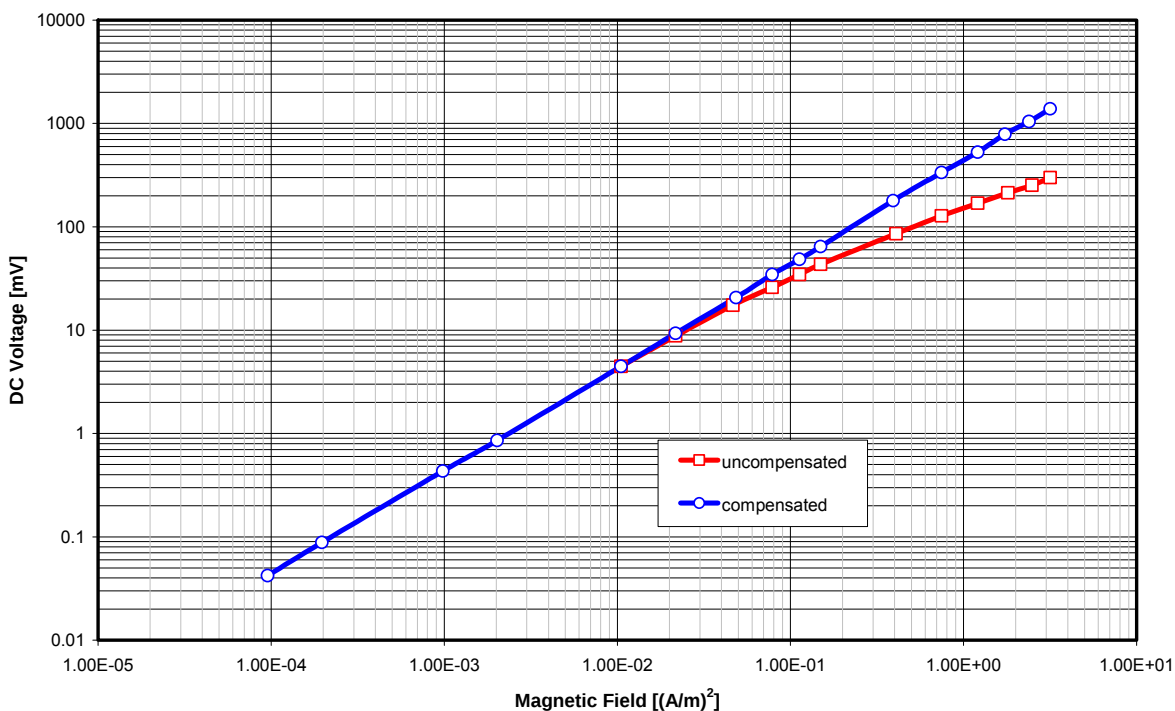
Receiving Pattern, Probe S/N 101, 1880MHz

 $\Theta=0^\circ$


Isotropy Error 1880 MHz**Isotropy:****0.10 dB**

Dynamic Range

Dynamic Range, Probe S/N 101, 1880MHz



Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2005.



SAR & HAC Instruments for Wireless • Consulting • Research • Standards • Compliance • Training

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-422

Client.: APREL

C E R T I F I C A T E O F C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic E field RF Probe

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 269

IN AIR Calibration

Calibration Procedure: SSI/DRB-TP-D01-038

Project No: Internal

Calibrated: 21nd May 2005

Released on: 21nd May 2005

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4161

Introduction

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-038 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 269.

References

SSI/DRB-TP-D01-038 E-Field Probe Calibration Procedure
IEEE Std 1309-2005 "Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9 kHz to 40GHz".

Conditions

Probe 269 was a new probe taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C

Sensor offset

Each probe is comprised of 3 electric field sensors and positioned at 90 degree to each other in XYZ arrangement. Their electric center makes the calibrated center of the probe. The center is aligned with the main axis of the probe. For constructional reasons it is located a small distance, specified as the vertical offset, above the tip of the probe. The actual offset is specified in the probe's calibration certificate to allow for proper referencing to the probe's calibrated center when the probe's vertical position relative to the tested object is set by touching it with the probe's tip.

Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	269
Frequency:	1880 MHz
Sensor Offset:	1.56 mm
Sensor Length:	2.5 mm
Tip Enclosure:	Ertalyte
Tip Diameter:	5 mm
Tip Length:	60 mm
Total Length:	290 mm

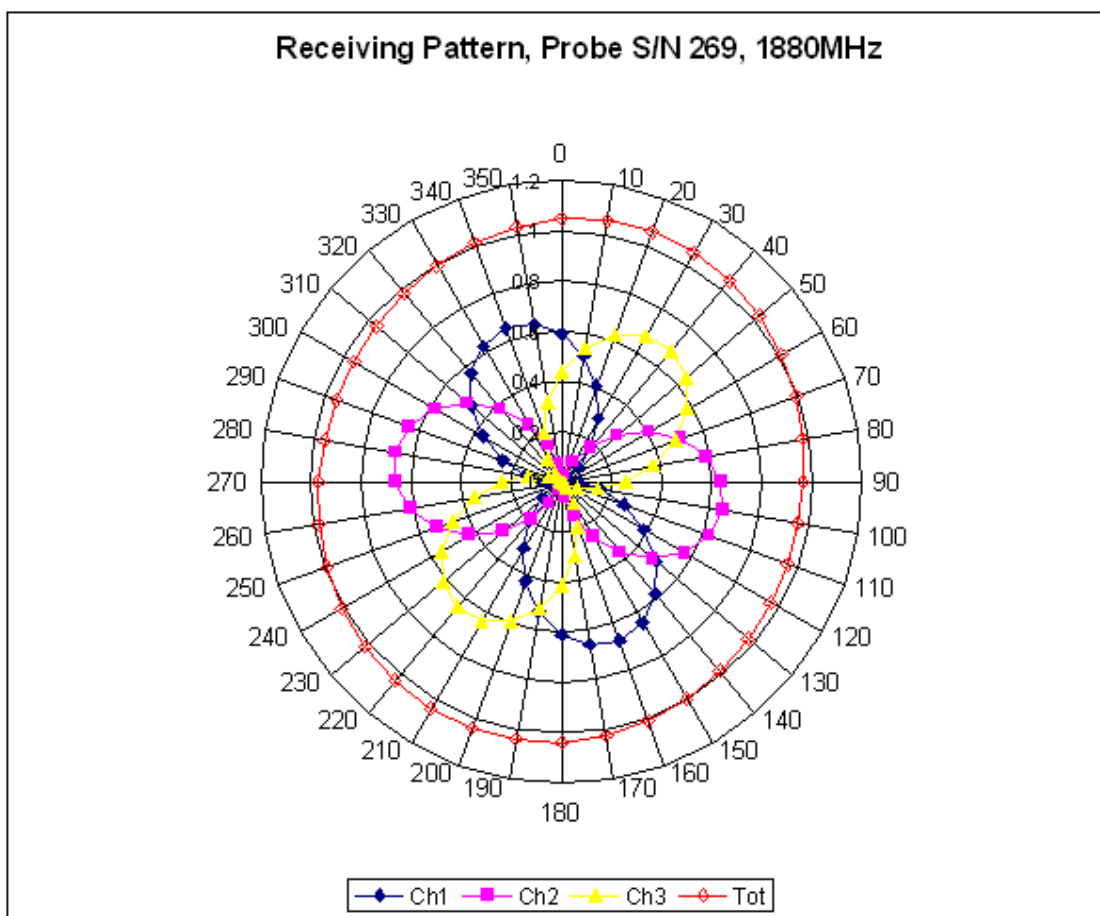
Sensitivity in Air

Channel X:	$1.2 \mu\text{V}/(\text{V}/\text{m})^2$
Channel Y:	$1.2 \mu\text{V}/(\text{V}/\text{m})^2$
Channel Z:	$1.2 \mu\text{V}/(\text{V}/\text{m})^2$
Diode Compression Point:	95 mV

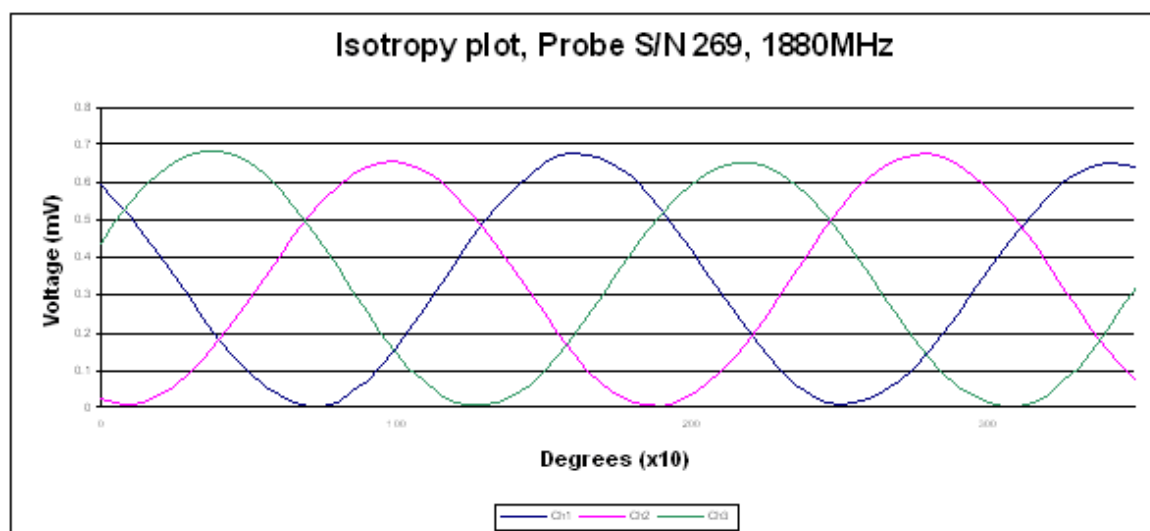
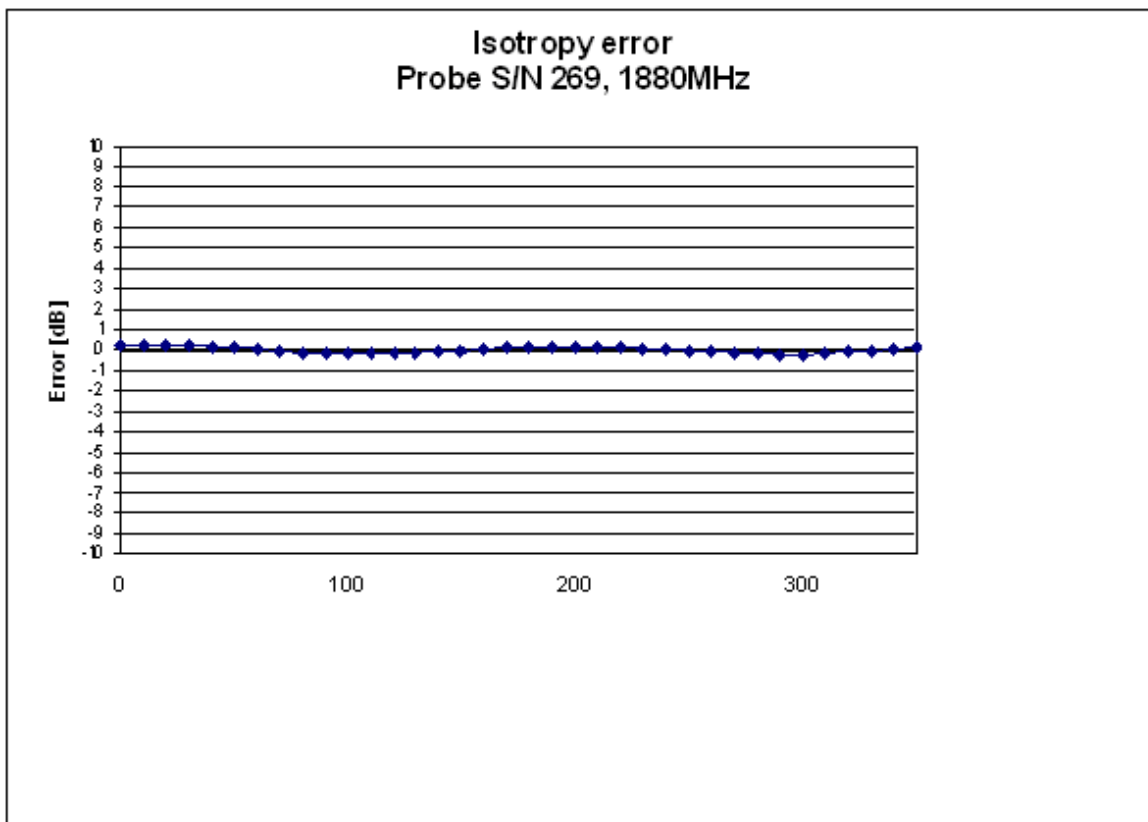
Spatial Resolution:

The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

Receiving Pattern at 1880 MHz



Isotropy Error 1880 MHz

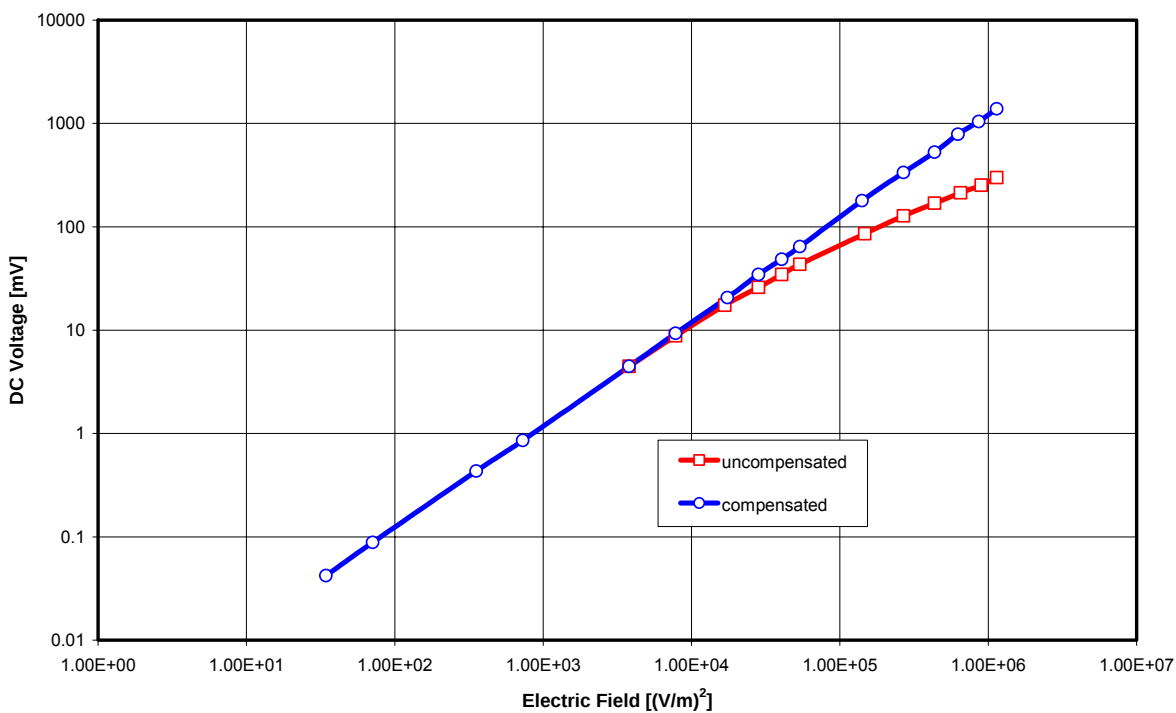


Isotropy:

0.10 dB

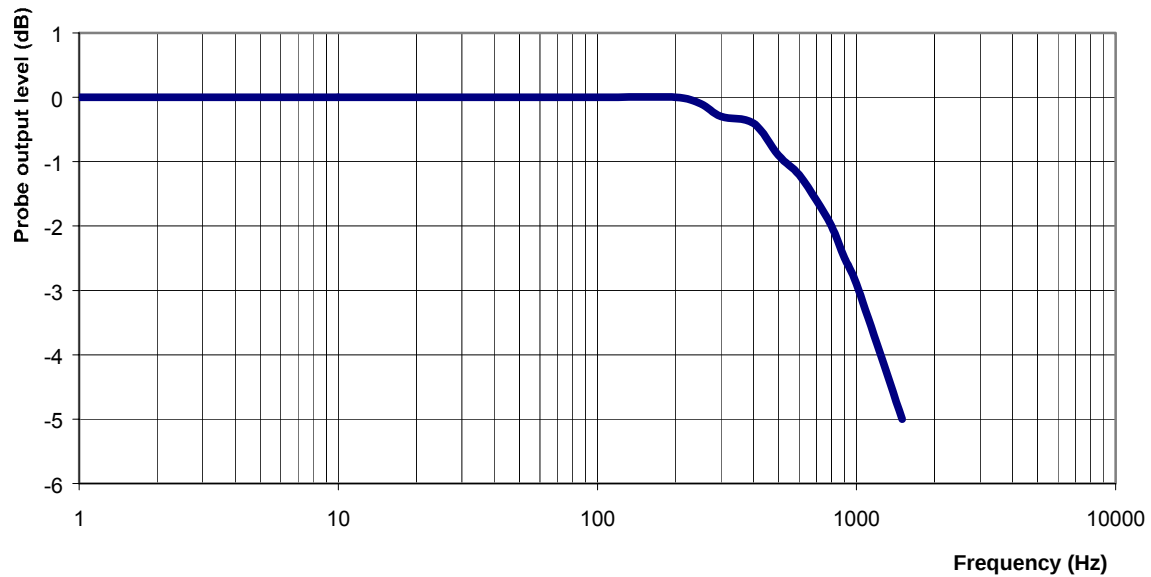
Dynamic Range

Dynamic Range, Probe S/N 269, 1880MHz



Video Bandwidth

Probe Frequency Characteristics



Video Bandwidth at 500 Hz 1 dB
Video Bandwidth at 1.02 KHz: 3 dB

Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2005.

Uncertainty Budget

Annex Estimation of WD Near-Field Emissions Measurement Uncertainty

Contribution	Data (%)	Data Type	Probability Distribution	Divisor	Std. Uncertainty (%)	Std. Uncertainty (dB)
RF Reflections	3.0	Tolerance	rectangular	$\sqrt{3}$	1.7	
Probe Calibration	3.5	Standard Deviation	normal	1	3.5	
Field Probe Axial isotropy	3.7	Tolerance	rectangular	$\sqrt{3}$	1.5	
Field Probe Hemispherical Isotropy	10.9	Tolerance	rectangular	$\sqrt{3}$	4.4	
Probe Linearity	4.7	Tolerance	rectangular	$\sqrt{3}$	2.7	
Detection Limit	1.0	Tolerance	rectangular	$\sqrt{3}$	0.6	
Readout Electronics	1.0	Standard Deviation	normal	1	1.0	
Response Time	0.8	Tolerance	rectangular	$\sqrt{3}$	0.5	
Integration Time	1.7	Tolerance	rectangular	$\sqrt{3}$	1.0	
Probe Positioning Accuracy	0.4	Accuracy	rectangular	$\sqrt{3}$	0.2	
Device Holder Uncertainty	2.0	Standard Deviation	normal	1	2.0	
System Repeatability	3.0	Tolerance	rectangular	$\sqrt{3}$	1.7	
EUT Repeatability	2.0	Standard Deviation	normal	1	0.0	
Combined Standard Uncertainty u_c			normal		7.6%	0.32
Expanded Uncertainty (coverage factor = 2) U			Normal (K=2)		15.2%	0.61

Measurement uncertainty reflects the quality and accuracy of a measured result as compared to the true value. Such statements are generally required when stating results of measurements so that it is clear to the user of these measurement results that the results may differ when reproduced by different laboratories. Measurement results vary due to the measurement uncertainty of the instrumentation, and measurement technique, even when using this standard for test setups and compliance measurements.

Most uncertainties are calculated using the tolerances of the instrumentation used in the measurement, the measurement setup variability, and the technique used in performing the test. While not generally included, the variability of the equipment under test also figures into the overall measurement uncertainty.

Another component of the overall uncertainty is based on the variability of repeated measurements (so-called Type A uncertainty). This may mean that the Hearing Aid immunity tests may have to be repeated by taking down the test setup and resetting it up so that there is a statistically significant number of repeat measurements to identify this very important aspect of measurement uncertainty. By combining the repeat measurement results with that of the instrumentation chain using the technique contained in NIS 81 and NIS 3003,¹ the overall measurement uncertainty can be estimated.

Equipment List

Equipment Description	Asset / Serial Number	Calibration Due Date
ALSAS-10U	301571	Prior to Test
Anritsu MT8801C	301598	June 2006
Daq-Paq	301573	6 Jan 2006
Pentium 4 Workstation	301574	Not Required
Signal Generator	301468	September 2005
Gigatronics Power Meter	301393	October 2005
Gigatronics Broad Band Power Sensor	301394	October 2005
HP-Directional Coupler	100251	October 2005
APREL Laboratories 800-4200MHz 12W Amplifier	301577	Prior to Test
APREL Laboratories 835MHz Validation Dipole	180-00554	November 2006
APREL Laboratories 1900MHz Validation Dipole	210-00705	June 2006
APREL Laboratories E-020 E-Field Probe	212	October 2006
APREL Laboratories H-020 E-Field Probe	101	April 2006

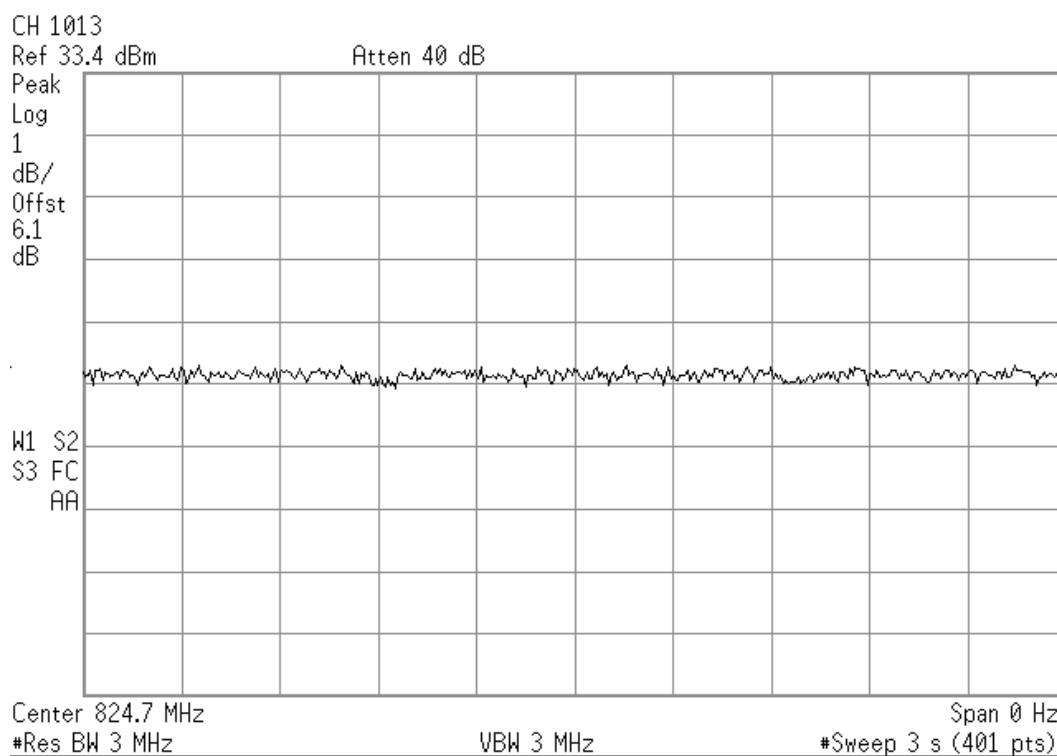
Zero Span & Wideband Spectrum Analyzer plots

Mobile Service Tester Willtek 4300 was used to register the WD, make a call and then to control the WD, i.e. the WD was not used in the test mode.

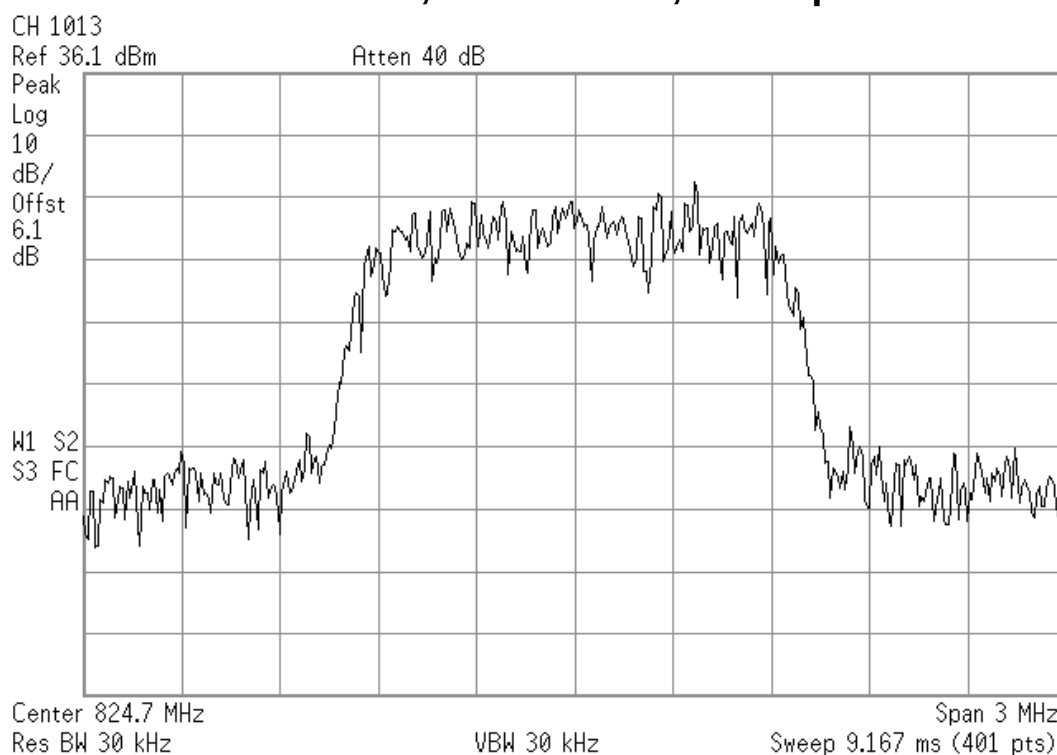
In order to establish the call it was set to the appropriate SIN (System ID) and NID (Network ID) numbers. The instrument was equipped with the appropriate antenna to communicate with the WD over the air.

The instrument was used to set both, the uplink channels and output power level of the WD.

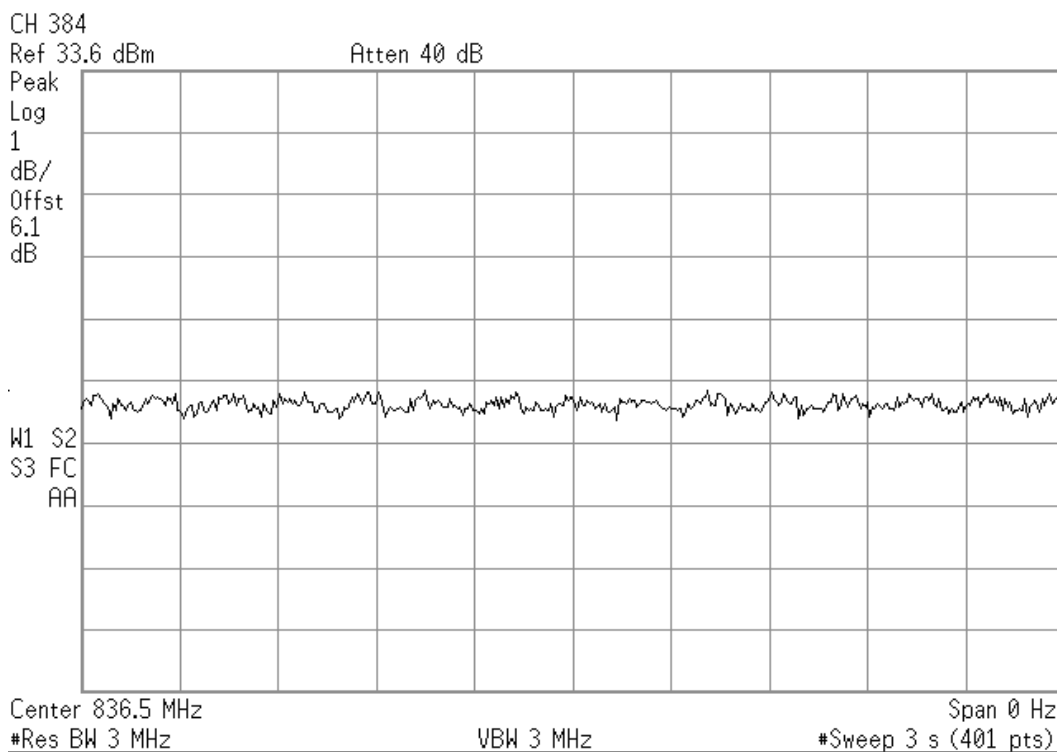
Three channels in each band, CDMA and PCS (low, middle and high) were tested. The channels were monitored with a Spectrum Analyzer to verify the correct type of modulation and channel frequencies were tested. Plots follow.



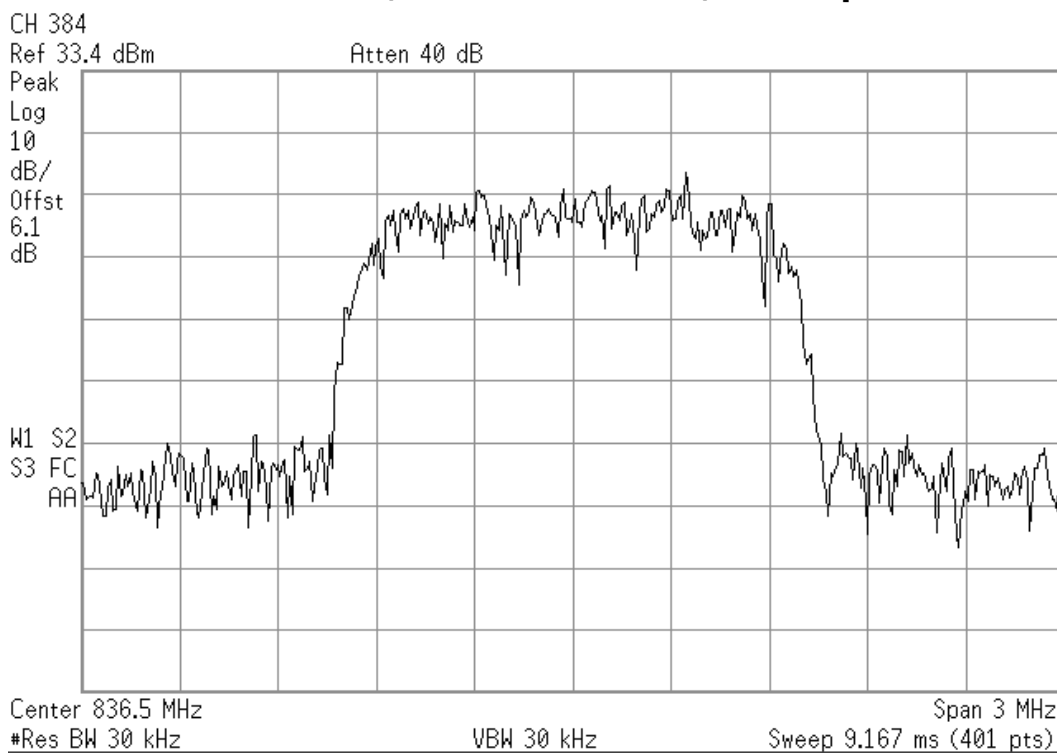
CDMA band, low channel, zero-span



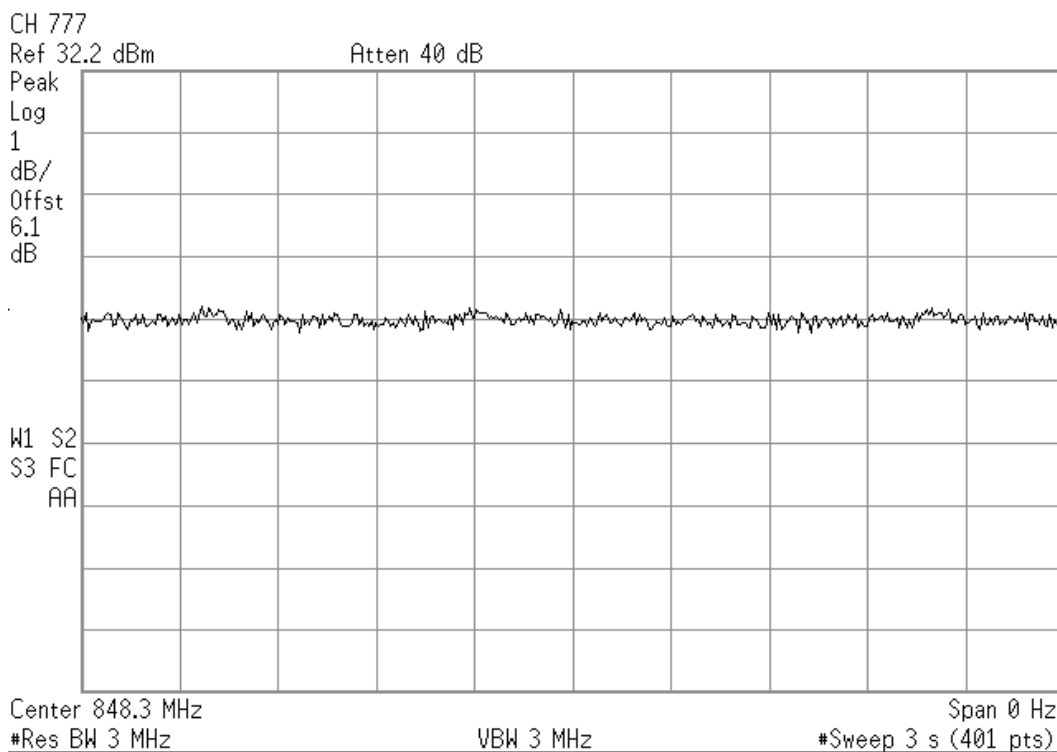
CDMA band, low channel, wideband



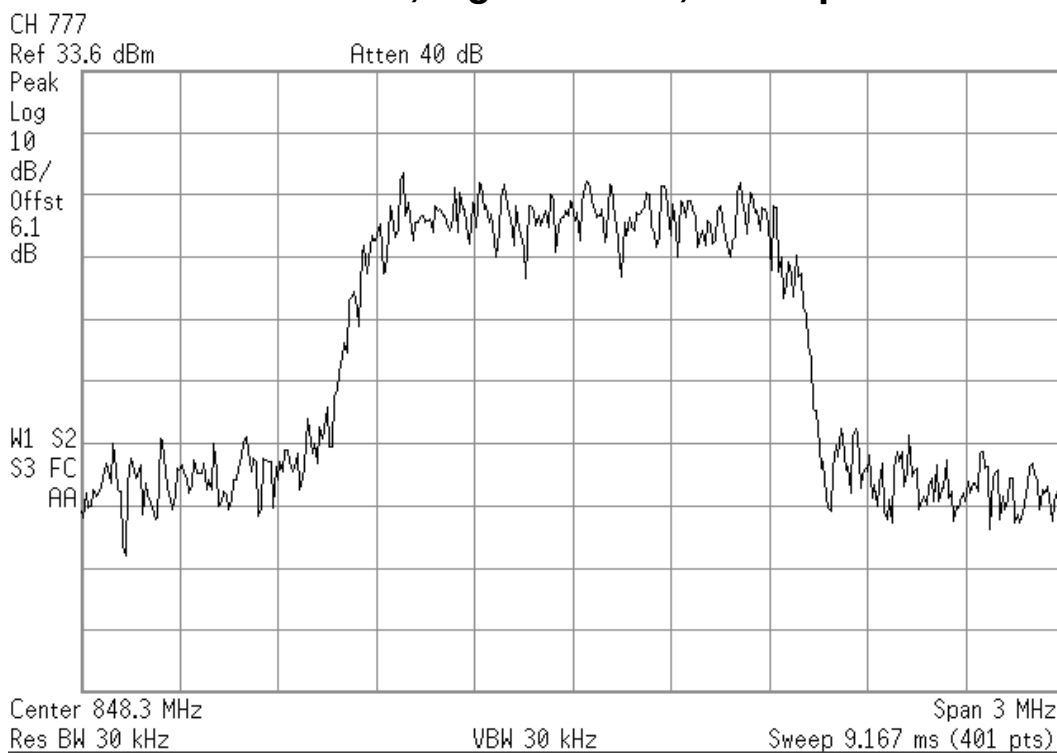
CDMA band, middle channel, zero-span



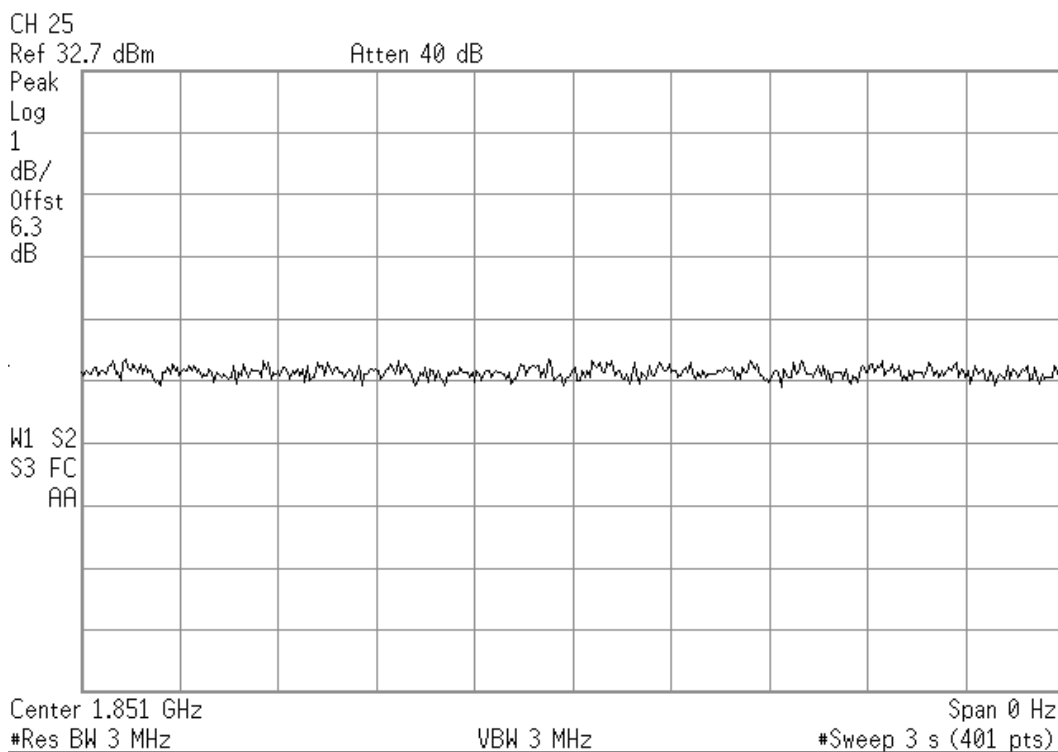
CDMA band, middle channel, wideband



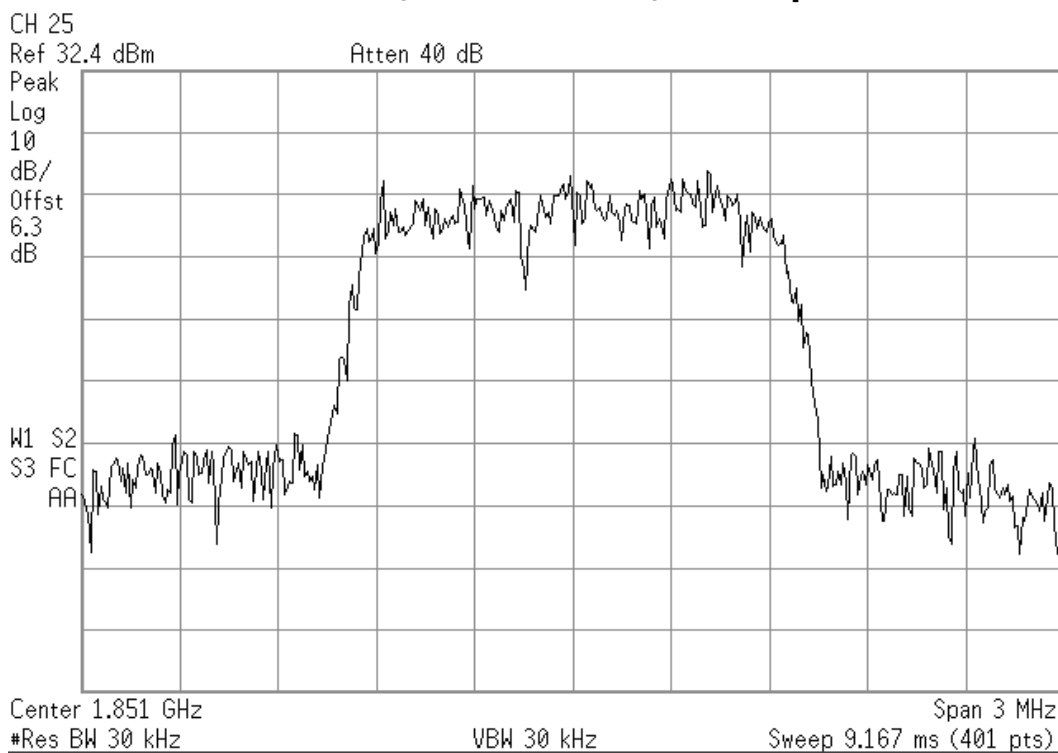
CDMA band, high channel, zero-span



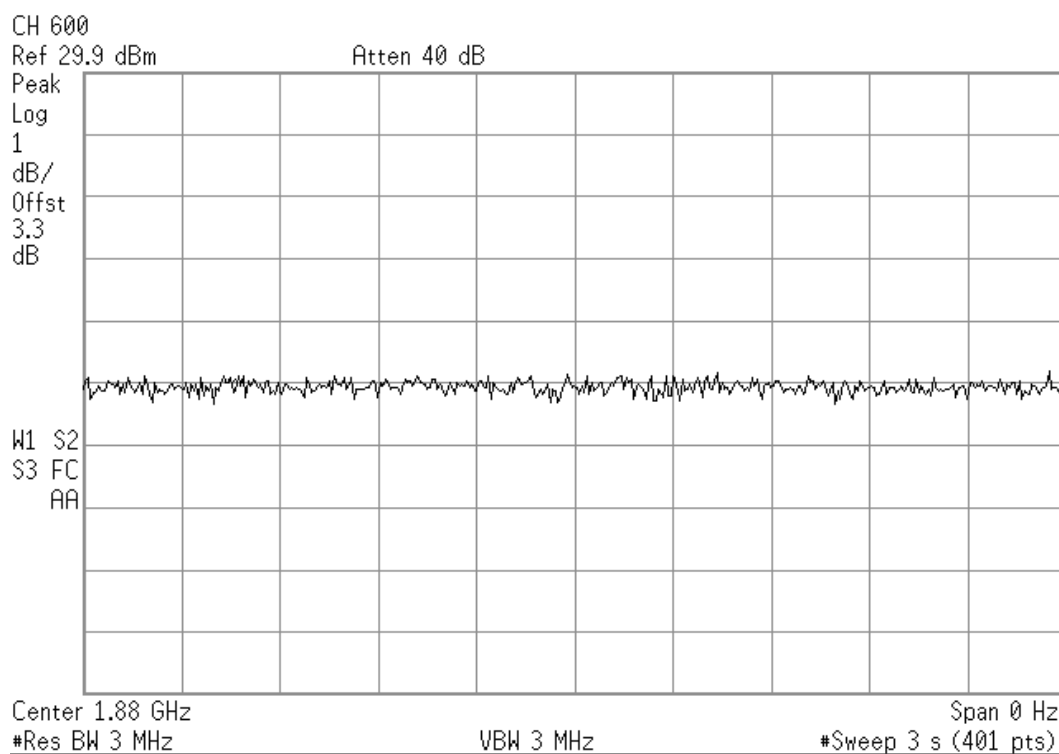
CDMA band, high channel, wideband



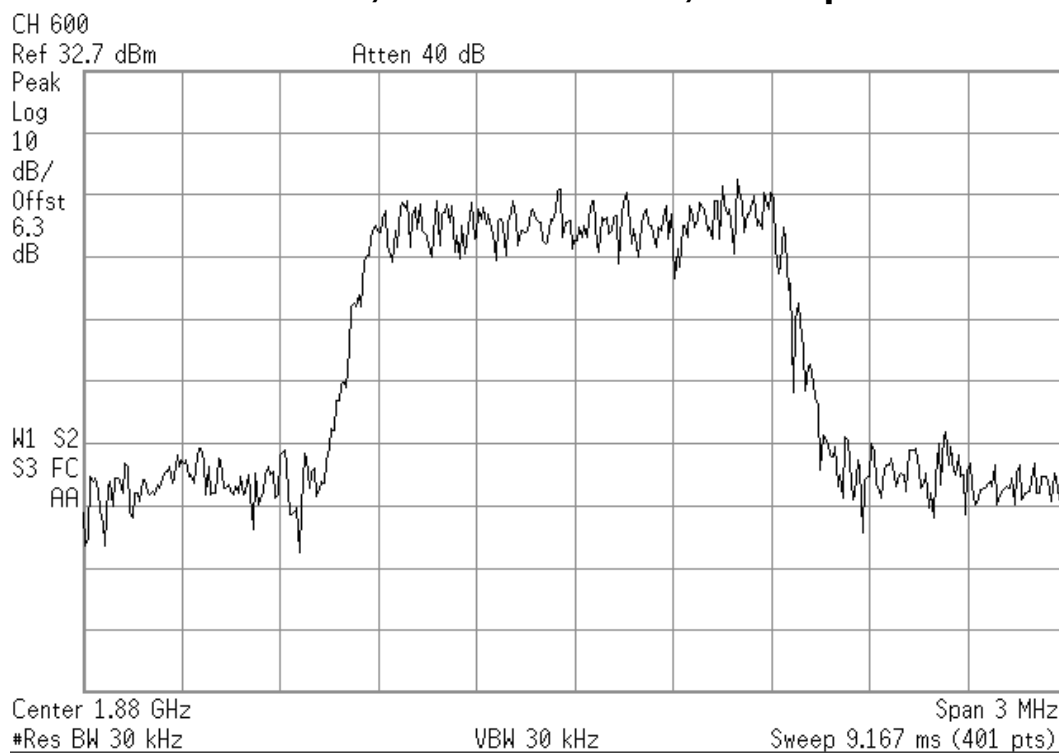
PCS band, low channel, zero-span



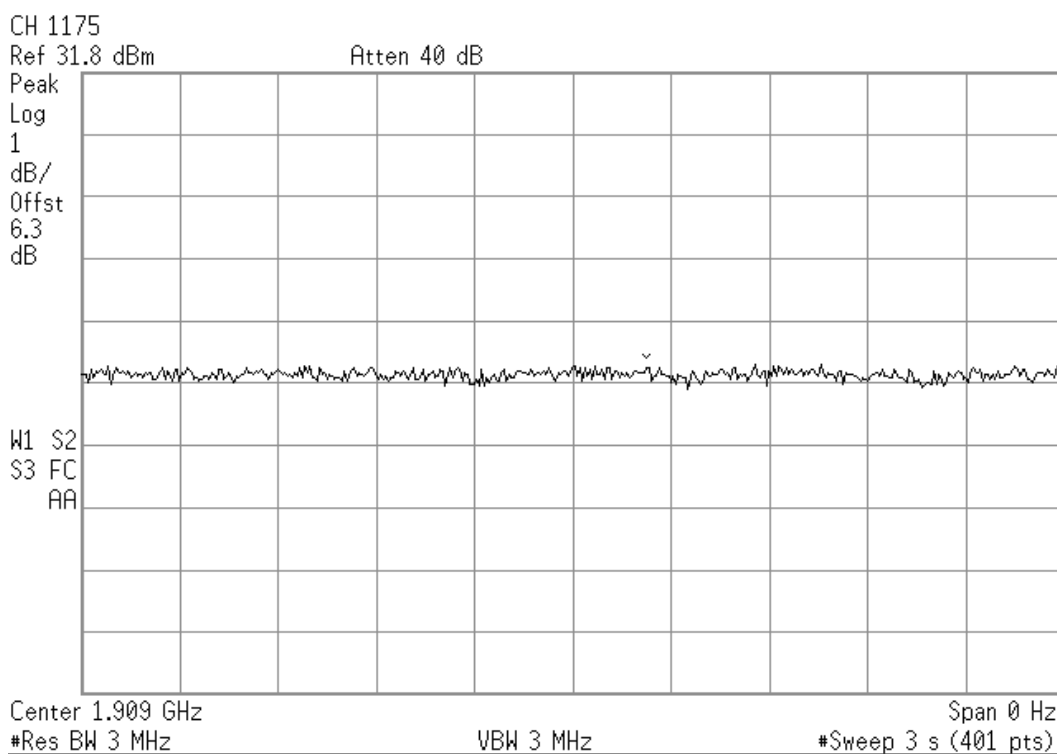
PCS band, low channel, wideband



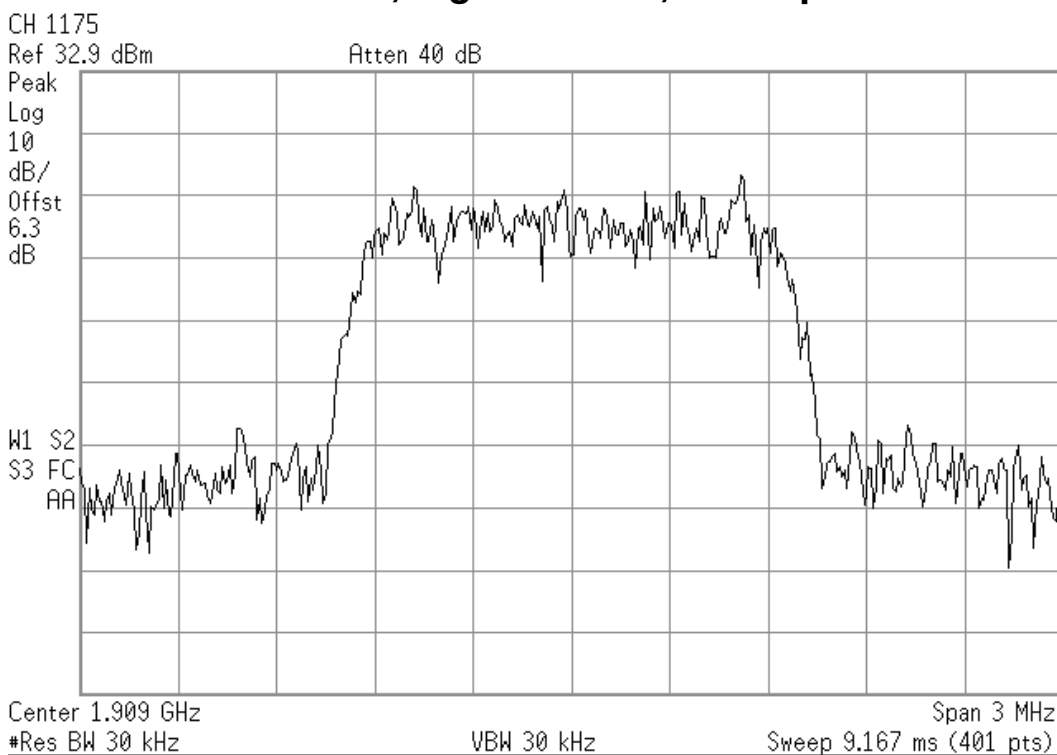
PCS band, middle channel, zero-span



PCS band, middle channel, wideband



PCS band, high channel, zero-span



PCS band, high channel, wideband