Annex A: Probe sensitivity and reference signal measurement plots

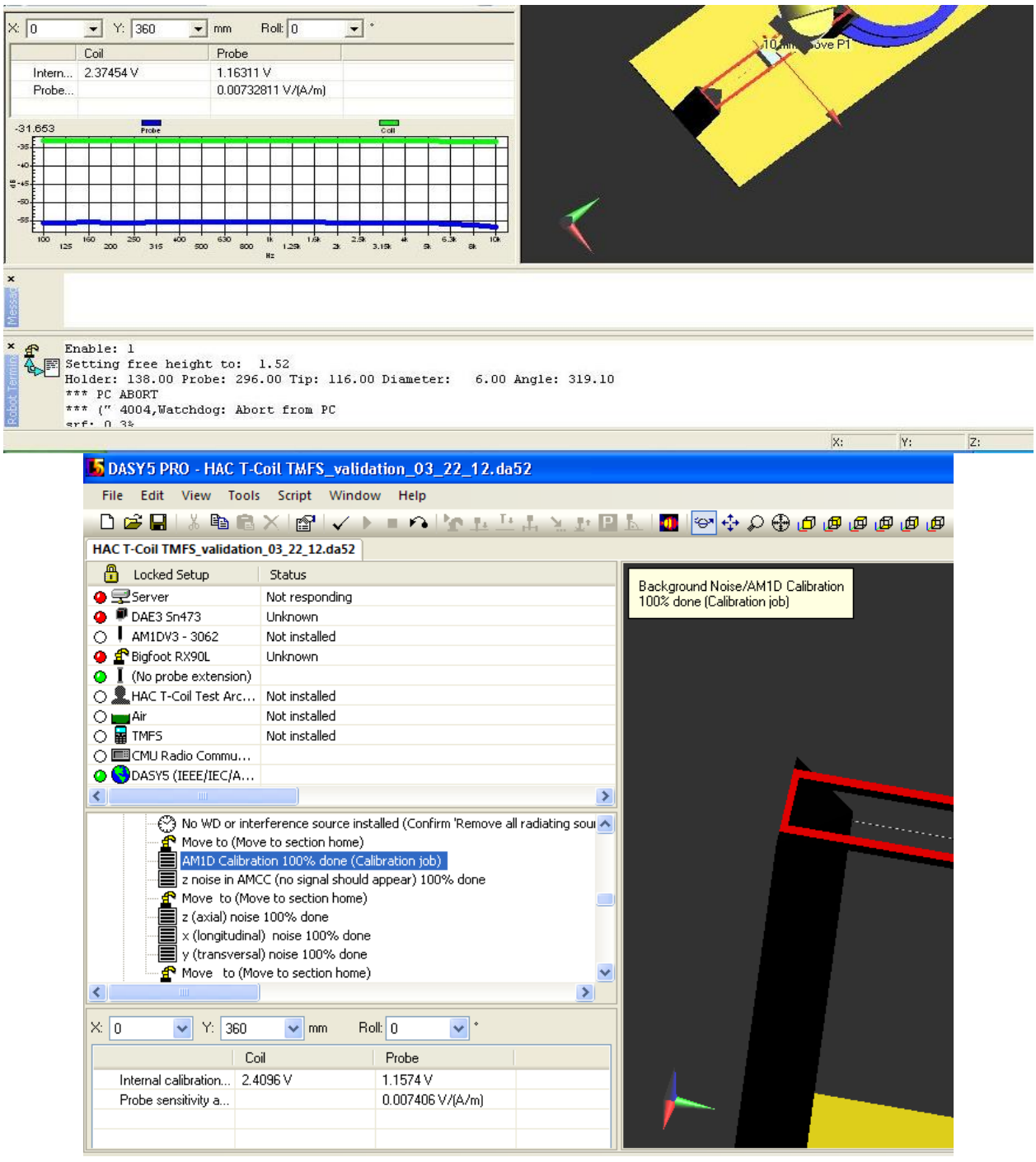


Figure A1: Probe calibration data for coil and probe

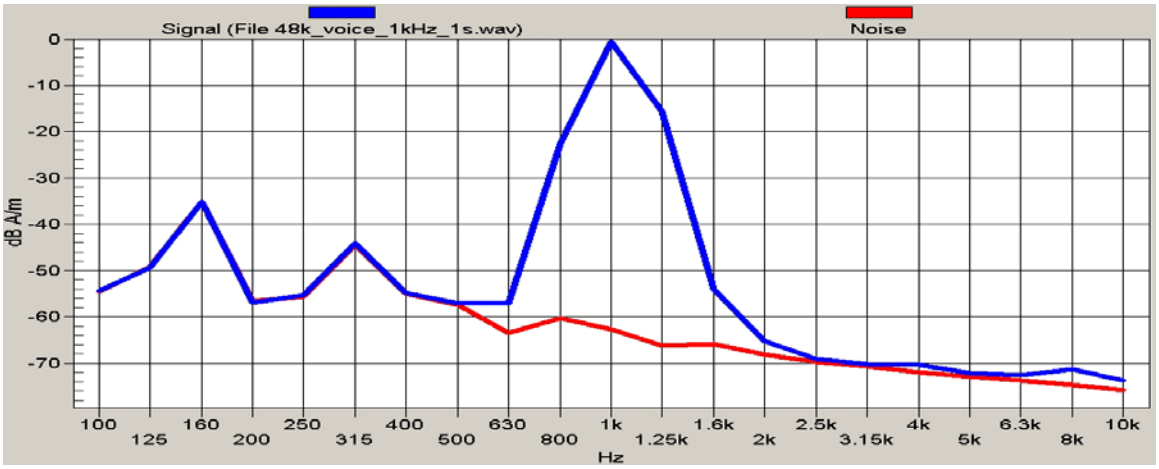


Figure A2: Reference voice 1 kHz signal and noise

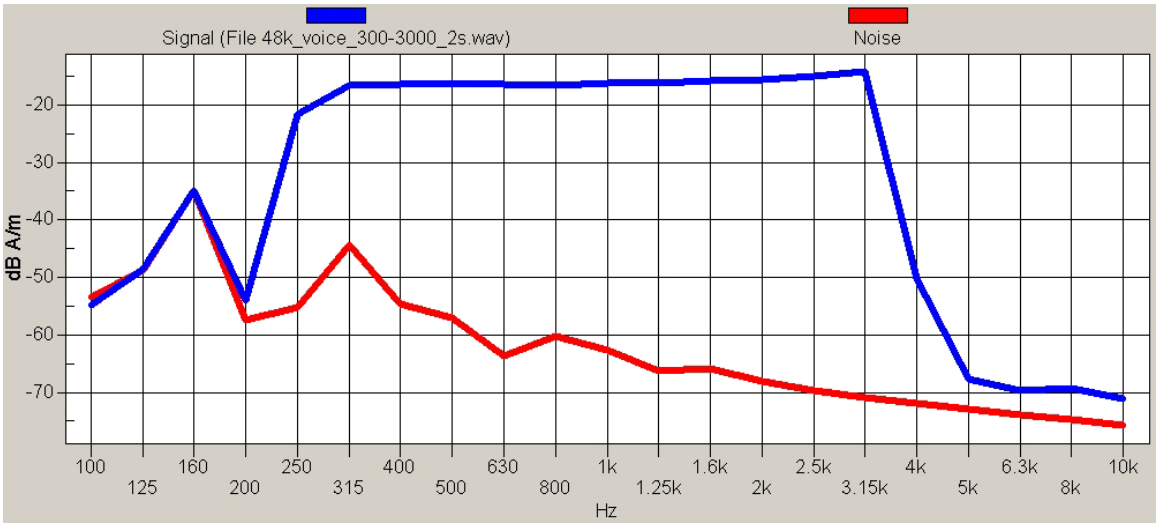


Figure A3: Reference voice simulated signal and noise

Annex B: TMFS system validation and ambient data/plots

Date/Time: 3/22/2012 2:26:08 PM

Test Laboratory: RIM Testing Services

HAC T-Coil TMFS_validation_03_22_12

DUT: TMFS; Type: TMFS-1

Communication System: CW; Frequency: 835 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: AM1DV3 - 3062; ; Calibrated: 1/12/2012
- Sensor-Surface: 0mm (Fix Surface), z = 3.0
- Electronics: DAE3 Sn473; Calibrated: 1/13/2012
- Phantom: HAC T-Coil Test Arch with AMCC; Type: SD HAC P01 BA;
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

T-Coil scan/Background Noise/z (axial) noise/ABM Noise Spectrum(x,y,z,f) (1x1x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Measure Window Start: 2000ms
Measure Window Length: 5000ms
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM = -56.03 dB A/m
Location: 0, 0, 13 mm

T-Coil scan/Background Noise/x (longitudinal) noise/ABM Noise Spectrum(x,y,z,f) (1x1x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Measure Window Start: 2000ms
Measure Window Length: 5000ms
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM = -56.01 dB A/m
Location: 0, 0, 13 mm

T-Coil scan/Background Noise/y (transversal) noise/ABM Noise Spectrum(x,y,z,f) (1x1x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Measure Window Start: 2000ms
Measure Window Length: 5000ms
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM = -55.93 dB A/m
Location: 0, 0, 13 mm

T-Coil scan/TMFS Validation/z (axial) 8 x 8 step 2/ABM Signal(x,y,z) (5x5x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 35.05
Measure Window Start: 0ms
Measure Window Length: 1000ms
BWC applied: 0.0031 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 comp = -20.48 dB A/m
BWC Factor = 0.0031 dB
Location: 0, 0, 3.7 mm

T-Coil scan/TMFS Validation/x (longitudinal) 52 x 16 step 4/ABM Signal(x,y,z) (14x5x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 35.05
Measure Window Start: 0ms
Measure Window Length: 1000ms
BWC applied: 0.0031 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 comp = -25.80 dB A/m
BWC Factor = 0.0031 dB
Location: -18, 0, 3.7 mm

T-Coil scan/TMFS Validation/y (transversal) 16 x 52 step 4/ABM Signal(x,y,z) (5x14x1):

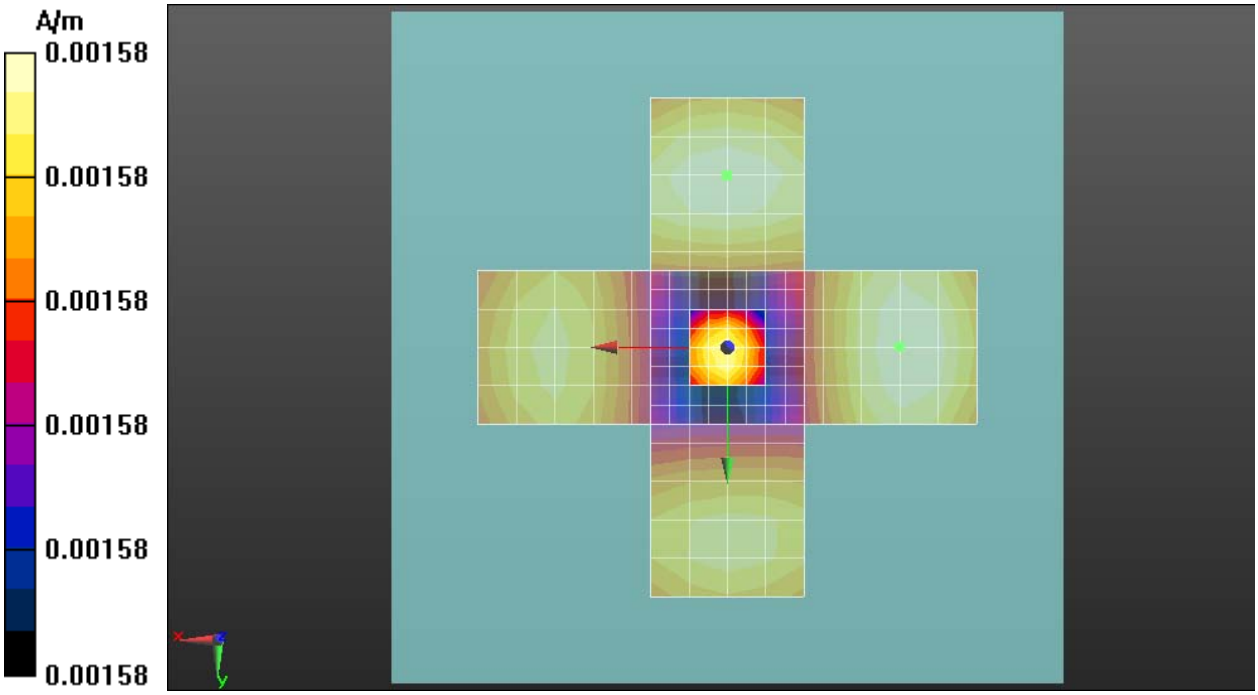
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 35.05
Measure Window Start: 0ms
Measure Window Length: 1000ms
BWC applied: 0.0031 dB
Device Reference Point: 0, 0, -6.3 mm

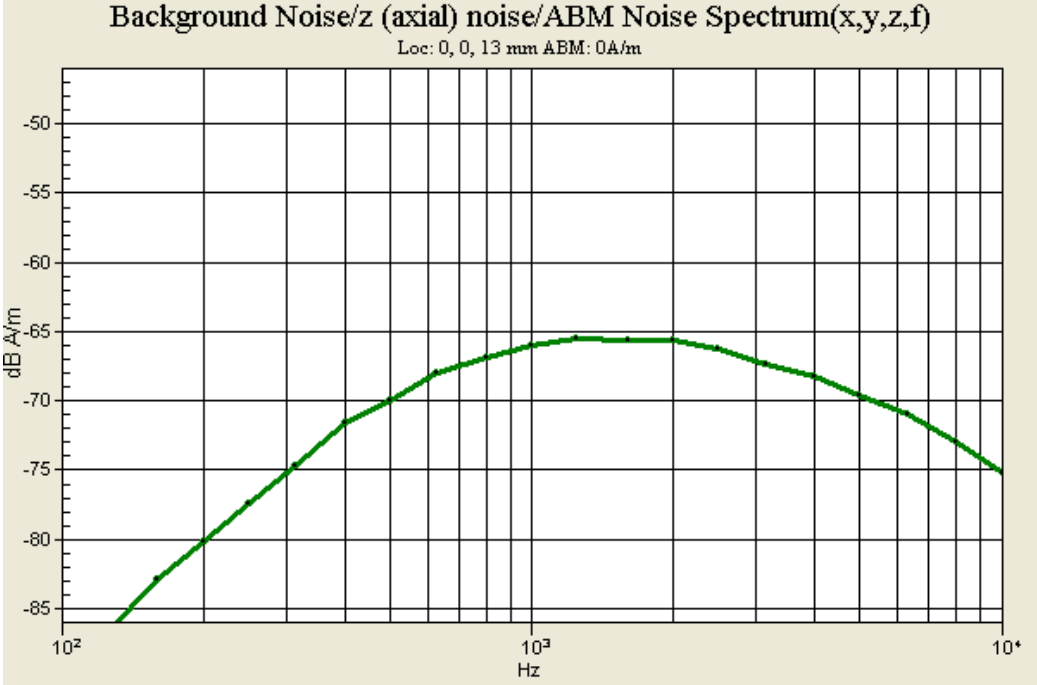
Cursor:
ABM1 comp = -25.76 dB A/m
BWC Factor = 0.0031 dB
Location: 0, -18, 3.7 mm

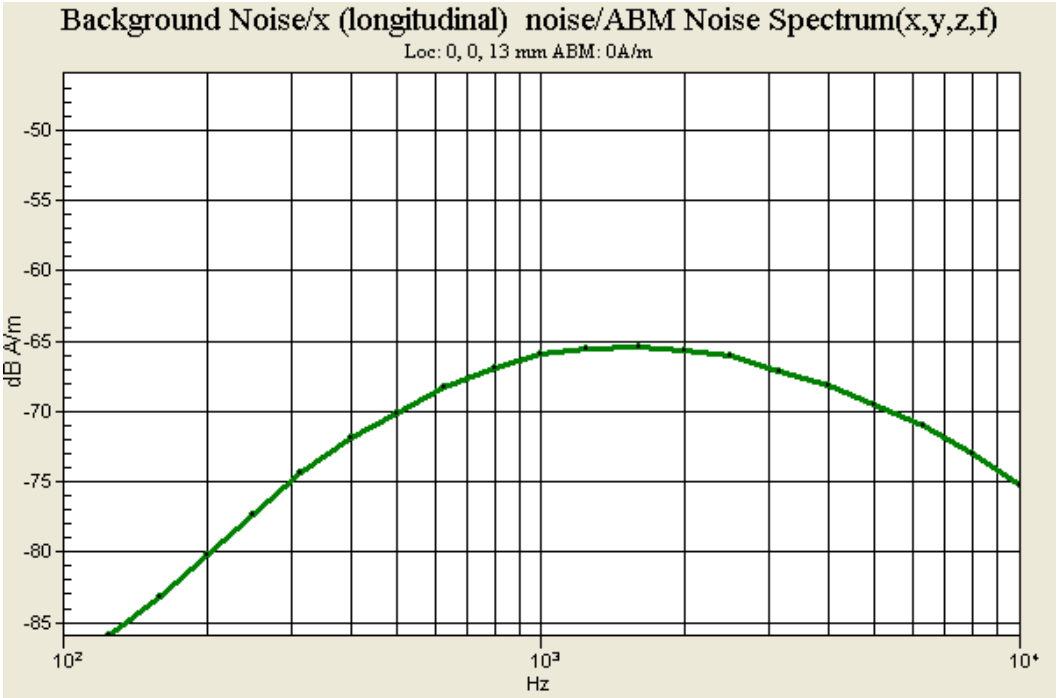
T-Coil scan/TMFS Validation/z (axial) at center 100% gain/ABM Freq Resp(x,y,z,f) (1x1x1):

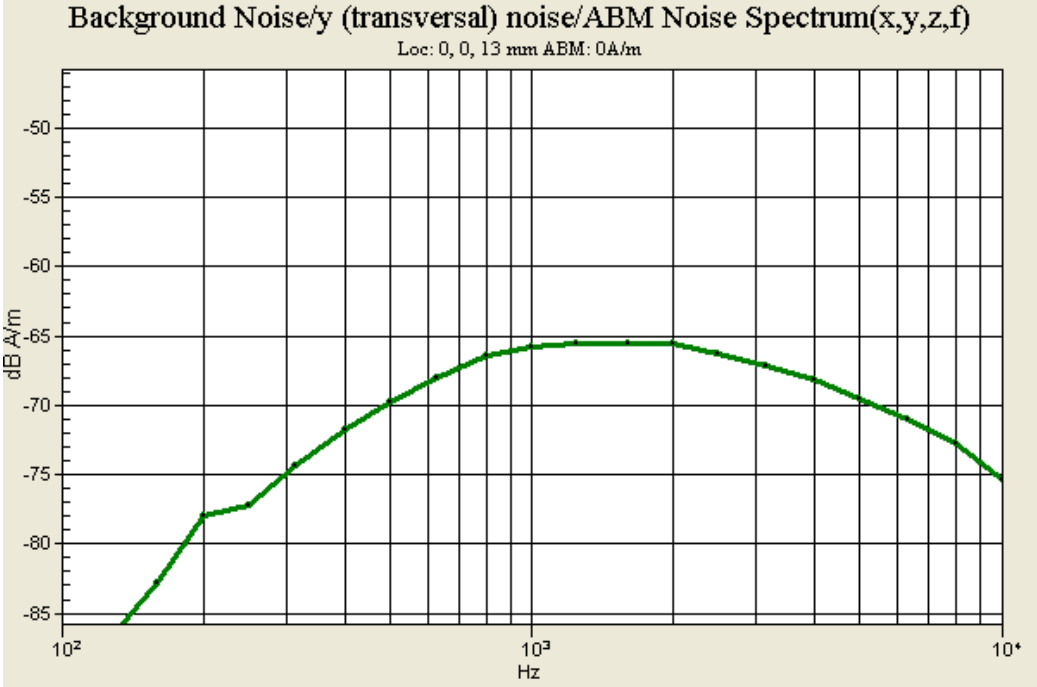
Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_multisine_50_10k_10s.wav
Output Gain: 87.2
Measure Window Start: 2000ms
Measure Window Length: 5000ms
BWC applied: 13.16 dB
Device Reference Point: 0, 0, -6.3 mm

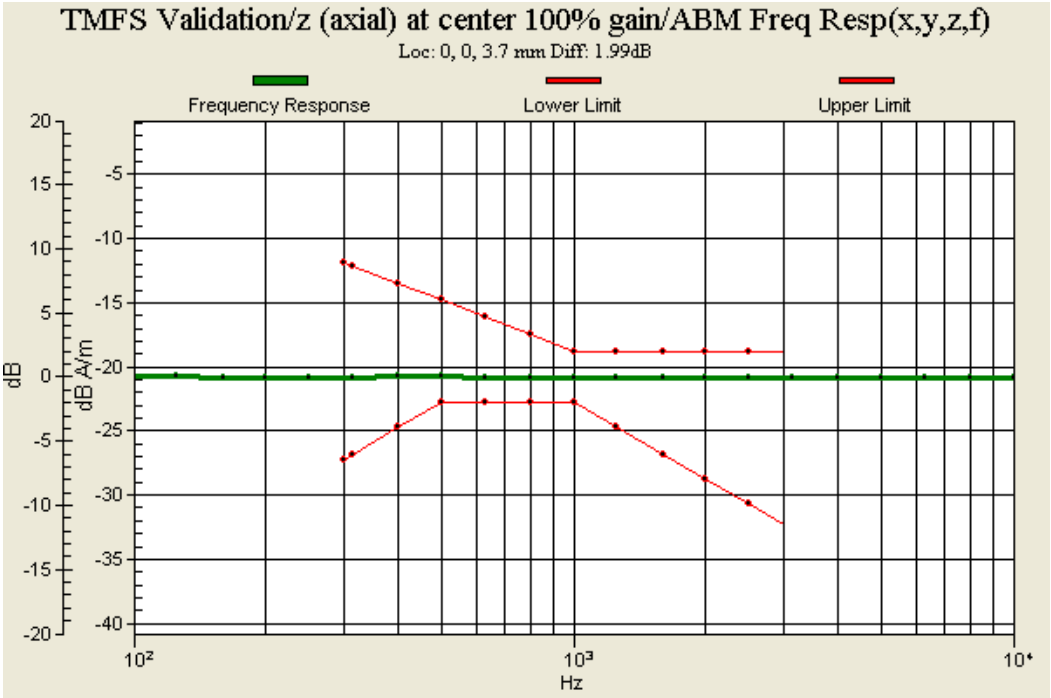
Cursor:
Diff = 1.99 dB
BWC Factor = 13.16 dB
Location: 0, 0, 3.7 mm











Annex C: Audio Band Magnetic measurement data and plots

Date/Time: 3/23/2012 10:15:26 AM

Test Laboratory: RIM Testing Services

HAC T-Coil_CDMA1700_Axial

DUT: BlackBerry; Type: Sample; Serial: 331D34F3

Communication System: CDMA AWS 1700_1/8th; Frequency: 1711.25 MHz, Frequency: 1732.5 MHz, Frequency: 1753.75 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: AM1DV3 - 3062; ; Calibrated: 1/12/2012
- Sensor-Surface: 0mm (Fix Surface), z = 3.0
- Electronics: DAE3 Sn473; Calibrated: 1/13/2012
- Phantom: HAC T-Coil Test Arch with AMCC; Type: SD HAC P01 BA; Serial: Not Specified
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

T-Coil scan/General Scans Low Ch./z (axial) 5.0mm 50 x 50/ABM SNR(x,y,z) (11x11x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

T-Coil scan/General Scans Low Ch./z (axial) 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 49.03 dB
ABM1 comp = 10.41 dB A/m
BWC Factor = 0.16 dB
Location: -5, -7, 4.4 mm

T-Coil scan/General Scans Low Ch./z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f) (1x1x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 69.12
Measure Window Start: 300ms
Measure Window Length: 2000ms
BWC applied: 10.80 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
Diff = 1.90 dB
BWC Factor = 10.80 dB
Location: -5, -5, 3.7 mm

T-Coil scan/General Scans Low Ch./z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f) (1x1x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 69.12
Measure Window Start: 300ms
Measure Window Length: 6000ms

BWC applied: 10.80 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
Diff = 0.61 dB
BWC Factor = 10.80 dB
Location: -5, -5, 3.7 mm

T-Coil scan/General Scans Mid Ch./z (axial) 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 49.61 dB
ABM1 comp = 10.19 dB A/m
BWC Factor = 0.16 dB
Location: -5, -7, 4.4 mm

T-Coil scan/General Scans Mid Ch./z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f) (1x1x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 69.12
Measure Window Start: 300ms
Measure Window Length: 2000ms
BWC applied: 10.80 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
Diff = 2.00 dB
BWC Factor = 10.80 dB
Location: 0, 0, 13 mm

T-Coil scan/General Scans Mid Ch./z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f) (1x1x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 69.12
Measure Window Start: 2000ms
Measure Window Length: 4000ms
BWC applied: 10.80 dB
Device Reference Point: 0, 0, -6.3 mm

T-Coil scan/General Scans High Ch./z (axial) 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 48.27 dB
ABM1 comp = 9.05 dB A/m
BWC Factor = 0.16 dB
Location: -7, -7, 4.4 mm

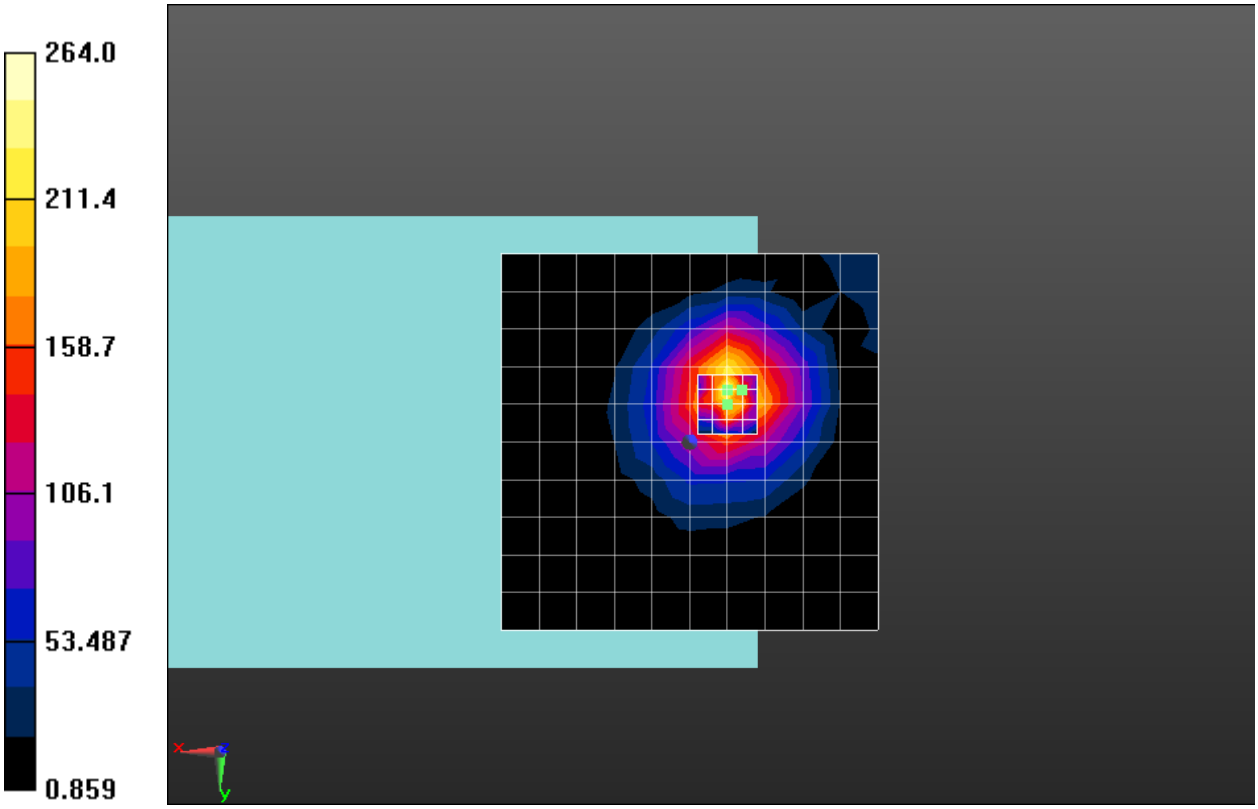
T-Coil scan/General Scans High Ch./z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f) (1x1x1):

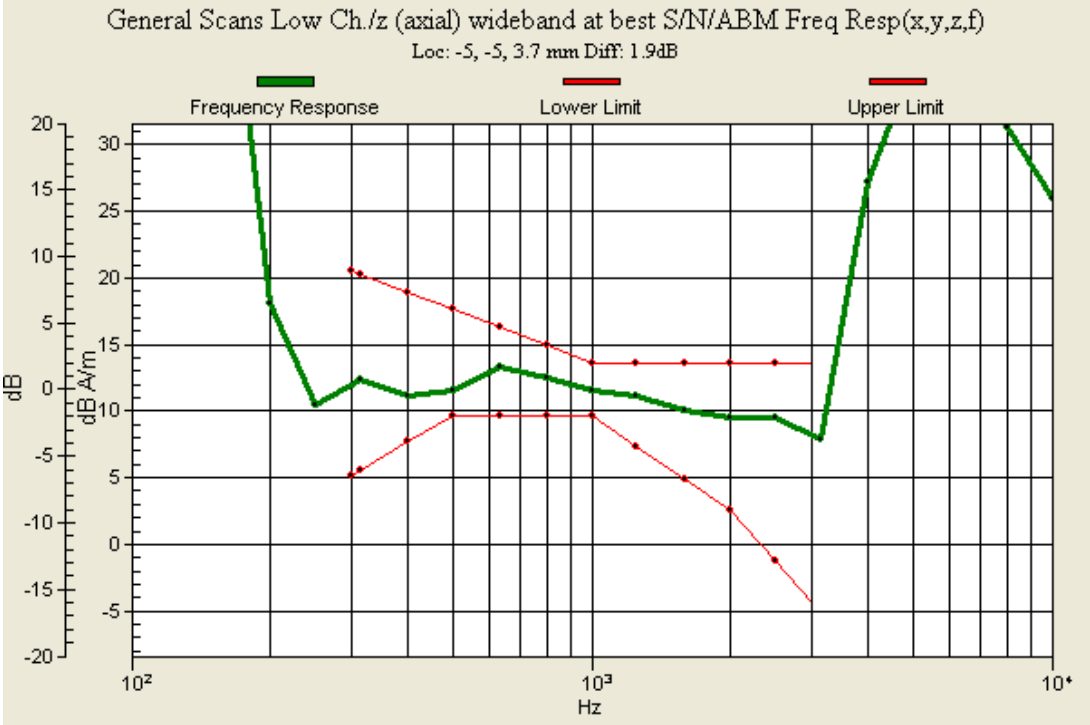
Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 69.12
Measure Window Start: 2000ms
Measure Window Length: 4000ms
BWC applied: 10.81 dB
Device Reference Point: 0, 0, -6.3 mm

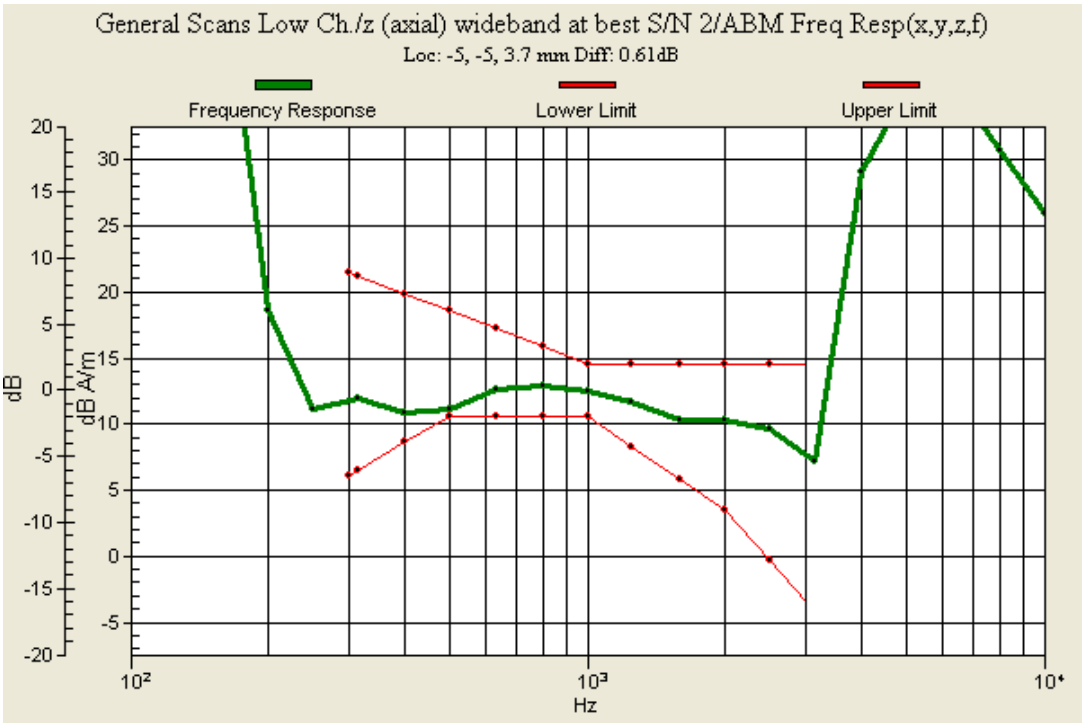
Cursor:
Diff = 2.00 dB
BWC Factor = 10.81 dB
Location: -5, -5, 3.7 mm

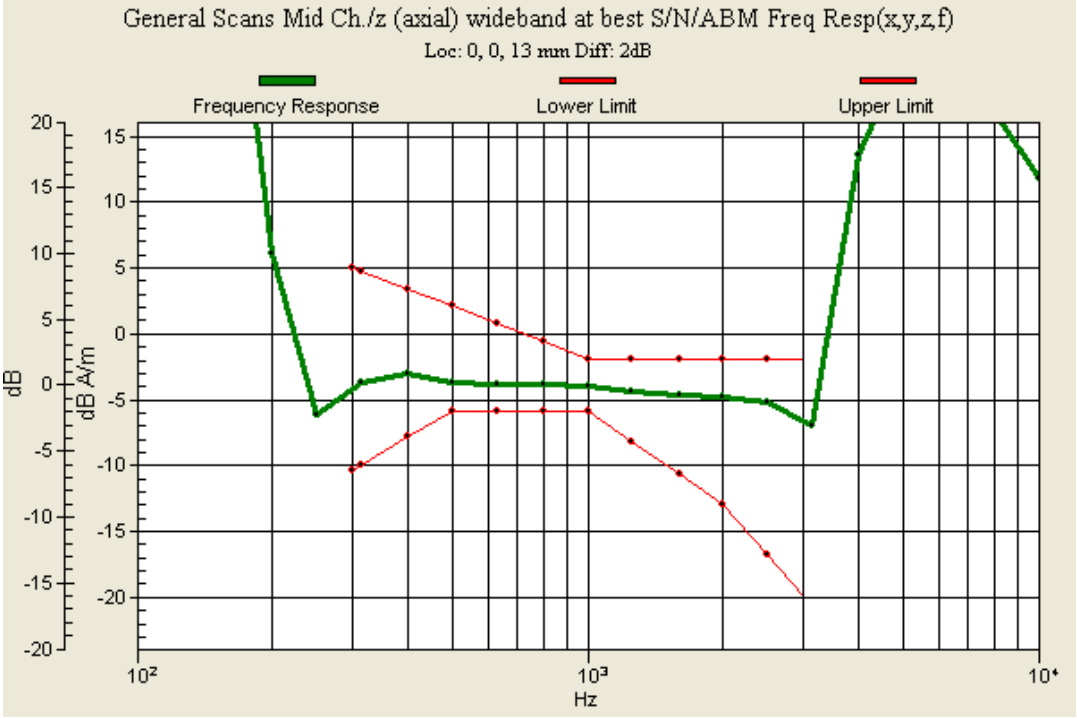
T-Coil scan/General Scans High Ch./z (axial) wideband at best S/N 2 2/ABM Freq Resp(x,y,z,f) (1x1x1):

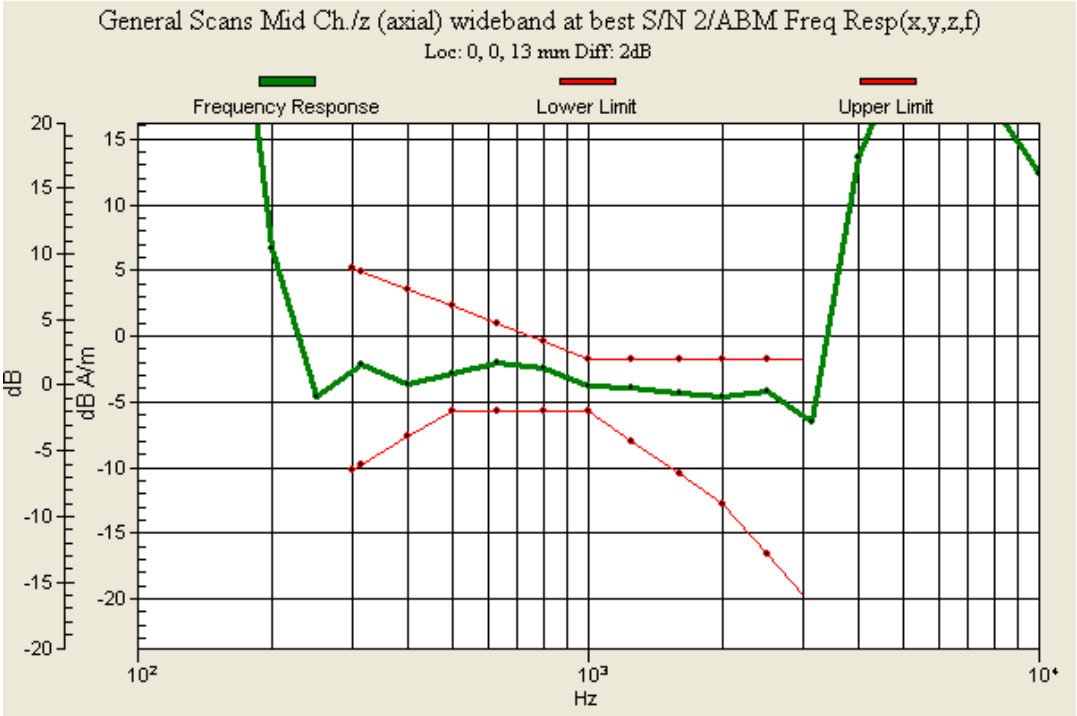
Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 69.12
Measure Window Start: 300ms
Measure Window Length: 2000ms
BWC applied: 10.81 dB
Device Reference Point: 0, 0, -6.3 mm

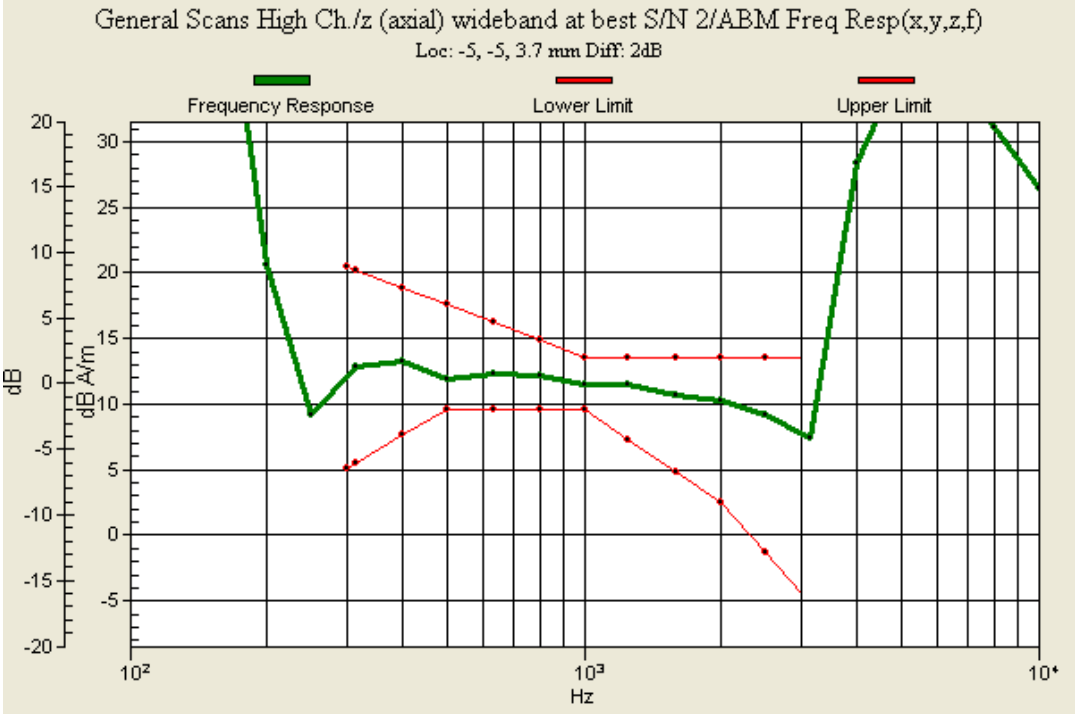


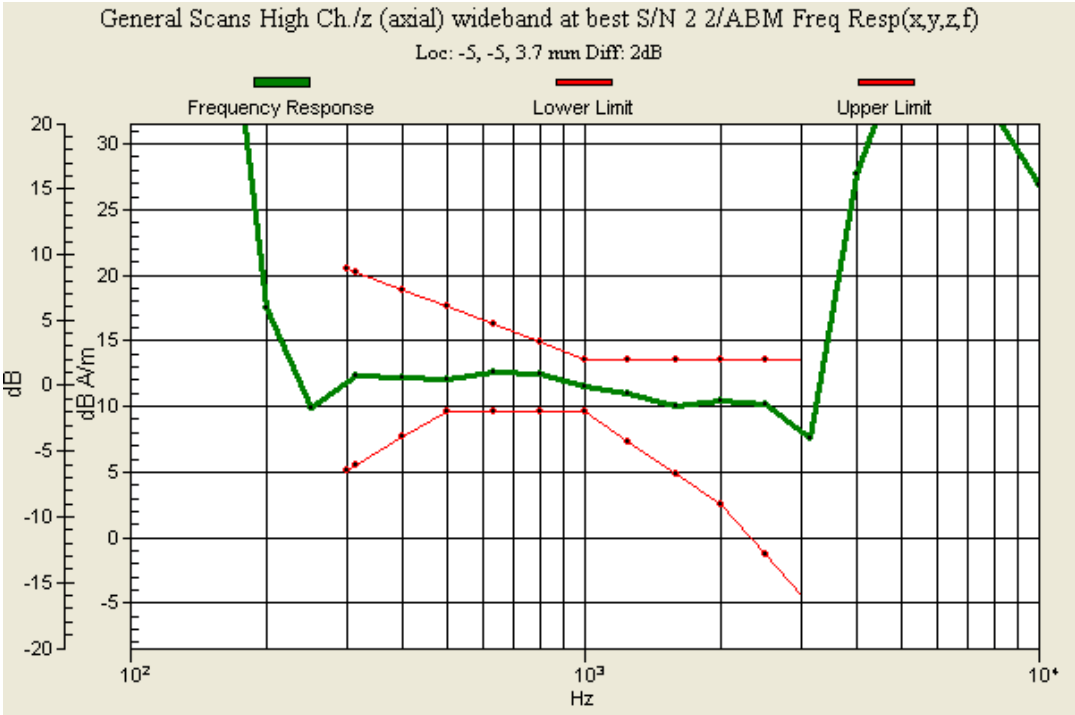












Date/Time: 3/23/2012 10:28:48 AM

Test Laboratory: RIM Testing Services

HAC T-Coil_CDMA1700_Radial_L

DUT: BlackBerry; Type: Sample; Serial: 331D34F3

Communication System: CDMA AWS 1700_1/8th; Frequency: 1711.25 MHz, Frequency: 1732.5 MHz, Frequency: 1753.75 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: AM1DV3 - 3062; ; Calibrated: 1/12/2012
- Sensor-Surface: 0mm (Fix Surface), z = 3.0
- Electronics: DAE3 Sn473; Calibrated: 1/13/2012
- Phantom: HAC T-Coil Test Arch with AMCC; Type: SD HAC P01 BA; Serial: Not Specified
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

T-Coil scan/General Scans Low Ch./x (longitudinal) 5.0mm 50 x 50/ABM SNR(x,y,z) (11x11x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

T-Coil scan/General Scans Low Ch./x (longitudinal) 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 45.80 dB
ABM1 comp = 1.20 dB A/m
BWC Factor = 0.16 dB
Location: 3, -5, 4.4 mm

T-Coil scan/General Scans Mid Ch./x (longitudinal) 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

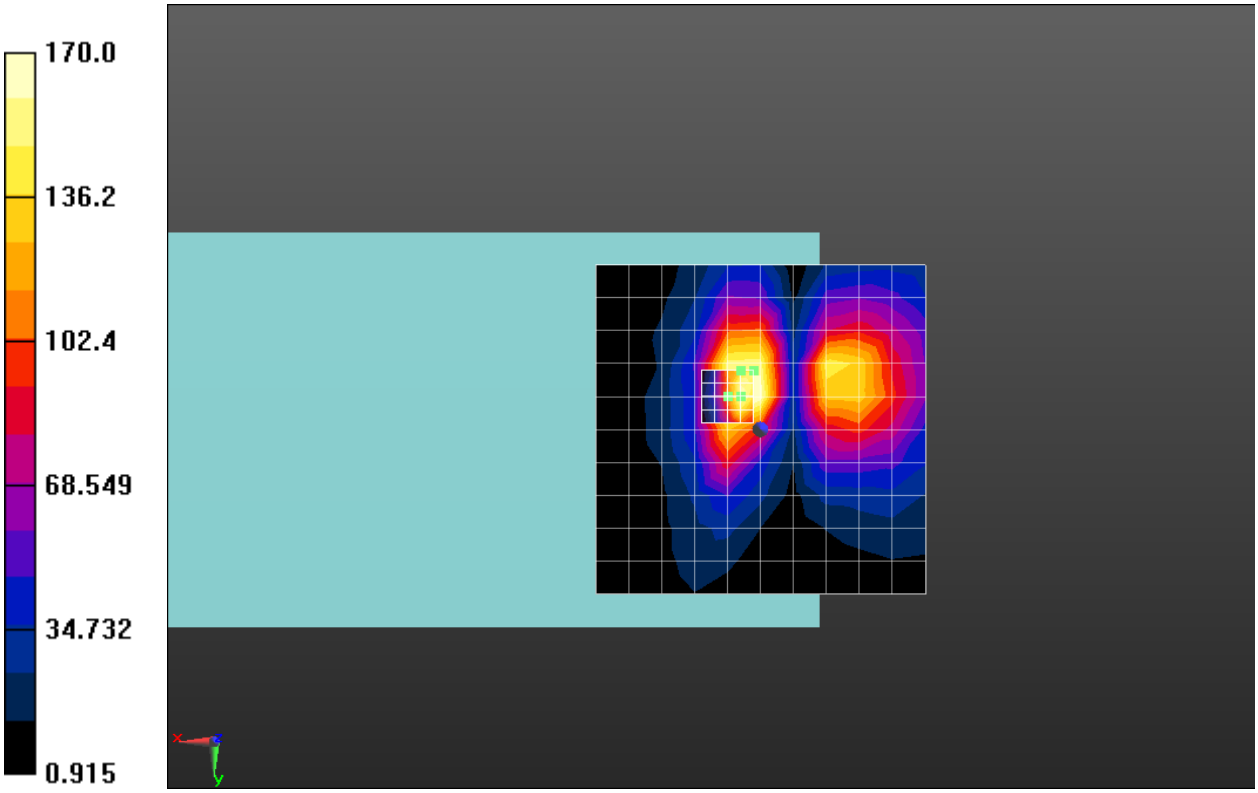
Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 47.19 dB
ABM1 comp = 0.51 dB A/m
BWC Factor = 0.16 dB
Location: 1, -9, 4.4 mm

T-Coil scan/General Scans High Ch./x (longitudinal) 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 46.30 dB
ABM1 comp = 1.35 dB A/m
BWC Factor = 0.16 dB
Location: 3, -9, 4.4 mm



Date/Time: 3/23/2012 10:42:17 AM

Test Laboratory: RIM Testing Services

HAC T-Coil_CDMA1700_Radial_T

DUT: BlackBerry; Type: Sample; Serial: 331D34F3

Communication System: CDMA AWS 1700_1/8th; Frequency: 1711.25 MHz, Frequency: 1732.5 MHz, Frequency: 1753.75 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: AM1DV3 - 3062; ; Calibrated: 1/12/2012
- Sensor-Surface: 0mm (Fix Surface), z = 3.0
- Electronics: DAE3 Sn473; Calibrated: 1/13/2012
- Phantom: HAC T-Coil Test Arch with AMCC; Type: SD HAC P01 BA; Serial: Not Specified
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

T-Coil scan/General Scans Low Ch./y (transversal) 5.0mm 50 x 50/ABM SNR(x,y,z) (11x11x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

T-Coil scan/General Scans Low Ch./y (transversal) 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 53.44 dB
ABM1 comp = -0.73 dB A/m
BWC Factor = 0.16 dB
Location: -7, 5, 4.4 mm

T-Coil scan/General Scans Mid Ch./y (transversal) 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

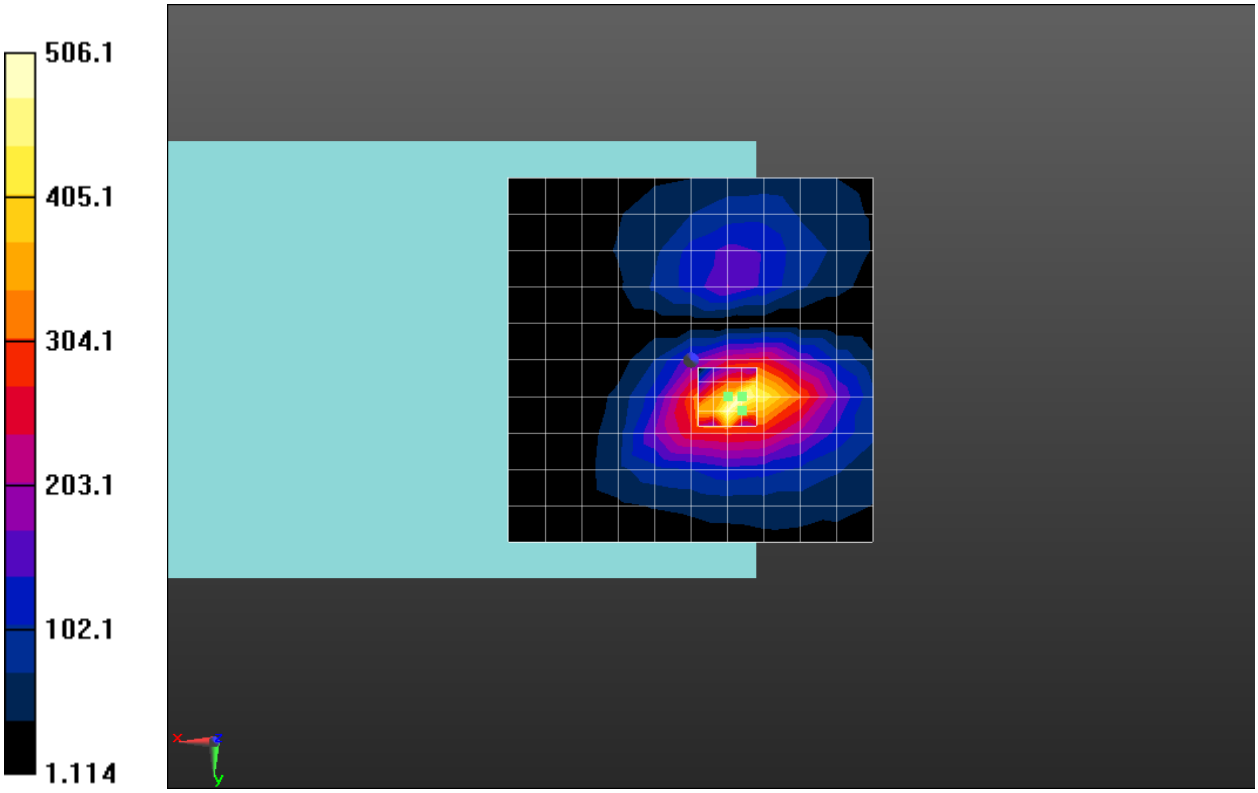
Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 53.60 dB
ABM1 comp = -0.09 dB A/m
BWC Factor = 0.16 dB
Location: -5, 5, 4.4 mm

T-Coil scan/General Scans High Ch./y (transversal) 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 35.28
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 53.76 dB
ABM1 comp = -0.65 dB A/m
BWC Factor = 0.16 dB
Location: -7, 7, 4.4 mm



Annex D: Probe/TMFS calibration certificate

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client: RTS (RIM Testing Services)

Certificate No: AM1DV3-3062_Jan12

CALIBRATION CERTIFICATE

Object: AM1DV3 - SN: 3062

Calibration procedure(s): QA CAL-24.v3
Calibration procedure for AM1D magnetic field probes and TMFS in the audio range

Calibration date: January 12, 2012

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	28-Sep-11 (No:11450)	Sep-12
Reference Probe AM1DV3	SN: 3000	17-Aug-11 (No. AM1D-3000_Aug11)	Aug-12
DAE4	SN: 781	20-Apr-11 (No. DAE4-781_Apr11)	Apr-12

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	1050	12-Oct-11 (in house check Oct-11)	Oct-13

	Name	Function	Signature
Calibrated by:	Dimce Iliev	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 13, 2012

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: AM1D-3062_Jan12 Page 1 of 3

References

[1] ANSI C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
[2] DASY5 manual, Chapter: Hearing Aid Compatibility (HAC) T-Coil Extension

Description of the AM1D probe

The AM1D Audio Magnetic Field Probe is a fully shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The pickup coil is compliant with the dimensional requirements of [1]. The probe includes a symmetric low noise amplifier for the signal available at the shielded 3 pin connector at the side. Power is supplied via the same connector (phantom power supply) and monitored via the LED near the connector. The 7 pin connector at the end of the probe does not carry any signals, but determines the angle of the sensor when mounted on the DAE. The probe supports mechanical detection of the surface.
The single sensor in the probe is arranged in a tilt angle allowing measurement of 3 orthogonal field components when rotating the probe by 120° around its axis. It is aligned with the perpendicular component of the field, if the probe axis is tilted nominally 35.3° above the measurement plane, using the connector rotation and sensor angle stated below.
The probe is fully RF shielded when operated with the matching signal cable (shielded) and allows measurement of audio magnetic fields in the close vicinity of RF emitting wireless devices according to [1] without additional shielding.

Handling of the item

The probe is manufactured from stainless steel. In order to maintain the performance and calibration of the probe, it must not be opened. The probe is designed for operation in air and shall not be exposed to humidity or liquids. For proper operation of the surface detection and emergency stop functions in a DASY system, the probe must be operated with the special probe cup provided (larger diameter).

Methods Applied and Interpretation of Parameters

- *Coordinate System:* The AM1D probe is mounted in the DASY system for operation with a HAC Test Arch phantom with AMCC Helmholtz calibration coil according to [2], with the tip pointing to "southwest" orientation.
- *Functional Test:* The functional test preceding calibration includes test of
  Noise level
  RF immunity (1kHz AM modulated signal). The shield of the probe cable must be well connected.
  Frequency response verification from 100 Hz to 10 kHz.
- *Connector Rotation:* The connector at the end of the probe does not carry any signals and is used for fixation to the DAE only. The probe is operated in the center of the AMCC Helmholtz coil using a 1 kHz magnetic field signal. Its angle is determined from the two minima at nominally +120° and –120° rotation, so the sensor in the tip of the probe is aligned to the vertical plane in z-direction, corresponding to the field maximum in the AMCC Helmholtz calibration coil.
- *Sensor Angle:* The sensor tilting in the vertical plane from the ideal vertical direction is determined from the two minima at nominally +120° and –120°. DASY system uses this angle to align the sensor for radial measurements to the x and y axis in the horizontal plane.
- *Sensitivity:* With the probe sensor aligned to the z-field in the AMCC, the output of the probe is compared to the magnetic field in the AMCC at 1 kHz. The field in the AMCC Helmholtz coil is given by the geometry and the current through the coil, which is monitored on the precision shunt resistor of the coil.

AM1D probe identification and configuration data

Item	**AM1DV3** Audio Magnetic 1D Field Probe
Type No	SP AM1 001 BA
Serial No	**3062**

Overall length	296 mm
Tip diameter	6.0 mm (at the tip)
Sensor offset	3.0 mm (centre of sensor from tip)
Internal Amplifier	20 dB

Manufacturer / Origin	Schmid & Partner Engineering AG, Zürich, Switzerland
Manufacturing date	October 30, 2008
Last calibration date	April 07, 2011

Calibration data

Connector rotation angle	(in DASY system)	**61.0 °**	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**0.18 °**	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	**0.00741 V / (A/m)**	+/- 2.2 % (k=2)

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client: RTS (RIM Testing Services)

Certificate No: TMFS_1003_Nov11

CALIBRATION CERTIFICATE

Object / Identification: TMFS – SN: 1003

Calibration procedure(s): QA CAL-24.v2
Calibration procedure for AM1D magnetic field probes and TMFS in the audio range

Calibration date: November 30, 2011

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The calibrations have been conducted in the R&D laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	28-Sep-11 (No:11450)	Sep-12

Secondary Standards	ID #	Cal / Check Date	Scheduled Calibration Check
AMCC	1050	12-Oct-11 (in house check Oct-11)	Oct-13
Reference Probe AM1DV2	SN: 1008	18-Jan-11 (No. AM1D-1006_Jan11)	Jan-12
AMMI Audio Measuring Instrument	1052	20-Sep-10 (in house check Sep-10)	Sep-12
Agilent WF Generator 33120A	MY40005266	12-Oct-11 (in house check Oct-11)	Oct-13

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Fin Bomholt	R&D Director	

Issued: December 5, 2011

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

References

[1] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
[2] DASY manual, Chapter "Hearing Aid Compatibility (HAC) T-Coil Extension"

Methods Applied and Interpretation of Parameters

- *Coordinate System:* The TMFS is mounted underneath the HAC Test Arch touching equivalently to a wireless device according to [2] 29.2.2.: In "North" orientation, the TMFS signal connector is directed to the north, with x and y axes of TMFS and Test arch coinciding (see fig. 1). The rotational symmetry axis of the TMFS is aligned to the center of the HAC test Arch. For East, South and West configuration, the TMFS has been rotated clockwise in steps of 90°, so the connector looks into the specified direction. The evaluation of the radial direction is referenced to the device orientation (x equivalent to South direction).

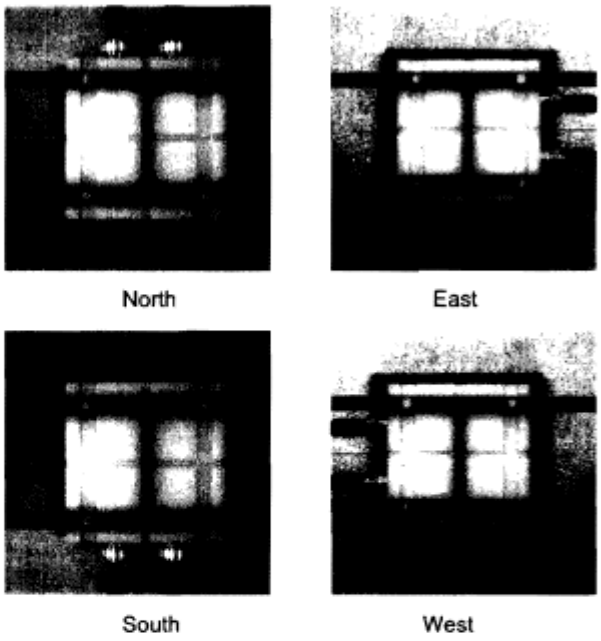


Fig. 1 TMFS scanning measurement configurations

- *Measurement Plane:* In coincidence with standard [1], the measurement plane (probe sensor center) is selected to be at a distance of 10 mm above the the surface of the TMFS touching the frame. The 50 x 50 mm scan area is aligned to the center of the unit. The scanning plane is verified to be parallel to the phantom frame before the measurements using the predefined "Geometry and signal check" procedure according to the predefined procedures described in [2].
- *Measurement Conditions:* Calibration of AM1D probe and AMMI are according to [2]. The 1 kHz sine signal for the level measurement is supplied from an external, independent generator via a BNC cable to TMFS IN and monitored at TMFS OUT with an independent RMS voltmeter or Audio Analyzer. The level is set to 0.5 Vrms and monitored during the scans.
- For the *frequency response*, a higher suppression of the background ambient magnetic field over the full frequency range was achieved by placing the TMFS in a magnetically shielded box. The AM1D probe was fixed without robot positioner near the axial maximum for this measurement. The background noise suppression was typ. 30 dB at 100 Hz (minimum) and 42 dB at 1 kHz. The predefined multisine signal (48k_multisine_50-10000_10s.wav) was used and evaluated in the third-octave bands from 100 Hz to 10000 Hz.

1 Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.6.2 (482)
DASY PP Version	SEMCAD	V14.4.5 (3634)
Phantom	HAC Test Arch	SD HAC P01 BA, #1002
Distance TMFS Top - Probe Centre	10 mm	
Scan resolution	dx, dy = 5 mm	area = 50 x 50 mm
Frequency	for field scans	1 kHz
Signal level to TMFS	for field scans	500 mV RMS
Signal	for frequency response	multisine signal 50-10000 Hz, each third-octave band

Table 1: System configuration

2 Axial Maximum Field

Configuration	East	South	West	North	Subset Average	Average
Axial Max	-20.36	-20.35	-20.38	-20.35		**-20.36**
TMFS Y Axis 1st Max	-26.11	-26.06	-26.11	-26.07		
TMFS Y Axis 2nd Max	-26.15	-26.15	-26.29	-26.16		
Longitudinal Max Avg	-26.13	-26.11	-26.20	-26.12	**-26.14**	
TMFS X Axis 1st Max	-25.95	-25.99	-26.02	-25.94		
TMFS X Axis 2nd Max	-25.91	-25.89	-25.95	-25.95		
Transversal Max Avg	-25.93	-25.94	-25.99	-25.95	**-25.95**	
Radial Max			-26.09			**-26.04**

Table 2: Axial and radial field maxima measured with probe center at 10mm distance in dB A/m

The maximum was calculated as the average from the values measured in the 4 orientations listed in table 2.

Axial Maximum **-20.36 dB A/m** (+/- 0.33dB, k=2)

3 Radial Maximum Field

In addition, the average from the 16 maxima of the radial field listed in table 2 (measured at 10mm) was calculated:

Radial Maximum **-26.04 dB A/m**

4 Appendix

4.1 Frequency response

Max. deviation measured, relative to 1 kHz: **min. -0.03, max. 0.01 dB**

Frequency [Hz]	Response [dB]
100	0.01
125	0.00
160	-0.03
200	0.00
250	-0.01
315	0.00
400	0.00
500	0.00
630	0.00
800	0.00
1000	**0.00**
1250	-0.01
1600	-0.01
2000	-0.01
2500	-0.01
3150	-0.01
4000	-0.02
5000	-0.02
6300	-0.03
8000	-0.03
10000	-0.03

Table 3: Frequency response

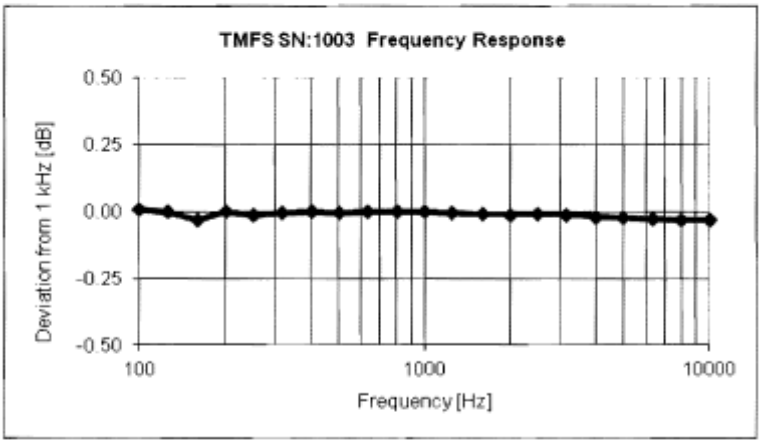


Fig. 2 Frequency response 100 to 10'000 Hz

4.2 Field plots

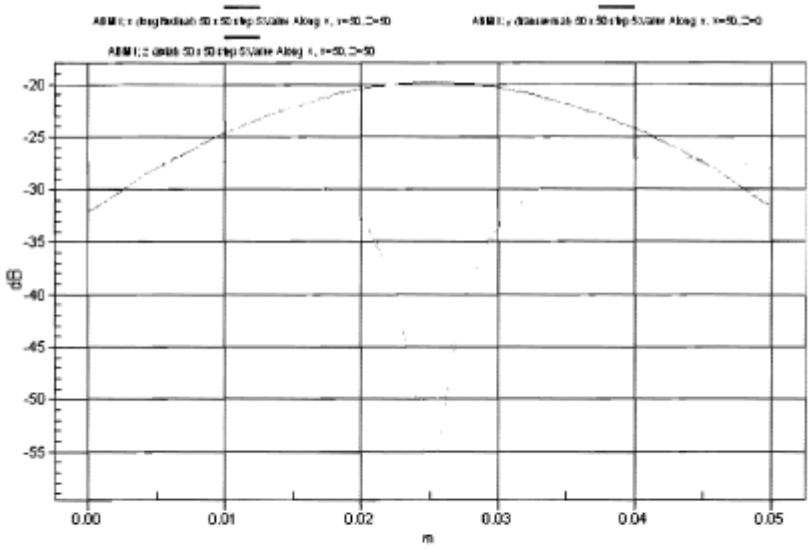


Fig. 3: Typical 2D field plots for x (red), y (green) and z (blue) components

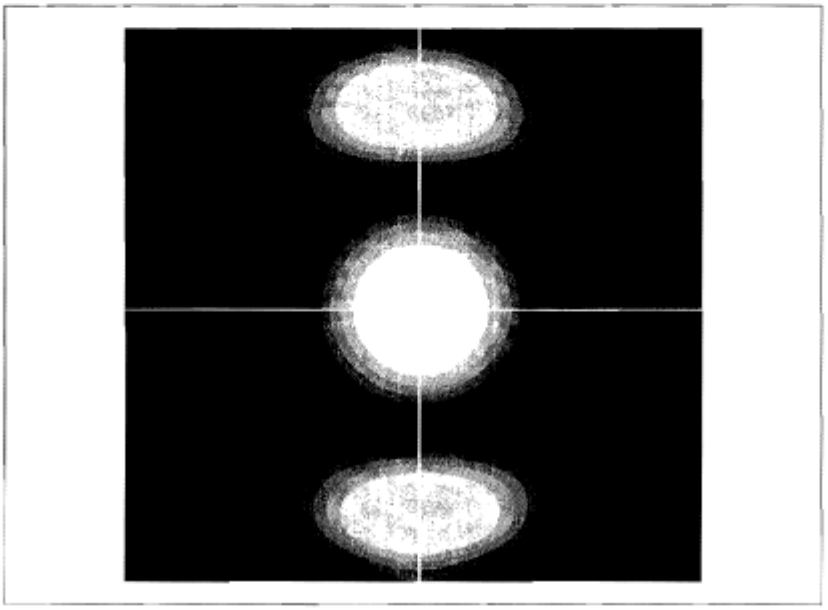


Fig. 4: Superponed field plots of z (axial), x and y radial magnetic field, 50 x 50 mm, individual scaling: white = max. field level, black = -4dB below max. The lines show the position of the 2D field plot of figure 3.