Technical Report

Test Site Correlation for H Field Measurement in Semi-Anechoic Chamber(SAC)

Support Test Report No.	**:**	BTL-FICP-2-1601C013,
		BTL-FICE-2-1601C013
Relevant Standard(s)	**:**	47 CRF 15.209
Measurement Procedure:	**:**	ANSI C63.10-2013
		KDB 937606

Date of Test	**:**	Feb. 17, 2016
Test Location	**:**	No.3, Jinshagang 1st Road, Shixia,
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1. GENERAL INFORMATION

1.1 PURPOSE

The purpose of this document is to proof that the H Field measurement result of the fundamental emission as reported in Test Report No.: BTL-FICP-2-1601C013, BTL-FICE-2-1601C013 are compliant with the 47 CFR 15.209 requirements for the certification of licence-exempt 15C Intentional Radiator by the way of the correlation of the H Field measurement in the FCC listed semi-anechoic chamber (SAC) site in 3m distance and an open field site measurement in 3 m and 30 m distance at the frequency of 145.2 kHz.

The measurement was performed with set-up consisting of a single turn loop antenna with a diameter of 0.85 m.

The radiated H fieldstrength at 145.2kHz generated by this set-up was measured with the same test setup as used in Test Report No.: BTL-FICP-2-1601C013, BTL-FICE-2-1601C013 in the SAC in 3 m distance first, and then repeated at the open field site in 3 m and 30 m distance.

1.2 REGULATION AND PROCEDURE

Procedure: ANSI C63.10-2013

LIMITS
FCC 15.31 Measurement standards.
(d) Field strength measurements shall be made, to the extent possible, on an open field site. Test sites other than open field sites may be employed if they are properly calibrated so that the measurement results correspond to what would be obtained from an open field site.
KDB 937606:
Test sites other than open field sites, such as anechoic chambers, may be employed only if calibrated so that the measurements correspond to those obtained on an open field site. Since there are no standards for validation of test sites below 30 MHz, calibration must be obtained by other means such as performing measurements at an alternate test site and comparing to measurements obtained on an open field site. Statistical analysis of the measurement data from several similar devices may be required to show correlation between the measurements from the alternate test site and an open field test site. The limit distance below 30 MHz is 30 meters or more and in most anechoic chambers it is not possible to perform measurements at such distances. This may make it difficult to show correlation between measurements made on an open field site at distances greater than the dimensions of the anechoic chamber and measurements made at the same distance in the anechoic chamber without further analysis and comprehensive testing.

2. MEASUREMENT DESCRIPTION

2.1 TEST PROCEDURES IN THE SAC

The measurement was performed in the semi-anechoic chamber at a test distance of 3 m.
A calibrated loop antenna as specified in ANSI C63.10 clause 4.3.2 was positioned with its plane vertical at the test distance from the field generating loop antenna and rotated about its vertical axis for maximum response at each azimuth about the field generating loop antenna. The center of the calibrated loop antenna was 1 m above the ground.

Radiated Emissions Test Characteristics	
Frequency range	145.2kHz
Test distance	3m
Test instrumentation resolution bandwidth	200Hz
Receive antenna height	1m

2.2 TEST PROCEDURES IN THE OPEN FIELD SITE

The measurement was performed in the open field site at a test distance of 3 m, 30m.
A calibrated loop antenna as specified in ANSI C63.10 clause 4.3.2 was positioned with its plane vertical at the test distance from the field generating loop antenna and rotated about its vertical axis for maximum response at each azimuth about the field generating loop antenna. The center of the calibrated loop antenna was 1 m above the ground.

Radiated Emissions Test Characteristics	
Frequency range	145.2kHz
Test distance	3 m, 30m
Test instrumentation resolution bandwidth	200Hz
Receive antenna height	1m

3. CORRELATION OF RESULTS

3.1 TEST RESULT SAC

Frequency range(kHz)	Detector	Distance(m)	Result(dBµV/m)
145.2	AV	3	27.8

3.2 TEST RESULT OPEN FIELD SITE

Frequency range(kHz)	Detector	Distance(m)	Result(dBµV/m)
145.2	AV	3	25.2
145.2	AV	30	0.5

3.3 TEST RESULT DIFFERENCE OF THE RADIATED EMISSION MEASUREMENT

Frequency range(kHz)	Detector	Distance(m)	F_{SAC}(dBµV/m)	F_{open}(dBµV/m)	f_C(dB)
145.2	AV	3	27.8	25.2	2.6

The difference of the radiated emission measurement from the open field site and the SAC at 3 m is thecorrelation factor f_C.

$f_C = F_{open} - F_{SAC}$

f_C is correlation factor from SAC to open field site field strength
F_{open} measured field strength at open field site
F_{SAC} measured field strength at SAC

This correlation factor has to be applied to the SAC measurement result to get the open field result.

$F_{open} = F_{SAC} + f_C$

4. REFINED FIELD STRENGTH CALCULATION FOR THE 145.2 KHZ RESULT ACC. TO TEST REPORT NO.: BTL-FICP-2-1601C013, BTL-FICE-2-1601C013

4.1 1ST APPROACH - EXTRAPOLATION FROM THE MEASUREMENT OF A SINGLE POINT
4.1.1 PROCEDURE
ANSI C63.10-2013: 6.4.4.2 Extrapolation from the measurement of a single point

$$FS_{limit} = FS_{max} - 40 \log \frac{d_{limit}}{d_{measure}}$$

where

FS_{limit} is the calculation of field strength at the limit distance, expressed in dBµV/m

FS_{max} is the measured field strength, expressed in dBµV/m at $d_{measure}$

$d_{measure}$ is the distance of the measurement point from the EUT

d_{limit} is the reference distance or the distance of the λ/2π point

Taking into account the additional SAC correlation factor:

$$FS_{limit} = FS_{max} + fc - 40 \log \frac{d_{limit}}{d_{measure}}$$

4.1.2 RESULT FOR 1ST APPROACH

Frequency	Detector	3m Result SAC	Distance Correction	Correlation factor	300m Result	300m Limit	Margin
(kHz)	-	dB(µV/m)	dB	dB	dB(µV/m)	dB(µV/m)	dB
145.2	AV	27.8	-80	-2.6	-54.8	24.36	79.16

$f_C = F_{open} - F_{SAC}$

f_C is correlation factor from SAC to open field site field strength

F_{open} measured field strength at open field site

F_{SAC} measured field strength at SAC

4.2 2ND APPROACH-EXTRAPOLATION FIELD STRENGTH FROM TWO POINT MEASUREMENT
4.2.1 PROCEDURE
A. ANSI C63.10-2013 § 6.4.4.4 Calculation of extrapolation factor from two points

$$N = 20 \, \frac{\log (E_1/E_2)}{\log (d_1/d_2)}$$

where

E_1 is the field strength at the measurement distance closest to the radiating source, expressed in μ V/m

E_2 is the field strength at the measurement distance farthest from the radiating source, expressed in µV/m

d_1 is the measurement distance closest to the radiating source

d_2 is the measurement distance farthest from the radiating source

N is the distance extrapolation factor in dB/decade of distance. The field strength at the limit distance shall then be calculated using the methods and formula described in 6.4.4.7.

If measurements of two or more points at distances greater than λ/2π are made, then it is not necessary to evaluate the field strength at distances closer than λ/2π or to determine the rate of decay of the field strength within the λ/2π boundary.

Frequency	E$_1$ open field site at 3m		E$_2$ open field site at 30 m		N
(kHz)	dBµV/m	μ V/m	dBµV/m	μ V/m	dB
110	25.2	331.13	0.5	1.122	-24.7

B. ANSI C63.10-2013 § 6.4.4.7 Calculating field strength at the limit distance

$$FS_{limit} = FS_{max} - N \log \frac{d_{measure}}{d_{limit}}$$

where

N is the value in dB/decade of distance determined using 6.4.4.4 or 6.4.4.5

FS_{limit} is the estimate of field strength at the limit distance, expressed in dBµV/m

FS_{max} is the maximum value of field strength, expressed in dBµV/m, measured during the measurement of the points used for extrapolation

$d_{measure}$ is the distance of the measurement point of FS_{max} from the radiating source

d_{limit} is the limit reference distance

Taking into account the additional SAC correlation factor:

$$FS_{limit} = FS_{max} + fc - N \log \frac{d_{measure}}{d_{limit}}$$

4.2.2 RESULT FOR 2ND APPROACH

Frequency	Detector	3m Result SAC	Distance Correction	Correlation factor	300m Result	300m Limit	Margin
(kHz)	-	dB(µV/m)	dB	dB	dB(µV/m)	dB(µV/m)	dB
145.2	AV	27.8	-49.4	-2.6	-24.2	24.36	48.56

5. SUMMARY

The correlation of the SAC and open field site measurement results at 145.2 kHz and 3 m distance shows that the SAC measurement result is slightly higher than the result of the open field site measurement.

Depending on the approach (single point measurement with conservative 40 dB/decade extrapolation or two-point measurement with calculated extrapolation factor) and taking into account the correlation factor between SAC and open field site the measured fundamental H field strength from Test Report No.: BTL-FICP-2-1601C013, BTL-FICE-2-1601C013 for 145.2 kHz can be refined resulting a final result being safely below specified limits.

6. TEST EQUIPMENT

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Active Loop Antenna	R&S	HFH2-Z2	830749/020	Sep. 07, 2016
2	EMI Test Receiver	R&S	ESCI	100895	Mar. 28, 2016

7. PHOTOGRAPHS OF TEST SETUP

H field measurement in SAC at 3 m distance

H field measurement at open field site at 3 m distance	H field measurement at open field site at 30 m distance