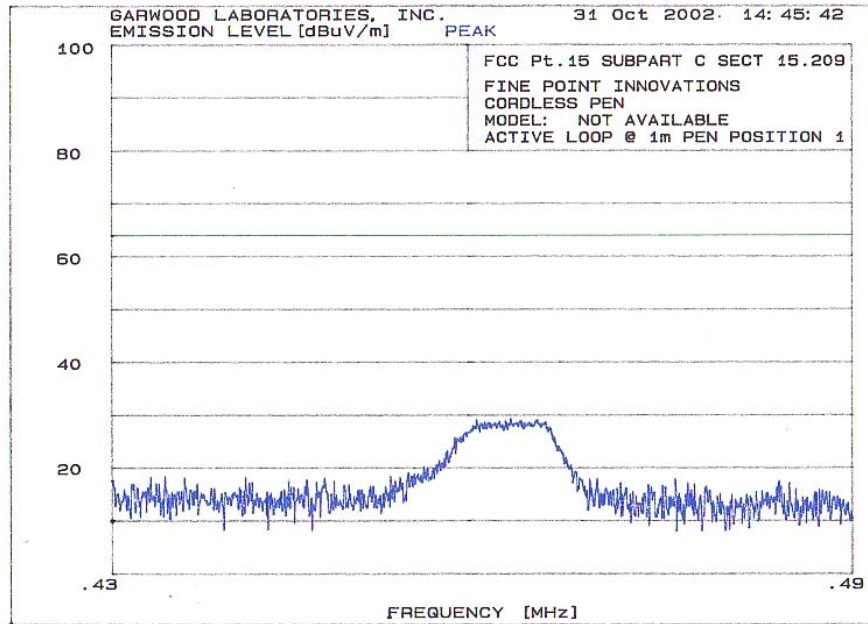


Retest of Cordless Pen Using Loop Antenna

Field Strength of the Fundamental:



Test Requirement: Field Strength of Emissions from Intentional Radiators (Reference: FCC PT.15, Subpart C, §15.209)

<i>Frequency (MHz)</i>	<i>Antenna Polarity (V or H)</i>	<i>Corrected Reading (dBuV/m)</i>	<i>Corrected Reading (uV/m)</i>	<i>FCC Limit 1 meter (uV/m)</i>
0.460	N/A	29.2	28.8	1565

Judgment: The EUT, Cordless Pen, complied with the specification requirements.

Test Details:

Procedure used to determine the limit at 1m:

For EUT operating frequency 460kHz:

Limit ($\mu\text{V/m}$) = $2400 / 460 = 5.22\mu\text{V/m}$ @ 300m

Measurements were performed at close-in distances and the limit L2 corresponding to the close-in distance d2 was determined by applying the following relation:

$$L2 = L1 (d1 / d2)$$

Where L1 is the specified limit in $\mu\text{V/m}$ at the distance d1.

Close in Limit ($\mu\text{V/m}$) = $5.22\mu\text{V/m} (300\text{m} / 1\text{m}) = 1565\mu\text{V/m}$ @ 1m

Close in Limit ($\text{dB}\mu\text{V/m}$) = $63.9\text{dB}\mu\text{V/m}$ @ 1m

Test Details (continued):

The measurements were now performed with a loop antenna; however, the FCC limits are stated in electric field strength ($\mu\text{V/m}$). The following procedure was used to obtain the equivalent electric field when measuring with a loop antenna:

Wave Impedance Z_w :

$$Z_w = |E| / |H|$$

In the far field $Z_w = 377\Omega$ (51.5dB Ω)

In the near field if the source is a magnetic source, then the wave impedance Z_w can be determined by,

$$Z_w = 120 \pi * [r_o / (\sqrt{r_o^2 + 1})]$$

$$\text{where, } r_o = (2 \pi r) / \lambda$$

r = distance from the source

The equivalent electric field can then be determined by,

$$|E| = Z_w * |H|$$

or equivalently in dB

$$|E|_{\text{dB}} = Z_w \text{ dB} + |H|_{\text{dB}}$$

Calculations:

$$r_o = (2 \pi * 1) / 652 = 0.009634$$

$$Z_w = 120 \pi * [0.009634 / (\sqrt{0.009634^2 + 1})] = 3.63\Omega \quad (11.2\text{dB})$$

Loop antenna measurement

$$H(\text{dB}\mu\text{A/m}) = S.A (\text{dB}\mu\text{V}) + \text{Loop Antenna Factor}$$

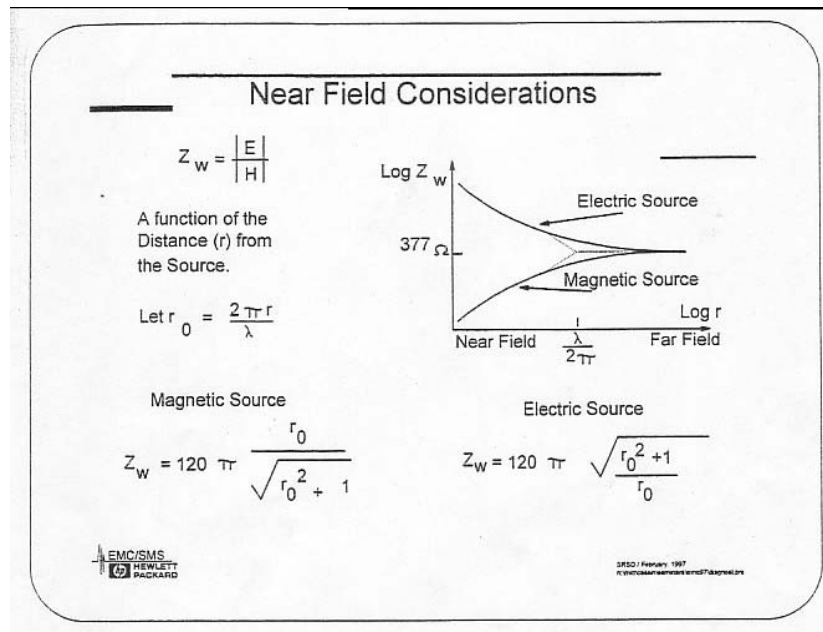
From the relation: $|E|_{\text{dB}} = Z_w \text{ dB} + |H|_{\text{dB}}$

$$E (\text{dB}\mu\text{V/m}) = Z_w \text{ dB} + S.A. (\text{dB}\mu\text{V}) + \text{Loop Antenna Factor}$$

$$E (\text{dB}\mu\text{V/m}) = 11.2 \text{ dB} + 54.1\text{dB}\mu\text{V} + (-36.1\text{dB/m}) = 29.2\text{dB}\mu\text{V/m}$$

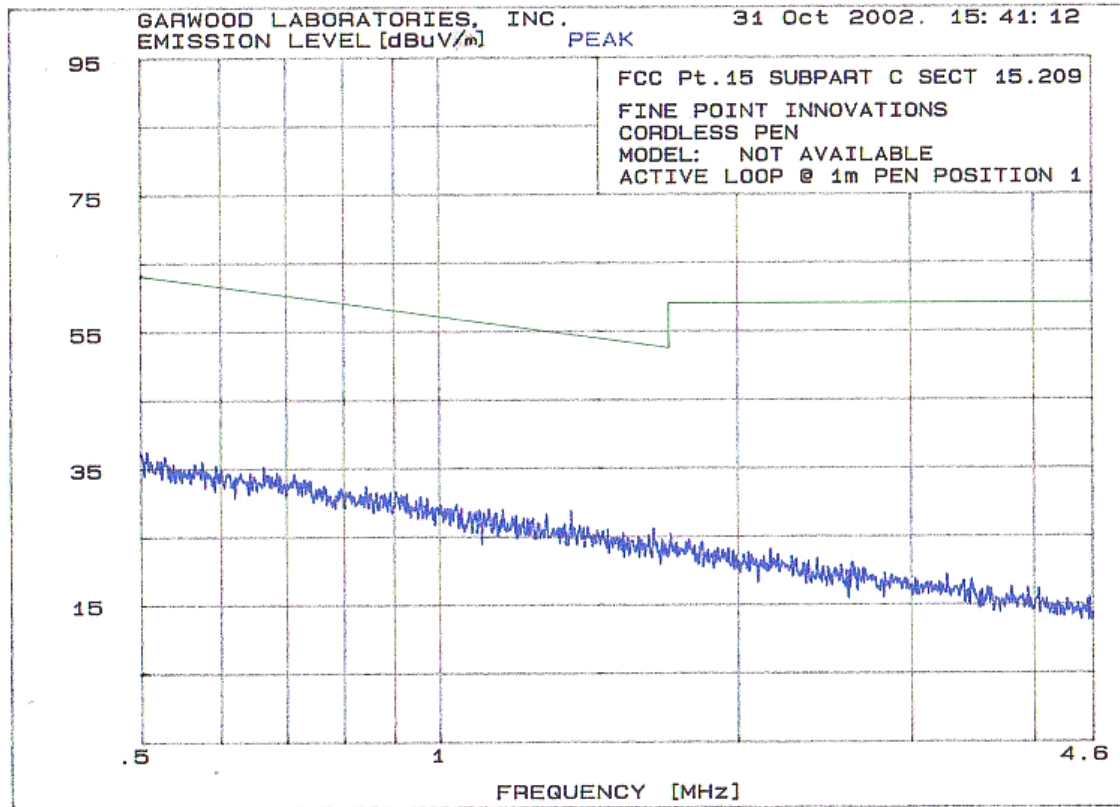
The equivalent electric field strength of the fundamental measured with the loop antenna was 29.2dB $\mu\text{V/m}$.

Reference:



Field Strength of Unwanted Emissions:

The plot below shows compliance with the Field Strength of Unwanted Emissions requirement. The EUT was tested in 3 different orientations (x, y, z-axis) and there were no detectable unwanted emissions.



Band Edge Plot:

The Band-edge plot below shows compliance with §15.205 at 495kHz. The device was operating on its highest operating frequency, which was measured at 488kHz.

