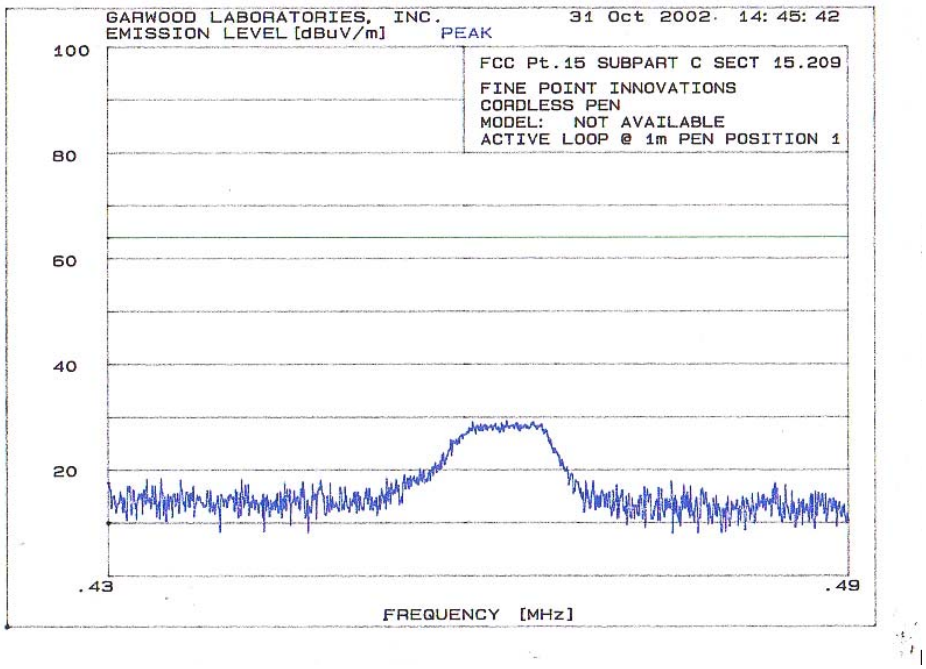
Retest of Cordless Pen Using Loop Antenna

Field Strength of the Fundamental:



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

Frequency (MHz)	*Antenna Polarity (V or H)*	*Corrected Reading (dBµV/m)*	*Corrected Reading (µV/m)*	*FCC Limit 1 meter (µV/m)*
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 (µV/m) = 2400 / 460 = 5.22µV/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 µV/m at the distance d1.

Close in Limit (µV/m) = 5.22µV/m (300m / 1m) = 1565µV/m @ 1m
Close in Limit (dBµV/m) = 63.9dBµV/m @ 1m

Test Details (continued):

The measurements were now performed with a loop antenna; however, the FCC limits are stated in electric field strength (μV/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 $Z_w = 377\Omega$ (51.5dBΩ)

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

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

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

$$|E|_{dB} = Z_{w\,dB} + |H|_{dB}$$

Calculations:

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

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

Loop antenna measurement

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

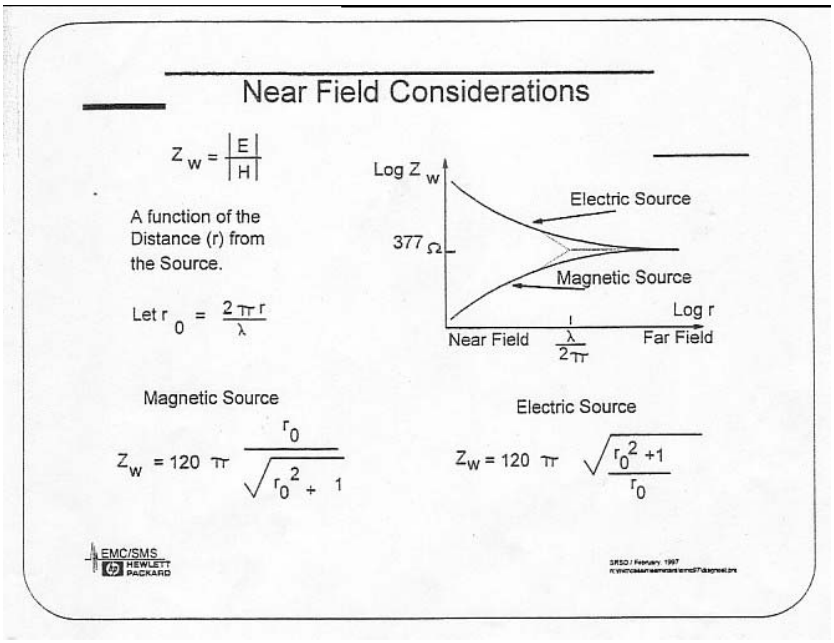
From the relation: $|E|_{dB} = Z_{w\,dB} + |H|_{dB}$

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

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

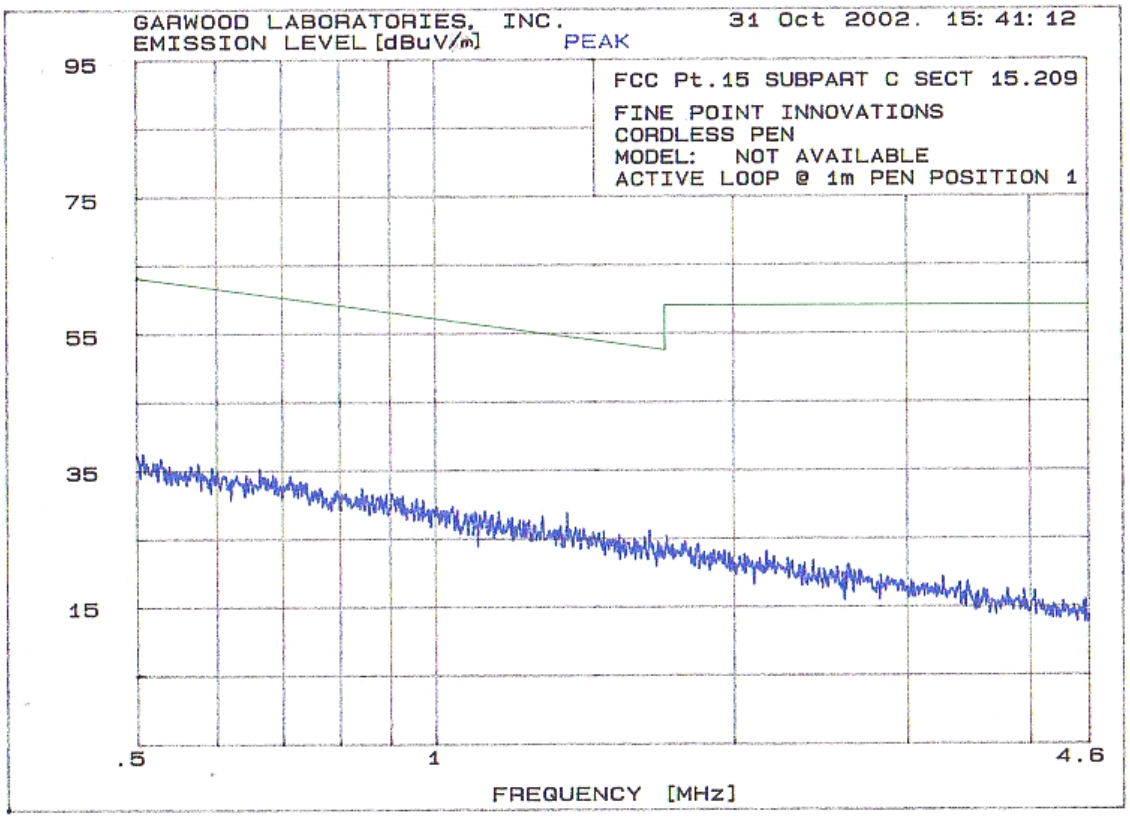
The equivalent electric field strength of the fundamental measured with the loop antenna was 29.2dBμV/m.

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.