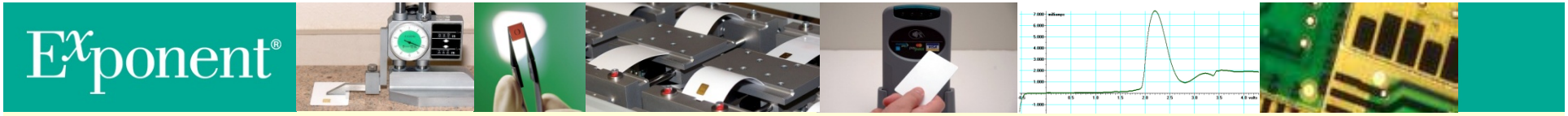

Exponent Comments Concerning Amendment 4: Additional PICC Classes Identification cards – Proximity cards – Part 2: Radio frequency power and signal interface

10 February 2010

Brad McGoran, PE, CSCIP
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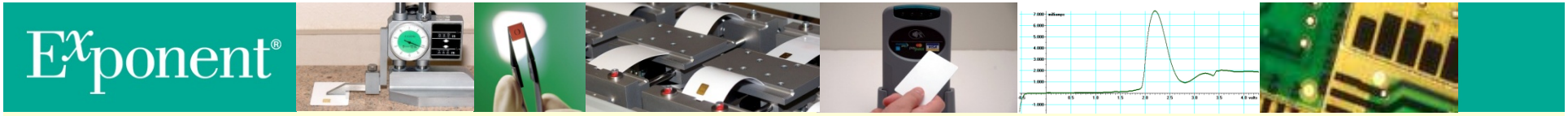
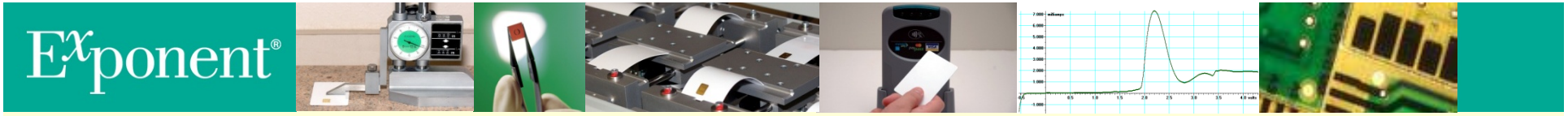


Items Reviewed

- Draft Amendment ISO/IEC 14443-2:2010/FPDAM4
  - Identification cards – Proximity cards – Part 2: Radio frequency power and signal interface
    - Amendment 4: Additional PICC classes
- Draft Amendment ISO/IEC 14443-1:2008/PDAM1
  - Identification cards – Proximity cards – Part 2: Radio frequency power and signal interface
    - Amendment 1: Additional PICC classes
- Draft Amendment ISO/IEC 10373-6
  - Identification cards – Test methods – Part 6: Proximity cards
    - Amendment 2: Additional PICC classes

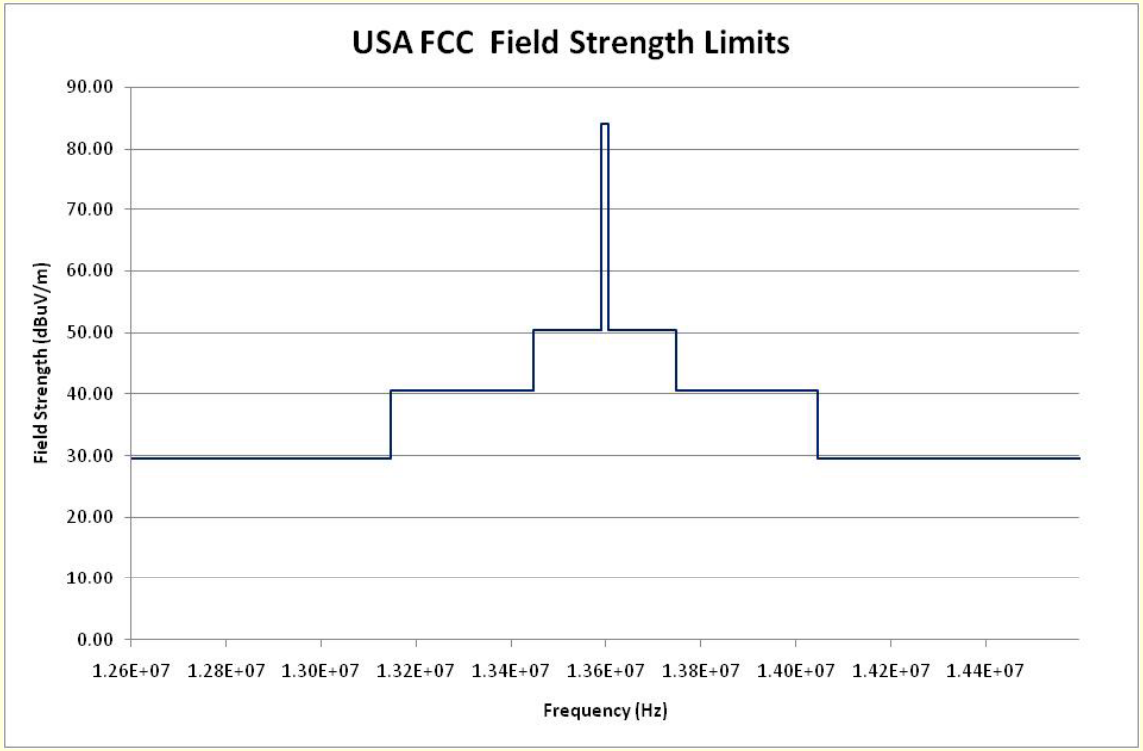


Before/After Amendment

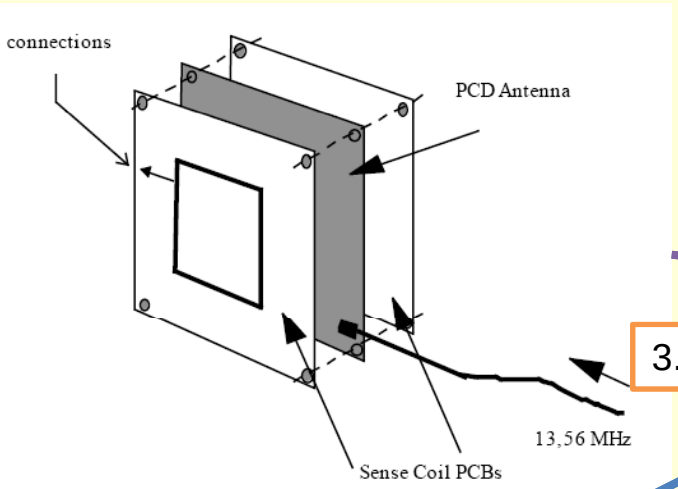
- Previous to Amendment
  - One class of proximity coupling device (PCD) generating a field strength of at least H_{min} and not exceeding H_{max} under un-modulated conditions for a proximity integrated circuit card (PICC)
    - H_{min} = 1.5 A/m; H_{max} = 7.5 A/m
- After Amendment
  - Six classes
    - Measured with Reference PICC 1
      - H_{min} = 1.5 A/m; H_{max} = 7.5 A/m
    - Measured with Reference PICC 2
      - H_{min} = 1.5 A/m; H_{max} = 10 A/m
    - Measured with Reference PICC 3
      - H_{min} = 1.5 A/m; H_{max} = 10 A/m
    - Measured with Reference PICC 4 (optional)
      - H_{min} = 2.0 A/m; H_{max} = 12 A/m
    - Measured with Reference PICC 5 (optional)
      - H_{min} = 2.5 A/m; H_{max} = 14 A/m
    - Measured with Reference PICC 6 (optional)
      - H_{min} = 4.5 A/m; H_{max} = 18 A/m
  - Note: Each class PICC is different size coil and/or field strength

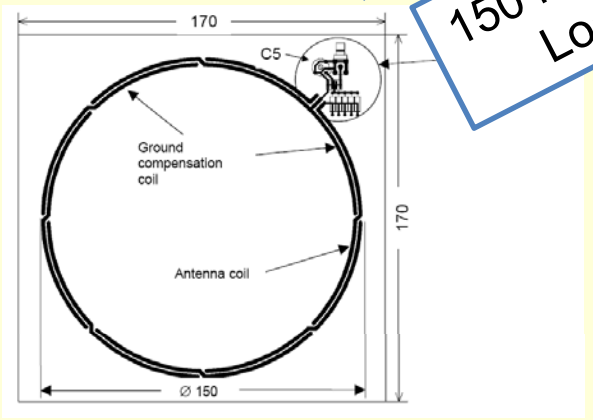
Question: Do the new field strength limits exceed FCC spectrum regulations?

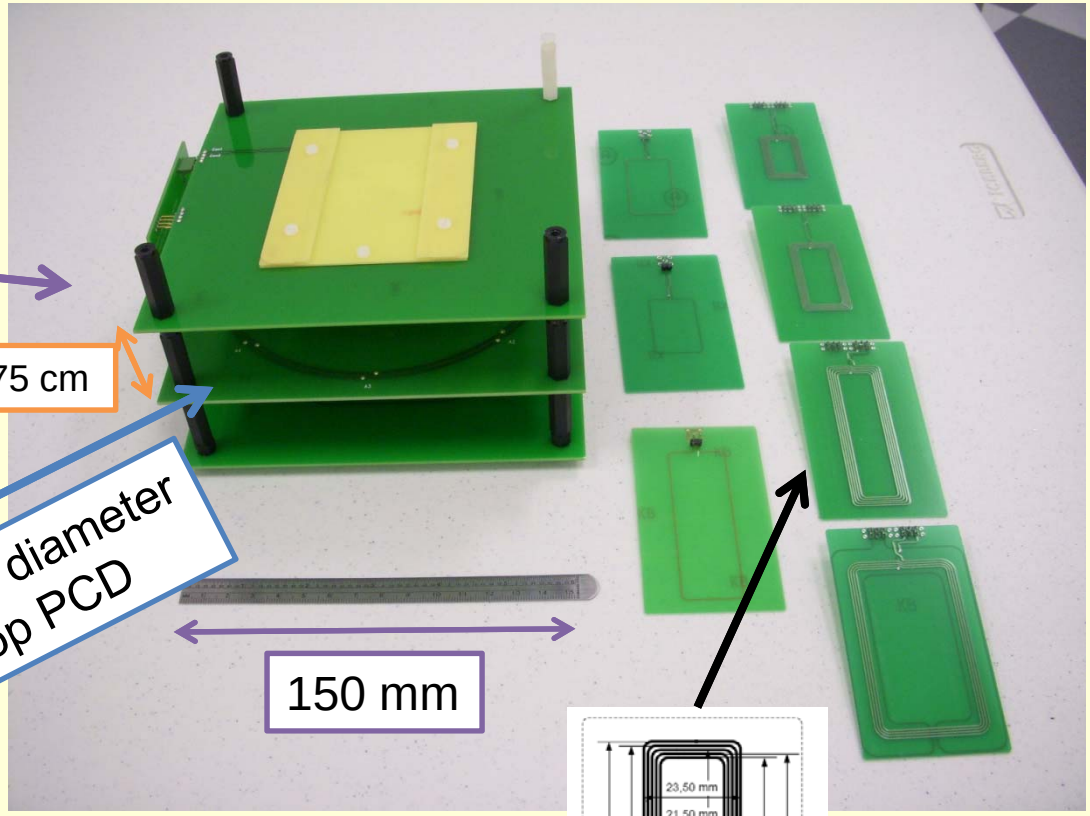
- USA, FCC Part 15.225
  - 13.553-13.567 MHz
    - Less than 15,848 uV/m (84 dBuV/m)
  - 13.410-13.553 MHz/13.567-13.710MHz
    - Less than 334 uV/m (50.5 dBuV/m)
  - 13.110-13.410 MHz/13.710-14.010 MHz
    - Less than 106 uV/m (40.5 dBuV/m)
- USA, FCC Part 15.209
  - From 1.705 MHz to 30 MHz
    - Less than 30 uV/m (29.5 dBuV/m)
- Measured at 30 meters

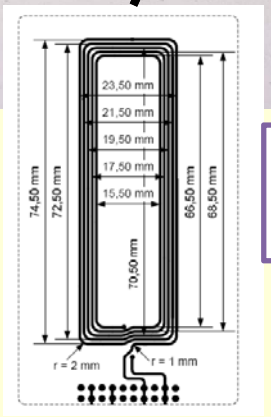


ISO/IEC 10373-6 Test Method to Verify Operation of a PICC or PCD According to ISO/IEC 14443-2

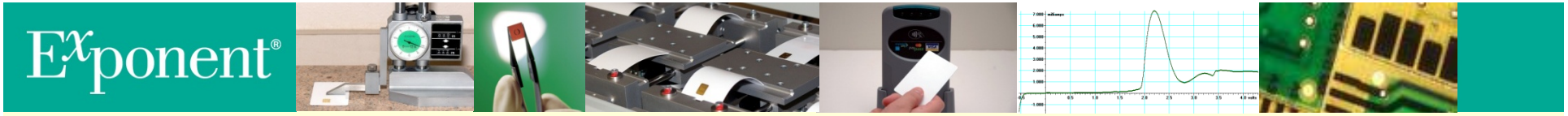








PICC Classes



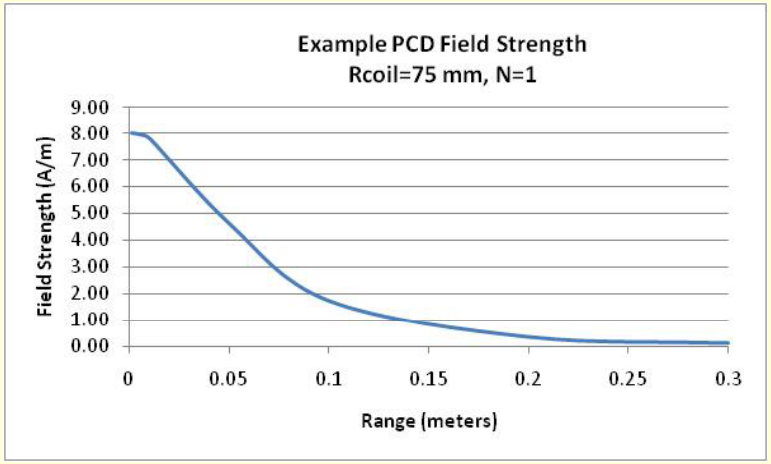
PCD Field Strength & PICC Resonance

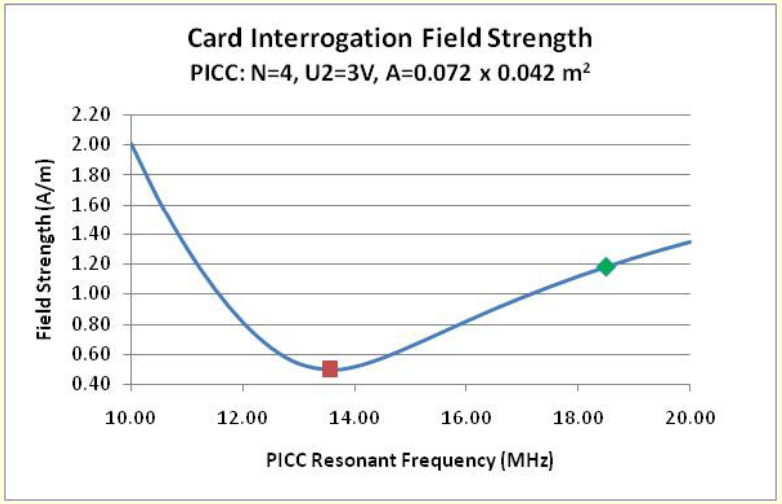
- For inductively coupled RFID systems at 13.56 MHz, the end of the near field radius (λ/2π) is 3.5 meters where the magnetic field strength with respect to range (x) attenuates as $1/x^3$ corresponding to 60 dB per decade of distance using a loop antenna [1].

$$x = \sqrt{\sqrt{\left(\frac{I \cdot N_1 \cdot R^2}{2 \cdot H_{min}}\right)^2} - R^2}$$

- Contactless tests for ISO/IEC 10373-6 occur at both H_{min} and H_{max} because a deviation of the PICC resonant frequency from the transmission frequency for the PCD (i.e. 13.56MHz) leads to higher required transponder interrogation field strengths [1].
  - For example when $\omega_0^2 - \omega^2 \neq 0$

$$H_{min} = \frac{u_2 \cdot \sqrt{\omega^2 \left(\frac{L_2}{R_L} + \frac{R_2}{\omega_0^2 L_2}\right)^2 + \left(\frac{\omega_0^2 - \omega^2}{\omega_0^2} + \frac{R_2}{R_L}\right)^2}}{\omega \mu_0 \cdot A \cdot N}$$

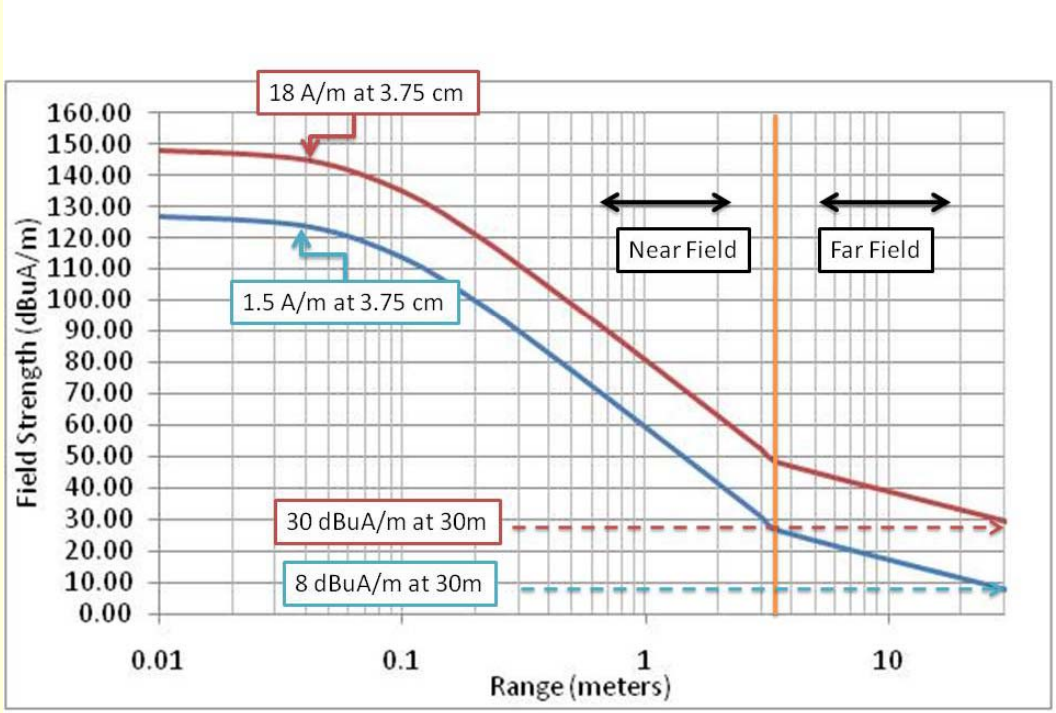




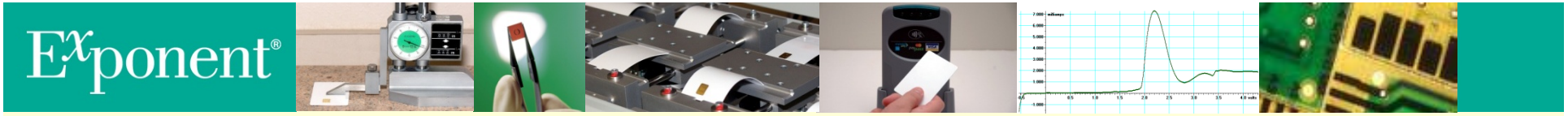
[1] Klaus Finkenzeller. RFID Handbook: Radio-Frequency Identification Fundamentals and Applications. John Wiley & Sons, 2nd Edition 2004.

Field Attenuation

- For loop antennas,
  - In the near field, the magnetic field attenuates 60 dB/decade excluding loop antenna size effects in the very near field
  - In the far field, the magnetic field attenuates 20 dB/decade
- In the far field at 30 meters, in free space, the following conversions can be made
  - 30 dBuA/m = 81.5 dBuV/m = 11,885 uV/m
  - 8 dBuA/m = 59.5 dBuV/m = 944 uV/m
- These values are within the Part 15, 225 FCC limits



Note: Values 1.5 A/m and 18 A/m at 3.75 cm range were chosen because they are the minimum and maximum fields represented in the old and new PICC classes at a range consistent with ISO/IEC 10373 test set up



What this did not take into account and suggested further analysis

- High data rate modulation effects
  - PCD to PICC rates up to 848 kbits/sec
  - ISO14443A or B