

## EMC REFERENCE DATA

Compiled by Henry W. Ott

Revised 2009

No. 1

The following lists some of the more useful EMC formulas and approximations

### Electric Field Coupling

$$V_n = 2\pi f C_{12} R_T V_s$$

### Approximate Capacitances

Wire in bundle	40 pF/ft
Twisted wire	20 pF/ft
Center-Shield RG-58	33 pF/ft
Center-Metal Tray	0.2pF/ft
Pin-pin Amphenol	2 pF
Man-AC power line	2 pF
1/2 W Res., end-end	1.5 pF

### Shielding = Absorption Loss

$$A(\text{dB}) = 9 \left[ \frac{\text{thickness}}{\text{skin depth}} \right]$$

### Skin Depth (inches)

f	Al	Steel
1 MHz	0.003	0.0003
10 MHz	0.001	0.0001
100 MHz	0.0003	0.00008
1000MHz	0.0001	0.00004

### Field Strength Extrapolation

Near field	$1/d^3$
Far field	$1/d$

Near/Far Field transition occurs at  $\lambda/2\pi \approx 1/6$  Wavelength.

@ 100 MHz,  $\lambda/6=0.5\text{m}$

### Common-Mode Emission\*

$$E(\text{V} / \text{m}) = 12.6 \times 10^{-7} f L I / d$$

### Differential-Mode Emission\*

$$E(\text{V} / \text{m}) = 263 \times 10^{-16} f^2 A I / d$$

\*where L=cable length, A = loop area & d = measuring distance

### Radiated Field Strength

AM:  

$$E(\text{V/m}) = \frac{\sqrt{P(\text{Kw})}}{d(\text{Kft})}$$

FM & TV:  $E(\text{V/M}) = 0.6E$  (for AM)

### Power Density to Volts/Meter

$$E(\text{V/m}) = \sqrt{3.77P_{(\mu\text{W}/\text{cm}^2)}}$$

200 V/m	10mW / cm <sup>2</sup>
100 V/m	3mW / cm <sup>2</sup>
20 V/m	100μW / cm <sup>2</sup>
10 V/m	30 μW / cm <sup>2</sup>
2 V/m	1 μW / cm <sup>2</sup>
1 V/m	0.3 μW / cm <sup>2</sup>

### Typical Susceptibility Levels

Minimum	1 V/m
Preferred	3 V/m
Severe Environment	10 V/m

### FCC Emission Limits (Digital Devices)

#### Class A- Commercial/Industrial

30 - 88 MHz	90μV/m @10m
88 - 216 MHz	150μV/m @ 10m
216 - 960 MHz	210μV/m @ 10m
above 960 MHz	300μV/m @ 10m

#### Class B - Residential

30 - 88 MHz	100μV/m @3m
88 - 216 MHz	150μV/m @ 3m
216 - 960 MHz	200μV/m @ 3m
above 960 MHz	500μV/m @ 3m

### Conducted (AC Power Line)

#### Class A- Commercial/ Industrial

0.15 - 0.5 MHz	79 dBμV quasi-peak 66 dBμV average
0.5 - 30 MHz	73 dBμV quasi-peak 60 dBμV average

#### Class B- Residential

0.15 - 0.5 MHz	66 - 56 dBμV quasi-peak 56 - 46 dBμV average
0.5 - 5 MHz	56 dBμV quasi-peak 46 dBμV average
5 - 30 MHz	60 dBμV quasi-peak 50 dB average