

Measuring Radiofrequency and Microwave Radiation from Varying Signal Strengths

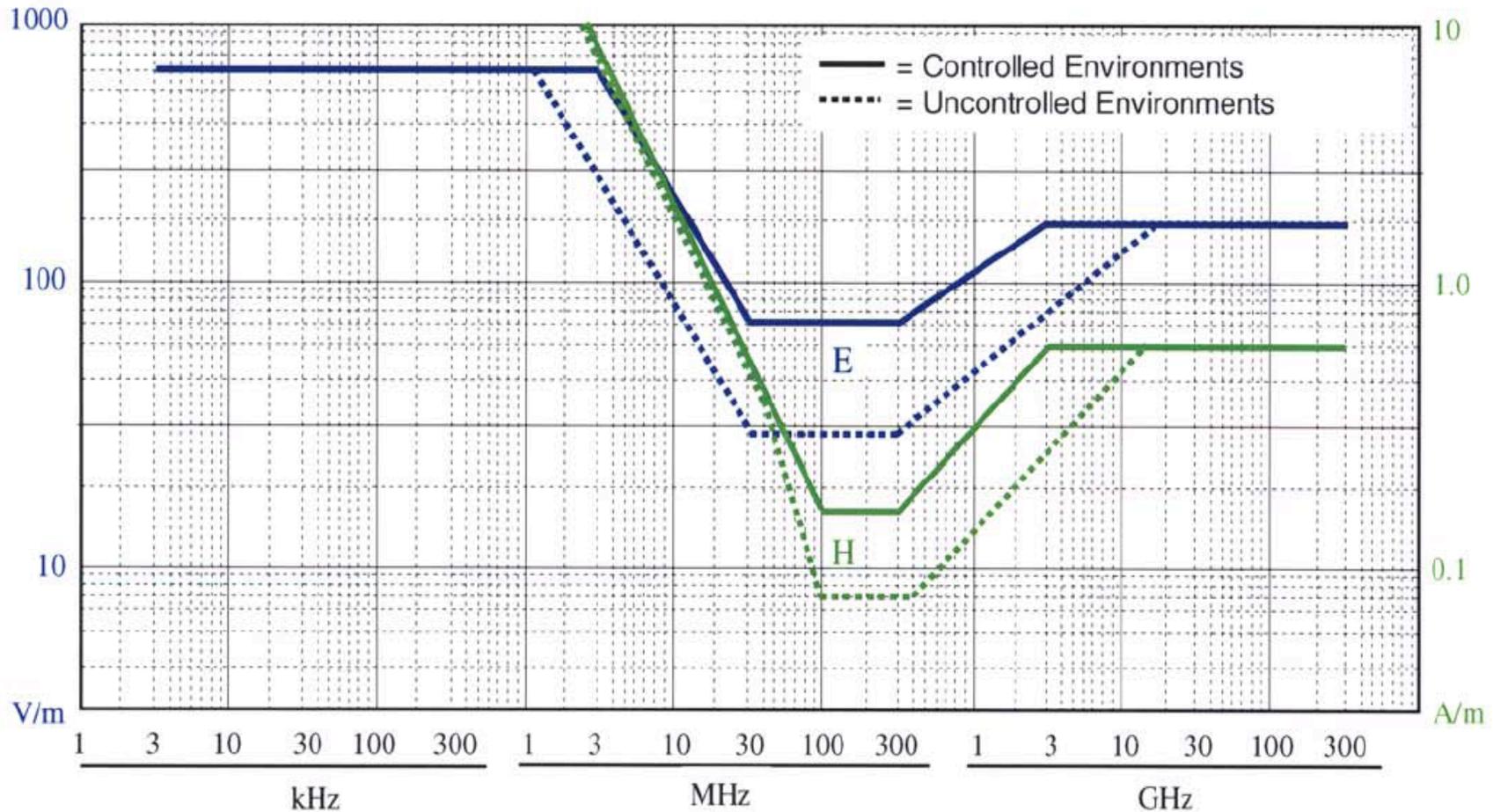
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Limits and Guidelines

- OSHA
 - From 10 MHz to 100 GHz 10 mW/cm² - 0.1 hr
- FCC
 - Varies with frequency range
 - For occupational worker and general public
- IEEE
- ACGIH
 - Both also vary with frequency

Typical Variable Standard (IEEE) Frequency Dependent



FCC Standard 47 CFR 1.1310

Limits for Maximum Permissible Exposure (MPE) Occupational Exposure

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6

f = frequency in MHz

* = Plane-wave equivalent power density

Compliance Follows Unity Rule

$$E_T = \sum_{i=1}^n \frac{p_i}{r_i} < 1$$

Where E_T

E_T total exposure

p_i power measured source i

r_i regulatory requirement at power i

Multiple Sources Contribute



Types of RF Signals

- Continuous output
 - Signal emitted at all times
- Pulsed output
 - Can be at regular intervals
 - Weather radar
- Irregular output
 - Police, ambulance, etc.

Interfering Radiations

- Wireless LAN
- Wi-Fi Hotspots
- Cell phones, towers
- Radio towers
- Security radios
- Ambulance, Fire, Police
- HDTV – high power
- Hospitals
- HVAC systems
- Elevator controls
- Cleaning equipment
- Light ballasts
- Paper shredders

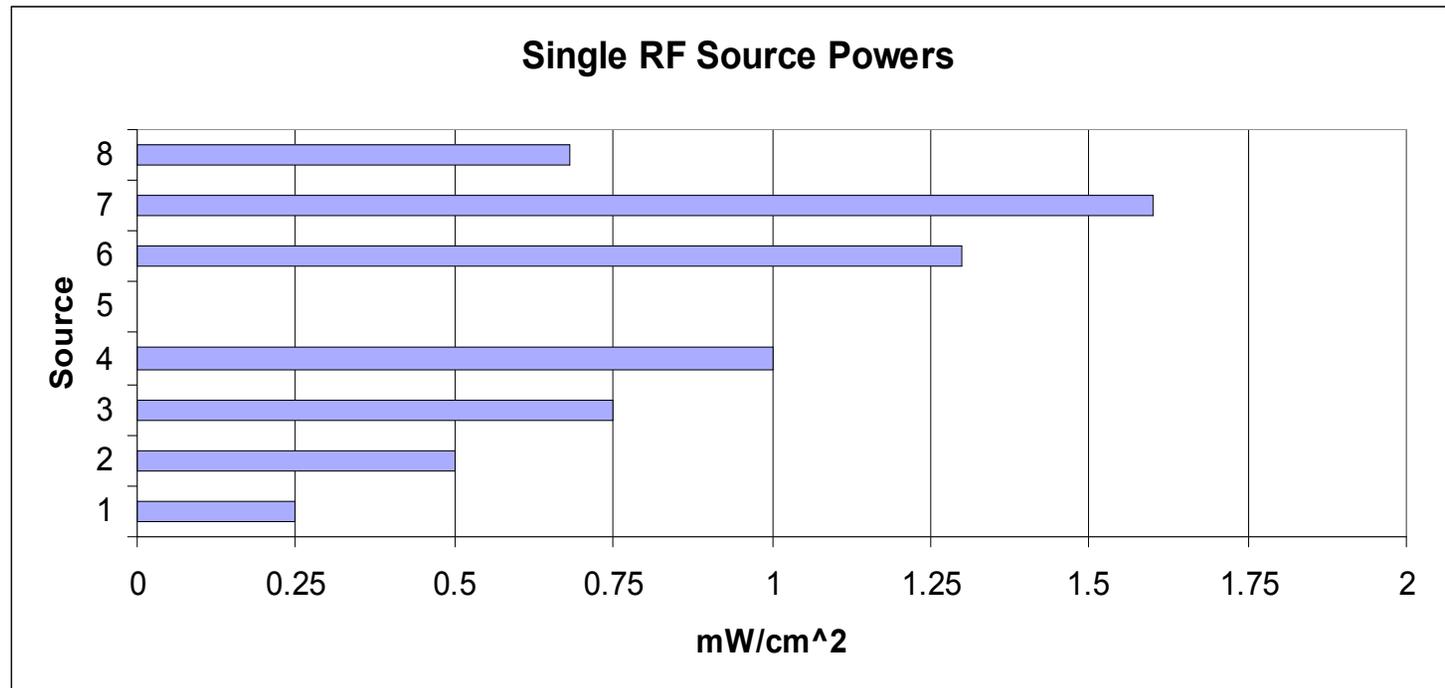
Different Frequencies Different Powers

- Wireless LAN 1 – 5 W
- Wi-Fi Hotspots 2 – 10 W
- Cell phones, towers 10 W
- Radio towers 100 kW
- Security radios 5 W
- Ambulance, Fire, Police 100 – 1000 W
- HDTV 1 million watt transmitters

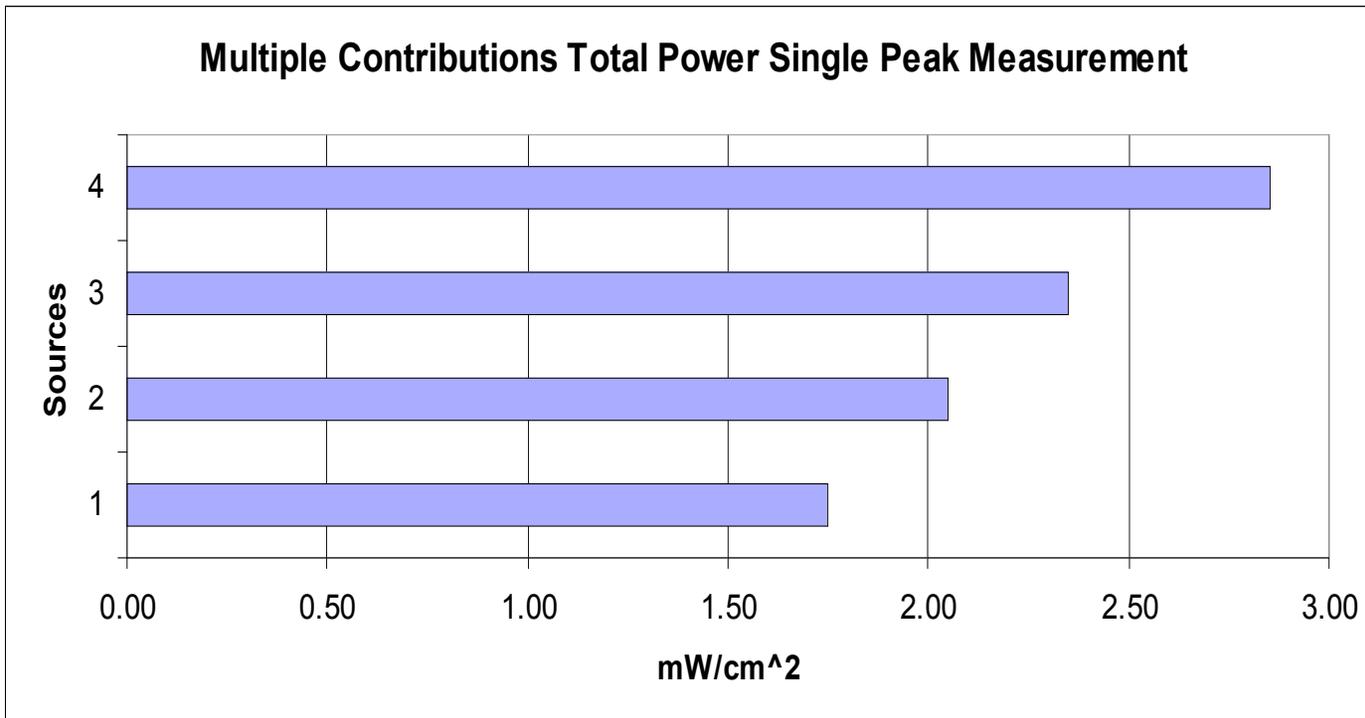
Power Summing - Peak Power

- Typical instruments are set for peak power
 - Irregardless of frequency
 - Sums over a broad range
 - Different correction factors for each frequency
 - Orientation affects reading
 - Irregardless of time averaging
 - Irregardless of spatial averaging
- Good if you never go over 1 mW/cm²

Contribution from Various Single Sources



Total Power from Multiple Sources



Are You Out of Compliance?

• Measured Power in mW/cm ²	• Standard	--	% limit
25 mW/cm ² @ 2.5 MHz	100 mW/cm ²	--	25%
0.75 mW/cm ² @ 125 MHz	1 mW/cm ²	--	75%
0.5 mW/cm ² @ 900 MHz	3 mW/cm ²	--	17%

Out of compliance IF:

Sources all radiating at once

For six minutes continuously

- in a broad field

- over whole body

In Compliance

- Know the generating frequency
- Know the pulse frequency
- Know the human exposure potential

Conclusion

- Monitor all sources
- Consider multiple sources
- Know frequency distribution
- Work with your radiofrequency and microwave equipment owners
- Trust their knowledge