

# Power Quality Issues and Recommendations

	<b>Old Practice or Code Minimum</b>	<b>Helpful Procedures or Current Recommended Practice</b>
<b>Receptacle outlets per 20 amp circuit</b>	13 maximum	3 to 6 maximum
<b>Neutrals</b>	Shared neutral, or even downsized neutral (on 3-phase systems)	Use double-size neutral or larger on 3-phase systems
	One neutral shared among equipment (single-phase branches)	Use separate full-size neutral for each phase, back to panel
<b>Phase Conductors</b>	Standard phase conductor sizing per Code	Use upsized phase conductors to minimize voltage fluctuations
<b>Circuits &amp; Panelboards</b>	Can be shared among many outlets and uses	Use separate branch circuits for sensitive loads, emanating from separate panelboards, supplied by separate feeders (from separate K-rated transformers, if possible)
<b>Grounding</b>	Can use metal conduit as grounding conductor	Use separate insulated copper wire as grounding conductor
	Downsized grounding conductor	Use full-size or upsized grounding conductor
	Grounding electrode system can consist of as little as a metal underground water pipe and an 8-foot ground rod	Use a copper ground ring (4/0 or larger ) and multiple interconnected ground rods to supplement the required electrodes in new construction
	Use a second ground rod if first measures over 25 ohms (no resistance measurement or further action is required)	Use multiple rods with a ground ring and measure before and after installation to ensure low resistance to ground (10 ohms or less is desirable, even less for certain sensitive applications, such as telecommunications facilities)
	Access floor used for equipotential grid in computer mainframe room	Use a copper grid system for equipotential grid
	No lightning or surge protection required	Use adequately sized lightning and surge protection systems
<b>Other Equipment</b>	Standard-rated transformers, circuit breakers, and panels	Use harmonic-rated transformers and panels where electronic loads are present
	Use standard-size neutral and ground buses in panel boards	Use 200% rated neutral and ground buses where electronic loads are present
<b>Circuit Breakers</b>	Can use bolt-in or snap-in circuit breakers	Use bolt-in circuit breakers for more secure, reliable connections

## **An Abbreviated Bibliography of Power Quality Information Sources**

- *Recommended Practice for Powering and Grounding Sensitive Electronic Equipment: IEEE Emerald Book*, Standard 1100-1999, IEEE, New York, N.Y., (ISBN 0-7381-1660-2)
- *Recommended Practice for Grounding of Industrial and Commercial Power Systems: IEEE Green Book*, Standard 142-1991, IEEE, New York, N.Y., (ISBN 1-55937-141-2)
- *National Electrical Code*, NFPA 70, National Fire Protection Assn., Quincy, Mass.
- *IAEI Soares Book on Grounding*, International Association of Electrical Inspectors, Richardson, Tex., 2001. (ISBN 1-890659-27-4)
- *Code for Protection Against Lightning*, NFPA 780, Quincy, Mass. 1992.
- *Grounding and Lightning Protection*, Robinson, M.D., Publication No. EL-5036, Electric Power Research Institute, Palo Alto, Calif., 1987.
- *Lightning Protection Systems*, Pub. No. 96A, Underwriters Laboratories Inc., Northbrook, Ill.
- *Dranetz Field Handbook for Power Quality Analysis*, Dranetz Technologies, Edison, N.J., 1991.
- *EC&M Practical Guide to Quality Power for Sensitive Electronic Equipment*, Second Edition, DeDad, John and Waggoner, Ray, Intertec Publishing, Overland Park, Kan., 1997. (ISBN 0-87288-667-0)

Copper Development Association Inc. also offers a CD-ROM on power quality, a videotape on understanding harmonics, several case histories and additional information on power quality and energy efficiency. Please call (888) 480-4276, or visit us at <http://www.copper.org>.

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