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The Impact of Power Quality in the Telecommunications Industry

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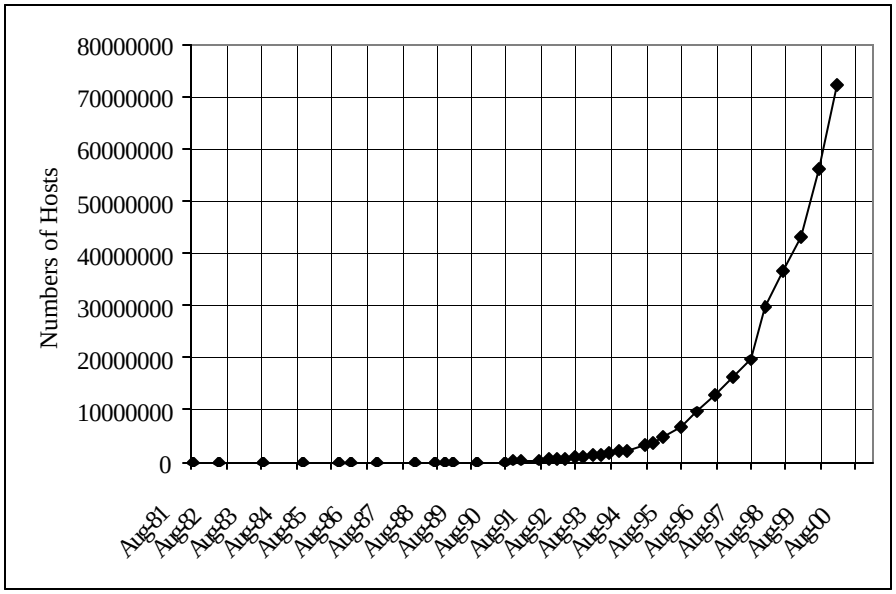
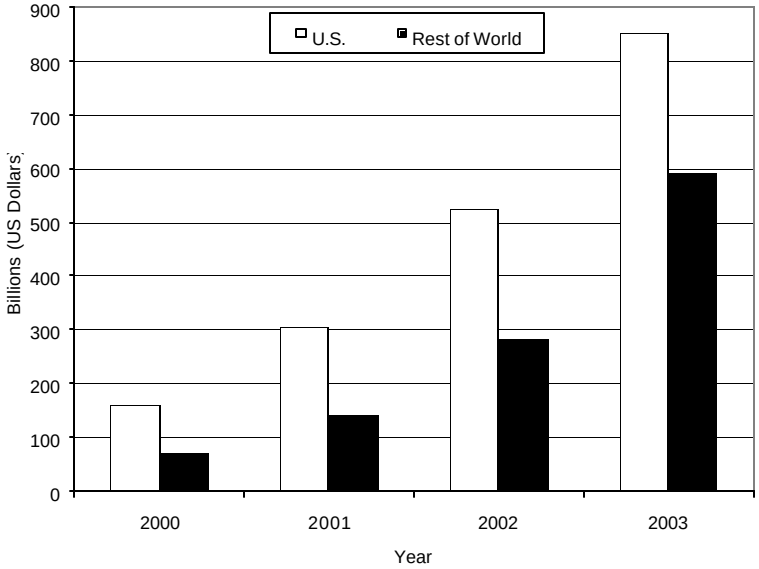
Characteristics of the Telecommunications Industry

- Tremendous growth



Growth of Internet Hosts

Characteristics of the Telecommunications Industry



Growth of eCommerce in the United States

Characteristics of the Telecommunications Industry

- Recent downturn merely an adjustment
  - Market was inflated
  - Infrastructure left in place
- Resurgence a certainty
- Extent of automation with sensitive, high frequency equipment
  - Electrical loads primarily non-linear
  - Improvements indicated by higher speeds and frequencies, lower voltages

Characteristics of the Telecommunications Industry

YEAR	PROCESSOR	SPEED (MHZ)	V_{cc} (V)	I_{cc} (A)
1979	8086	5 TO 8	5.0	<< 1
1985	Intel386	16 to 20	5.0	<1
1989	Intel486	25 to 100	3.3/5.0	1
1993	Pentium	60 to 66	5.0	3
1994	Pentium	90 to 233	2.8/3.3	5
1995	Pentium Pro	150 to 200	3.1/3.3	15
1997	Pentium II	233 to 300	2.8	14

Characteristics of the Telecommunications Industry

- Need for reliability
  - Expense of processes controlled
  - Criticality of data

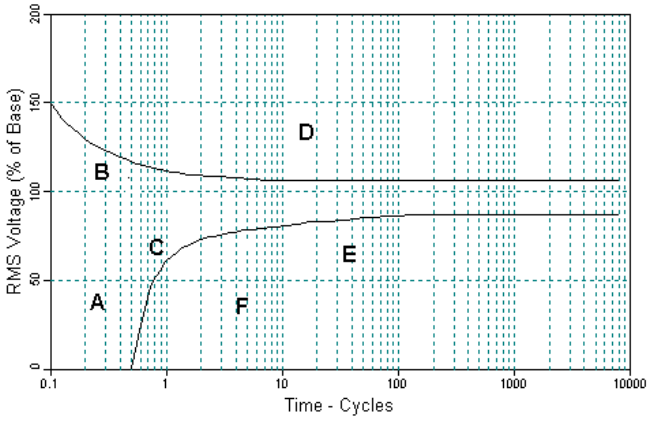
Level of Reliability	99.9%	99.99%	99.999%	99.9999%	99.99999%
Number of Nines (9's)	3	4	5	6	7
Duration of Equipment Downtime	8.8 hours	53 minutes	5.2 minutes	31.5 seconds	3.2 seconds

Power Quality Issues of Unique Importance

- Voltage sags
- Harmonics
- High frequency grounding

Power Quality Issues of Unique Importance

- Voltage sags
  - Reduction in voltage from the nominal
    - Very short duration
    - Can result in equipment misoperation

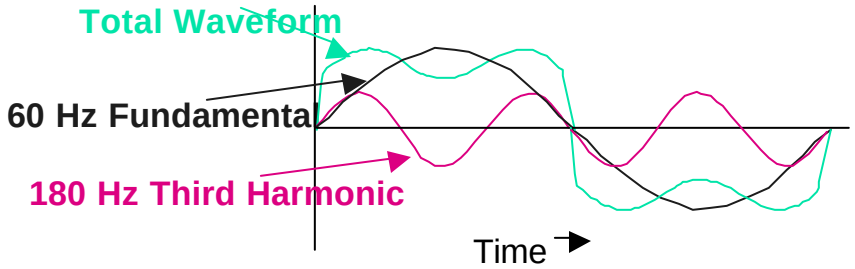


Power Quality Issues of Unique Importance

- Problem greater with increased use of sensitive equipment
  - Losses not uncommon at only 10%-15% voltage sag, for tenths of a second
  - Proportional to value-added product
- Causes: line faults, fog, brush fires
- Solutions straightforward, though
  - Isolation transformers
  - Uninterruptible Power Supplies (UPSs)

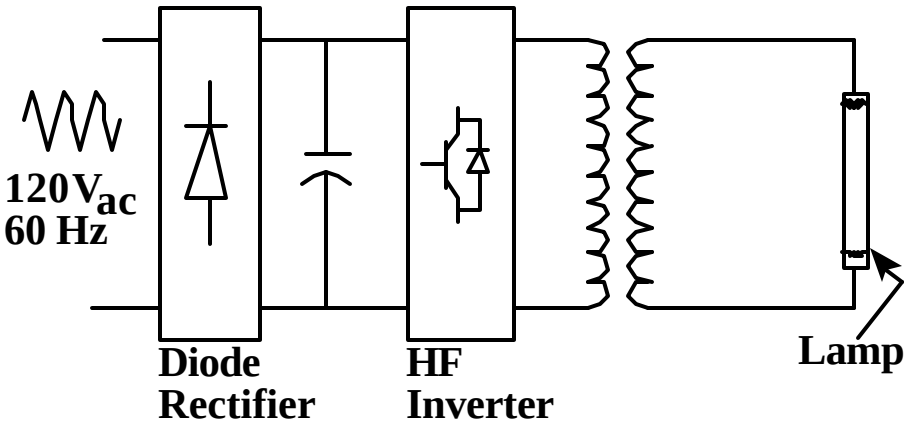
Power Quality Issues of Unique Importance

- Harmonics
  - Multiples of 60 Hz
  - Total Harmonic Distortion (THD) the sum of all harmonics



Power Quality Issues of Unique Importance

- Most common cause is converter-based equipment

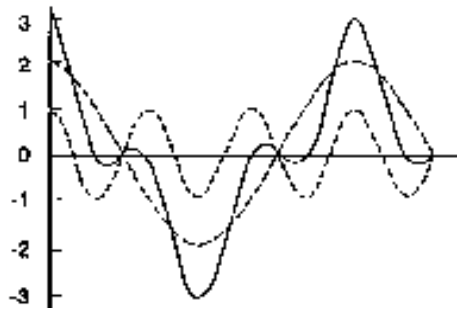


Power Quality Issues of Unique Importance

- Other Causes of harmonics
  - Saturated transformers
  - Arcing equipment (welders, blast furnaces, etc.)
  - Electrical generators

Power Quality Issues of Unique Importance

- Effects of Harmonics
  - Overheated neutrals in 3-phase, 4-wire systems
  - Overheated transformers due to circulating currents
  - Telephone Interference Factor (TIF)
  - Communications timing



Power Quality Issues of Unique Importance

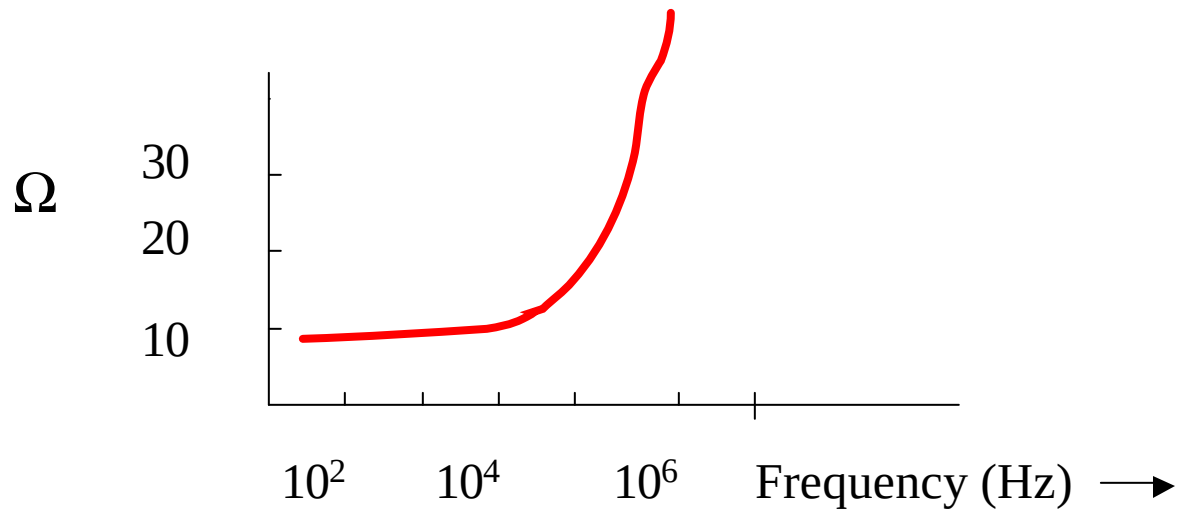
- Mitigation of Harmonics Effects
  - Filters
    - Passive
    - Active
  - Zig-zag transformers
  - K-Factor Transformers
  - Purchase equipment low in harmonics

Power Quality Issues of Unique Importance

- High frequency operations and grounding
  - Traditional purposes of grounding
    - Safety
    - Operations (noise control)
  - Grounding systems designed for 60 Hz
  - Current generations of equipment designed for MHz, GHz and up
  - Grounding systems essentially ineffective

Power Quality Issues of Unique Importance

- The effect of high frequency operations



Power Quality Issues of Unique Importance

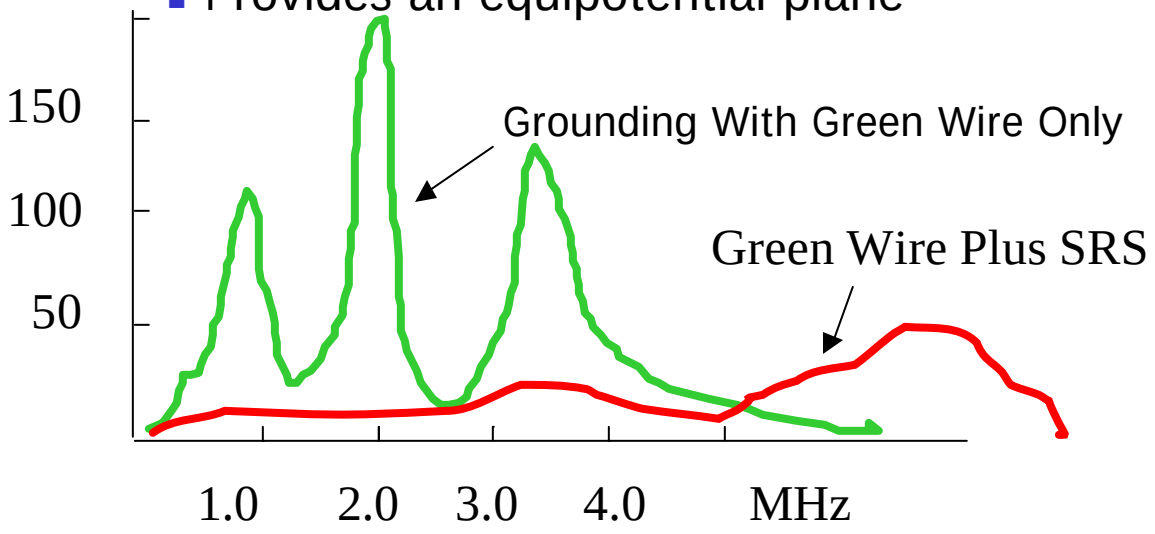
- The solution: a Signal Reference Structure

  "A system of conducting paths that reduce noise-induced voltage levels that minimize improper operation. Common configurations include grids and planes." (*Emerald Book, IEEE Std 1100-1999*)

  - Provide equipotential plane at many frequencies
  - Allows connections to ground of varying lengths

Power Quality Issues of Unique Importance

- Benefits of an SRS
  - Effective from DC to MHz
  - Provides an equipotential plane



Where to From Here?

- Can continue with traditional (60-Hz) approach
  - Failed operations
  - Damaged equipment
- Recommended approach
  - Recognize the significance of high frequency operations
  - Train in–house personnel
  - Use outside expertise selectively