



ELIMINATING HARMONICS PROBLEMS CAUSED BY VFDs

Presented by: John Houdek
John.houdek@artechepq.com

AGENDA

Assumptions

Impact of facility loads on distribution system power quality

Alternative techniques for mitigating harmonics

Performance expectations for alternative methods

Best practice

ASSUMPTIONS

- 1) Utilities generate sine wave power, not harmonics.
- 2) Harmonics are caused by customer non-linear loads and can cause distortion on the distribution system
- 3) Non-linear loads are found within commercial and industrial facilities.
- 4) Harmonics should be solved close to their source
- 5) Harmonics waste energy.

Common Types of Loads (3-phase)

Linear Load (ie: motor) – no rectifiers

6-pulse rectifier (most common)

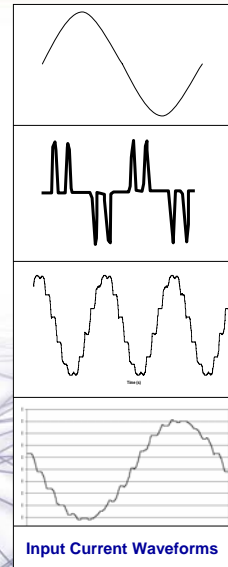
Uses 6-diodes on three phase source
Most common three phase rectification method

12-pulse rectifier

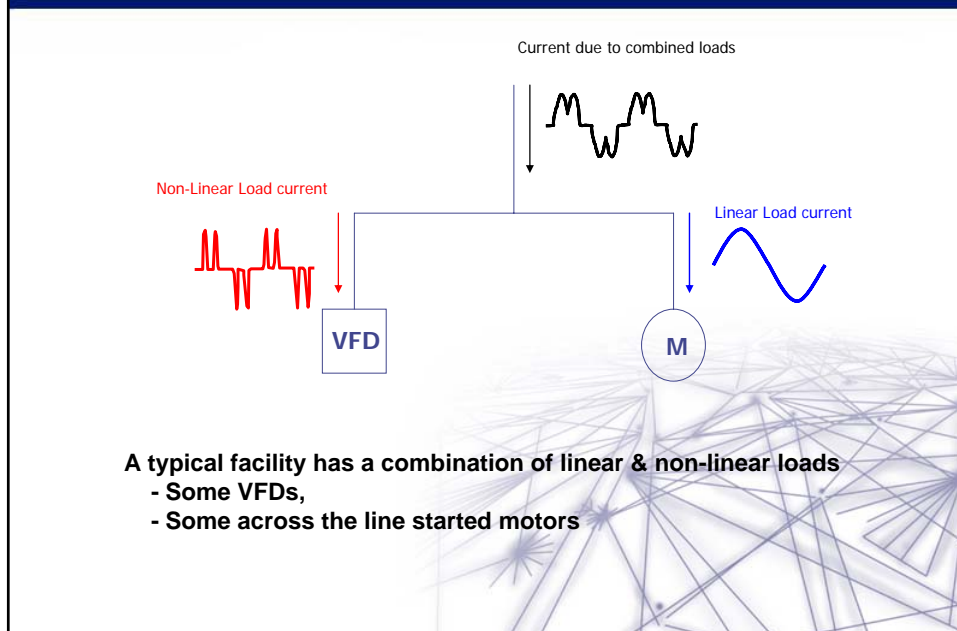
Uses 2 sets of 6-pulse rectifiers
Series or parallel connected
Fed by two phase shifted power sources

18-pulse rectifier

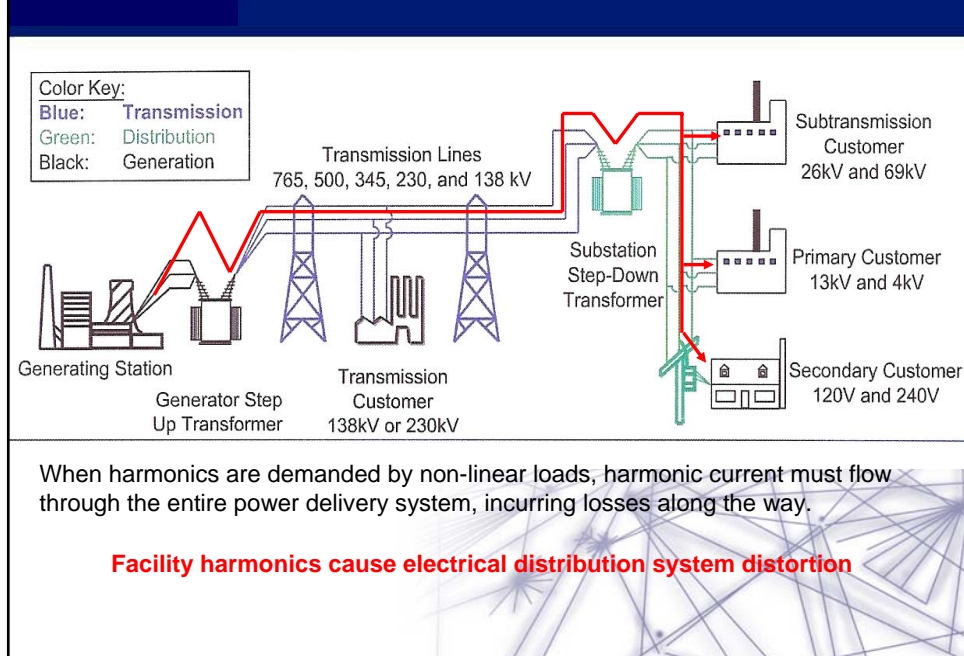
Uses 3 sets of 6-pulse rectifiers
Series or parallel connected
Fed by three phase shifted power sources



Combined Effect of Linear & Non-Linear Loads



Sourcing Harmonic Current

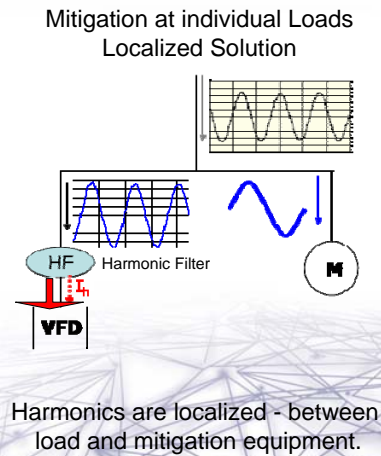
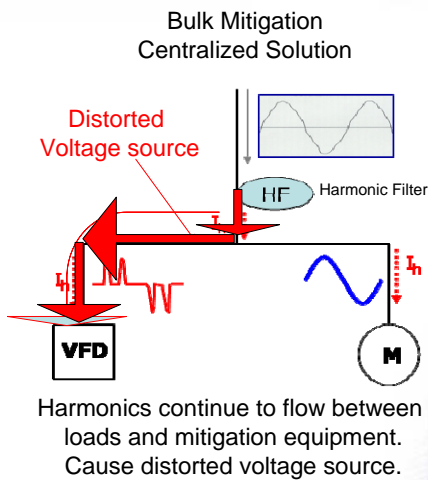


IEEE - 519

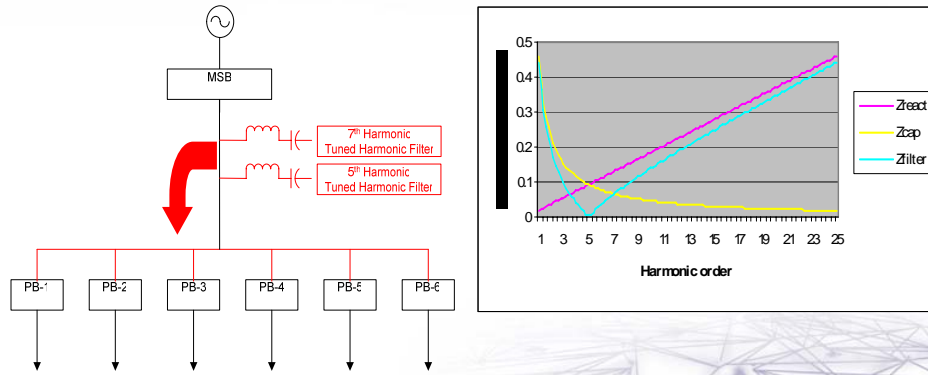
Current Distortion	
I_{sc} / I_L	TDD % Limit
< 20	5
20 < 50	8
50 < 100	12
100 < 1000	15
> 1000	20

Voltage Distortion	
General Systems	5 %
Dedicated Systems	10 %
Special Applications	3 %

Customer Choices

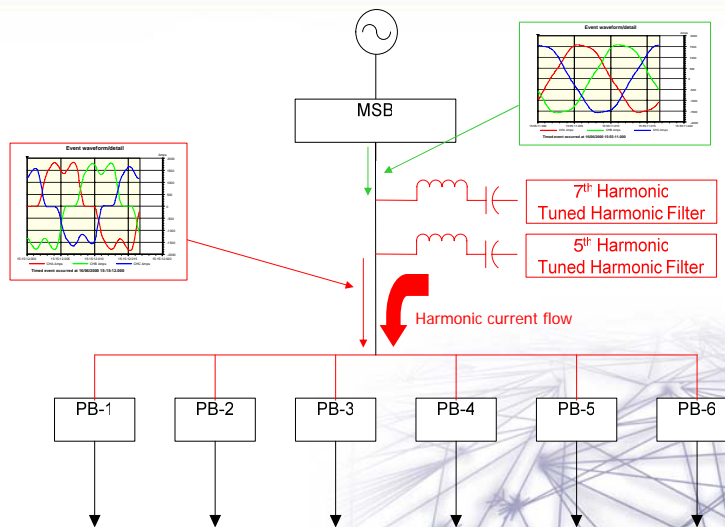


Tuned Harmonic Filters can remove specific harmonics

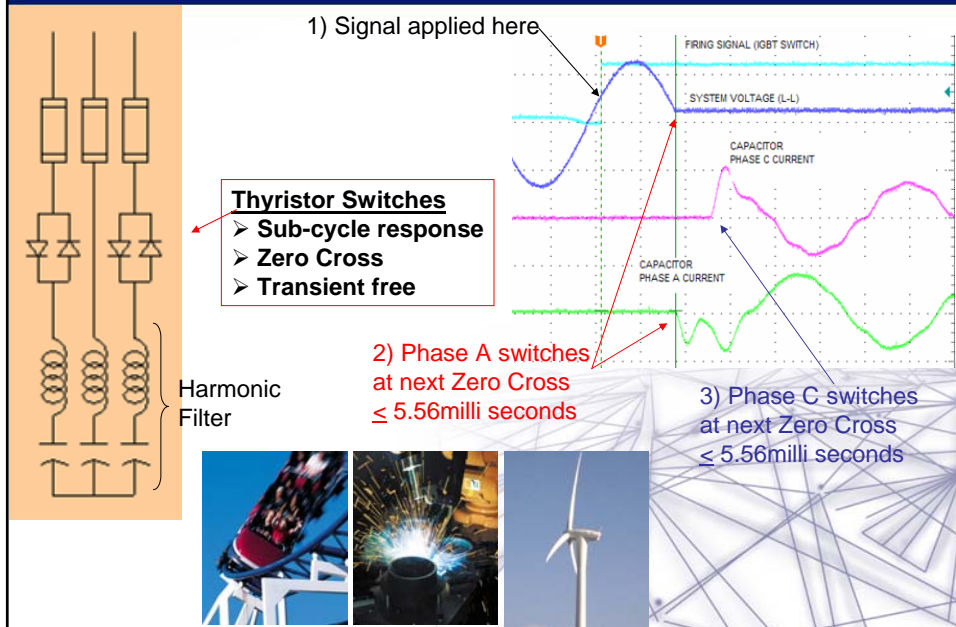


- Often applied as centralized solution
- Also improve Power Factor
- Requires automatic capability to compensate for changing load
- Requires analysis of harmonics (frequency, magnitude)
- Will attempt to source harmonics for any & all loads

Tuned Harmonic Filters

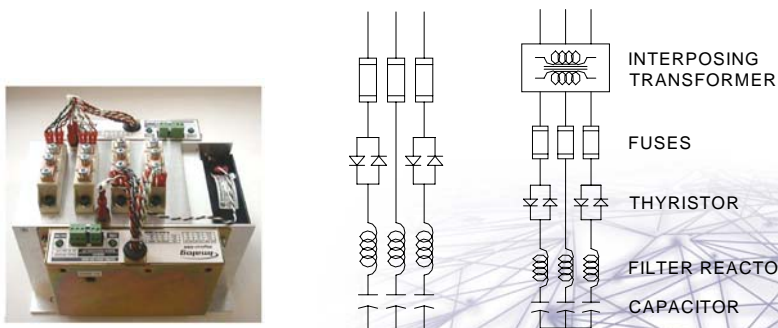


Tuned Harmonic Filter for Dynamic Loads

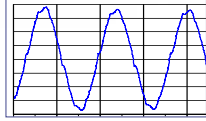


Dynamic Tuned Harmonic Filters

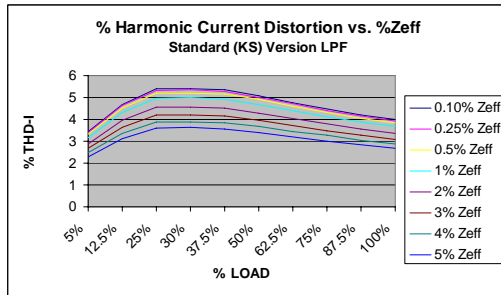
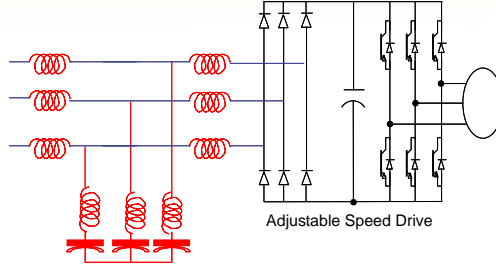
Medium Voltage applications are simplified by using LV filter with interposing transformer



Low Pass Harmonic Filter Filters ALL harmonic frequencies



Current at Filter input
 $\leq 5\%$ THD - I
 Always meets IEEE-519



Apply at either individual VFD
 or group of drives



Summary of Alternative Solutions



Harmonic Mitigation Solutions

That solve harmonic distortion right at the source!

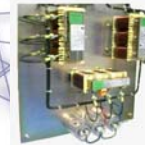
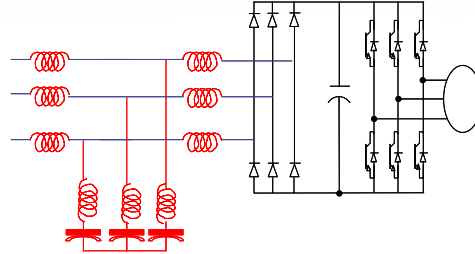


Type of Solution	Harmonic Mitigating Reactor	Tuned 5th Harmonic Filter	Low Pass (Wide Band) Harmonic Filter	Dynamic Harmonic Filter	12 or 18 Pulse Rectifier Conversion Kit	Active Harmonic Filter
Configuration						
Current Waveform						
Harmonic Current Distortion	35% to 45% THD-I	15% to 25% THD-I	5% or 10% THD-I	15% to 25% THD-I	5% to 10% THD-I	5% THD-I
Basic Product Photo						
Efficiency	99.5%	99.5%	99%	98%	92%	95%

Best Performance, Cost & Efficiency

Low Pass Harmonic Filters

- 60hz flows easily thru filter
- Always meets IEEE-519
- ALL harmonic frequencies are filtered
- $\leq 5\%$ THD-I
- Use for single or multiple VFDs
- Lowest THD-I at all load conditions
- Best efficiency vs. performance
- Best cost vs. performance



Any Questions ???

ARTECHE: 60 years of experience. Offering solutions for Power Quality, Distribution Automation and Reliability for electricity networks as well as for Commercial & Industrial facilities.

