Considerations for Variable Frequency Drives for Water and Wastewater
VFD Topics

- Type(s)
- Enclosure/Environment/Packaging
- Harmonics/Harmonic Mitigation IEEE 519
- Accessibility
- Sustainability
VFD Considerations

• The industry has standardized on PWM 6 pulse drives.
  • Where 6 pulse refers to the front end of the drive and a bridge of 6 diodes converting incoming AC to DC power.
  • A DC bus (capacitor)
  • Insulated Gate Bipolar Transistors (IGBT) as the output components
  • The output of which generates a simulated RMS waveform with a constant V/Hz ratio
One of These…
Packaging...  
NEMA UL  
Type 1/12  

Enclosed  

Altivar Plus  

MCC
Harmonics Mitigation

• This continues to be a big topic in Water and Wastewater
  • The motor loads on VFDs are a large percentage of the total load
• Many consultants have standardized on designs by HP requiring line reactors or multipulse drives (typically 18 pulse)
  • There are multiple solutions
    • One size does not fit all
Harmonics Reduction

Typical AC drive
100HP

- Typical 6 pulse AC drive
  - without line reactor

- Input voltage: orange

- Input current: cyan
  - Large current spikes due to capacitors charging
  - Peak currents = 300 amps

- Harmonic current distortion
  - Large double humped current waveform significantly contributes to harmonic content.

Total Harmonic Distortion Current
THDI = 80%
Harmonics Reduction

AC drive with 3% line reactor
100HP

- Typical 6 pulse AC drive
  - With 3% line reactor
- Input voltage: orange
- Input current: cyan
  - Lower current spikes due to capacitors charging
  - Peak currents = 190 amps
- Harmonic current distortion
  - Significant double humped current waveform reduced

Total Harmonic Distortion Current

THDI = 38%
18 Pulse Drive Using the Same 6 Pulse Inverter…

STD 6 Pulse Inverter

Line Reactor

18 pulse Diode Bridge

Phase Shifting XFMR
18-Pulse Power Converter Configuration

Line Reactor
A
B
C
DC+
DC-
Rectifier Assembly
Multipulse Transformer
Transformer Tertiary
Altivar 61/71 Drive
DC Bus connections

DC+ DC-
18-Pulse Drives: What You Get

6-Pulse power converter (no line reactor)

18-Pulse power converter

Clean power performance
Passive Harmonic Filter Drive Using the Same 6 Pulse Inverter...
Passive Harmonic Filter Drive

- Passive Harmonic Filter Mitigation provides as good or better than 18 pulse
  - Better mitigation given voltage imbalance
- Footprint of drive is typically smaller than 18 pulse
- Efficiency of drive is better than 18 pulse
  - Losses of 18 pulse bridge + Transformer + Line Reactor > Passive Harmonic Filter
- Cost is typically lower than 18 pulse
- Output to the motor is identical
Results
Results
Power Correction Used with One or Many 6 Pulse Drives...
Other Drive/System Application Considerations

• Enclosed drive or packaged drive short circuit current rating
  - SE = 100k amps as standard

• Power loss ride through – especially for pump stations
  - SE meets Semi F47 standards

• Communication capabilities
  - SE offers Modbus Serial and 11 additional Protocols as options.
  - Built in web server and diagnostic web displays with Ethernet.
  - Built in Bluetooth interface capability
Quiz

• True or False: the sequencing of multi-pulse drive pulses occurs in multiples of 6

• Which pulse drive is the industry standard?

• An effective alternative to pulse drives is the **Pxxxxxx Hxxxxxxx Filter**