Drive Systems and Harmonics

StacoSine® Active Harmonic Filter

StacoSine® Wall Mount Unit

Application Background

Various solutions have been developed and applied for mitigating harmonic concerns for many years. Designers and engineers will attempt to specify the harmonic limits for bus loads, which include switchgear and motor control centers (motors/drives), plus those used with drive systems.

IEEE Standard 519 provides a guideline for harmonic limits, whereby many applications will need to utilize an 18-pulse drive(s), or use added individual filter components with 12-pulse or 6-pulse drive(s), or incorporate an active harmonic filter. Additionally, interpretations of IEEE may suggest each drive is required to meet IEEE519, which can significantly impact the initial equipment costs.

For example a 6-pulse drive offers economics in up-front cost, however emits a higher harmonic content, creating technical issues, hence potentially driving-up overall operational costs. 12 and 18-pulse drives offer better control of most harmonics, however are expensive and may be prone to higher order harmonics, for example when lightly loaded. There's a clear need for solutions that are flexible, scalable, and easily designed and applied.

Drive applications

In looking at harmonic cancellation and those requirements to meet IEEE 519 guidelines, Tables 10.2 and 10.3 (voltage and current distortion) values should be followed. Typical total harmonic distortion (THD) values by device:

6-pulse drive 20-30% (5th and 7th orders)

12-pulse drive 10-15% (11th and 13th orders)

18-pulse drive 5-8% (17th and 19th + orders)

Typical correction by type of device:

Passive (traditional filter) reduction to 15-25%

Active harmonic filter reduction to 5% or less

Comparing the 12-pulse and 18-pulse drive with the active filter:

- Series type drive arrangement may have some losses and efficiency reduction (increasing harmonic levels) compared to active filter
- One (active front end) required for each drive product, vs. active filter which can accommodate multiple drive systems
- Drive "footprint" may be a concern, especially for retrofit projects; active filters can be integrated with MCC's switchgear, which will save space and cost, can also be offered as match-and-line or stand-alone installation
- Copper, aluminum and steel costs continue to increase, active filter is primarily power electronic by design; cost containment
- The use of a 6-pulse drive(s) and active filter combination may be less costly, versus a 12 or 18-pulse drive(s). Use of multiple (two/three or more) 6-pulse drives with an active filter typically offers a lower cost point when compared with use of 18-pulse drives and no active filter (equipment, installation and operating costs)
- 18-pulse drives may have higher harmonic levels when lightly or partially loaded (31st to 38th orders); typically 12-pulse (11th/13th dominant orders), 18-pulse (17th/19th dominant orders) mitigate the lower order harmonics, however higher frequency harmonic orders exist. VFD, 12-pulse and 18-pulse only lower harmonic currents, harmonics still remain, which may cause voltage distortion (impedance at the higher frequencies); this may reduce the load efficiency, in particular with motors; unbalanced conditions can be difficult to control harmonics
- Greater performance levels and more capability when active filter and 6-pulse drives combined

STACO ENERGY® PRODUCTS CO.

Digital
Control Panel

StacoSINE®

Product Highlights

- Immediately improves electrical system efficiency
- Reduces operations and maintenance costs
- Dynamically corrects a wide spectrum of harmonic orders
- Global or selectable harmonic parameters
- Quick, easy installation, with virtually no downtime
- No need for complex site analysis
- Stand-alone and multi-integrated systems, ideal for use with drives and MCCs
- Voltage ratings from 208 to 480 Vac, step-up transformer utilized for 600 Vac and higher voltages
- 25 to 200 amp ratings, parallel up to (6) six individual units
- Three wire and four wire (neutral) arrangements
- Open-chassis type, or enclosed—NEMA 1, 12, 3R ratings, UL508, c-UL

Why active filters? Because . . .

- Passive solutions (Inductors, filters etc.), are primarily designed to cancel one harmonic order with only some cancellation of two or three higher orders; Total Demand Distortion (TDD) minimally lowered (15-30% 5th order for example) depending on the filter type.
- Passive filters effectiveness can diminish at multiple frequencies. It's possible to install multiple passive filters to remove the 5th, 7th and 11th harmonics, but such a strategy isn't always workable or effective economically. Passive filters installed at each drive (multiple drive application), may not be as effective, as the total power system will be "summed" and each filter may not sustain its desired percentage of harmonic reduction, along with other inefficiencies due to losses.
- Passive filters are reliable and economical, however one passive filter is commonly used (per VFD); multiple drive systems can then become more costly
- Passive broadband filters and "custom" engineered filters/reactors can be expensive, may be physically large and will have added heat (efficiency) losses
- Active front-end with VFD, complex, expensive, no filtering if drive fails
- AHF lowers TDD to <5%, bus solution, no need for one-on-one design, helping to save cost
- AHF can be paralleled (up to six units), which is ideal for new or retrofit projects, offers optimum flexibility
- AHF also provides power factor correction capability where needed; while an arrangement of fixed or switched passive capacitors, inductors, can be effective, this type equipment will only mitigate a small number of harmonic orders; installation consideration for resonance
- AHF electrical losses (heat) may be lower, helping with efficiency and operating costs
- Active filters can be set to cancel all harmonics, selectable orders of harmonics plus correct power factor, giving full control of the filter. Active filters will never exacerbate or produce resonant conditions in the power system.

The StacoSine® Active Harmonic Filter

Active harmonic filters use power electronics to monitor the nonlinear load and dynamically correct every harmonic order from the 3rd to the 51st order, while the controller calculates and displays up to the 31st order—the more critical range of harmonics. By injecting a compensating current into the load, the sine wave is restored, attenuating harmonic levels at the point of installation. StacoSine® meets or exceeds Total Demand Distortion (TDD) limits specified in table 10.3 of the IEEE 519 Standards. One set of 2000:1 current transformers CT's are standard.

StacoSine®
Free Standing Unit

STACO ENERGY PRODUCTS CO.
Your tailored power solutions provider

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