WATER AND WASTEWATER GUIDE

Harmonics - is prevention better than reactive cure?

Factors to consider when selecting drive technology to mitigate harmonics in a reliable, energy-efficient, and cost-effective way

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Introduction
what are harmonics?

In the context of electrical networks, harmonics are unwanted frequency components that deviate from the standard sinusoidal waveform of alternating current generated by sources such as power stations, renewable energy sources and localised backup generators.

Operations Manager

"Why can harmonics be harmful?"

Traditional 6-pulse variable speed drives (VSDs) can generate harmonic distortions on power networks. Harmonics can distort the voltage and current waveforms in power supplies. In excess, this can result in poor power quality, leading to voltage fluctuations and disruptions or failure in other connected electrical equipment.

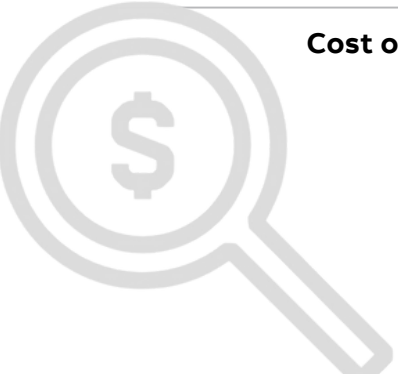
Are there harmonic compliance standards?
Electrical systems are designed to meet certain harmonic standards and regulations. Excessive harmonics can lead to non-compliance with these standards. This can potentially result in disconnection, penalties, legal consequences, or corrective action costs.

Plant Manager

"What does it cost to correct harmonics?"

The cost of correcting harmonics in electrical systems can vary widely depending on several factors and this can include the severity of the harmonic distortion, the size and complexity of the electrical system, and the specific corrective measures implemented.

Cost considerations to review
when trying to manage harmonics on a power network

	Consideration	Cost relationship
	**System analysis and monitoring**	• Identifying and analysing harmonics in an electrical system often requires specialised equipment and expertise • Conducting a thorough power quality analysis to understand the nature and extent of harmonic distortion can be complex and costly
	**Equipment upgrades or replacement**	• Existing equipment may need to be upgraded or replaced to handle higher levels of harmonics that have been introduced into an electrical network
	**Installation of harmonic filters**	• These are designed to reduce or mitigate harmonic distortion in electrical systems • Costs to purchase, install, and maintain harmonic filters is significant when correcting harmonics
	**Design modifications**	• Re-visiting or modifying the design of the electrical system to reduce harmonics may involve changes to the layout, distribution, and sizing of components • This may include redesigning grounding systems, adjusting capacitor bank configuration, or optimising the placement of harmonic-generating loads
	**Professional services**	• Acquiring services of experts, consultants, or engineers specialising in power quality and harmonics may be necessary. Their expertise is crucial in identifying the source of harmonics, designing effective solutions, and overseeing the implementation
	**Training and education**	• Training personnel to operate and maintain newly implemented harmonic correction measures is essential. Costs include ongoing training and materials
	**Cost of downtime**	• Equipment failure is more likely in power networks exposed to harmonic pollution • The associated downtime can result in lost productivity and revenue, contributing to a considerable increase in operational costs

Potential challenges of harmonics with electrical backup generators

Compatibility with generator systems
Backup generators can be very sensitive to harmonic distortions in the electrical load. High levels of harmonics can lead to issues such as overheating, voltage distortion, and reduced generator efficiency. When generators are expose to high level harmonics, it can even prevent them from starting or running in a stable condition.

Increased Generator sizing
Oversizing can help accommodate the additional harmonic pollution without overloading the generator or causing excessive instability. It can be typical to oversize a generator by almost double and that can be cost intensive.

Oversized generator challenges
When generators are oversized to manage harmonics, this impacts both operational efficiency and maintenance considerations. It is important for generators to maintain high load percentages and often expensive load banks are required in these circumstances to prevent engine damage.

Reduced stress and resonance on generators
Harmonics can contribute to both resonance challenges and additional stresses on generators, potentially leading to increased wear and maintenance requirements.

Minimised impact on other loads and voltage flicker
Harmonic distortions can contribute to voltage flicker which is the rapid and repetitive variation of voltage levels. This is particularly important in critical systems where the reliable operation of various loads is essential.

Take note
The cost of correcting harmonics should be balanced against the potential benefits, including improved equipment reliability, reduced downtime, and compliance with power quality standards. In some cases, the long-term savings from improved efficiency and reduced maintenance costs may justify the initial investment in harmonic correction measures.

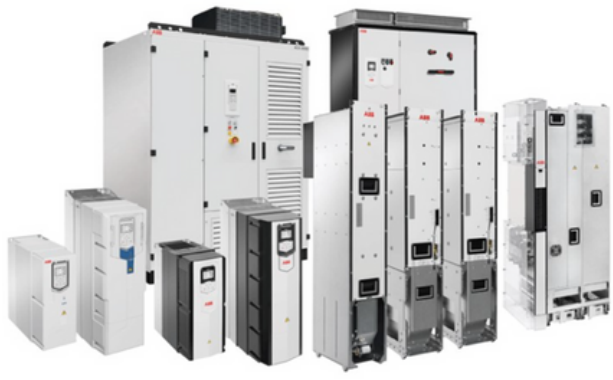
Is there an alternative solution to managing harmonics when using variable speed drives?

Variable speed drives (VSD's) control the speed of electric motors by adjusting the frequency and voltage of the power supplied to them. In the context of VSDs, "ultra-low harmonic" (ULH) typically refers to drives that inherently produce negligible levels of harmonic distortion in the electrical system compared to traditional VSD's.

Reasons why ULH VSDs may be considered better than traditional VSD's (those which require additional harmonic correction measures).

Inherent design
ULH VSD's are specifically designed to produce negligible harmonics. They often incorporate advanced technology such as active front-end converter technology that naturally results in minimal harmonic content.

Reduced costs
While correcting harmonics using filters, reactors, or other devices add to the overall cost of the system, ULH VSDs by virtue of their design, may actually eliminate or reduce the need for any or all of these additional corrective measures.



ABB's ultra-low harmonic drives

Simplicity and reliability
ULH VSD's offer a simpler single unit solution for effective motor control systems by eliminating the need for additional or third-party components and reduced complex system components.
These drives also grant the lowest risk and highest reliability design to systems both during commissioning and throughout the active life of the applications.

Compliance with standards
ULH VSDs are designed to meet standards without the need for extensive additional measures, always ensuring compliance with regulatory requirements. Third party or additional harmonic mitigation solutions can fail or be turned off, rendering the intended system design non-compliant to standards.

Space considerations and footprint
Harmonic correction devices can take up physical space within an electrical system. ULH VSDs can be a more compact option reducing the need for additional harmonic filters or other corrective equipment, particularly in applications with space constraints.

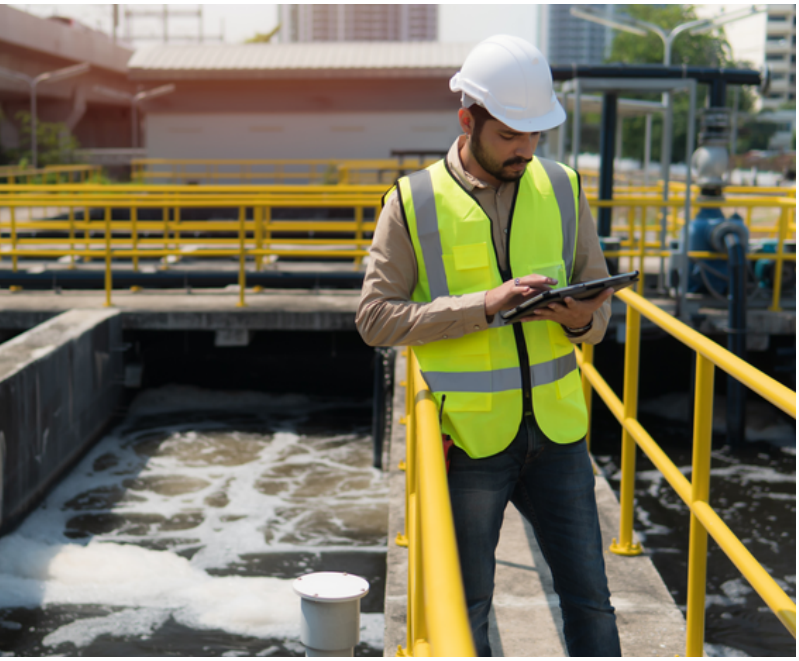
Energy efficiency
ULH VSDs often have beneficial features that enhance energy efficiency, which can contribute to long-term cost savings. They may include power factor correction and regenerative capabilities providing benefits beyond harmonic distortion reduction.

Ultra-low harmonic variable speed drives offer advantages when used with electrical backup generators

Generator sizing
Generators can be sized with minimal oversizing requirements due to both the inherent true unity power factor and negligible load harmonics. Operation and starting of the generator VSDs drives operate.

Operation lifespan
Generators are designed to be run with high load percentages and clean loads. Due to minimal oversizing needs, generators can run and be serviced within the manufacturers recommendations. With ULH VSD loads, the negative effects of significantly reduced loads can be mitigated.

Mitigation of voltage flicker
ULH VSD's help mitigate voltage flicker ensuring a more stable and reliable power supply from the backup generator for additional connected equipment.



While ultra-low harmonic variable speed drives are effective in reducing harmonic content and potentially reducing costs, the choice between ULH VSDs and correcting harmonics using additional measures depends on the specific requirements of the application, the overall system design, and compliance with relevant standards. It's important to evaluate the specific needs and constraints of your electrical system to determine the best solution.

ABB Australia has specialist engineers ready to offer support in the design and evaluation processes so you can select the optimal solution for your application.

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