



Lineator™ Case Study: Passive harmonic filter vs. Active filter in a data center



Background: Harmonic mitigation solutions for VSDs in data centers

Data centers are known to be heavy consumers of electrical power and have therefore been a target for energy reduction programs. With their ability to significantly reduce induction motor power consumption, Variable Speed Drives (VSDs) have recently been finding many more applications in data centers. These include chillers, chilled water pumps, cooling tower fans and computer room air conditioners (CRACs). Although they are very effective in reducing energy, they can introduce a serious power quality issue, known as harmonic distortion, if treatment is not considered.

There are many forms of treatment for the harmonics generated by VSDs. These include passive harmonic filters, multi-pulse drives, parallel active filters and active front-end drives. At a new data center for a Canadian financial institution located in Barrie, Ontario, Canada, two methods of treatment—passive harmonic filters and a built-in parallel active filter—were employed on the cooling systems to reduce harmonics. In July 2012, MIRUS International was brought in by ADM Engineering to conduct field testing at this data center. The goal was to provide a power quality analysis of the center's newly designed power distribution, including VSD systems with MIRUS Lineator Advanced Universal Harmonic Filters (AUHF) and a chiller equipped with a built-in parallel active harmonic filter.

The MIRUS Lineator is a purely passive device consisting of an inductor combined with a relatively small capacitor bank. Its innovative design achieves a reduction in all major harmonic currents generated by VSDs and other similar 3-phase, 6-pulse rectifier loads. The resulting current total harmonic distortion, ITHD, is reduced to less than 8%, and often as low as 5%. Although it's referred to as a filter, the Lineator exhibits none of the problems that plague conventional filters. Lineators were applied to all chilled water pumps totalling 430 HP.



Lineator AUHF and VSD on chilled water pump

The facility was also equipped with a 227 HP chiller equipped with a built-in parallel active harmonic filter to compensate for the harmonics generated by the chiller's VSD.

For testing purposes, the data center's power system was setup to supply all available loads from the diesel generator back-up system. Since harmonic distortion becomes worse when operating on a 'weak source' such as a diesel generator, this allowed MIRUS to test for harmonics and evaluate the performance of selected VSD applications found under worst case field conditions.

Chillers, chilled water pumps and cooling towers were amongst the VSD applications tested in the data center.

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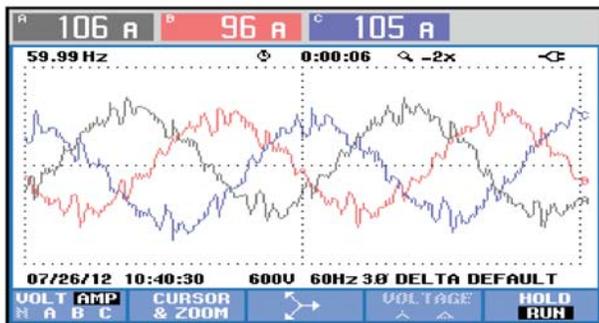
About Mirus International

Mirus designs and develops world class power quality improvement products for mission critical operations. Their uniquely specialized product line includes highly efficient harmonic filters, transformers, autotransformers and Data Center power distribution equipment. Comprised of a leading team of power quality experts, Mirus' solutions minimize disruption to the power supply, improve reliability and adhere to the strictest of regulatory requirements while also saving energy. Proven to perform, Mirus products are available globally and are real-world tested in its own Harmonics & Energy (H&E) Lab.

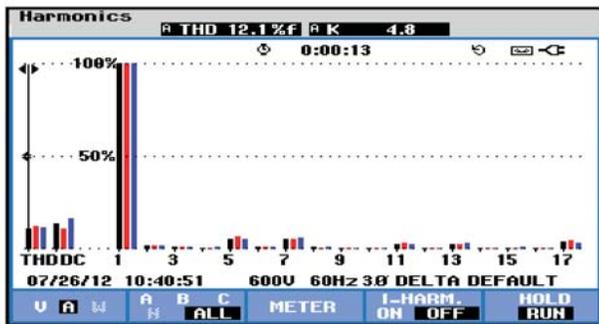
Findings: Active harmonic filter vs. a passive solution

Chiller with active harmonic filter

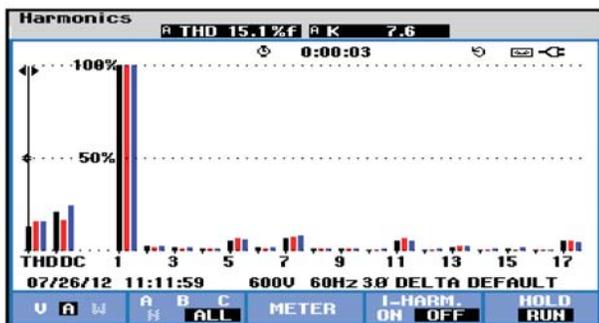
The data center's chillers were equipped with shunt type parallel active harmonic filters to compensate for harmonic distortion generated by the chiller's variable speed drive. Despite having a built in active harmonic filter, however, a higher than expected current waveform distortion was measured with high frequency components present. High frequency noise generated by the switching action of the IGBTs in active harmonic filters have been known to cause problems with sensitive data center equipment.



The performance of the built-in active harmonic filter was surprisingly poor, with measured current THD exceeding 12%.

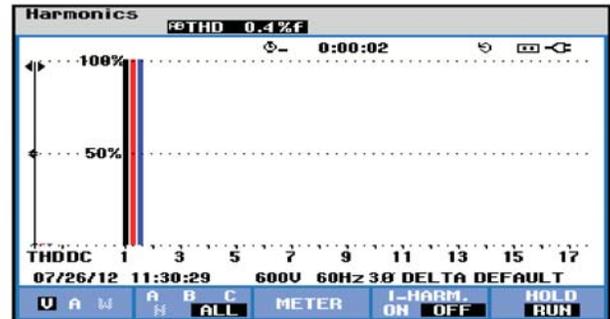


Even when the load demand of the chiller was decreased, the findings were repeated, and high frequency harmonics were present in the current waveform with measured current THD exceeding 15%.

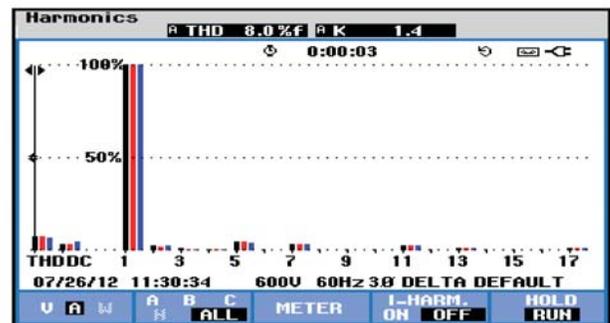


Chilled water pumps with passive harmonic filter

Next, MIRUS verified the harmonic performance for the center's chilled water pumps, all of which had MIRUS Lineator filters installed. The voltage harmonic distortion at input terminals measured only 0.4% THD.



Furthermore, current harmonics at input terminals measured only 8% THD.



Results: Optimal data center equipment performance

Low levels of current and voltage harmonics are essential for the reliable distribution of electric energy in data centers. With MIRUS Lineators installed, data center equipment performance operated at levels acceptable to the utility and to the user and met IEEE 519 standards.

Ali Sarrafian, the engineer who worked with the site's mechanical contractor to integrate MIRUS's harmonic mitigation solutions, was pleased with the results, saying, "The outcome is what we expected. Adding passive filters brought the THD safely into line and met IEEE 519. The client was very satisfied with the results." The MIRUS Lineator AUHF's used in the data center on 6-pulse VSD applications drew less than 15% capacitive reactive current at light load, which was well within the acceptable operating range of the data center's generators. The chiller equipped with the parallel active harmonic filter, on the other hand, had poorer harmonic mitigation performance, especially when higher frequency harmonics were taken into consideration.