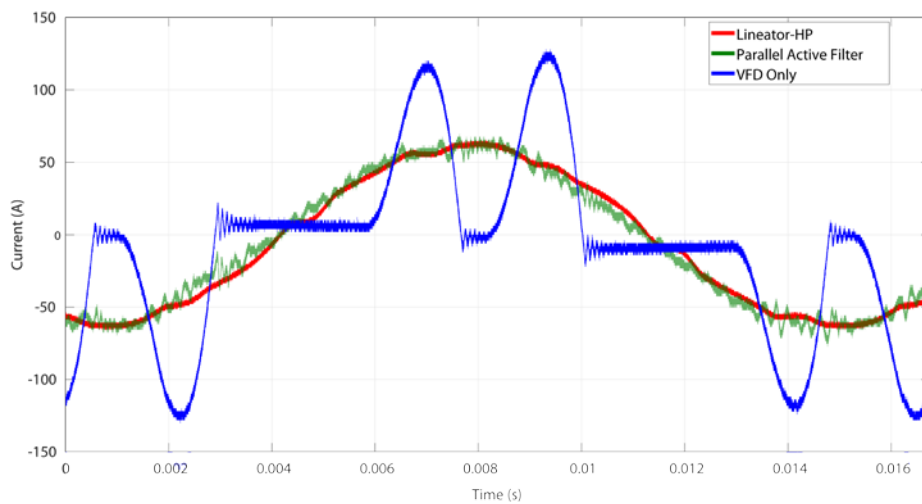


Lineator™ AUHF vs Active Harmonic Filter

When considering a harmonic mitigation solution, the choice between using passive or active harmonic filters is often encountered. While the best choice will depend on the application, this comparison document describes some of the pros and cons to each, and intends to highlight some of the most important considerations. In the majority of applications, where the loads are well known and have the possibility to run at least occasionally at or near full load, better performance at a lower cost is generally achieved with the selection of a good wide spectrum passive filter, such as the Lineator AUHF. The Lineator AUHF is guaranteed to provide a high level of performance and meet the recommended harmonic limits of IEEE Std 519, IEC, Marine and other common harmonic standards. For applications where many drive systems on the same common bus may only ever be operating under lightly loaded conditions (with a known total demand load), it can be effective to use a main bus connected parallel active filter. In some cases, a hybrid installation can be best.



(Oscilloscope recordings of a 6-pulse VFD load with and without harmonic mitigation. Side-by-side comparison test of Lineator-HP Filter and Parallel Active Filter equipment)

The below comparison is based on the Mirus Lineator AUHF, so some points may not be valid when considering other passive filters:

COST/COMMISSIONING

1. Commissioning is simple with the Lineator. Commissioning active harmonic filters requires complex startup arrangement and programming. Lineator is essentially plug-and-play.
2. Active filter manufacturers generally require inspection and service every 6 months. For the Lineator in typical environments, one simple inspection per year is recommended.
3. In most applications, installing Lineator harmonic filters results in a lower overall system cost, with exception being sites where max demand is guaranteed to be lower than the rated equipment capacity.
4. Active filters require AC line reactors be installed on all VSDs, as they operate as a low-impedance source, and increase the distorted current (ITHD) drawn by the VSDs unless AC line reactors are added. Lineators do not require AC line reactors be added as the impedance can be considered 'built-in'.

EFFICIENCY/COOLING

5. All active filters have cooling filter fans at a minimum. Larger active filters use complex water cooling systems to dissipate heat. Lineator filters are built with low-losses and naturally convection cooled, without power electronics that are sensitive to heat.
6. Lineator efficiency is 99%-99.5%, where active filter efficiency is 96%-97%. Since active filters are sized to treat only the harmonic amps, the overall system efficiency might be similar to the use of Lineator harmonic filters and

6-pulse drives. Active front end drive (AFE) solutions, on the other hand, have much lower system efficiencies than the Lineator or active filter options being compared here.

RELIABILITY

7. Lineator has no switching components or complex controls. Should the Lineator have a defective capacitor or fuse, the filter will still operate as a line reactor providing some harmonic mitigation. Failure of an active filter leads to high distortion levels since all harmonic mitigation is then lost. Occasionally, active filter failure results in injected harmonics being higher than needed, a failure mode that will make the situation worse.
8. Lineator can be used in environments with high background voltage distortion (VTHD) up to 8%. Extreme Duty (ED) model suitable for environments up to 12% pre-existing VTHD.

HIGH FREQUENCY GENERATION

9. Harmonics above the 50th can create problems and potential resonance conditions with sensitive equipment, and fail to meet the recommended harmonic standards. The switching frequency of an active filter is a source of high frequency (typically 4kHz – 20kHz). These higher order harmonics can damage other equipment operating on the same bus and create higher losses. As a passive device, the Lineator does not inject any high frequency content.
10. To reduce switching frequency, active filters have built-in passive L-C-L filters, typically tuned above the 50th harmonic and below 1/2 the lowest switching frequency. An L-C-L filter has a natural resonant condition, and can create oscillations of frequency above the 50th harmonic. Lineator filters are tuned below the 5th harmonic, so the opportunity for resonance with the power system or other equipment is not present.
11. Active filters produce significantly increased ground leakage currents due to their high frequency components.
12. Active filters, due to their high switching frequency, can emit EMI noise, which Lineator does not. Lineator helps to attenuate noise.

RESONANCE WITH THE POWER SYSTEM

13. Whenever capacitors are used in an electrical power system, they introduce the possibility of resonance. This is true for passive filters used to control the harmonics generated by 6-Pulse rectifier ASDs, such as the Lineator, or LCL filters used to control switching frequencies in active harmonic mitigation devices. Lineator is inherently designed to not resonate at the power system characteristic harmonics whereas, the higher tuning frequency of LCL filters makes them much more susceptible to power system resonance.

WARRANTY/PERFORMANCE GUARANTEE

14. When measurement considers harmonics above the 50th, active filters will often not meet their <5% ITHD claim. Many times this is not measured, or the meter can only record up to 25th or 50th harmonic. This makes troubleshooting high frequency problems very challenging and costly. Lineator filters can be selected with performance achieving <5% current distortion when required. *Case studies upon request.
15. Lineator has industry leading 3 year warranty with optional extension to 5+ years. Lineators can be expected to last 5-10+ years before requiring any service parts. Higher-end active filters generally have 1-2 year max warranty. Active filters have hundreds of small electrical components which increase failure modes, require an expert to diagnose, and are high cost to repair.

HARMONIC MITIGATION PERFORMANCE

16. With guaranteed performance of < 8% ITDD (optional < 5%), Lineator AUHF performance matches that of active filters at a much lower cost and without the introduction of high frequency harmonics.
17. Lineator reduces VTHD better than an Active filter because it does not introduce high frequency switching harmonics. Also, it will treat some of the upstream harmonics, where Active filter does not.
18. With the reduction of harmonic reactive power, Lineator filter improves power factor to >95% from 30% to 100% load level. The small capacitive kVAR of the Lineator ensures compatibility with generators and does not introduce problems resulting from leading power factor.
19. With Lineator filters, simple SOLV computer simulations can be performed to confirm the application meeting IEEE Standard 519 and other harmonic standards.