



Mirus International ~ Lineator Filters

Comparative Bullets Mirus Lineator Passive Filters on 6 Pulse Drives versus 18 Pulse VFD's

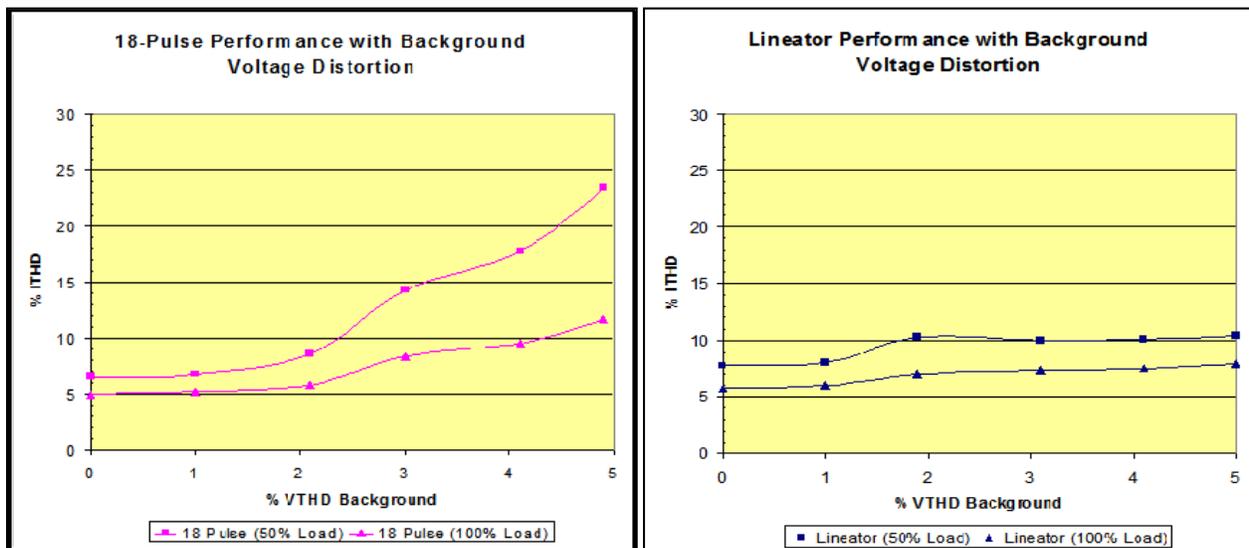
11/30/2012

18 Pulse VFD's have long been touted as the standard for compliance with IEEE 519. Unfortunately real world installations rarely measure up to the evaluation criteria the 18 Pulse manufacturers use to substantiate their offering. Real world conditions like Voltage Imbalance (Vimb), Background Voltage Distortion (Vd), and System Voltage Drop of the 18 Pulse Phase Shift Topology (Vdrop); all impact on the drives ability to operate efficiently and effectively relative to harmonic mitigation and operating energy consumption.

The following bullets are based on harmonic modeling and field verification of the competitive 18 Pulse VFD's performance in real world settings versus the Mirus Lineator Passive Filter in combination with a commercially available 6 pulse VFD.

Background Voltage Distortion and IEEE 519 Compliance

MIRUS Guarantees to Meet IEEE 519 TDD, even if the background Vd is as high as 5 Percent. 18 Pulse VFD's harmonic mitigation performance is substantially compromised based on the presence of even as low as 1% background voltage distortion from the potential source or harmonic contribution from other loads on the distribution bus. Below is a graph showing the impact of background Vd on an 18 Pulse VFD from our test lab comparing current distortion at two different load structures. As can be noted, as the background distortion increases, the resulting current harmonic created by the 18 Pulse increases substantially. It should be noted that at lighter loads, the impact of the background voltage distortion on current harmonic becomes even greater. Testing confirms that background voltage distortion will impact the 18 pulse performance so the device itself is not IEEE 519 compliant.



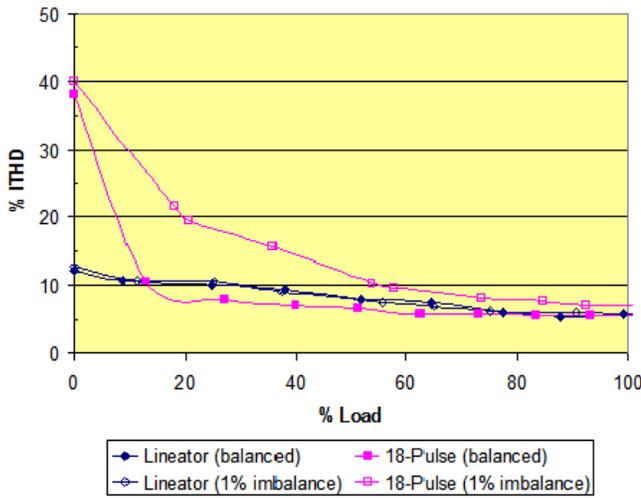
Also detailed above is the same circuit highlighting the performance of the Mirus Lineator Filter coupled with a Std. off the shelf 6 pulse VFD on the same test circuit as above. Notice that the background voltage distortion has little impact on the harmonic

mitigation of the Lineator filter, assuring compliance with IEEE 519 std. with Source or Distribution Bus background Vd as high as 5%.

Source Voltage Imbalance and IEEE 519 Compliance

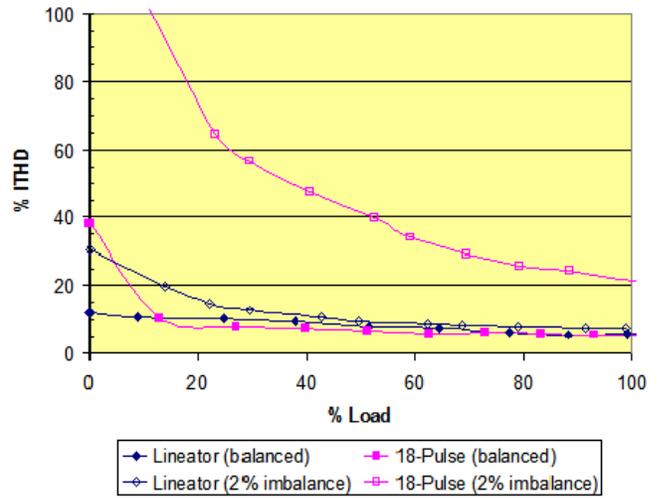
MIRUS Guarantees to Meet IEEE 519 TDD, even if the source voltage imbalance as high as 5 Percent. 18 Pulse VFD's harmonic mitigation performance is substantially compromised based on the presence of even as low as 1% source voltage imbalance from the potential source. Below is a graph showing the impact of Source Voltage Imbalance on an 18 Pulse VFD from our test lab comparing current distortion at two different load structures. As can be noted, as the source voltage imbalance increases, the resulting current harmonic created by the 18 Pulse increases substantially. It should be noted that at lighter loads, the impact of the background voltage distortion on current harmonic becomes even greater. Testing confirms that source voltage imbalance will impact the 18 pulse performance so the device itself is not IEEE 519 compliant. For this evaluation to help compare the performance of the Mirus Lineator to the 18 Pulse VFD, we have overlaid the results with the Mirus Lineator in Blue and the 18 Pulse in Red. The top chart shows a 1% Vimb, the second chart shows a 2% Vimb.

ITHD Comparison (18-Pulse vs Lineator)



1% Voltage Imbalance Comparison

ITHD Comparison (18-Pulse vs Lineator)



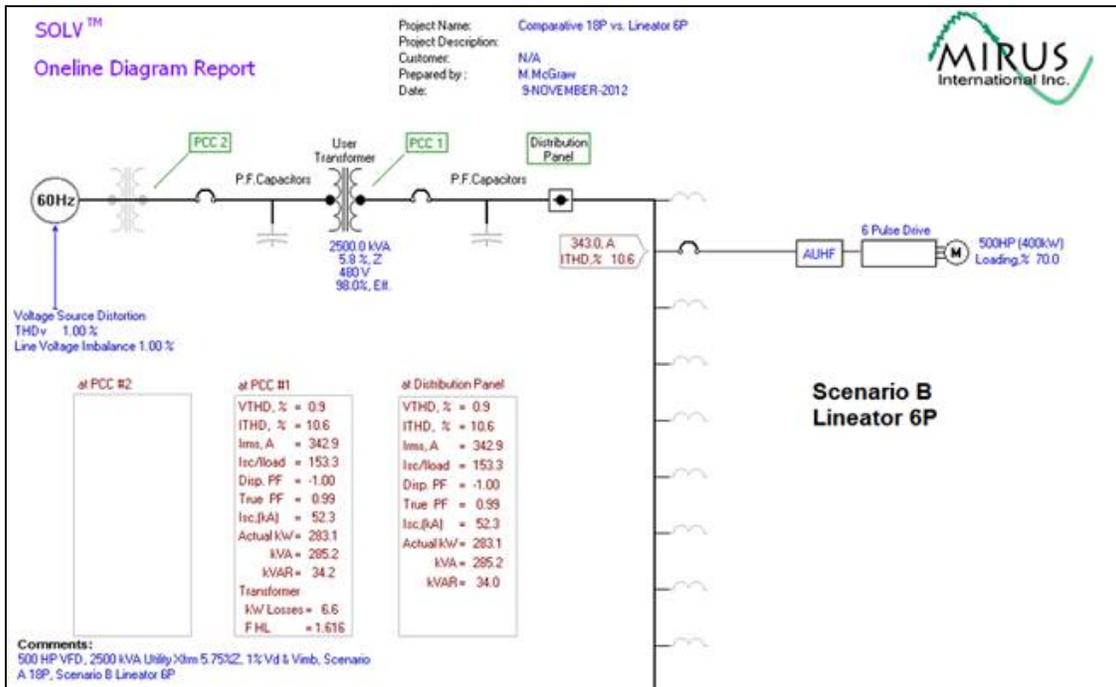
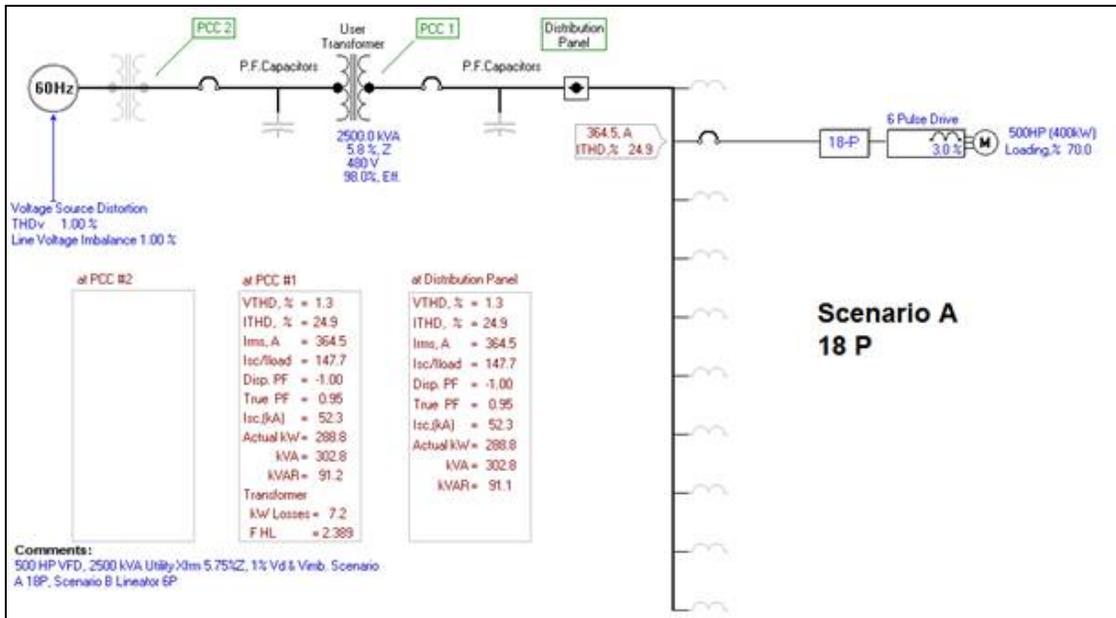
2% Voltage Imbalance Comparison

The significance of the Vimb on the 18 pulse performance along the full range operating speeds regardless of level of Vimb is significant and consequential. Actual field installations due to circuit loadings or utility conditions rarely have balanced source voltages, with a 1% to 2% range in phase voltages being quite common and expected. Under these conditions, the 18 Pulse VFD could not be expected to meet the IEEE 519 compliance criteria for Total demand Distortion (Itd), so therefore would not provide a credible solution to harmonic mitigation within those circuits. But, due to the configuration of the Mirus Lineator reactive and capacitive topology, the advent of a system voltage imbalance has little impact on the harmonic mitigation of the device.

Background Voltage Distortion & Source Voltage Imbalance Impact on Operating Efficiency and Operating Costs.

It stands to reason, that since Source Voltage Imbalance and Background Voltage Imbalance have both individually a significant impact on the performance of the 18 Pulse VFD harmonic mitigation; that the operating efficiency of the 18 Pulse VFD must be compromised under these circuit conditions. The following energy consumption calculations are based on the Mirus SOLV software comparing the 18 Pulse VFD Energy Consumption versus a Mirus Lineator Filter 6 Pulse package. For the comparison, we have assumed the following, 1% Vimb and Vd, a moderately stiff source, no linear loads exist within the circuit and a 70% load speed.

To highlight the drive performance itself we will use PCC #1 for comparison, since the better performance of the branch will by consequence offer the greatest overall system performance.



	PCC#1 Vthd	PCC #1 Ithd	IEEE 519 Compliance
Scenario A – 18P	1.3%	24.9%	Fail
Scenario B - Lineator	0.9%	10.6%	Pass



33427 Mayer Rd.
Waller, TX 77484
Phone: (877) 898-5103
Web: www.nsoem.com

Energy Consumption and Annual Cost of Operation Comparison
Assumptions: \$0.10per kWh
Operating Time: 24 hours per day, 365 days a year
Operating Cost Do Not Include 2500 kVA Transformer Losses

PCC #1			
Total Current (Arms)	364.5	342.9	-21.6
Displacement PF	-0.999	-0.998	0.001
True PF	0.954	0.993	0.039
kVA	302.8	285.2	-17.7
kVAR	91.2	34.2	-57.0
Actual kW	288.8	283.1	-5.7
Energy Consumption (kWhr/yr)	2529745	2480214	-49531
Energy Cost (\$/yr)	270301	265009	-5292

The Operating Cost for the 18 Pulse VFD was \$270301/year, while the Mirus Lineator 6 Pulse Package was \$265009.00/year. Representing a Savings of almost \$5300.00/year in energy cost. Actual saving may be greater once you factor in transformer losses due to higher harmonic loading on the transformer based on the 18 Pulse contribution.

Conclusion

Based on real world operating conditions, primarily Source Voltage Distortion and Voltage Imbalance, the 18 Pulse VFD most engineers have been specifying for IEEE 519 compliance may not be the best harmonic solution or the most energy efficient solution for their applications. The Mirus Lineator Passive Filter coupled with a 6 Pulse VFD can provide more effective harmonic mitigation and more a more energy efficient solution for your application.

For more Information, Applicational Assistance and Modeling Assistance please contact:

Mike McGraw

Cell Phone: 713-208-8534

Or

Boyd Derby

Phone: 877-898-5103