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12. How does the LINEATOR™ compare to a 12-Pulse or 18-Pulse VFD?

12 and 18-Pulse VFD's use phase shifting transformers and multiple bridges to reduce the current harmonics generated by the VFD. Under balanced voltage conditions, 12-Pulse VFD's can typically achieve current total harmonic distortion levels at full load in the 12% to 15% range while 18-Pulse VFD's can achieve 5% to 8%. Performance will degrade however when the applied voltages are even slightly unbalanced. In addition, the relatively high losses in the phase shifting transformers required for a multi-pulse application will lower the efficiency of the entire VFD package.

The LINEATOR™ applied to a 6-Pulse VFD, on the other hand, will match the performance of the 18-Pulse VFD in reducing current distortion while maintaining high efficiencies. Figures 12-1, 12-2 and 12-3 provide a comparison between a typical 18-Pulse VFD and a LINEATOR™ / 6-Pulse VFD combination. To ensure that a fair comparison was made, the identical 6-Pulse VFD module that was used in the 18-Pulse VFD was also used with the LINEATOR™ as well.

Although the 18-Pulse VFD solution and the LINEATOR™/6-Pulse combination compared favourably with respect to their ability to reduce input current distortion under balanced voltage conditions, the LINEATOR™/6-Pulse combination outperformed the 18-Pulse in many other areas.

Figure 12-1 shows the current distortion measurements with both well balanced and 1% imbalanced supply voltages. The LINEATOR™ / 6-Pulse maintained its excellent performance even with the voltage imbalance of 1%. The 18-Pulse solution had very good performance with a well balanced 3-phase supply but was much less effective with the higher voltage imbalance. Since a slight voltage imbalance is not unusual, the 18-Pulse solution will not always be able to guarantee good performance.

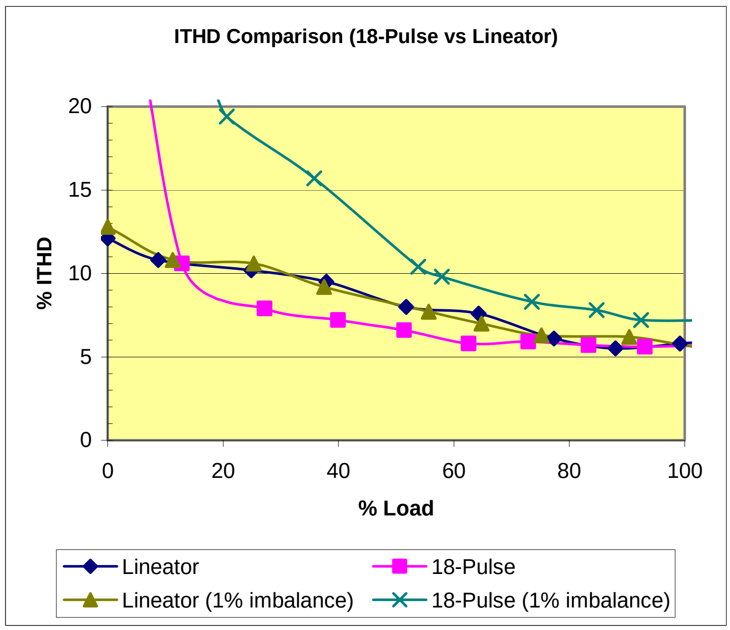

Figure 12-1: Input Current Distortion comparison – 18-Pulse vs

The advantages of the LINEATOR™/6-Pulse are even more evident when a comparison of efficiencies is observed. The LINEATOR™ /6-Pulse combination achieved efficiencies that were 2% - 3% points higher than the 18-Pulse across the entire operating range. This would translate into very substantial energy savings and an improved payback for the installation.

The VFD's DC bus voltage level is another interesting comparison. At light loads, the capacitors within the LINEATOR™ will tend to boost the VFD's DC bus voltage slightly. The unique reactor design of the LINEATOR™ allows it to achieve its excellent performance while minimizing this voltage boost to 5% or less.

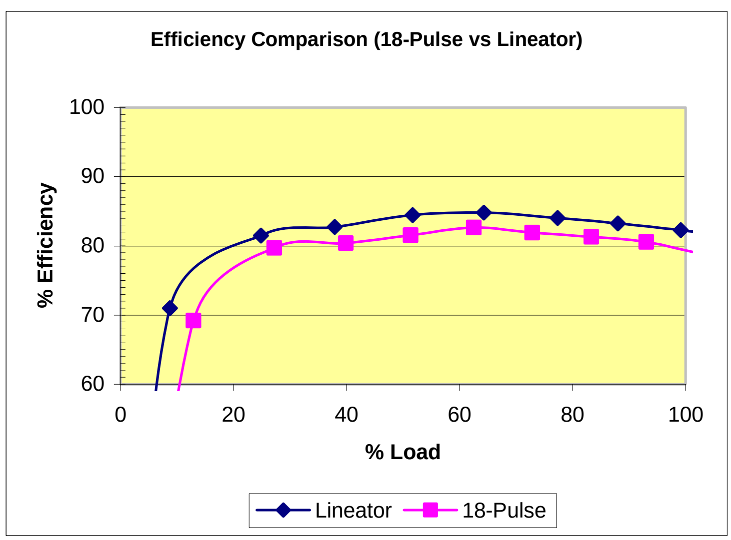

Figure 12-2: Efficiency comparison – 18-Pulse vs LINEATOR™/6-Pulse combination

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What is arguably more important is the DC bus voltage drop at full load. Any impedance added to reduce input current distortion will introduce a voltage drop as the VFD is loaded. Even a 5% AC line reactor will introduce a 5% voltage drop when operated at full load. As the voltage drops, the motor will have to draw more current in order to deliver the power required for the application. As current increases the losses in the motor will increase proportional to the square of this current. The motor will run much hotter and could be susceptible to overheating and pre-mature failure.

As shown in Figure 12-3, the 18-Pulse VFD introduced more than an 8% DC bus voltage drop at full load. This is due to the fact that the 18-Pulse solution requires significantly more impedance to reach the performance level of the LINEATOR™. The total impedance includes the phase shifting transformer, reactors to prevent cross-commutation, an AC reactor ahead of the phase shifting transformer and the AC line reactor within the VFD itself. The impedance of the LINEATOR™ is a combination of the reactor and capacitors resulting in much lower through impedance presented to the VFD. The high number of inductive components in the 18-Pulse VFD also explains why the losses are much higher and efficiency lower.

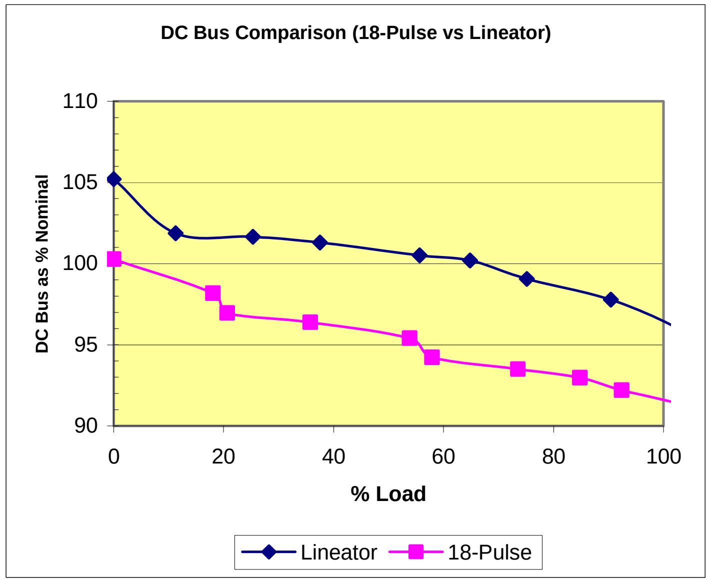

Figure 12-3: DC Bus Voltage comparison – 18-Pulse vs

13. Is the LINEATOR™ compatible with all VFD's?

The standard LINEATOR™ AUHF Type D is designed to reduce the harmonic currents generated by an AC PWM Variable Frequency Drive equipped with a 6-pulse diode bridge rectifier. This includes a VFD that uses an SCR bridge for pre-charge purposes. It is compatible with all PWM AC Drive configurations.

For thyristor bridge (or SCR) applications, such as DC Drives and industrial rectifiers, a Type T LINEATOR should be selected. The Type T unit is designed to accept the phase back angle introduced by the thyristor operation. Reduction of current distortion will be slightly less than that achieved with a Type D unit operating on a diode bridge but still will achieve < 8% ITHD at full load operation.