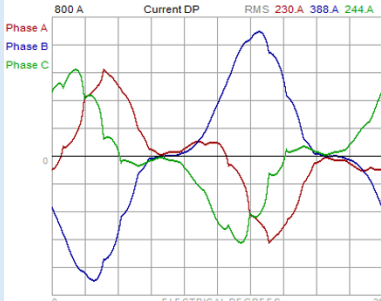
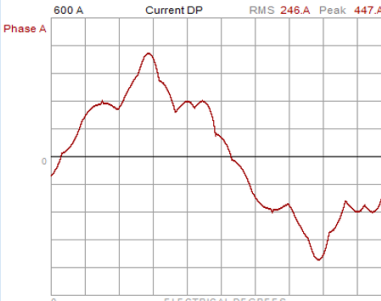
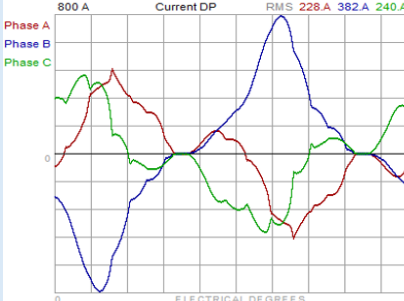


**18 Pulse Drive Utilizing a Phase Shift Autotransformer**

18 Pulse Drive utilize an Autotransformer assembly to create the phase shift configuration necessary for the multi-pulse current harmonic cancellation. Unfortunately this phase shift design is prone to serious compromise due to normal circuit conditions such as source voltage imbalance & source/background voltage distortion, in many cases rendering the harmonic performance no better than a standard 6 pulse drive.

In Water and Wastewater applications, you have to assume the system voltage imbalance will be around 2% and the source/background voltage distortion will be between 2% and 5% depending on the non-linear load topology of your circuit and the condition of the Utility source and/or specification of the Generator source feeding the facility.

		
<p><b>18 Pulse Drive feed from a 2% Voltage Imbalance Source - No Source Voltage Distortion</b>  <b>Ithd: 35.1% - 65.2%</b>  <b>(Fails IEEE519)</b>          Presence of very high P-N "3<sup>rd</sup> order harmonic of just under 70%. Significantly exceeds IEEE519 requirements.          (SC Ratio of 100 or greater allowing for a 15% Ithd)</p>	<p><b>18 Pulse Drive feed from a 2% Voltage Distortion Source - No Systemic Voltage Imbalance</b>  <b>Ithd: ~ 19.4%</b>  <b>(Fails IEEE519)</b>          Unstable di/dt current draw patterns. Significantly exceeds IEEE519 requirements.          (SC Ratio of 100 or greater allowing for a 15% Ithd)</p>	<p><b>18 Pulse Drive feed from a 2% Vd and 2% Source/Background</b>  <b>Ithd: 38.7% - 58.7%</b>  <b>(Fails IEEE519)</b>          The current imbalances and waveform di/dt challenges have combined. Significantly exceeds IEEE519 requirements.          (SC Ratio of 100 or greater allowing for a 15% Ithd)</p>

Typically, under either or both of these conditions, 18 Pulse LV VFD's will not comply with IEEE519 harmonic requirements, far exceeding the Current Harmonic requirements as specified in Table 2 of the standard. This level of current harmonic injection may create significant Vthd (Total Harmonic Voltage Distortion) exceeding IEEE519 Table 1 requirements and compromise other equipment within your circuit.



**AS7CP Series Five Star Electric Clean Power Drive versus Autotransformer 18 Pulse Drive - “Real World” Water Applications**

***Five Star Electric AS7CP Drive (Clean Power Configuration)***

The Five Star AS7 Series Clean Power Drive combines a 6 pulse VFD with integrated DC Link Inductor with a specially tuned passive filter design to rebalance source systemic voltage imbalance and block source/background voltage distortion to augment the rectifier operation, as well as comply with IEEE519 current harmonic requirements with up to 3% voltage imbalance and up to 5% source voltage distortion at the same time. The Extreme Duty option can be provided for high voltage distortion environments up and through 12% Vthd-bg.

<p><b>FSE-AS7CP Drive feed from a 2% Voltage imbalance Source - No Source Voltage Distortion</b>  <b>Ithd: 6.2% - 7.9%</b>  <b>(Exceeds IEEE519 Req.)</b>          Significantly Exceeds IEEE519 requirements.          (SC Ratio of 100 or greater allowing for a 15% Ithd)</p>	<p><b>FSE-AS7CP feed from a 2% Voltage Distortion Source – No Systemic Voltage Imbalance</b>  <b>Ithd: ~ 5.8%</b>  <b>(Exceeds IEEE519 Req.)</b>          Significantly exceeds IEEE519 requirements.          (SC Ratio of 100 or greater allowing for a 15% Ithd)</p>	<p><b>FSE-AS7CP feed from a 2% Vd and 2% Source/Background</b>  <b>Ithd: 6.8% - 8.3%</b>  <b>(Exceeds IEEE519 Req.)</b>          Significantly exceeds IEEE519          (SC Ratio of 100 or greater allowing for a 15% Ithd)</p>

	Ithd: 18 Pulse	IEEE Pass/Fail	Ithd FSE AS CP	IEEE Pass Fail	Performance Improvement %	Notes
2% Circuit Background Vd, No Voltage Imbalance	19.40%	Fail	5.80%	Pass	70.10%	Short Circuit Ratio for the subject evaluation was 130, which would allow a 15% Ithd for the IEEE 519 evaluation. In all cases, the FSE-CP AS series drive was well below the allowable IEEE519-2022 limits
8% Circuit Background Vd, No Voltage Imbalance	70.10%	Fail	11.00%	Pass	84.31%	
2% Voltage Imbalance, No Voltage Distortion	35.10% - 65.20%	Fail	6.20% - 7.90%	Pass	83.19% - 87.88%	
2% Circuit Background Vd & 2% Voltage Imbalance	38.70% - 58.70%	Fail	6.80% - 8.30%	Pass	82.43% - 85.86%	