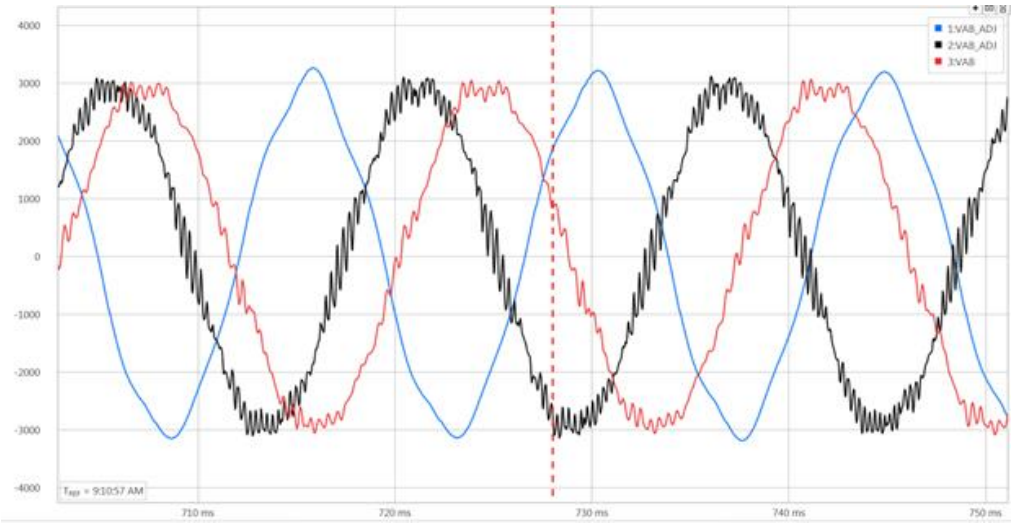
Sinewave Filter Comparison

A typical sinewave filter consists of a 5-12% impedance inductor L combined with a capacitor C (also may include resistor R) in a low-pass filter arrangement designed to convert the PWM pulsed DC voltage into a clean sinusoidal phase-to-phase voltage with total harmonic distortion THD(V) of 3 to 5%, depending on the make.

Sinewave filters reduce motor insulation stress by completely eliminating high voltage spikes at the motor terminals caused by high dv/dt, and are highly recommended for VSD/inverter applications with cable runs of > 300 feet (100m) up to 15,000 feet (4500m). For inverters utilizing semiconductors with very fast rise-times (dv/dt), the problems can exist even with shorter cable runs. Sinewave filters eliminate switching noise from reaching the motor, and by supplying the motor with sinusoidal voltage the motor losses are reduced. Moreover, sinewave filters eliminate pulse reflections in the motor cables thus reducing stresses and semiconductor losses in the frequency converter. These filters with the addition of common-mode chokes, also reduce bearing currents caused by PWM common-mode voltages and motor shaft common-mode voltages.

The comparison below shows field measurements for 3 manufacturer's sinewave filters. Unlike, the Mirus Inversine, residual switching frequency distortions are clearly evident in the other two filters.



Blue- Mirus Inversine
Red- Comp 1 Filter
Black- Comp 2 Filter

Figure 1: Voltage Waveform comparison of Mirus Inversine vs two other competitive sinewave filters in similar ESP applications

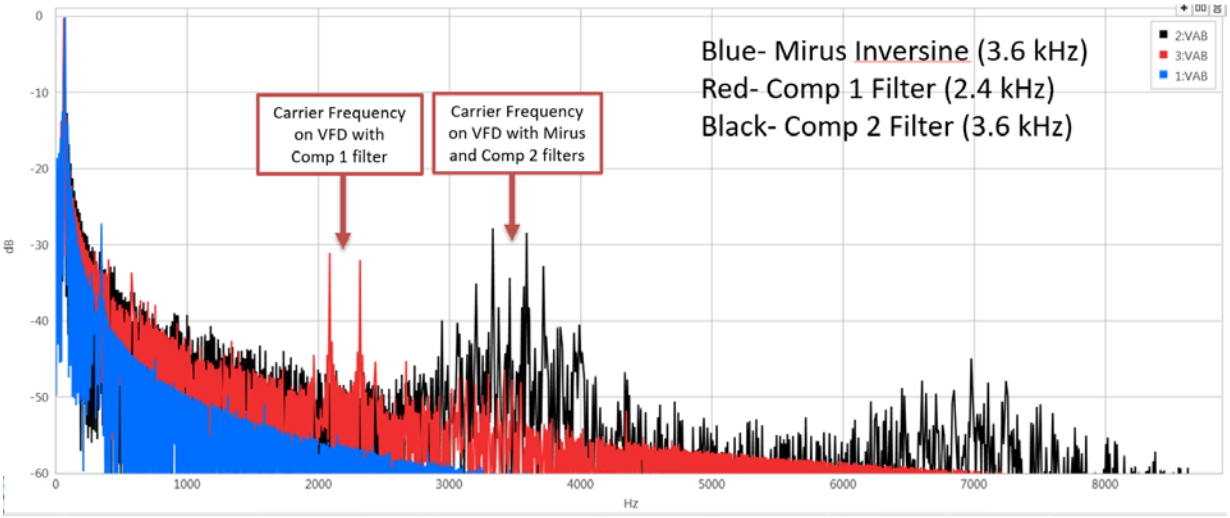


Figure 2: Voltage Spectrum comparison of Mirus Inversine vs two other competitive sinewave filters in similar ESP applications

The main differences between the major competitive filters vs the MIRUS Inversine™ Sinewave Filter are the following:

- Other filters have voltage drop (insertion loss) of 5-12%, limiting the motor power capability vs the Inversine™ filter which has voltage drop below 3%.
- Other filters target VTHD performance of 5% although they rarely meet this especially when measured above the 50th harmonic. MIRUS Inversine™ filters target <3% and will be <5% even when measured up to the 100th harmonic.
- MIRUS Inversine™ filters correct for low motor power factor, improving it to near unity. This helps with the efficiency and power output of the drive. Other filters are not designed to correct for power factor, so motor pf remains low.
- MIRUS Inversine™ are typically 1.5% to 2% more efficient than other filters, with lower power losses and heat rejection.
- Other filters often require fan cooling vs natural convection cooling for the MIRUS Inversine™ filters
- Other filters may require damping resistors with the capacitor banks. By designing to a lower 'knee' frequency, the Mirus Inversine™ does not require resistors to eliminate resonance conditions, making it more efficient and resonant-free than other filters.

ITEM	TRADITIONAL SINEWAVE FILTER	MIRUS INVERSINE	MIRUS is SAME or BETTER
Input Voltage Wave Form	PWM	PWM	SAME
Drive Operating Mode	Scalar (V/Hz)	Scalar (V/Hz)	SAME
Switching Frequency	2 - 8 KHz	1 - 8 KHz (or 8 - 16 kHz)	BETTER
Source Frequency	50 Hz, 60Hz, higher frequency models may be available	50 Hz, 60 Hz, 200Hz, 400Hz	SAME
Ambient Temperature	50°C Open 40ºC Enclosed	60°C Open 40ºC Enclosed ED version – 55ºC Enclosed	BETTER
Altitude without derating	1000 Meters	1000 Meters ED version – 4500m	BETTER
Relative Humidity	0 to 99% Non-Condensing	0 to 99% Non-Condensing	SAME
Current Rating	100% RMS	100% RMS	SAME
Intermittent Current Rating	150% for 1 Minute	150% for 1 Minute	SAME
Insertion Loss / Voltage Drop	5-12%	<3% of rated voltage	BETTER
THD(V) Output At 60 Hz	5%[1]	~3%	BETTER
Efficiency	< 98%	> 99%	BETTER
Location Of Sine Wave Filter	Within 50 Feet Of VFD	Within 50 Feet Of VFD	SAME
Cooling method	Fan Cooling often required	Natural Convection Cooling	BETTER
Requires Snubber Resistors	Often	No	BETTER

[1] Expected performance with competitor filters to be >5% when considering up to the 100th harmonic band