



PWM to Sine Wave Filter For motor protection

Section 1- General

1.1 Sine Wave Filter for motor protection

The sine wave filter is designed to the typical PWM output voltage waveform associated with 3-phase PWM inverters in order to improve the quality of voltage as supplied to the motor and to protect the motor from the effects of over-voltage as caused by voltage reflection in applications with long motor cables.

- 1.1.1 The filter shall connect in series between the inverter output terminals and the motor.
- 1.1.2 The filter shall be suitable for either constant or variable torque voltage source inverters.
- 1.1.2 The filter shall not require a feedback connection to the inverter DC link.
- 1.1.3 The filter shall be suitable for use with one or more motors up to its FLA rating.
- 1.1.4 The filter shall produce nearly sinusoidal output voltage with peak voltage not to exceed 150% of the line to line AC input voltage, and not more than 110% of the dc bus voltage.

1.2 Electrical Ratings:

- 1.2.1 System Voltage: [208, 230, 380, 400, 415, 480, 600, 690].
- 1.2.2 System Frequency: [50 hertz, 60 hertz, other]
- 1.2.3 Load Rating: motors rated 2.2kW (3HP) to 1500kW (2000HP) [Specify FLA, HP or kW rating].
- 1.2.4 Carrier Frequency: Must be set to [5kHz or higher (ideal), 4kHz or higher, 2-2.5kHz].

Section 2 – Basic Product Requirements

2.1 The Sine Wave Filter shall meet the following basic requirements:

- 2.1.1 The filter shall convert the inverter output PWM voltage to a near sine wave with voltage distortion of 10% or less when evaluated at full load, full speed conditions.
- 2.1.2 The filter shall consist of only passive elements.
- 2.1.3 Reactors used in filter must have per phase inductance balanced within 3% of nominal value so as not to cause unbalanced current to flow in the motor.
- 2.1.4 The filter shall not decrease load voltage by more than 8%.
- 2.1.5 Capacitors shall be low ESR, with +/- 4% tolerance or better and must be temperature rated for 85C.
- 2.1.6 The filter shall not use or require any power resistors or fans.
- 2.1.7 The filter shall be a standard catalog item for the manufacturer.
- 2.1.8 Product warranty period shall be 1 year.

2.2 Construction:

- 2.2.1 Three-phase, 3-wire.
- 2.2.2 Filter shall be suitable for free convection air cooling, no fans required.
- 2.2.3 Maximum ambient temperature shall be 40C [other].
- 2.2.4 Temperature rise shall be 115C [80C, other]
- 2.2.5 Construction shall be [open panel, Nema 1, Nema 3R, component kits, other]
- 2.2.6 Efficiency shall be at least 99% at full load at 25C ambient temperature.
- 2.2.7 Construction shall be in accordance with UL, CSA and ANSI requirements.

Section 3 - Acceptable Manufacturer

- 3.1 The approved and acceptable Sine Wave motor protection filter is the Type **SWF** as manufactured by APQ, LLC.

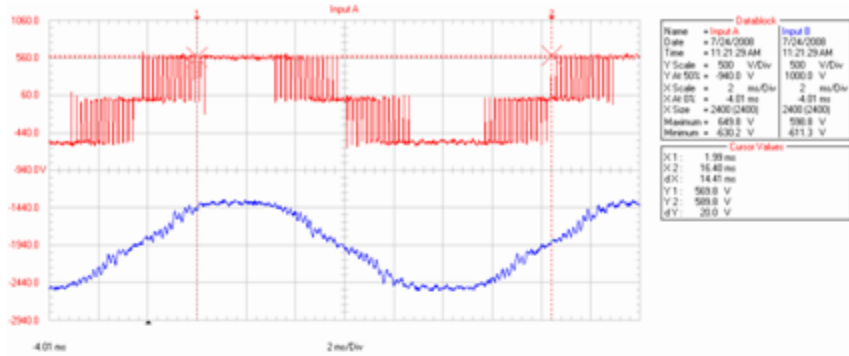
Section 4 – Reference Waveforms

The following illustrations demonstrate the expected and acceptable voltage waveforms at various output frequencies (motor speeds), with operating at light load. Operation of the motor at higher load conditions shall yield similar or improved voltage waveforms.

Typical results for 5KHZ type sine wave filter:

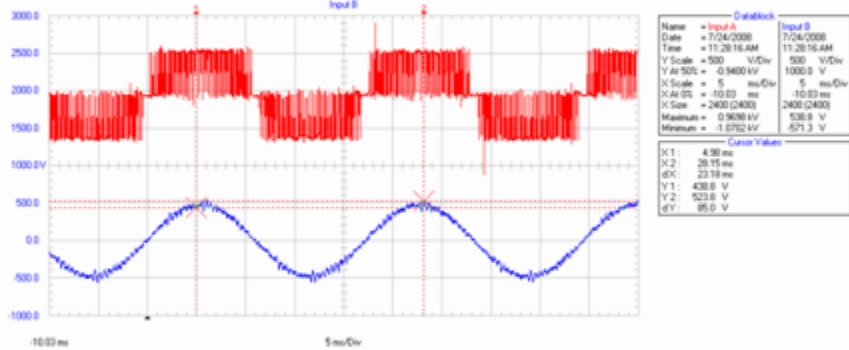
60Hz output, no load
Fc = 5khz

Red (top) = VFD output
Blue (bottom) = SWF output



45Hz output, no load
Fc = 5khz

Red (top) = VFD output
Blue (bottom) = SWF output



30Hz output, no load
Fc = 5khz

Red (top) = VFD output
Blue (bottom) = SWF output

