



## APPLICATION NOTE

### LONG AC MOTOR OUTPUT CABLES OUTPUT REACTORS / OUTPUT FILTERS

The need for an Output AC Line Reactor or some other type of Output Filter between the AC Drive Output and the AC Motor is both AC Motor dependent and Motor Lead Length dependent. If your AC Motor is located very close to the Drive you will generally not have any problems. If your AC Motor was wound with “Inverter Grade” insulation, and the distance between the AC Motor and AC Drive is not too great (200 to 300 feet), you will generally not have any problems either. Problems tend to occur when AC Motor Lead Length is either very long (500 to 600 feet or more), or when AC Motor Lead Lengths are several hundred feet (or more) and the AC Motor was not wound with “Inverter Grade” insulation.

The need for an Output AC Line Reactor or Output Filter is also AC Motor Voltage dependent. Problems are more likely to occur at shorter distances with higher voltage AC Motors (575 VAC and above). At 575 VAC problems may start to appear at 50 to 100 feet of Motor Cable if the AC Motor is not wound with “Inverter Grade” insulation.

All multiple conductor wire runs contain stray inductance and stray capacitance. This creates the possibility of a series resonant circuit in the motor cable system. The longer the motor cables, the lower the resonant frequency. The output of a PWM AC Drive contains switching frequencies that can excite this natural resonance. If the switching frequency of the output power devices is high enough, and if the resonant frequency of the motor cable system is low enough, voltage spikes at the AC Motor terminals can easily reach 1400 to 1500 volts (1700 to 1800 volts at 575 VAC). Unless the AC Motor is designed to handle these high voltage spikes (i.e. wound with “Inverter Grade” insulation), rapid failure of the motor insulation system is likely. The following recommendations are based on typical motor cable installation practices and the output switching frequency of our Drives:

#### Maximum Recommended Motor Cable Lengths (230 or 460 VAC Motors)<sup>1</sup>

Type of Filter (at Drive)	Maximum Cable Length With General Purpose Motor Feet [Meters]	Maximum Cable Length With “Definite Purpose Inverter-Fed Motor” <sup>5</sup> Feet [meters]
None	100 [30]	400 [120]
3 % Output Reactor <sup>2</sup>	300 [90]	600[180]
<i>dv/dt</i> Filter <sup>3</sup>	1000 [300]	3000 [915]]
Carrier Suppression Filter <sup>4</sup>	10 Miles [16 Kilometers]	10 Miles [16 Kilometers]

<sup>1</sup> Consult Factory for Higher Voltage AC Motors (575 VAC and above)

<sup>2</sup> Special Reactor designed for Inverter Output duty.

<sup>3</sup> *dv/dt* Filters are available from US Drives.

<sup>4</sup> Carrier Suppression Filters are available from US Drives. A Step-up-Transformer and/or Oversized AC Motor Cables must be used when an extremely long wire run is required.

<sup>5</sup> “Definite Purpose Inverter-Fed Motor” as defined in NEMA MG1- Part 31 section 31.40.4.2 “Voltage Spikes”.

**Most AC Motor manufacturers either include “Inverter Grade” (voltage spike resistant) insulation systems as a standard feature on all new Three Phase AC Motors or they offer it as an option. Older AC Motors (sold before the mid 1990’s) are unlikely to have this feature.**