SELECTING AND APPLYING OUTPUT FILTERS FOR USE WITH ABB ACS880 480V VFDS

Scope:

This document addresses the issue of how to decide when an output filter may be needed for an ABB 480V ACS880 drive, and gives other requirements and conditions that may apply for a given application.

Explanation:

The vast majority of Variable Frequency Drive (VFD) applications perform with no problems for either the motor or the drive with no need to add external output devices. It is sometimes necessary to consider applying a filter on the output of the drive though, especially when the motor leads are relatively long.

With the advent of IGBT technology, drives have much shorter switching times than those using earlier devices. The faster switching of these devices can lead to a faster rise time of the voltage waveform and a higher peak voltage at the motor terminals. This has led to an awareness of the possibility of increased incidents of motor winding failures. Relatively long motor lead lengths and the impedance characteristics of the cable from the VFD to the motor are primary factors that may determine if there could be possible damage to the motor insulation. Some other factors include: Motor insulation voltage rating, motor and drive impedances, IGBT switching algorithms and, of course, the input voltage to the drive.

Peak voltages observed at the terminals of a motor connected to a VFD can be quite high because of a voltage doubling effect that occurs because of a condition called *reflected wave.* This is a phenomenon that occurs because of an impedance mismatch at either end of the output cables that causes the voltage pulses to be reflected back in the opposite direction from their source. Then, as they encounter the other waves traveling toward them, their values can add on top of each other like what you might observe by watching the reflections of water waves against a seawall. It is the faster rise time and higher peak voltages that can be an issue for the motor.

The higher peak voltages can weaken the coating of the motor's magnet wire over time leading to a breakdown of the insulation of the stator windings. Often such a failure is likely to occur at the first one or two turns of each winding. This is because a faster voltage rise time (higher dV/dt) increases the stress on these coils.

Filter Selection:

The following flow charts have been created to help with the process of determining if a dV/dt filter would be recommended to be applied based on various application characteristics. It is important to consider all of the details of the application including the drive, the motor cables, and the motor when determining if a filter is needed. It is also important to follow each manufacturer's instructions and recommendations for best installation practices. Please select either Light-Overload or Heavy Duty from the following charts for the type of duty cycle required for the application you have in mind in order help to determine if a filter is needed.

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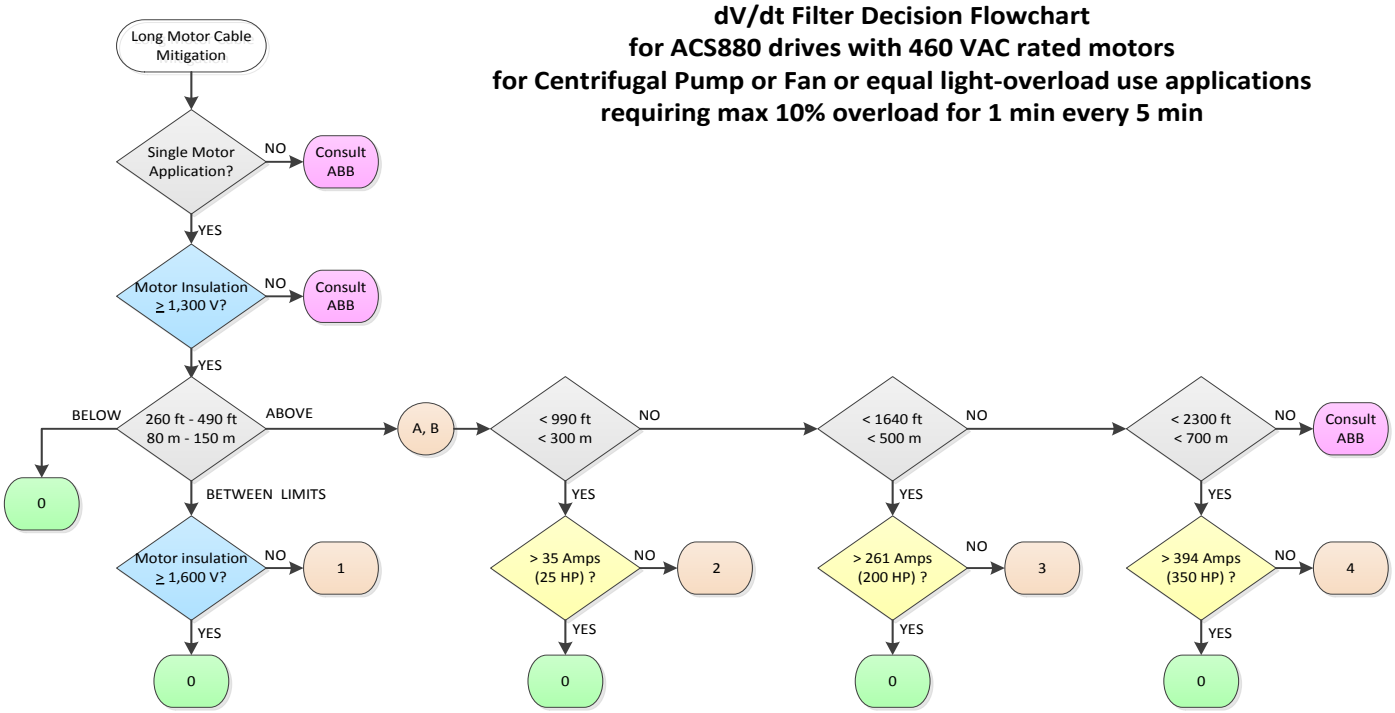
Light-Overload

dV/dt Filter Decision Flowchart
for ACS880 drives with 460 VAC rated motors
for Centrifugal Pump or Fan or equal light-overload use applications
requiring max 10% overload for 1 min every 5 min



Notes:
Switching frequency setting left at drive default values
0. No action required
1. Add dV/dt filter
2. Increase VFD rated current one rating
3. Increase VFD rated current one rating, min VFD current rating 14 Amps and, for DTC Control only, minimum motor rated current 2.3 Amps.
4. Increase VFD rated current one rating, min VFD current rating 40 Amps and, for DTC Control only, minimum motor rated current 6.7 Amps.

A. ABB can't guarantee EMC directive compliance for motor lead length over 490 ft / 150 m for drives rated less than 415 Amps (351 HP) and 325 ft / 100 m for drives rated above 415 Amps (351 HP) and less than 858 Amps (701 HP). Contact ABB if longer motor leads needed for special considerations.
B. ABB considers motor leads over 490 ft or 150 m to be equivalent to a dV/dt filter

Motor's Insulation system limits:
Per NEMA MG 1-2014 Part 31.4.4.2, the voltage insulation system needs to be rated is 3.1 * rated Vac (equals 1,400 V at rated 460 Vac) for "VFD rated motors".

Per ABB Drives, the voltage insulation system rated for 3.5 * rated Vac (equals 1,600 V) or better is good. ABB "VFD rated motors" comply with this.

Per ABB Drives, the voltage insulation system rated for 2.83 * rated Vac (equals 1,300 V) or below is not acceptable to be used with ABB VFDs.

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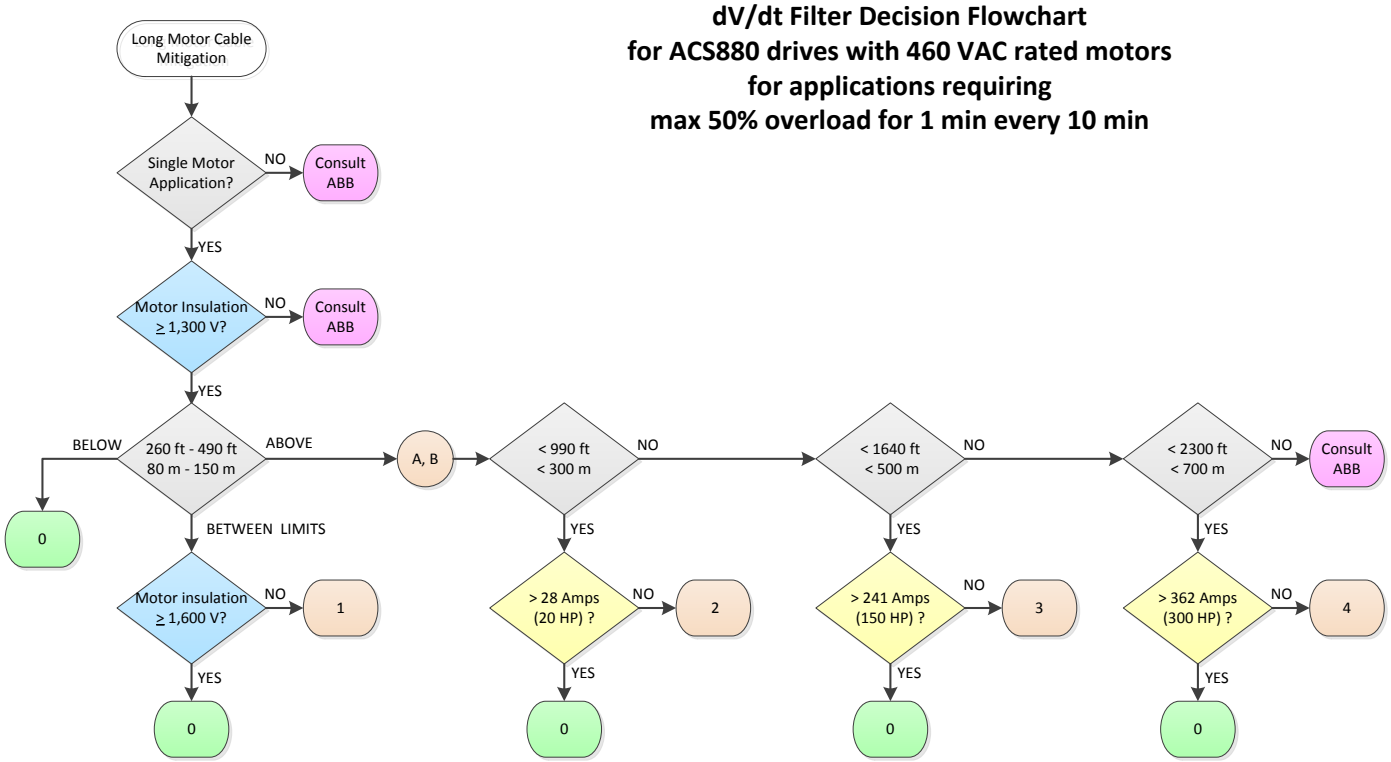
Heavy Duty – Overload

dV/dt Filter Decision Flowchart
for ACS880 drives with 460 VAC rated motors
for applications requiring
max 50% overload for 1 min every 10 min



Notes:
Switching frequency setting left at drive default values
0. No action required
1. Add dV/dt filter
2. Increase VFD rated current one rating
3. Increase VFD rated current one rating, min VFD current rating 11 Amps and, for DTC Control only, minimum motor rated current 1.8 Amps.
4. Increase VFD rated current one rating, min VFD current rating 34 Amps and, for DTC Control only, minimum motor rated current 5.6 Amps.

A. ABB can't guarantee EMC directive compliance for motor lead length over 490 ft / 150 m for drives rated less than 316 Amps (301 HP) and 325 ft / 100 m for drives rated above 316 Amps (301 HP) and less than 571 Amps (601 HP). Contact ABB if longer motor leads needed for special considerations.
B. ABB considers motor leads over 490 ft or 150 m to be equivalent to a dV/dt filter

Motor's Insulation system limits:
Per NEMA MG 1-2014 Part 31.4.4.2, the voltage insulation system needs to be rated is 3.1 * rated Vac (equals 1,400 V at rated 460 Vac) for "VFD rated motors".

Per ABB Drives, the voltage insulation system rated for 3.5 * rated Vac (equals 1,600 V) or better is good. ABB "VFD rated motors" comply with this.

Per ABB Drives, the voltage insulation system rated for 2.83 * rated Vac (equals 1,300 V) or below is not acceptable to be used with ABB VFDs.

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