

## APPLICATION NOTE

**NUMBER: 97217-01**

**SUBJECT: Proper Taping of motor leads in the motor junction box**

IGBT Transistor based drives switch at very high speeds. This fast switching creates high voltage transients in the power wiring to the motor. This may cause problems with power connections in motor conduit boxes.

This problem is not a **Powertec** problem. Neither is it a Brushless DC motor problem. It is an industry problem, and it is of special concern with flux-vector type inverters.

The extent of the problem increases as distance from the drive to the motor increases. A normal run should be 150 feet (50 meters) or less. Even at this distance, we can see transients greater than two times the bus voltage. That amounts to 1300 VDC on a drive powered from a 460 VAC line. Longer lines can produce voltages of up to 3 times bus voltage.

Fast thyristors switched in about 6 microseconds. GTO thyristors could switch up to 6 times as fast. IGBT Power transistors switch ten times as fast as the GTO thyristors. "DV/DT" is the change in voltage with respect to time. In IGBT drives it may be as high as **7000 volts per microsecond!** This level of dv/dt can produce high voltages across very small reactance.

We established standard methods for taping up motor wires in junction boxes in the days when we considered 600 VAC to be a high voltage. AC motors and DC motors operating on a 460 VAC or 575 VAC three-phase line required insulation to this level. It was not difficult to achieve.

We have to use better insulating methods, now. A motor wiring junction barely capable of withstanding 600VAC on an AC motor or DC motor will almost certainly break down on an IGBT based drive.

It is true that the responsibility for the correct wiring of the drive and motor belongs to the installer. However, remember that damage from incorrect taping of the motor leads will probably occur in the drive. We all know whom the customer calls when that happens. In addition, the installers of the industrial world need an education in the points made above.

Service people and Engineers participating in start-ups should examine the motor connections in the motor junction box. A visual examination may reveal situations likely to cause problems in the future. There are some which will cause problems even at lower voltages.

The high voltage transients develop between each phase and ground, between individual phases, and between each phase and the control wires coming into the junction box. Make sure that the isolation from the low voltage wiring is adequate. Look for conditions that do not adequately isolate the power wires, and for conditions that may lead to insulation failure.

One cause of junction insulation failure is the taping of irregular surfaces. This creates sharp edges that can cut the tape or stretch it and weaken the insulation strength. The 3M company published a product data sheet on SCOTCH® Brand No 33+ Vinyl Plastic Electrical Tape. In this data sheet they recommended that the irregular surfaces be padded with "SCOTCHFIL" Brand putty or "SCOTCH" Brand No 23 Tape before insulating with the 33+ tape. This eliminates sharp edges.

Another cause of insulation failure is inadequate tape coverage, or gaps in the coverage. The same data sheet cited above recommends applying the tape in "half-lapped" layers. This applies two layers of tape with no gaps in coverage. The sheet also recommends stretching the tape while applying it, to get a better seal. Do not stretch the last inch of tape, or it may pull loose.

In the data sheet, 3M makes a recommendation for "Fixture Wiring." It applies to all splices up to 1000 volts and 105 °C (220 °F) or less. They *shall* be overwrapped with a *minimum* of two half-lapped layers of No 33+ Vinyl Plastic Electrical Tape. An extra layer or two should add sufficient dielectric strength.

Many professional installers have used "mica" or glass tape to insulate motor leads for many years. This deserves consideration, also.

It would be a shame to have a smooth startup and production cycle messed up by such an insignificant thing as a poor insulation job on the motor leads. Take the time to check them out and encourage the customers to do it also.