NZ 0800 VSD HELP
(0800 873 4357)
AUS 1800 735 855

GENERAL APPLICATION NOTE
Environmental Factors Affecting Drive and Soft Starter Selection

---

Created: **D. O'Donoghue**
Position: **Managing Director (NZ)**
Date: **09/11/04**

Reviewed: **B. Sheridan**
Position: **Technical Director (NZ)**
Date: **09/11/04**

Environmental Factors Affecting Drive and Soft Starter Selection

1.0 Background

Many industrial environments are not ideal for installation of electrical equipment, due to various corrosive, conducting or "clogging" compounds in the atmosphere. The correct product selection, installation and operation can however, prevent many problems from occurring.

A drive or soft starter is comprised of a power section which may be many hundreds of amps and a control section with very small, tightly packed, surface mount components. This combination of high power, a complex computer, tight tolerances and an input/output interface in a difficult environment poses a unique set of problems.

Ideally potential environmental issues should be identified prior to product selection. Purchase of the correct product for the environment can prevent on-going problems which may be many times the purchase cost of the drive or soft starter. In addition common-sense installation procedures give further protection and ensure long trouble-free operation.

1.1 Some examples of compounds likely to be present in various industrial environments are;
Cement manufacturing - cement powder, lime, and water
Chemical processing - corrosive gases, corrosive dust,
Dairy factories - milk powder, protein, and water
Fertilizer works - sulphur dioxide, hydrogen sulphide, urea
Food Processing - chlorine, acids, dust particles, methyl bromide (pest control)
Metal Processing - metal oxides, oil spray
Plastics - plastic particles, static charged particles,
Pulp or paper manufacturing - cellulose, gum, steam
Road/rail Tunnels - carbon dust, oil residues
Rubber processing (tyres) - sulphur chloride, carbon dust (carbon black)
Seafood processing - ammonia, methane, hydrocarbons, sodium chloride and water
Sewage treatment - ammonia, hydrogen sulphide, methane, sulphur dioxide, urea, and water
Tanneries - hydrochloric acid, chromate, hydrogen peroxide, and water
Timber processing - aromatic compounds, chlorine, sulphur compounds and water
Water treatment stations – chlorine and water
Wool processing - lanolin, wool fibre

1.2 In addition various locations can pose additional atmospheric problems
Coastal locations - sodium chloride, humidity (condensation)
Hydrothermal locations - sulphur compounds, sulphur vapour, sulphur dioxide,
Warehousing - diesel fumes Carbon dust, oil residues,
Refrigeration - humidity, ammonia gases

2.0 Solutions for minimizing the effects of a harsh or corrosive environment

A corrosive or harsh industrial environment can cause a variety of faults to occur in a drive or soft starter ranging from discolouration of metal components through to electrical or display faults, over-temperature or nuisance tripping, and in severe cases complete failure.
Modern drives and starters use many surface mount components. These are much smaller than through hole plated components and therefore have much less conductive area. A chemical attack on surface mount components is more destructive as there is less “metal” to react with.
Corrosive gases can react with various electrical and electronic components - especially the metal “leg” connection to the PCB. This can cause open circuits, or short circuits depending on the reaction. The end result is typically intermittent faults or complete failure.
Areas of high humidity can cause condensation to form after switch-off, resulting in catastrophic failure.
Various solutions are available to protect drives and soft starters attack by chemical reaction, corrosive gases in the atmosphere, and condensation.

2.1 Installation in a Protected Area
Where possible install drives or starters in a protected area, to minimize contamination due to the environment or routine operations such as cleaning. Positive pressure rooms and switchboards can be effective. At times the drives or starters may need to be installed some distance from the motor to achieve adequate protection. This may result in long cable runs to the motor and control gear and electrical issues will need to be considered.

2.2 Conformal Coating
Protection of PCB’s and their components can be successfully achieved with the correct application of a high quality conformal coating. Surface mount components, in particular are susceptible to corrosive gases and moisture. Application of a thorough, even, non-atomized coating to a clean dry PCB is essential. Hand coating or atomized spray is not recommended as it typically results in a partial or inconsistent coating and is not effective. Conformal coating is best completed during PCB manufacture, as “post-manufacture” conformal coating can actually trap harmful contaminants.

2.3 Protective Enclosures
Protective enclosures can prevent or reduce solids or liquids from entry into a drive or soft starter. For example an IP21 enclosure can prevent atmospheric solids or water splashes from gaining top-entry into a drive or soft starter, and IP54 enclosures can prevent entry of atmospheric solids or water splashes. However unless the enclosure has a minimum of IP67 gases are not prevented from entering. Anti-condensation heaters can be fitted where humidity or condensation is an issue. Correct cabinet sizing is necessary to prevent overheating of the enclosed equipment.
Refer to Appendix A for a complete description of IP ratings

2.4 High Specification Components
Glass or Ceramic Military specified components can offer some benefits, but tend to be expensive and conformal coating is still essential.

2.5 Chemical scrubbers
Chemical scrubbers can remove airborne pollutants, but this can be a high maintenance and expensive solution.

3.0 POWER ELECTRONICS Specific Product Solutions

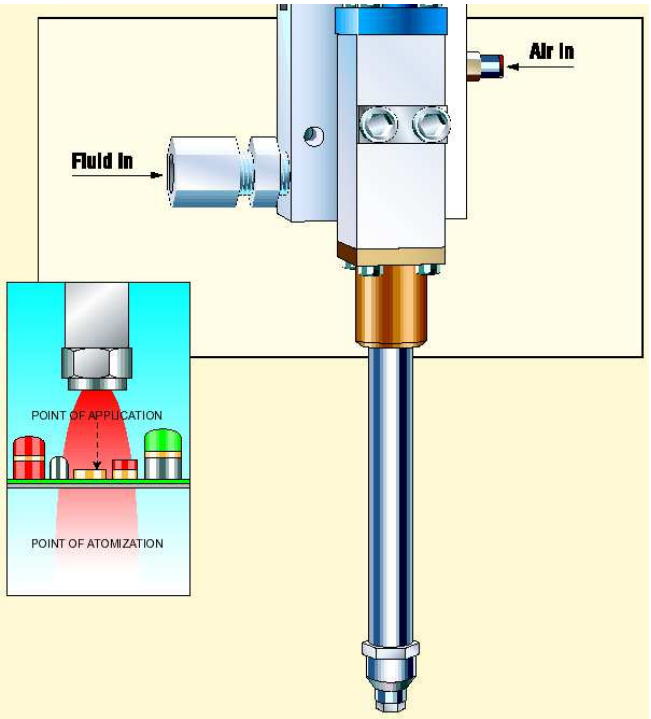
POWER ELECTRONICS products incorporate many design features to minimize the effects of corrosive, hazardous or harsh environments. Even so, further protective measures should be taken when there is any likelihood of damage due to environmental issues.

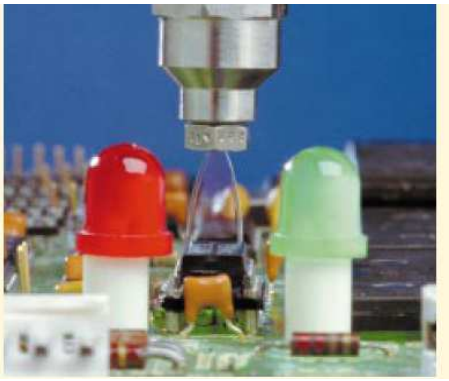
3.1 Design to Pollution degree 2
All Power Electronics products are designed to at least pollution degree 2. (See below for details of Pollution Degree). Correct types of components and adequate spacing minimize the chances of conductive pollution having a detrimental effect on the product.

3.2 Conformal coating
All Power Electronics products have their internal circuit boards conformally coated. The high quality acrylic based conformal coat offers a dielectric strength of 1500V at 50Hz and has an insulation rating of greater than 2.3×10^{14}ohms thus providing excellent protection from potential flashover. This coating is “pumped” on using a CNC robotic machine (see photos below) to ensure a consistent and complete coverage, without air bubbles, on all printed circuit boards. Application of the coating is undertaken in a sterile environment under vacuum to ensure that no contamination is coated “into” the PCB.

Whilst the coating is applied to the entire PCB critical areas such as high performance microprocessors and components, whose characteristics can be adversely affected by heat, are electronically “masked’ so that only the connection pins are coated. This ensures reliable operation of the components as self generated heat can be dissipated to the ambient environment. Application methods such as brushing or dipping make “masking” difficult, if not impossible, resulting in these critical components being partially or totally covered with coating.

This acrylic coating is of the latest technology which allows the coating to be removed with the application of heat (soldering iron) or solvent. This allows access for repair or replacement of the components mounted on the coated PCB.





3.3 Protective Enclosures
Most Power Electronics products are enclosed to IP20 although some variants are available in IP00 and IP54 versions. Where IP20 is inadequate the products may be put in a higher rating enclosure (typically IP54 or more), however consideration must be given to cooling.

4.0 Pollution Degrees

At times a pollution degree is specified and this typically relates to pollution that is conducting. Larger clearances and creepage distances between electrical components typically result in the product having less susceptibility to pollution and can therefore be rated for a higher pollution degree.

Pollution degree ratings are;
1 No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.
2 Normally, only non-conductive pollution occurs. Occasionally temporary conductivity caused by condensation can occur when the electrical equipment is out of operation.
3 Conductive pollution or dry non-conductive pollution occurs which becomes conductive due to condensation.
4 The pollution generates persistent conductivity caused, for example, by conductive dust or liquid.

5.0 Conclusion

Significant thought should be given to the environment in which a drive or soft starter is to be mounted prior to installation. An area free of dust, moisture and contaminants will enhance the working life of the electronic components contained within the drive or soft starter.

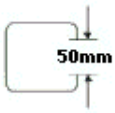
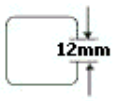
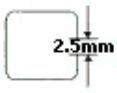
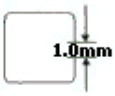
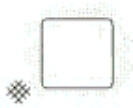
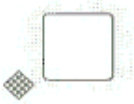
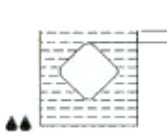
The vast majority of drive and soft starter installations are mounted in areas best defined by Pollution Degrees ratings 1 or 2. Given that these environments can be subjected to conductive pollutants on an occasional and intermittent basis the most common and cost effective solution to ensure reliable operation of the drive or soft starter is the installation of equipment that has been protected with a conformal coating to the specification as described in section 3.2. It is imperative that this conformal coating has been applied during original manufacture as coating of equipment “post manufacture” has proven to offer extremely limited results.

Standard IP rated cabinets and enclosures offer good protection from human touch, some solid objects and liquids (extent of protection dependant on specific IP rating) but it is generally impractical to install sufficiently IP rated enclosures to protect from gaseous contaminants. Drives and soft starters also produce heat during normal operation. When this type of equipment is installed in enclosures or cabinets consideration must be given to how this heat is removed from the enclosure. Often the heat that must be dissipated from the enclosure is enough to warrant the installation of additional cooling fans which source cool air from the general environment. Installation of such fans can allow airborne contaminants into the enclosure negating the enclosures effectiveness.

Solutions such as chemical scrubbing and dedicated constant pressure switch rooms or switchboards are an expensive and high maintenance alternative. They are dependant on external processes working reliably to ensure protection of the installed equipment. Even a small period of non-operation can allow contamination to electronic components installed within their boundaries. Constant type pressure solutions rely on continuous clean filtered air being passed into the switch room or switchboard to create a positive pressure area. These systems require regular checking and cleaning of filters which can become an ongoing headache.

APPENDIX A - IP Rating Table

IP54 = IP Letter Code ——— IP
1st Digit ——— 5
2nd Digit ——— 4

1st Digit	Protection from solid objects	2nd Digit	Protection from moisture
0	Non protected	0	Non protected
1	 Protected against solid objects greater than 50mm	1	 Protected against dripping water
2	 Protected against solid objects greater than 12mm	2	 Protected against dripping water when tilted up to 15°
3	 Protected against solid objects greater than 2.5mmØ	3	 Protected against spraying water
4	 Protected against solid objects greater than 1.0mmØ	4	 Protected against splashing water
5	 Dust protected	5	 Protected against water jets
6	 Dust tight	6	 Protected against heavy seas
Note: EN 60529 does not specify sealing effectiveness against the following: mechanical damage of the equipment; the risk of explosions; certain types of moisture conditions, e.g. those that are produced by condensation; corrosive vapours; funus; vermin		7	 .15m - 1m Protected against against the effects of immersion
		8	 1m+ Protected against submersion **(see note)**