Technical Application Note

Subject:

AUTOMATION IN AGGRESSIVE CONDITIONS – WHY CHOOSE A HARDENED MODICON PAC.

Affected Products

Modicon PAC range

Modicon M580 ePAC range

Modicon M340 range

Problem Description

This document describes the most common industrial environments for which the Schneider Electric Hardened PLC products are strongly recommended and details the benefits that this choice brings.

Operational Restrictions and Recommended Actions

If you have any questions regarding this Technical Application Note, contact your regional support office at https://www.schneider-electric.com/en/work/support/

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1. Introduction and Documentation Scope

This technical note aims to provide general guidelines to correctly manage Schneider Electric Modicon PAC platform installation and avoid or greatly reduce product degradation. Effectively managing the installed product environment is the only way to ensure a long and productive product life.

As of today, a large number of early product failures are caused by factors related to the environment, such as contamination from corrosive gases or temperature and humidity beyond the products specification.

An industrial installation environment can be significantly degraded by condensation and pollution:

- High values of relative humidity & temperature simultaneously.
- Presence of air contaminants such as salt mist or corrosive gases.
- Dust and other solid contamination.

All these environmental conditions have negative consequences on the product life and should be managed in the proper way.

Schneider Electric has designed a specific offer to ensure long and productive product performance in these challenging environments. This solution is called the Hardened or ruggedized PLC product line.

This document describes the most common industrial harsh environments for which the Schneider Electric Hardened PLC products are strongly recommended and details the benefits that this choice brings.

***Note**: Potential explosive environments and other special environments require dedicated equipment, strictly follow ad hoc standards and are out of this document scope.*

2. Principle Degradation Factors for Electronic Cards

The pictures below show the effects of degrading environments on products returned from the field and analyzed inside Schneider Electric laboratories.

Humidity and temperature

Figure 1: Figure 1 Evidences of humidity and temperature effects. Controller was returned because it would not power up.

High values of relative humidity & temperature simultaneously, have a strong impact on the electronic technology:

- reaction with chemicals (flux residues, pollutants on surface) for creation of acid compounds,
- reaction with metal and creation of some surface corrosion, oxidization or dendritic growth (Sn, Ag, ...)

Humidity and temperature may cause condensation through two processes: the increase of humidity at constant temperature and a temperature drop in at constant humidity (to overpass dew point).

Humidity source		Variation of temperature
Atmosphere		Excessive or discontinuous ventilation
Water leaks in the installation room		Insufficient thermal insulation
Presence of water in cable trenches		Heating/Cooling control system not well set up
Trees and plants around the substation walls		Cold air drafts from cable trenches or other openings (under doors, etc.)

Air corrosion

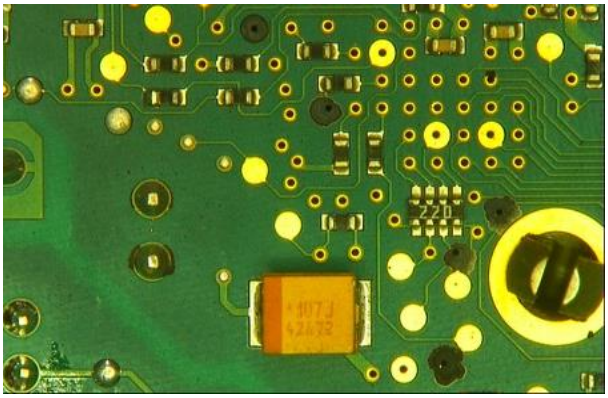

Figure 2:Corrosion attack (black deposits) on standard PCBA used in a dairy plant – the controller will not power up

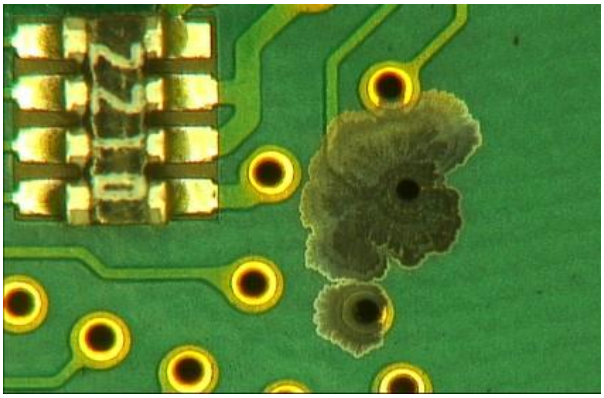

Figure 3: Corrosion attack (black deposits) on standard PCBA used in a dairy plant - the controller will not power up

Corrosion attack is one of the most common failure modes of an electronic card.

Some corrosive chemicals can be embedded in ambient air flow (Chlorine, Fluorine, Sulfur, …) and brought to the area where the PLC are installed. If air flow is not well filtered, with the accumulation in some areas, some local corrosion may appear on sensitive metals of components, PCBs, shields...

Example of corrosive sources are:

- External environments such as polluted urban areas, maritime atmospheres (Environments with high salt content, typical of the application used in or close to the sea).
- Side effects of the principal production process. This can be easily foreseeable (heavy metallurgy productions, presence of Sulphur acid, presence of other aggressive acid, waste water treatments) or less evident (acid created in the dairy industry, chemically active substances as part of paper productions).
- Process not directly linked to production activity (chemical cleaning products used around the plc installation).

Dust and Solid Contamination

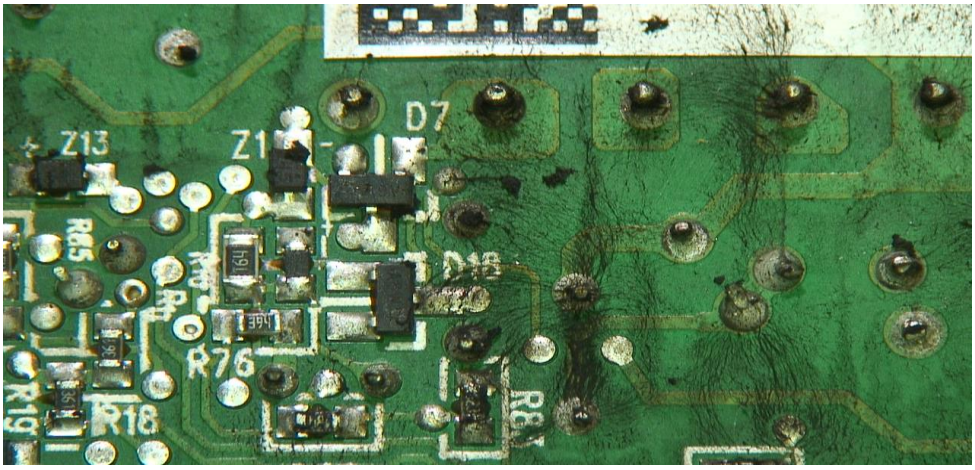

Figure 4: Dust Residues on PCBA

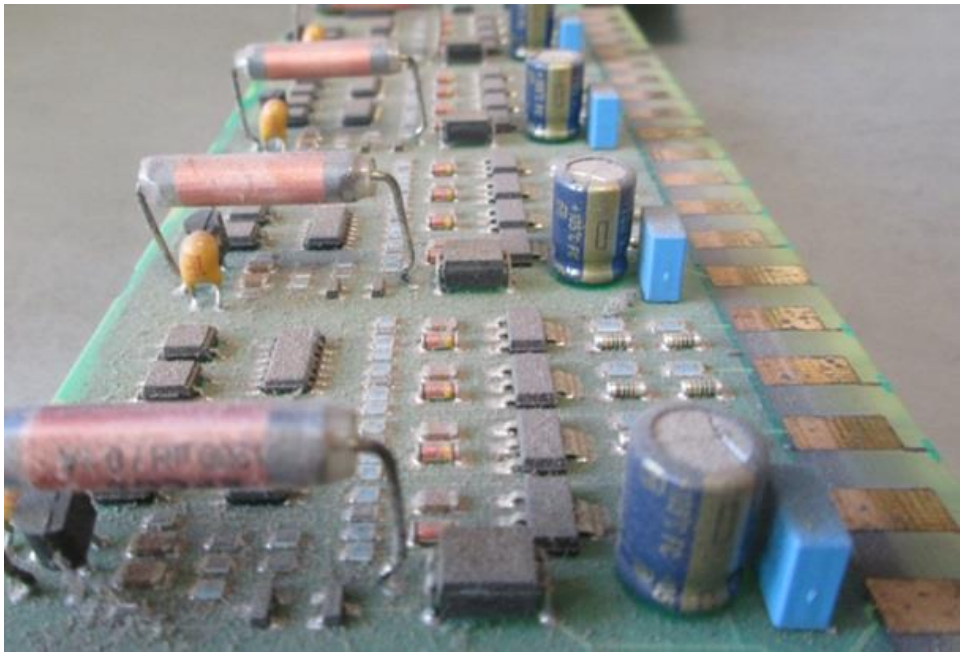

Figure 5: Dust residues on PCBA (2)

Dusty environments are never recommended for electronic components and cards, especially if the dust is conductive (mining, metallurgy production). Nonconductive dust has negative consequences too as the deposit can create some conductive leakages & reactions with chemicals on surface when combined with the humidity from the air.

Dust deposit must be under control and regular cleanup of the area where the PLC is installed is mandatory.

3. Guidelines and Standards

The IEC 61131 – 2 defines all the characteristics that a standard PLC should comply to. It defines the basic environmental conditions:

- Temperature From 5 to 55°C.
- Relative humidity from 10 to 90%, not condensing.
- Altitude From 0 to 2000m.
- Pollution degree max 2 as described in the IEC 60664-1: "only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected".

Outside these values, using a standard product may results in the effect seen in paragraph 2.

Environment severity levels are classified according to:

- **US Standard ISA-S71.04.** It concerns airborne contaminants influence that affects the industrial control systems and define 4 different severity levels from G1 to GX. GX level is a severe environment "in which only specially designed and packaged equipment would be expected to survive".
- **European Standard IEC 60721-3-3.** It concerns the environment classification and defines 4 classes for corrosive gases: 3C1 to 3C4. To be compliant to 3C2 class and over, the salt mix test needs to be performed. Each class defines the maximum value (mg/m3 and cm3/m3) of environmental parameter to be expected (sulphur dioxide, Hydrogen sulphide, Ammonia…)

4. How to Determine How Much Aggressive is an Environment

In a real environment, concentration and nature of the corrosive gases is difficult to be evaluated and could be different from the definition given by the standards (different contents, different pollutants, …).

A simple but effective way to define the severity level is to make a correlation between the customer's real environment and the levels defined in standards. To perform this correlation, a dedicated copper test coupon (a copper-plate metal strip mounted on a Plexiglas panel) is placed in the area for a given duration (1, 2, 3 months). Based on corrosion thickness over the time, it will be possible to correlate and determine the severity level as defined by standards.

5. What are the Solutions to Withstand Aggressive Conditions

To successfully use a controller in aggressive harsh environments (TH, Treatment for Hot and humid environments), two main solutions can be recommended:

Air tight cabinet and industrial location with a positive air flow

The first one is to place the electronic equipment in a cabinet or an industrial location with a minimum protective level IP54 (IEC 60529) or positive pressure of clean air. Being sheltered from external climatic conditions, temperature variations are small, the risk of condensation is minimized and the risk of dripping water is virtually non-existent.

Depending on temperature conditions, cooling or heating systems are required for the internal cabinet temperature with negative impact on energy consumption.

However, it's important to highlight that:

- often it is not possible to place the controllers inside this kind of cabinet (because of space, or because the modules are locally dispersed, ...)
- the protection level must be guaranteed throughout the lifetime of the products (filters to be regularly cleaned and maintained, cabinet door to be always kept closed, etc.)
- the installation, maintenance and management of the cabinets may require a significant investment.

Conformal coating and Hardened products

The preferred solution in terms of reliability and installation maintenance is to choose products treated with conformal coating.

Main advantages of conformal coating are the protection against humidity, condensation, and corrosive gases; the additional dielectric properties (to enable denser designed electronic board than would otherwise be possible); the powerful retardant effect against degradation.

Schneider Electric offers industrially hardened processors and power supply modules, I/O modules and racks which have protective coating on all their circuit boards. These are available both for M340 and M580 range.

This protection, together with an adequate installation and maintenance, makes the Modicon hardened & coated platforms suitable for usage in aggressive harsh environment classified up to 3C4 by the EN 60721-3-3 and up to GX by ISA-S71.04.

		Standard Version	Coated version (C)	Hardened Version (H)
Temperature	Operation	+0°C, +60°C	0°C, +60°C (*)	-25°C, + 70°C
	Storage	- 40°C, +85°C		
Relative Humidity (without condensation)	Cyclical	+5…+95% up to 55°C		
	Continuous	+5…+93% up to 60°C		
Altitude	Operation	From 0 to 2000m (full specification, temperature and isolation) 2000…5000m (temperature derating: 1°C /400m, isolation lost: 150V -- /1000m)		
Aggressive environment suitability		Degree 2 max	G1 to GX severe environment (US Std) 3C2, 3C3, 3C4 (EU Std)	

(*) some of the C product references can operate until -25°C – check the catalogue products for more details.

When a hardened Modicon PAC product is used, a lubricant protection gel for connectors, terminal blocks is strongly recommended (product reference BMXGEL0025).

This chemically seals electrical contacts from oxygen, moisture, aggressive gasses and other hostile elements and should be used during first installation, during periodic maintenance and whenever the modules are disconnected for any reason.

- All electrical contacts (such as front side field wiring connector contacts, RJ45, DB9 and USB connector contacts, backplane connectors, grounding pins) of each product should receive a light application of lubricant protection.
- For terminal blocks, the wire to be connected must be dipped into the lubricant protection before tightening the screw. No need to apply lubricant protection on the screw heads.
- All surfaces that must be protected are properly covered with the lubricant protection.
- Contact surfaces must be clean and dust free before applying the lubricant protection.
- In case of non-used connectors, specific covers are to be used. The terminal blocks cover to reduce exposition must be always kept in place.

6. Examples of industrial processes where hardened version is recommended

Oil refineries (air corrosion, dust)

Wastewater treatment plants (air corrosion humidity)

Dairy industry (air corrosion, dust)

Chlorine production (air corrosion, dust)

Maritime industry (high salt content, air corrosion, temperature & humidity)

Refineries, petrochemical complexes and lng plant (air corrosion, humidity & temperature)

	
Upstream onshore installation (dust, humidity & temperature, air corrosion)	**Industrial port environments (high salt contents, air corrosion, temperature & Humidity)**

7. Checklist to Evaluate Transport, Installation and Working Condition of a Controller

The above points can guide the user in the evaluation of the environment where the controllers are or will be installed.

It's important to highlight that the controllers must be kept under suitable conditions even before the installation and operation. The best working environment conditions will be useless if the installed product has been exposed to the aggressive elements during storage or transport.

✓ During the whole shipment to the customer' site, products must be properly handled, stocked as required by storage conditions and received without visible damage.	
✓ Products must be stocked before installation as required by storage conditions.	
✓ At the time of installation, room/area must be completed and climatic conditions stable.	
✓ During installation time, climatic conditions must be monitored.	
✓ Air Condition system cannot be turned off.	
✓ In case of shutdown, a redundant Air condition system is maintained.	
✓ Once environmental conditions are stable, the environment should be evaluated as per ISA-S71.04 or IEC 721-3-3. See copper coupon method, par 4.	
✓ Temperature and humidity must be evaluated during a sufficient timeframe.	
✓ Pollution degree must be evaluated during a sufficient timeframe.	
✓ Presence of machines / equipment / materials in the area with environmental impact (dust creation, chemical substances) must be taken into account.	
✓ Air circulation system must be present and maintained (presence of filters, filters maintenance…)	
✓ Cleaning products must be checked before use.	
✓ Maintenance and cleaning procedures must be defined and operative.	