Applying SEL Products in Harsh Chemical Environments

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Introduction

SEL products are installed in many critical applications. Some of these applications involve exposure to harsh chemical environments with measurable levels of the following gases:

- Chlorine (Cl_2)
- Hydrogen sulfide (H_2S)
- Nitrogen dioxide (NO_2)
- Sulfur dioxide (SO_2)

Prolonged exposure to certain concentrations of these chemical compounds can cause damage to surface mount technology (SMT) electronic components, resulting in possible failure of power protection, automation, communications, or metering equipment. This application note describes this problem in more depth, identifies some of the industry sectors where these compounds are present, and provides solutions to mitigate their effects.

Problem

The circuit boards in SEL products use SMT components with silver terminations. Exposed silver is susceptible to damage from high concentrations of the gases listed previously, particularly H_2S, so these silver terminations are covered by a protective airtight mask. If the mask fails in a product that is applied where harmful gas levels are greater than 10 parts per billion (ppb), the SMT components can be damaged after an extended period of time. Such damage can cause various types of relay failures, some of which may not be detected by the relay self-test function.

SEL has observed this problem in a small percentage of units installed in environments contaminated with H_2S gas. SEL analysis revealed that damage to these units was caused when H_2S gas reacted with exposed silver on the SMT component terminations. This reaction creates dendrites of silver sulfide (a nonconducting material), as shown in Figure 1; see Figure 2 for comparison. Over time, this reaction consumes the silver termination, causing component failure.

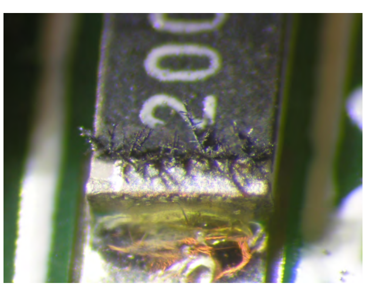

Figure 1 Failed Surface Mount Resistor With Silver Dendrites Caused From an H_2S Reaction

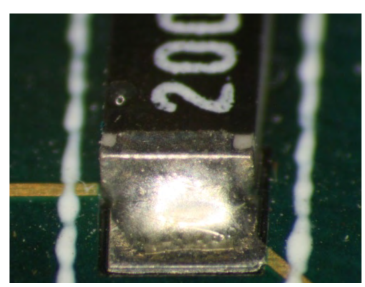

Figure 2 Surface Mount Resistor in Perfect Form for Comparison

Industry Sectors With Harsh Chemical Environments

SEL research has shown that relays installed in the following industry sectors may have an elevated exposure to harsh chemical environments:

- Organic and agricultural chemicals
- Oil and gas
- Water treatment
- Petroleum and petrochemical refining
- Pulp and paper
- Grain and sugar
- Geothermal power generation

In addition, any industry where H_2S or other corrosive gases are used in the manufacturing process or where these gases are a byproduct should be considered a harsh chemical environment. End users with relays operating in these environments are encouraged to order relays with conformal coating to protect the relay components from extended chemical exposure. Conformal coating is explained in the following section.

Solutions

Conformal Coating

Conformal coating is a thin layer of synthetic resin or organic polymer. When applied to printed circuit boards and components, it provides protection against environmental and chemical contaminants. "Conformal" refers to the fact that the coating conforms to the contours of the assembly, as shown in Figure 3.

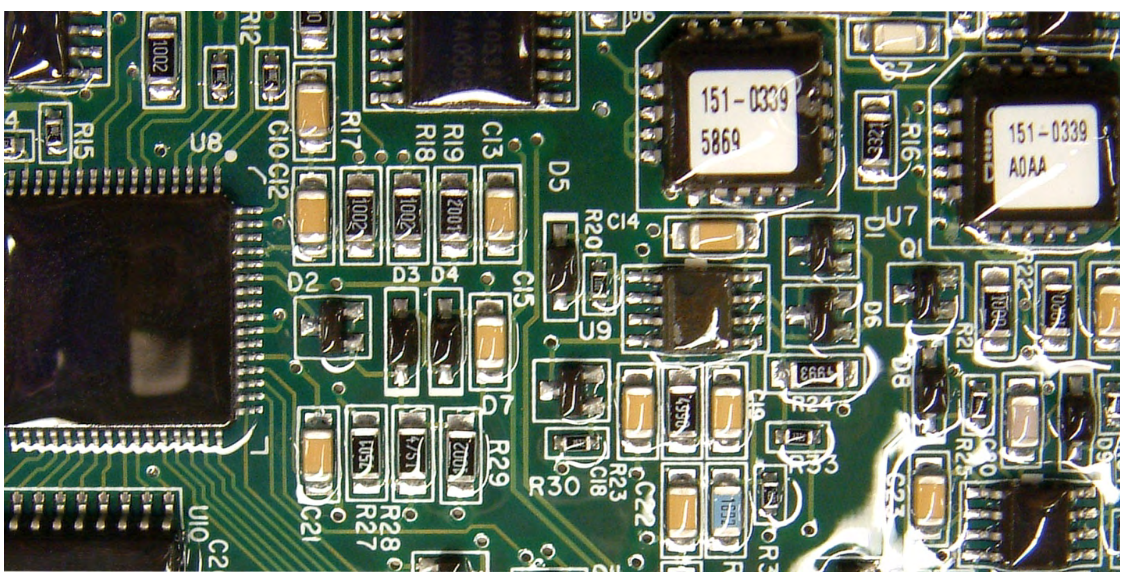

Figure 3 Circuit Board Showing Components Sealed With a Layer of Conformal Coating

Conformal coating provides a durable protective coating from moisture, salt, fungus, mechanical damage, and other environmental and chemical contaminants. SEL products with conformal coating have been tested and approved by independent laboratories to the following specifications for mixed flowing gas, hygroscopic dust, and damp heat:

- Telcordia Technologies GR-63-CORE, Issue 2, April 2002, *Network Equipment Building System (NEBS) Requirements: Physical Protection* (modified – test duration extended).
- EIA 364-65A Class IIIA (modified – test duration extended).
- IEC 60068-2-30-1980, 1985, *Basic Environmental Testing Procedures, Part 2: Tests – Test Db and Guidance: Damp Heat, Cyclic (12 + 12-hour cycle)* (severity level 25° to 55°C, 6 cycles, 95 percent relative humidity).

Per GR-63-CORE, the recommended test duration for mixed flowing gas is 14 days if testing to a service life of 20 years. SEL products were tested in a mixed flowing gas and hygroscopic dust environment for a duration of 31 days with no failures. Mixed flowing gas includes contaminants Cl_2, H_2S, NO_2, and SO_2. Hygroscopic dust can contain water-soluble salts, sulfates, nitrites, volatile organic compounds, SO_2, H_2S, ammonia (NH_3), nitric oxide (NO), nitrogen dioxide (NO_2), nitrous acid (HNO_2), ozone (O_3), and Cl_2.

SEL recommends the conformal coating option for products used where environmental contaminants are present. In such environments, hazardous chemicals can degrade unprotected circuit boards and components.

Other Mitigation Techniques

In many applications, electronic equipment is housed in small structures or buildings. Maintaining positive air pressure, in addition to filtering incoming air, limits the exposure of electronic equipment to high concentrations of harsh chemical gases.

Additional protection is provided by installing vulnerable equipment in enclosures approved by the National Electrical Manufacturers Association (NEMA). These sealed enclosures provide protection from harsh chemical environments.

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