

# Reliability of electronics to humidity-related failures

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# Reliability of electronics to humidity-related failures

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The quest for sustainable energy sources have led us to renewable sources of energy like wind, solar, tidal, fuel cells, geothermal energy etc. The energy produced from these sources have to be processed before feeding into the electrical grid. The processing of raw electric power produced by solar cells, wind turbines, fuel cells etc. have to be done using power electronic converters. Due to the currently ongoing move towards sustainable energy technologies, more and more power converters would find application in power production, transmission and processing. An example of this is the solid-state transformer (SST) which can provide voltage regulation, reactive power compensation, dc-sourced renewable integration, and communication capabilities, in addition to the traditional step-up/step-down functionality of a transformer [1].

Humidity related failures contribute around 20% to the total failures in electronics [2]. The failure mechanism due to humidity in electronics is the combined interaction of humidity and temperature on materials comprising the components and printed circuit board assemblies (PCBA) used in electronic control units (ECUs). High humidity if present inside the electronic enclosures can condense on PCBAs and components under certain conditions causing short circuit currents. Another mechanism which can cause short-circuit failures is electrochemical migration [3]. Failures can also result from leakage currents on PCBAs and components due to low-impedance paths created by adsorbed microscopic layer of water. The magnitude of the leakage current is amplified by the presence of hygroscopic ionic contamination left behind on the PCBAs from the PCB manufacturing and component assembly process.

This work demonstrates an ongoing research that seeks to:

1) Study how humidity accumulate inside electronics enclosures under constant and cycling conditions of temperature.
2) To predict humidity related issues in a given circuit design for a certain humidity and contamination concentration on PCB.
3) To predict humidity accumulation and condensation on PCBA for a particular climatic profile of relative humidity (RH) and temperature.
4) To study methods to prevent condensation and high humidity inside electronic enclosures.
   The methods studied include preferential condensation to remove excess humidity and heating to reduce the RH.

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