NAVSEA Component Testing

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Introduction

Our project consisted of testing surface mount components: Zener Diodes, Transistors, and MOSFETs. Manufacturers of these components will sometimes have grades of components such as automotive or commercial grade but will list the same datasheet for both grades. We wanted to find out if there were any differences between these grades by testing some of their key parameters and comparing the results.

Components

Zener Diode

The Zener Diode acts like a normal diode but also can conduct in the reverse direction after reaching its Zener voltage. The tests ran on this component were: Reverse Current Leakage, Forward Voltage, Breakdown Voltage, Scope Display, Forward Recovery Voltage and Time, and Surge Current.

BJT

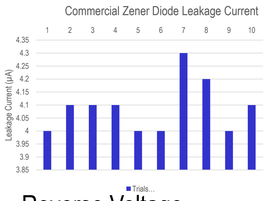
The BJT or Bipolar Junction Transistor has tons of applications, from switching to amplification and more. The tests ran on this component were: Breakdown Voltage, Collector to Emitter Voltage, Emitter to base cutoff current, Saturation Voltage, Characteristic Curves and DC current Gain.

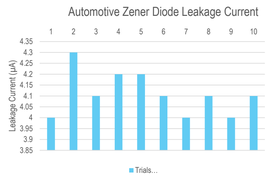
MOSFET

MOSFETs are similar to BJTs and also have a variety of applications. The tests ran on this component were: Breakdown Voltage (Gate to Source), Breakdown Voltage (Drain to Source), Drain Current, and Threshold Voltage.

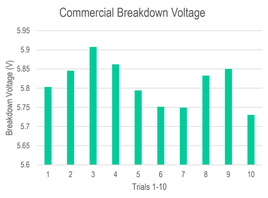
Zener Diode Results

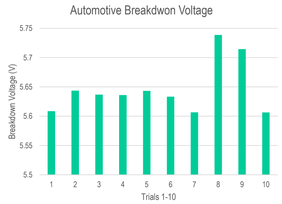
Reverse Current Leakage



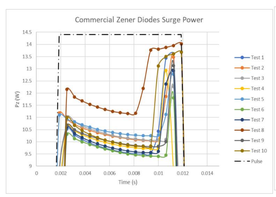


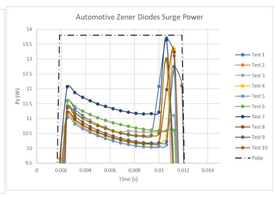
Reverse Voltage





Surge Current



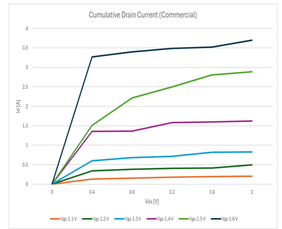


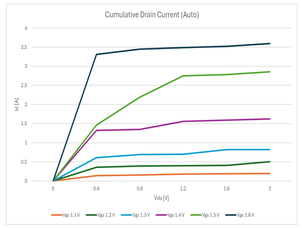
Temperature Cycling

- MOSFET, BJT, and Zener diode components underwent temperature cycling stress tests (-55 - +150°C)
- 20 cycles each
- ~30 mins in each extreme with the period of 1 cycle being just over an hour
- After exposing these components to extreme high/low temperatures, some expected results might be:
  - Changes in the switching behavior due to shifts in threshold voltages
  - Acceleration of unwanted dopant diffusion
    - Process of dopant atoms moving within the semiconductor material which could lead to a change in path resistance, junction depth, and/or junction leakage currents
  - An increase/decrease in carrier mobility

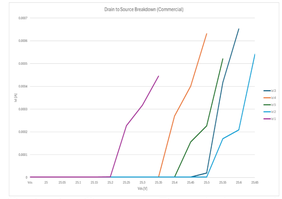
MOSFET Results

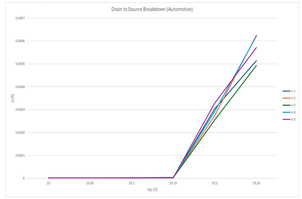
Drain Characteristics



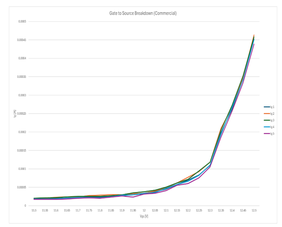


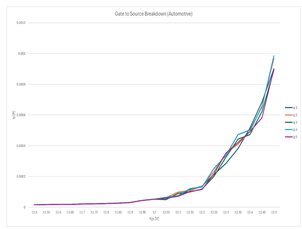
Drain to Source Breakdown Voltage





Gate to Source Breakdown Voltage



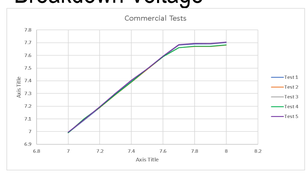


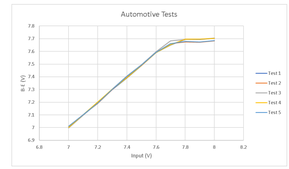
Autoclave

- After exposing parts to extreme moisture and pressure, the expected results would be:
  - Corrosion and oxidation of the metal contacts and interconnects could lead to high resistance in the electrical paths creating more power consumption, a decrease in performance, or even failure
  - Moisture can also affect the integrity of the packaging which would lead to more device exposure
  - Moisture ingress can affect the dielectric properties of insulating materials which causes higher leakages

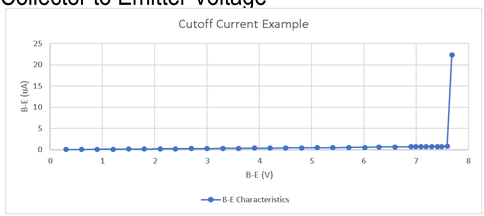
BJT Results

Breakdown Voltage

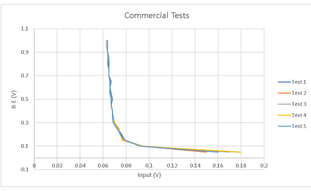


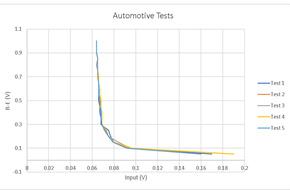


Collector to Emitter Voltage

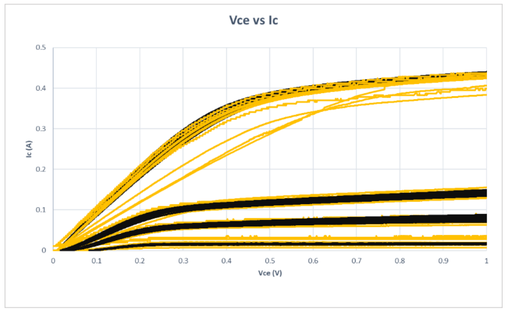


Emitter to Base Cutoff Current





Characteristic Curves



Conclusion

The results from our tests revealed that there are not too many differences between the grades of components. Some tests did reveal that automotive components had less deviation between each component compared to the commercial grade counterpart. We believe that there would have been more noticeable differences between the grades when testing them under the stressed conditions.