

# Investigation and Analysis of Failure Modes in 16A Switches

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## **Abstract**

This project work deals with the investigating and analysis of failure modes in 16A switch. The objective of this project is to increase the lifespan of the switches and to operate safer in high voltages. Mainly in water heater, due to fluctuation or over loading reasons, heat is produced in the switch terminals, and this causes the failure effects in electric switch components. Therefore, to avoid or reduce the switch internal components failure, this work is carried out. Different approaches are initiated to measure the switch failure reduction effects, such as, analyzing the effects by cooling paint coating used to decrease the heat effect and measuring the temperature reduction value. From the inference of the results, the suggestions to avoid the effects of 16 A switch damages have been provided.

**Keywords:** Switches, cooling paint, polycarbonate, switch socket

## **1. Introduction**

### **1.1 Switches**

Any device that interrupts the passage of electrons in a circuit is known as an electrical switch. Switches are fundamentally binary devices in that they are either fully on ("closed") or fully off ("open"). Switches come in a variety of shapes and sizes, and we'll look at a few of them in this chapter. Two electrical wires are brought into contact with each other by the action of an actuation mechanism in the simplest sort of switch.

### **1.2 Cooling Paint**

Cooling paint is a type of heat reflective paint that is meant to reflect more sunlight while absorbing less heat than a regular roof. Its use lowers the temperature of the roof and, as a result, lowers the temperature of the room. Because the temperature differential across

the slab is minimized in air-conditioned environments, the electricity usage is reduced. Cool paint material is meant to reflect more sunlight and absorb less heat than a regular roof, similar to how light-colored clothes may help keep you cool on a hot day. Cool Paint is an emissivity aqueous coating based on acrylic-resins that produces a highly reflecting form of paint.

### **1.3 Hiding Power**

Hiding power is a feature of paint that allows it to destroy whatever backdrop it is applied on beyond recognition. When the paint placed over a back backdrop has a reflectance of 0.98 of that applied in equal thickness over a white background, it is considered full concealment. As a result, concealing power is a function of the background contrast ratio and the paint thickness necessary to lower the contrast difference to 0.02. The figure 0.02 is based on the Weber-Fechner law, which asserts that for moderate light, changes of less than 2% are undetectable to the human eye.

### **1.4 Analysis by ANSYS**

Cooling paint is the solution for reduce the thermal effect in the switch terminal. Analyzing the thermal effect through the ANSYS software, finding the thermal resistance in the copper plate with the respective reading of the temperature difference and to carry out thermal conduction finite element analysis of copper plate section and to validate with the respective temperature calculation are performed. After completing the copper plate to meshing the section of the plate to identifying the difference of the temperature in the copper plate with the respective temperature to varying the thermal analysis. Geometry of the cross section is needed for the value of the copperplate and to extrude the thermal analysis.

## **2. Failure Investigation of Switches**

### **2.1 Construction**

Thermal effect in switches of coated and non-coated analyzing circuit .This circuit is help to identify the thermal effect in the switch terminal and rectifying the thermal impact and identifying the thermal impact failure of the 16A switches. In this experiment, a voltmeter, ammeter and variance resistor are connected with the connecting cables and attached to the switch terminal into the load of two rod water heater with the 1500watts and totally 3000watts.



**Figure 1.** Case 1 Non-Coated Switch

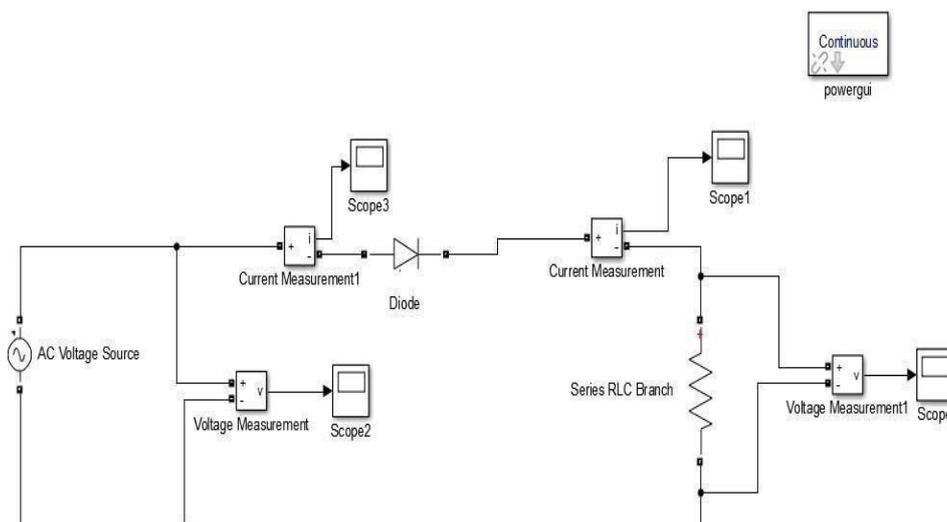


**Figure 2.** Case 2 Coated Switch

This switch terminal side is to test in the experiment to find the thermal effect and the thermal impact on the switch spring and containing the variation in the amps and the wire connection positive and the negative side in the switch terminal to bring the current to find the temperature of the effect.

This switch terminal side is coated with the cooling paint of 0.5mm thickness to reciter the heat process and to be tested in the experiment to find the thermal effect and the thermal impact on the switch spring and containing the variation in the amp sand the wire connection positive and the negative side in the switch terminal to bring the current to find the temperature of the effect.

## 2.2 Experimental Setup



**Figure 3.** Circuit for testing

### 3. Results and Discussion

To evaluate the accuracy of the measurements, experimental system was tested with 16A switches of coated and non-coated analyzing circuit Figure 3.1 shows the comparison between the measured effects of 16A switch with respective difference time limit and effects of coated 16A switch with respective difference time limit in which is evaluated by this circuit and analysis by the ANSYS of thermal impact in the terminal. As shown in Tabulation 3.6, the good agreement exists between the experimental data and predicted values.

- Finding a thermal effects in the 16A switch with variation of different amps
- Thermal analysis through the ANSYS software and
- Brittleness of the polycarbonate

#### 3.1 Effects of 16a Switch with Respective Differences

**Table 1.** Temperature Effects of Non-Coated Switch

Current (A)	Temperature °C					
	2min	4min	6min	8min	10min	12min
1	35.4	35.5	35.5	35.6	35.6	35.6
2	35.5	35.6	35.6	35.6	35.7	35.7
3	35.5	35.6	35.6	35.6	35.7	35.7
4	35.5	35.6	35.6	35.7	35.7	35.7
5	35.8	35.8	35.8	35.8	35.8	35.9
6	35.8	35.9	35.9	35.9	35.9	35.9
7	35.9	36.1	36.1	36.1	36.2	36.3
8	36.1	36.3	36.4	36.4	36.4	36.5
9	36.4	36.4	36.4	36.5	36.6	36.8
10	36.8	36.8	36.8	36.8	36.8	36.9
11	36.8	36.9	36.9	36.9	37.1	37.1
12	37.1	37.1	37.2	37.2	37.3	37.3
13	37.4	37.4	37.4	37.6	37.8	38.1
14	38.2	38.3	38.3	38.4	38.5	38.8
15	38.8	38.8	38.9	38.9	39.2	39.4

### 3.2 Thermal Effect of 16A With Respective Difference Amp

**Table 2.** Temperature Effect with Respective Amps

Current (A)	Voltage (V)	Temperature °C
0	0	35.4
1	60	35.4
2	88	35.5
3	110	35.5
4	148	35.5
5	186	35.8
6	218	35.8
7	230	35.9
8	246	36.1
9	256	36.4
10	272	36.8
11	288	36.8
12	296	37.1
13	312	37.4
14	326	38.2
15	338	38.8

### 3.3 Effects of Coated 16A Switch With Respective Difference

**Table 3.** Temperature effect of coated switches

Current (A)	Temperature °C					
	2min	4min	6min	8min	10min	12min
1	33.8	33.8	33.8	33.8	33.9	34.1
2	34.1	34.1	34.1	34.2	34.2	34.2
3	34.2	34.2	34.2	34.3	34.3	34.3
4	34.4	34.4	34.4	34.4	34.5	34.5
5	34.5	34.5	34.5	34.5	34.6	34.6
6	34.6	34.6	34.6	34.6	34.7	34.7

7	34.7	34.8	34.8	34.8	34.8	34.8
8	34.8	34.8	34.9	34.9	34.9	34.9
9	34.6	34.9	34.9	35.1	35.1	35.1
10	35.1	35.1	35.1	35.1	35.2	35.2
11	35.2	35.2	35.2	35.2	35.2	35.2
12	35.2	35.2	35.3	35.3	35.3	35.3
13	35.3	35.3	35.3	35.4	35.4	35.4
14	35.4	35.5	35.5	35.5	35.5	35.5
15	35.7	35.7	35.7	35.7	35.7	35.8

### 3.4 Thermal Effect of Coated 16A With Respective Difference Amp

**Table 4.** Temperature Effects of Switches with Respective Amps

Current (A)	Voltage (V)	Temperature °C
0	0	33.8
1	57	33.8
2	76	34.1
3	110	34.2
4	144	34.4
5	186	34.5
6	218	34.6
7	228	34.7
8	246	34.8
9	258	34.6
10	276	35.1
11	292	35.2
12	302	35.2
13	312	35.3
14	326	35.4
15	338	35.7

### 3.5 Graph for Thermal Effect in Coated and Non-Coated Switches

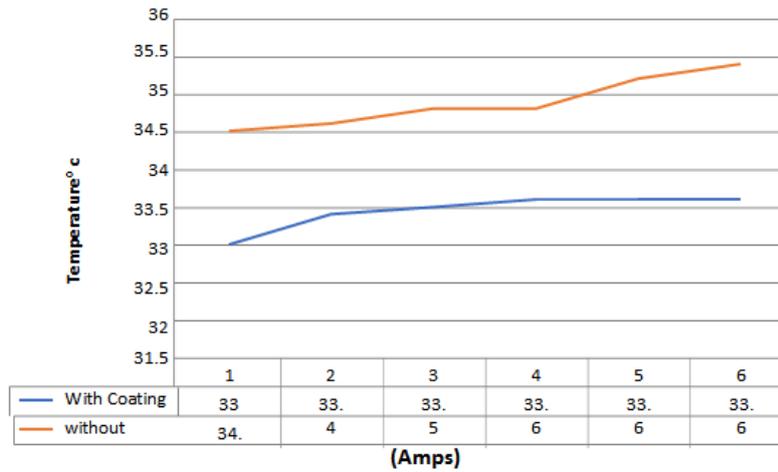


Figure 4. Graph for thermal effect

### 3.6 Analysis of 16A Switch Thermal Effect in Non- Coating

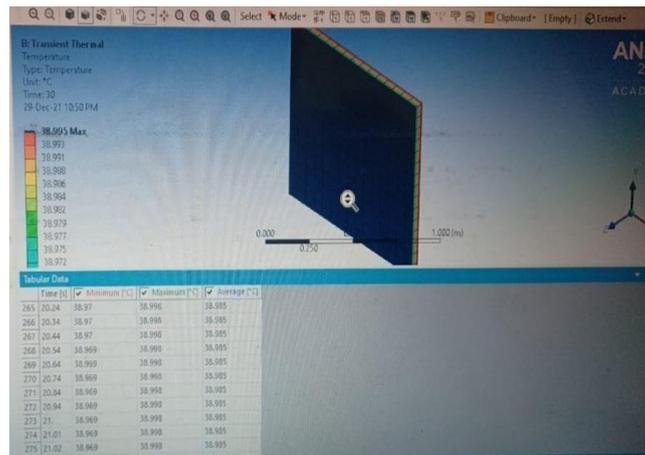


Figure 5. Front view of the copper plate

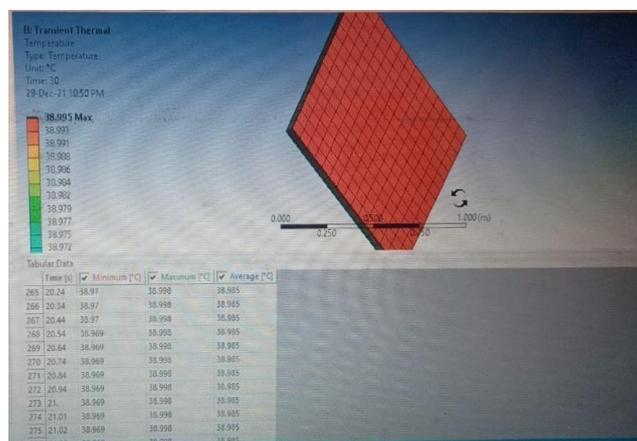


Figure 6. Back side of the copper plate

### 3.7 Heat Flow in the 16A Switch Terminal in Non- Coating



Figure 7. Heat flow in the copper plate

### 3.8 Analysis of 16A Switch Thermal Effect in Coating

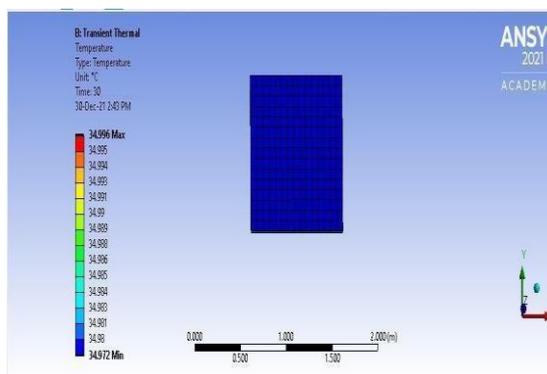


Figure 8. Front view of the coated plate

### 3.9 Heat Flow in the 16A Switch Terminal in Coating 2

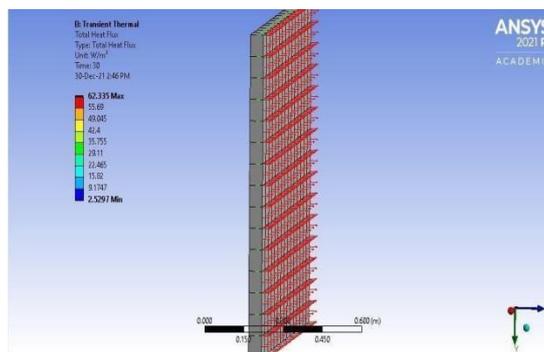


Figure 9. Heat flow in the coated plate

## 4. Conclusion

The work is carried out to investigate and analyze the failure modes in 16A switches. From these results expected to extend the life of the switches and make them for safer to use

at high voltages. Heat is produced in the switch terminals due to current passing level with respect to time of usage of power supply. Specially in water heaters failure of switches occurs frequently, its due to overloading or fluctuation of power supply these effects are the causes of failures of electric switch components. In this work experimental analysis is done using heater as a loading purpose to observe the effects of power supply in 16 A switches. And the ANSYS analysis results are used to understand the effects and investigate its performance. The failure causes due to overheat material behavior changes in internal components of switch. Mostly switch failure occurs in the spring locator point. To avoid this failure either spring locator point need to be strengthen else need to reduce the heat energy in spring during operation. In this work heat reduction process is considered for that purpose cooling paint is used. The experimental and analysis results of the coated switch and non-coated switches are monitored to measure the temperature reduction value and proved the effects of a cooling paint from the results used to reduce the heat effect..

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