# Basic Electricity II: Troubleshooting Opens

## EdTech 533: YouTube for Educators

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| **Author/Director** | **Douglas Bushong** |
| **Basic Description** | A basic course describing the technique for troubleshooting electrical opens. |
| **Target Learner** | Linemen, Electrical and Gas Service Technicians at the apprentice level. Students in an electrical technology program. |
| **Prereq Knowledge/ Skill Needed** | Students should have completed Basic Electricity I, and have a firm understanding of a multimeter's operation. |
| **Equipment Needed** | Training Center troubleshooting boards, multimeter. |

## Storyboard

| **Screen** | Audio | Production Notes |
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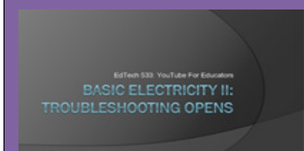
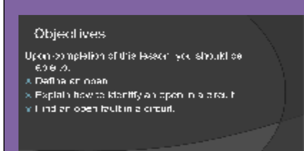
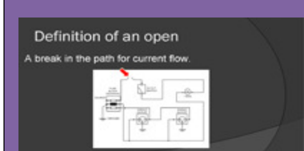
|  | Hello, and welcome to Basic Electricity II, Troubleshooting opens.<br><br>The purpose of this lesson is to teach you the basic theory behind troubleshooting an open fault in an electrical circuit. Before viewing this lesson, you should have completed Basic electricity I, and have a firm understanding of how to use your multimeter. | Static, introductory slide.<br><br>I used a PowerPoint Template for the slides, setting the dimensions to a 16x9 ratio.<br><br>I also used the Camtasia Studio trial for this video, recording at 1280x720 at 30fps.<br><br>Final edits were done using Adobe Premiere Pro. A Logitech USB microphone with a home-made pop guard was used to record the voice narration. |
|  | Upon completion of this lesson, you should be able to:<br><br>• Define an open.<br>• Identify the conditions of and troubleshoot an open.<br>• Find an open fault by taking voltage readings. | Static slide defining the lesson objectives. Bullet point introductions are animated in PowerPoint. |
|  | An open is an unintentional break in the path for current flow. The break that you see here is an example of an open. | Slide defining an open. Also contains a simple circuit depicting an open.<br><br>Animation for the arrow was accomplished on PowerPoint, while the animation of the circuit open was accomplished using a blinking layer between the arrow and the back image. |

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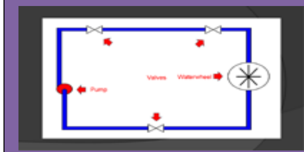
|  | Recall from basic electricity I that voltage is analogous to pressure in a fluid system. In this fluid system, we have a pump for our flow source, a water wheel for our load, and three valves that will serve as control devices.<br><br>Now notice that when the pump is turned on, we initially do not have flow through the water wheel because the three valves are shut. The blue line shows that the discharge pressure of the pump is being applied to the first valve, but nothing else.<br><br>If we open the first valve, we see the discharge pressure of the pump is applied to the second valve.<br><br>If we open the second valve, we see that the discharge pressure of the pump is applied to the water wheel and to the third valve. However, notice that the waterwheel still does not spin. This is because the flow necessary to spin the waterwheel requires a completed path in the circuit.<br><br>It is only when we open the third valve that the water from the discharge of the pump can reach the suction of the pump, and waterwheel can do work. | Animated slide depicting a mechanical fluid flow system. This system is analogous to an electrical system, and often allows students with mechanical backgrounds to more readily see how electrical circuits work.<br><br>This was done in layers using Paint.NET. Along with the arrow animations, the fluid flow was created using entrance animations with layered images.<br><br>**NOTE: when you are hitting the system's components, you are going to flow through these quickly. BE READY.** |
|  | Now, electrical circuit works on the same principles. That is, the electrons must have a complete path for current if they are to do anything useful. In this electrical circuit, we have a battery for our source, a lamp for our load, and three single pole single throw switches to serve as our control devices. Initially, the lamp is not energized because all three of the switches are open. That is, the electrons do not have a complete path for flow. The voltage from the battery is applied to the first switch, and that is all.<br><br>Now, if we shut the first switch, we see that the voltage is applied to the second switch.<br><br>When we shut the second switch, we see that the source voltage is applied to the lamp, but the lamp does not illuminate. Just as applying pressure to the waterwheel would not make it spin, simply applying voltage to our load will not cause it to light. It is only when we close the third switch, and complete the path for current flow, that we see the lamp light.<br><br>Now, it is this principle of operation that will help us find an open in a circuit. | Animated electrical equivalent to the mechanical system shown in the last slide. Developed using the same technique.<br><br>**NOTE: when you hitting the circuit components, you are going to flow through these quickly. BE READY.** |

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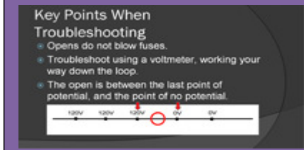
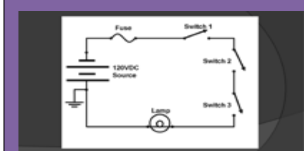
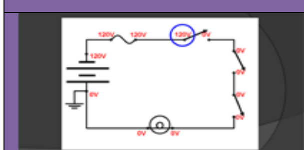
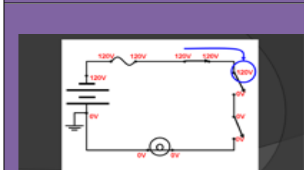
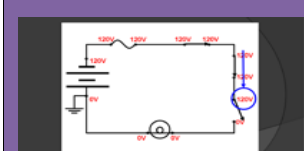
|   | Before we dive into the circuit, though, let's take a look at a few identifiers for opens.<br>First, opens do not blow fuses. Fuses blow because of a high current condition. If a circuit is open, however, the current through that circuit will be zero. If your initial condition is a blown fuse, then you are looking for a short, not an open.<br>When troubleshooting an open, you should use a voltmeter, or the voltmeter function on your multimeter. Connect the negative lead to your neutral or common, and work your way down the loop until your find a drop in potential.<br>The open will be between your last point of potential, and your point of no potential. | Text slide explaining the key points to troubleshooting opens.<br><br>The most important part of this slide is the third point: the fault is between the last point of potential and the point of no potential. |
|   | Consider this simple circuit, which contains a 120VDC Battery, a single fuse, three SPST switches, and a lamp. | Simple image depicting the circuit we are analyzing in the slides that follow. This circuit sets the tone for what is to come. Also, in clearing the symbols, we clarify the components for students that may be familiar with electrical theory, but not schematics. |
|  | During normal operation with the switches open, these are the voltages you will see. Since the first switch is an intentional break in the circuit, the last point of potential is directly upstream of that switch. | Basic image of the circuit's voltages with all of the switches open. This shows the relationship between voltage readings and switch position. |
|  | When we shut the first switch, we see that the last point of potential is now directly upstream of the second switch. | The circuit's voltages with the first switch closed. There's a slight animation to demonstrate that the electrical potential is reaching the next point. |
|  | With each successive switch, we move the last point of potential toward the load until all of the switches are closed. | The circuit's voltages with the second switch closed. Again, we show the continuation of the electrical potential to the third switch.<br><br>**NOTE: when you are recording your presentation, you are going to flow through these quickly. BE READY.** |

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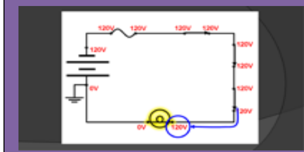
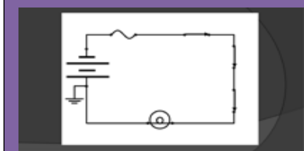
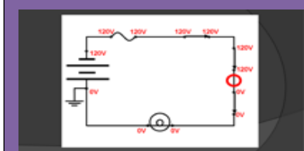
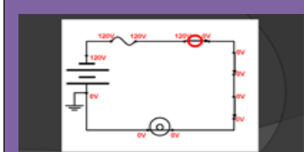
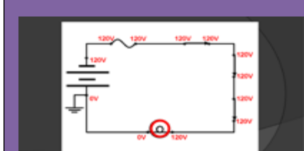
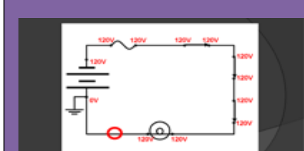
|  | At that point, the last point of potential will be at the lamp itself. Since the lamp is the only significantly resistive component in the circuit, it will drop nearly all of the voltage, and will light up. | The circuit's voltages with all switches closed and the light lit. |
|  | But what if you have all of the switches closed, but still have no light from the lamp? Based on what you know of this circuit, if the problem is an open, you should be able to predict the location of the problem based on the voltage readings. Let's take a look. | Static slide returning the circuit to tabula rasa, and showing the circuit with all of the switches closed, but no light coming from the lamp. |
|  | Given the following voltage readings, where do you believe the fault lies? I will pause the video at this point, and on each of the following three questions, to give you an opportunity to guess. When you have the answer, just push play to continue.<br><br>If you said the fault is in wire between the second and third switch, then you are correct. The last point of potential is directly downstream of the second switch, so the open must be in the downstream wire. | Electrical Fault 1 of 4, depicting an open between the second and third switch.<br><br>NOTE: **Don't jump the gun on the fault location on the next 3.** The audio will make it clear when it is time to hit it. |
|  | Now, consider this one? Given these readings, where do you believe the fault lies?<br><br>In this circuit, there is an open in the first control switch itself. Again, the open is between the last point of potential and the point of no potential. | Electrical Fault 2 of 4, depicting an open on the first switch. |
|  | How about now?<br><br>Though this may seem strange at first glance, this is probably the most common open fault – a simple blown bulb. This is important to know. Taken from the readings alone, a blown bulb looks just like a functioning circuit; the only difference is there is no light. | Electrical Fault 3 of 4, depicting an open filament. |
|  | Here's one more. Can you see where the open is? Remember to trust your indications.<br><br>In this example, the open is in the neutral line between the bulb and the positive terminal on the battery. As we stated before, even though 120V is present on the lamp, it cannot energize without a completed path for current. | Electrical Fault 4 of 4, depicting an open neutral. |

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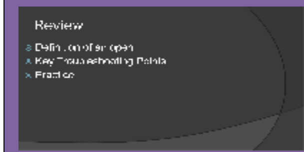
|  | OK. To recap, we have defined an open, identified key troubleshooting points, and gone through a few practice problems. In our next lesson, we will discuss troubleshooting shorts and shunts. I hope you have enjoyed this module; If you have any questions, please leave them in the comment section below. Have a great day. | Static, wrap-up slide reviewing the material covered, foreshadowing the next course (shorts and shunts), and informing the viewer where questions can be asked. |