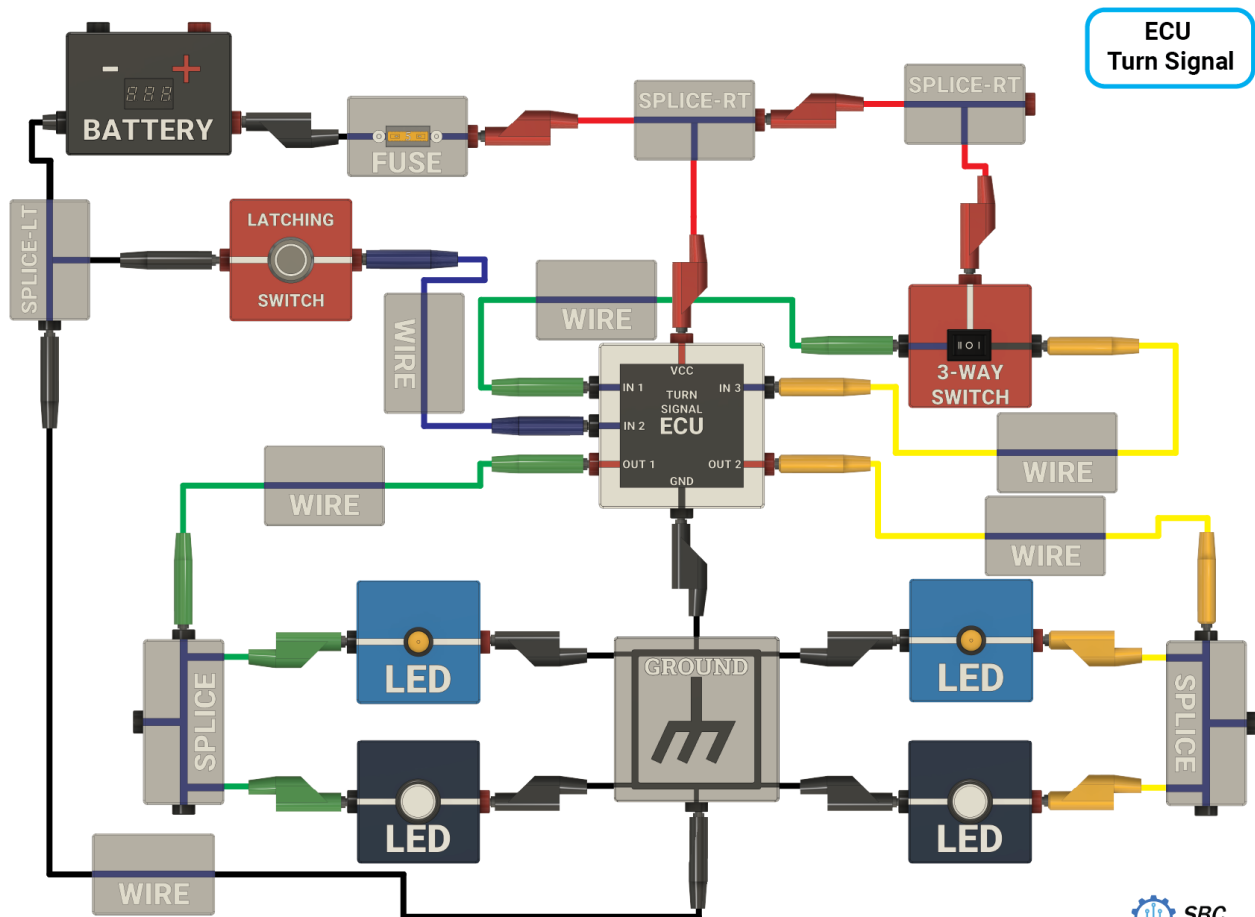


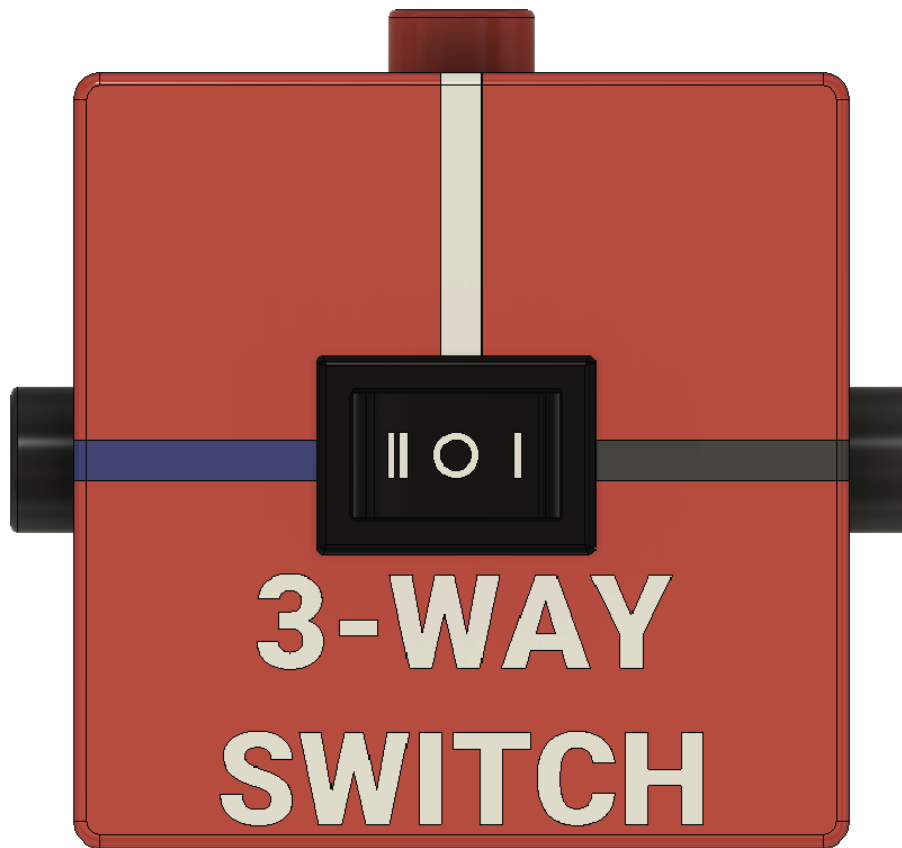
MMTS ECU Turn Signal Trainer

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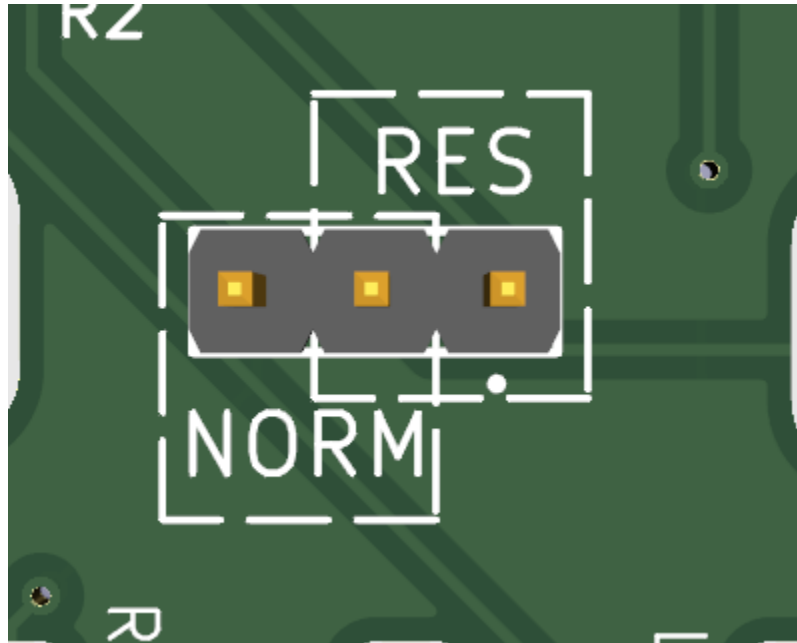
3-WAY SWITCH Node



NOTES

- The 3-WAY SWITCH Node is a switch with three positions
 - Left rocker switch position ||
 - Connects the top jack to the left jack
 - Center position O
 - Open switch position
 - Right rocker switch position |
 - Connects the top jack to the right jack

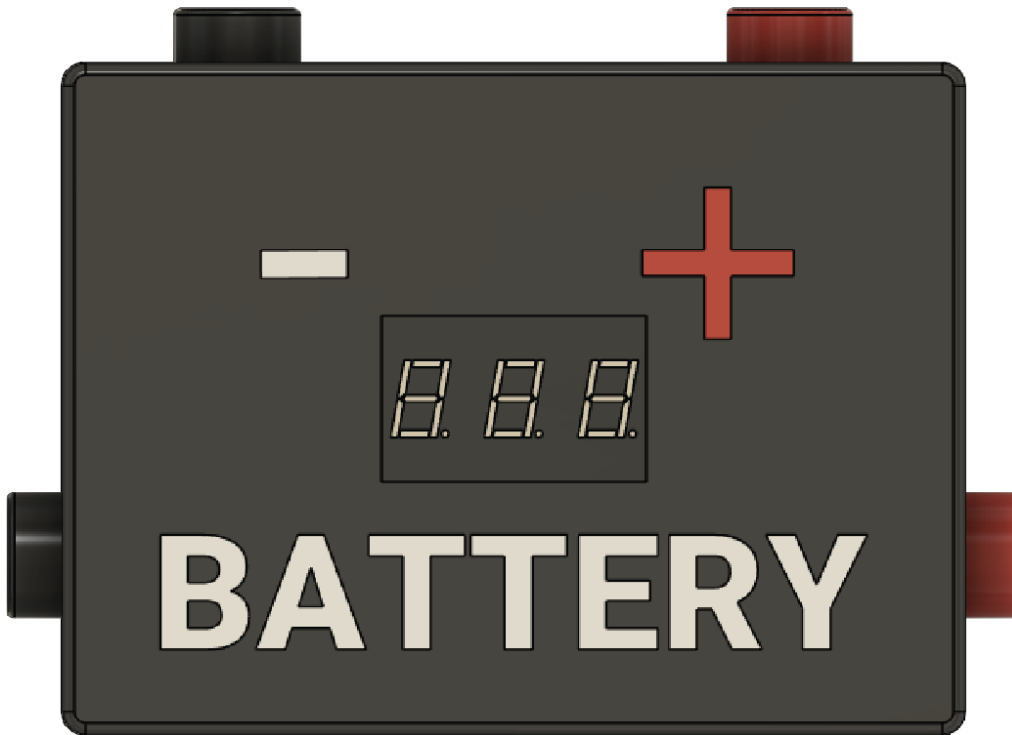
3-WAY SWITCH Node - Faults



Setting a FAULT

- Jumper placed across the two left pins NORM is the normal state of the Node.
- Jumper placed across the two right pins RES is the high resistance state. The resistance is around 33k ohms
 - The resistance will be between the top jack and the left jack
 - The right jack does not have a fault option

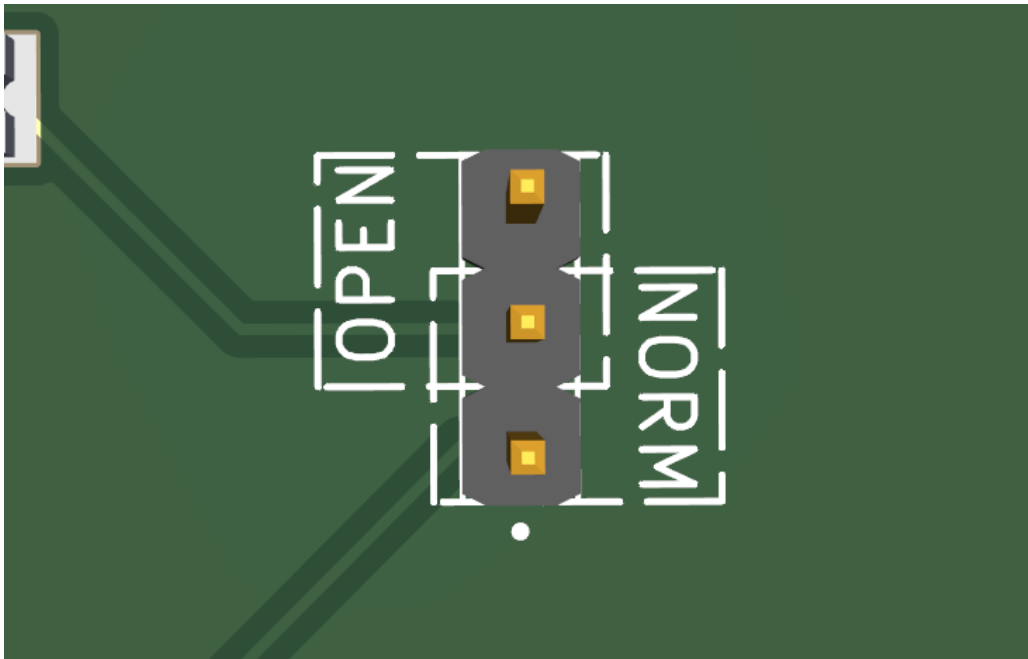
Battery Node



NOTES

- The BATTERY Node represents the battery in an electrical circuit but does not generate potential. Instead, the potential is supplied by the POWER SUPPLY, an external tool. When diagnosing the circuit, the POWER SUPPLY should not be considered as part of the circuit's internal components.
- POWER SUPPLY should be connected to the top red and black posts of the BATTERY Node
- Voltage reading will be displayed on the voltage display if connected to POWER SUPPLY.
- The voltage reading should display regardless of faults in the rest of the circuit

Battery Node - Faults



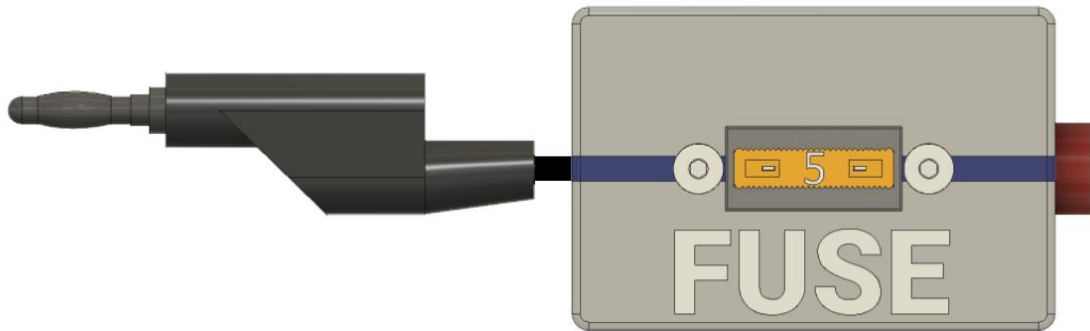
Setting a FAULT

- Jumper placed across the two lower pins NORM is the normal state of the Node. Everything in the Battery node should function correctly.
- The OPEN spot for the jumper is for storage of the jumper.
- The jumper does not need to be in the OPEN spot to create an open.
- The voltage display will not show POWER SUPPLY voltage when the BATTERY fault is set to OPEN. The lower red and black jacks will not have potential

TROUBLESHOOTING

- If the voltage display is not functioning
 - Verify correct polarity between POWER SUPPLY and top BATTERY jacks
 - Verify potential of POWER SUPPLY

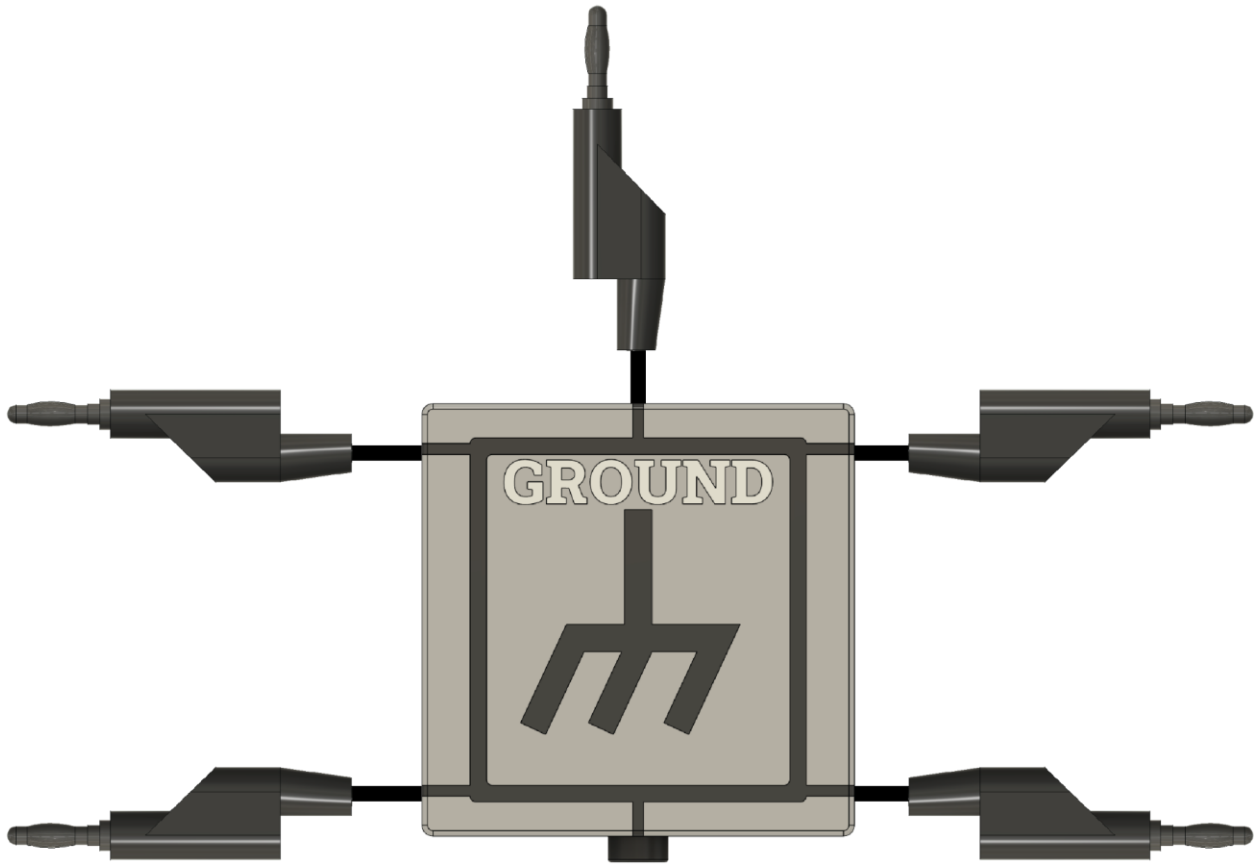
FUSE Node



NOTES

- The FUSE Node simulates the function of a typical automotive fuse.
- It does not contain a jumper to use as a fault.
- The Node includes a 5-amp ATC fuse.
- While an open fuse can be used as a fault in the circuit, we discourage this practice. An open fuse usually occurs due to a short to ground, and presenting an open fuse without this context may lead students to incorrectly believe that simply replacing the fuse will “fix” the circuit fault

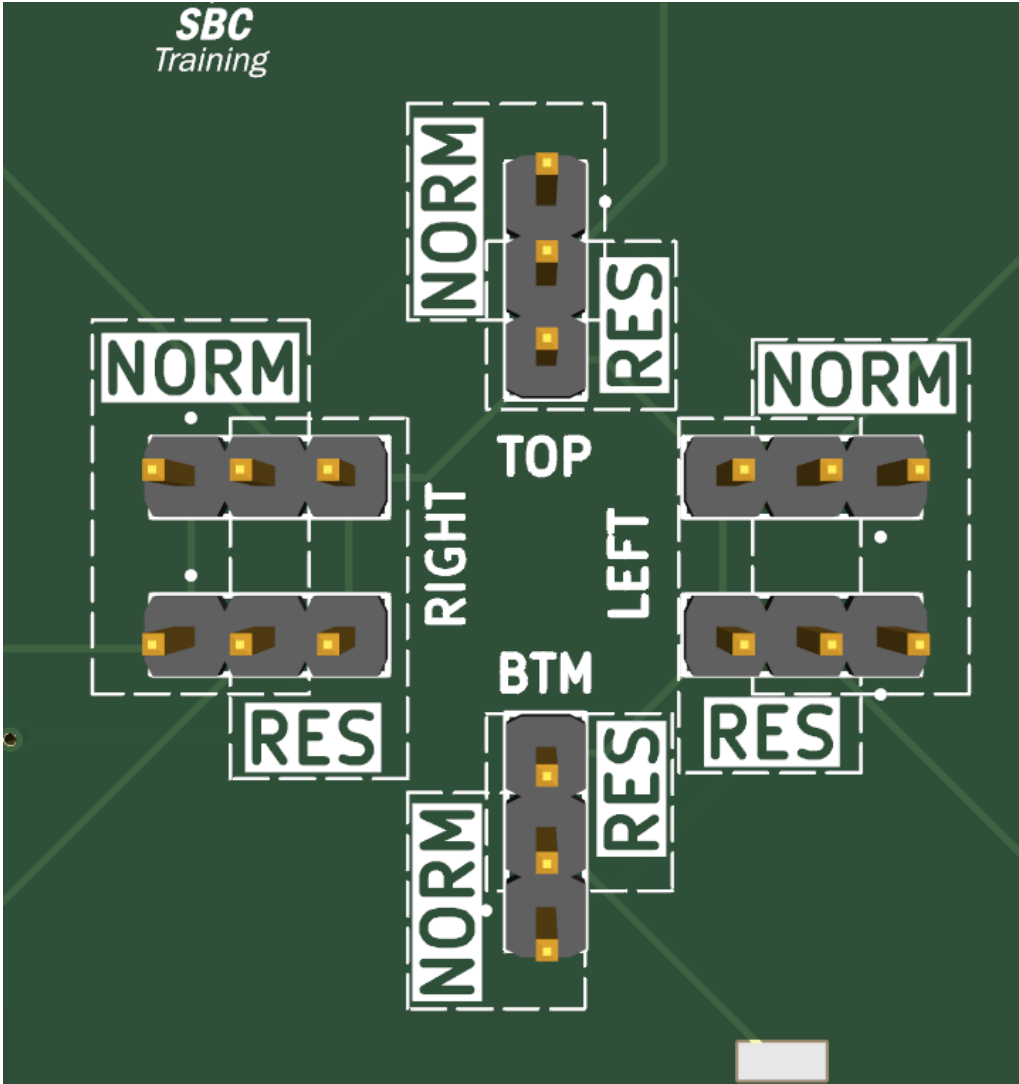
GROUND Node



NOTES

- The GROUND Node is a ground distribution block. All of the wires and the jack are connected

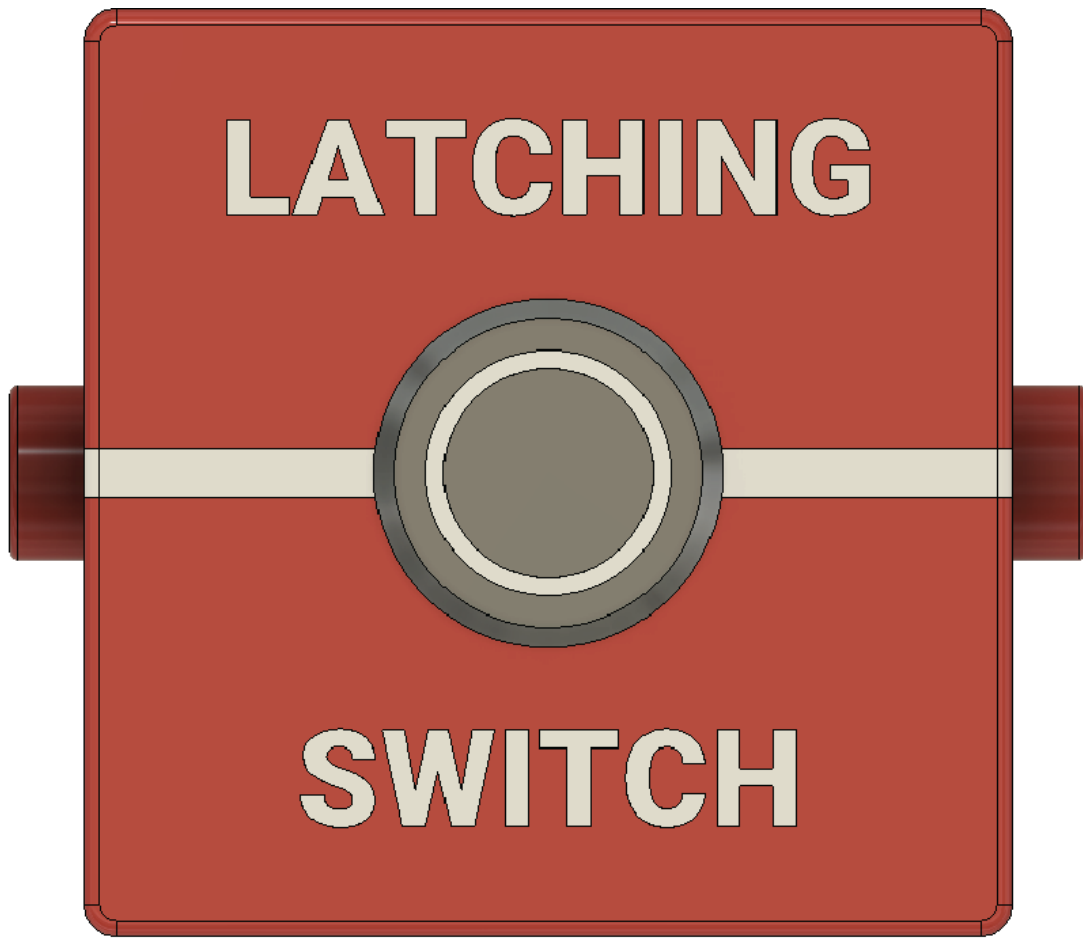
GROUND Node - Faults



Setting a FAULT

- The fault terminals correspond to each output option of the GROUND Node
- The labels in the center (TOP, LEFT, BTM, RIGHT) correspond to the the side of the board that the fault is on
- The NORM position on the RIGHT and LEFT side terminals applies to both the top and bottom fault terminals
- The RES position on the RIGHT and LEFT side terminals applies to both the top and bottom fault terminals

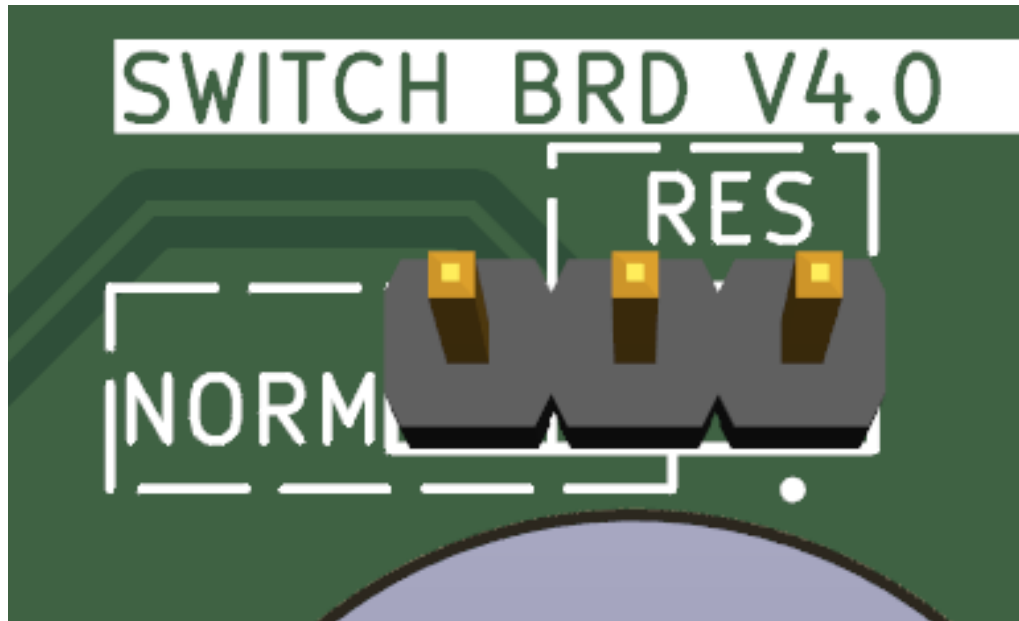
LATCHING SWITCH Node



NOTES

- The LATCHING SWITCH Node is a push-button switch that locks in the "on" position.
- The LATCHING SWITCH connections do not have polarity.
- The light ring around the LATCHING SWITCH does not illuminate

LATCHING SWITCH Node - Faults



Setting a FAULT

- Jumper placed across the two left pins NORM is the normal state of the Node.
- Jumper placed across the two right pins RES is the high resistance state. The resistance is around 33k ohms
- Jumper can be placed on a single pin for storage and set the Node to open

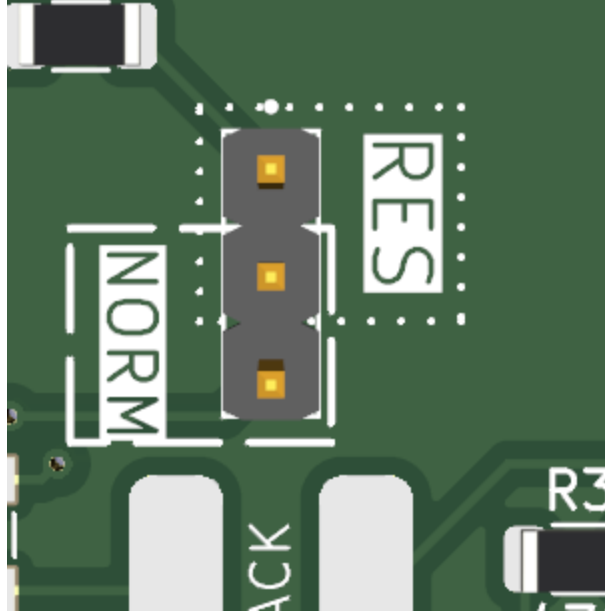
Large White LED Node



NOTES

- The large white LED Node is a load device for circuits.
- The LED is **bidirectional** and can be connected in either direction without regard to polarity.
- Unlike the consistent resistance found in ohmic components, an LED's resistance varies with the voltage applied to it. This is closely related to a concept known as the forward voltage (V_f) of an LED, which is essentially the minimum voltage needed to illuminate the LED. When the applied voltage is under this threshold, the LED behaves as if it has very high resistance, letting through barely any current — a fact that might be misleading when measured with a multimeter, which typically applies around 3 volts for such measurements.
- The calculated resistance of the large white LED is 2797 ohms at 12 Volts
- If you measure the resistance of the LED using an ohm meter you will get around 7.6 mega ohms. This is due to voltage of meter being around 2.8 volts when it is measuring resistance . The calculated resistance of the small yellow LED is 1228 ohms at 12 Volts
- [SEE Diode Forward Voltage Response Chart](https://developer.wildernesslabs.co/Hardware/Tutorials/Electronics/Part6/LEDs/)
(<https://developer.wildernesslabs.co/Hardware/Tutorials/Electronics/Part6/LEDs/>)

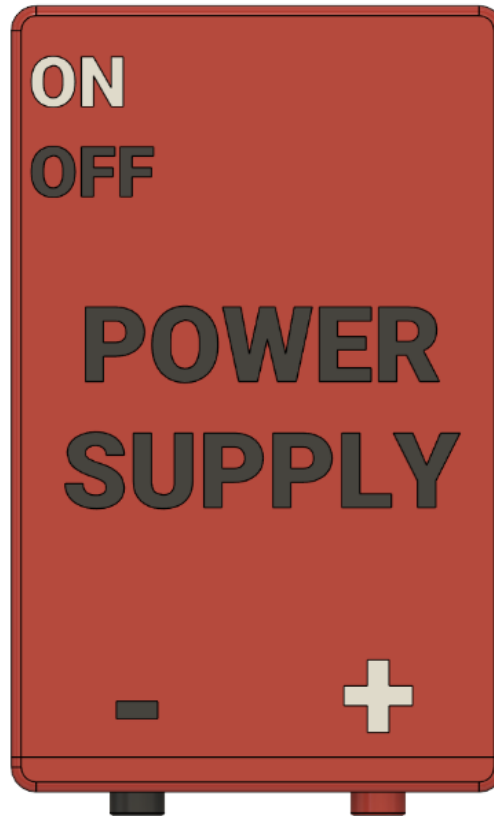
Large White LED Node - Faults



Setting a FAULT

- Jumper placed across the two bottom pins NORM is the normal state of the Node.
- Jumper placed across the two top pins RES is the high resistance state. The resistance is around 33k ohms
- Jumper can be placed on a single pin for storage and set the Node to open

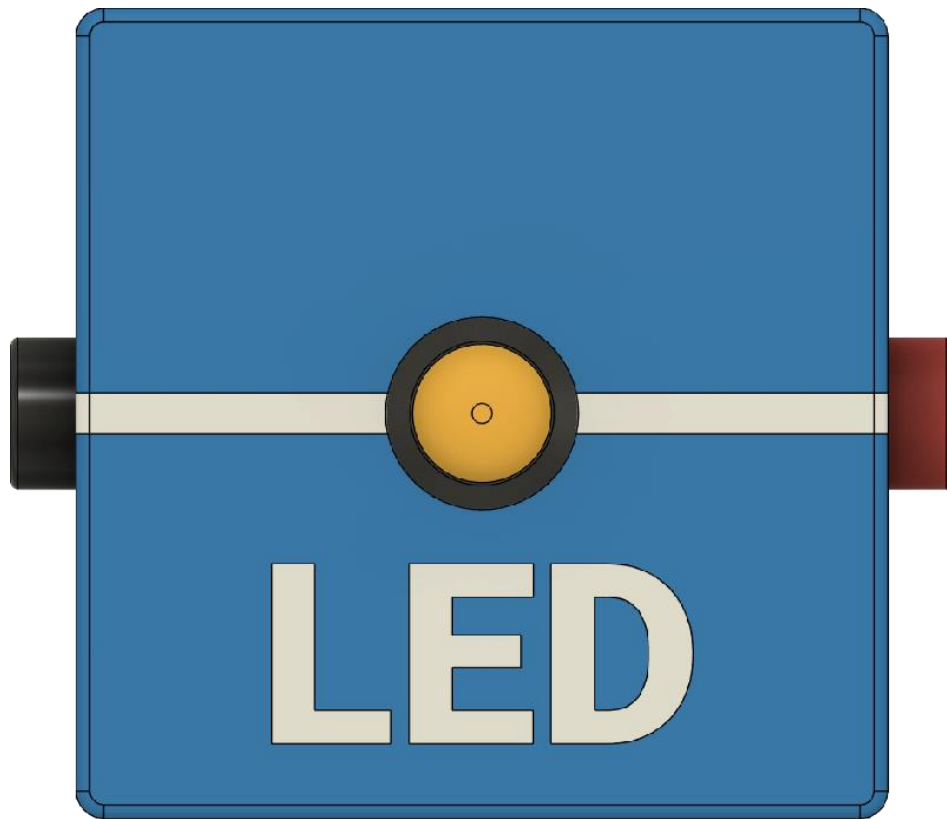
POWER SUPPLY



NOTES

- POWER SUPPLY contains 8 AA batteries.
- Sliding switch found on upper right side of supply
- 6 EA 2mm socket head screws can be found on the rear of the POWER SUPPLY. Remove to access the 8 AA batteries

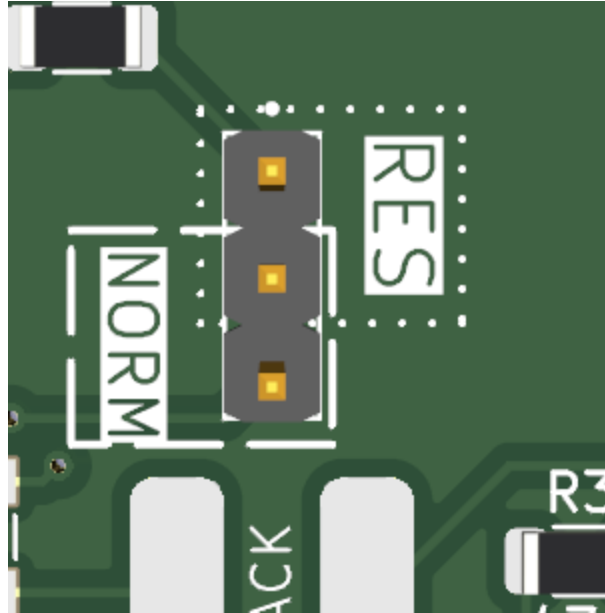
Small Yellow LED Node



NOTES

- The small yellow LED Node is a load device for circuits.
- The LED is **bidirectional** and can be connected in either direction without regard to polarity.
- Unlike the consistent resistance found in ohmic components, an LED's resistance varies with the voltage applied to it. This is closely related to a concept known as the forward voltage (V_f) of an LED, which is essentially the minimum voltage needed to illuminate the LED. When the applied voltage is under this threshold, the LED behaves as if it has very high resistance, letting through barely any current — a fact that might be misleading when measured with a multimeter, which typically applies around 3 volts for such measurements.
- The calculated resistance of the LED is 1228 ohms at 12 Volts
- If you measure the resistance of the LED using an ohm meter you will get around 2200 ohms. This is due to a resistor placed in parallel with the LED. The resistor is used to better simulate the voltage drop difference between the small yellow LED and the large white LED. The calculated resistance of the large white LED is 2797 ohms at 12 Volts
- [SEE Diode Forward Voltage Response Chart](https://developer.wildernesslabs.co/Hardware/Tutorials/Electronics/Part6/LEDs/)
(<https://developer.wildernesslabs.co/Hardware/Tutorials/Electronics/Part6/LEDs/>)

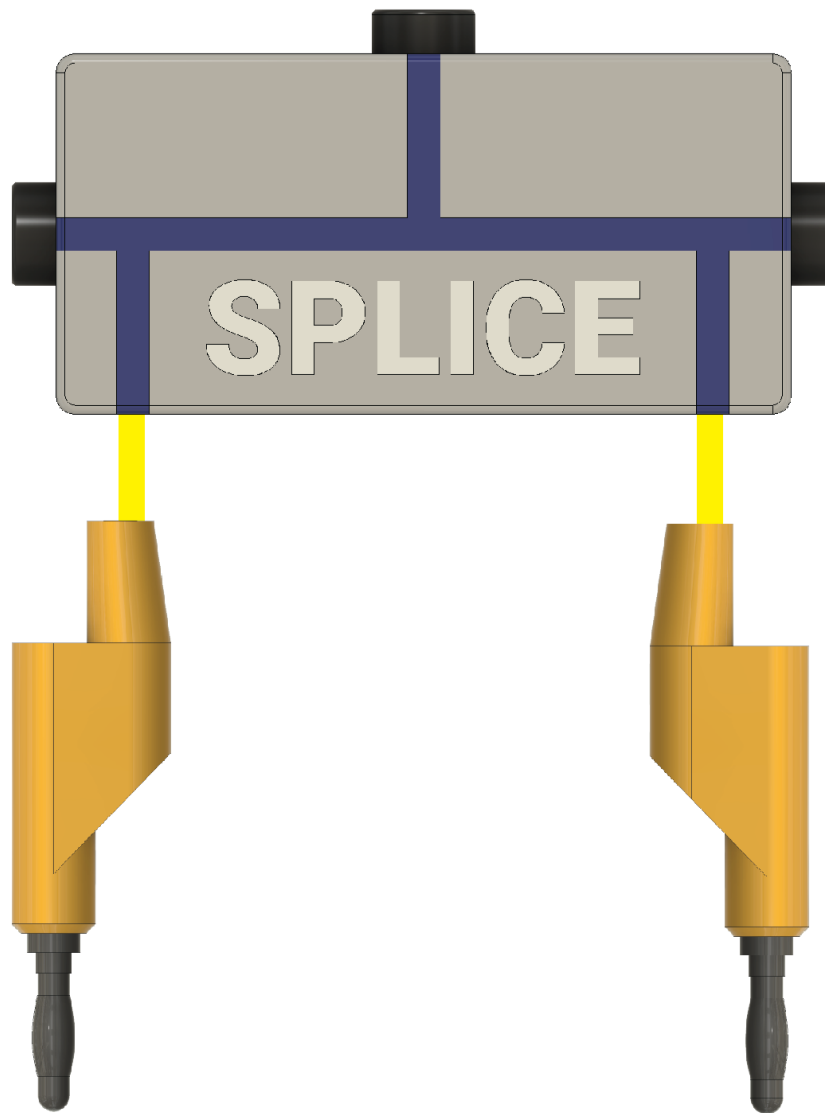
Small Yellow LED Node - Faults



Setting a FAULT

- Jumper placed across the two bottom pins NORM is the normal state of the Node.
- Jumper placed across the two top pins RES is the high resistance state. The resistance is around 33k ohms
- Jumper can be placed on a single pin for storage and set the Node to open

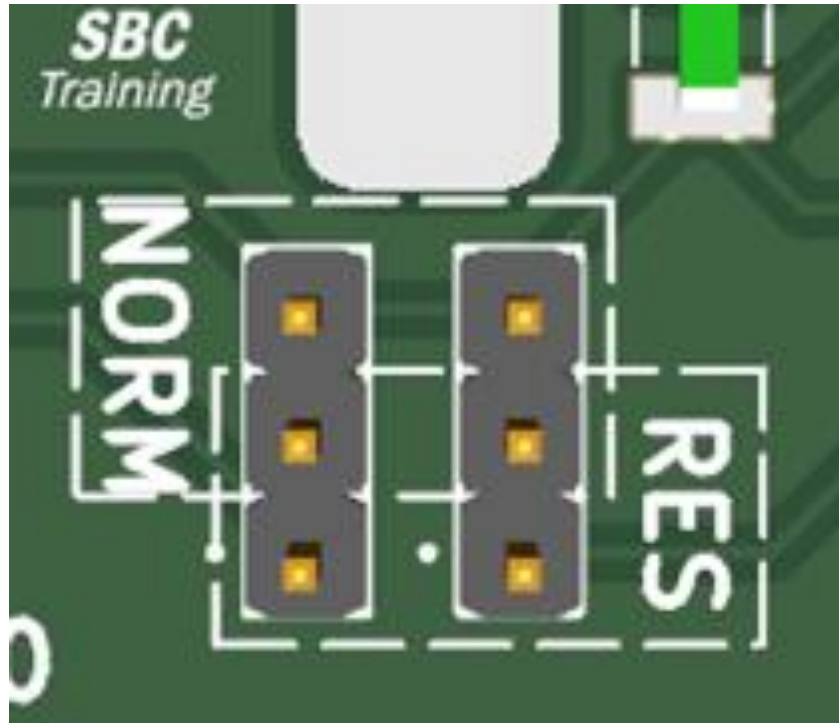
SPLICE Node



NOTES

- The SPLICE Node is a multi-terminal component, with continuity between every jack and wire.
- The yellow and green SPLICE Nodes are used solely to differentiate their placement on the electrical circuit map; there is no electrical difference between the Nodes

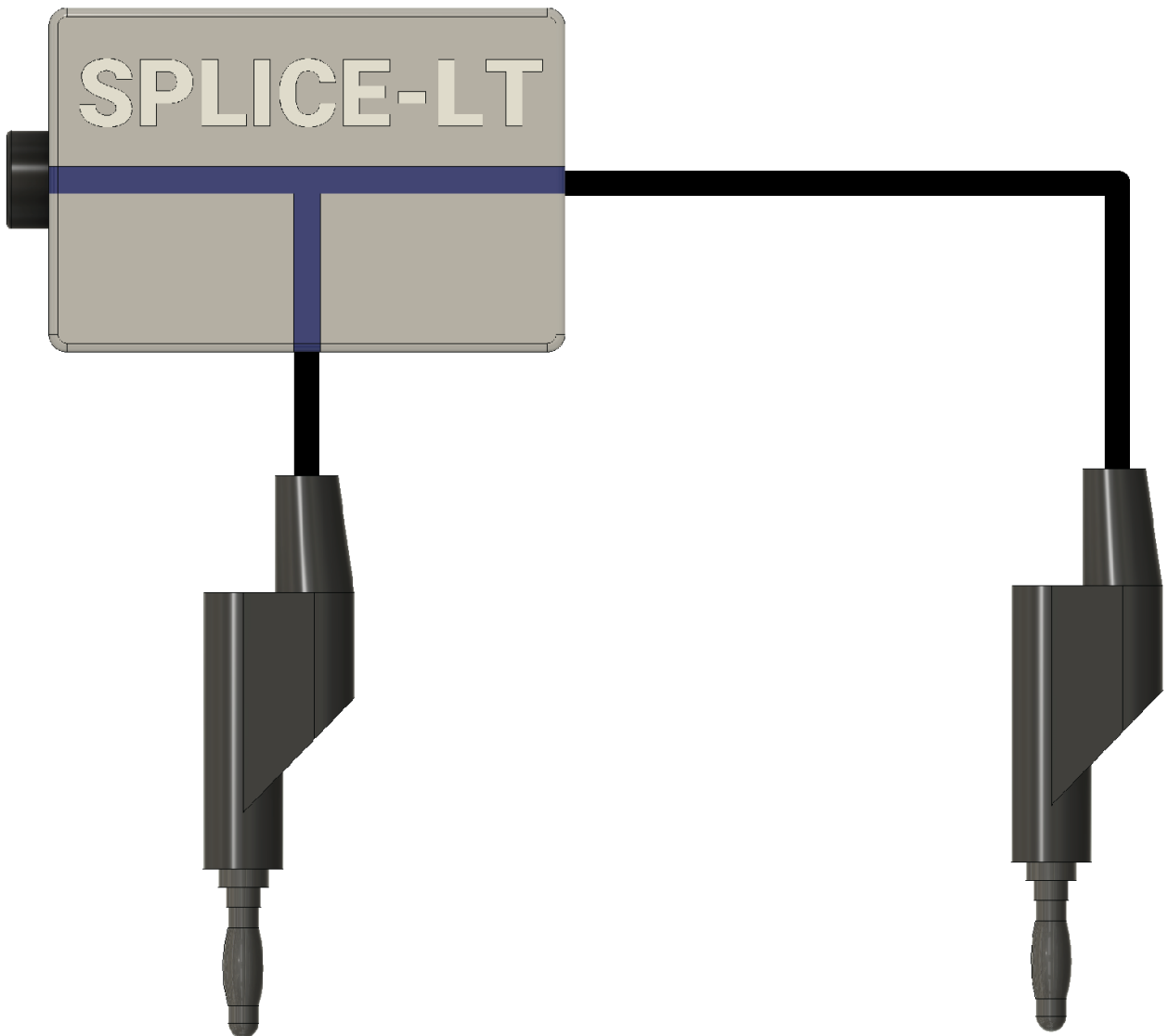
SPLICE Node - Faults



Setting a FAULT

- There are fault terminals for both sides of the SPLICE NODE. The left side fault and the right side fault. Both left and right side faults can be set to normal (NORM), high resistance (RES) or open.
- When the left side fault is set to high resistance (RES)
 - There will be high resistance at the following connections:
 - Top jack and left wire
 - Left side jack and left wire`
 - There will NOT be high resistance at
 - Top jack and left side jack
- The faults are similar for the right side fault terminals

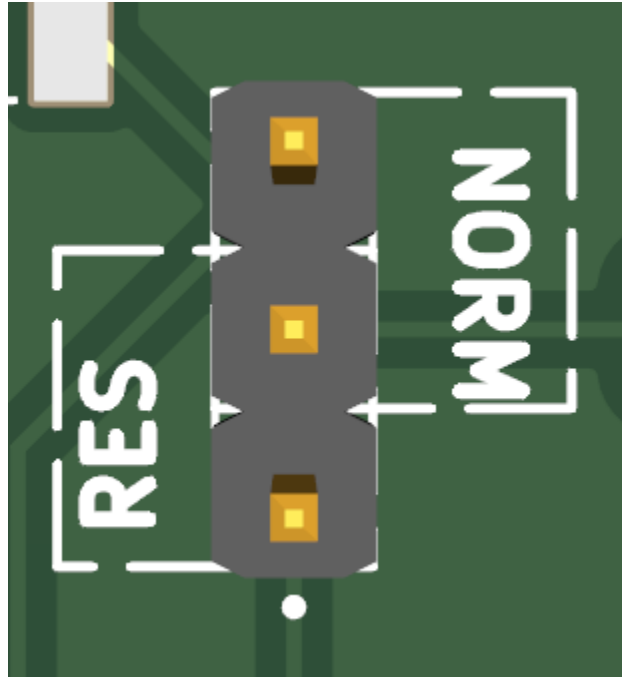
SPLICE-LT Node



NOTES

- The SPLICE-LT Node is a 3-way connection with 2 male wires and 1 female jack
- The position of the jack when reading the letters in a normal orientation designates it as a splice left

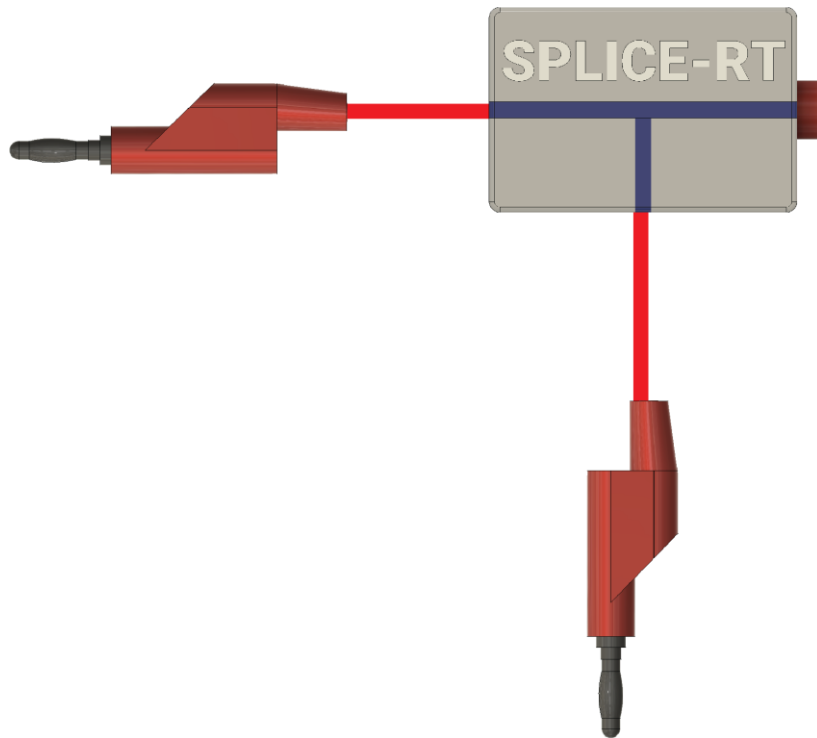
SPLICE-LT Node - Faults



Setting a FAULT

- Jumper placed across the two upper pins NORM is the normal state of the Node.
- Jumper placed across the two lower pins RES is the high resistance state. The resistance is around 33k ohms
 - When setting resistance fault the following wire connections will have resistance:
 - Jack to bottom wire
 - Right wire to bottom wire
 - The connection from Jack to right wire will not have resistance even when the RES jumper is in place
- Jumper can be placed on a single pin for storage and set the Node to open
 - When setting open fault the following wire connections will be an open
 - Jack to bottom wire
 - Right wire to bottom wire
 - The connection from Jack to right wire will not have an open even when the open fault is in place

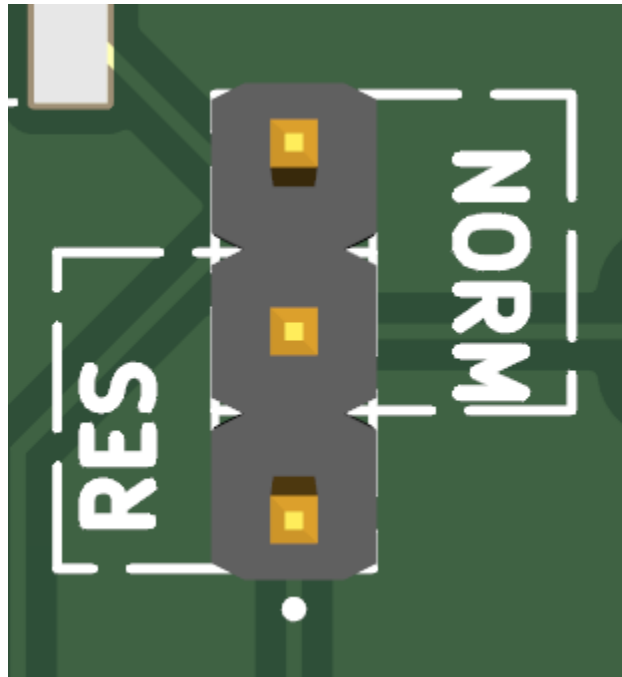
SPLICE-RT Node



NOTES

- The SPLICE-RT Node is a 3-way connection with 2 male wires and 1 female jack
- The position of the jack when reading the letters in a normal orientation designates it as a splice right

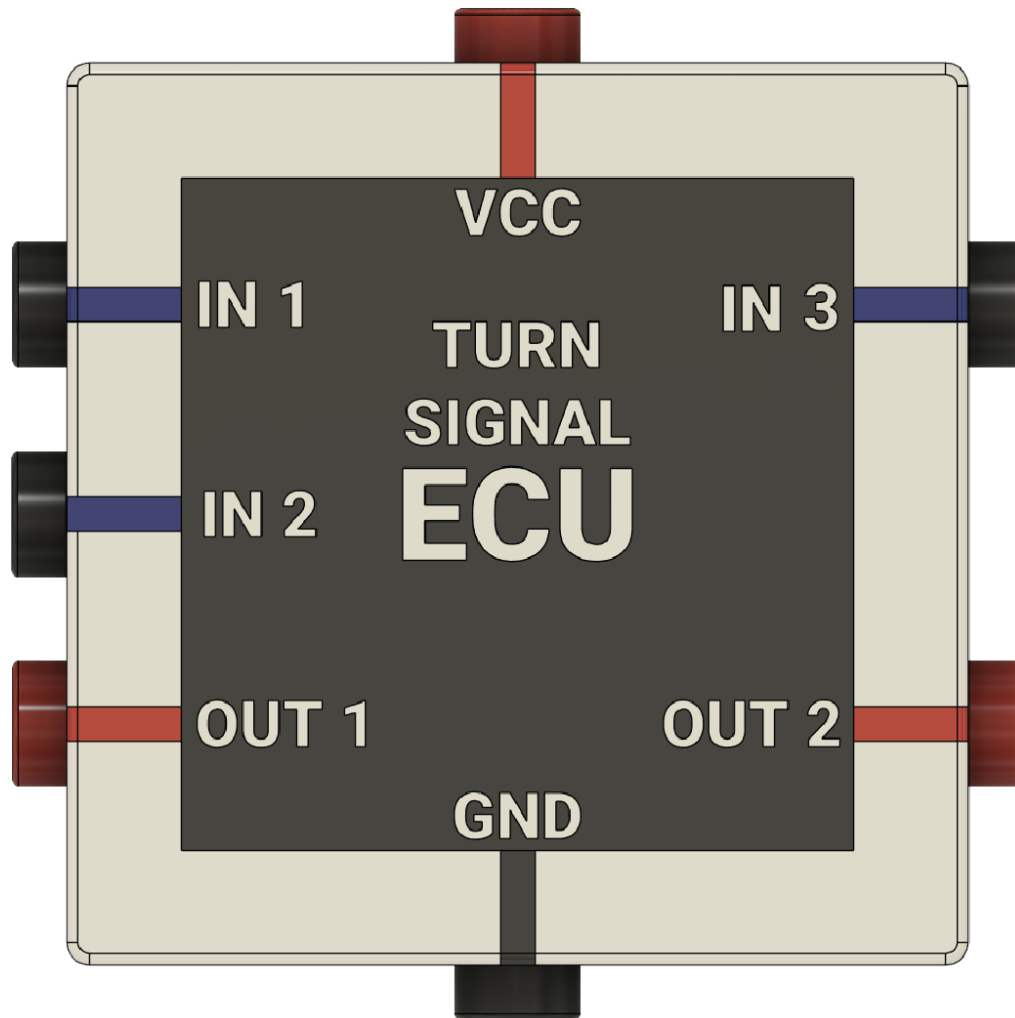
SPLICE-RT Node - Faults



Setting a FAULT

- Jumper placed across the two upper pins NORM is the normal state of the Node.
- Jumper placed across the two lower pins RES is the high resistance state. The resistance is around 33k ohms
 - When setting resistance fault the following wire connections will have resistance:
 - Jack to bottom wire
 - Left wire to bottom wire
 - The connection from Jack to left wire will not have resistance even when the RES jumper is in place
- Jumper can be placed on a single pin for storage and set the Node to open
 - When setting open fault the following wire connections will be an open
 - Jack to bottom wire
 - Left wire to bottom wire
 - The connection from Jack to left wire will not have an open even when the open fault is in place

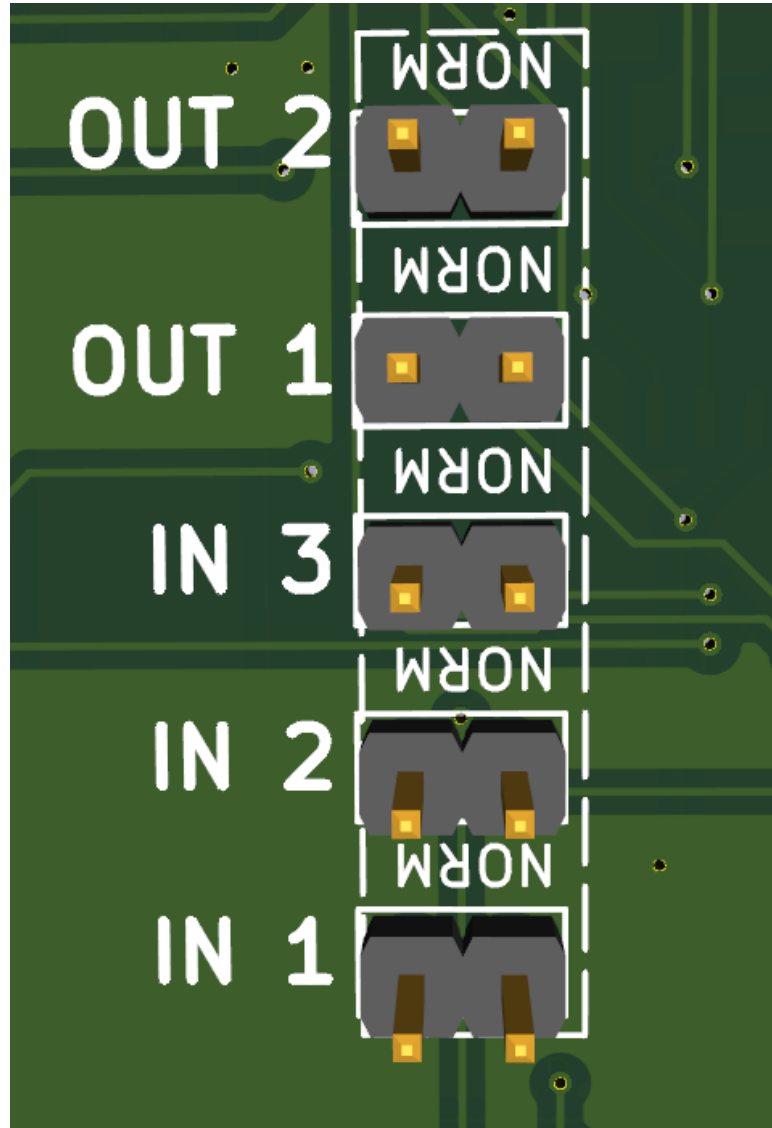
TURN Signal ECU Node



NOTES

- The TURN SIGNAL ECU Node is a computer node
- The TURN SIGNAL ECU Node has three inputs and two outputs.
 - IN 1 and IN 3 are power-side inputs, which connect to the positive side of the circuit
 - IN 2 is a ground-side input, connecting to the negative side of the circuit
 - OUT 1 and OUT 2 function as high-side drivers, which control the connection between the load and the positive supply voltage. They will output 12 Volts
 - VCC represents the positive side of the ECU and should be supplied with 11 V to 15 V.
 - GND represents the ground side of the ECU and should be connected to the negative side of the circuit.

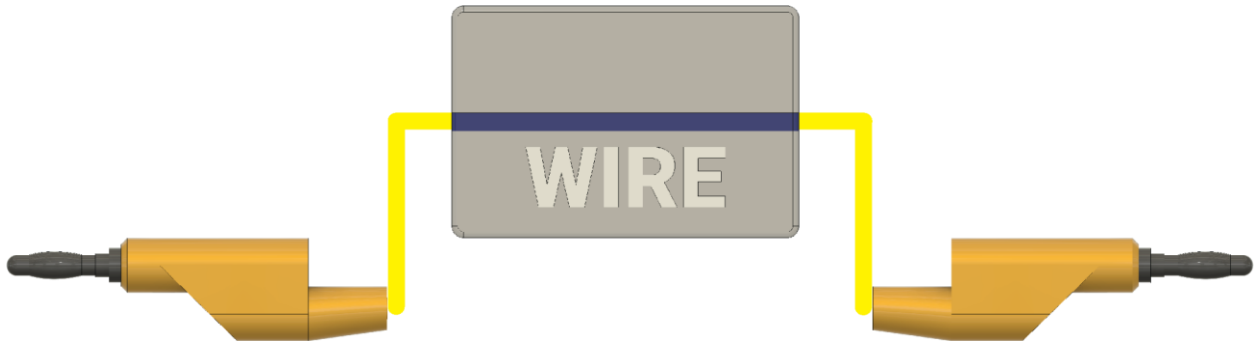
TURN Signal ECU Node - Faults



Setting a FAULT

- The pin name for each fault terminal is found on the left side. Removing the pin will set that terminal to an open condition
- There is no other fault type available for the ECU

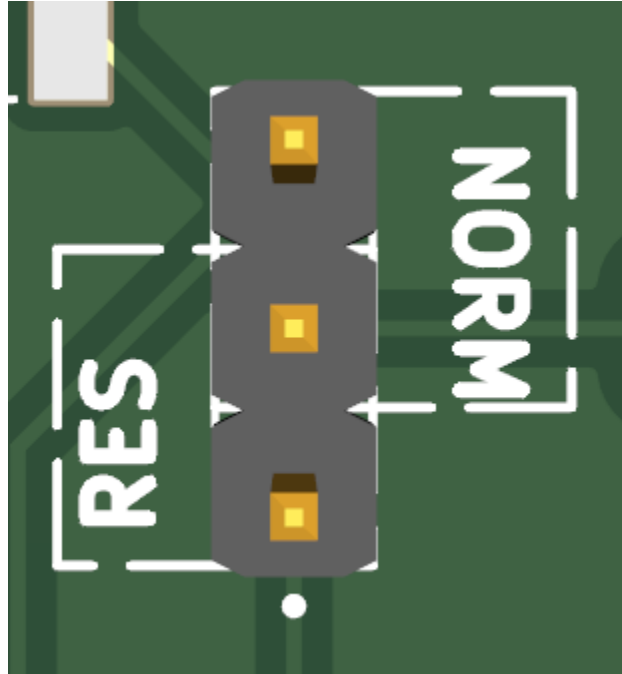
WIRE Node



NOTES

- The WIRE Node is used as a connection between other Nodes.
- The different colors of wires is only used as an aid for placing it on the magnetic sheet wiring diagram.
- Every color wire can be set to normal (NORM), high resistance (RES), or open (jumper removed)
- The red, white, yellow, blue and green wires are the same length, the black wire is extra long

WIRE Node - Faults



Setting a FAULT

- Jumper placed across the two upper pins NORM is the normal state of the Node.
- Jumper placed across the two lower pins RES is the high resistance state. The resistance is around 33k ohms
- Jumper can be placed on a single pin for storage and set the Node to open