BASIC ELECTRICAL

RELAYS

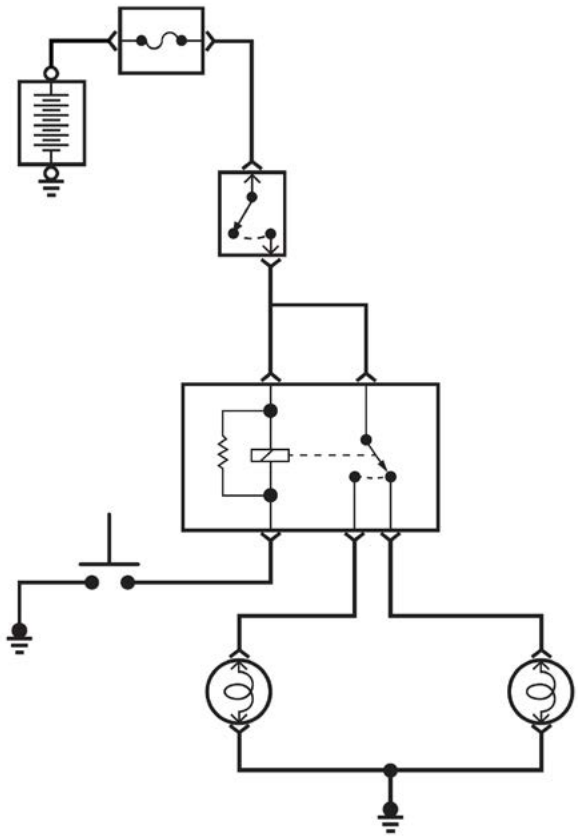
Relays allow a high-amperage circuit to be controlled by a relatively small switch. Without relays, large battery cables and even larger switches would be necessary on the bus's dashboard.

This section explains relay operation and testing.

LEARNING OBJECTIVES

By the end of this section, you should be able to:

- Explain relay operation
- Describe various relay types
- Discuss the testing of relays



RELAYS – CONTROLLING SYSTEMS

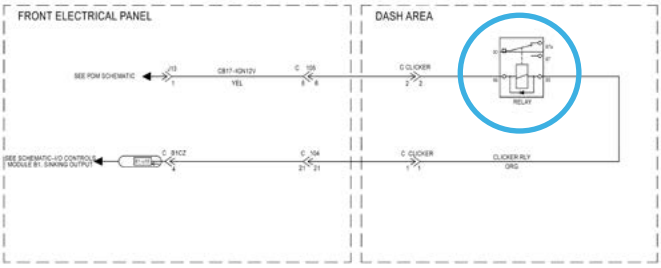
Relays are electrically operated switches with two separate circuits:
Control circuit

- Switch circuit

The control side activates an electromagnetic within the relay, drawing the switch contacts together. The switch side is a pair of contacts that open and close a circuit.

Because the control circuit and switch circuits are separate, a small toggle switch on the dash enables the operation of large current-draw components such as headlights, blower motors, and the starter motor.

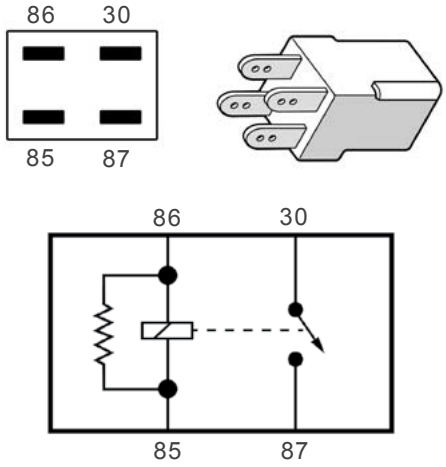
The schematic below shows an example of a relay's control side operated by control module B1.



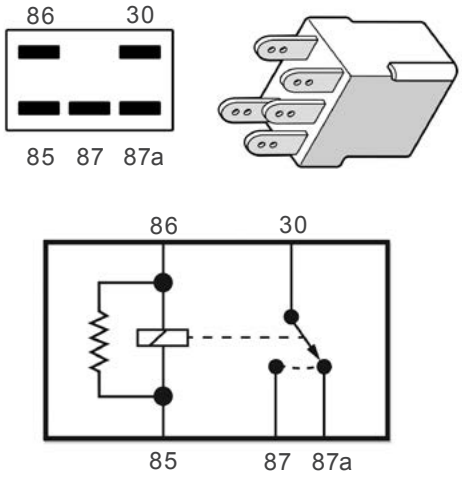
RELAY – TYPES

Four-pin and five-pin relays are the most common types used in buses. Both types usually contain a diode or resistor (shown in the schematic) to prevent the high voltage discharge from the relay's coil from damaging sensitive electronics.

4-Pin Relay



5-Pin Relay



RELAYS – 4-PIN

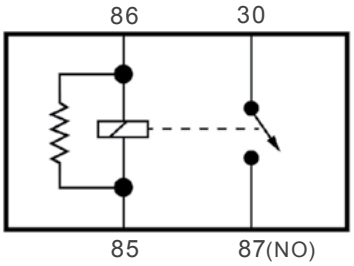
When a system uses a relay with four pins, two pins are used for the coil and two for the switch.

Location of coil pins:

- Pin 86 – Power side coil
- Pin 85 – Ground side coil

Location of switch pins:

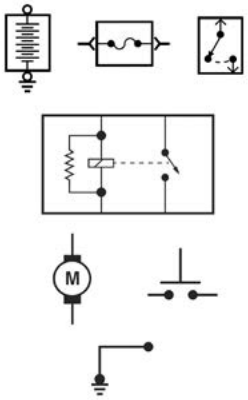
- Pin 30 – For power
- Pin 87 – Normally Open (NO) to control the load



4-PIN RELAY – ACTIVITY

Build a 4-Pin relay circuit with the components listed below:

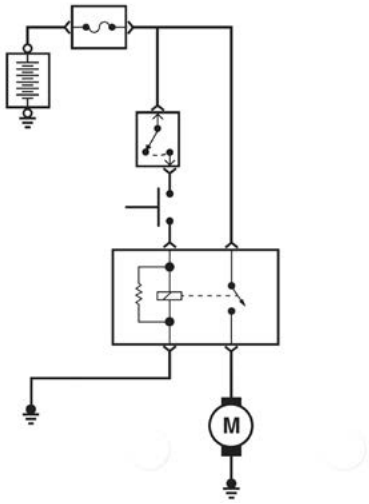
- Power
- Fuse
- Switch
- Relay
- Load
- Ground



NOTE: In this activity, connect the momentary contact switch to the power side of the coil to simulate a 'high-side' controlled relay.

4-PIN RELAY – RESULTS

When assembled, the circuit resembles a starting system circuit with the ignition switch being the high-side control to the relay.



Energizing the starter relay begins the process of providing the electrical-to-mechanical connection to start the engine.

The momentary contacts within the ignition switch energize the starter relay, completing the circuit to the starter solenoid.

The energized starter solenoid completes the high-current circuit from the battery B+ to the starter motor windings. The starter motor's armature turns when the voltage and high current flows from the battery, through the starter, and back to ground.

RELAYS – 5-PIN

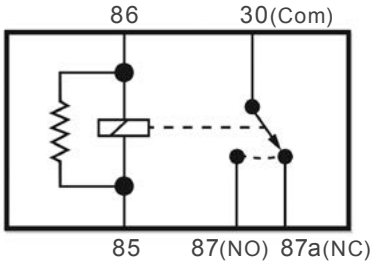
When a system uses a relay with five pins, two pins are used for the coil and three for the switch.

Location of coil pins:

- Pin 86 – Power side coil
- Pin 85 – Ground side coil

Location of switch pins:

- Pin 30 – Common (Com) for power
- Pin 87 – Normally Open (NO) to control the load
- Pin 87a – Normally Closed (NC) for a separate load

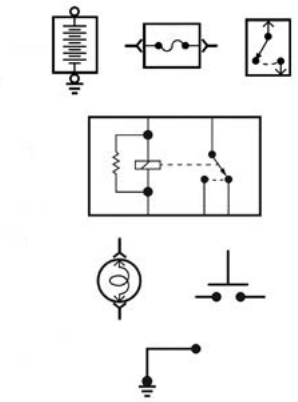


Relay Pin 87a has power in the de-energized state until the coil pulls the switch to the opposite pole at Pin 87.

5-PIN RELAY – ACTIVITY

Build a 5-Pin relay circuit with the components listed below:

- Power
- Fuse
- Switch
- Relay
- Load
- Ground

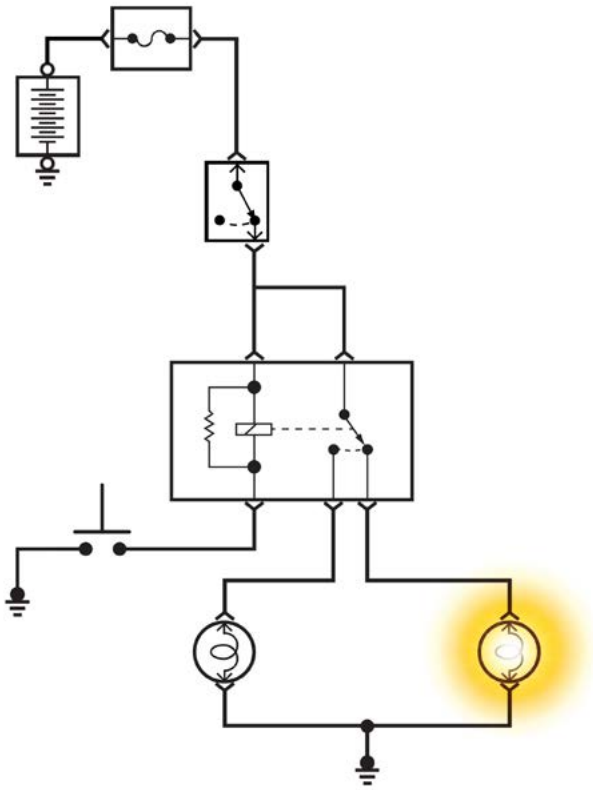


NOTE: In this activity, connect the momentary contact switch to the ground side of the coil to simulate a low-side controlled relay.

5-PIN RELAY – RESULTS

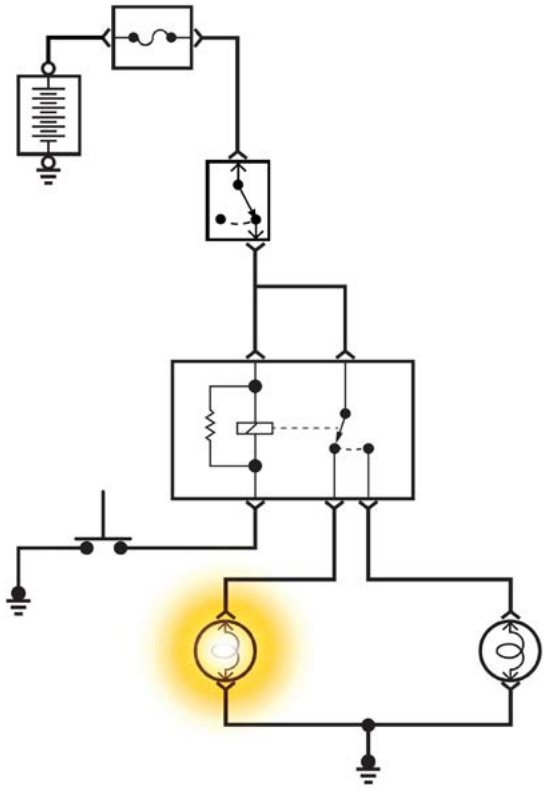
A 5-Pin relay is used when there is a need to provide power to separate circuits. The relay provides power to one circuit or another when the relay is de-energized or energized.

Relay De-energized



If two lighting circuits are powered by the relay circuit, voltage to the lights will toggle and the bulbs will illuminate OFF/ON based on the state of the relay.

Relay Energized



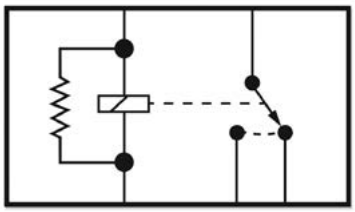
The low and high beam headlamp circuits use relays in a similar manner.

RELAY TESTING – THINGS TO KNOW

There are some standard diagnostic checks you can use to locate failure in the circuit.

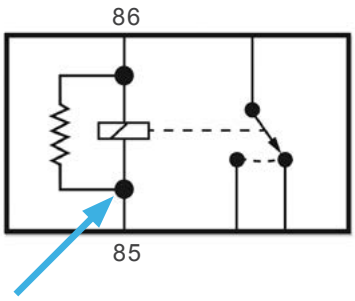
To test the relay:

1. First test the power and ground to the relay to ensure the relay can function.
2. Next check for proper resistance by testing connections to the:
   - Relay
   - Coil
   - Switch



RELAY TESTING – CHECKING THE COIL

To check the coil, measure between pins 85 and 86 to ensure the coil resistance is within specifications.

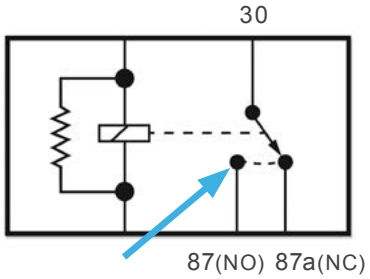


Measurements will vary depending upon the manufacturer and whether the relay is used in a 12V or 24V system.

Compare your readings with those of a known-good relay. Or, swap the suspect relay with a known-good relay and retest the circuit. If there is no change, the relay was not the cause and you need to diagnose further.

RELAY TESTING – CHECKING THE SWITCH

The switch side of the relay must be tested to ensure the connection is good and has very little resistance between the contacts.



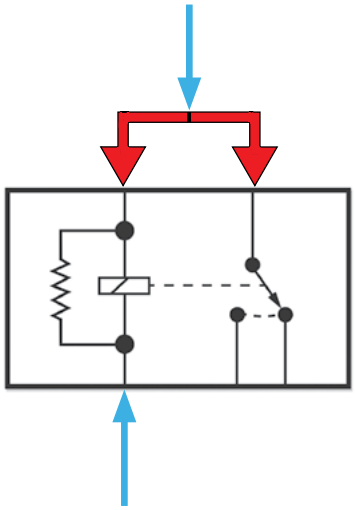
Testing between Pin 30 and Pin 87 (Pin 87a if applicable) will let you know if current can pass through with low resistance. If resistance is high, it will impede the flow of current to the load.

NOTE: Energize the relay with an auxiliary power source to check the resistance between pins 30 and 87.

RELAY TESTING – POWER AND GROUND

Testing relays is done to ensure there is proper power and ground.

It is important that connections to each of the pins are secure. This ensures that the power and ground parts of the circuit can provide current flow through the components. This includes fuses and other sources of power and grounds.



Diagnostic testing includes analyzing electrical schematics for all the following:

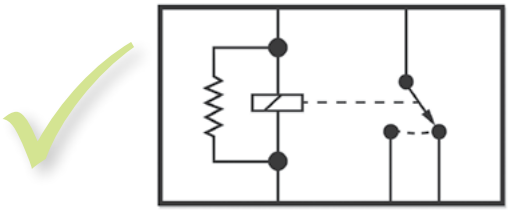
1. Power side – check all sources of power to the relay.
   - Fuses
   - Other relays
2. Ground – check that all grounds are operational.
   - Chassis
   - ECU
   - Filtered

RELAY TESTING – ACTIVITY

Test the relay to determine the condition of the following components:

- Coil
- Switch side
- Power
- Ground

As you work on this activity, document your findings on the activity sheet.



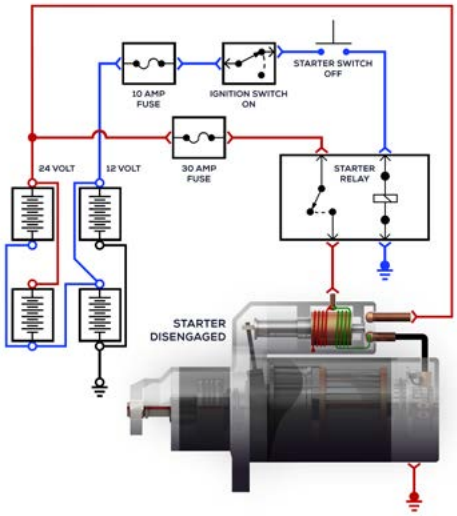
NOTE: Depending on each system, relays can be used with a 12V or 24V system.

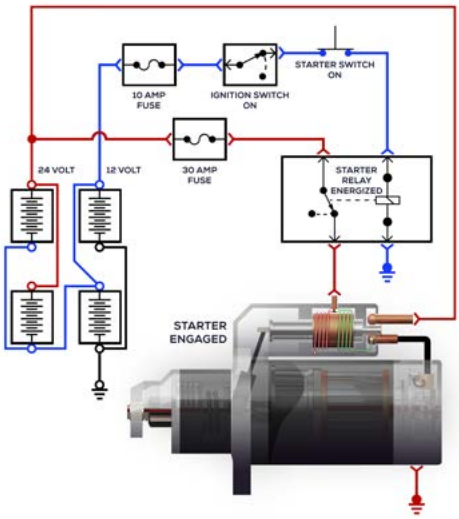
SUMMARY – RELAYS

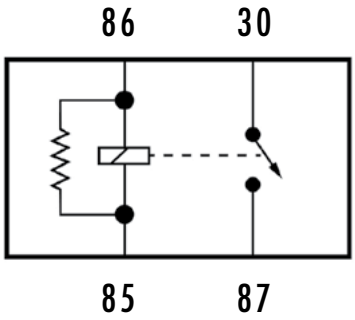
In this section, you have learned how relays operate in different configurations by building circuits containing 4-Pin and 5-Pin relays. You learned the common techniques to test relay operation.

4-PIN RELAY

Relays are electrically-operated switches that allow a high-amperage circuit to be controlled by a relatively small switch. A Single Pole Single Throw (SPST) 4-Pin relay controls one circuit. As with most relays, the switched side and the coil side can be different voltages.

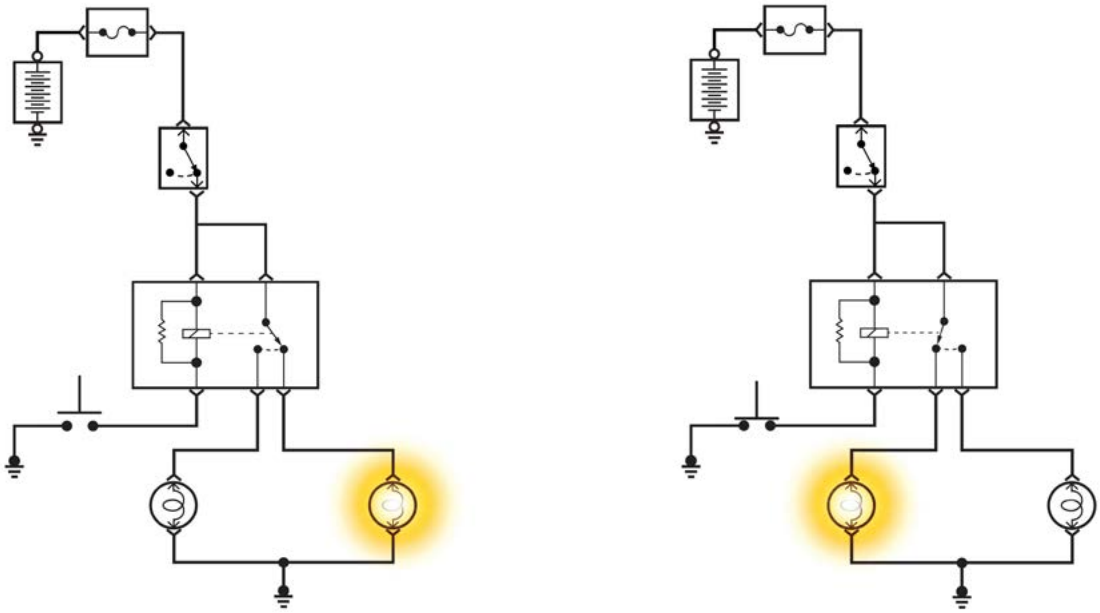


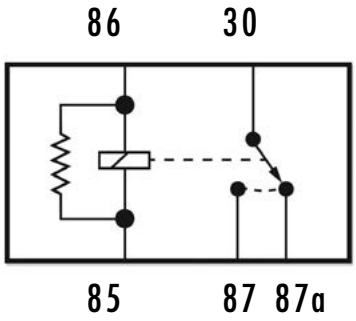




5-PIN RELAY

Double Pole, Double Throw (DPDT) relays can control two circuits.





RELAY COMPONENTS	NAME: DATE:

Describe the function of each relay component listed below. Review the material, if needed.

1. Coil –

2. Lever –

3. Pin 30 COM –

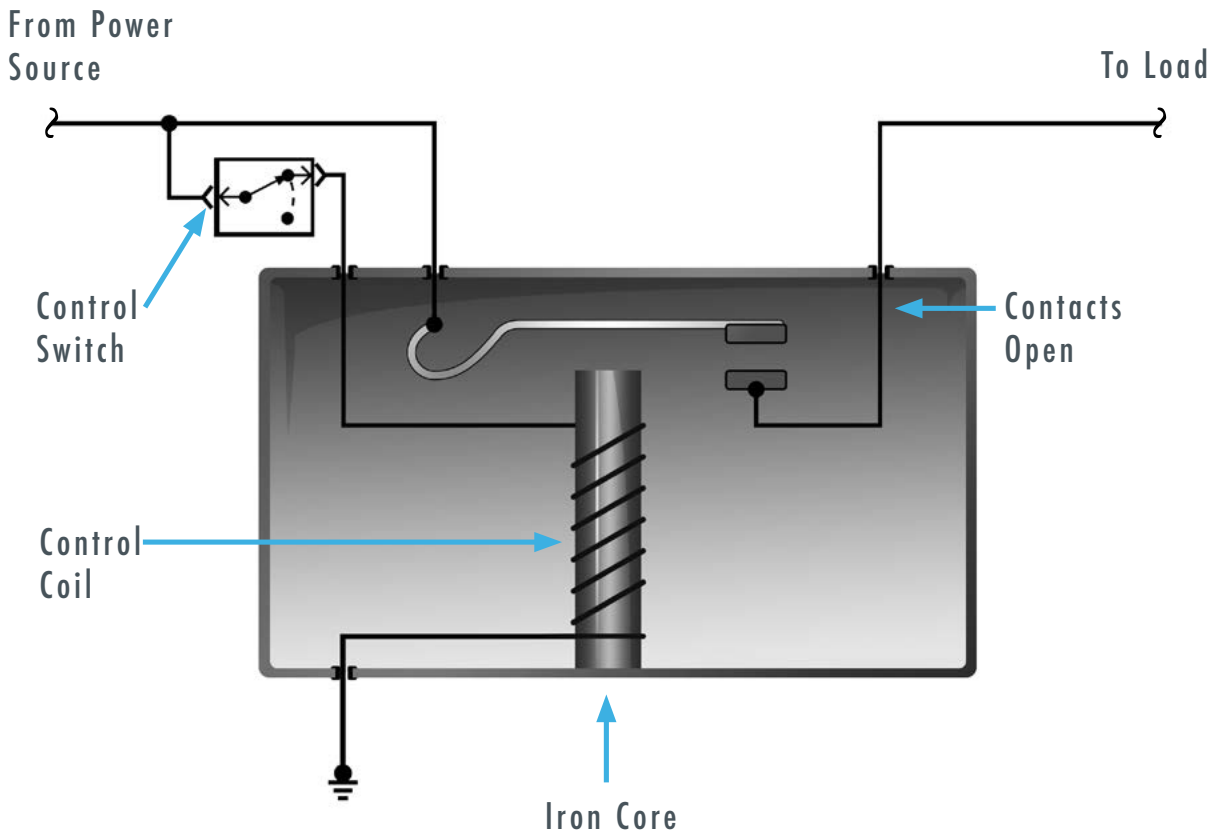
4. Pin 87 NO –

5. Pin 87A NC –

6. Pin 85 –

7. Pin 86 –

8. Label the relay points with the correct pin numbers.



RELAY ADD-ON ACTIVITY	NAME: DATE:

Assemble the relay circuit using a power source, a circuit protection device, a power switching device, a 5-pin relay, a push button switch and two light bulbs.

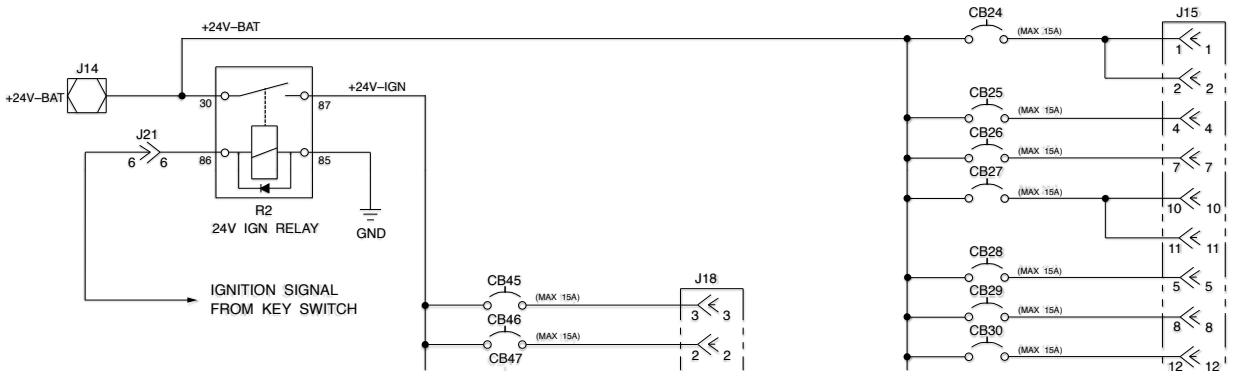
Using the equipment available, perform the following functions. Write values or answers in the space below.

1. Measure source voltage at the battery.
2. Measure available voltage to both power sources of the relay.
3. Close the momentary contact switch, what happens?
4. Measure voltage drop across both bulbs with the relay energized.
5. Measure voltage drop across both bulbs with the relay de-energized.
6. Why does the relay toggle power to the bulbs when it is energized and de-energized?
7. Measure the voltage drop across the coil side of the relay with the relay energized.
8. Measure the voltage drop across the switch side of the relay with the relay energized.
9. Does your measurement indicate proper function of the coil?
10. Measure total amperage of the relay circuit.

RELAY ACTIVITY	NAME:	DATE:

Use this schematic to answer the worksheet questions.

1. Draw a circle around the diode.



2. What type of relay is shown in the schematic?

3. If the relay fails to energize, list three tests you could perform to diagnose the malfunction.

4. What is the current rating for the circuit breaker CB24?

5. What is the operating voltage for the relay?

NOTES

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