

# Froggy came a-shortin'!



## Mazda Retractable Headlights: Part Two

**W**e began our dissection of the Mazda Miata retractable headlight system in Part One (April 2001 *Import Service*). The first article covered the circuitry of the Headlight Relay, Light Switch, Fog light Switch and Headlights and explained some basic troubleshooting strategies. Part Two completes our study of the Miata retractable headlight circuit by examining the Retractable Headlight Unit and Retractable Headlight Actuators.

### Standard Terminology

There will be many references to the retractable headlight system wiring schematic in this article. As you know, all electrical schematics employ a form of shorthand. That's because there's usually very little extra room on the page, which forces the engineers to abbreviate everything to save space. Probably the most common abbreviations are wire colors. Most of these are represented by the first letter or letters of the wire color. For example:

<b>W</b> = White	<b>G</b> = Green	<b>Y</b> = Yellow
<b>B</b> = Black	<b>R</b> = Red	<b>BR</b> = Brown

The only exception to this rule is the blue wire color. Rather than label all blue wires as BL like they did with brown (BR), most Japanese car manufacturers use the single letter L instead. The wire colors of wires containing more than one color (usually a solid-color wire with a contrasting tracer color) are separated by a forward slash (B/W for example). We'll observe the same wire color identification conventions in this article.

### Quick Review

**Figure 1** (page 18) shows the complete schematic of the Retractable Headlight Circuit. When the Headlight Relay contacts close, B+ is present in the W/B wire at the splice connection below the relay contacts which goes down to the Light Switch and over to the right to the Retractable Headlight Unit.

A close-up of the Retractable Headlight Unit schematic and the two Retractable Headlight Actuator schematics is shown in **Figure 2** (page 21). The Retractable Headlight Unit contains a solid-state timer, a relay and three diodes. The relay is shown in the relay rest position with the contacts open, as is customary on schematic diagrams. The Timer is a solid-state circuit to activate the headlights for a specific time period while passing if the headlights are not already ON.

## Label B+ (Voltage) Wires

To begin to untangle the wires and connections around the Retractable Headlight Unit schematic and the two Retractable Headlight Actuator schematics illustrated in **Figure 2**, we will label the B+ wires with notations to help understand the circuit. First we'll label the B+ inputs to the Retractable Headlight Unit. The W/B wire carries B+ from the headlight relay contacts. This B+ becomes the B+ source that gets the headlight circuit to turn ON. Mark this wire "B+ Headlight relay contacts."

The R/L wire carries B+ from the Headlight Fuse. Mark this wire "B+ Head Fuse." The R/W wire carries B+ from the Light Switch when the Light Switch is in LO/HI Beam or the Passing Switch is momentarily engaged. Mark this wire "B+ LO/HI Beam/Passing."

B+ to the Retractable Headlight Actuators appears on the R/Y wire in the UP condition and the W/R wire in the DOWN condition and on the R/G wire when the Retractor Switch is in the DOWN position. Label the R/Y wire "B+ UP" and the R/G wire "B+ DOWN."

## Label B- (Ground) Wires

The Retractable Headlight Unit is grounded to G100 through the B (black) wire. We can label this wire "B-." This grounds the Timer and the relay coil in the Retractable Headlight Unit. The Retractable Headlight Actuator assemblies are also grounded to G100 through a B wire. This grounds the DC motor, the NC relay contact (NC for normally closed), the relay coil and its spike suppression diode. Mark both these B wires "B-."

Now that we have the B+ and B- wires marked, we can begin to discuss circuit operation. Everything depends on B+ being present on the W/B wire from the relay contacts which goes to the Retractable Headlight Unit

when the Headlight Relay *closes* its contacts. The Retractable Headlight Unit processes the B+ on the W/B wire through a polarity sensing diode to protect the solid-state Timer. The B+ goes to the Timer and the top of the relay coil. Since the relay coil is permanently grounded through the B wire (B-), the relay energizes and closes the relay contacts. B+ from the Head Fuse on the R/L wire is connected to the relay's swinging contact, which now swings to make contact with the NO (for *normally open*) relay contact, which connects to the R/Y wire we have marked as "B+ UP."

Tracing along the R/Y wire, we see it splices B+ to both Retractable Headlight Actuator assemblies. The B+ enters each Retractable Headlight Actuator assembly through an internal polarity sensing diode. The polarity sensing diode protects the DC motor from turning backwards should reverse polarity voltage be connected to the car during a careless jump start attempt.

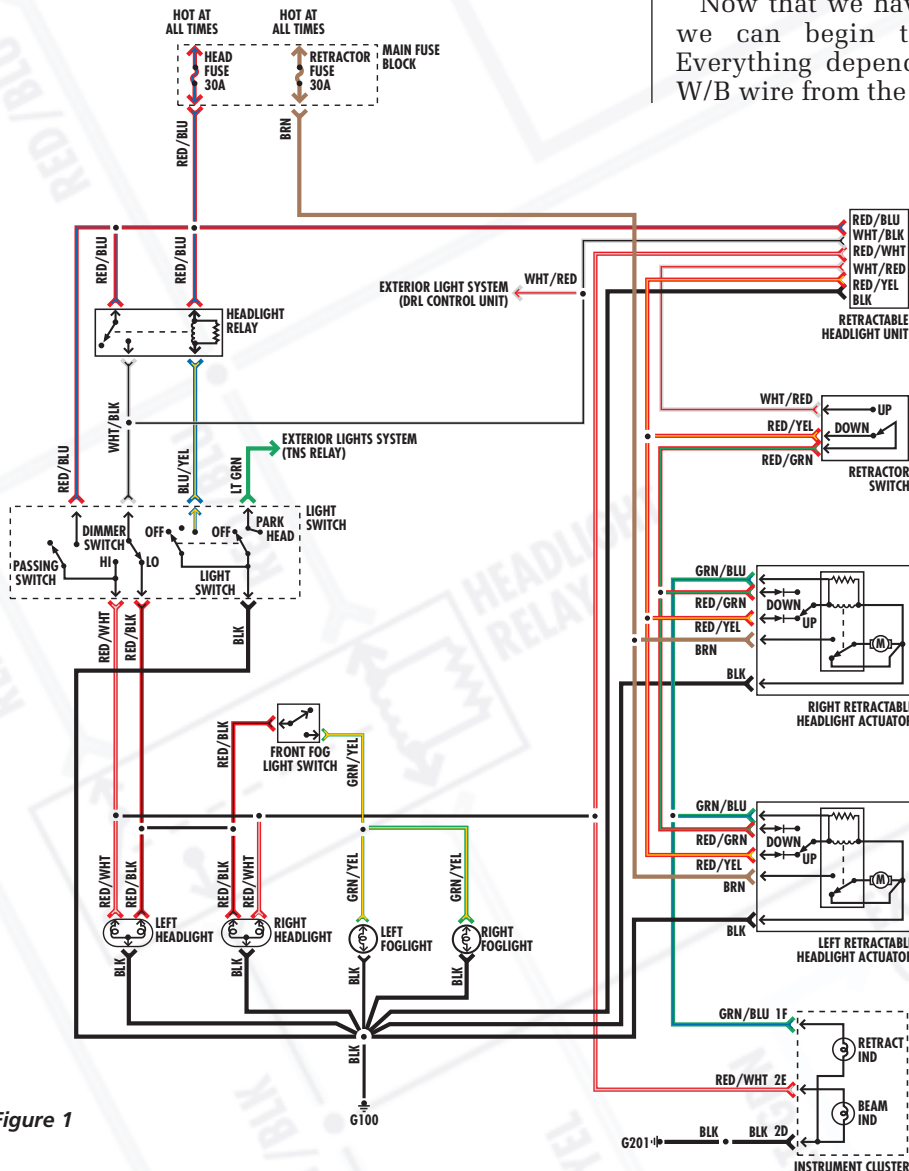


Figure 1

B+ from the polarity diode connects to the UP contact of the Retractable Headlight Actuator's internal UP/DOWN Switch. Remember this about the UP/DOWN Switch: It is always in the opposite position from the headlight position. If the headlights are DOWN, the UP/DOWN Switch is in the UP position. If the headlights are UP, the UP/DOWN Switch is in the DOWN position. This is to set up the next change of position.

Since the UP/DOWN switch is in the UP position (headlights are DOWN and the headlights are OFF) the relay coil gets B+ to the top of the relay coil. The relay coil is permanently grounded, so the relay energizes and closes its contacts. This applies B+ to the top of the DC motor through the closed relay contacts. The DC motor operates to open the door and raise the headlight. Both left and right Retractable Headlight Actuator assemblies operate at the same time. Once the motor has opened the door and raised the headlight, linkage flips the UP/DOWN Switch from the UP to the DOWN position. This is indicated on the schematic by the dotted line slicing through the DC Motor symbol and the UP/DOWN Switch swinging contact. As the swinging contact moves to the other switch contact, it removes B+ from the DC Motor which shuts OFF. The DC motor has completed its task of opening the door and raising the headlight of its respective Retractable Headlight Actuator Assembly.

Because this initial sequence was initiated by operating the Headlight Switch, the headlights are turned ON at the same time, as we discussed in Part One of this two-part article. If the headlights were not turned on, the Retractor Switch could be placed in the UP position to use B+ from the Head Fuse (R/L wire) through the normally closed contacts of the relay inside the Retractable Headlight Unit. This would supply B+ to the R/Y wire, which goes to both Retractable Headlight Actuator Assemblies. This places the headlights in the UP position when the Headlight Switch is OFF.

At this point we have the headlights raised and both headlights ON. Both UP/DOWN switches have been placed in the DOWN position (headlights are UP), waiting for the command to lower the headlights and turn them OFF. This occurs when the Headlight Switch is turned to OFF or to PARK. This ungrounds the Headlight Relay, and its contacts OPEN. The B+ on the W/B wire drops to zero volts, which removes the B+ from the Retractable Headlight Unit and de-energizes its relay. The relay contacts OPEN and the "B+ UP" wire (R/Y) goes to zero volts. When the contacts CLOSE, B+ from the HEAD Fuse is connected through the normally closed contact to the W/R wire we have already marked as "B+ DOWN." See how easy it becomes when we have wires 'pre-marked.'

If the Retractor Switch is placed in the DOWN position, the UP/DOWN Switch is in the DOWN position because the headlights are UP. B+ is supplied to the R/G wire through the closed contacts of the Retractor Switch. Since the UP/DOWN switches in the Retractable Headlight Actuator Assemblies were placed in the DOWN position when the headlights went UP, the relay is again energized and closes its contacts. This supplies B+ to the top of the DC motor, which operates to lower the headlight assembly. Once the headlight assemblies are retracted, the UP/DOWN Switches are flipped to the UP Position awaiting the next command to turn ON and raise the headlights.

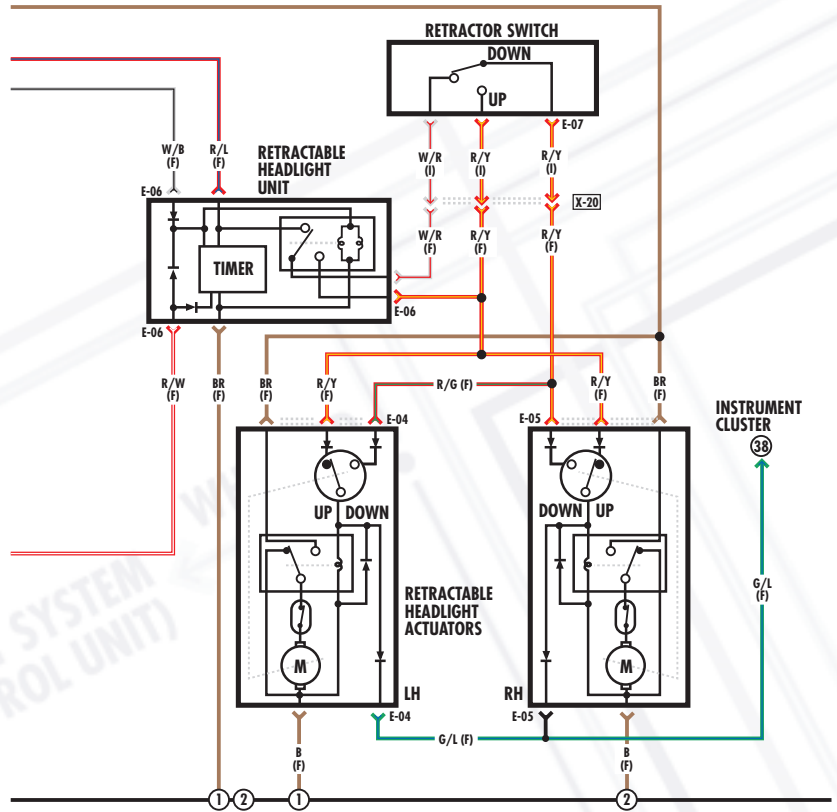


Figure 2

### Flashing Headlights When Passing

On later Miatas, the driver has the option to flash the HI beam headlights when passing, even if the headlights are not being used at the time. Activating the Passing

Switch, by pulling the Light Switch stalk toward the driver, directly turns the HI Beams ON and puts B+ on the R/W wire to the Retractable Headlight Unit to raise the retractable headlight units if they are down.

Inside the Retractable Headlight Unit, the B+ is applied to the Timer through a polarity-sensing diode connecting the R/W wire to the Timer. A B+ event on the R/W wire triggers the Timer to place B+ on top of the relay inside the Retractable Headlight Unit. Since the relay coil is permanently grounded through the B wire, the relay energizes, moves the swinging contact from the NC position to the NO position. This applies B+ directly to the R/Y wire and raises the headlights. Once the Timer's programmed elapsed time concludes, the Timer automatically shuts OFF and removes B+ from the top of the relay coil. The relay de-energizes and the swinging contact returns to the NC position. This lowers the headlights if the Retractor Switch is in the DOWN position. If the Retractor Switch is in the UP position it ignores the Timer's attempt to lower the headlights. Notice the middle diode in the Retractable Headlight Unit. It is placed across the Timer circuit as a spike voltage suppressor to protect the solid-state Timer from any voltage spike produced in the circuit or from the relay powering down.

Each Retractable Headlight Actuator assembly has four diodes. The two diodes connected to the UP/DOWN Switches are for polarity protection. The assemblies will not operate if reverse polarity is applied. Reverse polarity voltage would damage the DC motors and their linkage. The third diode is placed across the relay winding. This diode is used for spike voltage suppression when a Retractable Headlight Actuator assembly relay powers down. This is necessary because of the fourth diode which is connected to the B+ side of the relay coil with the other side connected to the G/L wire which goes to the Instrument Cluster.

If the spike suppression diode across the relay coil is not functioning when the relay powers down, a current surge is produced in the circuit — creating a voltage spike that would dump into the Instrument Cluster and cause damage to its solid-state components. The spike suppression diode deflects the surge, preventing a voltage spike and protecting the sensitive circuitry of the Instrument Cluster from spike voltage damage.

### **Troubleshooting the Retractable Headlight Circuit**

After scanning the schematic, we should notice a few things right away:

- Both Retractable Headlight Actuator assemblies are connected in parallel. They share a common B+ voltage source: the splice in the R/Y wire. A B+ problem above the splice would affect both assemblies.
- A B+ problem below the splice can affect only one assembly. They each have an independent ground wire that is spliced into the main ground wire. A ground problem may only affect one assembly if the problem is above the splice. A ground problem below the splice would affect both assemblies.

If both assemblies fail, the problem must be common to both Retractable Headlight Actuator assemblies — such as a defective relay contact in the Retractable Headlight Unit or a blown fuse. If only one Retractable Headlight Actuator assembly does not function, it has to be a problem relating to the assembly that is not operating. Forget about checking the Head and Retractor fuses. They have to be good because one Retractable Headlight Actuator assembly is operating.

The Retractable Headlight Actuator assembly that is not working may have an internal problem such as a defective motor, broken linkage, bad contacts in its UP/DOWN switch, a broken B ground wire, etc.

If the Retractor Switch is disconnected or has bad contacts, the Headlights will stay in the raised position after they are raised. They cannot be lowered. If you have a problem with lowering the headlights, check the Retractor Switch.



Verify there is B+ on the W/R wire going into the switch and there is B+ on the R/G wire coming out of the switch when the switch is in the DOWN position. If B+ is present but the headlights will not lower, something must be keeping the B+ from getting to the R/G wire going into the Retractable Headlight Actuator assemblies. Should you find B+ to both R/G wires at the Retractable Headlight Actuator assemblies, measure the voltage at both B wires to check the ground circuit. A reading of 0.10 volt indicates a good ground. If you find B+ on the B wires, it means they are not connected to ground. Look for an open circuit.

Suppose the headlights will not raise. What do you do first? Check the Head and Retractor Fuses. If the fuses are good, go to the Headlight Relay and see whether it clicks when the Light Switch is turned to PARK or HEAD. If the relay does not click, check for B+ and B- at the relay winding pins. If the relay clicks, check for B+ on the W/B wire and make sure it is at the connector to the Retractable Headlight Unit. This B+ connection starts the whole process.

Once B+ is found on the W/B wire, check for B+ on the R/Y wire coming out of the

Retractable Headlight Unit. No B+ means a problem with the Retractable Headlight Unit. Either it does not have B+ on the R/L or B- on the B wire. If the Retractable Headlight Unit has B+ and B- on the correct wires, determined by back-probing the connector with a DMM, try another Retractable Headlight Unit.

If you want to make sure before you order a new unit, connect a 25-amp fused jumper wire between the R/L wire and the R/Y wire. This bypasses the Retractable Headlight Unit and should raise the headlights if everything else is okay. We won't discuss headlight (lamp) operation here, since we covered that in Part One in the last issue.

It is very helpful to label wires B+ for voltage and B- for ground. Then label the wires that only receive B+ or B- under certain circumstances. For example, label wires that only receive B+ when voltage or ground is applied to a circuit through a switch. This will give you some basic information about the circuit before you start troubleshooting. Start doing this on each electrical diagnostic job you tackle and see how much it helps. ■

— By Vince Fischelli