

# Incandescent to LED Lamp Conversion

On a dark road dim yellowish headlamps never seemed bright enough, at Steve's suggestion; I ordered a pair of LED headlamps for the XC90. The installation was easy, remove the headlight housing, extract the low beam lamp, install the LED lamp, connect and stuff the power supply inside; replace the headlight assembly.

If you choose to convert your headlamps to LED, park the vehicle 12' from a wall, flip on the headlight lights and note the pattern. Without moving the vehicle, remove the headlamp housing and proceed with the conversion. Once the headlight housing is mounted, power the headlights and observe the bright 6500K white light pattern on the wall. Adjust the LED lamp reflector position so the beam matches the incandescent pattern, then lower it a bit so not to blind on coming drivers. (Hint: choose 6500K lamps.)

Several kinds of LED upgrade assemblies are available, select one that satisfies the following criteria: (1) it's compatible with your Volvo, (2) has a heat sink micro fan on the end of the lamp fixture, and (3) allows the LEDs to be repositioned to modify the beam pattern (not reflector position) in the unlikely event you need to do so.

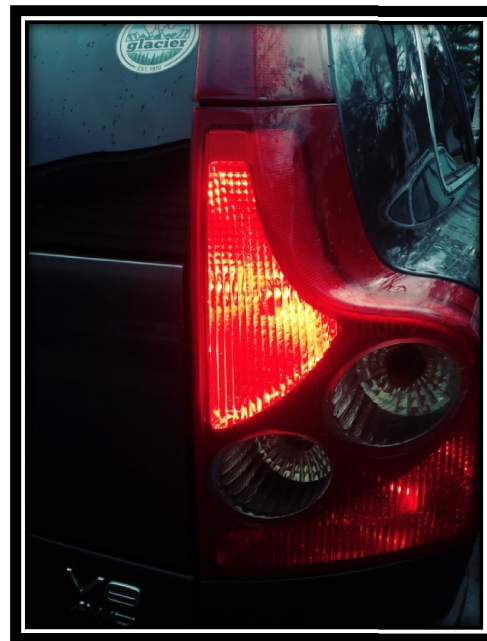
The following week I drove to Alabama to join a hunting party at Selwood Farms in southern Alabama. On the drive, a brake light lamp burned out. Figuring the LED headlamp upgrade was easy; I stopped and purchased a pair of LED stoplight replacement lamps. At my destination I removed the tail light assemblies and installed the LEDs. My friend pressed the brake pedal and the stop lights shone brightly. A welcome sigh of relief overcame me when I realized I'd not have to replace the LED lamps for years (50,000 hours or 13.7 years at 10 hours/day use). Yup, an easy upgrade!

Not all is perfect

Four days later, I departed and depressed the brake pedal and "CHECK STOP LAMP" popped up on the Dash Information Module (DIM) with the yellow "!" triangle. Then I recalled reading something regarding the possible necessity of placing a "load" resistor in the circuit to trick the Electronic Control Module (ECU) that an incandescent lamp is present and alive and extinguish the DIM message. Load resistor kits are available (eBay), but you can make your own.

I wanted to extinguish the irritating message, but I needed the ECU to tell me when the stop light LED failed, and not a state trooper short against a ticket quota deadline.

### LED stop lamps in tail light assembly



What to do?

The options: (1) replace the LEDs with stock incandescent lamps (7225), (2) live with the lamp failure warning each time the brake pedal was pressed--irritating, (3) program the ECU with lower stop lamp current threshold, or (4) place a load resistor across the circuit at each stop light socket.

The ECU measures the current draw of the (3) stop light lamp circuit, left, right and center. When the draw, in amperes, falls below a specified threshold, the stop light lamp failure warning is displayed on the DIM. Recalling Ockham's Razor (select the simplest solution as the best way to solve a problem), I opted for door #4. Ockham was a 14th century English philosopher.

Now the fun began (curiosity is a terrible thing). I grabbed several incandescent 7225 stoplight lamps and a multimeter. I measured the resistance and current draw of the lamps; they averaged 1.7 amps across a resistance of 7 ohms and at 12 volts with a power consumption of 20.4 watts. The replacement LED lamp absorbed 0.12 amps of current across 100 ohms with a power consumption of 1.44 watts, using 14 times less energy. Using Ohm's Law, I calculated that a 6

ohm 20 watt resistor, placed parallel in the circuit, would draw sufficient power to keep the ECU happy; however, if the ECU was to trigger a LED lamp failure. I conjectured a 5 ohm resistor was needed to establish the minimum current draw necessary to trigger a lamp failure message should the LED fail.

I reached into my stash of power resistors and daisy chained three 2 ohm 5 watt resistors together which were wired across the power and ground leads to the lamp socket. Eventually these resistors will be replaced with a 5 ohm or 5.5 ohm resistor.

I may flash the ECU with a lower "CHECK STOP LAMP" current threshold, but I'd have to find the code and the value will be hexadecimal. But then again Ockham may say, why bother when power resistors do the job.

When the next incandescent lamp burns out, it will be replaced with a LED and companion power resistor.

#### Incandescent 7225 Lamp Specifications

#### LED Specifications

<b>Voltage</b> <input type="text" value="12"/> (V)	<b>Voltage</b> <input type="text" value="12"/> (V)
<b>Current</b> <input type="text" value="1.7"/> (A)	<b>Current</b> <input type="text" value=".12"/> (A)
<b>Resistance</b> <input type="text" value="7.059"/> ( $\Omega$ )	<b>Resistance</b> <input type="text" value="100"/> ( $\Omega$ )
<b>Power</b> <input type="text" value="20.4"/> (W)	<b>Power</b> <input type="text" value="1.44"/> (W)

Ohm's Law was used to calculate the load value (delta) for both a LED and load resistor in the circuit to duplicate the current draw of the incandescent stop lamp.

### Delta

<b>Voltage</b>	<input type="text" value="12"/>	(V)
<b>Current</b>	<input type="text" value="1.58"/>	(A)
<b>Resistance</b>	<input type="text" value="7.595"/>	(Ω)
<b>Power</b>	<input type="text" value="18.96"/>	(W)

To duplicate the current draw of an incandescent lamp, place a 7.5 ohm resistor across the power and ground leads to the lamp.

In the unlikely event the LED lamp burns out, the load resistor ( $\Rightarrow 6.0$ ) may prevent the ECU from triggering the "CHECK STOP LAMP" failure message. To preserve the warning function, try a 5.0 or 5.5 ohm resistor, the exact value must be finessed. The sweet spot is a resistance which triggers a lamp failure message only when a LED lamp fails. Use trial and error to finesse the resistance needed to trigger a lamp failure message.

Heat sink power resistors are required for constant illumination lamps, such as tail light lamps. Power resistors generate heat, dissipated by the heat sink to the immediate area. Do not cover the heat sink, it must breathe.

## Power Resistor



All resistors and connections must be protected against salt water exposure. If you live in a road salt state, it may necessitate opening the wire harness and mount the resistor in the cabin.

### Signal lights:

Refer to the charts above, note LED lamps draw much less power than the incandescent lamp it replaces. With respect to turn signals, the LED's low current draw may cause hyper flashing, where the LED lamp blinks faster than the stock lamp; use 7.5-8 ohms in this application. In some vehicles, hazards may blink continuously when "off". Why? Because some ECUs regularly microsecond pulse the hazard signal lamps to verify continuity, without higher load resistance the LEDs will strobe with each pulse.

### Other lights

The 7225 tail light lamp has a filament that draws 0.33 amps. A 2 ohm 5 watt resistor should be suitable.

Side marker lights, the 2825 lamp, draw 0.4 amps. Installing a load resistor for marker lamps may prove challenging due to space. Ockham stipulates, "If the ECU does not trigger a message, no load resistor needed."

Front fog lights accept the H1 lamp which is identical to the low beam headlamp. In this application, select a LED lamp that does not have a heat sink cooling fan nor an external power regulator as internal fixture space is limited.

In each application, select a load resistor whose value does not exceed the resistance of the incandescent lamp it has replaced, just high enough to prevent

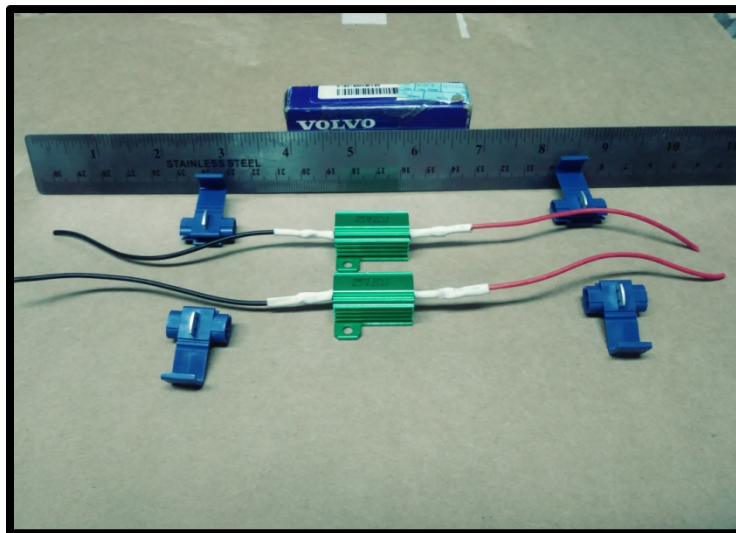
the ECU from triggering a lamp failure message, but not so high as to defeat lamp monitoring. Admittedly, this may be a difficult value to titrate.

For lamps on the same circuit (e.g., tail light, marker light), it may not be necessary to pair a load resistor with each LED as the ECU monitors the total current (ampere) load of the circuit, not each lamp. It may be possible to place a single high value resistor (10 ohms) across the circuit. Be certain to calculate the proper wattage.

This is useful information should you choose to replace side marker "position" lamps (2825) because the fixtures lack space for a load resistor.

Assemble a load resistor kit

Order multiple pairs of resistors (\$0.99 source: eBay). Solder short red/black wires to each resistor, shrink wrap exposed connections and place resistor parallel to the lamp load. Typically, one resistor is paired with a LED at the lamp socket.



Component sources

1.0, 2.0, 5.0, 5.5, 6.0, 7.5, 8.0, 9.0, 10 ohm resistors, and so on. Purchase 5 watt resistors, but do not exceed 20 watt resistors as they are larger and more costly. Search eBay for: shell power aluminum housed case wire wound resistor.

Consider ceramic wire wound resistors for teeny tiny occasional use LED lamps because they are smaller and generate negligible heat.

If the application requires 3 ohms resistance, string a 1 ohm and 2 ohm resistor in series or a 1 ohm and 5 ohm in parallel; either configuration yields 3 ohms total resistance. Having different value resistors on hand will enable you to configure the exact resistance for an application. Stated LED power resistance values are approximate because the ECU lamp failure warning threshold may vary by year and model. Don't use more resistance or wattage than absolutely necessary so as not to draw more current than the wires can handle.

My goal is to provide practical information so you can perform a conversion to LED lamps with confidence in a few hours. Some LED lamps are available with built-in load resistors. Using these eliminates the fun.

Ockham says, "First upgrade low beam headlamps." It's easy and quick.



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He'll respond pleasantly to questions about your Volvo.