Hood Louver driver circuit theory of operation.

This circuit uses an LM393 op-amp comparator (U1) to monitor the TPS voltage. The output of the LM393 drives a high-current PNP transistor (Q2), which turns on/off the hood louver solenoid relay.

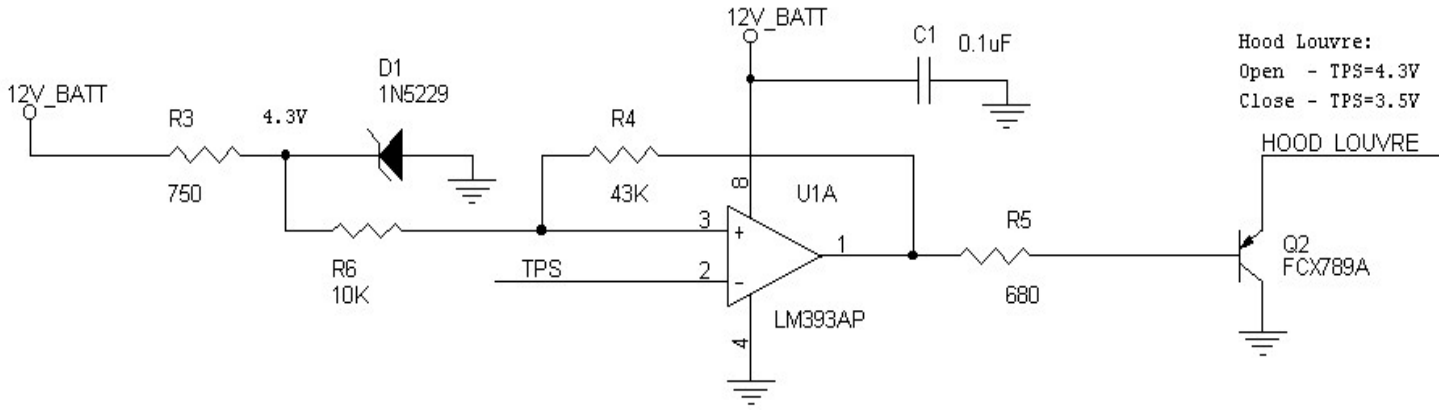

Figure 1

A note about op-amp comparators –

The output stage of the LM393 is an open-collector transistor circuit:

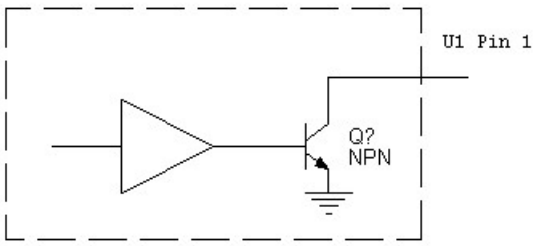

Figure 2

For the output of the comparator to go "low", the output transistor is turned on. For the output to go "high", the transistor is turned off placing the output pin in a high-impedance state. Typically a pullup resistor is placed on the output pin of the comparator to achieve a "high" voltage level at the output.

Circuit Operation -

R3 and D1 set up a reference voltage of 4.3V for the comparator. The TPS voltage increases with throttle position from about 0.5V at idle to about 5V at WOT. So under normal conditions (idle, cruising…etc) the TPS voltage is much lower than the 4.3V reference. This puts a much lower voltage potential on the inverting [-] input (pin 2) than on the non-inverting [+] input (pin 3) for low throttle levels. In this state the output transistor

is turned off and the output would normally be "high" (since the [+] input is dominant), but since there is no pullup resistor, then the output is in a high-impedance (or open-circuit) state. R6 and R4 create a voltage divider with only one voltage supply (or an open-circuit, see Figure 3) because the comparator's output transistor is turned off. Since there is no current flowing through R6 (and thus no voltage drop) this leaves the full 4.3V reference at the non-inverting input (not taking into account the negligible input bias current at the non-inverting [+] input). There is no path for current through the Emitter-Base junction of Q2, turning Q2 off and not allowing the hood louver solenoid relay to be energized.

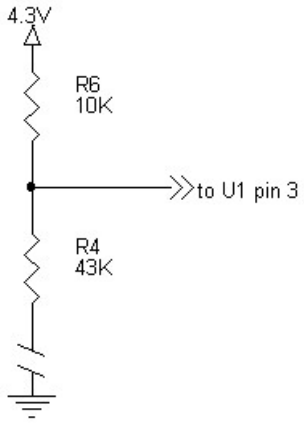

Figure 3

When the throttle is increased to near WOT, the TPS voltage becomes larger than the 4.3V reference. When this threshold is crossed the comparator output transistor turns on, pulling the output "low" (now the inverting [-] input is dominant). When the comparator output goes low, Q2 is turned on allowing current to flow through the hood louver solenoid relay, energizing the relay and opening the hood louvers. Now the voltage divider of R6 and R4 does have two supplies (the 4.3V reference and ground, see Figure 4) since the comparator output transistor is turned on pulling the output to ground. This reduces the reference voltage at pin 3, and thus the point at which the louvers will close again once the throttle position starts to decrease. The new reference can be calculated using the voltage divider formula:

$$Vref = \left[\frac{R4 * 4.3}{R4 + R6}\right] = 3.48V$$

So the louvers will not close until the TPS voltage drops below approximately 3.5V.

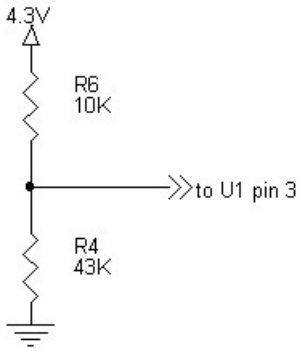

Figure 4