



Title: Low Fuel Warning Module		Rev: C	
		Size: 11x8.5	

Date: 26 Mar 2026	Drawn by: EP		
Sheet: 1	of	2	

Bill of Materials: <https://www.digikey.com/en/mylists/list/CFEKJK5A1K>
 Bill of Options: <https://www.digikey.com/en/mylists/list/2RBW4Q2Y1I>

Theory of Operation

1. **POWER SUPPLY.** 24V is provided to the circuit via pins 1 or 2 of J1, from two separate sources, and is isolated by diodes D1 and D2 to prevent back-feed in the event that one source fails. Power is switched by P-channel MOSFET Q1. [Note: The ZVP4424A was selected for its $V_{gs(max)}$ of +/-40V.]

Whenever the low level sensor detects fuel and sends 24V to the module, Q1's gate is held OFF ($V_{gs} = 0V$).

When the low level sensor doesn't detect fuel and its contacts open, Q1's gate is turned ON by pull-down resistor R1 ($V_{gs} = -24V$). This provides 24V to the comparator, U2, and the input of voltage regulator U1, which provides 12V for the rest of the circuit.

2. **NORMAL STATE: FUEL DETECTED.** The voltage divider composed of resistors R5 and R7 produces an approximate 2V reference at comparator U2.1's non-inverting input. When the low level sensor detects fuel and sends 24V to the module, current passes through diode D3 and resistor R4, charging capacitor C4 to greater than 2V in a few milliseconds. C4's terminal voltage is limited to 12V (protecting U2.1's inverting input) by Zener diode D4.

In this condition, the comparator's output transistor is ON, pulling its output to ground. This holds oscillator U3 in RESET and N-channel MOSFET Q2 OFF. There is therefore no output to the warning LED and the EFIS alarm output is open circuit (in a high-impedance state).

3. **TRIPPED STATE - NO FUEL DETECTED.** When the low level sensor doesn't detect fuel and its contacts open, C4 is no longer charged through D3 and R4. C4 discharges through R6 (the path through R4 and R1 to ground being blocked by D3). It takes about 20 seconds for C4 to discharge from 12V to 2V, below which U2.1's output transistor turns OFF, allowing pull-up resistor R2 to take oscillator U3 out of RESET and turn Q2 ON.

4. **OUTPUT.** With oscillator U3 out of RESET, it begins oscillating, sending its 1.5Hz output through U4, a 20mA constant-current LED driver IC, flashing the panel-mounted warning LED, D5. With Q2 turned ON, the EFIS alarm output is pulled to ground.

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