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## Fuel Supply Module (FSM) Troubleshooting

### Models Affected

Models Covered	Serial Number
135/150/175/200 Verado L4 200/225/250/275/300/350 SCi Verado L6	All
75/90/115 FourStroke EFI 80/100/115 FourStroke	USA - 1B366823 and Above Belgium - 0P459572 and Above

### Situation

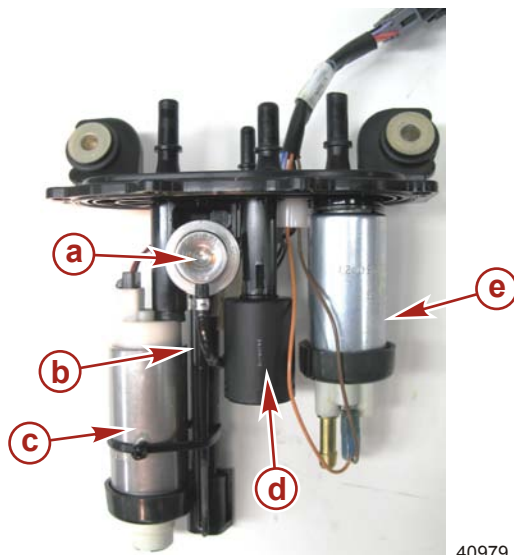
This bulletin is to help technicians better diagnose fuel problems on engines that utilize an FSM. It will explain how to use CDS data to determine what the FSM system is doing and how to use that data to diagnose an FSM related problem.

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## FSM Overview

The fuel supply module contains the fuel lift pump, high-pressure fuel pump, fuel level float switch, fuel pressure regulator, and a fuel cooler. The FSM is mounted aft and outside of the driveshaft housing, directly below the lower adapter plate on Verado models. The FSM is mounted under the top cowl at the front of the engine on the 75–115 FourStroke EFI models. There is no needle and seat controlling the amount of fuel entering the FSM. The filling of the FSM is controlled by the fuel level float switch inside the FSM. This switch is primarily for filling the FSM during the initial ignition key "ON." After the FSM is recognized as full, the PCM modulates the fuel lift pump to fill the FSM.



- a - Fuel pressure regulator
- b - Fuel pressure regulator reference hose
- c - High-pressure fuel pump
- d - Fuel float switch
- e - Fuel lift pump

## CDS-FSM Based Fuel System Parameters

### KEY ON, ENGINE OFF, CRANKING, STARTING

Every time the key switch is turned "ON," the PCM checks the FSM float switch and vent float switch status. If they are both "low," the PCM will turn the lift pump on for the amount of time listed, or until either switch reads "high."

Model	Seconds
Model year 2005	180 seconds
Model year 2006 and newer	25 seconds (early 2006 calibrations were 45 seconds)

**NOTE:** For model year 2005 only, a "Lift Pump Timeout" fault will be set if the FSM is not full after 180 seconds.

If the engine is cranked or started before the FSM is full, the PCM uses the following time listed until either switch reads "high." If the FSM does not fill in the following time listed, a "Lift Pump Timeout" fault will be set.

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Model	Charge Temperature (Intake Temperature)	Seconds
75-115 FourStroke	Above 50 °C (122 °F)	155 seconds (early calibrations are 135 seconds)
	Below 50 °C (122 °F)	45 seconds
Model		Seconds
135-350 Verado L4 and L6 SC		180 seconds

**ENGINE RUNNING**

If the status of both switches are "low," the PCM will turn on the lift pump after the specific amount of fuel is consumed. Refer to the following chart for fuel consumption information. If the FSM does not fill in time, a "Lift Pump Timeout" fault will be set.

Model	Grams Consumed
135-350 Verado L4 and L6	150 grams
75-115 FourStroke EFI	60 grams

**MISCELLANEOUS INFORMATION**

- If a "Lift Pump Timeout" fault is set, the lift pump will be disabled and the engine will run out of fuel.
- A full FSM holds approximately 450 grams (600 ml) of fuel.
- Reprogramming model year 2006 and newer engines will upgrade the fuel system parameters.

**CDS DISPLAYED DATA**

CDS Data Item	Description (what it displays)
Lift Pump On Time	Counter (seconds of lift pump run time)
Calculated Fuel Mass	Counter (grams of fuel consumed) (displayed CDS V8.xx)
Calculated Fuel Pressure	Pressure that should be present at the rail (± 4.64) (not actual pressure)
FSM Level Switch	Status (high or low), high = no continuity, low = continuity
Vent Switch	Status (high or low), high = no continuity, low = continuity
Vent Canister Purge Valve	Status (closed or open)
	Duty cycle (% on time)

**NOTE:** Model year 2005 Verado will only display calculated fuel pressure on CDS.

**Lift Pump On Time** - This line item displays in seconds the amount of time the PCM is signaling the lift pump to run. Maximum lift pump on time will typically be 5-10 seconds with the engine running at any load. If the lift pump on time exceeds 15-20 seconds to refill the FSM while the engine is running, the fuel system is restricted. Check for dirty filters, pinched lines, and stuck anti-siphon valves.

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**Calculated Fuel Mass** - This line item displays the amount of fuel consumed in grams. When the engine is in the run state, the PCM calculates the fuel consumed to determine when to turn the lift pump on. On a Verado based engine, the PCM will not cycle the lift pump until it has counted 150 grams of fuel used. On a 75–115, the PCM will not cycle the lift pump until it has counted 60 grams of fuel used. When this calculated fuel mass has been consumed, and both float switches are low, the PCM will excite the lift pump to supply fuel to the FSM. The lift pump will continue to run until either switch turns to "high" or until the lift pump timeout threshold is reached. Refer to the table on the preceding page.

**Calculated Fuel Pressure** - The mechanical rail pressure should measure close to this calculated pressure. This line item displays a calculated fuel pressure value of what the fuel rail pressure should be. Fuel pressure is dynamically controlled based on intake manifold absolute pressures. A Verado based engine can vary in actual fuel pressure from approximately 275.79 to 413.68 kPa (40 to 60 psi). This calculated fuel pressure provides a technician with the information needed to determine if the engine's mechanical fuel rail pressure is within specification.

**FSM Level Switch** - This line item displays the state of the FSM float switch. A float switch will read "high" when the FSM is full (opens the five volt signal going back to the PCM) and "low" when the FSM is not full (closes the five volt signal going back to the PCM). The PCM will only activate the lift pump based on the float switch and vent switches position. Both need to read "low" for the lift pump to activate during the key "ON" sequence. This will ensure the FSM is full before starting.

**Vent Switch** - This line item displays the state of the vent switch. The vent switch should always read "low." If the vent switch reads "high," there is fuel in the vent system or the vent switch circuit has failed to open (faulty switch or circuit). If the vent switch circuit reads "high," the PCM will output fault #220 (vent float switch high). This fault will trigger the PCM to shut down the lift pump and close the vent canister purge valve (VCPV). This is a "sticky" fault.

***NOTE:** If fuel is present at the vent float switch, the vent schrader valve must be pressed while tapping on the vent canister. This allows the trapped fuel to drain back into the FSM.*

**Vent Canister Purge Valve** - This valve is displayed with two line items of information. One line item will display "open" or "closed" and the other will display in duty cycle (percent on time). With the key "ON" and the engine off, the VCPV should show closed and 0% duty cycle. With the engine running, the VCPV will normally show open with a duty cycle percentage varying from approximately 15% to 80%, depending on the demand on the engine.

## Referencing Fuel Pressure Readings

The fuel rail pressure will vary according to the state of the intake manifold vacuum at idle, or if under pressure when the demands of the engine load are highest. This change from vacuum to pressure, and the subsequent changes of the fuel pressure, is maintained by a reference hose connection at the intake manifold to the fuel pressure regulator inside the FSM.

## Fuel Pressure Calculations with the Engine Running

When calculating the fuel pressure at different engine RPMs, a simple formula can be used to determine what the fuel pressure should approximately be: **(MAP – Barro) + regulator set point.**

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The following examples are with an ambient barometric pressure of 101 kPa (14.65 psi). If the intake manifold absolute pressure is below the barometric pressure (vacuum), and the CDS displays 32 kPa (4.64 psi), the formula appears as:

- **kPa:**  $32 - 101 = -69 + 350 = 281$ . The resulting 281 kPa is the calculated fuel pressure reading.
- **PSI:**  $4.64 - 14.65 = -10.1 + 50.76 = 40.75$ . The resulting 40.75 psi is the calculated fuel pressure reading.

If the intake manifold absolute pressure is above the barometric pressure (boost), and the CDS displays 191 kPa (27.70 psi), the formula appears as:

- **kPa:**  $191 - 101 = 90 + 350 = 440$ . The resulting 440 kPa is the calculated fuel pressure reading.
- **PSI:**  $27.70 - 14.65 = 13.05 + 50.76 = 63.81$ . The resulting 63.81 psi is the calculated fuel pressure reading.

**NOTE:** Depending on the engine model, calculated fuel pressure may be displayed on the CDS.

### Fuel Pressure Troubleshooting Chart

Engine State	Condition	Corrective Action
Key "ON"	Fuel pressure is less than $350 \pm 32$ kPa ( $50.76 \pm 4.64$ psi)	<p>Check CDS data items for the "FSM Level Switch" position.</p> <ul style="list-style-type: none"> <li>• If "LOW," the "Lift Pump On Time" seconds should be counting and the lift pump should be running. The lift pump will continue to run until the "FSM Level Switch" reaches the "HIGH" position or until the lift pump timeout limit is reached. To verify the lift pump is running, connect a vacuum gauge between the FSM and fuel filter. Lift pump vacuum should not exceed 3.0 in. Hg (10.16 kPa).</li> <li>• If "HIGH," the lift pump will not run and the PCM believes the FSM is full of fuel. Listen for the high-pressure pump to run at key "ON." If the pump is running, the FSM float switch is likely stuck in the "HIGH" position. When this happens no faults will be set.</li> </ul>
	Fuel pressure is $350 \pm 32$ kPa ( $50.76 \pm 4.64$ psi), but does not drop in pressure when started	The fuel pressure regulator changes the pressurization of the fuel, depending on the manifold pressure. Once the engine is started, the manifold pressure will drop and the fuel pressure will drop. The regulator in the FSM has a reference hose connected to it and the other end is connected to the FSM cover. From the cover, it is then connected to the intake. Check the hose from the FSM to the intake manifold. If alright, remove the FSM cover and inspect the line from the cover to the regulator. If the line inside the FSM were to split, or become disconnected, fuel will be drawn into the intake causing the engine to run rich.
	Fuel pressure at the rail is higher than the calculated fuel pressure on the CDS	Remove the FSM cover and then remove the fuel pressure regulator from the cover. Inspect the screen on the backside of the regulator for debris. If clean, replace the regulator.

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Engine State	Condition	Corrective Action
Running	Fuel pressure is fluctuating and the engine is starting to die	<p>Check CDS data items for the "FSM Level Switch" position.</p> <ul style="list-style-type: none"> <li>If "LOW," check the "Calculated Fuel Mass" and see if it is exceeding the number of grams of fuel used. If the number is higher than the specification for that model, the "Lift Pump On Time" should be counting and the lift pump should be running. If the seconds are exceeding 15–20 seconds before the "FSM Level Switch" reaches "HIGH," check the lift pump vacuum to verify it is not exceeding 3.0 in. Hg (10.16 kPa). A higher reading would indicate a restriction in the fuel system and a lower reading could indicate a possible lift pump failure.</li> <li>If "HIGH," the lift pump will not run and the PCM believes the FSM is full of fuel. If the float is stuck in the "HIGH" position, the engine will run out of fuel. When this happens, no faults will be set. Check the "Calculated Fuel Mass" to see if it exceeds the grams consumed for the specific engine model. If so, the float switch is likely sticking in the "HIGH" position.</li> </ul>

### FSM Related CDS Engine Faults

Fault Number	Fault Name	Warning Type	Fault Description	Possible Root Cause
207	Lift Pump Timeout	Critical <sup>1</sup> .	FSM did not fill in the specified time. Reference CDS-FSM Based Fuel System Parameters.	<ul style="list-style-type: none"> <li>Fuel filter is restricted</li> <li>Fuel restriction in boat</li> <li>Weak lift pump</li> </ul>
208	Lift Pump Output	Critical <sup>1</sup> .	Insufficient current draw at the lift pump.	<ul style="list-style-type: none"> <li>Lift pump failure</li> <li>Lift pump circuit open</li> </ul>
220	Vent Float Switch High	Critical <sup>1</sup> .	Vent switch is in the open position.	<ul style="list-style-type: none"> <li>Fuel is in the vent canister due to a failed FSM float switch or a pressurized fuel system.</li> <li>Vent switch failure</li> <li>Vent switch circuit open</li> </ul>
221	Lift Pump Float Switch High	Critical <sup>1</sup> .	FSM float switch is in the low position and the vent float switch is in the high position.	<ul style="list-style-type: none"> <li>FSM float switch or circuit has failed and has caused fuel to flow into the vent canister.</li> <li>Vent switch has failed to open and at the same time the FSM float switch is in the closed position.</li> </ul>

1. Continuous 6 second beep: Depending on the condition, the Engine Guardian system may engage and protect the engine by limiting the power.

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