General Service Bulletin (GSB):	**Flex Fuel (FF) GSB**
This GSB targets vehicles that have Flex Fuel (FF) capability	A Guide to understand how to diagnose Flex Fuel vehicle fuel systems utilizing the IDS
NOTE: This information is not intended to replace or supersede any warranty, parts and service policy, Work Shop Manual (WSM) procedures or technical training or wiring diagram information.	

Flex Fuel (FF) GSB

For 2004 Model Year and Newer Vehicles

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❑ Identifying FF Capability:

- ❑ OASIS Report
  - ❑ Vehicle Information section has been updated to identify FF capability for gasoline and FF vehicles. Figure 1
  - ❑ An identifier label of "Flex Fuel" will display a "Y" to indicate that the vehicle **is** FF capable.
  - ❑ The identifier displaying an "N" indicates that the vehicle listed is **not** FF capable.
- ❑ Yellow bezel on "Easy Fuel™" filler neck – Figure 2
- ❑ Yellow fuel filler cap – Figure 3
- ❑ Exterior badging (Rear of Vehicle) – Figure 4

• VEHICLE INFORMATION

VEHICLE DESCRIPTION: **2013 F-SERIES**
TRANSMISSION: **6 Speed Auto Transmission (6R140)**
PAINT COLOR: **Tuxedo Black**
AXLE RATIO: **3.73 Ratio**
SYNC VERSION: **V3 Gen2**
FLEX FUEL: **Y**

Figure 1 – The Vehicle Information section of OASIS with FF identifier.

Figure 2 – E85 Easy Fuel Filler Neck Bezel

Figure 3 – Standard Threaded Fuel Filler Cap

Figure 4 – Late Model FF Exterior Badging

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About E85 (Ethanol)

- Fuel ethanol (E85) is a mixture of a maximum of 85% denatured ethanol and 15% unleaded gasoline. The purpose of this fuel is to provide consumers with another fuel option that is from a renewable source, can lower some engine emission byproducts and be purchased at a lower cost per gallon.
- A major difference between gasoline and ethanol is oxygen content. Ethanol contains a significantly greater amount of oxygen.
- The energy content of E85 is about 30% less than that of gasoline.
- Due to the lower energy content of ethanol, vehicles running on E85 get fewer miles per gallon than vehicles operating on unleaded gasoline.
- Each molecule of ethanol contains less heat energy than gasoline. For E85, this means a richer air-fuel ratio (9.8:1) is required. Therefore, FF vehicles have fuel injectors capable of a higher flow rate to achieve the appropriate stoichiometric ratio.
- If a summer blend of ethanol is used in cold weather conditions (≤ 0°F/-18°C), increased cranking times, rough idle or hesitation symptoms may result due to the lower volatility of alcohol-blended fuels.
- Winter blends of ethanol may have up to 49 % unleaded gasoline (E51) to enhance cold-weather starting.
- Fuel ethanol will mix with water, but at high enough concentrations of water, the ethanol will separate from the gasoline.

	Gasoline	E85
Air-Fuel Ratio (Stoichimetric)	14.7:1	9.8:1
Heat of Combustion (Btu/gallon)	116,000	62,000 - 66,000
Octane (R+M)/2	86 - 94	96

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❑ Water Testing the Fuel to Determine Approximate Ethanol Percentage:

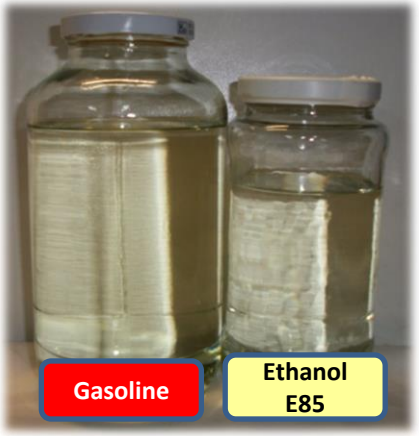
This test can help determine the approximate ethanol percentage for the fuel in question.

1. Obtain a clean and clear bottle and fill it halfway with water. (Figure 1)
2. Mark the water level on the bottle. (*Figure 1*)
3. Slowly add an **equal amount** of the fuel in question.
4. Secure the cap and shake the bottle to mix the water and fuel. This forces the water to mix with the ethanol.
5. Allow the mixture to stand and separate for approximately 3 minutes. The ethanol/water solution will settle to the bottom, while the gasoline rises to the top.
6. Compare the previous line on the side of the bottle with the new level of separation.
   - ❑ A small increase in the water level (≈10-15%) supports that the fuel is gasoline with a low concentration of ethanol present. (*Figure 2*)
   - ❑ A large increase in the water level supports that the fuel has a higher concentration of ethanol. (*Figure 3*)

The images on the right are samples of gasoline and ethanol/E85.

Note that the color and clarity of both fuels are quite similar, making a visual distinction difficult and unreliable.

Determining a difference based on odor is also difficult and not recommended.



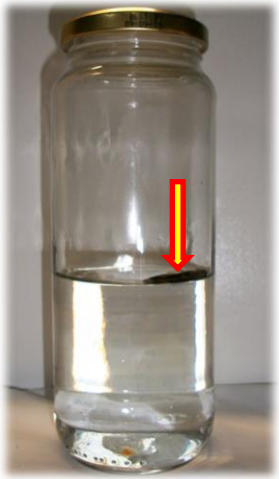


Figure 1 – ½ filled with water and the line marked to indicate the level.

Figure 2 – **Gasoline** added then shaken. Note the small increase in the water level.

Figure 3 – **Ethanol** added then shaken. Note the large increase in the water level.

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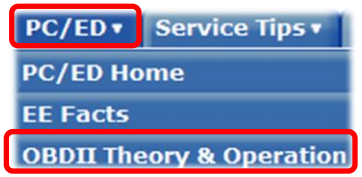
❑ Flex Fuel Strategy Overview:

- ❑ On 2004 MY and newer vehicles, the flex fuel sensor and module have been deleted and the ethanol percentage is now *inferred*. The closed loop fuel strategy uses a wide range O^2 sensor (UEGO) to measure equivalence ratio of the exhaust gas. This feedback is used to deliver the correct amount of fuel to the correct stoichiometric ratio. The fuel equation includes short (SHRTFT) and long term (LONGFT) fuel trim, MAF (Mass Air Flow) as well as ethanol inference to calculate the desired fuel mass.
- ❑ Ethanol detection uses the same logic as adaptive fuel, but it only makes adjustments when the system detects a significant fuel fill (>10% change in FLI level) and it believes that the fuel in the lines has been used. When the new fuel that was added to the tank is estimated to be at the tip of the injector, SHRTFT corrections needed to maintain stoichiometry are moved to FF_INF(inferred). Unlike adaptive fuel, the FF learning happens quickly. FF_INF affects the fuel pulse width in open and closed loop operation and applies during cranking.
- ❑ During the learning process, all changes in the air/fuel ratio (AFR) are stored in memory. As updates are made, the ethanol percentage is updated and stored in keep alive memory (KAM). Learning continues until the inference stabilizes with stabilized engine operating conditions.
- ❑ Resetting KAM will cause the PCM to initiate a relearn and infer the AFR immediately after going into closed loop operation.

$$\text{FUEL MASS} = \frac{\text{MAF} * \text{LONGFT}}{\text{AFR\_STOIC} * \text{SHRTFT}}$$

NOTE: ***Additional detailed information about Flex Fuel Operation can be found in the online OBDII manual under the 'PC/ED' ► 'OBDII Theory & Operation' tab of OASIS.***



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Adaptive Fuel viewer in IDS:

- On some 2013 and newer vehicles, there is an "Adaptive Fuel" viewer that can be selected in the Data Logger > Powertrain section of IDS. See the Adaptive Fuel Viewer GSB for how to use this tool to diagnose rich/lean conditions

- The Adaptive fuel control and Flex Fuel calculation are an integral part of the overall fuel delivery based on O2 sensor feedback. The Flex Fuel calculation has a priority of learning first when a relatively large re-fuel event is detected (or KAM reset). This means that the adaptive fuel will be disabled until the Flex Fuel percentage is "learned" after a major refueling event. Only after the Flex Fuel percentage is "learned" will the adaptive fuel start learning. In cases where a rich/lean system fault is intermittent, it may be difficult to determine the root cause based only on the adaptive viewer. If there is any doubt of the FF_INF value, a fuel sample should be taken and tested (Refer to PC/ED Manual, PP test HC, or Flex Fuel GSB).

Valuable PIDS:

- **FF_INF (Flex Fuel Inferred):** Displays the calculated percentage of ethanol in the fuel based on inputs and fuel delivery adjustments.

- **FF_LRND (Flex Fuel Learned):** Displays 'YES' or 'NO' to indicate the PCM's learned status after engine operations and fueling adjustments have stabilized.

- **SHRTFT (Short Fuel Trim):** Displays the immediate fueling correction percentage that the PCM is making to reach stoichiometry.

- **LONGFT (Long Fuel Trim):** Displays the fueling percentage corrections made over time. SHRTFT readings are eventually moved to LONGFT, as the SHRTFT readings are pushed closer to 0%.

- **FLI (Fuel Level Input):** Displays the fuel level percentage in the tank as reported by the sending unit.

- **LTF# CELL# (Long Fuel Trim Cell):** Displays the long fuel trim correction/adjustment percentage being made for each bank to reach stoichiometry based on the incoming air flow and load. Each CELL# represents an operating mode (e.g. idle, moderate loads, WOT. An incorrect FF learn will have an affect on **all** cell readings due to the fuel affecting all operating modes.

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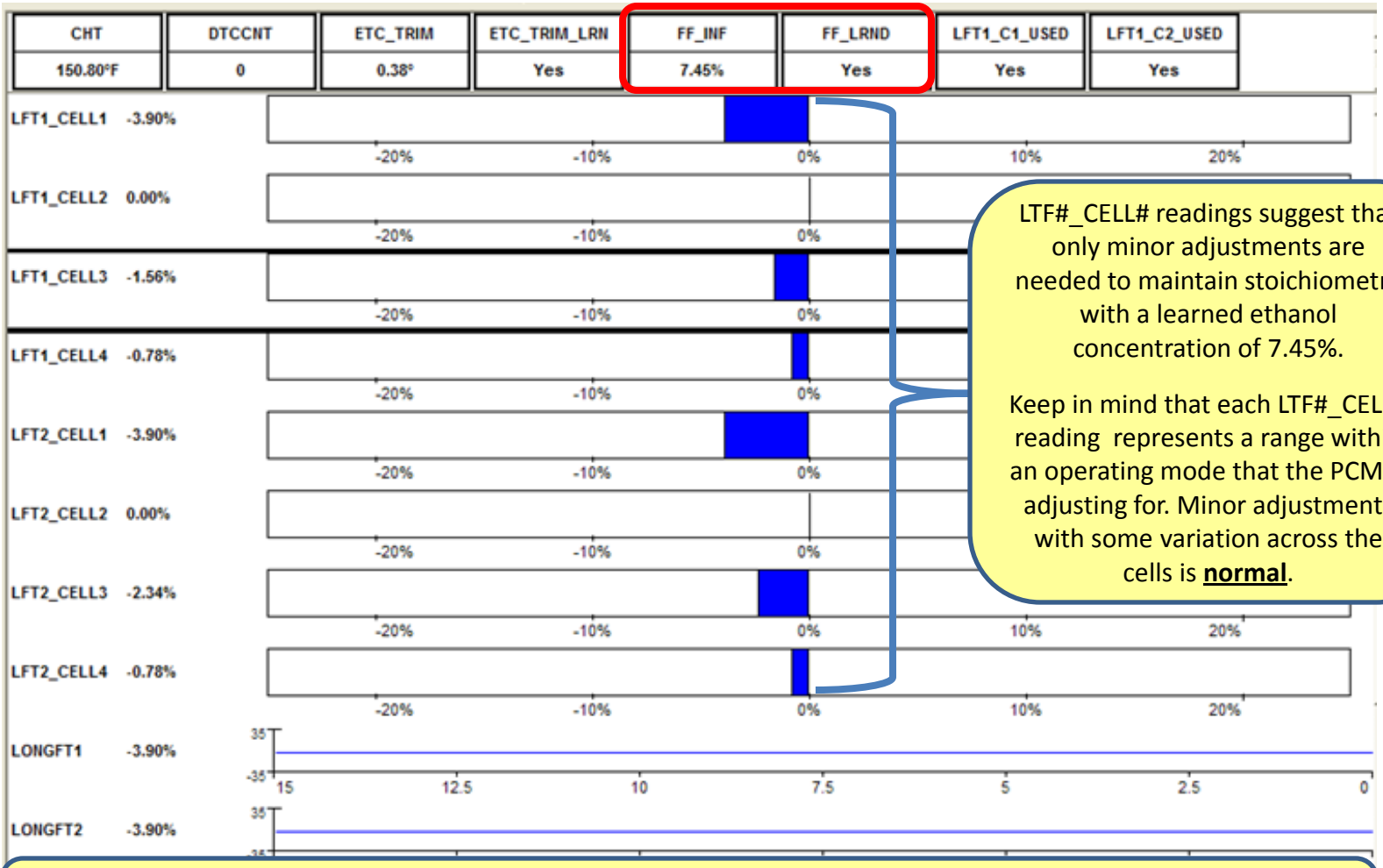

LTF#_CELL# readings suggest that only minor adjustments are needed to maintain stoichiometry with a learned ethanol concentration of 7.45%.

Keep in mind that each LTF#_CELL# reading represents a range within an operating mode that the PCM is adjusting for. Minor adjustments with some variation across the cells is **normal**.

2013 F150 – 5.0L: The above "Adaptive Fuel" data logger recording shows **normal** readings from a vehicle that is running on Gasoline.

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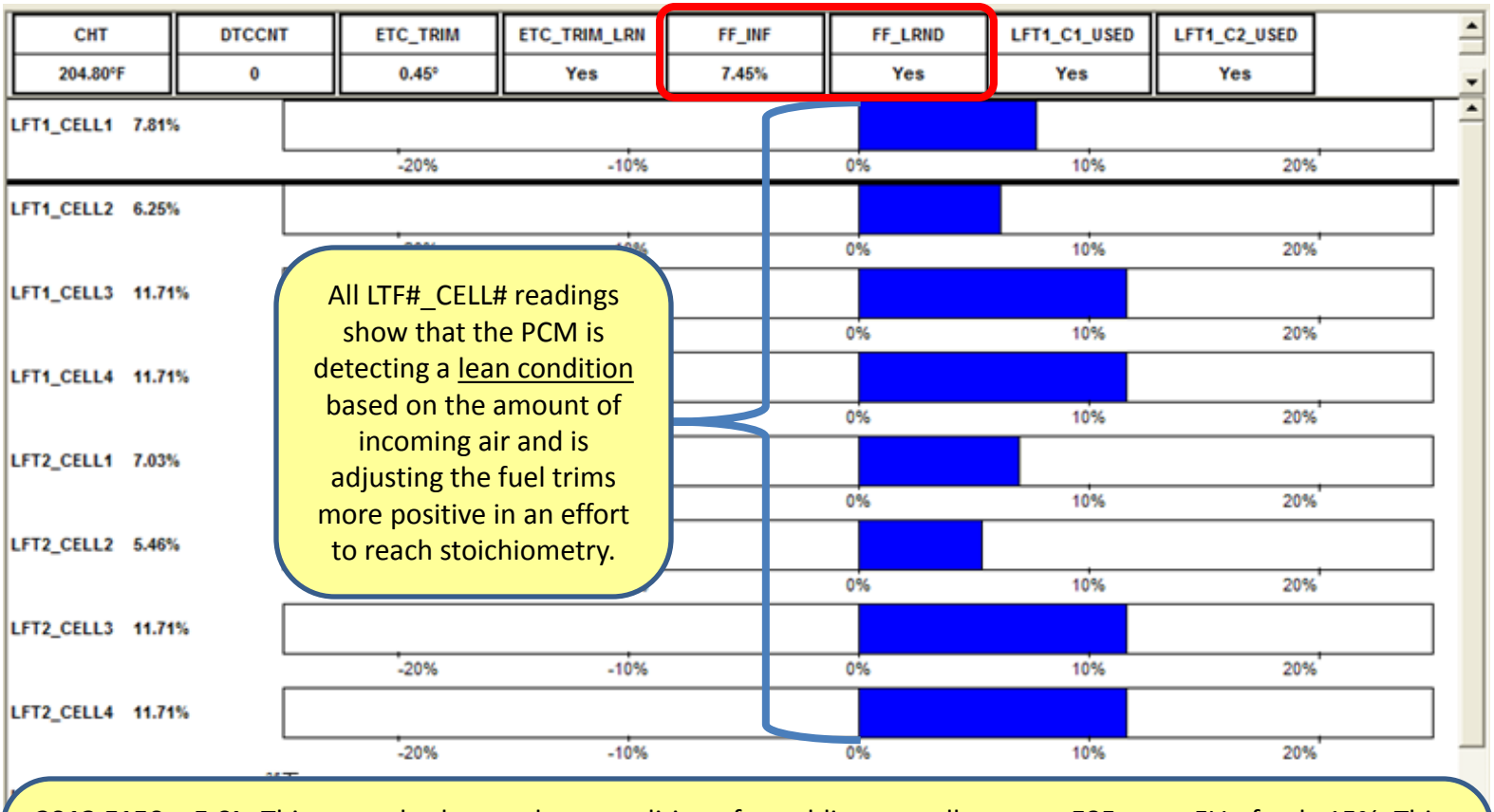

All LTF#_CELL# readings show that the PCM is detecting a lean condition based on the amount of incoming air and is adjusting the fuel trims more positive in an effort to reach stoichiometry.

2013 F150 – 5.0L: This example shows a lean condition after adding a small amount E85 to an FLI of only 15%. This small amount of E85 added, was enough to cause the engine to run lean and not initiate an FF relearn. The lean fuel mixture also caused the PCM to make positive corrections across all of the LTF#_CELL# readings.

NOTE: If a vehicle is running on E85 for an extended period of time, then refills with gasoline and a relearn is not completed, the LTF#_CELL# readings will display the opposite of what is shown above with negative corrections. This would be due to the system detecting a rich condition and the PCM is removing fuel to reach stoichiometry.

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Useful Tips

- Concerns typically associated with an incorrect FF learning can be: Intermittent long crank/hard start, no start, runs rough when cold with misfire DTC's (e.g. p0300/P0316) and/or rich or lean DTC's (e.g. p0172, p0175, P0171, p0174, P2195, P2196, P2197, P2198).
- Water testing the fuel is a reliable method to determine what the approximate ethanol concentration is. Side by side visual comparisons of gasoline and E85 are quite similar and can be misleading. Determinations based on smell are also not a reliable method and not recommended.
- If a lean condition is detected by the PCM and the FF_INF reading indicates that the PCM has learned a value that suggests gasoline, a KAM reset with IDS should be performed first. The vehicle should then be driven until FF_LRN changes to 'YES' and the FF_INF reading is stable. This will help differentiate between a fault induced by not learning the appropriate fuel concentration or a system functionality fault that requires additional diagnostics.
- If the FF_INF reading repeatedly learns a value that is not consistent with the ethanol concentration determined after water testing the fuel, continue with normal diagnostics in the PC/ED.
  - If directed to test the fuel pressure, ensure that it is tested under a driven load to see if the fuel delivery module can maintain sufficient pressure under high demands.
- If a battery disconnect or KAM reset is performed, the FF_INF value in IDS will not change and the FF_LRND will indicate "NO". The PCM will initiate a relearn and infer the AFR immediately after going into closed loop operation. A battery disconnect reset will cause the PCM to begin it's inference strategy from an initial setting of gasoline.
- Advise Customer:
  - It is best not to alternate between gasoline and E85. If fuels are switched, it is recommended to add as much fuel as possible, at least half a tank. Do not add less than five gallons (18.9L) when refueling. This may cause rich or lean operation due to an FF relearn not being initiated.
  - The vehicle should be driven immediately after refueling for at least 5-10 miles (8-13 km) to allow the vehicle to adapt to the change in ethanol concentration.