Adaptive Fuel Trim Display Tutorial

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To begin the tutorial , click this button.

How to Navigate the Adaptive Fuel Trim Display Tutorial

• Topic A	Hyperlink	Opens the topic/chapter.
	Advance button	Shows the next slide.
	Reverse button	Shows the previous slide.
	Return button	Shows the previous menu.

For example; To advance to the next slide, click this button. 

Adaptive Fuel Trim Display

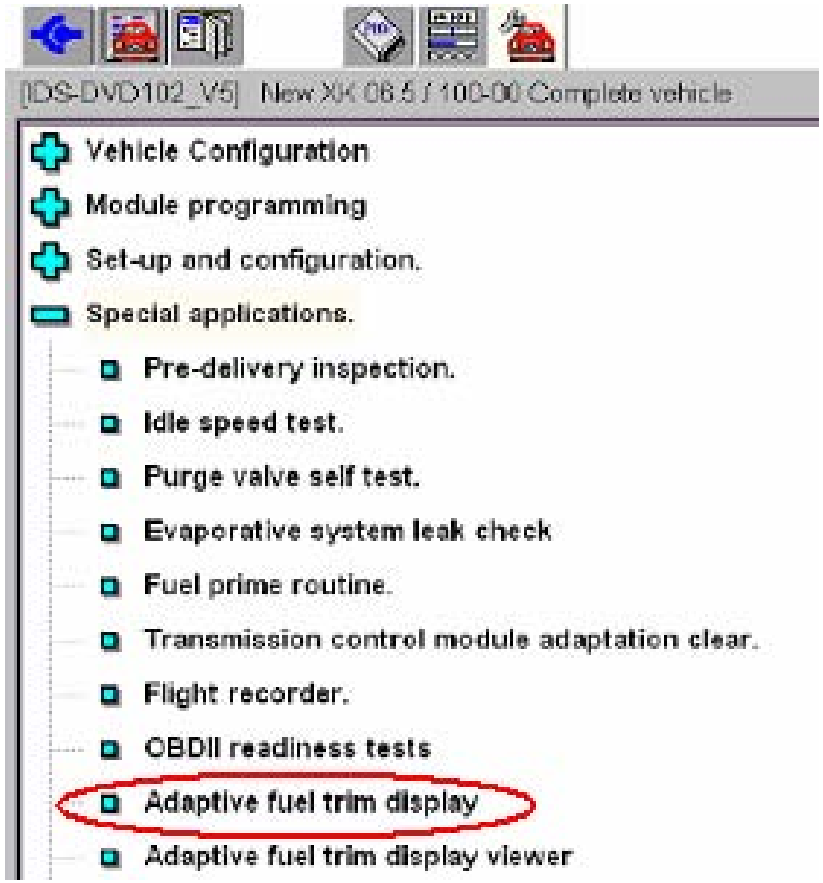
- Jaguar Tutorial
- Land Rover Tutorial

EXIT

Adaptive Fuel Trim Display
Jaguar Tutorial

- Accessing the Adaptive Fuel Trim Display
- Interpreting the Adaptive Fuel Trim Display

Brand Menu



Launching the Adaptive Fuel Trim Display – 2007 XK

Return

Jaguar Adaptive Fuel Trim Display Details

The Adaptive Fuel Trim Display application allows the technician to view 2 complete sets of adaptive values.

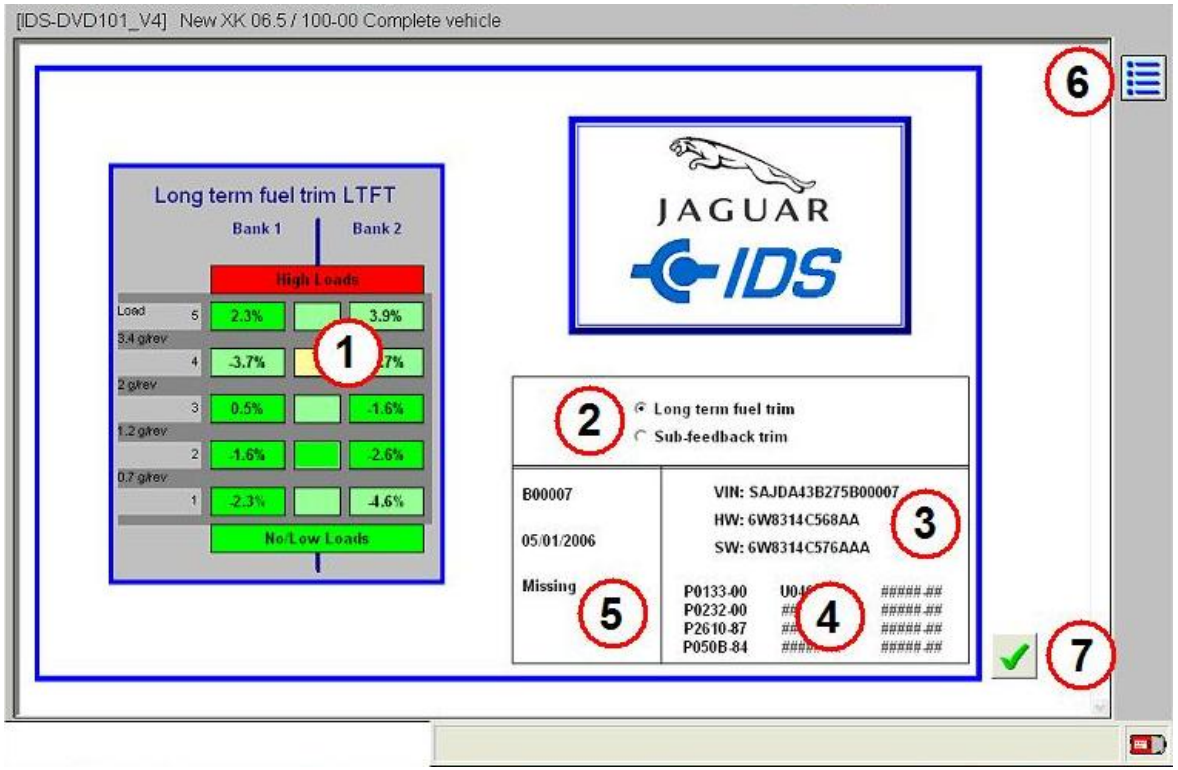
Each set of fuel trim values is related to a different area of engine operation, and DTC grouping.

- Long Term Fuel Trim (P017x DTC's)
- Sub-Feedback Fuel Trim (P209x DTC's)
- Color Coded Diagnostic Aids Explained

Tutorial Menu

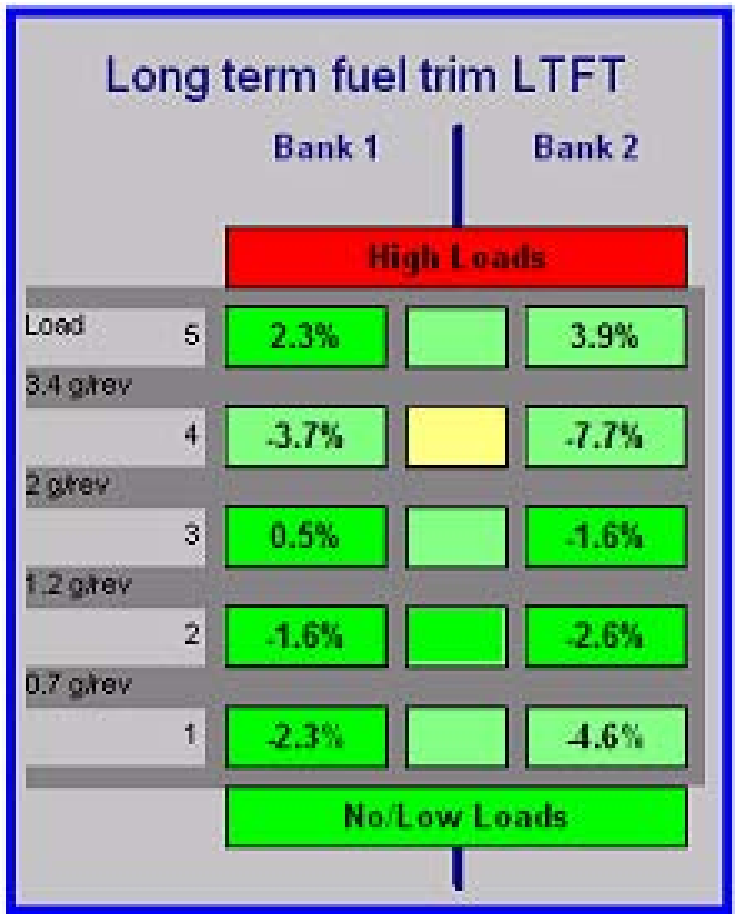
Long Term Fuel Trim Display

The Jaguar LTFT strategy is such that the ECM stores 5 adaptive values per cylinder bank of the engine. These 5 values are each associated with a different range of engine load from idle through maximum power development. When viewing the Jaguar LTFT both banks are displayed in a single panel display. (shown below as item #1)



1. LTFT Data
2. Data View Selection
3. ECM Details
4. Current DTC's read from ECM
5. Supplemental data
6. Menu Button
7. Continue Button

Long Term Fuel Trim Display



This display shows all 10 LTFT values in 2 columns of the 5 load ranges per cylinder bank.

The idle load ranges are at the bottom, and maximum power/full load ranges are at the top.

Each value is color keyed to indicate the general status of each adaptive value. Refer to the LTFT color code legend at the end of this tutorial for more info on this color coded diagnostic aid.

The Jaguar LTFT display also includes a single column of 5 color coded boxes between each bank of LTFT values. These color coded boxes indicate the bank-to-bank relationship or balance for each pair of LTFT values. This color coding is also explained at the end of this section.

Generally speaking, when the vehicle is operating as designed, all color coding in the LTFT display should be bright or pale green.

Sub-feedback Fuel Trim Display

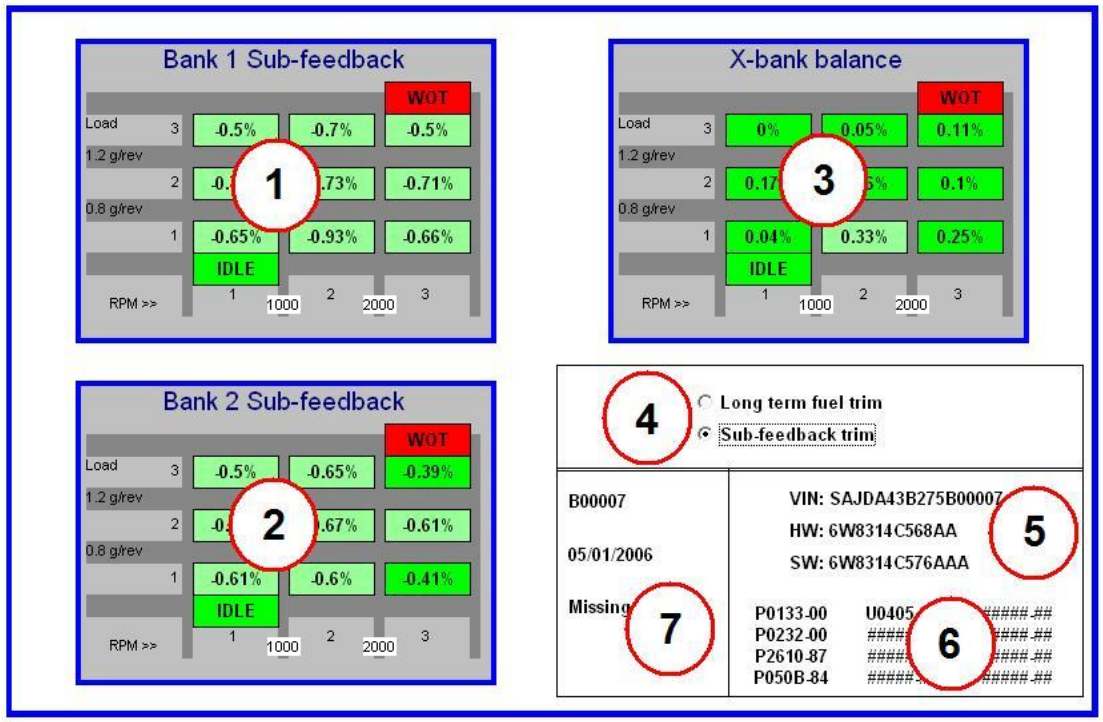
The Sub-Feedback Fuel Trim data is displayed using an identical layout for both Jaguar and Land Rover vehicles. When the Adaptive Fuel Trim Display application is toggled to display the Sub-Feedback values, an alternate collection of data will be shown.

Sub-feedback values indicate what percentage of "bias" is being applied to the UHEGO target for normal operation. This UHEGO "bias" produces a fine adjustment to tailpipe emissions when needed to compensate for aging UHEGO/HEGO sensors or catalysts.

When these sub-feedback trim values set DTC's, it indicates that a portion of this sub-feedback system is faulty. Carefully inspect all UHEGO and HEGO sensor function, as well as catalyst integrity for performance issues, or leaks etc.

There are 9 Sub-Feedback adaptive values that are stored for each cylinder bank of the engine. These 9 adaptive values are arranged in a 3 x 3 matrix, where each value corresponds to a specific area of engine operation defined by an RPM, and Engine Load range.

Sub-feedback Fuel Trim Display



1. Bank 1 Sub-feedback
2. Bank 2 Sub-feedback
3. Cross-Bank Comparison
4. Data View Selection
5. ECM data
6. Current DTC's read from ECM
7. Supplemental data

When viewing Sub-Feedback data, the values are displayed in 3 individual matrixes. There is one matrix for each bank of 9 values (Bank A & Bank B), and a third matrix that provides the bank-to-bank relative value for each of the 9 RPM/Load ranges (X-Bank Balance). All three matrixes employ a color coded diagnostic aid feature similar to the other LTFT displays.

Sub-feedback Fuel Trim Display

The downstream O2 sensors (HEGO) provide an additional input to the ECM other than the function to simply monitor catalyst efficiency. The ECM monitors the HEGO signals to determine the content of emissions exiting the catalyst. As this downstream feedback is processed by the ECM, it is incorporated into the main closed-loop feedback provided by the upstream O2 sensors (UHEGO) as a sub-feedback value.

If the HEGO values drift above or below a theoretical “optimum” target of operation over a long period of time, the ECM will apply a sub-feedback fuel trim to that cylinder bank to maintain optimum tailpipe emissions.

The sub-feedback adjustment is made by “biasing” the ECM’s UHEGO target for a theoretical 14.7:1 air-fuel ratio. As the engine management system makes the required fine adjustments to meet this “biased” UHEGO target, the final tailpipe emissions target for the HEGO is achieved.

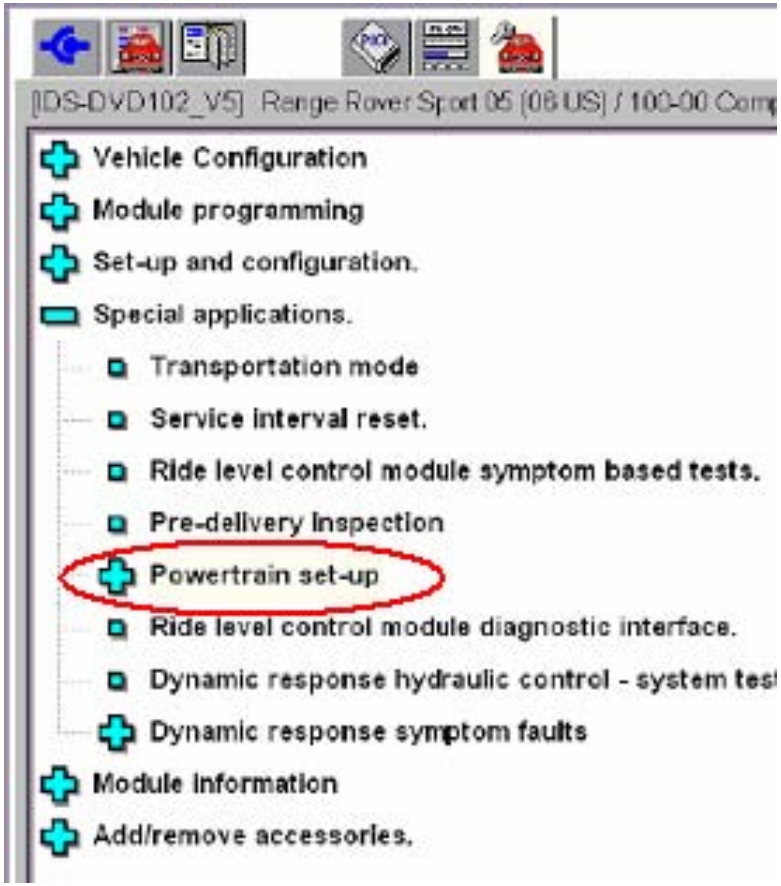
Sub-feedback fuel trim deviations are typically caused by aging, contaminated, or faulty UHEGO or HEGO sensors. They can also be affected by aging catalysts, or exhaust system leaks between the upstream and downstream oxygen sensors.

Compared to the Long Term Fuel Trim values which must respond to changes in the main feedback loop and Short Term Fuel Trim, Sub-feedback values adapt more slowly as they represent a fine adjustment that is only effective when applied slowly over a long period of vehicle operation.

Adaptive Fuel Trim Display
Land Rover Tutorial

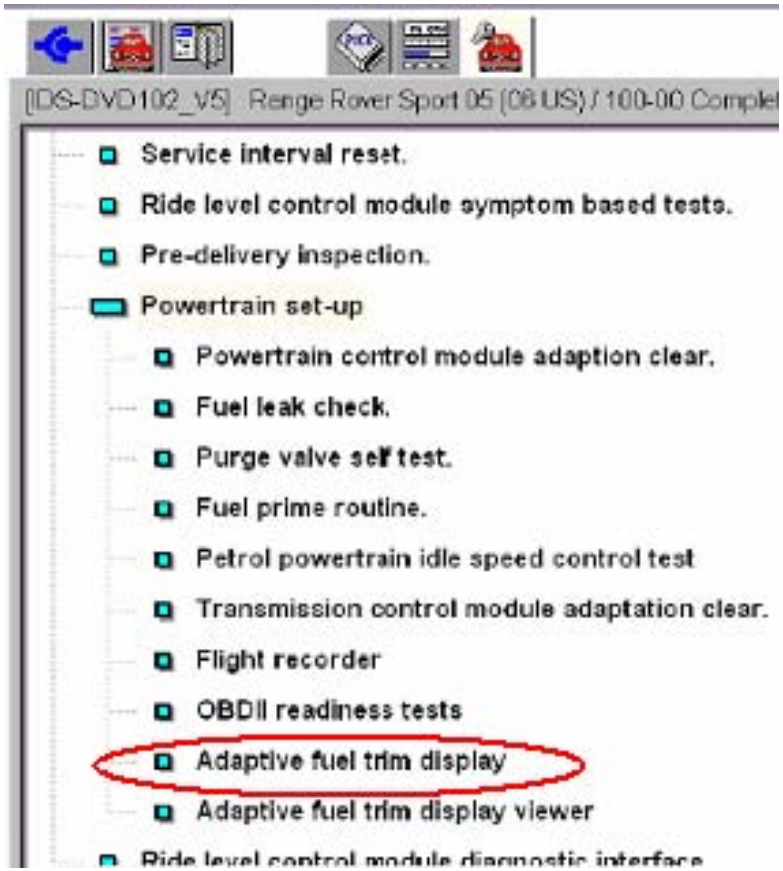
- Accessing the Adaptive Fuel Trim Display
- Interpreting the Adaptive Fuel Trim Display

Brand Menu



Launching the Adaptive Fuel Trim Display.

First expand “Special Applications” > “Powertrain set-up”…



Launching the Adaptive Fuel Trim Display.

Then the “Adaptive Fuel Trim Display” item will be shown.

Return

Land Rover Adaptive Fuel Trim Display Details

The Adaptive Fuel Trim Display application allows the technician to view 2 complete sets of adaptive values.

Each set of fuel trim values is related to a different area of engine operation, and DTC grouping.

- Long Term Fuel Trim (P017x DTC's)
- Sub-Feedback Fuel Trim (P013x & P015x DTC's)
- Color Coded Diagnostic Aids Explained

Tutorial Menu

Long Term Fuel Trim Display

The Land Rover Long Term Fuel Trim (LTFT) display involves great detail that is required to effectively display the 16 adaptive values that are stored for each cylinder bank of the engine.

These 16 fuel trim values are coincidentally arranged in a 4 x 4 matrix, where each corresponds to a specific area of engine operation defined by an RPM, and Engine Load range.

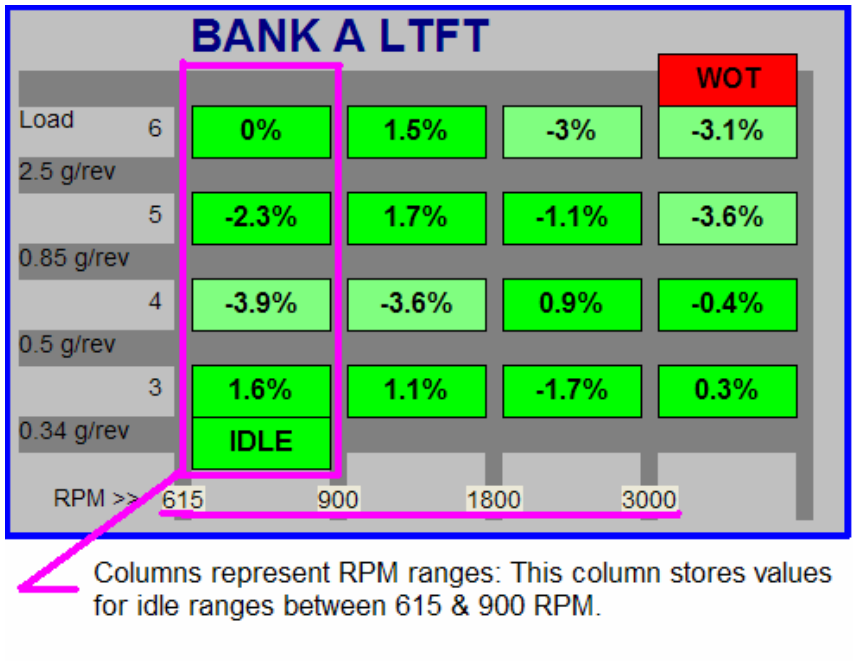
When viewing Land Rover LTFT, the values are displayed in 3 individual matrixes. There is one matrix for each bank of 16 LTFT values (Bank A & Bank B), and a third matrix that provides the bank-to-bank relative value for each of the 16 RPM/Load ranges (X-Bank Balance).

All three matrixes employ a color coded diagnostic aid feature.

Long Term Fuel Trim Display

1. Bank A LTFT
2. Bank B LTFT
3. Cross-Bank comparison
4. View Selection
5. ECM details
6. Current DTC's read from ECM
7. Supplemental data

Long Term Fuel Trim Display

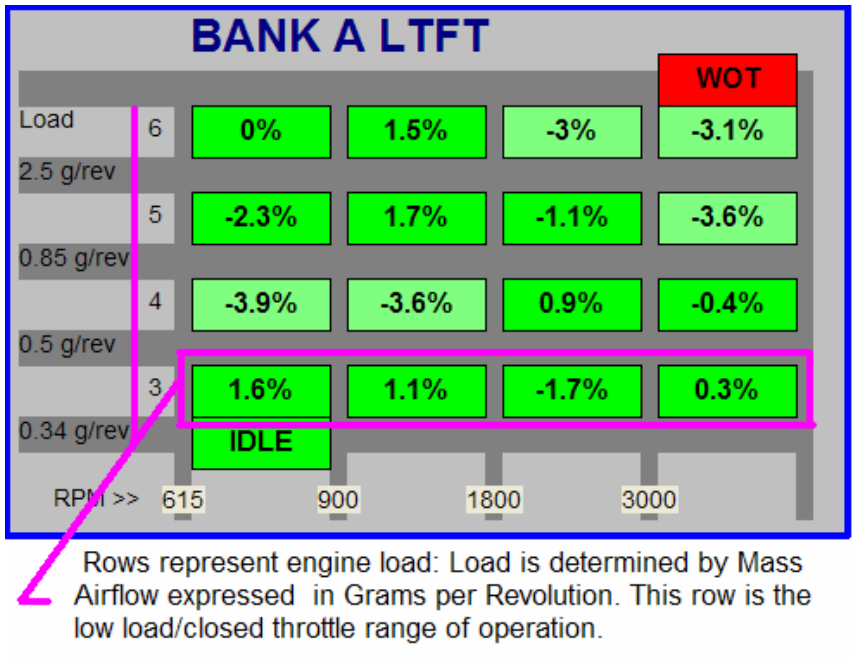


Each of the 3 Land Rover LTFT Matrixes is arranged in a similar layout of data.

Columns represent 1 of 4 engine RPM ranges.

The RPM ranges shown in the matrix are defined by the ECM calibration, and are often different from model to model. These RPM ranges may also change with updates to ECM calibrations within the same model.

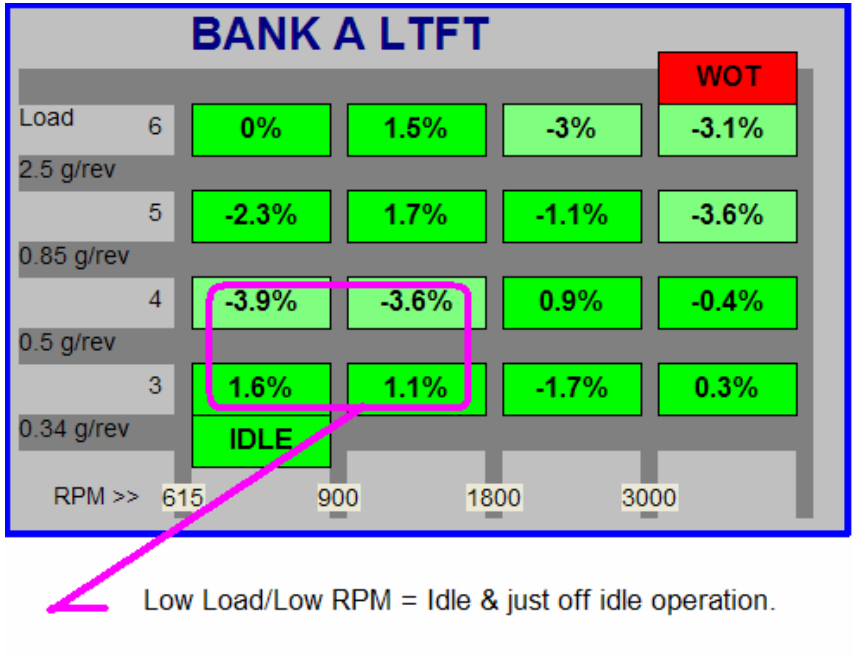
Long Term Fuel Trim Display



Each row represents 1 of 4 engine load ranges expressed in grams per revolution. These load ranges are also determined by the ECM calibration.

Although there is no corresponding grams/rev datalogger signal to display this load parameter, it is only important to understand that the lowest load ranges are associated with high engine vacuum conditions, and the highest load ranges are associated with low vacuum conditions. (And/or boost conditions on SC variants.)

Long Term Fuel Trim Display

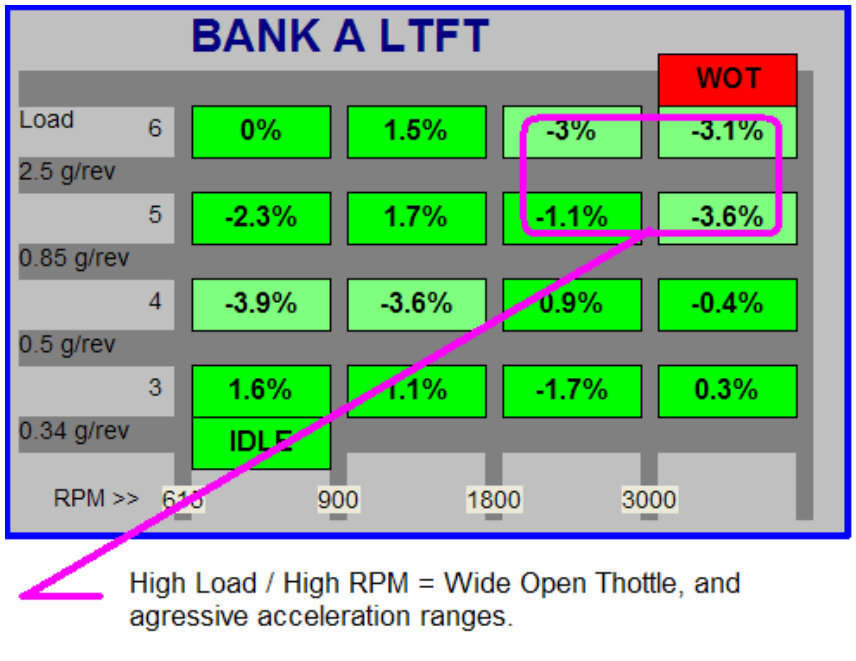


This screen shot shows how groups of cells can be associated with general areas of engine operation.

This allows for a quick evaluation of the current engine operating conditions for most P017x DTC diagnosis, without having to analyze each cell as a separate area of engine operation.

This is the Low Load/Low RPM grouping.

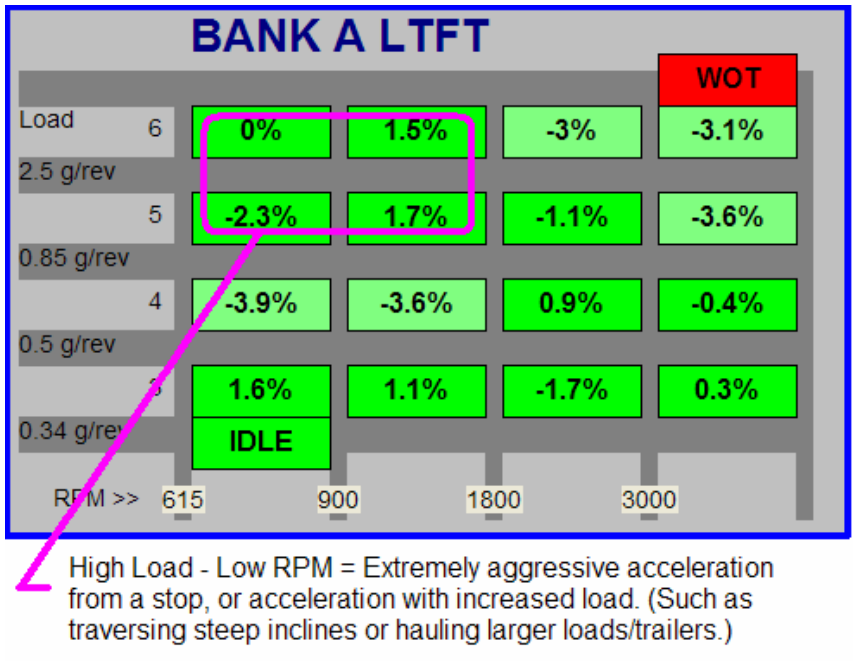
Long Term Fuel Trim Display



This concept can be applied to each group of four cells at the extreme corners of the 4 x 4 matrix.

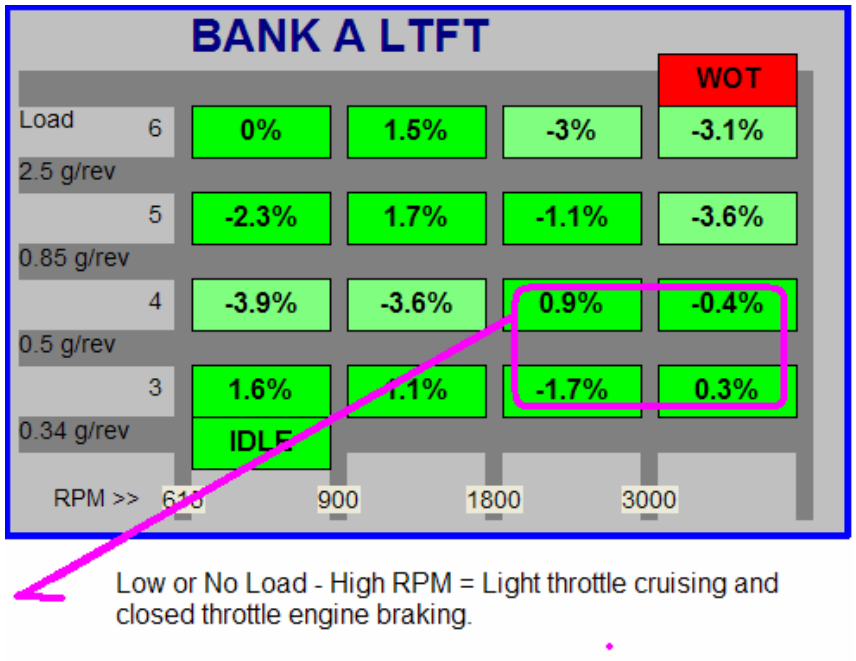
This is the High Load/High RPM grouping.

Long Term Fuel Trim Display



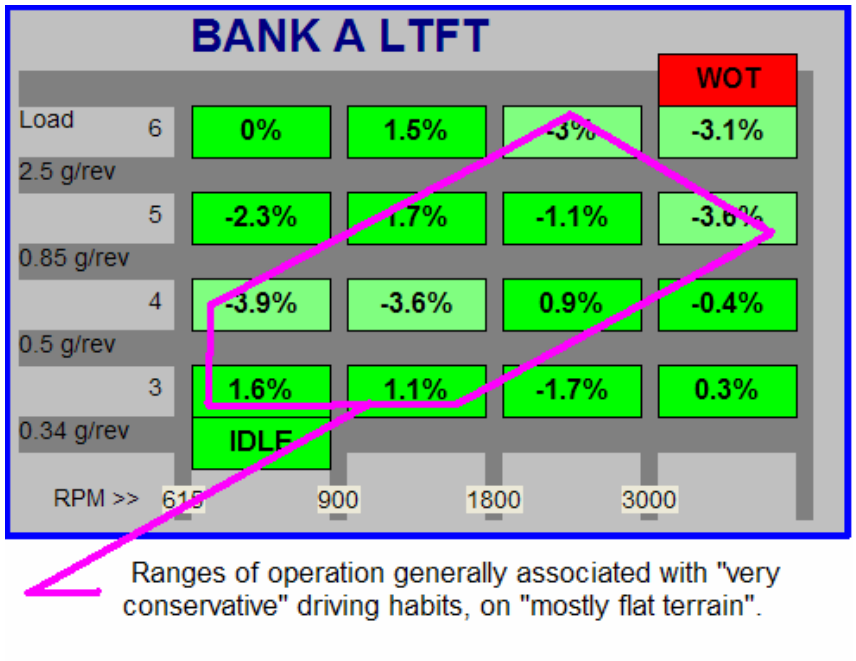
This grouping is associated with the highest load to RPM ratio, and is mainly associated with aggressive driving conditions.

Long Term Fuel Trim Display



This last grouping is associated with the lowest load to RPM ratio, and is generally associated with light throttle cruising, and engine braking.

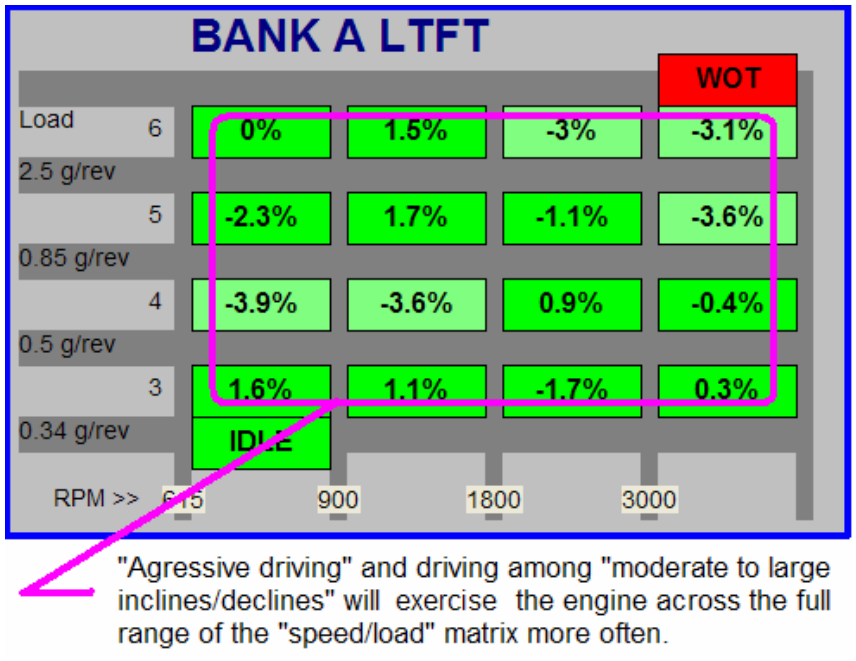
Long Term Fuel Trim Display



Ranges of operation generally associated with "very conservative" driving habits, on "mostly flat terrain".

Conservative driving habits, and operation over mostly flat terrain may not exercise the engine over the most extreme limits of operation that are represented by the entire 16 cell matrix.

Long Term Fuel Trim Display



"Agressive driving" and driving among "moderate to large inclines/declines" will exercise the engine across the full range of the "speed/load" matrix more often.

Only certain driving conditions will exercise the engine throughout the entire range of operation on a regular basis.

Try to bear this in mind when attempting to diagnose, and perform repair validation for these areas of engine operation.

Sub-feedback Fuel Trim Display

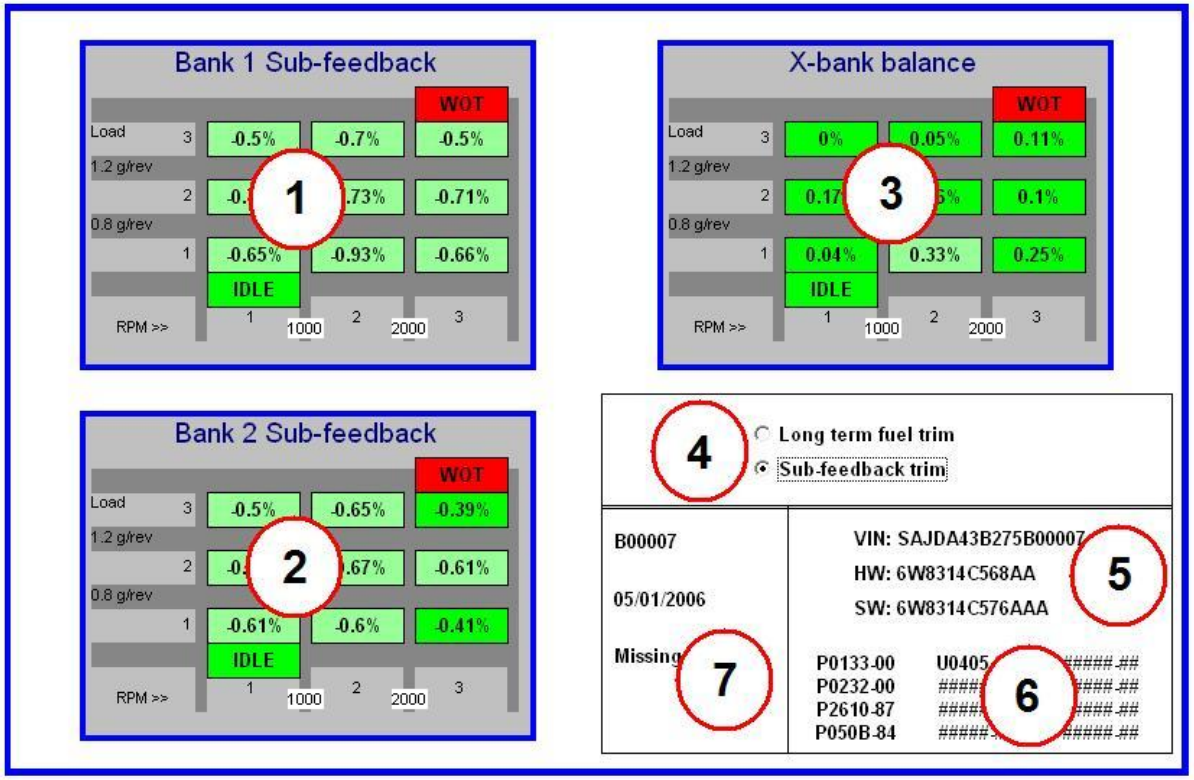
The Sub-Feedback Fuel Trim data is displayed using an identical layout for both Jaguar and Land Rover vehicles. When the Adaptive Fuel Trim Display application is toggled to display the Sub-Feedback values, an alternate collection of data will be shown.

Sub-feedback values indicate what percentage of "bias" is being applied to the UHEGO target for normal operation. This UHEGO "bias" produces a fine adjustment to tailpipe emissions when needed to compensate for aging UHEGO/HEGO sensors or catalysts.

When these sub-feedback trim values set DTC's, it indicates that a portion of this sub-feedback system is faulty. Carefully inspect all UHEGO and HEGO sensor function, as well as catalyst integrity for performance issues, or leaks etc.

There are 9 Sub-Feedback adaptive values that are stored for each cylinder bank of the engine. These 9 adaptive values are arranged in a 3 x 3 matrix, where each value corresponds to a specific area of engine operation defined by an RPM, and Engine Load range.

Sub-feedback Fuel Trim Display



1. Bank 1 Sub-feedback
2. Bank 2 Sub-feedback
3. Cross-Bank Comparison
4. Data View Selection
5. ECM data
6. Current DTC's read from ECM
7. Supplemental data

Sub-feedback Fuel Trim Display

The downstream O2 sensors (HEGO) provide an additional input to the ECM other than the function to simply monitor catalyst efficiency. The ECM monitors the HEGO signals to determine the content of emissions exiting the catalyst. As this downstream feedback is processed by the ECM, it is incorporated into the main closed-loop feedback provided by the upstream O2 sensors (UHEGO) as a sub-feedback value.

If the HEGO values drift above or below a theoretical “optimum” target of operation over a long period of time, the ECM will apply a sub-feedback fuel trim to that cylinder bank to maintain optimum tailpipe emissions.

The sub-feedback adjustment is made by “biasing” the ECM’s UHEGO target for a theoretical 14.7:1 air-fuel ratio. As the engine management system makes the required fine adjustments to meet this “biased” UHEGO target, the final tailpipe emissions target for the HEGO is achieved.

Sub-feedback fuel trim deviations are typically caused by aging, contaminated, or faulty UHEGO or HEGO sensors. They can also be affected by aging catalysts, or exhaust system leaks between the upstream and downstream oxygen sensors.

Compared to the Long Term Fuel Trim values which must respond to changes in the main feedback loop and Short Term Fuel Trim, Sub-feedback values adapt more slowly as they represent a fine adjustment that is only effective when applied slowly over a long period of vehicle operation.

Color Coded Diagnostic Aids

Recommended diagnostic process when Fuel Trim related DTC's are stored:

1. Read-out and print the current Adaptive Fuel Trim values before attempting *any* diagnosis or repairs.
2. Review all JLR technical publications for known issues related to this vehicle's symptoms, and/or this customer's complaint. ***If symptom specific information is found that includes a direct resolution to this vehicle's faults, follow those instructions first, before attempting any other diagnosis or repairs.*** (If not continue with step 3.)
3. Perform interactive diagnosis of this vehicle using any related diagnostic publications or personal diagnostic skills.
4. After the diagnosis and repairs are completed, clear the ECM adaptive values.
5. Perform a road test that focuses on the RPM and load ranges that were shown to be out of specification in the first Adaptive Fuel Trim Display readings.
6. When this targeted road testing is completed, return to the Adaptive Fuel Trim Display Application again to confirm an effective repair has been performed.
7. If repairs have been effective, then the original "faulty" Fuel Trim values should now be color coded bright or pale green. (+/-8.5%)
8. When color coding suggests that the repairs have not corrected the problem or a new one is revealed, recheck your work and contact JLR dealer technical support for assistance if required.


Color Coded Diagnostic Aids

In general terms, when the vehicle is operating as designed all color coding in all LTFT and Sub-Feedback displays should be bright or pale green.

Upstream LTFT color coding legend:	
When LTFT color coding matches these first 2 color keys, this indicates the ECM has not accumulated enough new data for this value after the adaptive values have been reset..	
	Black cells, have not accumulated enough adaptive values after clearing to validate a repair, these values are masked until a thorough drive cycle is completed.
-3.73%	Dark Blue cells are 50% to 75% completely adapted after clearing, more road testing is highly recommended, and these values may not be reliable for repair validation.
The following color keys will only apply to LTFT adaptive values that have accumulated between 75% and 100% of new LTFT data after being cleared.	
+/-3%	Values in this range represent near perfect LTFT!
+/- 3 to 8.5%	This indicates a "stable" fuel trim well within the safe limits for not setting P017x DTC's
- 8.5% to - 15%	The ECM is reducing fuel injector "on-time" to correct for a "rich" UHEGO feedback, if conditions deteriorate a fault may set
< -15%	Engine operation and ECM control are at the extreme limits of adjustment to correct a "rich" UHEGO feedback, and the vehicle is at risk of setting a fault unless corrective measures are taken.
+8.5% to +15%	The ECM is extending fuel injector "on-time" to correct for a "lean" UHEGO feedback, if conditions deteriorate a fault may set
beyond +15%	Engine operation and ECM control are at the extreme limits of adjustment to correct a "lean" UHEGO feedback, and the vehicle is at risk of setting a fault unless corrective measures are taken.

Color Coded Diagnostic Aids

Downstream Sub-feedback color coding legend:

Sub-feedback trim values relate to the following DTC's:
Land Rover - P0136 & P0156 DTC's.

IMPORTANT: Downstream Sub-Feedback values indicate the percentage of bias being applied to the UHEGO default target of 0mA = 14.7 to 1 Air Fuel ratio. The Sub-Feedback color coding strategy is *opposite* of what is used for the LTFT values. Color coding indicates what direction the UHEGO is being biased by the ECM to help maintain neutral HEGO feedback. Typical Sub-feedback values are often near -0.5%. Downstream sub-feedback trim color coding is *not* dependant on the accumulation of adaptive data, and IDS will always display the current adaptive value, even when no new data has been collected after the ECM adaptations have been cleared.

+/-0.5%	Values in this range represent near perfect Sub-Feedback fuel trim!
+/- 0.5% to 1%	This indicates a "stable" Sub-Feedback fuel trim well within the limits for setting Sub-Feedback related DTC's
+ 1% to + 1.5%	The ECM has applied a positive uA – "lean" bias to the UHEGO target to adapt for a "rich" feedback from the HEGO sensors. If conditions deteriorate a fault may be set.
> +1.5%	The ECM is near the threshold for setting P0136/P0156! The ECM has applied a positive uA – "lean" bias to the UHEGO target to adapt for a "rich" feedback from the HEGO sensors. Unless corrective action is taken to repair this vehicle, these DTC's are likely to be set or repeat.
-1% to -1.5%	The ECM has applied a negative uA – "rich" bias to the UHEGO target to adapt for a "lean" feedback from the HEGO sensors. If conditions deteriorate a fault may be set.
< -1.5%	The ECM is near the threshold for setting P0136/P0156! The ECM has applied a negative uA – "rich" bias to the UHEGO target to adapt for a "lean" feedback from the HEGO sensors. If conditions deteriorate a fault may be set. Unless corrective action is taken to repair this vehicle, these DTC's are likely to be set or repeat.

Color Coded Diagnostic Aids

Cross-Bank evaluation color coding legend:	
Applies to: **Land Rover LTFT X-BANK Matrix.** **Land Rover Sub-Feedback X-BANK Matrix.**	
	Items color coded "bright green" represent "Near Perfect" bank to bank fuel trim balance!
	Items color coded "pale green" represent "Very Good" bank to bank fuel trim balance!
	Items color coded "yellow" represent "Fair" bank to bank fuel trim balance. This may indicate that some elements of the engine operation are not performing equally on each bank of the engine.
	Items color coded "purple" represent "Poor" bank to bank fuel trim balance. This is a strong indication that some elements of the engine operation are not performing equally on each bank of the engine.

Color Coded Diagnostic Aids

More about “Fair” and “Unacceptable” values:

“Fair” fuel trim values indicate the ECM is working to overcome a condition where the engine may not operating as designed. This may not require corrective action at this time, but if conditions continue to deteriorate, fuel trim values may drift into ranges that will set DTC’s.

“Unacceptable” fuel trim values indicate the ECM is definitely working to overcome a condition that needs to be corrected to clear DTC’s and/or prevent it from being set again in the near future.

When the ECM has stored related DTC’s as historical codes:

If a fuel trim related DTC is set only as an historical code, you may or may not see any “fair” or “unacceptable” color-coded values, if the problem that caused the DTC was intermittent. Like any other DTC in the vehicle, if the problem is not currently present, it can be difficult to diagnose.

Even when the MIL light is intermittent, by using the Adaptive Fuel Trim Display you may see evidence of borderline values that are “fair” or “unacceptable”, and this can help you focus on locating the cause of intermittent DTC’s even if the MIL is not currently lit, and the DTC’s have cleared.

Color Coded Diagnostic Aids

Recommended diagnostic process when Fuel Trim related DTC's are stored:

1. Read-out and print the current Adaptive Fuel Trim values before attempting *any* diagnosis or repairs.
2. Review all JLR technical publications for known issues related to this vehicle's symptoms, and/or this customer's complaint. ***If symptom specific information is found that includes a direct resolution to this vehicle's faults, follow those instructions first, before attempting any other diagnosis or repairs.*** (If not continue with step 3.)
3. Perform interactive diagnosis of this vehicle using any related diagnostic publications or personal diagnostic skills.
4. After the diagnosis and repairs are completed, clear the ECM adaptive values.
5. Perform a road test that focuses on the RPM and load ranges that were shown to be out of specification in the first Adaptive Fuel Trim Display readings.
6. When this targeted road testing is completed, return to the Adaptive Fuel Trim Display Application again to confirm an effective repair has been performed.
7. If repairs have been effective, then the original "faulty" Fuel Trim values should now be color coded bright or pale green. (+/-8.5%)
8. When color coding suggests that the repairs have not corrected the problem or a new one is revealed, recheck your work and contact JLR dealer technical support for assistance if required.


Color Coded Diagnostic Aids

In general terms, when the vehicle is operating as designed all color coding in all LTFT and Sub-Feedback displays should be bright or pale green.

Upstream LTFT color coding legend:	
When LTFT color coding matches these first 2 color keys, this indicates the ECM has not accumulated enough new data for this value after the adaptive values have been reset..	
	Black cells, have not accumulated enough adaptive values after clearing to validate a repair, these values are masked until a thorough drive cycle is completed.
-3.73%	Dark Blue cells are 50% to 75% completely adapted after clearing, more road testing is highly recommended, and these values may not be reliable for repair validation.
The following color keys will only apply to LTFT adaptive values that have accumulated between 75% and 100% of new LTFT data after being cleared.	
+/-3%	Values in this range represent near perfect LTFT!
+/- 3 to 8.5%	This indicates a "stable" fuel trim well within the safe limits for not setting P017x DTC's
- 8.5% to - 15%	The ECM is reducing fuel injector "on-time" to correct for a "rich" UHEGO feedback, if conditions deteriorate a fault may set
< -15%	Engine operation and ECM control are at the extreme limits of adjustment to correct a "rich" UHEGO feedback, and the vehicle is at risk of setting a fault unless corrective measures are taken.
+8.5% to +15%	The ECM is extending fuel injector "on-time" to correct for a "lean" UHEGO feedback, if conditions deteriorate a fault may set
beyond +15%	Engine operation and ECM control are at the extreme limits of adjustment to correct a "lean" UHEGO feedback, and the vehicle is at risk of setting a fault unless corrective measures are taken.

Color Coded Diagnostic Aids

Downstream Sub-feedback color coding legend:

Sub-feedback trim values relate to the following DTC's:
Jaguar - P209x DTC's.

IMPORTANT: Downstream Sub-Feedback values indicate the percentage of bias being applied to the UHEGO default target of 0mA = 14.7 to 1 Air Fuel ratio. The Sub-Feedback color coding strategy is *opposite* of what is used for the LTFT values. Color coding indicates what direction the UHEGO is being biased by the ECM to help maintain neutral HEGO feedback. Typical Sub-feedback values are often near -0.5%. Downstream sub-feedback trim color coding is *not* dependant on the accumulation of adaptive data, and IDS will always display the current adaptive value, even when no new data has been collected after the ECM adaptations have been cleared.

+/-0.5%	Values in this range represent near perfect Sub-Feedback fuel trim!
+/- 0.5% to 1%	This indicates a "stable" Sub-Feedback fuel trim well within the limits for setting Sub-Feedback related DTC's
+ 1% to + 1.5%	The ECM has applied a positive uA – "lean" bias to the UHEGO target to adapt for a "rich" feedback from the HEGO sensors. If conditions deteriorate a fault may be set.
> +1.5%	The ECM has applied a positive uA – "lean" bias to the UHEGO target to adapt for a "rich" feedback from the HEGO sensors. Unless corrective action is taken to repair this vehicle, these DTC's are likely to be set or repeat.
-1% to -1.5%	The ECM has applied a negative uA – "rich" bias to the UHEGO target to adapt for a "lean" feedback from the HEGO sensors. If conditions deteriorate a fault may be set.
< -1.5%	The ECM has applied a negative uA – "rich" bias to the UHEGO target to adapt for a "lean" feedback from the HEGO sensors. If conditions deteriorate a fault may be set. Unless corrective action is taken to repair this vehicle, these DTC's are likely to be set or repeat.

Color Coded Diagnostic Aids

Cross-Bank evaluation color coding legend:	
Applies to: **Jaguar LTFT X-BANK indicators that run down the center of the 2 columns of the LTFT display.** **Jaguar Sub-Feedback X-BANK Matrix.**	
	Items color coded "bright green" represent "Near Perfect" bank to bank fuel trim balance!
	Items color coded "pale green" represent "Very Good" bank to bank fuel trim balance!
	Items color coded "yellow" represent "Fair" bank to bank fuel trim balance. This may indicate that some elements of the engine operation are not performing equally on each bank of the engine.
	Items color coded "purple" represent "Poor" bank to bank fuel trim balance. This is a strong indication that some elements of the engine operation are not performing equally on each bank of the engine.

Color Coded Diagnostic Aids

More about “Fair” and “Unacceptable” values:

“Fair” fuel trim values indicate the ECM is working to overcome a condition where the engine may not operating as designed. This may not require corrective action at this time, but if conditions continue to deteriorate, fuel trim values may drift into ranges that will set DTC’s.

“Unacceptable” fuel trim values indicate the ECM is definitely working to overcome a condition that needs to be corrected to clear DTC’s and/or prevent it from being set again in the near future.

When the ECM has stored related DTC’s as historical codes:

If a fuel trim related DTC is set only as an historical code, you may or may not see any “fair” or “unacceptable” color-coded values, if the problem that caused the DTC was intermittent. Like any other DTC in the vehicle, if the problem is not currently present, it can be difficult to diagnose.

Even when the MIL light is intermittent, by using the Adaptive Fuel Trim Display you may see evidence of borderline values that are “fair” or “unacceptable”, and this can help you focus on locating the cause of intermittent DTC’s even if the MIL is not currently lit, and the DTC’s have cleared.