AFIT Diesel Diagnostics Reference Guide

About This Guide

The purpose of this guide is to aid you in diagnosing a vehicle's injectors based on the test results. On the following pages, locate the screen that best represents your results for interpretation and recommend action to take. If additional testing is recommended, the procedure for that particular test is also provided at the end of that section.

Acronyms Used

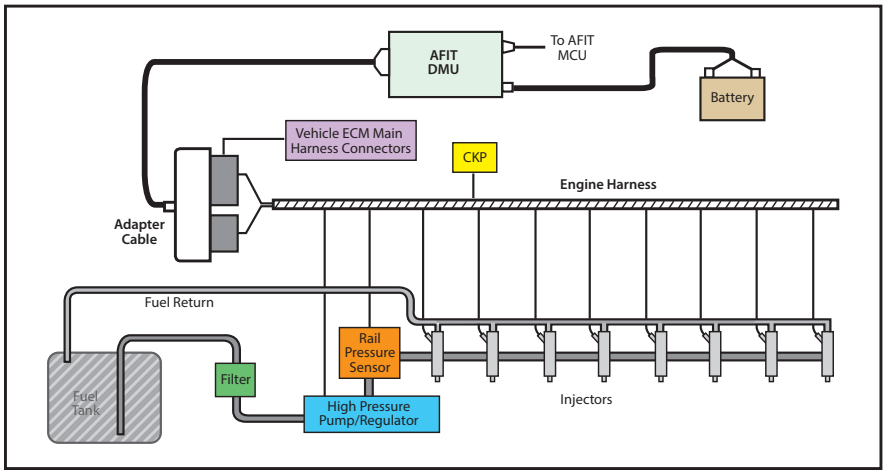
The following acronyms are used throughout this guide:

DLC—Data Link Connector
DMU—Drive & Measurement Unit
DTC—Diagnostic Trouble Code
ECM—Engine Control Module
FICM—Fuel Injectior Control Module
ICP—Injector Characteristic Performance
MCU—Main Control Unit

How the Diesel Fuel Injection System Works on Diesel Fuel Systems

The DMU connects to the vehicle harness and isolates the fuel injection system from all other engine components. No fuel system disassembly or connection is required.

When first connected and a test is initiated, the Injection System Tester does an electrical test on each injector on non-FICM engines. As the test routine unfolds, the relative flow of each injector on the vehicle is measured using a compensated pressure decay method. The results are presented on the MCU screen as ICP balance. This ICP balance is a comparison of the fuel consumed by each injector during engine operation.



During testing, the high-pressure fuel pump, starting system, and regulator are tested for proper operation. Also during the test sequence, the fuel injection system is monitored for return flow. The tester compensates for temperature, fuel, and other differences from vehicle to vehicle and derives a measure of return flow as compared to a properly performing engine called Leak Factor.

When the test is completed, the results are displayed on the MCU. The results can also be downloaded to a PC running the companion PC program supplied with the Tester. On the ICP balance screen, if some injectors are significantly out of balance it is an indication of a faulty injector. On the Pump Performance screen, an assessment of the high-pressure pump's ability to deliver fuel is presented. If Pump Performance is below expectations the cause could be the low-pressure fuel delivery system, so before replacing a pump always check the low-pressure fuel delivery. During the Pump Performance assessment, battery voltage, engine temperature, and cranking RPM enter into the calculations. Those measures are also presented on the Pump Performance screen.

On the Leakage screen, return flow results are presented as a Leak Factor. The higher the Leak Factor, the lower the return flow is. The fuel injector tester compares this factor to a normal vehicle and provides the technician with an indication of the severity of the leak. Only if an excessive leak is detected are further diagnostic steps, including some engine disassembly, to pinpoint the cause of the leak required. For LB7 engines, the tool can be used as an aid to isolate the leak to one of the engine banks. If Significant or Gross Leaks are measured, conventional beaker tests are used to isolate the faulty component. The tool offers the advantage that beaker tests are only indicated when Leak Factor is excessive and one or more components will definitely need to be replaced.

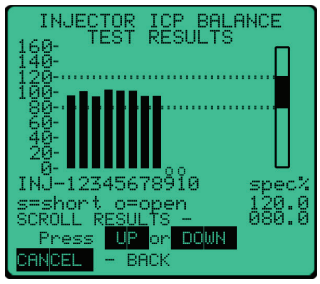
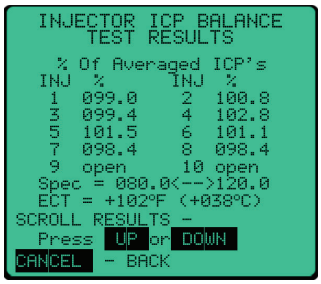
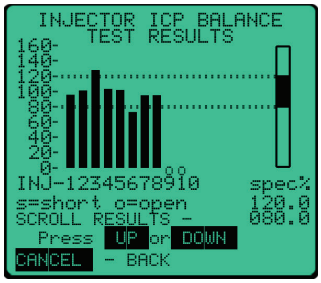
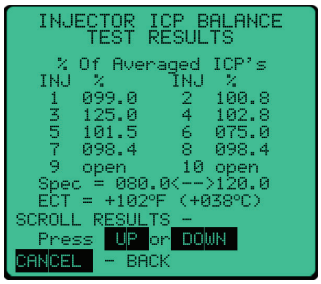
The tool determines high-pressure pump characteristics by measuring the fuel pressure developed at various engine speeds during each crank, compensates for any return flow, and compares the results to the expected Pressure vs. RPM profile built into the tool's database. It also measures battery voltage and cranking RPM and compares those results to specifications for the vehicle.

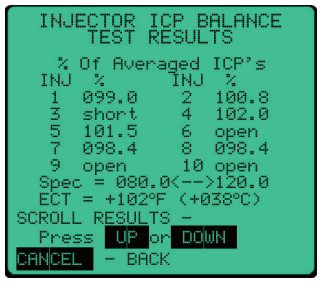
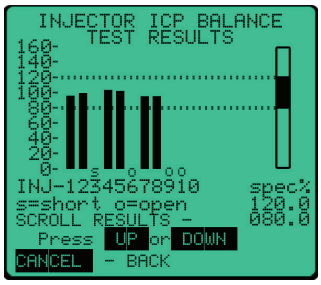
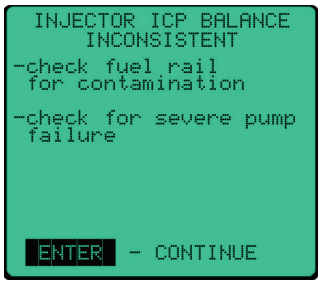
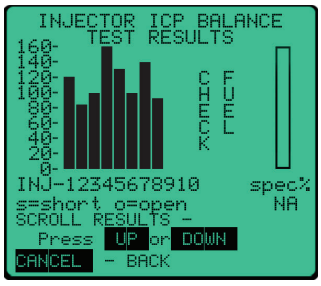
ICP Balance Test Results

These screens represent the results of tests that are performed to determine if there is a proper balance between the fuel used to move the internal parts of the injector and the amount of fuel injected into the cylinder for combustion.

The tester measures the fuel consumption of all the injectors and displays the results in two forms: graphically and numerically. The first screen shows all the injector ICP values in a bar graph form with dotted tolerance lines. The second screen displays the same information numerically along with the engine temperature (if the tester was connected to the DLC at the start of the test).

If one or more injectors are not using approximately the same amount of fuel as the other injectors it is an indication that the injector is not functioning properly.

Example Screen	Result	Interpreting Results	Action To Take
 	All injectors are between the tolerance lines	• All injectors are within tolerance.	• If the results for all injectors are *similar* in range, and no problem is indicated by the Fuel Rate Leakage Test and the Pump Performance Test, it is likely that the fuel injection system is not causing the DTC or symptom. • If the results for one or more injector(s) is *considerably* different and the symptom is rough idle with no DTCs, the injectors require further diagnostics as recommended by the vehicle's shop manual.
 	One or more injectors is above (overfueling/ rich) or below (underfueling/ lean) tolerance line	• Any Injector above the tolerance line is using considerably ***more*** fuel that the other injectors. • Any Injector below the tolerance line is considerably less fuel than the other injectors.	• Replace out of tolerance injectors and retest.

Example Screen	Result	Interpreting Results	Action To Take
 	Open (o) and/or short (s) is displayed for one or more injectors	An open or short may be present in the wiring harness or the injector itself. *Note: AFIT displays **open** (or **o** depending on the screen) for any cylinder not present on the vehicle. In this example, injectors 9 and 10 are open because is it an eight cylinder vehicle.*	If an open is indicated: • Verify the open injector ECM DTCs match the tester's results. If yes, see ***Pinpointing an Open***. If no, replace the ECM. If a short is indicated: • See ***Pinpointing a Short***.
 	Injector fuel consumption variation for the injectors is extreme	• Severe fuel system contamination caused by bad fuel. • Fuel system component failure has injected debris into the system. Note: Results for this test are presented for information, however the tolerance lines are not included on the bar graph screen.	• All fuel system components may require replacing. Refer the vehicle's shop manual.

Pinpointing an Open:

1. Disconnect the injector connector at the injector and short the two pins together.
2. Re-run the injection system test.
3. Does the injector show as Shorted?

   If yes – replace the injector

   If no – repair the harness

Pinpointing a Short

1. Disconnect the injector connector at the injector.
2. Re-run the injection system test.
3. Does the injector show as Open?

   If yes – replace the injector

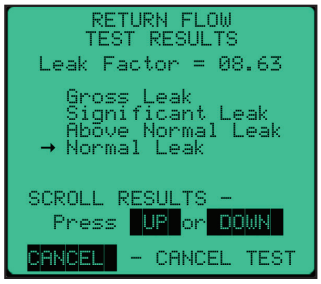
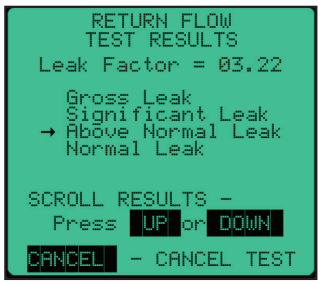
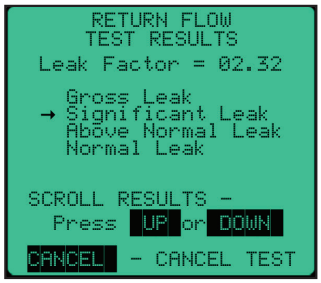
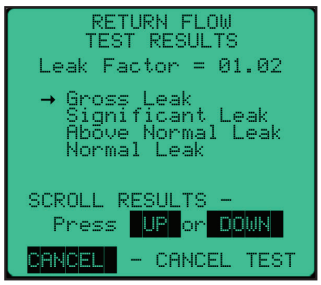
   If no – repair the harness

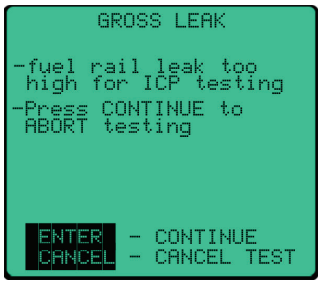
Return Flow Leakage Test Results

These screens represent the results of tests that are performed to determine the return flow of the fuel injection system.

The tester compensates for differences in fuel, temperature and other conditions that cause return flow to be different under different conditions. This compensated leak measure is referred to as the **Leak Factor**. The *higher* the Leak Factor the *lower* the return flow amount is. There are four Leak Factor categories:

• Normal Leak • Above Normal Leak • Significant Leak • Gross Leak

Example Screen	Result	Interpreting Results	Action To Take
	Leak Factor is >3.6	• Return flow is normal . • Reading is above what may cause a symptom or code caused by excessive return flow.	• None. Fuel Return Volume Test is ***not*** required.
	Leak Factor is 3.5 – 3.0	• Return flow is above normal. • Too low to cause a symptom or code. • Indicates fuel injection system component(s) deterioration. *Note: Further deterioration may cause a driveablitlty issue.*	• Check the fuel filter and fuel for contamination.
	Leak Factor is 2.9 – 1.6	• Return flow is above normal. • May cause a symptom or code, especially under harsh driving conditions (towing heavy loads, driving up steep grades, etc.) • Indicates one or more components of the fuel injection system (typically fuel injectors) have deteriorated significantly and require pinpointing and replacement.	• Disconnect the fuel return hose on the Over-Pressure valve and ensure there is no return flow from the Over-Pressure valve when the engine is cranked. If there is no return flow, see *Gross Leak* for further pinpoint recommendations. • Also check the fuel filter and fuel for contamination.
	Leak Factor is <1.5	• Return flow is excessive. • Will cause a symptom or code	Follow same action as listed for the Gross Leak Abort screen on the next page.

Example Screen	Result	Interpreting Results	Action To Take
	Gross Leak ABORT screen is displayed	• The fuel rail has a gross leak that is too high to continue testing.	• One or more fuel injection system component requires replacement. • Disconnect the fuel return hose on the Over-Pressure valve and ensure there is no return flow from the Over-Pressure valve when the engine is cranked. • Check the fuel filter and fuel for contamination. • See ***Pinpointing Procedure for Duramax Diesel Engines*** to determine the component(s) requiring replacement. *Note: See the Shop Manual for precautions and methods for disassembly of engine components and the high-pressure fuel system.*

LB7 Duramax Diesel Engine Pinpointing

The test has determined that one or more components are leaking excessively and must be replaced. Follow either *Method 1* or *Method 2* to isolate the component(s) that require replacement.

Method 1

Record the original Leak Factor reported by the tester.

1. Following the vehicle's shop manual, disassemble the engine as necessary to the point that the fuel pipe to one bank of the engine can be moved sufficiently to expose the distribution block. Plug the distribution block where the fuel pipe was removed.
2. Select the vehicle again and re-run the fuel injection test as prompted on the MCU screens. Select **No Start** if prompted about vehicle condition.
3. When the test is completed, a Leak Factor for the test is displayed on the MCU screen.
   - If the single bank Leak Factor is greater than 3.6 (Normal Leak) the leaking injector(s) is on the bank that was disconnected. Reconnect the fuel pipe and follow the vehicle's shop manual procedures to perform a Beaker Test on the injectors for the bank that was disconnected to pinpoint the injector(s) requiring replacement.
   - If the single bank Leak Factor is between 3.5 and 2.2 (Significant Leak) and the original Leak Factor was also a Significant Leak it is likely that the leaking components are in the bank that is still connected. Follow the vehicle's shop manual procedures to perform a Beaker Test on the injectors on the bank that is connected. If no injectors exhibit excessive return flow replace the High-pressure Pump.
   - If the single bank Leak Factor is between 3.5 and 2.2 (Significant Leak) and the original Leak Factor was below 2.2 (Gross Leak) both banks have leakage. Follow Shop Manual procedures to perform a Beaker Test on the injectors for both banks. If no injectors exhibit excessive return flow replace the High-pressure Pump.
   - If the single bank Leak Factor is below 2.2 (Gross Leak) and the original Leak Factor was also a Gross Leak It is likely that the leaking components are in the bank that is still connected. Follow the vehicle's shop manual procedures to perform a Beaker Test on the injectors on the bank that is connected. If no injectors exhibit excessive return flow replace the High-pressure Pump.

Method 2

Follow the vehicle's shop manual procedures for Beaker Testing to isolate the component(s) requiring replacement.

LMM, LBZ, LLY Duramax Diesel Engine Pinpointing

The test has determined that one or more components are leaking excessively and must be replaced. Follow the vehicle's shop manual procedures and perform a Beaker Test on the engine's injectors. Replace as necessary. If no injectors exhibit excessive return flow, replace the High-pressure Pump.

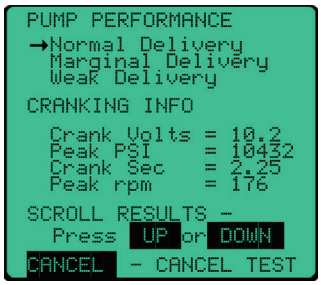
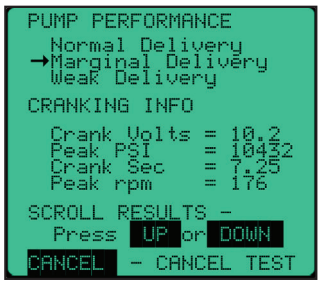
Pump Performance

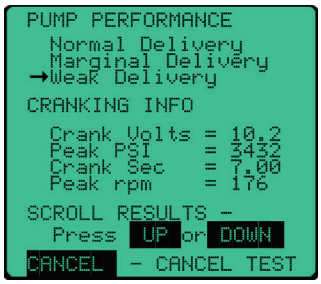
These screens present an evaluation of the ability of the fuel delivery system to provide sufficient fuel to the injectors.

The tester compensates for crank engine speed, system return flow, and other variables to determine if the High-Pressure Pump can supply sufficient fuel under all engine operating conditions. The low –pressure fuel delivery system can effect the Pump Performance measurements if it is restricted or sucking air.

It is important to evaluate the low-pressure system if the Pump Performance result is Marginal or Weak before replacing the High-Pressure Pump.

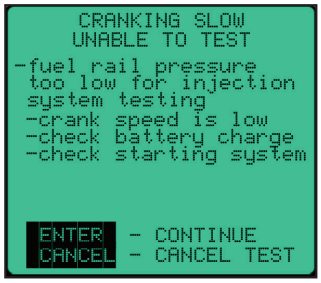
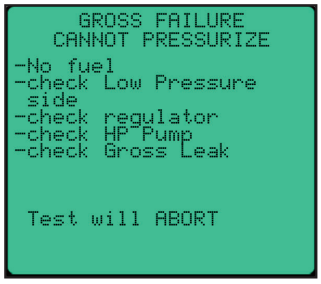
Crank Volts, Peak PSI and Peak RPM values are presented on this screen as additional information for the technician. The Pump Performance evaluation takes these values, along with the system leakage, into account when determining the Pump Performance result.

Example Screen	Result	Interpreting Results	Action To Take
	Normal Delivery Reading	If the symptom occurs *only* under heavy-load conditions (maximum fuel is demanded) and the tester does not indicate a fuel injection issue in the results screens • Restriction such as a clogged fuel filter or a small air leak into the low-pressure system may be the cause. If symptom *does not* occur under heavy-load conditions • Indicates the high Pressure Pump is delivering the pressures needed fro proper fuel injection system operation and is not the cause of the problem. *Note: If there is an indication of a Significant or Gross Leakage on the Fuel Rate Leakage screen, pump performance is set to Normal.*	If symptom occurs only under heavy fuel demand conditions: • Follow the vehicle's shop manual to be certain there is not an issue in the low-pressure fuel delivery system. If symptom does not occur under heavy fuel demand conditions: • No action related to the high-pressure pump is required
	Marginal Delivery Reading	• Indicates the High Pressure Pump's ability to provide sufficient pressure is marginal and may cause a symptom or code caused by insufficient high-pressure fuel. • Severely restricted low-pressure system or an severe air leak may cause the high-pressure pump to appear Marginal. If it is the high-pressure pump most likely harsh driving conditions such as towing heavy loads or driving up steep grades are where the symptom occurs or the code(s) is set. If the vehicle is sluggish under most driving conditions a low-pressure fuel delivery issue is the likely cause.	• Before replacing the Pump follow Shop Manual procedures to be certain there is not an issue with fuel contamination or the low-pressure fuel delivery. • If none found, replace high-pressure pump and re-test.

Example Screen	Result	Interpreting Results	Action To Take
	Weak Delivery Reading	• Indicates the High Pressure Pump is not delivering sufficient pressure for most engine operating conditions. • Severely restricted low-pressure system or severe air leak may cause the high-pressure pump to appear Weak.	• Before replacing the Pump follow Shop Manual procedures to be certain there is not an issue with fuel contamination or the low-pressure fuel delivery. • If none found, replace high-pressure pump and re-test.

Unable to Perform Test Screens

These screens represent the those that may displayed if AFIT is unable to complete a test because of severe conditions, such as the inability of the vehicle to build sufficient pressure.

Example Screen	Interpreting Results	Action To Take
	• The cranking speed of the engine is too slow to build sufficient pressure to allow testing of the fuel system	• The vehicle starting/charging system must be diagnosed and repaired to enable fuel injection system testing.
	• Fuel rail pressure is too low. The system is unable to develop sufficient pressure for any testing.	Following the vehicle's shop manual: • Test the fuel low side supply and the fuel filter restriction/contamination. • Test the pressure regulator If both of these items are not the cause of the low pressure, either there is extreme return flow, or the high-pressure pump is not working.

Error Screens

There are several error screens that are displayed if the unit determines there is an issue with some of the internal functions of the tester. These are not pertinent to diagnosing the vehicle under test. Most often these errors are caused by a poor connection to the vehicle battery on the DMU battery clips. A weak vehicle battery can also cause them. If they are displayed double check the connections and the battery before returning the unit for service.

For technical assistance or to order service parts, contact:

gmglobaltools.com

(1-800-468-6657)

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