



Diesel Fuel System Interface Control Document (ICD)

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard identifies the diesel fuel delivery interface requirements between Vehicle Platform (Chassis Fuel) and Powertrain Engineering (Fuel Delivery and Software & Controls).

1.2 Applicability. This document contains the standardized agreement content for use on all applications and explanations of engine specific requirements found in Diesel Fuel Delivery Applications Matrix (an Excel file contained in the Diesel Interface Control Document (ICD), of the Vehicle Information System (VIS), Vehicle Partitioning and Product Structure (VPPS)).

1.3 Remarks. This document includes standard working agreement information and, when used in conjunction with the Diesel Fuel Delivery Applications Matrix, is considered the complete Powertrain to Platform System Interface (PPSI) requirements.

This document is controlled by the Diesel PPSI Work Group. Changes to this document are completed by the Diesel PPSI workgroup and approved by the Vehicle/Powertrain Integration Team.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

DIN EN 590	ISO 16332	SAE J2044
EN 14214	ISO 19438	

2.2 GM Standards/Specifications.

GMW3059	GMW14507	GMW14839	GMW15695
GMW14081	GMW14555	GMW15311	

2.3 Additional References

- CG3366
- Fill Factory Fuel part numbers 9985074
- Fill Factory Fuel part numbers 9273275

2.3.1 GM Powertrain Specifications

- GMPT-5-002
- GMPT-5-004
- GMPT-5-011
- GMPT-5-019
- GMPT-5-020
- GMPT-5-021
- GMPT-5-022
- GMPT-5-024
- GMPT-5-025

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3 Requirements

3.1 Environment. The system shall be capable of operating in the environments as described in GMW15311 and GMW14081 without adverse effect to functional performance.

3.1.1 Fuel Environment. Fuels for which the low pressure circuit performance shall be characterized are summarized in Table 1 and Table 2.

Table 1: Standard Diesel Fuel

GMPT Number	Description
GMPT-5-002	Baseline 43 Cetane
GMPT-5-004	Extreme Cold Start 43 Cetane
GMPT-5-020	ULSD, B20
GMPT-5-021	ULSD, Euro 4 extreme cold
GMPT-5-022	ULSD, elemental sulfur
GMPT-5-025	DIN EN 590+10% FAME per EN 14214

Table 2: Biodiesel

GMPT Number	Description
GMPT-5-011	Severe Bio-Diesel 80/20 Soybean Methyl Ester (SME) - Acidic bio-diesel/diesel
GMPT-5-024	Ultra-Low Sulfur Diesel (ULSD) High Peroxide Bio-Diesel fuel
GMPT-5-019	Low Lubricity (second generation Bio-Diesel)

Note: All engine applications are considered capable of operating on B20 fuel.

3.1.1.1 Factory Fill Fuel. First fill factory fuel shall be part number 9985074 for North America and 9273275 for all other regions. The system shall be capable of operating and/or be exposed to the fuel for an extended period of time (in extended shipping or an unsold vehicle on a dealer lot).

3.2 Architectures or Mechanizations. The following architectures or mechanizations have been approved for use on GM vehicles. Reference Appendix A for schematics which describe each of these systems see Appendix A, Figures A1 through A9.

3.2.1 Engine. Figure 1 shows an example of high pressure engine fuel feed circuit for reference purposes only. The high pressure engine fuel feed circuit is the responsibility of GM Powertrain, and may vary depending upon engine Regular Production Option (RPO). The engine release engineer can provide engine specific high pressure fuel feed system details if necessary. The fuel feed solenoid, cooling and lubrication loop, and pressure holding device are all contained within the High Pressure Pump unit. System illustrations shown in Appendix A will show the high pressure pump only, without the detailed feed loops shown.

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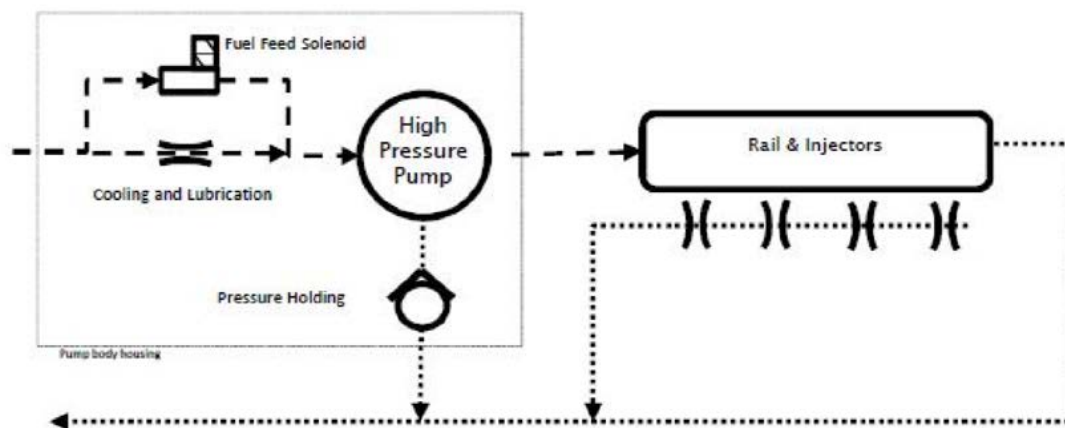


Figure 1: High Pressure Engine Fuel Feed Circuit

3.2.1.1 Fuel Feed Solenoid. The fuel feed solenoid is a Pulse Width Modulated (PWM) solenoid valve that is used to control fuel flow to the fuel rail. Alternatively, future systems may utilize a pre-stroke fuel metering method, where a positive displacement piston pumps a consistent amount of fuel each stroke. A solenoid within the valve controls the volume sent to the rail, returning the remaining fuel volume to the tank. Fuel flow through this channel will vary dependent upon engine speed and load conditions.

3.2.1.2 Cooling and Lubrication. The cooling and lubrication loop provides fuel to the positive displacement high pressure pump for the purposes of cooling and lubrication. Fuel flow through this channel is unregulated (e.g., changes with the pressure and load/speed on the pump).

3.2.1.3 Pressure Holding Valve. The pressure holding valve is located on the return side of the high pressure fuel pump and ensures a minimum pressure is achieved on the pump. Fuel pressure will reach a level which will unseat a ball and check valve arrangement at a predetermined pressure (e.g., 350 kPa), returning fuel bled past this valve to the tank. However, the pressure holding valve will not regulated pressure; therefore, as flow increases pressure may also increase depending upon the flow rate and orifice size of the pressure holding valve.

3.2.1.4 Priming Circuit. Priming of the system during normal engine start shall be minimized (3 s maximum) to avoid customer complaints for the low pressure system fuel pump noise run on during glow plug warming.

Note: Assembly plant priming may be longer to fill the empty system.

3.2.2 Negative Pressure or Suction Systems (Type A and B). Negative pressure systems are shown in Appendix A, Figures A1 and A2 as type A and B; however, suction systems are no longer the standard for diesel systems and are being phased out due to inefficiencies.

3.2.3 Positive Pressure Mechanically Controlled Chassis Systems. Low pressure fuel is delivered from the fuel tank via electrically powered fuel tank mounted pump and delivered to the engine mounted high pressure fuel pump interface. Fuel is circulated from fuel tank to engine, pressure at the engine is unregulated, and unused fuel is returned to the fuel tank.

The low pressure side of the fuel delivery system is limited by an overpressure relief device internal to the fuel pump module or filter assembly (Chassis Fuel System Management Team (SMT) responsibility). The in-tank fuel pump module reservoir filling is managed by a feed side jet pump. All mechanically controlled positive low pressure fuel systems are configured in this manner, exceptions by system type are defined in 3.2.3.1 through 3.2.3.5.

3.2.3.1 Type C. The low pressure circuit features a pressure regulating valve mounted in the fuel feed and return bundle near the engine. This regulating device regulates feed pressure to a predetermined level, at the high pressure pump inlet.

Note: GM Powertrain provides the fuel system feed pressure via the Excel Diesel Interface Engine Document found in VIS (see 1.3). All 100 kPa (1 bar) systems require a regulating valve or elsewhere in the system. The in-tank fuel pump module contains a return side jet driven pump to fill the reservoir.

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3.2.3.2 Type D and G. The in-tank fuel pump module contains a return side jet driven pump to fill the reservoir.

3.2.3.3 Type E. The low pressure circuit is common with Type D, a pressure holding valve is utilized to hold/create backpressure at the injector return line (on the injectors for performance). The low pressure fuel system is unaffected by this variant.

3.2.3.4 Type H The in tank fuel pump utilizes a feed side jet pump rather than a return fuel side jet pump, this is to reduce the back pressure in the return line as required by the engine delivery system supplier.

3.2.3.5 Type F. A venturi jet exists in the engine to evacuate fuel from the injector return line, eliminating backpressure at the injectors. The venturi is fed fuel by an additional circuit within the engine system and requires additional fuel flow to provide the evacuation function. This style of system is being phased out and will not be in future architectures.

3.2.3.6 Type I. The in-tank fuel pump module reservoir contains a thermostatic valve within the return line circuit. Under cold ambient/fuel temperature conditions, the return fuel is channeled directly to the fuel pump inlet, recirculating warm de-waxed fuel. The warm de-waxed fuel reduces the potential for filter and system plugging with gelled fuel.

In high ambient/fuel temperature conditions, fuel is directed to the bulk fuel to dilute the warm fuel with cold, avoiding drive-ability issues.

In some instances the switchable feature of the thermostatic valve is eliminated and return fuel is circulated continuously; however, only if the system meets the fuel feed temperature limit as defined in 3.5.1.10.

3.2.3.7 Positive Pressure Electronically Regulated Chassis Fuel System. Type I. Low pressure fuel is delivered from the fuel tank via electrically powered fuel tank mounted pumps and delivered to the engine mounted high pressure fuel pump interface. Fuel is circulated from the fuel tank to the engine, and unused fuel is returned to the fuel tank.

The low pressure side of the fuel delivery system is limited by an overpressure relief device internal to the fuel pump module or filter assembly (Chassis Fuel SMT responsibility). The in-tank fuel pump module reservoir filling is managed by a feed side jet pump.

Fuel feed pressure is regulated electronically utilizing an in-line feed pressure sensor/transducer and control software. This system limits the in-tank fuel pump power consumption by matching fuel delivery to engine flow demand. Fuel pressure is regulated by the closed loop electronics and the volume of return fuel is minimized.

3.2.4 Fuel Temperature Management. Fuel that is circulated from the engine to the fuel tank warms as a result of the high pressure pumping action and exposure to the engine. The warm fuel is preferentially recirculated during extreme cold ambients to suppress wax crystal formation (cloud point of the fuel), and prevent fuel filter plugging. The warm return fuel is channeled to either the fuel pump inlet or bulk fuel, based upon temperature, to optimize system heating and cooling functions. The type H system illustrates a thermostatic valve mounted within the in-tank fuel pump module, which directs the return fuel to the strainer or bulk based on its temperature. Additionally, an engine fuel heating mode that returns warm fuel to the Chassis Fuel System Interface (e.g., Active Return Fuel Heating), as defined on Table 3, shall be employed as part of the Global GM Powertrain Bill of Materials (BOM). Reference CG3366 for execution of the return heating mode by engine RPO.

Table 3: Active Return Fuel Heating

Tested per GMW14507	Change in return fuel temperature
First minute of operation	Delta of 8 °C
Second minute of operation	Delta of 6 °C

3.3 Interface Definition.

3.3.1 Fuel Delivery Interface. The interface between vehicle and engine low pressure delivery circuits is defined as the hydraulic connection (quick connect) which joins the engine mounted fuel lines to the chassis mounted fuel lines.

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3.3.2 Fuel Return Interface. The interface between the vehicle and engine low pressure return circuits is defined as the hydraulic connection (quick connect) which joins the engine mounted fuel lines to the chassis mounted fuel lines.

3.3.3 Hydraulic Connections. Connections between vehicle and engine systems shall be compatible with SAE J2044.

3.4 Fuel Filter Performance.

3.4.1 Filter Efficiency. Filter efficiency shall be in accordance with GMW14839.

3.4.2 Water Separation. Fuel filter water separation efficiency shall be in accordance with GMW14839, ISO 16332, and ISO 19438.

3.4.3 Filter heating capability. Fuel filter heater performance shall be as per GMW14839.

3.4.4 Filter Backpressure. Pressure drop across the filter assembly, in new condition and end of life condition, shall be as per GMW14839.

3.4.5 Filter Temperature Sensor. The temperature sensor at the fuel filter shall be on the inlet side and the sensor capability and signal shall be as defined in GMW14839.

3.5 Fuel Delivery Requirements - Engine. Engine fuel delivery performance definitions are defined in 3.5.1 through 3.5.3.

Note: Required pressure and flow values shall be provided by GM Powertrain in an accompanying file.

3.5.1 Minimum Delivery Pressure, Interface. Defines the minimum pressure required to maintain engine performance under all conditions. Measurement units are kPa (gage).

3.5.1.1 Recommendations (see Appendix B, Table B1)

- Determine a standard High Pressure (HP) system inlet pressure for both ICD and HP system requirements documents to suppliers: 360 kPa (covers both Denso and Bosch today)
- Determine a standard HP over pressure relief value. Meriva and D2xx using 500 kPa $\pm$ 50 kPa. Would provide for approximately 100 kPa separation between typical operating pressure and relief pressure.
- Modify electronic pressure control to progressively reduce sag correction factor which would provide more line loss accommodation at higher flow rates (where it's needed). Initial suggestion: 0.3 kPa/L/h reduction beginning at 50% WOT or 125 L/h.
- Determine a standard for fuel pump module maximum pressure. Suggest 510 kPa (pending supplier hardware capability).

Note: For practical purposes, the minimum delivery pressure will be provided continuously by the Chassis Fuel delivery system, although the minimum delivery pressure may be exceeded at the high pressure engine mounted pump interface in Mechanically Regulated Fuel System (MRFS). This is the result of the unregulated fuel pressure at the engine interface resulting from the in-tank fuel pump flow, engine consumption, and flow through the pressure holding device, cooling, and lubrication loops of the high pressure pump.

3.5.1.2 Fuel Delivery Flow. Defines the total minimum fuel delivery required for engine idle and Wide Open Throttle (WOT) conditions.

3.5.1.3 Idle Cooling and Lubrication. Defines the total minimum fuel delivery required for high pressure pump cooling and lubrication at idle conditions. Measurement units are liters/hour.

3.5.1.4 Idle Engine Consumption. Fuel consumption required to maintain engine idle conditions including injector actuation losses and injector leakage. Measurement units are in liters/hour.

3.5.1.5 Total Idle Fuel Delivery. Defines the total minimum fuel delivery required for engine idle conditions. This number is the sum total of idle engine consumption, pump cooling and lubrication. Measurement units are liters/hour.

3.5.1.6 WOT Cooling and Lubrication. Defines the total minimum fuel delivery required for high pressure pump cooling and lubrication at WOT conditions. Measurement units are liters/hour.

3.5.1.7 WOT Engine Consumption. Defines the fuel consumption to maintain engine WOT conditions (including injector actuation losses, injector leakage). Measurement units are liters/hour.

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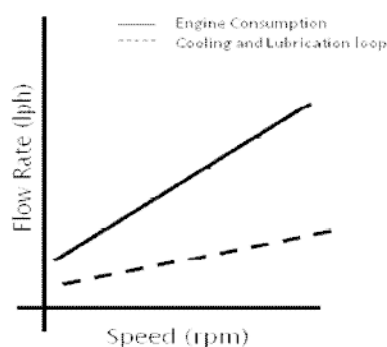
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3.5.1.8 Total WOT Fuel Delivery. Defines the total minimum fuel delivery required for engine WOT conditions. This number is the sum total of WOT engine consumption, pump cooling and lubrication. Measurement units are liters/hour.

3.5.1.9 High Pressure Pump Characteristics. Powertrain will provide in graphical form the characteristics associated with the high pressure engine mounted pump, which include (reference Figure 2):

- A speed vs. supply flow rate in 500 rpm increments beginning at zero flow and extending beyond expected operating range.
- Identify threshold value at which engine will not function (idle).
- Curves to depict engine consumption including various operating points (low engine consumption, high engine consumption).
- Curves to depict cooling and lubrication.
- Curves depicting fuel.



Note: Only idle and maximum flow and pressure characteristics of the high pressure pump will be provided at the time of sourcing. The data shown in Figure 2 will be provided later in the program as hardware and calibration is developed.

Figure 2: High Pressure Pump Characteristic - Flow vs. Speed

3.5.1.10 Fuel Temperature. Fuel feed temperature at the HP interface shall be $\leq 80^{\circ}\text{C}$ continuous, and not greater than 90°C for 100 h when tested per GMW14507 and GMW14555.

3.5.1.11 Pressure Rise Time. The fuel pump module outlet pressure shall rise from 0 kPa to 400 kPa within the minimum durations defined in GMW14081.

3.5.2 Return Pressure, Interface.

3.5.2.1 Minimum Return Pressure, Interface. Defines the minimum return pressure to maintain system performance measured at lowest return flow rate. Measurement units are kPa (gage).

3.5.2.2 Maximum Return Pressure, Interface. Defines the maximum return pressure to maintain system performance measured at highest return flow rate. Measurement units are kPa (gage).

3.5.2.3 Return System Characterization. Powertrain will provide in graphical form the characteristics associated with the return system characterization, which include (reference Figure 3):

- Backpressure vs. flow rate in 20 L/h increments beginning at zero flow and extending beyond expected operating range.
- Threshold value at which engine will not function (idle).
- Curves for various operating points (low engine consumption, high engine consumption).
- Return side backpressure assumption (if system return backpressure biased).

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