



Technical Comparison of PWM and Non-PWM Fuel System Control Strategies

Ford F150 and Mustang Applications

1. Introduction

This document outlines the operational differences between Pulse Width Modulated (PWM) and Non-PWM fuel system control strategies when utilizing KPM Fuel Systems products in late-model Ford F150 and Mustang platforms. Particular attention is given to fuel pump control, PCM interaction, fuel pressure regulation, and calibration requirements.

2. Diagnostic Trouble Code P0627

Both PWM-controlled and Non-PWM-controlled fuel system configurations will generate Diagnostic Trouble Code (DTC) P0627 when the original equipment (OE) fuel pump is disconnected.

DTC P0627 indicates a fault within the fuel pump control circuit and is triggered because the Powertrain Control Module (PCM) no longer detects the factory fuel pump load.

For all KPM fuel system installations, DTC P0627 must be disabled within the vehicle calibration. Failure to disable this fault code can result in unintended Fuel Pump Driver Module (FPDM) behavior and improper fuel system operation.

3. Non-PWM Fuel System Operation

3.1 System Overview

In a Non-PWM configuration, the factory FPDM is no longer actively controlling fuel pump speed. Once DTC P0627 has been disabled, the FPDM maintains a constant output to the fuel pump relay, supplying full battery or alternator voltage to the fuel pumps.

Under these conditions, the fuel pumps operate continuously at maximum speed, equivalent to 100% duty cycle operation.

3.2 Fuel Pressure Characteristics

At idle and low engine load conditions, fuel demand is minimal due to low injector pulse widths. Fuel pressure is therefore regulated primarily by the internal pressure regulator integrated within the KPM Fuel Systems fuel pump module.

Typical observed idle fuel pressure is approximately:

- 80 psi (550 kPa)

As engine load increases, fuel injector flow demand rises and system fuel pressure gradually decreases. This behavior is expected and represents normal operation of a fixed-speed fuel delivery system.



Fuel pressure stabilization occurs at the operating pressure determined by:

- Fuel pump capacity
- Injector flow demand
- Delivered engine horsepower

Providing fuel pressure remains above the minimum recommended operating threshold, system performance remains acceptable.

3.3 Calibration Considerations

Modern Ford engine management systems calculate fuel delivery using a combination of:

- Fuel pressure
- Injector characterization data
- Fuel flow models
- Measured airflow
- Modeled airflow
- Intake manifold pressure

Vehicles equipped with a fuel pressure sensor continuously monitor rail pressure and apply real-time corrections to fuel delivery calculations.

Accurate injector characterization data is critical to proper system operation. Incorrect injector data can significantly affect fuel mass calculations, torque modeling, drivability, and overall engine performance.

4. PWM Fuel System Operation

4.1 System Overview

PWM-controlled KPM fuel systems retain factory-style fuel pump speed control by utilizing the OE PWM command signal generated by the FPDM.

After disabling DTC P0627, the PCM continues to command fuel pump duty cycle as though the original fuel system remains installed.

The KPM PWM Controller interprets the factory PWM signal and modulates fuel pump voltage accordingly.



4.2 Fuel Pressure Control Strategy

Unlike a Non-PWM system, fuel pressure in a PWM-controlled system is actively regulated by the calibration.

At idle conditions:

- Fuel pump voltage is typically between 6–7 volts.
- Pump speed is reduced.
- Fuel pressure follows the commanded target pressure contained within the calibration.

As engine load increases:

1. The PCM increases fuel delivery by means of fuel injection.
2. The FPDM increases PWM duty cycle.
3. The KPM PWM fuel pump Controller raises fuel pump voltage.
4. Fuel pressure is maintained at the commanded target value.

This closed-loop strategy allows the calibrator to directly influence fuel pressure behavior throughout the operating range of the engine.

4.3 Fuel Pressure Monitoring

Factory Ford vehicles often display fuel pressure oscillations when viewed through datalogging software such as HP Tuners.

These fluctuations are characteristic of the OEM control strategy and should not automatically be interpreted as a fault condition.

However, if actual fuel pressure consistently falls below the commanded fuel pressure target, the installed fuel system has exceeded its available flow capacity and a larger KPM fuel system should be considered.

4.4 Calibration Considerations

As with Non-PWM systems, correct injector characterization data remains essential.

Although PWM control provides improved fuel pressure management, injector data errors cannot be compensated for through fuel pressure adjustments alone.

The PCM relies heavily on accurate injector modeling to maintain proper fuel mass delivery, torque calculations, and closed-loop fuel control.



5. Fuel Pressure Limits

Non-PWM Systems

Typical operating characteristics:

- Idle fuel pressure: ~80 psi
- Minimum operational pressure: 51 psi
- Recommended minimum pressure: 58–65 psi depending on vehicle application

Fuel pressure will naturally decrease as engine fuel demand increases.

PWM Systems

Fuel pressure follows the commanded value contained within the calibration.

Typical operating characteristics:

- User-defined fuel pressure targets
- Active pressure regulation via PWM control
- Minimum operational pressure: 51 psi
- Recommended minimum pressure: 58–65 psi depending on application

If commanded pressure cannot be maintained, fuel system capacity has been exceeded.

6. Fuel Injector Sizing

Proper injector sizing is fundamental to fuel system performance.

A common calibration error is attempting to compensate for undersized injectors by increasing fuel pressure targets.

While increasing fuel pressure may increase injector flow rate, it also increases fuel system head pressure, which reduces the available flow capacity of the fuel pumps.

The preferred engineering solution is to utilize injectors appropriately sized for the intended power level and fuel type rather than relying on elevated fuel pressure to compensate for insufficient injector capacity.



7. Summary

Non-PWM Fuel Systems

- Require DTC P0627 to be disabled.
- Fuel pumps operate continuously at full system voltage.
- Idle fuel pressure is typically ~80 psi.
- Fuel pressure decreases as engine fuel demand increases.
- Correct injector characterization data is essential.

PWM Fuel Systems

- Require DTC P0627 to be disabled.
- Maintain OEM-style fuel pump control strategy.
- Fuel pressure follows calibration targets.
- Fuel pump voltage varies according to the engines fuel demand.
- Allows active fuel pressure management across the operating range.
- Correct injector characterization data remains essential.

In both configurations, provided the fuel system is correctly sized and injector data is accurately calibrated, the PCM and fuel pressure control strategy will ensure proper fuel delivery under all operating conditions.

8. Fuel System Rating Disclaimer

All KPM Fuel Systems are rated using engine horsepower values based on 93-octane pump fuel.

When utilizing alternative fuels or different power measurement methods, fuel system requirements must be recalculated accordingly to ensure adequate fuel delivery capacity.