Component/ System	Fault Code	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
Fuel Rail Pressure (FRP) Sensor Performance (rationality)	P018B	This DTC detects a fuel pressure sensor response stuck within the normal operating range	Absolute value of fuel pressure change as sensed during intrusive test.	<= 30 kPa			Frequency: Continuous; 12.5 ms loop. 60 seconds between intrusive tests that pass Intrusive test requested if fuel system is clamped for >= 5 seconds or fuel pressure error variance <= typically (0.3 to 0.6) (calculated over a 2.5sec period); otherwise report pass Duration of intrusive test is fueling related (5 to 12 seconds). Intrusive test is run when fuel flow is below Max allowed fuel flow rate (Typical values in the range of 11 to 50 g/s)	DTC Type A 1 trip
					1. FRP Circuit Low DTC (P018C)	Not active		
					2. FRP Circuit High DTC (P018D)	Not active		
					3. FuelPump Circuit Low DTC (P0231)	Not active		
					4. FuelPump Circuit High DTC (P0232)	Not active		
					5. FuelPump Circuit Open DTC (P023F)	Not active		
					6. Reference Voltage DTC (P0641)	Not active		
					7. Fuel Pump Control Module Driver Over-temperature DTC (P064A)	Not active		
					8. Control Module Internal Performance DTC (P0606)	Not active		
					10. Emissions fuel level (PPEI $3FB)	>=5 seconds Not low		
					11. Fuel pump control	Enabled		

Component/ System	Fault Code	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
					12. Fuel pump control state	Normal or FRP rationality control		
					13. Engine fuel flow	> 0.047 g/s		
					14. ECM fuel control system failure (PPEI $1ED)	Not failed		
Fuel Rail Pressure (FRP) Sensor Circuit Low Voltage	P018C	This DTC detects if the fuel pressure sensor circuit is shorted low	FRP sensor voltage	< 0.14 V	Ignition	Run or Crank	72 failures out of 80 samples 1 sample/12.5 ms	DTC Type A 1 trip
Fuel Rail Pressure (FRP) Sensor Circuit High Voltage	P018D	This DTC detects if the fuel pressure sensor circuit is shorted high	FRP sensor voltage	> 4.86 V	Ignition	Run or Crank	72 failures out of 80 samples 1 sample/12.5 ms	DTC Type A 1 trip
Fuel Pump Control Circuit Low Voltage	P0231	This DTC detects if the fuel pump control circuit is shorted to low	Fuel Pump Current	> 14.48A	Ignition OR HS Comm OR Fuel Pump Control AND Ignition Run/Crank Voltage	Run or Crank enabled enabled 9V < voltage < 32V	72 test failures in 80 test samples if Fuel Pump Current <100A 1 sample/12.5 ms	DTC Type A 1 trip
Fuel Pump Control Circuit High Voltage	P0232	This DTC detects if the fuel pump control circuit is shorted to high	Voltage measured at fuel pump circuit	> 3.86 V	Commanded fuel pump output Fuel pump control enable	0% duty cycle (off) False	36 test failures in 40 test samples; 1 sample/12.5ms Pass/Fail determination made only once per trip	DTC Type A 1 trip

Component/ System	Fault Code	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
					Time that above conditions are met	>=4.0 seconds		
Fuel Pump Control Circuit (Open)	P023F	This DTC detects if the fuel pump control circuit is open	Fuel Pump Current AND Fuel Pump Duty Cycle	<=0.5A >20%	Ignition OR HS Comm OR Fuel Pump Control AND Ignition Run/Crank Voltage	Run or Crank enabled enabled 9V < voltage < 32V	72 test failures in 80 test samples; 1 sample/12.5ms	DTC Type A 1 trip
Fuel System Control Module Enable Control Circuit	P025A	This DTC detects if there is a fault in the fuel pump control enable circuit	PPEI (PPEI (Powertrain Platform Electrical Interface) Fuel System Request ($1ED)	≠ Fuel Pump Control Module Enable Control Circuit	Ignition AND PPEI Fuel System Request ($1ED)	Run or Crank valid	72 failures out of 80 samples 1 sample/12.5 ms	DTC Type A 1 trip
Control Module Read Only Memory (ROM)	P0601	This DTC will be stored if any software or calibration check sum is incorrect	Calculated Checksum (CRC16)	≠ stored checksum for any of the parts (boot, software, application calibration, system calibration)	Ignition OR HS Comm OR Fuel Pump Control	Run or Crank enabled enabled	1 failure if it occurs during the first ROM test of the ignition cycle, otherwise 5 failures Frequency: Runs continuously in the background	DTC Type A 1 trip
Control Module Not Programmed	P0602	Indicates that the FSCM needs to be programmed	This DTC is set via calibration, when KeMEMD_b_NoStartCal	= TRUE	Ignition OR HS Comm	Run or Crank enabled	Runs once at power up	DTC Type A 1 trip

Component/ System	Fault Code	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
					OR Fuel Pump Control	 enabled		
Control Module Long Term Memory Reset	P0603	Non-volatile memory checksum error at controller power-up	Checksum at power-up	≠ checksum at power-down	 Ignition OR HS Comm OR Fuel Pump Control	 Run or Crank enabled enabled	1 failure Frequency: Once at power-up	DTC Type A 1 trip
Control Module Random Access Memory (RAM)	P0604	Indicates that control module is unable to correctly write and read data to and from RAM	Data read	≠ Data written	 Ignition OR HS Comm OR Fuel Pump Control	 Run or Crank enabled enabled	1 failure if it occurs during the first RAM test of the ignition cycle, otherwise 5 failures Frequency: Runs continuously in the background.	DTC Type A 1 trip
Control Module Internal Performance 1. Main Processor Configuration Register Test	P0606	This DTC indicates the FSCM has detected an internal processor fault or external watchdog fault (PID 2032 discriminates the source of the fault)	1. For all I/O configuration register faults: •Register contents	Incorrect value.	 Ignition OR HS Comm OR Fuel Pump Control	 Run or Crank enabled enabled	Tests 1 and 2 1 failure Frequency: Continuously (12.5ms)	DTC Type A 1 trip

Component/ System	Fault Code	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
2. Processor clock test 3. External watchdog test			2. For Processor Clock Fault: •EE latch flag in EEPROM. OR • RAM latch flag. 3. For External Watchdog Fault: • Software control of fuel pump driver	0x5A5A 0x5A Control Lost	1. For all I/O configuration register faults: •KeMEMD_b_ProcFltCfgRegEnbl 2. For Processor Clock Fault: •KeMEMD_b_ProcFltCLKDiagEnbl 3. For External Watchdog Fault: •KeFRPD_b_FPExtWDogDiagEnbl 3. For External Watchdog Fault: •Control Module ROM(P0601) 3. For External Watchdog Fault: •Control Module RAM(P0604)	TRUE TRUE TRUE not active not active	Test 3 3 failures out of 15 samples 1 sample/12.5 ms	
Control Module Long Term Memory (EEPROM) Performance	P062F	Indicates that the NVM Error flag has not been cleared	Last EEPROM write	Did not complete	Ignition OR HS Comm OR Fuel Pump Control	Run or Crank enabled enabled	1 test failure Once on controller power-up	DTC Type A 1 trip
5Volt Reference Circuit (Short High/Low/Out of Range)	P0641	Detects continuous short or out of range on the #1 5V sensor reference circuit	Reference voltage AND Output	>= 0.5V inactive	Ignition	Run or Crank	15 failures out of 20 samples 1 sample/12.5 ms	DTC Type A 1 trip

Component/ System	Fault Code	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
			OR Reference voltage AND Output OR Reference voltage AND Output	>= 5.5V active <= 4.5V active				
			OR Reference voltage □	> 105% nominal (i.e., 5.25V) OR <95% nominal (i.e., 4.75V)				
Fuel Pump Control Module - Driver Over-temperature 1	P064A	This DTC detects if an internal fuel pump driver overtemperature condition exists under normal operating conditions	Pump Driver Temp	> 150C	Ignition OR HS Comm OR Fuel Pump Control KeFRPD_b_FPOverTempDiagEnbl Ignition Run/Crank	Run or Crank Enabled Enabled TRUE 9V<voltage<32V	3 failures out of 15 samples 1 sample/12.5 ms	DTC Type B 2 trips
Ignition 1 Switch Circuit Low Voltage	P2534	This DTC detects if the Ignition1 Switch circuit is shorted to low or open	Ignition 1 voltage	<= 6 V	Engine	Running	180 failures out of 200 samples 1 sample/25.0 ms	DTC Type A 1 trip

Component/ System	Fault Code	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
Fuel Pump Flow Performance (rationality)	P2635	This DTC detects degradation in the performance of the SIDI electronic return-less fuel system	Filtered fuel rail pressure error	<= Low Threshold (continuously calculated function of desired fuel rail pressure and actual fuel flow rate) OR >= High Threshold (continuosly calculated function of desired fuel rail pressure and actual fuel flow rate) **(See Supporting Tables tab and Supporting Calculations tab)**	1. FRP Circuit Low DTC (P018C)	Not active	Filtered fuel rail pressure error Time Constant = 12.5 seconds Frequency: Continuous 12.5 ms loop	DTC Type B 2 trips
					2. FRP Circuit High DTC (P018D)	Not active .		
					3. Fuel Rail Pressure Sensor Performance DTC (P018B)	Not active		
					4. FuelPump Circuit Low DTC (P0231)	Not active		
					5. FuelPump Circuit High DTC (P0232)	Not active		

Component/ System	Fault Code	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
					6. FuelPump Circuit Open DTC (P023F)	Not active		
					7. Reference Voltage DTC (P0641)	Not active		
					8. Fuel Pump Control Module Driver Over-temperature DTC's (P064A)	Not active		
					9. Control Module Internal Performance DTC (P0606)	Not active		
					10. An ECM fuel control system failure (PPEI $1ED)	Not occurred		
					11. The Barometric pressure (PPEI $4C1) signal	Valid (for absolute fuel pressure sensor)		
					12. Engine run time	>= 30 seconds		
					13. Emissions fuel level (PPEI $3FB)	Not low		
					14. Fuel pump control	Enabled		
					15. Fuel pump control state	Normal		
					16. Battery Voltage	11V<=voltage=<32V		
					17. Fuel flow rate **(See Supporting Tables tab)**	> 0.047 g/s **AND** <= Max allowed fuel flow rate as a function of desired rail pressure & Vbatt (Typical values in the range of 11 to 50 g/s)		
					18. Fuel Pressure Control System	Is not responding to an over-pressurization due to pressure build during DFCO or a decreasing desired pressure command.		

Component/ System	Fault Code	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
Control Module Communication Bus “A” Off	U0073	Detects that a CAN serial data bus shorted condition has occurred to force the CAN device driver to enter a bus-off state	Bus Status	Off	Power mode	Run/Crank	5 failures out of 5 samples (5 seconds)	DTC Type B 2 trips
Lost Communication With ECM/PCM “A”	U0100	Detects that CAN serial data communication has been lost with the ECM	Message $0C9	Undetected	1. Power mode 2. Ignition Run/Crank Voltage 3. U0073	Run/Crank 11V<voltage<32V not active	12 failures out of 12 samples (12 seconds)	DTC Type B 2 trips

P2635 - Fuel Pump Performance Maximum Fuel Flow map (grams / second)

X-axis= Desired Fuel Pressure (kiloPascals)
Y-axis= Battery voltage (volts)

	200	250	300	350	400	450	500	550	600
4.5	11.32	11.32	11.32	11.32	11.32	11.32	11.32	10.7	8.555
6	11.32	11.32	11.32	11.32	11.32	11.32	11.32	10.7	8.555
7.5	11.32	11.32	11.32	11.32	11.32	11.32	11.32	10.7	8.555
9	11.32	11.32	11.32	11.32	11.32	11.32	11.32	10.7	8.555
10.5	11.32	11.32	11.32	11.32	11.32	11.32	11.32	10.7	8.555
12	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
13.5	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
				11.32	11.32	11.32	11.32	11.32	11.32
16.5	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
18	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
19.5	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
21	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
22.5	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
24	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
25.5	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
27	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32
28.5	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32	11.32

P2635 - Fuel Injector Flow curve (grams / second)

X-axis= Fuel Pressure (kiloPascals)

128	148	168	188	208	228	248	268	288	308	328	348	368	388	408	428	448
2.087	2.201	2.316	2.43	2.544	2.658	2.772	2.886	3	3.115	3.229	3.343	3.457	3.571	3.637	3.719	3.802

468	488	508	528	548	568	588	608	628	648	668	688	708	728	748	768
3.852	3.953	4.087	4.189	4.291	4.393	4.495	4.597	4.699	4.801	4.903	5.006	5.108	5.21	5.312	5.414

P2635 - Minimum Fuel Injector Pulse Width curve (seconds)

X-axis= engine speed (revolutions / minute)

0	512	1024	1536	2048	2560	3072	3584	4096	4608	5120	5632	6144	6656	7168	7680	8192
0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797	0.797

Supporting Calculations

Calculation of Fault Thresholds:

Givens: Measured values observed at a typical operating point for an 80mph roadload --
Engine rpm = 1900 rev/min, Instantaneous Fuel Flow = 1.265 g/s, Fuel Line Pressure = 304 kPa (gage)

Example : Pressure Error Fault Threshold Low at chosen operating point:

Min Injector Flow [g/s] = Minimum Injector Pulse Width [ms] * Injector Slope[mg/ms/inj] * Number of Fuel Injectors / 2 [inj/rev] * Engine Speed [rev/min] * 1/60 [min/s] * 1/1000 [g/mg]

Min Injector Flow = 0.25 * 1.565918* 4 / 2 * 1900 / 60 / 1000 = 0.0247 g/s

Max Overfueling Error [] = (Instantaneous Injector Flow [g/s] / Min Injector Flow [g/s])
= 1.265 (g/s) / 0.0247 (g/s)
= 51.2147 / 100 (decimal conversion)
= 0.512147 (51 %)

The overfuelling fuel flow error is limited to the range of between 105% and 115% overfuelling depending on the actual fuel flow. The MaxOverfuelingError calculated above is **outside the scaling range**; therefore, the overperformance fault threshold for this operating point is then calculated using the limited value (105% or 1.05) as follows:

Pressure Error Fault Threshold Low[kPa]
= Injector Pressure Drop [kPa] *(1 -(Max Overfueling Error)^2)
= 304 * (1-(1.05 * 1.05))
= **-31.16 kPa**

Example : Pressure Error Fault Threshold High at same given operating point as the above example:

Max Injector Flow[g/s] = Injector Slope[mg/ms/inj] * Number of Fuel Injectors [inj] * 1/1000 [g/mg] * 1000 [ms/s]

Max Injector Flow[g/s] = 1.565918 * 4 *1/1000 *1000 = 6.26 g/s

Max Underfueling Error [] = (Instantaneous Injector Flow [g/s] / Max Injector Flow [g/s])
= 1.265 (g/s) / 6.26 (g/s)
= 0.202 (20%)

The underfuelling fuel flow error is limited to the range between 85% and 95% overfuelling depending on the actual fuel flow. The MaxUnderfuelingError calculated above falls **below limited range,** therefore it is **limited** to;

Max Underfueling Error [] = 0.85

The underperformance fault threshold for this operating point is then calculated as:

Pressure Error Fault Threshold High [kPa]

= Injector Pressure Drop [kPa] *(1 -(Max Underfueling Error)^2)
= 304 * (1-(0.85*0.85))
= **84.36 kPa**