

## 08 GRP03 All Engine

Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination		
Camshaft Control Electrical															
Bank 1 Intake	P0010	circuit continuity - open	Voltage	IC Internal	-	engine speed battery voltage battery voltage output	>	80	rpm	0.01 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative		
	P2088	circuit continuity - ground													
	P2089	circuit continuity - voltage													
Bank 1 Exhaust	P0013	circuit continuity - open													
	P2090	circuit continuity - ground													
	P2091	circuit continuity - voltage													
Bank 2 Intake	P0020	circuit continuity - open													
	P2092	circuit continuity - ground													
	P2093	circuit continuity - voltage													
Bank 2 Exhaust	P0023	circuit continuity - open													
	P2094	circuit continuity - ground													
	P2095	circuit continuity - voltage													
System - Control															
Bank 1 Intake	P0011	rationality low / high	difference to start test (filtered actual angle versus filtered desired angle) > (desired must remain above value to test to complete the evaluation) same as above, but offset added to the difference, during cold start only: filtered actual angle < filtered desired angle from test start within time (detects 5 sec slow [time constant])  for multiple activation occurrences (decrements upon activations where no difference is seen between desired and actual) same as above, but during cold start only:  difference (filtered actual angle max versus actual at test start) > ( to detect slow response versus stuck cam if above this limit ) at time (overlaps with time to detect above)  (passes after multiple good activations in both cam phase rotation directions)	6.0 . . . 11.0	degrees	engine speed engine run time	> >	480 1	rpm sec	approx. 20 sec  ( 2 times for 2.5 sec each )	0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative		
Bank 1 Exhaust	P0014				0	degrees	error: camshaft control circuit	complete not set	- -					- -	
Bank 2 Intake	P0021				2.5	sec	coolant temperature coolant temperature engine oil temperature engine oil temperature cam-crank alignment adaptatio	< > < > complete	143 -48 180 -48 -					° C ° C ° C ° C -	
Bank 2 Exhaust	P0024				10	count									( same as stated in "time required" column )
					3	count									
					1.5	degrees									
					2.5	sec									
System - Cam - Crank Alignment															
Bank 1 Intake	P0016	cam-crank adapted angle	adapted angle > or adapted angle < or actual angle with parked cams > and <	9.75	degrees	engine run time >	>	50	sec	approx. 600 sec	0.2 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative		
Bank 1 Exhaust	P0017	limit check		9.75	degrees	engine coolant temp >	>	0	° C						
Bank 2 Intake	P0018	(applies for each camshaft)		15	degrees	engine coolant temp <	<	95.25	° C						
Bank 2 Exhaust	P0019			21	degrees	model: engine oil temp <	<	120	° C						
Bank 1 / Idler Sprocket	P0008		adapted angle for both cams > adapted angle for both cams <	6	degrees	error: camshaft sensor	not set	-	-	2 adaptation cycles - required					
Bank 2 / Idler Sprocket	P0009			error: camshaft control circuit	not set	-	-								
Primary O2 Sensor Heating heater circuits - electrical															
bank 1 sensor 1 (primary)	P0030	circuit continuity - open	Voltage	IC Internal	-	engine speed battery voltage battery voltage output	>	80	rpm	0.01 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative		
	P0031	circuit continuity - ground													
	P0032	circuit continuity - voltage													
bank 2 sensor 1 (primary)	P0050	circuit continuity - open													
	P0051	circuit continuity - ground													
	P0052	circuit continuity - voltage													
bank 1 sensor 2 (secondary)	P0036	circuit continuity - open	Voltage	IC Internal	-	engine speed battery voltage battery voltage secondary O2 sensor heating	>	80	rpm	0.01 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous		
	P0037	circuit continuity - ground													
	P0038	circuit continuity - voltage													
bank 2 sensor 2 (secondary)	P0056	circuit continuity - open													

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	P0057 P0058	circuit continuity - ground circuit continuity - voltage				secondary O2 sensor dew point output	reached activated and deactivated for complete			0.5sec			or 50 sec cumulative	
Mass air flow sensor	P0101	range check low	measured mass air flow * threshold < Maximum modeled mass air flow	0.9	factor	battery voltage for time	> >	10.5 0.1	V sec		0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative	
		or fuel trim limits exceeded range - multiplicative and correction factor (modeled air mass at throttle / air mass measured by air mass flow meter)	> delta lambda correction	0.18	factor	crankshaft revolution counter ambient pressure valid desired cam angle valid long term fuel trim	> TRUE TRUE TRUE	0.3 150 -	sec rev -					
		range check high	measured mass air flow * threshold < minimum modeled mass air flow	1.1	factor	air flow mass air flow change gradient throttle angle change gradient engine running engine coolant temperature engine running time	> < < TRUE >	1.3888889 0.25 2 - 9.8 1	g/sec - - - ° C sec					
		or fuel trim limits exceeded range - multiplicative and correction factor (modeled air mass at throttle / air mass measured by air mass flow meter)	< delta lambda correction	-0.18	factor	Air flow meter readiness pressure ratio over throttle for time error: air flow meter (internal) error: throttle position sensor error: intake air temp. sensor	< > > not set not set not set	0.8 0.5 - - -	sec - - - -					
		range check low	> correction factor air mass	1.2	factor									
	P0100	open circuit check	sensor signal in period time	0	uS	battery voltage Engine is running Key on	> TRUE TRUE	10.5	V	5 sec				
	P0102	range check low	sensor signal in period time	66	uS	time after start	>	0.3	sec	1 sec				
	P0103	range check high	sensor signal in period time	910	uS									
Intake air temperature sensor	P0111	response check	max intake air temperature - min intake air temperature >	1.5	° C	drive period - count each with vehicle speed mass flow mass flow coolant temperature at start no fuel shut-off	>= >= < > <=	16 34.375 66.666667 6.666667 110	count mph g / sec g / sec ° C	2 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative	
	P0112 P0113	range check low range check high	intake air temperature > Temperature for closed loop control	132 -42	° C ° C	idle period - count each with vehicle speed coolant temperature at start coolant temperature ECT decrease since prior shut	>= <= <= > >	3 6.25 110 66 0	count mph ° C ° C ° C					
Engine coolant temperature sensor (w/ Real time clock)	P0116	difference from Engine temperature model after soaking	filtered difference ( ECT at key on - ECTmod at key on )	14.25	° C	Engine coolant model (cooled Soaking time after shut down	< >	50 19800	° C sec	35 for block heating	0.2 sec continuous	4 sec additional after block	immediate once code has been set	
		or filtered difference -( ECT at key on - ECTmod at key on )		14.25	° C	previous accumulated air mass previous engine run time ECT at shut down Controller Shut Down at end of Engine Off Timer value valid Block Heater	> > > > not detected not detected not detected	6000 600 81.75 - - -	g sec ° C - - -	check one filter update per cold start	heater check when filtered difference exceeds threshold	approx. 6 test average run length (15°C delta)		
Engine coolant	P0117	range check high	coolant temperature >	140.3	° C	If Startup IAT	>	72	° C	0.1 sec	0.1 sec	4 sec	two driving	

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temperature sensor	P0118	range check low	coolant temperature <	-42	° C	hot restart timer	>=	60	sec		continuous	continuous or 50 sec cumulative	cycles each with: 4 sec cont. or 50 sec cum.
						If Startup ECT   ECT-Startup ECT   (abs val integrated air mass increases and air mass timer	<	-42	° C				
	P0119	intermittent ( discontinuity )	delta coolant temperature < delta coolant temperature > weighted counter > ( up 10000 w/jump; down 1 with steady )	-3.75 3.75 60000	° C ° C count					approx. 300 sec	0.01 sec continuous		
Throttle Position Sensor 1 (primary)	P0121	range check poti voltage	sensor difference >	9	%	battery voltage	>	7	V	continuous	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec cont. or 50 sec cum.
	P0122 P0123	plausibility to other poti	sensor circuit low voltage < sensor circuit high voltage >	0.176 4.629	V V					continuous	0.1 sec continuous	4 sec continuous or 50 sec cumulative	immediate once code has been set
Sensor 2 (redundant)	P0221	range check poti voltage,	sensor difference >	9	%	battery voltage	>	7	V	continuous	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec cont. or 50 sec cum.
	P0222 P0223	plausibility to other poti	sensor circuit low voltage < sensor circuit high voltage >	0.156 4.883	V V					continuous	0.1 sec continuous	4 sec continuous or 50 sec cumulative	immediate once code has been set
Engine coolant temperature sensor	P0125	plausibility check	calculated coolant temperature model minus measured temperature >	9.8	° C	the model temperature increases depending on air flow				approx. 500 sec		or 50 sec cumulative	two driving cycles each with: 4 sec cont. or 50 sec cum.
Engine Coolant Thermostat Monitoring	P0128	Coolant Temperature Below Thermostat Regulating Temperature (plausibility check)	(calculated reference model coolant temp minus measured coolant temperature) >  reference model calculation limit  ( development vehicles indicated steady thermostat regulating temperatures of 89°C, as measured by the engine coolant temp. sensor. The thermostat opening temp. is 82°C. The thermostat is fully open by 95°C. All critical OBD and emission functions are enabled above 60°C. )	10.5  89.25	° C  ° C	debouncing time error: engine coolant temp error: vehicle speed sensor est. ambient temperature est. ambient temperature vehicle speed engine speed coolant temperature at start integrated air mass flow	> not set not set > < >=	20 - - -10.5 70 9.375	sec - - °C °C mph	approx. 900 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Oxygen Sensor sensor circuit (primary O2) bank 1 sensor 1 bank 2 sensor 1	P0131	short circuit to ground	primary O2 sensor voltage < and Secondary O2 sensor voltage >	0.06	V	engine running	TRUE	-	-	0.1 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
	P0151			0.5	V	battery voltage commanded lambda primary O2 heater active for and dew-point end passed error: injector circuit fault Lamda closed loop control Integrated air mass	> > > > TRUE not set TRUE >	10.5 0.995 5 not set 2200	V - sec g				

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bank 1 sensor 1 bank 2 sensor 1			primary O2 sensor voltage < and cold start conditions present	0.06	V	time primary O2 heater active for error: injector circuit fault time after start engine temp at stop engine temp	> > not set < > <	30 5 0 1 60 40	30 sec 0 sec ° C ° C				
	P0132 P0152	short circuit to battery voltage	primary O2 sensor voltage >	1.15	V	engine running battery voltage commanded lambda primary O2 heater active for and dew-point end passed error: injector circuit fault	TRUE > > > TRUE not set	- 10.5 0.995 5 not set	- V - sec	5.1	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Primary O2 sensor slow response Bank 1 Bank 2	P0133 P0153	slow response	Continuously filtered normalized switching cycle duration  20 valid closed loop switching cycles  (note: normalization of cycle duration revised with new enable window and failure threshold)	3	s	closed loop control engine speed engine speed engine load engine load exhaust gas temperature mode purge off or has been on for time scheduled by System Manager Primary O2 heater diagnosis finished high purge vapor concentration Evap. Leak diagnosis error: fuel adaptation error: purge valve error: misfire error: primary O2 heater error: secondary O2 heater error: secondary O2 slow sensor error: secondary O2 sensor	active > > < > > > set set not set not set not set not set not set not set not set not set	2400 1800 70 40 350 10	rpm rpm % % ° C sec		0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Oxygen Sensor sensor circuit (primary O2) bank 1 sensor 1 bank 2 sensor 1	P0134 P0154	sensor line disconnection	primary O2 sensor voltage > and primary O2 sensor voltage < Or primary O2 sensor voltage < and mod. Exhaust gas temp. > or primary O2 sensor internal resistance > and when modeled exhaust gas temperature > or primary O2 sensor voltage > and secondary O2 sensor voltage > and fuel cutoff achieved for time	0.4 0.6 0.55  20000 600  0.2 0.2 3	V V ° C  Ohm ° C  V V sec	engine running battery voltage mod. exhaust-gas temp. primary O2 heater active for and dew-point end passed error: injector circuit fault primary O2 heater duty cycle > or mod. exhaust gas temp. dew point end exceeded error: Primary O2 sensor Or Sec. O2 sensor readiness for time	TRUE > > > TRUE not set > > TRUE not set TRUE >	- 10.5 800 5 not set 0.68 600 not set 30	- V ° C sec  - ° C  sec	5 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Oxygen Sensor Heating heater performance (primary O2) bank 1 sensor 1 (primary) bank 2 sensor 1 (primary)	P0135 P0155	primary O2 sensor internal resistance above threshold	measured primary O2 sensor internal resistance > nominal internal resistance  multiply times degradation factor >  for time	88 ... 392 KFRINH / 2 5 ... 63 FRINH1 / 2 6	Ohms  factor sec	battery voltage battery voltage engine running engine starting fuel cut off pri. O2 internal resistance intake air temperature engine off soak time modeled exhaust temp. suspicion of primary O2 sensor open circuit primary O2 voltage supply scheduled by System Manager for time primary O2 sensor dewpoint ex no fault clear request during dri	> < TRUE complete FALSE valid > > < FALSE ON > > not set	10.5 18 - - - - -6.8 120 550 - 12 10	V V - - - - C sec C C sec sec	approx. 100 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative

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Oxygen Sensor sensor circuit (secondary O2) bank 1 sensor 2 bank 2 sensor 2	P0137 P0157	short circuit to ground	secondary O2 sensor voltage <	0.06	V	secondary O2 heating stable dew-point end of Sec. O2 for time > engine running battery voltage > time after start < engine temp at stop > engine temp < error: engine coolant temp not set	TRUE TRUE > TRUE > < > < -	- 90 10.5 1 60 40 -	- sec V sec ° C ° C -	0.1 sec   600.1 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
			secondary O2 sensor voltage < short term closed loop controller	0.06 1.25	V -	Or secondary O2 heating stable dew-point end of Sec. O2 for time > engine running battery voltage > for time > Commanded lambda <=	TRUE TRUE > TRUE > > 1.005	- - sec - V sec -					
	bank 1 sensor 2 bank 2 sensor 2	P0138 P0158	short circuit to battery voltage	secondary O2 sensor voltage >	1.15	V	secondary O2 heating stable dew-point end of Sec. O2 for time > engine running battery voltage >	TRUE TRUE > TRUE >	- 90 - 10.5	- sec - V	5.1 sec		
				bank 1 sensor 2 bank 2 sensor 2	P0140 P0160	sensor line disconnection	secondary O2 sensor voltage > and secondary O2 sensor voltage <	0.401 0.519	V V	secondary O2 heating stable dew-point end of Sec. O2 for time > and mod. Exhaust-gas temp. <	TRUE TRUE > 800	- sec ° C	60 sec
		Or secondary O2 sensor voltage > and secondary O2 sensor voltage <	0.401 0.5479	V V			secondary O2 heating stable dew-point end of Sec. O2 for time > and mod. Exhaust-gas temp. >=	TRUE TRUE > 800	- sec ° C				
		or secondary O2 sensor internal resistance > when modeled exhaust gas temperature >	40000 450	Ohm ° C	engine running battery voltage > mod. exhaust-gas temp. < secondary O2 heating stable dew-point end of Sec. O2 for time >	TRUE > < TRUE TRUE >	10.5 800	V ° C					
Oxygen Sensor (Secondary O2) Slow response voltage during bank 1 sensor 2 (secondary) bank 2 sensor 2 (secondary)	P013A P013C	secondary O2 sensor slow response in DCFO	slow response time >	0.5	sec	Decel. Fuel cut-off (DCFO)	TRUE	-	-	1	0.2 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
			Secondary HO2S voltage <=	0.4	V	Sec. HO2S internal resistance	TRUE	-	-	1			
			Secondary HO2S voltage >=	0.2	V	primary HO2S Readiness	TRUE	-	-	1			
			Or Secondary HO2S readiness			Secondary HO2S readiness	TRUE	-	-				
			battery voltage			Secondary HO2S readiness	TRUE	10.4	V				
			Secondary HO2S internal resistance			Secondary HO2S internal resistance	<=	500	500				
			mod. exhaust-gas temp. at secondary HO2S			mod. exhaust-gas temp. at secondary HO2S	>=	500	° C				
			Sec. HO2S voltage on rich side			Sec. HO2S voltage on rich side	TRUE	-	-				
	P013E P014A	secondary O2 sensor delayed response since DCFO	response delay time >	3	sec	Decel. Fuel cut-off (DCFO)	TRUE	-	-			4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
secondary O2 sensor voltage > since DCFO						>	0.59	V					
			secondary O2 sensor voltage <=			secondary O2 sensor voltage <=	<=	0.14	V				
			primary HO2S Readiness			primary HO2S Readiness	TRUE	-	-				
			Secondary HO2S readiness			Secondary HO2S readiness	TRUE	-	-				
			Primary HO2S			Primary HO2S	<	0.14	V				
			battery voltage			battery voltage	>	10.4	V				
			Secondary HO2S internal resistance			Secondary HO2S internal resistance	<=	500	500				

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						mod. exhaust-gas temp. at secondary HO2S Sec. HO2S voltage on rich side Or integrated Oxygen storage	>= TRUE >	500 - 3	° C - g				
Oxygen Sensor Heating heater performance (secondary bank 1 sensor 2 (secondary) bank 2 sensor 2 (secondary)	P0141 P0161	secondary O2 sensor internal resistance above threshold	measured secondary O2 sensor internal resistance > nominal internal resistance  multiply times degradation factor  for time	104 . . . 296  3.5 . . . 7.5  6	Ohms  factor  sec	battery voltage battery voltage engine running engine starting fuel cut off sec. O2 internal resistance intake air temperature engine off soak time modeled exhaust temp. at secondary O2 sensor suspicion of secondary O2 sensor open circuit secondary O2 voltage supply from the deactivation for time	> < TRUE complete FALSE valid > > in range  FALSE  ON >	10.5 18 - - - - -9.75 120 360 . . . 500  - - 120	V V - - - - C sec C  - - sec	approx. 100 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Fuel Injector circuit continuity Cylinder #1  Cylinder #2  Cylinder #3  Cylinder #4  Cylinder #5  Cylinder #6	P0201 P0261 P0262 P0202 P0264 P0265 P0203 P0267 P0268 P0204 P0270 P0271 P0205 P0273 P0274 P0206 P0276 P0277	circuit continuity - open circuit continuity - ground circuit continuity - voltage circuit continuity - open circuit continuity - ground circuit continuity - voltage circuit continuity - open circuit continuity - ground circuit continuity - voltage circuit continuity - open circuit continuity - ground circuit continuity - voltage circuit continuity - open circuit continuity - ground circuit continuity - voltage circuit continuity - open circuit continuity - ground circuit continuity - voltage	Voltage	IC Internal	-	engine speed battery voltage battery voltage output	> > <  activated and deactivated for complete checking	80 10 18.1	rpm V V	0.01 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Misfire Emission Level Multiple Cylinder Cylinder #1 Cylinder #2 Cylinder #3 Cylinder #4 Cylinder #5 Cylinder #6	P0300 P0301 P0302 P0303 P0304 P0305 P0306	crankshaft speed fluctuation cylinder 1 to cylinder 6	emissions relevant misfire rate	1.82	%	engine speed engine speed indicated torque (idle, no drive) indicated torque (drive) (MISAL) engine speed gradient volumetric efficiency gradient cylinder events after engine start air temperature rough road traction control clutch position sensor press / release leak detection active handling ABS engine drag control fuel cut off fuel level OR fuel level AND solid misfire MIL OR fuel level error	> < > > < < < > > not detected off transition  off not active not active not active > < on set	420 7000 10.16 10.5 . . . 29.3 200 . . . 362 225 . . . 1350 6 -30 - - FALSE - - - - - 11.160059 11.160059 - -	rpm rpm % % rpm/sec %/rev ignitions ° C - - - - - - - - %	1000 revs	cylinder firing frequency  continuous	4 sec continuous  After detection, the diagnostic can only pass if similar conditions are encountered encountered	Fault during 1st interval: 2 faults in 2 different drive cycles.  Fault during remaining intervals: 8 faults in 2 different drive cycles with at least 4 faults in each.

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Catalyst Damaging Level Multiple Cylinder Cylinder #1 Cylinder #2 Cylinder #3 Cylinder #4 Cylinder #5 Cylinder #6	P0300 P0301 P0302 P0303 P0304 P0305 P0306		OR Catalyst damaging misfire rate	18.1 ... 5 see Misfire supplemental data (h) (2.5.1)	%	Crankshaft position sensing off	not set	-	-	#REF! #REF! #REF! #REF! #REF!			First occurrence: immediate flashing while error present, then no MIL with no error.  Second occurrence: immediate flashing while error present, then solid MIL with no error.
						error: throttle position	not set	-	-				
						error: crankshaft sensor	not set	-	-				
						error: ref.mark of crank senso	not set	-	-				
						Includes all the above with the following exceptions:							
						First interval extention	<	47.25	°C				
engine coolant temperature	>=	11.156782	%										
fuel level	<	11.156782	%										
OR fuel level	blinking	-	-										
AND blinking MIL	-	-	-										
AND NOT first blink event	-	-	-										
Knock Control Circuit	P0324	test pulse	test pulse integral < for consecutive events	4 2	V count	engine coolant temp. knock control	> active	60 -	° C -	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec	
		or											
		null test (zero test)	absolute value (integrator gradient) > for consecutive events	200 2	V / sec count	zero test , parity fault assumpti measuring window engine coolant temp. knock control	not set > > active	- 1 60 -	- ms ° C -				
		or											
		parity check or SPI communication	cient RAM errors in knock IC, per 250 working c check word errors in knock IC, per 250 working	5 25	count count	test pulse , parity fault assumpt engine coolant temp. test pulse fault assumption	not set > not set	- 60 -	- ° C -				
Bank 1 circuit check Performance	P0326	short circuit to B+ or GND	faults detected on knock sensor pins, per 250 w	25	count	engine coolant temperature engine speed	> >	60 2200	° C rpm	approx. 20 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
	P0327	range check low	reference voltage < for consecutive events	0.088 ... 0.33 UDKSNU	V count	engine speed gradient engine load gradient error: knock control circuit (IC)	< < not set	500 ... 2500 50 ... 100 -	rpm / sec kPa / sec -				
	P0328	range check high	reference voltage > for consecutive events	5.7 ... 30.8 UDKSNO	V count								
		short circuit to B+ or GND	faults detected on knock sensor pins, per 250 working cycles (zkrks) >	100	count								
Bank 2 Performance	P0331	short circuit to B+ or GND	faults detected on knock sensor pins, per 250 w	25	count	engine coolant temperature engine speed gradient	> >	60 500 ... 2500	° C rpm / sec	approx. 20 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
	P0332	range check low	reference voltage < for consecutive events	0.088 ... 0.33 UDKSNU	V count	engine load gradient error: knock control circuit (IC)	< < not set	50 ... 100 -	kPa / sec -				
	P0333	range check high	reference voltage >	5.7 ... 30.8 UDKSNO	V								

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			for consecutive events	100	count								
Crankshaft Position Sensor	P0335	circuit continuity	no engine signal but phase signals available	0	rpm	camshaft revolutions detected	>	12	counts	approx. 5 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	immediate once code has been set with: 4 sec continuous or 50 sec cumulative
		rationality check	reference gap missing > ( sensor signal but no reference )	3	gaps								
	P0336	rationality check	unexpected re-synchronization > ( loss of reference mark )	6	count					approx. 2 sec	1 per rev continuous		
		rationality check	intermittent loss of engine speed signal >	28	count								
	P0338	rationality check	difference in counted teeth between reference gap position events >	8	teeth								
Camshaft Position Sensor Bank 1 Intake	P0341	plausibility check	signal erratic or out of position	4	count	engine in synchronized mode	TRUE	-	-	10 revolutions	1 per rev continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
	P0342	circuit low	signal permanently low	5	count	engine speed	<						
	P0343	circuit continuity or high	signal permanently high	5	count								
Bank 2 Intake	P0346	plausibility check	signal erratic or out of position										
	P0347	circuit low	signal permanently low										
	P0348	circuit continuity or high	signal permanently high										
Bank 1 Exhaust	P0366	plausibility check	signal erratic or out of position										
	P0367	circuit low	signal permanently low										
	P0368	circuit continuity or high	signal permanently high										
Bank 2 Exhaust	P0391	plausibility check	signal erratic or out of position										
	P0392	circuit low	signal permanently low										
	P0393	circuit continuity or high	signal permanently high										
Ignition Coil circuit continuity Cylinder #1	P0351	circuit continuity - open	Voltage >	20	revs	battery voltage	>	10	V	approx. 1 sec	engine cycle frequency	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
	P2300	circuit continuity - ground		20	revs	battery voltage	<	18.1	V				
Cylinder #2	P2301	circuit continuity - voltage		20	revs	engine speed	>	400	rpm				
	P0352	circuit continuity - open				engine speed	>	5000	rpm				
Cylinder #3	P2303	circuit continuity - ground											
	P2304	circuit continuity - voltage											
Cylinder #4	P0353	circuit continuity - open											
	P2306	circuit continuity - ground											
Cylinder #5	P2307	circuit continuity - voltage											
	P0354	circuit continuity - open											
Cylinder #6	P2309	circuit continuity - ground											
	P2310	circuit continuity - voltage											
Cylinder #6	P0355	circuit continuity - open											
	P2312	circuit continuity - ground											
	P2313	circuit continuity - voltage											
	P0356	circuit continuity - open											
	P2315	circuit continuity - ground											
Ignition Coil Driver Circuit Serial Communication	P167D	Internal SPI communication fault	IC Internal	-		battery voltage	<	18.1	v	0.01 sec			
						battery voltage	>	9	v				
						engine speed	<	6000	rpm				
Catalyst Bank 1	P0420	oxygen storage of catalyst	EWMA filtered catalyst aging factor less than catalyst aging factor of a limit catalyst <	0.2	factor	exhaust gas mass flow	>	5	g/sec	approx. 1000 sec	0.2 sec continuous	4 sec additional after block	immediate once code has been set
Catalyst Bank 2	P0430					exhaust gas mass flow	<	55.555556	g/sec				
						catalyst temp. model	<	850	° C				
						catalyst temp. model	>	400	° C				
						engine speed	>	1040	rpm				
						engine speed	<	2760	rpm				
						engine load	>	15	%				
						engine load	<	50	%				
						modeled catalyst temp. gradient	<	6	° C / sec	3 checks per driving cycle			approx. 3 tests average run length
						relative exhaust gas mass flow	<	0.6	%	3 checks per driving cycle			
						fuel system closed loop	active	-	-				



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Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination
						time after secondary O2 sensor dewpoint ambient temperature catalyst damaging misfire rate error: fuel system closed loop control at limit strong transient compensation catalyst clear out active (after f fast mixture adaptation complete Trigger condition for step change	> > set not set set set set set	10 ... 40 -10 - - - - -	sec ° C - - - - -	1 check per driving cycle			(9 samples)
Evaporative System and Leak Monitor Small Leak - 0.020 "	P0442	natural pressure/vacuum in tank	filtered fault index >  based on: ( peak pressure - peak vacuum ) <	0.6  540 ... 1430	-  Pa	Eng. Running Vac. pull down or vac. pulldown suspect leak est amb air temp est amb air temp Engine stop coolant temp engine run time trip distance travelled @ vehicle speed above evap fuel volatility factor fuel level fuel level fuel level change from keyoff error: vehicle speed error: engine coolant temp error: purge valve error: fuel tank pressure error: system voltage error: air mass meter error: intake air temp error: canister vent valve altitude adaption tank vacuum out of range start (coolant - intake air) start engine coolant temp Start intake air temp Start intake air temp time since previous test amb pressure battery voltage vehicle odometer	not set 0.020" leak > < > > > > > < > < < not set not set not set not set not set not set not set valid FALSE < < > < > > > > > > > >	P0455 for details ) P0455 for details ) 1.5 32.25 74.25 600 5.0625 1.5625 8 11.156782 88.373459 10.16 - - - - - - - - - - 9.75 42 1.5 32.3 0 68 10.8 12.5	° C ° C ° C sec miles mph factor % % % - - - - - - - - - - - ° C ° C ° C ° C sec kPa V miles	approx. 600 sec each test  approx. 6 test average run length	0.1 sec once per engine off cycle	filtered value exceeds threshold then 4 sec continuous	immediate once code has been set   approx. 6 test average run length  ( The MIL actually is requested during shut down soak. It becomes visible on the following drive. )
Evaporative Emission System Purge Solenoid Control Circuit	P0443 P0458 P0459	circuit continuity - open circuit continuity - ground circuit continuity - voltage	Voltage	IC Internal	-	engine speed battery voltage battery voltage output	> > < activated and deactivated for complete checking	80 10 18.1	rpm V V	0.01 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Evaporative System and Leak Monitor Tank vent valve	P0446	underpressure in tank	tank pressure <	-800	Pa	fuel system status vehicle speed engine battery voltage battery voltage fuel tank pressure fuel tank pressure ratio: ( MAP Model / Baro ) est amb air temp est amb air temp fuel level fuel level	closed loop < idling > < > < > < > < > < <	- 1.875 - 10.5 18.1 -2500 1000 0.555 1.5 32.25 11.156782 88.373459	- mph - V V Pa Pa - ° C ° C % %	approx. 5 sec  Only one test per driving cycle  The test will attempt to run up to 10 times	0.1 sec  one completed test per driving cycle	4 sec continuous	two driving cycles each with: 4 sec continuous or 50 sec cumulative

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Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination
						engine start temp - amb. temp time after engine start or fuel mixture adaptation amb pressure maximum number of attempts error: mass air flow error: coolant temp error: intake air temp error: fuel tank pres error: system voltage error: purge valve error: vehicle speed error: canister vent valve error: purge valve flow error: accelerator pedal	< > stable > < not set not set not set not set not set not set not set not set not set not set	9.75 600 - 68 10 - - - - - - - - -	° C sec - kPa - - - - - - - - - -	until it successfully completes a test			
Evap Vent Solenoid Control Circuit	P0449 P0498 P0499	circuit continuity - open circuit continuity - ground circuit continuity - voltage	Voltage	IC Internal	-	engine speed battery voltage battery voltage output	> > < activated and deactivated for complete	80 10 18.1	rpm V V	0.01 sec Only one test per	0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Fuel Tank Pressure Sensor	P0451	rationality - signal oscillation  or rationality - signal range check  rationality - incremental check and  rationality - drift check	delta pressure signal   ( = current pressure - old pressure ) >  sensor signal >= sensor signal >=  peak-peak sensor signal and peak-peak purge air mass    delta pressure signal   ( = current pressure - reference pressure at start ) >	813  1500 -2970  30 0.278  300	Pa  Pa Pa Pa g/s  Pa	ambient temperature model vehicle speed >= time after canister vent valve o  time after engine start time after canister vent valve o  vehicle speed modeled ambient temperature ambient pressure fuel level fuel level purge air mass tank pressure tank pressure  Vent solenoid valve open Canister purge flow (closed) ambient pressure fuel level fuel level fuel level fuel level Or fuel level valid for running Evap. leak detection Vehicle speed Vehicle speed Or ambient temperature model ambient temperature model time	> <= > > > > < > > > < > < <  <= >= >	-7.5 18.75 3  1 3  6.25 -7.5 68000 88.373459 11.156782 0 1000 -2500  - 0.0005417 68000 88.373459 11.156782 220.16733  - 0 93.75  - 2	° C mph sec  sec sec  mph ° C Pa % % g/s Pa Pa  - g / sec Pa % % %  - - mph mph  ° C ° C sec	25.5 sec  25 sec  25.5 sec  14 sec	0.1 sec continuous	4 sec continuous or 50 sec	two driving cycles each with: 4 sec or 50 sec cumulative
	P0452	circuit continuity - ground	sensor signal voltage <	0.1514	V	engine running	TRUE			14 sec			
	P0453	circuit continuity - voltage	sensor signal voltage >	4.702	V								
Evaporative System and Leak Monitor Large leak	P0455	vacuum pulldown slope	absolute value  of vacuum pulldown slope <  OR	30 . . . 70 KLGGRTE05	Pa	fuel system status vehicle speed engine battery voltage battery voltage fuel tank pressure	closed loop < idling > < >	- 1.875 - 10.5 18 -2500	- mph - V V Pa	11 sec  Only one test per driving cycle completed.	0.1 sec  one completed test per driving	4 sec continuous	two driving cycles each with: 4 sec continuous or 50 sec cumulative

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Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination
			tank vacuum > (Stuck Closed Purge valve)	-1.221	Pa	fuel tank pressure ratio: ( MAP Model / Baro ) est amb air temp est amb air temp fuel level fuel level engine start temp - amb. temp time after engine start or fuel mixture adaptation amb pressure error: mass air flow error: coolant temp error: intake air temp error: fuel tank pres error: system voltage error: purge valve error: vehicle speed error: canister vent valve error: purge valve flow error: accelerator pedal	< < > < > < > stable > not set not set not set not set not set not set not set not set not set not set	1000 - 1.5 32.25 11.156782 88.373459 9.75 600 - 68 - - - - - - - - -	Pa - ° C ° C % % ° C sec - kPa - - - - - - - - -	The test will attempt to run up to 10 times until it successfully completes a test	cycle		
Fuel Level Sensor Circuit fuel level sensor 1	P0461	rationality	fuel level change < and cumulative driving distance >	4.56 100	% km	Primary fuel level Secondary fuel level Or Primary fuel level Secondary fuel level and battery voltage battery voltage engine starting electrical fuel level sensor(s) without failure	< <= < > >= <= TRUE TRUE	41.12 7.93 41.12 7.93 10.46 18.09 - -	% liter liter liter V V - -		0.1 sec continuous	4 sec continuous or 50 sec cumulative	no
	P0462	range check low	voltage <	0.25	V	battery voltage battery voltage engine started	>= <= TRUE	10.46 18.09 -	V V -	60 sec	0.1 sec continuous	4 sec cont. or 50 sec cumulative	
	P0463	range check high	voltage >	3.2	V	battery voltage battery voltage engine started	>= <= TRUE	10.46 18.09 -	V V -	60 sec	0.1 sec continuous	4 sec cont. or 50 sec cumulative	
Cooling fan 1 relay Control Circuit	P0480 P0691 P0692	circuit continuity - open circuit continuity - ground circuit continuity - voltage	Voltage	IC Internal	-	engine speed battery voltage battery voltage	> > <	80 10 18.1	rpm V V	0.01 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Cooling fan 2 relay Control Circuit	P0481 P0693 P0694	circuit continuity - open circuit continuity - ground circuit continuity - voltage	Voltage	IC Internal	-								
Evaporative System and Leak Monitor Leaking purge valve	P0496	underpressure in tank	tank pressure loss gradient <	-60	Pa	fuel system status vehicle speed engine battery voltage	closed loop < idling >	- 1.875 - 10.5	- mph - V	about 4 sec Only one test per	0.1 sec one completed	4 sec continuous	two driving cycles with: 4 sec continuous

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Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination
						battery voltage fuel tank pressure fuel tank pressure ratio: ( MAP Model / Baro ) fuel level fuel level engine start temp - amb. temp time after engine start or fuel mixture adaptation amb pressure maximum number of attempts est amb air temp est amb air temp error: mass air flow error: coolant temp error: intake air temp error: fuel tank pres error: system voltage error: purge valve error: vehicle speed error: canister vent valve error: purge valve flow error: accelerator pedal	< > < < > < > > stable > < > < not set not set not set not set not set not set not set not set not set not set not set	18 -2500 1000 0.555 11.156782 88.373459 9.75 600 - 68 10 1.5 32.25 - - - - - - - - - -	V Pa Pa - % % ° C sec - kPa - ° C ° C - - - - - - - - -	driving cycle completed.  The test will attempt to run up to 10 times until it successfully completes a test	test per driving cycle		or 50 sec cumulative
Idle Speed System (disabled during cold start)	P0506  P0507	functional check	desired rpm - actual rpm >  desired rpm - actual rpm < or fuel cut off due to overspeed > during this idle	100  -200  3	rpm  rpm  count	load (for underspeed only) coolant temp. intake air temp vehicle altitude factor ( sea level = 1.0 time after engine start evap purge (high HC conc.) cold start idle speed control intrusive evap test error: throttle position error: vehicle speed error: coolant temperature error: intake air temperature error: evap system error: evap purge valve	< > > at idle > > FALSE FALSE not active not set not set not set not set not set not set not set	99.75 -10.5 -10.5  0.7 0	% ° C ° C  factor sec	10 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Idle Speed System (enabled during cold start)	P050A	functional check	desired rpm - actual rpm > during catalyst heating on desired rpm - actual rpm < during catalyst heating on	100  -200	rpm  rpm	load (for underspeed only) Engine coolant start temp. vehicle altitude factor ( sea level = 1.0 Engine coolant start temp. catalyst heating evap purge (high HC conc.) idle speed control catalyst heat intrusive evap test error: throttle position error: vehicle speed error: coolant temperature error: intake air temperature error: evap system error: evap purge valve	< > at idle > < TRUE FALSE TRUE not set not set not set not set not set not set not set	99.75 -10 .... +40  0.7 40.5 - - - - - - - - -	% ° C  factor ° C - - - - - - - - -	7 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
System Voltage	P0560 P0562 P0563	rationality range check low range check high	powertrain supply relay feedback input voltage voltage voltage	2.54 10 18.1	V V V	- time after engine start time after engine start vehicle speed	- > > >	- 180 180 3.125	- sec sec mph	2 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	no

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Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination	
ECM monitoring	P0601	rationality	wrong ROM checksum	-	-	checksum calculation at power down in the last driving cycle completely finished	TRUE	-	-	30 sec	0.01 sec at key off	4 sec continuous	code set then 5 sec	
		rationality	wrong cyclic ROM checksum of critical regions	-	-	partial checksum on critical variables				30 sec	0.01 sec at key on	4 sec continuous	code set then 5 sec	
	P0602	rationality - programming incomplete	service ECU bit set in calibration	service ECU bit s	-	-		-	-	1 sec	0.01 sec at key on	4 sec continuous	code set then 5 sec	
	P0603	ETC monitoring controller reset	SW internal	SW internal			power down calculation in the last driving cycle	completely finished	-	-	5 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	code set then 5 sec
	P0604	functional check cyclic RAM-check	RAM writeability check read and write test writeability check of RAM				power down calculation in the last driving cycle	completely finished	-	-	5 sec	0.01 sec at key off	4 sec continuous	code set then 5 sec
	P0606	Electronic Throttle Control (ETC) ch	SW internal ETC monitoring torque comparison ETC monitoring engine speed signal ETC monitoring volumetric efficiency signal ETC mon. vol. Eff., spark advance, A/D conv. grp. A, reaction crosscheck ETC monitoring throttle crosscheck ETC monitoring A/D conv group B, A/D converter supply voltage crosscheck ETC monitoring redundant pedal signal	SW internal	SW internal		power down calculation in the last driving cycle	completely finished	-	-	5 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	code set then 5 sec
Electronic Throttle Control	P0638	motor control range check short term  motor control range check long term	circuit duty cycle   > ( absolute value )	80	%	battery voltage	>	7	V	0.6 sec (recoverable)  5.0 sec (latched)	0.01 sec continuous	4 sec continuous or 50 sec cumulative	code set then 5 sec	
5V reference voltage monitoring	P0641 P0642 P0643  P0651 P0652 P0653  P0697 P0698 P0699	circuit continuity - open circuit continuity - ground circuit continuity - voltage  circuit continuity - open circuit continuity - ground circuit continuity - voltage  circuit continuity - open circuit continuity - ground circuit continuity - voltage	Voltage  Voltage  Voltage	IC Internal	-	ignition key on ECM power relay	TRUE TRUE	- -	- -	3 sec	0.01 sec	4 sec continuous	code set then 5 sec	
MIL Control Circuit	P0650	circuit continuity - open circuit continuity - ground circuit continuity - voltage	Voltage	IC Internal	-	engine speed battery voltage battery voltage output	> > <	80 10 18.1	rpm V V	0.01 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	no (but is shown in Mode \$03)	
Transmission Control Module MIL Illumination Request	P0700	OBD emission fault detected by the TCM (Specific TCM DTC shown in freeze frame)	signal input	-	-	-	-	-	-	0.01 sec	0.01 sec continuous	4 sec cont. or 50 sec cumulative	code set then 5 sec	
Vehicle speed sensor Manual Transmission	P0501 P0502	rationality (high range check) rationality (low range check)	vehicle speed vehicle speed	171.875 3.125	mph mph	- engine speed engine speed fuel shut off coolant temperature	- > > TRUE >	- 1800 3520 - 40	- rpm rpm - ° C	2 sec 3 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative	
Clutch Pedal Position Sensor	P0806	rationality -	detected clutch pedal press count <	2	count -	gear changes detected	>	20	count	approx.	0.1 sec	4 sec	code set	

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Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination
Manual Transmission		input ctuth pos. state changes				( ratio of engine speed to vehicle speed -- range change ) Delay between shift detection vehicle speed between gear change detects	> >	4 25	sec mph	500 sec	continuous	continuous or 50 sec cumulative	then 5 sec
	P0807 P0808	Circuit Continuity - Ground Circuit Continuity - Voltage	Voltage < Voltage >		V V								
	P080A P080A	rationality - bottom of pedal travel not learned	Pedal Position <	93	%	clutch pedal position greater start request from driver	> FALSE	69	%				
Engine Metal Overtemperature Protection ( Limp Home Function Active )	P1258	engine coolant temperature too high	engine coolant temperature >	135.8	° C	engine run time error: engine coolant temp	> not set	30 -	sec -	1 sec	0.1 sec continuous	4 sec cont. or 50 sec cumulative	code set then 5 sec
Electronic Throttle Control	P1551	limp-home throttle position out of range	throttle position < OR throttle position >	1.8006 13.0785	% %	vehicle speed engine speed engine coolant temperature engine coolant temperature intake air temperature intake air temperature battery voltage accelerator pedal position	<= < >= <= >= <= > <	0 40 5.25 84.75 5.25 60 9.99 14.9	mph rpm ° C ° C ° C ° C V %	5 sec	0.01 sec at key on	4 sec continuous or 50 sec cumulative	code set then 5 sec with: 4 sec continuous or 50 sec cumulative
Fuel Level Sensor Circuit fuel level sensor 2	P2066	rationality	fuel level change < and cumulative driving distance >	4.56	%	Primary fuel level Secondary fuel level	>= >=	41.12 7.93	% %		0.1 sec continuous	4 sec continuous or 50 sec cumulative	no
				100	km	Or Primary fuel level Secondary fuel level	< >	41.12 7.93	% %				
			and battery voltage battery voltage engine starting electrical fuel level sensor(s) without failure	>= <= TRUE TRUE	10.46 18.09 - -	V V - -							
			Or cumulative driving distance >=	100	km	Primary fuel level Secondary fuel level battery voltage battery voltage engine starting electrical fuel level sensor(s) without failure	>= < >= <= TRUE TRUE	41.12 7.93 10.46 18.09 - -	% % V V - -				
	P2067	range check low	voltage <	0.25	V	battery voltage battery voltage engine starting	>= <= TRUE	10.46 18.09 -	V V -	60 sec	0.1 sec continuous	4 sec cont. or 50 sec cumulative	
	P2068	range check high	voltage >	3.2	V	battery voltage battery voltage engine starting	>= <= TRUE	10.46 18.09 -	V V -	60 sec	0.1 sec continuous	4 sec cont. or 50 sec cumulative	
Secondary O2 Trim of primary O2 Sensor primary O2 sensor signal RICH / secondary O2 sensor signal LEAN Bank1 Bank 2	P2096 P2098	secondary O2 sensor fuel trim - rich shift - correction above threshold	secondary O2 sensor trim integral control >	0.8	sec	engine speed engine speed engine load engine load closed loop control active for time exhaust gas temp. model primary closed loop controller at upper limit	< > < > TRUE > > not set	2920 1200 16.5 .... 20.3 3 300 -	sec ° C % sec ° C -	200 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative

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Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination																										
primary O2 sensor signal LEAN / secondary O2 sensor signal RICH Bank 1 Bank 2	P2097	secondary O2 sensor fuel trim - lean shift - correction below threshold	secondary O2 sensor trim integral control <	-0.8	sec	at lower limit	not set	-	-																														
	secondary O2 sensor readiness					not set	-	-	error: catalyst clear out after DCFCO					not set	-	-	error: catalyst monitoring	not set	-	-	error: purge valve	not set	-	-	error: secondary O2 sensor response	not set	-	-	error: primary O2 heater	not set	-	-	error: secondary O2 heater	not set	-	-	error: fuel system monitoring	not set	-
Electronic Throttle Control	P2100	circuit switch-off	output circuits not deactivated as commanded	-	-	-	-	-	-	0.1 sec	0.01 sec at key on	4 sec continuous	code set then 5 sec																										
	P2101	difference between set and actual position of throttle blade	difference between set and actual position of throttle blade >	4 . . . 50	% on rate of change	electronic throttle adaptation battery voltage	not active >	- 7	- V	0.5 sec	0.01 sec continuous	4 sec cont. or 50 sec cumulative	code set then 5 sec																										
	P2105	Electronic Throttle Control (ETC) checks ETC monitoring watchdog shutdown path				power down processing in the last driving cycle	completely finished	-	-	5 sec	0.01 sec at key on	4 sec continuous	code set then 5 sec																										
	P2119	functionality of return spring	throttle blade return response	0.56	sec	vehicle speed engine speed engine coolant temperature engine coolant temperature intake air temperature intake air temperature battery voltage accelerator pedal position	<= < >= <= >= <= > <	0 40 5.25 84.75 5.25 60 9.99 14.9	mph rpm ° C ° C ° C ° C V %	0.56 sec	0.01 sec at key on	4 sec continuous	code set then 5 sec																										
Accelerator Pedal Position Sensor 1	P2122	range check low	voltage	0.8398	V	battery voltage	>	7	V	0.2 sec	0.01 sec continuous	4 sec cont. or 50 sec cumulative	code set then 5 sec																										
	P2123	range check high		4.8242	V																																		
Accelerator Pedal Position Sensor 2	P2127	range check low	voltage	0.6641	V	battery voltage	>	7	V	0.2 sec	0.01 sec continuous	4 sec cont. or 50 sec cumulative	code set then 5 sec																										
	P2128	range check high		4.8242	V																																		
Accelerator Pedal Position 1 versus Position 2	P2138	plausibility	voltage difference > idle range	0.2148 0.2734	V V	-	-	-	-	0.24 sec	0.01 sec continuous	4 sec continuous  or 50 sec cumulative	code set then 5 sec																										
			voltage difference pedal partially pressed >	0.2734	V																																		
			voltage difference > pedal fully pressed	1.0742	V																																		
			voltage pedal 1 >	1.1719	V																																		
			voltage difference pedal 2 >	0.039	V																																		
Electronic Throttle Control	P2176	throttle exchange detection learn fail or initial throttle learn failed or learning prohibited due to secondary parameters not met or minimum throttle position out of range	range check poti1 value at lower stop throttle potentiometer 1 voltage < or throttle potentiometer 1 voltage >	0.212 0.865	V V	vehicle speed engine speed engine coolant temperature engine coolant temperature intake air temperature intake air temperature battery voltage accelerator pedal position	<= < >= <= >= <= > <	0 40 5.25 84.75 5.25 60 9.99 14.9	mph rpm ° C ° C ° C ° C V %	1 sec	0.01 sec at key on	4 sec continuous	code set then 5 sec																										
range check poti2 value at lower stop throttle potentiometer 2 voltage < or throttle potentiometer 2 voltage >			4.14 4.84	V V	0 60 9.99 14.9	° C ° C V %																																	
Fuel System Lean/Rich Multiplicative						air mass flow air mass flow engine load	>= <= >=	7.5 83.333333 17	g/sec g/sec %	approx. 300 sec from engine	0.1 sec continuous	4 sec continuous or 50 sec	two driving cycles each with: 4 sec																										

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Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination		
Bank 1	P2177	fuel trim limits exceeded range - multiplicative ( load > threshold and air flow >	delta lambda correction > or delta lambda correction < threshold )	1.230011	factor	engine load	<=	45	%	start ( after adaptation has		cumulative	continuous or 50 sec cumulative		
	P2178			0.779999	factor	engine speed	>=	1200	rpm						
Bank 2	P2179	delta lambda correction > or delta lambda correction <	delta lambda correction > or delta lambda correction <	1.230011	factor	closed loop control	TRUE	-	-						
	P2180					0.779999	factor	throttle angle	<=					99.6	99.6
								engine coolant temperature	>					60	°C
								intake air temperature	<=					60	°C
								primary A/F sensor 1 readiness	TRUE					-	-
								primary A/F sensor 2 readiness	TRUE					-	-
								command lambda	<					1.2	-
								command lambda	>					0.83	-
								catalyst heating	not set					-	-
								critical misfire rate detected	not set					-	-
								deceleration fuel cut-off	not set					-	-
								transient compensation	not set					-	-
								wide open throttle	not set					-	-
								integrated fuel mass	>					700	g
								and empty-valid fuel level	not set					-	-
								error: cam control diagnosis	not set					-	-
								error: injection value fault	not set					-	-
				error: catalyst damaging misfire	not set	-	-								
Fuel System Lean/Rich additive											0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative		
Bank 1	P2187	range - additive low speed and low load	delta fuel load correction > or delta fuel load correction <	6.984	%	air mass flow	>=	1.3888889	g/sec						
	P2188			-6.984	%	air mass flow	<=	6.6666667	g/sec						
Bank 2	P2189	delta fuel load correction > or delta fuel load correction <	delta fuel load correction > or delta fuel load correction <	6.984	%	engine load	>=	7.5	%						
	P2190					-6.984	%	engine speed	>=					520	rpm
								engine speed	<=					1000	rpm
								closed loop control	TRUE					-	-
								engine coolant temperature	>					60	°C
								intake air temperature	<=					60	°C
								primary A/F sensor 1 readiness	TRUE					-	-
								primary A/F sensor 2 readiness	TRUE					-	-
								command lambda	<					1.2	-
								command lambda	>					0.83	-
								catalyst heating	not set					-	-
								critical misfire rate detected	not set					-	-
								deceleration fuel cut-off	not set					-	-
								transient compensation	not set					-	-
								wide open throttle	not set					-	-
								integrated fuel mass	>					700	g
								and empty-valid fuel level	not set					-	-
				error: cam control diagnosis	not set	-	-								
				error: injection value fault	not set	-	-								
				error: catalyst damaging misfire	not set	-	-								
Barometric Pressure Sensor Rationality	P2227	range check high	sensor signal >	115	KPa	error : barometric pressure sen electrical	not set	-	-	2 sec	continuous	4 sec	two driving cycles each with: 4 sec		
		range check low	or sensor signal <	50	KPa	for time error : barometric pressure sen electrical	> not set	0.2 -	sec -	2 sec	continuous	4 sec	continuous or 50 sec cumulative		
		sensor offset / jump test low	or sensor output change within 20 sec period > OR barometric pressure signal pressure jump from previous key off > AND sensor output + THRESHOLD < pressure model	10 30 5	KPa KPa KPa	error : barometric pressure sen electrical time since engine start error : barometric pressure sen air mass flow meter readiness engine running time	not set not set TRUE >	- 5 - - 1	- sec - - sec	2 sec	continuous	4 sec			



## 08 GRP03 All Engine

Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination
			or sensor output change within 20 sec period > OR barometric pressure signal pressure jump from previous key off > AND sensor output - THRESHOLD > pressure model	10	KPa	command air flow valid corrector factor calculation for mass-flow substitute load signal air flow meter signal valid enabling air flow meter diag. Evap. Leak detection active for time error: throttle position sensor error: air flow mass meter error : Baro pressure sensor electrical	TRUE TRUE TRUE not set > not set not set not set	- - - - 1 - -	- - - - sec -				
			sensor offset / jump test high	30	KPa	error : barometric pressure sen time since engine start error : barometric pressure sen	not set < not set	- 5 -	- sec -	2 sec	continuous	4 sec	
				5	KPa	air mass flow meter readiness engine running time command air flow valid corrector factor calculation for mass-flow substitute load signal air flow meter signal valid enabling air flow meter diag. Evap. Leak detection active for time error: throttle position sensor error: air flow mass meter error : Baro pressure sensor electrical	TRUE > TRUE TRUE not set > not set not set not set	- 1 - - sec -					
	P2228	range check low	voltage <	0.2	V	enabled by scheduler for time	>	1	sec	2 sec			
	P2229	range check high	voltage >	4.87	V	enabled by scheduler for time	>	1	sec				
Oxygen Sensor sensor circuit (primary O2) bank 1 sensor 1 bank 2 sensor 1	P2231 P2234	sensor line short circuit to heater output line	secondary O2 sensor voltage gradient > within time after heater turn off < for occurrences > out of heater turn offs  or primary O2 sensor voltage > and primary O2 sensor voltage < and secondary O2 sensor voltage <  or primary O2 sensor voltage > and primary O2 sensor voltage < and secondary O2 sensor voltage <	2 0.04 4 6  0.6 1.15 0.1  0.06 0.4 0.5	V s count count  V V V  V V V	engine running battery voltage commanded lambda primary O2 heater active for and dew-point end passed error: injector circuit fault  engine running battery voltage commanded lambda primary O2 heater active for and dew-point end passed error: injector circuit fault Lamda closed loop control Integrated air mass error: injector circuit fault time after start engine temp at stop engine temp	TRUE > > > TRUE not set  TRUE > > > TRUE not set TRUE > not set < > <	- 10.5 0.995 5  - 10.5 0.995 5  - 2200 0 1 60 40	- V - sec  - V - sec  - g 0 sec ° C ° C		0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
Oxygen Sensor sensor circuit (secondary O2) bank 1 sensor 2 bank 2 sensor 2	P2232 P2235	sensor line short circuit to heater output line	secondary O2 sensor voltage gradient > within time after heater turn off < for occurrences >	2 0.04 4	V sec count	secondary O2 heating stable dew-point end of Sec. O2 for time battery voltage	TRUE TRUE > >		sec V	10 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec

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Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination	
			out of heater turn offs	6	count	engine running	TRUE						cumulative	
Oxygen Sensor sensor response (secondary O2) bank 1 sensor 2 bank 2 sensor 2	P2270 P2272	oscillation check low	secondary O2 sensor voltage < for time > then ramping in enrichment by at gradient for time (after enrichment limit reached)	0.582 . . . 0.66 100 0.3 0.017 10	V sec lambda 1 / sec sec	engine running battery voltage secondary O2 sensor for time secondary O2 closed loop cont DFCO engine air flow (intrusive test) and engine air flow for time engine air flow (passive monito sec. O2 trim - fast lean correcti sec. O2 trim - fast rich correctio sec. O2 trim - slow correction sec. O2 aging DFCO test failed engine scheduled by System Manager	TRUE > ready > active FALSE > < > > FALSE FALSE FALSE FALSE running TRUE	- 10.5 - 10 - 5.555556 33.333333 3 9.7222222	- V - sec - g/sec g/sec sec g/sec		approx. 600 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative
bank 1 sensor 2 bank 2 sensor 2	P2271 P2273	oscillation check high	secondary O2 sensor voltage > for time > then ramping in enleanment by at gradient for time (after enleanment limit reached)	0.582 . . . 0.66 100 0.07 0.017 10	V sec lambda 1 / sec sec	engine running battery voltage secondary O2 sensor for time secondary O2 closed loop cont DFCO engine air flow (intrusive test) and engine air flow for time engine air flow (passive monito sec. O2 trim - fast lean correcti sec. O2 trim - fast rich correctio sec. O2 trim - slow correction sec. O2 aging DFCO test failed engine scheduled by System Manager	TRUE > ready > active FALSE > < > > FALSE FALSE FALSE FALSE running TRUE	- 10.5 - 10 - 5.555556 33.333333 3 9.7222222	- V - sec - g/sec g/sec sec g/sec		0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative	
Real time clock Engine off timer Status Check	P2610	engine off timer signal check	engine off timer not valid	3		engine start successful real time clock active	TRUE TRUE	- -	- -	0.1 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative	
Real time clock Engine off timer Rationality check	P2610	engine off timer incremental check	reference clock time delta - Engine Off Timer delta >  reference clock time delta - Engine Off Timer delta <	6  6	counts  counts	engine start successful failure counts  engine start successful failure counts	TRUE =>  TRUE =>	3  3	3  counts	0.1 sec	0.1 sec continuous	4 sec continuous or 50 sec cumulative	two driving cycles each with: 4 sec continuous or 50 sec cumulative	
Fuel Level Sensor Circuit fuel transfer pump	P2636	transfer pump failure	fuel level 1 < and fuel level 2 >	10.63829787 22.79635258	% %	sensor signal without failure fuel level state stable engine starting	TRUE TRUE complete	- - -	- - -	240 sec	0.1 sec continuous	4 sec cont. or 50 sec cumulative	no	
OBD ISO-15765 Communication Bus	U0073	ISO-15765 Bus Error	Invalid Message Received or Dual Port Ram Hardware Error; or No Communication / Bus Off			CAN Bus consisting of: ignition on for battery voltage > battery voltage < normal bus communication	initialized and ready > > < running	3 10.5 18 -	sec V V -	1 sec 0.01 sec 0.02 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	code set then 5 sec	
	U0101	Communication with TCM	TCM Message Timeout	message missing, delayed, or		Automatic Transmission CAN Bus consisting of: ignition on for	equipped initialized and ready >	- - 3	- - sec	2.5 sec	0.01 sec continuous	4 sec continuous or 50 sec cumulative	code set then 5 sec	

## 08 GRP03 All Engine

Component/ System	Fault Code	Monitor Strategy Description	Primary Malfunction Signal and Criteria	Threshold Value	Specified Units	Secondary Parameters	Enable Condition	Enable Value	Units	Time Required	Frequency of Checks	Criteria for Code	MIL Illumination
				invalid content		battery voltage battery voltage normal bus communication	> < running	10.5 18 -	V V -				

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P0011, P0021 **KFDWNWDMXE / 2** (internal manufacturer cross reference)

**Maximum Allowed Deviation - Intake Camshaft Position**

degrees crank	Modeled Engine Oil Temperature ( ° C )				
Engine Speed (rpm)	0	60	80	100	130
800	6.00	6.00	7.00	9.00	11.00
1200	6.00	6.00	6.00	6.00	7.00
1600	6.00	6.00	6.00	6.00	7.00
2000	6.00	6.00	6.00	6.00	6.00
2500	6.00	6.00	6.00	6.00	6.00
4000	6.00	6.00	6.00	6.00	6.00

P0116 **KLTCWCSTAB**

**Engine coolant temperature model based on ambient temperature + engine off timer output**

Time (seconds)	300	10800	14400	18000	21600	32400	43200	50400
Coefficient:	0.996	0.367	0.250	0.188	0.148	0.078	0.027	0.004

P0135, P0155 **KFRINV / 2** (internal manufacturer cross reference)

**Sensor Element (Ceramic) Impedance, Nominal Value - Secondary O2 Sensor**

Ohms	Modeled Exhaust Gas Temperature at Secondary O2 Sensor ( ° C )				
O2 Heater Power (watts)	350	450	550	650	750
0.67	392	312	200	128	88
0.78	288	224	160	104	88
1.03	184	144	112	96	88

**FRINV1 / 2** (internal manufacturer cross reference)

**Multiplication Factor for Internal Resistance KFRINH Nominal Value - Secondary O2 Sensor**

	Modeled Exhaust Gas Temperature at Secondary O2 Sensor ( ° C )				
	370	450	520	590	650
factor	63.00	16.00	7.00	5.00	5.00

P0141, P0161 **KFRINH / 2** (internal manufacturer cross reference)

**Sensor Element (Ceramic) Impedance, Nominal Value - Secondary O2 Sensor**

Ohms	Modeled Exhaust Gas Temperature at Secondary O2 Sensor ( ° C )				
O2 Heater Power (watts)	200	300	400	500	550
0.620	2040	1504	904	504	448
0.800	1400	848	448	304	248
1.000	752	400	248	192	184

**FRINH1 / 2** (internal manufacturer cross reference)

**Multiplication Factor for Internal Resistance KFRINH Nominal Value - Secondary O2 Sensor**

	Modeled Exhaust Gas Temperature at Secondary O2 Sensor ( ° C )				
	200	300	400	500	550

## 08 GRP03 All Engine

factor	63.00	50.00	30.00	14.00	14.00
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### NGKRWN

P0327, P0332, P032 RPM dynamic threshold for disabling knock diagnosis

RPM	400.0	800.0	1200.0	1600.0	2000.0	2400.0	2800	3200	3600	4000	4400	4800	5200	5600	6000	6400
RPM per second	600.01	800.01	1000.01	1200.02	1400.02	1500.02	1600.02	1700.02	1800	1900	2000	2100	2100	2100	2300	2300

P0327, P0332

### UDKSNU (internal manufacturer cross reference)

Reference voltage threshold for knock sensor diagnosis - Lower Limit

	Engine Speed ( rpm )															
	400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800	5200	5600	6000	6400
Peak RMS Voltage ( V )	0.040	0.040	0.053	0.074	0.084	0.100	0.128	0.144	0.164	0.229	0.254	0.339	0.414	0.476	0.616	0.753

P0328, P0333

### UDKSNO (internal manufacturer cross reference)

Reference voltage threshold for knock sensor diagnosis - Upper Limit

	Engine Speed ( rpm )															
	400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800	5200	5600	6000	6400
Peak RMS Voltage ( V )	1.450	1.450	1.459	1.577	1.906	2.121	2.574	3.049	3.826	4.751	5.149	6.193	8.661	11.513	11.539	11.686

P0442

### KFEONVPT (internal manufacturer cross reference)

Vacuum / Pressure Threshold for Fuel Tank Leak Detection

Vacuum / Pressure (hPa)	Ambient Temperature (Model) (C)									
Fuel Level (%)	-2.3	2.3	6	9.8	14.3	18	21.8	26.3	30	33.8
5	8.60	9.20	9.80	10.40	11.00	11.60	12.20	12.80	13.40	14.00
14	8.46	9.02	9.58	10.14	10.70	11.26	11.82	12.38	12.94	13.50
23	8.32	8.84	9.36	9.88	10.40	10.92	11.44	11.96	12.48	13.00
32	8.18	8.66	9.14	9.62	10.10	10.58	11.06	11.54	12.02	12.50
41	8.04	8.48	8.92	9.36	9.80	10.24	10.68	11.12	11.56	12.00
50	7.90	8.30	8.70	9.10	9.50	9.90	10.30	10.70	11.10	11.50
59	7.76	8.12	8.48	8.84	9.20	9.56	9.92	10.28	10.64	11.00
68	7.62	7.94	8.26	8.58	8.90	9.22	9.54	9.86	10.18	10.50
77	7.48	7.76	8.04	8.32	8.60	8.88	9.16	9.44	9.72	10.00
86	7.34	7.58	7.82	8.06	8.30	8.54	8.78	9.02	9.26	9.50
95	7.20	7.40	7.60	7.80	8.00	8.20	8.40	8.60	8.80	9.00

Tank Capacity 65.8 Liters

Vacuum / Pressure (Pa)	Ambient Temperature (Model) (C)									
Fuel Level (%)	-2.3	2.3	6	9.8	14.3	18	21.8	26.3	30	33.8
5	860	920	980	1040	1100	1160	1220	1280	1340	1400
14	846	902	958	1014	1070	1126	1182	1238	1294	1350
23	832	884	936	988	1040	1092	1144	1196	1248	1300
32	818	866	914	962	1010	1058	1106	1154	1202	1250
41	804	848	892	936	980	1024	1068	1112	1156	1200
50	790	830	870	910	950	990	1030	1070	1110	1150
59	776	812	848	884	920	956	992	1028	1064	1100
68	762	794	826	858	890	922	954	986	1018	1050
77	748	776	804	832	860	888	916	944	972	1000

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86	734	758	782	806	830	854	878	902	926	950
95	720	740	760	780	800	820	840	860	880	900

P0455

**KLGGRTED05** (internal manufacturer cross reference)

**Vacuum Gradient Threshold for Fuel Tank Leak Detection**

Fuel Level liters	0	10	20	30	40	45	50	55	60	70
hPa / sec	0.20	0.22	0.24	0.26	0.28	0.29	0.30	0.31	0.32	0.34
Tank Capacity		65.8 Liters								
Fuel Level ( % )	0	15.2	30.4	45.6	60.8	68.4	76.0	83.6	91.2	106.4
Pa / sec	20	22	24	26	28	29	30	31	32	34

P2101

**DWDKSBAMX** (internal manufacturer cross reference)

**Maximum Throttle Angle Deviation per computation cycle**

	Percent Throttle Opening ( % )				
	0	0.3	1	5	15
Percent Throttle Delta ( % )	4	6	11	20	50

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P0101

**KFMLDMN** (internal manufacturer cross reference)

**Mass Air Flow Threshold - Minimum**

Mass Air Flow ( kg / h )	Percent Throttle ( % )							
Engine Speed (rpm)	2	6	12	20	30	45	60	90
320	0	0	0	0	0	0	0	0
560	2.2	4.2	12.5	14.7	14.9	18.9	19.6	21.8
1000	3.2	5.2	17.7	25.2	29.7	32.4	33	36.1
1520	4	6.1	19.1	41.3	58.6	64.9	67.9	74.1
2000	4.2	6.2	19.1	49.4	77.2	85.9	90.5	97.1
3000	9	7.2	19.6	54	103.7	120	126.6	134.8
4000	12	10.2	21.5	54.9	115.1	145.9	167.2	176.8
5000	13	11	22.1	57.1	130.3	184.5	220.7	234
6000	15	14	22.8	55.2	138.1	206.3	238.2	264.1

Mass Air Flow ( g / sec )	Percent Throttle ( % )							
Engine Speed (rpm)	2	5	15	25	40	50	60	100
320	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
560	0.6	1.2	3.5	4.1	4.1	5.3	5.4	6.1
1000	0.9	1.4	4.9	7.0	8.3	9.0	9.2	10.0
1520	1.1	1.7	5.3	11.5	16.3	18.0	18.9	20.6
2000	1.2	1.7	5.3	13.7	21.4	23.9	25.1	27.0
3000	2.5	2.0	5.4	15.0	28.8	33.3	35.2	37.4
4000	3.3	2.8	6.0	15.3	32.0	40.5	46.4	49.1

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5000	3.6	3.1	6.1	15.9	36.2	51.3	61.3	65.0
6000	4.2	3.9	6.3	15.3	38.4	57.3	66.2	73.4

P0101

**KFM LDMX** (internal manufacturer cross reference)

**Mass Air Flow Threshold - Maximum**

Mass Air Flow ( kg / h )	Percent Throttle ( % )							
Engine Speed (rpm)	2	6	12	20	30	45	60	90
320	300	300	300	300	300	300	300	300
560	44	61.4	81.3	84.5	86.2	92.5	92.5	92.5
1000	50	68.2	103.2	120.8	129.7	132.6	131.6	131.6
1520	71	71.9	125.9	188	226.2	236.5	238.8	240.1
2000	73.1	73.1	136.7	226.2	288.3	303.5	307.9	307.9
3000	75	75	147.3	268	372.9	421.8	440.2	450.2
4000	77	77.1	153	294.1	435.7	507.1	571.9	593.4
5000	79	79	161.9	311.1	486.9	608.6	691.4	732.4
6000	91.3	91.3	167.2	329	539.2	721.5	792.2	873.6

Mass Air Flow ( g / sec )	Percent Throttle ( % )							
Engine Speed (rpm)	2	5	15	25	40	50	60	100
320	83.3	83.3	83.3	83.3	83.3	83.3	83.3	83.3
560	12.2	17.1	22.6	23.5	23.9	25.7	25.7	25.7
1000	13.9	18.9	28.7	33.6	36.0	36.8	36.6	36.6
1520	19.7	20.0	35.0	52.2	62.8	65.7	66.3	66.7
2000	20.3	20.3	38.0	62.8	80.1	84.3	85.5	85.5
3000	20.8	20.8	40.9	74.4	103.6	117.2	122.3	125.1
4000	21.4	21.4	42.5	81.7	121.0	140.9	158.9	164.8
5000	21.9	21.9	45.0	86.4	135.3	169.1	192.1	203.4
6000	25.4	25.4	46.4	91.4	149.8	200.4	220.1	242.7

P0141

**KFRINH** (internal manufacturer cross reference)

**Sensor Element (Ceramic) Impedance, Nominal Value - Secondary O2 Sensor**

Ohms	Modeled Exhaust Gas Temperature at Secondary O2 Sensor ( ° C )				
O2 Heater Power (watts)	200	300	400	500	600
0.7	304	240	200	152	144
0.8	224	184	160	128	120
1.0	128	104	96	96	88

**FRINH1** (internal manufacturer cross reference)

**Multiplication Factor for Internal Resistance KFRINH Nominal Value - Secondary O2 Sensor**

	Modeled Exhaust Gas Temperature at Secondary O2 Sensor ( ° C )				
	200	300	400	500	600
factor	7.50	3.25	2.75	2.75	2.75

P0324

**DKROFN** (internal manufacturer cross reference)

**Voltage Gradient Limit of Knock Sensor Integrator Rise for zero test**

	Test Period ( microseconds )					
	1000	1500	2000	3000	4000	5000
Voltage Rise ( V / sec )	60.0	50.0	45.0	40.0	40.0	40.0

	Test Period ( sec )					
	0.001	0.0015	0.002	0.003	0.004	0.005
Voltage Rise ( V / sec )	60.0	50.0	45.0	40.0	40.0	40.0



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P0327, P0332

UDKSNU (internal manufacturer cross reference)

**Reference voltage threshold for knock sensor diagnosis - Lower Limit**

	Engine Speed ( rpm )															
	400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800	5200	5600	6000	6400
Peak RMS Voltage ( V )	0.53	0.53	0.53	0.57	0.66	0.74	0.90	1.00	1.09	1.19	1.31	1.50	1.76	1.99	2.25	2.25

P0328, P0333

UDKSNO (internal manufacturer cross reference)

**Reference voltage threshold for knock sensor diagnosis - Upper Limit**

	Engine Speed ( rpm )															
	400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800	5200	5600	6000	6400
Peak RMS Voltage ( V )	24	24	24	24	24	24	26	37	39	50	60	69	82	89	97	97

P0420

KFOSCKTD (internal manufacturer cross reference)

**Oxygen Storage Capacity of Borderline Catalyst**

	Modeled Exhaust Gas Temperature in Catalyst ( ° C )								
Mass Flow in Catalyst (kg/h)	450	480	510	540	560	590	620	650	
20	120	135	150	150	150	150	150	150	
40	120	135	150	150	150	150	150	150	
60	115	145	150	155	155	155	155	155	
80	100	120	130	140	150	150	150	150	
100	90	103	109	117	120	127	137	137	
120	90	90	90	115	120	122	122	122	
140	90	90	90	100	115	117	120	120	
160	90	90	90	95	98	105	115	120	

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P0442

**KFEONVPT** (internal manufacturer cross reference)  
**Vacuum / Pressure Threshold for Fuel Tank Leak Detection**

Vacuum / Pressure (hPa)	Ambient Temperature (Model) (C)										
Fuel Level (%)	-2	2	6	10	14	18	22	26	30	34	
5	8.60	9.20	9.80	10.40	11.00	11.60	12.20	12.80	13.40	14.00	
14	8.46	9.02	9.58	10.14	10.70	11.26	11.82	12.38	12.94	13.50	
23	8.32	8.84	9.36	9.88	10.40	10.92	11.44	11.96	12.48	13.00	
32	8.18	8.66	9.14	9.62	10.10	10.58	11.06	11.54	12.02	12.50	
41	8.04	8.48	8.92	9.36	9.80	10.24	10.68	11.12	11.56	12.00	
50	7.90	8.30	8.70	9.10	9.50	9.90	10.30	10.70	11.10	11.50	
59	7.76	8.12	8.48	8.84	9.20	9.56	9.92	10.28	10.64	11.00	
68	7.62	7.94	8.26	8.58	8.90	9.22	9.54	9.86	10.18	10.50	
77	7.48	7.76	8.04	8.32	8.60	8.88	9.16	9.44	9.72	10.00	
86	7.34	7.58	7.82	8.06	8.30	8.54	8.78	9.02	9.26	9.50	
95	7.20	7.40	7.60	7.80	8.00	8.20	8.40	8.60	8.80	9.00	

Tank Capacity 65.8 Liters

Vacuum / Pressure (Pa)	Ambient Temperature (Model) (C)										
Fuel Level (%)	-2	2	6	10	14	18	22	26	30	34	
5	860.0	920.0	980.0	1040.0	1100.0	1160.0	1220.0	1280.0	1340.0	1400.0	
14	845.9	902.0	958.0	1014.0	1069.9	1126.0	1182.0	1238.0	1293.9	1350.0	
23	832.0	884.0	936.0	988.0	1040.0	1092.0	1144.0	1196.0	1248.0	1300.0	
32	818.0	866.0	913.9	962.0	1010.0	1058.0	1106.0	1154.1	1202.0	1250.0	
41	804.0	848.0	892.0	936.0	980.0	1024.0	1068.0	1112.1	1156.0	1200.0	
50	790.0	830.0	870.0	910.0	950.0	990.0	1030.0	1069.9	1110.0	1150.0	
59	776.0	812.0	848.0	884.0	920.0	956.1	991.9	1028.0	1064.0	1100.0	
68	762.0	793.9	826.0	858.0	890.0	922.0	954.0	986.0	1017.9	1050.0	
77	748.0	776.0	804.0	832.0	860.0	887.9	916.0	944.0	972.0	1000.0	
86	734.0	758.1	782.0	806.0	830.0	854.0	878.1	902.0	926.0	950.0	
95	720.0	740.0	760.0	780.0	800.0	819.9	840.0	860.0	880.0	900.0	

P0455

**KLGGRTED05** (internal manufacturer cross reference)  
**Vacuum Gradient Threshold for Fuel Tank Leak Detection**

Fuel Level liters	0	10	20	30	40	50	60	70	75	80
hPa / sec	0.300	0.350	0.400	0.450	0.500	0.550	0.600	0.650	0.675	0.700

Tank Capacity 65 Liters

Fuel Level ( % )	0	15.4	30.8	46.2	61.5	76.9	92.3	107.7	115.4	123.1
Pa / sec	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	67.5	70.0

P2101

**DWDKSBAMX** (internal manufacturer cross reference)  
**Maximum Throttle Angle Deviation per computation cycle**

	Percent Throttle Opening ( % )				
	0	0.3	1	5	15
Percent Throttle Delta ( % )	4	6	11	20	50

P2231

**KLSDULSUN** (internal manufacturer cross reference)  
**Sensor Voltage Delta Down Threshold - Maximum per Computation Cycle**

	Battery Voltage ( V )			
	11	13	15	17
Delta Voltage ( V )	-0.200	-0.200	-0.298	-0.498

**KLSDULSUP** (internal manufacturer cross reference)  
**Sensor Voltage Delta Up Threshold - Maximum per Computation Cycle**

	Battery Voltage ( V )			
	11	13	15	17
Delta Voltage ( V )	0.200	0.200	0.300	0.500

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KFUSHK

Target Rear Voltage for Downstream Lambda Control

	Engine Speed ( rpm )					
Volumetric Efficiency (%)	800	1200	1600	2000	3000	4000
9.75	0.6502	0.6397	0.6241	0.6189	0.6084	0.6032
22.50	0.6449	0.6345	0.6189	0.6136	0.6084	0.6032
37.50	0.6293	0.6189	0.6084	0.6032	0.5980	0.5928
60.00	0.6032	0.6032	0.6032	0.5928	0.5876	0.5824
75.00	0.5928	0.5876	0.5876	0.5824	0.5771	0.5719
97.50	0.5928	0.5876	0.5876	0.5824	0.5771	0.5719