CM2150 MR07 Controls Troubleshooting Guide Using CALTERMIII

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Please Forward Suggestions For Improvement To:
April Rinker

Overview: This document is intended to support on-site troubleshooting and diagnostics of customer complaints for **2007 Medium-Duty engine platforms** with the **CM2150 Controls System**. This document can be used along with CaltermIII for investigation, troubleshooting, and diagnosis of engine performance and electronic controls related issues.

Purpose: This document provides electronic controls troubleshooting information to those in the field as well as those based in Cummins engineering facilities. With Calterm, documentation of data within this document will provide more detailed definition of engine conditions associated with specific issues. This information, along with drive comments and concerns, will help in achieving a better responsiveness to customer needs an d allow us to develop products which meet or exceed customer expectations.

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TROUBLESHOOTING AND DIAGNOSTICS PARAMETER GUIDE INDEX

THE FOLLOWING INDEX IDENTIFIES CURRENTLY AVAILABLE TEST PARAMETERS

For: Engine Platforms Evolution '07 and Gryphon '07

	2007 CM2150 Controls Algorithm Diagnostics		System Diagnostics
1.	Charge Flow Derates	1.	Acceleration Noise Control
2.	Charge Manager	2.	Ambient Air Pressure Sensor – Poor Engine Performance
3.	Chi Strategy	3.	Clutch Engagement / Idle Overshoot
4.	Combustion Management System	4.	Cold Temp Stumble / IMT SOI Advance Control
5.	EGR Delta P Sensor Diagnostics	5.	Cruise Control - Autoresume
6.	EGR Fraction and Mass Charge Flow Determination	6.	Cruise Control - Engine Brakes
7.	EGR OFF Conditions	7.	Cruise Control - Highway Cruise Strategy Data Collection
8.	EGR Valve Controller	8.	Cruise Control - Switch Diagnostics
9.	EGR Valve Motor Diagnostics	9.	Cruise Control / Road Speed / Geardown Governors
10.	Emissions Manager	10.	Datalink Torque Calculation
11.	Emissions Manager - Compensate for Off-Nominal Emission Conditions	11.	Duty Cycle Logging Of Route
12.	Engine Brakes – Charge Flow Commanded Torque	12.	ECM Trip Info / Fuel Economy Accuracy
13.	Engine Torque Determination	13.	Engine Brake Activation Delay - Stationary Test
14	EPD (Engine Protection Derate	14.	Engine Braking
15	Fueling Determination	15.	Fan Control
16	Engine Fuel vs Engine Torque	16.	Fan Drive Activation
17	NDOT Governor	17.	FSSC: Cylinder Cut-Out
	Low Speed Idle	18.	High Speed Idle Stability
	Accelerator Based Torque	19.	J1939 Devices / J1939 Transmissions
	Accelerator Based Speed	20.	Low Power – Boost Response Test
	High Speed Idle	21.	Low Power – Geardown Protection
	Cruise Control Governor	22.	Low Power – Road Speed Control
	Road Speed Control	23.	Mission Data (fast data log)
	Power Takeoff (PTO) Governor	24.	Mission Data (slow data log)
18	OFC Fuel Limit	25.	No Load Friction / Light Load Throttle
19	SOI Timing Determination (SOI Advance)	26.	PTO Response
20	Thermal Managment/Aftertreatment	27.	Road Speed Control / Cruise Control Hiccup/Miss
21	TGC Controller	28.	Rough Idle
22	Torque Management	29.	Starter Lockout
23	VGT Electronic Controller	30.	Starting - Cold
		31.	Starting - Hard start / Startup and Overshoot
		32.	Stumble During Rapid Accel (OFC Limitation)
		33.	Throttle Characterization / Idle Validation Switches
		34.	Throttle Control – ABS
		35.	Throttle Control – ABT
		36.	Turbo Surge

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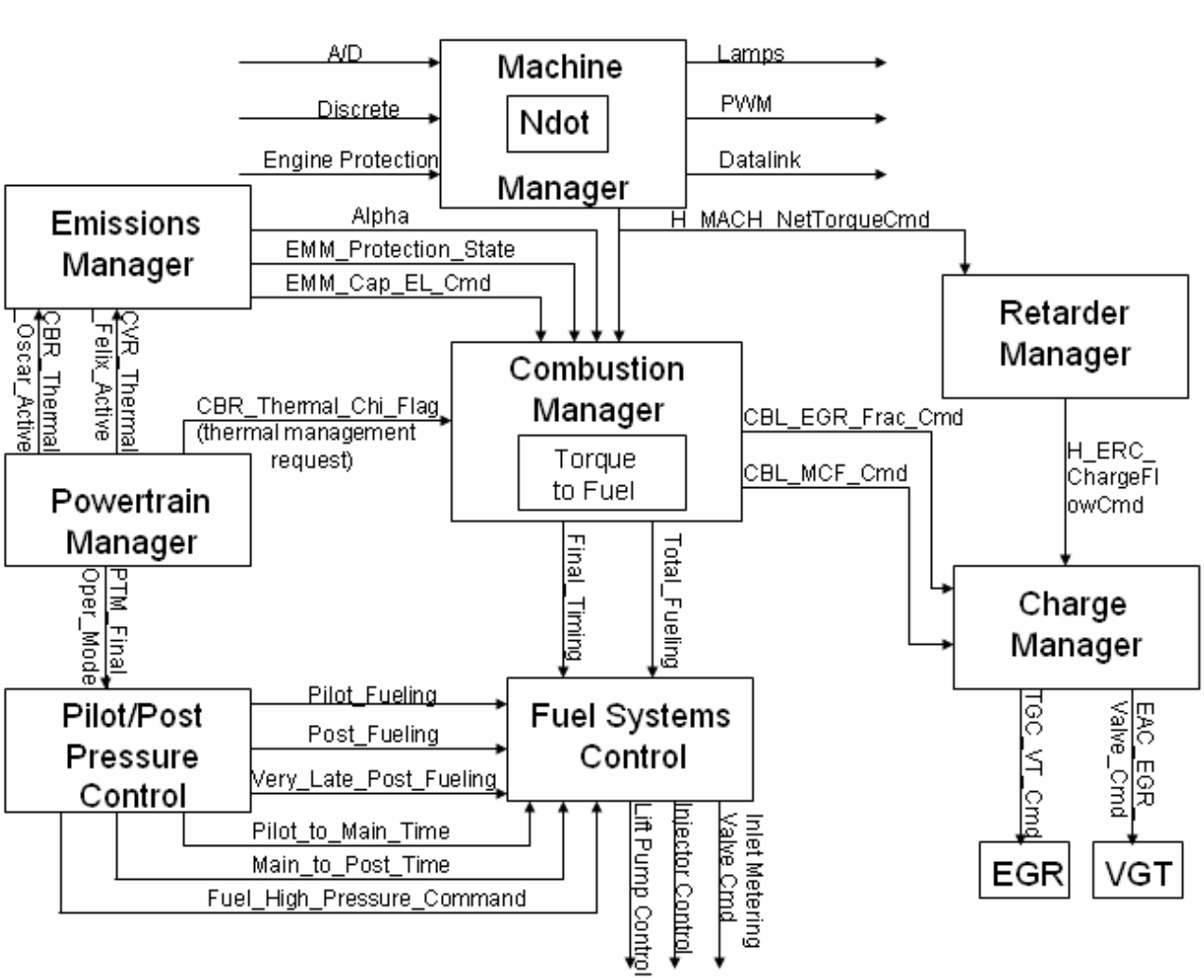
CM2150 CONTROL SYSTEM OVERVIEW



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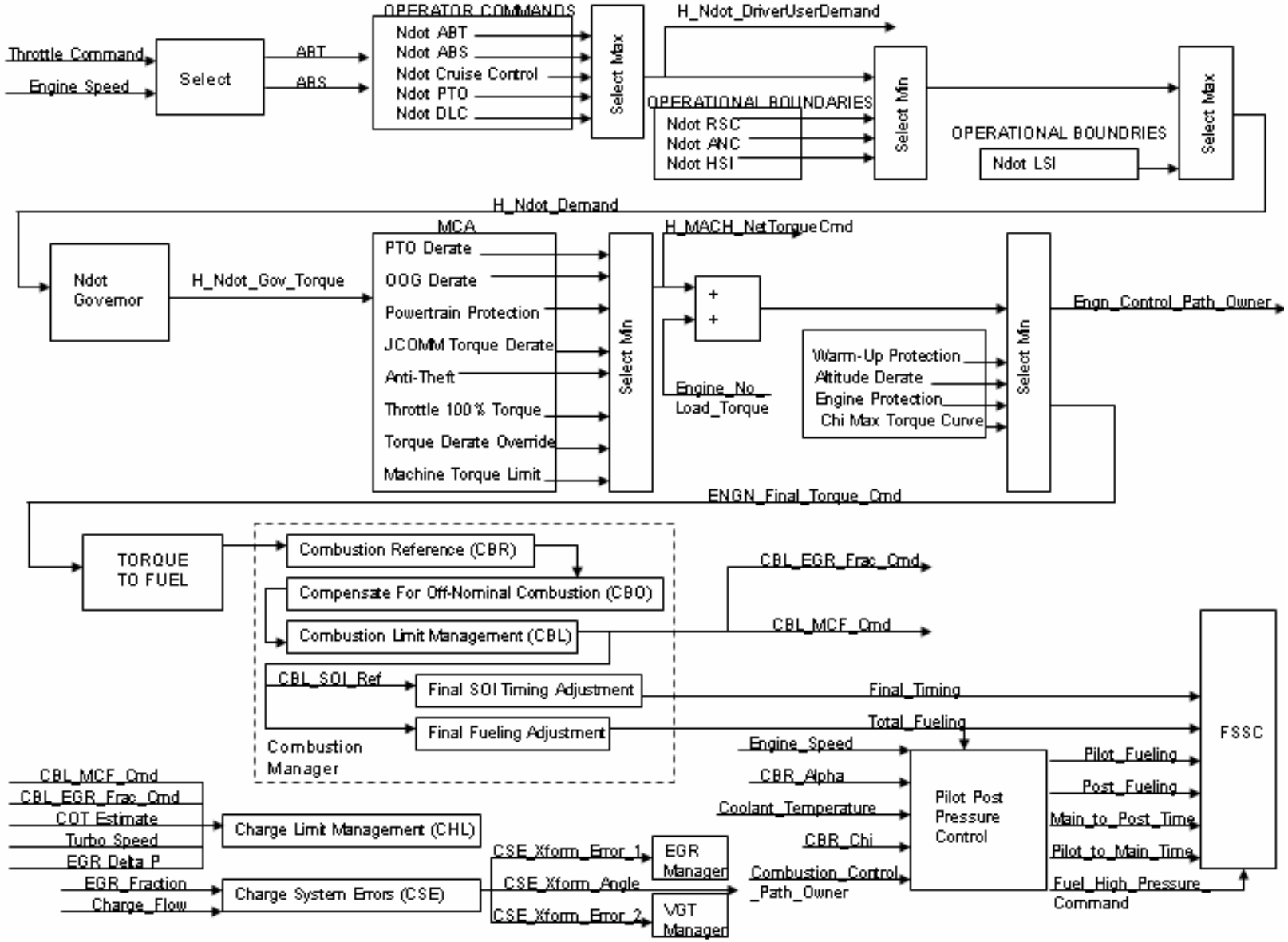
Ndot / Air Handling Overview



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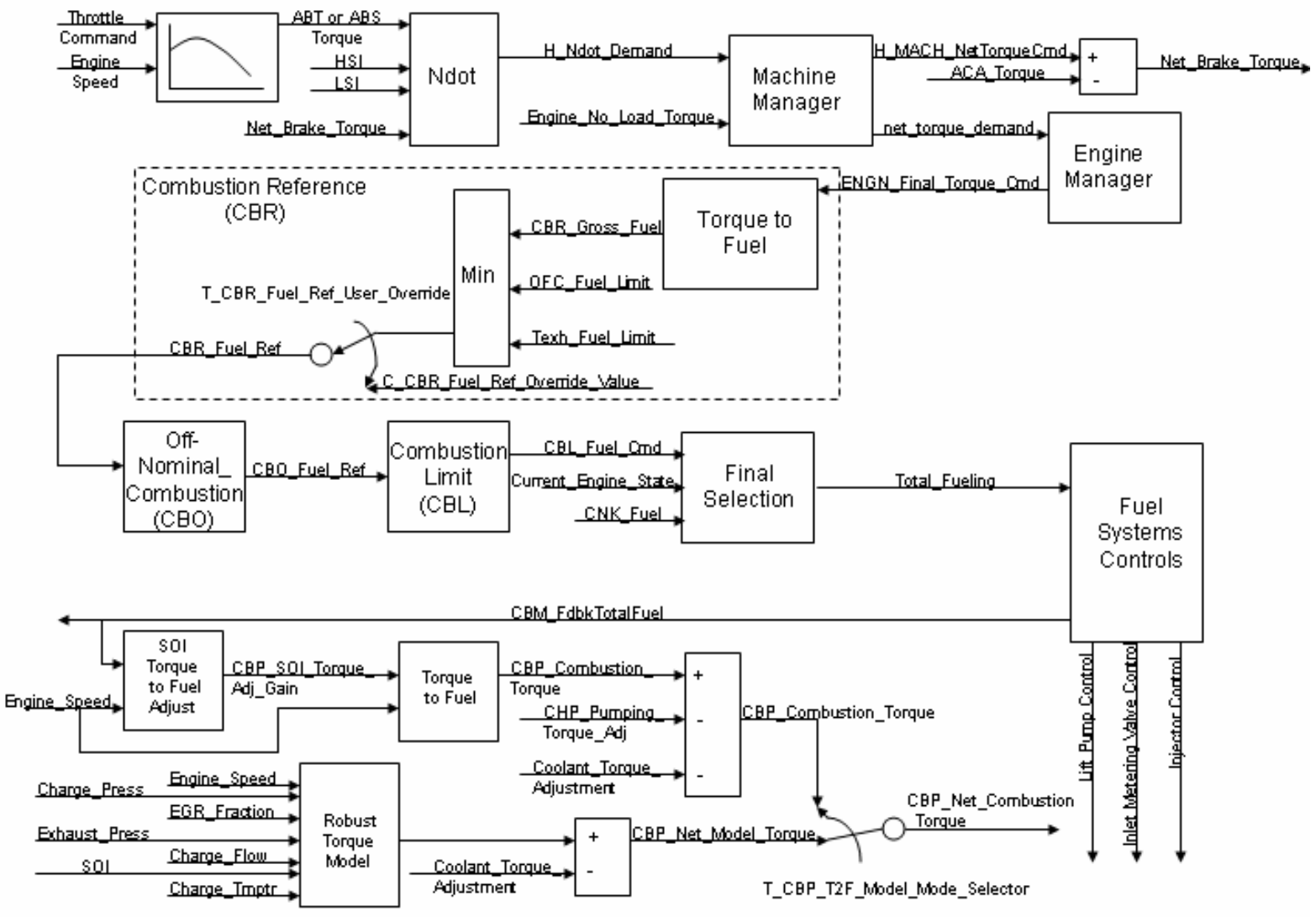
Torque to Fuel / Fuel to Torque Determination



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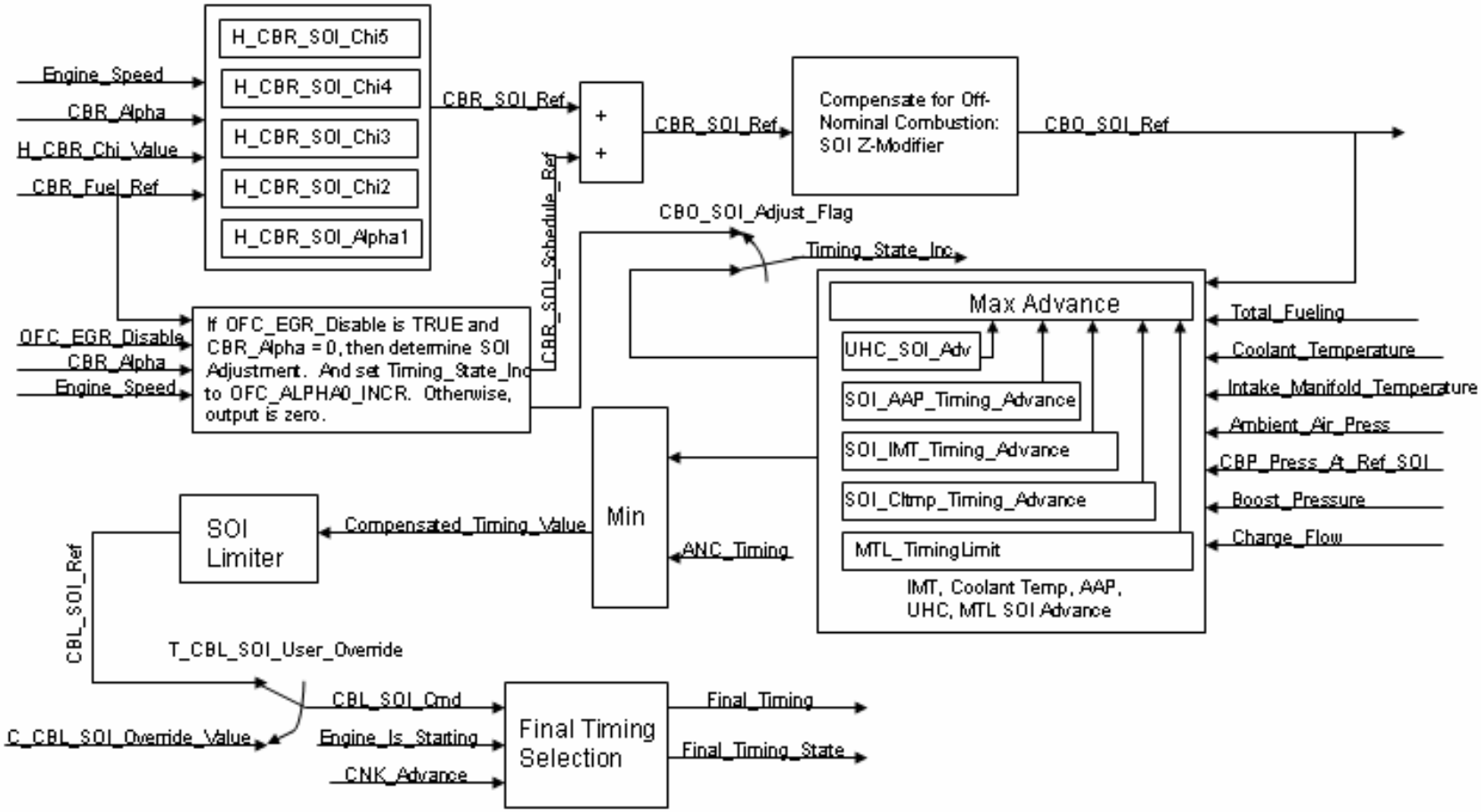
SOI Timing Determination



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CM2150 PARAMETER DATA DICTIONARY

BASIC ENGINE PARAMETERS

Alpha	ALPHA PARAMETER 0.0 = URBAN 1.0 = OPEN ROAD
Accelerator_Pedal_Position	Provides a measure of accelerator pedal position after all processing is completed
Ambient_Air_Press	Ambient_Air_Press
Battery_Voltage	Final linearized and filtered value for the battery voltage
APC_hp_Cmd	Accum press cmd used by the fuel system
APC_hp_Fdbk	Accumulator Pressure Feedback
CBP_Combustion_Torque	Gross_Engine_Torque from a fuel to torque conversion of Final_Fueling
Charge_Flow	Charge_Flow virtual sensor value
Combustion_Control_Path_Owner	Indicates the ID of the of the current final selected combustion command
Compressor_Outlet_Tmptr	Compressor_Outlet_Temperature after all post-processing
EAC_EGR_Valve_Cmd	EGR valve position command from staged EGR/Assist output
EGR_Delta_Press	Linearized and filtered EGR Delta P measurement
EGR_Flow	EGR_Flow virtual sensor value
EGR_Fraction	Charge Mgr demanded EGR fraction after limiters
EGR_Position	EGR_Position
EMM_AECD_State	16-bit indicator of which AECDs are active in the emissions manager
Engine_Speed	Variable 2^n pulse averaged and filtered engine speed
Engn_Actual_State	The state of the engine
Filtered_Gear_Ratio	First-order filtered value with input H_GEAR_FilteredRawGearRatio.
Filtered_Turbo_Speed	Turbo speed after filtering
Final_Timing	Timing Advance Value calculated by CORE
Final_Timing_State	Timing State for crank SOI or CBL_SOI_Adv
H_CBR_Chi_Value	Scalar indication of ambient environment combustion strategy
H_NDOT_Demand	Final selected Ndot Demand
NDOT_PathOwner	Indicates ID of the selected Ndot reference being controlled by Ndot Governor.
Ndot_Net_Torque_Cmd	Ndot_Net_Torque_Cmd is the final output of the Ndot governor
Net_Engine_Torque	Net engine torque
No_Load_Torque	Engine no load torque
SOI	Start of injection. Timing advance used by each modification feature as I/O
SOI_Timing_Advance	Max SOI advance chosen by this algorithm
Total_Fueling	Desired Total Fueling (Pilot+Main+Post)
V_SFR_Regen_Stage	Generated regeneration stage value
VGT_Position	VGT Position
Engine Start-up / Cranking	
CNK_Advance	Final timing advance under cranking conditions
CNK_ExitAdv	CRANK EXIT ADVANCE
CNK_ExitFuelAdj	CRANK EXIT FUEL ADJUSTMENT
CNK_ExitSpd	Exit RPM for crank routine
CNK_ExitTimer	CRANK EXIT TIMER
CNK_Fuel	FINAL FUEL OUTPUTED BY CRANK
CNK_JumpstartTimer	timer used to dictate a jumpstart condition
CNK_ReentrySpeed	re-entry RPM for crank routine
CNK_ExitAdv	CRANK EXIT ADVANCE
Throttle Command	
Accelerator_Pedal_Position	Provides a measure of accelerator pedal position after all processing
Primary_Accel_Ped_Pos	Provides a measure of accelerator pedal position after all processing
T_Dual_Accelerator_Enable	This is a required parameter which indicates to the tool whether the Dual Accelerator feature is enabled or disabled.
Secondary_Accel_Pedal_Pos	Secondary Accelerator Pedal Position after all processing (auto_zero, filter etc..) is completed
T_AIP_APP2_Ovrd_Enable	When set to 1, the H_AIP_APP2_User_Ovrd_Val value shall be used instead of the calculated secondary accelerator pedal position.
H_AIP_APP2_User_Ovrd_Val	Override value for Secondary Accelerator Pedal Position.
AIP_AccPd_User_Ovrd_Val	Override value for Accelerator_Pedal_Position
T_AIP_Accelerator_Ovrd_En	When set to 1, the AIP_Accelerator_Ovrd_Val value will be used instead of the calculated accelerator pedal position.
Idle_Validation_State	Indicate the state of the idle validation switches 0 = _NOT_IDLE 1 = _IDLE 2 = _NOT_SUPPORTED

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	3 = _ERROR
T_ABT_User_Selected_Acctr_Ctrl	This parameter determines whether the accelerator pedal will drive the production of a torque request (parameter==0), in the manner of a torque governor, or an acceleration request (parameter==1), in the manner of an All Speed Governor.

A/D SENSORS

Accumulator_Pressure	Accumulator Pressure from fixed rate processing. Samples on time based frequency. Use this unless need firing frequency.
APC_hp_Fdbk	Fuel_Rail_Pressure raw value linearized and filtered....Same as Accumulator_Pressure but samples by firing frequency.
Ambient_Air_Press	Ambient_Air_Pressure raw value linearized and filtered
Ambient_Air_Tmptr	Ambient Air Temperature raw value linearized and filtered
Battery_Voltage	Battery voltage raw value linearized and filtered. Internal to ECM.
Charge_Press	Value of Charge Pressure
Coolant_Level	Coolant level raw value linearized and filtered. True indicates coolant level is normal
Coolant_Temperature	Coolant_Temperature raw value linearized and filtered
EGR_Delta_Press	Linearized and filtered EGR Delta P measurement
EGR_Orifice_Tmptr	EGR_Orifice_Temperature raw value linearized and filtered
EGR_Position	EGR_Position raw value linearized
Exhaust_Press_Sensor	Exhaust Pressure raw value linearized and filtered
Fuel_Temperature	Fuel_Temperature raw value linearized and filtered
Intake_Manifold_Temperature	The linearized and filtered analog value for the intake manifold temperature
OEM_Pressure	OEM_Pressure value linearized and filtered (in CNTS)
OEM_Temperature	OEM_Temperature value linearized and filtered (in CNTS)
Oil_Pressure_Absolute	Oil_Pressure raw value linearized and filtered
Primary_Accel_Ped_Pos	Provides a measure of accelerator pedal position after all processing
Sensor_Supply_1_Voltage	Sensor_Supply_1_Voltage raw value linearized and filtered. AKA: Cat DeltaP, Remote Throttle, OEM Pressure, PPS2
Sensor_Supply_2_Voltage	Sensor_Supply_2_Voltage raw value linearized and filtered. AKA: PPS1
Sensor_Supply_3_Voltage	Sensor_Supply_3_Voltage raw value linearized and filtered. AKA: Amb Air Press, Amb Air Temp, Fuel Rail Press, Crank Case Press, Exhaust Manifold Press, Intake Manifold Press
Sensor_Supply_4_Voltage	Sensor_Supply_4_Voltage raw value linearized and filtered.
VGT_Position	VGT position
Accelerator_Supply_Voltage	Linearized voltage count of Accelerator Pedal Position supply
EEM_WIFState	This is indication of Water in Fuel is detected or no water detected in the system.

VIRTUAL SENSORS

Boost_Pressure	Gage value of linearized and filtered Charge Press.
Charge_Flow	Charge_Flow virtual sensor value
CHP_Predicted_IMT	Predicted IMT with EGR
Compressor_Inlet_Pressure	Compressor_Inlet_Pressure raw value linearized and filtered
Compressor_Inlet_Density	Current density of air at compressor inlet
Compressor_Outlet_Tmptr	Compressor_Outlet_Temperature raw value linearized and filtered
Coolant_Torque_Adjustment	Friction torque adjustment due to coolant temperature
EGR_Delta_Press	Linearized and filtered EGR Delta P measurement
EGR_Flow	EGR_Flow virtual sensor value
EGR_Fraction	Charge Mgr demanded EGR fraction after limiters
EGR_Position	EGR_Position raw value linearized
Turbo_Speed_Est	Estimation of turbo speed
Exhaust_Tmptr	Exhaust Temperature virtual sensor value
Fresh_Air_Flow	Fresh_Air_Flow virtual sensor value
Friction_Torque	Engine friction torque at current speed and normal engine temperatures
CBP_Combustion_Torque	Engine Torque from CBP_Adj_Total_Fueling & Engine_Speed
Net_Engine_Torque	Actual engine torque available to run all machine loads
Engine_No_Load_Torque	The amount of torque required to overcome frictional and pumping losses of the engine.
Oil_Pressure	The linearized and filtered analog oil pressure.
CHP_Pumping_Torque_Adj	Engine Pumping Torque based on engine delta pressure

ENGINEERING USER OVERRIDE ENABLES

Base Engine Controls:

C_AIF_AlphaAltDerateOvrEn	Enables altitude derate override logic in the alpha feature
C_AIF_AlphaEngProtOverrideEn	Parameter set true to enable alpha override selection based on engine protection limiting of torque or speed requests
C_AIF_AlphaUserOverrideEn	Parameter set true to enable alpha override selection
AIF_AlphaOverrideValue	Value of alpha desired by engineering applications
T_AIP_AMB_User_Override_En	Trim to enable the user override of Ambient_Air_Press.

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AIP_AMB_User_Override_Value	This is the value which replaces Ambient_Air_Press when the user enables the override.
T_AMB_Amb_Tmptr_User_Override	Ambient temperature user override enable trim: 0=FALSE
AIP_OEMAirTmptrOverrideVal	This is the value which replaces Ambient_Air_Press when the user enables the override.
C_SOI_AmbAirPrsAdvEn	Set true to enable ambient air pressure timing advance
T_AIP_Charge_Press_User_Ovrd_En	This enable allows the global value of Charge_Press to be set to AIP_Charge_Press_Override_Value
C_AIP_Charge_Press_Ovrd_Value	Charge_Press override value when T_AIP_Charge_Press_User_Ovrd_En is set
C_SOI_CltAdvEn	Set true to enable coolant timing advance
T_AIP_CT_User_Override	This cal if enabled will allow for the global value of Coolant_Temperature to be manaully assigned
AIP_Cool_Tmptr_Override_Value	This will replace the value of Coolant_Temperature if the override is enabled.
T_AIP_EGRDeltaPress_Ovrd_En	This enable allows the global value of EGR Delta Pressure to be set to C_AIP_EGRDeltaPress_Ovrd_Val
C_AIP_EGRDeltaPress_Ovrd_Val	EGR Delta Pressure user override value when T_AIP_EGRDeltaPress_Ovrd_En is set
T_AIP_EGROrificeTmptr_Ovrd_En	This enable allows the global value of EGR_Orifice_Tmptr to be set to C_AIP_ExhaustPress_Ovrd_Val
C_AIP_ExhaustPress_Ovrd_Val	Exhaust Pressure user override value when T_AIP_ExhaustPress_Ovrd_En is set.
T_EPD_Shutdown_Override_En	This trim, when enabled, allows the operator to override Engine Protection shutdown
DIP_Shutdwn_Ovrd_User_Ovrd_Val	Override value written to EPF_Shutdown_Override_Switch
H_EPS_s_UserOverrideSpeedEnable	Enable (=1) / Disable (=0) user override of Engine_Speed & EPS_Engine_Avg_Speed
H_EPS_n_UserOverrideSpeedValue	User override value for Engine_Speed & EPS_Engine_Avg_Speed
C_AIP_ExhaustPress_Ovrd_Val	Exhaust Pressure user override value when T_AIP_ExhaustPress_Ovrd_En is set.
T_AIP_ExhaustPress_Ovrd_En	This enable allows the global value of Exhaust_Press to be set to C_AIP_ExhaustPress_Ovrd_Val
C_FSI_s_FuelSupPrsUserOverrideEnable	enable user override value instead of normal processing
H_FSI_lp_FuelSupPrsOverrideValue	Fuel Supply Press user override value
C_FSI_s_FuelTempUserOverrideEnable	enable user override value instead of normal processing
H_FSI_t_FuelTempOverrideValue	Fuel Temperature user override value
C_SOI_IMTAdvEn	Set true to enable imt soi timing advance
T_DIP_Manual_Fan_User_Ovrd_En	Enables Override of the Manual Fan Input when enabled.
DIP_Manual_Fan_User_Ovrd_Val	Override used for Manual Fan Input switch when T_DIP_Manual_Fan_User_Ovrd_En is set to 1.
T_AIP_OP_User_Override	Override value for Absolute Oil Pressure sensor
AIP_Oil_Press_Override_Value	This will be the new value of Oil_Pressure if the override is enabled
T_AIP_OT_User_Override	This cal if enabled will allow for the global value of Oil_Temperature to be manaully assigned to AIP_Oil_Tmptr_Override_Value
AIP_Oil_Tmptr_Override_Value	This will replace the value of Oil_Temperature if the override is enabled.
T_VGA_DL_Cmd_User_Override	Enable for VGT position command C_VGA_DL_Cmd_Override_Value
C_VGA_DL_Cmd_Override_Value	VGT Position Command Override Value
T_Test_Cell_Throt_En	Test cell throttle switch override enable. When set to 1, the local auto_zero value is set to C_ACD_Test_Cell_Auto_Zero.
C_EPD_Derate_Suppress_En	This calibration will suppress all speed and torque derates when enabled.
T_Torque_Derate_Override_Enable	This is a flag which enables the torque derate override feature.
T_Turbo_Speed_Override	Override value for Turbo Speed sensor
T_Turbo_Speed_Override_Enable	Turbo speed override enable
T_CBL_Fuel_User_Override	Fueling user override in CLM algorithm before advance FS Control
C_CBL_Fuel_Override_Value	Fueling override value in CBL algorithm before Cranking or Advanced FS Control
T_CBL_SOI_User_Override	SOI user override in CBL algorithm before Cranking or Advanced FS Control
C_CBL_SOI_Override_Value	SOI override value in CBL algorithm before Cranking or Advanced FS Control
EGR Valve Control (EGA):	
T_EGA_Cmd_User_Override	EGR position Command override Enable for the egr valve controller
C_EGA_Cmd_Override_Value	EGA position cmd user override value
T_EGA_PWM_User_Override	EGR position Command override Enable for the egr valve controller
C_EGA_PWM_Override_Value	EGA PWM duty cycle user override value
VG Turbocharger (VGT):	
VGT_Actuator_Type	Indicates to the tool the type of VGT Actuator (electronic or pneumatic)
T_Turbo_Speed_Override_Enable	Turbo speed override enable
T_Turbo_Speed_Override	Turbo speed override value
T_VGA_DL_Cmd_User_Override	Enable for VGT position command C_VGA_DL_Cmd_Override_Value
C_VGA_DL_Cmd_Override_Value	VGT Position Command Override Value
VGA_DL_Mode_Command	VGT Actuator Operating Mode Command.
Aftertreatment	
V_SFP_mg_Soot_Load_Comb	Combined soot load estimate
C_SFP_Soot_Load_User_Reset_Val	Reset soot load for CBSLE
C_SFP_Soot_Load_User_Reset_En	Enable flag to reset CBSLE

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O_SFP_Soot_Load_Reset	Soot load override for the CSLE
H_PTM_Operator_Regen_Req	Pedal dance output permitting regen
V_SFR_Regen_Trigger	Trigger flag for the regeneration
O_SFR_Regen_Trigger_On	Override enable for the regeneration trigger state
ENGINEERING USER OVERRIDE ENABLES	
Combustion Limit Management (CLM):	
T_CBL_EGR_Frac_User_Override	EGR fraction user override enable in Combustion Manager
C_CBL_EGR_Frac_Override_Value	EGR fraction user override value before final output from Combustion Manager
T_CBL_Fuel_User_Override	Fueling user override in CLM algorithm before Advanced FS Control
C_CBL_Fuel_Override_Value	Fueling override value in CBL algorithm before Cranking or Advanced FS Control
T_CBL_MCF_User_Override	Mass charge flow user override enable on final output of Combustion Manager
C_CBL_MCF_Override_Value	Mass charge flow user override value before final output from Combustion Manager
T_CBL_SOI_Increment_Enable	Enable use of C_CBL_SOI_Increment
C_CBL_SOI_Increment	CPE User Commanded Timing Increment
T_CBL_SOI_User_Override	SOI user override enable in CBL algorithm before Cranking or Advanced FS Control
C_CBL_SOI_Override_Value	SOI user override value in CBL algorithm before Cranking or Advanced FS Control
Combustion Reference (CBR):	
T_CBR_Alpha_User_Override	Enables override of CBR_Alpha
C_CBR_Alpha_Override_Value	Force CBR_Alpha to this value upon override
T_CBR_Chi_User_Override	Set Chi = C_CBR_Chi_Override_Value
C_CBR_Chi_Override_Value	Force Chi to this value upon override
T_CBR_EGR_Off_User_Override	Use C_CBR_EGR_Off_Override_Value instead of EMM_EGR_Off_Permission
C_CBR_EGR_Off_Override_Value	Set to TRUE to permit EGR to be turned off by user override
T_CBR_Fuel_Ref_User_Override	Fueling user override in combustion manager after OFC limit
C_CBR_Fuel_Ref_Override_Value	Fueling override value in combustion manager after OFC limit
T_CBR_Gross_Fuel_User_Override	Fueling user override in combustion manager before OFC limit
C_CBR_Gross_Fuel_Override_Value	Fueling override value in combustion manager before OFC limit
OFC Fuel Limit (OFC):	
T_OFC_Equiv_Ratio_User_Override	OFC equivalence ratio user override
C_OFC_Equiv_Ratio_Value	OFC equivalence ratio user override value
T_OFC_Fuel_Limit_User_Override	OFC fuel limit user override
C_OFC_Fuel_Limit_Override_Value	Override value for OFC fuel limit
Charge Manager	
T_CSE_Xform_User_Override	Enable bit for user override of charge system transform angle
C_CSE_Xform_Override_Value	User override value for charge system transform angle (subject to limits)
C_EAC_Override_Value	Override value of unstaged controller output for EGR/Assist
T_EAC_User_Override	User override enable for EGR/Assist
T_TGC_User_Override	User override enable for turbocharger control
C_TGC_Override_Value	Override value for turbocharger position demand
Engine Brake Manager	
T_ERC_ChgFlwUserOverride	Enables user override of Charge Flow command from retarder
C_ERC_ChgFlwUserValue	User override charge flow value for ERC
T_DIP_EngBrkSel1SwOvrdEn	Trim which indicates user override enable or not on EngineBrakeSelector1Switch.
H_DIP_EngBrkSel1SwOvrdVal	User override value for EngineBrakeSelector1Switch.
T_DIP_EngBrkSel2SwOvrdEn	Trim which indicates user override enable or not on EngineBrakeSelector2Switch.
H_DIP_EngBrkSel2SwOvrdVal	User override value for EngineBrakeSelector2Switch.
T_DIP_EngBrkSel3SwOvrdEn	Trim which indicates user override enable or not on EngineBrakeSelector3Switch.
H_DIP_EngBrkSel3SwOvrdVal	User override value for EngineBrakeSelector3Switch.
T_ERC_TrqUserOvrdEn	Trim which allows the system to override the braking torque as determined by selectable switches
H_ERC_TrqUserOvrdVal	Engineering hook which override the torque determined by selectable switches
T_ERC_SwLvl_OvrdEn	Trim which allows the system to override the RetarderSwitchLevel calculation.
H_ERC_SwLvl_OvrdVal	User override value to override the calculation of RetarderSwitchLevel for COMPRESSION or EXHAUST brakes.

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Application Version Reference

To Determine Calibration Software Version In ECM

Monitor	Calibration_Version_Number	Application Software Phase Version Number
	Boot_Loader_Version	ECM Bootloader Version Number

1. CM2150 ECM Parameters

Calibration_Version_Number	Software Application Version Number
Boot_Loader_Version	The boot loader version currently in the ECM.
Reset_Count	CUMULATIVE COUNT OF NON-POWER UP RESETS
ECM_Status	Indicates the current main application load status. ECM_Status takes on values as identified in GTIS. Dependent on the value of ECM_Status is the application code which will run upon powerup. ECM_Status also controls whether a calibration may be downloaded into an ECM.
ECM_Run_Time	This data is an integer that counts up or increments every 200 ms
Security_Key	ECM Security Key Status
Run_Location	Indicator that code is executing from ROM(0),FLASH(1), or RAM(2).

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CM2150 ENGINEERING STATES

AIF_State

State	Enumeration
BASE	0
USER	1
ALTITUDE_DERATE	2
ENGINE_PROTECTION	3
SLAVE_STATE	4
ESP	5
CATALYST_REGEN	6

CC_AutoResumeFlag

State	Enumeration
AR_INACTIVE	0
AR_ACTIVE	1
AR_PRE_ACTIVE	2
AR_RESUME	3
AR_AFTER_TEST	4
AR_NOT_AFTER_TEST	5

CC_Command_Mode

State	Enumeration
CC_OFF	0
SET	1
RESUME	2
COAST	3
ACCEL	4
BUMP_DOWN	5
BUMP_UP	6
CC_HOLD	7
CANCEL	8

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Combustion_Control_Path_Owner, CBL_Fuel_State, NDOT_PathOwner, NDOT_UserPathOwner, SOI_State, Final_Timing_State

State	Enumeration
CTRL_NONE_SELECTED	0
CTRL_JCOMM_TORQUE	1
CTRL_HEAP_ID	2
CTRL_JCOMM_SPEED	2
CTRL_PTO	4
CTRL_LIMP_HOME_TORQUE	5
FUELING_LIMP_HOME_STATE	6
CTRL_ABS	7
CTRL_ABT	8
CTRL_CC	9
CTRL_RSC	10
CTRL_LSI	11
CTRL_HSI	12
CTRL_TURBO_OVERSPEED	15
CTRL_OFC_FUEL_LIMIT	16
CTRL_TRANSIENT_NOISE	17
CTRL_EPD_SPEED	18
CTRL_TORQUE_CURVE	19
CTRL_JCOMM_TORQUE_DERATE	20
CTRL_OOG_TORQUE_LIMIT	21
CTRL_CRANK	22
CTRL_FUEL_OVERRIDE	23
CTRL_RETARDER	24
CTRL_ENGINE_OVERSPEED	25
CTRL_STOP	26
CTRL_SHUTDOWN	27
CTRL_FSS_DERATE	28
CTRL_EPD_TORQUE_LIMIT	29
CTRL_ENGINE_START_OIL_LIMIT	33
CTRL_PTO_TORQUE_LIMIT	34
CTRL_POWERTAIN_PROTECTION	36
CTRL_ANTI_THEFT	41
CTRL_VAM	45
CTRL_AIR_DENSITY_FUEL_LIMIT	46
CTRL_CHI_FUEL_LIMIT	47
CTRL_TFC_FUEL_LIMIT	48
CTRL_GROSS_FUEL_OVERRIDE	49
CTRL_CHM_TORQUE_LIMIT	50
CTRL_LIMP_HOME_SPEED	52
CTRL_TIS_DYNO	53
CTRL_VSS_DIAGNOSTICS	54
CTRL_ESCC	55
CTRL_WPD	56
CTRL_TSD	57
CTRL_EWP	58
CTRL_JCOMM_SPEED_LIMIT	59
CTRL_FIW	61
CTRL_FIW_RAMP	62
CTRL_AFW	63
CTRL_REGEN	66
CTRL_RTD	67
CTRL_IRD	68
CTRL_LBSC	69
CTRL_XSC	70
CTRL_XPC	71
CTRL_FSS_TRQ_DERATE	256

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DL_Controlling_Device_ID

State	Enumeration
NO_DEVICE	0
TRANSMISSION_CONTROL	1
ABS_CONTROL	2
ASR_CONTROL	3
UNKNOWN_CONTROL	4

DL_EngineControlMode

State	Enumeration
OVERRIDE_DISABLE	0
SPEED_CONTROL	1
TORQUE_CONTROL	2
LIMIT_ENGINE	3

DL_RetarderControlMode

State	Enumeration
RETARDER_OVERRIDE_DISABLE	0
unused	1
RETARDER_TORQUE_CONTROL	2
LIMIT_RETARDER	3

EMM_AECD_State

State	bit	Conversion
Normal		0
Air Handling System Protection	0	1
Extreme Ambient Overheat Protection	1	2
Condensation Protection	2	4
White Smoke / Misfire Protection	3	8
Extended Idle & PTO Protection	4	16
Engine Starting & Warmup Protection	5	32
Engine Protection	6	64
System Modulation	7	128
Thermal Management	8	256

***To decode this parameter, either convert the number into binary and use the bit field to determine which states are active, or add the conversion together to get the value shown in the ECM.**

EMM_Protection_State

State	bit	
Normal		0
Cranking/Shutdown	0	1
Oscar Operation	1	2
Felix Operation	2	4
Aftertreatment Dosing	3	8
Engine Component Failure	4	16
Wet Stack Protection	5	32
Coolant Advance	6	64
Misfire Timing Limit	7	128
OFC Gain Adjust	8	256
Ambient Pressure Advance	9	512
Turbo Surge Protection	10	1024
UHC Advance	11	2048
Intake Condensation Protection	12	4096
Cooler Condensation Protection	13	8192
Aftertreatment Protection	14	16384
Engine Protection	15	32768

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Engn_Actual_State

State	Enumeration
STATE_STOP	0
STATE_CRANK	1
STATE_RUN	2
STATE_SHUTDOWN	3
STATE_BRAKE	4

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Fan_Drive_State

State	Enumeration
FAN_DRIVE_OFF	0
FAN_DRIVE_GENERAL_ENGINE	1
FAN_DRIVE_IMT_COOLING	2
FAN_DRIVE_OT_COOLING	3
FAN_DRIVE_CT_COOLING	4
FAN_DRIVE_MANUAL_SWITCH	9
FAN_DRIVE_AC_SWITCH	11
FAN_DRIVE_IMT_TIMER	12
FAN_DRIVE_LOADING	13
FAN_DRIVE_OTHER	14
FAN_DRIVE_J1939_NOT_AVAILABLE	15

Final_Timing_State, SOI_State

State	Enumeration
FOUR_D_TIMING	0
WET_STACK_TIMING	1
USER_COMMANDED_TIMING	2
ANC_TIMING	3
MAX_TIMING	4
CRANK_ADVANCE	5
E_BRAKE_TIMING	6
USER_OVERRIDE_TIMING	7
STOPPED_TIMING	8
OVERSPEED_TIMING	9
SHUTDOWN_TIMING	10
MISFIRE_TIMING_LIMIT	11
MS_OVERRIDE_TIMING	12
WET_STACK_COOLANT_TIMING	13
COOLANT_SOI_ADVANCE_STATE	14
IMT_SOI_ADVANCE_STATE	15
AMBIENT_PRESSURE_SOI_ADVANCE_STATE	16
SUM_COOLANT_AND_AIR	17
COMB_MGR	18
AIR_TEMP	19
COOLANT	20
AMB_PRESSURE	21
BOOST	22
EX_IDLE	23
CT_DERATE	24
CBR_SOI_REF_STATE	25
MAX_TIMING_STATE	27
MIN_TMING_STATE	28
COMB_MGR_MAX	28
COM_MGR_MIN	28
FUELPRESS	29

GHC_State

State	Enumeration
GHC_SETUP_STAGE	1
GHC_PREHEAT_STAGE	2
GHC_CRANKING_STAGE	3
GHC_POSTHEAT_STAGE	4
GHC_OFF_STAGE	5
GHC_SERVICETOOL_STATE	6

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HSI_BrkPtSpeedPathOwner

State	Enumeration
HSG_INJECTOR_FAULT_STATE	1
HSG_ZERO_VSS_STATE	2
HSG_ANC_DERATE_STATE	3
HSG_VSS_TAMPER_STATE	4
HSG_ENGINE_PROTECTION_STATE	5
HSG_BREAKPOINT_STATE	6
HSG_FSS_DERATE_STATE	7
HSG_JCOMM_OVERRIDE_STATE	8
HSG_JCOMM_LIMIT_STATE	9
HSG_TSG_DEFAULT_ENGINE_SPEED_STATE	10
HSG_PTO_THROTTLE_OVERIDE_STATE	11
HSG_ALT_BREAKPOINT_STATE	12
HSG_TC_STALL_STATE	13
HSG_LIMP_HOME_DERATE_STATE	14
HSG_TC_ROCK_CYCLE_STATE	15

Idle_Validation_State

State	Enumeration
NOT_IDLE	0
IDLE	1
NOT_SUPPORTED	2
ERROR	3

J39_VGT_Actuator_State

State	Enumeration
VGT_ACT_NONE	0
POSITION_CONTROL	1
SELF_CALIBRATION	2
ACT_LEARN	3
HYSTERESIS_TEST	4
STEP_RESPONSE_TEST	5
ACT_OVERRIDE	6

J39_VGT_Actuator_Status

State	Enumeration
OPERATION_OK	0
TEMP_FAULT	1
TEMP_WARNING	2
ACTUATION_ERRORS	3
NO_ACTUATOR_RESPONSE	4
MOTOR_DISABLED_BY_INT	5
INTERNAL_VOLTAGE_LOW	6
RUNNING_INTERNAL_TEST	7
CAN_COMM_SRC_TIMEOUT	8
LEARNED_STOP_SPAN_2_LARGE	9
STOP_HIGH_STOP_LOW_WARN	10
NO_COMM_SCR_FOUND	11
IGNITION_VOLT_LOW	15
PWM_COMM_SCR_IN_ERR	17
EFFORT_HAS_BEEN_LIMITED	22
REFERNECE_NOT_FOUND	23
UART_COMM_SRC_TIMOUT	30

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MACH_ECM_Powerdown_Inhibit

State	bit	
No Inhibit		0
Anti_Theft	0	1
EGR Delta P	1	2
TIB Data Complete	2	4
VGT	3	8
EGR	4	16
GHC	5	32
VSS	6	64

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OOG_ProtectionState

State	Enumeration
OOG_RAMPING_UP	1
OOG_RAMPING_DOWN	2
OOG_STEADY_STATE_INACTIVE	3
OOG_STEADY_STATE_ACTIVE	4

PTO_State

State	Enumeration
REMOTE_COUNT	0
REMOTE_RUN	1
WAIT	2
NORMAL_PTO	3

Reg_Oper_State

State	Enumeration
IDLE	0
STANDBY	1
STATIONARY_REGEN	2
REGEN_TIMED_OUT	3
REGEN_COMPLETE	4
REGEN_INEFFECTIVE	5
REGEN_INTERRUPTED	6

RSC_GD_State

State	Enumeration
GD_RESET_STATE	1
GD_HIGH_LOAD_STATE	2
GD_WAIT_FOR_FILTER_STATE	3
GD_PRESET_RAMP_STATE	4
GD_LOW_LOAD_STATE	5
GD_TOP_GEAR_STATE	6
GD_DECEL_STATE	7

T_ERC_RetarderType

State	Enumeration
EXHAUST_BRAKE	0
DRIVELINE_BRAKE	1
COMPRESSION_BRAKE	2

T_FCC_Fan_Type_Selection

State	Enumeration
ON_OFF	0
VARIABLE	1
THREE_SPEED	2
ELECTRIC_VISCOUS_NO_SPD_FEEDBACK	3
ELECTRIC_VARIABLE_WITH_SPEED_SENSOR	4
ELECTRIC_VARIABLE_WITHOUT_SPEED_SENSOR	5

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T_Gear_VSS_Transmission

State	Enumeration
MANUAL_TRANSMISSION	0
AUTOMATIC_TRANSMISSION	1
FULLY_AUTOMATED_MANUAL_TRANSMISSION	2
PARTIALLY_AUTOMATED_MANUAL_TRANSMISSION	3
AUTOMATED_WITHOUT_CLUTCH	4

T_TSP_SensorType

State	Enumeration
NONE	0
INDUCTIVE	1
MINI_GEN	2
TACHOGRAPH	3
DATALINK_TAILSHAFT_SPEED	4
DATALINK_ROAD_SPEED	5
DATALINK_TACHOGRAPH	6

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TIB_Trip_Info_State

State	Enumeration
TI_EPF_DEBATE	0
TI_AIR_COMPRESSOR	1
TI_BATTERY_AUTO_START	2
TI_BLOCK_AUTO_START	3
TI_BUNK_AUTO_START	4
TI_ENGINE_ESP	5
TI_DRIVER_REWARD_1	6
TI_DRIVER_REWARD_2	7
TI_DRIVER_REWARD_3	8
TI_VEHICLE_ESP	9
TI_FAN_DUE_TO_EXT	10
TI_FAN_DUE_TO_AC	11
TI_FAN_DUE_TO_ENGINE	12
TI_FAN_1_WITH_MPH	13
TI_FAN_1_WITHOUT_MPH	14
TI_VEHICLE_OUT_OF_GEAR	15
TI_ENGINE_DRIVE	16
TI_ENGINE_IDLE	17
TU_FAST_ENGINE_IDLE	18
TI_ENGINE_PTO	19
TI_HOT_SHUTDOWN	20
TI_WARMUP_VIOLATION	21
TI_IDLE_SHUTDOWN	22
TI_IDLE_SHUTDOWN_OVERRIDE	23
TI_ENGINE_REVVING	24
TI_ENGINE_OVERREV	25
TI_VEHICLE_DRIVE	26
TI_VEHICLE_PTO	27
TI_CRUISE	28
TI_RSG	29
TI_VEHICLE_COAST	30
TI_VEHICLE_ABOVE_SWEET_SPOT	31
TI_VEHICLE_BELOW_SWEET_SPOT	32
TI_VEHICLE_BRAKE	33
TI_TOP_GEAR	34
TI_GEAR_DOWN	35
TI_ENGINE_BRAKES	36
TI_VEHICLE_OVERSPEED_1	37
TI_VEHICLE_OVERSPEED_2	38
TI_VEHICLE_DECELERATION	39
TI_ECM	40
TI_FAN_2_ON	41
TI_ENIGINE_ON	42
TI_VEHICLE_PTO_LOADED_AND_NOT_MOVING	43
TI_VEHICLE_PTO_LOADED_AND_MOVING	44
TI_AUTO_START	45
TI_ENGINE_SLEEP_IDLE	46
TI_SPART_WORD2_BIT15	47

Timing_State_Incr

State	Bit	Conversion
OFC_ALPHA0_INCR	2	4
CBO_ADJUST	4	16
CBL_USER_INCR	8	256

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V_SFR_Regen_Stage

State	Enumeration
NONE	1
WARM_TO_PLATEAU	2
PLATEAU	3
PLATEAU_TO_TARGET	4
REGENERATING	5

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CM2150 FAULT CODE LIST

Fault Code	Lamp	Error Name	Cummins Description
111	Stop	RAM_HARDWARE_ERROR EEPROM_WRITE_ERROR ECM_SW_MISSION_DISABLING_FAILURE_ERROR	Engine Control Module Critical Internal Failure - Bad Intelligent Device or Component
115	Stop	EPS_Both_Failed_Error	Engine Magnetic Speed/Position Lost Both of Two Signals - Data Erratic, Intermittent, or Incorrect
122	Warning	CHARGE_PRESS_OOR_HIGH_ERROR	Intake Manifold 1 Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
123	Warning	CHARGE_PRESS_OOR_LOW_ERROR	Intake Manifold 1 Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
124	Warning	OVERBOOST_HIGH_ERROR	Intake Manifold 1 Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
131	Stop	SAMPLED_THROTTLE_HIGH_ERROR	Accelerator Pedal or Lever Position Sensor 1 Circuit - Voltage Above Normal, or Shorted to High Source
132	Stop	SAMPLED_THROTTLE_LOW_ERROR	Accelerator Pedal or Lever Position Sensor 1 Circuit - Voltage Below Normal, or Shorted to Low Source
133	Stop	REMOTE_ACCEL_POSN_HIGH_ERROR	Remote Accelerator Pedal or Lever Position Sensor 1 Circuit - Voltage Above Normal, or Shorted to High Source
134	Stop	REMOTE_ACCEL_POSN_LOW_ERROR	Remote Accelerator Pedal or Lever Position Sensor 1 Circuit - Voltage Below Normal, or Shorted to Low Source
135	Warning	OIL_PRESSURE_HIGH_ERROR	Engine Oil Rifle Pressure 1 Sensor Circuit - Voltage Above Normal, or Shorted to High Source
141	Warning	OIL_PRESSURE_LOW_ERROR	Engine Oil Rifle Pressure 1 Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
143	Warning	OIL_PRESSURE_FUELING_ERROR	Engine Oil Rifle Pressure - Data Valid but Below Normal Operational Range - Moderately Severe Level
144	Warning	COOLANT_TEMPERATURE_HIGH_ERROR	Engine Coolant Temperature 1 Sensor Circuit - Voltage Above Normal, or Shorted to High Source
145	Warning	COOLANT_TEMPERATURE_LOW_ERROR	Engine Coolant Temperature 1 Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
146	Warning	COOLANT_TEMPERATURE_HIGH_FC_ERROR	Engine Coolant Temperature - Data Valid but Above Normal Operational Range - Moderately Severe Level
151	Stop	COOLANT_TEMPERATURE_RPM_ERROR	Engine Coolant Temperature - Data Valid but Above Normal Operational Range - Most Severe Level
153	Warning	CHARGE_TMPTR_OOR_HIGH_ERROR	Intake Manifold 1 Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source
154	Warning	CHARGE_TMPTR_OOR_LOW_ERROR	Intake Manifold 1 Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
155	Stop	IMT_RPM_DERATE_ERROR	Intake Manifold 1 Temperature - Data Valid but Above Normal Operational Range - Most Severe Level
187	Warning	SENSOR_SUPPLY_2_VOLTAGE_LOW_ERROR	Sensor Supply 2 Circuit - Voltage Below Normal, or Shorted to Low Source
193	Warning	ANALOG_CRUISE_SWITCH_HIGH_ERROR ANALOG_CRUISE_SWITCH2_HIGH_ERROR	Cruise Control (Resistive) Signal Circuit - Voltage Above Normal, or Shorted to High Source
194	Warning	ANALOG_CRUISE_SWITCH_LOW_ERROR ANALOG_CRUISE_SWITCH2_LOW_ERROR	Cruise Control (Resistive) Signal Circuit - Voltage Below Normal, or Shorted to Low Source
195	Warning	COOLANT_LEVEL_HIGH_ERROR	Coolant Level Sensor 1 Circuit - Voltage Above Normal, or Shorted to High Source
196	Warning	COOLANT_LEVEL_LOW_ERROR	Coolant Level Sensor 1 Circuit - Voltage Below Normal, or Shorted to Low Source
197	Warning	ENGINE_COOLANT_LEVEL_LOW	Coolant Level - Data Valid but Below Normal Operational Range - Moderately Severe Level
199	Warning	ANALOG_CRUISE_SWITCH_DIFF_ERROR	
212	Warning	OIL_TEMPERATURE_HIGH_ERROR	Engine Oil Temperature Sensor 1 Circuit - Voltage Above Normal, or Shorted to High Source

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213	Warning	OIL_TEMPERATURE_LOW_ERROR	Engine Oil Temperature Sensor 1 Circuit - Voltage Below Normal, or Shorted to Low Source
214	Stop	OIL_TEMPERATURE_FUELING_ERROR OIL_TEMPERATURE_RPM_ERROR	Engine Oil Temperature - Data Valid but Above Normal Operational Range - Most Severe Level
221	Warning	AMBIENT_AIR_PRESSURE_HIGH_ERROR	Barometric Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
222	Warning	AMBIENT_AIR_PRESSURE_LOW_ERROR	Barometric Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
227	Warning	SENSOR_SUPPLY_2_VOLTAGE_HIGH_ERROR	Sensor Supply 2 Circuit - Voltage Above Normal, or Shorted to High Source
231	Warning	COOLANT_PRESSURE_HIGH_ERROR	Coolant Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
232	Warning	COOLANT_PRESSURE_LOW_ERROR	Coolant Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
233	Warning	COOLANT_PRESSURE_FUELING_ERROR	Coolant Pressure - Data Valid but Below Normal Operational Range - Moderately Severe Level
234	Stop	ENGINE_OVERSPEED_ERROR	Engine Crankshaft Speed/Position - Data Valid but Above Normal Operational Range - Most Severe Level
238	Warning	SENSOR_SUPPLY_3_VOLTAGE_LOW_ERROR EPS_Main_Supply_OOR_Low_Error	Sensor Supply 3 Circuit - Voltage Below Normal, or Shorted to Low Source
239	Warning	SENSOR_SUPPLY_3_VOLTAGE_HIGH_ERROR EPS_Main_Supply_OOR_High_Error	Sensor Supply 3 Circuit - Voltage Above Normal, or Shorted to High Source
241	Warning	VSS_SIGNAL_LOST_ERROR	Wheel-Based Vehicle Speed - Data Erratic, Intermittent, or Incorrect
242	Warning	VSS_TAMPERING_ERROR	Wheel-Based Vehicle Speed Sensor Circuit tampering has been detected - Abnormal Rate of Change
244	Warning	RETARDER_SELECTOR_SWITCH_OOR	Red Stop Lamp Driver Circuit - Voltage Below Normal, or Shorted to Low Source
245	Warning	FAN_CLUTCH_HIGH_CTRL_ERROR	Fan Control Circuit - Voltage Below Normal, or Shorted to Low Source
249	Warning	OEM_AMB_AIR_TMPTR_HIGH_ERROR	Ambient Air Temperature Sensor 1 Circuit - Voltage Above Normal, or Shorted to High Source
252	Warning	CXPS_TMSD_OLS_ERRATIC_ERROR	Engine Oil Level - Data Erratic, Intermittent, or Incorrect
253	Stop	OLM_OIL_LEVEL_LOW_ERROR	Engine Oil Level - Data Valid but Below Normal Operational Range - Most Severe Level
256	Warning	OEM_AMB_AIR_TMPTR_LOW_ERROR	Ambient Air Temperature Sensor 1 Circuit - Voltage Below Normal, or Shorted to Low Source
261	Warning	FDH_FUEL_TMP_ERROR	Engine Fuel Temperature - Data Valid but Above Normal Operational Range - Moderately Severe Level
263	Warning	FUEL_TEMPERATURE_OOR_HIGH_ERROR	Engine Fuel Temperature Sensor 1 Circuit - Voltage Above Normal, or Shorted to High Source
265	Warning	FUEL_TEMPERATURE_OOR_LOW_ERROR	Engine Fuel Temperature Sensor 1 Circuit - Voltage Below Normal, or Shorted to Low Source
271	Warning	APC_IMV_SHORT_ERROR	Fuel Pump Pressurizing Assembly 1 Circuit - Voltage Below Normal, or Shorted to Low Source
272	Warning	APC_IMV_OPEN_ERROR	Fuel Pump Pressurizing Assembly 1 Circuit - Voltage Above Normal, or Shorted to High Source
281	Warning	APC_DIESEL_CYL_PRS_IMBAL_ERROR	Fuel Pump Pressurizing Assembly 1 - Mechanical System Not Responding Properly or Out of Adjustment
285	Warning	J39_IDLE_INCREMENT_SWITCH_TIMEOUT_ERROR J39_IDLE_DECREMENT_SWITCH_TIMEOUT_ERROR J39_REAR_AXLE_RATIO_SWITCH_TIMEOUT_ERROR J39_REQ_PERCENT_FAN_SPD_TIMEOUT_ERROR J39_PARKING_BRAKE_SWITCH_TIMEOUT_ERROR J39_CC_ONSWITCH_TIMEOUT_ERROR J39_SERVICE_BRAKE_SWITCH_TIMEOUT_ERROR J39_CLUTCH_SWITCH_TIMEOUT_ERROR J39_CC_SETSWITCH_TIMEOUT_ERROR J39_CC_RESUMESWITCH_TIMEOUT_ERROR J39_TEST_SWITCH_TIMEOUT_ERROR J39_EPD_SHUTDOWN_OVERRIDE_SWITCH_TIMEOUT_ERROR J39_PTO_SWITCH_TIMEOUT_ERROR J39_PTO_REMOTE_SWITCH_TIMEOUT_ERROR	SAE J1939 Multiplexing PGN Timeout Error - Abnormal Update Rate

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		J39_PTO_RESUME_SWITCH_TIMEOUT_ERROR J39_PTO_SET_SWITCH_TIMEOUT_ERROR J39_AP_LOW_IDLE_SWITCH_TIMEOUT_ERROR J39_PTO_ACCEL_SWITCH_TIMEOUT_ERROR J39_PTO_COAST_SWITCH_TIMEOUT_ERROR J39_ACCELERATOR_PEDAL_POSITION_TIMEOUT_ERROR J39_REMOTE_ACCELERATOR_TIMEOUT_ERROR J39_AC_HIGH_PRESSURE_FAN_SWITCH_TIMEOUT_ERROR J39_REMOTE_ACCELERATOR_SWITCH_TIMEOUT_ERROR J39_AUXILIARY_SHUTDOWN_SWITCH_TIMEOUT_ERROR J39_TORQUE_DERATE_SWITCH_TIMEOUT_ERROR J39_ACCELERATOR_INTERLOCK_TIMEOUT_ERROR J39_RETARDERSWITCHLEVEL_TIMEOUT_ERROR J39_ESC_SET_SWITCH_TIMEOUT_ERROR J39_ESC_ON_SWITCH_TIMEOUT_ERROR J39_ESC_RESUME_SWITCH_TIMEOUT_ERROR J39_AUXILIARY_TEMPERATURE_1_TIMEOUT_ERROR J39_AUXILIARY_TEMPERATURE_2_TIMEOUT_ERROR J39_AUXILIARY_PRESSURE_1_TIMEOUT_ERROR J39_AUXILIARY_PRESSURE_2_TIMEOUT_ERROR J39_AUX_DISCRETE_INPUT_1_TIMEOUT_ERROR J39_PT_REGEN_FORCE_SWITCH_TIMEOUT_ERROR J39_PT_REGEN_INHIBIT_SWITCH_TIMEOUT_ERROR J39_COOLANT_LEVEL_TIMEOUT_ERROR	
286	Warning	J39_TEST_SWITCH_CONFIGURATION_ERROR J39_ACCELERATOR_INTERLOCK_CONFIGURATION_ERROR J39_ACCELERATOR_PEDAL_POSITION_CONFIGURATION_ERROR J39_AC_HIGH_PRESSURE_FAN_SWITCH_CONFIGURATION_ERROR J39_AP_LOW_IDLE_SWITCH_CONFIGURATION_ERROR J39_AUXILIARY_SHUTDOWN_SWITCH_CONFIGURATION_ERROR J39_CC_ONSWITCH_CONFIGURATION_ERROR J39_CC_RESUMESWITCH_CONFIGURATION_ERROR J39_CC_SETSWITCH_CONFIGURATION_ERROR J39_CLUTCH_SWITCH_CONFIGURATION_ERROR J39_TORQUE_DERATE_SWITCH_CONFIGURATION_ERROR J39_EPD_SHUTDOWN_OVERRIDE_SWITCH_CONFIGURATION_ERROR J39_IDLE_DECREMENT_SWITCH_CONFIGURATION_ERROR J39_IDLE_INCREMENT_SWITCH_CONFIGURATION_ERROR J39_PARKING_BRAKE_SWITCH_CONFIGURATION_ERROR J39_PTO_ACCEL_SWITCH_CONFIGURATION_ERROR J39_PTO_COAST_SWITCH_CONFIGURATION_ERROR J39_PTO_REMOTE_SWITCH_CONFIGURATION_ERROR J39_PTO_RESUME_SWITCH_CONFIGURATION_ERROR J39_PTO_SET_SWITCH_CONFIGURATION_ERROR J39_PTO_SWITCH_CONFIGURATION_ERROR J39_REAR_AXLE_RATIO_SWITCH_CONFIGURATION_ERROR J39_REMOTE_ACCELERATOR_SWITCH_CONFIGURATION_ERROR J39_REMOTE_ACCELERATOR_CONFIGURATION_ERROR J39_REQ_PERCENT_FAN_SPD_CONFIGURATION_ERROR J39_RETARDERSWITCHLEVEL_CONFIGURATION_ERROR J39_SERVICE_BRAKE_SWITCH_CONFIGURATION_ERROR J39_ESC_SET_SWITCH_CONFIGURATION_ERROR J39_ESC_ON_SWITCH_CONFIGURATION_ERROR J39_ESC_RESUME_SWITCH_CONFIGURATION_ERROR J39_AUXILIARY_PRESSURE_1_CONFIGURATION_ERROR J39_AUXILIARY_PRESSURE_2_CONFIGURATION_ERROR J39_AUXILIARY_TEMPERATURE_1_CONFIGURATION_ERROR J39_AUXILIARY_TEMPERATURE_2_CONFIGURATION_ERROR J39_AUX_DISCRETE_INPUT_1_CONFIGURATION_ERROR J39_PT_REGEN_FORCE_SWITCH_CONFIGURATION_ERROR J39_PT_REGEN_INHIBIT_SWITCH_CONFIGURATION_ERROR J39_COOLANT_LEVEL_CONFIGURATION_ERROR	SAE J1939 Multiplexing Configuration Error - Out of Calibration
287	Warning	J39_MUX_ACCEL_DATA_ERROR	SAE J1939 Multiplexed Accelerator Pedal or Lever Sensor System - Received Network Data In Error
288	Stop	J39_MUX_REM_ACCEL_DATA_ERROR	SAE J1939 Multiplexing Remote Accelerator Pedal or Lever Position Sensor System - Received Network Data In Error

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292	Stop	OEM_TEMPERATURE_FUELING_ERROR OEM_TEMPERATURE_RPM_ERROR	Auxiliary Temperature Sensor Input 1 - Special Instructions.
293	Warning	OEM_TEMPERATURE_HIGH_ERROR	Auxiliary Temperature Sensor Input 1 Circuit - Voltage Above Normal, or Shorted to High Source
294	Warning	OEM_TEMPERATURE_LOW_ERROR	Auxiliary Temperature Sensor Input 1 Circuit - Voltage Below Normal, or Shorted to Low Source
295	Warning	AMBIENT_AIR_PRESS_KEYON_ERROR	Barometric Pressure - Data Erratic, Intermittent, or Incorrect
296	Stop	OEM_PRESSURE_FUELING_ERROR OEM_PRESSURE_RPM_ERROR	Auxiliary Pressure Sensor Input 1 - Special Instructions.
297	Warning	OEM_PRESSURE_HIGH_ERROR	Auxiliary Pressure Sensor Input 1 Circuit - Voltage Above Normal, or Shorted to High Source
298	Warning	OEM_PRESSURE_LOW_ERROR	Auxiliary Pressure Sensor Input 1 Circuit - Voltage Below Normal, or Shorted to Low Source
319	Warning	RTC_POWER_INTERRUPT_ERROR	Real Time Clock Power Interrupt - Data Erratic, Intermittent, or Incorrect
322	Warning	Injector_1_Circuit_1_Error	Injector Solenoid Driver Cylinder 1 Circuit - Current Below Normal, or Open Circuit
323	Warning	Injector_5_Circuit_1_Error	Injector Solenoid Driver Cylinder 5 Circuit - Current Below Normal, or Open Circuit
324	Warning	Injector_3_Circuit_1_Error	Injector Solenoid Driver Cylinder 3 Circuit - Current Below Normal, or Open Circuit
325	Warning	Injector_6_Circuit_1_Error	Injector Solenoid Driver Cylinder 6 Circuit - Current Below Normal, or Open Circuit
331	Warning	Injector_2_Circuit_1_Error	Injector Solenoid Driver Cylinder 2 Circuit - Current Below Normal, or Open Circuit
332	Warning	Injector_4_Circuit_1_Error	Injector Solenoid Driver Cylinder 4 Circuit - Current Below Normal, or Open Circuit
338	Warning	ISD_RELAY_LOW_ERROR	Idle Shutdown Vehicle Accessories Relay Driver Circuit - Voltage Above Normal, or Shorted to High Source
339	Warning	ISD_RELAY_HIGH_ERROR	Idle Shutdown Vehicle Accessories Relay Driver Circuit - Voltage Below Normal, or Shorted to Low Source
343	Warning	POWEROFF_COMMAND_IGNORED_ERROR	Engine Control Module Warning Internal Hardware Failure - Bad Intelligent Device or Component
351	Warning	Low_Boost_Voltage_Error	Injector Power Supply - Bad Intelligent Device or Component
352	Warning	SENSOR_SUPPLY_1_VOLTAGE_LOW_ERROR	Sensor Supply 1 Circuit - Voltage Below Normal, or Shorted to Low Source
386	Warning	SENSOR_SUPPLY_1_VOLTAGE_HIGH_ERROR	Sensor Supply 1 Circuit - Voltage Above Normal, or Shorted to High Source
412	None	J1708_LINK_CANNOT_TRANSMIT_ERROR	SAEJ1587/J1922 Datalink - Data Erratic, Intermittent, or Incorrect
415	Stop	OIL_PRESSURE_RPM_ERROR	Engine Oil Rifle Pressure - Data Valid but Below Normal Operational Range - Most Severe Level
418	Warning	WATER_IN_FUEL_ERROR	Water in Fuel Indicator - Data Valid but Above Normal Operational Range - Least Severe Level
421	Warning	OIL_TEMPERATURE_ABOVE_NORMAL_ERROR	Engine Oil Temperature - Data Valid but Above Normal Operational Range - Moderately Severe Level.
422	Warning	COOLANT_LEVEL_READING_INCORRECT	Coolant Level - Data Erratic, Intermittent, or Incorrect
425	Warning	OIL_TEMPERATURE_IN_RANGE_ERROR	Engine Oil Temperature - Data Erratic, Intermittent, or Incorrect
427	None	J1939_AUX_NDOT_TIMEOUT_ERROR	SAE J1939 Datalink - Abnormal Update Rate
428	Warning	WATER_IN_FUEL_HIGH_ERROR	Water in Fuel Indicator Sensor Circuit - Voltage Above Normal, or Shorted to High Source
429	Warning	WATER_IN_FUEL_LOW_ERROR	Water in Fuel Indicator Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
431	Warning	THROTTLE_VALIDATION_SWITCH_LOW_ERROR THROTTLE_VALIDATION_SWITCH_HIGH_ERROR	Accelerator Pedal or Lever Idle Validation Switch - Data Erratic, Intermittent, or Incorrect
432	Stop	ACCELERATOR_PEDAL_VALIDATION_ERROR	Accelerator Pedal or Lever Idle Validation Circuit - Out of Calibration
435	Warning	OIL_PRESSURE_SWITCH_ERROR OIL_PRESS_KEYON_ERROR	Engine Oil Rifle Pressure - Data Erratic, Intermittent, or Incorrect
441	Warning	BATTERY_VOLTAGE_LOW_ERROR	Battery 1 Voltage - Data Valid but Below Normal Operational Range - Moderately Severe Level
442	Warning	BATTERY_VOLTAGE_HIGH_ERROR	Battery 1 Voltage - Data Valid but Above Normal

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			Operational Range - Moderately Severe Level
449	Stop	APC_DIESEL_VERY_HIGH_PRS_ERROR	Injector Metering Rail 1 Pressure - Data Valid but Above Normal Operational Range - Most Severe Level
451	Warning	APC_DIESEL_PRS_OOR_HIGH_ERROR	Injector Metering Rail 1 Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
452	Warning	APC_DIESEL_PRS_OOR_LOW_ERROR	Injector Metering Rail 1 Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
471	Warning	OLM_OIL_LEVEL_ADD_ERROR	Engine Oil Level - Data Valid but Below Normal Operational Range - Least Severe Level
499	Warning	CXPS_TMSD_OLS_FAILURE_ERROR	Engine Oil Level Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
527	Warning	DUAL_OUTPUT_A	Auxiliary Input/Output 2 Circuit - Voltage Above Normal, or Shorted to High Source.
528	Warning	TORQUE_CURVE_SEL_SW_VAL_ERROR	Auxiliary Alternate Torque Validation Switch - Data Erratic, Intermittent, or Incorrect
529	Warning	DUAL_OUTPUT_B	Auxiliary Input/Output 3 Circuit - Voltage Above Normal, or Shorted to High Source.
546	Warning	FUEL_SUPPLY_PRESS_OOR_HIGH_ERROR	Fuel Delivery Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
547	Warning	FUEL_SUPPLY_PRESS_OOR_LOW_ERROR	Fuel Delivery Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
553	Warning	APC_DIESEL_HIGH_PRS_ERROR	Injector Metering Rail 1 Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
554	Warning	APC_DIESEL_PRS_SIR_ERROR	Injector Metering Rail 1 Pressure - Data Erratic, Intermittent, or Incorrect
555	Warning	CRANKCASE_PRESSURE_MOD_HIGH	Crankcase Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
556	Stop	CRANKCASE_PRESSURE_SEV_HIGH	Crankcase Pressure - Data Valid but Above Normal Operational Range - Most Severe Level
559	Warning	APC_DIESEL_LOW_PRS_ERROR	Injector Metering Rail 1 Pressure - Data Valid but Below Normal Operational Range - Moderately Severe Level
584	Warning	SL_RELAY_LOW_ERROR	Starter Relay Driver Circuit - Voltage Above Normal, or Shorted to High Source
585	Warning	SL_RELAY_HIGH_ERROR	Starter Relay Driver Circuit - Voltage Below Normal, or Shorted to Low Source
596	Warning	AFW_HIGH_VOLTAGE_ERROR	Electrical Charging System Voltage - Data Valid but Above Normal Operational Range - Moderately Severe Level
597	Warning	AFW_LOW_VOLTAGE_ERROR	Electrical Charging System Voltage - Data Valid but Below Normal Operational Range - Moderately Severe Level
598	Stop	AFW_VERY_LOW_VOLTAGE_ERROR	Electrical Charging System Voltage - Data Valid but Below Normal Operational Range - Most Severe Level
599	Stop	OEM_COMMANDED_DUAL_OUTPUTS	Auxiliary Commanded Dual Output Shutdown - Special Instructions
649	Warning	LUBE_OIL_REQUIRES_CHANGE_ERROR	Engine Oil Change Interval - Condition Exists. Change engine oil and filter
686	Warning	TURBOCHARGER_1_SPEED_HIGH	Turbocharger 1 Speed - Data Erratic, Intermittent, or Incorrect
687	Warning	TURBOCHARGER_1_SPEED_LOW	Turbocharger 1 Speed - Data Valid but Below Normal Operational Range - Moderately Severe Level
688	Stop	OLM_OIL_LEVEL_HIGH_ERROR	Engine Oil Level - Data Valid but Above Normal Operational Range - Most Severe Level
689	Warning	EPS_Main_No_Sync_Error EPS_Main_No_Pulse_Error	Engine Crankshaft Speed/Position - Data Erratic, Intermittent, or Incorrect
691	Warning	COMP_IN_TMPTR_OOR_HIGH_ERROR	Turbocharger 1 Compressor Inlet Temperature Circuit - Voltage Above Normal, or Shorted to High Source
692	Warning	COMP_IN_TMPTR_OOR_LOW_ERROR	Turbocharger 1 Compressor Inlet Temperature Circuit - Voltage Below Normal, or Shorted to Low Source
697	Warning	ECM_INTERNAL_TEMPERATURE_HIGH_VOLTAGE_ERROR	ECM Internal Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source
698	Warning	ECM_INTERNAL_TEMPERATURE_LOW_VOLTAGE_ERROR	ECM Internal Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source

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731	Warning	EPS_Phase_Shift_Error	Engine Speed / Position Camshaft and Crankshaft Misalignment - Mechanical System Not Responding Properly or Out of Adjustment
757	Warning	ALL_PERSISTANT_DATA_LOST_ERROR	Electronic Control Module data lost - Condition Exists
769	Warning	SERVICE_BRAKE_SWITCH_HIGH_ERROR	Brake Switch Circuit - Voltage Above Normal, or Shorted to High Source
771	Warning	SERVICE_BRAKE_SWITCH_LOW_ERROR	Brake Switch Circuit - Voltage Below Normal, or Shorted to Low Source
778	Warning	EPS_Backup_No_Sync_Error EPS_Backup_No_Pulse_Error	
779	Warning	OEM_PRESSURE2_LOW_ERROR OEM_PRESSURE2_HIGH_ERROR OEM_TEMPERATURE2_LOW_ERROR OEM_TEMPERATURE2_HIGH_ERROR	Auxiliary Equipment Sensor Input 3 - Root Cause Not Known
784	None	J39_ADAPTIVE_CC_ERROR	Adaptive Cruise Control Mode - Data Erratic, Intermittent, or Incorrect
951	None	CBD_Trim_Limit_Error	Cylinder Power Imbalance Between Cylinders - Data Erratic, Intermittent, or Incorrect
952	Warning	POI_LOW_ERROR	Reserved for temporary use - Condition Exists
953	Warning	POI_HIGH_ERROR	Reserved for temporary use - Condition Exists
999	None	Injector_19_Circuit_1_Error Injector_20_Circuit_1_Error	Reserved for temporary use - Condition Exists
1117	None	PERSISTANT_DATA_LOST_ERROR	Power Supply Lost With Ignition On - Data Erratic, Intermittent, or Incorrect
1139	Warning	UFD_INJECTOR_1_ERROR	Injector Solenoid Driver Cylinder 1 - Mechanical System Not Responding Properly or Out of Adjustment
1141	Warning	UFD_INJECTOR_2_ERROR	Injector Solenoid Driver Cylinder 2 - Mechanical System Not Responding Properly or Out of Adjustment
1142	Warning	UFD_INJECTOR_3_ERROR	Injector Solenoid Driver Cylinder 3 - Mechanical System Not Responding Properly or Out of Adjustment
1143	Warning	UFD_INJECTOR_4_ERROR	Injector Solenoid Driver Cylinder 4 - Mechanical System Not Responding Properly or Out of Adjustment
1144	Warning	UFD_INJECTOR_5_ERROR	Injector Solenoid Driver Cylinder 5 - Mechanical System Not Responding Properly or Out of Adjustment
1145	Warning	UFD_INJECTOR_6_ERROR	Injector Solenoid Driver Cylinder 6 - Mechanical System Not Responding Properly or Out of Adjustment
1239	Warning	ACCEL_POS_SENSOR2_HIGH_ERROR	Accelerator Pedal or Lever Position Sensor 2 Circuit - Voltage Above Normal, or Shorted to High Source. High voltage detected at accelerator pedal position #2 signal circuit
1241	Warning	ACCEL_POS_SENSOR2_LOW_ERROR	Accelerator Pedal or Lever Position Sensor 2 Circuit - Voltage Below Normal, or Shorted to Low Source. Low voltage detected at accelerator pedal position #2 signal circuit
1242	Stop	DUAL_ACCEL_CONFORMANCE_ERROR	Accelerator Pedal or Lever Position Sensor 1 and 2 - Data Erratic, Intermittent, or Incorrect. Accelerator position sensors #1 and #2 are reading different values
1256	Warning	HARNESS_KEY_LEAST_SEVERE_ERROR	Control Module Identification Input State Error - Data Erratic, Intermittent, or Incorrect
1257	Stop	HARNESS_KEY_MOST_SEVERE_ERROR	Control Module Identification Input State Error - Data Erratic, Intermittent, or Incorrect
1548	Warning	Injector_7_Circuit_1_Error	Injector Solenoid Driver Cylinder 7 Circuit - Current Below Normal, or Open Circuit
1549	Warning	Injector_8_Circuit_1_Error	Injector Solenoid Driver Cylinder 8 Circuit - Current Below Normal, or Open Circuit
1551	Warning	Injector_10_Circuit_1_Error	Injector Solenoid Driver Cylinder 10 Circuit - Current Below Normal, or Open Circuit
1552	Warning	Injector_11_Circuit_1_Error	Injector Solenoid Driver Cylinder 11 Circuit - Current

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			Below Normal, or Open Circuit
1553	Warning	Injector_12_Circuit_1_Error	Injector Solenoid Driver Cylinder 12 Circuit - Current Below Normal, or Open Circuit
1554	Warning	Injector_13_Circuit_1_Error	Injector Solenoid Driver Cylinder 13 Circuit - Current Below Normal, or Open Circuit
1555	Warning	Injector_14_Circuit_1_Error	Injector Solenoid Driver Cylinder 14 Circuit - Current Below Normal, or Open Circuit
1556	Warning	Injector_15_Circuit_1_Error	Injector Solenoid Driver Cylinder 15 Circuit - Current Below Normal, or Open Circuit
1557	Warning	Injector_16_Circuit_1_Error	Injector Solenoid Driver Cylinder 16 Circuit - Current Below Normal, or Open Circuit
1558	Warning	Injector_17_Circuit_1_Error	Injector Solenoid Driver Cylinder17 Circuit - Current Below Normal, or Open Circuit
1559	Warning	Injector_18_Circuit_1_Error	Injector Solenoid Driver Cylinder 18 Circuit - Current Below Normal, or Open Circuit
1622	Warning	Injector_9_Circuit_1_Error	Injector Solenoid Driver Cylinder 9 Circuit - Current Below Normal, or Open Circuit
1663	Warning	DOC_THERM_REVERSED_ERR	Catalyst Inlet Temperature Sensor Swapped with Outlet - Condition Exists. The aftertreatment diesel oxidation catalyst inlet temperature and aftertreatment diesel particulate filter inlet temperature sensor connectors are reversed
1664	Warning	DOC_NOT_PRESENT_ERR	Catalyst Missing - Condition Exists
1665	Warning	DOC_IN_TMPTR_OOR_LO_ERR	Exhaust Gas Temperature 1 Circuit - Voltage Below Normal, or Shorted to Low Source
1666	Warning	DOC_IN_TMPTR_OOR_HI_ERR	Exhaust Gas Temperature 1 Circuit - Voltage Above Normal, or Shorted to High Source
1667	Warning	DOC_IN_TMPTR_KEYON_ERR DOC_IN_TMPTR_DITHER_ERR	Exhaust Gas Temperature 1 - Data Erratic, Intermittent, or Incorrect
1674	Warning	DOC_OUT_TMPTR_OOR_LO_ERR	Exhaust Gas Temperature 2 Circuit - Voltage Below Normal, or Shorted to Low Source
1675	Warning	DOC_OUT_TMPTR_OOR_HI_ERR	Exhaust Gas Temperature 2 Circuit - Voltage Above Normal, or Shorted to High Source
1676	Warning	DOC_OUT_TMPTR_KEYON_ERR DOC_OUT_TMPTR_DITHER_ERR	Exhaust Gas Temperature 2 - Data Erratic, Intermittent, or Incorrect
1691	Warning	DOC_EFF_WARNING_ERR	Catalyst Efficiency - Out of Calibration
1695	Warning	SENSOR_SUPPLY_5_VOLTAGE_HIGH_ERROR	Sensor Supply 5 - Voltage Above Normal, or Shorted to High Source
1696	Warning	SENSOR_SUPPLY_5_VOLTAGE_LOW_ERROR	Sensor Supply 5 - Voltage Below Normal, or Shorted to Low Source
1843	Warning	CRANKCASE_PRESS_OOR_HIGH_ERROR	Crankcase Pressure Circuit - Voltage Above Normal, or Shorted to High Source
1844	Warning	CRANKCASE_PRESS_OOR_LOW_ERROR	Crankcase Pressure Circuit - Voltage Below Normal, or Shorted to Low Source
1852	Warning	WATER_IN_FUEL_EXTENDED_TIME_ERROR	Water in Fuel Indicator - Data Valid but Above Normal Operational Range - Moderately Severe Level
1866	Warning	EGR_DELTA_PRESS_KEYON_ERROR EGR_DP_AUTOZERO_ERROR	Exhaust Gas Recirculation Valve Delta Pressure - Data Erratic, Intermittent, or Incorrect
1876	Warning	DPF_OUT_TMPTR_OOR_HI_ERR	Exhaust Gas Temperature 3 Circuit - Voltage Above Normal, or Shorted to High Source
1877	Warning	DPF_OUT_TMPTR_OOR_LO_ERR	Exhaust Gas Temperature 3 Circuit - Voltage Below Normal, or Shorted to Low Source
1878	Warning	DPF_OUT_TMPTR_KEYON_ERR DPF_OUT_TMPTR_DITHER_ERR	Exhaust Gas Temperature 3 - Data Erratic, Intermittent, or Incorrect
1879	Warning	DPF_DELTA_P_OOR_HI_ERR	Aftertreatment Particulate Trap Differential Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
1881	Warning	DPF_DELTA_P_OOR_LO_ERR	Aftertreatment Particulate Trap Differential Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
1883	Warning	DPF_DELTA_P_KEYON_ERR DPF_DELTA_P_DITHER_ERR	Aftertreatment Particulate Trap Differential Pressure Sensor - Data Erratic, Intermittent, or Incorrect
1893	Warning	J39_EGR_VALVE_COMM_TIMEOUT_ERROR	EGR Valve Control Circuit - Abnormal Update Rate
1896	Warning	EGA_VALVE_STUCK_ERROR	EGR Valve Controller - Out of Calibration
1899	Warning	EGR_DELTA_P_IR_LOW_ERROR	Exhaust Gas Recirculation Valve Delta Pressure - Data

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			Valid but Below Normal Operational Range - Moderately Severe Level
1911	Warning	APC_2S_MDV_TRIP_ERROR	Injector Metering Rail 1 Pressure - Data Valid but Above Normal Operational Range - Most Severe Level
1921	Warning	DPF_SOOT_LOAD_HI_ERR	Aftertreatment Particulate Trap Differential Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
1922	Stop	DPF_SOOT_LOAD_SEVERE_ERR	Aftertreatment Particulate Trap Differential Pressure - Data Valid but Above Normal Operational Range - Most Severe Level
1938	Warning	VGA_DL_VOLTAGE_LOW_ERROR	ECU Power Output Supply Voltage 1 - Data Valid but Below Normal Operational Range - Moderately Severe Level
1942	Warning	BEYOND_THD_AZ_ERROR	Crankcase Pressure - Data Erratic, Intermittent, or Incorrect
1943	None	CBR_DENSITY_DERATE_ERROR_ID	Ambient Air Density - Data Valid but Below Normal Operational Range - Least Severe Level
1962	Warning	VGA_DL_OVER_TEMPERATURE_ERROR	VGT Actuator Driver Over Temperature (Calculated) - Data Valid but Above Normal Operational Range - Least Severe Level
1968	Warning	DOC_OUT_OVERTEMP_ERR	Exhaust Gas Temperature 2 - Data Valid but Above Normal Operational Range - Moderately Severe Level
1969	Stop	DOC_SEVERE_TMPTR_ERR	Exhaust Gas Temperature 2 - Data Valid but Above Normal Operational Range - Most Severe Level
1972	Warning	DPF_OUT_OVERTEMP_ERR	Exhaust Gas Temperature 3 - Data Valid but Above Normal Operational Range - Moderately Severe Level
1973	Stop	DPF_SEVERE_TMPTR_ERR	Exhaust Gas Temperature 3 - Data Valid but Above Normal Operational Range - Most Severe Level
1974	Warning	CRANKCASE_PRESSURE_LEAST_SEV_HIGH	Crankcase Pressure - Data Valid but Above Normal Operational Range - Least Severe Level
1981	Warning	DPF_PLUGGED_ERR DPF_DELTAP_HIGH_ERR	Aftertreatment Particulate Trap Differential Pressure - Data Valid but Above Normal Operational Range - Least Severe Level
1993	Warning	DPF_NOT_PRESENT_ERR	Aftertreatment Particulate Trap Missing - Condition Exists
2182	Warning	ENG_BRK_DRV1_LOW_CONTROL_ERROR	Engine Brake Actuator Driver 1 Circuit - Voltage Above Normal, or Shorted to High Source
2183	Warning	ENG_BRK_DRV1_HIGH_CONTROL_ERROR	Engine Brake Actuator Driver 1 Circuit - Voltage Below Normal, or Shorted to Low Source
2185	Warning	SENSOR_SUPPLY_4_VOLTAGE_HIGH_ERROR	Sensor Supply 4 Circuit - Voltage Above Normal, or Shorted to High Source
2186	Warning	SENSOR_SUPPLY_4_VOLTAGE_LOW_ERROR	Sensor Supply 4 Circuit - Voltage Below Normal, or Shorted to Low Source
2195	Stop	OEM_SWITCH_RPM_ERROR OEM_SWITCH_FUELING_ERROR	Auxiliary Equipment Sensor Input 3 Engine Protection Critical - Special Instructions
2198	Warning	VGA_DL_COMMAND_SOURCE_ERROR	VGT Actuator Driver Circuit - Root Cause Not Known
2215	Warning	FUEL_SUPPLY_PRESS_VLOW_ERROR	Fuel Pump Delivery Pressure - Data Valid but Below Normal Operational Range - Moderately Severe Level
2249	Warning	APC_DIESEL_LOW2_PRS_ERROR	
2261	Warning	FUEL_SUPPLY_PRESS_HIGH_ERROR	Fuel Pump Delivery Pressure - Data Valid but Above Normal Operational Range - Least Severe Level
2262	Warning	FUEL_SUPPLY_PRESS_LOW_ERROR	Fuel Pump Delivery Pressure - Data Valid but Below Normal Operational Range - Least Severe Level
2263	Warning	BATTERY_TMPTR_HIGH_ERROR	Battery Temperature - Data Valid but Above Normal Operational Range - Moderately Severe Level
2264	Warning	BATTERY_TMPTR_LOW_ERROR	Battery Temperature - Data Valid but Below Normal Operational Range - Moderately Severe Level
2265	Warning	APC_LPP_OPEN_ERROR	Electric Lift Pump for Engine Fuel Supply Circuit - Voltage Above Normal, or Shorted to High Source
2266	Warning	APC_LPP_SHORT_ERROR	Electric Lift Pump for Engine Fuel Supply Circuit - Voltage Below Normal, or Shorted to Low Source
2272	Warning	EGA_VALVE_POSITION_ERROR	EGR Valve Position Circuit - Voltage Below Normal, or Shorted to Low Source
2273	Warning	EGR_DELTA_P_OOR_HIGH_ERROR	Exhaust Gas Recirculation Valve Delta Pressure Sensor Circuit - Voltage Above Normal, or Shorted to

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			High Source
2274	Warning	EGR_DELTA_P_OOR_LOW_ERROR	Exhaust Gas Recirculation Valve Delta Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
2288	None	TURBO_SPEED_TORQUE_DERATE_ERROR	Turbocharger 1 Speed - Data Valid but Above Normal Operational Range - Least Severe Level
2292	Warning	APC_DIESEL_FLOW_HIGH_ERROR	Fuel Inlet Meter Device - Data Valid but Above Normal Operational Range - Moderately Severe Level
2293	Warning	APC_DIESEL_FLOW_LOW_ERROR	Fuel Inlet Meter Device flow demand lower than expected - Data Valid but Below Normal Operational Range - Moderately Severe Level
2311	Warning	APC_IMV_RESIS_ERROR APC_IMV_INTERMITTENT_ERROR	Electronic Fuel Injection Control Valve Circuit - Condition Exists
2321	None	EPS_Main_Intermittent_Sync_Error	Engine Crankshaft Speed/Position - Data Erratic, Intermittent, or Incorrect
2322	None	EPS_Backup_Intermittent_Sync_Error	Engine Camshaft Speed / Position Sensor - Data Erratic, Intermittent, or Incorrect
2345	Warning	TURBO_SPEED_INVALID_RATE	Turbocharger 1 Speed - Abnormal Rate of Change
2346	None	CBR_TFC_DERATE_ERROR_ID	Turbocharger Turbine Inlet Temperature (Calculated) - Data Valid but Above Normal Operational Range - Least Severe Level
2347	None	COT_RPM_DERATE_ERROR COT_TORQUE_DERATE_ERROR	Turbocharger Compressor Outlet Temperature (Calculated) - Data Valid but Above Normal Operational Range - Least Severe Level
2349	Warning	EGA_DRIVER_OPEN_CIRCUIT_ERROR	EGR Valve Control Circuit - Current Below Normal, or Open Circuit
2351	Warning	EGA_DRIVER_SHORT_CIRCUIT_ERROR	EGR Valve Control Circuit - Voltage Below Normal, or Shorted to Low Source
2357	Warning	EGA_DRIVER_OC_ERROR	EGR Valve Control Circuit - Mechanical System Not Responding Properly or Out of Adjustment
2359	Warning	EGR_DELTA_P_IR_HIGH_ERROR	Exhaust Gas Recirculation Valve Delta Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
2363	Warning	ENG_BRK_DRV2_HIGH_CONTROL_ERROR	Engine Brake Actuator Driver Output 2 Circuit - Voltage Below Normal, or Shorted to Low Source
2365	Warning	ENG_BRK_DRV3_HIGH_CONTROL_ERROR	Engine Brake Actuator Driver Output 3 Circuit - Voltage Below Normal, or Shorted to Low Source
2367	Warning	ENG_BRK_DRV2_LOW_CONTROL_ERROR	Engine Brake Actuator Driver Output 2 Circuit - Voltage Above Normal, or Shorted to High Source
2368	Warning	ENG_BRK_DRV3_LOW_CONTROL_ERROR	Engine Brake Actuator Driver 3 Circuit - Voltage Above Normal, or Shorted to High Source
2372	Warning	PRS_FUEL_FILTER_CLOGGED_ERROR	Fuel Filter Differential Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
2373	Warning	EXHAUST_PRESS_OOR_HIGH_ERROR	Exhaust Gas Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source
2374	Warning	EXHAUST_PRESS_OOR_LOW_ERROR	Exhaust Gas Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
2375	Warning	EGR_ORIFICE_TMPTR_OOR_HIGH_ERROR	Exhaust Gas Recirculation Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source
2376	Warning	EGR_ORIFICE_TMPTR_OOR_LOW_ERROR	Exhaust Gas Recirculation Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
2377	Warning	FAN_CLUTCH_LOW_CTRL_ERROR	Fan Control Circuit - Voltage Above Normal, or Shorted to High Source
2387	Warning	VGA_DL_ACTUATION_ERROR *When this error is active, monitor J39_VGT_Actuator_Status to determine root cause of error. The enumerations are listed above	VGT Actuator Driver Circuit (Motor) - Mechanical System Not Responding Properly or Out of Adjustment
2425	Warning	GHC_HIGH_VOLTAGE_ERROR_2	Intake Air Heater 2 Circuit - Voltage Below Normal, or Shorted to Low Source
2426	Warning	GHC_LOW_VOLTAGE_ERROR_2	Intake Air Heater 2 Circuit - Voltage Above Normal, or Shorted to High Source
2448	Warning	COOLANT_LEVEL_MODERATELY_LOW	Coolant Level - Data Valid but Below Normal Operational Range - Least Severe Level
2449	Stop	VGA_DL_LEARNED_CAL_ERROR	VGT Actuator Controller - Out of Calibration
2451	None	EMT_RPM_DERATE_ERROR EMT_TORQUE_DERATE_ERROR	Turbocharger Turbine Inlet Temperature (Calculated) - Data Valid but Above Normal Operational Range -

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			Moderately Severe Level
2554	Warning	EXHAUST_PRESS_KEYON_ERROR	Exhaust Gas Pressure - Data Erratic, Intermittent, or Incorrect
2555	Warning	GHC_LOW_VOLTAGE_ERROR_1	Intake Air Heater 1 Circuit - Voltage Above Normal, or Shorted to High Source
2556	Warning	GHC_HIGH_VOLTAGE_ERROR_1	Intake Air Heater 1 Circuit - Voltage Below Normal, or Shorted to Low Source
2557	Warning	DPO_LOW_ERROR	Auxiliary PWM Driver 1 Circuit - Voltage Above Normal, or Shorted to High Source
2558	Warning	DPO_HIGH_ERROR	Auxiliary PWM Driver 1 Circuit - Voltage Below Normal, or Shorted to Low Source
2634	Stop	VGA_DL_DRIVER_CIRCUIT_ERROR	VGT Actuator Controller - Bad Intelligent Device or Component
2635	Stop	VGA_DL_MISMATCH_ERROR	VGT Actuator Driver Circuit - Condition Exists. A calibration mismatch between VGT actuator and the ECM has been detected
2636	Stop	J39_VGT_COMM_TIMEOUT_ERROR	VGT Actuator Driver Circuit - Abnormal Update Rate. No communications on the J1939 datalink between the engine ECM and the smart VGT controller
2637	None	DOC_FACE_PLUGGED_ERR	Catalyst Face Plugged - Root Cause Not Known
2638	None	DOC_LOW_EFFICIENCY_ERR	Catalyst Efficiency - Out of Calibration. The temperature increase across the aftertreatment catalyst is lower than expected
2639	None	DPF_SOOT_LOAD_MEDIUM_ERR	Aftertreatment Particulate Trap Differential Pressure - Data Valid but Above Normal Operational Range - Least Severe Level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits
2646	Warning	HIGH_COOLANT_TEMP_AECD7_ERROR	Engine Coolant Temperature - Condition Exists. The EGR valve was closed to reduce engine coolant temperatures
2659	None	HIGH_COOLANT_TEMP_AECD2_ERROR	Engine Coolant Temperature - Condition Exists. The EGR valve was closed to reduce engine coolant temperatures
2728	None	SFM_INEFF_DOSING_ERR	Aftertreatment Fuel Injector 1 - Data Valid but Above Normal Operational Range - Moderately Severe Level. Excessive fuel injection into the aftertreatment system has been detected
2742	None	STAT_REGEN_INEFFECTIVE	The temperatures in the aftertreatment system cannot reach the required temperatures for stationary regeneration
2743	Warning	STAT_REGEN_INEFFECTIVE_ERROR	The temperatures in the aftertreatment system cannot reach the required temperatures for stationary regeneration
2754	Warning	HIGH_EOPM_RATE_ERROR	Engine Particulate Trap Inlet Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
2764	Warning	EP_RPM_DERATE_ERROR	Exhaust Gas Pressure - Data Valid but Above Normal Operational Range - Moderately Severe Level
2765	None	MIT_BARCODE_ERROR	Engine Injector Bank 1 Barcodes - Out of Calibration
2774	Warning	EGR_DP_CLOGGED_TUBES_ERROR	Engine Exhaust Gas Recirculation (EGR) System - Condition Exists
2777	None	PTM_INHIBIT_SWITCH_HI_SOOT_ERR	Particulate Trap Active Regeneration Inhibited Due to Inhibit Switch - Condition Exists
2778	Warning	LUBE_OIL_FOD_REQUIRES_CHANGE_ERROR	Aftertreatment Fuel Rate - Data Valid but Above Normal Operational Range - Moderately Severe Level
2961	None	EGR_TORQUE_DERATE_ERROR	Exhaust Gas Recirculation Temperature - Data Valid but Above Normal Operational Range - Least Severe Level
2962	Warning	EGR_RPM_DERATE_ERROR	Exhaust Gas Recirculation Temperature - Data Valid but Above Normal Operational Range - Moderately Severe Level
2963	None	COOLANT_TEMPERATURE_FUELING_ERROR2	Engine Coolant Temperature - Data Valid but Above Normal Operational Range - Least Severe Level
2964	None	IMT_TORQUE_DERATE_ERROR	Intake Manifold 1 Temperature - Data Valid but

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			Above Normal Operational Range - Least Severe Level
2973	Warning	CHARGE_PRESS_IR_ERROR CHARGE_PRESS_KEYON_ERROR	Intake Manifold 1 Pressure - Data Erratic, Intermittent, or Incorrect
9798	None	VGA_DL_ACTUATION_TEMP_ERROR	Reserved for temporary use - Condition Exists
9799	None	VGA_DL_NOT_PARKED_ERROR	Reserved for temporary use - Condition Exists
9981	Warning	APC_DSL_BLD_OPEN_ERROR	Reserved for temporary use - Condition Exists
9982	Warning	APC_DSL_BLD_SHORT_ERROR	Reserved for temporary use - Condition Exists

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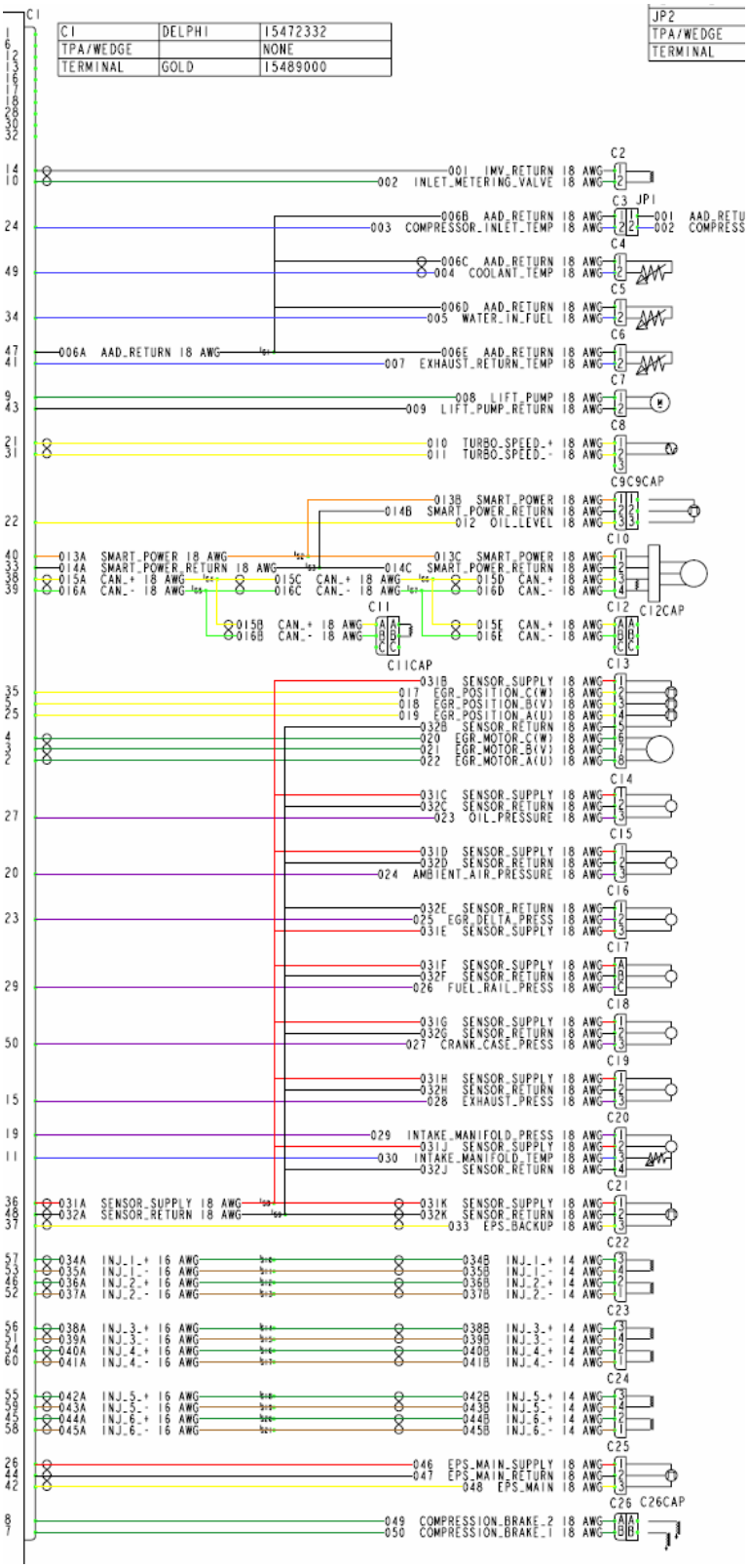
Gryphon Engine Wiring Harness



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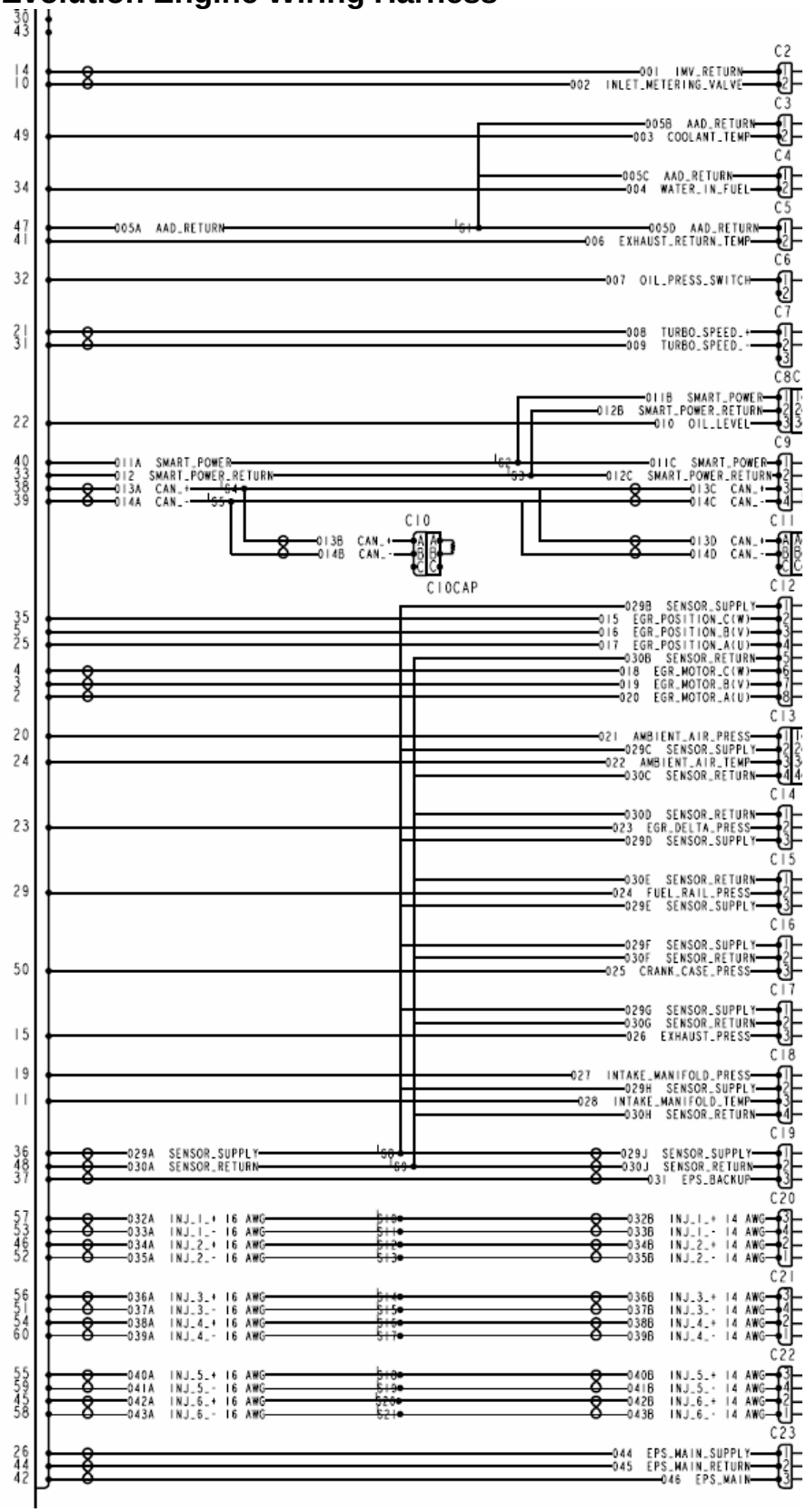
Evolution Engine Wiring Harness



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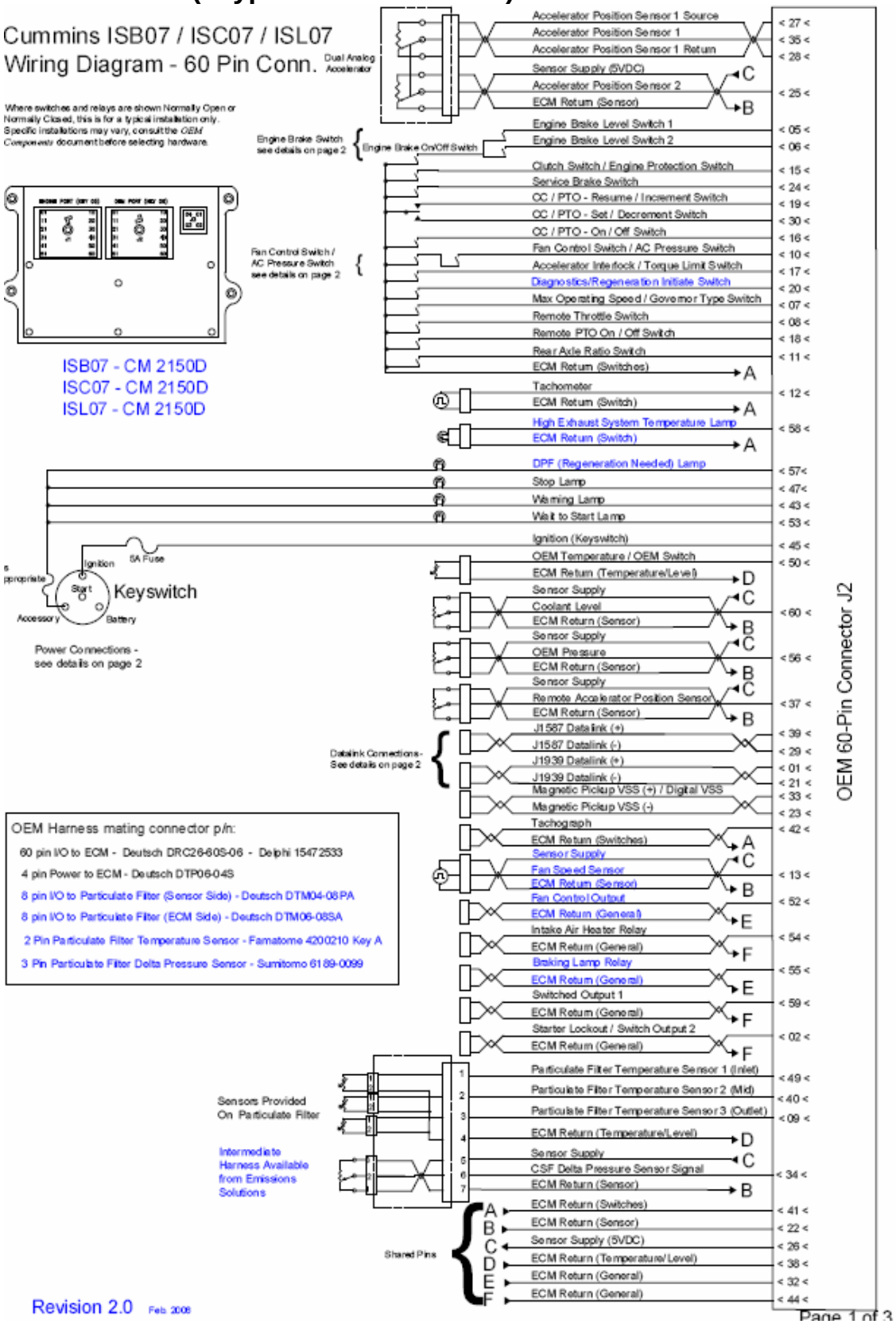
OEM Harness (Gryphon and Evolution)



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Low Pressure Fuel System

Lift pump operating parameters (Gryphon Only):

1. Nominal pump resistance – 1 to 10 ohms (could be higher than 10 ohms but typically looking for a short or an open pump)
2. Nominal pump current – 3 to 6 amps
3. Pump operating pressures – 1 to 11.5 psi (engine speed dependent)
4. Pump flow rates – 10 gph to 54 gph (engine speed dependent)

Lift Pump Troubleshooting Procedures (Gryphon Only):

1. Ensure pump is installed correctly	Long brass section of pump should be toward fuel filter
2. Listen to verify pump is running	
3. Check pump resistance at lift pump connector	Validates pump against an open or short (1 to 10 ohms)
4. Check lift pump feedback current on Calterm (APC_I_lppFlt_v) with lift pump running	Typical range is 3 to 5 amps (if zero and #2 checks good check pump ground circuit)
5. Verify pump pressure by checking pressure at filter inlet or outlet diagnostic port on filter head	Pressure should be 1.0 to 11.5 psi
6. Verify flow into bucket, using pump outlet line, by using engineering override (C_APC_ti_Override and C_APC_ti_LppTest) or by bumping the starter.	Based on a 25-second override time and no outlet restriction, amount of fuel in bucket should be ~0.5 gallon

Low Rail Pressure (Evolution)

Look at M-Prop commanded [APC_i_ImaCmd] and returned [APC_i_ImaFltr] current.
Current should range around 1.8A nominally at rated

- If current is below 1.0 , even under load, need to pursue leakage or low pressure fuel supply
- If return value is not tracking commanded valve need to look at m-prop (sticking).
- If no return (filtered) current is detected need to look at electrical connections feeding m-prop

Low Pressure Fuel Supply

To check for low pressure on the fuel supply – check the fuel pump characteristics.

Fuel pump drain flow - Maximum Flow: Run the engine at standard idle (750 rpm) and verify flow into a bucket from the fuel pump drain. Should acculate 500 ml (17 oz) in 30 seconds

Fuel pump supply flow to rail (for an engine that won't start): Minimum Flow: Run the engine at crank (150 RPM) and verify flow into a bucket from the fuel pump supply line. Should acculate 70 ml (2.4 oz) in 30 seconds

Internal Leakage check

To check for internal leakage, disconnect the injector return line at the rear of head and measure flow.

No load idle: 180ml/min) or less
Crank: 90ml/min or less

If flow is greater than need to investigate HPC, injectors, and/or their interface with Rail Blockoff Tool.

Note:
The engine operates closer to system capacity at lower speeds, i.e. put engine in:

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1)Full Load condition around 800rpm and check m-prop current. If current is below 1.0 or appears to be trending toward zero may be leak or fuel supply.
2)Full Load condition around rated and check m-prop current.
If current is greater than condition 1 look for internal leakage in system.
If current is less than condition 1 look for low pressure fuel supply issue.

Low Rail Pressure (Gryphon)

TBD

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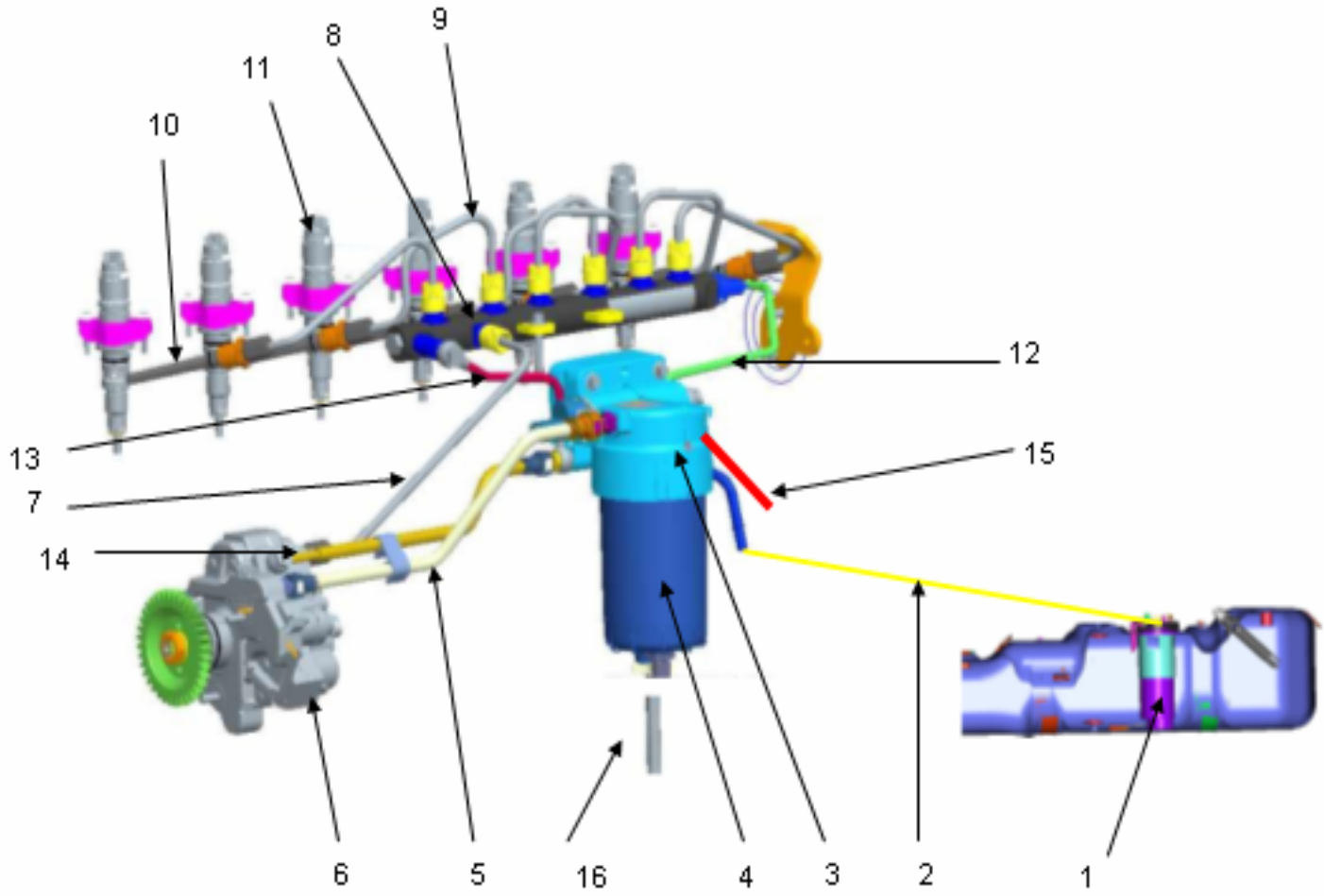
Fuel Systems Diagrams

Front Gear Train



1. Fuel lift pump in fuel tank (Gryphon only)
2. From fuel lift pump to fuel filter
3. Fuel filter head
4. Fuel filter / Water / fuel separator
5. To fuel pump
6. Fuel pump
7. To fuel rail
8. Fuel rail
9. To injectors
10. High-pressure connector
11. Injector
12. Fuel return from injectors to fuel filter head
13. Fuel return from fuel rail to fuel filter head
14. Fuel return from fuel pump to fuel filter head
15. Fuel return to fuel tank
16. Water fuel separator drain

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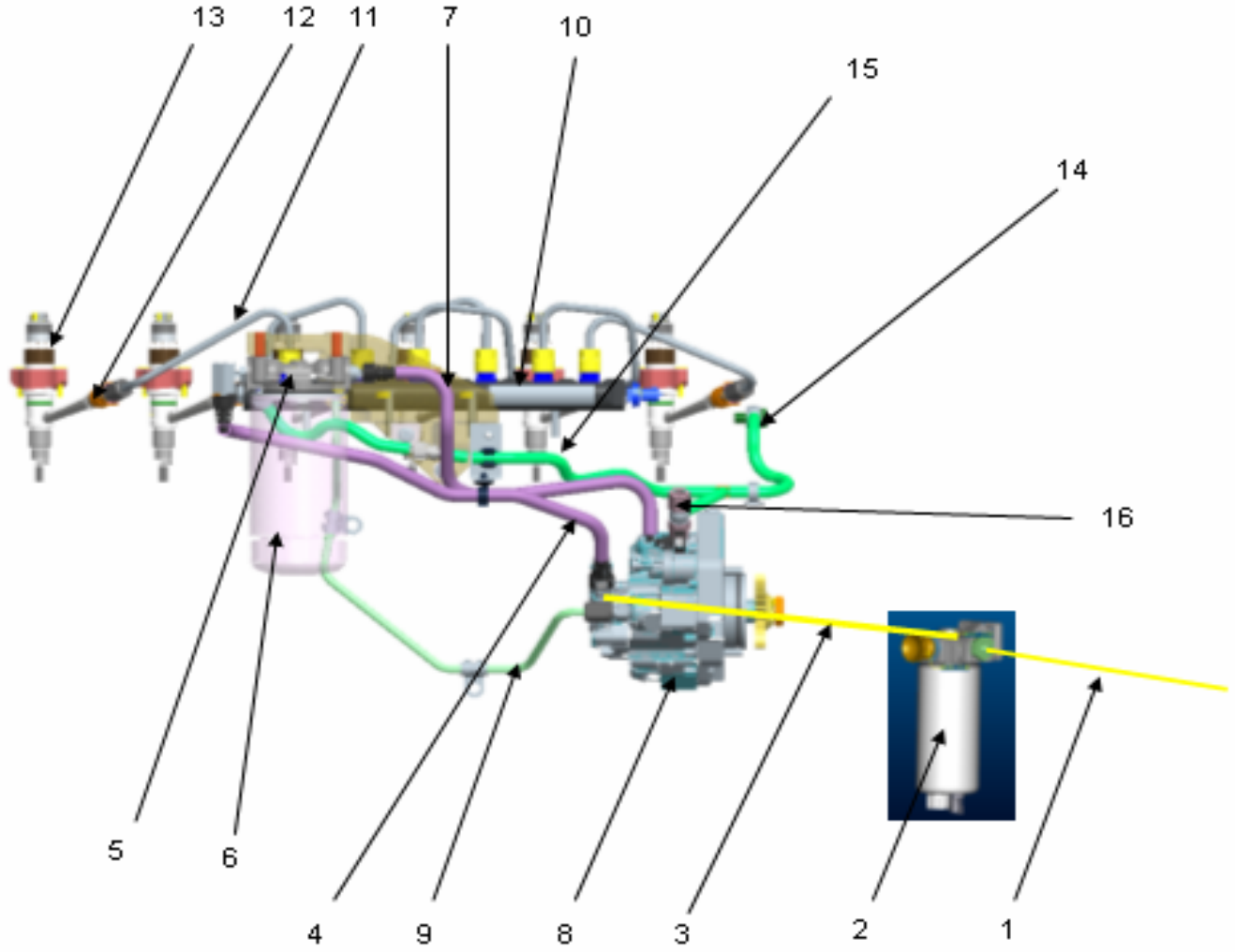
Rear Gear Train



1. From fuel supply tank
2. Priming pump /Water/fuel separator (remote mount or on engine mounted)
3. To fuel pump
4. To fuel filter
5. Fuel filter head
6. Fuel filter
7. To fuel pump
8. Fuel pump
9. To fuel rail
10. Fuel rail
11. To injectors
12. High-pressure connector
13. Injector
14. Fuel return from injectors
15. Fuel return from fuel rail
16. Fuel return from fuel pump to fuel supply tank.

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Cummins HPCR Fuel System User Notes

1. Objective:

The objective of this document is to provide basic information required to operate and diagnose the Core-2 version of the Cummins High Pressure Common Rail (HPCR), High Pressure Direct Injection (HPDI), etc. fuel system Controls

2. Overview:

The fuel system consists of several algorithms which operate together to properly control the Cummins HPCR, and derivitive, fuel system hardware. The fuel systems are a High Pressure Common Rail (HPCR) direct injection type. The following sections provide basic information about each algorithm and fault codes that are detected. Please refer to the controls schematic or the algorithm experts for further information.

3. Documentation ECM Compatibility:

The document is intended to match the Fuel System Specific Controls (FSSC) version 12.00.03 release, used with the CM2150 ECM.

4. Variable Naming

For the most part Fuel system algorithm variables follow a standard naming convention. Understanding this standard can be very advantageous in terms of .nding variables on a calterm or Nget tool.
General Format: [TypeField_]AlgorithmField_UnitField_DescriptionField
Type Field:

- The type .eld shall be a “C_” if the variable is non-volatile (calibration, trim)
- The type .eld shall be a “blank or H_” if the variable is volatile (calculated on the .y by the cpu)
- The type .eld shall be a “P_” if the variable is volatile (i.e. calculated on the .y by the cpu), saved at power-down and restored at power-up.

Algorithm Field: 3 letter identifier of algorithm. Each letter should be upper case.
Unit Field: 1 to 4 letter unit definition. All letters shall be lower case.

Unit Types

Unit Abbr.	Description	Software Unit	Unit Abbr.	Description	Software Unit
na	*Engine Acceleration*	*RPM/SEC/10*	p	*Percent*	*%/100*
ar	*Area*	*mm2/100*	r	*Ratio/Gain*	-
ca	*Crank Degrees*	*6/256 dBTDC*	Rloc	Resource locator	
ct	*Counter*	-	s	*Status*	-
f	*Frequency*	*Hz/10*	t	*Temperature*	*Deg C / 10*
ht	*Height*	*mm/1000*	tc	*Timer Cycles*	-
i	*Current*	*Amp/1000*	ti	*Error Timers*	*ms*
l	*vector length*	-	ti	*Physical Timers*	*us*
n	*Engine Speed*	*RPM/8*	v	*Voltage*	*mV*
lp	*Low Pressure*	*mbar*	vb	*Voltage (Boost Supply)*	*V*
hp	*High Pressure*	*bar/10*	th	*Tooth*	-
q	*Fueling*	*mm3/20 or mg/20*	w	*Energy (normalized to capacitance)*	*mJ/mF*
qt	*Timing Fuel*	*mm3/10*	x	*Unit less*	-
qr	*Fuel Flow Rate*	*10 mm3/s*			

Description Field: Description words should be ran together using case to differentiate each word. The .rst letter should be lower case.

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5. Where to Look

Table 1:

Question	Section
How do I command fixed on times and fixed pulse positions?	IFC - override mode
How do I command fixed Pilot, Post, and Main Fuel Quantities, along with injection positions?	IFC - not override mode FSI - override mode
Where is TDC relative to the Engine Speed Position signals?	EPS
I'm not getting any fuel pulses, why?	General Trouble Shooting
How do I command fixed Accumulator pressures?	FSI – override mode
How do I change the base Fuel Command and Timing Command?	FSI
How do I learn more about a fault code?	Fault Code Trouble shooting

6. Algorithm Information

6.1 Fuel System Interface (FSI)

FSI is intended to interface the fuel system with the non-fuel system base controls. These interfaces include the desired injection quantities and injection position of the vep1,. vep1, pilot, main, and post and late injection pulses. The figures 1 and 2 show how the injection interfaces relate to the injection control signals.

Figure 1: MY2002 Injection Waveform

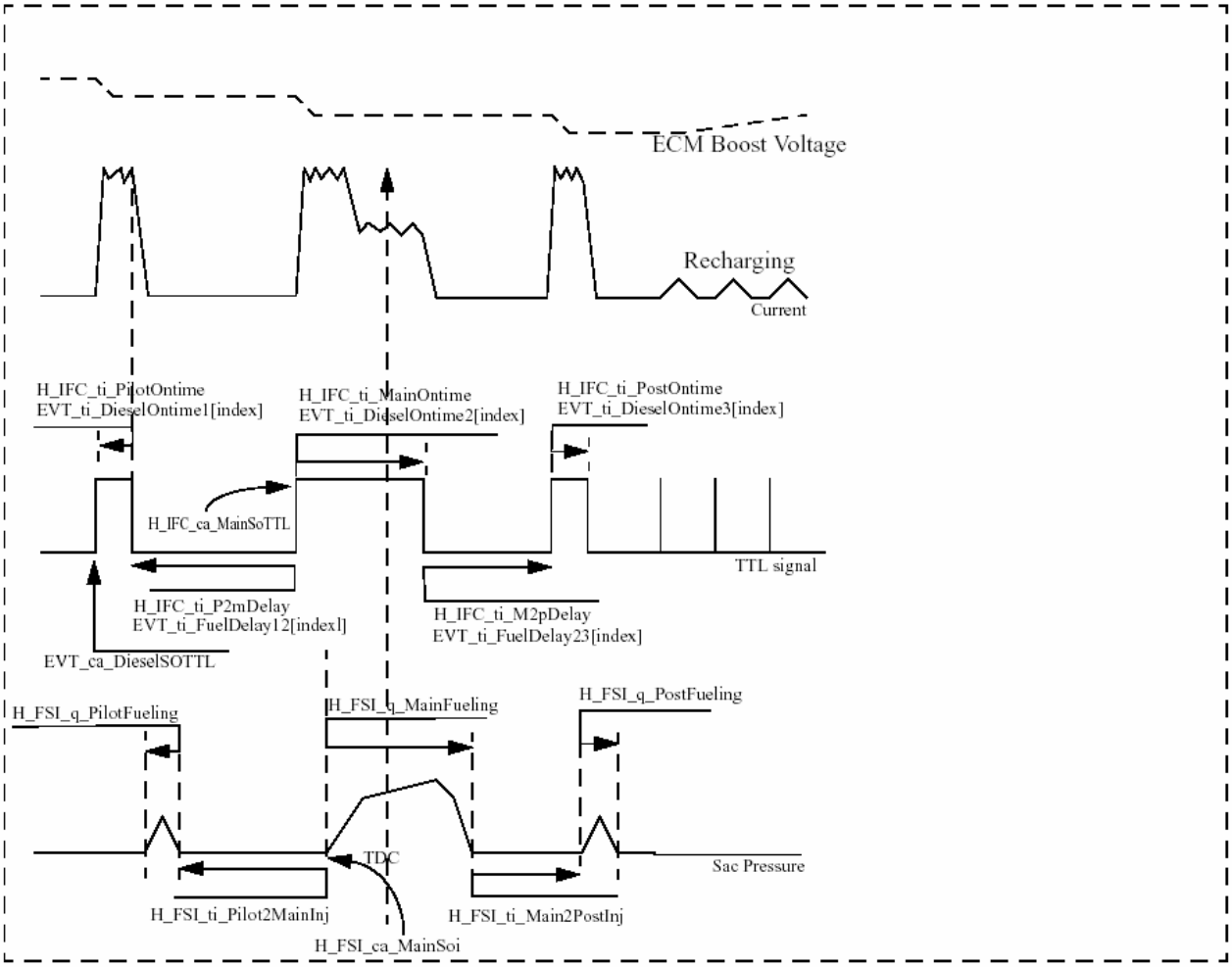

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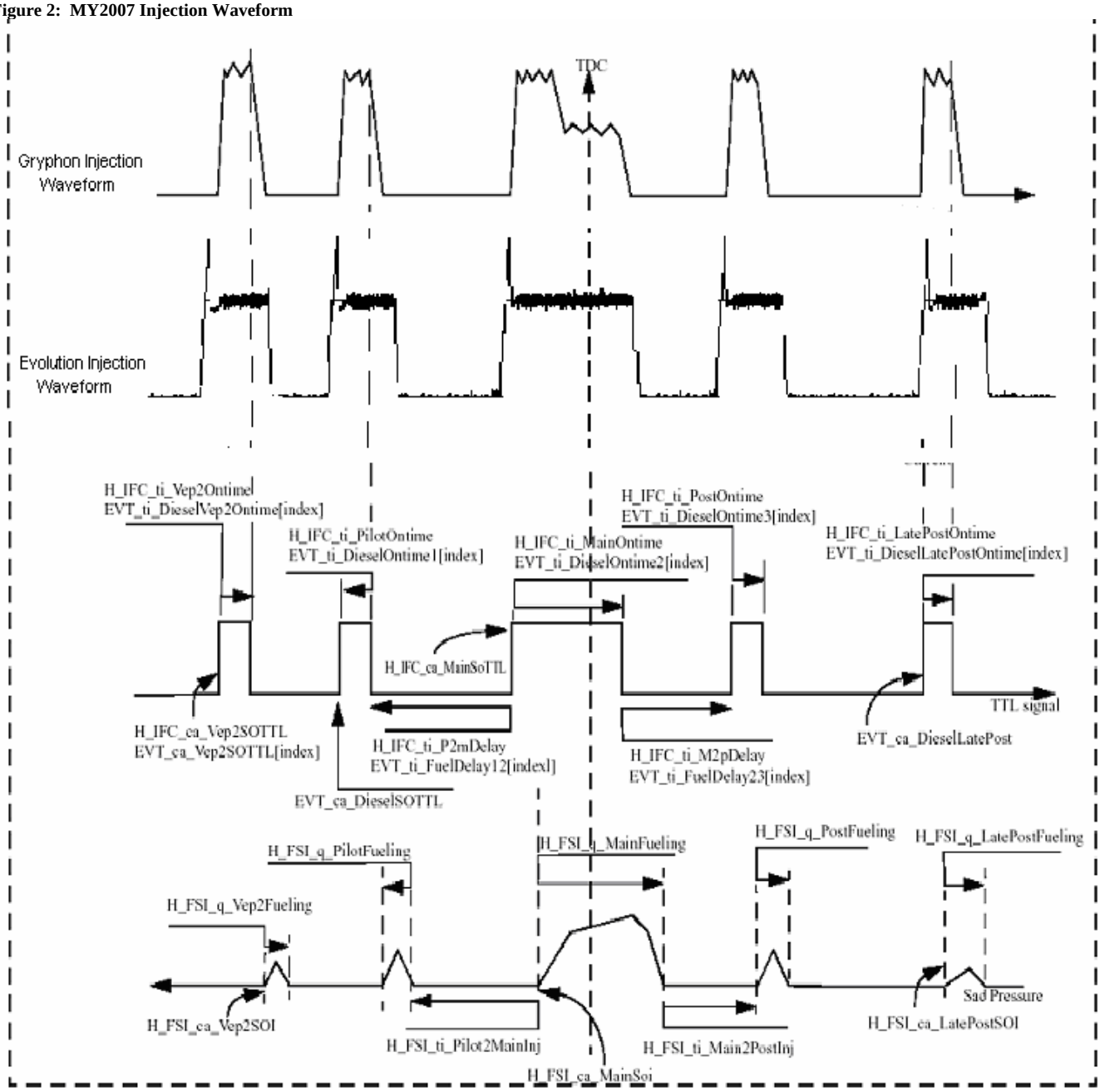
Figure 2: MY2007 Injection Waveform



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6.1.1 **FSI Injection Signals:**

Table 2: Fuel System Interface (FSI) Input Injection Conversions

Core2 Fuel Command Interface	FSI output variable	Comment
diesel total fueling and gas main fueling passed by function call	H_FSI_q_TotalFueling	Calculated by FSI as the sum of total diesel fueling and gas main fueling from base controls and then limited to be less than FDH_q_mustDerate
dsl late post (post2) fueling passed by call to fuel systems	H_FSI_q_LatePostFueling	Limited to be less than H_FSI_q_TotalFueling
dsl pilot fueling passed by call	H_FSI_q_PilotFueling	Limited to be less than(H_FSI_q_TotalFueling - H_FSI_q_LatePostFueling).
dsl VEP1 fueling passed by call	H_FSI_q_VEP1Fueling Ignored by the fueling to ontime conversions	Limited to be less than (H_FSI_q_TotalFueling - H_FSI_q_LatePostFueling - H_FSI_q_PilotFueling).
dsl VEP2 fueling passed by call	H_FSI_q_VEP2Fueling	Limited to be less than (H_FSI_q_TotalFueling - H_FSI_q_LatePostFueling - H_FSI_q_PilotFueling - H_FSI_q_Vep1Fueling)
dsl post fueling passed by call	H_FSI_q_PostFueling	Limited to be less than (H_FSI_q_TotalFueling - H_FSI_q_LatePostFueling - H_FSI_q_PilotFueling - H_FSI_q_Vep1Fueling - H_FSI_q_Vep2Fueling).
	fsi_main_fueling	temporary variable calculated as (H_FSI_q_TotalFueling - H_FSI_q_LatePostFueling - H_FSI_q_PilotFueling - H_FSI_q_Vep1Fueling - H_FSI_q_Vep2Fueling - H_FSI_q_PostFueling).
gas main fueling passed by call	fsi_main_gas_fueling	temporary variable limited to be less than fsi_main_fueling and also to be less than H_FSI_q_TotalFueling - diesel total fueling from the based controls).
	H_FSI_q_MainGasFueling	Case: C_FSM_FuelSystemType = 0 Diesel only { Forced to zero } Case ((C_FSM_FuelSystemType != 0) and (C_IFC_s_GasAndDiesel = 2)) gas from base controls { use fsi_main_gas_fueling } Case ((C_FSM_FuelSystemType != 0) and (C_IFC_s_GasAndDiesel = 1)) gas derived when not starting) { If H_FSI_s_Cranking = 0 use fsi_main_fueling else force to zero} Case ((C_FSM_FuelSystemType != 0) and (C_IFC_s_GasAndDiesel = 0)) gas always derived) { use fsi_main_fueling}
gas main fueling passed by call	H_FSI_q_MainGasFueling	forced to zero if ((C_IFC_s_GasAndDiesel = 0) or (FSI_s_Cranking=0)) set to fsi_main_with_gas if ((C_IFC_s_GasAndDiesel = 1) and (FSI_s_Cranking = 1)) this is the start on diesel case using the only interface method set to the minimum of fsi_main_with_gas and gas main fueling passed by function call if C_IFC_s_Cranking =2.
	H_FSI_q_MainFueling	Calculated as fsi_main_with_gas - H_FSI_q_MainGasFueling
dsl VEP1 SOI passed by call	H_FSI_ca_VEP1SOI (Not supported)	
dsl VEP2 SOI passed by call	H_FSI_ca_VEP2SOI	
dsl pilot to main inj sep passed by function call	H_FSI_ti_Pilot2MainInj	
dsl main to post inj sep passed by function call	H_FSI_ti_Main2PostInj	
dsl main SOI passed by call	H_FSI_ca_MainSoi	
dsl late post SOI passed by call	H_FSI_ca_LatePostSoi	

6.1.2 Overriding FSI Injection Commands

Often its desirable to command the FSI injection outputs independent of the base control. This is done using C_FSI_s_StopFuel as follows:

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Table 3: Fuel System Interface (FSI) Injection Overrides

C_FSI_s_StopFuel	Allow override mask for FSI parameters: Bit 0: Override total fueling (H_FSI_q_TotalFueling) Bit 1: Override rate shape, pilot & post (H_FSI_q_PilotFueling & H_FSI_q_PostFueling) Bit 2: Override commanded pressure (H_FSI_hp_Cmd) Bit 3: Override key switch flag (H_FSI_s_Key) Bit 4: Override measured battery voltage (H_FSI_v_Batt) Bit 5: Override cranking status flag (H_FSI_s_Crank) Bit 6: Override FSO valve command (H_FSI_s_FSO) Bit 7: not used
Override Final_Timing	Set User_Override_Timing_Enable = ENABLE Set User_Override_Timing to desired BTDC value
Override Final_Fueling	Set User_Override_Fueling_Enable = ENABLE Set User_Override_Fueling = desired value

* note, FSI injection outputs will not have any effect if C_IFC_s_StopOntime = 1.

6.1.3 Remaining Input Conversions and Overrides

Table 4: Fuel System Interface (FSI) Remaining Input Conversions and overrides

CM2150 Core Variable	FSI output variable	Comment
Harness_Key_ECM_Instance	FSI_ct_ECM	Indicates which ECM FSSC software is operating
Fuel_High_Pressure_Command	H_FSI_hp_Cmd	This is the desired Accumulator Pressure To override, set C_FSI_s_StopFuel |= 0x04, and type over H_FSI_hp_Cmd
Engn_Actual_State	H_FSI_s_Cranking	Indicates if the Cranking algorithm is in control of fueling To override, set C_FSI_s_StopFuel |= 0x20, and type over H_FSI_s_Cranking
FSO_Command	H_FSI_s_EnableFuel	Flow Demand to Inlet Metering Valve (IMV) is commanded OFF if Engine_Speed > 0 and H_FSI_s_EnableFuel is 0. To override, set C_FSI_s_StopFuel |= 0x40, and type over H_FSI_s_EnableFuel

6.1.4. FSI Outputs Back to the Non Fuel System Base Controls

Table 5: Fuel System Interface (FSI) Outputs to Base

FSI output variable	Derived From
dsl pilot feedback passed by function call	H_IFC_q_PilotFueling
diesel total feedback passed by function call	H_IFC_q_TotalFueling (total diesel fueling, does not include gas fueling)
dsl late post (post2) feedback passed by function call	H_IFC_q_LatePostFueling
dsl post feedback passed by function call	H_IFC_q_PostFueling
dsl feedback pilot to main passed by function call	H_IFC_ti_Pilot2MainInj
dsl feedback main to post passed by function call	H_IFC_ti_Main2PostInj
dsl main feedback SOI passed by function call	H_IFC_ca_MainSoi
dsl late post (post2) feedback SOI passed by function call	H_IFC_ca_LatePostSoi
diesel accumulator pressure feedback passed by function call	APC_hp_Fdbk
FSS_Key_Off_Shutdown	Does not exist in Core2
FSS_FSO_Request	Does not exist in Core2
FSS_Total_Fuel_Delivered	Not supported in Core2 yet Derived from EVT_q_totalFlDelivered_v, See expert for further information
FSS_Pressure_Error	Does not exist in Core2
FSS_EOI	Does not exist in Core2
FSS_Fueling_Derate_Executed	Does not exist in Core2
FSS_Fueling_Derate_Request	Does not exist in Core2
FSS_RPM_Derate	Does not exist in Core2

6.1.5 FSI Mfg Fueling Adjustment

Total fueling may be adjusted by a fixed percentage (T_FSI_r_MfgFuelAdj). The adjustment amount (H_IFC_q_AdjustedMain) is calculated by multiplying FSI_q_TotalFueling by T_FSI_r_MfgFuelAdj. The fueling adjustment is applied to the main diesel injection pulse. T_FSI_r_MfgFuelAdj is limited to the range of C_FSI_r_MfgFuelMinAdj to C_FSI_r_MfgFuelMaxAdj.

6.2 Injection Fueling Control (IFC)

IFC receives desired injection information from FSI, and determines the appropriate solenoid ontimes and positions to achieve the desired rate shape. Figures 1 and 2 indicate how the IFC outputs effect the injection control signals.

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Table 6: Injector Pulse Conversion Table

Fuel Cmd Input	Translated Fuel Cmd	Adjusted Fuel Cmd	Ontime Output
H_FSI_q_LatePostFueling	H_IFC_q_LatePostFueling	H_IFC_q_LatePostFueling (No adjustments)	H_IFC_ti_LatePostOntime
H_FSI_q_PilotFueling	H_IFC_q_PilotFueling	H_IFC_q_AdjustedPilot = H_IFC_q_PilotFueling + FTC_q_PilotComp	H_IFC_ti_PilotOntime
H_FSI_q_PostFueling	H_IFC_q_PostFueling	H_IFC_q_AdjustedPost = H_IFC_q_PostFueling + H_RSC_q_PostAdjustment + FTC_q_PostComp	H_IFC_ti_PostOntime
not supported	not supported	not supported	H_IFC_ti_Post2Ontime (for evaluation only, forced to 0 ms when C_IFC_s_StopOntime=0)
H_FSI_q_VEP1Fueling	Not supported	Not supported	Not supported
H_FSI_q_VEP2Fueling	H_IFC_q_VEP2Fueling	H_IFC_q_VEP2Fueling (No adjustments)	H_IFC_ti_VEP2Ontime
H_FSI_q_TotalFueling - H_IFC_q_PilotFueling - H_IFC_q_VEP2Fueling - H_IFC_q_PostFueling - H_IFC_q_LatePostFueling	H_IFC_q_MainFueling	H_IFC_q_AdjustedMain = H_IFC_q_MainFueling + H_RSC_q_MainAdjust + FTC_q_MainComp + H_IFC_q_MfgFuelAdj	H_IFC_ti_MainOntime
H_FSI_q_MainGasFueling	H_IFC_q_MainGasFueling	H_IFC_q_MainGasFueling (No Adjustment)	H_IFC_ti_GasMainOntime, (Gas systems only

6.2.1 Injected Fuel Command Conversion – Cylinder Independent

During normal operation, (C_IFC_s_StopOntime <> 1), IFC converts Fuel Commands into injector ontimes. Table 6 captures the appropriate variable names for each injection signal.

6.2.1.1 Fuel Commanded input Translation

IFC generally translates FSI fuel command inputs into IFC versions, limiting the number of allowed injection pulses to be no more than the driver signal BVC_ct_MaxInjPulses. Injection pulses are limited by setting the translated output to a 0mg/stk value. When limiting injection pulses VEP1 is given the lowest priority then Post, Vep2, Pilot, and then Late Post. Diesel Main Fueling is always allowed.

The Translated Fuel Command is also forced to zero when an injection pulse is too large to fit. See the IFC position calculation section for further details.

6.2.1.2 Fuel Command Compensation Adjustments

During normal operation, (C_IFC_s_StopOntime <> 1), IFC Adjusts the translated fuel command to compensate for inadequacies of the fueling to ontime conversion table. Generally, the adjusted fuel command is calculated as the sum of the translated fuel command and the adjustments applicable for the particular injection pulse.

6.2.1.3 Ontime Conversion

During normal operation, (C_IFC_s_StopOntime <> 1), IFC converts the Adjusted Fuel Command into an injection pulse ontime. Normally the conversion is done using the C_IFC_ti_DieselOntimeTable lookup table. As an option, the C_IFC_ti_AuxDieselOntime table can be selected when the appropriate bit of C_IFC_x_UseAuxFonMask is set.
Bit 0: Use C_IFC_ti_AuxDieselOntime to calculate H_IFC_ti_PilotOntime when set.
Bit 1: No Effect, C_IFC_ti_DieselOntime is always used to calculate H_IFC_ti_MainOntime.
Bit 2: Use C_IFC_ti_AuxDieselOntime to calculate H_IFC_ti_PostOntime when set.
Bit 3: No Effect, Reserved for VEP1.
Bit 4: Use C_IFC_ti_AuxDieselOntime to calculate H_IFC_ti_VEP2Ontime when set.
Bit 5: Use C_IFC_ti_AuxDieselOntime to calculate H_IFC_ti_LatePostOntime when set.
The Adjusted Fuel Command and Accumulator Pressure (APC_hp_Fdbk) are used as inputs to the Fueling to Ontime conversion table lookup for each injection pulse.

6.2.2 Injection Position Determination – Cylinder Independent

Table 7: Injection Pulse Conversion Table

Injection Position Input	Translated Position	Un-adjusted Conversion	Adjusted Position Output
H_FSI_ca_MainSoi	H_IFC_ca_MainSOI	H_IFC_ca_MainSOTTL using	H_IFC_ca_MainSOTTL

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		C_IFC_ti_SOIDelayTable	(No adjustment)
H_FSI_ti_Pilot2MainInj	H_IFC_ti_Pilot2MainInj	H_IFC_ti_P2mDelay using C_IFC_ti_SOIDelayTable and C_IFC_ti_EOIDelayTable (as function of pilot fueling)	H_IFC_ti_P2mDelay (No adjustment)
H_FSI_ti_Main2PostInj	H_FSI_ti_Main2PostInj	H_IFC_ti_M2pDelayBeforeRsc using C_IFC_ti_SOIDelayTable and C_IFC_ti_EOIDelayTable (as function of main fueling)	H_IFC_ti_M2pDelay = H_IFC_ti_M2pDelayBeforeRsc + H_RSC_ti_PostSoiDelayAdj.
not supported	not supported	H_IFC_ti_P2pDelay (for evaluation only, un-driven)	H_IFC_ti_P2pDelay (No adjustment)
H_FSI_ca_LatePostSOI	H_IFC_ca_LatePostSOI	H_IFC_ca_LatePostSOTTL	H_IFC_ca_LatePostSOTTL (No Adjustments)
H_FSI_ca_VEP2SOI	H_IFC_ca_VEP2SOI	H_IFC_ca_VEP2SOTTL	H_IFC_ca_VEP2SOTTL (No adjustment)
H_FSI_ca_GasMainSOI	H_IFC_ca_GasMainSOI	H_IFC_ca_GasMainSOTTL = H_IFC_ca_GasMainSOI (SOI delay compensation is not available)	H_IFC_ca_GasMainSOTTL (No adjustment)

6.2.3 Overriding Ontimes – Cylinder Independent

The “Ontime Outputs” (see table 6) and “Adjusted Position Outputs” (see table 7) can be directly override by the user by setting C_IFC_s_StopOntime to 1.

IFC overrides can be configured to take effect in all applicable ECM’s of a multiple ECM’s system. Setting C_IFC_s_CommDataExchEnable = 2 will cause the override ontime and position information in the primary fuel system ECM to be shared with the other ECM’s.
.

6.2.4 Fueling Adjustments Per Cylinder

Generally, IFC receives per-cylinder fueling adjustments from various algorithms and calculates the ontime change needed to make the fueling correction. Table 8 describes the variables used for the calculation for each injection pulse.

Table 8: Adjustment Conversion Table

Adjusted Fueling Adjustment Calculation	Unadjusted Ontime Input	Delta Ontime Adjustment
H_IFC_q_AdjustedPilot + P_CBD_q_TrimTable[ ](H_IFC_q_AdjustedPilot) + H_FSI_q_PilotBaseAdjust[ ]	H_IFC_ti_PilotOntime	H_IFC_ti_CbdPilotAdjust[ ]
H_IFC_q_AdjustedMain + P_CBD_q_TrimTable[ ](H_IFC_q_AdjustedMain) + H_FSI_q_MainBaseAdjust[ ]j + H_SNC_q_CylBias[]	H_IFC_ti_MainOntime	H_IFC_ti_CbdMainAdjust[ ]
H_IFC_q_AdjustedPost + P_CBD_q_TrimTable[ ](H_IFC_q_AdjustedPost)	H_IFC_ti_PostOntime	H_IFC_ti_CbdPostAdjust[ ]
H_IFC_q_VEP2Fueling + P_CBD_q_TrimTable[ ](H_IFC_q_VEP2Fueling) + H_FSI_q_VEP2BaseAdjust[ ]	H_IFC_ti_VEP2Ontime	H_IFC_ti_CbdVEP2Adjust[ ]

6.2.4.1 Array Indexing vs Cylinder Numbering

In most software applications, the algorithm sequences through the 10 array indexes at a fixed rate. The array index is defined as an index that EVT uses for processing and is NOT physical cylinder based. The index method allows Each ECM to convert and store less information assuming that a particular ECM will never drive more than 10 cylinders but some engines could have up to 18 cylinders total. Currently, the CBD look up is using the index while the CBD output is actually physical cylinder based. We are getting by today because the CBD interface is only used on a 6 cylinder engine where the EVT index and the physical cylinder are synonymous.

The software can be configured to calculate a physical cylinder on demand from an algorithm outside the fuel system. Currently FSSC is not directly supporting any of these applications.

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6.2.4.2 Other Inputs

C_IFC_s_UseCBD	Effect
C_IFC_s_UseCBD	Bi t 0: Enables CBD Pilot adjustment when set. Bi t 1: Enables CBD Main adjustment when set. Bi t 2: Enables CBD Post adjustment when set. Bi t 3: No effect, Reserved for CBD VEP1 adjustment. Bi t 4: Enables CBD VEP2 adjustment when set. Bi t 5: Enables CBD Pilot adjustment when set
C_IFC_s_StopOntime	If greater than 0, All Delta Ontime outputs forced to zero

6.2.5 Adjusting Multiple Cylinders Simultaneously

The ontime of the diesel main and gas main injection can be changed to several cylinders simultaneously. This is useful to apply a sudden bank imbalance for UFD or CBD testing. C_IFC_x_CylAdjSel can select which IFC-EVT array indexes receive the adjustments. The adjustment is local to the ECM and is not conveyed to the other ECM's in a multi-ECM system.

Table 10: Simultaneous Main Adjustment

Input	Output	Description
C_IFC_ti_CylAdj	ifc_ti_dieselontimeadj[ ]	Adjustment applied to the diesel main pulse injectors designated by C_IFC_x_CylAdjCel
C_IFC_ti_GasCylAdj	ifc_ti_gasontimeadj[ ]	Adjustment applied to the gas main pulse injectors designated by C_IFC_x_CylAdjCe

6.2.6 Determining what ontime the ECM used per cylinder

Each of the IFC cylinder independent outputs are mapped to EVT index outputs. The array index is defined as an index that EVT uses for processing and is NOT physical cylinder based. The index method allows Each ECM to convert and store less information assuming that a particular ECM will never drive more than 10 cylinders but some engines could have up to 18 cylinders total.

Table 11: Per Cylinder EVT outputs

Output Calculation	IFC cylinder dependant output variable
H_IFC_ti_PilotOntime + H_IFC_ti_CbdPilotAdjust[ ] + MIT_ti_PilotAdjust_T[]	EVT_ti_DieselOntime1[ ]
H_IFC_ti_MainOntime + H_IFC_ti_CbdMainAdjust[ ] + MIT_ti_MainAdjust_T[] + C_IFC_ti_UserTrim[] + ifc_ti_dieselontimeadj[ ]	EVT_ti_DieselOntime2[1]
H_IFC_ti_PostOntime + H_IFC_ti_CbdPostAdjust[ ] + MIT_ti_PostAdjust_T[]	EVT_ti_DieselOntime3[1]
H_IFC_ti_Post2Ontime (no adjustment)	EVT_ti_DieselOntime4[ ]

If (C_IFC_s_VepMode = 1)
{ 0 ms (Not supported) }
else
{ H_IFC_ti_VEP2Ontime + H_IFC_ti_CbdVEP2Adjust[ ] + MIT_ti_VEP2Adjust_T[]
}
	EVT_ti_DieselVEP1Ontime[ ]

If (C_IFC_s_VepMode = 1)
{ H_IFC_ti_VEP2Ontime + H_IFC_ti_CbdVEP2Adjust[ ] + MIT_ti_VEP2Adjust_T}
else
{ 0 ms (Not supported) }
	EVT_ti_DieselVEP2Ontime[ ]

If (C_IFC_s_KeepPostSOTTL == 0)
{ H_IFC_ti_P2mDelay (no adjustment) }
Else
{ H_IFC_ti_P2mDelay - H_IFC_ti_CbdMainAdjust[ ] - MIT_ti_MainAdjust_T[] }
	EVT_ti_DieselDelay12[ ]

H_IFC_ti_M2pDelay (no adjustment)	EVT_ti_DieselDelay23[ ]
H_IFC_ti_P2pDelay (no adjustment)	EVT_ti_DieselDelay34[ ]
H_IFC_ca_VEP2SOTTL (no adjustment)	EVT_ca_DieselVEPSOTTL[ ]
H_IFC_ca_VEP2SOTTL (no adjustment)	EVT_ca_DieselVEPSOTTL2[ ]
0 ms (not supported)	EVT_ti_DieselVEPDelay12[ ]

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If (H_IFC_ti_PilotOntime = 0)
{ H_IFC_ca_MainSOTTL }
else
{ H_IFC_ca_MainSOTTL + (H_IFC_ti_PilotOntime +
H_IFC_ti_P2mDelay) * Engine_Speed * 6 / 1000 }
	H_EVT_ca_FuelTTLSoi[ ]

H_IFC_ti_GasMainOntime + ifc_ti_gasontimeadj[ ] + H_MIT_q_GasMainTrim[ ] (Only available in gas hybrid software builds)	EVT_ti_GasOntime[ ]
H_IFC_ca_GasMainSOTTL (Only available in gas hybrid software builds)	H_EVT_ca_GasSOTTL[ ]

6.2.7 Cylinder Cutout

Cylinders can be cut out via C_FSI_x_CylCutOutMask. Bit 0 will cutout physical cylinder 1, Bit 1 will cutout physical cylinder 2 and so on. In gas systems both the diesel and gas direct injectors will be cutout.

Cylinder Cutouts can also occur as a result of service tool FTIS operations. Cylinders cutout from C_FSI_x_CutoutMask or from a tool operation can be determined by looking at FSI_x_CutoutMask which uses the same bitmapping scheme as C_FSI_x_CutoutMask.

FSI_s_CylindersCutOut_T can also be used to view cylinder cutout status. FSI_s_CylindersCutOut_T is mapped to physical cylinders where the 0 element if physical cylinder 1, the 1 element is physical cylinder 2 and so on. FSI_s_CylindersCutOut_t[cylinder-1] is 0 if the cylinder is unused, 1 if the cylinder is not cutout, 2 if the cylinder is cutout from a tool operation, and 3, if the cylinder is cutout from an injector electrical fault, or from C_FSI_x_CylCutOutMask.

Multi-Module systems: Cutouts are executed from the Primary Fuel system ECM. The Fuel Manager and the FSM IXPS component work together to communicate cylinder cutout information by reading FSI_x_CylCutoutMask in the Primary Fuel system ECM, and writing to the same variable in the Fuel system children. The primary fuel system is the ECM where C_FSI_ct_PrimaryFuelSystem is equal to FSI_ct_ECM, which corresponds to Harenss_Key_ECM_Instance.

The fuel manager communicates Fuel System per cylinder indexing information to the driver via an EVT buffer index system instead of physical cylinders. Physical cylinder based FSI_x_CylCutoutMask is translated to the EVT buffer index based Cylinder enable mask (FSI_x_ExtCylMask) using C_EVT_ct_CylToIndexMap_T (See the EVT Handling Section). The translation of FSI_x_CylCutoutMask to FSI_x_ExtCylMask occurs in each ECM independently. Only the first C_EPS_ct_Cylinders will be translated.

6.3 Gas MIT operation

Injector variation can be compensated for using Per Cylinder MIT Trim adjustments. MIT calculates pulse specific adjustments per cylinder based on adjustment tables.

MIT Input	MIT Output / Result
C_MIT_s_GasEnable	Allows the compensation to be selected per pulse Bit 0 reserved Bit 1 Main Compensation Bit 2 reserved Bit 3 reserved Bit 4 reserved
C_MIT_s_StopGasTrim	Causes MIT algorithm to stop executed allowing the user to manually type corrections in: H_MIT_q_GasMainTrim[ ]
H_IFC_q_GasMainFueling	H_MIT_q_GasMainTrim[ ] using T_MIT_q_GasCylTrimTable_x (where x = index)

6.4 Diesel MIT operation – TBD

6.5 Rate Shape Compensation (RSC)

6.5.1 RSC Overview

The purpose of the RSC algorithm is to compensate the injector ontime and position commands for interactions between the various injection pulses (pilot, main, post). Injection events create pressure wave dynamics that affect the metering of subsequent pulses. The injection interference is a sinusoidal bias in fuel delivery which is principally a function of separation. RSC adjusts the main injection pulse for the effects of the pressure disturbance created by the pilot injection pulse. The pilot-to-main (p2m) compensation is determined by a series of surface lookups. The principle inputs to the p2m interaction calculations are pilot-to main separation time, accumulator pressure, and pilot quantity. The main result of the p2m compensation is a fueling adjustment amount, H_RSC_q_MainAdjustment, which is used to bias the

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main fuel command prior to the FON table lookup in IFC. RSC also has an algorithm which counteracts the interference of the main injection event on the post injection metering. RSC calculates a post fueling adjustment, H_RSC_q_PostAdjustment, as a function of main2post separation. The m2p adjustment is added to the post fueling command immediately prior to the FON table lookup.

Table 12: Rate Shape Compensation (RSC)

RSC Variable	Description
H_RSC_q_MainAdjustment	The amount to adjust the main Fuel command by to maintain proper fueling given the pilot interaction. See the RSC SDR for further information.
H_RSC_q_PostAdjustment	The amount to adjust the post fuel command by to maintain proper fueling given the main interaction. See the RSC SDR for further information.
C_RSC_q_MainCorrPhaseTable	This is the principle table which characterizes the p2m interaction. The table typically is sinusoidal as pulse separation time varies at a fixed accumulator pressure.

6.5.2 RSC Enable

The RSC algorithm can be disabled or enabled via C_RSC_s_Enable. The least significant bit (bit0) enables compensation of main injection due to pilot (p2m) interaction. Bit 1 enables the main to post (m2p) interaction compensation.

6.6 Fuel System Derate Handler (FDH)

FDH determines derates based on Fuel system conditions and errors. The derate handler invoke fueling derates, torque derates, pressure command limit derates and shutdowns. Each derate action can be separately calibrated to occur from any error which is processed by the derate handler.

In addition to the error based derate system, a fueling derate as a function of accumulator pressure is supported. The pressure based derate is intended to protect the engine from damaged caused by very late injection which can occur at high fuel demands in combination with low accumulator pressures.

6.6.1 Error Mapping

FDH Variable	Description
H_FDH_x_ErrorState	A 32 bit Word containing all the errors processed by FDH, where each error is bit mapped as follows: bit 0: Accumulator pressure is very high bit 1: Accumulator pressure is higher than commanded bit 2: Accumulator pressure is low bit 3: Accumulator pressure is very low bit 4: Accumulator pressure signal is electrically out of range bit 5: Accumulator pressure signal is not rational (SIR) bit 6: EPS main sensor problem or running on backup sensor bit 7: EPS backup sensor problem bit 8: EPS phase error between main and backup sensor bit 9: Cylinder Balancing Diagnostic (CBD) Trim Error bit 10: Injector Boost Voltage is too low bit 11: IMV electrical resistance error bit 12: Inlet Metering Valve Flow Demand is higher than expected bit 13: Inlet Metering Valve Flow Demand is lower than expected bit 14: ADD Injector error bit 15: ADD FSPWM0 (Lift Pump) error bit 16: ADD FSPWM1 (IMV or Kom Act) error bit 17: Accumulator pressure Bank-to-Bank imbalance bit 18-19: not used bit 20: ShutDown From Other FSM CEN ECM bit 21: Large Derate From Other FSM CEN ECM bit 22: Moderate Derate From Other FSM CEN ECM bit 23: Selected Msg Time Out From Other FSM CEN ECM (fset when fdh_timeout_selection is != 0) bit 24: Pressure Cmd Derate From Other FSM CEN ECM: bit 25-31- not used

6.6.2 Fueling and Torque Error Based Derates

Variable	Description
H_FDH_q_MustDerate	Final Total Fueling Derate level selected by FDH as the lowest of: Error Based Derate

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	H_FDH_q_PRSBasedLimit GSE_Q_MasInjectedGasFueling (Only applicable to gas systems If both error based derates (Large and Moderate) are simultaneously selected, the Large Derate will win irrespective of which derate asks for the lowest fueling level.
H_FDH_r_TrqDerate	Selected error based Torque Derate Index. If both error based derates (Large and Moderate) are simultaneously selected, the Large Derate will win irrespective of which derate asks for the lowest torque level. The fuel system calculates maximum torque derate level by interpolating between EPD_Max_Derate and (EPD_No_Derate_Torque using H_FDH_r_TrqDerate as the interpolation index. An index of 1 will cause the fuel system to request EPD_Max_Derate
C_FDH_q_PrsBasedLimitTable	Table specifying derate necessary to protect the engine against late injection, as a function of accumulator pressure. Lookup result stored in H_FDH_q_PRSBasedLimit
H_FDH_q_PRSBasedLimit	Fueling derate selected by C_FDH_q_PrsBasedLimitTable but is limited to zero if any of the following conditions are true 1. EPS_s_Status is FAILED or STOPPED 2. APC_hp_Fdbk has not exceeded C_IFC_hp_MinStart since power up.
C_FDH_x_LargeDerateMask	Select's which errors should cause a large torque and fueling derate, using the same format as H_FDH_x_ErrorState. Multi-Module Consideration: A Large Derate can also invoked from other FS ECM's in the system. See the FDH multi module section for further information.
C_FDH_q_LargeDerate	The fueling derate Level commanded when Large error based derates are selected
C_FDH_r_LargeTrqDrtIdx	The torque derate index level commanded when Large error based derates are selected
C_FDH_x_ModerateDerateMask	Select's which errors should cause a moderate derate, using the same format as H_FDH_x_ErrorState. Multi-Module Consideration: A Large Derate can also invoked from other FS ECM's in the system. See the FDH multi module section for further information
C_FDH_q_ModerateDerate	The fueling derate Level commanded when moderate error based derates are selected
C_FDH_r_ModerateTrqDrtIdx	The torque derate index level commanded when moderate error based derates are selected
H_FDH_ct_DerateWinner	Indicates which algorithm triggered any active derate. Algorithms are enumerated based on errorState (bit0 = 1, bit1 =2, bit2 = 3...). A value of 0 indicates that only the pressure based derate is active. A value of 255 indicates that the derate was caused from a different ECM in a multimodule system

6.6.3 Pressure Derates

Variable	Description
FDH_hp_Derate	APC algorithm limits the commanded accumulator pressure (APC_hp_Cmd) to be less than this.
C_FDH_x_PrsDerateMask	Select's which errors should cause a pressure derate, using the same format as H_FDH_x_ErrorState. Commanded pressure is limited to C_FDH_hp_PrsDerateTbl.

6.6.4 Shutdown

Variable	Description
H_FDH_q_MustDerate	Maximum Total injected fueling allowed by the fuel system forced to 0 mg/ stk for shutdown
H_FDH_s_PumpDemand	Specifies how the pumping and ontime control should operate, as follows 1 Normal operation 2 Limp Home operation (ignore accumulator pressure) 0 ShutDown (Demanding zero pump flow)
C_FDH_x_ShutDownMask	Select's which errors should cause a shutdown, using the same format as H_FDH_x_ErrorState. A shutdown causes H_FDH_q_MustDerate to become 0 and also demands 0 pump flow
H_FDH_ct_ShutDownWinner	Indicates which algorithm triggered an active shutdown, Algorithms are enumerated based on errorState (bit0 = 1, bit1 =2, bit2 = 3...). A value of 0 indicates that shutdown is not active. A value of 255 indicates that the shutdown was caused from a different ECM or from a communications issue in a multimodule system

6.6.5 Limp Home Operation

FDH Variable	Description
C_FDH_x_LimpHomeMask	Select's which errors should cause the pump control to use limp Home control methods, ignoring the pressure sensor measurements. (usually triggered based on pressure sensor failure), using the same format as H_FDH_x_ErrorState.

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H_FDH_ct_LimpHomeWinner	Indicates which algorithm triggered the limp home demand. Algorithms are enumerated based on errorState (bit0 = 1, bit1 =2, bit2 = 3...). A value of 0 indicates that limp home is not active
H_FDH_s_PumpDemand	Specifies how the pumping and ontime control should operate, as follows 1 Normal operation 2 Limp Home operation (ignore accumulator pressure) 0 ShutDown (Demanding zero pump flow)

6.6.6 Multi-Module Considerations

Generally derates actions taken from other ECM's are indicated via the appropriate bits of FDH_x_ErrorState.FDH can than be calibrated to activate the derate in the receiving ECM. This allows the calibrator flexibility to coordinate derates between ECM's or keep derate actions local to an ECM.

Multi Module Variable	Description
FSI_x_MsgTimeout	FDH input indicating the status of FS related communications messages. Bit 0: Diesel Aux Timeout Bit 1: FSM Command Timeout Bit 2: Status Timeout Bit 3: Tool Command Timeout Bit 4: Gas Aux Time out Bit 5,6: Unused Bit 7: NO_CEN_Compatibility
C_FSI_x_MsgTimeoutShutDownMask	Sets bit 23 of FDH_x_ErrorState when the bitwise and of this and FSI_x_MsgTimeout is non zero.
fdh_timeout_selection	Result of bitwise and of FSI_x_MsgTimeout C_FSI_x_MsgTimeoutShutDownMask Sets bit 23 of FDH_x_ErrorState when the result is non zero
FSI_s_StatusFromOthers	Derate command status from other ECMs's. In a child ECM it is the derate command status from the primary ECM. In the primary ECM it is the composite of the derate command status from the other fuel system ECM's Bit 0: Shutdown action taken in other ECM Bit 1: Large Derate action taken in other ECM Bit 2: Moderate Derate action taken in other ECM Bit 3: Indicates a timeout has occurred bit 4-9: outside scope of FDH bit 10: Pressure cmd Derate action taken in other ECM bit 11-15: outside scope of FDH
FSI_s_StatusFromToOthers	Derate command status sent to other ECM's Bit 0: Shutdown action taken Bit 1: Large Derate action taken Bit 2: Moderate Derate action taken bit 3-9: outside scope of FDH bit 10: Pressure cmd Derate action taken bit 11-15: outside scope of FDH Generally the bit is set if the sending ECM is taking the action indicated and: 1) FSI_ct_ECM = C_FSI_ct_PrimaryECM or 2) Action taken is not from another ECM via FDH_x_ErrorState This allows all ECM's to coordinate a derate action while preventing the action to become locked in via a ring of communications between the Primary ECM and the Children

6.7 Event Handling (EVT)

EVT is a "Low" level algorithm which interfaces with EPS, IFC, and the TPU to generate the commanded injector ontime and position signals. EVT calibrations should only be modified by an expert

6.7.1 Task Scheduling

The EVT software handles the execution of fuel system tasks which are required to run at specific engine angle positions over the engine' 720o cycle. There are a .nite number of execution points. Depending on the health of the EPS sensors, the EVT software can schedule tasks on the main or backup EPS teeth. The EVT software outputs H_EVT_s_Target to indicate which EPS sensor is being used to schedule tasks.

Table 13: H_EVT_s_Target Output Description

H_EVT_s_Target	Description
0	tasks scheduled on main EPS teeth
1	tasks scheduled on backup EPS teeth

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The arrays C_EVT_x_MainSchedule1 and C_EVT_x_MainSchedule2 are used to schedule tasks on EPS main teeth. These arrays are 120 x 16-bits, one index for each main EPS tooth. Each array entry reserves the upper 11 bits to identify the task or tasks to run on that EPS main tooth. The lower 5 bits identifies the cylinder (or bank) on which the tasks in the upper .eld will operate. The following table depicts the bit assignments described above.

Table 14: C_EVT_x_MainSchedule Task Bit Assignments

H_EVT_s_Target	Description
15	Pressure Measurement
14	Diesel injection init (normal)
13	Gas injection init (normal)
12	Diesel recharge init (normal)
11	Gas recharge init (normal)
10	Reserved
9	Reserved
8	Reserved
7	Denso Pump Highside Init
6	Denso Pump Lowside Enable
5	Denso Pump Lowside Disable
0 – 4	Cylinder Number*

*value of field is one less than actual cylinder number

Multiple tasks can be scheduled per tooth. In this case, the tasks execute in the order of their assigned bit significant. Two arrays C_EVT_x_MainSchedule1 and C_EVT_x_MainSchedule2 allow scheduling tasks operating on two different cylinders for each main EPS tooth. The tasks in C_EVT_x_MainSchedule1 execute before the tasks in C_EVT_x_MainSchedule2.

The arrays C_EVT_x_BkupSchedule1 and C_EVT_x_BkupSchedule2 are used to schedule tasks on EPS backup teeth. These arrays are 24 x 16-bits. One index is consumed per tooth. Each array entry reserves the upper 11 bits to identify the task or tasks to run on that EPS backup tooth. The lower 5 bits identifies the cylinder (or bank) on which the tasks in the upper .eld will operate. The following table depicts the bit assignments described above.

Table 15: C_EVT_x_BkupSchedule Task Bit Assignments

Bit	Task
15	Pressure Measurement
14	Diesel injection init (normal)
13	Gas injection init (normal)
12	Diesel recharge init (normal)
11	Gas recharge init (normal)
10	Reserved
9	Reserved
8	Reserved
7	Denso Pump Highside Init
6	Denso Pump Lowside Enable
5	Denso Pump Lowside Disable
0 – 4	Cylinder No (minus 1)

Multiple tasks can be scheduled per tooth. In this case, the tasks execute in the order of their assigned bit significant. Two arrays C_EVT_x_BkupSchedule1 and C_EVT_x_BkupSchedule2 allow scheduling tasks operating on two different cylinders for each backup EPS tooth. The tasks in C_EVT_x_BkupSchedule1 execute before the tasks in C_EVT_x_BkupSchedule2.

A Matlab script (evt_calibrate.m) is available to assist calibrating the EVT schedule tables.

Pressure Measurement Task. Pressure samples are gathered crank synchronously. The Pressure Measurement task processes the pressure samples for use by the software application. One Pressure Measurement task should be scheduled per cylinder. Each scheduled tooth should be at the same relative position with respect to its cylinder's top dead center (TDC) position.

Injection Init Task. The primary functions of the Injection Init task are: (1) instruct the TPU to generate the commanded injection pulse waveforms and (2) set up the cylinder select outputs to activate the commanded low side driver. One Injection Init task should be scheduled per cylinder. If gas and diesel injection are both used, both Injection Init tasks can be scheduled per cylinder.

There are a couple of scheduling considerations when operating on the main EPS target. First, the Injection Init task stops all recharge pulsing on the present bank. Second, the Injection Init task must .nish before the injection is commanded to start. The scheduled tooth must be delayed as much as possible to achieve the most boost recharging. However, the scheduled tooth must be advanced to ensure the task always completes before the earliest possible injection pulse start.

Scheduling the Injection Init task on the backup EPS target is simpler, since there are fewer options. The scheduled tooth should be the backup EPS tooth that immediately precedes the cylinder's top dead center (TDC) position.

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Recharge Init Task. The primary functions of the Recharge Init task are: (1) instruct the TPU to generate the commanded recharge pulse waveforms and (2) set up the cylinder select outputs to activate the commanded low side driver(s). One Recharge Init task should be scheduled per cylinder. If gas and diesel injection are both used, both Recharge Init tasks can be scheduled per cylinder.

Choosing the scheduled tooth for the Recharge Init should be done carefully. The Recharge Init task stops all injection pulses on the present bank. The scheduled tooth should be late enough to not interfere with long main or post injection pulses. However, the Recharge Init task should be scheduled early as possible to achieve the most boost recharging.

Scheduling the Recharge Init on the backup EPS target is simpler, since there are fewer options. The scheduled tooth should be the backup EPS tooth that immediately follows the cylinder's top dead center (TDC) position.

Denso Pump Highside Init Task. The Denso Pump Highside Init task instructs the TPU to generate the commanded pump pulse waveforms. The present application will only allow Denso pump operation on the main EPS target. One Denso Pump Highside Init task should be scheduled per cylinder. Each scheduled tooth should be at the same relative position with respect to the cylinder's top dead center (TDC) position. The Highside Init task must .nish before the pumping is commanded to start. The scheduled tooth should be advanced early enough to ensure pump turn-on.

Denso Pump Enable Task. The Denso Pump Enable task turns on the pump's lowside driver. The present application will only allow Denso pump operation on the main EPS target. One Denso Pump Enable task should be scheduled per cylinder. Each scheduled tooth should be at the same relative position with respect to the cylinder's top dead center (TDC) position. The Denso Pump Enable task must be scheduled prior to pump highside turn-on. Scheduling the Denso Pump Highside Init and Enable tasks on the same tooth is recommended.

Denso Pump Disable Task. The Denso Pump Disable Task turns off the pump's lowside driver. The present application will only allow Denso pump operation on the main EPS target. One Denso Pump Enable task should be scheduled per cylinder. Each scheduled tooth should be at the same relative position with respect to the cylinder's top dead center (TDC) position.

6.7.2 Calibrating Relative Cylinder TDC Position

The array C_EVT_ca_CylOffset is used to identify cylinder top-dead center (TDC) positions relative to cylinder #1 TDC. Only array indices 0 through N-1 are used, where N is the number of cylinders. Each array element C_EVT_ca_CylOffset[i] will range from 0 to 720o, indicating the angle difference from the .rst cylinder's TDC to the (i+1)th cylinder's TDC. C_EVT_ca_CylOffset[0] should always be 0. For an example, here's how you would calibrate a 6-cylinder engine, where the TDCs are equally spaced 120o degrees apart, and the ring order is 1-5-3-6-2-4.

Table 16: C_EVT_ca_CylOffset[i] Calibration Example

I	C_EVT_ca_CylOffset[i]
0	0°
1	480°
2	240°
3	600°
4	120°
5	360°

6.7.3 Mapping Cylinder Injection Command to Low Side Driver

The EVT software is capable of directing both diesel and gas cylinder injection commands to any of the ECM injector driver outputs. There are six low side drivers, one for each ECM injector driver output. The array C_EVT_ct_DieselCylSelMap maps the cylinder's diesel injection commands to the correct ECM injector low side driver. Similarly, the array C_EVT_ct_GasCylSelMap maps the cylinder's gas injection commands. The array indices 0 through N-1 represent the injection commands for cylinder's 1 through N. The array can take on values from 0 to 5 which represent selects for the ECM injector low side drivers 1 through 6, respectively.

6.7.4 Mapping Cylinder Injection Command to High Side Driver

The EVT software is capable of directing both diesel and gas cylinder injection command to any of the ECM injector driver outputs. There are two high side drivers, one for each bank of injector driver outputs. The array C_EVT_ct_DieselFSTTLMap maps the cylinder's diesel injection commands to the correct ECM high side driver. Similarly, the array C_EVT_ct_GasFSTTLMap maps the cylinder's gas injection commands. The array indices 0 through N-1 represent the injection commands for cylinder's 1 through N. The array can take on values of 0 or 1 which represent the bank number.

6.7.5 Mapping Bank Recharge Command to Low Side Driver

The EVT software is capable of selecting one or more bank injectors to perform recharging. The array C_EVT_x_RechargeCylSelMask maps a bank's recharge command to the correct ECM injector low side driver outputs. The array indices 0 and 1 represent banks 0 and 1. The array can take on values based on a cylinder select bitmask. See the table below for specific bit .eld assignments.

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Table 17: C_EVT_x_RechargeCylSelMask bit field values

Bit	Function
15	Cylinder 1 Select
14	Cylinder 2 Select
13	Cylinder 3 Select
12	Cylinder 4 Select
11	Cylinder 5 Select
10	Cylinder 6 Select

6.7.6 Mapping Denso Pump PVC Command to ECM Output

The EVT software expects a cylinder number assignment with each scheduled Denso Pump PVC task. The array C_EVT_ct_PvcDriverMap maps the associated cylinder number to the correct ECM output. The array indices 0 through N-1 represent cylinders 1 through N, respectively. The array can take on values 0 or 1 which represent ECM outputs HB0 and HB1, respectively.

Table 18: EVT Calibration Descriptions

Parameter	Description
C_EVT_ca_BkupSOTTLLatency	Minimum amount of crank degrees needed to setup an injection pulse while on the backup EPS target. This should factor in CPU and TPU latency and RPM slope offset correction.
C_EVT_ca_CylOffset	see section"Calibrating Relative Cylinder TDC Position" on page 27
C_EVT_ca_MainSOTTLLatency	Minimum amount of crank degrees needed to setup an injection pulse while on the main EPS target. This should factor in CPU and TPU latency, match tooth advancement and RPM slope offset correction.
C_EVT_ct_DieselCylSelMap	see section "Mapping Cylinder Injection Command to Low Side Driver" on page 27
C_EVT_ct_DieselFSTTLMap	see section "Mapping Cylinder Injection Command to High Side Driver" on page 27
C_EVT_ct_GasCylSelMap	see section "Mapping Cylinder Injection Command to Low Side Driver" on page 27
C_EVT_ct_GaseFSTTLMap	see section "Mapping Cylinder Injection Command to High Side Driver" on page 27
C_EVT_ct_PvcDriverMap	see section "Mapping Denso Pump PVC Command to ECM Output" on page 28
C_EVT_p_FuelHoldLevel	percent duty cycle proportional to hold current level threshold
C_EVT_p_FuelPullinLevel	percent duty cycle proportional to pullin current level threshold
C_EVT_p_Recharge1Failed	percent duty cycle proportional to peak recharge current level used with one failed cylinder on bank
C_EVT_p_Recharge2Failed	percent duty cycle proportional to peak recharge current level used with two failed cylinders on bank
C_EVT_p_RechargeNormal	percent duty cycle proportional to peak recharge current level threshold
C_EVT_s_PvcEnable	Flag used to enable the configuration and operation of the Denso pump. A value of 0 will turn off the Denso pump controls. Any other value will turn them on.
C_EVT_ti_InjPullinDefault	Time the pullin/hold line is held high after the FSTTL line is asserted, when C_EVT_ti_InjPullin is 0 and the accumulator pressure sensor has failed.
C_EVT_ti_InjPullinVector	Table to select the time the pullin/hold line is held high after the FSTTL line is asserted, as a function of accumulator pressure, when C_EVT_ti_InjPullin is 0 and the accumulator pressure sensor is good.
C_EVT_ti_InjPullin	When greater than zero, Time the pullin/hold line is held high after the FSTTL line is asserted.
C_EVT_ti_InjPullinExtend	Time the pullin/hold line is held high after the FSTTL line is asserted, when boost voltage is below the threshold C_EVT_vb_PullinTimeExtend
C_EVT_vb_PullinTimeExtend	Boost voltage threshold below which the injection pullin time is extended.
C_EVT_x_BkupSchedule1	See section "Task Scheduling" on page 23
C_EVT_x_BkupSchedule2	See section "Task Scheduling" on page 23
C_EVT_x_MainSchedule1	See section "Task Scheduling" on page 23
C_EVT_x_MainSchedule2	See section "Task Scheduling" on page 23
C_EVT_x_RechargeCylSelMask	See section "Mapping Bank Recharge Command to Low Side Driver" on page 28
C_EVT_ct_CylToIndexMap_T	Table that maps physical cylinders to EVT index values index into table is calculated as:

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	(Physical Cylinder - 1) * 2 + Type, where Type is 0 for Diesel, and 1 for Gas Each Table entry is defined as: Bits 0-3 (lower nibble): ecm_number, where 0 is the master ECM Bits 4-7 (upper nibble: EVT ontime array index for the physical cylinder, and type

6.8 Accumulator Pressure Control (APC)

APC controls High Pressure Pump inlet fuel .ow to control Accumulator pressure based on Accumulator pressure command. High Pressure pump inlet .ow is supplied by a mechanical pump and possibly an auxiliary electric lift pump (eLPP) then controlled via an Inlet Metering Valve (IMV). The IMV & eLPP are activated for priming then deactivated at zero engine speed. Also the IMV & eLPP may be activated/deactivated for service troubleshooting.

Table 19: Accumulator Pressure Control (APC) Commonly used variables

Variable	Description
C_APC_ct_DieselPrsControlECM	ECM number for Master pressure control (see FSI_ct_ECM)
C_APC_ct_DieselPrsSlaveECM	ECM number for Slave pressure control ECM (see FSI_ct_ECM), no slave = 255. Slave will run a secondary IMV at approx the same flow as the master
H_FSI_hp_Cmd	Accumulator Pressure Command, determined outside of APC
H_APC_qr_DslFueling	Commanded diesel injection fueling rate.(= H_FSI_q_TotalFueling * Engine_Speed * No of Cylinders / 2 / 60)
H_APC_qr_GasFueling	Commanded gas injection fueling rate.(= H_FSI_q_TotalFueling * Engine_Speed * No of Cylinders / 2 / 60)
H_APC_qr_Fueling	Estimated gross diesel fueling rate (sum of compensated H_APC_qr_DslFueling & H_APC_qr_GasFueling)
H_APC_qr_Cmd	High Pressure Pump (HPP) flow total demand. (see also C_APC_s_Flow) * Forced to 0 if RPM>0 and APC is disabled or if H_FDH_s_PumpDemand = DISABLE_PUMPING (0) * Forced to maxFlow if RPM>0 and H_FDH_s_PumpDemand = LIMP_HOME(2) * Forced to maxFlow if RPM=0 and key on for less than APC_ti_startUp_c
C_APC_s_RateLimit	Enable (1) / Disable (0) commanded pressure rate limiter. Implemented for HPDI systems.
H_APC_qr_Cmd1 & H_APC_qr_Cmd2	Flow demand for Master and Slave HPPs respectively. For one HPP systems H_APC_qr_Cmd1 = H_APC_qr_Cmd & H_APC_qr_Cmd2 = 0. For 2 HPP systems H_APC_qr_Cmd2 ~= H_APC_qr_Cmd / 2 and H_APC_qr_Cmd1 = H_APC_qr_Cmd - H_APC_qr_Cmd2
C_APC_i_ImaVector (vs C_APC_qr_ImaVector)	Table to convert H_APC_qr_Cmd into actuator control current
H_APC_i_ImaCmd	IMA current demand, calculated from H_APC_qr_Cmd using C_APC_i_ImaVector table. Note: If H_APC_qr_Cmd = 0 and RPM= 0, H_APC_i_ImaCmd is forced to 0 independent of C_APC_i_ImaVector
H_APC_i_ImaFltr & H_APC_v_ImaFltr	Filtered IMA current feedback & IMA voltage command
H_APC_p_ImaDuty	Pulse Width Modulated Duty Cycle commanded at the ECM IMA driver output to achieve the H_APC_i_ImaCmd current.
H_APC_r_ImaFltr	Filtered IMA resistance calculated from voltage & current
C_APC_s_FdbkType	Selects Accumulator Processing mode used for APC_hp_Fdbk calculations. 0: Average of Peak measurement from the last two injections 1: Peak measurement from the last injection 2: Average of Peak and Valley measurement from the last two injections 3: Peak and Valley measurement from the last injection 4: Always use Fixed Rate Processing 5: Process using FDP_x_Data
C_APC_s_Enable (supersedes C_APC_s_Flow)	Enable/override APC functions bit 0: Force H_APC_qr_Cmd = 0 if RPM > 0 bit 1: Override H_APC_qr_Cmd by setting H_APC_qr_FltdCmd bit 2: Use C_FDH_q_LargeDerate for limp-home limit (else C_APC_qr_AdptHighLimit)

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	bit 3: Enable Swept Volume Fatigue (SVF) test mode (TBD in Core2) bit 4: Force limp-home mode bit 5: Enable APC control without engine speed bit 6: Enable 2-stage MDV diagnostic bit 7: Not used
C_APC_s_Flow	Calibratable override of APC ima flow = 0, Normal operation = 1, Force H_APC_qr_Cmd = 0 if RPM > 0 = 2, Override, allows user to specify H_APC_qr_Cmd by setting APC_qr_fltdCmd_v to desired flow
C_APC_s_LppTimeout	LPP Time out flag: = 0, Lpp runs while engine is turning = 1, Lpp turns off after C_APC_ti_Startup sec provided APC_hp_Fdbk > C_APC_hp_LppCutOff
C_APC_ti_Startup	Time out period for LPP, sec
C_APC_hp_LppCutOff	Feedback pressure above which the LPP startup timer will run
APC_hp_Fdbk	Average of accumulator pressure measured at about 54 and 174 Degrees before TDC of current cylinder
H_APC_hp_Accum	Accumulator pressure measured at ~54 degrees before TDC of the current cylinder
H_APC_hp_Deviation	Calculated total rms control error.
H_APC_s_Error	Error Status of APC, bit mapped as: bit 0: (LSB) 2-stage MDV detected overpressure bit 1: Accum Pressure Sensor Out of Range bit 2: Bank-to-Bank Accum Pressure deviation error bit 3: Accum Pressure Sensor In Range error bit 4: Flow Command Too high for conditions bit 5: Flow Command Too low for conditions bit 6: IMV resistance in range error bit 7: Accum Press Sensor OOR Suspect bit 8: Pressure Very High bit 9: Pressure Very High persistent inhibit (cal only) bit 10: Pressure High bit 11: Pressure Low bit 12: Pressure Very Low bit 13: LPP short or open bit 14: IMV short or open bit 15: Intermittent IMV
C_APC_s_ErrorEnable	Enable bits for diagnostic algorithms. See H_APC_s_Error for bit definitions
H_APC_s_ActOverride	Override flag which allows the IMV, eLPP & diesel bleed to be operated. Set: bit 0 (LSB) to turn on eLPP and/or bit 1 to turn on IMV and/or bit 2 to turn on the diesel bleed for C_APC_ti_Override sec.

6.8.1 Adaptive Feedforward & Limp Home

Feedforward adaptation is enabled/disabled by setting C_APC_s_AdptEnable to 1 or 0 respectively. When enabled the feedforward APC coefficients are adaptively adjusted based on the long term average performance of the HPP system to: 1) improve closed-loop control response, 2) provide for open-loop control in the event of pressure sensor failure and 3) diagnose HPP .ow errors. When an accumulator pressure sensor failure is detected FDH determines whether to switch APC to “Limp Home” mode. In this mode the commanded pressure range is restricted, the PID feedback control is disabled and the HPP is controlled based on the “learned” feedforward term. Feedforward adaptation should only be calibrated by an expert. The feedforward term of the APC control is a linear function of commanded fueling rate (H_APC_qr_Fueling_v). H_APC_s_AdptStatus indicates operational status of adaptation ***more on bit definitions.***

6.8.2 Flow Command Dither

The output .ow command will be dithered by setting C_APC_qr_DitherAmp > 0, in which case H_APC_qr_Cmd will be updated every C_APC_ti_DitherPeriod sec. The commanded .ow will be varied with a pseudo-random binary sequence of order C_APC_ct_DitherOrder (2 to 16). An order of 2 is a square wave with a period of 2 x C_APC_ti_DitherPeriod.

6.8.3 Support for multip-HPP, multi_ECM pressure controls

TBD

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6.8.4 Electric lift and Surge pump operation

The HHP "surge" pump is from the controls view an electric "lift" pump (eLPP). The pump can be either turned on indefinitely (see AC_APC_s_LppTimeOut) or set to time out (turn off) after C_APC_ti_Startup seconds. For the pump to time out feed back pressure (APC_hp_Fdbk) must be greater than C_APC_hp_LppCutOut.

6.8.5 Diesel Bleed Valve Control

APC will energize (close) a diesel bleed valve when C_APC_rloc_DslBleed is set to correspond to the correct ECM pin. The valve will be closed when pumping is enabled. *MORE TBD.*

6.8.6 Accumulator Pressure Diagnostics

Several fault conditions may be detected by the APC diagnostics, including:

- Sensor out of range high, out of range low or stuck in range
- Pumping Bank-to-Bank imbalance
- Pump .ow command above or below expected
- IMV resistance above or below normal
- Pressure very high
- Pressure higher than command
- Pressure lower than command

Detection of individual faults may be enabled or disabled by setting or clearing bits in C_APC_s_ErrorEnable.

6.9 Trip Information Fueling Accumulator

The fuel system maintains a running sum total of the diesel fuel and directly injected NG consumed since key on. This running total is used to supply the 'Trip Information' feature with data used to calculate fuel consumption and other statistics.

Table 20: TRP Related Variable

TRP Variable	Description
H_TRP_x_TotalDslLitersConsumed	The total volume of diesel fuel consumed since ECM power up, in liters.
H_TRP_x_TotalDiNgKgConsumed	The total mass of directly injected natural gas consumed since ECM power up, in Kg.
C_TRP_q_TblZ	This surface defines the relationship between commanded and delivered diesel fueling. This table can be used to tweak the fuel consumption accuracy without altering emissions performance. Most calibrations should have this table set up so that the fueling delivery estimate equals the commanded fueling.
C_TRP_q_NGTblZ	Similar to functionality as the table described above. This table handles the relationship between commanded and delivered direct inject NG.
C_TRP_r_FuelSpecificGravity	This variable contains the density assumption used to convert the diesel fuel delivery mass into a volume. The corporate standard for diesel fuel is a specific gravity of 0.85.
C_TRP_r_DslCylRatio	This is the ratio of diesel cylinders controlled by the master ECM to the total number of cylinders in the system. On single ECM configs this variable is 1. On multi-ECM configs this variable may be less than 1.
C_TRP_r_NGCylRatio	This is the ratio of NG cylinders controlled by the master ECM to the total number of cylinders in the system. On single ECM configs this variable is 1. On multi-ECM configs this variable may be less than 1.

6.10 Engine Position Sensor Processing (EPS)

6.10.1 Overview

An algorithm which interfaces with both the main and the backup engine position targets, to produce engine speed and engine position information.

Table 21: Commonly used EPS Variables

EPS Variable	Description
Engine_Speed	Speed calculated by selected sensor
H_EPS_n_MainRPM & H_EPS_n_BackupRPM	Calculated Engine Speed using the Main and Backup targets respectively
H_EPS_s_MainSyncState & EPS_s_BkupSync_ENUM	Synchronization state of Main and Backup targets respectively
C_EPS_s_Type	EPS target type: 0 - Cummins std (60-2/N+1), 1 - NA, 2 - Komatsu, 3-Disable EPS
C_EPS_s_CrankStartType	Enable flag for cam half-cycle determination algorithm w/ failed Backup

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	(Cam) sensor: 0 = None, 1 - 3 = Obsolete, 4 = CBD based fueling imbalance
H_EPS_s_SensorSelect	Current active sensor (MAIN or BACKUP)
EPS_s_Status	Overall Health of Engine HEALTHY if everything is fine DEGRADED if errors but engine can Run FAILED both sensors failed engine cannot run STOPPED no pulses from either sensor, engine cannot run
H_EPS_s_CamHalfCycle	Indicator of status of half cycle detection (which half of the cam cycle is the crank position in. DETERMINED (2): half cycle determined UNKNOWN (0): half cycle not determined yet NO_CAM (1): No Cam signal present, use other means to determine half cycle. Note: If not determined pulses may, or may not, be off by 360 degrees
H_EPS_ct_MainInterrupt	Main Tooth Counter, calculated over cam rev. Typically 6 degrees per increment. Count 1 occurs at first interrupt after the sync gap of the engine halfcycle with TDC#1
H_EPS_ct_BkupInterrupt	Indicates Backup tooth number (extra tooth is tooth 0)
EPS_s_MainLevel & EPS_s_BkupLevel	Flag indicating the level of Main & Backup sensor signals respectively when speed is too low to detect pulses, i.e., sensor status is NO_PULSE. (1= signal low, 2= signal high and 0= signal oscillating normally)
EPS_MS_Speed_Override_Enable	***Not implemented in Core-2*** Allows override of speed (Engine_Speed) by non-EPS algorithms (i.e., speed from master ECM) or user. (0= no override, 1= override). Filter_Engine_Speed is not set by EPS algorithms when in override.
EPS_s_MfgSyncEnable	Enables EPS override of the tachometer output pin when set to 1.
C_EPS_ct_MfgSyncRiseEdge & C_EPS_ct_MfgSyncFallEdge	Crank tooth count where tachometer output is set high and low respectively
H_EPS_s_Error	A 16 bit word indicating the status of EPS errors, bit mapped as follows: bit 0 (LSB): Reverse rotation bit 1: Backup sensor selected bit 2: Reserved bit 3: Reserved bit 4: Backup phase shift error bit 5: Both sensors failed bit 6: Cam half-cycle (hdwr) failed bit 7: unused bit 8: Backup No-pulse error bit 9: Backup No-sync error bit 10: Backup overspeed error bit 11: Backup intermittent error bit 12: Main No-pulse error bit 13: Main No-sync error bit 14: Main overspeed error bit 15 (MSB): Main intermittent error
H_EPS_ca_BkupPhase	Actual phase of C_EPS_ct_MainAtBkupNormalA tooth relative to TDC #1 determined from the Crank target. Nominally equal to C_EPS_ca_BkupOffset
C_EPS_ca_MainOffset	Specifies angle (BTDC) of sync tooth (1st tooth after gap) relative to TDC of cylinder 1.
C_EPS_r_MainOffset	Speed correction factor to C_EPS_ca_MainOffset.
C_EPS_ca_BkupOffset	Specifies angle (BTDC) of reference tooth (C_EPS_ct_BkupRef) relative to TDC of cylinder 1
C_EPS_r_BkupOffset	Speed correction factor to C_EPS_ca_BkupOffset.
H_EPS_ca_Offset	Current (Main or Backup) EPS offset corrected for speed.
C_EPS_ct_MainAtBkupNormalA	Main tooth count at Backup normal “A” tooth (tooth before sync tooth)
H_EPS_ct_MainAtBkupSync	Main tooth count at Backup “Sync” tooth. Set equal to C_EPS_ct_MainAtBkupNormalA + C_EPS_ct_BkupSyncSpace
H_EPS_ct_MainAtBkupNormalB	Main tooth count at Backup normal “B” tooth (tooth after sync tooth). Set equal to C_EPS_ct_MainAtBkupNormalA + C_EPS_ct_BkupNormSpace
C_EPS_ct_BkupNormSpace	Space in Main tooth counts between “normal” backup teeth.

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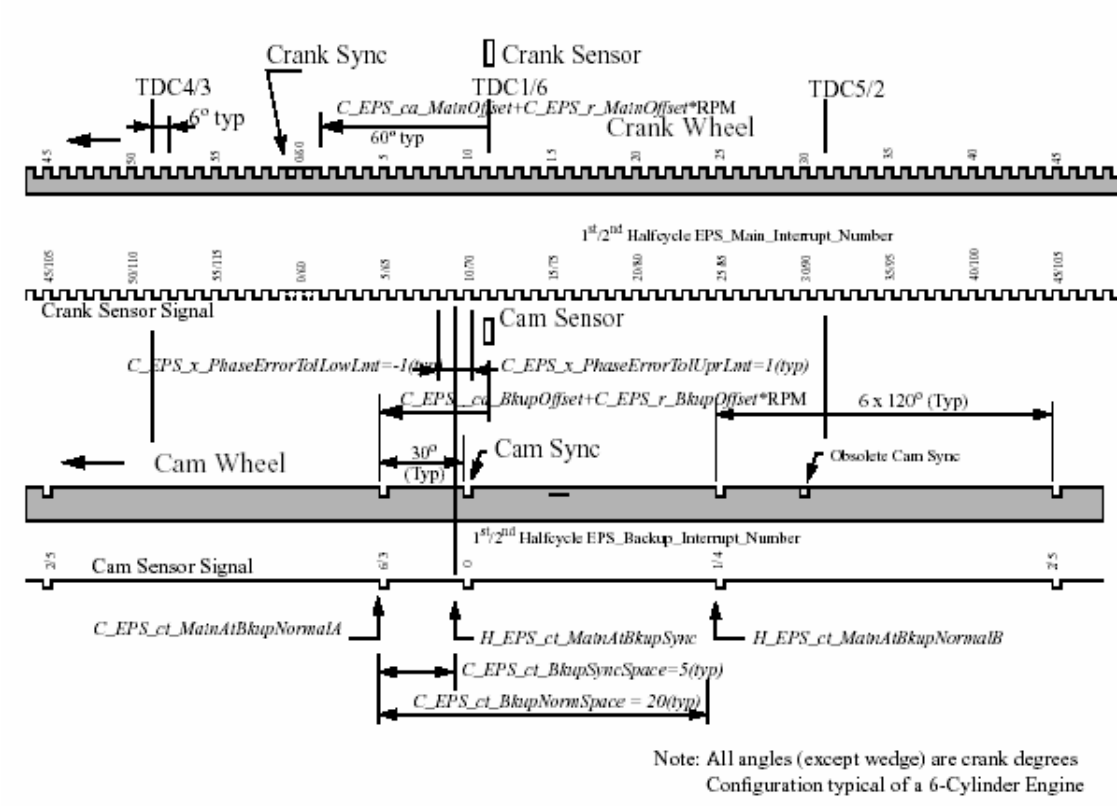
C_EPS_ct_BkupSyncSpace	Space in Main tooth counts between “sync” backup teeth.
H_EPS_th_ActMainAtBkupSync	Value of actual Main tooth at Backup sync tooth location
C_EPS_ct_BkupRef	Backup interrupt where TDC # 1 injection is initiated. Reference backup tooth for Backup phase measurement

6.10.2 EPS Target Diagram



6.10.3 Target Phasing:

Sometimes it is necessary to experimentally determine the Main (Crank) & Backup (Cam) target phasing. The C_EPS_MainOffset must be determined from the signal waveforms relative to engine TDC. C_EPS_MainOffset is approximately 720 / (2* C_EPS_ct_Cylinders), approx. 60 BTDC for a 6-cylinder engine.

The most common EPS problems are 1) engine half-cycle cannot be determined from the Backup target and 2) Backup phase error (FC 731). Either are, usually, due to calibrations that do not match the physical configuration. For the engine to determine the correct halfcycle *C_EPS_ct_MainAtBkupNormalA* and *H_EPS_ct_MainAtBkupSync* must be with 5 teeth of the actual target configuration. The actual sync tooth location (*H_EPS_th_ActMainAtBkupSync)* is measured when the engine is running and should match *H_EPS_ct_MainAtBkupSync*. *C_EPS_ct_MainAtBkupNormalA* should equal *H_EPS_th_ActMainAtBkupSync - C_EPS_ct_BkupSyncSpace*. A Backup phase error is reported when the actual sync tooth location (*H_EPS_th_ActMainAtBkupSync*) is outside of *H_EPS_ct_MainAtBkupSync +* C_EPS_x_PhaseErrorTolUprLmt (or C_EPS_x_PhaseErrorTolLowLmt), typically 1.

6.10.4 Sync Check Algorithm (SNC)

The SNC algorithm operates at engine startup when the Backup EPS sensor has failed to determine engine half-cycle so the Main interrupt number can be properly initialized. The algorithm operates by imposing a known fueling imbalance for a few seconds (typ 5sec) while CBD determines fueling imbalance. If the imbalance, determined by CBD, does not correspond to the imposed fueling imbalance the half-cycle is switched and the measurement repeated. When correspondence is found, half-cycle is correct, the measurement is repeated to verify the half-cycle and if successful the fueling balance is restored, and the algorithm is disabled until the next engine start. C_EPS_s_CrankStartType must be set to 4 (CBD_CAM_SYNC_CHECK) for the algorithm to execute. SNC_s_status_v will be SNC_NO_CHECK (0) when SNC is not executing, and either SNC_CHECK (1) or SNC_VERIFY (2) when executing.

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6.10.5 EPS ASIC Registers

Several General Purpose ASIC registers must be initialized for engine speed processing and injection to function. These registers are intended to be set by an engine protection component in Core-2. However, early versions of the FS Driver will set these registers (after engine protection) when C_EPS_s_OverspeedInitEnable = 1 (see table below).

Table 22:

Reg No	Function	Formula	Parameter(s)	Reg Value
RS 23	Main overspeed, on	60 / (S*T/2*4e-6)	S=4032 rpm T=120 th/cam rev	F03Eh
RS 24	Backup overspeed, on	60 / (S*T/2*4e-6)	S=4006 rpm T=24 th/cam rev	3138h
RS 25	Main overspeed, off	60 / (S*T/2*4e-6)	S=3787 rpm T=120 th/cam rev	F042h
RS 26	Backup overspeed, off	60 / (S*T/2*4e-6)	S=3799 rpm T=24 th/cam rev	3149h
RS 27	Main noise filter	P * 16	P=10 us	00A0h
RS 28	Main one-shot	60/(S*T/2*1e-6)	S=4504rpm T=120 th/cam rev	00DEh
RS 29	Backup noise filter	P * 16	P=10 us	00A0h
RS 30	Backup one-shot	60/(S*T/2*1e-6)	S=4496rpm T=24 th/cam rev	116h

6.11 Cylinder Balancing Diagnostic (CBD)

The CBD algorithm modifies fueling per cylinder to maximize power balance in the cylinders. CBD always keeps the overall fueling the same, only changing the balance between cylinders. CBD adjusts the power balancing by updating cylinder fueling trim tables (P_CBD_q_TrimTableX, where x is the cylinder number). The IFC algorithm receives these tables and adjusts the fueling per injection pulse based on them. CBD compensation is enabled when both C_CBD_s_Execution and C_CBD_s_Compensation are TRUE (1). Additionally there are several operating conditions which must be satisfied for CBD compensation, when all conditions are satisfied H_CBD_s_Adjusting is set to TRUE (1).

6.12 Boost Voltage Control (BVC)

To accomplish effective actuator control, the current at actuator turn on must rise very fast. This is accomplished by applying a very high voltage (Boost Voltage) to the injector solenoid until the desired pull in current level is accomplished. The boost voltage supply is controlled and replenished by special driver control methods when the injector is not fueling. The BVC algorithm controls this process by adding EVT_x_chargePulses_v recharge pulses after the injection is completed. The recharge pulses are small enough to not cause injection, but large enough to recover energy back to the V-Boost capacitor.

Table 23: Boost Voltage Control (BVC) Commonly used Variables

BVC Variable	Description
C_BVC_s_ChargeEnable	= 0 Disables Boost Recharging = 1 Enables Boost Recharging
C_BVC_vb_DesiredBoost	Desired Steady State Boost Voltage
H_BVC_vb_MeasuredBoost	Measured Boost Voltage
H_EVT_ct_ChargePulses	Number of recharging pulses to apply per cylinder

6.13 Actuator Driver Diagnostiscs (ADD)

6.13.1 Injector Driver Diagnostics

The injector diagnostic software performs several tasks:

- It communicates with the CM850 FSASIC hardware to record fault information related to the injector's electrical circuit.
- It reports persistent errors to the fault handler, which generates service fault codes.
- It overrides the ECM hardware's injector driver shutdown protection when intermittent faults are encountered.

The injector diagnostic software executes every 1080o. (That's one and one-half engine cycles.) This ensures an attempt to .re each injector was made at least once during the interval. The diagnostic runs continuously on healthy injectors. The diagnostic is run less frequently on failed injectors. The rate at which the diagnostic is retried on failed injectors is calibratible (C_ADD_ti_FsrFaultRetry). This retry rate should never be faster than the diagnostic cycle time itself.

The fault summary register (FSASIC RS00) is monitored for consecutive hardware fault reports. Once a consecutive number of hardware fault reports are counted, the failure is considered persistent. Otherwise, a hardware fault report is considered intermittent. A persistent failure will produce a service code and enable the FSASIC's driver shutoff protection. An intermittent does not produce a fault code and overrides the FSASIC's driver shutoff protection.

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A persistent fault can be cleared at powerup and during the diagnostic retry explained above. The fault summary register is monitored a calibratible number of times. If a hardware fault report is recorded over a calibratible percentage of times the failure is considered to remain persistent. Otherwise, the fault is cleared.

It's recommended the consecutive (set) and clear counts be calibrated at 17 counts. This yields a diagnosis time of 1.02s at 3000rpm and 10s and 306rpm. Increasing the count makes the diagnosis time slower at low engine speeds. This increases the chance a failure won't be reported. Decreasing the count makes the diagnosis time quicker at high engine speeds. This increases the chance an intermittent failure is reported as a persistent failure.

The fault summary register records both "short circuit" and "open circuit" faults. The diagnostic software individually counts both types of faults, although only a single service fault code is used for each injector. Because the injector drivers on a bank share a high side driver, a short circuit failure typically generates a service fault code for all three bank injectors. An open circuit failure only reports a service fault code on the affected injector.

The parameter naming references portion of the fault summary register where the fault is reported. The "short circuit" faults appear in the upper portion of the fault summary register. The calibrations associated with the "short circuit" fault will use the upper reference. The "open circuit" faults appear in the lower portion of the fault summary register. Similarly, the lower reference is used in the associated calibrations.

A calibratible table (C_ADD_ct_InjectorIndex) is used to resolve the driver outputs across multiple system ECMs to their corresponding fault code for the cylinder number and injector type. The input index to this table is system driver number. It's calculated by using the formula.

System Driver Number = ECM Number - 6 + ECM Driver Number

The table output assigns an injector index which represents the cylinder number and injector type. It's calculated by using the formula.

Injector Index = Injector Type – 32 + Cylinder Number

The injector type is either 0 for Diesel or 1 for Natural Gas.

Additionally, there is a calibration (C_ADD_s_PrimaryFuelType) which allows the relationship of primary/secondary to diesel/gas injector type to be .ipped. If C_ADD_s_PrimaryFuelType equals 0, the primary injector fault codes will be applied to the diesel injectors and secondary injector fault codes are applied to the gas injectors. This is the default. If C_ADD_s_PrimaryFuelType equals1, the application is reversed.

6.13.2 PWM Driver Diagnostics

The PWM diagnostic software performs several tasks:

- It communicates with the CM850 FSASIC hardware to record fault information related to the PWM driver's electrical circuit.
- It reports persistent errors to the fault handler, which generates service fault codes.
- It overrides the ECM hardware's injector driver shutdown protection when intermittent faults are encountered.

The PWM driver diagnostic software executes every 20ms. At this rate, the diagnostic software can quickly disengage the ASIC driver shutoff protection when intermittent or false positive error conditions are encountered. The diagnostic runs continuously on healthy PWM drivers. Once diagnosed as faulty, a driver error is recorded which can only be cleared after the next key cycle.

The output on fault and output off fault registers are monitored for consecutive hardware fault reports. Once a consecutive number of hardware fault reports are counted, the failure is considered persistent. Otherwise, a hardware fault report is considered intermittent. A persistent failure will enable the ASIC's driver shutoff protection. While the fault is considered intermittent, the ASIC driver shutoff protection will be overridden.

A persistent fault can be cleared at powerup only. The output on fault and output off fault registers are monitored a calilbratible number of times. If a hardware fault report is recorded over a calibratible percentage of times the failure is considered to remain persistent. Otherwise the fault is cleared.

Service fault codes can be reported directly from the ADD algorithm, although this will be handled by the application code in the future. The only service fault codes supported are those associated with the Diesel Lift Pump and Diesel Inlet Metering Valve PWM drivers. The fault reporting can turned on and off by calibration (C_ADD_x_ReportPWMFault).

The output on fault register records "short circuit" faults. The output off fault register records "open circuit" faults. The diagnostic software individually counts both types of faults. Where available a current monitor is used to supplement the driver fault detection, although this will be handled by the application code in the future. The only overcurrent and undercurrent monitors provided are those associated with the Diesel Lift Pump and Diesel Inlet Metering Valve PWM drivers. An overcurrent error is considered a "short circuit" fault, while an undercurrent error is considered an "open circuit" fault.

The parameter naming refers to the ASIC register where the fault is recorded. The "off" and "on" faults refer to the state the driver was in when the fault was diagnosed. "Open circuit" faults are typically diagnosed in the driver "off" state. "Short circuit" faults are typically diagnosed during the driver "on" state.

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When a PWM driver diagnostic is disabled, the ASIC driver logic can be continuously reset every 20ms. This allows the ASIC driver shutdown protection to be disengaged in the event of a false positive or intermittent driver fault. This is a useful alternative when a driver diagnostic has yet to be implemented or the reliability of the diagnostic implementation has yet to be tested.

FSPWM0 - Diesel Lift Pump PWM Driver. This diagnostic has the additional capability of reporting service fault codes and monitoring current levels.

Persistent off faults or under-current faults will generate the service fault code 2265. Persistent on faults or over-current faults will generate the service fault code 2266. Setting bit 0 of the calibration C_ADD_x_ReportPWMFault will enable the fault reporting for this driver. Clearing bit 0 turns off the fault reporting.

The over-current and under-current monitors are watching the value H_APC_i_LppFltr. This over-current monitor compares the value against the C_ADD_i_FspwmOverLimit[0] threshold. The under-current monitor compares the value against the C_ADD_i_FspwmUnderLimit[0] threshold whenever the command is above the minimum duty cycle threshold, C_ADD_p_FspwmLimit[0].

FSPWM1 - Diesel Inlet Metering Actuator PWM Driver. This diagnostic has the additional capability of reporting service fault codes and monitoring current levels.

Persistent off faults or under-current faults will generate the service fault code 272. Persistent on faults or over-current faults will generate the service fault code 271. Setting bit 1 of the calibration C_ADD_x_ReportPWMFault will enable the fault reporting for this driver. Clearing bit 1 turns off the fault reporting.

The over-current and under-current monitors are watching the value H_APC_i_ImaFltr. This over-current monitor compares the value against the C_ADD_i_FspwmOverLimit[1] threshold. The under-current monitor compares the value against the C_ADD_i_FspwmUnderLimit[1] threshold whenever the command is above the minimum duty cycle threshold, C_ADD_p_FspwmLimit[1].

GPPWMx Drivers. These diagnostics for drivers GPPWM0 through GPPWM9 report continuous and intermittent on and off state faults through a public service interface. The application is responsible for assigning and reporting fault codes.

HB0x as PWM Drivers. These diagnostics for drivers for HB0A and HB0B as PWM report continuous and intermittent on and off state faults through a public service interface. The application is responsible for assigning and reporting fault codes. The CM850 contains only one pair of current monitors for both HB0A and HB0B as PWM drivers. The hardware is no able to distinguish an on state fault from either HB0A or HB0B.

6.13.3 HBridge Driver Diagnostics

These diagnostics are for drivers HB0 and HB1 for applications where fuel system loads are assigned (e.g Komatsu application's fuel pump). These diagnostics perform a couple of tasks.

- It communicates with the CM850 GPASIC hardware to record fault information related to the hbridge driver's electrical circuit.
- It reports persistent errors to the fault handler, which generates service fault codes.

The hbridge driver diagnostic software executes every 20ms.

The hbridge fault register is monitored for consecutive hardware fault reports. Once a consecutive number of hardware fault reports are counted, the failure is considered persistent.

A persistent fault is cleared only at powerup. This is done automatically without regard to the status of the hbridge fault register. These diagnostics make no attempt to reset the GP-ASIC's driver shut-off protection. (Specifically for Komatsu, the pump controls do this automatically. The turning on and off of the low side driver each pump cycle, forces a reset of the driver shut-off protection). Service fault codes are to be reported by the application software.

The hbridge driver diagnostic software records two types of faults, "short circuit" faults and "open circuit" faults. The software counts these individually. "Open circuit" faults are typically diagnosed in the driver "off" state. "Short circuit" faults are typically diagnosed during the driver "on" state.

Table 24: ADD HBridge Diagnostic Parameter Descriptions

Parameter	Description	Recommended Value
C_ADD_x_HbEnable	Enables the hbridge diagnostic software. (b0 - HB0, b1 - HB1)	0x03
C_ADD_ct_HBxOpen	Consecutive count to determine persistent "open circuit" hbridge faults.	50 counts
C_ADD_ct_HBxShort	Consecutive count to determine persistent "short circuit" hbridge faults.	50 counts
H_ADD_x_HbridgeStatus	Buffer of Get_hbridge_status(), GPASIC hbridge fault status via O/S	N/A

Table 25: ADD Injector Service Fault Codes

	Injector Fault Code	
Cylinder Number	**Circuit #1**	**Circuit #2**
1	322	9951
2	331	9949

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3	324	9948
4	332	9947
5	323	9946
6	325	9945
7	1548	9944
8	1549	9943
9	1622	9942
10	1551	9941
11	1552	9939
12	1553	9938
13	1554	9937
14	1555	9936
15	1556	9935
16	1557	9934
17	1558	9933
18	1559	9932

Table 26: ADD Injector Diagnostic Parameter Descriptions

Parameter	Description	Recommended Value
C_ADD_ct_FsrLowerFaultClearThreshold	Diagnostic executions before determining whether “open circuit” fault is clear.	17 counts
C_ADD_ct_FsrLowerFaultSetThreshold	Consecutive count to determine persistent “open circuit” injector faults.	17 counts
C_ADD_ct_FsrUpperFaultClearThreshold	Diagnostic executions before determining whether “short circuit” fault is clear.	17 counts
C_ADD_ct_FsrUpperFaultSetThreshold	Consecutive count to determine persistent “short circuit” injector faults.	17 counts
C_ADD_p_FaultClearTolerance	Maximum percentage of faults reported to determine fault cleared.	25%
C_ADD_s_FsEnable	Enables the injector diagnostic software	1 (enabled)
C_ADD_ti_FsrFaultRetry	Period at which injector diagnostics is retried.	30 s
H_ADD_x_FaultSummaryRegister	Buffer of CM850 FSASIC RS00 - Fault Summary Register. Updated every 1080°	N/A
H_ADD_x_DetailedFaultRegister[x]	Buffers of CM850 FSASIC RS16-RS19 - Detailed Fault Register (DFR). Updated every 1080°. Indices 0-3 refer to DFR 1-4, respectively.	N/A

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Table 27: Fuel System Fault Code Summary

Fault Code	Description
449, 553 (2216_1)	Accumulator Pressure High (553), Very High (449)
559 (2215_1), 2249	Accumulator Pressure Low (559) or very low (2249)
451, 452, 554 (268_1)	Accumulator Pressure Sensor Out Of Range High (451) or Low (452) Stuck in Range (554)
281 (275_1)	HPP Pumping Cylinder Imbalance
689, 778 & 115	Failed Main (689), Backup (778) EPS signal or both (115)
2321, 2322	Intermittent Main (2321) or Backup (2322) EPS signal
731	Backup (vs Main) phase shift error
351	Injector Supply (Boost) Voltage Low
951	Cylinder Balancing Trim Fault
2292, 2293	Fuel Inlet Meter Device: Flow Demand Higher (2292)/Lower (2293) Than Expected
2311	IMV Resistance Out of Tolerance (High or Low)
2265 & 2266	eLPP Supply Circuit Open (2265) or Shorted (2266)
271 & 272	IMV (or Kom Pump Act #1) Supply Circuit Open (272) or Shorted (271)
273 & 274	Kom Pump Act #2 Supply Circuit Open (274) or Shorted (273)
2261, 2262, 2215, 581, 582	Fuel Supply Pressure: high error (2261), low error (2262), very low error (2215), out-of-range high (581) & out-of-range low (582)
261, 265, 263	Fuel Temp high error (261), out-of-range low (265) & out-of-range high (263)
9981, 9982	Diesel Bleed supply circuit Open (9981) or Shorted (9982)
322-325,331,332, 1548,1549,1622	Primary injector electrical fault(s) for cylinders: #1 (FC 322), #2 (FC 331), #3 (FC 324),#4 (FC 332), #5 (FC 323), #6 (FC 325), etc.

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1551-1559	See table Table 25 on page 45 for full listing.

Table 28: FC449 Accumulator Pressure Very High

Objective	Detects Error if Accumulator Pressure persistently is high enough to possibly amage the fuel system.
Fault Set Logic	Detects an error when all of the following is TRUE. • Accumulator pressure (APC_hp_Fdbk) is on average, persistently, above C_APC_hp_VHighPrsError. • H_APC_qr_Cmd is zero. Avoids detecting an error due to APC integrator wind up. If APC causes a Very High accumulator pressure condition, on Caps2, the diagnostic will remain inhibited until APC_hp_Fdbk falls back below the limit. The very low leakage on Caps2 may cause an overpressure condition to persist during motoring, even if pumping is stopped. • Engine_Speed is greater than C_APC_n_MinDiagSpeed • Coolant temp (FSI_t_Coolant) is over C_APC_t_MinDiagCoolant • Battery voltage is over C_APC_v_MinDiagBatt • C_IPC_s_PvcEnable == False or EPS_s_SensorSelect == Main
Fault Clear Logic	Detected errors are cleared when all of the following are TRUE: • Accumulator pressure is persistently, on average, below C_APC_hp_VHighPrsError • H_FSI_q_TotalFueling is less than C_APC_q_MaxClearHiCmd. • Engine_Speed is less than C_APC_n_MinDiagSpeed
“Look Outs”	• Errors can occur if the pressure control becomes unstable. The controls may go unstable with extreme air ingestion.
What to Log if problems	Log the following at least every 100 ms Engine_Speed, APC_hp_Fdbk, H_FSI_hp_Cmd, H_APC_ti_HighPrsError, H_APC_ti_VHighPrsError, H_APC_s_Error H_APC_qr_Cmd, H_APC_i_ImaFltr, H_FSI_q_TotalFueling, H_FDH_x_ErrorState
Diagnostic Algorithm Name	APC Diagnostic

Table 29 FC553 Accumulator Pressure High - Warning

Objective	Detects Error if Accumulator Pressure persistently above command such that missions or engine noise may be degraded.
Fault Set Logic	Detects an error when all of the following are TRUE • Accumulator pressure (APC_hp_Fdbk) is on average, persistently above the commanded pressure (H_FSI_hp_Cmd) plus _APC_hp_MaxErrorDev. • H_APC_qr_Cmd is equal to zero. This avoids a fault if APC is not commanding minimum flow due to integrator wind up. • H_FSI_q_TotalFueling is greater than C_APC_q_MinHiPrsFuel. Intent is to avoid detecting a fault during motoring, given the extremely low leakage on Caps2. • Engine_Speed is greater than C_APC_n_MinDiagSpeed • Coolant temp (FSI_t_Coolant) is over C_APC_t_MinDiagCoolant • Battery voltage is over C_APC_v_MinDiagBatt • C_IPC_s_PvcEnable == False or EPS_s_SensorSelect == Main
Fault Clear Logic	Detected errors are cleared when all of the following is TRUE. • Accumulator pressure (APC_hp_Fdbk) is on average, persistently below the commanded pressure plus C_APC_hp_MaxErrorDev. • H_FSI_q_TotalFueling is less than C_APC_q_MaxClearHiCmd. • H_FSI_q_TotalFueling is greater than C_APC_q_MinHiPrsFuel. • Engine_Speed is greater than C_APC_n_MinDiagSpeed
“Look Outs”	Errors can occur if the pressure control becomes unstable. The controls may go unstable with extreme air ingestion.
What to Log if problems	Log the following at least every 100 ms Engine_Speed, APC_hp_Fdbk, H_FSI_hp_Cmd, H_APC_ti_HighPrsError, H_APC_ti_VHighPrsError, H_APC_s_Error H_APC_qr_Cmd, H_APC_i_ImaFltr, H_FSI_q_TotalFueling, H_FDH_x_ErrorState
Diagnostic Algorithm Name	APC Diagnostic

Table 30 FC559 Accumulator Pressure Low - Warning

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Objective	Detects Error if Accumulator Pressure persistently is low enough to effect emissions or available engine power
Fault Set Logic	Detects an error when all of the following are TRUE • Accumulator pressure (APC_hp_Fdbk) is on average, persistently below the commanded pressure minus C_APC_hp_MaxErrorDev. • Note, during Cranking, APC_hp_Fdbk must also be greater than C_APC_hp_MinLowPrsError. Currently C_APC_hp_MinLowPrsError is calibrated to 0, effectively disabling this diagnostic during cranking. • H_APC_qr_Cmd is equal to H_APC_qr_Limit. This avoids a fault if APC is not commanding maximum flow due to integrator wind up. • Engine_Speed is greater than C_APC_n_MinDiagSpeed. • Coolant temp (FSI_t_Coolant) is over C_APC_t_MinDiagCoolant • Battery voltage is over C_APC_v_MinDiagBatt • C_IPC_s_PvcEnable == False or EPS_s_SensorSelect == Main
Fault Clear Logic	Detected errors are cleared when all of the following is TRUE. • Accumulator pressure (APC_hp_Fdbk) is on average, persistently above the commanded pressure minus C_APC_hp_MaxErrorDev. • Engine_Speed is greater than C_APC_n_MinDiagSpeed
"Look Outs"	Errors can occur if pressure control becomes unstable. The controls may become unstable with extreme air injection, sticky Inlet Metering Valve (IMV) or bad check valves in the high pressure pump.
What to Log if problems	Log the following at least every 100 ms Engine_Speed, APC_hp_Fdbk, H_FSI_hp_Cmd, C_APC_ti_LowPrsError, H_APC_s_Error, H_APC_qr_Cmd, H_APC_i_ImaFltr, H_FSI_q_TotalFueling, H_FDH_x_ErrorState
Diagnostic Algorithm Name	APC Diagnostic

Table 31 FC2249 Accumulator Pressure Very Low - Warning

Objective	Detects Error if Accumulator Pressure persistently is low enough to effect emissions or available engine power
Fault Set Logic	Detects an error when all of the following are TRUE • Accumulator pressure Low (FC 559) has occurred since key on. • Accumulator pressure (APC_hp_Fdbk) is on average, persistently below the commanded pressure minus C_APC_hp_MaxLow2Dev. • Note, during Cranking, APC_hp_Fdbk must also be greater than C_APC_hp_MinLowPrsError. • H_APC_qr_Cmd is equal to H_APC_qr_Limit. This avoids a fault if APC is not commanding maximum flow due to integrator wind up. • Engine_Speed is greater than C_APC_n_MinDiagSpeed. • Coolant temp (FSI_t_Coolant) is over C_APC_t_MinDiagCoolant • Battery voltage is over C_APC_v_MinDiagBatt • C_IPC_s_PvcEnable == False or EPS_s_SensorSelect == Main
Fault Clear Logic	Detected errors are cleared when all of the following is TRUE. • Engine_Speed is greater than C_APC_n_MinDiagSpeed. • Coolant temp (FSI_t_Coolant) is over C_APC_t_MinDiagCoolant • Battery voltage is over C_APC_v_MinDiagBatt • C_IPC_s_PvcEnable == False or EPS_s_SensorSelect == Main
"Look Outs"	Errors can occur if pressure control becomes unstable. The controls may become unstable with extreme air injection, sticky Inlet Metering Valve (IMV) or bad check valves in the high pressure pump.
What to Log if problems	Log the following at least every 100 ms Engine_Speed, APC_hp_Fdbk, H_FSI_hp_Cmd, C_APC_ti_LowPrsError, H_APC_s_Error, H_APC_qr_Cmd, H_APC_i_ImaFltr, H_FSI_q_TotalFueling, H_FDH_x_ErrorState
Diagnostic Algorithm Name	APC Diagnostic

Table 32 Accumulator Pressure Sensor Out Of Range (FC451, FC452)

Objective	Detects failed accumulator pressure sensor or harness by looking for a voltage which is too low or high.
Fault Set Logic	Detects a fault when H_AccumPrsSensRaw persists below C_AccumPrsSensLLim (**FC 452**, oor low) or above C_AccumPrsSensULim (**FC 451**, oor high).

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	H_AccumPrsSensRaw is in A/D counts and can be converted to voltage by Counts * 5.175 / 1023
Fault Clear Logic	Clears a fault when H_AccumPrsSensRaw persists above C_AccumPrsSensLLim (**FC 452**) or below C_AccumPrsSensULim (**FC 451**).
"Look Outs"	It might be possible to get these faults from a low sensor power supply voltage. Currently, these faults cause an engine shutdown on Cummins HPCR, or "Limp Home" on Echo2.
What to Log if problems	Log the following every 20 ms while the problem is occurring Engine_Speed, APC_hp_Fdbk, H_AccumPrsSensRaw, APC_hp_error_v
Diagnostic Algorithm Name	APC (Accumulator Pressure Control) Diagnostics

Table 33 Accumulator Pressure Sensor Stuck In Range (FC554)

Objective	Detects failed accumulator pressure sensor or tampering by looking for a voltage which is NOT changing as expected.
Fault Set Logic	Detects a fault when: H_APC_hp_SirPrsError (= Max - Min Accumulator Pressure, measured at 6 crank deg intervals over previous cam cycle) is persistently below C_APC_hp_SirPrsThreshold and H_FSI_q_TotalFueling is above C_APC_q_SirPrsLowLmt and APC_hp_Fdbk is above C_APC_hp_SirPrsLowLmt and below APC_hp_maxLimit_c
Fault Clear Logic	Clears fault when Max - Min Accumulator Pressure (measured at 6 crank deg intervals over previous cam cycle) is persistently over C_APC_hp_SirPrsThreshold and H_FSI_q_TotalFueling is above C_APC_q_SirPrsLowLmt and APC_hp_Fdbk is above C_APC_hp_SirPrsLowLmt and below APC_hp_maxLimit_c
"Look Outs"	Currently, these faults cause an engine shutdown on Cummins HPCR, or "Limp Home" on Echo2.
What to Log if problems	Log the following every 20 ms while the problem is occurring Engine_Speed, APC_hp_Fdbk, H_AccumPrsSensRaw, H_APC_hp_SirPrsError, H_APC_s_Error
Diagnostic Algorithm Name	APC (Accum Press Control) Diagnostics

Table 34: FC 281 HPP Pumping Cylinder Inbalance

Objective	Detects failed HPP (High Pressure Pump) cylinder.
Fault Set Logic	Detects a fault when: Bank to bank Accumulator Pressure difference (H_APC_hp_BankDev) is persistently above C_APC_hp_BankDevThreshold while H_FSI_q_TotalFueling is above C_APC_q_BankDevLowLmt and Engine_Speed is above APC_n_minSyncPressSpeed_c
Fault Clear Logic	Clears fault when: Bank to bank Accumulator Pressure difference (H_APC_hp_BankDev) is persistently below C_APC_hp_BankDevThreshold while H_FSI_q_TotalFueling is above C_APC_q_BankDevLowLmt and Engine_Speed is above C_APC_n_MinDiagSpeed_c
"Look Outs"	
What to Log if problems	Log the following every 20 ms while the problem is occurring Engine_Speed, APC_hp_Fdbk, H_AccumPrsSensRaw, H_APC_hp_SirPrsError, H_APC_s_Error
Diagnostic Algorithm Name	APC (Accum Press Control) Diagnostics

Table 35: EPS Problem: FC778, FC689, FC115, FC731, FC2321, FC2322

Objective	Detects problems with speed sensor.
Fault Set Logic	**FC 689:** Detected when Main Crank based speed signal is lost for C_EPS_ti_MainNoPulseErrorUprLmt sec (typ 3s), or cannot be synchronized for C_EPS_ti_MainNoSyncErrorUprLmt sec (typ 3s). **FC 778**: Detected when the Backup Cam based speed signal is lost for C_EPS_ti_BkupNoPulseErrorUprLmt sec (typ 3s), or cannot be synchronized for C_EPS_ti_BkupNoSyncErrorUprLmt sec (typ 3s). **FC 115**: EPS pulses but neither Main nor Backup sensors are HAVE_SYNC for C_EPS_ti_BothFailedUprLmt sec (typ 10s). **FC 731:** Detected when the phase between the Main and the Backup Signal is incorrect for more than C_EPS_ct_PhaseErrorUprLmt (typ 3) Cam revs, and Engine_Speed is within C_EPS_n_PhaseErrorLowLmt and C_EPS_n_PhaseErrorUprLmt. **FC 2321 or 2322**: Persistent, intermittent Main or Backup No-sync events. (typically 3 in 1200 sec)

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Fault Clear Logic	**FC689:** Normal Main (Crank) based speed signal for more than timeout limit. **FC778:** Normal Backup (Cam) based speed signal for more than timeout limit. **FC 115**: EPS pulses and either Main or Bakcup sensors are HAVE_SYNC for C_EPS_ti_BothFailedUprLmt sec (typ 10s). **FC 731:** Phase between the Main and the Backup signal is within tolerance, and Engine_Speed is within C_EPS_n_PhaseErrorLowLmt and C_EPS_n_PhaseErrorUprLmt. **FC 2321 or 2322:** No intermittent Main/Backup No-sync events for C_EPS_ti_BkupGlitchUprLmt (typ 1200sec).
"Look Outs"	**FC 115** is typically due to swapped Main & Backup sensors.
What to Log if problems	High speed (20 ms) Internal Log the following while the problem is occurring: Engine_Speed, EPS_s_Error, H_Main_Interrupt_Number, EPS_Backup_Interrupt_Number, EPS_s_MainSync_ENUM, EPS_s_BkupSync_ENUM, H_EPS_th_MainAtBkupSync
Diagnostic Algorithm Name	EPS (Engine Position Sensor)

Table 36: FC 351 Injector Supply (Boost) Voltage Low

Objective	Detects when Boost Voltage is too low such that injector performance may be degraded.
Fault Set Logic	Fault detection logic is disabled when: FSI_v_batt < C_BVC_v_lowBatteryxxxRPM OR EPS_Status = FAILED OR EPS_s_Sensor NOT = EPS_MAIN_SPEED_SENSOR (0) Detects an error when the measured boost voltage (H_BVC_vb_MeasuredBoost) is below C_BVC_vb_BoostThreshold for C_BVC_ti_LowBoostVoltage seconds.
Fault Clear Logic	Fault clear logic is disabled when: FSI_v_Batt < C_BVC_v_LowBatteryxxxRPM OR EPS_Status = FAILED OR EPS_s_Sensor NOT = EPS_MAIN_SPEED_SENSOR The BVC error is cleared when H_BVC_vb_MeasuredBoost persists above C_BVC_vb_BoostThreshold.
"Look Outs"	The fault may be caused by an electrical problem with the injector or injector harness. Always check the injection circuits external to the ECM first.
What to Log if problems	Log the following every 20 ms while the problem is occurring Engine_Speed, H_IFC_ct_InjPulses, FSI_v_Batt, H_EVT_ct_chargePulses, H_BVC_vb_MeasuredBoost, H_FDH_x_ErrorState
Diagnostic Algorithm Name	BVC (Boost Voltage Control)

Table 37: FC 951 Cylinder Balancing Trim Fault

Objective	Detects a bad injector or bad cylinder when a fueling trim for a given injector is above a calibratable limit.
Fault Set Logic	A CBD Trim Fault will be detected when the following occurs: The amount of fueling change for a given cylinder to keep an even power balance exceeds the value from table C_CBD_q_TrimLimit. Engine conditions are in a range where CBD actively trims cylinders.
Fault Clear Logic	A CBD Trim Fault will be set inactive when all of the following occurs The amount of fueling change per cylinder for all of the cylinders, to keep an even power balance does not exceed the value from table C_CBD_q_TrimLimit. Engine conditions are in a range where CBD actively trims cylinders.
"Look Outs"	FC 951 may occur if the engine is connected to a dyno. If this error occurs and the engine is known to be healthy, CBD can be disabled by setting C_CBD_s_Compensation = 0.
What to Log if problems	Log the following every 20 ms while the problem is occurring P_CBD_q_TrimTableX[1], X=1,...,6, Engine_Speed, H_FSI_q_TotalFueling, H_FSI_q_PilotFueling, APC_hp_Fdbk & C_CBD_s_Adjusting
Diagnostic Algorithm Name	CBD (Cylinder Balancing Diagnostic)

Table 38: FC 2292 Fuel Inlet Meter Device: Flow Demand Higher Than Expected

Objective	Detects conditions where steady-state pumping capacity is persistently too low for conditions, such that low power or poor emissions may occur.

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Fault Set Logic	**FC2292:** The Inlet Metering Valve (IMV) flow demand (H_APC_qr_Cmd) is persistently higher than expected, resulting in the feedforward adaptation constants (P_APC_qr_FfLineConstA and/or P_APC_qr_FfLineConstB) exceeding limits
Fault Clear Logic	FC2292 will be set inactive when the flow command is not higher than expected
"Look Outs"	Several failures can cause this condition, including A large HPCR leak to drain, a restricted fuel inlet, a Bad Electric Lift Pump, Plugged filter, or bad IMV.
What to Log if problems	Log the following every 20 ms while the problem is occurring: H_FSI_hp_Cmd, APC_hp_Fdbk, H_APC_qr_Cmd, H_APC_qr_FlowError
Diagnostic Algorithm Name	APC (Accumulator Pressure Control - Diagnostics)

Table 39: FC 2293 Fuel Inlet Meter Device: Flow Demand Lower Than Expected

Objective	Detects conditions where steady-state pumping capacity is persistently high for conditions, such that low power or poor emissions may occur.
Fault Set Logic	**FC2293:** The Inlet Metering Valve (IMV) flow demand (H_APC_qr_Cmd) is persistently lower than expected, resulting in the feedforward adaptation constants (P_APC_qr_FfLineConstA and/or P_APC_qr_FfLineConstB) exceeding limits
Fault Clear Logic	**FC2292:** will be set inactive when the flow command is not lower than expected
"Look Outs"	
What to Log if problems	Log the following every 20 ms while the problem is occurring: H_FSI_hp_Cmd, APC_hp_Fdbk, H_APC_qr_Cmd, H_APC_qr_FlowError
Diagnostic Algorithm Name	APC (Accumulator Pressure Control - Diagnostics)

Table 40: FC 2311 IMV Resistance Out of Tolerance (High or Low)

Objective	Detects conditions where IMV resistance is persistently high or low.
Fault Set Logic	The Inlet Metering Valve (IMV) resistance H_APC_r_ImaFltr is persistently lower than APC_r_imaResisNom_c - APC_r_imaResisTol_c or higher than C_APC_r_ImaResisNom + C_APC_r_ImaResisTol
Fault Clear Logic	IMV resistance is within tolerance
"Look Outs"	Measured resistance (H_APC_r_ImaFltr) is not updated when current H_APC_i_ImaFltr is less than C_APC_i_ImaResisThrshld
What to Log if problems	Log the following every 20 ms while the problem is occurring: H_APC_r_ImaFltr, H_APC_i_ImaFltr, H_APC_v_ImaFltr, H_APC_i_ImaCmd, H_APC_p_ImaDuty
Diagnostic Algorithm Name	APC (Accumulator Pressure Control - Diagnostics)

Table 41: FC 2265 & 2266 eLPP Supply Circuit Shorted High or Low

Objective	Detects conditions where Electric Low Pressure Pump (eLPP) circuit is either shorted high (**FC 2266)** or low (**FC 2265)**
Fault Set Logic	Consecutive counts of GP_ASIC outputs on/off fault register (b8)
Fault Clear Logic	(Poweron ONLY) Under threshold of counts for fault register (b8)
"Look Outs"	Shorted High (Open Circuit) run ONLY at keyon.
What to Log if problems	H_ADD_ct_OnFault[ ], H_ADD_ct_OffFault[ ].
Diagnostic Algorithm Name	ADD (Actuator Driver Diagnostic)

Table 42: FC 271 & 272 IMV Supply Circuit Shorted High or Low

Objective	Detects conditions where Inlet Metering Valve (IMV) circuit is either open / shorted high (**FC 271)** or shorted low (**FC 272).** Note: This is called the EFC (Electric Fuel Control) by service.
Fault Set Logic	Consecutive counts of GP_ASIC outputs on/off fault register (b9)
Fault Clear Logic	(Poweron ONLY) Under thershold of counts for fault register (b9)
"Look Outs"	Shorted High (Open Circuit) run ONLY at keyon.
What to Log if problems	H_ADD_ct_OnFault[ ], H_ADD_ct_OffFault[ ]
Diagnostic Algorithm Name	ADD (Actuator Driver Diagnostic)

Table 43: FC 322, 331, 324, 332, 323, & 325 Injector Circuit Error

Objective	Detects individual injector electrical fault(s) for cylinder: #1 (FC 322), #2 (FC 331), #3 (FC 324), #4 (FC 332), #5 (FC 323) & #6 (FC 325)
Fault Set Logic	Consecutive fault counts in ADD_x_faultSummaryRegister_v

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Fault Clear Logic	Low percentage of fault/no-fault counts in ADD_x_fautlSummaryRegister_v
"Look Outs"	None
What to Log if problems	ADD_x_detailedFaultRegister_v[]
Diagnostic Algorithm Name	ADD (Actuator Driver Diagnostic)

8 Basic Trouble Shooting

8.1 If No Fuel Pulses When Expecting Pulses

Verify H_FDH_x_ErrorState is 00000000 hex
Verify EPS_s_Status = HEALTHY and H_EPS_s_Error = 0000 hex.
Verify FSI_v_totalFueling_v is as expected
Verify H_IFC_ti_MainOntime is as expected
Verify H_APC_hp_Accum or APC_hp_Fdbk is reasonable
Verify H_EVT_ca_FuelTTLSoi is less than 24 BTDC (if not, either mainSOI is too advanced for RPM, or pilot/pilot separation is too advanced.
Verify H_FSI_x_ExtCylMask is 0.
Verify GP ASIC registers are valid (see section 6.8.5)

8.2 If Low Power:

Verify H_FDH_x_ErrorState is 00000000 hex
Verify EPS_s_Status = HEALTHY and H_EPS_s_Error = 0000 hex.
Verify H_FDH_x_ErrorState = 0. (If not, troubleshoot based on active errors)
Verify H_FSI_q_TotalFueling as expected (or if in ontime override mode, is H_IFC_ti_MainOntime as expected)
Verify H_FSI_x_ExtCylMask is 0.
Verify H_APC_hp_Accum or APC_hp_Fdbk is approximately H_FSI_hp_Cmd
Verify BVC_vb_measuredBoost_v is approximately BVC_vb_desiredBoost_c

9 Revision History

Rev 1, Jeff Rauch, PRCR tbd, Original Core-2 based version (ported from Core-1 caps2userdiagrams.doc rev 5)
Rev 2, Rick Dudek, Updated EVT section and added ADD section.
Rev 3, Dan Wilhelm, Added Diesel VEP information, Added physical cylinder to EVT index map
Rev 4, Jeff Rauch, Added electric Lift/Surge pump information.
Rev 5, Mike Tidwell, Expanded the description of the RSC algorithm.
Rev 7, Dan Wilhelm, Corrected H_FSH_x_ErrorState.
Rev 8, Jeff Rauch, Added description of Komatsu EPS target configuration.
Rev 9, Jeff Rauch, 5/29/03, Document EPS ASIC Registers
Rev 10, Rick Dudek, Added to PWM Driver Diagnostic section.
Rev 11, Jeff Rauch, Added Fault Code summary table. Added FC 115 to EPS faults
Rev 12, Jeff Rauch, Add 2-stage MDV, .ow command dither & C_APC_s_Enable state documentation. Corrected states definitions for H_EPS_s_CamHalfCycle.
Rev 12, Dan Wilhelm, Modified cylinder cutout notes to reflected updated multi-module cylinder cutout interface.
Rev 12, Rick Dudek, Updated Actuator Driver Diagnostics section.
Rev 13, Mike Tidwell, Updated RSC section. Added TRP section.
Rev 14, Jeff Rauch, Correct APC fault codes. Add "very low" press fault & pressure derate requested by Komatsu. Add documentation for Mfg Fueling Adjustment. Rick Dudek, Add Hbridge Driver Diagnostic section.
Rev 15, Dan Wilhelm, Update Cylinder cutout
Rev 16, Jeff Rauch, Revised Pressure Fault codes
Rev 17, Dan Wilhelm, Updated IFC sections to be more understandable, accurate, and to include late post information.
Rev 18, Dan Wilhelm, Updated FDH to describe multi-module changes, defined C_APC_s_FdbkType.
Rev 19, Jeff Rauch, Updated fault codes to Phase 11.1+

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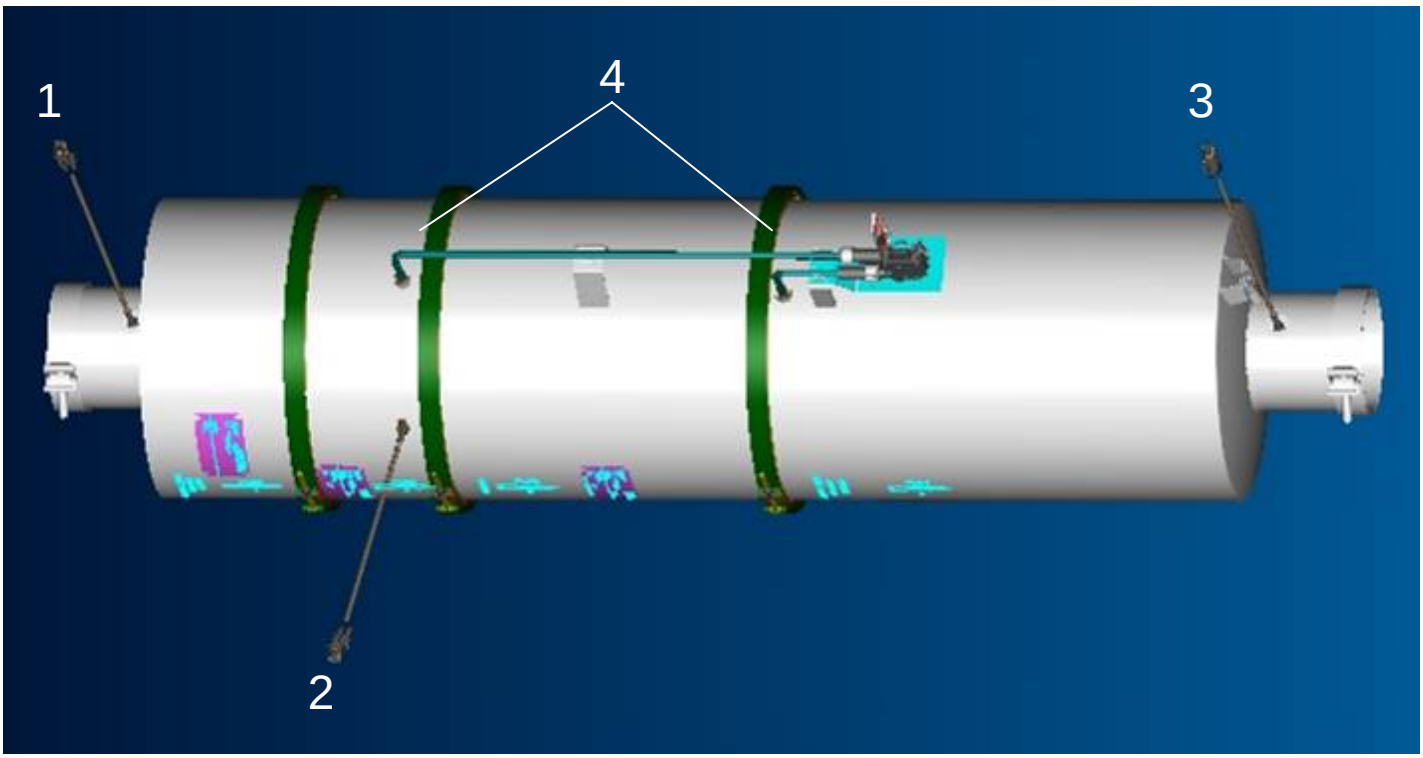
Aftertreatment User Notes:

Aftertreatment System Diagram



Sensor Number	Description	Filtered Value	Unfiltered Value	Raw Counts
1	DOC In Temperature	V_ATP_tr_DOC_In	V_AIM_ev_DOC_In_Tmptr	H_AIM_ct_DOC_In_Tmptr
2	DOC Out/DPF In Temperature	V_ATP_tr_DOC_Out	V_AIM_ev_DOC_Out_Tmptr	H_AIM_ct_DOC_Out_Tmptr
3	DPF Out Temperature	V_ATP_tr_DPF_Out	V_AIM_ev_DPF_Out_Tmptr	H_AIM_ct_DPF_Out_Tmptr
4	DFP Delta Pressure	V_ATP_pr_DPF_Delta	V_AIM_ev_DPF_DeltaP	H_AIM_ct_DPF_DeltaP

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Thermal Management

- Theremal management uses both air handling and fuel system levers
- Air handling uses both increased pumping work and charge flow suppression in appropriate portions of engine map
- All common rail levers (pressure, timing, post injection) are used

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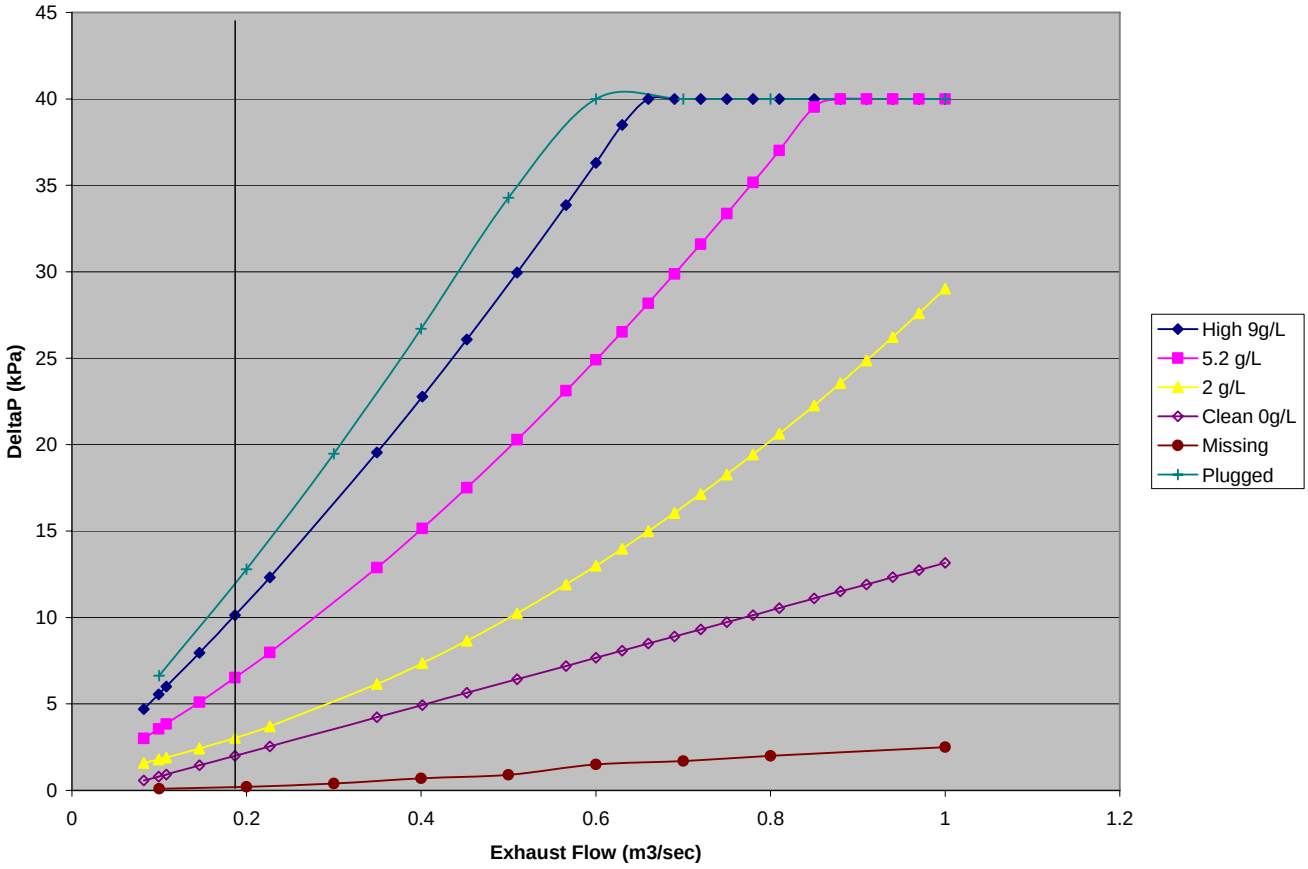
Delta Pressure Soot Load Estimate (DPSLE) Procedure

- Monitor delta pressure across soot filter (V_SFP_pr_Delta) and exhaust flow estimate from ECM (V_SFP_fv_DPF) to determine what the estimated soot load is on the filter. In Beta level calibrations this will be the same as the ECM DPSLE (V_SFP_mg_Soot_Load_DP).
- Run the engine across a range of flow to determine an accurate soot load estimate. Typically this can be achieved by running the engine up to high idle and back down again.

Evolution



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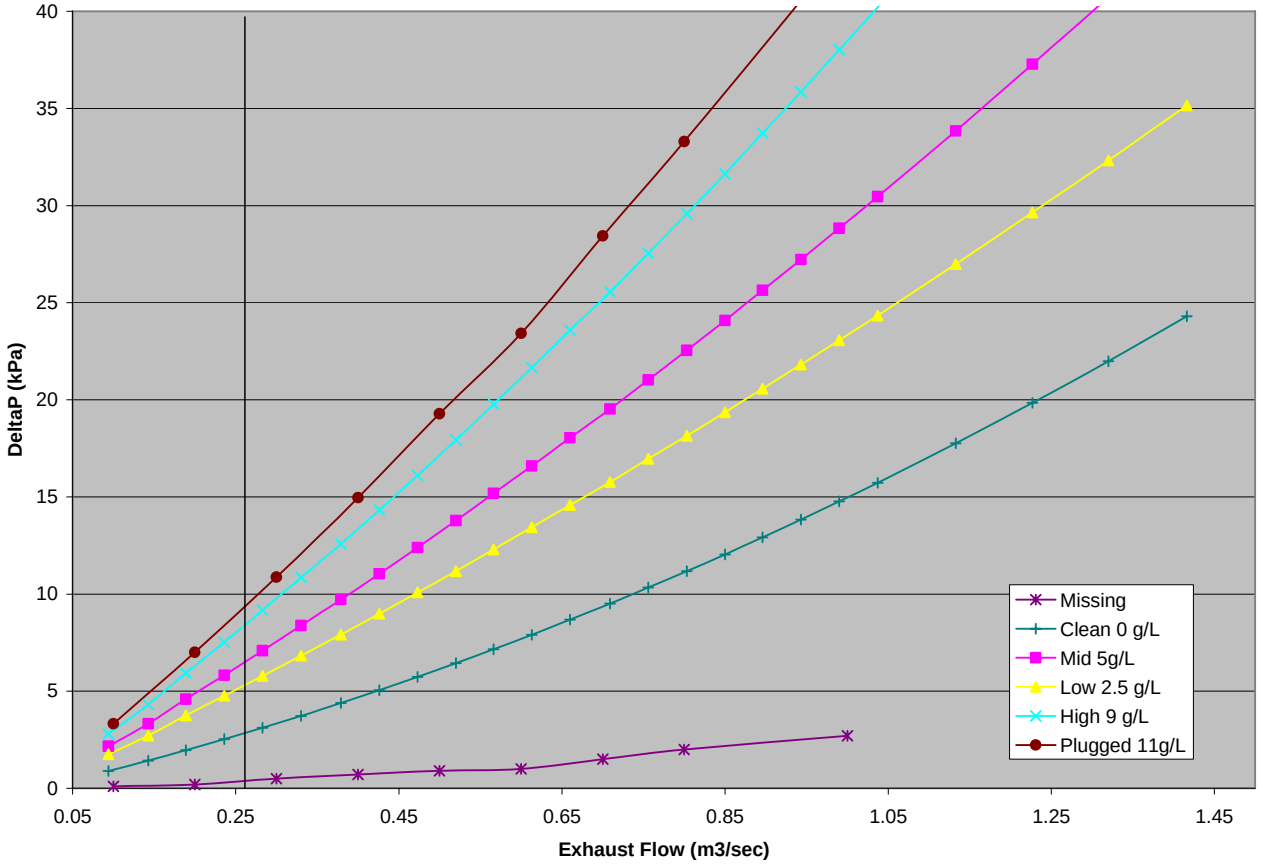
Gryphon



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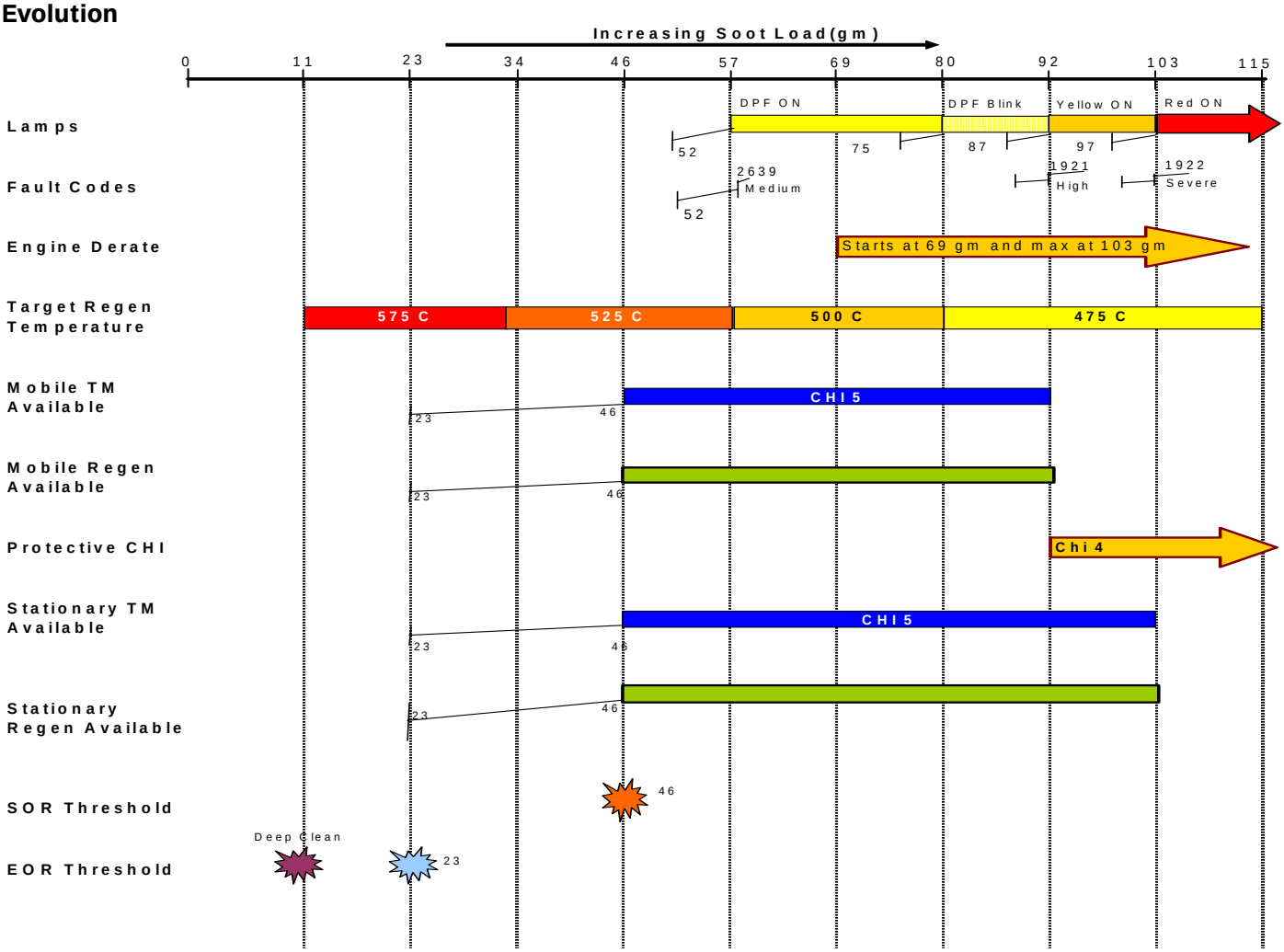
Tactics and Targets

Evolution



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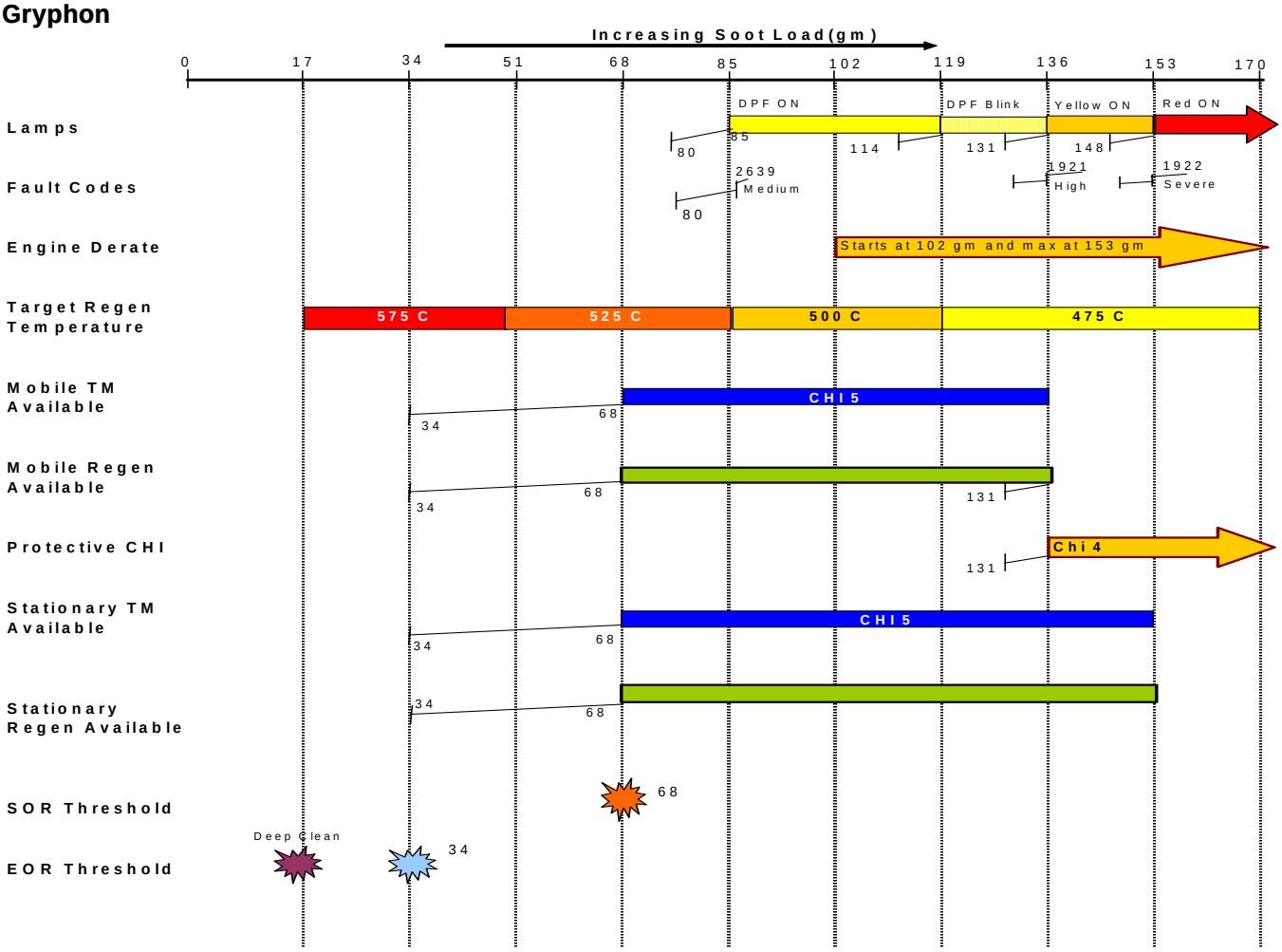
Gryphon



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Initiation of a Regeneration

- To initiate a regeneration based on the soot load in the filter, override the ECM estimated soot load (C_SFP_Soot_Load_User_Reset_Val) to the value determined in the DPSLE procedure.
- Set both (C_SFP_Soot_Load_User_Reset_En) and (O_SFP_Soot_Load_Reset) to one.
- Allow (V_SFP_mg_Soot_Load_Comb) to change to the value overridden in (C_SFP_Soot_Load_User_Reset_Val).
- Set both (C_SFP_Soot_Load_User_Reset_En) and (O_SFP_Soot_Load_Reset) back to zero. This will allow the ECM to take over estimating the soot load again. If they are left as ones the ECM soot load estimate ((V_SFP_mg_Soot_Load_Comb) will stay at the value in (C_SFP_Soot_Load_User_Reset_Val).
- If you are stationary, and a stationary regeneration switch is available, toggle switch to take engine to stationary regen speed. If switch is not available set (H_PTM_Operator_Regen_Req) to one. This will take the engine to an elevated speed to allow for greater flow through the particulate filter.
- Note: If the ECM soot load (V_SFP_mg_Soot_Load_Comb) is below 46 for Evolution and 68 for Gryphon the engine will not initiate a regeneration. If it is determined that a regeneration is needed at a soot load lower than the calibratable simply set the soot load higher than the calibratible.

Alternative method not using soot load (Damage can occur if filter is heavily loaded):

- To initiate a regeneration regardless of ECM estimated soot load (V_SFP_mg_Soot_Load_Comb) set (O_SFR_Regen_Trigger_On) to one. This will ignore any tactics or triggers that may apply to the actual soot load in the filter. If soot loading is very high this can cause damage to the filter. Refer to next section or “Tactics and Triggers” if needed.
- Monitor (V_SFR_Regen_Trigger), when the engine is attempting to regenerate this will be a one, If engine is not attempting to regenerate this will be a zero.
- To stop regeneration set (O_SFR_Regen_Trigger_On) back to zero.

Monitor the following when regenerating:

Variable	Description
V_ATP_tr_DOC_In	DOC Inlet Temperature
V_ATP_tr_DOC_Out	Post-processed DOC Out temperature.
V_ATP_tr_DPF_Out	Post-processed DPF Out temperature.
Very_Late_Post_Fueling	Desired Very Late Post Fueling
V_SFP_mg_Soot_Load_Comb	Combined soot load estimate

Initiation of a Stationary Regeneration

- To initiate a stationary regen, set C_PTM_SRT_Override_Value to 1 and T_PTM_SRT_User_Override to 1 or toggle T_DIP_SRegen_Switch_Inversion twice (if initially set to one, change to zero, and back to one, or if initially set to zero, change to one and back to zero).
- Check the current soot loading (V_SFP_mg_Soot_Load_Comb). If it is not above 46 for Evolution or 68 for Gryphon, then override it using the following steps:
    - Set C_SFP_Soot_Load_User_Reset_Val to the desired value (above 46 for Evo or above 68 for Gry)
    - Set both (C_SFP_Soot_Load_User_Reset_En) and (O_SFP_Soot_Load_Reset) to one.
    - Allow (V_SFP_mg_Soot_Load_Comb) to change to the value overridden in (C_SFP_Soot_Load_User_Reset_Val).
    - Set both (C_SFP_Soot_Load_User_Reset_En) and (O_SFP_Soot_Load_Reset) back to zero. This will allow the ECM to take over estimating the soot load again. If they are left as ones the ECM soot load estimate ((V_SFP_mg_Soot_Load_Comb) will stay at the value in (C_SFP_Soot_Load_User_Reset_Val).
- If the engine does not enter stationary regen (H_PTM_StatRegenTrigger is still 0) , then verify the following:
    - Accelerator_Pedal_Position = 0
    - Vehicle_Speed < 1kph
    - No VSS Errors
    - Engine Protection is not active
    - Clutch_Switch = 0
    - Service_Brake_Switch = 0
    - Out_Of_Gear = 1
    - PTO is off
    - Engine has been running for at least 5 seconds
    - No EGR or VGT faults

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Troubleshooting

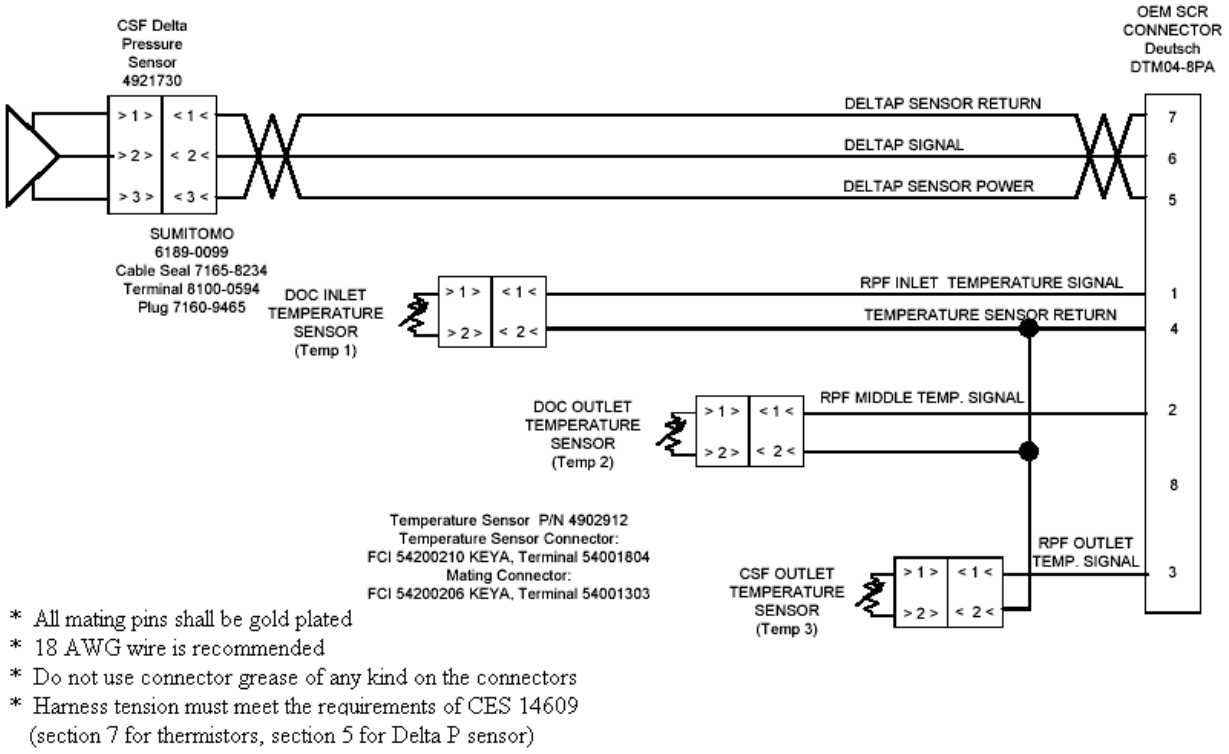
Face Plugging

When excessive dosing occurs it is possible for the face of the Diesel Oxidation Catalyst (DOC) to plug. This means that a heavy layer of soot has accumulated over the face of the DOC, restricting flow through it. This can cause excessive Hydrocarbon (HC) slip past the DOC and cause an exotherm across the Diesel Particulate Filter (DPF). Typically the risk of face plugging is worsened in a low speed and load type of duty cycle (ie urban pick-up and delivery) with excessive dosing. Face plugging can be cleaned up on engine, simply by running the engine at high flow and temperatures. There is an algorithm in the ECM that monitors how much time is spent dosing (depositing soot on the face of the DOC) and how much time is spent at high flow and temperature (cleansing the face of the DOC). Use the following parameters to monitor face plugging.

Variable	Description
P_OCL_tm_FacePlug_Count	Face plugging counter output
C_OCL_tm_FacePlug_HiThd	Face plugging counter out hi-threshold, (set faceplug flag, if bigger than HiThd)

If the face plugging counter output is greater than the counter hi-threshold a fault code (2637) will be activated and the engine will go into chi 4 until the face plugging counter reaches zero again. Dosing will also be prevented while the fault code is present.

Wiring Diagram



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Regeneration History Parameters

- Parameters with “T_PTM_ScaledRequest” are from the last regeneration and are the amount of time the engine spent requesting a regeneration.
- Parameters with “T_PTM_ScaledSuccess” are from the last regeneration and are the amount of time the engine spent with very_late_post_fueling above zero.
- Parameters with “T TimeRequest” are for the life of the cal and are the amount of time the engine spent requesting a regeneration.
- Parameters with “TimeSuccess” are for the life of the cal and are the amount of time the engine spent with very_late_post_fueling above zero.
- The different buckets are used for determining what type of regeneration related duty cycle the engine is running, a simple sum of them all is the total time.

T_PTM_Bucket_Five_Total	194	counts	Lifetime cumulative total of Bucket-5 regen events
T_PTM_Bucket_Four_Total	1220	counts	Lifetime cumulative total of Bucket-4 regen events
T_PTM_Bucket_One_Total	26504	counts	Lifetime cumulative total of Bucket-1 regen events
T_PTM_Bucket_Six_Total	22	counts	Lifetime cumulative total of Bucket-6 regen events
T_PTM_Bucket_Three_Total	2160	counts	Lifetime cumulative total of Bucket-3 regen events
T_PTM_Bucket_Two_Total	1577	counts	Lifetime cumulative total of Bucket-2 regen events
T_PTM_CurrentOperatingDay	0	None	Current thermal management operating 'day'. Saved to allow a day to span multipl
T_PTM_Day1_Bucket1	0	counts	Bucket #1 tally saved for Day 1
T_PTM_Day1_Bucket2	0	counts	Bucket #2 tally saved for Day 1
T_PTM_Day1_Bucket3	0	counts	Bucket #3 tally saved for Day 1
T_PTM_Day1_Bucket4	0	counts	Bucket #4 tally saved for Day 1
T_PTM_Day1_Bucket5	0	counts	Bucket #5 tally saved for Day 1
T_PTM_Day1_Bucket6	0	counts	Bucket #6 tally saved for Day 1
T_PTM_Day2_Bucket1	0	counts	Bucket #1 tally saved for Day 2
T_PTM_Day2_Bucket2	0	counts	Bucket #2 tally saved for Day 2
T_PTM_Day2_Bucket3	0	counts	Bucket #3 tally saved for Day 2
T_PTM_Day2_Bucket4	0	counts	Bucket #4 tally saved for Day 2
T_PTM_Day2_Bucket5	0	counts	Bucket #5 tally saved for Day 2
T_PTM_Day2_Bucket6	0	counts	Bucket #6 tally saved for Day 2
T_PTM_Day3_Bucket1	0	counts	Bucket #1 tally saved for Day 3
T_PTM_Day3_Bucket2	0	counts	Bucket #2 tally saved for Day 3
T_PTM_Day3_Bucket3	0	counts	Bucket #3 tally saved for Day 3
T_PTM_Day3_Bucket4	0	counts	Bucket #4 tally saved for Day 3
T_PTM_Day3_Bucket5	0	counts	Bucket #5 tally saved for Day 3
T_PTM_Day3_Bucket6	0	counts	Bucket #6 tally saved for Day 3
T_PTM_Day4_Bucket1	0	counts	Bucket #1 tally saved for Day 4
T_PTM_Day4_Bucket2	0	counts	Bucket #2 tally saved for Day 4
T_PTM_Day4_Bucket3	0	counts	Bucket #3 tally saved for Day 4
T_PTM_Day4_Bucket4	0	counts	Bucket #4 tally saved for Day 4
T_PTM_Day4_Bucket5	0	counts	Bucket #5 tally saved for Day 4
T_PTM_Day4_Bucket6	0	counts	Bucket #6 tally saved for Day 4
T_PTM_OCVG_User_Override	0	None	Allows user override of PTM_OCVG_Allowed
T_PTM_OCVGAuto_Enable	1	None	Allows auto-regen to affect PTM_OCVG_Allowed
T_PTM_OperDay_Timer	0	s	Current value of timer for determining the passage of thermal management "days"
T_PTM_OperStatRegen_Enable	1	None	Allows pedal-dance activation of stationary regen
T_PTM_Regen_Timed_Out_Counter	0	None	Number of times Wait-for-Regen timer has timed out
T_PTM_Scaled_1	126378.6	None	Weighted total time spent in Bucket 1
T_PTM_Scaled_2	17586.21	None	Weighted total time spent in Bucket 2
T_PTM_Scaled_3	0	None	Weighted total time spent in Bucket 3
T_PTM_Scaled_4	0	None	Weighted total time spent in Bucket 4
T_PTM_Scaled_5	0	None	Weighted total time spent in Bucket 5

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T_PTM_Scaled_6	0	None	Weighted total time spent in Bucket 6
T_PTM_ScaledRequest_1	61632.71	None	Weighted total time spent requesting regen in Bucket 1
T_PTM_ScaledRequest_2	8165.058	None	Weighted total time spent requesting regen in Bucket 2
T_PTM_ScaledRequest_3	0	None	Weighted total time spent requesting regen in Bucket 3
T_PTM_ScaledRequest_4	0	None	Weighted total time spent requesting regen in Bucket 4
T_PTM_ScaledRequest_5	0	None	Weighted total time spent requesting regen in Bucket 5
T_PTM_ScaledRequest_6	0	None	Weighted total time spent requesting regen in Bucket 6
T_PTM_ScaledSuccess_1	511.2896	None	Weighted total time spent providing regen capability in Bucket 1
T_PTM_ScaledSuccess_2	274.2	None	Weighted total time spent providing regen capability in Bucket 2
T_PTM_ScaledSuccess_3	0	None	Weighted total time spent providing regen capability in Bucket 3
T_PTM_ScaledSuccess_4	0	None	Weighted total time spent providing regen capability in Bucket 4
T_PTM_ScaledSuccess_5	0	None	Weighted total time spent providing regen capability in Bucket 5
T_PTM_ScaledSuccess_6	0	None	Weighted total time spent providing regen capability in Bucket 6
T_PTM_SRT_User_Override	0	None	Allows override of H_PTM_StatRegenTrigger
T_PTM_StatAutoRegen_Enable	0	None	Allows automatic stationary regeneration
T_PTM_Time_1	2099807	s	Lifetime total time spent in Bucket 1
T_PTM_Time_2	277160	s	Lifetime total time spent in Bucket 2
T_PTM_Time_3	0	s	Lifetime total time spent in Bucket 3
T_PTM_Time_4	0	s	Lifetime total time spent in Bucket 4
T_PTM_Time_5	0	s	Lifetime total time spent in Bucket 5
T_PTM_Time_6	0	s	Lifetime total time spent in Bucket 6
T_PTM_TimeRequest_1	1560116	s	Lifetime total time spent requesting regen in Bucket 1
T_PTM_TimeRequest_2	198261	s	Lifetime total time spent requesting regen in Bucket 2
T_PTM_TimeRequest_3	0	s	Lifetime total time spent requesting regen in Bucket 3
T_PTM_TimeRequest_4	0	s	Lifetime total time spent requesting regen in Bucket 4
T_PTM_TimeRequest_5	0	s	Lifetime total time spent requesting regen in Bucket 5
T_PTM_TimeRequest_6	0	s	Lifetime total time spent requesting regen in Bucket 6
T_PTM_TimeSuccess_1	48059	s	Lifetime total time spent successfully allowing regen in Bucket 1
T_PTM_TimeSuccess_2	22437	s	Lifetime total time spent successfully allowing regen in Bucket 2
T_PTM_TimeSuccess_3	0	s	Lifetime total time spent successfully allowing regen in Bucket 3
T_PTM_TimeSuccess_4	0	s	Lifetime total time spent successfully allowing regen in Bucket 4
T_PTM_TimeSuccess_5	0	s	Lifetime total time spent successfully allowing regen in Bucket 5
T_PTM_TimeSuccess_6	0	s	Lifetime total time spent successfully allowing regen in Bucket 6
T_PTM_UseTM_User_Override	0	None	Allows override of PTM_Use_TM
T_PTM_UseTMAuto_Enable	1	None	Allows automatic regen logic to affect PTM_Use_TM

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2007 CM2150 Controls System Algorithm Diagnostics

1. Charge Flow Derates

Req/Rec	0.5 sec	Engine_Speed	Filtered_Turbo_Speed
		Total_Fueling	CHL_COT_Drt_Offset
		Combustion_Control_Path_Owner	CHL_Turbo_Speed_Drt_Offset
		CBL_MCF_Cmd	CHL_Delta_P_Drt_Offset
		CBL_EGR_Frac_Cmd	CHL_MCF_Cmd
		Compressor_Outlet_Tmptr	CHL_EGR_Frac_Cmd
		EGR_Position	Charge_Flow
		EGR_Valve_Delta_Press	EGR_Fraction
		TGC_VT_Cmd	Ambient_Air_Press

2. Charge Manager

Req/Rec	0.5 sec	Engine_Speed	Charge_Flow
		Total_Fueling	CHL_MCF_Cmd
		Combustion_Control_Path_Owner	EGR_Fraction
		CHL_EGR_Frac_Cmd	CHL_EGR_Frac_Cmd
		CBL_MCF_Cmd	EGR_Position
		Compressor_Outlet_Tmptr	VGT_Position
		Filtered_Turbo_Speed	TGC_VT_Cmd
		EGR_Valve_Delta_Press	CSE_Xform_Error_1
		Ambient_Air_Press	CSE_Xform_Error_2
		H_ERC_ChargeFlowCmd	CSE_Xform_Angle
		EAC_EGR_Valve_Cmd	

3. Chi Strategy

Req/Rec	0.5 sec	Engine_Speed	Alpha
		Total_Fueling	H_CBR_Chi_Value
		Combustion_Control_Path_Owner	H_CBR_Chi_Source
		Compressor_Inlet_Density	CBR_EGR_Off
		Ambient_Air_Press	EMM_Cap_EL_Cmd
		Coolant_Temperature	CBR_SOI_Ref
		Exhaust_Tmptr	Final_Timing
		EGR_Position	VGT_Position

4. Combustion Manager

Req/Rec	0.1 sec	Engine_Speed	CBR_SOI_Ref
		Total_Fueling	Final_Timing
		Combustion_Control_Path_Owner	Final_Timing_State
		SOI_Torque_To_Fuel_Adj	EMM_Protection_State
		OFC_Fuel_Limit	EMM_Cap_EL_Cmd
		Alpha	EMM_AECD_State
		H_CBR_Chi_Value	CBL_MCF_Cmd
		EMR_Cap_EL_Ref	CBL_EGR_Frac_Cmd
		CBR_EGR_Off	
EDM	20 msec	Engine_Speed	CBO_Charge_Aggressiveness_Ref
		Total_Fueling	FSI_s_EBrakeOn
		Combustion_Control_Path_Owner	Pilot_Fueling
		H_CBR_Alpha	Post_Fueling
		Coolant_Temperature	Pilot_to_Main_Time
		Intake_Manifold_Temperature	Main_to_Post_Time
		H_ERC_ChargeFlowCmd	Fuel_High_Pressure_Command
		Very_Late_Post_Fueling	H_CBR_Chi_Value

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5. EGR Delta P Sensor Diagnostics

Req/Rec	0.1 sec	EGR_Delta_Press	H_EGR_Delta_Press_Raw
		EGR_Delta_Press_Sensor	
Req/Rec	0.2 sec	EGR_Delta_Press	EGR_Position
		EGR_Delta_Press_Sensor	EGR_Fraction
		H_EGR_Delta_Press_Raw	Engine_Speed
Req/Rec	0.4 sec	EGR_Delta_Press	EGR_Fraction
Or EDM	0.1 sec	EGR_Position	CHL_EGR_Frac_Cmd
		Engine_Speed	OFC_EGR_Disable
		CBR_Fuel_Ref	Combustion_Control_Path_Owner
		EGR_Delta_Press_Sensor	Total_Fueling
		H_EGR_Delta_Press_Raw	

6. EGR Fraction and Mass Charge Flow Determination

Req/Rec	0.5 sec	Engine_Speed	Combustion_Control_Path_Owner
		Charge_Press	Charge_Flow
		CHP_Volumetric_Efficiency	EGR_Fraction
		Exhaust_Tmptr	EGR_Position
		Exhaust_Press	EGR_Delta_Press
		Intake_Manifold_Temperature	Ambient_Air_Press
		Total_Fueling	CHL_MCF_Cmd

7. EGR OFF Conditions

EGA_Control_State should equal 1, EGA_ZERO_HOLD_STATE

Req/Rec	0.5 sec	Engine_Speed	EGR_Position
		Total_Fueling	EGR_Delta_Press
		Combustion_Control_Path_Owner	Exhaust_Tmptr
		Vehicle_Speed	Coolant_Temperature
		H_CBR_Alpha	Intake_Manifold_Temperature
		H_CBR_Chi_Value	Charge_Press
		H_CBR_Chi_Source	Compressor_Outlet_Tmptr
		CBR_EGR_Off	Compressor_Inlet_Density

8. EGR Valve Controller

Req/Rec	0.2 sec	Engine_Speed	EGR_Position
		Total_Fueling	EAC_EGR_Valve_Cmd
		EGA_Control_State	EGR_Delta_Press
Req/Rec	0.5 sec	Engine_Speed	CSE_Xform_Error_1
Or EDM	0.2 sec	Total_Fueling	CSE_Xform_Angle
		Net_Engine_Torque	EGR_Fraction
		EGR_Position	CHL_EGR_Frac_Cmd
		EAC_EGR_Valve_Cmd	Charge_Flow
		EGR_Delta_Press	CHL_MCF_Cmd
		Combustion_Control_Path_Owner	EGA_Control_State
		CSE_MCF_Error	

9. EGR Valve Motor Diagnostics

Req/Rec	0.1 sec	EGR_Delta_Press	EGA_Control_State
		EGR_Position	EAC_EGR_Valve_Cmd
Req/Rec	0.2 sec	EGR_Delta_Press	EAC_EGR_Valve_Cmd
		EGR_Position	EGR_Driver_Failure
		EGA_Control_State	EGA_Motor_Current
Req/Rec	0.5 sec	EGR_Delta_Press	EGA_PWM_Limited
Or EDM	0.2 sec	EGR_Position	EGA_Motor_Current
		EGA_Control_State	EAC_EGR_Valve_Cmd
		EGR_Driver_Failure	EGR_Orifice_Tmptr
		EGA_Electrical_Fault	Engine_Speed
		EGA_Device_Driver_Status	Total_Fueling
		EGA_Driver_Over_Current	Combustion_Control_Path_Owner

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10. Emissions Manager

Req/Rec	0.1 sec	Engine_Speed	H_CBR_Alpha
		Total_Fueling	EMR_Cap_EL_Ref
		Combustion_Control_Path_Owner	EMM_Cap_EL_Cmd
		Altitude	CBR_EGR_Off
		Ambient_Air_Tmptr	Alpha
		Net_Engine_Torque	

11. Emissions Manager - Compensate for Off-Nominal Emission Conditions

Req/Rec	0.1 sec	Engine_Speed	EMO_Air_Handling_AECD_Active
		Total_Fueling	EMO_Condensation_AECD_Active
		Combustion_Control_Path_Owner	EGR_Position
		Compressor_Inlet_Density	EMM_Cap_EL_Cmd
		Net_Engine_Torque	EMR_Cap_EL_Ref
		CHP_Predicted_IMT	CBR_EGR_Off
		Charge_Press	Coolant_Temperature

12. Engine Brakes – Charge Flow Commanded Torque

Req/Rec	0.2 sec	Engine_Speed	Combustion_Control_Path_Owner
		H_ERC_GrossTorqueLmtd	CBP_Combustion_Torque
		H_ERC_ChargeFlowCmd	ERC_DriverFractionCmd
Req/Rec	0.5sec	Engine_Speed	ERC_DriverFractionCmd
Or EDM	0.2 sec	Total_Fueling	FSI_s_EBrakeOn
		Combustion_Control_Path_Owner	Jcomm_Percent_Retarder_Torque
		H_ERC_GrossTorqueLmtd	RetarderSwitchLevel
		H_ERC_ChargeFlowCmd	VGT_Position
		Charge_Flow	H_ERC_GrossTorqueLmtd
		CBP_Combustion_Torque	EGR_Position
		Charge_Press	VGT_Position
		EngBrkDriver1	EngBrkDriver2

13. Engine Torque Determination

Req/Rec	0.5 sec	Engine_Speed	CBP_Net_Combustion_Torque
		Accelerator_Pedal_Position	CHP_Pumping_Torque_Adj
		Net_Engine_Torque	Coolant_Torque_Adjustment
		H_NDOT_Gov_Torque	Combustion_Control_Path_Owner
		Engine_No_Load_Torque	Coolant_Temperature
		SOI_Torque_To_Fuel_Adj	CBP_Combustion_Torque
		CBR_Gross_Fuel	H_ERC_GrossTorqueLmtd
		OFC_Fuel_Limit	H_MACH_NetTorqueCmd

14. EPD (Engine Protection Derate)

Req/Rec	0.4 sec	Engine_Speed	Charge_Tmptr
		Combustion_Control_Path_Owner	Coolant_Level
		Total_Fueling	Compressor_Outlet_Tmptr
		Net_Engine_Torque	Coolant_Pressure
		EPD_TrqDrtActive	Coolant_Temperature
		EPD_Engine_State	EGR_Orifice_Tmptr
		EPD_Torque_Derate_Value_id	Exhaust_Metal_Tmptr
		EPD_TorqueDerateValue	Fuel_Temperature
		Oil_Temperature	Oil_Pressure
		V_SFP_mg_Soot_Load_Comb	

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15. Fueling Determination

CBR_Gross_Fuel is the output of the Torque to Fuel conversion of ENGN_Final_Torque_Cmd after the overrides, derates, and limits. CBR_Fuel_Ref takes CBR_Fuel_Ref and applies TFC and OFC derates. CBL_Fuel_Cmd is the fuel command after CBL fuel overrides.

CBM_FdbkTotalFuel is the total fuel delivered via the fuel system. Comb_FSS_FdbkTotalFueling is CMB_FdbkTotalFuel – Late Post fuel. Total_Fueling is the final output to the fuel system which is CBL_Fuel_Cmd when the engine is running or CNK_Fuel when the engine is starting.

Req/Rec	0.5 sec	Engine_Speed	T_CBL_Fuel_User_Override
		Accelerator_Pedal_Position	C_CBL_Fuel_Override_Value
		Combustion_Control_Path_Owner	H_FSI_q_TotalFueling
		H_NDOT_Gov_Torque	CBR_Fuel_Ref
		Alpha	CBL_Fuel_Cmd
		ENGN_Final_Torque_Cmd	Total_Fueling
		Engn_Control_Path_Owner	H_CBR_Chi_Value
		SOI_Torque_To_Fuel_Adj	

16. Engine Fuel versus Engine Torque

H_MACH_NetTorqueCmd is the clamed output from the Ndot Governor. This is the final output of the Machine Manager which is input into Engine Manager. H_ENGN_Unadj_Torque_Demand takes the output of Machine Manger, add the requirements from the Accessory Control Agent, and applies an Engine Protection Derate, if necessary. ENGN_Final_Torque_Cmd selects between H_ENGN_Unadj_Torque_Demand and commands coming from the retarder and overspeed algorithms.

Net_Engine_Torque is an estimate of torque from the engine manager feedback. CBP_Combustion_Torque uses FSSFdckTotalFueling, Engine Speed, and SOI to estimate the torque produced from the combustion event.

Req/Rec	0.5 sec	Engine_Speed	CBR_Gross_Fuel
		Total_Fueling	OFC_Fuel_Limit
		Combustion_Control_Path_Owner	H_FSI_q_TotalFueling
		Accelerator_Pedal_Position	CBP_Adj_Total_Fueling
		H_NDOT_Gov_Torque	CBP_Combustion_Torque
		Engine_No_Load_Torque	Friction_Torque
		H_ERC_ActualGrossTrq	Coolant_Torque_Adjustment
		SOI_Torque_To_Fuel_Adj	CBP_Net_Combustion_Torque
		Mach_Engine_Demand_Torque	H_MACH_NetTorqueCmd

17. NDOT Governor

Note: H_NDOT_PropErrorFiltrd also applies to the intergral term, they are just filtered different. However, no test point exists for just the error

Req/Rec	0.1 sec	Engine_Speed	Total_Fueling
		NDOT_Driver_Demand	Combustion_Control_Path_Owner
Req/Rec	0.3 sec	Engine_Speed	Combustion_Control_Path_Owner
		H_NDOT_Gov_Torque	Effective_Gear_Ratio
		NDOT_Driver_Demand	Accelerator_Pedal_Position
		H_NDOT_PropErrorFiltrd	Vehicle_Speed
		H_NDOT_INT_Torque	Total_Fueling
		NDOT_PathOwner	
Req/Rec	0.5 sec	Engine_Speed	Combustion_Control_Path_Owner
Or EDM	0.2 sec	H_NDOT_INT_Torque	Effective_Gear_Ratio
		H_NDOT_Gov_Torque	Accelerator_Pedal_Position
		NDOT_Driver_Demand	Vehicle_Speed
		H_NDOT_PropErrorFiltrd	Torque_Derived_Ndot
		H_NDOT_PP_Torque	Engine_No_Load_Torque
		H_NDOT_FF_Torque	H_MACH_NetTorqueCmd
		H_Ndot_IntegratorResetAdj	Total_Fueling
		NDOT_PathOwner	

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17.1 NDOT Governor – Low Speed Idle (LSI)

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		H_LSI_NDOT_Demand	NDOT_Driver_Demand
Req/Rec	0.2 sec	Engine_Speed	H_LSI_NDOT_Demand
		Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd
Req/Rec	0.5 sec	Engine_Speed	H_LSI_NDOT_Demand
Or EDM	0.2 sec	Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd
		CBP_Net_Combustion_Torque	Accelerator_Pedal_Position
		H_NDOT_Gov_Torque	Vehicle_Speed
		H_NDOT_INT_Torque	Effective_Gear_Ratio
		LSI_ReferenceSpd	

17.2 NDOT Governor – Accelerator Based Torque (ABT) – formerly Four D

Please note there is currently no way to monitor this Ndot request

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		Accelerator_Pedal_Position	NDOT_Driver_Demand
Req/Rec	0.2 sec	Engine_Speed	Accelerator_Pedal_Position
		Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd
Req/Rec	0.5 sec	Engine_Speed	H_NDOT_DriverUserDemand
Or EDM	0.2 sec	Total_Fueling	NDOT_PathOwner
		Combustion_Control_Path_Owner	NDOT_Driver_Demand
		Accelerator_Pedal_Position	H_NDOT_PropErrorFiltrd
		Vehicle_Speed	Net_Engine_Torque
		Effective_Gear_Ratio	H_NDOT_Gov_Torque
		Torque_Derived_Ndot	H_NDOT_INT_Torque

17.3 NDOT Governor – Accelerator Based Speed (ABS) - formerly ASG

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		H_ABS_NDOT_Demand	NDOT_Driver_Demand
Req/Rec	0.2 sec	Engine_Speed	H_ABS_NDOT_Demand
		Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd
Req/Rec	0.5 sec	Engine_Speed	H_NDOT_DriverUserDemand
Or EDM	0.2 sec	Total_Fueling	NDOT_PathOwner
		Combustion_Control_Path_Owner	H_ABS_NDOT_Demand
		Accelerator_Pedal_Position	NDOT_Driver_Demand
		Vehicle_Speed	H_NDOT_PropErrorFiltrd
		Effective_Gear_Ratio	Net_Engine_Torque
		H_ABS_ReferenceSpd	H_NDOT_Gov_Torque
		Torque_Derived_Ndot	H_NDOT_INT_Torque

17.4 NDOT Governor – High Speed Idle (HSI)

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		H_HSI_NDOT_Demand	NDOT_Driver_Demand
Req/Rec	0.2 sec	Engine_Speed	H_HSI_NDOT_Demand
		Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd
Req/Rec	0.5 sec	Engine_Speed	H_HSI_NDOT_Demand
Or EDM	0.2 sec	Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd
		Net_Engine_Torque	Accelerator_Pedal_Position
		H_NDOT_Gov_Torque	Vehicle_Speed
		H_NDOT_INT_Torque	Effective_Gear_Ratio
		HSI_ReferenceSpd	

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17.5 NDOT Governor – Cruise Control Governor

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		H_CC_NDOT_Demand	NDOT_Driver_Demand
Req/Rec	0.2 sec	Engine_Speed	H_CC_NDOT_Demand
		Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd
Req/Rec	0.5 sec	Engine_Speed	H_CC_NDOT_Demand
Or EDM	0.2 sec	Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd
		Vehicle_Speed	H_NDOT_INT_Torque
		T_CC_MaxRoadSpeed	Net_Engine_Torque
		Accelerator_Pedal_Position	H_NDOT_DriverUserDemand
		Effective_Gear_Ratio	NDOT_PathOwner
		CC_Status	CC_ReferenceSpeed

17.6 NDOT Governor – Road Speed Control (RSC) - Formerly RSG

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		H_RSC_NDOT_Demand	NDOT_Driver_Demand
Req/Rec	0.2 sec	Engine_Speed	H_RSC_NDOT_Demand
		Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd

17.7 NDOT Governor – Power Takeoff (PTO) Governor

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		H_PTO_NDOT_Demand	H_PTO_NDOT_Demand
Req/Rec	0.2 sec	Engine_Speed	H_PTO_NDOT_Demand
		Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	H_NDOT_PropErrorFiltrd
Req/Rec	0.5 sec	Engine_Speed	NDOT_Driver_Demand
Or EDM	0.2 sec	Total_Fueling	H_NDOT_PropErrorFiltrd
		Combustion_Control_Path_Owner	H_NDOT_INT_Torque
		PTO_Status	H_NDOT_Gov_Torque
		H_PTO_RefSpeed	Net_Engine_Torque
		H_PTO_NDOT_Demand	H_NDOT_DriverUserDemand
		NDOT_PathOwner	

18. OFC Fuel Limit

FCLR = Fuel Command to Limit Ratio. This is the ratio of desired fuel to meet the gross torque request to the fuel allowed by OFC. FCLR > 1.00 need more O2, then OFC_EGR_Disable will become true and the EGR valve should close, if FCLR < 1.00 not OFC limited; Normal Nox controls.

Req/Rec	0.1 sec	Engine_Speed	OFC_EGR_Disable
		Total_Fueling	OFC_Fuel_Limit
Req/Rec	0.2 sec	Engine_Speed	OFC_Fuel_Limit
		Total_Fueling	OFC_EGR_Disable
		Combustion_Control_Path_Owner	CBR_Gross_Fuel
Req/Rec	0.4 sec	Engine_Speed	OFC_Fuel_Limit
Or EDM	0.2 sec	Total_Fueling	OFC_EGR_Disable
		Combustion_Control_Path_Owner	CBR_Gross_Fuel
		Vehicle_Speed	CBR_FCLR_Ref
		Filtered_Gear_Ratio	CBR_FCLR_On
		EGR_Position	CBR_FCLR_Off

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19. SOI Timing Determination (SOI ADVANCE)

Req/Rec	0.2 sec	Engine_Speed	Final_Timing
		Intake_Manifold_Temperature	Final_Timing_State
		Coolant_Temperature	Ambient_Air_Press
Req/Rec	0.4 sec	Engine_Speed	CBL_SOI_Cmd
		Total_Fueling	Compensated_Timing_Value
		Coolant_Temperature	SOI_AAP_Timing_Advance
		Intake_Manifold_Temperature	Ambient_Air_Press
		SOI_Cltmp_Timing_Advance	Final_Timing
		SOI_IMT_Timing_Advance	Final_Timing_State
Req/Rec	0.5 sec	Engine_Speed	MTL_TimingLimit
Or EDM	0.2 sec	H_CBR_Alpha	ANC_Timing
		H_CBR_Chi_Value	CBL_SOI_Cmd
		CBR_Fuel_Ref	UHC_SOI_Advance
		CBR_SOI_Ref	SOI_State
		CBO_SOI_Ref	Final_Timing_State
		Compensated_Timing_Value	Final_Timing
		SOI_IMT_Timing_Advance	SOI_AAP_Timing_Advance
		SOI_Cltmp_timing_Advance	

20. Thermal Management/Aftertreatment Regeneration

Req/Rec	1 sec	Charge_Tmptr	EGR_Fraction
Or EDM	0.5 sec	EMM_AECD_State	EMM_Protection_State
		Exhaust_Press	H_PTM_TMMode
		H_SFP_DPTrust_Fctr_Adjusted	H_SFP_mg_dt_NO2_Oxid_Rate
		H_SFP_mg_dt_O2_Oxid_Rate	H_SFR_Regen_Tactic
		P_SFR_Regen_Trigger_State	P_SFP_Soot_Stage
		V_ATP_fg_Turbo_Out	Post_Fueling
		V_ATP_mf_Turbo_Out_O2	V_ATP_mf_Turbo_Out_NOx
		V_ATP_tr_DOC_Out	V_ATP_mf_Turbo_Out_PM
		V_OCL_fg_HC_Cmd	V_ATP_tr_DOC_In
		V_OCL_HC_Desorb_Request	V_ATP_tr_DPF_Out
		V_OCR_fg_HC_Corr	V_OCL_fg_HC_LightOff_Limit
		V_OCR_fg_HC_Nominal	V_OCP_tr_Bed
		V_SFL_tr_Regen_Cmd	V_OCR_fg_HC_Cmd
		V_SFP_fn_Uniform_Dist_Factor	V_OCR_fg_HC_Int_Cntrl
		V_SFP_mg_Ash_Adj	V_OCR_fg_HC_Prp_Cntrl
		V_SFP_mg_Soot_Load_Comb	V_SFL_tr_Regen_Trgt
		V_SFP_pr_Delta	V_SFP_fv_DPF
		V_SFP_RegenDetected	V_SFP_mg_dt_NetSootAccumRate
		V_SFR_Regen_Trigger	V_SFP_mg_Soot_Load_DP
		VGT_Position	V_SFP_tr_DPF_Bed
		Very_Late_Post_Fueling	

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21. TGC Controller

EDM	0.1 sec	Filtered_Turbo_Speed	TGC_Error
		TGC_VT_Cmd	C_TGC_Adjsuted_P_Gain
		C_TGC_Adjusted_I_Gain	TGC_Final_LLim
		TGC_Final_ULim	
Req/Rec	0.5 sec	Engine_Speed	Filtered_Turbo_Speed
EDM	0.2 sec	TGC_VT_Cmd	Charge_Flow
		Combustion_Control_Path_Owner	C_TGC_Adjsuted_P_Gain
		CBR_Thermal_Oscar_Active	C_TGC_Adjusted_I_Gain
		CBR_Thermal_Felix_Active	TGC_Final_LLim
		CSE_Xform_Error_2	TGC_Final_ULim
		TGC_Error	TGC_Turbo_Spd_Drt_Error
		H_TGC_PRP_Cnt	CHL_Turbo_Drt_Limit
		H_TGC_Int_Cnt	C_TGC_P_Gain
		H_TGC_FFD_Cnt	C_TGC_I_Gain

22. Torque Management

Req/Rec	0.5 sec	Engine_Speed	H_Net_Torque_Demand
		H_NDOT_Gov_Torque	Engine_No_Load_Torque
		NDOT_PathOwner	ENGN_Final_Torque_Cmd
		H_MACH_NetTorqueCmd	Engn_Control_Path_Owner
		Mach_Control_Path_Owner	CBP_Combustion_Torque
		Net_Engine_Torque	Torque_Limit_At_Current_Speed
		CBP_Net_Combustion_Torque	Total_Fueling
		Combustion_Control_Path_Owner	

23. VGT Electronic Controller

Req/Rec	0.2 sec	Engine_Speed	VGT_Position
		Total_Fueling	TGC_VT_Cmd
		Boost_Pressure	Filtered_Turbo_Speed
Req/Rec	0.5 sec	Engine_Speed	CSE_Xform_Error_2
Or EDM	0.2 sec	Total_Fueling	CSE_Xform_Angle
		Net_Engine_Torque	EGR_Fraction
		VGT_Position	Charge_Flow
		TGC_VT_Cmd	CHL_MCF_Cmd
		Combustion_Control_Path_Owner	CHL_EGR_Frac_Cmd
		Filtered_Turbo_Speed	Boost_Pressure
		TGC_Error	

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System Diagnostics

1. Acceleration Noise Control

Req/Rec	0.3 sec	Engine_Speed	Vehicle_Speed
Or EDM	0.1 sec	Total_Fueling	ANC_Timing_Limit_Status
		Accelerator_Pedal_Position	Coolant_Temperature
		Combustion_Control_Path_Owner	Filtered_Gear_Ratio
		Final_Timing	NDOT_Driver_Demand

2. Ambient Air Pressure Sensor – Poor Engine Performance

Req/Rec	0.3 sec	Engine_Speed	Boost_Pressure
		Total_Fueling	Intake_Manifold_Temperature
		Combustion_Control_Path_Owner	Ambient_Air_Press_Source
		Ambient_Air_Press	

3. Clutch Engagement / Idle Overshoot

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		Total_Fueling	Vehicle_Speed
Req/Rec	0.2 sec	Engine_Speed	Combustion_Control_Path_Owner
		Vehicle_Speed	NDOT_Driver_Demand
		Total_Fueling	Accelerator_Pedal_Position
Req/Rec	0.4 sec	Engine_Speed	Accelerator_Pedal_Position
		Vehicle_Speed	Combustion_Control_Path_Owner
		Total_Fueling	OFC_Fuel_Limit
		H_LSI_NDOT_Demand	Filtered_Raw_Accel_Value
		NDOT_Driver_Demand	

4. Cold Temperature Stumble / IMT SOI Advance Control

Rapid accelerations under free-engine conditions may lead to white smoke and/or poor acceleration. A combination of data is recommended. The first set of data serves as the baseline to engine conditions at idle prior to the second data set. The second set of data captures various engine conditions and temperatures as the engine warms up. Record DATA 1 prior to DATA 2, then record DATA 1 again to document engine conditions as engine conditions change.

Req/Rec	0.2 sec	Engine_Speed	Charge_Flow
	DATA 1	Ambient_Air_Press	Total_Fueling
		Coolant_Temperature	Pilot_Fueling
		Intake_Manifold_Temperature	Boost_Pressure
Req/Rec	0.2 sec	Engine_Speed	Charge_Flow
	DATA 2	Total_Fueling	Pilot_Fueling
		Combustion_Control_Path_Owner	Boost_Pressure
		Final_Timing	Final_Timing_State

5. Cruise Control - AutoResume

Req/Rec	0.2 sec	Engine_Speed	Vehicle_Speed
		Total_Fueling	CC_Status
		Combustion_Control_Path_Owner	H_CC_Error
Req/Rec	0.4 sec	H_CC_Droop	CC_ReferenceSpeed
		Total_Fueling	H_CC_Error
		Combustion_Control_Path_Owner	CC_CommandMode
		Vehicle_Speed	CC_Status

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6. Cruise Control - Engine Brakes

Verify that T_CC_EB_Enable is ENABLE

Req/Rec	0.1 sec	Engine_Speed	Vehicle_Speed
		Total_Fueling	
Req/Rec	0.2 sec	Engine_Speed	Vehicle_Speed
		Combustion_Control_Path_Owner	NDOT_Driver_Demand
		H_CC_Error	Net_Engine_Torque
		Total_Fueling	
Req/Rec	0.5 sec	Engine_Speed	Combustion_Control_Path_Owner
		H_CC_Error	CC_ReferenceSpeed
		H_CC_NDOT_Demand	Accelerator_Pedal_Position
		NDOT_Driver_Demand	Vehicle_Speed
		Net_Engine_Torque	Boost_Pressure
		Total_Fueling	T_CC_MaxRoadSpeed

7. Cruise Control - Highway Cruise Strategy Data Collection

Also record:
Estimate of Gross Vehicle Combined weight
Route start location
Ambient conditions: Ambient_Air_Temperature, Ambient_Air_Pressure, Rel Humidity
Note odometer at start and end of datalog
Note route description during test, note any major events during test

Req/Rec	1.0 sec	Engine_Speed	Final_Timing
		Vehicle_Speed	Final_Timing_State
		Accelerator_Pedal_Position	AIF_AlphaFuelRate
		Total_Fueling	AIF_AlphaAltDerate_Timer
		Combustion_Control_Path_Owner	AIF_AlphaGovernor
		Alpha	Actual_Eng_Indicated_Perc_Trq
		Net_Engine_Torque	CC_AccelSwitch
		CC_CancelSwitch	CC_CoastSwitch
		CC_OnSwitch	CC_ResumeSwitch
		CC_SetSwitch	

8. Cruise Control Switch Diagnostics

Req/Rec	0.2 sec	Engine_Speed	Total_Fueling
		Combustion_Control_Path_Owner	Vehicle_Speed
		CC_ReferenceSpeed	CC_AccelSwitch
		CC_CancelSwitch	CC_CoastSwitch
		CC_OnSwitch	CC_ResumeSwitch
		CC_SetSwitch	

9. Cruise Control / Road Speed / Geardown Governors

Req/Rec	0.1 sec	Engine_Speed	Vehicle_Speed
		Total_Fueling	
Req/Rec	0.2 sec	Engine_Speed	Vehicle_Speed
		Combustion_Control_Path_Owner	NDOT_Driver_Demand
		Total_Fueling	Net_Engine_Torque
		H_CC_Error	
Req/Rec	0.5 sec	Engine_Speed	Combustion_Control_Path_Owner
Or EDM	0.2 sec	H_CC_Error	Accelerator_Pedal_Position
		H_CC_NDOT_Demand	Vehicle_Speed
		NDOT_Driver_Demand	Boost_Pressure
		Net_Engine_Torque	T_CC_MaxRoadSpeed
		Total_Fueling	CC_ReferenceSpeed

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10. Datalink Torque Calculations

Req/Rec	0.3 sec	Engine_Speed	Filtered_Gear_Ratio
		Total_Fueling	PrcntLoadAtCurSpdIndicated
		Combustion_Control_Path_Owner	FCR_Instantaneous_Fuel_Rate
		Actual_Eng_Indicated_Perc_Trq	Vehicle_Speed
		Engine_No_Load_Torque	H_DLC_Torque_Request
		ENGN_Final_Torque_Cmd	Net_Engine_Torque
		T_JPC_Reference_Engine_Torque	H_ERC_ActualGrossTrq

11. Duty Cycle Logging of Route

Req/Rec	0.3 sec	Engine_Speed	Net_Engine_Torque
		Vehicle_Speed	Final_Timing
		Boost_Pressure	TI_Vehicle_Total_ECM_Distance
		Total_Fueling	Accelerator_Pedal_Position
		Combustion_Control_Path_Owner	
Req/Rec	0.5 sec	Engine_Speed	Alpha
		Total_Fueling	Coolant_Temperature
		Combustion_Control_Path_Owner	Ambient_Air_Press
		Final_Timing	Intake_Manifold_Temperature
		Net_Engine_Torque	EGR_Position
		Boost_Pressure	EGR_Delta_Press
		Accelerator_Pedal_Position	VGT_Position
		TI_Vehicle_Total_ECM_Distance	

12. ECM Trip Information / Fuel Economy Accuracy

Record Odometer and Hubometer Miles at start and end of trip. Top-Off fuel tank at start and end of trip for comparison of fill gallons / miles against data-logged ECM data at start and end of trip.
Calculate ECM MPG accuracy based on actual (fill/odom/hubo) versus ECM.
Log data at state line crossings or freeway mile markers for reference to Trip_Distance.
Confidence in results increases with long trips. If possible, trips of sufficient length to require multiple fuel fills between start and end.

Req/Rec	1.0 sec	TI_Vehicle_Trip_Drive_Distance	Trip_RSG_Distance
		Trip_CC_Distance	TI_Vehicle_Trip_ECM_Distance
		TI_Vehicle_Trip_Gear_Down_Dist	TI_Vehicle_Trip_Coast_Distance
		TI_Vehicle_Trip_Top_Gear_Dist	TI_Engine_Brks_Trip_Time
		TID_Trip_ESP_Distance	TI_Vehi_Trip_Srv_Brake_Dist
		TI_Base_Trip_Fuel_Used	TI_Base_Trip_Drive_Time
		TI_Vehicle_Total_ECM_Distance	TI_Base_Total_Fuel_Used
		TI_Base_Trip_Average_Load	TI_Base_Trip_Idle_Fuel_Used
		TI_PTO_Trip_Fuel_Used	MMon_Trip_PTO_Time
		TI_Base_Trip_Drive_Fuel_Used	Trip_Histogram_Time
		MMon_Trip_ShortStop_IdleTime	MMon_Trip_Drive_Distance

13. Engine Brake Activation Delay - Stationary Test

Use with manual throttle event. Cycle throttle pedal. Engine speed snap throttles from High idle to low idle with Engine Brake switch ON.
Collect data at cold oil temperature and at every 20 deg F as engine warms up.

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		Accelerator_Pedal_Position	
Req/Rec	0.2 sec	Engine_Speed	Total_Fueling
		Accelerator_Pedal_Position	ERC_DriverFractionCmd
		Combustion_Control_Path_Owner	Oil_Temperature

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14. Engine Braking

Req/Rec	0.2 sec	Engine_Speed	Accelerator_Pedal_Position
		FSI_s_EBrakeOn	Vehicle_Speed
		Boost_Pressure	Total_Fueling
		Net_Engine_Torque	H_ERC_ActualGrossTrq
Req/Rec	0.4 sec	Engine_Speed	Boost_Pressure
		FSI_s_EBrakeOn	Vehicle_Speed
		H_ERC_ActualGrossTrq	Ambient_Air_Press
		Total_Fueling	Accelerator_Pedal_Position
		Net_Engine_Torque	Combustion_Control_Path_Owner
		EngBrkDriver1	EngBrkDriver2
Req/Rec	0.5 sec	Engine_Speed	Vehicle_Speed
Or EDM	0.2 sec	FSI_s_EBrakeOn	Intake_Manifold_Temperature
		ERC_DriverFractionCmd	Ambient_Air_Press
		Total_Fueling	Coolant_Temperature
		Net_Engine_Torque	Oil_Pressure
		Accelerator_Pedal_Position	Boost_Pressure
		Combustion_Control_Path_Owner	H_ERC_ActualGrossTrq
		RetarderCommand	EngBrkDriver1
		EngBrkDriver2	

15. Fan Control

Req/Rec	0.5 sec	Engine_Speed	Coolant_Temperature
		Total_Fueling	Intake_Manifold_Temperature
		Combustion_Control_Path_Owner	Manual_Fan_Input
		Fan_Drive_State	FCC_Fan_Clutch_Driver

16. Fan Drive Activation

Req/Rec	0.3 sec	Engine_Speed	Fan_Drive_State
		Total_Fueling	Intake_Manifold_Temperature
		Coolant_Temperature	
Req/Rec	0.5 sec	Engine_Speed	Intake_Manifold_Temperature
		Total_Fueling	Coolant_Temperature
		Combustion_Control_Path_Owner	Manual_Fan_Input
		Fan_Drive_State	Air_Conditioner_Pressure_Switch
		FCC_Fan_Request	FCC_Fan_Clutch_Driver

17. FSSC: Cylinder Cut-Out

Cylinder cut out applies to pilot, main, and post. When a cylinder is cut out, pilot and post are completely eliminated. The main pulse still occurs, but at an on time short enough to prevent injection. FSI_x_ExtCylMask_c is a word that maps which cylinder is being cut out in hex. All cylinders on, FSI_x_ExtCylMask_c shows (3F hex or 0011 1111 binary). The least significant bit (bit farthest to the right) corresponds to cylinder 1.

Cylinder	All on: FSI_x_ExtCylMask_c = 3F
Cyl 1 Off	FSI_x_ExtCylMask_c = 3E
Cyl 2 Off	FSI_x_ExtCylMask_c = 3D
Cyl 3 Off	FSI_x_ExtCylMask_c = 3B
Cyl 4 Off	FSI_x_ExtCylMask_c = 37
Cyl 5 Off	FSI_x_ExtCylMask_c = 2F
Cyl 6 Off	FSI_x_ExtCylMask_c = 1F

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18. High Speed Idle Stability

These parameters can be used for logging most HSG issues, Transient and Steady State.

Req/Rec	0.3 sec	Engine_Speed	H_NDOT_PropErrorFiltrd
		Total_Fueling	H_HSI_NDOT_Demand
		Combustion_Control_Path_Owner	NDOT_Driver_Demand
		HSI_ReferenceSpd	
Req/Rec	0.5 sec	Engine_Speed	H_ABS_NDOT_Demand
Or EDM	0.2 sec	Total_Fueling	Net_Engine_Torque
		Combustion_Control_Path_Owner	NDOT_Driver_Demand
		CBL_Fuel_Cmd	H_HSI_NDOT_Demand
		CBL_Fuel_State	H_NDOT_PropErrorFiltrd
		HSI_ReferenceSpd	H_NDOT_Gov_Torque
		Accelerator_Pedal_Position	

19. J1939 Devices / J1939 Transmissions

Req/Rec	0.5 sec	Engine_Speed	DL_Controlling_Device_ID
		Total_Fueling	HSI_ReferenceSpd
		Combustion_Control_Path_Owner	Accelerator_Pedal_Position
		DL_EngineControlMode	Vehicle_Speed
		H_DLC_ReferenceSpd	Jcomm_Engine_Torque_Command
		Jcomm_Engine_Speed_Limit_RPM	Net_Engine_Torque
		H_DLC_NDOT_Demand	FSI_s_EBrakeOn
		DL_RetarderControlMode	Jcomm_Percent_Retarder_Torque
		Engine_No_Load_Torque	

20. Low Power – Boost Response Test

Req/Rec	0.1 sec	Engine_Speed	Accelerator_Pedal_Position
		Boost_Pressure	
Req/Rec	0.2 sec	Engine_Speed	Net_Engine_Torque
		Filtered_Raw_Accel_Value	Accelerator_Pedal_Position
		Boost_Pressure	Vehicle_Speed
		Total_Fueling	VGT_Position
Req/Rec	0.3 sec	Engine_Speed	Boost_Pressure
		Combustion_Control_Path_Owner	VGT_Position
		Total_Fueling	Net_Engine_Torque
		Alpha	Accelerator_Pedal_Position
		Final_Timing_State	Vehicle_Speed
		Final_Timing	
Req/Rec	0.5 sec	Engine_Speed	Boost_Pressure
Or EDM	0.2 sec	Combustion_Control_Path_Owner	Ambient_Air_Press
		Total_Fueling	EGR_Position
		Alpha	VGT_Position
		Final_Timing_State	Filtered_Turbo_Speed
		Final_Timing	OFC_Fuel_Limit
		Accelerator_Pedal_Position	APC_hp_Fdbk
		Vehicle_Speed	APC_i_LppFltr

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21. Low Power – Geardown Protection

Req/Rec	0.1 sec	Engine_Speed	Vehicle_Speed
		Total_Fueling	
Req/Rec	0.2 sec	Engine_Speed	RSC_GD_State
		RSC_ReferenceSpeed	Total_Fueling
		Vehicle_Speed	Accelerator_Pedal_Position
		Boost_Pressure	
Req/Rec	0.4 sec	Engine_Speed	T_RSC_GD_GearRatio
		Total_Fueling	RSC_GD_State
		Combustion_Control_Path_Owner	Filtered_Gear_Ratio
		CBL_Fuel_State	Effective_Gear_Ratio
		Accelerator_Pedal_Position	Filtered_Gear_Ratio
		Actual_Gear_Ratio	

22. Low Power – Road Speed Control

Req/Rec	0.1 sec	Engine_Speed	Vehicle_Speed
		Total_Fueling	
Req/Rec	0.2 sec	Engine_Speed	Total_Fueling
		CBL_Fuel_State	Accelerator_Pedal_Position
		Boost_Pressure	Vehicle_Speed
Req/Rec	0.4 sec	Engine_Speed	H_RSC_NDOT_Demand
		Torque_Limit_At_Current_Speed	OFC_Fuel_Limit
		Combustion_Control_Path_Owner	OFC_EGR_Disable
		Total_Fueling	Vehicle_Speed
		Accelerator_Pedal_Position	Boost_Pressure
		NDOT_Driver_Demand	

23. Mission Data (fast data log – Internal Data Logger or EDM)

Make note of Ambient_Air_Temperature at start and end of datalog.

IDL	20 ms	Engine_Speed	EGR_Position
	0.2 sec	Total_Fueling	EGR_Delta_Press
		Combustion_Control_Path_Owner	VGT_Position
		Final_Timing	Filtered_Turbo_Speed
		Alpha	Boost_Pressure
		H_CBR_Chi_Value	Ambient_Air_Press
		Vehicle_Speed	Intake_Manifold_Temperature
		Net_Engine_Torque	Coolant_Temperature -OR- Oil_Temperature

24. Mission Data (slow data log – Monitor Data Logger)

Make note of Ambient_Air_Temperature at start and end of datalog.

Req/Rec	0.5 sec	Engine_Speed	EGR_Position
		Total_Fueling	EGR_Delta_Press
		Combustion_Control_Path_Owner	VGT_Position
		Final_Timing	Filtered_Turbo_Speed
		Alpha	Boost_Pressure
		H_CBR_Chi_Value	Ambient_Air_Press
		Vehicle_Speed	Intake_Manifold_Temperature
		Net_Engine_Torque	Coolant_Temperature -OR- Oil_Temperature

25. No Load Friction / Light Load Throttle Control

Take two sets of data: One with bare engine and one with fan control locked ON (optional).
Gently activate throttle to slowly ramp engine speed from low idle to high idle (30 second ramp).

Req/Rec	0.5 sec	Engine_Speed	Total_Fueling
EDM	0.2 sec	Filtered_Raw_Accel_Value	Accelerator_Pedal_Position
		Combustion_Control_Path_Owner	Final_Timing
		Boost_Pressure	NDOT_Driver_Demand
		Engine_No_Load_Torque	Oil_Temperature
		Net_Engine_Torque	

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26. PTO Response

Record Oil_Temperature, Coolant_Temperature, Intake_Manifold_Temperature
Ramp engine speed from idle to PTO speed via SET or RESUME switch.

Req/Rec	0.1 sec	Engine_Speed	Final_Timing
		Total_Fueling	
Req/Rec	0.3 sec	Engine_Speed	NDOT_Driver_Demand
		Total_Fueling	Combustion_Control_Path_Owner
		PTO_State	H_PTO_Error
		PTO_Status	PTO_Accel_Switch
		H_PTO_NDOT_Demand	PTO_Coast_Switch
		PTO_Set_Resume_Switch	PTO_Set_Switch

27. Road Speed Control / Cruise Control Hiccup / Miss

Logging at any slower rate with more parameters significantly reduces the likelihood of capturing the event.

Req/Rec	0.2 sec	Engine_Speed	Vehicle_Speed
Or EDM	5 ms	Out_Of_Gear	Total_Fueling
		Combustion_Control_Path_Owner	

28. Rough Idle

Record Oil_Temperature, Coolant_Temperature, Intake_Manifold_Temperature

Req/Rec	0.1 sec	Engine_Speed	Combustion_Control_Path_Owner
		Total_Fueling	Final_Timing
Req/Rec	0.2 sec	Engine_Speed	Combustion_Control_Path_Owner
		Total_Fueling	Final_Timing_State
		Final_Timing	
Req/Rec	0.5 sec	Engine_Speed	H_LSI_ActiveBrkPtSpd
Or EDM	0.2 sec	Total_Fueling	H_CBD_s_Adjusting
		Final_Timing	H_CBD_s_Error
		EPS_Engine_Avg_Speed	H_LSI_Error
		Fuel_Supply_Pressure	H_LSI_NDOT_Demand
		Combustion_Control_Path_Owner	NDOT_Driver_Demand
		H_NDOT_PropErrorFiltrd	

29. Starter Lockout

Req/Rec	0.2 sec	Engine_Speed	Accelerator_Pedal_Position
		Total_Fueling	Engn_Actual_State
		Combustion_Control_Path_Owner	at_starter_lockout_request_ptr

30. Starting - Cold

IDL	20 msec	Engine_Speed	GHC_WaitToStartLampState
		Total_Fueling	Battery_Voltage
		Combustion_Control_Path_Owner	Intake_Manifold_Temperature
		Final_Timing	Coolant_Temperature
		Final_Timing_State	APC_hp_Cmd
		EPS_s_MainSync	APC_hp_Fdbk
		EPS_s_BkupSync	GHC_State
		Reset_Count	

31. Starting - Hard Start / Startup and Overshoot

Req/Rec	0.1 sec	Engine_Speed	APC_hp_Cmd
		Total_Fueling	APC_hp_Fdbk
		Oil_Pressure	EPS_s_BkupSync
		EPS_s_MainSync	
Req/Rec	0.2 sec	Engine_Speed	APC_hp_Cmd
		Total_Fueling	APC_hp_Fdbk
		Engn_Actual_State	EPS_s_MainSync
		Combustion_Control_Path_Owner	EPS_s_BkupSync
		Final_Timing	

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32. Stumble During Rapid Accel (OFC) Limitation

OFC (Oxygen-Fuel Control) related stumble or poor acceleration.

Req/Rec	0.1 sec	Engine_Speed	OFC_Fuel_Limit
		Total_Fueling	
Req/Rec	0.4 sec	Engine_Speed	H_CBP_O2_Mass_Air
		Total_Fueling	Final_Timing
		OFC_Fuel_Limit	Final_Timing_State
		OFC_EGR_Disable	Alpha
		H_OFC_Equiv_Ratio_Limit	H_CBR_Chi_Value
		Charge_Flow	Boost_Pressure

33. Throttle Characterization / Idle Validation Switches

Make note of throttle pedal make and model.
Slowly ramp throttle from fully released to fully depressed to fully released – especially near 0 and 100 % throttle.
Engine speed data is useful in evaluating throttle deadband.

Req/Rec	0.4 sec	Engine_Speed	Filtered_Raw_Accel_Value
		Accelerator_Auto_Zero	Idle_Validation_State
		C_APP_Highest_Accelerator_Min	Total_Fueling
		Accelerator_Pedal_Position	Combustion_Control_Path_Owner
		Accelerator_Pedal_Position	

34. Throttle Control – Accelerator Based Speed – Formally known as ASG or VS

Make note of any tendency towards seat movement/chassis vibration, pedal events, etc. Is seat locked? Location of driver's foot.
How is driver's foot touching the throttle pedal?

Req/Rec	0.1 sec	Engine_Speed	H_ABS_NDOT_Demand
		Filtered_Raw_Accel_Value	H_ABS_ReferenceSpd
Req/Rec	0.2 sec	Engine_Speed	H_ABS_NDOT_Demand
		Combustion_Control_Path_Owner	NDOT_Driver_Demand
		Filtered_Raw_Accel_Value	Vehicle_Speed
		Accelerator_Pedal_Position	
Req/Rec	0.4 sec	Engine_Speed	Boost_Pressure
Or EDM	0.1 sec	Filtered_Raw_Accel_Value	Combustion_Control_Path_Owner
		H_ABS_NDOT_Demand	NDOT_Driver_Demand
		Total_Fueling	Net_Engine_Torque
		Accelerator_Pedal_Position	Vehicle_Speed

35. Throttle Control – Accelerator Based Torque Governor

Make note of any tendency towards seat movement/chassis vibration, pedal events, etc. Is seat locked? Location of driver's foot.
How is driver's foot touching the throttle pedal?

Req/Rec	0.1 sec	Engine_Speed	Filtered_Raw_Accel_Value
		Accelerator_Pedal_Position	Total_Fueling
Req/Rec	0.2 sec	Engine_Speed	Filtered_Gear_Ratio
		Filtered_Raw_Accel_Value	Accelerator_Pedal_Position
		Total_Fueling	Boost_Pressure
		Combustion_Control_Path_Owner	Vehicle_Speed
Req/Rec	0.4 sec	Engine_Speed	C_AIP_Accelerator_Range
Or EDM	0.2 sec	Filtered_Raw_Accel_Value	Accelerator_Auto_Zero
		Total_Fueling	NDOT_Driver_Demand
		Combustion_Control_Path_Owner	Net_Engine_Torque
		Accelerator_Pedal_Position	H_ABS_NDOT_Demand
		Vehicle_Speed	

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36. Turbo Surge Conditions

Req/Rec	0.1 sec	Engine_Speed	Accelerator_Pedal_Position
		Boost_Pressure	VGT_Position
Req/Rec	0.2 sec	Engine_Speed	VGT_Position
		Boost_Pressure	Ambient_Air_Press
		Accelerator_Pedal_Position	Total_Fueling
Time:	0.5 sec	Engine_Speed	VGT_Position
Or EDM	0.2 sec	Boost_Pressure	Charge_Flow
		Accelerator_Pedal_Position	CHL_MCF_Cmd
		Total_Fueling	EGR_Fraction
		CHL_EGR_Frac_Cmd	Filtered_Turbo_Speed
		Vehicle_Speed	EGR_Delta_Press
		Ambient_Air_Press	EGR_Position
		Intake_Manifold_Temperature	

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Procedure to Download to a New Module

1. Use Calterm3 to connect to the module
2. Open Security_Key in the monitor screen. If it is 0x00FF, then skip to step 7
3. If Security_Key is not 0x00FF, then go to Commands->Toggle Security Key
4. Power the module off. To do this, you will have to pull power from the module either through a battery disconnect switch or by pulling the 4-pin power connector off the ECM
5. Use Calterm3 to reconnect to the module.
6. Verify Security_Key was changed to 0x00FF. If not, then go back to step 3
7. Go Calibration -> Download and pick the ecfg and cal file. Hit Ok

If any problems occur during the download, close Calterm3, power the module off (either with a battery disconnect switch or by pulling the 4-pin power connector off the module), restart Calterm3. Verify the Run Location (listed in the bottom left corner of Calterm) is listed as ROM. If not, you may have to manually ROM-boot the module with a ROM boot connector. Also check ECM_Status. If it is set to 1DOA or 2B15, then change it to 0x5EED. Then try to download to the module again.

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Powerdown Troubleshooting

The ECM should nomally poweroff within 10 seconds of the keyswitch being off. If the ECM is staying powered up longer, first make sure the ECM indicates the key is off by looking to make sure Key_Switch = 0 and verify that Engine_Speed = 0. If it is indicating off, then look at MACH_ECM_Powerdown_Inhibit and for each bit active, follow the steps below

MACH_ECM_Powerdown_Inhibit, Bit 1 active (0x0001) - Anti-theft is inhibiting powerdown. If Keyswitch is off and AT_Engine_Lock_State == AT_STATUS_UNLOCKED and at_powerdown_timer !=0 (initially set to at_powerdown_delay_time)

MACH_ECM_Powerdown_Inhibit, Bit 2 active (0x0002) - EGR Delta P sensor is inhibiting powerdown. EGR_Delta_P_Autozero_Complete is not equal to 1 and C_EGR_Autozero_Allowed_Time has passed since keyoff, then verify that Engine_Speed = 0 and Key_Switch = 0. To allow the ECM to powerdown set EGR_Delta_P_AZ_Bypass to allow the ECM to powerdown.

MACH_ECM_Powerdown_Inhibit, Bit 3 active (0x0004) - Trip information is inhibiting powerdown while it saves parameters. If TIB_data_collection_complete = 0, then C_TIB_Enable can be set to 0 to force the ECM shutdown. Please note that trip information parameters will be lost.

MACH_ECM_Powerdown_Inhibit, Bit 4 active (0x0008) – Datalink VGT is inhibiting powerdown. Verify that Filtered_Turbo_Speed is 0. If not, then the turbo still sees a valid speed and will not allow the engine to shutdown until Filtered_Turbo_Speed = 0krpm.

If turbo speed is 0, then check the upper byte of VGA_DL_Mode_Command. If it is equal to 0x8000, then the VGT actuator is still powered and will not allow the ECM to shutdown. Make sure that Key_Switch = 0 and the turbo is still communicating with the ECM.

MACH_ECM_Powerdown_Inhibit, Bit 5 active (0x0010) - This state should never be observed in the Evolution/Gryphon software as it is applicable only to datalink EGRs

MACH_ECM_Powerdown_Inhibit, Bit 6 active (0x0020) - Grid Heaters are inhibiting powerdown. If T_Grid_Heater_Enable is ENABLE, then check GHC_State. If it does not equal OFF (state 5), then check Keyswitch = OFF. If GHC_State is GHC_SERVICETOOL_STATE (state 6) is active, then the service tool is running the grid heater test. To stop the test, set GHC_OverrideTimeRemaining = 0.

MACH_ECM_Powerdown_Inhibit, Bit 7 active (0x0040) - Vehicle Speed is inhibiting powerdown. Verify that Vehicle_Speed = 0 and that no vehicle speed related faults are active (ie, FC241)

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CHECKLIST / CUSTOMER/DRIVER SURVEY

Pre-Trip Checklist

- ☐ Preparation at Test Site:
  Distributor Contacts / Dealer Contact / Local Support
  Customer / Driver Pre-Trip Contact & Commitment / Mission Of Visit
- ☐ Travel Request / Authorization / Maps / Directions To Customer Site / Phone Numbers
  Service Engineering / Field Test Personnel Support
- ☐ Travel Documents:
  Passport / Airline Tickets / Credit Cards / Driver's License
  Rental Car / Hotel Reservations / Phone Numbers / Cash
- ☐ Equipment:
  Laptop / Datalink Adapter (Peak Adapter, Inline 2/4/5, CanCard) / Datalink Connectors / J1939 Cable
  DC Adapter / DC Splitter / AC Adapter
- ☐ Test Plans / Copies Of Backup Calibrations
- ☐ Pocket Recorder / Tapes / Camcorder / Tapes / Batteries
- ☐ Proper Calterm version / CONFIG.ECFG / Field Test Tool / Security Disks / Keys For Tools
  Backup earlier version of CaltermIII if working with new version / Alternate CONFIG.ECFGs
- ☐ CaltermIII Manual / User's Guide (if needed)
- ☐ Stop Watch / USB drive to backup datalogs
- ☐ Proper Dress for Weather / Business Attire / Work Cloths for
- ☐ Cellular Phone / Accessories As Appropriate
- ☐ Appropriate Wiring Diagram / Fault Code Information
- ☐ Electronics Training Package for CM2150 Controls (TBD)
- ☐ ETIF Test Plan and *.IDL internal datalogger script files (if available)

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Customer / Driver Survey

Questions intended to encourage feedback on engine performance. Make record of vehicle configuration, engine model rating, transmission, axle, etc. Where possible use open-ended questions to solicit driver feedback

Typical Driving Techniques

In what gear do you normally start?_____

Do you normally use the clutch when shifting?_____

Do you release the clutch while you foot is on the throttle?_____

What engine speed do you normally use to upshift?_____

What engine speed do you normally use to downshift?_____

Do you use cruise control often?_____

If not, do you run on the road speed governor?_____

When climbing a grade do you resume Cruise Control after a downshift, or keep foot down?_____

Engine Start

Is engine cranking time acceptable? Cold Start YES/NO Crank Secs _____

Hot Start YES/NO Crank Secs _____

Does engine start acceptably? YES/NO

Comment?_____

Does engine overshoot at startup? YES/NO

Comment?_____

Does the engine smoke at startup? YES/NO

If yes, is smoke: BLUE _____ WHITE _____

Ambient Temp ____ deg Fahr

Is throttle response noted after startup? Cold Start YES/NO Hot Start YES/NO

Comments?_____

Engine Idle

Idle speed used _____ RPM Idle Time (Driver Estimate) _____ % ECM Idle Time _____%

Does the engine idle smoothly? YES/NO

Does the engine surge at idle? YES/NO

Does the idle increment/decrement switch operate acceptably? YES/NO

Does the engine idle at desired speed? YES/NO

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Does idle undershoot when coming off higher RPM engine operation? YES/NO

Comment?_____

Is there any smoke during idle? YES/NO

If yes, is smoke: BLUE _____ BLACK _____ WHITE _____

Ambient Temp ____ deg Fahr

Comments?_____

Engine PTO Operation

PTO speed used _____ RPM PTO Time (Driver Estimate) _____ % ECM PTO Time _____%

Does the PTO operate smoothly? YES/NO

Does the engine surge on PTO? YES/NO

Does the PTO speed adjustment switch operate acceptably? YES/NO

Does the PTO operate at desired speed? YES/NO

Does PTO overshoot or undershoot when engaging PTO or changing RPM? YES/NO

Comment?_____

Is there any smoke during PTO? YES/NO

If yes, is smoke: BLUE _____ BLACK _____ WHITE _____

Ambient Temp ____ deg Fahr

Comments?_____

Clutch Engagement

Is clutch engagement torque acceptable? YES/NO What gear? _____

Does the engine start the load smoothly? YES/NO

On a grade? YES/NO Grade % _____

Other comments on clutch engagement behavior?_____

Cruise Control

Fill in customer trim information to detail how engine is trimmed

Road Speed Governor Upper Droop	_____	MPH
Road Speed Governor Lower Droop	_____	MPH
Cruise Control Upper Droop	_____	MPH
Cruise Control Lower Droop	_____	MPH

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Driver Input

Can the driver easily set the desired cruise speed? YES/NO

Comment?_____

Does the cruise control maintain desired set speed? YES/NO

Comment?_____

When setting	YES/NO	Road Speed Gain MPH _____ Road Speed Loss MPH _____
On hills	YES/NO	Road Speed Gain MPH _____ Road Speed Loss MPH _____
On level ground	YES/NO	Road Speed Gain MPH _____ Road Speed Loss MPH _____

Does the cruise control cause the engine to surge? YES/NO

At the bottom of hills?	YES/NO
When starting up a hill?	YES/NO

Does the engine respond when over-riding the cruise control with the throttle? YES/NO

Does the cruise control Auto-Resume perform acceptably? (IF TRIMMED) YES/NO
(Is there a noticeably time delay before resume occurs?)

Does the cruise control Auto-Resume overshoot/undershoot after clutch event?

On hills	YES/NO	Road Speed Gain MPH _____ Road Speed Loss MPH _____
On level ground	YES/NO	Road Speed Gain MPH _____ Road Speed Loss MPH _____

Engine Response

Is there a noticeably delay from the time when the throttle is depressed until the engine RPM begins to pick up? YES/NO

Does it occur at all engine speeds or in one range of engine speed? YES/NO
Range _____RPM

Is the response predictable when the throttle pedal is depressed? YES/NO
(Is it more sensitive in lower speed ranges, etc.)

Low Speed Maneuvering

What is idle speed setting when performing parking lot maneuvers? _____ RPM

Is throttle control acceptable for low speed maneuvers (parking lots, delivery terminals, etc)

Loaded	YES/NO	Bobtail	YES/NO

Is throttle control in reverse gear acceptable?

Loaded	YES/NO	Bobtail	YES/NO

Is there any nocteable surge when maneuvering at low speeds? YES/NO What gear? ____

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Engine Brake in Cruise Feature

Is the delay time from the expected brake actuation until the brakes actuate acceptable?	YES/NO	
Do the correct number of brakes actuate at the desired speed increment above cruise speed?	YES/NO	
Does the cruise control resume correctly after the brakes have deactivated?	YES/NO	
Does the cruise control surge when resuming?	YES/NO	
Does the cruise control overshoot?	YES/NO	_____ MPH
Does the cruise control undershoot?	YES/NO	_____ MPH
Does the auto cruise braking feature cause a surge when engaging in cruise?	YES/NO	
Does the engine brake manual shut off switch work correctly?	YES/NO	
Does the manual brake selector switch work correctly?	YES/NO	

EGR / VGT Control System

How does the performance of this engine compare to a previous Cummins engine you may have operated? BETTER/WORSE/NO CHANGE

Comments?_____

Please describe what you experience while operating/driving during:

Rapid Accels_____

Rapid Decels_____

Uphill Climb_____

Downhill Grades_____

In-City Driving_____

Highway Driving_____

Engine Idle_____

Truck Yard Manuevers_____

During Cruise Control Events_____

During Engine Brake Events_____

Cold Engine Start_____

Approximate outside temperature _____ deg F

Hot Engine Starts_____

At Altitude_____

Approximate altitude for engine operation _____ feet

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CaltermIII Data Logging

CaltermIII supports 4 different types of logging. This manual will cover 3 of them, leaving BAM out as EDM has replaced its functionality. The sections below will explain the different types, when to use each as well as basic instructions. A 5th option will be added (IDL2) to support logging during a keycycle. Currently, none of the listed logging methods are able to log data during a keyon event.

For all logging types, there are three different options for Log Update Rate. If the data being taken is time critical (ie. you MUST see the parameter changes every 10ms), then "Log Data at Specified Interval" should be used. This will force CaltermIII to write all parameters it has received since the last log update to the log file. Any parameters it has not received will be marked as either NaN or blank, depending on the CaltermIII version. If the parameters do not need to logged at a specified interval, then "Log when all data received" should be checked. This will force CaltermIII to write the parameters to the log file as soon as it has received them all. This will avoid having blank data cells.

Request/Receive

When to use: Data acquisition that does not require high speed data
Logging for very long periods of time
Macro-view of problems
When monitoring data while logging

Advantages of Request/Receive Datalogging:
Can monitor data while logging
Able to collect data on extended trips
Able to log fault codes
Does not require an unsecure ECM
Able to support Event Driven logging

Disadvantages of Request/Receive Datalogging:
Cannot capture high speed events
Timing may not be consistant between entries

Instructions for using Request/Receive datalogging:

1. Set-up monitor screen with parameters to data log.
2. On the top right side of screen, Choose "Request/Receive" for Mode.
3. Go to Tools->Options and click on the logging option.
4. Check "Log active faults" if logging faults is desired
5. Select the desired type of log update rate (please see notes above for description)
6. If logging over an extended period, consider checking "Create multiple log files based on file size threshold" and set a max file size, such as 6000KB.
7. Datalog files are saved to the path indicated by Log file path. If left as "Default Product Folder", the log files will reside in the product id directory in the CaltermIII folder. Ex: C:\Calterm III\BAF. The file name will consist of the date and time the log was started.
8. Choose OK to exit the monitor options screen.
9. Ensure that the ECM is currently connected and monitoring parameters (if its not, try clicking on the Start Data Monitoring Icon).
10. Go to Logging->Start
11. To Stop datalogging, go to Logging->Stop

EDM

When to use: For high speed data of many parameters (20-50)

Advantages of EDM Datalogging:
Faster than Request/Receive and allows more parameters than IDL
Can log fault codes
Lowest Datalink utitalization

Disadvantages of EDM Datalogging:
Limited to 50 parameters
Uses a lot of ECM CPU

Instructions for using EDM datalogging:

1. Set-up monitor screen with parameters to data log.
2. On the top right side of screen, Choose "EDM" for Mode.
3. Go to Tools->Options and click on the logging option.

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4. Select the desired type of log update rate (please see notes above for description). As a rule of thumb, EDM can log about 1ms per parameter. So if logging 20 parameters, set the update rate to 20ms.
5. If logging over an extended period, consider checking "Create multiple log files based on file size threshold" and set a max file size, such as 6000KB.
6. Datalog files are saved to the path indicated by Log file path. If left as "Default Product Folder", the log files will reside in the product id directory in the CalermIII folder. Ex: C:\Calterm III\BAF. The file name will consist of the date and time the log was started.
7. Choose OK to exit the monitor options screen.
8. Ensure that the ECM is currently connected and monitoring parameters (if its not, try clicking on the Start Data Monitoring Icon).
9. Go to Logging->Start. If the logger will not start, then either the CPU usage is too high and you should slow the monitor rate or there are too many parameters and some should be deleted.
10. To Stop datalogging, go to Logging->Stop

IDL

When to use:

For high speed data acquisition
Cranking, stumble, hiccups, idle or PTO quality, transient events
Snap throttle, quick accel
When there are a limited number of parameters (micro view)

Advantages of IDL:

Ability to log parameters quickly
Can monitor parameters while datalogging
Able to support Event Driven logging

Disadvantages of IDL:

Requires unsecure module
Manual processing time is increased, as the engineer must extract each dataset
Very small buffer size, therefore cannot log for extended periods
Cannot log fault codes
Cannot log data by addresses

Instructions for using IDL:

1. Set-up monitor screen with parameters to data log.
2. Verify request receive is displayed in the mode field
3. Go to Tools->Options and click on IDL logging.
4. Set refresh rate to the rate you want parameters logged
5. Select the desired logging mode. There are 3 choices:
    a. Stop: Stops the logger and saves data in the buffer following the STOP command
    b. Center: Centers the datafile by saving the previous half buffer of data and logs the next half buffer of data following the CENTER command. This mode is good for logging an intermittent symptom
    c. Fill: Starts logging data and fills the buffer following the FILL command. This mode is good for logging data on a predefined test
6. Check Auto Transfer IDL Buffer
7. Click OK to go back to monitor mode
8. Click Start IDL button
9. To stop the logger, Click the Stop IDL button
10. Follow the prompts to transfer the buffer.

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EXPERTS LIST

	PHONE	Cell Phone / Pager
Combustion Manager		
Randy Evans	812-377-3167	812-343-5825
Engine Manager		
Dan Borisuk	812-377-9485	812-343-5857
Chris Baird	812-377-3937	812-377-8800 pg# 3937
Scott Rittenhouse	812-377-7093	812-350-0689
Machine Manager/Ndot Governor		
Yi Yuan	812-377-7415	812-350-9718
Balaji Arumugam	812-377-5858	
Charge Manager		
Randy Evans	812-377-3167	812-343-5825
Brake Manager		
Scott Rittenhouse	812-377-7093	812-350-0689
Randy Evans	812-377-3167	812-343-5825
Dan Borisuk	812-377-9485	812-343-5857
Emmisions Manager		
Steve Hart	812-377-4382	812-377-8800 pg# 4462
Greg Hertle	812-377-0631	812-377-8800 pg# 4626
Aftertreatment/Thermal Management		
David Dixon	812-377-0705	812-377-8800 pg# 3900
Bob Kern	812-377-6997	812-377-8800 pg# 2842
Sunil Shenoy	812-377-3065	812-375-6925
Diagnostics		
Ricardo Carlos	812-377-9409	812-344-8173
Carey Jones	812-377-2936	
HPCR Fuel System		
Rick Reisinger	812-377-6396	812-377-8800 pg# 2694
J1587/J1708/J1939/USB Datalinks		
Nate Long	812-377-9085	812-350-6725
Carey Jones		
A/D Sensor Processing and Calibrations		
Chris Baird	812-377-3937	812-377-8800 pg# 3937
Melissia Trimnell	812-377-7177	
EGR and VGT Controllers		
Yi Yuan	812-377-7415	812-350-9718

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