ENGINE
APPLICATION MANUAL

Gen 5 V8 Engine
Marine Applications
Engine RPO: L83 & L86

General Motors Powertrain, OEM Sales
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PREFACE

This document will assist the reader in the application of the GM engine to the end product. It provides an overview of the engine, its features, as well as focus on the systems, subsystems and attachment points that interface between the engine and the application. A summary of acronyms is included in Section 10 for reference.

Although engine performance data is provided, it should be recognized that the performance of any engine is dependent on the design and processing of the interface systems, the components and the EMS control system architecture (hardware, software and calibration).

All dimensions and values in this manual are for reference only and may change during the course of a product year. The appropriate OEM Application Engineer can provide technical documents needed to support the application and validation process.

A request for reader support

Every effort has been made to ensure the accuracy of the information contained in this manual. If the reader identifies incorrect or suspect info, it would be appreciated if the item is brought to the appropriate Application Engineer's attention so any errors/omissions can be corrected in subsequent editions.

Finally, the reader is to be aware that this document uses color in various figures and can thus be best utilized when viewing the document in color.

1.0 INTRODUCTION

The Gen 5 V8 engine family is part of the GMPT OEM Sales group portfolio. The engine uses a 90° V aluminum engine block and shares common bore centers with the Gen 5 V6 and V8 engines. The engine uses aluminum cylinder heads and utilizes a "cam in block" architecture using pushrods to activate the 2 overhead valves.

Gen 5 90° V8 Engines

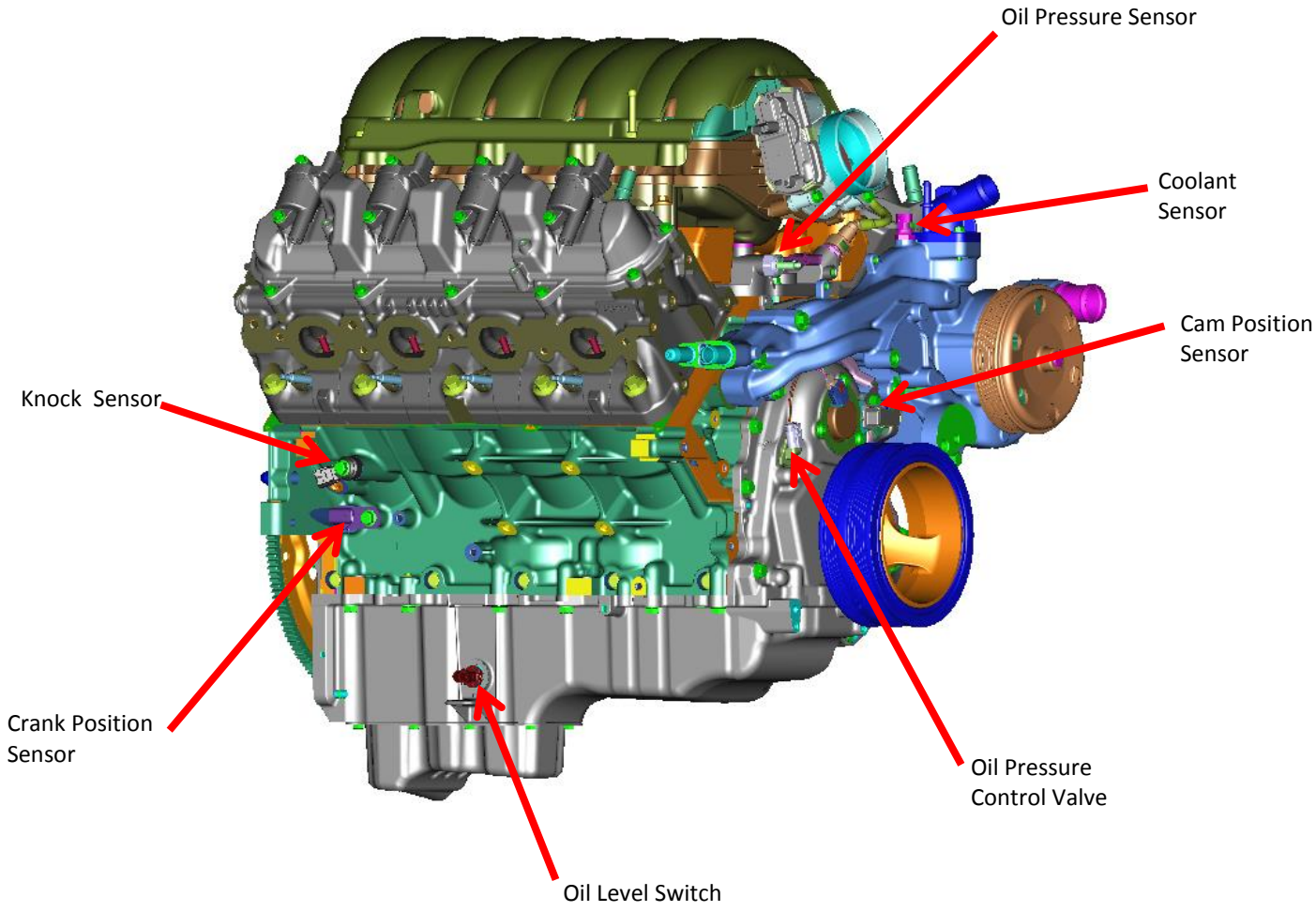
RPO	Displacement	2016 P/N	Intake	Fuel System	Camshaft	Ignition	Ring Gear	Miscellaneous
Marine								
L83	5.3L	12654221	Comp	SIDI	Truck	CNP	Front	
L86	6.2L	12657237					SIDI	

2.0 PRODUCT SUMMARY

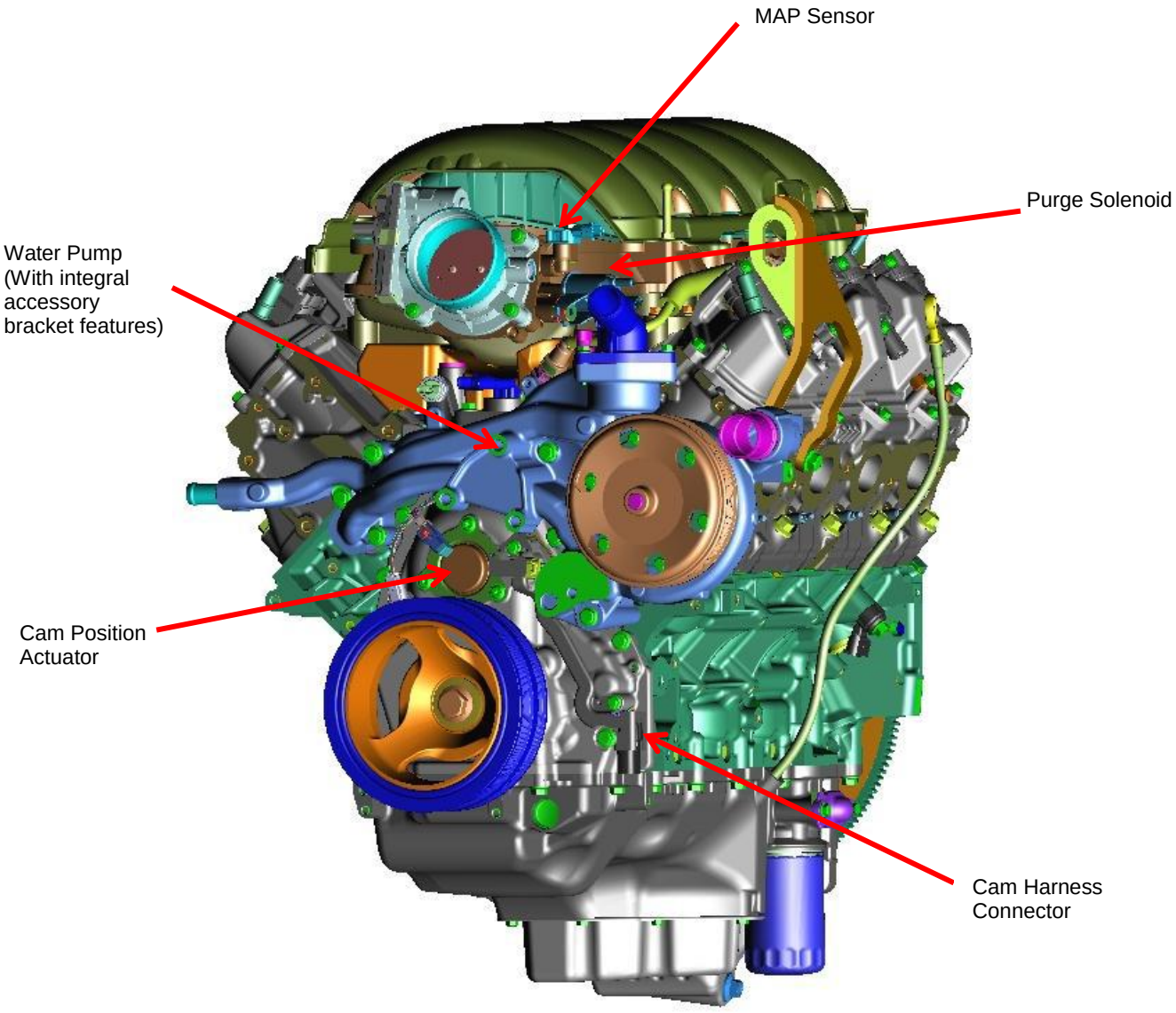
This section provides a general overview of the engine, including its appearance, specifications, performance, dress level, engine identification and other items of interest to our OEM customers.

2.1 Appearance

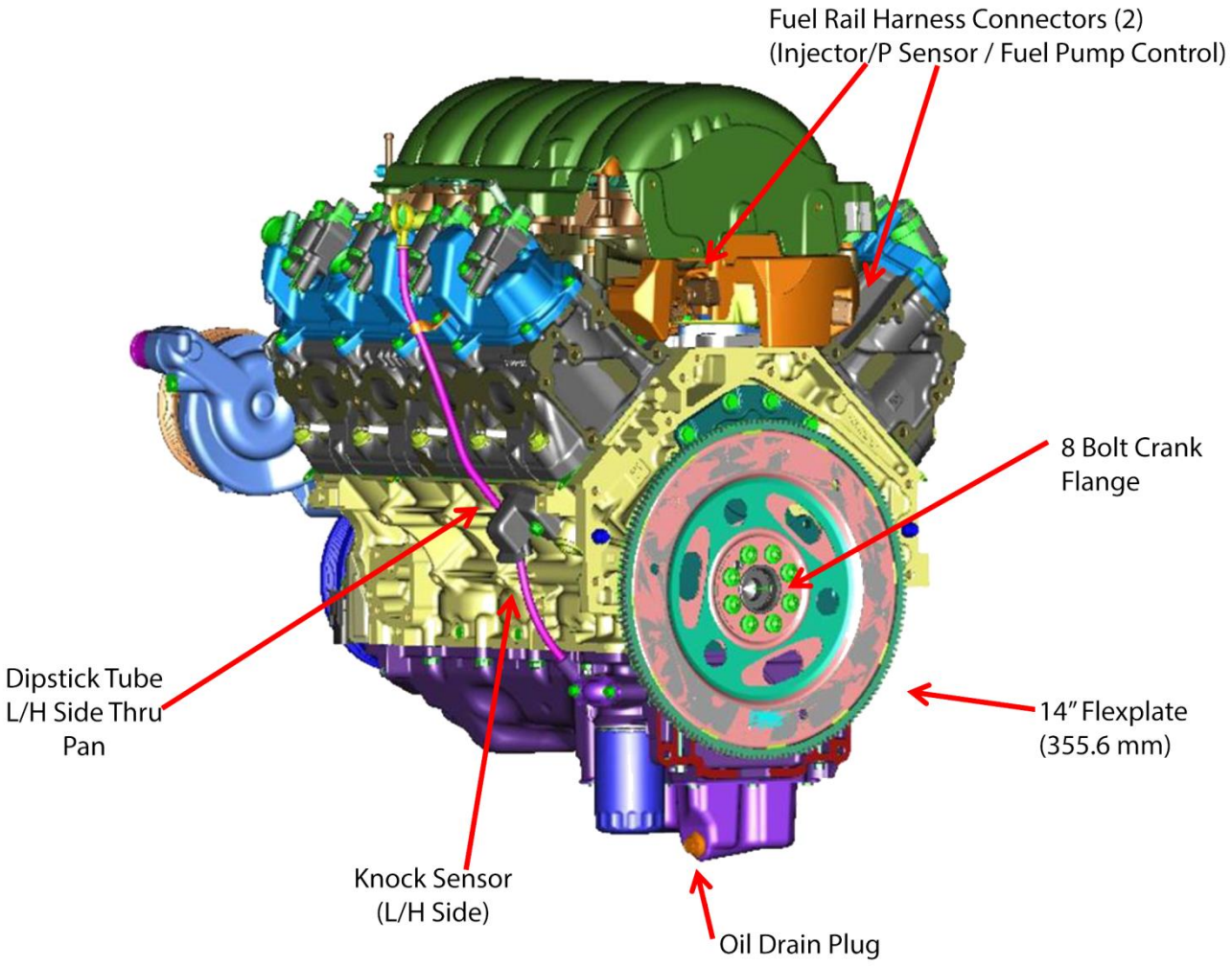
Figures 2.1-1, 2.1-2, 2.1-3, 2.1-4, and 2.1-5 show a marine variant of the 5.3L V8 engine as shipped.



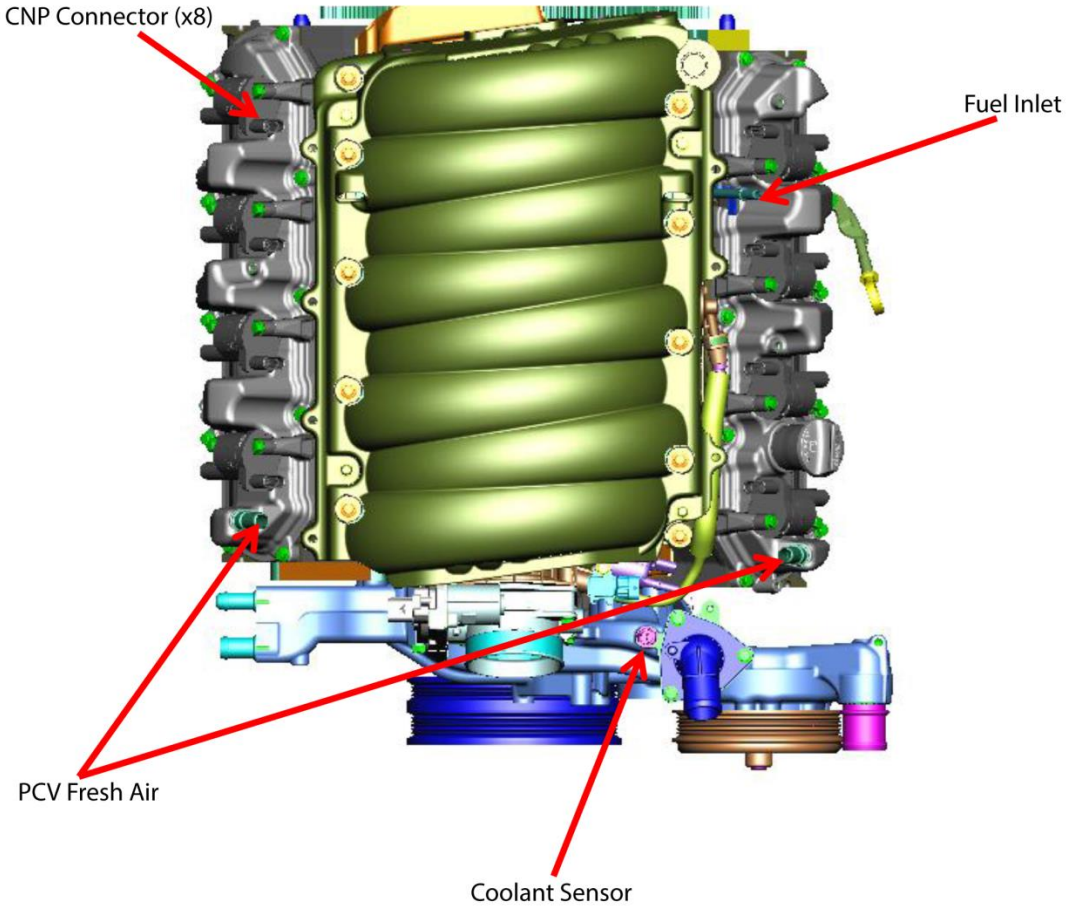
Gen 5 Marine
Figure 2.1-1



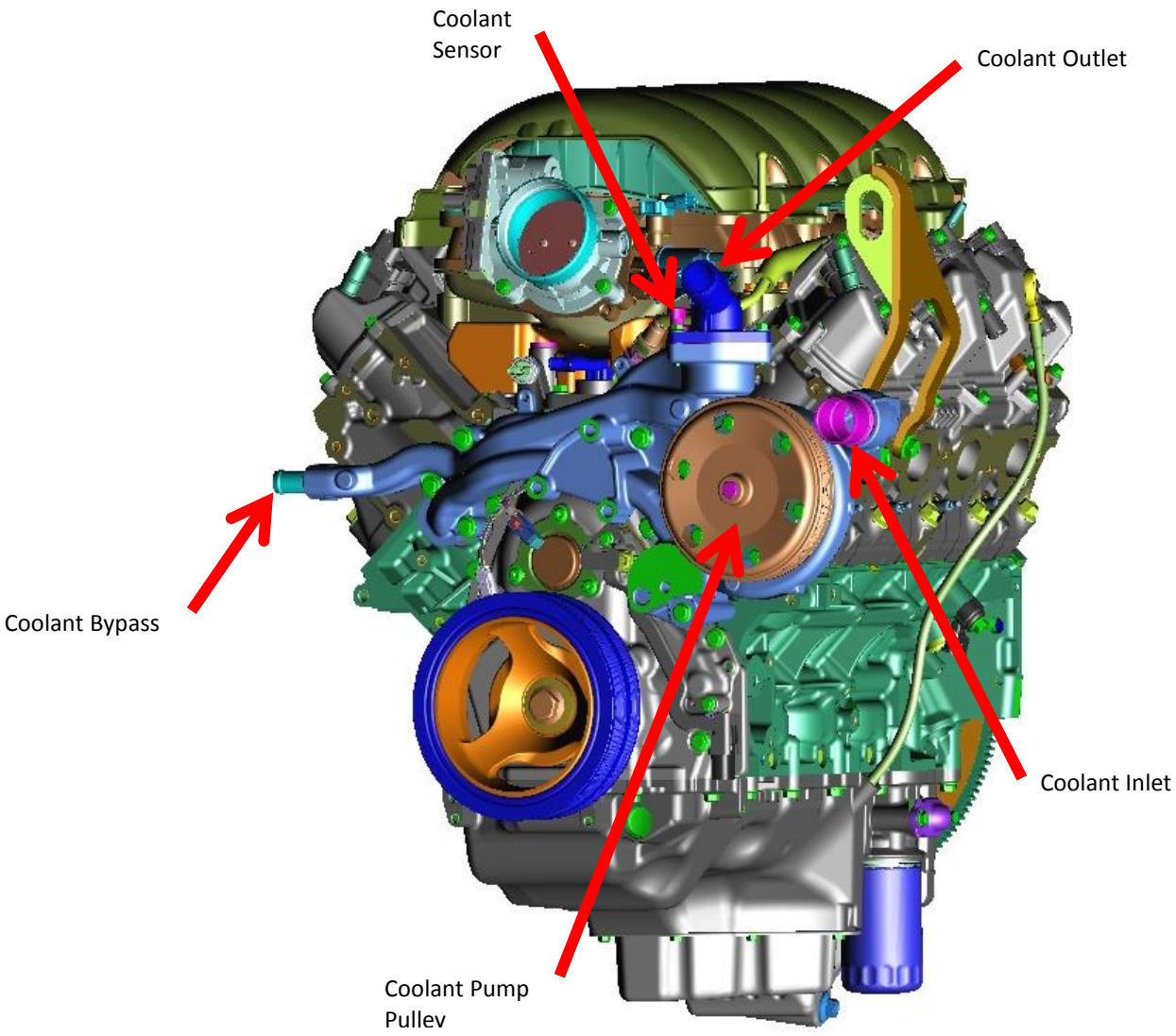
Gen 5 Marine
Figure 2.1-2



Gen 5 Marine
Figure 2.1-3



Gen 5 Marine
Figure 2.1-4



Gen 5 Marine
Figure 2.1-5

2.2 Features

All Gen 5 Engines incorporates a Spark Ignited Direct Injection (SIDI) fuel system

The more distinctive features of this family of engines are:

- Composite IAM
- Cast aluminum structural oil pan
- Coil near plug ignition system
- Dual knock sensors
- Variable displacement oil pump
- High pressure fuel pump
- Variable valve timing

2.3 Product Specification & Performance Summary

High level product specifications (general engine and subsystem architecture) for the marine and industrial variant are presented in section 2.3.1. Section 2.3.2 presents operating performance characteristics including torque and horsepower.

2.3.1 Product Specification

ENGINE RPO	MARINE L83	MARINE L86
ENGINE DESCRIPTOR / ARCHITECTURE		
Type / Aspiration	4 cycle - Naturally Aspirated	4 cycle - Naturally Aspirated
Engine Configuration	90° V8	90° V8
Displacement in cc (in^3)	5,300 cc (327 cid)	6,200 cc (383 cid)
Bore Spacing (mm)	111.76	111.76
Bore x Stroke (mm)	96.01 x 92	103.25 x 92
Compression Ratio	11:1	11:1
Fuel Compatibility	Gasoline	Gasoline
Engine Rotation (from the front)	CW	CW
Block / Head Material	Cast Aluminum / Cast Aluminum	Cast Aluminum / Cast Aluminum
Block Structure	Deep Skirt	Deep Skirt
Main Bearing Caps	6 Bolt	6 Bolt
Valvetrain Configuration	OHV - CIB	OHV - CIB
Valves Per Cylinder	2V	2V
Valve Lifter / Lash Adjuster	Roller Hydraulic	Roller Hydraulic
Cam Drive	3/8" Roller Chain	3/8" Roller Chain
Firing Order	1-8-7-2-6-5-4-3	1-8-7-2-6-5-4-3
SUB SYSTEMS		
MAIN BLOCK SUBSYSTEM		
Block Material	Cast Aluminum	Cast Aluminum
- Cylinder Material	Iron Liners	Iron Liners
Bearing Cap Material	Powdered Metal	Powdered Metal
Crankshaft Material & Journal Type	Forged Steel Even Fire	Forged Steel Even Fire
- Main Bearing Material	Steel Backed / Aluminum Alloy w/ coating	Steel Backed / Aluminum Alloy w/ coating
- Rod Bearing Material	Steel Backed / Aluminum Alloy w/ coating	Steel Backed / Aluminum Alloy w/ coating
Connecting Rod Type and Material	Cracked Powdered Metal	Cracked Powdered Metal
Torsional Damper Type	Inertia w/ Integral Pulley	Inertia w/ Integral Pulley
Flexplate/Flywheel	Modular Cast Iron	Flywheel – 14” Flat Faced

Table 2.3.1-1: Product Specifications

ENGINE VARIANT RPO	MARINE L83	MARINE L86
CYLINDER HEAD SUBSYSTEM		
Cylinder Head Material	Cast Aluminum	Cast Aluminum
Inlet Seat Material	FMS-33	FMS-33
Inlet Seat Angle	45 degrees	45 degrees
Exhaust Seat Material	FMS-33	FMS-33
Exhaust Seat Angle	45 degrees	45 degrees
VALVETRAIN SUBSYSTEM		
Camshaft Material	Modified 5150 Steel	Modified 5150 Steel
- Cam Bearing Material	Steel Backed SAE 788 Lined	Steel Backed SAE 788 Lined
Rocker Ratio	1:8:1	1:8:1
Inlet Valve Head Diameter	49 mm	49 mm
Inlet Valve Material	Sil Chrome 1	Sil Chrome 1
Exhaust Valve Head Diameter	39.5 mm	39.5 mm
Exhaust Valve Material	21-2N	21-2N
- Face Material	21-2N	21-2N
Valve Spring (seat load – valve closed)	400 N	400 N
Valve Rotator	None	None
COOLING SUBSYSTEM		
Thermostat Type (Location / bypass type)	Outlet	Outlet
- Start to Open Temp (^{o}F / ^{o}C)	212° F / 100º C	212° F / 100º C
- Fully Open Temp (^{o}F / ^{o}C)	239º F / 115° C	239º F / 115° C
LUBRICATION / VENTILATION		
Oil Pan Type and Material	Cast Structural Aluminum	Cast Structural Aluminum
- Oil Pan Capacity	9.0 qt	8.0 qt
Oil Filter Type	Full flow with anti-drain back top mount bypass	Full flow with anti-drain back top mount bypass
Oil Filter Number (if on EAS)	GM P/N 12637681 (PF 63)	GM P/N 12637681 (PF 63)
- Oil Filter Capacity (on Oil)	0.40L (0.42 quart)	0.40L (0.42 quart)
Crankcase Ventilation System Type	Fresh air	Fresh air
- PCV Type	PVC Orifice	PVC Orifice
Oil Pressure – Minimum - Hot	152 Kpa at 1,000 engine RPM 207 kPa at 2,000 engine RPM 228 kPa at 3,000 engine RPM	22 psig at 1,000 engine RPM 30 psig at 2,000 engine RPM 33 psig at 3,000 engine RPM
AIR INTAKE SUBSYSTEM		
Throttle Body Type	ETC	ETC
- Bore Size	ETC - 80 mm	ETC - 87 mm
Intake Manifold Type	SIDI	SIDI
- Material	Composite	Composite

FUEL SUBSYSTEM		
Fuel System	SIDI under IAM	SIDI under IAM
Gasoline Fuel System Pressure/Type	400-500 kPa return-less Supply 3-20MPa SIDI	400-500 kPa return-less Supply 3-20MPa SIDI

EXHAUST SUBSYSTEM		
Exhaust Manifold Type	N/A	N/A
- Material	N/A	N/A

IGNITION SUBSYSTEM		
Ignition Type	See Section 1.0 - P/N Summary	See Section 1.0 - P/N Summary
- Spark Plug Type	Iridium Tip Side Electrode	Iridium Tip Side Electrode
- Spark Plug Gap (mm)	1.025 ± .075	1.025 ± .075

Table 2.3.1-1: Product Specifications (continued)

2.3.2 Performance Summary

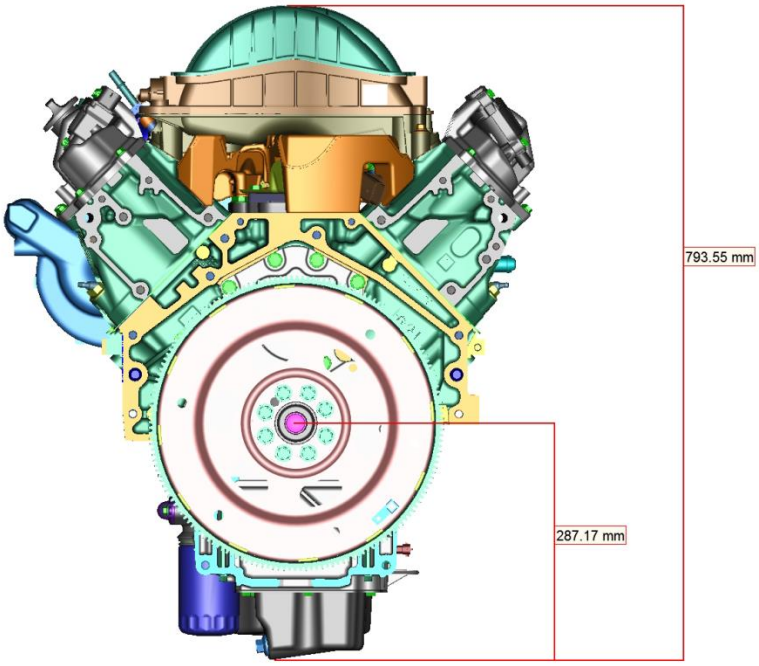
Overall engine performance in the final OEM application will likely be different as the final "as-installed" performance will be affected by:

1) OEM final application design features (inlet and exhaust restrictions)
2) OEM system calibration
3) Ambient temperatures and barometric pressures where operated

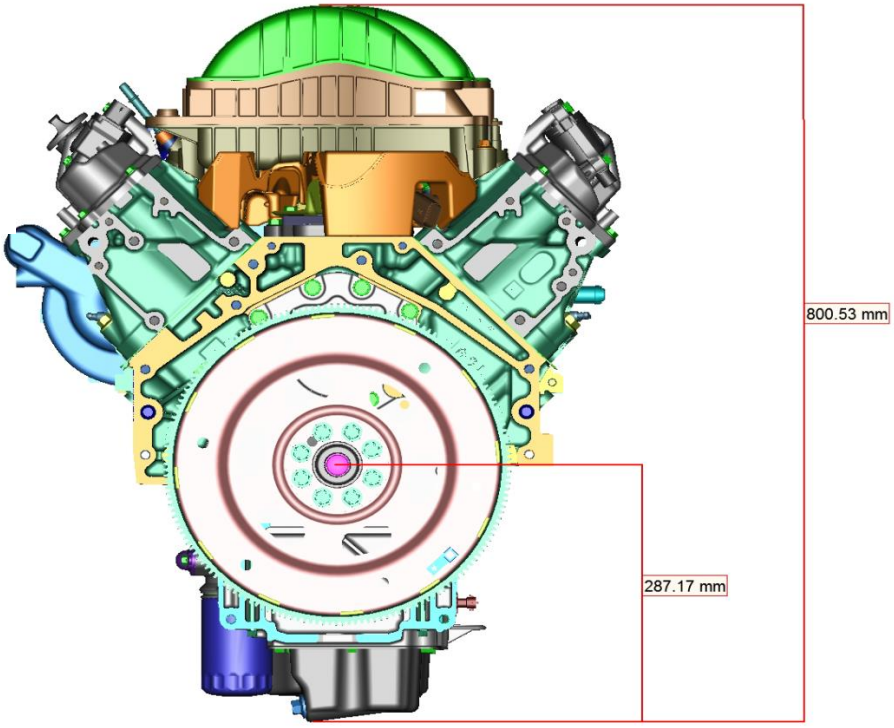
2.4 Feature Location Illustrations

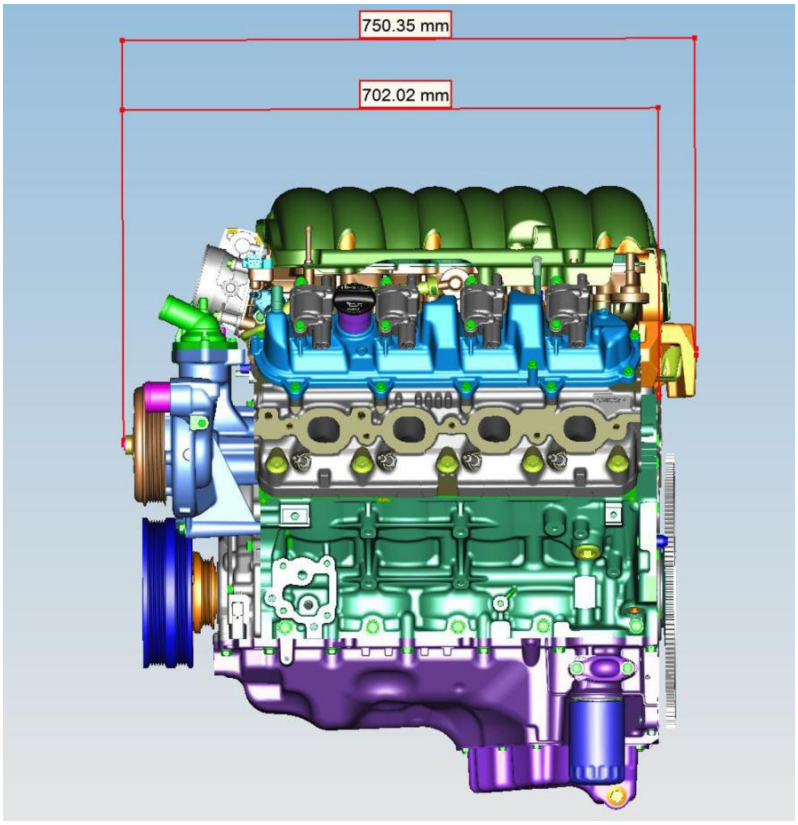
Front, rear, right hand and left hand views of the V8's are shown here with overall dimensions for preliminary packaging evaluations.

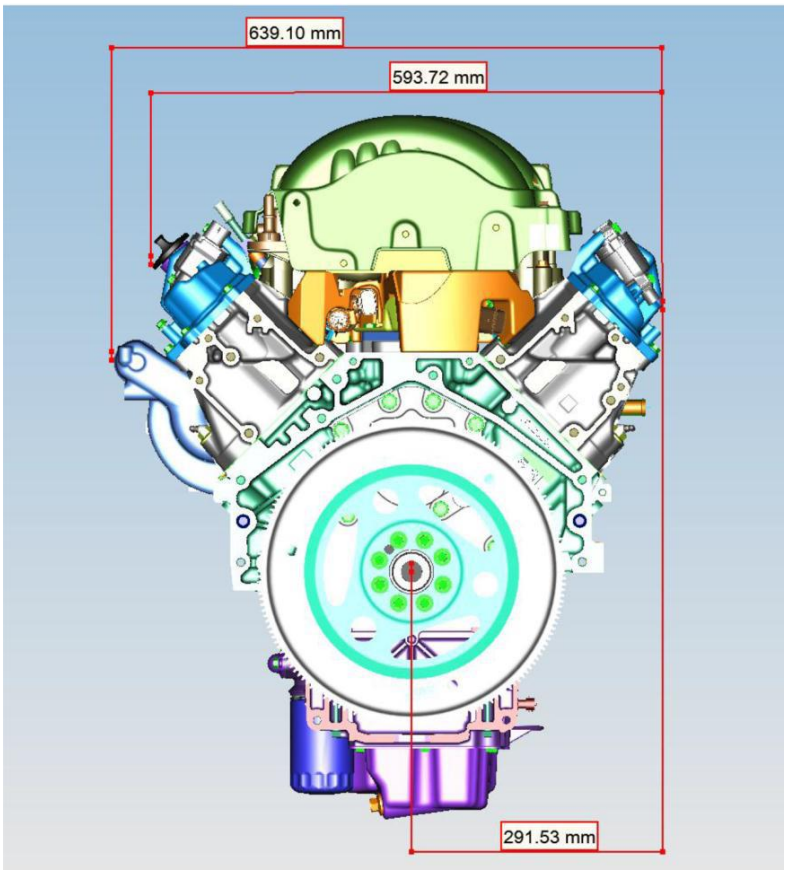
5.3L

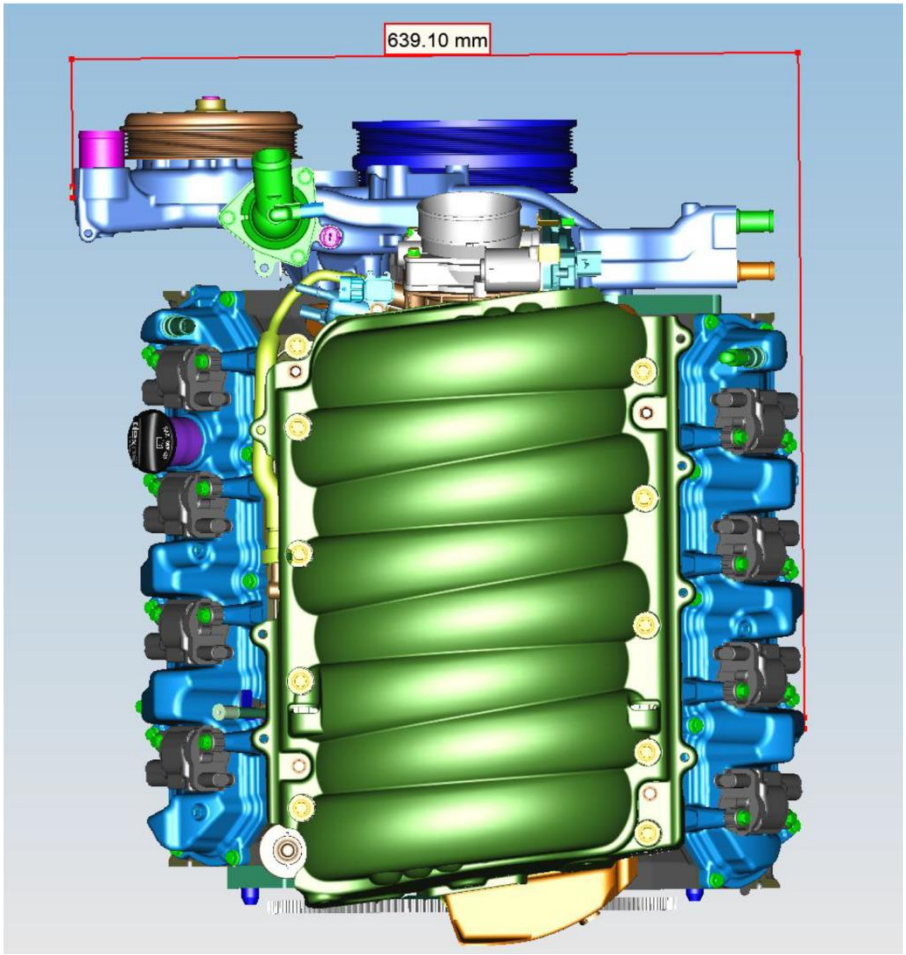


6.2L




750.35 mm
702.02 mm


639.10 mm
593.72 mm
291.53 mm



Gen 5 Marine
Figure 2.4-1

2.5 Configuration As Shipped and Optional Dress Parts

2.5.1 Engine As Shipped

The "engine as shipped" (EAS) from the engine plant is to conform to a specific content as defined by the GM Bill of Material (BOM). The chart below summarizes key interface hardware that the OEM needs to be aware of the existence on the EAS. This hardware is classified by a GM category (UPC) which is basically a cataloging system.

UPC	DESCRIPTION	2016 G5 V8'S P/N 12654221 & P/N 12657237
6C	Flywheel/Flexplate	Shipped with V6 Flywheel P/N 12639313
	Clutch	No
	Balancer/Pulley	Yes with dual pulley (193 mm) 6 groove (forward) & 4 groove (rear)
6G	Oil Level Indicator (Dipstick)	Yes
	Oil Filter – screw into / location	Oil Pan – L/H Side
6H	Ventilation / PCV System	"Fresh Air" System with PCV
	- Foul air plumbing	Yes – includes PCV
	- Fresh air plumbing	Rocker cover nipple only
6K	Water Pump	Yes
	Cooling – t/stat (start to open/full open)	100 / 115° C
6L1	Intake Manifold	3 pc composite with front entry
6L2	Exhaust Manifold	Deleted
6L3	EGR	Not applicable
6M1	Throttle Body	ETC
6M6/8	Gasoline fuel injectors/rail	SIDI with Hi Pressure SS rail – returnless
6X4	Accy. Drive Components	No
6Y1	Alternator / Braces / Brackets	No

Table 2.5.1-1: Gen 5 V6 Descriptive BOM (continued

UPC	DESCRIPTION	2016 G5 V8'S P/N 12654221 & P/N 12657237
6Y2	Starter	No
6Y3/4	Ignition	Coil Near Plug
	- Spark Plugs	Conventional J-gap (1 mm) w/ tips
	- Plug Wires & Retainers	No
	- Coils	Direct mount to rocker cover
12F	Computer (Engine Control Module)	MEFI 7 Available
	Sensors	
	- MAP	Intake Mounted
	- MAT	No-OEM responsibility if req'd
	- Crank Position	Internal 58X (Block Mount Sensor-R/H Rear)
	- Cam Position	4X – Front Cover
	- Coolant	In water pump crossover
	- Purge Solenoid	Intake Mounted
	- Knock Sensor	2 – L/H & R/H block sensors
	- Fuel Pressure Sensor	Fuel Rail mounted
	- Oil Pressure	Front of Block

Table 2.5.1-1: Gen 5 V6 Descriptive BOM (continued

Part Number	FNA Description	Quantity
12654221	ENGINE ASM-5.3L	1
12668746	ENGINE ASM-5.3L	1
12657237	ENGINE ASM-6.2L	1
12620290	BLOCK ASM-ENG, 5.3L	1
12619171	BLOCK ASM-ENG, 6.2L	1
12638139	BEARING-CR/SHF LWR, 5.3L	5
12654170	BEARING-CR/SHF LWR, 6.2L	5
12638138	BEARING-CR/SHF UPR, 5.3L	4
12654169	BEARING-CR/SHF UPR, 6.2L	4
12656815	BEARING-CR/SHF THR UPR, 5.3L	1
12656814	BEARING-CR/SHF THR UPR, 5.3L	1
11546565	BOLT/SCREW-CR/SHF BRG CAP	10
12620209	HEAD ASM-CYL (W/ VLV), 5.3L	2
12620544	HEAD ASM-CYL (W/ VLV), 6.2L	2
12622325	GASKET-CYL HD, 5.3L	2
12659260	GASKET-CYL HD, 6.2L	2
11546959	BOLT/SCREW-CYL HD	19
11611976	BOLT/SCREW-CYL HD	1
12570326	PIN-CYL HD LOC	4
12625969	BRACKET-ENG LIFT FRT	1
11588739	BOLT/SCREW-ENG LIFT FRT BRKT	2
12551983	BRACKET-ENG LIFT RR	1
11588739	BOLT/SCREW-ENG LIFT RR BRKT	2
12619781	CRANKSHAFT ASM, 5.3L	1
12623492	CRANKSHAFT ASM, 6.2L	1
12617790	HOUSING ASM-CR/SHF RR OIL SEAL	1
9982257	SEALER-CR/SHF RR OIL SEAL HSG	AR
12620312	BALANCER ASM-CR/SHF	1
11570046	BOLT/SCREW-CR/SHF BALR	1
11547372	BOLT/SCREW-CR/SHF BALR	1
12639313	FLYWHEEL ASM	1
12553332	BOLT/SCREW-FLYWHL	8
12662793	PISTON ASM-(W/ CONN ROD), 5.3L	4
12662803	PISTON ASM-(W/ CONN ROD), 6.2L	4
12662795	PISTON ASM-(W/ CONN ROD), 5.3L	4
12662805	PISTON ASM-(W/ CONN ROD), 6.2L	4
12624109	BEARING-CONN ROD, 5.3L	16

Part Number	FNA Description	Quantity
12651909	BEARING-CONN ROD, 6.2L	16
12619977	PAN ASM-OIL	1
12667045	PAN ASM-OIL	1
9982257	SEALER-OIL PAN	AR
12659938	PUMP ASM-OIL	1
12638926	PLUG ASM-ENG BLK OIL GAL	1
11546665	PLUG-ENG BLK OIL GAL	2
12656770	NOZZLE ASM-PSTN OIL	8
11546667	PLUG-DRV MOT OIL FIL HOLE	1
12649144	CAP-OIL FILL TUBE SHPG	1
12623678	INDICATOR ASM-OIL LVL (W/ IND TUBE)	1
11588712	BOLT/SCREW-OIL LVL IND TUBE	1
55573411	OIL-ENG	1
12619982	TUBE ASM-PCV, 5.3L	1
12650610	TUBE ASM-PCV, 6.2L	1
9982257	SEALER-ENG FRT CVR	AR
12621362	COVER ASM-ENG FRT	1
12657428	PUMP ASM-WAT (W/ MANIF)	1
12619779	MANIFOLD ASM-INT, 5.3L	1
12619755	MANIFOLD ASM-INT, 6.2L	1
12618333	RAIL ASM-DIR F/INJN FUEL, 5.3L	1
12658037	RAIL ASM-DIR F/INJN FUEL, 5.3L	1
12625815	RAIL ASM-DIR F/INJN FUEL, 6.2L	1
12658038	RAIL ASM-DIR F/INJN FUEL, 6.2L	1
12656932	INJECTOR ASM-DIR FUEL, 5.3L	8
12656931	INJECTOR ASM-DIR FUEL, 6.2L	8
12619823	CAMSHAFT ASM, 5.3L	1
12629512	CAMSHAFT ASM, 6.2L	1
12623372	ACTUATOR PKG-CM/SHF POSN	1
12589016	RETAINER-CM/SHF	1
12658045	MANIFOLD ASM-VLV LFTR OIL	1
12645723	GUIDE ASM-VLV LFTR	2
12619818	GUIDE ASM-VLV LFTR	2
12645724	GUIDE ASM-VLV LFTR	2
12619819	GUIDE ASM-VLV LFTR	2
11611383	BOLT/SCREW-VLV LFTR GDE	4
12619828	ROD ASM-VLV PUSH	16
12642273	GUIDE ASM-VLV LFTR FOLLOWER	1
11561455	BOLT/SCREW-CM/SHF RET	4
55573410	LUBRICANT-VLV PUSH ROD	AR
55573410	LUBRICANT-CM/SHF THR PLT	AR
55573410	LUBRICANT-CM/SHF	AR

Part Number	FNA Description	Quantity
12658184	COVER ASM-VLV RKR ARM (W/ IGN COIL & MDL)	1
12658185	COVER ASM-VLV RKR ARM (W/ IGN COIL & MDL)	1
12622455	COVER ASM-VLV RKR ARM (W/ IGN COIL & MDL)	1
12622456	COVER ASM-VLV RKR ARM (W/ IGN COIL & MDL)	1
12619829	ARM ASM-VLV RKR	16
55573410	LUBRICANT-VLV RKR ARM PIV	AR
12623095	SENSOR ASM-KNOCK	2
12623094	SENSOR ASM-CR/SHF POSN	1
11588722	BOLT/SCREW-CR/SHF POSN SEN	1
12640390	SHIELD-KNOCK SEN	1
11588722	BOLT/SCREW-KNOCK SEN SHLD	1
12622441	SPARK PLUG ASM	8
3736406	PIN-TRANS LOC	2
12625817	PUMP ASM-FUEL	1
12618338	PIPE ASM-FUEL FEED	1
12618337	PIPE ASM-FUEL FEED INTER	1
12618336	PIPE ASM-FUEL FEED INTER	1
12623125	INSULATOR-F/PMP	1
12659395	SENSOR ASM-ENG OIL PRESS	1

Table 2.5.1-1: Gen 5 V8 Descriptive BOM (continued)

2.5.2 Optional Dress Parts

GMPT has other "dress" parts (parts that are not part of the EAS) available for the engine thru GMPT's Global Supply Chain (GSC) organization. For the 2014 model year, select (hi usage) dress parts released for OEM's to purchase separately are shown in Table 2.5.2-1

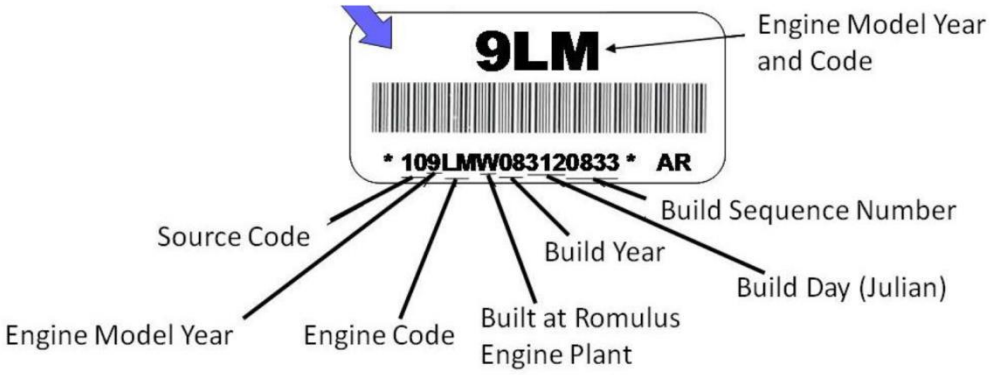
Component Name	GM P/N	Bolt	Bolt	Per Engine
Ignition				
Coil	12658183	11588714		8
Coil	12619161	11588714		8
Spark Plug Wire	12633447			8
Sensors				
Coolant Sensor	12608814			1
Knock Sensor	12623095			2
MAP Sensor	12644228			1
Oil Pressure Sensor	12635397			1
Oxygen (Sensor)	12659516			2
Misc.				
Tensioner	12626059	11588749		1
Idler Pulley	12629519	11570516		1
Starter	12655055			1
Belt – ACC Drive	12626076			1
Knock Sensor Shield	12640390	11588722		2
Flywheel	12639313			1

Table 2.5.2-1: Dress Parts Available thru GSC

If additional technical information is required, please contact the Application Engineer.

2.6 Identification and Marking

There are no permanent stampings on the engine to identify the engine. The engine identification label located on the rear of the cylinder head. The diagram below aids in deciphering the label.



Engine Label Identification / Decode

Figure 2.6-1

2.7 Engine Mass / Center of Gravity

The mass and center of gravity of the engine assembly are a function of the level and design of dress hardware provided. For reference, the mass of some select OEM engines in the "as shipped" configuration are shown in the table below.

Engine	Mass (lbs)/(Kg)	Notes
L83 & L86 (Marine)	461/209	Shipped with oil

Table 2.7-1: Engine Mass – Marine Example

As GMPT offers many engine variants, each with different content/mass, the Center of Gravity information is not typically generated for our OEM engine applications. The OEM is expected to determine the final system mass and COG for their application and test accordingly.

3.0 GMPT / OEM SYSTEM INTERFACES

This section provides an overview of both the mechanical and electrical interfaces to the engine. Installation angles are also discussed.

3.1 Mechanical Interface

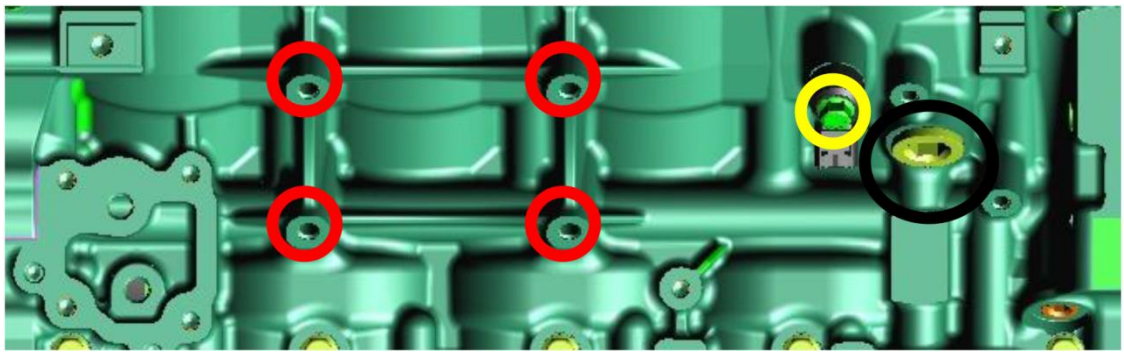
Mechanical interfaces include the basic geometries of the attachment points of the engine, the subsystem interfaces (flow requirements, etc.) as well as the cranktrain mass elastic properties. The accessory drive components (fan, alternator, etc.) are not covered in this manual as these components are not part of the engine as shipped.

3.1.1 Hard Attachments–Engine Mounts / Trans Flange / Accy Drive

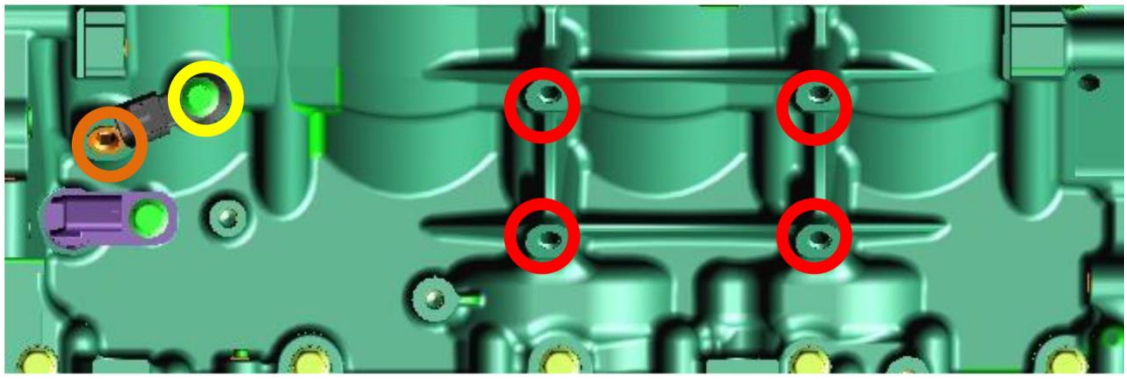
The following sections provide general location and thread sizes for the hard attachment points. It is important to note that a mix of English and metric threads are used in this engine. For dimensional details, utilize the available math data.

3.1.1.1 Side of Engine / Engine Mounts

The 2 figures below show the left and right hand engine views and the specific threaded holes and size.



Attachment Points – Engine L/H Side
Figure 3.1.1.1-1



Attachment Points – Engine R/H Side
Figure 3.1.1.1-2

M8 x 1.25

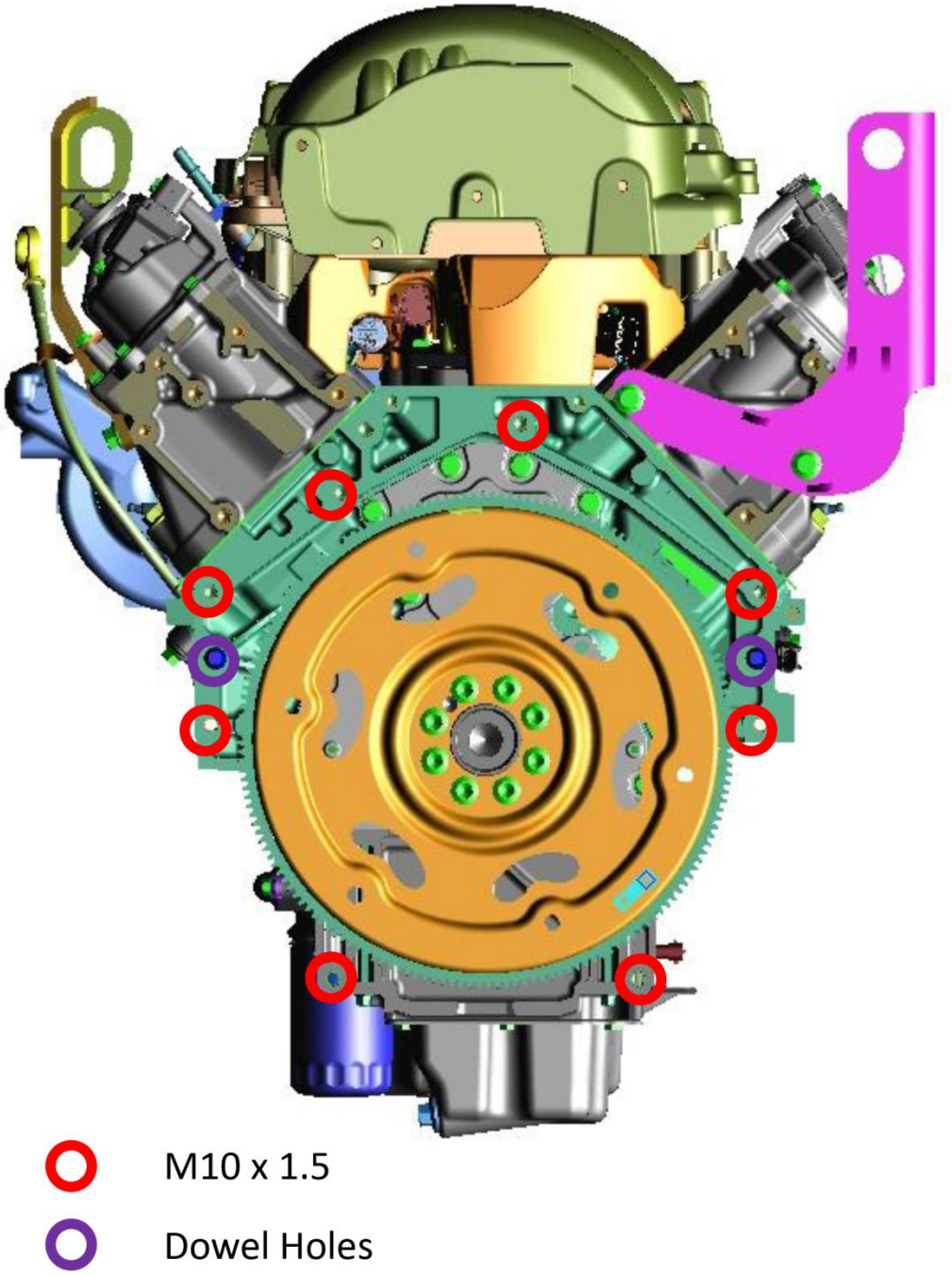
M10 x 1.5

M16 x 1.5

M28 x 1.5

3.1.1.2 Rear of Engine - Rear Face of Case (RFC) & Oil Pan Attachment

A transmission or bell housing adapter can be attached to the rear side of the engine which provides the flange face attachment. The rear face of the engine allows attachment to both the rear face of the aluminum cylinder block as well as the structural aluminum oil pan. These 8 fastening locations allow for a “full round” attachment for enhanced interface rigidity. The attaching points and thread sizes are illustrated in Figure 3.1.1.2-1.

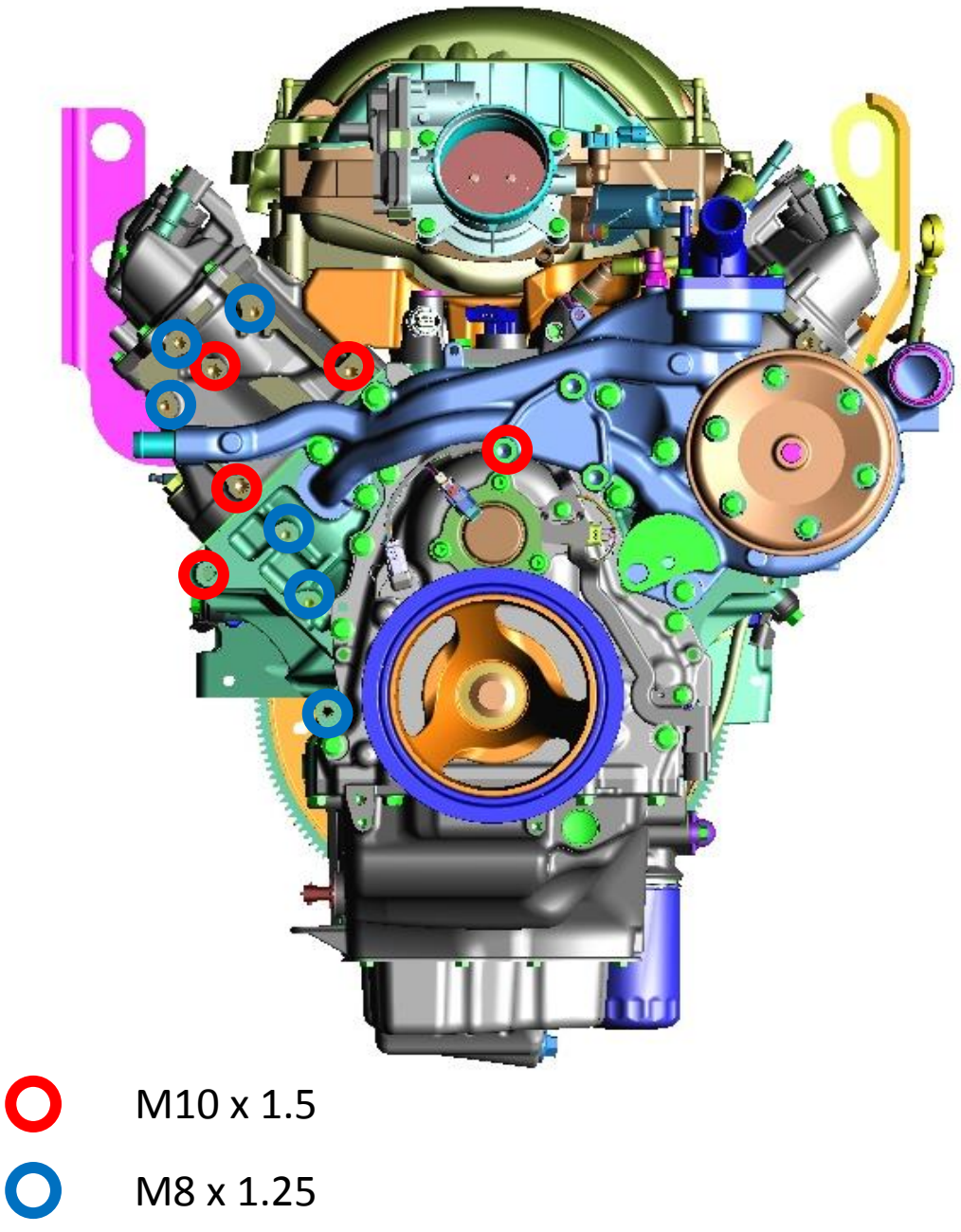


Rear of Engine – Mounting Bosses

Figure 3.1.1.2-1

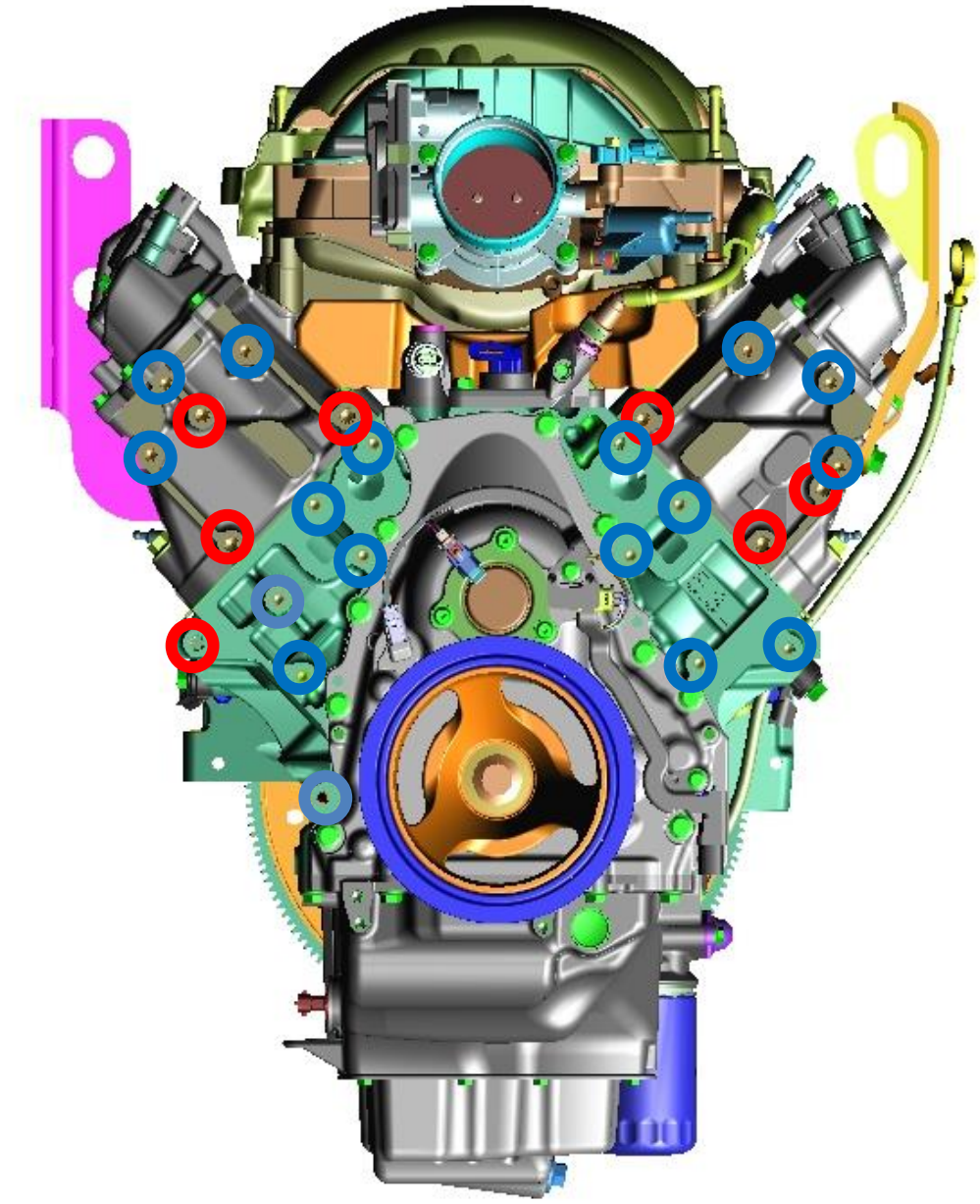
3.1.1.3 Front of Engine – Accessory Drive Mounting

The engine front face of case, as well as the cylinder heads, provide numerous attachment points for the OEM's use. Figure 3.1.1.3-1 below shows these locations and thread sizes.



Front of Engine – Accessory Drive Mounting

Figure 3.1.1.3-1



M10 x 1.5

M8 x 1.25

Front Face of Engine Assembly

Figure 3.1.1-3-2

3.1.1.4 Cylinder Heads – Exhaust Manifold Attachment Points

The Gen 5 V8 cylinder heads are reversible (between L/H and R/H side of engine). The exhaust manifolds are typically mounted via the symmetrically located attaching holes (1 each side of each port).

Cylinder Head Attaching Points

Figure 3.1.1.4-1

Various maximum crankshaft loads are provided:

Engine RPM	Hubload
600	**1950N**
1000	1700N
1500	1655N
2000	1640N
2500	1635N
3000	1645N
4000	1680N
6000	1710N

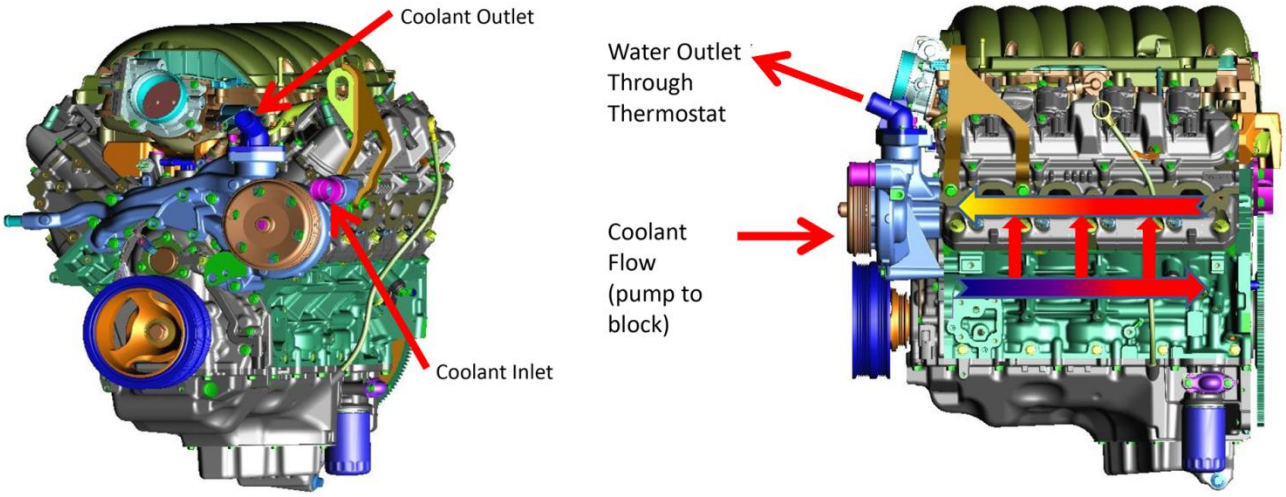
The engine as sold to our OEM's is released without an accessory drive system. The OEM incorporates accessory drive components and systems depending on the final application requirements.

3.1.2 Cooling System

The following sections describe the engine cooling system requirements and operating variables.

3.1.2.1 Engine Coolant Flow Path

The engine cooling flow path is shown in Figure 3.1.3.1-1. The Gen 5 V8 engine utilizes a conventional U-Flow path with water entering each bank from the water pump at the front of the engine, traversing up thru the heads. The thermostat is located in the water outlet of the water pump. This system utilizes water pump bypass to facilitate closed t/stat operation.



Gen 5 V8 Coolant Flow Path
Figure 3.1.2.1-1

The water inlet is located on the water pump and is a 40.15mm +/- 0.15mm machined feature. As described earlier, this engine is shipped with a thermostat. The OEM is to install a thermostat and cooling system capable of operating the engine under all conditions without exceeding the limits as described in section 5.2.1

3.1.2.2 Recommended Coolant Type

GMPT engines are liquid cooled and designed and validated to operate with a mix of ethylene glycol and water. For OEM applications, a 50/50 mix of extended drain DexCool and "pure" water is the GM recommendation. This "orange" colored coolant is a "non-silicated" coolant using Organic Acid Technology. The previously used green coolant (used prior to 1996) had low levels of silicates which are detrimental to the water pump seals longevity. The GM spec for the DexCool coolant can be provided upon request (GM 6277 M).

3.1.2.3 Recommended System Pressure

GMPT engines are designed to operate with a pressurized cooling system and surge tank. System pressure is controlled with a spring load pressure relief cap with a nominal setting of 15 psi.

3.1.2.4 System Fill and Deaeration Capability

GMPT requires the engine coolant system to be at least 95% filled before the engine is started. The OEM's cooling system shall be designed to displace all air in the engine, hoses, heater(s) and radiator into the deaeration tank while the engine is operating. GM vehicle cooling systems are designed for the system to run un-aerated within 20 minutes after a service fill – at this time, the only air in the cooling system should be located in the deaeration tank. GM design guidelines are for the cooling system to be capable of losing approximately 10% of coolant without aeration occurring or loss of flow (this allows the engine to operate without damage when only a 95% fill is obtained). A low coolant alarm (software or light) is typically activated when the coolant loss is less than or equal to the drawdown capacity (10%) occurring, but should also be calibrated to activate prior to coolant aeration occurring.

3.1.2.5 Coolant Flow Rates

Flow to the radiator and ancillary devices varies with pump speed, thermostat valve position and pressure drop across the heat exchangers. The table below provides some sample flow rates for an automotive application – this info is provided for reference only and is not necessarily representative for the OEM's final application.

RPM	Radiator Flow L/Min	Condition
750	33	Idle
1300	60	High Idle
2000	93	WOT
3000	140	WOT
4000	184	WOT
4600	198	WOT

Table 3.1.2.5-1: **Gen 5 V8 Coolant Flow Rates**

3.1.2.6 Engine Heat Rejection Rates

Engine heat is rejected primarily thru two media – engine oil and the cooling system. The maximum oil and coolant temperature limits are covered in section 5.2. Heat rejection levels for combined engine coolant and oil are measured per GM Test #9 and are a function of the hardware utilized and to a lesser extent, the engine calibration.

Gen 5 Engine Heat Rejection Rates				
		Total Engine Heat Rejection Rate to Coolant (kW)		
RPM	Condition	4.3L V6	5.3L V8	6.2L V8
550	Idle	5	5	8
1000	Fast Idle	10	10	10
1000	WOT	18	24	27
2000	WOT	43	41	51
3000	WOT	50	63	72
4000	WOT	74	86	101
5000	WOT	97	112	135
5500	WOT	108	119	149

Table 3.1.2.6-1: Gen 5 Heat Rejection

The OEM is responsible to ensure that adequate heat rejection exists to ensure proper engine operation by limiting oil and coolant temps appropriately.

3.1.2.7 Cooling System - Miscellaneous

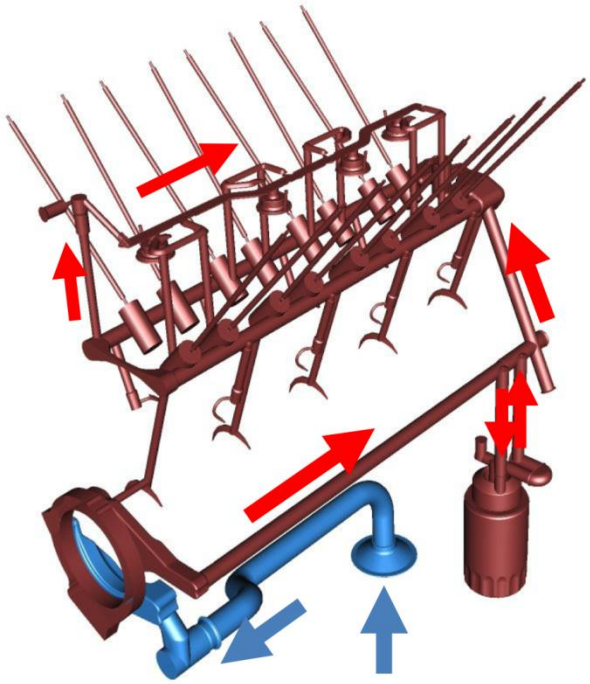
The cooling fan assembly is not part of the engine scope or extent of supply. Cooling fan and drive is designed, dimensioned and released by the OEM taking into account the heat rejection needed to evacuate from the engine through the radiator assembly.

3.1.3 Lubrication / Ventilation System

The following sections describe the engine lubrication and ventilation system requirements and operating variables.

3.1.3.1 GEN 5 V8 Engine Oil Flow Path

The engine oil flow path is shown in Figure 3.1.4.1-1. The Gen 5 V8 engine utilizes a wet sump oil pan. The service capacity is 8 quarts, with a dry filter.



Engine Lubrication Diagram

Figure 3.1.3.1-1

Oil pressure sensor is at the front of the block.

The engine is shipped with a block mounted (screw on) oil filter. When remote filters and/or oil cooling systems are utilized, it is the responsibility of the OEM to ensure the functionality of the entire lubrication system. Section 5.2.2 discusses the operating temperature limits for the oil.

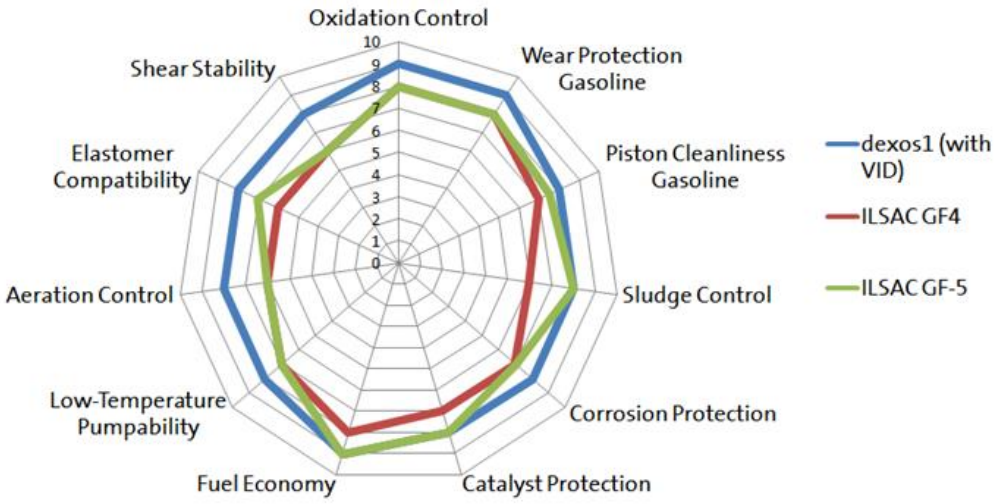
3.1.3.2 Recommended Oil Type

GMPT validates Gen V truck and automotive gasoline engine applications with motor oils meeting the dexos™ standard. The GM spec for this oil is 15827. Motor oils meeting this spec receive the green dexos™ symbol:

Oils meeting the dexos™ spec are improved over the previous ILSAC GF4 oils in many ways including:

- Reduced Phosphorous levels (20%) for reduced catalyst poisoning
- Improved oxidation resistance (4X oxidation inhibitor treat level = 100% improvement)
- Improved hi temp deposit control (1.5X detergents = 25% improvement)

It is noted that the dexos™ oils are "backward compatible" and are equal or better than previous grades of oil in all aspects.



GM's factory fill oil specification and oil recommendations for gasoline are based on extensive experience for our automotive (car and truck) applications. 0W20 dexos™ oil is what we recommend to meet fuel economy cold start objectives.

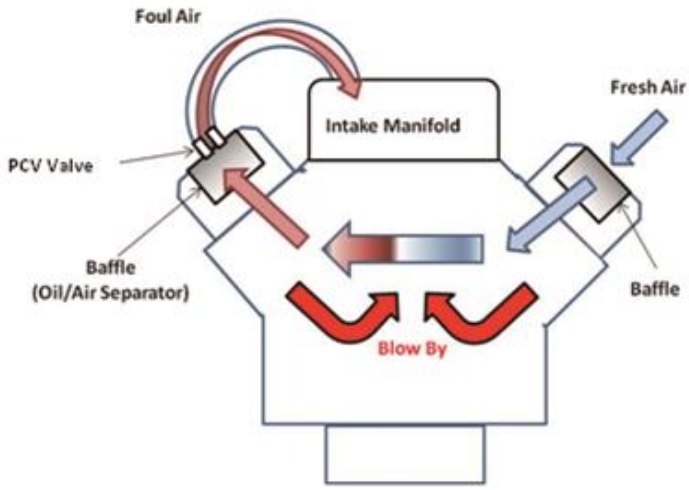
3.1.3.3 System Oil Capacity

The engine is shipped with 7.57 liters (8 quarts) of oil with oil in filter. Of this, the following capacities are approximated.

It is the OEM's responsibility to ensure oil level is appropriate for the application. Many OEM's install and utilize a remote oil filter and/or oil cooler. These systems will require additional oil to ensure proper lubrication. Oil cooler location is the same as GenIV and is accessible at the cover plate location on the oil pan.

3.1.3.4 Crankcase Ventilation

The Gen 5 V8 engine utilizes a fresh air positive ventilation system as shown in Figure 3.1.3.4-1. This view (as seen from the rear of the engine) has a fresh air supply provided thru the right-hand rocker cover and the foul air is removed to manifold vacuum from a PCV valve on the left-hand cover.



Gen 5 V8 Crankcase Ventilation Schematic

Figure 3.1.3.4-1

The engine is designed to run between +1 and -3 KPA crankcase pressure.

3.1.4 Air Inlet

Engines are shipped with an IAM (Section 1.0) incorporate an (as shown in figure 2.1-1) electronic throttle body. The throttle body is mounted in front of the intake manifold and the inlet is oriented horizontally.

	5.3L Throttle Body	6.2L Throttle Body
Bore ID (mm)	80mm	87mm
Inlet Duct Flange OD (mm)	90mm OD	97mm OD

Table 3.1.4-1: Throttle Body Dimensions

Induction system design is the responsibility of the OEM. It is recommended that air flow path at the air inlet not be obstructed causing loss of pressure or flow disturbance. In addition, the intake of air must avoid the suction of air coming from the hot spot areas inside of the engine bay and water injestion. Increased intake restriction and/or inlet air temp will result in the degradation of engine power.

GMPT requires an air filtration medium that is capable of removing 98.7% of the material contained in reference material SAE "Course Dust".

3.1.5 Fuel System

The marine engine is shipped with a SIDI fuel system. (refer to Section 1.0 – Introduction). This section provides information pertaining to this application only. The engine is capable of running on unleaded gasoline 87 octane fuel (R+M)/2 and is validated for ethanol blends up to 85%.

The fuel system is an external SIDI design utilizing a "return-less" fuel rail. The rail is stainless steel with inlet "male" tube end forms with sealing diameters as shown below:

Inlet (feed): Nominal size = 3/8" (seal diameter = 9.49mm)

For complete end form definition, refer to SAE J2044 specifications.

Single stage pump should run at 400 kpa, multi stage pump should boost to 500 kpa, over 4000 RPM. Inlet flow on the 5.3L LV1 is 19+ grams per second is required to feed the high pressure pump. The LV1 has 17cc/s injectors.

The fuel pressure sensor is used for service and is located at the rear of the rail. There is not a Schrader valve on the fuel system for service.

The fuel filter shall satisfy the following requirements:

a. Filter Media Efficiency

The fuel filter shall meet or exceed the following minimum efficiencies when tested per the conditions listed below:

Particle Size Larger than X (microns)	**In-Line External Filter Single Pass Minimum Particle Retention Efficiency (%)**	***In-Tank Filter Single Pass Minimum Particle Retention Efficiency (%)**
4	**48.0**	**50.0**
8	**86.0**	**95.0**
12	**96.5**	**98.0**
16	**99.0**	**99.0**
20	**99.5**	**99.5**
24	**99.6**	**99.8**

Filter Media Efficiency Test Conditions:

Fluid: MIL-H5606, 37.8C (100F)

Flow Rate: 22.7 liters/hr (6.0 gallons/hr) for 90 mm diameter sample

Contaminant: 5 to 80 micron PTI Dust (ISO medium test dust), 1.0 mg/l concentration

Test Condition: J1895 Single Pass

3.1.6 Exhaust

Exhaust system design is the responsibility of the OEM. All Gen 5 V8 OEM engines are shipped without exhaust manifolds. As shown in section 3.1.1.4, the exhaust manifolds are attached direct to the cylinder heads.

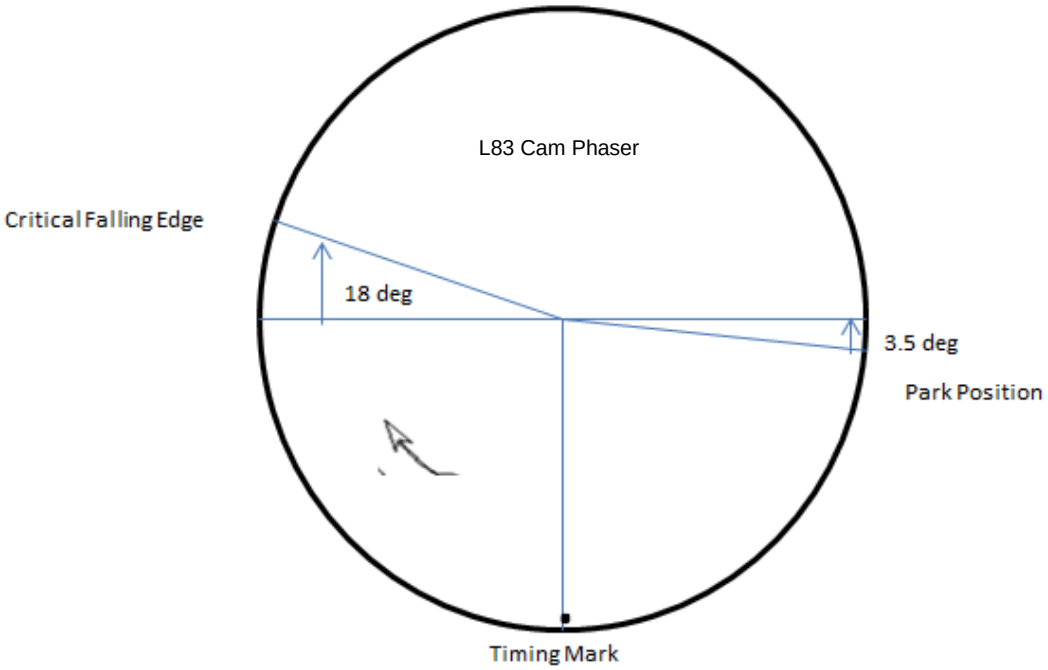
Shielding of the exhaust system may be required to ensure surrounding components are not subjected to excessive temperatures. Exhaust system design can enhance (via tuning) or degrade (via backpressure) overall engine performance.

3.1.7 Cam Phaser

Variable Valve Timing

The Gen V dual-equal cam phaser adjusts camshaft timing at the same rate for both intake and exhaust valves. A vane-type phaser is installed on the cam sprocket to turn the camshaft relative to the sprocket, thereby adjusting the timing of both intake and exhaust valve operation. The vane phaser is actuated by hydraulic pressure from engine oil, and managed by a solenoid that controls oil pressure on the phaser. The phaser uses a wheel or rotor with four vanes (like a propeller) to turn the camshaft relative to the cam sprocket, which turns at a fixed rate via chain from the crankshaft. The solenoid directs oil to pressure points on either side of the four phaser vanes; the vanes, and camshaft, turn in the direction of the oil flow. The more pressure, the more the phaser and camshaft turn. 150 kPA is the minimum oil pressure for rapid phasing movement and good stability. As pressure goes down, actuation rate and stability could degrade. The new MEFI 7 engine control module directs the phaser to advance or retard cam timing, depending on driving demands.

Cam park position is at cylinder #1 T.D.C. exhaust stroke advanced 3.5 cam degrees. Range of authority is 31 cam degrees. Critical falling edge is a function of the cam sensor location and is 18 degrees.



3.2 ELECTRICAL INTERFACE

The Gen 5 V8 engine requires an Engine Control Module to control the engine. The ECM monitors inputs from various sensors and utilizes these inputs to control signal outputs to various actuators. This section provides a high level overview of the sensors/actuators included, their mating electrical connectors, and some basic information often requested by OEMs. For additional technical information, contact the appropriate OEM Application Engineer.

3.2.1 Engine as Shipped - Sensors/Actuators (and Mating Connectors)

Table 3.2-1 lists the sensors/actuators that are part of the engine as shipped, but also lists a select few that are not part of the engine as shipped (for user clarification on the content). These and other optional sensors are available as shown in the dress list (section 2.5.2) and are available thru GSC.

Sub-system	Device	Device #	GM Connector #	Connector Supplier #	Connector Supplier	Comments	Sensor Characteristics
Air	Cam Jumper Harness	12626145	13580235	33472-0877	Molex	New connector and device	2X4
	Throttle Body (LV3)	12632171	13583851	2138387-5	Tyco	New connector and device	1X6
	LOMA (LV3)	12623135	13503504	33471-0506	Molex	New connector and device	No Drawing
	MAF with Humidity		13504800				
	MAP/TIAP	12644228		13639747	Delphi	Carryover Gen IV	Couldn't see pins
	Cam Phaser Magnet	12623906	89047381	54390239	FCI	New connector and device	1X2
	Camshaft Position	12623093	13503570	10010341	Kostal	New connector and device	1X3
	Crankshaft Position	12623094	13503570	10010341	Kostal	New connector and device	1X3
Cooling	Engine Coolant Temperature	12608814		15449028	Delphi	Carryover Gen IV	1X2
Ignition	Ignition Coil (L83/LV3)	12619161	13503518	34770-0402	Molex	New connector and device	1X4
	Knock Sensor	12623095	13503512	34752-0204	Molex	New connector and	1X2
P/N not found	Ignition Coil (L83/LV3)	12621750	13503518	34770-0402	Molex	New connector and device	Part number not found
Fuel	5.3L Fuel Injectors	12623116	15918773	34062-4008	Molex	New connector and device	1X2
	6.2L Fuel Injectors	12656931	15918773	34062-4008	Molex	New connector and device	1X2
	Fuel Rail (Bank1/Odd/ LH)	12618333	19178146	33472-1236	Molex	New connector and device	2X8
	Fuel Rail (Bank2/Even/ RH)	12628428	13576926	33472-1246	Molex	New connector and device	2X8
	Fuel Rail Pressure	12623130	13503575	10010346	Kostal	New connector and device	Part number not found
	Hi-Pres Fuel Pump	12618335	88988163	1-982-405-410	Bosch	New connector and device	No Part number found
Oil	Engine Oil Pressure	12635397	13503573	10010344	Kostal	New connector and device	1X3
	Engine Oil Level Switch	12630499		1-928-403-732	Bosch	Carryover (other GM)	1X2
ECM	J1	12617943	12615654				
	J2		12582677				
	J3		12582678				

Table 3.2.1-1: Engine Sensor/Actuator/Connectors

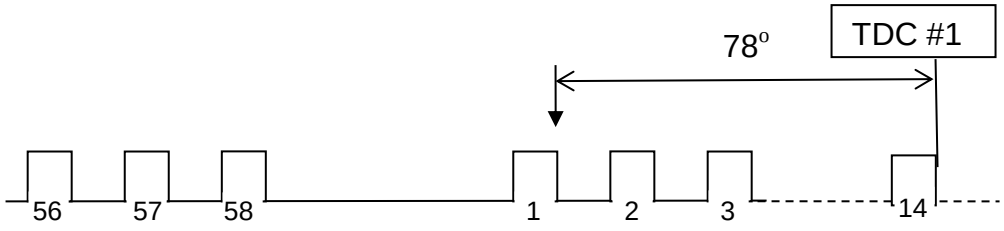
It is noted that the above table references the sensor/actuator P/N, and provides a single example of a mating connector P/N from a select source - other sources may be available. This list does not include the associated and required pins, seals, TPA, CPA, etc. - the OEM is required to contact the manufacturer for this hardware. The above list is intended only to provide initial guidance.

3.2.2 Inputs from Engine to ECM (Sensor Characteristics / Signals)

As previously defined, the "engine as shipped" is provided with sensors as shown in Table 3.2.1-1 (may differ by engine variant). This section provides basic information for those sensors providing signal to the ECM. Optional sensors are available thru GSC as shown in Table 2.5.2-1. Mechanization drawings, showing the wire diagrams for sensors to the MEFI controller, are available for users of the GM MEFI system. Contact the Application Engineer for additional sensor information not provided below.

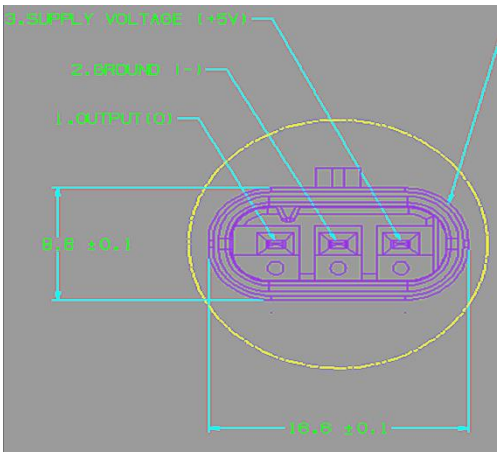
3.2.2.1 Crankshaft Position Sensor (CKP)

The Gen 5 V8 utilizes a "60X – 2" (aka 58X) crankshaft position reluctor ring (also known as a target wheel) installed at the crankshaft at the rear. As the rising and falling edges of this 181mm OD ring pass by the crankshaft position sensor, the sensor outputs a digital square wave signal for use by the ECM. The crankshaft rotation between falling edges of the signal is 6 degrees. Note the deletion of 2 teeth (to create 58X from a 60X concept) results in a 15 degree low signal gap. This tooth gap is used to identify the clocking position (position of crank wheel with respect to #1 cylinder at TDC). For the Gen V engine, the #1 tooth falling edge is located at 78° BTDC of cylinder 1 as shown in Figure 3.2.2.1-1.



Gen 5 V8 CKP Timing
Figure 3.2.2.1-1

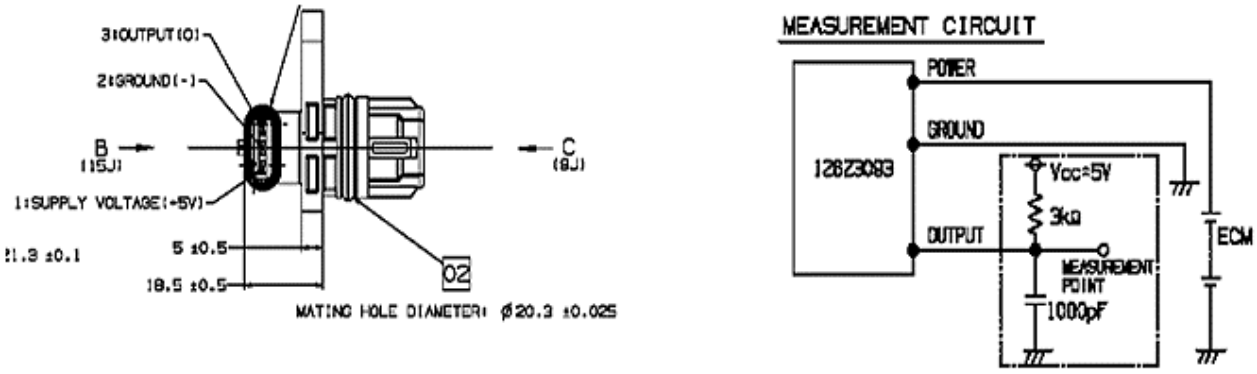
This signal is processed by the ECM to accurately determine crankshaft position. The CKP sensor connector pinouts are shown in the figure 3.2.2.1-2 (viewed looking into sensor).



Gen 5 V8 CKP Pinout
Figure 3.2.2.1-2

3.2.2.2 Camshaft Position Sensor (CMP)

4X cam position sensor. The output signal from this sensor is shown in the figure below:

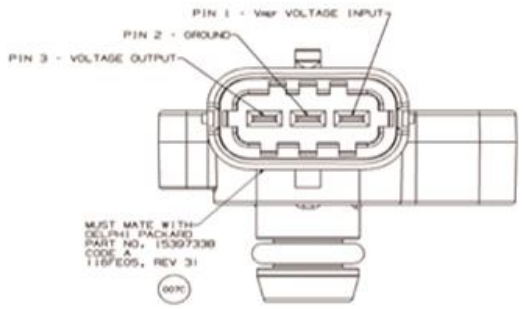


Gen 5 V8 CMP Pinout

Figure 3.2.2.2-1

3.2.2.3 Manifold Absolute Pressure (MAP) Sensor

A MAP sensor is incorporated on IAM equipped engines and is located at the front of the intake. Viewing the sensor into the connector end, the pinouts are labeled as shown in the legend.



Gen 5 V8 MAP Pinout

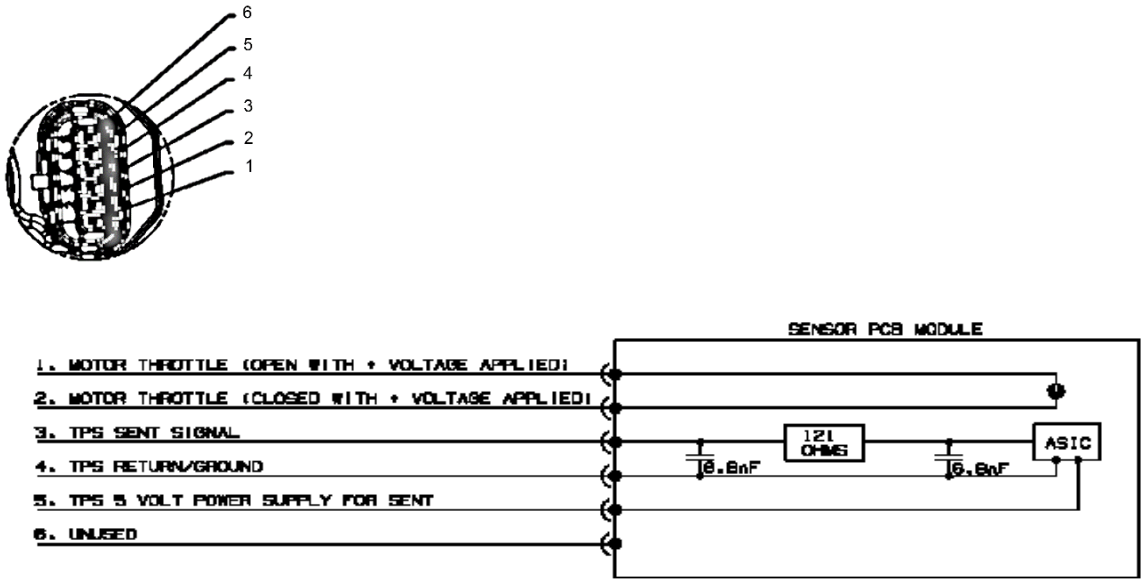
Figure 3.2.2.3-1

The sensor has the following range capability with the nominal outputs at the range limits:

Pressure 12.5 to 115 kPa

If additional sensor info (transfer function, etc.) is required, contact the Application Engineer.

The pin-out for the ETC throttle body is shown in Figure 3.2.2.3-2



Gen 5 V8 Electronic Throttle Body Pinout

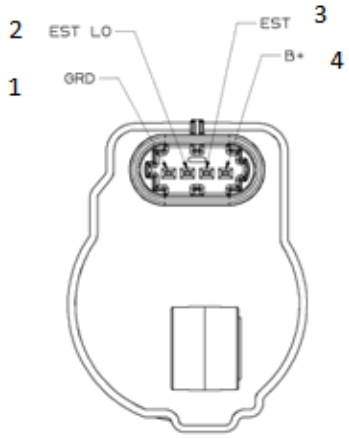
Figure 3.2.2.3-2

The throttle utilizes a digital output TPS sensor communicating with the EMS system per the SAE SENT Signal Interface specification. Contact the Application Engineer if additional detailed information is required. Contact the Application Engineer if additional detailed information is required.

3.2.2.4 Ignition System

The ignition system on all Gen V engines is CNP(refer to Section 1.0 – Coil Near Plug). The OEM can also procure various CNP ignition system components thru GSC (section 2.5.2). This section presents basic ignition system interfaces for these 2 systems.

Ignition Coil



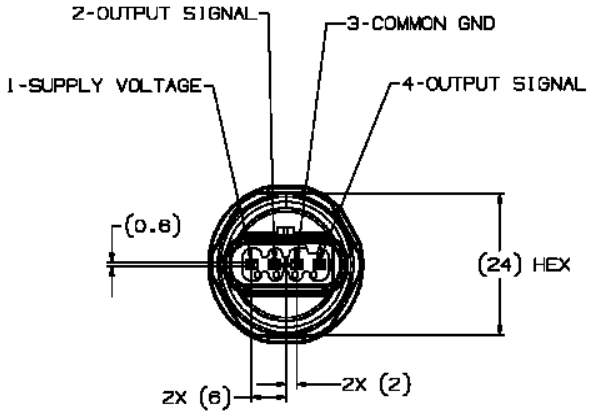
Gen 5 V8 Ignition Coil Pinout

Figure 3.2.2.4-1

3.2.2.5 Fuel Pressure Sensor

Fuel Pressure Sensor

The fuel pressure sensor provides feedback to the ECM to control fuel pressure in the rail using the high pressure fuel pump. The fuel pressure sensor pinouts are shown below.



Gen 5 V8 Fuel Pressure

Figure 3.2.2.4-2

3.2.2.6 Miscellaneous / Sensors Not Part of Engine As Shipped

Although not part of the engine as shipped, the following sensors are available thru GSC as shown in Table 2.5.2-1.

- Heated Oxygen Sensor

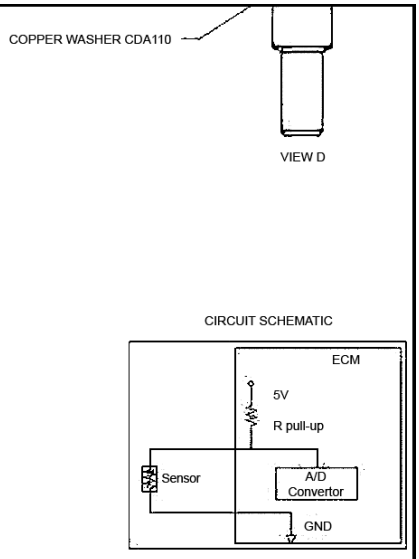
This manual will not provide the details for these sensors – contact the Application Engineer for technical information. GSC can be contacted for pricing.

3.2.2.7 Transfer Functions

Coolant Sensor

UNLOADED RESISTANCE - TEMPERATURE CHARACTERISTIC TABLE

TEMP (°C)	Res (Ω)	Res (±%)	Ref Acc (±°C)	TEMP (°C)	Res (Ω)	Res (±%)	Ref Acc (±°C)
-40	100865	4.87	0.70	60	671	2.19	0.60
-35	73437	4.64	0.70	65	559	2.15	0.60
-30	52594	4.43	0.70	70	469	2.11	0.60
-25	38583	4.21	0.70	75	395	2.07	0.60
-20	28582	4.00	0.70	80	334	2.04	0.60
-15	21371	3.80	0.70	85	283	2.00	0.60
-10	16120	3.60	0.70	90	241.8	2.10	0.60
-5	12261	3.40	0.60	95	207.1	2.21	0.70
0	9399	3.21	0.60	100	178.0	2.31	0.80
5	7263	3.06	0.60	105	153.6	4.42	0.80
10	5658	2.92	0.60	110	133.1	2.52	0.90
15	4441	2.78	0.60	115	115.7	2.61	0.90
20	3511	2.64	0.60	120	100.9	2.68	1.00
25	2795	2.50	0.60	125	88.3	2.75	1.00
30	2240	2.45	0.60	130	77.5	2.80	1.10
35	1806	2.40	0.60	135	68.3	2.84	1.10
40	1465	2.36	0.60	140	60.3	2.87	1.20
45	1195	2.31	0.60	145	53.4	2.89	1.20
50	980	2.27	0.60	150	47.5	2.90	1.20
55	809	2.23	0.60				



25°C 125°C	2795Ω ± 70Ω 88.3Ω ± 2.4Ω
TEMPERATURE (°C)	DRY CIRCUIT RESISTANCE (Ω)

Fuel Pressure Sensor

PRODUCTION SENSORS TO BE Cpk=1.33 CAPABLE TO THE FOLLOWING ACCURACIES:

UNFAULTED P1 ABSOLUTE ACCURACY IN % Vs FOR NEW PARTS/AFTER LIFETIME.LINEAR INTERPOLATE BETWEEN THE MAP POINTS OVER PRESSURE AND TEMPERATURE.

PRESSURE (BAR)	-40 °C	0 °C	100 °C	140 °C
0	±1.2 / 1.6	±0.8 / 1.3	±0.8 / 1.3	±1.2 / 1.6
125	±1.4 / 1.8	±1.1 / 1.6	±1.1 / 1.6	±1.4 / 1.8
250	±2.1 / 2.6	±1.5 / 1.8	±1.5 / 1.8	±2.1 / 2.6

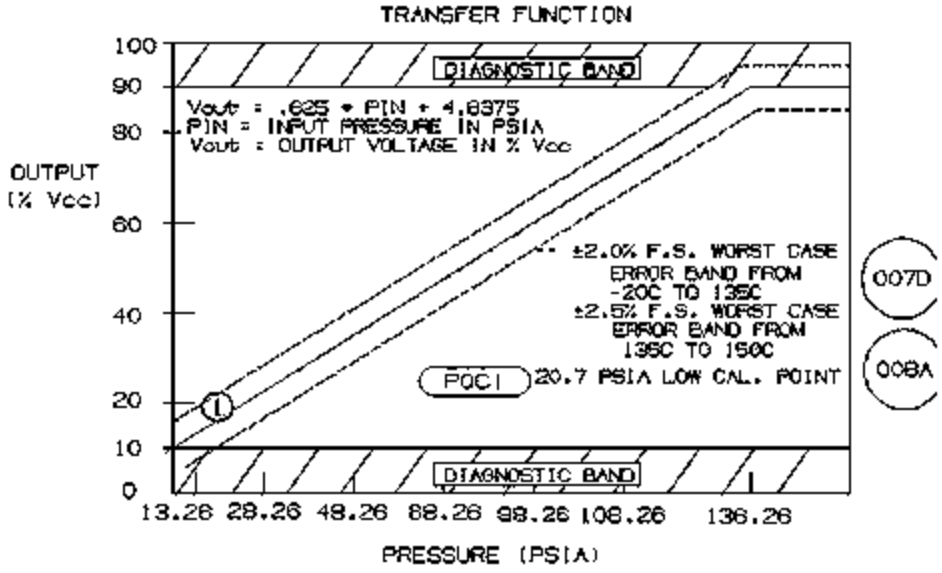
UNFAULTED P2 MATCHING ACCURACY IN % Vs WITH RESPECT TO P1 FOR NEW PARTS/AFTER LIFETIME.LINEAR INTERPOLATE BETWEEN THE MAP POINTS OVER PRESSURE AND TEMPERATURE.

PRESSURE (BAR)	-40 °C	0 °C	100 °C	140 °C
0	±2.4 / 4.6	±1.6 / 4.0	±1.6 / 4.0	±2.4 / 4.6
125	±2.8 / 5.0	±2.2 / 4.6	±2.2 / 4.6	±2.8 / 5.0
250	±4.2 / 6.6	±3.0 / 5.0	±3.0 / 5.0	±4.2 / 6.6

SPECIFICATIONS:

005A	SUPPLY VOLTAGE	:4.75 TO 5.25 VDC (5VDC NOMINAL)
	SUPPLY CURRENT	:15 mA MAX @ 5 Sigma.
	OPERATING TEMPERATURE RANGE	:-40° C TO +140° C
	OPERATING PRESSURE RANGE	:0 TO 250 BAR (GAGE)
	SYSTEM LOAD	:470 KΩ ± 40 KΩ PULL-DOWN
	PROOF PRESSURE	:300 BAR
	BURST PRESSURE	:430 BAR
	NOMINAL 0 BAR OUTPUT	:10% Vpwr
	NOMINAL SENSITIVITY	:16 mV / BAR
	HIGH CLAMP RAIL	:92% ± 2% Vpwr
	SENSOR WEIGHT	:40 g
	MAX. MOUNTING TORQUE	:40 Nm (SOCKET WRENCH)

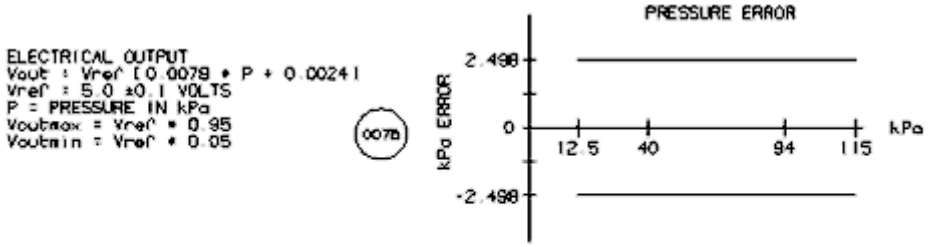
Oil Pressure Sensor



SPECIFICATIONS:

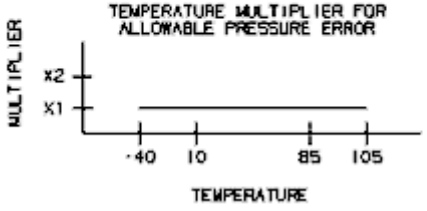
1. POWER SUPPLY VOLTAGE ---------- 4.90/5.10 VDC
2. SUPPLY CURRENT ---------- 12.0 mA MAX.
3. NORMAL OPERATING TEMPERATURE--- -20 TO 150 C
   EXCURSION TEMPERATURE---------- -40 TO 165 C
4. ALLOWABLE OUTPUT LOADS -------- 470 kohm PULL DOWN

MAP Sensor



PRESSURE ERROR IN kPa

INPUT PRESSURE	ALLOWABLE ERROR
12.5	±2.498
40	±2.498
94	±2.498
115	±2.498



TEMPERATURE MULTIPLIER FOR ALLOWABLE PRESSURE ERROR

TEMPERATURE	MULTIPLIER
-40	1
10	1
85	1
105	1

Oil Pressure Control

COIL RESISTANCE: 22.3 OHMS ±1.1 @ 20° C

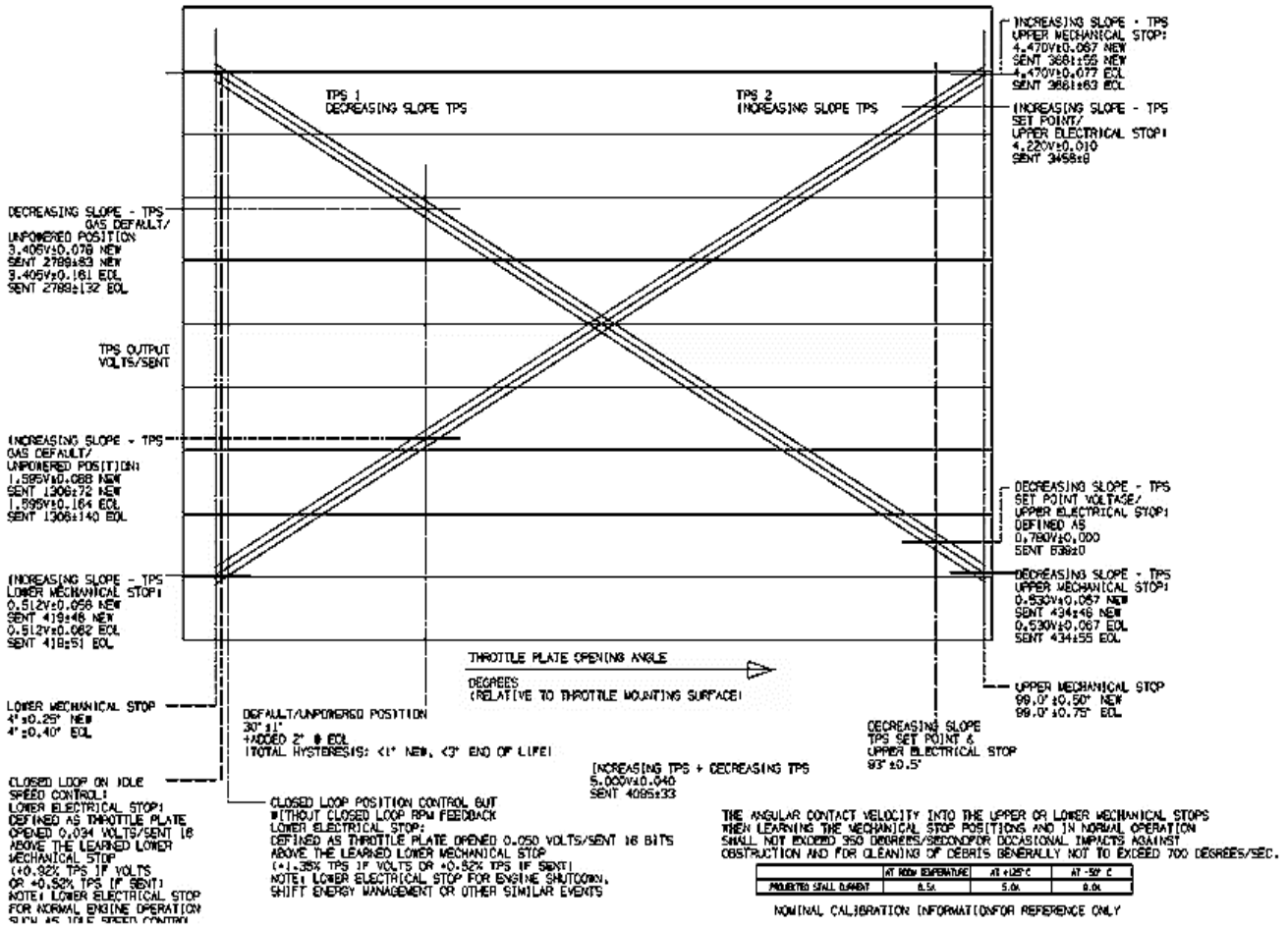
FILTER SCREEN: "P" PORT 150 MICRON

VALVE OPERATING TEMPERATURE: -40° C TO 150° C

MAX PRESSURE: 800Kpa

VOLTAGE RANGE: 10-16 VDC

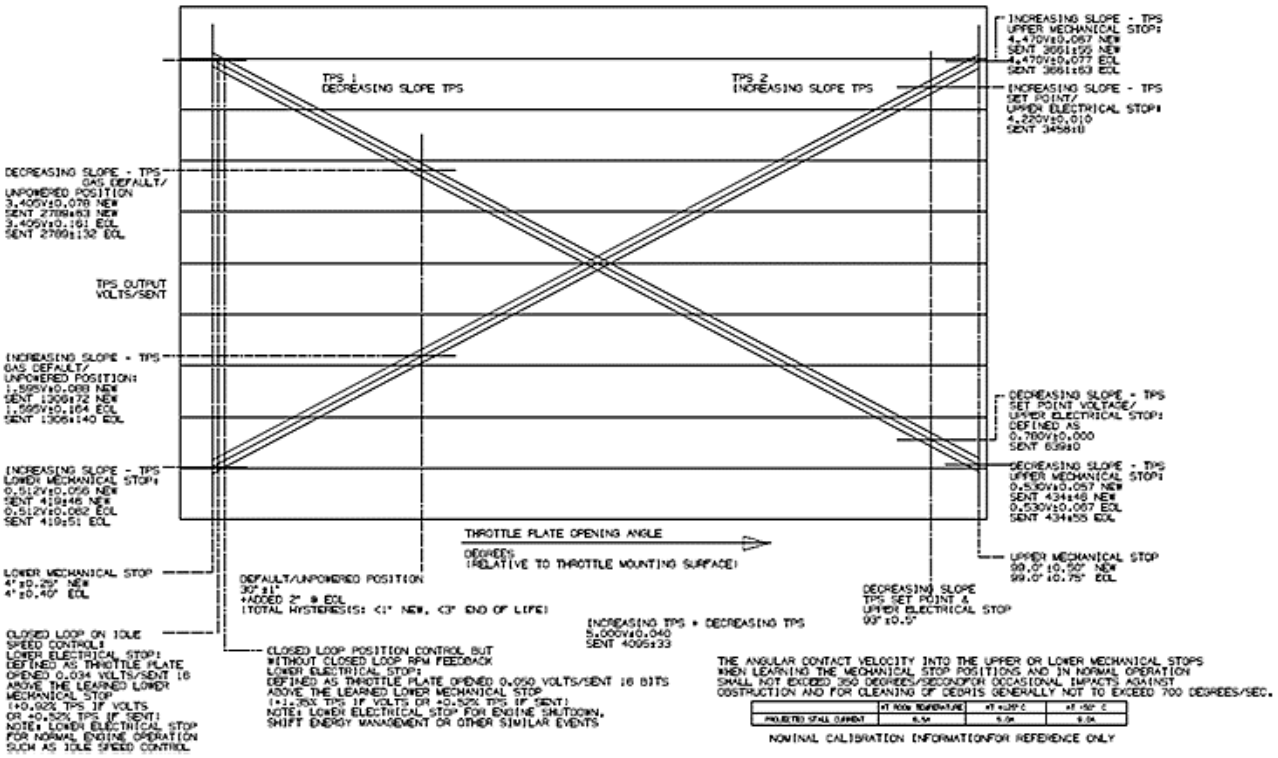
5.3L Throttle Body



5.3L Throttle Body

NO	Throttle Position (%)	Effective Flow Area (%)	Effective Area (m2)	Rate of Change (%)
1	0.00	0.12	0.0000044	---
2	0.80	0.16	0.0000069	5.93
3	1.80	0.22	0.0000102	6.25
4	2.90	0.29	0.0000138	6.39
5	4.10	0.36	0.0000174	5.71
6	5.40	0.44	0.0000218	6.18
7	6.80	0.52	0.0000261	6.12
8	8.30	0.61	0.0000309	6.12
9	10.00	0.71	0.0000363	6.09
10	12.00	0.84	0.0000424	5.87
11	14.00	0.97	0.0000492	6.48
12	16.00	1.12	0.0000566	7.08
13	18.00	1.29	0.0000661	9.09
14	20.00	1.47	0.0000773	10.73
15	22.00	1.69	0.0000900	12.24
16	24.00	1.96	0.0001053	14.64
17	25.90	2.26	0.0001208	15.61
18	27.70	2.61	0.0001373	17.54
19	29.40	3.01	0.0001581	23.41
20	31.00	3.49	0.0001831	29.93
21	32.60	4.10	0.0002128	35.62
22	34.30	4.95	0.0002577	50.63
23	36.00	6.07	0.0003072	55.73
24	37.80	7.46	0.0003673	64.04
25	39.70	9.11	0.0004385	71.73
26	41.70	11.02	0.0005178	75.97
27	44.00	13.40	0.0006172	82.78
28	48.00	18.06	0.0008126	93.62
29	55.00	27.76	0.0012257	113.04
30	65.00	44.31	0.0019919	146.81
31	76.00	66.01	0.0031049	193.83
32	88.00	91.42	0.0045213	226.14
33	100.00	100.00	0.0053617	134.17

6.2L Throttle Body



6.2L Throttle Body

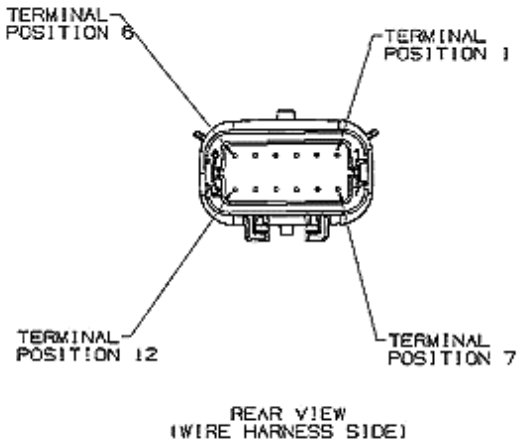
NO	Throttle Position (%)	Effective Flow Area (%)	Effective Area (m2)	Rate of Change (%)
1	0.00	0.08	0.0000046	---
2	0.80	0.14	0.0000080	7.20
3	1.80	0.19	0.0000113	5.60
4	2.90	0.25	0.0000144	4.96
5	4.10	0.32	0.0000187	6.01
6	5.40	0.40	0.0000231	5.87
7	6.80	0.48	0.0000278	5.68
8	8.30	0.56	0.0000327	5.67
9	10.00	0.67	0.0000389	6.27
10	12.00	0.79	0.0000464	6.38
11	14.00	0.93	0.0000544	6.84
12	16.00	1.07	0.0000625	6.96
13	18.00	1.26	0.0000737	9.57
14	20.00	1.47	0.0000861	10.62
15	22.00	1.72	0.0001003	12.24
16	24.00	1.97	0.0001151	12.52
17	25.90	2.24	0.0001307	14.13
18	27.70	2.58	0.0001506	18.95
19	29.40	3.06	0.0001786	28.21
20	31.00	3.63	0.0002116	35.33
21	32.60	4.23	0.0002468	37.71
22	34.30	5.17	0.0003019	55.51
23	36.00	6.24	0.0003643	62.88
24	37.80	7.56	0.0004412	73.23
25	39.70	9.05	0.0005282	78.48
26	41.70	10.82	0.0006317	88.63
27	44.00	13.12	0.0007657	99.89
28	48.00	17.35	0.0010128	105.84
29	55.00	26.13	0.0015248	125.32
30	65.00	42.20	0.0024624	160.68
31	76.00	63.95	0.0037320	197.77
32	88.00	80.81	0.0047160	140.51
33	100.00	102.05	0.0059555	177.00

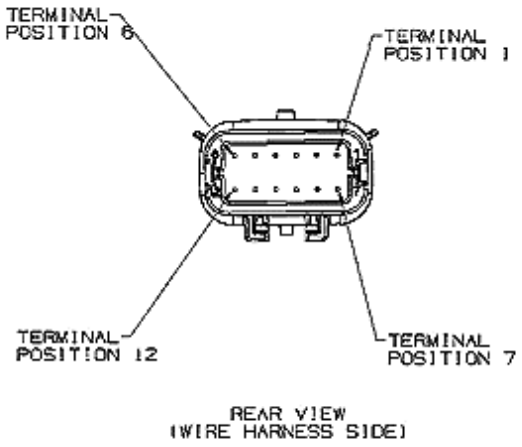
3.2.3 Outputs from ECM to Engine (Actuator Characteristics / Signals)

The engine as shipped is provided with actuators as shown in Table 3.2.1-1 (may differ by engine variant). This section provides basic information for those actuators receiving signal from the ECM.

3.2.3.1 Fuel Injector

The Gen V GM top feed injectors. This injector is a high pressure SIDI injector. Pinouts are shown in Figure 3.2.3.1-1.





Injector Driver 12 Pin Harness Odd Bank
Wires Are Twisted Pairs (Example)-Pins 1&5,2&7,3&8,4&9

1- Injector A High Voltage J3-72 Brown/White **CYL# 1**
2- Injector H High Voltage J3-69 Green/Grey **CYL# 3**
3- Injector F High Voltage J3-71 Green/White **CYL# 5**
4- Injector C High Voltage J3-70 White/Yellow **CYL# 7**
5- Injector A Enable J3-52 Brown **CYL# 1**
6- Fuel Rail Pressure Signal J3-3 Brown/Yellow — Pin 2 On Sensor
7- Injector H Enable J3-49 Green **CYL# 3**
8- Injector F Enable J3-51 White/Green **CYL# 5**
9- Injector C Enable J3-50 Yellow/Grey **CYL# 7**
10- Fuel Rail Pressure 5V REF J2-18 Brown/Red — Pin 1 On Sensor
11- Fuel Rail Pressure Signal J2-19 Blue/White — Pin 4 On Sensor
12- Fuel Rail Pressure 5V RTN J2-3 Black/Green — Pin 3 On Sensor

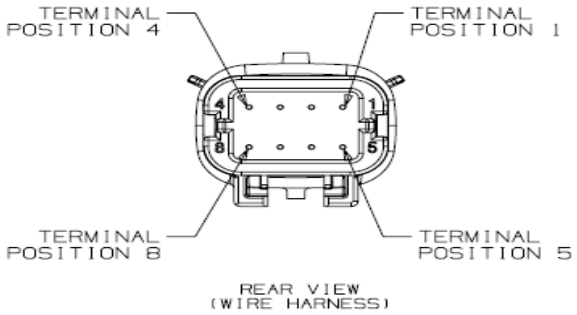
Injector Driver 12 Pin Harness Even Bank
Wires Are Twisted Pairs (Example)-Pins 1&5,2&8,3&9,4&10,11&12

1- Injector D High Voltage J3-66 Blue/Grey **CYL# 2**
2- Injector G High Voltage J3-65 Blue/White **CYL# 4**
3- Injector E High Voltage J3-67 Violet/Grey **CYL# 6**
4- Injector B High Voltage J3-68 Grey/White **CYL# 8**
5- Injector D Enable J3-46 Blue **CYL# 2**
6- N/A
7- N/A
8- Injector G Enable J3-45 Grey/Blue **CYL# 4**
9- Injector E Enable J3-47 Violet/Green **CYL# 6**
10- Injector B Enable J3-48 Grey **CYL# 8**
11- High Pressure Fuel Pump Enable (LSD) J3-32 Violet/Black — Pin 1 On Sensor
12- High Pressure Fuel Pump 12V Supply J3-16 Yellow — Pin 2 On Sensor

3.2.3.2 Camshaft Actuator and Sensor Jumper Harness

All Gen V engines are cam phased. Using engine calibration map and inputs from the cam sensor and oil pressure sensor the cam is controlled.

Connector & Cavity	Circuit Description
1	Cam Supply Voltage
2	Cam Return
3	Cam Signal
4	Oil Control
5	Cam Phaser Control
6	Cam Phaser Return
7	Oil Control Power
8	Blocked Cavity



3.2.4 Starting System

The Gen 5 V8 engine is shipped without a starter. A 1.4 kW starter and attaching bolts are available via GSC (section 2.5.2)

3.2.5 Engine Control Modules (ECM)

An engine control module (ECM) capable of running the required engine functions and meeting emissions/on-board diagnostic requirements is required. The OEM Sales Group can provide a high volume ECM which is fully capable of operating this engine in any application.

Contact the OEM Development Group representative for further information.

3.3 Engine Installation/Operation Angles

It is imperative during application operation that the engine oil pick up tube remain fully immersed in oil, and that the engine drainback design features are able to function properly under all engine operating conditions. Three factors which impact this are:

1) The installation angle (often referenced with respect to the crank centerline) (B)
2) The angle of operation experienced by the application (A)
3) Operation G forces (due to acceleration, deceleration or turning maneuvers)

All 3 of these combine to impact the relative position of the oil pick up tube with the oil surface. Also of concern is the relative relation of the crankshaft counterweights to the oil surface during extreme operating conditions – contact will promote oil aeration which can result in reduced engine power and lubrication capabilities.

GMPT engines are designed and dipsticks are calibrated to reflect appropriate oil levels as long as the engine is installed within 5 degrees of level as shown in Figure 3.3-1.

Side View Front View

Engine Installation Angle

Figure 3.3-1

As the 5 degree limit is exceeded by the OEM, care must be taken to ensure the dipstick calibration impact is considered.

GM Powertrain has validated our engines for various automotive applications applications. It is the OEM's responsibility to validate the final design for the various OEM applications with consideration given to installation/operation angles.

4.0 EMISSIONS AND DIAGNOSTICS

4.1 Exhaust and Evaporative Emissions

Vehicles (vessels, mobile industrial equipment, agricultural tractors, etc.) introduced into commerce in the US, must meet emission (exhaust and evaporative) requirements mandated by either the US EPA or CARB. The "certification" of these engines (and engine families) is the responsibility of the Manufacturer of Record (MOR). The SI engine emission standards depend on a number of factors:

- Point of Sale - California (CARB) vs. Federal (EPA)
- Marine vs. Industrial application
- Model Year introduced into commerce
- For industrial equipment - Stationary vs. Mobile
- Engine power/displacement

The regulatory agencies publish the rules which include the emission rollouts (standards and timelines) as well as other pertinent information (useful life, emission warranty, etc.).

GMPT is not the Manufacturer of Record (MOR) for the final customer application. It is the OEM's responsibility to emission certify the final product, or ensure the next tier customer performs this function.

4.2 On Board Diagnostics

On board diagnostics refers to the ability of the Powertrain Control System to self diagnose emission performance related problems and communicate the existence of such problems to the vehicle (vessel, forklift, tractors, etc.) operator via a warning light or buzzer. On board diagnostics are being mandated at an increasing level for both on-highway and off-highway (marine/industrial/ agricultural/etc.) applications. These diagnostic capabilities are incorporated into the hardware and software of a vehicle's on-board computer to monitor virtually every component that can affect emission performance. Each component is checked by a diagnostic routine to verify that it is functioning properly. Requirements for on-board diagnostics may have slight differences between the EPA and CARB.

GMPT has available a MEFI engine control module (refer to section 3.2.5) which is EPA/CARB compliant in meeting all on-board diagnostic requirements and can be interfaced with various industry wide service tools. For customers using the MEFI controller, GMPT has available a MEFI Diagnostic Manual that provides information on the diagnosis, the service procedures, the adjustments, and the specifications for the engines provided.

5.0 OPERATING ENVIRONMENT / USAGE CONSTRAINTS

The following sections define the outer limits of the envelope of operation that this engine has been validated to for the automotive application. Due to the extreme variation of potential usages by OEMs, the following information should only be used as a guide toward pursuing alternate applications. Operation "outside" of the described envelope should not be attempted without extensive testing and guidance from product engineering. Data monitoring and providing shutdown capability would provide additional assurance that the application's intended envelope is not violated. The following parameters warrant measurement consideration:

- Engine Speed
- Oil Temperature
- Oil Level
- Coolant Temperature
- Coolant Level

5.1 Critical Component Temperature Limits

The following table shows Critical Component Temperature Limits as a reference value for different components.

Component	Operating Temperature Range (°C)	Excursion Temperature (°C)
Coolant Temperature Sensor	-40 to 135	150
Knock Sensor	-40 to 150	150
Spark Plug Wire Conduit	-40 to 180	200
Spark Plug Wire Boots	-40 to 200	250
Fuel Injectors	-40 to 125	150
MAP	-40 to 105	
Fuel Rail	-40 to 125	150
Coil	-40 to 140	155
Crank Sensor	-40 to 150	170
Throttle Body	-50 to 125	150
Oil Pressure Sensor	-20 to 150	0
Oil Pan Gasket	-40 to 150	
Oil Pan Drain Plug Seal	-40 to 150	
Fuel Pressure Sensor	-40 to 140	140
Fuel Pump	Up to 120	120
Knock Sensor	-40 to 150	150

Table 5.1-1: Critical Critical Component Temperature Limits

5.2 Coolant / Oil Operating Temperature Limits

5.2.1 Coolant

When using coolant types and system pressures as outlined in section 3.1.3, this engine has been validated for continuous duty (including continuous operation at WOT) with the coolant temperature under thermostat control (see thermostat start to open and full open temperatures). Limited operation above thermostat full open temperature is allowed as shown in Table 5.2.1-1.

Operation	Max Allowable Temp
Extended Idle (up to 30 minutes) in ambient > 38°C	125°C
Low speed / moderate load operation	120°C
Hi speed / hi load operation	115°C
Soaks following operation	125°C

Table 5.2.1-1: Maximum Allowable Coolant Temperatures

5.2.2 Oil

Oil quality degrades with usage, and the degradation is accelerated with engine operation at low or high oil temps. If engine operation is such that the oil does not warm up (short trip, cold weather operation), then the oil will degrade faster due to higher concentrations of water and fuel in the oil. Under severe low temp conditions, corrosion will take place. Likewise, under high temperature operation (high speed/ load), varnishes will form and oxidation will cause viscosity to increase. Modern automotive engine oil life is maximized when the engine oil operating temperature is around 100^{o}C. The OEM is responsible to ensure the lube system design is capable of maintaining appropriate oil temperatures for the application. GMPT has validated this engine during continuous duty (including continuous operation at WOT) for sustained oil temperatures not to exceed 140^{o}C (oil sump temperature). When oil temps exceed this limit, the OEM is required to utilize oil cooling systems.

5.3 Electromagnetic Environment

Electromagnetic environment noise will not interfere with the engine system performance. On non-GM ECM (MEFI) applications, customers will package final application electrical system to avoid electromagnetic interference with the engine ECM.

5.4 Engine Pre-Conditioning Prior to Normal Operation

Ideally, an engine should have an initial break-in schedule with varying speeds to allow the engine rings to seat. It is recognized that various OEM applications operate only at a single speed. For these engines, GMPT would recommend that for the first 10 hours that these engines not operate at a continuous WOT condition.

5.5 Engine Speed Limits

The OEM needs to establish the application idle speed, typically based on a number of factors (including idle quality, shift quality and off idle performance). Idle speed is often calibrated to be a function of coolant temperature.

The maximum allowable operating speed for this engine is defined to ensure engine durability is achieved. Based on GM validation testing and known field experience, the allowable maximum operating engine speeds on a fully warmed up engine are shown in table 5.5-1.

Coolant Temp	Maximum
High Speed (80-115°)	5600 rpm

Table 5.5-1: Maximum Engine Operating Speeds

At lower coolant temperatures, maximum engine speeds should be limited appropriately until the coolant reaches "normal" operating temperatures.

6.0 MAINTENANCE SCHEDULE / SERVICE INTERVALS

The OEM is responsible to define the engine service intervals for the end product. GMPT can provide insight and support to help in this effort, but due to the diverse application usage for our engines, we can only provide conservative guidelines.

For reference, GM automotive applications typically reference two maintenance schedules relating to usage.

- **Severe Usage (Schedule I)**
  Severe usage or short trip/city conditions are defined by the following operating conditions
  - Most trips are less than 4 miles (6 km)
  - Most trips are less than 10 miles (16 km) and the ambient temperature is below freezing
  - The engine is at low speed most of the time (door to door delivery, stop and go traffic, etc.)
  - The vehicle is operated in dusty areas or off road frequently
  - The vehicle is used to tow a trailer

- **Non Severe or Long Trip/Highway Usage (Schedule II)**
  Long trip/highway shall continue to de fined as all typical vehicle usage not defined to be included in the sever usage schedule.

  Using the above definitions from a vehicle perspective; most marine, industrial and recreational applications are considered to fall into the Severe Usage (Schedule I) category. GMPT OEM engineering recommends more frequent service intervals.

  Provided below for reference only, is a generic service interval guideline for OEM engines.

Component	Part Number	Mileage Interval	OEM Application	Notes
Spark Plug	12622441	100,000 miles	500 hours	Platinum Tip Side Electrode Plug Gap: 1.025 mm AC Delco 12622441 Installation Torque: 22-32 Nm (16-24 lb-ft)
Oil Filter	12637681	Application Specific OLM	Every Oil Change	
Oil	dexos™ 5W-30	Application Specific OLM	100 hrs or annually (Higher change intervals possible depending on fuel type and application usage)	5W30 is acceptable for OEM applications - Refer to 3.1.4.2 for oil specifications

Table 6.0-1: GMPT Recommended Service Intervals

It is noted that the OEM team recommendations are generic and conservative. Longer intervals are often possible and practical, but it is the OEM's responsibility to determine these intervals based on data for their application. The OEM Engineering team can be consulted for methodologies and technical consultation. GMPT Service Manuals can be referenced for further automotive related information.

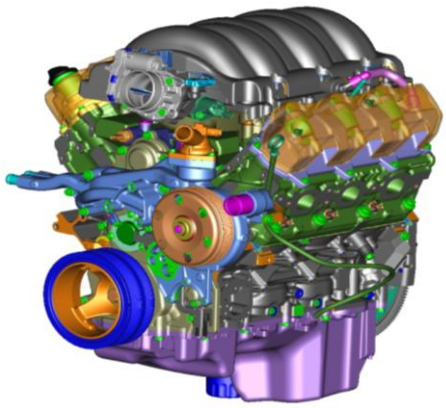
7.0 OTHER AVAILABLE DOCUMENTS / INFORMATION

7.1 Math Models

General Motors Powertrain has complete math data models for select variants of the engines we provide. These math models are to be utilized by the OEM to obtain basic part geometry and dimensions. GMPT utilizes the Unigraphics CAD/CAM software with the recognition that our customers use a variety of other CAD/CAM systems. To provide math models to our customers, the GMPT OEM Engineering group has secured the services of a third party to translate the files from UG to the customer required format. GMPT will provide only 1 format of model per customer. If our OEM customers require a 2nd format for one of their customers, it is the OEM customers' responsibility to provide the translation and model.

The OEM Engineering group has guidelines for the level of support offered to our OEM's – these guidelines include:

- Process to procure math data
- Level of data provided in model / print
- Support for GM owned data vs. Supplier owned data
- Special cases



For a full copy of the guidelines, please contact the GMPT OEM Application Engineer.

7.2 Shipping / Logistics Overview

The 5.3L LV1 engines are built at the GM Engine Plant in TBD. Customers order engines by contacting the Production Planner at the TBD Plant, and providing their requirements for engine builds. The OEM Sales Customer Manager can provide the appropriate name and contact information for the Production Planner.

Engines are shipped in metal racks, 6 engines per rack. A maximum of 78 engines (13 racks) can be placed per truck load. The OEM customer is to pick up the engine racks at the TBD Warehouse in TBD.

8.0 VALIDATION

GMPT conducts extensive testing to validate the automotive variants of any engine produced for the automotive market (passenger car, light or heavy duty truck). In addition, the OEM Engineering group may conduct additional validation tests specific to OEM conditions/parameters (marine and/or industrial). These tests are typically accelerated tests run on a specific fuel (gasoline and/or gaseous) and may include, but are not limited to:

- Hot and Cold Scuff
- Thermal Cycle and Deep Thermal Cycle
- Low Speed Durability
- Global Engine Durability (Automotive, Marine, Industrial forms of test)

These tests provide a basis for GMPT to confirm the basic engine design is capable of meeting GM engine reliability and durability requirements. GMPT does not test or validate for the numerous customer specific applications for many reasons beyond our control including:

- Many OEM's design and install their own unique interface hardware (fuel systems, induction systems, exhaust systems, accessory drive systems, ancillary systems, etc.)
- Many OEM's provide their own engine management systems including final application calibration
- Application specific issues (engine installation angle, fuel quality, cooling system, etc.)

GMPT can and does provide numerous recommendations to ensure the above factors do not become an issue, but the OEM and end customer have ultimate control on most of the above. Based on these issues, it is noted that the **OEM is responsible for validation of the final application.**

Special Notes

GMPT is not responsible for durability issues resulting from engine operation above and beyond the GM recommendations contained in this manual including:

- Maximum engine speed (Section 5.5)
- Engine torque/hp exceeding the GM validated power levels (Section 2.3.2)
- Base engine alterations made by OEMs to enhance performance
- Use of inferior fuel, coolant, motor oil, etc.

9.0 GMPT OEM WARRANTY

GMPT OEM Warranty is provided in two separate and distinct processes. The first is referred to as Factory Warranty or Factory Quality and the second is Field Warranty. The distinction between the two is important to understand and can be comprehended in the following definitions:

Factory Warranty (Factory Quality) - covers any "as shipped" quality issues related to defects in material and workmanship commencing from the time the OEM takes ownership and ends when the product successfully passes through the OEM's value chain. Issues related to Factory Warranty / Factory Quality are coordinated directly with the GM Manufacturing facility through the GMPT Quality System Field Representative.

Field Warranty - GMPT warrants to the OEM only, each new engine, manufactured or supplied by GMPT and sold to the OEM for installation in its **Industrial** application. The warranty period commences on the date the OEM Industrial equipment is delivered to the first retail purchaser or when the Industrial equipment is first placed in service prior to sales at retail. In either case, the warranty period will commence no later than one year after the engine's model year production ends. For a period of 36 months or 3,500 hours, whichever occurs first, GMPT will reimburse or credit the OEM for necessary repairs or replacements of any defective or malfunctioning parts of such engine, with the exception of water pumps.

In summary, Factory Warranty (Factory Quality) coverage applies to engines sold for Marine, Industrial and Recreational purposes. GMPT OEM's Field Warranty only applies to specific **Industrial** applications. Language pertinent to each of these policies appears as Addendums in the annual pricing package that is typically distributed to the OEM customers on April 1st of each year. Circumstances of "mis-applications" of our engines voiding some aspects of Field Warranty are identified in these Addendums. For further information, please contact the appropriate GMPT OEM Sales Customer Manager.

10.0 ACRONYMS, ABBREVIATIONS AND SYMBOLS (AA&S)

This list is common for all of the OEM Application Manuals. Not all of these AA&S are used in this particular manual.

2V	Two Valves (per cylinder)
4V	Four Valves (per cylinder)
A.R.	As Required
A/F	Air Fuel
AE	Application Engineer
AFM	Active Fuel Management
Al or Alum	Aluminum
API	American Petroleum Institute
bbl	Barrel
BOM	Bill of Material
BP	Back Pressure
BSFC	Break Specific Fuel Consumption
Btu	British Thermal Unit
CARB	California Air Resource Board
CCA	Cold Cranking Amps
CI	Cast Iron
CIB	Cam In Block
cid	cubic inch displacement
CKS	Crankshaft Position Sensor
CNP	Coil Near Plug
COG	Center of Gravity
COP	Coil on Plug
CPA	Connector Position Assurance
CPS	Camshaft Position Sensor
CR	Compression Ratio
CW	Clockwise
cyl	cylinder
DIS	Direct Ignition System (Waste Spark)
DOHC	Dual Over Head Cam
E85	Ethanol 85%
EAS	Engine as Shipped
ECM	Electronic Control Module
EFE	Early Fuel Evaporation
EGR	Exhaust Gas Recirculation
EMS	Engine Management System
EPA	Environmental Protection Agency
ETC	Electronic Throttle Control
Family 1	4 cylinder SOHC engine (1.6L L4)
Family 2	4 cylinder SOHC engine (2.4L L4)
Fe	Iron
FFC	Front Face of Case
g's	x times the force of gravity
Gen 1e	Enhanced Version of the Small Block V6 and V8
Gen IV	Small Block Al Head V8 4th Generation
gm	gram
GMPT	General Motors Powertrain
GSC	Global Supply Chain
HD	Heavy Duty
HEI	High Energy Ignition
HVS	High Voltage Switch
Hz	Hertz
IAFM	Integrated Air Fuel Module
ID	Inside Diameter
incl	includes
kg	kilogram
kJ	kilo Joule
kPa	kilo Pascals
kW	Kilowatts
L	Liter
L4	Line 4 - engine type
lbf	pound force
lb-ft	foot-pound
LD	Light Duty
LH	Left Hand
LPG	Liquefied Petroleum Gas
MAP	Manifold Absolute Pressure
MEFI	Marine Electronic Fuel Injection (controller)
min	minute
mm	millimeter
MOR	Manufacturer of Record
MY	Model Year
N	Newton
N/A	Not Applicable (or not part of assembly)
NA	Naturally Aspirated
NG	Natural Gas (CNG = Compressed NG)
NoC	Notice of Change
NPS	National Pipe Straight thread
NPTF	National Pipe Thread Taper Fine
^{o}C	Degrees Celsius
OD	Outside Diameter
OEM	Original Equipment Manufacturer
^{o}F	Degrees Fahrenheit
OHV	Over Head Valve
P/N	Part Number
p/s	power steering
pc	piece
PCV	Positive Crankcase Ventilation
PFI	Port Fuel Injection
PM	Powdered Metal
POA	Part of Assembly
PPS	Pedal Position Sensor
PTO	Power Take Off
QRC	Quick Reference Card
qt	quart
RFC	Rear Face of Case (the back of the block)
RH	Right Hand
RPO	Regular Production Option - a GM Option Code
SAE	Society of Automotive Engineers
SC	Super Charge
sec	second
SENT	Single Edge Nibble Transmission
SI	Spark Ignition
SIDI	Spark Ignited Direct Injection
SOHC	Single Overhead Camshaft
TB	Throttle Body
TDC	Top Dead Center (BTDC and ATDC variants)
TPA	Terminal Position Assurance
TPS	Throttle Position Sensor
TVD	Torsional Vibration Damper
UG	Unigraphics - a type of Design Data
UNC	Unified National Coarse (Thread)
UPC	Uniform Parts Classification - A GM parts classification
V6	Engine configuration - 6 cylinders arranged in a 'V'
V8	Engine configuration - 8 cylinders arranged in a 'V'
V V T	Variable Valve Timing
w/o	without