



ITT

Enidine / Conoflow
105 Commerce Way
Westminster, SC 29693
Tel: (864) 647-9521
Fax: (864) 647-9574

Engineered for life

INSTRUCTION AND MAINTENANCE MANUAL

HPNGV4 Series Compressed Natural Gas Vehicle Regulator

WARNING: These instructions must be read carefully prior to installation and system startup.

INTRODUCTION: The HPNGV4 Series regulator is a self contained, pressure reducing regulator designed and qualified for 3000 and 3600 psig CNG vehicular fuel systems. This regulator is factory calibrated and is not field adjustable. Various configurations of this regulator are available, based on the application needs. Consult the factory for part numbers, bowl kits, or configuration assistance.

SYSTEM REQUIREMENTS: High pressure CNG filtration (1 micron rating) is required to keep particulates in the gas stream from damaging the regulator and downstream components. The filter must be located upstream of the pressure regulator. Clean, burr free fittings and lines must be used to prevent particulate damage to the regulator.

CONNECTIONS: The HPNGV4 Series regulator is connected to the fuel system by inlet and outlet ports. These ports are SAE J1926 o-ring boss connections for 3/8" size tubing at the inlet connection (9/16-18 thread) and 1/2" size tubing at the outlet connection (3/4-16 thread). These connections are labeled "INLET" and "OUTLET". The inlet and outlet lines must be sized for sufficient flow, and the outlet fitting must provide a 3/8" minimum bore for gas flow.

A coolant circulation bowl is provided which permits engine heat to warm the regulator and prevent internal icing of the regulator valve. An optional coolant circulation bowl is available with a thermostat. Both types of coolant bowls are labeled for coolant inlet and outlet, adjacent to the connections. Standard coolant line connections are for 3/8" reinforced rubber hose, which is secured with hose clamps.

WARNING

Conoflow's products are designed and manufactured using materials and workmanship required to meet applicable standards. The use of these products should be confined to services specified and/or recommended in the Conoflow catalogs, instructions, or by Conoflow application engineers.

To avoid personal injury or equipment damage resulting from misuse or misapplication of a product, it is necessary to select the proper materials of construction and pressure-temperature ratings which are consistent with performance requirements.

Optional high pressure sensors are available (factory installed) to measure inlet pressure and provide a proportional DC voltage signal to measure tank pressure.

An integral high pressure solenoid is incorporated into the regulator to close off the flow of gas through the regulator when a voltage power signal is turned off.

Optional pressure bias controls (manifold pressure reference) are available.

A pressure relief device (PRD) is provided. Standard regulator configurations discharge directly to atmosphere, however capture pipes are available for enclosed spaces or heavy duty vehicle applications.

CAUTION: The regulator's PRD is a control and not a system safety device. It may not protect the regulator or fuel system under all possible / potential failure modes. A downstream safety valve or other failsafe strategy must be used to fully protect the fuel system and vehicle. The PRD port must not be blocked by any obstruction.

MOUNTING: Two (2) M8 X 1.25 threaded holes are provided in the regulator to enable sturdy mounting. The regulator may be oriented in any direction; however Conoflow recommends that the gas ports are horizontally oriented to minimize exposure of the gas lines, and prevent collection of oil and moisture in the downstream line. The regulator must be rigidly mounted on the vehicle.

WARNING: Do not mount the regulator by gas or coolant connections only. This regulator must be securely mounted by M8 x 1.25 bolts.

Please refer to the interface drawings for mounting dimensions, connection identification and connection details.

SPECIFICATIONS:

Maximum Operating Inlet Pressure: 3600 psig
(248 bar)

Outlet Pressure: Factory preset – see regulator label

Outlet Pressure Variation in Service: -10 to +18 psi from labeled setting throughout the range of operating inlet pressure, temperature and gas flow. See flow performance graph to see effect of inlet pressure and gas flow changes to the delivery pressure.

Temperature Range: -40° F to 250° F
(-40 °C to 120 °C)

Solenoid: Normally closed,
Pilot operated
12 or 24 VDC systems
2 Amp max draw.
5A line fuse recommended
Amp Superseal 1.5

Sensor: 5000 psi span
5 +/- 0.25 VDC Excitement
Ratiometric DC Output
Packard Metripak 150
(3 conductor)

Connection Torques: Inlet (SAE-6): 27 ft-lb
Outlet (SAE-8): 42 ft-lb
Mounting Bolts: 15 ft-lb

Flow Capacity: Up to 175 lb/hr of CNG (Flow varies by application – consult the factory for data)

PRD Opening: 200 +/- 40 psig (optional)
270 +/- 60 psig (standard)
350 +/- 60 psig (optional)

PRD Type: Reseatable

Approvals: ECE R110

MATERIALS OF CONSTRUCTION:

Body: 6061-T6 Aluminum
Bonnet: 6061-T6 Aluminum
Diaphragm / Seals: Nitrile Rubber class
Valve Trim: Stainless Steel / Polyimide / PEEK

NOTE: This regulator has been tested and certified for safe and reliable service in Natural Gas Vehicles. There are significant potential hazards associated with CNG which the user and / or installer must be aware of when using this product.

CAUTION: Install the regulator in accordance with NFPA 52, CAN/CGA-B149.4 and other codes and standards applicable to the jurisdiction of installation and service.

WARNING: CNG can cause damage and / or injury due to very high pressure, flammability, and extreme cold during expansion. Suitable safeguards must be employed during installation, commissioning and service to prevent harm to personnel and property.

PRINCIPLE OF OPERATION

The HPNGV4 series is a mechanical pressure regulator. The main valve, within the regulator, is coupled to a diaphragm assembly. A spring preload against the diaphragm assembly pushes the main valve open. As gas flows through the regulator, downstream pressure will increase and push the diaphragm assembly against the spring load, closing the main valve. The diaphragm and valve are dynamic, and will seek equilibrium so the inlet pressure is reduced and regulated throughout the useful range of gas flow.

When the solenoid valve is energized, the pilot valve will open when current flows through the solenoid coil. Once pressure builds in the pilot valve, the main orifice of the solenoid valve will open and permit full flow through the regulator.

When the engine is shut off, gas flow through the regulator ceases. The optional solenoid valve closes, and the regulator's main valve is pulled closed by the diaphragm assembly. Downstream pressure will be trapped in the low pressure side of the fuel system.

An engine coolant circulation bowl is fitted over the end of the regulator to provide engine heat to the regulator valve and the gas. This heat prevents ice buildup in the regulator, which could reduce performance and regulator life.

INSTALLATION GUIDELINES

WARNING: Inspect the unit after unpacking. If the unit appears to be damaged do not place in service.

1. Plan the installation for the best combination of accessibility, protection from engine exhaust heat, mechanical vibration or impact, and suitable mounting orientation.
* SEE SYSTEM IMPERATIVES ON PAGES 3 and 4
2. A suitable lubricant (oil, synthetic grease, etc) should be applied to the o-ring of the fitting, prior to installation, to help the o-ring seat and seal.

Do not use silicon grease – silicon may poison the oxygen sensor in some vehicles. Install the fitting in the applicable gas port. If applicable, lubricate the o-ring of your pressure transducer and install it into the SAE-3 port of the regulator to the recommended torque.

3. If the regulator is equipped with an optional PRD capture pipe, connect the system fitting to the capture pipe.
NOTE: If the optional 1/4" NPT PRD Capture Pipe is used, it must be wrench supported during connection.
4. Attach regulator securely to vehicle, using two M8 x 1.25 mounting bolts (not included).
5. Connect the inlet, outlet, and coolant connections. Assure any entrapped air in regulator is fully purged from coolant bowl. As applicable, connect the PRD, sensor and solenoid. See pages 6-8 for connection details
6. Pressurize the system and perform a leak test of gas connections with liquid leak detection solution or soapy water.
7. Energize the solenoid circuit to admit gas through the regulator and verify the outlet gas connection is leak tight.

SYSTEM IMPERATIVES

Imperatives are those conditions, when violated, can cause regulator or system failure and an increased risk of gas release. The following imperatives are listed with potential risks to assist the fuel system integrator with system design failure modes and effects analysis.

1. Upstream Coalescing Filter

This pressure regulator is equipped with a coarse internal filter. A larger, finer grade filter must be installed upstream of the regulator. This filter should be sized for suitable flow capacity. The purpose of this filter is to prevent excessive moisture and compressor oil droplets, or particulate contaminants from entering the regulator. A one (1) micron filter will sufficiently protect the regulator from particulate contamination damage.

2. Sealants

Sealants are not required for the SAE o-ring boss gas connections. The use of sealants as a fitting leakage preventive measure can contaminate the internal passages and valve(s) in the regulator and cause a malfunction. *Sealant use in these connections will void the factory warranty.*

3. Inlet / Outlet Lines

To prevent excessive pressure drop at flow, the inlet and outlet fuel lines should be of suitable size. The regulator has been designed for SAE o-ring boss fittings which correspond to 3/8 inch OD tubing (SAE-6) for the inlet,

and 1/2 inch OD tubing (SAE-8) for the outlet. These are the recommended line sizes. The minimum bore of the fittings must be a minimum of 0.27 inch (6.8 mm) for the SAE-6 inlet fitting and 0.37 inch (9.4 mm) for the SAE-8 outlet fitting. Fittings may be of type SAE J1926/2 or SAE J1926/3.

Tubing must be clean and free of burrs, which could contaminate the regulator or system. The outlet line should not be run upward from the regulator outlet port, due to the potential for excessive oil and condensate collection. A level or downward run is preferred to prevent collection.

4. Downstream Relief Valve

Although the regulator is equipped with a pressure relief device (PRD), a high flow relief valve or other protective strategy must be installed between the regulator outlet and the remainder of the fuel system. The regulator's PRD is not a high flow device and may not protect the regulator or fuel system in case of sudden failure.

5. Engine Coolant

The expansion of high pressure gas to low pressure creates a significant temperature drop. To prevent moisture from freezing inside the regulator and creating a blockage, heated engine coolant must be circulated within the regulator. The regulator is equipped with a coolant bowl for this purpose. Engine coolant must be maintained for at least -40 degree antifreeze protection. If the coolant were to freeze in the regulator, for any reason, the coolant containment integrity may be compromised.

Phosphate based coolants can damage the coolant seals in this product. Glycol based coolants are recommended.

6. Excessive Temperature

The regulator is designed for safe and reliable operation within a temperature range of -40 to 250 °F. Temperatures beyond 275 °F can cause permanent damage to internal seals and reduce the useful life of the pressure regulator. If the regulator is located in an area with the potential for high temperature (such as radiated energy from exhaust system components, etc), suitable heat shields must be employed.

7. Fitting Torque

The correct assembly torque for the inlet (SAE-6) fitting is 27 ft-lb.

The correct assembly torque for the outlet (SAE-8) fitting is 42 ft-lb.

Inadequate torque could allow the fitting to loosen in service and leak. Excessive torque could weaken or shear the threads in the inlet and / or outlet port of the regulator. Use correct tools and exercise caution when installing or connecting fittings to prevent injury.

The inlet and outlet fitting is sealed with an o-ring. Thread sealant is not required, nor recommended.

8. Submergence in water

Except for bonnet bias models, the regulator uses an atmospheric reference hole in the bonnet to sense ambient pressure. This hole is "filled" with a porous hydrophobic plastic plug to prevent water intrusion from splashing, wash down, etc. This plug may not prevent water intrusion if the regulator were to be submerged in water. For this reason, the regulator should not be mounted low in a vehicle which would normally cross flooded roads, etc.

9. Chemicals in Fuel

Any cleaners or abnormal additives, drying agents, etc in the fuel could cause damage to the regulator's internal seals. The regulator is tolerant to substances that occur in compressed natural gas, including most compressor oils, however ITT Conoflow should be contacted regarding other materials.

10. Rapid or Frequent Fuel System Decompression

CNG Fuel systems should not be rapidly or frequently decompressed of gas. Doing so will cause high pressure gas absorbed in non-metallic materials to attempt to escape those materials, decreasing the useful life of the regulator.

As part of your fuel system and vehicle protection review, ITT recommends the incorporation of a system warning label that clearly advises maintenance technicians to 1) NOT DISABLE any automatic upstream isolation valves and to 2) CLOSE upstream isolation valves and bleed system pressure prior to servicing.

WARNING: Bleed system pressure prior to removal and servicing of this pressure regulator.

TROUBLESHOOTING:

1. The regulator does not provide sufficient fuel pressure to the engine's fuel system.

This regulator uses a pilot operated solenoid valve. In the event there is downstream leakage when the vehicle is not operating, the flow from the pilot valve may not be sufficient to fully charge the fuel system when the engine is started and loaded immediately. This phenomenon is amplified at low tank pressure.

A 1 or 2 second dwell between energizing the solenoid and starting the engine will provide sufficient time for the pilot flow to charge the fuel system and

permit the high flow orifice of the solenoid valve to open fully. When the high flow orifice opens, the solenoid will emit an audible "click" noise.

2. The regulator "pops" when I turn on ignition key and activate solenoid valve(s).

This is caused by downstream leakage, or regulator damage caused by particulates. If the downstream pressure bleeds down, the inrush of high pressure CNG can cause the regulator outlet pressure to overshoot the PRD opening pressure and discharge excessive pressure from the line. Correct / repair any downstream leakage to prevent system depressurization when the vehicle is not operating.

3. After driving the vehicle, I see frost on the exterior of the regulator and outlet fuel line.

This is quite common for driving cycles where there is a significant amount of gas flow. Although the regulator is heated with engine coolant, this heat is used to protect the valve, and is not sufficient to heat the fuel completely. As the fuel flows to the engine, it will pick up heat from the fuel line. Some heavy duty applications may require a downstream heat exchanger.

In some installations, air may be trapped beneath the regulator body and must be vacuum purged from the coolant system.

4. When leak testing the system, our gas detector shows leakage from the white plug on the regulator.

A very slight amount of gas permeates from the regulator, and this is normal. A gas detector can show leakage "false alarms", as this instrument is very sensitive. Conoflow recommends using commercially available leak detection solution, or soapy water, to leak test the system.

5. Loud noises are coming from the regulator.

Noisy operation can be caused by a number of system interaction issues. If incorrect fittings or line sizes are used (small bore fittings, tubing too small), the regulator may be starved for pressure and overshoot the steady equilibrium it is trying to achieve. This will cause internal oscillation which can create noises ranging from a buzzing sound to a rapid internal knocking sound.

In rare instances, the regulator's resonant frequency (typically around 380 Hz) will match the fuel system's resonant frequency. Changing the length of the outlet line will usually solve this issue.

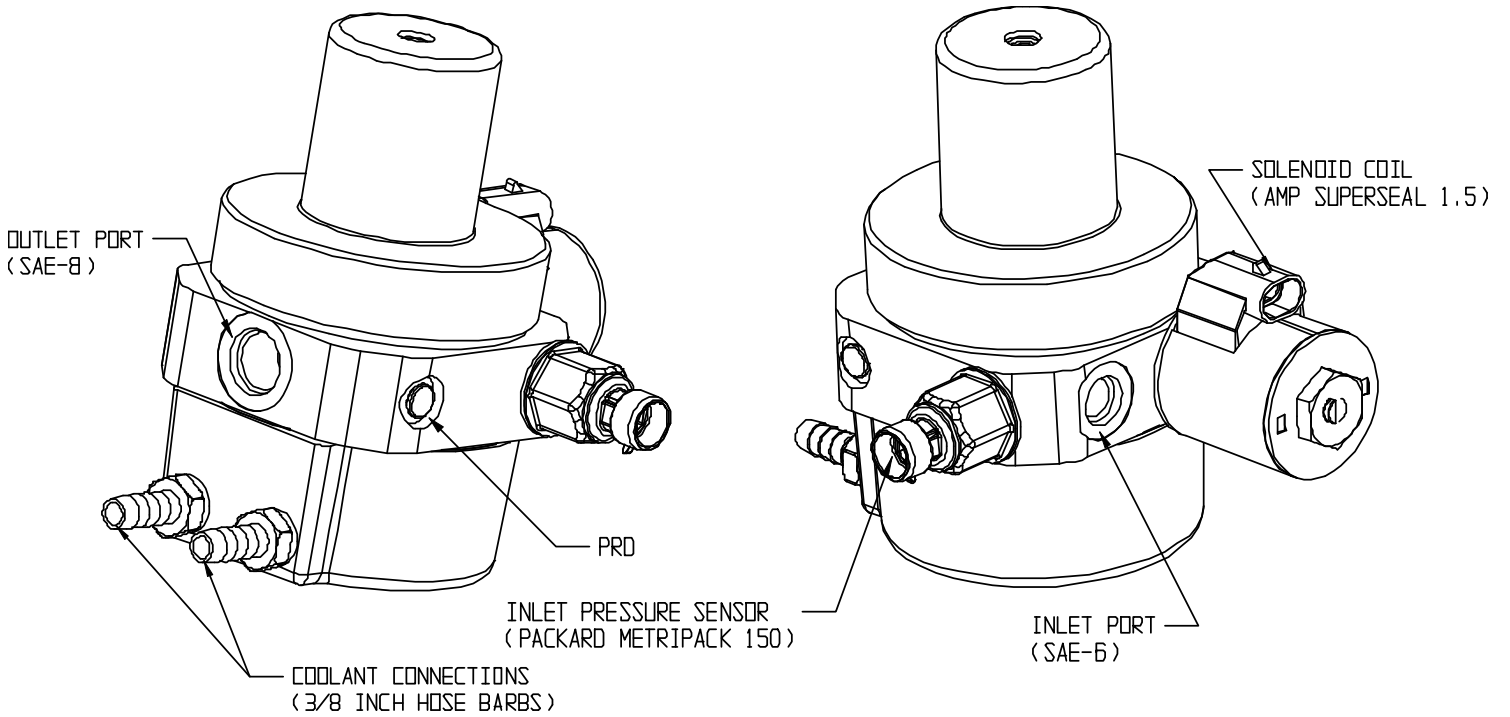
Regulator Model Breakdown (CED Code)

<u>Text Position</u>	<u>Option Code</u>	<u>Definition of Character</u>
1 through 6	HPNGV4	Regulator Model / Product Designation
7	Bonnet Option Codes	
S		Standard Bonnet
C		3/16" Straight Hose Barb Connection on Bonnet
E		1/4" Tube Elbow (for Poly Tubing) Connection on Bonnet
8-9	Sensor and Solenoid Option Codes	
03		12 solenoid / SAE-3 Sensor Port (no sensor installed – Port not plugged)
06		24 volt solenoid / SAE-3 Sensor Port (no sensor installed – Port not plugged)
04		12 volt solenoid / SAE-4 Sensor Port (no sensor installed – Port not plugged)
08		24 volt solenoid / SAE-4 Sensor Port (no sensor installed – Port not plugged)
12		Solenoid only – Normally Closed, 12 Volt DC Operation (sensor port plugged)
24		Solenoid only – Normally Closed, 24 Volt DC Operation (sensor port plugged)
X2		Sensor and Solenoid, 0.25 – 4.75 Volt / 12 Volt DC
X3		Sensor and Solenoid, 0.50 – 4.50 Volt / 12 Volt DC
X4		Sensor and Solenoid, 0.25 – 4.75 Volt / 24 Volt DC
X5		Sensor and Solenoid, 0.50 – 4.50 Volt / 24 Volt DC
10	Coolant Bowl Option Codes	
T		Thermostat Equipped Coolant Bowl
H		No Thermostat in Coolant Bowl
11	PRD Pressure Codes	
A		200 psi (+/- 40) PRD Setting
B		270 psi (+/- 60) PRD Setting
C		350 psi (+/- 60) PRD Setting
12	PRD Connection Codes	
X		PRD Discharges to atmosphere
P		1/4" Male NPT PRD Capture Pipe
T		1/2" Tube Stub PRD Capture Pipe
13 through 15	Output Pressure Setting Code	
XXX		Output Pressure Setting (PSI)

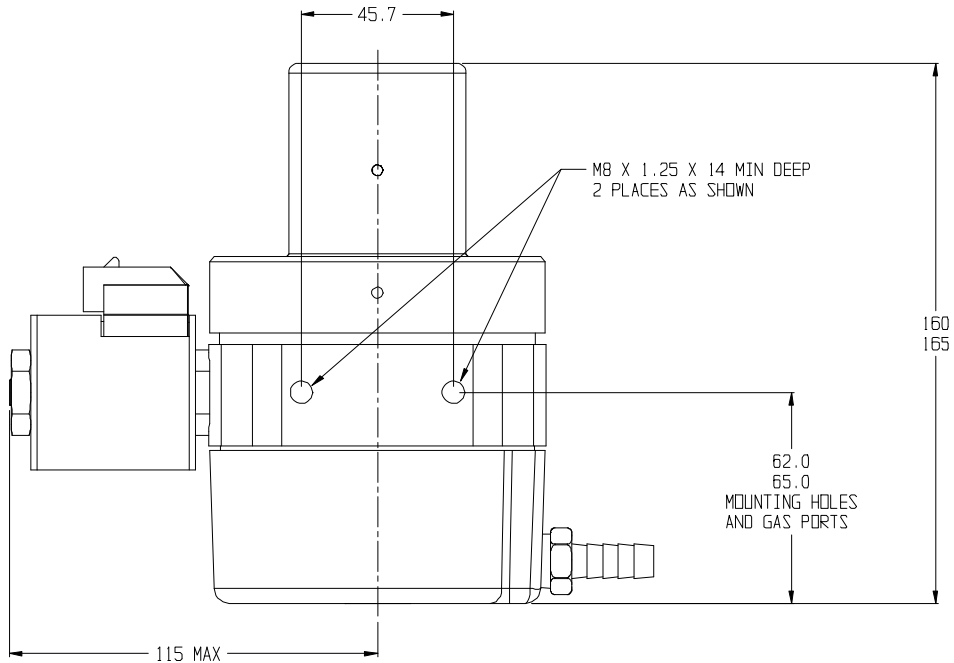
CAUTION: Regulator is factory preset. Changing the pressure setting can cause unexpected and/or potentially hazardous operation.

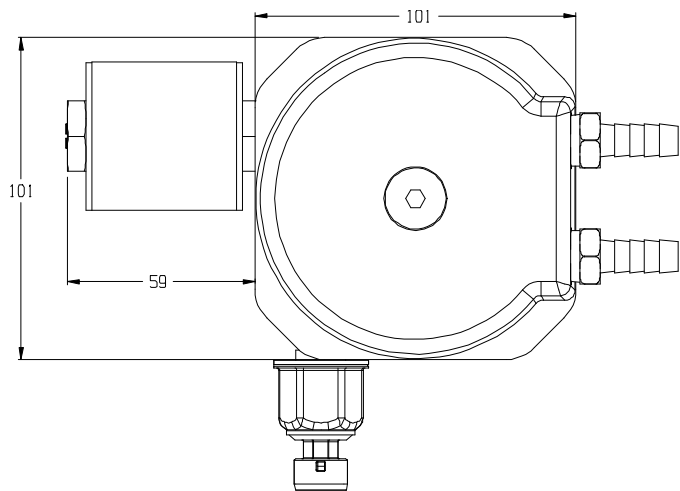
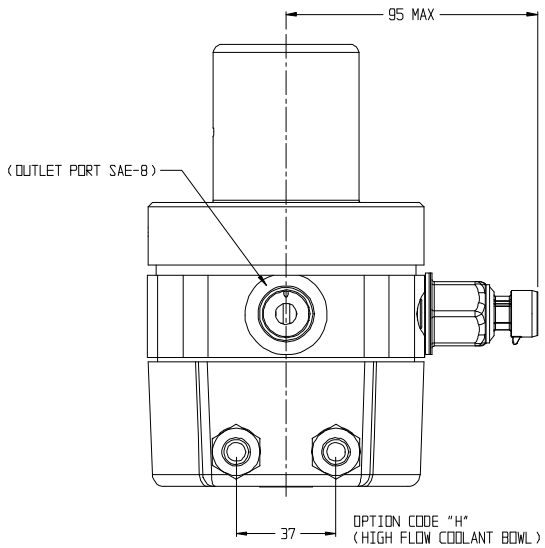
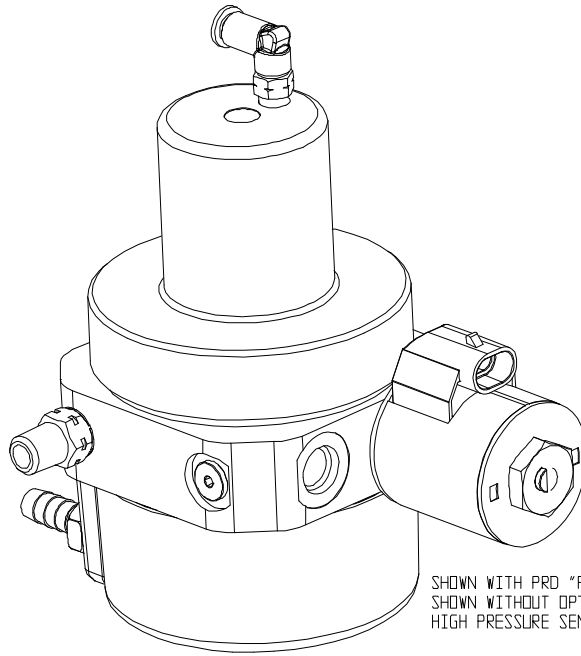
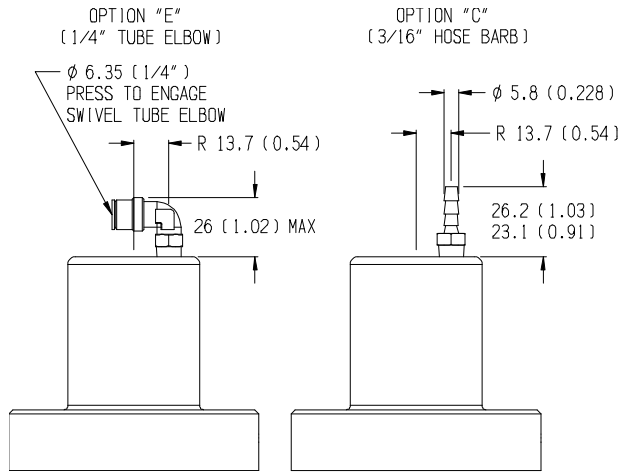
CAUTION: Stored spring compression within the regulator can be unexpectedly released if the regulator is disassembled incorrectly.

CONNECTION IDENTIFICATION AND TYPICAL GEOMETRY
HPNGV5SX_H_X CONFIGURATION SHOWN – DIMENSIONS IN MILLIMETER (INCH)



Interface Views – Options





**BODY PROFILE DIMENSIONS / BOTTOM
VIEW OF "H" COOLANT BOWL OPTION**

ELECTRICAL INTERFACE DATA

OEM solenoid lock-off valve electrical mating connector part numbers:

Housing: Amp / Tyco Electronics 282080-X (X designates color)

Contacts: Amp / Tyco Electronics 282110 female connector

Seal: Amp / Tyco Electronics 281934-2

Suggested wire gauge: 18 gauge

WARNING: Circuit protection with a 5A maximum current is required for solenoid valve wiring.

OEM pressure sensor electrical mating connector part numbers:

Housing: Delphi 12065287 (with included weather seal)

Contacts: Delphi 12110236

Suggested wire gauge: 18 gauge

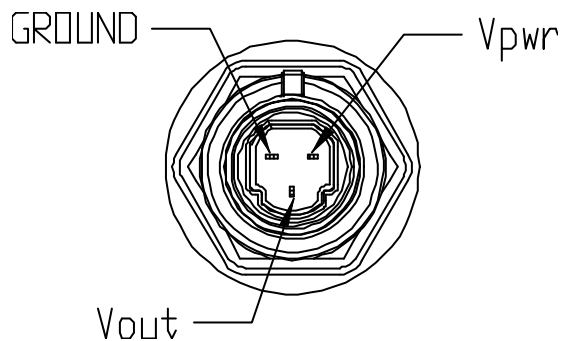
WARNING: Circuit protection with a 1A maximum current is required for sensor power lead wiring.

The components above may be substituted for functional equivalents. Other contacts and seals are available for alternative wire sizes. Consult OEM connector supplier data.

When selecting alternatives, the following guidelines must be considered:

- Mating terminals must be tin-plated. Gold-plated connectors may cause galvanic corrosion of the connection interface and ultimately prevent the solenoid valve and/or pressure sensor from operating.
- Weather seals must be used between the connector bodies, and at the cable ports.

Sensor polarity / pin connection diagram:



$V_{pwr} = 5.0 \pm 0.25 \text{ VDC}$

$V_{out} = \text{Ratiometric output (product dependent)}$

Ground = Common ground

There are no polarity requirements for the solenoid valve electrical connection.