2021 Thomas Built Saf-T-Liner C2
(Equipped with the Detroit Diesel DD5 engine)

Ventech

Rapid Supplemental Heater System / Liquid Heat Generator (LHG)

INSTALLATION MANUAL
Ventech Kit # 0078

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PLEASE READ

IMPORTANT INFORMATION BEFORE STARTING THE SYSTEM FOR THE FIRST TIME

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1 Foreword

The installation and service of Ventech products requires special expertise and training. Installations and servicing of Ventech products by untrained, unauthorized personnel and end-users voids all warranties and releases Ventech and Ventech authorized distributors, dealers, and their personnel from responsibility for damage to Ventech products, any resulting collateral property damage and personal injury.

Any use, operation, installation, modification, or application of the product not described in Ventech manuals or subjecting the product to extreme or unusual conditions beyond the limits of specified performance characteristics is misuse of the product.

Failure to comply with all installation instructions is a misuse of Ventech products. The same applies for all repairs without using genuine Ventech service parts. This will void the products warranty coverage.

1.1 Scope and Purpose

These installation instructions are intended to supportVentech trained and authorized distributors and dealers in the installation of the Liquid Heat Generator (LHG). These instructions are not intended for use by untrained or unauthorized personnel.

Location of Liquid Heat Generator (LHG), installation of coolant lines, wiring and control devices are important for proper operation. Failure to comply with the installation instructions provided may result in poor operation or damage to LHG and vehicle components.

1.2 Important Information – READ FIRST

1.2.1 About This Manual

This document is an Installation Manual for Ventech's Rapid Supplemental Heater (LHG700), Kit #0078 for the Thomas Saf-T-Liner C2, equipped with the Detroit Diesel DD5 engine.

1.2.2 Confirm you have the correct Installation Kit

Make sure that you have the correct LHG Installation Kit for your school bus (See Cover of Manual). Different vehicles use the same LHG700 and the same ECU/Harness system. However, each vehicle platform requires a unique kit.

The Kit-specific information includes:

- Kit Parts List and Quantities
- Installation Arrangement Drawing
- Coolant hose arrangement and configuration.

Before you begin the installation, check the Kit Parts List against the content of the Installation Kit box.

1.2.3 Best Practices

It is very important that the LHG be installed correctly no only to obtain maximum results, but also to minimize the possibility of unit failure. The following tips address some of the more common installation mistakes that have resulted in unit issues.

1.2.3.1 Fastener Torque

Torque all fasteners according to the table. Excessive fastener torque may cause damage to the bolts and/or threaded components. Too little torque may cause fasteners to loosen.

	Bolt Class			
Bolt Size	**8.8 ft-lbs**	**10.9 ft-lbs**	**8.8 (Nm)**	**10.9 (Nm)**
8	16	22.9	21.8	31.1
10	31.6	45.2	43.0	61.5
12	55.1	78.2	74.9	107.3

Figure 1 - Bolt Class

1.2.3.2 Use Threadlock – (LocTite)

When there are no Loc-Nuts used in a particular fastener application, LocTite 243 is to be applied to the bolt thread to secure the assembly.

1.2.3.3 Electrical Harness Installation

In most applications, the LHG's electrical system switch should be tied into an engine-run or ignition signal (in addition to power). Properly installed, the Ventech Supplemental Heater System will not drain the vehicle battery when the vehicle is not operating. Follow the electrical installation instructions for the exact connection points to the vehicle electrical system.

1.2.3.4 Belt Alignment

Belt alignment is critical to maintain the integrity of the LHG and its kit, but also to protect the belt from damage.

Ventech recommends that a laser alignment tool (we recommend Gates Part 91006) to verify that the belt 'squares up' across the entire belt path.

1.3 Primary Purpose of the Ventech LHG

The heart of the Ventech Rapid Supplemental Heater System is the proprietary Liquid Heat Generator (LHG).

The LHG is both an Idle Reduction Technology and rapid/high performance coolant heater. By providing fast engine and cabin warmup, excessive idling can be significantly reduced, saving fuel, reducing tailpipe emissions, and reducing wear & tear on the vehicle.

The LHG generates coolant heat by the rotation of an internal 'rotor' opposing a stationary 'stator' within the LHG Heater assembly. Fluid friction is caused by a process known as toroidal vortexing. The process is highly efficient (up to 98%) and also occurs instantaneously.

The digital ECU provided with the Ventech system determines when to activate the LHG, based on Coolant Temperature, Vehicle Voltage, Engine and LHG RPM, Ambient Air temperature, and other parameters monitored by the ECU.

The system is fully automatic. An optional dashboard switch is available (for Driver enable/disable) but is not necessary for a standard installation.

The LHG is a belt-driven vehicle accessory. Herein, the vehicle's belt drive arrangement may be referred to as the FEAD - Front Engine Accessory Drive.

LHG700 Performance Table	
Description	**Value**
Heat Output	17,000 Btu/hr. (5kW) to 45,000 BTU/ hr. (13kW)
Dimensions	5.24" (133mm) L x 7.09" (180mm) W x 7.36" (187mm) H
Weight	10.75 lbs. (4.89 Kg)
Mounting Location	Accessory drive belt area
Drive Belt	8-groove poly-vee serpentine (LHG equipped with an 8-groove poly-vee drive pulley)
Crank (Rotation)to Heating Efficiency	~ 98%
Voltage	12/24 Volts
Current	<4 Amperes
System Plumbing	In-series (Heavy-duty applications)
Installation Time	2-Hours
Warranty	1-Year Parts Only

***Figure 2* - LHG700 Performance Table**

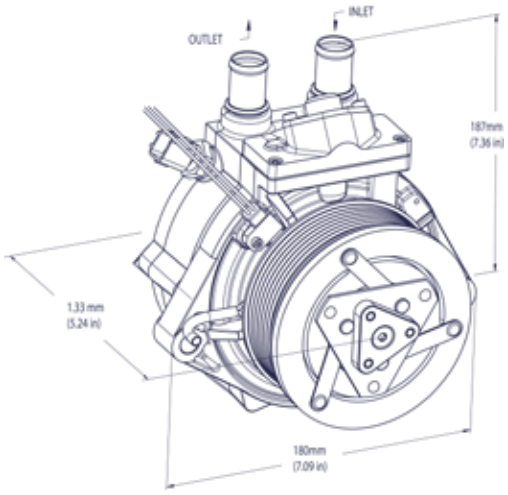


Figure 3 - LHG Dimensions

1.4 Illustration of Kit #0078 Installed on the Detroit Diesel DD5 Engine

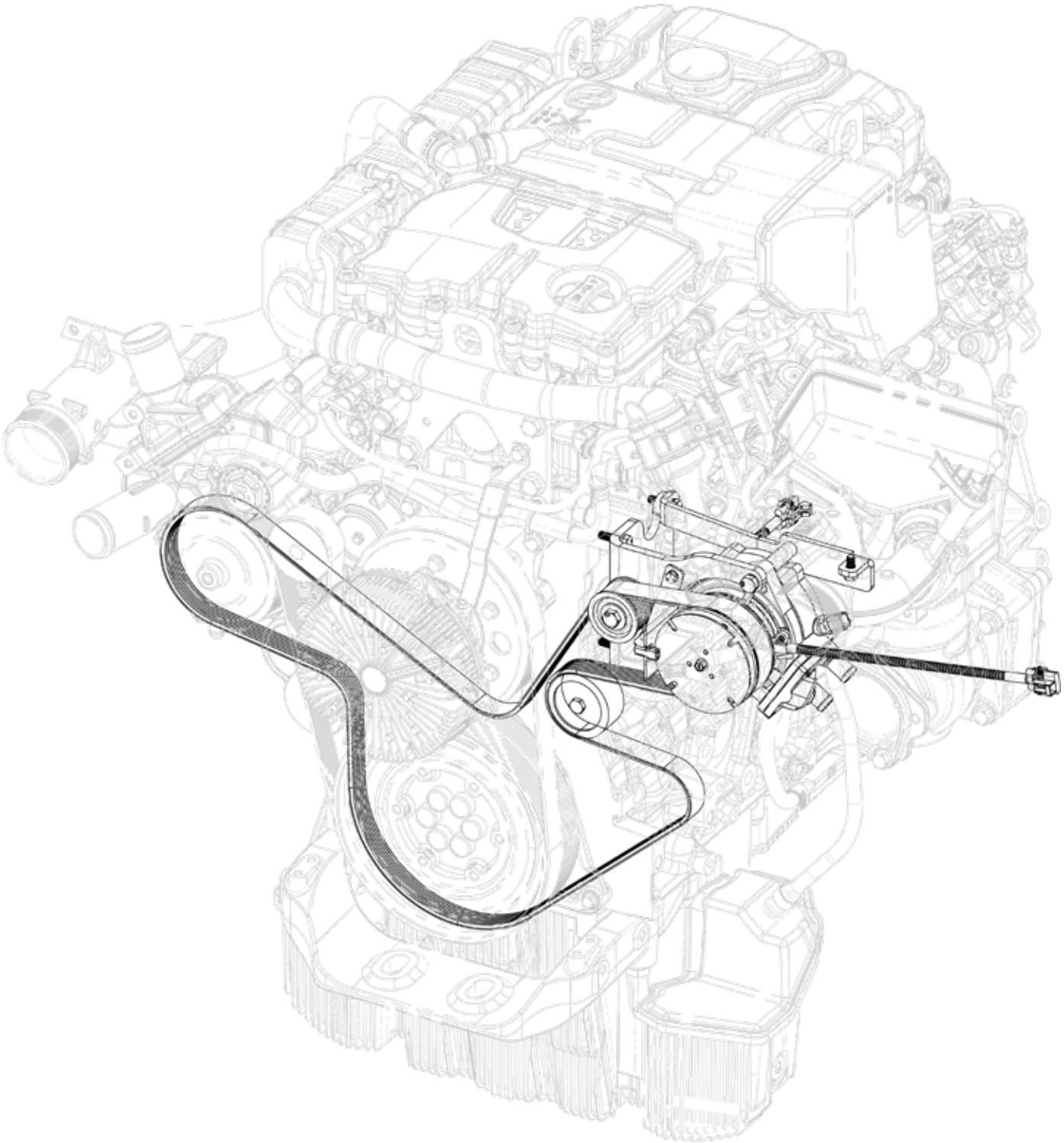


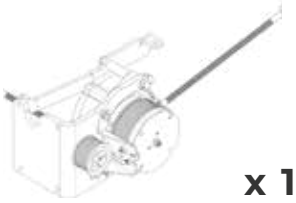
Figure 4 - Illustration of Kit #0078 Installed on the Detroit Diesel DD5

2 Installation

2.1 Preparation

2.1.1 What's in the Box – Kit #0078 Parts List

Installation kit 0078 includes the following assemblies and components. Use the table below to check the contents before beginning the installation. Contact Ventech for missing parts.



x 1

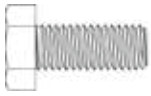
ITEM #1 160-0001-A0
LHG700 KIT SUBASSEMBLY

x 1

ITEM #2 135-0038-A0
DELUXE ECU

x 1

ITEM #3 135-0045-A0
ECU HARNESS



x 1

ITEM #4 920-0009-A0
M8-1.25 x 20MM HHCS

x 4

ITEM #5 920-0029-A0
M8-1.25 x 30MM HHCS

x 5

ITEM #6 925-0012-A0
M8 SPLIT LOCK WASHER

x 4

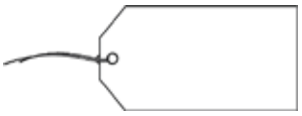
ITEM #7 920-0014-A0
#8 X 3/4" HEX HEAD
SELF-DRILLING SCREW

x 1

ITEM #8 990-0197-A0
COOLANT FLOW
RESTRICTOR

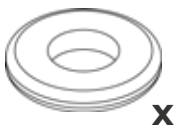
x 1

ITEM #9 981-0017-A0
IDLER PULLEY



x 1

ITEM #10 995-0113-A0
TAG, REMINDER,
STEERING SHAFT



x 1

ITEM #11 990-0200-A0
1-1/8" GROMMET

Kit #0078 Contents - 2021 Thomas Built Saf-T-Liner w/ Detroit Diesel DD5 engine				
Item No.	**Part No.**	**Rev.**	**Part**	**QTY**
Core Components				
1	160-0001	A0	KIT 0078 THOMAS BUILT BUS - DD5 - LHG700 KIT SUBASSEMBLY	1
2	135-0038	A0	DELUXE ECU	1
3	130-0045	A0	DELUXE ECU HARNESS ASS'Y, DUAL RPM SENSOR	1
Fasteners				
4	920-0009	A0	M8-1.25 x 20 HEX HD BOLT - 8.8 - ZINC PLATED	1
5	920-0029	A0	M8-1.25 X 30 HEX HD. BOLT - 8.8 - ZINC PLATED	4
6	925-0012	A0	M8 LOCK WASHER	5
7	920-0014	A0	#8 X 3/4" HEX HEAD SELF DRILLING SCREW	4
Misc Hardware				
8	990-0197	A0	COOLANT FLOW RESTRICTOR (TBB #66000366) [DTNA SUPPLIED]	1
9	981-0017	A0	IDLER PULLEY (DTNA #A 936 200 31 70) [DTNA SUPPLIED]	1
10	995-0113	A0	TAG, REMINDER, STEERING SHAFT	1
11	990-0200	A0	GROMMET, BUNA-N. FOR 1-1/8" HOLE DIAMETER, 1/4" THK, 3/4" ID	1
12	990-0012	A)	LOCTITE 0.5ML, BLUE	1
13	980-0077	A0	BELT, SERPENTINE, FLEETRUNNER K080944HD [DTNA SUPPLIED]	1

Figure 5 - Kit #0078 Contents - 2021 Thomas Built Saf-T-Liner w/ Detroit Diesel DD5 engine

x 1

ITEM #12 990-00012-A0
LOCTITE 0.5ML, BLUE

x 1

995-0077-A0
SERPENTINE BELT

2.1.2 What You Will Need

You will need to supply the following parts and tools for installation.

PARTS TO BE SUPPLIED BY INSTALLER				
Item No.	Part No.	Rev.	Core Components	QTY
--	995-0046	A0	HOSE COIL, 3/4", UNICOIL 48525	2
--	990-0068	A0	HOSE, HEATER, 3/4"	75"
--	990-0068	A0	HOSE, HEATER, 3/4"	92"
--	990-0133	A0	SAE #16 WORM-DRIVE HOSE CLAMPS	4
--	990-199	A0	3/4" CORRUGATED TUBING (SPLIT) - 5'	1

Figure 6 - Parts Supplied by Installer

x 2

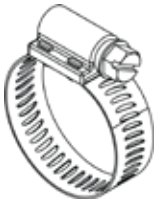
995-0048-A0
3/4" HOSE COIL

75"

990-0068-A0
3/4" HEATER HOSE

92"

990-0068-A0
3/4" HEATER HOSE



x 4

990-0133-A0
#16 HOSE CLAMPS

x 1

990-0199-A0
3/4" CORRUGATED TUBING
- 5'

REQUIRED TOOLS LIST
1/4" DRIVE RATCHET
1/4" DRIVE EXTENSION 3" LONG
1/4" DRIVE 5/16" SHORT WELL SOCKET
1/4" DRIVE 13MM SHORT WELL SOCKET
3/8" DRIVE RATCHET LONG
3/8" DRIVE EXTENSION 6" LONG
3/8" DRIVE EXTENSION 9" LONG
3/8" DRIVE, 13MM SHORT WELL SOCKET
3/8" DRIVE 13MM DEEP WELL SOCKET
3/8" DRIVE 18MM SHORT WELL SOCKET
1/2" DRIVE EXTENSION 3" LONG
1/2" DRIVE BREAKER BAR
1/2" DRIVE 15MM SHORT WELL SOCKET
1/2" DRIVE 17MM SHORT WELL SOCKET
13MM OPEN/BOX END WRENCH
17MM OPEN/BOX END WRENCH
#2 SQUARE TIP BIT
#2 PHILLIPS TIP BIT
1-1/8" HOLE SAW FOR STEEL
SIDE CUTTERS - TO TRIM ZIP TIES
UTILITY KNIFE - TO TRIM CORRUGATED TUBING
LARGE ADJUSTABLE WRENCH
1/4" DRIVE ELECTRIC IMPACT
1/2" DRILL ELECTRIC
1/2" DRIVE ELECTRIC IMPACT
1/4" AND 3/8" DRIVE ADAPTORS FOR THE 1/4" DRIVE ELECTRIC IMPACT
HEATER HOSE CLAMP OFF PLIARS
PRYBAR

Figure 7 - Required Tools

2.2 Installation At-A-Glance

Once you have inspected and checked the kit contents, the in-vehicle installation should be followed in the following order (each step is detailed later in this Manual):

2.2.1 Prepare the Vehicle

- Position the vehicle in a well-lit shop location to perform the installation.
- Once parked, but before turning off the engine, turn the steering to full-left lock, enabling access behind the front-left wheel well.
- Disconnect Batteries.
- Close Summer Valves (if installed).
- Drain engine coolant.
- Disconnect Power Steering shaft from steering gearbox and attach the **RED** Reminder Tag to steering gearbox spindle (provided in the kit).

2.2.2 LHG Hardware Installation

- Remove Primary Serpentine Belt from engine (fan belt).
- Remove secondary Serpentine Belt from Engine (accessory belt).
- Remove intake manifold support bracket from driver's side of engine.
- Install Idler Pulley (included in Kit) to front face of the engine block.
- Install LHG / bracket subassembly onto right side of engine block.
- Reinstall Power Steering shaft from steering gearbox. Remove the red Reminder Tag.
- Reinstall secondary Serpentine Belt from Engine (accessory belt).
- Reinstall Primary Serpentine Belt from engine (fan belt).

2.2.3 Coolant Hose Plumbing Installation

- Identify the two fittings on the LHG Heater.

  a. The lower fitting is the coolant supply (Cold IN) port “A”.

  b. The top fitting is the coolant return (Hot Out) port “B”.
- Remove the coolant hose that connects from the top of the engine to the rear heater core circuit.
- Using the hoses supplied, connect one hose between the bottom fitting “A” of the LHG Heater and the top engine fitting.
- Using the hoses supplied, connect one hose between the top fitting “B” of the LHG Heater and the top engine fitting and the previously disconnected rear heater core circuit fitting.
- Install the Nylon Flow Restrictor, included in the kit, into the 1” hose feeding the rear heater loop.

2.2.4 Harness and Controller Installation

- Drill an electrical access hole in the firewall and install grommet.
- Mount the LHG Digital Controller (ECU) on the LH fender using the screws provided in the kit.
- Install the Harness by inserting main connector into the ECU, feeding the power/ignition pigtail thru firewall to driver left-side access panel, and routing the remaining pigtails to the LHG heater assembly and front fender.
- Terminate all connectors at the LHG Heater.
- Mount the Outside Air Temperature Sensor (OATS) probe behind the left side of bumper.
- Connect the Power and Ignition wiring inside the junction box (driver left-side access panel).

2.2.5 Final Checks Before First Start Up

- Refill Coolant.
- Open all Summer Valves.
- Reconnect Vehicle Battery.
- **IMPORTANT - Reinspect the reinstallation of the Power Steering shaft.**

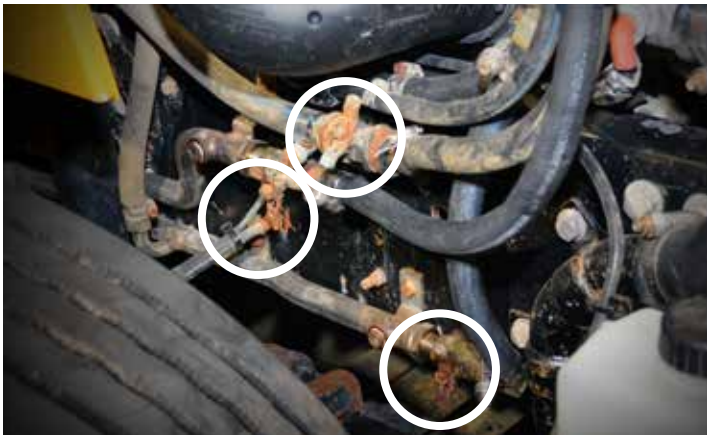
2.3 Step-by-Step Detailed Installation Instructions

2.3.1 Prepare the Vehicle

1. Position the vehicle in a well-lit shop location to perform the installation.

2. Disconnect the three Batteries by removing the negative(-) cables from the batteries with large adjustable wrench.

3. Close the 3 Summer Valves (if equipped) on the passenger side of the engine by turning them clockwise until the levers are perpendicular to the valve.



4. Release Radiator Pressure (if hot) by slowly unscrewing and removing the coolant degasser tank cap.

5. Drain Coolant System by opening petcock at the bottom of the radiator with an adjustable wrench. Make sure you have at least a 5-gallon container below to catch all coolant.

6. Disconnect the Power Steering Input Shaft from steering gearbox by removing bolt and nut with 17mm socket, 3" extension, and ½" impact driver. Use a 17mm open/box wrench to hold nut in position on the backside.

7. Pry steering shaft back from steering box with prybar. Be careful not to damage the steering box shaft oil seal.

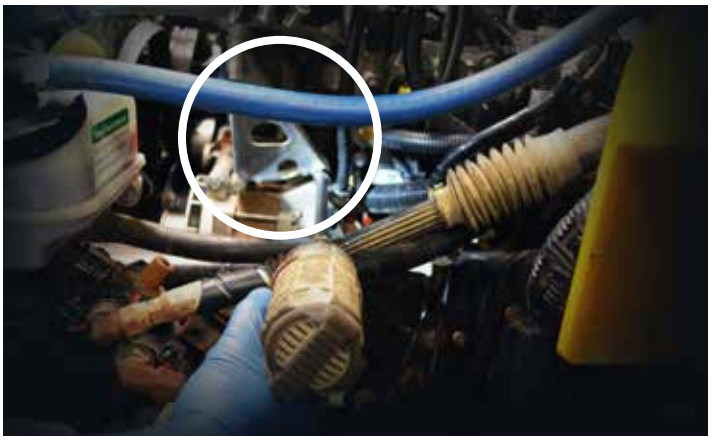
8. Attach the **RED** Reminder Tag to the power steering input shaft (tag provided in the kit).

2.3.2 LHG Hardware Installation

9. Remove primary Serpentine Belt (fan drive belt) from the pulleys by placing long 1/2” drive breaker bar with 15mm short well socket on the tensioner pulley bolt and rotate to release tensioner. Drape belt out of the way, you do not need to remove it completely.

10. Remove secondary Serpentine Belt from engine (accessory belt) by placing long 1/2” drive breaker bar with 15mm short well socket on the tensioner pulley bolt and rotate to release tensioner.

11. Remove Engine Intake Manifold Support Bracket from the engine using a 3/8” impact driver with the 6" and 9” extensions joined together and a 13mm short well socket. The last remaining bolt going into the bottom of the intake can be removed with a 3/8" impact driver and 13mm short well socket.

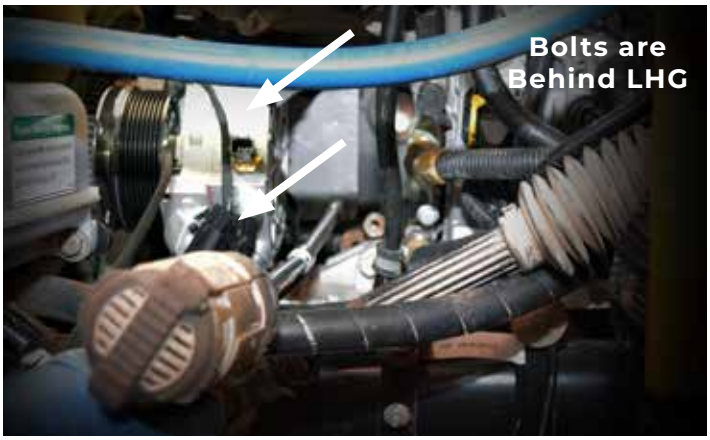


12. Install Idler Pulley to the front of engine using a 3/8” long ratchet and an 18mm short well socket. Put a few drops of Loctite 243 on the threads before installing. **IMPORTANT: Torque the idler pulley bolt to 85 Nm ± 5 Nm.**

13. Fit the LHG/Bracket subassembly through driver's side of engine block between the intake manifold and removed steering shaft.

14. Using the 3/8" impact driver, and the 9" and 6" extensions joined together along with the 13mm short well socket on the end to attach the two rear upper and lower m8x30mm bolts and washers provided in the kit. Put a few drops of Loctite 243 on the threads before installing.

15. For the forward two m8x30mm bolts and washers use a 1/4" ratchet with a 13mm short well socket. Put a few drops of Loctite 243 on the threads before installing. Finally, torque the bolts with a 13mm wrench.



16. Note: The LHG subassembly includes a rear backstay bracket that replaces the Engine Intake Manifold Support Bracket that was previously removed.

    To connect the new backstay bracket to the intake using one m8x20mm bolt and washer using the 3/8" impact driver, and 13mm short well socket. Put a few drops of LocTite 243 on the threads before installing.

2.3.4 Reinstallation of Belts

17. Install the new secondary Serpentine Belt (acessory belt) provided in the kit on the engine..

18. Reinstall primary Serpentine Belt on engine (fan belt) using the serpantine belt provided in kit.

2.3.5 Coolant Hose Plumbing Installation

19. Identify the two fittings on the LHG Heater and remove the black caps:

    The lower fitting is the Coolant Supply (Cold IN) port A.

    The upper fitting is the Coolant Return (Hot OUT) port B.

20. Remove the Coolant Hose from the top of the engine that feeds the rear heater core circuit. Remove other end of hose where it connects to the bus inlet heater core fitting, then remove hose from system.

21. Cut a 3” length of corrugated tubing and slide it over the power steering hose to protect the hose from LHG steel Unicoil hose springs that will be installed next.

22. Place one flexible Unicoil hose spring on one end of the 75" and 92", 3/4” diameter Coolant Hoses and bend in the spring to form a 90° elbow. Be careful not to kink the hose when bending the elbow.

23. Connect the 90° end of the 75” hose to the bottom fitting (port A) of the LHG Heater.

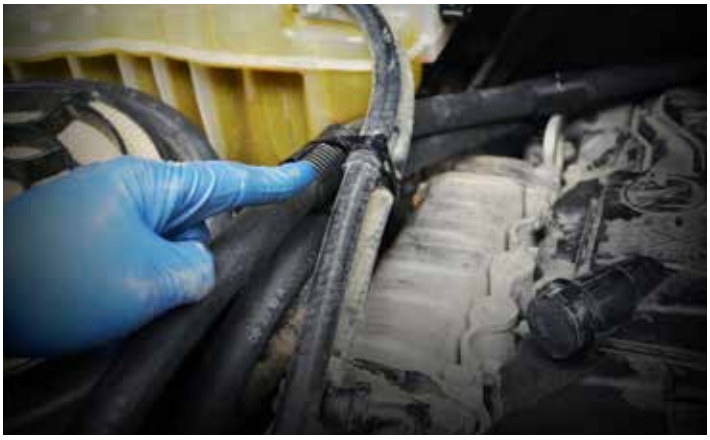
24. Connect the 90° end of the 92” hose to the top fitting (port B) of the LHG Heater.

25. Route the two hoses backward and up on the driver's side of the engine, across the rear of the engine, and forward along the passenger's side of the engine as shows in the following photo series.

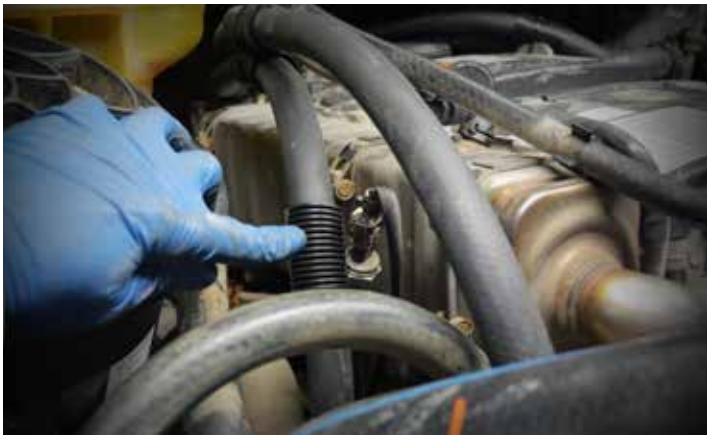
26. Cut two 3" lengths from the corrugated tubing. Zip tie hoses to transmission dipstick tube using the two 3" pieces of corrugated tubing and one zip tie to protect them from rubbing.

27. Cut two 3" lengths from the corrugated tubing. Zip tie hoses to driver's side engine lift bracket by incorporating corrugated tubing as shown in the photo.

28. Cut two 3" lengths from the corrugated tubing. Zip tie hoses to passenger's side engine lift bracket by incorporating corrugated tubing as shown in the photo. Zip tie hoses to degasser tank coolant hose bracket using two pieces 3" of corrugated tubing and one zip tie.

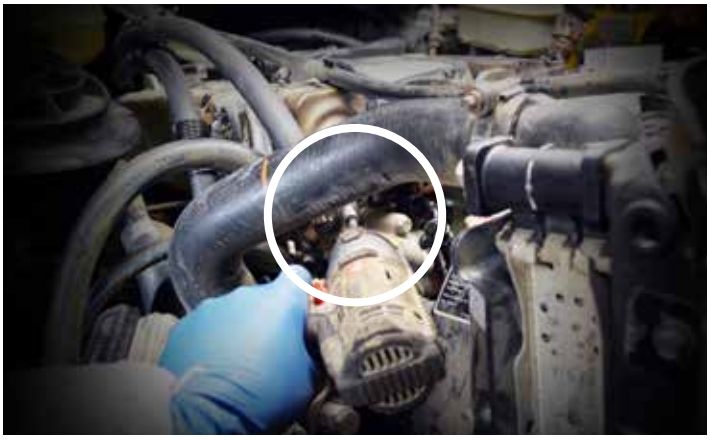


29. Install one piece of corrugated tubing over LHG outlet hose B to protect it from rubbing against the EGR sensor. Zip tie around corregated tubing only, do not zip tie to the EGR sensor.



30. Install a 19” piece of corrugated tubing over LHG outlet hose from fitting B.

31. Connect the 75” hose from fitting A (LHG Heater lower port) to the previously disconnected rear heater core circuit supply port on top of the engine.



32. Route the 92” hose from fitting B of the LHG (upper port) behind the intercooler tubing down to the heater core inlet fitting located on the chassis rail. Make sure the 19" corrugated tubing is protecting the hose from all wear points while routing.

33. Locate the 1" rubber heater hose return line (lower hose on frame rail) where it connects to the steel hose. Using the heater hose pliers, clamp off the rubber hose about 6" from the steel line. Using the impact driver with a 1/4" drive bit and 5/16" socket, loosen the hose clamp.

34. Remove the hose and install the supplied Coolant Flow Restricter into the rubber hose end. Reinstall the heater hose onto the steel line and tighten the hose clamp. Remove the heater hose pliers.

2.3.6 Aerial View of Installed Hoses

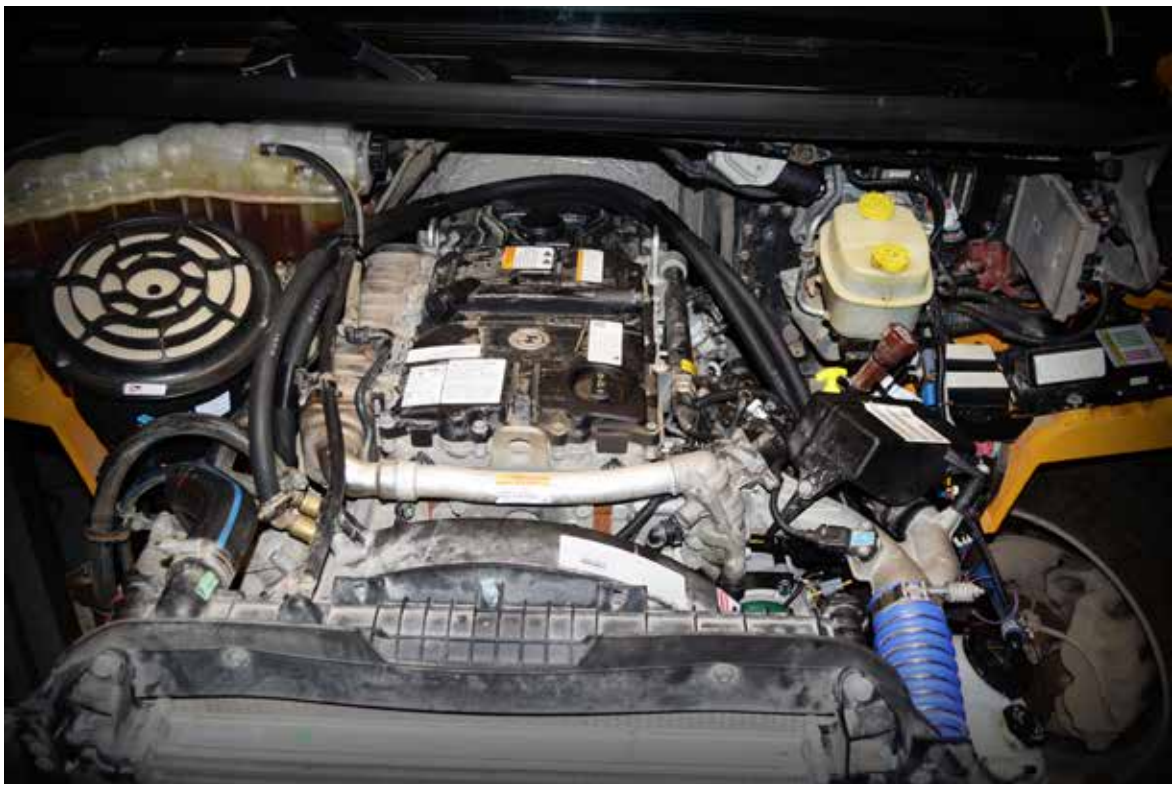


Figure 8 - Aerial View of Installed Hoses

2.3.7 Electrical Installation

35. Drill a 1-1/8” hole into firewall using a drill and 1 1/8” hole saw at the location shown in the photograph.

36. Place grommet in hole.

37. Using the 4 supplied self-drilling screws mount the LHG ECU on fender.

38. Remove the one screw closest to the firewall and engine. Lay the 23 pin Ampseal connector end of the harness in the vacinity of the multi-pin connnector of the ECU. Place harness fuse holder mounting hole over hole that goes through the ECU and fender and then reinstall screw.

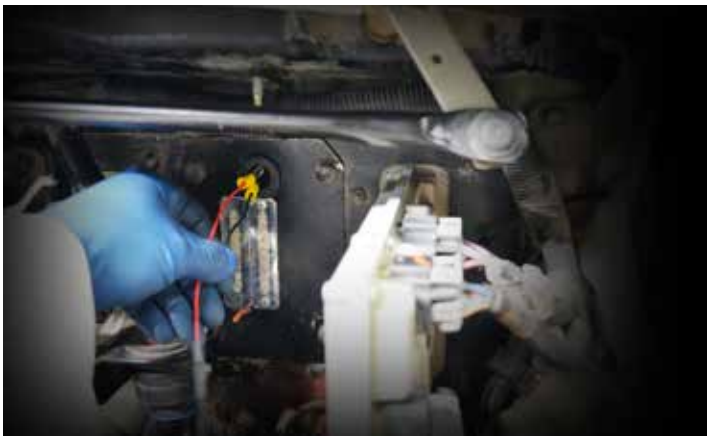
2.3.8 Harness and Controller Installation

39. Install LHG Harness.

a. Plug the LHG 23 pin Ampseal harness connector into the LHG ECU.

b. Route harness back toward firewall along corrugated tubing and zip tie to tubing.

c. Identify the power/ground pigtail. This pigtail has red and black wires fitted with ring terminals. Approximately 24" up the pigtail, there are also pink and gray wires with spade terminals. Route the power and ground pigtail through grommet in the firewall into the bus cabin. Push all of this pigtail through the grommet into the driver 's footwell area.



d. Route LHG power and ground pigtail under the dashboard (driver footwell), along the side of the parking brake housing and into the opening in the trim panel.

e. Route the remaining 3 pigtails of the harness above firewall toward brake master cylinder and zip tie to tubing.

f. Curve harness pigtails downward toward blue power steering hose and zip tie.

g. Route harness pigtails down blue power steering hose and zip tie to tubing as shown in the following photos.

Route the two harness pigtails that each have two connectors at the ends to the LHG.

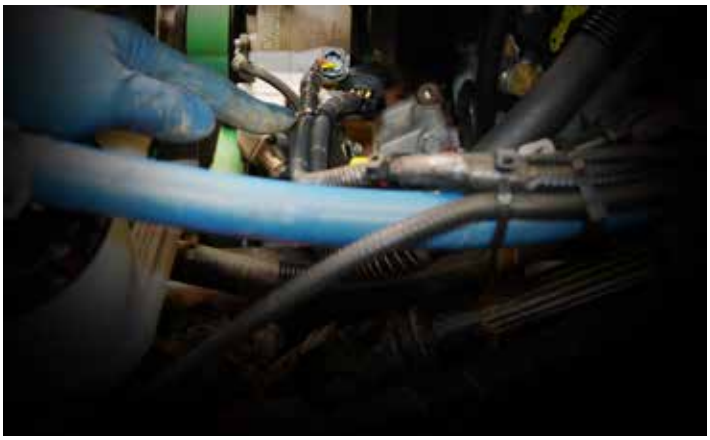
Connect temperature sensor plug to LHG.

Connect LHG clutch connector to LHG.

Connect the 4-pin RPM plug (color coded yellow) to the corresponding 4-pin RPM sensor (also yellow) on the LHG.

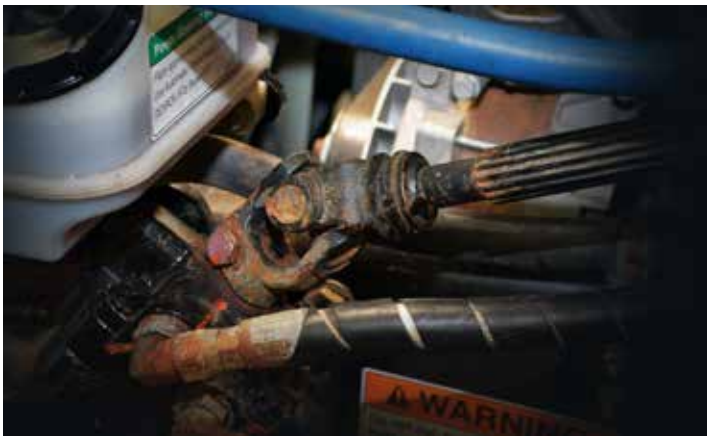
Connect the 4-pin RPM plug (color coded red) to the corresponding 4-pin RPM sensor (also red) on the LHG.

NOTE: Use caution as both sensors use the same style plug. Double check the red and yellow tags match on each pigtail. Leave enough slack in the harness to avoid stress on the LHG sensors.



40. Identify the ambient air temperature sensor pigtail (this pigtail has no connector on the end but is equipped with a thermistor covered with heat shrink at the end of the pigtail). Route this pigtail down under power steering reservoir, through the gear box, along the frame to the front bumper, and zip tie to the top of the engine block heater plug.

41. Re-intall the steering input shaft onto the steering gear box. Torque the bolt/nut back to factory specs. Remove the red tag.



42. Remove the six #2 square head screws from the switch panel compartment and remove panel.

43. Remove the compartment to the left of the switch panel.

44. Feed the power/ground pigtail (previously inserted through the firewell grommet into the driver compartment footwell) along top of steel plate to the left through both compartments.

45. Locate the power and ground connection lug posts in the compartment to the left of the switch panel compartment. Remove the power and ground nuts using a 13mm deep well socket and 9" extension with the 3/8" impact driver.

46. Connect the power (red) and ground (black) wire ring terminals to the power and ground lugs. Reinstall the power and ground lugnuts and torque to factory specifications.

47. Pull the pink wire with female spade terminal from the wiring harness through the top opening in the steel shelf. Connect pink wire to the 3 amp male spade terminal.

48. Reinstall both compartments. Reinstall the six #2 square head bolts into the switch panel and tighten.

49. Refill cooling system with coolant.

50. Reinstall coolant degasser tank cap.

51. Reopen the Summer Valves.

52. Reconnect the vehicle batteries.

Please Read IMPORTANT INFORMATION BEFORE STARTING THE SYSTEM FOR THE FIRST TIME

3 Final Inspection, Initial Start-up, and Concluding the Installation

IMPORTANT - Automatic Burnishing Sequence – First Startup

Immediately after the initial installation and startup of the LHG system, the LHG clutch will cycle for approximately 3 minutes (one cycle / second). THIS IS NORMAL. The ECU is programmed to perform a one-off 'burnishing' sequence, ensuring that the LHG clutch surfaces are clean and free of debris/rust formation.

3.1 Final Inspection

Inspect installation for:

- Loose fasteners.
- Coolant leaks.
- Loose heater hose clamps.
- Pinched heater hoses.
- Ensure heater hoses are properly routed and protected against chafing and related damage.
- Loose wiring connections and battery connections.
- Ensure wiring harness is routed properly and protected against chafing and related damage.
- Secure and dress harness using cable ties. Ensure that each harness termination point has some excess length, prevent unnecessary pulling on each connector.
- Ensure that the summer coolant valves are appropriately set (open).
- Install all vehicle parts, panels and components removed during heater installation.

3.2 Initial Start-up

- Reconfirm that cooling system is topped off with coolant per engine / vehicle manufacturers recommendations.
- **IMPORTANT: After filling the coolant system, it is critical to follow the coolant system deaeration procedures in the TBB / Freightliner / Detroit Diesel chassis maintenance manual.**
- Set **ALL** interior heater controls to maximum heat position (hot). This includes the rear compartment heaters and the dashboard heater.
- Activate the Boost Pump (always activate during heater operation).
- If the ambient temperature is above 50°F, place the tip of the OATS (Outside Ambient Temperature Sensor), previously installed behind front bumper, in a cup of iced water to simulate a cold morning. This will trigger the LHG system to operate.

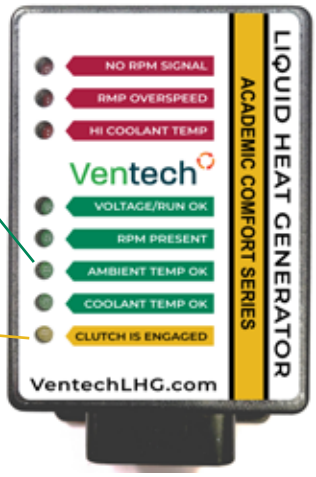
NOTE: The ambient air outside the bus must be less than 50˚F / 10˚C before the Liquid Heat Generator will engage.

NOTE: The engine coolant must be below 167˚F / 75˚C before the Liquid Heat Generator will engage.

- Upon completion of the installation the LHG ECU will perform two run-up sequences when the engine is first started. This only occurs during the first engine start immediately after the installation.
- Firstly, the LHG ECU will disable the LHG for the first three (3) minutes of operation (engine idling). During these first three minutes any air that may remain in the LHG coolant circuit will be purged from the system (air-purge).
- The second run-up sequence is an automatic burnishing of the LHG's electromagnetic clutch. This second sequence also takes about three (3) minutes and must be performed at LOW Idle (NOT HIGH Idle). During the second run-up sequence, the electromagnetic clutch will by cycled (burnished) 50 times. This burnishing process cleans the clutch surfaces that may have residue build up from the LHG's time in storage.

*During the air -purge sequence all **GREEN** LEDs will cycle in sequence.*

*During the burnishing sequence the **YELLOW** LED will cycle 50 times.*



- Start the vehicle engine and run at LOW idle (~800 engine RPM) for ~6 minutes allowing the two run-up sequences to complete (air-purge and burnishing sequences).

3.3 Concluding the Installation

While the engine is running, but after the two run-up sequences have completed, check the following:

- Hose connections for leaks.
- Coolant level in expansion tank (add coolant as needed).
- Elevate engine to FAST idle (~1200 engine RPM) to maximize heater performance while vehicle is stationary.

4 LHG Heater ECU (Digital Controller) Strategy

The Electronic Control Unit is designed to determine when to engage and disengage the LHG (via the LHG electromagnetic clutch) depending on various parameters including temperatures, RPMs, vehicle voltage, internal timers, and other conditions and parameters.

- Note: RPMs referenced are LHG RPM, not Engine RPM. Kit #78 (TBB / DD5) has a 1:2.35 ratio between Engine RPM and LHG RPM.

Idle Mode	Engine Speed	LHG Speed
LOW Idle	~ 800 RPM	~ 1,880 RPM
HIGH Idle	~ 1,200 RPM	~ 2,820 RPM

Figure 9 - LHG RPMS

Figure 10 summarizes the parameters and setpoints that determine whether the LHG is engaged or disengaged.

- **ALL** the engagement parameters must be met to activate the clutch while **ANY** individual disengagement parameter will deactivate the clutch.

Clutch Engages (if all occur)	Clutch Disengages (if any occur)
LHG RPM greater than 255 RPM	LHG RPM less than 256 RPM
LHG RPM less than 2,600 RPM	LHG RPM greater than 6,000 RPM
LHG Temperature less than 158°F	LHG Temperature greater than 176°F
Supply Voltage is above 13.0V (5 second delay)	Voltage to ECU is below 12.0V
Ambient Temperature (OATS) less than 50°F	RPM signal is unstable (rate of change > 400)
	RPM-RPM Differential >150 RPM over 50 milliseconds
	RPM-RPM Differential 50-150 RPM over 3 seconds

Figure 10 - Engagement Parameters

- When the clutch disengages, it will not re-engage until:

  a). **All** conditions required to engage the clutch are met as seen above **and**

  b). 2 to 5 seconds has elapsed after ALL engagement parameters have been met (time delay varies depending on parameter).

5 Understanding the ECU LEDs / Tool for Diagnosis of Operation

The Ventech ECU is equipped with 8 colored LEDs that indicate the operational status of the LHG heater system.

Three (3) LEDs are Red with corresponding descriptions (“No RPM Signal”, “RPM Overspeed”, and “Hi Coolant Temp”). The Red LEDs are known as “Off-Flags”. **Any illuminated Off-Flag will cause the LHG clutch to disengage.**

Four (4) LEDs are Green with corresponding descriptions (“Voltage/Run OK”, “RPM Present”, “Ambient Temp OK”, and “Coolant Temp OK”). The Green LEDs are known as “On-Flags”. **Every On-Flag must be illuminated for the LHG clutch to engage.**

One (1) LED is Yellow: “Clutch Engaged” (LHG heater is engaged and producing heat).

The LEDs emulate the key parameters detailed in Figure 10. In order for the LHG to engage, ALL Green LEDs must be ON and ALL Red LEDs must be OFF.

SOLID LIGHTS (LEDs)

No RPM Signal (RPM less than 256)
Overspeed (LHG >6000 / Engine >2,550)
Coolant Temp (LHG Out) >85°C / 185°F)

Supply Voltage >13V
RPM Present (LHG >256 RPM)
Ambient Air Temp <10°C / 50°F
Coolant Temp (LHG Out) <185°F / >167°F)
Clutch is Engaged (DC clutch voltage On)

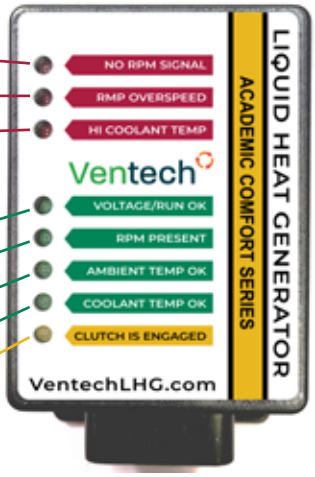


Figure 11 - Solid LED Signals

FLASHING LIGHTS (LEDs)

Clutch is Burnishing

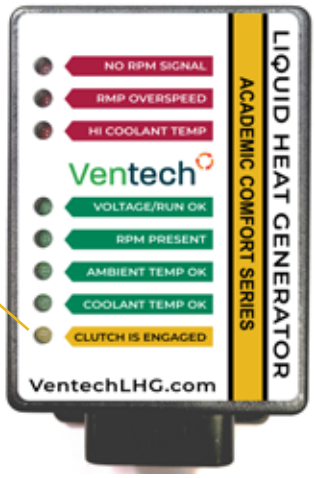


Figure 12 -Flashing LED Signal

FLASHING LIGHTS (LEDs)

If all of the LEDs alternate flashing all **RED** to all **GREEN**, it indicates that there is a clutch or sensor malfunction. Please contact Ventech for support.

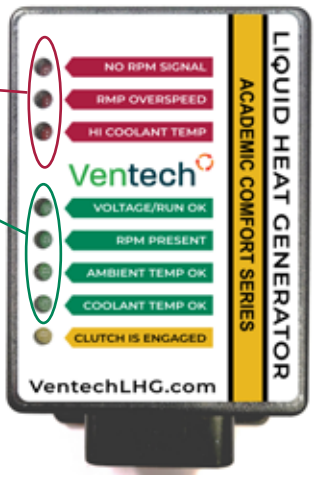


Figure 13 -Flashing Light Signals

6 Automatic Burnishing after extended periods of Non-Operation of the School Bus

During summer months, school breaks, or other reasons for not operating the LHG heater system over an extended period, the electromagnetic clutch plates of the LHG can become compromised by surface rust or debris collecting on the bare metal surfaces.

If ignored, the clutch performance may be compromised resulting in clutch slippage and part failure. The LHG ECU addresses this potential condition by performing a periodic burnishing routine based on the number of days that the LHG has not been operated.

This feature is fully automatic and requires no user-intervention. Automatic burnishing will occur at the intervals described below:

Interval of Non-Operation	Burnish Cycles (Upon startup after interval)	Approximate time to complete
14 Days	50 Clutch Cycles	~ 1 Minute
100 Days	100 Clutch Cycles	~ 3 Minutes

Figure 14 -Automatic Burnishing Schedule

At the intervals shown above, the automatic burnishing routine will start immediately after the bus engine is started, irrespective of ambient air temperature.

- WAIT for the burnishing routine to complete before driving the bus.
- If the burnishing routine is interrupted before completion (engine stopped), the full burnishing routine will restart the next time the engine is started.