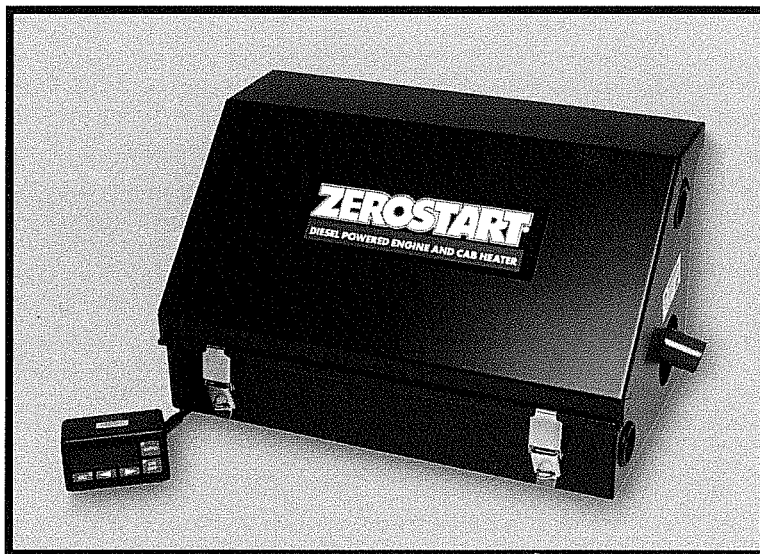




Diesel Powered Engine & Cab Heater



Operator Manual



EXPLANATION OF SAFETY MESSAGES



DANGER: This symbol indicates an imminently hazardous situation which, if not avoided, will result in death or injury.



WARNING: This symbol indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION: This symbol indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or property damage.

READ MANUAL COMPLETELY BEFORE PROCEEDING



WARNING

SHUT OFF SYSTEM WHEN REFUELING THE VEHICLE

Potential fire hazard exists from fuel contacting hot exhaust components.

DO NOT OPERATE SYSTEM IN CLOSED BUILDINGS

Possibility of asphyxiation and carbon monoxide poisoning exists.



CAUTION

DO NOT TURN THE UNIT OFF BY DISCONNECTING IT FROM BATTERY/POWER.

Damage may result from heat buildup in the combustion chamber.

DO NOT EXPOSE ELECTRONIC CONTROLLER TO TEMPERATURES ABOVE +185°F (+85°C).

ALWAYS BE SURE THE SYSTEM IS COMPLETELY SHUT OFF BEFORE STARTING THE VEHICLE.

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Introduction

READ THIS MANUAL COMPLETELY BEFORE OPERATING SYSTEM

The ZeroStart® Diesel Powered Engine & Cab Heater is an electronically controlled, diesel fuel fired heater designed to work with existing fuel, electrical, and cooling systems. The ZeroStart system provides hot water heat to the engine and cab/sleeper heater core, ensuring cold weather starts and operator comfort while eliminating the need to idle the engine.

The electronic controller may be turned on and off manually, or can be programmed to operate automatically based on time or coolant temperature.

Important: Complete and mail the registration card (packed with controller) to receive direct product information and updates to manuals.

Description of System Operation

The following describes the operation of the ZeroStart system, including the start cycle, continuous operation, and shut down. An overview of the cab air system is also included. This section is intended as a general description only.

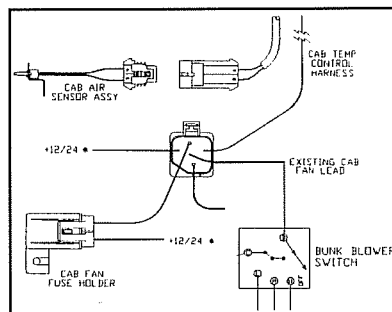
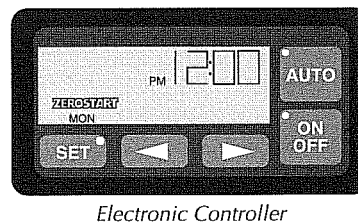
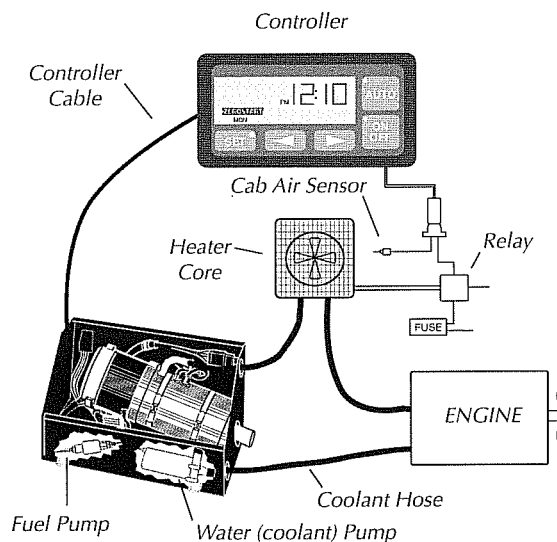
Major Components

The ZeroStart system consists of three major subsystems: the heating unit, the controller, and the cab air system (if installed).

The heating unit burns diesel fuel to create heat which is transferred to engine coolant through the heat exchanger. The coolant is circulated through the engine and heater core by the water pump.

The controller operates the system, and monitors system performance. The controller can be operated manually by using the ON/OFF key, or programmed to operate automatically.

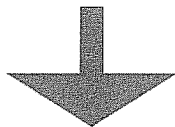
The cab air system is wired directly into the existing heater core fan, and turns the fan on and off to maintain a stable interior temperature. The desired interior temperature is selected by the operator. The temperature is monitored and controlled by the controller.



Start Cycle

When the ZeroStart® system is activated, and the coolant temperature in the heat exchanger is below 135°F (57°C), the unit will start combustion. If the coolant temperature is above 135°F (57°C), heat is not immediately required, and only the system water pump runs to circulate warm coolant. When the temperature drops below 135°F (57°C), combustion will start. The following describes the start cycle:

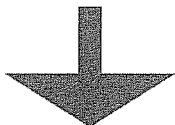
Glow plug preheats for 25 seconds.



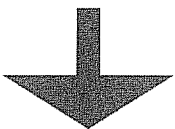
Combustion air fan starts.



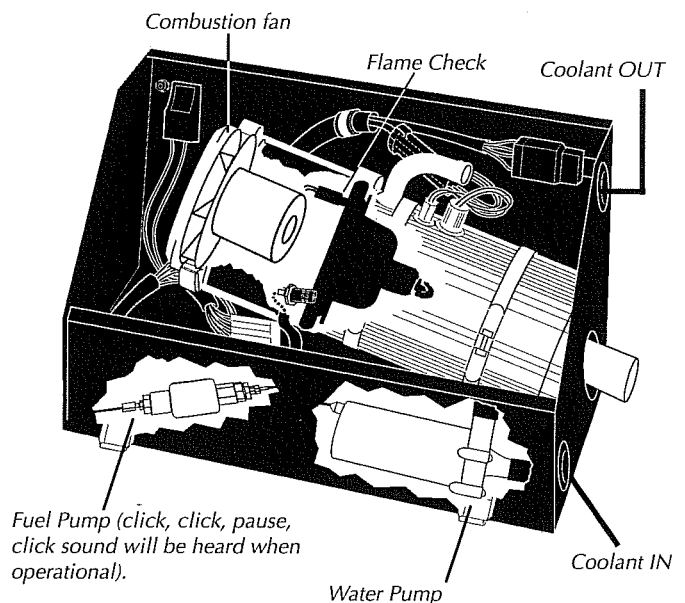
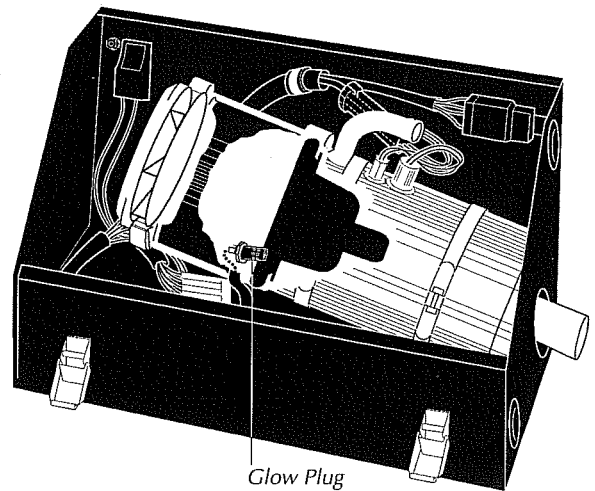
Fuel pump starts 2 seconds after combustion fan.



Fuel is delivered through the hot glow plug. During the first 60 seconds, the fuel pump is cycled on/off (click, click, pause, click sound). During continuous operation, the fuel pump cycles at a steady 4 cycles/second



Glow plug is turned off when flame check senses stable flame. Combustion air fan and fuel pump continue to run (unit is in continuous operation).



NOTE: If unit does not establish a stable flame during the first start cycle, it will automatically begin a second start cycle by repeating the steps listed above.

Introduction

Continuous Operation

CAUTION

DO NOT TURN UNIT OFF BY DISCONNECTING BATTERY/POWER.
Damage can result from heat buildup in the combustion chamber.

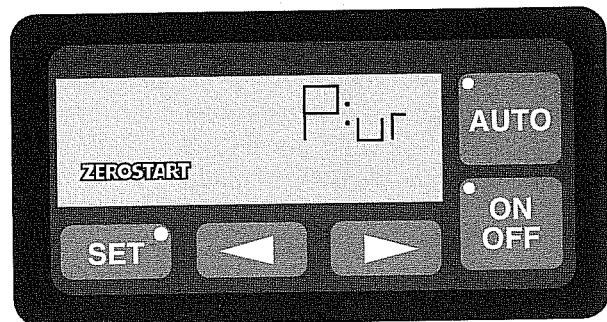
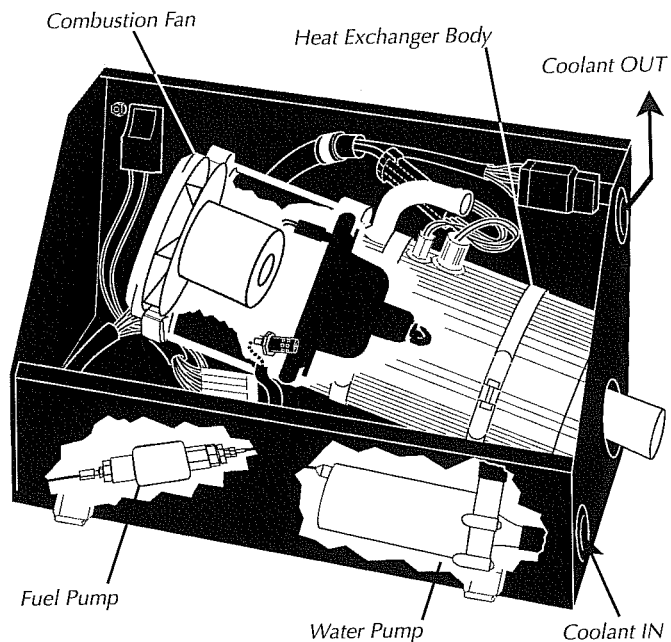
Once the system has completed the start cycle, it is in continuous operation. Heat is transferred to the coolant through the heat exchanger. When the unit reaches 100°F (38°C), the water pump is turned on and coolant is circulated through the system. The water pump is shut off when the coolant temperature is below 90°F (32°C).

When the unit reaches 185°F (85°C), the fuel pump is shut off, and the purge cycle begins. During the 2 min 15 sec minute purge cycle the combustion fan and the water pump remain on to complete combustion and cool the combustion chamber. After the purge cycle, the water pump continues to circulate hot coolant until the coolant temperature drops below restart temperature. When the restart temperature is reached, combustion is started, as previously described. This cycle is repeated until the system is shut off.

During the purge cycle, the controller displays "Pur". At the end of a normal purge cycle (after reaching shut-off temperature or if the system is turned off) the controller displays the current time.

The system also purges when it detects a potential problem, and will display a trouble code. Trouble codes are discussed in the following sections (see page 13 for complete list of trouble codes).

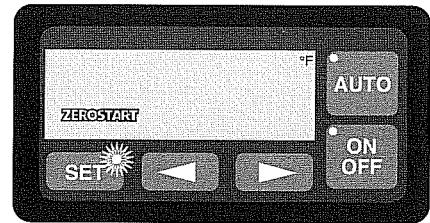
NOTE: Controller keys are disabled during the purge cycle.



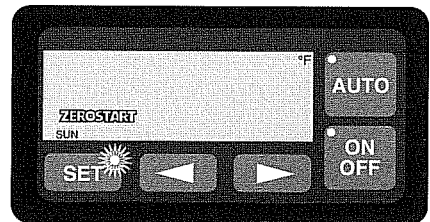
INITIAL CONTROLLER PROGRAMMING

When power is first connected or reconnected, the controller must be set for the correct day, time, and temperature preference (Fahrenheit or Celsius). **When power is first applied, the controller will display all of the characters for 2 seconds and the red "SET" light will glow.**

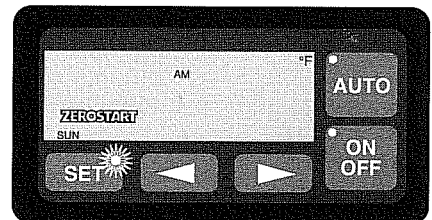
After two seconds the display will appear as shown at right. The controller is now in the program mode. °F is flashing. Use the arrow keys to choose °F or °C. With the desired temperature scale flashing, press the **SET** key to lock in selection.



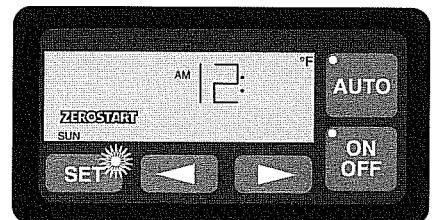
"SUN" is now flashing. Use the arrow keys to go through the days of the week, and stop when the current day is flashing. Press the **SET** key to lock in selection.



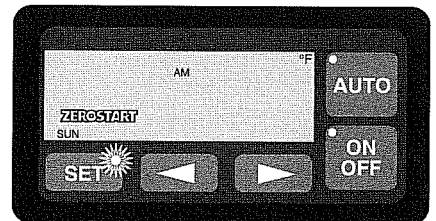
"AM" is now flashing. Use the arrow keys to select **AM, PM** or **24hr** (24hr is for a 24-hour time display). With the correct item flashing, press the **SET** key to lock in selection.



"12" on the clock face hours is now flashing. Use the arrow keys to select the current hour, and press the **SET** key to lock in selection.



"00" on the clock face minutes is now flashing. Use the arrow keys set the correct time and press the **SET** key to lock in selection.











The red **Set Light** should be off, and the controller should display the current day and time. Initial controller programming is now complete; the system is ready to operate. If errors were made during initial programming, the following sections detail how to reset the initial program, or controller power can be removed and reconnected to start over.

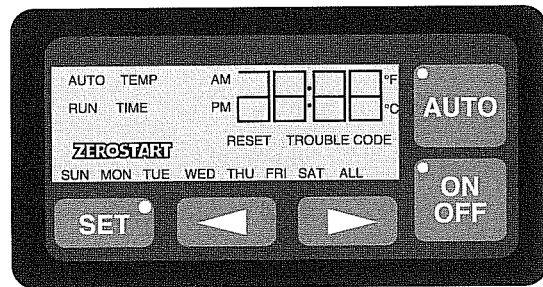





Electronic Controller

In case errors were made while setting time during initial programming, do this:

PRESS	OPTIONS	SELECT (Using   Keys)
	AUTO TEMP TIME RUNTIME TROUBLE CODE	TIME
	SUN MON TUE WED THU FRI SAT	Current day
	AM PM (IF 24HR ORIGINALLY CHOSEN, GO TO NEXT SET FUNCTION)	Current Time of day
	Hours	Current hour
	Minutes	Current minutes
	Key light shuts off, indicating all adjustments are complete and the system is ready to operate.	

All functions of the ZeroStart® system are managed by the controller. The key pad is used to program the controller and to turn the system on and off. The controller display is shown at right. The functions of the individual keys are described below.



Controller programming is performed by pressing the  key and either of the two arrow keys  .

Pressing This Key

Performs These Functions



- Allows access to program *OPTIONS*.
- *CHOOSES* the *OPTION* selected.
- *RESETS* the controller in the event of a trouble code.



- Advances through program *OPTIONS* (forward).
- Adjusts clock time forward.
- Adjusts temperature to a higher setting.
- Sets days of the week.






- Advances through program *OPTIONS* (reverse).
- Adjusts clock time reverse.
- Adjusts temperature to a lower setting.
- Sets days of the week.



- Manually starts and stops the system.



- Causes the system to start and stop automatically by the *OPTIONS* chosen.

Active option will flash on/off on the display. To view other options, press either of the   keys. When the desired option is flashing, press the  key to choose that option.

The ZeroStart® controller can operate in three different modes:

ON/OFF: Allows manual system operation. When activated with the ON/OFF key, the system will run indefinitely—until it is turned off or is interrupted by a trouble code.

AUTO ON: When the AUTO key is activated, the system will start at the preset “auto time” or “auto temp” programmed in the controller.

In “**auto time**” mode the system will run for the duration of the “RUN TIME” programmed in the controller. The “RUN TIME” is preset at three hours at the factory, and can be adjusted between one and nine hours in whole hour increments. In “**auto temp**” mode, the system will start when the programmed coolant temperature is reached. The unit will cycle between the programmed temperature and the shut-off temperature until the “AUTO” key is deactivated.

AUTO OFF: When both the “ON/OFF” and “AUTO” keys are activated, the system will run for the duration of the “RUN TIME” programmed in the controller and shut off automatically.

Controller Adjustable Functions:

The ZeroStart® controller permits adjustment of the following functions after the initial programming is performed:

Current Day: Informs controller of the current day.

Current Time: Informs the controller of the current time in 12 or 24 hour format.

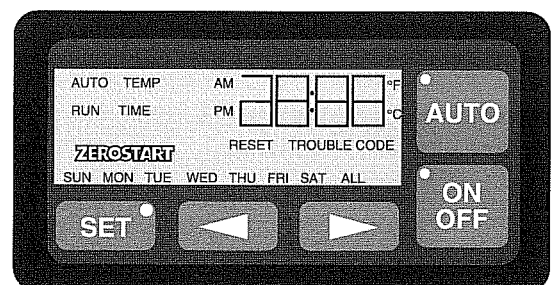
Cab Temp: Allows adjustment of interior (sleeper) air temperature setting (if installed).

Auto Start: Allows programming of an automatic start by time, or by temperature. Automatic starts by “**Time**” can be set up to seven days in advance; one start time for any single day of the week, or one start time for all days of the week.

Automatic starts by “**TEMPERATURE**” activates the system when the coolant sensor measures a temperature less than the set point programmed in the controller.

Run Time: Determines the length of time the ZeroStart® system will run when operated in the “AUTO ON” or “AUTO OFF” modes.

Trouble Code: Trouble codes are stored in the controller memory as they occur. Up to five trouble codes can be stored in memory. When recalled from memory, the most recent trouble code is displayed first. **It is best to refer to the maintenance manual to decipher trouble codes.**



Electronic Controller at startup

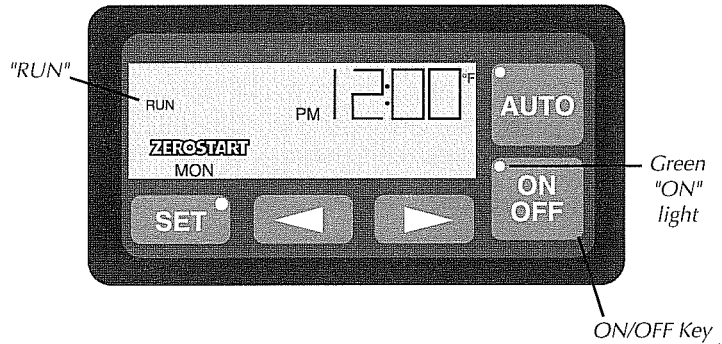
Electronic Controller Operation

System Operation

Once the controller has been programmed with the current day, time, and temperature scale during initial controller programming, the system is ready for operation. The system is operated using the controller. This section provides step by step instructions on how to operate the system both manually and in the automatic mode.

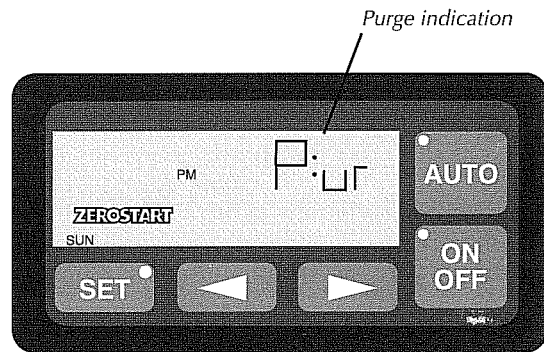
Manual Operation

To operate the system manually, simply press the "ON/OFF" key to start or stop the system. When the system is active, the green light will be illuminated, and the word "RUN" will be displayed during combustion. (NOTE: Coolant temperature must be below 135°F (57°C) for combustion to be initiated).



The system will now run indefinitely, until it is turned off, or detects a fault and generates a trouble code.

To turn off the system, simply press the "ON/OFF" key. If the system is shut off during combustion, the letters "Pur" will appear on the screen. This indicates that the system is purging. The system goes through a 2 min 15 sec minute purge cycle every time combustion is stopped.



Automatic Operation

There are two automatic modes to start the system: automatic start **by time**, and automatic start **by temperature**. Each automatic mode is detailed below.

Automatic start by time

Operating the system in the automatic time mode allows the system to turn on at a preset time (like an alarm clock) and run for a certain number of hours - without the operator present. For example, if a vehicle is parked over the weekend—and will not be used again until Monday morning—the controller can be programmed to start the system and heat the engine before the operator arrives on Monday morning. As described earlier, the system will start at the preset time, and run for the number of hours programmed in the “RUNTIME”. “RUNTIME” can be set between 1 and 9 hours in full hour increments.

To program an Automatic Start by Time

PRESS	OPTIONS	SELECT (Using ◀ ▶ Keys)
SET	AUTO TEMP TIME RUNTIME TROUBLE CODE	AUTO
SET	TIME TEMP	TIME
SET	SUN MON TUE WED THU FRI SAT ALL	Select desired start day.
SET	AM (If 24 hr. mode was originally chosen, go to next SET function.) PM	Select desired time of day.
SET	Current Hour displayed	Select desired “ON” time—hour.
SET	Current Minute displayed	Select desired “ON” time—minute.
SET	Current day & time displayed	
AUTO	System will operate at preset day and time. To stop AUTO START function during, before, or after system activation, press AUTO.	

NOTE: System will perform a purge cycle if program has already initiated. The controller keys are disabled during the 2.5-minute purge cycle.

To program System Run Time when Auto Start by Time has been selected

PRESS	OPTIONS	SELECT (Using ◀ ▶ Keys)
SET	AUTO TEMP TIME RUNTIME TROUBLE CODE	RUN TIME
SET	1 to 9 (whole hours)	Select desired running time.
SET	End of sequence	

System Operation

Automatic Start by Temperature

Operating the system in the **automatic temperature mode** allows the system to start automatically when a preset coolant temperature is reached. For example, if an operator does not want an engine to be colder than 40°F (4°C), this temperature is programmed into the controller and an **auto start by temperature** is selected. In this case, when the coolant temperature drops below 40°F (4°C) (as measured by the system coolant sensor) the unit will start and warm the engine to the shut-off temperature of 185°F (85°C) and restart when the system cools back down to 40°F (4°C). This feature is useful for stationary engines and construction equipment that must always be warm enough to start, but an exact time when the equipment is to be used is not known. In this mode, the system will run indefinitely until the "AUTO" key is deactivated, until the controller detects low battery voltage, or until the controller detects a fault in the system and generates a trouble code.

To program an Automatic Start by Temperature

PRESS	OPTIONS	SELECT (Using ◀ ▶ Keys)
SET	AUTO TEMP TIME RUNTIME TROUBLE CODE	AUTO
SET	TIME TEMP	TEMP
SET	+32° to +50°F (0° to +10°C)	Desired minimum temperature.
SET	Current Day & Time displayed	
AUTO	System will operate at preset temperature. To stop AUTO START function during or before system activation, press AUTO.	

NOTE: System will perform a purge cycle if program has already initiated. The controller keys are disabled during the 2.5-minute purge cycle.

Cab Air Temperature

This feature only applies if the cab air harness has been installed in the vehicle, as opposed to an "engine heat only installation". The cab air system is wired into the vehicle's heater core fan, and cycles this fan on and off to maintain a steady interior temperature. The interior temperature is programmed into the controller, and is preset at 70°F (21°C). If the cab air system is not installed, the controller recognizes its absence and does not present this option to the operator. The steps to adjust the cab air temperature are detailed below.

To adjust Cab Air Temperature with system ON

PRESS	OPTIONS	SELECT (Using ◀ ▶ Keys)
SET	+40° to +80°F (+4° to +27°C)	Desired temperature
SET	End of Sequence.	

To adjust Cab Air Temperature with system OFF

PRESS	OPTIONS	SELECT (Using ◀ ▶ Keys)
SET	AUTO TEMP TIME RUNTIME TROUBLE CODE	TEMP
SET	+40° to +80°F (+4° to +27°C)	Desired temperature
SET	End of Sequence.	

Trouble Codes

The ZeroStart® system is self-diagnostic. The controller monitors the function of all major components, including the vehicle battery voltage. In the event of a problem in the system (component failure, or in some cases a problem related to installation) the controller will shut down the system and display a trouble code in place of the clock. The red "SET LIGHT" will be illuminated, and the word "RESET" appears on the display. There are 10 trouble codes:

001	Low Voltage	006	Cab Air Sensor Circuit
002	Failed Start Attempt	007	Combustion Air Fan Motor Circuit
003	Loss of Flame During Operation	008	Control Module Malfunction
004	High Temperature Cut Out	009	Water Pump Circuit
005	Coolant Sensor Circuit	00F	Fuse Circuit

As stated above, a trouble code can indicate a failed component (broken wire, poor ground connection, etc.) or an installation/system problem (loss of fuel, no coolant, low voltage, etc.). Trouble codes that are intermittent can indicate a component beginning to wear or a result of improper installation. **It is best to refer to the maintenance manual to decipher trouble codes.** Whenever a trouble code is displayed, the red "SET LIGHT" will be on, and the words "RESET" and "TROUBLE CODE" appear on the display. **To reset the controller, press the set key.** The trouble code will be stored in memory and the clock display will return. Before restarting the system, the cause of the trouble code should be identified and corrected. If this is not done, and the system is restarted, the system will shut down and display the same trouble code. If the system is restarted and the trouble code does not reappear, the circuit or component related to the trouble code should be checked at the earliest convenience. Refer to the maintenance manual for troubleshooting instructions.

DANGER

DO NOT BYPASS SENSORS OR COMPONENTS.

Bypassing sensors could cause personal injury or fire. The controller will not permit the system to operate if a sensor or primary component is damaged.

Low Voltage Trouble code

The controller will shut down the system if the battery voltage drops below 10.5 volts (for 12 volt systems) or 21.5 volts (for 24 volt systems). The controller will display the low voltage trouble code "001". This is to ensure adequate battery power is available to start the engine. There are two options available if a low voltage trouble code occurs:

1. **Start the engine, or use other means available to charge the batteries.**
2. **Manual Override of "001" trouble code (described below).**

Press the "SET" key to reset the controller, and then press the "ON/OFF" to restart the system. Under these conditions, the controller will only allow the system to operate for one hour each time. After one hour, the system will shut off and display a "001" trouble code. This manual-override procedure can be repeated as many times as necessary, but it is intended to be used in emergency situations, such as when the vehicle is broken down and the operator needs to stay warm. Eventually, as battery voltage drops, the system will not be able to start, and the controller will display a "002" trouble code for failed start attempt. This procedure should only be used in emergencies, as it is possible to drain the batteries beyond their capability to start the vehicle or accept a full recharge.

System Operation

Trouble Codes

To reset the system in the event a Trouble Code is displayed:

Press **SET**. If the cause of the trouble code **was not a mechanical failure**, a restart can be attempted. If the cause of the failure is still present and the system will not operate properly, the failure mode will be recognizable and the trouble code will be issued again.

Trouble codes that **can be reset** and a start attempt made are:

TRouble CODE	INDICATION	PRESS (Left key first, then press right key)	
001	Low Voltage	SET ON OFF	The system can be operated in one-hour intervals if necessary. It would be advisable to charge the vehicle batteries before resetting the system.
002	Failed Start Attempt	SET ON OFF	Although the system may start, it would be advisable to determine the cause of the failed start attempt.
003	Loss of Flame During Operation	SET ON OFF	Although the system may start, it would be advisable to determine the cause of the loss of flame.
004	High Temperature Cut-out	SET ON OFF	The system will only reset if the coolant temperature at the heating unit is below +170°F (77°C). Determine the cause of overheat before turning the system ON.
005-	Unit Sensor		
006	Cab Sensor Circuit	SET ON OFF	The system may be started, but the fan system will have to be operated manually until the sensor circuit is repaired. Until the circuit is repaired, the controller will not allow the cab temperature to be set.

All other trouble codes require troubleshooting and service before restarting the system.

Preventive Maintenance

The ZeroStart® system is designed for long-term use. Routine preventive maintenance will keep the system functioning trouble-free. Check the following items during regular vehicle maintenance intervals:

Ground Connections	<i>Check all ground connections for wear or corrosion; repair as necessary.</i>
Hose Clamps	<i>All hose clamps on coolant and fuel lines should be checked for tightness and wear. Adjust the tension or replace as necessary.</i>
Hoses	<i>All fuel and coolant hoses should be checked for abrasion, cracking, and firmness. Replace those that are worn or questionable.</i>
Wiring	<i>All wires and connections should be checked. Replace all worn wires. Properly fasten new wires to prevent wear. All electrical connections should be tight, and free of any corrosion, rust, or insulating compounds. Clean and tighten as necessary.</i>
Mounting	<i>All four vibration mounts should be checked. Tighten or replace mounts as required.</i>
Exhaust	<i>Inspect the exhaust tube for wear, blockage, and routing. Remove any blockage. Route tubing to keep exhaust from entering the cab. Replace tubing if badly worn (do not exceed 12 feet [3.5 meters] with 1.25" [32 mm] tubing).</i>
Glow Plug	<i>Test the glow plug for serviceability at least once per year (procedure outlined in maintenance section). Replace as necessary.</i>

System Specifications

Description: The ZeroStart® system is an electronically controlled, diesel fuel fired heater designed to work with the existing vehicle fuel, battery, and coolant systems to provide heat for the engine and cab.

Output: 22,500 BTUH (6.5 kw)

Physical Dimensions

Heater:	Length	17 in. (432 mm)
	Width	9.5 in. (241 mm)
	Height	10 in. (254 mm)
Fuel Supply Tube:	Length	22.75 in. (578 mm)
	Outside Diameter	0.25 in. (6 mm)
Exhaust Tube:	Length	36 in. (914 mm)
	Inside Diameter	1.25 in. (32 mm)
	Maximum Length	12 ft. (3.65 m)
	Bend Radius	1.25 in. (32 mm)
Coolant Connections	Hose (I.D.)	0.75 in. (19 mm)
Weight	Main unit	38 lbs. (17 kg)

Electrical Requirements

Voltage (12v system)	10.5 - 15 VDC
Voltage (24v system)	21.5 - 30 VDC
Coolant Pump (12v)	1.5 Amps
Coolant Pump (24v)	0.75 Amps
Combustion Fan Motor	1.5 Amps
Glow Plug (on at start only)	15 Amps
Fuel Pump	0.8 Amps
Controller Module	0.2 Amps
Operation Maximum	4.0 Amps

Capacities

Coolant Pump Flow Rate

@36 inch (914 mm) Head	7.0 USGPM (1590 L/hr)
@72 inch (1829 mm) Head	4.5 USGPM (1022 L/hr)

Coolant Capacity

Heater	0.2 USG (0.75 L)
System Min	2.25 USG (8.5 L)
System Max	20.00 USG (75.7 L)

Fuel System

Max Flow Rate	0.16 USGPH (.60 L/hr)
Lift	36 in. (914 mm)
Pump	80 in. (2032 mm)
Inlet hose length (Max)	80 in (2032 mm)
Outlet hose length (Max)	236 in. (5994 mm)

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Limited Warranty

This limited warranty is expressly limited to the Company's products that have been purchased by the original consumer purchaser or for purposes of resale or use in the ordinary course of the purchaser's business. The term original consumer purchaser is defined as a person who purchases Company products for personal, family, or household use.

The Company's products are warranted against defects in materials and workmanship for a period of one year from date of purchase by purchaser. The exclusive remedy for any product found to be defective under this limited warranty consists of the repair or replacement of the defective product. This limited warranty does not apply to defects which arise from normal wear and tear, accident, misuse, abuse, neglect, mishandling, misapplication, faulty installation, modification, improper or extraordinary use or use inconsistent with any instruction or recommendation issued by the Company.

The foregoing limited warranty is exclusive and in lieu of all other warranties, whether written or oral, express, implied or statutory.

NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY. THE LIMITED WARRANTY CONTAINED HEREIN DOES NOT EXTEND TO INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF THIS PRODUCT, OR ARISING OUT OF A BREACH OF THIS WARRANTY. NOR DOES THIS WARRANTY EXTEND TO THE GLOW PLUG, FUSES, OR EXHAUST TUBE OF THE PRODUCT.

To obtain performance of this limited warranty, the alleged defective product must be returned, together with reasonable proof of purchase, postage or freight prepaid, directly to:

Warranty Department
Phillips & Temro Industries Inc.
9700 West 74th Street
Eden Prairie, MN 55344

The Company will return the repaired or replaced product, postage or freight prepaid. Final determination of defects shall be made in accordance with procedures established by the Company.

This limited warranty gives the original consumer purchaser specific rights. You may have other rights which vary from state to state or province to province depending upon the location of your residence. Some states do not allow the exclusion or limitation of incidental or consequential damages.

Manufacturer's rights retained:

The Company reserves the right to make changes in design, additions or improvements to any of its products at any time without incurring any obligation whatsoever to install or replace the same or improve upon products previously manufactured.

PHILLIPS & TEMRO
industries

A subsidiary of The Budd Company

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