

Maintenance Manual

Container Edition SG 3000e Series SGSM 3000e, SGCM 3000e, and SGCO 3000e Units

Revision A

TRANE

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Introduction

This manual is published for informational purposes only. Thermo King® makes no representations warranties express or implied, with respect to the information recommendations and descriptions contained herein. Information provided should not be regarded as all-inclusive or covering all contingencies. If further information is required, Thermo King Corporation Service Department should be consulted.

Thermo King's warranty shall not apply to any equipment which has been "so installed, maintained, repaired or altered as, in the manufacturer's judgment, to affect its integrity."

Manufacturer shall have no liability to any person or entity for any personal injury, property damage or any other direct, indirect, special, or consequential damages whatsoever, arising out of the use of this manual or any information, recommendations or descriptions contained herein. The procedures described herein should only be undertaken by suitably qualified personnel. Failure to implement these procedures correctly may cause damage to the Thermo King unit or other property or personal injury.

General Information

The maintenance information in this manual covers unit models:		
SGCO 3000e System Number	718202	
SGCM 3000e System Number	718203	
SGSM 3000e System Number	718204	
For further information, refer to:	·	
SGCO 3000e Parts Manual	TK 53717	
SGSM 3000e Parts Manual	TK 53706	
SGCM 3000e Parts Manual	TK 53725	
TKDV6 Engine Repair Manual	TK 55810	
Tool Catalog	ТК 5955	
The information in this manual is provided to assist owners, operators and service pe King units.	ople in the proper upkeep and maintenance of Thermo	
Model Nomenclature	SM: Side-mount unit frame CM: Center-mount unit frame	

CO: Clip-on unit frame

Revision History

Revision A

(01/2022) New Manual.

Customer Satisfaction Survey

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Serial Number Location

- Engine: Engine identification plate is located on the engine valve cover.
- **Generator:** The generator nameplate is attached to the generator housing. The serial number is located on this nameplate.
- SGUM Units: The unit serial number nameplate is attached to the unit frame near the rear mounting bracket or on the air cleaner bracket.
- SGCO Units: The unit serial number nameplate is attached to the unit battery box beside the engine compartment.
- **Controller:**The controller serial number nameplate is on the end of the controller and on mounting flange of controller.



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Safety Precautions

Danger, Warning, Caution, and Notice

Thermo King® recommends that all service be performed by a Thermo King dealer and to be aware of several general safety practices.

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this unit depend upon the strict observance of these precautions. The four types of advisories are defined as follows:

A DANGER

Hazard!

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

A WARNING

Hazard!

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

ACAUTION

Hazard!

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury and unsafe practices.

NOTICE

Hazard!

Indicates a situation that could result in equipment or property-damage only accidents.

General Practices

A WARNING

Personal Protective Equipment (PPE) Required!

Always wear goggles or safety glasses and proper PPE when working on a unit. Refrigerant liquid, oil, and battery acid can permanently damage your eyes. When working with or around hazardous chemicals, ALWAYS refer to appropriate Material Data Safety Sheets (MSDS) and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection, and handling instructions.

A WARNING

Equipment Damage and Risk of Injury!

Never drill holes into the unit unless instructed by Thermo King. Holes drilled into high voltage cables could cause an electrical fire, severe personal injury, or even death.

A WARNING

Risk of Injury!

When using ladders to install or service refrigeration systems, always observe the ladder manufacturer's safety labels and warnings. A work platform or scaffolding is the recommended method for installations and servicing.

Safety Precautions

NOTICE

Equipment Damage!

All unit mounting bolts must be installed, be the correct length for their application, and torqued to specifications. Missing bolts, incorrect bolt lengths and improper torque specifications can damage equipment and void the warranty.

Electrical Hazards

Electrical Precautions

- The possibility of serious or fatal injury from electrical shock exists when servicing a Genset unit. Extreme care must be used when working with a refrigeration unit that is connected to its power source.
- Extreme care must be used even if the unit is not running. Lethal voltage potentials can exist at the unit power cord, inside the control box, inside any high voltage junction box, at the motors and within the wiring harnesses.
- In general, disconnect the unit battery and disconnect any power cords before repairing or changing any Genset components.
- Even though the controller is turned off, one of the phases is still live and represents a potential danger of electrocution.

High Voltage

A DANGER

Hazardous Voltage!

High Voltage is present when engine is running! Disconnect main battery cables to ensure the unit cannot be started!

A DANGER

Hazardous Voltage!

Lethal amounts of voltage are present in some electrical circuits. Use extreme care when working on an operating unit. If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other local, state, or country-specific requirements for arc flash protection PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASHING CLOTHING. ELECTRICAL METERS AND EQUIPMENT MUST BE PROPERLY RATED FOR INTENDED VOLTAGE.

A WARNING

Hazardous Voltage!

Treat all wires and connections as if they were high voltage until a meter and wiring diagram indicate otherwise. Only use tools with insulated handles. Never hold uninsulated metal tools near exposed, energized conductors. If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other local, state, or country-specific requirements for arc flash protection PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASHING CLOTHING. ELECTRICAL METERS AND EQUIPMENT MUST BE PROPERLY RATED FOR INTENDED VOLTAGE.

A WARNING

Hazardous Voltage!

Never work alone on high voltage circuits in the unit. Another person should be nearby to shut off the unit and provide aid in the event of an accident. If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other local, state, or country-specific requirements for arc flash protection PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASHING CLOTHING. ELECTRICAL METERS AND EQUIPMENT MUST BE PROPERLY RATED FOR INTENDED VOLTAGE.



Safety Precautions

A WARNING

Personal Protective Equipment (PPE) Required!

In the event of an electrical accident, all required PPE should be near the work area in accordance with OSHA, NFPE 70E, or other local, state, or country-specific requirements for a Category 2 risk.

WARNING

Hazardous Voltage!

The unit On/Off switch must be turned Off before connecting or disconnecting the standby power plug. Never attempt to stop the unit by disconnecting the power plug.

A WARNING

Risk of Injury!

The unit power plug must be clean and dry before connecting it to a power source.

A WARNING

Risk of Injury!

Do not make rapid moves when working on high voltage circuits in the unit. Do not grab for falling tools because you might accidentally touch a high voltage source.

Low Voltage

A WARNING

Live Electrical Components!

Control circuits are low voltage (24 Vac and 12 Vdc). This voltage potential is not considered dangerous. Large amount of current available (over 30 amperes) can cause severe burns if shorted to ground. Do not wear jewelry, watch or rings. These items can shortcut electrical circuits and cause severe burns to the wearer.

Battery Installation and Cable Routing

AWARNING

Hazard of Explosion!

An improperly installed battery could result in a fire, explosion, or injury. A Thermo King approved battery must be installed and properly secured to the battery tray.

A WARNING

Hazard of Explosion!

Improperly installed battery cables could result in a fire, explosion, or injury. Battery cables must be installed, routed, and secured properly to prevent them from rubbing, chaffing, or making contact with hot, sharp, or rotating components.

A WARNING

Fire Hazard!

Do not attach fuel lines to battery cables or electrical harnesses. This has the potential to cause a fire and could cause serious injury or death.

Safety Precautions

A WARNING

Hazard of Explosion!

Always cover battery terminals to prevent them from making contact with metal components during battery installation. Battery terminals grounding against metal could cause the battery to explode.

A CAUTION

Hazardous Service Procedures!

Set all unit electrical controls to the OFF position before connecting battery cables to the battery to prevent unit from starting unexpectedly and causing personal injury.

NOTICE

Equipment Damage!

Do not connect other manufacturer's equipment or accessories to the unit or to the TK Batteries unless approved by Thermo King. Failure to do so can result in severe damage to equipment and void the warranty.

Battery Removal

AWARNING

Hazard of Explosion!

When removing battery cables, ALWAYS disconnect the negative battery terminal first. Then remove the positive terminal. When reconnecting the battery terminals, connect the positive terminal (+) first, and connect the negative (-) terminal last.

This order is important because the frame is grounded to the negative battery terminal. If the negative terminal is still connected, a complete circuit exists from the positive terminal of the battery to the frame. Metal objects contacting the positive side and the frame simultaneously will cause sparks or arcing. If there are sufficient hydrogen gases emitted from the battery, an explosion might occur, causing equipment damage, serious injury, even death.

Electrostatic Discharge Precautions

Precautions must be taken to prevent electrostatic discharge while servicing the microprocessor controller and related components. The risk of significant damage to the electronic components of the unit is possible if these precautionary measures are not followed. The primary risk potential results from the failure to wear adequate electrostatic discharge preventive equipment when handling and servicing the controller. The second cause results from electric welding on the unit and container chassis without taking precautionary steps.

Electrostatic Discharge and the Controller

You must avoid electrostatic discharges when servicing the controller. Solid-state integrated circuit components can be severely damaged or destroyed with less than a small spark from a finger to metal object. You must rigidly adhere to the following statements when servicing these units. This will avoid controller damage or destruction.

- Disconnect all power to the unit.
- Avoid wearing clothing that generates static electricity (wool, nylon, polyester, etc.).
- Do wear a static discharge wrist strap (refer to Tool Catalog) with the lead end connected to the controller's ground terminal. These straps are available at most electronic equipment distributors. *Do not* wear these straps with power applied to the unit.
- Avoid contacting the electronic components on the circuit boards of the unit being serviced.
- Leave the circuit boards in their static proof packing materials until ready for installation.
- Return a defective controller for repair in the same static protective packing materials from which the replacement component was removed.
- Check the wiring after servicing the unit for possible errors. Complete this task before restoring power.

THERMO KING Safety Precautions

Controller / Microprocessor Service Precautions

Take precautions to prevent electrostatic discharge when servicing the controller or microprocessor and its related components. Even tiny amounts of current can severely damage or destroy electronic components.

Observe the following precautions when servicing a controller or microprocessor control system to avoid damaging electronic components. Refer to the appropriate unit, controller, or microprocessor diagnostic manual for more information.

- If the unit has a service or microprocessor ON/OFF switch, turn it OFF before connecting or disconnecting the battery.
- Disconnect power to the unit.
- Avoid wearing clothing that generates static electricity (wool, nylon, polyester, etc.).
- Wear a wrist strap (P/N 204-622 or equivalent) with the lead end connected to the microprocessor or unit ground terminal (if equipped). These straps are available from most electronic equipment distributors. DO NOT wear these straps with power applied to the unit.
- Avoid unnecessary contact with the electronic components.
- Store and ship electronic components in antistatic bags and protective packaging.
- Leave electronic components in their antistatic packing materials until you're ready to use them.
- After servicing any electronic components, check the wiring for possible errors before restoring power to the unit.
- Never use a battery and a light bulb to test circuits on any controller or microprocessor-based equipment.

Welding on Refrigeration Units or Containers

Electric welding can cause serious damage to electronic circuits when performed on any portion of the refrigeration unit, genset, container, or container chassis with the refrigeration unit attached. It is necessary to verify that welding currents are not allowed to flow through the electronic circuits of the unit. The procedures below MUST be strictly followed when servicing units to avoid damage or destruction of the microprocessor.

- 1. Disconnect the battery connections (if equipped) and lock out tag out the unit according to local regulations.
- 2. Disconnect all power to or from the refrigeration unit or genset.
- 3. Disconnect all quick-disconnect wire harnesses from the back of the controller.
- 4. Switch all of the electrical circuit breakers in the control box to the Off position.
- 5. When steps 1 through 5 are complete, weld the unit and/or container using normal welding procedures. Keep ground return electrode as close to the area to be welded as practical. This will reduce the likelihood of stray welding currents passing through any electrical or electronic circuits.
- 6. When welding is complete, restore the unit power cables, wiring, and circuit breakers to their normal condition.

High Pressure Fuel Hazards

A WARNING

Hazardous Pressures!

After the engine has stopped, wait 10 to 15 minutes before opening the high pressure side of the fuel system.

A WARNING

Risk of Injury!

Do not use your fingers to check high pressure joints for leaks. Use a piece of paper or cardboard.

First Aid

ENGINE COOLANT

- Eyes: Immediately flush with large amounts of water for at least 15 minutes. Get prompt medical attention.
- Skin: Remove contaminated clothing. Wash thoroughly with soap and water. Get medical attention if irritation persists.

Safety Precautions

• Ingestion: Do not induce vomiting. Immediately contact local poison control center or physician.

BATTERY ACID

• Eyes: Immediately flush with large amounts of water for at least 15 minutes. Get prompt medical attention. Wash skin with soap and water.

ELECTRICAL SHOCK

Take IMMEDIATE action after a person has received an electrical shock. Get quick medical assistance, if possible.

The source of the shock must be quickly stopped, by either shutting off the power or removing the victim. If the power cannot be shut off, the wire should be cut with an non-conductive tool, such as a wood-handle axe or thickly insulated cable cutters. Rescuers should wear insulated gloves and safety glasses, and avoid looking at wires being cut. The ensuing flash can cause burns and blindness.

If the victim must be removed from a live circuit, pull the victim away with a non-conductive material. Use wood, rope, a belt or coat to pull or push the victim away from the current. DO NOT TOUCH the victim. You will receive a shock from current flowing through the victim's body. After separating the victim from power source, immediately check for signs of a pulse and respiration. If no pulse is present, start Cardio Pulmonary Resuscitation (CPR). If a pulse is present, respiration might be restored by using mouth-to-mouth resuscitation. Call for emergency medical assistance.

ASPHYXIATION

Move victim to fresh air and use Cardio Pulmonary Resuscitation (CPR) or mouth-to-mouth resuscitation to restore breathing, if necessary. Stay with victim until emergency personnel arrive.

Specifications

Generator

Туре	460/230 Vac, 3 Phase, 60/50 Hz
Output Power	15 Kw
Kilovolt-Amperes	18.75 kVA
RPM	1800 RPM

Electrical Control System

Controls		SG+ 1.5 Microprocessor Controller	
Voltage		12.5 Vdc (nominal)	
Battery		12 Volts, Group 31, 925 / 950 CCA @ -18 C (0 F)	
Fuse SI1 (Located on Control board)		30 Amp - RL4 Relay Fuse	
Fuse SI2 (Located on Control board)		30 Amp - Battery Charger Fuse	
Fuse SI3 (Located on Control board)		30 Amp - J9 to J13 Controller Fuse	
Electrical Components NOTE: Disconnect components from unit circuit to check resistance.			
	Current Draw (Amps) at 12.5 Vdc	Resistance — Cold (Ohms)	
Starter Motor	350-475*		
* On-the-engine cranking check. Bench test is approximately 140 amps.			

Specifications

Engine

SG 3000e	
Model	TK486VG Tier 2 EPA
Fuel Type	Diesel fuel must conform to EN590
Oil Capacity	12.3 litre (13 qt) Fill to full mark on dipstick
Oil Type	API CK4 grade or better Use multi-weight oils appropriate for the ambient temperature (delivered with 10W30 oil)
Oil Viscosity	Below -30 °C (-22 °F): SAE 0W-30 (Synthetic) -30 °C to +50 °C: SAE 5W-40 (Synthetic) -25 °C to +30 °C: SAE 10W-30 -25 °C to +40 °C: SAE 10W-40 -15 °C to +40 °C (or -10 °C to +50 °C): SAE 15W-40
Nominal Engine RPMSG-3000e NOTICE Equipment Damage!Do NOT operate the enginein ANY unit more than 100RPM over the high speedsetting shown to avoiddamage to the activerectifier.	High Speed : 1890 RPM Low Speed : 1560 - 1580 RPM
Engine Oil Pressure	120 to 320 kPa (1.2 to 3.2 bar) (18 to 47 psi)
Intake Valve Clearance	0.15 to 0.25 mm
Exhaust Valve Clearance	0.15 to 0.25 mm
Valve Setting Temperature	21 °C
Low Oil Pressure Switch (Normally Closed)	117 ± 21 kPa (1.17 ± 0.21 bar) (17 ± 3 psi)
High Coolant Temperature Switch	Sensor - 101.7 to 107.2 °C or higher (Shutdown)
	Note: SG 1.5 controller uses a sensor to provide engine high coolant temperature protection.
Engine Coolant Thermostat	71°C
Engine Coolant Type NOTICE System Contamination! Only OAT extended life coolants (Chevron Delo® XLC or equivalent) should be added to Thermo King systems. Conventional coolants should not be used (Typically identified by green or blue-green color). If a conventional coolant is combined with the Thermo King factory fill up to 25% by volume, the coolant must be changed at the next service opportunity. Above 25%, the coolant must be changed immediately. Conventional coolants dilute/interact with the additive packages of extended life coolant which significantly reduces the service life of the coolant.	 ELC (Extended Life Coolant), which is "RED" Factory filled with Chevron Delo® XLC extended life coolant (ELC), 50/50 glycol/water concentration. Freeze protection of -34 °F/ -37 °C Compatible coolants: Chevron Delo® XLC Havoline Delo® XLC (Europe) Caltex Delo® XLC (Asia) OR Meets the performance requirements of both ASTM D6210 and ASTM D3306 OAT extended life coolant, nitrite free
Coolant System Capacity	9.5 liter (10 qt) with overflow tank
Radiator Cap Pressure	90 kPa (0.90 bar) (13 psi)
Fan/Water Pump Belt Tension New or Field Reset:	15 to 35 tension number on belt tension gauge, TK P/N 204-427; or 19 to 25 mm (0.75 to 1.0 in.) deflection with 3 to 4 Kg (6 to 9 lb) of force.

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Controller Default Settings

Setting — Menu Location	Default Setting
Tank Size – Commands/System Setup	SGCO Units: 125 gallons (473L) SGCM Units: 50 gallons (189L) , OR 80 gallons (303L) SGSM Units: 75 gallons (284L)
Date/Time- Commands/System Setup	Software Date
ID Number– Commands/System Setup	0000000
C/F Mode – Misc. Functions	F
HM1 (Hour Meter 1) Threshold – Configuration	0
HM1 (Hour Meter 2) Threshold – Configuration	0
ENG (Engine) Off Hours – Configuration	0
Factory Reset – Configuration	Off
APU Connected – Configuration	Off
Output Voltage – Configuration	460
Fuel Sensor – Configuration	Off
Fuel Level – Configuration	0
Crank Restarts – Configuration	3
Telematic – Configuration	Off

Series Unit Weight

SGCO 3000e Unit Weight (net)	818 Kg (1804 lbs) - Including oil, coolant, battery, and 473 liter (125 gal.) fuel tank (excluding fuel)	
SGSM 3000e Unit Weight (net)	678 Kg (1495 lbs) - Including oil, coolant, battery, and 284 liter (75 gal.) fuel tank (excluding fuel)	
SGCM 3000e Unit Weight (net)	658 Kg (1450 lbs) including oil, coolant, battery and 303 liter (80 gal.) fuel tank (excluding fuel)	

Maintenance Inspection Schedule

Pretrip	Every 1,500 Hours	Every 3,000 Hours*	Inspect/Service These Items	
			Microprocessor:	
•			Run Pretrip Test (see "Performing a Pretrip Test").	
			Engine:	
•			Check fuel supply.	
•			Check engine oil level.	
•	•	•	Listen for unusual noises, vibrations, etc.	
•	•	•	Inspect belts for condition and proper tension.	
•	•	•	Check engine oil pressure hot, on high speed (should display "OK").	
•	•	•	Check engine coolant level and antifreeze protection (-30 F [-40 C]).	
	٠	•	Drain water from fuel tank and check vent.	
	Check engine mounts for wear.		Check engine mounts for wear.	
		•	Replace EMI 3000 air cleaner element (see "EMI 3000 Air Cleaner") at 3,000 hours or two years (whichever occurs first). See note.	
		•	Replace Primary EMI 3000 fuel filter/water separator. See note.	
Replace Secon		•	Replace Secondary EMI 3000 fuel filter. If equipped, see note.	
		•	Change engine oil and oil filter (hot). Requires oil with API Classification CJ-4 or CK-4. See Note. NOTE: For high biodiesel use (B20) the engine oil and filter should be changed every 1500 hours.	
Change ELC (red) engine coolant every 5 years or 12,000 hours. Uni equipped with ELC have an ELC nameplate on the expansion tank (s Cooling System").		Change ELC (red) engine coolant every 5 years or 12,000 hours. Units equipped with ELC have an ELC nameplate on the expansion tank (see "Engine Cooling System").		
	•	•	Check and adjust engine speed. See () "Engine Speed Adjustment"	
		•	Change fuel filter/water separator. See Note **	
		•	Test fuel injection nozzles at least every 3,000 hours. See Note ***	
		_	Replace fuel return lines between fuel injection nozzles every 10,000 hours.	
			Electrical:	
	Inspect battery terminals and electrolyte level.		Inspect battery terminals and electrolyte level.	
	•	•	Inspect wire harness for damaged wires or connections.	
	•	•	Inspect AC generator wire connections for tightness.	
			Structural:	
•	•	•	Visually inspect unit for fluid leaks.	
•	•	•	Visually inspect unit for damaged, loose, or broken parts.	
	•	•	Clean entire unit including radiator coil.	
	•	•	Check all unit and fuel tank mounting bolts, brackets, lines, hoses, etc.	

*3000 hours or two year, whichever occurs first.

**More frequent intervals may be necessary in extreme operating conditions.

***Based on EPA 40 CFR Part 89.

Unit Description

General Description

Thermo King generator sets (clip-on and under-mount) are self-contained fully-automatic, diesel powered units. The generator sets supply 230 or 460 Vac electrical power for container refrigeration units. Enclosed within the unit frame are the engine, dual voltage alternator, generator battery compartment, battery charging regulator and control panel.

ACAUTION

Risk of Injury!

DO NOT attempt to operate or maintain the generator until you have completely familiarized yourself with the equipment.

An exclusive TK486VG (EPA Tier 2) direct injection diesel engine drives a brushless generator to produce 15 KW of output power at 49 C (120 F) ambient temperature. A weatherproof box fastened inside the unit contains the unit controls.

Each unit features a welded, heavy-gauge steel frame with special sea-going finish; non-corrosive fittings, all stainless steel external hardware, brazed aluminum radiator, and poly-vinyl coating on the engine and generator.

Fuel tanks are provided as an integral part of each unit. Fuel capacities are: 473 liter (125 gal.) on SGCO clip-on models; 303 liter (80 gal.), or 189 liter(50 gal.) on SGCM center mount or SGSM side mount models.

The alternator is a brushless, rotating field ac generator. A rectified exciter armature output provides dc power for the field. The exciter field obtains its power from the full wave rectified output of the main generator. The alternator supplies 230 or 460 Vac, 3 phase, 4 wire, 60 Hz power at 1800 RPM.

This equipment develops normal output voltages (below 600 volts) whenever the engine is running. All output voltages normally reach 460 volts. Under malfunction conditions, 575 volts may be produced. Any electric potential more than 50 volts is hazardous. Exercise caution and discretion in the operation and maintenance of the equipment.

Unit Description

EMI 3000

These units are equipped with an EMI 3000 Extended Maintenance Interval package. The EMI 3000 package will result in lower total unit life cycle cost, because maintenance intervals have an important impact on unit operating costs.

The EMI 3000 package consists of the following key components:

- EMI 3000-Hour Cyclonic Air Cleaner Assembly and Air Cleaner Element
- EMI 3000-Hour 5-Micron Primary Fuel Filter / Water Separator
- EMI 3000-Hour Dual Element Oil Filter (blue with white lettering)
- API Classification CJ-4 or CK-4 Oil
- Five Year or 12,000 Hour Extended Life Coolant (ELC)

The EMI package allows standard maintenance intervals to be extended to 3,000 hours, or 2 years, whichever occurs first.

EMI 3000 equipped units are identified by a "ELC" decal tag on the coolant expansion tank, and blue and white colored oil filters. The EMI 3000 package allows standard genset maintenance intervals to be extended to 3000 hours. However, please note that units equipped with the EMI 3000 package still require regular inspection in accordance with Thermo King pretrip inspection and maintenance recommendations (see the Maintenance Inspection Schedule chapter in this manual).

SG Microprocessor Controller

The SG Microprocessor controller controls and monitors unit operation, records system faults and performs an automatic pre-trip check. The controller monitors all unit protection shutdown functions and the exciter system. The controller shuts down unit operation due to low engine oil pressure, low engine oil level, high coolant temperature, or alternator overload. The module also delays excitation power supply for 2 minutes after unit start-up. The SG Microprocessor controller is designed with the capability to have the software flash loaded.

Unit Instruments

Indicator LEDs

- **POWER LED:** A green Power LED lights up while the Unit On/Off Switch is in the ON position. It is located on the controller display.
- ALARM LED: A red Alarm LED illuminates when a shutdown condition has occurred. It is located on the controller display.

Unit Protection Devices

A WARNING

Equipment Damage and Risk of Injury!

The unit may start at any time without warning when the unit On/Off switch in the On position. Units equipped with a SG controller feature a Delayed Restart mode. The controller will make up to three (3) attempts every 20 minutes to restart the unit after a Delay Alarm has occurred. The Delayed Restart mode continues until the unit has been successfully restarted, or until a Shutdown Alarm is generated. Protection shutdown devices that cause an Delayed Restart shutdown condition include low oil pressure, low oil level, and high coolant temperature.

Fuel Level Sensor Option

The fuel level sensor option allows the controller to monitor and log fuel events. Units equipped with the fuel level sensor option must have the Fuel Sensor turned on in the Configuration Menu, and the fuel tank size set in the System Setup submenu.

Note: Only applies to gensets with the standard ultrasonic fuel sensor connected directly to the SG+1.5 controller, for gensets equipped with telematics the fuel level sensor option needs to be set to NO.

THERMO KING

Unit Description

Photos, Illustrations and Measurements

SGCO 3000e



1.	Fuel tank Cap	4.	Front Access Doors
2.	Corner Casting Mount	5.	Control Box Location
3.	Pin mount		

Photos, Illustrations and Measurements



1.	Fuel Tank Cap	3.	Control Box Location
2.	Front Access Door		

SGSM 3000e



Photos, Illustrations and Measurements

SGCO 3000e Control Box



1.	Flashload / Download port	4.	Quad Relay
2.	Unit ON / OFF Switch	5.	Opto Coupler
3.	460 VAC Power Receptacle Location	6.	Power Relay

SGCM/SGSM 3000e Control Box



1.	Flashload / Download port	4.	Quad Relay
2.	Unit ON / OFF Switch	5.	Microprocessor
3.	Opto Coupler	6.	Power Relay

Genset Model Features

SGSM 3000e	SGCM 3000e	SGCO 3000e	Model
S	S	S	TK486VG Tier 2 EPA Diesel Engine
S	S	S	460 Vac and 230 Vac 21 KW, 26.25 KVA, 3 Phase, 50/60 Hz, 4 Wire Generator
S	S	S	SG+ Control System
S	S	S	Battery with Post
S	S	S	Battery Charging System, Solid-state
S	—	—	Side-mount Unit mounting bracket
—	S	-	Center-mount Unit mounting arms
—	—	S	Clip-on Unit Frame
S	S	S	Combination Fuel Filter/Water Separator
S	S	S	Dry Air Cleaner
S	S	S	Stainless Steel Exhaust System
_	—	0	Header Pin, Mounting
S	S	S	EMI 3000 Extended Maintenance Interval Package
S	_	_	75 Gallon (284 Liter) Steel Fuel Tank
_	0	_	Integral 80 Gallon (303 Liter) Aluminum Fuel Tank
_	_	S	Integral 125 Gallon (473 Liter) Steel Fuel Tank
_	S	_	Integral 50 Gallon (190 Liter) Aluminum Fuel Tank
0	0	0	Fuel Monitoring - Monitoring and Recording of fuel level events.
0	0	0	Telematics
	_	0	Dual Mount
S = Standard O = Optional — = Not Applicable			

SG+ 1.5 Controller and Operating Instructions

SG+ 1.5 Controller Description

The SG+ 1.5 controller is a two-piece, self contained microprocessor for diesel generator sets. The SG+ 1.5 display is mounted on the control box cover. The SG+ 1.5 microprocessor is mounted inside the control box. Three external relays - two ECU Relays and the Start Relay are also mounted inside the control box near the microprocessor. Another Relay - the Preheat Relay, is located in the Engine Compartment.

This system automatically controls generator operation by providing:

- Automatic unit preheat and engine startup during initial startup or delayed restart
- Automatic Pretrip Test capability
- Delayed alternator excitation for 2 minutes
- Unit shutdown protection for the engine and alternator. The controller stops the unit due to low engine oil pressure, low engine oil level, high coolant temperature, or alternator overload.
- Automatic unit restart 20 minutes after unit shutdown due to an unknown condition, high engine water temperature, engine failure to start, check fuel alarm, or alternator overload (also low engine oil pressure if enabled). It will attempt one (1) restart and then stop.



Figure 1. SG+ Controller Display

SG+ 1.5 Controller and Operating Instructions

Microprocessor



1.	J6 Connector – To AC Circuits	13.	J12 8 Circuit Connection
2.	Fuse 30A - SI1 RL1 – RL4 Relay	14.	J19 USB Connection
3.	Fuse SI2 – 30 Amp Protects Battery Charger Output Circuit	15.	BT1 - Battery RTC Real Time Clock
4.	J9 2A Circuit Connection	16.	J27 - Not Used
5.	J11 CH Circuit Connection	17.	J4 Connector – To External Relay Circuits
6.	J10 GND Circuit Connection	18.	RL1 – Pull Relay
7.	Fuse 30A - S13 J9 to J13 Controller	19.	RL2 – Hold Relay
8.	Serial Port – For Flash Loading Software	20.	RL3 - Throttle Relay
9.	J3 Connector - Telematics	21.	J1 Connector – To Sensor and Fuel Solenoid Circuits
10.	J2 Connector – To SG+ 1.5 Controller Display	22.	RL4 - Quad Relay
11.	J20 Connector to CAN		
12.	J13 2C Circuit Connection		

SG+ 1.5 Controller and Operating Instructions

Controller Overview



1.	Display	A vacuum lucent display on the front panel shows operating information including output voltage, current test state during a Pretrip test and the controller menu. Normally it shows the Output Voltage (this is called the Standard Display). It will be blank when the unit On/Off switch is OFF.
2.	Escape Key	Press this key to escape a new setting or jump to the parent menu.
3.	Ир Кеу	Press this key to scroll UP through the menu display, or increase the value of a setting.
4.	Down Key	Press this key to scroll DOWN through the menu display, or decrease the value of a setting.
5.	Enter Key	Press this key to enter or execute controller menu tasks or commands.
6.	Alarm Key	Press this key to go directly to the Alarm List Menu and view the alarm information in the display.
7.	Alarm LED	Flashes when the controller has detected an alarm condition. It is off when there are no alarms.
8.	Power LED	Lights up while the Unit On/Off Switch is in the ON position. It is off when the Unit On/Off Switch is in the OFF position.
9.	Language Key	Press this key to change the language used on the display. English and Spanish are the languages that are currently available.
10.	Download Port	Is used to download the event logger and flash load new software.
11.	Unit ON / OFF Switch	In the ON position, the electrical control system energizes for unit operation. In the OFF position, the electrical control system including the fuel solenoid de-energizes to stop the engine. The unit will not operate.

Miscellaneous Controller Features

- Internal self-checking/diagnostic capability
- Pretrip test capability
- Hourmeter: The controller has a built-in run hourmeter that can be accessed through the Timers/Counters Submenu under the Misc. Functions Menu.
- The application software version is displayed by selecting the Program Version Submenu under the Misc. Functions Menu.
- Display menus: The SG+ controller contains extensive display menus that can be navigated via the keypad. The display menus are organized into seven Main Menus: Data Menu, Alarm List Menu, Warning List Menu, Commands Menu, Misc. Functions Menu, Configuration Menu, and Event Log Menu.

Microprocessor Inputs:

- Alternator Voltage
- Battery Voltage
- Coolant Level Sensor
- Water Temperature sensor
- Flywheel sensor
- Low pressure switch
- Oil level sensor
- Opto Coupler
- Feedback Starter circuit
- Feedback Pre-heat circuit
- Fuel Sender (Optional)

Microprocessor Outputs:

- Start Relay
- On Light
- Alarm Light
- Quad Relay
- Pull and Hold Relay
- Reheat relay
- Throttle solenoid

SG+ 1.5 Controller and Operating Instructions

SG+ 1.5 - Navigating the Controller Menus

Controller Display Menus

The SG+ 1.5 controller contains extensive display menus that can be navigated via the keypad. The display menus are organized into the following menus (or groups) in the Main Menu:

- Data Menu
- Alarm List Menu
- Message List Menu
- Commands Menu
- Misc. Functions Menu
- Configuration Menu
- Event Log Menu

The display also has some displays in addition to the Main Menus:

- Standard Display
- Pause Mode Display
- Composite Menu (Telematics have been added to the unit)

Each menu listed above will be described later in this chapter.

A complete listing of the controller menus is located on the 11 x 17 in. fold outs in the Diagrams section in the back of the manual (see last two pages in the manual). It is designed to be folded out so you can continuously view it as you are learning how to navigate the SG+ 1.5 Controller Menus. It is recommended to fold this flow diagram out and leave it folded out until you become familiar with the controller menus.

Navigating Controller Menus

Moving through the menus and their submenus and entering commands requires the use of the following keys:



1.	Escape Key: Press the ESCAPE key to escape a new setting or jump to the parent menu.
2.	Up Key: Press the UP key each time you want to scroll up to view another item in a menu or submenu), or increase the value of a setting.
3.	Down Key: Press the DOWN key each time you want to scroll down to view another item in a menu (or submenu), or decrease the value of a setting.
4.	Enter Key: Press the ENTER key each time you want to enter or execute controller menu tasks or commands.
5.	Alarm Key: Press the ALARM key to go directly to the Alarm List Menu and view the alarm information in the display.
6.	Language Key: Press the LANGUAGE key to change the language used on the display.

SG+ 1.5 Controller and Operating Instructions

Menu Overview

Press the **UP or DOWN** keys to scroll through the Main Menu or a Submenu. Press the **ENTER** key to enter a Submenu or Event. Press the **ESCAPE** key to return to the parent menu.

Main Menu	Submenu	Event				
	ENGINE	SHOW OUTPUTS				
DATA	GENERATOR	SHOW OUTPUTS				
DATA	UNIT	SHOW STATES				
	INTERNAL SATES / ENGINE OTHER	SHOW STATES				
	· ·					
ALARM LIST		Show Alarms				
MESSAGE LIST		SHOW MESSAGES				
	PTI	PERFORM TEST				
COMMANDS	MANUAL FUNCTION TEST	PERFORM 11 DIFFERENT PTI TESTS				
	SPEED CONTROL	Temporarily Select Engine Speed				
	C/F MODE	SELECT UNIT				
	SW / HW VERSION	VIEW HARDWARE / SOFTWARE VERSIONS				
MISC. FUNCTIONS	TIMERS	SHOW TIMERS				
	COUNTERS	SHOWS TIMERS				
	DATE TIME	CURRENT DATE AND TIME				
	CONTROLS	SELECT ENGINE SPEED				
	UNIT CONFIGURATION	CONFIGURE VALUES				
CONFIGURATION	OPTION CONFIGURATION	CONFIGURE VALUES				
	SYSTEM CONFIGURATION	CONFIGURE VALUES				
	MISCH CONFIGURATION	CONFIGURE VALUES				
	EVENTS	VIEW EVENTS				
EVENT LOG	FUEL EVENTS	VIEW EVENTS				
	USB COPY EVENTLOG	GENERATE LOG FILE				

Data Menu

The Data Menu contains the following submenus.

- Engine Displays engine operating information such as oil pressure and RPM.
- Generator displays generator operating information such as output voltage and the main battery voltage.
- Unit displays unit operating information such as the status of components, if the unit is running, and the engine RPM.
- Engine States / Engine Other displays unit hours, relay states, and unit operating information such as fuel and intake temperatures.

Alarm List Menu

The Alarm List Menu shows a list of the alarms recorded in the controller memory.

Message List Menu

The Message List Menu shows a list of the messages recorded in the controller memory.

Commands Menu

The Commands Menu contains the following submenus:

- PTI Pretrip Inspection Test is a functional test of the unit.
- Manual Function Test Used to perform 11 individual PTI Tests.
- Speed Control Used to temporarily select engine speed (high speed or low)

Misc. Functions Menu

The Misc. Functions Menu contains the following submenus:

- C/F Mode Used to select whether Celsius or Fahrenheit units are used to display temperature readings. This function can also be used to change your Pressure reading unit of measure i.e. Bars or PSI
- SW/HW Version Displays information about the controller software and hardware.
- Timers/Counters Displays information about the hourmeters and restart counters.
- Date/Time Displays current date and time.

Configuration Menu

The Configuration Menu is used to configure some of the controller functions such as Engine type, and hourmeter thresholds, factory reset, and output voltage system selection 230/460.

- Controls Used to select engine speed (high, low, or Auto based on load).
- Unit Configuration Menu Used to select engine, generator, voltage, and unit type.
- **Option Configuration Menu** Used to select fuel tank size, fuel sensor option, fuel low limit, and hour meter thresholds.
- System Configuration Shows unit configuration information.
- Misch Configuration Shows Genset ID number.

SG+ 1.5 Controller and Operating Instructions

Event Log Menu

The Event Log Menu contains the following submenus:

- Events Shows a list of events, warnings, and alarms recorded in the controller memory.
- Fuel Events Shows a list of fuel events recorded in the controller memory.
- USB Copy Eventlog Used to generate log file using USB port on control module.

Standard Display

The Standard Display shows the output voltage. It appears approximately one minute after the last key is pressed while the unit is running. The Standard Display floats within the display to prevent burn in.

Press the ENTER key or the ESCAPE key at the Standard Display to enter the Main Menu.



SG+ 1.5 Controller and Operating Instructions

Pause Mode Displays

A WARNING

Risk of Injury!

The engine may start at any time without notice when the unit is in a PAUSE mode.

A Pause mode display appears when normal unit operation has been interrupted because of a warning or alarm. The display will show the cause and controller action. For example, the following display appears if the engine fails to start.

ENGINE FAILED TO START

RESTART IN 20 MIN.

RAJ610

SG+ 1.5 Controller and Operating Instructions

Controller Link Down Display

The Controller Link Down display indicates there is no communication between the SG+ 1.5 controller and the display. This is typically caused by a defective SG+ 1.5 controller, a defective display, a defective cable, or a bad connection on the cable between the SG+ 1.5 controller and the display.

The Controller Link Down display also appears when software is be flash loaded into the controller.



RAJ611
SG+ 1.5 New Controller Set Up

When a new SG+ 1.5 controller is installed and used for the first time, it must be set up for the unit to work properly. This only applies to replacement controllers - new units from Thermo King come with the controllers that are set to the unit.

A WARNING

Equipment Damage and Risk of Injury!

After the unit is configured and the controller exits Configuration Mode, the unit will begin a start sequence.

- 1. Disconnect the unit battery to ensure the unit cannot operate. Remove the original controller.
- 2. Install the new SG+ 1.5 controller.
- 3. Reconnect the unit battery.
- 4. Turn the unit "ON".
- 5. The display will show:



- Press the ENTER key.
- 6. Set ENGINE type:
 - With the curser on ENGINE, press the ENTER key.



- Use the UP and DOWN keys to scroll to the correct engine:
 - YANMAR MECH (SG 3000e series units)
 - PCM (SG 4000 series units)
 - YANMAR HPCR (SG 5000 series units)
- When the correct engine is selected, press the ESC and ENTER keys at the same time to save the engine choice.



7. Set GENERATOR type:

- Use the UP and DOWN keys to put the curser on GENERATOR.
- Press the ENTER key when the curser is on GENERATOR.



- Use the UP and DOWN keys to scroll to the correct alternator:
 - MECC ALTE (SG 4000, SG 5000, and SG 3000e after December 2016)
 - STANFORD (SG 3000e Before December 2016)
 - Note: SG 3000e UNITS: Verify the generator type which is identified on the alternator serial plate.
- When the correct alternator is selected, press the ESC and ENTER keys at the same time to save the engine choice.



- 8. Set GENSET TYPE:
 - Use the UP and DOWN keys to put the curser on GENSET TYPE.
 - Press the ENTER key when the curser is on GENSET TYPE.



- Use the **UP** and **DOWN** keys to scroll to the correct Genset Type:
 - CLIP ON
 - SIDE
 - CENTER
- When the correct genset type is selected, press the ESC and ENTER keys at the same time to save the engine choice.



SG+ 1.5 Controller and Operating Instructions

- 9. Set SERIAL NUMBER:
 - Use the UP and DOWN keys to put the curser on SERIAL NO.
 - Press the ENTER key when the curser is on SERIAL NO.



- Enter the unit serial number by:
 - Use the arrow keys to scroll UP and DOWN to select the number or letter.
 - Press the ENTER key to move to the next serial number digit
- When the correct serial number is entered, press the ESC and ENTER keys at the same time to save the serial number.



10. Set unit OUTPUT VOLTAGE TYPE.

- Use the UP and DOWN keys to put the curser on OUTP. VOLT TYPE.
- Press the ENTER key when the curser is on OUTP. VOLT TYPE.



- Select the unit output voltage by:
 - Use the arrow keys to scroll UP and DOWN to select the correct output voltage (460V or 230V).
- When the correct voltage is selected, press the ESC and ENTER keys at the same time to save the voltage.



A WARNING

Equipment Damage and Risk of Injury!

After the unit is configured and the controller exits Configuration Mode, the unit will begin a start sequence.

FR THERMO KING SG+ 1.5 Controller and Operating Instructions

11. Set genset ID number:

Note: The ID number is not the unit serial #; it is a number created by the unit user, operator, or owner.

- From the MAIN MENU, use the UP and DOWN keys to find CONFIGURATION.
- Press the ENTER key.



- Use the UP and DOWN keys to SYSTEM CONFIGURATION.
- Press the ENTER key.



- Use the UP and DOWN keys to ensure the curser is on ID NO.
- Press the ENTER key when the curser is on ID NO.



- Enter the unit ID number by:
 - Use the arrow keys to scroll UP and DOWN to select the number or letter.
 - Press the ENTER key to move to the next ID number digit
- When the correct ID number is entered, press the ESC and ENTER keys at the same time to save the ID number.



SG+ 1.5 Operating Instructions

Pretrip Inspection

The pretrip inspection is an important part of the preventive maintenance program. It's designed to head off operating problems and breakdowns before they happen. The Pretrip Inspection is not a substitute for a regularly scheduled maintenance.

Visual Inspection

The following inspections should be made before loading the container or trailer:

- FUEL: The diesel fuel supply must be sufficient to guarantee engine operation to the next check point.
- Engine Oil: Engine oil level should be at the FULL mark. Never overfill. The dipstick is attached to the filler cap.
- **Coolant:** Engine coolant must be above the ADD mark with antifreeze protection of -34 C (-30 F). Check and add coolant in the expansion tank.
- Battery: Terminals must be clean. Electrolyte should be at the full mark.
- Electrical: Electrical connections should be securely fastened. Check wires and terminals for corrosion, cracks or moisture. Repair or replace if necessary.
- **Structural:** Visually inspect the unit for leaks, loose or broken parts and other damage. The radiator coil should be clean and free of debris. Clean if necessary. Use an air or water spray jet directed against the coil from the air discharge side.
- Mounting Bolts: Check the mounting bolts on the unit and engine. Tighten if necessary.

ACAUTION

Hazardous Pressures!

Do not remove expansion tank cap while coolant is hot.

ACAUTION

Risk of Injury!

Do not remove the radiator cap while the engine is hot.

NOTICE

System Contamination!

Do not add "GREEN" or "BLUE-GREEN" conventional coolant to cooling systems using "RED" Extended Life Coolant, except in an emergency. If conventional coolant is added to Extended Life Coolant, the coolant must be changed after 2 years instead of 5 years.

NOTICE

Equipment Damage!

Air pressure or water spray must not be high enough to damage coil fins.

Starting the Unit

Generator sets are designed to provide power for a refrigeration unit. Before starting the generator set, make sure the refrigeration unit power cord is connected to the generator set electric power receptacle. To operate the refrigeration unit on shore power, disconnect the power cord from the generator set and plug it into the proper power supply.

ACAUTION

Risk of Injury!

The unit may start automatically and at any time when the unit switches are On. Be sure to turn switches Off before inspecting or working on any part of the unit.

1. Turn unit ON/OFF switch to On. The switch is located below the SG+ 1.5 controller.

2. A series of displays called the Start Sequence appears on the display as follows:

SG+ 1.5 Controller and Operating Instructions

DISPLAY UNIT

REV 1.0.0

• SG+

X.X.X.X YYMMDD

MAIN MENU

DATA

DELAY 20 (or 19, 18, 17, etc. to 01)

The delay screen counts down from 20 to 01 while the controller performs some self checks.

MAIN MENU

DATA

INIT

The preheat buzzer is energized during the preheat period. Preheat time ranges from 5 to 120 seconds, depending on the engine temperature. Preheat may continue until after the engine starts.

MAIN MENU

DATA

FUEL RELAY ON

The controller energizes the fuel relay.

MAIN MENU

DATA

STARTER

The engine begins cranking. Pre-heat buzzer may remain energized during the cranking period.

MAIN MENU

.

DATA

DELAYED OUTPUT

This display appears while the controller delays energizing the alternator output for approximately 2 minutes.

NOTICE

Equipment Damage!

Never use starting fluid. Damage to the engine can occur.

After Start Inspection

After the engine has started:

- 1. Listen for abnormal noises.
- 2. Check for any alarms or messages using the Alarm List Menu and the Message List Menu.

Note: The engine must operate for approximately 2 minutes before the exciter circuit and battery charging circuits are energized.

SG+ 1.5 Controller and Operating Instructions

Main Menu

The Main Menu contains the following menus:

- Data Menu
- Alarm List Menu
- Message List Menu
- Commands Menu
- Misc. Functions Menu
- Configuration Menu
- Event Log Menu

To enter the Main Menu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. The Data Menu is typically the first menu displayed in the Main Menu.
 - Press the UP or DOWN key to scroll up or down through the Main Menu.

Data Menu

Note: The Data Menu only displays information, items can NOT be changed.

The Data Menu displays general unit operating information including electrical data, temperatures, etc. It contains the following submenus:

- Engine
- Generator
- Unit
- Internal States

To enter the Data Menu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. The Data Menu is typically the first menu displayed in the Main Menu.

Note: Press the UP or DOWN key to scroll up or down through the Main Menu to the Data Menu, if necessary.

- 4. Press the ENTER key to enter the Data Menu.
- 5. The Engine submenu will be displayed.
 - Press the ENTER key to enter Engine Submenu.
 - Press the UP or DOWN key to scroll up or down through the Data Menu.
 - Press the ESCAPE key to return to the Main Menu.

SG+ 1.5 Controller and Operating Instructions

Engine Menu

The Engine display the following unit operating information:

- Water Temp. (Engine Coolant Temperature)
- RPM
- RPM Requested
- Airheater Relay
- Oil Pressure Low
- Oil Level low

To enter the Engine Submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. The Data Menu is typically the first menu displayed in the Main Menu.

Note: Press the UP or DOWN key to scroll up or down through the Main Menu to the Data Menu, if necessary.

- 4. Press the ENTER key to enter the Data Menu.
- 5. The Engine submenu will be displayed.
- 6. Press the ENTER key to enter the Engine submenu.
 - Press the UP or DOWN key to scroll up or down through the Engine submenu.
 - Press the ESCAPE key to return to the Data Menu.



SG+ 1.5 Controller and Operating Instructions

Generator

The Generator submenu display the status of the following outputs:

- Voltage Measurement
- Running Frequency
- Generator
- Event Code

To enter the Generator submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. The Data Menu is typically the first menu displayed in the Main Menu.

Note: Press the UP or DOWN key to scroll up or down through the Main Menu to the Data Menu, if necessary.

- 4. Press the ENTER key to enter the Data Menu.
- 5. Press the UP or DOWN key to scroll up or down through the Data Menu to the Generator submenu.
- 6. Press the ENTERkey to enter the Generator submenu.
 - Press the UP or DOWN key to scroll up or down through the Generator submenu.
 - Press the ESCAPE key to return to the Data Menu.

SG+ 1.5 Controller and Operating Instructions

Unit

The Unit submenu display the status of the following outputs:

- Battery Voltage
- Battery Charger
- Fuel Level Mean (average)
- Low Coolant

To enter the Unit submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. The Data Menu is typically the first menu displayed in the Main Menu.

Note: Press the UP or DOWN key to scroll up or down through the Main Menu to the Data Menu, if necessary.

- 4. Press the ENTER key to enter the Data Menu.
- 5. Press the UP or DOWN key to scroll up or down through the Data Menu to the Unit submenu.
- 6. Press the ENTER key to enter the Unit submenu.
 - Press the UP or DOWN key to scroll up or down through the Unit submenu.
 - Press the ESCAPE key to return to the Data Menu.



SG+ 1.5 Controller and Operating Instructions

Internal States

The Internal States displays which of the following states the unit is in as it prepares to start, and after it starts or if it shuts down:

- INIT (Initiation Checks)
- Fuel Relay On
- Preheat On
- Preheat Off
- Restart 20 MI (Minutes)
- Running
- Shutdown
- HW Error
- Delay
- PTI
- RPM (Displayed Below the State)

To enter the Internal States complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- The Data Menu is typically the first menu displayed in the Main Menu.
 Note: Press the UP or DOWN key to scroll up or down through the Main Menu to the Data Menu, if necessary.
- 4. Press the ENTER key to enter the Data Menu.
- 5. Press the UP or DOWN key to scroll up or down through the Data Menu to the Internal States submenu.
- 6. Press the ENTER key to enter the Internal States.
- 7. Press the ESCAPE key to return to the Data Menu.

Figure 2. Internal States



Alarm List Menu SG+ 1.5

The Alarm List Menu displays alarms. Alarms are recorded in the controller memory to simplify unit diagnostic procedures. The alarms are listed in the reverse order of their occurrence. The Alarm LED flashes if a shutdown alarm is present. Enter the Alarm List Menu to view the and acknowledge the alarms.

Alarm Types

There are two types of alarms:

- **Delayed Restart Alarm:** Delayed restart alarms indicate the unit has stopped temporarily because of a problem or to prevent damage to the unit. The unit will attempt to restart in 20 minutes. The display will show information about the unit in the message screen and the time left to the restart attempt. A delayed restart alarm becomes a shutdown alarm after the third failed restart attempt in an hour.
- Shutdown Alarm: The Alarm LED flashes and unit stops. Shutdown alarms indicate the unit has been stopped to prevent damage to the unit. The condition must be corrected before restarting the unit.

Displaying and Acknowledging Alarms

Enter the Alarm List Menu to view and acknowledge the alarms as follows:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ALARM key to enter the Alarm List Menu directly. **Or** Enter the Alarm List Menu through the Main Menu as follows:
 - Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
 - Press the UP or DOWN key to scroll up or down through the Main Menu to the Alarm List Menu.
 - Press the ENTER key to enter the Alarm List Menu.
- 3. The Alarm List Menu will appear on the display. It shows the most recent alarm and the following information:
 - The alarm code (100 through 604).
 - The position of the alarm in the list of recorded alarms. For example, 1/2 means alarm one of two.
 - The alarm text.
 - The alarm status (Active or Acknowledged).
 - Write down the alarm code and the alarm text.
- 4. Write down the alarm code and the alarm text.
- 5. Press the ENTER key to acknowledge the alarm. The Alarm LED will continue flashing until the active alarms (and messages) have been acknowledged.
- 6. Press the DOWN key to scroll down to the next alarm, if necessary.
- 7. Write down the alarm code and the alarm text.
- 8. Press the ENTER key to acknowledge the alarm.
- 9. Repeat steps 6 through 8 until all active alarms have been written down and acknowledged.
- 10. Press the ESCAPE key to return to the Main Menu.

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Alarm Diagnosis

The Alarm List details the alarms, their causes, and possible diagnosis.

Alarm Code	Alarm Text	Alarm Type-Cause	Diagnostics
#0100	Water Temperature High	Alarm Operation Engine is running and water temperature is above 107 C (225 F) for 5 seconds. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	 Check for cause of engine overheating: Check engine coolant level. Check water pump belt. Check radiator for airflow and coolant flow restrictions. Check for faulty water temperature sensor.
#0101	Engine Failed To Crank	Alarm Operation Engine RPM below threshold during crank. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	 Check battery, battery cables, and starter. Check 8S circuit. Check Start Relay. Check for seized engine or alternator.
#0102	Engine Failed To Start	Alarm Operation PTI Engine failed to start. (RPM reading below 40 rpm) 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	 20 min restart. Check fuel level. Check fuel solenoid, fuel pump, and fuel system both electrically and mechanically. In cold ambient temperatures check for fuel gelling. Check for restricted air cleaner or air intake system. Check intake air heater.



Alarm Code	Alarm Text	Alarm Type-Cause	Diagnostics
#0104	Engine RPM Below Limit	Alarm Operation RPM below 800 or Engine overloaded 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	 Check engine speed. Check RPM sensor.
#0105	Oil Level Low	Alarm Operation Low oil level detected for 60 sec. If low oil level and low oil pressure is present at the same time. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu. Shutdown. No restart if low oil pressure is present.	 Check oil level. Check Oil Level Switch. Check circuits to Oil Level Switch. Check oil pressure using the Analog Inputs submenu of the Data Menu. Check Low Oil Pressure Switch. Check OPS circuit.
#0108	Coolant Level Low	Alarm Operation Low coolant level before engine start. Shutdown	 Check coolant level. Check Coolant Level Sensor. Check circuits to Coolant Level Sensor.
#0110	Engine Stopped	Alarm Operation Input from Low Oil Pressure Switch is low (grounded) and RPM equals 0 when engine should be running. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	 Check fuel level. Check fuel solenoid, fuel pump, and fuel system both electrically and mechanically. In cold ambient temperatures check for fuel gelling. Check for seized engine or alternator
#0111	Oil Pressure Low	Message Operation Engine is running and input from Low Oil Pressure Switch is low (grounded) for 60 seconds. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu. Shutdown No restart if low oil level is present.	 Check oil level. Check oil pressure using the Analog Inputs submenu of the Data Menu. Check Low Oil Pressure switch. Check OPS circuit.
#0112	Fuel Level Error	Message PTI Senor out of range during PTI.	 Check fuel level. Check Fuel Level Sensor. Check circuits to Fuel Level Sensor.
#0113	Speed Control Error	Message PTI High or Low speed error detected during PTI. High speed >1950, low speed <1350	 Check engine speed. Check RPM sensor.
#0114	Voltage Control Error	Message Operation High/Low Speed Voltage error during PTI. >500/<380	See "Alternator Diagnosis"

Alarm Code	Alarm Text	Alarm Type-Cause	Diagnostics
#0200	Generator Event Short Circuit	Alarm Operation Short circuit detected 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	See "Alternator Diagnosis"
#0201	Generator Event Over Excitation	Alarm Operation Generator at its limit. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	See "Alternator Diagnosis"
#0410	Line Voltage Exceeds Limit High	Alarm Operation Line Voltage above 549 voltage over 15 seconds. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	See "Alternator Diagnosis"
#0411	Line Voltage Exceeds Limit Low	Alarm Operation Line Voltage below 320 voltage over 4 seconds. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	See "Alternator Diagnosis"
#422	Line Frequency Low	Alarm Operation Line Frequency below 35 Hz over 5 seconds. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu	See "Alternator Diagnosis"
#423	Line Frequency High	Alarm Operation Line Frequency above 75 Hz over 5 seconds. 20 minutes restart. Becomes a Shutdown Alarm when number of restart attempts is greater than number of "Crank Restarts" set in Configuration Menu.	See "Alternator Diagnosis"
#601	Digital Output	Alarm Operation PTI No feedback when relay energized, (RL1, RL2, RL3, RL4) or feedback when RL relays are not energized.	 Check RL relay on controller RL1, RL2, RL3 and RL4. internal. Check PULL, HOLD, THROTTLE, QUAD, SR, and PSR circuits.
#602	Digital Input	Message Operation PTI Input in wrong state during startup.	This condition indicates noise on the line, a loose connection, or a bad sensor. Check all inputs
#604	Battery Charger	Message PTI Low battery charge voltage during PTI	 Check SI2 Fuse Check battery and cables



Alarm Code	Alarm Text	Alarm Type-Cause	Diagnostics
#720	Battery Voltage Low	Message PTI Battery voltage is below 12.2 voltage for 3 minutes. During air heater voltage below 9.0 volt for 3 seconds.	 Check battery Check battery cables
#803	AVR Comm Error	Message Operation No feedback from the DSR Status pin. OC wire.	See "Alternator Diagnosis"

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Message List Menu SG+ 1.5

The Message List Menu displays messages. Messages are recorded in the controller memory to simplify unit diagnostic procedures. The messages are listed in the reverse order of their occurrence. Enter the Message List Menu to view the and acknowledge the messages. Acknowledging a message clears it from the list.

Note: The unit will not start a PTI until all active messages have been acknowledged. The display will show "ACKNOWLEDGE MESSAGE" if there are messages that have not been acknowledged when trying to start a PTI.

Displaying and Acknowledging Messages

Enter the Message List Menu to view and acknowledge the messages as follows:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Message List Menu.
- 4. Press the ENTER key to enter the Message List Menu.
- 5. The Message List Menu will appear on the display. It shows the most recent message and the following information:
 - The message code (109 through 803).
 - The position of the message in the list of recorded messages. For example, 1/1 means message one of one.
 - The message text.
 - The message status (Active or Acknowledged).
- 6. Write down the message code and the message text.
- 7. Press the ENTER key to acknowledge the message. The Alarm LED will continue flashing until the active messages (and alarms) have been acknowledged.
- 8. Press the DOWN key to scroll down to the next message, if necessary.
- 9. Write down the message code and the message text.
- 10. Press the ENTER key to acknowledge the message.
- 11. Repeat steps 8 through 10 until all active messages have been written down and acknowledged.
- 12. Press the ESCAPE key to return to the Main Menu.
- 13. The unit will then enter the Start Sequence and start the engine.



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Commands Menu

The Commands Menu contains the following submenus that are used to test the operation or the unit and controller:

- PTI (Pretrip Inspection Test)
- Manual Function Test
- Speed Control

To enter the Commands Menu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Commands Menu.
- 4. Press the ENTER key to enter the Commands Menu.
- 5. The PTI submenu will be displayed.
 - Press the ENTER key to start the PTI.
 - Press the UP or DOWN key to scroll up or down through the Commands Menu.
 - Press the ESCAPE key to return to the Main Menu.



Pretrip Inspection Test (PTI)

To properly perform a PTI (Pretrip Inspection Test) on units equipped with a SG+ controller, do not apply a load to the alternator.

- 1. Start the unit.
- 2. Initiate an automatic PTI:

Note: Correct all existing alarm conditions and clear the alarm codes before performing a PTI.

- Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- Press the UP or DOWN key to scroll up or down through the Main Menu to the Commands Menu.
- Press the ENTER key to enter the Commands Menu.
- The PTI submenu will be displayed.
- Press the ENTER key to start the PTI.
- 3. The controller then performs the PTI. Observe the unit for proper operation and functions during the PTI. The display shows which component is being tested, and the test result (PASSED of FAILED):
 - "Please Wait"
 - The engine stops.
 - A display test is performed. Watch the display to verify it is operating properly.
 - Hold relay is tested.
 - Throttle relay is tested.
 - Coolant level Switch is tested.
 - Oil Level Switch.
 - Oil Press Switch.
 - Engine Start is tested. The engine starts, The display says:
 - "START ENGINE TEST (beep on, then off, then start appears briefly)
 - High speed is tested. (Engine still running similar results screen and test sequence to point above)
 - Generator start is tested. (Engine still running similar results screen and test sequence to point above)
 - Battery charger is tested. (Engine still running similar results screen and test sequence to point above)

Note: If a component fails its test, the PTI will stop at that point and display "FAILED - REBOOT". Correct the problem and repeat the PTI by pressing the ENTER Key.

- 4. When the PTI is complete, the test ends automatically and the controller display shows "PTI PASSED (or FAILED) REBOOT". Turn the On/Off Switch Off and back On to reboot and return the unit to normal operation.
- 5. If an operating problem occurs during the PTI, view and correct any alarms or messages. Then acknowledge the alarms or messages and repeat the PTI.

Note: Acknowledge the alarms or messages ONLY after the alarm codes are documented and problems repaired.

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Manual Function Test

The Manual Function Test submenu contains the following component tests:

- RLI Fuel Relay Pull Test
- RL2 Fuel Hold Relay Test
- RL3 Force Speed Test
- RL5 Pre–Heat Test
- RL6 Start Test
- RL4 DSR Test

The test result (PASSED of FAILED) is displayed after a test is performed. To enter the Manual Function Test complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Commands Menu.
- 4. Press the ENTER key to enter the Commands Menu.
- 5. The PTI submenu will be displayed.
- 6. Press the UP or DOWN key to scroll up or down through the Commands Menu to the Manual Function Test submenu.
- 7. Press the ENTER key to enter the Manual Function Test.
 - The engine will stop if it is running.
 - The Display Test is the first to appear. Press the ENTER key to perform the Display Test.
 - Press the UP or DOWN key to scroll up or down through the Manual Function Test submenu. Press the ENTER key to perform the selected test.
 - Press the ESCAPE key to return to the Commands Menu.

Speed Control

Speed control is used to temporarily set engine speed (either high or low speed) to aid in unit testing for 180 seconds. After 180 seconds the unit will return to normal operating RPM and the controller will exit to the main menu.

- HIGH
- LOW
- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Commands Menu.
- 4. Press the ENTER key to enter the Speed Control menu.
- 5. Press the UP or DOWN key to scroll up or down between HIGH rpm and LOW rpm.
- 6. Press the ESCAPE key to return to the Commands Menu.

Misc. Functions Menu

The Misc. Functions Menu contains the following submenus:

- C/F Mode
- SW / HW (Software/Hardware) Version
- Timers
- Counters
- Date / Time

To enter the Misc. Functions complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Misc. Functions Menu.
- 4. Press the ENTER key to enter the Misc. Functions Menu.
- 5. The C/F Mode submenu will be displayed.
 - Press the ENTER key to enter C/F Mode submenu to set the controller for Celsius or Fahrenheit units.
 - Press the UP or DOWN key to scroll up or down through the Misc. Functions Menu.
 - Press the ESCAPE key to return to the Main Menu.



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C/F Temperature and Language Mode

The C/F Mode submenu is used the change:

- Language: Allows unit to display English, Spanish, or Danish for all screens.
- C/F: Allows unit to display Celsius or Fahrenheit display temperature readings.

To enter the C/F Mode submenu and change the language or units displayed complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Misc. Functions Menu.
- 4. Press the ENTER key to enter the Misc. Functions Menu.
- 5. The C/F Mode submenu will be displayed.
- 6. Press the ENTER key to enter C/F Mode to change the units displayed.
- 7. Press the UP or DOWN key to toggle between UNITS and LANGUAGE. Press ENTER.
- 8. Press the UP or DOWN key to toggle between the Celsius and Fahrenheit settings or the available languages.
- 9. Press the ESCAPE key and the ENTER key at the same time to save the new setting and return to the Misc. Functions Menu.

Note: Press the ESCAPE key to return to the Misc. Functions Menu without saving the new setting.

Note: If you select C (Celsius) C for temperature and bars for pressure. If F (Fahrenheit) is selected then you'll get F for temperature and PSI for pressure reading.



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SW/HW Version (Software / Hardware)

The SW/HW Application Version submenu displays the following information about the controller:

- AP (Application)
- BL (Build)
- SN (Serial Number)
- Display version

To enter the Program Version submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Misc. Functions Menu.
- 4. Press the ENTER key to enter the Misc. Functions Menu.
- 5. Press the UP or DOWN key to scroll up or down through the Misc. Functions Menu to the Program Version submenu.
- 6. Press the ENTER key to enter the Program Version submenu.
- 7. Press the ESCAPE key to return to the Misc. Functions Menu.



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Timers

The Timers submenu displays the following hour meters:

- Run Hours The number of hours the unit has been running.
- Engine Off Hours The number of hours the unit has been running since Engine Off Hours was cleared. An alarm is generated when the reading reaches the threshold set in the Configuration Menu.
- Engine Run Hours Low Speed The number of hours the unit has been running at 50 Hz (low speed).
- Engine Run Hours High Speed The number of hours the unit has been running at 60 Hz (high speed).
- Hour Meter 1 The number of hours the unit has been running since Hour Meter 1 was cleared. A message is generated when the reading reaches the threshold set in the Configuration Menu.
- Hour Meter 2 The number of hours the unit has been running since Hour Meter 2 was cleared. A message is generated when the reading reaches the threshold set in the Configuration Menu.
- **Note:** The readings for Run Hours, Run Hours 50 Hz, and Run Hours 60 Hz can be adjusted. See "Setting Hour Meters". Thresholds and Resetting Hour Meters".

To enter the Timers submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Misc. Functions Menu.
- 4. Press the ENTER key to enter the Misc. Functions Menu.
- 5. Press the UP or DOWN key to scroll up or down through the Misc. Functions Menu to the Timers/Counters submenu.
- 6. Press the ENTER key to enter the Timers submenu.
 - Press the UP or DOWN key to scroll up or down through the Timers.
 - Press the ESCAPE key to return to the Misc. Functions Menu.



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Counters

The Counters submenu displays the following event counters:

- Restarts The number of restarts the controller has made since the last power up.
- Total Restarts The total number of restarts.

To enter the Counters submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Misc. Functions Menu.
- 4. Press the ENTER key to enter the Misc. Functions Menu.
- 5. Press the UP or DOWN key to scroll up or down through the Misc. Functions Menu to the Counters submenu.
- 6. Press the ENTER key to enter the Counters submenu.
 - Press the UP or DOWN key to scroll up or down through the Timers.
 - Press the ESCAPE key to return to the Misc. Functions Menu.



Date and Time

The Date and Time submenu is used to set the date clock in the controller. To enter the Date/Time submenu and set the clock complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Misc. Functions Menu.
- 4. Press the ENTER key to enter the Misc. Functions Menu.
- 5. Press the UP or DOWN key to scroll up or down through the MISC. FUNCTIONS submenu to the Date Time submenu.
- 6. Press the ENTER key to enter the Date Time submenu to set the date and clock.
- 7. Press the ENTER key to enable the edit the date and time.
- Use the ENTER key to move the cursor (to the right) to select the value you want to change.
 Note: The ENTER key does not move the cursor to the right in the Time value. You must use the UP or DOWN keys to scroll the total Time value up or down.
- 9. Press the UP or DOWN key to scroll the selected value up or down to the new setting.
- 10. Repeat steps 8 and 9 until you have changed all the values to the new settings.
- 11. Press the ESCAPE key and the ENTER key at the same time to save the new settings and return to the System Setup submenu.

Note: Press the ESCAPE key to return to the Misc. Functions submenu without saving the new settings.





Configuration Menu

The Configuration Menu is used to configure the following controller functions (also see the flowcharts on the following pages):

A WARNING

Equipment Damage and Risk of Injury!

The unit will begin a start sequence and attempt to start when Configuration Mode is exited on the controller.

- Controls Set engine RPM control mode to AUTO / HIGH / LOW for service procedures.
- Unit Configuration Set unit Engine type, Generator type, Genset type, Serial Number, and Output Voltage settings.
- Option Configuration Set controller selectable options such as Tank Size, Fuel Sensor, Low Fuel Limit, Restarts, Speed Solenoid, HRG Gizmo, Water in Fuel, Composite, HM1 Threshold, HM2 Threshold.
- System Configuration Set the unit ID number. The ID number is not the unit serial #; it is a number created by the unit user, operator, or owner.
- MISCH Configuration The default setting is OFF. When this is set to ON, the controller will reset all run timers to 0 when the unit is turned Off and then back On.

To enter the Configuration Menu, complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Configuration Menu.
- 4. Press the ENTER key to enter the Configuration Menu.



Controls

The Controls submenu is used to temporary set engine RPM to AUTO / HIGH / LOW for service purposes. To enger the Controls submenu, complete the flowing steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the CONFIGURATION Menu.
- 4. Press the ENTER key to enter the CONFIGURATION Menu.
- 5. Press the UP or DOWN key to scroll up or down through the CONFIGURATIONS submenu to the CONTROLS submenu.
- 6. Press the ENTER key to enter the CONTROLS submenu.
- 7. Press the ENTER key again to enable CONTROL setting changes.
- 8. Press the UP or DOWN key to the change the setting between AUTO, HIGH, and LOW.
- 9. Press the ESCAPE key and the ENTER key at the same time to save the new settings and return to the System Setup submenu.

Note: Press the ESCAPE key to return to the Misc. Functions submenu without saving the new settings.


Unit Configuration

The unit configuration submenu contain the following settings and is used to set up the controller for the specific unit it is controlling:

- Engine Select the specific engine type in the unit.
- Generator Select the specific generator type in the unit.
- Genset Type Select the specific genset type of the unit (side, center, clip on mount)
- Serial Number Enter the correct serial number of the unit which is found on the unit's serial number tag.
- Output Voltage Type Select the unit output voltage (460V or 230V)

A WARNING

Equipment Damage and Risk of Injury!

After the unit is configured and the controller exits Configuration Mode, the unit will begin a start sequence.

Follow the steps below to ensure the unit is configured correctly.

- 1. Turn the unit "ON".
- 2. Use the UP and DOWN arrows to view the MAIN MENU, UNIT CONFIGURATION submenu.
 - Press the ENTER key.



- 3. Set ENGINE type:
 - With the curser on ENGINE, press the ENTER key.



- Use the UP and DOWN keys to scroll to the correct engine:
 - YANMAR MECH (SG 3000e series units)
 - PCM (SG 4000 series units)
 - YANMAR HPCR (SG 5000 series units)
- When the correct engine is selected, press the ESC and ENTER keys at the same time to save the engine choice.



4. Set GENERATOR type:

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- Use the UP and DOWN keys to put the curser on GENERATOR.
- Press the ENTER key when the curser is on GENERATOR.



- Use the UP and DOWN keys to scroll to the correct alternator:
 - MECC ALTE (SG 5000, SG 4000, and SG 3000e after December 2016)
 - STANFORD (SG 3000e Before December 2016). Could be MECC ALTE if generator has been replaced, see not below.
 - Note: SG 3000e UNITS: Verify the generator type which is identified on the alternator serial plate.
- When the correct alternator is selected, press the ESC and ENTER keys at the same time to save the engine choice.



- 5. Set GENSET TYPE:
 - Use the **UP** and **DOWN** keys to put the curser on GENSET TYPE.
 - Press the ENTER key when the curser is on GENSET TYPE.



- Use the UP and DOWN keys to scroll to the correct Genset Type:
 - CLIP ON
 - SIDE
 - CENTER
- When the correct genset type is selected, press the ESC and ENTER keys at the same time to save the engine choice.



6. Set SERIAL NUMBER:

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- Use the UP and DOWN keys to put the curser on SERIAL NO.
- Press the ENTER key when the curser is on SERIAL NO.



- Enter the unit serial number by:
 - Use the arrow keys to scroll UP and DOWN to select the number or letter.
 - Press the ENTER key to move to the next serial number digit
- When the correct serial number is entered, press the ESC and ENTER keys at the same time to save the serial number.



- 7. Set unit OUTPUT VOLTAGE TYPE.
 - Use the UP and DOWN keys to put the curser on OUTP. VOLT TYPE.
 - Press the ENTER key when the curser is on OUTP. VOLT TYPE.



- Select the unit output voltage by:
 - Use the arrow keys to scroll UP and DOWN to select the correct output voltage (460V or 230V).
- When the correct voltage is selected, press the ESC and ENTER keys at the same time to save the voltage.



A WARNING

Equipment Damage and Risk of Injury!

After the unit is configured and the controller exits Configuration Mode, the unit will begin a start sequence.

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8. After all the unit configuration setting are set and saved, press the ESC key twice to return to the main menu screen



Option Configuration

The Option Configuration submenu allows setting values for the following unit options:

- Fuel Tank Size Select the correct fuel tank size for the unit (50, 75, 80, 125 gallon).
- Fuel Level Sensor Select if the unit is equipped with a fuel level sensor (YES / NO).
- **Note:** Only applies to gensets with the standard ultrasonic fuel sensor connected directly to the SG+1.5 controller, for gensets equipped with telematics fuel level sensor option needs to be set to NO.
- Fuel Low Limit Set fuel level at which a fuel level warning is set.
- Restarts Set number of times the unit will attempt to restart after a failed start (default 1).
- Speed Solenoid Select if the unit is equipped with a speed solenoid (YES / NO) (SG 3000e Only).
- HRG Gizmo Select if the unit is equipped with a HRG Gizmo (YES / NO).
- Water in Fuel Select if the unit is equipped with a water level sensor in the fuel filter (SG5000 Only)
- Composit Telematics installed, will auto select (Yes / No).
- HM1 Thredshold Set the number of hours for the HM1 hour meter.
- HM2 Thredshold Set the number of hours for the HM2 hour meter.

To enter the Option Configuration submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Configuration option.
- 4. Press the ENTER key to enter the Configuration menu.
- 5. Press the UP or DOWN key to scroll up or down through the Configuration Menu to the Option Configuration submenu.
- 6. Press the ENTER key to enter the Option Configuration submenu.
 - Press the UP or DOWN key to scroll up or down through the options.
 - Press the ESCAPE key to return to the Option Configuration Menu.

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System Configuration

The System Configuration submenu allows the use to set the unit ID number.

Note: The ID number is not the unit serial #; it is a number created by the unit user, operator, or owner.

Follow the steps below to set the unit ID number:

- 1. From the MAIN MENU, use the UP and DOWN keys to find CONFIGURATION.
- 2. Press the ENTER key.



- 3. Use the UP and DOWN keys to SYSTEM CONFIGURATION.
- 4. Press the ENTER key.



- 5. Use the UP and DOWN keys to ensure the curser is on ID NO.
- 6. Press the ENTER key when the curser is on ID NO.



- 7. Enter the unit ID number by:
 - Use the arrow keys to scroll UP and DOWN to select the number or letter.
 - Press the ENTER key to move to the next ID number digit

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8. When the correct ID number is entered, press the ESC and ENTER keys at the same time to save the ID number.



9. After the unit ID number is entered and saved, press the ESC key twice to return to the main menu screen.



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MISCH Configuration

The MISCH Configuration is used as a factory reset for all settings. The function will set all custom settings back to the factory original settings.

The MISCH Configuration submenu allows setting values for the following unit options:

• Factory Reset – Select YES to activate a factory reset of all settings.

To enter the MISCH Configuration submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Configuration option.
- 4. Press the ENTER key to enter the Configuration menu.
- 5. Press the UP or DOWN key to scroll up or down through the Configuration Menu to the MISCH Configuration submenu.
- 6. Press the ENTER key to enter the MISCH Configuration submenu.



Event Log Menu

The Event Log Menu allows user access to view saved events and to perform a USB download.

The Event Log menu has these submenus:

- Events View configuration, settings changes, and messages saved by the controller.
- Fuel Events View fuel system messages and events.
- USB Copy Event Log Allows user to generate a log file of all events onto a USB device for PC viewing.
- To enter and use the Event Log Menu, complete the following steps:
- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Event Log menu.
- Press the ENTER key to enter the Event Log submenu.
- Press the UP or DOWN key to scroll up or down through submenu.
- Press the ESCAPE key to return to the Main Menu.



SG+ 1.5 Controller and Operating Instructions

Events

The Event Log is a list of events that are recorded in the controller memory. Examples of recorded events are a system power up, alarms, and messages. Events are listed in the reverse order of their occurrence. Viewing the event log can be helpful when diagnosing a problem.

Note: The Event Log will log 128 events. When full, the controller uses a first in first out overwriting of events.

To enter the Event Log submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Event Log Menu.
- 4. Press the ENTER key to enter the Event Log Menu.
- 5. The Event Log submenu will be displayed.
- 6. Press the ENTER key to enter the Event Log submenu.
- 7. The Event Log will appear on the display. It shows the most recent event and the date and time of that event.
- 8. Press the DOWN key to scroll down to the next event.
- 9. Press the UP or DOWN key to scroll up or down through the event log.
- 10. Press the ESCAPE key to return to the Event Log Menu.



Fuel Events

The Fuel Events is a list of fuel events that are recorded in the controller memory on units equipped with the fuel level sensor option. An example of a recorded event is when fuel is added to the fuel tank. Fuel Events are listed in the reverse order of their occurrence.

Note: Only applies to gensets with the standard ultrasonic fuel sensor connected directly to the SG+1.5 controller, for gensets equipped with telematics fuel level sensor option needs to be set to NO.

Note: The Fuel Events will log 128 events. When full, the controller uses a first in first out overwriting of events.

To enter the Fuel Events submenu complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Event Log Menu.
- 4. Press the ENTER key to enter the Event Log Menu.
- 5. The Event Log submenu will be displayed.
- 6. Press the UP or DOWN key to scroll up or down to the Fuel Events submenu.
- 7. Press the ENTER key to enter the Fuel Events submenu.
- 8. The Fuel Events will appear on the display. It shows the most recent fuel event and the date and time of that event.
- 9. Press the DOWN key to scroll down to the next fuel event.
- 10. Press the UP or DOWN key to scroll up or down through the fuel events.
- 11. Press the ESCAPE key to return to the Event Log Menu.



SG+ 1.5 Controller and Operating Instructions

USB Copy Event Log

The USB Copy Event Log is a function that allows the download of all logged events onto a USB drive located on the controller board.

Format USB drive to Fat 32 system. Use a blank USB drive.

Note: A Logman II PC 2.8.1 can also be used to download the log.

To enter the USB Copy Event Log submenu and complete ad download, complete the following steps:

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Event Log Menu.
- 4. Press the ENTER key to enter the Event Log Menu.
- 5. The Event Log submenu will be displayed.
- 6. Press the UP or DOWN key to scroll up or down to the USB Copy Event Log submenu.
- 7. Press the ENTER key to enter the USB Copy Event Log submenu.
- 8. Press ENTER to generate log file.
- 9. Wait for display to show !!DONE!!.
- 10. Turn genset OFF, insert USB drive, turn genset ON.
- 11. DO NOT turn genset OFF until it starts to count down on the display.
- 12. Turn genset OFF and remove USB drive.
- 13. Log files are saved.

SG+ 1.5 Controller and Operating Instructions



SG+ 1.5 Controller and Operating Instructions

LogView and Viewing SG+ Logs

With the release of LogView software version 5.9.2.0 (or later), you can now view SG+ Event logs. The following will outline how to interpret the SG+ log. To understand now to use LogView refer to the Help file found within LogView.

The SG+ log can store up to 128 Event logs. The oldest events will be over written in the log automatically.

The latest LogView files can be found on our Web site under Global Marine Solutions Info Central.

Note: Logman II PC Rev. 2.7.0 (or later) is required to flashload software or to download the data logger.

Event Description			
Alarm	Alarm Code	An alarm is activated, see "Alarm List" on page 63 for alarm descriptions	
Message	Message code	A message is activated, see "Message List" for message descriptions	
	Shutdown alarm	If an alarm is active and entering shutdown state	
Engine	Engine running	The engine is running	
	Restart engine	Restart sequence started	
	PTI started	PTI start event	
Pre Trip	PTI failed	PTI failed	
	РТІ ОК	PTI completed	
Configura-	Factory reset	Factory reset initiated by user	
tion	Clock set	Time and date adjusted	
Dowor	Power off	Time and date for controller power off	
Power	Power on	Time and date for controller power on	
Log retrieved	Log retrieved	The event log is retrieved from the unit	
	High to low speed - was XXX RPM	RPM above shift point	
	Low to high speed - was XXX RPM	RPM below shift point	
	Low to high speed RPM below limit	RPM below 1500 RPM	
Crood	High to low speed MAGNUM unit detected	A TK MAGNUM unit is detected	
Speed	Low to high speed compressor start detected	Reefer unit controller is resetting	
	Low to high speed water temperature to high Water temperature XXX	If water temperature is above 5 C below alarm high limit	
	Failed to detect speed solenoid	This event is set in the state "LOAD MEAS" if it fails to detect the speed change	
Fuel	Positive change from X.X to X.X Ga Change in level; +X.X Ga	Positive fuel change detected	
ruei	Negative change from X.X to X.X Ga Change in level; - X.X Ga	Negative fuel change detected	
System	Flashload completed OLD: XXX to NEW: XXX	A new version of the application is loaded	

SG+ 1.5 Controller and Operating Instructions

Figure 3. Example of SG+ Log



RAJ645

SG+ 1.5 Controller and Operating Instructions

Setting Hour Meter Thresholds and Resetting Hour Meters

The Hour Meter Threshold feature sets the controller to alert the user that the unit has operated for a defined number of hours. The number of operating hours are entered in the controller in the Hour Meter Threshold display. The controller then generates a message when the hour meter reaches the threshold setting.

Note: If the user does not desire to use the Hour Meter Threshold feature to measure maintenance intervals, etc., leave the settings at "00000" to avoid nuisance messages.

The readings for Run Hours, Run Hours 50 Hz, and Run Hours 60 Hz can be adjusted.

To set the HM1 Threshold or the HM2 Threshold, or to reset Run Hours, Run Hours 50 Hz, or Run Hours 60 Hz, complete the following steps.

- 1. Place the On/Off switch in the "ON" position.
- 2. Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- 3. Press the UP or DOWN key to scroll up or down through the Main Menu to the Configuration Menu.
- 4. Press the UP or DOWN key to scroll up or down through the Configuration Menu to the Option Configuration menu.
- 5. Press the ENTER key to enter the Option Configuration menu.
- 6. The Option Configuration menu will be displayed.
- 7. Press the UP or DOWN key to scroll up or down through the Option Configuration menu to HM1 Threshold and HM2 Threshold.
- Press the ENTER key to select HM1 or HM2. Use the ENTER and UP or DOWN keys to set the desired hour interval.
 Note: For example, to change the setting for the HM1 Threshold to 400 hours, press the ENTER key until the cursor is under the third digit from the right. Then press the UP key until that value reads 4.
- 9. Press the UP or DOWN key to scroll the selected value up or down to the new setting.
- 10. Repeat steps 8 and 9 until you have changed all the values to the new settings.
- 11. Press the ESCAPE key and the ENTER key at the same time to save the new settings and return to the Option Configuration menu.

Note: Press the ESCAPE key to return to the Configuration Menu without saving the new settings.

Electrical Maintenance

Battery

ACAUTION

Risk of Injury!

Place the unit On/Off switch in the "OFF" position, Before connecting or disconnecting the unit battery.

Inspect and clean the battery terminals, check the electrolyte level during scheduled maintenance inspections. The minimum specific gravity should be 1.235. Add distilled water as necessary to maintain the proper water level.

A dead or low battery can be the cause of an ammeter indicating discharge due to lack of initial excitation of the alternator.

Note: If the battery was discharged enough that a boost was needed, the alternator may not recharge the battery. This is because there may not be adequate current to excite the alternator field.

Electrical Maintenance

Relays

All the relays are 12 Vdc relays. The relays on the microprocessor PC board are interchangeable. The relays mounted on the inside of the control box are interchangeable. The relays on the microprocessor PC board are not interchangeable with the relays mounted on the inside of the control box. Test a relay by interchanging it with a known good relay.

Pull Relay

The Run relay (RL1) is located on the PC board. The RL1 LED on the PC board will light up when the Run relay is energized.

Hold Relay

The Ignition relay (RL2) is located on the PC board. The RL2 LED on the PC board will light up when the Hold relay is energized.

Throttle Relay

The Throttle relay (RL3) is located on the PC board. It supplies power to the throttle. The RL3 LED on the PC board will light up when the Throttle relay is energized.

Quad Relay

The Quad relay (RL4) is located on the PC board. The RL4 LED on the PC board will light up when the Quad relay is energized.

Start Relay

The Start relay (RL5) is mounted on the inside of the control box. It is energized by the controller after proper preheat time has occurred. When this relay energizes, the starter solenoid receives power and the engine cranks. If the Start relay fails in the open position, the engine would not crank. If the relay failed in the closed position, the starter would continue to crank after the unit started.

Preheat Relay

The Preheat relay (RL6) is mounted on the inside of the control box. If the preheat relay fails the controller will display a message.







1.	Relay RL4 - Quad Relay	3.	Relay RL2 - Hold Relay
2.	Relay RL3 - Throttle Relay	4.	Relay RL1 - Pull Relay

Fuses

Fuse SI1 (Located on Control board)	30 Amp - RL Relays Fuses
Fuse SI2 (Located on Control board)	30 Amp - Battery Charger Fuse
Fuse SI3 (Located on Control board)	10 Amp - J9 to J13 Controller Fuse

Unit Wiring

Inspect the unit wiring and wire harnesses during scheduled maintenance inspections for loose, chaffed or broken wires. This will protect against unit malfunctions due to open or short circuits.

Wire Harness Routing

Do not change the factory routing of the wire harnesses inside the unit.

12 Vdc Charging System

Battery charging current is supplied by Controller. The battery charging circuit provides current to the battery until the proper charge level is attained (13.1 to 14.6 volts).

Electrical Maintenance

The alternator exciter field is controlled by the DSR. This initiates battery charging approximately 15 seconds after unit has output voltage.

Note: The engine must run for approximately 120 seconds before the battery charging circuit is energized.

Engine Maintenance

EMI 3000

EMI 3000 is an extended maintenance interval package. The EMI 3000 package consists of the following key components:

- EMI 3000-Hour Cyclonic Air Cleaner Assembly and Air Cleaner Element
- EMI 3000-Hour 5-Micron Fuel Filter
- EMI 3000-Hour Dual Element Oil Filter (blue with white lettering)
- API Classification CJ-4 or CK-4 Oil
- Five Year or 12,000 Hour Extended Life Coolant (ELC)

The EMI package allows standard maintenance intervals to be extended to 3,000 hours, or 2 years, whichever occurs first.

Note: Units equipped with the EMI 3000 package do require regular inspection in accordance with Thermo King's maintenance recommendations.

Note: The new EMI 3000 oil filters and new EMI 3000 air cleaners are NOT interchangeable with the oil filters and air cleaners previously used in trailer units.

Engine Oil Change

The engine oil should be changed according to the Maintenance Inspection Schedule.

Note: See Specifications chapter for correct oil type.

- *Important:* Never overfill the engine oil. Overfilling the oil can result in increased oil consumption, high oil temperature, accelerated oil degradation rate, and increase engine load.
- 1. Verify the unit is on a level surface for draining and oil level checking. The engine should be warm when draining the oil.
- 2. Turn the Service Switch (Unit ON/OFF switch) to the OFF position.
- 3. Drain the engine oil into a suitable container.

Note: It is important to get as much of the oil out as possible because most of the dirt particles are contained in the last smallest quantity of oil that drains out of the pan.

- 4. Refill the oil sump with fresh engine oil. A new oil filter must also be filled with oil before it is installed; therefore, use a total oil volume required to fill the filter and sump, approximately: . Fully thread the dipstick back into the oil pan, then remove it to check oil level.
- 5. Turn the Service Switch (Unit ON/OFF switch) to the ON position.
- 6. Start and run the unit and check for oil leaks.
- 7. Shut unit off.
- 8. Remove the dipstick from the oil pan and wipe it clean. Fully thread the dipstick back into the oil pan, then remove it to check oil level.
- 9. Add oil if needed. The oil level must be within the cross-hatch area of the dipstick. Never overfill the engine oil.
- 10. Properly dispose of the used engine oil and filter.

Oil Filter Change

The oil filter should be changed along with the engine oil. Use a genuine Thermo King extended maintenance oil filter.

- 1. Remove the filter.
- 2. Fill the new oil filter with clean engine oil.
- 3. Apply oil to the two inner O-rings of the new filter and install the filter.
- 4. Hand tighten the filter until it seats firmly. The exposed dust seal ring, if equipped, does not need to be compressed.
- 5. Start the unit and check for leaks.

Engine Maintenance

Low Oil Pressure

Oil pressure is affected by oil temperature, oil viscosity, and engine speed.

- Low oil pressure can usually be traced to the lack of oil, a faulty oil pressure regulating valve, or worn bearings.
- Low oil pressure is not normally caused by a faulty oil pump.
- Use the "Low Oil Pressure Flow Chart" (Figure 5, p. 94) to help diagnose low oil pressure.

Figure 5. Low Oil Pressure Flow Chart



Engine Cooling System

The engine employs a closed, circulating type, pressurized cooling system. Correct engine temperatures are controlled and maintained by a radiator, fan, and thermostat. The coolant is circulated through the system by a belt driven centrifugal pump. The pump draws the coolant from the side of the radiator, circulates it through the cylinder block and

head and returns it to the radiator. A thermostat mounted in the coolant outlet line from the cylinder head to the radiator automatically maintains coolant temperature within the specified temperature range.

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Engine Maintenance

All water cooled engines are shipped from the factory with a 50 percent permanent type antifreeze concentrate and 50 percent water mixture in the engine cooling system.

This provides the following:

- 1. Prevents freezing down to -30 F (-34 C).
- 2. Retards rust and mineral scale that can cause engine overheating.
- 3. Retards corrosion (acid) that can attack accumulator tanks, water tubes, radiators, and core plugs.
- 4. Provides lubrication for the water pump seal.

Extended Life Coolant (ELC)

ELC is used in this unit. A nameplate near the coolant expansion tank identifies units with ELC.

NOTICE

System Contamination!

Do not add "GREEN" or "BLUE-GREEN" conventional coolant to cooling systems using "RED" Extended Life Coolant, except in an emergency. If conventional coolant is added to Extended Life Coolant, the coolant must be changed after 2 years instead of 5 years.

Note: The new engine coolant, Chevron Extended Life Coolant, is RED in color instead of the current GREEN or BLUE-GREEN colored coolants.

Figure 6. ELC Nameplate Located Near Expansion Tank



The following are the Extended Life Coolants currently approved by Thermo King for use in ELC units for five years or 12,000 hours:

- Chevron Dex-Cool
- Texaco ELC (nitrite free)
- Havoline Dex-Cool (with nitrates)
- Havoline Dex-Cool (nitrite free)
- Shell Dexcool
- Shell Rotella
- Havoline XLC (Europe)
- Saturn/General Motors Dex-Cool
- Caterpillar ELC
- Detroit Diesel POWERCOOL Plus

Note: The use of 50/50 percent pre-mixed Extended Life Coolant (ELC) is recommended to assure that de-ionized water is being used. If 100 percent full strength concentrate is used, de-ionized or distilled water is recommended over tap water to insure the integrity of the cooling system is maintained.

Engine Maintenance

Antifreeze Maintenance Procedure

As with all equipment containing antifreeze, periodic inspection on a regular basis is required to verify the condition of the antifreeze. Inhibitors become worn out and must be replaced by changing the antifreeze. Change ELC (red) engine coolant every five years or 12,000 hours (whichever occurs first).

Do not mix green or blue-green engine coolant with ELC (red) engine coolant. See "Extended Life Coolant (ELC)" for more information about ELC.

The factory recommends the use of a 50/50 antifreeze mixture in all units even if they are not exposed to freezing temperatures. This antifreeze mixture will provide the required corrosion protection and lubrication for the water pump.

Checking the Antifreeze

Check the solution concentration by using a temperature compensated antifreeze hydrometer or a refractometer (P/N 204-754) designed for testing antifreeze. Maintain a minimum of 50 percent permanent type antifreeze concentrate and 50 percent water solution to provide protection to -30 F (-34 C). Do not mix antifreeze stronger than 68 percent permanent type coolant concentrate and 32 percent water for use in extreme temperatures.

Changing the Antifreeze

1. Run the engine until it is up to its normal operating temperature. Stop the unit.

ACAUTION

Risk of Injury!

Avoid direct contact with hot coolant.

- 2. Open the engine block drain and completely drain the coolant. Observe the coolant color. If the coolant is dirty, proceed with steps a, b, and c. Otherwise proceed to step 3.
 - a. Run clear water into the radiator and allow it to drain out of the block until it is clear.
 - b. Close the block drain and install a commercially available radiator and block flushing agent, and operate the unit in accordance with instructions of the flushing agent manufacturer.

ACAUTION

Risk of Injury!

Avoid direct contact with hot coolant.

- c. Open the engine block drain to drain the water and flushing solution.
- 3. Inspect all hoses for deterioration and hose clamp tightness. Replace if necessary.
- 4. Inspect the radiator cap. Replace the cap if the gasket shows any signs of deterioration.
- 5. If using ELC concentrate, mix one gallon of ELC concentrate and one gallon of de-ionized or distilled water in a container to make a 50/50 mixture (Do not add antifreeze and then water to the unit. This procedure may not give a true 50/50 mixture because the exact cooling system capacity may not always be known).
- 6. Refill the radiator with the 50/50 antifreeze mixture and verify to bleed the air from the cooling system as needed.

Bleeding Air from the Cooling System

Jiggle pin thermostats are original equipment on units that have engines from the TK486 family of engines. Jiggle pin thermostats make it unnecessary to bleed the air out of the engine block because they keep air from being trapped in the engine block. Normally, all but about 1.5 qt (1.4 liters) of coolant drain out of the cooling system when it is drained. If approximately half of the Cooling System Capacity (see Specifications Chapter) seems to fill the cooling system after it has been drained, air has been trapped in the block. Bleed the air out of the block using the following procedure:

NOTICE

Equipment Damage!

Do not start the engine without bleeding the air out of the block.

Note: If an engine runs with air trapped in the block, the engine may be damaged. The high water temperature switch may not protect an engine that has air trapped in the block, because the high water temperature switch is designed to protect an engine from overheating due to failures in the cooling system.

THERMO KING Engine Maintenance

- 1. Remove the plug from the front end of the water pump below the thermostat housing as shown (Figure 7, p. 97).
- 2. Slowly pour the coolant into the system until you see coolant at the plug fitting.
- 3. Reinstall the plug.
- 4. Pour coolant into the system until it appears to be full.

Figure 7. Remove Plug from Water Pump



- 5. Verify that the amount of coolant that goes back into the system is approximately equal to the amount of coolant that came out of the system.
- 6. Start the engine and monitor the coolant temperature with the unit engine coolant temperature gauge, or by using a non-contact thermometer pointed at the thermostat housing in the location of the high water temperature switch or sensor.
 - a. When the temperature reaches 150 F (66 C), shut the engine off for two minutes.
 - *Note:* This allows time for the thermostat to heat soak and open fully, ensuring that any remaining air will be purged out of the engine block when the engine is restarted.
- 7. Restart the engine and run it in low speed.
 - a. Remove the cap from the expansion tank and slowly pour coolant into expansion tank until it is full, then reinstall the expansion tank cap.
- 8. Repeat steps 6 and 7 until the coolant level stabilizes.

Engine Thermostat

For the best engine operation, use a thermostat year-round.

Engine Maintenance

Engine Fuel System

The components of the fuel system are:

- Fuel tank
- Fuel filter
- Water separator
- Hand fuel pump
- Injection pump
- Injection nozzles

The hand fuel pump is used to manually draw fuel from the tank up to the transfer pump if the unit should run out of fuel. Fuel is drawn from the fuel tank through the prefilter by the transfer pump (or electric fuel pump). The transfer pump (or electric fuel pump) delivers fuel to the water separator and fuel filter. Filtered fuel passes through a line from the outlet fitting on the filter base to the injection pump.

Operation

Fuel is drawn from the fuel tank and through the fuel pre-strainer and inlet strainer by the fuel transfer pump. The fuel transfer pump delivers fuel to the fuel filter/water separator. Two orifices in the filter head control the pressure in the fuel system by allowing a certain amount of fuel to return to the tank. One orifice is located in the center of the filter head. It bleeds off water. The other orifice is located off-center on the filter head. It bleeds off air. Filtered fuel passes through a line from the outlet fitting on the filter base to the injection pump.

The injection pump forces the fuel, at a very high pressure, through the injection nozzles. The injection nozzles atomize the fuel as it is injected directly into the combustion chambers.

Injection pump leakage, injection nozzle overflow and excess fuel from the fuel filter orifice are then all sent back to the fuel tank through the return line.

Fuel Line Routing

The fuel lines from the fuel tank connect to the fittings on the fuel filter. Do not change the factory routing of the fuel lines from the fuel filter to the injection pump.

Maintenance

The injection pump and fuel transfer pump are relatively trouble-free and if properly maintained will usually not require major service repairs between engine overhauls.

Contamination is the most common cause of fuel system problems. Therefore, to ensure best operating results, the fuel must be clean and fuel tanks must be free of contaminants. Change the fuel filter/water separator regularly, inspect/ clean the fuel pre-strainer, and clean the inlet strainer on the inlet side of the fuel transfer pump.

Important: Do not open the fuel system unless required.

Note: The injection nozzles must be cleaned and tested (and repaired if necessary) at least every 3,000 hours in accordance with EPA 40 CFR Part 89.Normal conditions are considered to be the use of clean high quality fuel, blended oils are not recommended, and regular maintenance of the fuel system according to the Maintenance Inspection Schedule. Refer to the Engine Overhaul Manual TK 50136 for injection nozzle testing and repair procedures.

Whenever the fuel system is opened, take the following precautions to prevent dirt from entering the system:

- Cap all fuel lines.
- Work in a relatively clean area whenever possible.
- Complete the work in the shortest possible time.

Any major injection pump or nozzle repairs should be done by a quality diesel injection service shop. The necessary service equipment and facilities are not found in most engine rebuild shops because of the large investment required.

The following procedures can be accomplished under field conditions:

- Bleeding air from the fuel system.
- Fuel tank and filter system maintenance.
- Priming pump (hand) replacement or repair.

Engine Maintenance

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- Fuel transfer pump replacement or repair.
- Injection line replacement.
- Engine speed adjustments.
- Injection pump timing.
- Nozzle spray pattern testing and adjustment.
- Injection nozzle testing, adjustment, and minor repair.
- Trochoid feed pump replacement.

Figure 8. Fuel System



1.	Return line	5.	Fuel Transfer Pump
2.	Filter Head	6.	Hand Pump

Engine Maintenance

3.	Bleed Screw	7.	Fuel Filter/Water Separator
4.	Mono-plunger and Distributor Injection Pump		

Fuel Return Line Replacement

Use the following procedure to replace the fuel return lines and end cap.

1. Remove the clamps, the end cap, the short fuel return lines between the injection nozzles, and the long fuel return line from the injection nozzle to the banjo fitting on the injection pump.

Figure 9. Fuel Return Line Replacement



1.		т.	Short i dei Ketdi ii Eilles
2.	Larger Clamp	5.	Long Fuel Return Lines
3.	Smaller Clamps		

- 2. Discard the old clamps, end cap, and fuel return lines.
- 3. Install the end cap and clamp. Note that the end cap has a larger OD than the other hoses and requires the larger clamp.
- 4. Install the fuel return lines and clamps. It may be necessary to adjust the banjo fitting slightly to obtain the straightest routing for the long return line.
- 5. Be sure all the fittings are tight and check for leaks.
- 6. Write the date and engine hours on the decal.

Bleeding the Fuel System

If the engine runs out of fuel, repairs are made to the fuel system, or if air gets into the system for any other reason, the air must be bled out of the fuel system.

Note: Make sure the fuel tank vent is kept open. If the vent becomes clogged, a partial vacuum develops in the tank, and this increases the tendency for air to enter the system.

To bleed air from the fuel system:

- 1. Loosen the bleed screw about one turn.
- 2. Unscrew the priming pump handle and manually prime the fuel system until air bubbles are no longer visible in the fuel coming out of the bleed screw.
- 3. Tighten the bleed screw and screw the priming pump handle back in.
- 4. Loosen the injection lines at the injection nozzles.
- 5. Crank the engine until fuel appears at the nozzles.

Engine Maintenance

- 6. Tighten the injection lines.
- 7. Start the engine and observe the engine run for a few minutes. If the engine fails to start, or starts but stops in a few minutes, repeat the procedure.

Draining Water from Fuel Tank

Water run through the system may damage the fuel injection system components. Damage to the fuel injection system will subsequently cause more expensive damage to the engine. A large accumulation of water in the bottom of the fuel tank will stop a diesel engine. Water should be drained during scheduled maintenance inspections to prevent breakdowns. Drain the water after the fuel tank and unit have remained idle for an hour.

- 1. Place a container under the fuel tank to catch the draining water and fuel.
- 2. Remove the drain plug from the bottom of the fuel tank.
 - **Note:** Some fuel tanks have a check valve in the drain plug fitting. Push the check valve open with a small screwdriver to drain the tank.
- 3. Let the water and fuel drain into the container until no water is visible in the fuel draining from the tank.
 - a. If the water and fuel do not drain freely, the vent may be plugged. If so, clean or replace the vent.
- 4. Install the drain plug.

Fuel Filter/Water Separator

The fuel filter/water separator filters the fuel, removes water from the fuel, and returns only fuel to the tank.

Fuel Filter/Water Separator Replacement

Replace the fuel filter/water separator at intervals according to the Maintenance Inspection Schedule.

- 1. Unscrew the fuel filter/water separator canister with a strap wrench. Drain, and dispose of properly.
- 2. Clean the filter head seal surface.
- 3. Lubricate the canister seal with clean fuel.
- 4. Through one of the small openings in the top of the canister, fill the new fuel filter/water separator canister with clean fuel. This will purge the air from the canister. Do not fill canister through the center hole.

Figure 10. Filling Fuel Filter/Water Separator



1.	Fill Through Small Openings
2.	Do Not Fill Through Center Hole

5. Screw the new canister on hand-tight. Using a strap wrench, tighten another 1/4 turn.

Engine Speed Adjustments

When the diesel engine fails to maintain the correct engine speed, check the following before adjusting the speed:

- 1. Check the speed.
- 2. Bleed the air out of the fuel system. Check the speed.
- 3. Bleed the air out of the nozzles. Check the speed.



Make the engine speed adjustments with the engine fully warmed up.

Engine Maintenance

Injection Pump Timing

Use this timing procedure when installing a new injection pump. It is not necessary to use this timing procedure when removing and reinstalling the original injection pump. In that case, align the index marks on the injection pump and the gear case as they were before removing the injection pump.

1. Before removing the old injection pump, note the alignment of the index marks on the injection pump and the gear case. The index mark on the injection pump is usually aligned with the index mark on the gear case. If not, make a mark on gear case in line with the index mark on the injection pump (see Figure 13, p. 104).

Figure 11. Index Mark Location



1. Index Marks

Figure 12. Index Mark Alignment



1.	Index Mark on Injection Pump
2.	Index Mark on Gear Case

Figure 13. Marking Gear Case



Engine Maintenance

1.	Index Mark on Injection Pump
2.	Existing Index Mark on Gear Case
3.	Make New Mark on Gear Case If Needed

2. Clean the area with brake cleaner or something similar. Place an injection angle sticker on the gear case so the center line on the sticker is aligned with the index mark on the injection pump. An injection angle sticker is provided with the new injection pump.

Figure 14. Place Injection Angle Sticker on Gear Case



1.	Index Mark on Injection Pump
2.	Injection Angle Sticker

Figure 15. Injection Angle Sticker



1.	-1.0 Degrees Mark
2.	Center Line (0 Degrees Mark)
3.	+1.0 Degrees Mark

- 3. Remove the old injection pump. Use the injection pump gear tool P/N 204-1011 to remove the injection pump gear without removing the timing gear cover (see "Injection Pump Removal," p. 109).
 - **Note:** Remove the injection pump gear by removing the nut and lock washer that secure the injection pump gear assembly to the injection pump shaft. The injection pump gear assembly is made of three pieces; the flange, the gear, and the transfer pump cam. Do not loosen or remove the four bolts that fasten the gear to the flange because that changes the factory-set timing. The EPA certification is based on the factory-set timing. If the factory-set timing is changed, the EPA certification is void.

Engine Maintenance

Figure 16. Removing Injection Pump Gear



4. Record the injection angle marked on the old injection pump (see the following photographs). The injection angle mark is located on the side of the pump facing the engine. The injection angle mark on the pump does not use a decimal point. Add a decimal point before the last digit of the injection angle mark to get the injection angle. The injection angle mark in the following photographs is 67. That equals an injection angle of 6.7 degrees.

Examples	
Injection Angle Mark	Injection Angle
67	6.7 Degrees
85	8.5 Degrees





1. Injection Angle Mark

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Figure 18. Injection Angle Mark



1.	Injection Angle Mark

Note: If you cannot read the injection angle mark, contact the Thermo King Service Department with the injection pump serial number or the engine serial number and they will provide the injection angle. The injection pump serial number is located on the bottom of the sticker on the injection pump.

Figure 19. Injection Pump Serial Number Location



- 5. Record the injection angle marked on the side of the new injection pump.
- 6. Calculate the injection angle difference by subtracting the injection angle of the old injection pump from the injection angle of the new injection pump.

Examples		
Injection Angle of New Injection Pump (Degrees)	8.5	6.1
 Injection Angle of Old Injection Pump (Degrees) 	- 6.7	- 6.7
 Injection Angle Difference (Degrees) 	= +1.8	= -0.6

 Install the new injection pump on the gear case and position it so the index mark on the injection pump is aligned with the mark equal to the injection angle difference on the injection angle sticker (see the following examples). Tighten the injection pump mounting nuts when the index mark is aligned as necessary with the injection angle sticker.

Engine Maintenance

Figure 20. Examples of Injection Pump Index Mark Alignment with Injection Angle Sticker



8. Install the injection pump gear, lock washer, and nut. Torque the nut to 58 to 65 ft-lb (78 to 88 N•m).

Note: If the timing gear cover was removed to remove the injection pump gear, make sure the timing marks on the timing gears are aligned as shown below. It helps to install the idler gear last when aligning the timing marks.

Figure 21. Timing Mark Alignment



1.	Fuel Injection Pump Gear
2.	Idler Gear
3.	Camshaft Gear
4.	Crankshaft Gear

Note: The oil pump is located in the timing gear cover on TK486V25 / TK486V25L / TK486V25L1 / TK486V25X / TK486V25X1 / TK486VHA engines. The inner rotor of the oil pump fits around the crankshaft gear. Make sure that the flat sides of the inner rotor are aligned with the flat sides on the crankshaft gear when installing the timing gear cover.
THERMO KING Engine Maintenance

Figure 22. Align Flat Sides of Crankshaft Gear with Flat Sides of Inner Rotor in Timing Gear Cover



1.	Crankshaft Gear
2.	Oil Pump Cover
3.	Outer Rotor
4.	Inner Rotor
5.	Timing Gear Cover
6.	Flat Sides on Inner Rotor
7.	Flat Side on Crankshaft Gear

Injection Pump Removal

The injection pump drive gear will not fit through the gear housing when removing the pump, the gear must be separated from the pump. Using tool P/N 204-1011, it will not be necessary to remove the belts, crankshaft pulley, crankshaft seal or front plate. See Figure 25, p. 111.

1. Note the alignment of the index marks on the injection pump and the gear case. The index mark on the injection pump is usually aligned with the single index mark on the gear case. If not, mark it so the injection pump can be returned to the same position when it is reinstalled.



Figure 23. Index Mark Location

Engine Maintenance

Figure 24. Index Mark Alignment



1. Index Mark on Injection Pump

2. Index Mark on Gear Case

- 2. Remove the starter for clearance, remove throttle linkage, fuel lines, harness and mounting hardware from injection pump.
- 3. Remove the cover plate from the gear case. Remove the nut and lock washer which secure the gear to the injection pump shaft. Use a shop rag to prevent the lock washer or nut from falling into the gear case.

Note: The injection pump gear assembly is made of three pieces; the flange, the gear, and the transfer pump cam. Do not loosen or remove the four bolts that fasten the gear to the flange because that changes the timing.

- 4. Use the hardware from the cover plate to attach the tool plate (with the marked side pointing up and out) to the gear case.
- 5. Align the threaded holes in the injection pump gear with the two holes in the tool plate by rotating the engine crankshaft. Attach the gear to the tool plate with the screws provided with the tool plate.
- 6. Thread the long screw supplied with the tool plate into the small end of the adapter, also supplied with the tool plate. Insert the adapter into the tool plate and rotate to provide a solid position to force the injection pump shaft from the gear. Caution should be made to align the screw over the center of the injection pump shaft.
- 7. Remove the screw and adapter leaving the tool plate in place. This holds the gear in proper tooth alignment until the injection pump is re-installed.

Engine Maintenance

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Figure 25. Injection Pump Gear Tool



1.	Injection Pump	5.	Adapter (Tool)
2.	Gear Case	6.	Tool Long Screw (Tool)
3.	Cover Plate	7.	Tool Short Screw (Tool)
4.	Cover Plate Bolt	8.	Tool Plate (Tool)

Injection Pump Reinstallation

- 1. Position injection pump shaft into gear, rotating shaft to mate key with keyway in gear. Take care to make sure the key mates with the keyway.
- 2. Secure injection pump to gear case with previously removed hardware. Make sure to align the index marks on the injection pump and the gear case like they were in step 1 of "Injection Pump Removal," p. 109.

Note: If a different injection pump is being installed, see "Injection Pump Timing," p. 104 to set the timing.

- 3. Remove hardware holding gear to tool plate, then remove tool plate.
- 4. Secure the gear to the injection pump shaft with the lock washer and nut. Use a shop rag, as before, to prevent the lock washer or nut from falling into the gear case. Torque the nut to 58 to 65 ft-lb (78 to 88 N•m).
- 5. Fasten cover plate to gear case and reinstall all components removed previously to facilitate injection pump removal.

Fuel Solenoid Replacement

- 1. Disconnect the fuel solenoid wire connector from the main/unified wire harness and remove the old fuel solenoid.
- 2. Connect the new fuel solenoid wire connector to the main/unified wire harness.
- 3. Press the ON Key to turn the unit on.
- 4. Use the microprocessor keypad to enter the Output Test Mode. Refer to the appropriate Microprocessor Diagnostic Manual for specific information about the Output Test Mode.
- 5. Perform a visual functionality check per step 8 in "Testing the Fuel Solenoid" above to verify the fuel solenoid operates correctly.
- 6. Energize the fuel solenoid by energizing the run relay with the Output Test Mode.

Engine Maintenance

Note: The fuel solenoid must be energized when it is installed. If not, the plunger and the linkage may not line up correctly and the fuel solenoid will not function properly.

7. Place the O-ring in the groove in the end of the fuel injection pump. Make sure that the O-ring is positioned correctly during installation to avoid damage and leaks.





1.	Fuel Solenoid
2.	O-ring
3.	Groove in Fuel Injection Pump

- 8. Install the new fuel solenoid.
- 9. Press the OFF Key to turn the unit off after installing the fuel solenoid.

Engine Valve Clearance Adjustment

The valve clearance should be adjusted every 3,000 hours.

- 1. Remove the rocker arm cover.
- 2. Remove the round cover (plug) from the timing mark access hole on the front of the bell housing.

A WARNING

Risk of Injury!

Loosen all of the injection lines at the injection nozzles to prevent the possibility of the engine firing while it is being rotated.

- 3. Place the engine at top dead center of the compression stroke for the number one cylinder. See steps a through d.
 - a. Rotate the engine in the normal direction of rotation (clockwise viewed from the water pump end) until the 1-4 timing mark on the flywheel lines up with the index mark in the timing mark access hole.





1.	Index Mark
2.	Top Dead Center Mark for 1 and 4

- b. Check the rocker arms on the number one cylinder to see if they are loose.
- c. If the rocker arms are loose, the engine is at top dead center of the compression stroke for the number one cylinder.
- d. If the rocker arms are tight, the engine is at top dead center of the exhaust stroke for the number one cylinder. Rotate the engine 360 degrees to place the engine at top dead center of the compression stroke for the number one cylinder.
- 4. Use a feeler gauge to check the valve clearance on both valves for the number one cylinder, the intake valve for the number two cylinder, and the exhaust valve for the number three cylinder. The valve clearance for both the intake valve and the exhaust valve should be 0.006 to 0.010 in. (0.15 to 0.25 mm).
 - a. Check to verify that the valve stem cap is in good condition and is positioned squarely on the top of the valve stem. Replace the valve stem cap if it shows significant wear.
- 5. Adjust the valves if necessary by loosening the locknut and turning the adjustment screw until the valve clearance is correct.

Figure 28. Adjusting the Valve Clearance



AEA705

- 6. Hold the adjustment screw in place and tighten the locknut.
- 7. Recheck the valve clearance.
- 8. Rotate the engine one full turn (360 degrees) in the normal direction of rotation (clockwise viewed from the water pump end), and align the 1-4 timing mark on the flywheel with the index mark in the timing mark access hole. This is top dead center of the compression stroke for the number four cylinder.
- 9. Check and adjust the exhaust valve for the number two cylinder, the intake valve for the number three cylinder, and both valves for the number four cylinder.
- 10. Replace the rocker arm cover, the cover for the timing mark access hole, and tighten the fuel injection lines when finished.

Engine Maintenance

Valve Adjustments and Cylinder Configurations								
	Rear	Flywheel End					Front	Pulley End
Cylinder Number		1		2		3		4
Valve arrangement	E	Ι	E	Ι	E	Ι	E	Ι
Piston in No. 1 cylinder is at TDC on compression stroke	\bigcirc	\bigcirc		\bigcirc	\bigcirc			
Piston in No. 4 cylinder is at TDC on compression stroke			\bigcirc			\bigcirc	\bigcirc	\bigcirc

Crankcase Breather

Gases formed in the crankcase are directed to the intake manifold. Harmful vapors that would otherwise collect in the crankcase and contaminate the oil, or escape to the outside, are drawn back into the engine and burned.

The crankcase breather is located in the valve cover. A restrictor is cast into the fitting for the breather hose on the intake manifold. The restrictor limits the flow of gases from the crankcase to the intake manifold and keeps the crankcase pressure from getting too low in vacuum. A breather hose connects the crankcase breather to the intake manifold.

Figure 29. Crankcase Breather



Normal crankcase pressures with a new air cleaner are 0 to 12 in. (0 to 300 mm) H_2O of vacuum. The vacuum will increase as the air cleaner gets dirty and becomes more restrictive. Check the air restriction indicator before checking the crankcase pressure. Replace the air cleaner if the reading on the air restriction indicator exceeds 20 in. (508 mm) H_2O of vacuum. A dirty air cleaner may cause excessive vacuum, leading to oil carry over and high oil consumption.

The crankcase breather and the breather hose should be inspected when the air cleaner element is replaced to verify they are not plugged or damaged. Inspect the insulation to verify it is in place and undamaged. The insulation is used to prevent freezing in cold weather.

The following items can affect the crankcase pressure readings:

Crankcase Pressure Effect	Typical Cause
Increase	Piston Rings Stuck or Worn
Increase	Breather Hose or Restrictor Plugged with Dirt or Ice
Decrease	Air Cleaner Dirty or Plugged

EMI 3000 Air Cleaner

The EMI 3000 air cleaner is a dry element air cleaner. Replace the EMI 3000 air cleaner element at 3,000 hours or 2 years, whichever occurs first.

Note: The severe duty air cleaner is similar to the EMI 3000 air cleaner but allows the air cleaner element to be replaced at 4,000 hour intervals under normal operating conditions.

Figure 30. EMI 3000 Air Cleaner Assembly



Figure 31. EMI 3000 Air Filter Element



Water Pump Belt Service

The water pump pulley is a split type. Adjust the belt tension by adding or removing shims between the water pump pulley sheaves.

A WARNING

Risk of Injury!

The unit can start at any time without warning. Press the OFF key on the HMI control panel, place the unit Service Switch (On/Off switch) in the Off position, and disconnect the battery before inspecting or servicing any part of the unit.

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Risk of Injury!

Do not attempt to adjust belts with the unit running.

Belt Removal

1. Turn the unit OFF and disconnect the negative battery terminal to ensure unit cannot be operated.

Engine Maintenance

- 2. Access the front of the engine.
- 3. Remove the (4) fan to spacer bolts. It may be necessary to loosen the fan shroud mounts to allow better access the bolts.



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1.	Fan to Spacer Bolts (4)	2.	Fan

- 4. Move the fan forward into the shroud. DO NOT allow the fan to contact the radiator fins.
- 5. Remove the (4) fan spacer nuts, spacer, pulley shims, washer, and outer pulley sheave. Make note of position and thickness of all pulley shims for reuse.



RAJ841

1.	Spacer Nuts (4)	5.	Outer Pulley Sheave
2.	Fan Spacer	6.	Shims that Set Belt Tension
3.	Extra Shims for Belt Tension Setting	7.	Belt
4.	Washer		

6. Remove the belt from the unit and inspect all pulley sheaves. Replace if excessive wear is found.

Engine Maintenance

Belt Installation and Tension Setting

- 1. Install the belt around the crankshaft pulley and water pump inner sheave hub.
- Install the outer pulley sheave, washer, extra shims, fan spacer, and (4) spacer nuts. Torque the nuts to specification: 6.6 ft-lbs (9 Nm).

Important: Belt tension is adjusted by adding, removing, or changing the thickness of shims between the water pump pulley sheaves. It is important to note the number of and thickness of any shims that are removed during service procedures.

3. Check belt tension using a commercially available belt tension tool.

Water Pum	p Belt Tension Specification
New Belt	126 Hz (40 lbs)
Field Reset (used belt)	118 Hz (32 lbs)

- 4. Adjust shims as necessary by removing the (4) fan spacer nuts, spacer, washer, and outer sheave. Change the thickness or number of shims in Location 1. Extra shims are found and stored at Location 2.
 - Additional shims can be purchased and are found in the unit's parts manual.



ſ	
Location 1:	Location 2:
Shims To Adjust Belt Tension	Spare Shims Kept Here

- 5. After belt tension is set correctly, ensure the (4) spacer nuts are torqued to specification: 6.6 ft-lbs (9 Nm).
- 6. Manually rotate the engine four revolutions or connect the unit battery and the unit for 1–2 minutes.
 - **Important:** Rotating the engine allows the belts to seat properly in the sheaves and ensures the (4) pulley nuts can be properly tightened.
- Position the fan back onto the fan spacer. Install the (4) fan to spacer bolts and torque to specification: 6.6 ft-lbs (9 Nm).
- 8. Install fan shroud hardware (if removed).
- 9. Connect battery terminals and verify unit function.

Alternator Operation and Diagnosis

General Description

The 460/230 Vac alternator consists of three principal components: the main alternator, the integral direct-connected exciter, and an externally mounted excitation control system.

The main alternator may be subdivided into the 4-pole rotating main field and the alternator stator (ALT). The rotating main field, the rotating rectifier and the exciter armature are all mounted on a common shaft. Output of the exciter is rectified by the shaft mounted rotating bridge rectifier to provide the rotating main field excitation.

The externally mounted excitation control system is energized from the alternator output through an digital simplified regulator (DSR). Excitation power is derived from a separate 2-lead stator winding. Positive voltage build up from residual levels is provided through the semiconductor power circuitry of the DSR. The rotor contains a magnetism to maintain a residual voltage level.

The residual voltage supplies initial excitation power to the DSR. The initial excitation power increases alternator output until steady state output voltage is reached. The DSR derives a sample voltage from the output windings for voltage control purposes. In response to this sample voltage, the DSR controls the power fed to the exciter field (FLD) and thereby the rotating main field. The DSR provides closed loop control of the output voltage within the specified limits, compensating for load, speed, temperature and power factor of the generator.

Note: The generator set is factory wired for 460V power output.





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Alternator Operation and Diagnosis

Alternator Function

Starting Excitation

The initial excitation for the alternator is supplied by residual magnetism in the main field. Residual main stator voltage provides initial excitation power to the digital simplified regulator (DSR) from a separate 2-lead stator quad winding. The controller energizes Quad Relay 2 minutes after the engine starts. Energizing the Quad Relay starts current flow from the DSR to yellow wire. The yellow wire sends the current through the exciter field to build voltage in the stator windings. The exciter field current then returns through the blue wire to chassis ground.

Running Excitation and Control

When the alternator output reaches the rated voltage, excitation is provided by the alternator excitation winding. The magnetic field that was formed in the exciter field winding induces voltage in the exciter rotating winding. This output voltage is changed from three-phase ac to dc by the rotating rectifier. The dc current is transferred to the rotating main field winding induces a voltage in the alternator stator windings. This voltage is sent out of the alternator stator leads to the power plug and load. 460 Vac, 3-phase output can be measured at the power plug. In addition to being powered from the stator excitation winding, the DSR monitors the stator output for voltage control purposes. The DSR controls the voltage fed to the exciter field to maintain the alternator output voltage within specified limits.

Overload

For temporary overloads (such as refrigeration unit start up), the DSR controls the voltage fed to the exciter field to maintain the alternator output voltage. Over voltages caused by open circuit sensing terminals are avoided by loss detection sensing circuitry that reduces the alternator terminal voltage to a safe fixed level.

Overload Shutdown

The overload shutdown is provided by the controller.

If an overload condition becomes more than temporary, the reduction in alternator output voltage due to the overload causes the DSR to increase field current through yellow wire. The DSR senses the overload current and sends a signal out through the Open Collect circuit. The controller reads this signal and shuts down the engine. A 20 minute restart is initiated.

If the controller shuts down unit operation, it indicates one of the following:

- 1. There is a malfunction in the load causing the load to fail to start or to draw single phase current.
- 2. The engine speed or power is low due to improper speed adjustment, fuel supply problems or other mechanical conditions while the generator is supplying motor starting current to the load.
- 3. Internal component failure in the excitation control system, resulting in excessive field current. This includes possible malfunction of protective elements in the excitation control.
- 4. Failure in the alternator rotating elements (exciter armature, rotating diode assemblies or main field) can cause the regulator to supply excessive exciter field current.
- 5. Engine shutdown on low engine oil level, low oil pressure or high water temperature.

Alternator Diagnosis

Preliminary Checks

A WARNING

Risk of Injury!

Extreme care must be used when working with an operating generator set. Lethal voltage potentials exist inside the control box, at terminals on the DSR and at the power receptacle.

Before attempting the more complicated diagnosis procedures, check the following items to ensure a superficial problem is not overlooked.

Note: Further diagnosis is a waste of time until these items are checked, since a problem in one of these areas will influence test results.

Alternator Operation and Diagnosis

- 1. If the generator malfunction is accompanied by excessive black exhaust smoke and engine lugging, double check all possible engine problems such as fuel supply, injection timing, engine speed, restricted air cleaner, etc.
- 2. Disconnect the refrigeration unit from the generator and check the output voltage at the plug. Voltage between the three phases should be between 230 to 250 Vac or 400 to 500 Vac depending on engine speed and whether the alternator stator is wired for 230 or 460 Volt operation. All three phases should be within 3% of each other. If the voltages appear normal, make sure the refrigeration unit is not at fault. Reconnect refrigeration unit and run in Cool mode. Check the amperage draw with an induction type ammeter (amprobe), and compare it with the load plate on the refrigeration unit.
- 3. Check all push-in plugs on control circuits for loose pins or sockets. Make sure all wire terminals are tight. Be sure J6 connector is plugged in to controller, if disconnected can cause a Message 122.

Test Instruments

If the preceding checks did not uncover the cause of the malfunction, more extensive diagnosis procedures will be required. The following tests will require various electrical test instruments, and the technician performing the tests should have a good working knowledge of their basic electrical principles.

The tests are intended to determine whether the source of difficulty lies in the generator itself or in the excitation control system. Following the procedures carefully will, in many cases, avoid unnecessary dismantling and reassembly of the generator when easily corrected problems may exist in the external circuitry.

The test instruments required:

- 1. AC-DC voltmeter 2.5 Volts to 500 V ranges (± 2% max. error)
- 2. AC induction ammeter (amprobe)
- 3. DC ammeter (preferably induction type TK No. 204-947)
- 4. Ohmmeter
- 5. Megohmmeter (Megger®)

Alternator Troubleshooting

A WARNING

Risk of Injury!

WARNING: When servicing or repairing a generator set, the possibility of serious or even fatal injury from electrical shock exists. Extreme care must be used when working with an operating generator set. Lethal voltage potentials can exist at the unit power cord, inside the exciter control box, inside any high voltage junction box and within the wiring harnesses.

Normal alternator output voltage is 460 +/- 10 VAC with engine rpm 1800 +/- 25 rpm and no load applied. If the generator produces no or low voltage output at the plug, perform the tests listed below to identify the component that may be causing a generator malfunction.

- Symptom: Low Output Voltage-0 to 100 Vac
- **Note:** The DSR has a glass fuse (5AF 250 Volt) on the board. Check fuse if this fuse is blown, replace it and check output voltage.

Note: Using a flashlight visually inspect exciter rotor for signs of being burnt, if burnt replace alternator.

Test 1 - Determine if problem is with the DSR or the Alternator

During the 2 minute delayed output, perform the following steps:

- 1. Turn unit OFF.
- Open the junction box on the alternator and disconnect the Blue and Yellow wires from the DSR pins 1 and 2. Connect jumper wire from 12 VDC positive post of unit battery to the Yellow wire. Connect another jumper wire to the Blue wire.

Note: Do not connect blue wire to ground yet.

- 3. Connect an AC volt meter to the output terminals U1 and V1.
- Start genset engine will be in low speed.

Alternator Operation and Diagnosis

- 4. Momentarily connect the jumper wire from the Blue wire to negative post of battery and monitor the output voltage. Output voltage should be >400 VAC.
- Note: If output voltage is not >400 VAC go to Test 2
- 5. If the output is >400 VAC,
 - a. Stop genset and check the resistance on the Quad winding.
 - b. Disconnect the Red wire on Pin 3 and Red wire to DSR wire,
 - c. Check resistance between the Red wires, should be 1.6 ohms.
 - d. If resistance is correct go to step 6.
- Check the Quad relay circuit. Connect the ohm meter to the DSR wire and Quad wire. Turn genset on and go to Commands/Manual Function Test, select Quad relay test. Observe if ohm meter changes when relay turns ON and OFF. If relay is working replace DSR.

Test 2 - Alternator Exciter Field Testing

- Disconnect the Blue and Yellow wires from pin 1 and 2 on the DSR field wire. Measure the resistance of the field circuit (Blue to Yellow). The standard value is 9.7 (±10%) ohms at 77 F (25C). If field is open or resistance value is low replace exciter field.
- 2. Measure Blue or yellow wires to GND for possible shorted to ground coils. Megger blue to stator case to check for insulation break down, @ 500 Volts must be more than 1 M ohm. If exciter field is OK, go to test 3.

Test 3 - Alternator Stator Testing

Test 3 covers testing the main alternator stator, the rotating rectifier, the rotating exciter field, and the rotating field armature.

- 1. Main alternator stator windings
 - a. Disconnect the stator leads from the terminal board and neutral stud in the terminal box. Check for continuity between the following pairs. 1-2, 3-4, 5-6, 7-8, 9-10, 11-12. The resistance between any of the pairs should be 0.239 (±10%) Ohms at 25 C (77 F).
 - b. Check resistance between the pairs of coils (example: 1-3, 1-5, 1-7, 1-9, 1-11, then 3-5, 3-7, etc...). If any continuity or resistance is found, there is a short between pairs (leg to leg) and the alternator needs to be replaced.
 - c. Using a megger meter, check for insulation break down between each pair (1 to gnd, 3 to gnd, 5 to gnd, etc...)of leads to the stator case. @ 500 Volts must be more than 1 M Ohms. If less than 1 M Ohms, replace alternator.

Alternator Operation and Diagnosis





Alternator Operation and Diagnosis

Test 4- Exciter and Diode Test

Test 4 covers testing the exciter and diodes. Each plate has one positive and one negative diode mounted to it. Disconnect the main alternator field leads to test the diodes.

- 1. Remove rear grille from the alternator.
- 2. Disconnect wires from 1, 2, and 3.
- 3. Measure the resistance between 1 and 1. The main field resistance should be 1.3 Ohms +/- 10%.
- 4. Use a megger meter to check for a break in the insulation from 1 to rotor case.
- 5. Measure the resistance between 2 to 2, 2 to 2, and 2 to 2. The rotating field and exciter armature resistance should be**0.420 Ohms +/- 10%.**



Alternator Operation and Diagnosis





1.	Main Field
2.	DC Voltage
3.	Exciter Rotor
4.	AC Voltage

- Unbolt the main field armature leads. Along with the main field armature leads are leads to a MOV. The MOV is a high voltage suppression device. When measured it will show open, it closes with peak voltage more than 600V cannot test. Check for continuity between the armature leads. The resistance between the leads should be 1.33 (±10%) ohms at 25 C (77 F).
 - a. Using a megger meter, check for insulation break down between leads to the rotor shaft. @ 500 Volts must be more than 1 M ohm.
- 7. Test rectifier. Each plate as one positive and one negative diode mounted to it. Use a volt /ohm meter in the diode test setting to check each diode in the forward and reverse direction. A good diode will have a high resistance reading in one direction and no reading when ohmmeter leads are reversed. Replace if a short is found or the diode flows in both directions.

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Alternator Operation and Diagnosis



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Megohmmeter

The use of a megohmmeter can be a valuable addition to the repair and maintenance of the generator set. The megohmmeter is essentially a high-range resistance meter (ohmmeter) with a built-in direct-current generator. This meter is of special construction with both current and voltage coils-enabling true ohms to be read directly, independently of the actual voltage applied.

The meter gives you a direct reading of insulation resistance in "ohms" or "megohms" (1 megohm = 1,000,000 ohms). For good insulation, the resistance usually reads in the megohm range.

Normally, good insulation has high resistance; poor insulation, relatively low resistance. The actual resistance values can be higher or lower, depending upon such factors as the temperature or moisture content of the insulation (resistance decreases with increase in temperature or moisture). They can be quite different for a generator tested three days in a row, yet not mean bad insulation. What really matters is the trend in readings over a time period, showing lessening resistance and warning of coming problems. Periodic testing is, therefore, your best approach to preventive maintenance.

Maintenance Procedures

The following paragraphs cover detailed maintenance procedures, including disassembly and assembly of equipment for necessary component removal and replacement. Many repair or replacement operations can be performed without extensive disassembly of the generator.

A WARNING

Risk of Injury!

DO NOT attempt adjustments or changes in wiring while a unit is in operation. The unit generates sufficient voltage to cause severe and possible fatal shock. Use extreme caution when operating in wet or damp locations.

General Inspection

Inspect the entire unit to see that controls are in order and that there are no loose nuts, bolts, electrical connections or fittings. Inspect for secure engine to generator mountings. Remove any waste material from area around the unit. Check battery connections.

Insulation

Inspect insulation on wires, coils and control components. See that insulation is not frayed, broken or deteriorated. Replace wire having damaged insulation.

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Field Coils, Stator Windings

Visually inspect the field coils and stator windings, their leads and connections to determine if they are electrically and mechanically satisfactory. Look for any evidence of overheating, burned or frayed insulation, loose connections, foreign matter, etc.

Generator Housing

Feel the alternator housing cautiously for abnormal temperatures as determined by previous experience with the unit. If the generator is overheated, check the winding temperature with thermometer, locate the cause such as lack of ventilation, overload, etc., and correct the condition or shut down the generator. Inspect the generator housing for obstruction of air passages.

Generator Bearing

All alternators covered in this manual are fitted with a permanently lubricated bearing which requires no maintenance in normal service.

Impeller Fan

Visually inspect the impeller fan to ascertain that no vanes are missing. Visually inspect the fan is not encrusted with dirt or other foreign matter to the point where it will not function properly.

Coupling

Disc type coupling. Inspect to see that coupling bolts are tight and that the generator is solidly secured to the engine.

Alternator Operation and Diagnosis



1.	Rotor Assembly	9.	Rear Bearing
2.	Gasket - cover	10.	Rectifier
3.	Terminal Board	11.	Armature
4.	DSR Regulator	12.	Rotor
5.	Rear Grille	13.	Blower, Generator
6.	End Bracket	14.	Alternator Frame
7.	O-Ring	15.	Dowel Pin
8.	Stator Bracket		

Alternator Replacement

Structural/Accessory Maintenance

Unit Inspection

Inspect the unit during unit pre-trip inspection and scheduled maintenance intervals. Look for loose or broken wires or hardware, and other physical damage which might affect unit performance. Repair if required.

Note: See Maintenance Inspection Schedule chapter in this manual for the correct service interval for your unit. 250 or 500 hour inspection/service intervals are required in extreme operating conditions.

Mounting Bolts

Check and tighten all engine and control box mounting bolts every 1,000 operating hours. Unit mounting hardware should be inspected for tightness during every pretrip.

Mounting Bolt	Torque Specification					
SGSM Units						
Tubular Mounting Arm to Unit Frame	203 Nm (150 ft-lbs)					
I-Beal Clamp Screw	203 Nm (150 ft-lbs)					
SGCM						
Mounting Arm to Unit Frame	88 to 115 Nm (65 to 85 ft-lbs)					
Chassis Clip Bolt	162 to 176 Nm (120 to 130 ft-lbs)					
SGCO						
Upper Clamp	Lock Clamp with Lock Pawl					
Lower Mounting Bolts	300 to 380 Nm (220 to 280 ft-lbs)					
All Units						
Engine Mounting Bolts	203 Nm (150 ft-lbs)					
Exciter Control Box	20 to 27 Nm (15–20 ft-lbs)					

Structural/Accessory Maintenance

SGSM Typical Unit Installation

- 1. Attach the mounting arm assemblies on each end of the unit. Two sets of mounting bolt holes are provided on the mounting arms.
 - **Note:** The clear insulator pad should be located between the steel mounting arms and the inside of the unit frame members. The stainless steel plate should be placed on the outside of the unit frame members.
- 2. Move the unit under container or trailer chassis. Place each mounting channel on top of a chassis frame member. Locate each channel as close to the vertical web of the chassis member as possible.

ACAUTION

Service Procedures!

Keep all container or trailer electrical lines and air lines away from the channel to prevent damage during unit installation and operation.

3. Torque the mounting bolts:

• Mounting Arm to Unit Frame: 203 Nm (150 ft-lb)



1.	Mounting Arm Tube and Channel Assembly
2.	Unit Mounting Bracket Assembly

Structural/Accessory Maintenance

SGSM Keener Arm Unit Installation

- 1. Attach mounting arm assemblies to unit with clamp screw end of the channel facing the rear side of the unit. Torque mounting bolts that fasten mounting arms to the unit to 203 Nm (150 ft-lb).
- 2. Place mounting arm clamp screw assemblies in open (down) position.
- 3. Open each slider channel at least 200 mm (8 in.).
- 4. Move the unit under container or trailer chassis. Place fixed gripper channels on unit over edge of chassis I-beam.
- 5. Seat the chassis I-beam against the back of both fixed gripper channels. Move each slider channel forward over the back edge of the chassis I-beam.
- 6. Place the eye bolts over the slider pins by adjusting the bolt length as necessary.
- 7. Insert quick release pins in eye bolt handles to lock the eye bolts in the closed (lock) position.
- 8. Place the clamp screw assemblies on the rear edge of the second chassis I-beam.
- Seat each clamp firmly against the edge of the l-beam and tighten clamp screw. Torque each clamp screw to 203 Nm (150 ft-lb).



1.	Clamp Channel	7.	Unit
2.	Clamp Screw	8.	Unit Mounting Bracket Assembly
3.	Mounting Arm Clamp	9.	Chain and Quick Release Pin
4.	Mounting Arm Tube	10.	Eye Bolt
5.	Slider Channel	11	Slider Pin
6.	Fixed Gripper Channel		

Structural/Accessory Maintenance

SGCM Unit Installation

1. Attach the mounting arm assemblies on each end of the unit.



1.	Fasten Chassis Clips on the Outside Edge of each I-Beam and Tighten Bolts
2.	Tighten Mounting Arm to Unit Bolts

2. Move the unit under container or trailer chassis. Place each mounting clip on top of a chassis frame member. Locate each clip as close to the vertical web of the chassis member as possible.

ACAUTION

Service Procedures!

Keep all container or trailer electrical lines and air lines away from the clips to prevent damage during unit installation and operation.

3. Torque the mounting bolts:

- Mounting Arm to Unit Frame: 88 to 115 Nm (65 to 85 ft-lb)
- Chassis Clip Bolt: 162 to 176 Nm (120 to 130 ft-lb)

Structural/Accessory Maintenance

SGCO Clip-on Corner Clamp Unit Installation

- 1. Pull the lock pawl handle forward. Lift the clamp handle to rotate the clamp shaft 90 Degrees.
- 2. Lift the unit into mounting position on front wall of the container. The foot of generator set mounting clamp should fit into mounting hole on each side of the container.

ACAUTION

Risk of Injury!

Take adequate precautions when lifting and mounting the generator set to prevent personal injury or unit damage.

3. Insert the foot of the mounting clamp fully into the container mounting hole. Pull lock pawl handle forward. Pull the clamp handle down to rotate the clamp shaft bolt 90° and clamp generator set to container.

A CAUTION

Service Procedure!

Watch the clamp flat on threaded end of the mounting shaft when rotating the handle. The clamp flat should turn as the clamp handle rotates. With the mounting clamp in the locked position (handle down), the clamp flat must be horizontal. If the flat is not horizontal, check the clamp handle for a broken shoulder screw.

4. Release the lock pawl to hold the clamp handle in the locked (down) position.

ACAUTION

Service Procedure!

Excessive vibration or unit malfunction can occur if mounting clamps are not properly secured. The generator set MUST be tight against the container.

5. Check to be sure the generator set frame fits tightly against the container. Turning the mounting clamp handle should pull the generator set frame tight against the container front wall. If necessary, tighten the mounting clamp. The mounting clamp can be tightened or loosened by turning the nut on the head of the clamp shaft.

Structural/Accessory Maintenance





1.	Lift (Unlock) Lock Pawl	5.	Lift (Unlock) Lock Pawl
2.	Rotate Clamp Handle Up 90 degrees	6.	Rotate Clamp Handle Down 90 degrees
3.	Release (Lower) Lock Pawl	7.	Release (Lower) Lock Pawl
4.	Insert Mounting Clamp Foot in Container Mounting Hole		

6. Install the lower mounting bolts:

- a. Remove the retaining pin from the lower mounting bracket.
- b. Remove the mounting bolt and backup plate from the keeper nut. Put the mounting bolt through the backup plate and install the bolt in the mounting hole.
- c. Tighten the lower mounting bolts to 300 to 380 Nm (220 to 280 ft-lb).
- d. Install the retaining pin and hair pin key to prevent accidental loss of the mounting bolt and backup plate during unit operation.

Telematics Information

Telematics General Description

The telematics system allows the unit owner real-time remote genset monitoring and management access. This system monitors and communicates the following information to the unit owner through the Thermo King Telematics System:

- Asset Name
- Unit Location (GPS Tracking)
- Genset Status (ON/OFF)
- Battery Voltage
- Fuel Level
- Engine RPM
- Engine Load %
- Engine Temperature
- Generator Voltage
- Generator Hz
- Total Hours

Important: Typically technicians and repair facilities will not have access to the information the telematics system is transmitting. This special access is controlled and managed by the genset unit owner.



Telematics Information

Telematics Component Locations



Figure 37.	Telematics	Module
riguic 07.	reicinatios	module

1.	Main Control Harness Connection / Unit Data	3.	GPS Antenna Connector (from antenna)
2.	Diagnostic LED (can flash red, green, or yellow in color)	4.	LTE / Cell Connection (from antenna)

Telematics Module Cycle Identification (LED Flash)

- *Important:* When the unit is ON the telematics system will communicate with the unit owner at least every 15 minutes (see the communication schedules below). When the units is turned OFF, the telematics system sends only GPS, battery voltage, and fuel level information once a day.
- *Important:* Typically, service technicians will not know there is an issue with the telematics system until the unit owner reports unit problems. If telematics issues are reported by the unit owner, the technician can perform some diagnostic checks and repair on the unit and/or telematics system.

The telematics module features an LED flashing sequence that can be used to check the operation mode. The LED is located on the front of the device in between the antenna connectors and the main connector.

The telematics module goes through three communication cycles (the unit can be ON or OFF):

- CELL COMMUNICATION CYCLE The telematics module communicates to the server to transmit location and reefer data once every 15 minutes.
- GPS COMMUNICATION CYCLE The telematics module communicates to GPS satellites to obtain location data once every 10 minutes.
- GENSET COMMUNICATION CYCLE The telematics module communicates to the controller to obtain data every 30 seconds.

Communication cycles can be identified by a unique flashing sequence of the LED on the front of the telematics module. This flashing sequence is repeated three times for each communication cycle:

CELL COMMUNICATION CYCLE: A call is made every 15 minutes which can be identified by:

- 3 short orange flashes The telematics module is busy making a call
- 3 short green flashes The telematics module has successfully made a call
- 3 short red flashes The telematics module is unable to call in



Telematics Information

	CELL COMMUNICATION CYCLE (every 15 minutes)																
LED																	Module has successfully called in
Flashes																	Module was not able to call in
																	BA 11053

Important: The ability of the device to call in depends on the availability and strength of the GSM / CELL signal. A missing or bad signal can result in 3 red flashes. This does not mean that there is a problem with the telematics module. Allow the module to go through several call cycles before continuing diagnostics or module replacement.

- *Important:* The GPS / CELL antenna may not be able to receive signal indoors (shop bay). The function must be verified outdoors where good signal can be reached.
- **Note:** Verify CELL signal by viewing your mobile phone signal level. This check will give an estimate on CELL signal strength level, but can be inaccurate due to the many telecom providers.

Telematics Information

GPS COMMUNICATION CYCLE: Location records are obtained every 10 minutes which can be identified by:

- 2 short orange flashes The telematics module is obtaining GPS data
- 2 short green flashes The telematics module has successfully obtained GPS data
- 2 short red flashes The telematics module is unable to obtain GPS data

	GPS CYCLE (every 10 minutes)													
LED												Module has successfully obtained GPS data		
Flashes	Flashes Module was not able to obtain GPS data													
												RAJ1053		

Important: The ability of the device to obtain GPS data depends on the availability and strength of the GPS signal. A missing or bad signal can result in 2 red flashes. This does not mean that there is a problem with the telematics module. Allow the module to go through several GPS cycles before continuing diagnostics or module replacement.

Important: The GPS / CELL antenna may not be able to receive signal indoors (shop bay). The function must be verified outdoors where good signal can be reached.

Note: Verify CELL signal by viewing your mobile phone signal level. This check will give an estimate on CELL signal strength level, but can be inaccurate due to the many telecom providers.

GENSET COMMUNICATION CYCLE: Genset data is obtained every 30 seconds which can be identified by:

- 1 short orange flash The telematics module is obtaining data from the unit controller
- 1 short green flash The telematics module has successfully obtained data from the unit controller
- 1 short red flash The telematics module is unable to obtain data from the unit controller

	GENSET COMMUNICATION CYCLE (every 30 seconds)											
LED	LED Module has successfully obtained genset data											
Flashes										Module was not able to obtain genset data		

RAJ1054

Important: Sometimes the device cannot obtain genset data from the unit controller due to various reasons. This will result in 1 red flash. This does not mean that there is a problem with the telematics module. Allow the telematics module to go through several cycles before continuing diagnostics or module replacement.

Telematics Diagnostic Information

Important: The telematics system (when operating normally) will communicate with the unit owner non-stop - even when the SG unit is turned OFF. Typically, service technicians will not know there is an issue with the telematics system until the unit owner reports problems. If telematics issues are reported by the unit owner, the technician can perform some diagnostic checks and repair on the unit and/or telematics system.

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Telematics Information

Important: Each unit is uniquely paired to a telematics module on the assembly line:

- Do not swap telematics modules between units.
- If the telematics module is replaced, it must be uniquely paired to the unit using an app and a compatible device.

If the telematics system is not working correctly, perform the following steps before replacing the telematics module: 1. Put the unit into ECU SERVICE MODE found in the COMMANDS MENU:

- Fut the unit into ECO SERVICE MODE found in the COMMANDS
- Place the SG unit main On/Off switch in the "ON" position.
- Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
- Press the UP or DOWN key to scroll up or down through the Main Menu to the Commands Menu.
- Press the ENTER key to enter the Commands Menu.
- The PTI submenu will be displayed.
- Press the UP or DOWN key to scroll up or down through the Commands Menu and select the ECU SERVICE MODE.

Putting the SG unit into ECU SERVICE MODE allows the telematics system to operate normally, and will prevent the engine from starting.

- 2. Verify the SG unit is supplying battery voltage to the telematics system on connections J12 (switched B+ with unit ON/OFF switch) and J13 (B+) on the controller. If battery voltage is not present, diagnose the issue with the SG unit.
- 3. Verify all other telematics connections are correct and tight at the controller:



1.	J13 Connection - Red Power Supply Wire Connection for Telematics System with Fuse (B+)
2.	J12 Connection - White Power Supply Wire Connection for Telematics System (B+ switched by unit On / Off switch)
3.	J3 Connection - Telematics Connector Location

4. Check the telematics system 2A fuse located on the telematics J13 connection in an individual fuse holder near the control module and replace if necessary:

Telematics Information



- 5. Turn the SG unit OFF. Disconnect the telematics module main connector and check main harness wiring continuity from the control box to the telematics module. Ensure the terminals inside the main connector are tight and the connector is engaged firmly to the module. Check the module pins and verify that are not bent out of place.
- 6. Put the SG unit into ECU SERVICE MODE found in the COMMANDS MENU:
 - Place the SG unit main On/Off switch in the "ON" position.
 - Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
 - Press the UP or DOWN key to scroll up or down through the Main Menu to the Commands Menu.
 - Press the ENTER key to enter the Commands Menu.
 - The PTI submenu will be displayed.
 - Press the UP or DOWN key to scroll up or down through the Commands Menu and select the ECU SERVICE MODE.

Putting the SG unit into ECU SERVICE MODE allows the telematics system to operate normally, and will prevent the engine from starting.

7. With the main connector disconnected, verify battery voltage (B+) is present on pin 2 and 10. Verify ground (B-) is present on pin 1. Replace the telematics harness if continuity or power and ground supply are not present at the telematics module.





THERMO KING Telematics Information

Back of Connector

	Main Connector Pin Information												
Pin 1	Black Wire - B- Ground	Pin 8	Not Used										
Pin 2	Red Wire - B+ Voltage	Pin 9	Not Used										
Pin 3	Not Used	Pin 10	White Wire - B+ Voltage (switched by unit On / Off switch)										
Pin 4	Not Used	Pin 11	Not Used										
Pin 5	Not Used	Pin 12	Not Used										
Pin 6	Green Wire - Unit Information Signal	Pin 13	Red Wire - Fuel Sender Signal										
Pin 7	Brown Wire - Unit Information Signal	Pin 14	White Wire - Fuel Sender Signal										

- 8. Turn the SG unit OFF and reconnect all telematics connections.
- 9. Put the SG unit into ECU SERVICE MODE found in the COMMANDS MENU:
 - Place the SG main On/Off switch in the "ON" position.
 - Press the ENTER key or the ESCAPE key to enter the Main Menu, if necessary.
 - Press the UP or DOWN key to scroll up or down through the Main Menu to the Commands Menu.
 - Press the ENTER key to enter the Commands Menu.
 - The PTI submenu will be displayed.
 - Press the UP or DOWN key to scroll up or down through the Commands Menu and select the ECU SERVICE MODE.

Putting the SG unit into ECU SERVICE MODE allows the telematics system to operate normally, and will prevent the engine from starting.

- 10. Observe the telematics module LED flash sequence:
 - If the LED is <u>NOT</u> flashing a sequence and the connections, harness, power and ground supply are all verified good, replace the telematics module.
 - If the LED is flashing RED in any of the three sequences (CELL, GPS, GENSET), allow the system to go through a few communications cycles. Ensure the unit is outside and has access to CELL and GPS signal.
 - **Note:** Verify CELL signal by viewing your mobile phone signal level. This check will give an estimate on CELL signal strength level, but can be inaccurate due to the many telecom providers.
 - If LED RED flashes continue for the GPS and CELL, verify the antenna pod and harness are not damaged. Verify the antenna connections at the telematics module are tight. Replace the antenna if necessary.
 - If LED RED flashes continue for the GENSET cycle and all connections and harness have been verified good, the telematics module may need replacement.

Telematics Information

Note: The SG controller will show a communication error on the screen of the microprocessor is not communicating. In that case, the microprocessor must be replaced. If the SG controller is working normally, but GENSET LED RED flashes persist, the issue is with the telematics module.

11. Exit ECU SERVICE MODE when service procedures are complete, turn the SG unit main switch off.

Telematics Fuel Level Sensor (optional)

The fuel level sensor is a captive type sensor that transmits a signal to the telematics module. If the unit owner reports fuel level information faults, first perform these electrical checks on the system:

- 1. Verify the SG unit is supplying battery voltage and ground to the telematics system and the fuel level sensor. If battery voltage and ground are not present, diagnose the issue with the SG unit or harness.
- 2. Check the telematics 2A fuse.
- 3. Verify the sensor is receiving battery power (B+) on pin 1 and has a good ground (B-) on pin 2 at the connector.
- 4. Verify the pins are tight in the harness connectors.
- 5. Verify the harness continuity between the sensor, unit controller, and the telematics module (see the wiring diagram in the back of this manual).



After the electrical side of the fuel level sensor is verified as working properly, there could be debris and sludge causing issues that need to be inspected.

6. Cut the fuel level sensor anti-tamper device to allow sensor removal.



7. Cut the bandwraps securing the sensor harness. Unplug the sensor from the unit wiring.

8. Turn the sensor 30 degrees counter clock wise to disengage the retaining lugs. Remove the sensor by lifting it upward out of the tank.



9. Inspect the sensor and fuel tank for sludge and debris that can block the pipe and cause incorrect fuel level readings. Clean the sensor and fuel tank if needed.





1.	Fuel Sensor Pipe	3.	Clean Diesel Fuel
2.	Fuel Sensor Pipe Spring	4.	Possible Debris / Sludge

Telematics Information

10. Inspect O-ring and replace if necessary.

- 11. Reinstall the sensor after cleaning by rotating it 30 degrees clockwise until the anti-tamper lock features align.
- 12. Connect sensor and verify (with the unit owner) that the telematics fuel level system is operating correctly.
- 13. Install anti-tamper device, secure the sensor harness with bandwraps.

If the electrical components are verified good, the sensor and tank are free of sludge / debris, and fuel level issues are still reported, replace the fuel level sensor and verify operation with the unit owner.

Telematics Antenna

The telematics antenna transmits GPS and CELL signal to the telematics module. If the module cannot connect to GPS or CELL according to the flash codes, or if the unit owner reports connection or data issues:

- Verify the SG unit is supplying battery voltage and ground to the telematics system. If battery voltage and ground are not present, diagnose the issue with the SG unit or harness.
- Check the telematics 2A fuse.
- View the LED flash sequence.
- Check the connections at the telematics module.
- Verify the pins are tight in the harness connectors.
- Verify the antenna harness is not damaged.

If problems are not found with the fuse, wire harness, or connections, replace the antenna. If communication or connectivity issues persist, replace the telematics module.

Important: The GPS / CELL antenna may not be able to receive signal indoors (shop bay). The function must be verified outdoors where good signal can be reached. See the flash code descriptions in this chapter.

Note: Verify CELL signal by viewing your mobile phone signal level. This check will give an estimate on CELL signal strength level, but can be inaccurate due to the many telecom providers.
THERMO KING Telematics Information





1.	Controller (inside control box)	4.	Antenna (GPS and CELL)
2.	Fuel Level Sensor	5.	14 Pin Main Harness Connector (Pin view from the BACK of connector)
3.	Telematics Module		

Telematics Information

Pairing Telematics Module to SG Unit

Important: Each SG unit is uniquely paired to a telematics module on the assembly line:

- Do not swap telematics modules between SG units.
- If the telematics module is replaced, it must be uniquely paired to the SG unit using an app and a compatible device.

Before a new telematics module will activate, it must be paired with the SG unit.

1. Install the following FREE app on a smart phone or other compatible device: GT Install Globe Tracker ApS:



2. Open the app. Create an account (new users) or sign in (existing users):

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- First time users will need to create an account. Enter username, password, email address and tap the SIGNUP button.
- DO NOT enter TOTP Code if shown, this is not used.



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3. Select New Installation.



Telematics Information

- 4. Tap **Company** and choose the customer / unit owner from the list. If the unit owners company is not listed, contact: **support@globetracker.com**.
- 5. Tap Continue.

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- 6. Tap Asset Type and choose Genset.
- 7. Tap **Asset ID** and enter the **customers Genset number**. Optional: You can also add a picture of the Genset and add it into the telematics system by selecting **ADD PICTURE**.
- 8. Tap Continue.

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- 9. Tap Manufacturer and choose the correct SG genset type: TK: SG clip-on or TK: SG under-mount.
- 10. Tap Container Size and select Container Size Not Applicable.
- 11. Scroll down and tap Fuel Probe and select GT Probe if the unit is equipped with the optional fuel level sensor.
- 12. Scroll down and tap Fuel Tank Profile and select Thermo King SG (Clip-On) or SG (undermount).
- 13. DO NOT enter certification, or notes. Leave these blank.
- 14. Tap Continue.

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- 15. Scan the QR-code on the telematics module by pressing the barcode icon **OR** manually enter the telematics module serial number printed on the module nameplate.
- 16. Tap **ADD PICTURE** and take picture of the QR code and serial number.
- 17. Tap Continue.

Important: This installation can be done remotely once all information is available.





18. DO NOT choose any optional sensor. Leave this blank.

19. Tap Summary.

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20. Verify all information is correct, then tap **Submit**.

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THERMO KING Telematics Information

- 21. Leave the app running.
- 22. Install the new telematics module. Verify all electrical connections are secure, check the telematics fuse, and wire harnesses.
- 23. Go back to the home screen and tap List of Installations.



24. Select the unit just entered and press REFRESH. This retrieves data from the telematics unit.

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Telematics Information

25. Start the SG unit and let it run until all four indicators have turned green in the app.

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- 26. Verify the flash codes on the module indicate normal operation.
- 27. Pairing is now complete.

Mechanical Diagnosis

CONDITION	POSSIBLE CAUSE	REMEDY
Unit Switch ON; Controller display does not come on	Corroded battery terminals / cable Battery discharged Fuse S13 open Defective ON / OFF Switch Open Circuit	Clean and tighten Charge or replace battery Check circuit and replace fuse Check switch Check 2, 2B, 2C, and 8 circuit
Unit Switch ON; Controller display ON, but engine does not crank	Battery discharged Corroded battery terminals / cable Defective starter relay or open circuit Defective starter solenoid Defective starter Water in cylinders	Charge or replace battery Clean and tighten Replace relay; check 2A, 8S, SR, and PSR circuits Replace solenoid Repair starter Check for hydrostatic lock. Remove injectors and manually turn engine slowly.
	Electrical problem	Check and repair electrical system
	Defective starter solenoid	Replace solenoid
Engine will not crank	Defective starter	Repair starter
	Water in cylinders	Check for hydrostatic lock. Remove injectors and turn engine slowly
Starter motor turns but engine does not crank	Starter clutch defective	Replace
	Voltage falls below 6 Vdc at ECU while starter cranking	Repair cause of low voltage at ECU while starter cranking
	Problem with ECU controlled engine function	Use EXXODiag diagnostic tool to diagnose problem
	Electric fuel pump not energized	Check FP+ and GND circuits
Engine cranks but fails to start	Electric fuel pump defective	Replace electric fuel pump
	Air in fuel system	Bleed air
	Compression low	Overhaul engine
	Air cleaner clogged	Replace air filter
	Exhaust plugged	Clean exhaust
	Alarm LED Flashing	Check alarm code and repair fault
	Air in fuel system	Bleed fuel system
Engine stops after starting	Fuel filter obstructed	Replace filter element
	Vent of fuel tank obstructed	Unclog vent
	Clogged fuel tank or fuel lines	Clean fuel tank and fuel lines
	High head pressure	Eliminate cause of high head pressure

Mechanical Diagnosis

CONDITION	POSSIBLE CAUSE	REMEDY
	Air intake system clogged	Clean air intake system
	Fuel tank vent clogged	Unclog vent
	Clogged fuel tank or fuel lines	Clean fuel tank and fuel lines
	Insufficient fuel volume leaving filter	Check for dirty filter or air in system
Engine does not develop full power	Air cleaner clogged	Replace air filter
	Delivery of electric fuel pump insufficient	Repair pump
	Problem with ECU controlled engine function	Use EXXODiag diagnostic tool to diagnose problem
	Compression low or unbalanced	Overhaul engine
Engine speed too high	Problem with ECU controlled engine function	Use EXXODiag diagnostic tool to diagnose problem
Engine fails to stop when unit is OFF	Problem with ECU controlled engine function	Use EXXODiag diagnostic tool to diagnose problem
	Air in system	Bleed fuel system
	Wrong fuel	Change fuel
Engine knocks beavily	Compression too low	Overhaul engine
	Valve out of adjustment	Adjust valves
	Fuel return line plugged	Remove return line restriction
	Rod or main bearing worn	Replace rod or main bearings
	Dirty radiator	Wash radiator
	Coolant level is low	Add coolant
Engine runs hot	Cooling system heavily scaled	Cleaning cooling system
	Cylinder head gasket leaks	Replace cylinder head gasket. Use correct gasket
	Faulty thermostat	Check or replace thermostat
	Insufficient oil in pan	Add oil
	Faulty oil pressure switch	Check oil pressure switch. Replace if necessary
Oil pressure low	Oil control valve defective	Check oil pressure control valve
	Worn oil pump, camshaft, main or connecting rod bearings, loose oil gallery plug	Repair engine
	10 hour engine break in running was not successfully completed	Run unit for 10 hours in continuous high speed with varying load.
	Oil leakage	Check and eliminate possible causes at rocker arm cover, oil lines, oil filter, front timing cover or crankshaft seals
High oil consumption	Damaged valve seals	Replace seals on valve stem
	Worn valve stem	Replace valves
	Broken piston rings or cylinder bore worn or scored	Have engine repaired and rebored. Replace broken piston rings
	Clogged air cleaner system	Unclog air cleaner

Diagram Index

The following table lists the diagrams that are relevant to this unit.

Drawing No.	Drawing Title
3E79362	DIAGRAM WIRING, SG3000 SG1.5 (1 pages)
3E79363	DIAGRAM SCHEMATIC, SG3000 SG1.5 (1 pages)



Figure 39. 3E79362 (1 of 1)

Figure 40. 3E79363 (1 of 1)



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CONTROLLER MENU GUIDE



Keypad Operating Tips

STANDARD DISPLAY

SG+

Text Input:

- To enter a number: Press the **UP** or **Down** key to increase or decrease the value of a digit in the display.
- Press the ENTER key to scroll the cursor to the right.

To Enter a Controller Menu or Submenu:

- Press ALARM key to directly enter the Alarm List Menu.
- Press the ENTER key or the ESCAPE key to enter the Main Menu.
- Press ENTER key to enter a menu from the Main Menu, or a submenu from its parent menu.
- Press **Escape** key to return to the Main Menu from a menu, or a menu from a submenu.

To Scroll in a menu:

- Press UP key to scroll up.
- Press Down key to scroll down.

To Enter a Command or execute a task: • Press Enter key.

- To Enter a New Value in a Screen:
- Press ENTER key and ESCAPE key at the same time.
- To change language
- Press Language key.



Footnotes:

¹"dELAy/ AC." screen indicates controller has a 2 minute delay. ²"RESTART IN XX MIN." screen indicates controller has stopped unit operation due to an alarm. Controller will attempt to restart unit in the time shown.

CONTROLLER MENU GUIDE



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Controller Menu Guide

CONTROLLER MENU GUIDE



Keypad Operating Tips

STANDARD DISPLAY

Next Page

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Press 1 of 1 key to sciol value.
 Press 2 and 2 key at same time to save new settings and return to Misc. Functions Menu.
 Press 2 key to return to Configuration Menu without saving new settings.

• Press 👔 or 🖶 key to scroll value.

• Press 👔 or 퇒 key to scroll value. Press and example to actin value.
Press and return to Configuration Menu.
Press key to return to Configuration Menu without saving new settings.

RAJ848

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