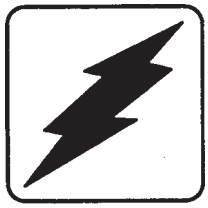
Training Manual

Residential Generator Sets



8.5RES / 12RES
G220 ATS

ISO 9001
KOHLER GENERATORS
INTERNATIONALLY REGISTERED
U.S.A. Plant ISO Registered

KOHLER®
POWER SYSTEMS

TP-6309
5/03/04

Table Of Content

Introduction

This manual covers operation, troubleshooting, and features of Kohler Commercial / Residential Generator Sets.

This manual is only intended as a training guide and is to be used as a supplement to classroom material. This is not a service manual and does not contain all available product information. **Do not attempt to service generator sets without consulting the service manual and following all safety warnings.**

Pictures, illustrations, and wiring diagrams in this manual are only representative of the various models and may differ slightly even within the same model designation series.

This manual is not intended as an installation or troubleshooting guide.

Kohler Company History
Founded by John Michael Kohler on Dec. 3, 1873, Kohler Co. has grown to become the nation's largest manufacturer of plumbing and specialty products as well as a major producer of generators and four-cycle engines. In recent years, the company has also acquired two distinguished furniture manufacturers and opened a variety of highly successful hospitality businesses. Headquartered in Kohler, Wis., Kohler Co. is one of the oldest and largest privately held companies in the country and employs more than 20,000 people.

Power Systems Group
Kohler Co., a major producer of engines, generators and electrical products, entered the power systems market in the early 1900's. Its first power systems products included cast iron internal combustion engines and Automatic Power and Light, a remarkable improvement in auxiliary power in its day. Generators, then known as electrical plants, supplied power during Admiral Richard Byrd's Antarctic exploration in the late 1920's. In the post-war years, Kohler expanded its engine and generator product lines and continued to improve the durability and performance of all of its power systems units. Consequently, the number of markets for Kohler power systems products grew throughout the United States and beyond. Today, Power Systems International, created in 1989 and based in Kohler, Wis., is responsible for all Kohler generator and engine product sales outside of the United States.

Generator Division
In use throughout the world, Kohler generators are available for the marine, home, mobile, commercial, and industrial markets. In addition to generator sets, Kohler also manufactures transfer switches, switchgear and accessories for all product lines. Kohler generators are produced in a manufacturing facility located in the town of Mosel, eight miles north of Kohler, Wis. In 1997 Kohler opened and operates a manufacturing facility in Singapore for the international product line.

Engine Division
One of the world's major manufacturers of air-cooled, four-cycle engines, Kohler Co. produces models ranging from 4 horsepower single-cylinder engines to 26 horsepower twin-cylinder engines. These engines are used by major manufacturers to power lawn and turf, agricultural, industrial construction and recreational equipment. The Kohler engine is also used in Kohler generator models, specifically the residential/ commercial product lines. Kohler engines are manufactured in Kohler, Wis. and Hattiesburg, Miss.

Kohler de Mexico, S.A. de C.V.
Created in 1964 and located in Mexico City, Kohler de Mexico manufactures four-cycle engines.

Safety Precautions and Instructions

A generator set, like any other electromechanical device, can pose potential dangers to life and limb if improperly maintained or imprudently operated. The best way to prevent accidents is to be aware of the potential dangers and to always use good common sense. In the interest of safety, some general precautions relating to the operation of a generator set follow. Keep these in mind. This manual contains several types of safety precautions that are explained below.

DANGER

Danger is used to indicate the presence of a hazard, which will cause severe personal injury, death, or substantial property damage if the warning is ignored.

WARNING

Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.

CAUTION

Caution is used to indicate the presence of a hazard, which will or can cause minor personal injury or property damage if the warning is ignored.

NOTE

Note is used to notify people of installation, operation, or maintenance information, which is important but not hazard-related.

Safety decals are affixed to the generator set in prominent places to advise the operator or service technician of potentially hazardous situations. The decals are reproduced here to improve operator recognition and thereby increase decal effectiveness.

⚠ WARNING

Carbon monoxide.
Can cause severe nausea, fainting, or death.

The exhaust system must be leakproof and routinely inspected.

Generator set operation. Carbon monoxide can cause severe nausea, fainting, or death. Never operate the generator set inside a building unless the exhaust gas is piped safely outside. Never operate in any area where exhaust gas could accumulate and seep back inside a potentially occupied building. Avoid breathing exhaust fumes when working on or near the generator set. Carbon monoxide is particularly dangerous because it is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short period of time.

Carbon monoxide symptoms. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is a poisonous gas which is present in exhaust gases. Carbon monoxide poisoning symptoms include but are not limited to the following:

• Light-headedness, dizziness

• Physical fatigue, weakness in joints and muscles

• Sleepiness, mental fatigue, inability to concentrate or speak clearly, blurred vision

• Stomach ache, vomiting, nausea

If experiencing any of these symptoms and carbon monoxide poisoning is possible, affected persons should seek fresh air immediately. They should remain active. They should not sit, lie down, or fall asleep. Alert others to the possibility of carbon monoxide poisoning. If the condition of affected persons does not improve within minutes of breathing fresh air, they should seek medical attention.

⚠ CAUTION

Hazardous noise.
Can cause loss of hearing.

Never operate generator without a muffler or with faulty exhaust system.

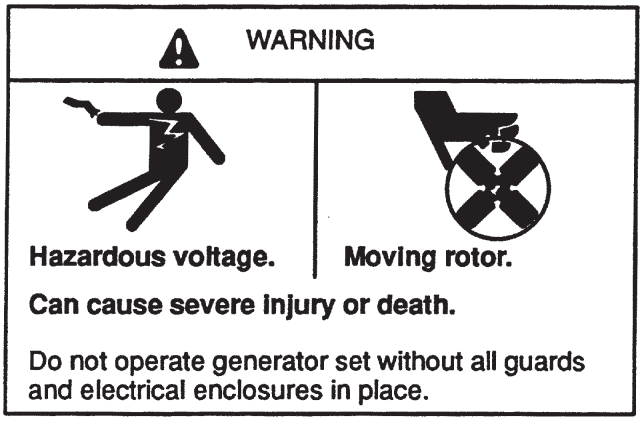
Engine noise. Hazardous noise can cause loss of hearing. Generator sets not equipped with sound enclosures can produce noise levels greater than 105 dBA. Prolonged exposure to noise levels greater than 85 dBA can cause permanent hearing loss. Wear hearing protection when near an operating generator set.

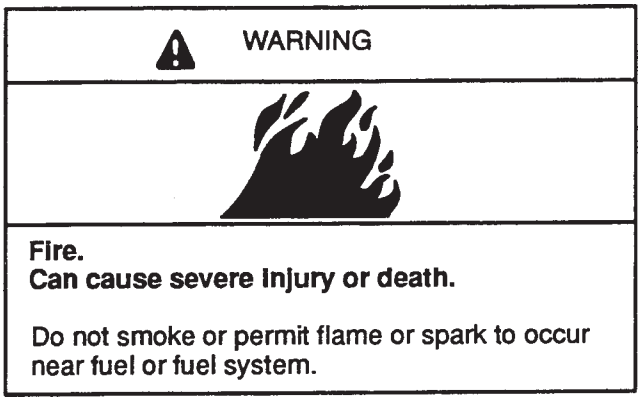
⚠ WARNING

Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe Injury or death. Disconnect battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator. Place controller MASTER switch to OFF position. The generator set can be started by remote start/stop switch unless this precaution is followed.





Exposed moving parts can cause severe Injury or death. Keep hands, feet, hair, clothing, and test leads away from belts and pulleys when unit is running. Replace guards, covers, and screens before operating generator set. Some scheduled maintenance procedures require the generator set to be running while performing service. If the sound shield has been removed leaving belts and pulleys exposed, be especially careful of this area.

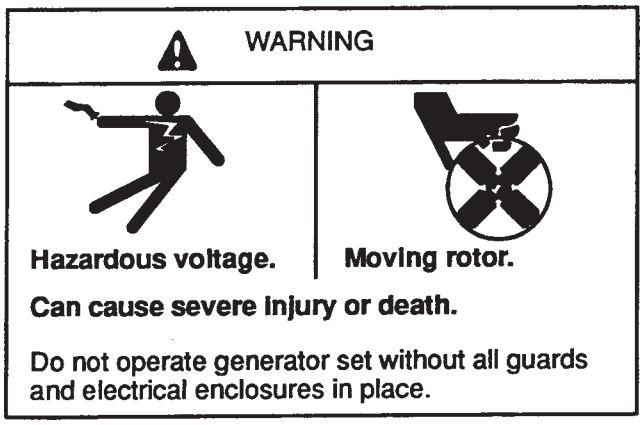
Flying projectiles can cause severe Injury or death. Retorque all crankshaft and rotor hardware after servicing. When making adjustments or servicing generator set, do not loosen crankshaft hardware or rotor thru-bolt. If rotating crankshaft manually, direction should be clockwise only. Turning crankshaft bolt or rotor thru-bolt counterclockwise can loosen hardware and result in serious personal injury from hardware or pulley flying off engine while unit is running.

A flash fire can cause severe injury or death. Do not Smoke or permit flame or spark to occur near carburetor, fuel line, fuel filter, fuel pump, or other potential sources of spilled fuel or fuel vapors. When removing fuel line or carburetor, use a proper container to catch all fuel.

A sudden backfire can cause severe Injury or death. Do not operate with backfire flame arrestor removed. *(gasoline models only)*

A sudden backfire can cause severe Injury or death. Do not operate with air cleaner/ silencer removed.

A sudden flash fire can cause severe Injury or death. Do not smoke or permit flame or spark to occur near fuel system. Keep the compartment and generator set clean and free of debris to minimize chances of fire. Wipe up



Grounding generator set. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the generator set and electrical circuits when in use. Never contact electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution increases under such conditions.

High voltage test. Hazardous voltage can cause severe injury or death. Follow instructions of test equipment manufacturer when performing high-voltage test on rotor or stator. An improper test procedure can damage equipment or lead to future generator set failures.

Installing battery charger. Hazardous voltage can cause severe injury or death. Electrical shock may occur if battery charger is not electrically grounded. Connect battery charger enclosure to ground of a permanent wiring system. As an alternative, install an equipment grounding conductor with circuit conductors and connect to equipment grounding terminal or lead on battery charger. Perform battery charger installation as prescribed in equipment manual. Install battery charger in compliance with local codes and ordinances.

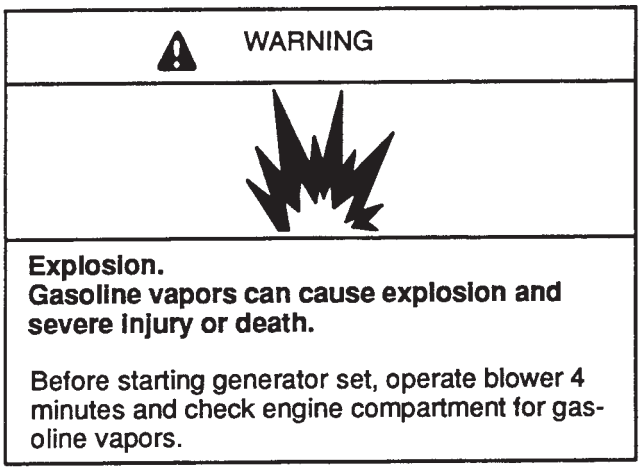
Connecting battery and battery charger. Hazardous voltage can cause severe injury or death. Reconnect battery correctly to avoid electrical shock and damage to battery charger and battery(ies). Have a qualified electrician install battery(ies).

Testing voltage regulator. Hazardous voltage can cause severe injury or death. High voltage is present at the voltage regulator heat sink. Do not touch voltage regulator heat sink when testing voltage regulator or electrical shock will occur. *(PowerBoost-, PowerBoost- ///, and PowerBoost- V voltage regulator models only.)*

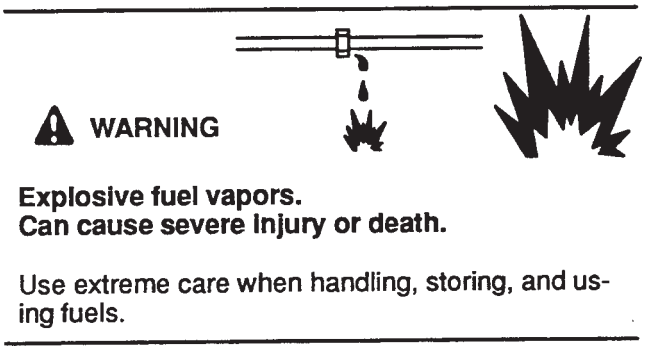
Engine block heater. Hazardous voltage can cause severe injury or death. Engine block heater can cause electrical shock. Remove engine block heater plug from electrical outlet before working on block heater electrical connections.

Electrical backfeed to utility. Hazardous backfeed voltage can cause severe injury or death. Install a transfer switch in standby power installations to prevent connection of standby and other sources of power. Electrical backfeed into a utility electrical system can cause serious injury or death to utility personnel working on transmission lines.

Fuel system. Explosive fuel vapors can cause severe injury or death. All fuels are highly explosive in a vapor state. Use extreme care when handling and storing fuels. Store fuel in a well-ventilated area away from spark-producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running because spilled fuel may ignite on contact with hot parts or from spark. Do not smoke or permit flame or spark to occur near sources of spilled fuel or fuel vapors. Keep fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Use flexible sections to avoid breakage caused by vibration. Do not operate generator set in the presence of fuel leaks, fuel accumulation, or sparks. Repair systems before resuming generator set operation.



Explosive fuel vapors can cause severe injury or death. Take additional precautions when using the following fuels: Gasoline - Store gasoline only in approved red containers clearly marked GASOLINE.



Propane (LP)-Adequate ventilation is mandatory. Propane is heavier than air; install propane gas detectors low in room. Inspect detectors often.

Natural Gas-Adequate ventilation is mandatory. Natural gas rises; install natural gas detectors high in room. Inspect detectors often.

Gas fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check LP vapor gas or natural gas fuel system for leakage using a soap-water solution with fuel system test pressurized to 6-8 ounces per square inch (10-14 inches water column). Use a soap solution containing neither ammonia nor chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

LP liquid withdrawal fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check LP liquid withdrawal gas fuel system for leakage using a soap-water solution with fuel system test pressurized to at least 90 psi (621 kPa). Use a soap solution containing neither ammonia nor chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

⚠ WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

Use protective goggles and clothes. Can cause permanent damage to eyes, burn skin, and eat holes in clothing.

Battery acid. Sulferic acid in batteries can cause severe injury or death.
If battery acid is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large Quantities of clean water. In the case of eye contact, seek immediate medical aid. Never add acid to a battery once the battery has been placed in service. Doing so may result in hazardous spattering of electrolyte.

Explosion can cause severe Injury or death.
Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc. to prevent bums and to prevent sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (-) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together or sparks could ignite battery gases or fuel vapors. Any compartment containing batteries must be well ventilated to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being charged and always turn charger off before disconnecting battery connections. When disconnecting battery, remove negative lead first and reconnect it last.

⚠ WARNING

Hot coolant and steam.
Can cause severe injury or death.

Before removing pressure cap stop generator, allow to cool and loosen pressure cap to relieve pressure.

⚠ WARNING

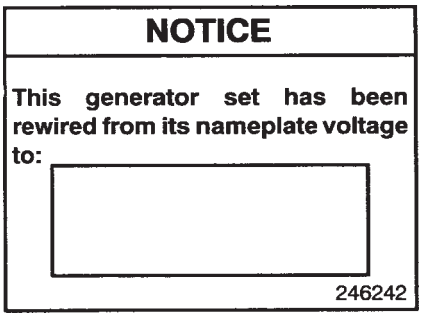
Hot engine and exhaust system.
Can cause severe injury or death.

Do not work on generator set until unit is allowed to cool.

Hot coolant can cause severe Injury or death.
Allow engine to cool and release pressure from cooling system before opening pressure cap. To release pressure, cover the pressure cap with a thick cloth then turn ft slowly counterclockwise to the first stop. After pressure has been completely released and the engine has cooled, remove cap. If generator set is equipped with a coolant recovery tank, check coolant level in tank.

Hot parts can cause severe Injury or death.
Do not touch hot engine parts. An engine gets hot while running and exhaust system components get extremely hot.

Notice

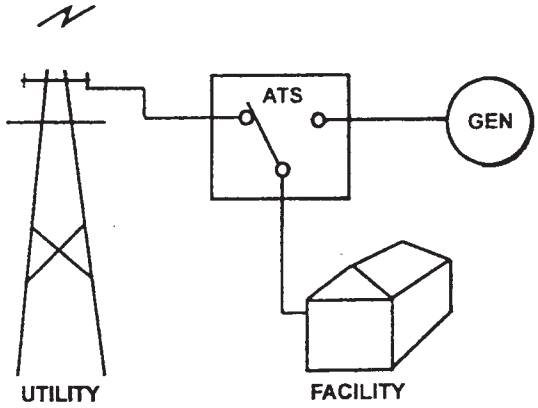


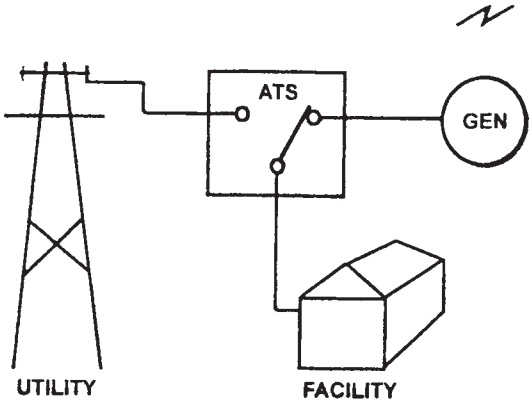
NOTICE
Voltage reconnection! Affix notice to generator set after reconnecting to a voltage different from the nameplate. Order voltage reconnection decal 246242 from authorized service distributors/dealers.

NOTICE
Hardware damage! Engine and generator set may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of bolt heads and nuts.

NOTICE
When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. American Standard hardware uses a series of markings and metric hardware uses a numeric system to indicate hardness. Check markings on bolt head and nuts for identification.

NOTICE
Canadian installations only: For standby service connect output of generator set to a suitably rated transfer switch in accordance with Canadian Electrical Code, Part 1.





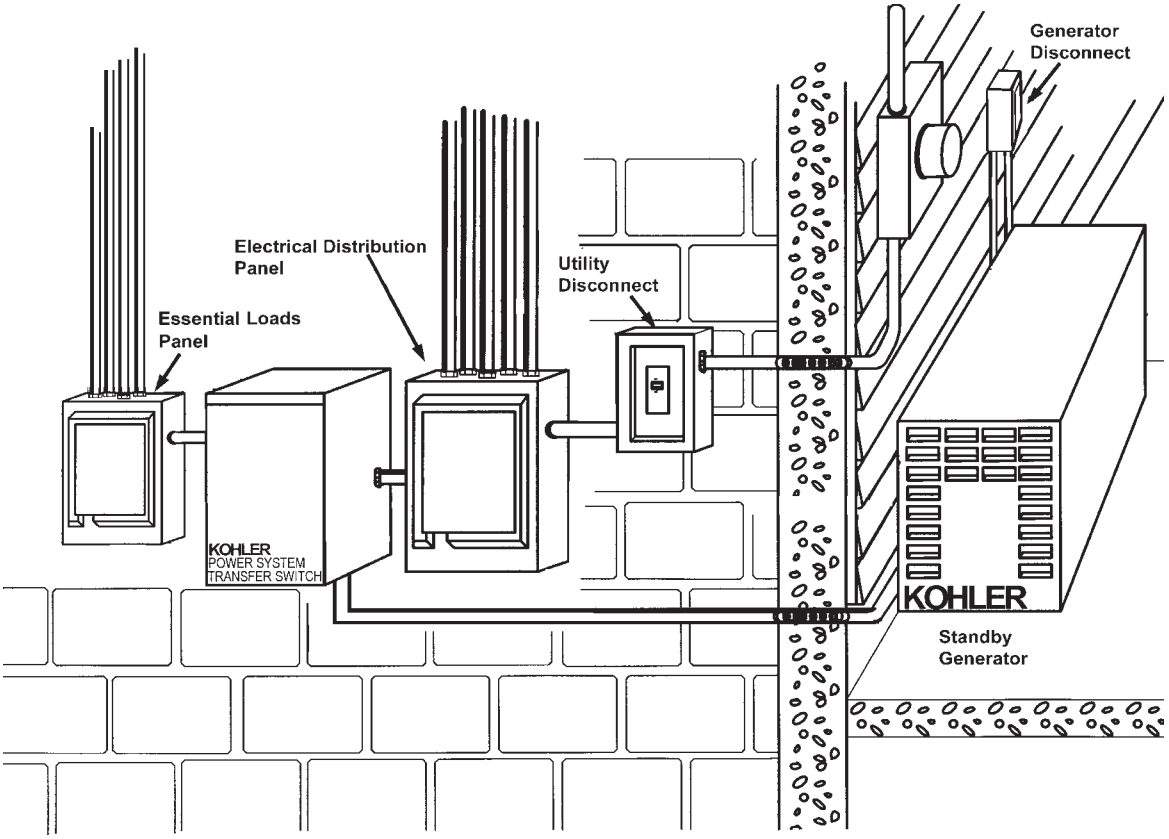
System Concept

The system concept features a utility (primary) source, generator (backup) source, and an automatic transfer switch connected to a building load.

The generator is designed to provide a dependable alternate source of electrical power. When connected to an automatic transfer switch (ATS) the generator will be signaled to start and building load transferred to the generator if the utility supply fails or falls below a specified level. When utility returns the ATS will transfer back to utility and allow the generator to go into a cooldown mode before shutting down the generator. The system is designed to require no manual intervention from the homeowner when operating automatically.

Note: when planning an installation of a home standby generator and ATS the installer must follow all municipal codes for the region. Installers must be familiar with and comply to all Natural Gas or LP fuels codes as well as all electrical safety codes.

System Concept

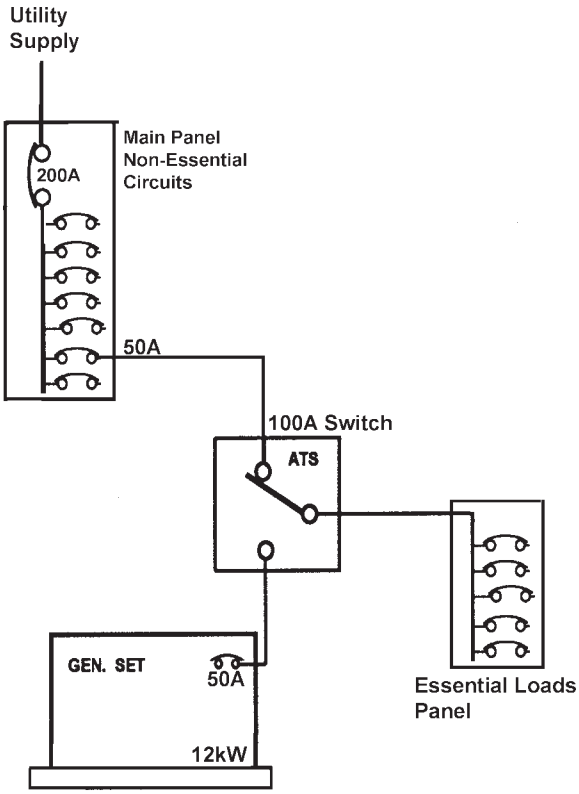


Essential Loads Panel

Prior to installing a Kohler power system the installer should carefully determine the size generator and ATS required. The generator will be sized to meet one of two electrical designs. Essential loads application (shown above) or Whole House Power. The “essential loads” refers to providing power for those devices that a customer designates as essential during an emergency utility power outage. Sump pumps, furnaces, air conditioning, refrigerators, freezers and security lighting could all be considered essential.

During installation these devices are wired through an “essential loads” distribution panel, which in turn is wired to the generator and ATS.

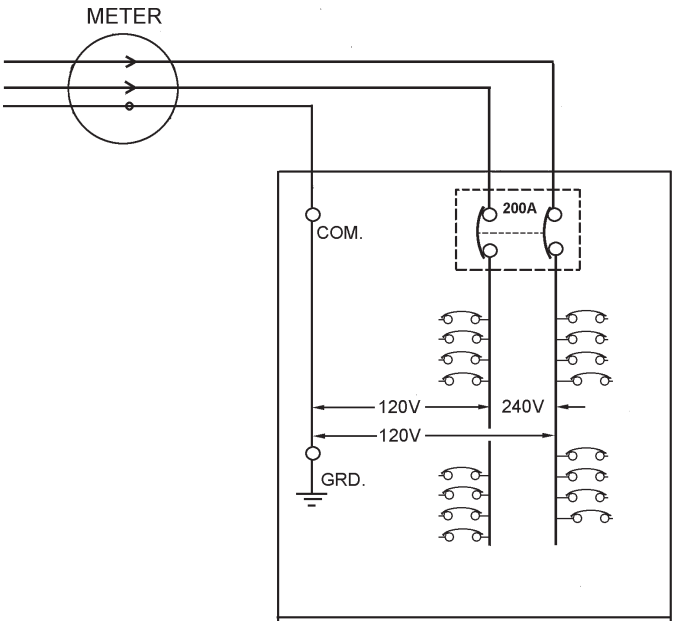
Sizing the generator for “essential loads” allows the customer to use a smaller generator to meet the homes electrical power needs during a power outage.



System Concept

The majority of newer residential utility service entrances in the United States are protected by a 100 or 200 amp circuit breaker. This main disconnect circuit breaker is generally located in a panel with the distribution circuit breakers.

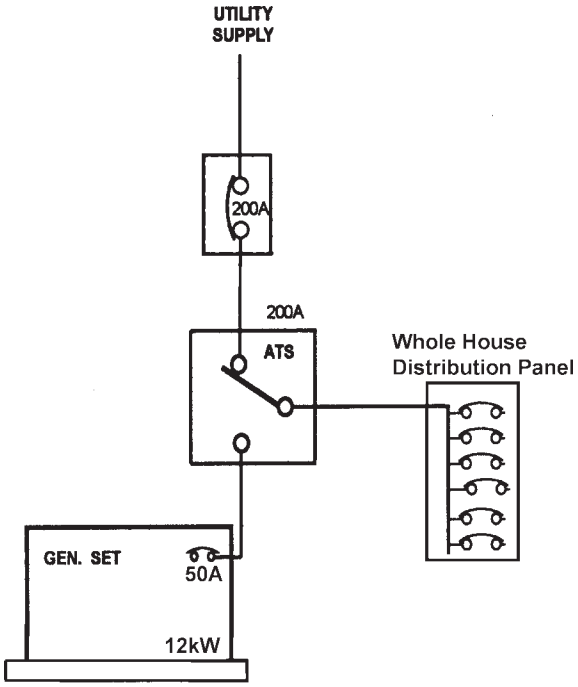
The Normal 60 Hz. voltage supply from the meter is usually single phase , 3 wire, 220 to 240 volts measured line to line and 110 to 120 volts line to neutral. The neutral or common is tied to a ground lug.



When designing a Standby Power System the Emergency Generator set must match the voltage and frequency of the Normal source.

The Transfer switch must also have the same voltage and frequency rating of the Normal and Emergency power supplies for operation of the transfer mechanism.

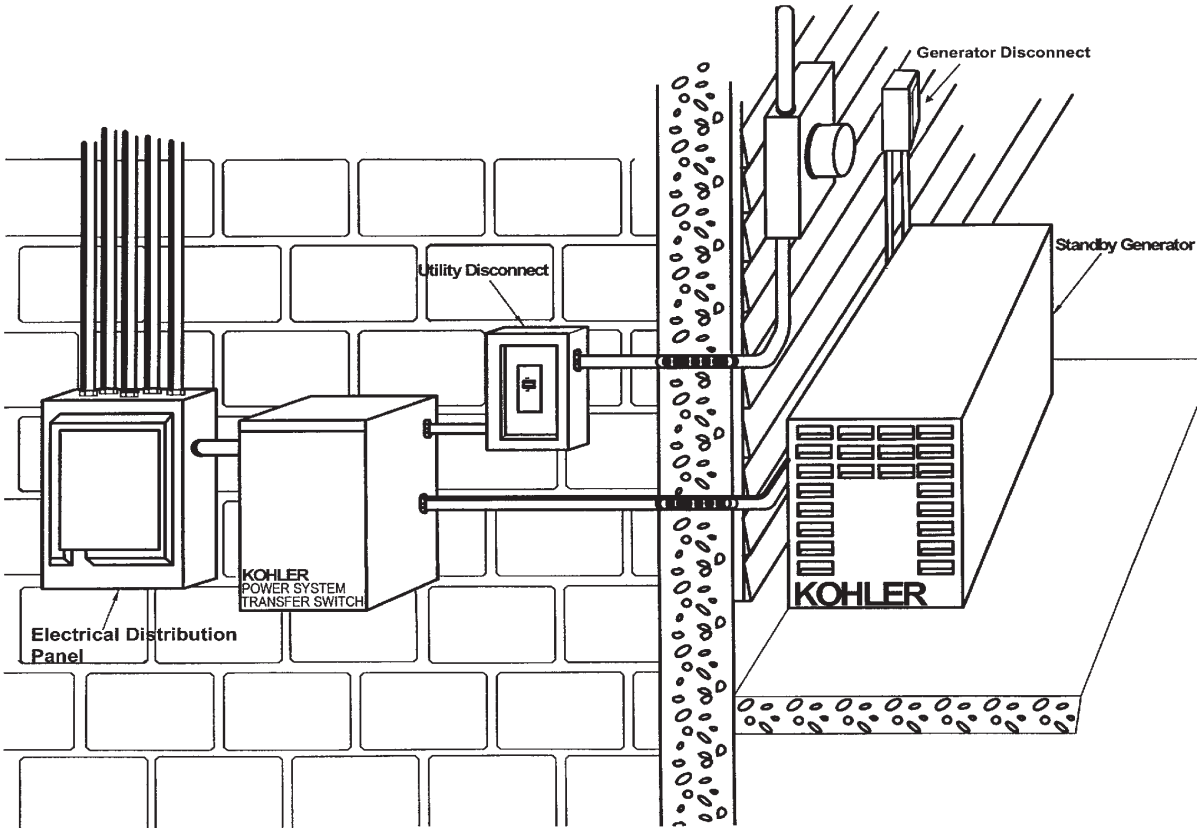
If the total load of a 200 amp service is connected to the transfer switch, the switch must meet or exceed the 200 amp rating even though the generator may only be capable of supplying 50 amperes.



The load applied to the generator can be reduced if required by manually opening distribution breakers.

Normally not all circuits are considered as critical loads and therefore need not be powered by the generator. An emergency supply of 8.5 to 12kW in most cases is adequate.

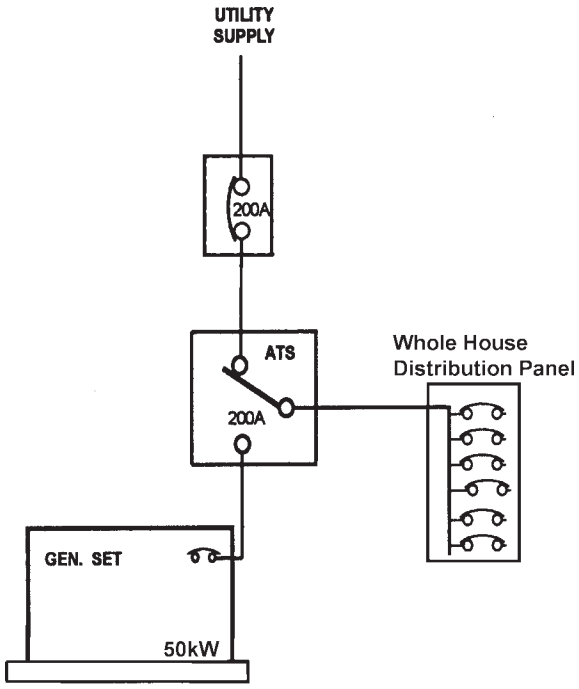
There are various design schemes that an electrical contractor can offer that can meet customers particular needs.



Whole House Power

When the customer decides that the generator should power the whole house, just as if normal utility power is working, the generator and ATS must be wired directly into the homes electrical distribution panel (as shown). Care must be taken when sizing the generator and ATS switch for each application, refer to the specification sheets of the generator and automatic transfer switch to make sure the current and voltage ratings meet the energy needs of the installation.

Typically when sizing a whole house system, the generator current ratings should be equal to the main circuit breaker rating. If not then the installer should calculate current draw of all electrical devices that may be on during an emergency power outage and size the generator accordingly. Failure to do so will result in the generator being overloaded causing possible harm to the generator or electrical load.



Residential Power Systems Sizing Chart

Home Appliances Wattage Requirements

This sizing chart is intended to help you estimate the essential wattage requirements for the appliances you wish to use during an emergency utility outage. Your total wattage requirement will help determine which Kohler residential generator set system will best serve your needs.

When selecting your essential appliances, please note the following:

1. Wattage loads for appliances are calculated two different ways:

   a. Resistive Loads
   Circuits that do not have electric motors; ovens, toaster, TV, lighting

   b. Inductive Loads
   Circuit that have electric motors; AC, dryer, washer, furnace, sump pump

   Starting wattage - additional wattage is required to start electric motors used in home appliances..

2. These estimates are intended to assist in the specification phase of assessing your generator set requirements. Actual appliance wattage will vary depending on the appliance manufacturer and application.

3. By staggering when you use specific appliances, the chart allows you to determine practical usage during an emergency utility failure.

Typical AC Electrical Requirements for Residential Installation

Use the chart on the next page to calculate your estimated wattage. After you have your total estimated wattage calculated, go back and determine, from a practical standpoint, those appliances you would actually run (need) at the same time. Keep in mind you can stagger appliance usage (for example, turn off an electric range element to run a toaster).

This practical home wattage requirement should be equal to or less than the kilowatt rating of your selected Kohler generator set.

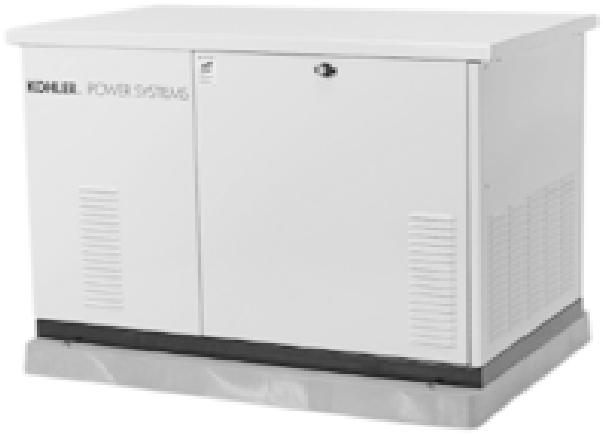
	Running Watts	Starting Watts	Total Watts Required
Typical Essential Loads			
Air conditioner, window, 10,000 BTU (*other choices below)	1500	2200	
Air conditioner, central, 20,000 BTU (*other choices below)	2800	4300	
Electric range, 6 in. element	1500	—	
Electric range, 8 in. element	2100	—	
Freezer	500	1000	
Furnace fan, 3/4 HP	800	2000	
Heat pump	4700	10000	
Light bulb, 75 watts (total wattage on bulbs)	75	—	
Refrigerator/freezer	700	1800	
Security system	180	—	
Sump pump, 1/3 HP	400	1000	
Sump pump, 3/4 HP	750	2000	
TV	500	—	
Well pump, 1/3 HP	1000	2000	
Additional Personal Items			
Coffee maker	1500	—	
Computer	800	—	
Dehumidifier	800	1000	
Electric dryer	5400	6800	
Fan, attic	1000	1800	
Fan, ceiling	800	1400	
Garage door opener, 1/3 HP	600	1600	
Iron	1200	—	
Microwave oven	900	—	
Oven	3400	—	
Radio	100	—	
Space heater	1800	—	
Toaster	1650	—	
Toaster oven	1400	—	
Washing machine	1200	2300	
Water heater	4000	—	
Air Conditioners *			
Air conditioner, window, 5,000 BTU	1000	1900	
Air conditioner, window, 18,000 BTU (1.5 ton)	3000	4100	
Air conditioner, window, 24,000 BTU (2 ton)	3900	5100	
Air conditioner, central, 10,000 BTU	1500	2200	
Air conditioner, central, 32,000 BTU (2.7 ton)	5000	6100	
Air conditioner, central, 48,000 BTU (4 ton)	6500	8500	
		Total Estimated Wattage	

FEATURES AND SPECIFICATIONS

Models 8.5 and 12RES are powered by V-Twin, Kohler Command ™ CH20 and CH740 air cooled, overhead valve engines.

The generator set can utilize either LP or Natural Gas for the fuel supply. The model designation corresponds with the full load kW rating of a 60 hertz unit operating on LP gas. Due to the lower BTU rating of Natural gas approximately 12% less than the LP rating is normal when fueled by Natural gas.

Systems are available for both single phase, 3 wire 120/240 volt, 60 hertz and 110/220 volt, 50 hertz applications. Both voltage and frequency are field adjustable to closely match the utility supply.



Generator Ratings

Model Series	Voltage	Phase	Hz	Generator Model	Standby Amps		Standby Ratings, kW/kVA	
					Natural Gas	LP Gas	Natural Gas	LP Gas
8.5RES	120/240	1	60	2F4	29	35	7.0/7.0	8.5/8.5
8.5RES	115/230	1	50	2F4	27	33	6.3/6.3	7.5/7.5
12RES	120/240	1	60	2F4	43	50	10.4/10.4	12.0/12.0
12RES	115/230	1	50	2F4	40	46	9.3/9.3	10.5/10.5

RATINGS: Standby ratings apply to installations served by a reliable utility source. All single-phase units are rated at 1.0 power factor. The standby rating is applicable to variable loads with an average load factor of 80% for the duration of the power outage. No overload capacity is specified at this rating. Ratings are in accordance with ISO-3046/1, BS5514, AS2789, and DIN 6271. GENERAL GUIDELINES FOR DERATING: *ALTITUDE*: Derate 4% per 305 m (1000 ft.) elevation above 153 m (500 ft.). *TEMPERATURE*: Derate 1.5% per 5.5°C (10°F) temperature increase above 16°C (60°F). Availability is subject to change without notice. Kohler Co. reserves the right to change the design or specifications without notice and without any obligation or liability whatsoever. Contact your local Kohler Co. generator distributor for availability.

* Due to the cycling operation of many electrical appliances, the generator set may not run all appliances simultaneously. Check the appliance manufacturer's specifications for actual power requirements. Consult a Kohler® Power Systems professional for your exact residential power system requirements.

G4-97 (8.5/12RES) 1/04a

Alternator Specifications

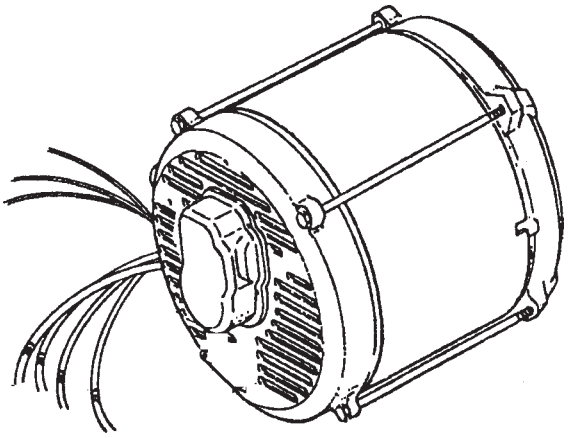
Compliance with NEMA, IEEE, and ANSI standards for temperature rise.

Self-ventilation and drip-proof construction.

Vacuum-impregnated windings with fungus-resistant epoxy varnish for dependability and long life.

Superior voltage waveform and minimum harmonic distortion from skewed alternator construction.

A rotating-field alternator with static exciter for excellent load response.



Alternator Specification	8.5/12RES
Frequency Hz	50/60
Phase	Single-Phase
Number of leads	4
Excitation method	Static Excited
Voltage regulator type	Digital
Coupling type	Direct
Thrubolt torque, Nm (ft. lb.)	40 (28)
Overbolt torque, Nm (in. lb.)	7 (60)
Insulation (rotor and stator)	Epoxy varnish, vacuum impregnated Class 180 (H)
Winding material	Copper
Bearing, number and type	1, replaceable ball
Circuit protection	
Controller	10 amps
Aux. winding	20 amps
Generator AC output	Dependent on voltage configuration
Rotor resistance, ohms, cold	4.0
Stator resistance, ohms,* cold	
Leads: 1-2, 3-4	0.07
11-44	0.14
55-66	0.70
Stator output voltage with separately excited rotor using 12-volt battery, minimum	
Leads: 1-2, 3-4	132V
11-44	264V
55-66	145V
Rotor field voltage/current readings at rated output voltage, hot	
No load	8V/2.5 amps
Full load	47V/7.4 amps
Brush length, new	19.05 mm (0.75 in.)

* Most ohmmeters do not give accurate readings when measuring less than 1 ohm. The stator can be considered good if a low resistance reading (continuity) is obtained and there is no evidence of shorted windings (discoloration). Do not confuse a low resistance reading with a reading indicating a shorted winding.

Engine Specification

The 8.5/12RES generator sets are equipped with four-cycle, twin cylinder, air-cooled Kohler engines. Some of the engine features include:

One-side serviceability of air cleaner, carburetor, oil fill, dipstick, and oil drain.

Efficient overhead valve design and full pressure lubrication for maximum power, torque, and reliability under all operating conditions.

Electronic governor to ensure AC power output is maintained at desired frequency.

Overspeed shutdown to prevent governed frequency from exceeding 70 Hz.

Low oil pressure cutout to prevent failure.

Dependable, maintenance free electronic ignition.

Digital Spark Advance Module (DSAM) optimizes engine timing for natural gas or LP fuel (12RES only)

Parts subject to the most wear and tear made from precision formulated cast iron.

Hydraulic valve adjusters to eliminate the need for valve adjustments.

Fuel systems that allow fuel changeover from natural gas to LP vapor (and vice-versa) while maintaining CARB certification.

Engine Specification	8.5RES (60 Hz)	12RES (60 Hz)
Manufacturer	Kohler	
Model	CH20	CH740
Cycle	4	
Number of cylinders	2	
Compression ratio	8.5:1	9.0:1
Displacement, cc (cu. in.)	624 (38.0)	725 (44.0)
Rated power, propane fuel, kw (hp)	11.5 (15.4)	17.6 (23.6)
Rpm	3600	
Bore x stroke, mm (in.)	77 x 67 (3.03 x 2.64)	83 x 67 (3.27 x 2.64)
Valve material	Steel/Stellite®	
Cylinder block material	Aluminum w/cast iron liners	
Cylinder head tightening torque, Nm (ft. lb.)	30 (40.7)	
Cylinder head material	Aluminum	
Piston rings	2 compression/1 oil	
Crankshaft material	Heat-treated ductile iron	
Main bearings: number, type	2, parent material	
Governor	Electronic	
Lubrication system	Full pressure	
Oil capacity (w/filter), L (qt.)	1.9 (2.0)	2 (2.1)
Oil pressure, kPa (psi)	172-241 (25-35)	
Fuel system	LP gas or natural gas	
LP/natural gas minimum supply pressure, in. H_2O ($oz./in.^2$)	7-11 (4-6)	
Battery voltage	12 VDC	
Battery ground	Negative	
Spark plug gap, mm (in.)	0.76 (0.030)	
Spark plug tightening torque, Nm (ft. lb.)	24.4/29.8 (18/22)	
Ignition system	Capacitor Discharge	Smart Spark Capacitor Discharge
Starter motor	Electric, solenoid shift	
Cooling system	Air-cooled	

Controller Specifications

Advanced Digital Controller
LED display
- Run time hours
- Crank Cycle Status
- Diagnostics
- Application Software Version

LED display faults
- High Battery Voltage
- Low Battery Voltage
- Low Oil Pressure
- Overcrank
- Overspeed
- Overfrequency
- Overvoltage
- Undervoltage
- UnderFrequency

Password Protected
Run / Off-reset / Auto mode
Digital Isochronous Governor
Digital Voltage Regulator
Cyclic cranking

Environmental Specification	8.5/12RES
Operating temperature	-20° to 70°C
Storage temperature	-60° to 70°C
Humidity	0-95% condensing
Power requirements:	
Voltage	12 or 24 VDC
Current	250 mA @ 12 VDC 125 mA @ 24 VDC

Air Intake

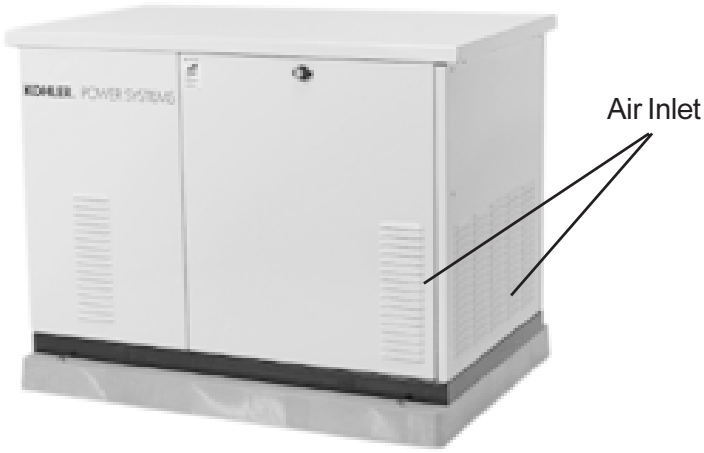
Cooling

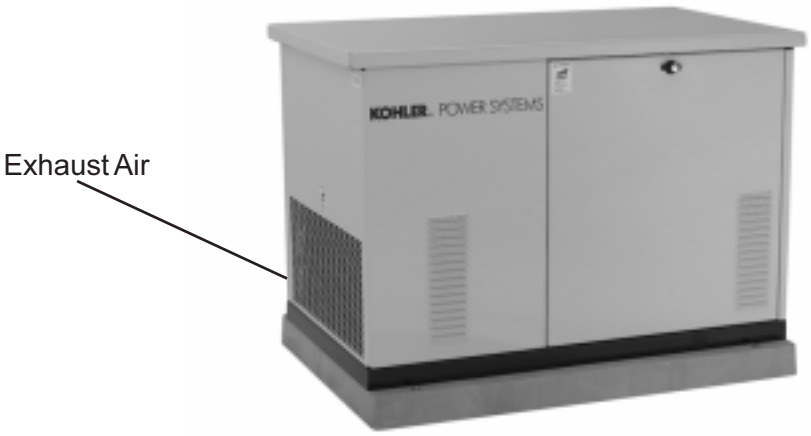
The enclosed unit is cooled by a directed air flow system.

Two fans, one attached to the engine flywheel and the other to the alternator rotor draw in ambient air to cool the engine, alternator, and controller, as well as purge the compartment of hot air.

The engine fan draws air from the housing inlet and forces it across the cylinder cooling fins. A portion of air is also directed through the controller . An opening in the controller shelf provides air flow for the voltage regulator.

The Alternator fan draws cool air into openings in the end bracket to cool the rotor and stator





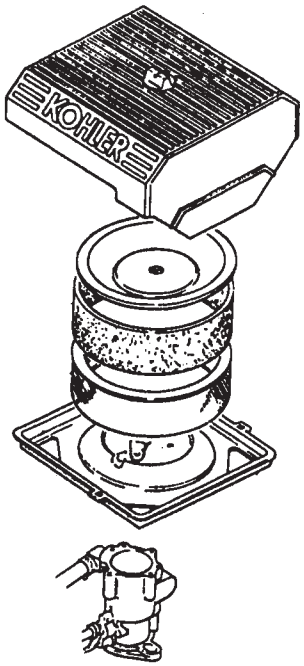
Air Cleaner

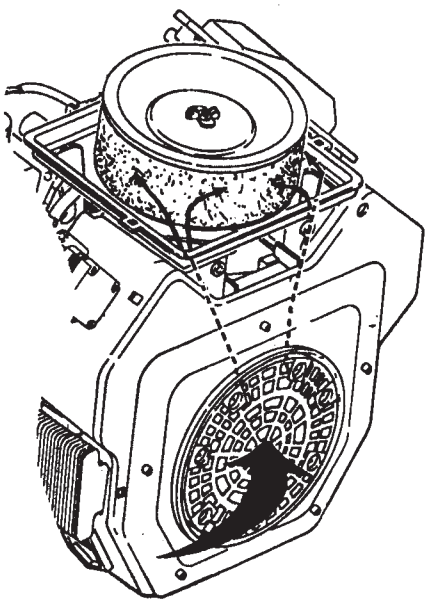
A portion of the outside ambient air is directed from the flywheel fan to the Gas/Air mixer (carburetor) for combustion.

The air is first filtered by an oiled-foam precleaner and replaceable paper element air cleaner.

It is important that the filters are serviced at the recommended scheduled times and that the unit is not operated with the filters removed. Dirt particles entering the intake will cause premature engine wear and failure.

A clogged filter may cause excessive fuel consumption and a loss of engine power.





Fuel System

The generator set will operate on either Natural or LP fuel in a gaseous state. Manual shut-off valves and Primary regulators are installed by the fuel supplier.

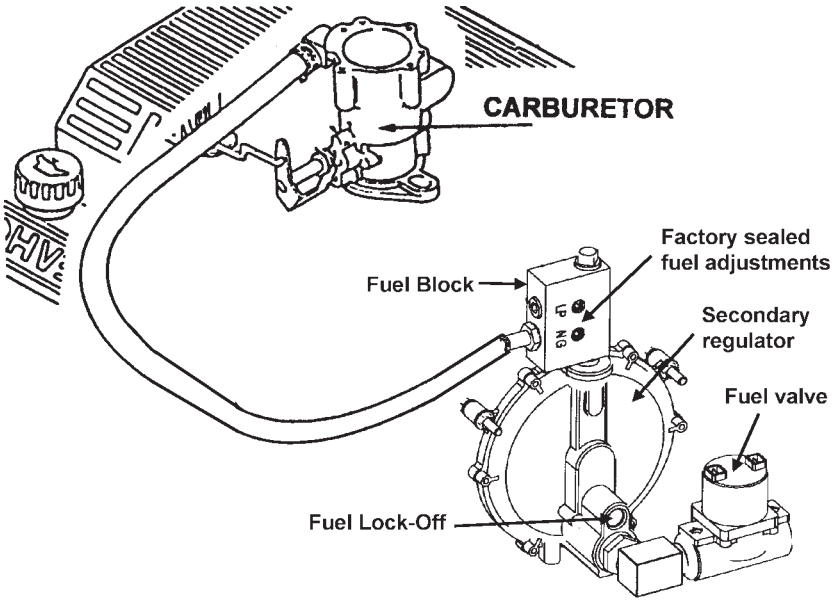
A secondary regulator and 12vdc solenoid valve are located in the front inlet air compartment. The solenoid valve is energized from the controller to open at start and deenergize at shutdown. A ½" NPT inlet is provided.

Inlet gas pressure to the regulator should not exceed 6oz. The regulator controls the pressure on engine demand. A plug is provided at the regulator input for installation of a gauge or manometer if a pressure check is required.

A fuel lock-off is also located in the regulator which prevents fuel flow when the engine is not operating. This is adjusted at the factory and should not be used in an attempt to adjust fuel mixture or engine speed.

The fuel system employs the use of a fuel block which allows either natural gas or LP fuels to be used. Fuel changeover is completed by switching inlet ports and if necessary changing the ignition timing connection. (see ignition systems)

The fuel block has adjustment for optimum engine performance on either NG or LP fuels. The adjustments are set and sealed at the factory and should not be modified.



Natural Gas System

The natural gas as supplied from the utility is in a vapor state. The primary regulator for a natural gas system will be the responsibility of the utility that supplies the natural gas.

The heating value of Natural gas should be 1000BTU per cubic foot. When heating content falls below 1000BTU the set will not produce rated power and will need to be derated. Always check the specification sheet for the rating of the generator while running on natural gas, many applications require derating of the full load power on natural gas.

When installing or troubleshooting the fuel system the following factors must be considered.

- Pressure loss due to length of pipe
- Pressure loss due to other appliances on same fuel supply
- Pressure loss due to number of fittings or elbows

Measured pressure at the inlet to the secondary regulator should be 4 – 6 ounces per square inch or 7 – 11 inches water column. The outlet or carburetor side of the secondary regulator should measure 4-5 inches water column under load.

Physical Property @ 60°F (15°C)	**Natural Gas**
Normal Atmospheric State	Gas
Boiling Point	
Initial	–259°F (–162°C)
End	–259°F (–162°C)
Heating Value, Btu's per:	
Gallon (Net – LVH)	63,310
Gallon (Gross)	
Cubic Foot (Gas)	1000
Density	
Cubic feet of Gas per Gallon (Liquid)	57.75
Weight (lbs.) per Gallon Liquid	2.65
Octane Number:	
Research	110+
Motor	

LP Gas

LP gas is supplied as a liquid in pressure tanks, which makes it easily adaptable to stationary generator applications where complete independence of a fuel source is required.

LP gas is propane, butane, or a mixture of the two gases. The ratio of butane to propane is especially important when an outdoor tank is used. LP gas suppliers may supply the tank in warm summer months with a mixture composed mostly of butane, this mixture my work well in summer but may not provide sufficient vaporized pressure at cold temperatures (below 32°) to start and run the engine. Check with you LP gas supplier for mixture content when hard starting symptoms exist.

The heating value for propane is 2,516 BTU per cubic foot with a boiling point of -44° F and butane is 3,264 BTU per cubic foot with a boiling point of 32° F.

Inlet pressure into the secondary regulator should be 4 – 6 ounces per square inch or 7 – 11 inches water column. Outlet pressure to the carburetor will be a negative pressure of about –11/2 inches water column.

Physical Property @ 60°F (15°C)	**Butane**	**Propane**
Normal Atmospheric State	Gas	Gas
Boiling Point		
Initial	+32°F (0°C)	–44°F (–42°C)
End	+32°F (0°C)	–44°F (–42°C)
Heating Value, Btu's per:		
Gallon (Net – LVH)	94,670	83,340
Gallon (Gross)	102,032	91,547
Cubic Foot (Gas)	3264	2516
Density Cubic feet of Gas per Gallon (Liquid)	31.26	36.39
Weight (lbs.) per Gallon Liquid	4.81	4.24
Octane Number:		
Research	94	110+
Motor	90	97

Pipe Size Requirement for Gaseous System

When installing the generator and laying the pipe for a gaseous system a few things need to be considered, the type of fuel, the distance it must travel from gas meter or tank to the fuel shutoff solenoid, and the amount of fuel consumed by the engine. To figure the correct pipe size for a specific installation, refer to the chart and follow the procedure outlined.

1. Determine length of pipe between gas meter/tank and fuel shutoff solenoid at generator set. Example: 35ft.

2. Find figure closest to pipe length in “Length of Pipe” column on chart. Example: For 35ft it would be 40ft.

3. Refer to fuel consumption from the generator specification sheet. Note type of fuel, and consumption of fuel at 100% load. Example: The 8.5RES for natural gas operating at 100% full load uses 132cfh (cubic feet per hour).

4. Refer to correction factors below. Locate factor for specific gravity of fuel used. Example: natural gas specific gravity - .65, correction factor - .962.

5. Divide consumption figure (132cfh) by the correction factor (.962).

   132÷.962= 137cfh.

6. Move vertically across page to determined point in “length of pipe” column (40ft) go down column and stop at first figure equal to or greater then corrected consumption figure (137cfh).

7. Move to left column from figure (137cfh) to determine correct pipe size. The correct pipe size for a 8.5RMY with a pipe run of 35 ft. should be 3/4 inch.

Correction Factors

Fuel	Specific Gravity	Factor
Sewage Gas	0.55	1.040
Natural Gas	0.65	0.962
Air	1.00	0.775
Propane	1.50	0.633
Butane	2.10	0.535

Maximum capacity of Pipe in Cubic Feet of gas per Hour for a Gas pressure of 0.5Psig or less

(Based on a 0.60 Specific Gravity Gas)

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet						
		10	20	30	40	50	60	70
1/4	.364	43	29	24	20	18	16	15
3/8	.493	95	65	52	45	40	36	33
1/2	.622	175	120	97	82	73	66	61
3/4	.824	360	250	200	170	151	138	125
1	1.049	680	465	375	320	285	260	240
1–1/4	1.380	1,400	950	770	660	580	490	460
1–1/2	1.610	2,100	1,460	1,180	990	900	810	750
2	2.067	3,950	2,750	2,200	1,900	1,680	1,520	1,400
2–1/2	2.469	6,300	4,350	3,520	3,000	2,650	2,400	2,250
3	3.068	11,000	7,700	6,250	5,300	4,750	4,300	3,900
4	4.026	23,000	15,800	12,800	10,900	9,700	8,800	8,100

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet						
		80	90	100	125	150	175	200
1/4	.364	14	13	12	11	10	9	8
3/8	.493	31	29	27	24	22	20	19
1/2	.622	57	53	50	44	40	37	35
3/4	.824	118	110	103	93	84	77	72
1	1.049	220	205	195	175	160	145	135
1–1/4	1.380	460	430	400	360	325	300	280
1–1/2	1.610	690	650	620	550	500	460	430
2	2.067	1,300	1,220	1,150	1,020	950	850	800
2–1/2	2.469	2,050	1,950	1,850	1,650	1,500	1,370	1,280
3	3.068	3,700	3,450	3,250	2,950	2,650	2,450	2,280
4	4.026	7,500	7,200	6,700	6,000	5,500	5,000	4,600

A pressure drop of 0.5 inch water column has been calculated into the chart to make allowances for a nominal number of fittings.

Governor System

The frequency of the alternator output is determined by the speed of the engine. A 2-pole alternator must be driven at 3600 RPM to provide 60 hertz. (3000 rpm/50 Hz)

The engine speed is maintained by an electronic governor system consisting of a magnetic pickup, electric actuator and electronic control assembly.

The microprocessor based ADC controller maintains generator speed based on the mag pick-up input. The magnetic pick-up, which monitors the flywheel ring gear, provides the speed reference signal to the ADC controller

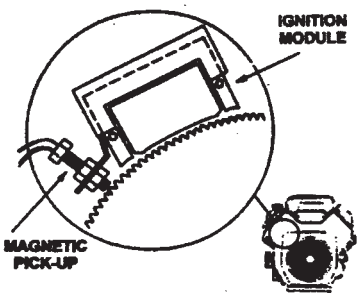
The ADC provides regulated power to the bi-directional stepper motor actuator, which is linked, to the carburetor throttle arm.

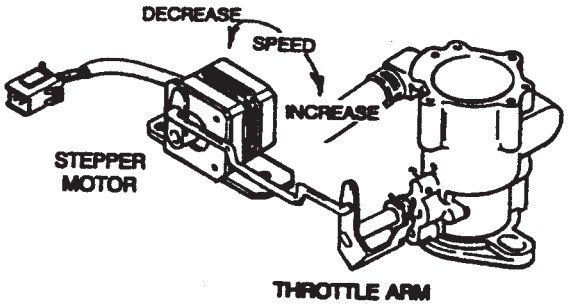
Failure or loss of the input speed signal from the pick-up will result in a low or idle speed condition.

At cranking speed of a properly adjusted pick-up should produce a minimum of 1.75vac. Air gap is factory set at 0.040 in. (1.02mm).

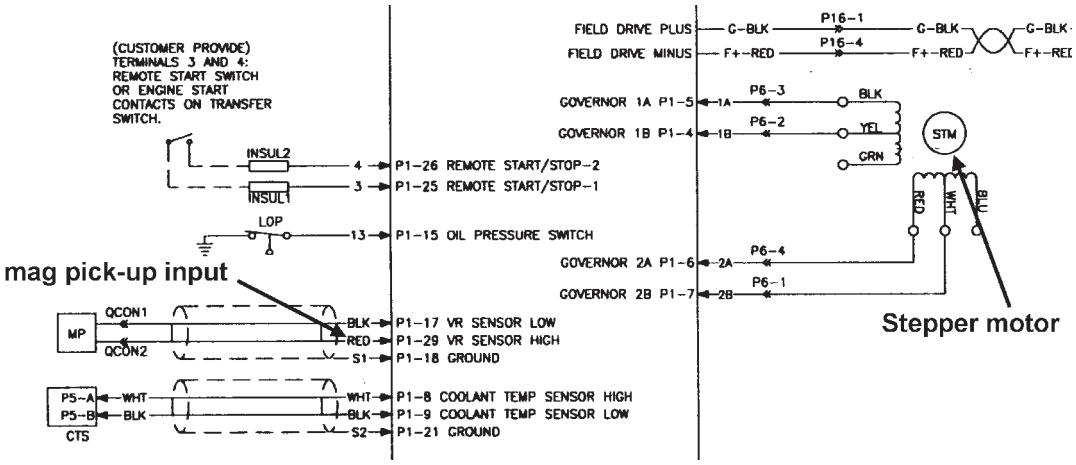
Engine speed is adjustable to +/- 5% which allows a range of speed adjustment between 3420 rpm and 3776 rpm. This adjustment is made through the advance programming menu of the ADC controller.

Speed Gain has an adjustment of +/- 5% . Adjustments are made through the advanced setting menu in the ADC program.





ADC2100



Lube System

The Kohler Command engine features a pressurized oil lubrication system.

The gear driven pump is located in the sump and supplies approximately 25-35 psi of lubricant to the internal components at nominal engine speed. Pressure is limited by a relief valve.

A dipstick is provided for periodic oil level checks. As with any engine do not operate with the level below or above the designated markings.

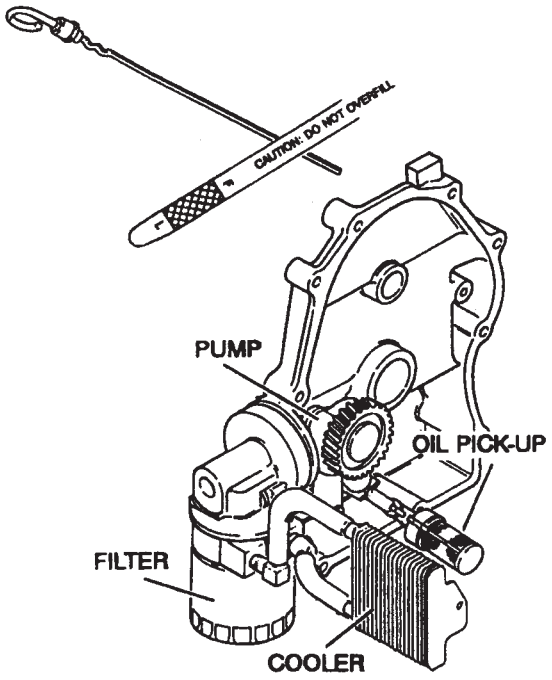
It is also very important to adhere to a good maintenance program. Replace the oil and filter at the recommended intervals.

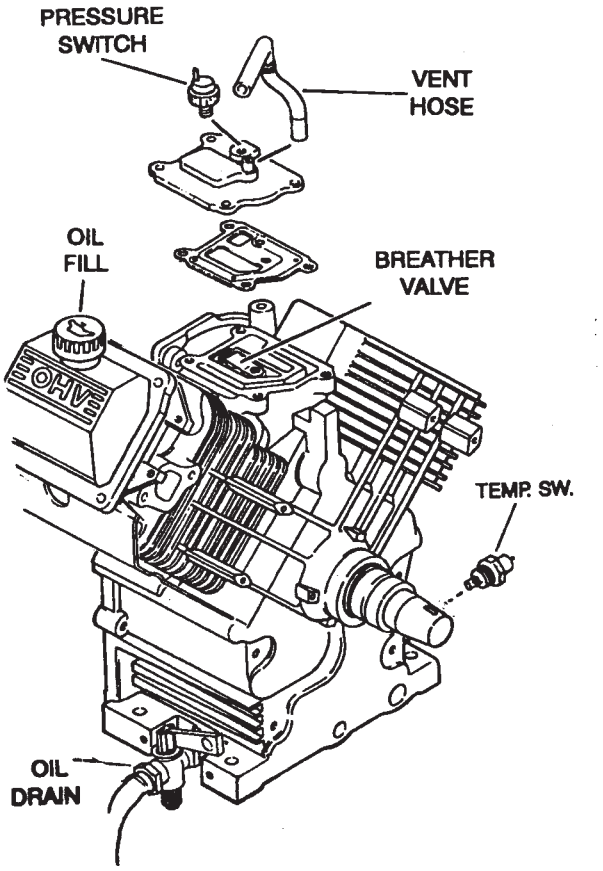
To aid in operating under high ambient conditions an oil cooler is provided, Heat is transferred to the fins and dissipated in the air flow.

The engine operates with a partial vacuum in the crankcase. This is controlled by a "breather" assembly consisting of a reed valve. A pressurized crankcase due to a faulty or clogged valve could cause oil leaks at seals and gaskets.

A hose attached to the valve vents the crankcase fumes to the mixer air intake for ingestion into the combustion chambers.

A pressure switch is installed in an oil passage in the breather cover to protect the engine in the event of a fault which would cause oil pressure to drop to an unsafe operating level. Contacts in the switch will close when the pressure drops below 3 to 5 psi and will initiate an engine shut-down.





Ignition System CH20

The CH20 engine feature dual capacitor discharge ignition modules to fire the two sparkplugs. They are installed on the cylinders in close proximity to the flywheel.

A permanent magnet is located on the flywheel which is keyed to the crankshaft providing a fixed timed ignition. (CH20)

As the magnet approaches the L1 coil a potential is generated which is rectified by the D1 diode and stored in the C1 capacitor.

Further rotation of the flywheel causes a current to be induced in the L2 coil which triggers the SCR discharging the capacitor to the primary of the T1 ignition coil.

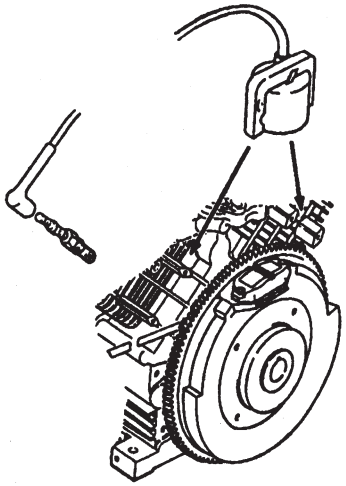
This rapid flow of current in the primary induces a very high voltage in the T1 secondary windings sufficient to jump the spark plug gap and ignite the cylinder fuel mixture.

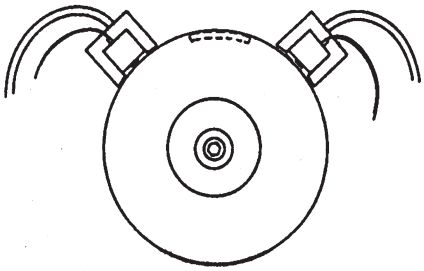
This firing occurs on every revolution of the flywheel.

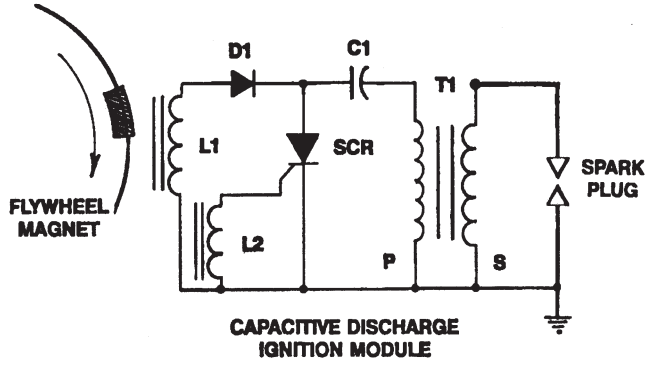
Ignition is terminated by shorting the high side of the primary circuit to ground. This is accomplished by the **K5** relay contacts.

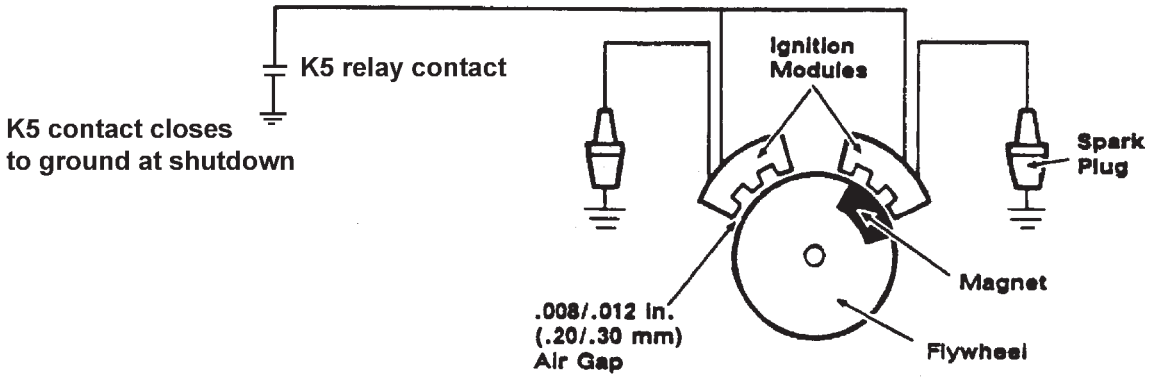
Air gap between the core of the modules and the magnet is .010 in. (0.25mm)

This magneto type ignition requires no external battery supply or timing adjustments.









Ignition System CH740

The CH25/CH740 engine features a “SMART SPARK” or DSAM module mounted externally at the rear cylinder shroud. Operation is similar to the capacitive discharge ignition except a spark advance circuit is provided to the triggering circuit and a battery voltage supply is required. (70a)

The CH20 CD ignition module relies on the fixed timing circuit based on the L2 coil to trigger the SCR circuit. The CH25/CH740 uses a microprocessor based circuit (DSAM) to trigger the SCR circuit. This change allows for better engine timing in relation to fuels used.

The timing of spark is controlled by the location of the flywheel magnet as referenced to the engine TDC and the delay created by the Spark advanced module

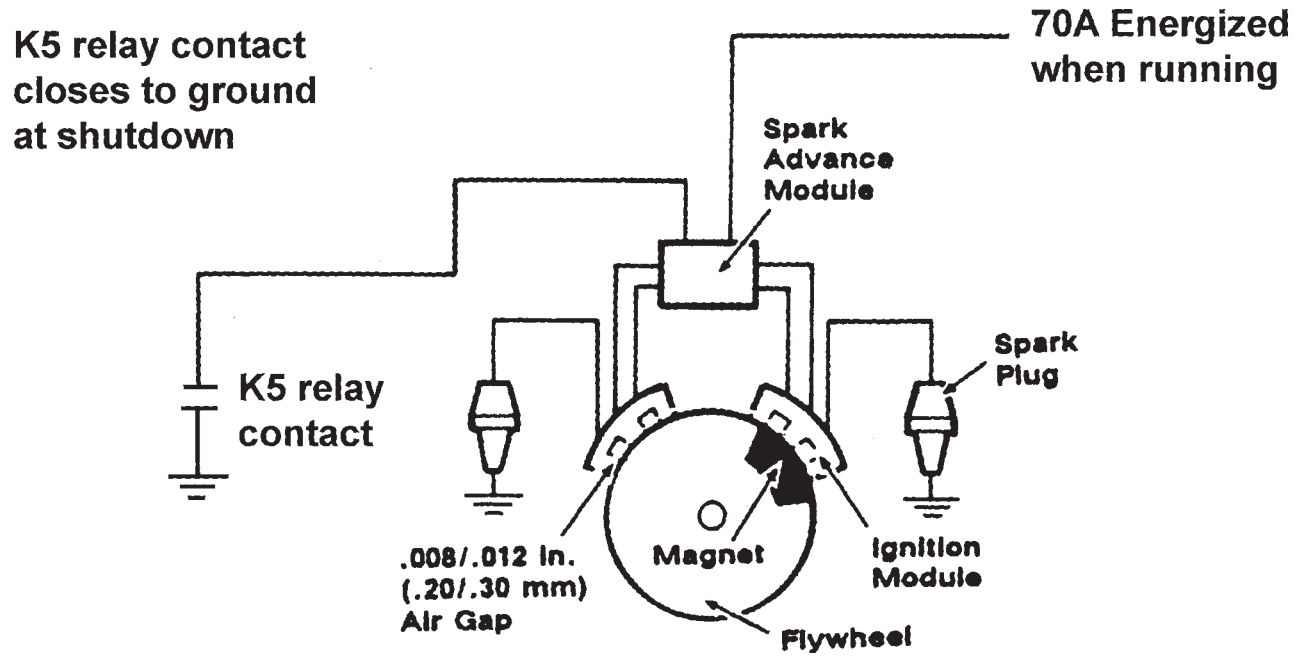
Previous CH25 engines used a SAM or analog spark advance module, this module has since been upgraded with a mocroprocessor controlled spark advance or DSAM.

Ignition Timing

There is an ignition timing connection located near the secondary gas regulator. This connection needs to be made when using natural gas to run the 12RES generators. This connection should be open when running LP with the 12RES.

The conection should be open on the 8.5RES when running either NG or LP.

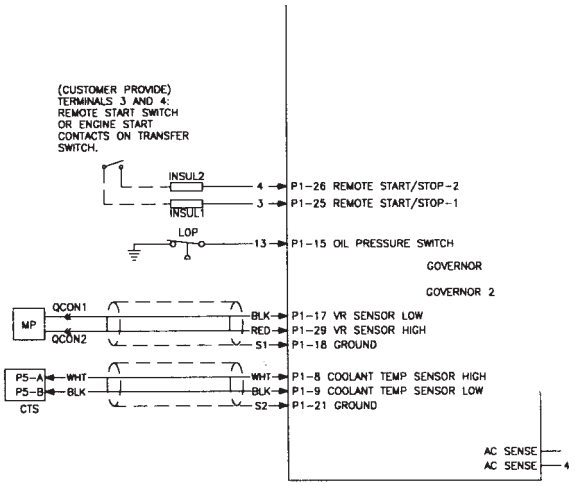
Ignition Timing Connection



Starting System

The generator set can be started locally by placing the start selector switch in the “RUN” position.

When placed in the “AUTO” position the generator set can be started from a remote location (automatic transfer switch) by contact closure between wires 3 & 4 on the ADC controller. A 10 amp fuse (F2) protects the Crank/Run circuit.

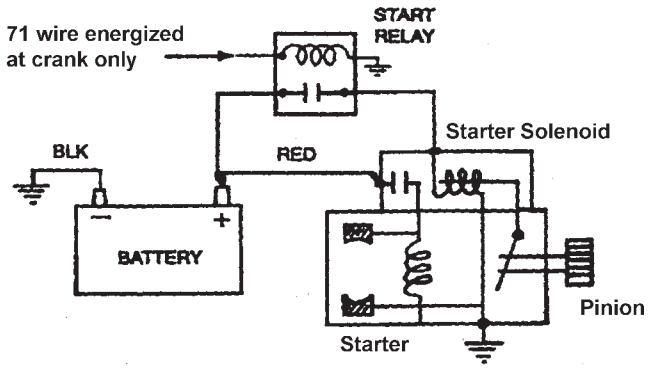


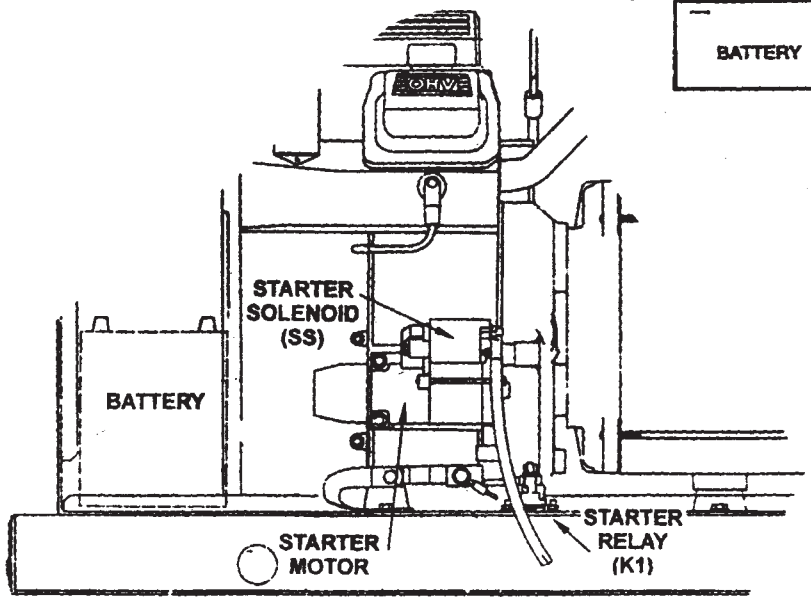
The electric starting system requires a 12 volt lead acid battery with a minimum 675 cold cranking amp rating.

The unit is designed for negative ground connections . The controller will not allow an engine crank with a reversed battery connection, and system damage may occur.

The Starter Solenoid (SS) contains contacts that connect the battery to the starter brushes and a spring loaded drive mechanism which engages the starter motor pinion to the flywheel ring gear.

To insure a successful start-up the battery must be properly maintained and kept fully charged.





Cyclic Cranking

A cyclic cranking feature is provided which allows the starter to be energized for a preset time followed by a preset rest time. This cycle will repeat until the total time allocated by the controller has lapsed or a successful start occurs.

Cranking time (ON) is factory set for 15 sec., Rest period (OFF) is set for 15 sec. This is a microprocessor based setting and cannot be changed.

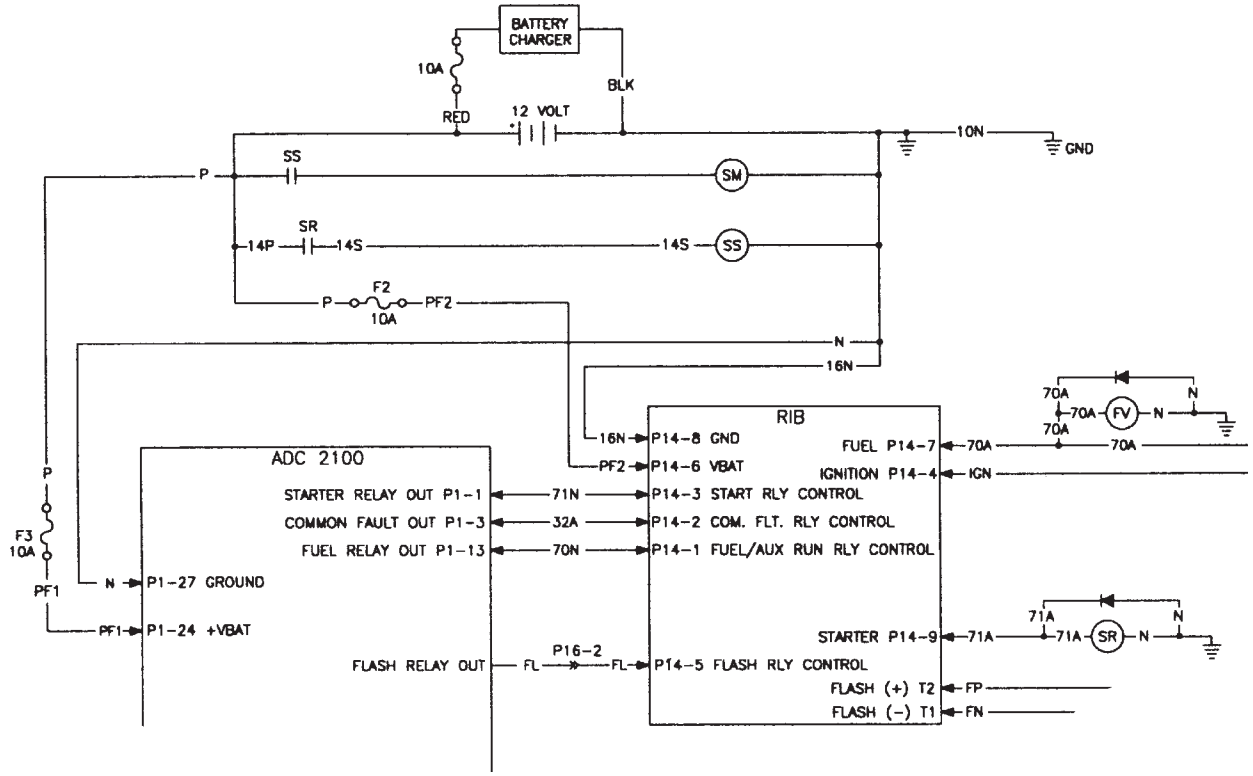
If the engine does not start within the total cyclic time the starting attempt will be terminated and an indication of "overcrank" (OC) will result. The selector switch must be placed in the "Reset/Off" position prior to attempting another start cycle.

Cyclic cranking provides the starting components a rest or reset period to prevent overheating and allows more efficient use of available battery power before it is depleted. This is important especially for remote starting of an unattended unit.

When a start signal is provided, voltage is applied to the cyclic cranking circuit. During the "crank" cycle the Start relay contacts will close energizing the cranking control relay SR. When the SR contacts close the starter solenoid and Starter Motor will be energized.

If the engine starts within the cranking time of the cycle the Start relay will deenergize removing power from the coil of the SR relay and terminate engine cranking.

The Gas valve and Run relay will also be energized during the cranking cycle.



Battery Charger

6-Amp Battery charger

The 8.5 and 12RES generator sets are equipped with a factory installed battery charger. The battery charger is powered by a 120vac source. The 120vac source must be available when either utility or generator power is available.

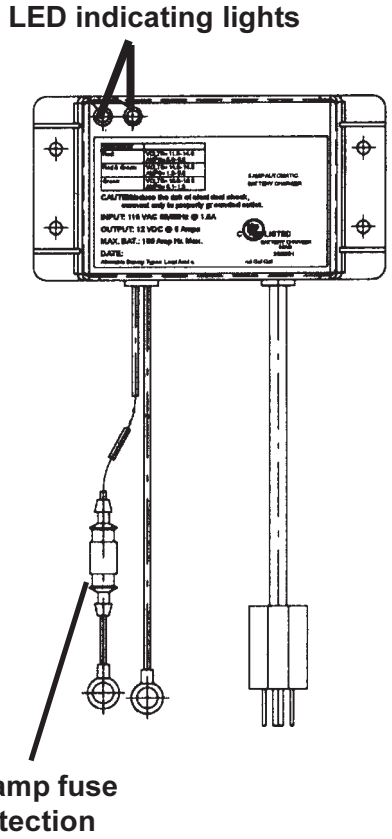
The 6-amp charger has 3 modes of operation, bulk rate, absorption rate, and float.

Bulk rate indicates the battery is discharged and the charger rate is 6 amps.

Absorption rate is when the charger is at a rate of 1.5 to 5 amps. This mode of charging tops off the battery and reduces harmful sulfating.

Float rate is when the charger rate has dropped below 1.5 amps. At 1.5 amps the battery is at 90% charge, the charger rate will drop to .1 amps as the battery approaches 100% charge. The charger will maintain this float rate without overcharging the battery.

The 6-amp charger has 2 LED's (Red, Green) to indicate battery charger mode.
Bulk charge mode - Red on, Green off
Absorption mode - Red on, Green on
Float mode - Red off, Green on



Scheduled Maintenance

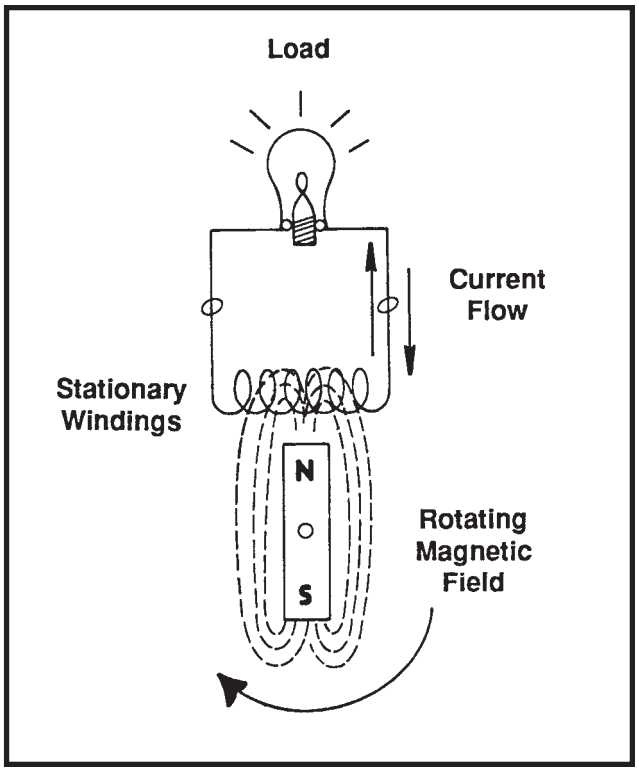
System Component or Procedure	See Section	Procedure					Frequency
		Visually Inspect	Check	Change	Clean	Test	
Fuel							
Flexible lines and connections		X		R			Quarterly
Main tank supply level			X				Weekly
Fuel piping		X					Yearly
Lubrication	3.3						
Oil level		X	X				8 hours or before use
Crankcase breather*		X		X			Yearly or 500 hours
Change oil				X			Yearly or 100 hours
Replace filter*				X			Yearly or 200 hours
Cooling	3.6						
Air ducts, louvers			X		X		Yearly
Exhaust Line	3.7						
Leakage		X	X				Weekly
Insulation, fire hazards		X					Yearly
Hangers and supports		X					Yearly
DC Electrical System	3.8						
Battery charger operation, charge rate (if equipped)		X					Monthly
Remove corrosion, clean and dry battery and rack		X			X		Yearly
Clean and tighten battery terminals		X	X				Yearly
Battery electrolyte level and specific gravity†			X				Yearly
AC Electrical System							
Visible wear or damage		X					Quarterly
Wire abrasions where subject to motion		X	X				Six Months
Tighten control and power wiring connections			X				Yearly
Wire-cable insulation breakdown *		X					3 Years or 500 hours
Engine and Mounting							
Visible wear or damage		X					Weekly
Air cleaner service	3.5			R			Yearly or 100 hours
Spark plugs	3.4			X			Yearly or 300 hours
Replace stepper motor coupling and bushing *				X			500 hours
Compartment condition		X			X		Weekly
Remote Control System							
Remote control						X	Monthly
Run generator set						X	Weekly
Generator							
Visible wear or damage	2.1	X					Quarterly
Exercise generator set	2.2					X	Weekly
Rotor and stator *		X			X		Yearly
Measure and record resistance readings of windings with insulation tester (Megger, with SCR assembly or rectifier disconnected)						X	3 Years
General Condition of Equipment							
Evidence of vibration, leakage, excessive noise, temperature, or deterioration		X	X		X		Weekly
Interior of sound enclosure		X			X		Quarterly
* Contact your local distributor/dealer for parts or service. † Not necessary for maintenance-free batteries.		X Action R Replace as necessary					

Alternator Design

Mechanical alternators or generators that produce an AC output are either the rotating armature or the rotating field design and require 3 basic things.

1. Conductors
2. A magnetic field
3. Movement between the two.

1. The **conductors** are copper wires wound in slots of laminated steel referred to as the armature and provide the generated output voltage.
2. The **field** is the invisible magnetic force produced by electro-magnetic pole pieces.
3. **Movement** between the field and conductors is necessary to create current flow in the armature windings and is usually provided by a gas or diesel engine.

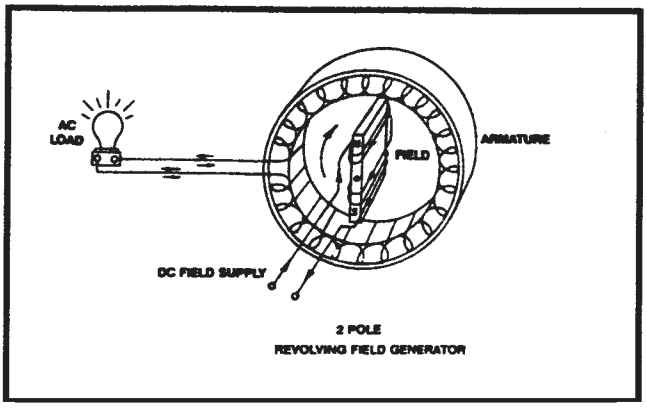


Kohler residential generators are of the rotating field design.

Rotating Field Generators

Alternators used on most generator sets today are of the rotating field design. The magnetic poles of the rotor rotate past the armature windings of the stator. The rotor is energized with a DC field by some type of excitation. As the field rotates the magnetic flux lines cut the conductors, which are distributed so as to induce a sinusoidal voltage in the stator.

The stationary stator also allows for easy reconnection of the windings to permit various three phase or single phase voltages.



Alternator

The Alternator is of the Rotating Field design and consists of two major components, the Rotor and Stator.

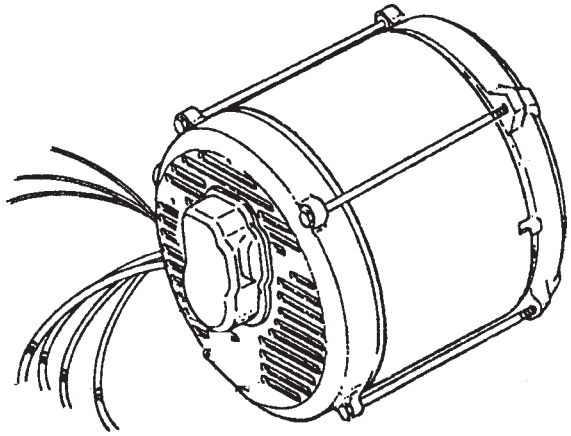
The Rotor which is located within the Stator is of the 2 pole design and is directly coupled to the tapered engine crankshaft stub with a thru-bolt.

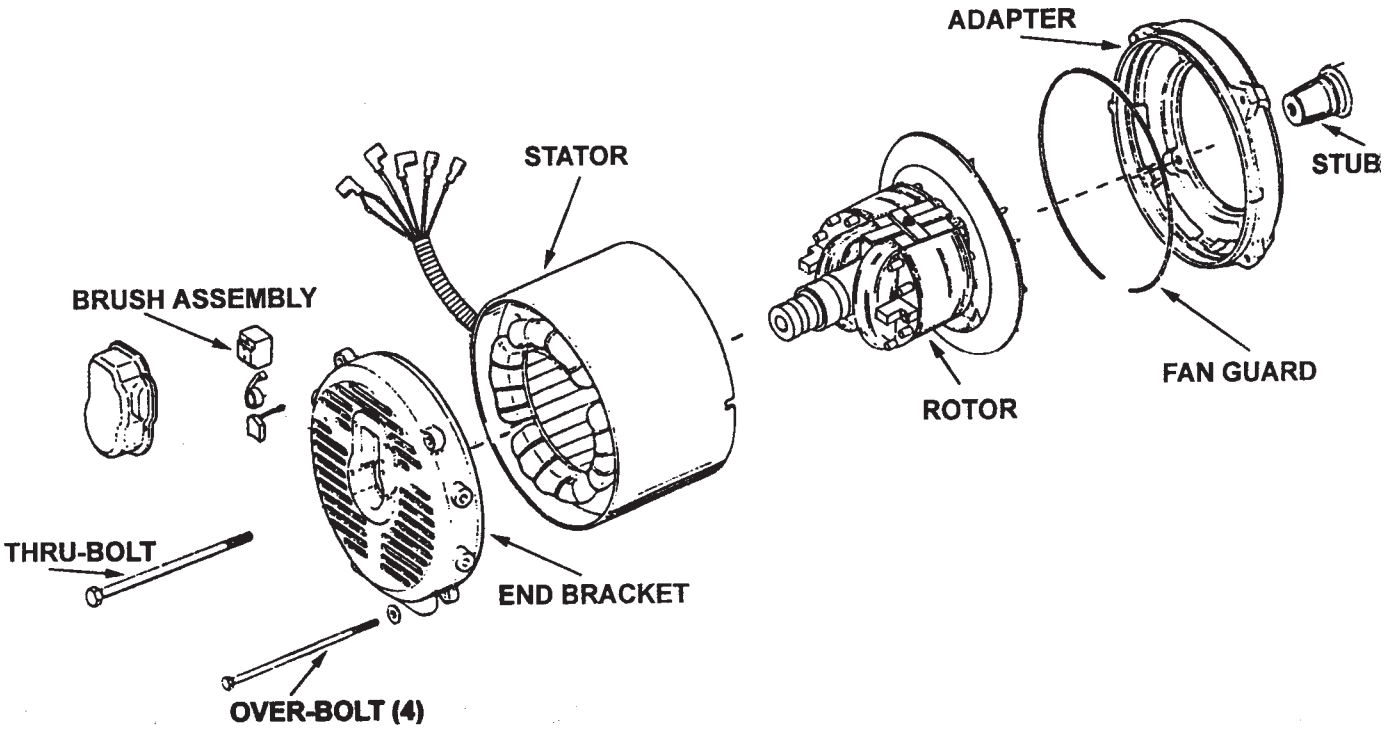
Excitation slip rings are mounted outboard of the end bearing and accessible from the exterior of the end bracket. The fan is permanently mounted to the rotor shaft

The Stator contains the copper windings which provide the load current and is assembled to the engine adapter with an end bracket and overbolts.

The 4 lead stator is wound for single phase applications only and is factory connected to provide a 3 wire 110/220 to 120/240 volt supply.

The DC excitation to the rotor slip rings is supplied by an adjustable static exciter/regulator.





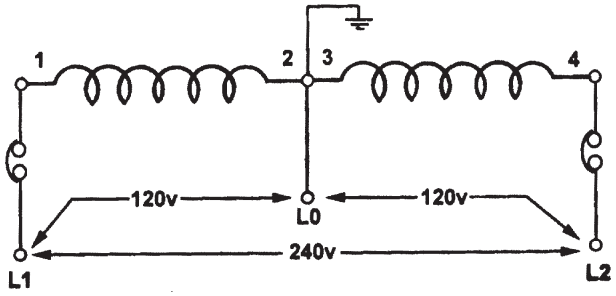
Stator

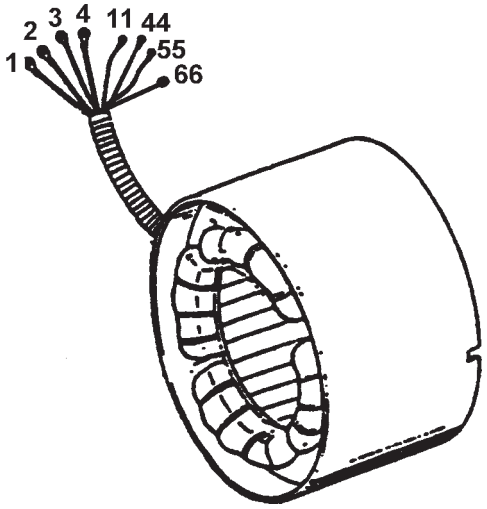
120 / 240 v 3 Wire.
110 / 220 v 3 Wire.

The 4 lead stator is factory connected to provide two low voltage (110-120) circuits and one high (220-240) voltage circuit. The rated load amps can be divided between these three circuits.

A 2 pole circuit breaker is provided for load disconnect. Customer load connections are made at the breaker.

Most Standby applications require a 240 volt circuit including the G120 Automatic Transfer Switch.

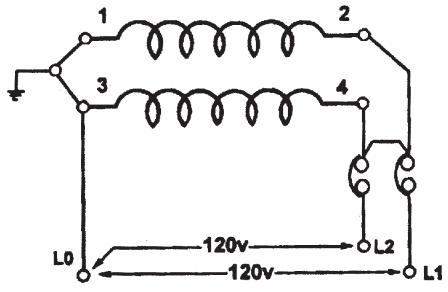




Stator leads 11, 44 are common to stator leads 1 and 4 and provide the voltage sensing for the voltage regulator circuit. Leads 55 and 66 provide the excitation power for voltage regulation.

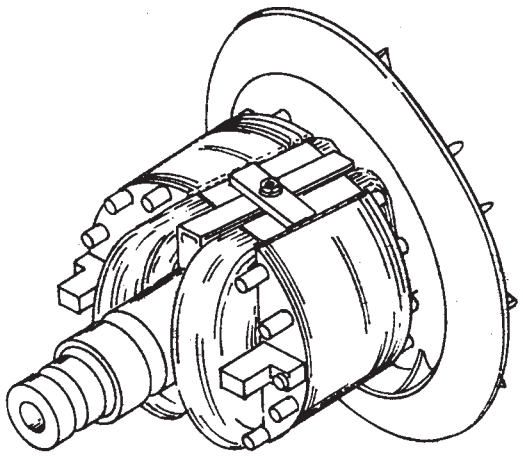
120 v 3 Wire.
110 v 3 Wire.

The Stator can be reconnected to a straight single voltage 2 wire or 3 wire configuration if required. A jumper is placed on the line side of the circuit breaker to balance the load between the two windings.



Rotor

The rotor is a powerful electromagnet which when rotating induces current flow in the stator windings.



The rotor windings (field coils) are energized by a DC supply from the Exciter/Regulator via brushes and slip rings and magnetize the two laminated iron pole pieces.

The DC supply is increased or decreased depending on load demand applied to the generator and is automatically controlled or regulated by the voltage regulating portion of the ADC contrioller logic.

The rotating speed of the rotor determines the frequency of the alternator output. A two pole rotor must rotate at 3600 RPM to produce 60Hz. (3000 RPM / 50Hz)

The rotor, which is directly coupled to the engine tapered stub shaft, is supported by a bearing in the end bracket assembly.

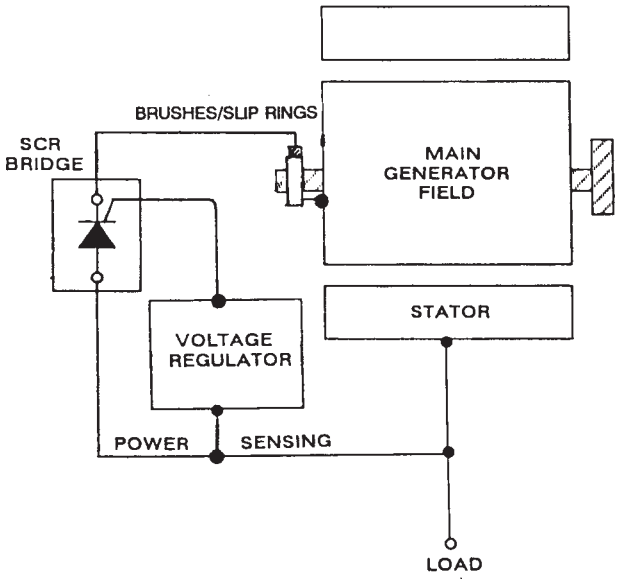
Field Excitation

The rotor field windings are energized through field excitation. Field excitation comes from a variable DC source called an exciter. By varying the exciter voltage we can control the voltage and current induced into the rotor thus controlling the voltage generated in the stator.
To control the exciter voltage a voltage regulator is incorporated into the alternator design and its selection is based on the type of excitation used on the alternator and the application of the generator.

Static Excited (Brush Type)

This system rectifies AC power from the output of the generator and sends a controlled DC current to the rotating field through brushes/ collector rings. This exciter is typically an SCR bridge controlled by a solid state voltage regulator circuit. This system can be designed to have excellent load response and voltage regulation.

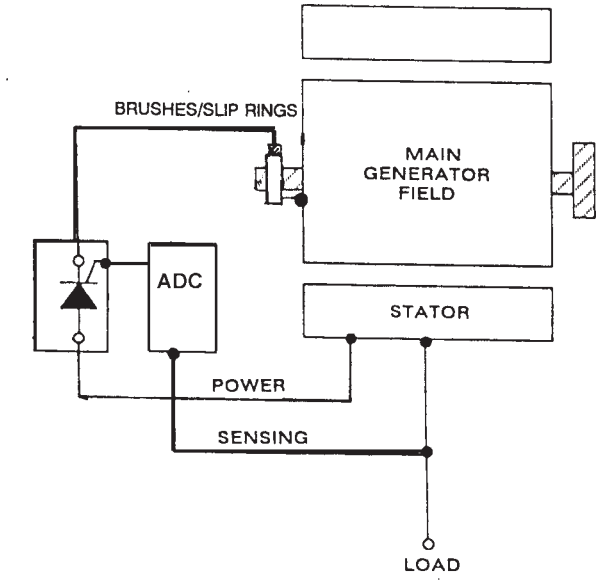
The disadvantages of static excited designs are found in the brushes and collector rings. These components are subject to routine maintenance such as inspections of brush wear and buildup of dirt and carbon on the collector rings.



(PowerBoost™)

The Kohler version of static excited generators feature a patented PowerBoost™ exciter regulator. It employs a separate auxiliary stator winding (independent of the main output) to power the field during fluctuations caused by load-on load-off situations.

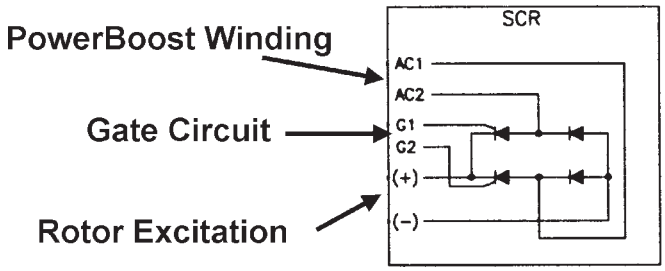
This system provides excellent motor starting ability and maintains virtually constant voltage.



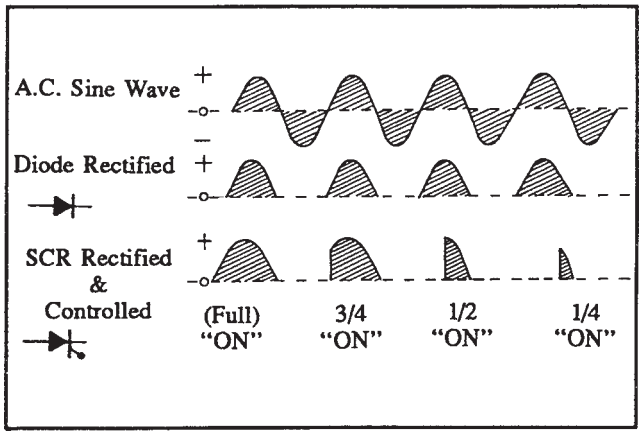
SCR Rectification

SCR's (silicon controlled rectifiers) are used to rectify the AC output voltage to a DC input voltage for rotor excitation.

A sensing circuit in the voltage regulator monitors the generator output voltage and provides a signal for controlled gating or conduction of the SCR's.



The regulation circuit will provide a DC output to the rotor whenever the voltage monitored is below the nominal setting. A voltage above the setting will turn the regulator (DC output) off. The regulator circuit is constantly turning on and off in its attempt to maintain its nominal setting.



Digital Voltage Regulator

The rotor provides the magnetic field flux. The DC supply required to produce the magnetic field is provided to the rotor from the PowerBoost™ exciter/regulator.

Initial excitation at engine start-up (field flash) is supplied to the rotor bush and slip ring assembly from the starting battery via relay contacts (Flash Relay).

On sensing a successful engine start and alternator build-up (app. 30 vac from Powerboost™ winding) the battery supply is disconnected and excitation is provided from regulated rectified output from the SCR module to rotor via the FP, FN leads and brushes.

The Digital Voltage Regulation circuit is packaged in the ADC controller. The SCR module is separate and is located at the rear of the stator.

The excitation component (SCR) rectifies AC from the auxiliary power coil (55-66) of the stator. The voltage regulator circuit monitors the alternator AC output (11 – 44) and controls the firing (Field drive +/-) of the SCR gate circuit providing regulated DC to the rotor slip rings.

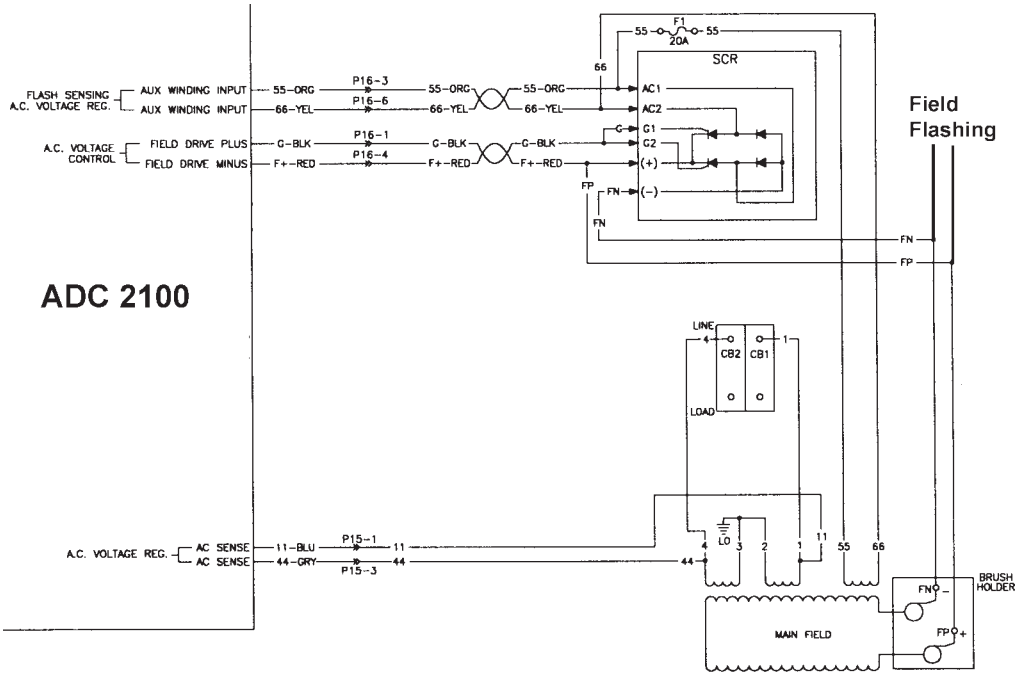
The digital regulator provides ± 1.5% RMS Regulation.

Course and Fine Voltage adjustments can be made using the Dynamic settings in the ADC controller (see controller dynamics settings)

The regulator can also be field adjusted for minimum voltage fluctuation and light flicker using the ADC dynamic settings. (see controller dynamic settings)

A Volts per Hertz feature automatically reduces the voltage if an overload causes the frequency to drop below a preset level. (factory set at 58hertz)

A 10-amp fuse (F1) is provided to protect the power input circuit.

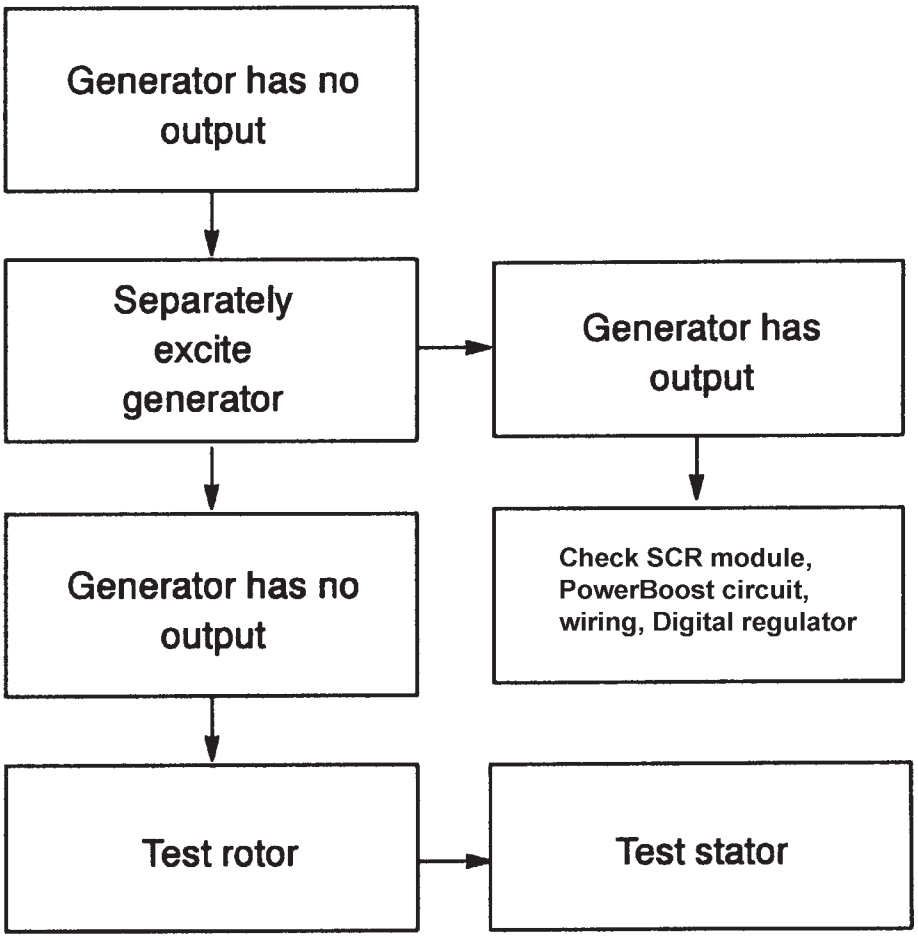


Alternator

General Troubleshooting

This section will cover general trouble-shooting fundamentals used when diagnosing alternator problems. When servicing a generator use specified service manual and follow all safety precautions.

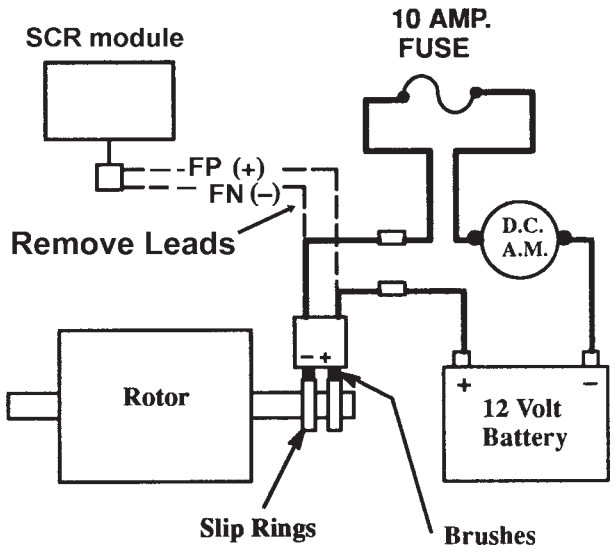
Follow the troubleshooting flowchart to determine the cause of no or low AC output from the generator.



Disconnect generator starting battery before testing any parts of the alternator assembly!!!!

Separate Excitation

To determine the cause of no or low AC output, separately excite the generator. The generator field (rotor) may be magnetized using an alternative DC power source (12-volt automotive battery) and following the procedure below. While separately exciting the generator to determine the presence of a faulty voltage regulator, it is possible to determine if a running fault exists in the rotor and/or stator. A generator component that appears good while static (stationary) may exhibit a running open or short while dynamic (moving). This fault can be caused by centrifugal forces acting on the windings while rotating or insulation breakdown as temperatures increase.



Procedure for separate excitation:

1. Disconnect all leads from voltage regulator.

2. Connect an ammeter and a 12-volt automotive battery to the (+) and (-) brush leads. Include a 10amp fuse in the circuit in case of a shorted rotor.

3. The appropriate ammeter reading should be battery voltage divided by specified rotor resistance. Consult service manual for resistance specifications.

4. Start generator and check that ammeter remains stable. An increase indicates a shorted rotor. A decreasing or erratic meter reading indicates a running open.

5. If Ammeter reading is stable compare the stator winding output results with the specifications for the specific alternator found in the service manual. If output readings vary from specification the stator is likely to be at fault.

6. If the rotor and stator test good the voltage regulator is probably defective.

Testing Stator

The stator consists of a series of wire coils placed in a laminated steel frame. The stator leads can supply voltage to the AC load, voltage regulator, or controller depending on the function of that output coil. Prior to testing, inspect the stator for heat discoloration and visible damage to housing, exposed coil windings and exposed varnished areas of frame laminations. If visible damage exists the stator will need to be repaired or replaced.

Checking Stator Continuity and Resistance

Tools required: Ohmmeter, Megger
The example illustrates a single phase alternator.

Note: Refer to service manual for all specifications with reguards to winding resistance values.

Continuity
1. To check stator continuity, set ohm meter to a low resistance setting. This test will check if any coils are shorted to each other or there is a short to ground.

2. Dissconnect all stator leads prior to performing measurements.

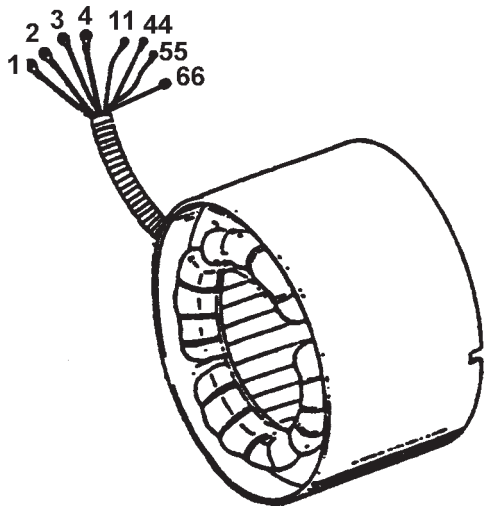
Leads1, 2, 3, and 4 are the generator output leads. Leads 11, 44, are the voltage regulator sensing. Leads 55-66 are control power for the excitation.

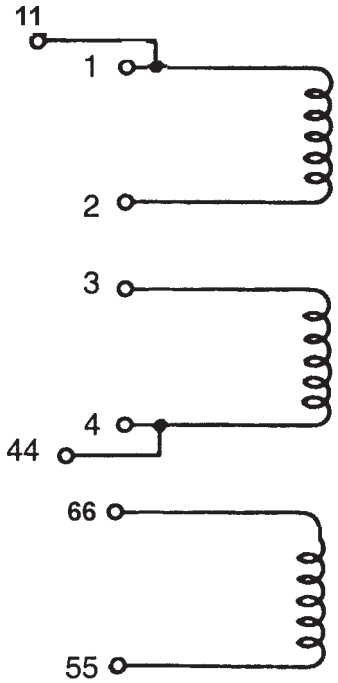
3. Check continuity of all windings, the meter should show continuity when checking between leads 1-2, 3-4, 55-66.

4. Check for continuity between coil groups, meter should show no continuity. If the meter indicates continuity this means the two coil groups are shorted together.

5. Check continuity between each coil group and the frame of the stator, meter should show no continuity. If the meter shows continuity this indicated the coil is shorted to ground.

Resistance
Most ohmmeters will not provide accurate readings when measuring less then 1 ohm, which is typical for a stator winding. The stator can be considered good if a low resistance reading is obtained in each coil group and there is no evidence of an internally shorted winding (heat discoloration).



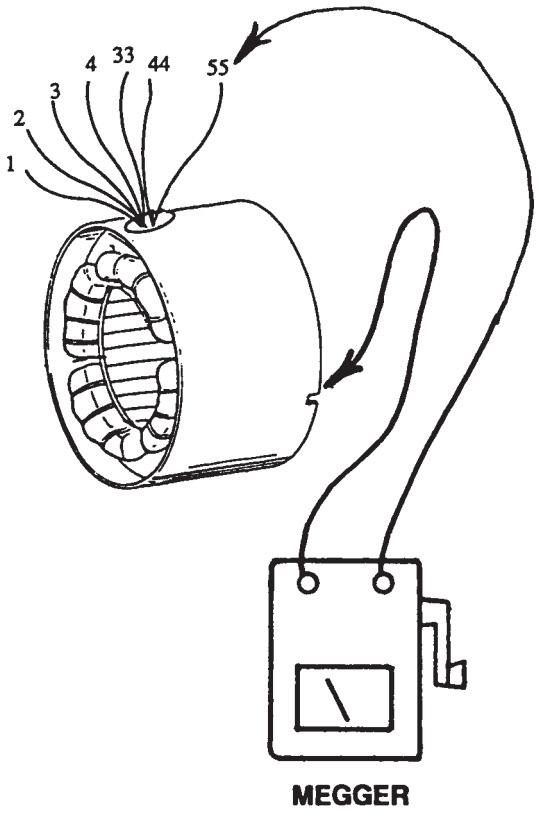


Megger Testing

The purpose of insulation is to prevent shorting between the windings, lamination slots and any conductive material used in the generator construction. If this insulation deteriorates or breaks down a current path can be created between the copper windings and the frame structure. This breakdown may not be detected when performing a continuity test.

Dirt, grease, chemical fumes, aging and moisture are some of the contributing factors that can lead to the insulation breaking down.

A megger can be used to test for possible current leakage to ground that was not detected during continuity testing. Meggers apply a voltage between the insulated conductor and the material they are insulated from, usually ground. They determine the resistance flow across the insulation of the conductor. These resistance values are very high, in the millions of ohms.



1. Prior to operating a megger disconnect all stator leads

2. You can keep the load leads connected together but it is recommended that you disconnect all individual coils and test each one individually.

3. The positive lead of the megger should be attached to the lead coil being tested on the alternator and the ground lead attached to the frame.

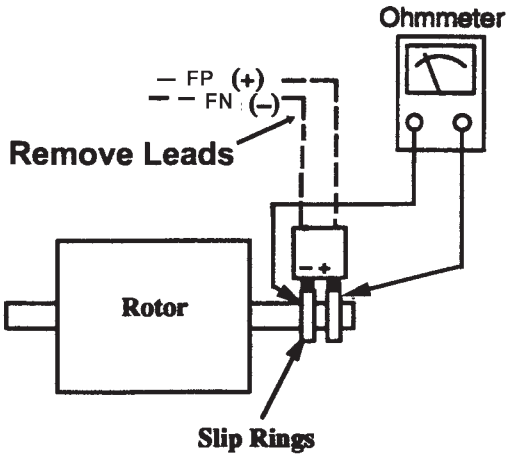
4. Perform the megger test following the instrument instructions.

5. As a general guideline if the insulation resistance is greater then 1.5 megohms the insulation leakage is considered acceptable. If it is below 1.5 megohms the stator needs to be serviced. Always refer to instrument instruction or generator specification when determining when insulation leakage is suffcient to warrant repair or replacement.

Testing Rotor (Brush Type)

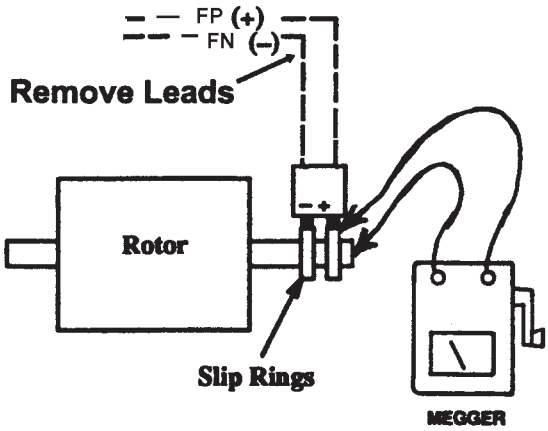
Prior to testing the rotor, inspect exposed coil windings, brushes and collector ring surfaces. Check rotor bearing for noisy operation, excessive wear, and heat discoloration. Replace or repair if needed.

To check the rotor for continuity place the meter leads on the two collector rings. Set meter to lowest setting for measuring resistance. If a high resistance reading is found this indicates an open winding. Typical measurement readings can be found in the specification section of the service manual for the particular rotor being tested.



To test for a grounded rotor place one meter lead to a collector ring and the other lead to the rotor shaft. Meter should register no continuity.

Megger readings can also be taken by placing one lead of the megger to a collector ring and the other to the rotor shaft. If reading is above .5 megohms the insulation leakage is acceptable. If reading is below .5 megohms this indicates there may be current leakage to ground and servicing is needed. The rotor may have moisture and needs to be dried out or the insulation is weak and the rotor will need to be serviced or replaced.

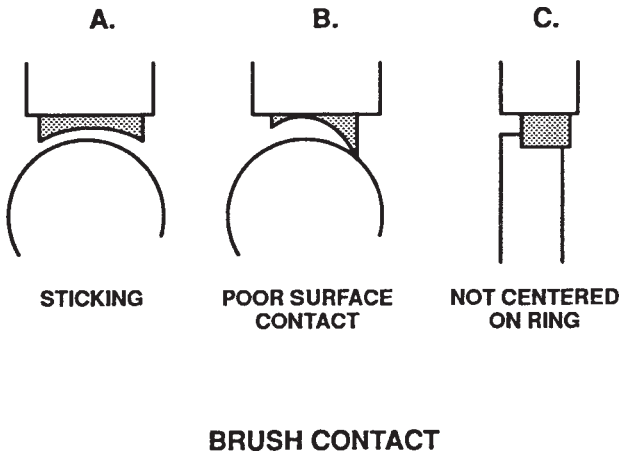


Note: Make sure when taking resistance readings or performing a megger test that the brushes are not in contact with the slip rings.

Brush / Collector Ring Maintenance

When performing inspection on brushes it is important to note the brushes are not sticking, have good surface contact with the rings, and the brushes are centered and riding completely on the rings. Severe arching on the brushes may cause regulator to fail and also damage the slip rings.

Collector rings acquire a glossy brown finish in normal operation and cleaning to maintain a bright machined surface is unnecessary. If grooves have developed on the collector rings a commuter stone should be used to level the surface. Never use emery cloth or carborundum paper to level or clean collector rings.



BRUSH CONTACT

ADC 2100 Controller

The ADC 2100 is a microprocessor-based controller. The controller allows for manual and automatic operation. The controller has built in diagnostics with the ability to display both generator warnings and shutdowns. The controller keypad allows access to system configuration and voltage and frequency adjustment.

The LED display indicates generator set status. When operating normally the generator total run hours will be displayed. The LED display will also show active faults or warnings.

System Faults:
Auxiliary Fault – AF
High Engine Temperature – HE
Low Oil Pressure – LOP
Overcrank – OC
Overfrequency – OF
Overspeed – OS
Overvoltage – OU
Underfrequency – UF
Undervoltage – UU

System Warnings
High Battery – HB
Low Battery – LB

The start selector switch is a three-position device. The generator can be started locally by placing the switch to RUN.

When an Automatic Transfer Switch or remote start is utilized the generator will be signaled to start when the selector switch is in the AUTO position and a contact closure occurs across leads 3 and 4.

The generator will shutdown when the switch is placed in the OFF/RESET position.

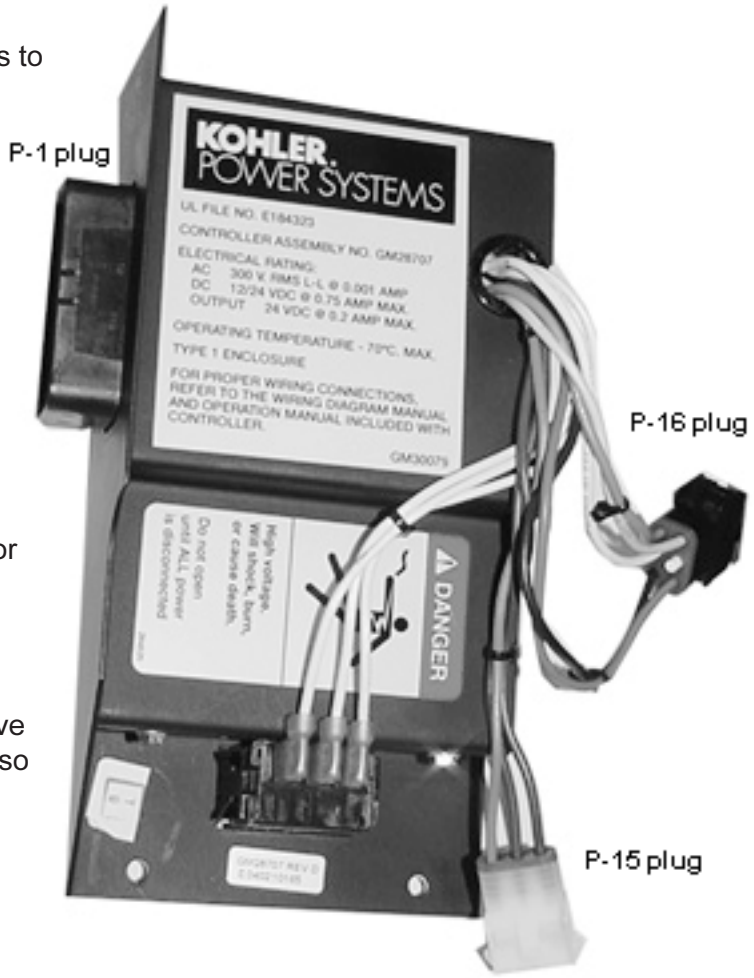
ADC Interface

The ADC controller utilizes 3 plug connections to control the interface between the controller, engine, and alternator.

The P-1 plug is the termination point for all DC connections. The DC inputs include Low Oil Pressure, Coolant Temperature, Remote Start, Battery positive and negative, and the mag pick-up input.
The DC outputs include the 71N (starter relay), 70N (run relay), and DC output to the governor stepper motor.

The P-15 plug is the input connection for AC sensing. The ADC controller uses this input for voltage regulation and a secondary means of crank disconnect.

The P-16 plug connections are for the PowerBoost™ winding input, and the field drive outputs to control excitation. The P-16 plug also has the FL output which controls the Field Flashing relay.



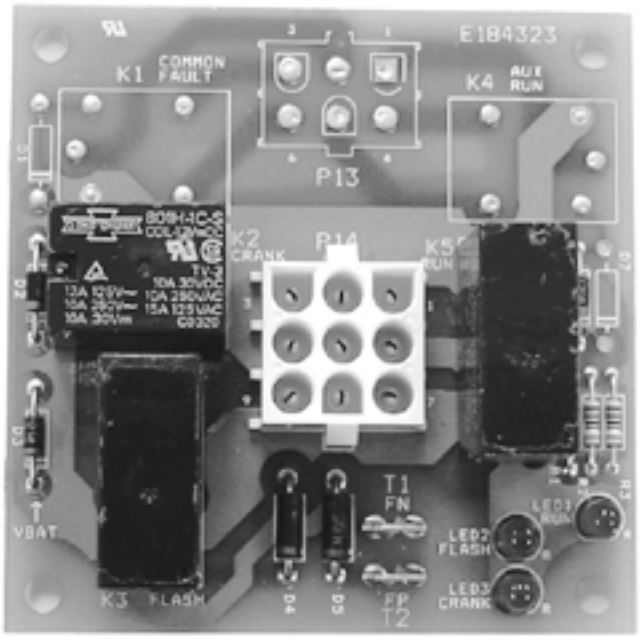
Relay Control Board

The ADC controller does not have relays mounted internally to the controller. A relay board is required to interface controller logic to the generator start and stop functions. Mounted on the relay board are 3 relays, Crank, Run, and the Field Flash Relay. There are LED's on the relay board that illuminate when the functioning relay is energized.

Crank Relay is energized when the control logic is in the crank mode
Run Relay is energized when cranking or running
Flash Relay is energized during crank and run and is disconnected when the aux winding output has reached 30 vac

A 10 amp fuse powers the relay board and relay outputs contacts.

An optional relay board is available with an auxiliary run relay and common fault relay for customer connections.



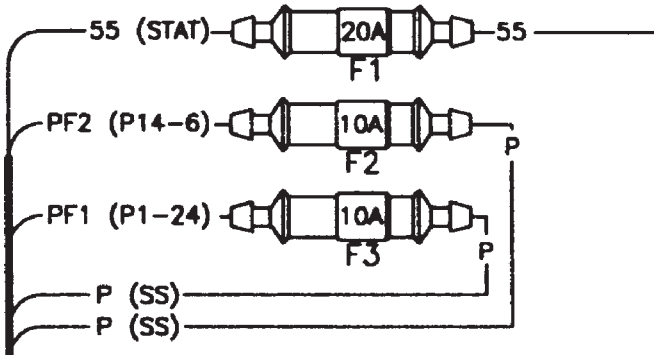
Circuit protection

The wiring harness has 3 in-line fuses installed. F1, F2, and F3

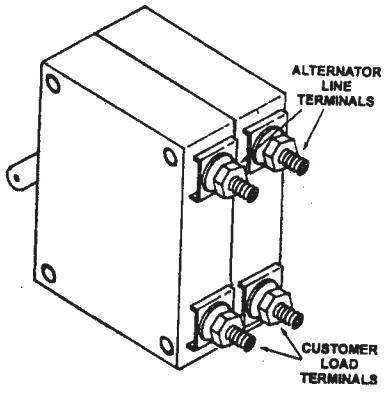
F1 - 20 amp fuse, protects the PowerBoost winding. The Power Boost winding is responsible for the excitation of the rotor.

F2 - 10 amp fuse, circuit protection for relay board, fuel solenoid, SR relay, and ignition module.

F3 - 10 amp fuse, circuit protection for the ADC controller

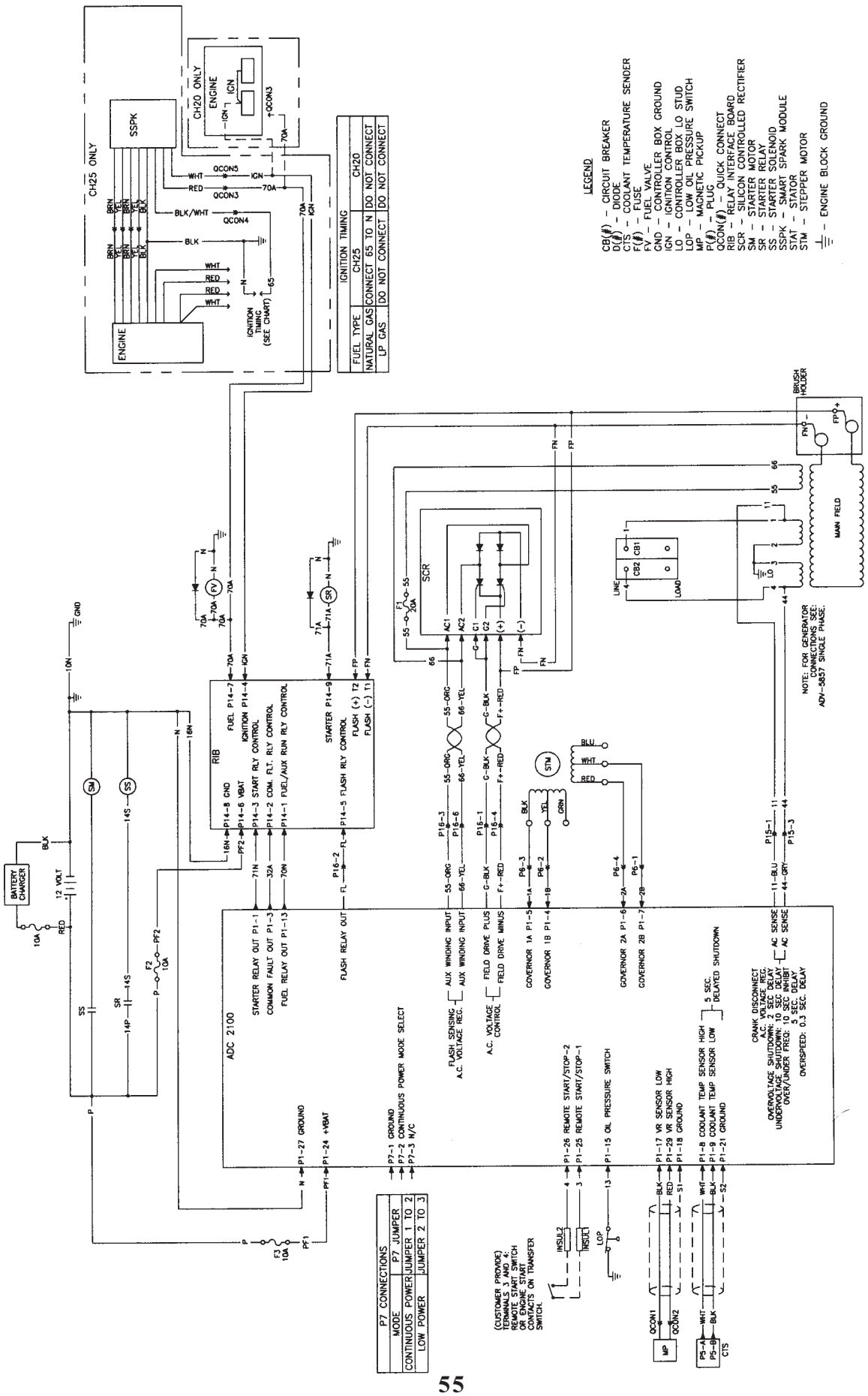


The **CIRCUIT BREAKER** is a two-pole device with trip elements in each pole and is used as a circuit disconnect between the load and alternator. The toggles are tied together. Moving the toggle will open or close both poles. An over current fault exceeding the trip rating of the breaker will also trip both poles. Current and trip ratings are located on the terminal side of the breaker.



8.5RES - 40 amp breaker

12RES - 50 amp breaker


CH25 ONLY
SSPK
CH20 ONLY
ENGINE
IGN
QCON5
QCON3
QCON4
BLK/WHT
BLK
WHT
RED
IGNITION TIMING (SEE CHART)
IGNITION TIMING
FUEL TYPE | CH25 | CH20
NATURAL GAS | CONNECT 65 TO N | DO NOT CONNECT
LP GAS | DO NOT CONNECT | DO NOT CONNECT
LEGEND
CB(#) - CIRCUIT BREAKER
D(#) - DIODE
CTS - COOLANT TEMPERATURE SENDER
F(#) - FUSE
FV - FUEL VALVE
GND - CONTROLLER BOX GROUND
IGN - IGNITION CONTROL
LOP - CONTROLLER BODY LO STUD
LOP - LOW OIL PRESSURE SWITCH
MP - MAGNETIC PICKUP
P(#) - PLUG/JACK CONNECT
QCON(#) - QUICK CONNECT
RIB - RELAY INTERFACE BOARD
SCR - SILICON CONTROLLED RECTIFIER
SM - STARTER MOTOR
SR - STARTER RELAY
SS - STARTER SOLENOID
SSPK - SMART SPARK MODULE
STAT - STATOR
STM - STEPPER MOTOR
- ENGINE BLOCK GROUND
BATTERY CHARGER
12 VOLT
ADC 2100
RIB
SCR
MAIN FIELD
BRUSH HOLDER
STM
SM
SS
SR
F1 30A
F2 10A
F3 10A
STARTER RELAY OUT P1-1
COMMON FAULT OUT P1-3
FUEL RELAY OUT P1-13
FLASH RELAY OUT
FLASH SENSING A.C. VOLTAGE REG.
A.C. VOLTAGE CONTROL
AUX WINDING INPUT
FIELD DRIVE PLUS
FIELD DRIVE MINUS
GOVERNOR 1A P1-5
GOVERNOR 1B P1-4
GOVERNOR 2A P1-6
GOVERNOR 2B P1-7
P1-27 GROUND
P1-24 +VBAT
P7-1 GROUND
P7-2 CONTINUOUS POWER MODE SELECT
P7-3 N/C
P1-26 REMOTE START/STOP-2
P1-25 REMOTE START/STOP-1
P1-15 OIL PRESSURE SWITCH
P1-17 VR SENSOR LOW
P1-29 VR SENSOR HIGH
P1-18 GROUND
P1-8 COOLANT TEMP SENSOR HIGH
P1-9 COOLANT TEMP SENSOR LOW
P1-21 GROUND
5 SEC. DELAYED SHUTDOWN
CRANK DISCONNECT
AC SENSE
OVERVOLTAGE SHUTDOWN: 2 SEC DELAY
UNDERVOLTAGE SHUTDOWN: 10 SEC DELAY
OVER/UNDER FREQ: 10 SEC (MHIBT)
5 SEC. DELAY
OVERSPEED: 0.3 SEC. DELAY
NOTE: FOR GENERATOR CONNECTIONS SEE: ADV-5857 SINGLE PHASE.
P7 CONNECTIONS
MODE | P7 JUMPER
CONTINUOUS POWER | JUMPER 1 TO 2
LOW POWER | JUMPER 2 TO 3
(CUSTOMER PROVIDE) TERMINALS 3 AND 4: REMOTE START SWITCH OR ENGINE START CONTACTS ON TRANSFER SWITCH.
INSUL2
MSU01
LOP
QCON1
QCON2
MP
P5-A
P5-B
CTS

Understanding the Schematic

1. Fused battery power enters what pin connections to the relay control board?

2. Field flashing is controlled by which relay?

3. The Field flashing is required when?

4. Fuse F1 protects the voltage regulator circuitry. T or F

5. When is wire #70A energized?

6. When is wire #71A energized?

7. What is the purpose of the Magnetic Pickup?

8. Which stator winding is responsible for excitation?

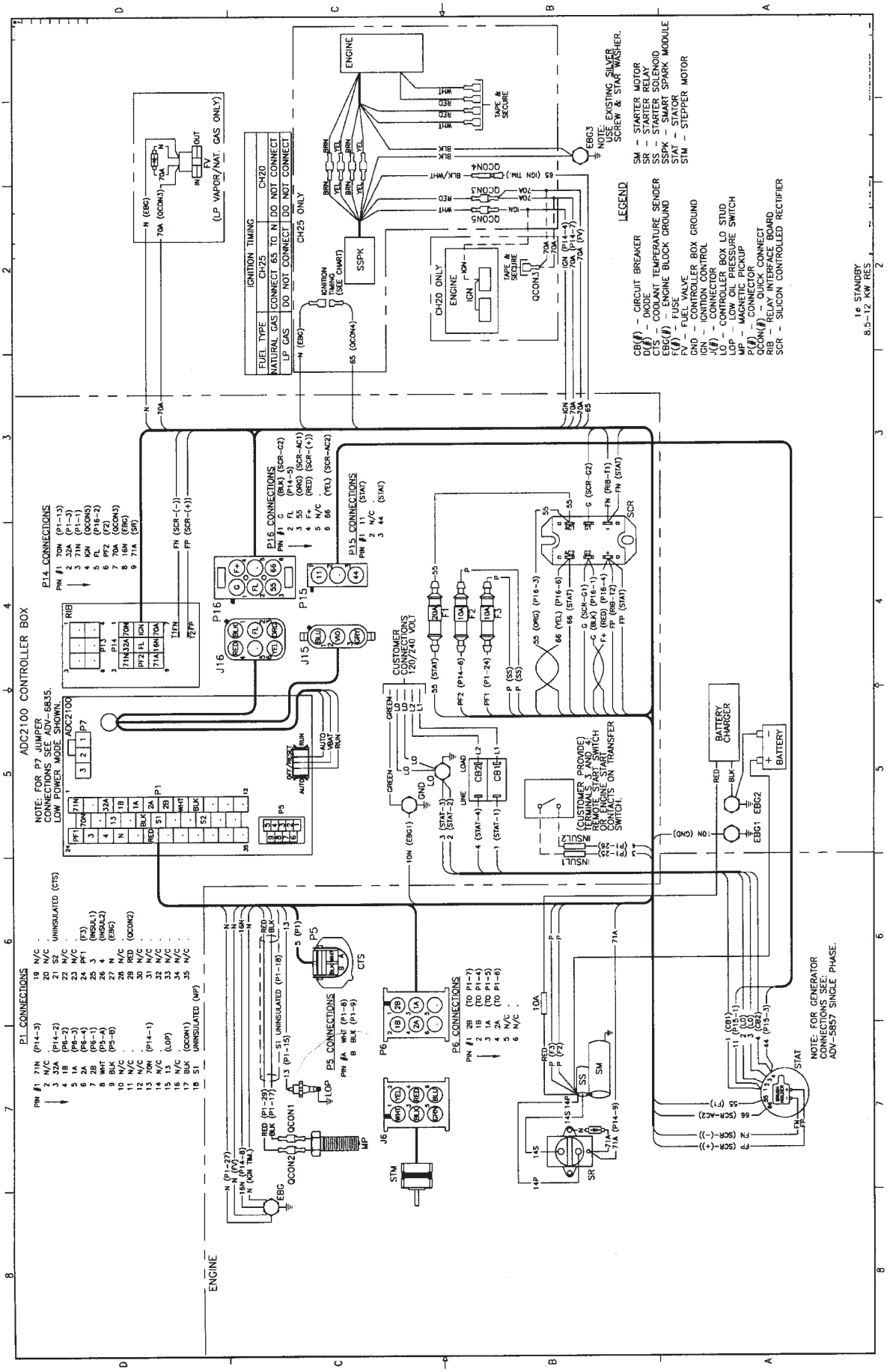
9. What is the CTS, ?

10. What symptoms will be observed if the Gas Valve coil electrically opens?

11. What symptom will be seen if the Magnetic pick-up loses output?

12. What symptom will be seen if the F2 fuse opens?

Controller


ADC2100 CONTROLLER BOX
NOTE: FOR P7 JUMPER CONNECTIONS SEE ADV-6835. LOW POWER MODE SHOWN.
ADC2100
P1 CONNECTIONS
P14 CONNECTIONS
P15 CONNECTIONS
P16 CONNECTIONS
P5 CONNECTIONS
P6 CONNECTIONS
IGNITION TIMING
FUEL TYPE
CH25
CH20
NATURAL GAS
LP GAS
CONNECT 65 TO N
DO NOT CONNECT
DO NOT CONNECT
CH25 ONLY
CH20 ONLY
ENGINE
SSPK
IGNITION TIMING (SEE CHART)
FV (LP VAPOR/NAT. GAS ONLY)
CUSTOMER CONNECTIONS 120/240 VOLT
(CUSTOMER PROVIDED) REMOTE START SWITCH OR ENGINE START CONTACTS ON TRANSFER SWITCH.
BATTERY CHARGER
BATTERY
CTS
MP
STM
SS
SM
SR
STAT
SCR
EBG
EBG1
EBG2
EBG3
NOTE: USE EXISTING SILVER SCREW & STAR WASHER.
NOTE: FOR GENERATOR CONNECTIONS SEE: ADV-5857 SINGLE PHASE.
1e STANDBY 8.5-12 KW RES
LEGEND
CB(#) - CIRCUIT BREAKER
D(#) - DIODE
CTS - COOLANT TEMPERATURE SENDER
EBG(#) - ENGINE BLOCK GROUND
F(#) - FUSE
FV - FUEL VALVE
GND - CONTROLLER BOX GROUND
IGN - IGNITION CONTROL
J(#) - CONNECTOR
LO - CONTROLLER BOX LO STUD
LOP - LOW OIL PRESSURE SWITCH
MP - MAGNETIC PICKUP
P(#) - CONNECTOR
QCON(#) - QUICK CONNECT
RIB - RELAY INTERFACE BOARD
SCR - SILICON CONTROLLED RECTIFIER
SM - STARTER MOTOR
SR - STARTER RELAY
SS - STARTER SOLENOID
SSPK - SMART SPARK MODULE
STAT - STATOR
STM - STEPPER MOTOR

To read the point to point diagram start at any device in the diagram. The wire at the component will have a wire number followed in parentheses by the component the wire goes to and to where it terminates.

Reading the Diagram

1. You want to check the control voltage to the Start Relay (SR), what termination points should your meter leads be on?

2. Field flashing leads terminate at RIB-T1 and T2, What is RIB

3. Looking at the P14 connector plug, where does wire #71A terminate. List the starting and ending point.

4. You need to check the magnetic pick-up voltage. How would you do this? What voltage should be measured during crank?

5. What wire energizes the FV?

6. What is the point to point connection for LOP, list the starting and ending points.

7. At what pin location does positive voltage enter the relay control board? Is this a fused input?

8. What does the F1 fuse provide protection for?

9. To change the ignition timing of the CH740 engine when running on natural gas the 65 wire should be connected to ground? T or F

10. Is wire 14P a fused power source? What is the purpose of 14P?

System Configuration

Shipped with application program, this means typically you will never have to enter the system configuration menu of the ADC controller.

Reasons to go into the systems configuration may be controller replacement, voltage or frequency adjustments, gain adjustment, reconfigure stator output voltage.

System configuration includes:
genset model
phase
frequency
voltage
unit utilization (marine, mobile, standby)
unit data (analog inputs, digital inputs, magnetic pick-up)
battery voltage (12- or 24-VDC)
communication setting
Dynamic settings
- voltage adjust
- frequency adjust
- gain adjustments
- volts/Hz adjustment

Password Protection

The ADC configuration menu can only be entered with the use of a password.

Using the password
1. Hold the select button and toggle the start switch to run - the generator will not start. After approximately 5 seconds the software version will be displayed.
2. Continue to hold the select button and press the down arrow, then the up arrow, do this 3 times.
3. If performed correctly 4 LED segments will be displayed. This display is the first menu for configuration setup.

Note: The display will revert to run time hours after 1 minute of non-use and only saved settings will remain.

Select

Down

Up

Configuration Menu's

Uu0X = Unit utilization (phase, frequency, voltage)
Uc0X = Unit configuration (marine, mobile, residential)
EcXX = Engine configuration (generator model)
Adnc = Advanced Configuration Level
EdXX = Engine data (Advanced Config. Level)
Bt12 or Bt24 = Battery voltage (Adv. Config. Level)
Cn0X = Communication Setting (Adv. Config. Level)
SAVE

X=numeric value

To navigate the menu's

Once in a menu use the UP arrow to toggle through the menu settings, if you pass over a data selection use the DOWN arrow to go back.

When you find the data selection in a particular menu press the SELECT button this will advance you to the next menu. Whatever data selection you had displayed is what will now be programmed into your system configuration.

Use the SELECT button to navigate through each menu and the UP and DOWN buttons to navigate within each menu.

The final menu will be SAVE. To save all your settings press the UP arrow.

If you fail to save setting the configuration will revert back to original settings.

Once you have saved your settings the controller takes you out of the system configuration menus. You will need to use the password to go back into the configuration menu.

Select

Down

Up

Press the UP button to save settings

System Set-Up

Phase, Frequency, Voltage

The first configuration code you want to select is for the system phase, voltage and frequency. Press the UP button to find the correct code for your system. Once this code is selected press the SELECT button to advance to the next menu.

LED Display	Settings
Uu00	Single Phase, 60 Hz, 120 VAC
Uu01	Single Phase, 60 Hz, 120/240 VAC
Uu02	Single Phase, 50 Hz 230 VAC
Uu03	Three Phase, 50 Hz, 115/200 or 230/400 VAC
Uu04	Three Phase, 60 Hz, 138/240 or 277/480 VAC
Uu05	Single Phase, 50 Hz, 115 VAC
Uu06	Single Phase, 50 Hz, 115/230 VAC

Application

Next you need to select the generator application (marine, standby, mobile). Choose the correct code. Press Select to advance to the next menu.

Uc00=Marine
Uc01=Standby
Uc02=Mobile

Generator Model

Choose the correct code for the generator model. As the product lines advance more models will be listed. When models are listed the software version will change to accommodate the new data in the software. If you are changing out a controller and the model is not found you will need to upgrade the software in the controller. Press the SELECT button to advance to the next menu.

LED Display	Generator Model	Engine Type
Ec00	8.5/12 RES	Kohler CH20
Ec01	8EOZD/6.5EFOZD	Yanmar TNE
Ec02	10-24EOZD/9-20EFOZD	Yanmar TNV
Ec03	TBD	TBD
Ec04	TBD	TBD
Ec05	TBD	Yanmar TNV
Ec06	TBD	TBD
Ec07	28-32EOZD/23-27EFOZD	TNV
Ec08	TBD	TBD
Ec09	TBD	TBD
Ec10	TBD	TBD
Ec11	TBD	TBD
Ec12	TBD	TBD

Adnc (Advance Configuration)

The advance menu has three sub menus. Engine Data, Battery Voltage, and Communication. The advance menu is typically an area you will not have to go into unless you are make a generator modification in the field such as installing the remote gauge package for our marine product line. To bypass this selection press SELECT to go to the SAVE menu.

Adnc, Engine Data

The engine data is automatically loaded into the system configuration when you choose the model number. The only time you may have to modify the data selection is if an option sender device is added. Press the SELECT button to advance to next Adnc sub menu.

LED Display	Low Oil Pressure	Low Coolant Level	Low Coolant Temp.	Mag. Pick-Up
Ed00	Digital	Digital	Digital	n/a
Ed01	Digital	Digital	Analog	n/a
Ed02	Analog	Digital	Digital	n/a
Ed03	Analog	Digital	Analog	n/a
Ed04	Digital	Digital	Digital	X
Ed05	Digital	Digital	Analog	X
Ed06	Analog	Digital	Digital	X
Ed07	Analog	Digital	Analog	X
Ed08	Digital	Analog	Digital	n/a
Ed09	Digital	Analog	Analog	n/a
Ed10	Analog	Analog	Digital	n/a
Ed11	Analog	Analog	Analog	n/a
Ed12	Digital	Analog	Digital	X
Ed13	Digital	Analog	Analog	X
Ed14	Analog	Analog	Digital	X
Ed15	Analog	Analog	Analog	X

Adnc, Battery Voltage

The battery voltage data is automatically loaded when you enter the model number code the default setting should be left as is. Press SELECT button to advance to next sub-menu

Bt12 (12 VDC)
Bt24 (24 VDC)

Adnc, Communications

Communication setting will need to be changed if you add optional equipment which requires J1939 can communications. This is not required for the 8.5 and 12RES product .

Cn00 = No Comm
Cn01 = SAE J1939*
Cn02 = Future

SAVE

The SAVE menu is the final menu, press the UP arrow to save all previous settings.

Dynamic adjustments

The generator must be running to make dynamic adjustments such as voltage raise and lower or speed raise and lower.

To enter the dynamic adjustments menu:
1. Start the generator and press the SELECT button until the software version is displayed.
2. Continue to hold the SELECT button and press the down button and then the UP button, repeat this 3 times.
3. If done correctly you will enter the first menu Voltage adjust.

Voltage Adjust (coarse)
The course voltage adjustment is your first setting. When in the menu you will notice the third digit flashing. Adjusting the number up will raise the output voltage. Adjusting down will lower the output voltage. Before making any adjustments you should have a calibrated VOM measuring output voltage. Each increment will change the output between 5-7 vac. Press the SELECT button to advance to the fine voltage adjust.

Voltage Adjust (fine)
when in the fine voltage adjust mode the fourth digit will flash. In fine adjust each increment will change the output voltage between .5 and .7 volts. Press SELECT button to advance to Regulator Gain menu.

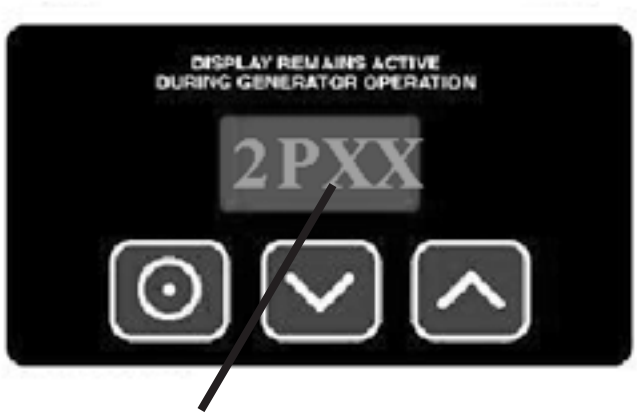
Regulator Gain
Gain adjustment may need to be done if the generator output voltage responds slowly to load changes, (gain set to low) or the generator has voltage instability or light flicker (gain set to high).

To set gain adjustments an analog meter should be used to monitor the output voltage. Adjust the gain UP until the analog meter reading shows instability, turn DOWN the gain setting until voltage becomes stable. Cycle load on the generator output to make sure voltage response is acceptable. SELECT both course and fine adjust the press SELECT to advance to Volts/Hz.

Dynamic adjustment menu's

1PXX = Voltage adjust
2PXX = Regulator gain (Gain Adjust)
3PXX = Under-frequency Voltage Droop (Volts/Hz)
4PXX = Governor speed adjust
5PXX = Governor gain adjust

When in course voltage adjust the third digit will flash. When in fine adjust the fourth digit will flash.



When in course Regulator Gain adjust the third digit will flash. When in fine adjust the fourth digit will flash.

Volts/Hz

The Volts/Hz adjustment for the voltage regulator comes preset from the factory and typically no adjustments should or need to be made. The default setting is 4.(2% voltage droop)

The programmed roll-off point for 60Hz applications is 58Hz, for 50Hz applications it is 48Hz.

When in the Volts/Hz menu the fourth digit will represent the percentage of nominal voltage droop.

0=No droop
1=0.5% of nominal
2=1.0% of nominal
3=1.5% of nominal
4=2.0% of nominal
5=2.5% of nominal
6=3.0% of nominal
7=3.5% of nominal
8=4.0% of nominal
9=4.5% of nominal

Example:
system voltage = 240 v
system frequency = 60 Hz - roll-off is 58Hz
Volts/Hz setting is 4 (2% of nominal) = 4.8v per cycle

If the generator frequency would drop to 50Hz, that would be a 8Hz drop after roll-off. 58-50.
8Hz x 4.8 V per cycle = 38.4 v
Nominal voltage 240 - 38.4 = 201.6 v @50Hz

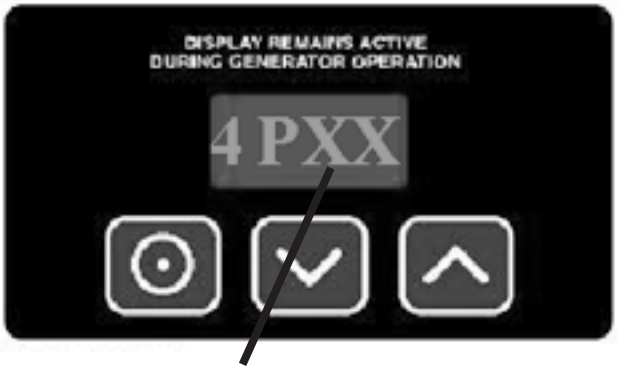
The Volts/Hz setting allows the generator to respond quicker to heavy load changes. Should the frequency drop due to an increased load the voltage regulator will automatically decrease voltage thus shedding kW and allowing the generator to recover to the proper frequency and voltage output. When the Volts/Hz is set incorrectly response to load changes will take longer then desired.

When set-point is selected press SELECT to advance to the Governor Speed menu.

Governor Speed (Coarse adjustment)

The course Speed adjustment is your first setting. When in the menu you will notice the third digit flashing. Adjusting the number up will raise the speed. Adjusting down will lower the speed. Before making any adjustments you should have a calibrated VOM measuring output Frequency. Speed adjust range is +/- 5%

Fine Speed Adjustment
when in the fine speed adjust mode the fourth digit will flash. Press SELECT button to advance to Governor Gain menu.

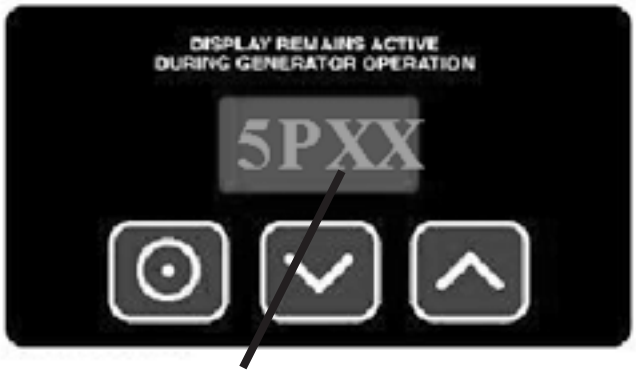


When in course Speed adjust the third digit will flash. When in fine adjust the fourth digit will flash.

Governor Gain Adjust

Gain adjustment may need to be done if the Engine responds slowly to load changes, (gain set to low) or the engine has voltage instability or hunting (gain set to high).

To set gain adjustments adjust the gain UP until the engine starts hunting (similar to a dog barking) then turn DOWN the gain setting until the engine becomes stable. Cycle load on the generator output to make sure engine response is acceptable. The final test would be to allow the generator to cool then start the generator, this will verify that the engine does not respond to slowly causing the engine to overspeed.



When in course Governor Gain adjust the third digit will flash. When in fine adjust the fourth digit will flash.

When speed gain is set press SELECT button until the SAVE menu is displayed, press the UP button to save all settings.

Press the UP button to save settings

Upgrading ADC Software

To upgrade the ADC 2100 requires:
1. Program Loader (version 2.3 or higher)
2. Null modem cable
3. TT-1285, instructions for downloading software to ADC controller
4. ADC 2100 Application Program
5. Service Manual: TT-6196 (RES)
6. Access to controller DB9 port (RS 232)

Once the ADC software has been upgraded the ADC controller will require configuration and adjustment of parameters specific to generator

Distributors have access to Program Loader software and the ADC application software via the internet.

Controller Replacement

ADC has no replaceable assemblies
Potting does not allow component changes
Order kit: GM33159
Includes TT-1364 for setup

The ADC as a replacement controller requires that it be configured for the application. It is not shipped from the factory ready for operation. Programming systems menus will be required before the generator can be operated.

Automatic Transfer Switch

Concept

The Transfer Switch is a required component of an emergency or standby electrical power system. It not only serves to transfer the load between electrical supplies but also to prevent the sources from being connected together resulting in destruction of the system.

An Automatic Transfer Switch (ATS) consists of three major components.

1. Stationary and movable heavy duty CONTACT ASSEMBLIES.

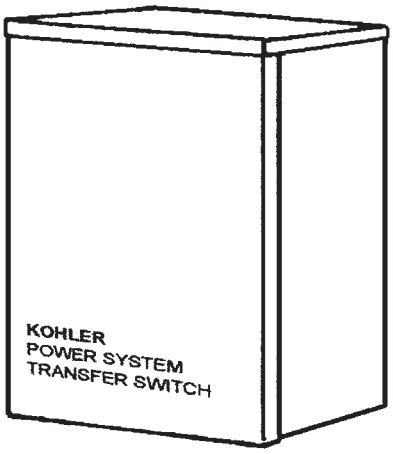
2. An OPERATING MECHANISM for the moveable contacts.

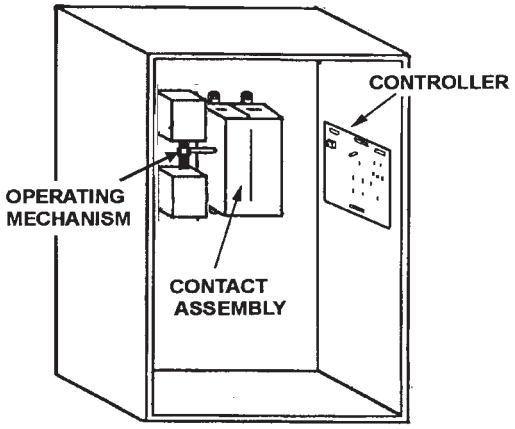
3. A CONTROLLER to monitor the system and provide signals for engine start and contact transfer.

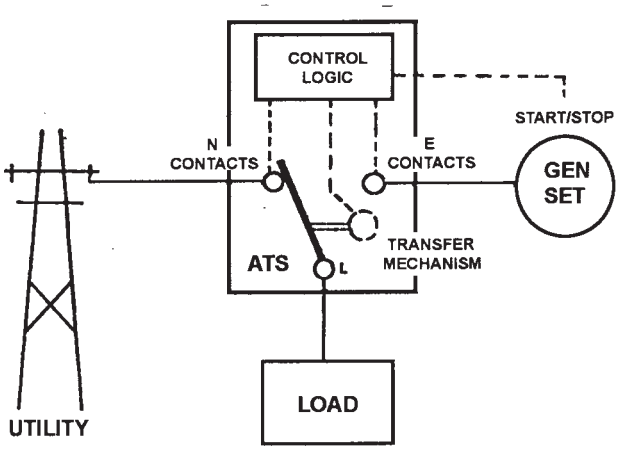
The controller logic constantly monitors the condition of the utility or normal power supply. A signal for an engine start will be give when the voltage or frequency is not at a predetermined level or fails completely.

When the Generator voltage and frequency are acceptable to the monitoring circuit, the transfer operating mechanism will be energized, causing a Load (L) transfer from the Normal (N) to the Emergency (E) source.

The controller will seek the primary source and on return of acceptable power will retransfer the load back to the normal source and initiate an engine shutdown.





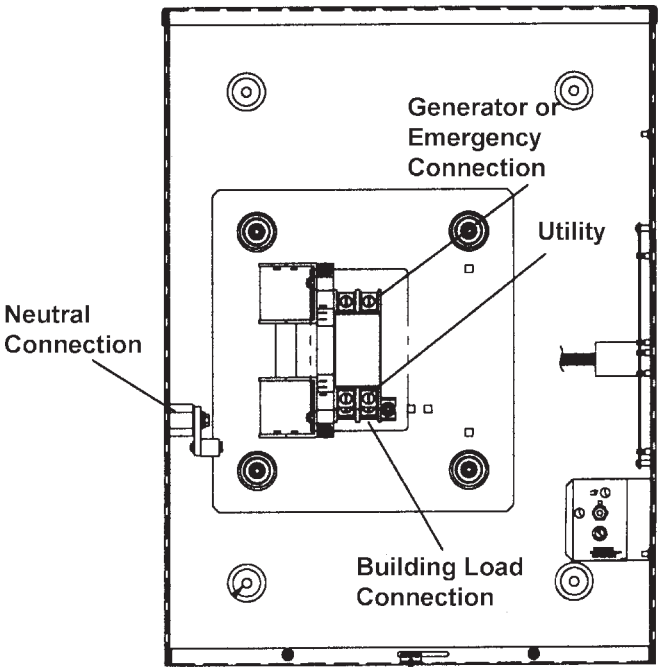


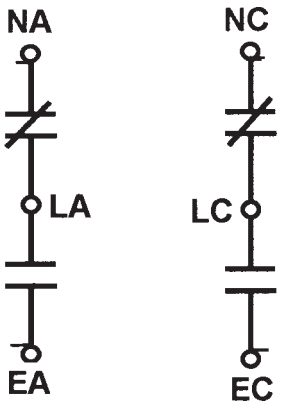
Contactor

The 2-pole, G220 Series contactor is available for 100 and 200 amp Standby Systems.

This contactor is designed for use on line to line 220 - 240 volt single phase utility systems as provided to the majority of residences. The emergency source or generator set must also provide this same power.

A diagram is provided inside the ATS enclosure to aid installation of line power connections. push-on tab terminals are provided at each of these terminals for controller voltage sensing and the transfer operator coil supply.

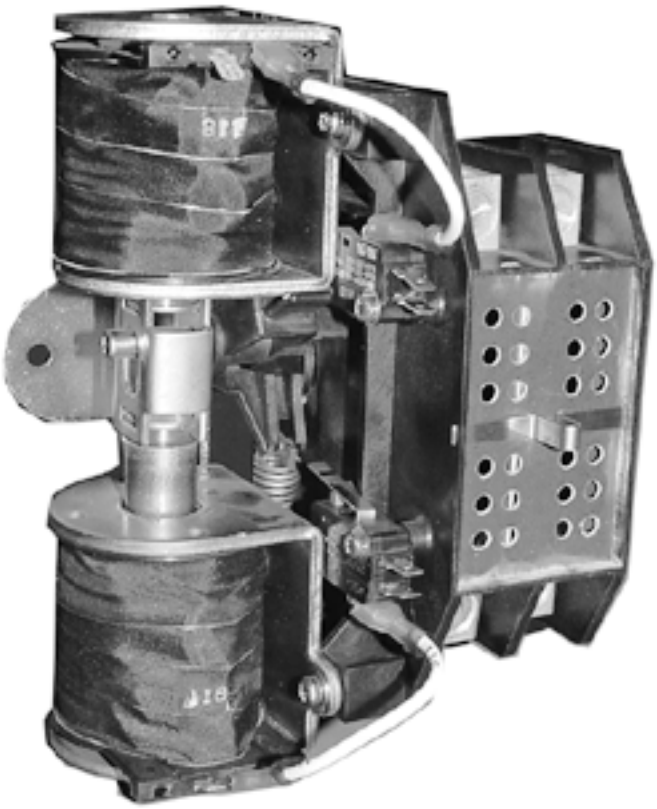


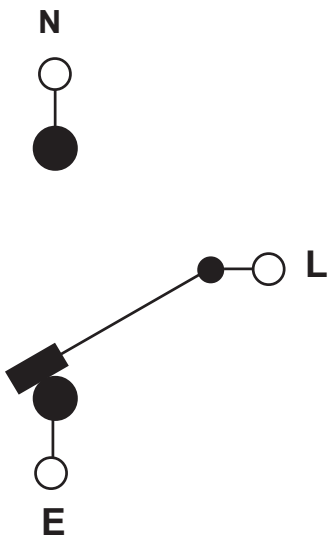


The contact assemblies are not identical for the 100-amp and 200-amp contactors. Refer to the Service manual when performing service work.

Contactor

These contactors are electrically operated double throw switching devices. The Normal and Emergency power sources are connected to stationary contacts and the movable Load contacts assembled to a pivot shaft. This provides a mechanical interlock to assure both power sources cannot be connected simultaneously.





Two electric solenoids operate the linkage to flip the moveable contact between the power sources. A complete transfer occurs within 50 milliseconds.

The solenoid is powered by 120 vac rectified line voltage from the source to which the load will be transferred. (Normal or Emergency)

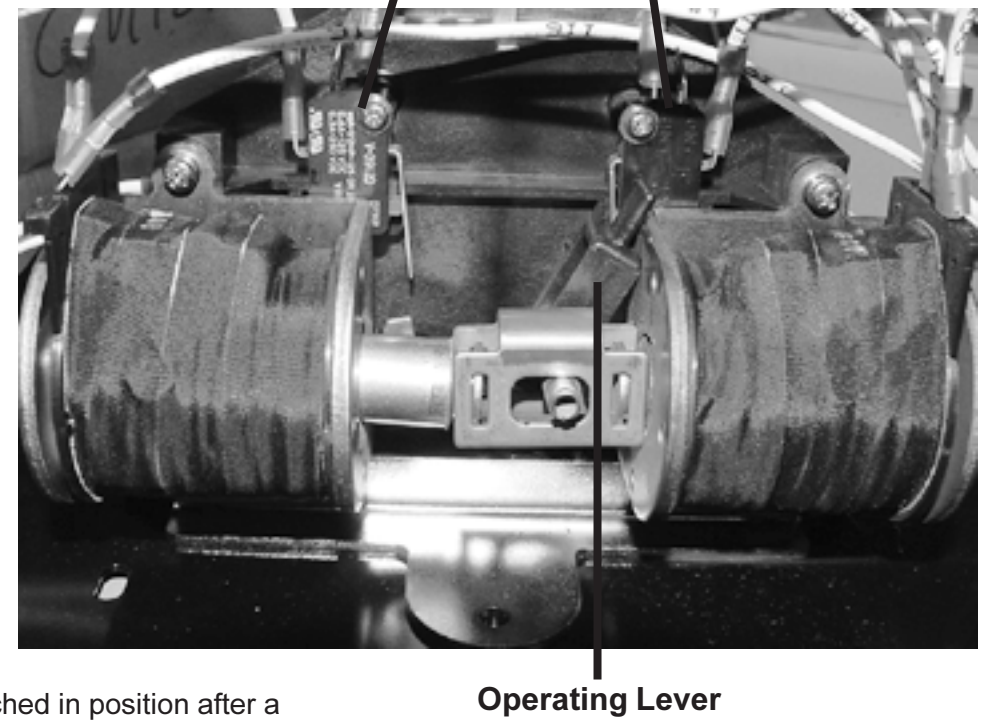
A full wave bridge assembly rectifies the AC line voltage to DC. Input is to terminals labeled AC. There is no polarity preference of the solenoid to the + and - rectifier output terminals.

The DC Voltage to the solenoid coil is supplied only momentarily. The circuit is disrupted by cam actuated limit switches after full travel of the solenoid plunger.

Coil, varistor, and bridge rectifier are assembled as one piece. Disassemble/unsolder the components before testing for an open or shorted circuit.

Contactor

When the contactor is in the Normal position the operating lever allow limit contacts SCN to be open and SCE to be closed. The opposite occurs when in the Emergency position.



The limit switch assemblies are factory set and nonadjustable. They are wired in series with control relay contacts NR and ER.

The contactor is always mechanically latched in position after a transfer.

During installation or when servicing the contactor a manual transfer can be performed by using the manual operating handle provided.

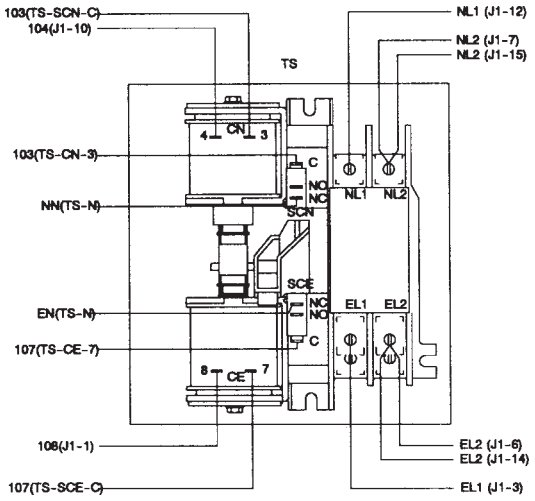
ELECTRICAL POWER MUST BE DISCONNECTED FROM THE CONTACTOR WHEN MANUALLY TRANSFERRING

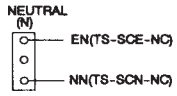
Harness

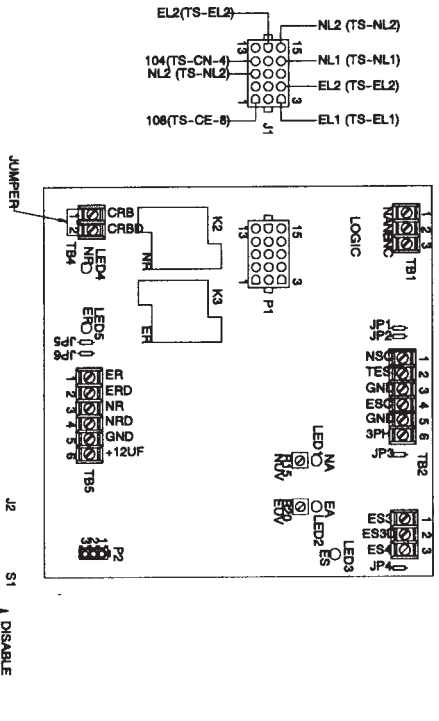
The contactor assembly is interconnected to the controller by a harness and plug connector.

Connections at the contactor assembly are made with push-on tab terminals. A 15 pin plug connector designated as J1 is attached at the controller end of the harness .

Use caution when testing for voltage or continuity between plug pins. Any **voltage present on the normal or emergency contacts is also preset at the connector pins.**

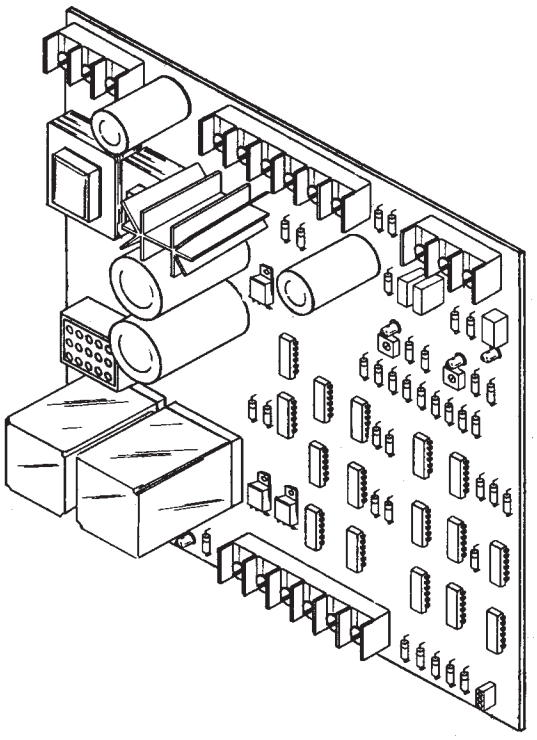






Automatic Transfer Switch

G220 Controller



The decision making process of the automatic transfer switch is performed by the Controller.

The controller monitors the systems electrical sources and logically energizes control relays for engine starting and switch transfer. Voltage supply to the transfer mechanism is provided by the source to which the switch is transferring.

The Utility is the NORMAL or Primary source and the control circuit will always seek the normal source.

The controller is sensitive to the system voltage. Transformers reduce the line voltage to low more manageable voltage for the sensing and control circuits. Logic circuitry is both relay and solid state.

STANDARD FEATURES

Normal and Emergency voltage sensing is factory set at 160 vac drop-out and 190 vac pick-up.

DROP-OUT :
If the Normal utility voltage fails completely or drops below 160 volts (line to line) a signal for an engine start would be initiated.

PICK-UP:
When the Emergency Generator voltage reaches 190 vac A transfer to the Emergency source will be initiated.

The same specifications apply for pick-up on return of the Normal source voltage. (190 vac)

TDES:
3 second time delay on engine start.

This feature prevents nuisance engine start attempts if only a momentary (under 3 seconds) loss of power occurs.

If the Normal source returns prior to completion of the timing no engine start will be attempted and the timer will reset.

TDNE:
2 second time delay on a Normal to Emergency transfer.

After a successful engine start a delay of 2 seconds is provided to allow the engine to attain operating speed and stabilize prior to applying load.

TDEN:
12 second time delay on an Emergency to Normal transfer.

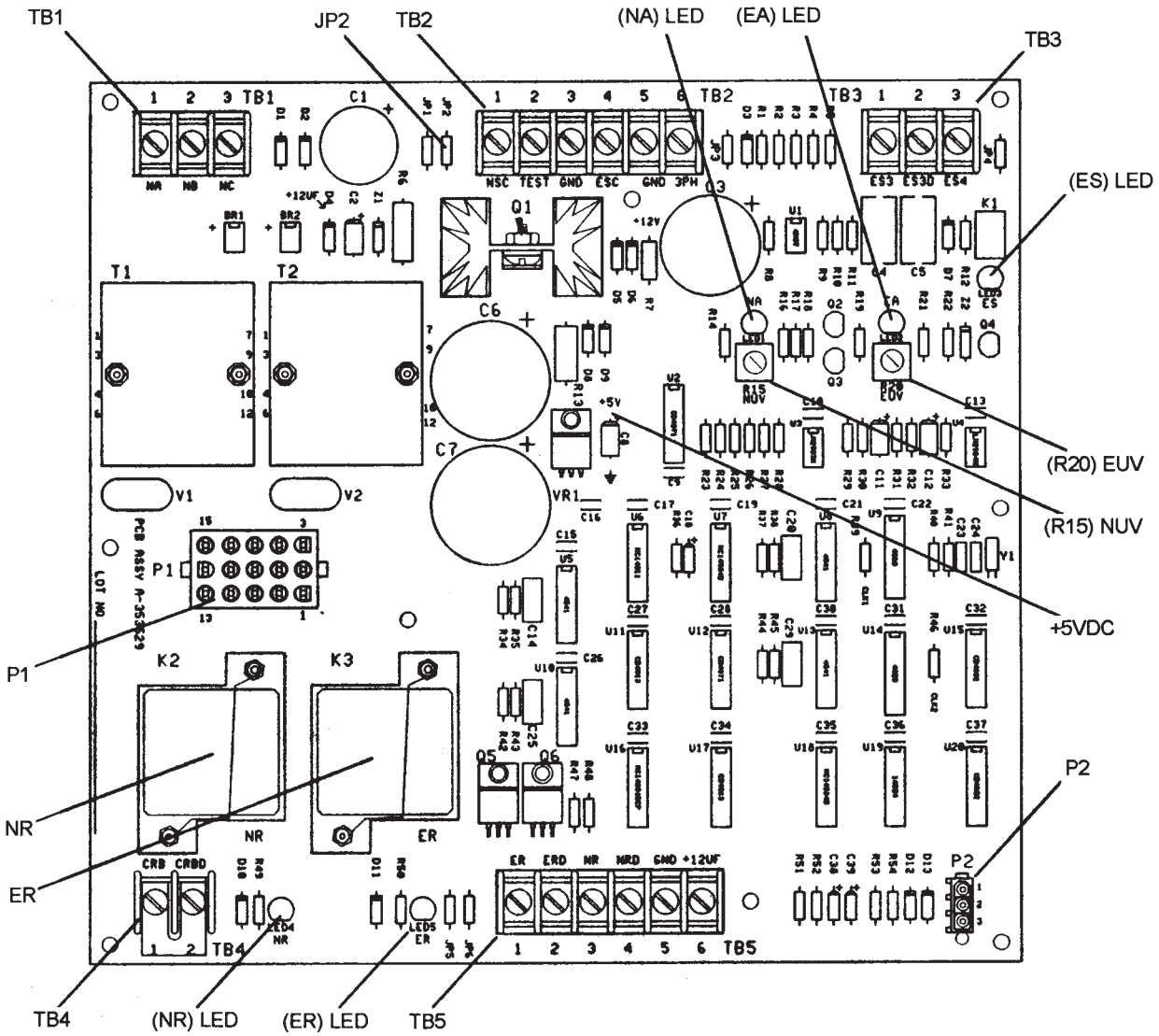
When Normal power returns to the Pick-up voltage (190 vac) a delay of 12 seconds will commence before allowing a transfer back to the Normal Source. This is to allow the Utility power to stabilized. If Normal power fails within this timing period, timing will be terminated and reset.

TDEC:
2 minute time delay for Engine cooldown.

On a successful retransfer back to the Utility the engine will operate for two minutes unloaded to allow a cooldown period prior to shutting down.

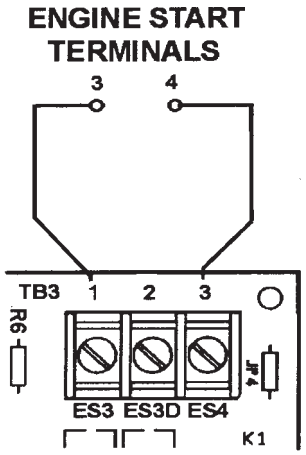
Circuit Board

The main control board contains the intelligence logic as well as transformers, relays, jumpers and terminal strips. Not all terminals and components are used in this application.



Circuit Board

TB3
Connections to the engine start circuit are made to terminals 1&3 . A dry set of K1 relay contacts will close between terminals 1&3 when an engine start is required.



(ES) LED
The ES LED will light when the K1 is energized.

(NR) LED
The NR LED will light when the NR relay coil is energized.

(ER) LED
The ER LED will light when the ER relay coil is energized.

(NA) LED
The NA LED will light when the Normal source voltage is at the acceptable level.

(EA) LED
The EA LED will light when the Emergency source voltage is at the acceptable level.

NR
Normal source control relay

ER
Emergency source control relay.

(R20) EUV
Emergency source voltage pick-up adjust. (Factory set)

(R15) NUV
Normal source voltage pick-up adjust. (Factory set)

+ 5VDC
5v. logic voltage test point.

P2
Plant exerciser selector switch harness connector.

TB5
Power supply and relay status terminal strip.

TB4
Transfer disable option jumper terminal strip.

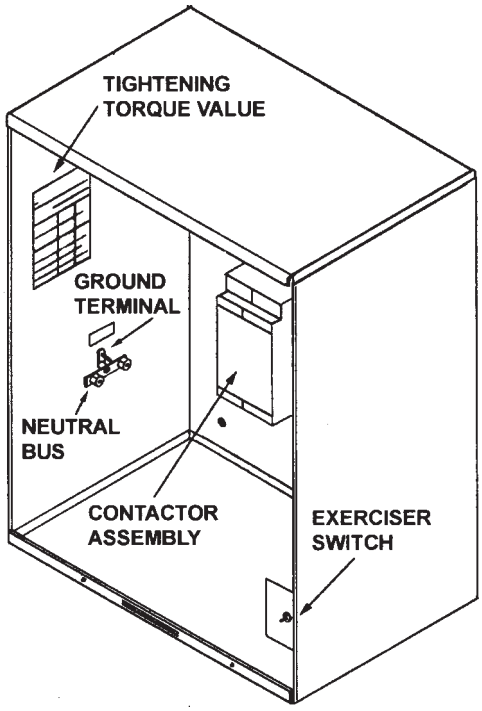
TB2
Test switch option terminals.

TB1
3 phase sensing module terminal strip.

JP2
Test switch jumper.

Neutral / Ground

An equipment ground terminal and Neutral bus is provided in the enclosure.

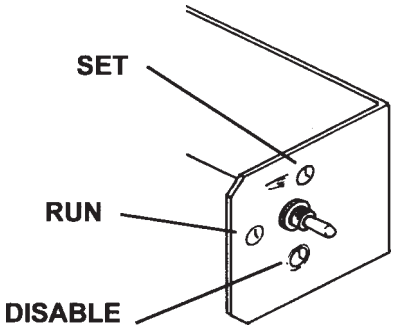


Engine Exerciser Feature

To insure the generator set will start and perform when needed, a circuit is provided which allows the engine to automatically start and run for 20 minutes a week. The engine will run unloaded. The switch will not transfer unless a power failure occurs during the exercise period.

The day and time of day that the feature was set will be the day and time the exercise will occur each week until reset or disabled.

A 3-position switch provides the setting and disabling functions.



SET

Placing the switch in this momentary position will set the start time as well as the day of week the exercise will occur.

RUN

The switch will return to this position when released from setting. This is the normal position when the weekly exercise option is selected.

DISABLE

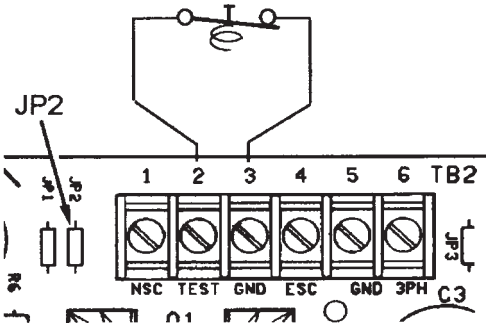
If the exercise option is not desired it can be turned off when left in this position. The disable position effects the exercise option only. It has no effect on transfer switch operation.

The internal exercise clock requires either the Normal or Emergency source to be present to maintain its memory.

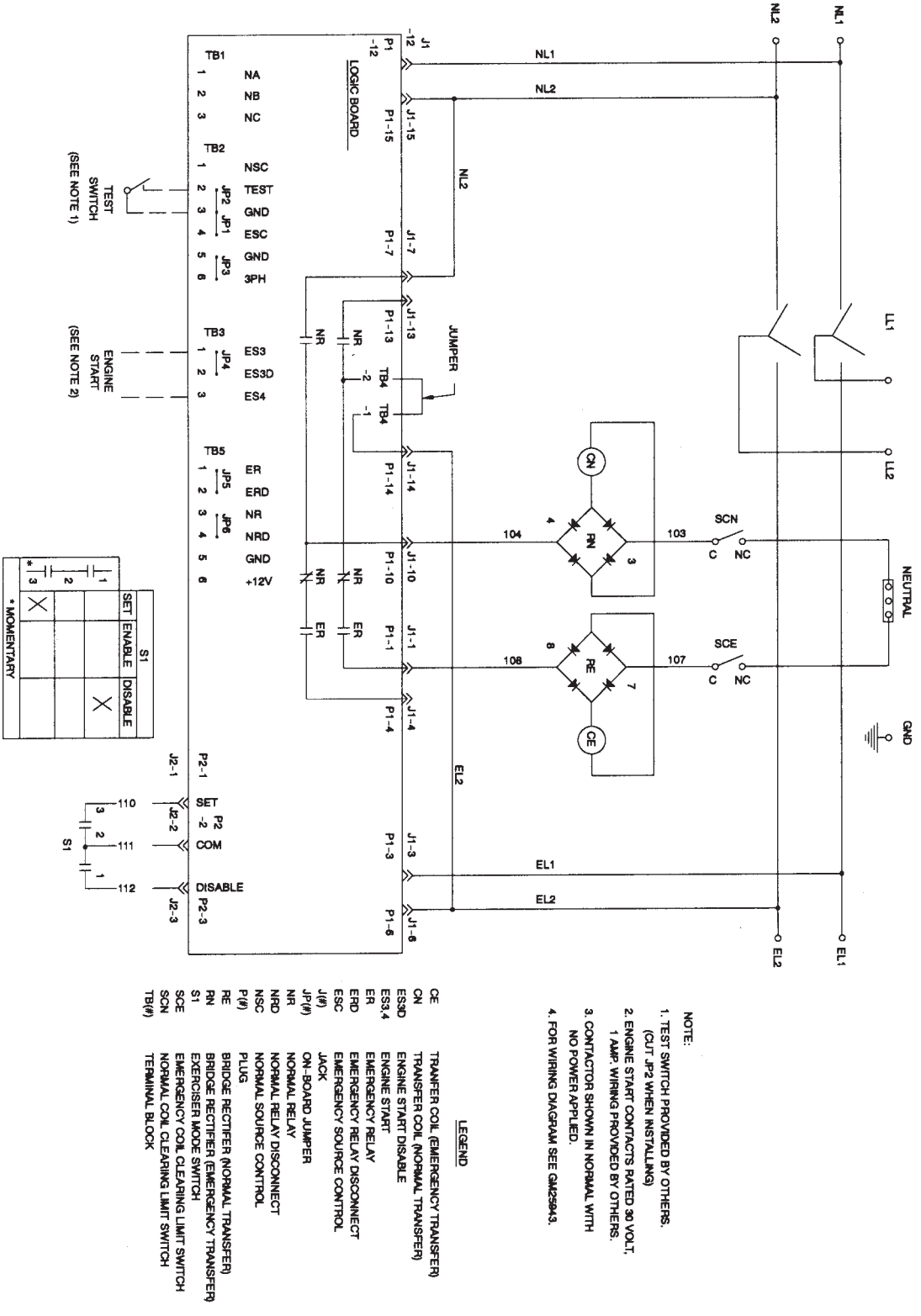
If both sources are absent for longer than 90 seconds the time and day selected will be lost and automatically reset to the time and day power was restored.

Transfer Test Switch

The complete system can be tested by removing the JP2 jumper and installing an optional toggle switch between terminals 2 (TEST) and 3 (GRD) of the TB2 terminal strip on the Controller board. A normally closed push button or momentary toggle is recommended. Opening the switch contacts will simulate a loss of the Utility power and initiate an engine start-up and transfer of load to the Generator set.



Automatic Transfer Switch



NOTE:

1. TEST SWITCH PROVIDED BY OTHERS. (CUT JP2 WHEN INSTALLING)
2. ENGINE START CONTACTS RATED 30 VOLT, 1 AMP. WIRING PROVIDED BY OTHERS.
3. CONTACTOR SHOWN IN NORMAL WITH NO POWER APPLIED.
4. FOR WIRING DIAGRAM SEE GM25843.

LEGEND

CE	TRANFER COIL (EMERGENCY TRANSFER)
CN	TRANSFER COIL (NORMAL TRANSFER)
ES3D	ENGINE START DISABLE
ES3,4	ENGINE START
ER	EMERGENCY RELAY
ERD	EMERGENCY RELAY DISCONNECT
ESC	EMERGENCY SOURCE CONTROL
J(#)	JACK
JP(#)	ON-BOARD JUMPER
NR	NORMAL RELAY
NRD	NORMAL RELAY DISCONNECT
NSC	NORMAL SOURCE CONTROL
P(#)	PLUG
RE	BRIDGE RECTIFIER (NORMAL TRANSFER)
RN	BRIDGE RECTIFIER (EMERGENCY TRANSFER)
S1	EXERCISER MODE SWITCH
SCE	EMERGENCY COIL CLEARING LIMIT SWITCH
SCN	NORMAL COIL CLEARING LIMIT SWITCH
TB(#)	TERMINAL BLOCK