Training Manual

Residential / Commercial
Generator Sets

17RY / 22RY

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

KOHLER®
POWER SYSTEMS

TP-6097
4/15/00

Table Of Content

Introduction

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

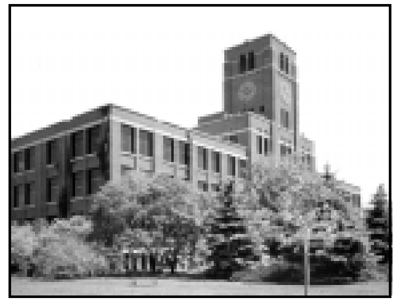
This manual is only intended as a training guide and is to be used as a supplement to classroom material. This is not a service manual and does not contain all available product information. **Do not attempt to service generator sets without consulting the service manual and following all safety warnings.**

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.

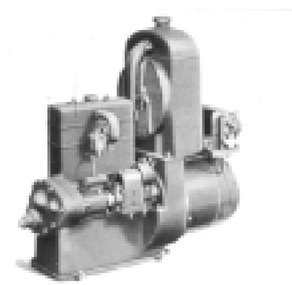
Kohler Company History

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.



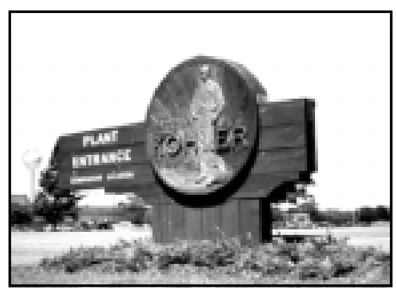
Power Systems Group

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. They are also found on Kohler generator models. 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 ⚠

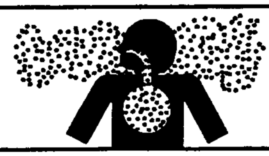
Caution is used to indicate the presence of a hazard, which will or can cause minor personal injury or property damage if the warning is ignored.

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. For a further explanation of decal information, reference the accompanying safety precautions. Before operating or servicing the generator set, be sure you understand the message of these decals. Replace decals if missing or damaged.

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

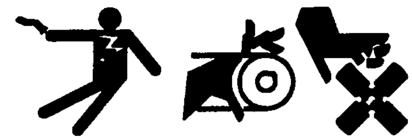
• Physical fatigue, weakness in joints and muscles

• 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.

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. The generator set can be started by remote start/stop switch unless this precaution is followed.

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.

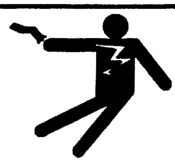
CAUTION

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.

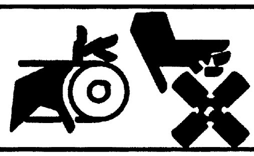
WARNING



Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

WARNING



Rotating parts.
Can cause severe injury or death.

Do not operate generator set without all guards, screens, or covers in place.

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.

WARNING

Fire.
Can cause severe injury or death.

Do not smoke or permit flame or spark to occur near fuel or fuel system.

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. *(diesel models only)*

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

WARNING

Hazardous voltage. Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

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- III, 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.

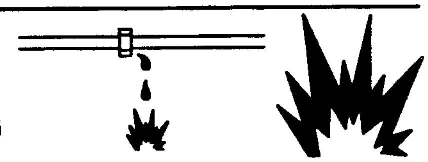
Natural Gas-Adequate ventilation is mandatory. Natural gas rises; install natural gas detectors high in room. Inspect detectors often.

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.

WARNING

Explosion.
Gasoline vapors can cause explosion and severe injury or death.

Before starting generator set, operate blower 4 minutes and check engine compartment for gasoline vapors.



WARNING

Explosive fuel vapors.
Can cause severe injury or death.

Use extreme care when handling, storing, and using fuels.

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.

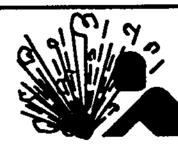
Use protective goggles and clothes. Can cause permanent damage to eyes, burn skin, and eat holes in clothing.

Battery acid. Sulferic acid in batteries can cause severe injury or death.

all spilled fuel and engine oil. *(gasoline and diesel models)*
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

This generator set has been rewired from its nameplate voltage to:

246242

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

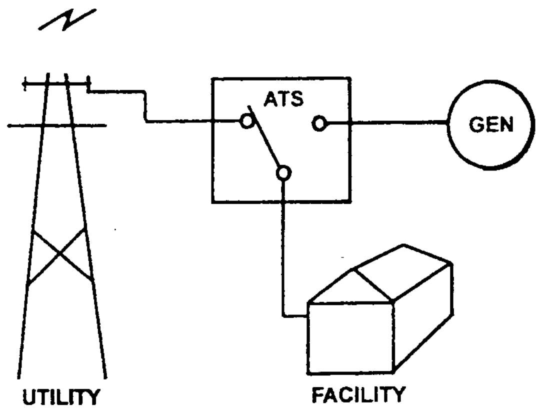
Hardware damage! Engine and generator set may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of bolt heads and nuts.

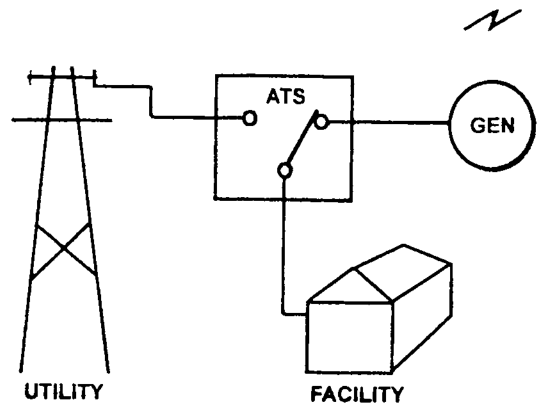
NOTICE

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.



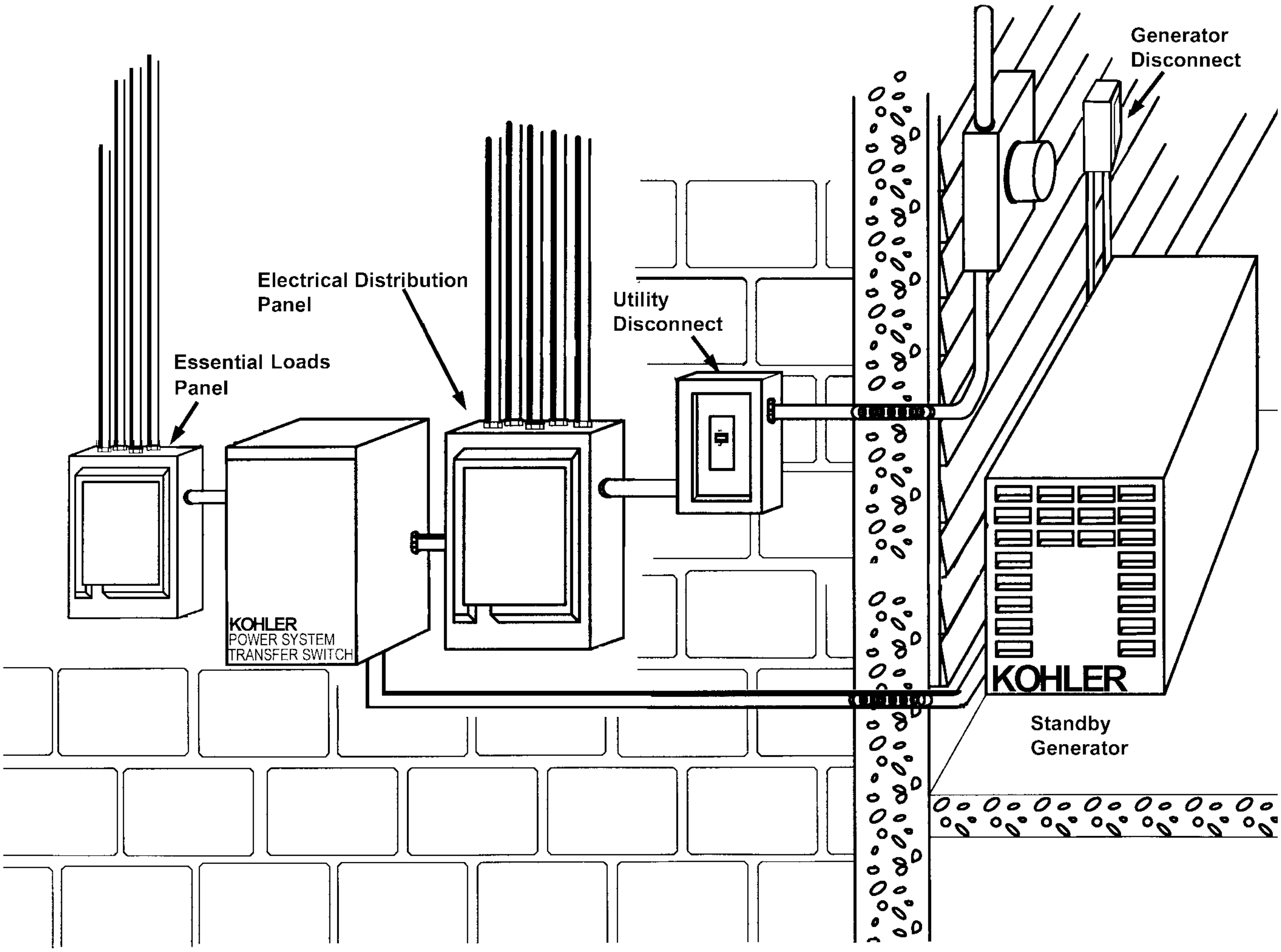


System Concept

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 or LP fuels codes as well as all electrical safety codes.



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 (following page). 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.

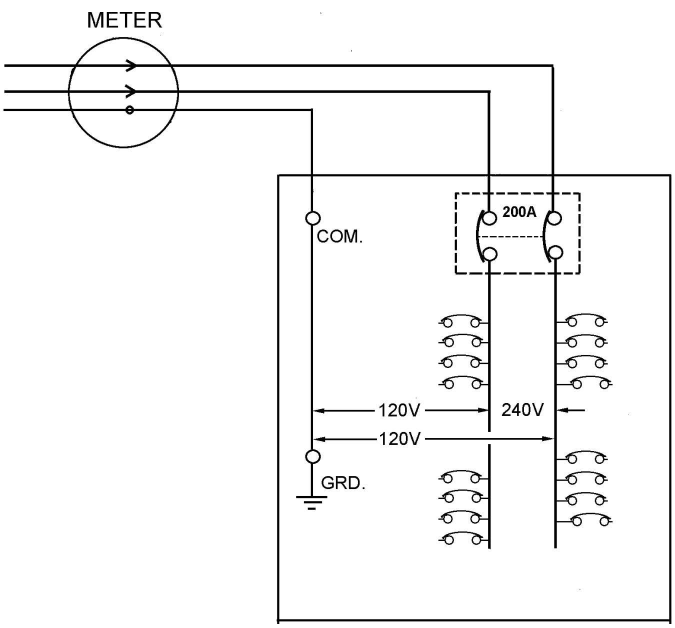
During installation these devices are wired through an "essential loads" distribution panel, which in turn is wired to the generator and ATS.

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.

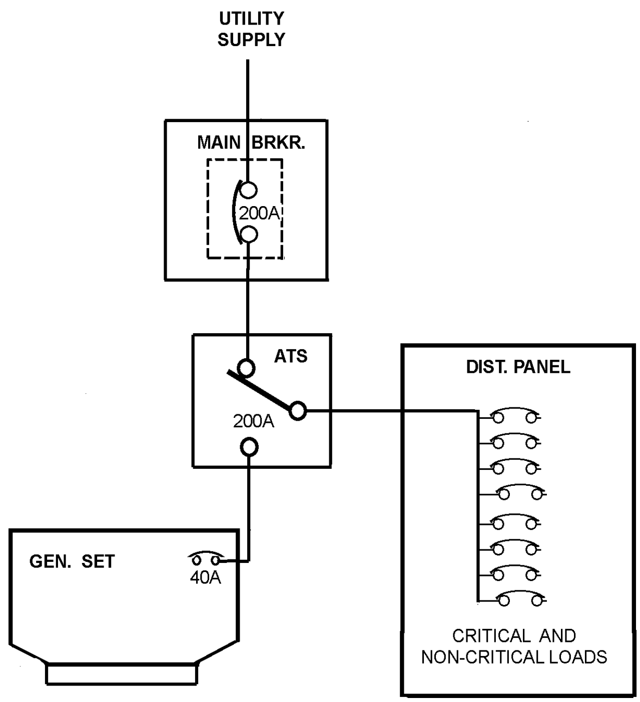
The Normal 60 Hz. voltage supply from the meter is usually single phase , 3 wire, 220 to 240 volts measured line to line and 110 to 120 volts line to neutral. The neutral or common is tied to a ground lug.



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 40 amperes.

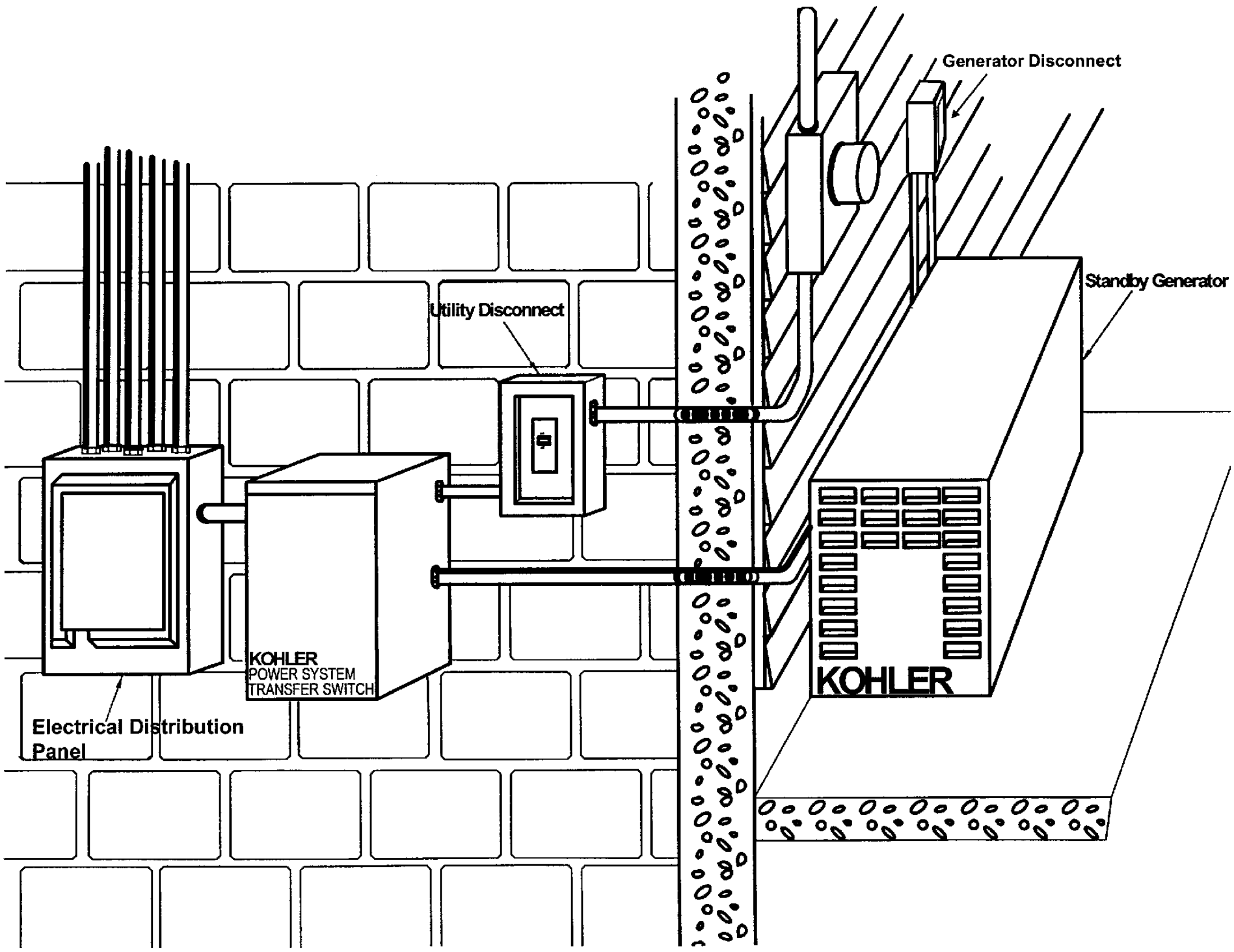


The load applied to the generator can be reduced if required by manually opening distribution breakers.

Normally not all circuits are considered as critical loads and therefore need not be powered by the generator. An emergency supply of 8 to 11kW in most cases is more than adequate.

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

System Concept



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.

How much power does my home need during an emergency?

This wattage chart is intended to help you determine the essential requirements for typical home appliances. Things like heating, air conditioning, your security system, freezer, refrigerator, sump pump, microwave or predetermined lighting, etc. The chart also allows you to determine or "stagger" special loads by alternating the usage of specific appliances.

Typical AC electrical requirements for a residential installation.

Appliance		Wattage Requirement
Air Conditioner (Central)		
10,000 BTU		*2200
20,000 BTU	1.7 Ton	*3300
24,000 BTU	2.0 Ton	*4950
32,000 BTU	2.7 Ton	*6500
40,000 BTU	3.4 Ton	*7800
48,000 BTU	4.0 Ton	*9400
Air Conditioner (Window)		
5,000 BTU		*1400
7,000 BTU		*1800
10,000 BTU		*3000
18,000 BTU	1.5 Ton	*5700
24,000 BTU	2.0 Ton	*6000
Clothes Dryer		
Gas		*2500
Electric		*7550
Coffee Maker		1750
Computer (Home)		500 to 1200
Dehumidifier		*1450
Dish Washer		*2100 to 2850
Electric Blanket		400
Electric Fry Pan		1100 to 1500
Electric Range		
6 in. element		1500
8 in. element		2100
Broiler		1400
Oven		6000
Fan		
Attic		350
Window		100 to 200
Furnace (Gas or Oil)		
1/8 Hp Fan		*800
1/6 Hp Fan		*1250
1/4 Hp Fan		*1600
1/3 Hp Fan		*2100
1/2 Hp Fan		*3225

Appliance	Wattage Requirement
Garage Door Opener	
1/4 Hp	*2000
1/3 Hp	*2500
1/2 Hp	*4000
Hair Dryer	300 to 1500
Iron	1200
Light Bulbs	Watts on Bulbs
Microwave Oven	
625 Watt Power	*2500
850 Watt Power	*3200
Radio	50 to 200
Refrigerator/Freezer	*3100
Security System	250
Space Heater	1200
Sump Pump	
1/3 Hp	*2150
1/2 Hp	*3200
Television	300
Toaster	
2 Slice	1050
4 Slice	1650
Vacuum Cleaner	800 to 1100
Water Heater	4500 Per element
Well Pump	
1/3 Hp	*2150
1/2 Hp	*3100

*Starting Wattage (Appliance needs more current to start than to run.)

These estimates are intended to assist in the specification phase of assessing your generator requirements. Actual appliance wattage will vary depending on the manufacturer and application. Consult your local KOHLER Generator Distributor or Dealer for exact specifications.

Calculating Loads

To assist in determining how much power your customer will need to operate an emergency standby system use the wattage chart to calculate power consumption for the application. This chart will give you estimated power consumption for various appliances including the motor starting requirements.

Gaseous Fuel System

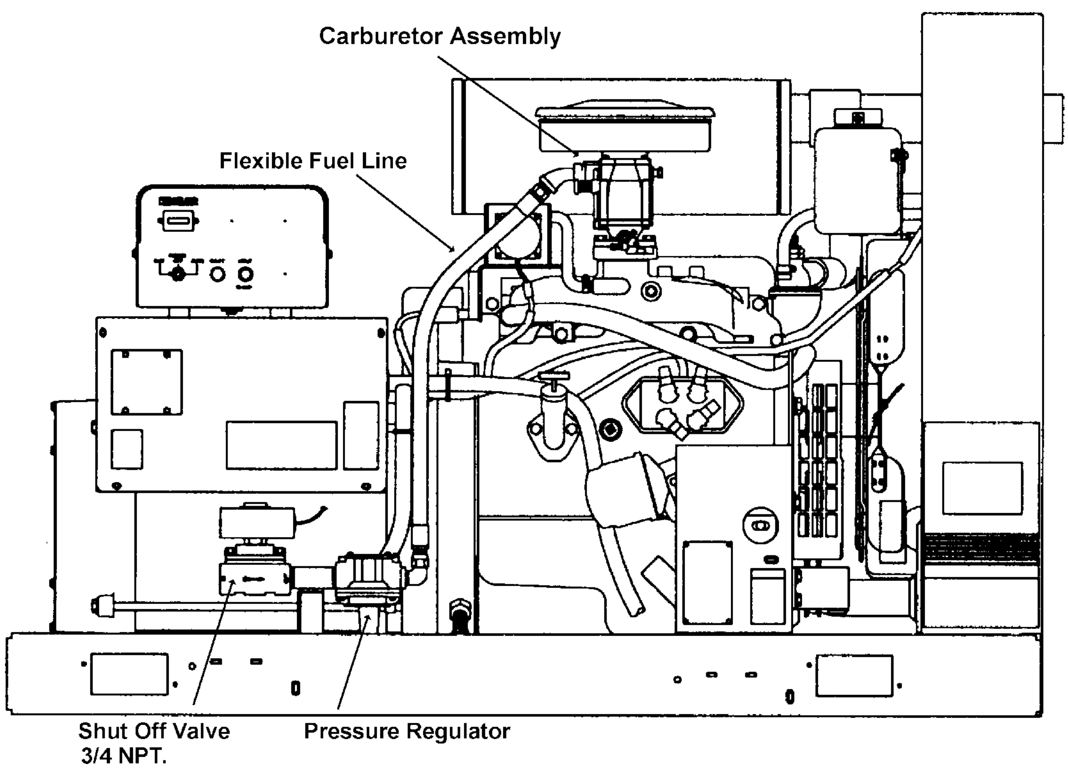
The straight gas fuel system utilizes a fuel valve to control fuel flow to the regulator. The fuel valve is used to shut off the fuel when the engine stops. The fuel valve is located before the regulator and flexible fuel line to prevent the accumulation of an explosive mixture of gas and air should the regulator or fuel line develop a leak. The gas valve is energized by the run relay from the controllers' logic circuit board.

The generator-mounted regulator reduces fuel pressure as fuel passes to the carburetor.

The carburetor controls the ratio of fuel to air mixture into the engine under varying load conditions.

A flexible fuel connector is used between the stationary gas piping and engine-mounted carburetor, the flexible connector is used due to the shifting and vibration of the engine while running.

The 17.5 and 22 kW generators are designed to operate on either Natural gas or LP gas. The Fuel regulator is mounted with the spring compartment facing downward which makes it compatible with both fuels, when used with natural gas the spring and retainer are installed in the regulator when used with LP gas the spring is removed.



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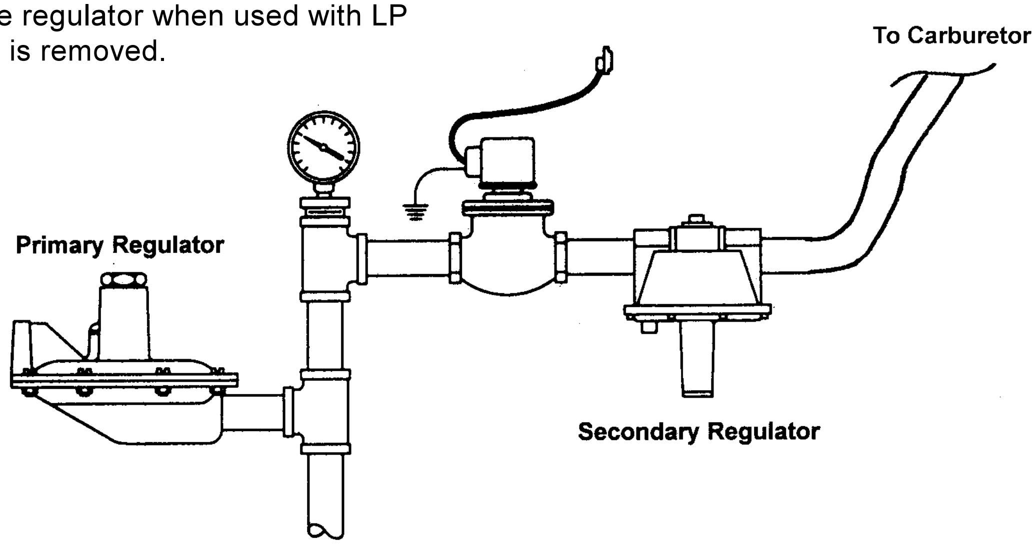
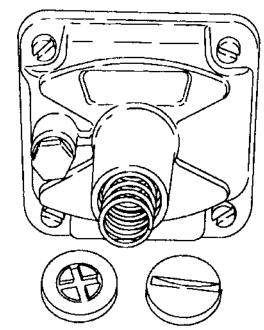


Secondary Regulator

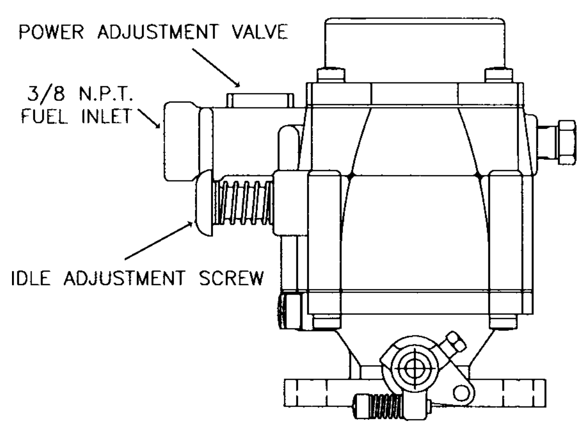
The generator set can be operated on natural gas or LP gas. If the set is to operate on LP gas the regulator must be pointing downward and the internal spring must be removed. To remove the internal spring from the gas regulator, remove the retaining screw from the underside of the regulator. Remove retainer and spring then reinstall retaining screw.

When converting the generator back to natural gas reinstall spring and retainer screw. A pressure gauge or manometer must be installed on the carburetor side of the gas regulator. Rotate spring retainer on regulator to obtain a constant 5 inches water column or 3 ounces per square inch while generator is running under full load conditions.



Carburetor Adjustments

The only carburetor adjustment necessary or possible is the engine fuel mixture (power adjust valve). This adjustment is factory set and should not require field adjustment. However if the carburetor is removed or tampered with, carburetor adjustment may be required. To adjust the carburetor, run the generator set at approximately half load. Rotate power adjust valve CW or CCW until engine runs smoothly. Apply varying loads, minor adjustment may be done to achieve smooth engine performance at all loads.



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.

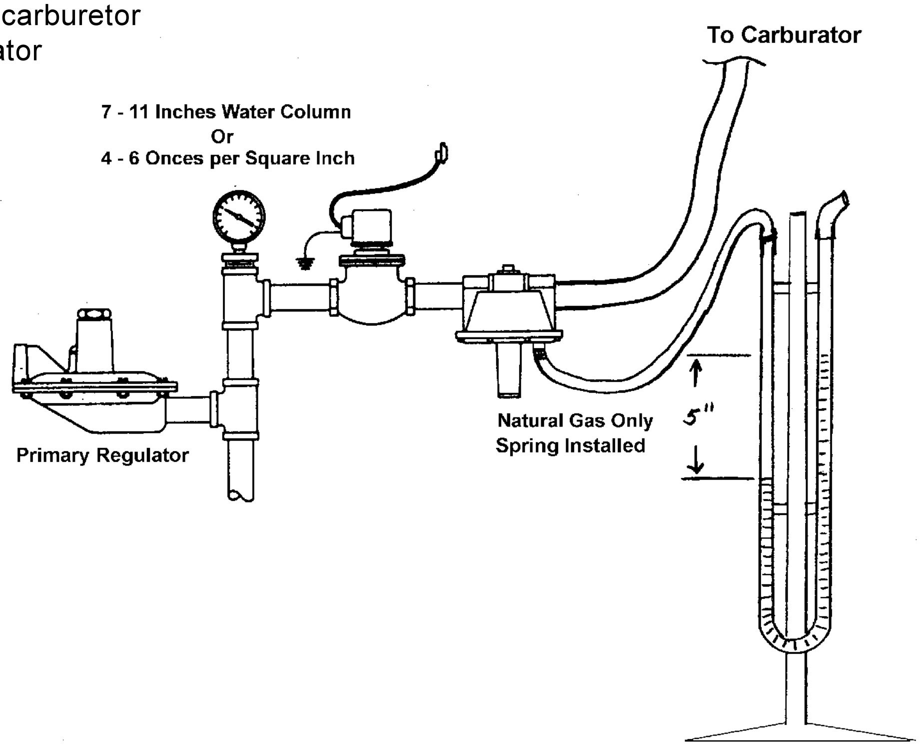
The heating value of Natural gas should be 1000BTU per cubic foot. When heating content falls below 1000BTU the set will not produce rated power and will need to be derated. Always check the specification sheet for the rating of the generator while running on natural gas, many applications require derating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

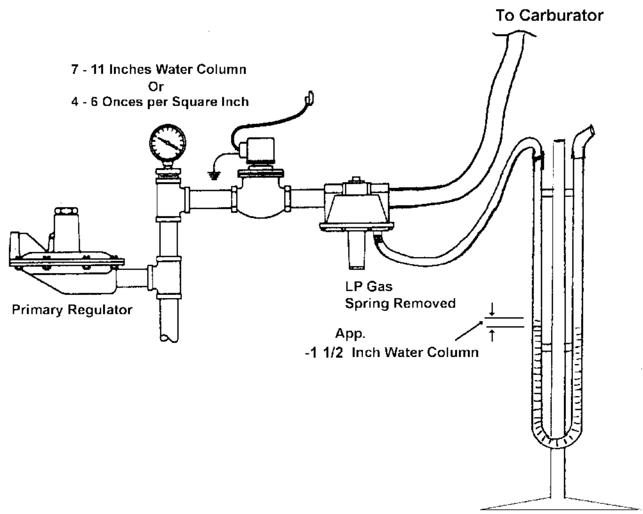
Physical Property @ 60°F (15°C)	**Natural Gas**
Normal Atmospheric State	Gas
Boiling Point Initial End	 –259°F (–162°C) –259°F (–162°C)
Heating Value, Btu's per: Gallon (Net – LVH) Gallon (Gross) Cubic Foot (Gas)	 63,310 1000
Density Cubic feet of Gas per Gallon (Liquid)	57.75
Weight (lbs.) per Gallon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

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.



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 may 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 17RY for natural gas operating at 100% full load uses 307cfh (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 (307cfh) by the correction factor (.962).

   307÷. 962= 320cfh.

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 (320cfh).

7. Move to left column from figure (320cfh) to determine correct pipe size. The correct pipe size for a 17RY with a pipe run of 35 ft. should be 1 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

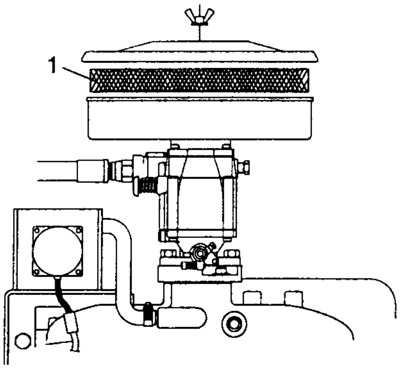
A pressure drop of 0.5 inch water column has been calculated into the chart to make allowances for a nominal number of fittings.

Air Cleaner

The air cleaner filters air entering the engine induction system and acts as a silencer and flame arrestor when assembled to the engine.

Air that contains dirt and grit produces an abrasive fuel mixture and can cause severe damage to the cylinder walls and piston rings. This can cause high oil consumption and shorten engine life. A restricted or dirty air cleaner will also cause a rich fuel mixture leading to excessive fuel consumption.

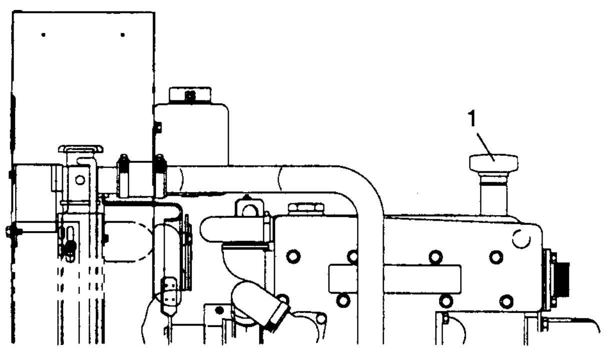
It is critical that the air cleaner be serviced at recommended intervals or sooner depending on the operating environment.



1. Air cleaner element

Crankcase Ventilation System

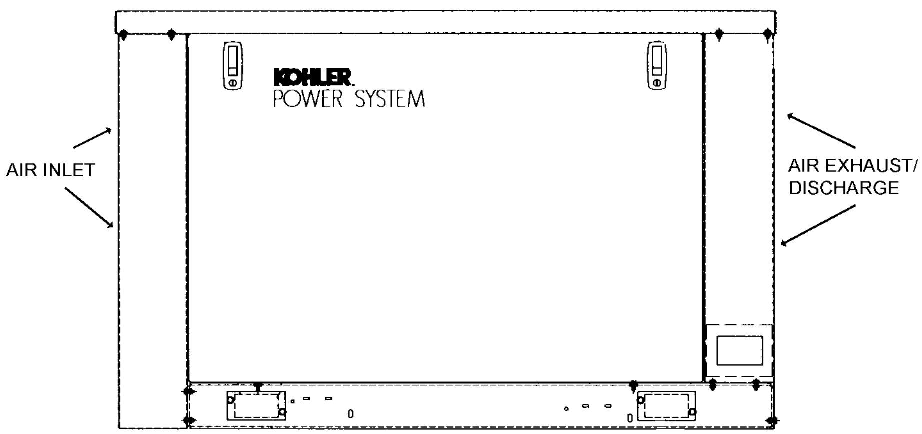
The engine has a positive crankcase ventilation system (PCV). Clean air is supplied from the air cleaner by a tube to the oil filler cap on the rocker cover. A calibrated port in the breather cap regulates the flow of fumes. A second tube vents the fumes via the intake manifold into the cylinder for combustion. The cap should be cleaned in petroleom solvent at recomended service intervals.



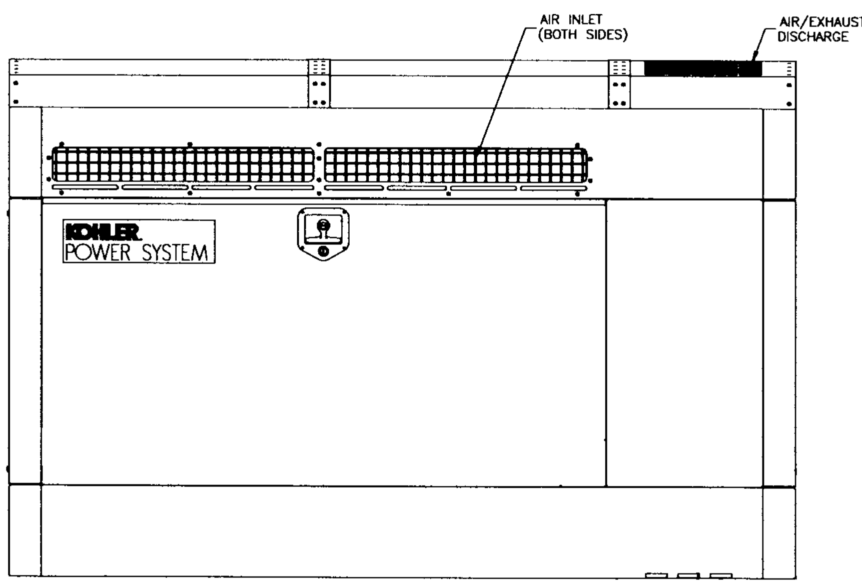
1. Breather cap

Air Requirements

Allow access for Air flow and servicing the generator when planning an installation or renovating the area near the generator. The recomended distance between buildings, landscaping or obstructions should be approximately 3 feet. The 17RY or 22RY generator requires 3,250 cubic feet per minute of air flow through the enclosure to provide proper cooling and intake air for the engine. Failure to provide adequate airflow will result in the generator having poor output performance and possible overheating of the engine.



WEATHER HOUSING

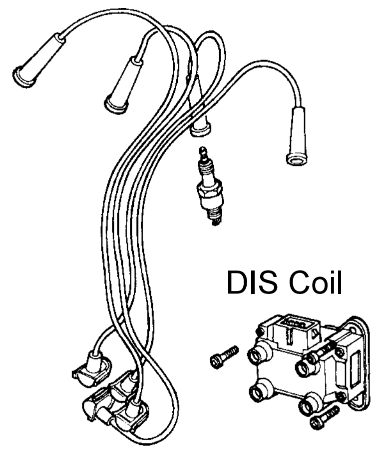


SOUND ENCLOSURE

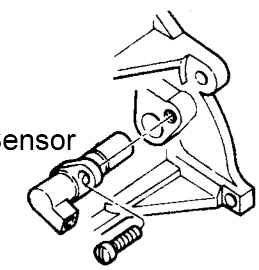
Distributorless Ignition System

The system compromises the following components:

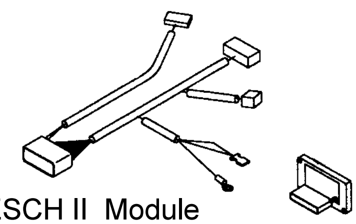
DIS Coil Assembly
Internally, the DIS coils have two primary windings and two high voltage secondary windings. One secondary coil supplies high-tension voltage to cylinders 1 and 4 and the other supplies cylinders 2 and 3 via high tension leads and spark plugs. When either of the two secondary coils are energized, two sparks are released, one going to a cylinder on the compression stroke, e.g. No. 1 cylinder and the other to No. 4 cylinder which is on the exhaust stroke. The unused spark on No. 4 does not have any detrimental effect on the engine.


DIS Coil

Crankshaft Position/ Engine Speed Sensor
The engine speed sensor is located on the rear of the engine block and points towards the flywheel. The sensor monitors a pattern of depressions on the flywheel and one special longer depression corresponds to 90° before TDC on piston number one. As the engine speed increases, so does the frequency and amplitude of the variable reluctance sensor voltage output signal.

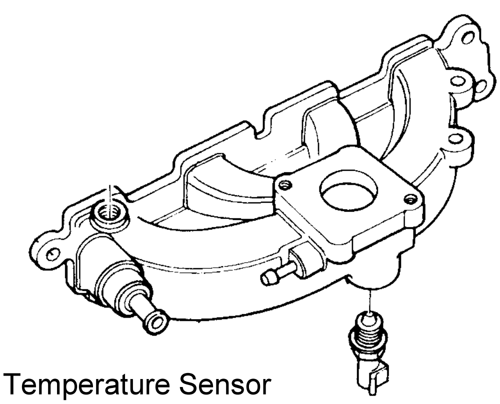

Engine Speed Sensor

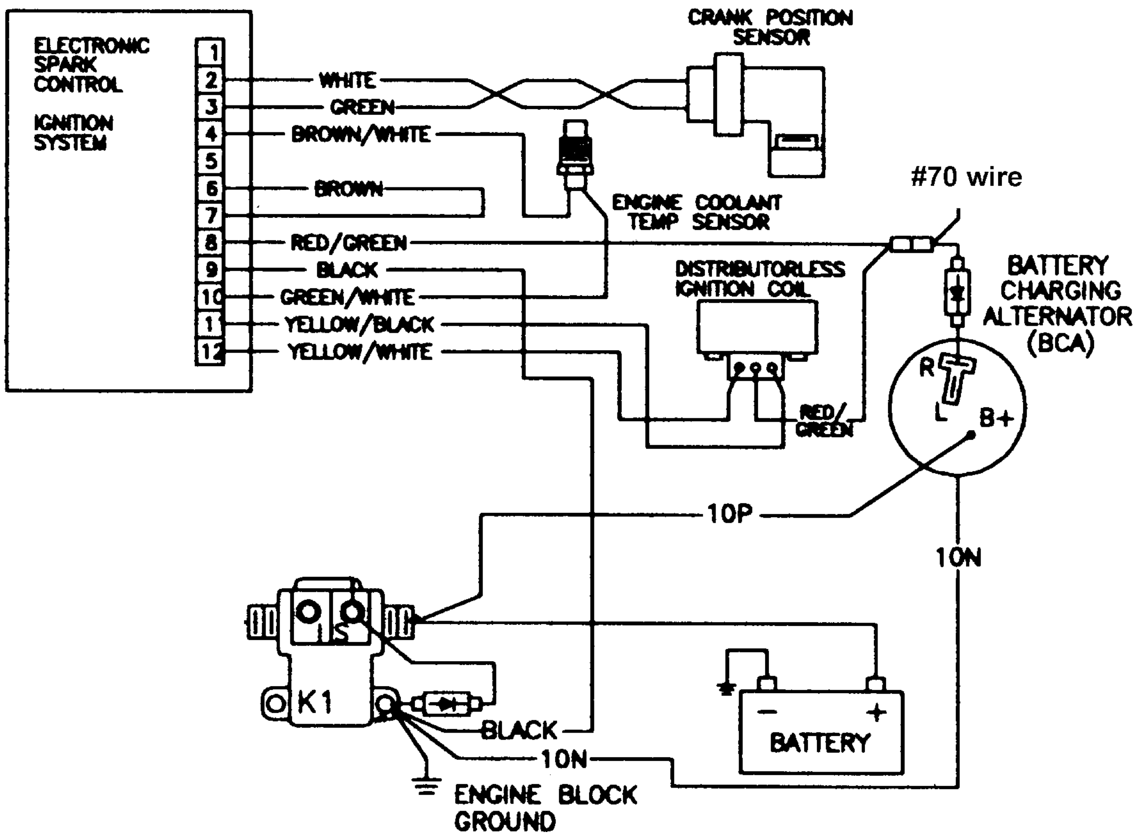
ESCH II Module
This receives the alternating signals from the sensor and computes this information together with engine load (based on engine vacum) and temperature, to determine the optimum ignition advance for all engine-operating conditions. It then interrupts the primary voltage to the DIS coils releasing the ignition spark at the optimum moment.


Harness and ESCH II Module

The ignition circuit is maintenance free, with only the spark plugs and spark plug wires requiring inspection and replacement at specified intervals.

The ignition timing is fixed and no adjustment is necessary. The ESC module controls the timing position in the start mode at 10° BTDC until the rpm reaches 250, after that the sensors are processed and timing is set to be compatible with engine speed, crankshaft position, engine load, and engine coolant temperature.


Coolant Temperature Sensor



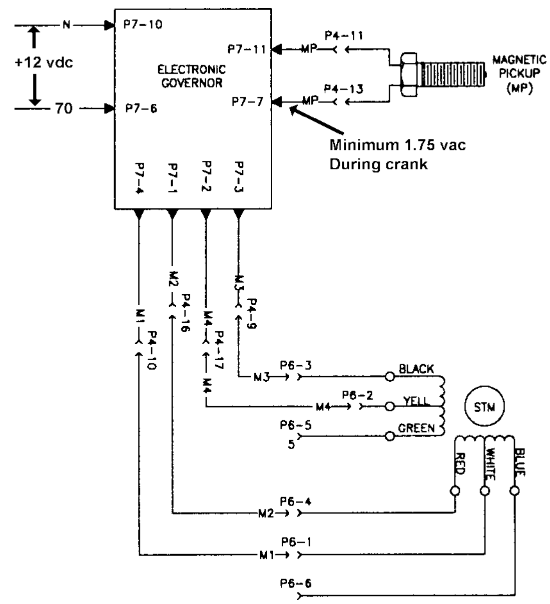
The #70 wire is required to the ESC Module (input terminal 8) and also to the DIS coil. The #70 wire is electrically hot (battery voltage) when the generator is in the crank or run mode. A ground is also required to terminal 9 of the ESC module.

Sensor Fail-Safe

If the ESC module identifies a failure of any of its inputs, other than the position speed sensor, it will substitute a fixed value for that input until the fault on the input is rectified. A failed sensor is defined as the instantaneous reading of a sensor that is above or below the maximum or minimum reading as defined as the systems constants.

Engine Coolant Temperature	Minimum -38° F Maximum 232° F
Manifold Absolute Pressure	Minimum 6.22" Hg Maximum 29.91" Hg

Electronic Governor



The governor system consists of an electronic isochronous governor, an electromechanical stepper motor, and a magnetic pickup. The magnetic pickup supplies electrical pulses to the isochronous governor control unit each time one of the ring gear teeth passes the pickup. The control unit then compares the frequency of these pulses to a preset reference and provides a signal to the stepper motor which in turn controls the carburetor throttle position and hence the engine speed. This is a closed-loop system and typically provides steady state speed regulation of +/- 0.5%

The factory sets the electronic governor and it normally requires no further adjustment. If generator set operates erratically, check the following items BEFORE readjustment.

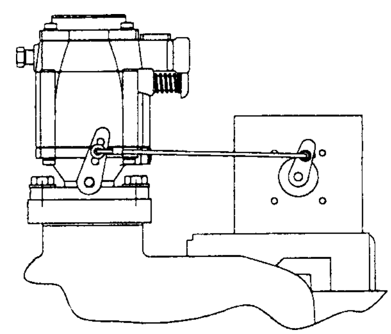
1. Check electrical connections. Check the stepper motor, controller box, and governor connector (inside the controller) for clean and tight connections.

2. Check magnetic pickup connections. Poor connections may cause an erratic signal. As long as this signal is being received, the unit will not shut down because of loss of pickup.

3. Check electrical ground connections. Provide a good DC ground to the controller assembly and governor circuit.

4. Check for dirt buildup on magnetic pickup. Metal filings or caked-on dirt/grease decrease the output signal of magnetic pickup.

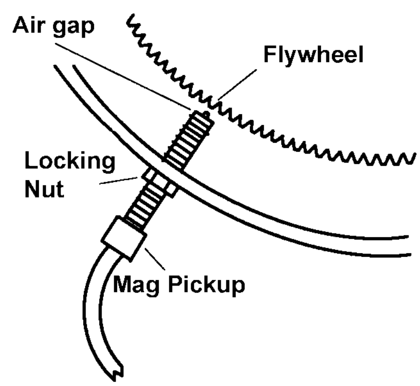
5. Check the carburetor for dirt, grime, or misadjustment. Check throttle linkage for binding.



Magnetic Pick-up

The magnetic pick-up monitors the flywheel ring gear and provides the speed reference signal to the electronic governor control module.

Failure or loss of the input speed signal from the pick-up will result in a low or idle speed condition. At cranking speed a properly adjusted pick-up should produce a minimum of 1.75vac. Air gap is factory set at 0.040 in.



Governor Adjustments

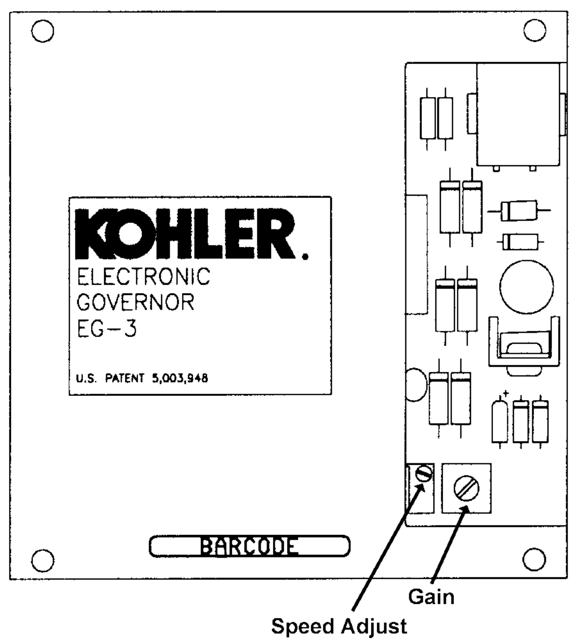
Attach a frequency meter to the AC output leads, start and run the generator and allow the generator to reach normal operating temperatures.

Speed Adjust:
Adjust the speed adjust potentiometer to obtain desired engine speed, 60hertz (3600rpm) or 50hertz (3000rpm) depending on application. Turn speed pot clockwise to increase frequency and counterclockwise to decrease frequency.

The governor being isochronous means the generator will operate at the fixed frequency with no droop in speed as long as the generator is not overloaded.

Gain adjust:
1. Check stability of frequency with generator running at no load.
2. Ramp the gain adjust up until the generator starts to hunt/surge.
3. Back the gain down in small increments until the audible hunting stops.
4. Apply rated load, the generator should be able to pick up rated load with only a slight delay. Generator should stabilize with no hunting.
5. Drop off load, generator speed should remain stable with no hunting.

If hunting occurs this indicates the gain is set to high, reduce gain.



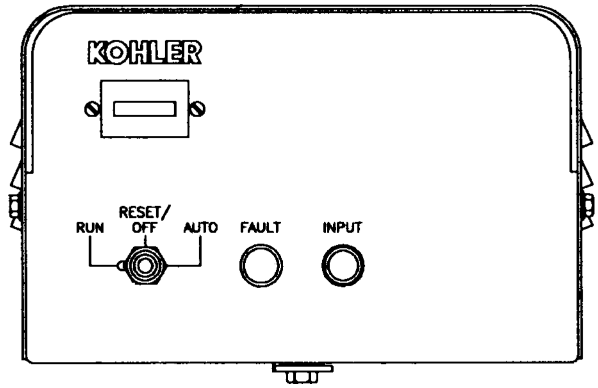
After setting the gain it is always a good idea to shut the unit off and let the system cooldown, then restart the generator to make sure the unit does not go into an overspeed or starts hunting. If this occurs the gain is set too high, decrease gain.

Hunting or surging indicates the gain is set too high. Slow response time indicates the gain is set to low or there may be engine or carburetor related problems.

Starting System

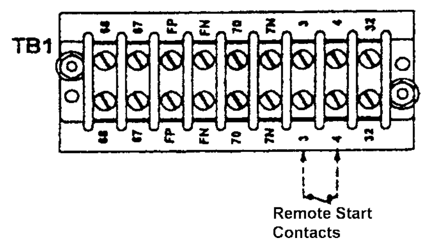
The generator set can be started locally by placing the start selector switch in the “RUN” position.

When placed in the “Auto” position the generator set can be started from a remote location (automatic transfer switch) by contact closure between terminals 3 and 4 on the controller terminal strip TB1. The F1 fuse protects the Crank/Run circuit.

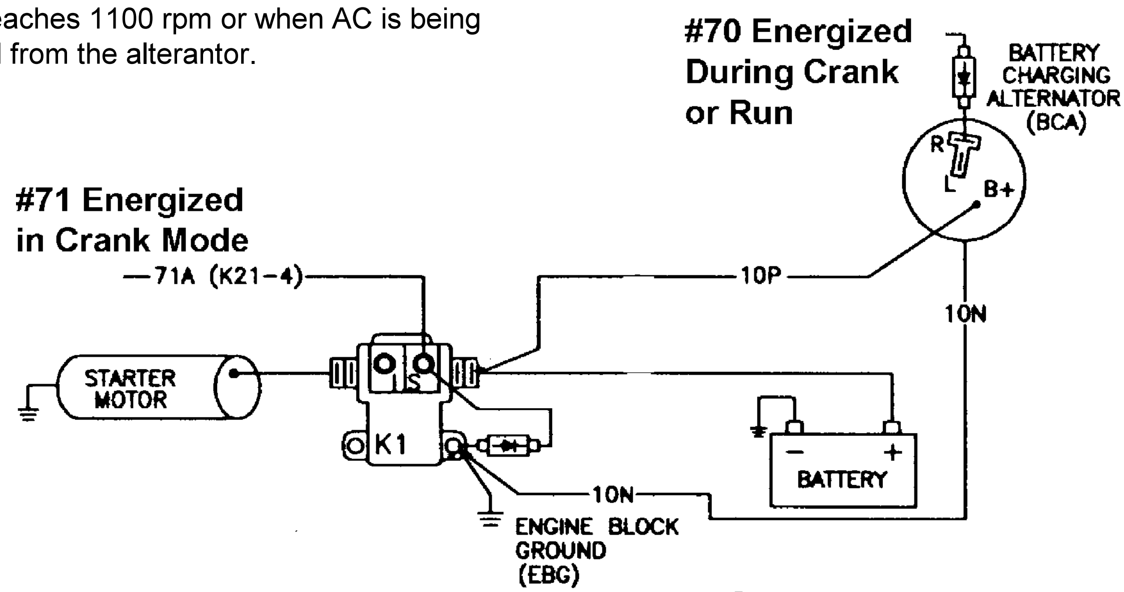


The electrical starting system requires a 12volt lead acid battery with a minimum 670 cold cranking amp rating. To insure a successful start-up the battery must be properly maintained and kept fully charged. A quality 12volt charger is recommended.

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

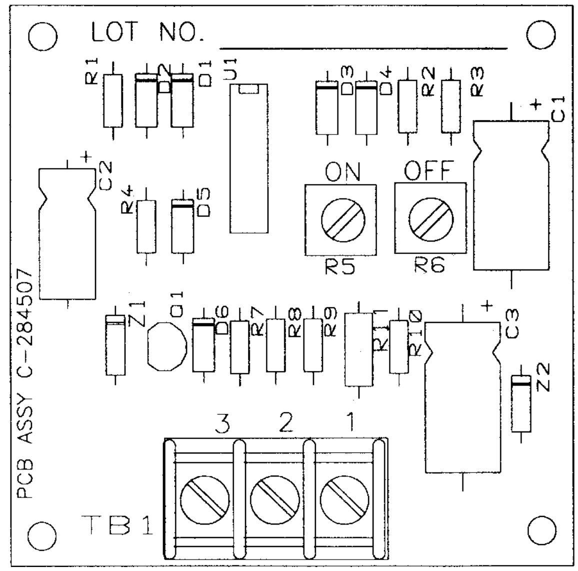


The starter is engaged when the K1 relay is energized completing the circuit from the battery to the starter motor. The #71 wire is energized through the controller board during the crank mode. The starter is disconnected when the engine reaches 1100 rpm or when AC is being produced from the alterantor.



Crank Cycling

A crank cycling feature is provided which allows the starter to be energized for a preset "on" time followed by a preset "off" time. This cycle will repeat until the total time allocated by the controller (30 sec) has lapsed or a successful start occurs.



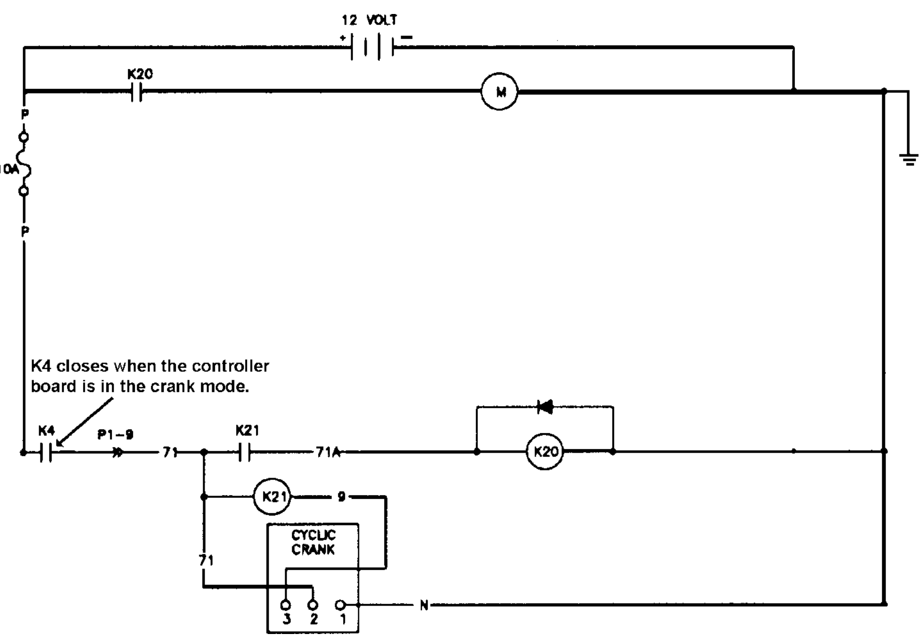
Cranking time (on) is factory set for 8 seconds, crank time (off) is set for 3 seconds. Times are approximate and depend on battery and temperature conditions. Cranking time may be field adjusted if required. The cycle cranking feature will not function if both pots are turned fully counterclockwise.

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

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

When the start signal is provided (K4 relay), voltage is applied to the cyclic cranking circuit. During the "crank" cycle the K21 relay energizes closing the k21 contacts enabling k20. When the k20 contacts close the starter motor is energized. During the "off" cycle the K21 relay is deenergized and the starter motor is disengaged.

If the engine starts within the cranking time of the cycle the K4 relay is deenergized removing power to the K20 relay and terminates engine cranking.

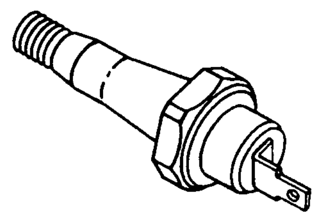


Low Oil Pressure Shutdown

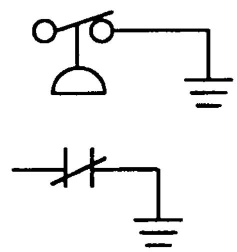
This device protects against internal damage in the event the oil pressure drops too low resulting in insufficient lubrication. This is a pressure sensitive switch.

The oil pressure switch is a normally closed switch which means the contact is closed when the engine is not running and opens when the engine is started and reaches normal operating pressures. The switch will then reclose if the pressure drops below the switch rating. The switch is wired into the engine shutdown circuit that activates on closure of switch.

A short time delay circuit is required to bypass the oil pressure switch during start-up so the engine doesn't experience nuisance shutdowns.



Normally Closed Contacts



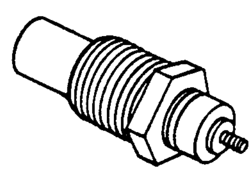
LOP – Low Oil Pressure

High Coolant Temperature

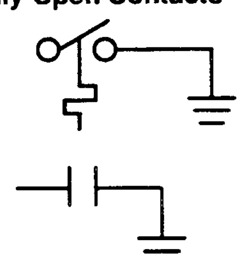
Coolant temperature switches are typically a normally open contact device. They are located in an engine coolant passage and sense the coolant temperature.

The switch contacts will close to activate the shut down circuit when the temperature exceeds the switch rating. The switch will self reset when the coolant drops to a safe operating temperature.

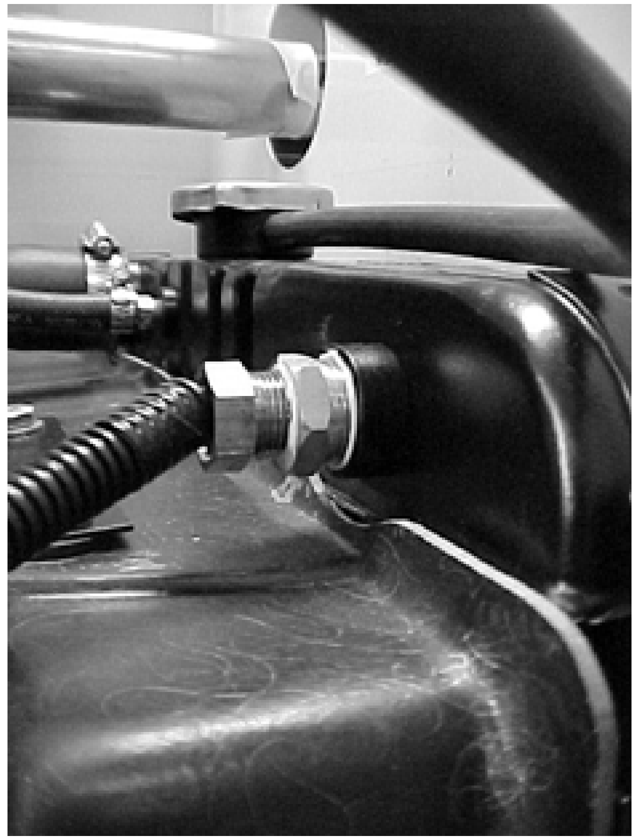
The switch does not protect an engine with no coolant in the system or a sudden loss of coolant. This switch requires the presence of coolant to activate.



Normally Open Contacts



HWT – High Water Temperature



Coolant Level Sensor (LWL)

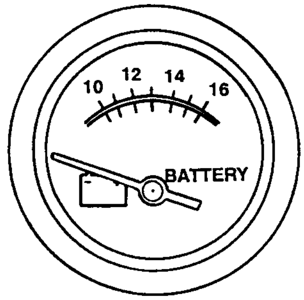
The liquid sensor is located in the upper portion of the radiator tank and detects the presence or absence of liquid at the probe tip. The device will provide a (-) signal via wire #31 to the relay control board to initiate an engine shutdown.

The sensor is a single terminal device, meaning the plus voltage is connected to the terminal and the ground connection is made through the radiator housing and back to chassis ground. Voltage at the sensor terminal during normal operating conditions when emersed in coolant is 12 vdc. The resistance value of the device will decrease when the coolant is removed from the probe. The decrease in resistance will cause the voltage to drop to approximately 7 volts initiating an engine shutdown.

There is a 5-second delay before a shutdown occurs.

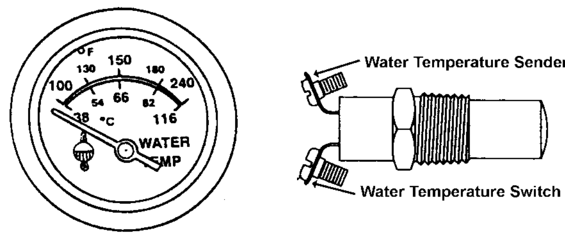
Engine Gauges

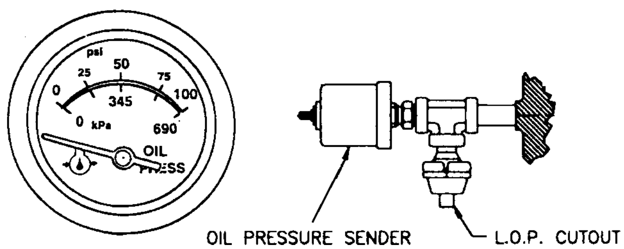
Electric 2” English/Metric series gauges with international symbols for oil pressure, water temperature, and battery voltage are standard for the DecisionMaker™ 1 Expanded controller option. The gauges are rated at 2% Full-Scale accuracy.



The battery voltage gauge monitors the battery charging system. Nominal charging voltage is between 13-15VDC on a 12 VDC system.

Variable resistance type senders for water temperature and oil pressure are located on the engine block. The water temperature sender has a dual function and also serves as the high water temperature shutdown switch.



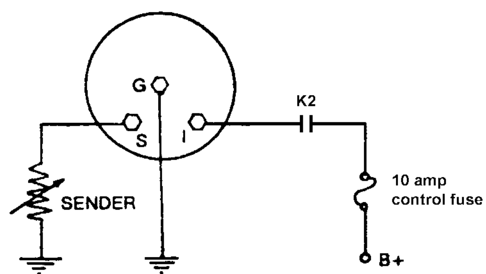


Water Temperature Sender Resistance Values

Temperature	Resistance-ohms
130°F (54°C)	59-75
180°F (82°C)	143-187

Oil Pressure Sender Resistance Values

Pressure	Resistance-ohms
0 psi (KPa)	225-257
25 psi (172KPa)	138-165
100 psi (690KPa)	33.5

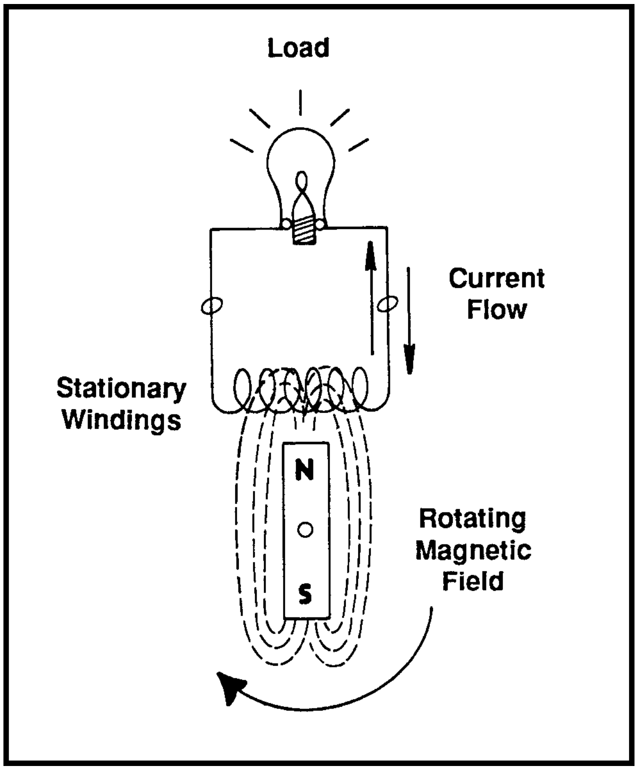


Alternator Design

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.

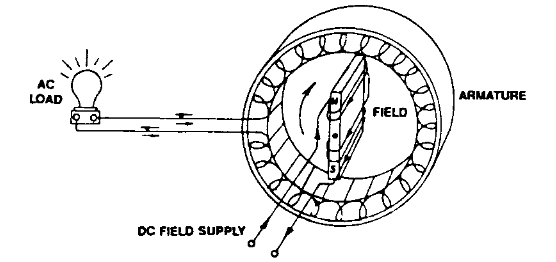


Kohler residential generators are of the rotating field design.

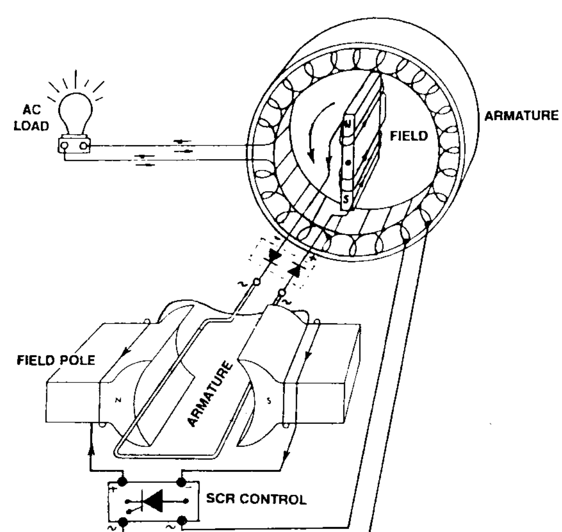
Rotating Field Generators

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 armature windings are stationary, no brushes are required for a transfer of AC power to the customer load.

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



2 POLE
REVOLVING FIELD GENERATOR



Alternator Design

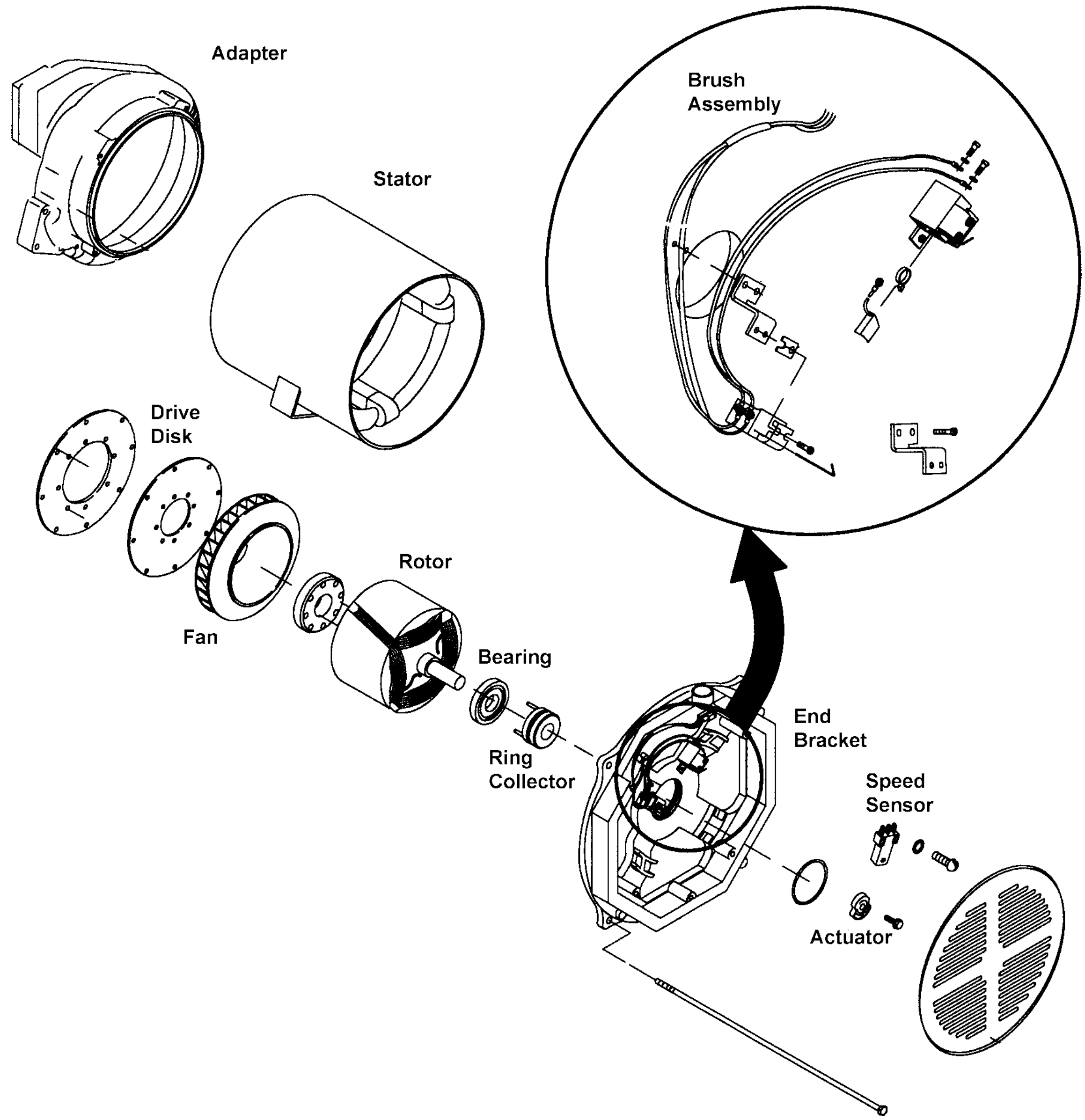
The Alternator is of the rotating field design and consists of two major components, the rotor and stator.

The rotor which is located within the stator is of the 2 pole design and is directly coupled to the engine using drive disks

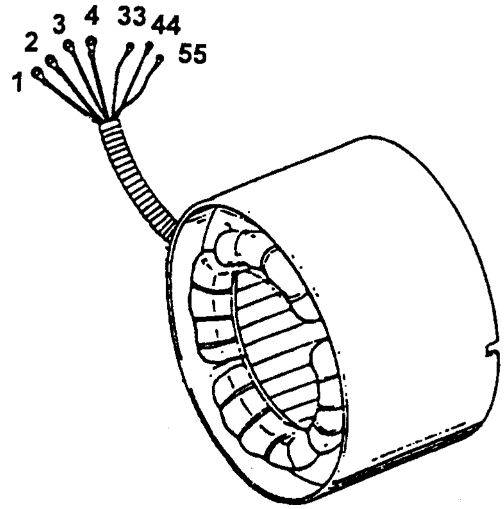
Excitation slip rings are mounted to the exterior of the end bracket and are accessible when the end bracket cover is removed. The generator fan is pressed on-to the rotor shaft.

The stator contains the copper windings which provide the load current to the building and is assembled to the engine adapter and endbracket and secured with bolts.

The alternator assembly is available in either a single phase or three phase reconnectable design.



Stator (Single Phase)



The stator contains the conductors. It consists of a core of slotted, laminated steel, in which coils of insulated wire (conductors) are wound.

Wire size and the number of windings placed in the insulated slots are selected by the desired electrical characteristics of the design.

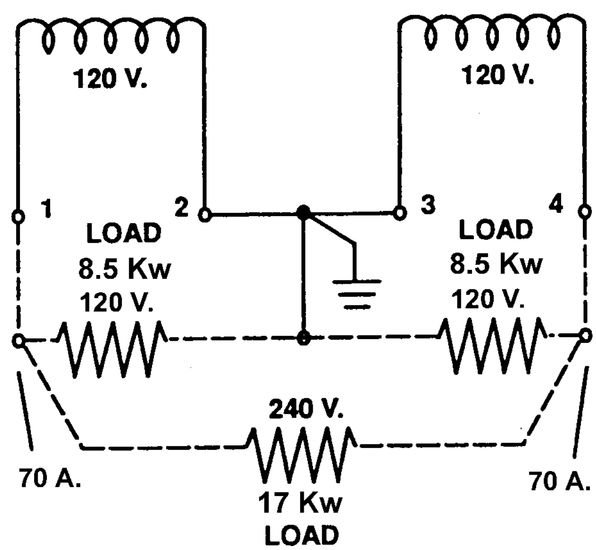
Stator leads 33, 44 are common to stator leads 3 and 4 and provide the voltage sensing input for the voltage regulator circuit. Lead 55 provides the excitation power supply for the exciter / regulator. Leads 1,2,3, and 4 are main output leads.

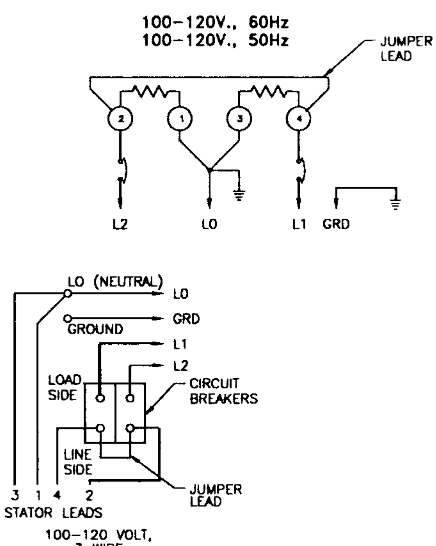
Single Phase Design

120/240 vac 3 wire (60 hz)
110/220 vac 3 wire (50 hz)

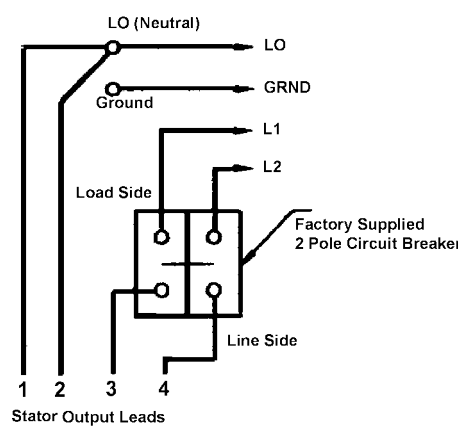
The 4 lead stator is factory connected to provide two 110-120 vac circuits or one 220-240 vac circuit. The rated load amps can be divided between these three circuits.

When connecting the main output windings to building load it must be remembered that the ampere ratings of each individual circuit must not exceed the ampere rating of the stator coils.





120 Volt Connection



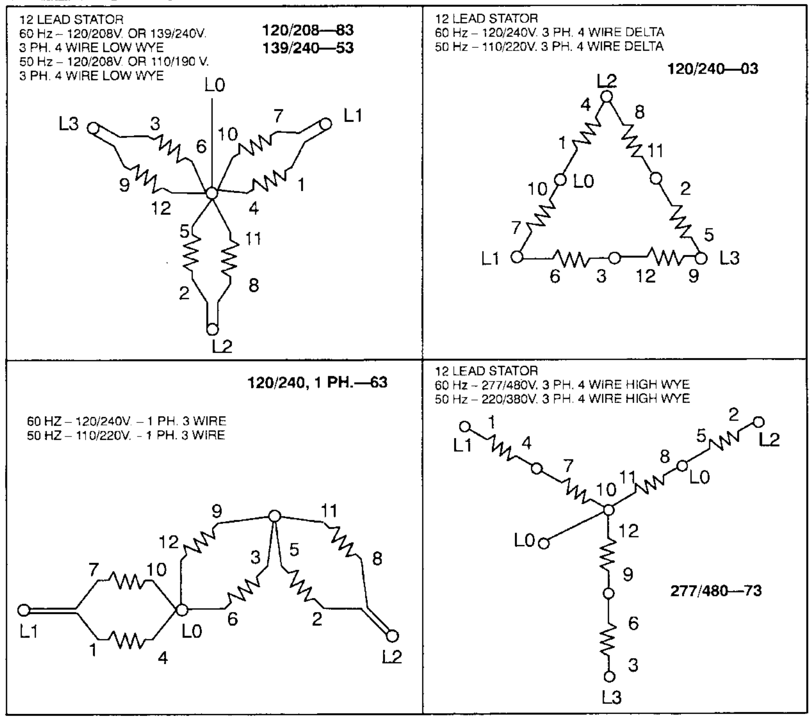
120/240 Volt
3 Wire

Three Phase Alternator

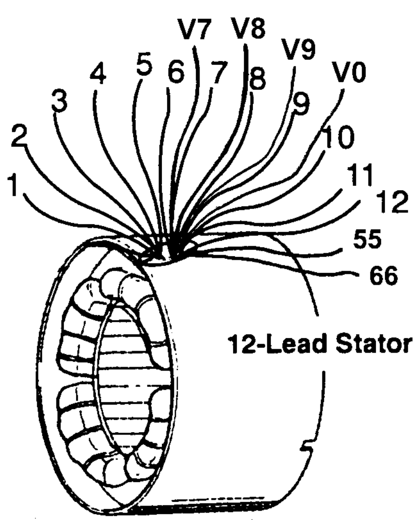
Some applications require a three phase alternator. Pictured is the configuration diagram for connecting the alternator for different voltage applications.

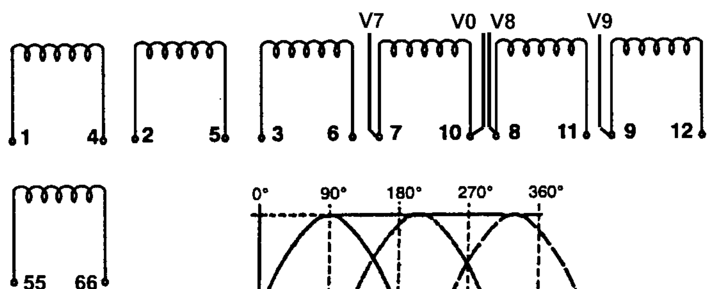
The three phase alternator application uses the PowerBoost™ V voltage regulator. The Stator will have 6 groups of windings for the main output leads 1-4, 2-5, 3-6, 7-10, 8-11, and 9-12, additionally you will have 55, 66 leads for supply power to the regulator. Also Sensing leads are required for control applications; V7 and V8 are used as sensing leads for the voltage regulator and V7 and V0 are used for sensing leads into the controller board as a means of a secondary crank disconnect.

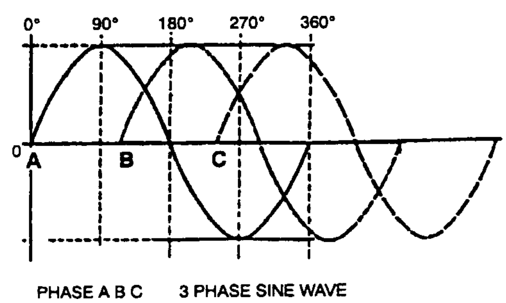
12-LEAD STATOR



Voltage Reconnections with 12-Lead Stator

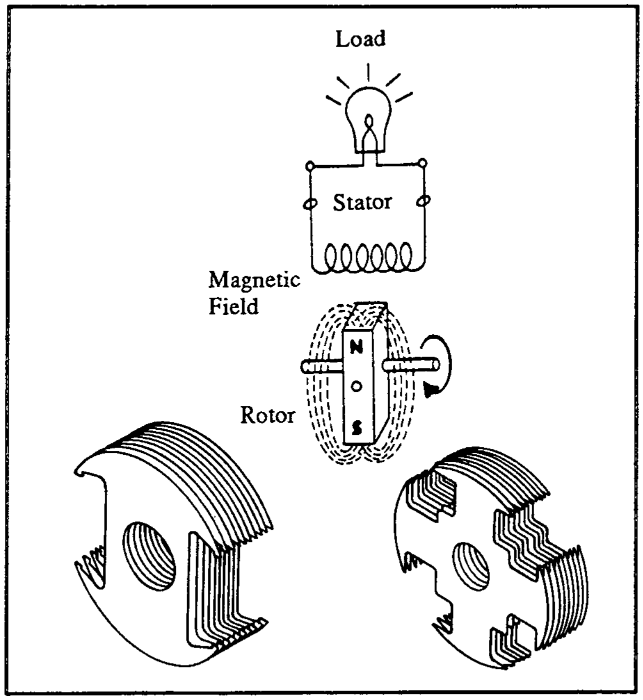






PHASE A B C 3 PHASE SINE WAVE

Rotor Design



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

The rotor windings (field coils) are energized by a DC supply from the voltage regulator via brushes and slip rings.

The DC supply is increased or decreased depending on load demand applied to the generator and is automatically controlled by the voltage regulator.

The rotating speed of the rotor determines the frequency of the alternator output. A two pole rotor must rotate at 3600rpm to produce 60hz.

The rotor is directly coupled to the engine and is supported by a bearing in the end bracket assembly.

The number of poles and the rotational speed will determine the frequency of the generated output potential.

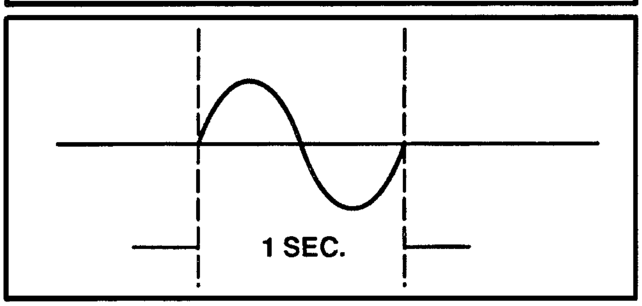
$$\text{SPEED (RPM)} = \frac{\text{Hz} \times 120}{\text{POLES}}$$

$$\frac{60 \times 120}{4} = \frac{7200}{4} = 1800 \text{ RPM}$$

$$\frac{60 \times 120}{2} = \frac{7200}{2} = 3600 \text{ RPM}$$

The two-pole generator will produce a 60 cycle (hertz) output if it rotates at 3600 RPM.

The two-pole generator will produce a 50 cycle (hertz) output if it rotates at 3000 RPM.



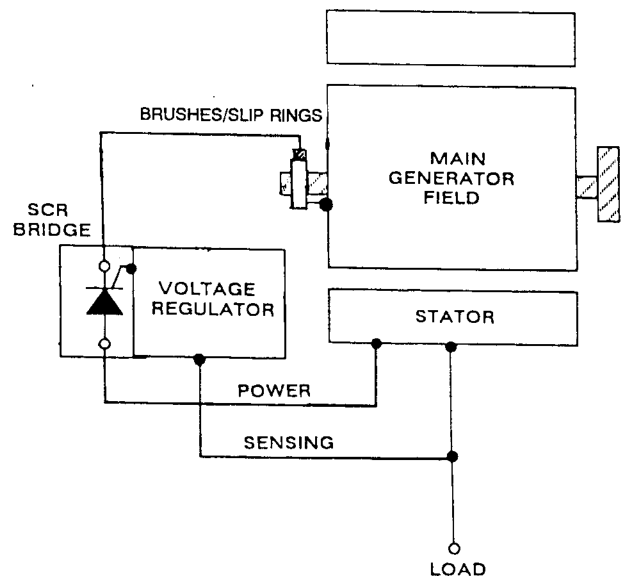
1 Hertz = 1 cycle/second

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.

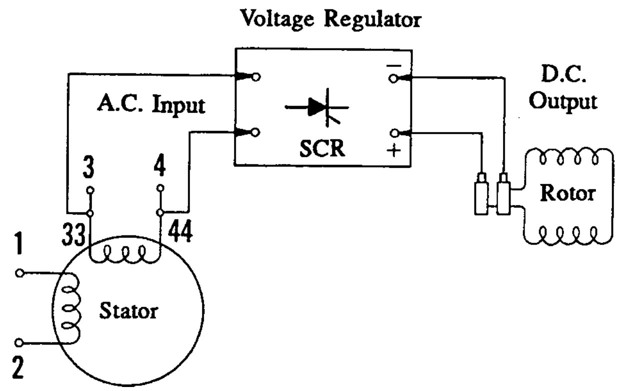
(Power Boost)

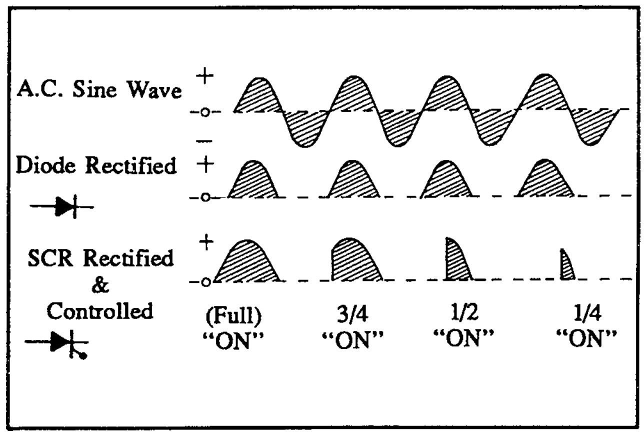
The Kohler version of static excited generators feature a patented Power Boost exciter regulator. It employs a separate auxiliary stator winding (independent of the main output) to power the field during fluctuations caused by load-on load-off situations.

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





Exciter / Regulator
PowerBoost™ IIIE

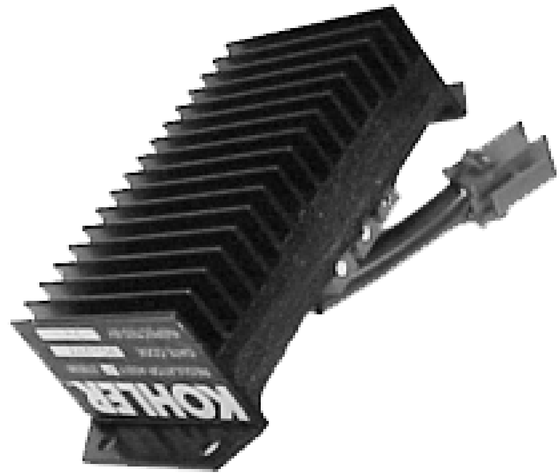
The PowerBoost™ IIIE is the voltage regulator used on the 4 lead single phase generators. The DC supply required to produce the magnetic field is provided to the rotor from the Power Boost IIIE voltage regulator.

Initial excitation at engine start-up (field flash) is supplied to the rotor brush and slip ring assembly from the starting battery via relay contacts (K21).

On sensing a successful engine start and alternator field build-up the battery supply is disconnected and excitation is provided from the regulated rectified output of the voltage regulator.

The excitation component (SCR) rectifies AC from the auxiliary power coil (55) of the stator. The voltage regulator circuit monitors the AC stator output (leads 33, 44) and controls the firing of the SCR providing regulated DC to the rotor slip rings.

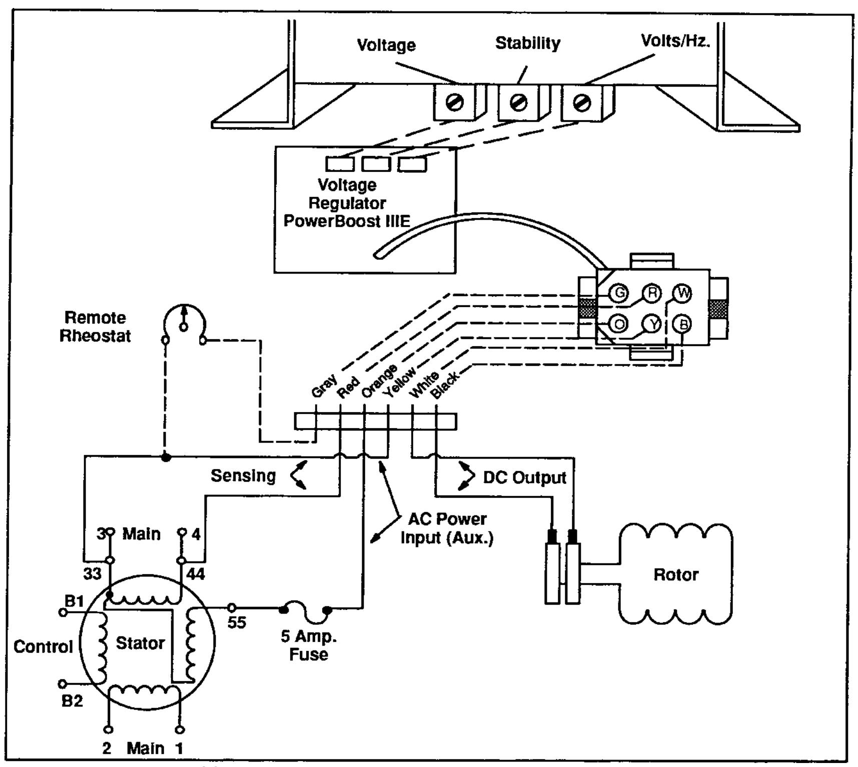
A 5-amp fuse (F2) is provided to protect the power input circuit. (55)



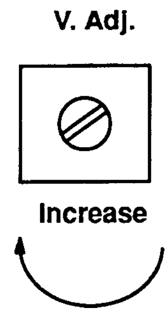
PowerBoost™ IIIE

Specifications:

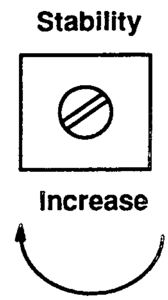
- Voltage regulation +/- 2%
- voltage adjust range 100-130 volts
- remote rheostat (optional) 10K ohms 1/2 watt
- remote rheostat range 5 volts
- stability adjust
- volts-per-hertz adjust factory set at 57.5 hertz



Voltage Adjustments
PowerBoost™ IIIE

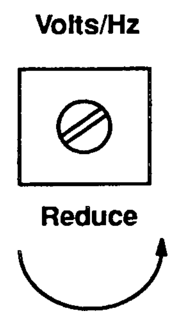


Volts adjustment - provides an output selection from 100 to 130 VAC.



Stability - "fine tunes" regulator for minimum light flicker and voltage fluctuation.

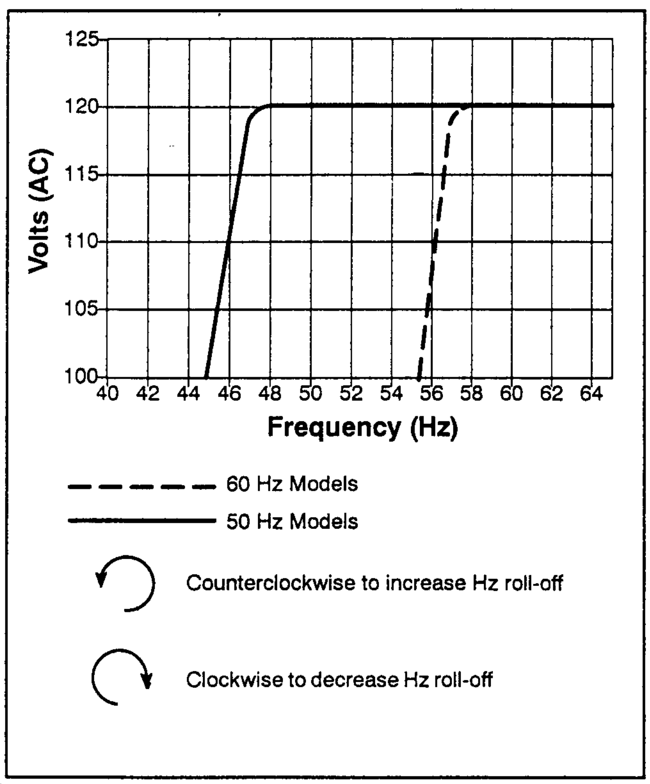
To set stability:
1. With generator off rotate stability pot fully counterclockwise.
2. Start generator.
3. Turn stability pot clockwise until minimum flicker is obtained.



Volts-per-hertz -These regulators are factory set to reduce the generator output voltage if the frequency drops below 57.5 hertz. Field adjustments are typically not necessary.

To set Volts/Hz
1. With generator set off, rotate Volts/Hz pot. fully couterclockwise.
2. Connect voltmeter to AC circuit or an electrical outlet.
3. Connect frequency meter to AC circuit or an electrical outlet.
4. Start generator set and adjust engine speed to desired frequency (factory setting 57.5 Hz for 60 Hz operation; 47.5 Hz for 50 Hz operation) as measured on frequency meter. Generator load does not affect this adjustment.
5. Rotate Volts/Hz pot. clockwise until voltage level begins to drop (as measured on voltmeter). Once voltage drop is measured stop adjusting pot.
6. Return frequency back to desired setting.

Adjustment is complete, when set to these specifications the generator will attempt to maintain nominal output until engine speed drops to the adjusted cutout point.



PowerBoost™ V (B-258296)

The Kohler PowerBoost™ V is a versatile +/-2% volts per hertz voltage regulator for use on the 12 lead single and three phase 50 and 60 hertz generators.The power circuit consists of a diode/SCR full wave bridge to provide the generator field excitation.

Power requirements:

Input Power: 140-170vac
Sensing: 120 - 240vac

Both a plug and terminal strip are provided for input and output connections.

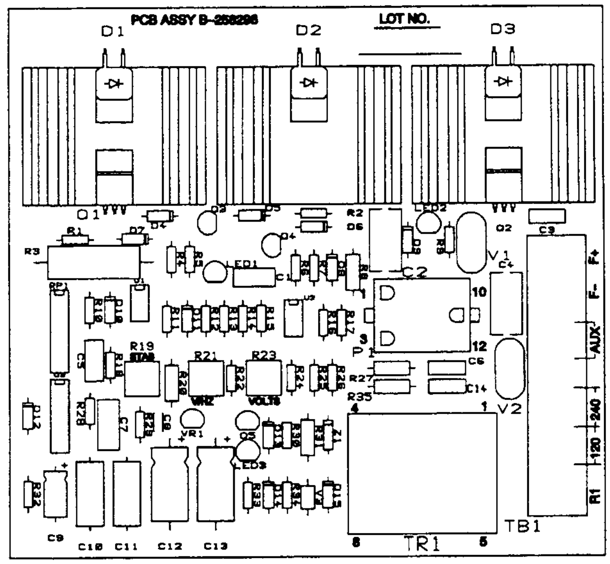
LED's on the regulator board offer a visual indication of sensing, input power, and field output availability.

LED 1: Input Power to the board (Green)
LED 2: DC output to the exciter field (Red)
LED 3: Sensing voltage into the board (Yellow)

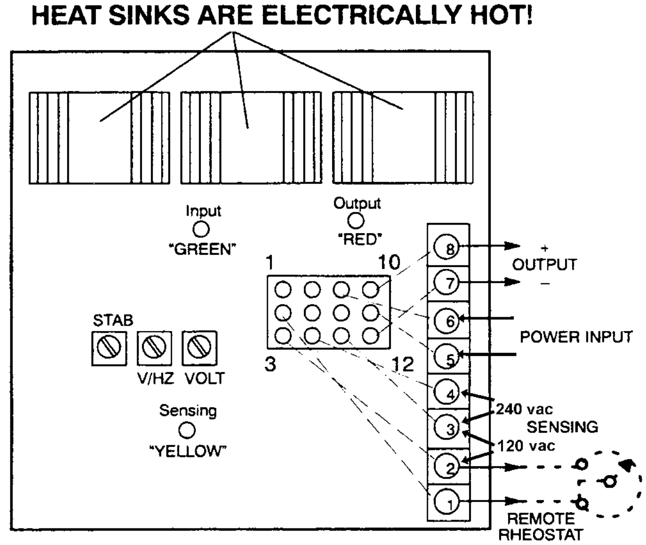
The regulator board has three adjustment potentiometers; voltage adjustment, stability, and volts per hertz.
The voltage adjustment allows a generator output range of 190 to 277 volts (line to line) Terminals are provided for an optional remote rheostat to allow for a 5-volt deviation. (10K-1/2W)
The stability potentiometer fine-tunes the regulator circuit for minimum light flicker.
The volt per hertz adjustment is factory set at 57.5-58 HZ for 60 HZ applications and 47.5-48 Hz for 50 Hz operation.
The volts per hertz feature reduces generator output voltage if the frequency drops below the preset value. This drop usually occurs due to a heavy load application and allows to the engine to recover speed.

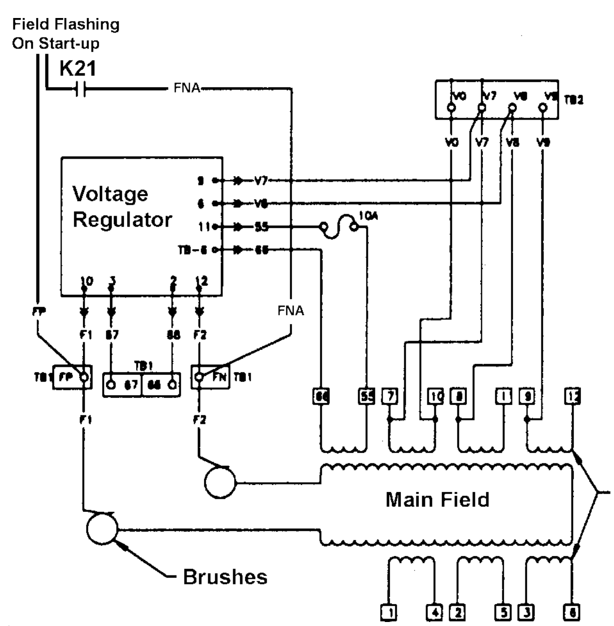
Volts per Hertz adjustment procedure: (Requires AC voltmeter and frequency meter)

1. Rotate the V\Hz potentiometer fully counterclockwise.
2. Reduce engine speed to desired cut-in frequency.
3. Adjust V\Hz pot clockwise until the voltage just begins to drop.
4. Return engine speed to normal operation.



HEAT SINKS ARE ELECTRICALLY HOT!

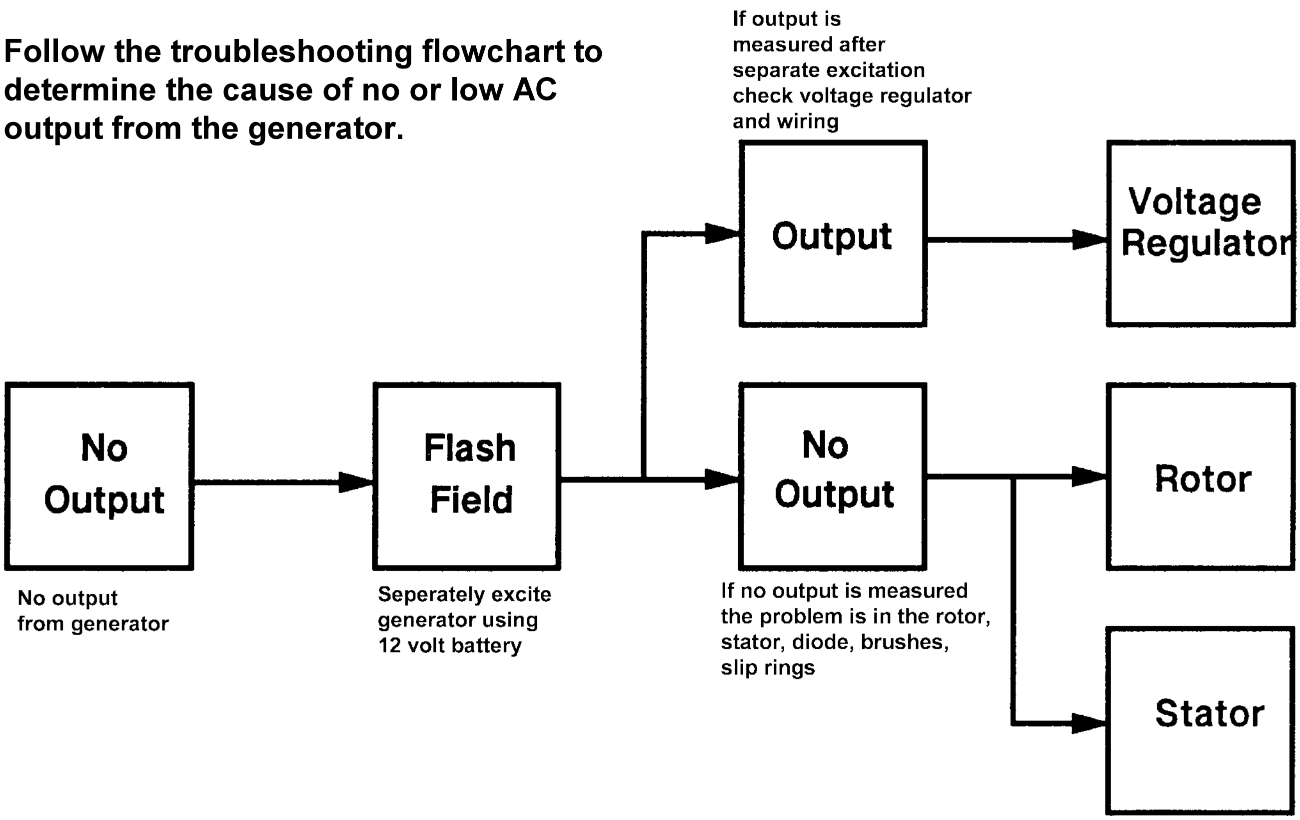




General Troubleshooting

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

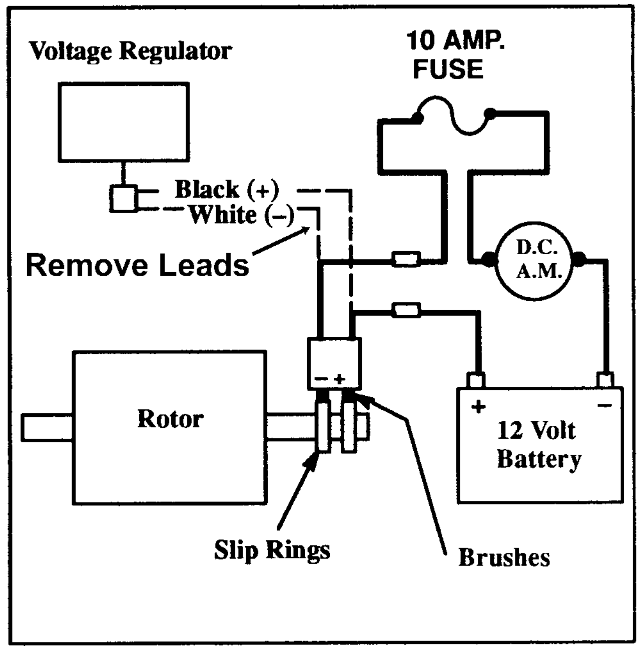
Follow the troubleshooting flowchart to determine the cause of no or low AC output from the generator.



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

Separate Excitation
Power Boost IIIE
PowerBoost™ V

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.



PowerBoost™ IIIE
or
PowerBoost™ V

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.

$$\frac{\textbf{Volts (battery voltage)}}{\textbf{Ohms (exciter resistance)}} = \textbf{Amps (Exciter Current)}$$

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 illistrates a single phase alternator.

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

Continuity

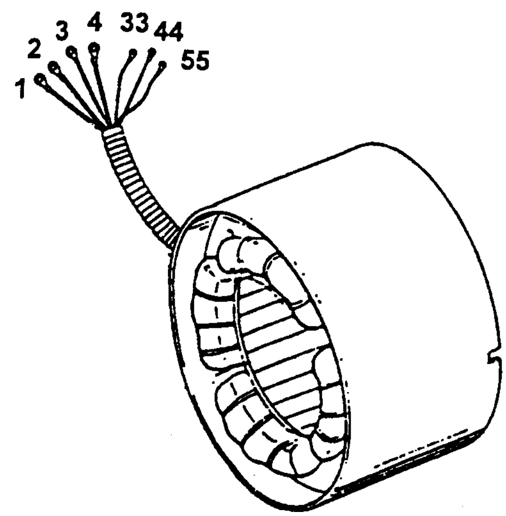
1. To check stator continuity, set ohm meter to a low resistance setting. This test will check if any coils are shorted to each other or there is a short to ground.
2. Dissconnect all stator leads prior to performing measurements.

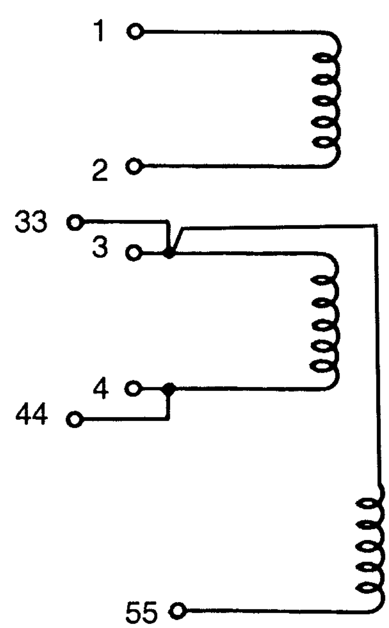
Leads1, 2, 3, and 4 are the generator output leads. Leads 33, 44, 55, and 66 are the voltage regulator sensing and power leads.

3. Check continuity of all windings, the meter should show continuity when checking between leads 1-2, 3-4, 33-44, 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 acurate 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).





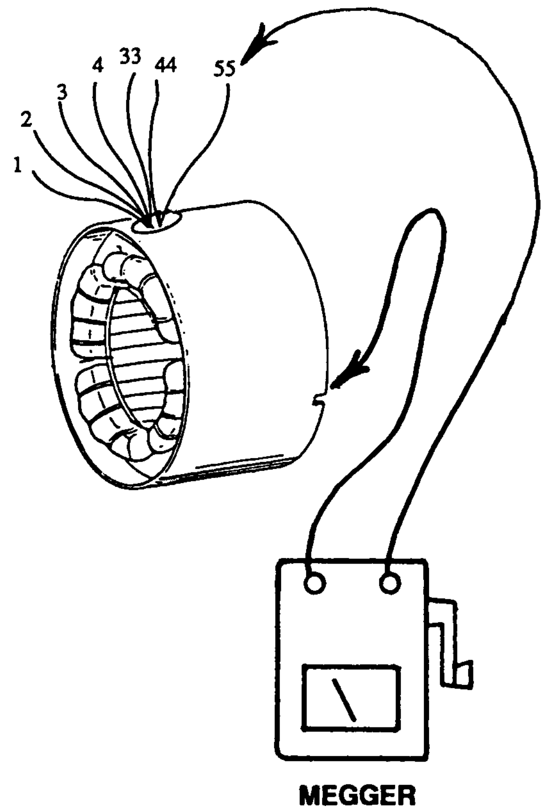
Note: Use same procedure on three phase 12 lead generators.

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 sufficient 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.

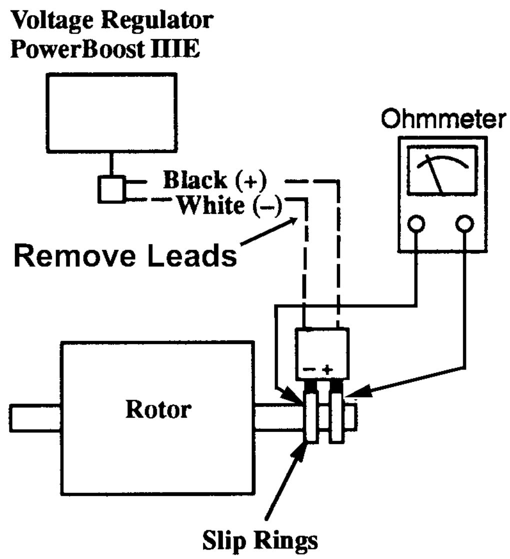
To test for a grounded rotor place one meter lead to a collector ring and the other lead to the rotor shaft. Meter should register no continuity.

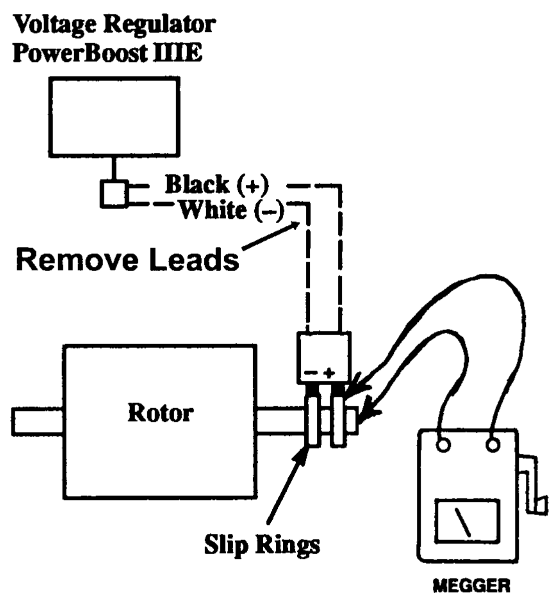
Megger readings can also be taken by placing one lead of the megger to a collector ring and the other to the rotor shaft. If reading is above .5 megohms the insulation leakage is acceptable. If reading is below .5 megohms this indicates there may be current leakage to ground and servicing is needed. 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.

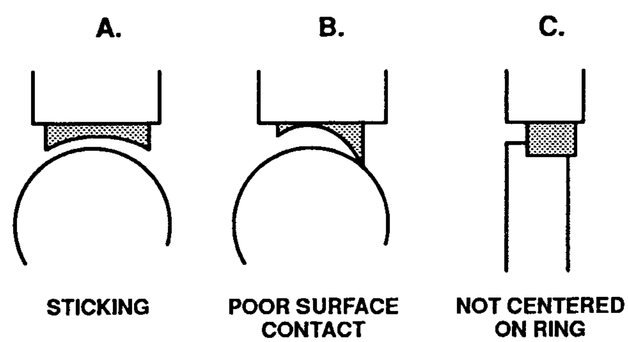
Note: Make sure when taking resistance readings or performing a megger test that the brushes are not in contact with the slip rings.

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.







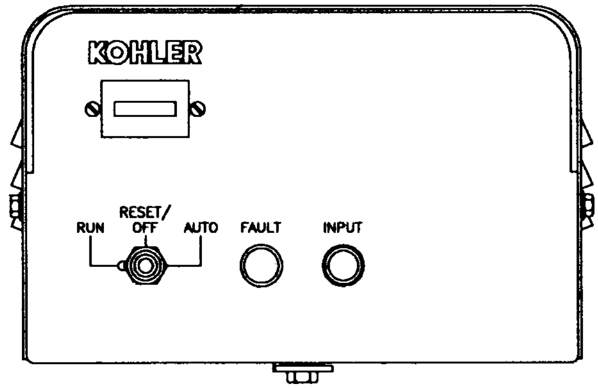
BRUSH CONTACT

4-Lead, Single-Phase Generator		
	Value	
Component Specification	17RY	22RY
Controller/battery electrical system	12 volts DC	
Rotor resistance ohms (cold)	4.2	5.6
Stator resistance ohms (cold) Leads: 1-2, 3-4 33-44 55-33	 0.03 0.03 0.53	 0.02 0.02 0.44
Stator output voltages with separately excited rotor using 12-volt battery 1-2, 3-4 55-66	 105 140	 88 117
Rotor field voltage/current readings at rated output voltage (hot) (240 V/60 Hz 1.0 PF) No load Full load	 16V/3.9A 46V/7.6A	 19V/3.9A 53V/7.4A

12-Lead, Three-Phase Generator		
	Value	
Component Specification	17RY	22RY
Controller/battery electrical system	12 volts DC	
Rotor resistance ohms (cold)	4.2	5.6
Stator resistance ohms (cold) Leads: 1-4, 2-5, 3-6, 7-10, 8-11, 9-12 55-66	 0.09 0.19	 0.06 0.18
Stator output voltages with separately excited rotor using 12-volt battery 1-4, 2-5, 3-6, 7-10, 8-11, 9-12 55-66	 140V 190V	 112V 150V
Rotor field voltage/current readings at rated output voltage (hot) (240V/60 Hz, 0.8 PF) No load Full load	 12V/2.5A 63V/9.8A	 15V/2.2A 69V/9.6A

Generator Controller

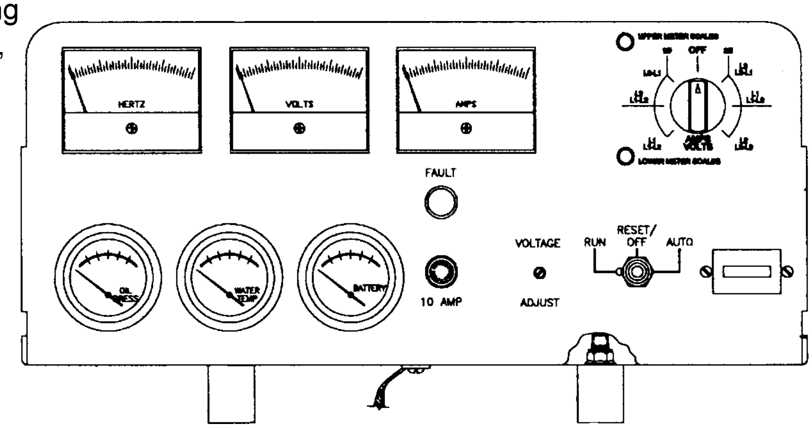
Two controllers are offered for the 17 – 22 kW residential product lines.



Decision-Maker™ 1
1 light relay controller

Decision-Maker™ 1 Expanded
1 light relay controller with gauges and metering

The controller cabinet contains the engine control components: Relay Control Board, Governor Controller, Cycle Cranking Board, K20 relay, AC terminal strip, Hourmeter, 10 Amp fuse, and the Start \ Stop Switch.

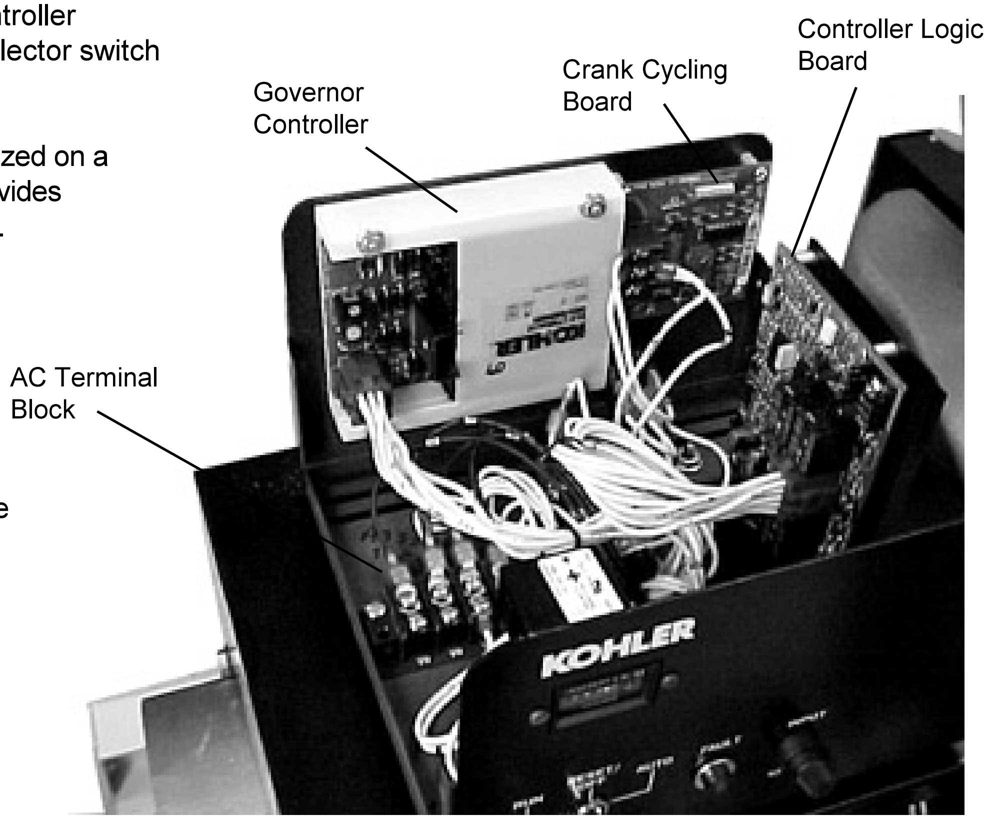


The 10 Amp F1 fuses provide protection of the control circuits supplied by the 12 volt starting battery.

The relay controller with meters have 3 additional 1.5 Amp 250 volt fuses labeled V7, V8, and V9. These fuses provide protection to the AC circuit in the controller including the voltage selector switch and meters.

The hour meter is energized on a start \ run signal and provides a recorded total run time. The meter has polarized terminals (+ -).

The single fault light illuminates on all engine faults, OC, OS, HWT, LOP, LWL, and must be reset at the generator controller by moving the Start \ Stop switch to the OFF \ RESET position.



CONTROL BOARD

The main control board contains relays for starting and stopping the Generator set.

The board features a timer to provide 30 seconds of total engine cranking time and terminates cranking if a successful run signal is received.

A circuit is also provided which after an engine start, allows a 5 second delay prior to sensing the Oil Pressure and Engine Temperature condition. This is to allow time for the engine to stabilize and build up oil pressure.

The control circuit provides starter motor reengagement protection when the engine is running via input signals of generated AC as well as shaft rotation.

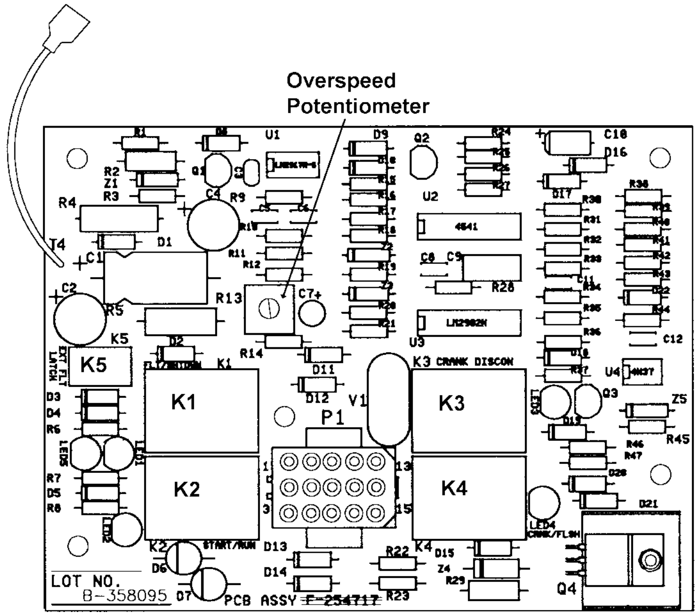
An engine overspeed circuit is provided and factory set to shut down the generator set if engine speed exceeds 4320 RPM (72 Hz).

Five relays are mounted to the board for control of Engine Cranking (K4), Cranking Disconnect (K3), Start / Run (K2), Fault Shut Down (Kl) and Remote Latch (K5).

LED's are connected across the relay coils for visual operational analysis.

Placing the switch to the OFF/ RESET position after a normal run will shut down the engine and deenergize all control relays. If the engine is shut down due to a fault the K2 and K5 relays will remain energized until the selector switch is placed in the OFF position.

The RUN LATCH feature is provided to prevent resetting the logic and restarting the engine from a remote location without first correcting the cause of failure. Lead T4 provides (K5) contact closure across the remote start leads to prevent remote restart after the unit shuts down on a fault, forcing the operator to reset the fault at the generator, (K5) closes on a fault and opens on a reset.



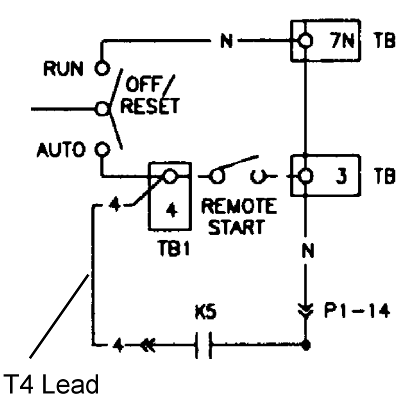
K1- Energized on fault, OC, OS, HWT, LOP, LWL

K2- energized in run or crank mode

K3- Energized on crank disconnect

K4- Energized when cranking

K5- Energized on fault (remote latch)

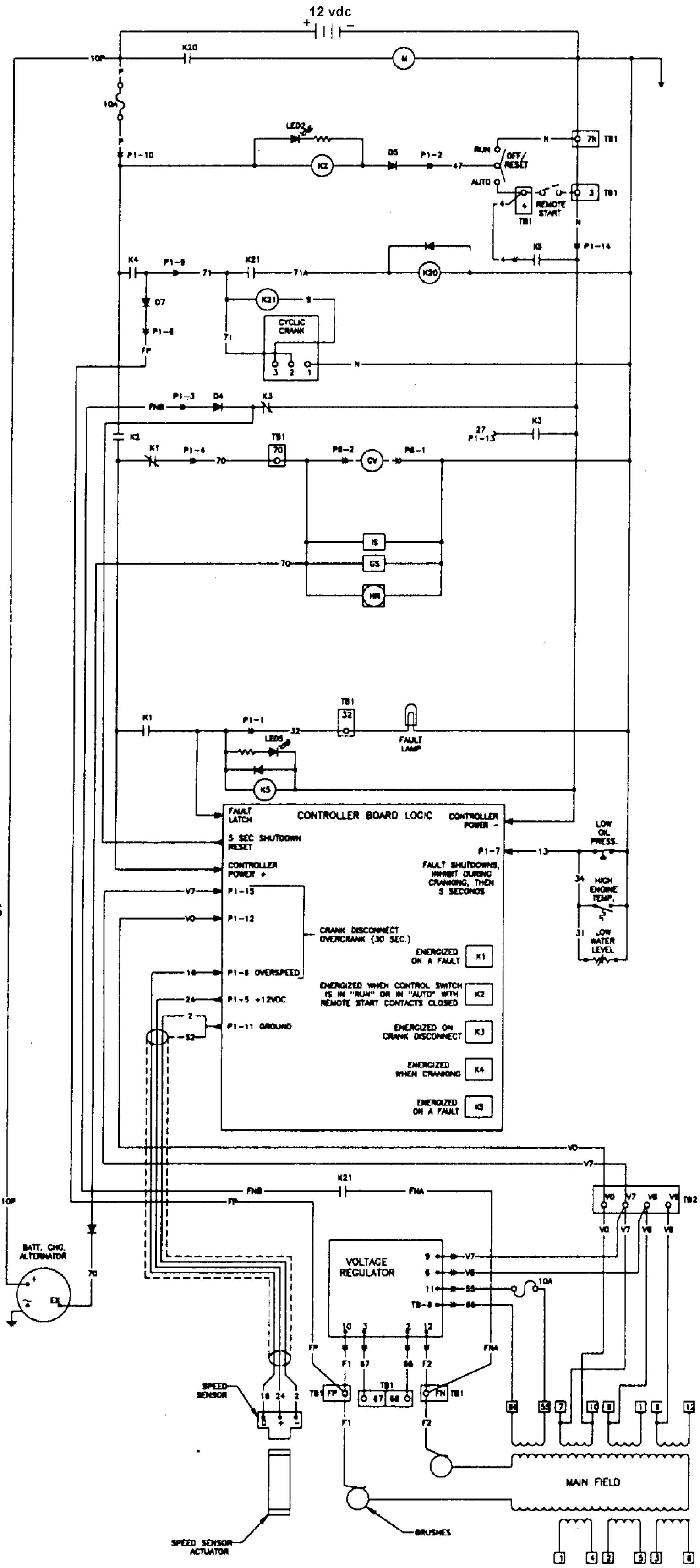


Sequence of Operation

The schematic diagram shown is for the residential (17-22KW) generator using the B-358095 single fault relay board.

Starting the generator:

- Close Start/Stop switch, a path between wire #47 and #N is made. (local or remote)
- K2 is energized (LED 2 lights)
- Normally open K2 contacts close to energize board (control power input). Also power flows through normally closed K1 contact energizing wire #70 which powers GV (gas valve), IS (Ignition System), GS (Governor System), and HR (Hourmeter).
- With control power to the Board the K4 picks up (K4 LED lights), Normally open K4 contact closes energizing the cyclic cranking relay. Also energizes wire FP (+) connection for flashing the field.
- During the "on" crank cycle K21 is energized closing K21 contact energizing the K20 relay.
- Normally open K20 relay contact closes energizing the starter motor (M).
- K21 contact closes (-) connection to flash the field.



LEGEND

CB – CIRCUIT BREAKER
ECS – ENGINE CONTROL SWITCH
F(#) – FUSE
GV – GAS VALVE
HET – HIGH ENGINE TEMPERATURE SWITCH
HM – HOUR METER
K1 – STARTER RELAY
K5 – IGNITION RELAY
K21 – CYCLIC CRANK RELAY
K25 – CONTROL POWER RELAY
LOP – LOW OIL PRESSURE SWITCH
O/RS – OFF/RESET SWITCH
SM – STARTER MOTOR
SS – STARTER SOLENOID
SSPK – SMART SPARK MODULE
STM – STEPPER MOTOR
TB1 – INTERCONNECT TERMINAL BLOCK
TB2 – A.C. TERMINAL BLOCK

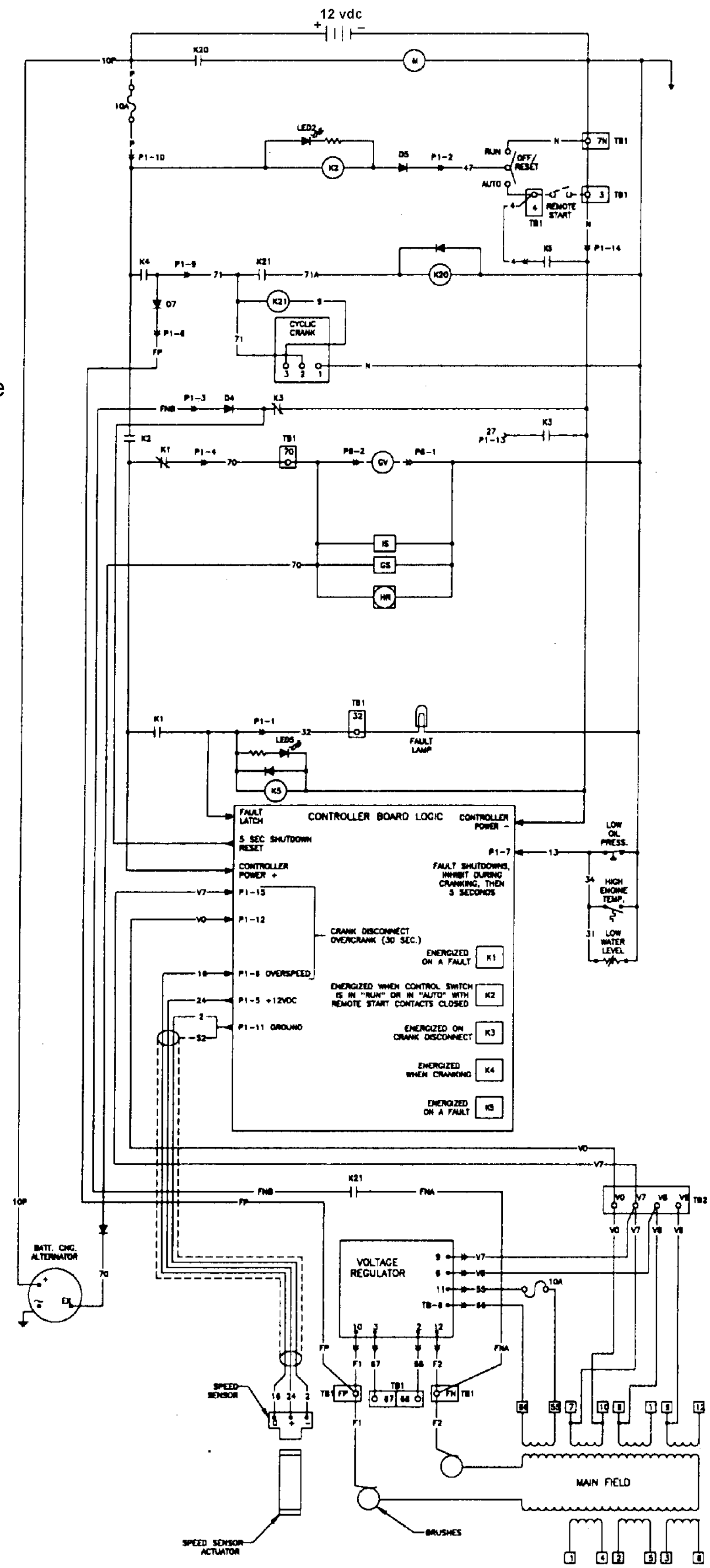
Running

- When the speed sensor senses 1100RPM the relay board logic energizes K3 relay (LED 3 lights) should the speed sensor fail the board senses voltage inputs V7 and V0, as a means for a secondary crank disconnect.
- K3 relay normally closed contact opens disconnecting the K4 crank relay. (internal logic on board)
- K4 contact opens removing power to the crank circuit and (+) circuit for the field flashing circuit.
- K21 contact opens to remove (-) circuit for the field flashing.

Shutting Down on Fault

Overcrank
- If generator fails to start after 30 seconds the logic board will go into an overcrank condition and energize K1 relay (LED 1 lights)
- K5 is energized (LED 5 lights)
- K1 normally closed contact opens removing power to wire #70.
- K5 normally open contact closes holding a ground to the remote start lead wire #4.
- K1 normally open contact closes illuminating fault light.

Overspeed
- If generator exceeds 72Hz (sensed by speed sensor) the logic board will go into an overspeed condition and energize K1 relay (LED 1 lights)
- K5 is energized (LED 5 lights)
- K1 normally closed contact opens removing power to wire #70.
- K5 normally open contact closes holding a ground to the remote start lead wire #4.
- K1 normally open contact closes illuminating fault light.



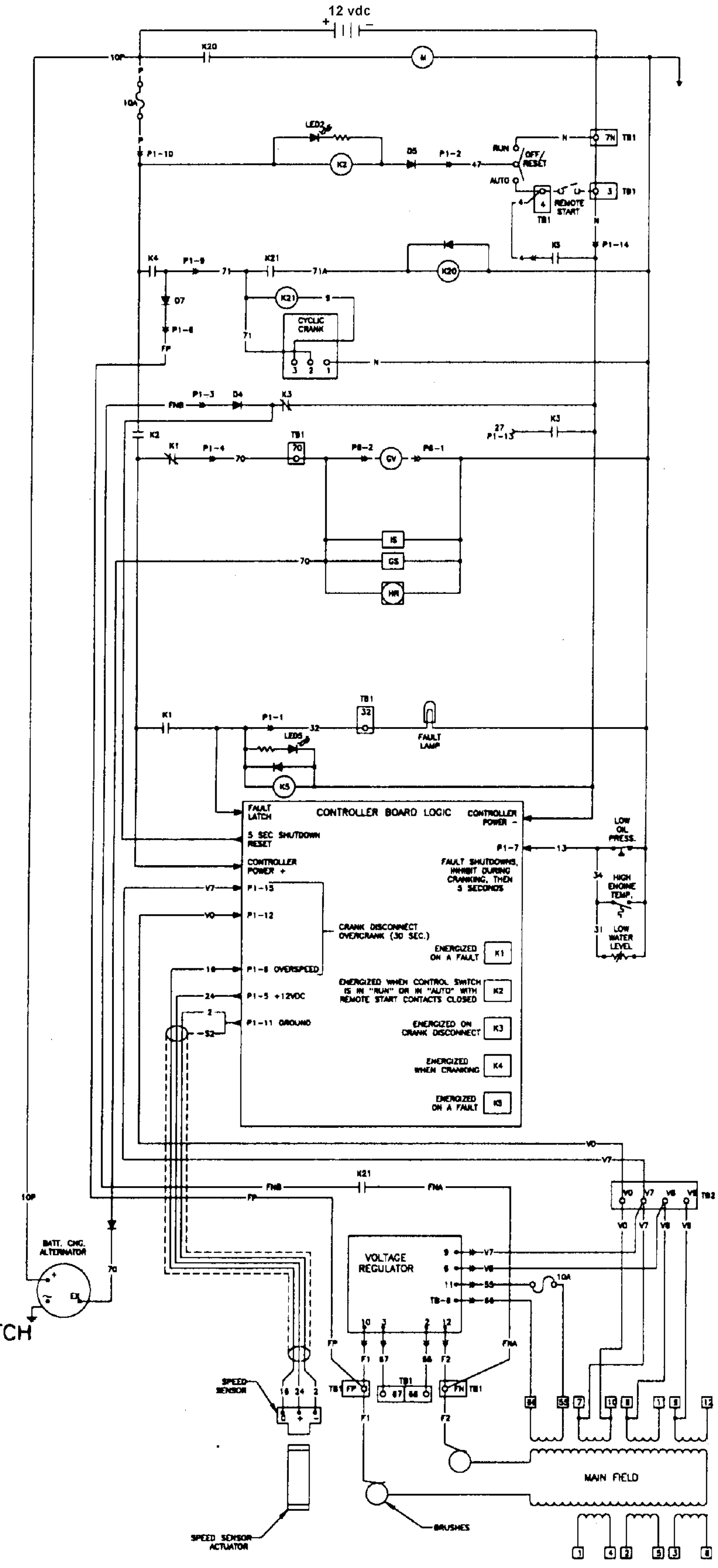
Engine Faults

Engine faults LOP, HWT, and LWL

- Engine faults are inhibited during crank .
- After initial crank and start, if any engine fault switch closes to "ground" for 5 seconds the relay logic board energizes the K1 relay (LED 1 lights).
- K5 is energized (LED 5 lights)
- K1 normally closed contact opens removing power to wire #70.
- K5 normally open contact closes holding a ground to the remote start lead wire #4.
- K1 normally open contact closes illuminating fault light.

Stopping the Generator

- Move Start/Stop Switch to the OFF/ RESET position, removing path from wire #47 to "ground".
- K2 relay is deenergized
- K2 contact opens removing power to wire #70 and removing "control power" to the relay board.

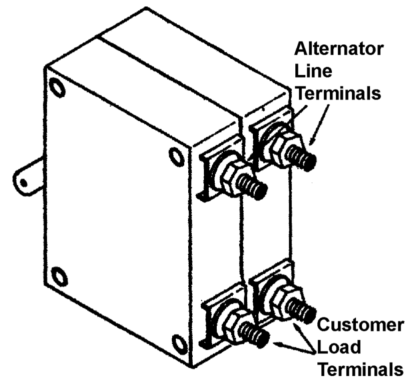


LEGEND

CB – CIRCUIT BREAKER
ECS – ENGINE CONTROL SWITCH
F(#) – FUSE
GV – GAS VALVE
HET – HIGH ENGINE TEMPERATURE SWITCH
HM – HOUR METER
K1 – STARTER RELAY
K5 – IGNITION RELAY
K21 – CYCLIC CRANK RELAY
K25 – CONTROL POWER RELAY
LOP – LOW OIL PRESSURE SWITCH
O/RS – OFF/RESET SWITCH
SM – STARTER MOTOR
SS – STARTER SOLENOID
SSPK – SMART SPARK MODULE
STM – STEPPER MOTOR
TB1 – INTERCONNECT TERMINAL BLOCK
TB2 – A.C. TERMINAL BLOCK

Controller/Junction Box

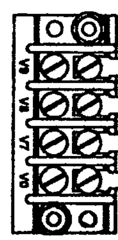
The **CIRCUIT BREAKER** is a two or three-pole device with trip elements in each pole and is used as a circuit disconnect between the load and alternator. Moving the toggle will open or close all poles. An over current fault exceeding the trip rating of the breaker will also trip all poles. Current and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



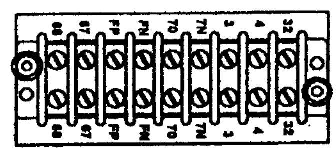
The **TB2** terminal strip provides terminating points (V7 - VO) for the 120vac sensing to the control circuit board. Voltage present at these terminals indicates the unit is running and output voltage is being generated. TB2 terminations vary depending on style controller, the controller using meters will have additional termination points for CT connections.

The **TBI** terminals provide connections for the REMOTE START (3 - 4), FIELD FLASH (FP FN) and DC SUPPLY (70 - 7N) to supply the Electric Governor, Gas valve and Ignition.

TB2



TB1

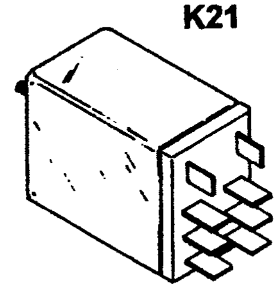


The **CYCLIC CRANKING** board is an adjustable ON / OFF timer. It is energized on a crank signal from the control board.

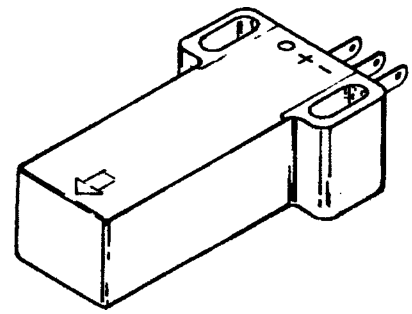
The contacts of the **K21** relay provide the control circuit to the **K20** engine cranking slave relay coil.

The K21 relay is energized during the “ON” cycle and deenergized during the “OFF” cycle.

K21

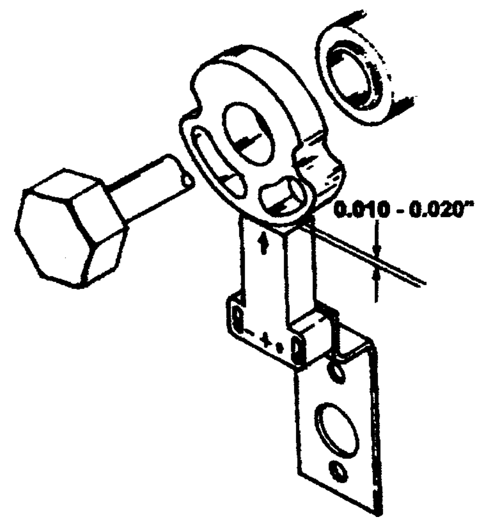


SPEED SENSOR
(Proximity Sensor)



The Speed Sensor provides the Main Control board with digital information on the rotating status of the generator set.

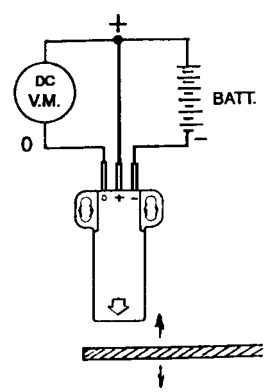
Input voltage to the sensor (+/-) is battery potential (12vdc). During engine cranking and running a pulsed voltage signal (+/o) is sent to the relay control board each time the proximity sensor comes into contact with the ferrous metal speed actuator. The controller board circuitry takes this information and provides overcrank and overspeed protection to the genset.

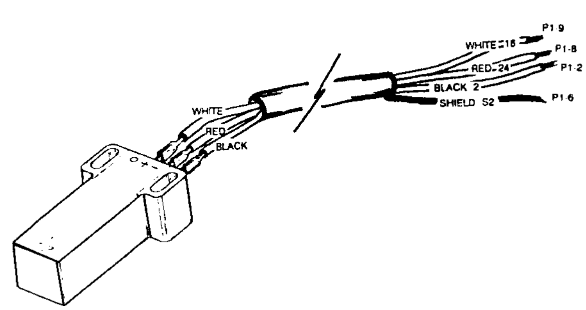


The sensor is located on the end bracket and mounted so an air gap of 0.010 - 0.020 in. is between the sensor and actuator. The actuator is mounted to the rotor shaft with the thrubolt.

A shielded harness is required between the sensor and the controller. Connections to the controller are made through the P2 connector at the rear of the controller.

The device can be bench checked by applying 12vdc to the input (+/-) and observing an output (+/o) when the internal circuit is triggered by placing a piece of steel or iron in close proximity to the sensing surface.





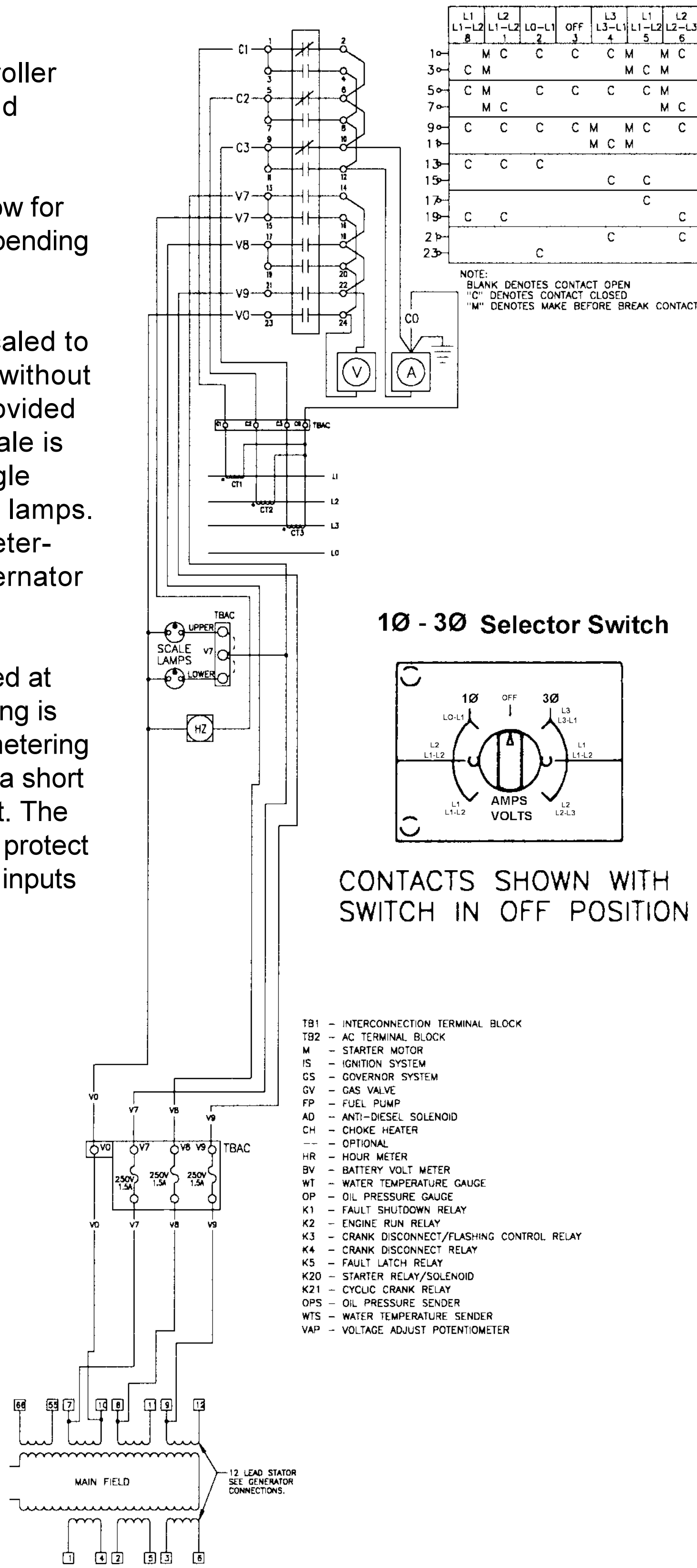
Metering

The DecisionMaker™ 1 Expanded controller includes metering for voltage, amps, and frequency.

A meter selector switch is provided to allow for single phase or three phase metering depending on the alternator voltage configuration.

The voltmeter and ammeter are dual scaled to allow for reconnection of the alternator without replacing the meters. Two lights are provided (UPPER, LOWER) to indicate which scale is read. A jumper on TBAC is used to toggle between the upper and lower indicating lamps. Refer to the reconnection diagram to determine correct jumper location for the alternator voltage configuration.

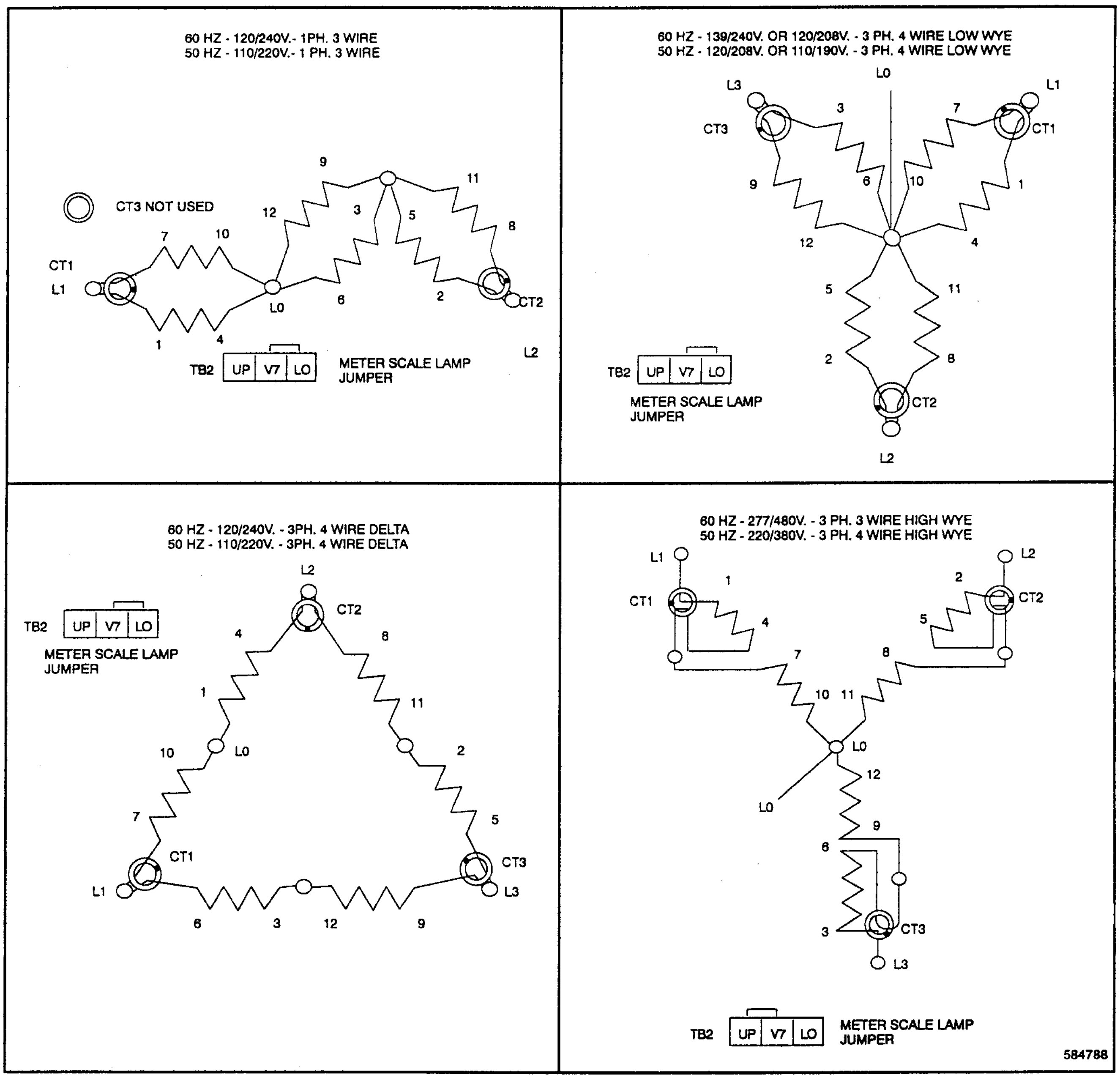
AC voltage leads V7, V8, and V9 are fused at TBAC using 250 volt 1.5A fuses. The fusing is provided to allow for isolation of the AC metering from the voltage regulation circuit should a short circuit or fault occur in the metering circuit. The fusing protects the metering but does not protect sensing inputs to the voltage regulator or inputs V7, V0 into the relay control board.

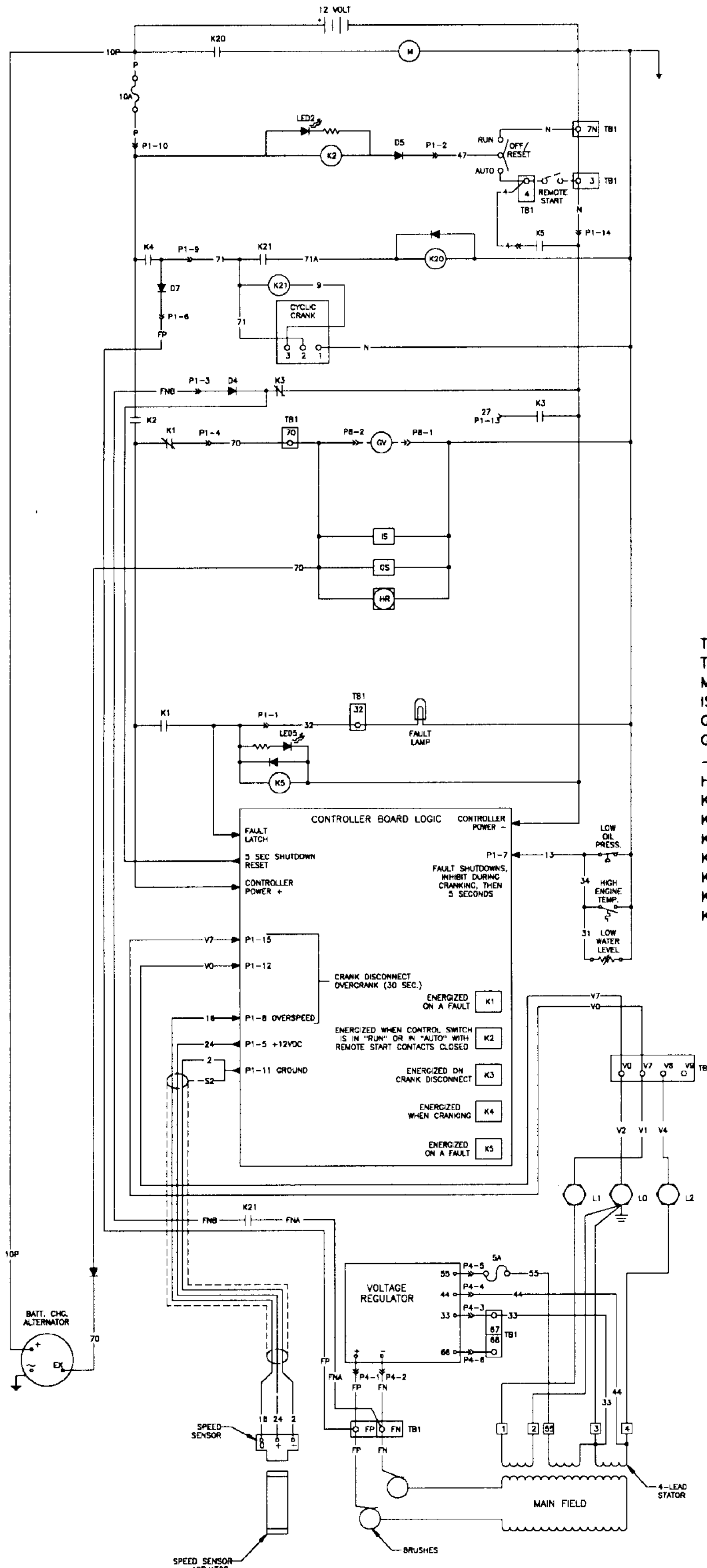


Current Transformer

Current transformers are used only on generators equipped with controllers with metering.

Current transformers allow the use of low amperage (5A) meter movement for ammeters when monitoring high AC amperage flow. When an AC load-carrying conductor is placed through the core of a CT a proportional current will be induced in the secondary winding surrounding the core. Transformers are matched by the ratio between their primary and secondary and are matched to the full scale of the ammeter for the controller. For example a current transformer with a ratio of 100:5 is matched to a 0-100 full-scale ammeter. A current flow of 100 amps through the primary of the CT will produce 5 amps of secondary current to the ammeter and indicate 100 amps (full scale).



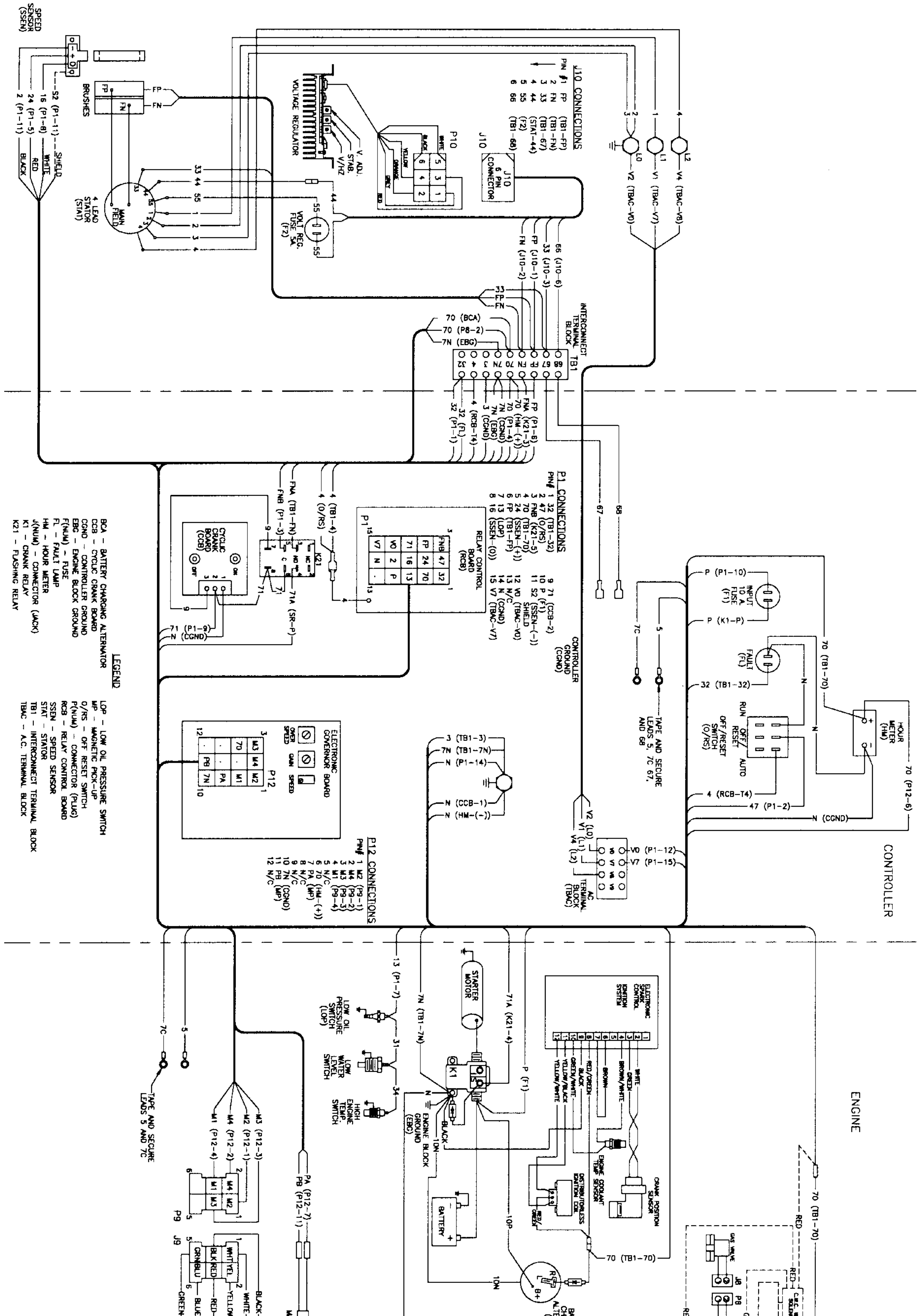


TB1 – INTERCONNECTION TERMINAL BLOCK
TB2 – AC TERMINAL BLOCK
M – STARTER MOTOR
IS – IGNITION SYSTEM
GS – GOVERNOR SYSTEM
GV – GAS VALVE
-- – OPTIONAL
HR – HOUR METER
K1 – FAULT SHUTDOWN RELAY
K2 – ENGINE RUN RELAY
K3 – CRANK DISCONNECT/FLASHING CONTROL RELAY
K4 – CRANK DISCONNECT RELAY
K5 – FAULT LATCH RELAY
K20 – STARTER RELAY/SOLENOID
K21 – CYCLIC CRANK RELAY

Decision-Maker™ 1
PowerBoost™ IIIE

Understanding The Schematic

1. What symptoms will you see if the K20 relay “opens” electrically?
2. If the LOP contact remains closed after the generator starts what will happen?
3. What symptoms will you see if the 10 Amp control fuse opens.
4. If the stator winding #55 is open what symptoms will be seen?
5. What is the purpose of wires V7, V0 into the controller relay board?
6. When is the K2 relay energized?
7. What two contacts must close before the hour meter is energized?
8. When is wire #71 energized?
9. When is wire #70 energized?
10. What is the function of the K5 relay
11. What are the safety shutdowns for this application?
12. What are the two functions of the speed sensor?


CONTROLLER
ENGINE
J10 CONNECTIONS
P1 CONNECTIONS
P12 CONNECTIONS
LEGEND

Controller

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 where it terminates.

Reading the Diagram

1. What is the plug number of the controller relay board?

2. Looking at the P1 plug on the relay board, where does wire #FNB terminate? List the starting and ending point.

3. Where on the generator is the voltage regulator mounted?

4. Looking at the #44 wire on the stator, where does this wire terminate?

5. What is the fuse rating of the input to the voltage regulator?

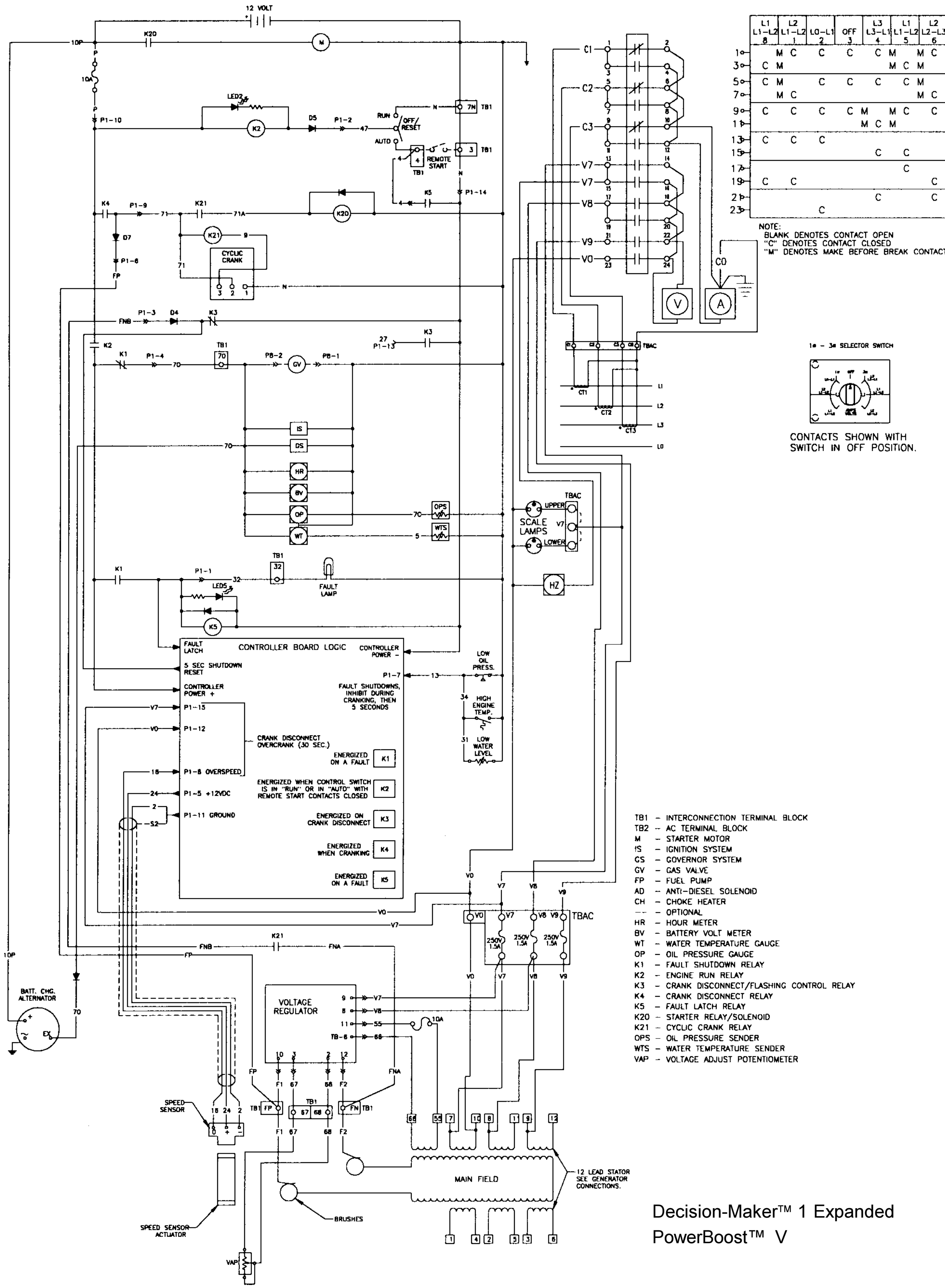
6. What is the fuse rating of the input into the controller?

7. At what plug and pin location does the positive 12 vdc enter the relay board? Is this a fused input? What pin location does "ground" enter the board?

8. What is the wire numbers of all safety shutdowns? At what plug and pin number does this wire enter the relay board?

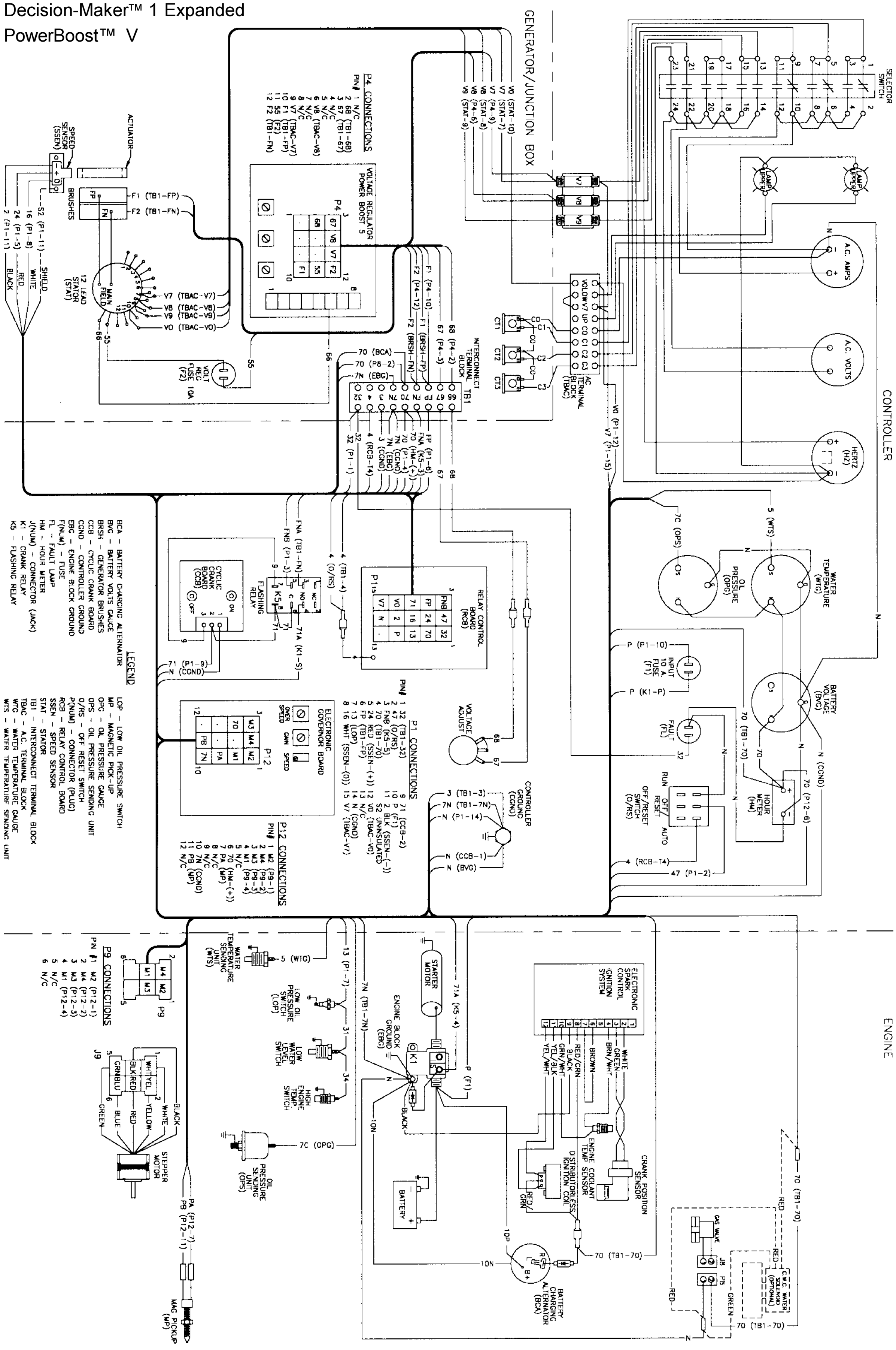
9. Control power for the Electronic Spark Control Module enters at what terminal point?

10. Interconnect for remote start leads are terminated at what terminal strip and on what terminal points?



Decision-Maker™ 1 Expanded
PowerBoost™ V

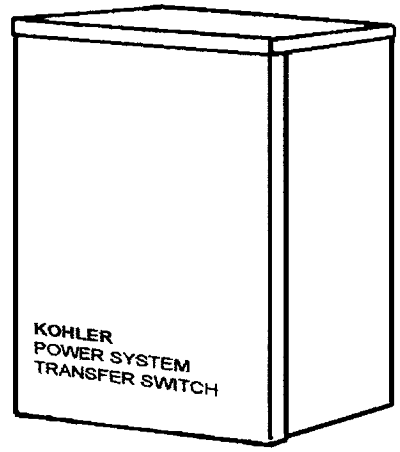
Decision-Maker™ 1 Expanded
PowerBoost™ V



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.

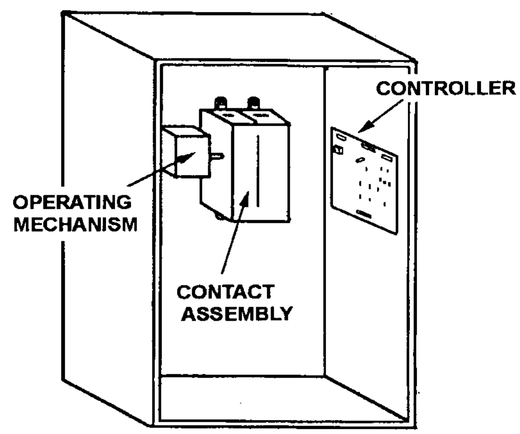


An Automatic Transfer Switch (ATS) consists of three major components.

1. Stationary and movable heavy duty **contact assemblies**

2. An **operating mechanism** for the moveable contacts.

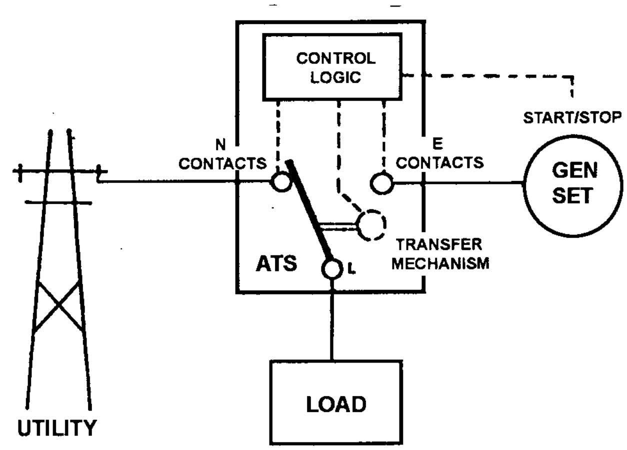
3. A **controller** to monitor the system and provide signals for engine start and contact transfer.



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.

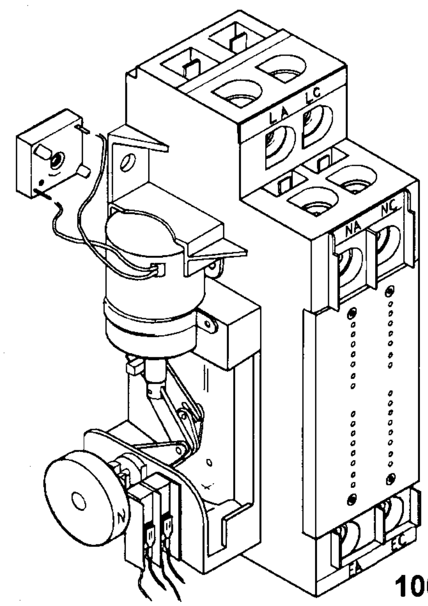


Contactor

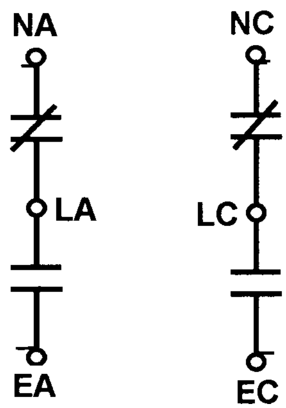
The 2-pole, **G120 Series** contactor is available for 100 and 200 amp Standby Systems.

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. Three phase contactors and other voltage ratings are also available.

Normal or utility Power connections are made to terminals NA and NC. Generator or Emergency Power is connected to terminals EA and EC and the Load is connected to Terminals LA and LC. Push-on tab terminals are provided at each of these terminals for controller voltage sensing and the transfer operator coil TS supply.

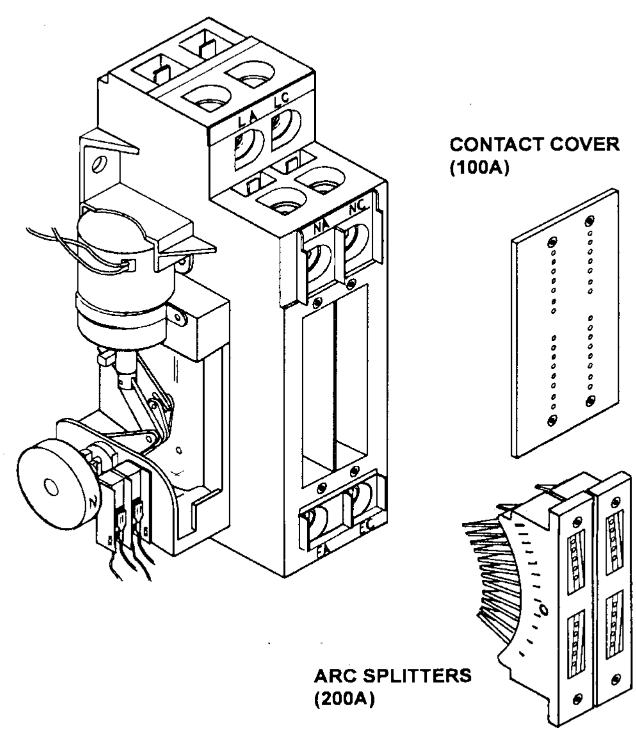


100 A CONTACTOR



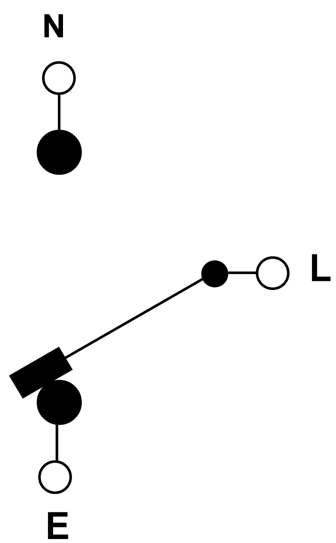
Due to the higher current interruption require-ments, arc splitters are use on the 200 amp contactors.

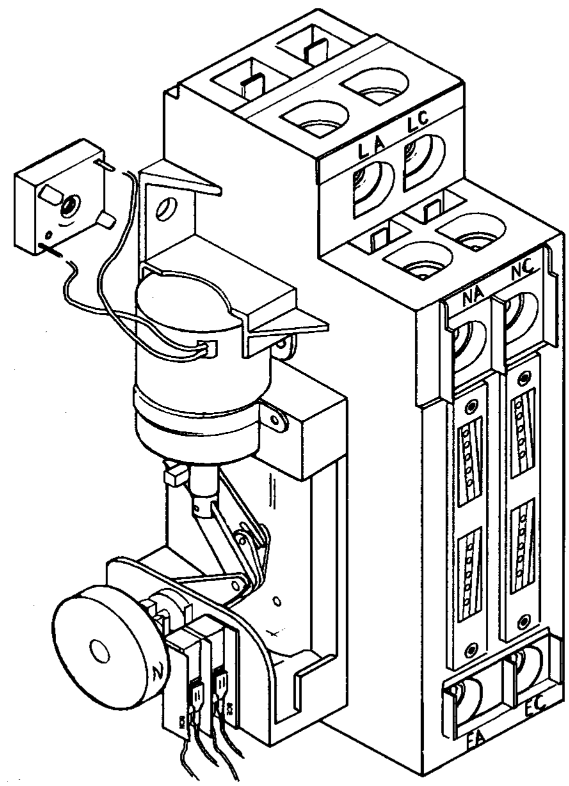
The arc splitters insure any arcing which is present when contacts open under load will be extinguished before the contacts close to the other source.



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.



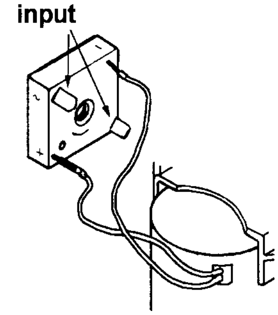


200 A
CONTACTOR

An electric solenoid operates the linkage to flip the moveable contact between the power sources. A complete transfer occurs within 50 milliseconds.

The solenoid is powered by 240V rectified line voltage from the source to which the load will be transferred. (Normal or Emergency)

Coil resistance of the 240v solenoid is 28.8 ohms ± 5% and can be measured at the + and – terminals of the BR bridge rectifier assembly.

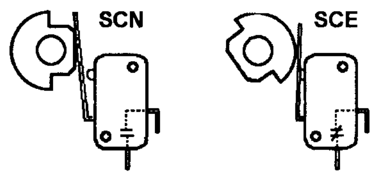


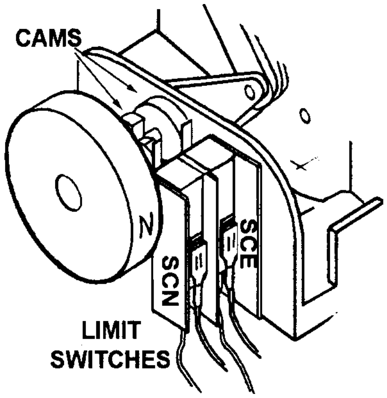
A full wave bridge assembly rectifies the AC line voltage to DC. Input is to terminals labeled AC. There is no polarity preference of the solenoid to the + and - rectifier output terminals.

The DC Voltage to the solenoid coil is supplied only momentarily. The circuit is disrupted by cam actuated limit switches prior to full travel of the solenoid plunger. Flywheel inertia completes the transfer.

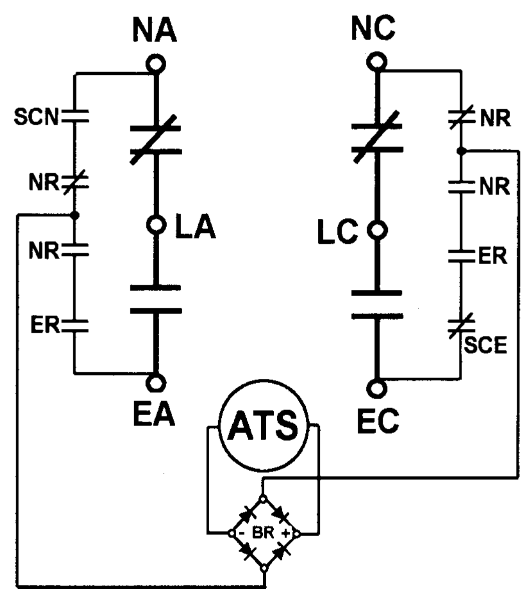
Contactor

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





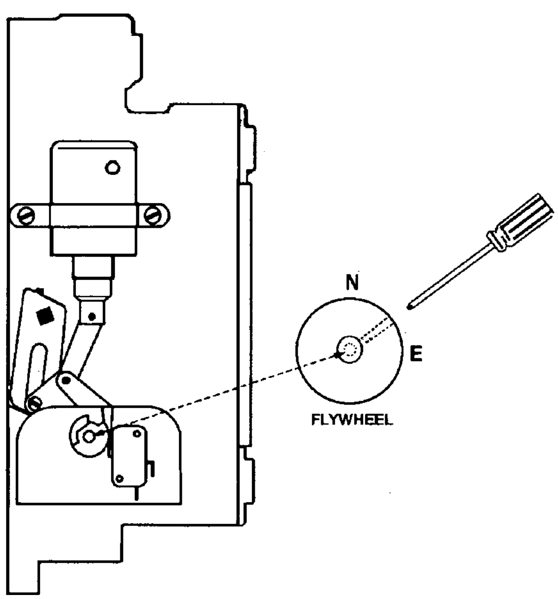
The limit switch assemblies are factory set and non-adjustable. They are wired in series with control relay contacts NR and ER.



Switch in Normal position with Normal source available.

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 inserting a #2 Phillips screw driver or similar tool in the hole provided in the flywheel and rotating the shaft. *



ILLUSTRATED IN THE EMERGENCY POSITION

*

ELECTRICAL POWER MUST BE DISCONNECTED FROM THE CONTACTOR WHEN MANUALLY TRANSFERRING

The position to which the Load contacts are connected (N or E) are stamped in the flywheel and visible from the front .

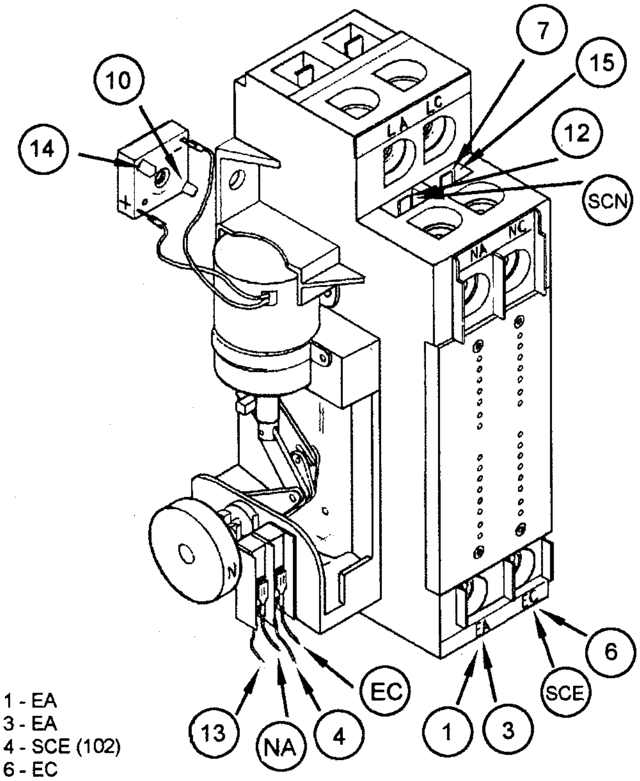
Harness

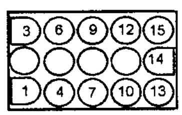
The contactor assembly is interconnected to the controller by a harness and plug connector.

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 .

Pin 9 is used to sense B phase of the Normal source in 3 phase applications and therefore not terminated on the 2 pole contactor.

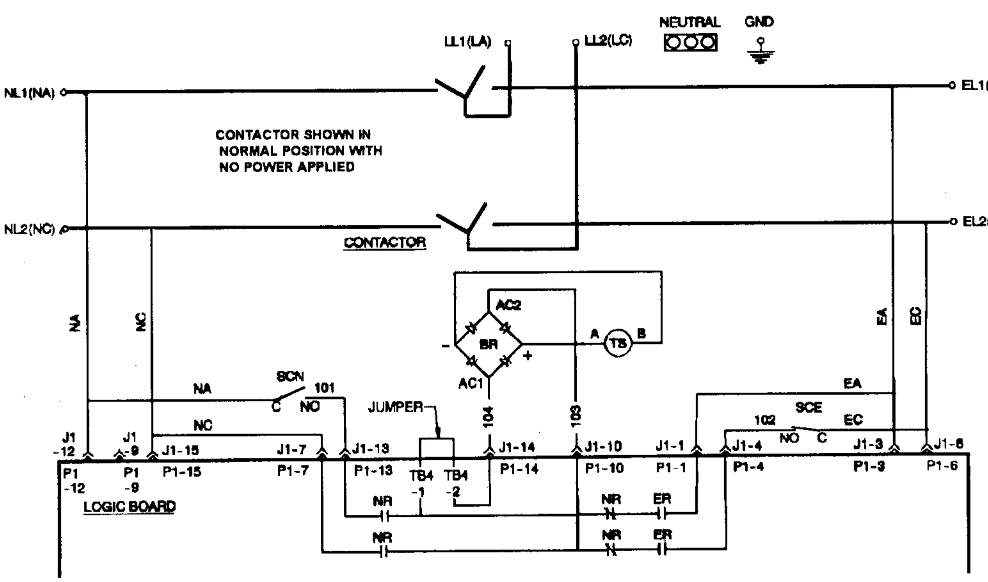
Use caution when testing for voltage or continuity between plug pins. **Any voltage present on the normal or emergency contacts is also present at the connector pins.**





J1

1 - EA
3 - EA
4 - SCE (102)
6 - EC
7 - NC
9 - NB (NOT USED)
10 - BR (103)
12 - NA
13 - SCN (101)
14 - BR (104)
15 - NC



LEGEND

BR	BRIDGE RECTIFIER
ER	EMERGENCY RELAY
NR	NORMAL RELAY
SCE	EMERGENCY COIL CLEARING LIMIT SWITCH
SCN	NORMAL COIL CLEARING LIMIT SWITCH
TS	TRANSFER SOLENOID
J1/P1	JACK AND PLUG CONNECTOR
NA / NC	NORMAL SOURCE A&C PHASE
EA / EC	EMERGENCY SOURCE A & C PHASE
LA / LC	LOAD A & C CONNECTION.

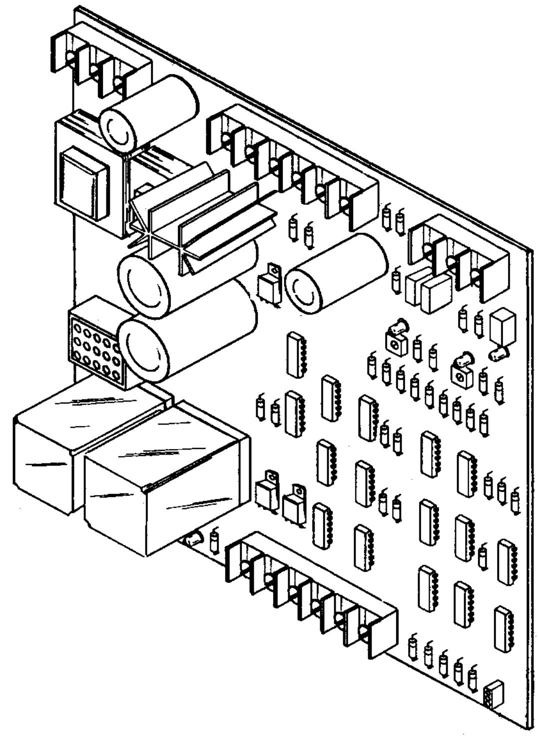
G120 Controller

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 managable 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 160vac drop-out and 190vac 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 190vac A transfer to the Emergency source will be initiated.

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

TDES:
3 second time delay on engine start.

This feature prevents nuisence 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 attemped 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.

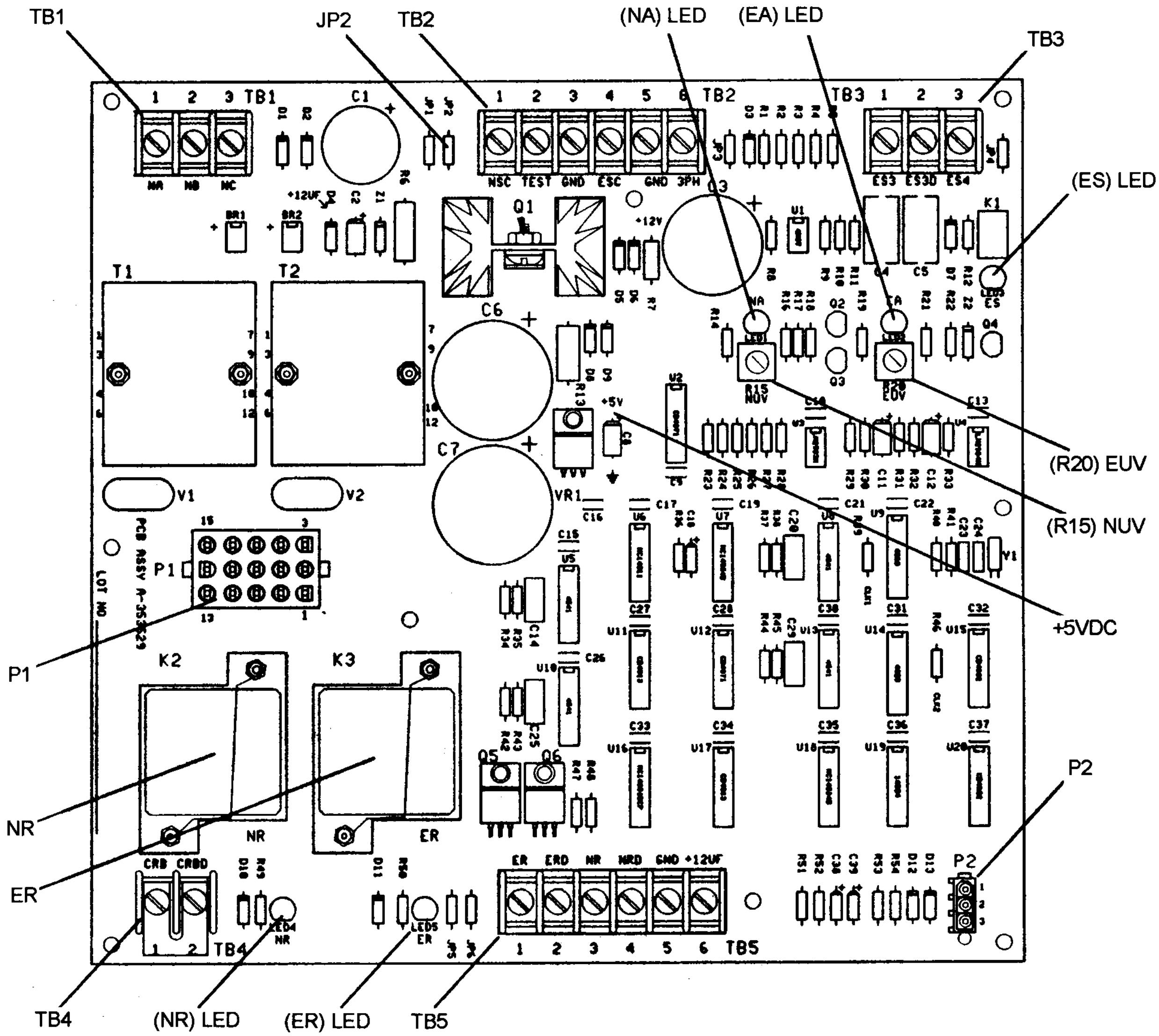
When Normal power returns to the Pick-up voltage (190vac) a delay of 12 seconds will commence before allowing a transfer back to the Normal Source. This is to allow the Utility power to stabilized. If Normal power fails within this timing period, timing will be terminated and reset.

TDEC:
2 minute time delay for Engine cooldown.

On a succeesful retransfer back to the Utility the generator 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.



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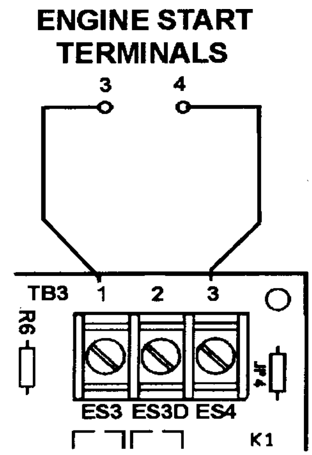
Circuit Board

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.

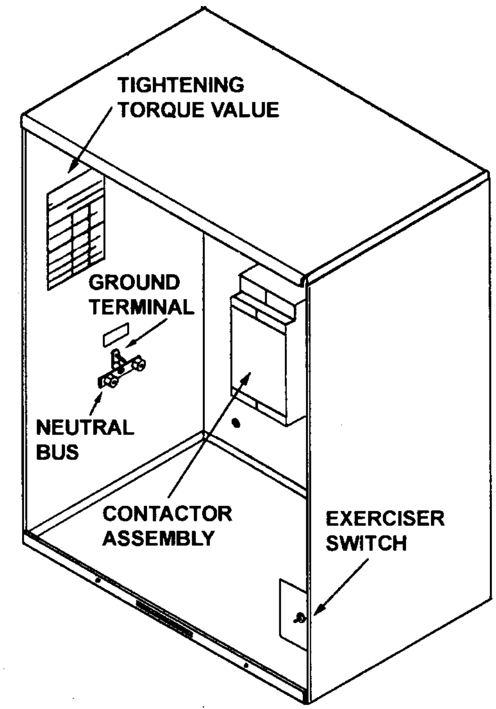
TB2
Test switch option terminals.

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.

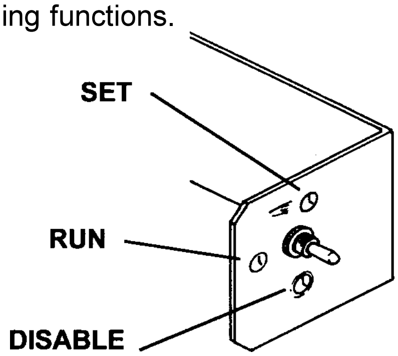


Engine Exerciser Feature

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.

<u>The day and time of day that the feature was set will be the day and time the exercise will occur each week</u> 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 positiion when released from setting. This is the normal position when the weekly exercise option is selected.

DISABLE

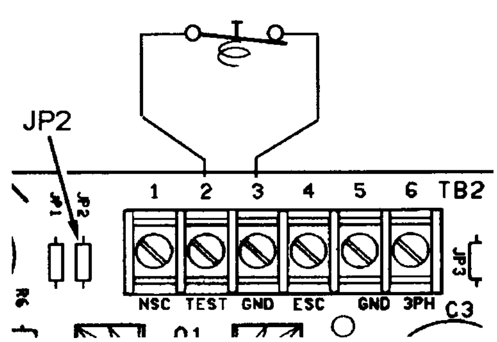
If the exercise option is not desired it can be turned off when left in this position. The disable positiion effects the exercise option only. It has no effect on transfer switch operation.

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

<u>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</u>.

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.

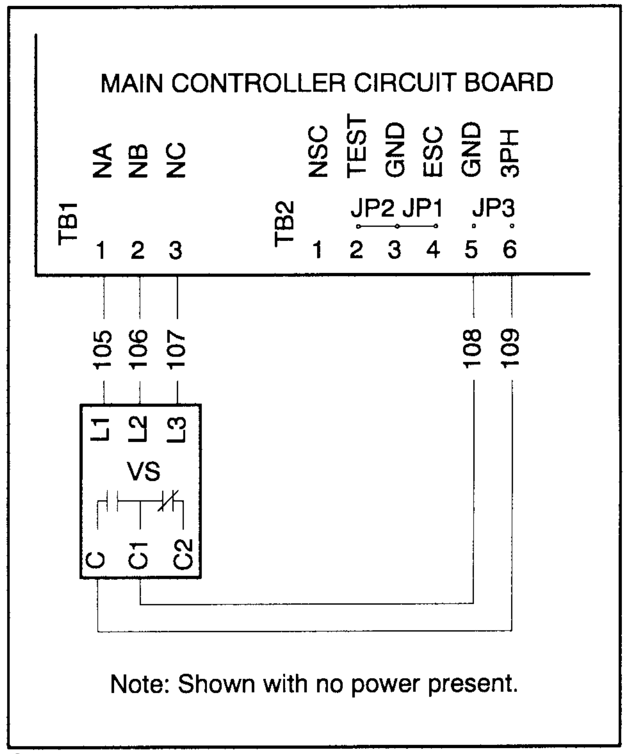


Voltage Sensing (Normal Source)

The main circuit board monitors A-C of the normal power source. The normal available LED lights on the main controller when normal power is acceptable. On single-phase switches the jumper JP3 connects terminals GND and 3PH on the main controller circuit board. The controller considers normal source unacceptable when voltage on phase A-C is below 160vac and acceptable when phase A-C is above 190vac.

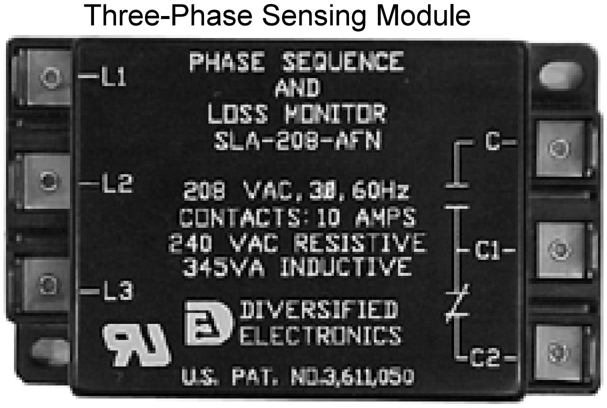
On three-phase switches a contact on a three-phase module (VS) is connected across terminals 3PH and GRD, and jumper JP3 is taken out. When the contact is closed single phase sensing determines source acceptability. When the contact is open, the controller considers the normal source to have failed.

The three-phase module considers all three phases for source acceptability and opens the contact when the voltage on any phase drops below the three-phase dropout specification. Also if the phase sequence is not A-B-C the contact will remain open and the normal source will be unacceptable. The modules contact will not close until the sequence is A-B-C and the voltage is above the pick-up point on all three phases.



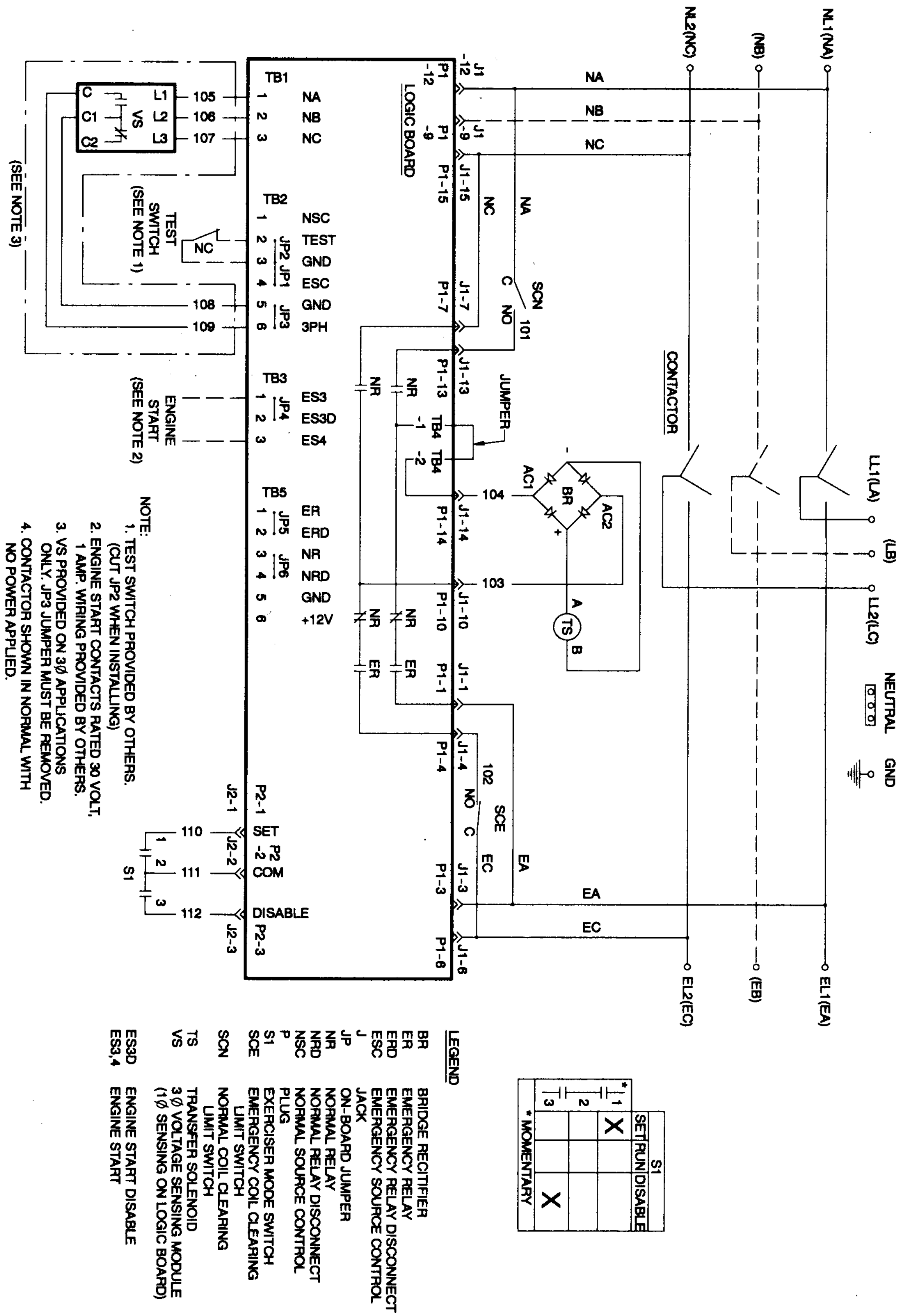
Cut JP3 when using three-phase voltage sensing module.

Three-Phase Sensing Module



Operating Specifications

Operating Voltage	Drop Out Voltage
208	187
220	198
240	216



NL1(NA)
(NB)
NL2(NC)
EL1(EA)
(EB)
EL2(EC)
LL1(LA)
(LB)
LL2(LC)
NEUTRAL
GND
CONTACTOR
LOGIC BOARD
TB1 1 NA 2 NB 3 NC
TB2 1 NSC 2 TEST 3 GND 4 ESC 5 GND 6 3PH
TB3 1 ES3 2 ES3D 3 ES4
TB5 1 ER 2 ERD 3 NR 4 NRD 5 GND 6 +12V
SET
COM
DISABLE
TEST SWITCH (SEE NOTE 1)
ENGINE START (SEE NOTE 2)
(SEE NOTE 3)
JUMPER
SCN
SCE
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. VS PROVIDED ON 3Ø APPLICATIONS ONLY. JP3 JUMPER MUST BE REMOVED.
4. CONTACTOR SHOWN IN NORMAL WITH NO POWER APPLIED.
S1
SET RUN DISABLE
* MOMENTARY
LEGEND
BR BRIDGE RECTIFIER
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
S1 EXERCISER MODE SWITCH
SCE EMERGENCY COIL CLEARING LIMIT SWITCH
SCN NORMAL COIL CLEARING LIMIT SWITCH
TS TRANSFER SOLENOID
VS 3Ø VOLTAGE SENSING MODULE (1Ø SENSING ON LOGIC BOARD)
ES3D ENGINE START DISABLE
ES3,4 ENGINE START