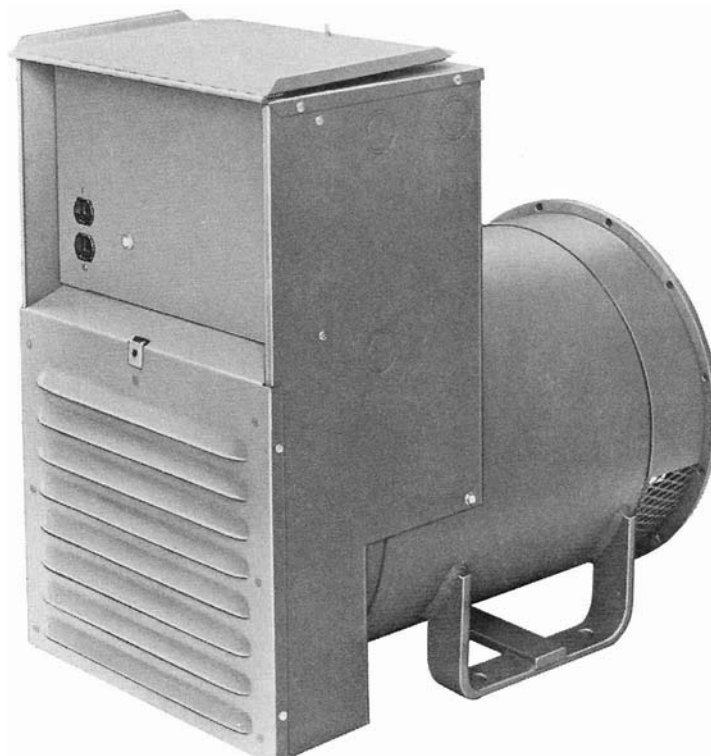


# INTERNALLY REGULATED GENERATORS

## SERVICE INFORMATION, ASSEMBLY and OPERATING INSTRUCTIONS



**Attention:** Read all instructions in this manual before attempting to install, operate, or service your generator. This manual covers all internally regulated generators.

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## **Testing Policy**

Before any generator is shipped from the factory, it is fully checked for performance. The generator is loaded to its full capacity, and the voltage, current, and frequency are carefully checked. A test card with this data is filed by unit serial number for permanent record of performance.

Rated output of generators is based on factory tests of typical units, and is subject to, and limited by, the temperature, altitude, fuel, and other conditions specified by the manufacturer of the applicable engines.

<b>NOTE:</b> This instruction book covers only the generator, <b>not</b> the engine. See the engine manufacturer's operator's manual regarding any problems pertaining to the engine.
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## General Information

### Description and Features

All models meet CSA, IEEE and NEMA standards and have Class F insulation. Rotors are wet wound with fungus proof thixotropic single component epoxy and then assembled and baked for permanent rattle-free performance. All units are dynamically balanced during manufacture. Each generator is equipped with an outboard mounted Lundell Type exciter, which can be disassembled in a single piece to greatly simplify servicing. The exciter armature is also easily removable, fully exposing the heavy-duty rotor bearing.

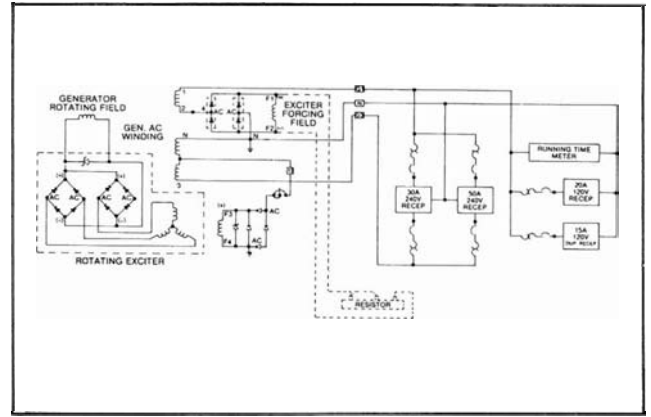
All ITR generators are dripproof and come with an end mounted, weather protected control box having knockouts on both sides. The top and vertical front panels are easy to remove and allow complete access to generator for testing, or maintenance. The recessed control panel is available blank or can be ordered with a variety of instrumentation.

### Principles of Operation

Unlike the conventional or rotating armature generator which picks the output voltage from the armature slip rings through brushes, the brushless, rotating field generator's output voltage is produced in the stationary windings.

The brushless rotating field generator consists of a stator, rotor, rectifier assembly, and an exciter generator. The exciter generator consists of a stationary field coil of the Lundell type and rotating armature which produces the AC excitation voltage. The voltage is rectified in the rotating rectifier assembly. The rectified voltage is applied to the rotor field windings to produce an electromagnetic field. When this rotating electromagnetic field cuts the stationary windings (stator) current is produced. The input current to the stationary exciter field coil is controlled internally by a solid state shelf assembly. The sensing voltage for this regulation is taken from the generator stator windings.

Although this manual covers all internally regulated (ITR) generators, there are some differences between models. This difference is in the exciter field circuitry. Some models have a compound forcing excitation winding for improved motor-starting capabilities, and some have an adjustable load compensating resistor in the forcing field. The electrical circuitry that maintains the exciter control winding and the exciter compound forcing field is on the shelf assembly located in the control box (Refer to typical schematic).



### Safety Information

**CAUTION:** Possible damage to equipment

**CAUTION**

Caution notes indicate any condition or practice, which if not strictly observed or remedied, could result in damage or destruction of the equipment.

**WARNING:** Personal danger



Warning notes indicate any condition or practice, which if not strictly observed, could result in personal injury or possible loss of life.

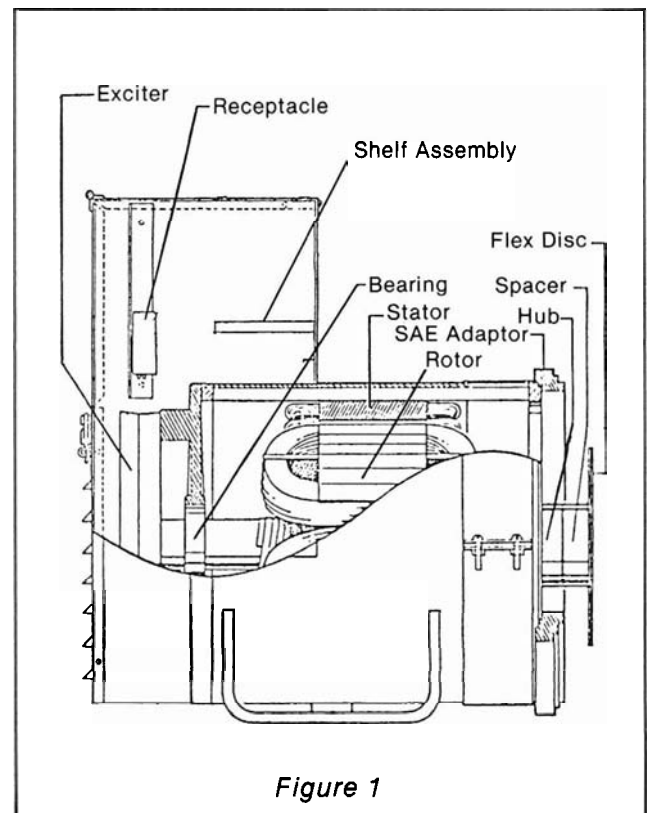


Figure 1

## General Safety

1. Avoid contact with live terminals or receptacles.
2. Use extreme caution if operating this unit in rain or snow.
3. Do not make or break receptacle connections under load.
4. Use only grounded receptacles and extension cords.
5. Properly ground the engine-generator set.
6. All drive systems should be provided with safety guards.
7. Keep all guards and shields in place and securely fastened.
8. Provide adequate ventilation and ducting of exhaust gas.
9. Wear hearing protection as needed.
10. Remove oily rags and any other material that may create a fire hazard.



Despite the safe design of this generator, operating it imprudently, neglecting its maintenance, or being careless with it can cause serious injury or death. This generator is powerful enough to deliver a fatal electric shock. Allow only a responsible and capable person to operate this generator.

## Unpacking and Inspection

Before accepting shipment from the transportation company, carefully inspect the crating to determine if any damage has occurred during transit. If damage is noted, have the representative of the transportation company write the nature of the damage on the freight bill so that a claim may be filed later if necessary.

Unpack the unit and lift it from the crating by the eyebolt provided. Carefully inspect the generator externally for any obvious damage which could have occurred in transit. If damage is noted, contact the transportation company immediately and give complete and accurate details of the nature of the damage.

If the generator is to be stored for a period of the time before use, it should be replaced in the crating after inspection and stored in a clean, dry area. If high humidity conditions prevail, place desiccant bags inside the control box. Tag the unit to insure that desiccant bags are removed before use.

## Drive Requirements

The standard 60 Hertz generator is designed to operate in the 1800 RPM range. When determining the engine size, bear in mind that the power rating of the engine varies with its RPM and that it must maintain a nearly constant drive speed for the generator. Approximately 1.6 to 2.0 horsepower, based on engine rating and design, should be allowed for every 1000 watts of generator capacity.

Since all engines have a tendency to slow down when a load is applied, the governor on the engine

must be sensitive enough to hold the speed constant within 5%. Variations in speed affect not only the voltage level but also the frequency. Slight frequency variation has no appreciable effect on motors, lights and most appliances, but electronic equipment and clocks will be affected unless the generator is turning at exactly 1800 RPM.

## Preparation for Use

Although the generator has been carefully inspected and tested before leaving the factory, it is recommended that the unit be thoroughly inspected before use. Mechanical and electrical soundness of all terminal connections should be inspected and all bolts and fasteners checked for tightness. Remove all packing material, blocks and skids used to prevent vibration and movement during shipment.

## Assembly and Installation

### Hardware

A single bearing generator is ordered to match a particular SAE housing, flywheel size and offset, depending upon the type, size and brand of engine. The generator will come equipped with all necessary mating adaptors and drive discs to assemble the engine and generator into a single unit. However, certain small hardware, such as common bolts and washers, are not provided. All bolts should be at least SAE grade five and lock washers and/or locking compound must be used in all applications.

### Assembly Instructions

**NOTE:** Prior to assembly insure dimensions A, B, and G in Figure 2 are correctly matched.



All lifting equipment must be of sufficient capacity to handle the combined engine-generator weight. Never position hands, feet, etc. under suspended units. Do not use the generator lifting eye to handle the entire engine-generator set.

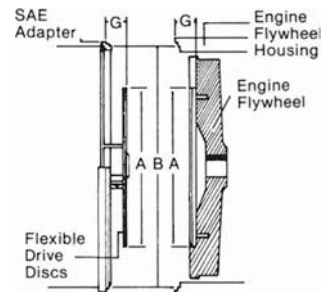


Figure 2  
SAE Adapter Sketch

It is suggested that assembly take place on a solidly supported surface. The following general assembly procedures may be used on most engine-generator combinations. Units may be assembled directly upon a trailer bed.

1. Loosen or remove the two retaining bolts and slide back or remove generator sheet metal impeller cover.
2. Rotate engine flywheel so that one flywheel bolt hole is in the 12 o'clock position.
3. Make a locating pin by cutting the head from a 1" long bolt of the correct size. Grind the shank to a slight taper and cut a slot in the end.
4. Thread the locating pin ¼" into the top flywheel bolt hole.

**CAUTION** To avoid rubbing the rotor against the stator on single bearing units, lift the drive end of the rotor when turning.

5. Rotate the generator drive disc and rotor so that one bolt hole is in the 12 o'clock position.
6. Using the locating pin as a guide, bring the engine and generator together.

**CAUTION** The rotor should be raised slightly for the drive discs to enter the inset in the flywheel. Exercise caution to avoid bending the drive discs.

7. Assemble the generator to the engine and the drive discs to the flywheel. Use new lock washers and/or thread locking compound and torque uniformly. Use SAE torque specifications for the SAE bolt grade and size used. On some applications it may be necessary to use a universal socket to tighten the flywheel bolts.
8. Bolt engine-generator set to base and shim as required to distribute the load evenly.

**CAUTION** Be sure to remove the locating pin and replace with a bolt and lockwasher.

## Preventive Maintenance

Timely preventive maintenance can keep costly repairs and generator down-time to a minimum. Compliance with the following list will insure long life for your generator.

1. Adequate cooling air is very important for long life and correct operation of the generator. Check regularly to insure that air intakes and vents are clear of any obstruction.
2. As a precaution against moisture and dust collecting in the generator and to keep the engine properly lubricated, the engine-generator set should be operated at least once a week. Engine-generator exercising may be required more frequently in areas of high humidity or blowing sand.
3. Check drive components and generator regularly for loose nuts, bolts and fasteners.
4. The bearings used are factory lubricated and double sealed and require no maintenance under normal conditions. Bearings should be checked if the generator is disassembled for other maintenance and should be replaced if worn.

## Trouble Shooting

As with any machine, trouble can develop in engine-generator sets and their associated control equipment. The following trouble shooting chart lists various symptoms of poor generator operation as well as possible causes and what corrective action can be taken. Engine-generator sets are under continuous vibration while running; therefore, it is advisable to check for loose wires or connectors whenever the generator control box is opened.

The following minimum test equipment should be on hand for field trouble shooting and maintenance. (See the section on test procedures when the problem area is pin-pointed.)

1. Volt-ohmmeter—20,000 ohms per volt
2. Frequency Meter—58 to 62 Hertz (cycles per second)
3. Clamp-on Ammeter—0 to 100 ampere range

The trouble shooting chart lists the following malfunctions and their possible causes and corrections.

1. No Output Voltage
2. Low Output Voltage
3. Low Output Voltage (Full load only)
4. High Output Voltage
5. Fluctuating Voltage
6. Generator Overheating
7. Generator Noise and Vibration

## Trouble Shooting Table

Symptom	Possible Cause	Correction
No output voltage	Load circuit breaker open	Reset/Replace
	Voltage adjust rheostat dirty	Rotate knob back and forth, then reset. Test/Replace
	Loss of initial exciter residual magnetism	Flash the exciter field
	Loose or shorted wires in control box	Check all wiring and repair as needed
	Defective rectifier	Carefully follow test procedure. Replace
	Shorted or open exciter field coil	Measure exciter field coil resistance for open or short. Replace
	Shorted or open exciter armature	Measure exciter armature resistance for open or short. Replace
	Shorted or open rotor	Measure rotor resistance for open or short. Replace
	Shorted or open stator	Measure stator resistance for open or short. Replace
Low output voltage	Engine speed too low	Check no load engine speed with a frequency meter and adjust governor to give 61.5 Hertz
	Generator overloaded	Calculate load being run and compare with name plate rating. With 3-phase generators, the load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg.
	Defective rotating rectifier	Carefully follow test procedure. Replace
	Defective rotor winding	Measure resistance between rotor leads and compare with the unit's Technical Data Sheet. Replace
	Defective stator winding	Measure resistance between stator leads and compare with the unit's Technical Data Sheet. Replace
Low output voltage (full load only)	Defective compound forcing field diodes	Replace defective diodes
	Defective compound field Broken or poor forcing circuit connections	Replace Exciter Repair
High output voltage	Engine speed too high	Check no load engine speed with a frequency meter and adjust governor to give 61.5 Hertz
Fluctuating voltage	Erratic engine speed	Refer to the engine manufacturer's maintenance manual
	Loose terminal or load connection	Make better mechanical and electrical connection
	Intermittent short in exciter field coil	Measure exciter field coil resistance for short. Replace
Generator overheating	Air vents obstructed	Clear obstruction
	Inadequate ventilation	Provide adequate compartment ventilation. Provide a fresh air inlet duct.
	High intake air temperature	Improve ventilation. Allow at least two feet clearance around generator.
	Generator overloaded or unbalanced	Calculate load being run and compare with name plate rating. With three-phase generators, the load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg.
	Shorted turns in either rotor or stator	Measure rotor and stator resistance for short. Replace
Generator noisy and/or vibrates	Loose sheetmetal	Check hold-down fasteners. Tighten
	Rotor or impeller rubbing	Repair or replace defective part
	Bearing defective	Replace bearing
	Rotor unbalanced	The rotor should have small balancing washers or bars attached at one or both ends. If these are missing, contact the factory.
	Drive engine unbalanced	Refer to the engine manufacturer's maintenance manual

## Testing Procedures

The following test procedures are outlined in sequence for trouble-shooting generator components in decreasing levels of reliability. If the trouble-shooting chart indicates a particular component, proceed to that portion of the test procedures. The control box cover and louvered front panel will have to be removed to conduct the tests. On some models the control panel will have to be removed. Component testing for all ITR generators is the same, except for models which do not have compound forcing fields or adjustable control fields. This difference will be spelled out in each test procedure. All tests should be made with a volt-ohmmeter.

**CAUTION** High Voltage test equipment should not be used.

To properly check out electronic components and generator wiring, they must be isolated from associated circuitry. Always mark leads for correct reconnection.

1. Rectifier Testing—The exciter control field and rotating field rectifiers are full wave bridge rectifiers. The exciter control rectifier is located on the shelf assembly, and the rotating field rectifiers (2) are located on the rotating rectifier assembly. This assembly is mounted on the end of the rotor shaft. Access to these rectifiers is accomplished by removing the three screws holding the cover. A full wave bridge rectifier has four terminals, two AC terminals, a DC positive (+) terminal, and a DC negative (–) terminal.

**NOTE:** Disconnect leads and mark for reconnection prior to testing. (See Fig. 3)

Set meter to ohms, RX1 scale. Put one meter lead on the positive (+) terminal and put the other lead to each of the AC terminals in turn. A high or low resistance should be obtained. If the meter reading is low to one AC terminal, the reading to the other should be low. Reverse the meter leads, and an opposite reading should be observed. Now check from the negative (–) terminal to each of the AC terminals, using the same procedures as above. Check each terminal to the case, and no resistance reading should be observed.

2. Surge Suppressors—All models have surge suppressors on the rotating rectifier assembly and some models also have a surge suppressor in the control field circuit mounted on the shelf assembly. When testing the surge suppressors, they must be isolated from associated circuitry. Set the meter to ohms RX10 scale. Connect a meter lead to each suppressor lead and observe the meter reading. Correct readings should be a

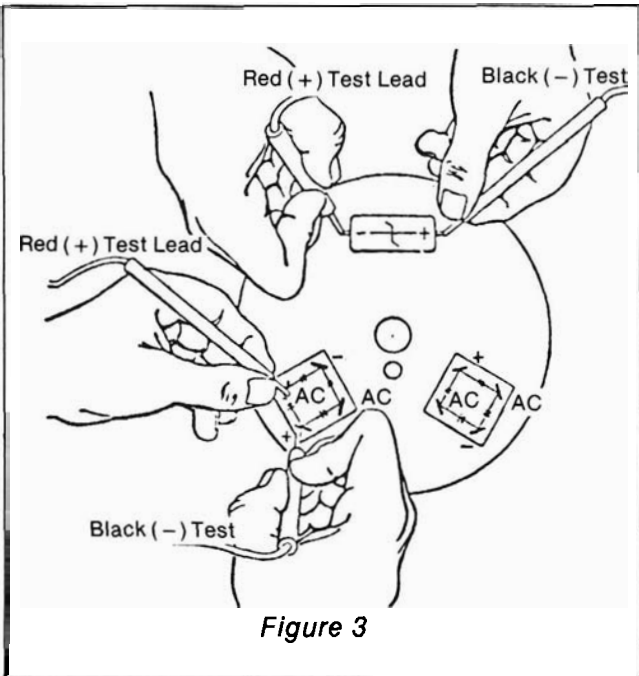
high resistance reading one way and infinity the other. (See Fig. 3)

3. Compound Forcing Field Diodes—There are two types of diodes used in the forcing field circuitry. One is a standard polarity and the other is a reverse polarity. To test, disconnect the diode lead to isolate the diode from other circuitry. Set the meter to ohms RX1 scale. Connect one meter to the diode terminal and the other to the base. The meter will indicate a low resistance or infinity. Reverse the meter leads and the reading should be opposite.
4. Control Exciter Field and Compound Forcing Field Coils—Some ITR model generators do not have a compound forcing field winding. These models have two exciter field leads marked F1(+) and F2(–). Models with compound forcing field windings have four leads, with the compound field coil leads marked F1(+) and F2(–), and the control exciter field leads marked F3(+) and F4(–). Both fields are checked for opens and shorts. Disconnect the positive and negative leads of the field being checked. Set the meter to ohms RX1 scale. Connect the meter leads to each coil lead, and the meter should indicate a resistance reading. (Resistance of compound field will read approximately zero on most ohmmeters.) Leave one meter lead connected to the coil lead, and connect the other meter lead to ground. The meter should indicate infinity. Test both fields in this manner. On models with adjustable control fields, test the rheostat for opens and full range continuity. Isolate the rheostat by disconnecting the rheostat lead wire at the shelf rectifier. Set meter to ohms, RX1 scale for this test.
5. Exciter Armature—The exciter armature is tested for opens and shorts. Disconnect the three armature leads from the rectifiers on the rotating rectifier assembly. Set the meter to ohms RX1 scale. Connect one meter lead to one of the armature leads and connect the other meter lead to each of the remaining leads in turn. The meter should indicate a very low resistance reading (less than one ohm). The meter should indicate infinity between each armature lead and the rotor shaft.
6. Rotating Field—The rotating field is tested for opens and shorts. The leads are connected at the surge suppressor terminal block on the rotating rectifier assembly. (See Fig. 3) Mark leads for correct reconnection. Set the meter to ohms RX1 scale. Connect meter leads to each rotor lead. Resistance should be between 2.5 and 5 ohms. Now connect one meter lead to a rotor lead and the other to the rotor shaft. The meter should indicate infinity.
7. Stator—To test the stator for opens and shorts the windings must be isolated. Refer to the schematic diagram for your model generator for stator lead wire identification. Disconnect the load leads from the terminal block. Disconnect all stator leads except those connected to the terminal block.

**CAUTION**

Mark all leads for correct reconnection.

Some leads may be ganged to test the individual stator coils (refer to schematic). Set the meter to ohms RX1 scale and check each coil or set of coils for continuity. Check each coil or set of coils for shorts to ground.



## Load Compensation Resistor

Some model ITR generators are equipped with adjustable resistors located on the shelf assembly. Refer to the schematic of your model generator for installation verification. The resistor is electrically connected in parallel with the compound forcing field. The function of the resistor is to adjust the output voltage to match the load, be it inductive or resistive. The resistor is factory set and will not need adjustment under normal conditions.



Do not make any adjustments while generator is in operation.

If while under load, the generator output voltage is low or connected motors are hard starting, shut down the generator and adjust the sliding contact to increase the resistance. If the generator output voltage under load is high, adjust the sliding contact to decrease resistance.

Re-check output voltage under load and readjust compensating resistor if necessary.



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