

# ST Series

## **Single-Phase AC Synchronous Generator**

Instructions for  
Operation and Maintenance

## *ST Series of Single-Phase AC Synchronous Generators*

### **Description**

The ST Series synchronous generators are designed to operate as a primary AC power source for standard electrical lighting, household electrical appliances, and general small-scale residential use. The range of power ratings available in this series of generators make them suitable for households, farms and ranches, and even small villages, as well as supplying electricity for marine applications.

These units employ harmonic excitation to allow them to provide self-excitation and relatively constant voltage operation without a separate voltage regulator. This simple system minimizes complexity and has proven quite reliable in operation.

ST Series Generators are designed for continuous duty operation within their power ratings. When driven at constant rotational speed they generate single-phase current at constant AC voltage and frequency. Internal connections may be changed to provide for 230 or 115Vacrms at either 50Hz or 60Hz. Conversion between nominal voltages and frequencies is a matter of changing contacts on a terminal strip inside the terminal box.

Generators may be coupled to the prime mover (driving engine) either by direct shaft-to-shaft coupling or by a flexible belt and sheaves or pulleys. The AC frequency of the output power is determined solely by the speed of rotation of the prime mover and the number of poles in the generator. Four pole generators must spin at 1500 RPM to generate 50Hz power, and 1800 RPM to generate 60 Hz power. Two pole generators must spin at 3000 RPM for 50Hz and 3600 RPM for 60Hz output frequency.

Please read these instructions completely and ensure that you understand them thoroughly before operating your ST series generator. This will allow you to operate your generator correctly and achieve the longest and most reliable service from your unit.

Specifications for the ST Series generators are shown in the following table. Please locate and become familiar with the specifications for your unit.

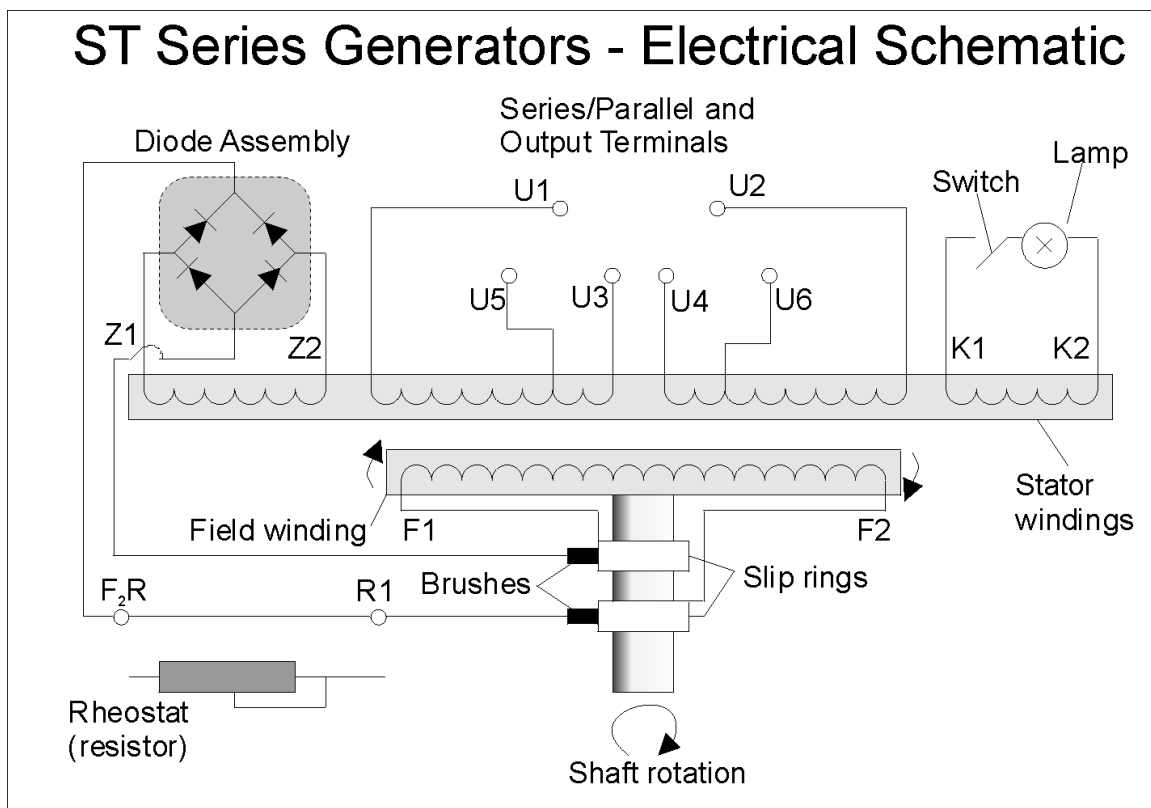
Frame No.	Output (KW)	Current (A)		Voltage (V)		# Poles	Power Factor
		Series	Parallel	Series	Parallel		
ST-1-2	1	4.35	8.7	230	115	2	1
ST-2-2	2	8.7	17.4	230	115	2	1
ST-3-2	3	13	26	230	115	2	1
ST-5-2	5	21.8	43.5	230	115	2	1
ST-2	2	8.7	17.4	230	115	4	1
ST-3	3	13	26	230	115	4	1
ST-5	5	21.8	43.5	230	115	4	1
ST-7.5	7.5	32.6	65.2	230	115	4	1
ST-10	10	43.5	87	230	115	4	1
ST-12	12	52.2	104	230	115	4	1
ST-15	15	65.3	130	230	115	4	1
ST-20	20	87	174	230	115	4	1
ST-24	24	100	200	240	120	4	1

## Construction

ST Series generators are “rotating field” types. In this type of generator, the output power comes from windings held fixed in position on the motor frame (the stator) while an electrically-generated magnetic field is rotated past the stator windings by turning the rotating assembly (the rotor). The rotor windings carry DC current obtained by rectifying a portion of the generator’s AC output. This “exciting current” is self-generated, and is used in a manner which causes the output voltage to be self-regulating to a large extent.

ST Series generator construction is intended to be drip-proof – that is, a few drops of liquid onto the generator should not immediately cause damage. However, like all electrical equipment, the generator should be protected from damp conditions, immersion in water, or water dripping onto the generator.

The frame and end covers are cast iron. The stator is built from high quality 0.5mm thick silicon steel laminations, wound with Class E temperature rated insulated wire. The rotor is wound with Class B temperature rated insulated wire. Overall, the generator carries a protective class rating of IP 21. Schematic and details of wiring are shown below.

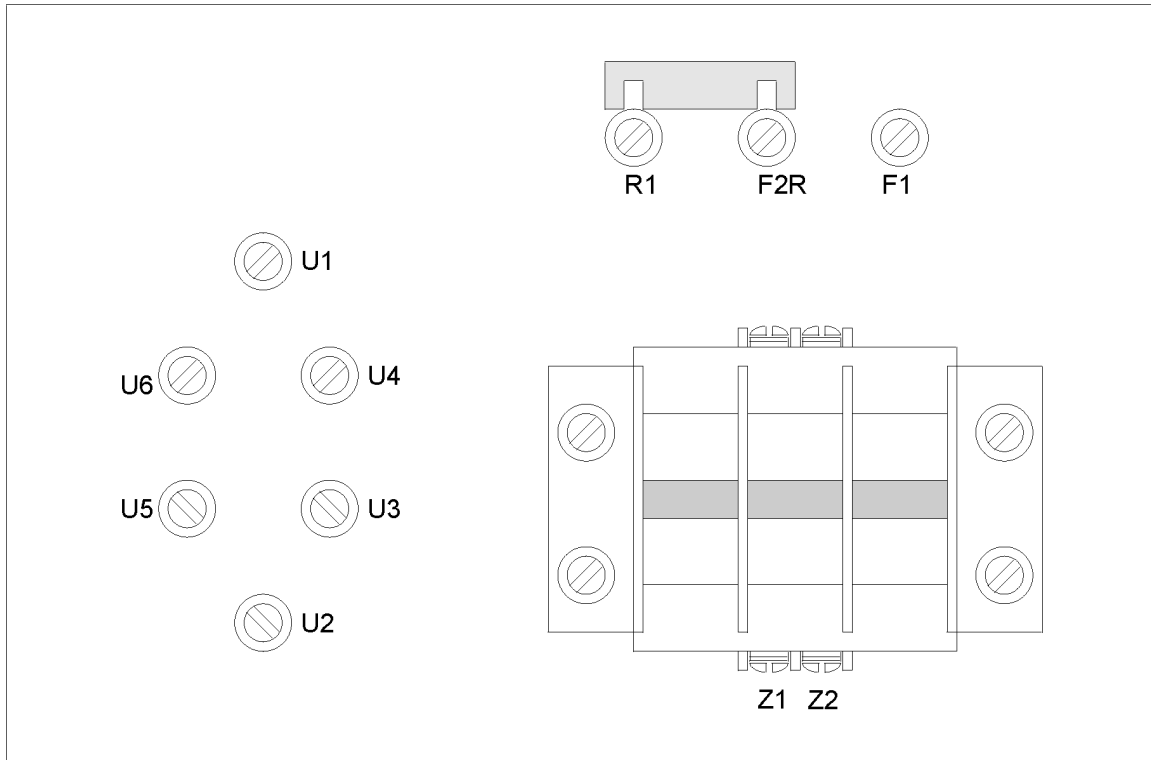


The output frequency of the generator is completely dependent on the rotational speed of the generator shaft. If accurate output frequency is needed, then some means must be provided to accurately govern the speed of the prime mover which drives the generator.

However, the output voltage is also dependent on the rotational speed of the prime mover (as well as the amount of current in the field windings). If very accurate frequency of the

output power is not necessary, as might be the case for incandescent lighting applications, it is possible to use the output voltage as an indicator of the proper rotational speed.

All that is necessary is to regulate the speed of the prime mover so that the voltmeter indicates the rated voltage. Since the output voltage depends partially on the prime mover's rotational speed, the output voltage provides a fairly accurate estimate of the rotational speed. The resulting frequency may not match commercial power line standards exactly, but the voltage will be correct and for applications such as incandescent lighting, correct voltage and close frequency is sufficient for use.



### Terminal Locations inside the terminal box

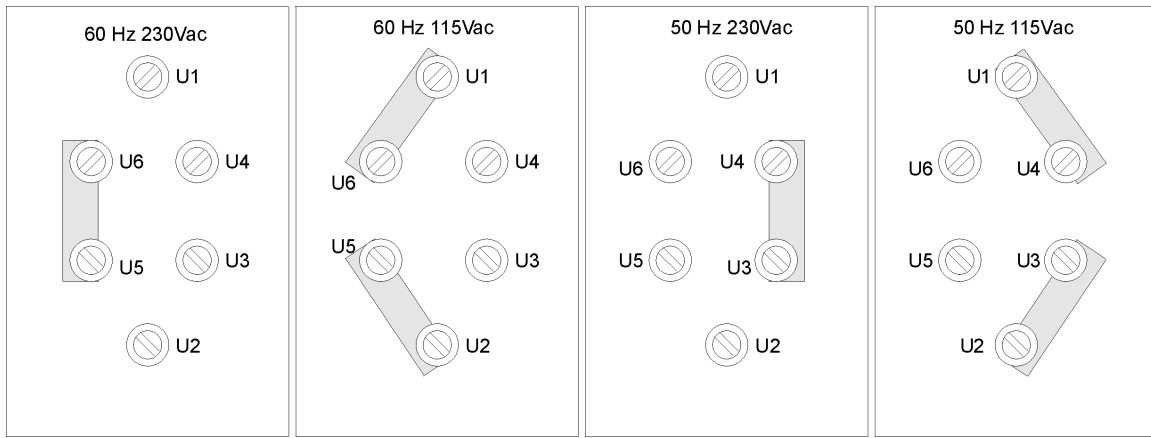
If an exact adjustment of voltage is needed, you must set both the rotational speed and the current through the field windings. Remove the short connection strip between terminals F2R and R1 in the terminal box, and connect a rheostat (variable power resistor) between these two points. Set the prime mover speed to the exact required speed by means of a tachometer on the prime mover or a frequency meter on the output power. (Either method works equally well as the output frequency is controlled only by the prime mover rotational speed.)

The output frequency will now be exactly 50Hz or 60Hz. Adjust the rheostat resistance to set the desired output voltage. Once the rheostat is adjusted in this manner with no load, it is generally unnecessary to readjust it for correct voltage under load. Rheostats should be rated for 10 ohms, 150W for ST1 through ST7.5 generators, and 5 ohm, 200W for ST10 through ST20 generators.

Suitable rheostats are available on separate special order at additional cost.

## Before Operating the Generator

Check to ensure that all the internal terminals are correctly connected for the desired output voltage and frequency, as shown in the wiring diagram below.



Connect output wiring to the output terminals U1 and U2 inside the terminal box of the generator. Pay particular attention to making sure that the wires connected to the generator output are of a heavy enough wire gauge to carry the output current rated output current.

Open the outer covering plate of the rear cover and inspect the brushes to ensure that the brushes are making good contact with the slip rings. If this is the first operation of the generator, the slip rings should be cleaned with fine emery cloth abrasive sheet.

Ensure that the wiring to the load is correctly installed, secure, and that switches and fuses or circuit breakers rated for carrying and interrupting the rated power output are in place.

Switches and/or circuit breakers capable of isolating all electrical loads should be correctly installed, and should be opened before starting the generator. Once the generator is up to speed and indicating the correct output voltage, the switches may be closed.

## Starting and Stopping

### Starting

- Start the prime mover operating and bring it up to the rated speed. When the rotational speed of the prime mover and generator near the rated speed, the generator will start generating voltage by the self-excitation circuit.
- Adjust the speed of the prime mover exactly if needed. Read the voltmeter on the unit. This should be at or near the rated value.
- After a short warm up time under no load, the generator voltage will drop slightly. This is a consequence of the changes that increased temperature cause in the self-excitation circuit. If needed, the voltage rheostat may be adjusted for a more precise output voltage after this initial warm up.
- Once the frequency and voltage are acceptably adjusted, turn on the output switch(es) to the load(s).

### Stopping

- a. Remove the load(s) from the output by opening the output switch(es).
- b. Stop the prime mover.

**Cautions:**

- a. Be very careful not to allow short circuits at the output of the generator. This can damage the rectifier diodes in the voltage regulating circuit.
- b. Before stopping the generator, remove all output electrical loading first before turning off the prime mover. If you turn off the prime mover while the generator is under load, the resulting spin-down and gradually reducing electric fields will erase the residual magnetism in the rotor that allows the generator to start self-excitation.
- c. If the residual magnetism in the rotor is too weak to start self-excitation, the rotor will need to be re-magnetized.

## **Problems and Troubleshooting**

First, verify that all internal and external connections are correct. Once this has been verified, if there is no voltage output then possible causes are:

### ***Loss of residual magnetism***

The rotor's residual magnetism, which enables self-excitation, may be lost over time if the generator is unused for a long time or suddenly if the generator's prime mover is turned off while the electrical load is still connected to the generator.

To re-magnetize the rotor, connect a 12V storage battery to the field winding while the generator is rotating. The positive (+) battery lead must be connected to terminal F1, the negative (-) battery lead must be connected to terminal F2. Do not connect the battery in the reverse direction.

### ***Rotational speed too slow***

Measure the rotating speed of the prime mover with a tachometer and adjust it.

### ***Open circuit or short circuit in the harmonic (self-excitation) winding***

Replace the winding.

### ***No DC output to the self excitation circuit (damaged rectifiers)***

Replace the rectifier assembly.

### ***Field winding is open or short circuited***

Replace field winding.

### ***Poor contact between the brush(es) and slip ring(s)***

Clean the slip rings with fine emery cloth, and inspect or replace brushes or springs to ensure good contact.

### ***Loose connection or poor contacts on the terminals***

Clean and tighten the connections.

# Maintenance and Repair

## ***General Maintenance***

- a. If the generator is to be stored, ensure that the storage place is dry and clean. If the generator is to be stored on earth or concrete floors, place a wooden base under it to prevent contact between the generator and floor. Cover the generator with a water repellent tarpaulin or other water resistant covering to prevent water and dust from entering the generator.
- b. Take steps to prevent water, dust, metal chips and shavings, and other foreign material from entering the generator.
- c. Do not cover the generator with cloth, wood, paper, etc. while operating. The generator should have free, unimpeded air circulation to allow it to dissipate normal internal heat build up. The generator may be damaged by heat build up if it is covered during operation.
- d. Do not overload the generator. Provide circuit breakers or other means to prevent this.
- e. During operation, check the generator periodically for unusual sounds and/or sparks from the brushes and slip rings. Stop the generator immediately if such sounds or sparks are noticed, and then inspect and repair the generator.
- f. Do not operate the generator in atmospheres that are very humid or dusty, or when there are combustible gasses in the area of the generator.
- g. Remove and replace the grease in the ball and roller bearings after every 1500 hours of operation, or at least once per year. The bearing housing should normally be filled to about half its volume with grease – do not fill it more than half full. Replace the grease only with a good grade of molybdenum disulfide lithium-based grease. The maximum permissible temperature of the ball and roller bearings is 95C (203F).

## ***Inspecting and Overhauling***

The generator should be inspected at intervals of no more than six months.

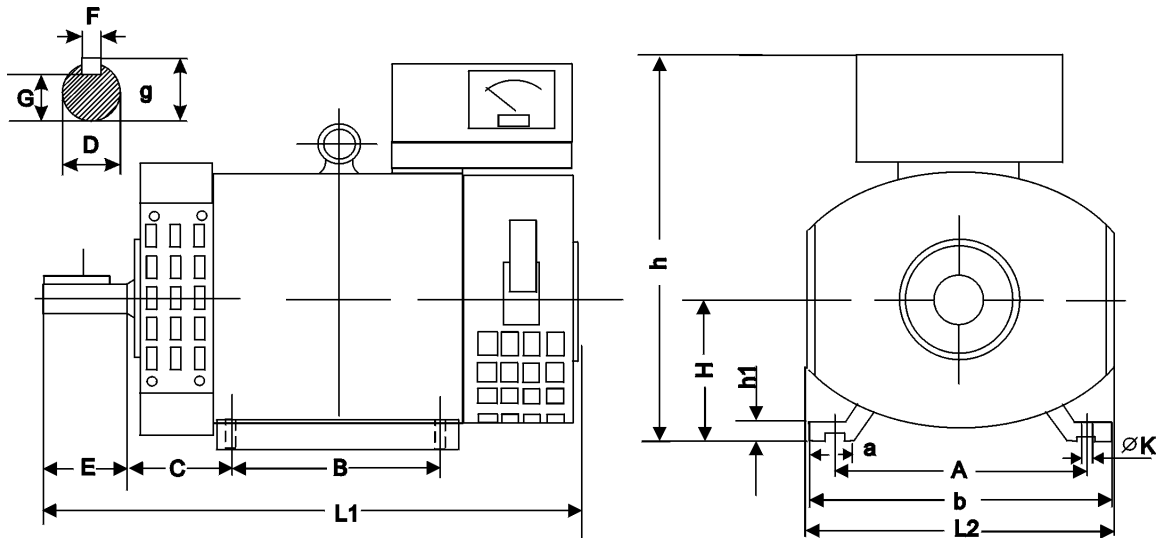
- a. Remove the window cover and clean out any dust that may have accumulated in the generator. The preferred method for this is to use compressed air at not more than  $0.4\text{kg/cm}^2$  (5.7 psi)
- b. Clean the slip rings. Wipe the rings clean with a piece of coarse cloth lightly moistened with kerosene. Do not use waste yarn or other fibrous material. Once the slip ring surfaces are clean, wipe them dry with a dry cloth.
- c. Inspect the bearings. Remove the outer covering of the bearing and determine whether the grease is at a sufficient level and clean. If the grease is dirty or contaminated, remove the old grease and replace with the correct level of fresh grease.
- d. Inspect the brushes and spring assemblies for wear and tear. Replace worn out brushes and springs with new ones.

## ***Necessary Precautions***

When inspecting and overhauling the generator, follow these precautions:

- Keep the disassembled parts in a suitable container to prevent loss or contamination.
- Mark terminal leads before disconnecting them so they can be easily identified and replaced in the correct positions on reassembly.
- Whenever the bearing covers are removed, take care to prevent contamination of the bearing with dirt and dust. Clean the surrounding area before opening the cover, and protect the bearing cover and bearing with clean paper.
- When mounting a brush, make certain that its position is correct and that it makes good contact with the slip rings.
- After the generator is properly installed, turn the rotor by hand to make sure that it moves freely.

## Dimensions and Mechanical Data



	KW	Installation Dimensions									External Size							Wt. (kg)
		A	B	C	D	E	F	G	H	K	a	b	h1	h	L1	L2	g	
ST1-2	1	190	159	70	28	60	8	24	112	12	30	220	15	335	410	235	30.5	35
ST2-2	2	190	159	70	28	60	8	24	112	12	30	220	15	335	410	235	30.5	40
ST3-2	3	216	178	89	32	80	10	27	132	12	34	250	18	385	480	270	34.8	60
ST5-2	4	216	178	89	32	80	10	27	132	12	34	250	18	385	480	270	34.8	65
ST2	2	216	178	89	32	80	10	27	132	12	34	250	18	385	480	270	34.8	65
ST3	3	216	178	89	32	80	10	27	132	12	34	250	18	385	480	270	34.8	70
ST5	5	254	254	108	38	80	10	33	160	15	50	310	25	440	580	325	40.8	120
ST7.5	7.5	254	254	108	38	80	10	33	160	15	50	310	25	440	580	325	40.8	130
ST10	10	279	203	121	42	110	12	37	180	15	60	339	25	480	610	365	44.8	140
ST12	12	279	203	121	42	110	12	37	180	15	60	339	25	480	610	365	44.8	155
ST15	15	318	228	133	48	110	14	42.5	200	19	60	378	30	540	660	400	51.2	192
ST20	20	318	228	133	48	110	14	42.5	200	19	60	378	30	540	660	400	51.2	202
ST24	24	318	228	133	48	110	14	42.5	200	19	60	378	30	540	660	400	51.2	