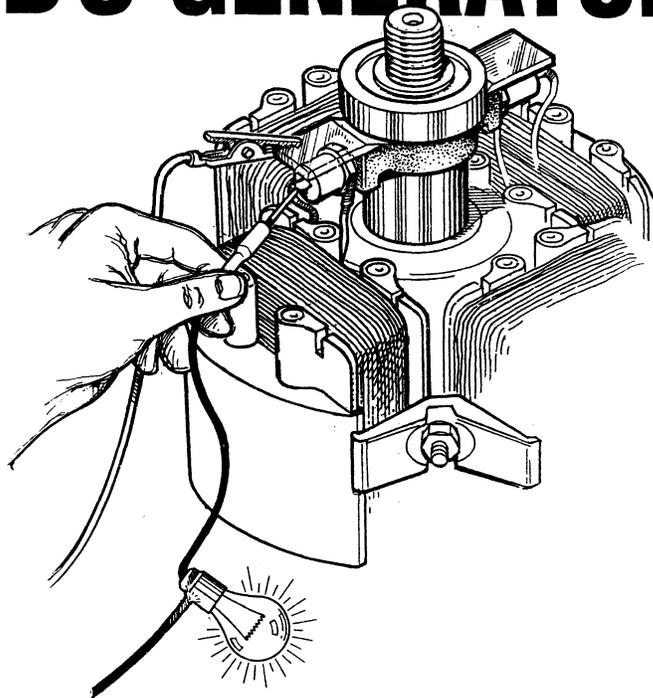




# AC ELECTRICAL TESTING AND TROUBLESHOOTING GUIDE BC GENERATORS



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 Member National Marine Manufacturers Association

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# BC GENERATOR ELECTRICAL TESTING

## DESCRIPTION

The BC generator is a brushless, self-excited generator which requires only the driving force of the engine to produce an AC output. The stator houses two sets of windings; the main stator windings and the exciter windings. When the generator is started, residual magnetism in the four rotating poles induces a voltage in the stator which then generates an even larger voltage in the exciter windings. This mutual build up of voltage in the four rotating poles and in the exciter windings quickly reaches the saturation point of the capacitor(s) and a regulated energy field is then maintained in the stator. At the same time, this regulated field produces a steady voltage in the stator windings which can then be drawn off the generator's AC terminals to operate AC equipment. The generator is a single-phase, reconnectable 120 volt AC two-wire or 115 volt AC two-wire or 230 volt AC two-wire, at 50 hertz.

The generator's data plate gives the voltage, current and frequency rating of the generator. An AC wiring decal is affixed to the inside of the louvered cover at the generator end. A diagram of the various AC voltage connections is provided on the decal. An Integral Controller (IC) is mounted inside the generator and supplies a continuous DC charge to the generators starting battery when the generator is running.

## INTRODUCTION TO TROUBLESHOOTING

The following test procedures can be used to troubleshoot WESTERBEKE'S 4 POLE SINGLE AND DUAL CAPACITOR BRUSHLESS GENERATORS. Due to the simplicity of the generator, troubleshooting is relatively easy.

Field testing and repairing can be accomplished with basic tools and repair parts which should include the following:

A **quality multimeter [multitester]** capable of reading less than one ohm and with a specific diode testing function.

**Basic electrical tools** including cutters, soldering iron, wire strapper/crimper, terminals connectors, etc.

**Repair parts** such as diodes, fuses, bridge rectifier, etc.

## PRELIMINARY CHECKING

Before electrical testing check for proper engine speed/hertz adjustment. Low engine speed will cause low AC voltage output, high engine speed-high AC output.

Refer to WESTERBEKE'S operators manual or service manual for engine speed/hertz adjustment or for other possible engine related problems.

Before testing, get a clear explanation of the problem that exists, be certain it relates to generator components.

**⚠ WARNING: AC and DC circuits often share the same distributor panel. Be certain to unplug AC power cords and shutdown DC/AC inverters. Simply switching off circuit breakers will not do the job since it will still leave hot wires on the supply side of the panel.**

## GENERATOR TROUBLESHOOTING CHART

A, B, C, & D refer to the components of the **INTERNAL WIRING DIAGRAM** and their test procedures in the following pages.

**NOTE:** This fault finding chart is compiled assuming the engine is operating at the correct speed/hertz.

FAULT	CAUSE	TEST/CORRECTION
No AC Output	Shorted stator	B
	Open stator	B
	Shorted diodes [two]	A
Residual Voltage 4-6 VAC (Hot N) at no-load	Faulty capacitor	C
	Open exciter	B
	Shorted exciter	B
	Engine speed [hertz] is too low	Adjust*
High AC Output at No-Load	Electrical connections are faulty	Inspect wiring connections
	Incorrect voltage tap on capacitor	C
	Incorrect capacitor	C
	Incorrect hertz tap on capacitor	C
Low AC Output 60-106V	Engine speed [hertz] is too high	Adjust*
	Faulty rotor winding	A
Voltage Drop Under Load (or at No-Load)	Faulty diode	A
	Faulty capacitor	C
	Engine speed [hertz] is too low	Adjust*
No Battery Charge Low Battery Charge	Faulty bridge rectifier	D
	Faulty integral controller	D
	Blown fuse	B
High Voltage Output when Load is applied	Faulty winding	B
	Engine speed [hertz] is too high	Adjust*
Unstable Voltage	Electrical connections are faulty, loose	Inspect wiring connections
Noisy Operation	Faulty support bearing	Inspect rear bearing**
	Generator rotor connection to engine is loose	Check rotor security**

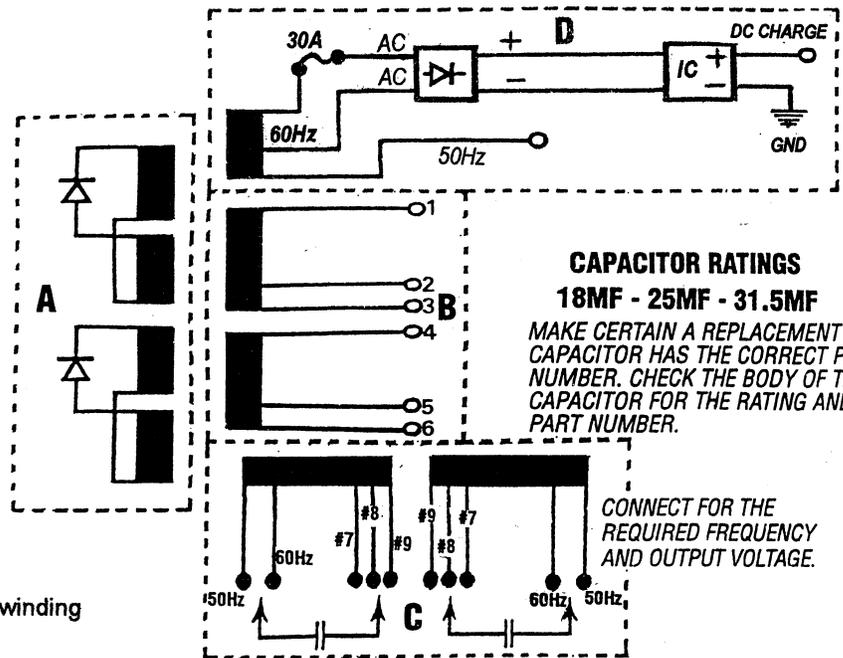
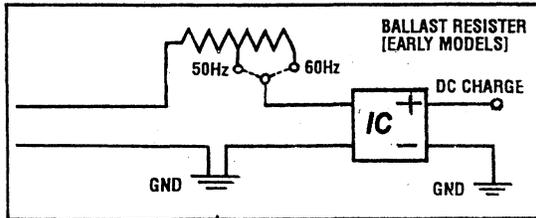
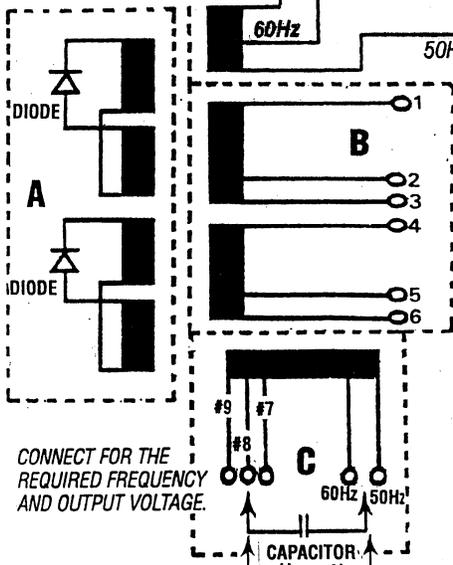
\* Refer to the **GENERATORS OPERATOR MANUAL**

\*\* Refer to the **GENERATORS SERVICE MANUAL**

# INTERNAL WIRING SCHEMATIC DC BATTERY CHARGING CIRCUIT

FUSE - INTEGRAL CONTROLLER  
WINDING: NO TIME DELAY  
Pn#43634 30A  
250V MDA-30

- A - ROTOR WINDINGS
- B - STATOR WINDINGS
- C - CAPACITOR WINDING
- D - BATTERY CHARGE WINDING



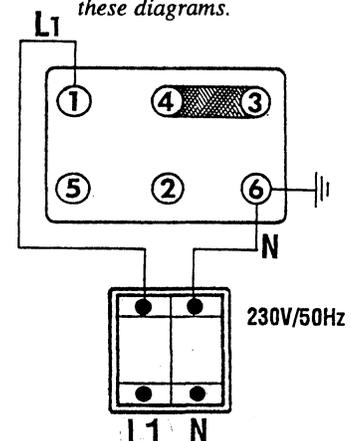
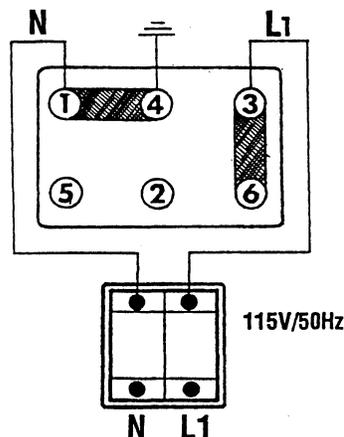
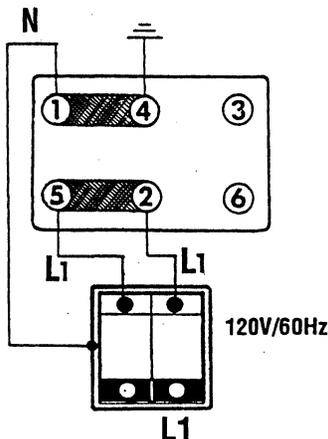
### WINDING RESISTANCE VALUES IN OHMS

MODEL- SINGLE CAPACITOR	A	ROTOR	3.8Ω
	B	STATOR	0.6Ω
	C	EXCITER	1.9Ω
	D	CHARGER	0.14Ω
MODEL- DUAL CAPACITOR	A	ROTOR	4.0Ω
	B	STATOR	0.4Ω
	C	EXCITER	2.2Ω
	D	CHARGER	0.14Ω
MODEL- DUAL EXCITER CIRCUIT	A	ROTOR	4.0Ω
	B	STATOR	0.3Ω
	C	EXCITER	1.3 ohm/winding
	D	CHARGER	0.08Ω

**CAPACITOR RATINGS**  
18MF - 25MF - 31.5MF  
MAKE CERTAIN A REPLACEMENT CAPACITOR HAS THE CORRECT PART NUMBER. CHECK THE BODY OF THE CAPACITOR FOR THE RATING AND PART NUMBER.

### A C TERMINAL BOARD CONNECTIONS WITH CIRCUIT BREAKER [CURRENT MODELS]

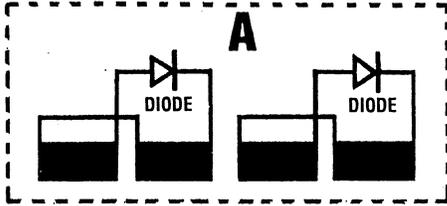
**NOTE:** When changing from 60Hz to 50Hz, make certain the ground wire is properly repositioned according to these diagrams.



# LOW VOLTAGE - ROTATING FIELD AUXILIARY WINDINGS TESTS

**⚠ WARNING:** *Some of the following tests require the generator to be running, make certain the front pulley cover and timing belt covers are in place.*

## ROTATING FIELD/AUXILIARY WINDINGS



### Description

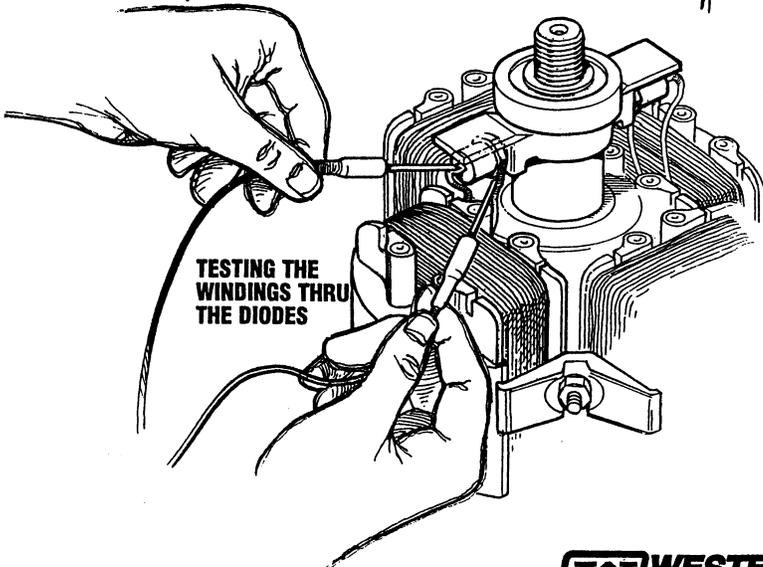
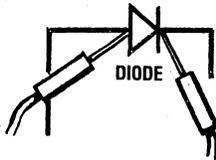
Two sets of windings are found in the rotor assembly. An AC voltage is produced in two groups of windings as the rotor turns at rated rpm. The AC voltage passes through each of the two diodes mounted on the isolated fixture just before the rotor carrier bearing. The AC sine wave is changed to a DC and this DC voltage is passed through the two groups of rotating field windings producing a DC field around these windings. This field affects the AC winding of the two main stator groups inducing an AC voltage in these windings that is available at the AC terminal block connections.

### Testing The Windings Thru the Diodes

To check the resistance values, rotate the engine's crankshaft to position the diode(s) on the generator's shaft at 12 o'clock. To make a quick check of these windings, presume the diode is OK and place one of the ohmmeter's leads on the connection at the top of the diode and the other lead at the connection at the base of the diode. Compare readings with the figures below.

#### STANDARD RESISTANCE VALUES ROTATING FIELD / AUXILIARY WINDINGS

Single Capacitor	3.8 Ohms
Dual Capacitor	4.0 Ohms

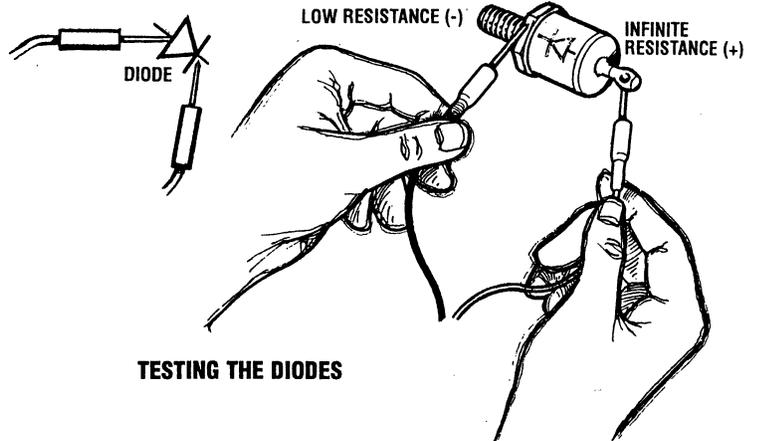


TESTING THE WINDINGS THRU THE DIODES

## TESTING THE DIODES

If a distinct difference is noted in the ohm value, carefully unsolder the lead on the top of the diode and remove the diode from its isolated heat sink using a thin walled, deep well 7/16 in (11 mm) socket.

To check the diode, unsolder the connection from the top of the diode. Place one ohmmeter lead on the connection at the top of the diode and the other ohmmeter lead to the diode's base. Then reverse the position of the ohmmeter leads.



TESTING THE DIODES

A low resistance should be found with the leads in one direction, and infinite resistance (blocking) in the other direction.

**DIODES: 1.4 - 1.5 OHMS (APPROX)**

USING A 260 FLUKE 76 METER

*Note that different meter models may show different ohm values, but should read the same for both diodes.*

**DIODES RATING 1600 VOLTS 26 AMPS**

The diode's rating is far in excess of the circuit's requirements. Most likely a diode failure will result from a generator overspeed or load surge.

**⚠ CAUTION: [ON SOLDERING]** *When soldering, use a large enough soldering iron to get the job done quickly. Excessive heat will damage the diodes. Also make certain no soldering splashes onto the windings as it will melt the insulation.*

# LOW VOLTAGE - ROTATING FIELD AUXILIARY WINDINGS TESTS

## Testing the Rotor Field Auxiliary Windings

With the diode removed, both leads for the first group of rotating field/auxiliary windings will be isolated with no interference from a possibly faulty diode.

Check the resistance value of the rotating windings by placing the ohmmeter's probes across the two exposed leads.

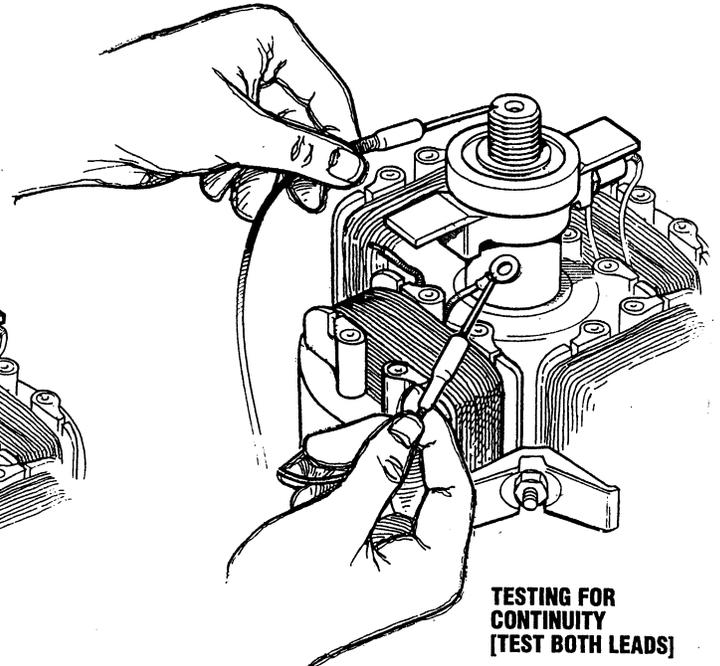
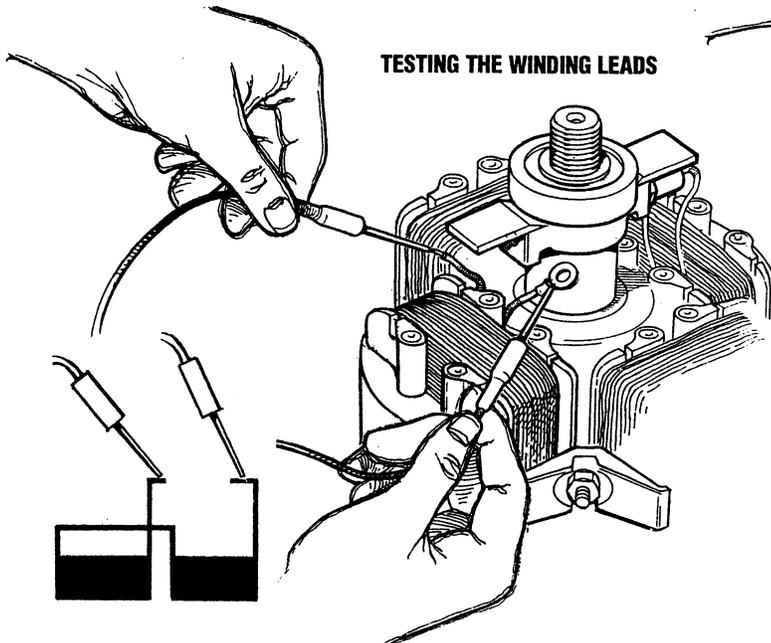
### ROTOR WINDINGS RESISTANCE VALUES

Single Capacitor	3.8 ohms
Dual Capacitor	4.0 ohms
Dual Exciter Circuit	4.0 ohms

## Testing Continuity

Check that no continuity exists between either of the winding leads and the generator shaft. If continuity is found, there is a short in the windings.

Repeat the above tests on the second set of windings on the opposite side.



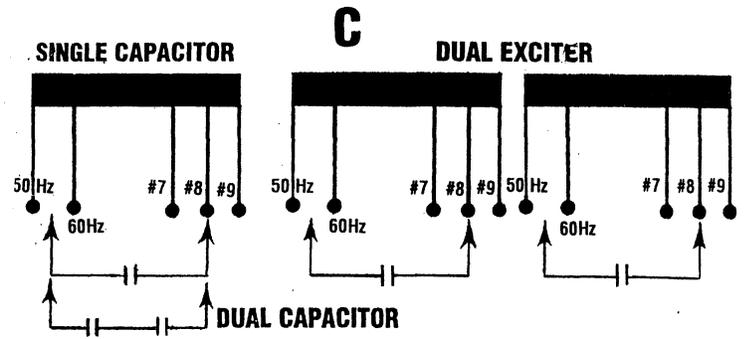
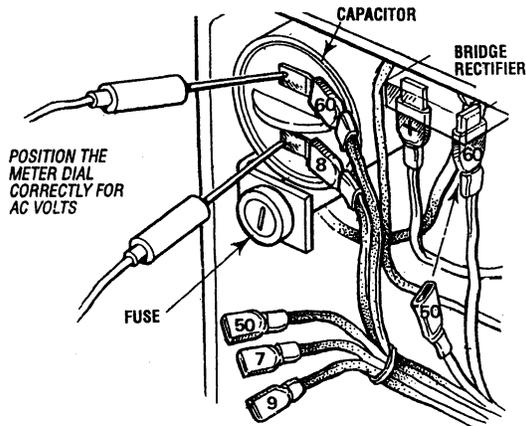
# RESIDUAL VOLTAGE - EXCITER CIRCUIT TESTS

## TESTING THE EXCITER WINDINGS

AC voltage can be measured across the capacitor(s) while the generator is operating. This voltage may be as high as 400 to 500 volts AC. This voltage buildup is accomplished as the exciter windings charge the capacitor(s) and the capacitor(s) discharge back into the exciter windings. This AC voltage reading is taken between the #60 Hertz connector and the # connection plugged into the capacitor(s) while the generator is operating at its rated Hertz (60.5 - 61.5 for gasoline models and 61.5 - 62.0 for diesel models). This flow of saturating AC in the exciter windings produces a phase-imbalance type of field that effects the auxiliary windings: a beneficial result that produces good motor starting characteristics for this type of generator.

## MEASURING AC VOLTAGE

GENERATOR RUNNING



# EXCITER CIRCUIT CAPACITOR(S) TESTS

## Measuring Resistance

To measure the resistance of the exciter winding locate the #9 and the #50 Hertz capacitor connections.

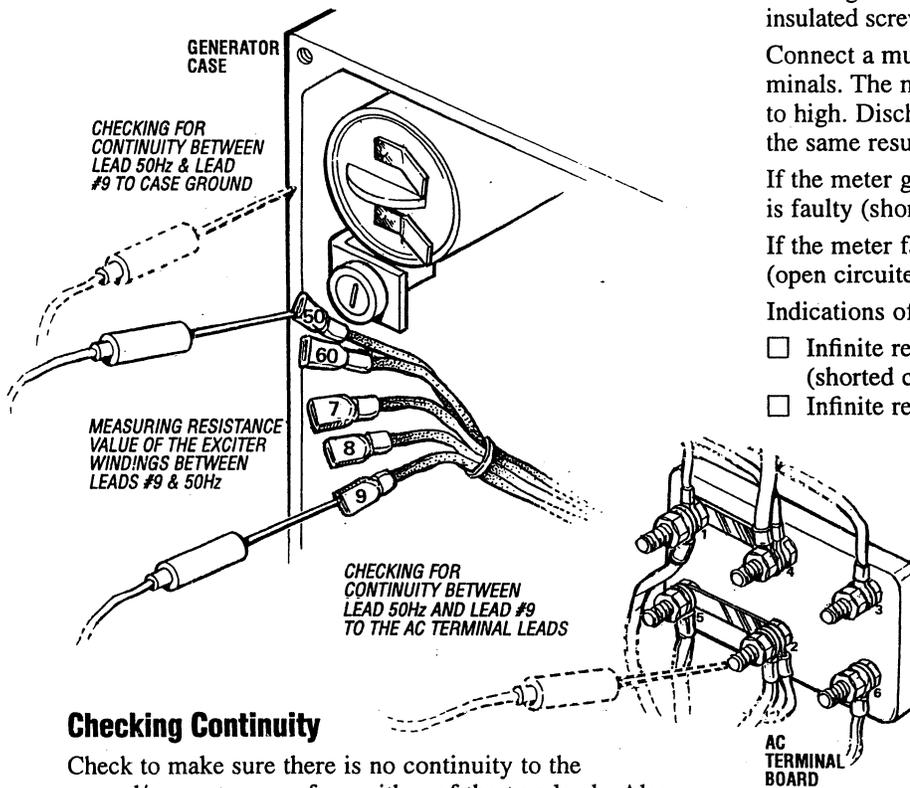
**NOTE:** Three numbered capacitor connections exist: #7, #8, and #9; and two Hertz connections #50 and #60.

Unplug any other connections from the capacitor noting their position on the capacitor. Place one probe of the multimeter on plug connection #9 and the other probe on the 50 Hertz lead. Measure the resistance value of the exciter windings and compare to the figures below.

**NOTE:** Lower residual voltage along with a lower winding resistance will confirm a faulty winding.

### EXCITER WINDINGS RESISTANCE

Single Capacitor	Dual Capacitor	Dual Exciter	BCA Model
1.9 ohms	2.2 ohms	1.3 ohms	1.5 ohms



## Checking Continuity

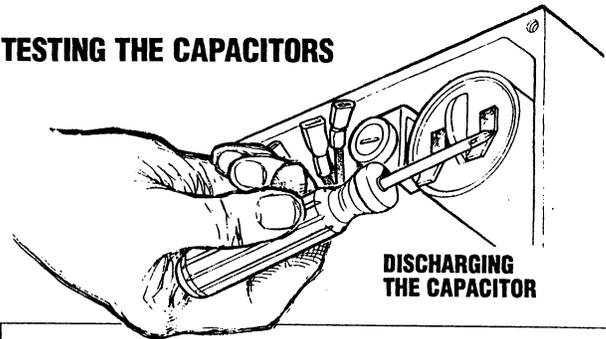
Check to make sure there is no continuity to the ground/generator case from either of the two leads. Also check that no continuity exists between either the #50 Hertz plug or the #9 plug and any of the main stator winding leads on the AC output. If continuity is found here, a fault exists between these two winding groups.

An AC voltage is induced in these windings by the rotating field. Checking the residual voltage output from this winding can determine the condition of the winding when troubleshooting. Test between leads #50 and #9 with leads lifted off the capacitor(s).

### RESIDUAL VOLTAGE:

Single Capacitor Model:	10 - 14 Volts AC from each winding
Dual Exciter Model:	7 - 9 Volts AC from each winding
Dual Capacitor Model:	14 - 16 Volts AC from each winding

## TESTING THE CAPACITORS



**⚠ WARNING:** Capacitors must be discharged before handling as they store electricity and can pack a potentially lethal charge even when disconnected from their power source.

Discharge the capacitor by bridging the terminals with an insulated screwdriver.

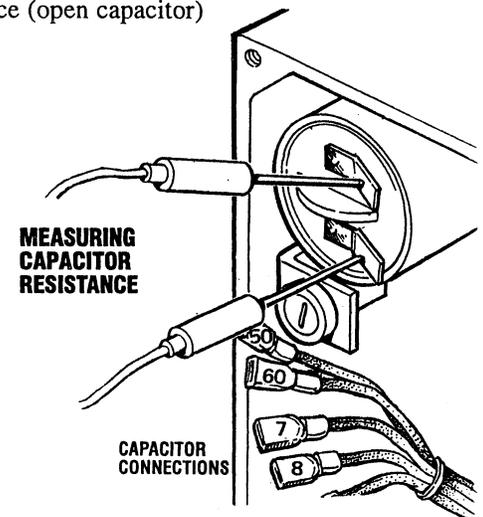
Connect a multimeter (highest ohm scale) to the capacitor terminals. The meter should go to zero ohms and slowly return to high. Discharge the capacitor again and reverse the leads, the same results should be obtained.

If the meter goes down and stays at zero ohms, the capacitor is faulty (shorted).

If the meter fails to go down to zero, the capacitor is faulty (open circuited).

Indications of a defective capacitor:

- Infinite resistance, or no rise in resistance (shorted capacitor)
- Infinite resistance (open capacitor)



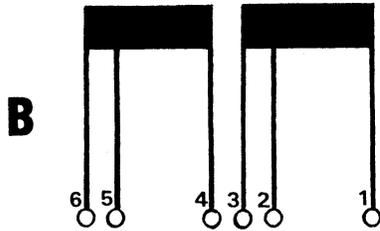
### CAPACITOR RATINGS

Single Capacitor Models	25.0 MFD	Pn#035985
Dual Capacitor Models	31.5 MFD	Pn#035978
Dual Exciter Models	18.0 MFD	Pn#039556

**NOTE:** The older single capacitor models have 25.0 microfarad capacitors. New models now have 31.5 microfarad capacitors. Dual exciter models have a 18.0 MFD capacity.

The capacitor rating is marked on the housing of the capacitor.

# NO VOLTAGE OUTPUT - MAIN STATOR WINDINGS TESTS



**NOTE:** The studs on the AC terminal board are identified by the six red wire that attach to them. These wires are numbered 1 thru 6. There are no numbers on the terminal block.

## EXCITING THE GENERATOR

The generator may be excited using 12 volts DC taken from the engine's starting battery. This voltage is applied across the #50 and #9 leads of the exciter circuit windings (unplugged) with any other numbered leads unplugged from the capacitors. The generator's reaction during flashing will help determine its fault.

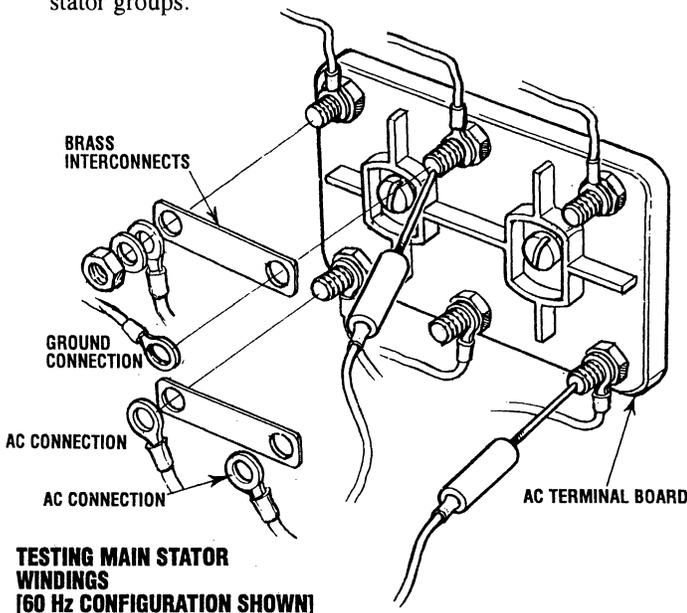
### NORMAL VOLTAGE OUTPUT RANGE DURING 12 VOLT EXCITATION

Single Capacitor	22 - 26 VAC
Dual Capacitor	24 - 28 VAC
Dual Exciter	12 - 14 VAC

- A slight rise in the output voltage with the loading of the engine and/or a growling noise from the generator end will indicate a fault in the main stator windings.
- No rise or a very slight rise in the output voltage will indicate a fault in the exciter windings.
- Normal output voltage as specified above, check exciter circuit.

## TESTING THE MAIN STATOR WINDINGS

Test the main stator windings at the AC terminal board by first removing all the AC output leads, the ground connection, and the brass interconnects. This will isolate the six leads on the terminal board which make up the two stator groups.



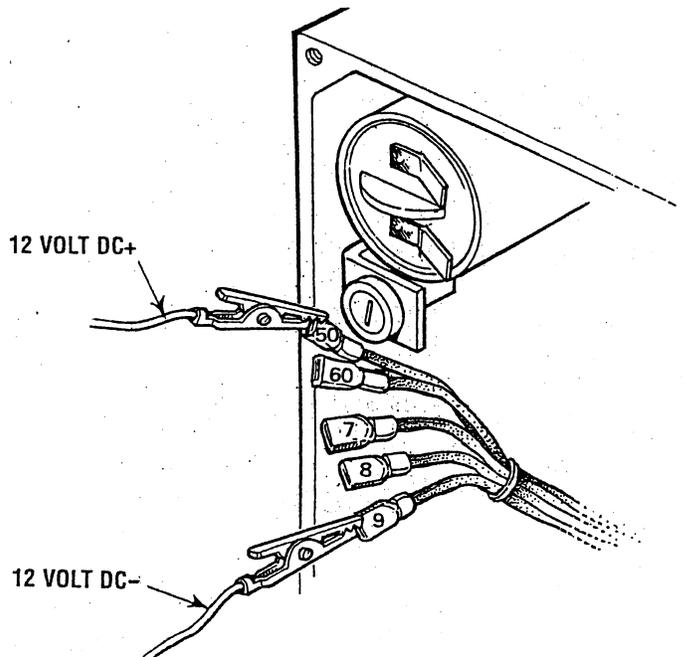
**TESTING MAIN STATOR WINDINGS**  
[60 Hz CONFIGURATION SHOWN]

## Testing Residual Voltage

Test for residual voltage between terminal #1 and terminal #3. Then test between terminal #4 and #6 (shown above).

**RESIDUAL VOLTAGE**      2 - 3 VOLTS AC

Correct readings will indicate the stator windings are okay. Check the exciter windings.



## CHECK RESISTANCE

**GROUP 1** - Test the resistance value between the #1 terminal and the #3 terminal.

**GROUP 2** - Test the resistance value between the #4 terminal and the #6 terminal.

### RESISTANCE VALUES

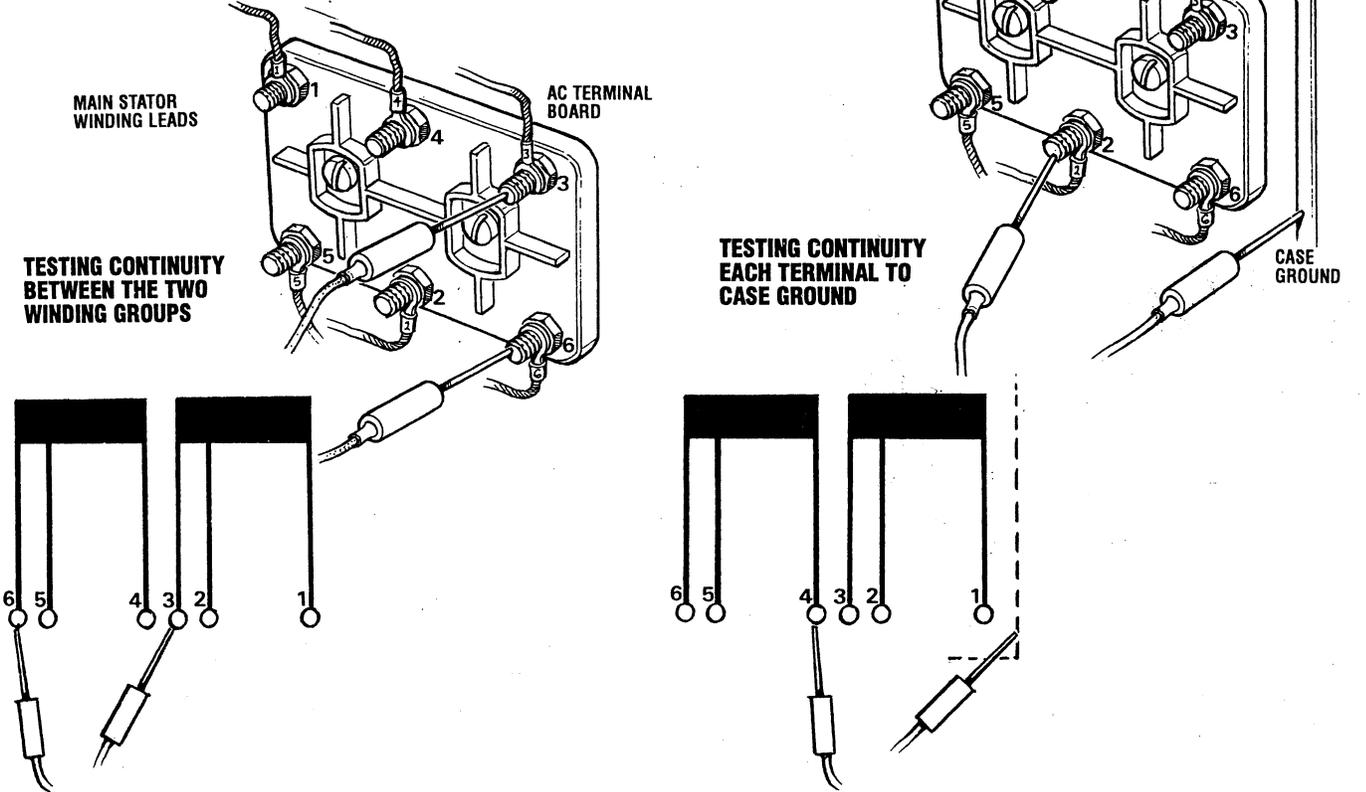
Single Capacitor	0.6 ohms
Dual Capacitor	0.5 ohms
BCA Model	0.3 ohms
Dual Exciter Circuit	0.5 ohms

# NO VOLTAGE OUTPUT - MAIN STATOR WINDINGS TESTS

## Testing Continuity

There should not be any continuity between these two winding groups. Test between terminal #3 and terminal #6. If continuity exists, there is a short in the windings.

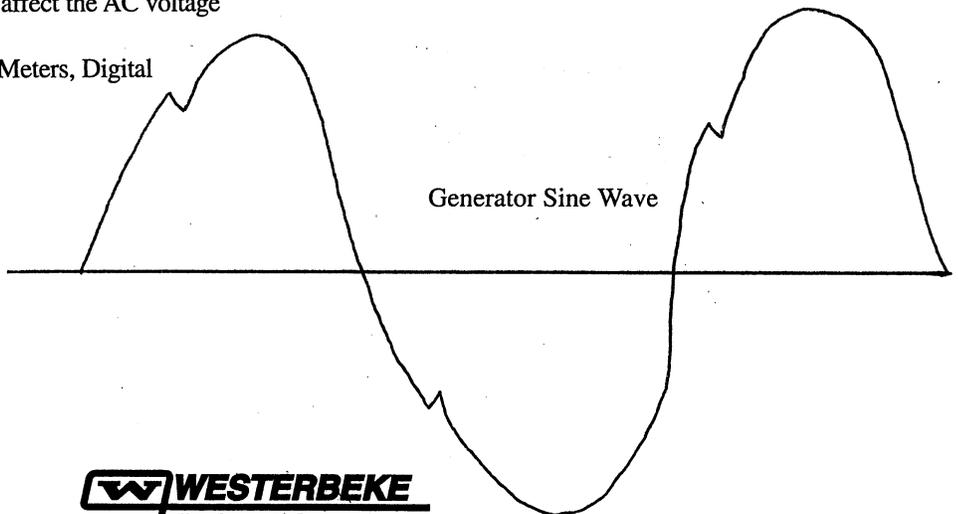
There also should be no continuity between the terminals and the generator case (ground).



## Generator Sine Wave

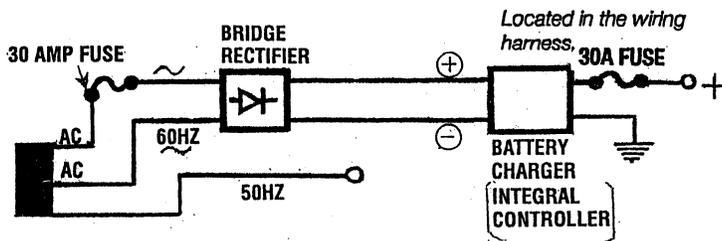
The illustration shows a typical sine wave produced by a capacitor excited generator. Some sine waves may be more distorted than others. This distortion in the sine wave can affect the operation of various equipment sensitive to the sine wave produced by the generator supplying AC voltage. This distortion in the sine wave can affect the AC voltage received by the equipment,

Equipment such as Inverters, Hertz Meters, Digital Clocks/Microwave ovens, etc.



# BATTERY CHARGING CIRCUIT / BRIDGE RECTIFIER

## TESTING THE BATTERY CHARGING CIRCUIT

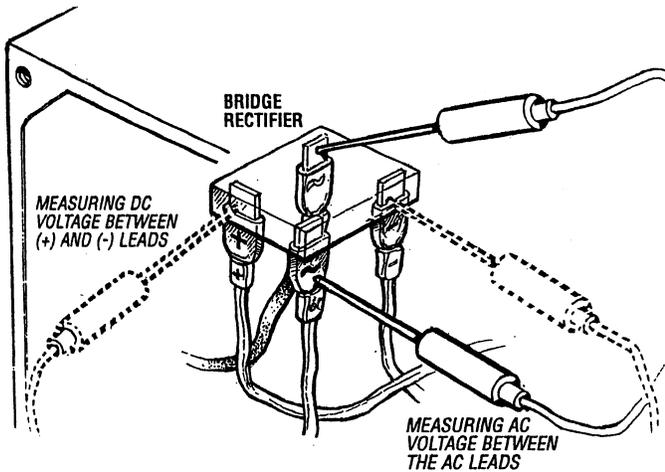


**NOTE:** The battery charging circuit is totally separate from the AC output of the generator. The generator output affects the circuits output, but not the reverse.

Normal AC voltage running to the rectifier (while the engine is operating at 1800 rpm) is measured across the two AC connections on the bridge rectifier (shown below).

### AC VOLTAGE TO THE BRIDGE RECTIFIER (APPROXIMATELY):

No-load off the generator	16.0 volts AC
Full-load off the generator	17.5 volts AC



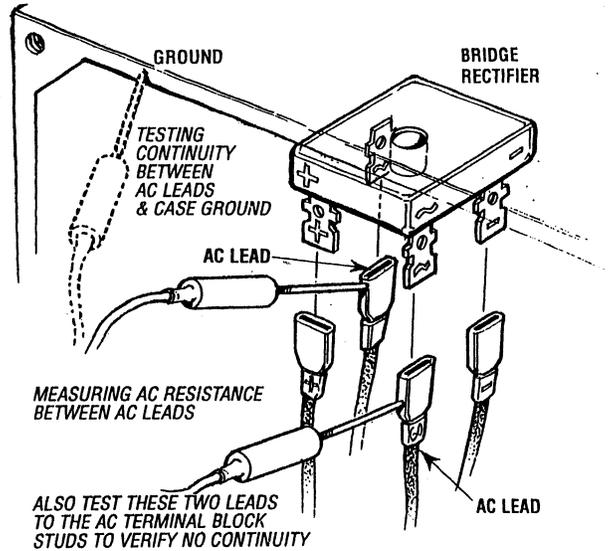
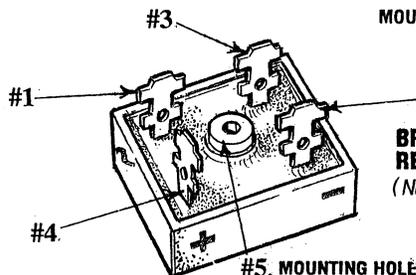
Normal DC voltage running out of the rectifier (in volts DC) is measured across the two DC connections of the bridge rectifier, that is + and - as illustrated.

### DC VOLTAGE FROM THE BRIDGE RECTIFIER (APPROXIMATELY):

No-load off the generator	17.0 volts DC
Full-load off the generator	18.5 volts DC

Lift the two AC wire leads off the bridge rectifier and measure the resistance between these two leads. It should measure 0.14 ohm. No continuity should exist between these two leads and the ground or the main stator windings.

**RESISTANCE BETWEEN AC LEADS 0.14 OHMS**

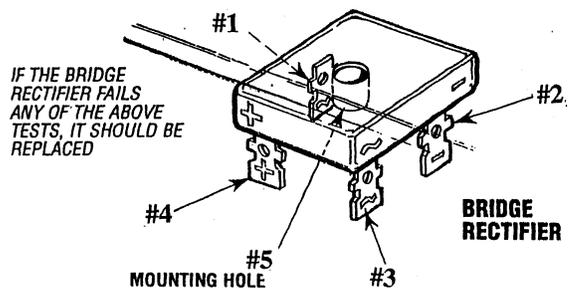


## TESTING THE BRIDGE RECTIFIER

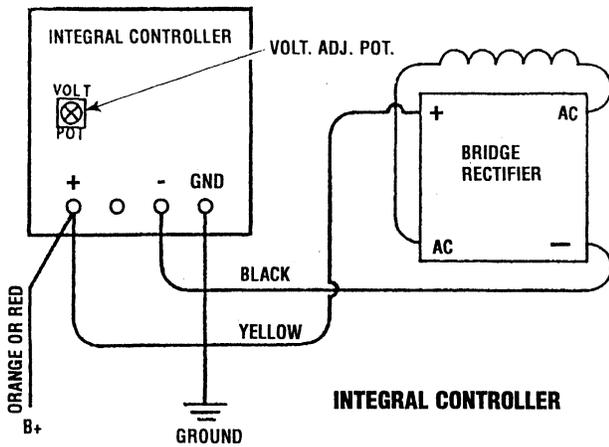
(meter used - FLUKE multimeter)

- Set the meter on Ohms scale.
- Connect the positive (+) lead from the meter to point #4. Taking the negative (-) lead, momentarily touch points #1, #2, #3, and #5. There should be no Ohm value registered on the meter.
- Remove the positive (+) lead from point #4 and connect the negative (-) lead to it. Momentarily touch points #1, #2 and #3. The Ohm meter should register an arbitrary Ohm value at each point it touches.
- Leaving the negative (-) lead on point #4, touch point #5 with the positive (+) lead. The meter should register no Ohm value.
- Place the positive (+) lead on point #1 and the negative (-) lead on point #3. The meter again should register no Ohm value. Reverse these connections and the meter should register no Ohm value.

If the rectifier fails any of the previous tests B through E, replace the rectifier as it is defective.



# INTEGRAL CONTROLLER / BALLAST RESISTOR



## INTEGRAL CONTROLLER (I.C.)

The Integral Controller (I.C.) is an encapsulated, solid-state unit that supplies a DC charging voltage to the generator's starting battery while the generator is operating.

**Charging Voltage:** 13.0 - 14.0 volts DC

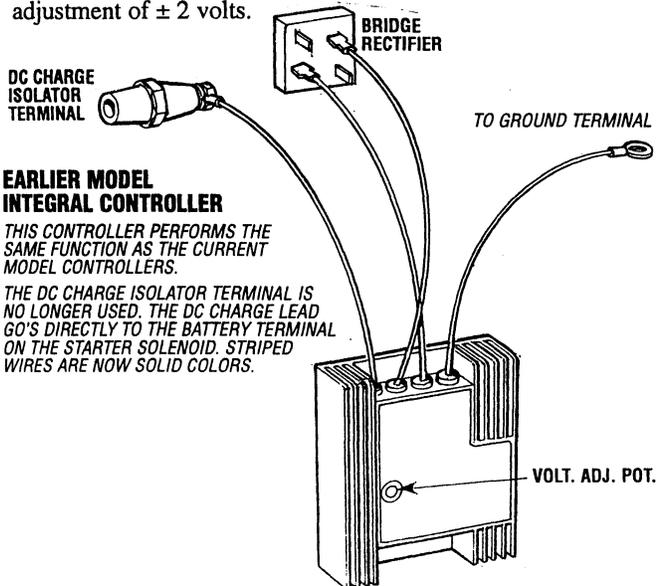
**Charging Amperage:** 0 - 10 amps DC [Early Models]

**Charging Amperage:** 0 - 17 amps DC [Current Models]

A separate group of stator windings supplies AC voltage to a bridge rectifier which converts the AC current to supply the I.C. unit. The I.C. unit senses the needs of the starting battery and supplies a DC charge when one is needed. If you suspect that the I.C. unit is faulty (that is, if the battery's charge is low), check the charging circuit and it's components as described in the following steps. Check all connections for cleanliness and tightness including the ground before replacing the I.C. unit.

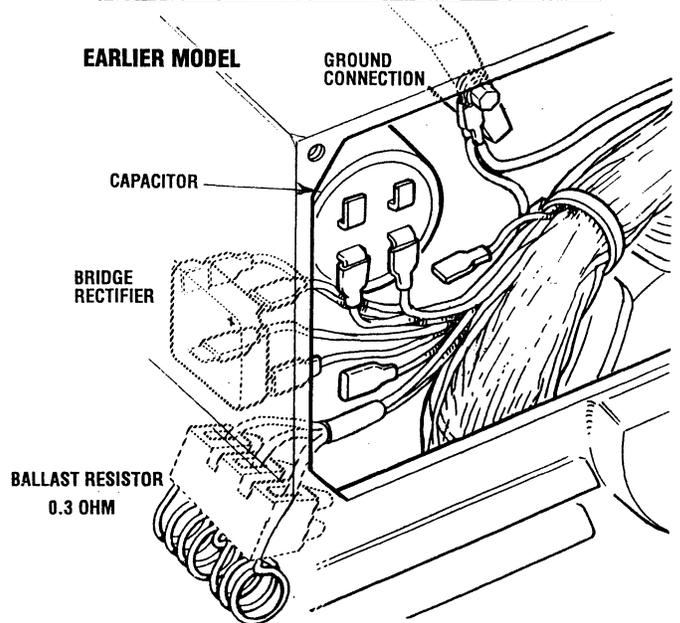
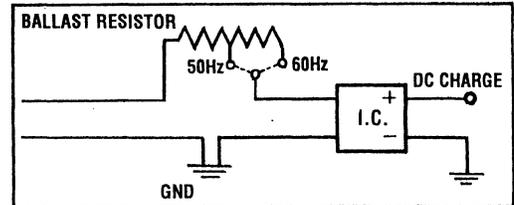
**NOTE:** When the generator is first started, the I.C. unit will produce a low charging rate. This charging rate will rise as the generator is operated.

The Integral Controller is mounted inside the generator housing in the 12:00 position. There is a voltage output adjustment on the controller that will allow a DC voltage output adjustment of  $\pm 2$  volts.



## BALLAST RESISTOR

Early model integral controllers have a ballast resistor installed along the DC(+) lead running from the bridge rectifier to the integral controller. This coil-type resistor functions to suppress high amperage draw coming from the controller when it is trying to charge a discharged starting battery.



## Measuring Resistance

The resistance value of the ballast coil is measured between the lifted (+) lead at the bridge rectifier and the 60 Hertz connection unplugged from the controller (that is, controllers having plugs in the connector).

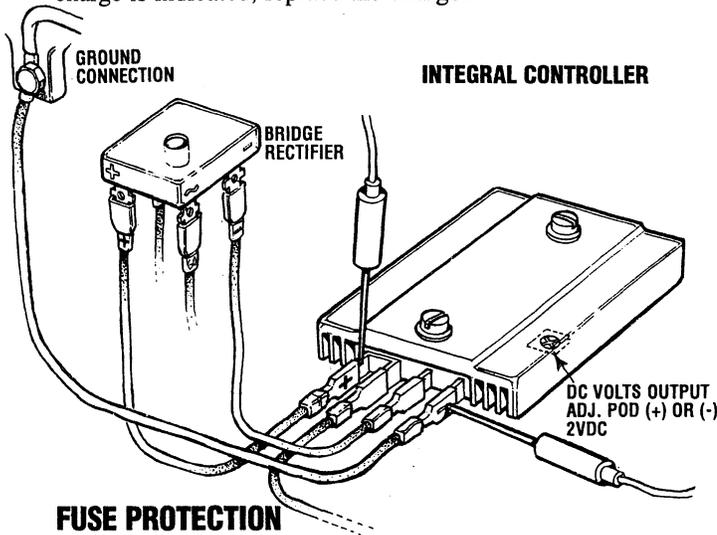
Controllers with three leads coming from the controller measure resistance between the unplugged 60 Hertz connection at the bridge rectifier and the brown lead connection on the coil resistor terminal block.

**NOTE:** New four wire controllers eliminate the ballast resistor circuit since the ballast resistor's function is now handled internally. Whenever replacing an early style controller with the newer four wire model, remove the ballast resistor and its wiring.

# INTEGRAL CONTROLLER / NO-LOAD VOLTAGE ADJUSTMENT

## TESTING THE INTEGRAL CONTROLLER

To test the battery charger, put a multimeter between the positive (+) and negative (-) leads to the battery. It should indicate 13.5V to 14V with the engine running. If only the battery voltage is indicated, check that the battery charger terminal connections are tight. With the unit running, test between the (+) and (-) terminals for 13.5V to 14V. If no charge is indicated, replace the charger.

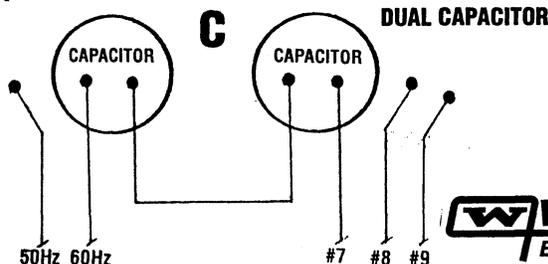


## FUSE PROTECTION

A 30 amp fuse protects the windings from a failure of the bridge rectifier or integral controller (high amperage or a short)

## SINGLE AND DUAL CAPACITOR NO-LOAD VOLTAGE ADJUSTMENT

1. Remove the louvered metal plate, at the back of the generator, covering the AC terminal connections and the capacitor(s).
2. Start the generator and allow it to run for approximately five minutes so the engine can warm up. Make sure the generator is operating without any equipment drawing AC current from the generator (that is, shut off all electrical appliances). Make sure the engine's speed (Hertz) is correct. Adjust the governor as needed to obtain the correct engine speed before proceeding.
3. Refer to the AC TERMINAL BOARD CONNECTIONS DIAGRAM for the correct configuration then check the generator's no-load voltage by measuring the voltage across the neutral lead and the hot lead with a voltmeter. Make sure you record this reading. The generator's no-load voltage is 115 - 124 volts at 60.5 - 61.5 Hertz. If the voltage output is higher or lower than specified, proceed.
4. **Shut off** the generator. Make sure the correct Hertz lead (60 Hertz #6, or 50 Hertz #5) is plugged into the capacitor(s).

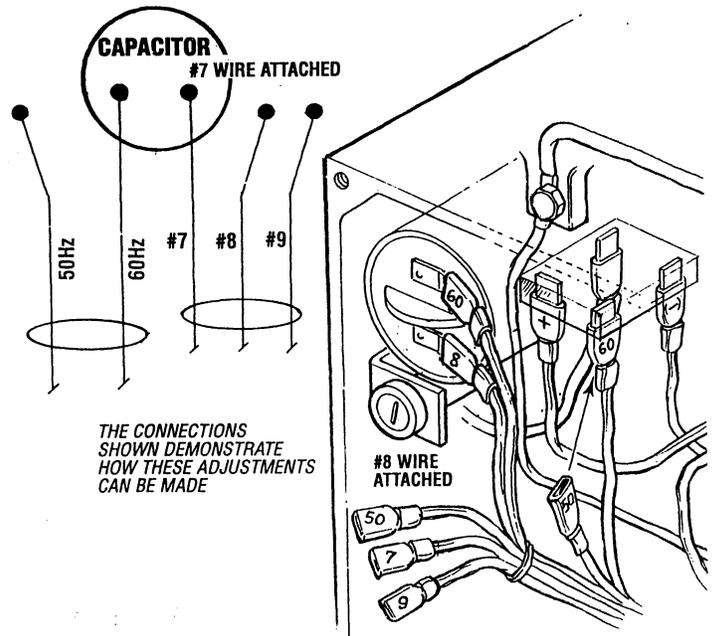


**⚠ WARNING:** Capacitors must be discharged before handling as they store electricity and can pack a potentially lethal charge even when disconnected from their power source.

**NOTE:** Simply cross the capacitor's two terminals with an insulated (plastic handle) screwdriver. This will discharge any excess electricity.

**⚠ WARNING:** Do not attempt to make a no-load voltage adjustment while the generator is operating. The capacitor can produce a 400-500 volt charge. Touching any wiring can produce a severe electrical shock. In addition, attempting to make a no-load voltage adjustment while the generator is operating could cause your fingers to be caught in the generator's rotor.

5. There are three plugs grouped for the right capacitor terminal, #7, #8, and #9. If the generator's no-load voltage is low, then disconnect the lower numbered plug and connect the plug with the next higher number. If the generator's no-load voltage is high, then disconnect the higher numbered plug and connect the plug with the next lower number. Note that the plug presently connected to this terminal may be any one of the three plugs available.
6. If the generator's no-load voltage cannot be adjusted because the voltage needs to be increased and the highest numbered plug is already connected to the right terminal, or the voltage needs to be lowered and the lowest numbered plug is connected, refer to *HERTZ ADJUSTMENT* in the operators manual.



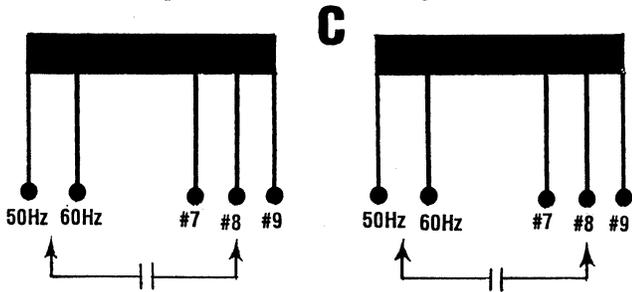
# NO-LOAD VOLTAGE ADJUSTMENT DUAL EXCITER

## DUAL EXCITER CIRCUIT MODEL

These generators have dual Hertz and no-load voltage adjustment connectors at each capacitor. There are five connectors available for each capacitor. Two connectors are for Hertz selection, 60 Hertz or 50 Hertz, and three connectors, #7, #8, and #9, are for no-load voltage adjustment.

When making Hertz change or no-load voltage adjustments proceed as follows:

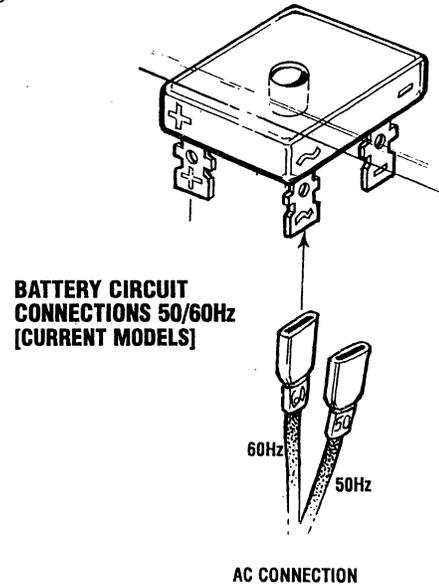
1. Shut the generator down.
2. Select the appropriate Hertz connection to plug into each capacitor #60, 60 Hertz, 1800 RPM or #50 Hertz, 1500 RPM. The three other connectors at each capacitor, #7, #8, and #9, will have an effect on the no-load voltage produced by the generator. One connector from each group can be plugged into each capacitor. No-load voltage will increase or decrease approximately 8 - 10 volts between connectors used in any pair combination to achieve the prescribed no-load voltage.



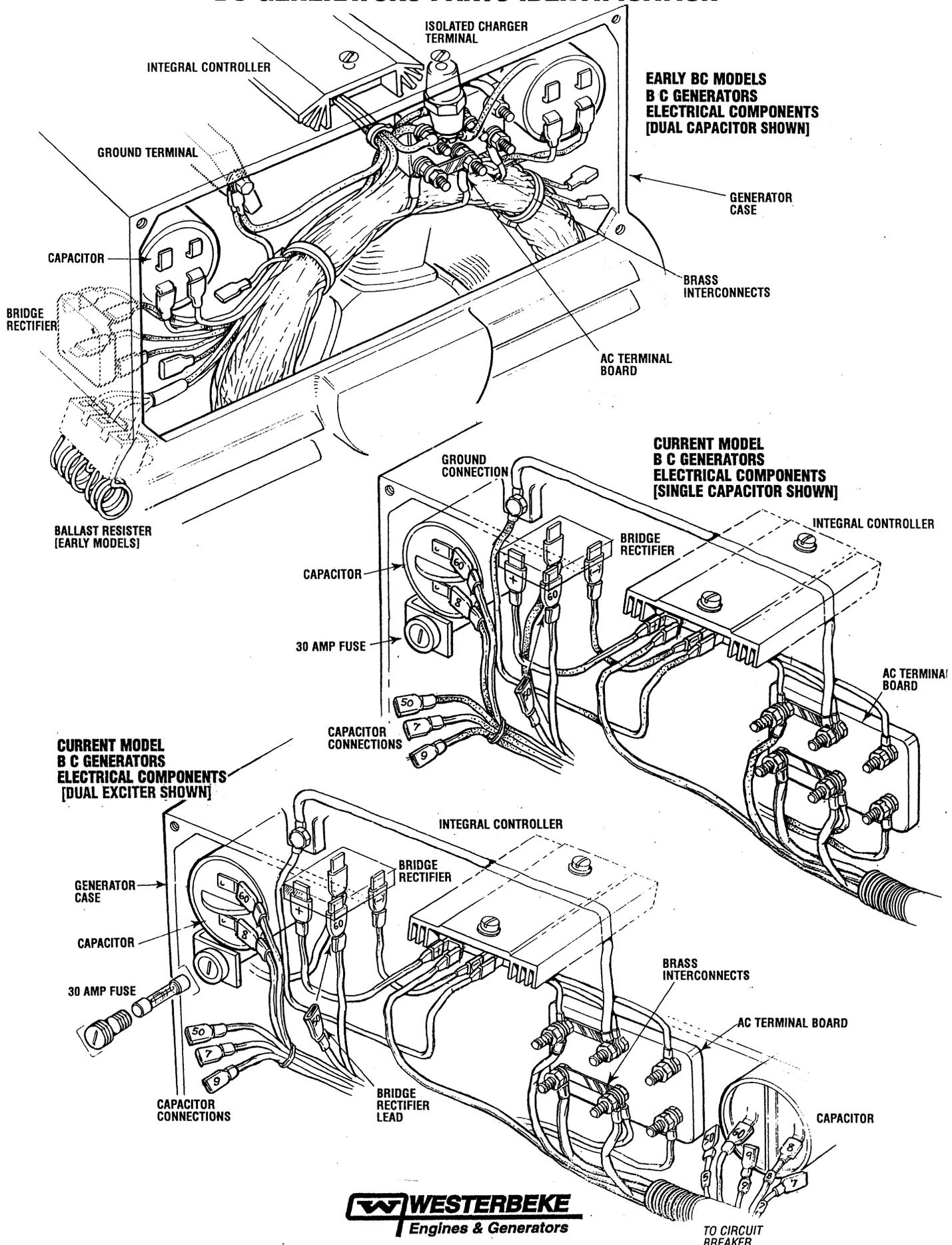
**WARNING:** Make certain the insulating covers on the unused leads are in place and are NOT in contact with each other or in contact with the generator's housing.

**NOTE:** When changing Hertz produced by the generator, an engine speed adjustment at the governor **must** be made. The AC output connections on the terminal blocks **must** be selected for the voltage and Hertz to be produced. The Hertz plug connection at the capacitor **must** be changed for 50 Hertz (#5) or 60 Hertz (#6). The frame ground wire **must** be moved when changing from 115 volts, 50 Hertz to 230 volts, 50 Hertz. Refer to the AC TERMINAL BOARD CONNECTIONS.

3. On later model BC generators, a 50Hz/60Hz connection is provided for the DC battery circuit. When changing hertz, connect the proper lead (50Hz or 60Hz) to the bridge rectifier.



# BC GENERATORS PARTS IDENTIFICATION







1185/6-2013