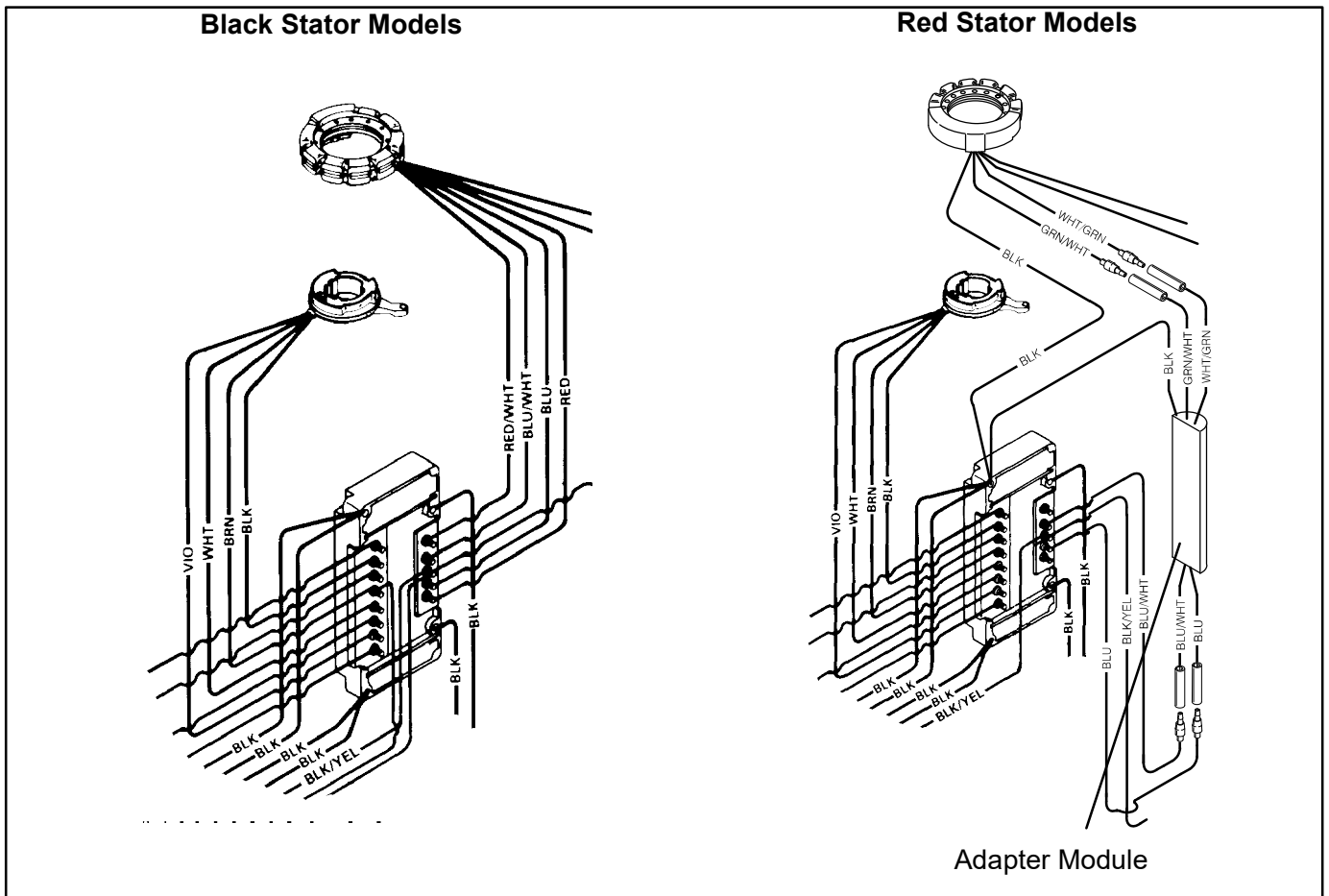




# Ignition System



## Description

The ignition system is alternator-driven with distributor-less capacitor discharge. Major components of the ignition system are the flywheel, stator assembly, trigger assembly, switch box, ignition coils and spark plugs.

The stator assembly is mounted below the flywheel and has 2 coils. The flywheel is fitted with permanent magnets inside the outer rim. As the flywheel rotates, the permanent magnets pass the stationary stator ignition coils. This causes the ignition coils to produce AC voltage. The AC voltage then is conducted to the switch boxes where it is rectified and stored in a capacitor.

The trigger assembly (also mounted under the flywheel) has 2 coils. The flywheel likewise has a second set of magnets (located around the hub). As the flywheel rotates, the second set of permanent magnets passes the trigger coils. This causes the trigger coils, in turn, to produce an AC voltage that is conducted to an electronic switch (SCR) in the switch box.

The switch discharges the capacitor voltage into the ignition coil at the correct time and in firing order sequence.

Capacitor voltage is conducted to the ignition coil primary. The ignition coil multiplies this voltage to a value high enough to jump the gap at the spark plug.

The preceding sequence occurs once-per-engine-revolution for each cylinder.

Spark timing is changed (advanced/retarded) by rotating the trigger coil position in relation to the permanent magnets on the flywheel hub.

## Red Stator Models

Red stators require an adapter module that gets connected between the stator and switch box. Without the adapter module, the voltage supplied by the stator would exceed the voltage capability of the switch box.



## Ignition Troubleshooting

### **⚠ WARNING**

**DANGER - HIGH VOLTAGE/SHOCK HAZARD! Do not touch ignition components and/or metal test probes while engine is running and/or being "cranked". STAY CLEAR OF SPARK PLUG LEADS. To assure personal safety, each individual spark plug lead should be grounded to engine.**

Before troubleshooting the ignition system, check the following:

- Make sure that electrical harness, lanyard switch, ignition switch, and mercury switch are not the source of the problem.
- Check that plug-in connectors are fully engaged and terminals are free of corrosion.
- Make sure that wire connections are tight and free of corrosion.
- Check all electrical components, that are grounded directly to engine, and all ground wires to see that they are grounded to engine.
- Check for disconnected wires and short and open circuits.

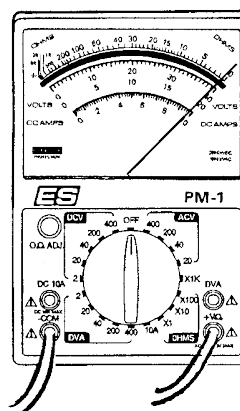
### Checking for Loss of Spark

The use of an inductive timing light while cranking or running the engine will show whether there is spark present or not. The timing light will not show the strength of the spark. Incorrect spark strength may not allow the spark plug to fire under compression

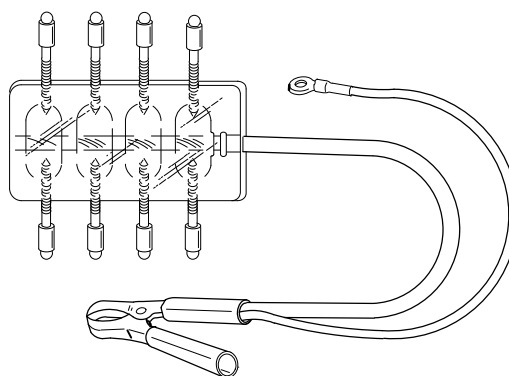
The use of a spark gap or spark gap board will give a visual indication of the strength of the spark. Normal ignition spark is BLUE in color. A YELLOW or RED spark indicates a weak ignition.

## Troubleshooting Test Equipment

Multimeter / DVA Tester 91-99750



Spark Tester 91-850439

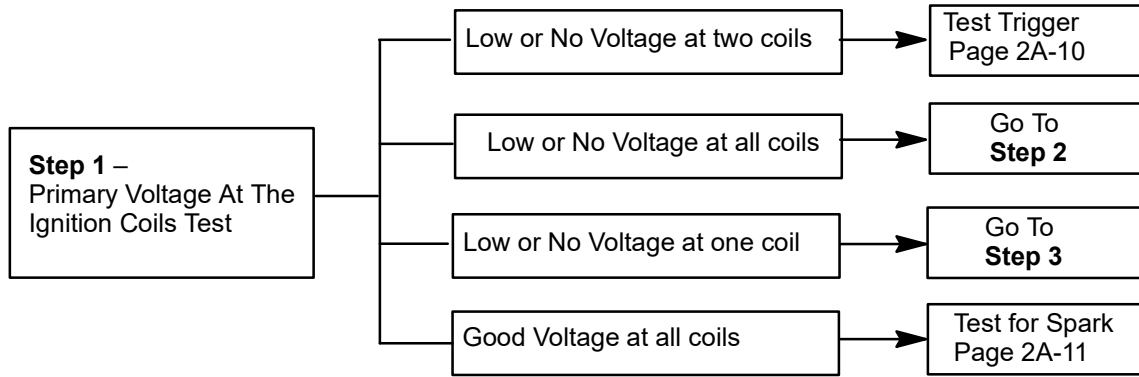




# Ignition Troubleshooting (Engines With Black Stator)

## Troubleshooting Sequence Chart – (Engines with Black Stator)

Start the ignition troubleshooting by first performing Step 1, then continue the series of steps to locate the problem. Refer to the troubleshooting steps on the following pages.



### DVA TESTS – 9 AMP BLACK STATOR

Tested Part	Selector Position	Red	Black	Reading At 300 - 1000 RPM	Reading At 1000 - 4000 RPM
Coil Primary	400 VDC*	Coil (+) Terminal	Coil (-) Terminal	160 - 250	180 - 275
Stop Circuit	400 VDC*	Black/Yellow Terminal	Ground	200 - 360	200 - 360
Stator Low Speed	400 VDC*	Blue Sw. Box Term.	Ground	210 - 310	190 - 310
Stator High Speed	400 VDC*	Red Sw. Box Term.	Ground	25 - 90	140 - 310

### DVA TESTS – 16 AMP BLACK STATOR (398-9710A33 & 398-9710A42)

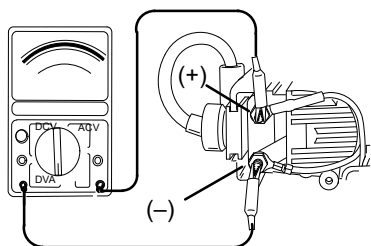
Tested Part	Selector Position	Red	Black	Voltage @ 300 RPM	Voltage @ 1000 RPM	Voltage @ 4000 RPM
Coil Primary	400 VDC*	Coil (+) Terminal	Coil (-) Terminal	110 - 140	250 - 300	215 - 265
Stop Circuit	400 VDC*	Black/Yellow Terminal	Ground	160 - 200	315 - 385	270 - 330
Stator Low Speed	400 VDC*	Blue Sw. Box Term.	Ground	160 - 200	315 - 385	270 - 330
Stator High Speed	400 VDC*	Red Sw. Box Term.	Ground	8 - 10	27 - 33	165 - 205
Switch Box Bias	20 VDC or 40 VDC	Ground	White/Black Switch Box Terminal	2 - 10	10 - 30	10 - 30

\* If using a meter with a built-in DVA, place selector switch in the DVA/400 VDC position.



# Ignition Troubleshooting (Engines With Black Stator)

## STEP 1 – Primary Voltage At The Ignition Coils Test



1. Use Multimeter / DVA Tester 91-99750.
2. Crank engine and observe meter reading.

### TEST RESULTS

- No voltage output or low voltage output on all coils. Go to STEP 2 – Stop Circuit Test.
- Good voltage on two coils. Go to Trigger Test.
- Good voltage on all coils. Go to Testing For Spark.

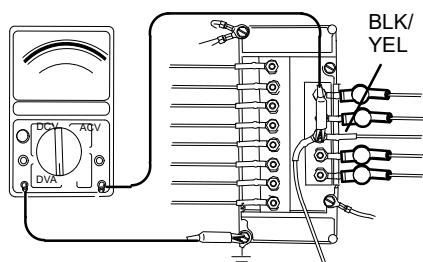
### IGNITION VOLTAGE – 9 AMP STATOR

Tested Part	Selector Position	Red	Black	Reading At 300 - 1000 RPM	Reading At 1000 - 4000 RPM
Coil Primary	400 VDC	Coil (+) Terminal	Coil (-) Terminal	160 - 250	180 - 275

### IGNITION VOLTAGE – 16 AMP STATOR (398-9710A33 & 398-9710A42)

Tested Part	Selector Position	Red	Black	Voltage @ 300 RPM	Voltage @ 1000 RPM	Voltage @ 4000 RPM
Coil Primary	400 VDC	Coil (+) Terminal	Coil (-) Terminal	110 - 140	250 - 300	215 - 265

## STEP 2 – Stop Circuit Test



1. Use Multimeter / DVA Tester 91-99750.
2. Crank engine and observe meter reading.

### IGNITION VOLTAGE – 9 AMP STATOR

Tested Part	Selector Position	Red	Black	Reading At 300 - 1000 RPM	Reading At 1000 - 4000 RPM
Stop Circuit	400 VDC	Black/Yellow Terminal	Ground	200 - 360	200 - 360

### IGNITION VOLTAGE – 16 AMP STATOR (398-9710A33 & 398-9710A42)

Tested Part	Selector Position	Red	Black	Voltage @ 300 RPM	Voltage @ 1000 RPM	Voltage @ 4000 RPM
Stop Circuit	400 VDC	Black/Yellow Terminal	Ground	160 - 200	315 - 385	270 - 330

### TEST RESULTS

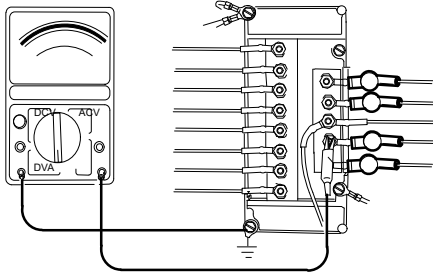
- Good voltage output. Go to STEP 3 – Stator Low Speed and High Speed Test
- High voltage output. The trigger or switch box is defective. Go to Trigger Test and test trigger. If trigger tests OK, replace switch box and repeat step.
- No voltage output or low voltage output. Remove BLK/YEL wires from switch box terminal and repeat test. If voltage output is now OK, either the ignition switch, stop switch or wiring is defective. If no voltage or low voltage remains, go to STEP 5 – Stator, Low and High Speed Test.



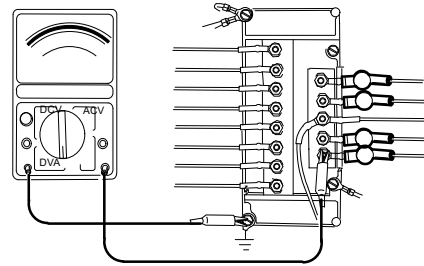
# Ignition Troubleshooting (Engines With Black Stator)

## STEP 3 – Stator Low Speed and High Speed Test

**Stator Low Speed Test**



**Stator High Speed Test**



1. Use Multimeter / DVA Tester 91-99750.
2. Crank engine and observe meter reading.

### IGNITION VOLTAGE – 9 AMP STATOR

Tested Part	Selector Position	Red	Black	Reading At 300 - 1000 RPM	Reading At 1000 - 4000 RPM
Stator Low Speed	400 VDC	Blue Sw. Box Term.	Ground	210 - 310	190 - 310
Stator High Speed	400 VDC	Red Sw. Box Term.	Ground	25 - 90	140 - 310

### IGNITION VOLTAGE – 16 AMP STATOR (398-9710A33 & 398-9710A42)

Tested Part	Selector Position	Red	Black	Voltage @ 300 RPM	Voltage @ 1000 RPM	Voltage @ 4000 RPM
Stator Low Speed	400 VDC	Blue Sw. Box Term.	Ground	160 - 200	315 - 385	270 - 330
Stator High Speed	400 VDC	Red Sw. Box Term.	Ground	8 - 10	27 - 33	165 - 205

### TEST RESULTS

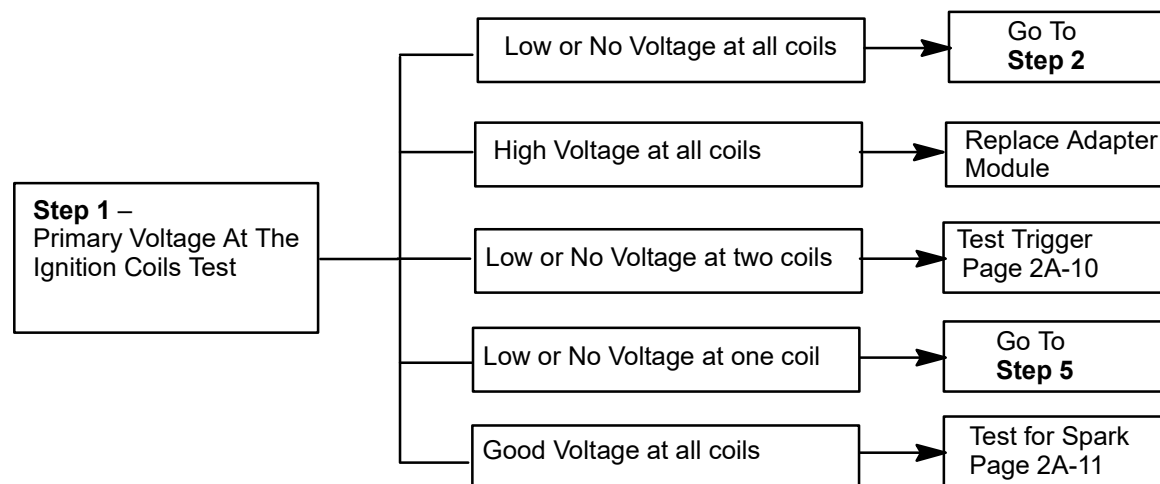
- If voltage output is low to either the stator low speed or stator high speed, the stator or switch box is defective. Go to stator test and test stator. If stator tests OK, replace switch box and repeat step.
- If voltage output is good to either the stator low speed or stator high speed, replace the switch box and repeat step



# Ignition Troubleshooting (Engines With Red Stator)

## Troubleshooting Sequence Chart – (Engine with Red Stator)

Start the ignition troubleshooting by first performing Step 1, then continue the series of steps to locate the problem. Refer to the troubleshooting steps on the following pages.



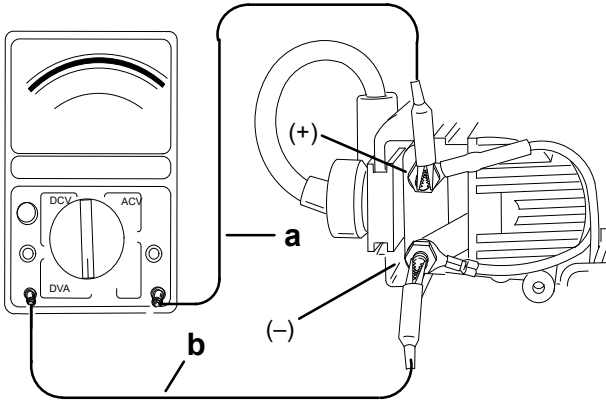
## RED Stator DVA Test

Test	Selector Switch Position	RED DVA Lead	BLACK DVA Lead	Voltage @ 300 RPM	Voltage @ 1000 RPM	Voltage @ 4000 RPM
Coil Primary	400 VDC	Coil (+) Terminal	Coil (-) Terminal	130 Volts Minimum	195 to 275	195 to 275
Stop Circuit	400 VDC	Black/Yellow Sw. Box Terminal	Ground	190 Volts Minimum	275 to 320	260 to 320
Blue Sw. Box Terminal	400 VDC	Blue Sw. Box Terminal	Ground	190 Volts Minimum	275 to 320	260 to 320
Blue/White Sw. Box Terminal	400 VDC	Blue/White Sw. Box Terminal	Ground	190 Volts Minimum	275 to 320	260 to 320



# Ignition Troubleshooting (Engines With Red Stator)

## STEP 1 – Primary Voltage At The Ignition Coils Test



- a - Connect (+) Test Lead To (+) Coil Terminal
- b - Connect (-) Test Lead To (-) Coil Terminal

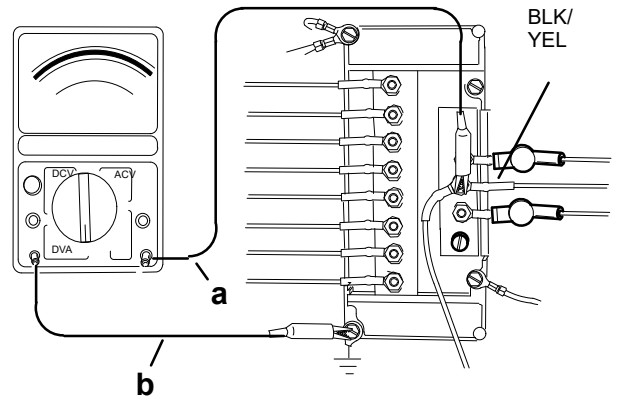
1. Use Multimeter / DVA Tester 91-99750. Set switch position to – 400 DVA.
2. Crank engine and observe meter reading.

Voltage at 300 RPM (cranking)	Voltage at 1000 – 4000 RPM (Running)
130 Volts	195 to 275 Volts

### TEST RESULTS

- Voltage output is high on all coils. The adapter module is defective. Replace adapter module.
- No voltage output or low voltage output on all coils. Go to STEP 5 – Stator, Adapter Module, and Switch Box Test.
- Good voltage on two coils. Go to Trigger Test.
- Good voltage on all coils. Go to Testing For Spark.

## STEP 2 – Stop Circuit Test



- a - Connect (+) Test Lead To BLK/YEL Wire Terminal On Switch Box
- b - Connect (-) Test Lead To Engine Ground

1. Use Multimeter / DVA Tester 91-99750. Set switch position to – 400 DVA.
2. Crank engine and observe meter reading.

Voltage at 300 RPM (cranking)	Voltage at 1000 – 4000 RPM (Running)
190 Volts	275 to 320 Volts

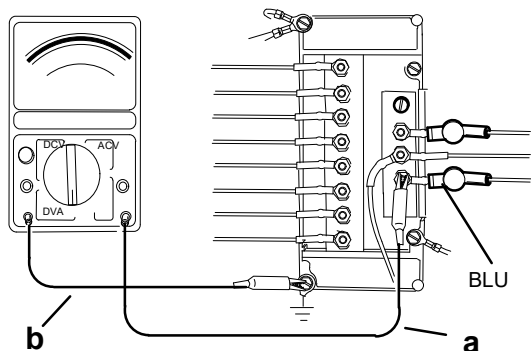
### TEST RESULTS

- Voltage output is high. The adapter module is defective. Replace adapter module.
- Good voltage output. Go to STEP 3 – Switch Box (BLU Wire) Circuit Test.
- No voltage output or low voltage output. Remove BLK/YEL wires from switch box terminal and repeat test. If voltage output is now OK, either the ignition switch, stop switch or wiring is defective. If no voltage or low voltage remains, go to STEP 5 – Stator, Adapter Module, and Switch Box Test.



# Ignition Troubleshooting (Engines With Red Stator)

## STEP 3 – Switch Box (BLU Wire) Circuit Test



- a - Connect (+) Test Lead To BLU Wire Terminal On Switch Box
- b - Connect (-) Test Lead To Engine Ground

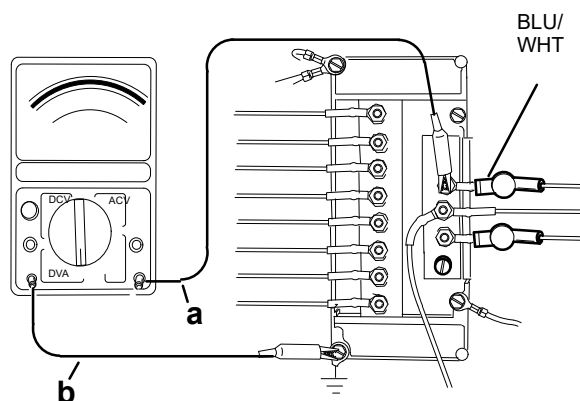
1. Use Multimeter / DVA Tester 91-99750. Set switch position to – 400 DVA.
2. Crank engine and observe meter reading.

Voltage at 300 RPM (cranking)	Voltage at 1000 – 4000 RPM (Running)
190 Volts	275 to 320 Volts

### TEST RESULTS

- Voltage output is high. The adapter module is defective. Replace adapter module.
- Good voltage output. Go to STEP 3 – Switch Box (BLU/WHT Wire) Circuit Test.
- No voltage output or low voltage output. Go to STEP 5 – Stator, Adapter Module and Switch Box Test.

## STEP 4 – Switch Box (BLU/WHT Wire) Circuit Test



- a - Connect (+) Test Lead To BLU/WHT Wire Terminal On Switch Box
- b - Connect (-) Test Lead To Engine Ground

1. Use Multimeter / DVA Tester 91-99750. Set switch position to – 400 DVA.
2. Crank engine and observe meter reading.

Voltage at 300 RPM (cranking)	Voltage at 1000 – 4000 RPM (Running)
190 Volts	275 to 320 Volts

### TEST RESULTS

- Voltage output is high. The adapter module is defective. Replace adapter module.
- Good voltage output..
- No voltage output or low voltage output. Go to STEP 5 – Stator, Adapter Module and Switch Box Test.

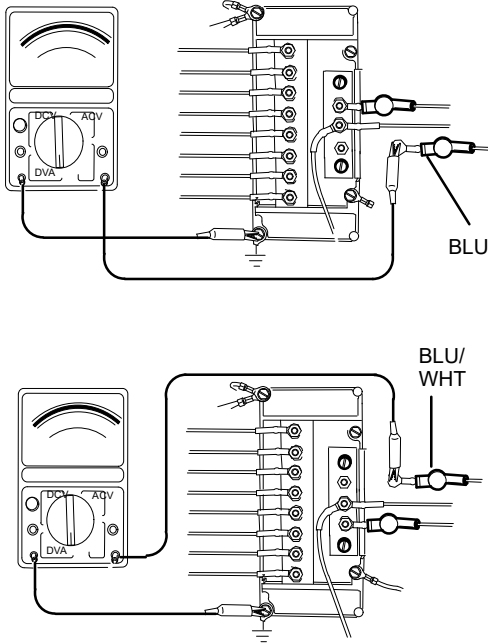




# Ignition Troubleshooting (Engines With Red Stator)

## STEP 5 – Stator, Adapter Module, and Switch Box Test

### Elimination Test



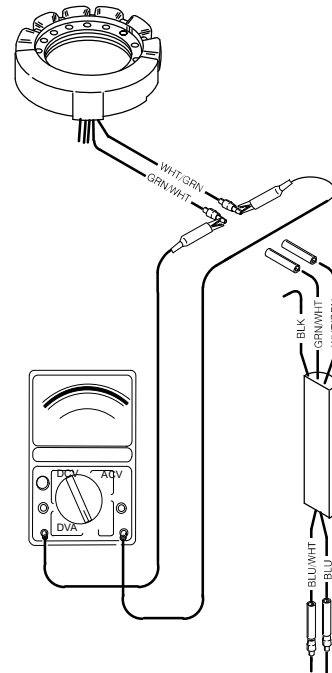
1. Set multipurpose switch position to – 400 DVA.
2. Disconnect only the BLU wire from the switch box. Connect test leads between BLU wire and engine ground.
3. Crank engine and observe meter reading.
4. Reconnect BLU wire.
5. Disconnect only the BLU/WHT wire from the switch box. Connect test leads between BLU/WHT wire and engine ground.
6. Crank engine and observe meter reading.

Voltage at 300 RPM (cranking)
190 to 260 Volts

### TEST RESULTS

- If voltage output is good on both wires, the switch box is defective.
- Voltage output is low on either wire, continue with test.

7. Disconnect the GRN/WHT and WHT/GRN (stator) leads from the adapter module.



8. Measure the resistance between the GRN/WHT and WHT/GRN (stator) leads.

Test Leads To –	Ohm Scale	Meter Reading
Between GRN/WHT and WHT/GRN (Stator) leads	R x 100	660-710 Ohms

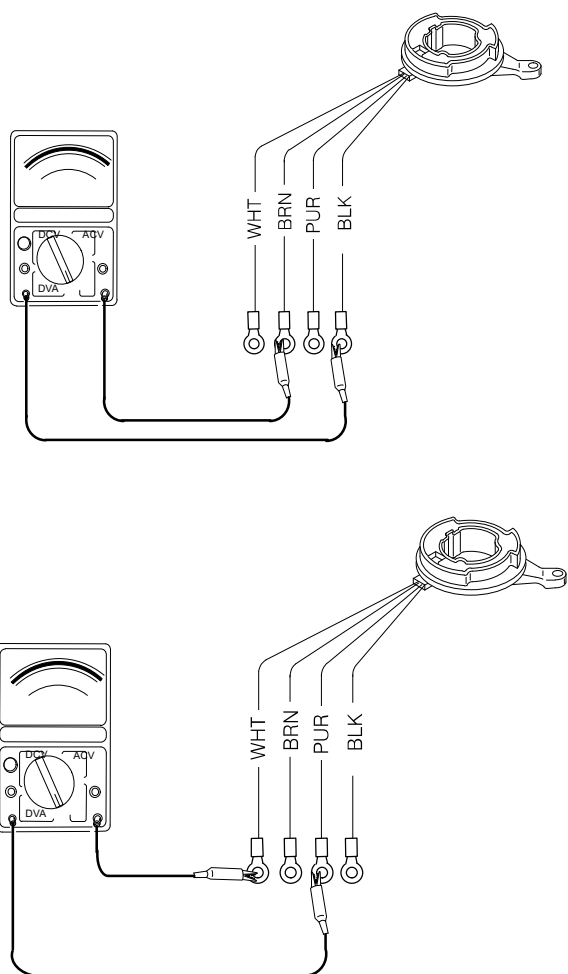
### TEST RESULTS

- If the resistance is OK (660 to 710 ohms), the adapter module is defective. Replace adapter module.
- If the resistance is incorrect, the stator is defective. Replace stator.



# Ignition Component Testing

## Trigger Test



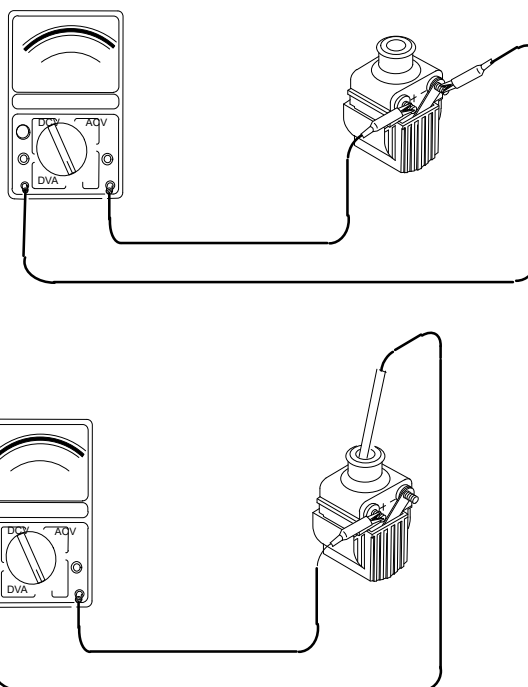
1. Disconnect all trigger leads from switch box.
2. Use a VOA meter and perform the following checks.

Test Leads To –	Ohm Scale	Meter Reading
Between BRN lead and BLK lead	R x 100	700-1000 Ohms
Between WHT lead and PUR trigger lead	R x 100	700-1000 Ohms

**NOTE:** Above resistance readings are for a cold engine (room temperature). Resistance will increase if engine is warm.

3. If meter readings are not as specified, replace trigger.

## Ignition Coil Test



1. Disconnect wires from coil terminals.
2. Pull spark plug lead out of coil tower.
3. Use a VOA meter and perform the following checks.

Test Leads To –	Ohm Scale	Meter Reading
Between (+) and (-) Coil Terminals	R x 1	.02-.04* Ohms
Between Coil Tower and (-) Coil Terminal	R x 100	800-1100** Ohms

\* The primary DC resistance of these coils generally is less than one (1) OHM. If a reading resembling a short is obtained, this would be acceptable.

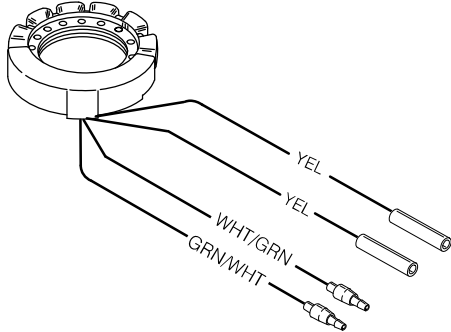
\*\* Copper wire is an excellent conductor, but it will have a noticeable difference in resistance from cold to hot temperatures. Reasonable variations from these readings are acceptable.

4. If meter readings are not as specified, replace ignition coil.

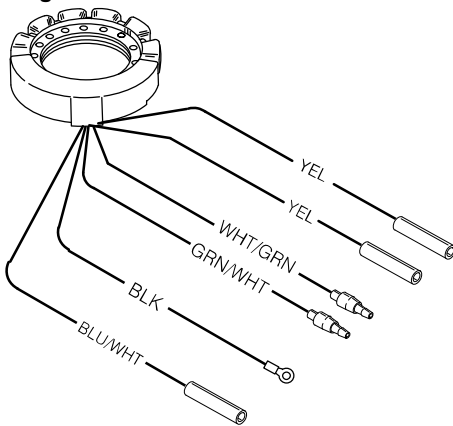


## Stator Test (Red Stator)

### Electric Start Engines



### Manual Start Engines



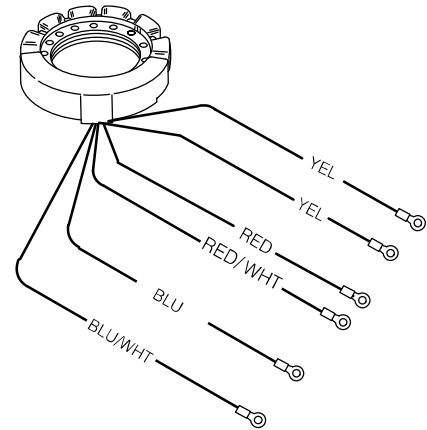
1. Disconnect all stator leads.
2. Use a VOA meter and perform the following checks.

Electric Start Engines		
Test Leads To –	Ohm Scale	Ohm Reading
GRN/WHT and WHT/GRN	R x 100	660-710
YEL and YEL	R x 1	0.165–0.181
Manual Start Engines		
Test Leads To –	Ohm Scale	Ohm Reading
GRN/WHT and WHT/GRN	R x 100	660-710
BLK/WHT and BLK	R x 100	130-145
YEL and YEL	R x 1	0.17–0.19

**NOTE:** Above resistance readings are for a cold engine (room temperature). Resistance will increase if engine is warm.

If meter readings are other than specified, replace stator.

## Stator Test (Black Stator)



1. Disconnect all stator leads.
2. Use a VOA meter and perform the following checks.

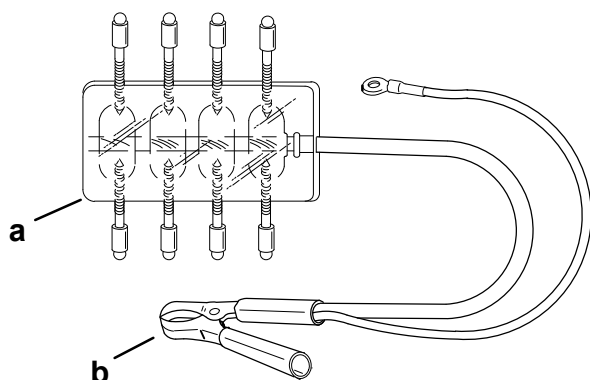
9 AMP Stator		
Test Leads To –	Ohm Scale	Ohm Reading
Blue and Blue/White	R x 1000	5.7-8.0
Red and Red/White	R x 1	56-76
Blue and Engine Ground	R X 1000	No Reading
Red and Engine Ground	R X 1000	No Reading
YEL and YEL	R x 1	.5-1.0
16 AMP Stator (398-9710A33 & 398-9710A42)		
Test Leads To –	Ohm Scale	Ohm Reading
Blue and Blue/White	R x 1000	1000-1400
Red and Red/White	R x 1	15-30
Blue and Engine Ground	R X 1000	No Reading
Red and Engine Ground	R X 1000	No Reading
YEL and YEL	R x 1	.10-.50

**NOTE:** Above resistance readings are for a cold engine (room temperature). Resistance will increase if engine is warm.

If meter readings are other than specified, replace stator.



## Test For Spark (Cranking)



- a - Spark Tester 91-850439
- b - Connect Ground Lead To Engine Ground

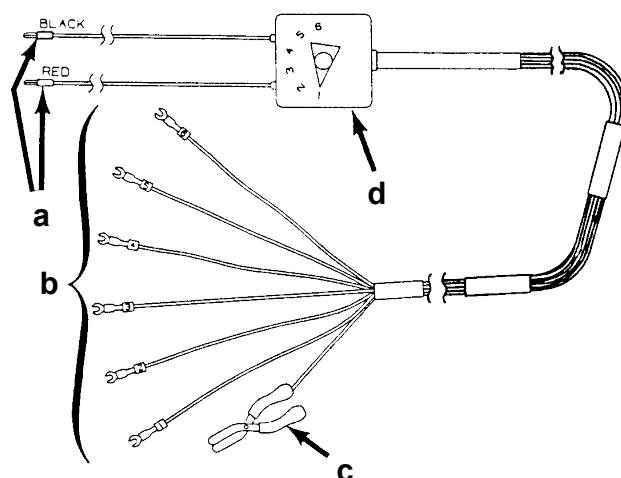
1. Remove the spark plug leads from the spark plugs.
2. Adjust the spark tester to 1/2 in. (12mm) gap setting.
3. Connect the spark plug leads to the tester. Attach the tester ground lead to engine ground.
4. Crank the engine. Spark should jump each tester gap.

### TEST RESULTS

**NOTE:** Normal ignition spark is BLUE in color. A YELLOW or RED spark indicates a weak ignition.

- Normal spark on all cylinders. Go to Primary Voltage Test (Engine Running).
- Intermittent, weak or no spark output on all cylinders usually indicates a defective trigger. Go to Trigger Test.
- Intermittent, weak or no spark output on any one cylinder indicates a bad ground, defective ignition coil, defective spark plug lead, or switch box. Go to Ignition Coil Test.

## Primary Voltage Test (Engine Running)



- a - Plug into Meter
- b - Attach to Appropriate Terminals
- c - Attach to Engine Ground
- d - Selector Switch

1. If the ignition system tests OK, it may be necessary to check the output voltage while running the engine under load up to 4000 RPM. Using Test Harness 91-14443A1 allows performing DVA Tests from the driver seat inside the boat. Refer to DVA Tests preceding.



## Ignition (Key) Switch Test

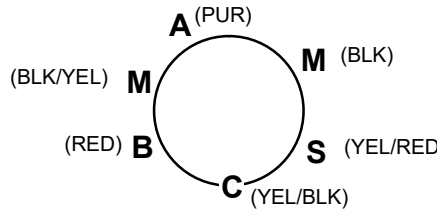
1. Disconnect remote control wiring harness and instrument panel connector.

**NOTE:** Wiring diagram for control boxes is located in SECTION 2D.

2. Set ohmmeter on R x 1 scale for the following tests:

### COMMANDER KEY SWITCH

BLK • BLACK  
PUR • PURPLE  
RED • RED  
YEL • YELLOW



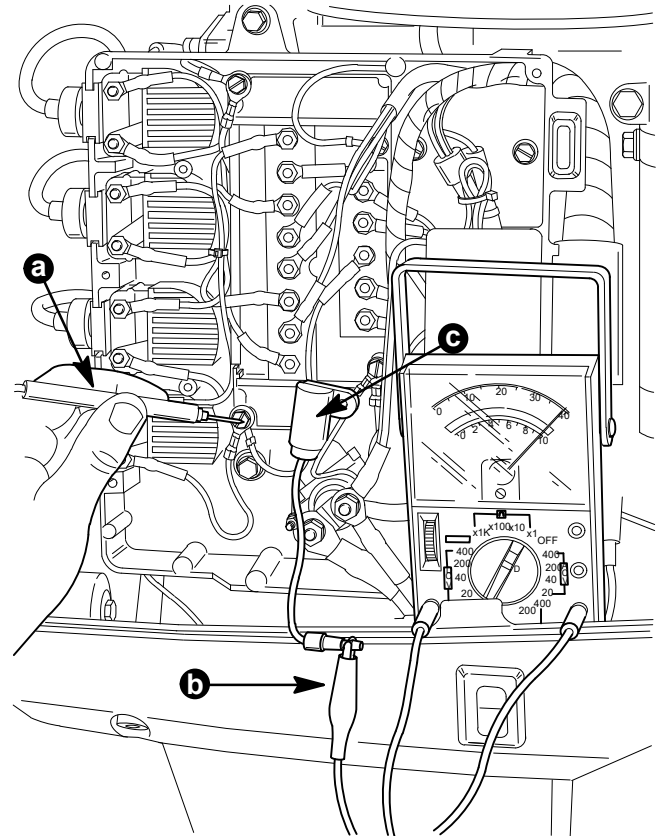
KEY POSITION	CONTINUITY SHOULD BE INDICATED AT THE FOLLOWING POINTS:					
	BLK	BLK/YEL	RED	YEL/RED	PUR	YEL/BLK
OFF	• - - - - •					
RUN			• - - - - •		• - - - - •	
START			• - - - •	• - - - •	• - - - •	
CHOKE*			• - - - •	• - - - •	• - - - •	• - - - •

\* Key switch must be positioned to "RUN" or "START" and key pushed in to actuate choke, for this continuity test.

3. If meter readings are other than specified in the preceding test, verify that switch and not wiring is faulty. If wiring checks OK, replace switch.

## Mercury (Tilt) Stop Switch Test

1. Remove mounting screw that secures mercury switch to outboard.
2. Connect Ohmmeter (R x 1 scale) between black lead and black/yellow lead or terminal stud on mercury switch.
3. Test mercury switch as follows:
  - a. Position mercury switch as it would be installed when engine is in "down" position. The meter should indicate no continuity.
  - b. Tilt mercury switch up. The meter should indicate continuity.
  - c. If these readings are not obtained, replace mercury switch.



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- a - Red Ohm Lead  
b - Black Ohm Lead  
c - Mercury Switch