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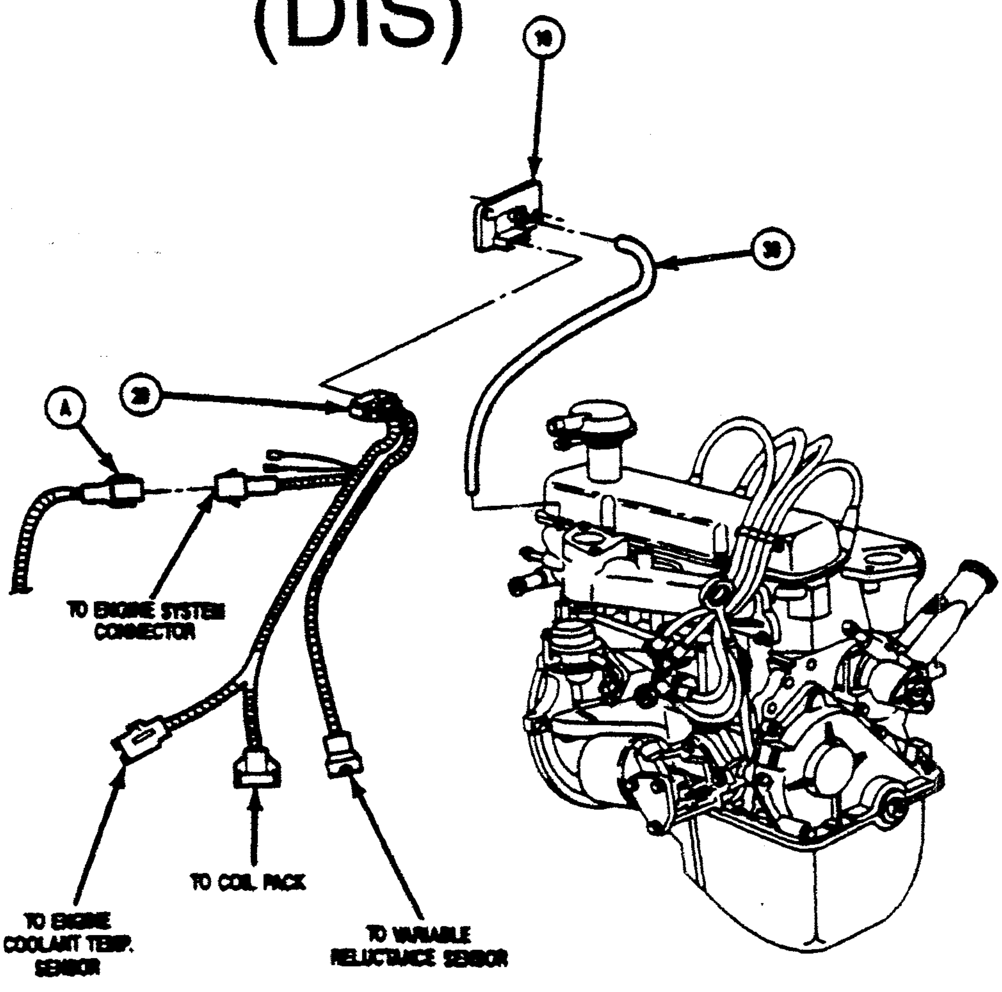
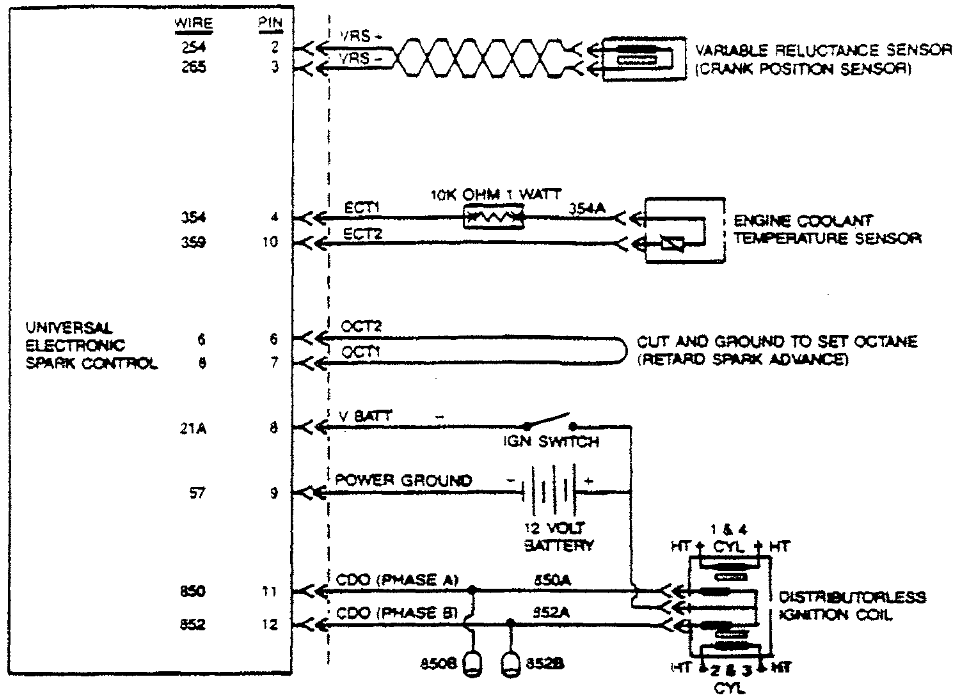
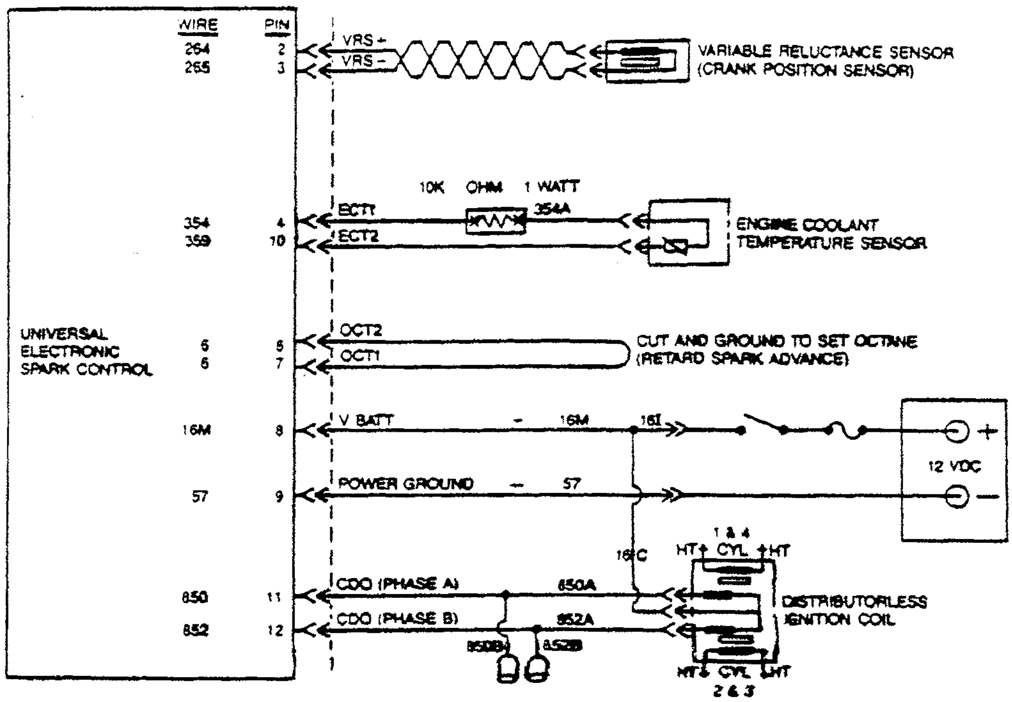
VSG-411/413 ENGINE DISTRIBUTORLESS IGNITION SYSTEM (DIS)





VSG DISTRIBUTORLESS IGNITION SYSTEM (DIS) WIRING DIAGRAM REFERENCE (E8JL-12A200-AC)

UESC PIN	NO	CIRCUIT DESCRIPTION	GA	BASIC COLOR	STRIPE COLOR	SPEC
		BLANK (NO WIRE)				
2	264	UESC TO VRS +	18	WHITE		
3	265	UESC TO VRS –	18	GREEN		
4	354	UESC TO RESISTOR	18	BROWN	WHITE	
5		BLANK (NO WIRE)				
6	6	UESC SPARK RETARD OS2	18	BROWN		
7	6	UESC SPARK RETARD OS1	18	BROWN		
8	21A	UESC TO IGN ON IGN SWITCH (SWITCHED)	18	YELLOW		
9	57	UESC TO BAT GROUND	18	BLACK		
10	359	UESC TO ECTS GROUND	18	GREEN	WHITE	
11	850	UESC TO SPLICE	18	YELLOW	BLACK	
12	852	UESC TO SPLICE	18	YELLOW	WHITE	
—	16	DIS COIL TO BAT POWER (NOT SWITCHED)	18	RED	GREEN	
—	354A	RESISTOR TO ECTS	18	BROWN	WHITE	
—	850A	SPLICE TO DIS COIL 1	18	YELLOW	BLACK	
—	850B	SPLICE TO ELECTRONIC GOVERNOR OR TACHOMETER	18	YELLOW	BLACK	
—	852A	SPLICE TO DIS COIL 2	18	YELLOW	WHITE	
—	852B	SPLICE TO ELECTRONIC GOVERNOR OR TACHOMETER	18	YELLOW	WHITE	



VSG DISTRIBUTORLESS IGNITION SYSTEM (DIS) WIRING DIAGRAM REFERENCE (E8JL-12A200-AD)

UESC PIN	NO	CIRCUIT DESCRIPTION	GA	BASIC COLOR	STRIPE COLOR	SPEC
1		BLANK (NO WIRE)				
2	264	UESC TO VRS +	18	WHITE		
3	265	UESC TO VRS −	18	GREEN		
4	354	UESC TO ECTS	18	BROWN	WHITE	
5		BLANK (NO WIRE)				
6	6	UESC SPARK RETARD OS2	18	BROWN		
7	6	UESC SPARK RETARD OS1	18	BROWN		
8	16M	UESC PIN 8 TO SPLICE	18	RED	GREEN	
9	57	UESC TO BAT GROUND	18	BLACK		
10	359	UESC TO ECTS	18	GREEN	WHITE	
11	850	UESC TO DIS COIL 1 SPLICE	18	YELLOW	BLACK	
12	852	UESC TO DIS COIL 2 SPLICE	18	YELLOW	WHITE	
—	16C	DIS COIL TO SPLICE	18	RED	GREEN	
—	354A	RESISTOR TO ECTS	18	BROWN	WHITE	
—	16I	IGNITION SWITCH TO SPLICE	18	RED	GREEN	
—	852B	SPLICE TO ELECTRONIC GOVERNOR — TACHOMETER	18	YELLOW	WHITE	
—	852A	SPICE TO DIS COIL 2	18	YELLOW	WHITE	
—	850B	SPLICE TO ELECTRONIC GOVERNOR — TACHOMETER	18	YELLOW	BLACK	
—	850A	SPLICE TO DIS COIL 1	18	YELLOW	BLACK	

DIAGNOSING AND TESTING DIS

DIS DIAGNOSIS EQUIPMENT

To accurately diagnose DIS, certain diagnostic equipment and tools are required. In addition, the suggested diagnostic equipment may make the job easier and more convenient.

Prior to diagnosing DIS, obtain the following test equipment or equivalent.

- DIS diagnostic harness PPO111429 or equivalent
- SPARK TESTER, NEON BULB TYPE (CHAMPION CT-436 OR EQUIVALENT)

There is no need to disconnect a plug wire: just place this spark tester on a spark plug wire to determine if spark is being provided to the plug. This is especially useful for those hard to reach plug wires.

- SPARK TESTER, GAP TYPE (SPECIAL SERVICE TOOL D81P-6666-A OR EQUIVALENT)

Connect this gap type spark tester between any spark plug wire and engine ground to instantly determine if spark is being provided to the plug. A spark plug with a broken side electrode is not sufficient to check for spark and may lead to incorrect results.

- VOLT-OHMMETER (ROTUNDA 014-00575 OR EQUIVALENT)

A volt-ohmmeter is essential for gathering system operating data during diagnosis, testing, and engine servicing procedures. This digital volt-ohmmeter (DVOM) can also be used for general purpose electrical troubleshooting on conventional starting and charging systems.

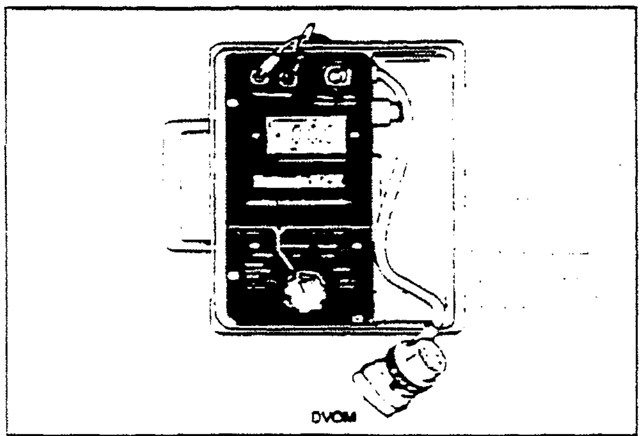


FIG. 10 Volt-Ohmmeter

- 12-14 VOLT TEST LAMP

TIMING LIGHT (ROTUNDA 059-00006 OR EQUIVALENT)

This timing light uses an inductive pickup for convenience and safety on 12 volt systems. This timing light includes a tachometer which reads from zero to 3000 RPM (Figure 11).

DIS DIAGNOSING

Identify the engine harness Ford part number and use the following electrical harness part number sketch that corresponds to the engine harness part number being checked.

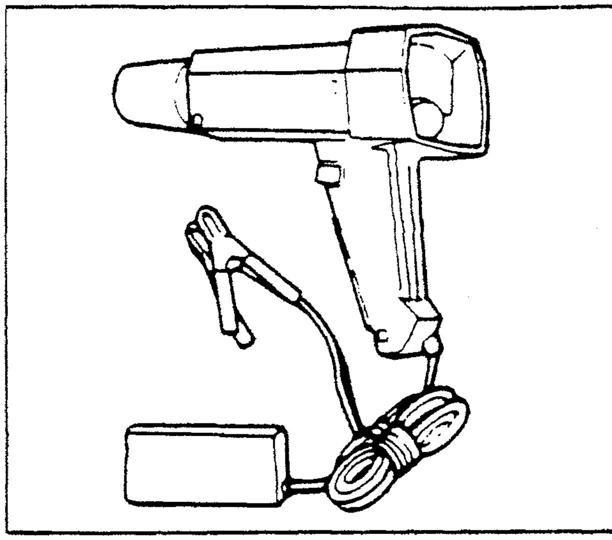


FIG. 11 Timing Light

The first check will test the engine harness, connectors and sensors for both continuity and resistance.

1. Remove the 12 pin UESC harness plug from the UESC module. Pins 1 and 5 are not used, therefore, do not have female connectors in the 12 pin harness connector plug.
2. Check the following circuits with the volt-ohmmeter (with the sensors connected) per the following chart with reference to pages; 2B-06 through 2B-15.

If the DIS Engine Harness checks are not to the chart specifications (page 2B-⚠), complete the following:

- Remove the wire harness connector to the UESC
- Remove each sensor or component from the harness
- Using a high impedance digital volt-ohmmeter (DVOM) check each wire for continuity or resistance (ref. 2B-⚠) for wire numbers & colors for the harness being used.
- If the wire harness has open circuits or resistance higher than specifications repair or replace the harness.
- If the wire harness checks are to specifications — reconnect each sensor and component and complete another DIS Engine Harness check (ref. page 2B-⚠)
- If the same sensor or component circuit does not test to specifications — replace that sensor or coil.
- If the engine will not start and/or run install a new module and make a normal start.

⚠ *Use the electrical sketch that corresponds to harness part number reference pages 2B-06-2B15 and fold-out page.*

DIS ENGINE HARNESS CHECKS (UESC HARNESS CONNECTOR REMOVED ALL SENSORS CONNECTED TO HARNESS)

Test No.	Engine Harness (12A200) Part Number	Harness Connector PIN Nos.	DVOM Set Selection	Reading Ohms/VDC	Codes	Description of Circuit, Wires Checked & Circuit Function
1	E8JL-AC, AD	2 to 3	Ω	200-600		Engine RPM & Crank Position, Wires 264, 265 & V.R. Sensor
2	E9JL-CA	Same as Test 1				
3	E9JL-CB, CC	Same as Test 1				
4	E8JL-AC, AD	4 to 10	Ω	105,000④	①③	Eng. Coolant Temp. Sensor, Wires 354, 354A and 359.
5	E9JL-CA	Same as Test 4				
6	E9JL-CB, CC	4 to 10		95,000④	①②	Eng. Coolant Temp. Sensor, Wires 354 & 359.
7	E8JL-AC, AD	6 to 7	Ω	Continuity 0.00 Resis.		Eng. Spark Adv. Circuit, Wires 6 & 6 No Grounds Equals S/A Set for 87 Oct.
8	E9JL-CA	Same as Test 7				
9	E9JL-CB, CC	Same as Test 7				
10	E8JL-AC*	8 to 9	20 VDC	12 VDC		With the Ignition Switch "ON" — Wires Checked 21A, 16M & 57.
11	E9JL-CA	Same as Test 10				*AD & CC-Ign. Switch "ON", Wires Checked 16I, 16C, 16M & 57 — 12 VDC Inidcated
12	E9JL-CB*	Same as Test 10				
13	E8JL-AC, AD	11 to 12	Ω	0.5-1.0		Wires 850 or 850A, 852 or 852A & Coil Circuit Has Cointinuity.
14	E9JL-CA	Same as Test 13				
15	E9JL-CB, CC	Same as Test 13				
16	E8JL-AC	Coil Sec. 1-4**	Ω	14000 ± .05		**Remove the 4 Spark Plug Wires and Measure the Sec. Resistance.
17	E9JL-CA	Same as Test 16				
18	E9JL-CB	Same as Test 16				
19	E8JL-AC	Coil Sec. 2-3	Same as Test 16			
20	E9JL-CA	Same as Test 16				
21	E9JL-CB	Same as Test 16				

H.T. spark plug wire resistance 9,000 to 16,000 ohms — (maximum 30,000 per wire)

CODES — TEMPERATURE SENSOR CHARACTERISTICS CHART (TSCC)

① Column A converts the sensor only resistance to a temperature reading (page 2B-07)
Column B converts the sensor and harness resistance to a temperature (page 2B-07)
② Use column A when the sensor is connected to the harness (page 2B-07) (Harness does not have 10K resistor)
③ Use column B when the sensor is connected to the harness (page 2B-07) (Harness has 10K resistor)
④ E.C.T.S. brass only in 32°F ice water

REMOVAL AND INSTALLATION

IGNITION COIL

Removal

1. Disconnect battery ground lead.
2. Disconnect ignition coil multiplug.

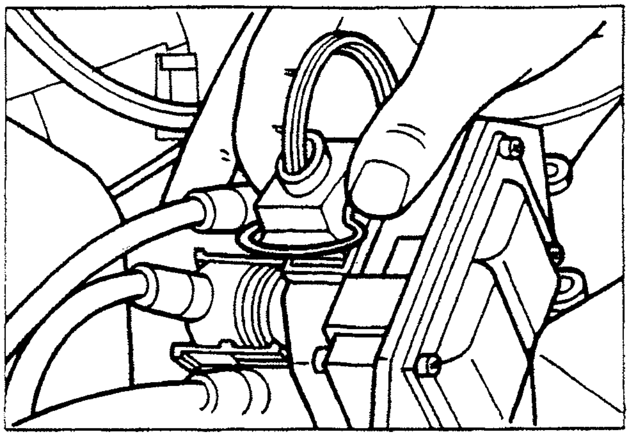


FIG. 3 Removing Ignition Coil Multiplug

3. Compress 2 lugs and disconnect HT leads at coil.

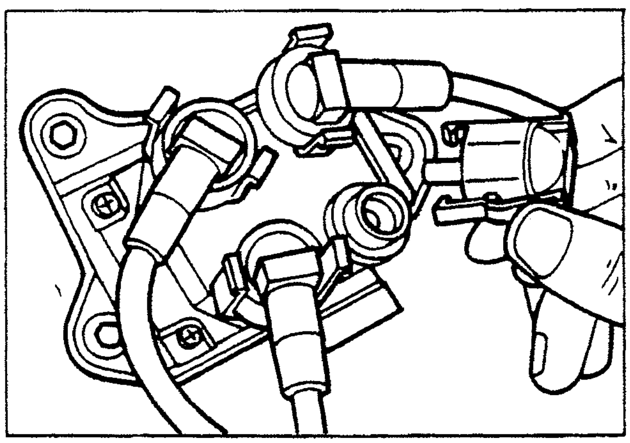


FIG. 4 Disconnecting HT Leads

4. Remove three screws and detach coil assembly.

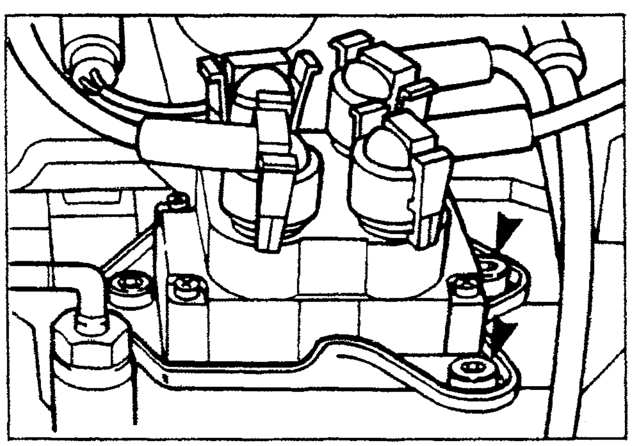


FIG. 5 Ignition Coil Retaining Screws

Installation

1. Position coil assembly, secure with three screws.
2. Connect HT leads at coil, ensuring that locking tabs snap into position.

NOTE: HT connections at coil are marked 1 to 4. It is important that each HT lead is connected in correct sequence.

3. Connect ignition coil multiplug.
4. Connect battery ground lead. Start engine and check coil operation.

ENGINE SPEED SENSOR

Removal

1. Disconnect battery ground cable.
2. Disconnect multiplug from sensor. Remove engine speed sensor, (one screw).

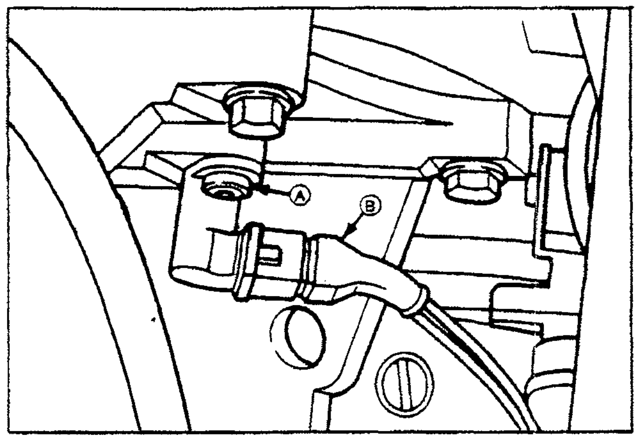


FIG. 6 Engine Speed Sensor
A — Retaining Bolt
B — Multiplug

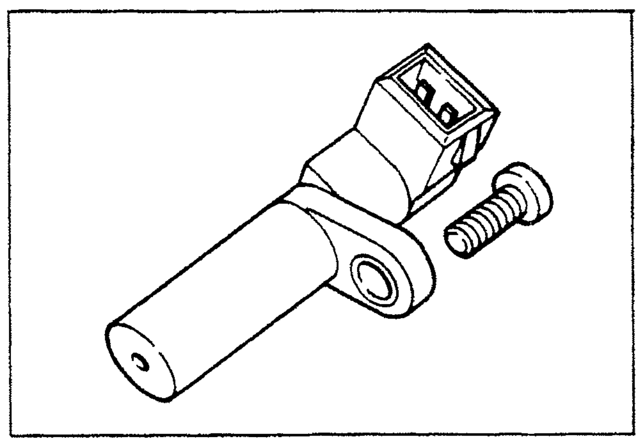


FIG. 7 Engine Speed Sensor (Removed)

Installation

1. Fit engine speed sensor and secure with screw.
2. Refit sensor multiplug.
3. Connect battery ground cable.

ENGINE COOLANT TEMPERATURE SENSOR

Removal

1. Disconnect battery and release cooling system pressure.

WARNING: When releasing system pressure, cover cap with a thick cloth to prevent coolant scalding.

2. Place a clean drain tray below engine under radiator drain plug and remove drain plug. To assist draining remove radiator cap.
3. Remove temperature sensor multiplug, located below the intake manifold. To remove multiplug, pull on multiplug, do not pull on wiring.
4. Unscrew sensor from intake manifold

Installation

1. Install sensor into inlet manifold, do not overtighten sensor. Connect multiplug, ensuring that locking tabs snap into position.
2. Replace radiator drain plug and refill system with correct solution. Remove rubber blanking cap on water outlet. When coolant is evident, refit blanking cap. Fill container to "maximum" mark allowing time for air in system to bubble through. Install radiator cap.
3. Connect battery and start engine. Allow engine to warm to normal operating temperature. Check, and if necessary, add coolant.

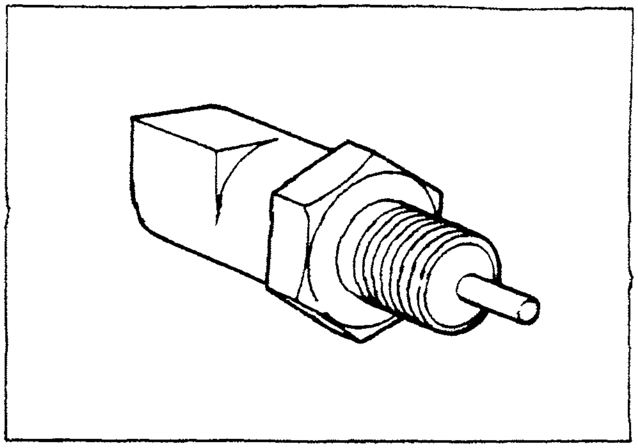


FIG. 8 Temperature Sensor

PART 2B — Ignition System — Distributorless

WARNING

- High tension voltage produced by a distributorless ignition system is higher than for a conventional ignition system.
- When carrying out service operations on an engine equipped with distributorless ignition, it is important to be aware of the above point as well as all the usual safety measures to prevent the possibility of electric shocks.

DESCRIPTION

The purpose of an engine's ignition system is to ignite the fuel/air mixture at the correct time and sequence based upon the input it receives.

The Distributorless Ignition System (DIS) used on the VSG 411/413 engines is a state-of-the-art ignition system. The brain of this system is the Universal Electronic Spark Control (UESC) module. This module normally receives four inputs:

- Crankshaft position
- Crankshaft speed
- Engine temperature
- Engine vacuum (load)

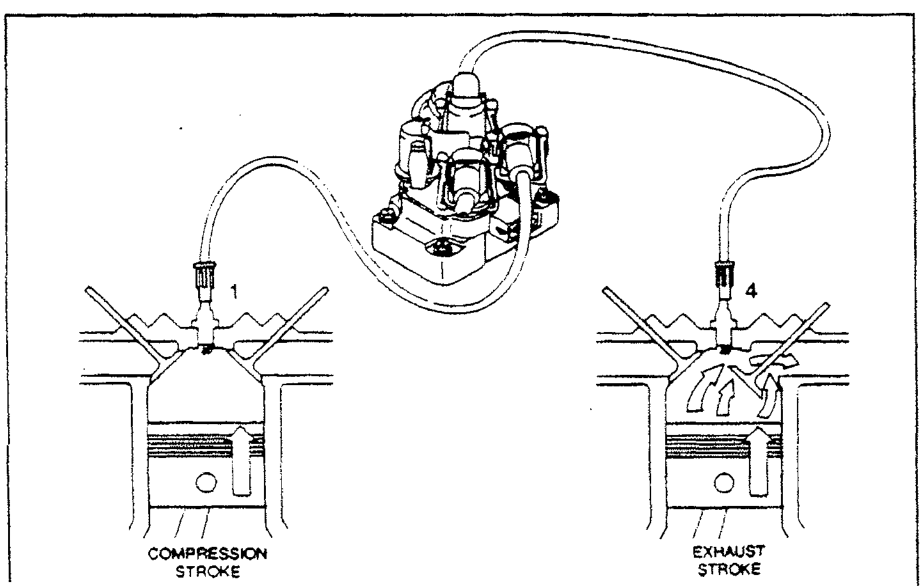
From these inputs, the UESC computes spark strategy (spark advance) to obtain optimum engine performance for correct input conditions.

OPERATION

With this system, the electronic control module monitors the engine load, speed, and operating temperature and decides what degree of spark advance is correct for all of the operating conditions. This system maximizes the benefits of the high compression swirl design. Because timing is set for life inherently in the design of the engine, and there are no moving parts in the ignition system itself, no maintenance is required except for periodic spark-plug checks. The system provides for fixed spark advance at start-up, for cold weather starting, fixed advance for service checking, and for "average value" default settings in case of component failure. Particular attention has been given to spark optimization for excellent fuel economy in the warm-up mode, which is coupled with improved warm-up and a new carburetor.

The spark plugs are paired so that one plug fires during the compression stroke and its companion plug fires during the exhaust stroke. The next time that coil is fired, the plug that was on exhaust will be on compression, and the one that was on compression will be on exhaust. The spark in the exhaust cylinder is wasted but little of the coil energy is lost.

The spark strategy is based on sensors and manifold vacuum input to the UESC module, which include the following **inputs:**



1. Engine Speed and C/S Position

The crankshaft position and speed information comes to the UESC from the Variable Reluctance Sensor (VRS). The VRS is triggered by teeth cast into the engine side of the flywheel. The 36-1 teeth, spaced 10° apart, indicate to the UESC the crankshaft speed. The missing tooth indicates crankshaft position.

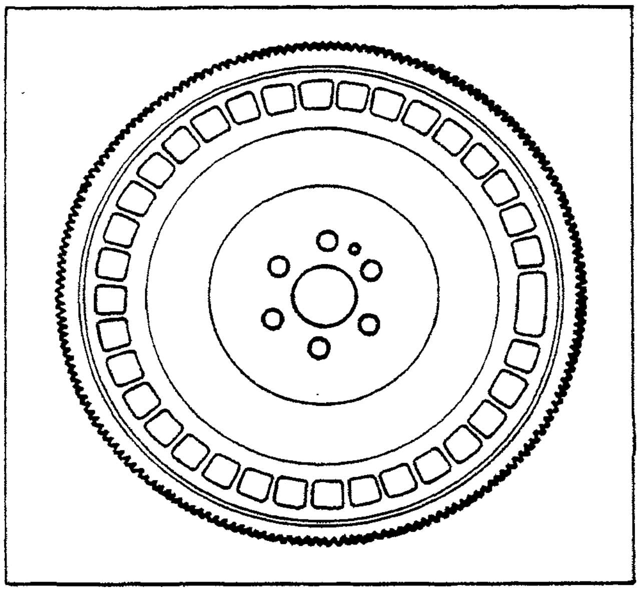


FIG. 2 Toothed Flywheel

2. Engine Load

The engine load information is processed into the UESC's electronics by a pressure transducer located within the UESC. A vacuum line connects the transducer to the engine intake manifold. The engine vacuum is proportional to it's load.

3. Engine Temperature

The Engine Coolant Temperature Sensor (ECTS) sends engine temperature information to the UESC. The ECTS is located in the intake manifold water jacket.

4. Fuel Octane Level Adjustment

Another input to the UESC (which is not usually used in the U.S.) retards the spark.

The UESC module outputs are:

IGNITION COIL DRIVER

The UESC switches two ignition coils on and off at the correct times to give the desired spark advance.

SENSOR FAIL-SAFE

If the UESC identifies a failure of any of its inputs, other than the engine speed/position sensor, it will substitute a fixed value for that input until such time that the fault on the input is rectified. A failed sensor is defined as the instantaneous reading of a sensor being made that is either above or below the maximum or minimum reading as defined by the system constants below:

Engine Coolant Temperature	minimum -39°C	(-38°F)
	maximum 112 °C	(232°F)
Manifold Absolute Pressure	minimum 21 KPA	(6.22" Hg)
	maximum 101 KPA	(29.91" Hg)

Ignition timing is adjusted constantly by the UESC module. Many factors, including all the sensors affect the final ignition setting.

CRANKING MODE

Cranking mode is the area of engine operating speed within which the ignition timing is at a static position. The static spark advance is fixed at 10 degrees BTDC up to 250 RPM.

RUN MODE

In this mode the RPM is above 250 and the spark advance is calculated in three main sections which are added together. The UESC sections are: Base Spark Advance (BSA) plus Spark Advance Offset Temperature (SAOT) plus Spark Advance Offset Detonation ECT (SAODE).

The final spark advance is then corrected, for propagation delays and finally the spark advance is limited by the system ranges and the spark slew rate limited.

The Base Spark Advance (BSA) is calculated by the UESC module looking at speed and load inputs.

The Spark Advance Offset Temperature (SAOT) will change ignition timing from the function of Engine Coolant Temperature (ECT). This allows the spark advance to be altered during cold engine conditions to improve starting and operation.

Spark Advance Offset Detonation ECT (SAODE) the ignition timing is offset as a function of Engine Coolant Temperature (ECT). This allows the spark advance to be reduced during hot engine conditions to avoid detonation and allow base spark advance to be calibrated near to the best performance curve.

TRANSIENT MODE

This function is to provide detonation protection when the engine load is increased rapidly by fast opening of the throttle plate. Rapid increases in engine load are determined by large changes in consecutive Manifold Absolute Pressure (MAP) values to the UESC module.

OVERSPEED MODE

If the instantaneous engine speed is greater than the maximum speed threshold, then the spark events are terminated until the instantaneous engine speed falls below 6375 RPM. During this time all other UESC calculations are performed as normal.

SERVICE ADJUSTMENTS AND CHECKS

1. Each 400 hours of engine operation remove the spark plugs and clean & adjust the electrode.
2. Clean and visually check spark plug high tension leads and check for secure fit, replace if necessary.
3. To retard the spark advance if the engine is operated on lower than specified fuel octane it may be necessary to retard the timing. 87 octane or higher fuel does not require any adjustment.
4. To retard the spark advance, cut the wire loop in the harness that connects to pins number 6 and 7. For assistance, or further information, consult Ford Power Products Engineering.

Pin Grounded	Pin Above Ground	Retarded °
7	6	1-2
6	7	2-4
6&7		6-8

The UESC module must be mounted above the intake manifold vacuum fitting to prevent fuel from entering the UESC module chamber.

The connecting rubber hose must be compatable with gasoline and be as short as possible. It is recommended that a fuel vapor trap be used in line in the connecting hose.

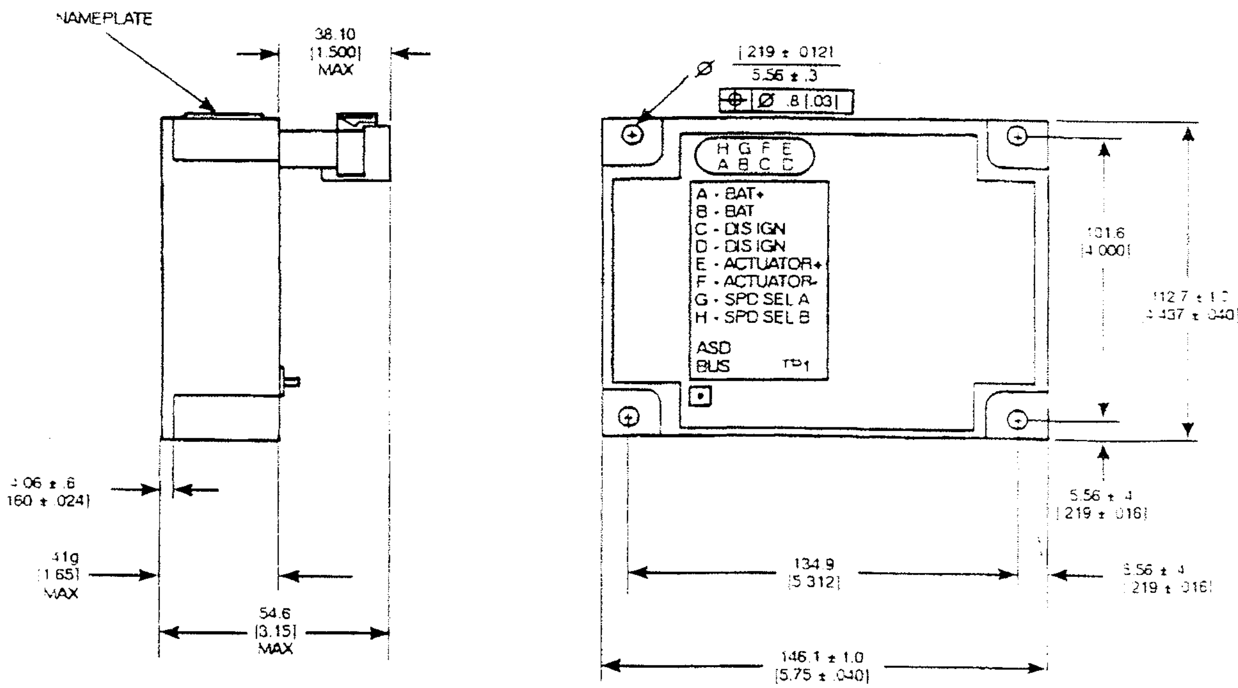
ELECTRONIC DIAGNOSIS AND TESTING

…vernor system is comprised of three major components: the carburetor, actuator and controller. The objective of this document is to help a technician identify which component is creating a problem so it can be fixed or replaced.

CONDITION	POSSIBLE SOURCE	ACTION
I. Governor appears dead.	1. Battery power is not supplied to controller.	Remove the connector from the controller and with a voltmeter check for battery power across pins A & B of the wiring harness connector.
		If battery power is not present, check wiring to the controller.
	2. Controller is not receiving the speed signal NOTE: This controller receives its speed signal from the ignition.	If the controller is connected to an engine with a distributor, pins C & D should both be connected to the negative side of the coil, or the tachometer output.
		If the controller is connected to an engine with a DIS ignition, pin C should be connected to one of the two tachometer outputs, and pin D should be connected to the other tachometer output. The DIS ignition utilizes two coils. NOTE: Do not short the tach leads; doing so could damage the spark controller.
		Using an ohmmeter, check continuity from pins C & D to the termination points. If continuity is not present, repair the wiring.
	3. Actuator fails to operate.	Remove the 2-pin connector at the actuator. With a DC voltmeter, check between the purple wire and chassis (battery) ground. The voltmeter should read 12 volts, ± 2 volts.
		If the voltage is low, disconnect the 8-pin connector from the controller, and check continuity between the wiring harness pins E & F, to their respective actuator terminals. If there is no continuity, check for openings in the wires.
		Using a voltmeter, check for battery voltage from controller terminal E to chassis (battery) ground. If battery power is not found, replace the controller and check the actuator and actuator wiring for grounds and shorts. NOTE: Check wiring before replacing controller. Bad wiring might destroy the new controller.
		Check continuity across actuator wires. 2 ohms ± .5 ohm should be measured. Check the continuity of actuator wires to the case. The ohms measured should be 1M or greater. If these values are out of tolerance, replace actuator.
II. Engine doesn't change speeds.	1. Incorrect engine speed.	With the engine running, connect battery power to pin H. This will select Run 2. If Run 2 is set a higher speed than Run 1 and the speed does not change, replace the controller. Contact OEM for speed settings.
		With the engine running, connect battery power to pin G. This will select Run 3. If Run 3 is set higher than the previous speed and the speed does not change, replace the controller. Contact OEM for speed settings.
		With the engine running, connect battery power to pins G & H. This will select Run 4. If Run 4 is set higher than the previous speed and the speed does not change, replace the controller. Contact OEM for speed settings.

ELECTRONIC DIAGNOSIS AND TESTING (Continued)

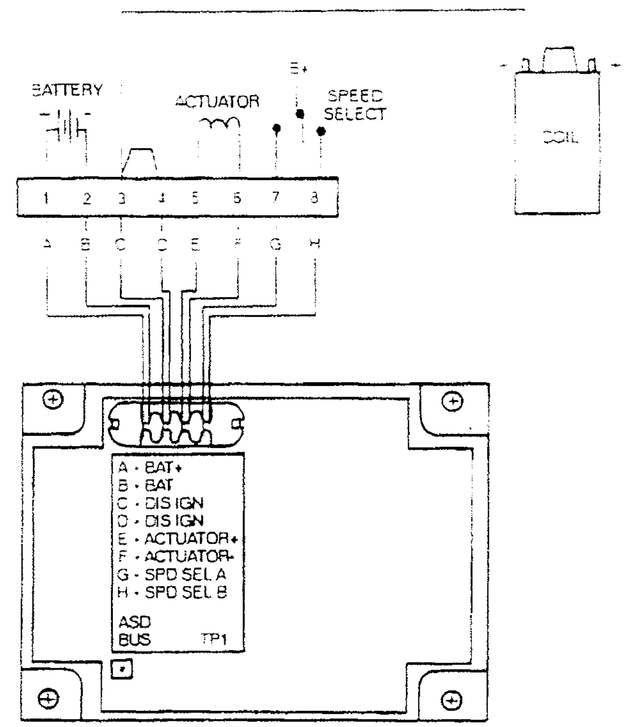
CONDITION	POSSIBLE SOURCE	ACTION
III. Engine is hunting.	1. Engine is misfiring due to idle mixture mis-adjustment. This causes engine hunt at no-load condition.	Disconnect the connector from the controller. The governor is now disabled and a warm engine should be running at a mechanical idle of approximately 600 RPM.
		If the engine is not running at the mechanical idle and is governed by an integrated carburetor, loosen the three actuator fasteners and rotate the actuator to achieve an idle of 600 RPM. If the engine is governed by a linear actuator, adjust the idle speed screw to achieve 600 RPM.
		Slowly rotate the idle mixture screw clockwise (CW) until the engine speed begins to decrease. Slowly turn the idle mixture screw counterclockwise (CCW) until the engine speed begins to decrease. Now, turn the idle mixture screw clockwise (CW) until maximum idle speed is achieved. The idle mixture is now adjusted.
	2. Engine is misfiring.	Disconnect the connector from the controller and consult the engine repair manual.

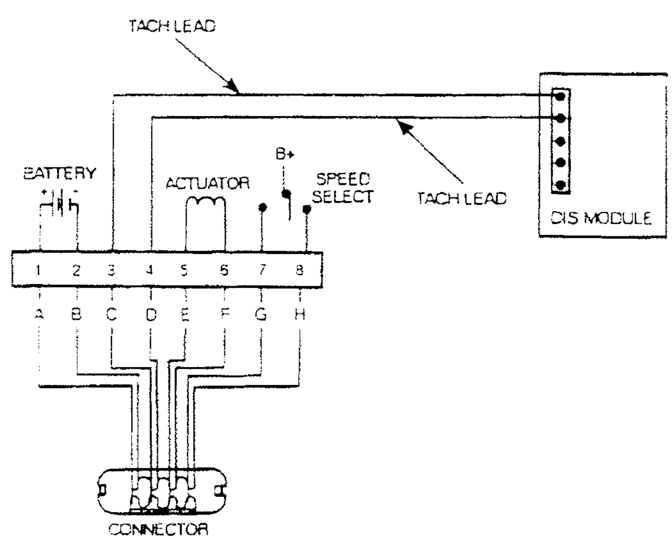


Calibration

Initial speed settings, as well as other parameters, can be set using a special interface connector, and an IBM compatible PC 286 minimum with 640K RAM, of which 512K of conventional RAM must be available. Also required is a 1.44 Meg High Density floppy drive and a VGA graphic display. Programming of the controller is covered in a separate publication.

ELECTRONIC DIAGNOSIS AND TESTING (Continued)





SECTION 07 — Cooling System

DESCRIPTION AND OPERATION

The system is of the full flow type with a centrifugal pump. The thermostat, located in the cylinder head, controls the flow through the system maintaining the proper temperature.

The coolant flow is from the bottom of the radiator to the pump which delivers it to the cylinder block. It then flows through the cored passages to cool the entire length of each cylinder wall. Upon reaching the rear of the cylinder block, the coolant is directed upward into the cylinder head where it cools the combustion chambers, valves and valve seats.

The coolant from the cylinder head flows past the thermostat, if it is open, through the coolant outlet housing and into the top of the radiator.

Another passage in the head routes the warm coolant through the intake manifold to help atomize the fuel mixture, and then through a hose to the inlet hose of the water pump.

ADJUSTMENTS

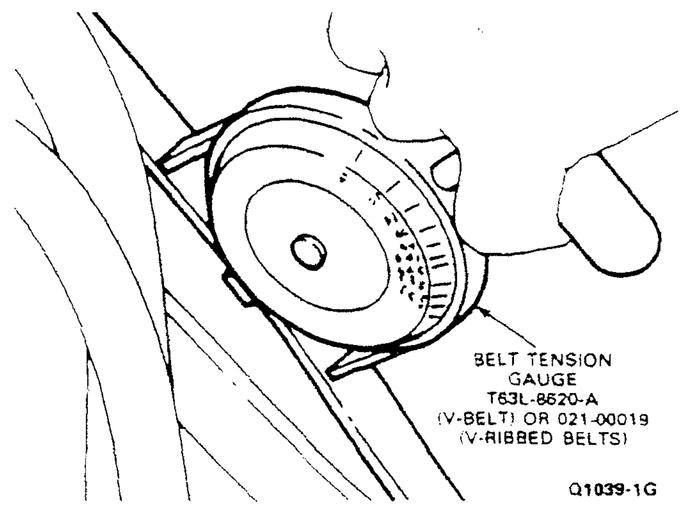
ve Belt

ne fan drive belt should be properly adjusted at all times. A loose drive belt can cause improper generator, fan and water pump operation. A belt that is too tight places a severe strain on the water pump and the generator bearings.

A properly tensioned drive belt minimizes noise and also prolongs the service life of the belt. Therefore, it is recommended that a belt tension gauge be used to check and adjust the belt tension. **Any belt that has been operated for a minimum of 10 minutes is considered a used belt, and when adjusted, it must be adjusted to the used tension shown in the specifications.**

Belt Tension

1. Install the belt tension tool on the drive belt and check the tension.
2. If adjustment is necessary, loosen the generator mounting and adjusting arm bolts. Move the generator toward or away from the engine until the correct tension is obtained. Remove the gauge.
3. Tighten the generator adjusting arm and mounting bolts. Install the tension gauge and recheck the belt tension.



SECTION 08 — Specifications

SPECIFICATIONS

ENGINE MODEL YEARS 1993+

General Specifications	
LSG-411	4 Cylinder — 1.1 Liter
LSG-413	4 Cylinder — 1.3 Liter
Bore and Stroke 1.1L	68.68 and 75.48 mm (2.704 and 2.971 in)
1.3L	73.96 and 75.48 mm (2.912 and 2.971 in)
Firing Order	1-2-4-3
Idle Speed	700-800 rpm
Rated Engine Speed — Maximum	Full Load 2800 rpm
	No Load 3050 rpm
Cylinder Block	
Number of Main Bearings	5
Cast Marks 1.1L	93BM-6015-AA
1.3L	89BM-6015-FA
Cylinder Bore Diameter 1.1L	68.680-68.710 mm (2.7039-2.7051 in)
1.3L	73.94-73.97 mm (2.9110-2.9122 in)
Out-of-Round Maximum	0.038 mm (0.0015 in)
Wear Limit	0.127 mm (0.005 in)
Taper Maximum	0.0254 mm (0.0010 in)
Wear Limit	0.254 mm (0.010 in)
Main Bearing Bore Standard	60.623-60.636 mm (2.3868-2.3872 in)
Oversize	61.003-61.016 mm (2.4017-2.4022 in)
Camshaft Bearing Bore Standard	42.888-42.918 mm (1.6886-1.6896 in)
Oversize	43.396-43.420 mm (1.7086-1.7094 in)
Cylinder Block Liner Bore Diameter 1.1L	71.826-71.852 mm (2.8278-2.8288 in)
1.3L	77.086-77.112 mm (3.0349-3.0359 in)
Deck Height (Oil Pan Rail to Head Deck) 1.1L	194.6 ± 0.065 mm (7.6614 ± 0.0026 in)
1.3L	194.6 ± 0.065 mm (7.6614 ± 0.0026 in)
℄ of Crankshaft Above Oil Pan Rail 1.1L & 1.3L	2.578 ± 0.115 mm (0.1015 ± 0.0045 in)

All specifications are in millimeters (inches).
For Conversion Factors see page 5.

SPECIFICATIONS (Continued)

ENGINE MODEL YEARS 1993+

Piston Pin	
Diameter 1.1L and 1.3L	18.026-18.029 mm (0.7097-0.7098 in)
Length 1.1L	58.6-59.4 mm (2.31-2.33 in)
1.3L	63.6-64.4 mm (2.51-2.53 in)
Interference Fit in Rod at 21°C 1.1L and 1.3L	0.016-0.048 mm (0.0006-0.0018 in)
Clearance in Piston at 21°C 1.1L and 1.3L	0.008-0.014 mm (0.0003-0.0006 in)
Piston Rings	
Top Compression Ring Thickness 1.1L and 1.3L	1.503-1.505 mm (0.05918-0.05925 in)
Bottom Compression Ring Thickness 1.1L and 1.3L	1.728-1.740 mm (0.0680-0.0685 in)
Top Compression Ring Side Clearance 1.1L and 1.3L	.013-.027 mm (0.0005-0.0011 in)
Bottom Compression Ring Side Clearance 1.1L and 1.3L	.005-.042 mm (0.0002-0.0017 in)
Compression Ring Side Clearance — Wear Limit	0.15 mm (0.006 in)
Oil Ring Thickness 1.1L and 1.3L	2.978-2.990 mm (0.1172-0.1177 in)
Oil Ring Side Clearance 1.1L and 1.3L	0-.032 mm (0-0.0012 in)
Top Compression Ring — Standard Bore — Ring Gap [a]	0.25-0.45 mm (0.010-0.017 in)
Bottom Compression Ring — Standard Bore — Ring Gap [a]	0.25-0.45 mm (0.010-0.017 in)
Oil Ring — Standard Bore — Ring Gap [a]	0.20-0.40 mm (0.008-0.015 in)
Cylinder Head	
Maximum permissible cylinder head distortion 1.1L and 1.3L: Measured over a distance of 26 mm	0.04 mm (0.0015 in)
Measured over a distance of 152 mm	0.08 mm (0.003 in)
Measured over the entire length	0.15 mm (0.006 in)
Valve Stem Bore 1.1L and 1.3L	7.063-7.094 (0.2781-0.2793 in)
Valve Seat Angle	45°
Valve Seat Insert – Exhaust, Outside Diameter [b] 1.1L and 1.3L	31.500-31.515 mm (1.2402-1.2407 in)
Combustion Chamber Volume 1.1L	27.24-29.24 cc (4.22-4.53 cu in)
1.3L	31.79-33.79 cc (4.93-5.24 cu in)
Reface cylinder head mating surface: The following minimum combustion chamber depth must be left after skimming — 1.1L and 1.3L	14.4 mm ± 0.15 mm (0.567 in ± 0.006 in)

All specifications are in millimeters (inches).

For Conversion Factors see page 8.

[a] Ring Gap may exceed these specifications by 0.15 mm (0.006 in) when measurement is made in the block.

[b] Insert must be chilled in liquid nitrogen or dry ice prior to assembly.

SPECIFICATIONS (Continued)

ENGINE MODEL YEARS 1993+

Ignition System	
Firing Order	1-2-4-3
DIS [b] (with 87 Octane Unleaded Gasoline) 1.1L and 1.3L	Fixed
Spark Plugs — AGRF 22 C1 (Gap)	1.0 mm (0.040 in)
Distributorless Type	
Coil Type	High Output DIS Coil
Coil Output	37.0 KV Minimum
Primary Resistance (at the Coil Tower)	0.50-1.00 Ohm
High Tension Leads	30.000 Ohms Max. per Lead
Belt Tension	
Alternator New	351-449 N (79-101 lbs)
Used-Reset (Minimum)	249-334 N (56-75 lbs)
Governor New	334 N (75 lbs)
Used-Reset (Minimum)	222 N (50 lbs)
Fuel System	
1.1L and 1.3L Unleaded 1986-	87 Octane
Pump Delivery Pressure	0.24-0.38 Bar (3.5-5.5 psi)
Starter — Current Draw	
Normal Engine Cranking	175 amps
Maximum Load — at Stall	410 amps
No Load	35 to 55 amps

[a] specifications are in millimeters (inches).
For Conversion Factors see page 8.
[b] Distributorless Ignition System.

SPECIFICATIONS (Continued)

ENGINE MODEL YEARS 1993+

Crankshaft	
Main Bearing Journal Dia. 1.1L Standard	56.99-57.00 mm (2.2437-2.2441 in)
Yellow	56.98-56.99 mm (2.2433-2.2437 in)
Main Bearing Journal Dia. 1.3L Standard	56.980-57.000 mm (2.2433-2.2441 in)
Yellow	—
Main Bearing Clearance 1.1L	0.009-0.046 mm (0.0004-0.0018 in)
Main Bearing Clearance 1.3L	0.009-0.056 mm (0.0004-0.0022 in)
Rod Bearing Journal Dia. 1.1L Standard	40.99-41.01 mm (1.6138-1.6145 in)
Green	40.74-40.76 mm (1.6039-1.6047 in)
Rod Bearing Journal Dia. 1.3L Standard	42.99-43.01 mm (1.6926-1.6933 in)
Green	42.74-42.76 mm (1.6827-1.6834 in)
Rod Bearing Clearance 1.1L and 1.3L	0.006-0.060 mm (0.0003-0.0023 in)
End Play 1.1L and 1.3L	0.075-0.285 mm (0.003-0.011 in)
Camshaft	
Journal Diameter 1.1L and 1.3L	39.615-39.636 mm (1.5596-1.5605 in)
Bearing I.D. 1.1L and 1.3L	39.662-39.713 mm (1.5615-1.5635 in)
Bearing Clearance (Standard Bearing) 1.1 and 1.3L	0.026-0.067 mm (0.001-0.002 in)
Wear Limit	0.0762 mm (0.003 in)
Camshaft Thrust Plate Thickness 1.1L and 1.3L	4.457-4.508 mm (0.1754-0.1774 in)
End Play	0.02-0.19 mm (0.0008-0.0075 in)
Cam Lift 1.1L Intake	5.15 mm (0.203 in)
Exhaust	4.92 mm (0.194 in)
Camshaft Lift 1.3L Intake	5.70 mm (0.224 in)
Exhaust	5.76 mm (0.227 in)
Drive 1.1L and 1.3L	Chain
Connecting Rod	
Piston Pin Bore 1.1L and 1.3L	17.990-18.010 mm (0.7083-0.7091 in)
Rod Bearing Bore 1.1L and 1.3L	43.990-44.010 mm (1.7319-1.7327 in)
Maximum Twist or Bend	0.10 mm (0.004 in)
End Play 1.1 and 1.3L	0.10-0.25 mm (0.004-0.010 in)
Piston	
Diameter 1.1L	68.670-68.700 mm (2.7035-2.7047 in)
Diameter 1.3L	73.930-73.955 mm (2.9107-2.9116 in)
Piston to Bore Clearance	0.015-0.050 mm (0.0006-0.0019 in)

All specifications are in millimeters (inches).
For Conversion Factors see page 8.

SPECIFICATIONS (Continued)

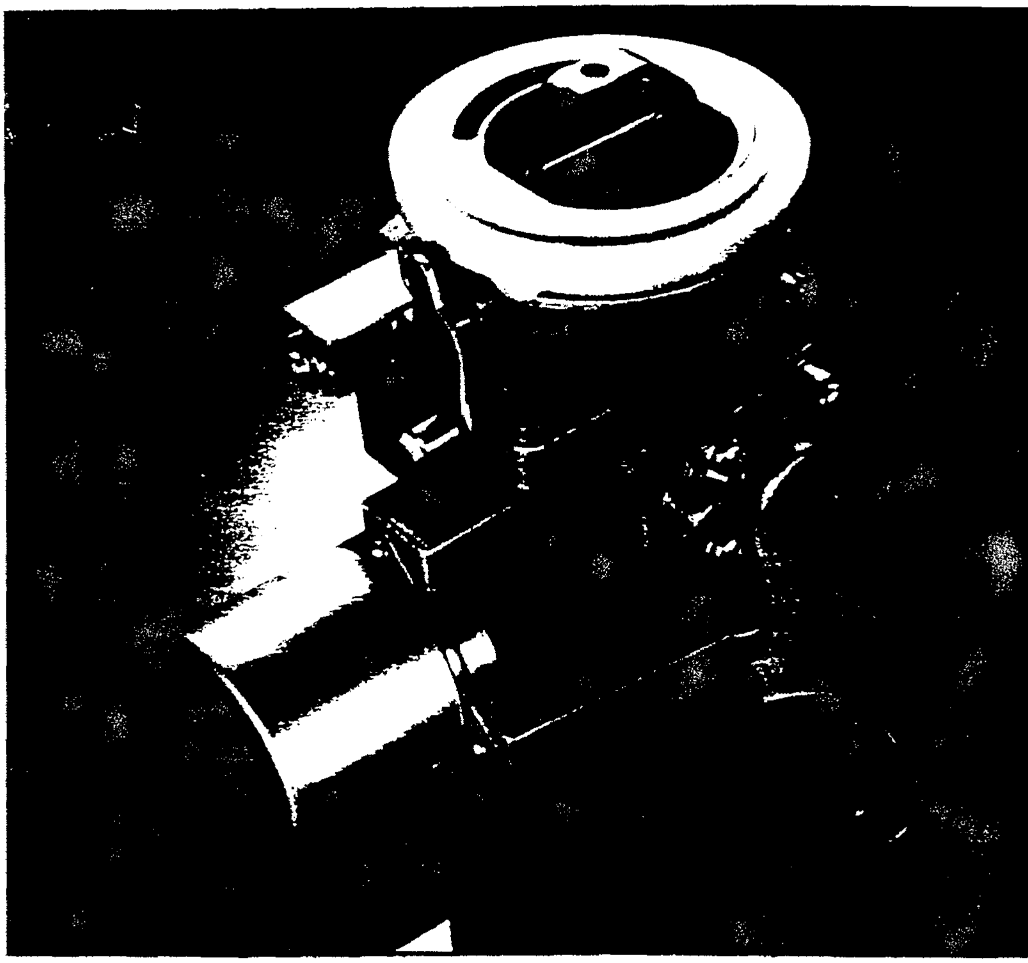
ENGINE MODEL YEARS 1993+

Valve Mechanism	
Lash Intake — Cold	0.22 mm (0.009 in)
Exhaust — Cold	0.32 mm (0.013 in)
Stem Diameter Intake	7.025-7.043 mm (0.2766-0.2772 in)
Exhaust	6.999-7.017 mm (0.2756-0.2762 in)
Stem to Guide Clearance Intake	0.021-0.069 mm (0.0008-0.0027 in)
Exhaust 1.1L	0.046-0.095 mm (0.0018-0.0037 in)
1.3L	0.043-0.091 mm (0.0017-0.0036 in)
Length Intake	103.70-104.40 mm (4.083-4.110 in)
Exhaust	104.02-104.72 mm (4.096-4.122 in)
Head Diameter 1.1L Intake	32.90-33.10 mm (1.296-1.303 in)
Exhaust	28.90-29.10 mm (1.138-1.145 in)
Head Diameter 1.3L Intake	34.40-34.60 mm (1.355-1.362 in)
Exhaust	28.90-29.10 mm (1.138-1.145 in)
Seat Angle 1.1L and 1.3L	44.0°-44.5°
Spring Free Length 1.1L and 1.3L, Intake/Exhaust	41.0 mm (1.61 in)
Spring Assembled Height (Pad to Retainer)	33.22 mm (1.308 in)
Spring Load at Assembled Height	270 newtons (60.7 lb)
Tappet Diameter	13.081-13.094 mm (0.5150-0.5155 in)
Block Bore	13.110-13.143 mm (0.5162-0.5174 in)
Clearance to Block	0.016-0.062 mm (0.007-0.0024 in)
Rocker Shaft — Diameter	15.82-15.85 mm (0.6229-0.6240 in)
Rocker Bore	15.875-15.913 mm (0.6250-0.6264 in)
Shaft Clearance in Rocker	0.02-0.09 mm (0.0008-0.0035 in)
Lubrication	
Oil Type	Motorcraft Super Engine Oil, API SG
Oil Capacity With Filter (FL 400)	3.25 Liters (3.5 qts)
Without Filter	2.75 Liters (2.9 qts)
Oil Pressure — Hot at 2000 rpm (minimum)	1.5 Bars (22 psi)
Relief Valve Opens	2.41-2.75 Bars (35-40 psi)
Oil Pump Outer Rotor to Housing Clearance	0.14-0.26 mm (0.006-0.010 in)
Inner to Outer Rotor Gap	0.051-0.127 mm (0.002-0.005 in)
End Play — Rotors to Pump Cover	0.025-0.06 mm (0.0010-0.0023 in)

Specifications are in millimeters (inches).
Conversion Factors see page 8.

IMPROVED ZENITH MODEL 33

Downdraft Carburetor With Electronic Actuator



ENHANCED DESIGN EQUALS HIGHER ENGINE PERFORMANCE

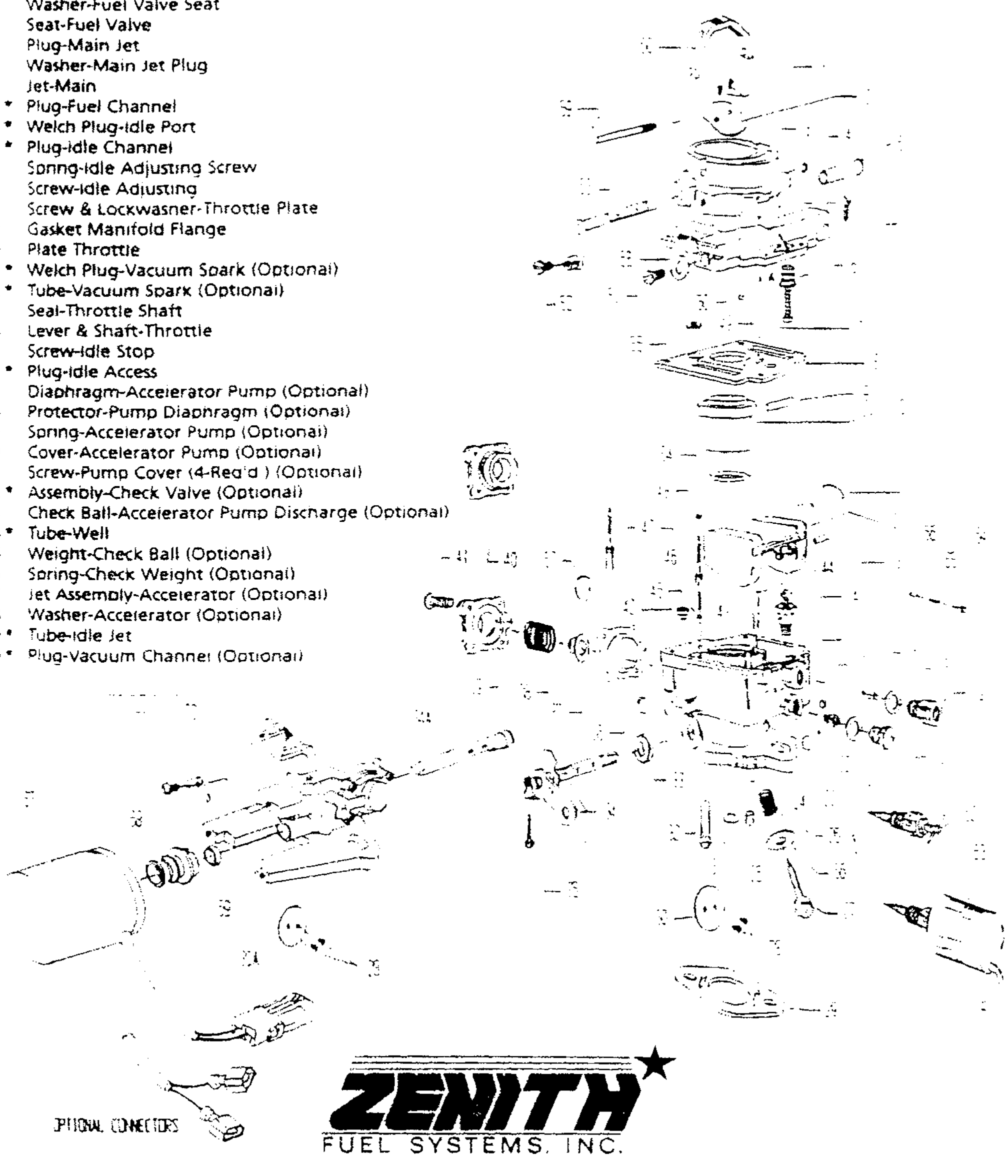
The Model 33 Carburetor with Electronic Actuator is an integrated, electronically controlled fuel system, which maintains precise engine speed control with no droop over the entire power range. Adding to its impressive features, recent design improvements have increased this model's durability and improved governor performance.

- Larger throttle shaft bearings provide improved load bearing characteristics and longer life.
- Controlled throttle shaft axial movement results in reduced friction between throttle plate and bore.
- Machined throttle plate for better sealing and reduced friction.
- Encapsulated accelerator check valve assembly and jet design improves accelerator pump output consistency.

MODEL 33 EXPLODED VIEW

1 Screw & Lockwasher-Choke Plate
2 Plate-Choke
3 Body-Air Intake
4 * Cup Plug-Choke Shaft Hole
5 Screws-Air Intake Assembly
6 Piston-Vacuum Power (Optional)
7 * Tube-Well Filler
8 Gasket-Air Intake To Throttle Body
9 * Tube-Main Discharge
10 Venturi
11 Retainer-Float Axle
12 Assembly-Float
13 Axle-Float
14 Valve-Power Jet (Optional)
15 Body-Throttle
16 Valve-Fuel Needle
17 * Cup Plug-Throttle Shaft Hole
18 Washer-Fuel Valve Seat
19 Seat-Fuel Valve
20 Plug-Main Jet
21 Washer-Main Jet Plug
22 Jet-Main
23 * Plug-Fuel Channel
24 * Welch Plug-Idle Port
25 * Plug-Idle Channel
26 Spring-Idle Adjusting Screw
27 Screw-Idle Adjusting
28 Screw & Lockwasher-Throttle Plate
29 Gasket Manifold Flange
30 Plate Throttle
31 * Welch Plug-Vacuum Spark (Optional)
32 * Tube-Vacuum Spark (Optional)
33 Seal-Throttle Shaft
34 Lever & Shaft-Throttle
35 Screw-Idle Stop
36 * Plug-Idle Access
37 Diaphragm-Accelerator Pump (Optional)
38 Protector-Pump Diaphragm (Optional)
39 Spring-Accelerator Pump (Optional)
40 Cover-Accelerator Pump (Optional)
41 Screw-Pump Cover (4-Req'd.) (Optional)
42 * Assembly-Check Valve (Optional)
43 Check Ball-Accelerator Pump Discharge (Optional)
44 * Tube-Well
45 Weight-Check Ball (Optional)
46 Spring-Check Weight (Optional)
47 Jet Assembly-Accelerator (Optional)
48 Washer-Accelerator (Optional)
49 * Tube-Idle Jet
50 * Plug-Vacuum Channel (Optional)
51 Screw-Choke Cable
52 Screw-Choke Swivel
53 Lever & Shaft Choke
54 O-Ring Venturi
55 Washer-New Style Accelerator Jet (Optional)
56 Washer-Idle Adjusting Needle
57 Spacer-Accelerator Pump (Optional)
58 Washer-Choke Cable
59 * Pin-Air Cleaner Bracket (Optional)
60 * Bracket-Air Cleaner (Optional)
61 * Tube-Emissions (Optional)
62 Adjustment-Main Jet (Optional)
63 Solenoid-Fuel Shut-Off (Optional)
64 Needle-Spring Loaded Fuel Valve (Optional)
65 Spring (Optional)
66 Pin-Spring Loaded Fuel Valve Needle (Optional)

*Not Normally Removed For Service



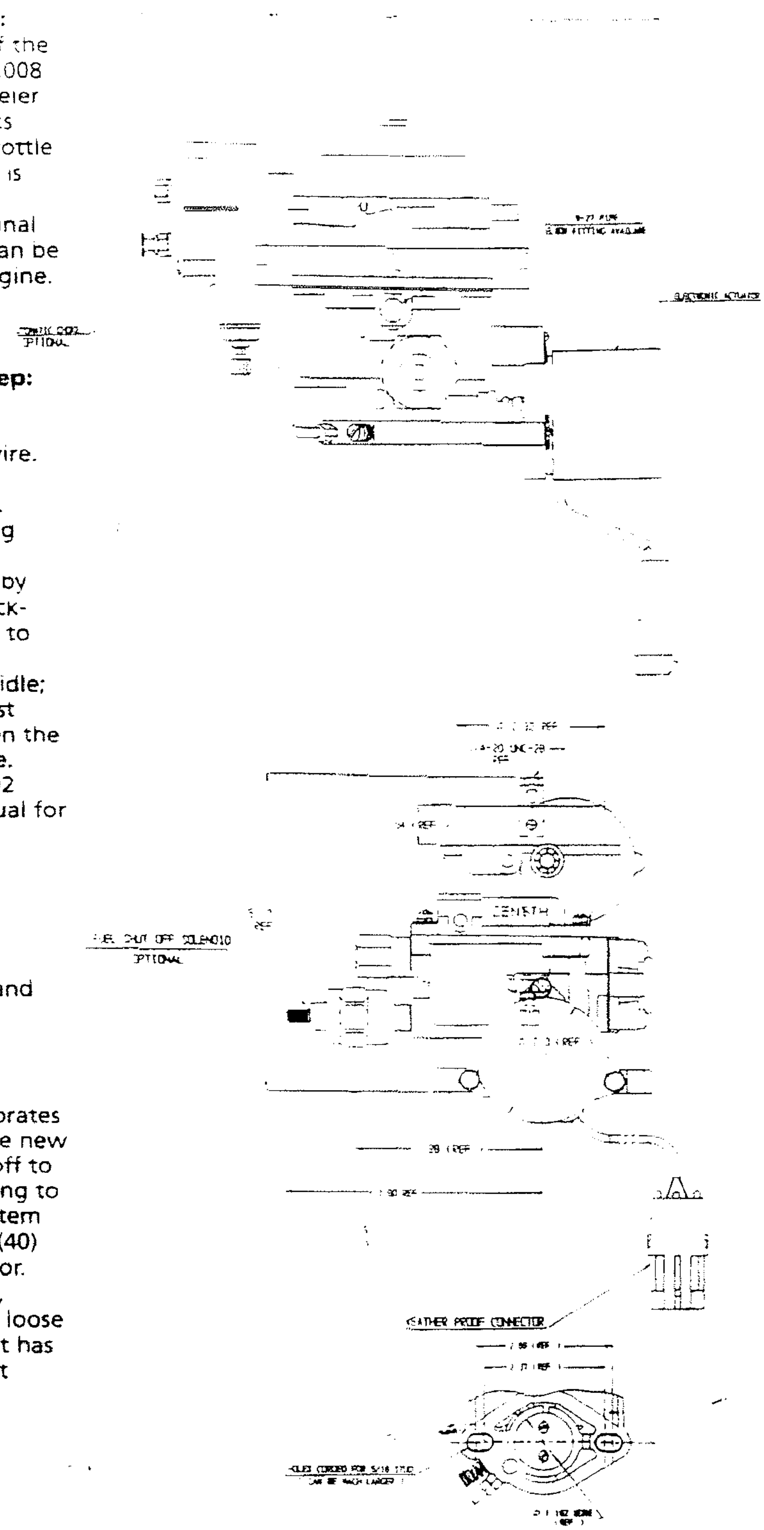
ZENITH
FUEL SYSTEMS, INC.

Setting the Actuator on the Bench:
To preset the actuator on the bench, if the carburetor has been removed, use an .008 inch-thick, narrow (< 1/4 inch wide) feeler gage or shim stock (a wire feeler works well). Adjust the actuator until the throttle just touches the feeler when the gage is against the throttle bore. Tighten the retaining screws. This setting is a nominal value, which insures that the engine can be started for final adjustment on the engine. (Consult your owner's manual for the specifics for your machine.)

Adjusting the Actuator Step-By-Step:

1. Warm up the engine.
2. Shut off the ignition.
3. Disconnect at least one actuator wire.
4. Re-start the engine.
5. Insure that the choke is fully open.
6. Loosen the three actuator retaining screws.
7. Adjust idle speed to specifications by rotating the actuator housing (clockwise to increase speed), using care to avoid bending tabs.
8. Adjust idle mixture screw for best idle; adjust so that the engine speed just starts to drop from maximum when the idle adjustment is turned clockwise. Mixture can also be set using a CO2 meter. (Consult your owner's manual for correct setting.)
9. Recheck idle speed; readjust if necessary.
10. Tighten retaining screws.
11. Turn off ignition.
12. Reconnect actuator wire(s).
13. Insure that all hoses, connections and fittings are in place.
14. Close the engine compartment.

New-Accelerator Pump System
The Model 33 Carburetor now incorporates a revised accelerator pump system. The new system features a more positive shut-off to prevent fuel pull-over and better sealing to prevent internal leakage. The new system contains a new pump cover assembly (40) which contains the spring and protector. This replaces the plastic protector (38), spring (39), and spacer (57), which are loose parts. The previous style accelerator jet has been replaced by a new accelerator jet cartridge (47).



DESCRIPTION OF CHANGE-IS (WAS)	BY
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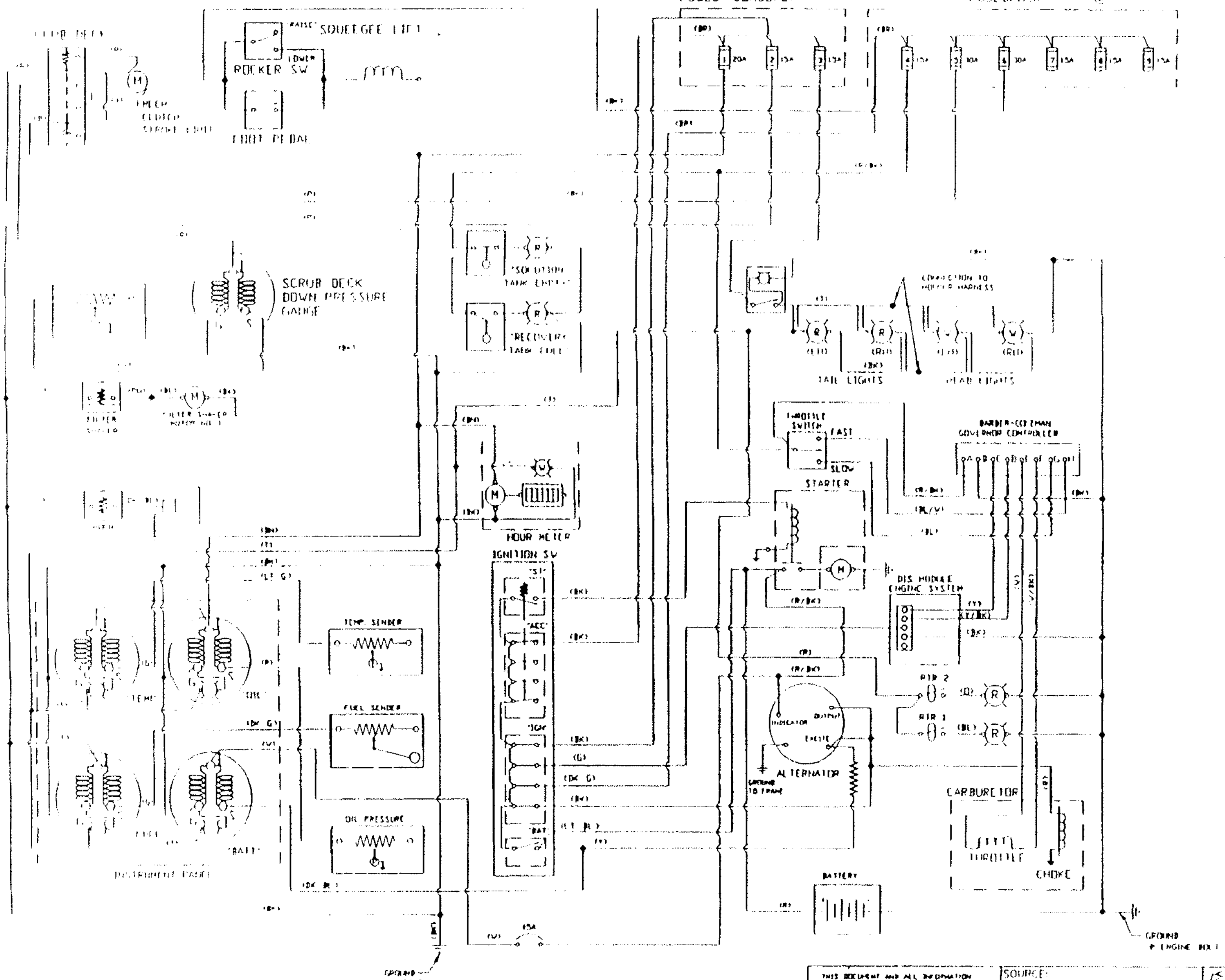

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NOTES:

1. NOMENCLATURE FOR WIRE COLORS
   - Y - YELLOW
   - R - RED
   - W - WHITE
   - BL - BLUE
   - BK - BLACK
   - BN - BROWN
   - G - GREEN
   - GY - GREY
   - O - ORANGE
   - PU - PURPLE
   - T - TAN
   - Y/W - YELLOW WITH WHITE STRIPE (NOMENCLATURE FOR STRIPED WIRE)
2. ACTUAL COMPONENT. TEXT INSIDE THIS BOX IS TYPICALLY STAMPED ON THE COMPONENT
3. GROUPING OF RELATED COMPONENTS
4. ALL SWITCHES SHOWN IN OFF POSITION

THIS DOCUMENT AND ALL INFORMATION CONTAINED IN THIS DOCUMENT ARE CONFIDENTIAL AND PROPRIETARY TO AAR POWER BOSS, INC. [illegible]

SOURCE:
PN:
MATL:
FINISH:
UNSPECIFIED TOLERANCES

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SCHEMATIC DIAGRAM FOR 1SS/82 AND 1SS/90

BARBER COLMAN COMPANY
a Siebe company

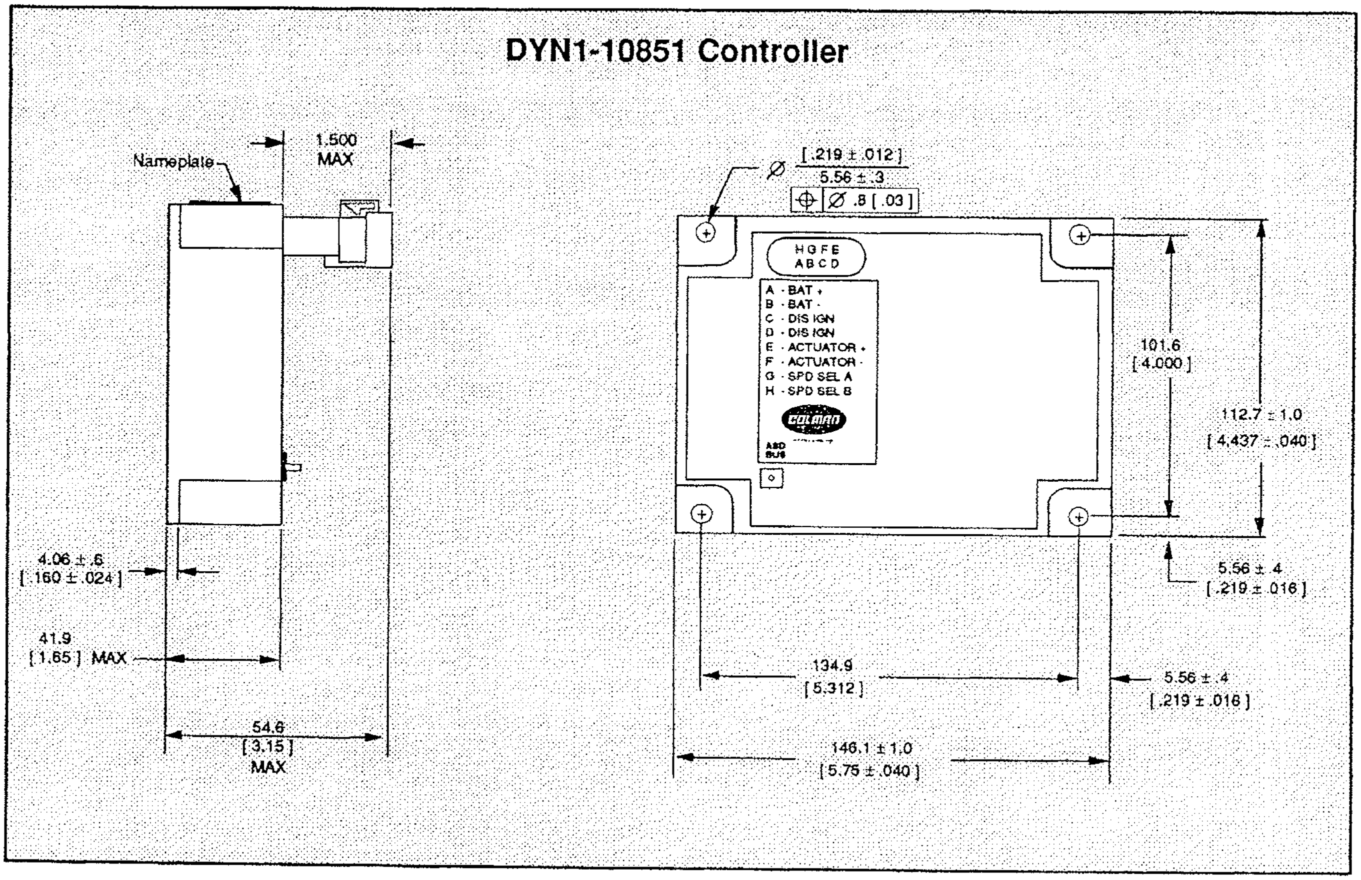
Service Information Troubleshooting & Wiring

Troubleshooting Information for DYN1-10851 Controller

This governor system is comprised of three major components; the carburetor, actuator and controller. The objective of this document is to help a technician identify which component is creating a problem so it can be fixed or replaced.

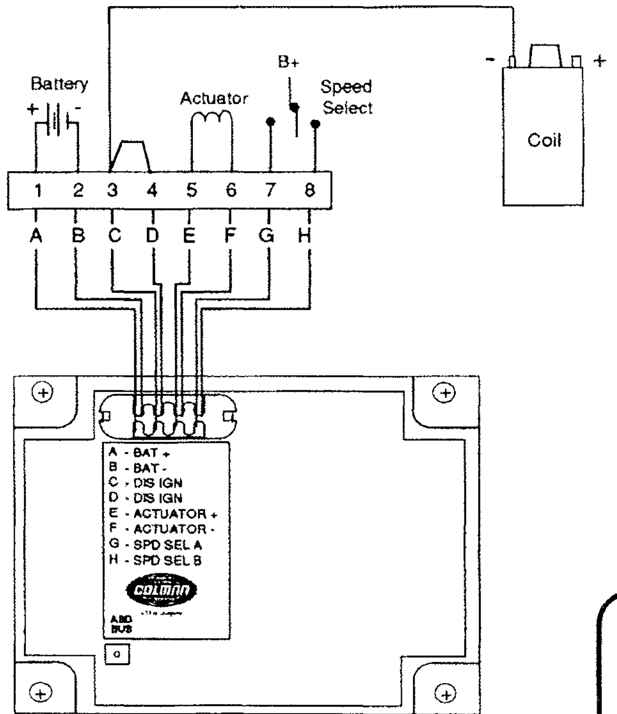
Problem	Cause	Corrective Action
I. Governor appears dead.	1. Battery power is not supplied to controller	Remove the connector from the controller and with a voltmeter check for battery power across pins A & B of the wiring harness connector.
		If battery power is not present, check wiring to the controller.
	2. Controller is not receiving the speed signal. — NOTE— This controller receives its speed signal from the ignition.	If the controller is connected to an engine with a distributor, pins C & D should both be connected to the negative side of the coil, or the tachometer output.
		If the controller is connected to an engine with a DIS ignition, pin C should be connected to one of the two tachometer outputs, and pin D should be connected to the other tachometer output. The DIS ignition utilizes two coils. — NOTE — Do not short the tach leads; doing so could damage the spark controller
		Using an ohmmeter, check continuity from pins C & D to the termination points. If continuity is not present, repair the wiring.
	3. Actuator fails to operate.	Remove the wires connected to the actuator. With a DC voltmeter, check between the actuator wires to Battery (-). The voltmeter should read 12 volts ± 2 volts.
		If the voltage is low, disconnect the connector from the controller and check continuity between the wiring harness pins, E & F, to their respective actuator terminals. If there is no continuity, check for openings in the wires.
		Using a voltmeter, check for battery voltage from controller terminals E & F to Battery (-). If battery power is not found, replace the controller and check the actuator and actuator wiring for grounds and shorts. — NOTE — Check wiring before replacing controller. Bad wiring might destroy the new controller.
		Check continuity across actuator wires. 2 ohms ± .5 ohms should be measured. Check the continuity of actuator wires to the case. The ohms measured should be 1M or greater. If these values are out of tolerance, replace actuator.

Installation Dimensions
(For reference only)

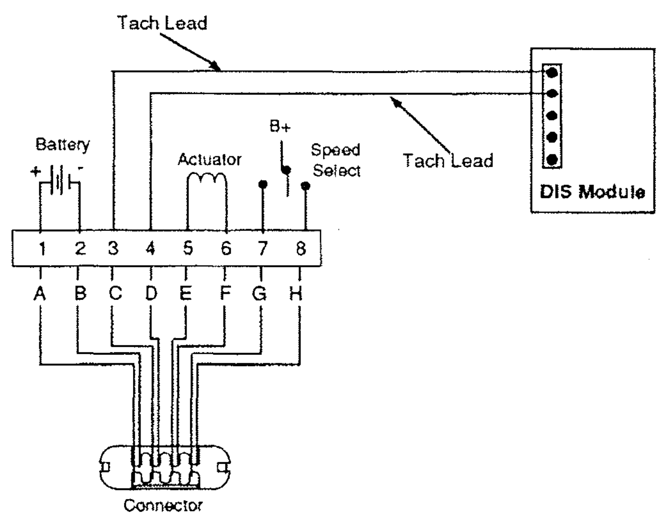


Dimensions in mm
Inches in brackets [ ]

Basic Wiring Diagram — DYN1-10851 Controller



Wiring for DIS Ignition



CAUTION

As a safety measure, the engine should be equipped with an independent overspeed shutdown device in the event of failure which may render the governor inoperative.

NOTE

Barber-Colman believes that all information provided herein is correct and reliable and reserves the right to update at any time. Barber-Colman does not assume any responsibility for its use unless otherwise expressly undertaken.

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Troubleshooting Information (continued)

Problem	Cause	Corrective Action
II. Engine doesn't change speeds.	1. Incorrect engine speed.	With the engine running, connect battery power to pin H. This will select Run 2. If Run 2 is set at a higher speed than Run 1 and the speed does not change, replace the controller. Contact OEM for speed settings.
		With the engine running, connect battery power to pin G. This will select Run 3. If Run 3 is set higher than the previous speed and the speed does not change, replace the controller. Contact OEM for speed settings.
		With the engine running, connect battery power to pins G & H. This will select Run 4. If Run 4 is set higher than the previous speed and the speed does not change, replace the controller. Contact OEM for speed settings.
III. Engine is hunting.	1. Engine is misfiring due to idle mixture mis-adjustment. This causes engine hunt at no load condition.	Disconnect the connector from the controller. The governor is now disabled and a warm engine should be running at a mechanical idle of ap-proximately 600 RPM.
		If the engine is not running at the mechanical idle and is governed by an integrated carburetor, loosen the three actuator fasteners and rotate the actuator to achieve an idle of 600 RPM. If the engine is governed by a linear actuator, adjust the idle speed screw to achieve 600 RPM.
		Slowly rotate the idle mixture screw clockwise (CW) until the engine speed begins to decrease. Slowly turn the idle mixture screw counterclockwise (CCW) until the engine speed begins to decrease. Now, turn the idle mixture screw clockwise (CW) until maximum idle speed is achieved. The idle mixture is now adjusted.
	2. Engine is misfiring.	Disconnect the connector from the controller and consult the engine repair manual.

Standard Features:
- Construction: Aluminum die cast construction with replaceable venturi to accommodate different engine sizes.
- Throttle Bore: 30 mm, 22 mm, (1.181 - .866)
- Choke Bore: 46 mm (1.804 in)
- Venturi diameter: 12 - 28 mm available
- Flexible air cleaner mounting: This design accommodates a variety of air intake systems.
- Manual choke: Levers may be specified on either side of the carburetor.

Optional Features:
- Accelerator pump: Mechanical or vacuum operated
- Automatic electric choke
- Fuel shut-off solenoid: Prevents dieseling
- Adjustable main jet: Provides flexibility
- Power system: Optimizes full load performance while allowing calibration for economy and emissions control.
- Vacuum port: Provides signal for ignition system or EGR control.
- PCV connection

Description of Operations:
The carburetor throttle is coupled to the actuator, which is in turn controlled by current from the Electronic Control Module (ECM). The ECM is a closed loop controller, which manipulates the throttle actuator to maintain a programmed speed in response to measured engine speed.

Different speeds can be selected for various operating conditions, using signals from switches, etc. The actuator can also be operated as an all-speed governor, using a variable resistor connected to the throttle.

The actuator transmits rotary motion to the throttle shaft through a coupling formed by spring clips attached to the end of the actuator shaft. The clips mate with two flats on the throttle shaft. This arrangement allows for slight misalignment between the actuator and the throttle shaft. The closed-throttle stop is internal to the actuator. There is no conventional throttle stop screw or idle speed adjusting screw. The position of the actuator establishes the closed throttle position when no power is supplied to the actuator.

The combination of the actuator and the throttle forms a high precision positioning system. Care is required to insure proper alignment of the actuator shaft to the throttle shaft with no lost motion between the two and with no friction. Ball bearings are used throughout the system to insure minimum friction.

Removing the Actuator:
To remove the actuator from the carburetor, disconnect the electrical connector located on the cable coming from the actuator and remove the three retaining screws and clips. Carefully withdraw the actuator, noting the orientation of the electrical wires for reinstallation.

Installing the Actuator:
Make sure the mating surfaces between the actuator and the carburetor are clean. Make a trial inspection without the dust seal and without installing the retaining screws and clips. Check the clearance between the ends of the throttle shaft and the actuator shaft. Insure that there is about .016 inch (.4 mm) clearance with the throttle plate closed. During this trial installation, make sure that the actuator is oriented so that its spring clips properly engage with the flats on the throttle shaft. Remove the actuator and install the protective dust cover, then reinstall the actuator, retaining clips and screws. (Do not tighten the screws.) Position the actuator so that the wires are oriented the same way as when the actuator was removed.

Setting the Actuator on the Engine:
The engine should be at operating temperature for this procedure. With the choke open, rotate the actuator until approximately 1/32 inch open, which can be accomplished visually, or by feel. Rotate the actuator in the direction to close the throttle (toward the idle mixture adjusting screw) until resistance is felt, then rotate in the opening direction until the periphery of the actuator housing moves about 1/32 inch. Leaving the retaining screws loose enough to allow rotation of the actuator, disconnect at least one wire from the actuator. Start the engine and adjust the actuator for an idle speed slightly below normal governed idle speed. (700 to 800 RPM is a good default value.) Adjust the idle mixture screw for best idle. Stop the engine, reconnect the actuator wire(s), restart the engine, and observe the idle speed. (Consult your owner's manual for the setting for your machine.) Tighten the retaining screws.