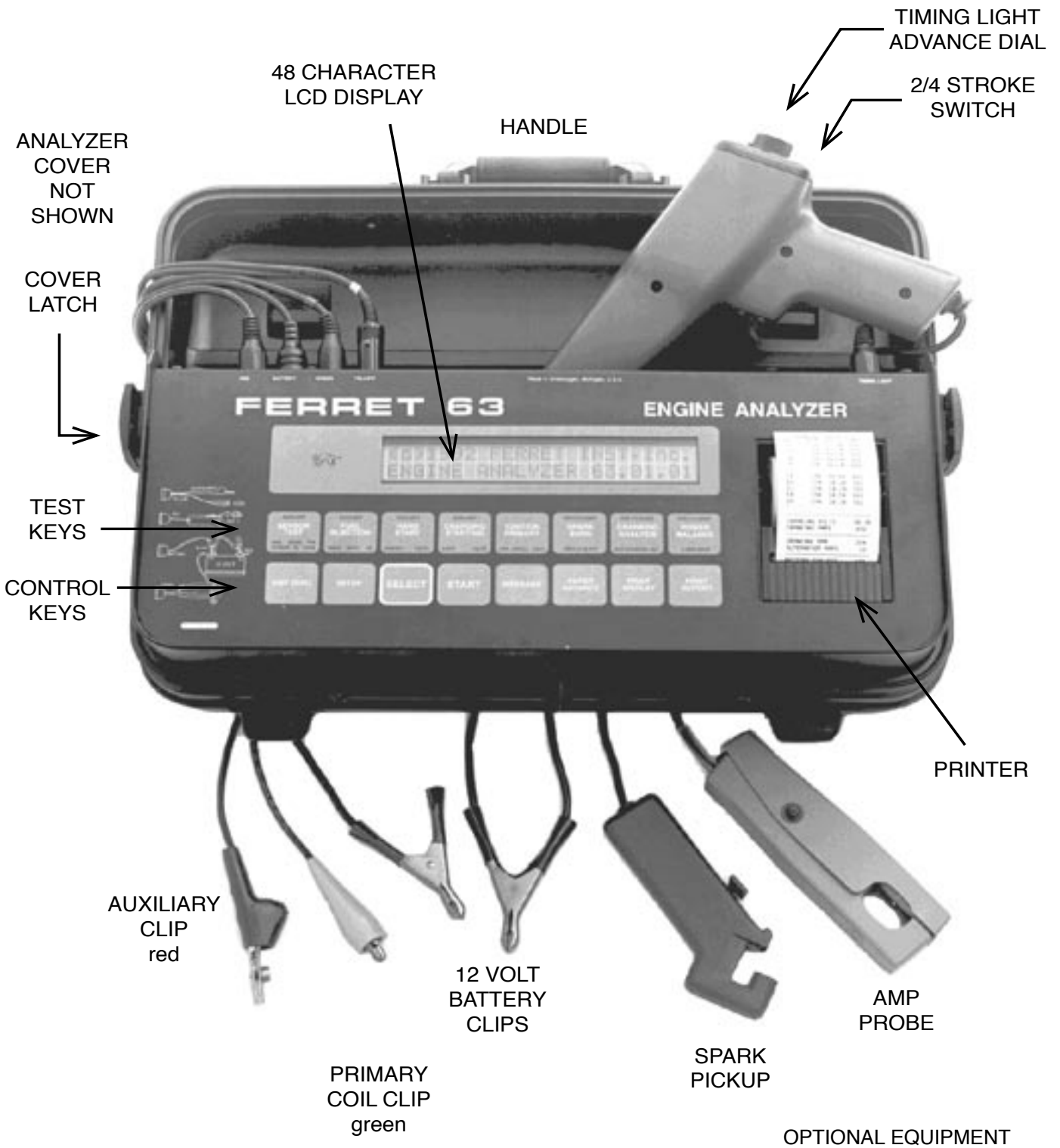
FERRET®
INSTRUMENTS

DIAGNOSTIC ENGINE ANALYZER 63

CONTENTS

OPERATOR'S MANUAL

FERRET 63
DIAGNOSTIC ENGINE ANALYZER



OPTIONAL EQUIPMENT
854 - Magnetic TDC Detector
754 - Diesel Injection Detector

INTRODUCTION

The Engine Analyzer is a time saving instrument for troubleshooting automotive ignition, fuel injection and electrical power systems. It provides computer controlled measurements that are usually only found on diagnostic 'scopes. Measurement methods have been engineered to reduce hookup effort and give speedy test results.

The analyzer is designed for use on 2,3,4,5,6,8,10 and 12 cylinder as well as 2 and 3 rotor, distributor ignition, 2 and 4 stroke, 12 volt automotive engines.

It has a large LCD display with 2 lines of 24 characters showing numbers, words and symbols. All test keys display related multiple simultaneous measurements.

Diagnostic messages are given when the analyzer detects combinations of signals which suggest an engine defect.

A built-in printer records the screen being shown or prints the data saved from tests. The printout is formatted to make easy before-and-after repair comparisons. Print options include a vehicle identification form, and a vehicle equipment visual checklist report to help give complete repair information to the vehicle owner.

For time-efficient testing, an Auto-Test Sequence leads the user through all of the tests for a complete printed test report.

Test leads include a Timing-Advance Strobe Light, an Inductive Amps Probe, an Inductive Spark Pickup, a 2 clip signal lead set, a power lead set, and an extension harness, each of which are plug-in field replaceable.

WARNING

It can be hazardous to operate both a moving car and the analyzer. Get someone to drive the car while you read the display.

SPECIFICATIONS

TEST	ACCURACY	RANGE
Volts, Battery	1%	8 to 18 Battery Volts
Volts, Aux. [10 meg]	1%	0 to 20 Volts
Amps, Inductive	3%	0 to +/- 600 Amps
Tachometer	1%	100 to 10,000 RPM
Fuel Injector	0.2mS	to 63 mSec
Pulse frequency	1%	to 250 Hz

Coil Energy	5%	to 90 milliVolt-Seconds
Coil Oscillations		to 10 Oscillations
Spark Burn Time	0.2mS	to 9.9 milliSeconds
Spark burn slope		+/- 99 units
Test duration		Seconds
Cranking		RPM, Volts, Amps
Alternator		Amps & Ripple
Battery		CCA

Timing Advance	1.5°	to 60.0 Degrees
Dwell, Ignition	0.5°	Degrees, %, mSec
Points/Driver Res.	0.1v	to 2.5 Volts
Dwell Variation		to 90.0 Degrees
Timing Variation		to 90.0 Degrees
Cylinder Power Balance		% RPM Change
Relative Compression		Cranking Amps Peak

Ohms	5%	1 to 50K ohms
Diode		Forward Volts
Position Sensor		Glitch catcher
O2 Sensor		Volts & crossings
Wiggle Scope		HI/LO from 3.5 volts

DIMENSIONS

Size	140 x 350 x 470 mm	5.5" x 14" x 18.5"
Leads	1.7 m	5 feet
Extension Harness	2.5 m	8 feet
Operation	4° to 44°C	35°F to 120°F
Storage	-20° to 60°C	-20°F to 130°F
Weight	8 kg	18 lbs.
Power Requirement		12 Volt Vehicle Battery

The measurement capabilities of this analyzer were selected to serve the diagnostic needs of the professional automotive service technician. **Because of the complexity and variety of the tests, the user must refer to the vehicle specific diagnostic manuals to be assured that correct conclusions are reached.** This manual is limited to describing the features of the analyzer and its application requirements.

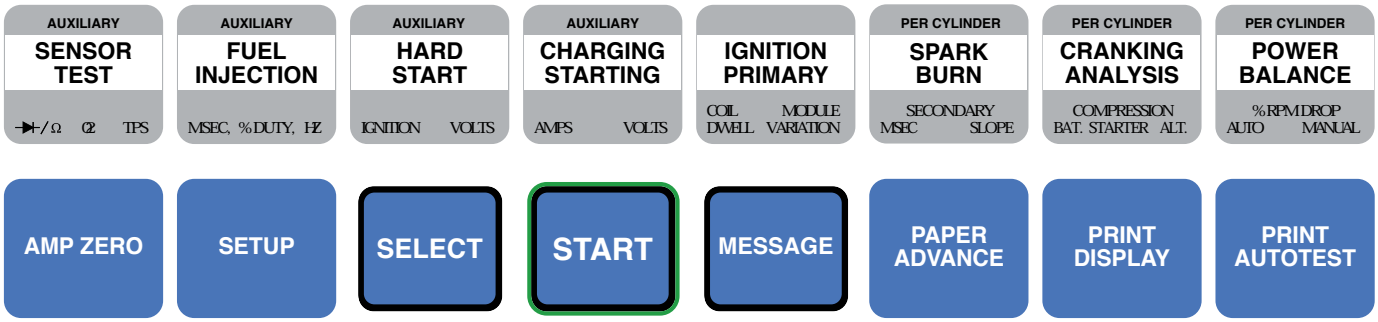
OPERATING FEATURES

DISPLAY

The 2 by 24 character LCD dot matrix display provides a versatile screen for the display of multiple sets of meter outputs as well as data arrayed by cylinder. Contrast can be adjusted with the SETUP key. A cast acrylic window protects the display.

HOUSING

The case is designed to be a convenient to use protective enclosure. Rounded corners and the plastic base were chosen to help guard mechanical and electrical contact with the battery, engine, and car body parts. In use, place the unit on a cart, in the engine compartment, or inside the car. The compartment under the control panel is made to store the leads and harness.



CONTROL PANEL

A MEMBRANE KEYBOARD controls the analyzer. It is a pressure sensitive lamination of metalized plastic sheets with small spaces between contacts. It is very durable but can be harmed by chemical solvents or punctured by sharp objects.

THE TEST KEYS on the top row activate readouts or initiate tests which require actions by the user to arrange engine and vehicle test conditions.

BOTTOM ROW KEYS select test options, start action, and make adjustments.

A BEEPER inside the analyzer indicates contact with keys and signals warnings.

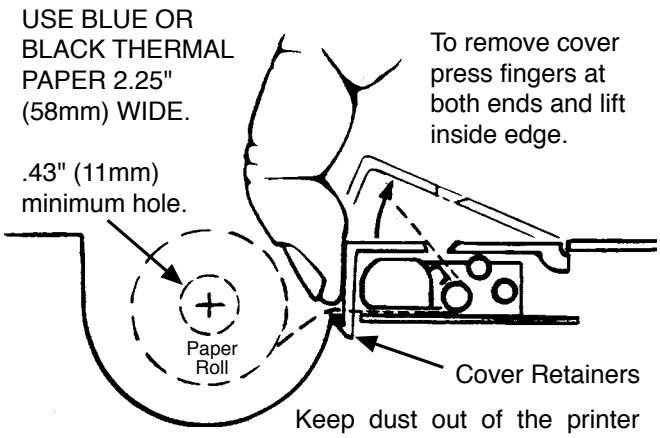
PRINTER

The printer will capture any displayed data or message during non-sequenced testing if **PRINT DISPLAY** is pressed, and at the end of the sequenced tests it will print the resulting data and messages from the **PRINT AUTOTEST - Print Data** command. If only some of the data saving tests have been done since power-up, they will be the only ones printed. **PRINT REPORT** offers an AutoTest option to complete a full set of printed tests in the shortest possible time.

The **PAPER ADVANCE** key is used to feed a new roll of paper into the printer. Once the paper is in place it may be pulled through to extend the end of a report before tearing it off. Do not pull the paper backwards through the mechanism.

Only the outside surface of the paper roll is sensitized for printing, so it must feed from the bottom of the roll into the mechanism. Getting the paper started is easiest if the leading edge is cut cleanly. Push it into the slot 2 to 3 cm and press **PAPER ADVANCE**. Each key press moves the paper feed 2 lines. If it does not feed, lift the printer cover for better access and try again.

See the Printing Reports section (p28) for more details.

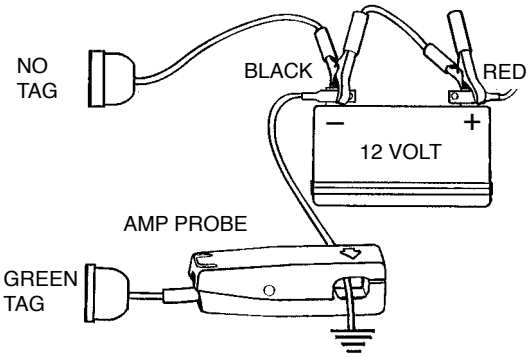


Keep dust out of the printer to prevent accelerated lead screw wear.

LEADS AND SENSORS

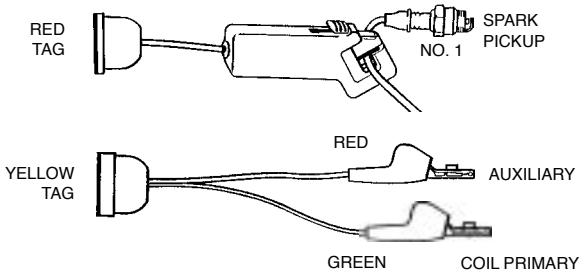
12 VOLT BATTERY CLIP LEAD SET

This is a multiconductor cable which draws power from the battery and senses the voltage. It should be the first set of lead clips connected.



INDUCTIVE SPARK PICKUP

Cylinder synchronization and tachometer input are the function of this lead. Features of this easy to use 8mm wire spark current sensing pickup are dependable spark pulse detection, ruggedness and plug-in replacement. The unique design has an easy grip handle and a latching jaw mechanism for durability. The housing is made of glass fiber reinforced plastic with high temperature strength and solvent resistance.



INDUCTIVE AMPS PROBE

The Hall effect Amps Probe senses DC current in wires without having to disturb connections and without introducing any voltage drop. Up to 20 mm (.75") diameter cables may be read. A distinctive arrow is marked on both sides which indicates the direction of positive current flow for a positive analyzer readout. Materials in the probe are selected for enduring performance. If damaged, a new probe may be plugged into the analyzer without additional service.

EXTENSION HARNESS

A set of 4 identical cables are sheathed to form a harness to extend the leads enough to reach from a car's interior to the engine. They have color markers for lead coordination. The long tailed end connects to the analyzer connector. Take care between door panels that it does not get pinched enough to shear. Any of the leads may be plugged directly into the analyzer without the extension.

COIL PRIMARY / AUXILIARY LEAD CLIPS

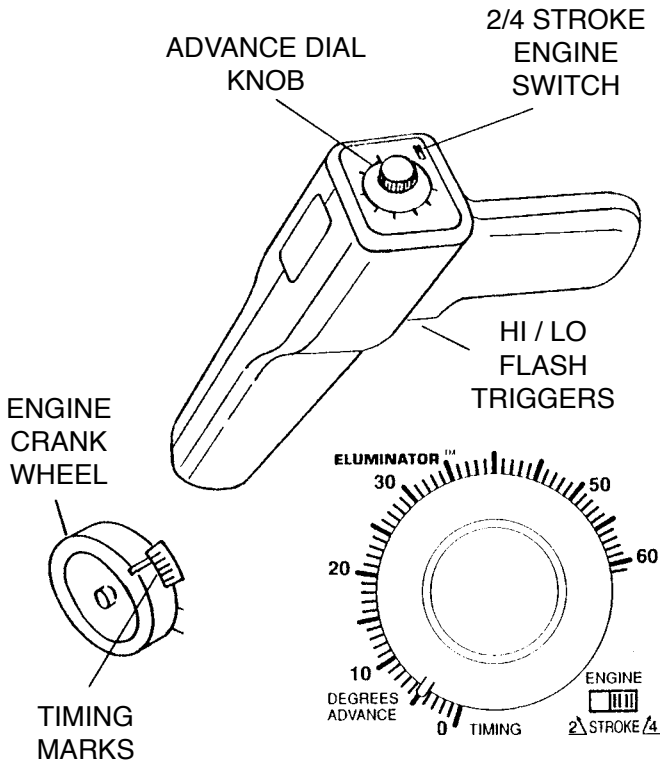
Both clips have a prod tip and an insulation penetrating pin cluster so they are adaptable to many connections. The wires are neoprene insulated copper. The red clip is used for auxiliary tests. The green clip lead, is always connected to coil primary TACH.

TIMING-ADVANCE STROBE LIGHT

The Timing Light may be used when a spark signal and power from the analyzer leads are present. Advance settings are controlled and read directly from the calibrated dial. The 2/4 stroke switch changes the dial calibration by a factor of 2 for the ignition type.

To measure an engine's spark advance, clean the crank wheel marks for good visibility and run the engine with the appropriate test conditions. Turn the advance dial to about the expected reading, press the light's trigger while shining the light at the wheel marks, and then adjust the knob so the marks appear aligned to TDC. The dial setting is the spark advance angle in degrees of crank shaft rotation.

The two trigger buttons control flash brightness. Operation of the analyzer is not affected by the Timing Light so it may be unplugged any time.

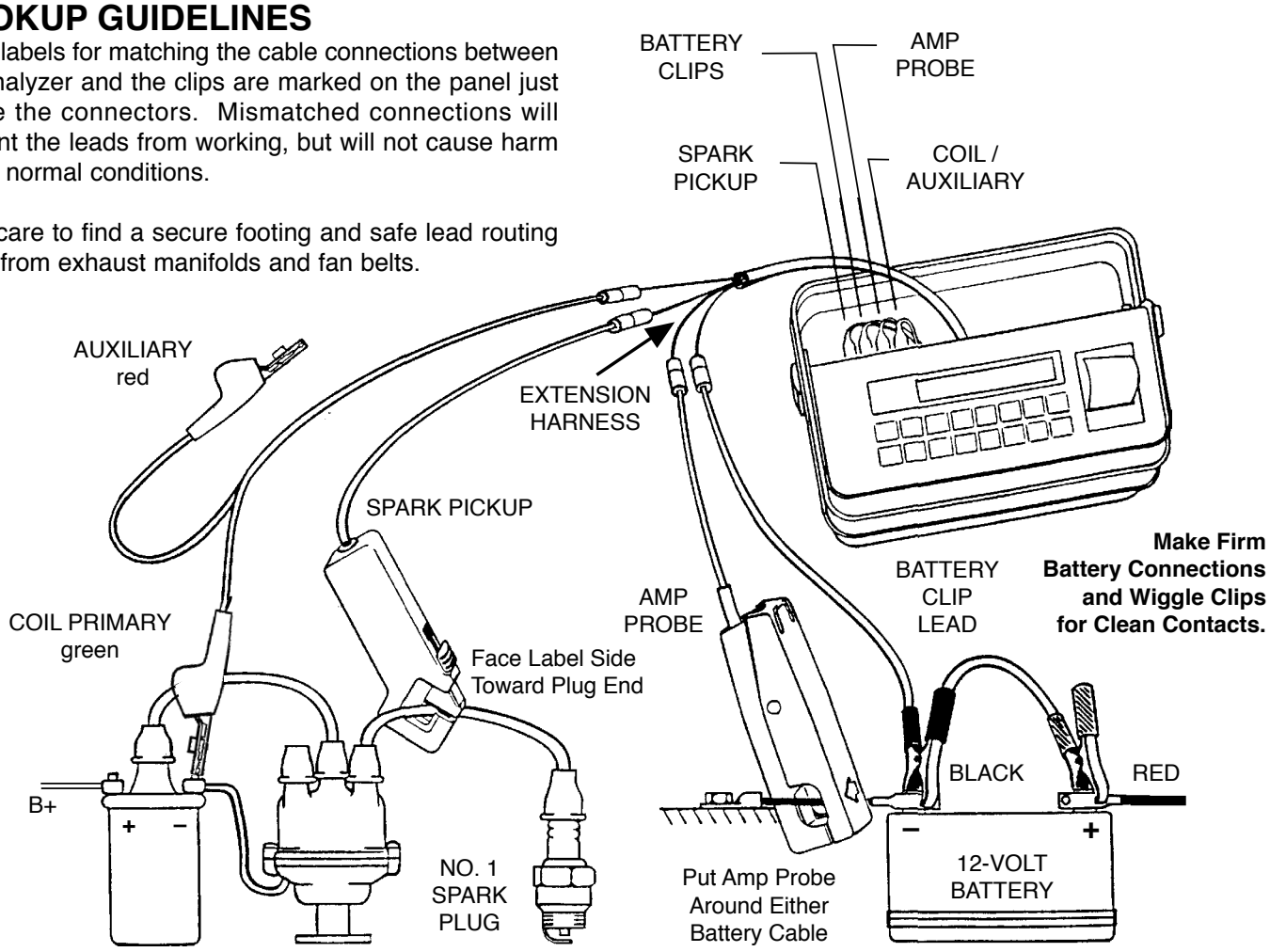


SETTING UP FOR TESTS

HOOKUP GUIDELINES

Color labels for matching the cable connections between the analyzer and the clips are marked on the panel just above the connectors. Mismatched connections will prevent the leads from working, but will not cause harm under normal conditions.

Take care to find a secure footing and safe lead routing away from exhaust manifolds and fan belts.



12 VOLT BATTERY CLIP LEAD SET

These clips must have a solid connection to the battery terminals. Reliable analyzer operation depends upon a continuous power source. Intermittent power will reset the analyzer to its start-up state. It is possible to draw power from other points in the vehicle wiring, but the measurements may be misleading because wiring resistance may interfere with the tests.

AUXILIARY CLIP LEAD

This red clip does not have a specific connection for the basic hookup. It is the input for Auxiliary Volts, Ohms/ Diode readings, Wiggle Scope, and Sensor/Fuel Injector Pulses. See **SENSOR TEST** test descriptions for connection locations.

WARNING

Do not run engine with the Auxiliary lead connected to engine sensors while the spark pickup and coil primary leads are connected to the ignition. The analyzer leads can couple ignition noise into the engine computer and disrupt engine operation.

IGNITION COIL PRIMARY CLIP LEAD

This green clip connects to the ignition coil primary winding minus terminal, sometimes labeled “TACH”. It is the signal source for all of the ignition measurements, and it is necessary for ignition suppression.

INDUCTIVE SPARK PICKUP

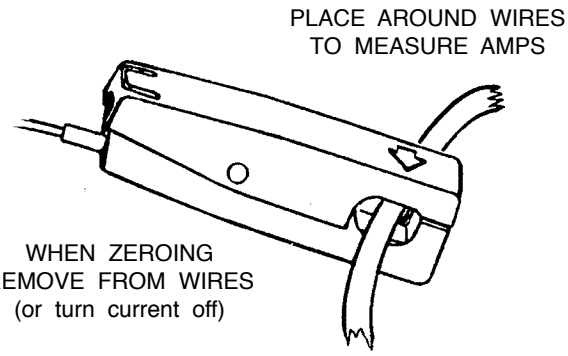
The best hookup arrangement is to place the pickup around the spark plug wire, as far from the spark plug as possible, and with the “Spark Plug” labeled side pointing toward the spark plug end of the wire. Be sure the pickup magnetic cores are touching.

Placing the pickup far from the spark plug keeps it away from the hot exhaust manifold, and improves performance, because spark current impulses are “cleaner” near the distributor.

When the pickup is not being used, LEAVE THE JAWS IN THE OPEN position. The magnetic cores are made of ferrite ceramic and when kept apart they are more likely to not break if the pickup is dropped.

NDUCTIVE DC AMP PROBE

The reading range is 000 to +/-600 amps DC in 1 amp steps. Starter and alternator output current measurement is the primary application. It also allows the measurement of vehicle accessory currents. Placing the probe on the battery cable, while the engine is off, and then watching the change when operating switches allows checking many loads rapidly. Use **AMP ZERO** to restore the reading to zero before putting the probe around any wires.



SETUP STEPS

1. CONNECT ONLY THE BATTERY CLIPS. The Battery Clips must go to the engine's 12 volt battery terminals, red clip to plus, black clip to minus. The model description will be displayed momentarily.

The analyzer may give you a choice of languages. Once a language is selected it cannot be changed until the analyzer power is disconnected.

2. DO THE SETUP. The display will automatically switch to the Setup function. The **SETUP** key is only used to change settings. Use **SELECT** for selecting choices. Press **START** when the correct selection is displayed which will advance the analyzer to the next Setup item.

There are 4 selections of contrast for the display. More "=" makes the display darker

```
SELECT:====
LCD Contrast  then START
```

This is when the operator tells the analyzer about the engine.

```
SELECT: Elect./ 4S Sroke
Ignition      then START
```

The ignition type and engine strokes selection are combined. The combinations are of Electronic or Points Contact, and 2 or 4 Stroke.

```
SELECT:     4 CYL
CYLINDERS     then START
```

Selections are 2,3,4,5,6,8,10,12 CYLinders, and 2 or 3 ROTors.

```
SELECT:  mSec
Dwell Scale   then START
```

Select DEGrees, mSeconds, or % (percent)

3. Then the Amp Probe reading is zeroed.

```
Remove AMPPROBE from CAR
                then START
```

The probe should not be around any wires when you press START. When complete, the analyzer will automatically go to the HARD START test.

4. HOOKUP THE REMAINING LEADS.
Now see that all analyzer leads are connect, and then run the engine.

If there is not yet an active signal into the coil primary clip it will show:

```
   Check Connections!
     -Run Engine-
```

The data screen will appear when inputs are active.

```
 356 RPM  msg  Bat 10.34
IgEgy 38   Aux>POS- 1.34
```

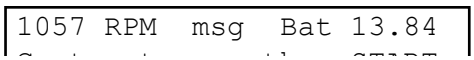
5. PRESS ANY TEST KEY.
If the HARD START test screen shows normal readings indicating that the analyzer hookup is working, we suggest that you do a general ingine review using the AUTOTEST at the **PRINT AUTOTEST** key.

If the analyzer resets on its own check that the Battery clips have good connections. Also, if the engine has metallic secondary ignition wires, try replacing the coil to distributor wire for the test with a 10 K to 20 K ohm resistance wire.

DOING TESTS

AUXILIARY INPUT TEST KEYS

Typical features of the tests are the RPM and the Battery Volts readouts.



The RPM reading in the upper left of the display gets the signal input from the Inductive Spark Pickup. Scaling is determined by the setup selections.

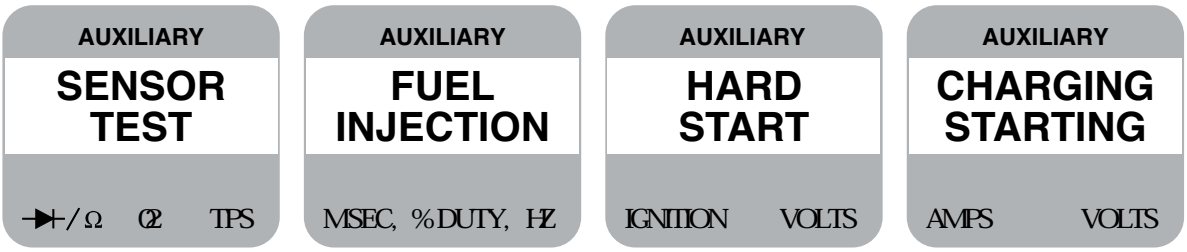
The Battery Volts reading in the upper right display corner comes from the Battery Clips.

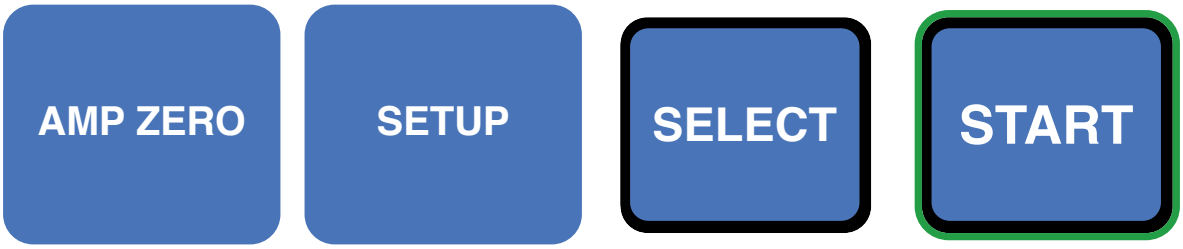
SENSOR TEST has the following sensor and signal tests. The Ohmmeter can be used for resistance checks of spark plug wires or components. The Diode test measures forward and reverse diode voltage. The Oxygen Sensor test measures the activity level of the O2 Sensor voltage. The Throttle Position Sensor test is a computer aided test to find intermittent TPS sensors. The Wiggle Test, and GM & Ford Code tests will help you retrieve trouble codes from some computer controlled engines. See pages 8-10.

FUEL INJECTION helps to trouble shoot EFI, PFI, TBI, and Computer Controlled Carburetor engines. The Duty Cycle test reads Hertz (Frequency) and Duty Cycle (Dwell) for use on solenoid equipped carburetors. Also use for checking pressure, flow, Hall effect, and other sensors that are specified by these measurements. The Fuel Injection test measures the milliSeconds of voltage drive to an injector. See page 11.

Use **HARD START** to find the problem area on a no start engine. Ignition Energy indicates the ignition's strength. Auxiliary Volts is used to confirm that voltage is present at the ignition. RPM and Battery Voltage are used to measure the performance of the cranking system. Special diagnostics pick out problems with the spark plugs, wires, cap and rotor. See page 12.

CHARGING STARTING measures cranking speed, voltage regulator setting, starter draw, accessory draws, and alternator output. The Auxiliary Volts is great for voltage drop tests. Diagnostics monitor the alternator for excessive amps ripple indicating a bad diode or stator. See page 13.





CONTROL KEYS

This lower row of keys select test choices, look up messages, restart tests, and operate the printer.

Pressing **AMP ZERO** subtracts whatever the amps reading was so that the reading becomes zero. If amps fails to work, read the Amp Probe Check procedure in this manual's Service section.

SETUP is used to input information about the engine being tested, and provides four levels of display contrast adjustment.

When there are choices in a test, **SELECT** steps through the selection. The last displayed choice is made active by pressing **START**.

START takes the operation to the next test step. It continues an operation after some conditions have been prepared by the operator.

START also clears Min and Max readings on Spark Burn and Fuel Injection tests.

ENGINE DYNAMICS TEST KEYS

These keys measure engine power cycle functions to find causes of rough running. “PER CYLINDER” tests store the gathered data in memory for after-test review and printout. This permits seeing trend and cylinder differences in the engine data.

The sequenced tests in the next column have pauses to display instructions. Press **START** for the next step after an instruction has been completed.

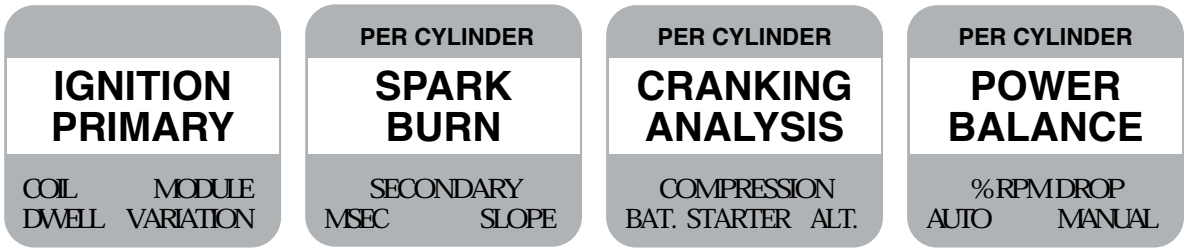
IGNITION PRIMARY is used to find bad ignition coils and modules using the measurements of Oscillations, Ignition Coil Energy, Dwell, and Driver Voltage. Use the Dwell and Timing Variation tests to find loose timing chains, worn distributor shafts and bearings. See page 14.

SPARK BURN easily finds defects with spark plugs, sparkplug wires, distributor cap, and rotor. It measures the Minimum, Average, and Maximum Spark Burn Time for each cylinder. Spark Slope is measured to indicate a lean or rich fuel mixture. A Burn Time Range bar graph is produced with the printed report. See pages 16-17.

CRANKING ANALYSIS has two test sequences to measure Relative Compression, Cranking Volts, Cranking Amps, Cranking RPM, Alternator Amps, and the CCA of the battery. The Compression test finds cylinders with low relative compression, and shows it on the printout bar graph. See pages 20-23.

POWER BALANCE performs an Automatic or Manual Power Balance test to locate low power cylinders. Each spark plug is turned off one at a time and the RPM drop is measured. The greater the drop in RPM, the stronger the cylinder. Cylinders with a small drop should be tested further to determine the problem. A Power Balance bar graph is produced with the printed report. See page 18.

Ignition suppression is used in **CRANKING ANALYSIS** and **POWER BALANCE**. The analyzer can suppress the usual inductive discharge distributor ignition, but will not work on capacitive discharge and multicoil ignitions. A compatibility check is done by the analyzer before it will apply suppression. If the check finds it incompatible, the user will be notified to manually disable either the ignition or fuel system.



Press **MESSAGE** when "msg" appears in the middle of the display. This means a diagnostic check detects an out of limit condition. Repeated presses of **MESSAGE** will step through all the diagnostic messages and finally back to the test. Messages may appear intermittently if the condition is on the threshold of being a problem.

Messages suggest causes of problems, but do not prove the suggested item is bad.

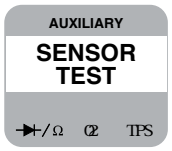
PAPER ADVANCE feeds 2 lines of paper for each press.

PRINT DISPLAY prints what is on the display.

PRINT AUTOTEST prints test reports and is the Auto-Test entry key. The Auto-Test will run all of the engine dynamics tests in an automatic sequence. At the conclusion of the data report, you can also print the visual inspection checklist. See pages 28-29.

“SENSOR TEST” KEY

Use **SELECT** and **START** to choose tests for measuring ohms or diode volts, measuring oxygen sensor voltage and crossings, checking for irregular throttle position sensors (TPS), watching for intermittent voltage with the Wiggle Scope, and reading fault flash codes from Ford and GM engine control computers. The red Auxiliary Clip is the signal input.



OHMS RESISTANCE / DIODE VOLTS

The resistance of a device is measured by connecting the red Auxiliary Clip to one of the device’s terminals and contacting the other device terminal to the battery/engine ground. A continuity beeper sounds when readings are below 25 ohms, and “OVER” shows for greater than 50K ohms. (Ground = chassis)

```
SELECT: OHMS to GROUND
 TEST          then START
```

Prior to using ohms the analyzer must do an open/ground lead test which checks the low and high range ends.

```
Disconnect AUX lead
               then START
```

STEP 1: Infinite resistance is checked.

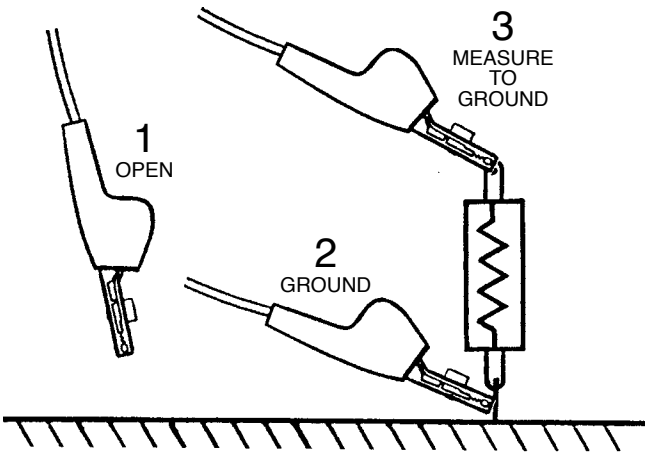
```
Connect AUX to GND
               then START
```

STEP 2: Ground zero calibration is done.

Responses are given to guide the calibration process. If the car’s battery voltage drifts during the test the calibration may also drift. Press **START** to redo the recalibration procedure.

```
OHMS to GND    Bat 12.45
 OHMS                  0
```

STEP 3: Read resistance to ground.



METER PROCEDURE

"DIODE" voltage in the forward and reverse directions can also be read by changing the test with **SELECT**.

```
OHMS to GND    Bat 12.45
DIODE             12.45v
```

Note that resistance is measured by applying the car’s battery voltage through a 1000 ohm resistor in the analyzer, so that up to 15 milliamps may pass through the tested device. An advantage of this current is that LEDs can be checked for light output, and diode forward and reverse voltages can be checked at a more normal operating level.

OXYGEN LAMBDA SENSOR

The red Auxiliary Clip has a 10 megohm input for this test. The display shows the average sensor output voltage, the number of times the voltage crosses the 0.45 level per second, and whether the immediate voltage indicates rich or lean by the R/L display.

```
Oxygen Sensor     0.83 v
 0.0 Crossings/Sec   R/L
```

Typical cross count readings for warm engines running at a steady fast idle are in the 1 to 3 range. Low rates may indicate a damaged O2 sensor. Multiports usually cross count fastest and carbureted engines the slowest.

Connect at sensor harness plug or ECM. Do not penetrate wire insulation where moisture could cause electrical leakage to ground.

THROTTLE POSITION SENSOR

This is a computer aided test to check for skips in a position sensor signal sweep. When a position sensor on a throttle or air flow vane is moved from the rest position to the top, the output voltage should move just like the position shaft. The voltmeter reading for this test updates rapidly so that small irregularities are not likely to be missed.

```
SELECT : POSITION SENSOR
 TEST          then START
```

Press **START**.

```
CONNECT Aux to TP Sensor
Engine OFF;  Key ON
```

Then connect Auxiliary Clip to the output wire and press **START**.

Using the following voltmeter display, check that the output responds to a typical range of 1 to 4 volts when the position sensor shaft is turned.

```
                    0.84 v
for test:     Press START
```

In the TP Sensor test the analyzer detects abrupt voltage changes that an intermittent sensor contact would make. Be ready to smoothly turn or press the position sensor through its full sweep. Press **START**.

```
DETECT ON           0.84 v
Move SLOWLY to W.O.T
```

With the "DETECT ON" display, make a smoothly increasing sweep during 3 to 7 seconds to the top position. The test ends automatically when the voltage stops changing. Findings are reported when the test ends.

```
Possible Problem   1.93v
               Press START
```

If glitches were detected, the corresponding voltage levels will be reported. Recheck the sensor for intermittent faults near the reported problem voltages.
If no irregularities were detected it will show:

```
No GLITCHES Found;
               Press START
```

If the test was run too fast or slow it will show:

```
Too FAST; Retest Slower
```

```
Too SLOW; Retest Faster
```

WIGGLE SCOPE

The Wiggle Scope display can be selected to see a line trace of slow or intermittent voltage changes. It has a 10 megohm input impedance.

```
SELECT:  WIGGLE SCOPE
 TEST          then START
```

This display is like a chart recorder that is written at the left of the screen and flows off the right end. It shows voltage levels and changes **above or below 4 volts** sensed by the Auxiliary Clip.

Level changes during an interval are shown different ways: an **/** or **** shows a simple change, a T or its inverse means there was a change but the start and end were the same, **III** shows that there were many changes.

Wiggle Scope can be used to watch for regular or intermittent pulses on wires for accessories, sensors, lamps, solenoids, slow computer codes, or other on/off electrical signals. The shortest step is about 1/10th second on the fastest scan.

```
WIGGLE SCOPE Scan  2 Sec
˘˘/\|/T\/__\/-----------
```

The number following "SCAN" is the time for the signal to sweep across the display. **SELECT** can choose a 2, 4, 8 or 16 second sweep.

FORD SLOW CODES

The Code Reader can be selected to count and display fault code pulse trains from Ford engine computers.

```
SELECT: FORD SLOW CODES
 TEST          then START
```

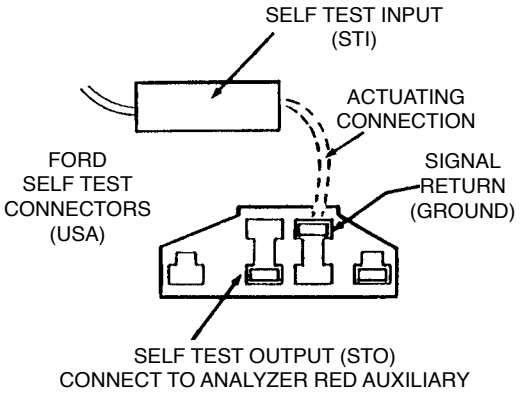
Press **START**.

```
Hook AUX CLIP to
car's fault code OUTPUT
```

Hook the red Auxiliary Clip to the Self Test Output pin.

Press **START**.

Read by following the Ford service manual instructions for voltmeter connections to the Self Test Connector. Readings are similar to a Ford STAR tester.



Ford has different engine test modes for reading codes such as:

KEY-ON ENGINE-OFF
ENGINE-RUNNING
OUTPUT CYCLING (engine off)
WIRE WIGGLE

STI and STO are used on other shapes of Ford connectors throughout the world.

EXAMPLE: Ford's QUICK TEST: Hook the red Auxiliary Clip to the STO pin in the Ford Self Test Connector, and connect a separate wire to the STI pin (be prepared to switch the loose end to ground). Because some engine code tests require the technician to operate brakes, steering, and throttle it is most convenient to place the analyzer and STI-to-ground connection next to the driving controls.

Have the Ford's engine key off, then turn the key on, and ground the STI connection. Wait at least 15 seconds for the code pulses to be read and shown on the display. An "11" is the usual end of codes.

```
FORD SLOW CODE          11
 11
```

The last code read will show at the top with the first six along the bottom line. Repeated codes are not saved. Once the screen is filled the analyzer will continue counting and displaying, but no more codes are saved.

For regular ECM trouble shooting we suggest that a scan tool with connector adaptors, code translating software, and data stream readouts be used.

GM LAMP CODES

The specific vehicle service manual is required to perform this test. The usual procedure is to connect the Auxiliary Clip to pin D of the ALDL connector, which is the "Service Engine Soon" lamp terminal.

```
Hook AUX Clip to
car's fault code OUTPUT
```

Press **START**.

Have the engine stopped with the ignition on, and enter the diagnostic mode by bridging Test Terminal pin B to pin A or ground.

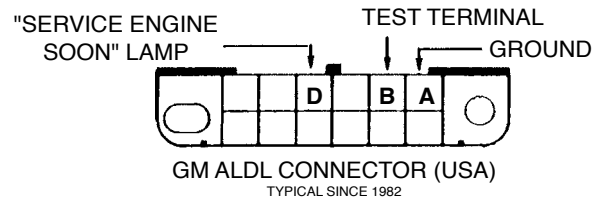
```
GM LAMP CODES           12
 12
```

Use trouble codes by following the vehicle service manual instructions.

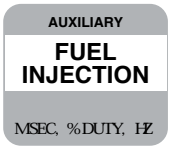
Only six codes are saved on the screen. Once the screen is filled the analyzer will continue counting and displaying, but no more are saved.

To clear the screen for a retest, press **START** and then **SELECT**.

```
SELECT:    to ERASE codes
START:     to KEEP  codes
```



"FUEL INJECTION" KEY



Injector solenoid pulses and sensor signal frequency are read by these tests through the red Auxiliary Clip.

SOLENOID DUTY & HERTZ

Use Solenoid Duty on mixture controlled carburetors, or frequency output sensors such as some pressure and air flow sensors. Also use this test to check Hall-effect switches. "Hz" should go up and down directly with changes in RPM, and "DUTY" should be constant within a few %. "DUTY" is usually about 50%.

The term "DUTY" means the portion of time that the signal is switched to ground, which is when power is applied to solenoids, etc. Duty is not shown for signals over 60 Hz. Frequency up to 250 Hz can be read.

```
SELECT: Solenoid Duty
 TEST          then START
```

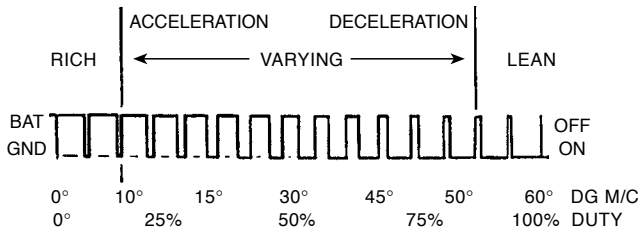
```
 640 RPM        Bat 14.06
28>31  % DUTY Rate 10 Hz
```

SELECT changes the scaling of the "DUTY" reading for either:

milliSeconds	(mS DUTY)
Percent	(% DUTY)
degrees / 60	(Dg M/C)

The lower left reading shows averages of the longest and shortest duty. If the numbers match, the duty is steady. If there is a difference, the signal pulse width is varying which may mean that there is active control (closed loop), or if it should not vary it could be a defective signal source or connection.

The "M/C" display changes to "LEAN" if the readings are over 50, and "RICH" if less than 10.



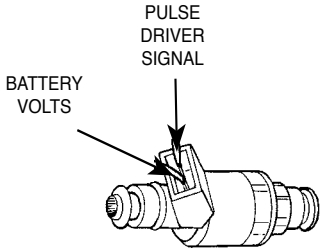
MIXTURE CONTROL CARBURETOR DWELL RANGE

FUEL INJECTOR

Press **FUEL INJECTION** and **SELECT** Fuel Injector milliSecond readings.

```
SELECT: Fuel Injector
 TEST          then START
```

Hook the Auxiliary Clip to the injector driver wire.

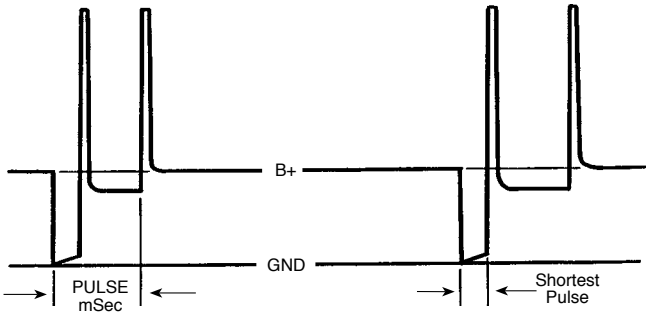


Connections are reversed on different engines.

The detector is made to read the time that current flows in a solenoid by watching the voltage drop from the 12V battery level.

```
 640 RPM        Bat 14.06
 0.8Min   1.7mS   6.5Max
```

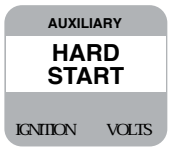
When engine RPM is run up and down quickly, "Min" and "Max" hold the shortest and longest milliSeconds pulse widths while the center reading shows what is presently happening. **START** is used to reset the "Min" and "Max" readings. Up to 63 milliSeconds can be measured.



REGULATED CURRENT INJECTOR SIGNAL

“HARD START” KEY

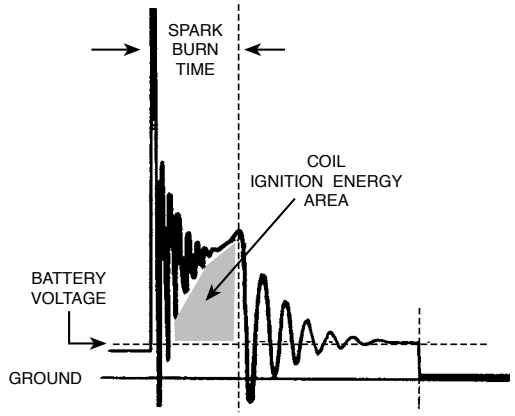
If there is a problem with the engine ignition or analyzer hookup, the analyzer will give messages of the likely causes. Use this test before other tests to confirm that the ignition hookup is working by seeing that the RPM and Ignition Energy readings are normal. See the next page for using Auxiliary Volts to search out connection problems.



IGNITION ENERGY

The signal comes from the ignition coil primary minus [TACH] terminal through the green Coil Primary Clip connection. The engine must be cranking or running to produce a readable signal.

As the figure shows, Ignition Energy strength is the voltage times the spark duration milliSeconds, as measured at the coil primary. This indicates the coil "kick" in millivoltSeconds (mVS) and is displayed as "IgEgy".



COIL PRIMARY (TACH) SIGNAL

```
 356 RPM  msg  Bat 10.34
IgEgy 38   Aux>POS- 1.34
```

"IgEgy" is proportional to the primary energizing current and the quality of the ignition coil inductance. Typical standard ignition coils produce 25 to 40 mVS. High energy ignitions have 40 to 60 mVS. Readings below 20 mVS suggest that an inadequate ignition charge is being delivered by the coil. Low coil current may be the reason, caused by a bad primary connection, bad drive module, worn points, low dwell time, low battery voltage, or an open ballast resistor bypass switch. Use **IGNITION PRIMARY** to check the coil drive voltage, dwell, and coil oscillations.

If "msg" appears, press **MESSAGE**. The following messages may be set after the engine has been cranked or run several seconds. These are suggested problems indicated by the combination of signal measurements. **Refer to the vehicle specific service manual for tests to confirm the suggested defects.** Visual inspection and direct component measurement should be used to confirm that there is an actual problem.

Investigate the following messages further using **SPARK BURN**.

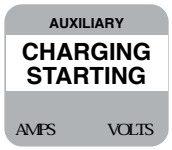
```
Plugs GAP Narrow ?

? Coil - Distributor ?
 or Plugs: Wide GAP?

Shorted
? Coil - Distributor ?
```

Check the following messages further using **IGNITION PRIMARY**.

```
POINTS  RESISTANCE High

COIL PRIMARY-DRIVE Bad?
```

“CHARGING STARTING” KEY

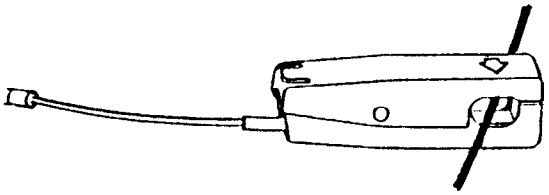
Use this set of tests for general electrical troubleshooting of starter, alternator and load currents, along with connection voltage losses. The special measurements are Inductive Amps and Auxiliary Volts.



INDUCTIVE AMPS

Before hooking up the Amp Probe see that the reading is zero. Press **AMP ZERO** to eliminate zero offsets.

```
1057 RPM  msg  Bat 13.84
   0 AMPS  Aux>NEG 10.34
```



"AMPS" uses the signal from the Inductive Amp Probe. By placing the pickup around a wire the DC current within a +/- 600 ampere range can be measured. Resolution is 1 ampere. An automatic diagnostic check tests for ripple in the current when it is over 20 amps. If ripple is high, indicating an alternator with a bad diode or stator, a message "msg" notifies the user:

```
AMPS RIPPLE ?Alternator?
```

ALTERNATOR OUTPUT VOLTAGE DROP TEST

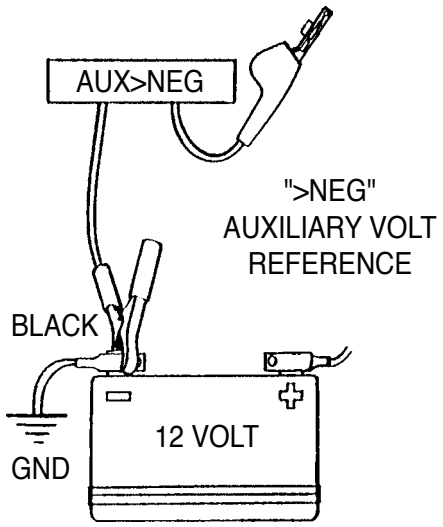
Charging systems will not keep a battery charged if the alternator output connections are bad. The following is a basic wiring test for a common defect.

1. Connect the Auxiliary Clip to the alternator output terminal, and **SELECT** the "Aux>POS" reference.
2. Run the engine at about 1500 RPM and switch the headlights and heater blower on high.
3. If more than 0.5 volt is seen, the voltage drop is too high and the connection between the alternator output and battery positive is bad.
4. Then connect the Auxiliary Clip to the alternator case and **SELECT** the "Aux>NEG" reference. If more than 0.2 volt is seen with the engine, lights and blower still running as before, there is a bad ground connection to the alternator.
5. Repair any defects found before proceeding.

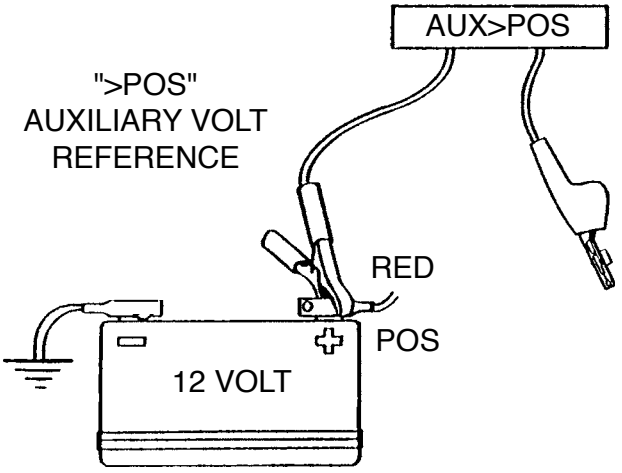
AUXILIARY VOLTS

It receives the signal from the red Auxiliary Clip, and is referenced to either the positive or negative vehicle battery terminal through the analyzer Battery Clip leads. The range is 0 to 20 volts, has 0.01 volt resolution, and has a 10 megohm input impedance to the black Battery Clip.

Press **SELECT** to change the "Aux>POS" or "Aux>NEG" reference noted on the display.



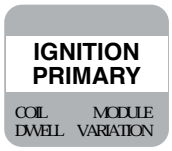
Using the "Aux>GND" reference, it works just as if the voltmeter had a black clip hooked to the battery negative terminal.



The "Aux>POS" reference is useful for voltage drop measurements of wiring resistance between battery positive and connections to accessory loads or from the alternator output. Readings will be negative to all points on the vehicle wiring except on the alternator output wire when it is generating current.

"IGNITION PRIMARY" KEY

Use to check the input power and response of the ignition coil. **SELECT** the two screens to see all measurements including Coil Ignition Energy ("IgEgy"), Coil Oscillations ("Osc"), Driver Module On Voltage ("Drvr"), Ignition Dwell ("DWL"), and the Variation of dwell and timing in degrees ("VARIES").



The signal is taken from the coil primary terminal with the green Coil Primary Clip.

```
 957 RPM  msg  Bat 13.84
Osc 3 IgEgy 38 Drvr 0.8v
```

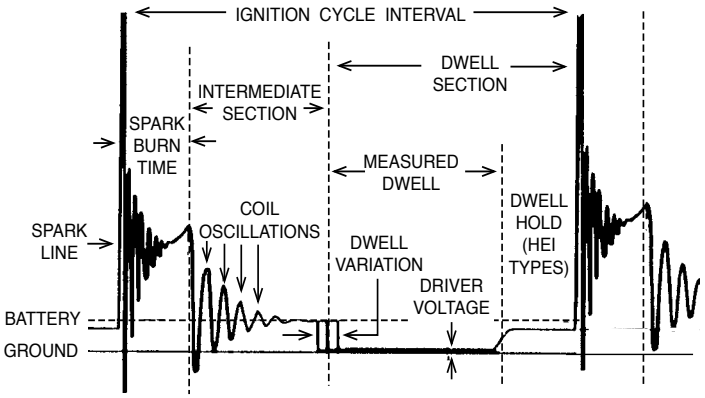
COIL OSCILLATIONS

This is an indicator of liveliness in the ignition coil. Shorts in coil insulation or in connected components usually dampen the oscillations so they are reduced or eliminated.

Points driven ignition coils usually show 4 to 8 oscillations, which are more than electronic ignitions which do 1 to 4. Some Chrysler ignition modules begin dwell immediately after the spark burn time so they normally don't show any oscillations.

DRIVER MODULE / POINTS VOLTAGE

"Drvr" is the voltage during the dwell time. For mechanical points it should be less than 0.3 volts. Electronic modules typically have 0.5 to 1.5 volts. Ignitions made alike should compare within 0.2 volts. In this test a high voltage indicates a failing (high resistance) coil driver output transistor, bad points, or a high resistance connection to ground.



COIL PRIMARY SIGNAL

DWELL

Readings in degrees and percent are useful for setting mechanical points. MilliSeconds are useful for checking electronic HEI type ignitions, which take a fixed time to charge the coil with current. A typical HEI reads about 3.5 mS up to 3000 RPM, and more while cranking.

Use **SETUP** and **SELECT** to choose whether dwell is displayed by degrees (DEG), percent(%), or milliSeconds (mS). If dwell is displayed in degrees it is scaled according to the number of cylinders selected in **SETUP**.

This analyzer measures dwell according to the interval that points are closed, or the transistor driver is fully on. The coil amps dwell hold time which sometimes follows amps buildup is not included in these readings.

IGNITION ENERGY (See **HARD START** page12)

SELECT the display showing "VARIES" which reads RPM, Dwell, Dwell Variation, and Timing Variation.

```
 957 RPM msg DWL 3.3mSec
Dwl  0.6 VARIES Tmg  2.9
```

Variation gauges the engine's control stability.

DWELL VARIATION

This is the difference in degrees between the longest and shortest dwell period. It could be from an unstable coil drive module. Mechanical sloppiness in the distributor shaft bearings and cam shaft drive is the prime cause. At higher speeds on point contact ignitions the problem can be floating contacts from weak springs and poor lubrication. Readings should be less than 3 degrees.

TIMING VARIATION

This is the difference in engine shaft degrees of the longest and the shortest time between ignition firings. Variations in timing are associated with defective engine operation. On pre-computer engines variation meant looseness in the mechanical drive from the crankshaft to the points cam. This is still generally true for distributor located ignition sensors, but sometimes timing is intentionally varied by engine computers.

Irregular idle RPM from O2 feedback fuel metering can cause an apparent timing variation. Operating the engine at higher RPM should reduce the variation to under 3 degrees. The point to be alert to is the erraticness of timing variation which points to sloppiness in the gears, bearings and chains leading to the ignition timing sensor. Confirm timing variation with a Timing Light triggered from the coil-distributor wire by watching the paired marks.

Read variation from 1000 to 3000 RPM with the RPM held steady.

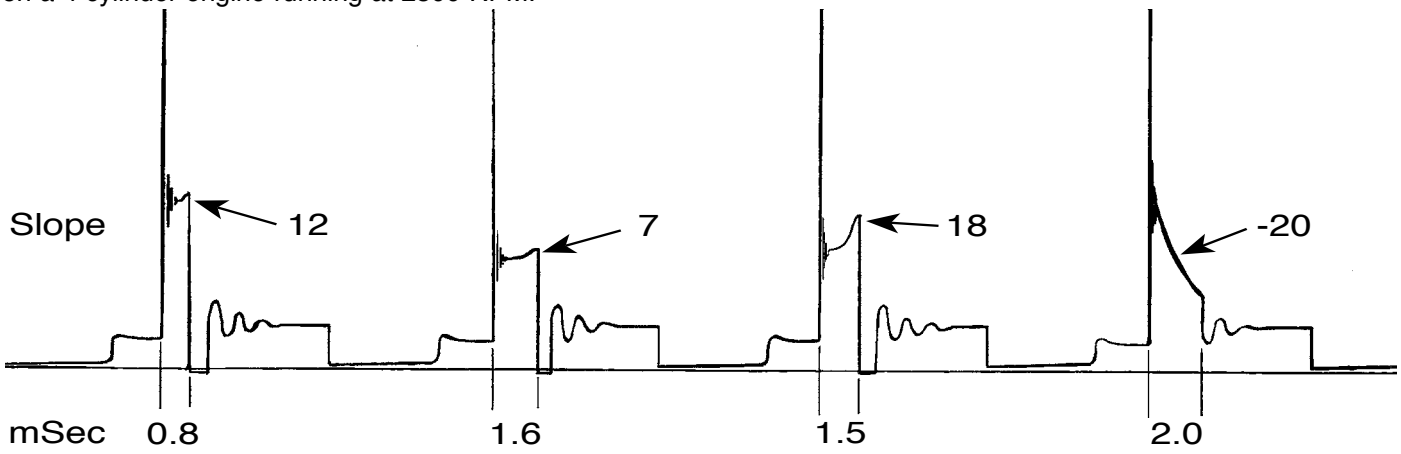
BURN TIME READINGS and PRIMARY PARADE WAVEFORM

This figure illustrates the spark plug readings that this engine analyzer extracts from an ignition waveform, and then shows on the display. Tha analyzer would also give two diagnostic messages:

```
GAP Wide, Seq #1
PLUG foul?  CAP track?
seq #4
```

The signal shown is of a current limited electronic ignition on a 4 cylinder engine running at 2500 RPM.

The No. 1 cylinder, in the first position of the waveform has a gap in the spark plug wire which causes the short burn time. The next two cylinders are normal. The last cylinder has a fouled spark plug, as is seen by the much more negative spark line slope.




```
SPARK     0.8 1.6 1.5 2.0
mSec
```

```
SPARK      12   7  18 -20
Slope
```

See the **BURN TIME** key test explanation on the next page.

COMPARING READINGS TO AN OSCILLOSCOPE

Ignition oscilloscopes are primarily designed for measuring kilovolts. While high voltages are the means which start the sparks, the important ignition factor to check is the time that the spark is exposed to the fuel mixture in each cylinder.

For each spark, KV and the spark burn duration have a trade-off relationship, where if one gets longer the other must get shorter. This is why either measurement may be used to evaluate ignition performance.

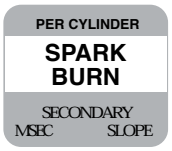
This analyzer excels in automatically measuring and displaying spark burn durations for individual cylinders. Because it measures each and every spark, both the averages, the longest (Max) and the shortest (Min) burn times are saved in analyzer memory and used for comparisons of the cylinders by the analyzer diagnostics as well as by the user.

This is in contrast to the usual oscilloscope traces that require recollection of the spark events to be from the users memory after interpreting the readings from each cylinder's trace. Reading individual spark plug burn times from an oscilloscope trace can be difficult because the scale line is usually along the bottom of the screen and the stacked raster pattern covers the whole screen. Additionally, many scopes don't even have a millisecond scale, and the screen sweep is only given in engine degrees for setting or checking ignition contacts.

This analyzer is made to investigate the essential ignition performance factors. It measures the coil's Ignition Energy response to see that a strong spark is possible without having to open a sparkwire. The analyzer reads the total operating range of spark durations while the engine is idling and accelerating. The numerical results can be watched live as well as from the printed report to see if long enough fuel igniting spark is delivered under all conditions.

“SPARK BURN” KEY

Measures secondary spark events. Continuous operation of all the spark plugs can be watched with this test. The Average, Minimum, Maximum, and Slope cylinder data can be chosen with **SELECT**. "Min" holds the shortest milliSeconds, and "Max" holds the longest. Diagnostic messages will be set by the analyzer if symptoms appear regularly, but will go away if the symptoms are reduced. The measurements for this test come from the ignition coil primary signal that “reflects” the coil secondary events.



Spark Burn Analysis has an entry instruction:

```
Briefly Open Throttle
do not exceed 2500 RPM
```

The "briefly open throttle" procedure captures the operating limits burn times. The analyzer checks for excessive open throttle RPM and may inform the user to redo the "open throttle" step. Such as;

```
     TEST INVALID
 REDO WITH LOWER RPM
```

If this happens, press START and then "briefly open throttle", but do not let the RPM get so high.

The first data display shows the Spark Burn milliSeconds and Spark Slope averages of all the cylinders.

```
 956 RPM      SPARK 1.5mS
IgEgy 38        Slope - 7
```

Press **SELECT** to change between the average, minimum, maximum, and slope spark plug data displays.

```
SPARK    1.3 0.9 1.5 1.4
mSec  msg1.9 1.7  Bank B
```

The "mSec" screen gives the average reading from each spark plug. Use it to watch individual cylinders as engine operation is varied. The "Min" screen is used to find cylinders with short reserves. The "Max" screen is used to find insulation failures and fouled plugs.

To clear the "Min" and "Max" numbers press **START**.

When more than 8 cylinders are displayed there will be a "Bank A" or "Bank B" shown for the first half or second half of the firing sequence.

Compare each cylinder’s average Burn Time to the others. A 0.3 difference from the displayed average is significant. When comparing Slopes, a consistent difference of 20 above or below the measured average should be investigated further.

BURN TIME

This is the duration of a spark in milliSeconds. It is affected by the energy available to push the spark current through the plug circuit. If there is little resistance to block the current it will go longer, more resistance and it will burn out quicker. The usual time is about 1.5 milliSeconds (mS) with 0.8 to 2.3 milliSeconds the typical range limits.

Some ignitions may be designed for longer or shorter spark durations. Compare similar engines if in doubt.

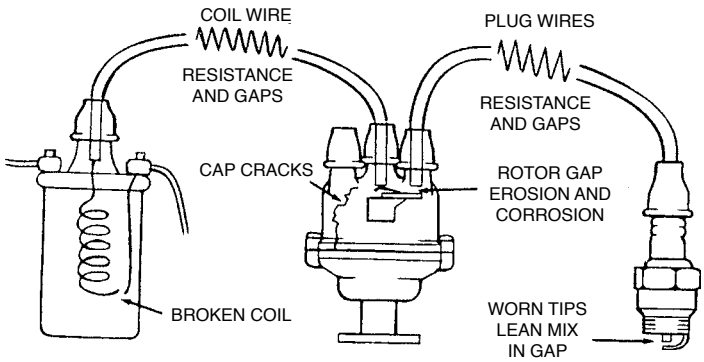
Short Burn Time is caused by breaks in secondary ignition wires, wide sparkplug gaps, worn plug and rotor electrodes, high circuit resistances, and very lean fuel mixtures.

Long Burn Time comes from narrow or fouled plug gaps, distributor or insulation shorts, rich fuel mixture, and low cylinder compression. Usually long times seen with the "Max" data set show intermittent misfires from shorted secondary insulation in the cap, rotor, wires, or plugs.

A reduction in burn times, with snap acceleration, is only caused by the change within the plug gap from burning fuel and pressure. So this test is an ideal check for worn out spark plugs.

Open the throttle momentarily for engine acceleration to check the Burn Time reserve. The Min Burn Time display shows the shortest times measured when an engine works against its own inertia. Compare these times to 0.8 milliSeconds for the reserve.

Problems with other parts like wire breaks, wide rotor gaps and high secondary resistance are most easily detected at a moderate and steady RPM such as between 1000 and 2000 since they are not affected by the cylinder pressures.

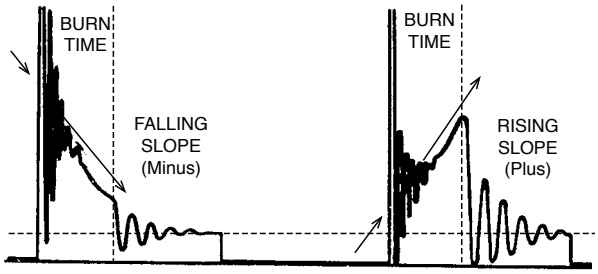


IGNITION SECONDARY CIRCUIT

BURN TIME SLOPE

Slope tells about the fuel mixture at the end of burn time. Lean makes the voltage rise (plus) and rich makes it fall (minus) during the end of the spark.

```
SPARK     -20 -18 - 5 -11
Slope msg   9    6
```



COIL PRIMARY WAVEFORMS

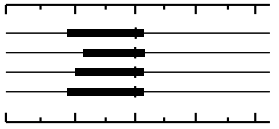
When a spark has a slope more than 20 counts over the overall averages and burn time is short, look for a wide or worn plug gap. If burn time is normal, the cause may be: a lean fuel mix, a manifold or EGR leak, a low fuel pressure regulator, or a cylinder valve leak.

When the slope is 20 counts less than the overall average, look for a richer fuel mix or high resistance spark wire. On multiport fuel injection engines a leaking injector will be likely to cause a consistently lower slope than the other cylinders.

Most engines have slopes in the +30 to -30 range. Good engines usually have all the values within about 10 counts either side of average. Keep in mind that these readings are highly variable because they are affected by the fuel burning. The key is to look for the obviously different cylinders.

When **PRINT DATA** is used the Spark Burn test data will be printed and graphed. The graph spans "MIN" to "MAX" and has a mark at the "AVE" data value. The readings are in firing order from top to bottom.

```
==SPARK BURN ANALYSIS==
RPM    IGEGY    BATTERY
 772     43      14.13

      IN FIRING ORDER
 MIN    AVE    MAX   SLOPE
 0.9    2.0    2.1     10
 1.1    2.0    2.2     10
 1.0    2.0    2.1     15
 0.9    2.0    2.1     17

0    1    2    3    4 MS
```



```
BURN TIME RANGE
```

DIAGNOSTIC MESSAGES

Messages are caused by odd combinations of Spark Burn Time and Slope. Follow up on these suggestions with visual inspection and component testing.

It is recommended that messages about multiple cylinders be ignored until single cylinder messages have been looked into. Since most of the messages are based upon comparisons of each cylinder to the others, it is possible that one bad cylinder may make the others look relatively out of line. Additionally, an open arcing spark plug wire can cause test effects that trigger many messages. Retest after each repair.

The following displays pick out individual cylinders from the firing sequence and suggest possible problem causes:

```
GAP Narrow
Seq. # 5  6
```

Additional problem categories include:

```
WIRE   RESISTANCE High, PLUG Foul ? ,
CAP Track ?, GAP Wide ? , FUEL Lean?
```

The next messages relate to all spark plugs together:

```
Plug GAP Narrow?

Shorted
?Coil - Distributor?

?Coil-Distributor?
or Plugs:  Wide GAP?

Fuel Rich?
```

Additionally if Ignition Energy is very low it will show:

```
COIL PRIMARY DRIVE Bad?
```

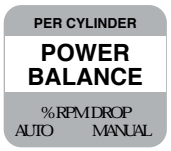
Note, if the Spark Pickup is not working the spark plug data will not be available. A message will show:

```
no SPARK PICKUP Signal
```

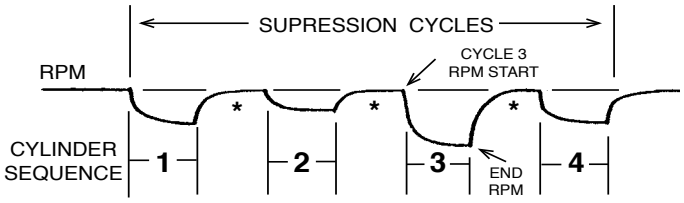
Diagnostic messages from this analyzer are based upon a range of Burn Time that is typical for most engines. There are however, some engines which are designed differently and have performance ranges that may appear to be abnormal to the analyzer so that it will produce messages indicating a possible defect. Compare the measured values to readings from similar engines or specifications from the engine service manual to confirm that the messages apply.

"POWER BALANCE" KEY

This test measures each cylinder's contribution relative to the others by turning off the spark plugs one at a time and measuring the drop in RPM. The more decrease seen, the more a cylinder must have been contributing. A comparison of an engine's entire set of readings is necessary because of engine to engine variations. If a cylinder shows only 1/3 of the drop of the average cylinder it should be checked further with the other analyzer tests. Low power cylinder problems are associated with spark plugs and wires, piston rings, valves and valve springs, vacuum leaks, fuel unbalance, head gaskets, and EGR problems. If a cylinder test produces a higher RPM it may be from crossed spark plug wires, an open intake valve, leaking EGR, or an engine computer effect.



The test relies upon steady timing, fixed air-fuel feed and a constant amount of engine drag during the test to make valid comparisons between all of the cylinders.



RPM DROPS FROM SPARK SUPPRESSION
"*" shows recovery times

A steady drag on the engine can improve the test results. Turning the heater fan on high and headlights on bright is usually the best method. Particular attention should be directed to eliminating loads that can turn on or off in the middle of the test such as the air conditioner compressor and radiator fan motor.

Operating the engine above the controlled idle RPM will minimize the effects of idle compensators and put the engine at a smoother operating point. RPM's of 1000 to 2500 are suitable for the test. Listen to the sound of the engine as suppression is applied. The initial RPM drop tells if power is strong.

On non-computerized engines the timing, fuel mix and idle setting do not vary with time. However, active control systems may have to be put in open-loop mode to keep the timing and fuel mixture fixed.

The idle speed motor may have to be unplugged if the test is done at idle. Disconnecting the coolant temperature sensor will usually cause the computer to operate in open-loop fuel control as if the engine were cold. Where the oxygen sensor is easily reached it can be unplugged to lockup the fuel control. Timing can usually be fixed by disconnecting the MAP sensor hose, or as on Fords, pulling the timing test plug. EGR valves should be disabled by removing and plugging the vacuum hose to the valve. On some engines there is a running test mode that can be set through the diagnostic connector which lets the test run without interaction effects. Refer to the engine service manuals for details.

After the test, carefully restore the disengaged parts. Service codes may have to be cleared, but they will usually clear automatically after 50 to 100 starts.

The results of this test, if compared to the Cranking Amps and Spark Burn tests, can provide additional clues to the cause of poor cylinder performance.

A manual cylinder selection version of the test is provided to check for engine noise changes when power is removed from a particular cylinder.

WARNING

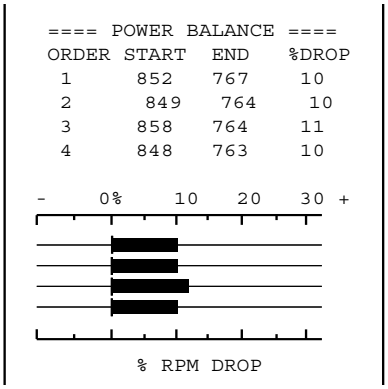
This test causes unburned fuel to be passed into the exhaust. Catalytic converters burning this fuel will become hotter. Repeating the test frequently may cause excessive heat under the car.

When **PRINT DATA** is used the Power Balance test data will be printed and graphed. The % RPM graph shows the percentage drop by cylinder. Weak cylinders will show up as a very short bar. Strong cylinders will show up as a long bar.

TEST PROCEDURE

BASIC TEST

You should have completed the analyzer **SETUP** Steps, and used **IGNITION PRIMARY** to check the leads to engine hookup. Press **POWER BALANCE** to begin. The following screens will appear:



Press **START**

Use **SELECT** to choose between the automatic sequence test, "Auto-", and the manual cylinder selection "Manual". Then press **START**.

```
==== POWER BALANCE ====
 -RUN with Engine Warm-
```

Refer to the vehicle service manual.

```
SELECT:    Auto-
 TEST          then START
```

Allow the RPM to appear and stabilize before pressing **START**.

```
 Disable Engine Control
Turn FAN & LIGHTS ON HI
```

```
1262 RPM       Bat 14.15
Set RPM at 1000 to 2000
```

In "Auto-", pressing **START** begins the automatic ignition suppression cycling of 5 seconds applied and 5 seconds recovery.

```
1280 Start RPM  DROP    %
1088 End Auto-Kill #  1
```

After each suppression cycle the RPM % Drop is shown along with the ending RPM. When all have been tested it will show:

```
PWR-BAL   13    9 - 3  12
% DROPmsg  2   11   Bank A
```

The cylinder power drop data is arranged by the firing order sequence (top: 1,2,3,4; bottom: 5,6,7,8).

If more than 8 cylinders are tested the data will be shown in sets called "Bank A" and "Bank B".

Press **START** to see each set displayed.

TEST VARIATIONS

The analyzer will check for signals from the ignition. Both a Spark Pickup and Coil Primary TACH signal from an Inductive discharge ignition with a distributor are necessary. If the signals do not match, the analyzer may show:

```
   Check Connections!
      -Run Engine-
```

or other indications of problems.

If the test was run once already, the operator will be asked to press **SELECT** for a new test, and thus erase the past saved data, or to press **START** to review the previous test results.

```
SELECT:     run  NEW TEST
START:      view OLD DATA
```

A throttle position holding tool should be used. The analyzer will not work over 3000 RPM for 8 cylinder engines, nor 6000 for 4's. Others are proportionately limited.

In "Manual", pressing **START** shows the "Manual Kill" display with a firing order sequence number. Use **SELECT** to choose a cylinder and press **START** to have it suppressed for 5 seconds.

```
1280 Start RPM DROP    %
1088 End Manual Kill#  1
```

Repeat the test using **SELECT** and **START**. Results are not saved in memory.

Press **MESSAGE** if "msg" is present.

Low power occurs from a drop less than 1/3 of the average.

```
Low POWER Cylinder
Seq. #    5
```

RPM may increase if a cylinder had been firing too soon.

```
RPM  INCREASED
Seq.  #   3
```

The following message indicates that during the test the last cylinder "Start RPM" had changed too much from the first. Too much change suggests that the test should be rerun to see if it gives the same results. Try to find the cause of the change.

```
RPM SETTING Drifted
```

"CRANKING ANALYSIS" KEY

CRANKING HISTORY

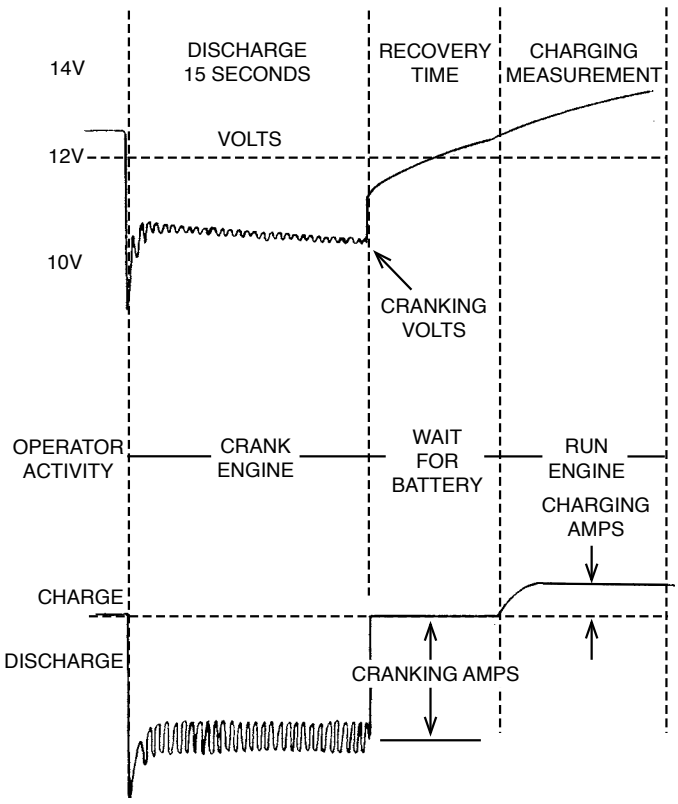
PER CYLINDER
CRANKING ANALYSIS
COMPRESSION
BAT. STARTER ALT.

An electrical power system test of the engine is the primary feature of this sequenced procedure. Performance measurements of the alternator, battery, and starter allow comparison to ratings.

This test records battery voltage and amps while the starter cranks the engine for 15 seconds, then there is a wait to check battery recovery time, followed by a measurement of the charging current when the engine is started.

The Cranking Analysis test procedure for a standard engine follows the basic test procedure in the left-hand column below. Test variations are described in the right-hand column for nonstandard vehicles and conditions.

CRANKING HISTORY TEST



WARNING

THE ENGINE MAY START DURING THE TEST.

STEP ONE

BASIC TEST

You should have completed the analyzer **SETUP** steps, including the check for good readings with **HARD START**.

Press **CRANKING ANALYSIS" to** begin.

```
    CRANKING ANALYSIS
Engine Warm, Brakes Set.
```

Press **START**.

Using **SELECT**, there is a choice of the complete "Cranking History" test or doing the "Electronic Compression" test.

```
SELECT: Compression
 TEST         then START
```

SELECT "Cranking History", press **START**.

Keep the car doors closed during the test to reduce battery drain.

```
Switch ACCESSORIES OFF!
Close Doors,  then START
```

Press **START**.

TEST VARIATIONS

If the test has been done before, it will show:

```
SELECT:     run  NEW TEST
START :     view OLD DATA
```

Running a new test will erase the old data when the new data recording begins.

```
                  Bat  12.04
Recharge BATTERY
```

The test will stop if the battery is below 12.30V indicating a discharged, weak, or loaded battery.

STEP TWO
(CRANKING HISTORY)

BASIC TEST

The user should operate the starter by the usual vehicle operator controls. With the automatic suppression, ignition will be held off.

```
Crank ENGINE 15 Seconds
```

is shown momentarily, then,

```
    RPM        Bat 12.34
  8 AMPS   Not Cranking?
```

Data logging will begin when cranking current is sensed. Or press **START** to proceed immediately.

```
394 RPM        Bat 10.34
182 AMPS            3 Sec
```

—— Continue test on next pages ——

TEST VARIATIONS

Alternately, a remote starter switch may be used, but power must be on the ignition or cranking RPM will not be measured.

The engine may start if ignition compatibility has not been established. Allow it to run for a minute until the situation is resolved.

If the green Coil Primary Clip is not getting a signal, or if the ignition does not have a distributor, and has not been disabled, the engine may start and the test will be interrupted with the display:

```
No PRIMARY TACH pulses
```

If the ignition cannot be automatically suppressed because it has more than one coil, or is not the usual inductive discharge type, then the user must manually disable the engine.

```
No PRIMARY TACH pulses
Disable FUEL or IGNITION
```

Use the recommended method to disable the engine for compression cranking tests from the vehicle service manual. This will usually be by unplugging the power wire or fuse to the fuel injectors or ignition coils. Additionally, unless there is a simulated Coil Primary TACH signal, RPM cannot be read. When ready, press **START**.

If the battery voltage falls below 9.6 volts during the test, it is too low to continue and one of the following messages will be shown:

```
      TEST ABORTED
AMPS high, check STARTER
```

```
      TEST ABORTED
  ?Battery CONNECTIONS?
```

The test will stop and the operator should check the battery-starting system accordingly.

STEP THREE
(CRANKING HISTORY)

BASIC TEST

After the 15 second test the display will show:

```
STOP CRANKING  Bat 10.14
IGNITION OFF          Sec
```

When the operator stops cranking, a waiting period begins which checks the voltage recovery time of the battery. Good batteries will spring back in 1 or 2 seconds. Worn out or undercharged batteries need over 10 seconds to recover. Make sure all battery drains such as dome lamps are off during this test. Keep doors closed.

If the engine was manually disabled, it should be restored during the recovery period. A reminder will be shown after recovery.

```
Restore FUEL or IGNITION
```

Press **START** when completed.

STEP FOUR
(CRANKING HISTORY)

BASIC TEST

When battery voltage has recovered or 30 seconds has passed, the ignition will be enabled and the display will show:

```
     RPM        Bat 12.34
Run Engine over 1500 RPM
```

The operator should quickly bring the engine to a speed where the alternator can charge at a full rate (1500 to 2000 RPM), and before there has been enough charge added for the battery to recover to the regulated voltage.

After a few seconds the display will beep and momentarily show:

```
TEST COMPLETE
```

TEST VARIATIONS

If battery charging is not sensed this step may be passed by pressing **START**.

STEP FIVE
(CRANKING HISTORY)

BASIC TEST

To compensate the measurement of battery CCA rating (SAE Cold Cranking Amps), the operator can **SELECT** one of three temperature ranges that best matches the battery electrolyte.

```
SELECT: Battery Temp.
DEG. C=  over 15
```

SELECT degrees Celsius from: -10 to 0, 0 to 15, or over 15.

Press **START** to continue:

TEST VARIATIONS

This choice will not be asked if recovery was over 30 seconds.

Temperature choices and Fahrenheit equivilents are:

Celsius	Fahrenheit
-10° to 0°	10° to 30°
0° to 15°	30° to 60°

STEP SIX
(CRANKING HISTORY)

BASIC TEST

Display the results and data using **START** and **MESSAGE**.

The seconds of cranking data have the following display form:

```
306 RPM        Bat 11.57
122 AMPS          3 Sec
```

Pressing **MESSAGE** repeatedly will show the following measurements taken during cranking.

```
Cranking Volts      10.66
Cranking AMPS        111
```

```
Cranking RPM         288
Alternator AMPS       38
```

```
BATTERY CCA est.     487
RECOVERY SECONDS      23
```

Leave the messages by pressing **START** or any test key.

Use **CHARGING STARTING** next if any of the test results suggest battery, starter, or alternator problems.

TEST VARIATIONS

If the battery charging current had excessive ripple, indicating an alternator with bad diodes or stator, a message will show:

```
AMPS RIPPLE ?Alternator?
```

If a battery has a slow recovery or will not accept charging, the CCA performance will not be measured and a message will show:

```
CCA not CALCULATED
RECOVERY too SLOW
```

The message display readings are taken from different times in the test sequence. The Cranking volts, Amps, and RPM are the 15th second cranking measurements. During the 1500 RPM period alternator amps are read before the battery is recharged. The estimate of battery CCA (Cold Cranking Amps) is taken from the cranking amps and volts and should correspond to the SAE rating label on the battery. Multiply DIN and BS ratings by 1.5 to approximate SAE. A CCA reading 20% below the battery rating shows weakness.

When **PRINT REPORT** is used the Cranking History data is printed and graphed.

```
====CRANKING HISTORY====
SEC    RPM  BATT   AMPS
 1          13.33  151
 2     326  11.88  129
 3     306  11.57  122
 4     301  11.35  116
 5     300  11.17  114
 7     292  11.03  113
 9     291  10.85  112
11     289  10.76  112
13     288  10.70  112
15     288  10.66  111
------------------------
CRANKING VOLTS     10.66
CRANKING AMPS        111
------------------------
CRANKING RPM         288
ALTERNATOR AMPS       38
------------------------
BATTERY CCA EST.     487
RECOVERY SECONDS      23
------------------------
```

"CRANKING ANALYSIS" Key

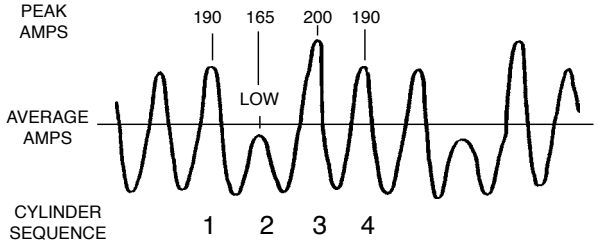
ELECTRONIC COMPRESSION

The cranking-amps-per-cylinder readings of this test give an indication of engine cylinder compression uniformity. This is possible because starter motor amperage is related to the cranking torque, and the cranking torque varies as cylinders go into compression and then spring back .

If all peak amps readings from this test are within a 5% range, compression is probably within the typical specification of 75% of the highest gauge reading. If at least one amps reading is more than 8% lower than the highest, it is likely that there is a problem.

When a leaky cylinder springs back less than a sealed one, the cranking amps of the following cylinder will read higher than it would otherwise. The test is pretty good for catching 20% to 70% compression cylinders, but totally dead cylinders may not show well because they have neither compression or springback torque. Totally dead cylinders will usually be apparent by the engine sound anyway.

Engines with 4 cylinders have a good readings-to-cylinder correspondence. Six cylinder engines have a readings overlapping effect, and 8's overlap so much that the lowest amps reading may correspond to bad compression in the preceding cylinder. This can make the interpretation of these readings complicated.
The way to interpret this test is to first look for a uniform



CRANKING PEAK AMPS WAVEFORM

set of readings which indicates that compression is not a likely engine problem. Then look for at least one cylinder which is notably low, thus suggesting doing a gauge compression test so that the actual pressures/cylinder are measured before extensive work is prescribed. In between these decisions is the gray area where the decision to go to the gauge test must be made with the weight from other engine symptoms such as corresponding weak performance in the Power Balance test, an indication of lean burn for a cylinder in the Spark Burn test, poor emissions output, a noisy valve, a popping or spitty exhaust pulsation, a steady jerking as engine load increases, or other mechanical signs.

WARNING

THE ENGINE MAY START DURING THE TEST.

The Cranking Peak-Amps per cylinder test procedure for a standard engine is as follows in the left-hand column. When there are test complications, variations may appear which are described in the right-hand column.

STEP ONE

Press **CRANKING ANALYSIS** to begin.

Using **SELECT**, there is a choice of "Cranking History" or running only the "Compression" test.

SELECT "Compression" test.

```
SELECT:  Compression
 TEST          then START
```

Press **START**.

The following display will appear:

```
    CRANKING ANALYSIS
Engine Warm, Brakes Set.
```

Press **START**.

```
Switch ACCESSORIES off!
Close Doors, then START
```

Close Doors, then **START**.

STEP TWO
(COMPRESSION)

BASIC TEST

With a beep, the display will show:

```
Crank ENGINE   8 Seconds
Hold THROTTLE Wide OPEN
```

Crank the engine with the ignition key on and the engine intake manifold throttle held wide open. With automatic suppression the ignition will be held off.

Data saving will not begin until cranking current is sensed. While waiting for amps and primary TACH signals from cranking, the analyzer will show:

```
    RPM        Bat 12.34
 8 AMPS  Not Cranking?
```

Once started, the display during the test will constantly show:

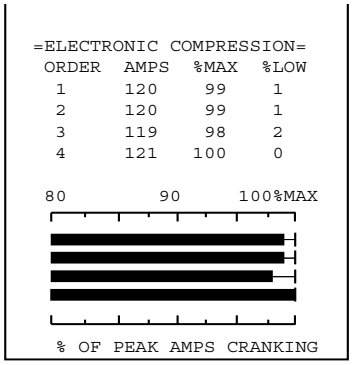
```
Crank ENGINE   8 Seconds
Hold THROTTLE Wide OPEN
```

A timed data gathering process begins here. It relies upon a good electrical system and a steady cranking speed to get consistent results. Holding the throttle wide open ensures that the cylinders get a full charge of air to compress. Over 80% throttle also puts many computer controlled engines in a reduced fuel mode so less fuel will be dumped into the exhaust during the test.

If the engine diesels during cranking, the test data may not be reliable.

—— Continue test on next page ——

The graph shows the results of the relative compression test. The cylinder with the highest relative compression will have a 100% bar. The weakest cylinder will have the shortest bar.



TEST VARIATIONS

If previous use of the analyzer has verified that the ignition can be suppressed and that the Spark Pickup is working, the ignition will be suppressed immediately. Otherwise when cranking begins the engine may run momentarily for signal verification.

If a coil primary signal cannot be sensed the test will abort. Check connections using **HARD START** and then retry.

```
no SPARK PICKUP Signal
```

```
no PRIMARY TACH pulses
```

The operator may bypass starter current sensing for very small or unusual engines, and start saving data immediately by pressing **START**.

Checks are done when cranking begins to verify that the battery has enough voltage, and that the RPM is neither too slow nor fast for reliable data measurements. Interruption displays indicate possible problem causes.

```
Compression Test Aborted
RPM too high to test
```

If during the test, the battery voltage falls below 9.6 volts it is too low to continue and one of the following will be shown:

```
      TEST ABORTED
 ?Battery CONNECTIONS?
```

```
      TEST ABORTED
AMPS high, check STARTER
```

```
      TEST ABORTED
   ?CABLES or STARTER?
```

The test will stop and the operator should check the battery-starting system.

STEP THREE
(CRANKING PEAK-AMPS)

BASIC TEST

WARNING

THE ENGINE MAY START DURING THE TEST

At test completion the ignition will be enabled momentarily to sense the Spark Pickup on cylinder plug #1. The display will show:

```
STOP CRANKING
```

Stop cranking.

As soon as the spark is detected the engine should stop.

The analyzer looks at the data to check for irregularities, followed by this display which shows peak amps for each cylinder.

```
AMPS pk  190 200 164 188
/CYL  msg194 182
```

If "msg" appears, press **MESSAGE**. In this test **MESSAGE** also displays the last Cranking Analysis messages. Passing the last saved message or pressing **START** returns the display to showing test data.

Press **START** to see the percent lower-than-the-highest-cylinder amps. Readings over 10% indicate an unusual cylinder.

```
AMPS  %    5   0  18   6
LOW   msg  3   9
```

The display is arranged by firing sequence.
(top: 1,2,3,4; bottom: 5,6,7,8).

If more than 8 cylinders are tested the data will be shown in sets called "Bank A" and "Bank B", which are the first and second halves of the firing sequence. Press **START** to see both.

Pressing **START** additionally displays the last Cranking History data. The displays recycle.

TEST VARIATIONS

The saved measurement data is first analyzed for consistency. If it is too irregular the display may show a blank and there will be the following messages:

```
Engine Data Unsteady
RESULTS UNUSABLE
```

This may be caused by a battery that weakens during the test, or it could be from a type of engine starter that has interfering vibrations.

If the spark plug signal is absent the data results will not be synchronized with the engine, but can still give an indication of cylinder compression uniformity.

```
Cylinders not in Sync.
No SPARK PICKUP Signal
```

If there is a cylinder with 10% lower amps this message will be shown:

```
Low COMPRESSION Likely
   Check with Gauge
```

Note that the temperature and friction of the engine affect the amperage. A very hot or cold engine, or one that has new piston rings and bearings may draw higher than normal starter current, thus tending to cover up the compression variations in the current.

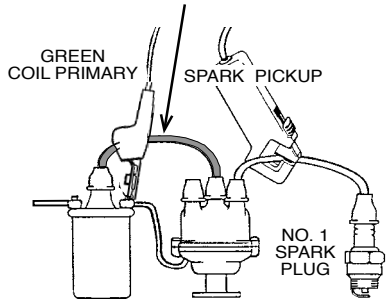
Some users have found that some engines needing an oil change can show large variations in peak amps. Normal peak-amps are restored with fresh oil.

REFERENCE INFORMATION

TESTING ENGINES THAT MAKE RADIO INTERFERENCE NOISE:

Engines that have metallic (non-resistance) wires going to the ignition distributor usually radiate radio interference. If severe enough it can cause the engine analyzer operation to be disrupted. This usually causes it to return to Setup or to display strange characters. If you have these problems the interference will have to be reduced.

Placing resistance in the distributor to coil wire will help. Substitute a 10K to 20K ohm length of wire, or use a plug-in resistance adaptor while testing the engine.



Test for severe radio noise by seeing if the analyzer works better with the spark pickup disconnected. Sometimes noise is caused by bad sparkwire insulation and dirt which can allow sparks to track along the outside of a wire.

PRINTING REPORTS

PRINT AUTOTEST

The printed report brings all of the saved data together in a condensed form that is easy to review for signal trends and for comparing cylinder performance tests.

Data is saved from the Cranking, Power Balance and Spark Burn tests. **PRINT REPORT** includes as many of these tests as have been done. Data will not be printed if none of these tests have been done.

Measurements from the test keys on the left side of the panel depend on test circumstances, so the printout is done with **PRINT DISPLAY**, which makes it easy to record the effects of test variations, such as when RPM changes voltage or dwell.

AUTO-TEST PROCEDURE

Although tests may be done in any order by using the test keys, the Auto-Test feature has been provided as the fastest way to gather all of the information for a complete printed engine dynamics report. The sequence starts ith Cranking History, does the Spark Burn Analysis, takes the Ignition Primary readings, does the Power Balance test, and finishes with the Electronic Compression test. To have good measurements, all of the usual test conditions have to be followed according to the screen instructions.

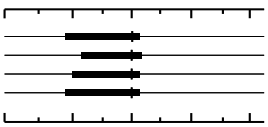
To use the Autotest, pressing **PRINT AUTOTEST**, and **SELECT**. Then proceed through the steps following the instruction screens.

```
SELECT:  Do AUTO-TEST
START :  Print DATA
```

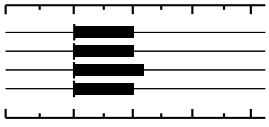
If "Print DATA" is chosen, the printed report will include the last test readings and messages, if any. Thus if the Auto-Test had already been done, and then **SPARK BURN** was used, a "Print DATA" command would printout the same data as before except for the new burn times.

Disconnecting power will erase all stored readings.

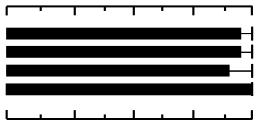
```
------------------------
   ENGINE DATA REPORT
------------------------

====CRANKING HISTORY====
SEC    RPM  BATT   AMPS
 1          13.33  151
 2     326  11.88  129
 3     306  11.57  122
 4     301  11.35  116
 5     300  11.17  114
 7     292  11.03  113
 9     291  10.85  112
11     289  10.76  112
13     288  10.70  112
15     288  10.66  111
------------------------
CRANKING VOLTS     10.66
CRANKING AMPS        111
------------------------
CRANKING RPM         288
ALTERNATOR AMPS       38
------------------------
BATTERY CCA EST.     487
RECOVERY SECONDS      23
------------------------

==SPARK BURN ANALYSIS==
RPM   IGEGY   BATTERY
 772    43    14.13

     IN FIRING ORDER
 MIN   AVE   MAX  SLOPE
 0.9   2.0   2.1     10
 1.1   2.0   2.2     10
 1.0   2.0   2.1     15
 0.9   2.0   2.1     17

0    1    2    3    4 MS
```



```
    BURN TIME RANGE

 ====IGNITION PRIMARY====
  850 RPM       BAT 14.01
OSC 2 IGEGY 43 DRVR 0.8V

  847 RPM     DWL 3.6MSEC
DWL  0.3 VARIES TMG  4.8

 ==== POWER BALANCE ====
ORDER START  END   %DROP
 1     852   767    10
 2     849   764    10
 3     858   764    11
 4     848   763    10

-    0%    10   20   30 +
```



```
      % RPM DROP

=ELECTRONIC COMPRESSION=
ORDER  AMPS  %MAX  %LOW
 1     120    99    1
 2     120    99    1
 3     119    98    2
 4     121   100    0

80        90      100%MAX
```



```
 % OF PEAK AMPS CRANKING
```

VISUAL CHECKLIST

At the end of report printing there is the option to add a list of visual inspection items. This is usually done to help inform the car's owner of any defects that should be repaired.

Use **SELECT** to choose one of the three printed line endings. The initial setting for each line is “N/A” which means Not Applicable, and it bypasses printing the item. “OK”, “LOW”, and “BAD” are endings that print along with the list item and indicate what inspection showed it to be.

```
SELECT: VISUAL CHECKLIST
START : Print ID FORM
```

REPORT IDENTIFICATION

The "ID FORM" option is a report identification footer. This provides a standard method to neatly mark the test record with the car, its odometer reading, and the date. You can bypass the form printout by pressing any test key.

The footer entries are then written on the report.

ANALYZER SERVICE

When power is applied to the analyzer it does a self-check and will indicate a problem if one is found. Also during operation, checks are done to verify that necessary test signals are working. If a test will not work or the analyzer indicates abnormal operation, the leads associated with the test should be checked as described below before sending it in for service.

If the analyzer will not respond to the keys, disconnect power and try again. Be attentive to the connectors in the battery cable. Wiggle them to detect intermittent connections. Apply 12 volt battery to power leads for all checks. The analyzer does not have any user serviceable internal parts.

BATTERY POWER LEAD CHECK

If the display does not appear after 10 seconds when hooked to a 12-volt battery try the following substitution: Plug the Coil Primary/Auxiliary Lead into the analyzer's 12-volt battery panel connector. Connect the red Auxiliary Clip to the 12-volt battery plus, and the green Coil Primary clip to minus. Be sure the battery is good. If the analyzer display appears, the analyzer works, so the power lead must have a bad connection. If the display does not appear after 10 seconds the analyzer probably needs service.

The Black clip goes to the three center conector contacts, and the Red clip goes to the end contacts.

COIL PRIMARY LEAD CHECK

Press **IGNITION PRIMARY**. Do the following test while watching the analyzer "Drvr" reading: using a 1.5 volt flashlight cell (AA, C, or D): touch the cell minus terminal to the black Battery Power Clip; touch the green Coil Primary Clip to the flashlight cell plus terminal. If the reading is 1 to 2 volts the lead is okay. If —-v shows, the cell is backwards but the lead is okay. If there is no response the lead is open.

AUXILIARY VOLTMETER CHECK

Press **CHARGING STARTING**. Use **SELECT** and read the "Aux>NEG" voltage. Touch the red Auxiliary Clip to the analyzer red Battery Clip. The "Aux>NEG" reading should match the "Bat" reading within 0.05. Also touch the red Auxiliary Clip to the black Battery Clip to see a reading of 0.00 within 0.05. If there is any response the lead is good. If the readings are not correct the analyzer needs service.

AMP PROBE CHECK

Press **CHARGING STARTING** to be able to read the Amps display. Be sure that the probe is away from wires and magnets. Press **AMP ZERO**. It will not operate if the current sensed is over 20 amps during a zero check. Wait a few seconds and watch that the reading is 0+/-1. Wiggle the connectors to check for intermittent connections which would show that the probe cable has failed. If the amps reading is zero it should be okay. If instead of a reading the following display appears, the probe or analyzer has failed.

```
AMP ZERO Bad:      2 AMPS
See OPERATORS MANUAL
```

Press **START** to continue. Unplug the amp probe from the analyzer and press **AMP ZERO**. If the amps reading does not become 0 +/-1 the analyzer needs service. Otherwise the amp probe needs replacement.

EXTENSION HARNESS CHECK

There are four identical 5-wire cables within the Extension Harness. First connect them all in series so that at one end there is a pair of free ends. To put them in series, on one end of the harness put red to yellow and green to blank, then on the other end put green to yellow and use the remaining red and blank ends for the analyzer and test lead connections.

Check the cables by plugging the series linked harness from the battery power lead set to the corresponding analyzer connector. The display must turn on. Press **CHARGING STARTING** to see that the battery voltage reading is normal. Wiggle the connectors to check for intermittent connections. If the display does not come on or the reading is too low, some wires are open and the test should be tried with each separate cable in the harness to find the bad one.

TIMING LIGHT CHECK

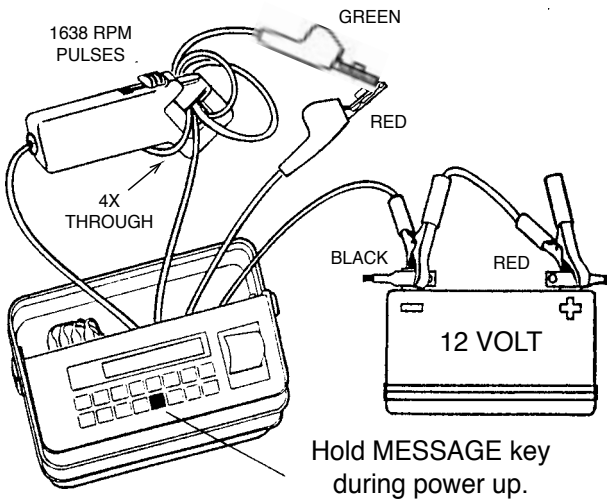
Triggering the Timing Light depends upon pulses from the spark pickup. To make the light flash without hooking it up to an engine, set up the "SPARK PICKUP CHECK" on the next page to get trigger pulses to the pickup. Then press the light's trigger buttons to see if it will flash.

SPARK PICKUP CHECK

With this test the analyzer is put in a special test mode that produces simulated spark pulses to test the Spark Pickup. At the same time some other internal function self-tests are done.

SPARK PICKUP SELF TEST

Refer to the connection diagram when doing the following steps. There must not be any connections other than the following:



1. Pass the green Coil Primary Clip wire four times through the Spark Pickup opening such that the clip end comes out the spark plug label side. Close the pickup jaw.

2. Connect the green Coil Primary Clip to the red Auxiliary Clip.

3. Connect the analyzer red BatterY Clip to 12 volt battery plus.

4. Press and hold **MESSAGE** while connecting the analyzer black Battery Clip to battery minus.

5. If all connections and operations are correct the display will show:

```
COIL PRI & AUX CONNECTED
4 times thru SPRK PICKUP
```

Press **START**.

If a wire is not hooked up properly, or broken it will show:

```
BAD Connection
FIX and START to RETEST
```

Press **START** to retry the test. If the hookup is okay one of the clip wires is probably open. Verify by doing the "COIL PRIMARY LEAD CHECK" and the "AUXILIARY VOLTMETER CHECK". If the wires check okay the analyzer is probably broken.

If the connections are good but the spark pickup is not working it will show:

```
1638 RPM output OKAY
no SPARK PICKUP Signal
```

Try wiggling the pickup lead terminations and check the core contacts for a gap or breaks. Double check the direction of the coil Primary Clip wire through the pickup.

If the pickup is working the "no SPARK PICKUP Signal" line will go away leaving only the "1638 RPM output OKAY" to show that all is working.

With this arrangement the pulses in the test lead may be used to check the calibration of other secondary ignition tachometers. More turns may be needed in other pickups to sense the pulses. (4 stroke scale, 1% accuracy)

6. Leave the self test mode by pressing any test key.

REPLACEMENT PARTS

	PART NUMBER
Coil Primary/Auxiliary Clip Lead	W004-93
Battery Clip Lead	W004-02
Extension Harness, 8'	W000-04
Inductive Spark Pickup	X008-01
Inductive Amp Probe, 5'	X000-02
Timing Light	X006-01
Printer Paper, Pk. of 3 rolls	H013-01
Paper Spindle	G016-09
Printer Cover	G016-08

Test Key	Measurement	Typical Readings	Interpretation
HARD START	Battery Volts (Engine Off)	12.4 to 12.8 Volts	Checks battery state of charge. Below 12.3V, charge is low, or load may be on.
	Ignition Energy (Cranking)	More than 20 mVSec	Shows that there is coil energy available to start the engine.
CHARGING STARTING	Battery Volts (Engine Running)	13.2 to 15.2 Volts	Shows the voltage regulator setting and if the alternator functions.
	Amps Ripple (Engine Running)	None	If alternator has a bad diode or stator a message will appear.
IGNITION PRIMARY	Ignition Energy (Engine Running)	35-55 mVSec	Checks for faulty coils, and driver modules.
	Dwell (Engine Running)	60% w/ Ballast 3 to 4 mSec current limited	Adjust as necessary. Checks ignition modules.
	Dwell Variation (Engine Running)	3.0° or less	Checks primary ignition system performance. Test from Idle to Cruise RPM.
	Timing Variation (Engine Running)	3.0° or less	Shows ignition timing irregularity if too high.
	Driver Voltage (Engine Running)	Electronic less than 1.5V Points less than 0.3V	Shows coil driver module, and module ground resistance if too high.
	Coil Oscillations (Engine Running)	Electronic 1 to 4 Osc Points 4 to 8 Osc	Checks for shorts in coil insulation or connected components.
SPARK BURN	Burn Time Average (Engine at Idle)	0.8 to 2.3 mSec	Checks condition of secondary ignition system Finds open or grounded spark plug wires.
	Burn Time Minimum (Accelerate Engine)	more than 0.8 mSec	Shows worn or wide gap plugs if less.
	Burn Time Maximum	less than 2.3 mSec	Finds grounded plugs or wires. Locates ignition misfires.
	Burn Slope	-30 to +30	Lean mix or wide plug gap if 20 greater than average. Rich mix or high resistance plug if 20 less than average.
CRANKING ANALYSIS	Cranking Volts	9.6 to 12 Volts	Checks battery and starter condition performance.
	Cranking Amps	100 to 300 Amps	High amps, possible bad starter. Low amps, possible bad connections, or bad battery.
	Cranking RPM	Over 150 RPM	Checks starter performance.
	Alternator Amps	50 to 100 Amps	Compare alternator output to specs.
	Battery CCA est.	300 to 600 CCA Compare to Battery Spec's	If 20% lower than the rating on the battery,the battery is weak and may be ready for replacement.
	Amps Peak	Less than 5 percent	Probably low compression, if more than 8%.
POWER BALANCE	%RPM drop when each cylinder is shut off	5 to 15% within 2:1 ratio	The higher the number the stronger the cylinder. A negative number means the engine speed increased.
FUEL INJECTION	Port Injection	0.4 to 20 mSec	Measures on-time of the injector drive.
	Solenoid Duty	30° to 60° M/C, 10 Hertz	Checks function of mixture control solenoid.
SENSOR TEST	Throttle Position Sensor	0.5 to 5V with no glitches	Checks function of throttle position sensor.
	Oxygen Sensor	0.45V & over 1 Cross./Sec.	Checks activity of the oxygen sensor.
	Ohmmeter	1 to 50K Ohm	Measures resistance to ground.
	Diode Volts	0.5 to 0.7 Volts	Measures diode forward voltages.

Note: Use repair manuals and compare similar engines to obtain actual specifications. Typical readings shown apply to most normal vehicles.

DIESEL TIMING & RPM

The analyzer also provides diesel engine RPM and injection timing tests. The necessary input signals come from the optional Ferret 854 Magnetic TDC Detector, and from a No.1 cylinder Diesel Injection Detector. See instructions provided with the optional detectors.

```
SELECT:  Diesel/ 4Stroke
Ignition       then START
```

The analyzer SETUP has a diesel ignition selection. If selected, analyzer operation is limited to the following tests. Press any test key to find these tests.

```
SELECT:
 TEST          then START
```

```
Injct RPM, V & A
 Mag  RPM, V & A
Mag Probe Timing
Ohms to Ground
```

DIESEL INJECTION DETECTOR TESTS

Connect the injection detector pulse sensor around the No.1 cylinder fuel line, and connect the detector to the Analyzer Spark Pickup input. For the most reliable measurements SELECT Diesel in the analyzer SETUP.

Injct RPM, V & A:
The "Injector RPM" test reads RPM from the No.1 cylinder injection detector input, and displays battery volts, aux. volts, and the amp probe current. The screen is like the "Charging Starting" test.

```
XXXX RPM        Bat 13.76
 XXX AMPS  Aux>Gnd 10.43
```

Diesel Strobo Timing:
Diesel Timing can also be measured with the strobo timing light when the No.1 cylinder signal is provided by the Diesel Injection Detector. The light can be used without selecting a specific test.

OHMS TO GROUND

This is the same "Sensor Test" key function.

MAG PROBE TESTS
TDC signals can be detected from timing probes mounted on engines. The TDC detector is designed to work with timing wheels having either notches or pins. When the magnetic probe is aligned with a wheel mark the detector sends a pulse to the engine analyzer and flashes an indicator lamp on the detector. To operate, plug the TDC Detector into the analyzer timing connector, and connect the magnetic probe to the Detector.

Mag RPM, V & A:
Reads RPM from the Mag Probe signal, and displays battery volts, aux. volts, and the amp probe sensed current. The test calls for selection of the number of wheel dents: (pins or notches) Choose 1 & VW, 2, 3, or 4. Magnetic Probe RPM readings work from cranking to 6000 RPM.

Mag Probe Timing:
The display shows No.1 cylinder RPM, timing advance degrees, and the selected Offset. The test reads the ignition timing angle between the No.1 cylinder pulse and the mag probe pulse with the offset angle subtracted. The test selections for mag probe offset are: 20°, 0°, 10°, 15°, & VW. Timing measurements work from idle to 6,000 RPM.

```
XXXX RPM          ADV xxx
START to save. 20 Offset
```

Up to five readings can be saved and printed as data.

This test is also available for spark ignition engines. Press the SENSOR TEST key to SELECT the test. Without the TDC Detector connected this test may show strange readings. More detailed instructions are enclosed with the 854 Magnetic TDC Detector and Diesel Injection Detector.

SAFETY PRECAUTIONS

— Read All Instructions Before Using The Analyzer —

- Always wear eye protection when testing vehicles. Be extra careful near batteries and moving parts. Do not lay tools on a battery.

- Battery gas is highly explosive.

  a. If a battery explodes flush the acid away from persons skin with generous amounts of water. Follow up with a neutralizing solution of baking soda and then more water.

     Treat clothing, vehicle parts, and equipment similarly. Any acid traces inside equipment must be removed by generous rinsing. Dry equipment and place in a warm 50°C (120°F) oven until thoroughly dry.

  b. Never use a wrench on the ungrounded battery terminal until the grounded one has been disconnected. Contact between the vehicle body metal and the hot terminal can cause sparks to ignite gas or even weld tools into a battery short circuit.

  c. Keep the space around a battery well ventilated.

  d. Do not make sparks or allow flames near batteries.

- Before working on a vehicle set the brakes and block the wheels. Beware of automatic parking brake releases.

- Keep your work area well ventilated and free of exhaust. Engine exhaust contains deadly poisons.

- Avoid electrical shocks caused by getting close to live ignition wires or touching the coil TACH terminal. A person's reaction near a live engine can be more damaging than the shock.

- Keep spark producing devices at least 0.5m (18") above the floor to reduce the hazard of igniting gasoline vapor.

- Do not let test leads wind up in a moving fan or pulley. Route leads away.

E016-09B **Printed in USA**