Enhanced Diagnostic Lead Set

OPERATOR'S MANUAL

Vetronix Corporation
Diagnostic Solutions For Vehicle Electronics

Enhanced Diagnostic Lead Set

OPERATOR'S MANUAL

SOME THINGS YOU SHOULD KNOW

⚠ CAUTION: EXHAUST GAS

When performing any checks with the engine running in an enclosed space such as a garage, be sure there is proper ventilation. Never inhale exhaust gases; they contain carbon monoxide, a colorless, odorless extremely dangerous gas which can cause unconsciousness or death.

⚠ CAUTION:

To help avoid personal injury always set the parking brake securely and block the drive wheels before performing any checks or repairs on the vehicle.

⚠ CAUTION:

The EDLS Adapter and associated test leads should only be used with automotive applications.

DO NOT connect to 120V/220V power source!

DISCLAIMER

The TECH 1, TECH 1A and Mastertech are designed for use by trained service personnel only. They have been developed for the sole purpose of diagnosing and repairing automotive electronic systems. Every attempt has been made to provide complete and accurate technical information based on factory service information available at the time of publication. However, the right is reserved to make changes at any time without notice.

FCC COMPLIANCE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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Manual P/N 02002747

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EDLS NEW FEATURES

The EDLS software included in the Multi-Function Tester (MFT) Professional Version 1.0 includes several significant enhancements. For a quick reference, the changes are summarized below:

OSCILLOSCOPE MODE

- The Oscilloscope secondary ignition mode (DI & EI) have been improved by increasing the ignition waveform accuracy.

- The Oscilloscope trigger level position can now be moved with the arrow keys when measuring automotive signals. This is helpful when wanting to view pre-trigger measurements.

- The newly added Vetronix Current probe is now available for use with the EDLS adapter.
  - Current Probe Amperage signals can be displayed, plotted, and saved using the Oscilloscope Mode.

DIGITAL METER MODE

- Pulse Width meter with "Time High" and "Time Low" switching capability. The pulse width also records the "MIN" and "MAX" measured values.

- Vetronix Current probe is now available for use with the EDLS adapter.
  - Amperage readings can now be measured from 0 to 30 amps.
  - "MIN" and "MAX" values displayed.

- Vetronix Temperature Probe is now available for use with the EDLS adapter.
  - Temperature can be measured from 32 to 1000 °F.
  - Temperature can be toggled from °F to °C.
  - "MIN" and "MAX" values displayed.

- Enhanced help screens for all Digital Meter Mode selections.

ENHANCED DIAGNOSTIC LEAD SET

DIGITAL METER MODE (Cont.)

WAVEFORM ASSISTANT

- Newly added waveforms including:
  Fuel injector – Amps
  Fuel Pump – Amps

- Improved waveforms including:
  DI – Secondary Single
  DI – Secondary All
  EI – Secondary Single - Pos
  EI – Secondary Single - Neg

INTRODUCTION

This manual describes the operation and application of the Enhanced Diagnostic Lead Set (EDLS). Please read the entire contents of this manual and familiarize yourself with Mastertech and EDLS before beginning any diagnostic test procedure.

The EDLS Kit (P/N 01001985) contains an EDLS Adapter, RPM Probe, KV Probe, and operator's manual. The EDLS Kit is designed to work with the Mastertech toolset and program card containing the EDLS software.

When the EDLS Adapter (P/N 02002033) is connected to the Mastertech, two additional function modes can be selected when in the Oscilloscope mode. These additional modes will not appear if the Diagnostic Lead Set (DLS) Adapter (P/N 02001766) is installed.

The EDLS Adapter is designed to measure +/- 600 volts while using the Oscilloscope mode of the Mastertech.

USING THE EDLS KIT

The EDLS Kit is an accessory to the Mastertech that increases automotive diagnostic capability and greatly simplifies the testing of many vehicle components. The EDLS Kit provides signal input to the Mastertech oscilloscope and digital meter functions. The EDLS Kit allows connection and diagnosis of high voltage automotive components and systems such as ignition primary and secondary signals. The EDLS Kit also provides oscilloscope preset configurations for most vehicle sensors, actuators, fuel injectors, distributor signals, ignition signals, and current signals.

NOTE: When using the EDLS Kit, the tester should be connected to the vehicle's power source via the Diagnostic Link Connector (DLC) or battery adapter cable.

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1.0 DESCRIPTION

The EDLS Kit (P/N 01002084) comes with several components with which you should become familiar (See illustration on the following page). Some components are required that are not included in the kit. Below is a list of the components that come with or work with the EDLS Kit.

- **Mastertech Program Card**
  Although not a component of the EDLS Kit, a field re-programmable Mastertech program card with EDLS software is required. The EDLS software has additional user modes available only when the EDLS Adapter is connected. These modes are Sensors, Actuators, Injectors, Distributer and Ignition. See following section(s) of this manual for more information.

- **EDLS Adapter**
  The EDLS Adapter (P/N 02002033) is designed to work with the Mastertech much in the same way that the DLS Adapter does. However, the EDLS Adapter has more functionality, including the ability to measure up to ± 600 volts directly.

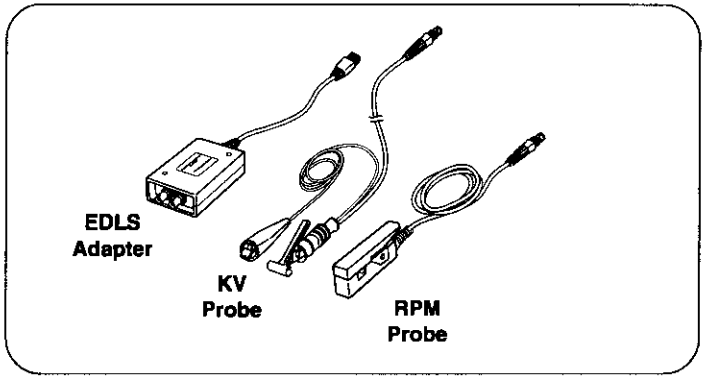
- **RPM Probe**
  The RPM Probe (P/N 02002040) is used with the EDLS Adapter only. It is a clamp-on inductive pickup which provides an oscilloscope trigger input on certain signals.

- **KV Probe**
  The KV Probe (P/N 02002039) is used with the EDLS Adapter only. It is a clamp-on capacitive pickup which provides the high-voltage secondary ignition signal input and a ground reference to the EDLS Adapter. This probe allows measurement of ignition signals up to 50 KV.

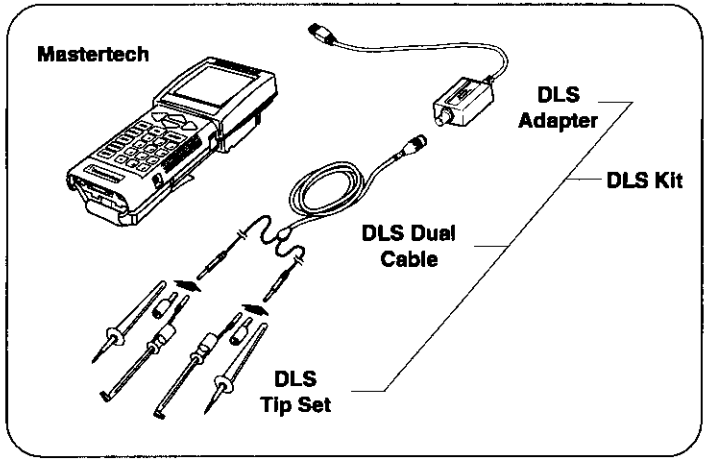
- **DLS Dual Cable and DLS Tip Set**
  Although not part of the EDLS Kit, the DLS Dual Cable (P/N 02001767) and DLS Tip Set (P/N 02001768) are used with the EDLS Adapter to measure electronic engine control, anti-lock brake components, ignition system primary signals, and many other automotive signals. Both the DLS Dual Cable and the DLS Tip Set are standard items of the Mastertech kit.

ENHANCED DIAGNOSTIC LEAD SET

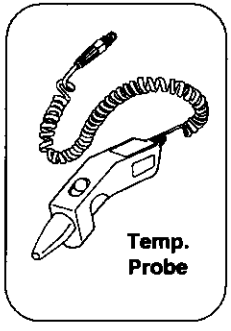
EDLS KIT

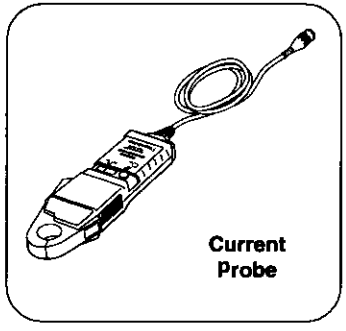


MASTERTECH AND INCLUDED ACCESSORIES

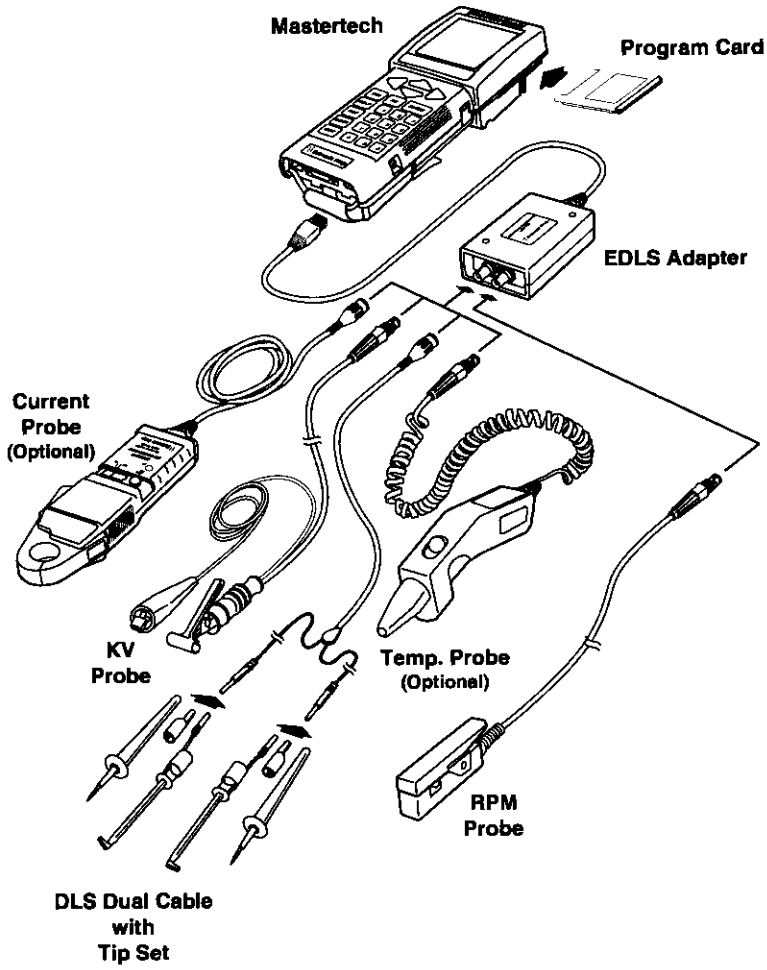


MASTERTECH OPTIONAL ACCESSORIES





EDLS SETUP
(Optional probes shown)



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2.0 GENERAL LEAD CONNECTION INFORMATION

The EDLS software has lead connection information screens that will appear when Single Channel, Dual Channel, Sensors, Actuators, Injector, Distributor, Ignition, or Current modes are selected. Follow these instructions carefully and remember the following information:

MAXIMUM DIRECT VOLTAGE INPUT

The Mastertech oscilloscope and digital meter can accept input from the DLS Adapter or the EDLS Adapter. Without the EDLS Adapter, maximum voltage input is ± 20V. Using the EDLS Adapter, maximum voltage to the Mastertech oscilloscope input is ± 600V and maximum voltage to the digital meter input is ± 20V.

MAXIMUM VOLTAGE INPUTS

FUNCTION	DLS ADAPTER	EDLS ADAPTER
OSCILLOSCOPE	± 20V maximum input	± 600V maximum input
DIGITAL METER	± 20V maximum input	± 20V maximum input

NOTE: The mode F3: OSCILLOSCOPE must be selected to enable the ± 600V maximum input.

⚠ CAUTION:

The EDLS Adapter and associated test leads should only be used with automotive applications.

DO NOT connect to 120V/220V power source.

ENHANCED DIAGNOSTIC LEAD SET

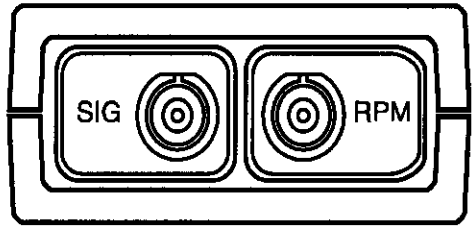
EDLS LEAD CONNECTIONS

The EDLS Adapter has two connections that are labeled SIG and RPM, and a short cable that connects to the Mastertech Instrumentation Port (I/P). Refer to the EDLS Lead Connections table below. The SIG and RPM connections can be used as follows:

SIG- The SIG connection is designed for use with the KV Probe, the DLS Dual Cable, the Current Probe, or the Temperature Probe to receive the input signal that is currently being measured.

DO NOT connect any other type of cable to this connection.

RPM- The RPM connection is only designed for use with the RPM Probe, which receives the revolutions per minute (RPM) signal that is being input to the oscilloscope for external trigger functions.



EDLS LEAD CONNECTIONS

COMPONENT	CONNECTS TO SIG	CONNECTS TO RPM	DESCRIPTION
DLS Dual Cable	Yes	No	Normal Direct Input (same as the DLS Adapter, except increased voltage input of ± 600V in oscilloscope mode)
KV Probe	Yes	No	Measures Ignition Secondary Signals (up to 50 kv)
RPM Probe	No	Yes	Provides cylinder reference for Secondary Ignition
Temp Probe	Yes	No	Measures temp. from 32°F to 1000°F
Current Probe	Yes	No	Measures current from 0 to 30 Amps

3.0 EDLS SOFTWARE

The EDLS software is designed to work with the Mastertech oscilloscope and digital meter functions.

DIGITAL METER FUNCTION

The following digital meter functions are available when using the EDLS hardware.

- Voltage
- Duty Cycle
- Frequency
- Pulse Width
- Current (requires optional Current probe)
- Temperature (requires optional Temperature probe)

Refer to the MFT Manual for additional information.

NOTE: Input voltage to the digital meter is limited to ± 20V. Refer to the MFT Program Card manual for information on using the digital meter functions.

OSCILLOSCOPE PRESELECT FUNCTION

The MFT oscilloscope includes preselect functions for Sensor, Actuator, Injector, Distributor, Ignition, and Current signals. By selecting one of the functions, a list of components that are found on powertrain systems is displayed. Once the component that is desired to test is selected, a text connection screen is displayed, which is followed by the oscilloscope screen. The setup information on the display has been set with field researched values, and enables a particular waveform to be displayed sooner in the setup process. Each of the functions is designed to speed up the oscilloscope setup time, so waveform review can begin almost immediately.

For more information on each mode, refer to section 4 of this manual.

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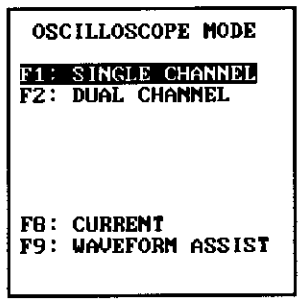
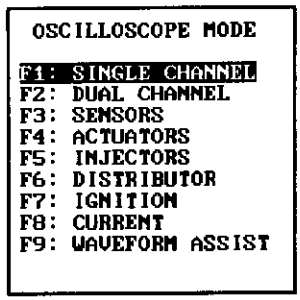
4.0 OSCILLOSCOPE MODES

The EDLS Kit is designed to work with the Single Channel, Dual Channel, Sensors, Actuators, Injectors, Distributor, Ignition, and Current modes that are selectable from the F3: Oscilloscope Mode menu. To make a selection from any of the Sensors, Actuators, Injectors, Distributor, Ignition, and Current modes, the EDLS Adapter must be connected to the Mastertech. Once any of the modes have been selected, a list of components will be displayed. Choosing a component from the list will display a text connection screen and then an oscilloscope screen with the preselected oscilloscope settings (known as "preselects").



WITHOUT EDLS ADAPTER CONNECTED



WITH EDLS ADAPTER CONNECTED

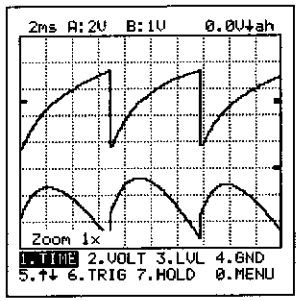
ENHANCED DIAGNOSTIC LEAD SET

The following table defines the leads and connections required to accompany the EDLS Adapter for different automotive systems.

EXAMPLES OF AUTOMOTIVE CIRCUITS USING THE EDLS ADAPTER

SYSTEM	EXAMPLE of SIGNAL UNDER TEST	SIGNAL RANGE	REQUIRED ACCESSORIES
Solenoid Circuits	Fuel Injector	+/- 150V	DLS Dual Cable and Tip Set
Solenoid Circuits	EGR Solenoid Evaporative Purge Solenoid, etc.	+/- 75V	DLS Dual Cable and Tip Set
Conventional Ignition (DI w/Contact Points)	Primary Side	+/- 600V	DLS Dual Cable and Tip Set
	Secondary Side	Up to 50kV	KV Probe and RPM Probe
Conventional Ignition (DI w/Transistor)	Primary Side	+/- 600V	DLS Dual Cable and Tip Set
	Secondary Side	Up to 50kV	KV Probe and RPM Probe
Distributorless Ignition System (EI)	Secondary Side	Up to 50kV	KV Probe and RPM Probe

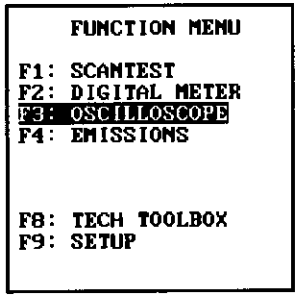
The Oscilloscope function displays signal waveforms for diagnostic evaluation and analysis. The Oscilloscope can measure and display signals from a DC voltage to 15KHz (Single Channel), and DC voltage to 7.5KHz (Dual Channel). The time scale is selectable from 0.2ms / div to 20s/div. The voltage scale is selectable from 0.1V / div to 5V / div. The Oscilloscope has an Auto Setup feature that sets the time scale, voltage scale and trigger level based on the input signal. The waveform can also be frozen on the screen and zoomed up to 5 times the set resolution (5x zoom).



NOTE: The Oscilloscope is useful for evaluation of signals typically encountered on a vehicle. It is not intended to be a lab-quality bench-top test instrument.

SELECTING THE OSCILLOSCOPE FUNCTION

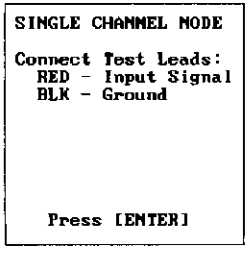
Press **F3** from the MFT Function Menu to select the OSCILLOSCOPE function.



SINGLE CHANNEL

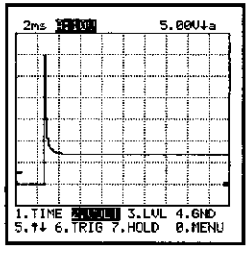
In single channel mode, the red lead is the input channel and the black lead is the ground reference. The tester displays a single waveform. The displayed waveform represents the voltage difference between the test leads. This is known as "differential" mode since the voltage at the black lead (ground) is subtracted from the voltage at the red lead (input signal).

SINGLE CHANNEL MODE TEST LEAD CONNECTIONS

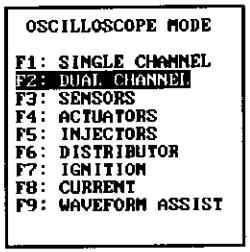


In single channel mode, the red test lead should be connected to the signal to be measured. The black lead should be connected to the vehicle ground or other ground reference. Verify the test lead connections and press ENTER to display the Oscilloscope screen.

EXAMPLE OF SINGLE CHANNEL WAVEFORM

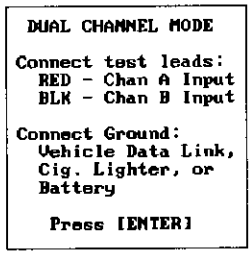


DUAL CHANNEL



In dual channel mode, both the red and black leads are input channel(s) — red is channel A, black is channel B — with the vehicle data link or cigarette lighter power cable acting as the ground reference. The tester displays the voltage from each lead separately. This is known as "single-ended" mode since each input channel is measured against the Tester ground. In dual channel mode, each waveform is independent. The Tester can display each channel separately, both channels at the same time, or the two input channels can be summed or differenced.

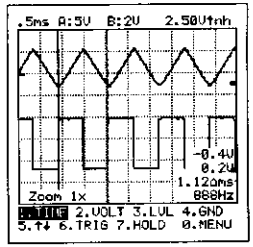
DUAL CHANNEL MODE TEST LEAD AND TESTER CONNECTIONS



In dual channel mode, the red test lead should be connected to the first signal to be measured. The red lead is referred to as channel A. The black lead should be connected to the second signal to be measured. The black lead is referred to as channel B. The Tester must be connected to the vehicle ground for accurate measurements. The Tester can be connected to the vehicle ground through the DLC cable or 12V power connection. Verify the test lead and Tester power connections are correct and press ENTER to display the Oscilloscope screen.

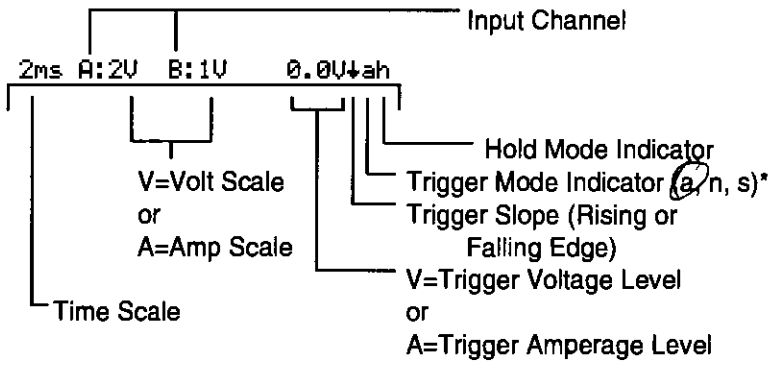
NOTE: F4 toggles between the channels to be adjusted.

EXAMPLE OF DOUBLE CHANNEL WAVEFORM



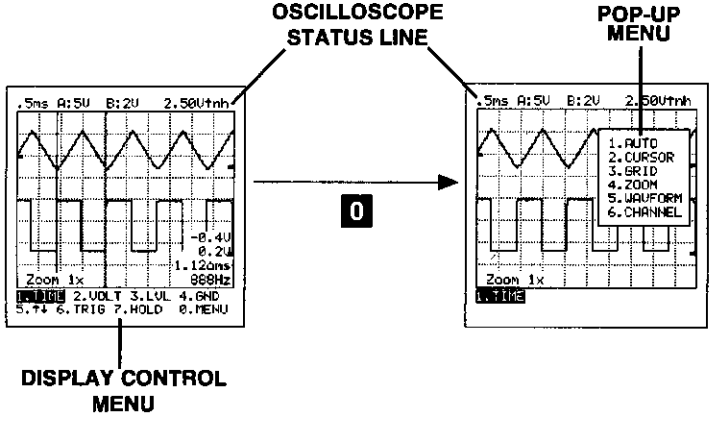
OSCILLOSCOPE DISPLAY & CONTROL

The status line at the top of the display indicates the current settings for the Oscilloscope.



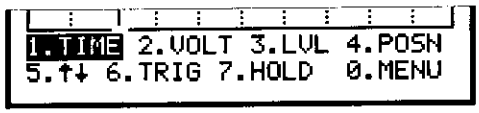
* a=auto, n=normal, s=single

EXAMPLE OF OSCILLOSCOPE DISPLAYS



DISPLAY CONTROL

The Oscilloscope display configuration may be adjusted to display the data in different formats. The Display Control menu at the bottom indicates keys that are used to change the Oscilloscope settings. The ↑ and ↓ keys are used to change the highlighted setting. To adjust a different setting, press the key on the tester which corresponds with the number to the left of the setting.



—Display Control Menu

1.TIME
Use ↑ and ↓ to change the Time Scale. The supported time per division scaling is: .2ms, .5ms, 1ms, 2ms, 5ms, 10ms, 20ms, 50ms, 0.1s, 0.2s, 0.5s, 1s, 2s, 5s, 10s, 20s.

2.VOLT
Use ↑ and ↓ to change the Volts Scale. The supported volts per division scaling is: 0.1V, 0.2V, 0.5V, 1V, 2V, 5V. In dual channel mode, pressing F2 allows you to change the volt scale independently for each channel.

3.LVL
Use ↑ and ↓ to make coarse adjustments to the trigger level. Trigger level is set in 1/2 division increments. Use * ↑ and * ↓ to make fine adjustments to the trigger level.

4.POSN
The trigger level position moves independently of the ground level.
- Use ← and → to adjust the trigger position.
- Use ↑ and ↓ to adjust the ground level.

NOTE: When in dual channel mode, the ground level can be changed independently for each channel. Pressing F4 allows you to select the channel to be adjusted. However, for trigger position, the channels do not move independently. They are consistent with channel 1. (For channel selection options, refer to the Pop-Up Menu Functions section of this chapter.)

TRIGGER CONTROL

5.↑↓ Toggles the trigger slope (rising or falling). The current trigger slope is indicated on the top right of the display.

6.TRIG There are three Trigger Modes: NORMAL, AUTO, and SINGLE SHOT. Pressing F6 cycles through the three modes.

NORMAL- The tester waits for the trigger to occur before the waveform is displayed. Normal mode is indicated by a "n" in the upper right corner of the display. (NORMAL is the default mode.)

AUTO- If a trigger does not occur for 250ms, a trigger is forced to occur. This allows signals to be found easier since the display shows the waveform even when a trigger does not occur. This is useful for viewing DC signals. Auto mode is indicated by an "a" in the upper right corner of the display.

SINGLE SHOT- The trigger is only activated when the signal voltage crosses the trigger level, or the ENTER key is pressed. While waiting for the trigger the single shot indicator shows an upper case "S". When a trigger occurs the indicator changes to a lower case "s". The display remains frozen until the ENTER key is pressed, or a new trigger mode is chosen.

7.HOLD The HOLD mode freezes the current display so that the waveform can be analyzed. The display is frozen until the F7 key is pressed again, the trigger mode is changed, or the display is adjusted (time scale or volt scale changed). When the hold mode is active, the right Red LED is turned on.

POP-UP MENU FUNCTIONS

0.MENU

When 0.MENU is selected, a menu will "Pop-Up" on the screen. This menu allows selection of additional display controls and Oscilloscope modes. The additional functions available are: Auto Setup, Cursor, Grid Display, Zoom, Waveform Save & Recall, and Input Channel Selection.

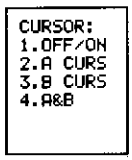
1.AUTO

The tester automatically sets the Time Scale, Volt Scale, and Trigger Level based on the signal measured. This allows the signal to be easily found on the screen. After AUTO setup is performed, further manual adjustments may be made to configure displayed waveforms in the most useful format.

ACTIVE KEYS

1 Auto Setup
EXIT Return to Display Control

2.CURSOR



When 2.CURSOR is selected, the pop-up menu changes to the Cursor Control menu. Press the key to the left of the cursor selection to change the setting.

There are two cursors: "A" & "B". The A cursor is represented by a solid line, the "B" cursor is represented by a dotted line. Cursors can be moved with the left and right arrow keys (faster movement can be achieved by pressing * ← and * →). To move the "B" cursor to the "A" position press the YES key.

When the cursor is turned on, a three or four line window appears in the bottom right part of the screen as follows:

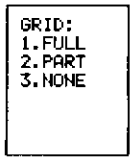
X.XV (or A)- Voltage or Amperage at the "A" (solid) cursor position
X.X ms- Time difference of "A" and "B" cursor position
XXXXHz- Computed frequency for above

ACTIVE KEYS

1 Turn cursor off or on.
2 Control "A" (solid) cursor
3 Control "B" (dotted) cursor
4 Control "A"&"B" cursors together
EXIT Return to previous menu

POP-UP MENU FUNCTIONS

3.GRID



When 3.GRID is selected, the pop-up menu changes to the Grid Control menu. Press the key to the left of the grid selection to change the grid display.

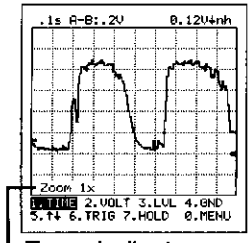
ACTIVE KEYS

- ❶ Full grid, similar to a standard oscilloscope.
- ❷ Partial grid, only the 0V line and halfway time mark are displayed.
- ❸ No grid is displayed.
- EXIT Return to previous menu

4.ZOOM

When 4.ZOOM is selected and the cursor is turned on, the display resolution is changed to place the section of the waveform between the cursors to a full screen. This function is only available when the HOLD mode is active.

NOTE: The maximum zoom is to the 0.2ms/div range.



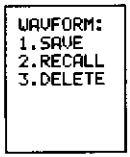
A typical scenario would be to continuously measure a signal until an intermittent problem is seen, then press F7 to freeze the waveform on the display screen. Using the cursor function, place a cursor on either side of the problem selection. Then use the ZOOM function to increase the resolution in order to analyze the waveform. For example, if a waveform viewed at 10ms/Div is frozen using the HOLD function and the cursors are used to Zoom in on a particular section, the first time Zoom is selected the Time Scale would change to 5 ms/Div (2x); and the second time Zoom is selected the Time Scale would change to 2 ms/Div (5x).

ACTIVE KEYS

- ❹ Zoom Display
- EXIT Return to previous menu

POP-UP MENU FUNCTIONS

5.WAVEFORM

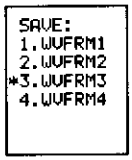


When 5.WAVEFORM is selected the pop-up menu changes to allow you to save a waveform, recall a previously saved waveform, or delete a saved waveform.

ACTIVE KEYS

1 - 3 Select menu item
EXIT Return to previous menu

1.SAVE



When 1.SAVE is selected, the pop-up menu displays the available save waveform slots. Up to four waveforms can be saved. Press the number of the slot to save the current waveform.

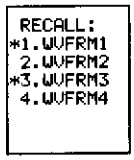
HINT: Use the HOLD Function to freeze the display before saving. This way you are sure of the waveform that is saved.

A "*" appears next to the slots that have waveforms previously saved. To overwrite a saved waveform, select the slot with a "*".

ACTIVE KEYS

1 - 4 Select menu item
EXIT Return to previous menu

2.RECALL

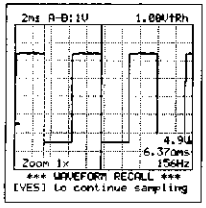


When 2.RECALL is selected, the pop-up menu displays the available save waveform slots. Up to four waveforms can be saved. A "*" indicates a waveform has been saved in the slot. Select the waveform to recall (1-4).

ACTIVE KEYS

1 - 4 Select menu item
EXIT Return to previous menu

POP-UP MENU FUNCTIONS



When a waveform is selected for Recall, the display will change to show the waveform. A limited number of functions are available during waveform recall: CURSOR, GRID, ZOOM, and WAVEFORM. All other normal functions of the Oscilloscope are disabled during Waveform Recall.

When you are finished reviewing the waveform, press the YES key to return to continuous sampling of the input channels.

3.DELETE

```
DELETE:
*1.WVFRM1
 2.WVFRM2
*3.WVFRM3
 4.WVFRM4
```

When 3.DELETE is selected, the pop-up menu changes to allow deletion of a saved waveform. A "*" indicates that a waveform has been saved in the corresponding slot. Select the waveform to delete (1-4). The deleted waveform will no longer be available for recall.

ACTIVE KEYS

1 - 4 Delete Waveform
EXIT Return to previous menu

6.CHANNEL

```
CHAN SEL
1.A
2.B
3.A,B
4.A + B
5.A - B
```

When 6.CHANNEL is selected the pop-up menu changes to allow selection of the input channels. The Oscilloscope can be configured to measure and display only the "A" channel, only the B channel, both the "A" and "B" channels (Dual Channel mode), "A"+"B", and "A"-"B" (differential mode).

ACTIVE KEYS

1 - 5 Select Channel mode
EXIT Return to previous menu

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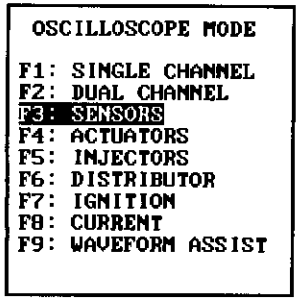
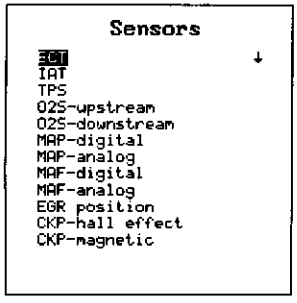
SENSORS

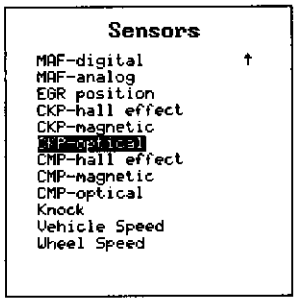


The sensor mode is intended to provide the initial oscilloscope setup to view the most popular vehicle sensors. By selecting a specific sensor, the oscilloscope is automatically configured specifically for that particular type of sensor. This makes sensor testing and diagnosing a quick and easy task. The sensor mode is selected by pressing F3.



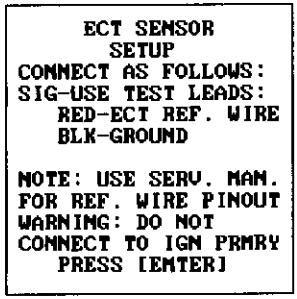
Once the sensor mode is entered, a list of vehicle sensors is displayed. Of the many vehicle sensors found on various make/model vehicles, most will be found in this pre-configured list. Using the ↑ and ↓ keys, move the highlight box to the desired sensor and press ENTER.

If a vehicle sensor is not listed press EXIT to return to Oscilloscope Menu, then press either F1 for single channel or F2 for dual channel mode for testing and diagnosing the sensor.

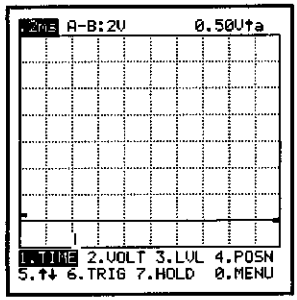


Once the specific sensor is selected, a setup screen is displayed. This screen supplies information on the test leads and vehicle connections to be made. The setup screen also provides hints and warnings specific to the sensor under test.

Press ENTER to start the oscilloscope display.



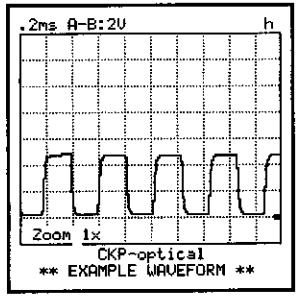
NOTE: In some cases during waveform viewing, the oscilloscope functions may require adjustment (time base and/or voltage base, trigger level, etc.) in order to properly view the signal under test.



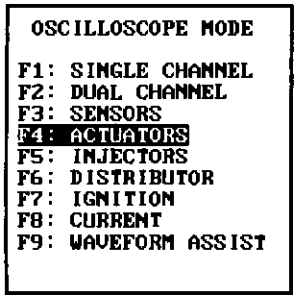
The following is an example of what the oscilloscope screen looks like while not measuring any signals.

HOT KEYS

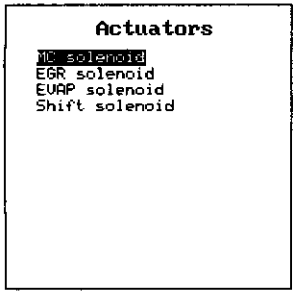
✱ F9 The Hot Key toggles screens to a known good waveform for the Sensor, Actuator, Injector, Distributor, Ignition, or Current waveform you are testing.



ACTUATORS



The actuators mode is intended to provide the initial oscilloscope setup to view the most popular vehicle actuators. By selecting a specific actuator, the oscilloscope is automatically configured specifically for that particular type of actuator. This makes actuator testing and diagnosing a quick and easy task. The actuator mode is selected by pressing F4.



Once the actuator mode is entered, a list of vehicle actuators or solenoids is displayed. Using the ↑ and ↓ keys, move the highlight box to the desired actuator and press ENTER.

If a vehicle actuator is not listed, press EXIT to return to Oscilloscope Menu, then press either F1 for single channel or F2 for dual channel mode for testing and diagnosing the actuator.

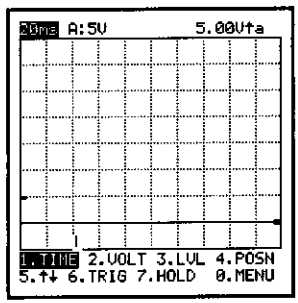
```
MIXTURE CONTROL SOL.
      SETUP
CONNECT AS FOLLOWS:
SIG-USE TEST LEADS:
   RED-MC SOL WIRE
   BLK-GROUND

NOTE: USE SERV. MAN.
FOR SOL WIRE PINOUT
WARNING: DO NOT
CONNECT TO IGN PRMRY
   PRESS [ENTER]
```

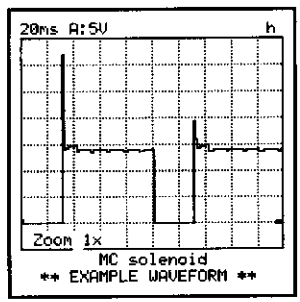
Once the specific actuator is selected, a setup screen is displayed. This screen supplies information on the test leads and vehicle connections to be made. The setup screen also provides hints and warnings specific to the signal under test.

Press ENTER to start the oscilloscope display.

NOTE: In some cases during waveform viewing, the oscilloscope functions may require adjustment (time base and/or voltage base, trigger level, etc.) in order to properly view the signal under test.



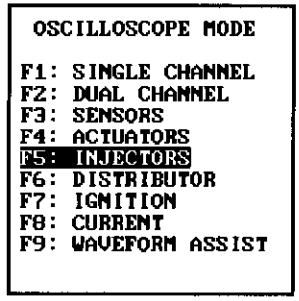
The following is an example of what the oscilloscope screen looks like while not measuring any signals.



HOT KEYS

✱ F9 The Hot Key toggles screens to a known good waveform for the Sensor, Actuator, Injector, Distributor, Ignition, or Current waveform you are testing.

INJECTORS



The injectors mode is intended to provide the initial Oscilloscope setup to view the most popular vehicle injectors. By selecting a specific injector type, the oscilloscope is automatically configured specifically for that signal. This makes injector testing and diagnosing a quick and easy task. The injectors mode is selected by pressing F5.

Once the injectors mode is entered, a list of the most common injector types is displayed. Using the ↑ and ↓ keys, move the highlight box to the desired injector type and press ENTER.

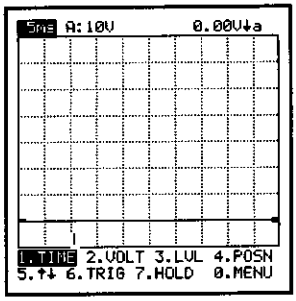
```
    INJ - PEAK/HOLD
          SETUP
CONNECT AS FOLLOWS:
SIG-USE TEST LEADS:
   RED-INJ. WIRE
   BLK-GROUND

NOTE: USE SERV. MAN.
FOR INJ WIRE PINOUT
WARNING: DO NOT
CONNECT TO IGN PRMRY
   PRESS [ENTER]
```

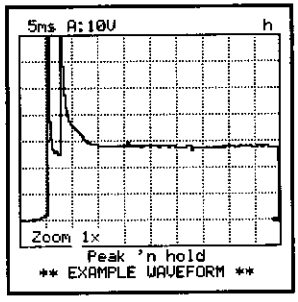
Once the specific injector is selected, a setup screen is displayed. This screen supplies information on the test leads and vehicle connections to be made. The setup screen also provides hints and warnings specific to the signal under test.

Press ENTER to start the oscilloscope display.

NOTE: In some cases during waveform viewing, the oscilloscope functions may require adjustment (time base and/or voltage base, trigger level, etc.) in order to properly view the signal under test.



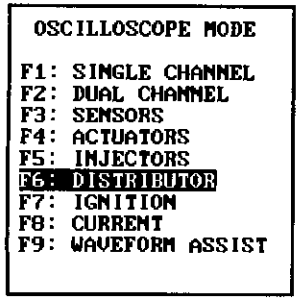
The following is an example of what the oscilloscope screen looks like while not measuring any signals.



HOT KEYS

✱ F9 The Hot Key toggles screens to a known good waveform for the Sensor, Actuator, Injector, Distributor, Ignition, or Current waveform you are testing.

DISTRIBUTOR



The distributor mode is intended to provide the initial oscilloscope setup to view the most popular methods of referencing the engine's position. Different make/model vehicles utilize different methods to monitor the engine's rotational position so that the spark is distributed to the spark plugs at the precise time. By selecting a specific method, the oscilloscope is automatically configured specifically to view that distributor reference signal. This makes testing and diagnosing the distributor timing reference a quick and easy task. The distributor mode is selected by pressing F6.

Once the distributor mode is entered, The most common types of distributor referencing can be selected from this pre-configured list. Using the ↑ and ↓ keys, move the highlight box to the desired method and press ENTER.

If a vehicle distributor reference type is not listed, press EXIT to return to Oscilloscope Menu. Then press either F1 for Single Channel, or F2 for Dual Channel mode for testing and diagnosing the distributor component.

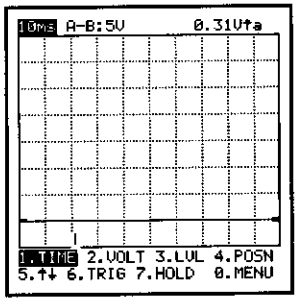
```
 HALL-EFFECT PICK-UP
       SETUP
CONNECT AS FOLLOWS:
SIG-USE TEST LEADS:
   RED-HALL P/U WIRE
   BLK-GROUND

NOTE: USE SERV. MAN.
FOR P/U WIRE PINOUT
WARNING: DO NOT
CONNECT TO IGN PRMRY
   PRESS [ENTER]
```

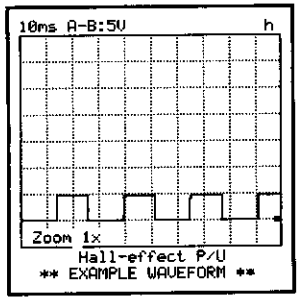
Once the specific method is selected, a setup screen is displayed. This screen supplies information on the test leads and vehicle connections to be made. The setup screen also provides hints and warning specific to the signal under test.

Press ENTER to start the oscilloscope display.

NOTE: In some cases during waveform viewing, the oscilloscope functions may require adjustment (time base and/or voltage base, trigger level, etc.) in order to properly view the signal under test.



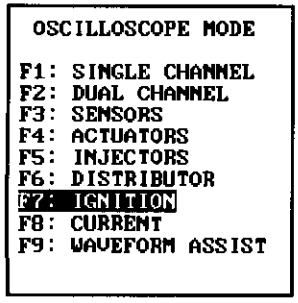
The following is an example of what the oscilloscope screen looks like while not measuring any signals.



HOT KEYS

✱ F9 The Hot Key toggles screens to a known good waveform for the Sensor, Actuator, Injector, Distributor, Ignition, or Current waveform you are testing.

IGNITION

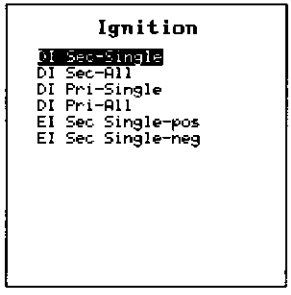


In Ignition mode, the oscilloscope setup can be preselected from the ignition list. Distributor Ignition (DI) and Electronic Ignition (EI) system types can be selected (DI refers to ignition systems that have a distributor, and EI refers to ignition systems that do not have a distributor. DI and EI are terms in accordance with the SAE J1930 standard).

NOTE: When this product is used on late model ignition systems, results may vary depending on the vehicle you are testing.

SELECTING AN IGNITION PRE-SELECT

There are six preselects for the Ignition mode. Distributor and Electronic Ignition systems can be selected from the list. With Secondary and Primary ignition signals, single cylinder or all cylinders can be selected. With EI (distributorless ignition) systems, the polarity can be selected.



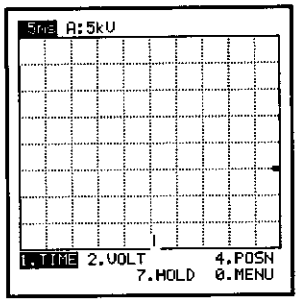
OPERATING PROCEDURE

1. Highlight the desired ignition Pre-select (use ↑ or ↓ keys to move the highlight bar to the Pre-select).
2. Press ENTER.
3. A connection screen will appear. Follow the instructions on the screen (or those mentioned in this section).

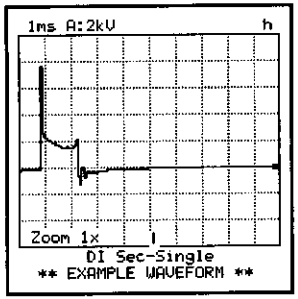
```
   DI SEC-SINGLE
        SETUP
CONNECT AS FOLLOWS:
RPM-PLUG WIRE FOR
   PREVIOUS CYL IN
   FIRING ORDER
SIG-COIL WIRE & GND

NOTE: REFER TO
SERVICE MANUAL FOR
FIRING ORDER
   PRESS [ENTER]
```

Once the ignition system is selected, a setup screen is displayed. This screen supplies information on the test leads and vehicle connections to be made. The setup screen also provides hints and warnings specific to the signal under test.



The following is an example of what the oscilloscope screen looks like while not measuring any signals.



HOT KEYS

✱ F9 The Hot Key toggles screens to a known good waveform for the Sensor, Actuator, Injector, Distributor, Ignition, or Current waveform you are testing.

MAXIMUM FIRING VOLTAGE INDICATOR

When Secondary Ignition signals are viewed on the Mastertech display, a maximum firing voltage indicator for each cylinder will appear on the display. The indicator, shaped like a "T", moves upward as maximum firing voltage increases when the Mastertech is monitoring the ignition signal. The purpose of the maximum firing voltage indicator is to display and hold the maximum firing voltage that has occurred while also displaying the instantaneous secondary ignition signal.

RESETTING THE MAXIMUM FIRING VOLTAGE INDICATOR

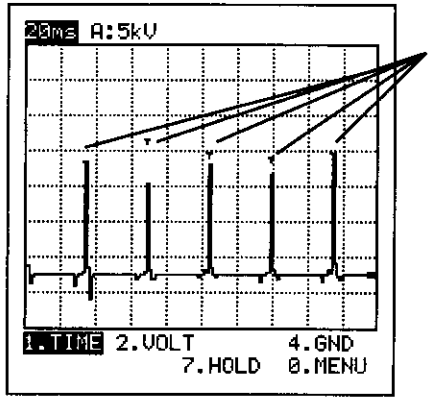
After monitoring the ignition signal for a period of time, reset of the maximum firing voltage indicator is possible. The Oscilloscope F:7 HOLD function is used to reset the maximum firing voltage indicator. Resetting the indicator can help with finding intermittent firing voltage problems. Follow the steps below to reset the maximum firing voltage indicator:

1. While viewing the ignition wave form, press F7 to turn on the HOLD function.

2. Press F7 again to turn off the HOLD function.

3. The small maximum firing voltage indicator(s) will now be reset, and will begin to adjust to each cylinder's maximum firing voltage.

NOTE: The maximum firing voltage indicator(s) will only appear on a current live display, and maximum voltages are not displayed. Use cursors to obtain voltage levels.



Maximum Firing Voltage Indicators

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ENHANCED DIAGNOSTIC LEAD SET

CONNECTION TO DISTRIBUTOR IGNITION (DI)

Ignition Coil, Secondary side, Single cylinder:

1. Connect the RPM Probe to the cylinder spark plug wire that precedes the one you want to view in the firing order.

   Example: If the firing order is 1-3-4-2 and cylinder #1 is desired to view, connect the RPM Probe to cylinder #2.

2. Connect the KV Probe to the ignition coil wire, and the alligator lead to engine block or vehicle chassis ground.

Ignition Coil, Secondary side, All cylinders:

1. Connect the RPM Probe to the spark plug wire of the last cylinder in the firing order.

   Example: If the firing order is 1-3-4-2, connect the RPM probe to cylinder #2.

2. Connect the KV Probe to the ignition coil wire, and the alligator lead to engine block or vehicle chassis ground.

Ignition Coil, Primary side, Single cylinder:

1. Connect the RPM Probe to the spark plug wire that proceeds the cylinder you desire to view.

   Example: If the firing order is 1-3-4-2 and cylinder #1 is desired to view, connect the RPM Probe to cylinder #2.

2. Use the DLS Kit connected to the SIG terminal on the EDLS Adapter. Connect the RED lead to the ignition coil negative terminal, and the BLACK lead to engine block or vehicle chassis ground.

Ignition Coil, Primary side, All cylinders:

1. Connect the RPM Probe to the spark plug wire that proceeds the number one cylinder.

   Example: If the firing order is 1-3-4-2, connect the RPM Probe to cylinder #2.

2. Use the DLS Kit connected to the SIG terminal on the EDLS Adapter. Connect the RED lead to the ignition coil negative terminal, and the BLACK lead to engine block or vehicle chassis ground.

CONNECTION TO ELECTRONIC IGNITION (EI)

To obtain proper connection to electronic ignition systems with exposed spark plug wires, the signal polarity selection is required. Since one ignition coil is used to fire two cylinders, one of the spark plugs will fire positive and the other will fire negative. Refer to the chart at the end of this section for assistance on General Motors, Ford, and Chrysler EI equipped engines (remember that EI refers to distributorless ignition systems and the term EI conforms to SAE specification J1930).

Ignition Coil, Secondary side, Single cylinder (positive fire):

1. Connect the RPM Probe to the cylinder spark plug wire that precedes the one you want to view in the firing order.

2. Connect the KV Probe to the same cylinder spark plug wire that you connected the RPM Probe to, and the alligator lead to engine block or vehicle chassis ground.

Ignition Coil, Secondary side, Single cylinder (negative fire):

1. Connect the RPM Probe to the cylinder spark plug wire that precedes the one you want to view in the firing order.

2. Connect the KV Probe to the same cylinder spark plug wire that you connected the RPM Probe to, and the alligator lead to engine block or vehicle chassis ground.

ENHANCED DIAGNOSTIC LEAD SET

EI SYSTEM COIL POLARITY CHARTS

GENERAL MOTORS

1987-1992 2.0L

									CYLINDER PAIRING
Firing Order	1	3	4	2					1-4, 3-2
Polarity	pos	pos	neg	neg					

1990-1992 2.2L

Firing Order	1	3	4	2					1-4, 3-2
Polarity	pos	pos	neg	neg					

1988-1992 2.3 Quad4

Firing Order	1	3	4	2					1-4, 3-2
Polarity	neg	neg	pos	pos					

1992 2.3L OHC

Firing Order	1	3	4	2					1-4, 3-2
Polarity	neg	neg	pos	pos					

1987-1991 2.5L

Firing Order	1	3	4	2					1-4, 3-2
Polarity	neg	neg	pos	pos					

1987-1990 2.8L, 3.1L

Firing Order	1	2	3	4	5	6			1-4, 2-5
Polarity	neg	pos	pos	pos	neg	neg			3-6

General Motors (continued)

1986-1989 3.0L, 3.8L

									CYLINDER PAIRING
Firing Order	1	6	5	4	3	2			1-4, 2-5
Polarity	pos	neg	pos	neg	pos	neg			3-6

1988-1992 3800,3300

Firing Order	1	6	5	4	3	2			1-4, 2-5
Polarity	pos	neg	pos	neg	pos	neg			3-6

1991-1992 3.4L

Firing Order	1	2	3	4	5	6			1-4, 2-5
Polarity	neg	pos	pos	pos	neg	neg			3-6

FORD

1990-1992 1.9L

									CYLINDER PAIRING
Firing Order	1	3	4	2					1-4, 3-2
Polarity	pos	pos	neg	neg					

1989-1992 2.3L

Firing Order	1	3	4	2					1-4, 3-2
Polarity	pos	pos	neg	neg					

1989-1990 3.0L, 3.8L

Firing Order	1	4	2	5	3	6			1-5, 3-4
Polarity	pos	neg	pos	neg	pos	neg			2-6

ENHANCED DIAGNOSTIC LEAD SET

Ford (continued)

1990 4.0L

									CYLINDER PAIRING
Firing Order	1	4	2	5	3	6			1-5, 3-4
Polarity	pos	neg	pos	neg	pos	neg			2-6

1990-1993 4.6L

Firing Order	1	6	7	2	6	5	4	8	1-6, 3-5
Polarity	neg	neg	pos	neg	pos	pos	neg	pos	7-4, 2-8

1994 4.6L

Firing Order	1	3	7	2	6	5	4	8	1-6, 3-5
Polarity	pos	pos	neg	pos	neg	neg	pos	neg	7-4, 2-8

CHRYSLER

1990-1991 1.6L

Firing Order	1	3	4	2					1-4, 3-2
Polarity	pos	pos	neg	neg					

1988-1990 2.0L

Firing Order	1	3	4	2					1-4, 3-2
Polarity	pos	pos	neg	neg					

1994-1995 2.0L (Neon)

Firing Order	1	3	4	2					1-4, 3-2
Polarity	pos	neg	neg	pos					

1990-1991 3.3L

Firing Order	1	2	3	4	5	6			1-4, 3-6
Polarity	pos	neg	pos	neg	pos	neg			2-5

Chrysler (continued)

1994 3.3L (VIN T)

									CYLINDER PAIRING
Firing Order	1	2	3	4	5	6			1-4, 3-6
Polarity	pos	neg	pos	neg	pos	neg			2-5

1995 3.3L (VIN T)

Firing Order	1	2	3	4	5	6			1-4, 3-6
Polarity	neg	neg	pos	pos	pos	neg			2-5

1993 3.5L (VIN F)

Firing Order	1	2	3	4	5	6			1-4, 3-6
Polarity	pos	pos	pos	neg	neg	neg			2-5

1994 3.5L (VIN F)

Firing Order	1	2	3	4	5	6			1-4, 3-6
Polarity	neg	neg	pos	pos	pos	neg			2-5

1995 3.5L (VIN L)

Firing Order	1	2	3	4	5	6			1-4, 3-6
Polarity	pos	neg	pos	neg	pos	neg			2-5

1994-1995 3.8L (VIN)

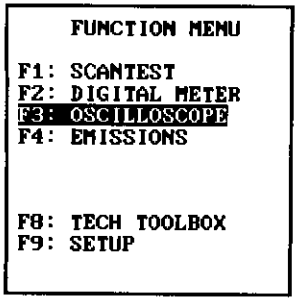
Firing Order	1	2	3	4	5	6			1-4, 3-6
Polarity	pos	neg	pos	neg	pos	neg			2-5

1995 3.3L (VIN R)

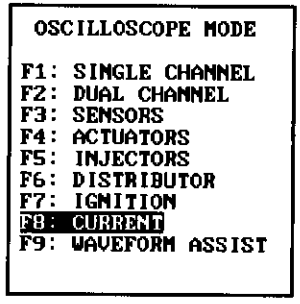
Firing Order	1	2	3	4	5	6			1-4, 3-6
Polarity	neg	neg	pos	pos	pos	neg			2-5

CURRENT

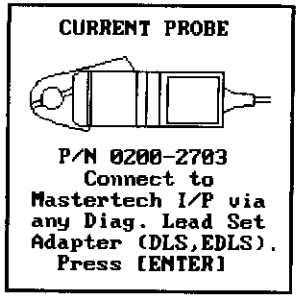
The optional Automotive Low Current Probe allows the user to view current waveforms with a resolution of 50mA from 0mA to 30 Amps.



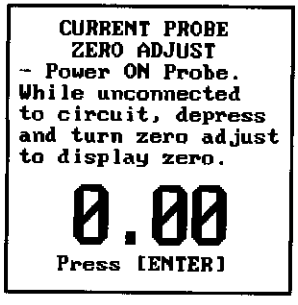
1. Press F3 from the FUNCTION MENU to select OSCILLOSCOPE MODE.



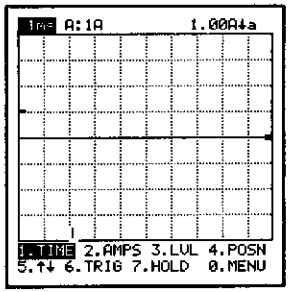
2. Press F8 From the OSCILLOSCOPE MODE MENU to select CURRENT PROBE.



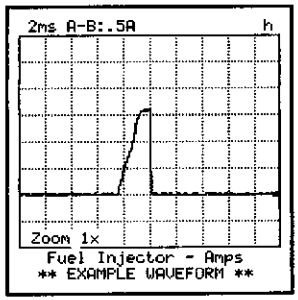
3. Connect the Current Probe BNC connector to the BNC connector marked "SIG" on the EDLS Adapter. Connect the free end of the EDLS Adapter to the I/P port located on the bottom of the Mastertech, at the right. Then press ENTER.



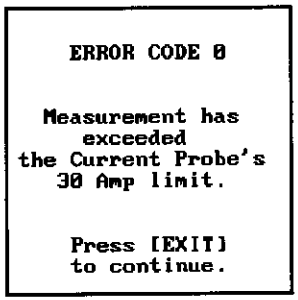
4. Power ON Probe and confirm the Red LED on the probe is illuminated. While not connected to a circuit, depress and turn the zero adjustment wheel on the current probe until the display reads zero.



5. Clamp the current probe around the connector. To read the current waveform, be sure the "+" indicator, marked on the jaw of the current probe, points toward the correct orientation.

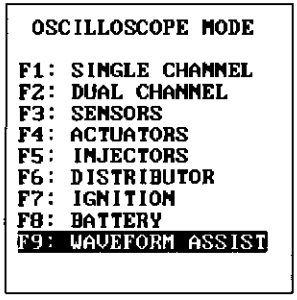


NOTE: The probe is sensitive to the direction of the current flow. If the probe is not oriented correctly, the direction of the current flow through the circuit will cause a waveform that is upside down. Verify that the arrow and the "+" sign point toward the positive side of the circuit.



The current probe will display Error Code 0 when the circuit under test exceeds 30 Amps.

WAVEFORM ASSISTANT



The Waveform Assistant contains a library of example waveforms. Utilizing stored example waveforms, the Waveform Assistant will assist when questionable signals or unfamiliar waveforms are encountered while performing diagnosis. The Waveform Assistant mode is selected by pressing F9.

You can Hot Key between an actual on-vehicle waveform and the Waveform Assistant to assist in diagnosing vehicle component problems. Press ✱ + F9 to take advantage of this Hot Key capability.

The Waveform Assistant can be previewed without connection to the vehicle, or can be used while a current live waveform is being monitored. For more information on the Waveform Assistant, refer to the MFT PRO Manual.

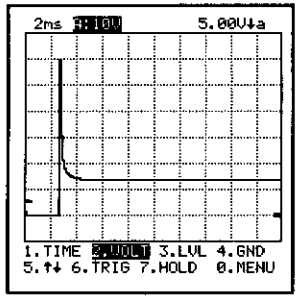
5.0 SAMPLE OSCILLOSCOPE WAVEFORMS

The following sample waveforms are intended to provide information on the type of signals and oscilloscope settings used to capture the measured signal.

In each case, the Mastertech and EDLS Kit were used to measure the components' waveform. Take the time to try these sample settings and waveforms on a vehicle. Doing so will help you become familiar with the Mastertech Oscilloscope and its operation with the EDLS Kit. Remember that these waveforms are a single representation of several ways to capture automotive signals using an oscilloscope, and represent one of many methods to check a particular automotive electrical component (sensors, actuators, etc.). Refer to the MFT PRO User Manual for additional oscilloscope waveforms.

SAMPLE WAVEFORM 1 - PFI FUEL INJECTOR

This waveform was captured on a 1995 Honda Accord with a 3.0L engine. The ignition key was in the ON position with a warm engine running at IDLE. The EDLS Kit was connected to the Mastertech, with the DLS Kit attached to the SIG connection on the EDLS Adapter, the RED diagnostic lead to the injector wire that the ECU is controlling, and the BLACK diagnostic lead to engine block. No RPM Probe connection is required. MFT ground was provided by the 12V DC power cable.



Vehicle lead connections:
Red test lead to injector wire
Black test lead to ground

Settings:
Saturation injector preselect was used.

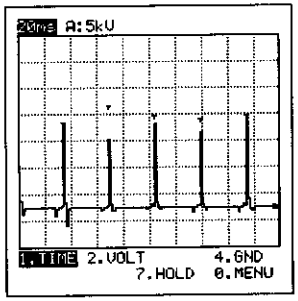
Time scale	:2ms/division
Voltage scale	:10V/division
Trigger	:Automatic
Trigger edge	:Falling
Trigger level	:5V

Information inferred from captured waveform:

Injector peak voltage	:60V
Injector pulse width	:2.5mS
Injector off voltage	:14V

SAMPLE WAVEFORM 2 - DISTRIBUTOR IGNITION (DI), SECONDARY, ALL CYLINDERS

This waveform was captured on a 1980 Toyota truck with a 2.2L engine. The ignition key was in the ON position with a warm engine running at IDLE. The EDLS Kit was connected to the Mastertech, with the KV Probe attached to the SIG connection on the EDLS Adapter, the RPM Probe attached to the RPM connection on the EDLS Adapter, and the ground lead to the engine block. MFT ground was provided by the 12V DC power cable.



Vehicle lead connections:
RPM lead to last cylinder in firing order
KV lead to ignition coil wire
Alligator clip to ground

Settings:
DI secondary ignition, all cylinders preselect was used.

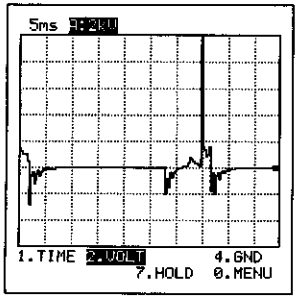
Time scale	:20ms/division
Voltage scale	:5kV/division
Trigger	:RPM Probe

Information inferred from captured waveform:

Maximum peak secondary voltage	:19kV
Time between cylinder firing	:35ms

SAMPLE WAVEFORM 3 - DISTRIBUTOR IGNITION (DI), SECONDARY, SINGLE CYLINDER

This waveform was captured on a 1980 Toyota truck with a 2.2L engine. The ignition key was in the ON position with a warm engine running at IDLE. The EDLS Kit was connected to the Mastertech, with the KV Probe attached to the SIG connection on the EDLS Adapter, the RPM Probe attached to the RPM connection on the EDLS Adapter, and the ground lead to the engine block. MFT ground was provided by the 12V DC power cable.



Vehicle lead connections:
RPM lead to previous cylinder in firing order
KV lead to ignition coil wire
Alligator clip to ground

Settings:
DI secondary ignition, single cylinder preselect was used.

Time scale	:5ms/division
Voltage scale	:2kV/division
Trigger	:RPM Probe

Information inferred from captured waveform:

Maximum peak secondary voltage	:above 10kV
Time between cylinder firing	:(7 divisions x 5ms/division)=35ms
Approximate dwell time	:7ms
Approximate dwell angle:	(7ms/35ms) x 180 degrees* = 36 degrees

* (a four cylinder engine fires every 180 degrees)

APPENDICES

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A: OSCILLOSCOPE KEY — QUICK REFERENCE

F1	Select Time Scale adjustment
F2	Select Volt Scale adjustment
F3	Select Trigger Level adjustment
F4	Select Trigger Position and Ground Level adjustment
↑ ↓	Change Oscilloscope setting
F5	Change Trigger Slope
F6	Change Trigger Type
F7	Freeze Waveform
F0	Pop-up Menu
✱ F9	View Example Waveform from library

When Cursors are active:

← →	Move Selected Cursor
✱ ←	Move Cursor fast
✱ →	Move Cursor fast

When Waveform Recall or Waveform Library is active:

YES	Return to live sampling

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B: GLOSSARY AND ABBREVIATIONS

CKP	Crankshaft Position
CMP	Camshaft Position
DI	Distributor Ignition (ignition systems with a distributor)
ECT	Engine Coolant Temperature
ECU	Electronic Control Unit
EDLS	Enhanced Diagnostic Lead Set
EGR	Exhaust Gas Recirculation
EI	Electronic Ignition (ignition systems without a distributor, or distributorless)
EVAP	Evaporative Canister
GND	Ground
IAT	Intake Air Temperature
LVL	Level (of trigger)
KV	Kilovolts
MAF	Mass Air Flow
MAP	Manifold Air Pressure
MC	Mixture Control
NEG	Negative
O2S	Oxygen Sensor
PFI	Port Fuel Injection
POS	Positive
PRI	Primary
RPM	Revolutions per minute
SAE	Society of Automotive Engineers
SEC	Secondary
SIG	Input signal that is currently being measured
TPS	Throttle Position Sensor
TRIG	Trigger
VOLT	Voltage

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