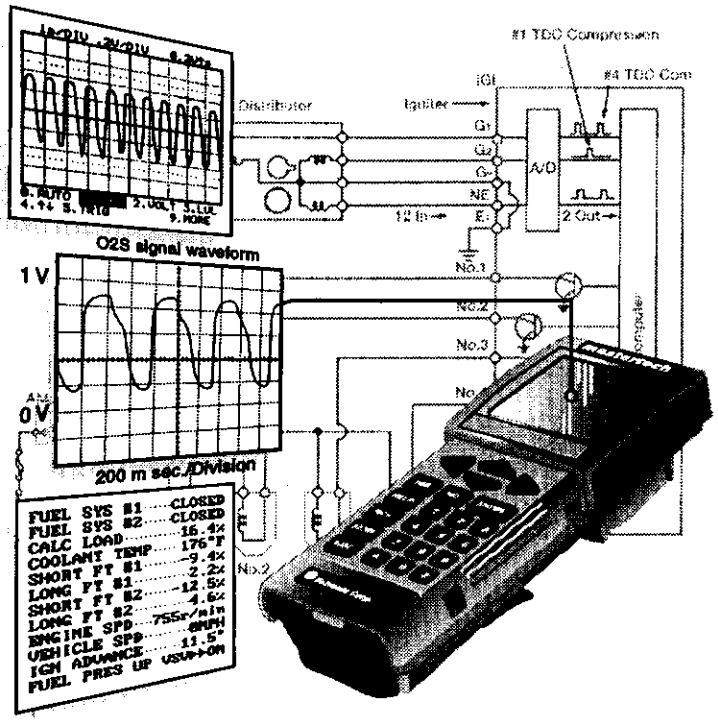
MULTI-FUNCTION TESTER

MFT PRO SERIES APPLICATION SOFTWARE

Operator's Manual



Vetronix Corporation
Diagnostics for Vehicle Electronics

MULTI-FUNCTION TESTER

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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.

DISCLAIMER

The Mastertech is designed for use by trained service personnel only. It has 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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MULTI-FUNCTION TESTER OPERATOR'S MANUAL

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

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MULTI-FUNCTION TESTER OPERATOR'S MANUAL

INTRODUCTION

This manual describes the operation of the Mastertech Multi-function Tester (MFT) Program Card. Please read the entire contents of this manual and familiarize yourself with the tester hardware before beginning any diagnostic test procedure.

The MFT software provides the following functionality:

- **Scantest**

The Mastertech Scantest mode uses the vehicle's diagnostic Data Link Connector (DLC) to combine the traditional scan tool functions with bi-directional test capabilities. The Scantest mode allows you to look at diagnostic data parameters and trouble codes as well as capture data during road tests.

- **Multi-Function Display**

When viewing scan data using both the program card and TECH 1 application cartridge, the Mastertech uses a multi-function screen mode that displays diagnostic information in a split screen view (Upper half scan data and lower half digital meter). The split screen can simultaneously display vehicle serial data parameters and meter type measurements all on one screen.

- **Enhanced Functions**

The scan tool data can also be viewed using the Enhanced Functions. Enhanced Functions makes use of the large tester screen to display live serial data parameters in several different easy to understand display screens. Enhanced Functions include: Custom Data list mode, Bar Graph Mode, Line Graph Mode, Enhanced DTC's, Enhanced Snapshot and Enhanced Data Replay.

- **Digital Meter**

The Digital Meter functions are capable of measuring the following automotive signals: Voltage, Frequency, Duty Cycle, Pulse Width, Current and Temperature.

- **Oscilloscope**

The Oscilloscope supports measuring and displaying common automotive analog and digital signal waveforms found on all electronically controlled vehicles. The oscilloscope is a great tool for finding intermittent electrical problems as well as verifying automotive sensor & actuator signals. The Oscilloscope user selections include: Single Channel, Dual Channel, Current Probe and Waveform Assistant modes of operation.

- **Tech Toolbox**

The Tech Toolbox supports math functions (calculator, unit conversions, formula computation), clock functions (stop watch, count down timer) and shop functions (parts, labor and total estimates, technician earnings).

HELP FEATURE

One very important feature of the Mastertech MFT is the Help feature. Help is available while using any of the Multi-Function Tester functions by pressing **HELP** on the keypad. The help feature provides information on the keys available for the particular mode and a description of the function (or mode) that you are currently using. While the operator's manual contains all information about the Multi-Function Tester operation and should always be used, it is our hope that the help feature will limit your time referencing the operator's manual

SUMMARY

The Mastertech is an automotive diagnostic tool that is designed to work for you in an automotive environment, and will remain as the center of a powerful diagnostic toolset. Please continue reading the manual to become familiar with Mastertech functions and capabilities before engaging in diagnostics for the first time.

1.0 GETTING STARTED

The Multi-Function Tester (MFT) Program Card contains the software to operate the Mastertech in three configurations:

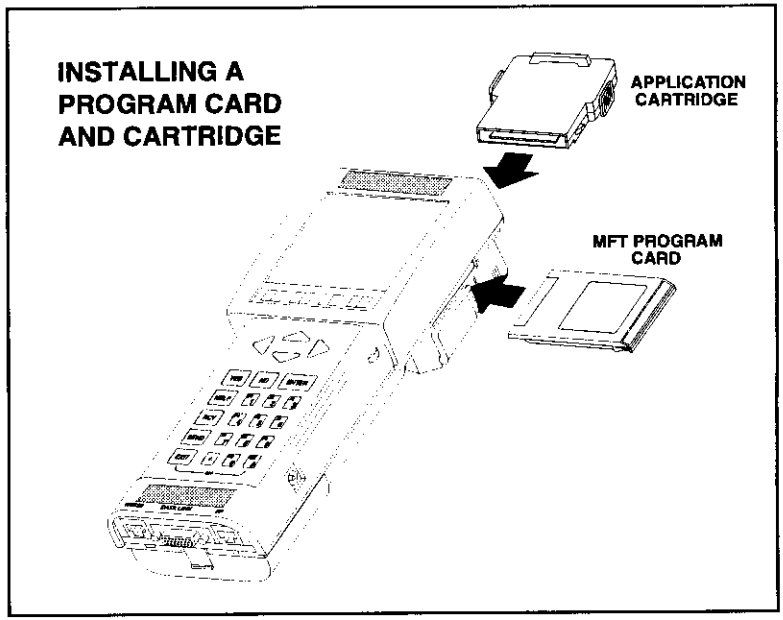
- Stand-alone Functions
- Vehicle Data Link Diagnostics
- Digital Meter/Oscilloscope Functions

The MFT Program Card must be installed in the Mastertech before any of the configurations can be used.

The following steps must be performed to use the Multi-Function Tester Program Card.

1. Insert the program card into the slot on the upper right side of the tester (below the display). The program card slot is keyed so the card can only be installed in the proper orientation.

2. If you wish to perform cartridge based scan test diagnostics, insert an application cartridge into the cartridge slot at the top rear of the tester. Application cartridges include: Tech 1 Multiple Application Cartridge (MAC) and Mass Storage Cartridge (MSC).

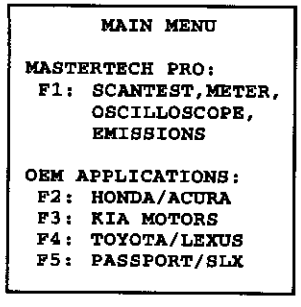


3. Connect the tester to a power source. A power source may be the vehicle cigarette lighter, battery clips, 16-pin (J1962) OBD II data link connector, or the AC/DC power supply. The Mastertech will illuminate a green LED on the right side to indicate that 12v power is applied to the tester. Refer to the Mastertech Operator's Manual for further instructions.

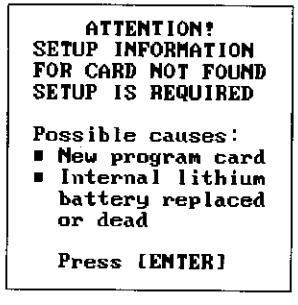
4. Press the ON key.

1.1 POWER UP DISPLAY

When the tester is powered up with the Multi-Function Tester Program Card installed, the tester displays the Power Up Screen. Press ENTER to go to the MAIN MENU.



NOTE: This display will not appear if none of the program card based OEM applications were purchased along with the Multi-Function Tester Program Card.



NOTE: If the ATTENTION! screen is displayed, press ENTER until the FUNCTION MENU is displayed, then press F9 to select SETUP from the menu. Refer to Section 6.0 to set up the tester.

1.2 HELP SCREENS

A list of the active keys for the screen displayed on the tester is available by pressing the HELP key. The HELP screens display information about which key to press to select a different mode, how to move the marker (cursor or highlight), print, or exit from the display. The example illustrates the Key Help screen displayed when HELP is pressed while oscilloscope is active. For some functions, pressing ↓ will display additional information about the active function. Small arrows displayed in the lower right corner of the display indicate that more information is available by pressing ↑ or ↓.

When HELP is pressed.

```
          KEY HELP

↑/↓:   Change value of the
       highlighted item:
  1:     - Time Scale
  2:     - Volt Scale
  3:     - Trigger Level
  4:     - Ground Level

5:     Trigger Edge (↑↓)
6:     Trig Mode (a,s,n)
7:     Freeze Display
0:     Pop-Up Menu

                        (↓)
```

When ↓ is pressed.

```
     DISPLAY CONTROL
1.TIME:  Pressing "1"
selects the Set Time Scale
mode.  The time scale can
then be changed by
pressing the ↑ and ↓ keys.

2.VOLT:  Pressing "2"
selects the Set Voltage
Scale mode.  The voltage
scale can then be changed
by pressing the ↑ and ↓
keys. In dual channel mode
pressing "2" again toggles
between channels A and B.
                      (↑/↓)
```

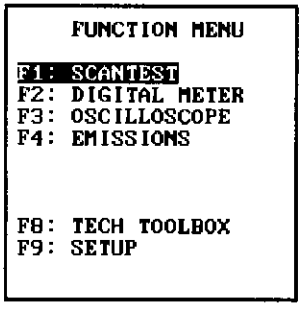
1.3 SCREEN PRINT

With the MFT Program Card installed, the Mastertech has the capability to perform a screen print to a compatible printer. The screen print function is available in any MFT Program Card operation. Press # and SEND simultaneously to print the currently displayed Mastertech screen.

1.4 MENUS

Menus display the available function selections. To activate a function, press the key, F0 - F9, next to the desired function. Alternatively, use ↑ and ↓ to move the highlight bar to the desired function and press the ENTER key.

1.5 FUNCTION MENU



The FUNCTION MENU is the top level selection menu for the Program Card. This menu provides access to all of the Program Card functions.

NOTE: The EMISSIONS function is only applicable for the PXA-1000 Gas Analyzer.

Please refer to the appropriate section in this manual for more information on each of these function groups.

FUNCTION	SECTION
F1: SCANTEST	2.0
F2: DIGITAL METER	3.0
F3: OSCILLOSCOPE	4.0
F4: EMISSIONS	*
F8: TECH TOOLBOX	5.0
F9: SETUP	6.0

* For information on the EMISSIONS function, please refer to the PXA-1000 Gas Analyzer Manual (P/N 02002067). Emissions sub-modes include Gas Analysis, O2S Waveform, Set Gas/ Scantest, and Replay Snapshot.

1.6 STAND-ALONE FUNCTIONS

With the MFT Program Card installed, the Mastertech can perform the following functions in the STAND-ALONE configuration:

- Tech Toolbox (Math, Timer, and Shop Management Functions)
- Waveform Assistant
- Tester Setup Functions

No other connections are needed to use the Stand-alone Functions.

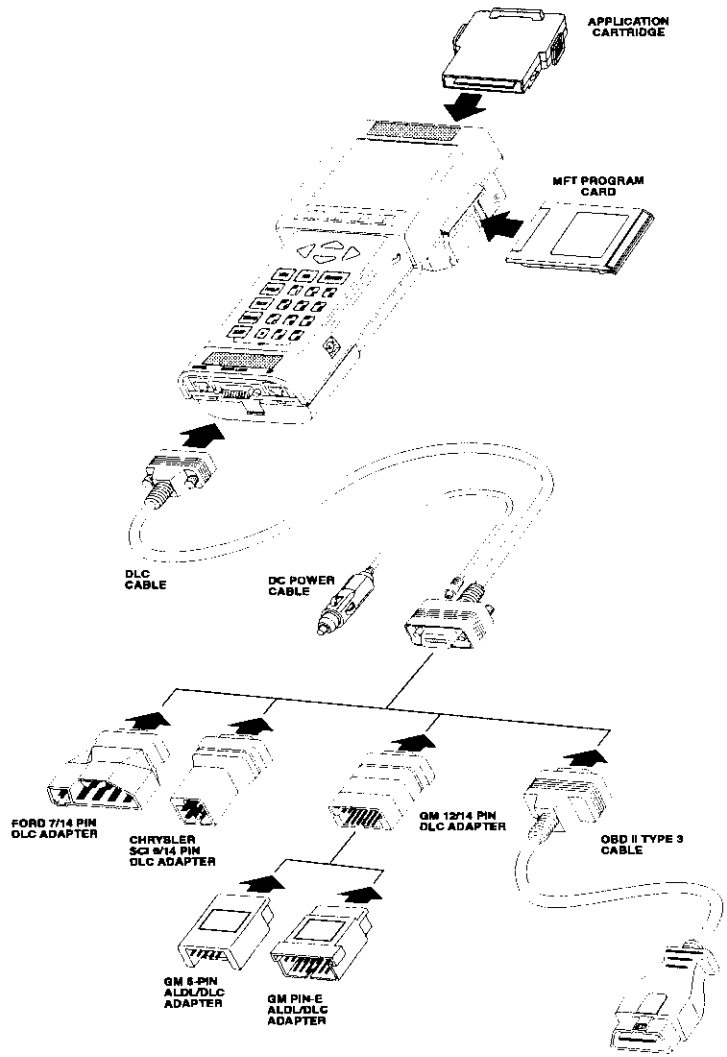
1.7 VEHICLE DATA LINK DIAGNOSTICS

The Scantest mode is used to diagnose specific vehicle problems via the DLC. The Mastertech communicates with the vehicle to display ECU diagnostic data parameters as well as display and clear diagnostic trouble codes. Depending on the selected Scantest Application, the tester can also perform specific bi-directional vehicle tests such as controlling engine RPM or performing a shift solenoid actuator test.

The application software must be installed in the tester and the tester must be connected to the Data Link Connector (DLC) on the vehicle in order to perform diagnostics via the vehicle DLC. All Stand-alone Functions are also available. To perform the Vehicle Data Link Diagnostics, the Mastertech must be set up as follows:

1. Insert the program card into the Mastertech.
2. For cartridge based diagnostics remove the cartridge cover and insert the Application cartridge into the back of the tester.
3. Connect the DLC cable to the tester.
4. Depending on the vehicle and the tests to be performed, connect the appropriate adapter or adapter cable to the DLC cable.
5. Connect the DC Power Cable to the DLC cable, then insert the cigarette lighter plug into the vehicle cigarette lighter socket.
6. If Digital Meter or Oscilloscope functions are required, see page 1-9 to connect the Diagnostic Lead Set (DLS) kit to the tester.
7. Turn the vehicle ignition ON.
8. Press ON to turn the tester ON.
9. Select the vehicle that you wish to test and the appropriate diagnostic mode.

MASTERTECH CABLE AND ADAPTER CONNECTIONS



1.8 DIGITAL METER/OSCILLOSCOPE FUNCTIONS

The Diagnostic Lead Set (DLS) kit provides input to the following test capabilities:

- Digital Volt Meter
- Duty Cycle Measurement
- Frequency Counter
- Pulse Width
- Current Probe
- Temperature Probe
- Oscilloscope

The Diagnostic Lead Set (DLS) kit must be connected to the Mastertech in order to perform the Digital Meter and Oscilloscope Functions.

All Stand-alone functions are available when using the Digital Meter/Oscilloscope functions. To perform Digital Meter/Oscilloscope functions in conjunction with Vehicle Data Link Diagnostics, a diagnostic applications cartridge must be installed and the tester must be connected to the vehicle. Refer to Section 3.0 for Digital Meter operating instructions, and Section 4.0 for Oscilloscope operating instructions.

NOTE: The Diagnostic Lead Set (DLS) kit provided with the Mastertech kit is only intended for automotive-type signal measurement. It is not intended to be lab-quality bench-top test equipment.

⚠ CAUTION:

Do not connect the diagnostic leads to voltage potentials greater than 20V. Tester damage could result from excessive voltage levels.

The following steps must be performed to connect the Diagnostic Test Lead Set to the Mastertech:

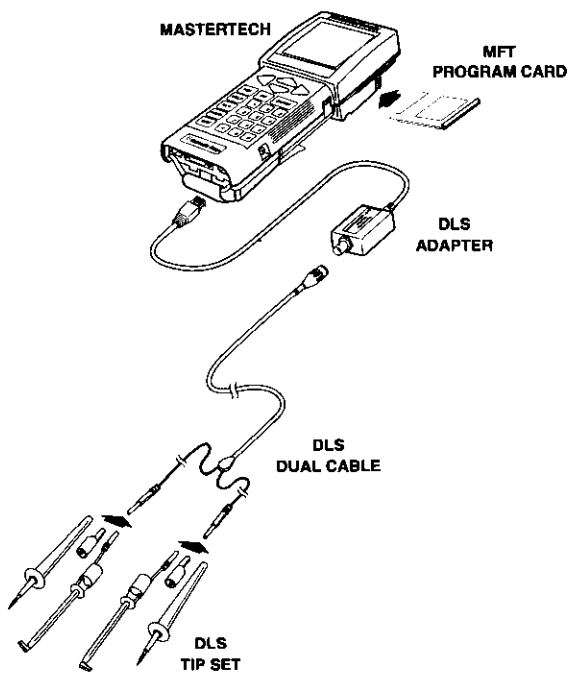
1. Connect the Diagnostic Lead Set (DLS) Adapter to the I/P port on the lower right side of the Mastertech.

2. Connect the Diagnostic Lead Set (DLS) dual cable to the Diagnostic Lead Set (DLS) Adapter.

3. Install DLS tips (test pin probes, alligator clips, or insulation piercing hooks) onto the DLS dual cable.

NOTE: Voltage potentials greater than 20V require an Enhanced Diagnostic Lead Set (EDLS).

DIAGNOSTIC TEST LEAD SET (DLS) KIT



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2.0 SCANTEST

The Mastertech ScanTest mode uses the vehicle's diagnostic Data Link Connector (DLC) to combine the traditional scan tool functions with bi-directional test capabilities. The ScanTest mode allows you to look at diagnostic data parameters and trouble codes as well as capture data during road tests.

Bi-directional testing allows you to control various aspects of the vehicle's operations, such as turning solenoids "on" and "off" or overriding certain vehicle parameters (e.g. changing the RPM by controlling the IAC). The bi-directional control capabilities vary from vehicle to vehicle, and requires the use of a TECH 1 application cartridge which must be operated from the multi-function display.

The ScanTest mode provides diagnostic tests that are specific to the vehicle to be diagnosed. Refer to the cartridge operator's manual for specific test availability.

In addition, certain vehicle makes, models, and systems allow the use of Enhanced Mode functions for displaying and analyzing data. Enhanced Data List or DTC Mode is available when [RCV] FOR ENHANCED is displayed at the bottom of the multi-function display screen. The Enhanced mode functions are explained on page 2-6.

OPERATING PROCEDURE:

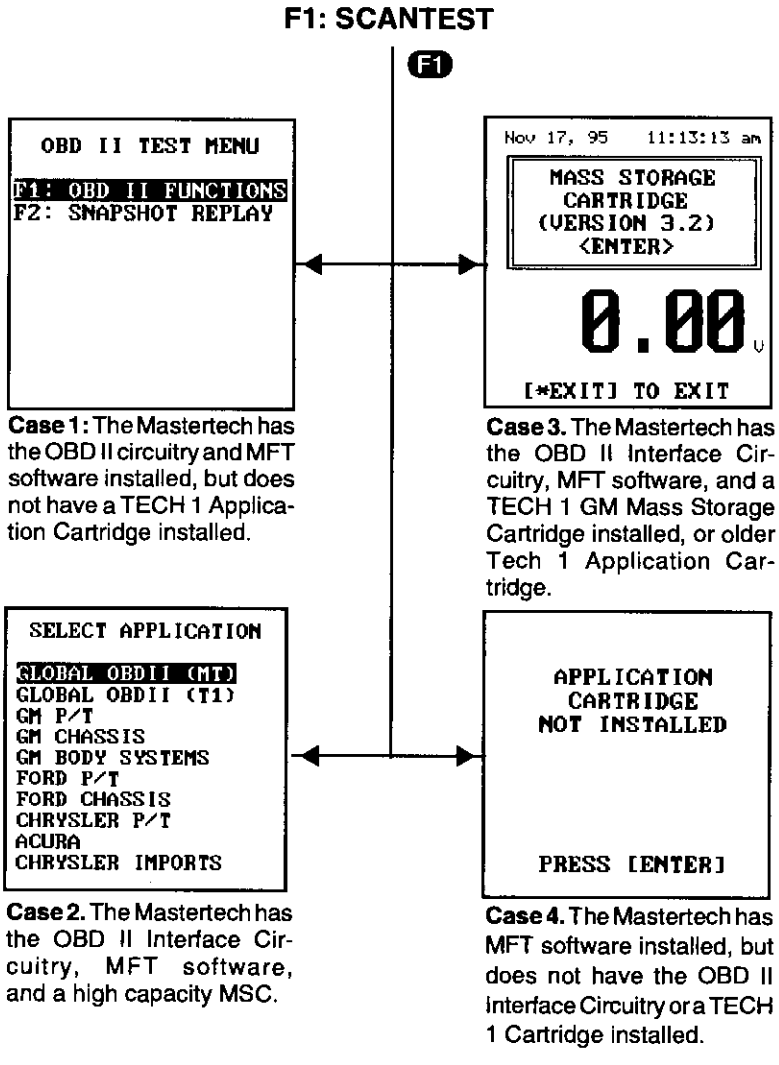
1. Press F1 to select ScanTest from the Function Menu.

2. Depending on the installed interface hardware and application software, one of four Advanced Menu software screens will be displayed.

2.1 ADVANCED MENUS

When ScanTest is selected from the Function Menu, the Mastertech performs a test to identify which interface hardware and application software configuration is installed.

If OBD II Interface Circuitry is present, the tester will display one of the following screens:



Case 1: The Mastertech has the OBD II circuitry and MFT software installed, but does not have a TECH 1 Application Cartridge installed.

Case 2. The Mastertech has the OBD II Interface Circuitry, MFT software, and a high capacity MSC.

Case 3. The Mastertech has the OBD II Interface Circuitry, MFT software, and a TECH 1 GM Mass Storage Cartridge installed, or older Tech 1 Application Cartridge.

Case 4. The Mastertech has MFT software installed, but does not have the OBD II Interface Circuitry or a TECH 1 Cartridge installed.

Mastertech Case 1: The Mastertech has the OBD II circuitry and MFT software installed, but does not have a TECH 1 Application Cartridge installed.

After the hardware configuration has been determined, the Mastertech will display the OBD II TEST MENU. This menu allows you to proceed with vehicle communications via the OBD II FUNCTIONS selection. It also allows you to replay data from previously captured snapshot events without being connected to a vehicle.

Mastertech Case 2. The Mastertech has OBD II Interface Circuitry, MFT software, and a TECH 1 Application Cartridge or 2MB/8MB high capacity MSC installed.

For many of the TECH 1 Cartridges, the Mastertech will display a list of the TECH 1 Applications plus the Generic OBD II Application. Use the ↑, ↓, →, and ← keys to highlight the desired application and then press ENTER to select it. If more applications are available than will fit on the display, the list of applications will scroll when you get to the top or bottom of the display.

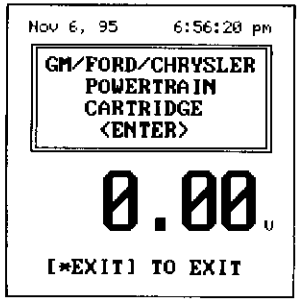
Mastertech Case 3. The Mastertech has the OBD II Interface Circuitry, MFT software, and a TECH 1 GM Mass Storage Cartridge installed, or older Tech 1 Application Cartridge

When using the TECH 1 GM Mass Storage Cartridge, the OBD II software cannot be used with the TECH 1 Cartridge installed. For these cartridges, the Mastertech will enter the TECH 1 mode where the tester displays a 64-character window emulating the TECH 1 display.

Mastertech Case 4. The Mastertech has MFT software installed, but does not have the OBD II Interface Circuitry or a TECH 1 Cartridge installed.

In this case, no SCANTEST functions can be performed. In order to acquire scantest functionality, you must obtain the OBD II Interface Circuitry, MFT software, or Application Cartridge from your distributor.

2.2 MULTI-FUNCTION DISPLAY



The Multi-Function display of the ScanTest mode shows the TECH 1 display along with a digital meter. Diagnostic data parameters (serial data), Diagnostic Trouble Codes (DTCs) and additional information about the vehicle under test is shown in the vehicle interface window in the top half of the display. Simultaneously, the tester can display measured values from the Diagnostic Lead Set.

The keypad is used to enter information, select tests, and answer questions displayed in the vehicle interface window. Additional special keys are used to change the meter measurement mode, switch to Enhanced Functions or exit the ScanTest mode.

Multi-Function Display Keys

RCV	Switch to or Exit from Enhanced Functions (when available).
EXIT	Exit Enhanced Functions.
* ENTER	Change the digital meter mode.
* EXIT	Exit ScanTest, and return to Function Menu.

Multi-Function Display Vehicle Selection

The vehicle under test must be properly selected in the application cartridge so that the tester uses the correct interface and protocol to communicate with the vehicle. The vehicle selection process is different for each auto manufacturer. Please refer to the application cartridge operator's manual for specific vehicle selection information.

If you are using the OBD II software, there is no need to select the vehicle because the tester will automatically determine the correct interface and protocol to communicate with the vehicle.

Multi-Function Display Diagnostic Functions

The actual diagnostic functions available are dependent on the software installed and the vehicle being tested. Please refer to the cartridge or software operator's manual for more information on available diagnostic functions.

In order to return to the FUNCTION menu from the ScanTest Mode, press ✱ EXIT (hold the ✱ key and then press EXIT). Other test functions can then be selected (e.g. Oscilloscope) without terminating the scan function. To return to the ScanTest, re-select SCANTEST from the Function Menu. Operation will return to the previous ScanTest display. This function only works while the Tech 1 screen is displayed.

Multi-Function Display Digital Meter

In addition to serial data information, the tester can display measured voltage, frequency, duty cycle and pulse width on the multi-function display screen. These measurements are made concurrent to viewing diagnostic test information in the vehicle interface display box.

The Digital Meter measures voltages, frequencies, duty cycles, and pulse width between the red and black leads of the DLS. The measured value is displayed on the lower half of the screen. See page 1-9 for instructions on connecting the Diagnostic Lead Set (DLS) to the tester.

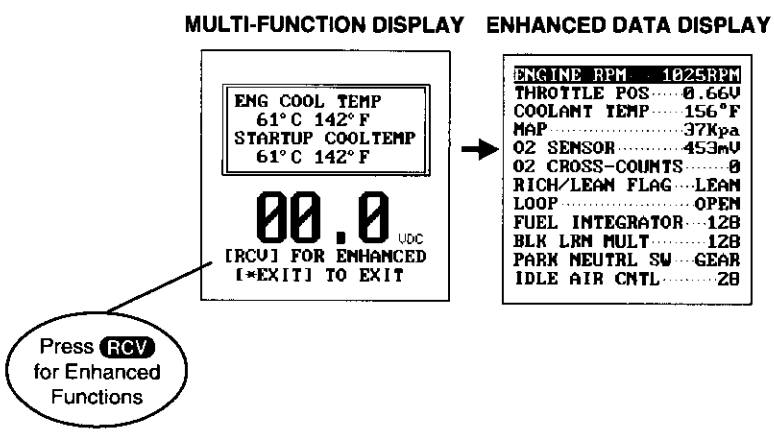
The currently selected measurement mode is indicated by the units of the displayed value. When the voltage display is active, the units are "V". When the frequency display is active, the units are "Hz" or "kHz", depending on the signal. When the duty cycle display is active, the units are "%" and when pulse width is selected, the units are microseconds "µs" or milliseconds "Ms" depending on the signal.

The multi-function digital meter mode can be changed by pressing ✱ ENTER (hold down the ✱ key then press ENTER). The display changes from voltage to frequency to duty cycle to pulse width and then back to voltage.

2.3 ENHANCED FUNCTIONS

Certain vehicle makes and models support Enhanced Functions of the tester. The Enhanced Functions make use of the large tester screen to display diagnostic data parameters in several different forms. The ALL DATA mode displays up to 16 parameters at a time. The LED/LIST mode uses the red and green LEDs to indicate the status of switched signals. The Bar Chart and Line Graph modes display the data values graphically. DTCs display and Snapshot capture and replay are also supported in the Enhanced Functions.

Enhanced Functions are usually available when Data List, DTCs, or Snapshot functions are active on the vehicle interface window. When Enhanced Functions are available, "[RCV] FOR ENHANCED" is displayed at the bottom of the screen. Press the RCV key to switch to the Enhanced functions. Pressing RCV or EXIT returns to the normal ScanTest display.



Enhanced Data List

The Enhanced Data List displays the diagnostic data parameters supplied by the vehicle electronic controller. The name of each diagnostic data parameter is displayed on the left of the screen, with the corresponding value and unit on the right.

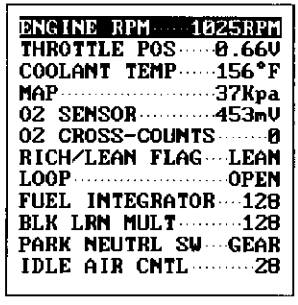
The data list has several different modes for displaying data.

1: ALL DATA mode	Displays up to 16 diagnostic data parameters at a time. Additional parameters can be viewed by scrolling the screen.
2: CUSTOM LIST mode	Displays up to 16 diagnostic data parameters in a user definable order.
3: LED/LIST mode	Uses the LEDs at the bottom of the screen to indicate the status of switched signals (e.g ON/OFF, RICH/LEAN).
4: BAR GRAPH mode	Displays up to 6 diagnostic data parameters with a bar indicating the data value.
5: LINE GRAPH mode	Displays two diagnostic data parameters on a line graph showing a "time history" of the data value.

All Data Mode

The All Data mode is the default display for the Enhanced Functions. Press 1 to select the ALL DATA mode from any enhanced display. The All Data mode displays all diagnostic data parameters supplied by the vehicle electronic controller.

All diagnostic data parameters can be viewed by use of the ↑, ↓, *↑, or *↓ keys. Up to twelve diagnostic data parameters using large characters or 16 diagnostic data parameters can be displayed at one time.

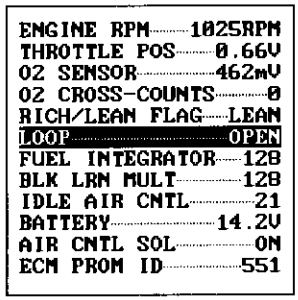


ACTIVE KEYS

↑/↓	Move the highlight bar up or down one parameter.
*↑ *↓	Move the highlight bar up or down one screen.
2	Go to CUSTOM LIST mode.
3	Go to LED/LIST mode.
4	Go to BAR GRAPH mode.
5	Go to LINE GRAPH mode.
9	Changes between large and compressed character size.
0	Toggle the highlight bar on and off.
SEND	Print entire Data List.

Custom List Mode

Press 2 to select the CUSTOM LIST mode from any enhanced display. The CUSTOM LIST allows the order of the displayed diagnostic data parameters to be changed, allowing a custom configuration of up to 16 diagnostic data parameters on one display screen.



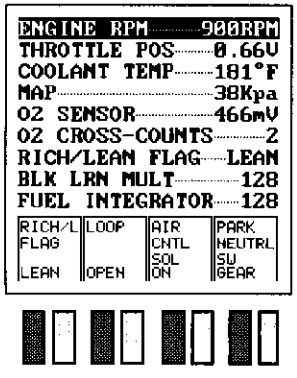
ACTIVE KEYS

- ↑/↓ Move the highlight bar up or down one parameter.
- YES Changes the highlighted parameter to the next parameter in the list.
- NO Changes the highlighted parameter to the previous parameter in the list.
- * YES Changes to highlighted parameter to the next parameter not currently displayed.
- * NO Changes to highlighted parameter to the previous parameter not currently displayed.
- 1 Go to ALL DATA mode.
- 3 Go to LED/LIST mode.
- 4 Go to BAR GRAPH mode.
- 5 Go to LINE GRAPH mode.
- 9 Changes between large and compressed character size.
- 0 Toggle the highlight bar on and off.
- SEND Print entire Data List.

LED/LIST Mode

Press 3 to select the LED/LIST mode from any enhanced display. The LED/LIST gives a quick view of the status of four discrete diagnostic data parameters displayed in boxes at the bottom of the Data List display. The LED/LIST also allows you to change the order of the displayed diagnostic data parameters, including the diagnostic data parameters in the four boxes at the bottom of the display.

The status of the selected diagnostic data parameters is displayed at the bottom of the box and is also indicated by the red and green lights beneath each box. The diagnostic data parameter display can be selected with the Active Keys.

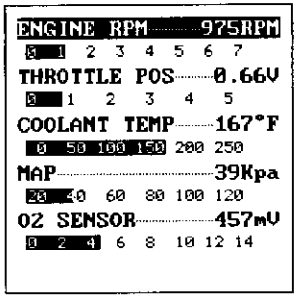


ACTIVE KEYS

- ↑/↓ Move the highlight bar up or down one parameter.
- YES Changes the highlighted parameter to the next parameter in the list.
- NO Changes the highlighted parameter to the previous parameter in the list.
- * YES Changes to highlighted parameter to the next parameter not currently displayed.
- * NO Changes to highlighted parameter to the previous parameter not currently displayed.
- 1 Go to ALL DATA mode.
- 2 Go to CUSTOM LIST mode.
- 4 Go to BAR GRAPH mode.
- 5 Go to LINE GRAPH mode.
- 9 Changes between large and compressed character size.
- 0 Toggle the highlight bar on and off.
- SEND Print entire Data List.

Bar Graph Mode

Press 4 to select the BAR GRAPH mode from any enhanced display. The Bar Graph shows relationships among up to six different diagnostic data parameters. The displayed diagnostic data parameters can be custom configured with the Active Keys.

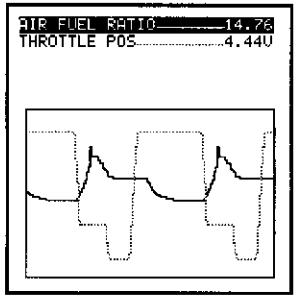


ACTIVE KEYS

- ↑/↓ Move the highlight bar up or down one parameter.
- YES Changes the highlighted parameter to the next parameter in the list.
- NO Changes the highlighted parameter to the previous parameter in the list.
- * YES Changes the highlighted parameter to the next parameter not currently displayed.
- * NO Changes the highlighted parameter to the previous parameter not currently displayed.
- 1 Go to ALL DATA mode.
- 2 Go to CUSTOM LIST mode.
- 3 Go to LED/LIST mode.
- 5 Go to LINE GRAPH mode.
- 9 Changes between large and compressed character size.
- 0 Toggle the highlight bar on and off.
- SEND Print entire Data List.

Line Graph Mode

Press 5 to select the LINE GRAPH mode from any enhanced display. The Line Graph displays two diagnostic data parameters on the moving line graph. The displayed diagnostic data parameters can be custom configured with the Active Keys.

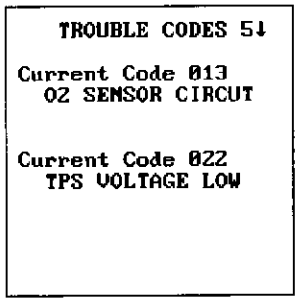


ACTIVE KEYS

- ↑/↓ Move the highlight bar up or down one parameter.
- YES Changes the highlighted parameter to the next parameter in the list.
- NO Changes the highlighted parameter to the previous parameter in the list.
- 1 Go to ALL DATA mode.
- 2 Go to CUSTOM LIST
- 3 Go to LED/LIST mode.
- 4 Go to BAR GRAPH mode.
- 9 Changes between large and compressed character size.
- 0 Toggle the highlight bar on and off.
- SEND Print entire Data List.

Enhanced DTCS

The Enhanced DTC display shows two trouble codes at one time. Both history and current DTCs can be displayed. Use ↑ and ↓ to scroll through the list of DTCs. The total number of DTCs is displayed in the upper right corner of the screen.



ACTIVE KEYS

- EXIT — Return to SELECT MODE Menu.
- ↑/↓ — Scroll through trouble codes.
- SEND — Print all trouble codes.

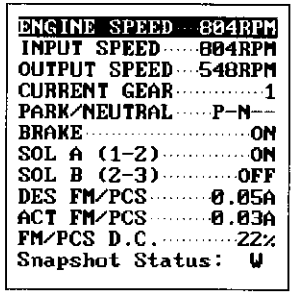
Enhanced Snapshot

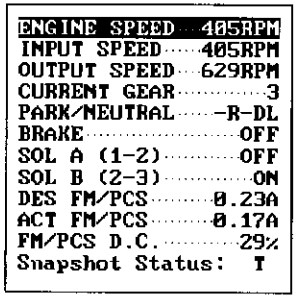
The Enhanced Snapshot provides an Enhanced Data List display during capture and replay. When the Snapshot mode and trigger type (manual, automatic, trouble code) have been selected on the Multi-Function screen, the tester display can be changed to Enhanced Snapshot by pressing the RCV key. The Enhanced Snapshot has the same modes as Enhanced Data List.

Enhanced Snapshot (Continued)

Data Capture

Up to fifteen diagnostic data parameters can be displayed at a time. Use ↑ and ↓ to scroll through all diagnostic data parameters. "SNAPSHOT STATUS: W" is displayed at the bottom of the screen until the Snapshot is triggered. When a trigger occurs, "SNAPSHOT STATUS: T" is displayed at the bottom of the screen while data is being saved.





ACTIVE KEYS

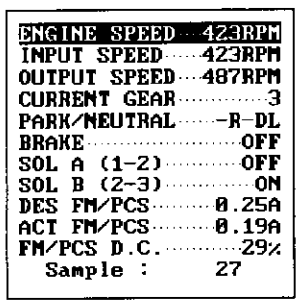
↑/↓	Move the highlight bar up or down one parameter.
*↑	Move the highlight bar up or
*↓	down one screen.
ENTER	Triggers the Snapshot.
1	Go to ALL DATA mode.
2	Go to CUSTOM LIST
3	Go to LED/LIST mode.
4	Go to BAR GRAPH mode.
5	Go to LINE GRAPH mode.
YES	Changes the highlighted parameter to the next parameter in the list.
NO	Changes the highlighted parameter to the previous parameter in the list.
* YES	Changes the highlighted parameter to the next parameter not currently displayed.
* NO	Changes the highlighted parameter to the previous parameter not currently displayed.

NOTE: Do not operate the keypad while the tester is saving vehicle data.

Enhanced Snapshot (Continued)

Data Replay

At the completion of the data capture, "SAMPLE" and the sample number are displayed at the bottom of the screen. Data captured in the Snapshot mode can be displayed in all of the formats that are available in the Enhanced Data List function.



ACTIVE KEYS

- ↑/↓ Move the highlight bar up or down one parameter.
- ✱↑ / ✱↓ Move the highlight bar up or down one screen.
- ←/→ Sequence through the sample displayed.
- 1 Go to ALL DATA mode.
- 2 Go to CUSTOM LIST mode.
- 3 Go to LED/LIST mode.
- 4 Go to BAR GRAPH mode.
- 5 Go to LINE GRAPH mode.
- YES Changes the highlighted parameter to the next parameter in the list.
- NO Changes the highlighted parameter to the previous parameter in the list.
- ✱YES Changes the highlighted parameter to the next parameter not currently displayed.
- ✱NO Changes the highlighted parameter to the previous parameter not currently displayed.
- SEND Print current Snapshot sample.

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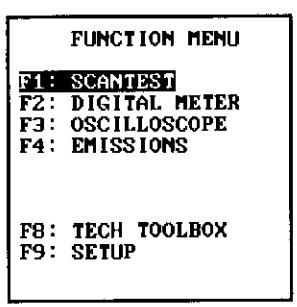
3.0 DIGITAL METER

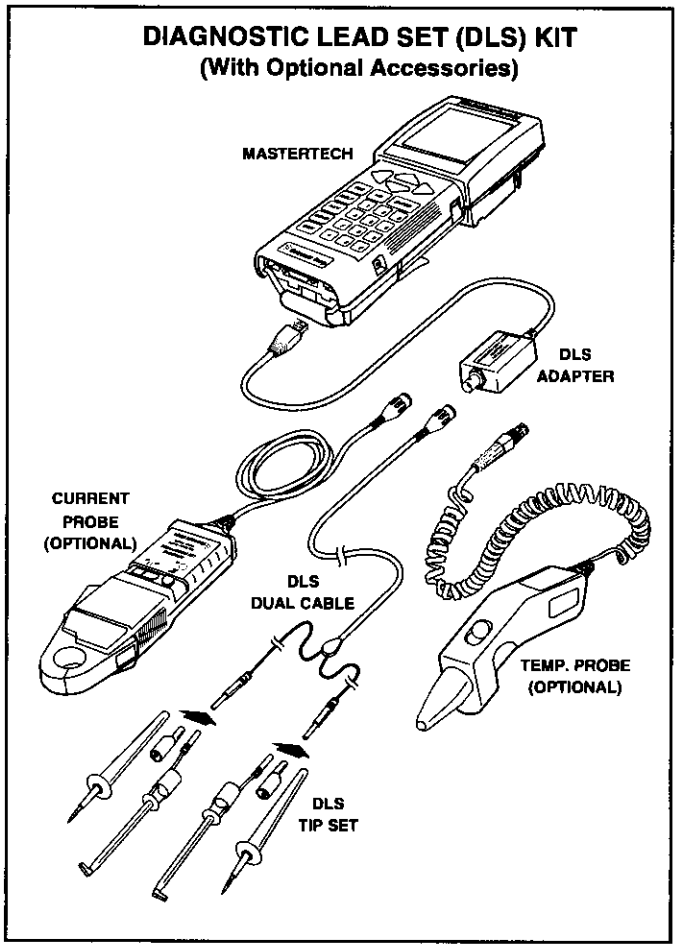
The Digital Meter (DM) Functions measure voltage, frequency, pulse width, current, and temperature. These functions can be used to measure signals such as:

Battery Voltage (DC)
Switched signals (e.g. A/C ON/OFF switch)
MAF Sensor frequency
Idle Air Control Valve
Pulse width modulated EGR Valve signals
Mixture Control Solenoid Duty Cycle
Alternator Output Current measured in Amps
Engine Coolant Temperature
Catalytic Converter Temperature
Brake Rotor Temperature

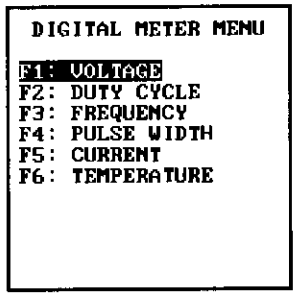
The Diagnostic Lead Set (DLS) Kit, also known as Diagnostic Test Lead Set, is used in conjunction with the Digital Meter Functions. An illustration on the following page, entitled Diagnostic Lead Set (DLS) Kit with optional accessories, shows how the DLS Kit and optional accessories connects to the Mastertech.

Digital Meter Functions can be accessed from the Digital Meter Menu. To select this menu, press F2 from the Function Menu.

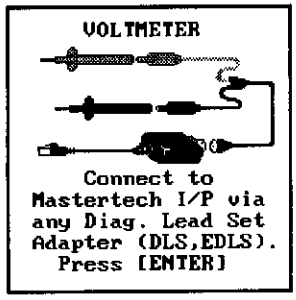



DIAGNOSTIC LEAD SET (DLS) KIT
(With Optional Accessories)
MASTERTECH
DLS
ADAPTER
CURRENT
PROBE
(OPTIONAL)
DLS
DUAL CABLE
TEMP. PROBE
(OPTIONAL)
DLS
TIP SET

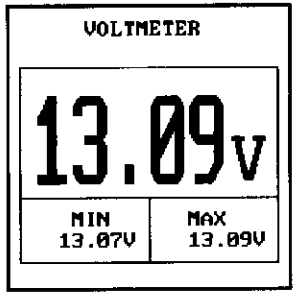
3.1 VOLTAGE MEASUREMENT



1. Press F1 from the Digital Meter Menu to select the voltage measurement display function.



2. Connect the DLS Kit to the Mastertech. To assemble the DLS Kit, connect the BNC end of the DLS Dual Cable to the BNC end of the DLS Adapter. Once these are in place, connect the free end of the DLS Adapter to the I/P connector located on the bottom of the Mastertech, at the right.



3. The Voltage selection displays the voltage between the red and black leads of the DLS Kit. Connect the red and black leads between the point to be measured and the ground reference (black is usually ground). The voltage measured is displayed on the tester screen.

NOTE: Do not measure voltages greater than 20 Volts

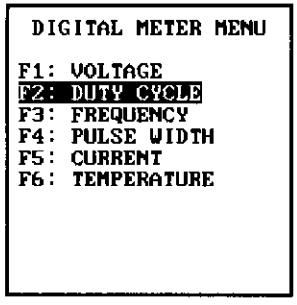
VOLTAGE METER SPECIFICATIONS

METER	RANGE	MIN/MAX
Voltmeter	+/- 20 V DC	Yes

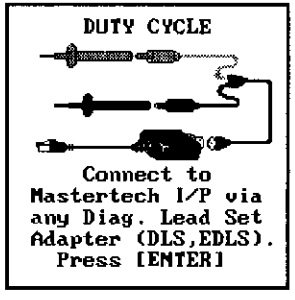
ACTIVE KEYS

ENTER Reset MIN and MAX voltage
EXIT Exit Voltage Measurement
HELP Voltage Measurement Help

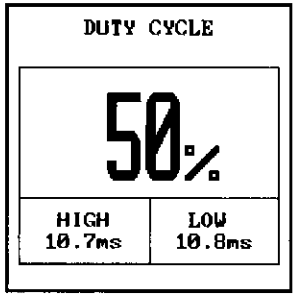
3.2 DUTY CYCLE



1. Press F2 from the Digital Meter Menu to select the Duty Cycle display function. This function measures the ratio of the low portion of the signal to the entire signal and displays the result in terms of a percentage.



2. Connect the DLS Kit to the Mastertech. To assemble the DLS Kit, connect the BNC end of the DLS Dual Cable to the BNC end of the DLS Adapter. Once these are in place, connect the free end of the DLS Adapter to the I/P connector located on the bottom of the Mastertech, at the right.



3. Connect the red and black test leads between the point to be measured and the ground reference. If the signal measured is not cycling, the tester displays "NO SIGNAL". The display also shows the time of the High and Low pulse, or the minimum and maximum duty cycle values.

DUTY CYCLE SPECIFICATIONS

METER	RANGE
Duty Cycle	0 – 100%

ACTIVE KEYS

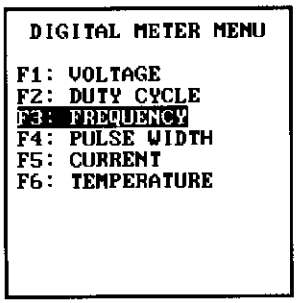
F1 Toggle display between minimum/maximum duty ratio and width of the high and low pulses (in ms).

ENTER Reset MIN and MAX voltage

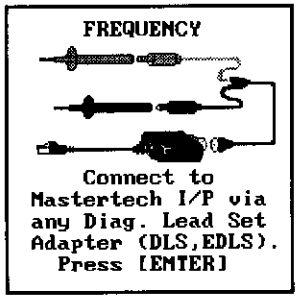
EXIT Exit Voltage Measurement

HELP Duty Cycle Help

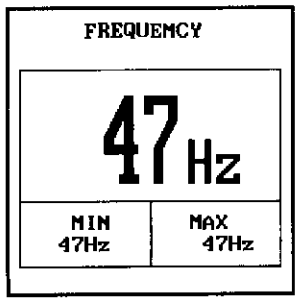
3.3 FREQUENCY



1. Press F3 from the Digital Meter Menu to select the Frequency display function. This function measures and displays the frequency of the sampled signal.



2. Connect the DLS Kit to the Mastertech. To assemble the DLS Kit, connect the BNC end of the DLS Dual Cable to the BNC end of the DLS Adapter. Once these are in place, connect the free end of the DLS Adapter to the I/P connector located on the bottom of the Mastertech, at the right.



3. Connect the red and black test leads between the point to be measured and the ground reference. The tester can measure frequencies from 0Hz to 10kHz. If the signal measured is not cycling, the tester displays "NO SIGNAL". This means the test leads are not connected, or the signal is a DC voltage. The tester also displays the minimum and maximum frequencies measured.

FREQUENCY METER SPECIFICATIONS

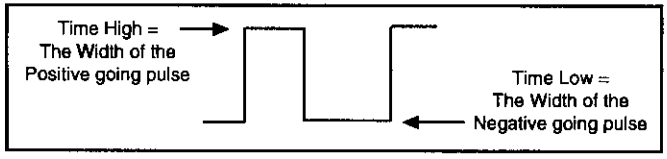
METER	RANGE	MIN/MAX
Frequency Meter	0 - 10kHz	Yes

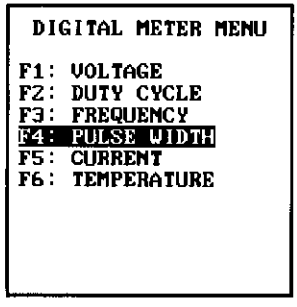
ACTIVE KEYS

ENTER Reset MIN and MAX voltage
EXIT Exit Voltage Measurement
HELP Frequency Help

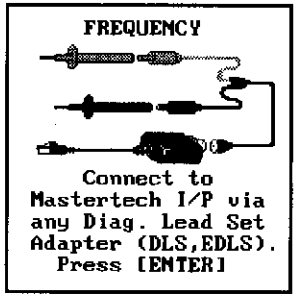
3.4 PULSE WIDTH

The Pulse Width meter measures and displays the time that a signal is low or high. Pulse width is measured in milliseconds (ms) and microseconds (µs). The pulse width software defaults to the "Time High" and can be toggled to the "Time Low" by pressing F1.

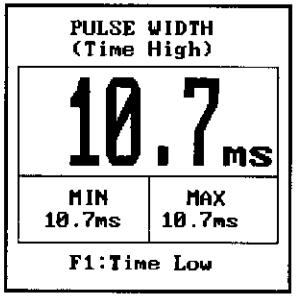




1. Press F4 from the Digital Meter Menu to select the Pulse Width.



2. Connect the DLS Kit to the Mastertech. To assemble the DLS Kit, connect the BNC end of the DLS Dual Cable to the BNC end of the DLS Adapter. Once these are in place, connect the free end of the DLS Adapter to the I/P connector located on the bottom of the Mastertech, at the right.



3. Connect the red and black test leads between the point to be measured and the ground reference. If the signal measured is not cycling, the tester displays NO SIGNAL. This means the test leads are not connected, or the signal is a DC voltage.

PULSE WIDTH SPECIFICATIONS

METER	RANGE	MIN/MAX
Pulse Width	5 µs - 200 ms	Yes

ACTIVE KEYS

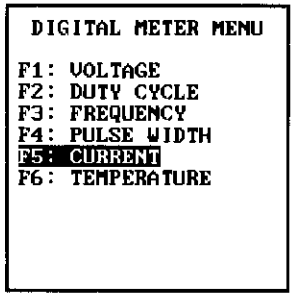
ENTER Reset MIN and MAX voltage

F1 Toggle Time Low / Time High

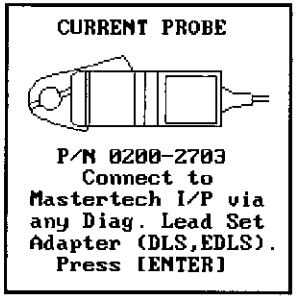
HELP Pulse Width Help

3.5 CURRENT PROBE

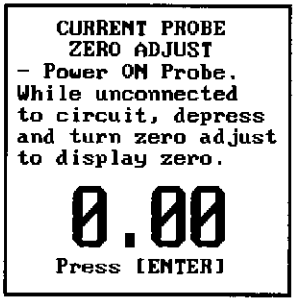
The optional Current Probe measures and displays current from 0 to +/-30 Amps.



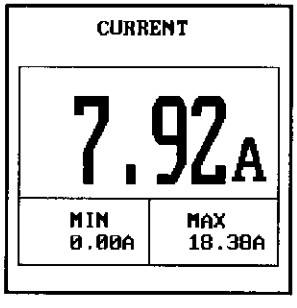
1. Press F5 from the DIGITAL METER MENU to select the Current Probe function.



2. Connect the Current Probe BNC connector to the DLS Adapter. Connect the free end of the DLS Adapter to the I/P port located on the bottom of the Mastertech, at the right.

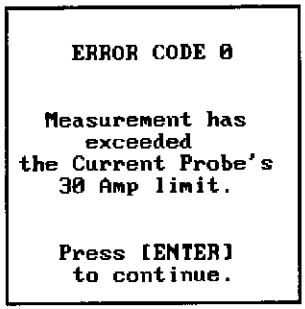


3. Power on Probe and confirm the Red LED on the probe is illuminated. While not connected to a circuit, depress and turn the zero adjustment wheel on the current probe until the display reads zero.

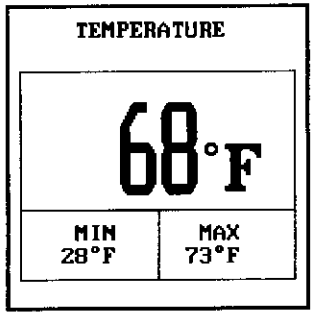


4. Clamp the current probe around the conductor; be sure the arrow with the "+" sign marked on the jaw of the Current Probe points toward the correct orientation as described in the following note.

NOTE: The Current Probe is sensitive to the direction of the current flow. If the probe is not oriented correctly, the direction of current will cause the amperage to read 0. Verify that the arrow with the "+" sign points toward the positive side of the circuit under test.



5. The Current Probe will display ERROR CODE 0 when the circuit under test exceeds 30 Amps.



CURRENT PROBE SPECIFICATIONS

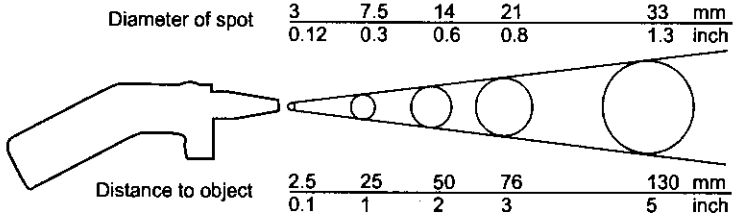
METER	RANGE	MIN/MAX
Current Probe	0 to +/- 30A	Yes

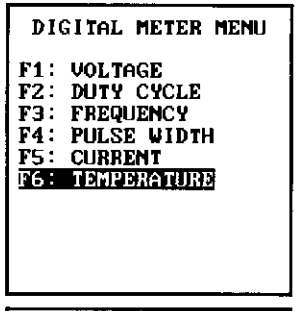
ACTIVE KEYS

ENTER Reset MIN/MAX
HELP Current Probe Help

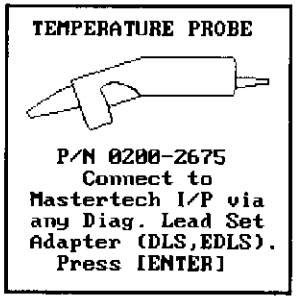
3.6 TEMPERATURE PROBE

The Temperature Probe measures the radiated temperature from any object. The probe has a temperature range of 32°F to 1,000°F with a basic accuracy of 2% of reading. Temperature accuracy depends on the distance to object. Refer the Distance To Spot Ratio Chart referenced below:

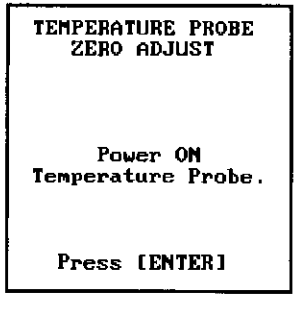




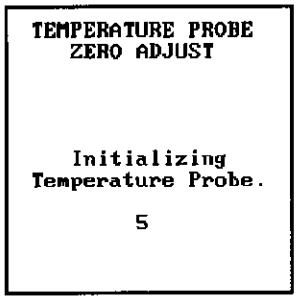
1. Press F6 from the DIGITAL METER MENU to select the Temperature Probe function.



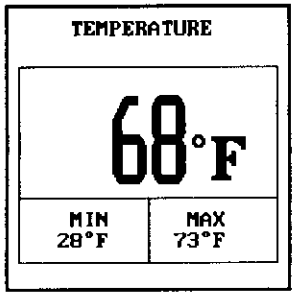
2. Connect the Temperature Probe BNC connector to the DLS Adapter. Connect the free end of the DLS Adapter to the I/P port located on the bottom of the Mastertech, at the right.



3. Power ON Temperature Probe and Press ENTER.



4. The Temperature Probe has a required 5 second startup procedure every time the probe is powered on.



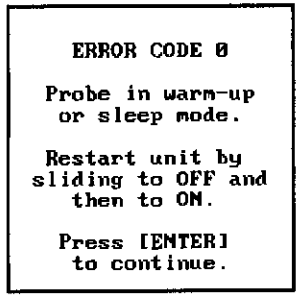
5. Point the temperature probe at the object you want to measure. Follow the Distance To Spot Ratio Chart for accurate readings.

TEMPERATURE PROBE SPECIFICATIONS

METER	RANGE	MIN/MAX
Temperature Probe	32°F – 1000°F	Yes

ACTIVE KEYS

- ENTER Reset MIN/MAX
- F1 Toggle °F / °C
- F2 Measuring Distance
- HELP Temp Probe Help



NOTE: Temperature Probe will display ERROR CODE 0 after Temp Probe has been "ON" for more than 10 minutes or signal from tester is no longer present. Refer to the Temperature Probe Specifications manual for additional error codes.

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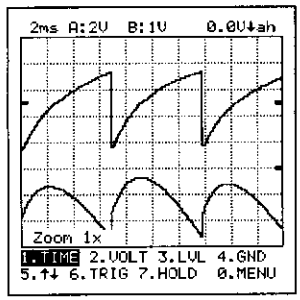
4.0 OSCILLOSCOPE

Press F3 from the Function Menu to select the OSCILLOSCOPE Function. The Oscilloscope function supports single channel, dual channel and current probe modes of operation, including the Waveform Assistant. Additionally, the Oscilloscope mode supports the optional Enhanced Diagnostic Lead Set (EDLS) when connected.

The Waveform Assistant provides 37 stored waveforms which can be recalled from memory for your viewing. The waveforms are known good waveforms from actual vehicle components.

When using the single or dual channel modes, up to four captured waveforms can be saved and recalled for later use.

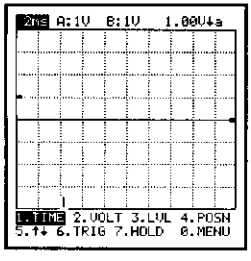
The Oscilloscope function displays signal waveforms for diagnostic evaluation and analysis. The Oscilloscope can measure and display signals from a DC voltage to 15KHz. The time scale is selectable from 0.2ms / div to 2s/div. The voltage scale is selectable from 0.1V / div to 5V / div. The Oscilloscope 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.

The Oscilloscope is used in conjunction with the Diagnostic Lead Set (DLS) kit. See page 1-9 for instructions on connecting the DLS kit to the tester.

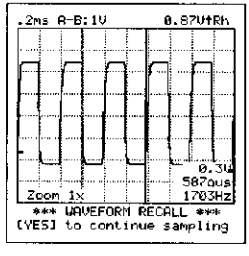
4.1 SINGLE CHANNEL MODE TEST LEAD CONNECTIONS



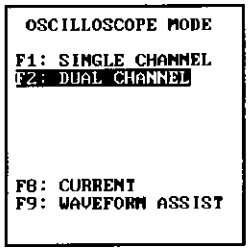
In the single channel mode, the tester displays a single waveform. The displayed waveform represents the voltage difference between the test leads. The red test lead should be connected to the signal to be measured. The black lead should be connected to the vehicle ground or other ground reference. This is known as differential mode since the voltage at the black lead (ground) is subtracted from the voltage at the red lead (input signal). Verify the test lead connections and press ENTER to display the Oscilloscope screen.

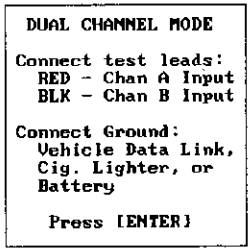
NOTE: It is recommended that the tester be powered by the vehicle battery.

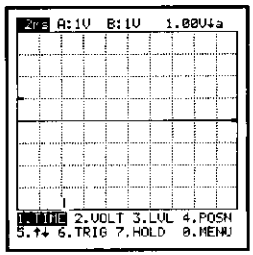
EXAMPLE OF SINGLE CHANNEL OSCILLOSCOPE DISPLAY



4.2 DUAL CHANNEL MODE TEST LEAD AND TESTER CONNECTIONS



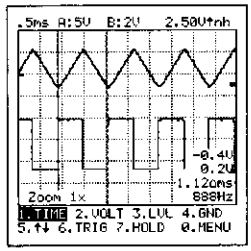




In dual channel mode, the tester can display a waveform measured by each channel separately, both channels at the same time, or the two input channels can be summed or differenced. The red test lead (referred to as channel A) should be connected to the first signal to be measured. The black lead (referred to as channel B) should be connected to the second signal to be measured. The tester must be connected to the vehicle ground for accurate measurements. This should be done through the 12V DC power cable or the data link cable. This is known as single-ended mode since each input channel is measured against the vehicle ground. Verify the test lead and tester power connections and press ENTER to display the Oscilloscope screen.

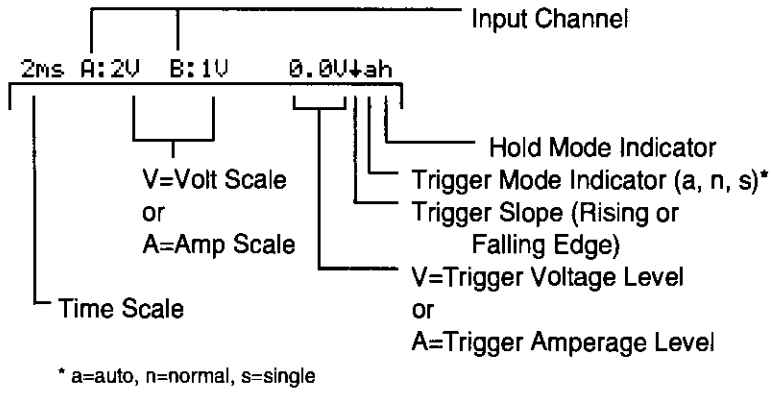
NOTE: The tester should be connected to vehicle ground through the DLC cable or 12V DC power cable.

EXAMPLE OF DUAL CHANNEL OSCILLOSCOPE DISPLAY



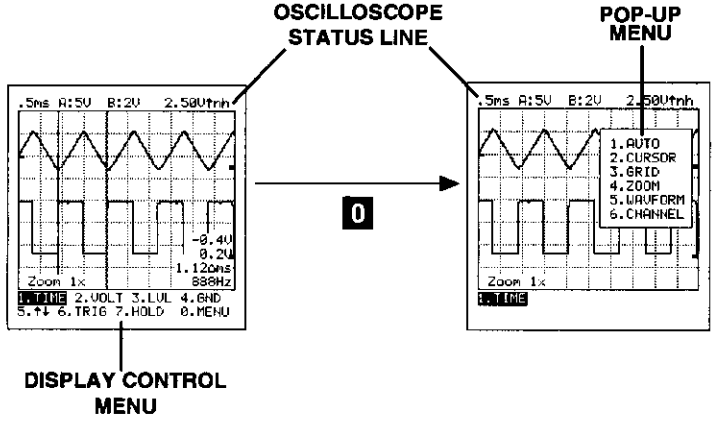
4.3 OSCILLOSCOPE DISPLAY & CONTROL

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



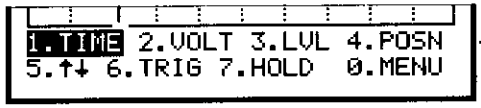
* a=auto, n=normal, s=single

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 which corresponds with the number to the left of the setting to be changed.



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 default mode) - 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.

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.

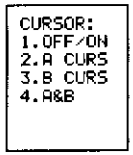
1.AUTO

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:

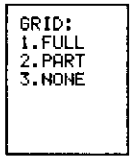
X.X V (or "A") - Voltage or Amperage at the "A" (solid) cursor position
X.X ms - Time difference of "A" and "B" cursor position
XXXX Hz - computed frequency for above

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 (Continued)

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.

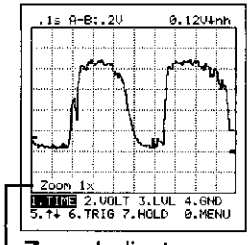
ACTIVE KEYS

- 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.



Zoom Indicator

A typical scenario would be to continuously measure a signal until an intermittent problem is seen, then press the 7.HOLD key 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 (Continued)

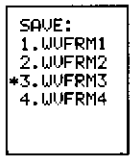
5.WAVEFORM

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.

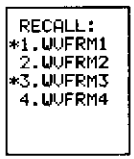
HINT: Use the HOLD Function to freeze the display before saving. This way you are sure of the waveform that is saved.

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

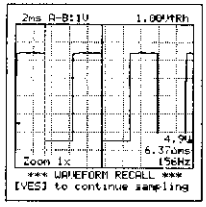


When 2.RECALL is selected, the pop-up menu displays the available save waveform slots. Up to four waveforms can be saved. A "*" indicates a waveform has been saved in the slot. Select the waveform to recall (1-4).

ACTIVE KEYS

1 - 4 Select menu item
EXIT Return to previous menu

Pop-Up Menu Functions (Continued)



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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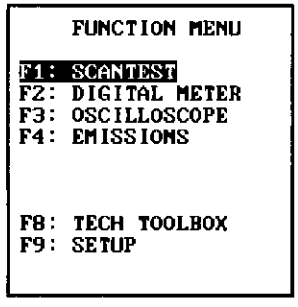
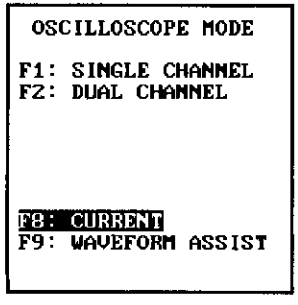
4.4 CURRENT PROBE

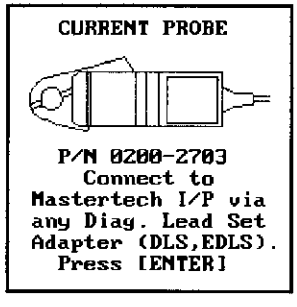
The optional Current selection from the Oscilloscope mode menu allows the user to view current waveforms from 0 to 30 amps.



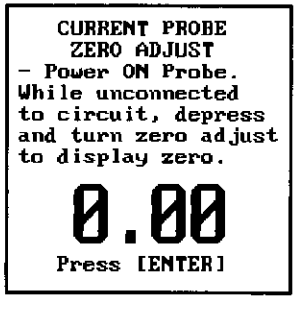
1. Press F3 from the FUNCTION MENU to select OSCILLOSCOPE MODE.



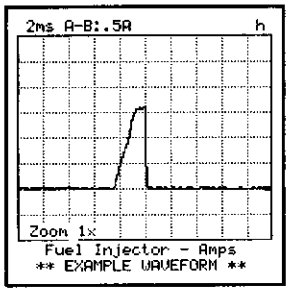
2. Press F8 From the OSCILLOSCOPE MODE MENU to select CURRENT.



3. Connect the Current Probe BNC connector to the DLS Adapter. Connect the free end of the DLS 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. Then press ENTER.



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 as described in the following note.

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 an upside down waveform. Verify that the arrow with the "+" sign points toward the positive side of the circuit.

```
ERROR CODE 0

Measurement has
   exceeded
the Current Probe's
   30 Amp limit.

Press [ENTER]
  to continue.
```

NOTE: The current probe will display ERROR CODE 0 when the circuit under test exceeds 30 Amps.

4.5 WAVEFORM ASSISTANT

Introduction

The Waveform Assistant is a library of example waveforms that can be a valuable resource when diagnosing vehicle electrical problems. When viewing vehicle sensors or actuator waveforms, you can easily hot key to the Waveform Assistant and verify if the sensor or actuator waveform you are testing matches the known good waveforms from the Waveform Assistant.

The Waveform Assistant has the following categories of available waveforms to choose from:

- Sensors
- Actuators
- Fuel Injectors
- Distributors
- Ignition Signals
- Current Measurements

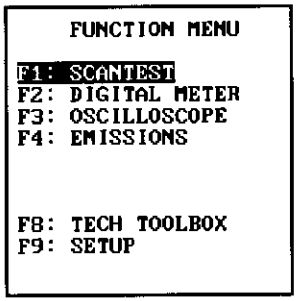
All waveforms were taken from known good vehicles using the Diagnostic Lead Set (DLS) for voltages below 20 volts and Enhanced Diagnostic Leads Set (EDLS) for the voltages above 20 volts. The Current Measurement waveforms were made using the optional Current Probe.

All example waveforms can be viewed without having the tester connected to the vehicle.

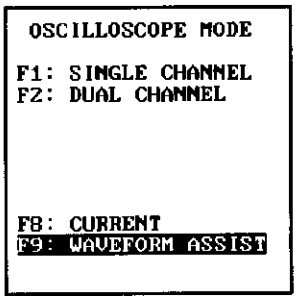
OFF Vehicle or ON Vehicle Testing

Select the Waveform Assistant mode from the Oscilloscope mode menu, then select the desired waveform you wish to view. Again, no live connection to the component is needed if you are only previewing the waveforms.

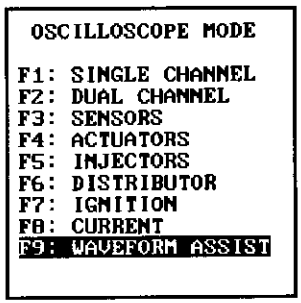
OPERATING PROCEDURE



1. From the Function Menu, Select F3: OSCILLOSCOPE by pressing F3 or ↓ until F3: Oscilloscope is highlighted, then press ENTER.



2. If using the DLS kit, the Oscilloscope mode menu should look like the screen on the left. Press F9 or ↓ until F9: WAVEFORM ASSIST is highlighted, then press ENTER.



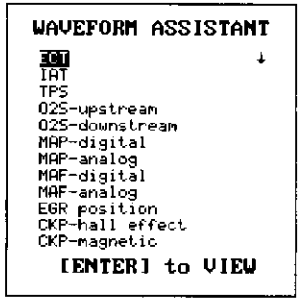
NOTE: If using the EDLS kit, the Oscilloscope mode menu should look like the waveform screen to the left. Press F9 or ↓ until F9: WAVEFORM ASSIST is highlighted, then press ENTER.

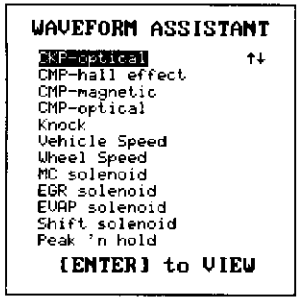
Selecting an Example Waveform

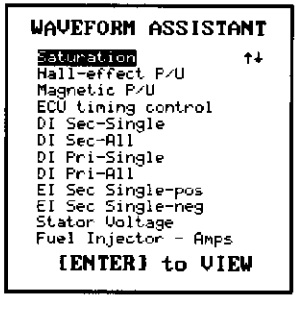
There are 37 example waveforms available from the Waveform Assistant menu. The example waveforms were captured while connected to a correctly operating vehicle system.

These waveforms are provided as examples only. Use your own judgement when diagnosing vehicle systems.

OPERATING PROCEDURE







1. Highlight the desired example waveform. Use ↑ or ↓ to move the highlight bar to the waveform. Or press ✱ and ↓ to move down a page, and press ✱ and ↑ to move up a page

2. Press ENTER.

3. A sample waveform will appear. Refer to the waveform library section starting on page 4-19.

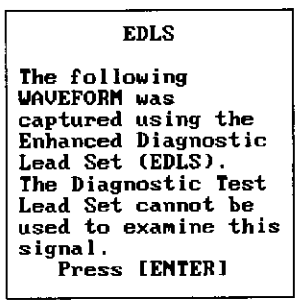
4. Press EXIT to mode back to the Waveform Assistant menu.

NOTE: When the down arrow (↓) appears on the display, there is another page of information to view after the current page. When both the up and down arrows (↑↓)appear on the display, there is a page of information before and after the current page. When the up arrow (↑) appears on the display, there is another page before the current page.

A Note About Information Screens

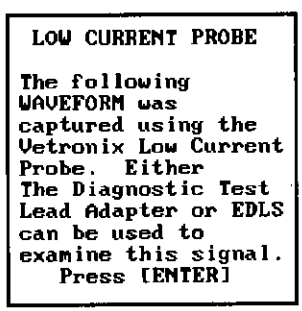
When using the Waveform Assistant to view selected waveforms, an information screen will be displayed before the example waveform. This display screen indicates the EDLS lead set was used to capture the example waveform, and that the diagnostic test lead set should not be used.

The following example waveforms have this screen:



MC Solenoid
EGR Solenoid
EVAP Solenoid
Shift Solenoid
Peak 'n Hold Injector
Saturation Injector
DI Secondary-Single
DI Secondary-All
DI Primary-Single
DI Primary-All
EI Secondary Single-Positive
EI Secondary Single-Negative

The following example waveforms have this screen:



Fuel Indicator - Amps
Fuel Pump - Amps

Selecting Example Waveform Using the HOTKEY

The Hotkey to waveform assistant mode allows the user to compare current waveforms readings to known good waveform readings stored in the tester without exiting out of the oscilloscope mode. The Hotkey to waveform assistant is only available when used with the Enhanced Diagnostic Lead Set (EDLS).

HOTKEY SETUP PROCEDURE:

1. With the EDLS plugged into the Mastertech, select **F3: OSCILLOSCOPE** from the Function Menu.

2. Select one of the following engine systems available from the **OSCILLOSCOPE MODE** Menu and press **ENTER**:

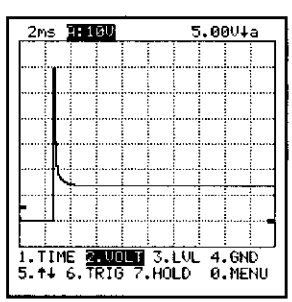
   F3 Sensors
   F4 Actuators
   F5 Injectors
   F6 Distributor
   F7 Ignition

3. Scroll up and down to select the specific sensor, actuator, injector, distributor or ignition component to test and press **ENTER**. This will setup the oscilloscope (Volts per division and Time per division) to read the waveform you selected.

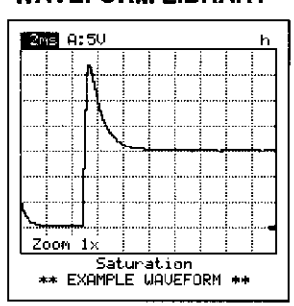
4. Measure the selected vehicle component.

5. Confirm the measured waveform is correct by using the * + F9 keys. This will display a known good waveform from the Waveform Assistant. Selecting the * + F9 key again will return you to the measured waveform. See example below.

CURRENT LIVE WAVEFORM



EXAMPLE FROM WAVEFORM LIBRARY



Waveform Library

The waveforms that are available in the Waveform Assistant are organized in the following Operators Manual categories:

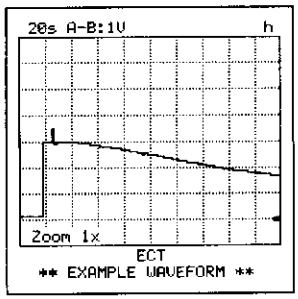
- Sensors
- Actuators
- Fuel injectors
- Distributors
- Ignition Signals
- Current Measurements
- Alternator

All waveforms were captured on vehicles that were in good operational condition with no known faults.

Sensors

ENGINE COOLANT TEMP (ECT)
INTAKE AIR TEMP (IAT)

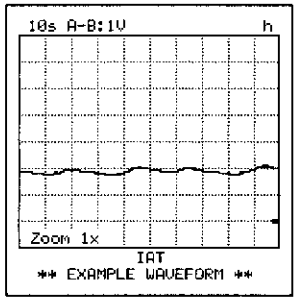
ENGINE COOLANT TEMP and INTAKE AIR TEMP sensors are negative temperature coefficient (NTC) thermistors. The electrical resistance changes as temperature changes. The resistance of the NTC thermistor goes down as its temperature goes up, and its resistance goes up when the temperature goes down.



ECT - ENGINE COOLANT TEMPERATURE SENSOR

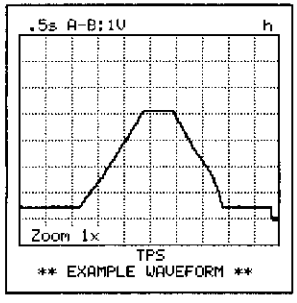
ECT sensor resistance falls as the temperature rises. The sensor is connected in series with a pull-up resistor in the ECU, which acts as a voltage divider. As the resistance of the sensor falls with increasing coolant temperature, the voltage drop across the sensor also falls. The sensor circuit generates an analog voltage signal which varies inversely with the temperature of the engine coolant.

Sensors (Cont.)



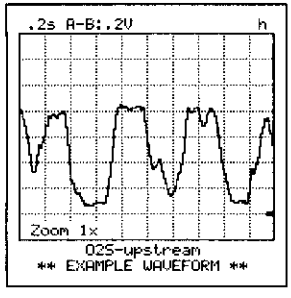
IAT - INTAKE AIR TEMPERATURE SENSOR

This IAT waveform was recorded while the engine was at normal operating temperature. As the voltage signal goes down, temperature is increasing. As the voltage signal goes up the temperature decreases.



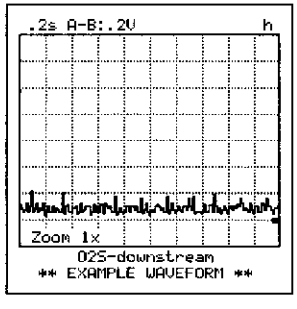
TPS - THROTTLE POSITION SENSOR

This TPS waveform was recorded while sweeping the throttle from idle to wide open throttle (WOT) and then back to idle.



O2S-UPSTREAM

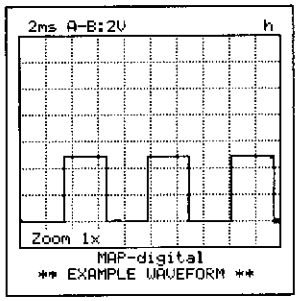
Oxygen Sensor (Upstream) provides an output voltage that represents the amount of oxygen in the exhaust stream. The maximum peak voltage should reach at least 0.8 volts while the minimum peak should reach at least 0.2 volts or less. Peak to peak voltages should be at least 0.6 volts or greater with an average of .45 volts.



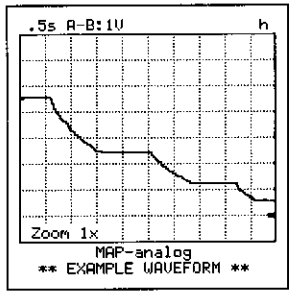
O2S-DOWNSTREAM

Oxygen Sensor (Downstream) is used to provide catalytic converter efficiency information to the vehicle engine controller. The signal amplitude from the down stream oxygen sensor will increase when the efficiency of the catalytic converter declines.

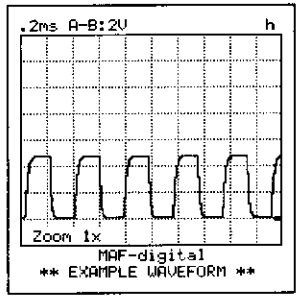
Sensors (Cont.)



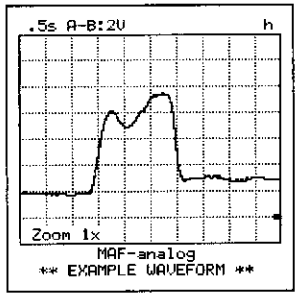
MAP-DIGITAL
Digital MAP Sensor signal frequency increases as the throttle is opened (vacuum decreases) as the throttle closes (vacuum increases) the frequency decreases.



MAP-ANALOG
A high voltage level indicates high intake manifold pressure (low vacuum). A low voltage level indicates low intake manifold pressure (high vacuum). As the throttle plate opens, manifold pressure rises (manifold vacuum lowers).

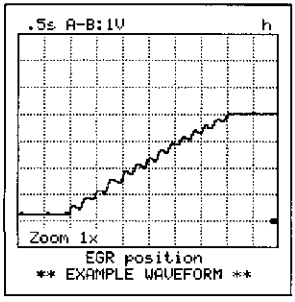


MAF-DIGITAL
Sensor signal frequency increases as the throttle is opened (vacuum decreases) as the throttle closes (vacuum increases) the frequency decreases.



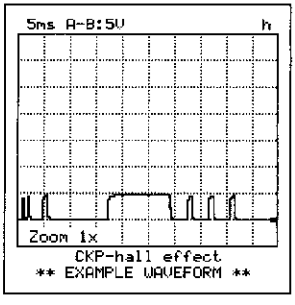
MAF-ANALOG
A high voltage level indicates high intake manifold pressure (low vacuum). A low voltage level indicates low intake manifold pressure (high vacuum). As the throttle plate opens, manifold pressure rises (manifold vacuum lowers). The ECM interprets the higher voltage as increased load placed on the engine, increasing injection quantity and retarding spark.

Sensors (Cont.)



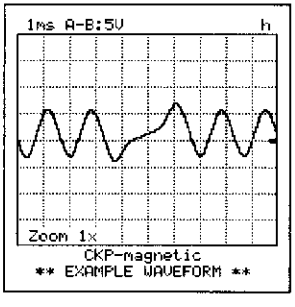
EGR POSITION

DC voltage level changes as the arm on the variable resistor is moved. The changing DC voltage is used as an input to the ECU to indicate EGR operation.



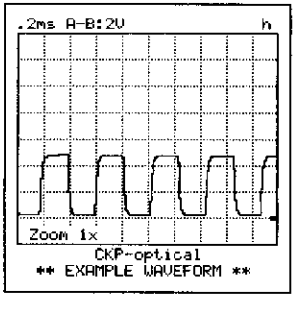
CKP-HALL EFFECT

Output voltage amplitude is constant and frequency changes as RPM changes. The upper horizontal lines should reach reference voltage while the lower horizontal lines should reach ground. Voltage transitions should be straight and vertical. The peak to peak voltages should equal reference voltage.



CKP-MAGNETIC

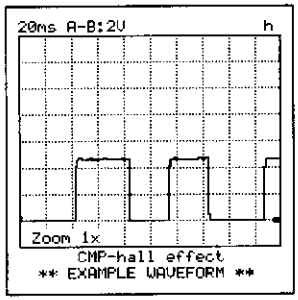
Crank Position sensor (magnetic) output voltage and frequency very as vehicle speed changes. Maximum peak levels should be equal to each other. If one is shorter than another, look for chipped or bent teeth on the trigger wheel.



CKP-OPTICAL

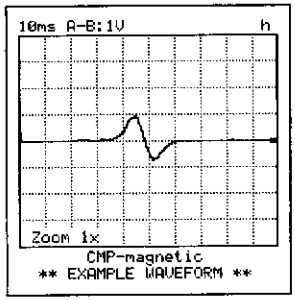
Crank Position Sensor (optical) output voltage and frequency very as vehicle speed changes. Maximum peak levels should be equal to each other. If one is shorter than another, look for chipped or bent teeth on the trigger wheel.

Sensors (Cont.)



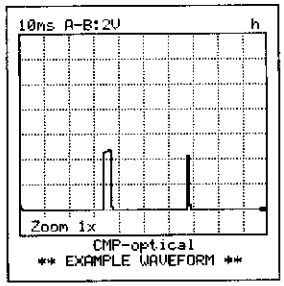
CMP-HALL EFFECT

Output voltage amplitude is constant and frequency changes as RPM changes. The upper horizontal lines should reach reference voltage while the lower horizontal lines should reach ground. Voltage transitions should be straight and vertical. The peak to peak voltages should equal reference voltage.



CMP-MAGNETIC

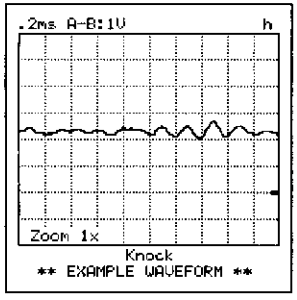
Camshaft Position sensor (magnetic) output voltage and frequency very as vehicle speed changes. Maximum peak levels should be equal to each other. If one is shorter than another, look for chipped or bent teeth on the trigger wheel. The camshaft sensor uses permanent magnet generators.



CMP-OPTICAL

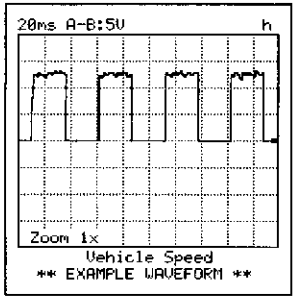
Crank Position Sensor (optical) output voltage and frequency very as vehicle speed changes. Maximum peak levels should be equal to each other. If one is shorter than another, look for chipped or bent teeth on the trigger wheel.

Sensors (Cont.)



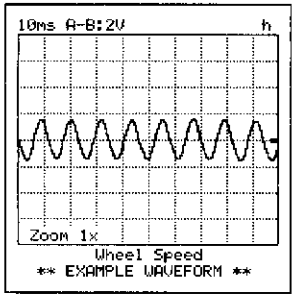
KNOCK SENSOR

The Piezoelectric knock sensor generates a voltage when it senses engine vibration. The Piezoelectric sensor produces an electrical signal that has a unique signature based on the knock condition. The pattern from the knock sensor is directly related to the severity of the knock. For this reason, each signal looks slightly different. When the ECU receives a knock signal from the knock sensor, it retards ignition timing until the knock disappears.



VEHICLE SPEED

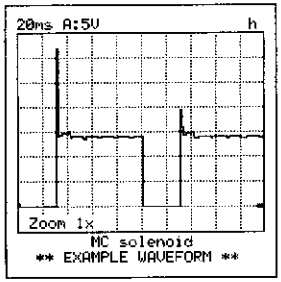
The vehicle speed sensor (VSS) transmits a signal in proportion to the vehicle speed. The example waveform is from a Hall effect vehicle speed sensor.



WHEEL SPEED SENSOR (MAGNETIC)

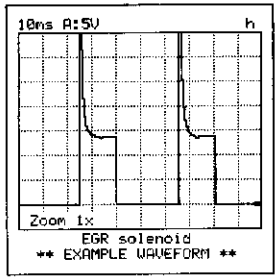
Small signal voltages are induced as the teeth of a trigger wheel pass through the magnetic field of a stationary magnet and coil. Peak to peak values should be identical and the signal should look symmetrical at constant speed. Improper gap or missing teeth on a trigger wheel will cause an erratic signal.

Actuators



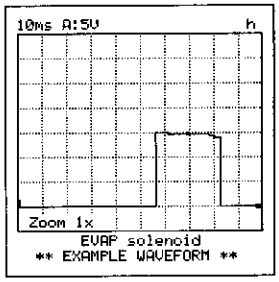
MIXTURE CONTROL (MC) SOLENOID

The Mixture Control Solenoid is duty cycled by a solid-state grounding switch in the ECU. When the solenoid is activated, metering rods are forced downward restricting fuel flow. When the ECU opens the circuit , the restriction in the main metering system is removed, thus providing a rich mixture.



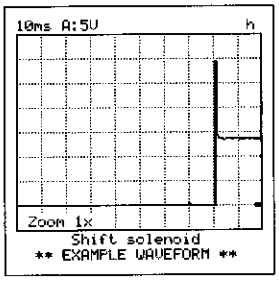
EXHAUST GAS RECIRCULATION (EGR) SOLENOID

The ECU controls the application of the EGR by applying or blocking vacuum providing a signal to de-energize or energize a solenoid, or by using pulse-width-modulated solenoid.



EVAPORATIVE CANISTER SOLENOID EVAP SOLENOID

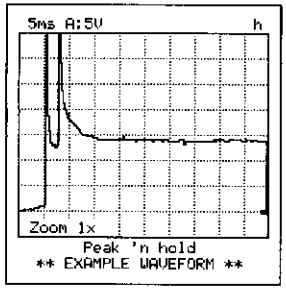
The evaporative canister solenoid wave form shows the canister solenoid com manded ON and then OFF.



SHIFT SOLENOID

The Shift solenoid waveform is from a electronically controlled automatic transmission. The waveform shows the Shift solenoid switching from one state to another.

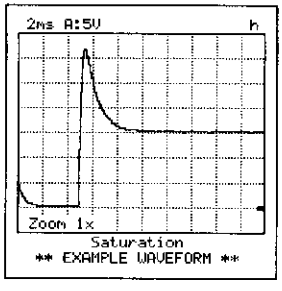
Fuel Injectors



PEAK 'N HOLD FUEL INJECTOR

Peak and Hold injector circuits use two circuits to energize the injectors. Both circuits come on to energize the injector, this sends a high initial current to the injector, allowing it to operate quickly.

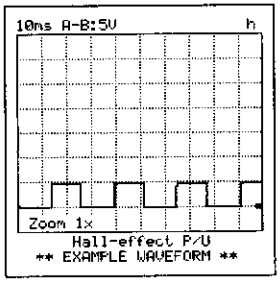
After the injector opens, one circuit releases, leaving the second circuit to hold the injector open through the duration of it's on-time. This circuit adds a resistance to the circuit, to reduce the current flow through the injector. When the second circuit shuts off, the injector closes, ending the injectors on-time. To measure injector pulse width, look for the falling edge of the on-time pulse, and the second rising edge which indicates where the second circuit shut off.



SATURATION FUEL INJECTOR

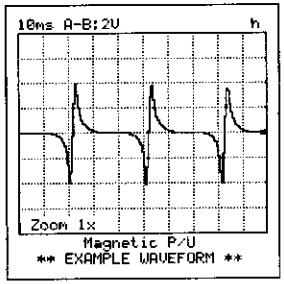
The injector driver transistor applies constant current to the injector. Some injectors use a resistor to limit the current flow; others have a high internal resistance. These injectors have a single rising edge.

Distributors



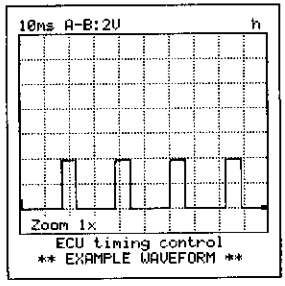
DISTRIBUTOR HALL EFFECT PICKUP
HALL-EFFECT P/U

A Hall Effect switch distributor has a stationary sensor and a rotating trigger wheel which requires a small input voltage to generate an output voltage. The duty cycle of the signal remains fixed, determined by the spacing between shutter blades. Frequency of the signal increases as the speed of the engine increases.



DISTRIBUTOR MAGNETIC PICKUP
MAGNETIC P/U

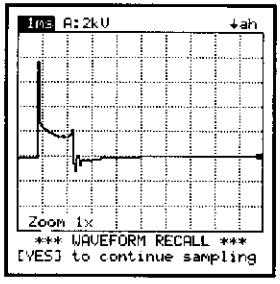
Magnetic sensors used for distributor triggering have a permanent magnet and a pole piece. Fine wire is wrapped around the pole piece to form a pickup coil. Maximum peak levels should be equal to each other. If one is shorter than the other look for a chipped or bent tooth on the trigger wheel. Minimum peak levels should be equal to each other. If one is shorter than the other look for a chipped or bent tooth on the trigger wheel. The waveform signature is created from the unique shape of the trigger wheel tooth, passing the pickup coil.



ECU TIMING CONTROL

This waveform shows the engine controller sending signals to the Ignition module advancing or retarding timing.

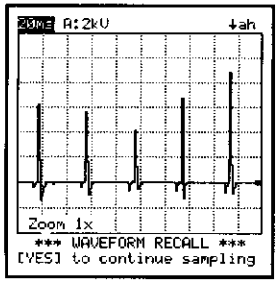
Ignition Signals



DI SEC-SINGLE

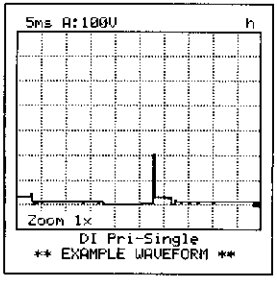
The distributor Ignition (DI) secondary ignition - single (1 cylinder) view can determine the following information.

1. Points close or transistor turns ON
2. Dwell
3. Points open or transistor turns OFF
4. Firing Line
5. Spark Line
6. Burn time
7. Coil Oscillations



DI SEC-ALL

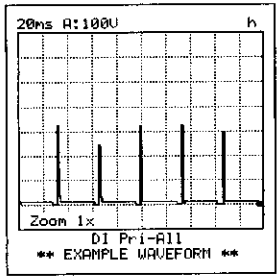
The Distributor Ignition (DI) Secondary Ignition - All (All Cylinders) view is a quick view of all cylinder firing lines clearly displayed for easy comparison. Firing lines should be equal. A short line indicates low resistance in the wire. A high line indicates high resistance in the wire.



DI PRI-SINGLE

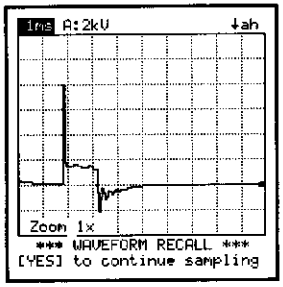
The primary circuit single cylinder shows low voltage current supplied to the ignition cell. In the coil, this low voltage is stepped up to the high voltage necessary for ignition by electromagnetic induction. The current flow in the coil primary winding creates a magnetic field. At primary turn off (end of dewell period), the current flow stops suddenly and the magnetic field collapses. This induces a voltage into the primary windings.

Ignition Signals (Cont.)



DI PRI-ALL

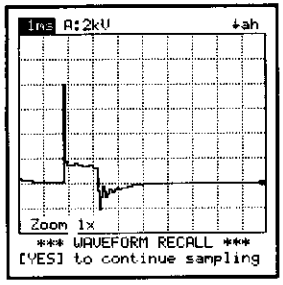
This waveform shows magnetic saturation developing in the coil. It normally takes about 10 to 15 milliseconds (.010 to .015 seconds) for an ignition coil to develop complete magnetic saturation from the primary circuit.



EI SEC SINGLE-POS

The distributor Ignition (DI) secondary ignition - single (1 cylinder) view can determine the following information.

1. Points close or transistor turns ON
2. Dwell
3. Points open or transistor turns OFF
4. Firing Line
5. Spark Line
6. Burn time
7. Coil Oscillations

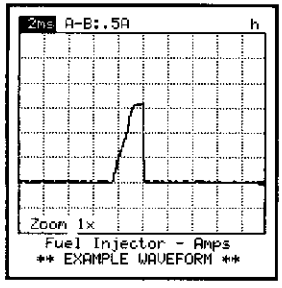


EI SEC SINGLE-NEG

The distributor Ignition (DI) secondary ignition - single (1 cylinder) view can determine the following information.

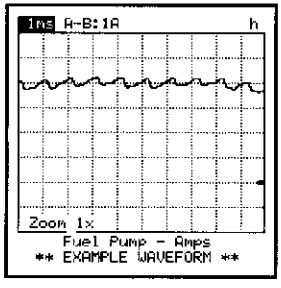
1. Points close or transistor turns ON
2. Dwell
3. Points open or transistor turns OFF
4. Firing Line
5. Spark Line
6. Burn time
7. Coil Oscillations

Current Measurements



FUEL INJECTOR

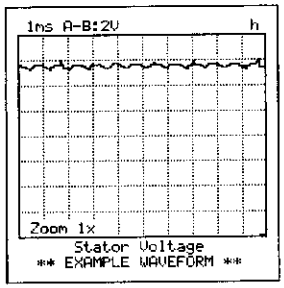
This shows the injector coil field collapsing into an open circuit as the injector pintle is pulled off its seat. Notice that in this current waveform there are no spikes as you would expect in a voltage waveform.



FUEL PUMP

The Fuel Pump amperage waveform is a useful tool in diagnosing the health of the fuel pump. Fuel pump failures can be seen when current draw drops to 0 amps. The fuel pump waveform shown here is from a normally operating fuel pump.

Alternator



STATOR VOLTAGE
This waveform shows DC voltage as measured from the alternator stator.

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5.0 TECH TOOL BOX

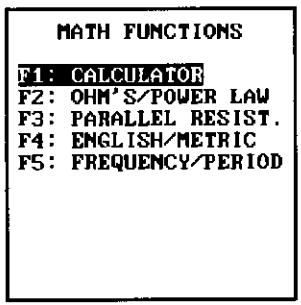
The TECH TOOLBOX menu provides access to several useful functions that can enhance automotive service productivity by decreasing the time to perform a job. Included are several math functions including a basic calculator, a stopwatch, a countdown time and the clock / calendar setup.

TECH TOOLBOX is meant to provide technicians with functions, formulas, and calculations that are common with the automotive shop environment. TECH TOOLBOX is designed to display the most common functional modes in a logical manner, arranged the way you would expect to find them.

If there is a function, formula, or calculation that you would like to see included, please contact Vetronix Corporation.

5.1 MATH FUNCTIONS

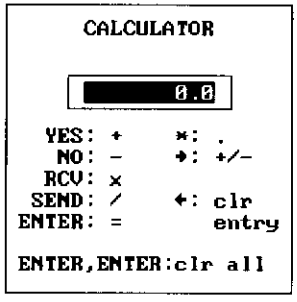
The Math Functions include a basic calculator and common automotive service related formulas.



Press F4 from the FUNCTION MENU to select the Math functions. The Math Functions are comprised of a basic calculator, Ohm's Law computation, Power Law computation, Parallel resistance computation, English/Metric unit conversions, and frequency/period conversion.

Calculator

Press F1 from the MATH FUNCTIONS menu to select the calculator. The Calculator function performs simple math functions such as add, subtract, multiply, and divide. To use the calculator, enter the first number, choose a function (add, subtract, multiply or divide), enter the second number, and then press ENTER to complete the function. The ENTER key acts like the = key on a normal calculator. Up to ten digits can be entered or displayed at a time.



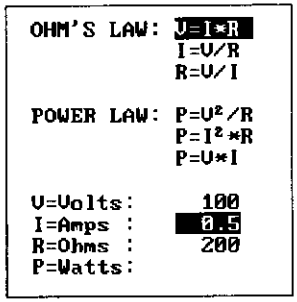
ACTIVE KEYS

0 - 9	Enter digits into display.
YES	Add.
NO	Subtract.
RCV	Multiply.
SEND	Divide.
ENTER	Perform computation.
*	Enter a decimal point.
→	Functions as +/-.
←	Erase the entered number (clear display).

OHM'S Law/Power Law

Press F2 from the MATH FUNCTIONS menu to select the Ohm's and Power Law functions. These functions allow the calculation of voltage, current, resistance and power using Ohm's Law and the Power Law relationships.

Use ↑ and ↓ to select an equation. Press ENTER to begin data entry. Use ↑, ↓, and ENTER to move between data entry fields. Enter digits into the appropriate highlighted field. The final value is calculated as the data is entered. Press EXIT to go back to the top of the display and choose a different function or to exit the display.

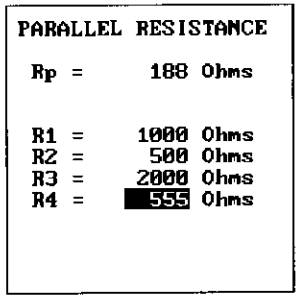


ACTIVE KEYS

ENTER	Select Equation and toggle between variables to be input.
↑/↓	Move highlight to different equation or data entry field.
0 - 9	Enter digits into display.
*	Enter a decimal point.
←	Erase the last entered digit.
EXIT	Go back to equation select.

Parallel Resistance

Press F3 from the MATH FUNCTIONS menu to select the Parallel resistance computation. This function allows entry of up to four resistance values, and then calculates the total parallel resistance. Use the 0 - 9 keys and the ↑ and ↓ keys to enter up to four resistance values. The Parallel resistance is calculated as the individual resistances are entered. Values from 1 to 1M can be entered.

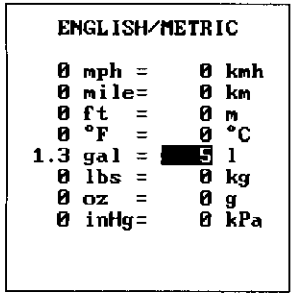


ACTIVE KEYS

0 - 9	Enter digit.
↑/↓	Move to next entry.
←	Erase the last entered digit.

English/Metric Conversion

Press F4 from the MATH FUNCTIONS menu to select the English/Metric Unit Conversions. This function will convert English and metric units of speed, distance, temperature, volume, mass/weight, and pressure. Use ↑ and ↓ to scroll through the different English and metric units. Use the 0 - 9 keys to enter data. The corresponding unit conversion is performed as the data is entered.

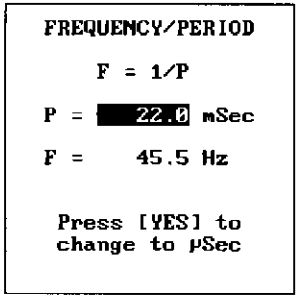


ACTIVE KEYS

- 0 - 9 Enter digits into display.
- ← Erase the last entered digit.
- ↑/↓ Move to next unit.
- ENTER Move between English and Metric unit.

Frequency/Period Computation

Press F5 from the MATH FUNCTIONS menu to select the Frequency/Period computation. Enter either the frequency or the period value into the tester, and the corresponding value will be calculated. Use ↑, ↓ or ENTER to move between frequency and period input field.

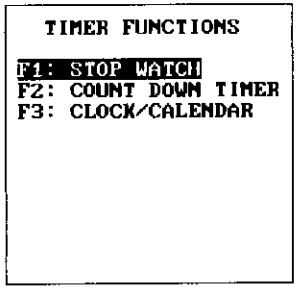


ACTIVE KEYS

- 0 - 9 Enter digits into display.
- ← Erase the last entered digit.
- ↑/↓ Move to next field.
- ENTER Move to next field.
- YES Changes scale between mS and µS.

5.2 TIMER FUNCTIONS

The Timer Functions provide several different time related functions composed of a stop watch, a count down timer and a system clock and calendar. Press F2 from the TECH TOOLBOX menu to select the Timer Functions.

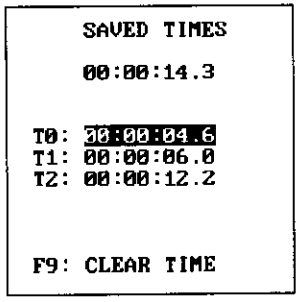


ACTIVE KEYS

F1 - F3 Select menu item.

Stop Watch

Press F1 from the TIMER FUNCTIONS menu to select the Stop Watch. The Stop Watch can be used to time procedures or processes up to 100 hours in length. The Stop Watch time can be stopped and started without having to reset. Press F4 to save the time for later comparison. The number of saved times is displayed in reverse video. Press F5 to display the saved times.

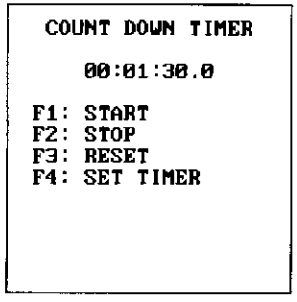


ACTIVE KEYS

F1	Start Timer.
F2	Stop Timer.
F3	Reset Timer.
F4	Save Time for later review.
F5	View all saved Times.
F6	Clear all saved times.
F9	Delete the highlighted Save Time.
↑/↓	Move to the next Save Time.

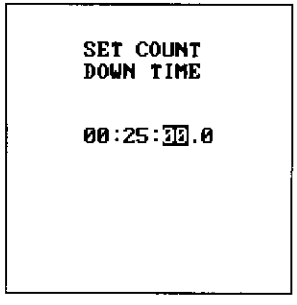
Count Down Timer

Press F2 from the TIMER FUNCTIONS menu to select the Count Down Timer. The Count Down Timer counts for a designated amount of time, then sounds an alarm. The Count Down Timer can be stopped and restarted during the count down. To enter the starting value, press the F4 key and then enter the hours, minutes and seconds of the count down timer. Press ENTER to complete starting time entry.



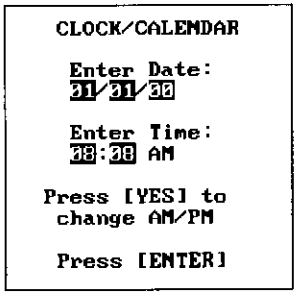
ACTIVE KEYS

- F1 Start the Count Down.
- F2 Stop the Count Down.
- F3 Reset to entered value.
- F4 Set Count Down Value.
- ←/→ Move to next digit entry.



Clock/Calendar

Press F3 from the TIMER FUNCTIONS menu to select the Clock/Calendar function. The time of day and current date can be set through this function.



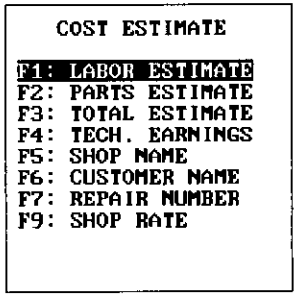
ACTIVE KEYS

0 - 9	Enter digit.
YES	Change AM/PM indicator.
ENTER	Starts the clock and returns to the menu.
←/→	Move to previous/next digit entry.

5.3 SHOP MANAGEMENT

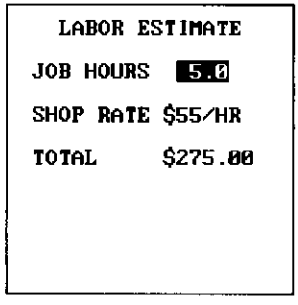
The Shop Management functions aid in calculating repair estimates and technician earnings. The standard shop rate, sales tax, and applicable service fees are saved by the tester, and used for calculation of labor estimate, parts estimate and total repair estimate.

Press F3 from the TECH TOOLBOX menu to select the Shop Management functions.



Labor Estimate

Press F1 from the menu to select the Labor Estimate function. Enter the total number of hours estimated to complete the repair. Note: the shop rate is entered on the SHOP RATE screen (Section 7.8) and recalled from the tester memory. The labor estimate is automatically calculated as digits are entered. The labor estimate is also displayed on the TOTAL ESTIMATE screen.

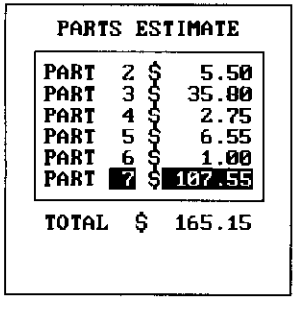


ACTIVE KEYS

- 0 - 9 Enter digit.
- ← Erase last entered digit.
- SEND Print Estimate information.

Parts Estimate

Press F2 from the menu to select the Parts Estimate function. This function will add the cost of all estimated parts. Up to 99 different part costs can be entered. The total parts estimate is automatically calculated as digits are entered. Use the ENTER key and ↑ and ↓ to move between part numbers. The parts estimate is also displayed on the TOTAL ESTIMATE screen.

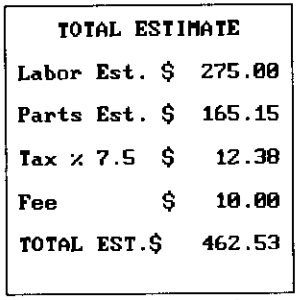


ACTIVE KEYS

- 0 - 9 Enter Digit.
- * Enter decimal point.
- ENTER Move to next/previous part number.
- ↑ ↓ Move to next/previous part number.
- ← Erase last entered digit.
- SEND Print Estimate information.

Total Estimate

Press F3 from the menu to select the Total Estimate function. The Total Estimate function uses the previously calculated labor estimate and parts estimate, along with the sales tax rate and the applicable shop fees to calculate the total repair estimate. The sales tax rate and shop fees are entered on the SHOP RATE screen.

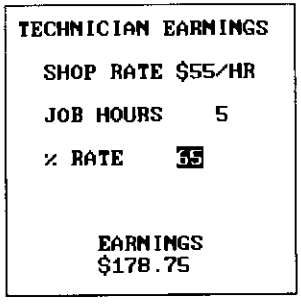


ACTIVE KEYS

SEND Print Estimate information.

Technician Earnings

Press F4 from the menu to select Technician Earnings. This function estimates a technician's earnings for a particular repair job. Enter the number of hours spent on the repair, and the technician's percentage of shop rate earned. The tester automatically calculates the technician earnings as digits are entered.



ACTIVE KEYS

0 - 9 Enter Digit.

ENTER Move to next/previous part number.

↑/↓ Move to next/previous part number.

← Erase last entered digit.

Shop Name

Press F5 from the menu to enter the Shop Name. The Shop Name will be saved in the tester memory and printed at the top of the sheet when using the print function (SEND) in the Enhanced Data List, Enhanced DTCs, and the Total Estimate.

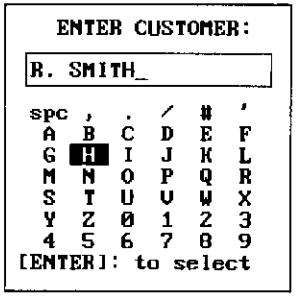
ACTIVE KEYS

- ↑/↓ Move cursor to desired
- ←/→ letter or number.
- ENTER Select current letter or number.
- NO Erase last entered letter.

Customer Name

Press F6 from the menu to enter the Customer Name. The Customer Name will be saved in the tester memory and printed at the top of the sheet when using the print function (SEND) in the Enhanced Data List, Enhanced DTCs, and the Total Estimate.

NOTE: To ensure correct printouts, always check that the Customer Name is correct before diagnosing a vehicle.



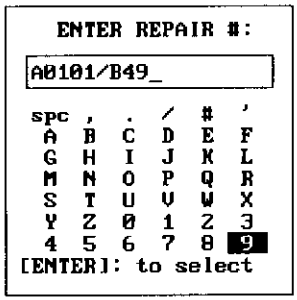
ACTIVE KEYS

- ↑/↓ Move cursor to desired
- ←/→ letter or number.
- ENTER Select current letter or number.
- NO Erase last entered letter.

Repair Number

Press F7 from the menu to enter the Repair Number. The Repair Number will be saved in the tester memory and printed at the top of the sheet when using the print function (SEND) in the Enhanced Data List, Enhanced DTCs, and the Total Estimate.

NOTE: To ensure correct printouts, always check that the Repair Number is correct before diagnosing a vehicle.

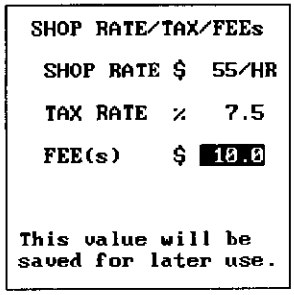


ACTIVE KEYS

- ↑/↓ Move cursor to desired
- ←/→ letter or number.
- ENTER Select current letter or number.
- NO Erase last entered letter.

Shop Rate

Press F9 from the menu to select the Shop Rate function. This function allows entry of the shop hourly repair rate, sales tax percentage and additional service fees. The values entered on this screen will be saved in the tester memory. The data is used to calculate the labor and total repair estimates.



ACTIVE KEYS

- 0 - 9 Enter Digit.
- * Enter decimal point.
- ENTER Move to next/previous entry.
- ↑/↓ Move to next/previous entry.
- ← Erase last entered digit.
- EXIT Return to previous screen.

SAMPLE PRINTOUT

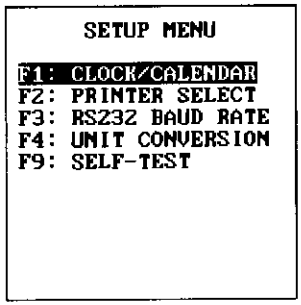
JOE'S GARAGE

TOTAL ESTIMATE
Date: 11/22/95
Cust Name:
Order No : A101/B49

Labor Estimate	$	275.00
Parts Estimate	$	165.15
Tax 7.5 %	$	12.38
Fee	$	10.00
TOTAL ESTIMATE	$	462.53

6.0 USING THE SETUP MODE

Press F9 to select the SETUP mode from the FUNCTION MENU. The SETUP mode allows you to change the internal functions of the tester and to perform Mastertech self-tests.

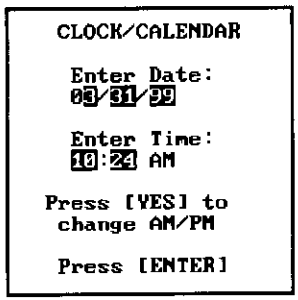


ACTIVE KEYS

- F1 Sets the time and date functions.
- F2 Select the printer type.
- F3 Sets up the tester to send data to a printer.
- F4 Selects the units of measurement for displaying data.
- F9 Selects the SELF-TEST MENU.
- ↑/↓ Move the highlight bar up or down.
- ENTER Select the highlighted menu item.

6.1 CLOCK/CALENDAR

Press F1 from the SETUP MENU to select the CLOCK/CALENDAR mode, which allows you to set the date and time.



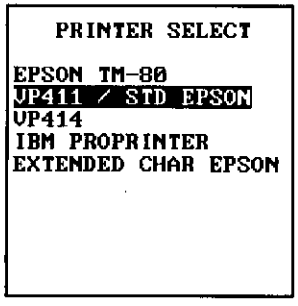
ACTIVE KEYS

- 0 - 9 Enter the digit numbers for the date and time.
- YES Changes from AM to PM or from PM to AM.
- ENTER Starts the clock and returns to the SETUP MENU.
- ↑/↓ Move highlight up or down.
- ←/→ Move highlight left or right.

6.2 PRINTER SELECT

Press F2 from the SETUP MENU to display a list of printer types that can be used with the Mastertech.

NOTE: The default setting is for the optional VP-411 printer. If you are using a printer other than the VP-411, connect the printer to the tester and try to print. If the printer does not print, select a different printer type and try again.



ACTIVE KEYS

↑/↓ Move the highlight bar up or down to select a printer.

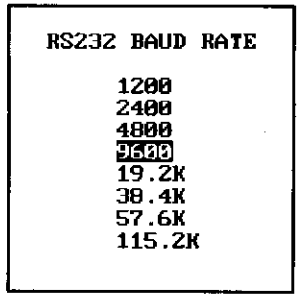
EXIT Saves the selected printer and returns to the SETUP MENU.

EXIT Saves the selected printer and returns to the SETUP MENU.

6.3 BAUD RATE

Press F3 from the SETUP MENU. The baud rate of the printer you are using is selected. The baud rate information is included in the Operator's Manual for the printer.

NOTE: The default baud rate setting for the optional VP-411 printer is 9600 baud.



ACTIVE KEYS

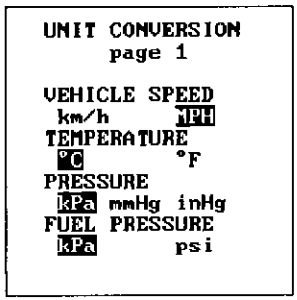
↑/↓ Move the highlight bar up or down to select the baud rate.

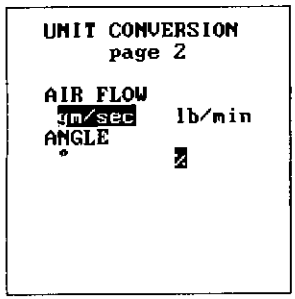
EXIT Saves the baud rate for the printer and returns to the SETUP MENU.

ENTER Saves the baud rate for the printer and returns to the SETUP MENU.

6.4 UNIT CONVERSION

Press F4 from the SETUP MENU to select the UNIT CONVERSION mode. Use the arrow keys to highlight the preferred units of measurement for displaying data, then press ENTER. Not all conversions are available for all models or systems.





ACTIVE KEYS

- ↑/↓ Move the cursor (blinking highlight) up or down.
- ENTER Saves the selected units and returns to the SETUP MENU.
- ←/→ Moves the highlight left or right.

6.5 SELF-TESTS

The SELF-TESTS check the following Mastertech functions:

- Display/LEDs
- Keyboard
- Sound
- Memory/Internal Circuits
- Data Link
- RS232 port
- Instrumentation port
- OBD II Interface

If the Mastertech does not pass all of the tests, double check that the SELF-TEST Adapters (required for certain tests) are properly installed and making good contact during the testing.

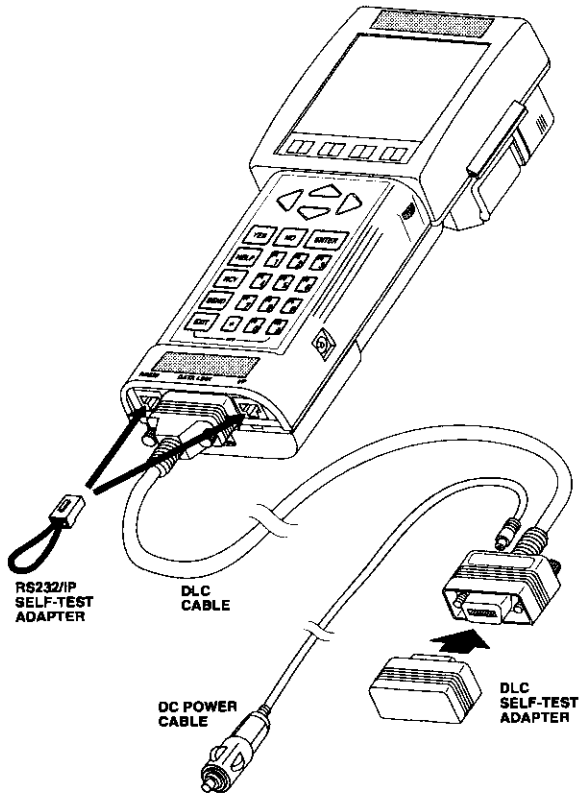
- Self Test Adapters are used for the following tests:

TEST	ADAPTER
DATA LINK	DLC CABLE AND DLC SELF-TEST ADAPTER
RS232 and INST PORT	RS232/IP SELF-TEST ADAPTER

NOTE:

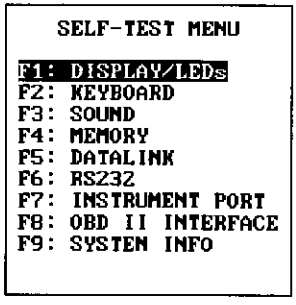
- Do not connect the DLC cable (and DLC cable adapter) to the vehicle while the self test is being performed.

SELF-TEST SETUP



6.6 SELF-TEST MENU

Press F9 to select the SELF-TEST mode from the SETUP MENU and display the SELF-TEST MENU. The SELF-TEST mode allows you to perform any of a series of eight Self Tests.

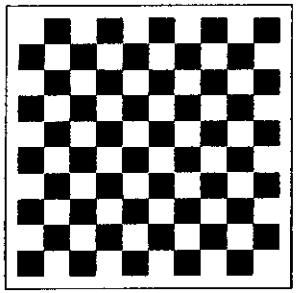


ACTIVE KEYS

- **F1** Displays a checkerboard pattern, and cycles the LEDs on and off.
- **F2** Tests for proper operation of the keyboard.
- **F3** Instructs you to press the 0-9 keys to play sound.
- **F4** Checks the integrity of many of the critical circuits inside the Mastertech and the program card inserted in the tester.
- **F5** Checks the DLC and the DLC cable.
- **F6** Checks for proper operation of the RS232 Port (printer connector).
- **F7** Checks for proper operation of the Instrumentation Port.
- **F8** Checks for OBD II interface circuitry present or proper operation.
- **F9** Displays the production dates of the Mastertech and program card software.
- **↑ ↓** Move the highlight bar up or down.
- **ENTER** Select the highlighted menu item.

Display/LED

Press F1 to select the DISPLAY/LEDs test from the SELF-TEST MENU. This test checks the LCD and LED displays.



ACTIVE KEYS

ENTER Changes the LCD display.
EXIT Returns to the SELF-TEST MENU.

Keyboard

Press F2 to select the KEYBOARD test from the SELF-TEST MENU. This test checks for proper operation of the keyboard keys.

```
KEYBOARD SELF TEST

  ←   ↑   ↓   →
YES  NO  ENTER
HELP 1   2   3
RCV  4   5   6
SEND 7   8   9
EXIT *   0   #

[*EXIT] TO EXIT
```

ACTIVE KEYS

All Keys Select the key to highlight.
* EXIT Returns to the SELF-TEST MENU.

Sound

Press F3 to select the SOUND test from the SELF-TEST MENU.
Press 0 - 9 to play sound.

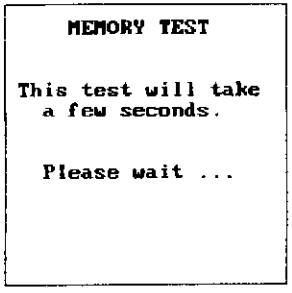
```
SOUND SELF TEST


Press [0]-[9] to
  play sounds.
```

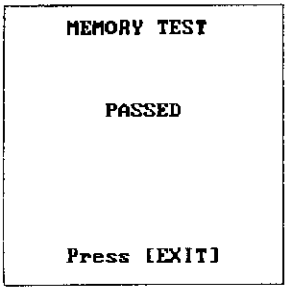
ACTIVE KEYS

0 - 9 Play sound.
EXIT Returns to the SELF-TEST MENU.

Memory

Press F4 from the SELF-TEST MENU to select the MEMORY test. The MEMORY test checks the integrity of many of the critical circuits inside the tester.





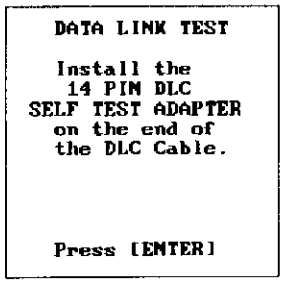
ACTIVE KEY

EXIT Returns to the SELF-TEST MENU.

Data Link

Press F5 to select the DATA LINK test from the SELF-TEST MENU. The DATA LINK test checks for proper operation of the DLC cable.

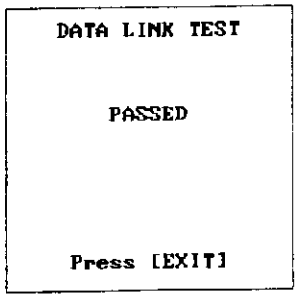
NOTE: When this test is selected, you are instructed to install the 14-pin DLC Self Test Adapter on the end of the DLC cable.



ACTIVE KEY

ENTER Runs the test.

The DATA LINK TEST result is displayed.



ACTIVE KEY

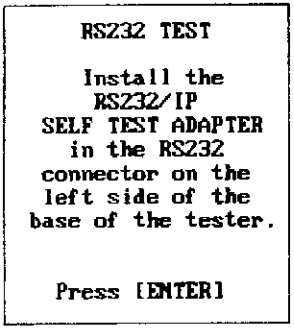
EXIT Returns to the SELF-TEST MENU.

RS232

Press F6 to select the RS232 test from the SELF-TEST MENU. The RS232 test checks for proper operation of the RS232 Port.

NOTE: When this test is selected, you are instructed to install the RS232/IP Self Test Adapter in the RS232 Port.

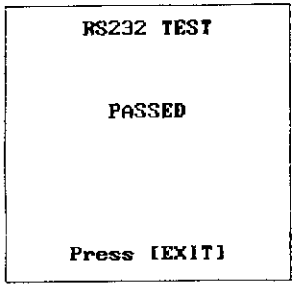
Install the RS232/IP Self Test Adapter. After the ENTER key is pressed, the tester will check the RS232 Port.



ACTIVE KEY

ENTER Runs the test.

The RS232 TEST result is displayed.



ACTIVE KEY

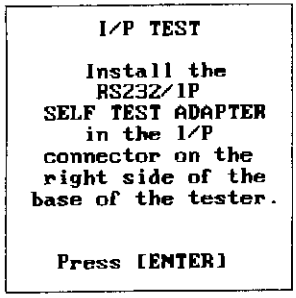
EXIT Returns to the SELF-TEST MENU.

Instrumentation Port

Press F7 to select the INSTRUMENTATION PORT test from the SELF-TEST MENU. The INST PORT test checks for proper operation of the I/P (Instrumentation Port) connector.

NOTE: When this test is selected, you are instructed to install the RS232/IP Self Test Adapter in the I/P connector.

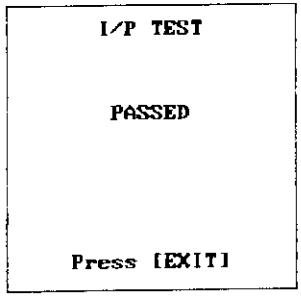
Install the RS232/IP Self Test Adapter, then press ENTER. The tester checks the Instrumentation Port connector.



ACTIVE KEY

ENTER Runs the test.

The I/P TEST result is displayed.



ACTIVE KEY

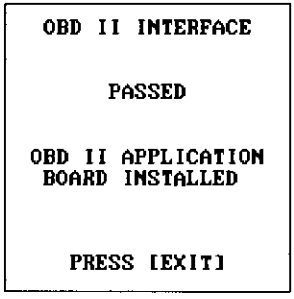
EXIT Returns to the SELF-TEST MENU.

OBD II Interface Self-Test

Press F8 to select the OBD II Interface test from the SELF-TEST MENU. The OBD II Interface test checks for OBD II Interface Circuitry present or proper operation.

If one of the following error messages is displayed, it is recommended that the OBD II I/F Self-Test be performed.

- Application cartridge not installed.
- OBD II communications failed to initialize 1 time.
- Error: no response from vehicle.



ACTIVE KEY

EXIT Returns to the SELF-TEST MENU.

System Info

Press F9 to select SYSTEM INFO from the SELF-TEST MENU. The System Info test displays the production dates of the program card, the Mastertech resident program, and the I/O resident program.

NOTE: I/O RESIDENT date is not displayed when an application cartridge is plugged into the Mastertech.

```
SYSTEM INFORMATION

PROGRAM CARD:
MFT:PRO 1.0  (US)
03/30/99

RESIDENT:
03/10/98

I/O RESIDENT:
07/26/94
```

ACTIVE KEY

EXIT Return to the SELF-TEST MENU.

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APPENDIX

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A: SAMPLE OSCILLOSCOPE WAVEFORMS

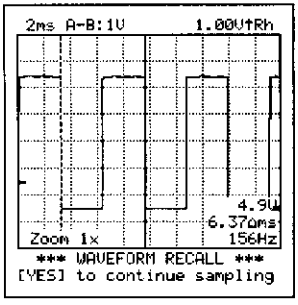
The following sample waveforms are intended to give you a look at what type of signals can be measured and what oscilloscope function settings were used to capture the measured signal.

Depending on your familiarity with Oscilloscopes, you may find these sample waveforms and their settings helpful to try out on a test vehicle. Doing so will help you become familiar with the Mastertech Oscilloscope function. Remember that these waveforms are a representation of one of many ways to capture automotive signals using an Oscilloscope, and represent only one of many methods to check a particular automotive sensor.

Refer to the Waveform Assistant section on page 4-14 for additional waveform information. The Waveform Assistant is a library of example waveforms that can be viewed on the Mastertech display.

SAMPLE WAVEFORM 1 – FORD MAP SENSOR

This waveform was captured on a 1993 Ford F150 with a 4.9L engine. The ignition key was in the ON position with the engine OFF (KOEO). The Mastertech Oscilloscope was in the Single Channel Mode, with the red lead on the MAP signal line (to the PCM) and the black lead was on signal reference (ground).



Settings:

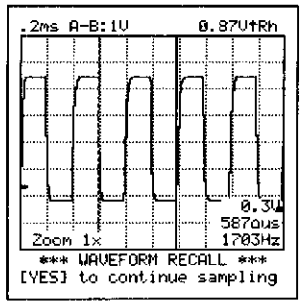
Time Scale : 2 ms/division
Volt Scale : 1 V/division
Trigger : Automatic

Information inferred from captured waveform:

Waveform min/max voltage : 0-4.9 volts
Voltage at cursor A position : 4.9 volts
Period : 6.37 ms
Frequency : 156 Hz

SAMPLE WAVEFORM 2 – MAF SENSOR

This waveform was captured on a 1994 Pontiac with a 3800 engine and equipped with a Hitachi MAF sensor. The ignition key was in the ON position with a warm engine running at IDLE. The Mastertech Oscilloscope was in the Single Channel Mode, with the red lead on the MAF signal return line (to the PCM) and the black lead on engine ground (near the thermostat housing).



Settings:

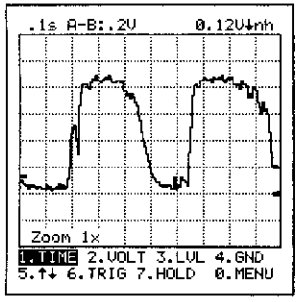
Time Scale : 0.2 ms/division
Volt Scale : 1 V/division
Trigger : Automatic

Information inferred from captured waveform:

Waveform min/max voltage : 0-5 volts
Voltage at cursor A position : 0.3 volts
Period : 587 µs
Frequency : 1703 Hz

SAMPLE WAVEFORM 3 – OXYGEN SENSOR

This waveform was captured on a 1993 Chevrolet 4WD truck with a 5.7L (VIN "K") engine. The ignition key was in the ON position with a warm engine running at 2500 RPM. The Mastertech Oscilloscope was in the Single Channel Mode, with the red lead (channel A) on the oxygen sensor signal return line (to the PCM) and the black lead connected to engine ground.



Settings:

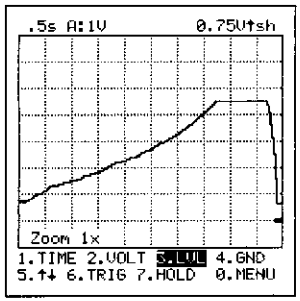
Time Scale : 0.1 Sec/division
Volt Scale : 0.2 V/division
Trigger : Automatic, hold "on"

Information inferred from captured waveform:

Waveform min/max voltage : 0-0.9 volts

SAMPLE WAVEFORM 4 – THROTTLE POSITION SENSOR

This waveform was captured on a 1993 Chevrolet 4WD truck with a 5.7L (VIN "K") engine. The ignition key was in the ON position with a warm engine running at IDLE. The Mastertech Oscilloscope was in the Dual Channel Mode, with the red lead (channel A) on the Throttle Position Sensor signal return line (to the PCM) and the black lead disconnected. MFT ground was provided by the Data Link cable.



Settings:

Time base : 0.5 Sec/division
Voltage base : 1 V/division
Trigger : Automatic, hold "on"

Information inferred from captured waveform:

Waveform min/max voltage : 0-4.5 volts

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B: GLOSSARY AND ABBREVIATIONS

CKP	Crankshaft Position
CMP	Camshaft Position
DI	Distributor 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
µs	Microseconds
Ms	Milliseconds
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
VDC	Volts Direct Current

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